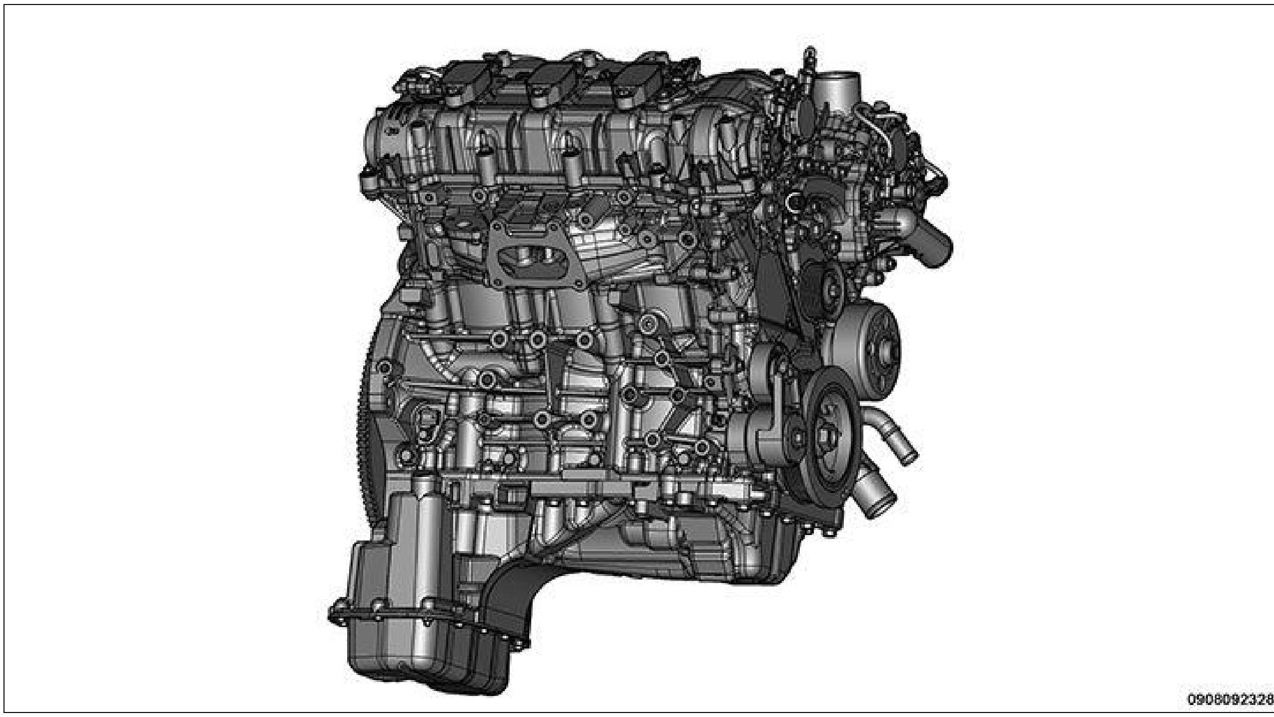
DESCRIPTION > DESCRIPTION

> ⚠ *CAUTION:*
>
> *If the engine has experienced a catastrophic failure, THE INTAKE MANIFOLD MUST BE REPLACED!*

Fig 1: 3.6L (219.7 CID) V-6 Engine



Courtesy of CHRYSLER GROUP, LLC

The 3.6 liter (219.7 CID) 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 MECHANICAL DIAGNOSTIC TABLE

CONDITION	POSSIBLE CAUSES	CORRECTIONS
NOISY VALVES	1. High or low oil level in	1. Refer to STANDARD

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

DIAGNOSIS AND TESTING > CYLINDER COMPRESSION TEST

NOTE:

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

NOTE:

Be certain 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 plug from the cylinder being tested 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 third 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 LEAKAGE TEST .

DIAGNOSIS AND TESTING > CYLINDER LEAKAGE TEST

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

Cylinder leakage testing will detect:

- Exhaust and intake valve leaks (improper seating).
- Leaks between adjacent cylinders or into water jacket.
- Any causes for combustion 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 a regulated air pressure at 552 kPa (80 psi).
7. Perform the test procedures on each cylinder according to the tester's manufacturer instructions. Set the piston of the cylinder to be tested at TDC on the compression stroke.
8. As each cylinder is pressurized, listen for the 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.

If leakage is greater then 25%, Refer to CYLINDER LEAKAGE DIAGNOSIS CHART below.

CYLINDER 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.

DIAGNOSIS AND TESTING > OIL CONSUMPTION TEST AND DIAGNOSIS

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

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

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

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

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

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

> *NOTE:*
>
> *Because a few drops of external oil leakage per mile can quickly account for the loss of one quart of oil in a few hundred miles, be certain there is no external engine oil leaks 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.**

DIAGNOSIS AND TESTING > OIL CONSUMPTION TEST AND DIAGNOSIS > 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, recheck for any external engine oil leaks, repair as necessary, if no external engine oil leaks are present, continue with oil consumption diagnosis.

