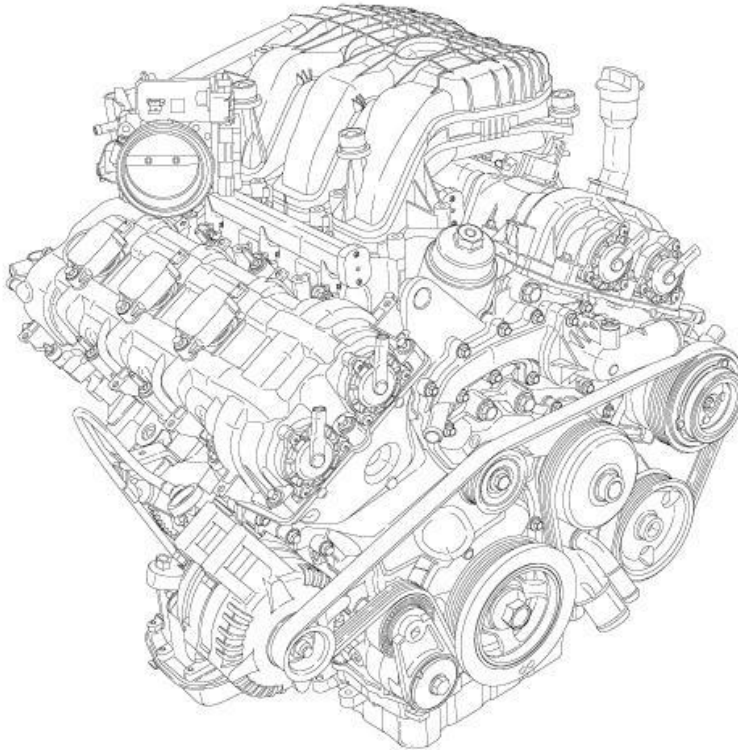


**2012 ENGINE****3.6L - Service Information - Wrangler****DESCRIPTION****DESCRIPTION**

2778955

**Fig. 1: 3.6L (219.7 CID) Flexible Fuel V-6 Engine**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** WK engine shown in illustration, JK engine similar.

The 3.6 liter (219.7 CID) flexible fuel V-6 engine features Variable Valve Timing (VVT), Dual Overhead Camshafts (DOHC) and a high-pressure die-cast aluminum cylinder block with steel liners in a 60° configuration. The 3.6 liter engine has a chain driven variable discharge oil pump with a two-stage pressure regulator for improved fuel economy. The exhaust manifolds are integrated into the cylinder heads for reduced weight. The cylinders are numbered from front to rear. The right bank is numbered 1, 3, 5 and the left bank is numbered 2, 4, 6. The firing order is 1-2-3-4-5-6. The engine serial number is located on the left side of the cylinder block at the transmission flange.

**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 **ENGINE MECHANICAL DIAGNOSTIC TABLE** and **ENGINE PERFORMANCE DIAGNOSTIC TABLE** for possible causes and corrections of malfunctions.

Refer to **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. Refer to **MANIFOLD, INTAKE, DIAGNOSIS AND TESTING**.

#### ENGINE PERFORMANCE DIAGNOSTIC TABLE

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE WILL NOT START	1. Weak battery	1. Charge or replace as necessary. Refer to <b><u>BATTERY, DIAGNOSIS AND TESTING</u></b> .
	2. Corroded or loose battery connections.	2. Clean and tighten battery connections. Refer to <b><u>CLEANING</u></b> .
	3. Faulty engine starting system.	3. Diagnose engine starting system. Refer to <b><u>DIAGNOSIS AND TESTING</u></b> .
	4. Faulty coil or control unit.	4. Replace ignition coil. Refer to <b><u>COIL, IGNITION, 3.6L, REMOVAL</u></b> .
	5. Incorrect spark plug gap.	5. Correct as necessary.
	6. Incorrect cam timing.	6. Verify cam timing. Refer to <b><u>Engine/Valve Timing - Standard Procedure</u></b> .
	7. Dirt or water in fuel system.	7. Clean fuel system.
	8. Faulty fuel pump or wiring.	8. Repair or replace as necessary.
	9. Faulty Camshaft Position (CMP) sensor.	9. Replace sensor. Refer to <b><u>SENSOR, CAMSHAFT POSITION, 3.6L, REMOVAL</u></b> .
	10. Faulty Crankshaft	10. Replace sensor. Refer to <b><u>SENSOR,</u></b>

## 2012 Jeep Wrangler Sport S

2012 ENGINE 3.6L - Service Information - Wrangler

	Position (CKP) sensor.	<b><u>CRANKSHAFT POSITION, REMOVAL .</u></b>
ENGINE STALLS OR ROUGH IDLE	1. Vacuum leak.	1. Inspect intake manifold and vacuum hoses, repair or replace as necessary.
	2. Faulty Crankshaft Position (CKP) sensor.	2. Replace sensor. Refer to <b><u>SENSOR, CRANKSHAFT POSITION, REMOVAL .</u></b>
	3. Faulty ignition coil.	3. Replace ignition coil. Refer to <b><u>COIL, IGNITION, 3.6L, REMOVAL .</u></b>
	4. Incorrect cam timing.	4. Verify cam timing. Refer to <b><u>Engine/Valve Timing - Standard Procedure.</u></b>
ENGINE LOSS OF POWER	1. Dirty or incorrectly gapped spark plugs.	1. Correct as necessary. Refer to <b><u>SPARK PLUG, REMOVAL .</u></b>
	2. Dirt or water in fuel system.	2. Clean fuel system.
	3. Faulty fuel pump.	3. Replace fuel pump. Refer to <b><u>MODULE, FUEL PUMP, REMOVAL .</u></b>
	4. Leaking cylinder head gasket.	4. Replace cylinder head gasket. Refer to <b><u>CYLINDER HEAD, REMOVAL.</u></b>
	5. Low compression.	5. Determine the cause and repair as necessary. Refer to <b><u>CYLINDER COMBUSTION PRESSURE LEAKAGE.</u></b>
	6. Burned, warped or pitted valves.	6. Replace as necessary. Refer to <b><u>VALVES, INTAKE AND EXHAUST, REMOVAL.</u></b>
	7. Plugged or restricted exhaust system.	7. Inspect and replace as necessary.
	8. Faulty ignition coil.	8. Replace ignition coil. Refer to <b><u>COIL, IGNITION, 3.6L, REMOVAL .</u></b>
	9. Incorrect cam timing.	9. Verify cam timing. Refer to <b><u>Engine/Valve Timing - Standard Procedure.</u></b>
ENGINE MISSES ON ACCELERATION	1. Dirty or incorrectly gapped spark plugs.	1. Correct as necessary. Refer to <b><u>SPARK PLUG, REMOVAL .</u></b>
	2. Dirt in fuel system.	2. Clean fuel system.
	3. Burned, warped or pitted valves.	3. Replace as necessary. Refer to <b><u>VALVES, INTAKE AND EXHAUST, REMOVAL.</u></b>
	4. Faulty ignition coil.	4. Replace ignition coil. Refer to <b><u>COIL, IGNITION, 3.6L, REMOVAL .</u></b>
ENGINE MISSES AT HIGH SPEED	1. Dirty or incorrectly gapped spark plugs.	1. Correct as necessary. Refer to <b><u>SPARK PLUG, REMOVAL .</u></b>
	4. Faulty ignition coil.	2. Replace ignition coil. Refer to <b><u>COIL, IGNITION, 3.6L, REMOVAL .</u></b>
	3. Dirt or water in fuel system.	3. Clean fuel system.

### ENGINE MECHANICAL DIAGNOSTIC TABLE

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**2012 Jeep Wrangler Sport S**

2012 ENGINE 3.6L - Service Information - Wrangler

CONDITION	POSSIBLE CAUSES	CORRECTIONS
NOISY VALVES	1. High or low oil level in crankcase.	1. Refer to <b><u>Engine/Lubrication/OIL - Standard Procedure</u></b> .
	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 <b><u>CYLINDER HEAD, REMOVAL</u></b> .
	8. Excessive runout of valve seats on valve faces.	8. Refer to <b><u>VALVES, INTAKE AND EXHAUST, STANDARD PROCEDURE</u></b> .
CONNECTING ROD NOISE	1. Insufficient oil supply.	1. Refer to <b><u>Engine/Lubrication/OIL - Standard Procedure</u></b> .
	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 <b><u>Engine/Lubrication/OIL - Standard Procedure</u></b> .
	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 converter.	7. Tighten to correct torque

**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 SYSTEM PRESSURE RELEASE**.
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.

Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART.**

#### 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

##### DIAGNOSTIC PROCEDURES

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

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

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

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

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

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

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

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

#### **OIL CONSUMPTION TEST**

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

#### **OIL CONSUMPTION DIAGNOSIS**

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

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

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

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

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

**2. Distorted Cylinders**

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

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

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

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

**4. Worn Piston Ring Grooves**

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

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

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

**6. Cracked or Broken Ring Lands**

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

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

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

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

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

#### **9. Fuel Dilution**

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

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

#### **10. Contaminated Cooling Systems**

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

#### **11. Oil Viscosity**

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

#### **12. Dirty Engine Oil**

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

**13. Crankcase Overfull**

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

**14. Excessively High Oil Pressure**

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

**15. Aftermarket Performance Chips and Modification**

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

**16. Lugging Engine**

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

**17. Turbocharged Engines**

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

**18. Restricted Air Intake**

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

**19. Intake Manifold port seals**

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

# ENGINE 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 <b><u>SEAL, CRANKSHAFT OIL, REAR, REMOVAL.</u></b>
	3. Crankshaft seal flange. Scratched, nicked or grooved.	3. Polish or replace crankshaft.
	4. Oil pan flange cracked.	4. Replace oil pan. Refer to <b><u>PAN, OIL, REMOVAL.</u></b>
	5. Engine timing cover seal, damaged or misaligned.	5. Replace seal. Refer to <b><u>SEAL, CRANKSHAFT OIL, FRONT, REMOVAL.</u></b>
	6. Scratched or damaged vibration damper hub.	6. Polish or replace damper.
OIL PRESSURE DROP	1. Low oil level.	1. Check and correct oil level.
	2. Faulty oil pressure sensor.	2. Replace sensor. Refer to <b><u>SENSOR, OIL PRESSURE, REMOVAL.</u></b>
	3. Low oil pressure.	3. Check main bearing clearance. Refer to <b><u>BEARING(S), CRANKSHAFT, MAIN, STANDARD PROCEDURE.</u></b>
		3. Check rod bearing clearance. Refer to <b><u>BEARING(S), CONNECTING ROD, STANDARD PROCEDURE.</u></b>
	4. Clogged oil filter.	4. Replace oil filter. Refer to <b><u>FILTER, ENGINE OIL, REMOVAL.</u></b>
	5. Worn oil pump.	5. Replace oil pump. Refer to <b><u>PUMP, ENGINE OIL, REMOVAL.</u></b>
	6. Thin or diluted oil.	6. Change oil and filter. Refer to <b><u>Engine/Lubrication/OIL - Standard Procedure.</u></b>
	7. Excessive bearing clearance.	7. Replace crankshaft bearings. Refer to <b><u>BEARING(S), CRANKSHAFT, MAIN, STANDARD PROCEDURE.</u></b>
		7. Replace rod bearings. Refer to <b><u>BEARING(S), CONNECTING ROD, STANDARD PROCEDURE.</u></b>
	8. Oil pump relief valve stuck.	8. Replace oil pump. Refer to <b><u>PUMP, ENGINE OIL, REMOVAL.</u></b>
	9. Oil pump pick-up tube loose, damaged or clogged.	9. Replace oil pump pick-up. Refer to <b><u>PICK-UP, OIL PUMP, REMOVAL.</u></b>

# 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.

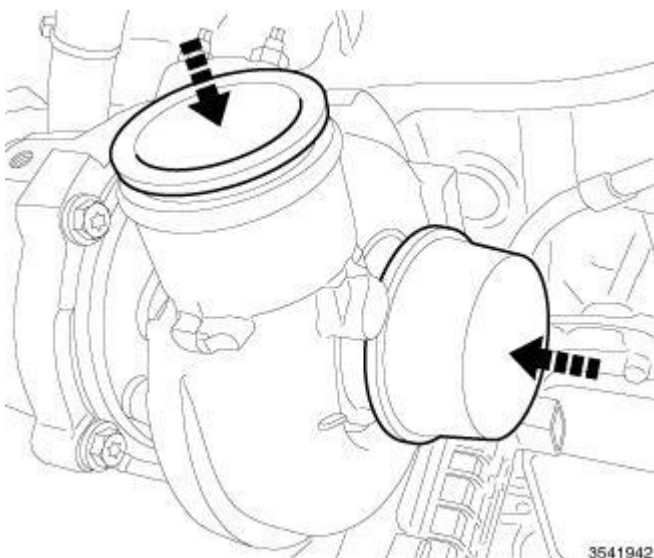
3. Replace cylinder heads. Refer to **CYLINDER HEAD, REMOVAL**.

4. Leaking valve guide seals.

4. Replace valve guide seals. Refer to **SEAL(S), VALVE GUIDE, REMOVAL**.

## STANDARD PROCEDURE

### DUST COVERS AND CAPS

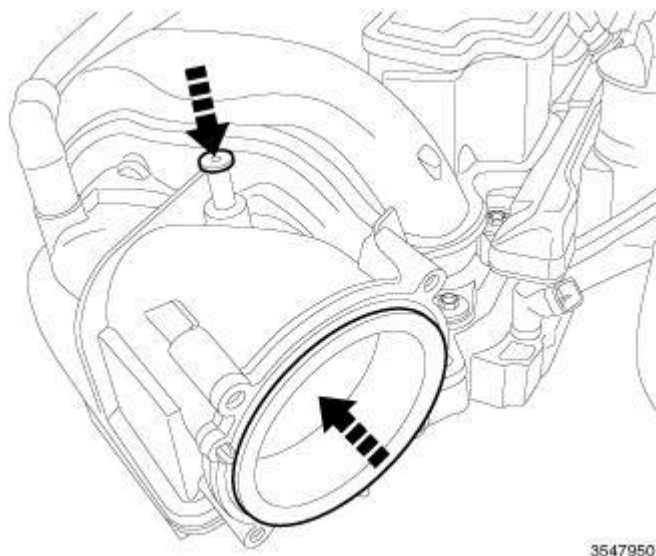


**Fig. 2: Covers/Caps**

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** free of grease or oil. Surfaces should be cleaned with Mopar® brake parts

cleaner prior to sealer application. After the sealer is applied, the parts should be assembled in no more than 10 minutes.

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

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

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

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

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

**MOPAR® 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**

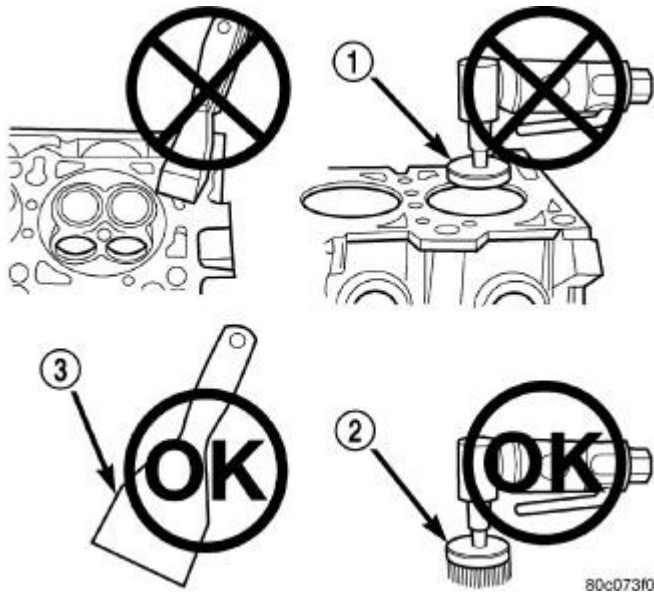
Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. Be certain the material surrounds each mounting hole. Excess material can easily be wiped off. Components should be torqued in place within 15 minutes. The use of a locating dowel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

1 - ABRASIVE PAD

2 - 3M ROLOC™ BRISTLE DISC

3 - PLASTIC/WOOD 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.

**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

### SPECIFICATIONS

#### GENERAL SPECIFICATIONS

DESCRIPTION	SPECIFICATION	
Type	60° DOHC V-6 24-Valve	
Compression Ratio	10.2:1	
Lead Cylinder	#1 Right Bank	
Firing Order	1-2-3-4-5-6	
	Metric	Standard
Displacement	3.6 Liters	220 Cubic Inches
Bore and Stroke	96.0 x 83.0 mm	3.779 in. x 3.268 in.

#### CYLINDER BLOCK

Description	Specification	
	Metric	Standard
Cylinder Bore Diameter - Grade 1	95.995 mm $\pm$ 0.005 mm	3.7793 in. $\pm$ 0.0002 in.
Cylinder Bore Diameter - Grade 2	96.005 mm $\pm$ 0.005 mm	3.7797 in. $\pm$ 0.0002 in.
Cylinder Bore Out-of-Round (Max.)	0.009 mm	0.00035 in.
Cylinder Bore Cylindricity	0.014 mm	0.0006 in.
Crankshaft Bore Taper* (Max.)	0.006 mm	0.0002 in.
*Measured over length of bulkhead		

#### PISTONS

Description	Specification	
	Metric	Standard
Material	Cast Aluminum Alloy	
Piston Diameter (Metal to Metal) - Grade 1	95.955 mm $\pm$ 0.005 mm	3.7778 in. $\pm$ 0.0002 in.
Piston Diameter (Metal to Metal) - Grade 2	95.965 mm $\pm$ 0.005 mm	3.7781 in. $\pm$ 0.0002 in.
Piston Diameter (Metal to Coating) - Grade 1	95.970 - 96.000 mm	3.7783 - 3.7795 in.
Piston Diameter (Metal to Coating) - Grade 2	95.980 - 96.010 mm	3.7787 - 3.7835 in.
Clearance at Size Location (Metal to Metal)	0.030 - 0.050 mm	0.0012 - 0.0020 in.

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Clearance at Size Location (Metal to Coating)	0.010 - 0.030 mm	0.0004 - 0.0012 in.
Piston Weight	354 - 364 grams	12.487 - 12.840 oz.
Piston Pin Offset	0.8 mm	0.031 in.
Piston Ring Groove Diameter - No. 1	88.24 - 88.44 mm	3.474 - 3.482 in.
Piston Ring Groove Diameter - No. 2	86.54 - 86.74 mm	3.407 - 3.415 in.
Piston Ring Groove Diameter - No. 3	89.16 - 89.36 mm	3.510 - 3.518 in.

**PISTON PINS**

Description	Specification	
	Metric	Standard
Type	Full Floating	
Pin Diameter	21.9985 ± 0.0015 mm	0.86608 ± 0.00006 in.
Clearance in Piston	0.002 - 0.011 mm	0.0001 - 0.0004 in.
Clearance in Rod	0.011 - 0.024 mm	0.0004 - 0.0009 in.

**PISTON RINGS**

Description	Specification	
	Metric	Standard
Ring Gap - Number 1 Ring (Top)	0.25 - 0.40 mm	0.010 - 0.016 in.
Ring Gap - Number 2 Ring (Center)	0.30 - 0.45 mm	0.012 - 0.018 in.
Ring Gap - Oil Control Ring (Steel Rails)	0.15 - 0.66 mm	0.006 - 0.026 in.

**PISTON RING SIDE CLEARANCE**

Description	Specification	
	Metric	Standard
Number 1 Ring (Top)	0.025 - 0.083 mm	0.0010 - 0.0033 in.
Number 2 Ring (Center)	0.030 - 0.078 mm	0.0012 - 0.0031 in.
Oil Control Ring (Steel Rails)	0.007 - 0.173 mm	0.0003 - 0.0068 in.

**PISTON RING WIDTH**

Description	Specification	
	Metric	Standard
Number 1 Ring (Top)	3.00 - 3.20 mm	0.118 - 0.126 in.
Number 2 Ring (Center)	3.59 - 3.85 mm	0.141 - 0.152 in.
Oil Control Ring (Steel Rails)	1.930 - 2.083 mm	0.076 - 0.082 in.

**CONNECTING RODS**

Description	Specification	

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	<b>Metric</b>	<b>Standard</b>
Bearing Clearance (With Crush)	0.023 - 0.064 mm	0.0009 - 0.0025 in.
Side Clearance	0.070 - 0.370 mm	0.0028 - 0.0146 in.
Side Clearance (Max.)	0.370 mm	0.0146 in.
Piston Pin Bore Diameter	22.016 ± 0.005 mm	0.8668 ± 0.0002 in.
Bearing Bore Out of Round (Max.)	0.008 mm	0.0003 in.
Total Weight (Less Bearing)	546.7 ± 8 grams	19.28 ± 0.28 oz.

**CRANKSHAFT MAIN BEARING JOURNALS**

<b>Description</b>	<b>Specification</b>	
	<b>Metric</b>	<b>Standard</b>
Diameter	71.996 ± 0.009 mm	2.8345 ± 0.0035 in.
Bearing Clearance	0.024 - 0.050 mm	0.0009 - 0.0020 in.
Bearing Clearance (Max.)	0.050 mm	0.0020 in.
Out of Round (Max.)	0.005 mm	0.0002 in.
Taper (Max.)	0.005 mm	0.0002 in.
End Play	0.050 - 0.290 mm	0.0020 - 0.0114 in.
End Play (Max.)	0.290 mm	0.0114 in.

**CONNECTING ROD JOURNALS**

<b>Description</b>	<b>Specification</b>	
	<b>Metric</b>	<b>Standard</b>
Diameter	59.0 ± 0.009 mm	2.3228 ± 0.0035 in.
Bearing Clearance	0.023 - 0.064 mm	0.0009 - 0.0025 in.
Out of Round (Max.)	0.005 mm	0.0002 in.
Taper (Max.)	0.005 mm	0.0002 in.

**CAMSHAFT**

<b>Description</b>	<b>Specification</b>	
	<b>Metric</b>	<b>Standard</b>
Bore Diameter - No. 1 Cam Towers	32.020 - 32.041 mm	1.2606 - 1.2615 in.
Bore Diameter - No. 2, 3, 4 Cam Towers	24.020 - 24.041 mm	0.9457 - 0.9465 in.
Bearing Journal Diameter - No. 1	31.976 - 31.995 mm	1.2589 - 1.2596 in.
Bearing Journal Diameter - No. 2, 3, 4	23.977 - 23.996	0.9440 - 0.9447 in.
Bearing Clearance - No. 1	0.025 - 0.065 mm	0.00010 - 0.0026 in.
Bearing Clearance - No. 2, 3, 4	0.024 - 0.064 mm	0.0009 - 0.0025 in.
End Play	0.075 - 0.251 mm	0.003 - 0.010 in.

**VALVE TIMING-INTAKE VALVES**

<b>Description</b>	<b>Specification</b>
Opens	2° (ATDC)

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Closes	82° (ABDC) or 262° (ATDC)
Duration	260°
Centerline	128°
Note: Units are in crank degrees, using 0.1524 mm (0.006 in.) valve lift as the threshold.	

**VALVE TIMING-EXHAUST VALVES**

Description	Specification
Opens	59° (BBDC) or 239° (BTDC)
Closes	12° (ATDC)
Duration	251°
Valve Overlap	10°
Note: Units are in crank degrees, using 0.1524 mm (0.006 in.) valve lift as the threshold.	

**CYLINDER HEAD**

Description	Specification	
	Metric	Standard
Gasket Thickness* (Compressed)	0.48 - 0.60 mm	0.019 - 0.024 in.
Flatness (Head Gasket Surface)	0.09 mm	0.0035 in.
Valve Seat Angle	44.75° ± 0.25° from the valve guide axis	
Valve Seat Runout (relative to the valve guide axis) - Intake and Exhaust	0.050 mm	0.002 in.
Intake Valve Seat Width	1.0 - 1.2 mm	0.04 - 0.05 in.
Exhaust Valve Seat Width	1.41 - 1.61 mm	0.055 - 0.063 in.
Guide Bore Diameter (Std.)	6.00 - 6.02 mm	0.236 - 0.237 in.
Valve Guide Height** - Intake and Exhaust	16.05 - 16.55 mm	0.632 - 0.652 in.
*Measured at the fire ring, not at the outer edge		
**Measured from cylinder head valve spring seat surface to top of guide		

**VALVES**

Description	Specification	
	Metric	Standard
Face Angle	45.25° ± 0.25°	
Head Diameter - Intake	39.0 ± 0.100 mm	1.535 ± 0.004 in.
Head Diameter - Exhaust	30.0 ± 0.100 mm	1.181 ± 0.004 in.
Length-Intake (Overall)	116.54 ± 0.23 mm	4.588 ± 0.009 in.
Length-Exhaust (Overall)	115.6 ± 0.23 mm	4.551 ± 0.009 in.
Stem Diameter - Intake	5.968 ± 0.009 mm	0.2350 ± 0.0004 in.
Stem Diameter - Exhaust	5.961 ± 0.009 mm	0.2347 ± 0.0004 in.
Stem-to-Guide Clearance - Intake (New)	0.023 - 0.061 mm	0.0009 - 0.0024 in.
Stem-to-Guide Clearance - Exhaust (New)	0.030 - 0.068 mm	0.0012 - 0.0027 in.
Stem-to-Guide Clearance-Intake (Max., Rocking Method)	0.29 mm	0.011 in.

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Stem-to-Guide Clearance - Exhaust (Max., Rocking Method)	0.37 mm	0.015 in.
Valve Lift-Intake (Zero Lash)	10.3 mm	0.406 in.
Valve Lift-Exhaust (Zero Lash)	10.0 mm	0.394 in.
Valve Stem Tip Height* - Intake	52.4 - 53.5 mm	2.063 - 2.106 in.
Valve Stem Tip Height* - Exhaust	51.8 - 52.9 mm	2.039 - 2.083 in.
*Valve tip to aluminum spring seat boss		

**VALVE SPRING**

Description	Specification	
	Metric	Standard
Free Length - Intake AND Exhaust (Approx.)	52.5 mm	2.067 in.
Spring Force - Intake AND Exhaust (Valve Closed)	295 ± 13 N @ 40.0 mm	66 ± 3 lbs. @ 1.57 in.
Spring Force - Intake (Valve Open)	688 ± 31 N @ 10.3 mm	155 ± 7 lbs. @ 0.4055 in.
Spring Force - Exhaust (Valve Open)	676 ± 30 N @ 10.0 mm	152 ± 6 lbs. @ 0.3937 in.
Number of Coils - Intake AND Exhaust	9.35	
Wire Diameter - Intake AND Exhaust	3.18 x 3.99 mm (ovate)	0.125 x 0.157 in. (ovate)
Installed Height - Intake AND Exhaust (Spring seat top to bottom of retainer)	40.0 mm	1.575 in.

**OIL PRESSURE**

Description	Specification	
	Metric	Standard
(NOTE: At Normal Operating Temperatures)		
Pressure @ Curb Idle Speed*	34.7 kPa Min.	5 psi Min.
Pressure @ 600 - 1200 RPM	34.7 (warm) - 958.0 (cold) kPa	5 (warm) - 139 (cold) psi
Pressure @ 1201 - 3500 RPM	206.8 (warm) - 958.0 (cold) kPa	30 (warm) - 139 (cold) psi
Pressure @ 3501 - 6400 RPM	427.0 (warm) - 958.0 (cold) kPa	62 (warm) - 139 (cold) psi
*CAUTION: If oil pressure is zero at idle, DO NOT run engine at 3000 RPM.		

**TORQUE SPECIFICATIONS**

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.
Air Inlet Hose - Band Clamps	4	-	35
Air Inlet Hose to Core Support	12	-	106
A/C Compressor to Engine - M8 Bolts	28	21	-
Camshaft Chain			



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Tensioner (Primary) - M6 T30	12	-	106
Camshaft Chain Guide (Primary) - M6 T30	12	-	106
Camshaft Chain Idle Sprocket - M8 T45	25	18	-
Camshaft Chain LH Tensioner (Secondary) - M6 T30	12	-	106
Camshaft Chain LH Guide (Secondary) - M6 T30	12	-	106
Camshaft Chain RH Tensioner (Secondary) - M6 T30	12	-	106
Camshaft Chain RH Guide (Secondary) - M6 T30	12	-	106
Camshaft Position (CMP) Sensor to Cylinder Head - 6M T30	9	-	80
Camshaft Bearing Cap - M6 T30	9.5	-	84
Connecting Rod Cap - M9 Bolts	20 + 90° Turn	15 + 90° Turn	-
Coolant Pump to Engine Timing Cover - M6 Bolts	12	-	106
Coolant Crossover Housing to Engine Timing Cover - M6 Bolts	12	-	106
Crankshaft	10	-	89

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Target Wheel to Counterweight - M6 T30			
Crankshaft Outer Main Bearing Cap and Windage Tray - M8 Bolts	21 + 90° Turn	16 + 90° Turn	-
Crankshaft Inner Main Bearing Cap - M11 Bolts	20 + 90° Turn	15 + 90° Turn	-
Crankshaft Side Main Bearing Cap (Tie Bolt) - M8 Bolts	28	21	-
Crankshaft Vibration Damper - M16 Bolt	40 + 105° Turn	30 + 105° Turn	-
Crankshaft Position (CKP) Sensor to Engine Block - M6 Bolt	12	-	106
Crankshaft Rear Oil Seal Retainer - M6 T30	12	-	106
Cylinder Head Oil Restrictor - M8 Plug	15	-	133
Cylinder Head to Engine Block - M12 Bolts in Sequence	See <b>INSTALLATION</b> Procedure.		
Cylinder Head Cover - M6 Bolts	12	-	106
Engine Coolant Temperature (ECT) Sensor	11	-	97
Left/Right Engine Mount Isolator to Engine - Bolts	61	45	-
Left Engine Mount Heatshield to	12	-	106

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Engine Mount - M6 Bolts			
Left/Right Engine Mount Isolator to Frame - Bolt and Nut	61	45	-
Flexplate to Crankshaft - M10 Bolts	95	70	-
Fuel Rail to Lower Intake Manifold - M6 Bolts	7	-	62
Heater Core Coolant Supply Tubes to Right Upper Intake Manifold Support Bracket - M6 Nuts	10	-	89
Ignition Capacitor to Cylinder Head - M6 Bolts	10	-	89
Ignition Coil to Cylinder Head Cover - M6 Bolts	8	-	71
Intake Manifold (Upper) - M6 Bolts	8	-	71
Intake Manifold (Lower) - M6 Bolts	8	-	71
Negative Battery Cable to Battery	5	-	45
Engine Block Oil Gallery - M24 Plugs	10 + 1250° Turn	-	89 + 1250° Turn
Oil Control Valve - Cam Phaser M18	150	110	-
Upper Oil Pan to Engine Block - M8 Bolts	25	18	-
Transmission to			

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Upper Oil Pan - M10 Bolts	55	41	-
Torque Converter Dust Shield - M8 Bolt	12	-	106
Oil Cooler to Oil Filter Housing Screws	4	-	35
Upper Oil Pan to Rear Seal Retainer - M6 Bolts	12	-	106
Oil Pan Drain - Plug M14	27	20	-
Oil Pressure Sensor to Oil Filter Housing	20	-	177
Oil Temperature Sensor to Oil Filter Housing	20	-	177
Lower Oil Pan to Upper Oil Pan - M6 Bolts	11	-	97
Piston Oil Cooler Jet to Engine Block - M5	6	-	53
Oil Filter Housing/Oil Cooler to Engine Block - M6 Bolts	12	-	106
Oil Filter Housing Cap	25	18	-
Oil Pump to Block - M6 Bolts	12	-	106
Oil Level Indicator to Cylinder Head - M6 Bolt	12	-	106
Oil Pump Sprocket - M8 T45	25	18	-
Oil Pump Pick Up Tube Bracket	12	-	106

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to Windage Tray - M6 Bolt			
Oil Pump Pick Up Tube to Oil Pump - M6 Bolt	12	-	106
Oxygen Sensor to Exhaust Pipe - M18	50	37	-
PCV Valve - M5 T25	4	-	35
Power Steering Pump Bracket to Engine - M8 Bolts	24	18	-
Spark Plug to Cylinder Head - M12	17.5	13	-
Starter Mounting - M10 Bolts	55	41	-
Throttle Body - M6 Bolts	7	-	62
Engine Timing Cover - M6 Bolts	12	-	106
Transmission to Engine Block - M10 Bolts	55	41	-
Transmission Fluid Indicator to Transmission - M6 Bolt	12	-	106
Torque Converter - M8 Bolts	42	31	-
Left Rear Upper Intake Manifold Support Bracket to Upper Intake Manifold - M6 Nuts	10	-	89
Left Rear Upper Intake Manifold Support Bracket to Cylinder Head - M8 Studbolts	20	-	177
Left Front Upper			

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Intake Manifold Support Bracket to Upper Intake Manifold - M6 Nuts	10	-	89
Left Front Upper Intake Manifold Support Bracket to Cylinder Head - M6 Bolts	10	-	89
Right Upper Intake Manifold Support Bracket to Cylinder Head Cover Studbolts - M6 Nuts	10	-	89
Right Upper Intake Manifold Support Bracket to Upper Intake Manifold - M6 Bolts	8	-	71
Upper Intake Manifold Insulation Pad Brackets - Bolts	8	-	71
Variable Valve Timing Solenoid to Cylinder Head Cover - M5 T25	4	-	35
Wire Harness Retainer to RH Cylinder Head - Bolt	12	-	106
Rear Engine Mount Bracket to Manual Transmission - Bolts	54	40	-
Rear Engine Mount Isolator to Rear Engine Mount Bracket - Bolts	28	21	-
Rear Engine Mount Bracket			

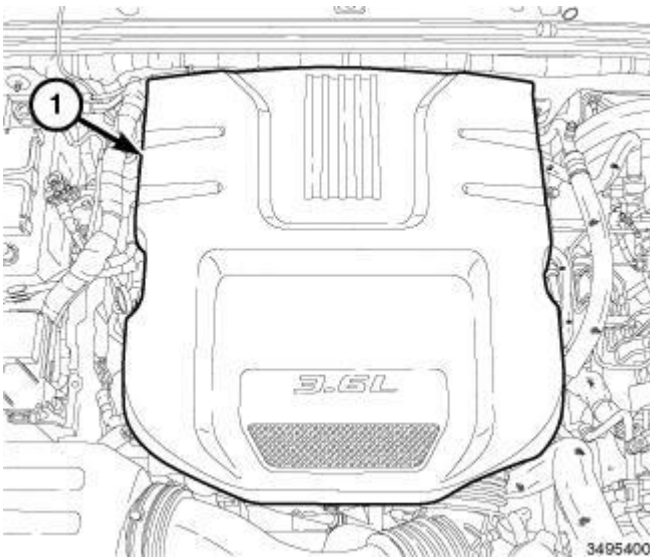
## 2012 Jeep Wrangler Sport S

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to Automatic Transmission - 4x2	33	24	-
Rear Engine Mount Bracket to Automatic Transmission - 4x4	54	40	-

## REMOVAL

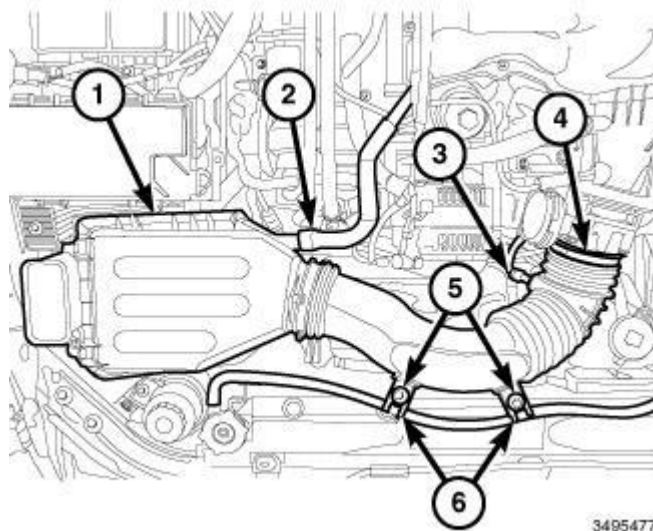
### REMOVAL



**Fig. 5: Engine Cover**

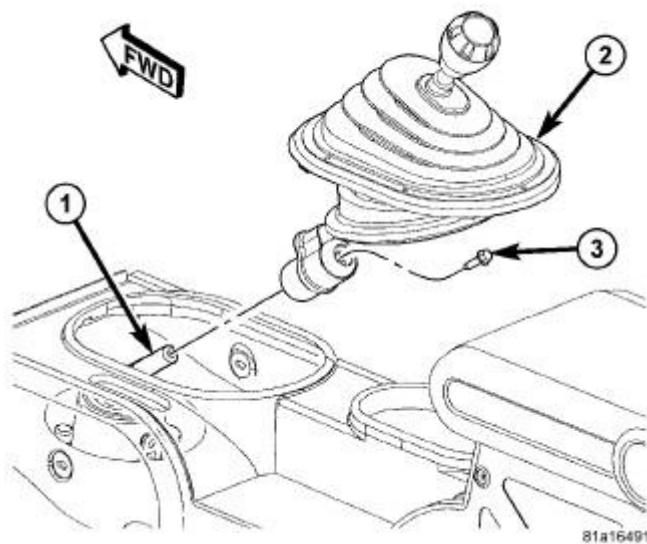
Courtesy of CHRYSLER GROUP, LLC

1. Perform the fuel pressure release procedure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Remove the engine cover (1).



**Fig. 6: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**  
Courtesy of CHRYSLER GROUP, LLC

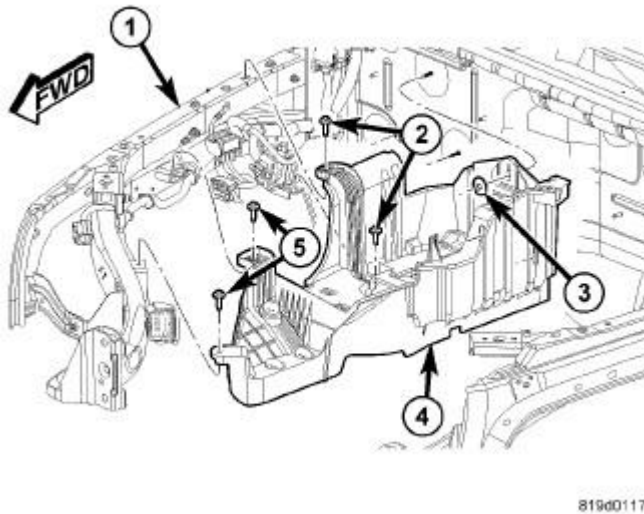
4. Remove the air cleaner body (1). Refer to **BODY, AIR CLEANER, REMOVAL**.



**Fig. 7: Shifter Shaft, Boots & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

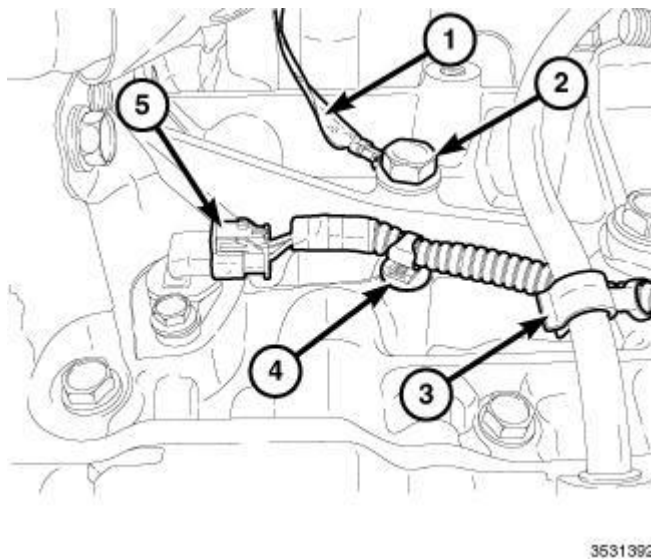
5. If equipped with a manual transmission, remove the shift lever (2). Refer to **LEVER, SHIFT, REMOVAL**.





**Fig. 8: Battery Tray Components**  
Courtesy of CHRYSLER GROUP, LLC

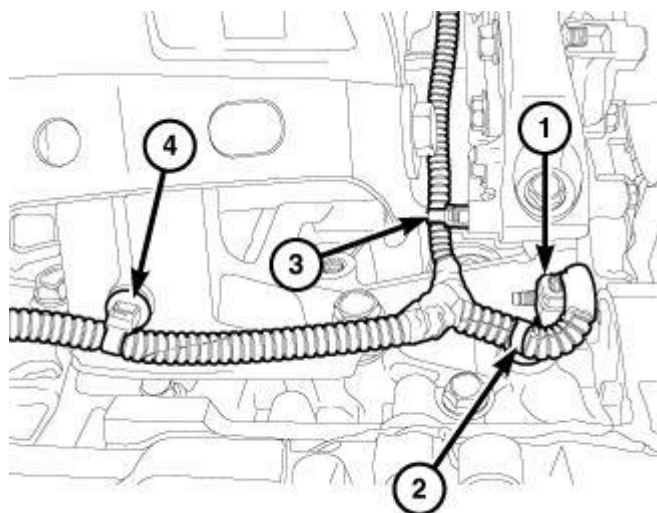
6. Remove the battery, Totally Integrated Power Module (TIPM) and battery tray (4). Refer to **TRAY, BATTERY, REMOVAL**.



**Fig. 9: Ground Strap, Bolt, Retainers & Crankshaft Position (CKP) Sensor**  
Courtesy of CHRYSLER GROUP, LLC

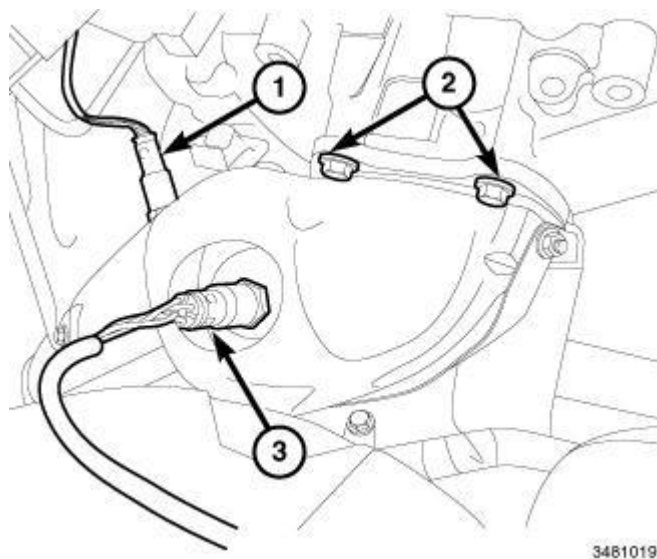
7. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
8. Drain the cooling system. Refer to **STANDARD PROCEDURE**.
9. If required, drain the engine oil. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
10. Remove the front wheelhouse inner splash shields. Refer to **SHIELD, SPLASH, WHEELHOUSE, REMOVAL**.

11. Disconnect the main wire harness from the Crankshaft Position (CKP) sensor (5).
12. Disengage one main wire harness retainer (4) from the engine block and one main wire harness retainer (3) from the oil level indicator.
13. Remove the bolt (2) and ground strap (1) from the engine block.



**Fig. 10: Oil Pump Solenoid Electrical Connector & Wire Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC

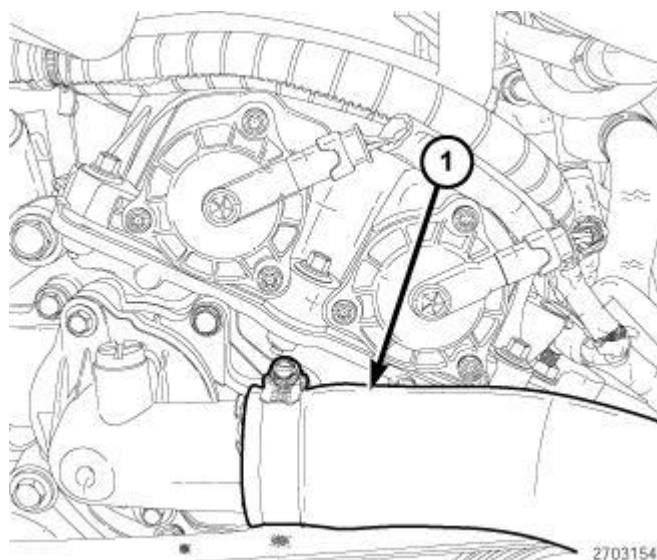
14. Disconnect the oil pump solenoid electrical connector (1).
15. Disengage one wire harness retainer (2) from the engine block, one wire harness retainer (3) from the power steering pump mounting bracket and one wire harness retainer (4) from the right engine mount.



**Fig. 11: Right And Left Upstream And Downstream Oxygen Sensor Connectors & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

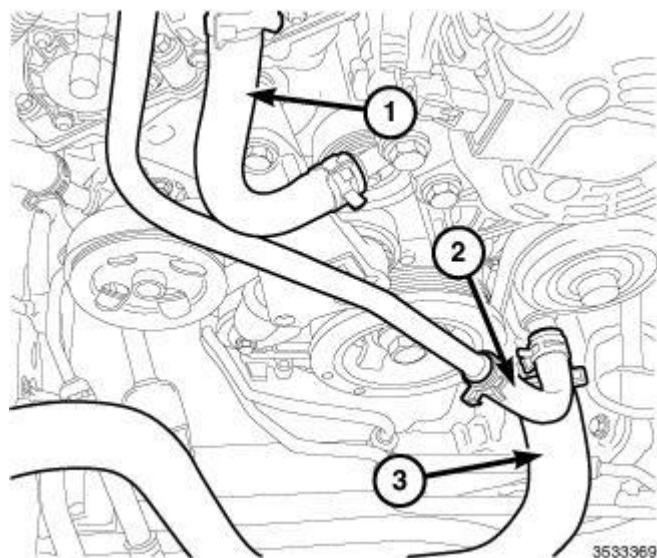
**NOTE:** Right catalytic converter shown in illustration, left catalytic converter similar.

16. Disconnect the right and left upstream (3) and downstream (1) oxygen sensor connectors from the main wire harness.
17. Remove the right and left catalytic converters. Refer to CONVERTER, CATALYTIC, REMOVAL .



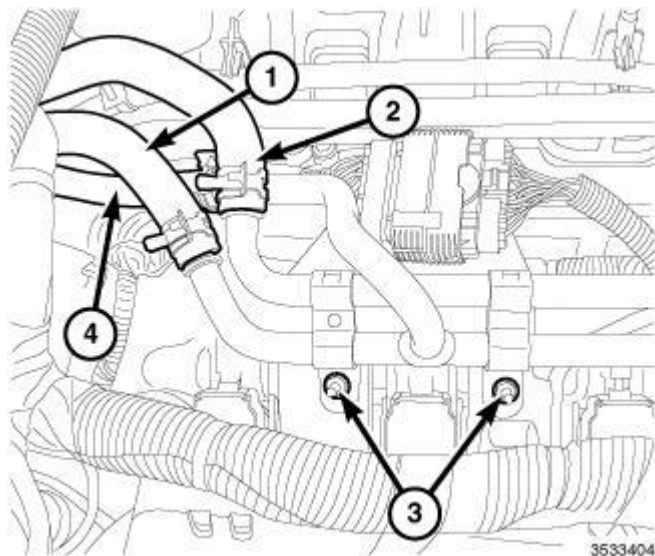
**Fig. 12: Upper Radiator Hose**  
Courtesy of CHRYSLER GROUP, LLC

18. Lower the vehicle.
19. Remove the upper radiator hose (1) from the engine thermostat housing.



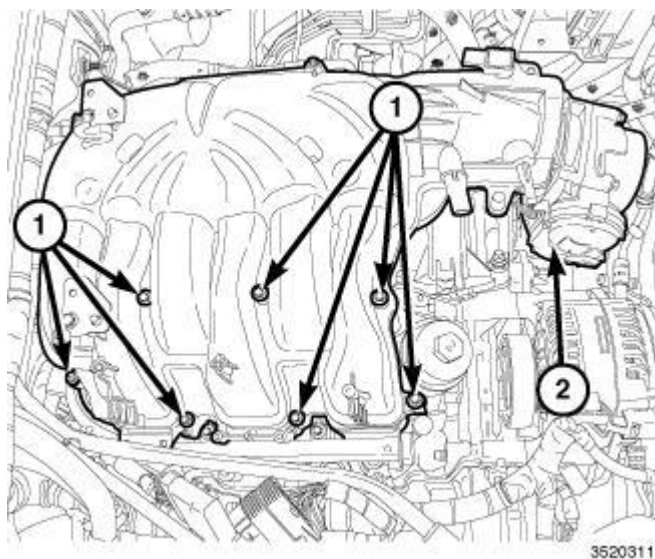
**Fig. 13: Heater Core Supply Hose, Heater Core Return Hose & Lower Radiator Hose**  
Courtesy of CHRYSLER GROUP, LLC

20. Remove the heater core supply hose (1) from the heater core tube assembly.
21. Remove the heater core return hose (2) from the heater core tube assembly.
22. Remove the lower radiator hose (3) from the engine coolant pump housing.



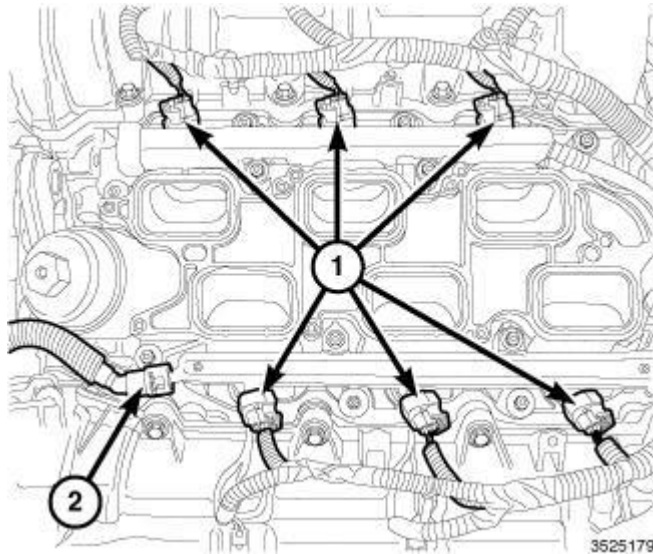
**Fig. 14: Heater Core Return Hose, Heater Core Supply Hose, Nuts & Oil Cooler Return Hose**  
 Courtesy of CHRYSLER GROUP, LLC

23. Remove the heater core supply hose (2), heater core return hose (1) and oil cooler return hose (4) from the heater core tube assembly.
24. Remove two nuts (3) and the heater core tube assembly from the right upper intake manifold support bracket.



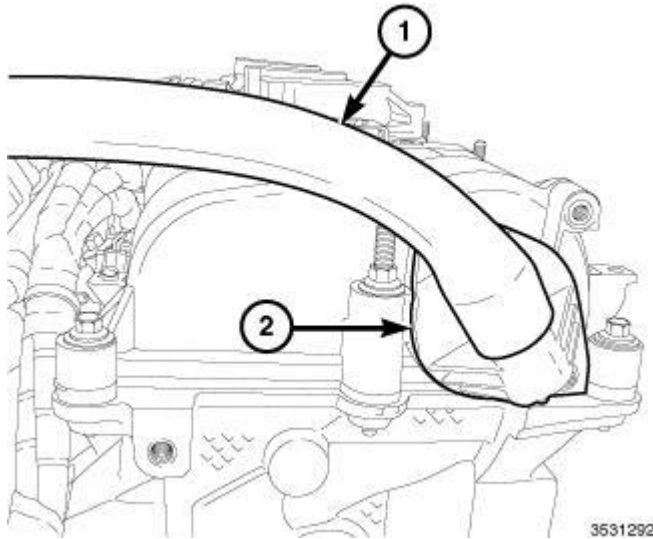
**Fig. 15: Upper Intake Manifold & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

25. Remove the upper intake manifold (2) and insulator. Refer to **MANIFOLD, INTAKE, REMOVAL**.



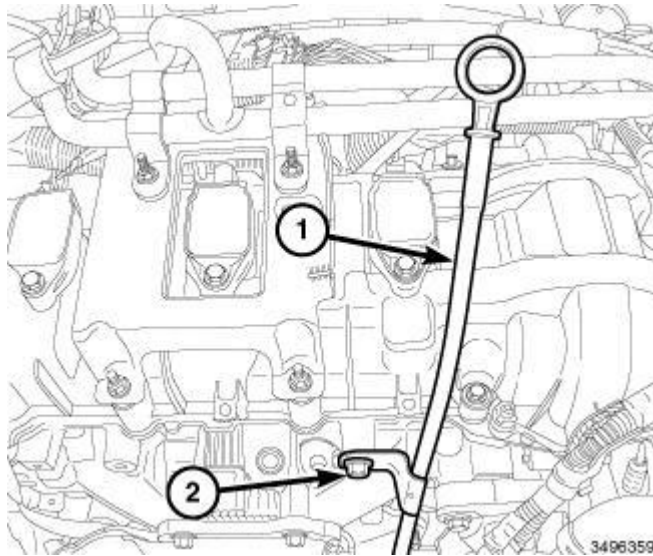
**Fig. 16: Fuel Supply Line And Connectors**  
Courtesy of CHRYSLER GROUP, LLC

26. Disconnect the fuel supply hose (2) from the fuel rail. Refer to **FITTING, QUICK CONNECT**.



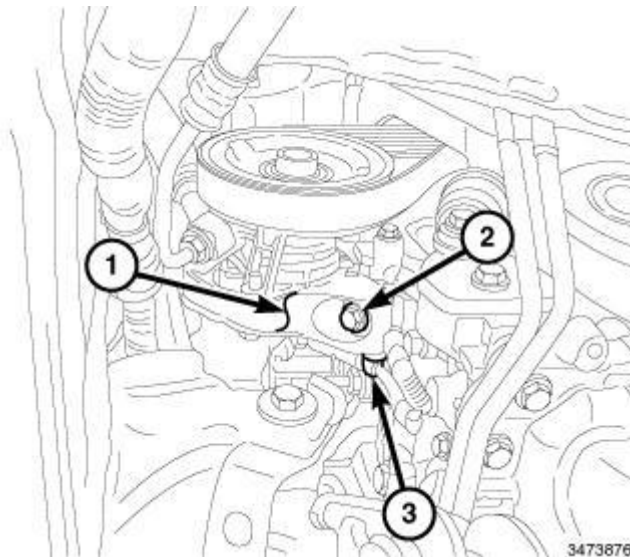
**Fig. 17: PCV Hose & Valve**  
Courtesy of CHRYSLER GROUP, LLC

27. Remove the PCV hose (1) from the PCV valve (2).



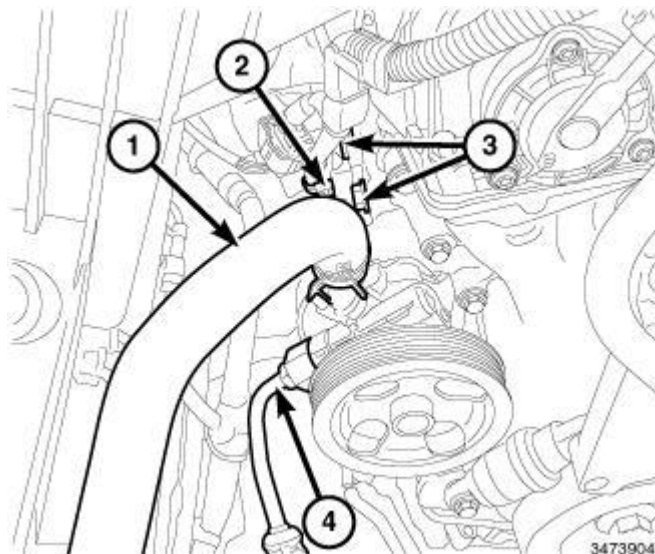
**Fig. 18: Oil Level Indicator & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

28. Remove the bolt (2) and the oil level indicator (1).



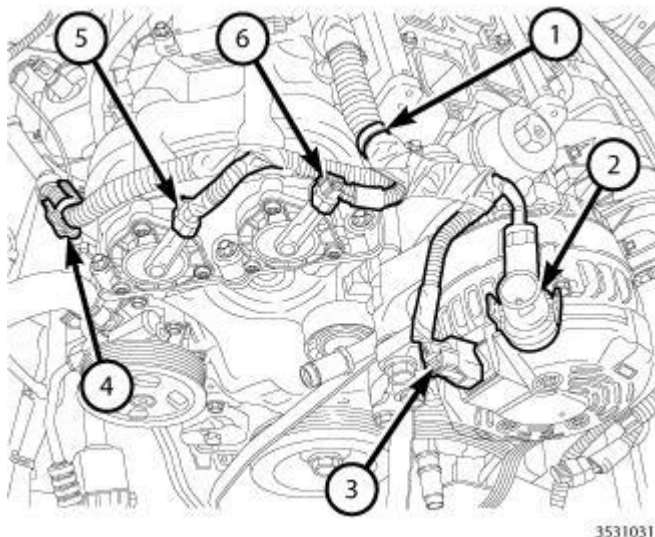
**Fig. 19: Power Steering Pump Bracket, Bolt & Retainer**  
Courtesy of CHRYSLER GROUP, LLC

29. Remove the accessory drive belt. Refer to **BELT, SERPENTINE, REMOVAL**.
30. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
31. Disengage the wiring harness routing retainer (3) from the power steering pump bracket (1).
32. Remove the lower power steering pump retaining bolt (2).



**Fig. 20: Power Steering Return Hose, Supply Line, Retainer & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

33. Lower the vehicle.
34. Disengage the wiring harness routing retainer (2) from the power steering pump bracket.
35. Remove the upper power steering pump bracket retaining bolts (3) and reposition the pump (with bracket).

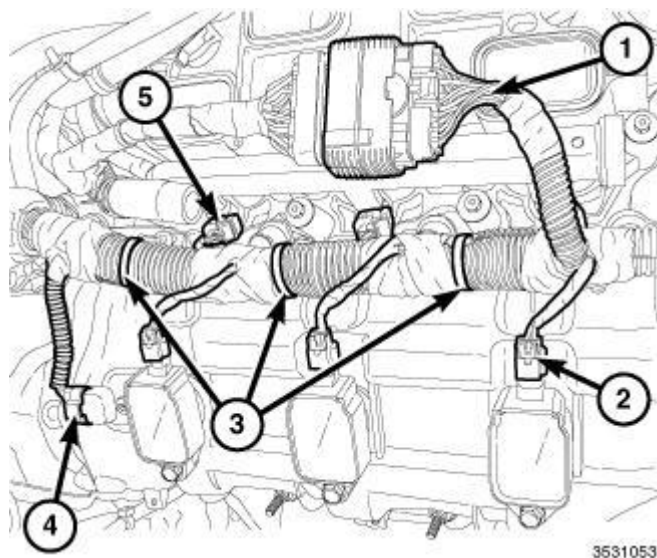


**Fig. 21: Generator Stud, Connector, Retainers & Right Exhaust And Right Intake Variable Valve Timing Solenoid Electrical Connectors**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Mark the variable valve timing solenoid connectors (5 and 6) with a paint pen or equivalent so that they may be reinstalled in their original locations.

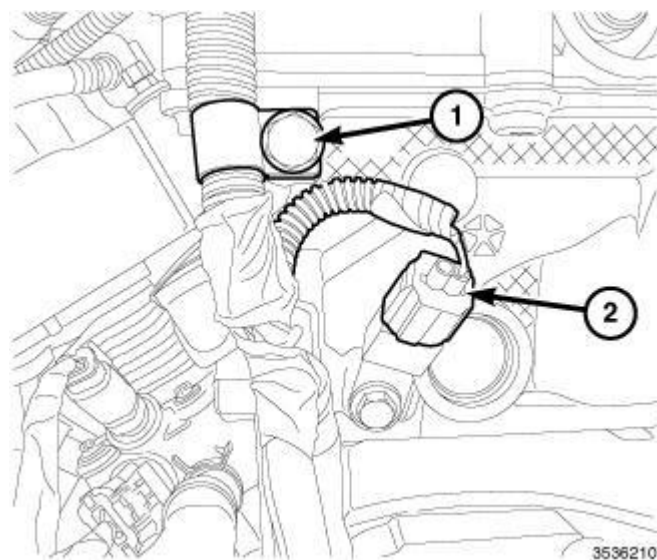
36. Disconnect the field circuit connector (3) from the generator.

37. Remove the B+ terminal from the generator stud (2).
38. Disconnect the right exhaust variable valve timing solenoid electrical connector (5).
39. Disconnect the right intake variable valve timing solenoid electrical connector (6).
40. Disengage the wire harness retainers (1 and 4) from the right cylinder head cover.



**Fig. 22: Engine Injection/Ignition Harness, Ignition Coil Electrical Connectors, Retainers, Camshaft Position (CMP) Sensor Connector & Fuel Injector Electrical Connectors**  
Courtesy of CHRYSLER GROUP, LLC

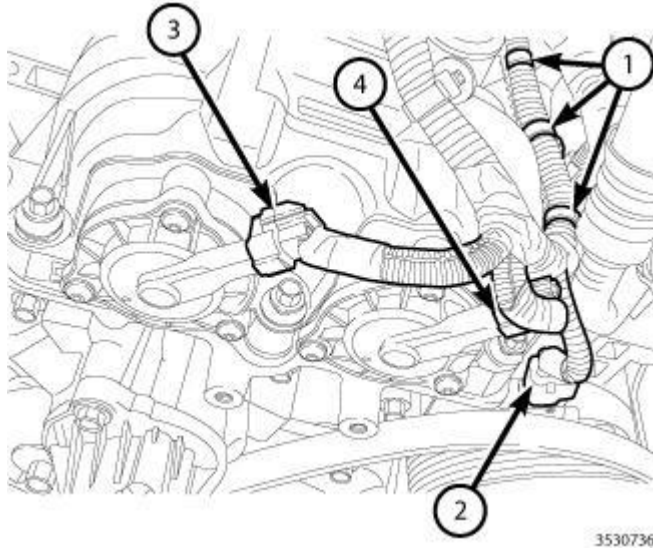
41. Disconnect the main harness from the engine injection/ignition harness (1).
42. Disconnect three fuel injector electrical connectors (5).
43. Disconnect three ignition coil electrical connectors (2).
44. Disconnect the electrical connector (4) from the right Camshaft Position (CMP) sensor.
45. Disengage three main wire harness retainers (3) from the right cylinder head cover.





**Fig. 23: Ignition Coil Capacitor Electrical Connector & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

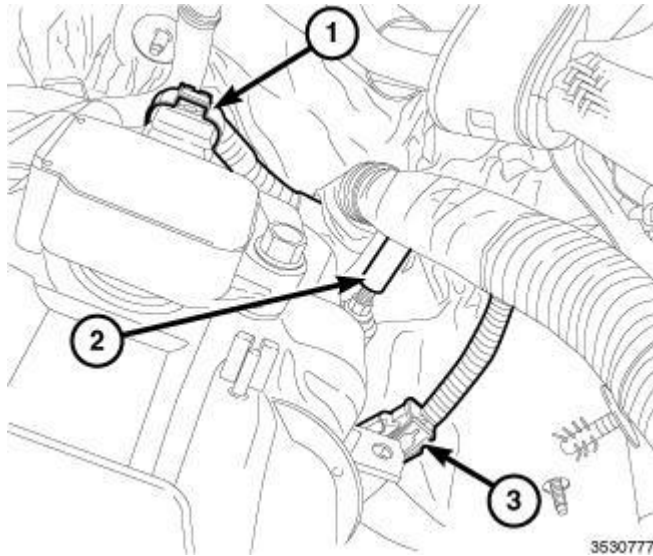
46. Disconnect the electrical connector (2) from the ignition coil capacitor.
47. Remove the bolt (1) and the main wire harness retainer from the rear of the right cylinder head.



**Fig. 24: Retainers, A/C Compressor Electrical Connector & Left Intake And Left Exhaust Variable Valve Timing Solenoid Electrical Connectors**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Mark the variable valve timing solenoid connectors (3 and 4) with a paint pen or equivalent so that they may be reinstalled in their original locations.

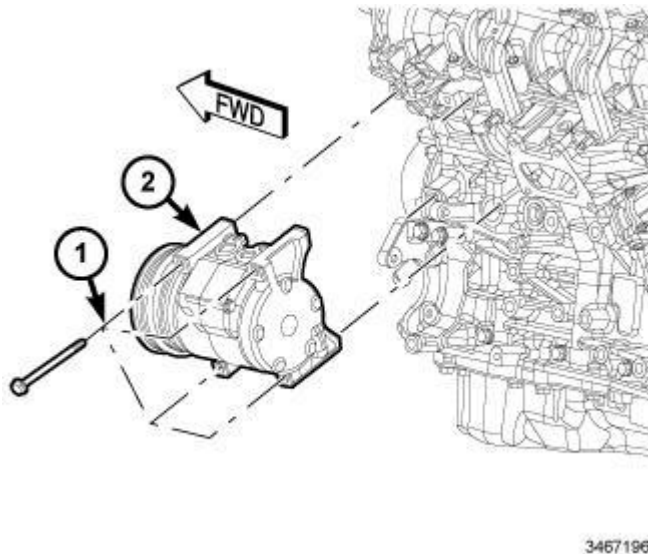
48. Disconnect the A/C compressor electrical connector (2).
49. Disconnect the left exhaust variable valve timing solenoid electrical connector (4).
50. Disconnect the left intake variable valve timing solenoid electrical connector (3).
51. Disengage three wire harness retainers (1) from the left cylinder head cover.



**Fig. 25: Camshaft Position (CMP) Sensor, Retainer & Engine Coolant Temperature (ECT) Sensor Connector**

Courtesy of CHRYSLER GROUP, LLC

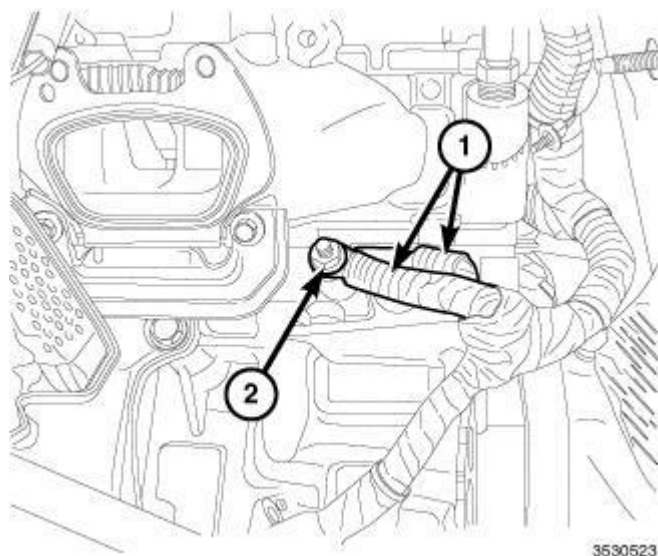
52. Disconnect the Engine Coolant Temperature (ECT) sensor connector (3).
53. Disconnect the left Camshaft Position (CMP) sensor (1).
54. Disengage the main wire harness retainer (2) from the cylinder head cover mounting stud.



**Fig. 26: A/C Compressor & Mounting Bolts**

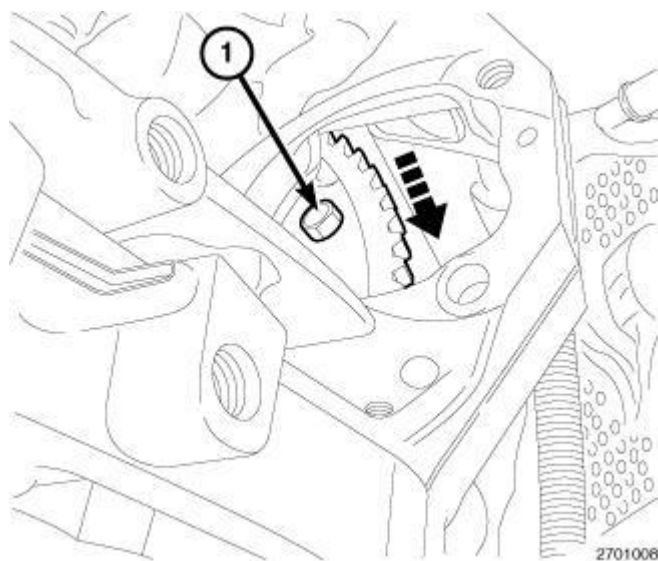
Courtesy of CHRYSLER GROUP, LLC

55. Remove the four A/C compressor mounting bolts (1) and reposition the A/C compressor (2).



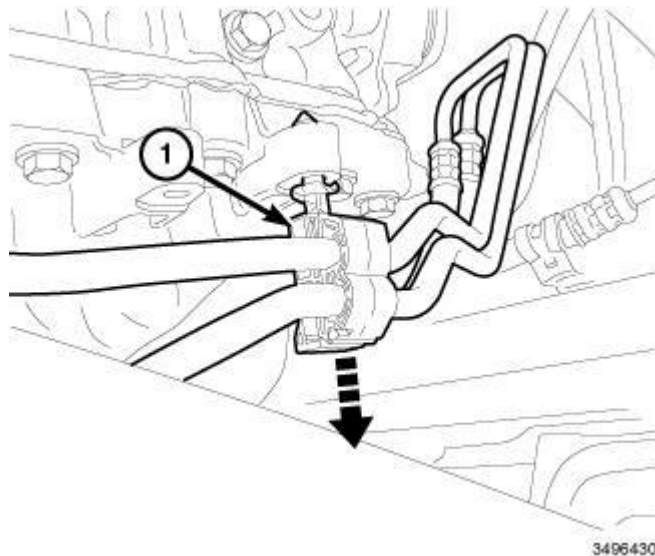
**Fig. 27: Ground Straps & Nut**  
Courtesy of CHRYSLER GROUP, LLC

56. Remove the starter. Refer to **STARTER, REMOVAL**.
57. Disconnect the power cord from the engine block heater (if equipped).
58. Remove the nut (2) and ground straps (1).



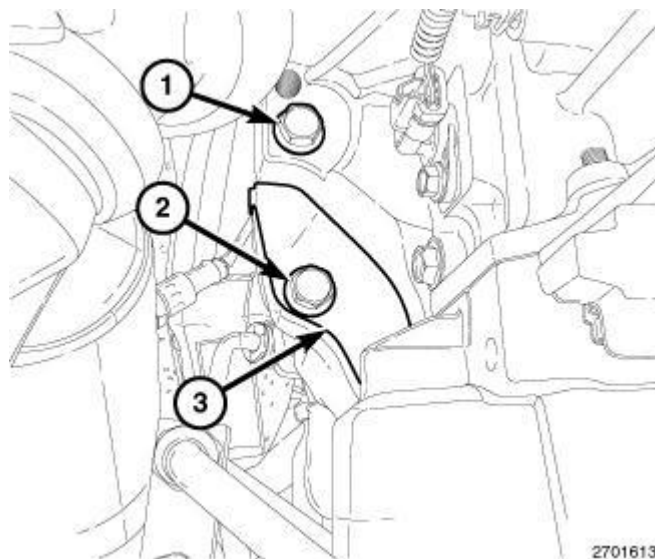
**Fig. 28: Torque Converter Bolt**  
Courtesy of CHRYSLER GROUP, LLC

59. Remove the manual transmission, if equipped. Refer to **REMOVAL**.
60. If equipped with an automatic transmission, rotate the crankshaft in a clockwise direction until the torque converter bolts (1) are accessible through the starter mounting. Remove the six torque converter bolts (1).



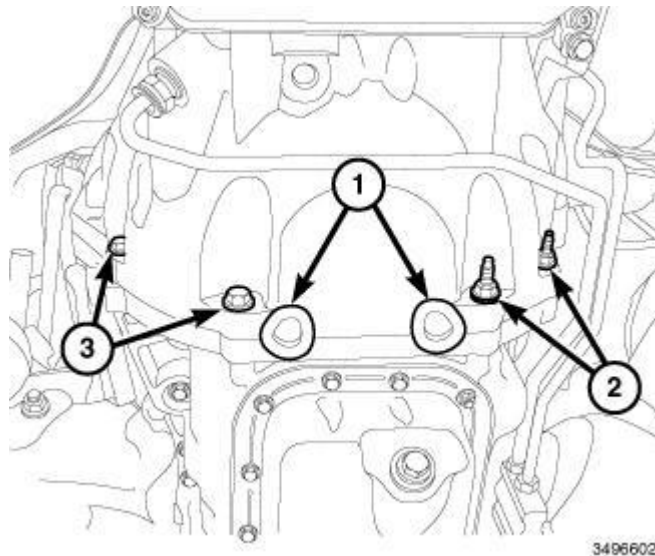
**Fig. 29: Disengaging Transmission Cooler Line Retainer**  
Courtesy of CHRYSLER GROUP, LLC

61. If equipped with an automatic transmission, disengage the transmission cooler line retainer (1) from the oil pan flange.



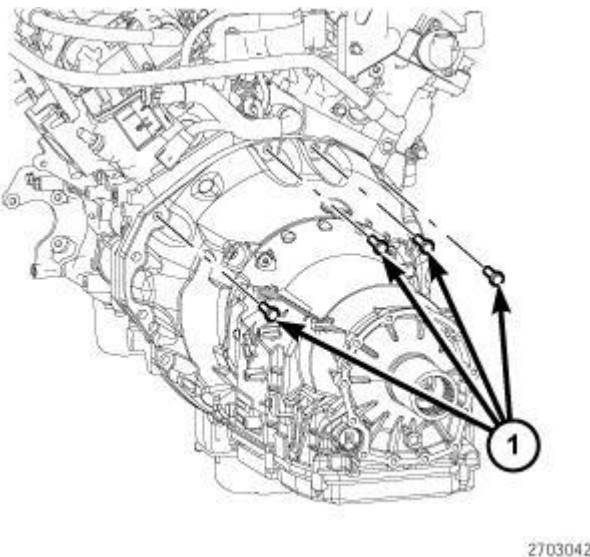
**Fig. 30: Side Engine-To-Transmission Bolt, Transmission Dust Shield Retaining Bolt & Dust Shield**  
Courtesy of CHRYSLER GROUP, LLC

62. If equipped with an automatic transmission;
- Remove the bolt (2) and the torque converter dust shield (3).
  - Remove the side engine to transmission bolt (1).



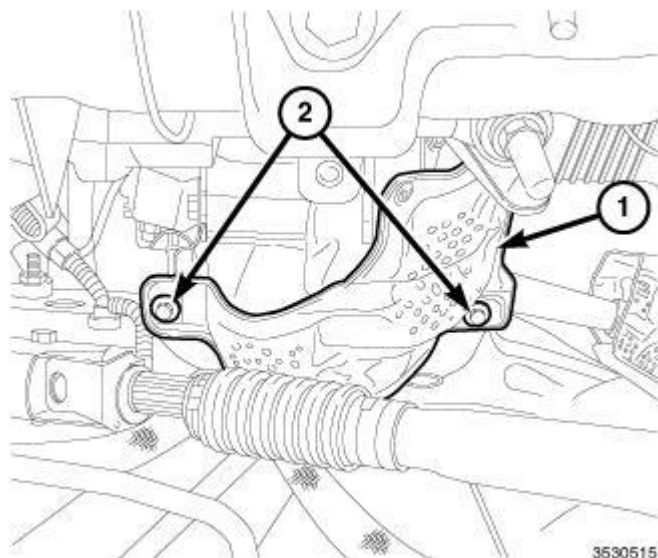
**Fig. 31: Rubber Plugs & Transmission To Engine Oil Pan Bolts**  
Courtesy of CHRYSLER GROUP, LLC

63. If equipped with an automatic transmission;
- Remove two rubber plugs (1) covering the rear oil seal retainer flange bolts.
  - Remove four transmission to the engine oil pan bolts (2 and 3).



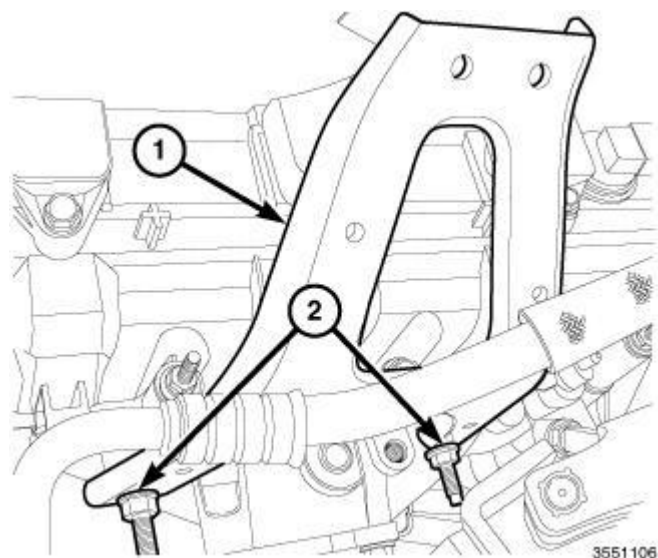
**Fig. 32: Upper Transmission Engine Bolts**  
Courtesy of CHRYSLER GROUP, LLC

64. If equipped with an automatic transmission, remove four upper transmission to engine bolts (1).



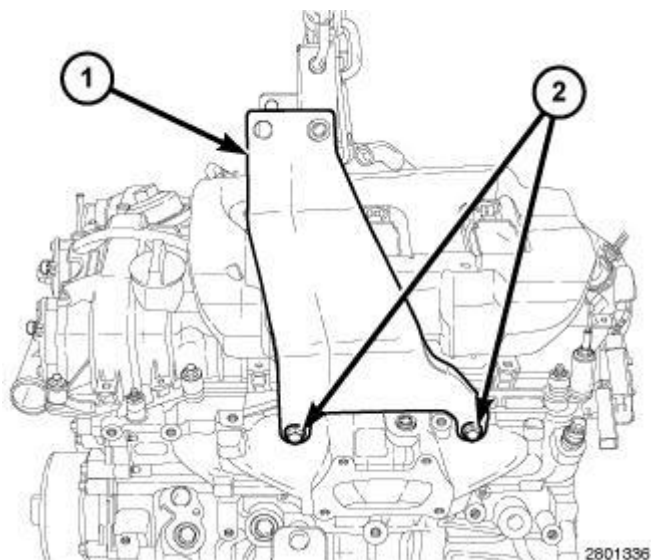
**Fig. 33: Engine Mount Heatshield & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

65. Lower the vehicle.
66. Remove the two bolts (2) and the engine mount heatshield (1) from the left engine mount.



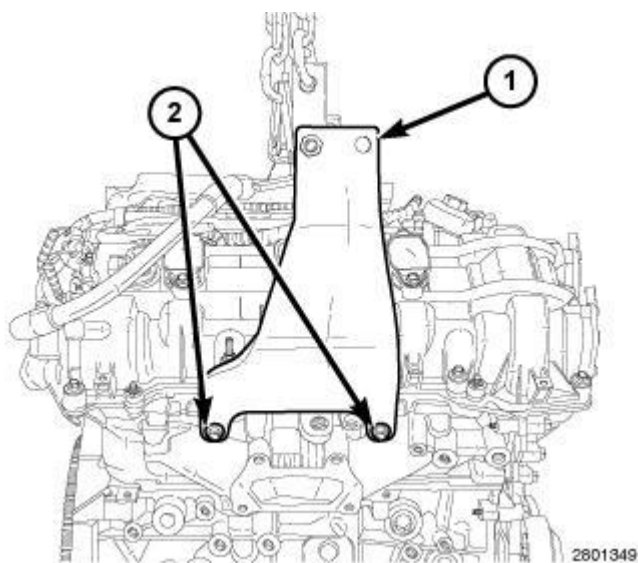
**Fig. 34: Left Rear Upper Intake Manifold Support Bracket & Studbolts**  
 Courtesy of CHRYSLER GROUP, LLC

67. Remove the two studbolts (3) and remove the left rear upper intake manifold support bracket (1).



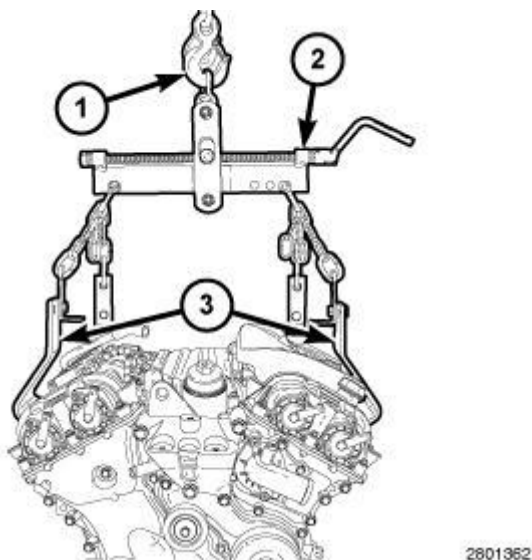
**Fig. 35: Driver Side Engine Lifting Bracket & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

68. Install the Driver Side Engine Lifting Bracket (special tool #10242-1, Brackets, Engine Lifting, Left Side) (1) on the LH cylinder head with bolts (2) provided with the Engine Lifting Bracket. Tighten the bolts to 21 N.m (15 ft. lbs.).



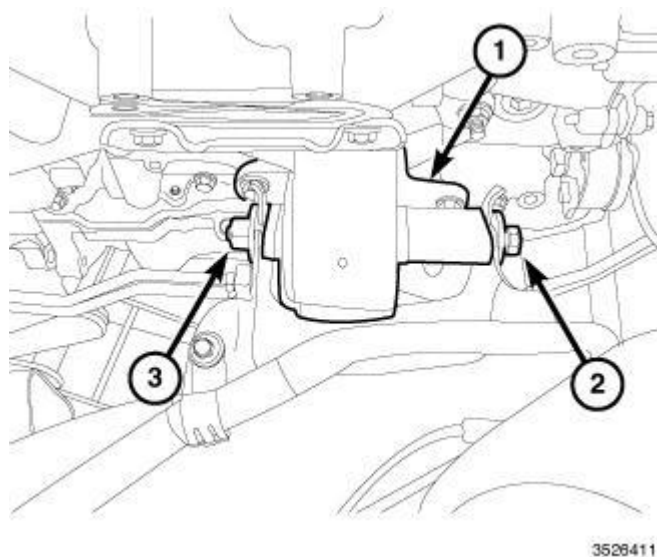
**Fig. 36: Passenger Side Engine Lifting Bracket & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

69. Install the Passenger Side Engine Lifting Bracket (special tool #10242-2, Brackets, Engine Lifting, Right Side) (1) on the RH cylinder head with bolts (2) from the Engine Lifting Bracket. Tighten the bolts to 21 N.m (15 ft. lbs.).



**Fig. 37: Lifting Sling, Engine Lifting Brackets & Engine Hoist**  
 Courtesy of CHRYSLER GROUP, LLC

70. Reposition the main wire harness to the rear of the engine compartment.
71. Position a load-leveling lifting sling (2), such as OTC® 4305 Engine Load Leveler or equivalent, between the engine lifting brackets (3) and an engine hoist (1).



**Fig. 38: Right Engine Mount & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Right engine mount shown in illustration, left engine mount similar.

72. If equipped with an automatic transmission, support the transmission with a suitable jack.
73. Loosen both the left and right engine mount nuts (3).



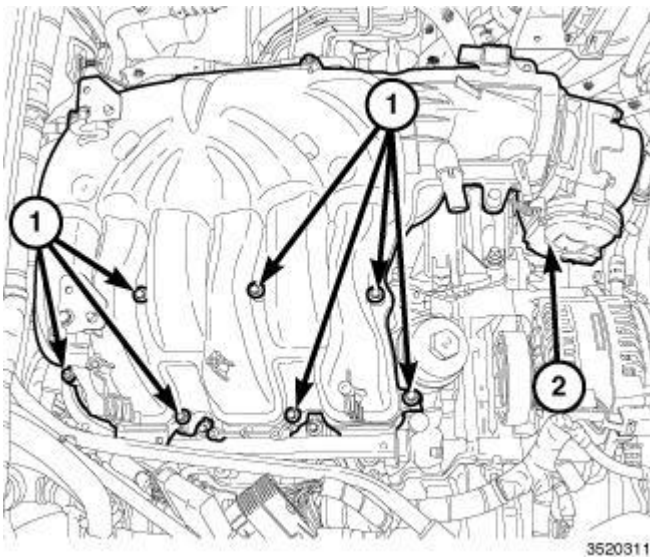
**CAUTION:** While slowly separating the engine from the vehicle, constant checks must be made to assure proper positioning and that no damage to other components or wiring harnesses occur during separation.

74. Carefully remove the engine from the engine bay area.
75. If required, remove the following components for installation on the replacement engine:

- LH engine mount isolator
- RH engine mount isolator
- Accessory drive belt tensioner
- Generator
- Flywheel or flexplate
- Block heater (if equipped)

## INSTALLATION

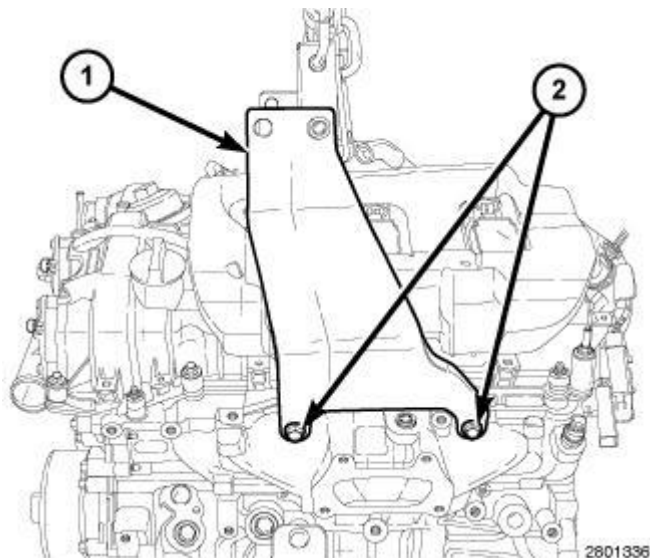
### INSTALLATION



**Fig. 39: Upper Intake Manifold & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

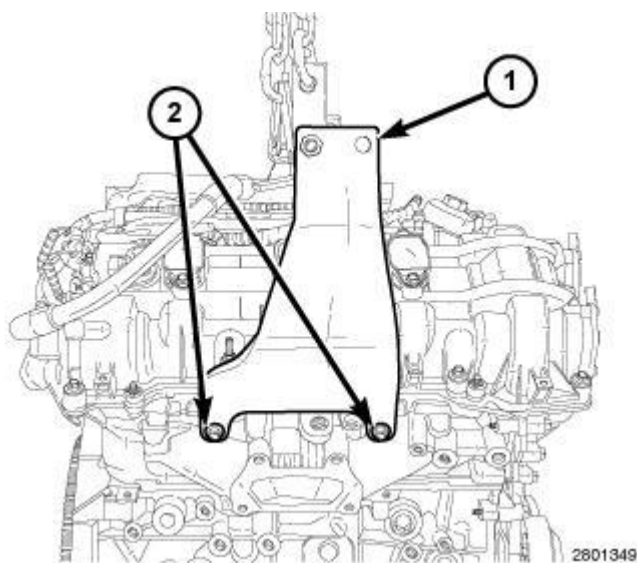
**NOTE:** If installing a replacement engine, transfer components such as engine mount isolators, block heater, accessories, heater hoses and tubes to the replacement engine.

1. If required, remove the upper intake manifold (2). Refer to MANIFOLD, INTAKE, REMOVAL.



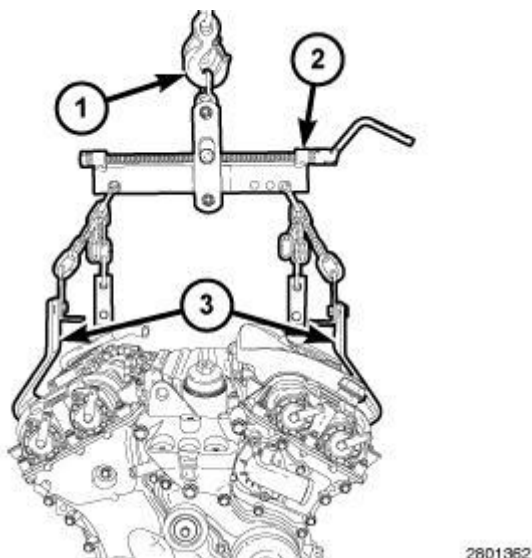
**Fig. 40: Driver Side Engine Lifting Bracket & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

2. Install the Driver Side Engine Lifting Bracket (special tool #10242-1, Brackets, Engine Lifting, Left Side) (1) on the LH cylinder head with bolts (2) provided with the Engine Lifting Bracket. Tighten the bolts to 21 N.m (15 ft. lbs.).



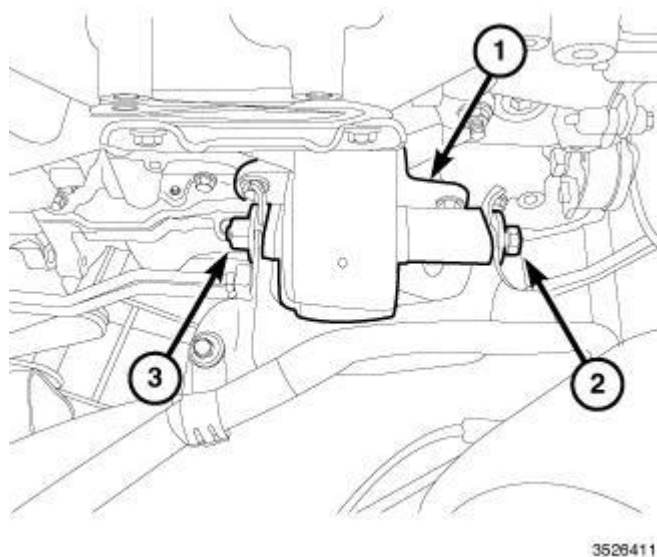
**Fig. 41: Passenger Side Engine Lifting Bracket & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

3. Install the Passenger Side Engine Lifting Bracket (special tool #10242-2, Brackets, Engine Lifting, Right Side) (1) on the RH cylinder head with bolts (2) from the Engine Lifting Bracket. Tighten the bolts to 21 N.m (15 ft. lbs.).



**Fig. 42: Lifting Sling, Engine Lifting Brackets & Engine Hoist**  
 Courtesy of CHRYSLER GROUP, LLC

4. Position a load-leveling lifting sling (2), such as OTC® 4305 Engine Load Leveler or equivalent, between the engine lifting brackets (3) and an engine hoist (1).
5. Reposition the main wire harness to the rear of the engine compartment.

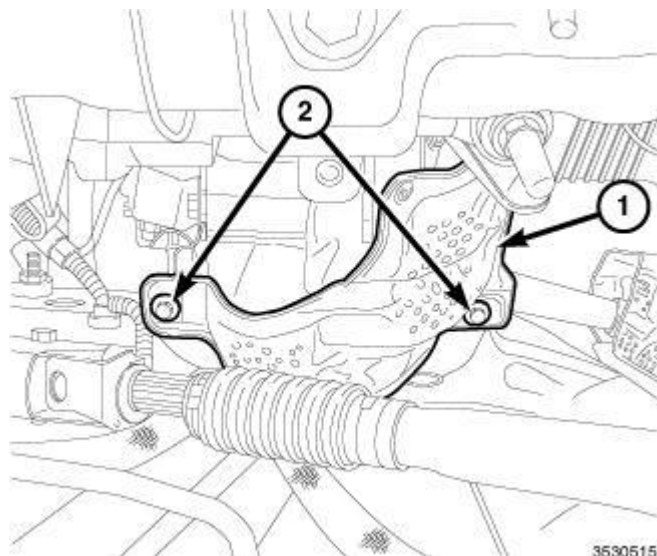


**Fig. 43: Right Engine Mount & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Right engine mount shown in illustration, left engine mount similar.

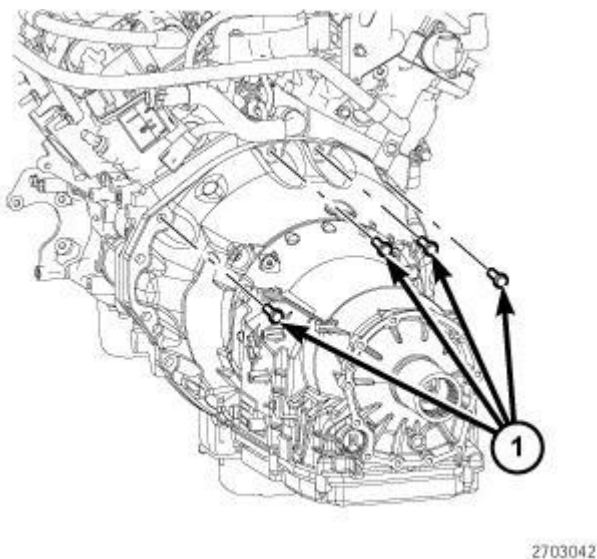
6. Position the engine in the vehicle. If equipped with an automatic transmission, align the two locator dowels into the transmission housing.
7. Align the left and right engine mount isolators (1) within the frame mounting brackets and lower the engine so the weight is resting on the mounting bolts (2).

8. Tighten the left and right engine mount nuts (3) to 61 N.m (45 ft. lbs.).



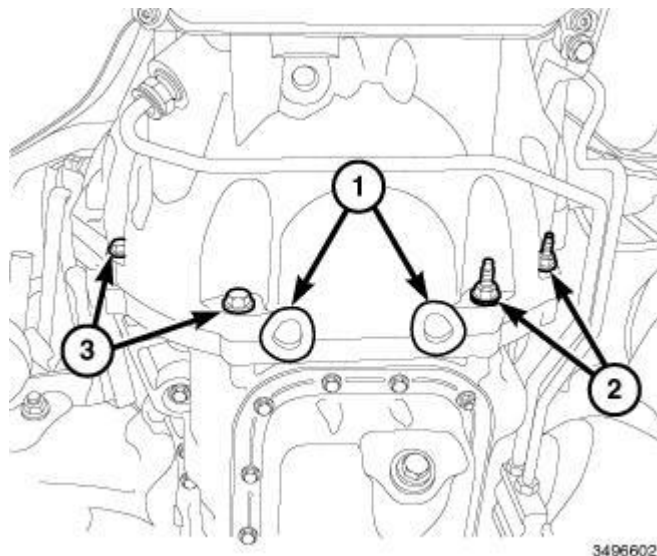
**Fig. 44: Engine Mount Heatshield & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

9. Install the engine mount heatshield (1) to the left engine mount with two bolts (2) tightened to 12 N.m (106 in. lbs.).



**Fig. 45: Upper Transmission Engine Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

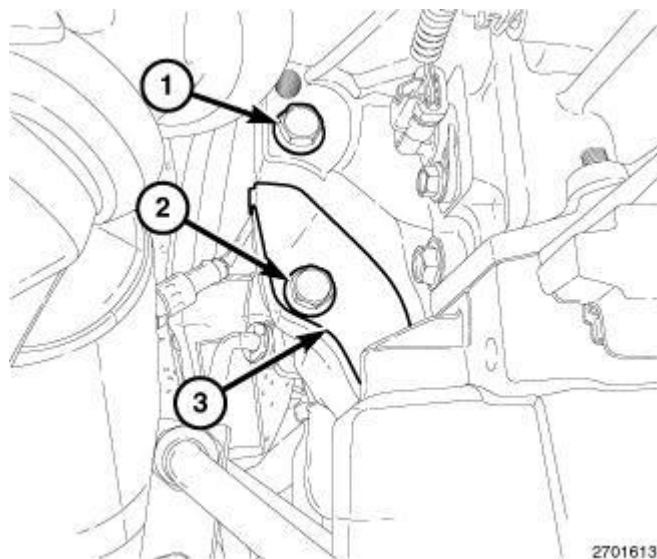
10. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
11. Install the manual transmission, if equipped. Refer to **INSTALLATION**.
12. If equipped with an automatic transmission, install the four upper transmission to engine bolts (1). Tighten the bolts to 55 N.m (41 ft. lbs.).



**Fig. 46: Rubber Plugs & Transmission To Engine Oil Pan Bolts**  
Courtesy of CHRYSLER GROUP, LLC

13. If equipped with an automatic transmission;

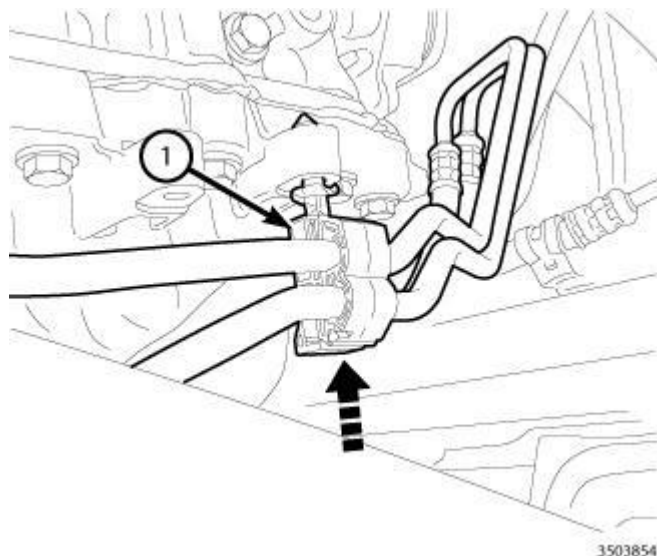
- Install four transmission to the engine oil pan bolts (2 and 3) and tighten to 55 N.m (41 ft. lbs.).
- Install two rubber plugs (1) covering the rear oil seal retainer flange bolts.



**Fig. 47: Side Engine-To-Transmission Bolt, Transmission Dust Shield Retaining Bolt & Dust Shield**  
Courtesy of CHRYSLER GROUP, LLC

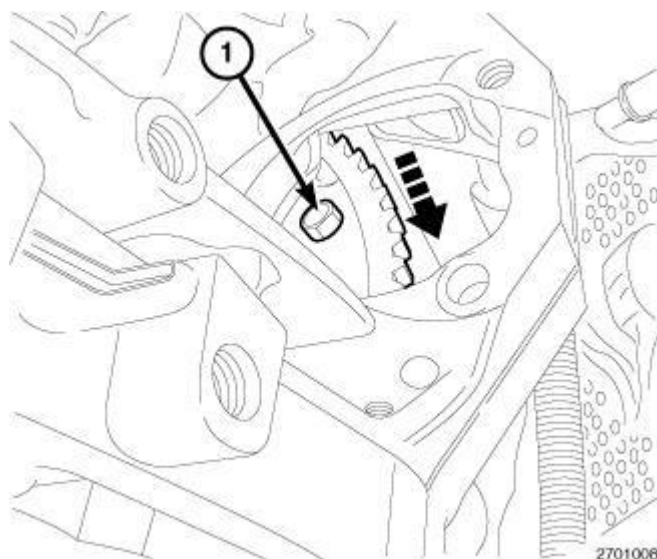
14. If equipped with an automatic transmission;

- Install the side engine to transmission bolt (1). Tighten the bolt to 55 N.m (41 ft. lbs.).
- Install the torque converter dust shield (3) with the bolt (2). Tighten the bolt to 12 N.m (106 in. lbs.).



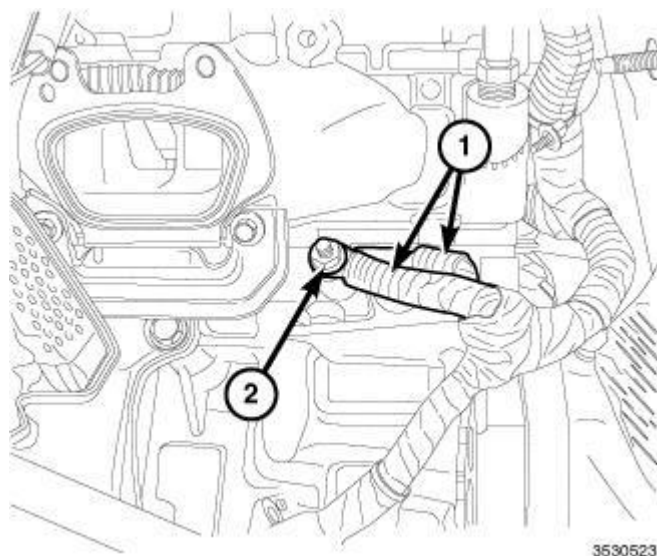
**Fig. 48: Engaging Transmission Cooler Line Retainer**  
Courtesy of CHRYSLER GROUP, LLC

15. If equipped with an automatic transmission, engage the transmission cooler line retainer (1) to the oil pan flange.



**Fig. 49: Torque Converter Bolt**  
Courtesy of CHRYSLER GROUP, LLC

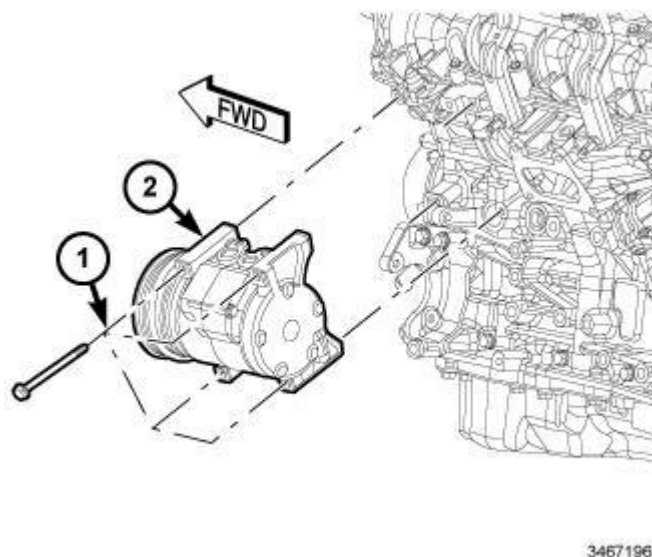
16. If equipped with an automatic transmission, rotate the crankshaft in a clockwise direction and install the six torque converter bolts (1) through the starter mounting. Tighten the bolts to 42 N.m (31 ft. lbs.).



**Fig. 50: Ground Straps & Nut**

Courtesy of CHRYSLER GROUP, LLC

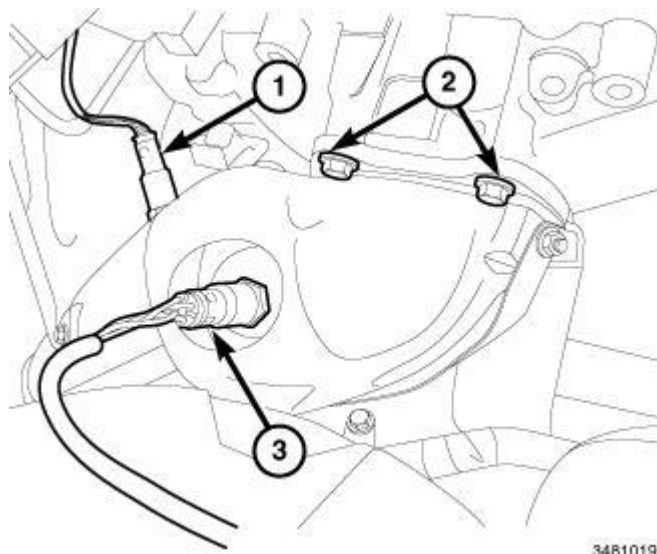
17. Connect the power cord to the engine block heater (if equipped).
18. Install the ground straps (1) with one nut (2) tightened to 12 N.m (106 in. lbs.).
19. Install the starter. Refer to **STARTER, INSTALLATION** .



**Fig. 51: A/C Compressor & Mounting Bolts**

Courtesy of CHRYSLER GROUP, LLC

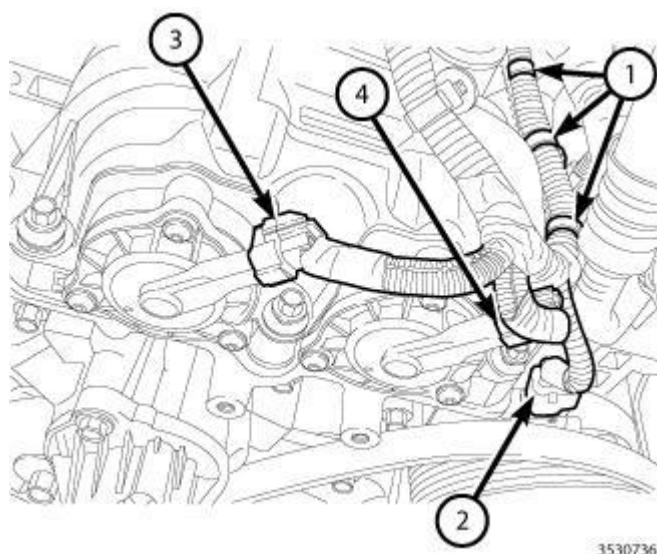
20. Install the A/C compressor (2) onto the engine with four bolts (1) tightened to 28 N.m (21 ft. lbs.).



**Fig. 52: Right And Left Upstream And Downstream Oxygen Sensor Connectors & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Right catalytic converter shown in illustration, left catalytic converter similar.

21. Install the right and left catalytic converters. Refer to **CONVERTER, CATALYTIC, INSTALLATION** .
22. Connect the right and left upstream (3) and downstream (1) oxygen sensor connectors to the main wire harness.

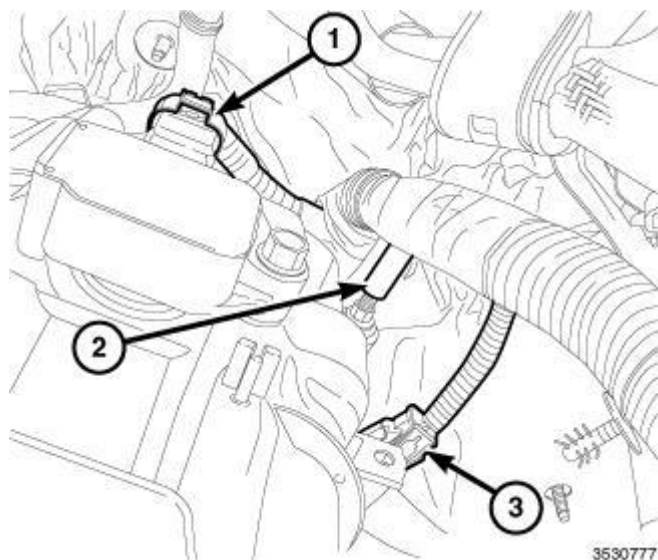


**Fig. 53: Retainers, A/C Compressor Electrical Connector & Left Intake And Left Exhaust Variable Valve Timing Solenoid Electrical Connectors**  
 Courtesy of CHRYSLER GROUP, LLC

23. Route the main wire harness on the left side of the engine.



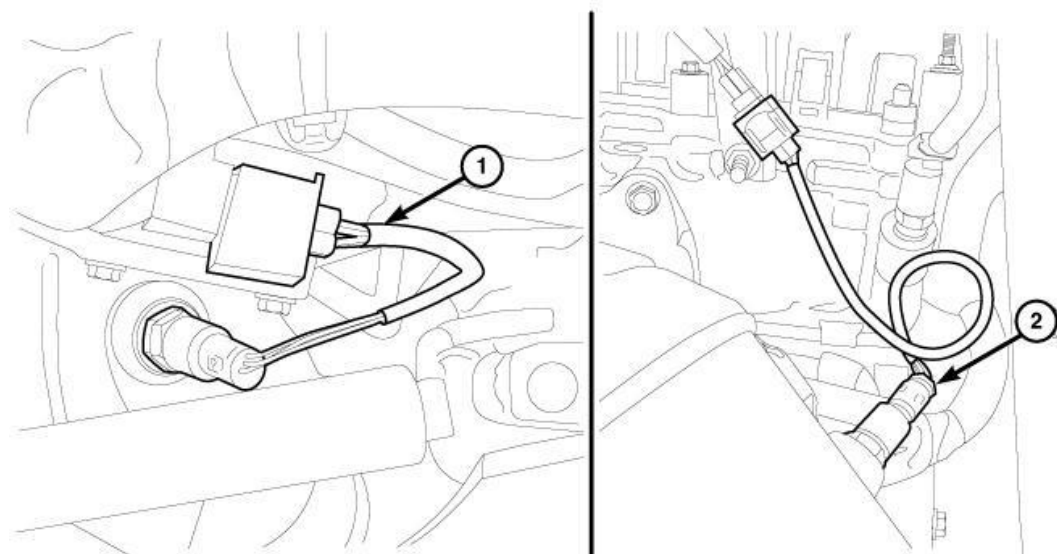
24. Connect the A/C compressor electrical connector (2).
25. Connect the left exhaust variable valve timing solenoid electrical connector (4).
26. Connect the left intake variable valve timing solenoid electrical connector (3).
27. Engage three wire harness retainers (1) to the left cylinder head cover.



**Fig. 54: Camshaft Position (CMP) Sensor, Retainer & Engine Coolant Temperature (ECT) Sensor Connector**

**Courtesy of CHRYSLER GROUP, LLC**

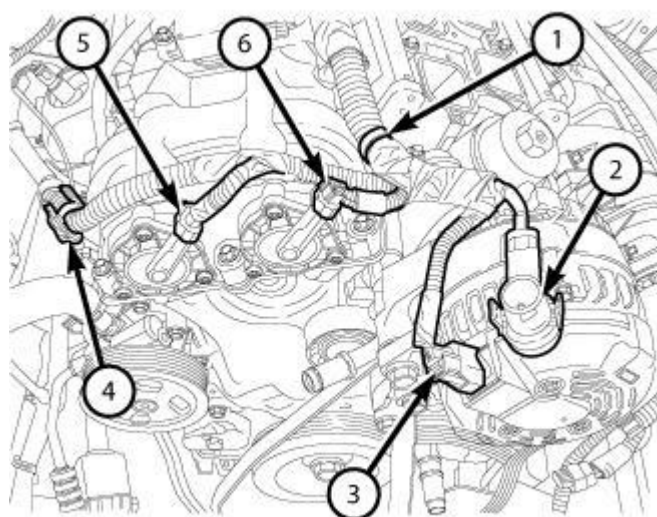
28. Connect the Engine Coolant Temperature (ECT) sensor connector (3).
29. Connect the left Camshaft Position (CMP) sensor (1).
30. Engage the main wire harness retainer (2) to the cylinder head cover mounting stud.



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**Fig. 55: Left Upstream Oxygen Sensor & Left Downstream Oxygen Sensor Electrical Connectors**  
Courtesy of CHRYSLER GROUP, LLC

31. Connect the left upstream oxygen sensor (1) and the left downstream oxygen sensor (2) electrical connectors.

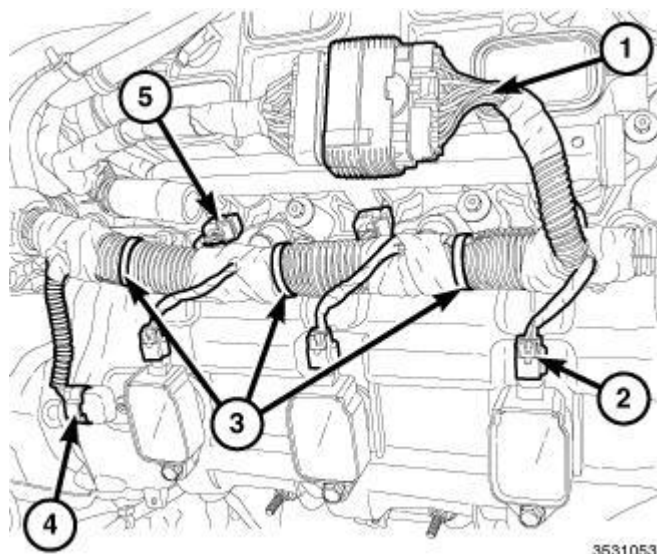


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**Fig. 56: Generator Stud, Connector, Retainers & Right Exhaust And Right Intake Variable Valve Timing Solenoid Electrical Connectors**  
Courtesy of CHRYSLER GROUP, LLC

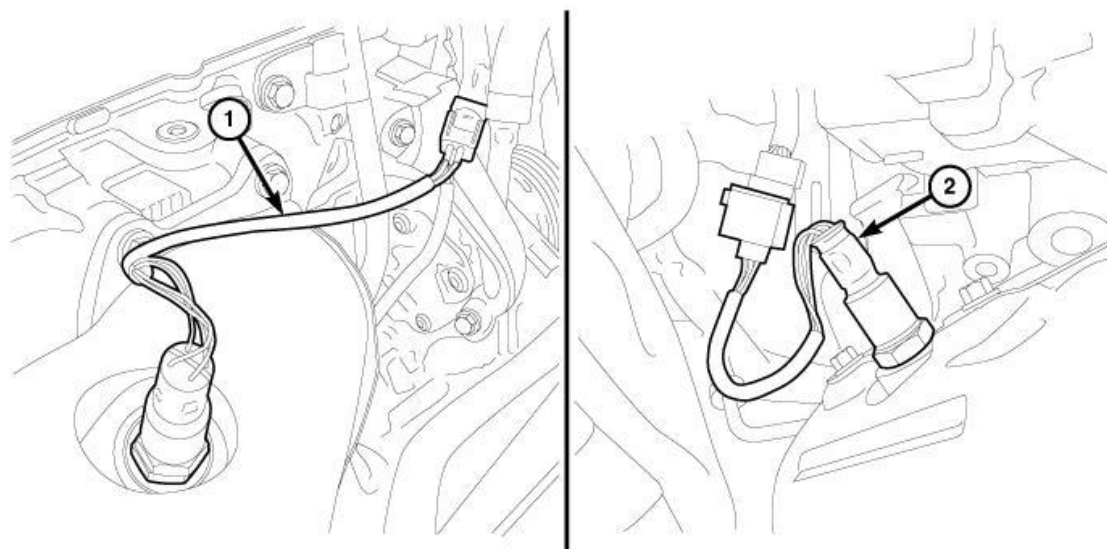
32. Route the main wire harness on the right side of the engine.

33. Install the B+ terminal to the generator stud (2) and tighten the nut to 11 N.m (97 In. lbs.).
34. Connect the field circuit connector (3) to the generator.
35. Connect the right exhaust variable valve timing solenoid electrical connector (5).
36. Connect the right intake variable valve timing solenoid electrical connector (6).
37. Engage the wire harness retainers (1 and 4) to the right cylinder head cover.



**Fig. 57: Engine Injection/Ignition Harness, Ignition Coil Electrical Connectors, Retainers, Camshaft Position (CMP) Sensor Connector & Fuel Injector Electrical Connectors**  
 Courtesy of CHRYSLER GROUP, LLC

38. Connect three fuel injector electrical connectors (5).
39. Connect three ignition coil electrical connectors (2).
40. Connect the electrical connector (4) to the right Camshaft Position (CMP) sensor.
41. Connect the main harness to the engine injection/ignition harness (1).
42. Engage three main wire harness retainers (3) to the right cylinder head cover.

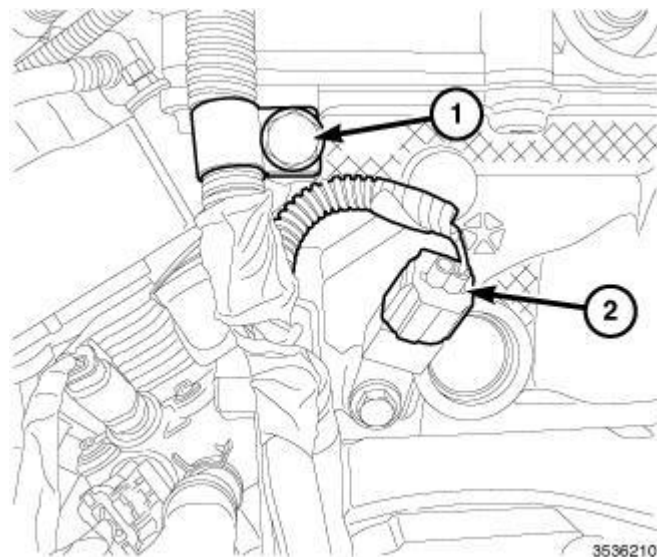


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**Fig. 58: Right Upstream Oxygen Sensor & Right Downstream Oxygen Sensor Electrical Connectors**

Courtesy of CHRYSLER GROUP, LLC

43. Connect the right upstream oxygen sensor (1) and the right downstream oxygen sensor (2) electrical connectors.



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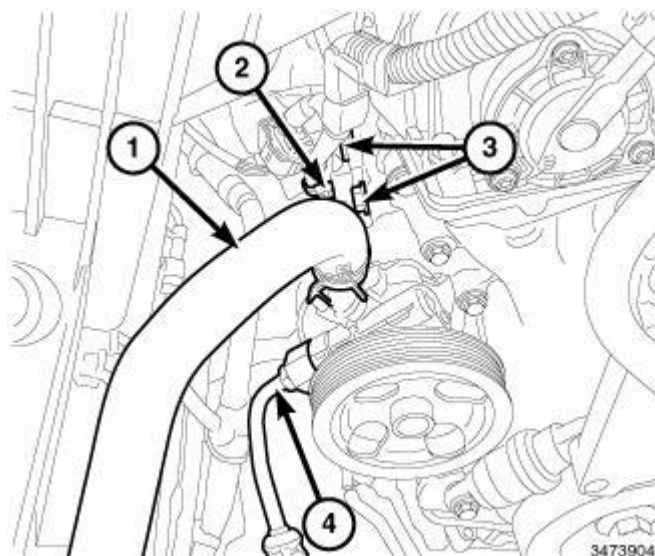
**Fig. 59: Ignition Coil Capacitor Electrical Connector & Bolt**

Courtesy of CHRYSLER GROUP, LLC

44. Secure the main wire harness retainer to the rear of the right cylinder head with the bolt (1) tightened to

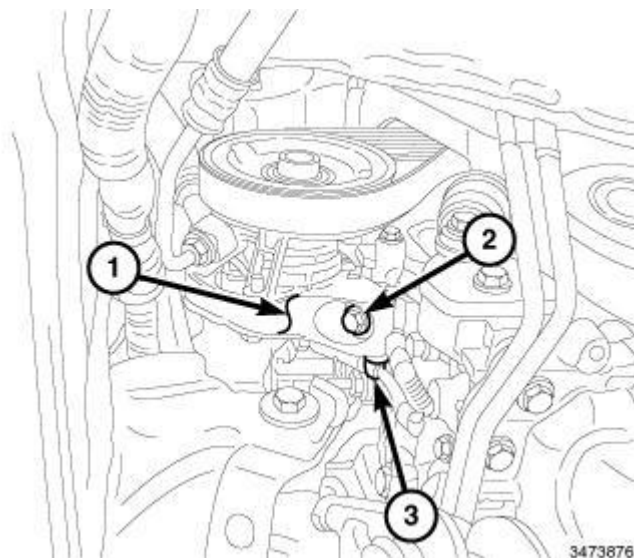
12 N.m (106 in. lbs.).

45. Connect the electrical connector (2) to the ignition coil capacitor.



**Fig. 60: Power Steering Return Hose, Supply Line, Retainer & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

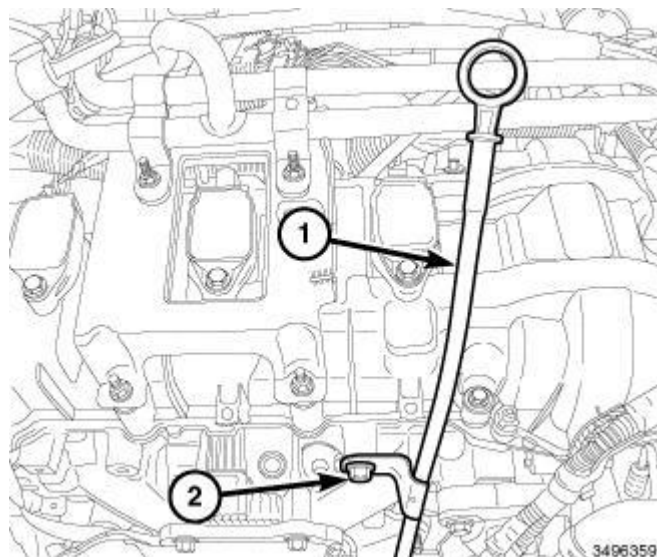
46. Position the power steering pump (with bracket) and install the upper power steering pump bracket retaining bolts (3). Do not tighten at this time.
47. Engage the wiring harness routing retainer (2) to the power steering pump bracket.



**Fig. 61: Power Steering Pump Bracket, Bolt & Retainer**  
Courtesy of CHRYSLER GROUP, LLC

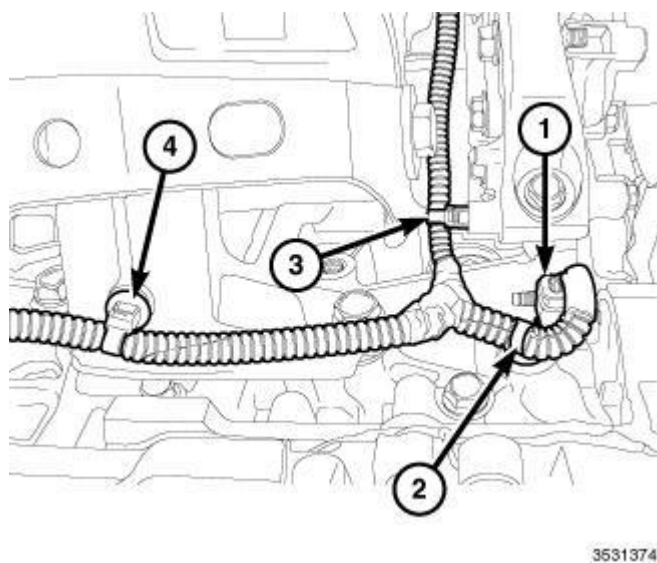
48. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
49. Engage the wiring harness routing retainer (3) to the power steering pump bracket (1).

50. Install the lower power steering pump retaining bolt (2) and tighten **all three** retaining bolts to 24 N.m (18 ft. lbs.).
51. Install the accessory drive belt. Refer to **BELT, SERPENTINE, INSTALLATION** .



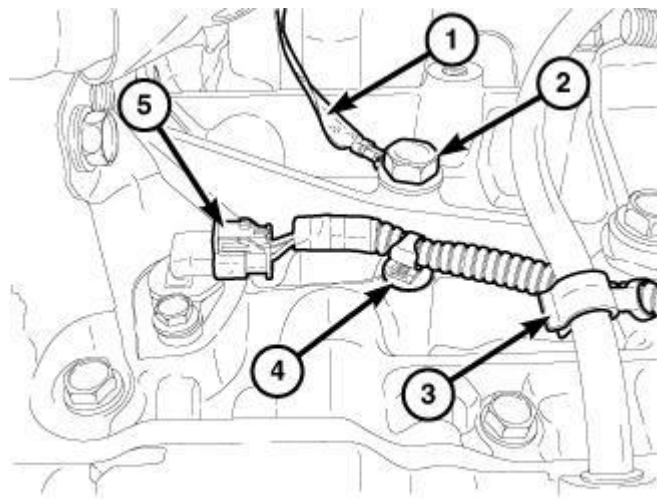
**Fig. 62: Oil Level Indicator & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

52. Install the oil level indicator (1) with the bolt (2) tightened to 12 N.m (106 in. lbs.).



**Fig. 63: Oil Pump Solenoid Electrical Connector & Wire Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC

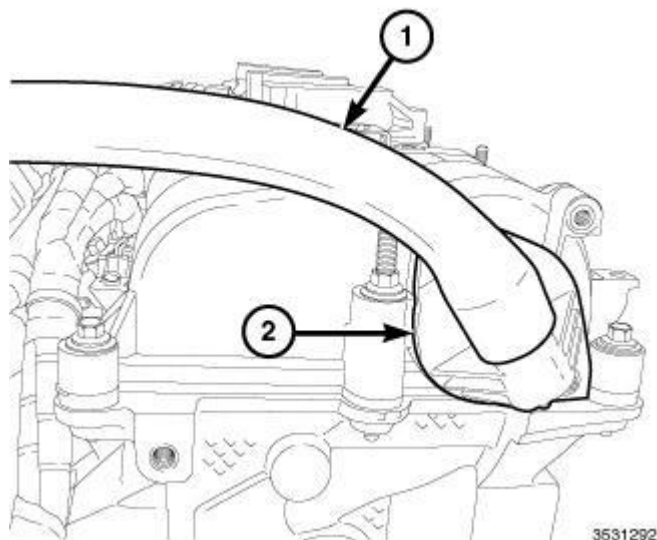
53. Connect the oil pump solenoid electrical connector (1).
54. Engage one wire harness retainer (2) to the engine block, one wire harness retainer (3) to the power steering pump mounting bracket and one wire harness retainer (4) to the right engine mount.



3531392

**Fig. 64: Ground Strap, Bolt, Retainers & Crankshaft Position (CKP) Sensor**  
Courtesy of CHRYSLER GROUP, LLC

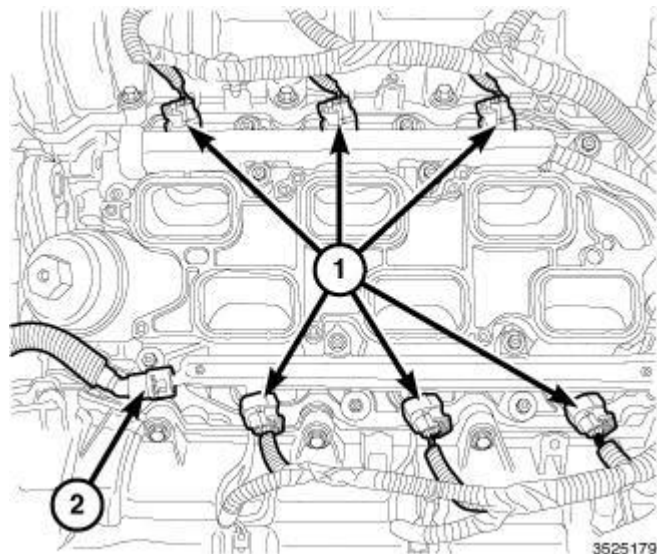
55. Install the ground strap (1) with bolt (2) tightened to 12 N.m (106 in. lbs.).
56. Connect the main wire harness to the Crankshaft Position (CKP) sensor (5).
57. Engage one main wire harness retainer (4) to the engine block and one main wire harness retainer (3) to the oil level indicator.



3531292

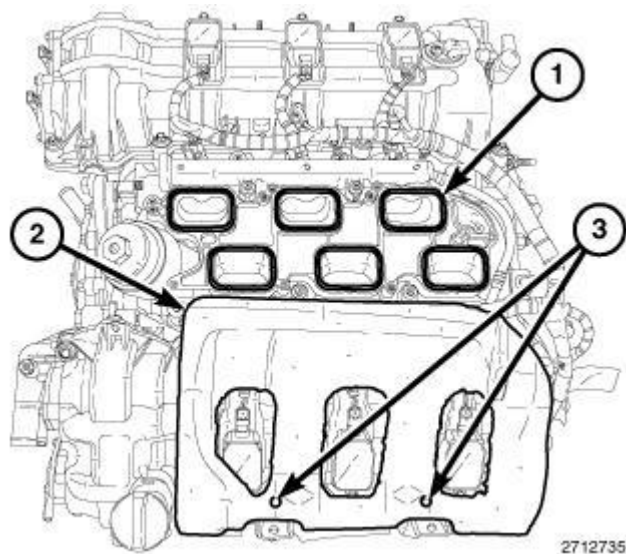
**Fig. 65: PCV Hose & Valve**  
Courtesy of CHRYSLER GROUP, LLC

58. Install the PCV hose (1) to the PCV valve (2).



**Fig. 66: Fuel Supply Line And Connectors**  
Courtesy of CHRYSLER GROUP, LLC

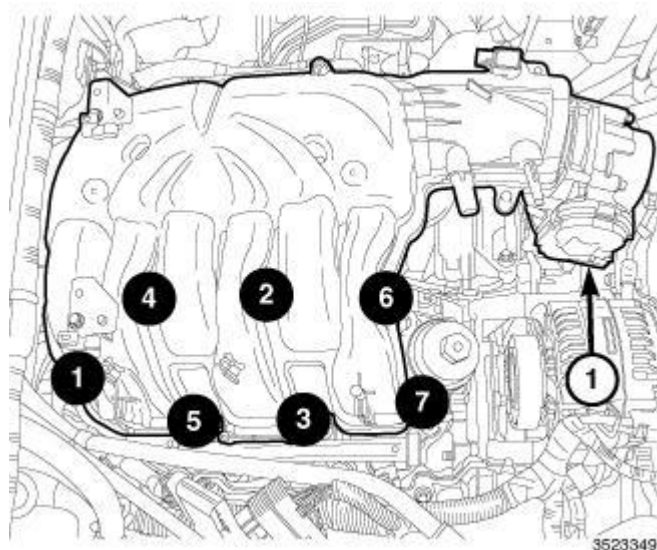
59. Connect the fuel supply hose (2) to the fuel rail. Refer to **FITTING, QUICK CONNECT** .



**Fig. 67: Intake Ports, Insulator & Alignment Posts**  
Courtesy of CHRYSLER GROUP, LLC

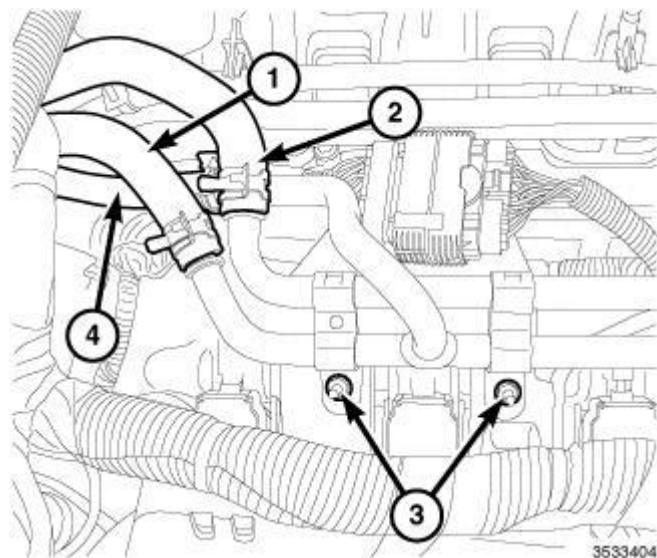
60. Install the insulator (2) to the two alignment posts (3) on top of the LH cylinder head cover.





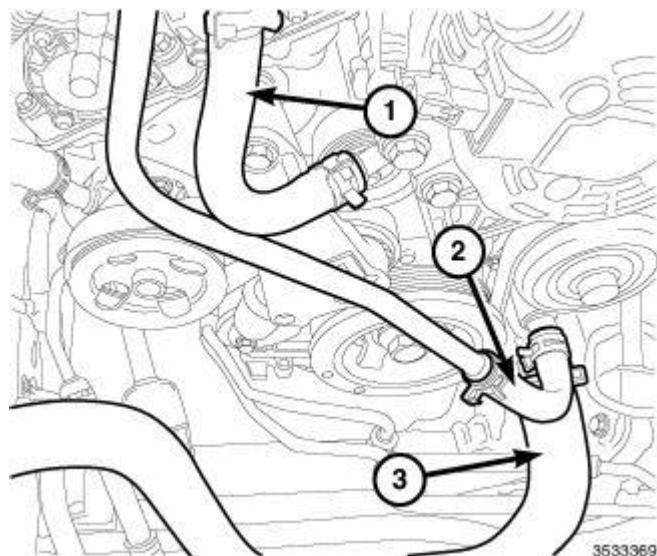
**Fig. 68: Upper Intake Manifold Tightening Sequence**  
Courtesy of CHRYSLER GROUP, LLC

61. Install the upper intake manifold and insulator. Refer to MANIFOLD, INTAKE, INSTALLATION.



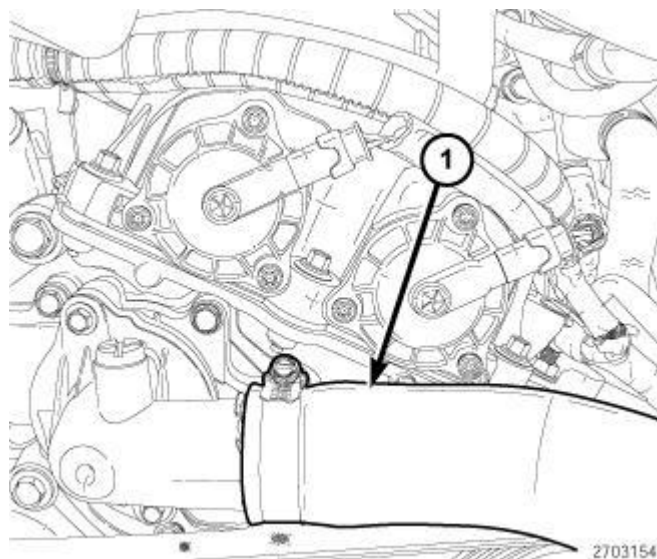
**Fig. 69: Heater Core Return Hose, Heater Core Supply Hose, Nuts & Oil Cooler Return Hose**  
Courtesy of CHRYSLER GROUP, LLC

62. Position the heater core tube assembly and install the heater core supply hose (2), heater core return hose (1) and oil cooler return hose (4).
63. Secure the heater core tube assembly to the right upper intake manifold support bracket with two nuts (3) tightened to 12 N.m (106 in. lbs.).



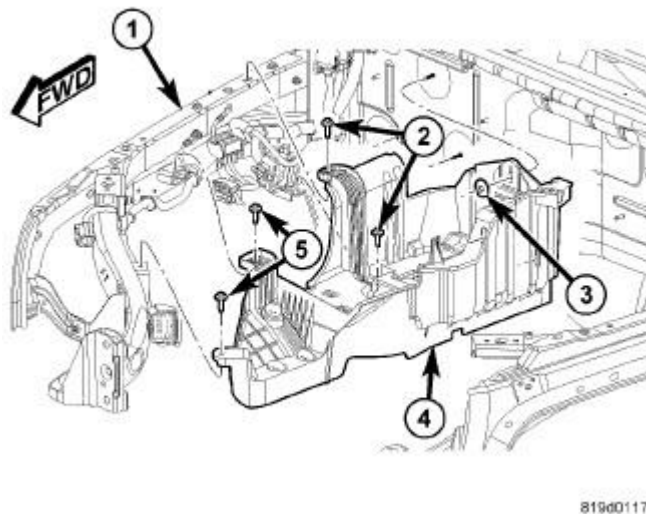
**Fig. 70: Heater Core Supply Hose, Heater Core Return Hose & Lower Radiator Hose**  
Courtesy of CHRYSLER GROUP, LLC

- 64. Connect the heater core supply hose (1) to the heater core tube assembly.
- 65. Connect the heater core return hose (2) to the heater core tube assembly.
- 66. Install the lower radiator hose (3) to the engine coolant pump housing.



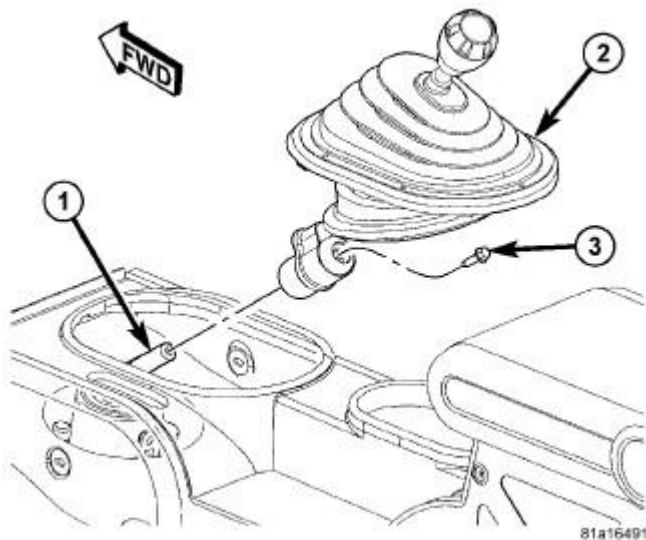
**Fig. 71: Upper Radiator Hose**  
Courtesy of CHRYSLER GROUP, LLC

- 67. Install the upper radiator hose (1) to the engine thermostat housing.



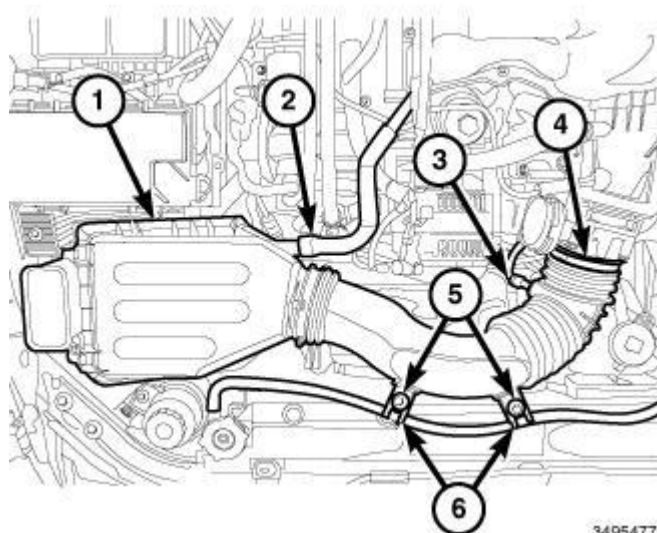
**Fig. 72: Battery Tray Components**  
Courtesy of CHRYSLER GROUP, LLC

68. Install the battery tray (4), Totally Integrated Power Module (TIPM) and battery. Refer to **TRAY, BATTERY, INSTALLATION**.
69. Install the front wheelhouse inner splash shields. Refer to **SHIELD, SPLASH, WHEELHOUSE, INSTALLATION**.



**Fig. 73: Shifter Shaft, Boots & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

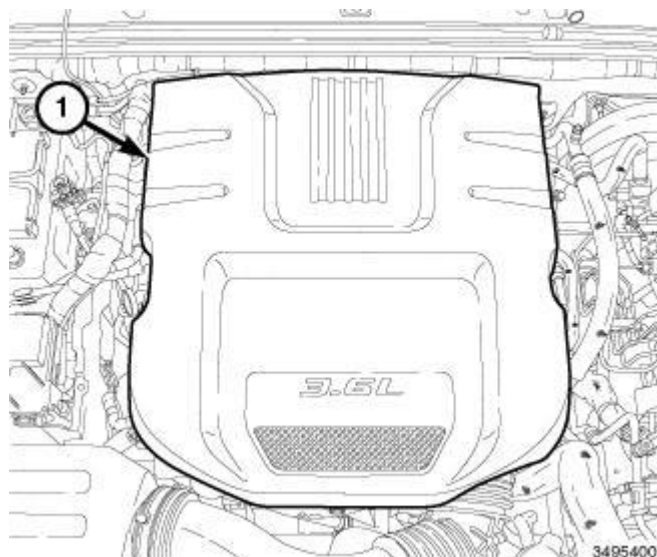
70. If equipped with a manual transmission, install the shift lever (2). Refer to **LEVER, SHIFT, INSTALLATION**.



**Fig. 74: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

Courtesy of CHRYSLER GROUP, LLC

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



**Fig. 75: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

72. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
73. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
74. Install the engine cover (1).
75. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
76. 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.

## SPECIAL TOOLS

### SPECIAL TOOLS

10198 - Holder, Vibration Damper  
(Originally Shipped In Kit Number(s) 10223.)  
10199 - Installer, Crankshaft Front Oil Seal  
(Originally Shipped In Kit Number(s) 10223.)  
10200-1 - Holder, Timing Chain, Left Side  
10200-3 - Pin  
10202 - Locks, Camshaft/Phaser  
10202-1 - Lock, Camshaft/Phaser, Right Side  
10202-2 - Lock, Camshaft/Phaser, Left Side  
10224 - Adapter, Valve Spring  
(Originally Shipped In Kit Number(s) 10223.)  
10242-1 - Brackets, Engine Lifting, Left Side  
(Originally Shipped In Kit Number(s) 10223.)  
10242-2 - Brackets, Engine Lifting, Right Side  
(Originally Shipped In Kit Number(s) 10223.)  
10255 - Installer, Spark Plug Tube  
10256 - Installer, Cam Installer, Cam Sensor/ Spark Plug Tube Seal  
(Originally Shipped In Kit Number(s) 10256.)  
10368 - Set, Universal Protective Cap  
10369 - Holder, Timing Chain  
7700-A - Tester, Cooling System  
8189 - Guide Pins  
(Originally Shipped In Kit Number(s) 8180, 8180CC, 8263, 8263CC.)  
8511 - Remover, Seal  
(Originally Shipped In Kit Number(s) 8283, 8283CC, 8527, 8527CC, 8575, 8575CC, 9975.)  
8514 - Pins, Tensioner  
(Originally Shipped In Kit Number(s) 8283, 8283CC, 8527, 8527CC, 8575, 8575CC, 9975.)  
8534B - Fixture, Driveline Support  
(Originally Shipped In Kit Number(s) 8534, 8534B, 8849, 9565.)  
C-119 - Cylinder Indicator  
C-3292A - Gauge, Pressure  
C-3339A - Set, Dial Indicator  
(Originally Shipped In Kit Number(s) 9202.)  
C-3422-D - Compressor, Valve Spring

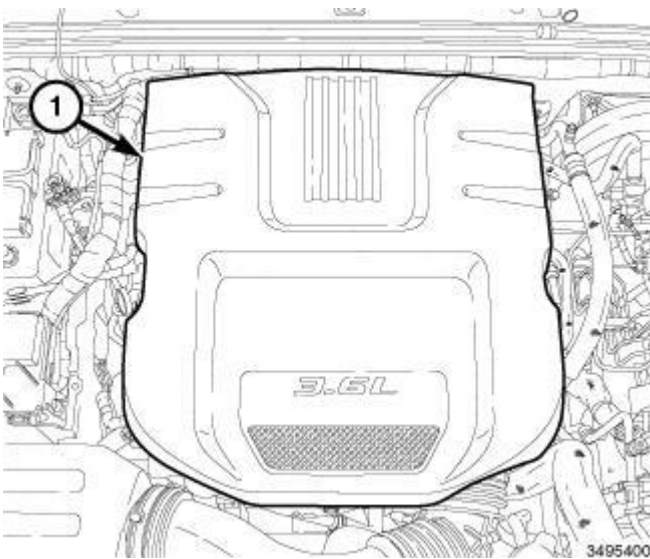
C-3685-A - Bloc-Chek Kit  
C-385 - Compressor, Piston  
MD998772A - Compressor, Valve Spring  
(Originally Shipped In Kit Number(s) 8678, 8853, 8854.)

## AIR INTAKE SYSTEM

### AIR CLEANER

#### REMOVAL

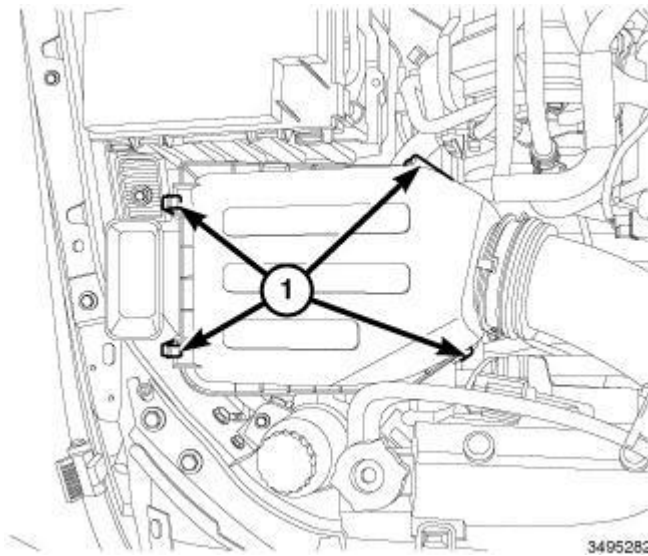
#### REMOVAL



**Fig. 76: Engine Cover**

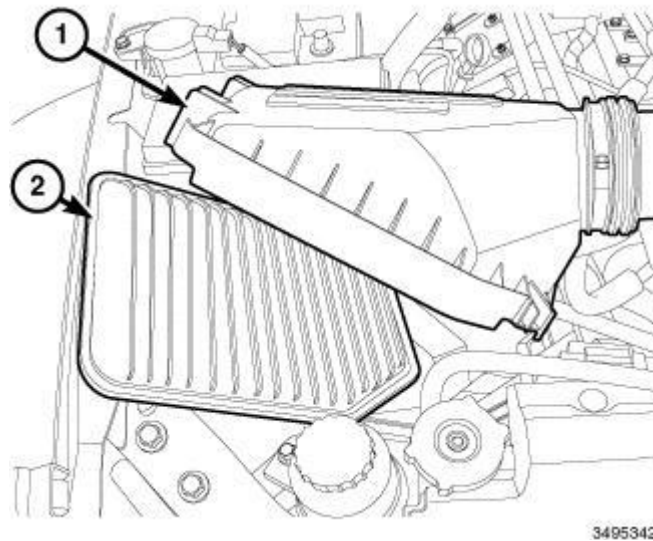
Courtesy of CHRYSLER GROUP, LLC

1. Remove the engine cover (1).



**Fig. 77: Air Cleaner Housing Cover Latches**  
Courtesy of CHRYSLER GROUP, LLC

2. Release the four air cleaner housing cover latches (1).



**Fig. 78: Air Cleaner Housing Cover & Air Cleaner Element**  
Courtesy of CHRYSLER GROUP, LLC

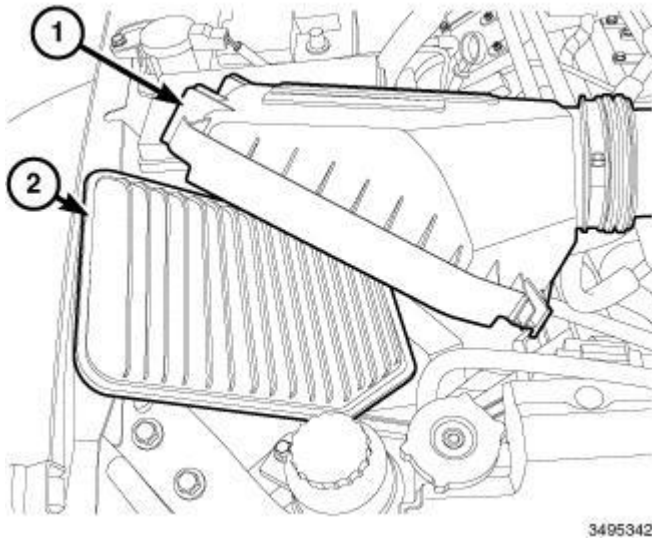
3. Lift the cover (1) and remove the air cleaner element (2).

**CAUTION:** Do not use compressed air to clean out the air cleaner housing without first covering the air inlet to the throttle body. Dirt or foreign objects could enter the intake manifold causing engine damage.

4. Remove any dirt or debris from the bottom of the air cleaner housing.

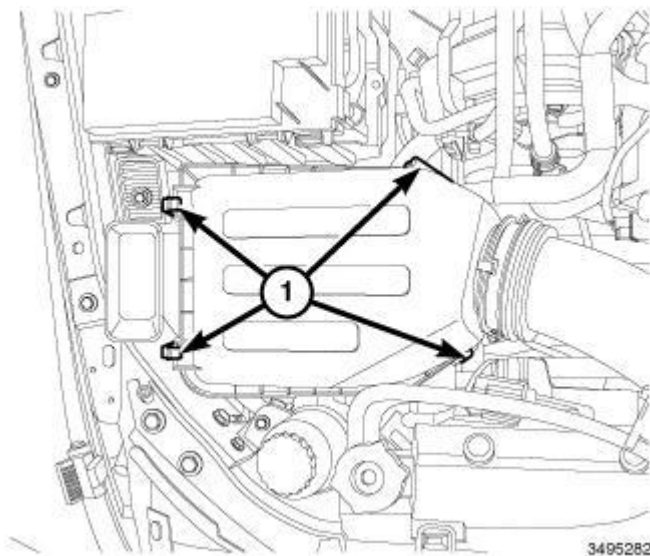
## INSTALLATION

### INSTALLATION



**Fig. 79: Air Cleaner Housing Cover & Air Cleaner Element**  
 Courtesy of CHRYSLER GROUP, LLC

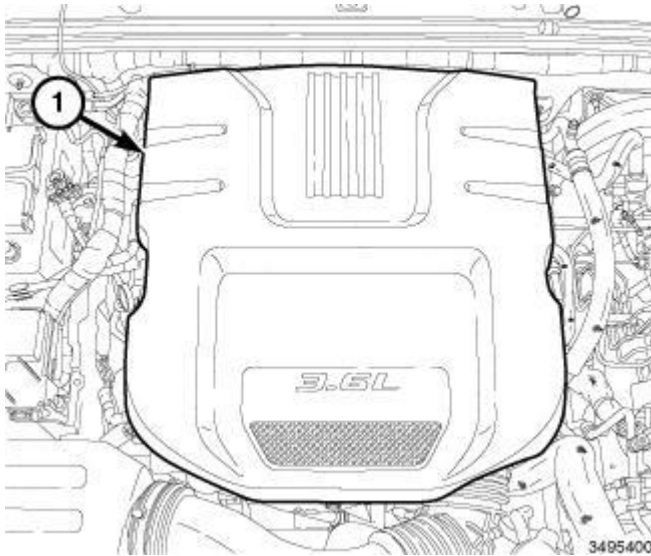
1. Install the air cleaner element (2) into the air cleaner housing.



**Fig. 80: Air Cleaner Housing Cover Latches**  
 Courtesy of CHRYSLER GROUP, LLC

2. Seat the cover onto the housing and secure the four housing cover latches (1).





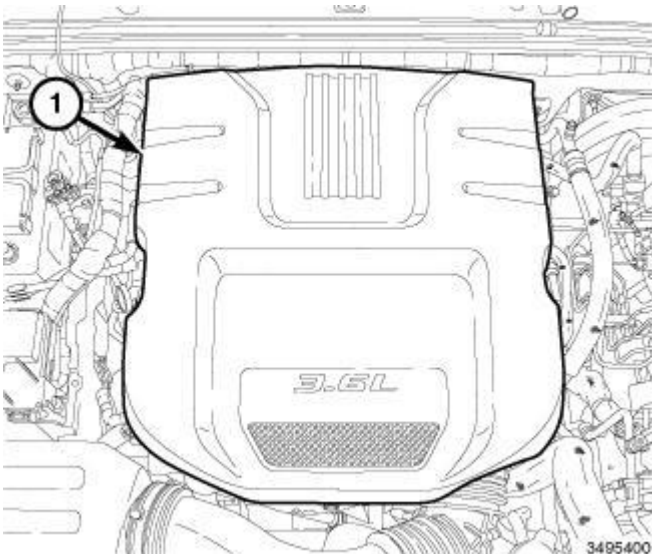
**Fig. 81: Engine Cover**  
Courtesy of CHRYSLER GROUP, LLC

3. Install the engine cover (1).

## **BODY, AIR CLEANER**

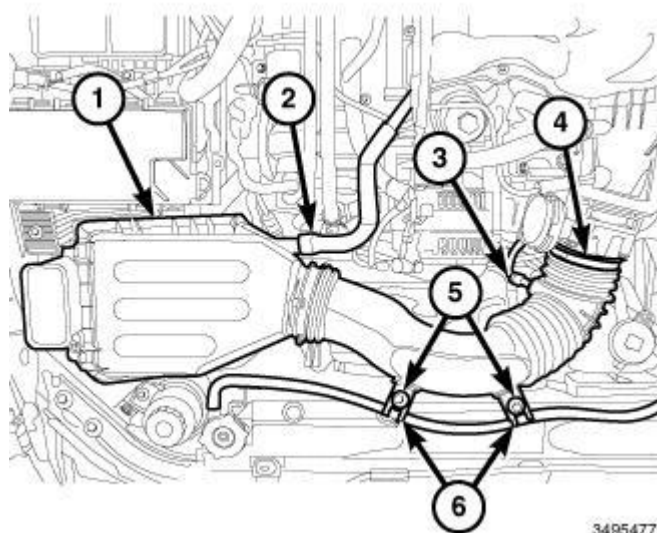
### **REMOVAL**

### **REMOVAL**



**Fig. 82: Engine Cover**  
Courtesy of CHRYSLER GROUP, LLC

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



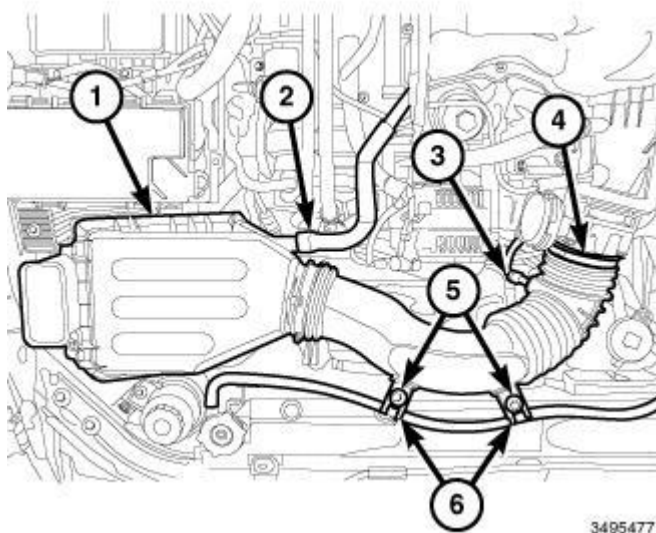
**Fig. 83: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

Courtesy of CHRYSLER GROUP, LLC

3. Disconnect the electrical connector (3) from the Inlet Air Temperature (IAT) sensor.
4. Loosen the clamp (4) at the throttle body.
5. Disconnect the fresh air makeup hose (2) from the air cleaner body.
6. Disengage the coolant hose from the two retainers (6).
7. Remove the two bolts (5) from the air inlet hose.
8. Disengage the air inlet hose from the throttle body and pull the air cleaner body (1) straight up off of the three locating pins.

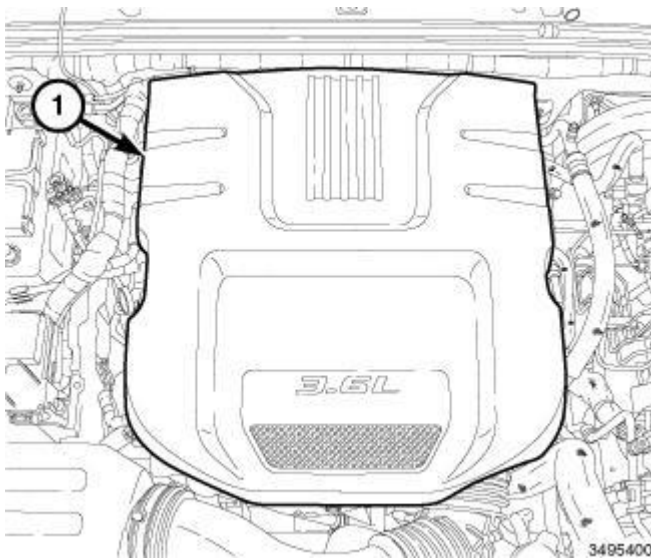
## INSTALLATION

## INSTALLATION



**Fig. 84: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**  
Courtesy of CHRYSLER GROUP, LLC

1. Install the air cleaner body (1) straight down on the three locating pins while engaging the air inlet hose to the throttle body.
2. Install the two bolts (5) to the air inlet hose and tighten to 12 N.m (106 in. lbs.).
3. Engage the coolant hose to the two retainers (6).
4. Install the fresh air makeup hose (2) to the air cleaner body.
5. Tighten the clamp (4) at the throttle body to 4 N.m (35 in. lbs.).
6. Connect the electrical connector (3) to the Inlet Air Temperature (IAT) sensor.



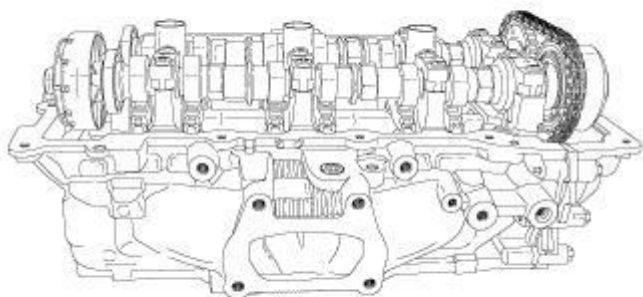
**Fig. 85: Engine Cover**  
Courtesy of CHRYSLER GROUP, LLC

7. Install the engine cover (1).
8. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

## CYLINDER HEAD

### DESCRIPTION

### DESCRIPTION



2793404

**Fig. 86: Aluminum Cylinder Head**

Courtesy of CHRYSLER GROUP, LLC

The 3.6L aluminum cylinder heads are a unique design with left and right castings. The exhaust manifolds are integrated into the cylinder heads. The cylinder head features four valves per cylinder with pressed in powdered metal valve guides. The valve guides are not serviceable. The DOHC valvetrain uses roller rocker arms with hydraulic lifters. The cylinder head's camshaft bearing caps are made of powdered metal and the location and direction of each cap is marked on the side of the caps. The spark plug tubes are pressed into the cylinder heads and sealed in place. The tubes are a thin wall design and caution must be taken when working in the spark plug tube area.

## 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.

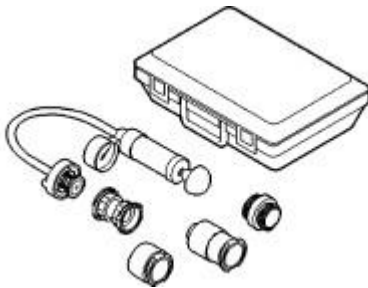
**CYLINDER-TO-WATER JACKET LEAKAGE TEST**

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

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

Install Cooling System Tester (special tool #7700-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. 88: Bloc-Chek-Kit - C-3685-A**

Courtesy of CHRYSLER GROUP, LLC

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

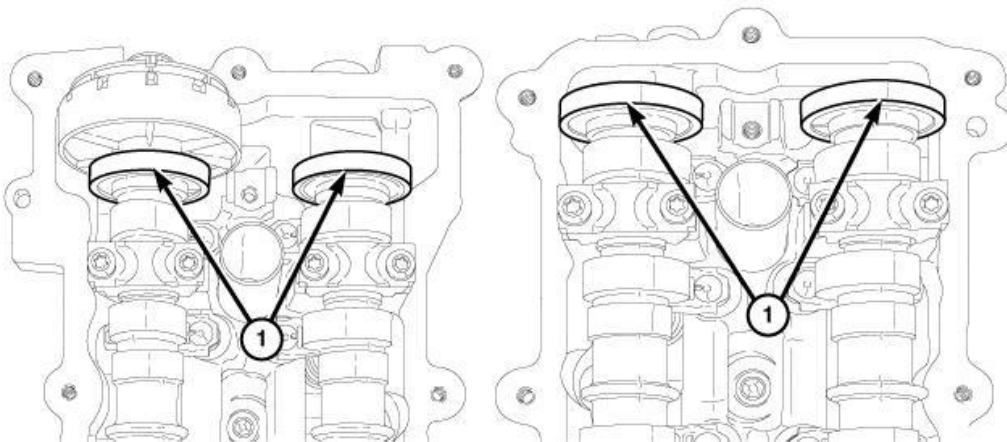
### HYDRAULIC LASH ADJUSTER

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 cylinder head. Low speed running up to 1 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 passage in cylinder head gasket 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 cylinder head.
11. Faulty lash adjuster.
  - a. Check lash adjusters for "sponginess" while installed in cylinder head and cam on camshaft at base circle. Depress part of rocker arm over adjuster. Normal adjusters should feel firm when pressed quickly. When pressed very slowly, lash adjusters should collapse.
  - b. Remove suspected lash adjusters, and replace.
  - c. Before installation, make sure adjusters are full of oil. This can be verified by little plunger travel when lash adjuster is depressed quickly.

### REMOVAL

#### LEFT

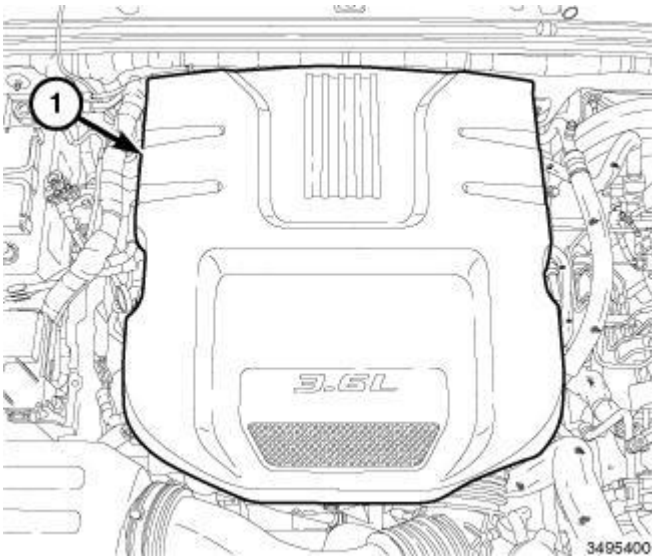


2715130

**Fig. 89: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.

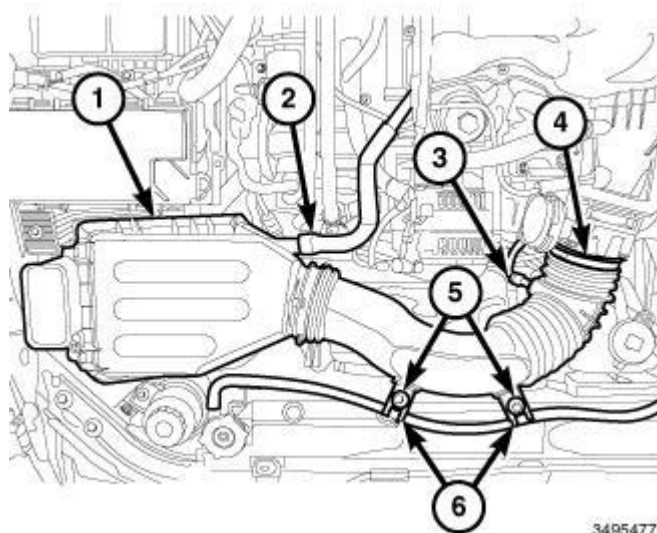


3495400

**Fig. 90: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

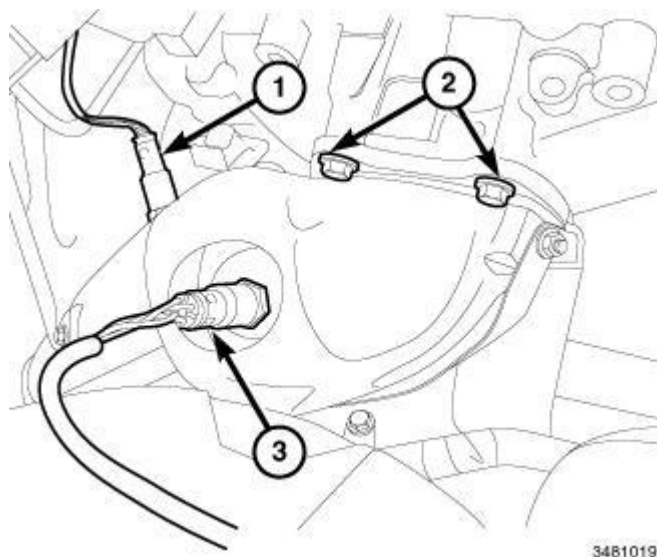
1. Perform the fuel pressure release procedure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Remove the engine cover (1).



**Fig. 91: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

Courtesy of CHRYSLER GROUP, LLC

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



**Fig. 92: Right And Left Upstream And Downstream Oxygen Sensor Connectors & Bolts**

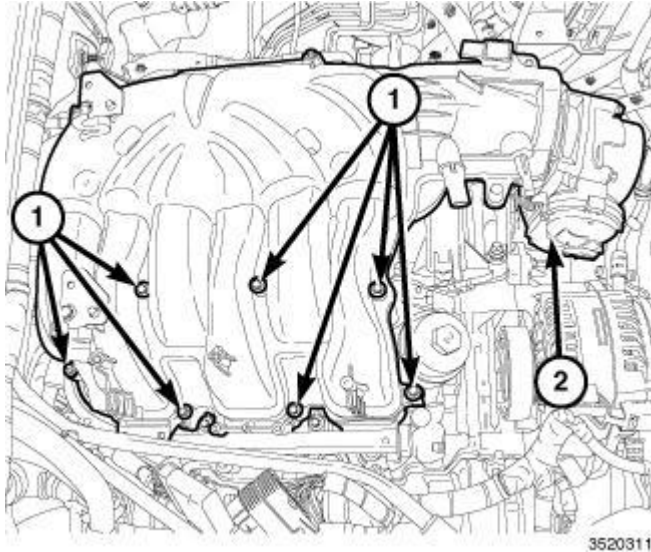
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Right catalytic converter shown in illustration, left catalytic converter similar.

5. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
6. Drain the cooling system. Refer to **STANDARD PROCEDURE**.
7. Drain the engine oil. Refer to **Engine/Lubrication/OIL - Standard Procedure**.

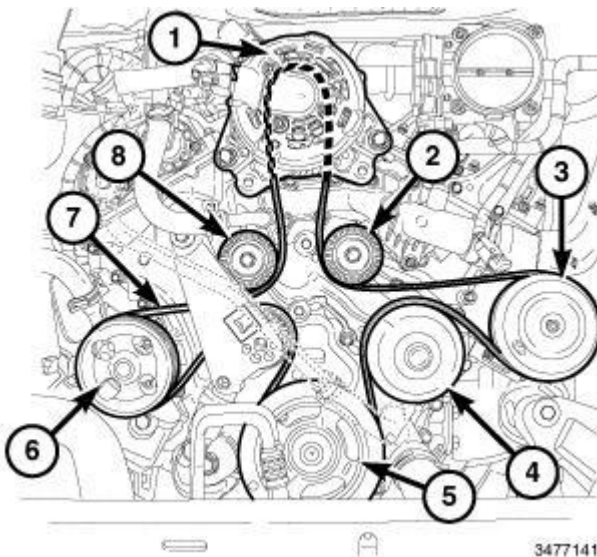


8. Disconnect the left upstream (3) and downstream (1) oxygen sensor connectors from the main wire harness.
9. Remove the left catalytic converter. Refer to **CONVERTER, CATALYTIC, REMOVAL**.



**Fig. 93: Upper Intake Manifold & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

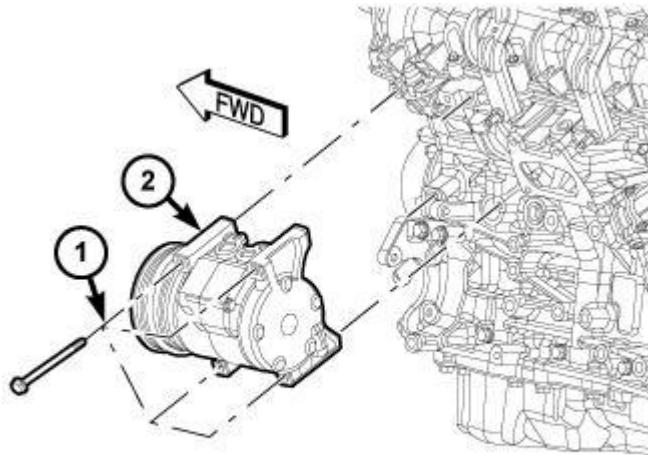
10. Lower the vehicle.
11. Remove the upper and lower intake manifolds (2) and insulator. Refer to **MANIFOLD, INTAKE, REMOVAL**.



**Fig. 94: Drive Belt Tensioners & Assembly With Drive Belt Routing**  
Courtesy of CHRYSLER GROUP, LLC

12. Remove the right and left cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.

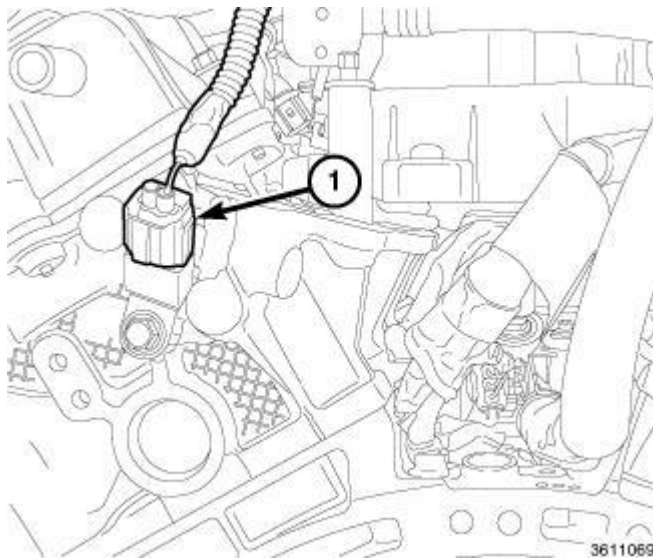
13. Remove the accessory drive belt (7). Refer to **BELT, SERPENTINE, REMOVAL** .



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**Fig. 95: A/C Compressor & Mounting Bolts**  
Courtesy of CHRYSLER GROUP, LLC

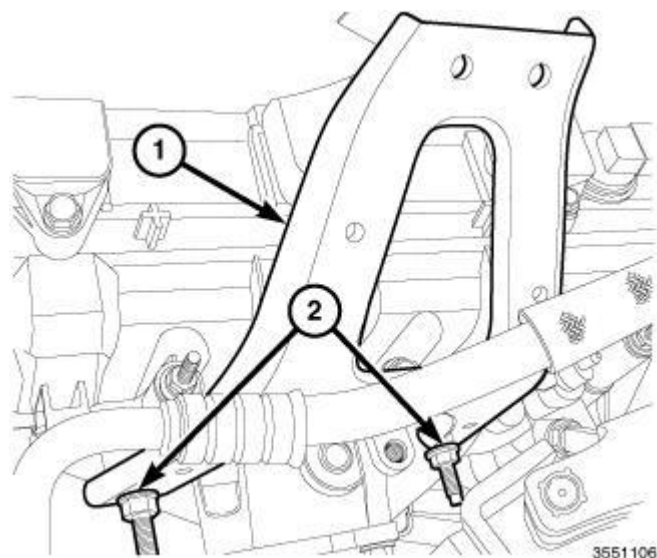
14. Remove the four bolts (1) and reposition the A/C compressor (2).



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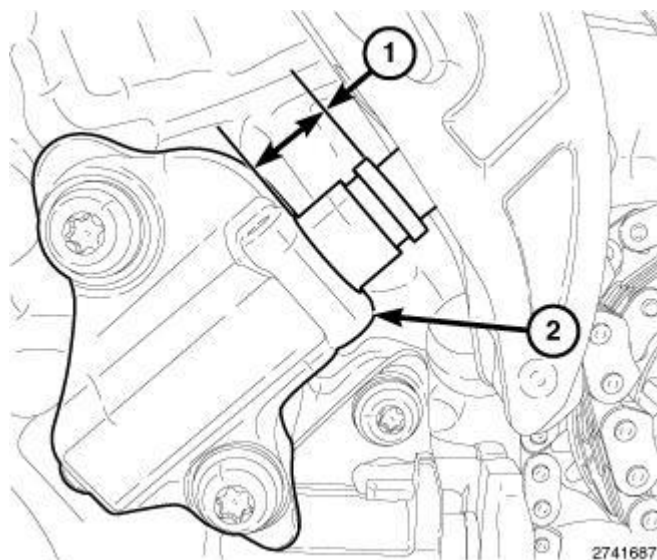
**Fig. 96: Ignition Coil Capacitor Electrical Connector**  
Courtesy of CHRYSLER GROUP, LLC

15. Disconnect the ignition coil capacitor electrical connector (1).



**Fig. 97: Left Rear Upper Intake Manifold Support Bracket & Studbolts**  
Courtesy of CHRYSLER GROUP, LLC

16. Remove the two studbolts (3) and remove the left rear upper intake manifold support bracket (1).

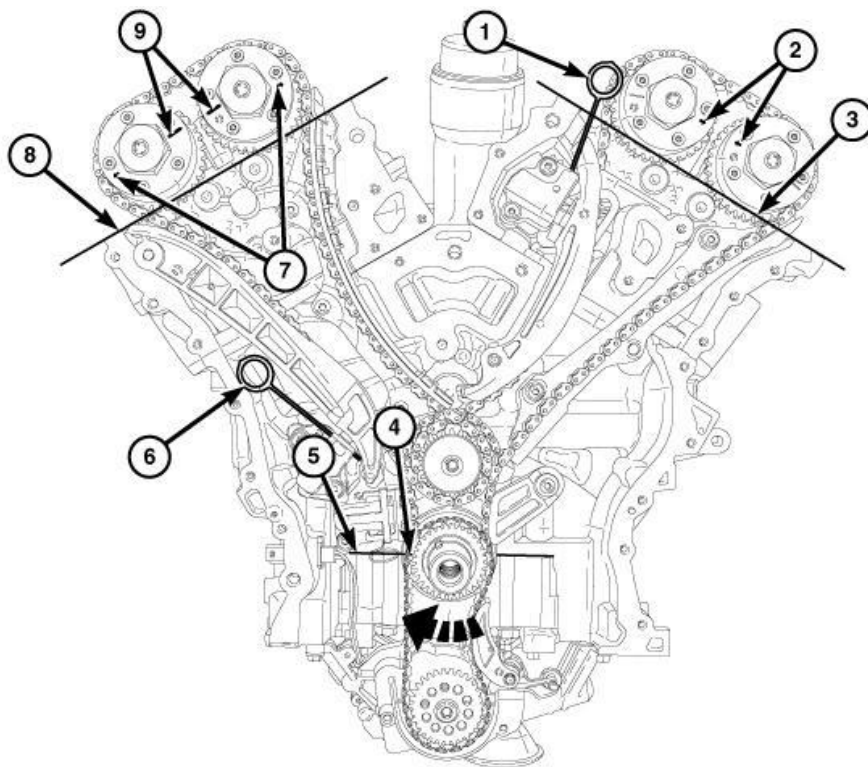


**Fig. 98: Piston Extension & RH Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

17. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL**.
18. Remove the upper oil pan, crankshaft vibration damper and engine timing cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.

**NOTE:** Take this opportunity to measure timing chain wear. Refer to **Engine/Valve Timing - Standard Procedure**.

19. Lower the vehicle.



2661245

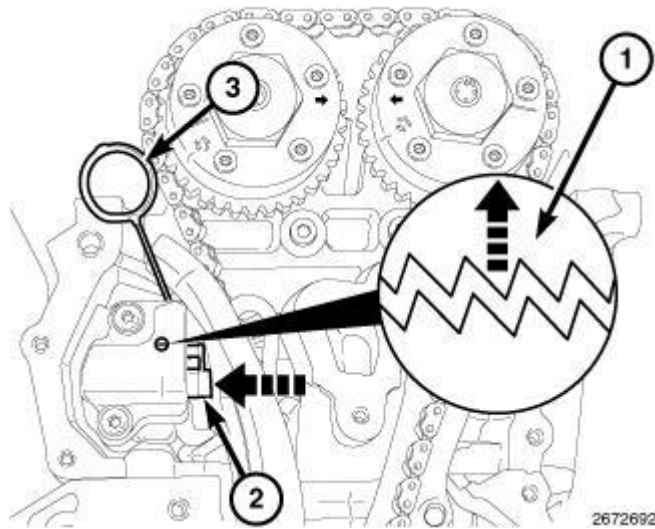
**Fig. 99: Rotating Crankshaft Clockwise To Position No. 1 Piston At TDC On Exhaust Stroke**  
Courtesy of CHRYSLER GROUP, LLC

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

20. Rotate the crankshaft CW to place the number one piston at TDC on the exhaust stroke by aligning the dimple (4) on the crankshaft with the block/bearing cap junction (5). The left side cam phaser arrows (2) should point toward each other and be parallel to the valve cover sealing surface (3). The right side cam phaser arrows (7) should point away from each other and the scribe lines (9) should be parallel to the valve cover sealing surface (8).

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

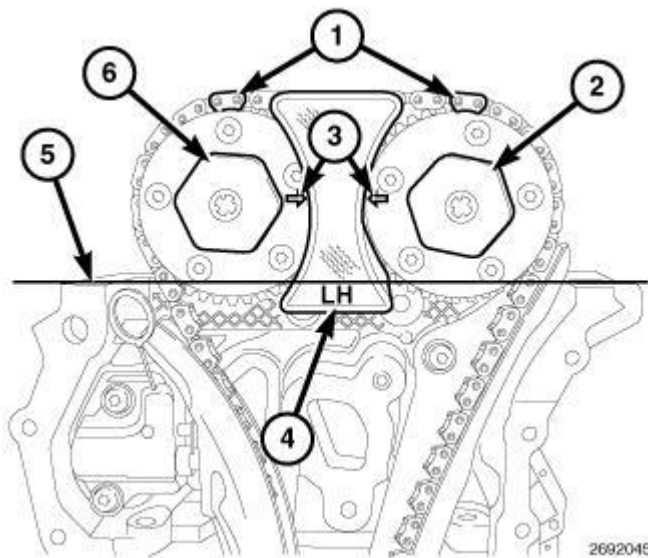
21. Mark the direction of rotation on the timing chain using a paint pen or equivalent to aid in reassembly.



**Fig. 100: Resetting Left Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

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

22. Reset the LH cam chain tensioner by lifting the pawl (1), pushing back the piston (2) and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (3). Refer to **Engine/Valve Timing - Standard Procedure**.

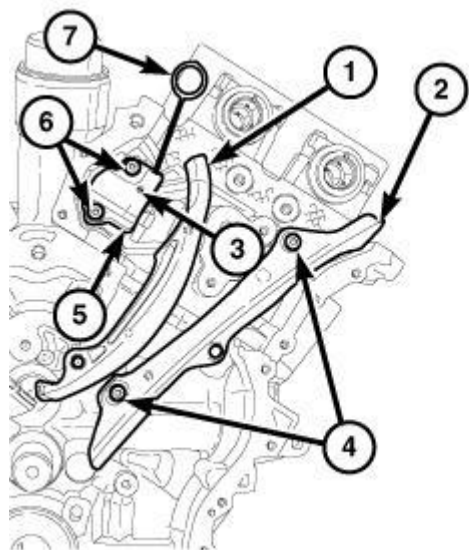


**Fig. 101: Phaser Timing Marks, Oil Control Valves & LH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the

**camshaft phaser lock.**

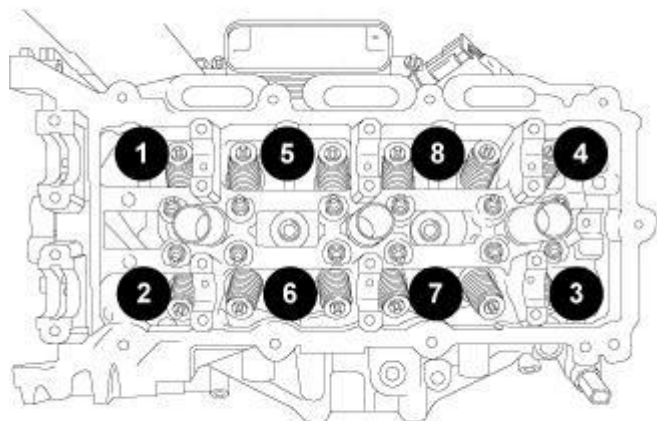
23. Install the LH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) (4).
24. Loosen both the intake oil control valve (6) and exhaust oil control valve (2).
25. Remove the LH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) (4).
26. Remove the oil control valve (2) from the left side exhaust cam phaser and pull the phaser off of the camshaft.
27. Remove the oil control valve (6) from the left side intake cam phaser and pull the phaser off of the camshaft.



2659731

**Fig. 102: Left Cam Chain Tensioner, Arm, Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

28. Remove the LH cam chain tensioner arm (1).
29. Remove two T30 bolts (6) and the LH cam chain tensioner (5).
30. Remove two T30 bolts (4) and the LH cam chain guide (2).



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**Fig. 103: Cylinder Head Retaining Bolt Removal Sequence - Left**  
Courtesy of CHRYSLER GROUP, LLC

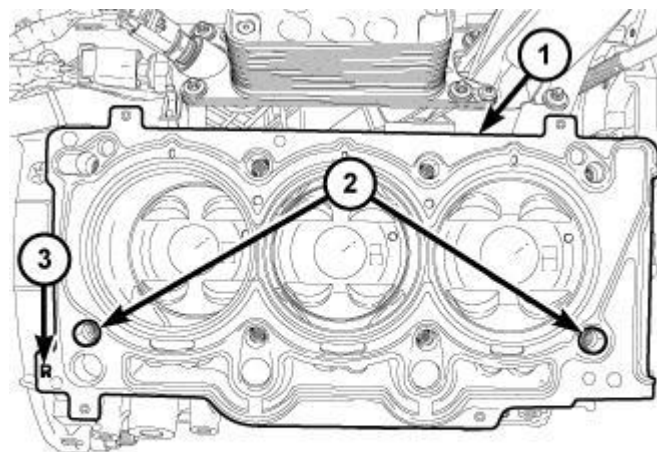
31. Remove the left camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL.

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

32. Remove the rocker arms. 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.

33. If required, remove the hydraulic lifters. Refer to LIFTER(S), HYDRAULIC, REMOVAL.  
34. Using the sequence shown in illustration, remove the cylinder head retaining bolts.



2800384

**Fig. 104: Head Gasket & Locating Dowels**

Courtesy of CHRYSLER GROUP, LLC

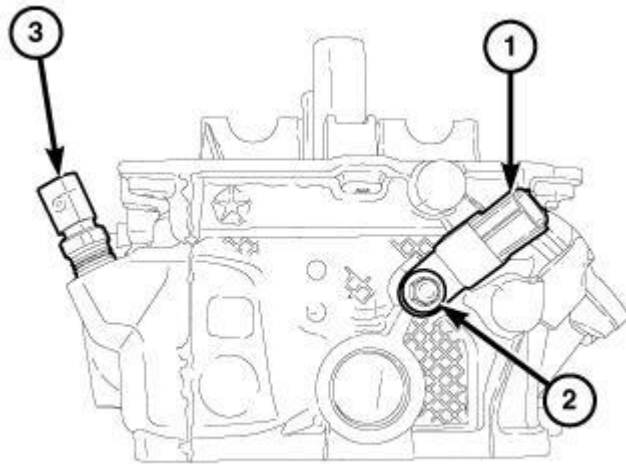
**NOTE:** Right head gasket shown in illustration, left head gasket similar.

**WARNING:** The multi-layered steel head gaskets have very sharp edges that could cause personal injury if not handled carefully.

**NOTE:** The head gasket (1) crimps the locating dowels (2) and the dowels may pull out of the engine block when the head gasket is removed.

35. Remove the cylinder head and gasket (1). Discard the gasket.

**CAUTION:** Do not lay the cylinder head on its gasket sealing surface, due to the design of the cylinder head gasket, any distortion to the cylinder head sealing surface may prevent the gasket from properly sealing resulting in leaks.



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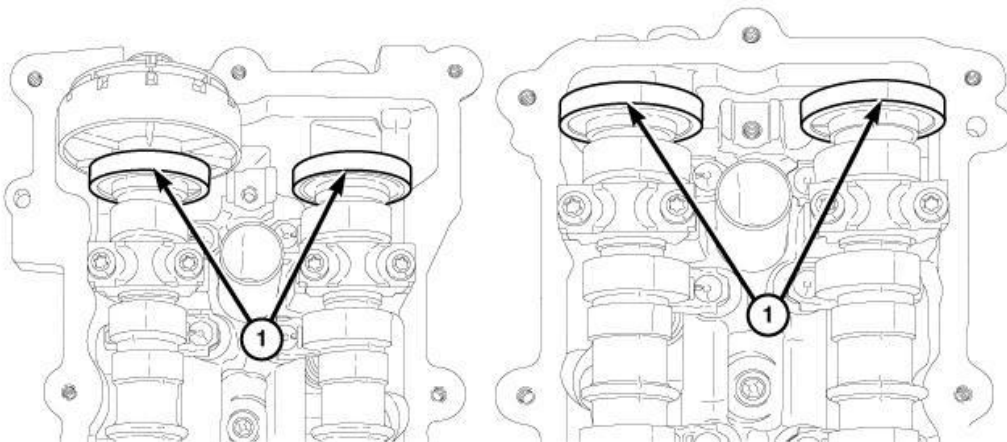
**Fig. 105: Ignition Coil Capacitor, Bolt & Engine Coolant Temperature (ECT) Sensor**

Courtesy of CHRYSLER GROUP, LLC

36. If required, remove the Engine Coolant Temperature (ECT) sensor (3).  
37. If required, remove the bolt (2) and the ignition coil capacitor (1).

**RIGHT**

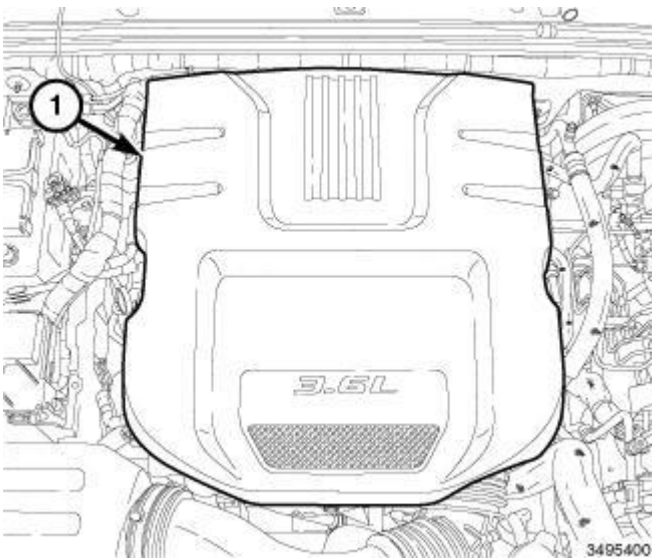




**Fig. 106: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

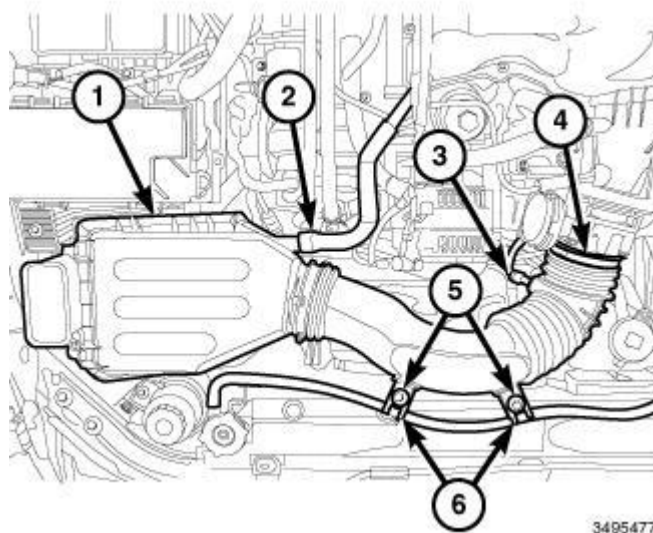
**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



**Fig. 107: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

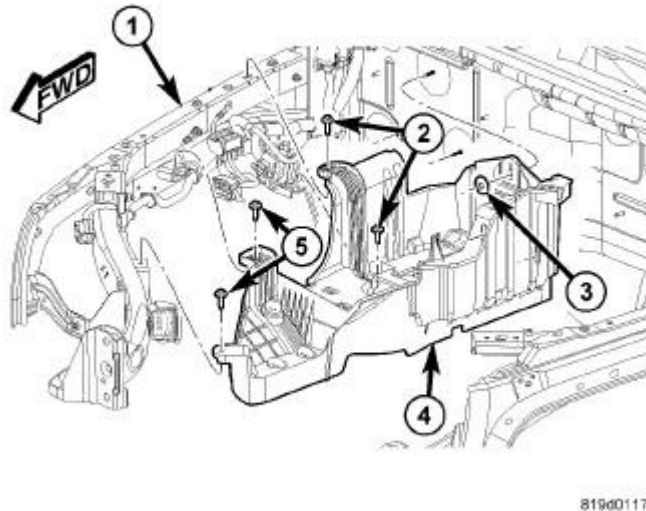
1. Perform the fuel pressure release procedure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Remove the engine cover (1).



**Fig. 108: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

Courtesy of CHRYSLER GROUP, LLC

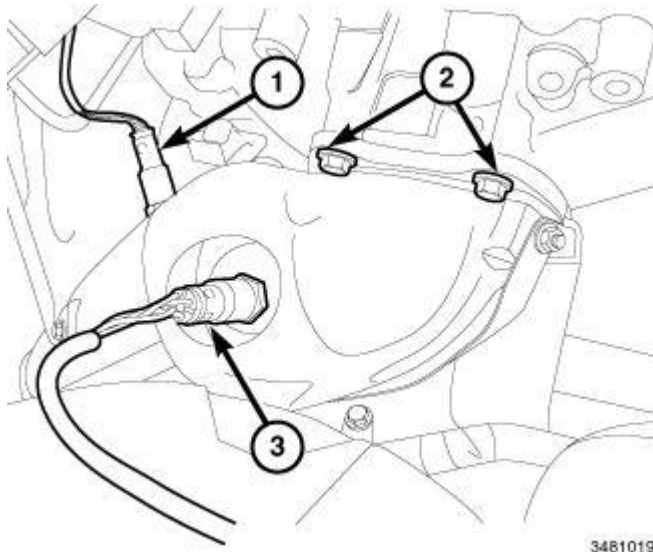
4. Remove the air cleaner body (1). Refer to **BODY, AIR CLEANER, REMOVAL**.



**Fig. 109: Battery Tray Components**

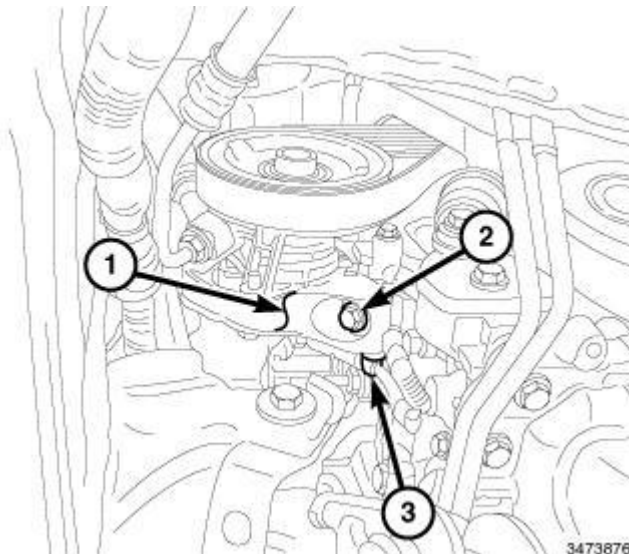
Courtesy of CHRYSLER GROUP, LLC

5. Remove the battery, Totally Integrated Power Module (TIPM) and battery tray (4). Refer to **TRAY, BATTERY, REMOVAL**.



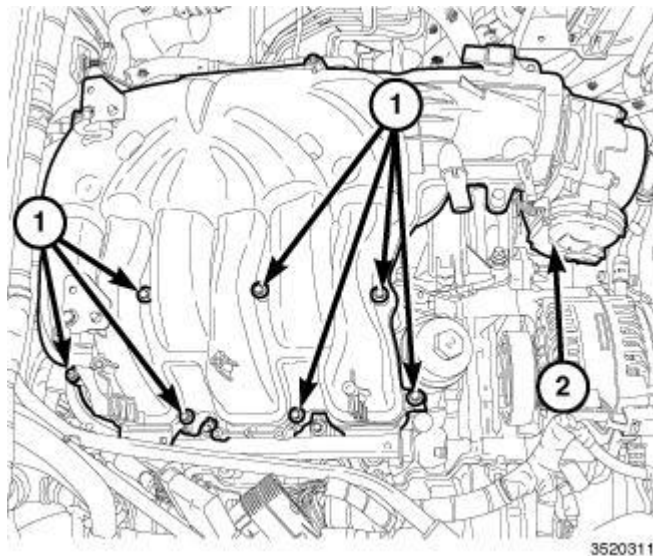
**Fig. 110: Right And Left Upstream And Downstream Oxygen Sensor Connectors & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

6. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
7. Drain the cooling system. Refer to **STANDARD PROCEDURE** .
8. Drain the engine oil. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
9. Disconnect the left upstream (3) and downstream (1) oxygen sensor connectors from the main wire harness.
10. Remove the right catalytic converter. Refer to **CONVERTER, CATALYTIC, REMOVAL** .



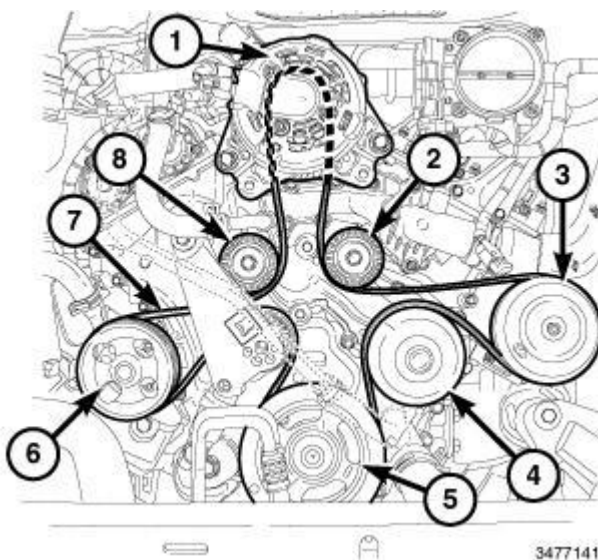
**Fig. 111: Power Steering Pump Bracket, Bolt & Retainer**  
 Courtesy of CHRYSLER GROUP, LLC

11. Disengage the wiring harness routing retainer (3) from the power steering pump bracket (1).
12. Remove the lower power steering pump retaining bolt (2).



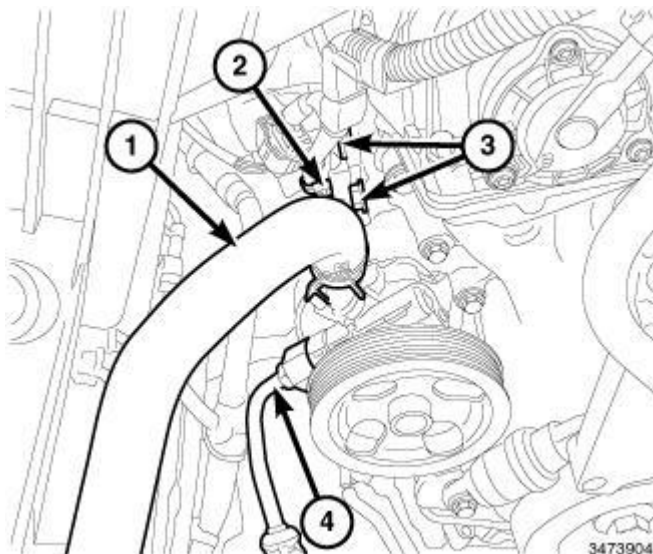
**Fig. 112: Upper Intake Manifold & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

13. Lower the vehicle.
14. Remove the upper and lower intake manifolds (2) and insulator. Refer to **MANIFOLD, INTAKE, REMOVAL**.



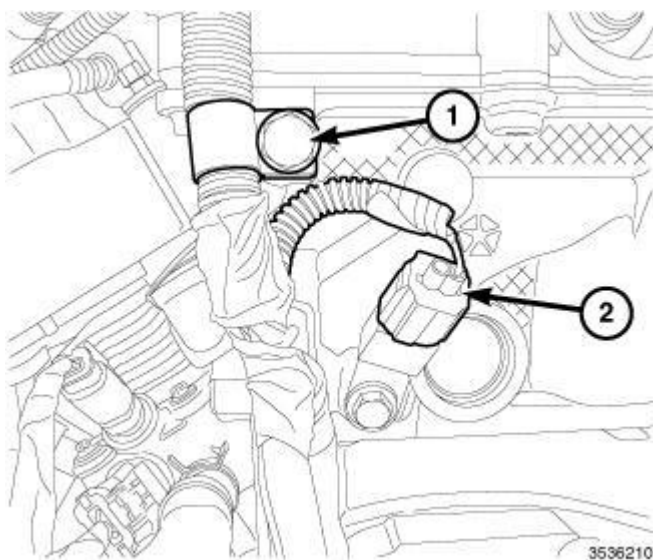
**Fig. 113: Drive Belt Tensioners & Assembly With Drive Belt Routing**  
 Courtesy of CHRYSLER GROUP, LLC

15. Remove the right and left cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
16. Remove the accessory drive belt (7). Refer to **BELT, SERPENTINE, REMOVAL**.



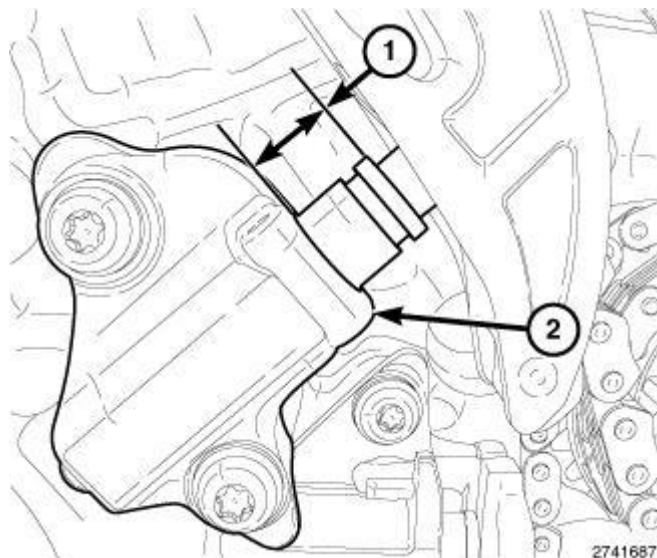
**Fig. 114: Power Steering Return Hose, Supply Line, Retainer & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

17. Disengage the wiring harness routing retainer (2) from the power steering pump bracket.
18. Remove the upper power steering pump bracket retaining bolts (3) and reposition the pump (with bracket).



**Fig. 115: Ignition Coil Capacitor Electrical Connector & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

19. Disconnect the electrical connector (2) from the ignition coil capacitor.
20. Remove the bolt (1) and the main wire harness retainer from the rear of the right cylinder head.

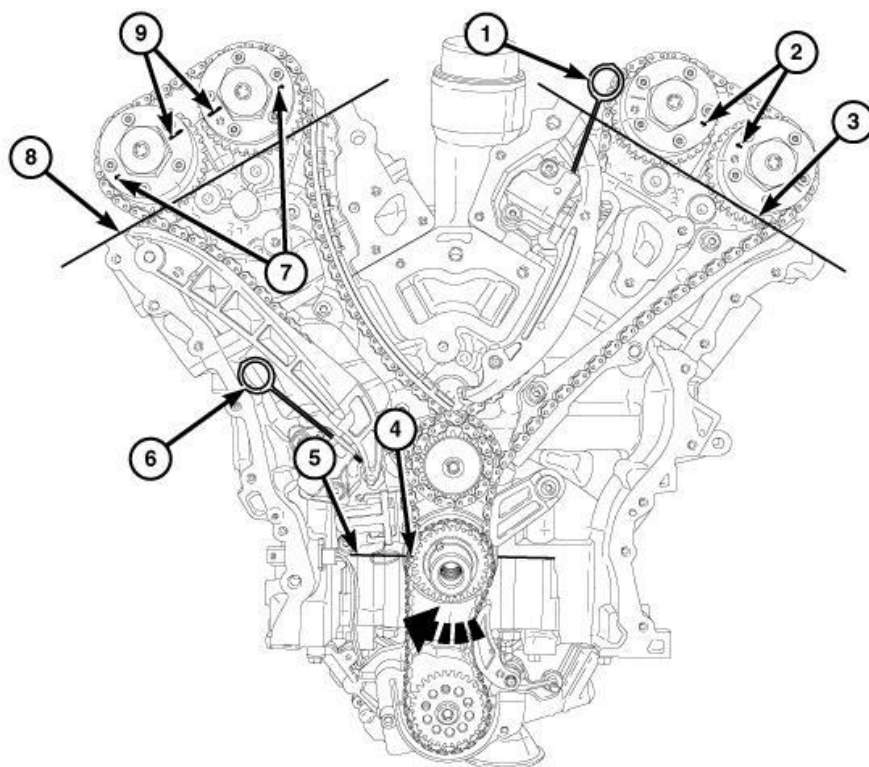


**Fig. 116: Piston Extension & RH Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

21. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL** .
22. Remove the oil pan, crankshaft vibration damper and engine timing cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.

**NOTE:**       **Take this opportunity to measure timing chain wear. Refer to Engine/Valve Timing - Standard Procedure.**

23. Lower the vehicle.



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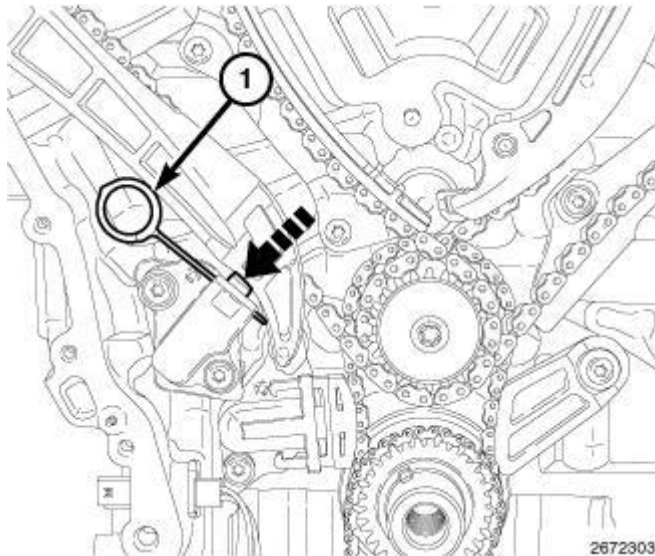
**Fig. 117: Rotating Crankshaft Clockwise To Position No. 1 Piston At TDC On Exhaust Stroke**  
Courtesy of CHRYSLER GROUP, LLC

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

24. Rotate the crankshaft CW to place the number one piston at TDC on the exhaust stroke by aligning the dimple (4) on the crankshaft with the block/bearing cap junction (5). The left side cam phaser arrows (2) should point toward each other and be parallel to the valve cover sealing surface (3). The right side cam phaser arrows (7) should point away from each other and the scribe lines (9) should be parallel to the valve cover sealing surface (8).

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

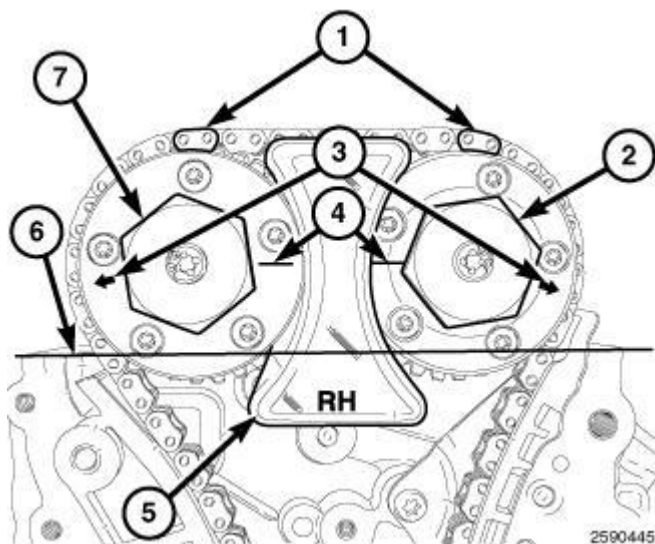
25. Mark the direction of rotation on the timing chain using a paint pen or equivalent to aid in reassembly.



**Fig. 118: Resetting Right Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

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

26. Reset the RH cam chain tensioner by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (1).

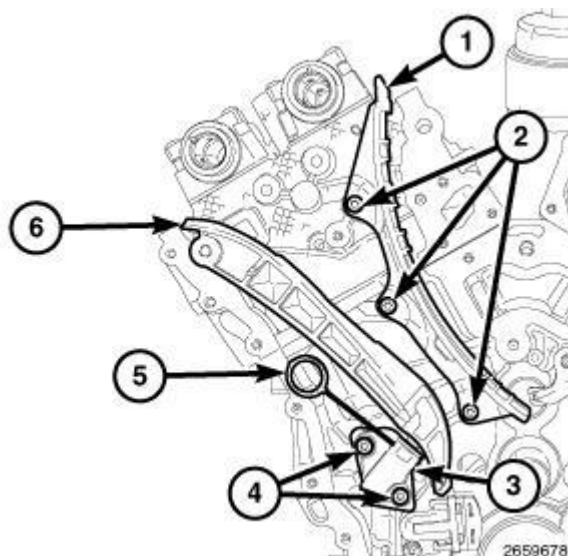


**Fig. 119: Phaser Timing Marks, Oil Control Valves & RH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the camshaft phaser lock.

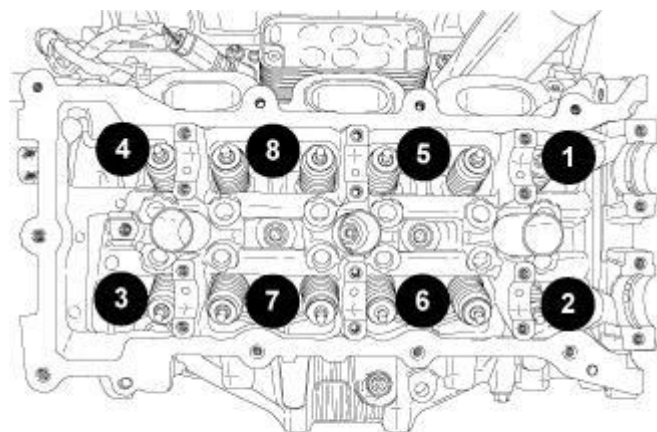


27. Install the RH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) (5).
28. Loosen both the intake oil control valve (2) and exhaust oil control valve (7).
29. Remove the RH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) (5).
30. Remove the oil control valve (2) from the right side intake cam phaser and pull the phaser off of the camshaft.
31. Remove the oil control valve (7) from the right side exhaust cam phaser and pull the phaser off of the camshaft.



**Fig. 120: Right Cam Chain Tensioner, Arm, Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

32. Remove the RH cam chain tensioner arm (6).
33. Remove two T30 bolts (4) and the RH cam chain tensioner (3).
34. Remove three T30 bolts (2) and the RH cam chain guide (1).



**Fig. 121: Cylinder Head Retaining Bolt Removal Sequence - Right**  
Courtesy of CHRYSLER GROUP, LLC

35. Remove the right camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL.

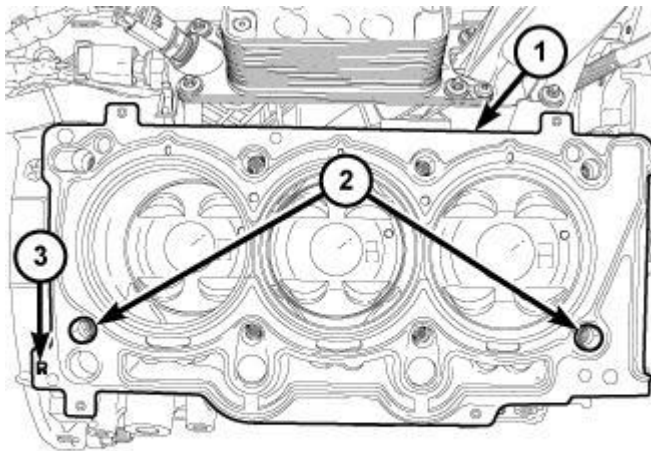
**NOTE:** If the rocker arms are to be reused, identify their positions so that they can be reassembled into their original locations.

36. Remove the rocker arms. 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.

37. If required, remove the hydraulic lifters. Refer to LIFTER(S), HYDRAULIC, REMOVAL.

38. Using the sequence shown in illustration, remove the cylinder head retaining bolts.



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**Fig. 122: Head Gasket & Locating Dowels**  
Courtesy of CHRYSLER GROUP, LLC

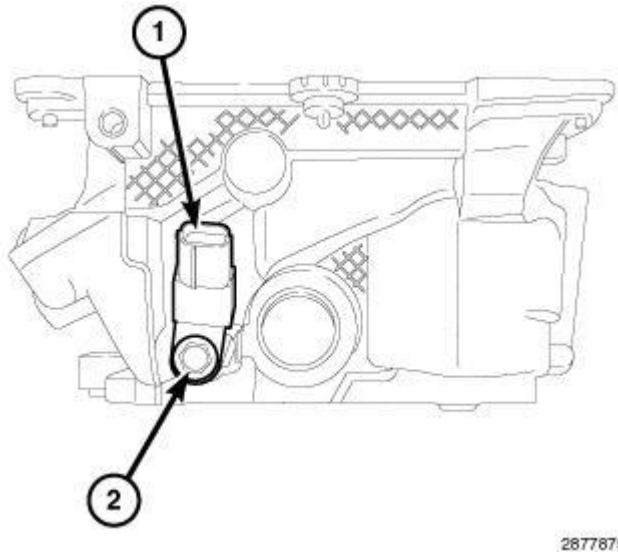
**WARNING:** The multi-layered steel head gaskets have very sharp edges that could cause personal injury if not handled carefully.

**NOTE:** The head gasket (1) crimps the locating dowels (2) and the dowels may pull out of the engine block when the head gasket is removed.

39. Remove the cylinder head and gasket. Discard the gasket.

**CAUTION:** Do not lay the cylinder head on its gasket sealing surface, due to the design of the cylinder head gasket, any distortion to the cylinder

head sealing surface may prevent the gasket from properly sealing resulting in leaks.



**Fig. 123: Ignition Coil Capacitor & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

40. If required, remove the bolt (2) and the ignition coil capacitor (1).

## 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.

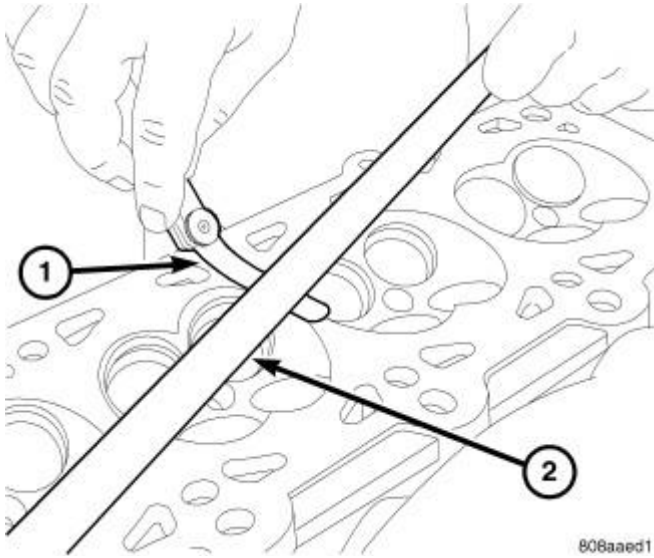
1. Remove all gasket material from cylinder head and block. Refer to Engine - Standard Procedure. Be careful not to gouge or scratch the aluminum head sealing surface.
2. Clean all engine oil passages.

**CAUTION:** Non-compressible debris such as oil, coolant or RTV sealants that are not removed from bolt holes can cause the aluminum casting to crack when tightening the bolts.

3. Clean out the cylinder head bolt holes in the engine block.

## INSPECTION

### INSPECTION



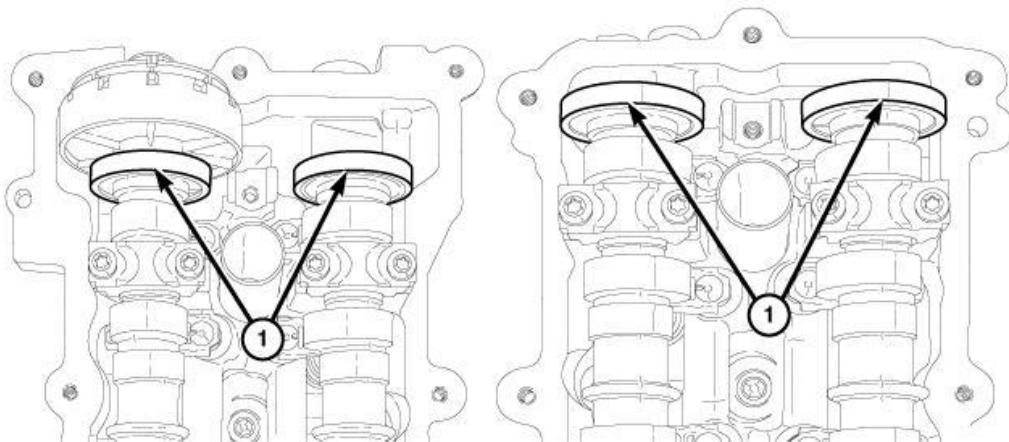
**Fig. 124: Checking Cylinder Head Flatness**

Courtesy of CHRYSLER GROUP, LLC

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

## INSTALLATION

### LEFT

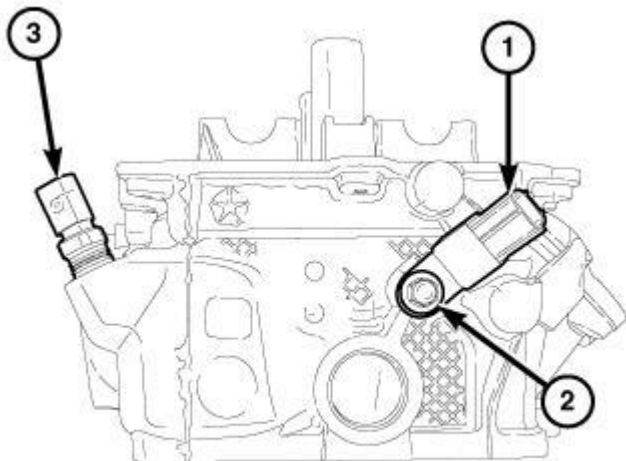


2715130

**Fig. 125: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.

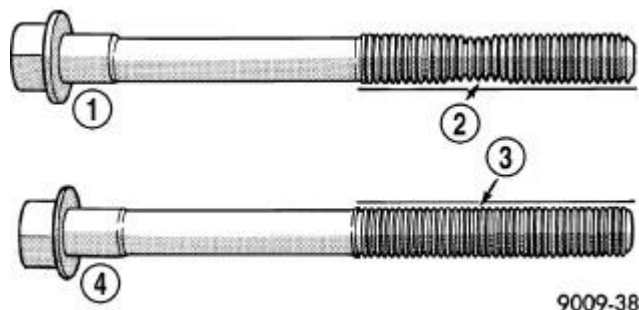


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**Fig. 126: Ignition Coil Capacitor, Bolt & Engine Coolant Temperature (ECT) Sensor**

Courtesy of CHRYSLER GROUP, LLC

1. If removed, install the Engine Coolant Temperature (ECT) sensor (4) and tighten to 11 N.m (97 in. lbs.).
2. If removed, install the ignition coil capacitor (1) with a M6 bolt (2) tightened to 10 N.m (89 in. lbs.).

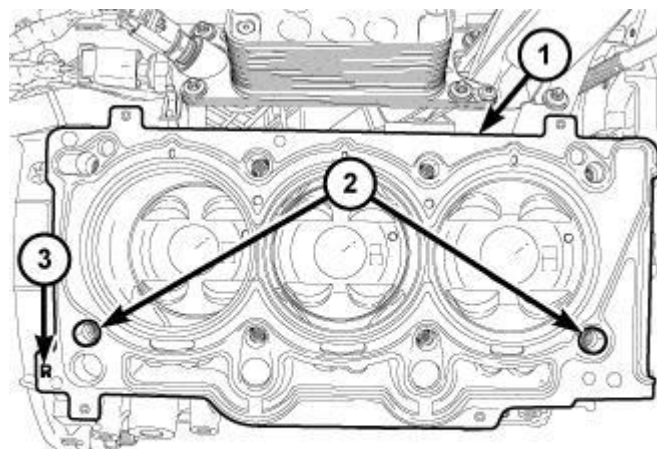


**Fig. 127: Checking Cylinder Head Bolts For Stretching (Necking)**  
 Courtesy of CHRYSLER GROUP, LLC

**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.

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

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



**Fig. 128: Head Gasket & Locating Dowels**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Right head gasket shown in illustration, left head gasket similar.

**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.

4. Clean and prepare the gasket sealing surfaces of the cylinder head and block. Refer to **Engine - Standard Procedure**.

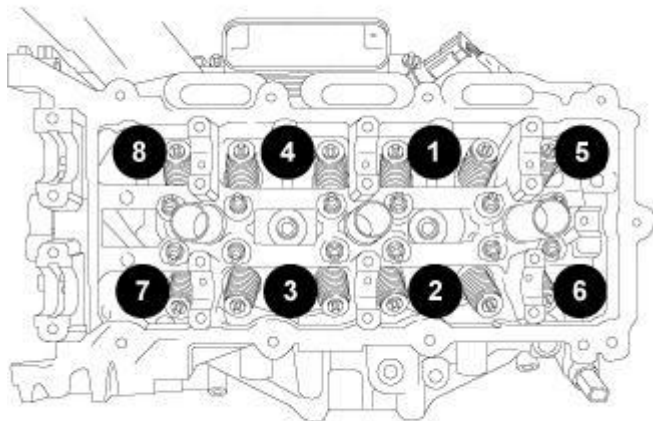
**CAUTION:** Non-compressible debris such as oil, coolant or RTV sealants that are not removed from bolt holes can cause the aluminum casting to crack when tightening the bolts.

5. Clean out the cylinder head bolt holes in the engine block.

**WARNING:** The multi-layered steel head gaskets have very sharp edges that could cause personal injury if not handled carefully.

**CAUTION:** The cylinder head gaskets are not interchangeable between the left and right cylinder heads and are clearly marked (3) with "R" for right and "L" for left.

6. Position the new cylinder head gasket (1) on the locating dowels (2).



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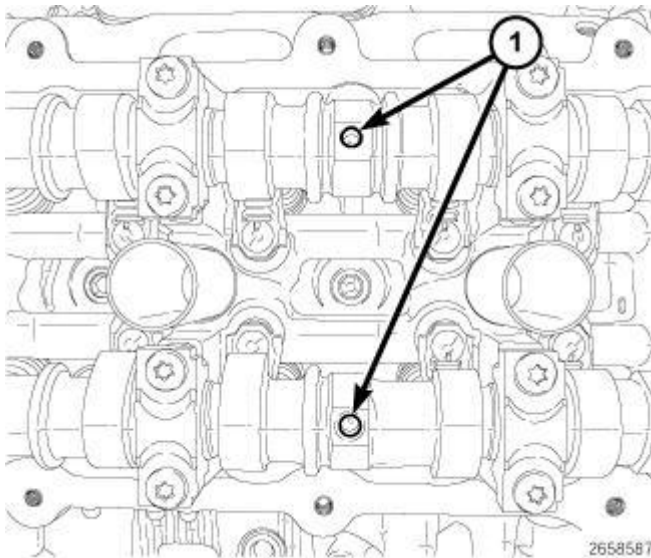
**Fig. 129: Cylinder Head Retaining Bolt Tightening Sequence - Left**  
Courtesy of CHRYSLER GROUP, LLC

7. Position the cylinder head onto the cylinder block. Make sure the cylinder head seats fully over the locating dowels.

**NOTE:** Do not apply any additional oil to the bolt threads.

8. Install the eight head bolts finger tight.
9. Tighten the cylinder head bolts in the sequence shown in illustration, following this 9 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 45 N.m (33 ft. lbs.)
- Step 3: All + 75° Turn **Do not use a torque wrench for this step.**
- Step 4: All + 50° Turn **Do not use a torque wrench for this step.**
- Step 5: Loosen all fasteners in reverse of sequence shown in illustration
- Step 6: All to 30 N.m (22 ft. lbs.)
- Step 7: All to 45 N.m (33 ft. lbs.)
- Step 8: All + 70° Turn **Do not use a torque wrench for this step.**
- Step 9: All + 70° Turn **Do not use a torque wrench for this step.**



**Fig. 130: Positioning Camshaft Alignment Holes Vertically**  
 Courtesy of CHRYSLER GROUP, LLC

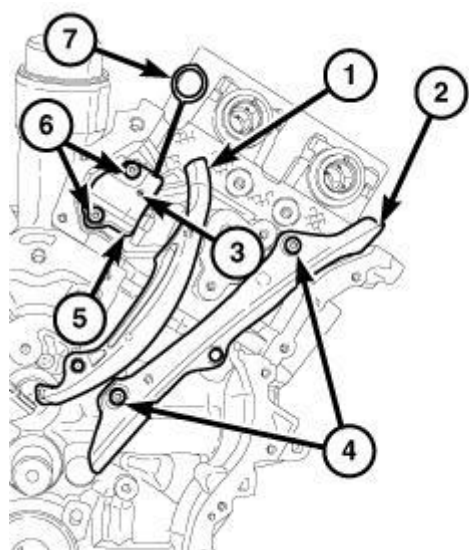
**NOTE:** If the hydraulic lifters are being reused, reassemble them into their original locations.

10. If removed, install the hydraulic lifters. Refer to LIFTER(S), HYDRAULIC, INSTALLATION.

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

11. Install the rocker arms and camshafts. Refer to CAMSHAFT, ENGINE, INSTALLATION.
12. Rotate the camshafts CW to TDC by positioning the alignment holes (1) vertically.

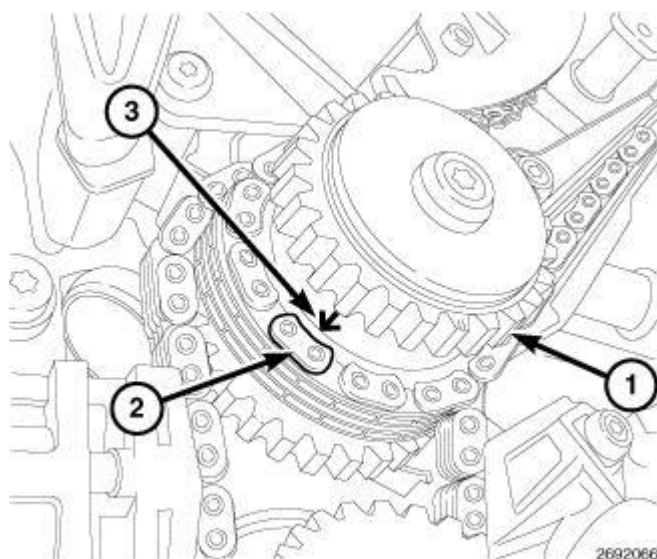




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**Fig. 131: Left Cam Chain Tensioner, Arm, Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

13. Install the LH cam chain guide (2) with two bolts (4). Tighten the T30 bolts (4) to 12 N.m (106 in. lbs.).
14. Install the LH cam chain tensioner (5) to the cylinder head with two bolts (6). Tighten the T30 bolts (6) to 12 N.m (106 in. lbs.).
15. Reset the LH cam chain tensioner (5) by lifting the pawl (3), pushing back the piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (7). Refer to **Engine/Valve Timing - Standard Procedure**.
16. Install the LH tensioner arm (1).



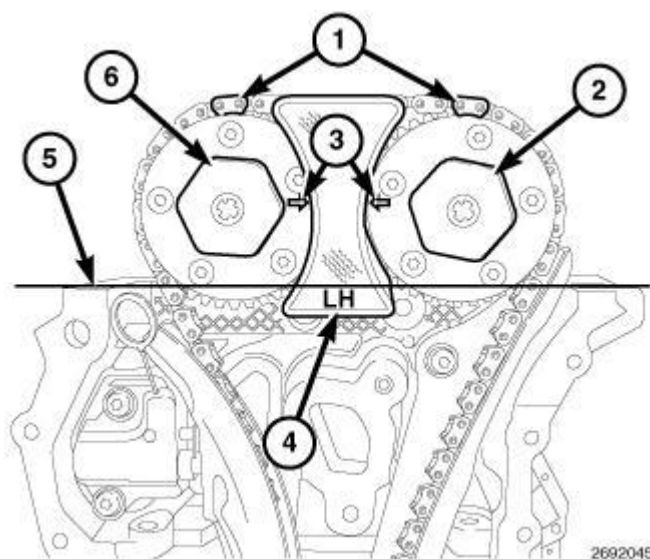
2692066

**Fig. 132: Idler Sprocket, Plated Link & Arrow**  
Courtesy of CHRYSLER GROUP, LLC

17. Press the LH intake cam phaser onto the intake camshaft. Install and hand tighten the oil control valve.

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

18. Drape the left side cam chain over the LH intake cam phaser and onto the idler sprocket (1) so that the arrow (3) is aligned with the plated link (2) on the cam chain.

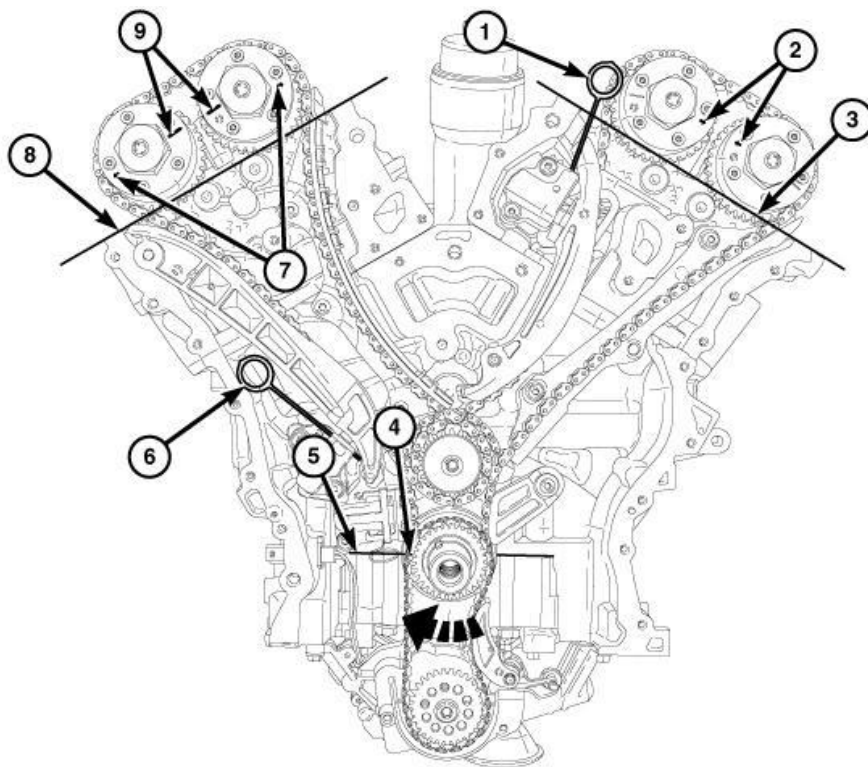


**Fig. 133: Phaser Timing Marks, Oil Control Valves & LH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

19. While maintaining this alignment, route the cam chain around the exhaust and intake cam phasers so that the plated links are aligned with the phaser timing marks (1). Position the left side cam phasers so that the arrows (3) point toward each other and are parallel to the valve cover sealing surface (5). Press the exhaust cam phaser onto the exhaust cam, install and hand tighten the oil control valve (2).

**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the camshaft phaser or phaser lock.

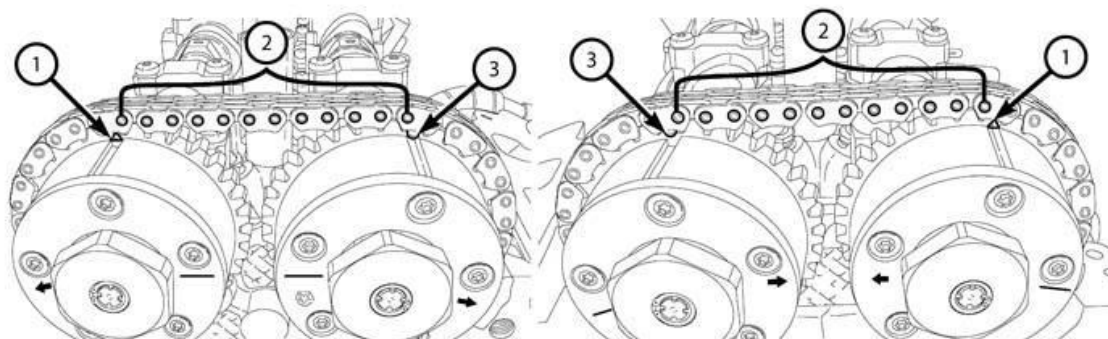
20. Install the LH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) (4) and tighten the oil control valves (2) and (6) to 150 N.m (110 ft. lbs.).



2661245

**Fig. 134: Rotating Crankshaft Clockwise To Position No. 1 Piston At TDC On Exhaust Stroke**  
Courtesy of CHRYSLER GROUP, LLC

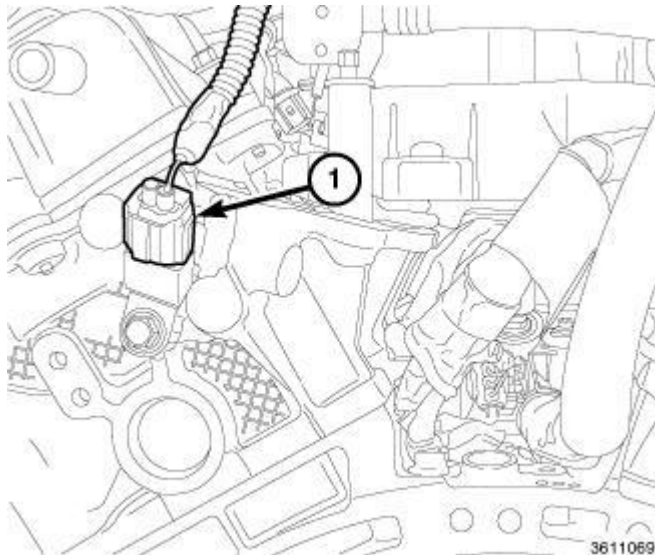
21. Remove the LH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser).
22. Remove the Tensioner Pin (special tool #8514, Pins, Tensioner) (1) from the LH cam chain tensioner.
23. Rotate the crankshaft CW two complete revolutions stopping when the dimple (4) on the crankshaft is aligned the with the block/bearing cap junction (5).
24. While maintaining this alignment, verify that the arrows on the left side cam phasers (2) point toward each other and are parallel to the valve cover sealing surface (3) and that the right side cam phaser arrows (7) point away from each other and the scribe lines (9) are parallel to the valve cover sealing surface (8).



2714685

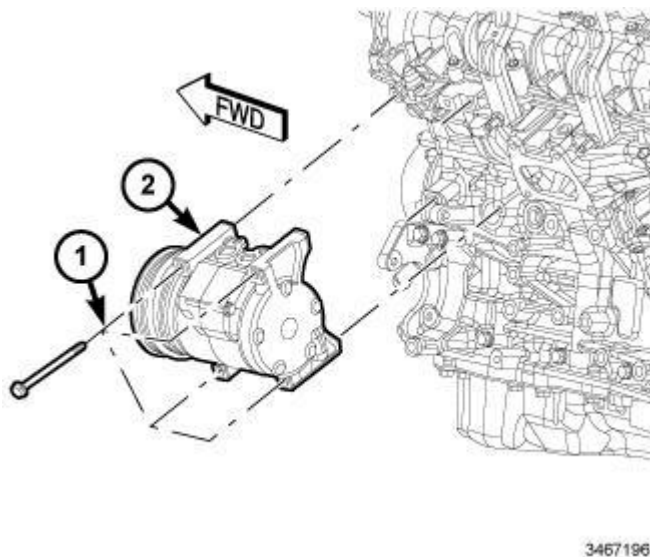
**Fig. 135: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking**  
Courtesy of CHRYSLER GROUP, LLC

25. There should be 12 chain pins (2) between the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3).
26. If the engine timing is not correct, repeat this procedure.
27. Install the engine timing cover, crankshaft vibration damper, upper and lower oil pans. Refer to **COVER (S), ENGINE TIMING, INSTALLATION**.



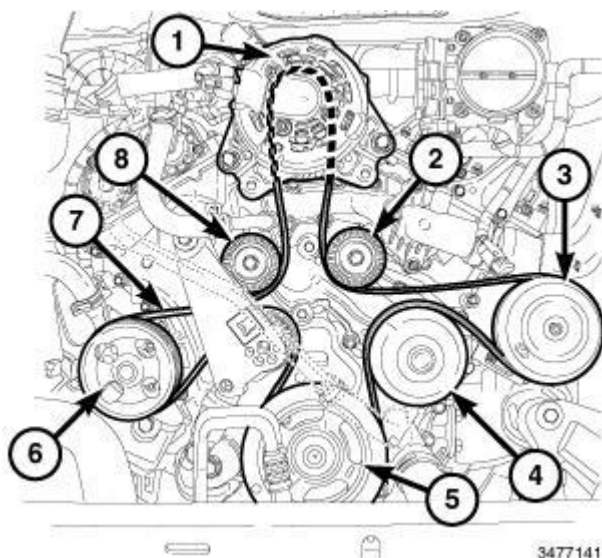
**Fig. 136: Ignition Coil Capacitor Electrical Connector**  
 Courtesy of CHRYSLER GROUP, LLC

28. Connect the ignition coil capacitor electrical connector (1).



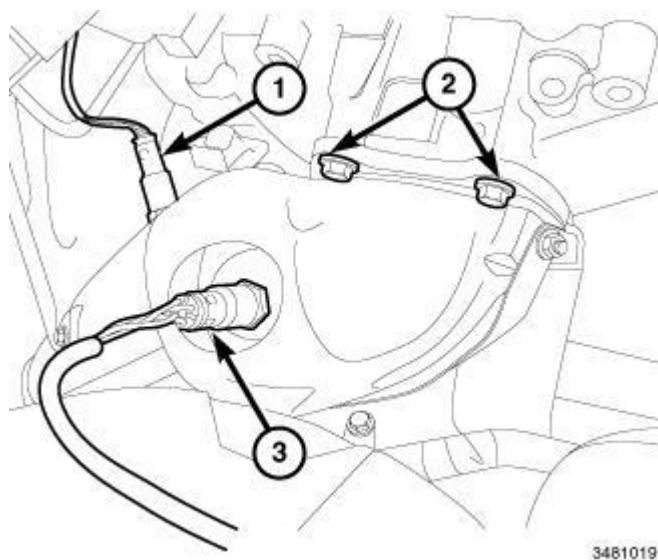
**Fig. 137: A/C Compressor & Mounting Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

29. Install the A/C compressor (2) onto the engine with four bolts (1) tightened to 28 N.m (21 ft. lbs.).



**Fig. 138: Drive Belt Tensioners & Assembly With Drive Belt Routing**  
Courtesy of CHRYSLER GROUP, LLC

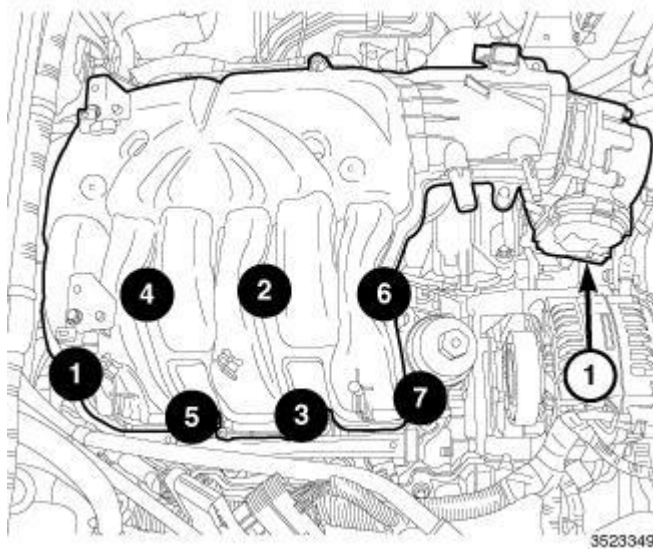
30. Install the accessory drive belt (7). Refer to **BELT, SERPENTINE, INSTALLATION** .
31. Install the right and left cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.



**Fig. 139: Right And Left Upstream And Downstream Oxygen Sensor Connectors & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

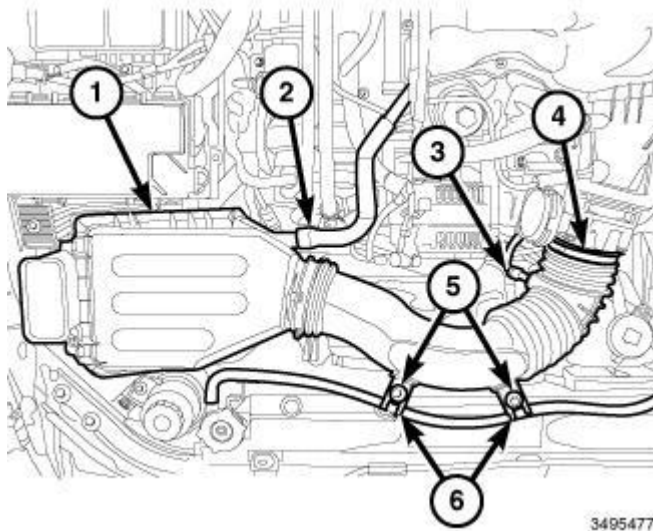
**NOTE:** Right catalytic converter shown in illustration, left catalytic converter similar.

32. Install the left catalytic converter. Refer to **CONVERTER, CATALYTIC, INSTALLATION** .
33. Connect the upstream (3) and downstream (1) oxygen sensor connectors to the main wire harness.



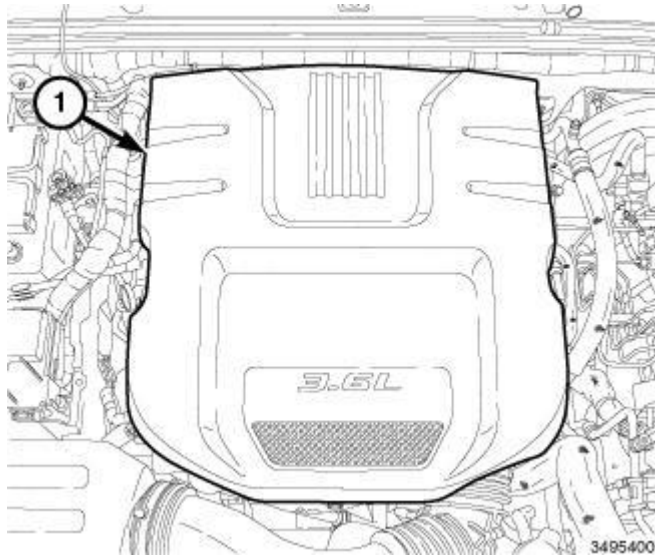
**Fig. 140: Upper Intake Manifold Tightening Sequence**  
Courtesy of CHRYSLER GROUP, LLC

34. Install the upper and lower intake manifolds. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
35. Install the front wheelhouse inner splash shields. Refer to **SHIELD, SPLASH, WHEELHOUSE, INSTALLATION**.



**Fig. 141: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**  
Courtesy of CHRYSLER GROUP, LLC

36. Install the air inlet hose (3) and the air cleaner body. Refer to **BODY, AIR CLEANER, INSTALLATION**.



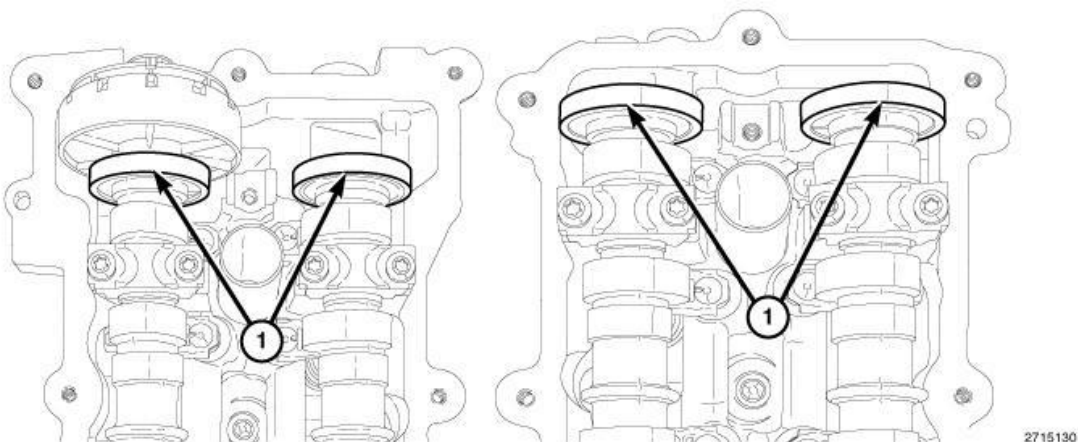
**Fig. 142: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

37. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
38. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
39. Install the engine cover (1).
40. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
41. 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.

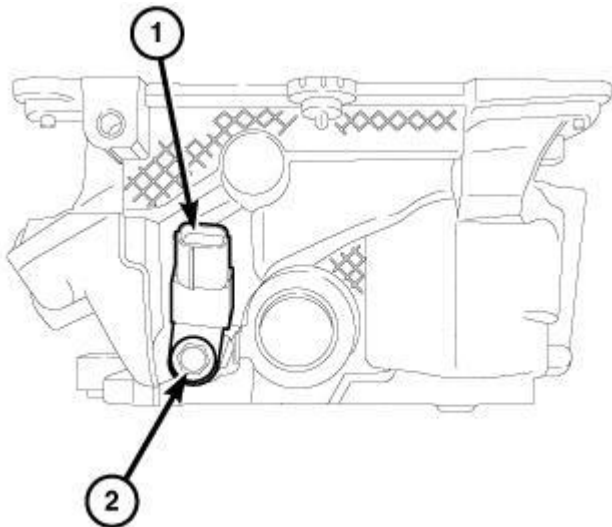
**RIGHT**



**Fig. 143: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.

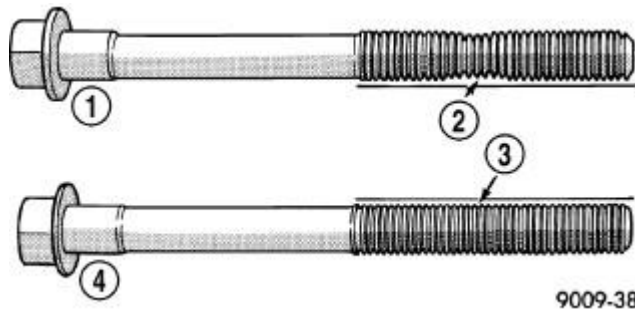


2877875

**Fig. 144: Ignition Coil Capacitor & Bolt**

Courtesy of CHRYSLER GROUP, LLC

1. If removed, install the ignition coil capacitor (1) with a M6 bolt (2) tightened to 10 N.m (89 in. lbs.).



9009-38

**Fig. 145: Checking Cylinder Head Bolts For Stretching (Necking)**

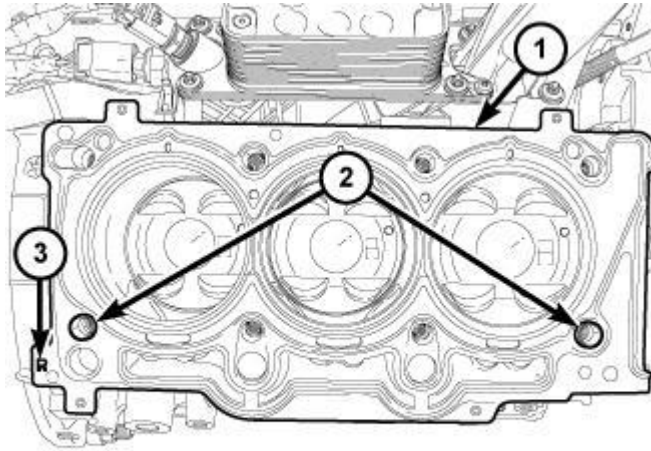
Courtesy of CHRYSLER GROUP, LLC

**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.

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



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



2800384

**Fig. 146: Head Gasket & Locating Dowels**

Courtesy of CHRYSLER GROUP, LLC

**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.

3. Clean and prepare the gasket sealing surfaces of the cylinder head and block. Refer to **Engine - Standard Procedure**.

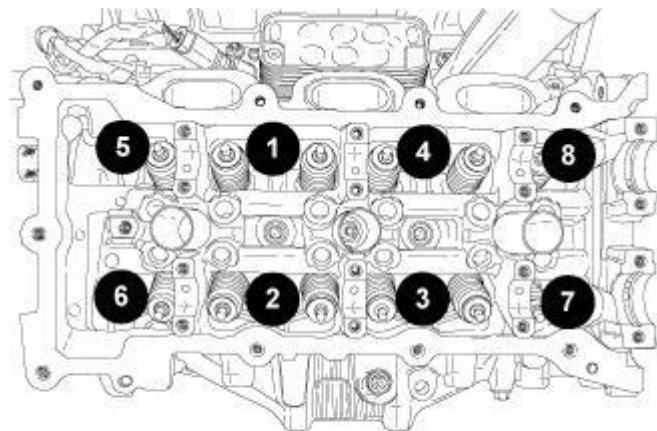
**CAUTION:** Non-compressible debris such as oil, coolant or RTV sealants that are not removed from bolt holes can cause the aluminum casting to crack when tightening the bolts.

4. Clean out the cylinder head bolt holes in the engine block.

**WARNING:** The multi-layered steel head gaskets have very sharp edges that could cause personal injury if not handled carefully.

**CAUTION:** The cylinder head gaskets are not interchangeable between the left and right cylinder heads and are clearly marked (3) with "R" for right and "L" for left.

5. Position the new cylinder head gasket (1) on the locating dowels (2).

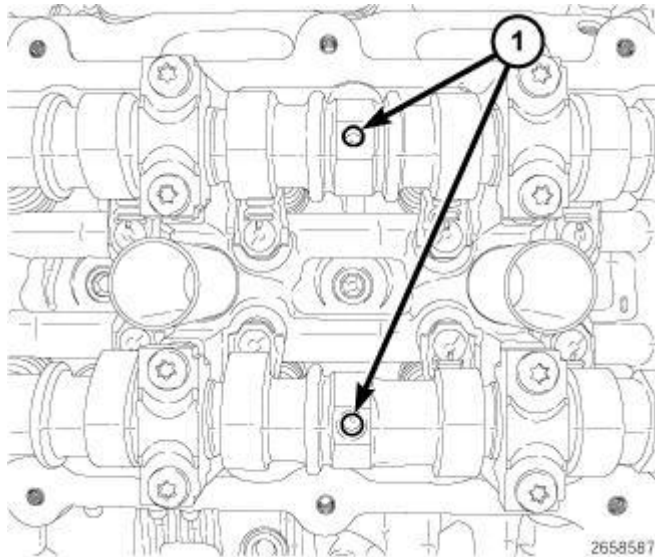


**Fig. 147: Cylinder Head Retaining Bolt Tightening Sequence - Right**  
Courtesy of CHRYSLER GROUP, LLC

6. Position the cylinder head onto the cylinder block. Make sure the cylinder head seats fully over the locating dowels.

**NOTE:** Do not apply any additional oil to the bolt threads.

7. Install the eight head bolts finger tight.
8. Tighten the cylinder head bolts in the sequence shown in illustration, following this 9 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 45 N.m (33 ft. lbs.)
  - Step 3: All + 75° Turn **Do not use a torque wrench for this step.**
  - Step 4: All + 50° Turn **Do not use a torque wrench for this step.**
  - Step 5: Loosen all fasteners in reverse of sequence shown in illustration
  - Step 6: All to 30 N.m (22 ft. lbs.)
  - Step 7: All to 45 N.m (33 ft. lbs.)
  - Step 8: All + 70° Turn **Do not use a torque wrench for this step.**
  - Step 9: All + 70° Turn **Do not use a torque wrench for this step.**



**Fig. 148: Positioning Camshaft Alignment Holes Vertically**  
Courtesy of CHRYSLER GROUP, LLC

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

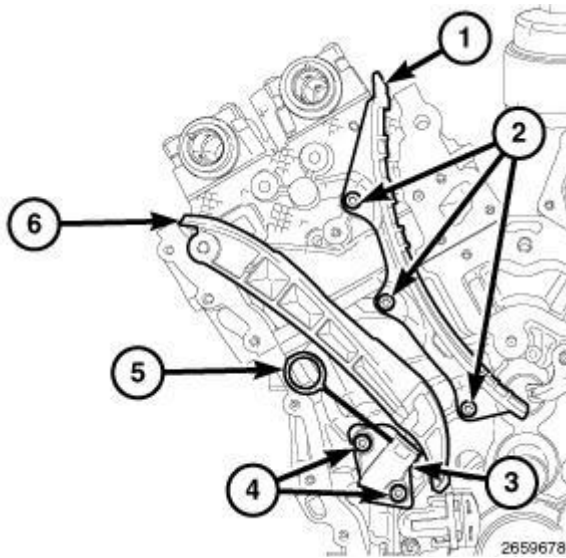
9. If removed, install the hydraulic lifters. Refer to LIFTER(S), HYDRAULIC, INSTALLATION.

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

10. Install the rocker arms and camshafts. Refer to CAMSHAFT, ENGINE, INSTALLATION.

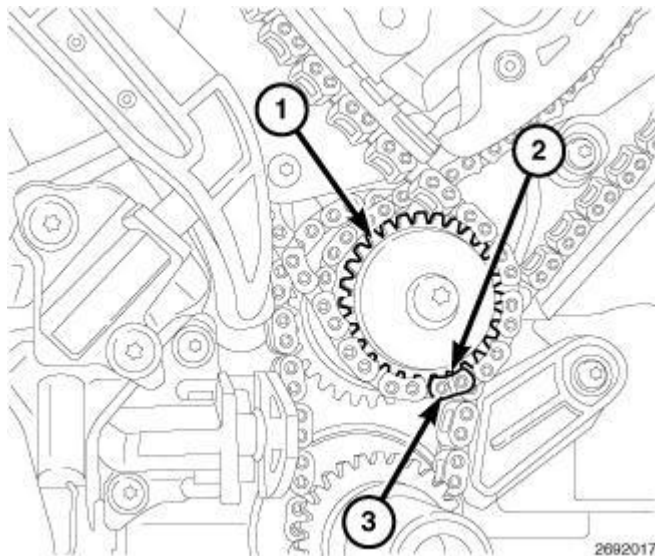
**CAUTION:** Do not rotate the camshafts more than a few degrees independently of the crankshaft. Valve to piston contact could occur resulting in possible valve damage. If the camshafts need to be rotated more than a few degrees, first move the pistons away from the cylinder heads by rotating the crankshaft counterclockwise to a position 30° before-top-dead-center. Once the camshafts are returned to their top-dead-center position, rotate the crankshaft clockwise to return the crankshaft to top-dead-center.

11. Verify that the camshafts are set at TDC by positioning the alignment holes (1) vertically.



**Fig. 149: Right Cam Chain Tensioner, Arm, Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

12. Install the RH cam chain guide (1) with three bolts (2). Tighten the T30 bolts (2) to 12 N.m (106 in. lbs.).
13. Install the RH cam chain tensioner (3) to the engine block with two bolts (4). Tighten the T30 bolts (4) to 12 N.m (106 in. lbs.).
14. Reset the RH cam chain tensioner (3) by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (5).
15. Install the RH tensioner arm (6).

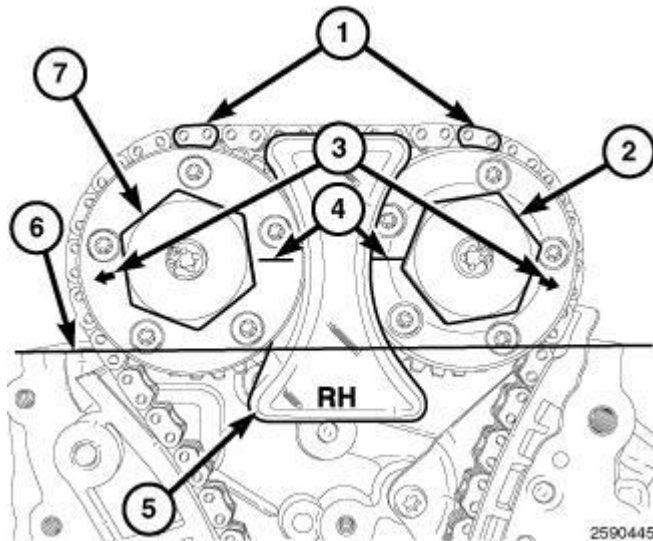


**Fig. 150: Idler Sprocket, Dimple & Plated Link**  
Courtesy of CHRYSLER GROUP, LLC

16. Press the RH exhaust cam phaser onto the exhaust camshaft. Install and hand tighten the oil control valve.

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

17. Drape the right side cam chain over the RH exhaust cam phaser and onto the idler sprocket (1) so that the dimple (2) is aligned with the plated link (3) on the cam chain.

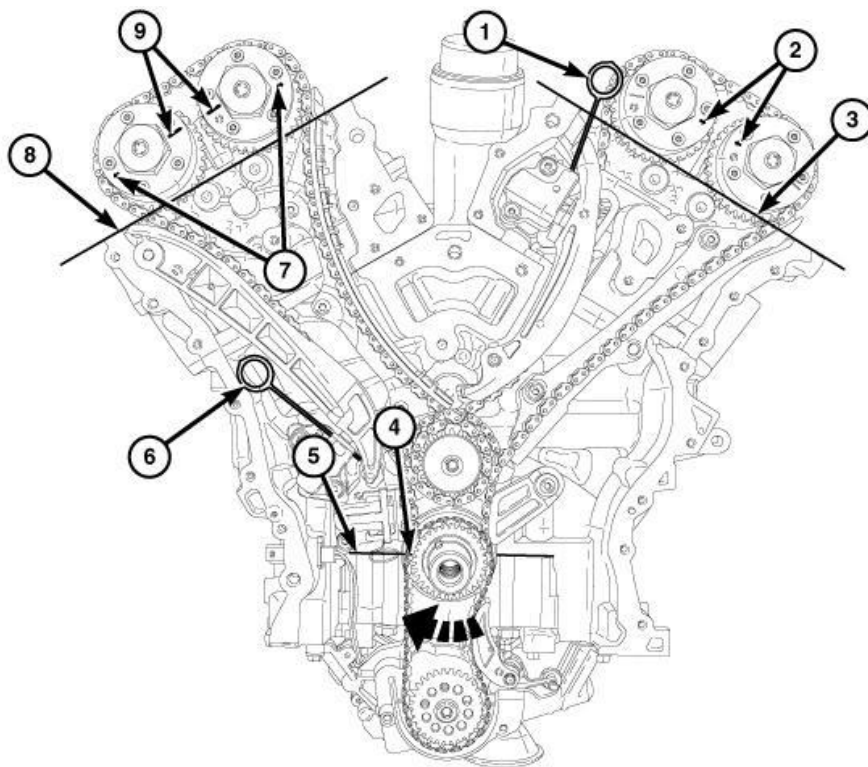


**Fig. 151: Phaser Timing Marks, Oil Control Valves & RH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

18. While maintaining this alignment, route the cam chain around the exhaust and intake cam phasers so that the plated links are aligned with the phaser timing marks (1). Position the right side cam phasers so that the arrows (3) point away from each other and the scribe lines (4) are parallel to the valve cover sealing surface (6). Press the intake cam phaser onto the intake cam, install and hand tighten the oil control valve (2).

**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the camshaft phaser or phaser lock.

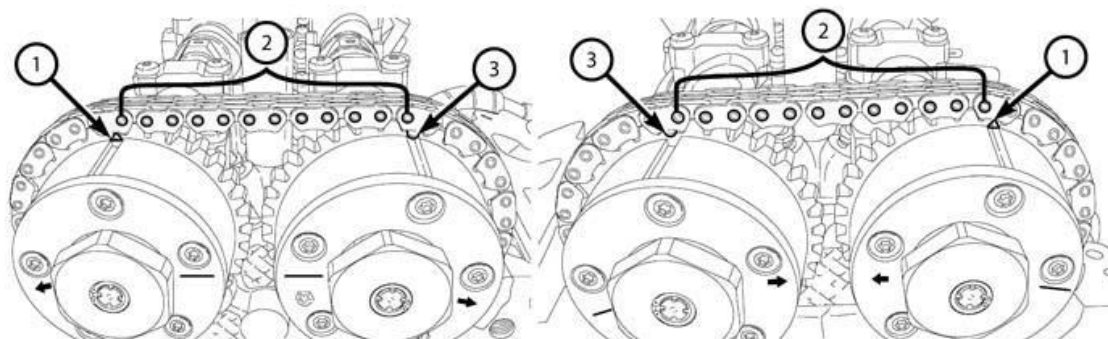
19. Install the RH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) (5) and tighten the oil control valves (2) and (7) to 150 N.m (110 ft. lbs.).



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**Fig. 152: Rotating Crankshaft Clockwise To Position No. 1 Piston At TDC On Exhaust Stroke**  
Courtesy of CHRYSLER GROUP, LLC

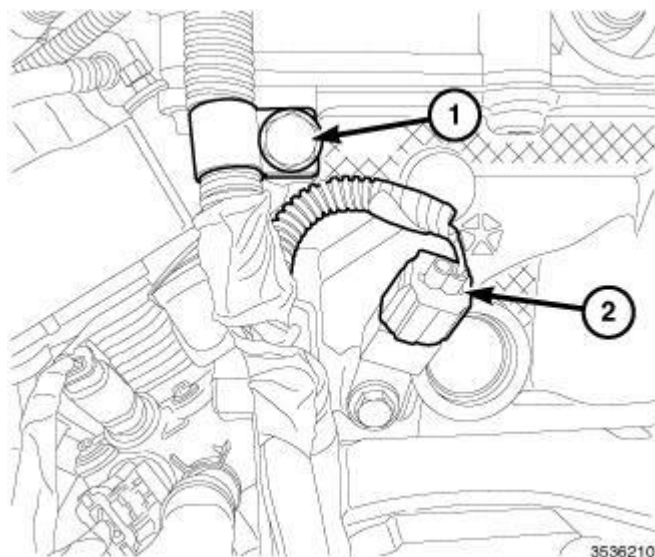
20. Remove the RH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser).
21. Remove the Tensioner Pin (special tool #8514, Pins, Tensioner) (6) from the RH cam chain tensioner.
22. Rotate the crankshaft CW two complete revolutions stopping when the dimple (4) on the crankshaft is aligned the with the block/bearing cap junction (5).
23. While maintaining this alignment, verify that the arrows on the left side cam phasers (2) point toward each other and are parallel to the valve cover sealing surface (3) and that the right side cam phaser arrows (7) point away from each other and the scribe lines (9) are parallel to the valve cover sealing surface (8).



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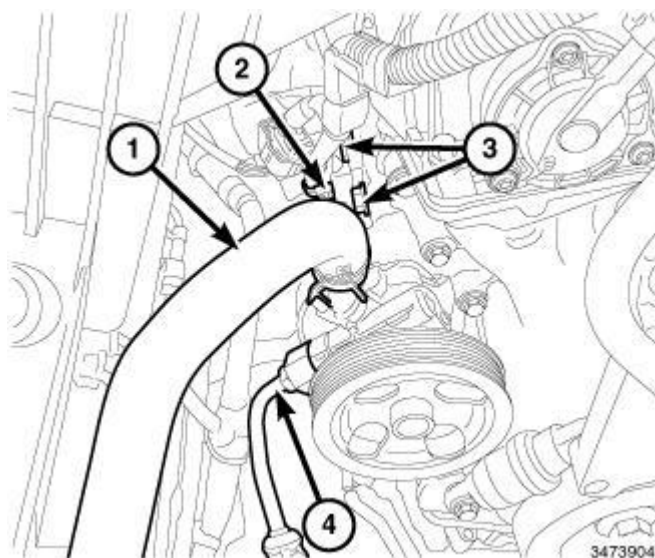
**Fig. 153: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking**  
Courtesy of CHRYSLER GROUP, LLC

24. There should be 12 chain pins (2) between the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3).
25. If the engine timing is not correct, repeat this procedure.
26. Install the engine timing cover, crankshaft vibration damper, upper and lower oil pans. Refer to **COVER (S), ENGINE TIMING, INSTALLATION**.