DIAGNOSIS AND TESTING > OIL CONSUMPTION TEST AND DIAGNOSIS > OIL CONSUMPTION DIAGNOSIS

1. Check the Positive Crankcase Ventilation (PCV) system. Make sure the system is not restricted and the PCV valve has the correct part number and correct vacuum source (18-20 in. Hg at idle below 3000 ft. above sea level is considered normal).
2. Perform a cylinder compression test and cylinder leakage test using the standard cylinder leakage tester and following manufacturers suggested best practices. Refer to CYLINDER COMPRESSION TEST and CYLINDER LEAKAGE TEST .

   > *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 25% leak down further engine tear down and inspection will be required.

DIAGNOSIS AND TESTING > OIL CONSUMPTION TEST AND DIAGNOSIS > 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;

   1. Excess fuel can enter and mix with the oil via a leaking fuel injector
   2. Gasoline contaminated with diesel fuel
   3. Restricted air intake
   4. 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.

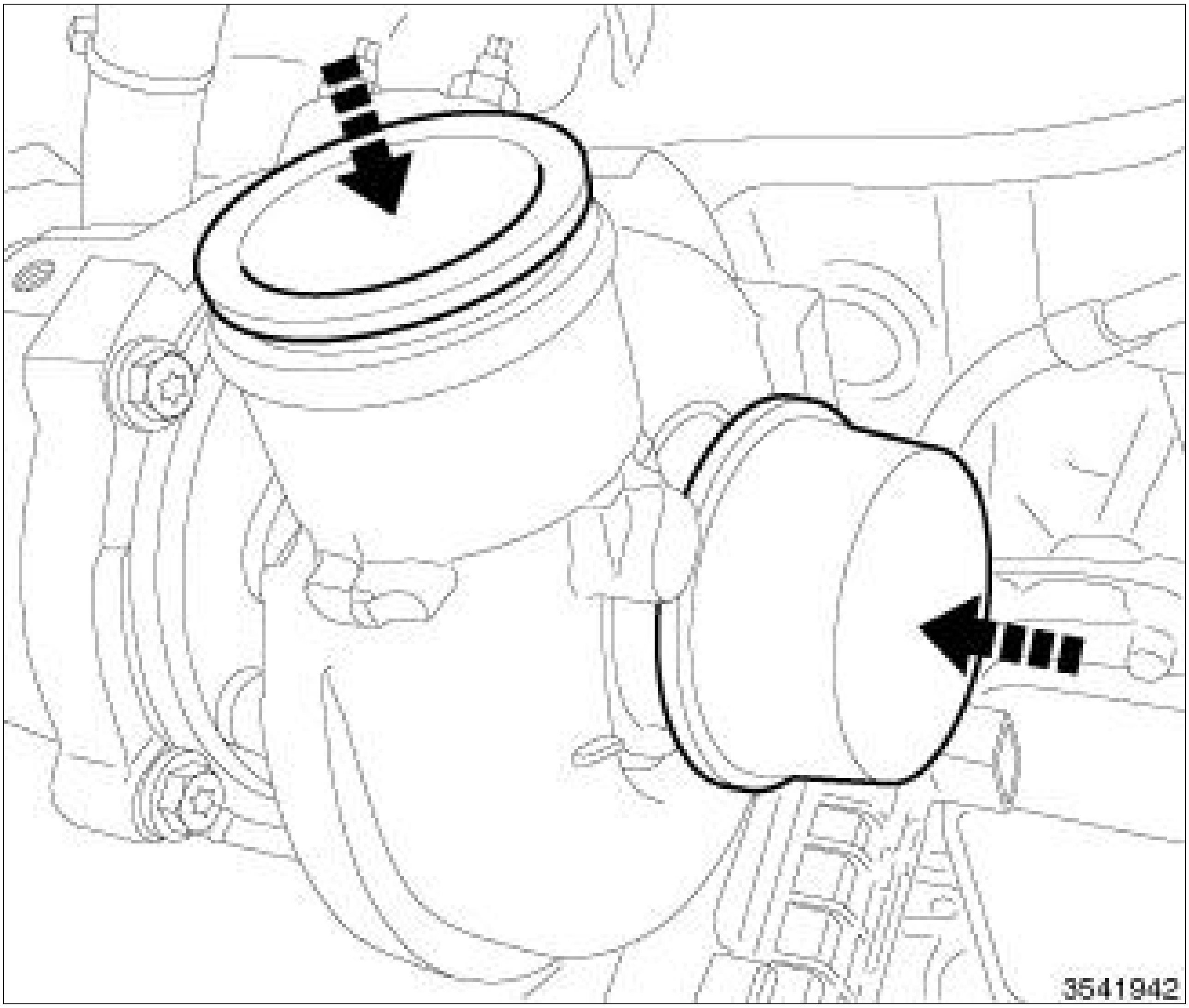
DIAGNOSIS AND TESTING > ENGINE LUBRICATION DIAGNOSTIC TABLE

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	1. Misaligned or damaged gaskets and O-rings.	1. Replace as necessary.
	(a) Loose fasteners, broken or porous metal parts.	(a) Tighten fasteners, Repair or replace metal parts.
	2. Crankshaft rear oil seal.	2. Replace rear crankshaft oil seal. Refer to SEAL, CRANKSHAFT OIL, REAR, REMOVAL .
	3. Crankshaft rear oil seal surface. Scratched, nicked or grooved.	3. Polish or replace crankshaft.
	4. Oil pan flange cracked.	4. Replace oil pan. Refer to PAN, OIL, REMOVAL .
	5. Damaged or misaligned crankshaft front oil seal.	5. Replace front crankshaft oil seal. Refer to SEAL, CRANKSHAFT OIL, FRONT,