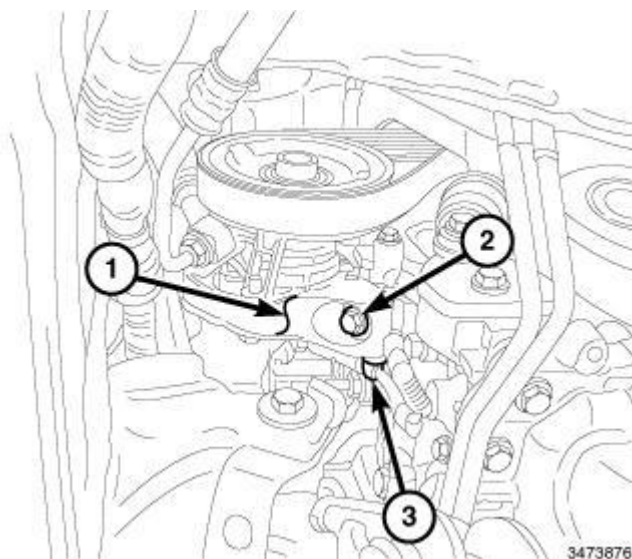
**Fig. 154: Ignition Coil Capacitor Electrical Connector & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

27. Secure the main wire harness retainer to the rear of the right cylinder head with the bolt (1) tightened to 12 N.m (106 in. lbs.).
28. Connect the electrical connector (2) to the ignition coil capacitor.



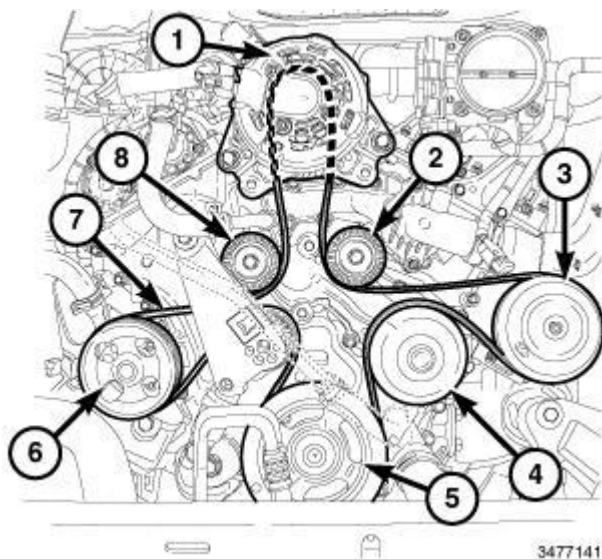
**Fig. 155: Power Steering Return Hose, Supply Line, Retainer & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

29. Position the power steering pump (with bracket) and install the upper power steering pump bracket retaining bolts (3). Do not tighten at this time.
30. Engage the wiring harness routing retainer (2) to the power steering pump bracket (1).



**Fig. 156: Power Steering Pump Bracket, Bolt & Retainer**  
Courtesy of CHRYSLER GROUP, LLC

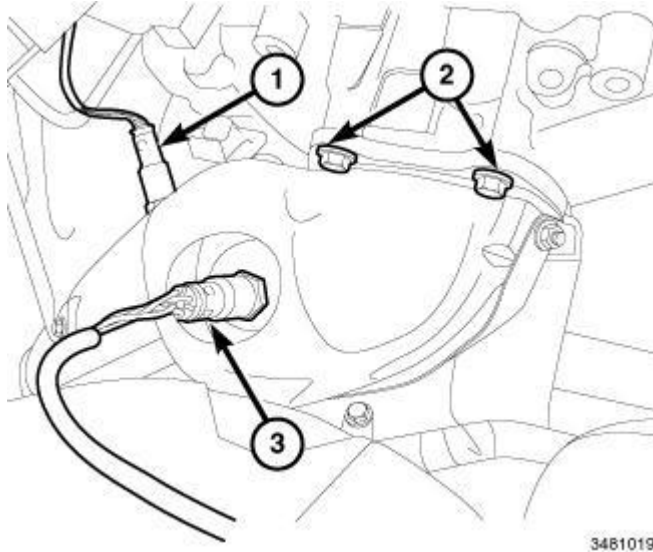
31. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
32. Engage the wiring harness routing retainer (3) to the power steering pump bracket (1).
33. Install the lower power steering pump retaining bolt (2) and tighten **all three** retaining bolts to 24 N.m (18 ft. lbs.).



**Fig. 157: Drive Belt Tensioners & Assembly With Drive Belt Routing**  
Courtesy of CHRYSLER GROUP, LLC

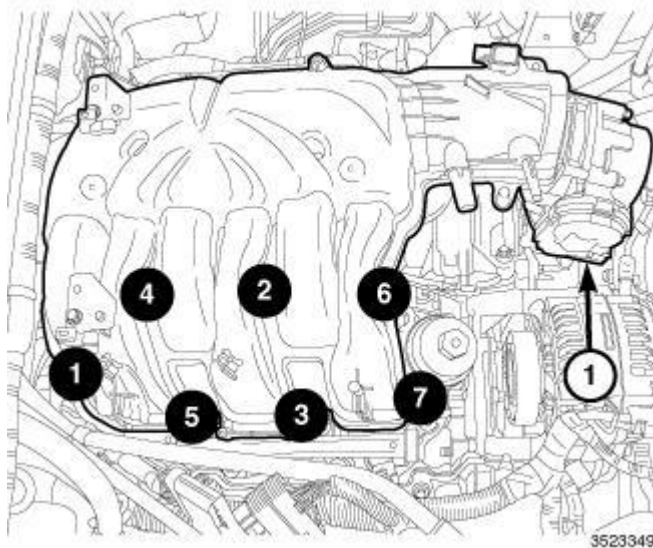


34. Install the accessory drive belt (7). Refer to **BELT, SERPENTINE, INSTALLATION**.
35. Install the right and left cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.



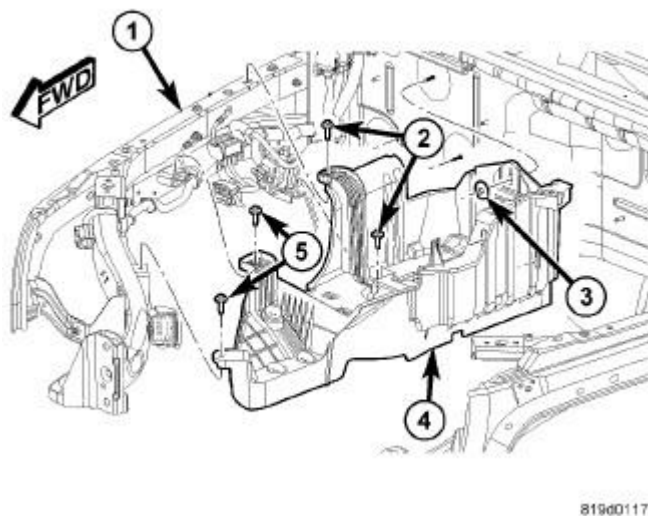
**Fig. 158: Right And Left Upstream And Downstream Oxygen Sensor Connectors & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

36. Install the right catalytic converter. Refer to **CONVERTER, CATALYTIC, INSTALLATION**.
37. Connect the upstream (3) and downstream (1) oxygen sensor connectors to the main wire harness.



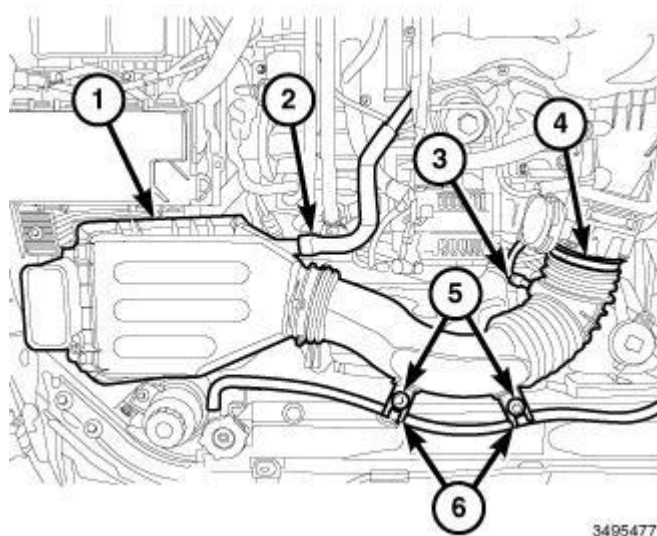
**Fig. 159: Upper Intake Manifold Tightening Sequence**  
Courtesy of CHRYSLER GROUP, LLC

38. Install the upper and lower intake manifolds. Refer to **MANIFOLD, INTAKE, INSTALLATION**.



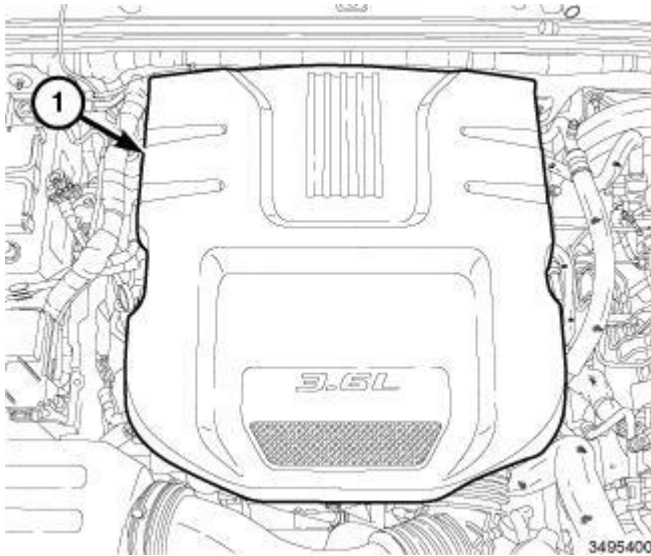
**Fig. 160: Battery Tray Components**  
Courtesy of CHRYSLER GROUP, LLC

39. Install the battery tray (4), Totally Integrated Power Module (TIPM) and battery. Refer to **TRAY, BATTERY, INSTALLATION**.
40. Install the front wheelhouse inner splash shields. Refer to **SHIELD, SPLASH, WHEELHOUSE, INSTALLATION**.



**Fig. 161: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**  
Courtesy of CHRYSLER GROUP, LLC

41. Install the air inlet hose (3) and the air cleaner body. Refer to **BODY, AIR CLEANER, INSTALLATION**.



**Fig. 162: Engine Cover**  
 Courtesy of CHRYSLER GROUP, LLC

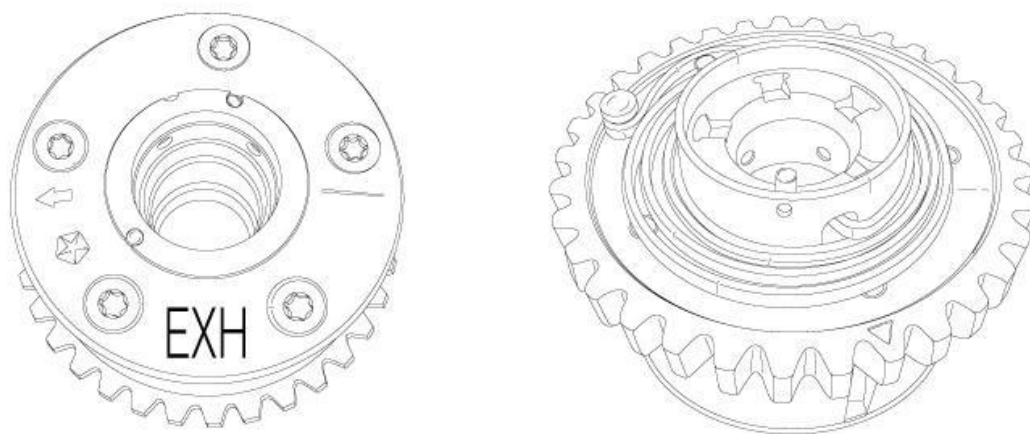
42. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
43. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
44. Install the engine cover (1).
45. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
46. 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.

## ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE

### DESCRIPTION

### DESCRIPTION



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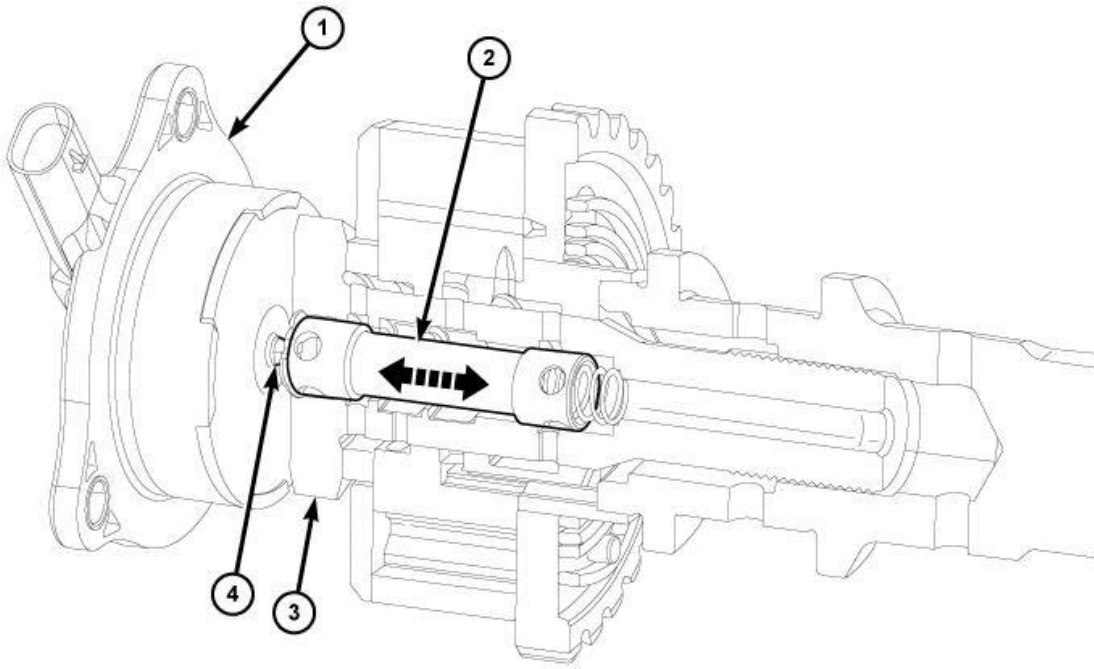
**Fig. 163: Exhaust Phaser Assembly**  
Courtesy of CHRYSLER GROUP, LLC

The 3.6L engine is equipped with Variable Valve Timing (VVT). This system adjusts the timing of all four camshafts independently using solenoids and oil control valves to direct oil pressure into the camshaft phaser assemblies. The camshaft phaser assembly advances and/or retards camshaft timing to improve engine performance, mid-range torque, idle quality, fuel economy, and reduce emissions. The four phasers are located on the front of the camshafts, behind the VVT solenoids, inside of the engine timing cover. The exhaust phasers are identified with EXH and the intake phasers are identified with INT. The exhaust phaser has a clockspring, the intake phaser does not. The camshaft sprockets are integrated with the camshaft phaser and are serviced as an assembly. Do not attempt to disassemble the phasers, they are not serviceable. Phasers are interchangeable between the right and left cylinder heads but should be installed in the same location as removed.

The 3.6L engine has an Oil Control Valve (OCV) for each phaser. The OCV also acts as a bolt for mounting the Phaser to the camshaft. The OCVs spool valve is spring loaded and should move freely within the OCV body. The four OCVs are identical but should be installed in the same location as removed.

## OPERATION

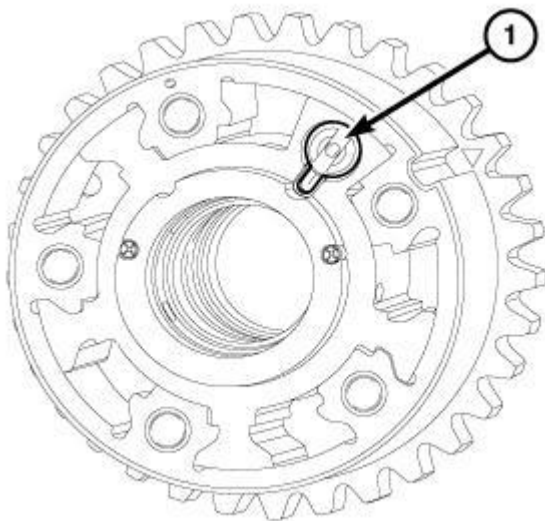
## OPERATION



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**Fig. 164: Oil Control Valve (OCV), VVT Solenoid, Solenoid Pintle & Internal Spool Valve**  
 Courtesy of CHRYSLER GROUP, LLC

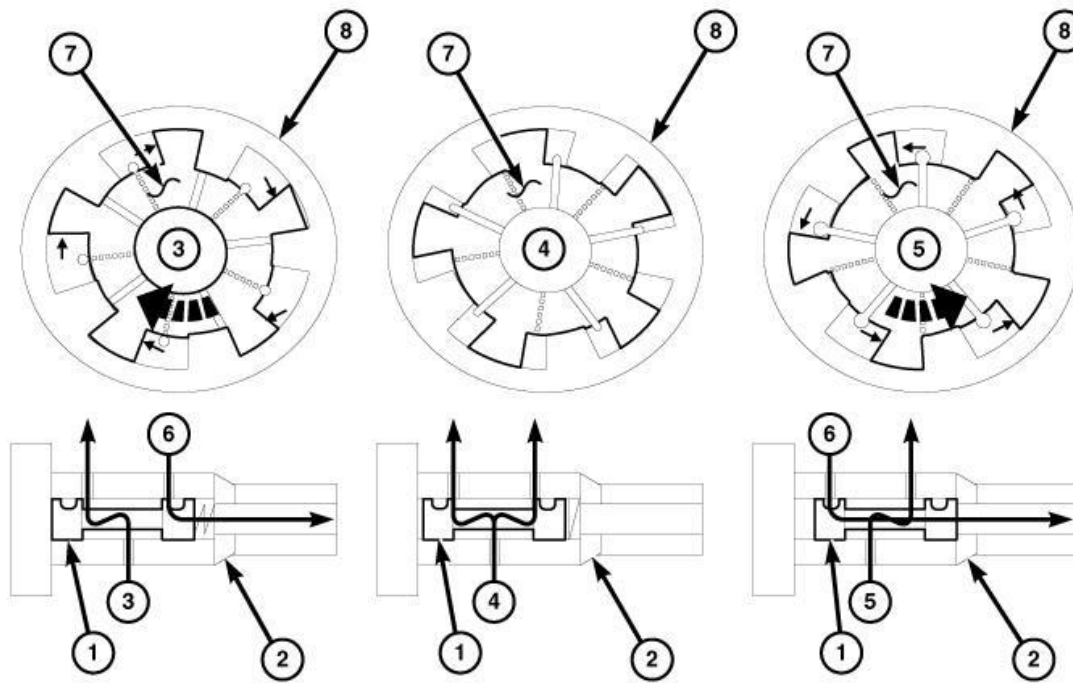
Each phaser position is adjusted using regulated oil pressure through the Oil Control Valve (OCV) (3). To begin phaser movement, a voltage signal is applied to the VVT solenoid (1) to extend or retract the solenoid pintle (4). The pintle pushes against an internal spool valve (2) within the OCV moving the valve forwards and backwards to direct oil flow.



2813724

**Fig. 165: Phasers In Lock-Pin Position**  
 Courtesy of CHRYSLER GROUP, LLC

At engine startup, system oil pressure overcomes spring pressure and unlocks the phaser lock-pin (1) in preparation for phasing. The phasers remain in this position until a PCM signal is given to pulse-width modulate the VVT solenoid. At engine shutdown, as oil pressure is reduced, both Phasers return to their lock-pin position (1). However, because the exhaust Phaser needs to travel to a position above and beyond the standard camshaft clockwise rotation, the assistance of a clock spring is required. The intake Phaser on the other hand, simply relies on the torsional resistance from the valvetrain to push it back towards lock-pin position.



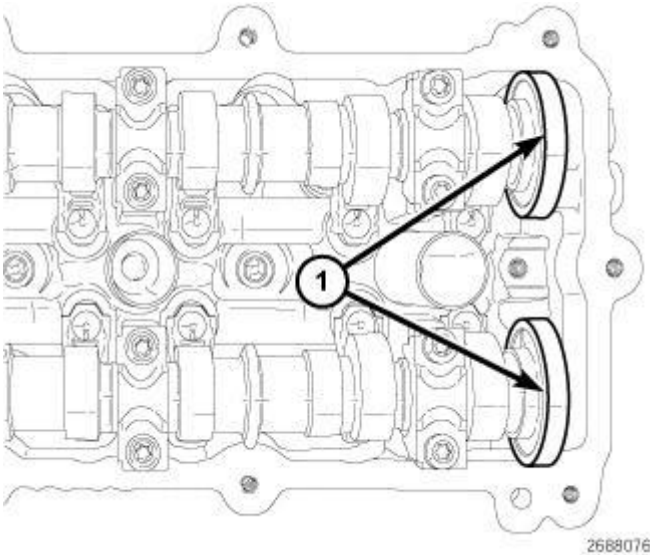
2813615

**Fig. 166: Spool Valve, Vanes, OCV & Advance, Hold Or Retard Position**  
Courtesy of CHRYSLER GROUP, LLC

The position of the spool valve (1) inside the OCV (2) determines which ports and chambers inside the phaser are being fed, either to advance (3), hold (4) or retard (5) the timing of the phaser sprocket relative to the camshaft. The spool valve also returns oil from the chambers to the sump (6). The Camshaft Position (CMP) sensor monitors the position of the camshaft with respect to the crankshaft and provides feedback to the PCM. As oil pressure pushes against the vanes (6) of the phaser rotor, the rotor begins to move. Since this rotor is physically attached to the camshaft, rotor rotation causes the camshaft position to rotate relative to the standard sprocket (7) position.

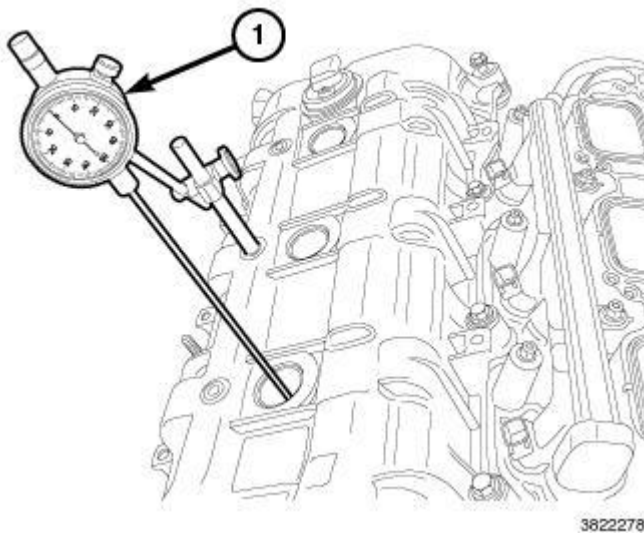
## REMOVAL

### LEFT



**Fig. 167: Magnetic Timing Wheels**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



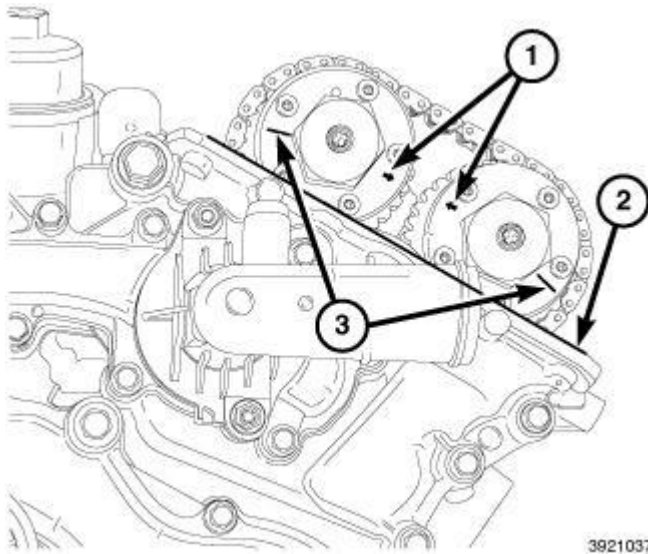
**Fig. 168: Mount Dial Indicator Set To Stationary Point On Engine**  
Courtesy of CHRYSLER GROUP, LLC

1. Remove the upper intake manifold, left ignition coils and left cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
2. Remove the right ignition coils and all 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.**

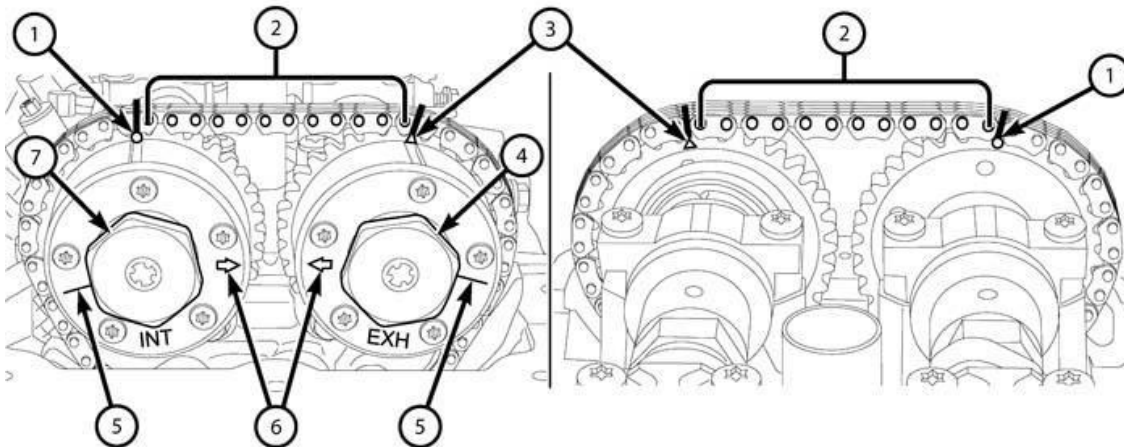
3. Mount Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) (1) to a stationary point on the engine, such as the number three cylinder ignition coil mount. Position the indicator probe into the number one cylinder, rotate the crankshaft clockwise (as viewed from the front) to place the number one cylinder piston at top-dead-center on the exhaust stroke and set the indicator dial to zero.



3921037

**Fig. 169: Arrows, Scribe Lines & Cylinder Head Cover Mounting Surface**  
Courtesy of CHRYSLER GROUP, LLC

4. The left side cam phaser **SCRIBE LINES** (3) should face away from each other and the **ARROWS** (1) should point toward each other and be parallel to the cylinder head cover mounting surface (2) when the number one cylinder piston is positioned at top-dead-center on the exhaust stroke.



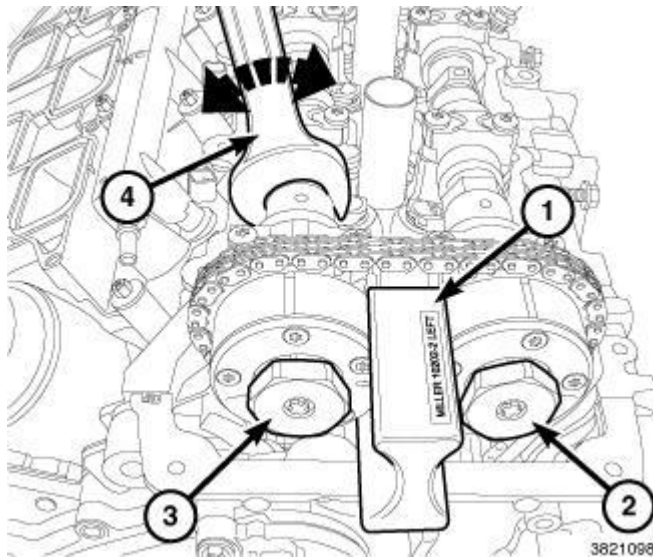
3821049



**Fig. 170: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The phaser markings (1 and 3) could align with either an external or internal chain link. Either alignment is acceptable as long as there are twelve chain pins between the markings.

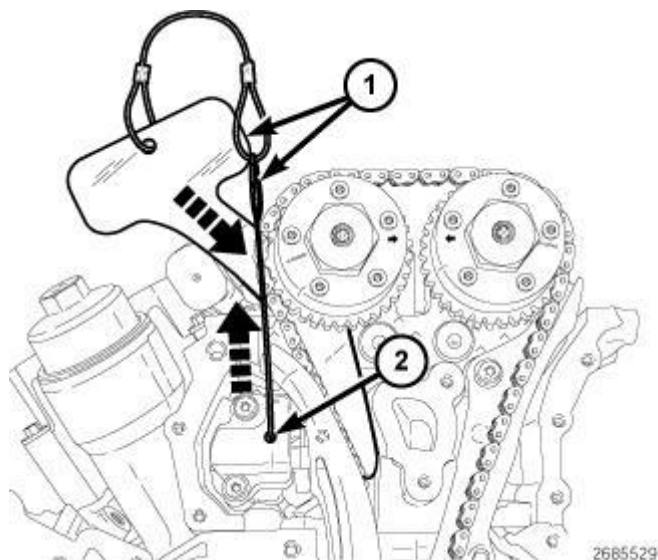
5. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (3) and the intake cam phaser circle marking (1) as viewed from either the front or rear of the cam phasers.
6. Mark both sides of the cam chain at the phaser timing marks (1 and 3) using a paint pen or equivalent to aid in reassembly.



**Fig. 171: Camshaft Phaser Lock, Oil Control Valves & Wrench**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (4) when installing the camshaft phaser lock.

7. Install the (special tool #10202-2, Lock, Camshaft/Phaser, Left Side) (1) against the cylinder head cover mounting surface with the tool number facing up.
8. Loosen, but do not remove, the exhaust oil control valve (2) and the intake oil control valve (3).
9. Remove the (special tool #10202-2, Lock, Camshaft/Phaser, Left Side) (1).

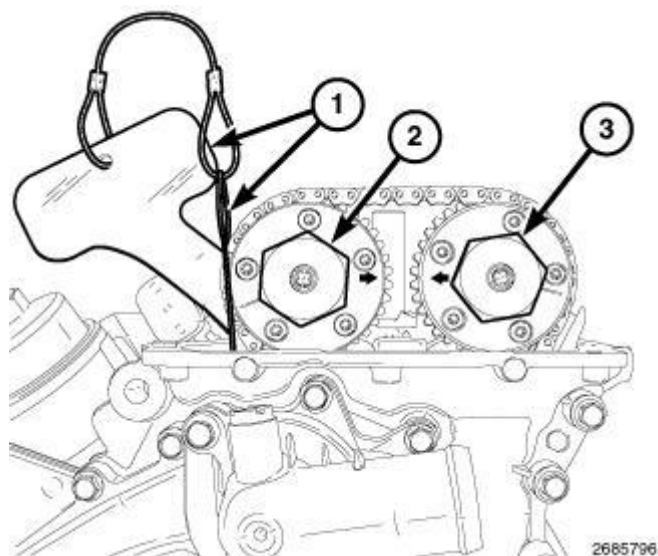


**Fig. 172: Pin, Rack & Timing Chain Holder**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Graphic shows engine timing cover removed for clarity.

10. Using (special tool #10200-3, Pin) (2), lift the pawl off of the rack (3). While holding the pawl off of the rack, push (special tool #10200-1, Holder, Timing Chain, Left Side) (1) into place between the cylinder head and the cam chain guide to force the rack and piston back into the tensioner body. The holder remains in place while the phasers are removed. Refer to **Engine/Valve Timing - Standard Procedure**.

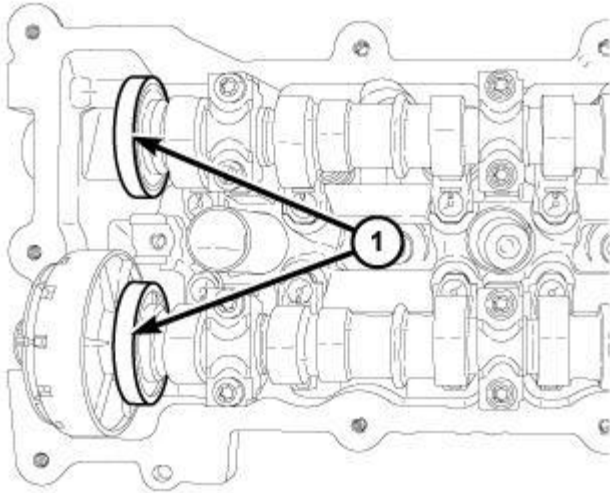


**Fig. 173: Pin, Rack, Timing Chain Holder & Oil Control Valves**

Courtesy of CHRYSLER GROUP, LLC

11. Remove the oil control valve (4) and pull the left side exhaust cam phaser off of the camshaft.
12. Remove the oil control valve (3) and pull the left side intake cam phaser off of the camshaft.

RIGHT

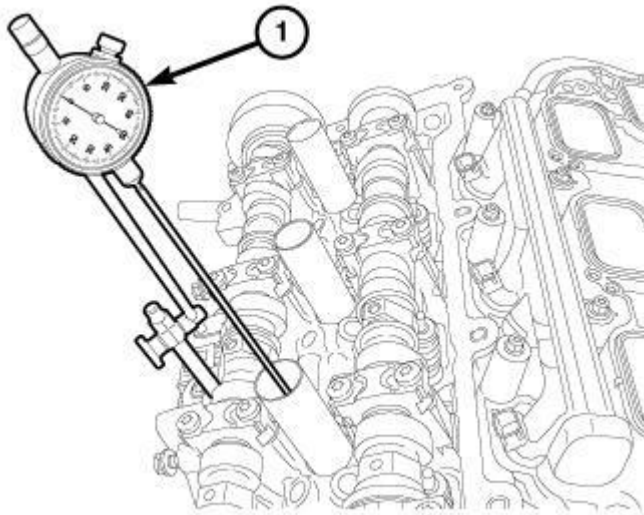


2691700

**Fig. 174: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



3822244

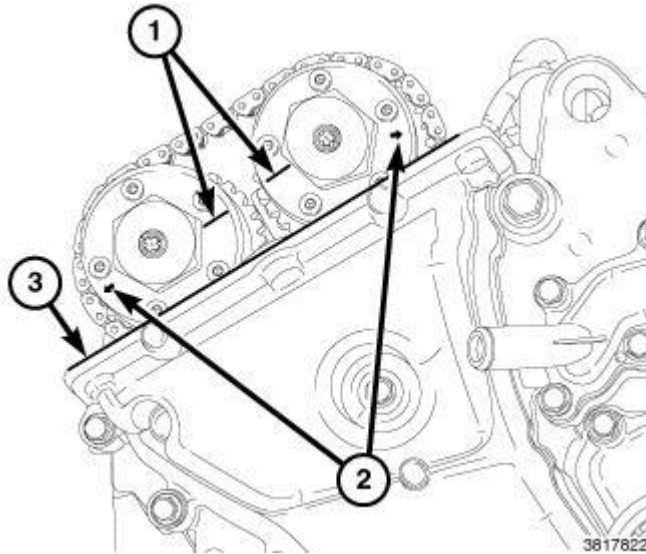
**Fig. 175: Mount Dial Indicator Set To Stationary Point On Engine**

Courtesy of CHRYSLER GROUP, LLC

1. Remove the upper intake manifold, right ignition coils and right cylinder head cover. Refer to **COVER (S), CYLINDER HEAD, REMOVAL**.
2. Remove the left ignition coils and all spark plugs. Refer to **SPARK PLUG, REMOVAL**.

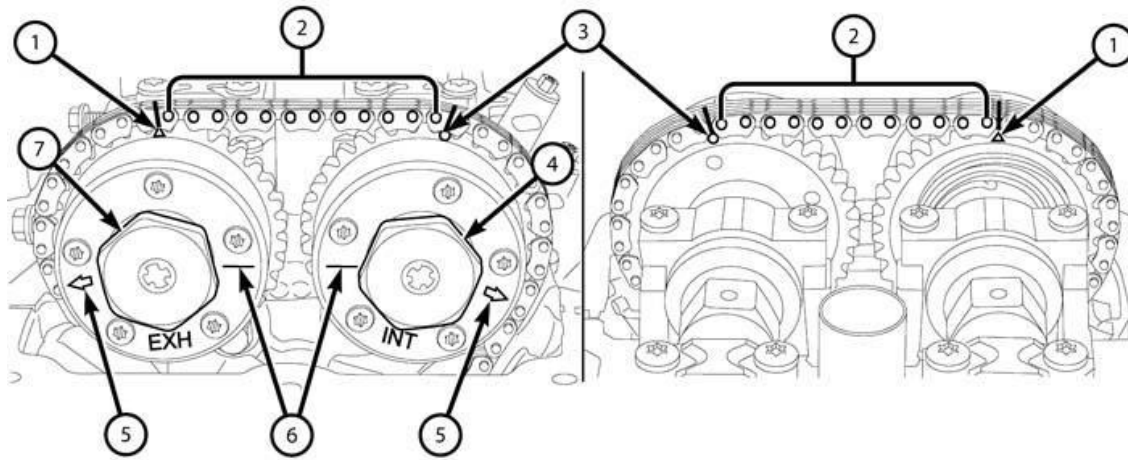
**CAUTION:** When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.

3. Mount Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) (1) to a stationary point on the engine, such as the cylinder head cover mounting surface. Position the indicator probe into the number one cylinder, rotate the crankshaft clockwise (as viewed from the front) to place the number one piston at top-dead-center on the exhaust stroke and set the indicator dial to zero.



**Fig. 176: Arrows, Scribe Lines & Cylinder Head Cover Mounting Surface**  
Courtesy of CHRYSLER GROUP, LLC

4. The right side cam phaser **ARROWS** (2) should point away from each other and the **SCRIBE LINES** (1) should be parallel to the cylinder head cover mounting surface (3) when the right side number one cylinder piston is positioned at top-dead-center on the exhaust stroke.



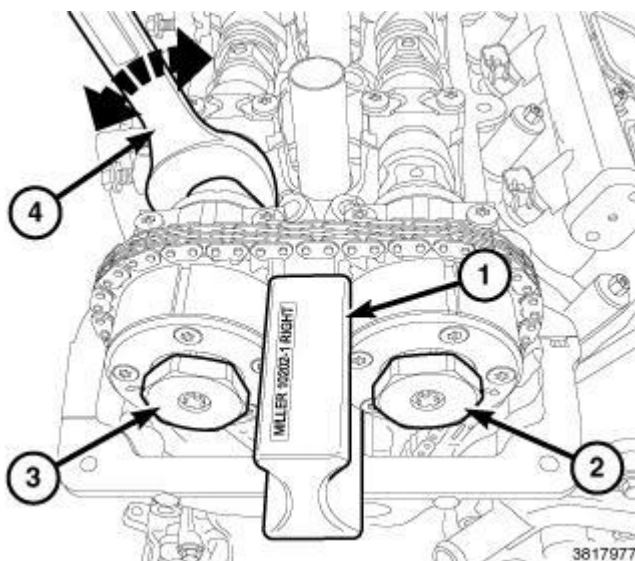
3817937

**Fig. 177: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The phaser markings (1 and 3) could align with either an external or internal chain link. Either alignment is acceptable as long as there are twelve chain pins between the markings.

5. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3) as viewed from either the front or rear of the cam phasers.
6. Mark both sides of the cam chain at the phaser timing marks (1 and 3) using a paint pen or equivalent to aid in reassembly.



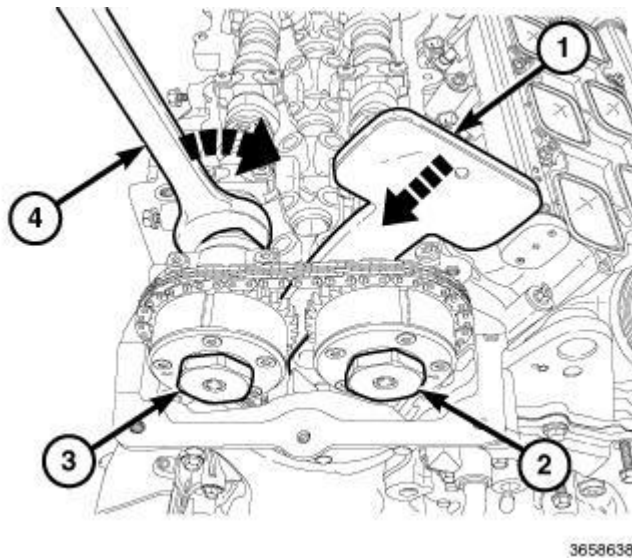
3817977

**Fig. 178: Camshaft Phaser Lock, Oil Control Valves & Wrench**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (4) when installing the camshaft phaser lock.

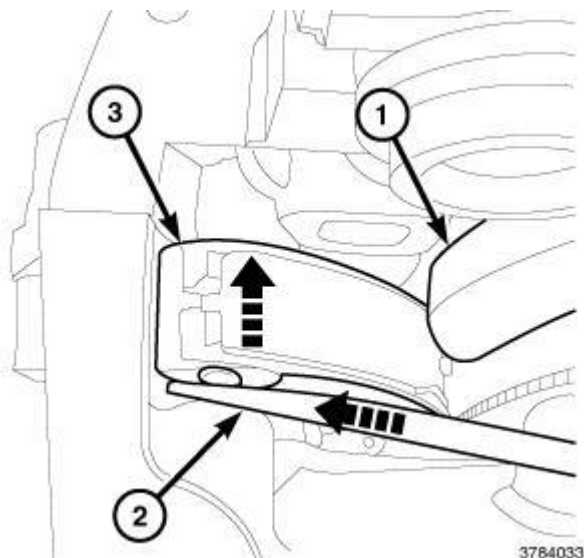
7. Install the (special tool #10202-1, Lock, Camshaft/Phaser, Right Side) (1) against the cylinder head cover mounting surface with the tool number facing up.
8. Loosen, but do not remove, the exhaust oil control valve (3) and the intake oil control valve (2).
9. Remove the (special tool #10202-1, Lock, Camshaft/Phaser, Right Side) (1).



**Fig. 179: Compressing Tensioner By Slightly Rotating Exhaust Camshaft Clockwise**  
Courtesy of CHRYSLER GROUP, LLC

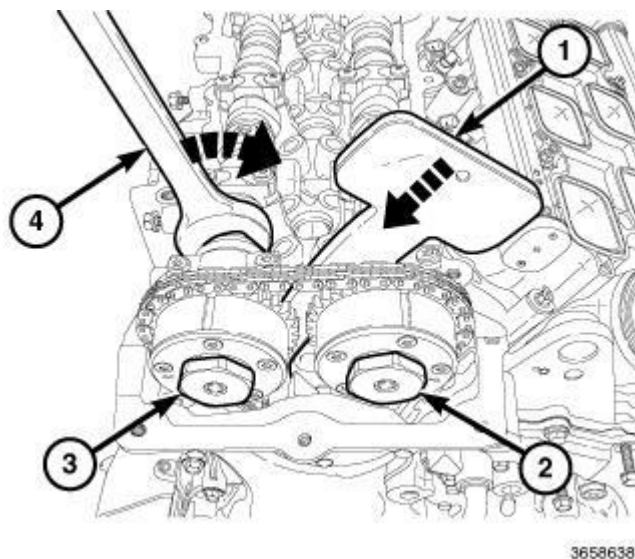
**CAUTION:** Do not insert the Timing Chain Holder into position without first compressing the tensioner. The Timing Chain Holder is not designed to compress the tensioner and excessive force can damage the timing chain tensioner arm.

10. Use the timing chain to compress the tensioner by slightly rotating the exhaust camshaft clockwise (4). Insert (special tool #10369, Holder, Timing Chain) (1) into place between the cylinder head boss and the tensioner arm to hold the tensioner in the compressed position. The Timing Chain Holder remains in place while the phasers are removed.



**Fig. 180: Timing Chain Holder, Trim Stick & Tensioner Arm**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** If the Timing Chain Holder (1) does not engage or slips from position, wedge a trim stick (2) or equivalent between the front cover and the tensioner arm (3) to push the tensioner arm towards the rear of the engine and then repeat the previous step.

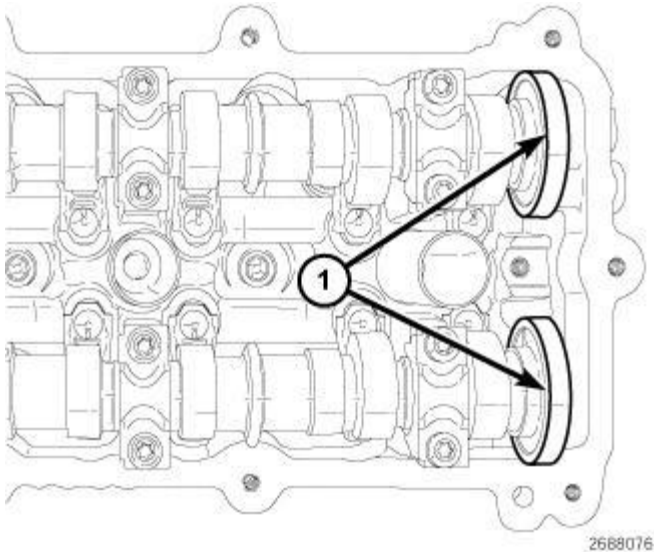


**Fig. 181: Compressing Tensioner By Slightly Rotating Exhaust Camshaft Clockwise**  
 Courtesy of CHRYSLER GROUP, LLC

11. Remove the oil control valve (3) and pull the right side exhaust cam phaser off of the camshaft.
12. Remove the oil control valve (2) and pull the right side intake cam phaser off of the camshaft.

#### INSTALLATION

LEFT

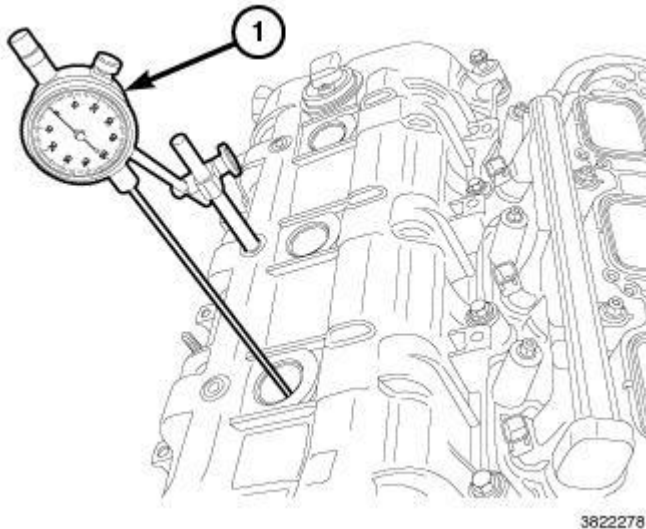


2688076

**Fig. 182: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



3822278

**Fig. 183: Mount Dial Indicator Set To Stationary Point On Engine**

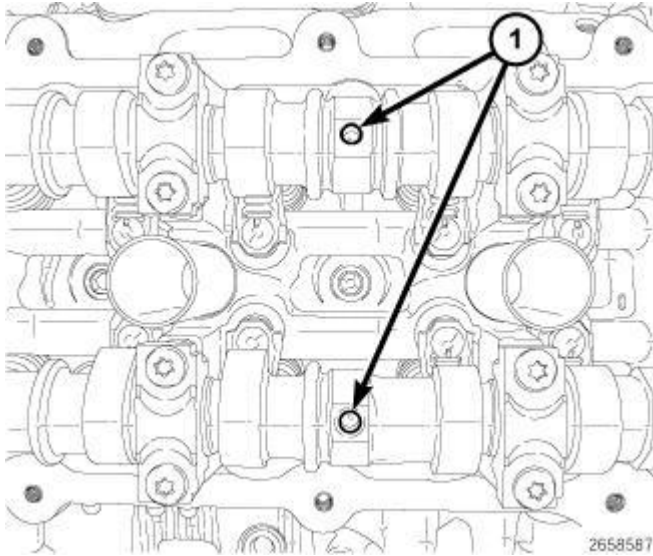
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not rotate the crankshaft more than a few degrees independently of the camshafts. Piston to valve contact could occur resulting in possible valve damage. If the crankshaft needs to be rotated more than a few degrees,



**first remove the camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL.**

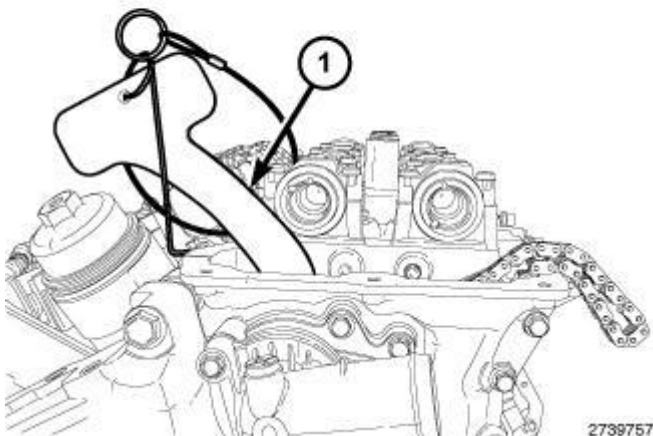
1. Verify that the indicator dial (1) is set to zero when the right side number one cylinder piston is positioned at top-dead-center on the exhaust stroke.



**Fig. 184: Positioning Camshaft Alignment Holes Vertically**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not rotate the camshafts more than a few degrees independently of the crankshaft. Valve to piston contact could occur resulting in possible valve damage.

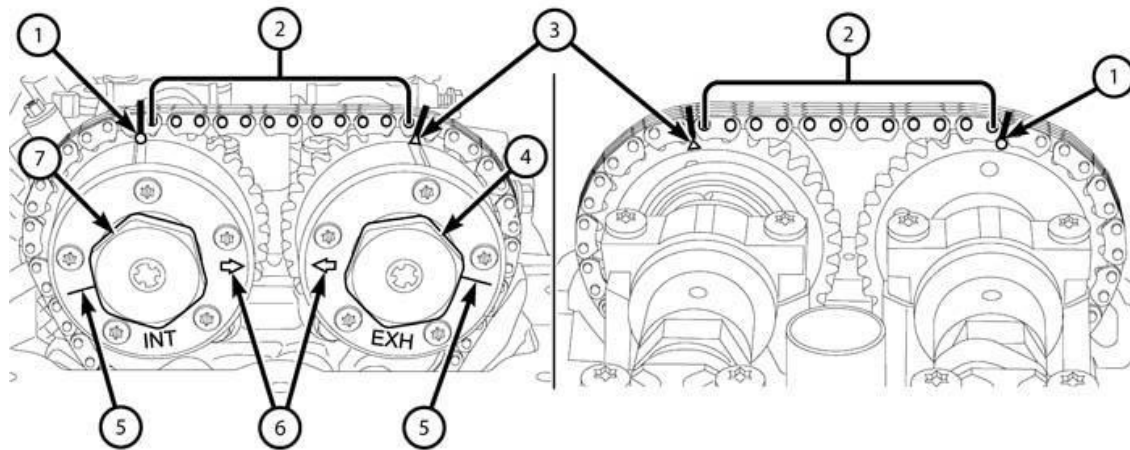
- 2.
3. Verify that the camshafts are set at top-dead-center by positioning the alignment holes (1) vertically.



**Fig. 185: Timing Chain Holder**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The Timing Chain Holder (1) should still be in place as inserted during the Removal procedure. If required, the Timing Chain Holder can be reinserted by repeating Step 10 of the Removal procedure. Refer to ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE, REMOVAL.



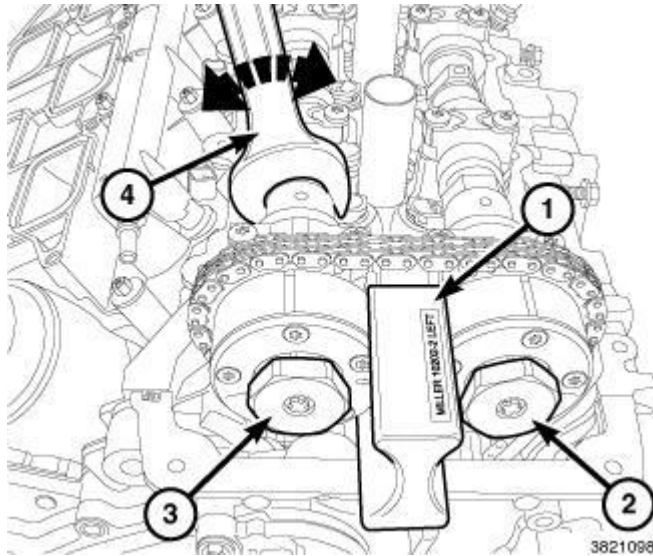
3821049

**Fig. 186: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the camshaft phaser.

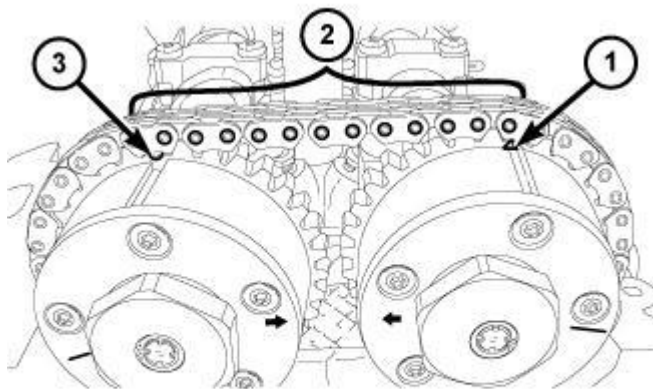
4. Route the cam chain around the left intake cam phaser while aligning the paint mark with the phaser timing mark (1). Press the left intake cam phaser onto the intake camshaft. Install and hand tighten the oil control valve (7).
5. While maintaining this alignment, route the cam chain around the exhaust cam phaser so that the paint mark is aligned with the phaser timing mark (3). Press the exhaust cam phaser onto the exhaust cam, install and hand tighten the oil control valve (4).
6. The **SCRIBE LINES** (5) on the cam phasers should face away from each other and the **ARROWS** (6) should point toward each other and be parallel to the cylinder head cover mounting surface. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (3) and the intake cam phaser circle marking (1).



**Fig. 187: Camshaft Phaser Lock, Oil Control Valves & Wrench**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (4) when installing the camshaft phaser lock.

7. Install the (special tool #10202-2, Lock, Camshaft/Phaser, Left Side) (1) against the cylinder head cover mounting surface with the tool number facing up.
8. Tighten the oil control valves (2) and (3) to 150 N.m (110 ft. lbs.).
9. Remove the Camshaft Phaser Lock (1) and the Timing Chain Holder.



**Fig. 188: Chain Pins, Arrows, Scribe Lines, Cam Phaser Triangle Marking & Circle Marking**  
Courtesy of CHRYSLER GROUP, LLC

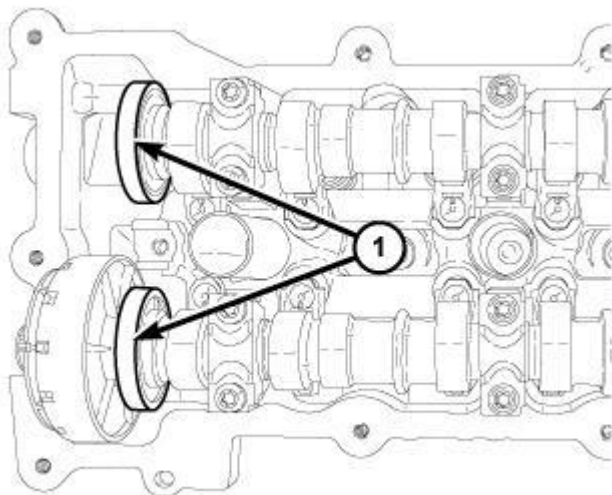
10. Rotate the crankshaft clockwise two complete revolutions stopping when the right side number one cylinder piston is again positioned at top-dead-center on the exhaust stroke. To assure correct engine

timing, verify the following;

- The indicator dial is set to **ZERO** when the right side number one cylinder piston is positioned at top-dead-center on the exhaust stroke.
  - The **SCRIBE LINES** (3) on the left side cam phasers face away from each other.
  - The **ARROWS** (4) on the left side cam phasers point toward each other and are parallel to the cylinder head cover mounting surface.
  - There are twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3).
11. If the engine timing is not correct, repeat this procedure.
  12. Install the spark plugs. Refer to **SPARK PLUG, INSTALLATION** .
  13. Install the right ignition coils. Refer to **COIL, IGNITION, 3.6L, INSTALLATION** .
  14. Install the left cylinder head cover and left ignition coils. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.
  15. Install the upper intake manifold and air cleaner housing assembly. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
  16. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
  17. Start the engine and perform the appropriate POWERTRAIN VERIFICATION TEST located in appropriate Electrical Diagnostics article.
    - Cam/Crank Variation Relearn
    - Target Coefficient Relearn

**NOTE:** Following the first restart after a DTC driven phaser replacement, clear all DTCs and verify that subsequent restarts do not set any additional codes. For any DTCs that reset, refer to appropriate Electrical Diagnostics article.

**RIGHT**

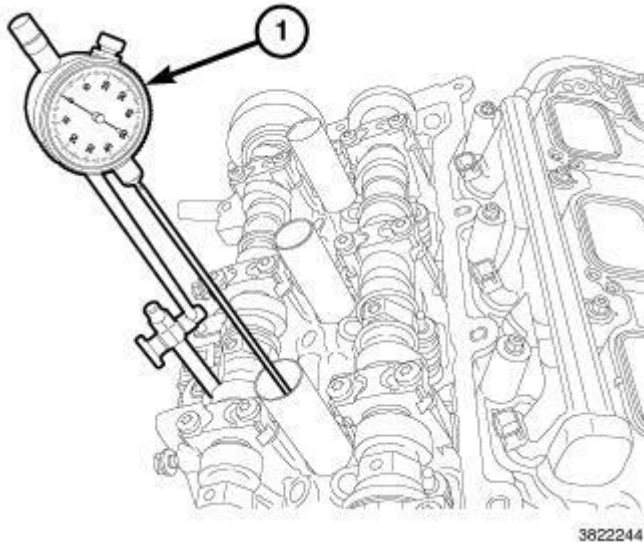


2691700

**Fig. 189: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

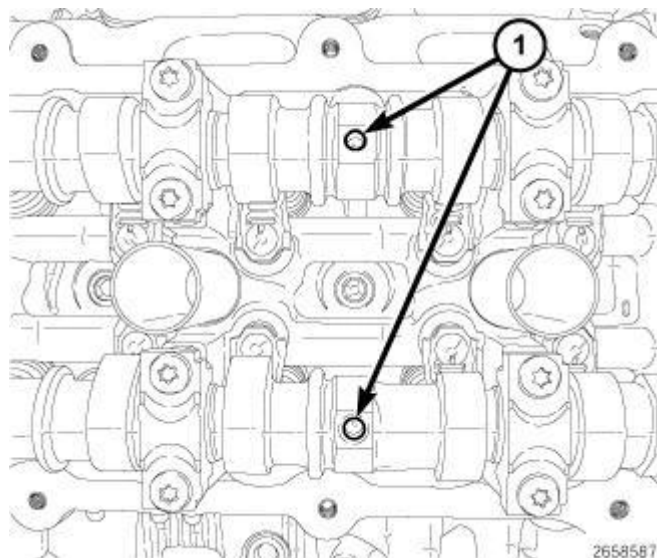
**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



**Fig. 190: Mount Dial Indicator Set To Stationary Point On Engine**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not rotate the crankshaft more than a few degrees independently of the camshafts. Piston to valve contact could occur resulting in possible valve damage. If the crankshaft needs to be rotated more than a few degrees, first remove the camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL.

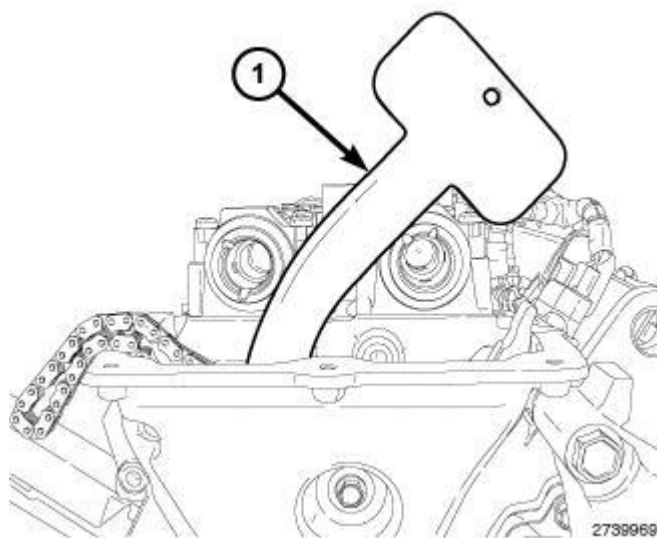
1. Verify that the indicator dial (1) is set to zero when the right side number one cylinder piston is positioned at top-dead-center on the exhaust stroke.



**Fig. 191: Positioning Camshaft Alignment Holes Vertically**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not rotate the camshafts more than a few degrees independently of the crankshaft. Valve to piston contact could occur resulting in possible valve damage.

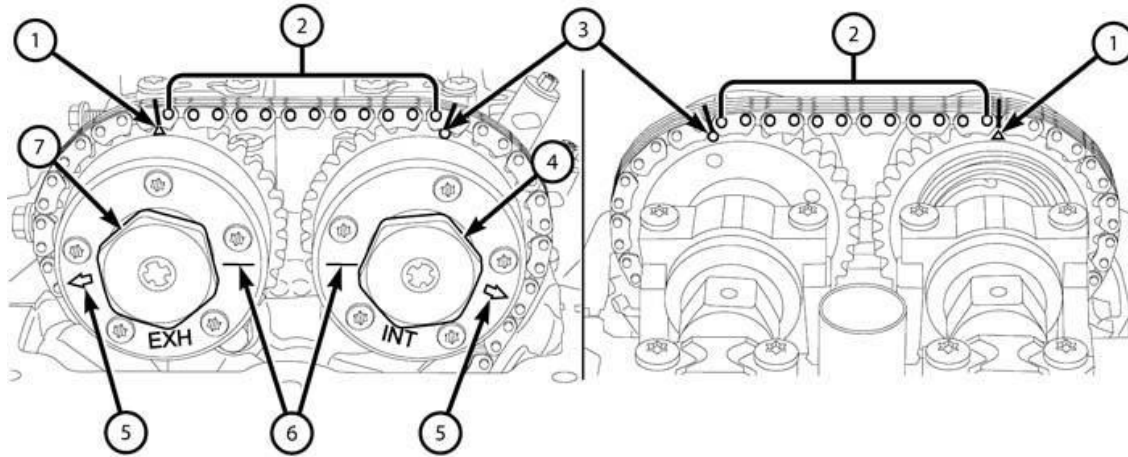
- 2.
3. Verify that the camshafts are set at top-dead-center by positioning the alignment holes (1) vertically.



**Fig. 192: Timing Chain Holder**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The Timing Chain Holder (1) should still be in place as inserted during the Removal procedure. If required, the Timing Chain Holder can be reinserted

by installing the exhaust cam phaser and repeating Step 10 of the Removal procedure. Refer to **ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE, REMOVAL**.



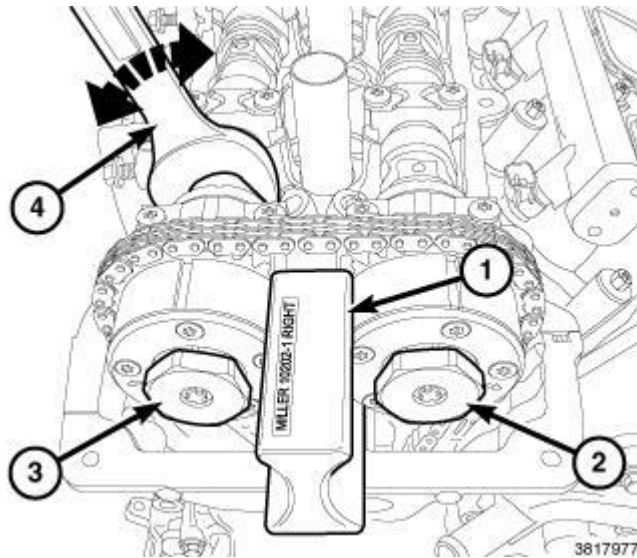
3817937

**Fig. 193: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the camshaft phaser.

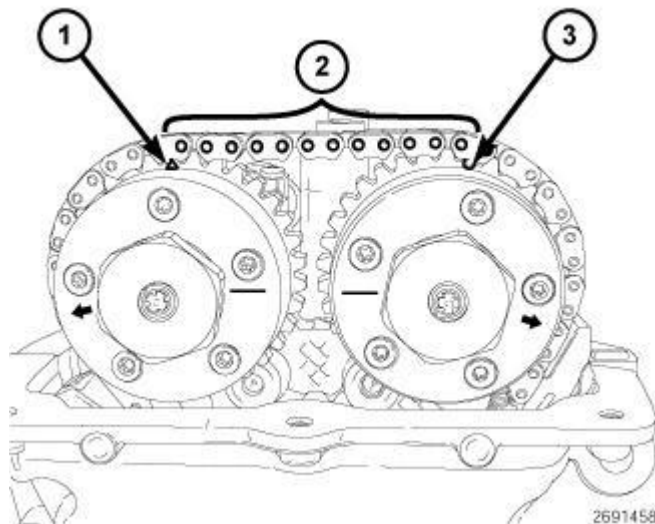
4. Route the cam chain around the right exhaust cam phaser while aligning the paint mark with the phaser timing mark (1). Press the right exhaust cam phaser onto the exhaust camshaft. Install and hand tighten the oil control valve (7).
5. While maintaining this alignment, route the cam chain around the intake cam phaser so that the paint mark is aligned with the phaser timing mark (3). Press the intake cam phaser onto the intake cam, install and hand tighten the oil control valve (4).
6. The **ARROWS** (5) on the cam phasers should point away from each other and the **SCRIBE LINES** (6) should be parallel to the cylinder head cover mounting surface. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3).



**Fig. 194: Camshaft Phaser Lock, Oil Control Valves & Wrench**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (4) when installing the camshaft phaser lock.

7. Install the (special tool #10202-1, Lock, Camshaft/Phaser, Right Side) (1) against the cylinder head cover mounting surface with the tool number facing up.
8. Tighten the oil control valves (2) and (3) to 150 N.m (110 ft. lbs.).
9. Remove the Camshaft Phaser Lock (1) and the Timing Chain Holder.



**Fig. 195: Chain Pins, Arrows, Scribe Lines, Cam Phaser Triangle Marking & Circle Marking**  
Courtesy of CHRYSLER GROUP, LLC

10. Rotate the crankshaft clockwise two complete revolutions stopping when the right side number one cylinder piston is again positioned at top-dead-center on the exhaust stroke. To assure correct engine



timing, verify the following;

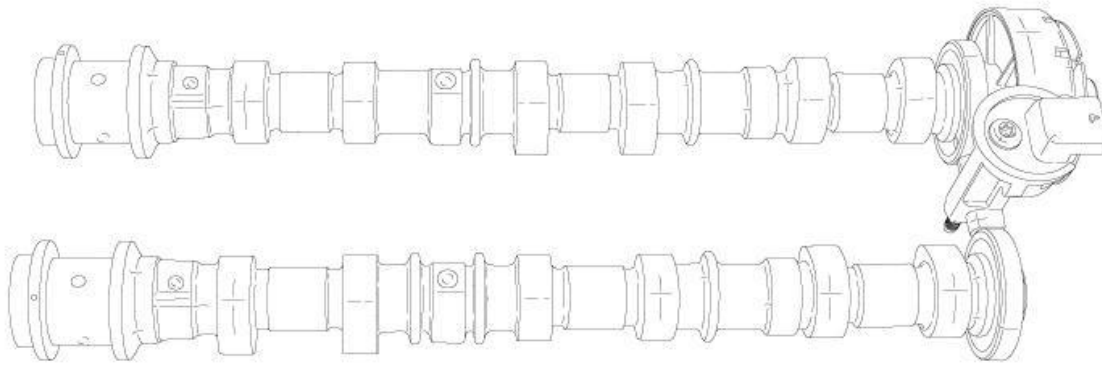
- The indicator dial is set to **ZERO** when the right side number one cylinder piston is positioned at top-dead-center on the exhaust stroke.
  - The **ARROWS** (4) on the right side cam phasers point away from each other.
  - The **SCRIBE LINES** (5) on the right side cam phasers are parallel to the cylinder head cover mounting surface.
  - There are twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3).
11. If the engine timing is not correct, repeat this procedure.
  12. Install the spark plugs. Refer to **SPARK PLUG, INSTALLATION** .
  13. Install the left ignition coils. Refer to **COIL, IGNITION, 3.6L, INSTALLATION** .
  14. Install the right cylinder head cover and right ignition coils. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.
  15. Install the upper intake manifold and air cleaner housing assembly. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
  16. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
  17. Start the engine and perform the appropriate POWERTRAIN VERIFICATION TEST located in appropriate Electrical Diagnostics article.
    - Cam/Crank Variation Relearn
    - Target Coefficient Relearn

**NOTE:**        **Following the first restart after a DTC driven phaser replacement, clear all DTCs and verify that subsequent restarts do not set any additional codes. For any DTCs that reset, refer to appropriate Electrical Diagnostics article.**

## CAMSHAFT, ENGINE

### DESCRIPTION

### DESCRIPTION



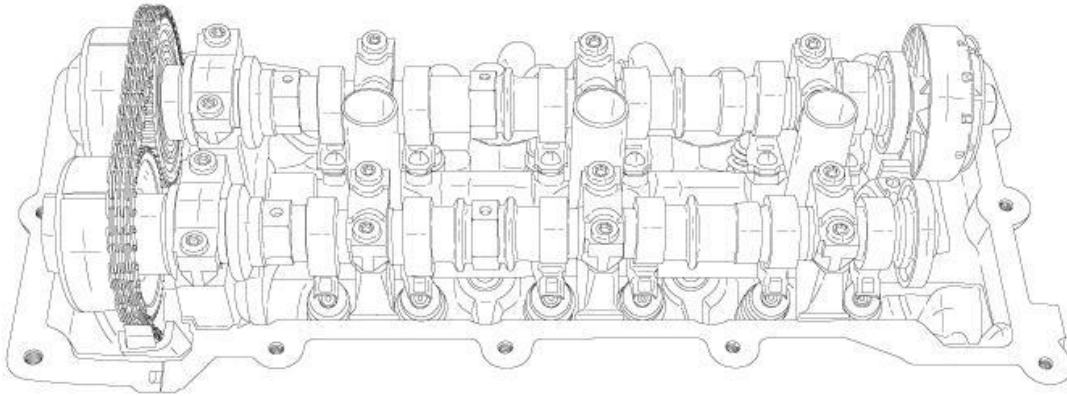
2820031

**Fig. 196: Dual Over Head Camshaft (DOHC) Configuration**  
**Courtesy of CHRYSLER GROUP, LLC**

The 3.6L engine uses a Dual Over Head Camshaft (DOHC) configuration. The camshafts are a nodular cast iron design and have a pressed on magnetic timing wheel that is magnetic encoded. The two Camshaft Position (CMP) sensors are located between the timing wheels. Attached to the rear of the right exhaust camshaft is a centrifuge which is part of the crankcase ventilation system. The centrifuge is used to separate oil droplets from the crankcase gases before they enter the PCV valve. Four bearing journals are machined into the camshaft. Camshaft end play is controlled by two thrust walls that border the nose piece journal.

#### **OPERATION**

#### **OPERATION**

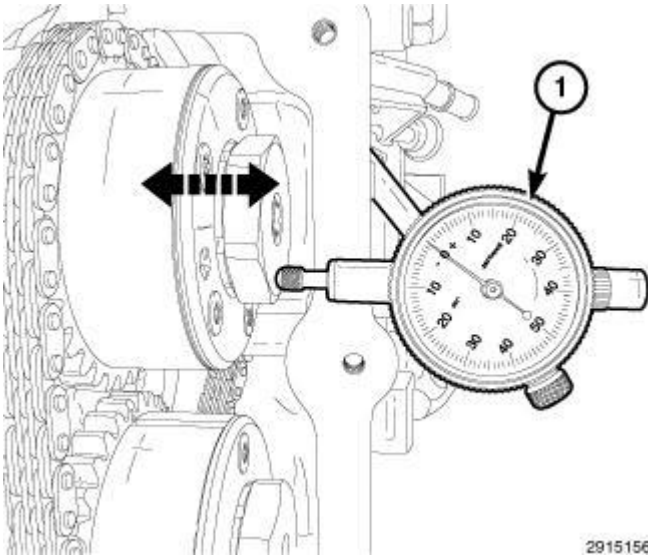


2820145

**Fig. 197: Right Hand Camshafts****Courtesy of CHRYSLER GROUP, LLC****NOTE: RH camshafts shown in illustration, LH camshafts similar.**

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

**STANDARD PROCEDURE****STANDARD PROCEDURE - CAMSHAFT END PLAY**



2915156

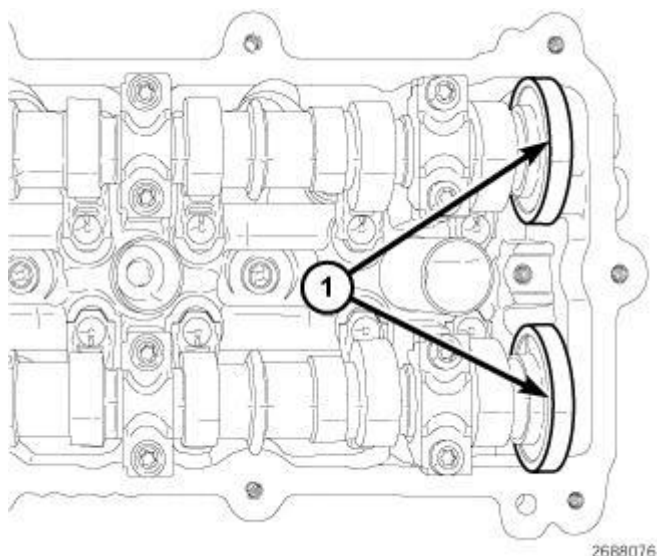
**Fig. 198: Measuring Camshaft End Play Using Dial Indicator**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Right intake camshaft shown in illustration, other camshafts similar.

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

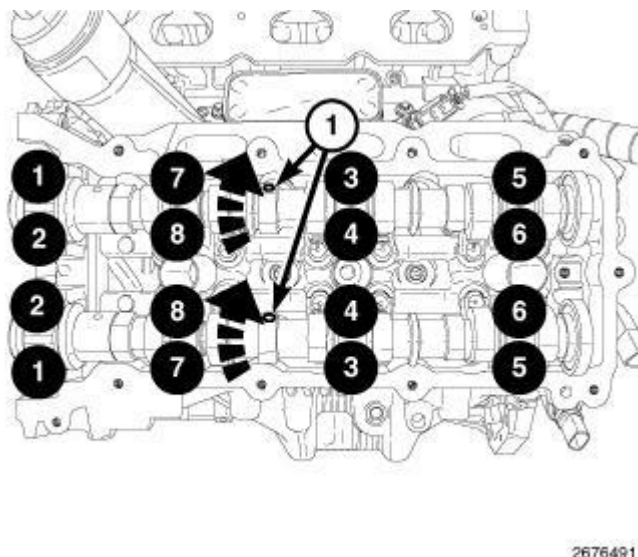
### LEFT



**Fig. 199: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



**Fig. 200: Camshaft Bearing Cap Bolts Removal Sequence - Left**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** When the timing chain is removed and the cylinder heads are still installed, Do not forcefully rotate the camshafts or crankshaft independently of each other. Severe valve and/or piston damage can occur.

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

1. Remove the upper intake manifold, all ignition coils, all spark plugs, left cylinder head cover and left cam phasers. Refer to **ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE, REMOVAL**.
2. Rotate the camshafts counterclockwise to position the alignment holes (1) approximately 30° before top-dead-center. This places the camshafts in the neutral position (no valve load).

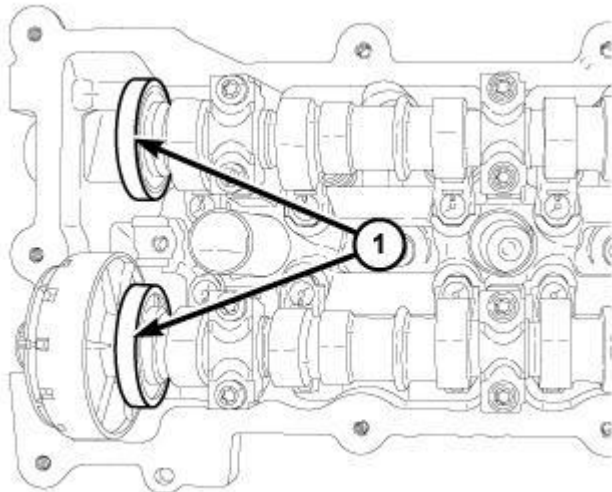
**NOTE:** Camshaft bearing caps should have been marked during engine manufacturing. For example, the number one exhaust camshaft bearing cap is marked "1E->". The caps should be installed with the notch forward.

3. Loosen the camshaft bearing cap bolts in the sequence shown in illustration.

**NOTE:** When the camshaft is removed the rocker arms may slide downward, mark the rocker arms before removing the camshaft.

4. Remove the camshaft bearing caps and the camshafts.

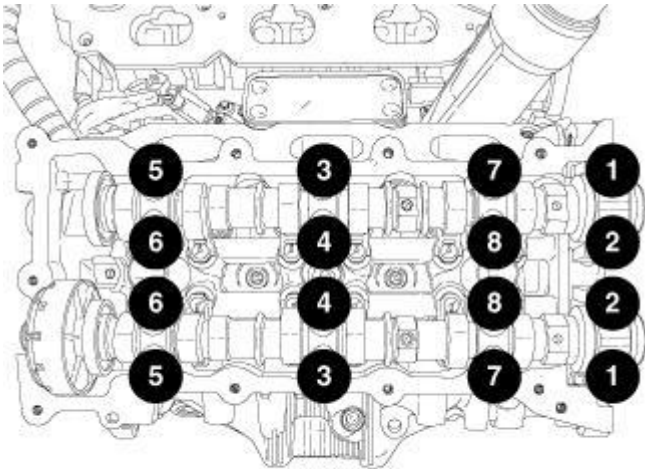
RIGHT



2691700

**Fig. 201: Magnetic Timing Wheels**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



2668694

**Fig. 202: Camshaft Bearing Cap Bolts Removal Sequence - Right**  
 Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** When the timing chain is removed and the cylinder heads are still installed, Do not forcefully rotate the camshafts or crankshaft independently of each other. Severe valve and/or piston damage can occur.

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

1. Remove the upper intake manifold, all ignition coils, all spark plugs, right cylinder head cover and right cam phasers. Refer to ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE, REMOVAL.

**NOTE:** Camshaft bearing caps should have been marked during engine manufacturing. For example, the number one exhaust camshaft bearing cap is marked "1E->". The caps should be installed with the notch forward.

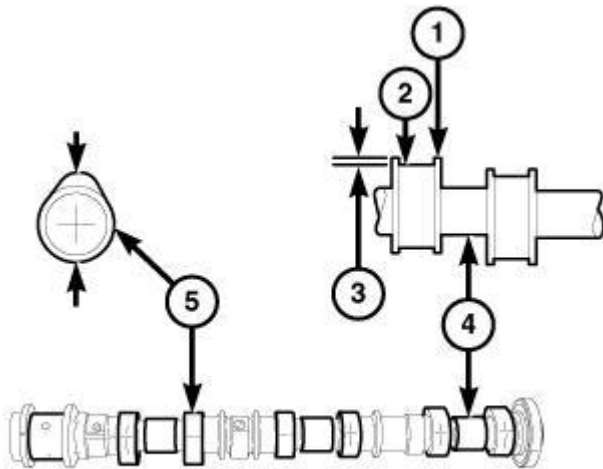
2. Loosen the camshaft bearing cap bolts in the sequence shown in illustration.

**NOTE:** When the camshaft is removed the rocker arms may slide downward, mark the rocker arms before removing the camshaft.

3. Remove the camshaft bearing caps and the camshafts.

## INSPECTION

## INSPECTION



2819808

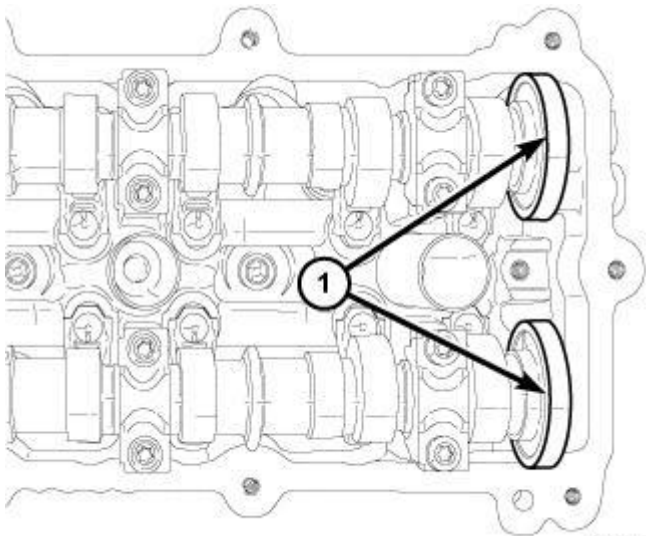
**Fig. 203: Inspecting Camshaft Bearing Journals & Cam Lobes**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** RH intake camshaft shown in illustration, other camshafts similar.

1. Inspect camshaft bearing journals (4) for damage and binding. If journals are binding, check the cylinder head for damage. Also check cylinder head oil holes for clogging.
2. Check the surface of the cam lobes (5) for abnormal wear (3). Measure and compare the unworn area (1) to the worn area (2). Replace camshafts that are not within specification. Refer to **Engine - Specifications**.

## INSTALLATION

### LEFT



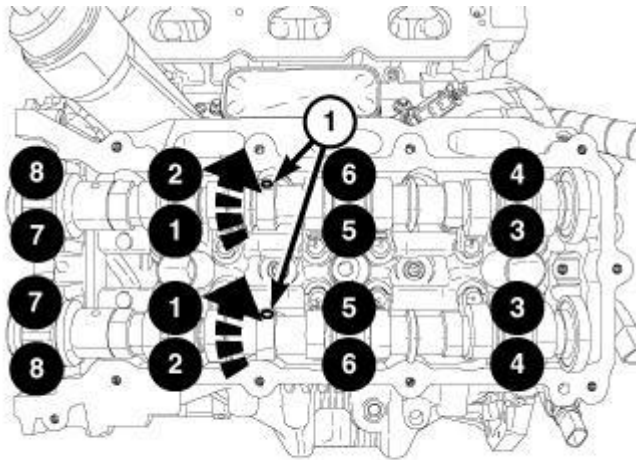
2668076

**Fig. 204: Magnetic Timing Wheels**



Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



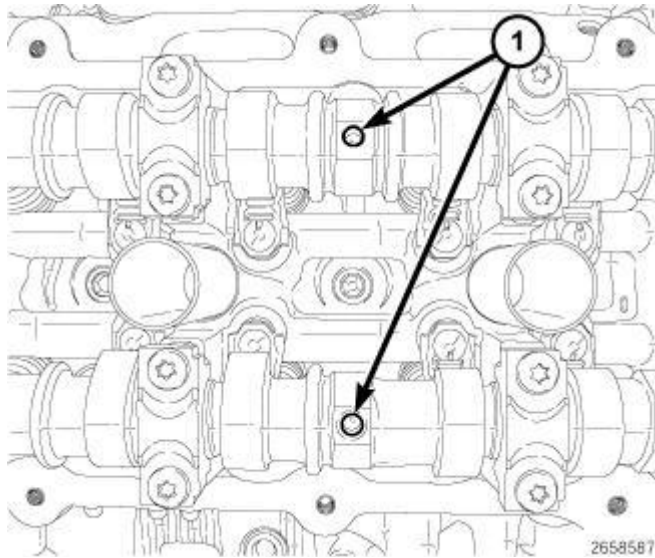
2666894

**Fig. 205: Bearing Cap Retaining Bolts Tightening Sequence - Left**  
Courtesy of CHRYSLER GROUP, LLC

1. Lubricate the camshaft journals with clean engine oil.
2. Install the left side camshaft(s) with the alignment holes (1) positioned approximately 30° before top-dead-center. This will place the camshafts at the neutral position (no valve load) easing the installation of the camshaft bearing caps.
3. Install the camshaft bearing caps and hand tighten the retaining bolts to 2 N.m (18 in. lbs.).

**NOTE:** Caps are identified numerically (1 through 4), intake or exhaust (I or E) and should be installed from the front to the rear of the engine. All caps should be installed with the notch forward so that the stamped arrows (<) on the caps point toward the front of the engine.

4. Tighten the bearing cap retaining bolts in the sequence shown in illustration to 9.5 N.m (84 in. lbs.).

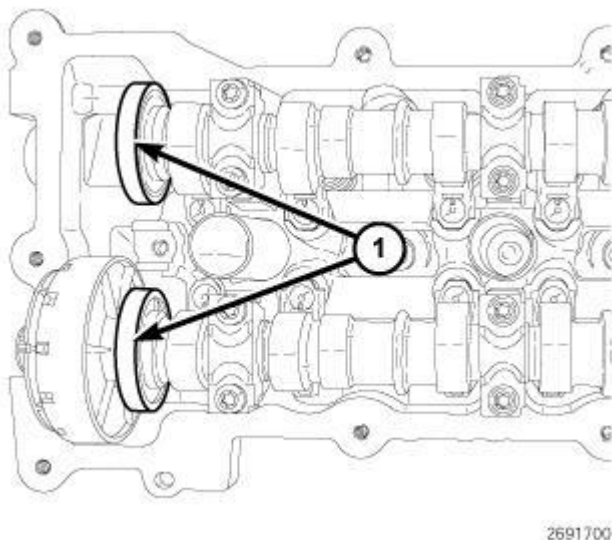


**Fig. 206: Positioning Camshaft Alignment Holes Vertically**  
Courtesy of CHRYSLER GROUP, LLC

5. Rotate the camshafts clockwise to top-dead-center by positioning the alignment holes (1) vertically.
6. Install the left cam phasers, cylinder head cover, spark plugs, ignition coils and the upper intake manifold. Refer to **ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE, 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.

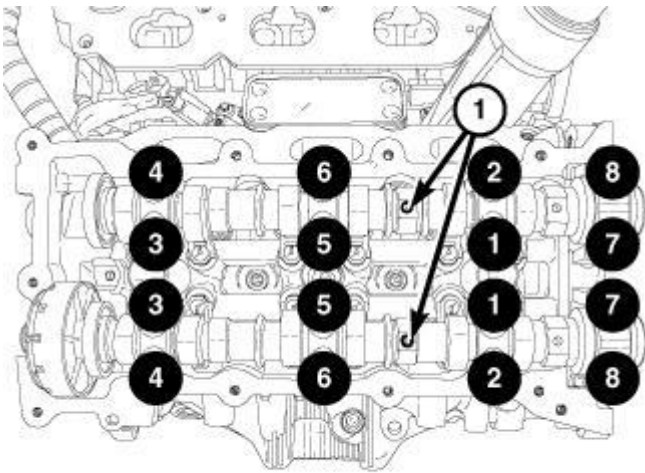
**RIGHT**



**Fig. 207: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



2668733

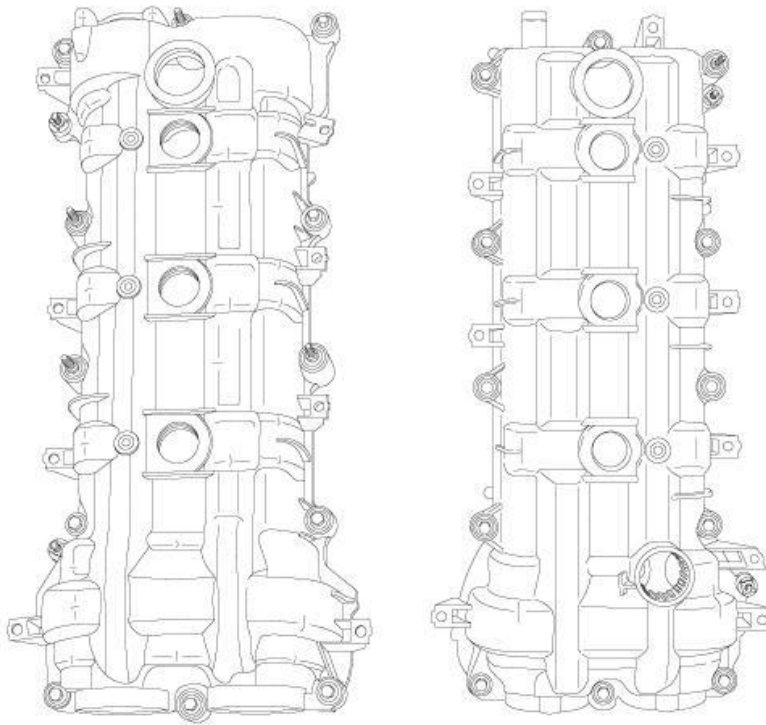
**Fig. 208: Bearing Cap Retaining Bolts Tightening Sequence - Right**  
Courtesy of CHRYSLER GROUP, LLC

1. Lubricate camshaft journals with clean engine oil.
2. Install the right side camshaft(s) at top-dead-center by positioning the alignment holes (1) vertically. This will place the camshafts at the neutral position (no valve load) easing the installation of the camshaft bearing caps.
3. Install the camshaft bearing caps and hand tighten the retaining bolts to 2 N.m (18 in. lbs.).

**NOTE:** Caps are identified numerically (1 through 4), intake or exhaust (I or E) and should be installed from the front to the rear of the engine. All caps should be installed with the notch forward so that the stamped arrows (<) on the caps point toward the front of the engine.

4. Tighten the bearing cap retaining bolts in the sequence shown in illustration to 9.5 N.m (84 in. lbs.).
5. Install the right cam phasers, cylinder head cover, spark plugs, ignition coils and the upper intake manifold. Refer to **ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE, 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.

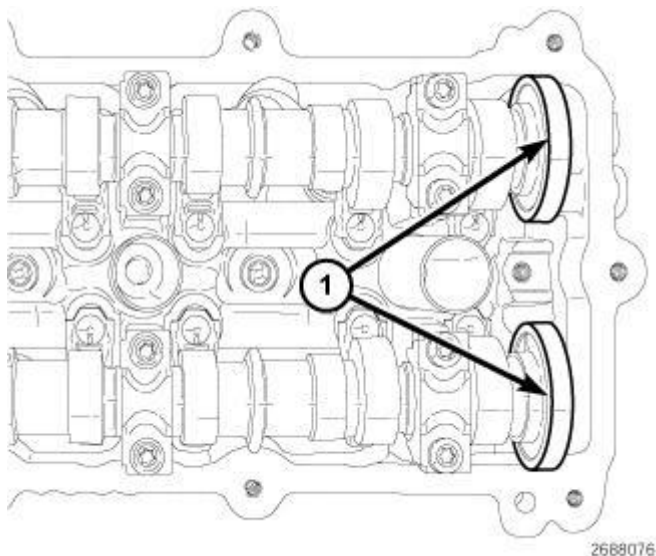
**COVER(S), CYLINDER HEAD****DESCRIPTION****DESCRIPTION**

2819308

**Fig. 209: Cylinder Head Covers****Courtesy of CHRYSLER GROUP, LLC**

The cylinder head covers are made of a carbon and fiberglass composite. The cylinder head covers are not interchangeable from side-to-side. The cylinder head covers are sealed with a press-in-place gasket that is designed to isolate the cover from the cylinder head for improved NVH. There are two dowel pins on the outboard side of the cover flange to locate the cover to holes in the cylinder head. RTV is used to seal the T-joint at the timing cover, cylinder head and cylinder head cover.

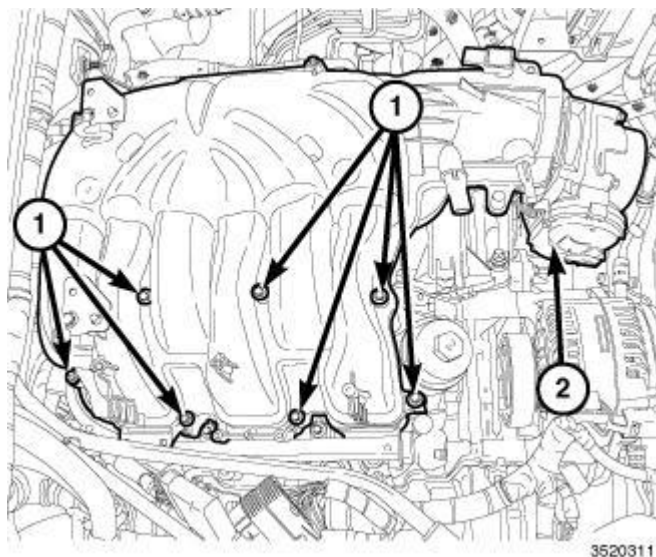
**REMOVAL****LEFT**



**Fig. 210: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

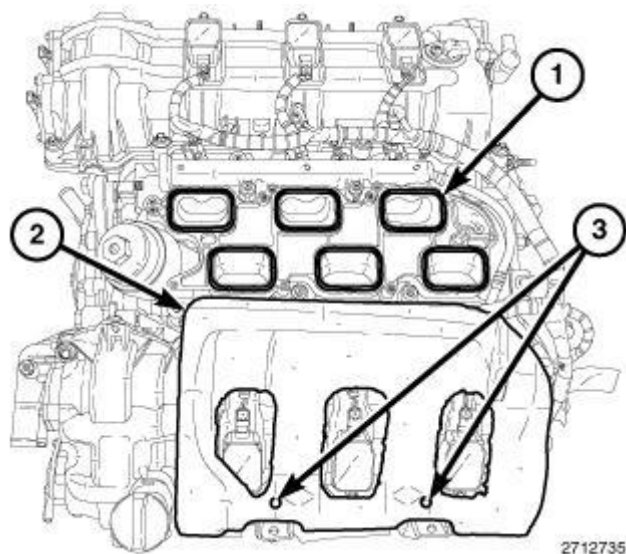
**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



**Fig. 211: Upper Intake Manifold & Fasteners**

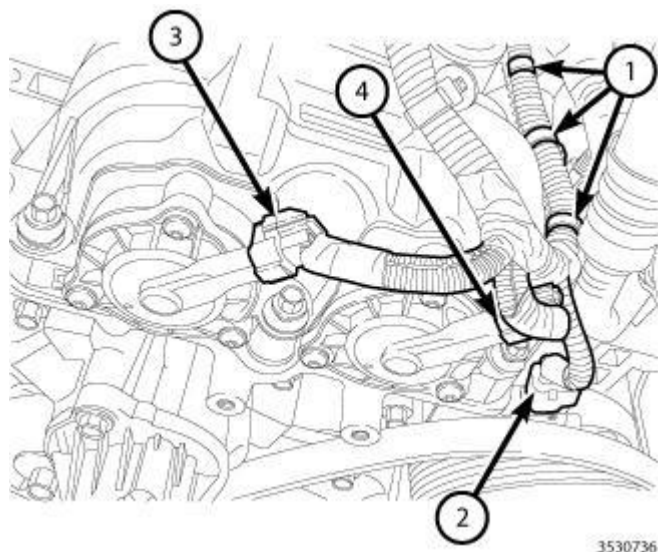
Courtesy of CHRYSLER GROUP, LLC

1. Disconnect and isolate the negative battery cable.
2. Remove the air cleaner body and upper intake manifold (2). Refer to **MANIFOLD, INTAKE, REMOVAL**.



**Fig. 212: Intake Ports, Insulator & Alignment Posts**  
 Courtesy of CHRYSLER GROUP, LLC

3. Cover the open intake ports (1) to prevent debris from entering the engine.
4. Remove the insulator (2) from the LH cylinder head cover.

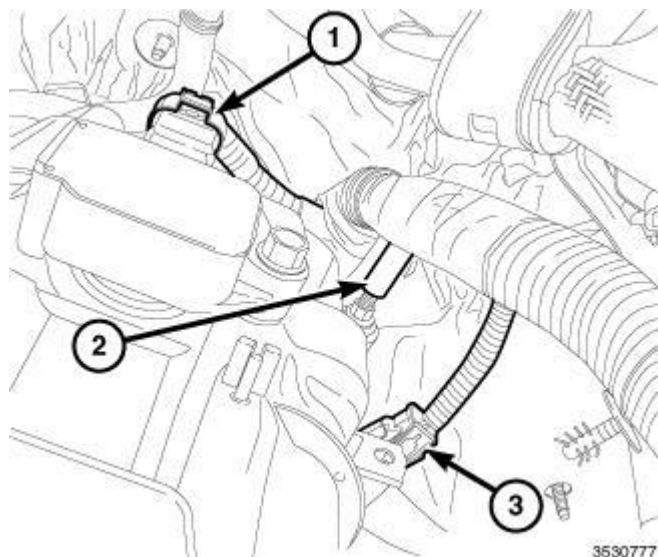


**Fig. 213: Retainers, A/C Compressor Electrical Connector & Left Intake And Left Exhaust Variable Valve Timing Solenoid Electrical Connectors**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Mark the variable valve timing solenoid connectors (3 and 4) with a paint pen or equivalent so that they may be reinstalled in their original locations.

5. Disconnect the A/C compressor electrical connector (2).
6. Disconnect the left exhaust variable valve timing solenoid electrical connector (4).

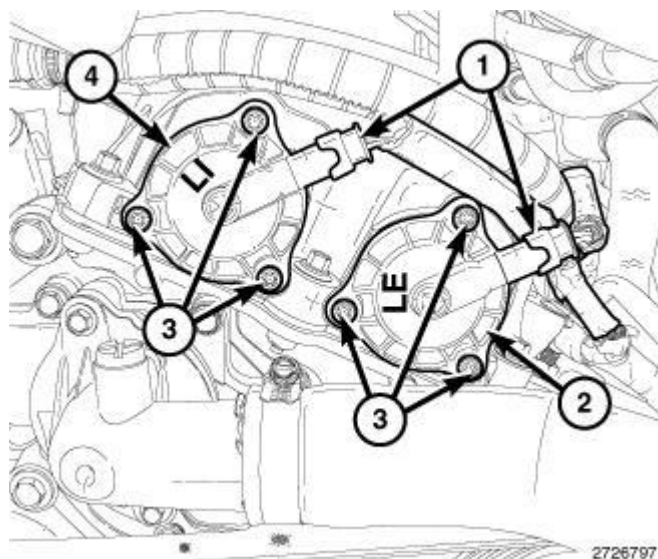
7. Disconnect the left intake variable valve timing solenoid electrical connector (3).
8. Disengage three wire harness retainers (1) from the left cylinder head cover.



**Fig. 214: Camshaft Position (CMP) Sensor, Retainer & Engine Coolant Temperature (ECT) Sensor Connector**

Courtesy of CHRYSLER GROUP, LLC

9. Disconnect the Engine Coolant Temperature (ECT) sensor connector (3).
10. Disconnect the left Camshaft Position (CMP) sensor (1).
11. Disengage the main wire harness retainer (2) from the cylinder head cover mounting stud.



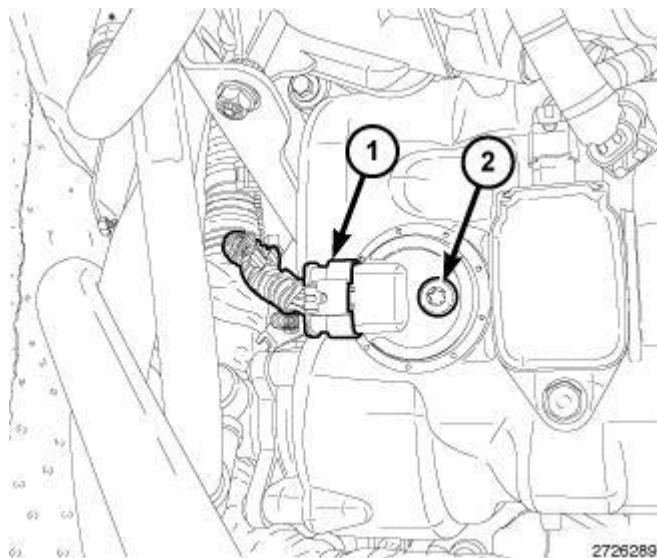
**Fig. 215: Variable Valve Timing Solenoids, Connectors & Bolts**

Courtesy of CHRYSLER GROUP, LLC

12. Mark the variable valve timing solenoids (2 and 4) with a paint pen or equivalent so that they may be

reinstalled in their original locations.

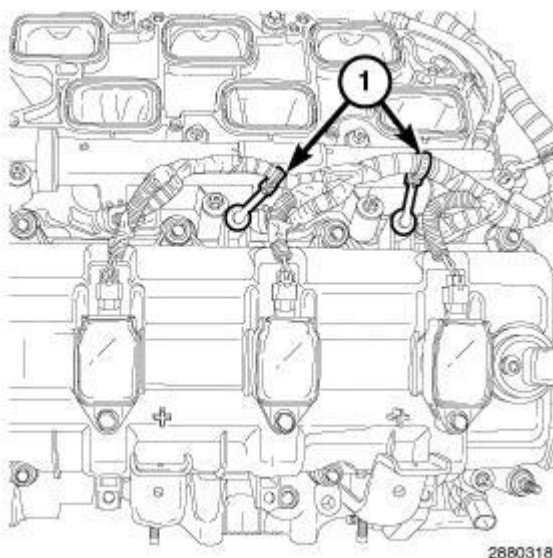
13. Remove the variable valve timing solenoids. Refer to **SOLENOID, VARIABLE VALVE TIMING, REMOVAL**.



**Fig. 216: CMP Sensor & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The RH CMP sensor is shown in illustration, the LH CMP sensor is similar. If removing both RH and LH CMP sensors, mark the sensors so they can be installed in their original locations.

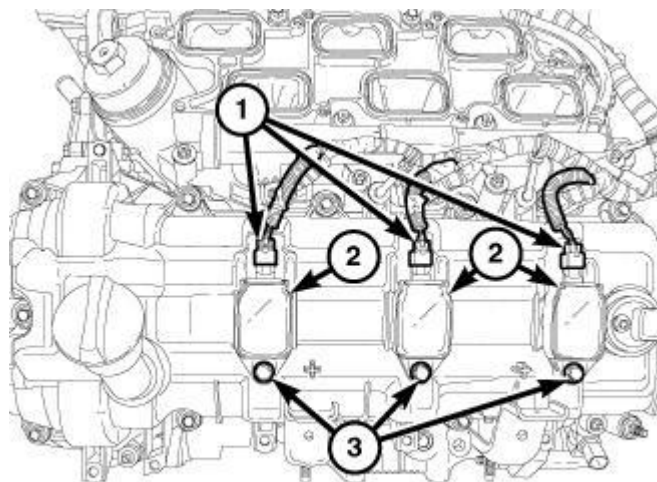
14. Remove the camshaft position sensor. Refer to **SENSOR, CAMSHAFT POSITION, 3.6L, REMOVAL**.



**Fig. 217: Injection/Ignition Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC



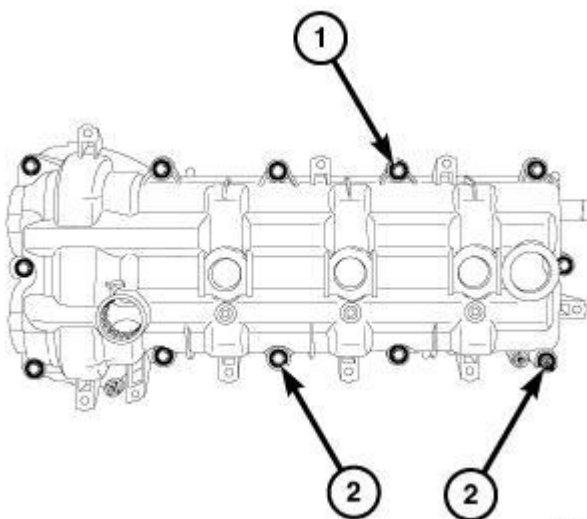
15. Disengage two injection/ignition harness retainers (1) from the left cylinder head cover.



2726572

**Fig. 218: Electrical Connector, Ignition Coils & Ignition Coil Retaining Bolts**  
Courtesy of CHRYSLER GROUP, LLC

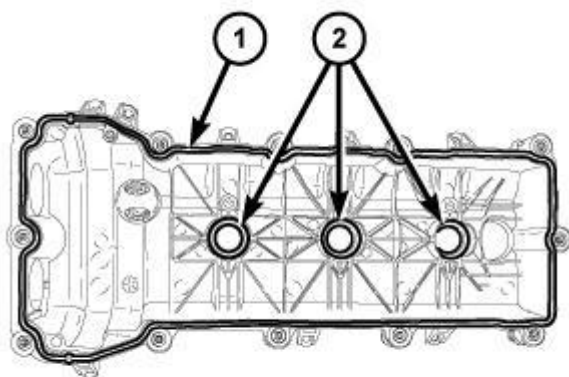
16. Remove the ignition coils (2). Refer to **COIL, IGNITION, 3.6L, REMOVAL** .



2719912

**Fig. 219: Cylinder Head Cover Mounting Bolts & Studbolts**  
Courtesy of CHRYSLER GROUP, LLC

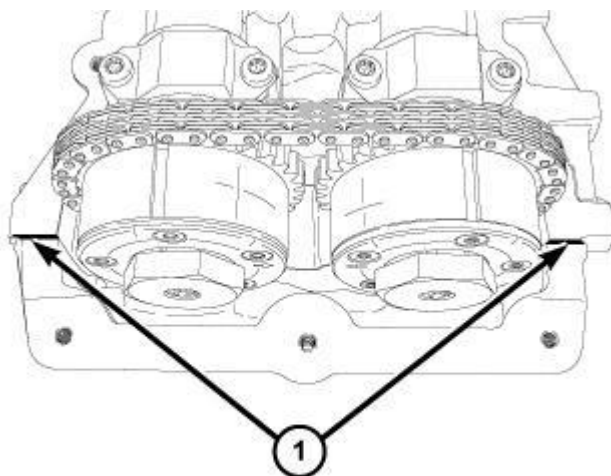
17. Loosen ten cylinder head cover mounting bolts (1) and two studbolts (2) and remove the cylinder head cover.



2776066

**Fig. 220: Cylinder Head Cover Gasket & Spark Plug Tube Seals**  
 Courtesy of CHRYSLER GROUP, LLC

18. Remove and discard the cylinder head cover gasket (1).
19. The spark plug tube seals (2) can be reused if not damaged.



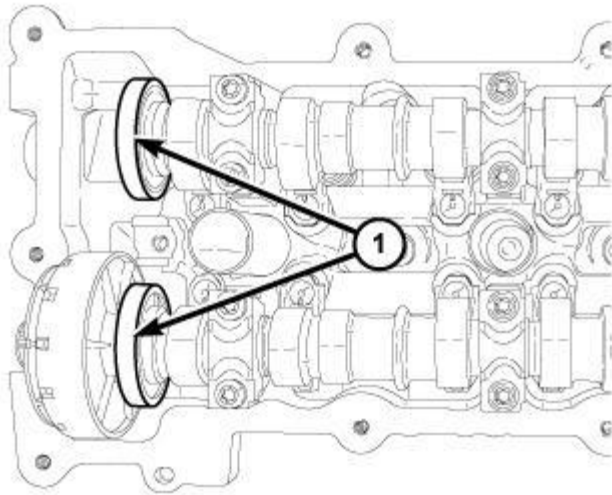
2776075

**Fig. 221: RTV Sealant Locations**  
 Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not use oil based liquids, wire brushes, abrasive wheels or metal scrapers to clean the engine gasket surfaces. Use only isopropyl (rubbing) alcohol, along with plastic or wooden scrapers. Improper gasket surface preparation may result in engine fluid leakage.

20. Remove all residual sealant (1) from the cylinder head, timing chain cover and cylinder head cover mating surfaces. Refer to **Engine - Standard Procedure**.

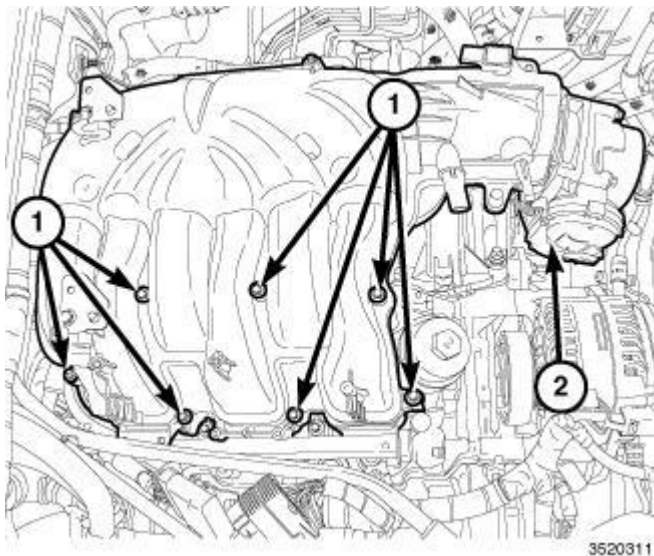
RIGHT



2691700

**Fig. 222: Magnetic Timing Wheels**  
Courtesy of CHRYSLER GROUP, LLC

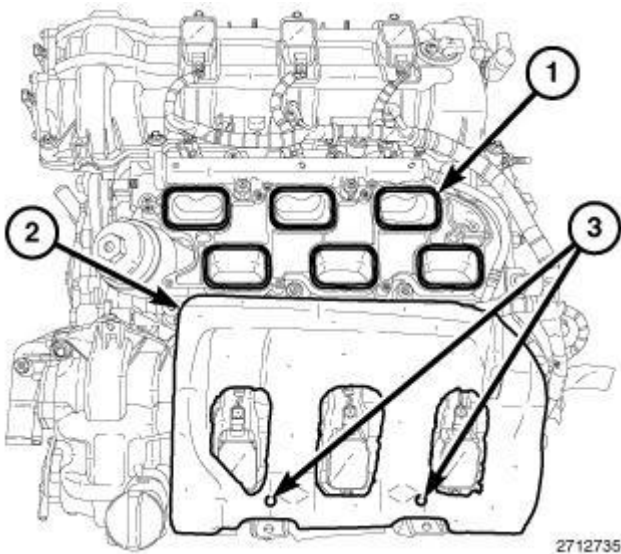
**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



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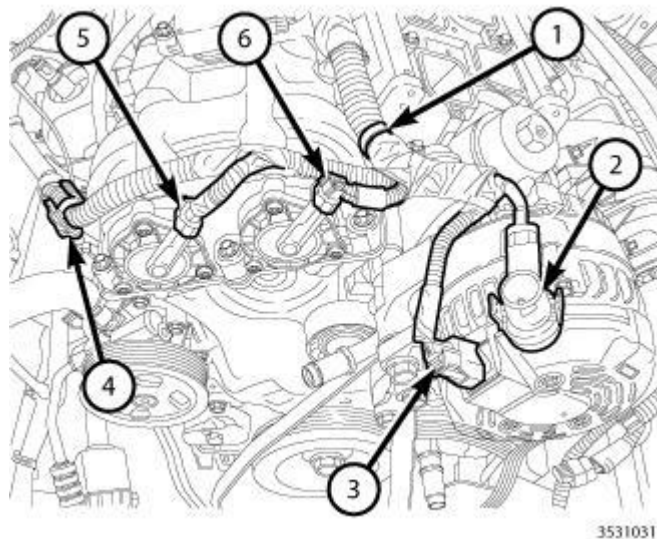
**Fig. 223: Upper Intake Manifold & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

1. Disconnect and isolate the negative battery cable.
2. Remove the air cleaner body and upper intake manifold (2). Refer to **MANIFOLD, INTAKE, REMOVAL**.



**Fig. 224: Intake Ports, Insulator & Alignment Posts**  
 Courtesy of CHRYSLER GROUP, LLC

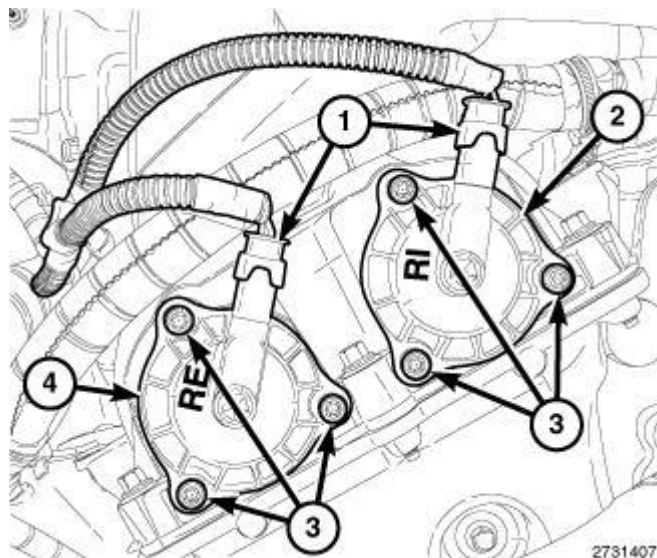
3. Cover the open intake ports (1) to prevent debris from entering the engine.



**Fig. 225: Generator Stud, Connector, Retainers & Right Exhaust And Right Intake Variable Valve Timing Solenoid Electrical Connectors**  
 Courtesy of CHRYSLER GROUP, LLC

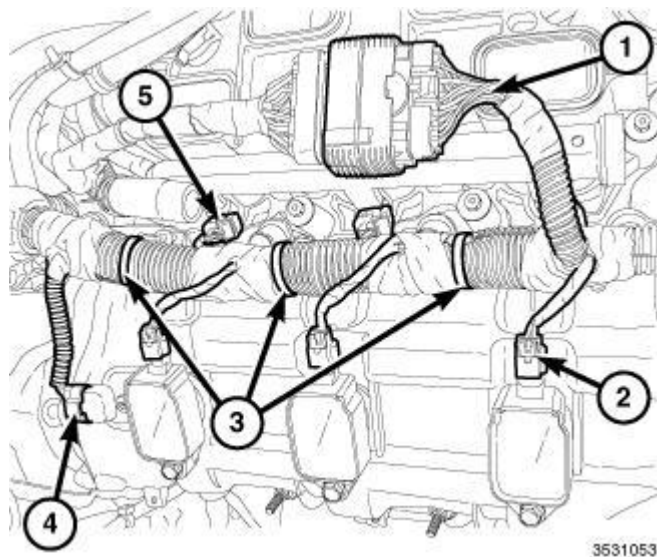
**NOTE:** Mark the variable valve timing solenoid connectors (5 and 6) with a paint pen or equivalent so that they may be reinstalled in their original locations.

4. Disconnect the right exhaust variable valve timing solenoid electrical connector (5).
5. Disconnect the right intake variable valve timing solenoid electrical connector (6).
6. Disengage the wire harness retainers (1 and 4) from the right cylinder head cover.



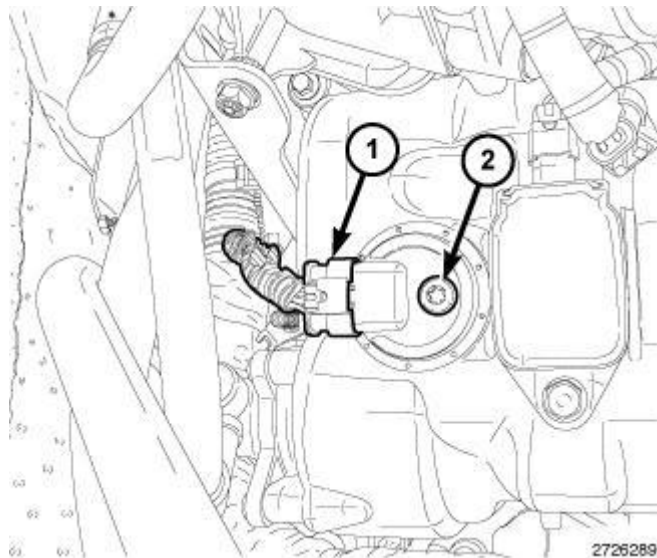
**Fig. 226: Variable Valve Timing Solenoids, Connectors & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

7. Mark the variable valve timing solenoids (2 and 4) with a paint pen or equivalent so that they may be reinstalled in their original locations.
8. Remove the variable valve timing solenoids. Refer to **SOLENOID, VARIABLE VALVE TIMING, REMOVAL**.



**Fig. 227: Engine Injection/Ignition Harness, Ignition Coil Electrical Connectors, Retainers, Camshaft Position (CMP) Sensor Connector & Fuel Injector Electrical Connectors**  
Courtesy of CHRYSLER GROUP, LLC

9. Disconnect three ignition coil electrical connectors (2).
10. Disconnect the electrical connector (4) from the right Camshaft Position (CMP) sensor.
11. Disengage three main wire harness retainers (3) from the right cylinder head cover.

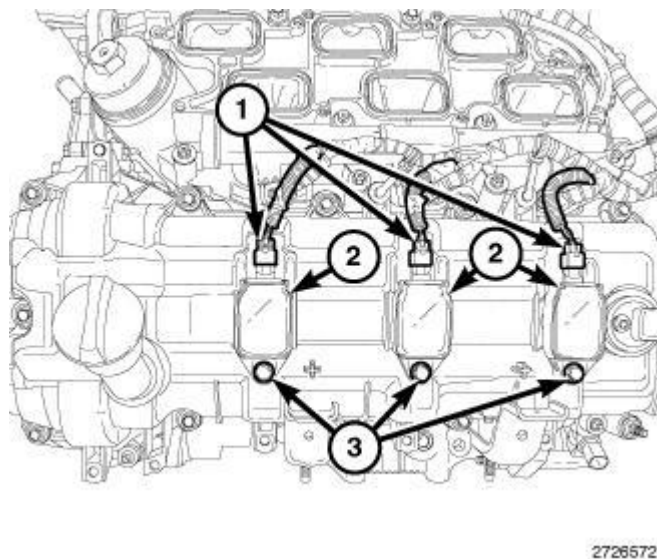


**Fig. 228: CMP Sensor & Bolt**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** If removing both RH and LH CMP sensors, mark the sensors so they can be installed in their original locations.

12. Remove the camshaft position sensor. Refer to **SENSOR, CAMSHAFT POSITION, 3.6L, REMOVAL** .

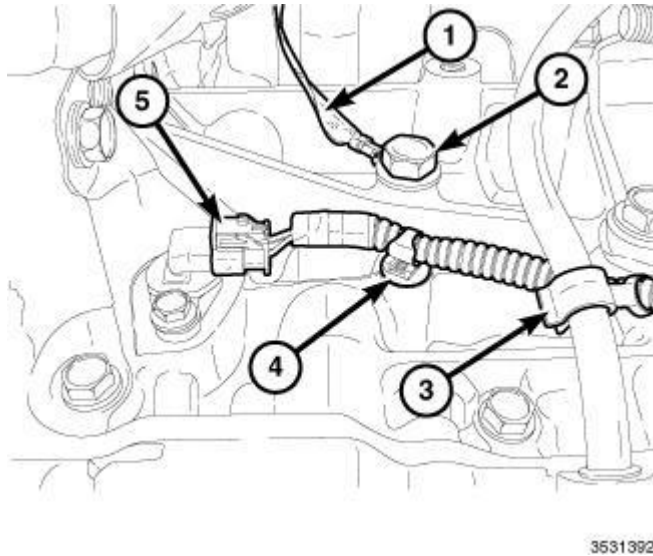


**Fig. 229: Electrical Connector, Ignition Coils & Ignition Coil Retaining Bolts**

Courtesy of CHRYSLER GROUP, LLC

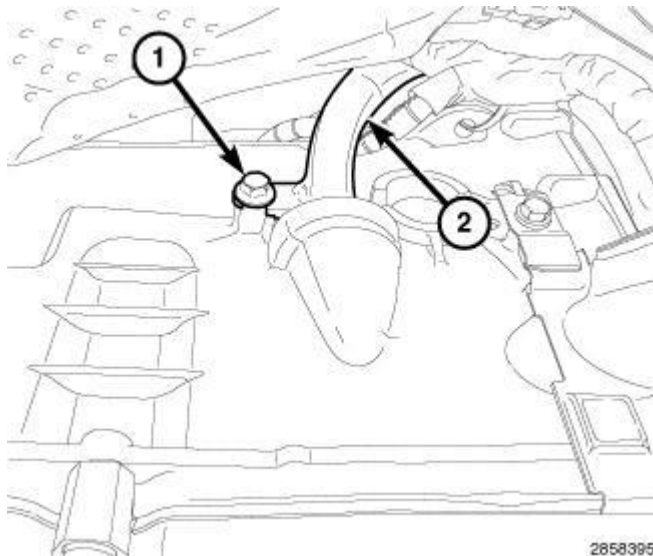
**NOTE:** The LH ignition coils are shown in illustration, the RH ignition coils are similar.

13. Remove the ignition coils (2). Refer to **COIL, IGNITION, 3.6L, REMOVAL** .



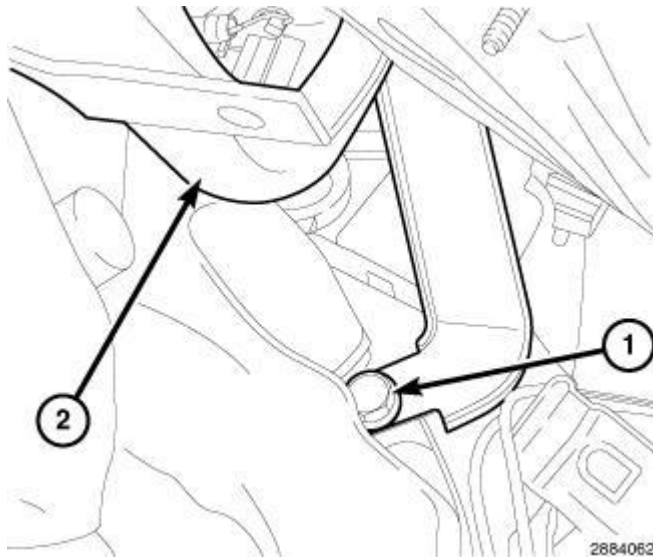
**Fig. 230: Ground Strap, Bolt, Retainers & Crankshaft Position (CKP) Sensor**  
 Courtesy of CHRYSLER GROUP, LLC

14. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
15. Disengage the main wire harness retainer (3) from the oil level indicator.



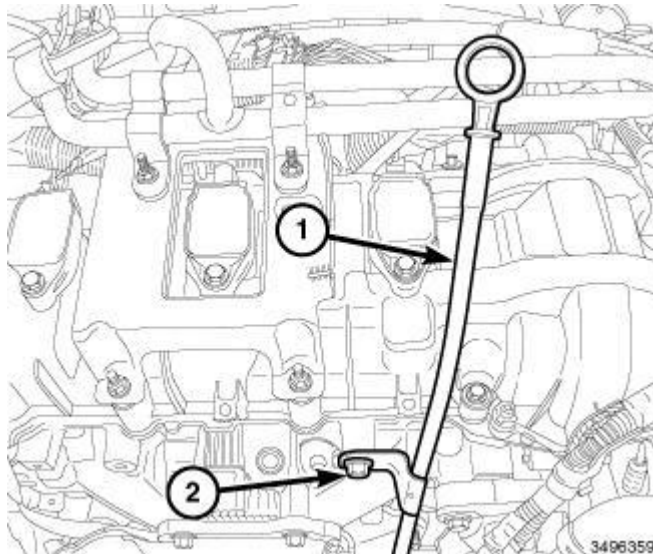
**Fig. 231: Transmission Fluid Level Indicator Tube & Bolt**  
 Courtesy of CHRYSLER GROUP, LLC

16. Loosen the bolt (1) securing the transmission fluid level indicator tube (2) to the transmission housing.



**Fig. 232: Upper Transmission-To-Engine Bolt & Transmission Oil Level Indicator Tube**  
 Courtesy of CHRYSLER GROUP, LLC

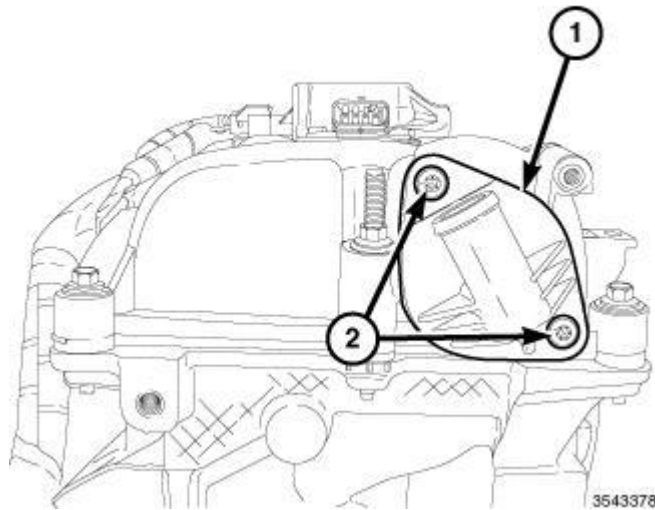
17. Remove the upper transmission to engine bolt (1) and reposition the transmission oil level indicator tube (2).



**Fig. 233: Oil Level Indicator & Bolt**  
 Courtesy of CHRYSLER GROUP, LLC

18. Lower the vehicle.
19. Remove the bolt (2) and the oil level indicator (1).

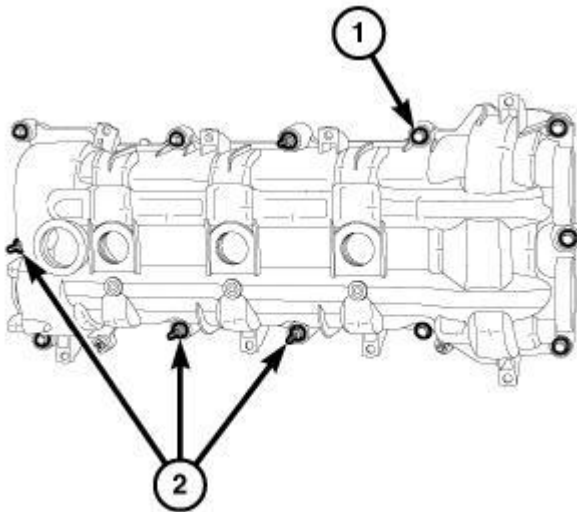




**Fig. 234: PCV Valve & Bolts**

Courtesy of CHRYSLER GROUP, LLC

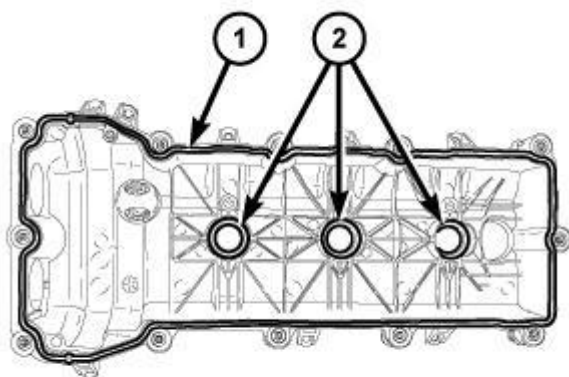
20. Remove the PCV valve (1). Refer to **VALVE, POSITIVE CRANKCASE VENTILATION (PCV), REMOVAL**.



**Fig. 235: Cylinder Head Cover Mounting Bolts & Studbolts**

Courtesy of CHRYSLER GROUP, LLC

21. Loosen nine cylinder head cover mounting bolts (1) and three studbolts (2) and remove the cylinder head cover.



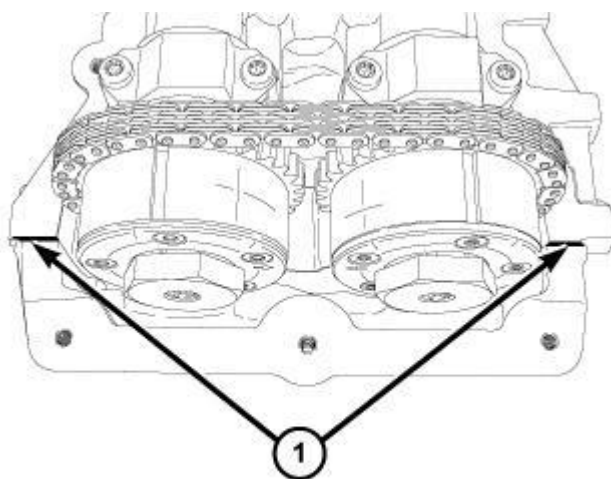
2776066

**Fig. 236: Cylinder Head Cover Gasket & Spark Plug Tube Seals**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The LH cylinder head cover is shown in illustration, the RH cylinder head cover is similar.

22. Remove and discard the cylinder head cover gasket (1).
23. The spark plug tube seals (2) can be reused if not damaged.



2776075

**Fig. 237: RTV Sealant Locations**

Courtesy of CHRYSLER GROUP, LLC

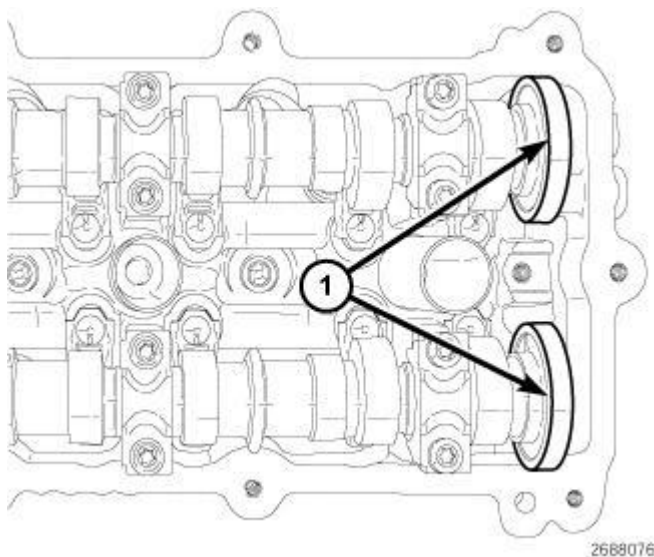
**NOTE:** The LH cylinder head cover T-joints are shown in illustration, the RH cylinder head cover T-joints are similar.

**CAUTION:** Do not use oil based liquids, wire brushes, abrasive wheels or metal scrapers to clean the engine gasket surfaces. Use only isopropyl (rubbing) alcohol, along with plastic or wooden scrapers. Improper gasket surface preparation may result in engine fluid leakage.

24. Remove all residual sealant (1) from the cylinder head, timing chain cover and cylinder head cover mating surfaces. Refer to Engine - Standard Procedure.

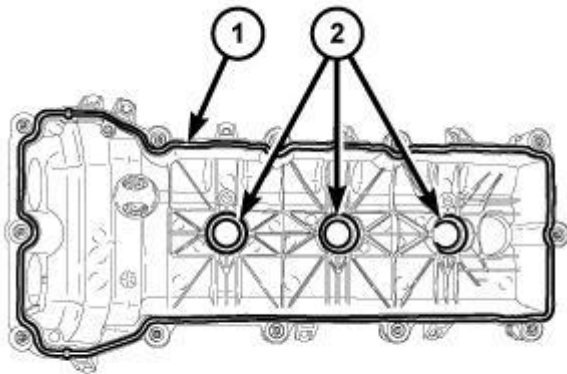
## INSTALLATION

### LEFT



**Fig. 238: Magnetic Timing Wheels**  
Courtesy of CHRYSLER GROUP, LLC

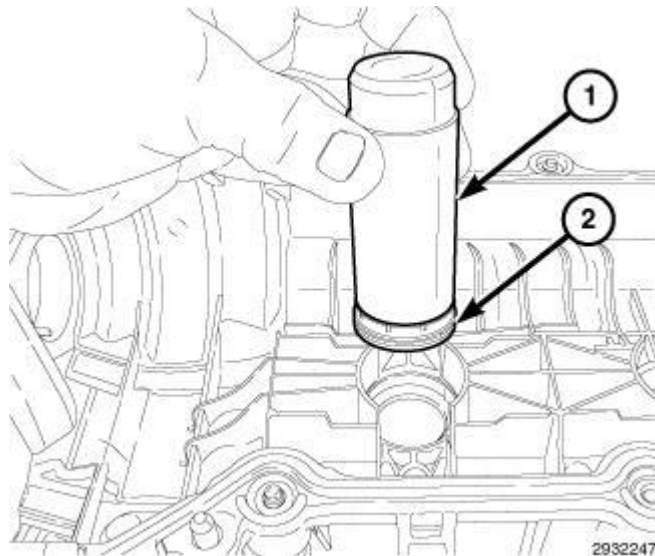
**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



2776066

**Fig. 239: Cylinder Head Cover Gasket & Spark Plug Tube Seals**  
Courtesy of CHRYSLER GROUP, LLC

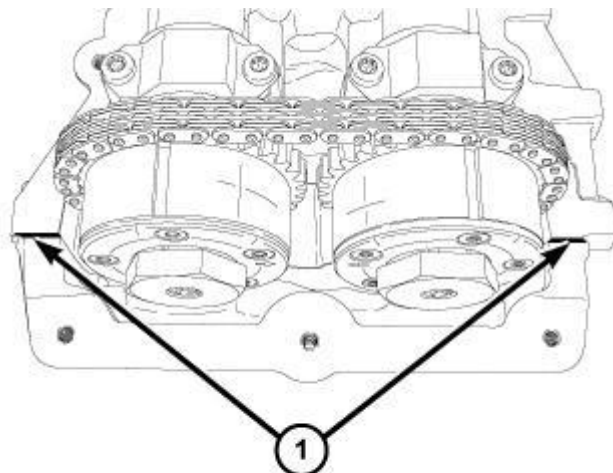
1. Install the cylinder head cover gasket (1).
2. The spark plug tube seals (2) can be reused if not damaged.



2932247

**Fig. 240: Spark Plug Tube Seal & Installer**  
Courtesy of CHRYSLER GROUP, LLC

3. If required, install new spark plug tube seals (2) in the cylinder head cover:
  - Lubricate the spark plug tube seal inner and outer diameters with clean engine oil.
  - Place the spark plug tube seal (2) on the Cam Sensor/Spark Plug Tube Seal Installer (special tool #10256, Installer, Cam Installer, Cam Sensor/ Spark Plug Tube Seal) (1).
  - Push the seal into the cylinder head cover until the base of the seal is seated.
  - Remove the tool.



2776075

**Fig. 241: RTV Sealant Locations**

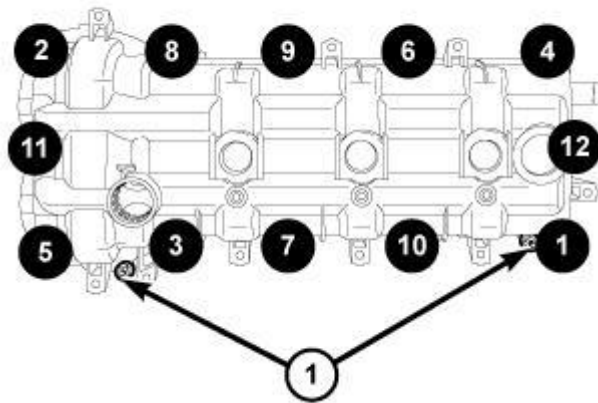
Courtesy of CHRYSLER GROUP, LLC

4. Clean the timing engine timing cover, cylinder head and cylinder head cover mating surfaces with isopropyl alcohol in preparation for sealant application.

**CAUTION:** Engine assembly requires the use of a unique sealant that is compatible with engine oil. Using a sealant other than Mopar® Threebond Engine RTV Sealant may result in engine fluid leakage.

**CAUTION:** Following the application of Mopar® Threebond Engine RTV Sealant to the gasket surfaces, the components must be assembled within 20 minutes and the attaching fasteners must be tightened to specification within 45 minutes. Prolonged exposure to the air prior to assembly may result in engine fluid leakage.

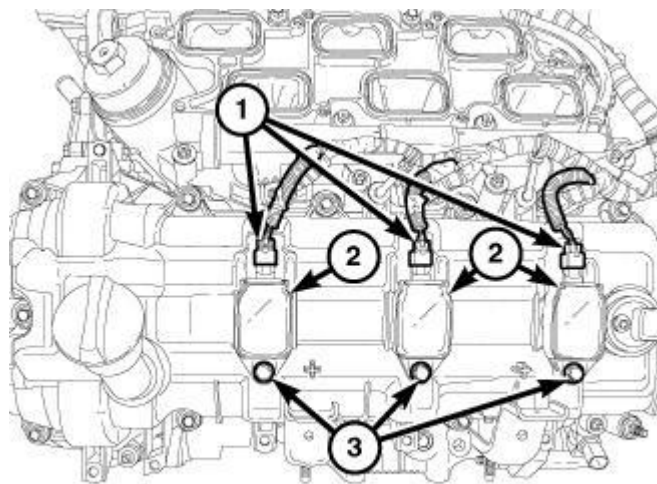
5. Apply a 2 to 3 mm wide bead of Mopar® Threebond Engine RTV Sealant (1) to the two engine timing cover to cylinder head T-joints as shown in illustration.



2719729

**Fig. 242: Cylinder Head Cover Bolts & Double Ended Studs Tightening Sequence - Left**  
Courtesy of CHRYSLER GROUP, LLC

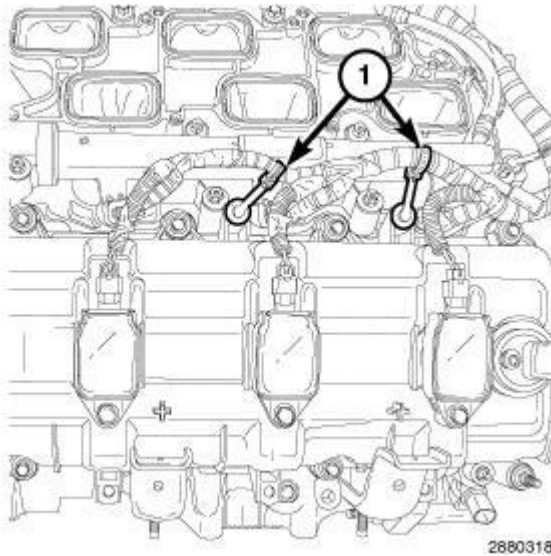
6. Align the locator pins (1) to the cylinder head and install the cylinder head cover.
7. Tighten the cylinder head cover bolts and double ended studs in the sequence shown in illustration to 12 N.m (106 in. lbs.).



2726572

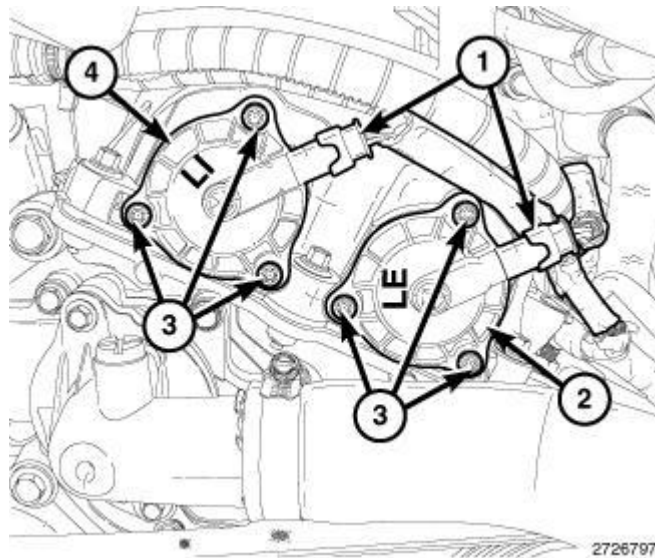
**Fig. 243: Electrical Connector, Ignition Coils & Ignition Coil Retaining Bolts**  
Courtesy of CHRYSLER GROUP, LLC

8. If removed, install the spark plugs. Refer to **SPARK PLUG, INSTALLATION**.
9. Install the ignition coils. Refer to **COIL, IGNITION, 3.6L, INSTALLATION**.



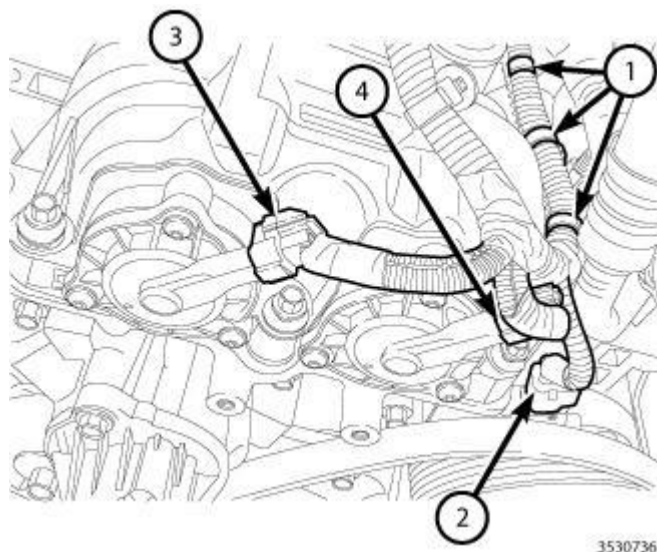
**Fig. 244: Injection/Ignition Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC

10. Engage two injection/ignition harness retainers (1) to the left cylinder head cover.



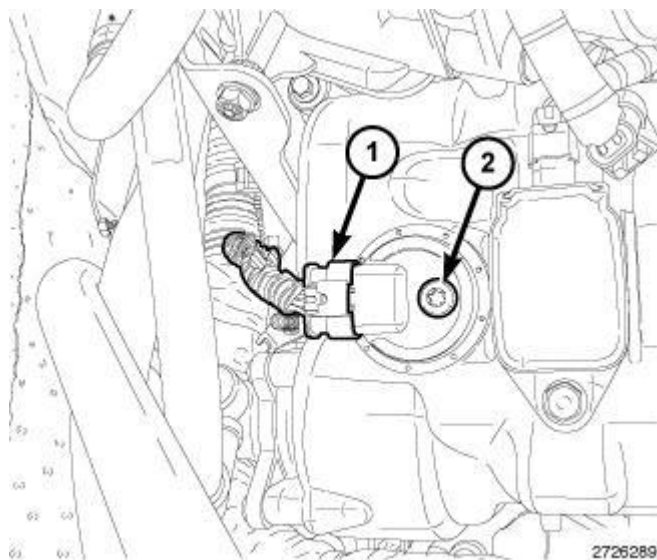
**Fig. 245: Variable Valve Timing Solenoids, Connectors & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

11. Refer to the markings made at disassembly and install the variable valve timing solenoids (2 and 4) in their original locations. Refer to **SOLENOID, VARIABLE VALVE TIMING, INSTALLATION**.



**Fig. 246: Retainers, A/C Compressor Electrical Connector & Left Intake And Left Exhaust Variable Valve Timing Solenoid Electrical Connectors**  
 Courtesy of CHRYSLER GROUP, LLC

12. Connect the A/C compressor electrical connector (2).
13. Connect the left exhaust variable valve timing solenoid electrical connector (4).
14. Connect the left intake variable valve timing solenoid electrical connector (3).
15. Engage three wire harness retainers (1) to the left cylinder head cover.

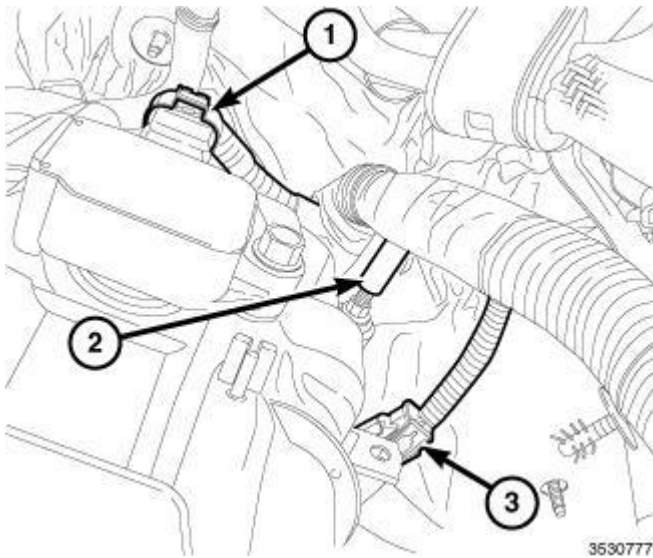


**Fig. 247: CMP Sensor & Bolt**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The RH CMP sensor is shown in illustration, the LH CMP sensor is similar. If both RH and LH CMP sensors were removed, install them into their original locations.

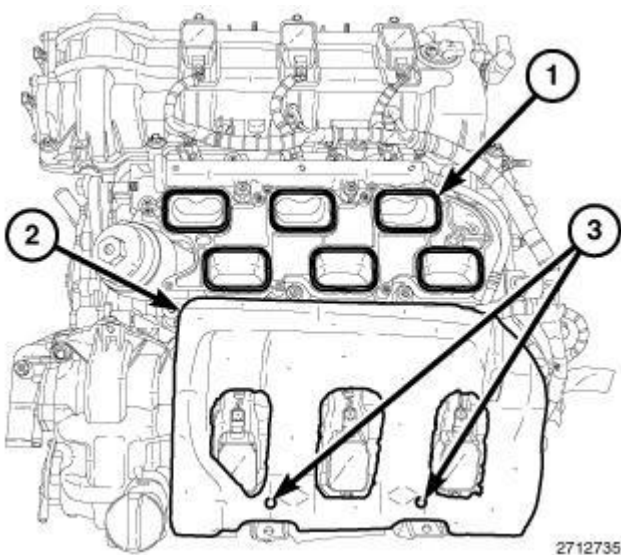


16. Install the camshaft position sensor. Refer to **SENSOR, CAMSHAFT POSITION, 3.6L, INSTALLATION**.



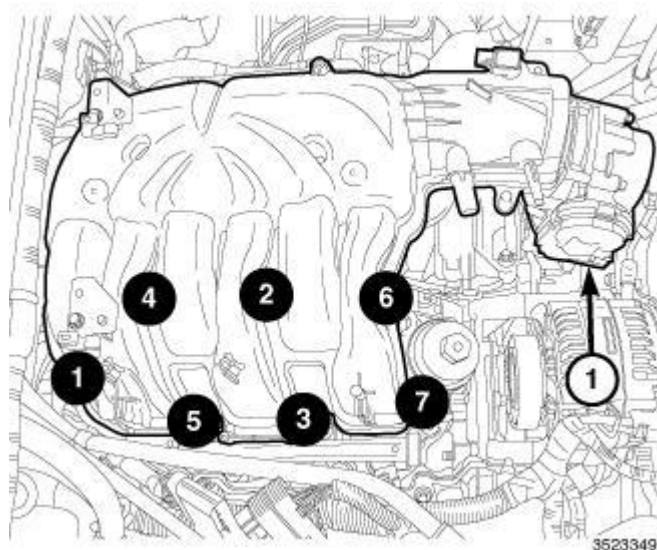
**Fig. 248: Camshaft Position (CMP) Sensor, Retainer & Engine Coolant Temperature (ECT) Sensor Connector**  
 Courtesy of CHRYSLER GROUP, LLC

17. Connect the Engine Coolant Temperature (ECT) sensor connector (3).
18. Connect the left Camshaft Position (CMP) sensor (1).
19. Engage the main wire harness retainer (2) to the cylinder head cover mounting stud.



**Fig. 249: Intake Ports, Insulator & Alignment Posts**  
 Courtesy of CHRYSLER GROUP, LLC

20. Install the insulator (2) to the two alignment posts (3) on top of the LH cylinder head cover.



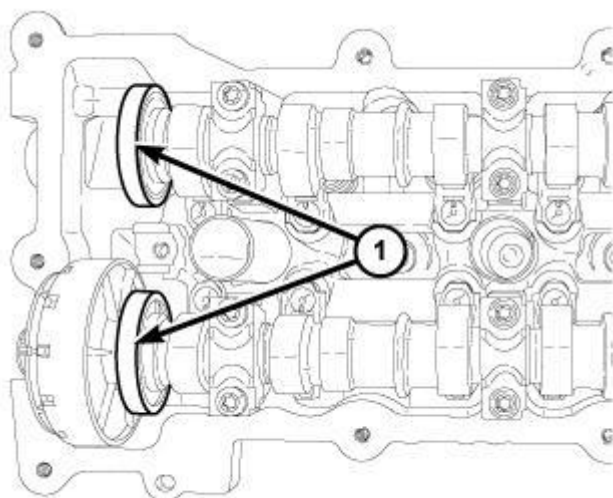
**Fig. 250: Upper Intake Manifold Tightening Sequence**

Courtesy of CHRYSLER GROUP, LLC

21. Install the upper intake manifold (1), support brackets and air cleaner body. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
22. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

**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.

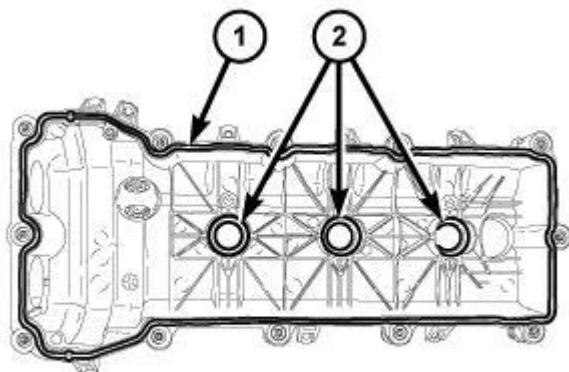
RIGHT



**Fig. 251: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.

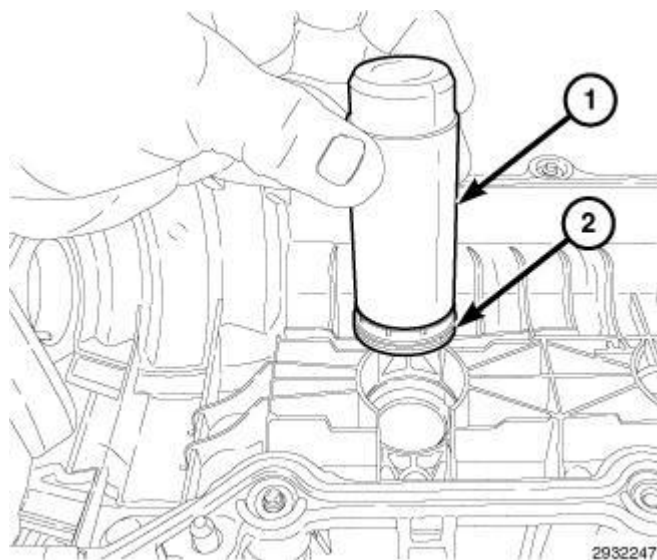


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**Fig. 252: Cylinder Head Cover Gasket & Spark Plug Tube Seals**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The LH cylinder head cover is shown in illustration, the RH cylinder head cover is similar.

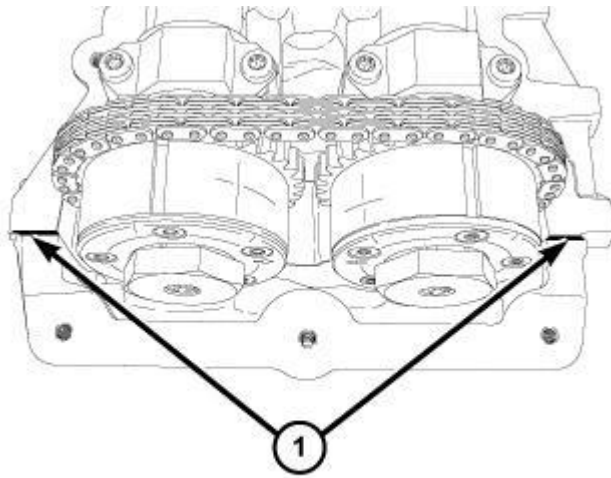
1. Install the cylinder head cover gasket (1).
2. The spark plug tube seals (2) can be reused if not damaged.



**Fig. 253: Spark Plug Tube Seal & Installer**

## Courtesy of CHRYSLER GROUP, LLC

3. If required, install new spark plug tube seals (2) in the cylinder head cover:
  - Lubricate the spark plug tube seal inner and outer diameters with clean engine oil.
  - Place the spark plug tube seal (2) on the Cam Sensor/Spark Plug Tube Seal Installer (special tool #10256, Installer, Cam Installer, Cam Sensor/ Spark Plug Tube Seal) (1).
  - Push the seal into the cylinder head cover until the base of the seal is seated.
  - Remove the tool.



2776075

**Fig. 254: RTV Sealant Locations**

Courtesy of CHRYSLER GROUP, LLC

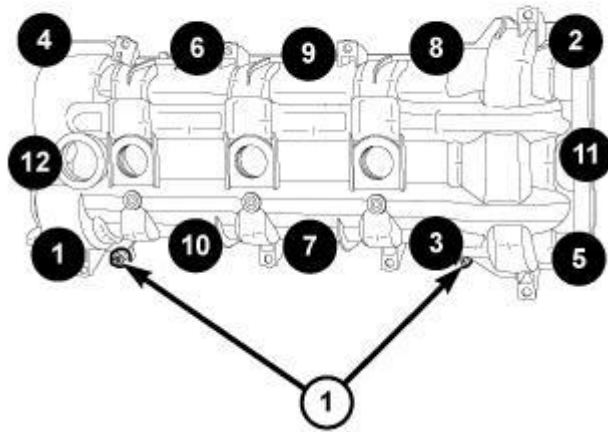
**NOTE:** The LH cylinder head cover T-joint is shown in illustration, the RH cylinder head cover T-joint is similar.

4. Clean the timing engine timing cover, cylinder head and cylinder head cover mating surfaces with isopropyl alcohol in preparation for sealant application.

**CAUTION:** Engine assembly requires the use of a unique sealant that is compatible with engine oil. Using a sealant other than Mopar® Threebond Engine RTV Sealant may result in engine fluid leakage.

**CAUTION:** Following the application of Mopar® Threebond Engine RTV Sealant to the gasket surfaces, the components must be assembled within 20 minutes and the attaching fasteners must be tightened to specification within 45 minutes. Prolonged exposure to the air prior to assembly may result in engine fluid leakage.

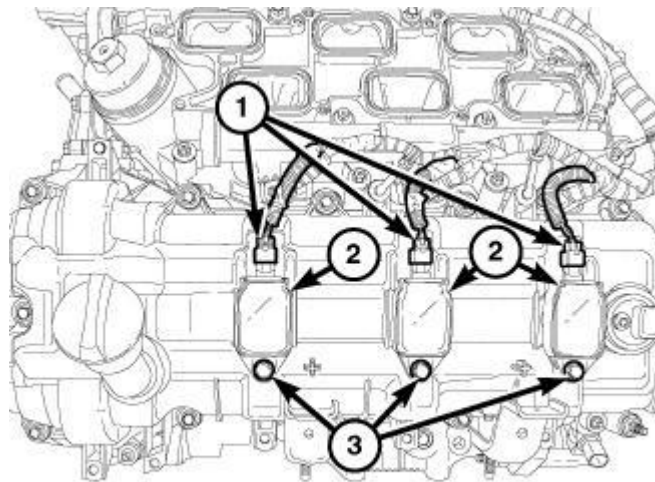
5. Apply a 2 to 3 mm wide bead of Mopar® Threebond Engine RTV Sealant (1) to the two engine timing cover to cylinder head T-joints as shown in illustration.



2719834

**Fig. 255: Cylinder Head Cover Bolts & Double Ended Studs Tightening Sequence - Right**  
Courtesy of CHRYSLER GROUP, LLC

6. Align the locator pins (1) to the cylinder head and install the cylinder head cover.
7. Tighten the cylinder head cover bolts and double ended studs in the sequence shown in illustration to 12 N.m (106 in. lbs.).

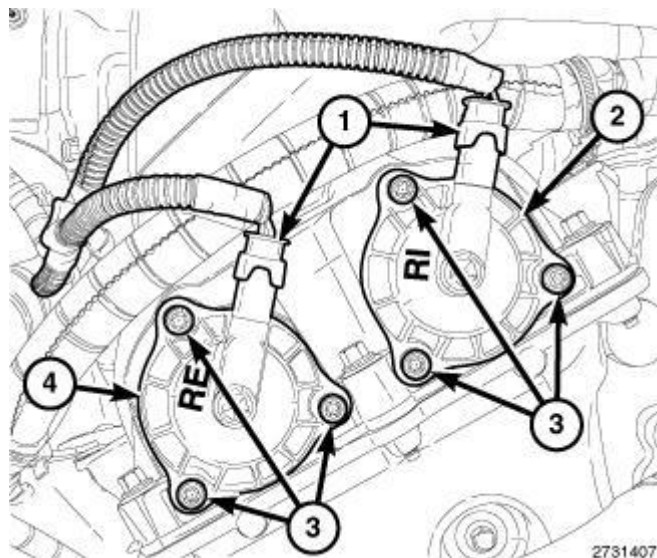


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**Fig. 256: Electrical Connector, Ignition Coils & Ignition Coil Retaining Bolts**  
Courtesy of CHRYSLER GROUP, LLC

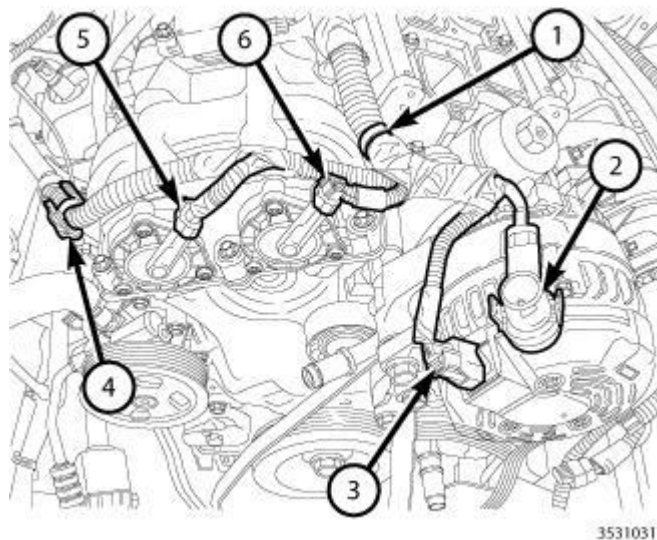
**NOTE:** The LH ignition coils are shown in illustration, the RH ignition coils are similar.

8. If removed, install the spark plugs. Refer to [SPARK PLUG, INSTALLATION](#) .
9. Install the ignition coils (2). Refer to [COIL, IGNITION, 3.6L, INSTALLATION](#) .



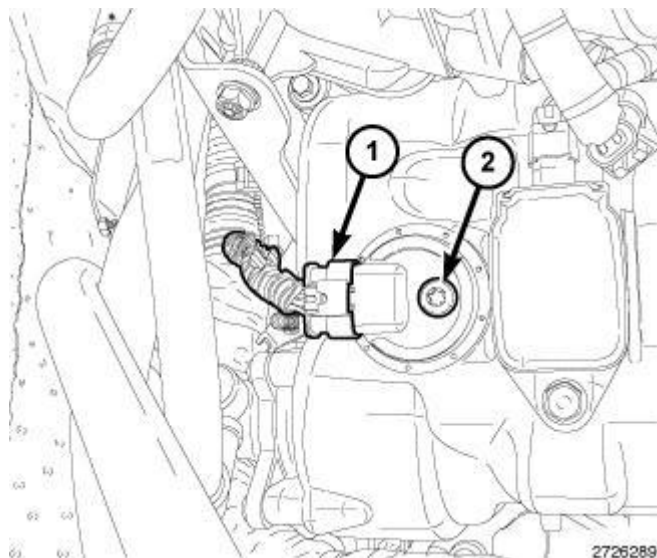
**Fig. 257: Variable Valve Timing Solenoids, Connectors & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

10. Refer to the markings made at disassembly and install the variable valve timing solenoids (2 and 4) in their original locations. Refer to **SOLENOID, VARIABLE VALVE TIMING, INSTALLATION**.



**Fig. 258: Generator Stud, Connector, Retainers & Right Exhaust And Right Intake Variable Valve Timing Solenoid Electrical Connectors**  
Courtesy of CHRYSLER GROUP, LLC

11. Connect the right exhaust variable valve timing solenoid electrical connector (5).
12. Connect the right intake variable valve timing solenoid electrical connector (6).
13. Engage the wire harness retainers (1 and 4) to the right cylinder head cover.

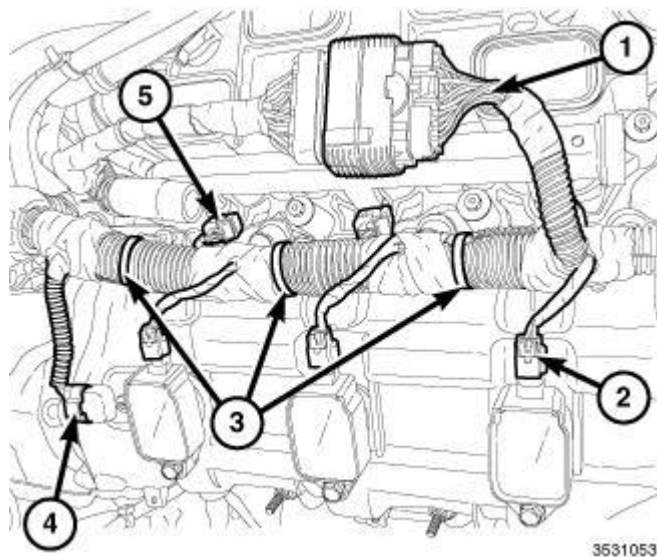


**Fig. 259: CMP Sensor & Bolt**

Courtesy of CHRYSLER GROUP, LLC

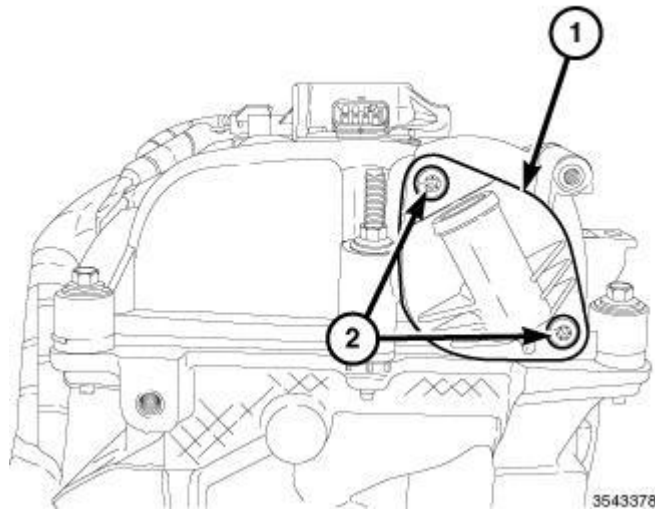
**NOTE:** If both RH and LH CMP sensors were removed, install them into their original locations.

14. Install the camshaft position sensor. Refer to **SENSOR, CAMSHAFT POSITION, 3.6L, INSTALLATION**.



**Fig. 260: Engine Injection/Ignition Harness, Ignition Coil Electrical Connectors, Retainers, Camshaft Position (CMP) Sensor Connector & Fuel Injector Electrical Connectors**  
Courtesy of CHRYSLER GROUP, LLC

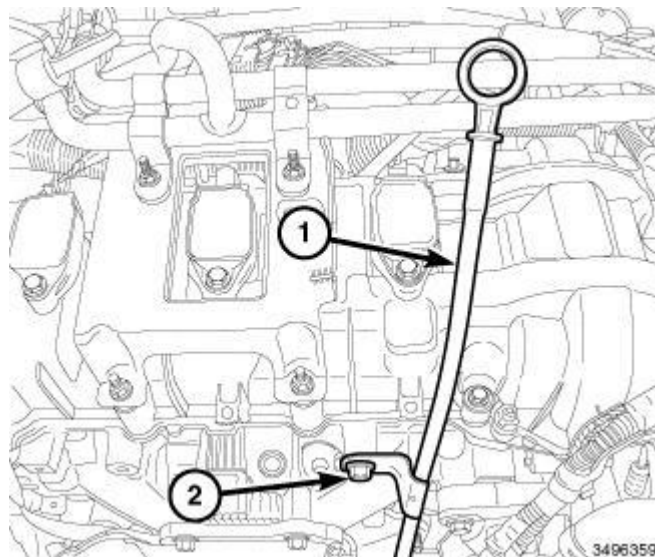
15. Connect three ignition coil electrical connectors (2).
16. Connect the electrical connector (4) to the right Camshaft Position (CMP) sensor.
17. Engage three main wire harness retainers (3) to the right cylinder head cover.



**Fig. 261: PCV Valve & Bolts**

Courtesy of CHRYSLER GROUP, LLC

18. Install the PCV valve (1). Refer to **VALVE, POSITIVE CRANKCASE VENTILATION (PCV), REMOVAL** .

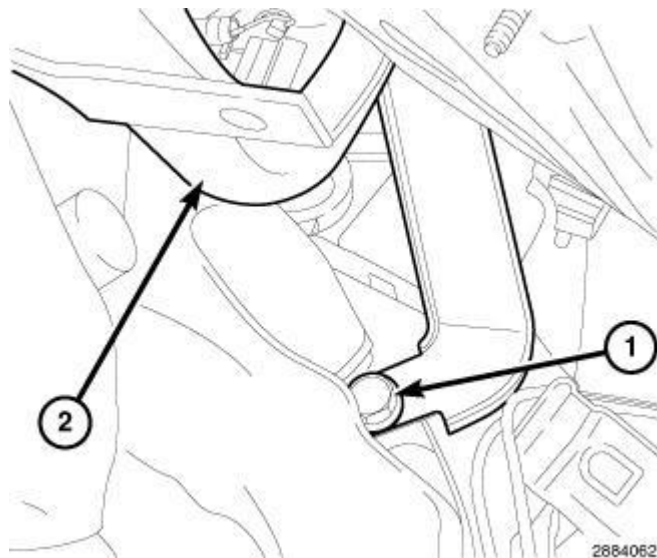


**Fig. 262: Oil Level Indicator & Bolt**

Courtesy of CHRYSLER GROUP, LLC

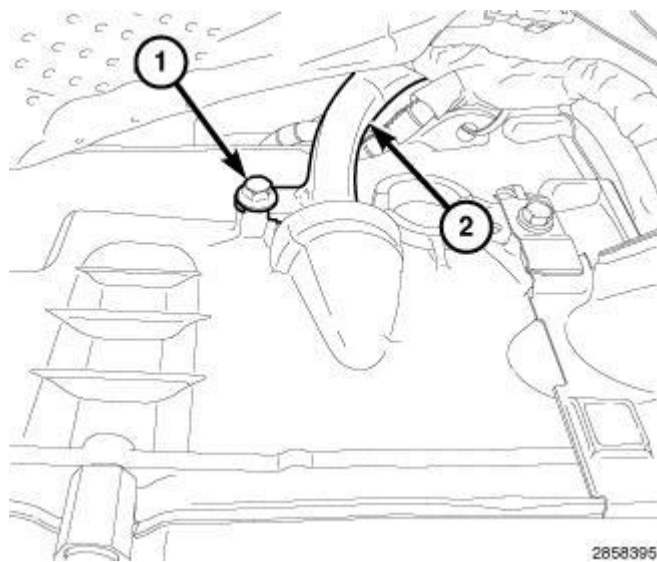
19. Install the oil level indicator (1) with the bolt (2) tightened to 12 N.m (106 in. lbs.).





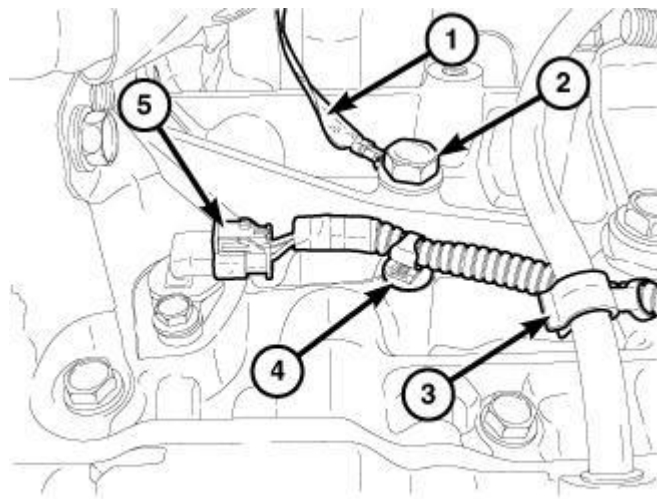
**Fig. 263: Upper Transmission-To-Engine Bolt & Transmission Oil Level Indicator Tube**  
 Courtesy of CHRYSLER GROUP, LLC

20. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
21. Install the transmission oil level indicator tube (2) with the upper transmission to engine bolt (1) tightened to 55 N.m (41 ft. lbs.).



**Fig. 264: Transmission Fluid Level Indicator Tube & Bolt**  
 Courtesy of CHRYSLER GROUP, LLC

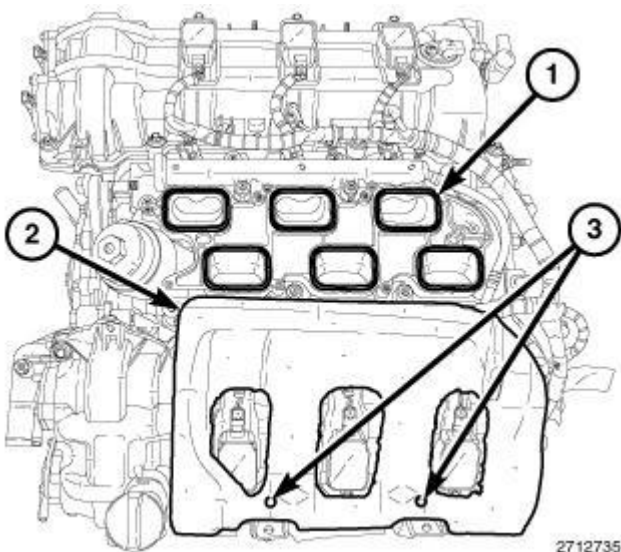
22. Install the bolt (1) securing the transmission fluid level indicator tube (2) to the transmission housing and tighten to 12 N.m (106 in. lbs.).



3531392

**Fig. 265: Ground Strap, Bolt, Retainers & Crankshaft Position (CKP) Sensor**  
 Courtesy of CHRYSLER GROUP, LLC

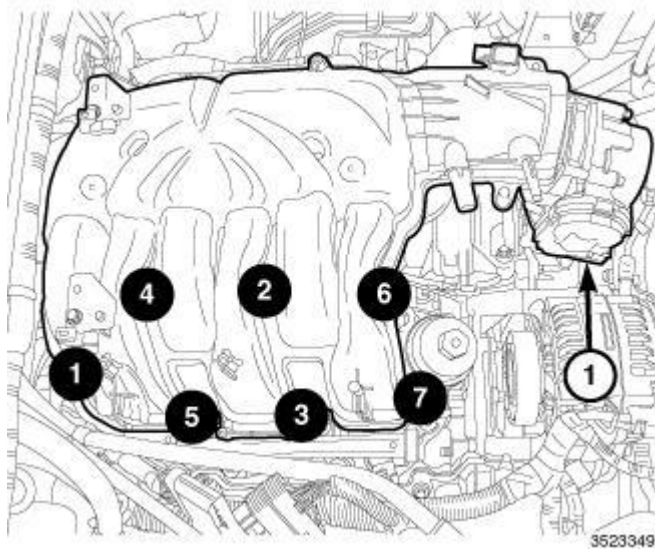
23. Engage the main wire harness retainer (3) to the oil level indicator.



2712735

**Fig. 266: Intake Ports, Insulator & Alignment Posts**  
 Courtesy of CHRYSLER GROUP, LLC

24. Lower the vehicle.
25. If removed, install the insulator (2) to the two alignment posts (3) on top of the LH cylinder head cover.



**Fig. 267: Upper Intake Manifold Tightening Sequence**  
 Courtesy of CHRYSLER GROUP, LLC

26. Install the upper intake manifold (1), support brackets and air cleaner body. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
27. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

**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.

## LIFTER(S), HYDRAULIC

### DIAGNOSIS AND TESTING

#### DIAGNOSIS AND TESTING - HYDRAULIC LIFTER(S) NOISE DIAGNOSIS

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

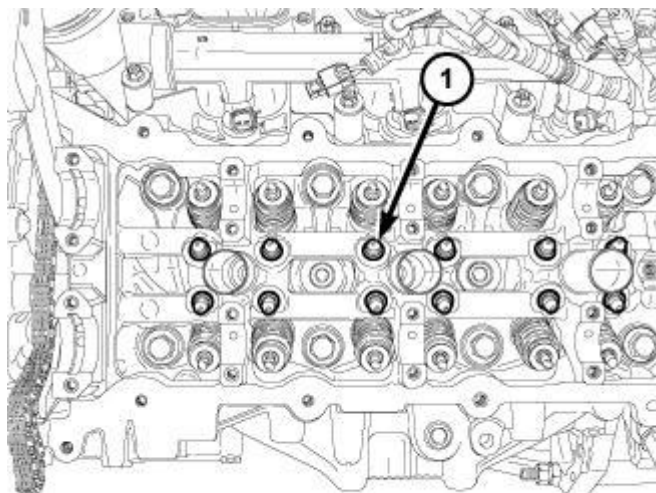
## 2012 Jeep Wrangler Sport S

2012 ENGINE 3.6L - Service Information - Wrangler

	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: (a) Check lash adjusters for sponginess while installed in the cylinder head. Depress the rocker arm over the adjuster. Normal adjusters should feel very firm. Very spongy adjusters can be bottomed out easily. (b) If the lash adjuster(s) are still spongy, replace the lash adjuster(s). Refer to <b><u>LIFTER(S), HYDRAULIC, REMOVAL</u></b> .
4. Low oil pressure.	4. See below: (a) Check and correct the engine oil level. (b) Check the engine oil pressure. Refer to <b><u>CHECKING ENGINE OIL PRESSURE</u></b> . (c) Check for excessive main bearing clearance and correct. Refer to <b><u>BEARING(S), CRANKSHAFT, MAIN, STANDARD PROCEDURE</u></b> . (d) Check for a worn oil pump. Refer to <b><u>PUMP, ENGINE OIL, INSPECTION</u></b> .
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 <b><u>VALVES, INTAKE AND EXHAUST, INSPECTION</u></b> .
7. Air ingested into oil due to broken or cracked oil pump pickup tube.	7. Inspect pickup tube and replace as necessary. Refer to <b><u>PICK-UP, OIL PUMP, REMOVAL</u></b> .
8. Collapsed lash adjuster due to debris ingestion.	8. Clean debris from engine and replace lash adjuster(s). Refer to <b><u>LIFTER(S), HYDRAULIC, REMOVAL</u></b> .

### REMOVAL

### REMOVAL



2742108

**Fig. 268: Hydraulic Lifters**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The LH cylinder head hydraulic lifters are shown in illustration, the RH cylinder head hydraulic lifters are similar.

1. Disconnect and isolate the negative battery cable.
2. 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.

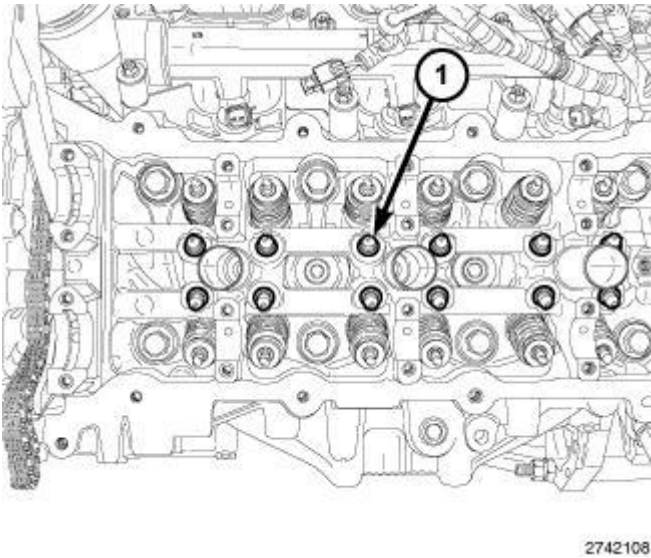
3. Remove the rocker arm(s). Refer to ROCKER ARM, VALVE, REMOVAL.

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

4. Remove the hydraulic lifter(s) (1).

## INSTALLATION

## INSTALLATION



**Fig. 269: Hydraulic Lifters**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The LH cylinder head hydraulic lifters are shown in illustration, the RH cylinder head hydraulic lifters are similar. If the hydraulic lifters are being reused, reassemble them into their original locations.

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.
2. Install the hydraulic lifter(s) (1).

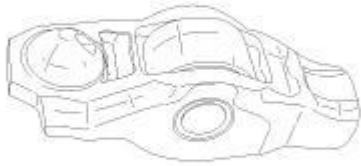
**NOTE:** If the rocker arms are being reused, reassemble them into their original locations.

3. Install the rocker arm(s). Refer to ROCKER ARM, VALVE, INSTALLATION.
4. Install the camshaft(s), phasers, cylinder head cover(s) and upper intake manifold. Refer to CAMSHAFT, ENGINE, INSTALLATION.
5. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

## ROCKER ARM, VALVE

### DESCRIPTION

### DESCRIPTION

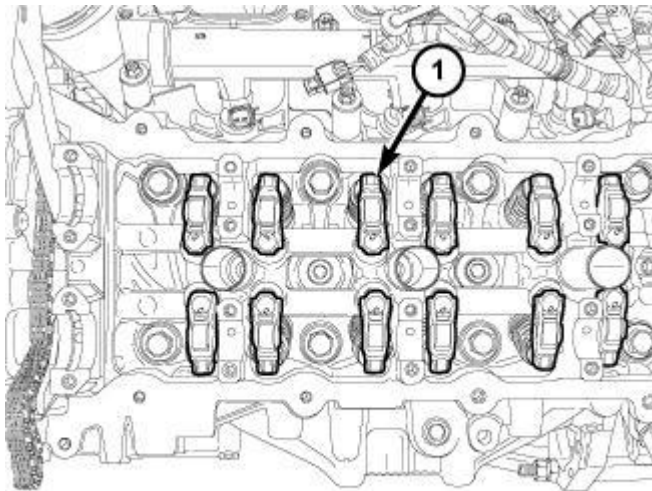
**Fig. 270: Rocker Arm**

Courtesy of CHRYSLER GROUP, LLC

The rocker arms are steel stampings with an integral roller bearing. The rocker arms incorporate a 0.5 mm oil hole in the lash adjuster socket for roller and camshaft lubrication.

#### REMOVAL

#### REMOVAL

**Fig. 271: Locating Rocker Arms**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The LH cylinder head rocker arms are shown in illustration, the RH cylinder head rocker arms are similar.

1. Disconnect and isolate the negative battery cable.
2. Remove the camshaft(s). Refer to **CAMSHAFT, ENGINE, REMOVAL**.

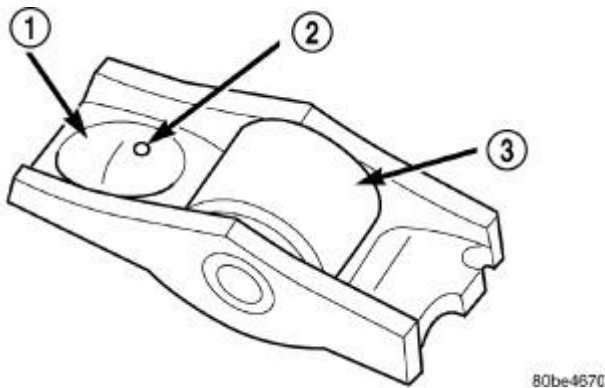
**NOTE:** If the rocker arms are to be reused, identify their positions so that they can

be reassembled into their original locations.

3. Remove the rocker arm(s) (1).

#### INSPECTION

#### INSPECTION



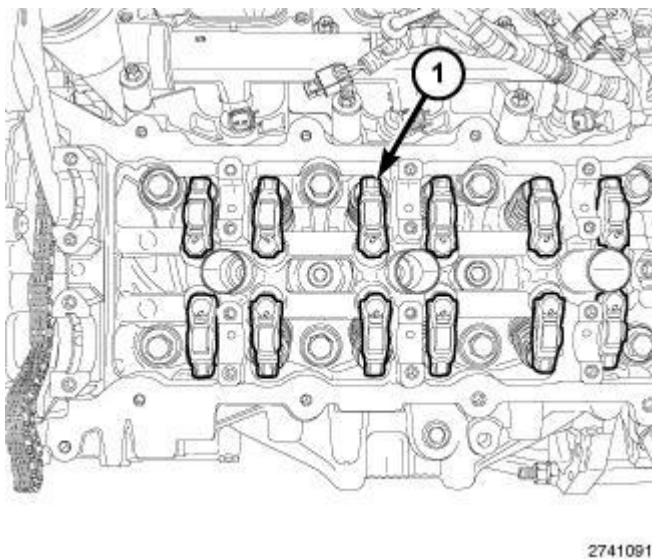
**Fig. 272: Rocker Arm**

Courtesy of CHRYSLER GROUP, LLC

Inspect the cam follower assembly for wear or damage. Refer to **Fig. 272**. Replace as necessary.

#### INSTALLATION

#### INSTALLATION



**Fig. 273: Locating Rocker Arms**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The LH cylinder head rocker arms are shown in illustration, the RH cylinder



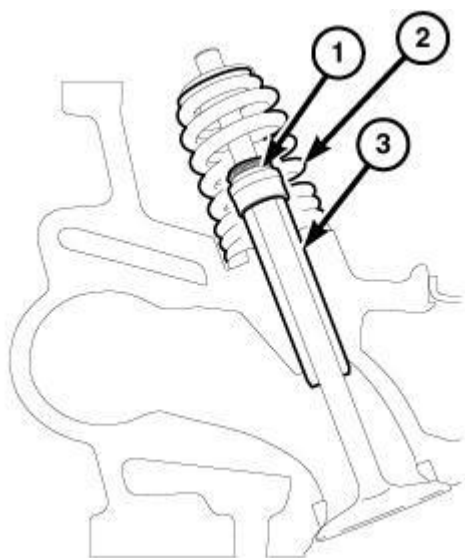
**head rocker arms are similar. If the rocker arms are being reused, reassemble them into their original locations.**

1. Lubricate the rocker arms with clean engine oil before installation.
2. Install the rocker arm(s) (1).
3. Install the camshaft(s), phasers, cylinder head cover(s) and upper intake manifold. Refer to **CAMSHAFT, ENGINE, INSTALLATION**.
4. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

## SEAL(S), VALVE GUIDE

### DESCRIPTION

### DESCRIPTION

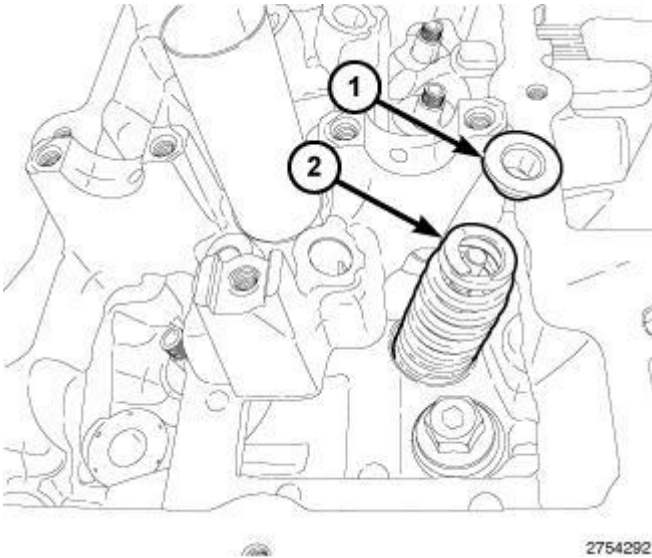


**Fig. 274: Valve Stem Oil Seal, Valve Spring & Valve Guide**  
Courtesy of CHRYSLER GROUP, LLC

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

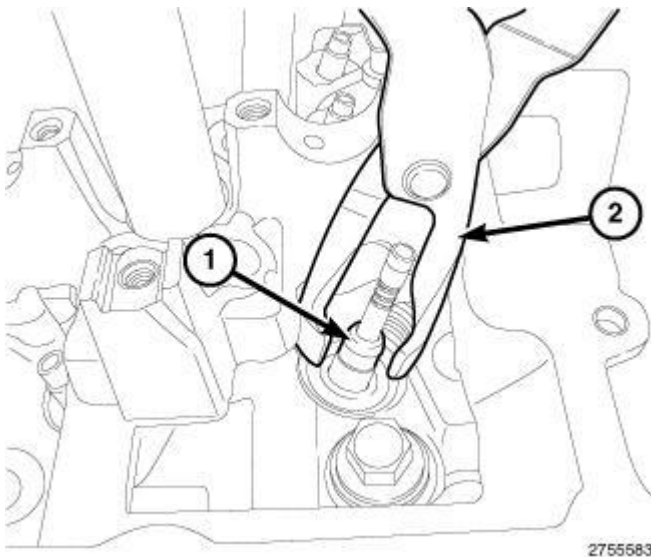
### REMOVAL



**Fig. 275: Valve Spring & 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 5 cylinder exhaust valve spring shown in illustration, all other valve springs similar.

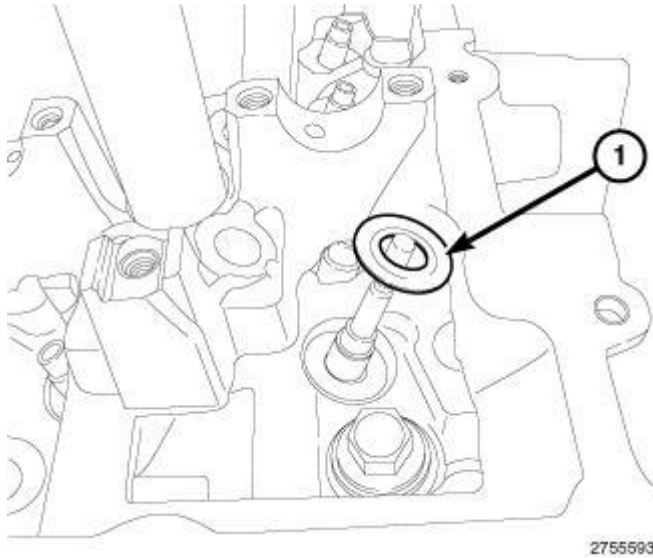
1. Remove the valve spring(s) (2). Refer to **SPRING(S), VALVE, REMOVAL**.



**Fig. 276: Valve Guide Seal & Valve Seal Tool**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Number 5 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. 277: Valve Spring Seat**

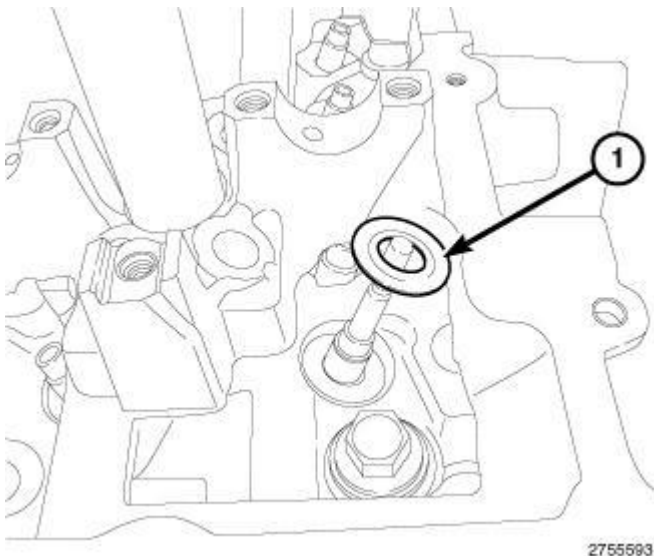
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Number 5 cylinder exhaust valve spring seat shown in illustration, all other valve spring seats similar.

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



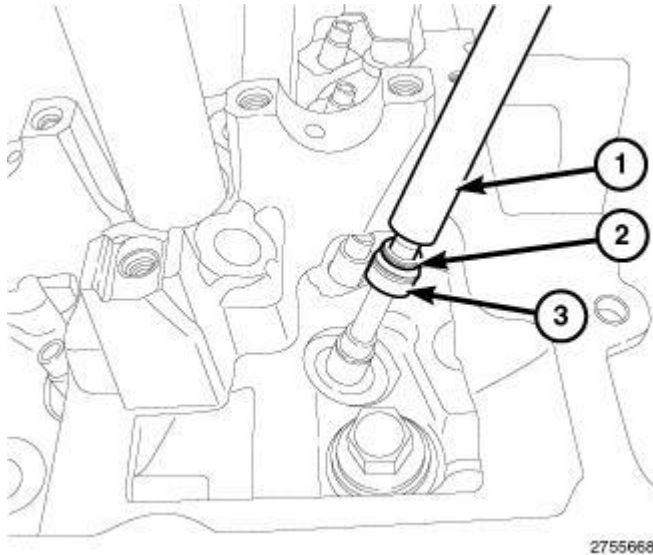
**Fig. 278: Valve Spring Seat**

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 is within specification. Refer to Engine - Specifications. Number 5 cylinder exhaust valve shown in illustration, all other valves similar.

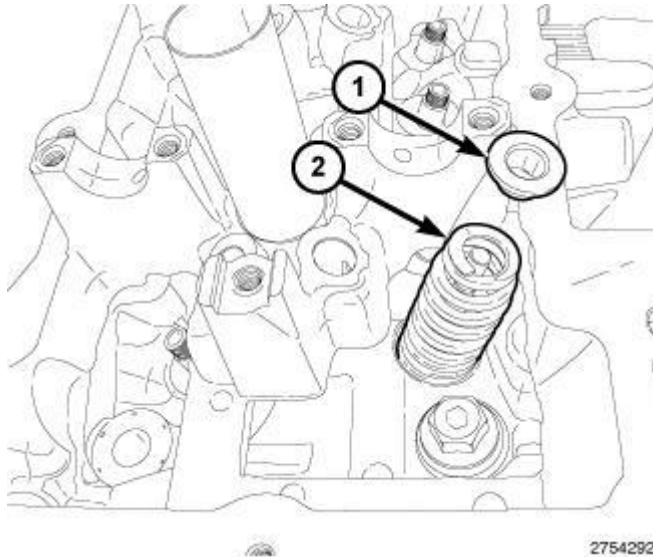
2. If removed, install the spring seat (1) over the valve guide.



**Fig. 279: Installing 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:** Ensure that the garter spring (2) is intact around the top of the valve guide seal (3). Number 5 cylinder exhaust valve guide seal shown in illustration, all other valves similar.



**Fig. 280: Valve Spring & Valve Spring Retainer**  
Courtesy of CHRYSLER GROUP, LLC

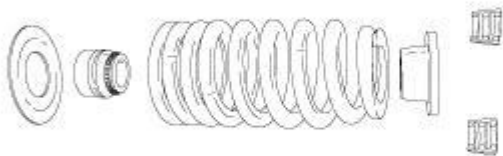
**NOTE:** If the valve springs are being reused, reassemble them into their original locations. Number 5 cylinder exhaust valve spring shown in illustration, all other valves similar.

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

## SPRING(S), VALVE

### DESCRIPTION

### DESCRIPTION



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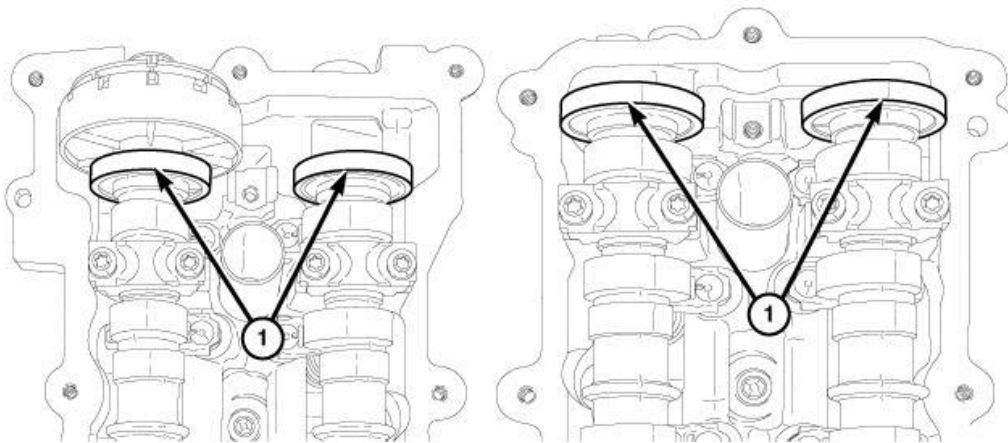
**Fig. 281: Valve Spring Components**

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 valve spring seat is a flat steel washer. 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.

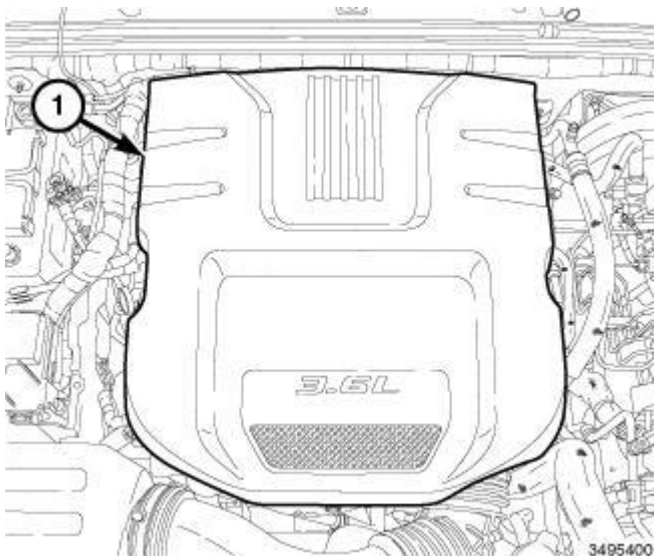
REMOVAL

IN VEHICLE



**Fig. 282: Magnetic Timing Wheels**  
Courtesy of CHRYSLER GROUP, LLC

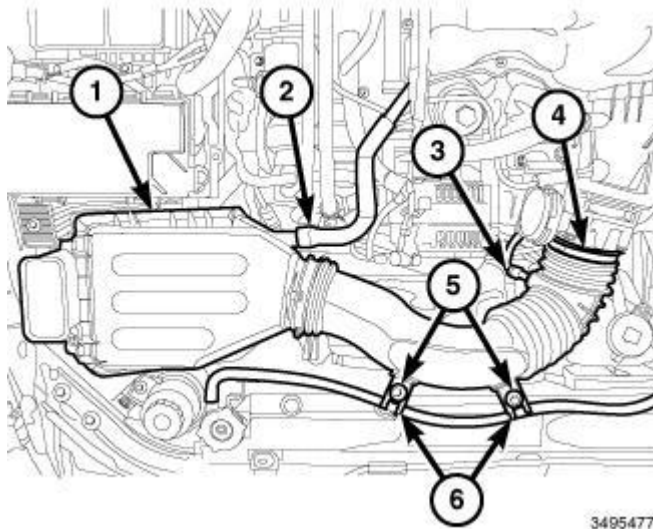
**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



**Fig. 283: Engine Cover**

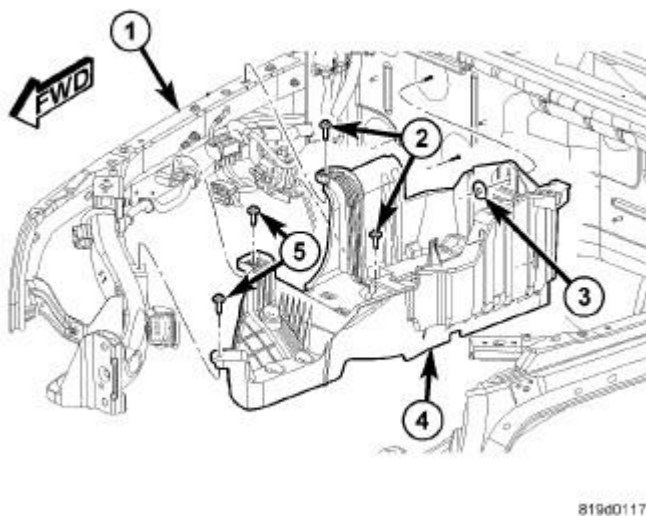
Courtesy of CHRYSLER GROUP, LLC

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

**Fig. 284: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

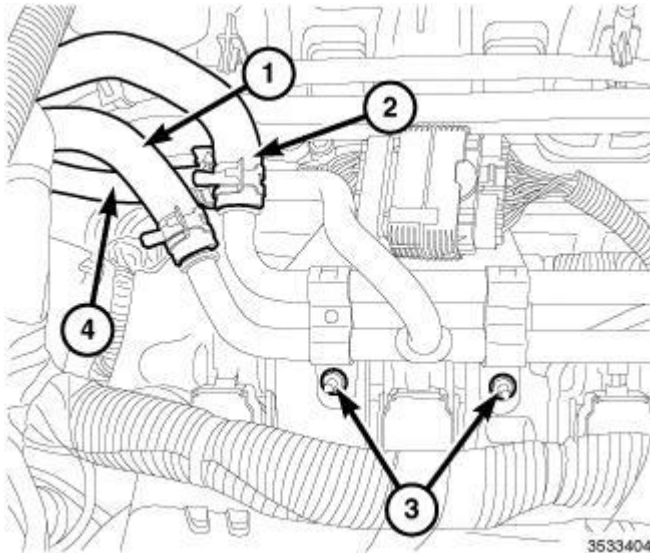
Courtesy of CHRYSLER GROUP, LLC

3. Remove the air cleaner body (1). Refer to **BODY, AIR CLEANER, REMOVAL**.

**Fig. 285: Battery Tray Components**

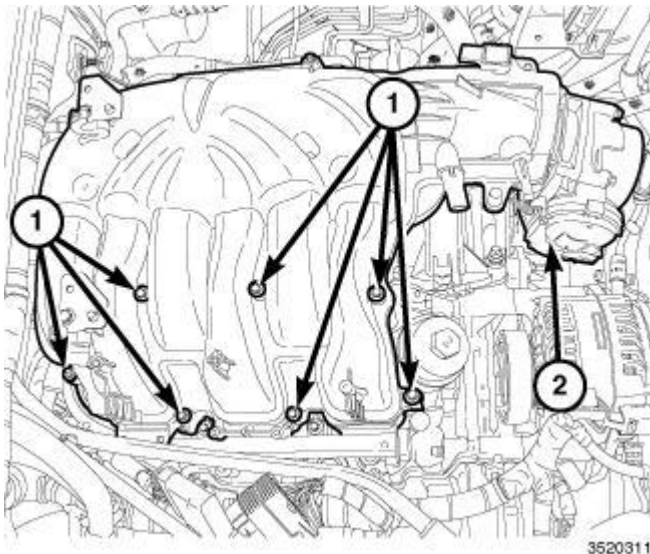
Courtesy of CHRYSLER GROUP, LLC

4. If removing the RH valve springs, remove the battery, Totally Integrated Power Module (TIPM) and battery tray (4). Refer to **TRAY, BATTERY, REMOVAL**.



**Fig. 286: Heater Core Return Hose, Heater Core Supply Hose, Nuts & Oil Cooler Return Hose**  
Courtesy of CHRYSLER GROUP, LLC

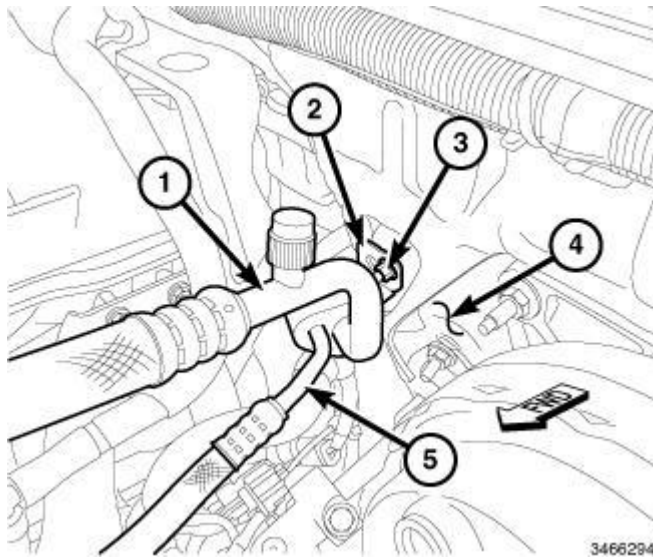
5. If removing the RH valve springs, drain the cooling system. Refer to **STANDARD PROCEDURE**.
6. If removing the RH valve springs, remove the heater core supply hose (2), heater core return hose (1) and oil cooler return hose (4) from the heater core tube assembly.
7. If removing the RH valve springs, remove two nuts (3) and reposition the heater core tube assembly to the front of the engine.



**Fig. 287: Upper Intake Manifold & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

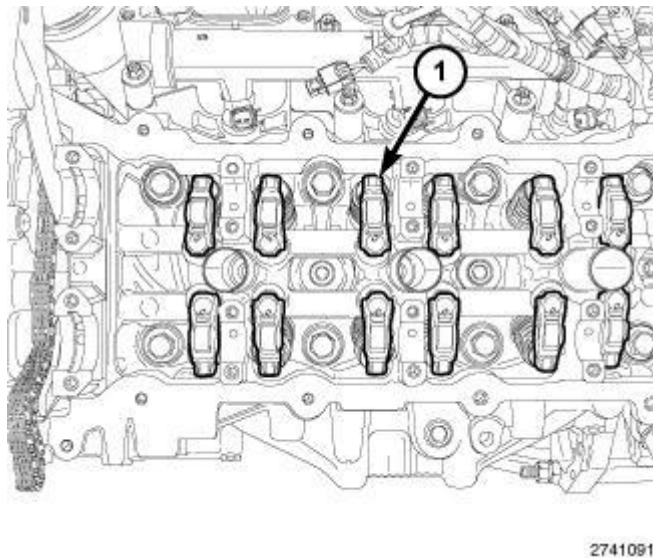
8. Remove the upper intake manifold (2) and both cylinder head covers. Refer to **COVER(S), CYLINDER**



**HEAD, REMOVAL.**

**Fig. 288: A/C Suction & Liquid Line Assembly**  
 Courtesy of CHRYSLER GROUP, LLC

9. If removing the LH exhaust valve springs, recover the refrigerant from the refrigerant system and remove the A/C suction and liquid line assembly (1 and 5). Refer to **LINE, A/C SUCTION, REMOVAL** .



**Fig. 289: Locating Rocker Arms**  
 Courtesy of CHRYSLER GROUP, LLC

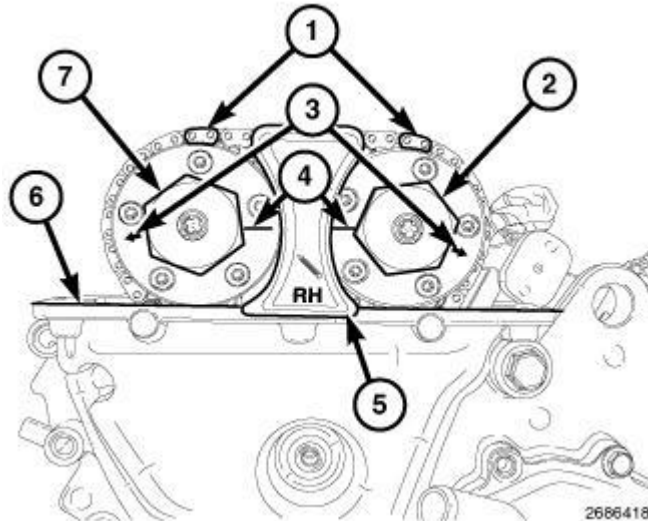
**NOTE:** The LH cylinder head rocker arms are shown in illustration, the RH cylinder head rocker arms are similar.

**NOTE:** Only remove the camshafts from one head at a time. The opposite head must remain assembled in order to lock the crankshaft against rotation.

10. 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.

11. Remove the rocker arm(s) (1). Refer to ROCKER ARM, VALVE, REMOVAL.

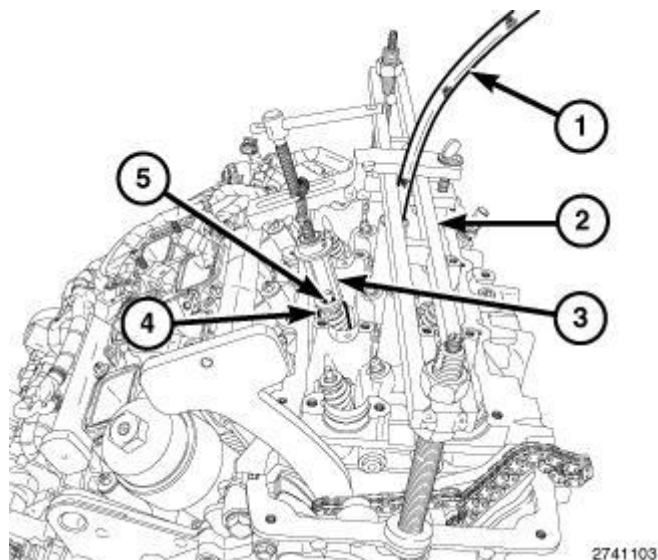


**Fig. 290: Phaser Timing Marks, Oil Control Valves & RH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** RH camshaft phaser lock shown in illustration, LH camshaft phaser lock similar.

**CAUTION:** Air pressure applied to the cylinder holds the valves in place. This air pressure also has a tendency to force the piston down and rotate the crankshaft. Do not allow the crankshaft to rotate. Crankshaft rotation may damage the timing chain or front timing cover and affect camshaft timing.

12. If removing the LH camshafts, install the RH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) (5) to lock the crankshaft against rotation. If removing the RH camshafts, install the LH Camshaft Phaser Lock (special tool #10202, Locks, Camshaft/Phaser) to lock the crankshaft against rotation.



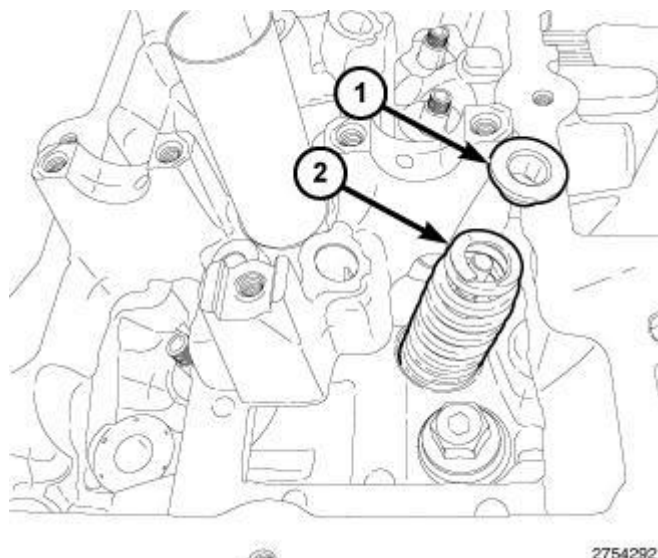
**Fig. 291: Shop Air Supply & Valve Spring Compressor**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Number 4 cylinder intake valve spring compression shown in illustration, all other valves similar.

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

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

16. Using Valve Spring Compressor Adapter (special tool #10224, Adapter, Valve Spring) (3), compress valve spring (4) and remove valve retaining locks (5).

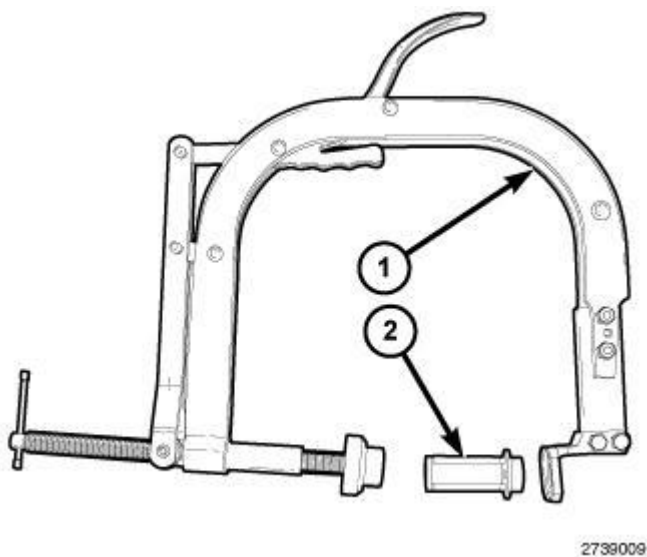


**Fig. 292: Valve Spring & Valve Spring Retainer**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** If the springs are to be reused, identify their positions so that they can be reassembled into their original locations. Number 5 cylinder exhaust valve spring shown in illustration, all other valve springs similar.

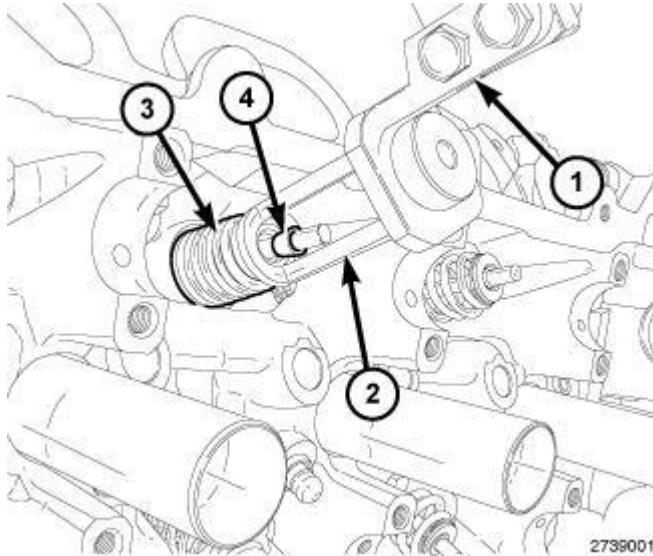
17. Release the valve spring compression and remove the valve spring retainer (1) and valve spring (2).
18. If required, remove the valve guide seal and spring seat. Refer to **SEAL(S), VALVE GUIDE, REMOVAL**.

#### OFF VEHICLE



**Fig. 293: Valve Spring Compressor Components**  
Courtesy of CHRYSLER GROUP, LLC

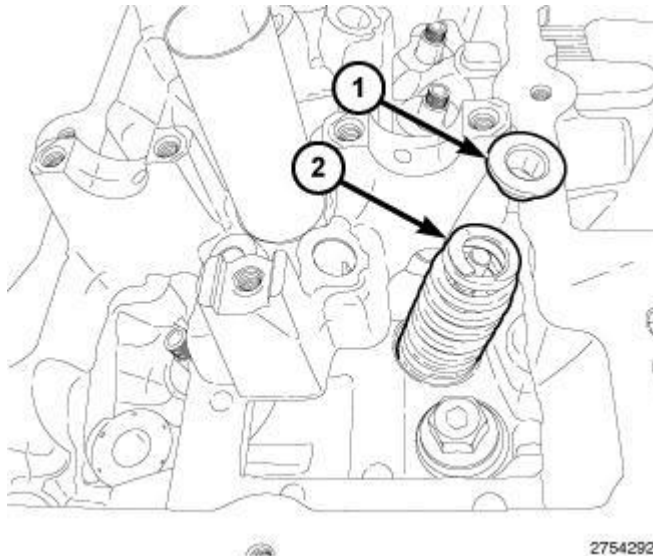
1. Remove the cylinder head(s). Refer to **CYLINDER HEAD, REMOVAL**.
2. Position the Valve Spring Compressor Adapter (special tool #10224, Adapter, Valve Spring) (2) in the Valve Spring Compressor (special tool #C-3422-D, Compressor, Valve Spring) (1).



**Fig. 294: Compressing Valve Spring & Locating Valve Retaining Locks**  
Courtesy of CHRYSLER GROUP, LLC

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

3. Compress the valve spring (3) and remove the valve retaining locks (4).



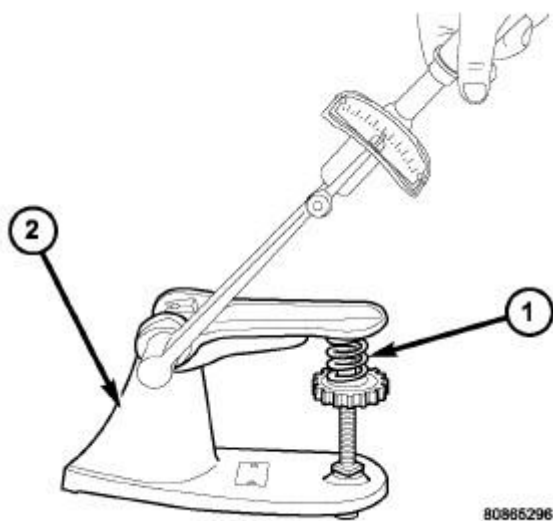
**Fig. 295: Valve Spring & Valve Spring Retainer**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** If the springs are to be reused, identify their positions so that they can be reassembled into their original locations. Number 5 cylinder exhaust valve spring shown in illustration, all other valves similar.

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

## INSPECTION

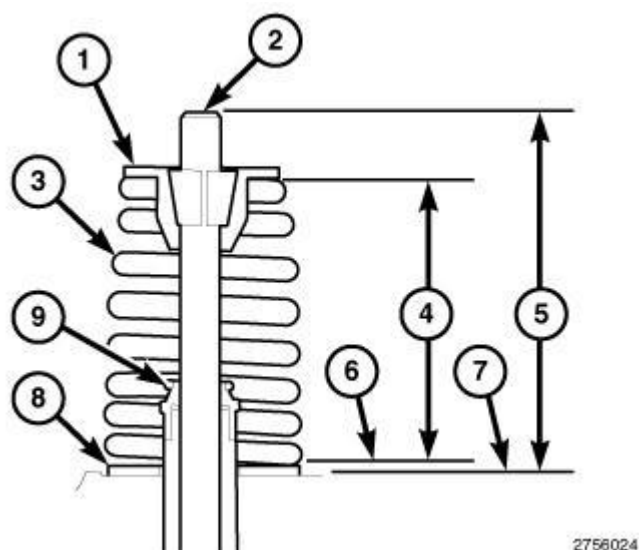
## INSPECTION



**Fig. 296: 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.



2756024

**Fig. 297: Checking Valve Spring Installed Height**

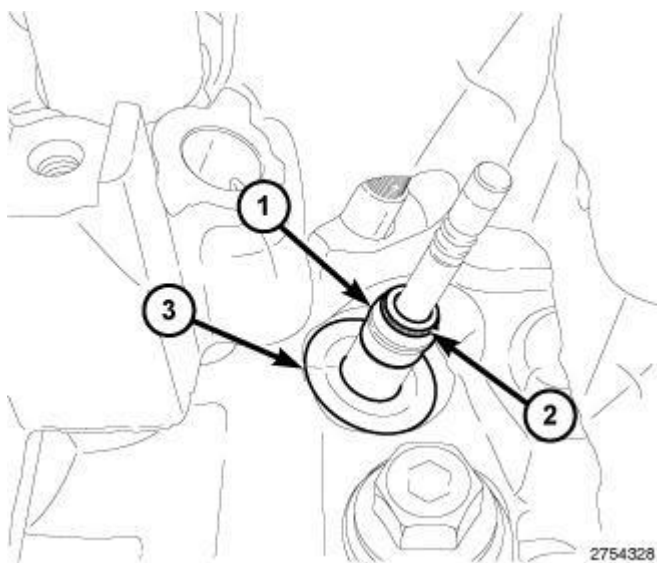
Courtesy of CHRYSLER GROUP, LLC

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 and the installed valve spring height (4) is greater than 40.0 mm (1.575 in.), install an additional spring seat (8) in the head counterbore under the original valve spring seat (8) to bring the spring height back within specification. Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1).

## INSTALLATION

### IN VEHICLE



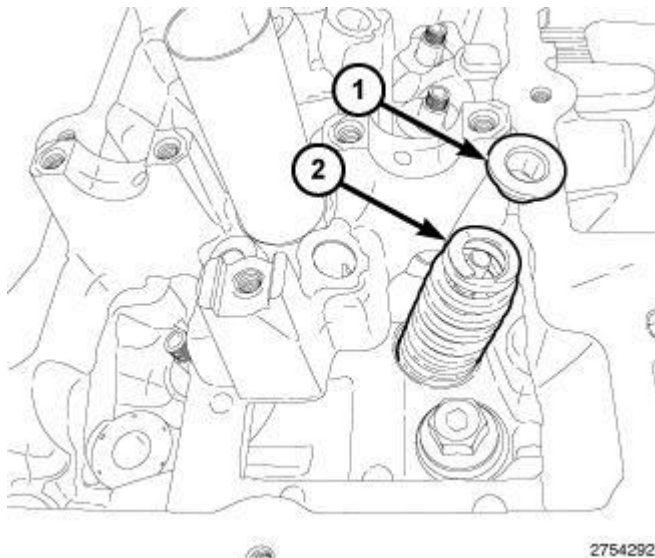
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**Fig. 298: Spring Seat, Valve Guide Seal & Garter Spring**

Courtesy of CHRYSLER GROUP, LLC

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

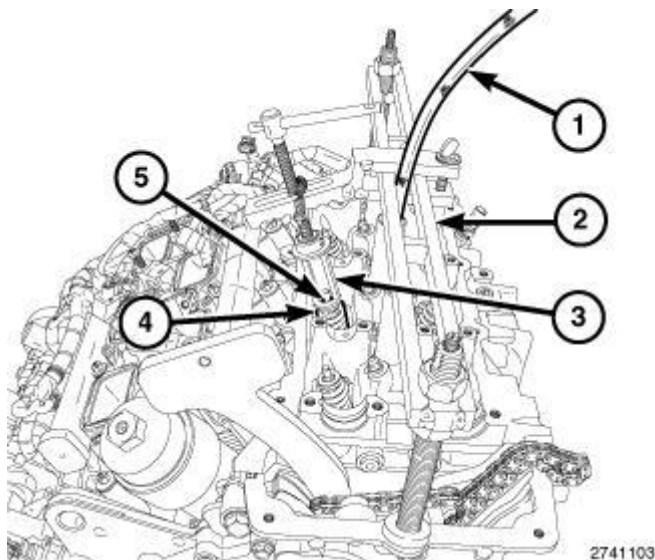
**NOTE:** Ensure that the garter spring (2) is intact around the top of the valve guide seal (1). Number 5 cylinder exhaust valve guide seal shown in illustration, all other valves similar.



**Fig. 299: Valve Spring & Valve Spring Retainer**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** If the valve springs are being reused, reassemble them into their original locations. Number 5 cylinder exhaust valve spring shown in illustration, all other valves similar.

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



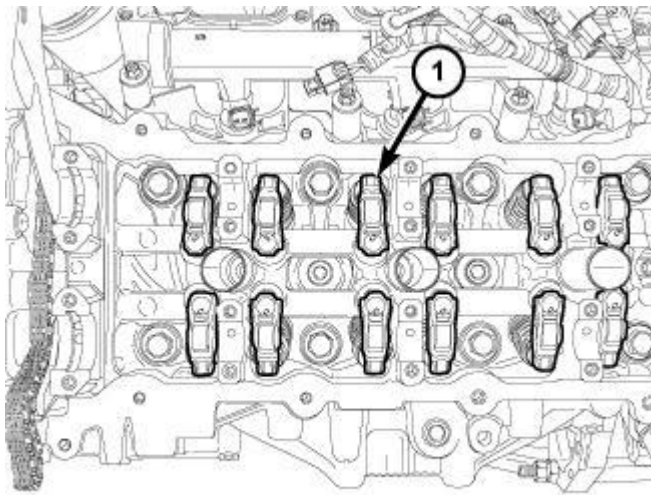


**Fig. 300: Shop Air Supply & Valve Spring Compressor**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Number 4 cylinder intake valve spring compression shown in illustration, all other valves similar.

3. Using Valve Spring Compressor Adapter (special tool #10224, Adapter, Valve Spring) (3) with Valve Spring Compressor (special tool #MD998772A, Compressor, Valve Spring) (2), compress the valve spring (4) **only enough** to install the valve retaining locks (5).
4. Relieve the air pressure and remove the spark plug adapter.
5. Install the spark plug and tighten to 17.5 N.m (13 ft. lbs.). Refer to **SPARK PLUG, INSTALLATION**.



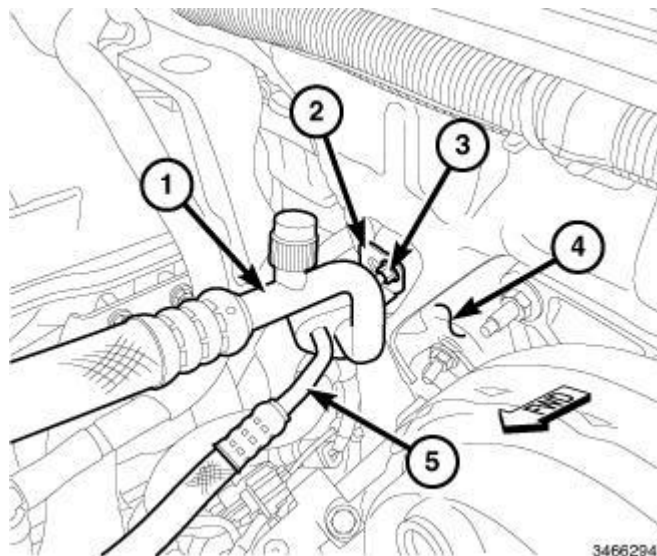
2741091

**Fig. 301: Locating Rocker Arms**

Courtesy of CHRYSLER GROUP, LLC

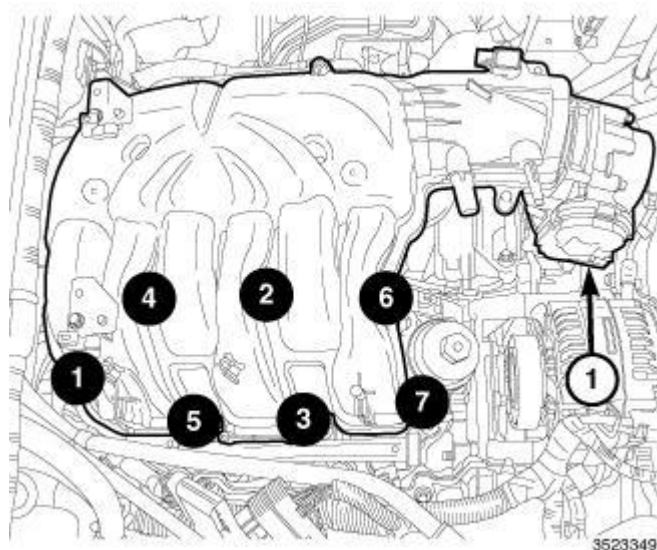
**NOTE:** The LH cylinder head rocker arms are shown in illustration, the RH cylinder head rocker arms are similar. If the rocker arms are being reused, reassemble them into their original locations.

6. Install the rocker arm(s) (1) and camshaft(s). Refer to **ROCKER ARM, VALVE, INSTALLATION**.



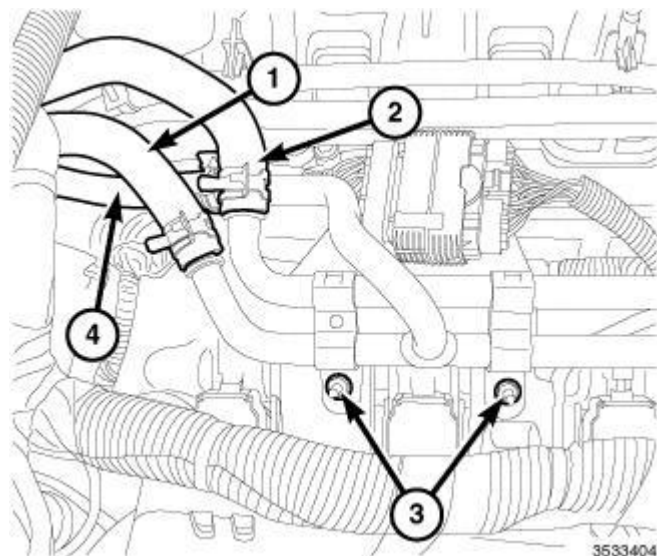
**Fig. 302: A/C Suction & Liquid Line Assembly**  
Courtesy of CHRYSLER GROUP, LLC

7. If removed, install the A/C suction and liquid line assembly (1 and 5). Refer to **LINE, A/C SUCTION, INSTALLATION**.



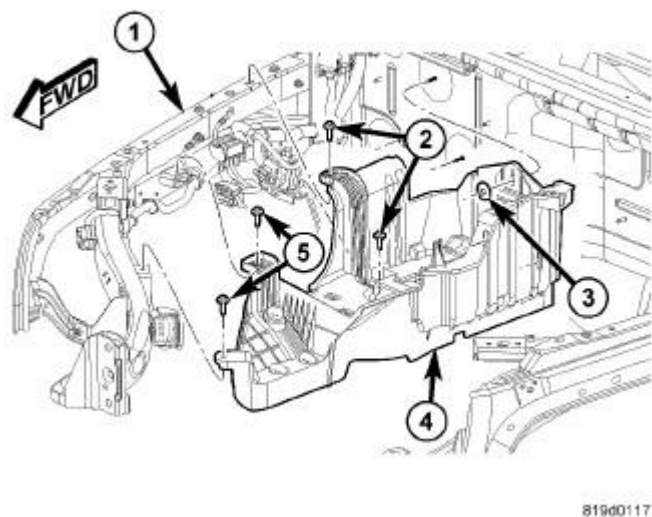
**Fig. 303: Upper Intake Manifold Tightening Sequence**  
Courtesy of CHRYSLER GROUP, LLC

8. Install the cylinder head cover(s) and upper intake manifold (1). Refer to **CAMSHAFT, ENGINE, INSTALLATION**.



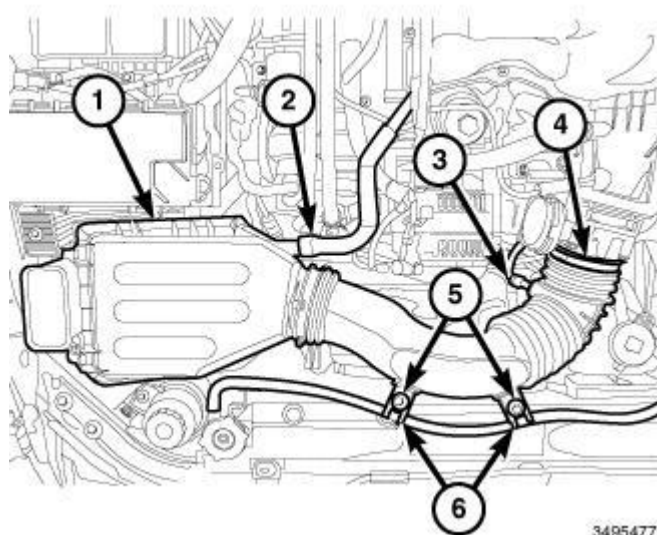
**Fig. 304: Heater Core Return Hose, Heater Core Supply Hose, Nuts & Oil Cooler Return Hose**  
Courtesy of CHRYSLER GROUP, LLC

9. If removed, position the heater core tube assembly and install the heater core supply hose (2), heater core return hose (1) and oil cooler return hose (4).
10. Secure the heater core tube assembly to the right upper intake manifold support bracket with two nuts (3) tightened to 12 N.m (106 in. lbs.).



**Fig. 305: Battery Tray Components**  
Courtesy of CHRYSLER GROUP, LLC

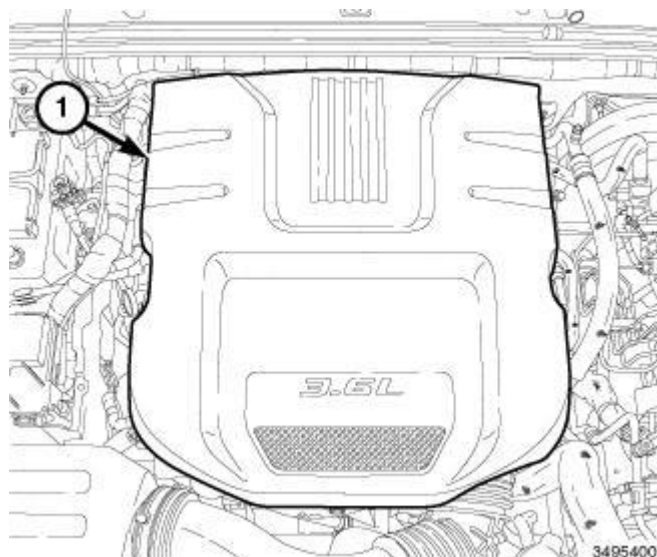
11. If removed, install the battery tray (4), Totally Integrated Power Module (TIPM) and battery. Refer to **TRAY, BATTERY, INSTALLATION**.



**Fig. 306: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

Courtesy of CHRYSLER GROUP, LLC

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



**Fig. 307: Engine Cover**

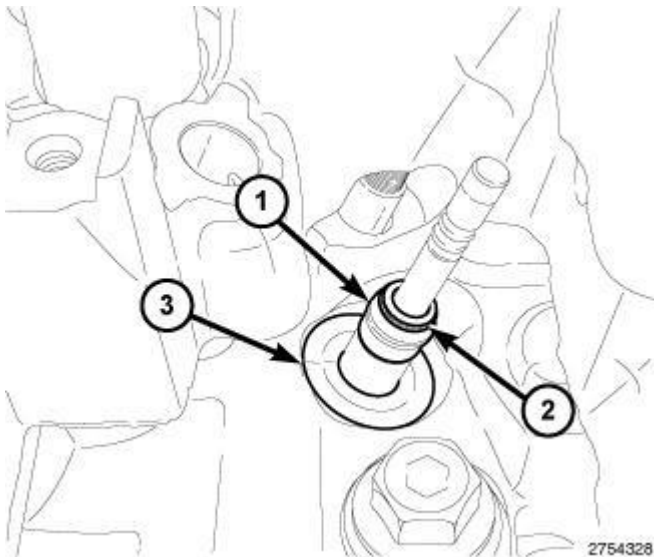
Courtesy of CHRYSLER GROUP, LLC

13. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
14. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
15. Install the engine cover (1).
16. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
17. 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.

#### OFF VEHICLE



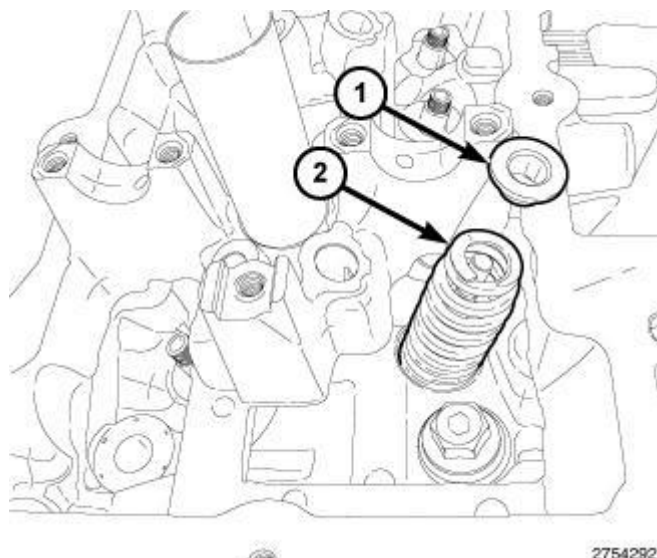
**Fig. 308: Spring Seat, Valve Guide Seal & Garter Spring**  
Courtesy of CHRYSLER GROUP, LLC

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 is within specification. Refer to **Engine - Specifications**. Number 5 cylinder exhaust valve shown in illustration, all other valves similar.

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

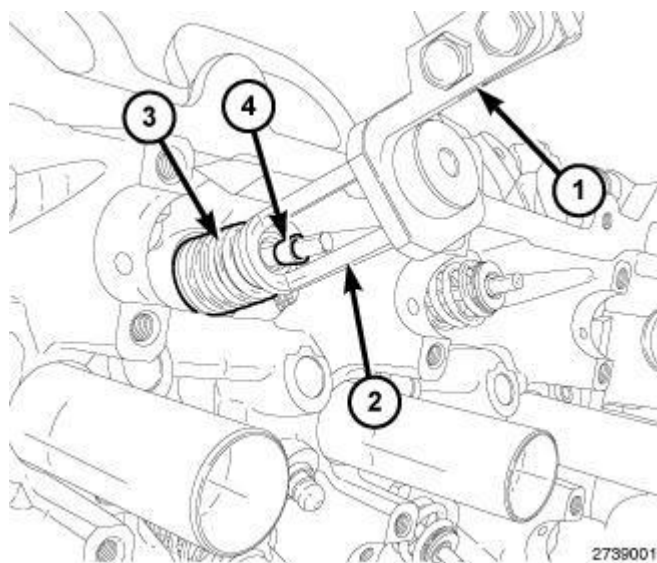
**NOTE:** Ensure that the garter spring (2) is intact around the top of the valve guide seal (1). Number 5 cylinder exhaust valve guide seal shown in illustration, all other valves similar.



**Fig. 309: Valve Spring & Valve Spring Retainer**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** If the valve springs are being reused, reassemble them into their original locations. Number 5 cylinder exhaust valve spring shown in illustration, all other valves similar.

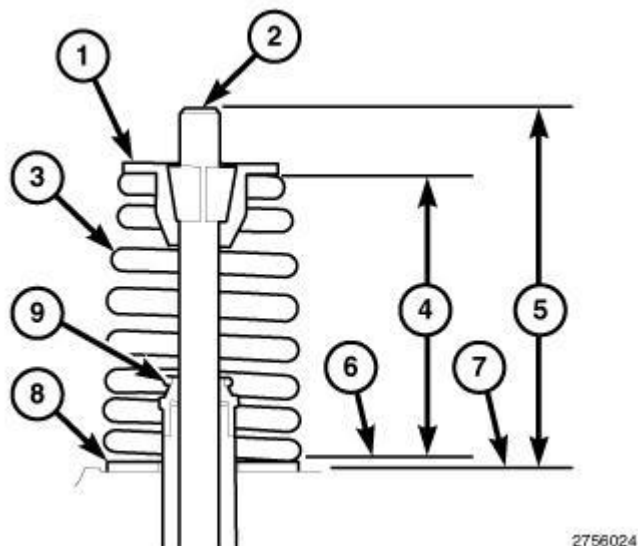
3. Install the valve spring (2) and valve spring retainer (1).



**Fig. 310: Compressing Valve Spring & Locating Valve Retaining Locks**  
Courtesy of CHRYSLER GROUP, LLC

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

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



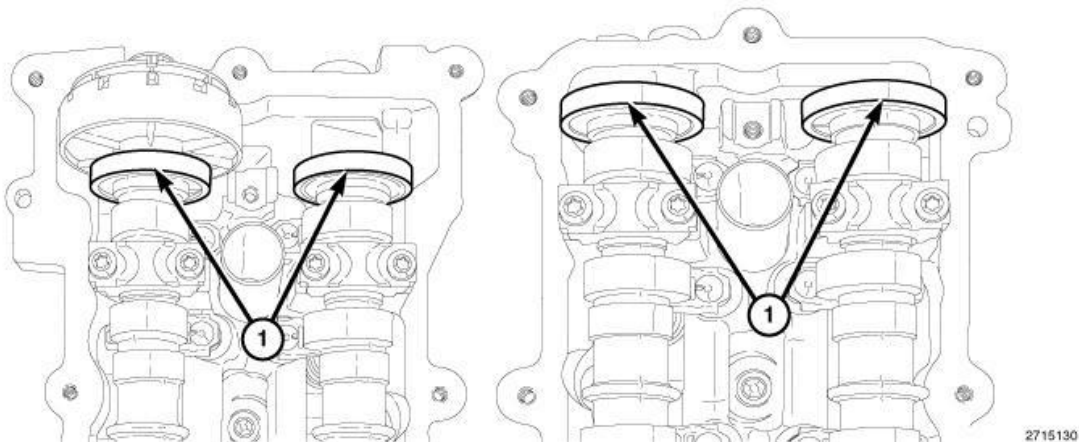
**Fig. 311: Checking Valve Spring Installed Height**  
Courtesy of CHRYSLER GROUP, LLC

5. If the valves or valve seats have been refinished, check the installed height of the valve springs (4). If the installed valve spring height (4) is greater than 40.0 mm (1.575 in.), install an additional spring seat (8) in the head counterbore under the original valve spring seat (8) to bring the spring height back within specification. Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1).
6. Install the cylinder head(s). Refer to **CYLINDER HEAD, INSTALLATION**.

## TUBE, SPARK PLUG

### REMOVAL

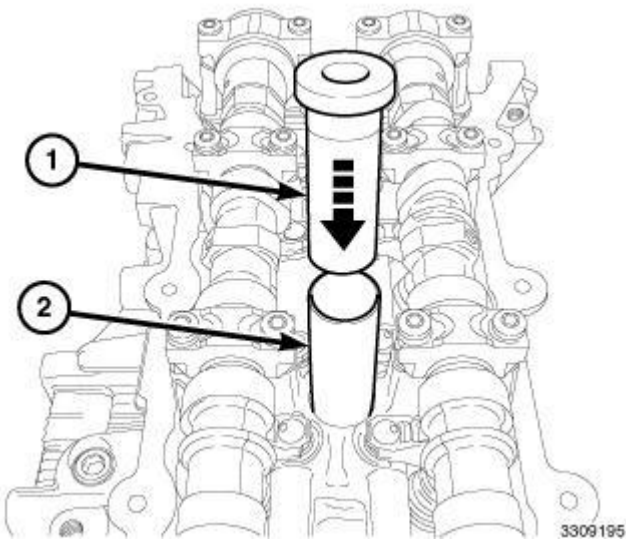
### REMOVAL



**Fig. 312: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.

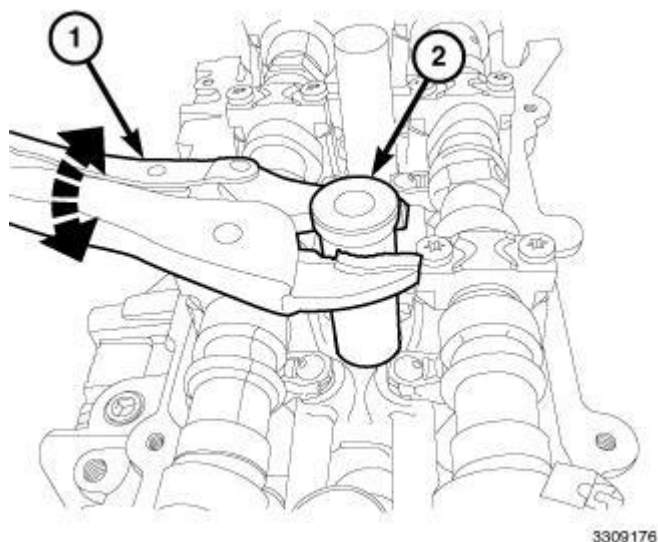


**Fig. 313: Spark Plug Tube Installer & Spark Plug Tube**

Courtesy of CHRYSLER GROUP, LLC

1. Disconnect and isolate the negative battery cable.
2. Remove the ignition coils. Refer to **COIL, IGNITION, 3.6L, REMOVAL** .
3. Using compressed air, blow out any dirt or contaminates from around the top of the spark plugs.
4. Remove the cylinder head cover(s). Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
5. Install the top half of Spark Plug Tube Installer (special tool #10255, Installer, Spark Plug Tube) (1) into the spark plug tube to be removed (2).



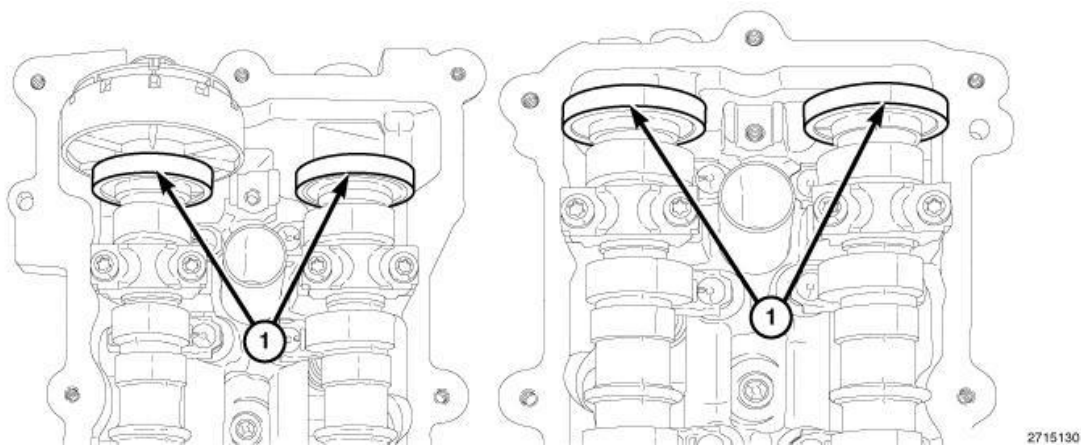


**Fig. 314: Locking Pliers & Spark Plug Tube**  
 Courtesy of CHRYSLER GROUP, LLC

6. Using suitable locking pliers (1), remove the spark plug tube (2) from the cylinder head and discard the tube.
7. Clean the area around the spark plug tube mounting with Mopar® Parts Cleaner or equivalent.

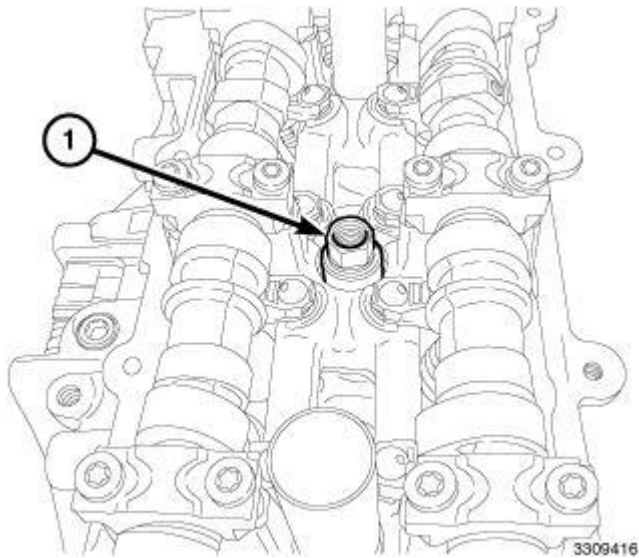
## INSTALLATION

## INSTALLATION



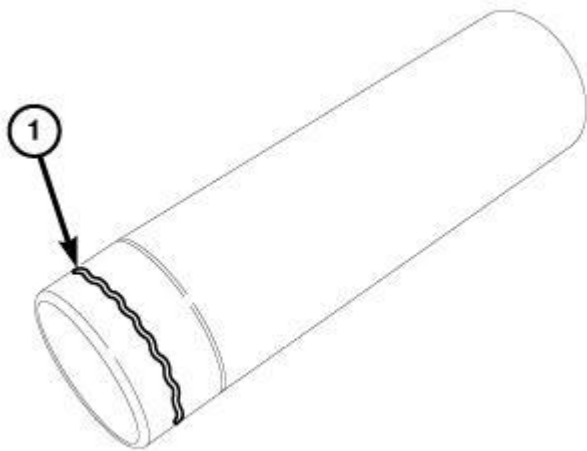
**Fig. 315: Magnetic Timing Wheels**  
 Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



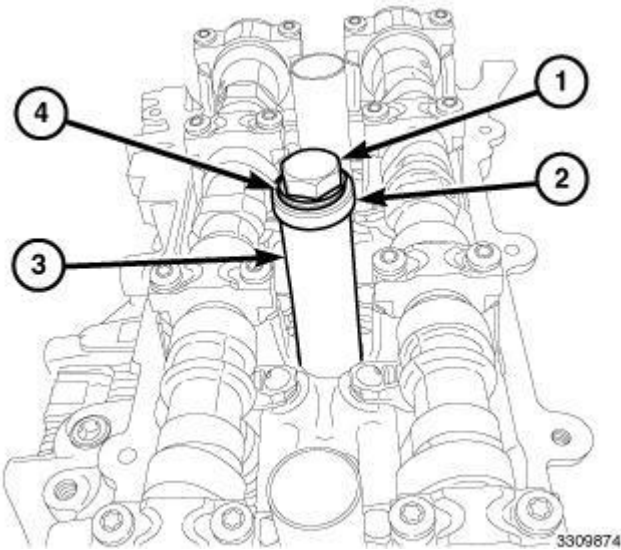
**Fig. 316: Spark Plug Tube Installer**  
Courtesy of CHRYSLER GROUP, LLC

1. Remove the spark plug. Refer to **SPARK PLUG, REMOVAL** .
2. Install the lower half of Spark Plug Tube Installer (special tool #10255, Installer, Spark Plug Tube) (1) into the cylinder head and tighten to 17.5 N.m (13 ft. lbs.).



**Fig. 317: Applying Stud & Bearing Mount Bead To Spark Plug Tube**  
Courtesy of CHRYSLER GROUP, LLC

3. Apply Mopar® Stud and Bearing Mount to the new spark plug tube approximately 3 mm (0.118 in.) from the end of the tube, in a 2 mm (0.078 in.) wide bead (1).

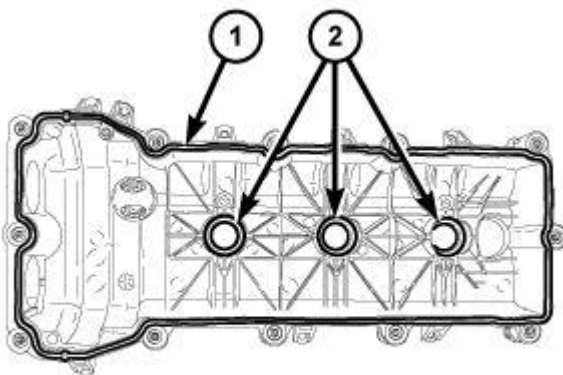


**Fig. 318: Spark Plug Tube, Thrust Washers, Spark Plug Tube Installer & Bolt**  
 Courtesy of CHRYSLER GROUP, LLC

4. Position the spark plug tube (3) on the top half of Spark Plug Tube Installer (special tool #10255, Installer, Spark Plug Tube) (2) and assemble the tool on the cylinder head. Make sure there are two thrust washers (4) installed.

**CAUTION: Do not overtighten the bolt (1). Overtightening can damage the cylinder head spark plug threads.**

5. Tighten the bolt (1) to draw the spark plug tube into position. When the top half of the tool contacts the bottom half of the tool, the tube is installed.



**Fig. 319: Cylinder Head Cover Gasket & Spark Plug Tube Seals**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** LH cylinder head cover shown in illustration, RH cylinder head cover similar.

**CAUTION:** Spark plug torque is critical and must not exceed the specified value. Overtightening stretches the spark plug shell reducing its heat transfer capability resulting in possible catastrophic engine failure.

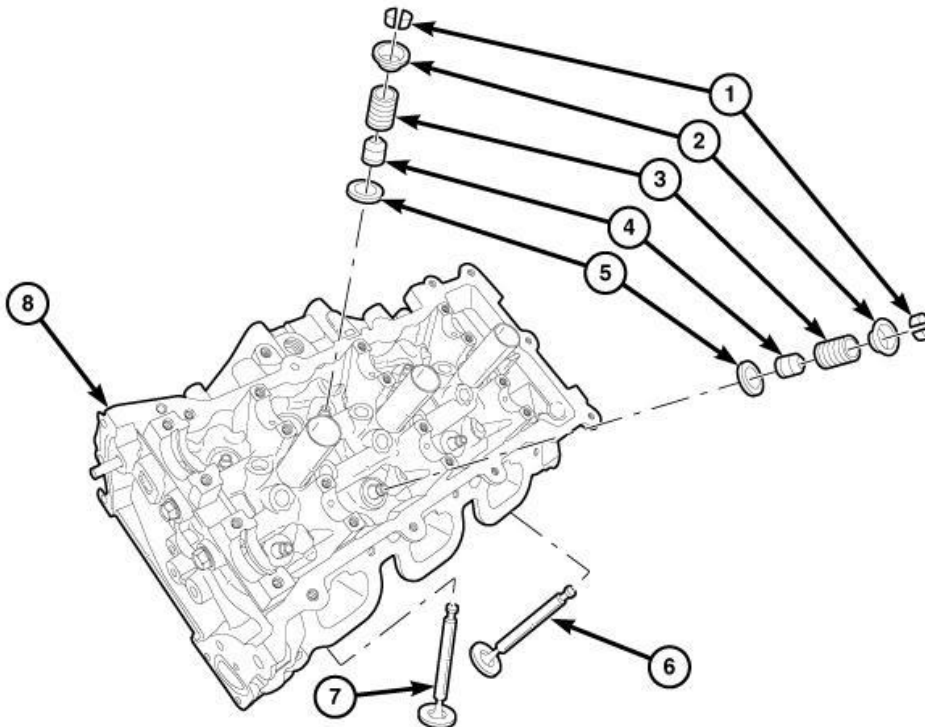
6. Install the spark plug and tighten to 17.5 N.m (13 ft. lbs.). Refer to SPARK PLUG, INSTALLATION.
7. If required, install a new spark plug tube seal (2). Refer to COVER(S), CYLINDER HEAD, INSTALLATION.
8. Install the cylinder head cover(s). Refer to COVER(S), CYLINDER HEAD, INSTALLATION.

Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

## VALVES, INTAKE AND EXHAUST

### DESCRIPTION

### DESCRIPTION



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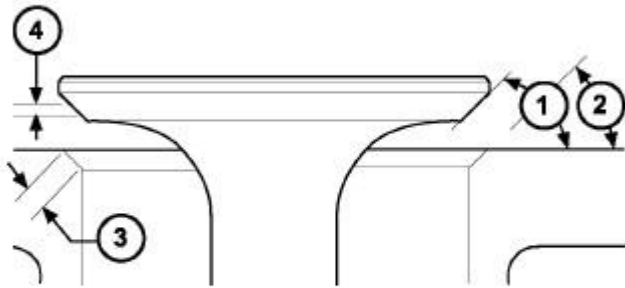
**Fig. 320: Intake Valve & Exhaust Valve Component Configuration**  
Courtesy of CHRYSLER GROUP, LLC

The intake valve (6) is made from a one piece forged heat resistant (martensitic) steel. The exhaust valve (7) is a two piece construction with a forged (austenitic) head welded to the (martensitic) stem. Both valves have a

nitrided surface treatment to prevent scuffing except at the tip and lock grooves. The four valves per cylinder are actuated by roller rocker arms, which pivot on stationary lash adjusters. All valves use three bead lock keepers (1) to retain springs (3) and to promote valve rotation.

#### STANDARD PROCEDURE

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



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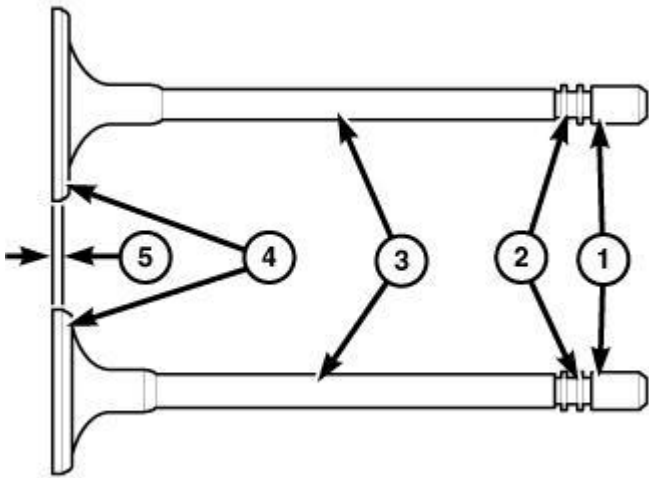
**Fig. 321: Valve Face & Seat**

Courtesy of CHRYSLER GROUP, LLC

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

The intake and exhaust valves have a  $45.25 \pm 0.25$  degree face angle (1). The valve seats (2) have a  $44.75 \pm 0.25$  degree face angle.

#### VALVES

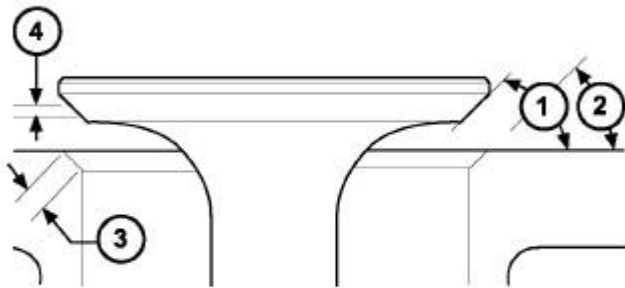


2755802

**Fig. 322: Inspecting Valve Margin**

Courtesy of CHRYSLER GROUP, LLC

Inspect the remaining margin (5) after the valves are refaced. Refer to **Engine - Specifications**.

**VALVE SEATS**

809c3e96

**Fig. 323: Valve Face & Seat**

Courtesy of CHRYSLER GROUP, LLC

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

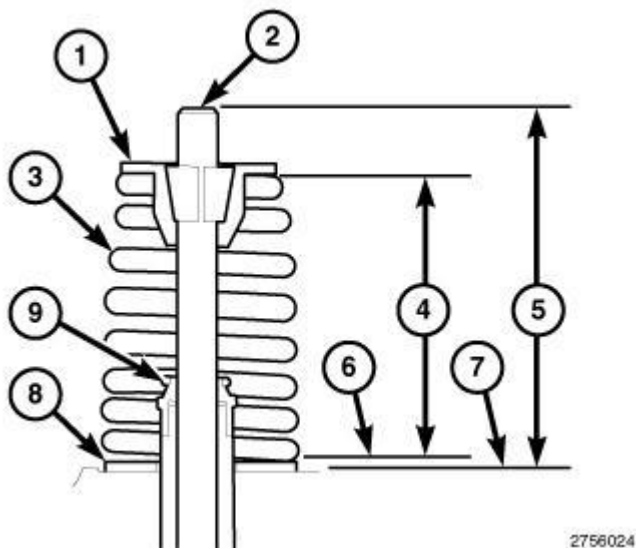
**NOTE:** When refacing the valve seats, it is important that the correct size valve guide pilot be used for the reseating stones. A true and complete surface must be obtained.

1. Measure the concentricity of the valve seat using a dial indicator. Total runout should not exceed 0.050 mm (0.002 inch.) total indicator reading.
2. Inspect the valve seat (3) with Prussian blue to determine where the valve contacts the seat. To do this, coat 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 seat should be 1.0 - 1.2 mm (0.04 - 0.05 in.) and the exhaust seats should be 1.41 - 1.61 mm (0.055 - 0.063 in.).

#### VALVE AND SPRING INSTALLED HEIGHT



**Fig. 324: Checking Valve Spring Installed Height**

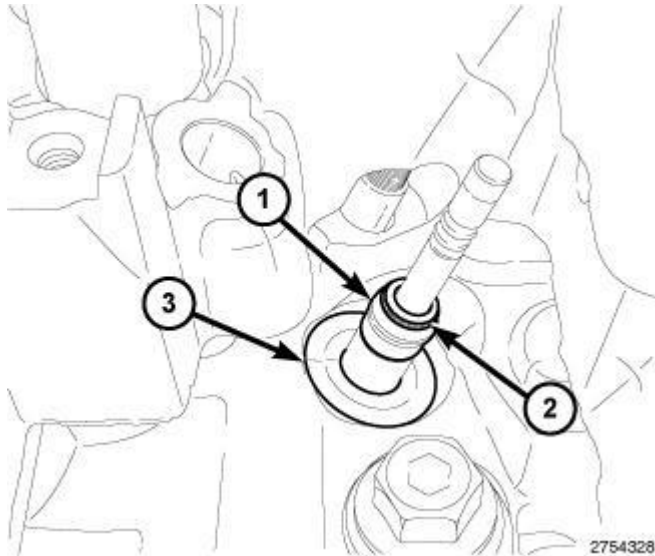
Courtesy of CHRYSLER GROUP, LLC

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)

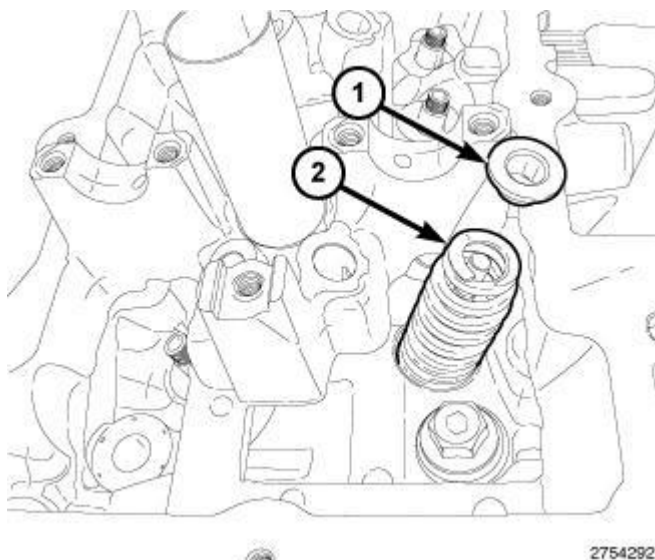
exceeds the specification, grind the valve tip until it is within specification. Refer to **Engine - Specifications**. Make sure the measurement is taken from the cylinder head surface (7) to the top of the valve stem (2).



**Fig. 325: Spring Seat, Valve Guide Seal & Garter Spring**  
Courtesy of CHRYSLER GROUP, LLC

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

**NOTE:** Ensure that the garter spring (2) is intact around the top of the valve guide seal (1). Number 5 cylinder exhaust valve guide seal shown in illustration, all other valves similar.

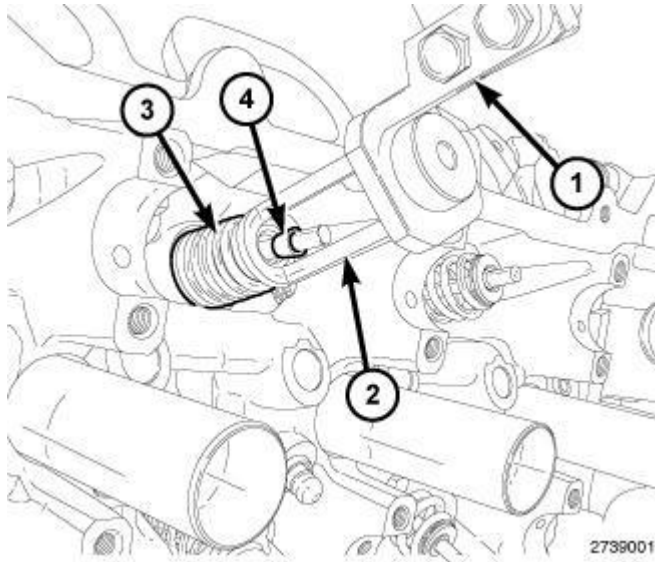


**Fig. 326: Valve Spring & Valve Spring Retainer**  
Courtesy of CHRYSLER GROUP, LLC



**NOTE:** If the valve springs are being reused, reassemble them into their original locations. Number 5 cylinder exhaust valve spring shown in illustration, all other valves similar.