		REMOVAL .
	6. Scratched or damaged vibration damper hub.	6. Polish or replace vibration damper.
OIL PRESSURE DROP	1. Low oil level.	1. Check and correct oil level.
	2. Faulty oil pressure sensor.	2. Replace oil pressure sensor. Refer to SENSOR, OIL PRESSURE, REMOVAL .
	3. Low oil pressure.	3. Check main bearing clearance. Refer to STANDARD PROCEDURE . 3. Check rod bearing clearance. Refer to STANDARD PROCEDURE .
	4. Clogged oil filter.	4. Replace oil filter. Refer to FILTER, ENGINE OIL, REMOVAL .
	5. Worn oil pump.	5. Replace oil pump. Refer to PUMP, ENGINE OIL, REMOVAL .
	6. Thin or diluted oil.	6. Change oil and filter. Refer to STANDARD PROCEDURE .
	7. Excessive bearing clearance.	7. Replace crankshaft bearings. Refer to STANDARD PROCEDURE . 7. Replace rod bearings. Refer to STANDARD PROCEDURE .
	8. Oil pump relief valve stuck.	8. Replace oil pump. Refer to PUMP, ENGINE OIL, REMOVAL .
	9. Oil pump pickup tube loose, damaged or clogged.	9. Replace oil pump pick-up. Refer to PICK-UP, OIL PUMP, REMOVAL .
OIL PUMPING AT RINGS	1. Worn or damaged rings.	1. Hone cylinder bores and replace rings. Refer to 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

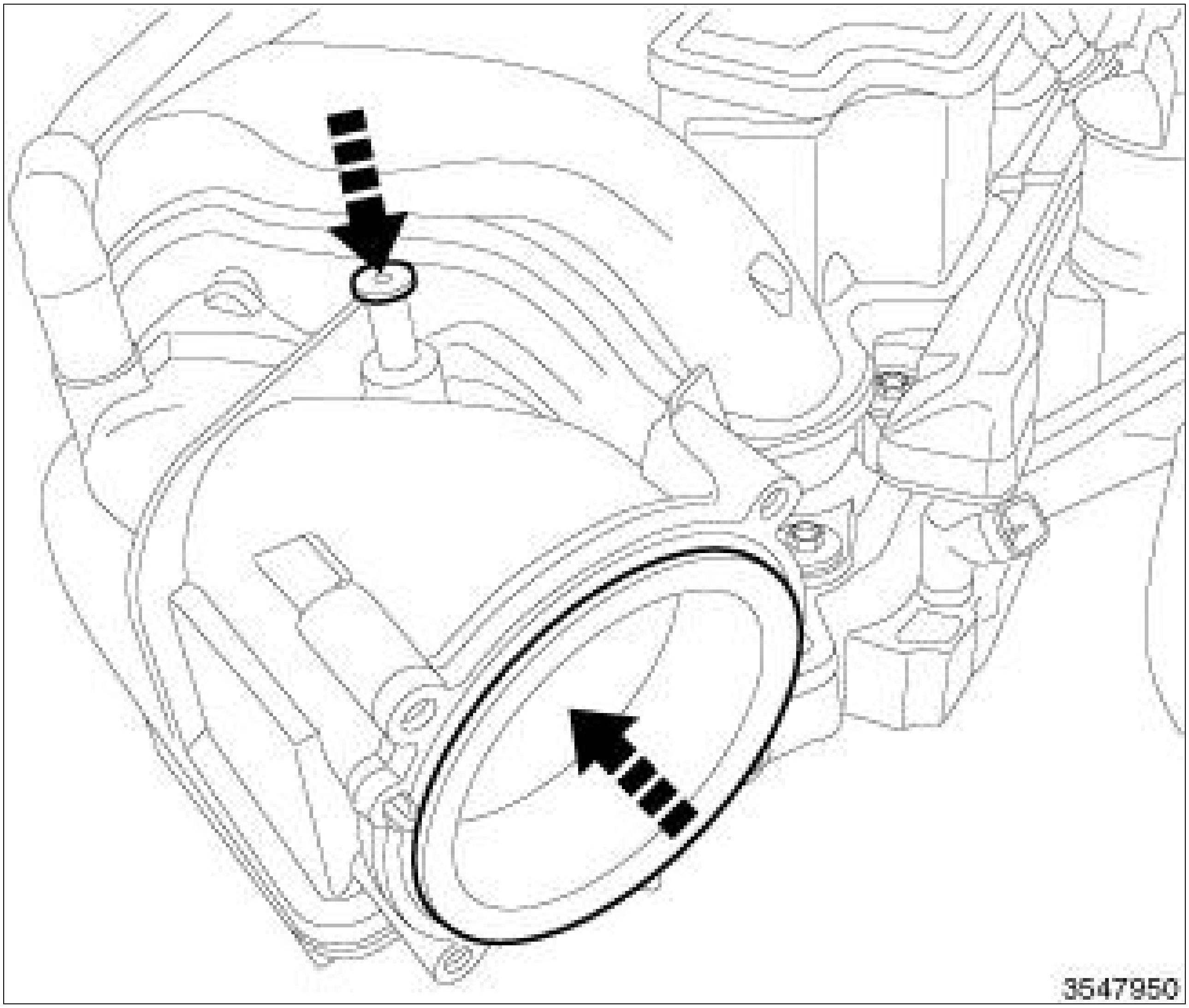
Fig 1: Covers/Caps



Courtesy of CHRYSLER GROUP, LLC

To avoid the possibility of dust, dirt, moisture and other foreign debris being introduced to the engine during service, cover or cap all openings when hoses and tubes are removed.

Fig 2: Opening Cover



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Covers installed over openings will reduce the possibility of foreign materials to entering the engine systems. Using miller tool Universal Protective Cap Set (special tool #10368, Set, Universal Protective Cap), select the appropriate cover needed for the procedure.

STANDARD 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.

STANDARD PROCEDURE > 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 service information for specific sealer usage.*

There are numerous places where Form-In-Place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets to assure obtaining the desired results.**Do not use form-in-place gasket material unless specified.** Bead size, continuity, and location are of great importance. Too thin a bead can result in leakage while too much can result in spill-over which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free gasket. All sealing surfaces that use form-in-place gaskets and sealers **must** be free of grease or oil. Surfaces should be cleaned with Mopar® brake parts cleaner prior to sealer application. After the sealer is applied, the parts should be assembled within 10 minutes.

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

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

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

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

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

MOPAR® THREEBOND ENGINE RTV SEALANT is a unique gasket material that is specially made to retain adhesion and sealing properties when used to seal components exposed to engine oil.

STANDARD PROCEDURE > FORM-IN-PLACE GASKETS AND SEALERS > SEALER

APPLICATION

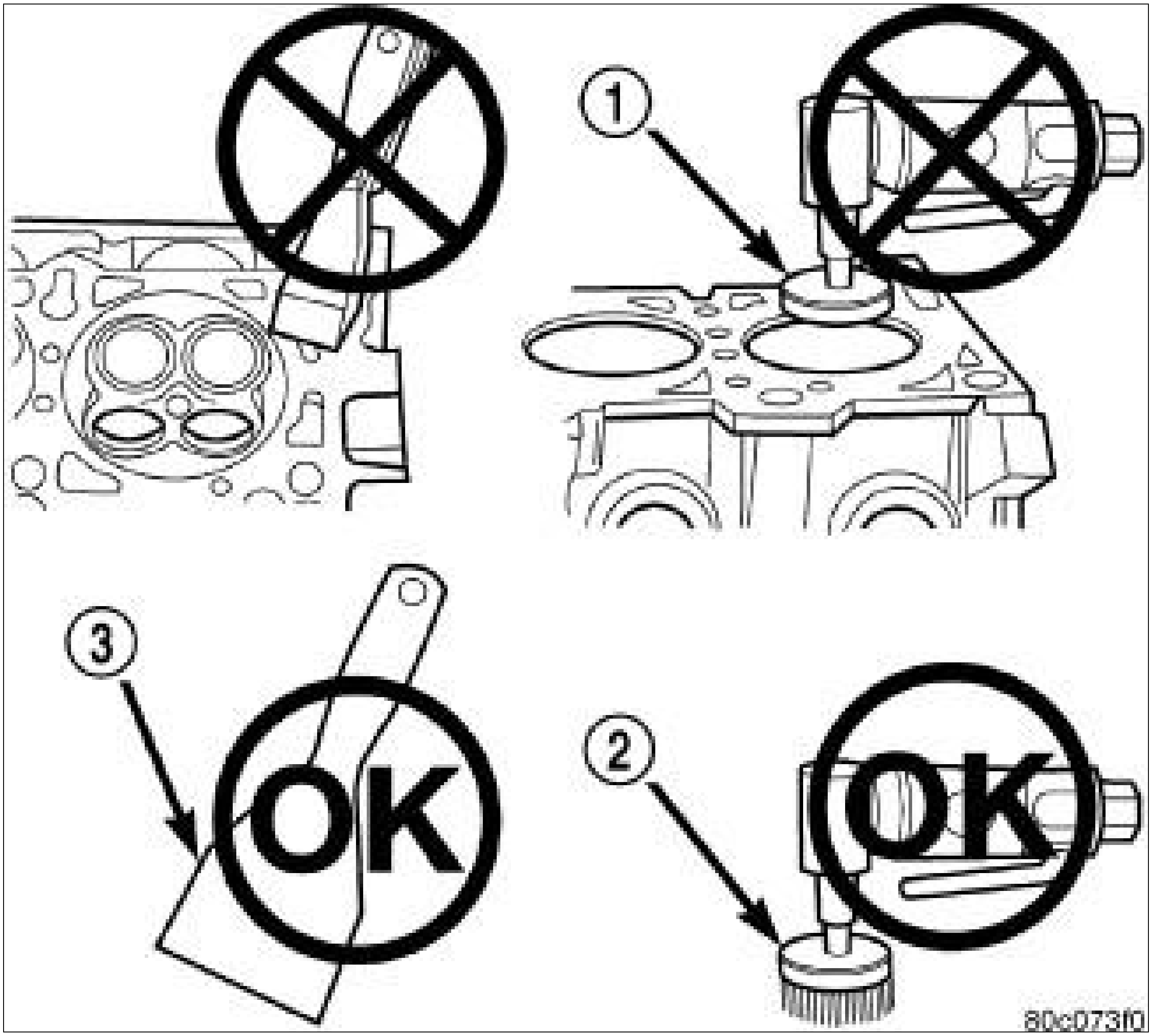
Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. Be certain the material surrounds each mounting hole. Excess material can easily be wiped off. Components should be torqued in place within 15 minutes. The use of a locating dowel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