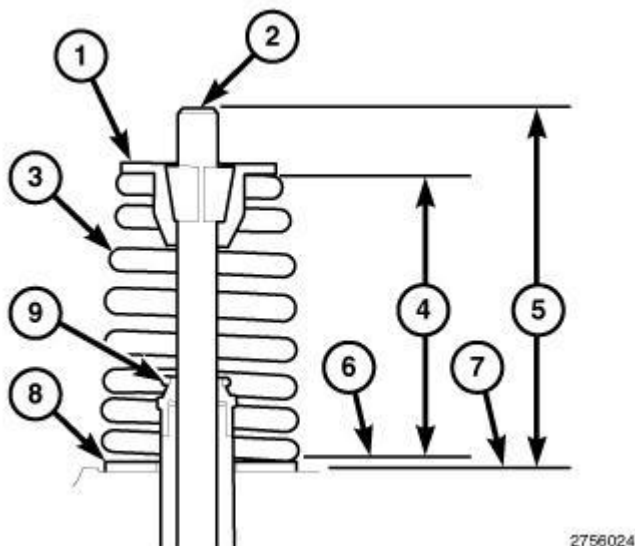
4. Install the valve spring (2) and valve spring retainer (1).



**Fig. 327: Compressing Valve Spring & Locating Valve Retaining Locks**  
Courtesy of CHRYSLER GROUP, LLC

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

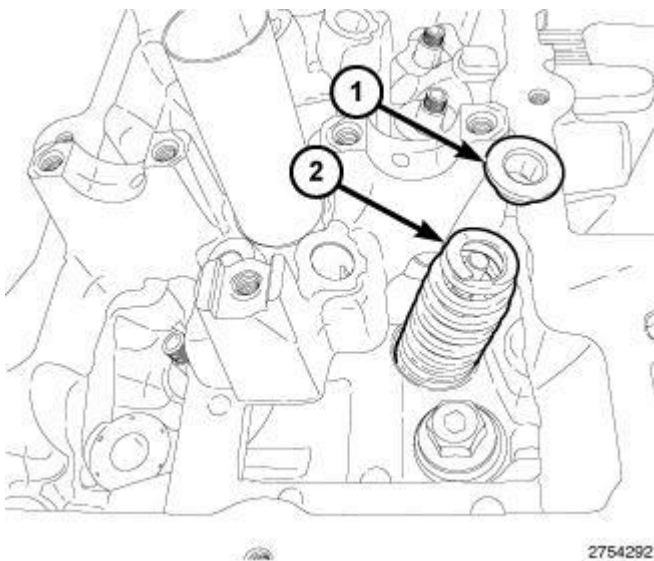
5. Compress valve springs (3) with the Valve Spring Compressor Adapter (special tool #10224, Adapter, Valve Spring) (2) mounted in the Valve Spring Compressor (special tool #C-3422-D, Compressor, Valve Spring) (1). Install the retaining locks (4) and release the valve spring compression.



**Fig. 328: 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). If the installed valve spring height (4) is greater than 40.0 mm (1.575 in.), install a second spring seat (8) in the head counterbore under the valve spring seat (8) to bring the spring height back within specification. Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1).

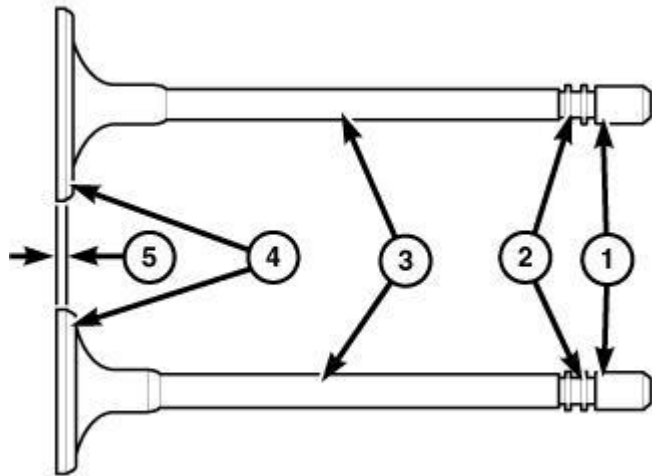
**REMOVAL****REMOVAL****Fig. 329: Valve Spring & Valve Spring Retainer**

Courtesy of CHRYSLER GROUP, LLC

1. Remove the cylinder head(s). 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 5 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**.

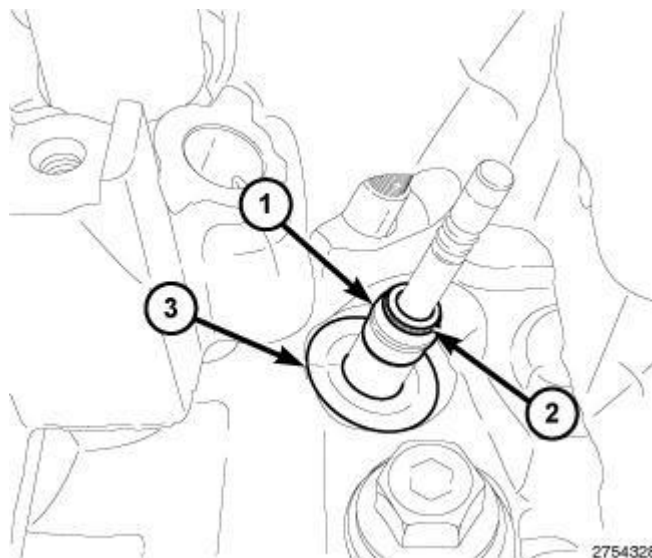


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**Fig. 330: Inspecting Valve Margin**  
Courtesy of CHRYSLER GROUP, LLC

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



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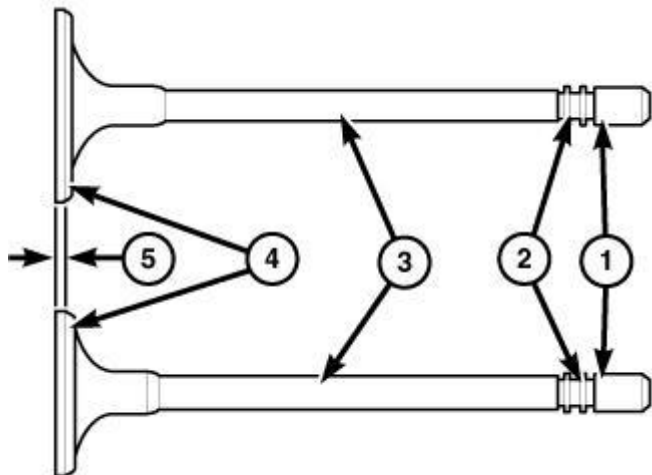
**Fig. 331: Spring Seat, Valve Guide Seal & Garter Spring**  
Courtesy of CHRYSLER GROUP, LLC

4. If required, remove the valve guide seal (1) and spring seat (3). Refer to **SEAL(S), VALVE GUIDE, REMOVAL**.

## INSPECTION

## INSPECTION

## VALVES



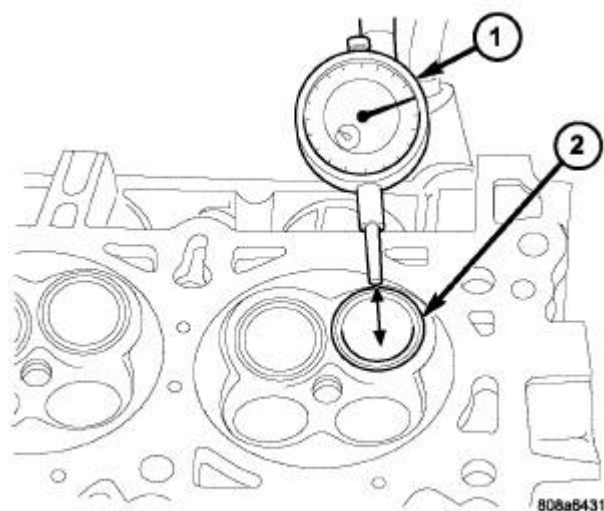
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**Fig. 332: Inspecting Valve Margin**

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. 333: Measuring Valve Guide Wear**

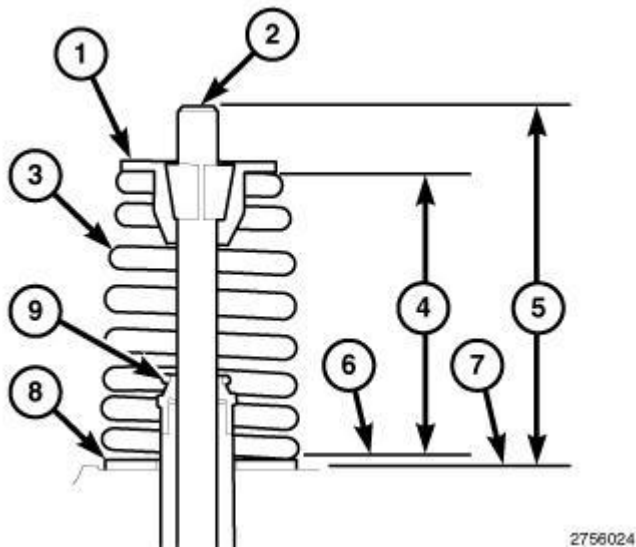
## Courtesy of CHRYSLER GROUP, LLC

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

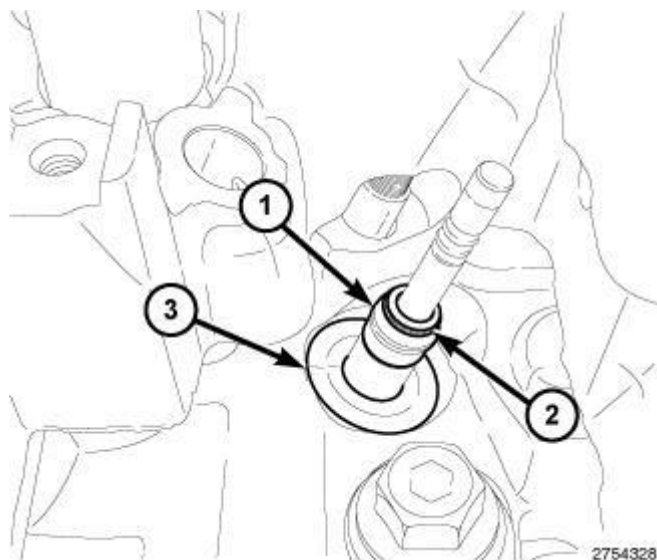


**Fig. 334: Checking Valve Spring Installed Height**  
Courtesy of CHRYSLER GROUP, LLC

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.

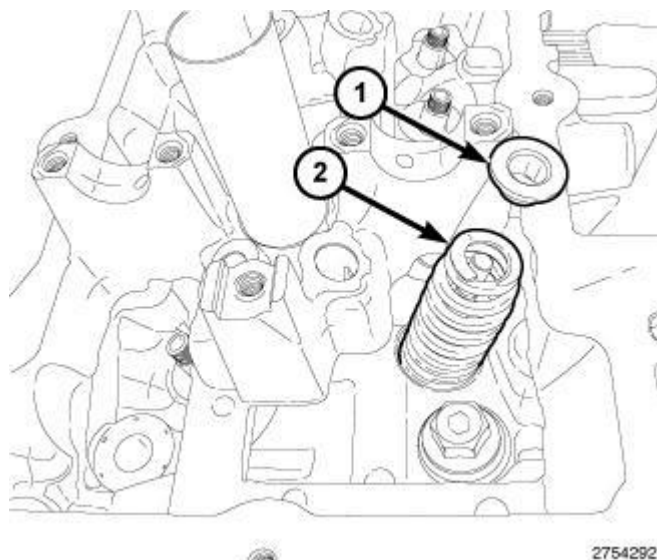
2. If the valves or valve seats have been refinished, check the valve tip height (5). If the valve tip height (5) exceeds the specification, grind the valve tip until it is within specification. Refer to **Engine - Specifications**. Make sure the measurement is taken from the cylinder head surface (7)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



**Fig. 335: Spring Seat, Valve Guide Seal & Garter Spring**  
Courtesy of CHRYSLER GROUP, LLC

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

**NOTE:** Ensure that the garter spring (2) is intact around the top of the valve guide seal (1). Number 5 cylinder exhaust valve guide seal shown in illustration, all other valves similar.



**Fig. 336: Valve Spring & 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

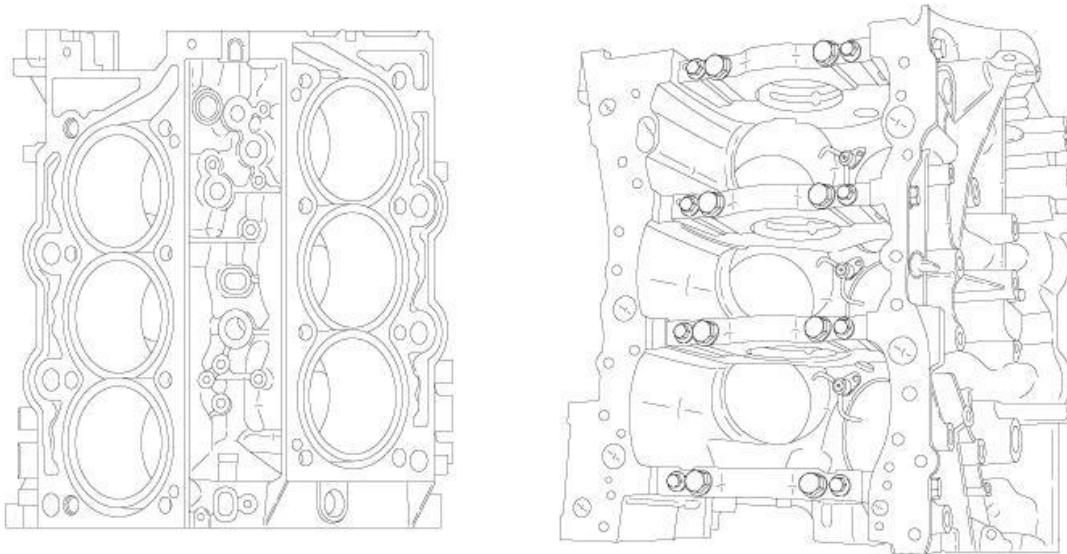
valve seats have been refinished, verify that the valve spring installed height is within specification. Refer to Engine - Specifications. Number 5 cylinder exhaust valve spring shown in illustration, all other valves springs similar.

5. Install the cylinder head(s). Refer to CYLINDER HEAD, INSTALLATION.

## ENGINE BLOCK

### DESCRIPTION

### DESCRIPTION



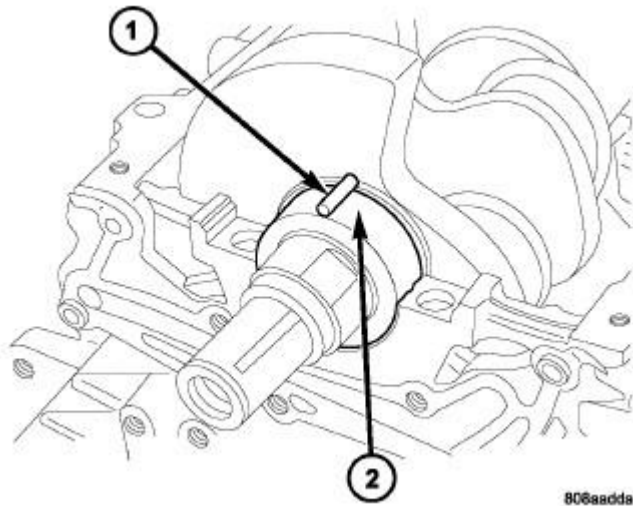
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**Fig. 337: Cylinder Block & Main Bearing Caps**  
Courtesy of CHRYSLER GROUP, LLC

The cylinder block is a 60 degree high-pressure die cast aluminum design with cast steel cylinder liners. The leading side of the block is on the right side and houses cylinders 1, 3 and 5. The cylinder block is an open deck design with cut slots between each cylinder. Two knock sensors are located in the block valley. The cylinder block has three sets of piston cooling jets which are attached to the main oil gallery. The four powdered metal main bearing caps are a cross-bolted design and have directional arrows molded into the caps. The number 2 main bearing is the location for the two piece upper half thrust bearings. The thrust bearings are installed with the oil grooves facing outward. The main bearing caps are a 6-bolt design and cross-bolted for improved lower end strength. There are three oil drain back drillings located on each of the cylinder banks.

### STANDARD PROCEDURE

## MEASURING BEARING CLEARANCE USING PLASTIGAGE



**Fig. 338: Plastigage Placed In Lower Shell**  
Courtesy of CHRYSLER GROUP, LLC

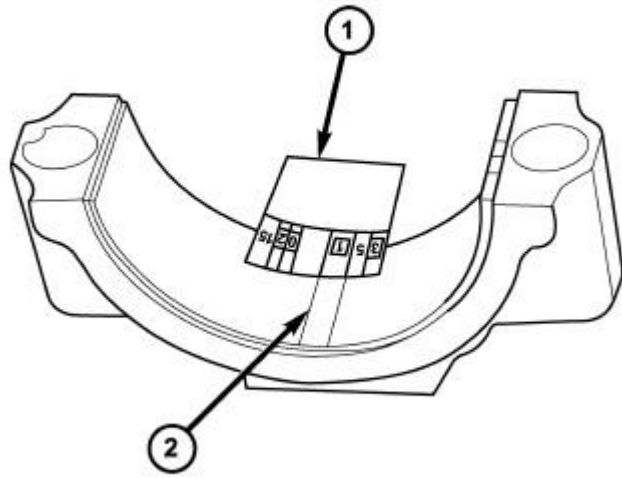
**NOTE:** Typical crankshaft journal shown in illustration.

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 specifications. Refer to **Engine - Specifications**.

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



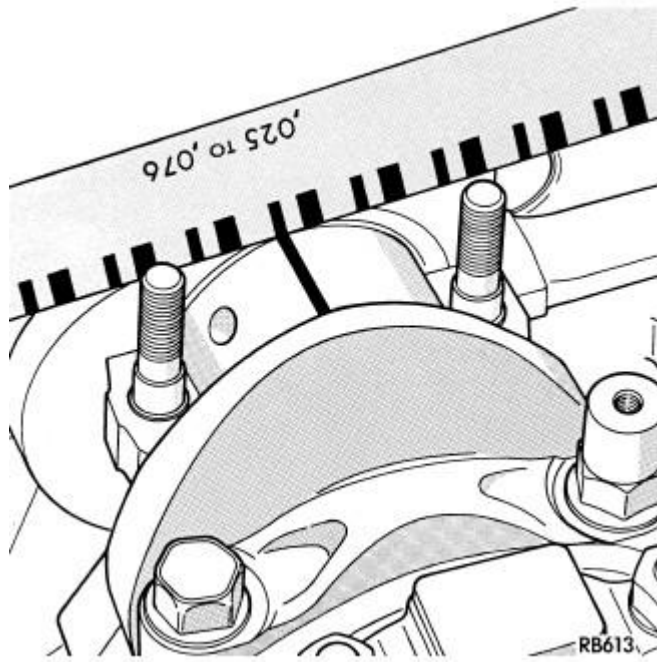


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**Fig. 339: Measuring Bearing Clearance With Plastigage**  
Courtesy of CHRYSLER GROUP, LLC

**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 engine specifications. Refer to **Engine - Specifications**.



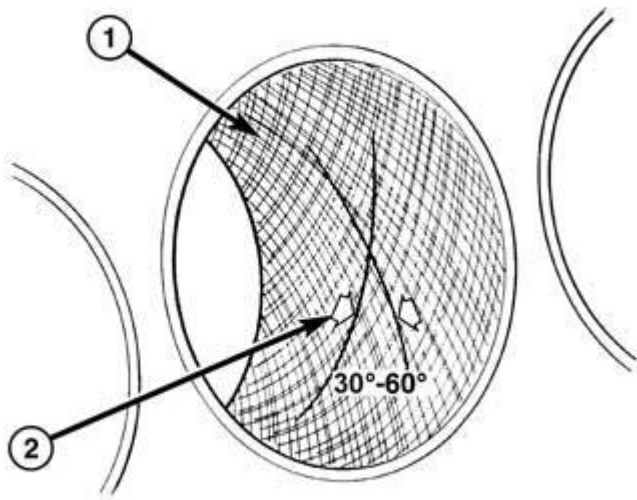
**Fig. 340: Checking Connecting Rod Bearing Clearance With Plastigage**  
Courtesy of CHRYSLER GROUP, LLC

**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.

#### CYLINDER BORE HONING



**Fig. 341: Cylinder Bore Crosshatch Pattern**  
 Courtesy of CHRYSLER GROUP, LLC

Before honing, stuff plenty of clean shop towels under the bores and over the crankshaft to keep abrasive materials from entering the crankshaft area.

1. Used carefully, a cylinder bore sizing hone equipped with 220 grit stones, is the best tool for this job. In addition to deglazing, it will reduce taper and out-of-round, as well as removing light scuffing, scoring and scratches. Usually, a few strokes will clean up a bore and maintain the required limits.

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

2. Deglazing of the cylinder walls may be done if the cylinder bore is straight and round. Use of a cylinder surfacing hone equipped with 280 grit stones, about 20-60 strokes, depending on the bore condition, will be sufficient to provide a satisfactory surface. Use a light honing oil, available from major oil distributors.

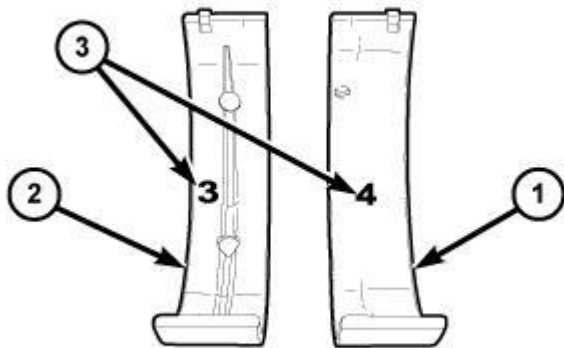
**CAUTION: DO NOT use engine or transmission oil, mineral spirits, or kerosene.**

3. Honing should be done by moving the hone up and down fast enough to get a crosshatch pattern. The hone marks should INTERSECT at 50° to 60° 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 50° to 60° angle (2). Faster up and down strokes increase the crosshatch angle.
5. After honing, 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.

## INSPECTION

### INSPECTION

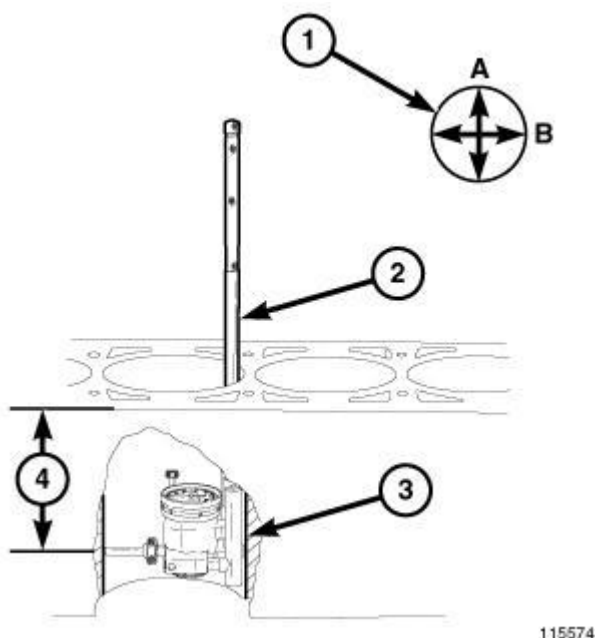


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**Fig. 342: Main Bearing Inserts**

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

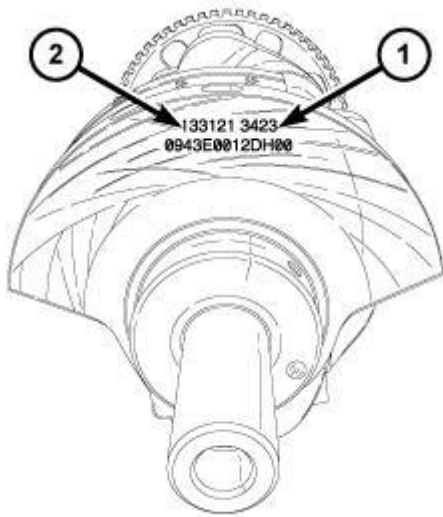
9. Use Cylinder Indicator (special tool #C-119, Cylinder Indicator) (2) to correctly measure the inside diameter of the cylinder bore (3). A cylinder bore gauge capable of reading in 0.003 mm (0.0001 in.) INCREMENTS is required. If a bore gauge is not available, do not use an inside micrometer.
10. Measure 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 specifications. 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 specifications. 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/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

#### CONNECTING ROD BEARING FITTING



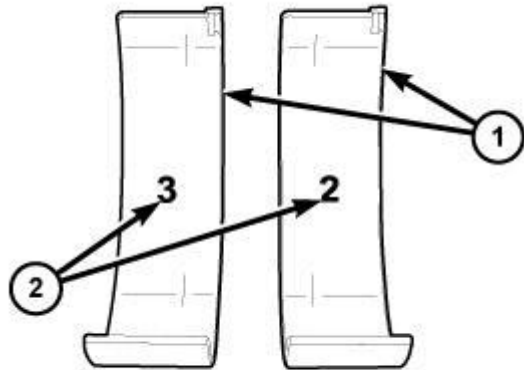
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**Fig. 344: Crankshaft Main Bearing Journal Diameter Grade Markings & Connecting Rod Bearing Journal Diameter Grade Markings**  
 Courtesy of CHRYSLER GROUP, LLC

The connecting rod bearings are "select fit" to achieve proper oil clearance. Connecting rod bearing journal diameter grade markings (2) are stamped into the front crankshaft counterweight. These marks are read from left to right, corresponding with journal number 1, 2, 3, 4, 5, 6. Select the bearing size that corresponds to the crankshaft markings for each rod bearing journal.

Connecting rod bearing journal diameter grade markings correspond to specific journal diameters. The chart below identifies the three crankshaft grade markings and their associated journal diameters.

Crankshaft Marking	Journal Size mm (in.)
1	58.9910 - 58.9969 mm (2.3225 - 2.3227 in.)
2	58.9970 - 59.0029 mm (2.3227 - 2.3229 in.)
3	59.0030 - 59.0090 mm (2.3229 - 2.3232 in.)



2769568

**Fig. 345: Connecting Rod Bearing Shells & Bearing Size**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Install the rod bearings in pairs. Do not mix sizes or use a new bearing half with an old bearing half.

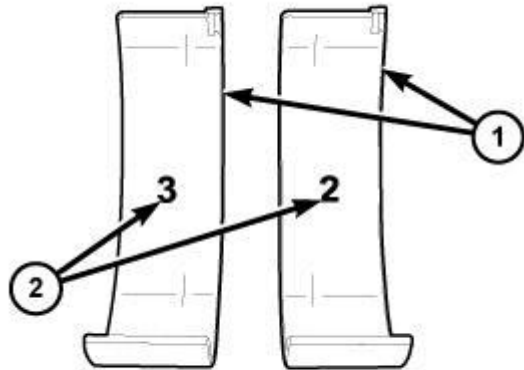
The connecting rod bearing shells (1) are marked with the bearing size (2) on the bearing lining surface. The bearings are available in three different sizes in order to achieve the desired oil clearance.

Rod bearing shells are available in three sizes. The chart below identifies the three bearing sizes.

Bearing Marking	Size mm (in.)
1	1.583 - 1.580 mm (0.0623 - 0.0622 in.)
2	1.580 - 1.577 mm (0.0622 - 0.0621 in.)
3	1.577 - 1.574 mm (0.0621 - 0.0620 in.)

Bearing oil clearance can also be determined by using Plastigage or equivalent. Refer to **Engine/Engine Block - Standard Procedure**.

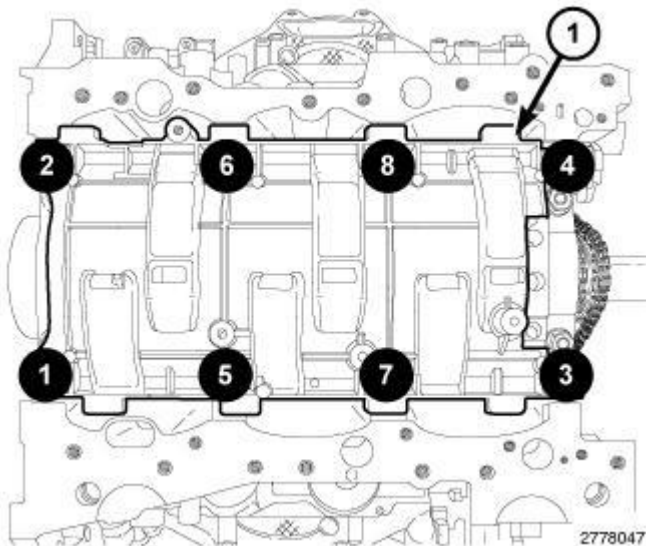
#### CONNECTING ROD BEARING REPLACEMENT



2769568

**Fig. 346: 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**.

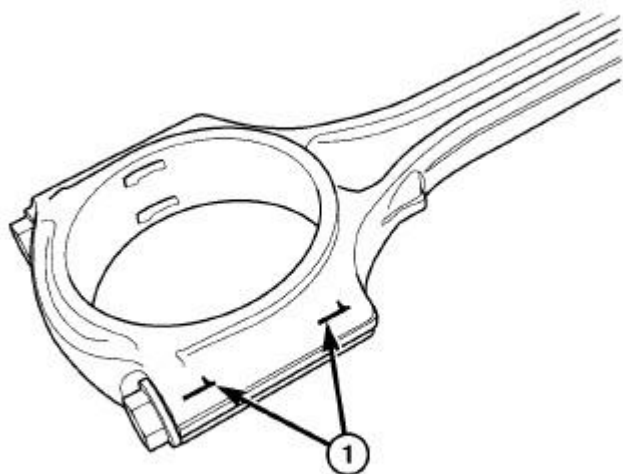


2778047

**Fig. 347: 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 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 from the windage tray in the sequence shown in illustration and remove the windage tray (1).





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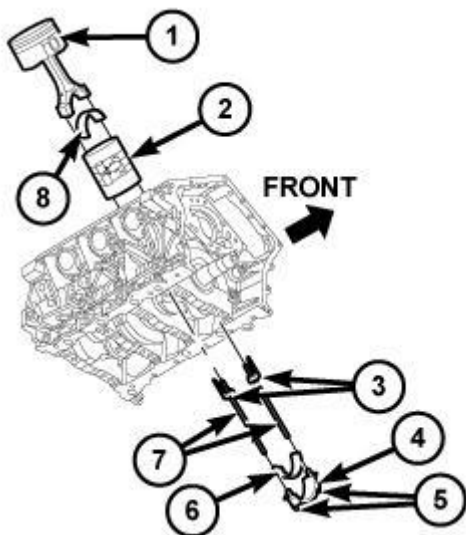
**Fig. 348: Connecting Rod To Cylinder Identification**

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.



2778313

**Fig. 349: 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.

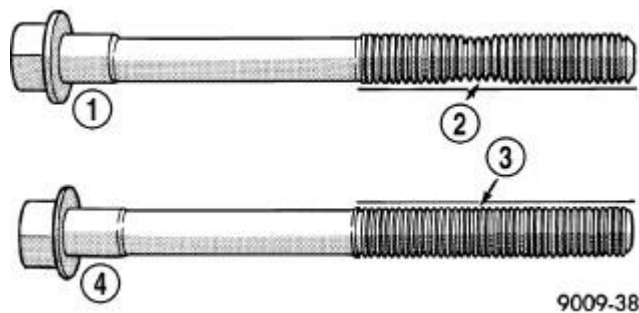
8. Rotate the crankshaft away from the connecting rod and remove the bearing shell.
9. If required, select and fit new bearings to the connecting rod. Refer to **BEARING(S), CONNECTING ROD, STANDARD PROCEDURE**.
10. Install the bearing shell (8) on the connecting rod with the tang inserted into the machined 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).

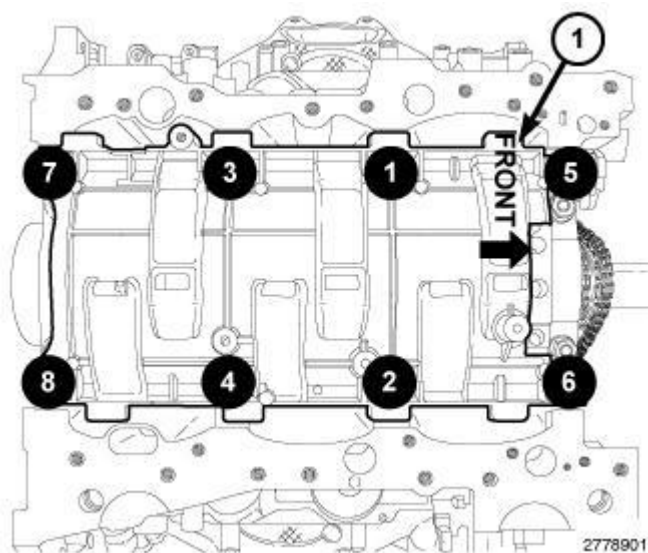
13. Install the connecting rod cap and bearing with the tang on the same side as the rod. Tighten the NEW connecting rod cap bolts (5) to 20 N.m (15 ft. lbs.) plus 90°.
14. If required, check the connecting rod side clearance. Refer to **Engine/Engine Block/ROD, Piston and Connecting - Standard Procedure**.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



**Fig. 350: 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. 351: Windage Tray With Main Bearing Cap Bolts Installation Sequence**  
Courtesy of CHRYSLER GROUP, LLC

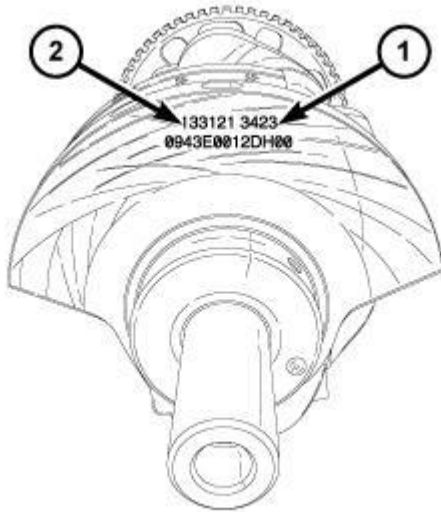
17. Install the windage tray with eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to 21 N.m (16 ft. lbs.) plus 90°.
18. Install the engine oil pump, oil pump pick-up and oil pan. Refer to **PUMP, ENGINE OIL, INSTALLATION**.
19. Install the spark plugs and ignition 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 **Engine/Lubrication/OIL - Standard Procedure**.
21. Connect the negative battery 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

#### MAIN BEARING FITTING



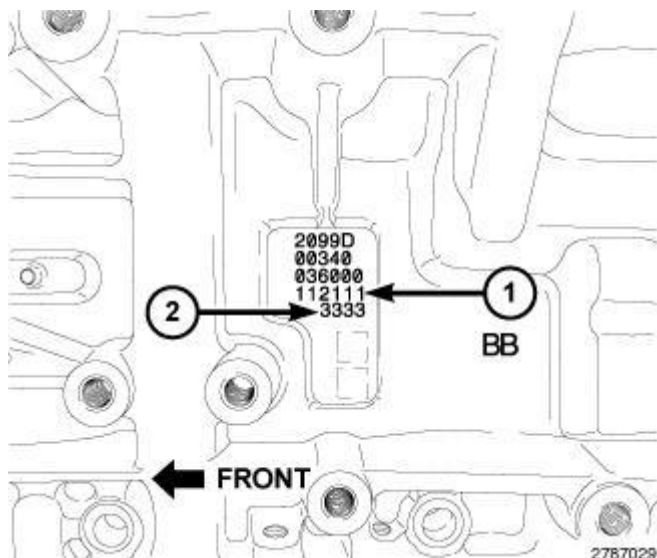
2767957

**Fig. 352: Crankshaft Main Bearing Journal Diameter Grade Markings & Connecting Rod Bearing Journal Diameter Grade Markings**  
 Courtesy of CHRYSLER GROUP, LLC

The upper and lower main bearings are "select fit" to achieve proper oil clearances. Crankshaft main bearing journal diameter grade markings (1) are stamped into the front crankshaft counterweight. These marks are read from left to right, corresponding with journal number 1, 2, 3, 4.

Crankshaft main bearing journal diameter grade markings correspond to specific journal diameters. The chart below identifies the five crankshaft grade markings and their associated journal diameters.

Crankshaft Marking	Journal Size mm (in.)
1	71.9870 - 71.9905 mm (2.8341 - 2.8343 in.)
2	71.9906 - 71.9941 mm (2.8343 - 2.8344 in.)
3	71.9942 - 71.9977 mm (2.8344 - 2.8345 in.)
4	71.9978 - 72.0013 mm (2.8346 - 2.8347 in.)
5	72.0014 - 72.0050 mm (2.8347 - 2.8348 in.)



**Fig. 353: Engine Block Cylinder Bore Diameter Grade Markings & Engine Block Main Bearing Journal Diameter Grade Markings**

Courtesy of CHRYSLER GROUP, LLC

Engine block main bearing journal diameter grade markings (2) are stamped into the left side of the engine block. These marks are read from left to right, corresponding with journal number 1, 2, 3, 4.

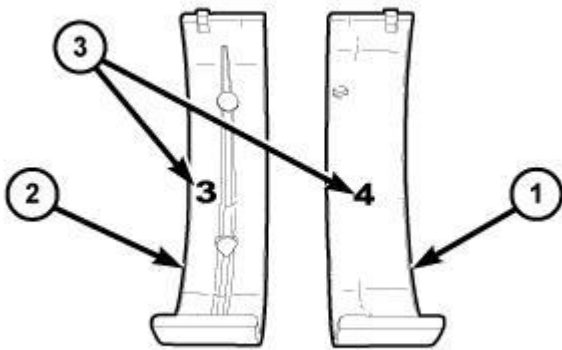
Engine block main bearing journal grade markings correspond to specific journal diameters. The chart below identifies the five engine block grade markings and their associated journal diameters.

Engine Block Marking	Journal Size mm (in.)
1	77.0055 - 77.0090 mm (3.0317 - 3.0318 in.)
2	77.0019 - 77.0054 mm (3.0316 - 3.0317 in.)
3	76.9983 - 77.0018 mm (3.0314 - 3.0316 in.)
4	76.9947 - 76.9982 mm (3.0313 - 3.0314 in.)
5	76.9910 - 76.9946 mm (3.0311 - 3.0313 in.)

For upper and lower main bearing selection, obtain the grade identification marks from the crankshaft and engine block. Main bearings are available in five sizes. Upper and lower sizes can be mixed on a journal in order to achieve the desired oil clearance. The chart below identifies the five sizes available and how they should be selected based on crankshaft and engine block grade markings.

Engine Block Marking	Crankshaft Marking				
	1	2	3	4	5
1	1/1	1/2	2/2	2/3	3/3
2	1/2	2/2	2/3	3/3	3/4
3	2/2	2/3	3/3	3/4	4/4
4	2/3	3/3	3/4	4/4	4/5
5	3/3	3/4	4/4	4/5	5/5
UPPER/LOWER Main Bearings to Achieve 0.024 - 0.050 mm (0.0009 - 0.0020)					

in.) Oil Clearance



2767936

**Fig. 354: Main Bearing Inserts**

Courtesy of CHRYSLER GROUP, LLC

The upper main bearing shell (2) and lower main bearing shell (1) are marked with the bearing size (3) on the bearing lining surface. The upper and lower bearings are available in five different sizes and can be mixed on a journal in order to achieve the proper oil clearance.

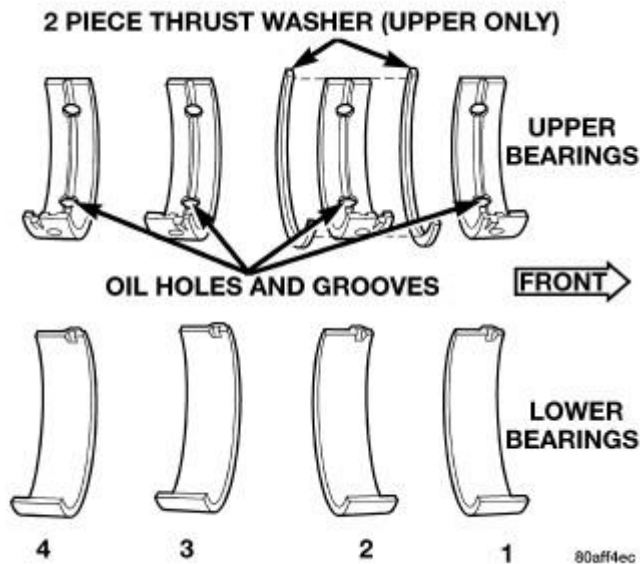
Upper and lower main bearing shells are available in five sizes. The chart below identifies the five bearing sizes.

Bearing Marking	Size mm (in.)
1	2.4951 - 2.4987 mm (0.0982 - 0.0984 in.)
2	2.4915 - 2.4951 mm (0.0981 - 0.0982 in.)
3	2.4879 - 2.4915 mm (0.0979 - 0.0981 in.)
4	2.4843 - 2.4879 mm (0.0978 - 0.0979 in.)
5	2.4807 - 2.4843 mm (0.0977 - 0.0978 in.)

**NOTE:** Crankshaft thrust washers are not selectable and are only available in a single thickness.

Bearing oil clearance can also be determined by using Plastigage or equivalent. Refer to **Engine/Engine Block - Standard Procedure**.

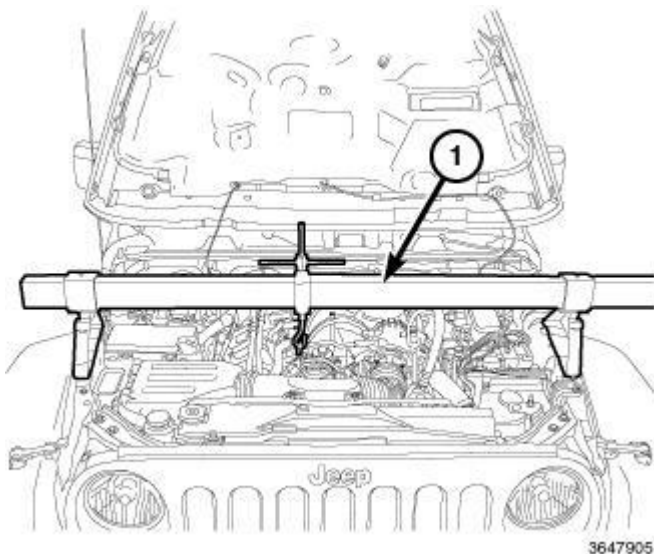
#### STANDARD PROCEDURE - MAIN BEARING REPLACEMENT



**Fig. 355: Main Bearing Identification**

Courtesy of CHRYSLER GROUP, LLC

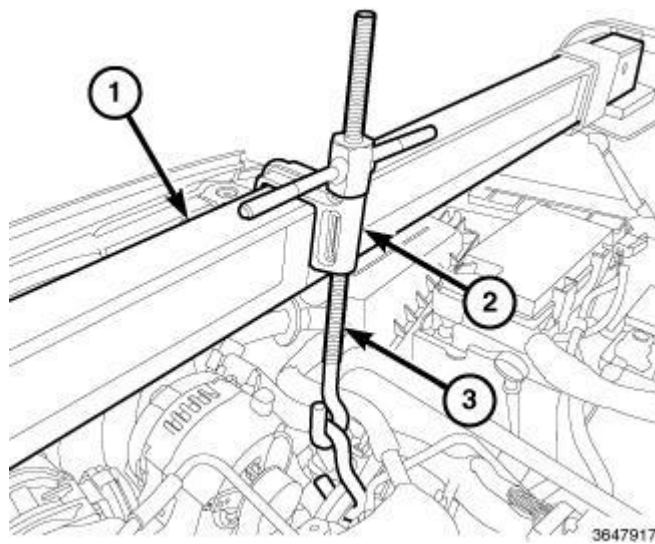
The main bearings are serviced in-vehicle. They must be replaced one-at-a-time in order to properly support the crankshaft. The upper and lower main bearing shells are NOT interchangeable. The upper and lower main bearings are "select fit" to achieve proper oil clearances. Refer to **BEARING(S), CRANKSHAFT, MAIN, STANDARD PROCEDURE.**



**Fig. 356: Driveline Support Fixture**

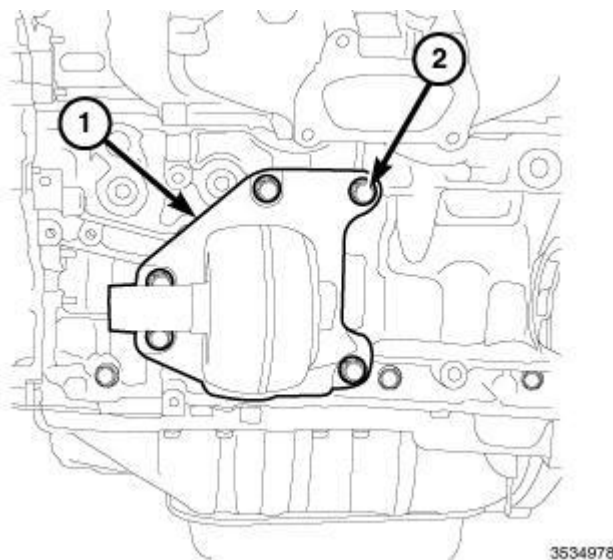
Courtesy of CHRYSLER GROUP, LLC

1. Disconnect and isolate the negative battery cable.
2. Position (special tool #8534B, Fixture, Driveline Support) (1) over the engine bay.



**Fig. 357: Engine Support Fixture & Adapters**  
Courtesy of CHRYSLER GROUP, LLC

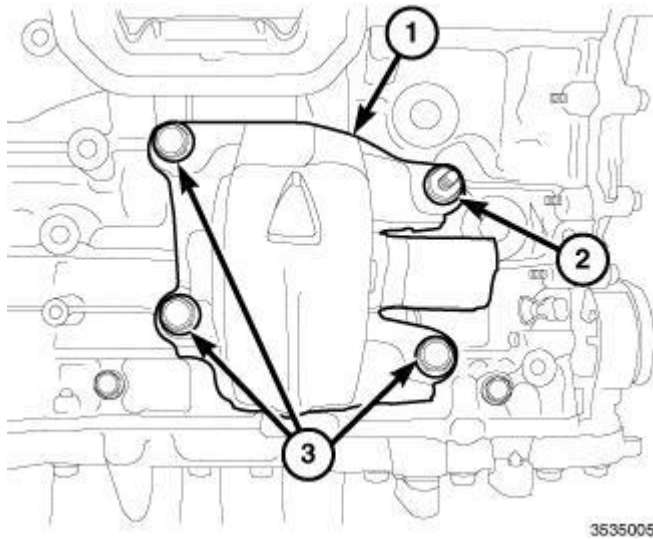
3. Install Adapters 8534-11(3) and 8534-13 (2) between the Engine Support Fixture 8534B (1) and the engine front cover. Carefully lift the engine to remove weight from both right and left engine mount isolators.



**Fig. 358: Left Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

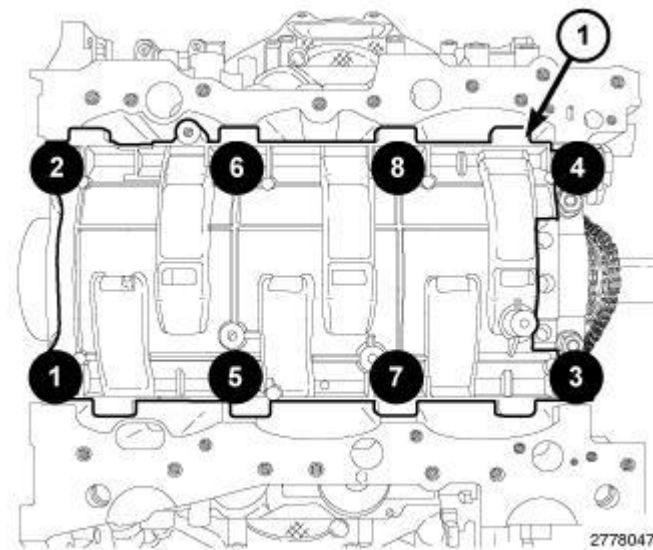
4. Remove the left engine mount isolator (1). Refer to **INSULATOR, ENGINE MOUNT, LEFT, REMOVAL**, **INSULATOR, ENGINE MOUNT, RIGHT, REMOVAL** and **INSULATOR, ENGINE MOUNT, REAR, REMOVAL**.





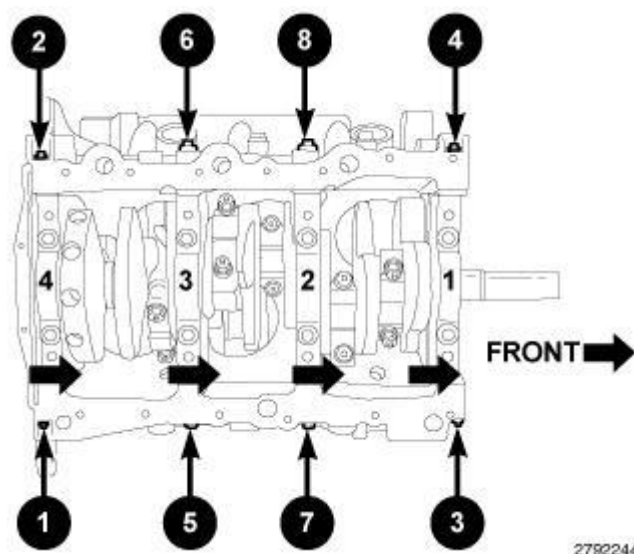
**Fig. 359: Right Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

5. Remove the right engine mount isolator (1). Refer to INSULATOR, ENGINE MOUNT, LEFT, REMOVAL, INSULATOR, ENGINE MOUNT, RIGHT, REMOVAL and INSULATOR, ENGINE MOUNT, REAR, REMOVAL.



**Fig. 360: Main Bearing Cap Bolts From Windage Tray Removal Sequence**  
Courtesy of CHRYSLER GROUP, LLC

6. Remove the oil pan, oil pump pick-up and engine oil pump. Refer to PUMP, ENGINE OIL, REMOVAL.
7. Remove the eight main bearing cap bolts from the windage tray in the sequence shown in illustration and remove the windage tray (1).



**Fig. 361: Main Bearing Tie Bolts Removal Sequence**  
 Courtesy of CHRYSLER GROUP, LLC

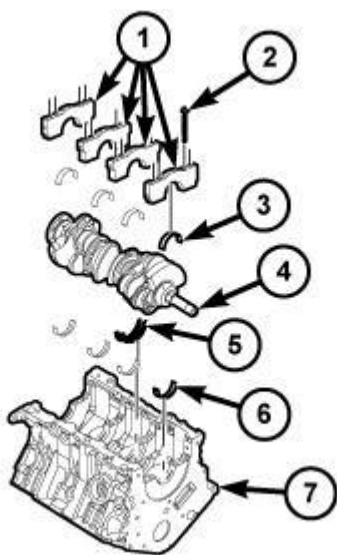
**NOTE:** Typical V6 engine configuration shown in illustration.

8. Remove the eight main bearing tie bolts in the sequence shown in illustration.

**CAUTION:** DO NOT use a number stamp or a punch to mark main bearing caps, as damage to main bearings could occur.

**NOTE:** Main bearing caps are not interchangeable and are marked to insure correct assembly.

9. Mark the main bearing cap positions using a permanent ink marker or a scribe tool.



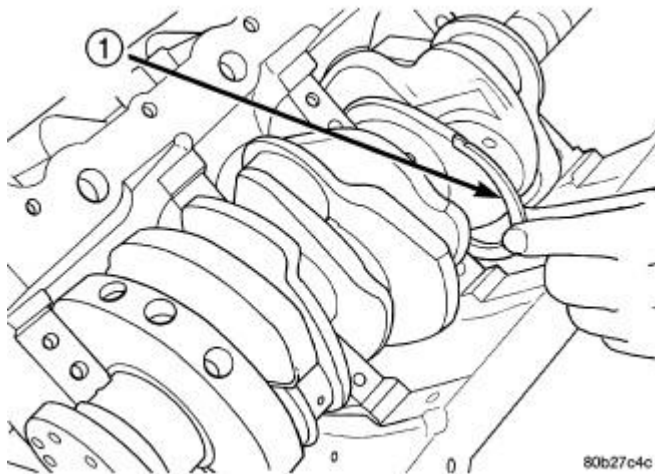
**Fig. 362: Main Bearing Caps, Bolts, Crankshaft & Engine Block**  
Courtesy of CHRYSLER GROUP, LLC

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

**CAUTION:** Replace only one main bearing at a time while all other main bearing caps remain properly tightened. If all main bearing caps are removed, the weight of the unsupported crankshaft will damage the crankshaft oil seals.

**NOTE:** Replace the main bearings in the following order; 2, 3, 1, 4.

10. Remove the two cap bolts (2) and remove the main bearing cap (1).
11. When removing the No. 2 bearing cap, also remove the thrust washers (5).
12. Slide the upper main bearing half (6) out from between the crankshaft and the engine block.
13. If required, select fit new main bearings to the engine block. Refer to **BEARING(S), CRANKSHAFT, MAIN, STANDARD PROCEDURE**.
14. Lubricate the upper main bearing half (6) with clean engine oil and slide the bearing into position.

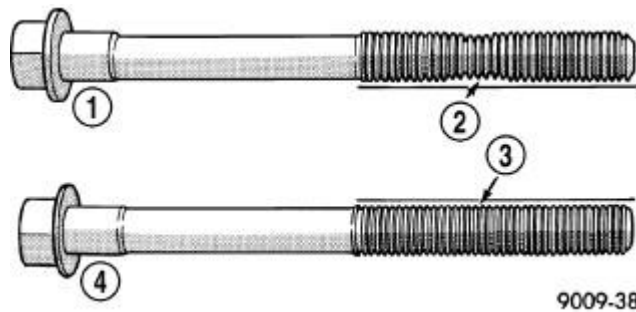


**Fig. 363: Thrust Washer Installation**  
Courtesy of CHRYSLER GROUP, LLC

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

15. When installing thrust washers (1) at the No. 2 main bearing location, use the following procedure:
  1. Move the crankshaft forward to the limit of travel. Lubricate and install the front thrust washer (1) by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft thrust surface.
  2. Move the crankshaft rearward to the limit of travel. Lubricate and install the rear thrust washer by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft

thrust surface.

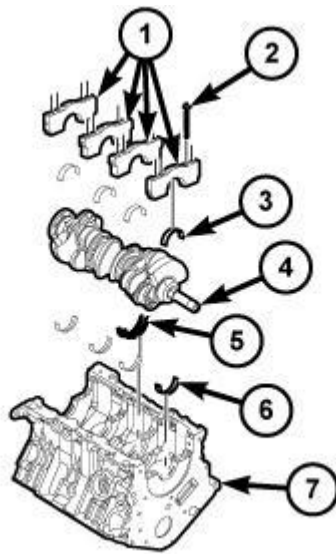


**Fig. 364: Checking Cylinder Head Bolts For Stretching (Necking)**

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.



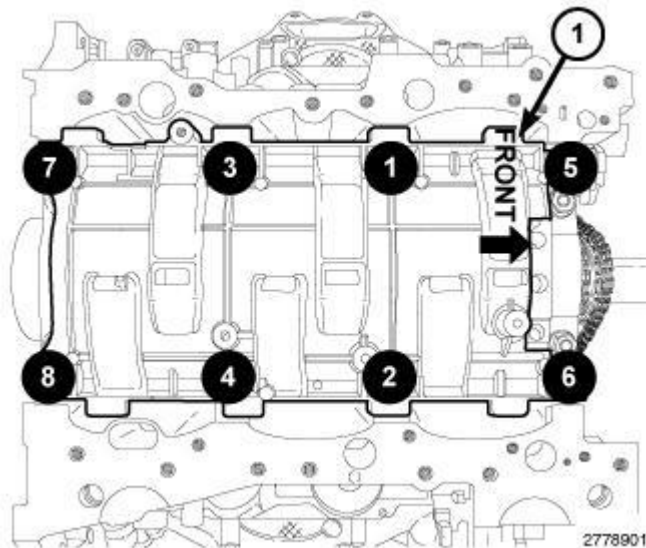
**Fig. 365: Main Bearing Caps, Bolts, Crankshaft & Engine Block**

Courtesy of CHRYSLER GROUP, LLC

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

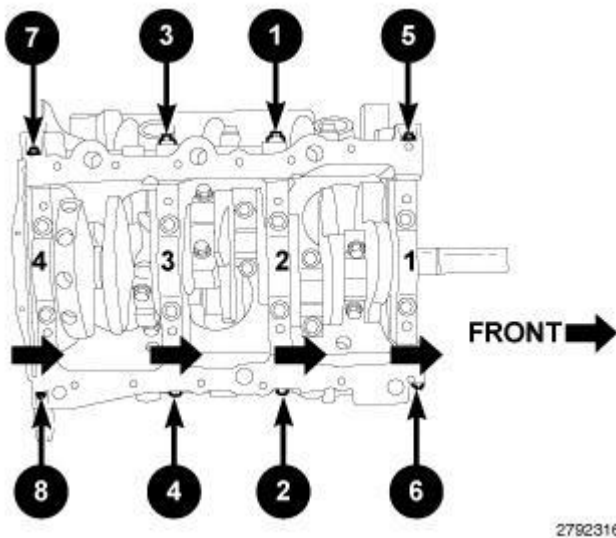
17. Lubricate and install the lower bearing half (3) onto the main cap (1).
18. Install the main bearing cap (1) with two inner main bearing cap bolts (2) tightened to 20 N.m (15 ft. lbs.) plus 90°.
19. Repeat the previous steps for main bearings 3, 1 and 4.

20. Measure crankshaft end play. Refer to Engine/Engine Block/CRANKSHAFT - Standard Procedure.



**Fig. 366: Windage Tray With Main Bearing Cap Bolts Installation Sequence**  
Courtesy of CHRYSLER GROUP, LLC

21. Install the windage tray with eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to 21 N.m (16 ft. lbs.) plus 90°.

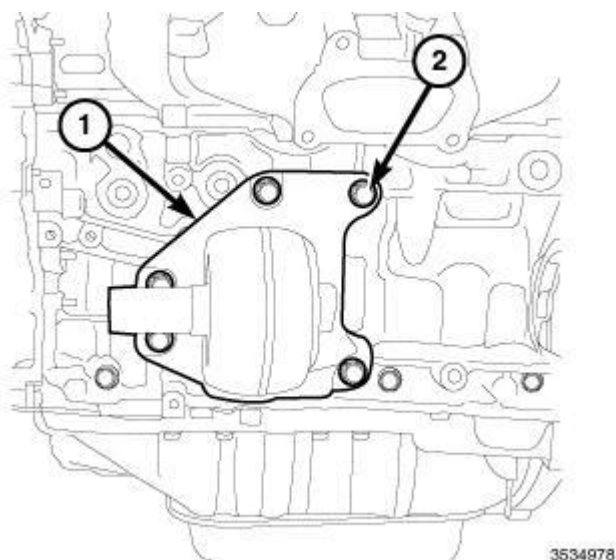


**Fig. 367: Main Bearing Tie Bolts Installation Sequence**  
Courtesy of CHRYSLER GROUP, LLC

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

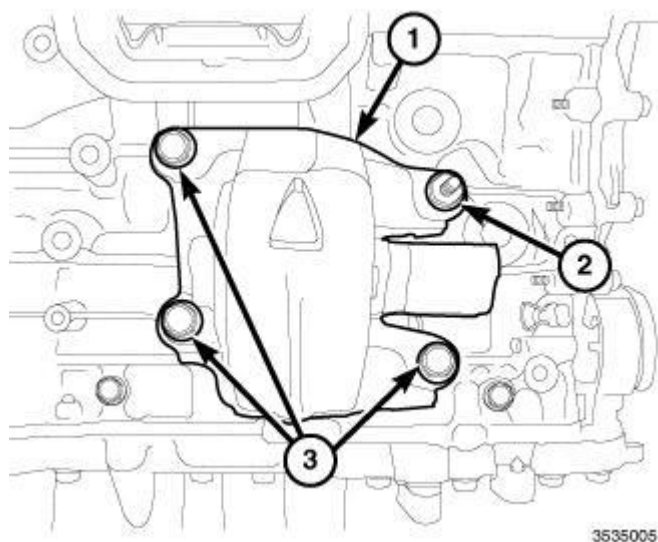
22. Install the eight main bearing tie bolts. Tighten the bolts in the sequence shown in illustration to 28 N.m (21 ft. lbs.).

23. Install the engine oil pump, oil pump pick-up and oil pan. Refer to **PUMP, ENGINE OIL, INSTALLATION**.



**Fig. 368: Left Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

24. Install the left engine mount isolator (1). Refer to **INSULATOR, ENGINE MOUNT, LEFT, INSTALLATION**, **INSULATOR, ENGINE MOUNT, RIGHT, INSTALLATION** and **INSULATOR, ENGINE MOUNT, REAR, INSTALLATION**.



**Fig. 369: Right Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

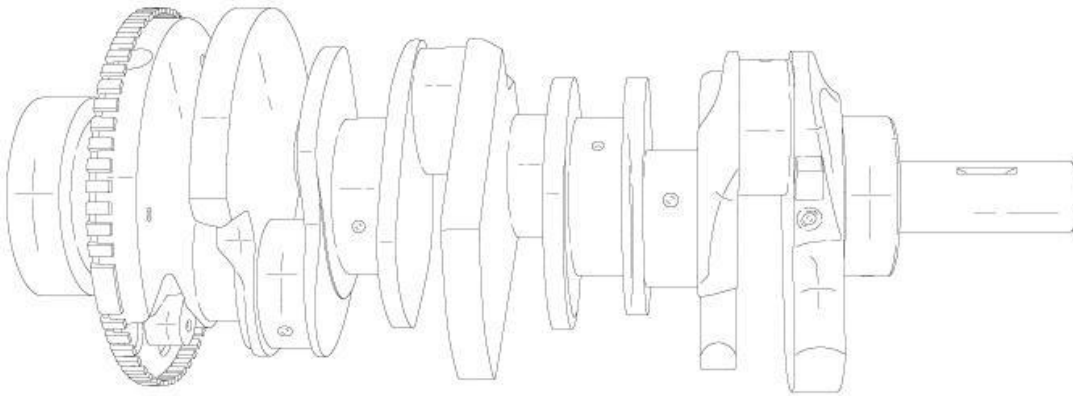
25. Install the right engine mount isolator (1). Refer to **INSULATOR, ENGINE MOUNT, LEFT, INSTALLATION**, **INSULATOR, ENGINE MOUNT, RIGHT, INSTALLATION** and **INSULATOR, ENGINE MOUNT, REAR, INSTALLATION**.

26. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
27. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
28. Operate the engine until it reaches normal operating temperature.

## CRANKSHAFT

### DESCRIPTION

### DESCRIPTION



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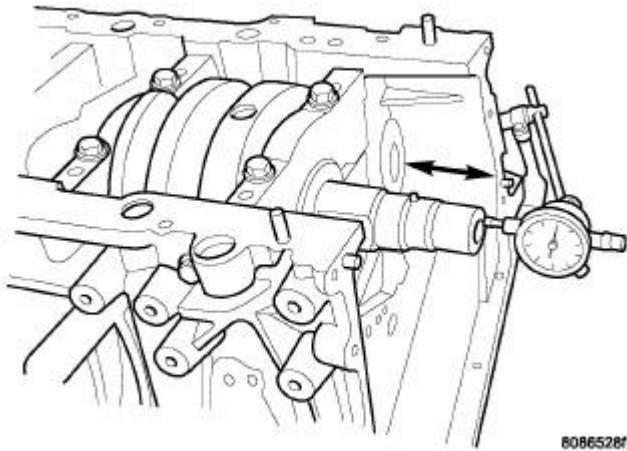
**Fig. 370: Crankshaft**

Courtesy of CHRYSLER GROUP, LLC

The crankshaft is a cast design and is constructed using ductile iron. The crankshaft is a three throw split pin design with counterweights for balancing purposes. The main journals are cross drilled for rod bearing lubrication. The crankshaft is supported by four select fit main bearings with number 2 serving as the thrust washer location. The rear counterweight has provisions for crankshaft position sensor target wheel mounting. Both the front and rear seals are a single piece design and are mounted to the timing cover and cylinder block.

### STANDARD PROCEDURE

### STANDARD PROCEDURE - END PLAY



**Fig. 371: Checking Crankshaft End Play**  
Courtesy of CHRYSLER GROUP, LLC

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

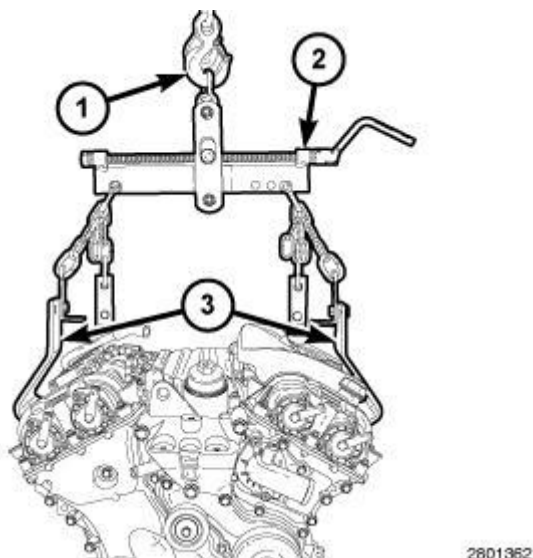
1. Mount Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) to a stationary point at the front of the engine. Locate the probe perpendicular against the nose of the crankshaft.
2. Move the crankshaft all the way to the rear of its travel.
3. Zero the dial indicator.
4. Move the crankshaft forward to the limit of travel and read the dial indicator. Compare the measured end play to the specification. Refer to Engine - Specifications.

**NOTE:** Crankshaft thrust washers are not selectable and are only available in a single thickness.

REMOVAL

REMOVAL

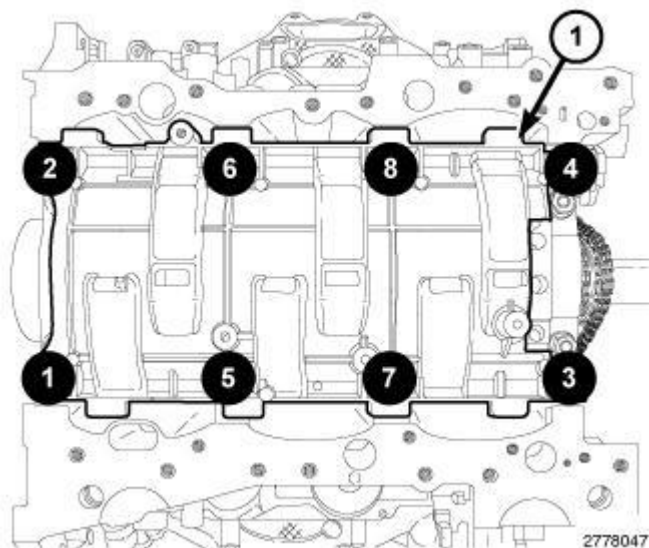




**Fig. 372: Lifting Sling, Engine Lifting Brackets & Engine Hoist**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** To remove the crankshaft from the engine, the engine must be removed from the vehicle.

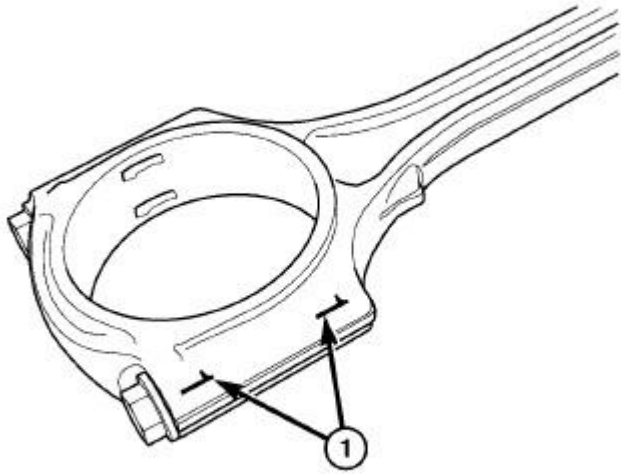
1. Remove the engine. Refer to **REMOVAL**.



**Fig. 373: Main Bearing Cap Bolts From Windage Tray Removal Sequence**  
Courtesy of CHRYSLER GROUP, LLC

2. Remove the cylinder head covers, spark plugs, upper oil pan, engine timing cover, timing chain and sprockets. Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.
3. Remove the flexplate and the rear crankshaft oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR, REMOVAL**.
4. Remove the oil pump pick-up and engine oil pump. Refer to **PUMP, ENGINE OIL, REMOVAL**.

5. Remove the eight main bearing cap bolts from the windage tray in the sequence shown in illustration and remove the windage tray (1).



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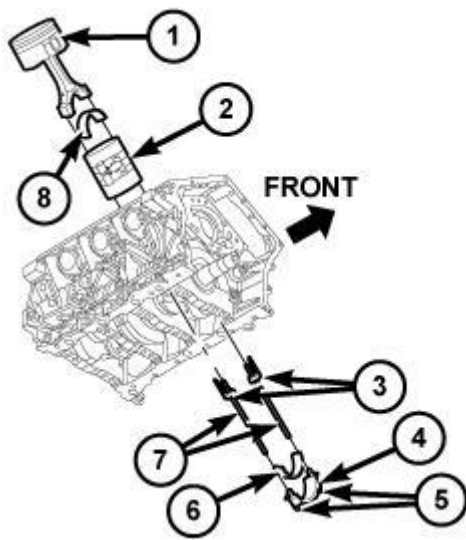
**Fig. 374: Connecting Rod To Cylinder Identification**

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.

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



**Fig. 375: 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.

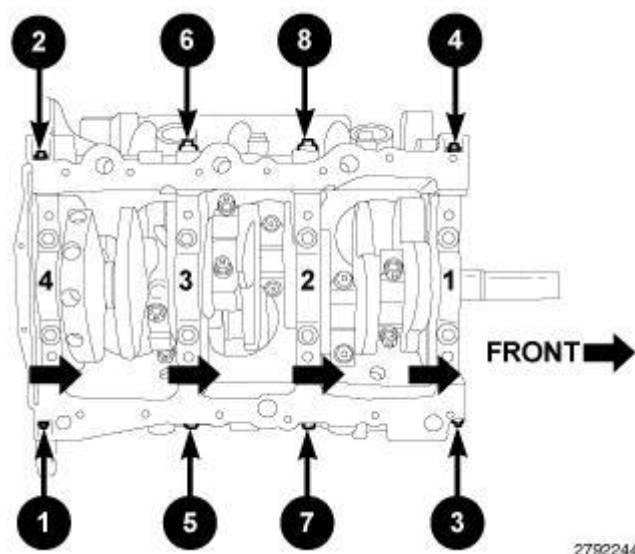
7. Remove the connecting rod cap bolts (5) and the connecting rod caps (4). Discard the cap bolts.

**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.

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

9. Push the connecting rod and piston into the cylinder until the connecting rod is clear of the crankshaft journal. Remove the guide pins. Repeat this procedure at each cylinder until all of the connecting rods are clear of the crankshaft.



**Fig. 376: Main Bearing Tie Bolts Removal Sequence**

Courtesy of CHRYSLER GROUP, LLC

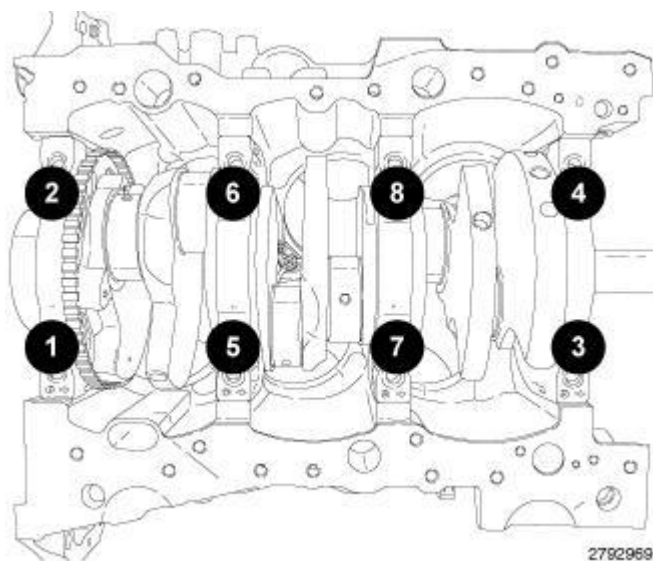
**NOTE:** Typical V6 engine configuration shown in illustration.

Remove the main bearing cross bolts in the sequence shown in illustration.

**CAUTION:** DO NOT use a number stamp or a punch to mark main bearing caps, as damage to main bearings could occur.

**NOTE:** Main bearing caps are not interchangeable and are marked to insure correct assembly.

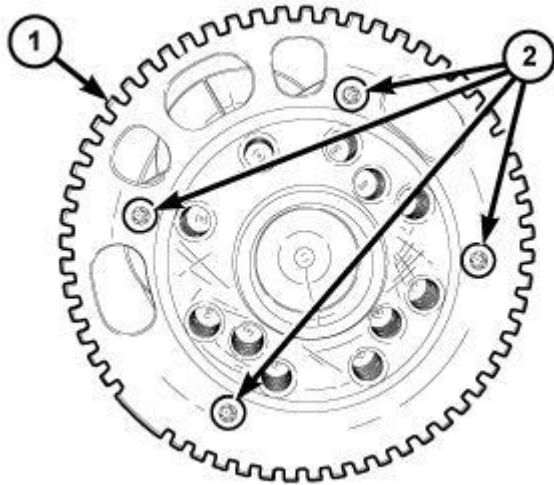
10. Mark the main bearing cap positions using a permanent ink marker or a scribe tool.



**Fig. 377: Main Bearing Cap Bolts Removal Sequence**

Courtesy of CHRYSLER GROUP, LLC

11. Remove the eight main bearing cap bolts in the sequence shown in illustration and remove the main bearing caps.



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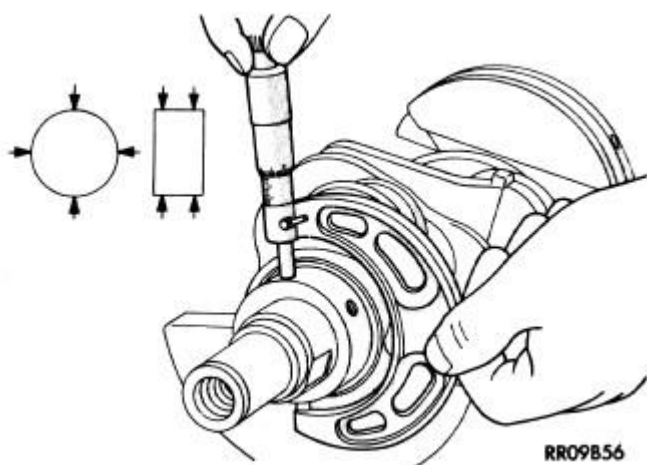
**Fig. 378: Target Wheel & Bolts**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not rest the crankshaft on the target wheel (1). Damaged or bent target wheel teeth will destroy the target wheels ability to correctly relay crankshaft position to the crankshaft position sensor.

12. Remove the crankshaft from the engine block.
13. If required, remove the four bolts (2) and the target wheel (1). Discard the four bolts.

**INSPECTION****INSPECTION**



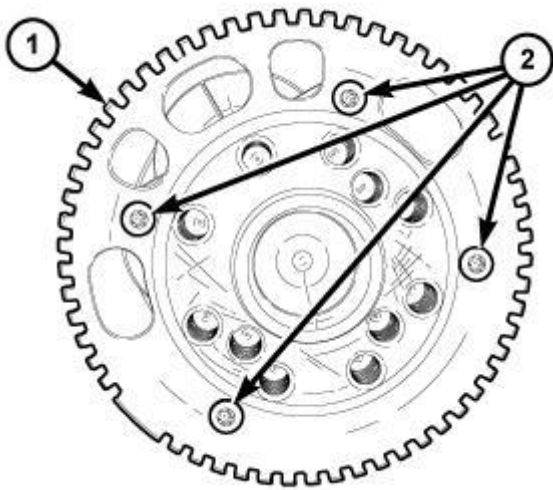
**Fig. 379: Measuring Crankshaft Journal**  
Courtesy of CHRYSLER GROUP, LLC

**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. Select the bearing size that corresponds to the crankshaft markings for each rod bearing journal that will provide the proper oil clearance. Refer to **BEARING(S), CONNECTING ROD, STANDARD PROCEDURE**.
4. Compare the measured main bearing journal diameter to the crankshaft main bearing journal diameter grade marking chart. 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. Refer to **BEARING(S), CRANKSHAFT, MAIN, STANDARD PROCEDURE**.
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

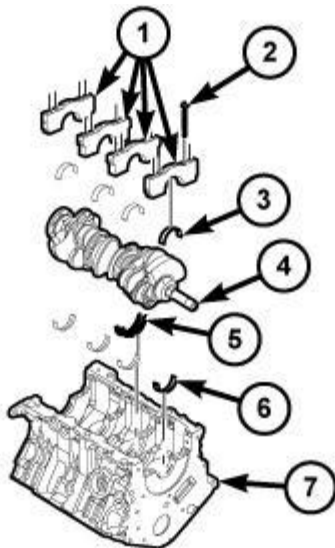


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**Fig. 380: Target Wheel & Bolts**

Courtesy of CHRYSLER GROUP, LLC

1. If required, select and fit new crankshaft main bearings to the engine block. Refer to **BEARING(S), CRANKSHAFT, MAIN, STANDARD PROCEDURE**.
2. If required, select and fit new bearings to the connecting rod. Refer to **BEARING(S), CONNECTING ROD, STANDARD PROCEDURE**.
3. If removed, install the target wheel (1) to the crankshaft with four new bolts (2). Ensure the threaded holes in the crankshaft are free of residual thread lock adhesive. Tighten the bolts to 10 N.m (89 in. lbs.).



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**Fig. 381: Main Bearing Caps, Bolts, Crankshaft & Engine Block**

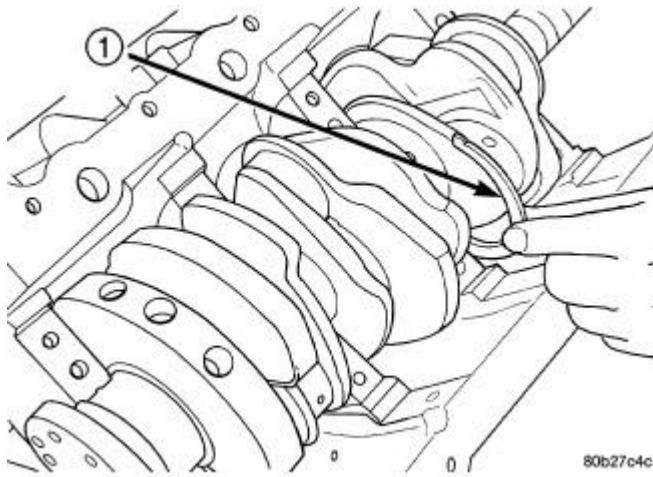
Courtesy of CHRYSLER GROUP, LLC

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

4. If removed, lubricate and install the upper main bearing halves (6) into the engine block (7).

**CAUTION:** When installing the crankshaft, use care not to damage bearing surfaces on the crankshaft.

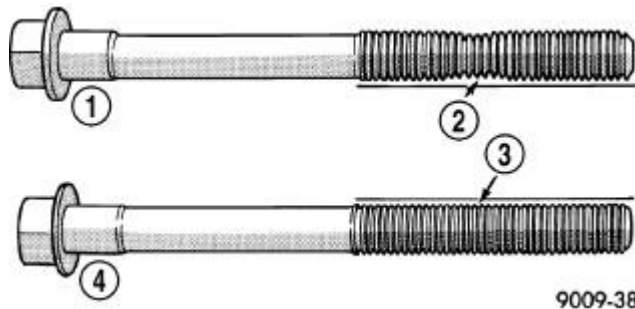
5. Install the crankshaft (4) into the engine block (7).



**Fig. 382: Thrust Washer Installation**  
Courtesy of CHRYSLER GROUP, LLC

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

6. Installing thrust washers (1) at the No. 2 main bearing location, using the following procedure:
  1. Move the crankshaft forward to the limit of travel. Lubricate and install the front thrust washer (1) by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft thrust surface.
  2. Move the crankshaft rearward to the limit of travel. Lubricate and install the rear thrust washer by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft thrust surface.



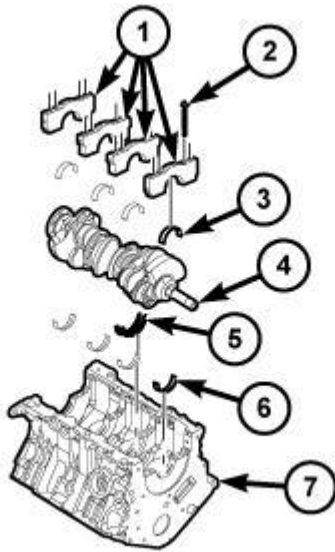
**Fig. 383: Checking Cylinder Head Bolts For Stretching (Necking)**  
Courtesy of CHRYSLER GROUP, LLC

**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.**

7. 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.

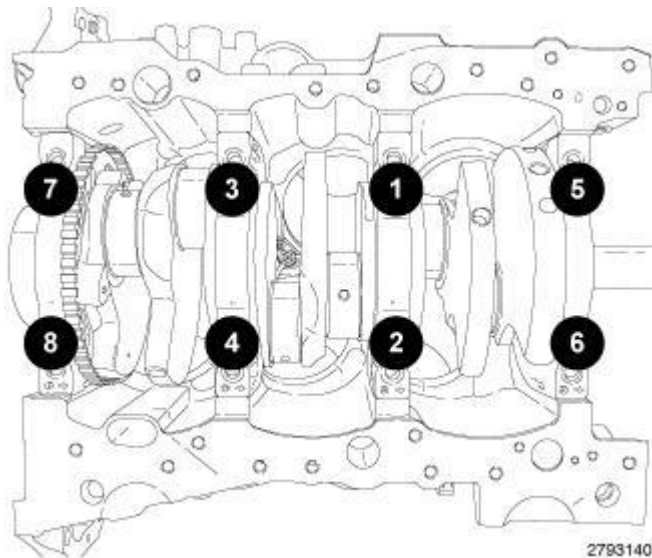


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**Fig. 384: Main Bearing Caps, Bolts, Crankshaft & Engine Block**  
Courtesy of CHRYSLER GROUP, LLC

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

8. If removed, lubricate and install the lower main bearing halves (3) onto the main caps (1).
9. Install the main bearing caps (1) with two inner main bearing cap bolts (2).

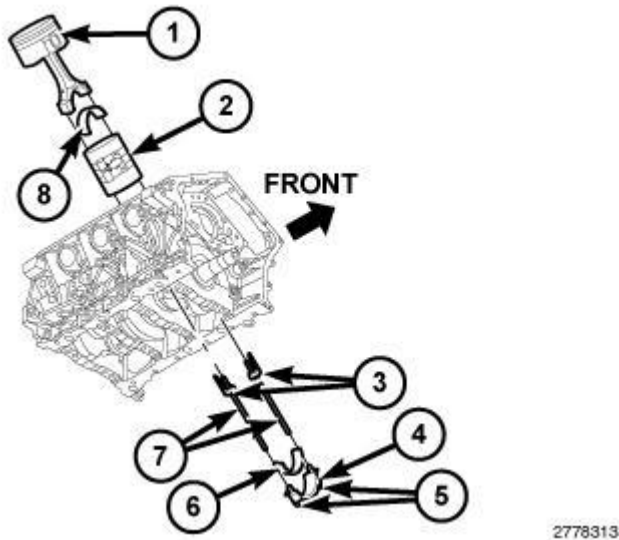


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**Fig. 385: Inner Main Bearing Cap Bolts Tightening Sequence**

Courtesy of CHRYSLER GROUP, LLC

10. Tighten the inner main bearing cap bolts in the sequence shown in illustration to 20 N.m (15 ft. lbs.) plus 90°.
11. Measure crankshaft end play. Refer to Engine/Engine Block/CRANKSHAFT - Standard Procedure.



**Fig. 386: Piston, Connecting Rod Cap, Bolts, Plastic Guide Plates & Guide Pins**  
Courtesy of CHRYSLER GROUP, LLC

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

12. If removed, 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.

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

13. 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.

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

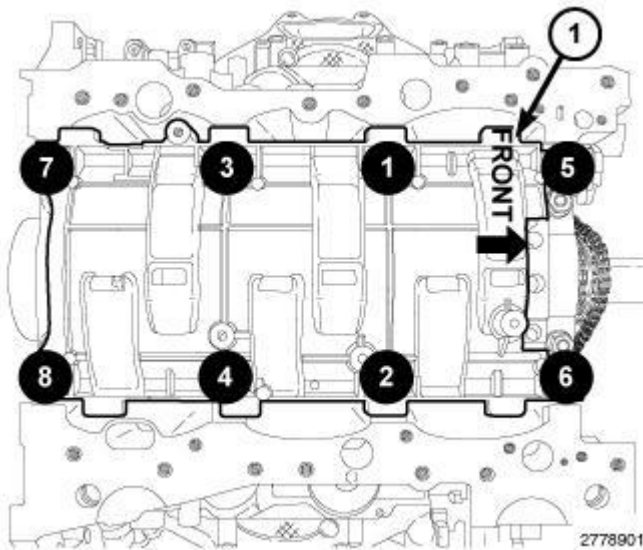
14. Pull the connecting rod and piston toward the crankshaft until the connecting rod is seated on the crankshaft journal. Remove the guide pins.

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

15. If removed, 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.

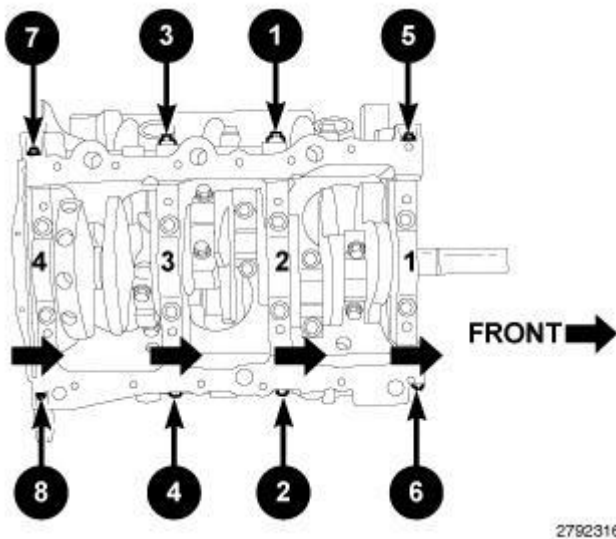
**NOTE:** Do not lubricate the threads of the connecting rod cap bolts (5).

16. 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°.
17. If required, check the connecting rod side clearance. Refer to **Engine/Engine Block/ROD, Piston and Connecting - Standard Procedure**.
18. Repeat the previous steps for the remaining connecting rods.



**Fig. 387: Windage Tray With Main Bearing Cap Bolts Installation Sequence**  
Courtesy of CHRYSLER GROUP, LLC

19. Install the windage tray (1) with eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to 21 N.m (16 ft. lbs.) plus 90°.

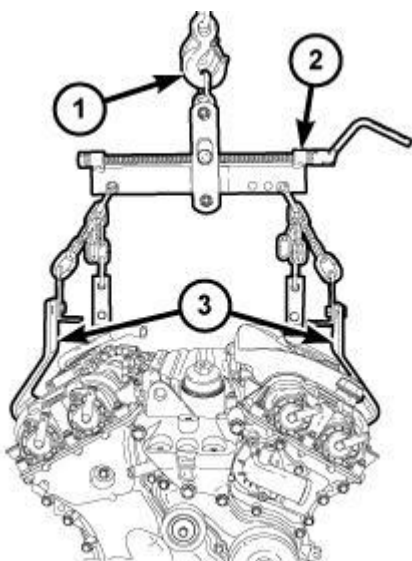


**Fig. 388: Main Bearing Tie Bolts Installation Sequence**

Courtesy of CHRYSLER GROUP, LLC

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

20. Install the eight main bearing tie bolts. Tighten the bolts in the sequence shown in illustration to 28 N.m (21 ft. lbs.).
21. Install the engine oil pump and oil pump pick-up. Refer to **PUMP, ENGINE OIL, INSTALLATION.**
22. Install the rear crankshaft oil seal and flexplate. Refer to **SEAL, CRANKSHAFT OIL, REAR, INSTALLATION.**
23. Install the timing chain and sprockets, engine timing cover, oil pans, spark plugs and cylinder head covers. Refer to **CHAIN AND SPROCKETS, TIMING, INSTALLATION.**



**Fig. 389: Lifting Sling, Engine Lifting Brackets & Engine Hoist**

Courtesy of CHRYSLER GROUP, LLC

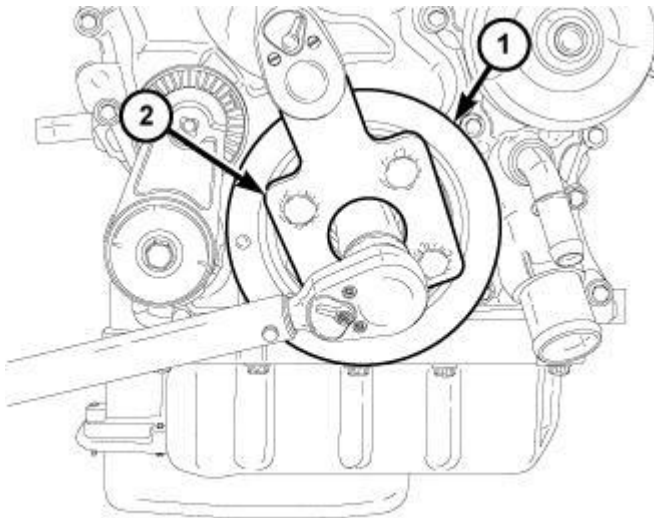
24. Install the engine. Refer to **INSTALLATION**.
25. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
26. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
27. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
28. Operate 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.

## DAMPER, VIBRATION

### REMOVAL

### REMOVAL

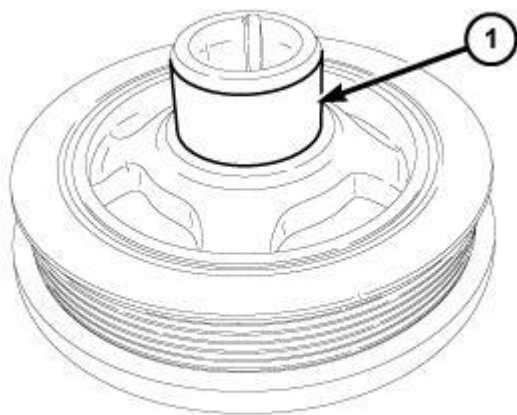


**Fig. 390: Crankshaft Vibration Damper & Vibration Damper Holder**  
Courtesy of CHRYSLER GROUP, LLC

1. Remove the accessory drive belt. Refer to **BELT, SERPENTINE, REMOVAL**.

**NOTE:** A force greater than 350 N.m (260 ft. lbs.) may be required to remove the crankshaft vibration damper bolt.

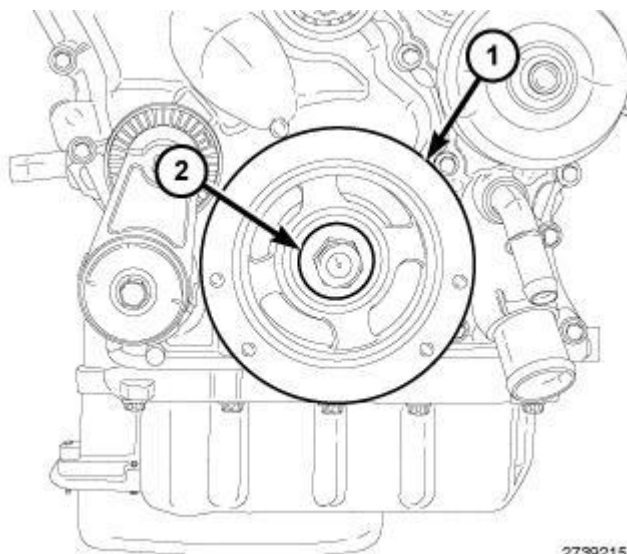
2. Hold the crankshaft vibration damper (1) with Vibration Damper Holder (special tool #10198, Holder, Vibration Damper) (2) and remove the crankshaft vibration damper bolt.
3. Pull the crankshaft vibration damper (1) off of the crankshaft.

**INSTALLATION****INSTALLATION**

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**Fig. 391: Front Crankshaft Seal Surface**  
Courtesy of CHRYSLER GROUP, LLC

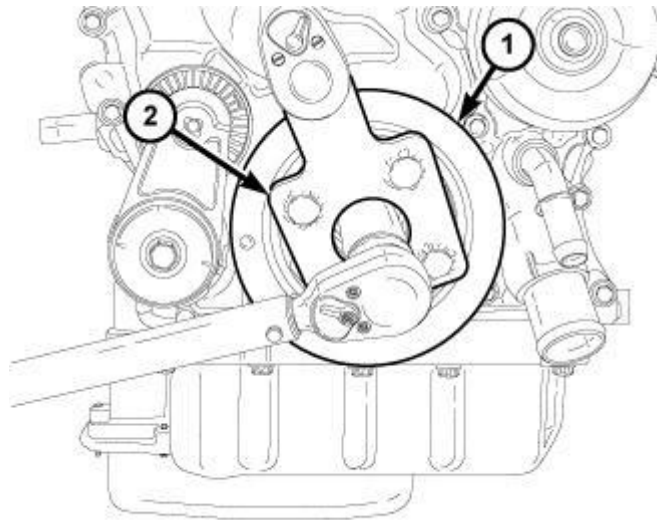
1. Apply a light coating of engine oil to the front crankshaft seal surface (1).



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**Fig. 392: Crankshaft Vibration Damper & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

2. Align the crankshaft vibration damper (1) to the flywheel key on the crankshaft and install the damper. Seat the damper on the crankshaft sprocket.
3. Install and hand tighten the crankshaft vibration damper bolt (2).



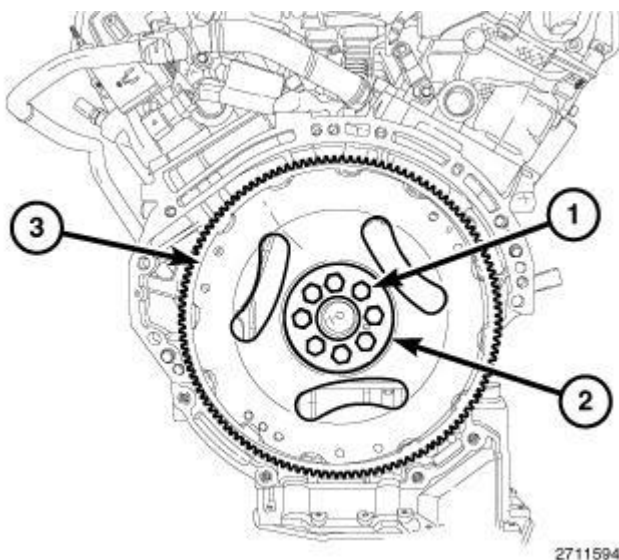
**Fig. 393: Crankshaft Vibration Damper & Vibration Damper Holder**  
 Courtesy of CHRYSLER GROUP, LLC

4. Hold the crankshaft vibration damper (1) with Vibration Damper Holder (special tool #10198, Holder, Vibration Damper) (2) and tighten the crankshaft vibration damper bolt to 40 N.m + 105° (30 ft. lbs. + 105°).
5. Install the accessory drive belt. Refer to **BELT, SERPENTINE, INSTALLATION** .

## FLEXPLATE

### REMOVAL

### REMOVAL

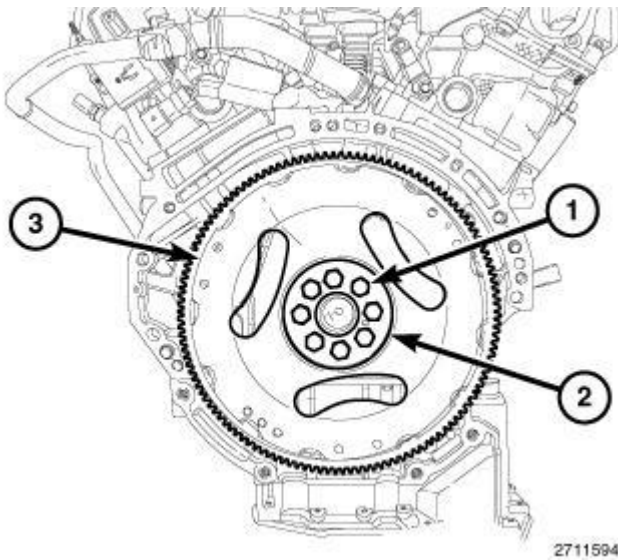


**Fig. 394: Flexplate, Spacer Plate & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

1. Remove the transmission. Refer to **REMOVAL** .
2. Remove the bolts (1) and the spacer plate (2).
3. Remove the flexplate (3).

## INSTALLATION

### INSTALLATION



**Fig. 395: Flexplate, Spacer Plate & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

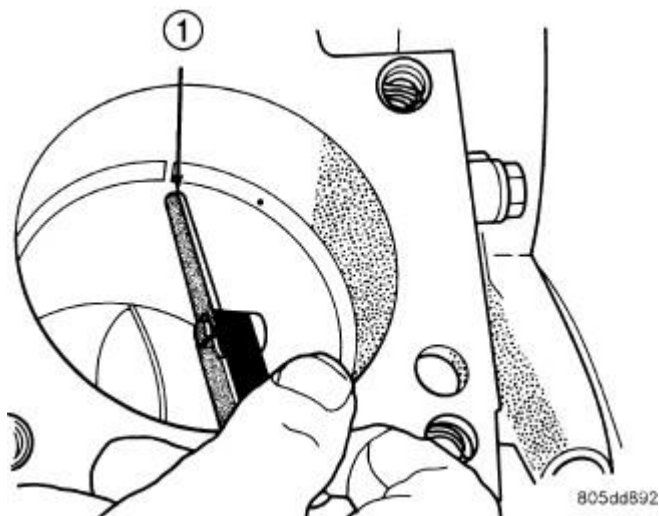
1. Position the flexplate (3) onto the crankshaft.
2. Install the spacer (2) and the bolts (1) hand tight.
3. Tighten the flexplate retaining bolts (1) to 95 N.m (70 ft. lbs.) in a criss-cross pattern.
4. Install the transmission. Refer to **INSTALLATION** .

## RING(S), PISTON

### STANDARD PROCEDURE

#### STANDARD PROCEDURE - PISTON RING FITTING

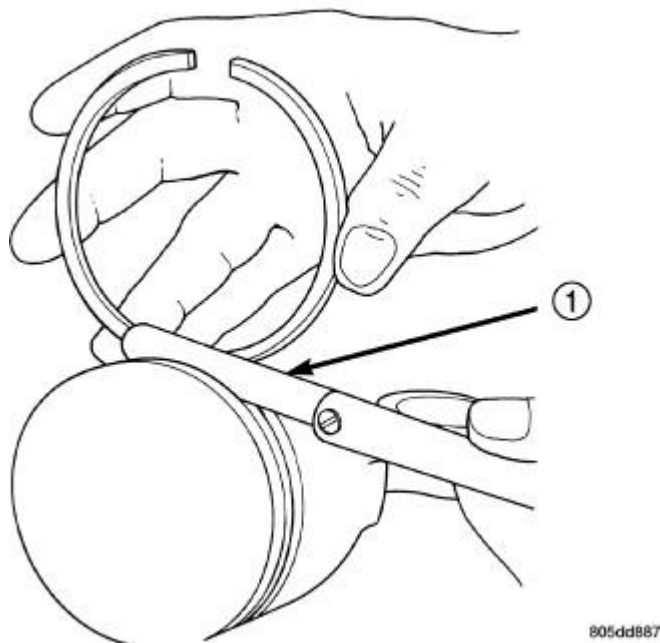




**Fig. 396: Measuring Piston Ring End Gap**  
Courtesy of CHRYSLER GROUP, LLC

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.)



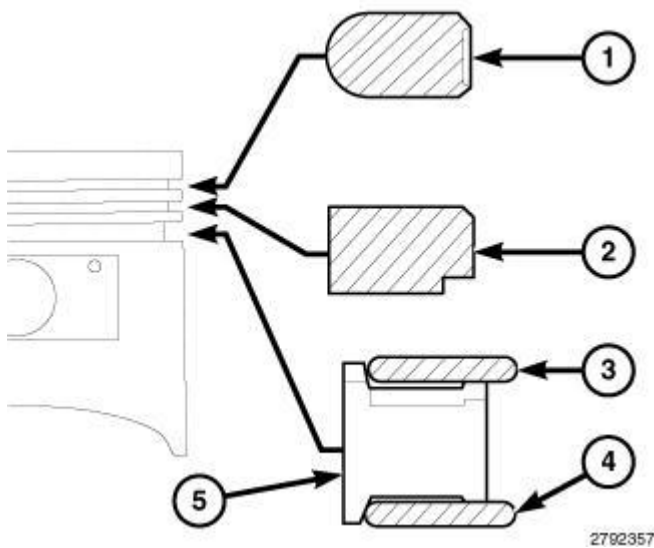
**Fig. 397: Checking Piston Ring Grooves Clearances**  
 Courtesy of CHRYSLER GROUP, LLC

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. 398: Piston Ring Removal/Installation Sequence**

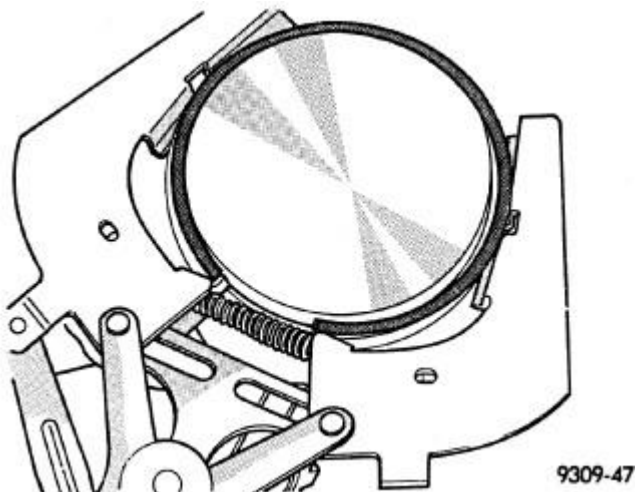
Courtesy of CHRYSLER GROUP, LLC

**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. 399: 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.



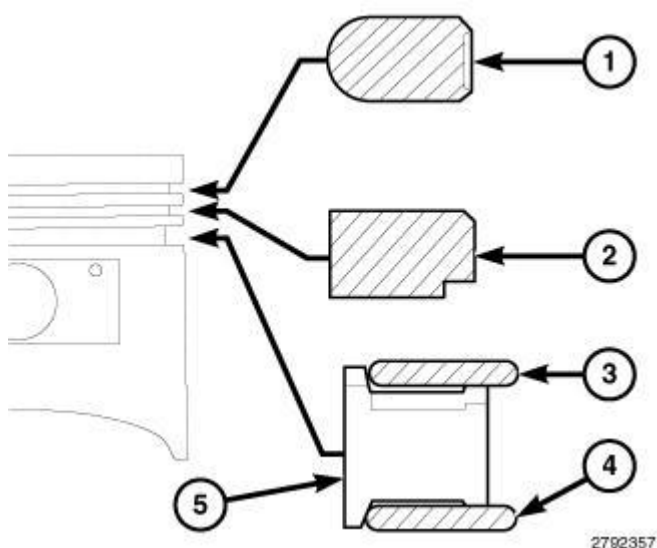
**Fig. 400: Removing/Installing Piston Ring Side Rail**  
Courtesy of CHRYSLER GROUP, LLC

**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



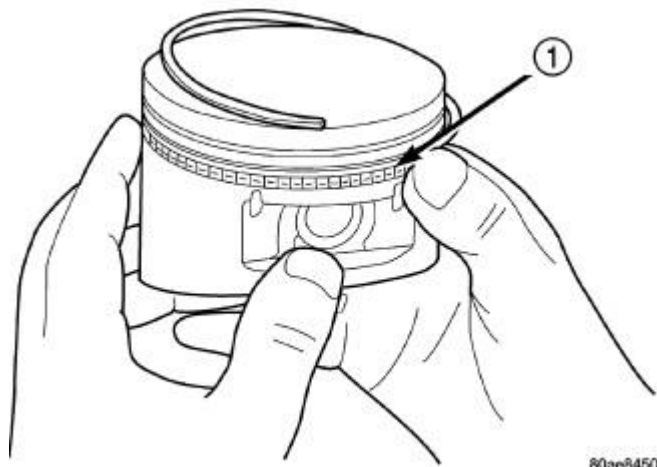
**Fig. 401: Piston Ring Removal/Installation Sequence**  
 Courtesy of CHRYSLER GROUP, LLC

**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)

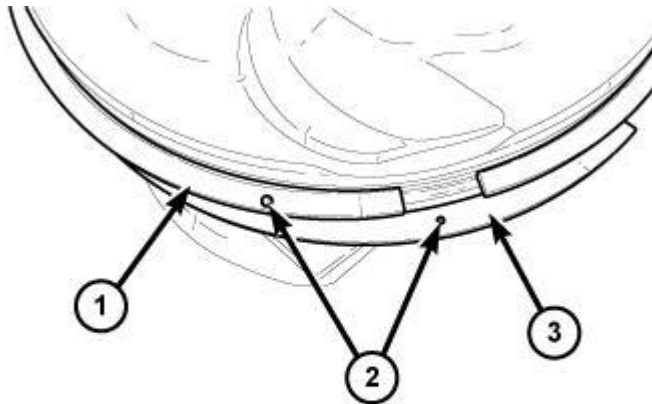


**Fig. 402: Removing/Installing Piston Ring Side Rail**

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.

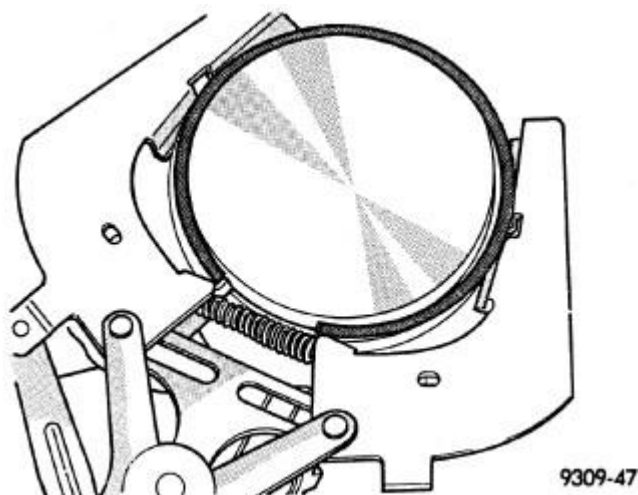


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**Fig. 403: Dot Marks On Piston Rings**

Courtesy of CHRYSLER GROUP, LLC

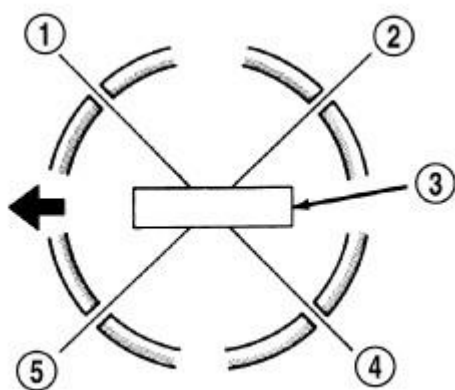
**NOTE:** The No. 1 (upper) piston ring (1) and No. 2 (intermediate) piston ring (3) have a different cross section. Install the rings with manufacturers I.D. mark (dot) (2) facing up, towards the top of the piston.



**Fig. 404: 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. 405: Piston Ring End Gap Position**  
Courtesy of CHRYSLER GROUP, LLC

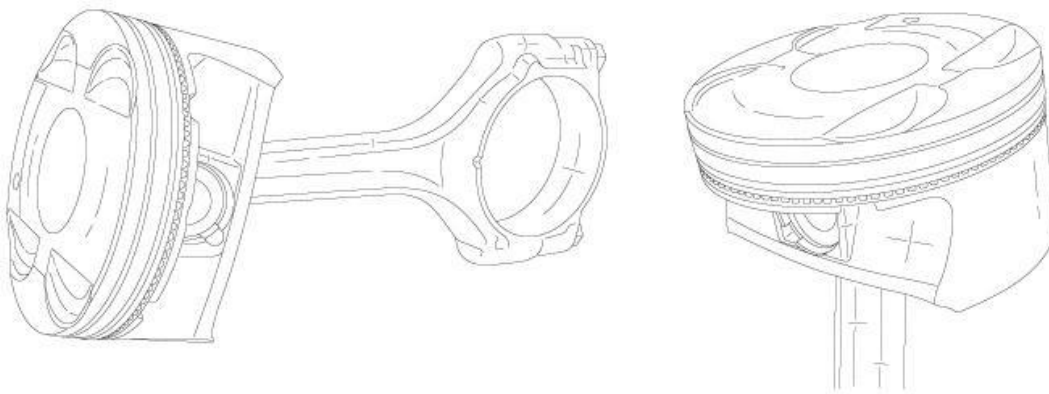
8. Position the piston ring end gaps as follows:
  - Oil ring expander gap (5)
  - Oil ring lower side rail end gap (4)
  - Oil ring upper side rail end gap (1)
  - No. 2 (intermediate) ring end gap (5)
  - No. 1 (upper) ring end gap (2)

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

## ROD, PISTON AND CONNECTING

### DESCRIPTION

### DESCRIPTION



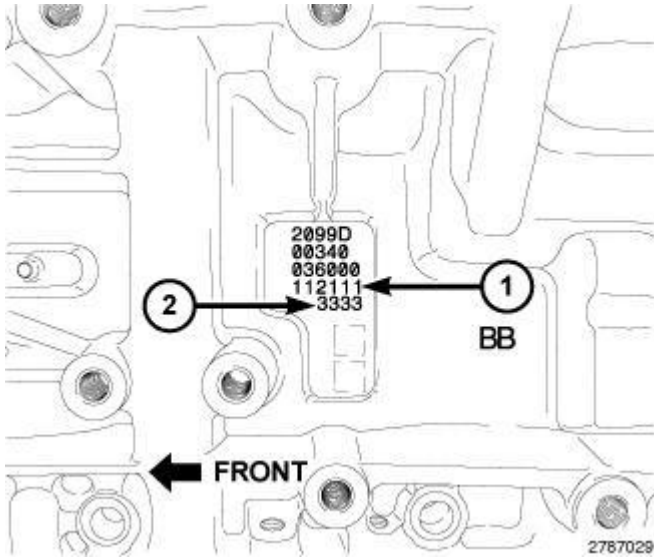
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**Fig. 406: Piston & Connecting Rod**  
Courtesy of CHRYSLER GROUP, LLC

**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**

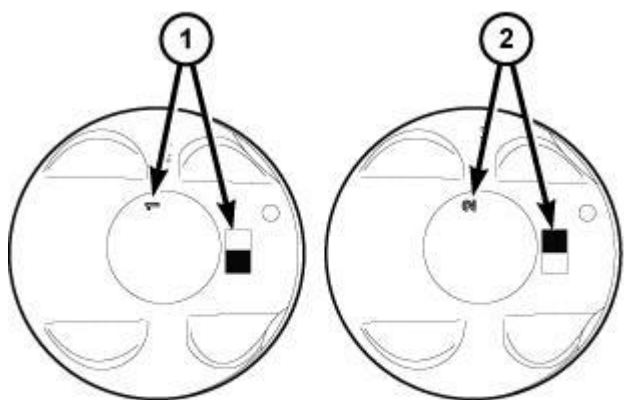
**Fig. 407: Engine Block Cylinder Bore Diameter Grade Markings & Engine Block Main Bearing Journal Diameter Grade Markings**

Courtesy of CHRYSLER GROUP, LLC

The pistons are "select fit" to achieve proper oil clearance. Engine block cylinder bore diameter grade markings (1) are stamped into the left side of the engine block. These marks are read from left to right, corresponding with cylinder number 1, 2, 3, 4, 5, 6.

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

Engine Block Marking	Cylinder Bore Size mm (in.)
1	95.995 ± 0.005 mm (3.7793 ± 0.0002 in.)
2	96.005 ± 0.005 mm (3.7797 ± 0.0002 in.)



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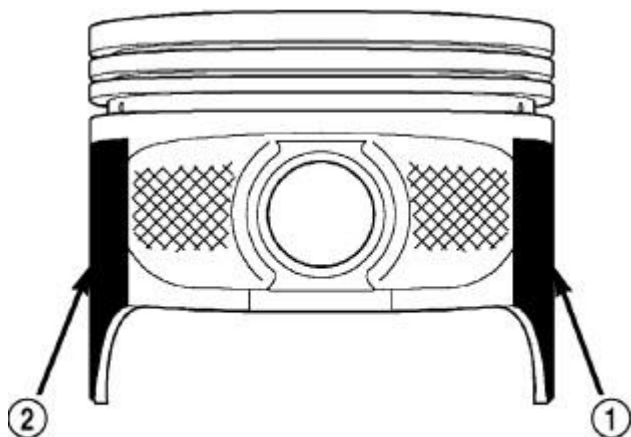
**Fig. 408: Piston Size Located On Piston Crown**

Courtesy of CHRYSLER GROUP, LLC

The piston is marked with the piston size (1 and 2) on the piston crown. The pistons are available in two 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 two sizes. The chart below identifies the two piston sizes.

Piston Marking	Size mm (in.)	
	Metal to Metal	Metal to Coating
1	95.995 ± 0.005 mm (3.7793 ± 0.0002 in.)	95.970 - 96.000 mm (3.7783 - 3.7795 in.)
2	95.965 ± 0.005 mm (3.7781 ± 0.0002 in.)	95.980 - 96.010 mm (3.7787 - 3.7835 in.)



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**Fig. 409: Coating Material On Piston**

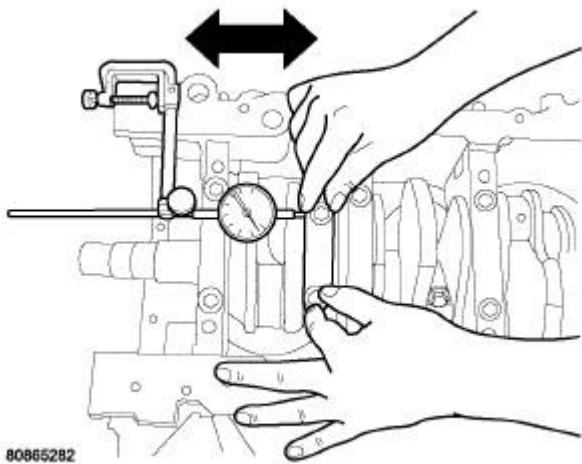
Courtesy of CHRYSLER GROUP, LLC

**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

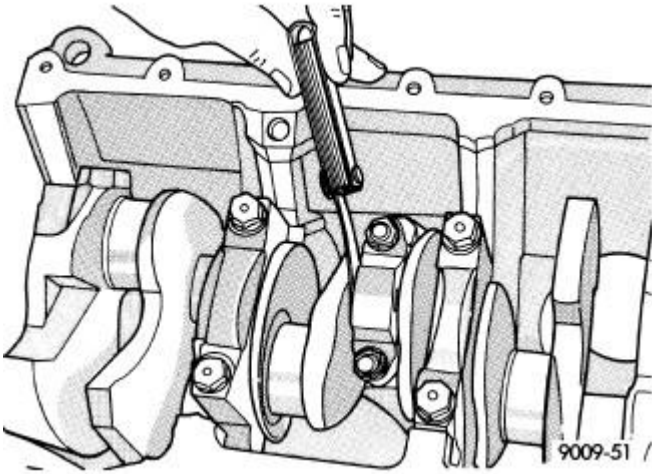
##### DIAL INDICATOR



**Fig. 410: 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



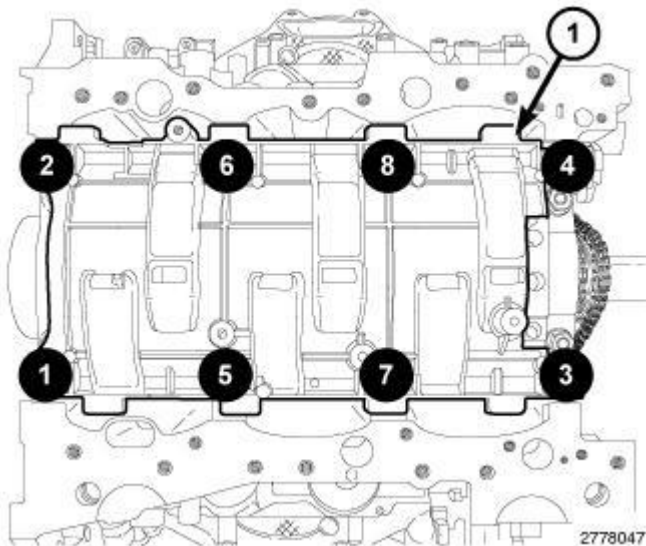
**Fig. 411: Measuring Gap Between Connecting Rod & Crankshaft Journal Flange**

Courtesy of CHRYSLER GROUP, LLC

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

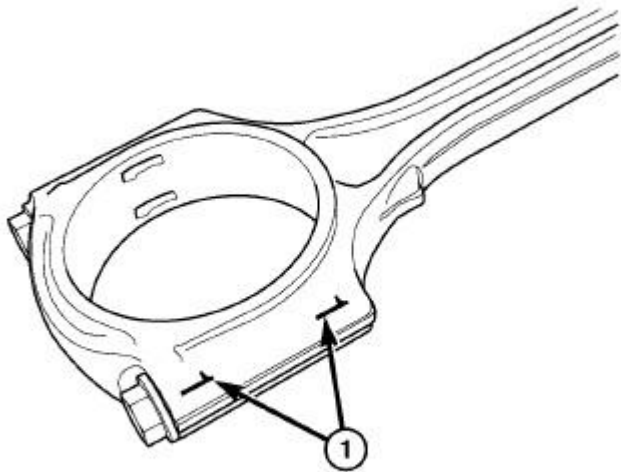


**Fig. 412: Main Bearing Cap Bolts From Windage Tray Removal Sequence**

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).



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**Fig. 413: Connecting Rod To Cylinder Identification**

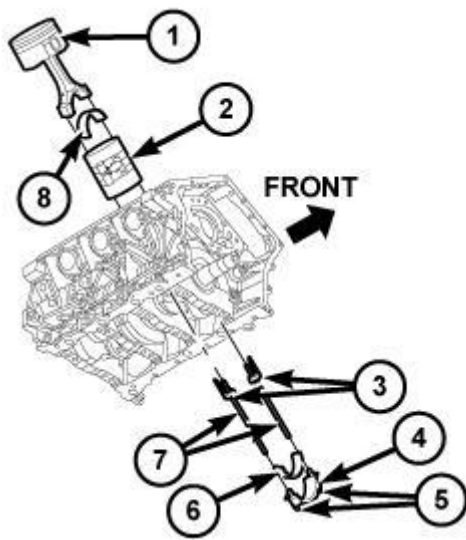
Courtesy of CHRYSLER GROUP, LLC

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. 414: 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

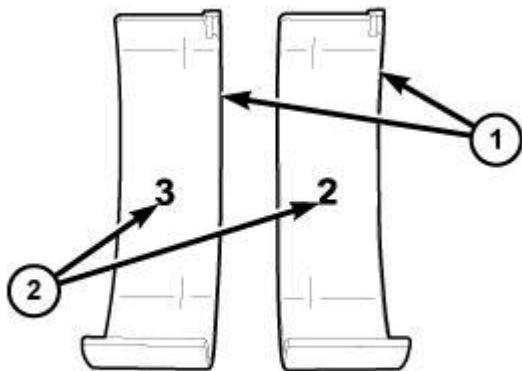
**CAUTION:** DO NOT use a wire wheel or other abrasive cleaning device to clean the pistons or connecting rods. The pistons have a Moly coating, this coating must not be damaged.

**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

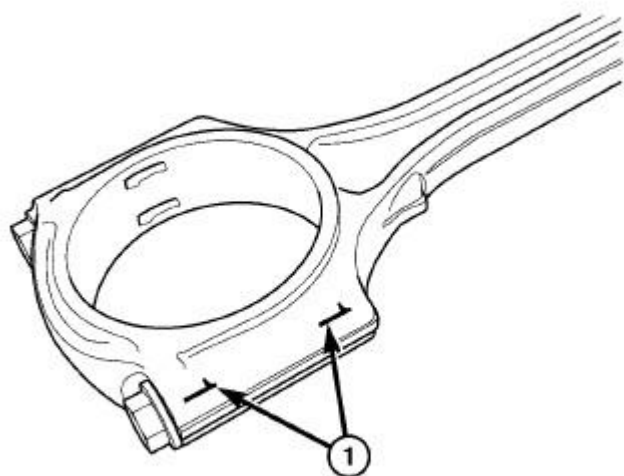
## INSPECTION



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**Fig. 415: Connecting Rod Bearing Shells & Bearing Size**  
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**.



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**Fig. 416: Connecting Rod To Cylinder Identification**

Courtesy of CHRYSLER GROUP, LLC

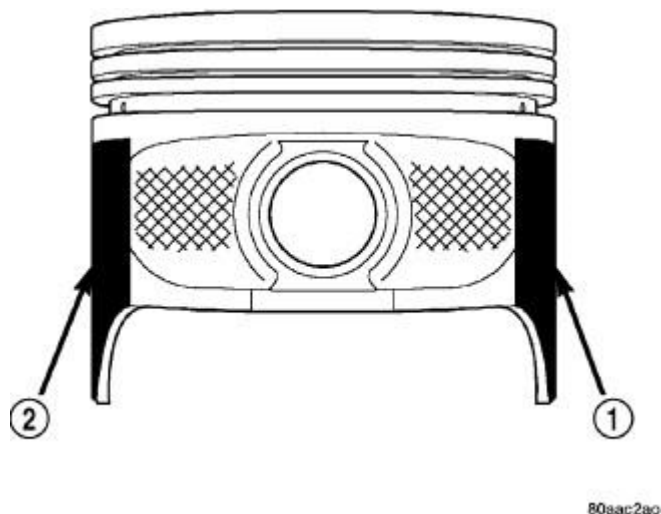
6. Inspect the connecting rod bearing bores for signs of scoring, nicks and burrs.

**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 Engine/Engine Block/ROD, Piston and Connecting - Standard Procedure.





**Fig. 417: 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.
9. Check the piston for taper and out of round shape.

**NOTE:** The coating material (1 and 2) is applied to the piston after the final piston machining process. Measuring the outside diameter of a coated piston will not provide accurate results. Therefore measuring the inside diameter of the cylinder bore with a dial Bore Gauge is **MANDATORY**. Refer to **ENGINE BLOCK, INSPECTION**.

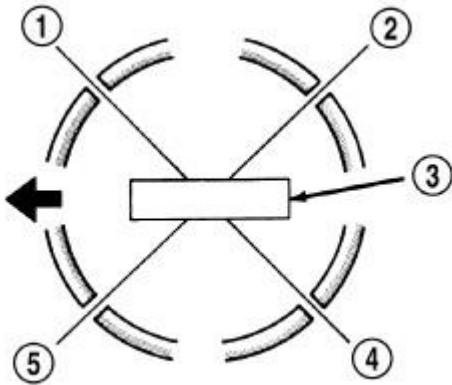
10. Compare the measured cylinder bore diameter to the engine block cylinder bore grade marking chart. Select the piston size that corresponds to the engine block markings for each cylinder to provide the proper oil clearance. Refer to **Engine/Engine Block/ROD, Piston and Connecting - Standard Procedure**.

**NOTE:** 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.

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

## INSTALLATION

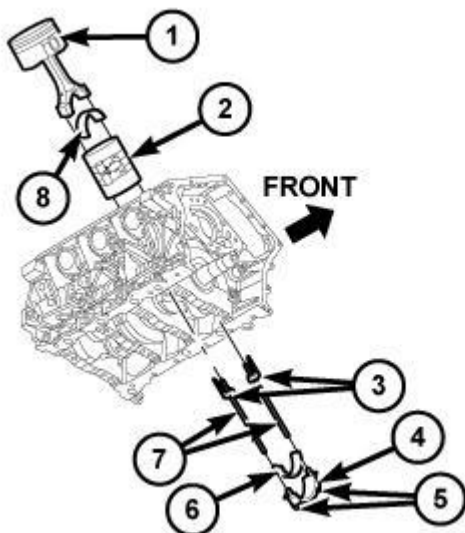
## INSTALLATION



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**Fig. 418: Piston Ring End Gap Position**  
Courtesy of CHRYSLER GROUP, LLC

1. If required, select and fit new piston and connecting rod assemblies to the engine block. Refer to **Engine/Engine Block/ROD, Piston and Connecting - Standard Procedure**.
2. If required, select and fit new bearings to the connecting rod. Refer to **BEARING(S), CONNECTING ROD, STANDARD PROCEDURE**.
3. If required, hone the cylinder bores. Refer to **Engine/Engine Block - Standard Procedure**.
4. If removed, install the piston rings. Refer to **RING(S), PISTON, INSTALLATION**.
5. 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)



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**Fig. 419: Piston, Connecting Rod Cap, Bolts, Plastic Guide Plates & Guide Pins**  
Courtesy of CHRYSLER GROUP, LLC

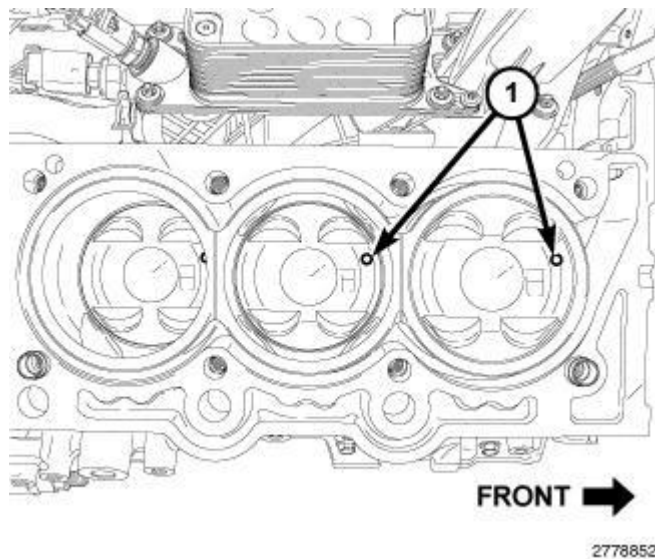
**NOTE:** Typical V6 engine configuration shown in illustration.

**NOTE:** Ensure the position of the ring end gaps does not change when installing the ring compressor.

6. Lubricate the piston rings with clean engine oil. Position Piston Compressor (special tool #C-385, Compressor, Piston) (2) over the piston and rings. Tighten the compressor (2).

**NOTE:** Install the rod bearings in pairs. Do not mix sizes or use a new bearing half with an old bearing half.

7. 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.
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 installed.



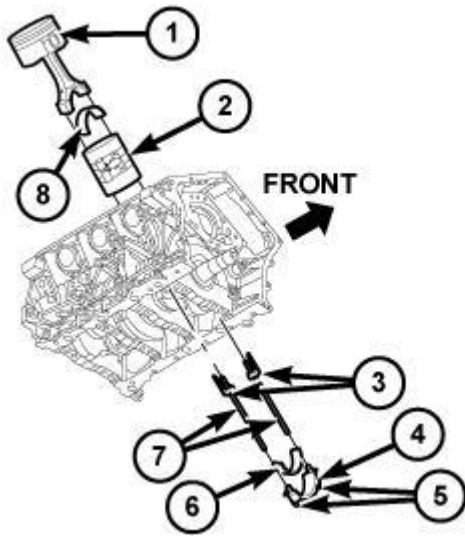
**Fig. 420: Piston Installation Position**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Right cylinder bank shown in illustration, left cylinder bank similar.

9. The pistons crowns are stamped with a mark (1) indicating installation position. This mark must be positioned toward the front of engine on both cylinder banks.
10. Wipe the cylinder bore clean and lubricate with clean engine oil.
11. Rotate the crankshaft until the connecting rod journal is on the center of cylinder bore.

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

12. Insert the piston and connecting rod into the cylinder bore and carefully position the guide pins over the crankshaft journal.
13. Tap the piston down in the cylinder bore using a hammer handle while guiding the connecting rod into position over the rod journal.



**Fig. 421: Piston, Connecting Rod Cap, Bolts, Plastic Guide Plates & Guide Pins**  
Courtesy of CHRYSLER GROUP, LLC

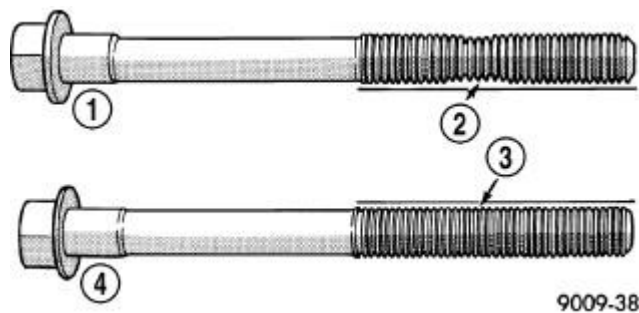
**NOTE:** Typical V6 engine configuration shown in illustration.

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

14. 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).