STANDARD PROCEDURE > ENGINE GASKET SURFACE PREPARATION

Fig 1: 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 > ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS - 1 OF 2

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

GENERAL SPECIFICATIONS - 2 OF 2

Description	**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 ± 0.005 mm	3.7793 in. ± 0.0002 in.
Cylinder Bore Diameter - Grade 2	96.005 mm ± 0.005 mm	3.7797 in. ± 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		
Engine Oil Galley Plug**	0.0 mm - 2.0 mm	0.0 in - 0.0787 in
**Measured proud of machined surface		

PISTONS

Description	Specification	
	Metric	Standard
Material	Cast Aluminum Alloy	
Piston Diameter (Metal to Metal) - Grade 1	95.955 mm ± 0.005 mm	3.7778 in. ± 0.0002 in.
Piston Diameter (Metal to Metal) - Grade 2	95.965 mm ± 0.005 mm	3.7781 in. ± 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.
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	
	Metric	Standard
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

Description	Specification	
	Metric	Standard
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

Description	Specification	
	Metric	Standard
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

Description	Specification

	Metric	Standard
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.
Duration - Intake	260°	
Duration - Exhaust	251°	
End Play	0.075 - 0.251 mm	0.003 - 0.010 in.
Valve Lift-Intake (Zero Lash)	10.3 mm	0.406 in.
Valve Lift-Exhaust (Zero Lash)	10.0 mm	0.394 in.

VALVE TIMING-INTAKE VALVES

Description	Specification
Opens	2° (ATDC)
Closes	82° (ABDC) or 262° (ATDC)
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)
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.
Stem-to-Guide Clearance - Exhaust (Max., Rocking Method)	0.37 mm	0.015 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 the engine.		

SPECIFICATIONS > TORQUE SPECIFICATIONS

ENGINE BLOCK

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.	NEW FASTENER *

Connecting Rod Cap Bolts	20 + 90° Turn	15 + 90° Turn	-	-
Crankshaft Target Wheel to Counterweight Bolts	11	8	-	-
Crankshaft Outer Main Bearing Cap and Windage Tray M8 Bolts	21 + 90° Turn	15 + 90° Turn	-	-
Crankshaft Inner Main Bearing Cap M11 Bolts	20 + 90° Turn	15 + 90° Turn	-	-
Crankshaft Side Main Bearing Cap (Tie Bolt) M8 Bolts	30	22	-	-
Crankshaft Position (CKP) Sensor to Engine Block M6 Bolt	12	9	-	-
Engine Block Heater - M6 Bolt	12	9	-	-
Lower Oil Pan to Upper Oil Pan - M6 Bolts	11	8	-	-
Knock Sensor to Engine Block M8 Bolt	21	15	-	-
Upper Oil Pan to Engine Block M8 Bolts	23	17	-	-
Oil Cooler to Oil Filter Housing Screws	12	-	106	-
Upper Oil Pan to Rear Seal Retainer M6 Bolts	10	-	89	-
Oil Pan Drain Plug	27	20	-	-
Oil Pressure Sensor to Oil Filter Housing	20	-	177	-
Piston Oil Cooler Jet to Engine Block Bolt	6	-	53	-
Oil Filter Housing/Oil Cooler to Engine Block M6 Bolts	12	-	106	-
Oil Filter Housing Cap	25	18	-	-
Oil Pump to Engine Block M6 Bolts	12	-	106	-
Oil Level Indicator to Intake Manifold Bolt	9	-	80	-

Oil Pump Sprocket M8 Bolt	26	18	-	-
Oil Pump Pick Up Tube Bracket to Windage Tray M6 Bolt	12	-	106	-
Oil Pump Pick Up Tube to Oil Pump M6 Bolt	12	-	106	-

* **NEW FASTENERS:** Do not reuse these fasteners. If removed, a new fastener must be installed and tighten to specifications.

CYLINDER HEAD

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.	NEW FASTENER *
Camshaft Bearing Cap Bolts	10	-	89	-
Camshaft Chain Tensioner (Primary) Bolt	12	9	-	-
Camshaft Chain Guide (Primary) Bolt	12	9	-	-
Camshaft Chain Idler Sprocket Bolt	26	19	-	-
Camshaft Chain LH Tensioner (Secondary) Bolt	12	9	-	-
Camshaft Chain LH Guide (Secondary) Bolt	12	9	-	-
Camshaft Chain RH Tensioner (Secondary) Bolt	12	9	-	-
Camshaft Chain RH Guide (Secondary) Bolt	12	9	-	-
Camshaft Position (CMP) Sensor to Cylinder Head Bolt	9	-	80	-
Cylinder Head Oil Galley Plug	18	9	-	-
Cylinder Head Oil Restrictor M8 Plug	15	11	-	-
Cylinder Head Bolts	Refer to CYLINDER HEAD, INSTALLATION .			-

Cylinder Head Cover M6 Bolts	12	9	-	-
Catalytic Converter to Cylinder Head M8 Bolts	23	17	-	-
Fuel Rail to Lower Intake Manifold M6 Bolts	7	-	62	-
Heater Core Supply Tube to Cylinder Head M8 Bolt	12	9	-	-
Ignition Capacitor to Cylinder Head M6 Bolts	10	-	89	-
Ignition Coil to Cylinder Head Cover M6 Bolts	8	-	71	-
Intake Manifold (Upper) M6 Bolts	10	-	89	-
Intake Manifold (Lower) M6 Bolts	12	9	-	-
Oil Control Valve/Cam Phaser Bolt - Exhaust	150	118	-	-
Oil Control Valve/Cam Phaser Bolt - Intake	30 + 45° Turn	22+45° Turn	-	-
Oil Temperature Sensor to Cylinder Head	11	8	-	-
Spark Plug to Cylinder Head	18	13	-	-
Upper Intake Manifold Support Bracket to Cylinder Head M8 Bolt	17	13	-	-
Upper Intake Manifold Support Bracket to Upper Intake Manifold M6 Nuts	9	-	80	-
Variable Valve Timing Solenoid to Cylinder Head Cover Bolt	4	-	35	-
Variable Valve Lift Solenoid Bolt	10	7	-	-
Wire Harness Retainer Bracket to LH Cylinder Head Bolts	10	7	-	-
* **NEW FASTENERS:** Do not reuse these fasteners. If removed, a new fastener must be installed and tighten to specifications.				

FRONT ENGINE

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.	NEW FASTENER *
Coolant Crossover Housing to Engine Timing Cover M6 Bolts	11	8	-	-
Engine Timing Cover M6 Bolts	12	9	-	-
Engine Timing Cover M8 Bolt	25	18	-	-
Engine Timing Cover M10 Bolts	55	41	-	-
Thermostat Housing to Coolant Crossover M6 Bolts	12	9	-	-
Vibration Damper M16 Bolt	40 + 115° Turn	30 + 115° Turn	-	-
Water Pump to Engine Timing Cover M6 Bolts	11	8	-	-
Water Pump to Engine Timing Cover - M10 Bolt	55	41	-	-
* **NEW FASTENERS:** Do not reuse these fasteners. If removed, a new fastener must be installed and tighten to specifications.				

REAR ENGINE

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.	NEW FASTENER *
Flexplate to Crankshaft Bolts	94	69	-	-
Rear Crankshaft Oil Seal Retainer Bolts	12	9	-	-
Torque Converter to Flexplate Bolts	42	31	-	-
Transaxle to Engine Block Bolts	50	37	-	-
Transaxle to Upper Oil Pan Bolts	50	37	-	-
* **NEW FASTENERS:** Do not reuse these fasteners. If removed, a new fastener must be installed and tighten to specifications.				

ENGINE MOUNTING

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.	NEW FASTENER *
Left Engine Mount Bracket to Engine Block Bolts	61	45	-	-
Left Engine Mount Isolator to Bracket Bolts	61	45	-	-
Left Engine Mount Isolator to Frame Bolt	61	45	-	-
Left Engine Mount Heat Shield Bolts	12	9	-	-
Rear Mount Bracket to Transmission Bolts	33	24	-	-
Rear Mount to Rear Mount Bracket Bolt	61	45	-	-
Rear Mount Crossmember to Frame Bolts	55	41	-	-
Rear Mount to Crossmember Bolt	61	45	-	-
Right Engine Mount Bracket to Engine Block Bolts	61	45	-	-
Right Engine Mount Isolator to Engine Mount Bracket Bolts	61	45	-	-
Right Engine Mount Isolator to Frame Bolts	61	45	-	-
Right Engine Mount Heat Shield Bolts	12	9	-	-
Left Crossmember Brace to Crossmember Bolts	55	41	-	-
Right Crossmember Brace to Crossmember Bolts	55	41	-	-
* **NEW FASTENERS:** Do not reuse these fasteners. If removed, a new fastener must be installed and tighten to specifications.				

ACCESSORY DRIVE

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.	NEW FASTENER *
A/C Compressor Bolts	24	18	-	-
Belt Tensioner Bolt	55	41	-	-
Generator Bolts	25	18	-	-
Idler Pulley Bolt	25	18	-	-
Power Steering Pump Bracket Bolts	28	21	-	-
Power Steering Pump Heat Shield Bolts	23	17	-	-
* **NEW FASTENERS:** Do not reuse these fasteners. If removed, a new fastener must be installed and tighten to specifications.				