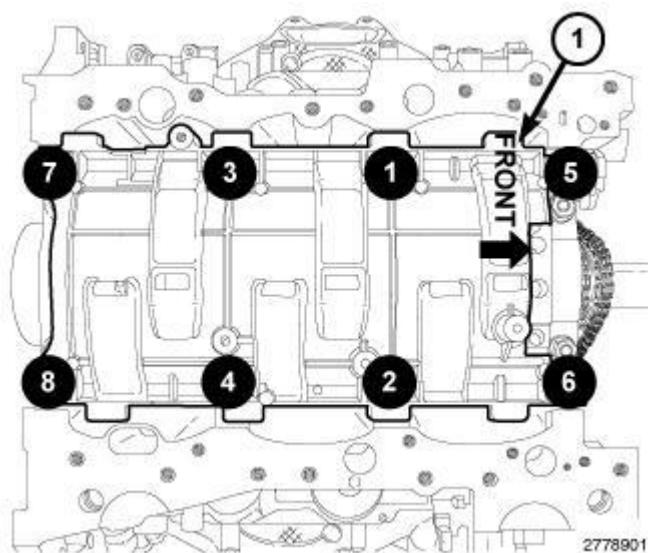
15. Install the connecting rod cap and bearing with the tang on the same side as the rod. Tighten the **NEW** connecting rod cap bolts (5) to 20 N.m (15 ft. lbs.) plus 90°.
16. If required, check the connecting rod side clearance. Refer to **Engine/Engine Block/ROD, Piston and Connecting - Standard Procedure**.
17. Repeat the previous steps for each piston being installed.



**Fig. 422: 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.

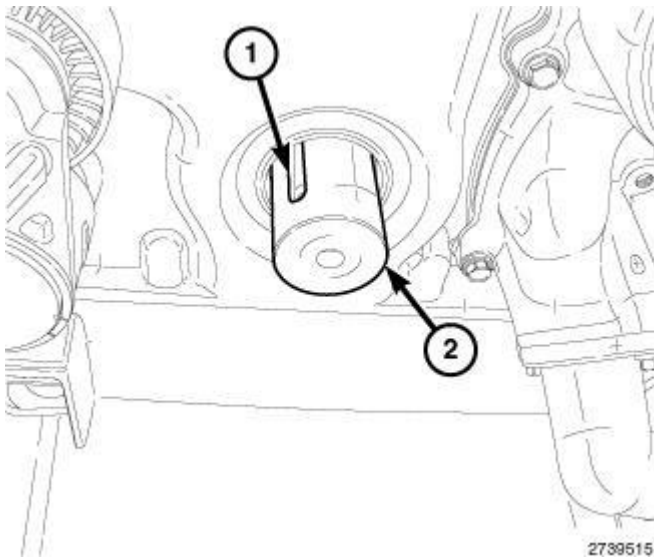
18. Check the main bearing cap bolts for necking by holding a scale or straight edge against the threads. If all the threads do not contact the scale (2) the bolt must be replaced.



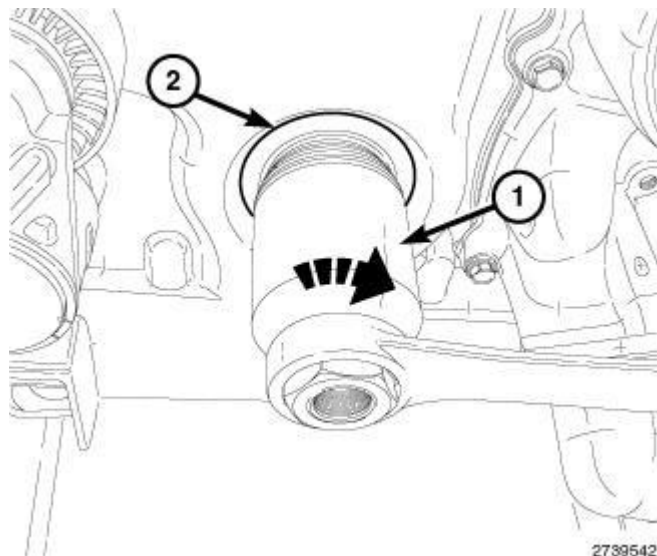
**Fig. 423: Windage Tray With Main Bearing Cap Bolts Installation Sequence**  
Courtesy of CHRYSLER GROUP, LLC

19. Install the windage tray with eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to 21 N.m (16 ft. lbs.) plus 90°.
20. Install the engine oil pump and oil pump pick-up. Refer to **PUMP, ENGINE OIL, INSTALLATION**.
21. Install the cylinder heads, engine timing cover and oil pans. Refer to **CYLINDER HEAD, INSTALLATION**.
22. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
23. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

24. Fill the cooling system. Refer to **STANDARD PROCEDURE** .
25. Operate the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE** .

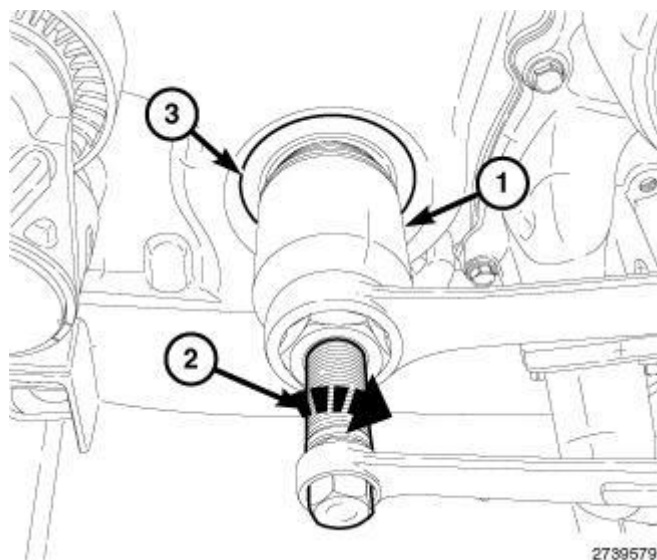
**SEAL, CRANKSHAFT OIL, FRONT****REMOVAL****REMOVAL****Fig. 424: Sleeve & Flywheel Key****Courtesy of CHRYSLER GROUP, LLC**

1. Remove the accessory drive belt and the crankshaft vibration damper. Refer to **DAMPER, VIBRATION, REMOVAL**.
2. Install the sleeve (2) from Seal Remover (special tool #8511, Remover, Seal) around the flywheel key (1) and onto the nose of the crankshaft.



**Fig. 425: Seal Remover & Front Crankshaft Oil Seal**  
Courtesy of CHRYSLER GROUP, LLC

3. Screw Seal Remover (special tool #8511, Remover, Seal) (1) into the front crankshaft oil seal (2).

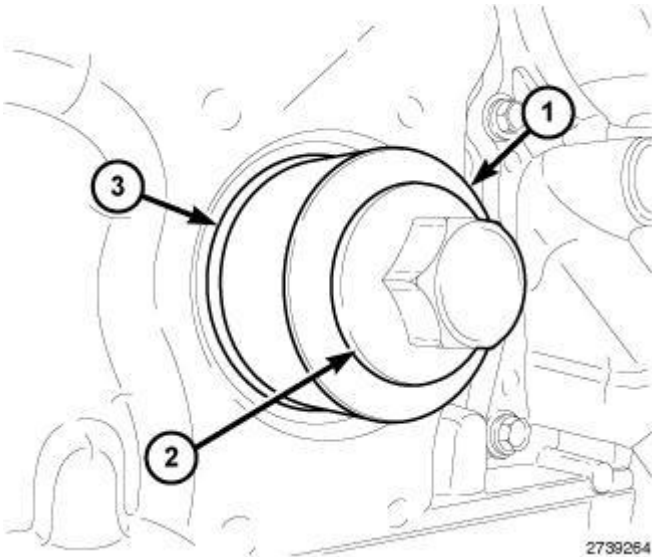


**Fig. 426: Extractor Screw, Seal Remover & Front Crankshaft Oil Seal**  
Courtesy of CHRYSLER GROUP, LLC

4. Install the extractor screw (2) into the Seal Remover (special tool #8511, Remover, Seal) (1). Hold the seal remover stationary and tighten the extractor screw against the sleeve until the front crankshaft oil seal (3) is removed from the engine timing cover.

## INSTALLATION

## INSTALLATION



**Fig. 427: Front Crankshaft Seal Installer & Oil Seal**  
Courtesy of CHRYSLER GROUP, LLC

1. Position the front crankshaft oil seal (3) into place on the engine timing cover.
2. Align the Front Crankshaft Seal Installer (special tool #10199, Installer, Crankshaft Front Oil Seal) (1) to the flywheel key on the crankshaft and against the front crankshaft oil seal (3).

**CAUTION:** Only tighten the crankshaft vibration damper bolt until the oil seal is seated in the cover. Overtightening of the bolt can crack the front timing cover.

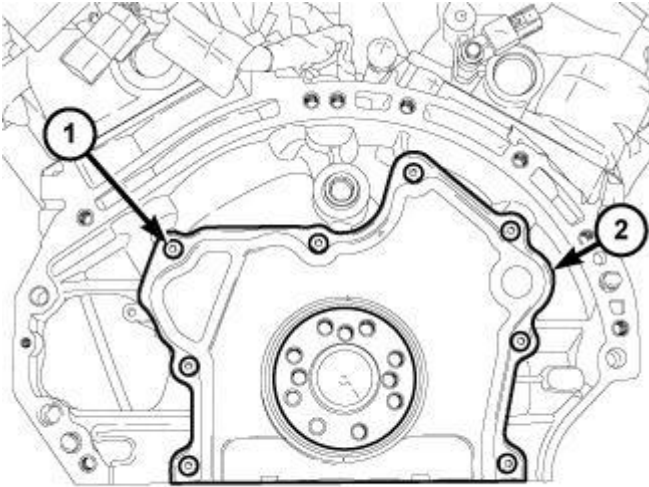
3. Install and tighten the crankshaft vibration damper bolt (2) until the Crankshaft oil seal is seated in the engine timing cover.
4. Install the crankshaft vibration damper and accessory drive belt. Refer to **DAMPER, VIBRATION, INSTALLATION**.

## SEAL, CRANKSHAFT OIL, REAR

### REMOVAL

### REMOVAL





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**Fig. 428: Seal Retainer & Attaching Screws**

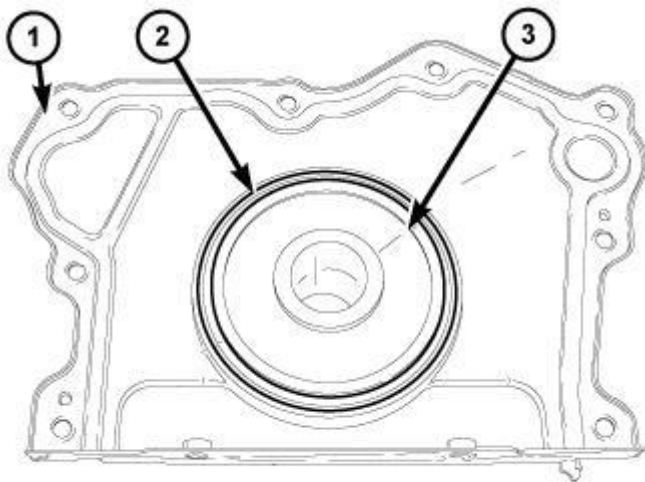
Courtesy of CHRYSLER GROUP, LLC

The rear crankshaft oil seal is incorporated into the seal retainer (2) and can not be removed from the retainer. The rear crankshaft oil seal and seal retainer (2) are serviced as an assembly.

1. Remove the automatic transmission, if equipped. Refer to **REMOVAL** .
2. Remove the manual transmission, if equipped. Refer to **REMOVAL** .
3. Remove the flexplate, if equipped. Refer to **FLEXPLATE, REMOVAL**.
4. Remove the flywheel, if equipped. Refer to **FLYWHEEL, REMOVAL** .
5. Remove the upper oil pan. Refer to **PAN, OIL, REMOVAL**.
6. Remove the eight seal retainer attaching screws (1).
7. Remove and discard the seal retainer (2).

## INSTALLATION

## INSTALLATION



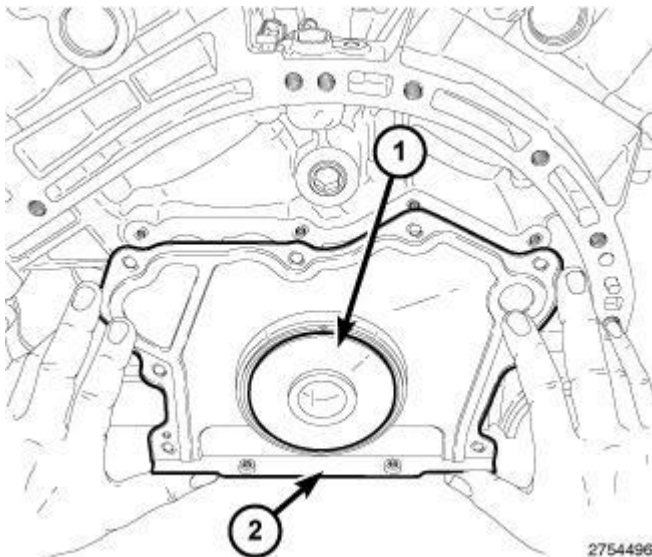
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**Fig. 429: Rear Crankshaft Oil Seal, Retainer & Seal Protector**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The rear crankshaft oil seal (2) and retainer (1) are an assembly. To avoid damage to the seal lip, DO NOT remove the seal protector (3) from the rear crankshaft oil seal before installation onto the engine.

**CAUTION:** Whenever the crankshaft is replaced, the rear crankshaft oil seal must also be replaced. Failure to do so may result in engine fluid leakage.



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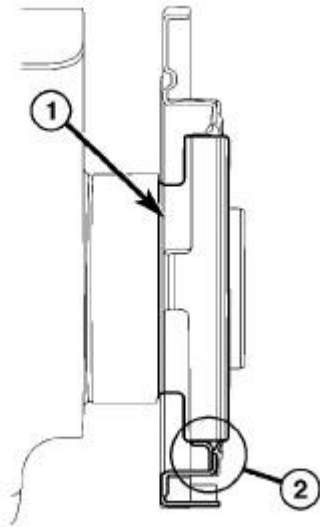
**Fig. 430: Oil Seal Retainer Assembly & Seal Protector**

Courtesy of CHRYSLER GROUP, LLC

1. Inspect the crankshaft to make sure there are no nicks or burrs on the seal surface.
2. Clean the engine block sealing surfaces thoroughly.

**NOTE:** It is not necessary to lubricate the seal or the crankshaft when installing the seal retainer. Residual oil following installation can be mistaken for seal leakage.

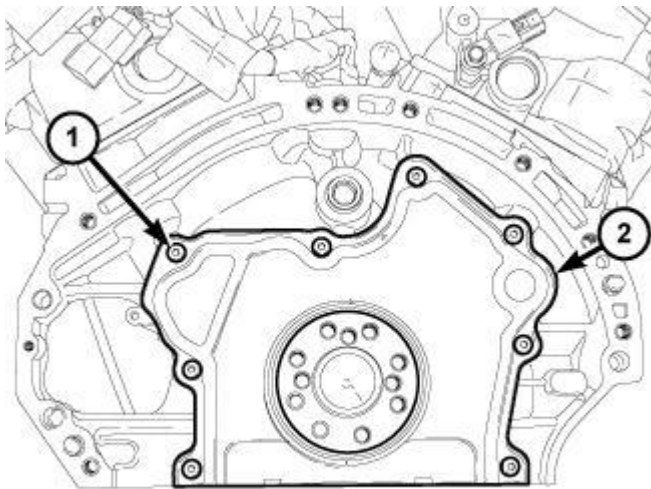
3. Carefully position the oil seal retainer assembly (2), and seal protector (1) on the crankshaft and push firmly into place on the engine block (during this step, the seal protector will be pushed from the rear oil seal assembly as a result of installing the rear oil seal).



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**Fig. 431: Rear Seal Installed**  
Courtesy of CHRYSLER GROUP, LLC

4. Verify that the seal lip (2) on the retainer is uniformly curled inward toward the engine on the crankshaft (1).



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**Fig. 432: Seal Retainer & Attaching Screws**

Courtesy of CHRYSLER GROUP, LLC

5. Install the eight seal retainer bolts (1) and tighten to 12 N.m (106 in. lbs.).

**NOTE:** Make sure that the seal retainer flange is flush with the engine block oil pan sealing surface.

6. Install the flexplate, if equipped. Refer to FLEXPLATE, INSTALLATION.
7. Install the flywheel and clutch, if equipped. Refer to DISC, CLUTCH, INSTALLATION.

Install the automatic transmission, if equipped. Refer to INSTALLATION.

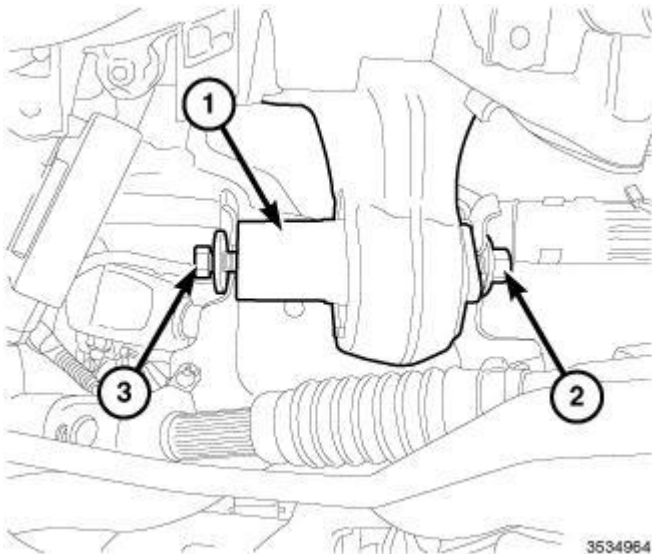
8. Install the manual transmission, if equipped. Refer to INSTALLATION.
9. Install the upper oil pan. Refer to PAN, OIL, INSTALLATION.
10. Fill the engine crankcase with the proper oil to the correct level. Refer to Engine/Lubrication/OIL - Standard Procedure.

## ENGINE MOUNTING

### INSULATOR, ENGINE MOUNT, LEFT

#### REMOVAL

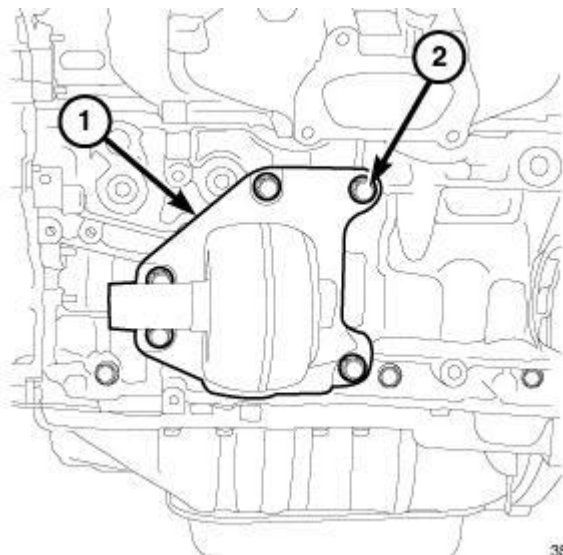
#### REMOVAL



**Fig. 433: Engine Mount & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

1. Raise and support the vehicle. Refer to HOISTING, STANDARD PROCEDURE.
2. Loosen the right engine mount nut (2).

3. Using a suitable jack stand and a block of wood positioned under the oil pan, raise the engine until the weight is off of the isolator.
4. Remove the left engine mount nut (2) and bolt (3).



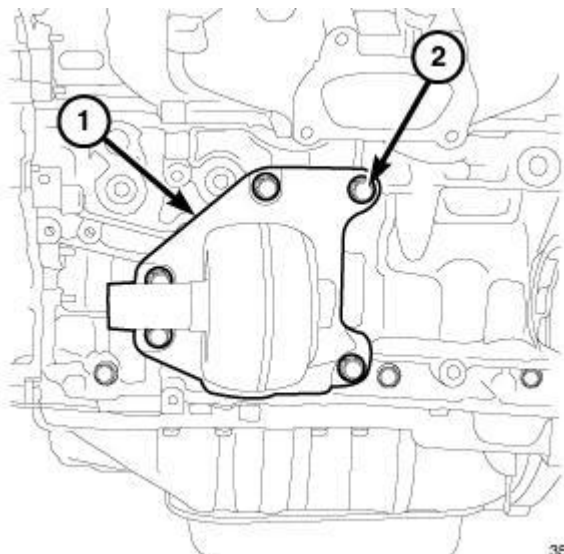
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**Fig. 434: Left Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

5. Remove the five bolts (2) and the left engine mount isolator (1) from the vehicle.

## INSTALLATION

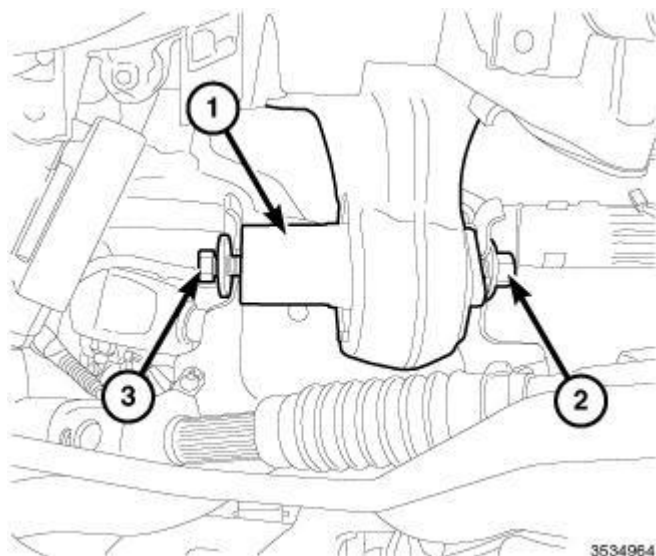
## INSTALLATION



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**Fig. 435: Left Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

Install the left engine mount isolator (1) to the engine block with five bolts (2) tightened to 61 N.m (45 ft. lbs.).



**Fig. 436: Engine Mount & Fasteners**

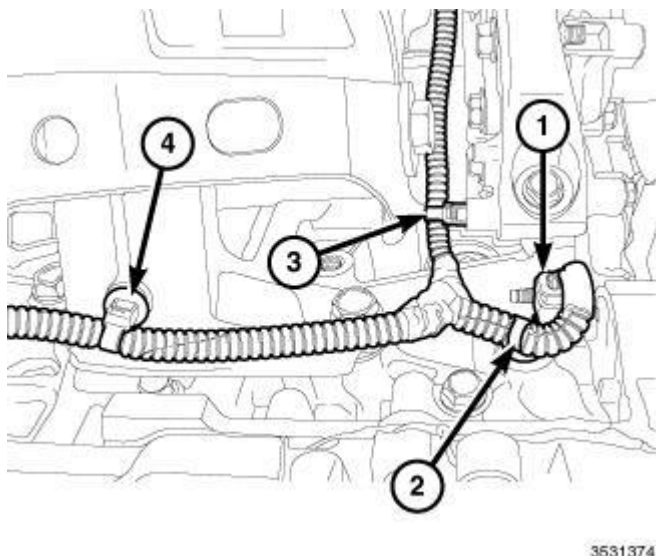
Courtesy of CHRYSLER GROUP, LLC

1. Install the engine mount bolt (2) and nut (3). Lower the engine until the weight is on the isolator and tighten the nut (3) to 61 N.m (45 ft. lbs.).

## INSULATOR, ENGINE MOUNT, RIGHT

### REMOVAL

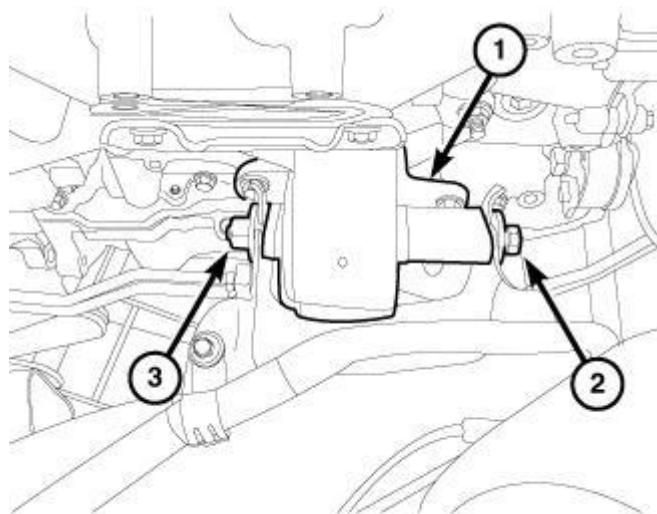
### REMOVAL



**Fig. 437: Oil Pump Solenoid Electrical Connector & Wire Harness Retainers**

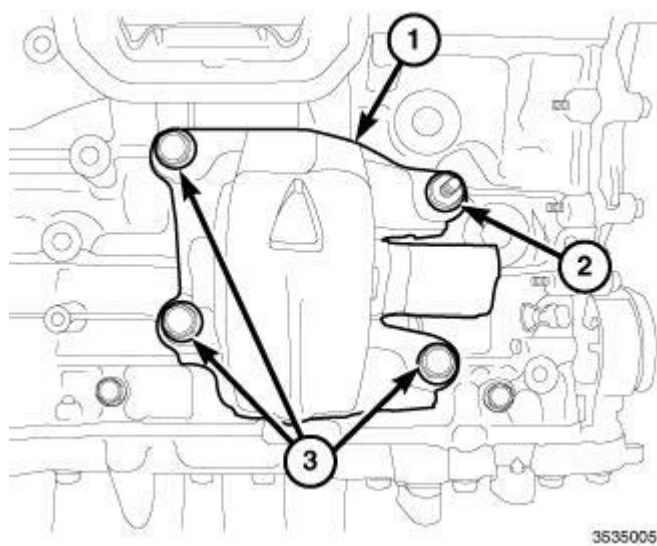
Courtesy of CHRYSLER GROUP, LLC

1. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
2. Remove the right front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, REMOVAL** .
3. Disengage one main wire harness retainer (4) from the right engine mount insulator.



**Fig. 438: Right Engine Mount & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

4. Loosen the right engine mount nut (3).
5. Using a suitable jack stand and a block of wood positioned under the oil pan, raise the engine until the weight is off of the isolator.
6. Remove the right engine mount nut (3) and bolt (2).

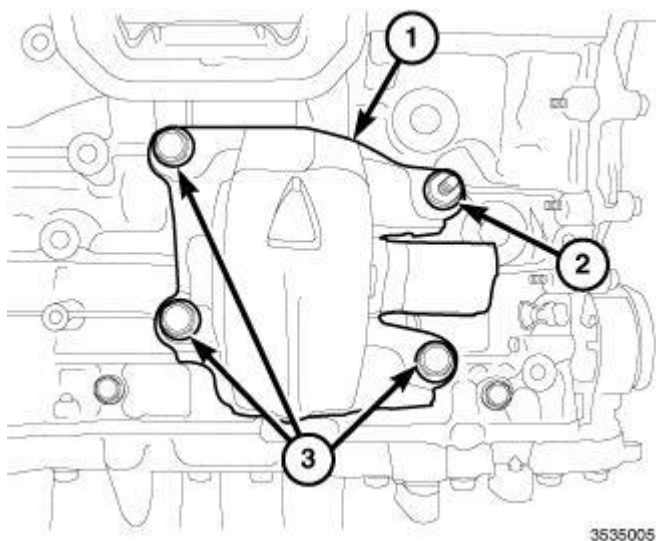


**Fig. 439: Right Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

7. Remove one studbolt (2), three bolts (3) and the right engine mount isolator (1) from the vehicle.

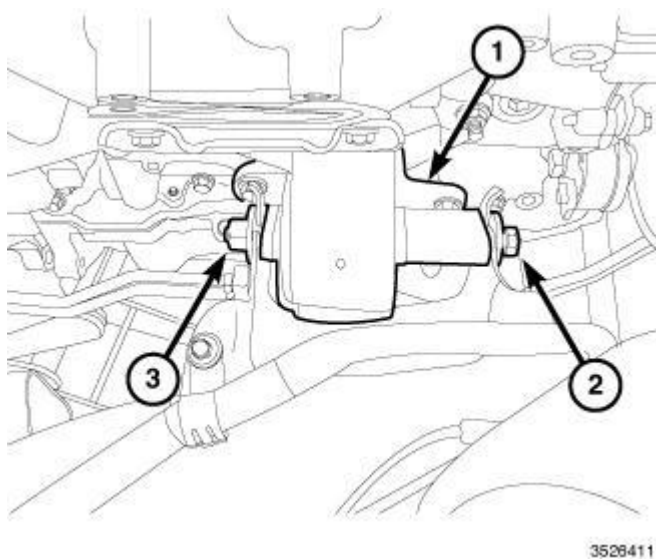
## INSTALLATION

### INSTALLATION



**Fig. 440: Right Engine Mount Isolator & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

Install the right engine mount isolator (1) to the engine block with one studbolt (2) and three bolts (3) tightened to 61 N.m (45 ft. lbs.).

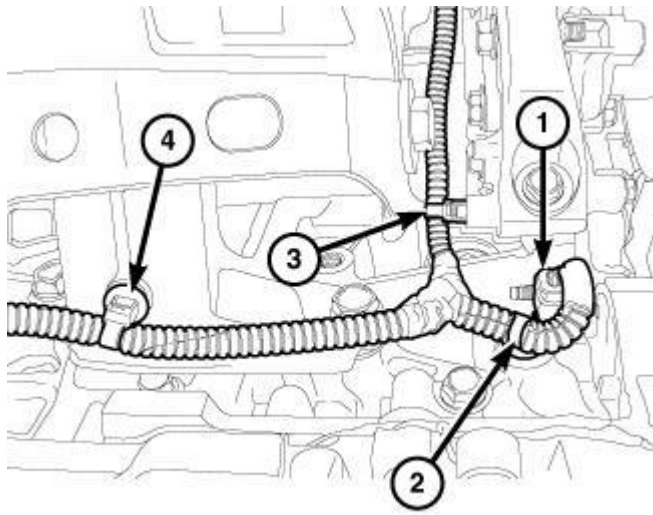


**Fig. 441: Right Engine Mount & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

1. Install the engine mount bolt (2) and nut (3). Lower the engine until the weight is on the isolator and



tighten the nut (3) to 61 N.m (45 ft. lbs.).



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**Fig. 442: Oil Pump Solenoid Electrical Connector & Wire Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC

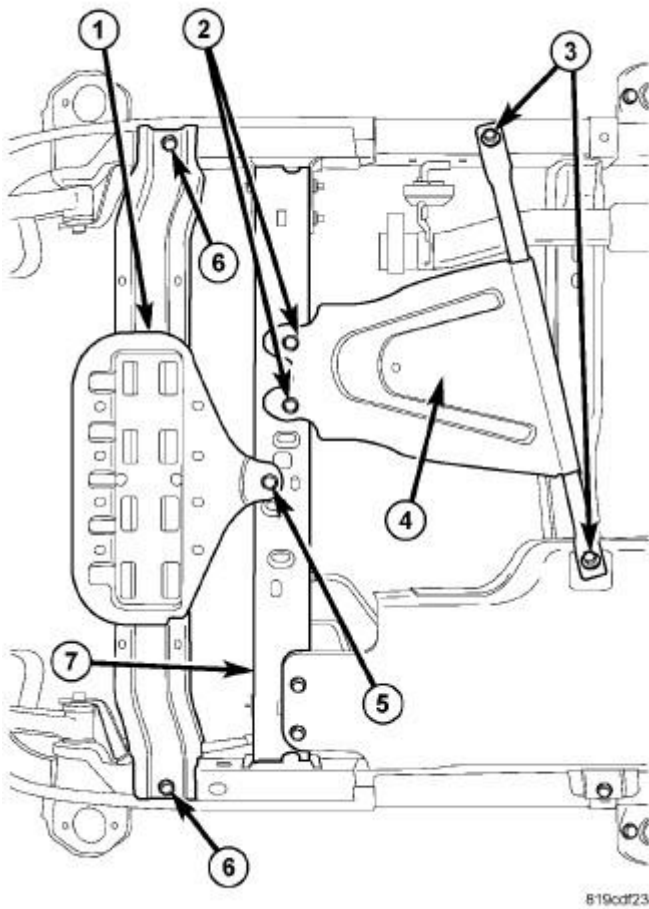
2. Engage one main wire harness retainer (4) to the right engine mounting bracket.
3. Install the right front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, INSTALLATION**.

## INSULATOR, ENGINE MOUNT, REAR

### REMOVAL

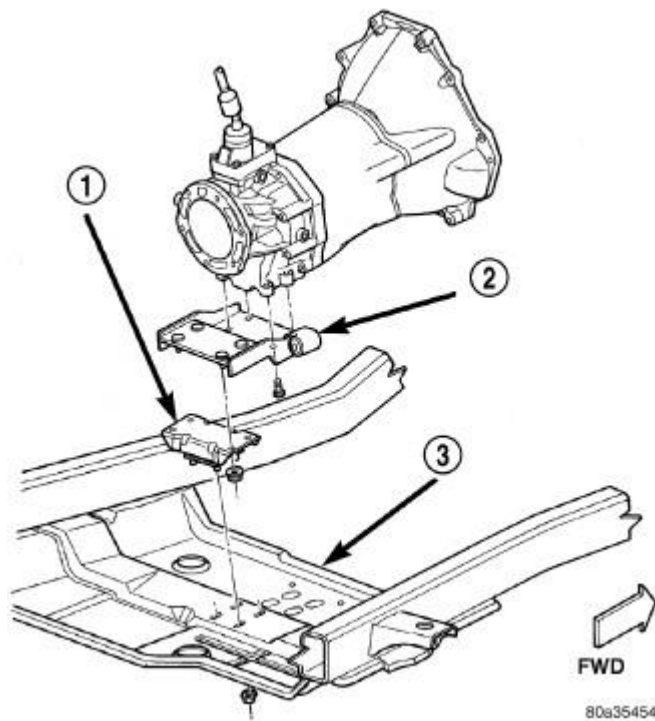
### REMOVAL

### MANUAL TRANSMISSION



**Fig. 443: Crossmember, Skid Plates & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

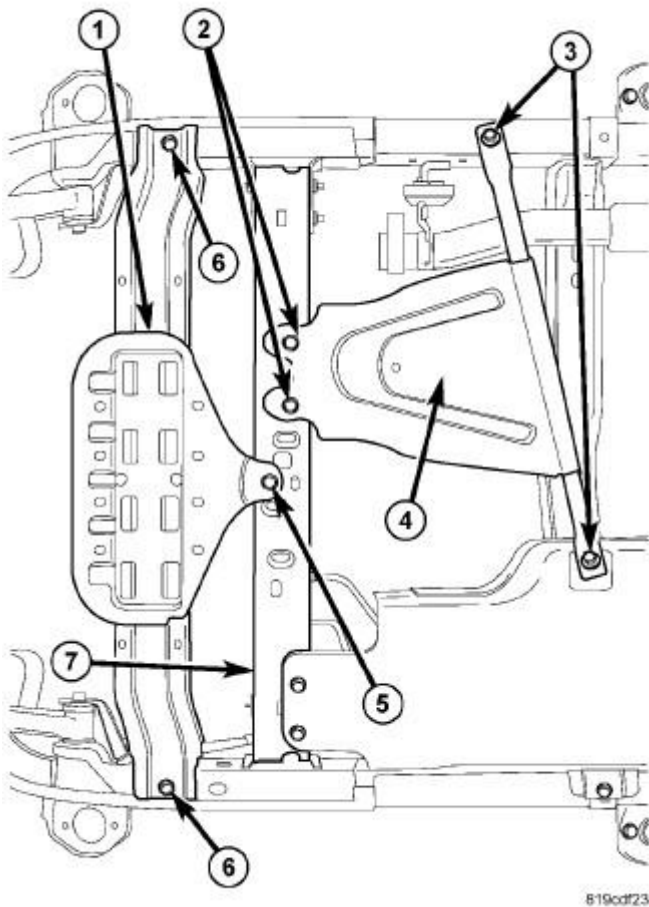
1. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
2. Using a suitable jack stand and a block of wood positioned under the transfer case, raise the transmission until the weight is off of the isolator.
3. Remove the skid plate and transmission crossmember (7). Refer to **CROSSMEMBER, TRANSMISSION, REMOVAL** .



**Fig. 444: Rear Engine Mount Isolator & Bracket (Manual Transmission)**  
Courtesy of CHRYSLER GROUP, LLC

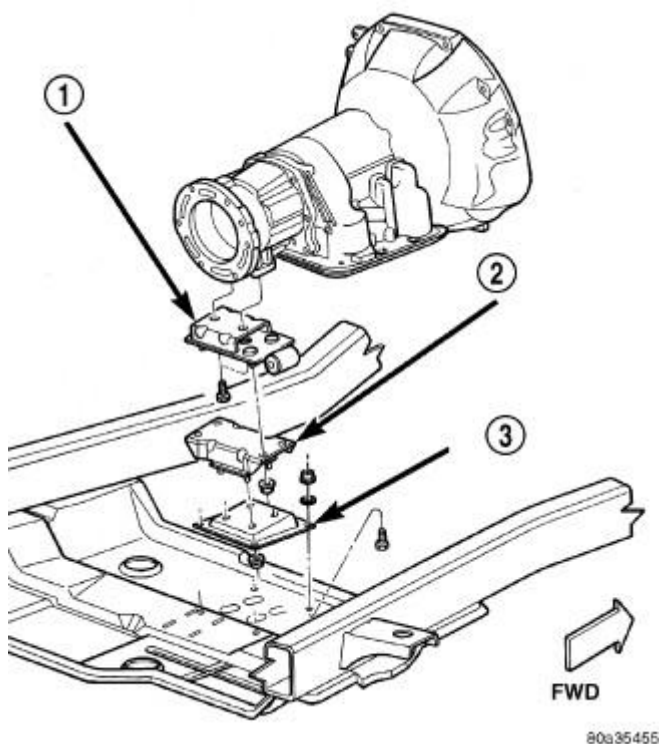
4. Remove the nuts and the rear engine mount isolator (1).
5. If required, remove the bolts and the rear engine mount bracket (2).

#### **AUTOMATIC TRANSMISSION**



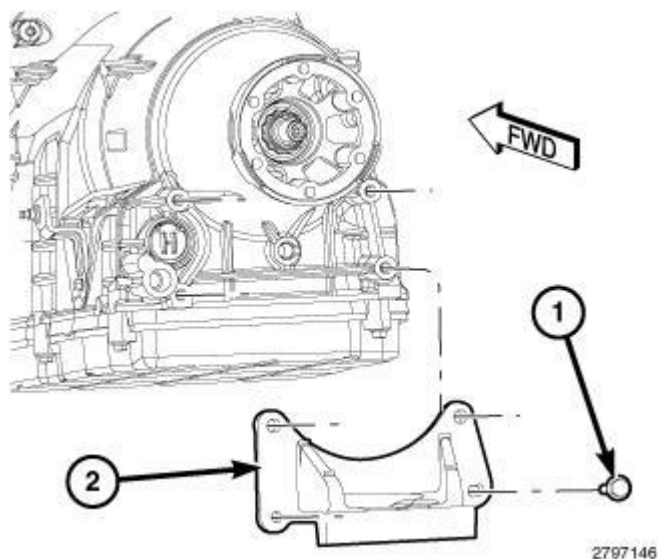
**Fig. 445: Crossmember, Skid Plates & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

1. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
2. Using a suitable jack stand and a block of wood positioned under the transfer case, raise the transmission until the weight is off of the isolator.
3. Remove the skid plate and transmission crossmember (7). Refer to **CROSSMEMBER, TRANSMISSION, REMOVAL** .



**Fig. 446: Rear Engine Mount Isolator & Bracket (Automatic Transmission)**  
Courtesy of CHRYSLER GROUP, LLC

1. Remove the nuts and the rear engine mount isolator (2).
2. On 4x4 vehicles If required, remove the bolts and the rear engine mount bracket (1).



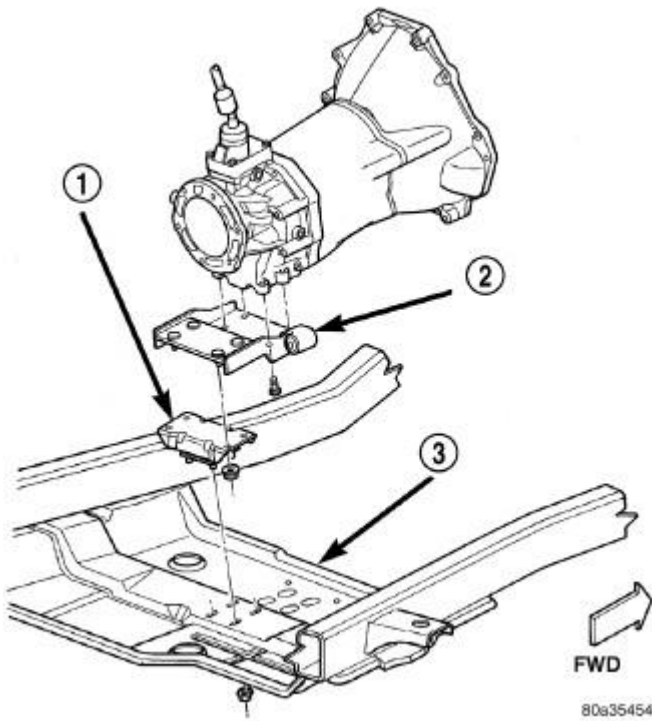
**Fig. 447: Rear Engine Mount Bracket & Bolts (4x2)**  
Courtesy of CHRYSLER GROUP, LLC

3. On 4x2 vehicles if required, remove four bolts (1) and the rear engine mount bracket (2).

## INSTALLATION

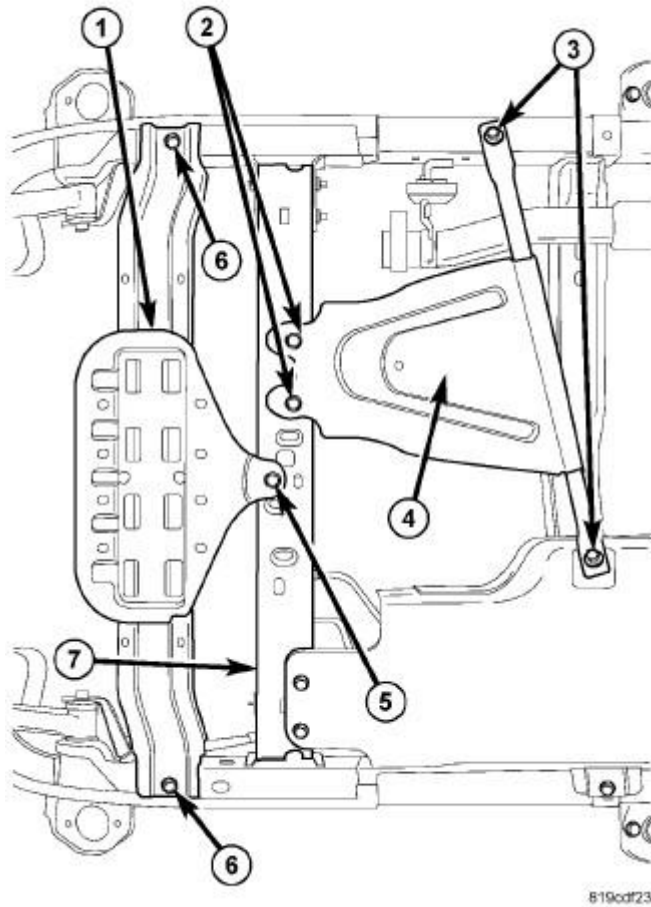
## INSTALLATION

## MANUAL TRANSMISSION

**Fig. 448: Rear Engine Mount Isolator & Bracket (Manual Transmission)**

Courtesy of CHRYSLER GROUP, LLC

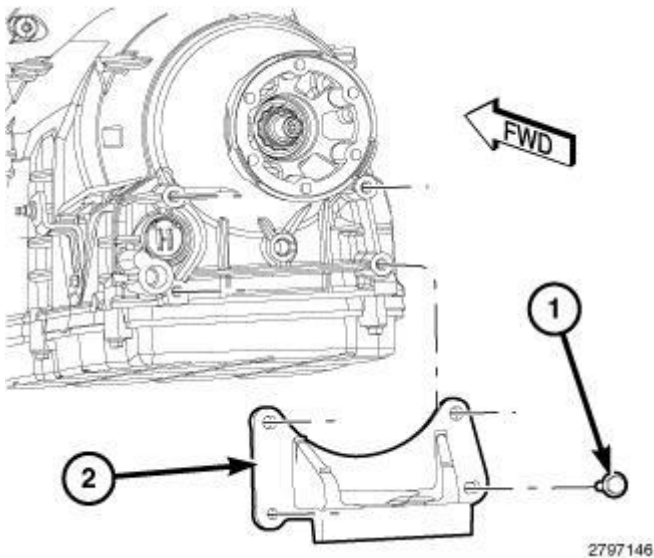
1. If removed, install the rear engine mount bracket (2) to the transmission. Tighten the bolts to 54 N.m (40 ft. lbs.).
2. Install the rear engine mount isolator (1) to the rear engine mount bracket (2). Tighten the nuts to 28 N.m (21 ft. lbs.).



**Fig. 449: Crossmember, Skid Plates & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

3. Install the transmission crossmember (7) and skid plate. Refer to **CROSSMEMBER, TRANSMISSION, INSTALLATION** .

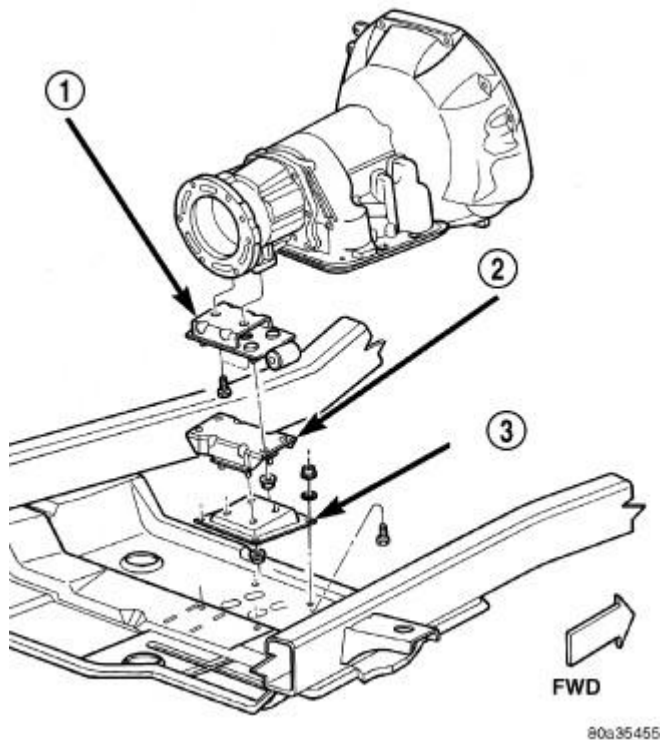
#### AUTOMATIC TRANSMISSION



**Fig. 450: Rear Engine Mount Bracket & Bolts (4x2)**

Courtesy of CHRYSLER GROUP, LLC

1. On 4x2 vehicles if removed, install the rear engine mount bracket (2) with four bolts (1) tightened to 33 N.m (24 ft. lbs.).



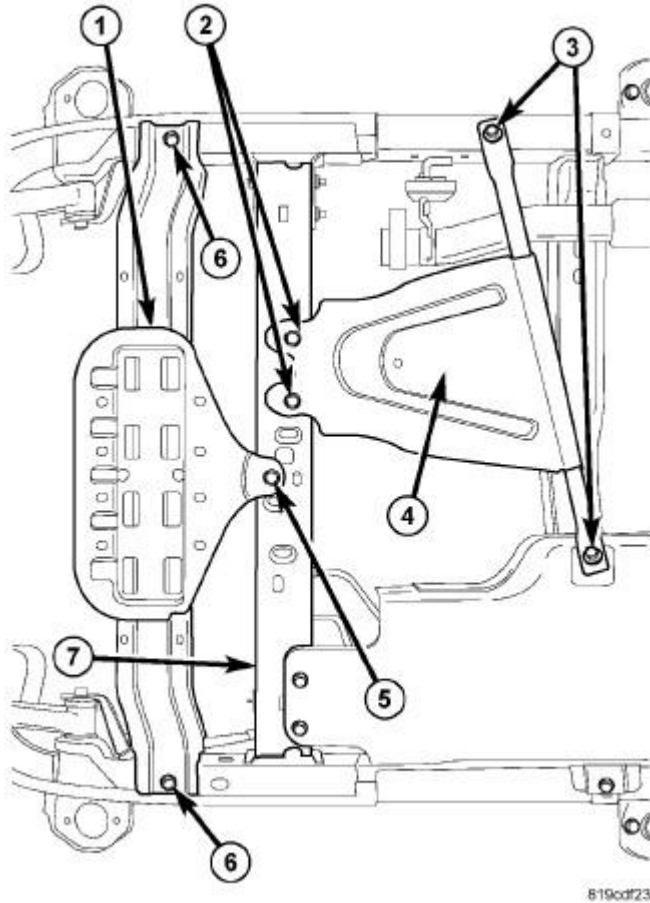
**Fig. 451: Rear Engine Mount Isolator & Bracket (Automatic Transmission)**

Courtesy of CHRYSLER GROUP, LLC

2. On 4x4 vehicles if removed, install the rear engine mount bracket (1) to the transmission. Tighten the bolts to 54 N.m (40 ft. lbs.).



3. Install the rear engine mount isolator (2) to the rear engine mount bracket (1). Tighten the nuts to 28 N.m (21 ft. lbs.).



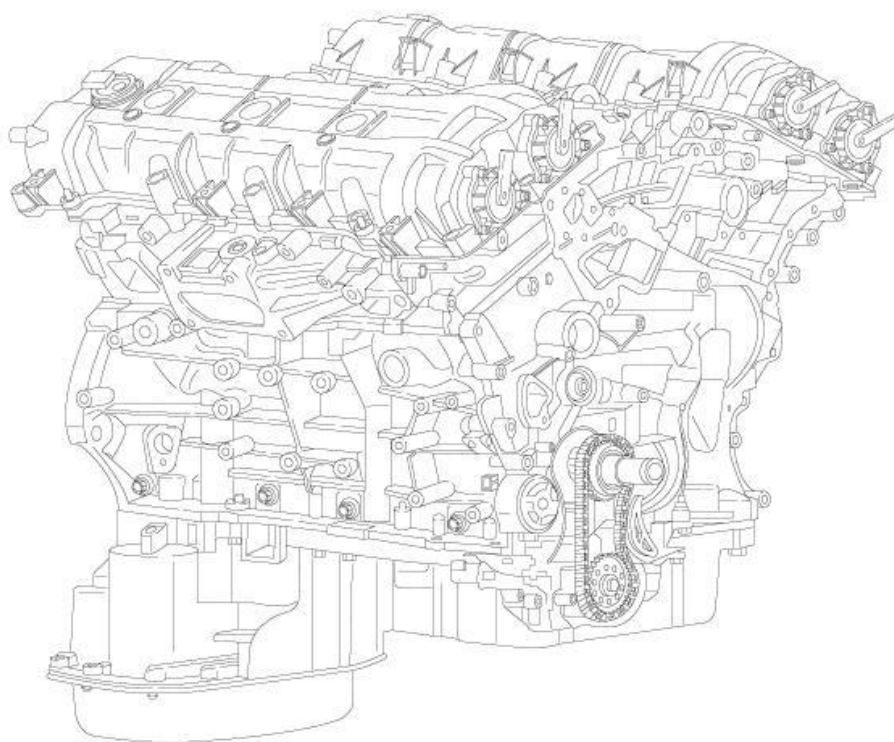
**Fig. 452: Crossmember, Skid Plates & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

4. Install the transmission crossmember (7) and skid plate. Refer to **CROSSMEMBER, TRANSMISSION, INSTALLATION**.

## LUBRICATION

### DESCRIPTION

### DESCRIPTION



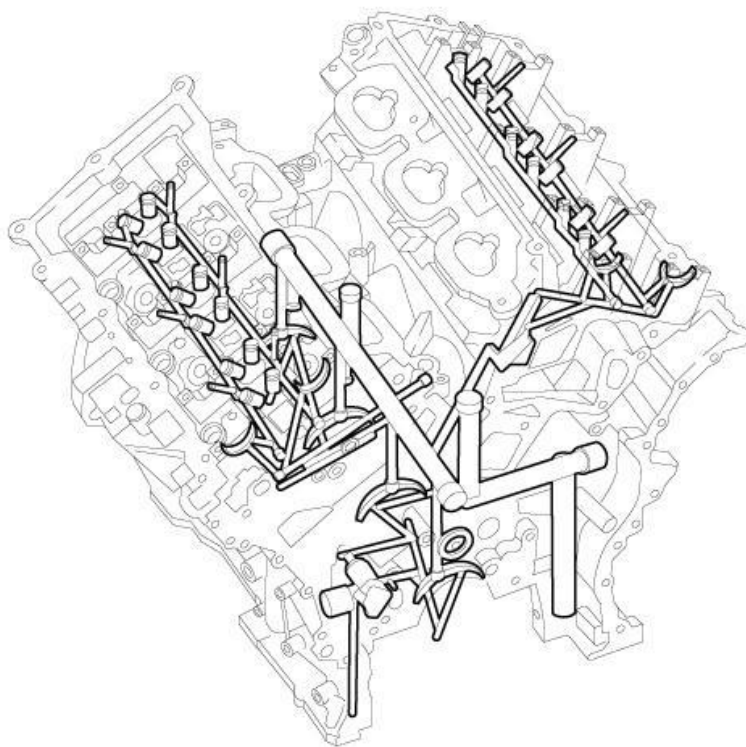
2825865

**Fig. 453: 3.6L Engine****Courtesy of CHRYSLER GROUP, LLC**

The lubrication system is a full flow filtration, pressure feed type lubrication system. The oil pump is mounted to the bottom of the cylinder block and chain driven by the crankshaft sprocket. The oil pump pick-up tube is attached to the oil pump and supported at the windage tray. There are three oil gallery plugs installed in the engine block. A system oil pressure sensor allows oil pressure to be monitored with a diagnostic scan tool. The oil pressure and oil temperature sensors are located on the oil filter housing assembly which is mounted to the top of the engine block between the cylinder heads. The oil cooler is mounted to the oil filter housing. There is a pressure relief valve in the oil pump that is only activated on a cold start or for emergency relief since the oil pump output is self-regulating. There are three piston oil cooler jets mounted to the engine block. Each jet cools two pistons.

## **OPERATION**

### **OPERATION**



**Fig. 454: Engine Lubrication Flow**  
 Courtesy of CHRYSLER GROUP, LLC

The oil from the oil pan is pumped by a vane type oil pump mounted to the bottom of the cylinder block that is chain driven by the crankshaft sprocket. The oil from the pump travels to the oil filter element and then to the oil cooler assembly. After the oil has been filtered and cooled, the oil enters the main oil gallery. The pressurized oil travels through the main gallery to the four main journals to lubricate the crankshaft main bearings. The pressurized oil travels through the crankshaft main journals to cross-drilling supplying oil to the connecting rod journals. From the number one main bearing gallery, oil travels to the right secondary chain tensioner and to the primary chain idler shaft. The main oil gallery also supplies oil to three sets of piston oil cooling jets. From the cylinder block the oil flows through drillings into the left and right cylinder heads. Left cylinder head oil is supplied to the left secondary timing chain tensioner, camshaft journals and hydraulic lash adjusters. Right cylinder head oil is supplied to the right camshaft journals and hydraulic lash adjusters. The camshaft valve lobes and rocker arms are lubricated through a small hole in the rocker arm; oil flows through the lash adjuster then through the rocker arm and onto the camshaft lobe. Oil also flows through each of the four forward camshaft bearings into the camshafts and phasers.

#### ENGINE LUBRICATION FLOW CHART

FROM	TO
Oil Pickup Tube	Oil Pump
Oil Pump	Oil Filter
Oil Filter	Oil Cooler
Oil Cooler	Block Main Oil Gallery
Block Main Oil Gallery	1. Crankshaft Main Journals 2. Left Cylinder Head

## 2012 Jeep Wrangler Sport S

2012 ENGINE 3.6L - Service Information - Wrangler

	3. Right Cylinder Head 4. Piston Cooling Jets
Crankshaft Number One Main Journal	1. Primary Chain Idler Shaft 2. Right Secondary Chain Tensioner 3. Oil Pump Feedback
Crankshaft Main Journals	Crankshaft Rod Journals
Left Cylinder Head	1. Left Secondary Chain Tensioner 2. Hydraulic Lash Adjusters 3. Camshaft Journals 4. Phaser Oil Control Valves
Right Cylinder Head	1. Hydraulic Lash Adjusters 2. Camshaft Journals 3. Phaser Oil Control Valves
Hydraulic Lash Adjusters	1. Rocker Arms 2. Cam Lobes

### 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 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 below.

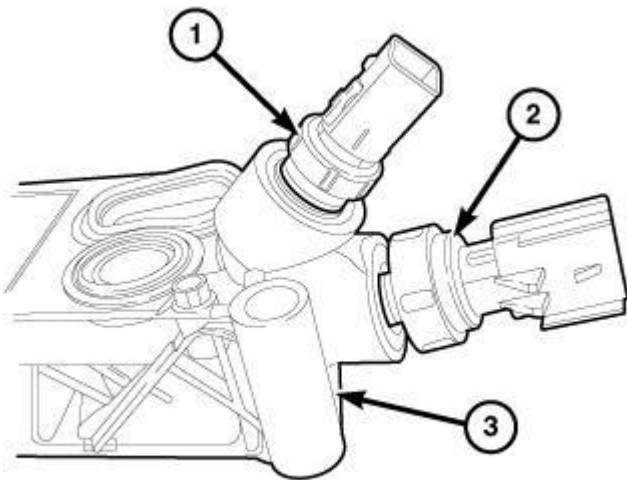
#### AIR LEAK DETECTION TEST METHOD

1. Disconnect the make-up air hose from the cylinder head cover. 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 1 psi to 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 oil seal area, follow the procedures for rear seal area leaks. Refer to **REAR SEAL AREA LEAKS**.
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.

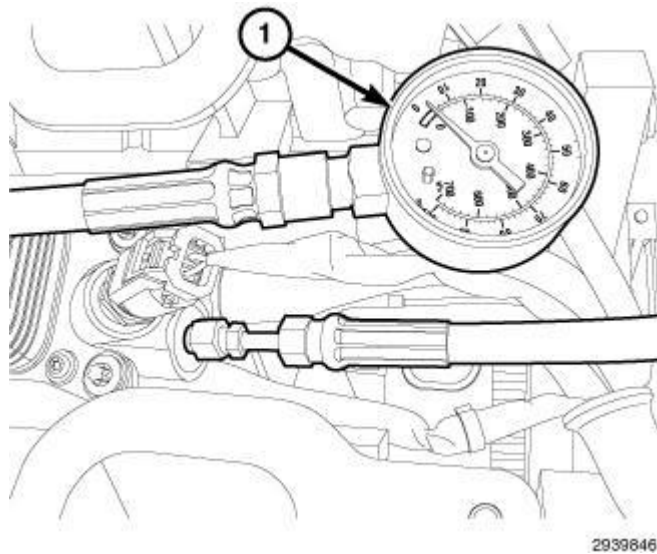
#### CHECKING ENGINE OIL PRESSURE



2710795

**Fig. 455: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
 Courtesy of CHRYSLER GROUP, LLC

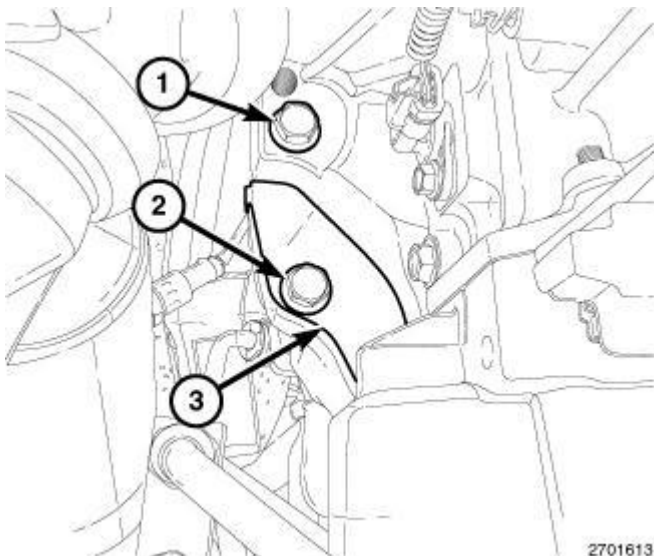
1. Disconnect and isolate the negative battery cable.
2. Remove the oil pressure sensor (2) from the oil filter housing (3). Refer to **SENSOR, OIL PRESSURE, REMOVAL**.



**Fig. 456: Pressure Gauge Installed To Oil Pressure Port**  
Courtesy of CHRYSLER GROUP, LLC

3. Install Pressure Gauge (special tool #C-3292A, Gauge, Pressure) (1) to the oil pressure port. Tighten to 20 N.m (177 in. lbs.).
4. Install the upper and lower intake manifolds and air inlet hose. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
5. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
6. Start and idle the engine. If oil pressure is 0 at idle, shut off the engine and consult the Engine Lubrication and Diagnostic Table. Refer to **ENGINE LUBRICATION DIAGNOSTIC TABLE**.
7. Run the engine until it reaches normal operating temperature.
8. Verify that the engine has acceptable oil pressure. Refer to **Engine - Specifications**.

#### REAR SEAL AREA LEAKS

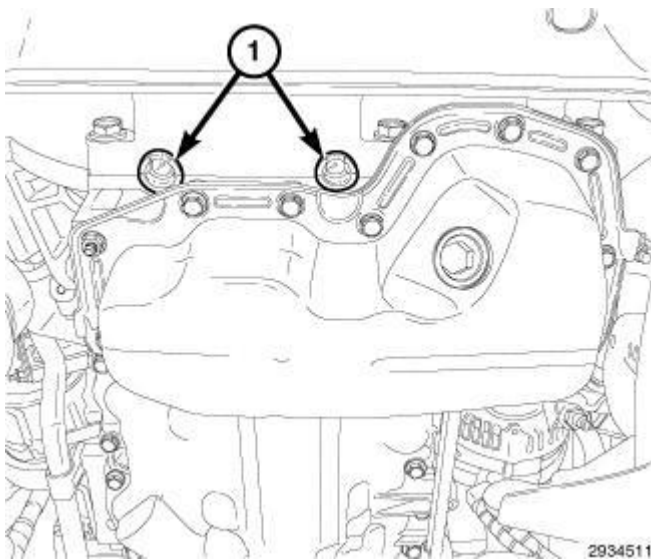


**Fig. 457: Side Engine-To-Transmission Bolt, Transmission Dust Shield Retaining Bolt & Dust Shield**  
Courtesy of CHRYSLER GROUP, LLC

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

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

1. Disconnect and isolate the negative battery cable.
2. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
3. Remove the bolt (2) and the torque converter dust shield (3).



**Fig. 458: Rubber Plugs**  
Courtesy of CHRYSLER GROUP, LLC

4. Remove two rubber plugs (1) covering the rear oil seal retainer flange bolts.
5. Inspect the flexplate and rear of the block for evidence of oil. Use a black light to check for the oil leak:
  1. Circular spray pattern generally indicates seal leakage or crankshaft damage.
  2. Where leakage tends to run straight down, possible causes are a porous block, rear oil seal retainer, oil galley pipe plug and rear seal retainer to oil pan mating surfaces.
6. If no leaks are detected, use the AIR LEAK DETECTION METHOD as outlined in Engine Oil Leak. Refer to **AIR LEAK DETECTION TEST METHOD**.

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

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

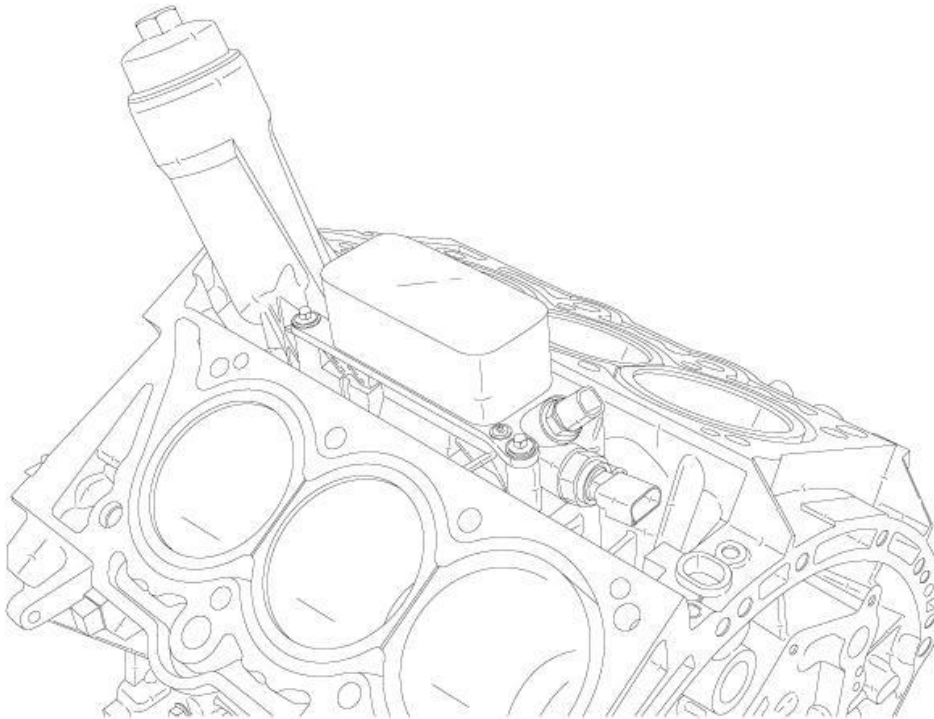
**CAUTION:** Use extreme caution when crankshaft polishing is necessary to remove minor nicks or scratches. The crankshaft seal flange is specially machined to complement the function of the rear oil seal.

8. For bubbles that remain steady with shaft rotation, no further inspection can be done until disassembled. Refer to **SEAL, CRANKSHAFT OIL, REAR, REMOVAL**.

## COOLER, OIL

### DESCRIPTION

### DESCRIPTION



2826514

**Fig. 459: Oil Filter Housing**

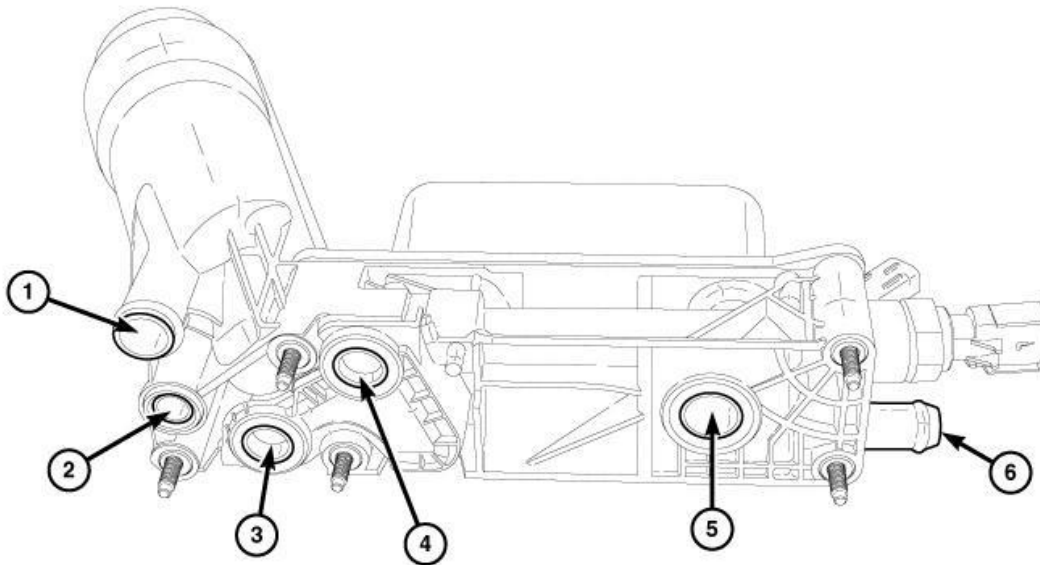
Courtesy of CHRYSLER GROUP, LLC

The oil cooler is attached to the top of the oil filter housing which is located in the V of the cylinder block. The oil cooler is a plate style coolant-to-oil heat exchanger.

### OPERATION

### OPERATION





2826564

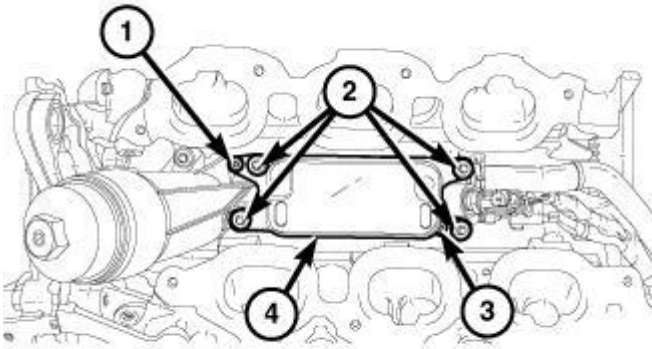
**Fig. 460: Oil Flow & Coolant Flow Locations**  
Courtesy of CHRYSLER GROUP, LLC

Oil flows from the engine oil pump to the oil filter housing inlet (1) and to the oil filter element located within the oil filter housing. After the oil is filtered it travels internally through the engine oil cooler and then to the main oil gallery (5).

Coolant flows from the right cylinder block water jacket (3) and from the left cylinder block water jacket (4) into the housing. The coolant flows through the oil cooler and exits the housing from the rear hose nipple (6) where it is returned to the water pump. A coolant by-pass in the housing is designed to direct excessive coolant flow around the oil cooler for continuous circulation.

## REMOVAL

## REMOVAL



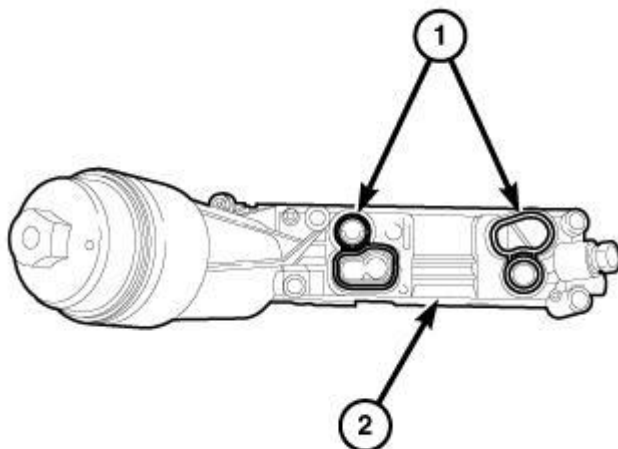
2707169

**Fig. 461: Oil Cooler & Fasteners**

Courtesy of CHRYSLER GROUP, LLC

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

1. Perform the fuel pressure release procedure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Drain the cooling system. Refer to **STANDARD PROCEDURE** .
4. Remove the air cleaner housing assembly, upper and lower intake manifolds. Refer to **MANIFOLD, INTAKE, REMOVAL**.
5. Remove four bolts (2) and two screws (1) and (3).
6. Remove the oil cooler (4).



2710718

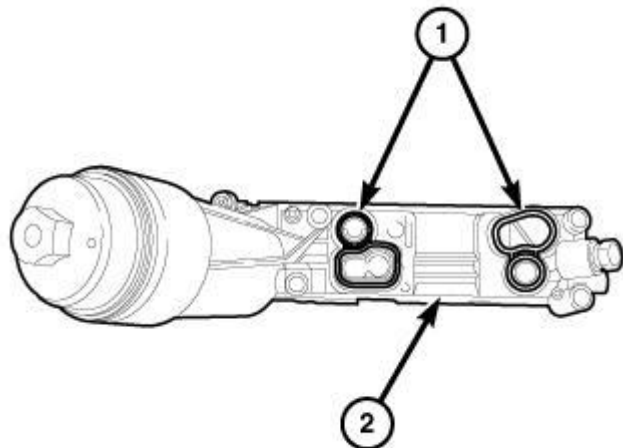
**Fig. 462: Oil Cooler Seals & Oil Filter Housing**

Courtesy of CHRYSLER GROUP, LLC

7. Remove and discard the oil cooler seals (1).

## INSTALLATION

## INSTALLATION

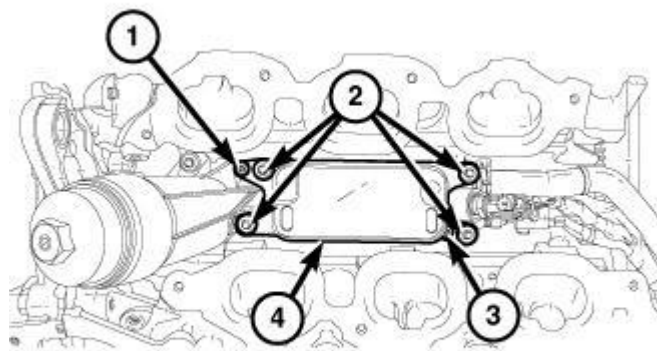


2710718

**Fig. 463: Oil Cooler Seals & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Always use new dry seals (1) when installing the oil cooler. Do not lubricate the seals.

1. Install the new oil cooler seals (1) onto the oil filter housing (2).



2707169

**Fig. 464: Oil Cooler & Fasteners**

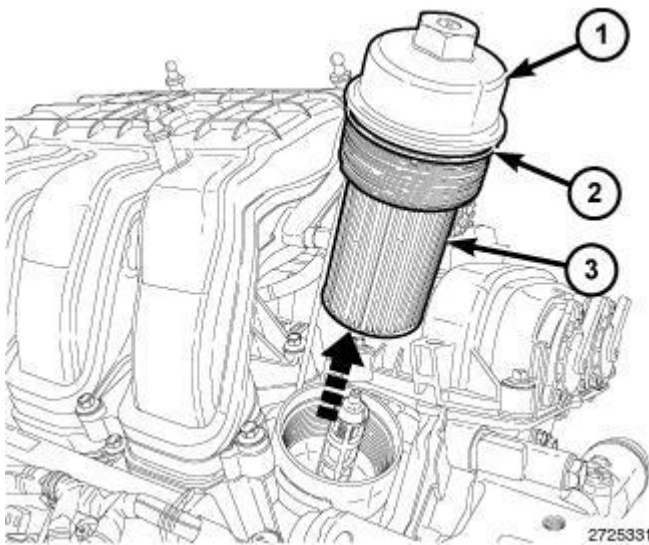
Courtesy of CHRYSLER GROUP, LLC

2. Position the oil cooler (4) on the oil filter housing.
3. Install two screws (1) and (3). Tighten the screws to 4 N.m (35 in. lbs.).
4. Install four bolts (2) and tighten to 12 N.m (106 in. lbs.).
5. Install the upper and lower intake manifolds and air cleaner housing assembly. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
6. Fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
7. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
8. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
9. Operate the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE**.

## FILTER, ENGINE OIL

### REMOVAL

### REMOVAL

**Fig. 465: Oil Filter Cap, O-Ring Seal & Oil Filter**

Courtesy of CHRYSLER GROUP, LLC

All engines are equipped with a high quality full-flow, disposable type oil filter. Chrysler Corporation recommends a Mopar® or equivalent oil filter be used.

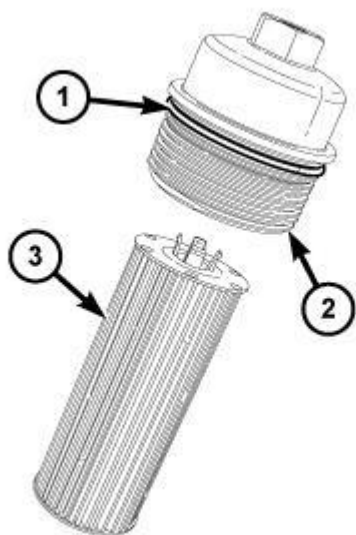
**CAUTION:** When performing an engine oil change, the oil filter cap must be removed. Removing the oil filter cap releases oil held within the oil filter cavity and allows it to drain into the sump. Failure to remove the cap prior to

**reinstallation of the drain plug will not allow complete draining of the used engine oil.**

1. Place an oil absorbent cloth around the oil filter housing at the base of the oil filter cap.

**NOTE:** The oil filter (3) is attached to the oil filter cap (2).

2. Rotate the oil filter cap (1) counterclockwise and remove the cap (1) and filter (3) from the oil filter housing.



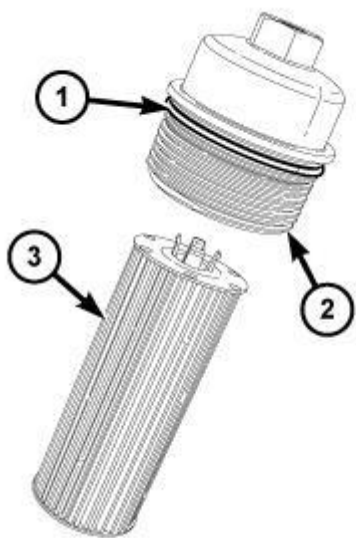
2725389

**Fig. 466: O-Ring Seal, Oil Filter Cap & Oil Filter**  
Courtesy of CHRYSLER GROUP, LLC

3. Remove the oil filter (3) from the oil filter cap (2).
4. Remove and discard the O-ring seal (1).

## INSTALLATION

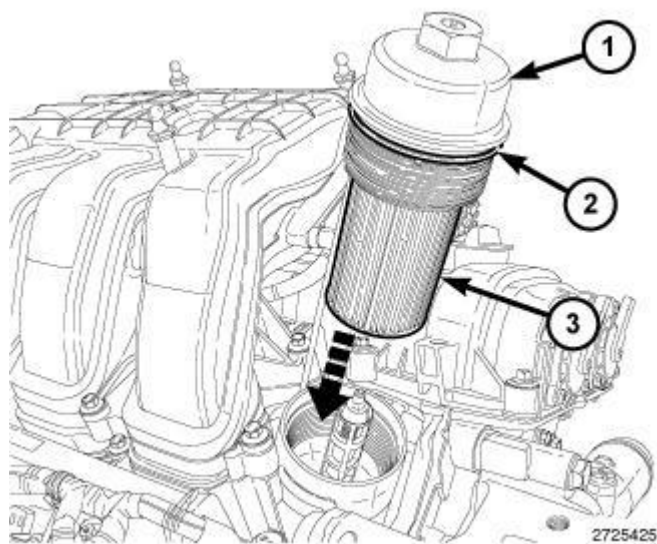
## INSTALLATION



**Fig. 467: O-Ring Seal, Oil Filter Cap & Oil Filter**  
Courtesy of CHRYSLER GROUP, LLC

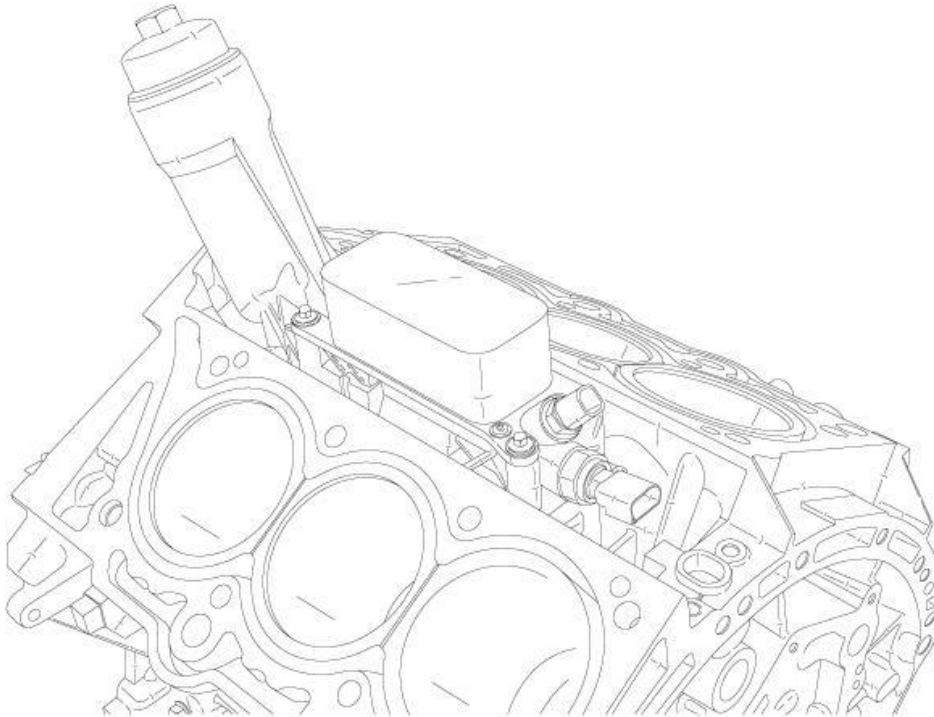
**NOTE:** It is not necessary to pre-oil the oil filter or fill the oil filter housing.

1. Lightly lubricate the new O-ring seal (1) with clean engine oil.
2. Install the O-ring seal (1) on the filter cap (2).
3. Install the new oil filter (3) into the oil filter cap (2).



**Fig. 468: Oil Filter Cap, O-Ring Seal & Oil Filter**  
Courtesy of CHRYSLER GROUP, LLC

4. Thread the oil filter cap (1) into the oil filter housing and tighten to 25 N.m (18 ft. lbs.).
5. Add oil, verify crankcase oil level and start engine. Inspect for oil leaks, refer to **Engine/Lubrication/OIL - Standard Procedure**.

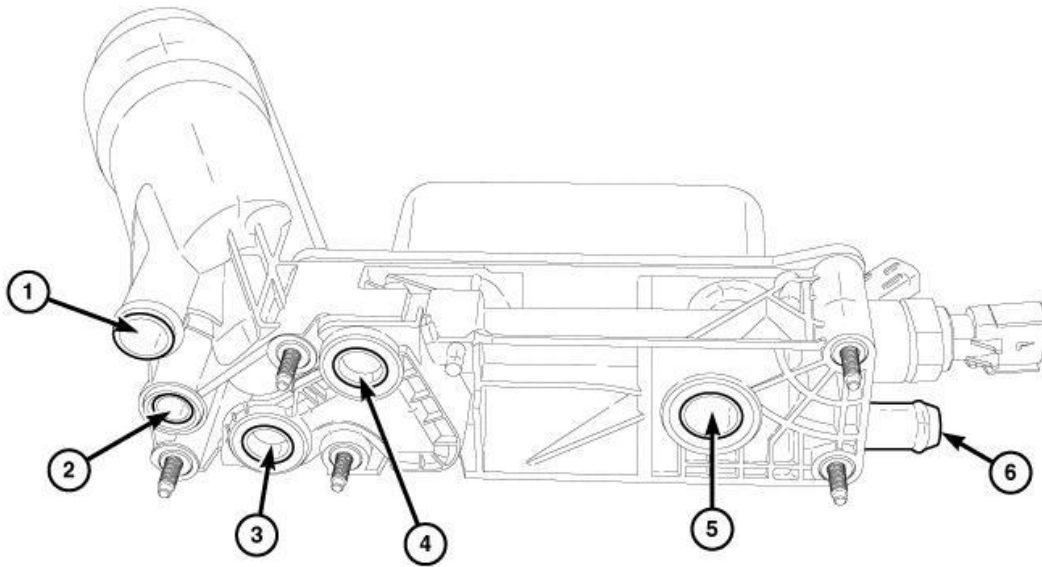
**HOUSING, OIL FILTER****DESCRIPTION****DESCRIPTION**

2826514

**Fig. 469: Oil Filter Housing****Courtesy of CHRYSLER GROUP, LLC**

The oil filter housing is located in the V of the cylinder block. The oil filter element is located within the housing and the engine oil cooler is attached to the top of the housing. Both the oil pressure and oil temperature sensors are located at the rear of the housing.

**OPERATION****OPERATION**



2826564

**Fig. 470: Oil Flow & Coolant Flow Locations**  
Courtesy of CHRYSLER GROUP, LLC

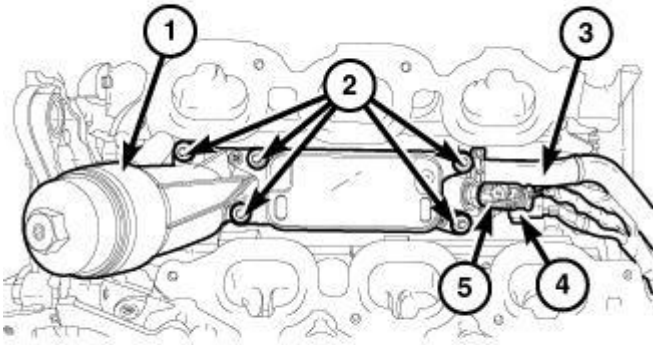
Oil flows from the engine oil pump to the oil filter housing inlet (1) and to the oil filter element located within the oil filter housing. After the oil is filtered and then cooled it travels to the main oil gallery (5). An oil filter by-pass is built into the housing and is not serviceable. Removing the oil filter cap from the housing allows oil to drain from the oil filter cavity into to the crankcase (2).

Coolant flows from the right cylinder block water jacket (3) and from the left cylinder block water jacket (4) into the housing. The coolant flows through the oil cooler and exits the housing from the rear hose nipple (6) where it is returned to the water pump. A coolant by-pass in the housing is designed to direct excessive coolant flow around the oil cooler for continuous circulation.

## REMOVAL

## REMOVAL

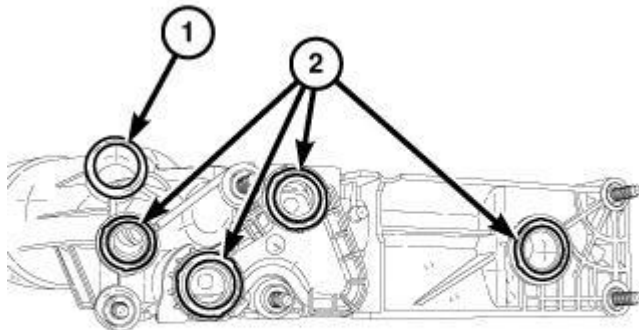




2707704

**Fig. 471: Oil Temperature Sensor Electrical Connector, Oil Pressure Sensor Electrical Connector, Oil Filter Housing, Heater Hose & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

1. Perform the fuel pressure release procedure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Drain the cooling system. Refer to **STANDARD PROCEDURE** .
4. Remove the air cleaner housing assembly, upper and lower intake manifolds. Refer to **MANIFOLD, INTAKE, REMOVAL**.
5. Disconnect the oil temperature sensor electrical connector (5).
6. Disconnect the oil pressure sensor electrical connector (4).
7. Remove five bolts (2) and remove the oil filter housing (1).
8. Lift the oil filter housing (1) and remove the heater hose (3).

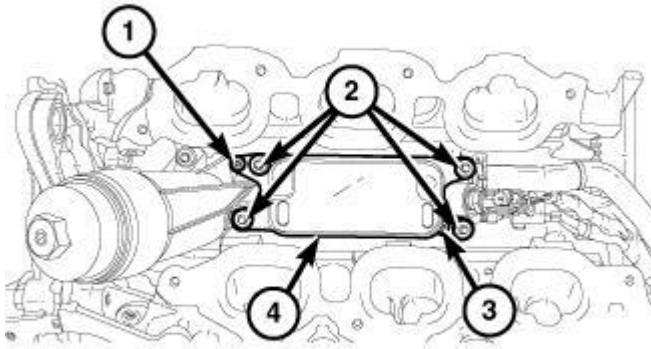


2707844

**Fig. 472: Oil Filter Housing Seals & O-Ring Seal**

Courtesy of CHRYSLER GROUP, LLC

9. Remove and discard the oil filter housing seals (2). The O-ring seal (1) can be reused.

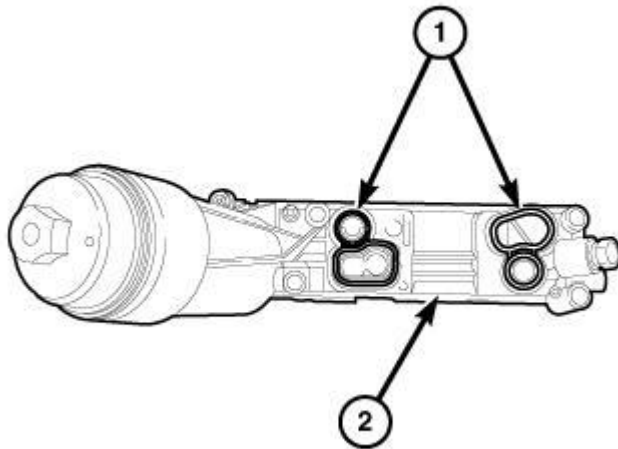


2707169

**Fig. 473: Oil Cooler & Fasteners**

Courtesy of CHRYSLER GROUP, LLC

10. If required, remove two screws (1) and (3) and remove the oil cooler (4) from the oil filter housing.

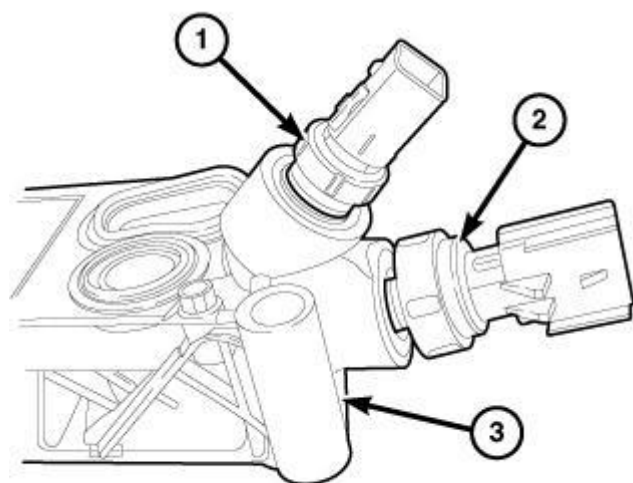


2710718

**Fig. 474: Oil Cooler Seals & Oil Filter Housing**

Courtesy of CHRYSLER GROUP, LLC

11. Remove and discard the oil cooler seals (1).



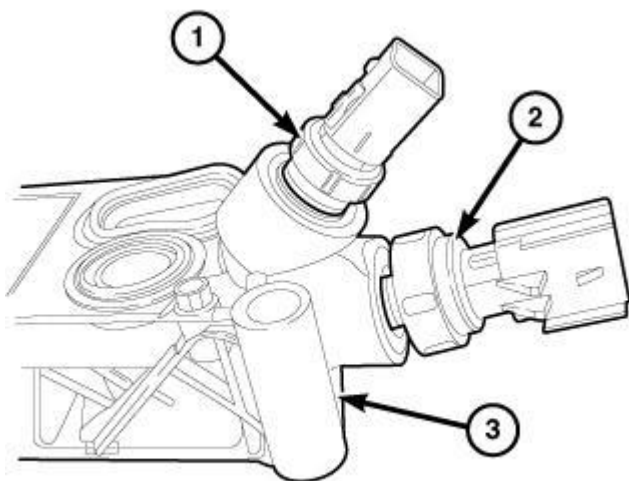
2710795

**Fig. 475: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

12. If required, remove the oil temperature sensor (1) from the oil filter housing (3).
13. If required, remove the oil pressure sensor (2) from the oil filter housing (3).

#### INSTALLATION

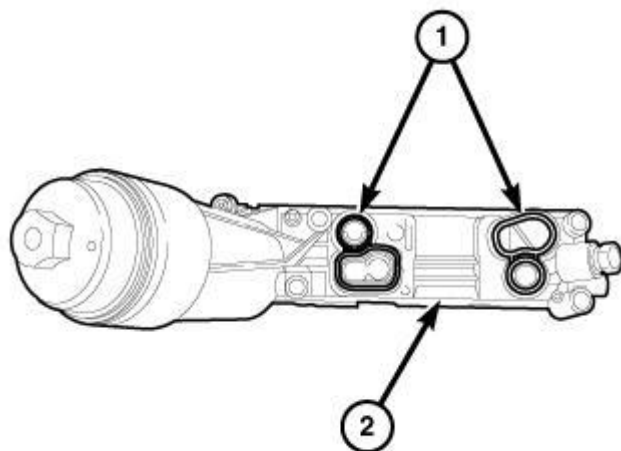
#### INSTALLATION



2710795

**Fig. 476: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

1. If removed, install the oil pressure sensor (2) and tighten to 20 N.m (177 in. lbs.).
2. If removed, install the oil temperature sensor (1) and tighten to 20 N.m (177 in. lbs.).

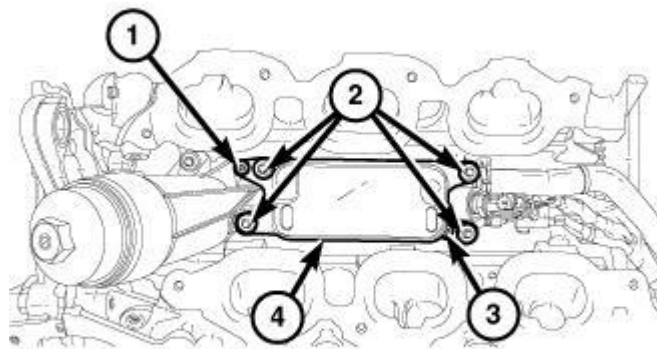


2710718

**Fig. 477: Oil Cooler Seals & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Always use new dry seals (1) when installing the oil cooler. Do not lubricate the seals.

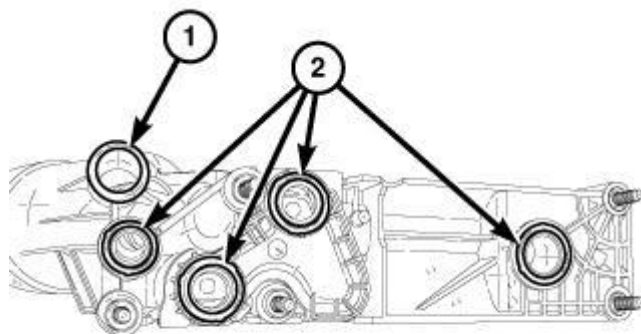
3. If removed, install the new oil cooler seals (1) onto the oil filter housing (2).



2707169

**Fig. 478: Oil Cooler & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

4. If removed, position the oil cooler (4) on the oil filter housing and install two screws (1) and (3). Tighten the screws to 4 N.m (35 in. lbs.).

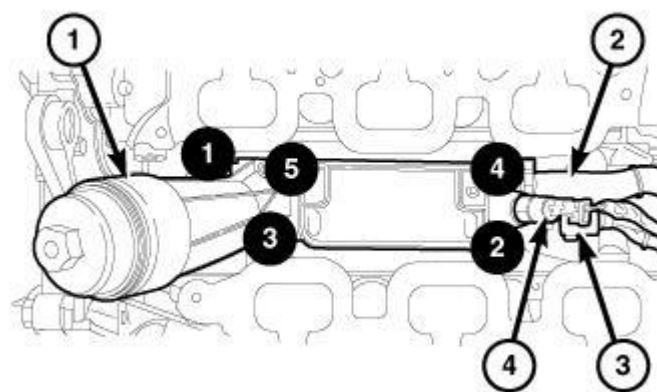


2707844

**Fig. 479: Oil Filter Housing Seals & O-Ring Seal**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Always use new dry seals (2) when installing the oil filter housing. Do not lubricate the seals. The O-ring seal (1) can be reused. Lubricate the O-ring seal with clean engine oil prior to installation.

5. Install new oil filter housing seals (2) onto the oil filter housing.



2710852

**Fig. 480: Heater Hose, Electrical Connectors, Oil Filter Housing & Bolt Tightening Sequence**  
 Courtesy of CHRYSLER GROUP, LLC

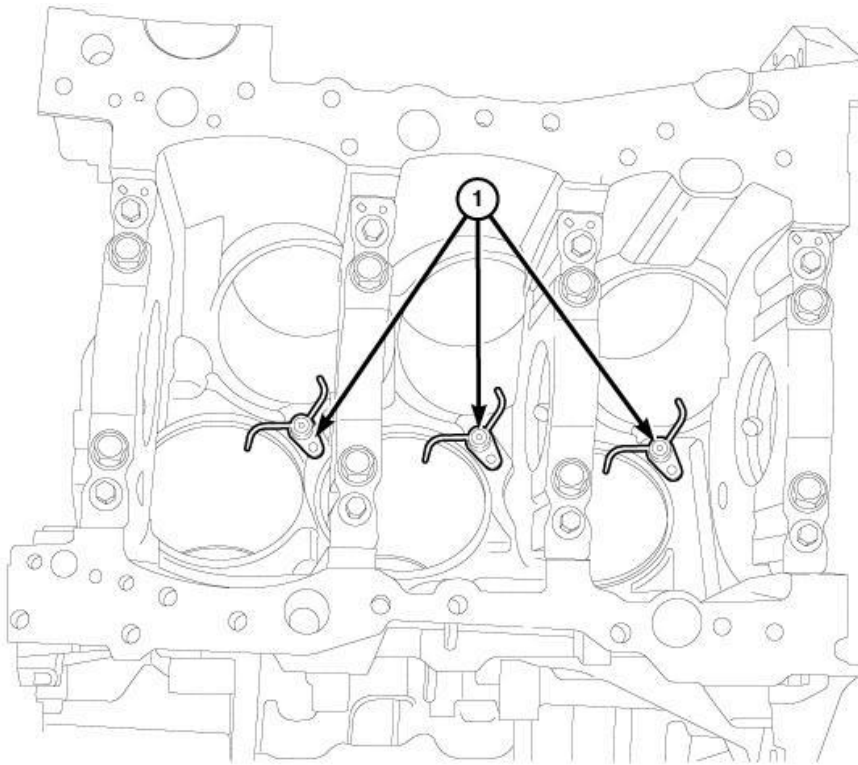
6. Install the heater hose (2) to the oil filter housing (1).
7. Position the oil filter housing (1) on the engine block.
8. Install five bolts and tighten in the sequence shown in illustration to 12 N.m (106 in. lbs.).

9. Connect the oil pressure sensor electrical connector (3).
10. Connect the oil temperature sensor electrical connector (4).
11. Install the upper and lower intake manifolds and air cleaner housing assembly. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
12. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
13. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
14. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
15. Operate the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE**.

## JET, PISTON OIL COOLER

### DESCRIPTION

### DESCRIPTION



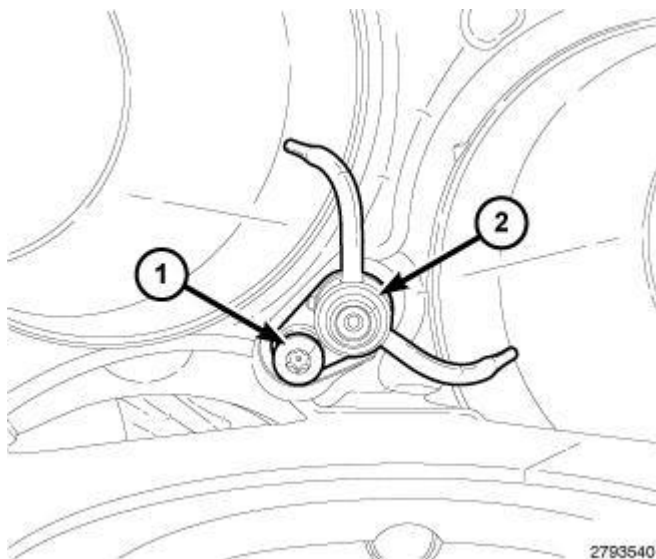
2867027

**Fig. 481: Engine Blocked-Mounted Oil Jets**  
Courtesy of CHRYSLER GROUP, LLC

The 3.6 liter engine has three engine blocked-mounted oil jets (1) installed to cool the underside of each piston. The oil jets are fed by the main oil gallery, and spray upward on the bottom of the pistons and cylinder walls. Each set of jets has a check valve which closes below 2.5 bar (35 psi) to maintain ample oil pressure at idle. All three sets of oil jets are identical and seal to the engine block using an o-ring and fastener.

## REMOVAL

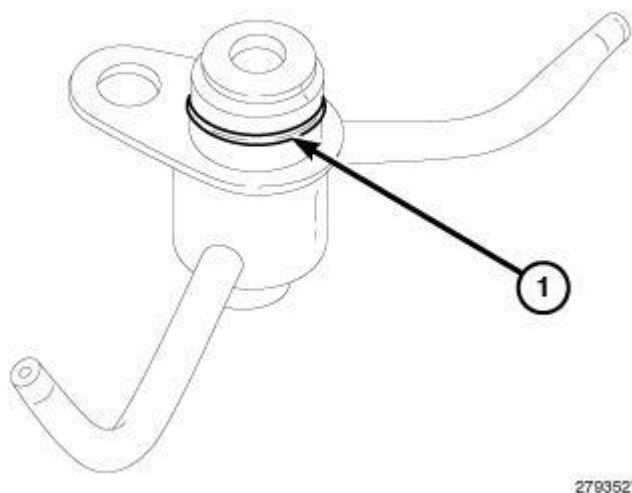
## REMOVAL



**Fig. 482: Piston Oil Cooler Jet & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Piston oil cooler jet for cylinders one/two shown in illustration. Piston oil cooler jets for cylinders three/four and five/six are similar.

1. Remove the crankshaft. Refer to **CRANKSHAFT, REMOVAL**.
2. Remove the bolt (1) and the piston oil cooler jet(s) (2) from the engine block.

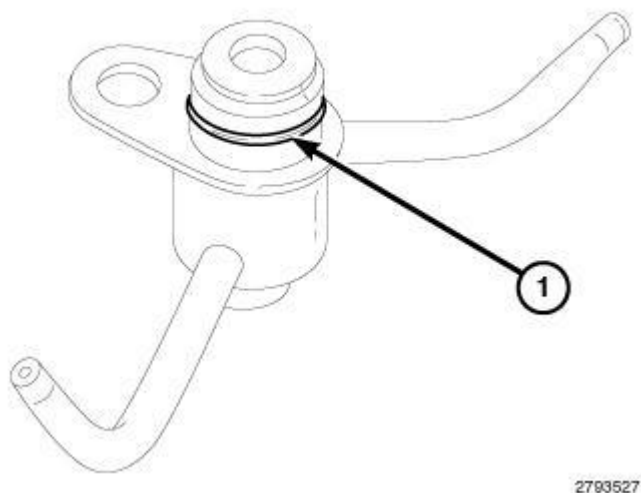


**Fig. 483: Piston Oil Cooler Jet O-Ring Seal**  
Courtesy of CHRYSLER GROUP, LLC

3. Remove and discard the O-ring seal (1) from the piston oil cooler jet(s).

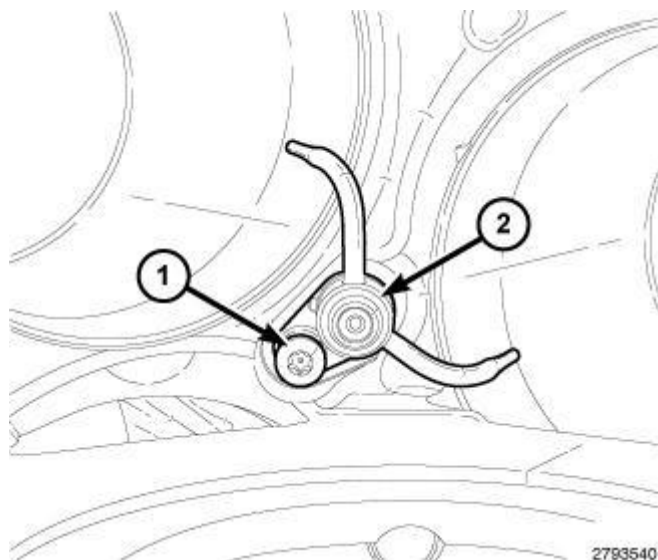
## INSTALLATION

### INSTALLATION



**Fig. 484: Piston Oil Cooler Jet O-Ring Seal**  
Courtesy of CHRYSLER GROUP, LLC

1. Lubricate a new O-ring seal (1) with engine oil and install on the piston oil cooler jet(s).



**Fig. 485: Piston Oil Cooler Jet & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Piston oil cooler jet for cylinders one/two shown in illustration. Piston oil cooler jets for cylinders three/four and five/six are similar.



2. Install the piston oil cooler jet(s) (2) into the engine block and tighten the retaining bolt (1) to 6 N.m (53 in. lbs.).
3. Install the crankshaft. Refer to **CRANKSHAFT, INSTALLATION**.
4. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
5. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
6. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
7. Run the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE**.

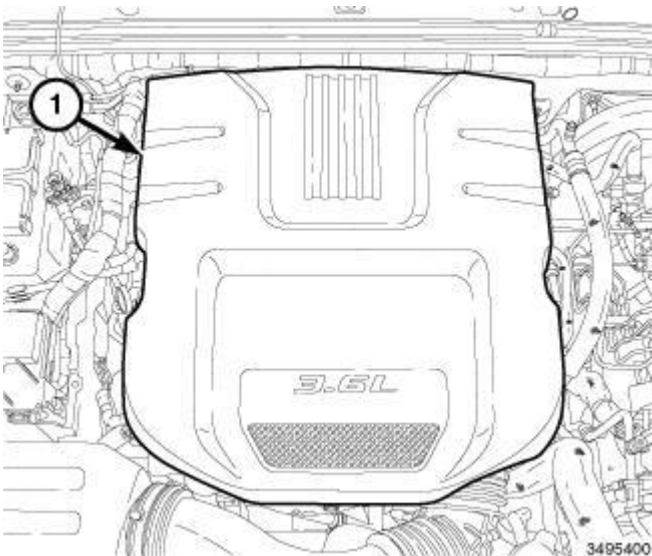
## OIL

### STANDARD PROCEDURE

#### 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.

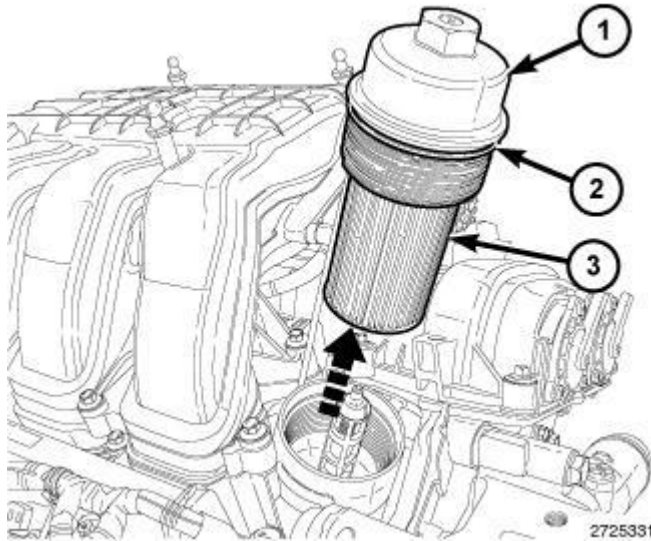
Change the engine oil and filter at mileage and time intervals described in the Maintenance Schedule. Refer to **MAINTENANCE SCHEDULES, DESCRIPTION**.



**Fig. 486: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

1. Run the engine until achieving normal operating temperature.
2. Position the vehicle on a level surface and turn the engine off.
3. Remove the engine cover (1).



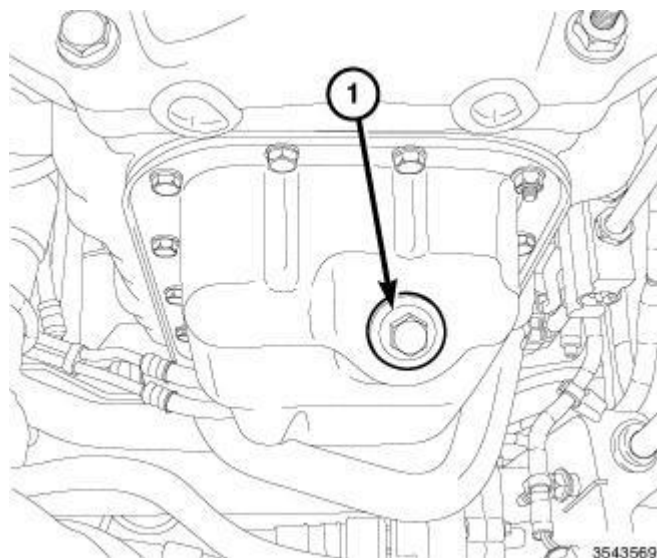
**Fig. 487: Oil Filter Cap, O-Ring Seal & Oil Filter**  
 Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** When performing an engine oil change, the oil filter cap must be removed. Removing the oil filter cap releases oil held within the oil filter cavity and allows it to drain into the sump. Failure to remove the cap prior to reinstallation of the drain plug will not allow complete draining of the used engine oil.

4. Place an oil absorbent cloth around the oil filter housing at the base of the oil filter cap.

**NOTE:** The oil filter (3) is attached to the oil filter cap (2).

5. Rotate the oil filter cap (1) counterclockwise and remove the cap (1) and filter (3) from the oil filter housing.



**Fig. 488: Oil Pan Drain Plug**

Courtesy of CHRYSLER GROUP, LLC

6. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
7. Place a suitable drain pan under the crankcase drain plug (1).
8. Remove the drain plug (1) from oil pan and allow the oil to drain into the pan. Inspect the drain plug threads for stretching or other damage. Replace the drain plug and gasket if damaged.
9. Install the drain plug (1) in the oil pan and tighten to 27 N.m (20 ft. lbs.).



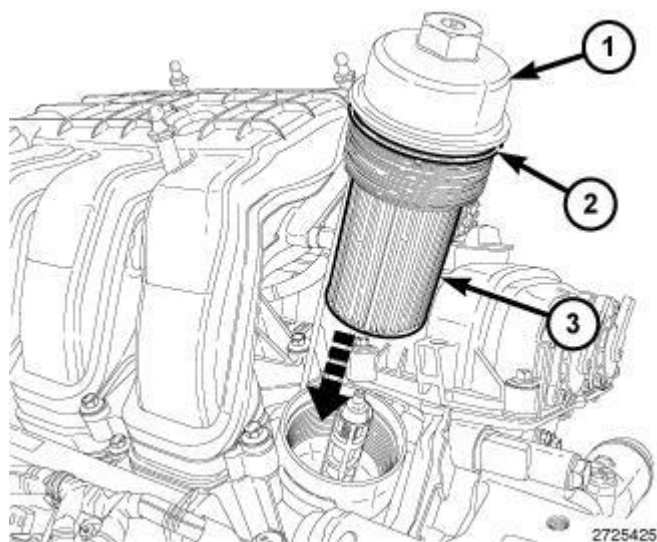
**Fig. 489: O-Ring Seal, Oil Filter Cap & Oil Filter**

Courtesy of CHRYSLER GROUP, LLC

10. Lower the vehicle.
11. Remove the oil filter (3) from the oil filter cap (2).
12. Remove and discard the O-ring seal (1).

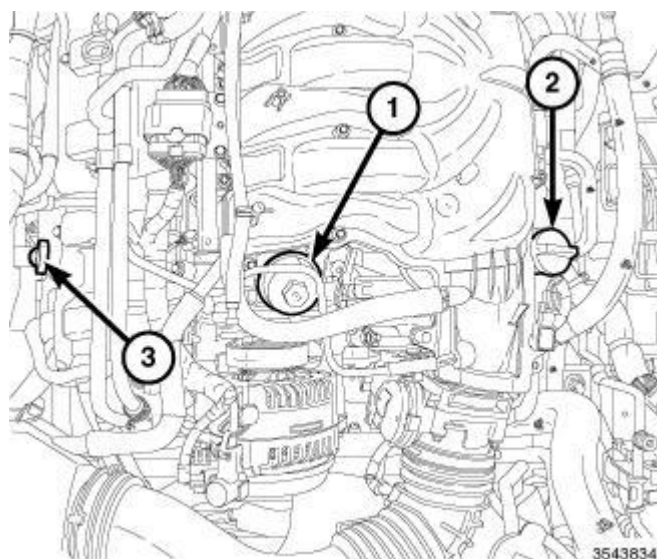
**NOTE:** It is not necessary to pre-oil the oil filter or fill the oil filter housing.

13. Lightly lubricate the new O-ring seal (1) with clean engine oil.
14. Install the O-ring seal (1) on the filter cap (2).
15. Install the new oil filter (3) into the oil filter cap (2).



**Fig. 490: Oil Filter Cap, O-Ring Seal & Oil Filter**  
Courtesy of CHRYSLER GROUP, LLC

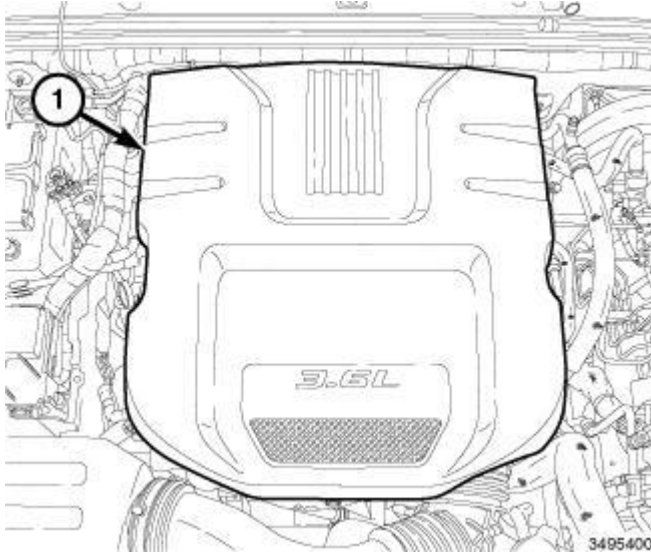
16. Thread the oil filter cap (1) into the oil filter housing and tighten to 25 N.m (18 ft. lbs.).



**Fig. 491: Oil Filter Cap, Oil Fill Cap & Oil Level Dipstick**  
Courtesy of CHRYSLER GROUP, LLC

17. Remove the oil fill cap (2). Fill the crankcase with the specified type and amount of engine oil. Refer to **CAPACITIES AND RECOMMENDED FLUIDS, SPECIFICATIONS**.

18. Install the oil fill cap (2).
19. Start the engine and inspect for leaks.
20. Stop the engine and check the oil level (3).



**Fig. 492: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

21. Install the engine cover (1).

#### **OIL FILTER SPECIFICATION**

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

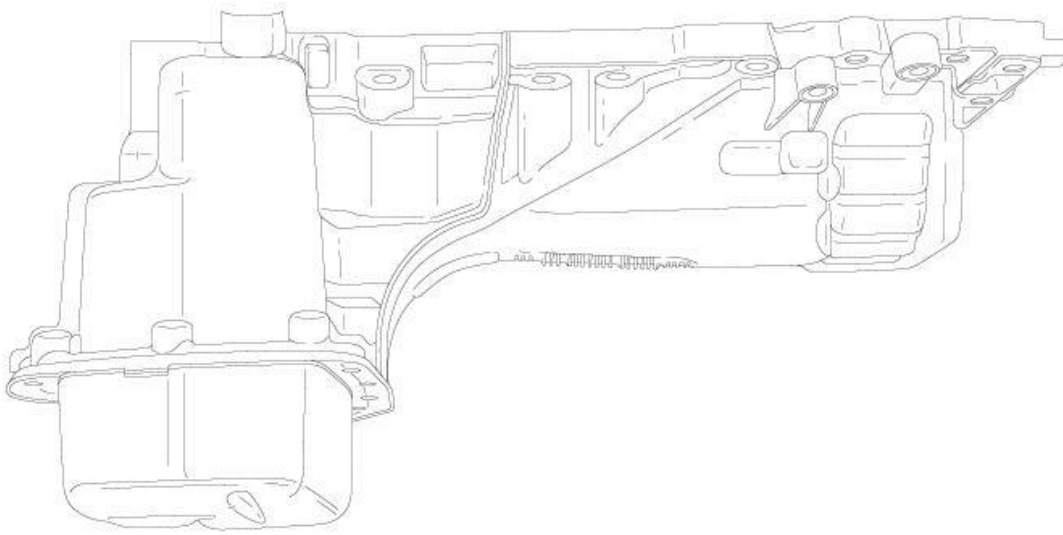
#### **USED ENGINE OIL DISPOSAL**

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

#### **PAN, OIL**

##### **DESCRIPTION**

##### **DESCRIPTION**



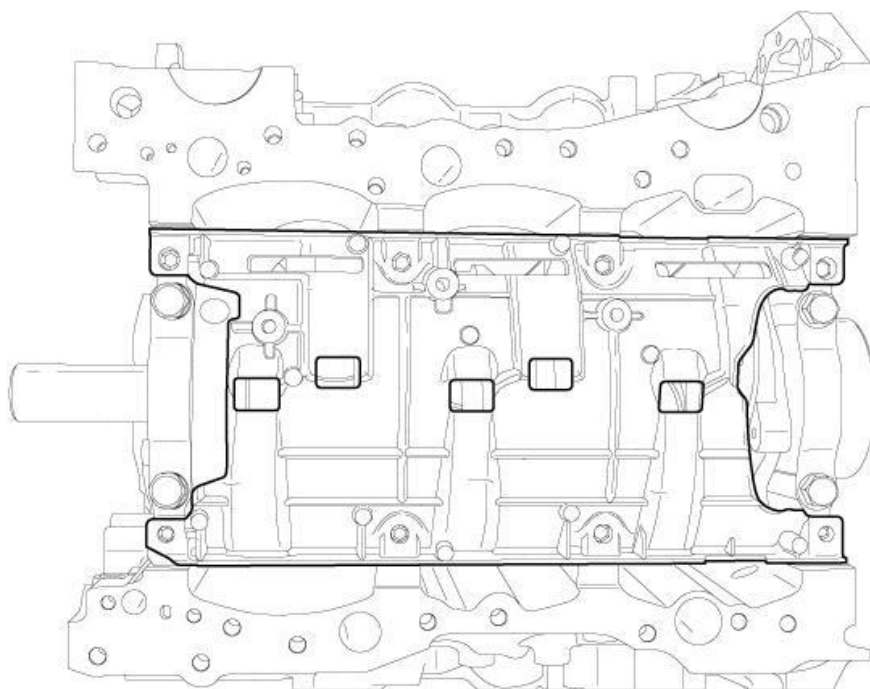
2830282

**Fig. 493: Upper & Lower Oil Pan**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:**      **Typical 3.6L engine upper and lower oil pans shown in illustration.**

There is an upper and lower oil pan. The upper oil pan is cast aluminum and also serves as the engine lower end structural support. The lower pan is a stamped steel design. Both upper and lower oil pans are sealed using Mopar® Threebond Engine RTV Sealant.



2830423

**Fig. 494: Windage Tray**

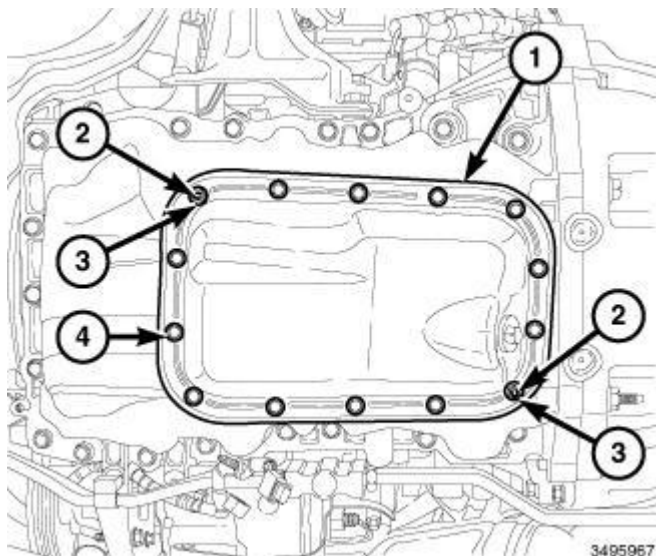
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not attempt to support the weight of the engine on the windage tray. The windage tray is a thin cast aluminum construction and can be easily damaged.

The high pressure die cast aluminum windage tray is mounted to the main bearing caps and is designed to keep oil off of the connecting rods as the crankshaft rotates. When the oil is kept off the connecting rods, the engine rotates easier and oil foaming decreases. Like the oil pan, the windage tray is designed to stiffen the lower end of the engine. The tray is directional and the main bearing cap bolts hold it in place.

## REMOVAL

### LOWER



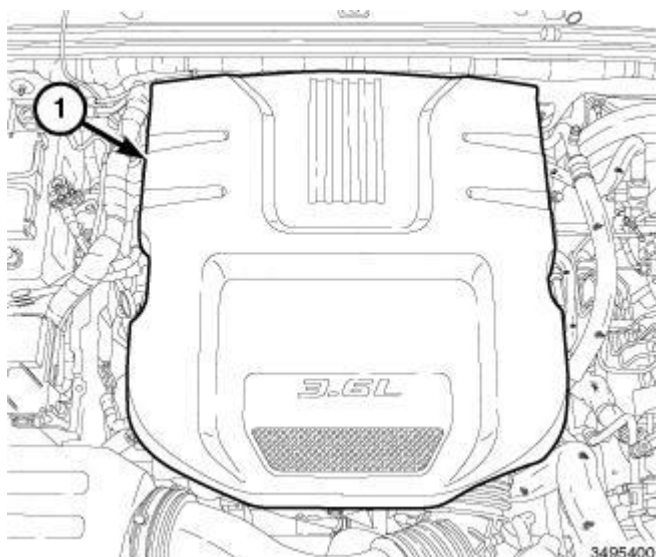
**Fig. 495: Lower Oil Pan & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

1. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
2. Drain the engine oil. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
3. Remove twelve bolts (4), two nuts (3) and two studs (2) from the flange of the lower oil pan (1).

**CAUTION: Do not pry on the lower oil pan flange. There are no designated pry points for lower oil pan removal. Prying on only one or a few locations could bend the flange and damage the pan.**

4. Apply a side force to the lower oil pan (1) in order to shear the sealant bond and remove the pan.
5. Remove all residual sealant from the upper and lower oil pans. Refer to **PAN, OIL, CLEANING**.

#### UPPER

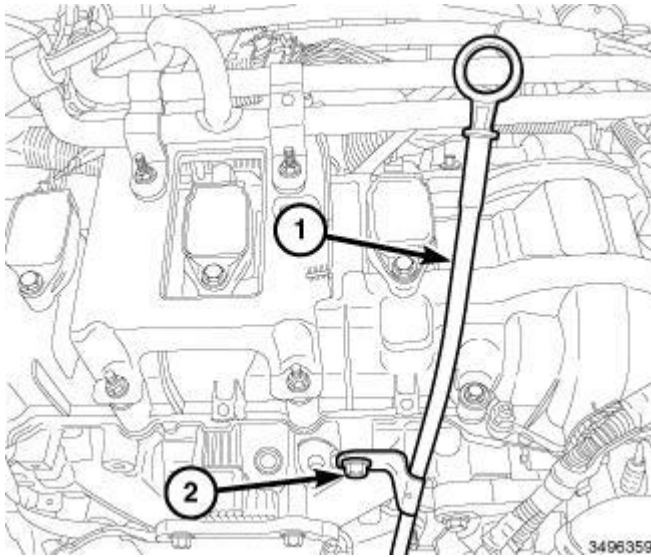




**Fig. 496: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

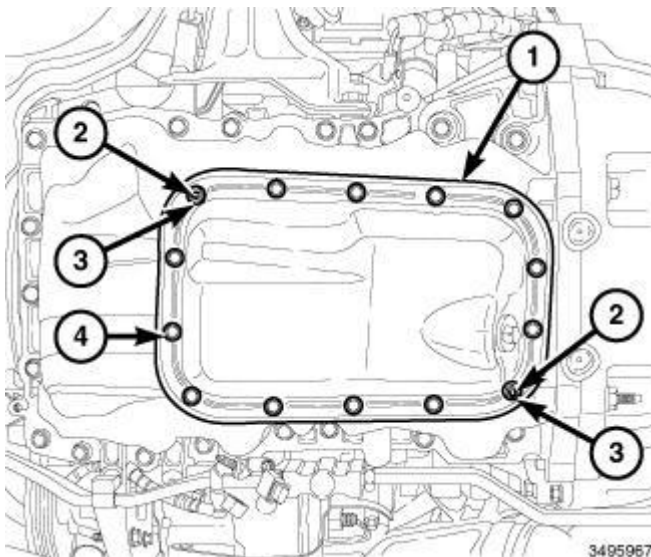
1. Remove the engine cover (1).



**Fig. 497: Oil Level Indicator & Bolt**

Courtesy of CHRYSLER GROUP, LLC

2. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
3. Remove the right front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, REMOVAL** .
4. Remove the bolt (2) and remove the oil level indicator (1).



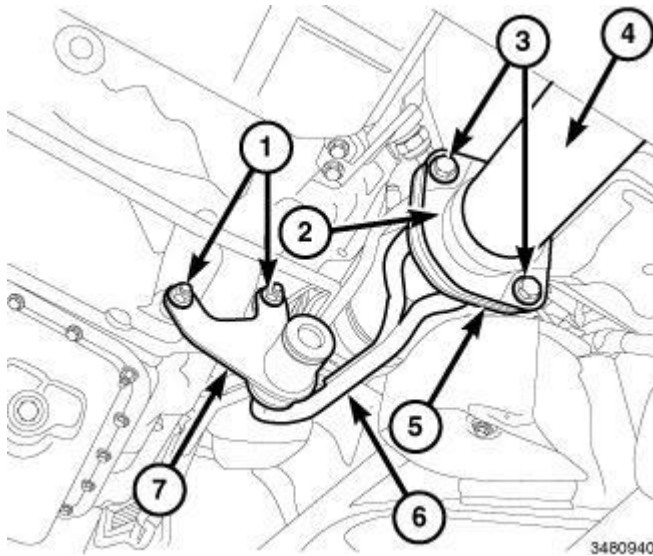
**Fig. 498: Lower Oil Pan & Fasteners**

Courtesy of CHRYSLER GROUP, LLC

5. Drain the engine oil. Refer to Engine/Lubrication/OIL - Standard Procedure.

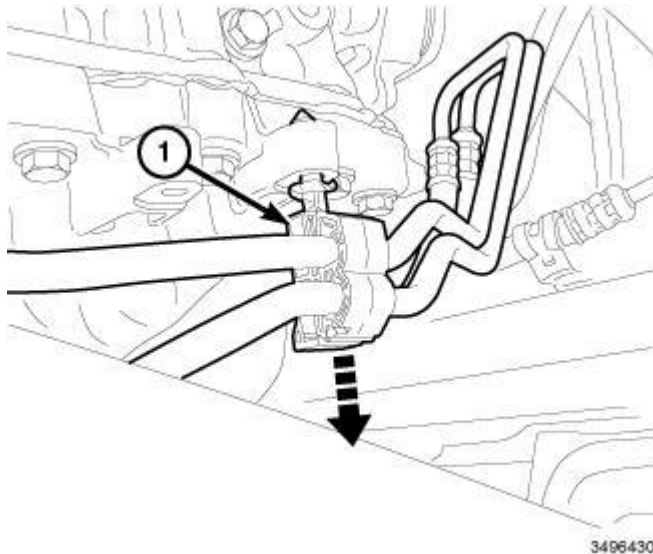
**NOTE:** The lower oil pan (1) does not need to be removed when removing the upper oil pan.

6. If required, remove the lower oil pan (1). Refer to PAN, OIL, REMOVAL.



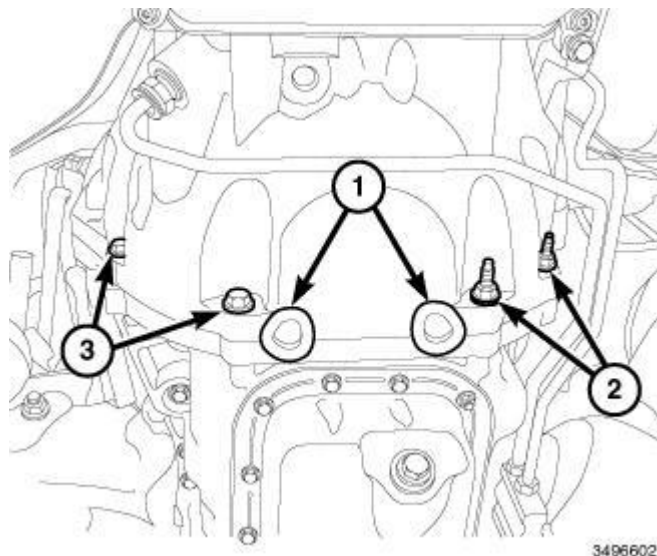
**Fig. 499: Exhaust Hanger Bracket Assembly & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

7. Remove the two nuts (1) and the exhaust hanger bracket (7).



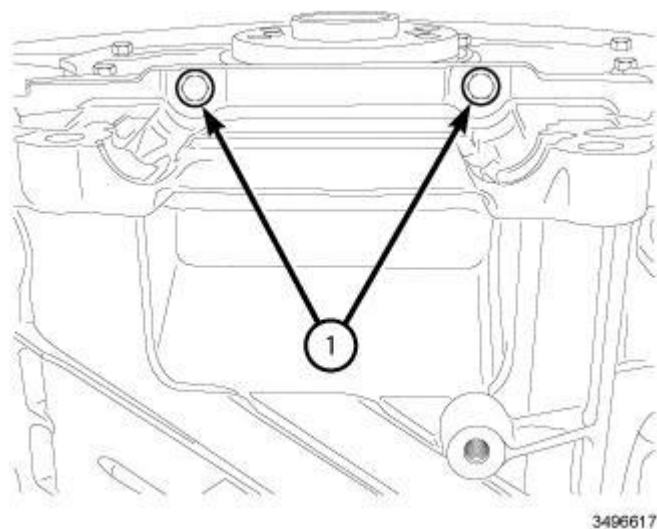
**Fig. 500: Disengaging Transmission Cooler Line Retainer**  
Courtesy of CHRYSLER GROUP, LLC

8. Disengage the transmission cooler line retainer (1) from the oil pan flange.



**Fig. 501: Rubber Plugs & Transmission To Engine Oil Pan Bolts**  
Courtesy of CHRYSLER GROUP, LLC

9. Remove four transmission to the engine oil pan bolts (2 and 3).
10. Remove two rubber plugs (1) covering the rear oil seal retainer flange bolts.