MISCELLANEOUS COMPONENTS

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.	NEW FASTENER *
Air Inlet Hose Band Clamps	5	-	44	-
Negative Battery Cable	5	-	45	-
Oxygen Sensor	50	37	-	-
Starter Mounting Bolts	47	35	-	-
Throttle Body Bolts	9	-	80	-
* **NEW FASTENERS:** Do not reuse these fasteners. If removed, a new fastener must be installed and tighten to specifications.				

REMOVAL > REMOVAL

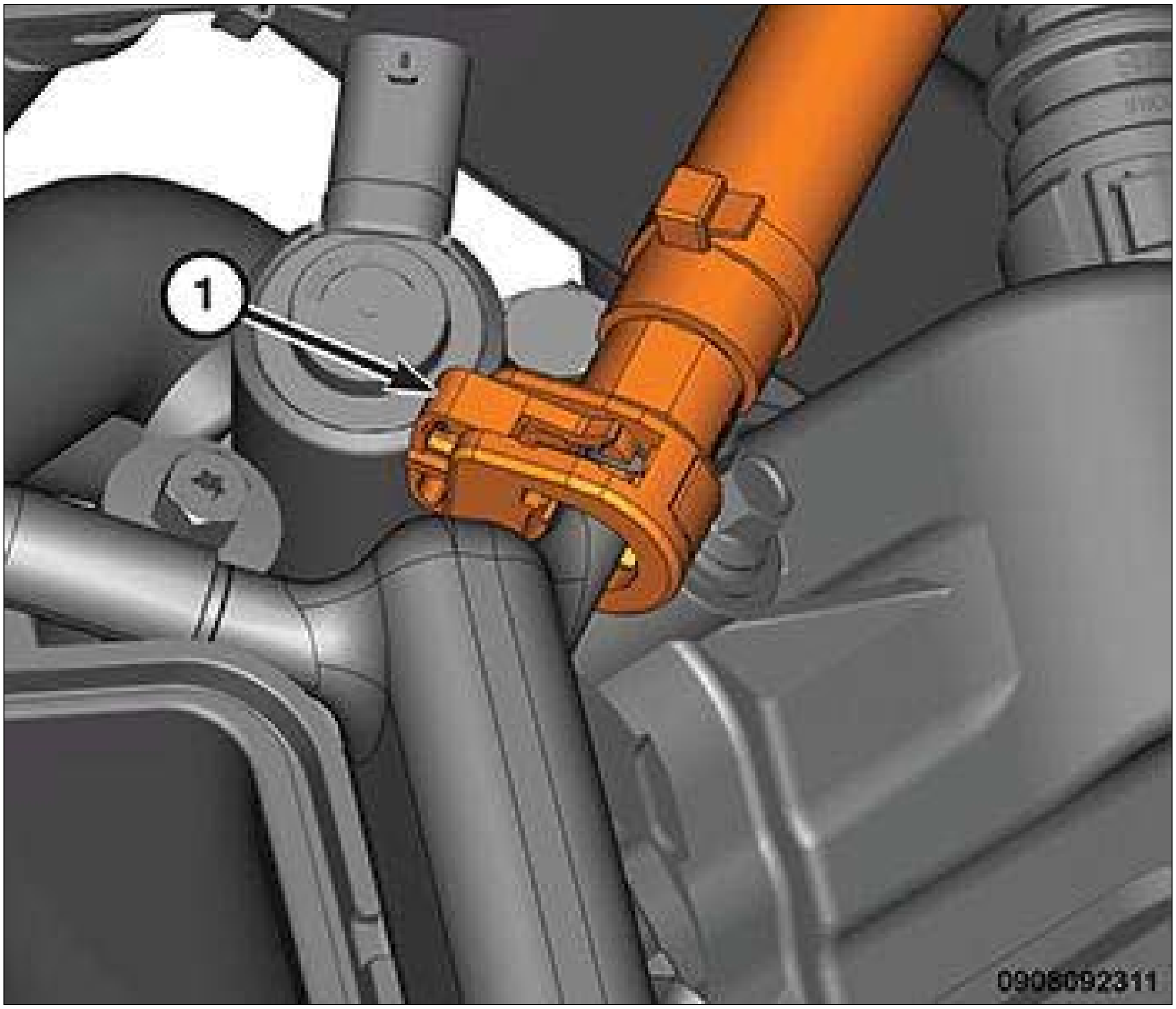
CAUTION:

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

1. Perform the fuel pressure release procedure. Refer to FUEL SYSTEM PRESSURE RELEASE .
2. Disconnect and isolate the negative battery cable.