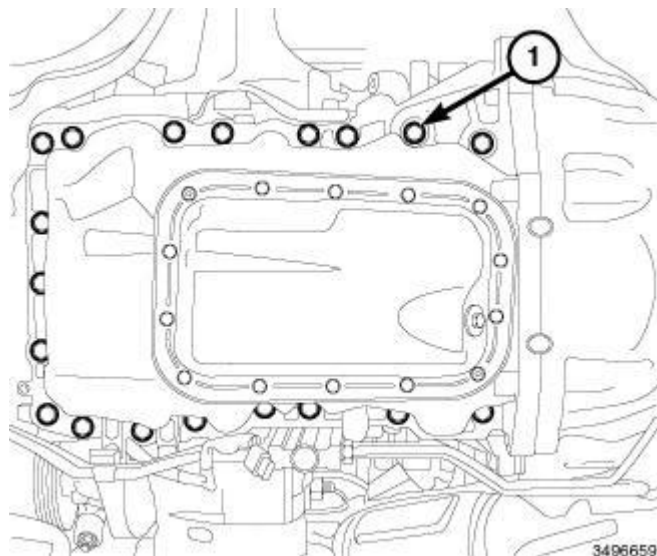


**Fig. 502: Rear Oil Seal Retainer Flange Bolts**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Shown in illustration with transmission removed for clarity.

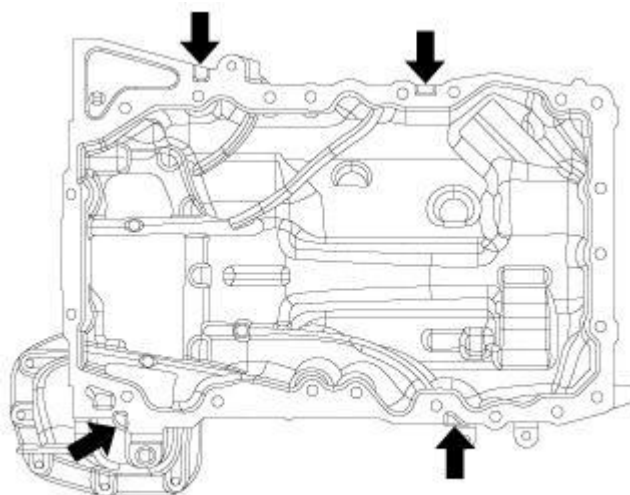
**CAUTION:** There are two hidden M6 bolts that must be removed from the rear of the upper oil pan flange. If these bolts are not removed, the rear oil seal retainer flange will be severely damaged.

11. Remove two M6 bolts (1) from the rear oil seal retainer flange.



**Fig. 503: Oil Pan Mounting Bolts**  
Courtesy of CHRYSLER GROUP, LLC

12. Remove nineteen M8 oil pan mounting bolts (1).



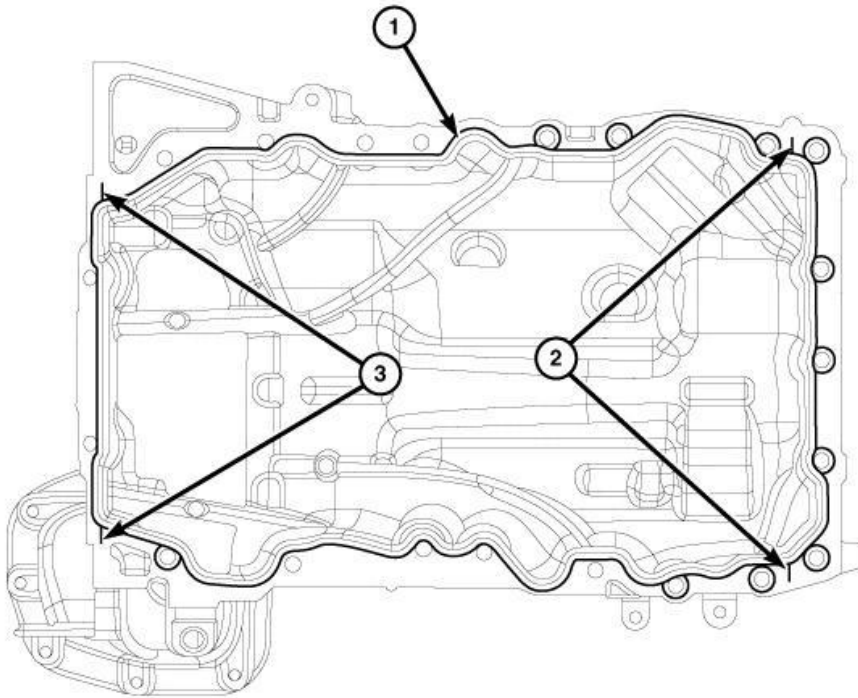
**Fig. 504: Pry Points**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** WK oil pan shown in illustration, JK oil pan similar.

13. Using the four indicated pry points, carefully remove the upper oil pan.
14. Remove all residual sealant from the upper and lower oil pans, timing chain cover, rear seal retainer and engine block mating surfaces. Refer to **PAN, OIL, CLEANING**.

#### CLEANING

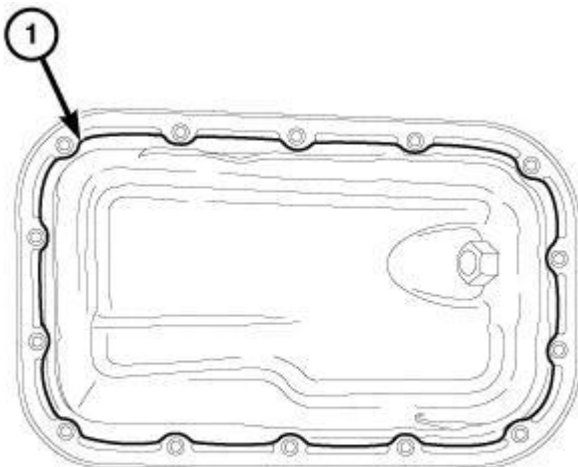
## CLEANING



2774053

**Fig. 505: Mopar® Threebond Engine RTV Sealant Locations**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** WK upper oil pan shown in illustration, JK upper oil pan similar.



3496059

**Fig. 506: Oil Pan RTV Sealant**  
Courtesy of CHRYSLER GROUP, LLC

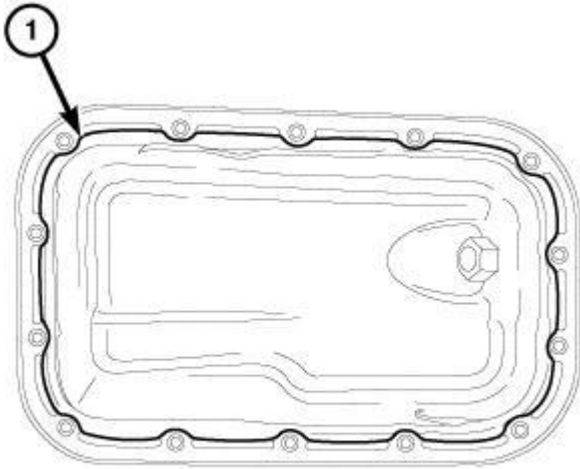
1. Clean the oil pan in solvent and wipe dry with a clean cloth.

**CAUTION:** Do not use oil based liquids, wire brushes, abrasive wheels or metal scrapers to clean the engine gasket surfaces. Use only isopropyl (rubbing) alcohol, along with plastic or wooden scrapers. Improper gasket surface preparation may result in engine fluid leakage.

2. Remove all residual sealant (1) from the upper and lower oil pans. Refer to Engine - Standard Procedure.

## INSTALLATION

### LOWER



3496059

**Fig. 507: Oil Pan RTV Sealant**  
Courtesy of CHRYSLER GROUP, LLC

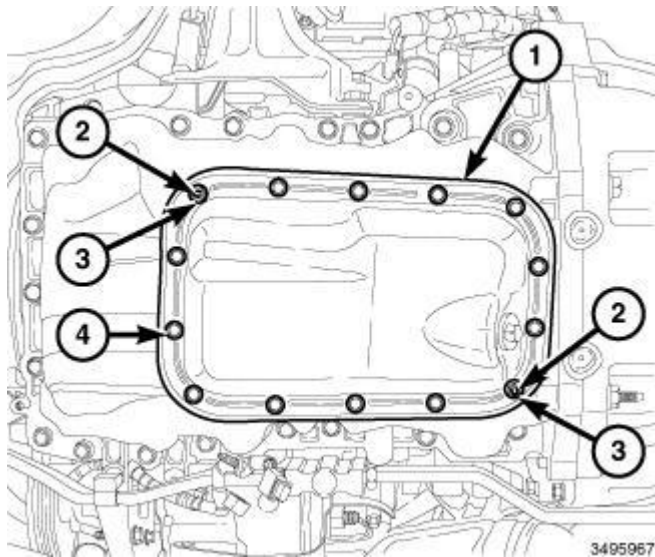
1. Clean the upper and lower oil pan mating surfaces with isopropyl alcohol in preparation for sealant application.

**CAUTION:** Engine assembly requires the use of a unique sealant that is compatible with engine oil. Using a sealant other than Mopar® Threebond Engine RTV Sealant may result in engine fluid leakage.

**CAUTION:** Following the application of Mopar® Threebond Engine RTV Sealant to the gasket surfaces, the components must be assembled within 20 minutes and the attaching fasteners must be tightened to specification within 45 minutes. Prolonged exposure to the air prior to assembly may result in engine fluid leakage.

2. Apply a 2 to 3 mm wide bead of Mopar® Threebond Engine RTV Sealant (1) to the lower oil pan as

shown in illustration.



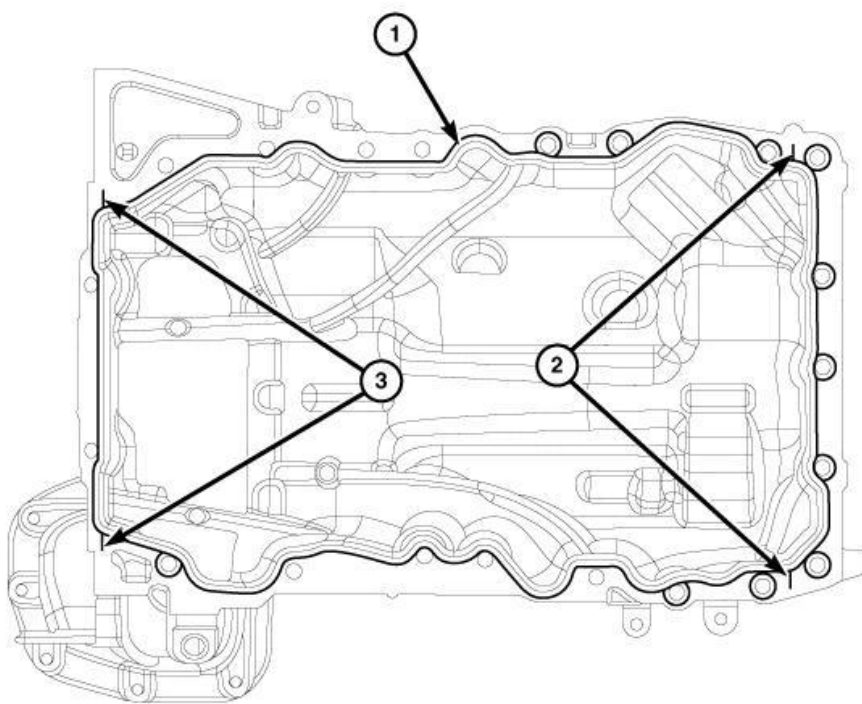
**Fig. 508: Lower Oil Pan & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

3. Install two studs (2) into the upper oil pan flange.
4. Install the lower oil pan (1) to the upper oil pan with twelve bolts (4) and two nuts (3) tightened to 11 N.m (97 in. lbs.).

**CAUTION:** Following assembly, the Mopar® Threebond Engine RTV Sealant must be allowed to dry for 45 minutes prior to adding oil and engine operation. Premature exposure to oil prior to drying may result in engine fluid leakage.

5. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
6. Start and run the engine until it reaches normal operating temperature.

#### UPPER



2774053

**Fig. 509: Mopar® Threebond Engine RTV Sealant Locations**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** WK oil pan shown in illustration, JK oil pan similar.

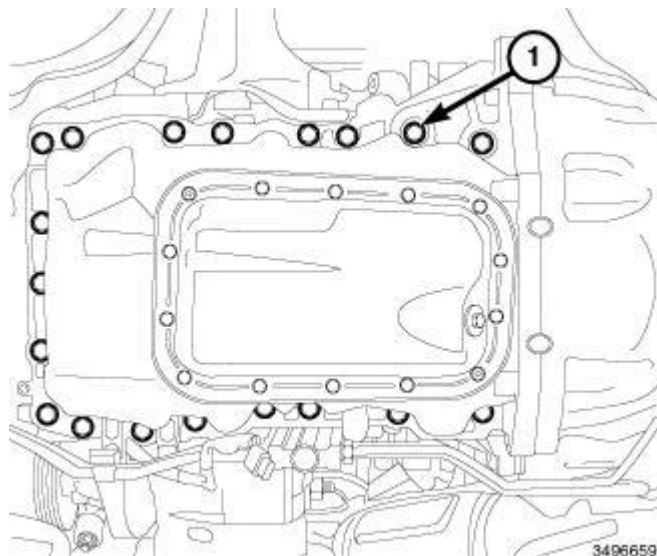
1. Clean the upper and lower oil pans, timing chain cover, rear seal retainer and engine block mating surfaces with isopropyl alcohol in preparation for sealant application.

**CAUTION:** Engine assembly requires the use of a unique sealant that is compatible with engine oil. Using a sealant other than Mopar® Threebond Engine RTV Sealant may result in engine fluid leakage.

**CAUTION:** Following the application of Mopar® Threebond Engine RTV Sealant to the gasket surfaces, the components must be assembled within 20 minutes and the attaching fasteners must be tightened to specification within 45 minutes. Prolonged exposure to the air prior to assembly may result in engine fluid leakage.

2. Apply a 2 to 3 mm wide bead of Mopar® Threebond Engine RTV Sealant to the upper oil pan as shown in illustration in the following locations:
  - Oil pan to engine block flange (1)
  - Two timing cover to engine block T-joints (2)
  - Two rear seal retainer to engine block T-joints (3)

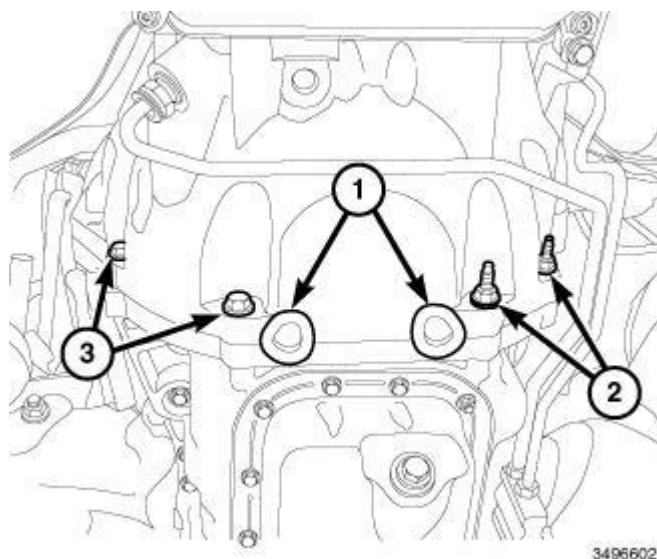




**Fig. 510: Oil Pan Mounting Bolts**  
Courtesy of CHRYSLER GROUP, LLC

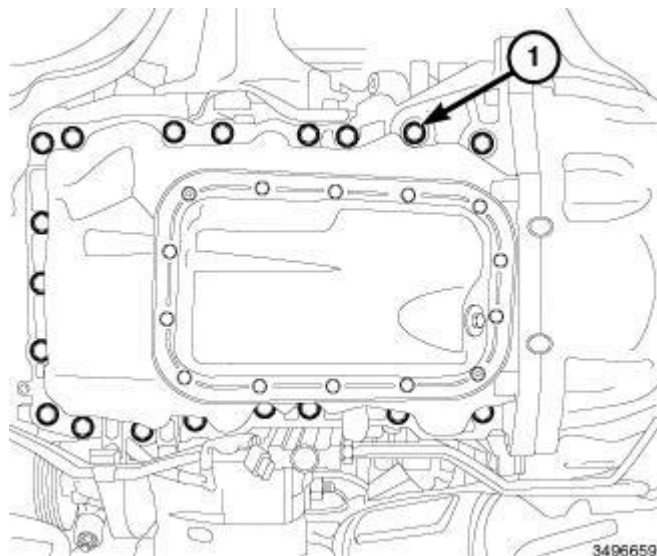
**CAUTION:** Make sure that the rear face of the oil pan is flush to the transmission bell housing before tightening any of the oil pan mounting bolts. A gap between the oil pan and the transmission could crack the oil pan or transmission casting.

3. Install the oil pan to the engine block and flush to the transmission bell housing. Secure the oil pan to the engine block with nineteen M8 oil pan mounting bolts (1) finger tight.



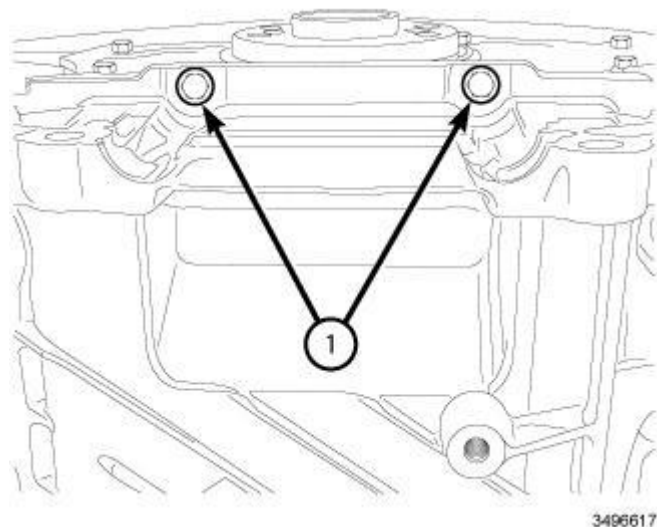
**Fig. 511: Rubber Plugs & Transmission To Engine Oil Pan Bolts**  
Courtesy of CHRYSLER GROUP, LLC

4. Install four transmission to the engine oil pan bolts (2 and 3) and tighten to 55 N.m (41 ft. lbs.).



**Fig. 512: Oil Pan Mounting Bolts**  
Courtesy of CHRYSLER GROUP, LLC

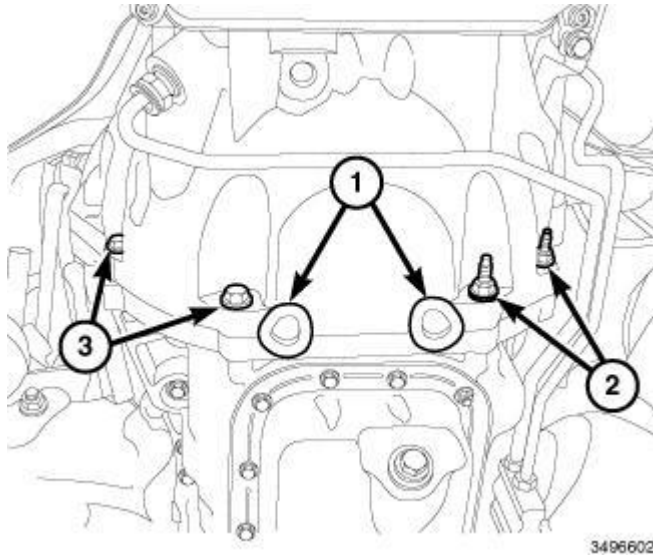
5. Tighten the nineteen previously installed M8 oil pan mounting bolts (1) to 25 N.m (18 ft. lbs.).



**Fig. 513: Rear Oil Seal Retainer Flange Bolts**  
Courtesy of CHRYSLER GROUP, LLC

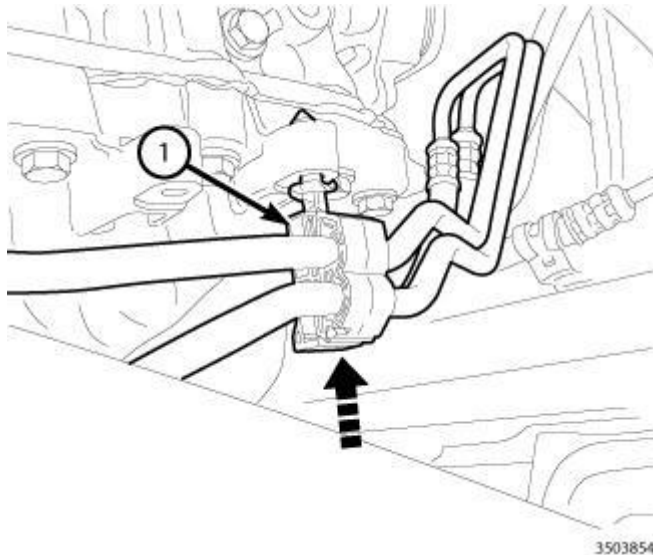
**NOTE:** Shown in illustration with transmission removed for clarity.

6. Install two M6 bolts (1) to the rear oil seal retainer flange and tighten to 12 N.m (106 in. lbs.).



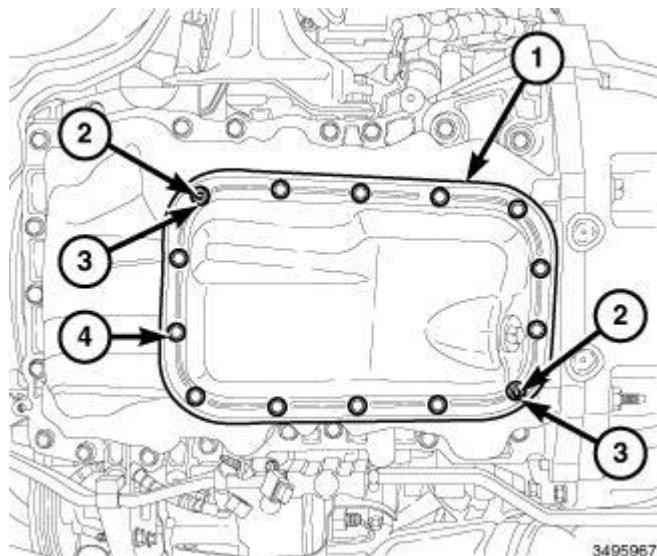
**Fig. 514: Rubber Plugs & Transmission To Engine Oil Pan Bolts**  
Courtesy of CHRYSLER GROUP, LLC

7. Install two rubber plugs (1) covering the rear oil seal retainer flange bolts.



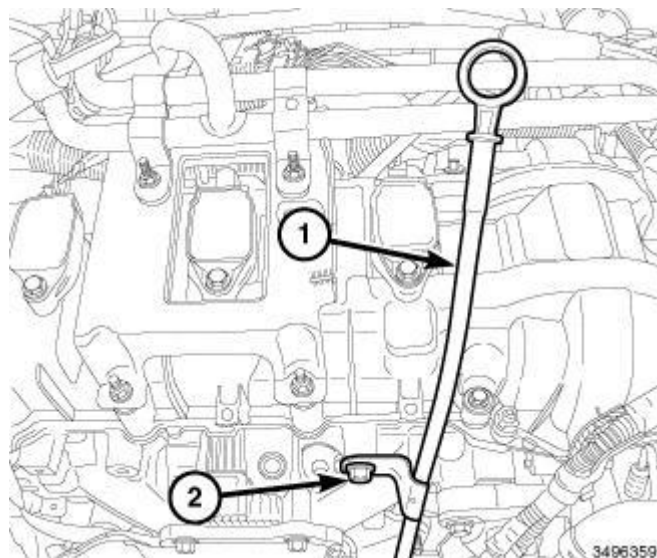
**Fig. 515: Engaging Transmission Cooler Line Retainer**  
Courtesy of CHRYSLER GROUP, LLC

8. Engage the transmission cooler line retainer (1) to the oil pan flange.



**Fig. 516: Lower Oil Pan & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

9. If removed, install the lower oil pan. Refer to **PAN, OIL, INSTALLATION**.



**Fig. 517: Oil Level Indicator & Bolt**  
Courtesy of CHRYSLER GROUP, LLC

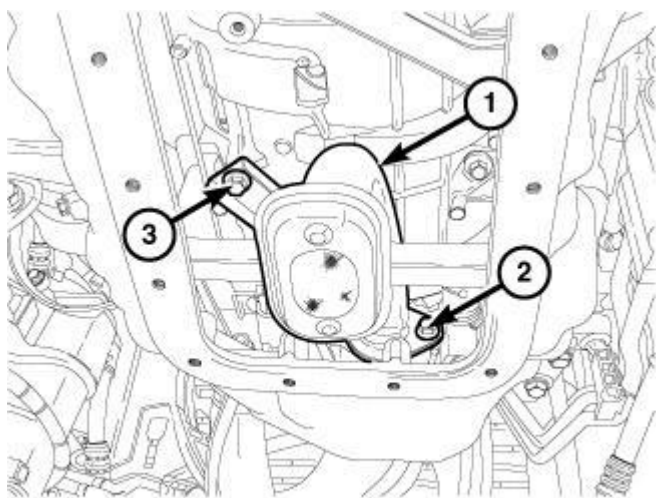
10. Install the oil level indicator (1) with bolt (2) tightened to 12 N.m (106 in. lbs.).
11. Install the right front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, INSTALLATION**.
12. Lower the vehicle.
13. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
14. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

15. Start and run the engine until it reaches normal operating temperature.

## PICK-UP, OIL PUMP

### REMOVAL

### REMOVAL

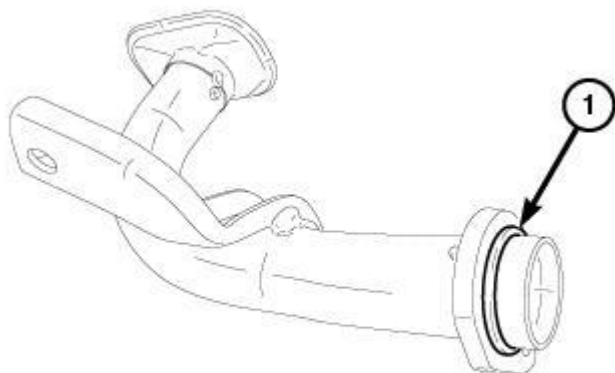


3495920

**Fig. 518: Oil Pick-Up Tube & Bolts**

Courtesy of CHRYSLER GROUP, LLC

1. Disconnect and isolate the negative battery cable.
2. Remove the lower oil pan. Refer to **PAN, OIL, REMOVAL**.
3. Remove the bolt (3) from the oil pump pick-up tube support bracket.
4. Remove the bolt (2) from the oil pick-up tube and remove the oil pick-up tube (1) from the oil pump.



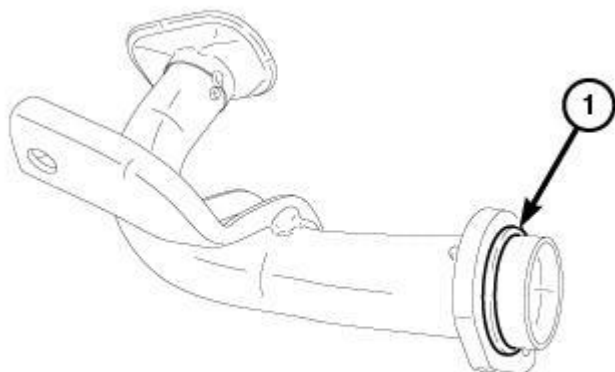
3495932

**Fig. 519: Oil Pick-Up Tube O-Ring Seal**  
Courtesy of CHRYSLER GROUP, LLC

5. Remove and discard the O-ring seal (1) from the oil pick-up tube.

## INSTALLATION

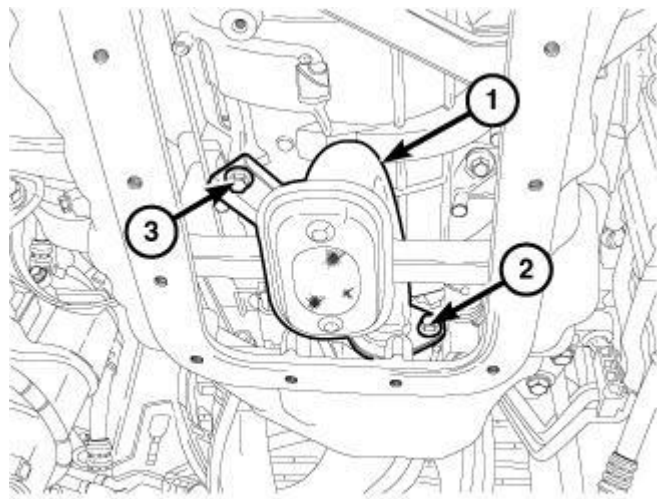
## INSTALLATION



3495932

**Fig. 520: Oil Pick-Up Tube O-Ring Seal**  
Courtesy of CHRYSLER GROUP, LLC

1. Lightly lubricate the new O-ring seal (1) with engine oil and install on the oil pick-up tube.



3495920

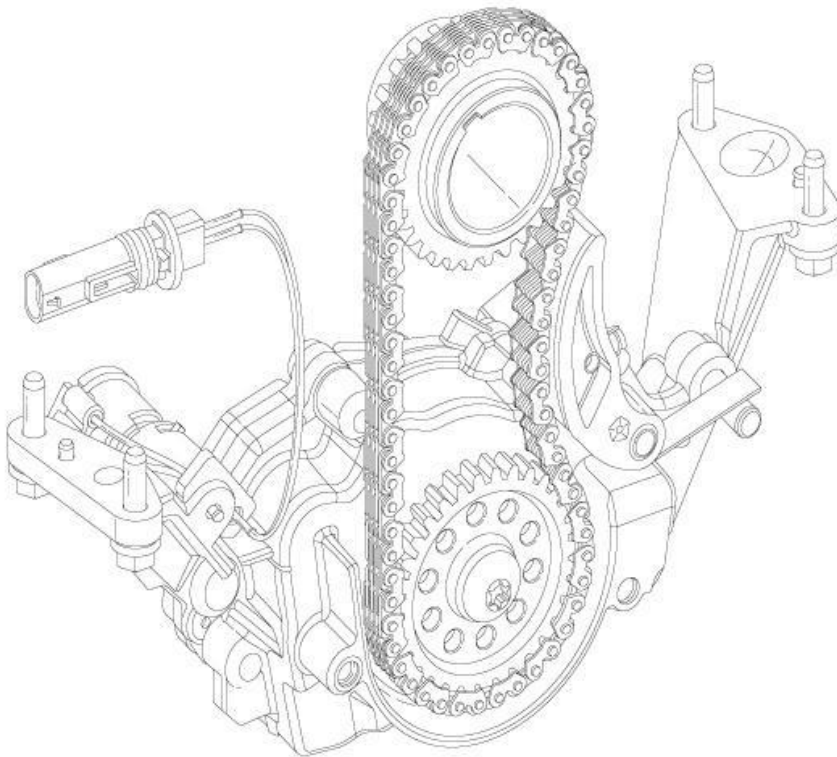
**Fig. 521: Oil Pick-Up Tube & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

2. Install the oil pick-up tube (1) with two bolts (2 and 3). Tighten the bolts to 12 N.m (106 in. lbs.).
3. Install the lower oil pan. Refer to **PAN, OIL, INSTALLATION**.
4. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
5. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
6. Start and run the engine until it reaches normal operating temperature.

## PUMP, ENGINE OIL

### DESCRIPTION

### DESCRIPTION



**Fig. 522: Oil Pump Chain**

Courtesy of CHRYSLER GROUP, LLC

The vane type engine oil pump is mounted to the underside of the cylinder block and is driven by the oil pump chain off the crankshaft at a 1:1 drive ratio. This pump location improves efficiency compared to an on-crankshaft location. The pump is driven with a silent chain which is tensioned using a spring loaded tensioner. The pump is not timed to the engine.

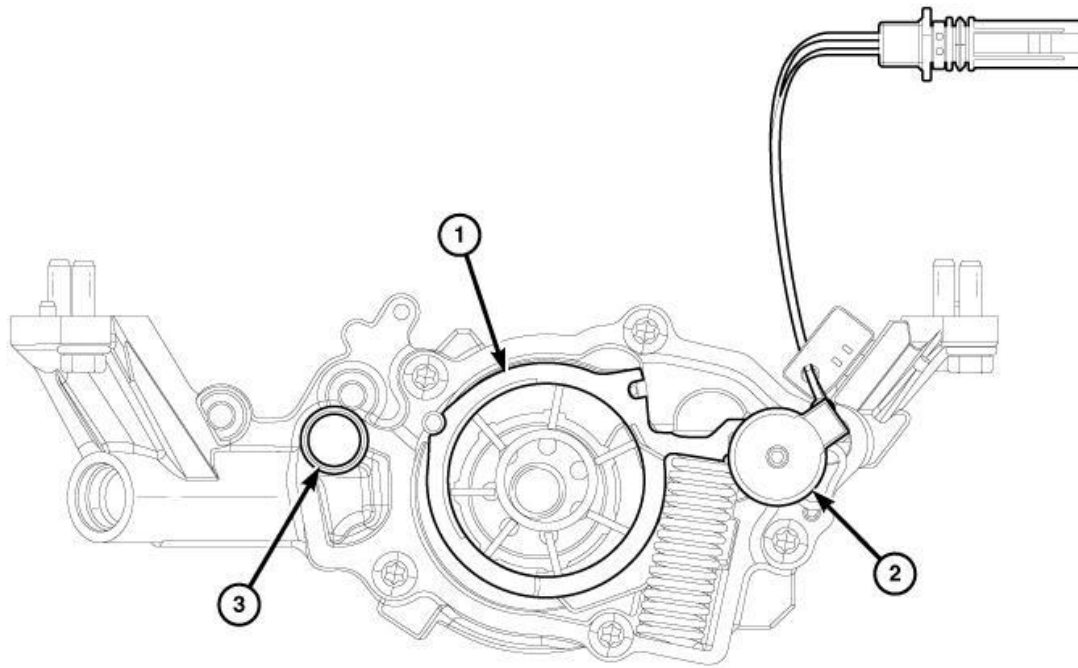
An internal mechanical ball and spring type relief valve prevents excess pressure in the engine by dumping oil into the sump and provides emergency protection at conditions such as a cold start with high engine speed.

The pump has a moving slide mechanism for variable displacement capability and an on-off solenoid for two-

stage pressure regulation. The pump and the solenoid are not to be disassembled. Both are non-serviceable items and are to be replaced as a complete assembly.

## OPERATION

## OPERATION



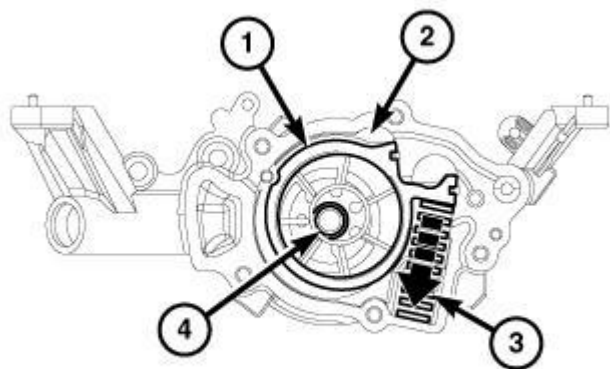
2832737

**Fig. 523: Moving Element, On/Off Solenoid & Relief Valve**  
Courtesy of CHRYSLER GROUP, LLC

The engine oil pump features seven vanes and a moving element (1) that continuously adjusts to maintain a regulated oil pressure supply by varying the displacement of the pump. The pump has two regulated pressure stages of operation controlled by an on/off solenoid (2). Low pressure mode regulation (solenoid on) is approximately 200 kPa (29 psi) and high pressure mode regulation (solenoid off) is approximately 450 kPa (65 psi). The Powertrain Control Module (PCM) switches the pump between stages based on engine operating conditions, oil and coolant temperatures, speed and load. Under most typical conditions, the pump will run in low mode from idle up to around 3000 rpm, and switch from low to high mode between 3000 and 4000 rpm.

The maximum oil pressure in the engine is limited to 1000 kPa (145 psi) by the relief valve (3). Pressure in the main oil gallery of the engine can be monitored with diagnostic equipment through the oil pressure sensor mounted on the rear of the oil filter module. The minimum pressure for the engine is 41 kPa (6 psi) at any operating condition. Anything under this pressure could result in damage to critical moving parts.

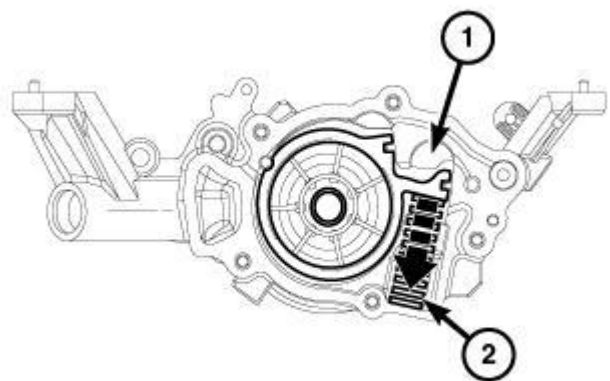




2832771

**Fig. 524: Moving Element, Main Gallery Oil Pressure, Spring Pressure & Pump Driveshaft**  
 Courtesy of CHRYSLER GROUP, LLC

In high pressure mode regulation (solenoid off) main gallery oil pressure (2) is applied to the moving element (1). The main gallery oil pressure works against spring pressure (3) to move the element to a more concentric location about the pump driveshaft (4) thus reducing displacement and pump output.



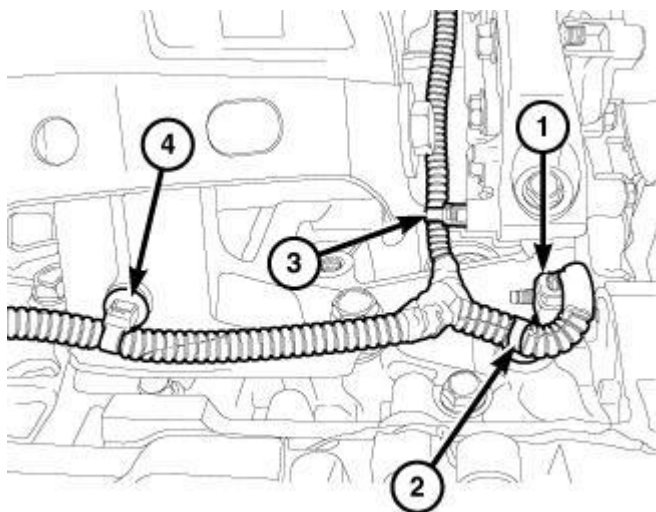
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**Fig. 525: Chamber & Spring**  
 Courtesy of CHRYSLER GROUP, LLC

In low pressure mode regulation (solenoid on) the energized solenoid opens an additional chamber (1) to main gallery oil pressure increasing the force on the spring (2) to further reduce displacement and output pressure.

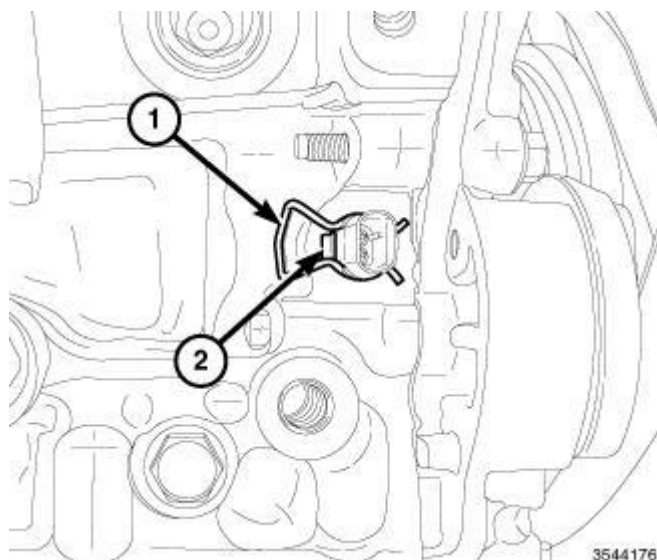
## REMOVAL

## REMOVAL



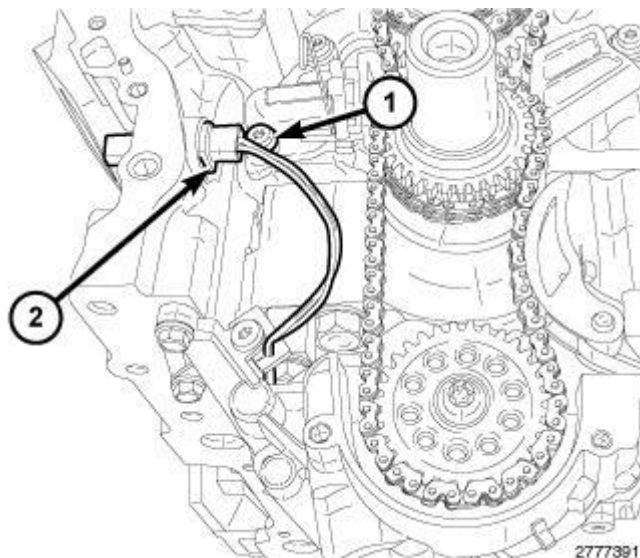
**Fig. 526: Oil Pump Solenoid Electrical Connector & Wire Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC

1. Disconnect and isolate the negative battery cable.
2. Remove the upper oil pan. Refer to **PAN, OIL, REMOVAL**.
3. Remove the oil pump pick-up. Refer to **PICK-UP, OIL PUMP, REMOVAL**.
4. Disconnect the engine wire harness from the oil pump solenoid electrical connector (1).



**Fig. 527: Oil Pump Solenoid Electrical Connector Retaining Clip & Retention Lock Tab**  
Courtesy of CHRYSLER GROUP, LLC

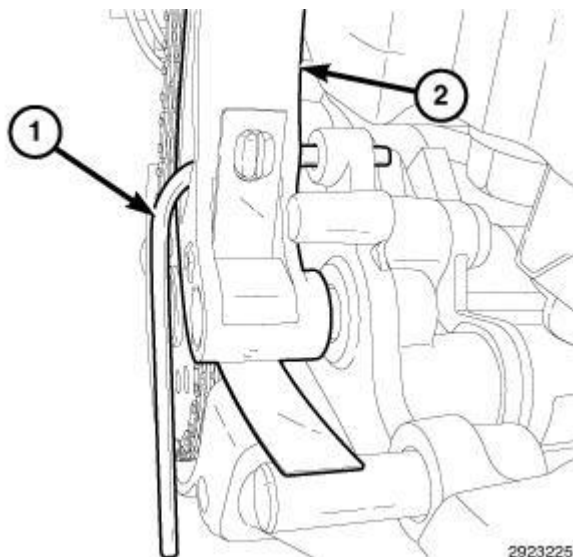
5. Remove the connector retaining clip (1).
6. Depress the connector retention lock tab (2) to disengage the oil pump solenoid electrical connector from the engine block.



**Fig. 528: Oil Pump Solenoid Electrical Connector & Primary Chain Tensioner Mounting Bolt**  
Courtesy of CHRYSLER GROUP, LLC

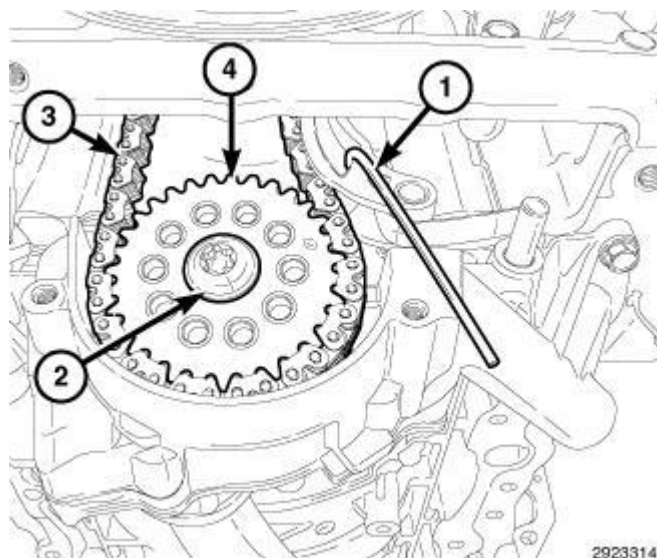
**NOTE:** Graphic shows the engine timing cover removed for clarity.

7. Push the oil pump solenoid electrical connector into the engine block, rotate the connector slightly CW, push it past the primary chain tensioner mounting bolt (1) and into the engine.



**Fig. 529: Oil Pump Chain Tensioner & Retaining Pin**  
Courtesy of CHRYSLER GROUP, LLC

8. Push back the oil pump chain tensioner (2) and insert a suitable retaining pin (1) such as a 3 mm Allen wrench.



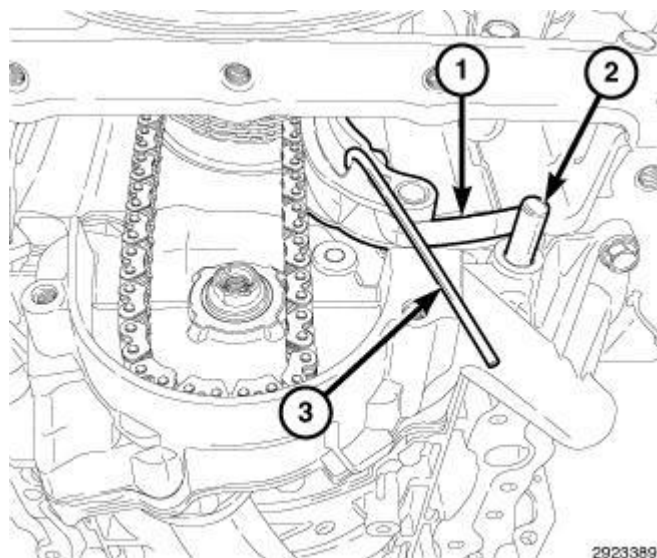
**Fig. 530: Retaining Pin, Retaining Bolt, Oil Pump Chain & Sprocket**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

9. Mark the direction of rotation on the oil pump chain (3) and sprocket (4) using a paint pen or equivalent to aid in reassembly.

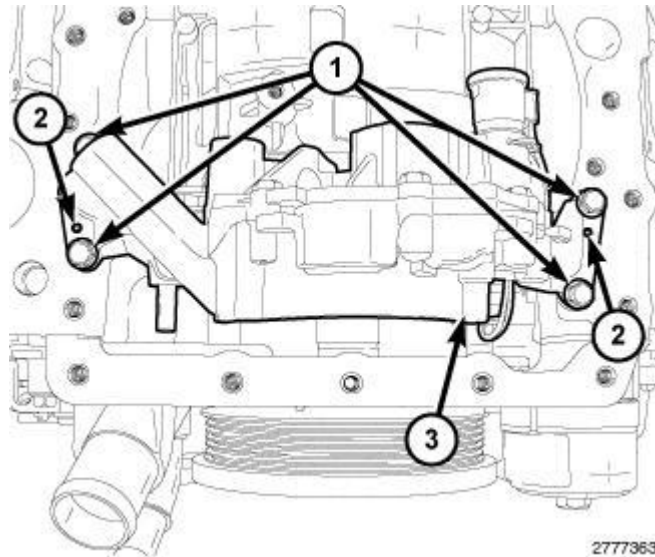
**NOTE:** There are no timing marks on the oil pump gear or chain. Timing of the oil pump is not required.

10. Remove the oil pump sprocket T45 retaining bolt (2) and remove the oil pump sprocket (4).



**Fig. 531: Retaining Pin, Oil Pump Chain Tensioner Spring & Dowel Pin**  
**Courtesy of CHRYSLER GROUP, LLC**

11. Remove the retaining pin (3) and disengage the oil pump chain tensioner spring (1) from the dowel pin (2).
12. Remove the oil pump chain tensioner from the oil pump.

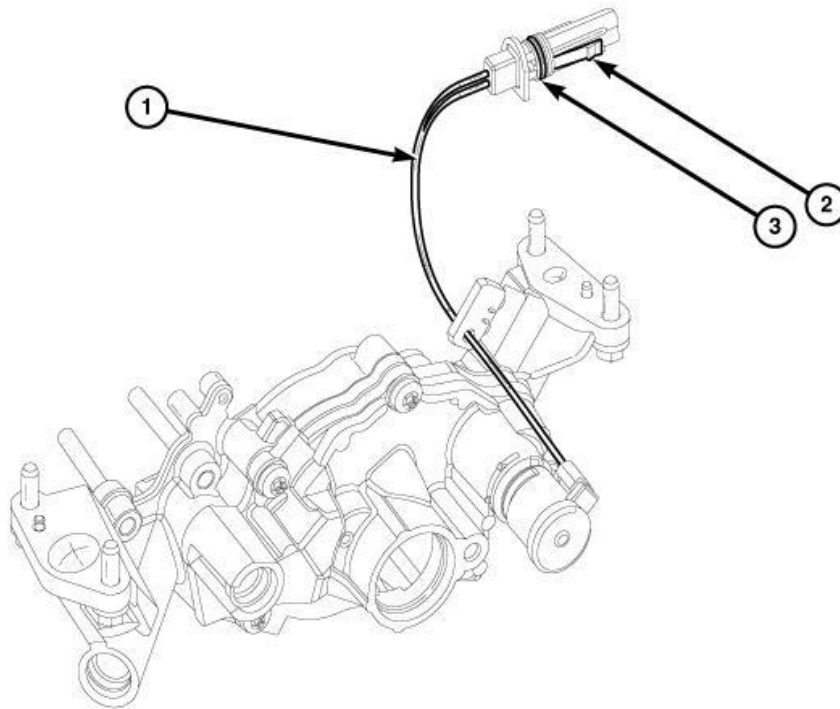


**Fig. 532: Oil Pump, Locator Pins & Bolts**  
**Courtesy of CHRYSLER GROUP, LLC**

13. Remove the four oil pump bolts (1) and remove the oil pump (3).

## INSPECTION

## INSPECTION



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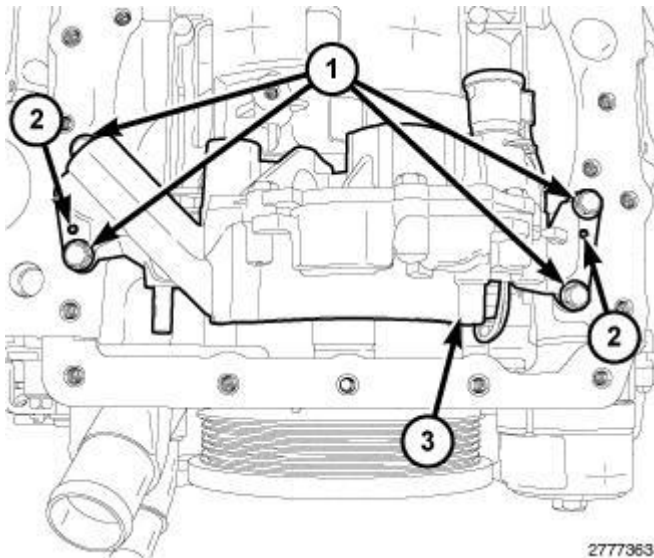
**Fig. 533: Solenoid Wires, Connector Retention Lock Tab & O-Ring Seal**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The 3.6L Oil pump is released as an assembly. The assembly includes both the pump and the solenoid. There are no serviceable sub-assembly components. In the event the oil pump or solenoid are not functioning or out of specification they must be replaced as an assembly.

1. Inspect the solenoid wires (1) for cuts or chaffing.
2. Inspect the condition of the connector O-ring seal (3).
3. Inspect the connector retention lock tab (2) for fatigue or damage.

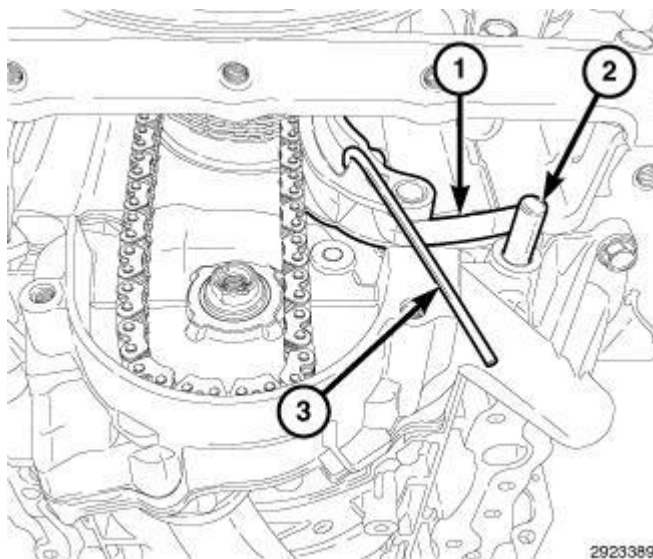
## INSTALLATION

## INSTALLATION



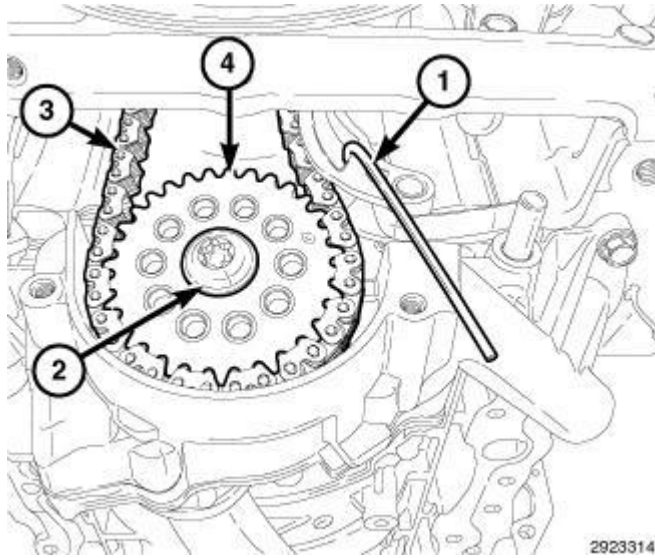
**Fig. 534: Oil Pump, Locator Pins & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

1. Align the locator pins (2) to the engine block and install the oil pump (3) with four bolts (1). Tighten the bolts to 12 N.m (106 in. lbs.).



**Fig. 535: Retaining Pin, Oil Pump Chain Tensioner Spring & Dowel Pin**  
Courtesy of CHRYSLER GROUP, LLC

2. Install the oil pump chain tensioner on the oil pump.
3. Position the oil pump chain tensioner spring (1) above the dowel pin (2).
4. Push back the oil pump chain tensioner and insert a suitable retaining pin (3) such as a 3 mm Allen wrench.



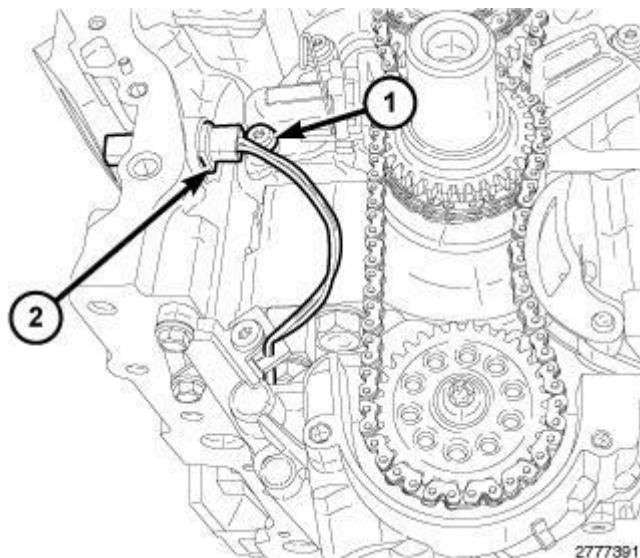
**Fig. 536: Retaining Pin, Retaining Bolt, Oil Pump Chain & Sprocket**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** There are no timing marks on the oil pump gear or chain. Timing of the oil pump is not required.

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

5. Place the oil pump sprocket (4) into the oil pump chain (3). Align the oil pump sprocket with the oil pump shaft and install the sprocket. Install the T45 retaining bolt (2) and tighten to 25 N.m (18 ft. lbs.).
6. Remove the retaining pin (1). Verify that the oil pump chain is centered on the tensioner and crankshaft sprocket.
7. Rotate the crankshaft CW one complete revolution to verify proper oil pump chain installation.

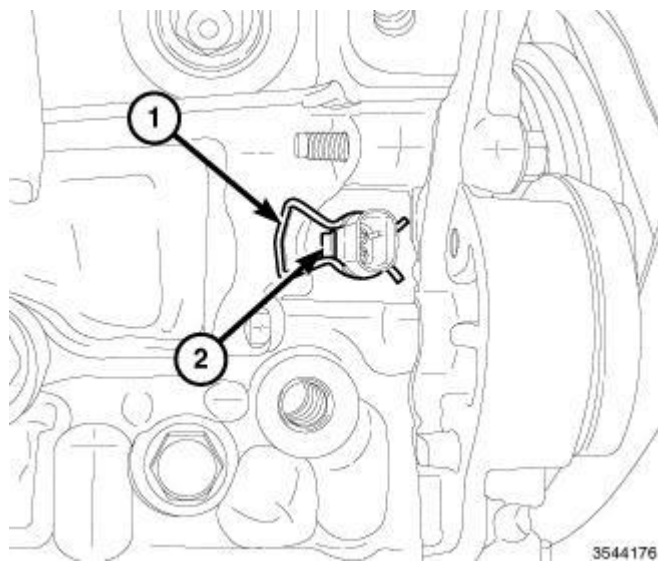




**Fig. 537: Oil Pump Solenoid Electrical Connector & Primary Chain Tensioner Mounting Bolt**  
Courtesy of CHRYSLER GROUP, LLC

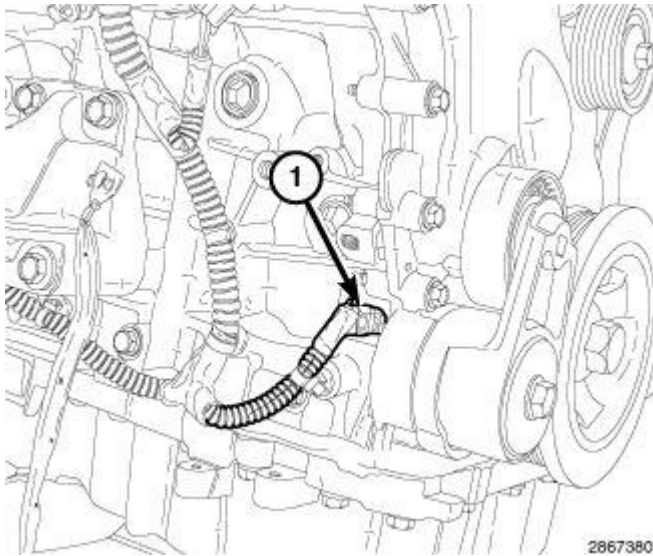
**NOTE:** Graphic shows the engine timing cover removed for clarity.

8. Position the oil pump solenoid electrical connector (2) into the engine block. Rotate the connector so that it can be pushed past the primary chain tensioner mounting bolt (1). Then rotate the connector slightly CCW and push it into the engine block until it locks in place.



**Fig. 538: Oil Pump Solenoid Electrical Connector Retaining Clip & Retention Lock Tab**  
Courtesy of CHRYSLER GROUP, LLC

9. Verify that the oil pump solenoid electrical connector retention lock tab (2) is engaged to the engine block.
10. Install the connector retaining clip (1).



**Fig. 539: Oil Pump Solenoid Electrical Connector**  
Courtesy of CHRYSLER GROUP, LLC

11. Connect the engine wire harness to the oil pump solenoid electrical connector (1).
12. Install the oil pump pick-up. Refer to **PICK-UP, OIL PUMP, INSTALLATION**.
13. Install the oil pan. Refer to **PAN, OIL, INSTALLATION**.
14. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
15. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

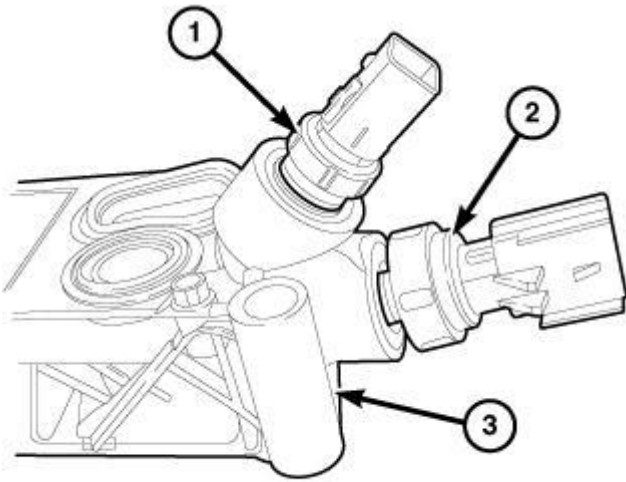
**CAUTION: A MIL or low oil pressure indicator that remains illuminated for more than 2 seconds may indicate low or no engine oil pressure. Stop the engine and investigate the cause of the indication.**

16. Start and run the engine until it reaches normal operating temperature.

## SENSOR, OIL PRESSURE

### DESCRIPTION

### DESCRIPTION



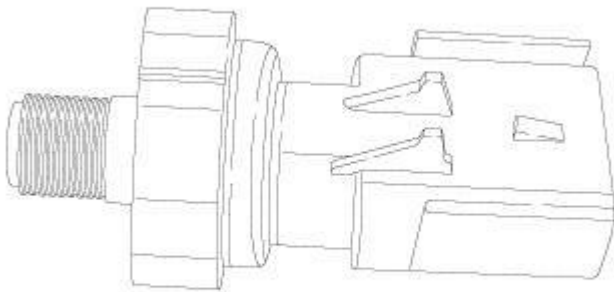
2710795

**Fig. 540: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
 Courtesy of CHRYSLER GROUP, LLC

The oil pressure sensor (2) is located on the oil filter housing (3). The oil pressure sensor is a three wire sensor with a tapered threaded sensor port. The sensor port is mounted to the oil filter housing through an access hole. A thread lock patch seals the oil pressure sensor to the oil filter housing.

#### OPERATION

#### OPERATION



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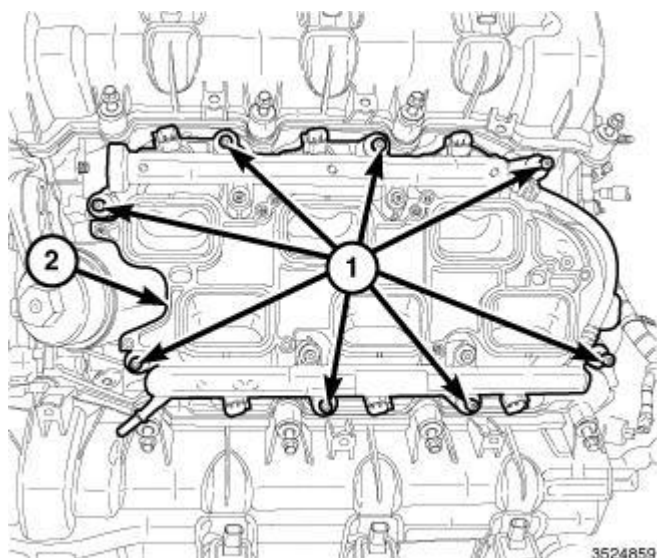
**Fig. 541: Oil Pressure Sensor**  
 Courtesy of CHRYSLER GROUP, LLC

The oil pressure sensor is a silicon based sensing unit that measures the pressure of the engine oil. The Powertrain Control Module (PCM) supplies a 5 volt reference and a ground to the sensor. The input to the PCM occurs on the signal return circuit. The oil pressure sensor is a linear sensor; as pressure changes, voltage

changes proportionately and returns a voltage signal to the PCM that reflects oil pressure. The zero pressure reading is 0.5 volt and full scale is 4.5 volt.

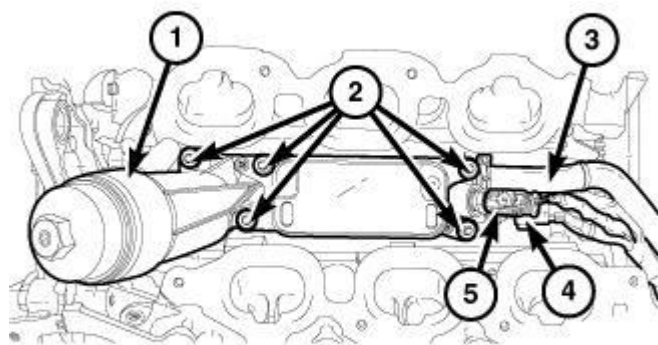
## REMOVAL

## REMOVAL



**Fig. 542: Lower Intake Manifold & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

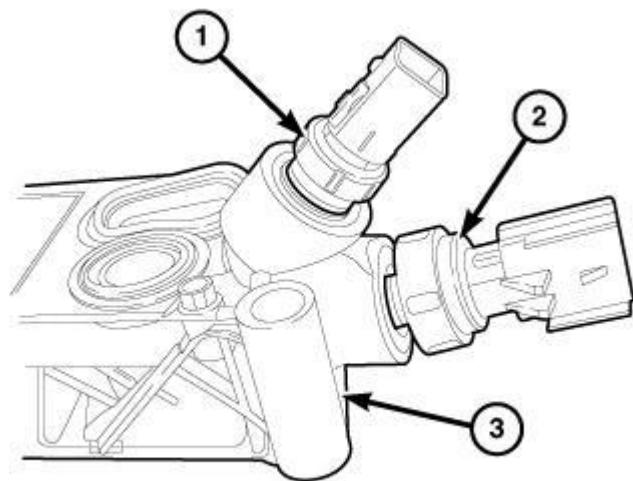
1. Release fuel system pressure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Remove the air inlet hose, upper intake manifold and lower intake manifold with the fuel injectors and fuel rail (2). Refer to **MANIFOLD, INTAKE, REMOVAL**.



**Fig. 543: Oil Temperature Sensor Electrical Connector, Oil Pressure Sensor Electrical Connector,**

**Oil Filter Housing, Heater Hose & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

4. Disconnect the oil pressure sensor electrical connector (4).



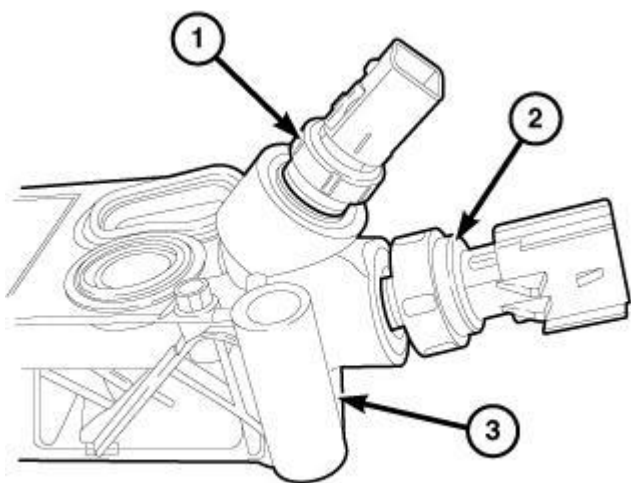
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**Fig. 544: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

5. Remove the oil pressure sensor (2) from the oil filter housing (3).

**INSTALLATION**

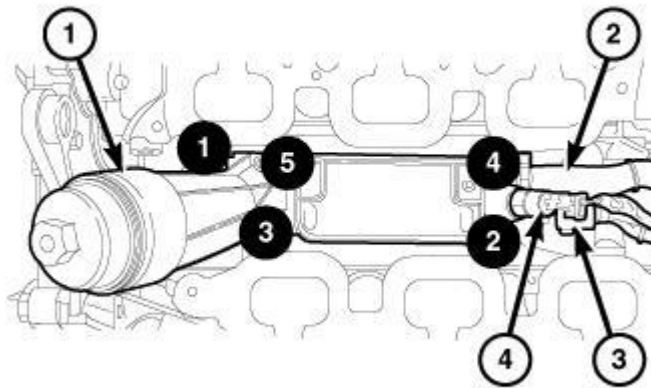
**INSTALLATION**



2710795

**Fig. 545: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

1. Install the oil pressure sensor (2) and tighten to 20 N.m (177 in. lbs.).



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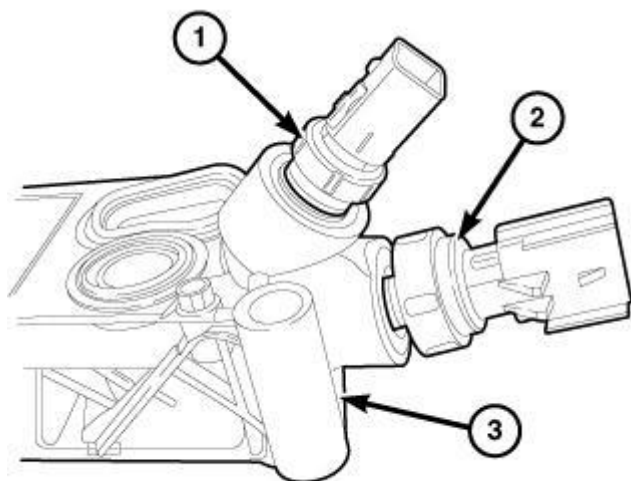
**Fig. 546: Heater Hose, Electrical Connectors, Oil Filter Housing & Bolt Tightening Sequence**  
Courtesy of CHRYSLER GROUP, LLC

2. Connect the oil pressure sensor electrical connector (3).
3. Install the upper and lower intake manifolds and air cleaner housing assembly. Refer to **MANIFOLD, INTAKE, INSTALLATION.**
4. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

## SENSOR, OIL TEMPERATURE

### DESCRIPTION

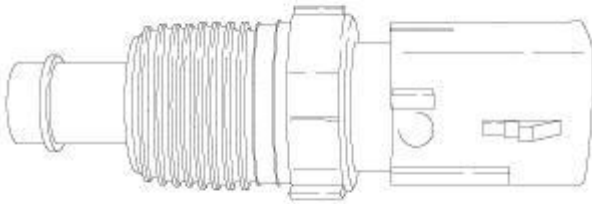
### DESCRIPTION



2710795

**Fig. 547: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
**Courtesy of CHRYSLER GROUP, LLC**

The oil temperature sensor (1) is located on the oil filter housing (3). The oil temperature sensor is a two wire sensor with a tapered threaded sensor probe. The sensor probe is mounted to the oil filter housing through an access hole. A thread lock patch seals the oil temperature sensor to the oil filter housing.

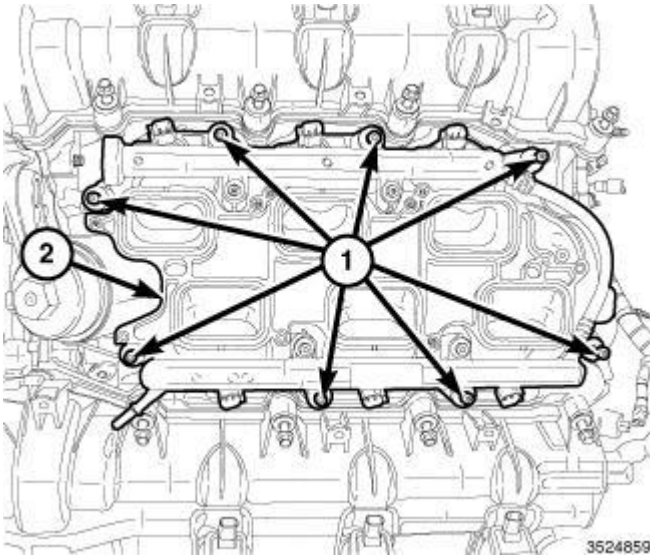
**OPERATION****OPERATION**

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**Fig. 548: Oil Temperature Sensor**  
**Courtesy of CHRYSLER GROUP, LLC**

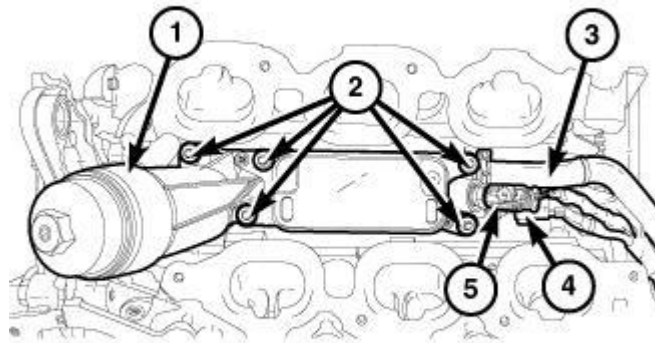
The oil temperature sensor is a variable resistor that measures the temperature of the engine oil. The Powertrain Control Module (PCM) supplies a 5 volt reference and a ground to the sensors low reference signal circuit. When the oil temperature is low, the sensor resistance is high. When the oil temperature is high, the sensor resistance is low.

**REMOVAL****REMOVAL**



**Fig. 549: Lower Intake Manifold & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

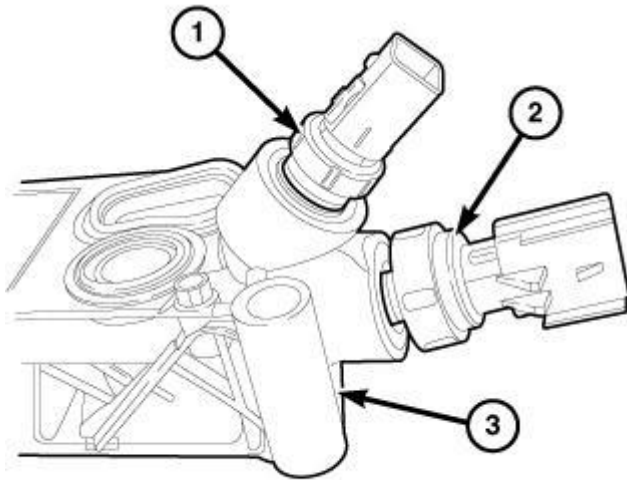
1. Release fuel system pressure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Remove the air inlet hose, upper intake manifold and lower intake manifold with the fuel injectors and fuel rail (2). Refer to **MANIFOLD, INTAKE, REMOVAL**.



**Fig. 550: Oil Temperature Sensor Electrical Connector, Oil Pressure Sensor Electrical Connector, Oil Filter Housing, Heater Hose & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

4. Disconnect the oil temperature sensor electrical connector (5).





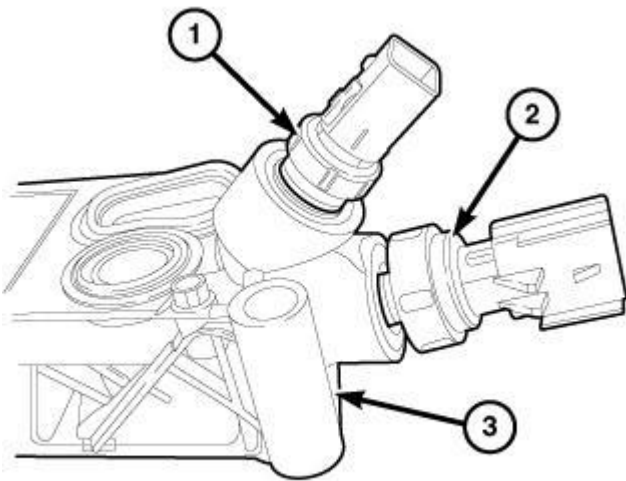
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**Fig. 551: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

5. Remove the oil temperature sensor (1) from the oil filter housing (3).

#### INSTALLATION

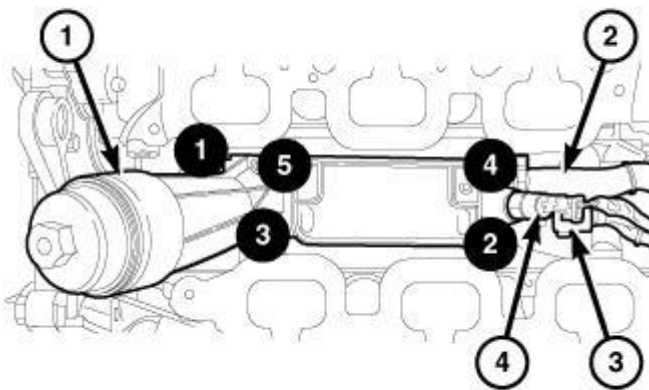
#### INSTALLATION



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**Fig. 552: Oil Temperature Sensor, Oil Pressure Sensor & Oil Filter Housing**  
Courtesy of CHRYSLER GROUP, LLC

Install the oil temperature sensor (1) and tighten to 20 N.m (177 in. lbs.).



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**Fig. 553: Heater Hose, Electrical Connectors, Oil Filter Housing & Bolt Tightening Sequence**  
 Courtesy of CHRYSLER GROUP, LLC

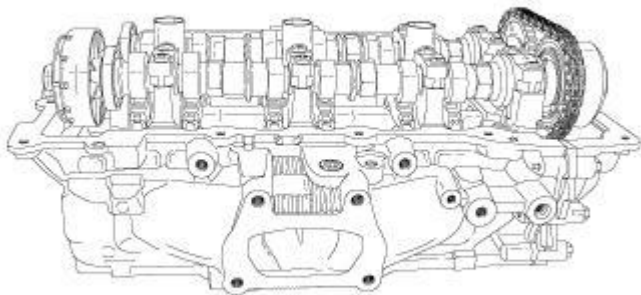
1. Connect the oil temperature sensor electrical connector (4).
2. Install the upper and lower intake manifolds and air cleaner housing assembly. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
3. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

## MANIFOLDS

### MANIFOLD, EXHAUST

#### DESCRIPTION

#### DESCRIPTION

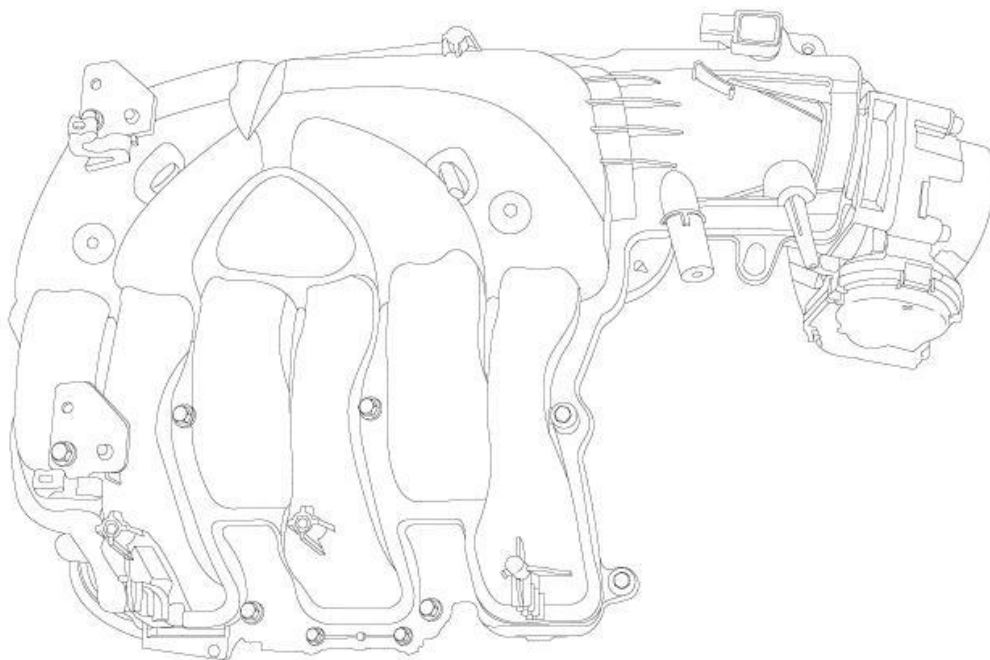


2793404

**Fig. 554: Aluminum Cylinder Head**

Courtesy of CHRYSLER GROUP, LLC

The 3.6L aluminum cylinder heads are a unique design with left and right castings. The exhaust manifolds are integrated into the cylinder heads. If any damaged is found to the exhaust manifold portion, the cylinder head must be removed for repair or replacement. Refer to **CYLINDER HEAD, REMOVAL**.

**MANIFOLD, INTAKE****DESCRIPTION****DESCRIPTION****UPPER INTAKE MANIFOLD**

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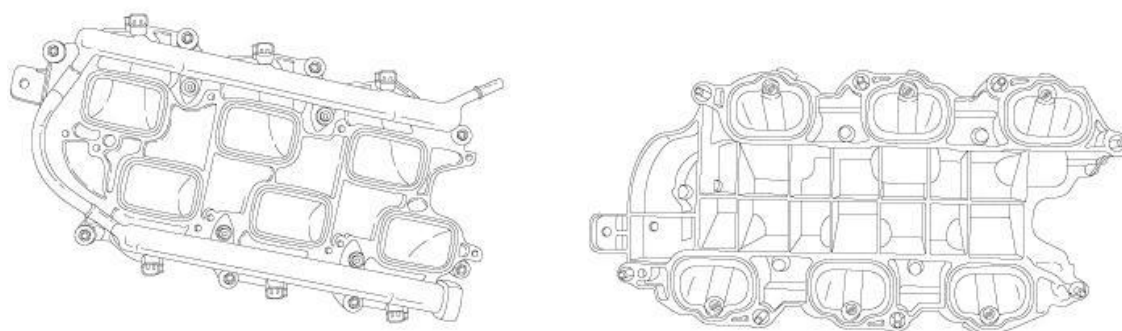
**Fig. 555: Upper Intake Manifold**

Courtesy of CHRYSLER GROUP, LLC

The upper intake manifold is an injection molded nylon composite design. The upper intake manifold is sealed to the lower intake manifold using six individual press-in-place port silicone gaskets. Replace the gaskets whenever the upper intake manifold is removed from the engine. There are silencer pads positioned at the rear of the intake manifold and between the upper and lower intake manifolds for improved noise, vibration and harshness (NVH). The left cylinder head cover has two alignment posts to aid proper installation of the silencer pad and there are two brackets bolted to the intake manifold to provide attachment points for the rear silencer pad. The seven upper intake manifold fasteners thread directly into the composite lower intake manifold and are a self-taping design. If the upper intake manifold is damaged or cracked, it must be replaced.

The Electronic Throttle Control (ETC) and Manifold Air Pressure (MAP) sensor are attached directly to the upper intake manifold. The upper intake manifold also provides vacuum ports for brake booster, positive crankcase ventilation (PCV) and emissions control.

## LOWER INTAKE MANIFOLD



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**Fig. 556: Lower Intake Manifold Design**  
Courtesy of CHRYSLER GROUP, LLC

The lower intake manifold is an injection molded nylon composite design. The lower intake manifold is sealed to the cylinder heads using six individual press-in-place port silicone gaskets. Replace the gaskets whenever the lower intake manifold is removed from the engine. The seven upper intake manifold fasteners thread directly into the composite lower intake manifold and are a self-taping design.

The fuel injection fuel rail is also a composite design. The four fuel rail fasteners thread directly into the composite lower intake manifold and are a self-taping design. The lower intake manifold can be serviced without removing the fuel injector rail. The fuel rail and fuel injectors must be installed into the lower intake manifold as an assembly. Do not attempt to install the fuel rail when the injectors are in the manifold. Always install new O-rings on the fuel injectors.

If the lower intake manifold is damaged or cracked, it must be replaced.

## DIAGNOSIS AND TESTING

### DIAGNOSIS AND TESTING - INTAKE MANIFOLD LEAKS

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more

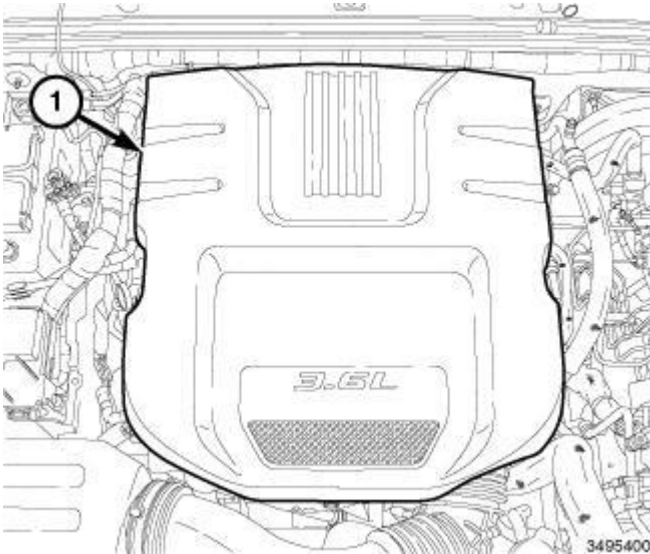
cylinders may not be functioning.

**WARNING:** Use extreme caution when the engine is operating. Do not stand in a direct line with the fan. Do not put your hands near the pulleys, belts or the fan. Do not wear loose clothing.

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

## REMOVAL

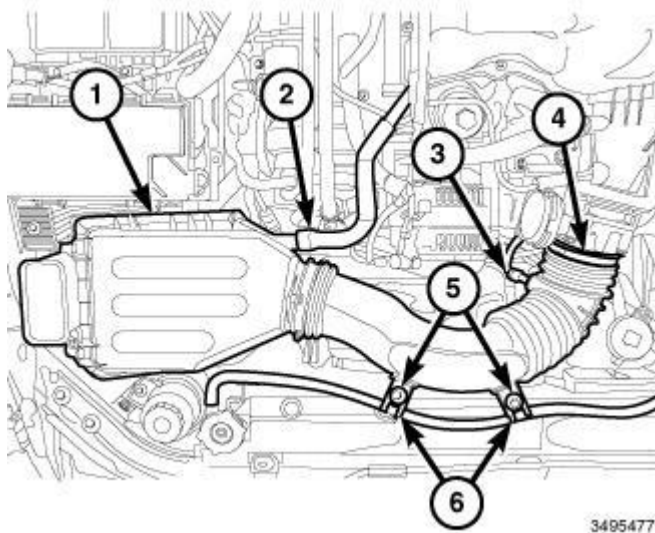
### UPPER



**Fig. 557: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

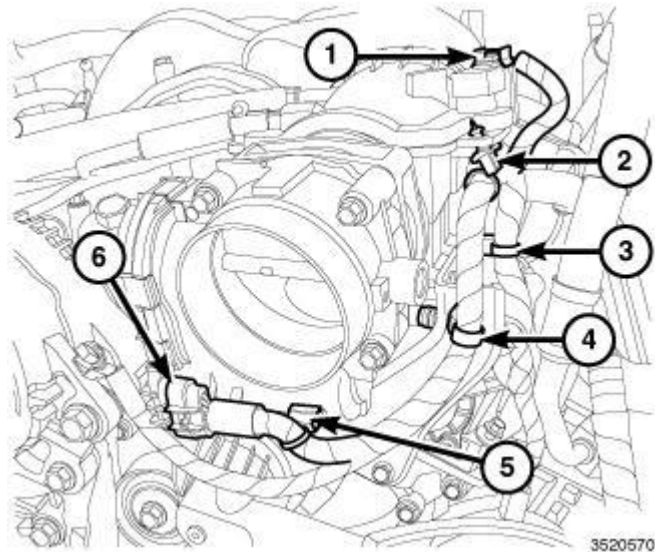
1. Disconnect and isolate the negative battery cable.
2. Remove the engine cover (1).



**Fig. 558: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

Courtesy of CHRYSLER GROUP, LLC

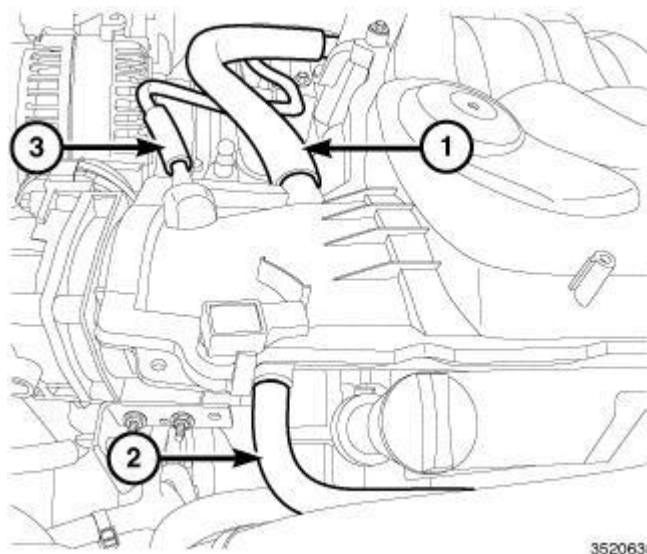
3. Remove the air cleaner body (1). Refer to **BODY, AIR CLEANER, REMOVAL**.



**Fig. 559: Manifold Absolute Pressure (MAP) Sensor, Electronic Throttle Control (ETC), Clip & Retainers**

Courtesy of CHRYSLER GROUP, LLC

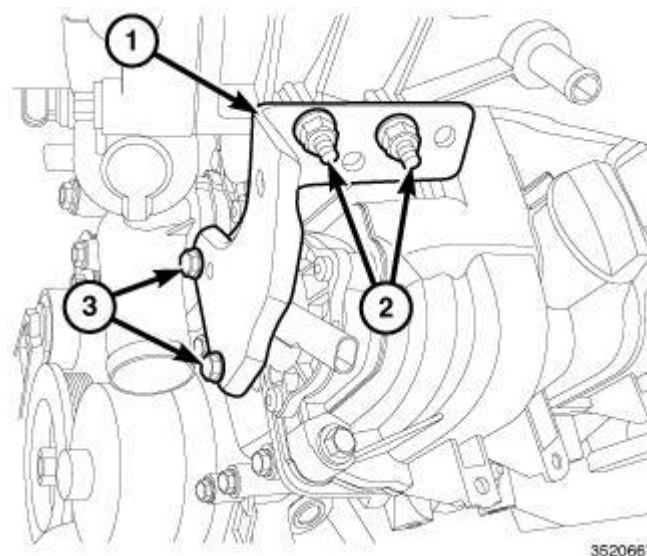
4. Disconnect the electrical connectors from the Manifold Absolute Pressure (MAP) sensor (1) and the Electronic Throttle Control (ETC) (6).
5. Disengage the ETC harness from the clip (5) on the throttle body.
6. Disengage the wire harness retainer (2) from the upper intake manifold.
7. Disengage the wire harness retainers (3 and 4) from the left front upper intake manifold support bracket and reposition the wire harness.



**Fig. 560: Positive Crankcase Ventilation (PCV), Brake Booster & Vapor Purge**  
Courtesy of CHRYSLER GROUP, LLC

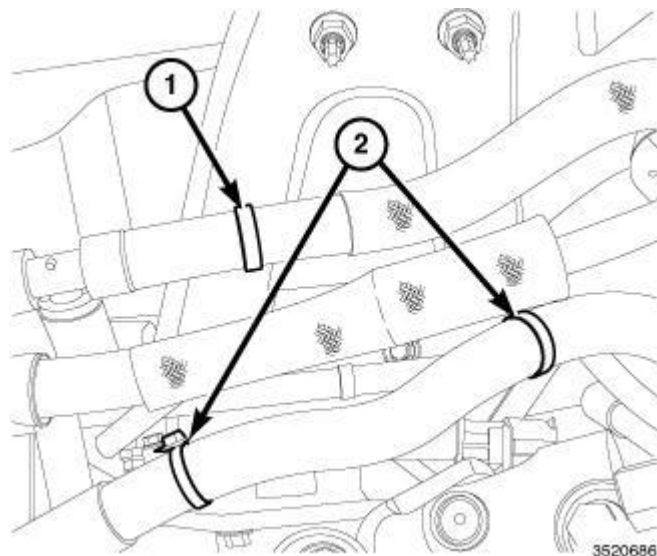
8. Disconnect the following hoses from the upper intake manifold:

- Positive Crankcase Ventilation (PCV) (1)
- Vapor purge (3)
- Brake booster (2)



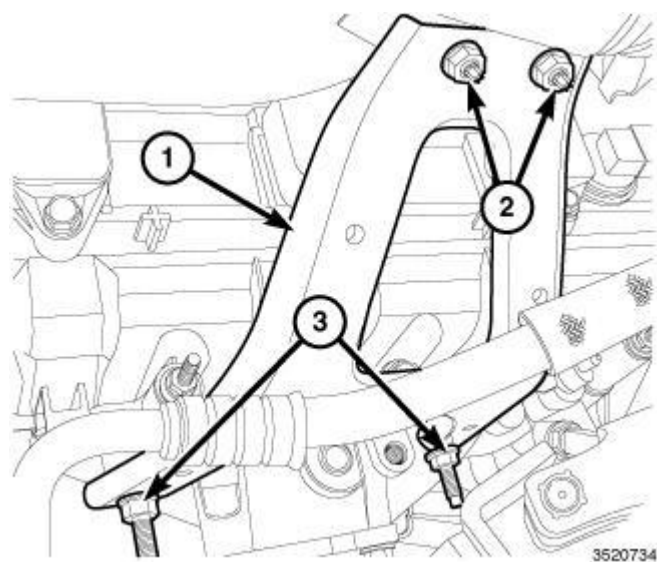
**Fig. 561: Left Front Upper Intake Manifold Support Bracket & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

9. Remove two nuts (2), two bolts (3) and the left front upper intake manifold support bracket (1).



**Fig. 562: Brake Booster Hose Retainer & Wire Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC

10. Disengage the brake booster hose retainer (1) from the left rear upper intake manifold support bracket.
11. Disengage the wire harness retainers (2) from the left rear upper intake manifold support bracket and reposition the wire harness.

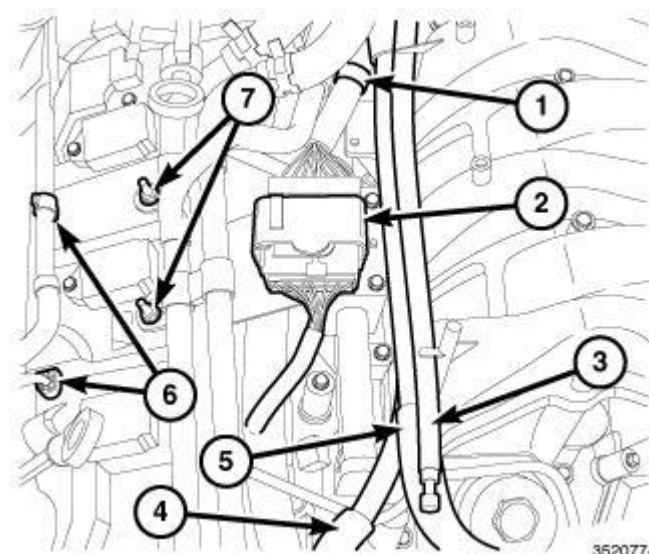


**Fig. 563: Left Rear Upper Intake Manifold Support Bracket & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

12. Remove two nuts (2) from the left rear upper intake manifold support bracket (1).
13. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
14. Remove the left front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, REMOVAL**.
15. Loosen two studbolts (3) and reposition the left rear upper intake manifold support bracket (1) away from



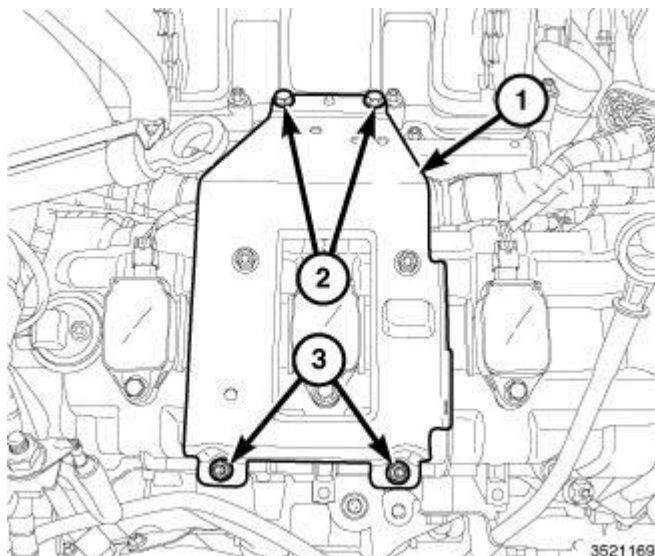
the upper intake manifold.



**Fig. 564: Transfer Case Vent Hose, Fresh Air Makeup Hose, Positive Crankcase Ventilation (PCV) Hose, Retainers & Fasteners**

Courtesy of CHRYSLER GROUP, LLC

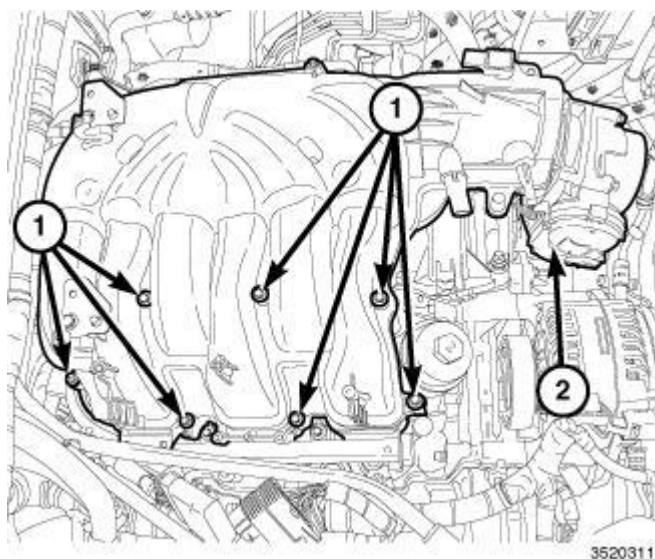
16. Lower the vehicle.
17. Disengage and reposition the following hoses from the upper intake manifold:
  - Transfer case vent (3)
  - Positive Crankcase Ventilation (PCV) (5)
  - Fresh air makeup (4)
18. Disengage the wire harness retainer (1) from the upper intake manifold.
19. Disengage the wire harness connector retainer (2) from the right upper intake manifold support bracket.
20. Disengage two purge tube retainers (6) from the right upper intake manifold support bracket.
21. Remove two nuts (7) and reposition the heater core coolant tube assembly.



**Fig. 565: Right Upper Intake Manifold Support Bracket & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Heater core coolant tube assembly not shown in illustration for clarity.

22. Remove two bolts (2) from the right upper intake manifold support bracket (1).
23. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
24. Remove the right front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, REMOVAL**.
25. Remove two nuts (3) and the right upper intake manifold support bracket (1).



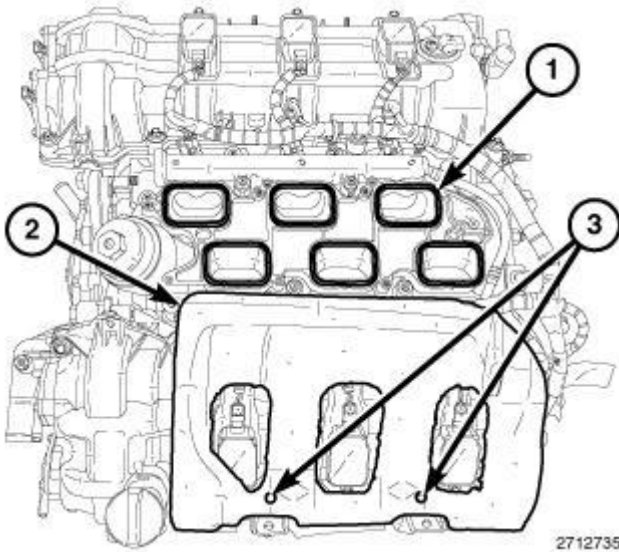
**Fig. 566: Upper Intake Manifold & Fasteners**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The upper intake manifold attaching bolts are captured in the upper intake

manifold. Once loosened, the bolts will have to be lifted out of the lower intake manifold and held while removing the upper intake manifold.

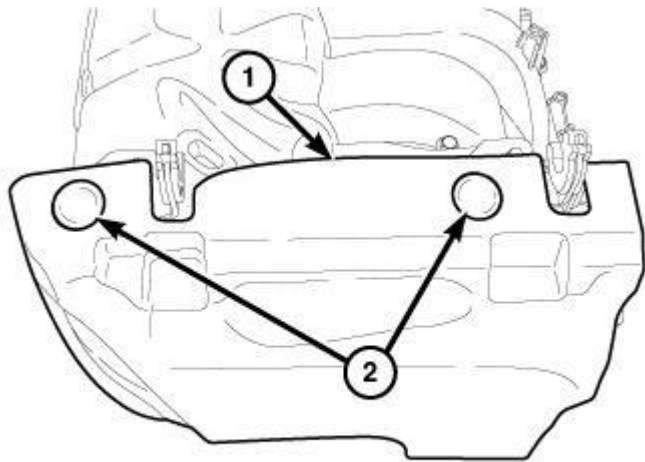
**NOTE:** Exercise care not to inadvertently loosen the two fuel rail attachment bolts that are in close proximity of the upper intake manifold attaching bolts.

26. Remove seven upper intake manifold attaching bolts (1) and remove the upper intake manifold (2).



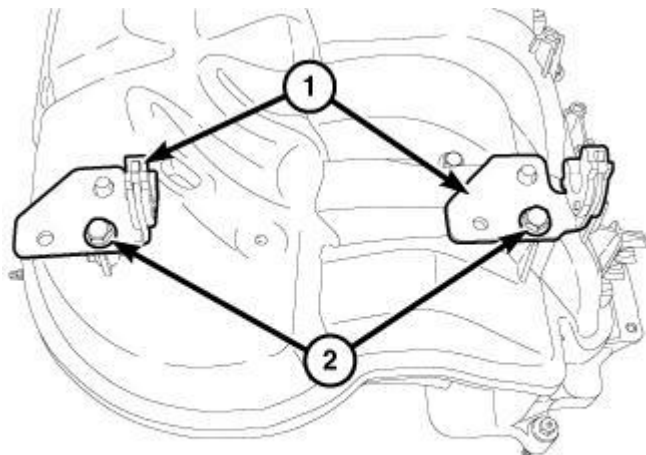
**Fig. 567: Intake Ports, Insulator & Alignment Posts**  
Courtesy of CHRYSLER GROUP, LLC

27. Remove and discard the six upper to lower intake manifold seals (1).  
28. Cover the open intake ports to prevent debris from entering the engine.  
29. If required, remove the insulator (2) from the LH cylinder head cover.



**Fig. 568: Rear Insulation Pad & Push-Pins**  
 Courtesy of CHRYSLER GROUP, LLC

30. If required, remove the push-pins (2) and the rear insulation pad (1) from the upper intake manifold.

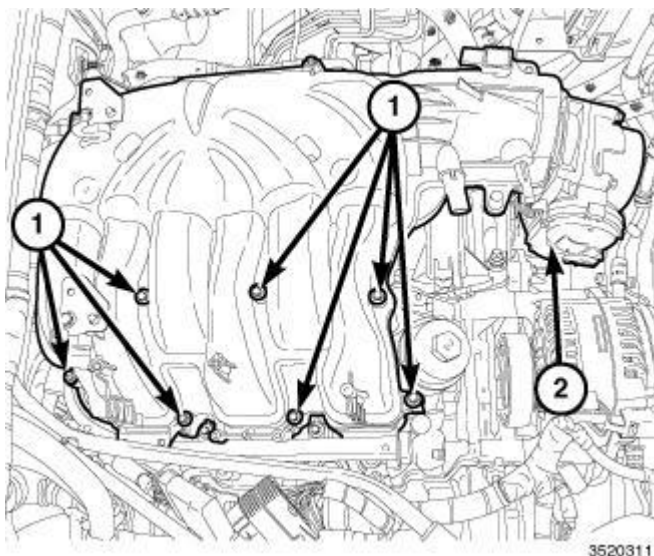


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**Fig. 569: Upper Intake Manifold Brackets & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

31. If required, remove the bolts (2) and the brackets (1) from the upper intake manifold.
32. If required, remove the Manifold Air Pressure (MAP) sensor from the upper intake manifold. Refer to **SENSOR, MANIFOLD AIR PRESSURE (MAP), REMOVAL**.
33. If required, remove the throttle body from the upper intake manifold. Refer to **THROTTLE BODY, REMOVAL**.

#### LOWER



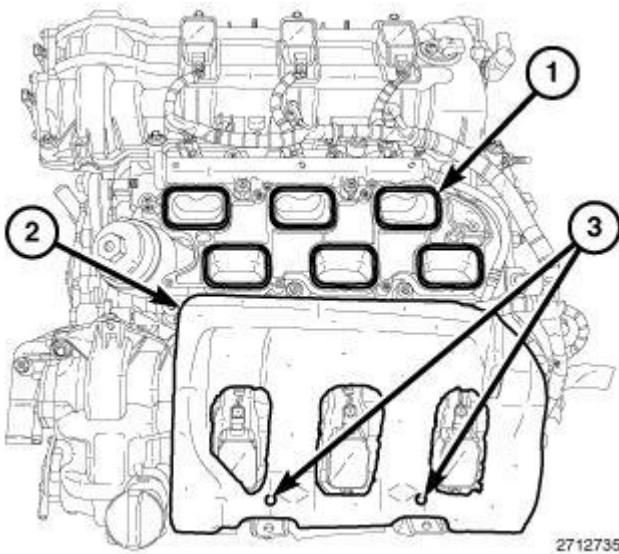
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**Fig. 570: Upper Intake Manifold & Fasteners**

Courtesy of CHRYSLER GROUP, LLC

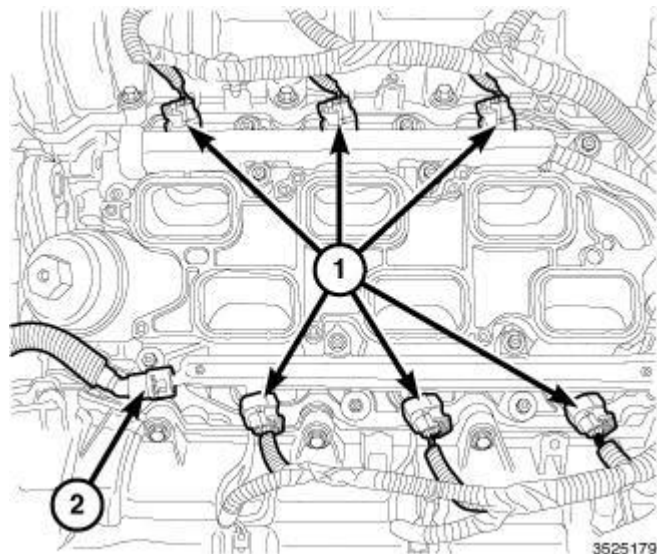
**WARNING:** The fuel system is under constant pressure even with engine off. Before servicing the fuel rail, fuel system pressure must be released.

1. Release fuel system pressure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
2. Disconnect and isolate the negative battery cable.
3. Remove the air cleaner body and upper intake manifold (2). Refer to **MANIFOLD, INTAKE, REMOVAL**.

**Fig. 571: Intake Ports, Insulator & Alignment Posts**

Courtesy of CHRYSLER GROUP, LLC

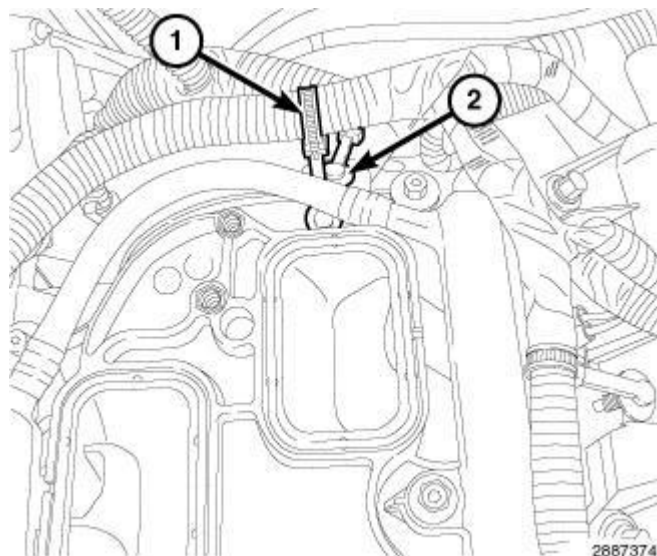
4. Remove the insulator (2) from the LH cylinder head cover.



**Fig. 572: Fuel Supply Line And Connectors**

Courtesy of CHRYSLER GROUP, LLC

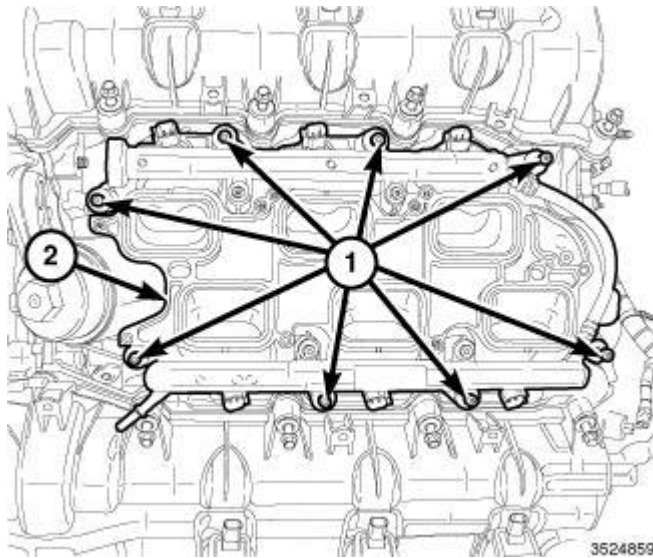
5. Disconnect the fuel supply hose (2) from the fuel rail. Refer to **FITTING, QUICK CONNECT**.
6. Disconnect the fuel injector electrical connectors (1).



**Fig. 573: Injection/Ignition Harness Retainer & Main Wire Harness Retainer**

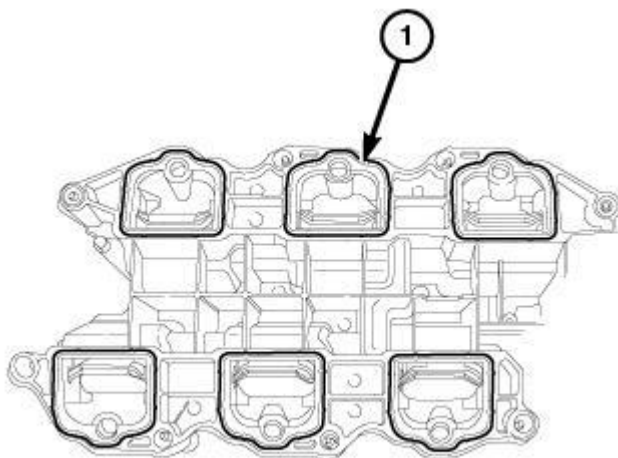
Courtesy of CHRYSLER GROUP, LLC

7. Disengage the injection/ignition harness retainer (1) from the rear of the lower intake manifold.
8. Disengage the main wire harness retainer (2) from the rear of the lower intake manifold.



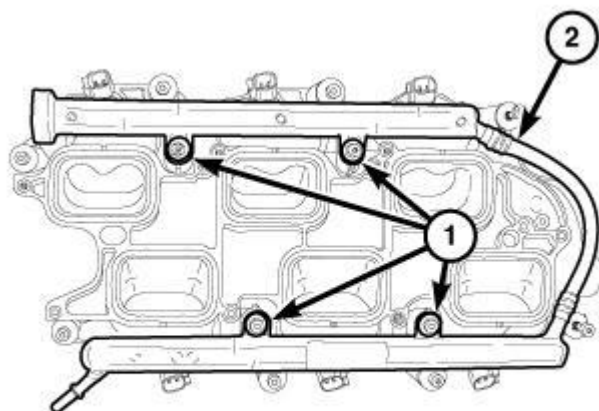
**Fig. 574: Lower Intake Manifold & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

9. Remove the eight lower intake manifold attaching bolts (1).
10. Remove the lower intake manifold (2) with the fuel injectors and fuel rail.



**Fig. 575: Lower Intake Manifold To Cylinder Head Seals**  
 Courtesy of CHRYSLER GROUP, LLC

11. Remove and discard the six lower intake manifold to cylinder head seals (1).



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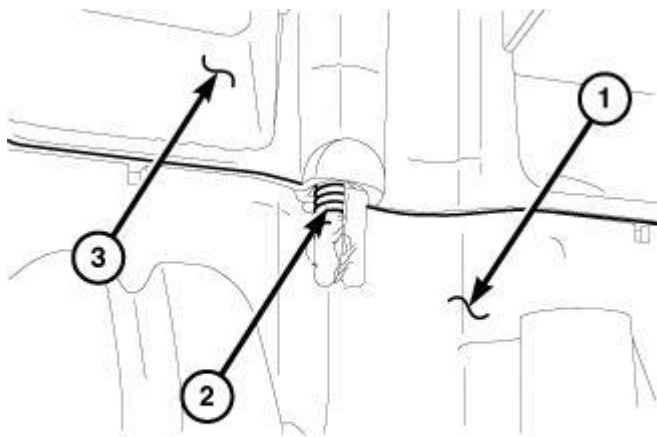
**Fig. 576: Bolts & Fuel Rail**

Courtesy of CHRYSLER GROUP, LLC

12. If required, remove the fuel rail (2) and fuel injectors from the lower intake manifold. Refer to **RAIL, FUEL, REMOVAL**.

#### INSPECTION

#### INSPECTION



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**Fig. 577: Non-Repairable Damage To Lower Intake Manifold Due To Cross Threading Of An Upper Intake Manifold Attaching Bolt**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** When the upper intake manifold (3) and lower intake manifold (1) are not aligned properly, cross threading of the upper intake manifold attaching bolts can



occur. The graphic shows non-repairable damage to the lower intake manifold (1) due to cross threading of an upper intake manifold attaching bolt (2).

Check both the upper and lower intake manifolds for:

- Damage and cracks
- Gasket surface damage or warping

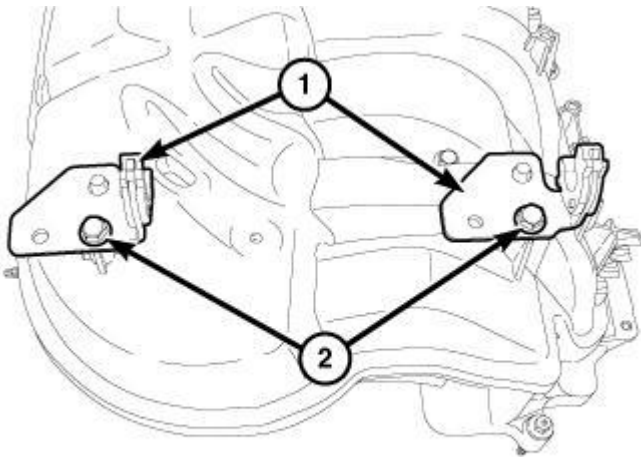
Check the lower intake manifold for:

- Damaged fuel injector ports

If either the upper or lower manifold exhibits any damaged or warped conditions, replace the manifold.

## INSTALLATION

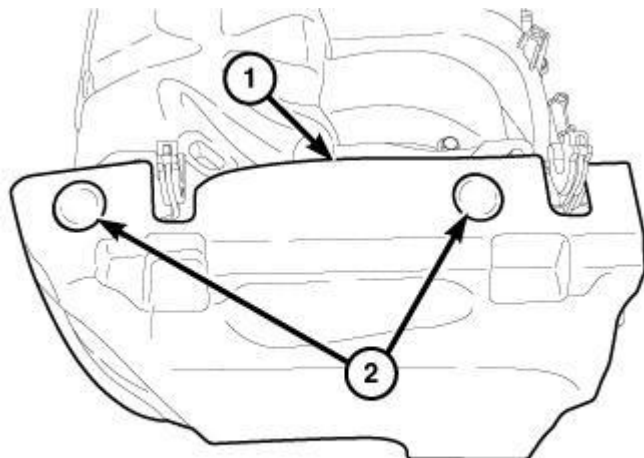
### UPPER



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**Fig. 578: Upper Intake Manifold Brackets & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

1. If removed, install the throttle body to the upper intake manifold. Refer to **THROTTLE BODY, INSTALLATION** .
2. If removed, install the Manifold Air Pressure (MAP) sensor to the upper intake manifold. Refer to **SENSOR, MANIFOLD AIR PRESSURE (MAP), INSTALLATION** .
3. If removed, install the brackets (1) to the upper intake manifold with bolts (2) tightened to 8 N.m (71 in. lbs.).

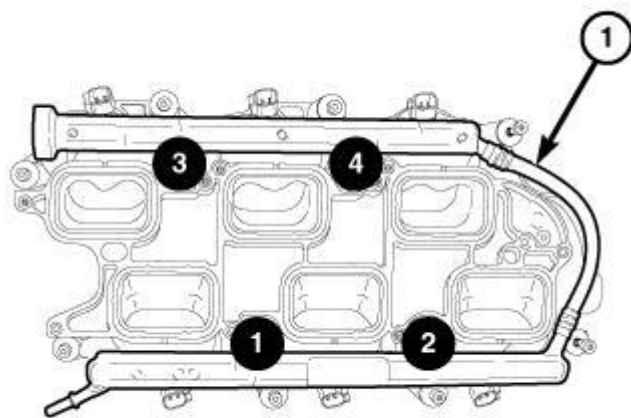


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**Fig. 579: Rear Insulation Pad & Push-Pins**

Courtesy of CHRYSLER GROUP, LLC

4. If removed, install the rear insulation pad (1) with push-pins (2) to the upper intake manifold.

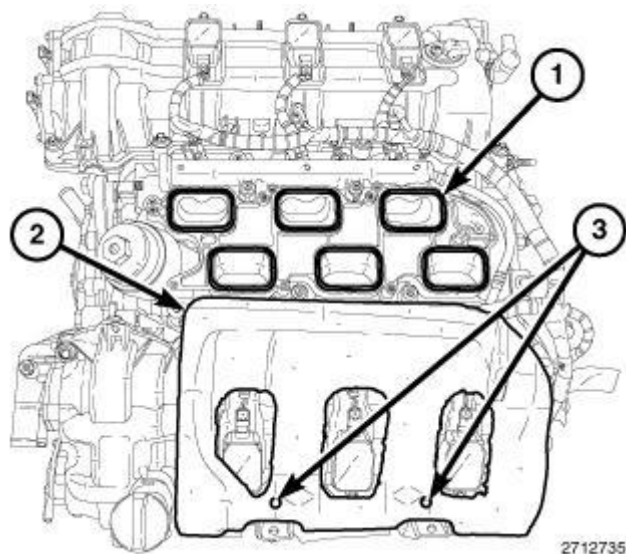


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**Fig. 580: Fuel Rail Bolt Tightening Sequence**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Prior to installing the upper intake manifold, verify that the four fuel rail bolts were not inadvertently loosened. The bolts must be tightened in the sequence shown in illustration to 7 N.m (62 in. lbs.). Refer to RAIL, FUEL, INSTALLATION.

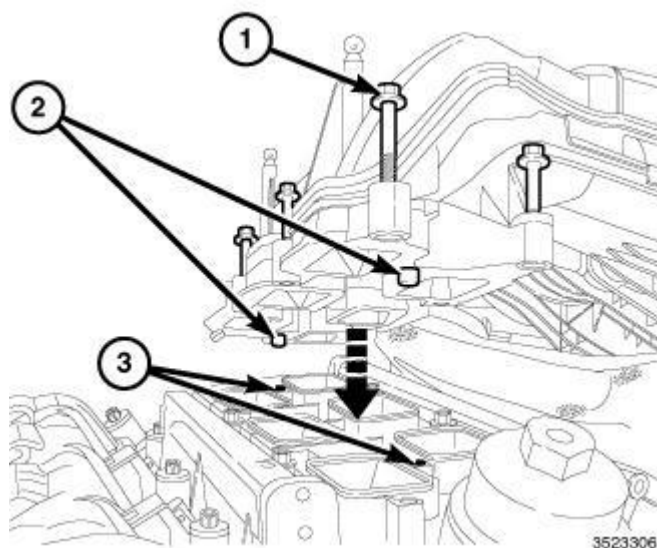


**Fig. 581: Intake Ports, Insulator & Alignment Posts**  
 Courtesy of CHRYSLER GROUP, LLC

5. Clean and inspect the sealing surfaces. Install new upper to lower intake manifold seals (1).

**NOTE:** Make sure the fuel injectors and wiring harnesses are in the correct position so that they don't interfere with the upper intake manifold installation.

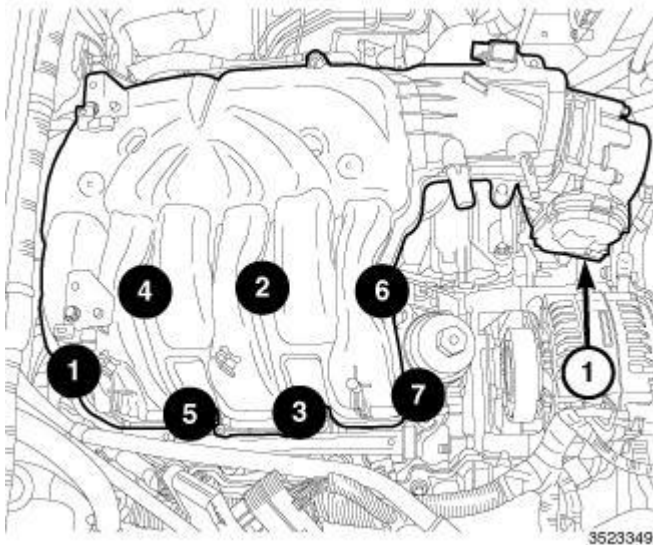
6. If removed, install the insulator (2) to the two alignment posts (3) on top of the LH cylinder head cover.



**Fig. 582: Upper Intake Manifold & Bolts**  
 Courtesy of CHRYSLER GROUP, LLC

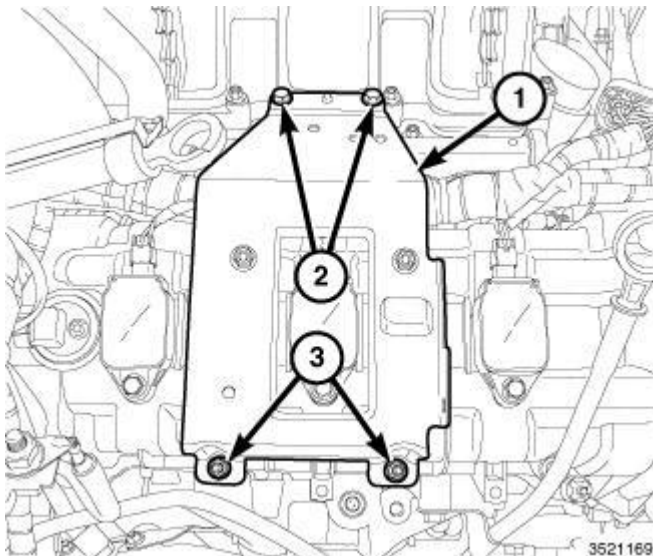
7. Lift and hold the seven upper intake attaching bolts (1) clear of the mating surface. Back the bolts out slightly or if required, use an elastic band to hold the bolts clear of the mating surface.

8. Position the upper intake manifold (1) onto the lower intake manifold so that the two locating posts (2) on the upper intake manifold align with corresponding holes (3) in the lower intake manifold.



**Fig. 583: Upper Intake Manifold Tightening Sequence**  
Courtesy of CHRYSLER GROUP, LLC

9. Install the seven upper intake manifold attaching bolts. Tighten the bolts in the sequence shown in illustration to 8 N.m (71 in. lbs.).

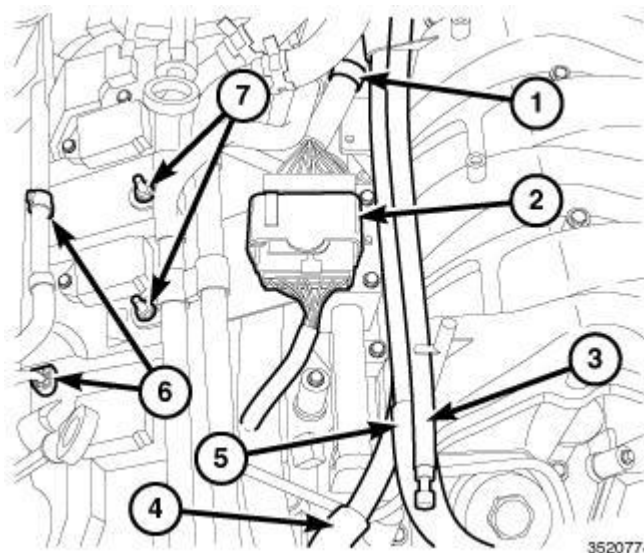


**Fig. 584: Right Upper Intake Manifold Support Bracket & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Heater core coolant tube assembly not shown in illustration for clarity.

10. Install the right upper intake manifold support bracket (1) with two bolts (2) tightened to 8 N.m (71 in. lbs.).

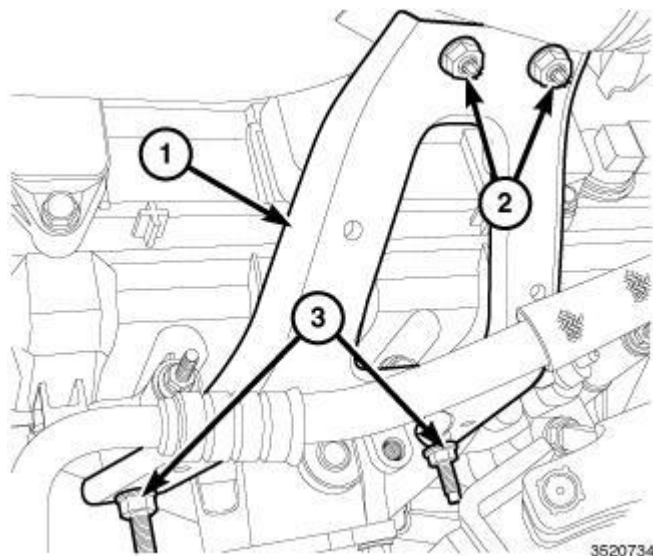
11. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
12. Install two nuts (3) to the right upper intake manifold support bracket (1) and tighten to 10 N.m (89 in. lbs.).
13. Install the right front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, INSTALLATION**.



**Fig. 585: Transfer Case Vent Hose, Fresh Air Makeup Hose, Positive Crankcase Ventilation (PCV) Hose, Retainers & Fasteners**

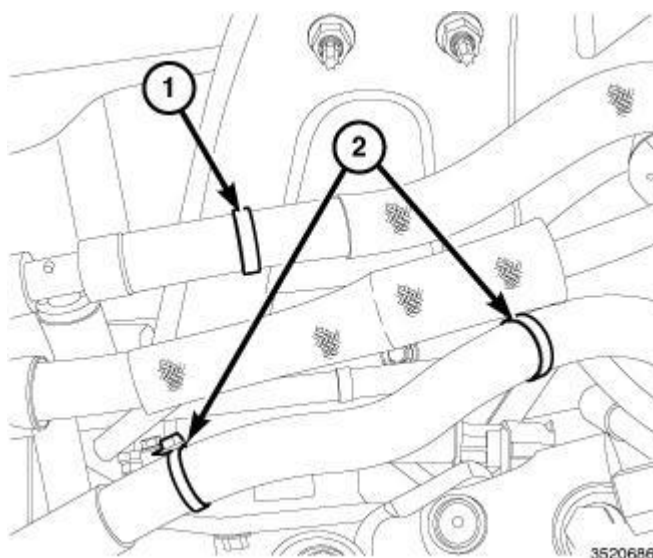
Courtesy of CHRYSLER GROUP, LLC

14. Lower the vehicle.
15. Install the heater core coolant tube assembly with two nuts (7) tightened to 10 N.m (89 in. lbs.).
16. Engage two purge tube retainers (6) to the right upper intake manifold support bracket.
17. Engage the wire harness retainer (1) to the upper intake manifold.
18. Engage the wire harness connector retainer (2) to the right upper intake manifold support bracket.
19. Engage the following hoses to the upper intake manifold:
  - Fresh air makeup (4)
  - Positive Crankcase Ventilation (PCV) (5)
  - Transfer case vent (3)



**Fig. 586: Left Rear Upper Intake Manifold Support Bracket & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

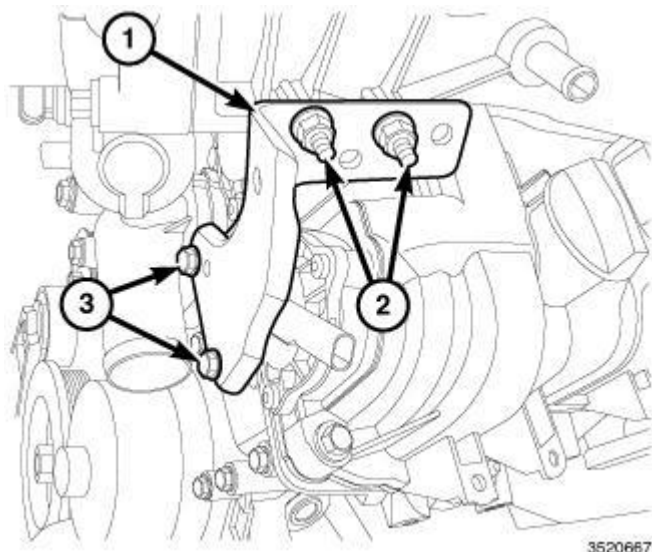
20. Install the left rear upper intake manifold support bracket (1) with two nuts (2) tightened to 10 N.m (89 in. lbs.).
21. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
22. Install two studbolts (3) to the left rear upper intake manifold support bracket (1) and tighten to 20 N.m (177 in. lbs.).
23. Install the left front wheelhouse inner splash shield. Refer to **SHIELD, SPLASH, WHEELHOUSE, INSTALLATION** .



**Fig. 587: Brake Booster Hose Retainer & Wire Harness Retainers**  
Courtesy of CHRYSLER GROUP, LLC

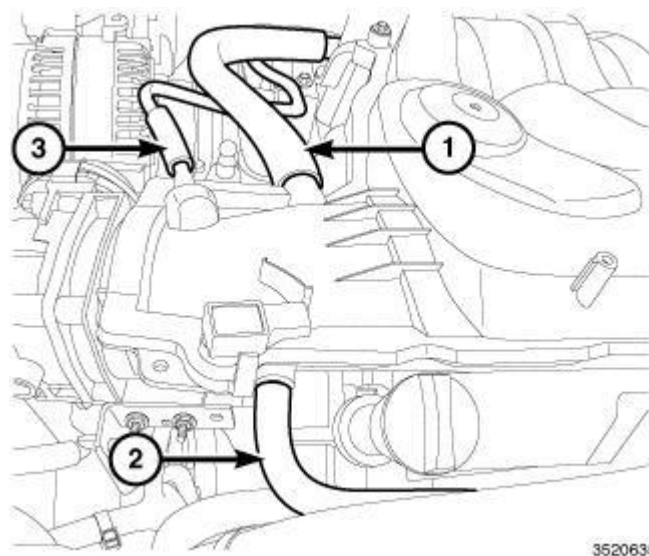
24. Lower the vehicle.

25. Position the wire harness and engage the wire harness retainers (2) to the left rear upper intake manifold support bracket.
26. Engage the brake booster hose retainer (1) to the left rear upper intake manifold support bracket.



**Fig. 588: Left Front Upper Intake Manifold Support Bracket & Fasteners**  
Courtesy of CHRYSLER GROUP, LLC

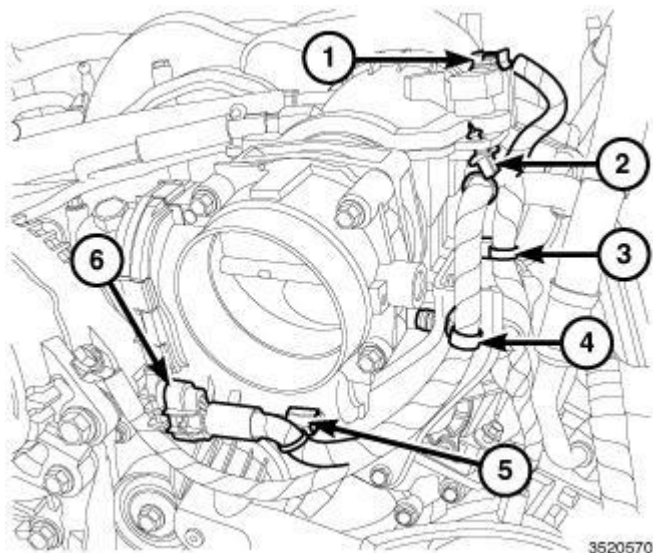
27. Install the left front upper intake manifold support bracket (1) with two nuts (2) and two bolts (3). Tighten the nuts (2) to 10 N.m (89 in. lbs.) and tighten the bolts (3) to 10 N.m (89 in. lbs.).



**Fig. 589: Positive Crankcase Ventilation (PCV), Brake Booster & Vapor Purge**  
Courtesy of CHRYSLER GROUP, LLC

28. Connect the following hoses to the upper intake manifold:
  - Positive Crankcase Ventilation (PCV) (1)

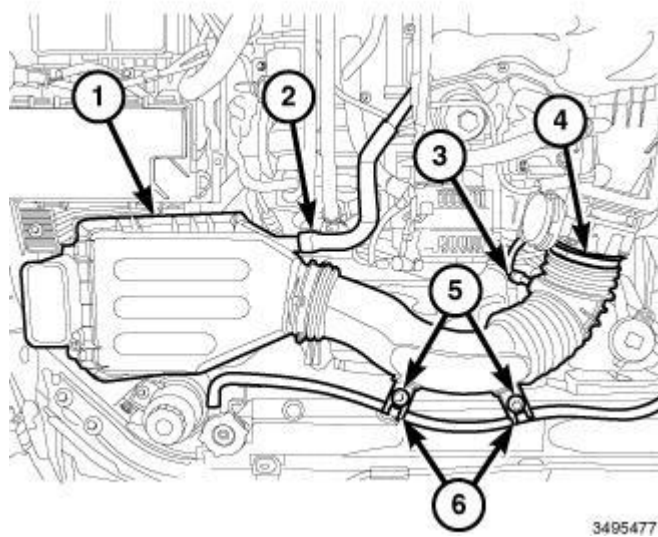
- Vapor purge (3)
- Brake booster (2)



**Fig. 590: Manifold Absolute Pressure (MAP) Sensor, Electronic Throttle Control (ETC), Clip & Retainers**

Courtesy of CHRYSLER GROUP, LLC

29. Position the wire harness and connect the electrical connectors to the Manifold Absolute Pressure (MAP) sensor (1) and the Electronic Throttle Control (ETC) (6).
30. Engage the ETC harness to the clip (5) on the throttle body.
31. Engage the wire harness retainer (2) to the upper intake manifold.
32. Engage the wire harness retainers (3 and 4) to the left front upper intake manifold support bracket.

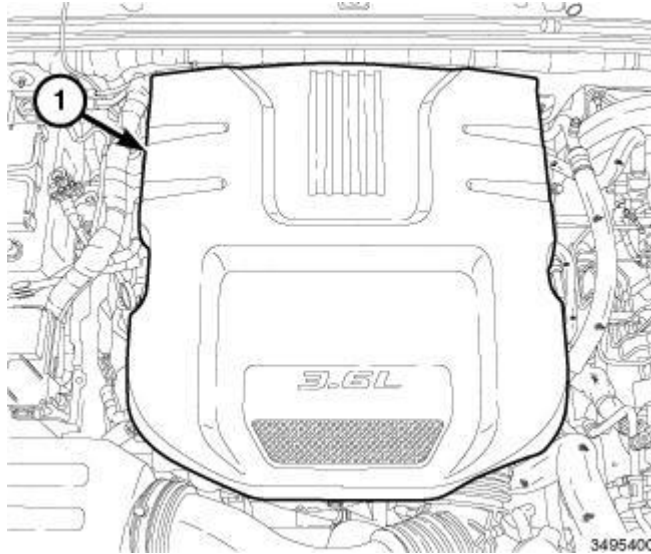


**Fig. 591: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**



Courtesy of CHRYSLER GROUP, LLC

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

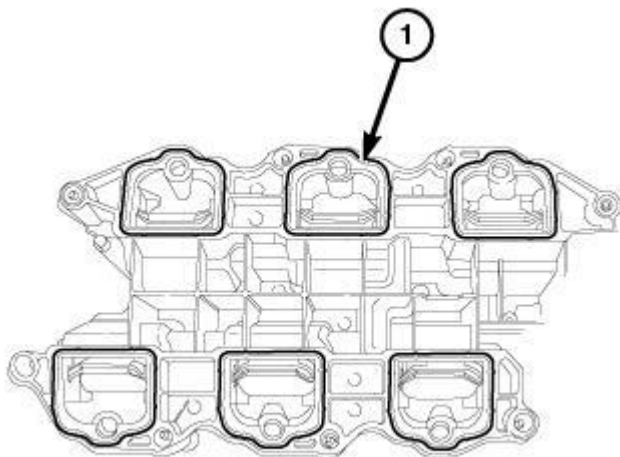


**Fig. 592: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

34. Install the engine cover (1).  
35. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

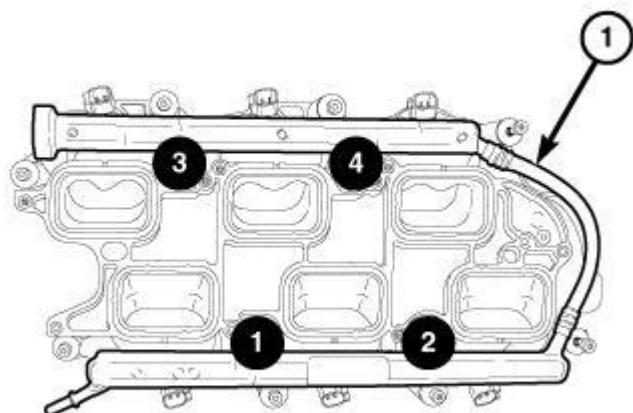
#### LOWER



**Fig. 593: Lower Intake Manifold To Cylinder Head Seals**

Courtesy of CHRYSLER GROUP, LLC

1. Clean and inspect the sealing surfaces. Install new lower intake manifold to cylinder head seals (1).

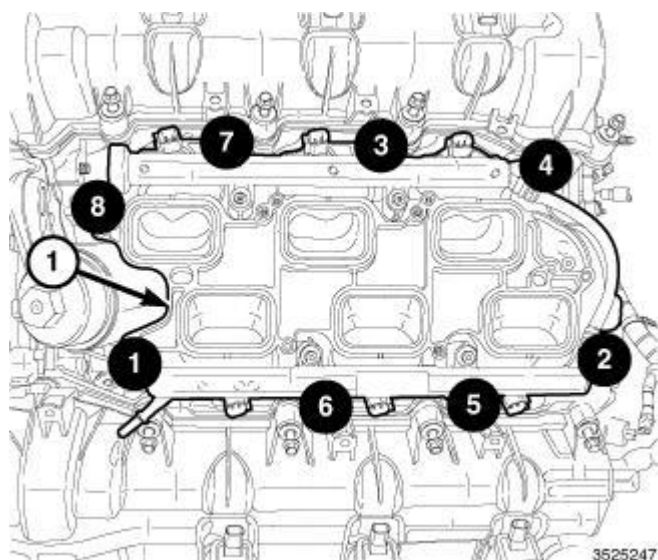


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**Fig. 594: Fuel Rail Bolt Tightening Sequence**

Courtesy of CHRYSLER GROUP, LLC

2. If removed, install the fuel injectors and the fuel rail (1) to the lower intake manifold. Tighten the four bolts in the sequence shown in illustration to 7 N.m (62 in. lbs.). Refer to **RAIL, FUEL, INSTALLATION**.

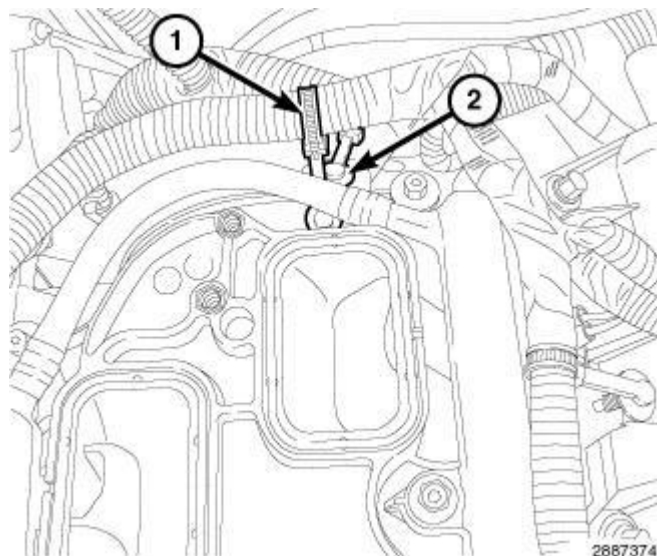


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**Fig. 595: Lower Intake Manifold Tightening Sequence**

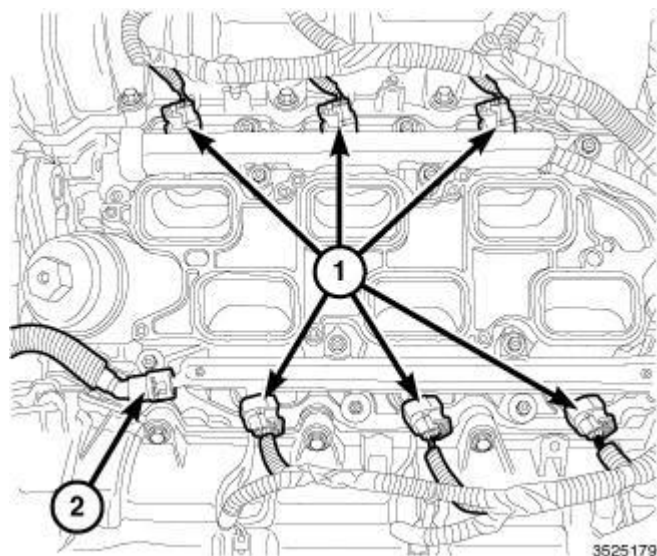
Courtesy of CHRYSLER GROUP, LLC

3. Position the lower intake manifold (1) on the cylinder head surfaces.
4. Install the manifold attaching bolts and tighten in the sequence shown in illustration to 8 N.m (71 in. lbs.).



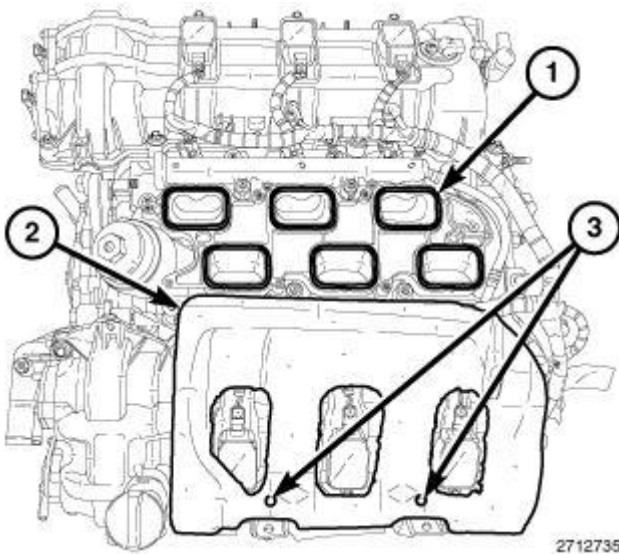
**Fig. 596: Injection/Ignition Harness Retainer & Main Wire Harness Retainer**  
Courtesy of CHRYSLER GROUP, LLC

5. Engage the main wire harness retainer (2) to the rear of the lower intake manifold.
6. Engage the injection/ignition harness retainer (1) to the rear of the lower intake manifold.



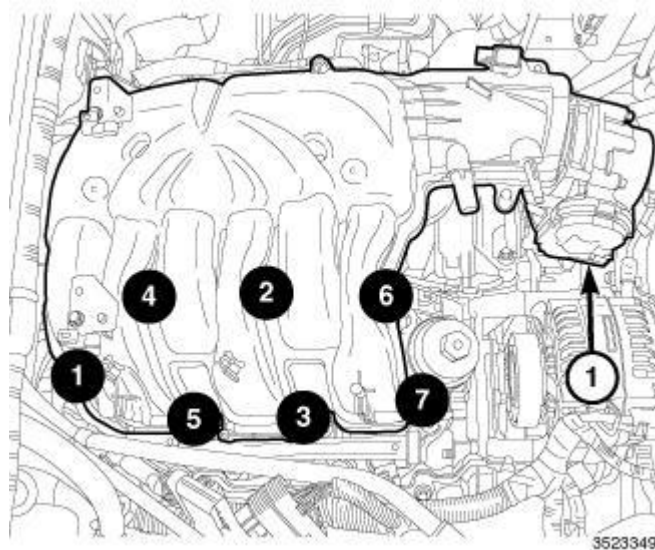
**Fig. 597: Fuel Supply Line And Connectors**  
Courtesy of CHRYSLER GROUP, LLC

7. Connect the fuel injector electrical connectors (1).
8. Connect the fuel supply hose (2) to the fuel rail. Refer to **FITTING, QUICK CONNECT** .



**Fig. 598: Intake Ports, Insulator & Alignment Posts**  
Courtesy of CHRYSLER GROUP, LLC

9. Install the insulator (2) to the two alignment posts (3) on top of the LH cylinder head cover.



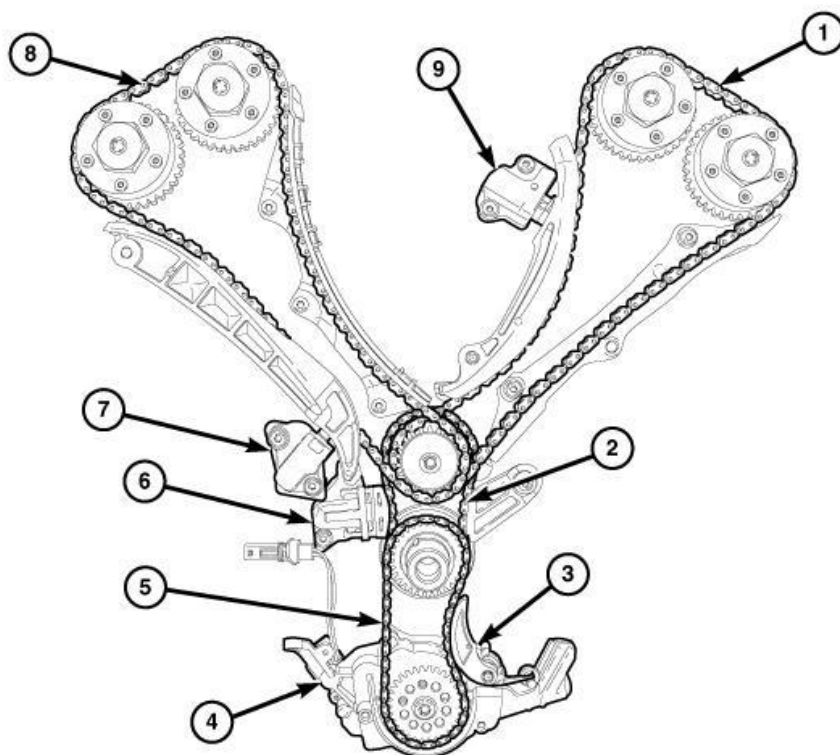
**Fig. 599: Upper Intake Manifold Tightening Sequence**  
Courtesy of CHRYSLER GROUP, LLC

10. Install the upper intake manifold (1), support brackets and air cleaner body. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
11. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
12. Start the engine and check for leaks.

## VALVE TIMING

### DESCRIPTION

## DESCRIPTION



2869852

**Fig. 600: Valve Timing System Components**  
 Courtesy of CHRYSLER GROUP, LLC

The timing drive uses four silent chains. The silent chain link design improves sprocket engagement and reduces noise, vibration and harshness (NVH). One chain (5) drives the oil pump (4) and three chains drive the camshafts in a two stage design. The left secondary camshaft chain (1) uses an oil pressure controlled chain tensioner (9) with a ratcheting device. The right secondary camshaft chain (8) uses an oil pressure controlled tensioner (7) without a ratchet. The primary chain (2) also uses an oil pressure controlled tensioner (6) without a ratchet. A spring loaded tensioner (3) takes up the slack in the oil pump chain (5). The chain guides and tensioner arms are made of glass filled nylon with nylon wear faces.

## OPERATION

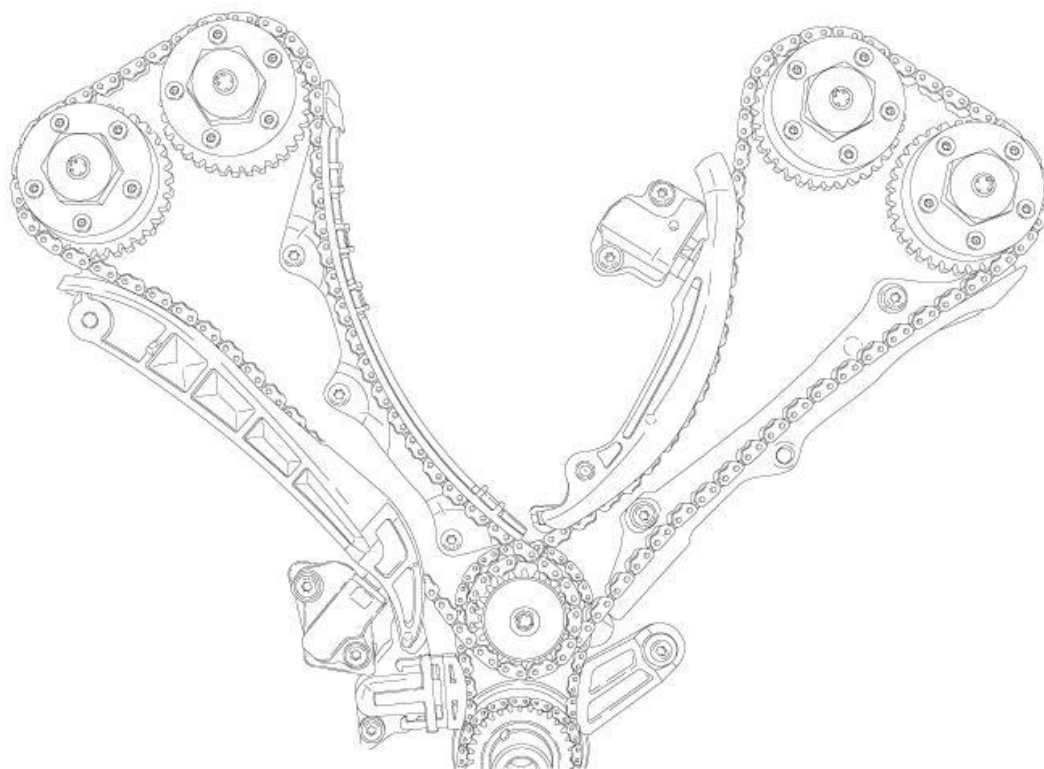
## OPERATION



2873481

**Fig. 601: Primary Chain, Idler Sprocket & Crankshaft Sprocket**  
**Courtesy of CHRYSLER GROUP, LLC**

The primary timing chain is a silent type. The primary chain drives the 28 tooth idler sprocket directly from a 21 tooth crankshaft sprocket. This results in a 75% speed reduction to the idler sprocket. The idler sprocket assembly connects the primary chain drive and the secondary chain drive. The idler sprocket assembly consists of two integral 22 tooth sprockets a 28 tooth sprocket. The idler sprocket assembly spins on a stationary idler shaft. The idler shaft is a light press-fit into the cylinder block. A large washer on the idler shaft bolt and the rear flange of the idler shaft are used to control sprocket thrust movement. Pressurized oil is routed through the center of the idler shaft to provide lubrication for the bushings used in the idler sprocket assembly. Primary chain motion is controlled by a hydraulic oil damped tensioner and a fixed guide. The tensioner and the guide both use nylon plastic wear faces for low friction and long wear. The primary chain receives oil splash lubrication.



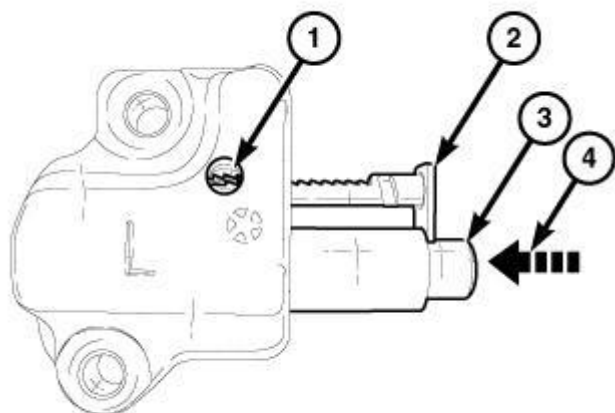
**Fig. 602: Secondary Drive Chains**

Courtesy of CHRYSLER GROUP, LLC

There are two identical secondary drive chains, both are silent type, one to drive the camshafts in each double overhead cam (DOHC) cylinder head. The secondary chains drive the 33 tooth camshaft sprockets directly from the 22 tooth idler sprockets. This speed reduction combined with the crankshaft to idler sprocket speed reduction produces the required 2:1 camshaft drive ratio. A fixed chain guide and a hydraulic oil damped tensioner are used to maintain tension in each secondary chain system. The left hydraulic secondary chain tensioner is fed from the main oil gallery through the cylinder head. The right hydraulic secondary chain tensioner is fed from the number one main bearing journal. Each tensioner incorporates a controlled leak path through a device known as a vent disc located in the nose of the piston to manage chain loads. Only the left tensioner has a mechanical ratchet system that limits chain slack if the tensioner piston bleeds down after engine shut down. The tensioner arms and guides also utilize nylon wear faces for low friction and long wear. The two secondary timing chains are lubricated by holes in the oil controlled tensioners that spray oil through an opening in the tensioner arms. The holes are protected from clogging by a fine mesh screen which is located on the back of the hydraulic tensioners.

## STANDARD PROCEDURE

### RESETTING LEFT CAM CHAIN TENSIONER

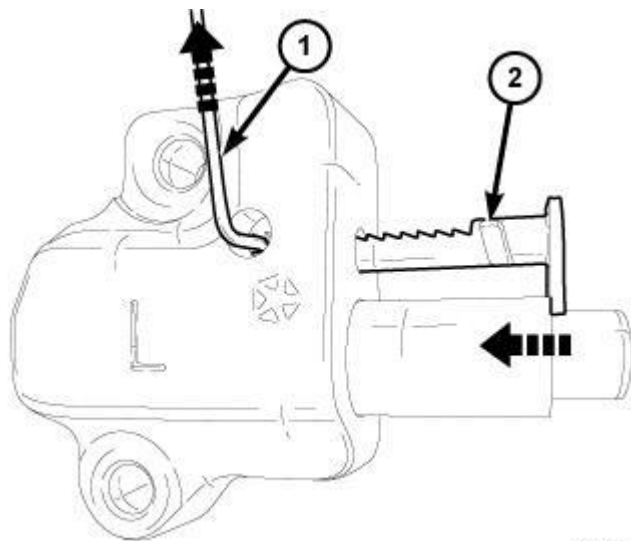


2661778

**Fig. 603: Left Side Cam Chain Tensioner Ratchet Components**  
Courtesy of CHRYSLER GROUP, LLC

The left side cam chain tensioner used on the 3.6L engine is equipped with a ratchet. The ratchet consists of a rack (2) and a pawl (1). In use, the rack (2) extends with the piston (3) from the tensioner body. The pawl (1) will not allow the rack (2) to retract back into the tensioner body. In order to reset the tensioner, the pawl (1) must be disengaged from the rack (2) so that the piston (3) and rack (2) can be pushed back (4) into the tensioner body.

**WITH ENGINE TIMING COVER REMOVED**



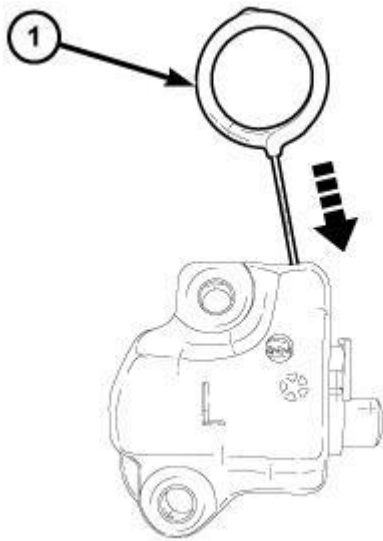
2661831

**Fig. 604: Locating Slot In Rack & Allen Wrench**  
Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The slot (2) in the rack provides an anchor point for a pin that holds the rack in the retracted position.



1. Using a suitable tool, such as an allen wrench (1), lift the pawl off of the rack.
2. While holding the pawl off of the rack, push the rack and the piston into the tensioner body.

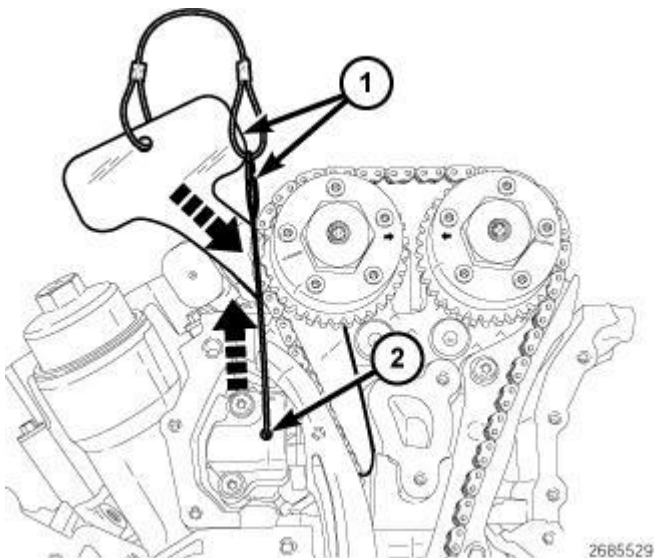


2681934

**Fig. 605: Inserting Tensioner Pin To Hold Rack & Piston In Retracted Position**  
 Courtesy of CHRYSLER GROUP, LLC

3. When the slot is aligned with the hole in the tensioner body, insert Tensioner Pin (special tool #8514, Pins, Tensioner) (1) to hold the rack and piston in the retracted position.

**WITH ENGINE TIMING COVER INSTALLED**

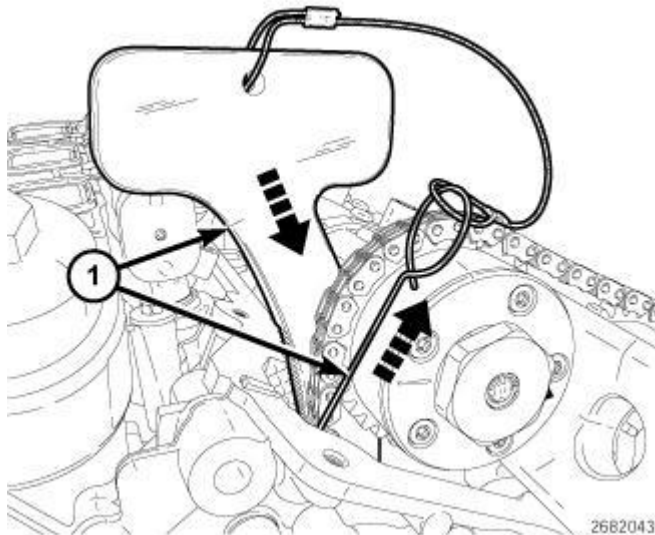


2685529

**Fig. 606: Pin, Rack & Timing Chain Holder**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** Graphic shows timing cover removed for clarity.

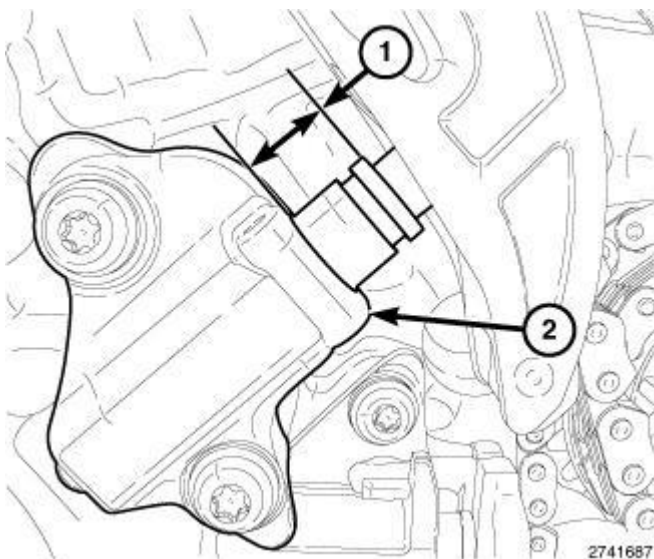
1. Using (special tool #10200-3, Pin) (2), lift the pawl off of the rack (3).



**Fig. 607: Positioning Timing Chain Holder To Force Rack & Piston Back Into Tensioner Body**  
Courtesy of CHRYSLER GROUP, LLC

2. While holding the pawl off of the rack, push (special tool #10200-1, Holder, Timing Chain, Left Side) (1) into place between the cylinder head and the cam chain guide to force the rack and piston back into the tensioner body. The holder must remain in place during service to keep the rack and piston in the retracted position.

#### MEASURING TIMING CHAIN WEAR

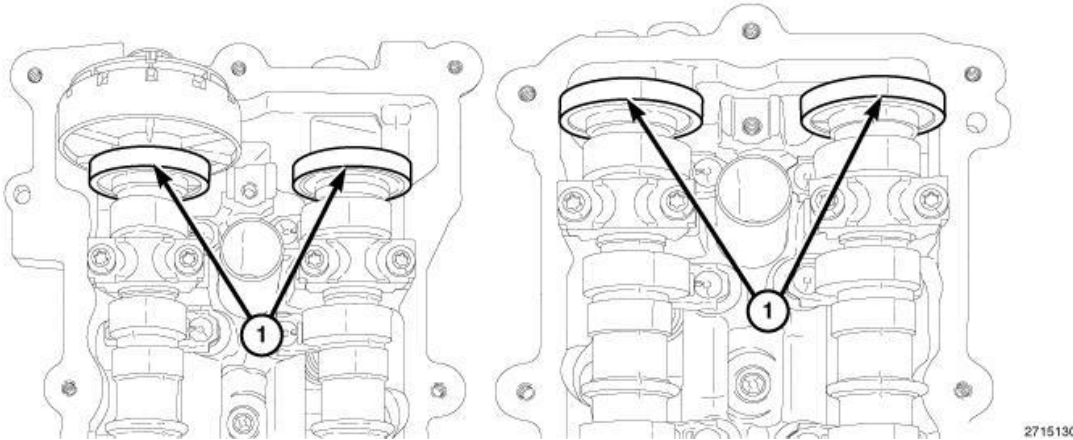


**Fig. 608: Piston Extension & RH Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

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

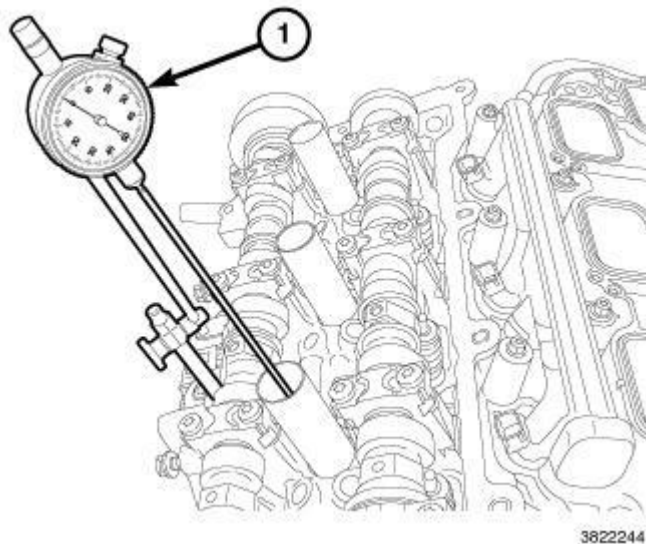
2. To determine if the timing chains are worn, rotate the crankshaft clockwise until maximum tensioner piston extension (1) is obtained on the RH cam chain tensioner (2). Measure the distance between the secondary timing chain tensioner housing and the step ledge on the tensioner piston (1). Piston extension (1) must be less than 16 mm (0.630 in.).
3. Piston extension greater than 16 mm (0.630 in.) indicates that all timing chains are worn and require replacement. Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.

#### ENGINE TIMING VERIFICATION



**Fig. 609: Magnetic Timing Wheels**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



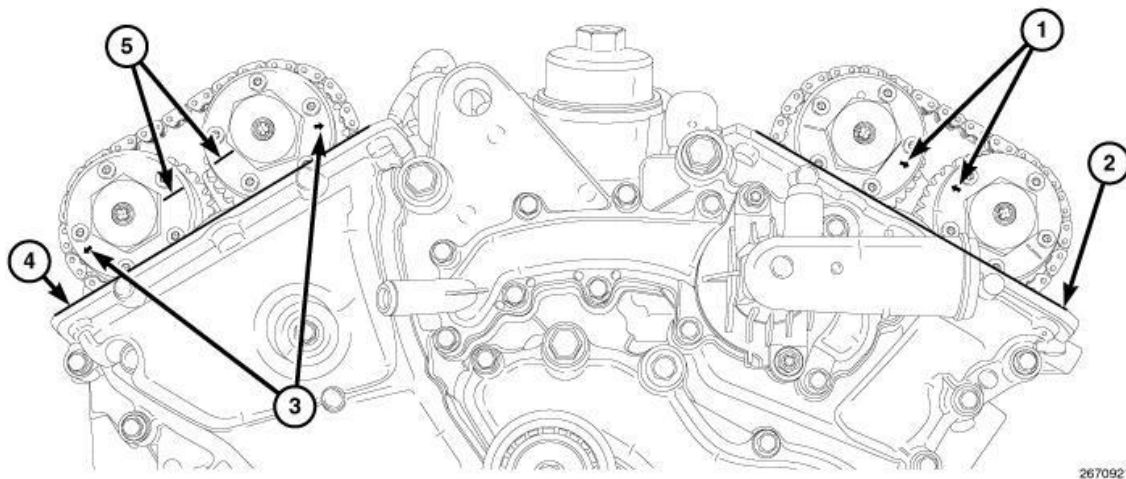
**Fig. 610: Mount Dial Indicator Set To Stationary Point On Engine**  
Courtesy of CHRYSLER GROUP, LLC

Correct timing is critical for the NON free-wheeling designed, 3.6L engine. Engine timing can be verified by using the following procedures:

1. Remove the upper intake manifold and both cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
2. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL**.

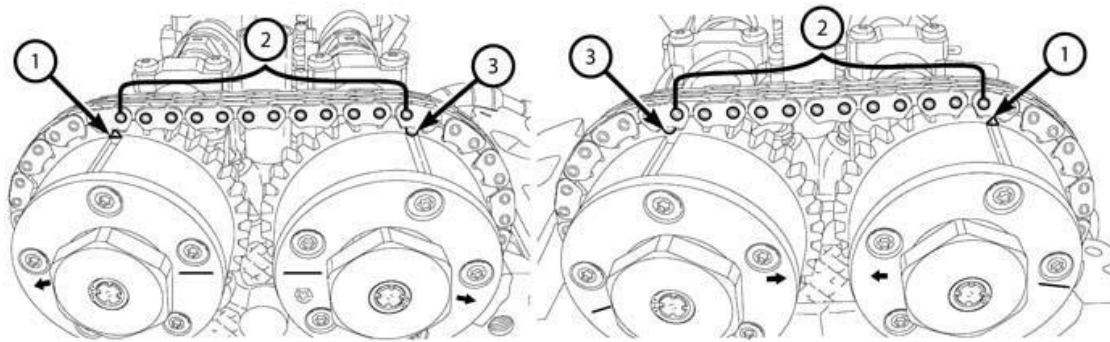
**CAUTION: When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.**

3. Mount Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) (1) to a stationary point on the engine, such as the cylinder head cover mounting surface. Position the indicator probe into the number one cylinder, rotate the crankshaft clockwise (as viewed from the front) to place the number one piston at top-dead-center on the exhaust stroke and set the indicator dial to **ZERO**.



**Fig. 611: Arrows, Scribe Lines & Cam Phasers**  
Courtesy of CHRYSLER GROUP, LLC

4. While maintaining this alignment, verify that the **ARROWS** (1) on the left side cam phasers point toward each other and are parallel to the cylinder head cover mounting surface (2) and that the right side cam phaser **ARROWS** (3) point away from each other and the **SCRIBE LINES** (5) are parallel to the cylinder head cover mounting surface (4).



2714685

**Fig. 612: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking**  
Courtesy of CHRYSLER GROUP, LLC

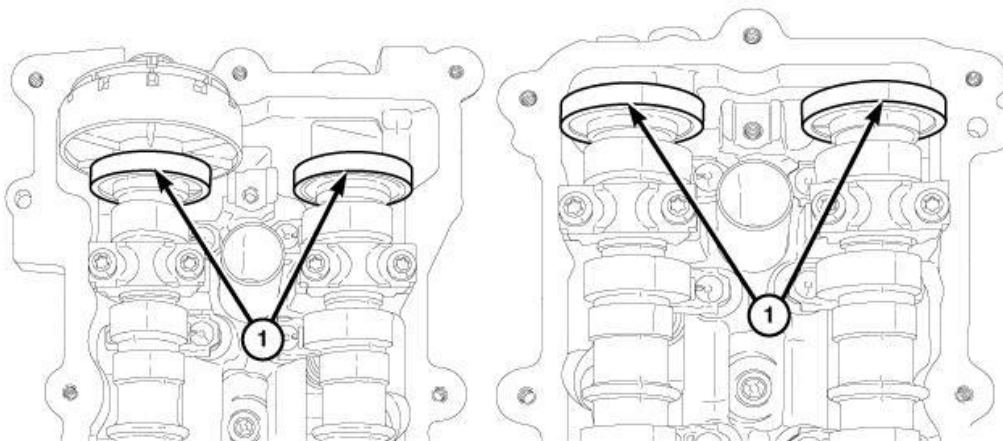
**NOTE:** The phaser markings (1 and 3) could align with either an external or internal chain link. Either alignment is acceptable as long as there are twelve chain pins between the markings.

5. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3) as viewed from either the front or rear of the cam phasers.
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

### REMOVAL

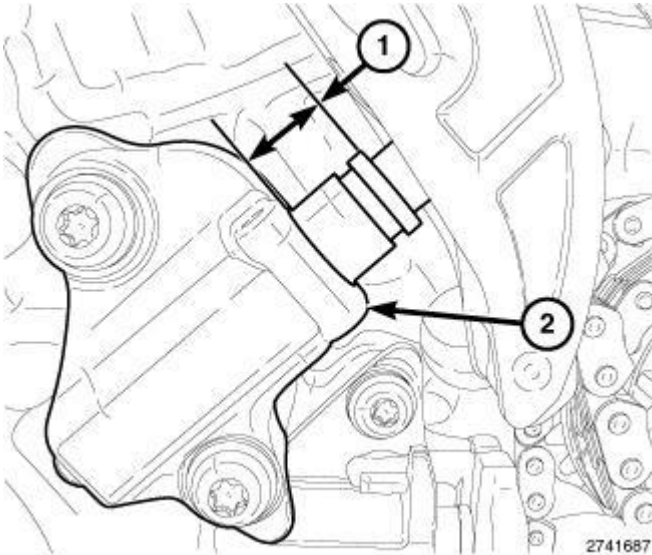


2715130

**Fig. 613: Magnetic Timing Wheels**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets

(pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.



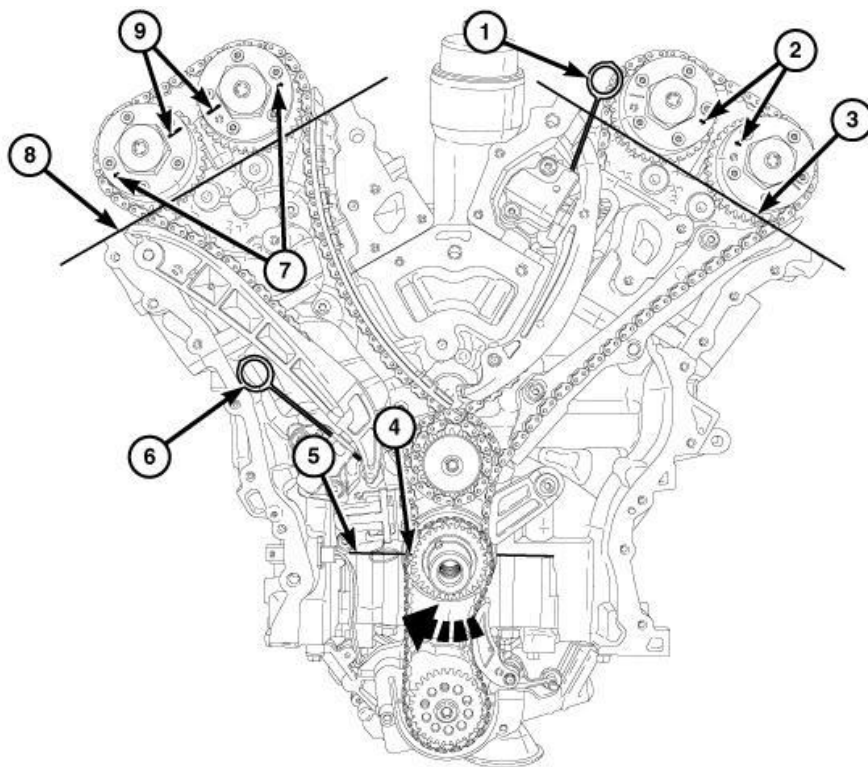
**Fig. 614: Piston Extension & RH Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

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

**NOTE:** The Variable Valve Timing (VVT) assemblies (Phasers) and Oil Control Valves (OCVs) can be serviced without removing the engine timing cover. Refer to **ASSEMBLY, VARIABLE VALVE TIMING, PHASER / OIL CONTROL VALVE, REMOVAL.**

1. Disconnect and isolate the negative battery cable.
2. Remove the air cleaner housing assembly and upper intake manifold. Refer to **MANIFOLD, INTAKE, REMOVAL.**
3. Remove both cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, REMOVAL.**
4. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL .**
5. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE .**
6. Drain the cooling system. Refer to **STANDARD PROCEDURE** .
7. Remove the oil pan, accessory drive belts, crankshaft vibration damper and engine timing cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL.**

**NOTE:** Take this opportunity to measure timing chain wear. Refer to **Engine/Valve Timing - Standard Procedure.**

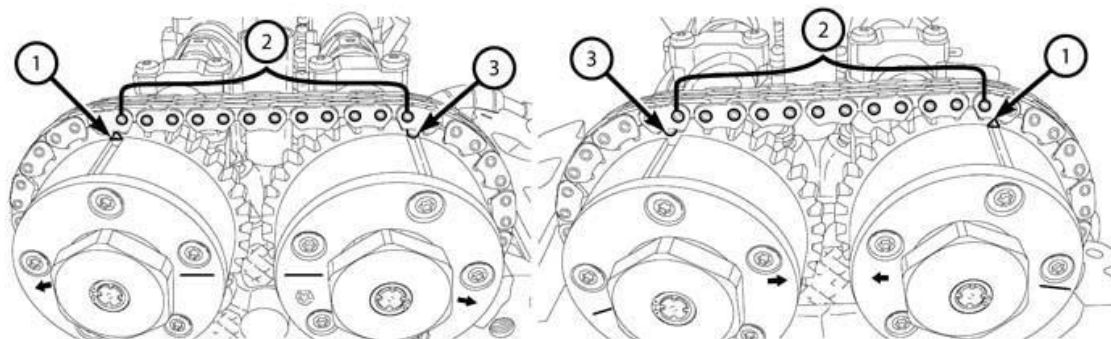


2661245

**Fig. 615: Rotating Crankshaft Clockwise To Position No. 1 Piston At TDC On Exhaust Stroke**  
Courtesy of CHRYSLER GROUP, LLC

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

8. Rotate the crankshaft clockwise (as viewed from the front) to place the number one cylinder piston at top-dead-center on the exhaust stroke by aligning the dimple (4) on the crankshaft with the block/bearing cap junction (5).
9. While maintaining this alignment, verify that the **ARROWS** (2) on the left side cam phasers point toward each other and are parallel to the cylinder head cover mounting surface (3) and that the right side cam phaser **ARROWS** (7) point away from each other and the **SCRIBE LINES** (9) are parallel to the cylinder head cover mounting surface (8).



2714685

**Fig. 616: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking**  
Courtesy of CHRYSLER GROUP, LLC

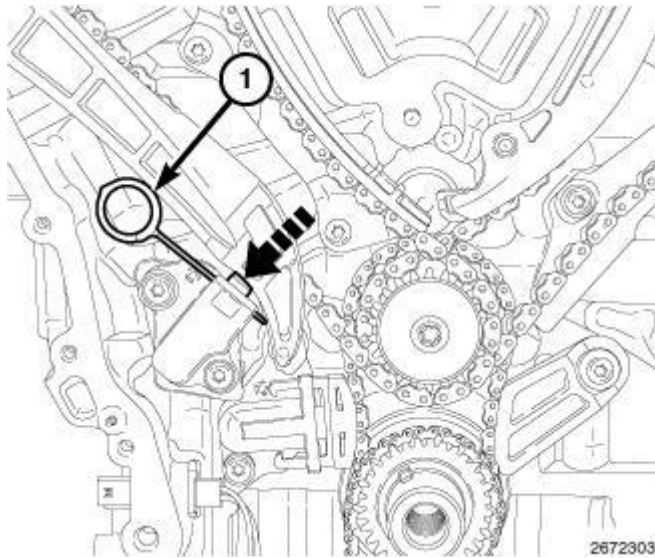
**NOTE:** The phaser markings (1 and 3) could align with either an external or internal chain link. Either alignment is acceptable as long as there are twelve chain pins between the markings.

10. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3) as viewed from either the front or rear of the cam phasers.

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

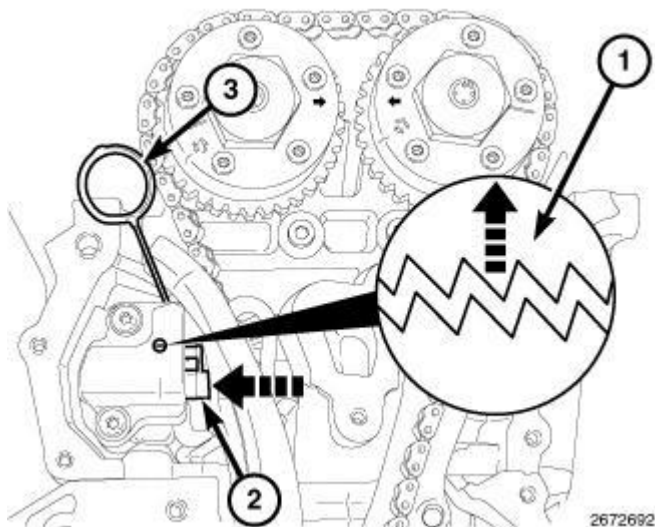
11. Mark the direction of rotation on the following timing chains using a paint pen or equivalent to aid in reassembly:
- Left side cam chain
  - Right side cam chain
  - Oil pump chain
  - Primary chain





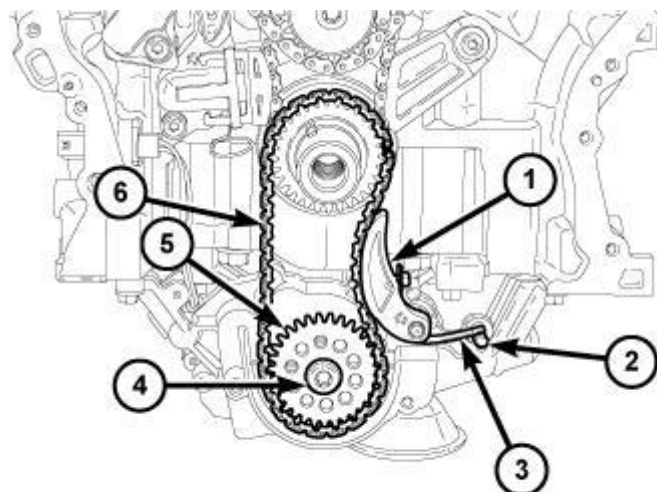
**Fig. 617: Resetting Right Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

12. Reset the right side cam chain tensioner by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (1).



**Fig. 618: Resetting Left Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

13. Reset the left side cam chain tensioner by lifting the pawl (1), pushing back the piston (2) and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (3). Refer to **Engine/Valve Timing - Standard Procedure**.

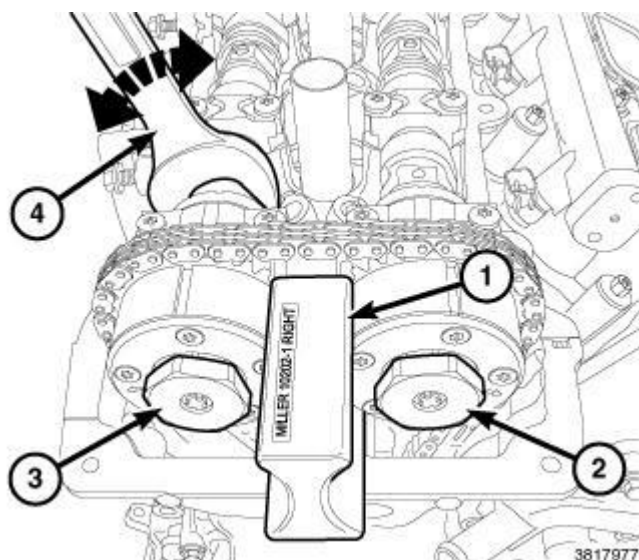


2662471

**Fig. 619: Oil Pump Chain Tensioner, Spring, Retaining Bolt, Dowel Pin, Oil Pump Sprocket & Oil Pump Chain**

Courtesy of CHRYSLER GROUP, LLC

14. Disengage the oil pump chain tensioner spring (3) from the dowel pin (2) and remove the oil pump chain tensioner (1).
15. Remove the oil pump sprocket T45 retaining bolt (4) and remove the oil pump sprocket (5) and oil pump chain (6).



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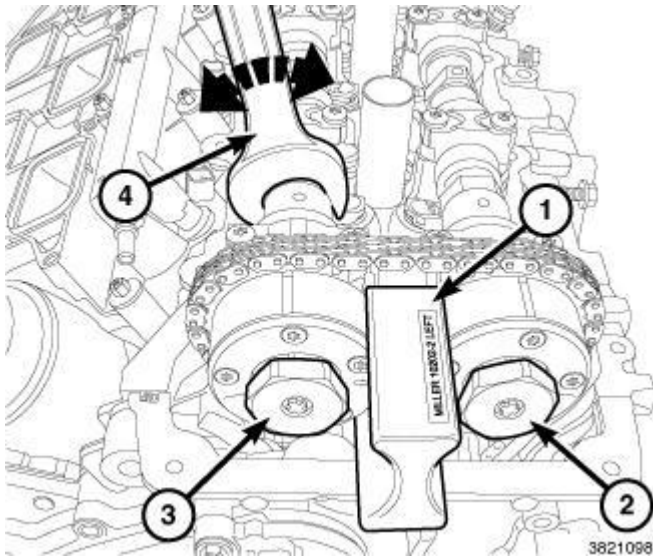
**Fig. 620: Camshaft Phaser Lock, Oil Control Valves & Wrench**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (4) when installing the camshaft phaser lock.

16. Install the (special tool #10202-1, Lock, Camshaft/Phaser, Right Side) (1) with the tool number facing up.

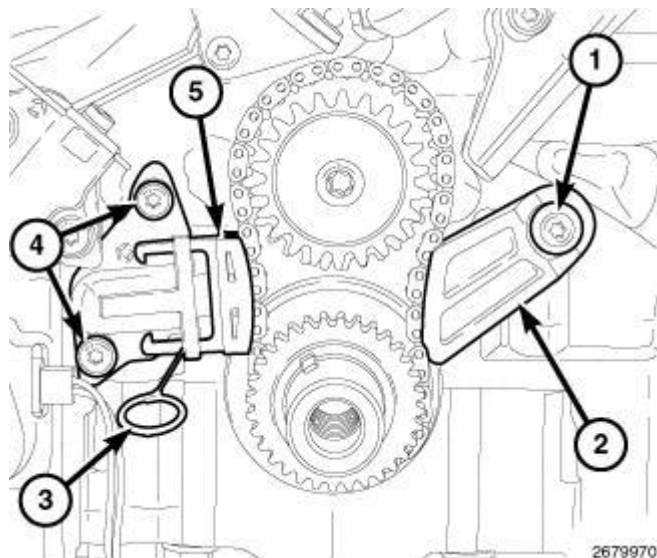
17. Loosen, but do not remove, the exhaust oil control valve (3) and the intake oil control valve (2).
18. Remove the (special tool #10202-1, Lock, Camshaft/Phaser, Right Side) (1).
19. Remove the oil control valve (2) from the right side intake cam phaser.
20. Pull the right side intake cam phaser off of the camshaft and remove the right side cam chain.
21. If required, remove the oil control valve (3) and pull the right side exhaust cam phaser off of the camshaft.



**Fig. 621: Camshaft Phaser Lock, Oil Control Valves & Wrench**  
 Courtesy of CHRYSLER GROUP, LLC

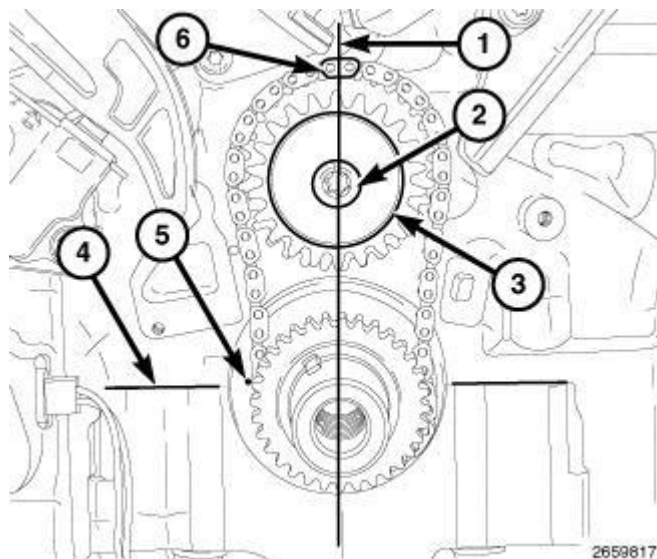
**NOTE:** It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (4) when installing the camshaft phaser lock.

22. Install the (special tool #10202-2, Lock, Camshaft/Phaser, Left Side) (1) with the tool number facing up.
23. Loosen, but do not remove, the exhaust oil control valve (2) and the intake oil control valve (3).
24. Remove the (special tool #10202-2, Lock, Camshaft/Phaser, Left Side) (1).
25. Remove the oil control valve (2) from the left side exhaust cam phaser.
26. Pull the left side exhaust cam phaser off of the camshaft and remove the left side cam chain.
27. If required, remove the oil control valve (3) and pull the left side intake cam phaser off of the camshaft.



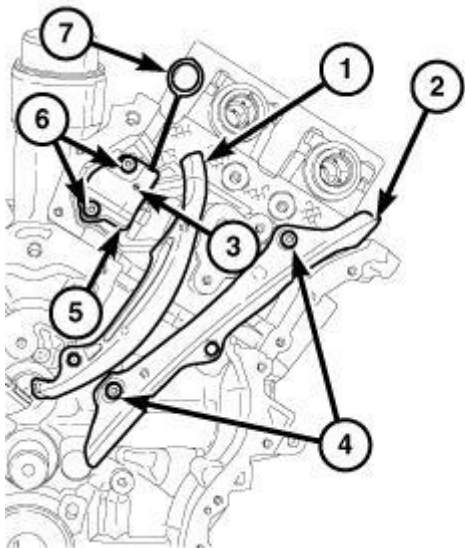
**Fig. 622: Primary Chain Tensioner, Tensioner Pin, Primary Chain Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

28. Reset the primary chain tensioner (5) by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (3). Remove two T30 bolts (4) and remove the primary chain tensioner.
29. Remove the T30 bolt (1) and the primary chain guide (2).



**Fig. 623: Timing Chain Plated Link At 12 O'Clock, Washer, Retaining Bolt, Block/Bearing Cap Junction & Dimple**  
Courtesy of CHRYSLER GROUP, LLC

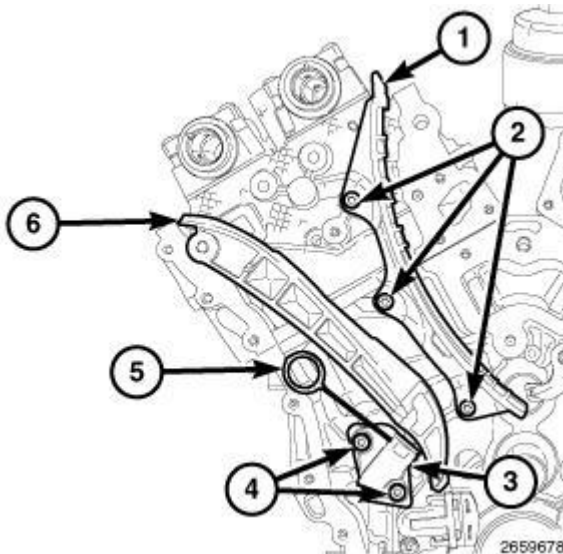
30. Remove the idler sprocket T45 retaining bolt (2) and washer (3).
31. Remove the primary chain, idler sprocket and crankshaft sprocket as an assembly.



2659731

**Fig. 624: Left Cam Chain Tensioner, Arm, Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

32. If required, remove two T30 bolts (6) and the left side cam chain tensioner (5).
33. If required, remove two T30 bolts (4) and the left side cam chain guide (2) and tensioner arm (1).



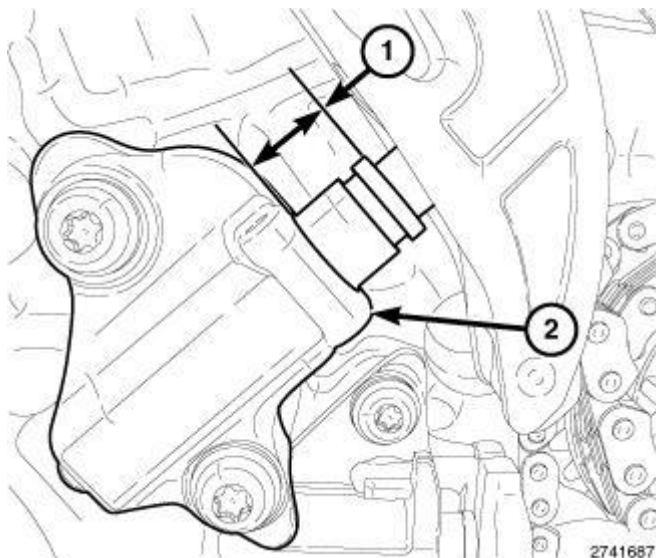
2659678

**Fig. 625: Right Cam Chain Tensioner, Arm, Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

34. If required, remove two T30 bolts (4) and the right side cam chain tensioner (3).
35. If required, remove three T30 bolts (2) and the right side cam chain guide (1) and tensioner arm (6).
36. Inspect all sprockets and chain guides. Replace if damaged.

## INSPECTION

## INSPECTION



**Fig. 626: Piston Extension & RH Cam Chain Tensioner**  
Courtesy of CHRYSLER GROUP, LLC

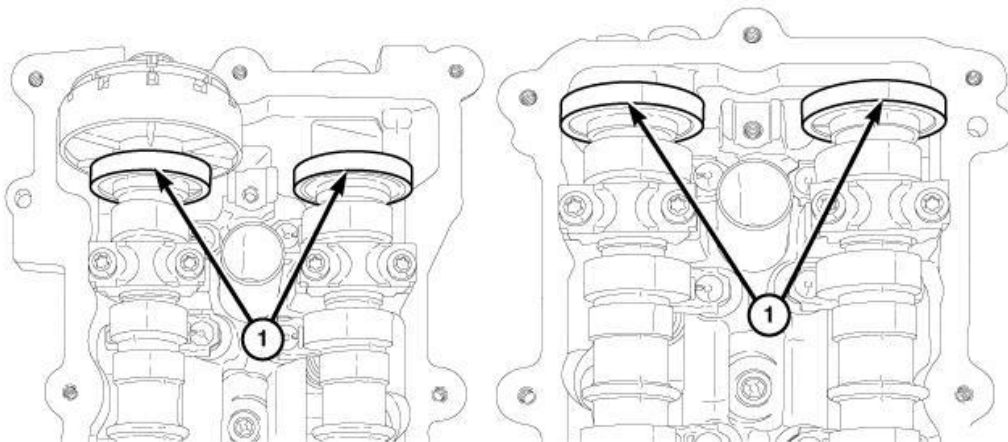
Prior to disassembly of the timing chains and sprockets, measure the timing chain wear (1). Refer to **Engine/Valve Timing - Standard Procedure**.

Inspect the following valve timing components:

- Sprockets for excessive tooth wear. Some tooth markings are normal and not a cause for sprocket replacement.
- Idler sprocket assembly bushing and shaft for excessive wear.
- Chain guides and tensioner arms. Replace these parts if grooving in plastic face is more than 1 mm (0.039 in.) deep.
- Secondary chain tensioner piston and ratcheting device. Inspect for evidence of heavy contact between tensioner piston and tensioner arm. If this condition exist the tensioner arm and chain should be replaced.
- Primary chain tensioner plastic faces. Replace as required.

## INSTALLATION

## INSTALLATION

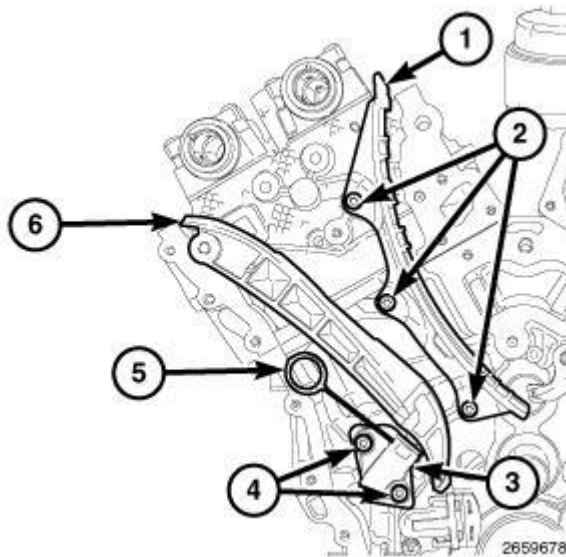


2715130

**Fig. 627: Magnetic Timing Wheels**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** The magnetic timing wheels (1) must not come in contact with magnets (pickup tools, trays, etc.) or any other strong magnetic field. This will destroy the timing wheels ability to correctly relay camshaft position to the camshaft position sensor.

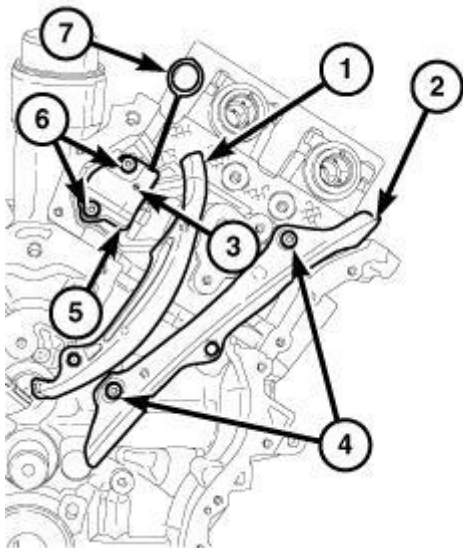


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**Fig. 628: Right Cam Chain Tensioner, Arm, Guide & Bolts**

Courtesy of CHRYSLER GROUP, LLC

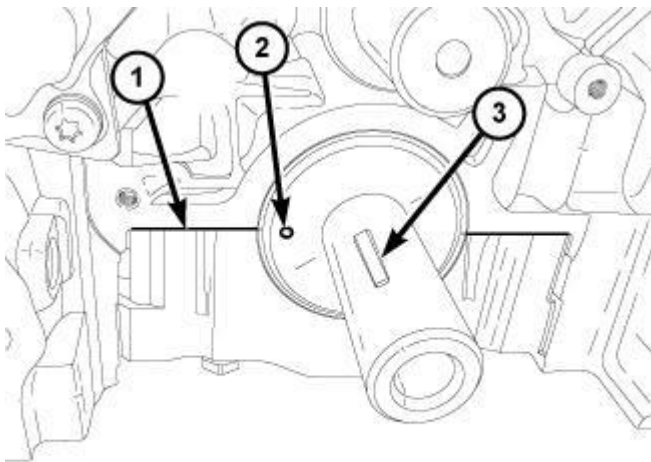
1. Inspect all sprockets and chain guides. Replace if damaged.
2. If removed, install the right side cam chain guide (1) and tensioner arm (6). Tighten attaching T30 bolts (2) to 12 N.m (106 in. lbs.).
3. If removed, install the right side cam chain tensioner (3) to the engine block with two bolts (4). Tighten the T30 bolts (4) to 12 N.m (106 in. lbs.).
4. Reset the right side cam chain tensioner (3) by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (5).



2659731

**Fig. 629: Left Cam Chain Tensioner, Arm, Guide & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

5. If removed, install the left side cam chain guide (2) and tensioner arm (1). Tighten attaching T30 bolts (4) to 12 N.m (106 in. lbs.).
6. If removed, install the left side cam chain tensioner (5) to the cylinder head with two bolts (6). Tighten the T30 bolts (6) to 12 N.m (106 in. lbs.).
7. Reset the left side cam chain tensioner (5) by lifting the pawl (3), pushing back the piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (7). Refer to **Engine/Valve Timing - Standard Procedure**.



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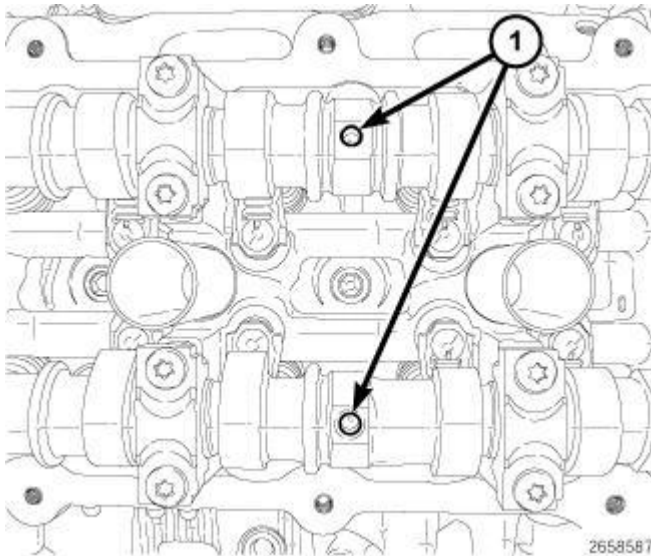
**Fig. 630: Crankshaft Key, Dimple & Block/Bearing Cap Junction**  
Courtesy of CHRYSLER GROUP, LLC

8. Verify that the key (3) is installed in the crankshaft.



**CAUTION:** Do not rotate the crankshaft more than a few degrees independently of the camshafts. Piston to valve contact could occur resulting in possible valve damage. If the crankshaft needs to be rotated more than a few degrees, first remove the camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL.

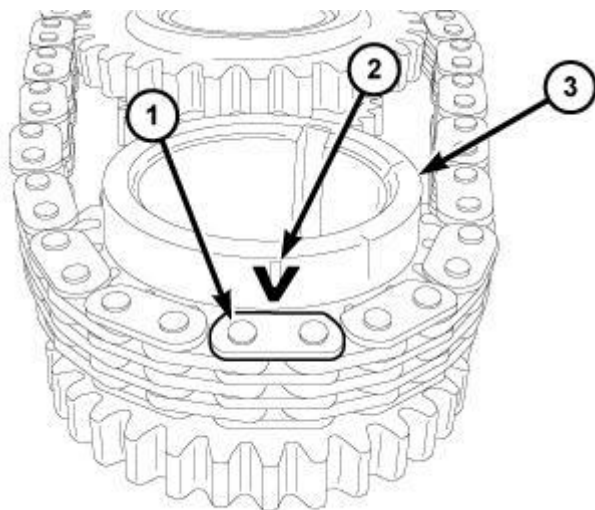
- 9.
10. Verify that the number one cylinder piston is positioned at top-dead-center by aligning the dimple (2) on the crankshaft with the block/bearing cap junction (1).



**Fig. 631: Positioning Camshaft Alignment Holes Vertically**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not rotate the camshafts more than a few degrees independently of the crankshaft. Valve to piston contact could occur resulting in possible valve damage. If the camshafts need to be rotated more than a few degrees, first move the pistons away from the cylinder heads by rotating the crankshaft counterclockwise to a position 30° before-top-dead-center. Once the camshafts are returned to their top-dead-center position, rotate the crankshaft clockwise to return the crankshaft to top-dead-center.

- 11.
12. Verify that the camshafts are set at top-dead-center by positioning the alignment holes (1) vertically.



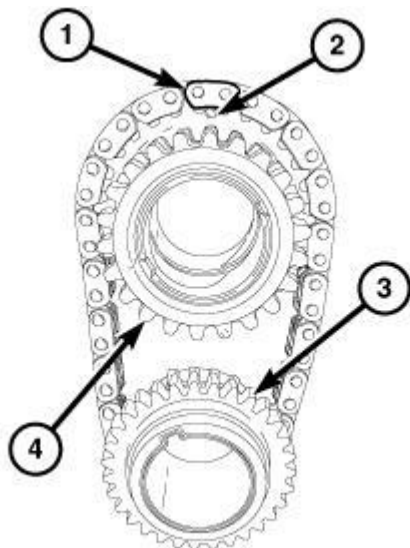
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**Fig. 632: Aligning Arrow With Plated Link On Primary Chain**

Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

13. Place the primary chain onto the crankshaft sprocket (3) so that the arrow (2) is aligned with the plated link (1) on the timing chain.



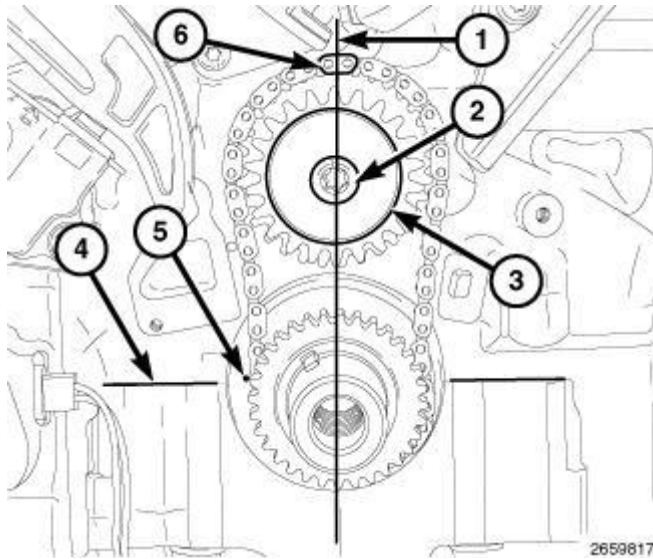
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**Fig. 633: Placing Idler Sprocket Into Timing Chain So That Dimple Is Aligned With Plated Link On Timing Chain**

Courtesy of CHRYSLER GROUP, LLC

14. While maintaining this alignment, invert the crankshaft sprocket and timing chain and place the idler

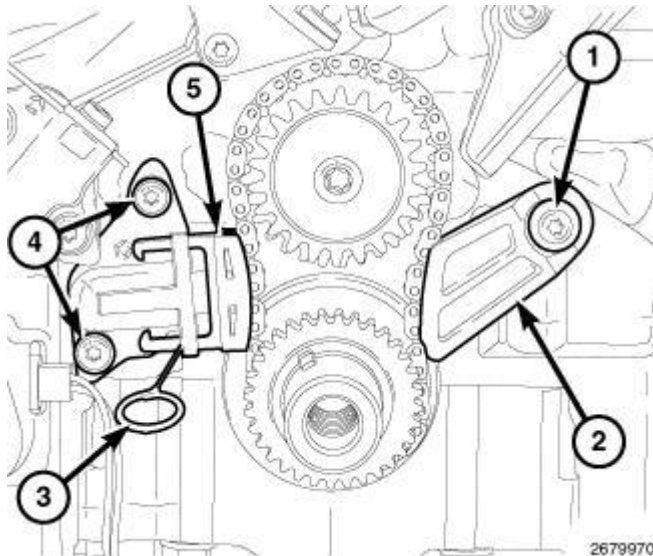
sprocket (4) into the timing chain so that the dimple (2) is aligned with the plated link (1) on the timing chain.



**Fig. 634: Timing Chain Plated Link At 12 O'Clock, Washer, Retaining Bolt, Block/Bearing Cap Junction & Dimple**

Courtesy of CHRYSLER GROUP, LLC

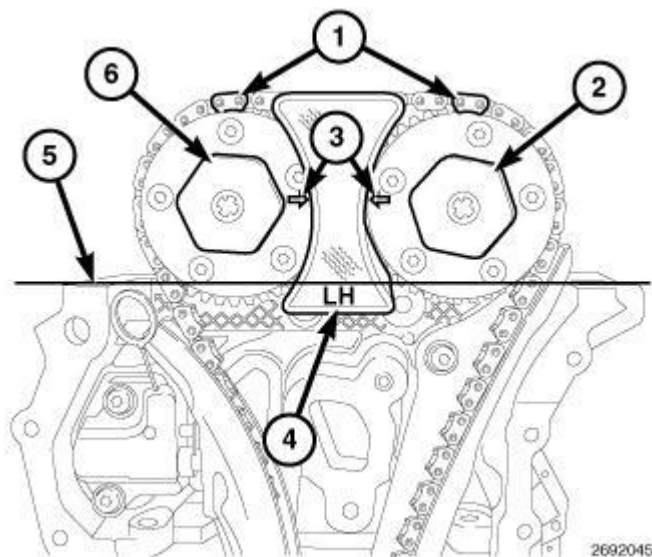
15. While maintaining this alignment, lubricate the idler sprocket bushing with clean engine oil and install the sprockets and timing chain on the engine. To verify that the timing is still correct, the timing chain plated link (6) should be located at 12:00 (1) when the dimple (5) on the crankshaft is aligned with the block/bearing cap junction (4).
16. Install the idler sprocket retaining bolt (2) and washer (3). Tighten the T45 bolt (2) to 25 N.m (18 ft. lbs.).



**Fig. 635: Primary Chain Tensioner, Tensioner Pin, Primary Chain Guide & Bolts**

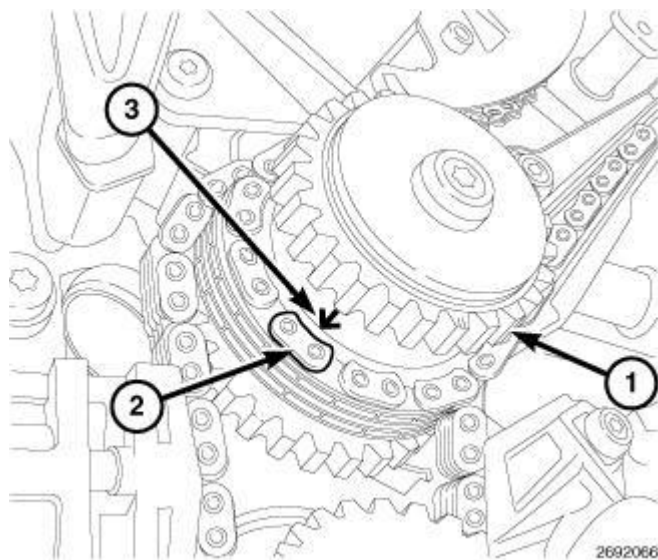
Courtesy of CHRYSLER GROUP, LLC

17. Install the primary chain guide (2). Tighten attaching T30 bolt (1) to 12 N.m (106 in. lbs.).
18. Reset the primary chain tensioner (5) by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (3).
19. Install the primary chain tensioner (5) to the engine block with two bolts (4). Tighten the T30 bolts (4) to 12 N.m (106 in. lbs.) and remove the Tensioner Pin (special tool #8514, Pins, Tensioner) (3).



**Fig. 636: Phaser Timing Marks, Oil Control Valves & LH Camshaft Phaser Lock**  
 Courtesy of CHRYSLER GROUP, LLC

20. Press the left side intake cam phaser onto the intake camshaft. Install and hand tighten the oil control valve (6).

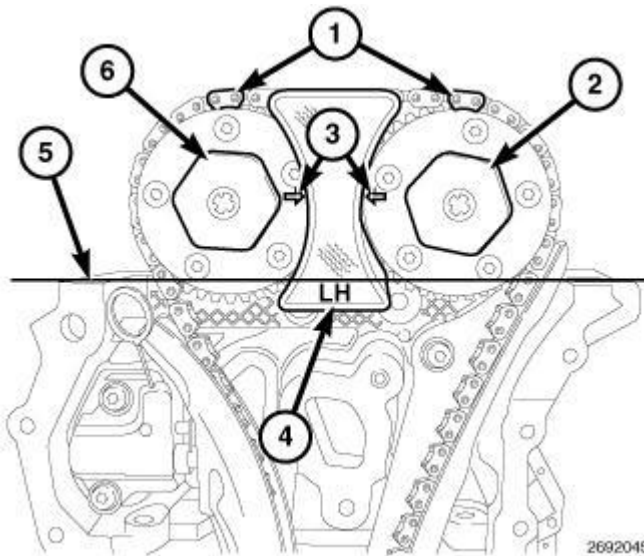


**Fig. 637: Idler Sprocket, Plated Link & Arrow**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** The left side and right side cam chains are identical.

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

21. Drape the left side cam chain over the left side intake cam phaser and onto the idler sprocket (1) so that the arrow (3) is aligned with the plated link (2) on the cam chain.

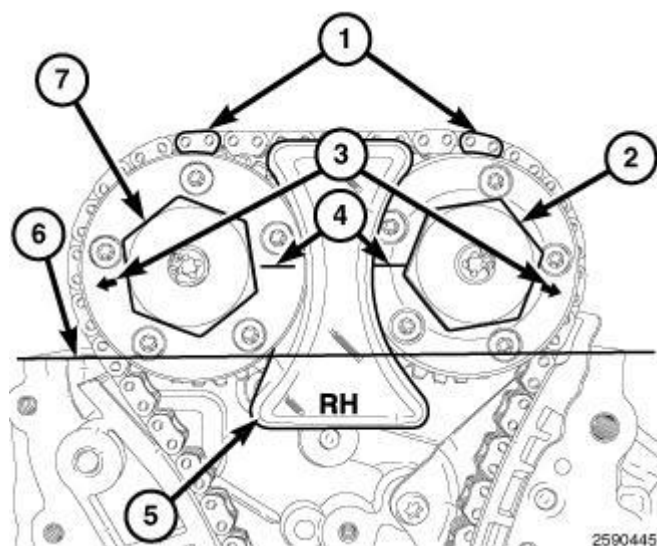


**Fig. 638: Phaser Timing Marks, Oil Control Valves & LH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

22. While maintaining this alignment, route the cam chain around the exhaust and intake cam phasers so that the plated links are aligned with the phaser timing marks (1). Position the left side cam phasers so that the arrows (3) point toward each other and are parallel to the cylinder head cover mounting surface (5). Press the exhaust cam phaser onto the exhaust cam, install and hand tighten the oil control valve (2).

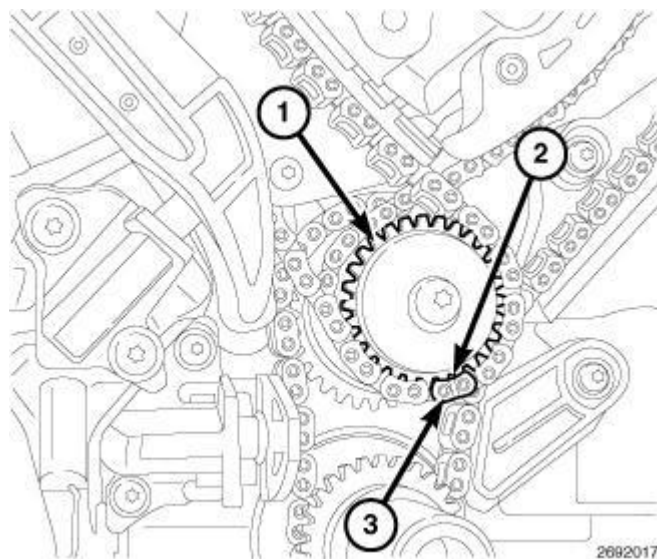
**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the camshaft phaser or phaser lock.

23. Install the (special tool #10202-2, Lock, Camshaft/Phaser, Left Side) (4) with the tool number facing up.  
24. Tighten the oil control valves (2) and (6) to 150 N.m (110 ft. lbs.).  
25. Remove the Camshaft Phaser Lock (4).



**Fig. 639: Phaser Timing Marks, Oil Control Valves & RH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

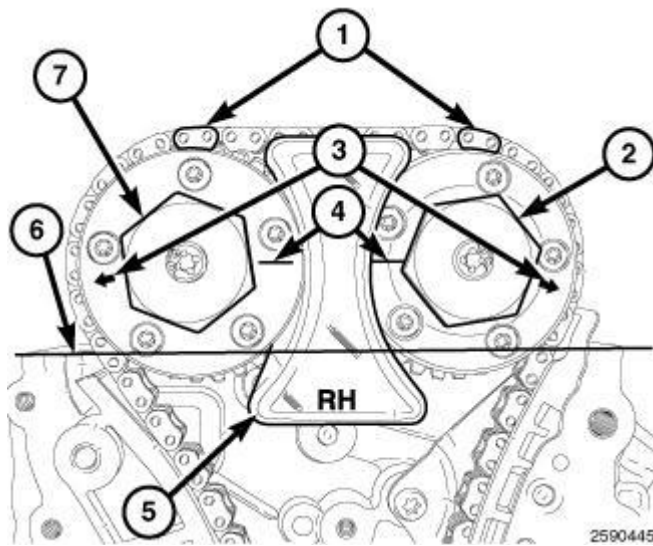
26. Press the right side exhaust cam phaser onto the exhaust camshaft. Install and hand tighten the oil control valve (7).



**Fig. 640: Idler Sprocket, Dimple & Plated Link**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

27. Drape the right side cam chain over the right side exhaust cam phaser and onto the idler sprocket (1) so that the dimple (2) is aligned with the plated link (3) on the cam chain.

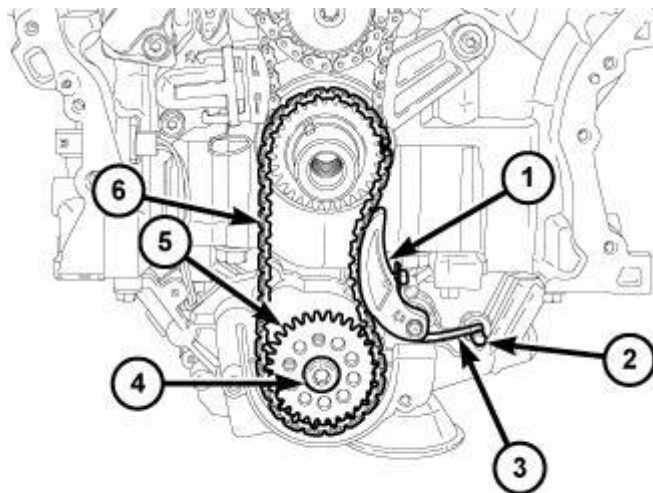


**Fig. 641: Phaser Timing Marks, Oil Control Valves & RH Camshaft Phaser Lock**  
Courtesy of CHRYSLER GROUP, LLC

28. While maintaining this alignment, route the cam chain around the exhaust and intake cam phasers so that the plated links are aligned with the phaser timing marks (1). Position the right side cam phasers so that the arrows (3) point away from each other and the scribe lines (4) are parallel to the cylinder head cover mounting surface (6). Press the intake cam phaser onto the intake cam, install and hand tighten the oil control valve (2).

**NOTE:** Minor rotation of a camshaft (a few degrees) may be required to install the camshaft phaser or phaser lock.

29. Install the (special tool #10202-1, Lock, Camshaft/Phaser, Right Side) (5) with the tool number facing up.
30. Tighten the oil control valves (2) and (7) to 150 N.m (110 ft. lbs.).
31. Remove the Camshaft Phaser Lock (5).

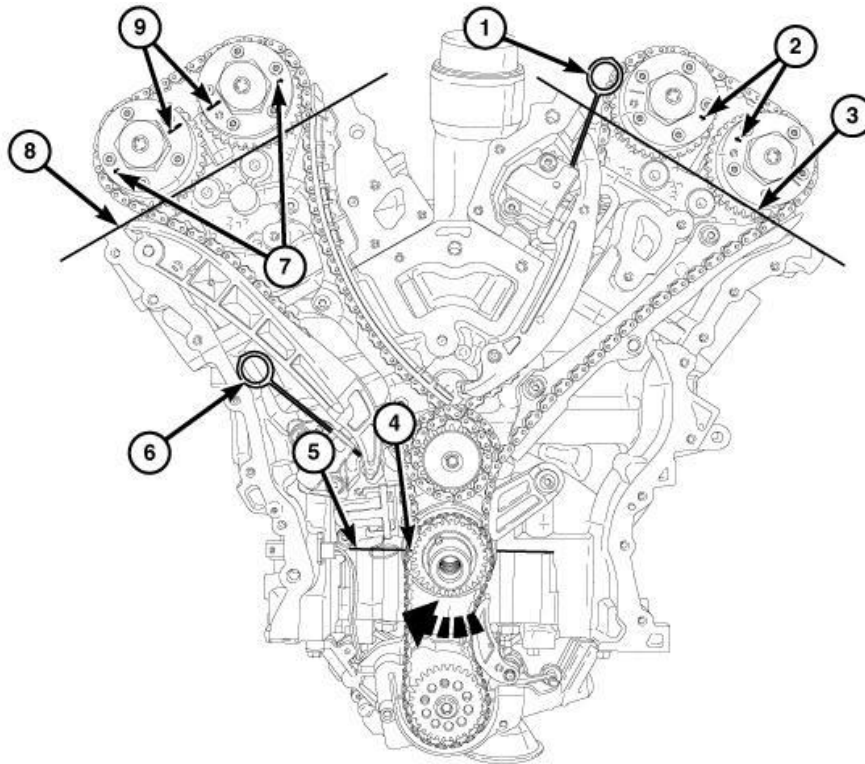


**Fig. 642: Oil Pump Chain Tensioner, Spring, Retaining Bolt, Dowel Pin, Oil Pump Sprocket & Oil Pump Chain**  
 Courtesy of CHRYSLER GROUP, LLC

**NOTE:** There are no timing marks on the oil pump gear or chain.

**CAUTION:** Always reinstall timing chains so that they maintain the same direction of rotation. Inverting a previously run chain on a previously run sprocket will result in excessive wear to both the chain and sprocket.

32. Place the oil pump sprocket (5) into the oil pump chain (6). Place the oil pump chain onto the crankshaft sprocket while aligning the oil pump sprocket with the oil pump shaft. Install the oil pump sprocket T45 retaining bolt (4) and tighten to 25 N.m (18 ft. lbs.).
33. Install the oil pump chain tensioner (1). Insure that the spring (3) is positioned above the dowel pin (2).



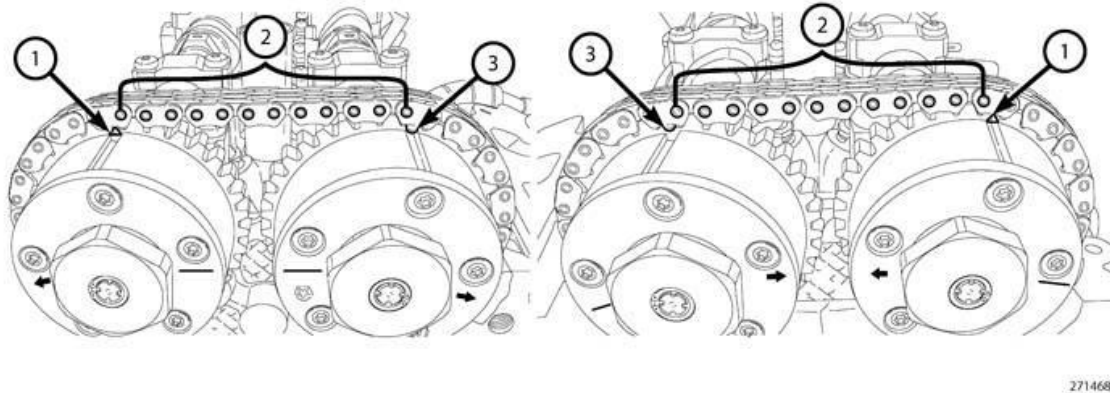
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**Fig. 643: Rotating Crankshaft Clockwise To Position No. 1 Piston At TDC On Exhaust Stroke**  
 Courtesy of CHRYSLER GROUP, LLC

34. Remove the Tensioner Pins (special tool #8514, Pins, Tensioner) (1) and (6) from the right side and left side cam chain tensioners.
35. Rotate the crankshaft clockwise (as viewed from the front) two complete revolutions stopping when the dimple (4) on the crankshaft is aligned with the block/bearing cap junction (5).
36. While maintaining this alignment, verify that the **ARROWS** (2) on the left side cam phasers point toward each other and are parallel to the cylinder head cover mounting surface (3) and that the right side cam



phaser **ARROWS** (7) point away from each other and the **SCRIBE LINES** (9) are parallel to the cylinder head cover mounting surface (8).



**Fig. 644: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking**  
Courtesy of CHRYSLER GROUP, LLC

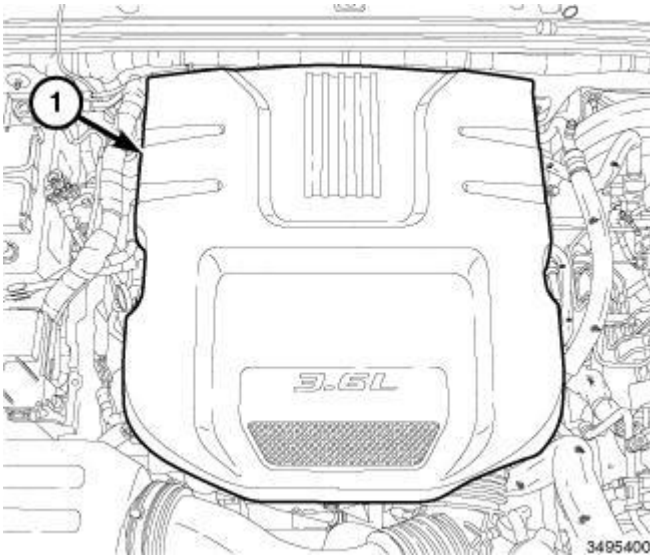
37. There should be 12 chain pins (2) **BETWEEN** the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3) as viewed from either the front or rear of the cam phasers.
38. If the engine timing is not correct, repeat this procedure.
39. Install the engine timing cover, crankshaft vibration damper, accessory drive belts and oil pan. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.
40. Install the spark plugs. Tighten to 17.5 N.m (13 ft. lbs.). Refer to **SPARK PLUG, INSTALLATION**.
41. Install the cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.
42. Install the upper intake manifold and air cleaner housing assembly. Refer to **MANIFOLD, INTAKE, INSTALLATION**.
43. Fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
44. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
45. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
46. Operate 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

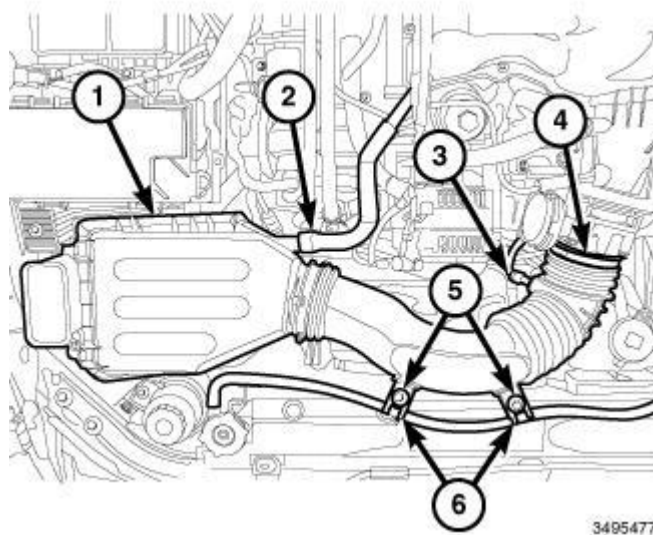
### REMOVAL



**Fig. 645: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

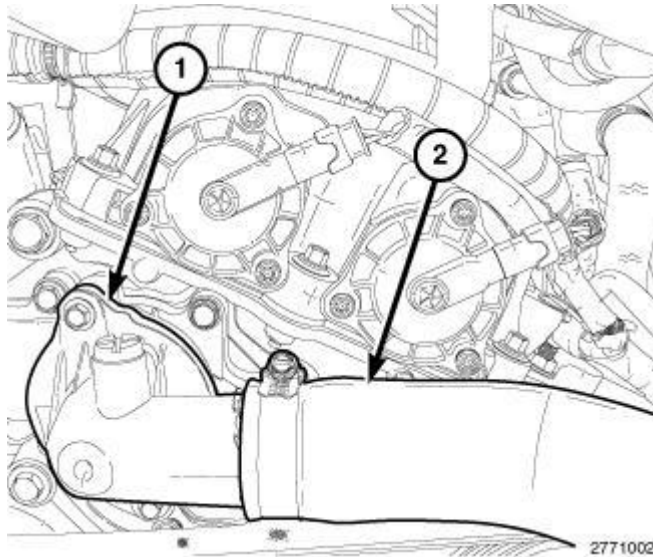
1. Disconnect and isolate the negative battery cable.
2. Remove the engine cover (1).



**Fig. 646: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

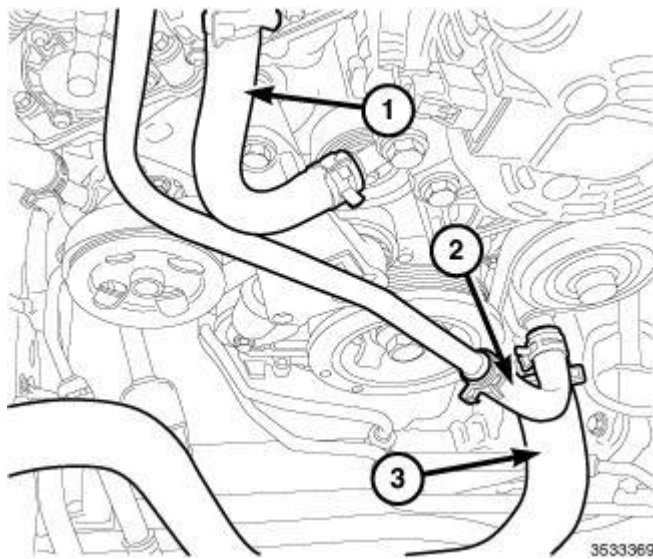
Courtesy of CHRYSLER GROUP, LLC

3. Remove the air cleaner body (1). Refer to **BODY, AIR CLEANER, REMOVAL**.



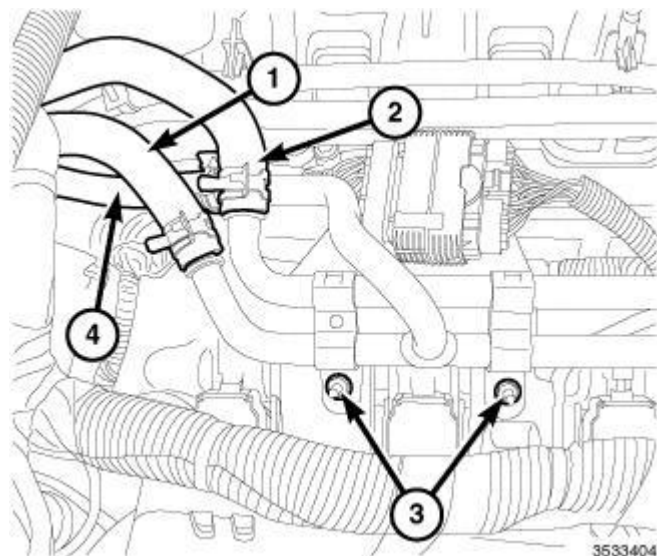
**Fig. 647: Upper Radiator Hose & Thermostat Housing**  
Courtesy of CHRYSLER GROUP, LLC

4. Drain the cooling system. Refer to **STANDARD PROCEDURE** .
5. Remove the upper radiator hose (2) and thermostat housing (1). Refer to **THERMOSTAT, REMOVAL** .



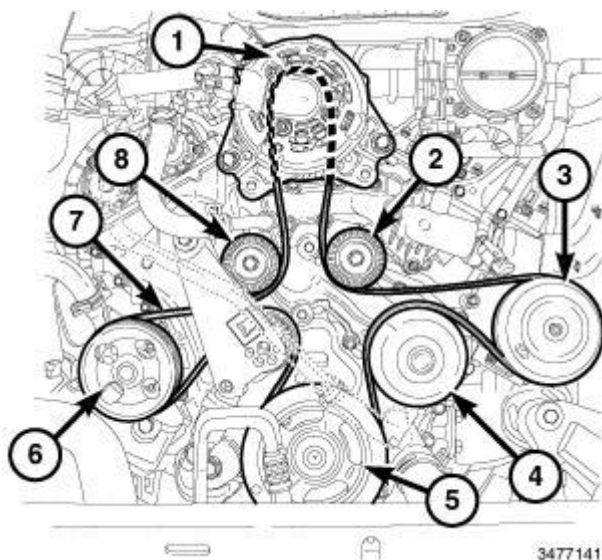
**Fig. 648: Heater Core Supply Hose, Heater Core Return Hose & Lower Radiator Hose**  
Courtesy of CHRYSLER GROUP, LLC

6. Remove the heater core supply hose (1) from the coolant outlet housing.
7. Remove the heater core return hose (2) from the water pump housing.
8. Remove the lower radiator hose (3) from the water pump housing.



**Fig. 649: Heater Core Return Hose, Heater Core Supply Hose, Nuts & Oil Cooler Return Hose**  
Courtesy of CHRYSLER GROUP, LLC

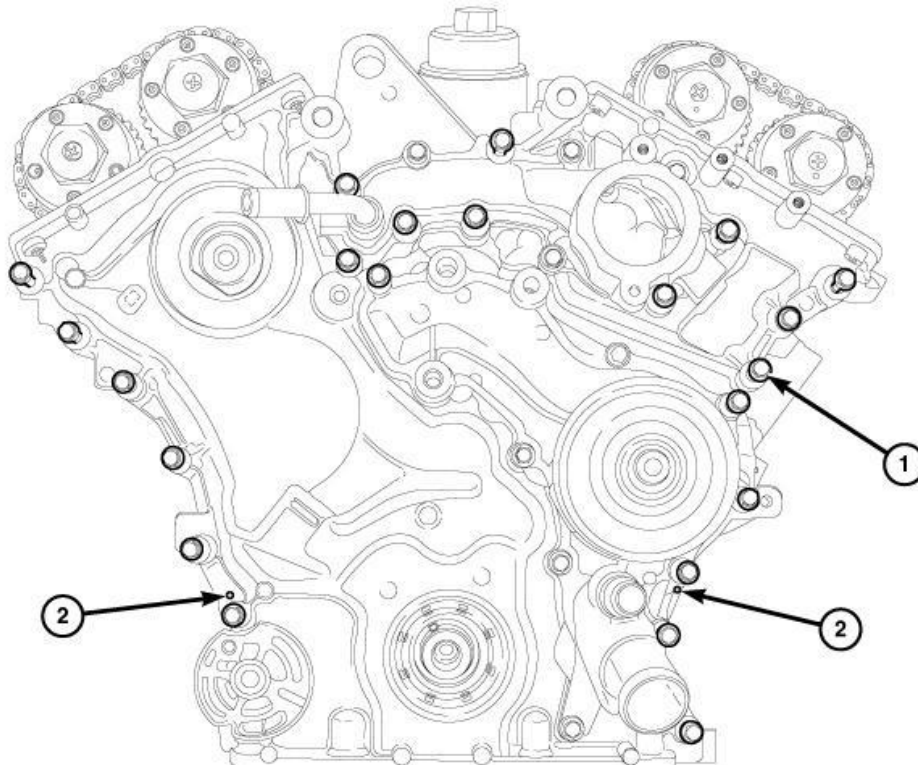
9. Remove two nuts (3) and reposition the heater core supply tube.



**Fig. 650: Drive Belt Tensioners & Assembly With Drive Belt Routing**  
Courtesy of CHRYSLER GROUP, LLC

10. Remove the generator (1). Refer to **GENERATOR, REMOVAL**.
11. Remove the accessory drive belt (7). Refer to **BELT, SERPENTINE, REMOVAL**.
12. Remove the accessory drive belt tensioner. Refer to **TENSIONER, BELT, REMOVAL**.
13. Remove the accessory idler pulleys (2 and 8). Refer to **PULLEY, IDLER, REMOVAL**.
14. Remove the power steering pump pulley (6). Refer to **PULLEY, POWER STEERING PUMP, REMOVAL**.
15. Remove the crankshaft vibration damper (5). Refer to **DAMPER, VIBRATION, REMOVAL**.

16. Remove the upper intake manifold. Refer to **MANIFOLD, INTAKE, REMOVAL**.
17. Remove the right and left cylinder head covers. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
18. Remove the upper oil pan. Refer to **PAN, OIL, REMOVAL**.



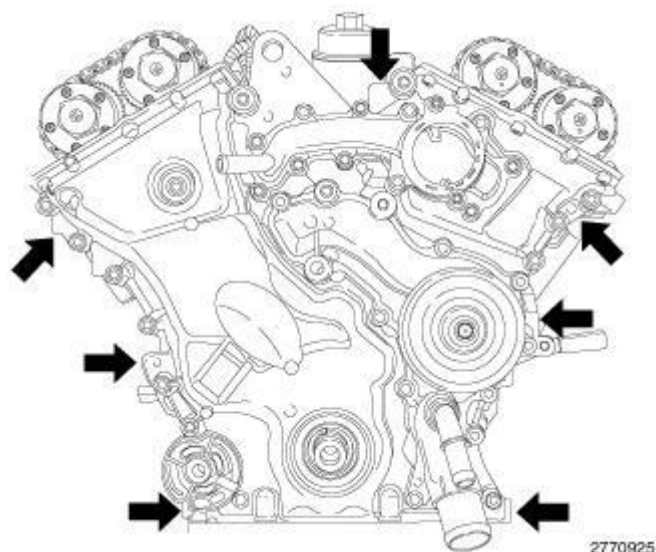
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**Fig. 651: Engine Timing Cover Bolts & Pins**

Courtesy of CHRYSLER GROUP, LLC

**NOTE:** It is not necessary to remove the water pump or the coolant outlet housing for engine timing cover removal.

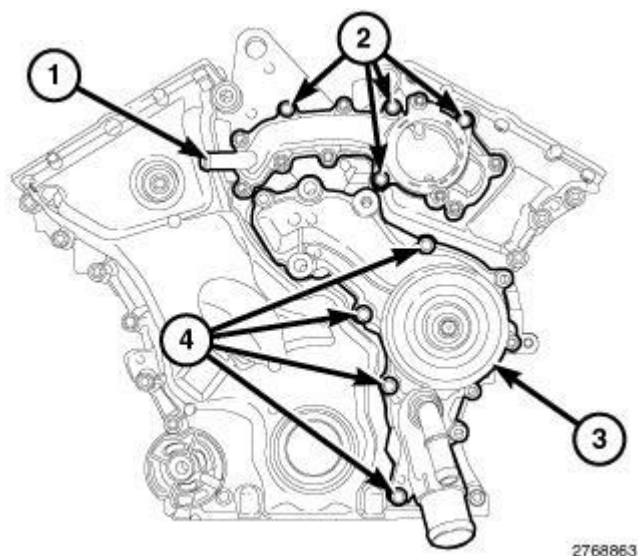
19. Remove only the twenty-two highlighted M6 bolts (1).



**Fig. 652: Timing Cover Removal Pry Points**

Courtesy of CHRYSLER GROUP, LLC

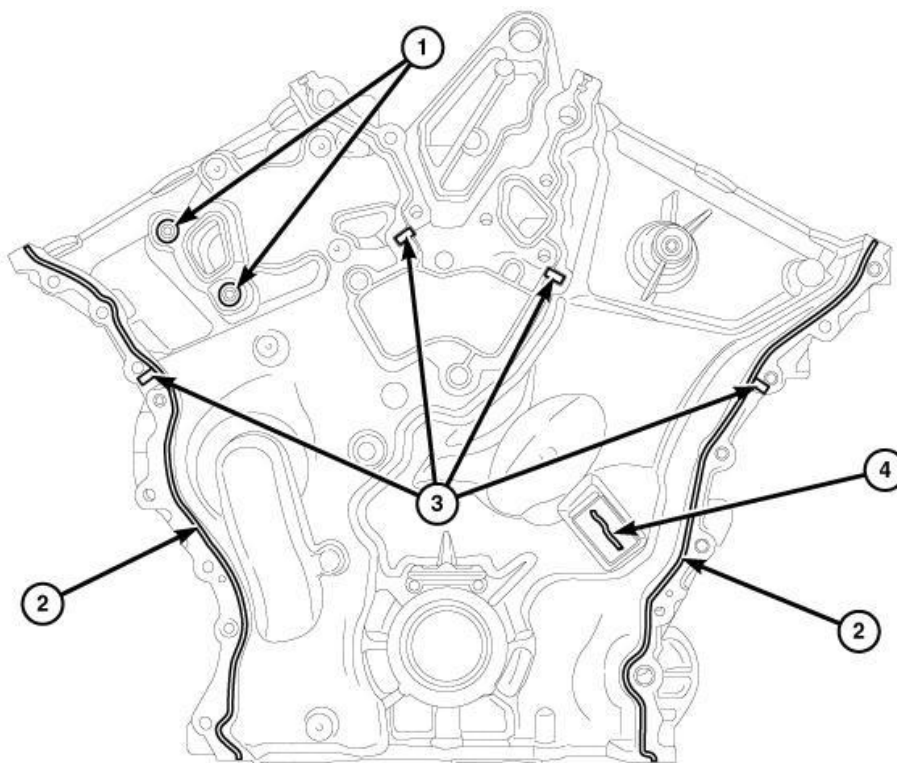
20. Using the seven indicated pry points, carefully remove the timing cover.



**Fig. 653: Coolant Outlet Housing, Water Pump & Bolts**

Courtesy of CHRYSLER GROUP, LLC

21. If required, remove the remaining four M6 bolts (2) and the coolant outlet housing (1) from the engine timing cover.
22. If required, remove the remaining four M6 bolts (4) and the water pump (3) from the engine timing cover.

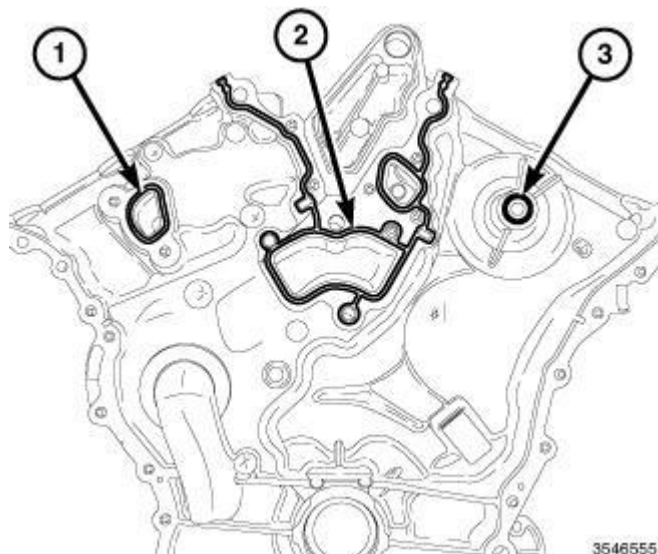


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**Fig. 654: Mopar® Threebond Engine RTV Sealant Front Cover Locations**  
Courtesy of CHRYSLER GROUP, LLC

**CAUTION:** Do not use oil based liquids, wire brushes, abrasive wheels or metal scrapers to clean the engine gasket surfaces. Use only isopropyl (rubbing) alcohol, along with plastic or wooden scrapers. Improper gasket surface preparation may result in engine fluid leakage.

23. Remove all residual sealant from the timing chain cover, cylinder head and engine block mating surfaces. Refer to Engine - Standard Procedure.

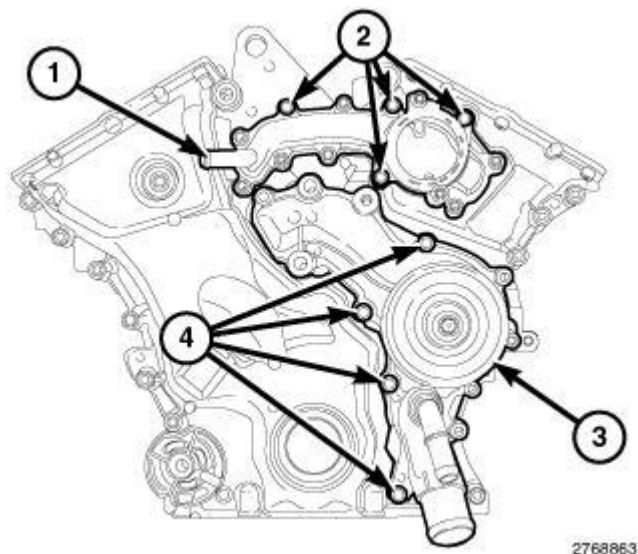


**Fig. 655: Coolant Outlet Housing Gasket, Water Pump Gasket & O-Ring**  
Courtesy of CHRYSLER GROUP, LLC

24. Remove and discard the coolant outlet housing gasket (1), the water pump gasket (2) and the O-ring (3).

#### INSTALLATION

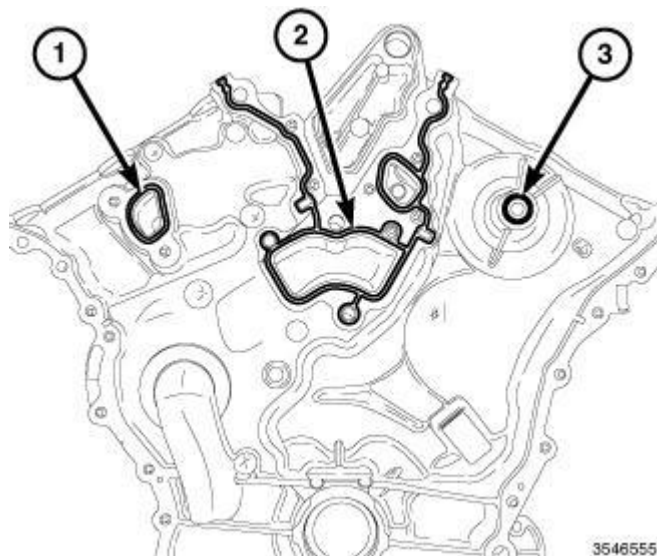
#### INSTALLATION



**Fig. 656: Coolant Outlet Housing, Water Pump & Bolts**  
Courtesy of CHRYSLER GROUP, LLC

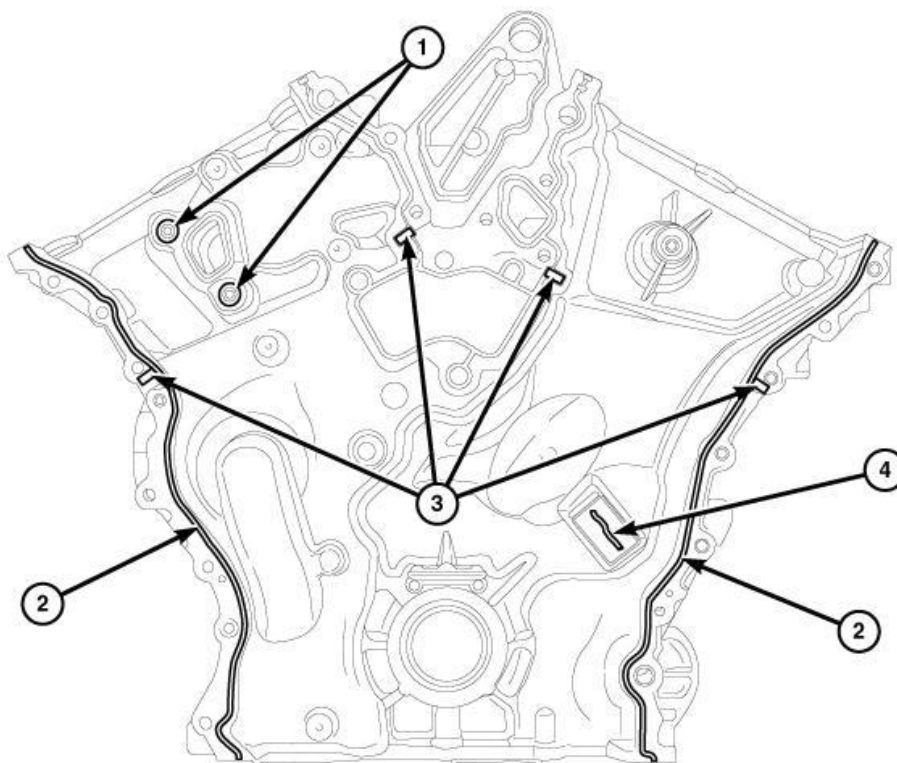
1. If removed, install the coolant outlet housing (1) to the timing cover with a new gasket using only the four bolts (2) shown in illustration tightened to 12 N.m (106 in. lbs.).
2. If removed, install the water pump (3) to the timing cover using only the four bolts (4) shown in illustration tightened to 12 N.m (106 in. lbs.). Refer to **PUMP, WATER, INSTALLATION** .





**Fig. 657: Coolant Outlet Housing Gasket, Water Pump Gasket & O-Ring**  
Courtesy of CHRYSLER GROUP, LLC

3. Install the coolant outlet housing gasket (1), the water pump gasket (2) and the O-ring (3).



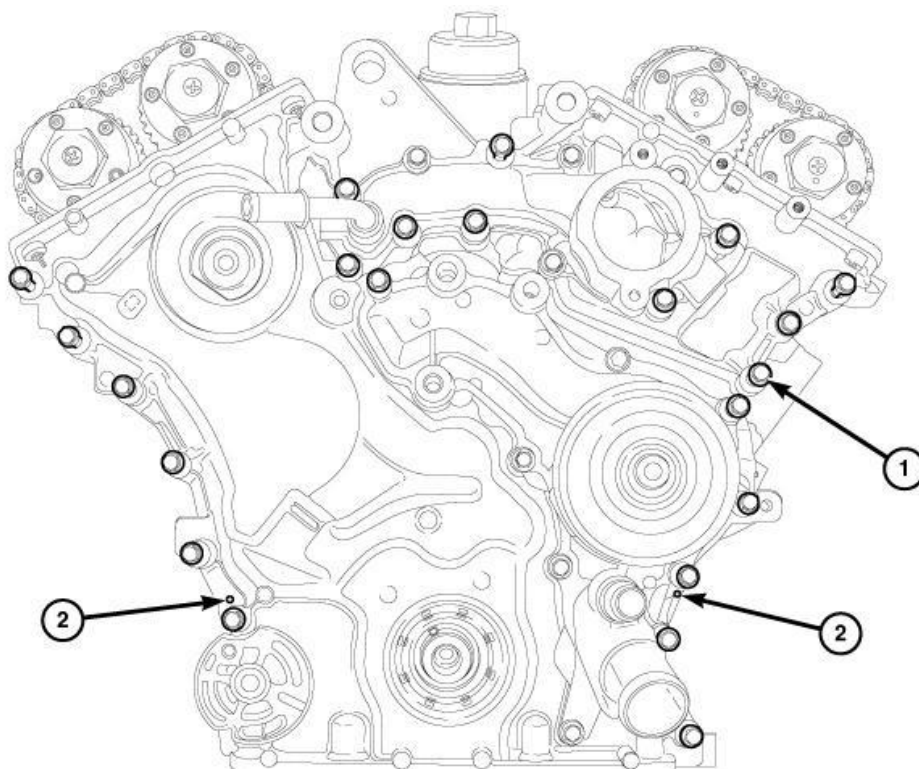
**Fig. 658: Mopar® Threebond Engine RTV Sealant Front Cover Locations**  
Courtesy of CHRYSLER GROUP, LLC

4. Clean the engine timing cover, cylinder head and block mating surfaces with isopropyl alcohol in preparation for sealant application.

**CAUTION:** Engine assembly requires the use of a unique sealant that is compatible with engine oil. Using a sealant other than Mopar® Threebond Engine RTV Sealant may result in engine fluid leakage.

**CAUTION:** Following the application of Mopar® Threebond Engine RTV Sealant to the gasket surfaces, the components must be assembled within 20 minutes and the attaching fasteners must be tightened to specification within 45 minutes. Prolonged exposure to the air prior to assembly may result in engine fluid leakage.

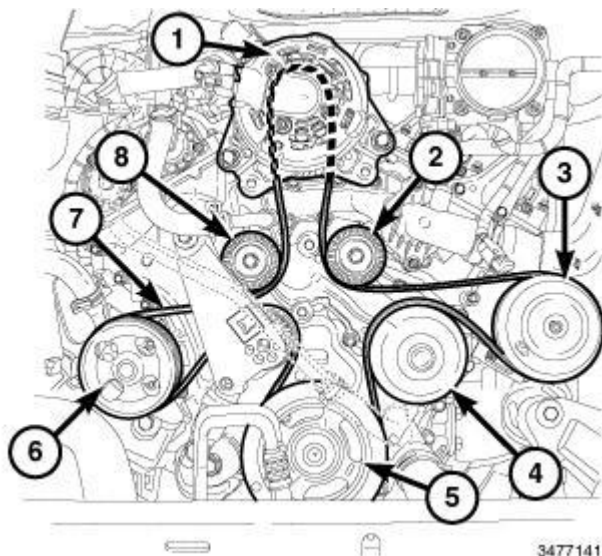
5. Apply a 2 to 3 mm wide bead of Mopar® Threebond Engine RTV Sealant to the front cover as shown in illustration in the following locations:
- Two cylinder head bosses (1)
  - Right and left flanges (2)
  - Four cylinder head to engine block T-joints (3)
  - Cover to right cam chain tensioner gap (4)



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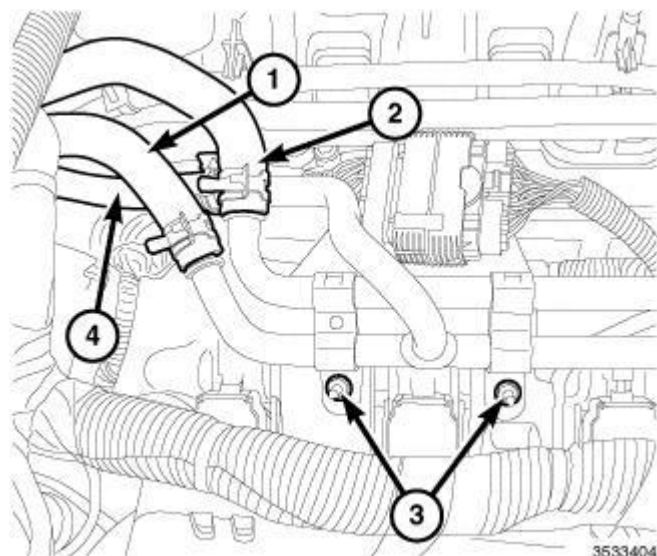
**Fig. 659: Engine Timing Cover Bolts & Pins**  
Courtesy of CHRYSLER GROUP, LLC

6. Align the locator pins (2) on the engine block to the engine timing cover and install the cover.
7. Install and tighten the twenty-two highlighted M6 bolts (1) to 12 N.m (106 in. lbs.).



**Fig. 660: Drive Belt Tensioners & Assembly With Drive Belt Routing**  
Courtesy of CHRYSLER GROUP, LLC

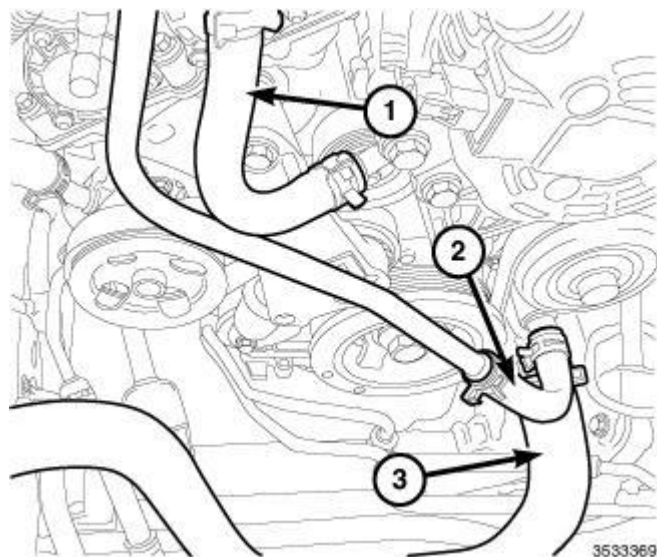
8. Install the upper and lower oil pans. Refer to PAN, OIL, INSTALLATION.
9. Install the right and left cylinder head covers. Refer to COVER(S), CYLINDER HEAD, INSTALLATION.
10. Install the upper intake manifold. Refer to MANIFOLD, INTAKE, INSTALLATION.
11. Install the crankshaft vibration damper (5). Refer to DAMPER, VIBRATION, INSTALLATION.
12. Install the power steering pump pulley (6). Refer to PULLEY, POWER STEERING PUMP, INSTALLATION.
13. Install the accessory idler pulleys (2 and 8). Refer to PULLEY, IDLER, INSTALLATION.
14. Install the accessory drive belt tensioner. Refer to TENSIONER, BELT, INSTALLATION.
15. Install the generator (1) and accessory drive belt (7). Refer to GENERATOR, INSTALLATION.



**Fig. 661: Heater Core Return Hose, Heater Core Supply Hose, Nuts & Oil Cooler Return Hose**

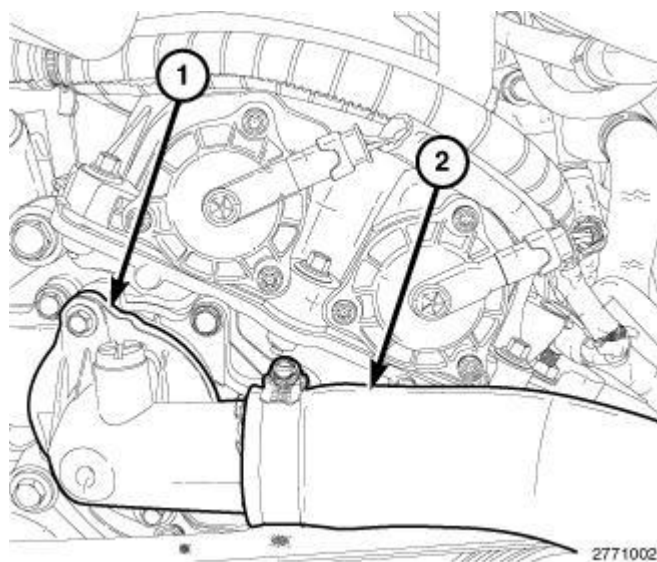
Courtesy of CHRYSLER GROUP, LLC

16. Install the heater core tube assembly to the right upper intake manifold support bracket with two nuts (3) tightened to 12 N.m (106 in. lbs.).



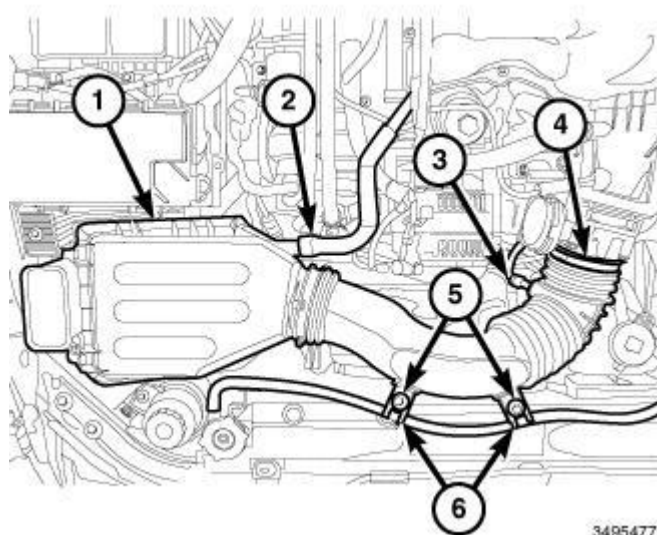
**Fig. 662: Heater Core Supply Hose, Heater Core Return Hose & Lower Radiator Hose**  
Courtesy of CHRYSLER GROUP, LLC

17. Connect the heater core supply hose (1) to the coolant outlet housing.  
18. Connect the heater core return hose (2) to the engine coolant pump housing.  
19. Install the lower radiator hose (3) to the engine coolant pump housing.



**Fig. 663: Upper Radiator Hose & Thermostat Housing**  
Courtesy of CHRYSLER GROUP, LLC

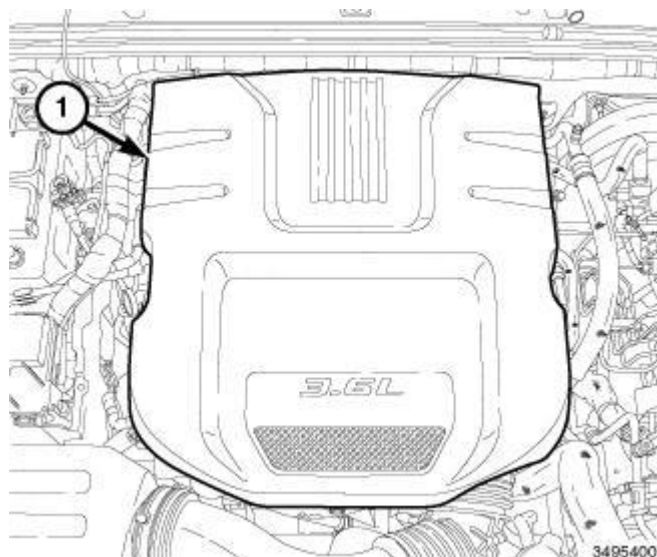
20. Install the thermostat housing (1) and upper radiator hose (2). Refer to **THERMOSTAT, REMOVAL**.



**Fig. 664: Air Cleaner Body, Fresh Air Makeup Hose, Electrical Connector, Clamp, Bolts & Retainers**

Courtesy of CHRYSLER GROUP, LLC

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



**Fig. 665: Engine Cover**

Courtesy of CHRYSLER GROUP, LLC

22. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
23. Install the engine cover (1).
24. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
25. Fill the cooling system. Refer to **STANDARD PROCEDURE**.
26. Run the engine until it reaches normal operating temperature. Check cooling system for correct fluid

## 2012 Jeep Wrangler Sport S

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level. Refer to **STANDARD PROCEDURE** .