3. Remove the hood. Refer to HOOD, REMOVAL .
4. Remove the cowl extension panel. Refer to SILENCER, COWL EXTENSION, REMOVAL .
5. Raise and support the vehicle. Refer to HOISTING, STANDARD PROCEDURE .
6. If equipped, remove the front skid plate, the front suspension skid plate, the transmission skid plate and the transfer case skid plate. Refer to PLATE, SKID, FRONT, REMOVAL , PLATE, SKID, FRONT SUSPENSION, REMOVAL , PLATE, SKID, FUEL TANK, REMOVAL , PLATE, SKID, TRANSMISSION, REMOVAL and PLATE, SKID, TRANSFER CASE, REMOVAL .
7. Drain the cooling system. Refer to STANDARD PROCEDURE .
8. Drain the engine oil. Refer to STANDARD PROCEDURE .
9. Remove the resonator and the air cleaner body. Refer to BODY, AIR CLEANER, REMOVAL .
10. Remove the upper intake manifold and insulator. Refer to MANIFOLD, INTAKE, REMOVAL .
11. Remove the Exhaust Gas Recirculation (EGR) cooler. Refer to COOLER, EXHAUST GAS RECIRCULATION (EGR), REMOVAL .
12. Remove the electric vacuum pump and mounting bracket. Refer to PUMP, ELECTRIC VACUUM, REMOVAL .
13. Remove the A/C compressor retaining bolts and studs, then position aside. Refer to COMPRESSOR, A/C, REMOVAL .

Fig 1: Fuel Supply Hose At Fuel Rail



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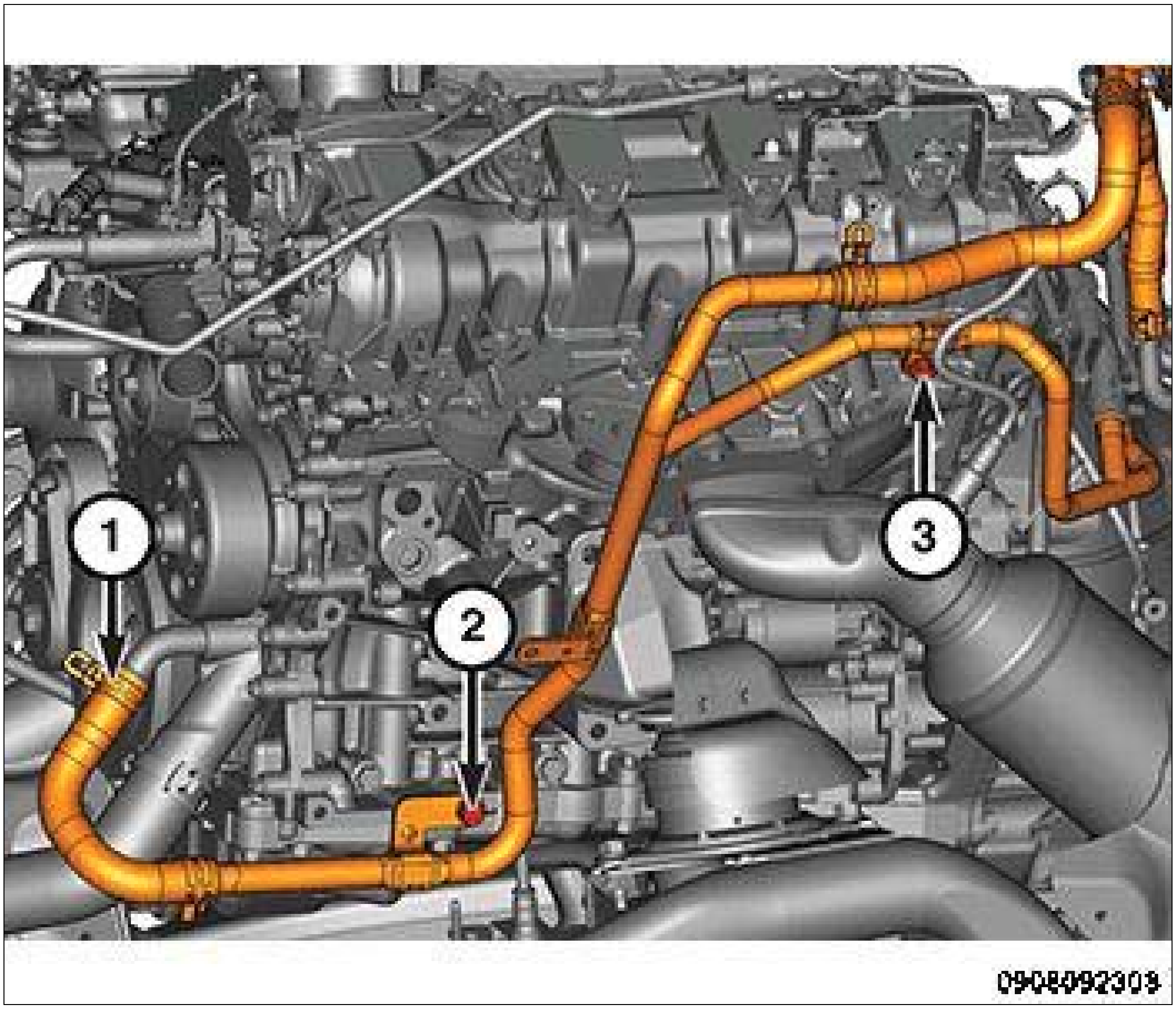
14. Disconnect the fuel supply hose from the fuel rail. Refer to FITTING, QUICK CONNECT .

Fig 2: Heater Core Return Hose At Water Pump Bypass, Retaining Bolts At Engine Block & Cylinder Head



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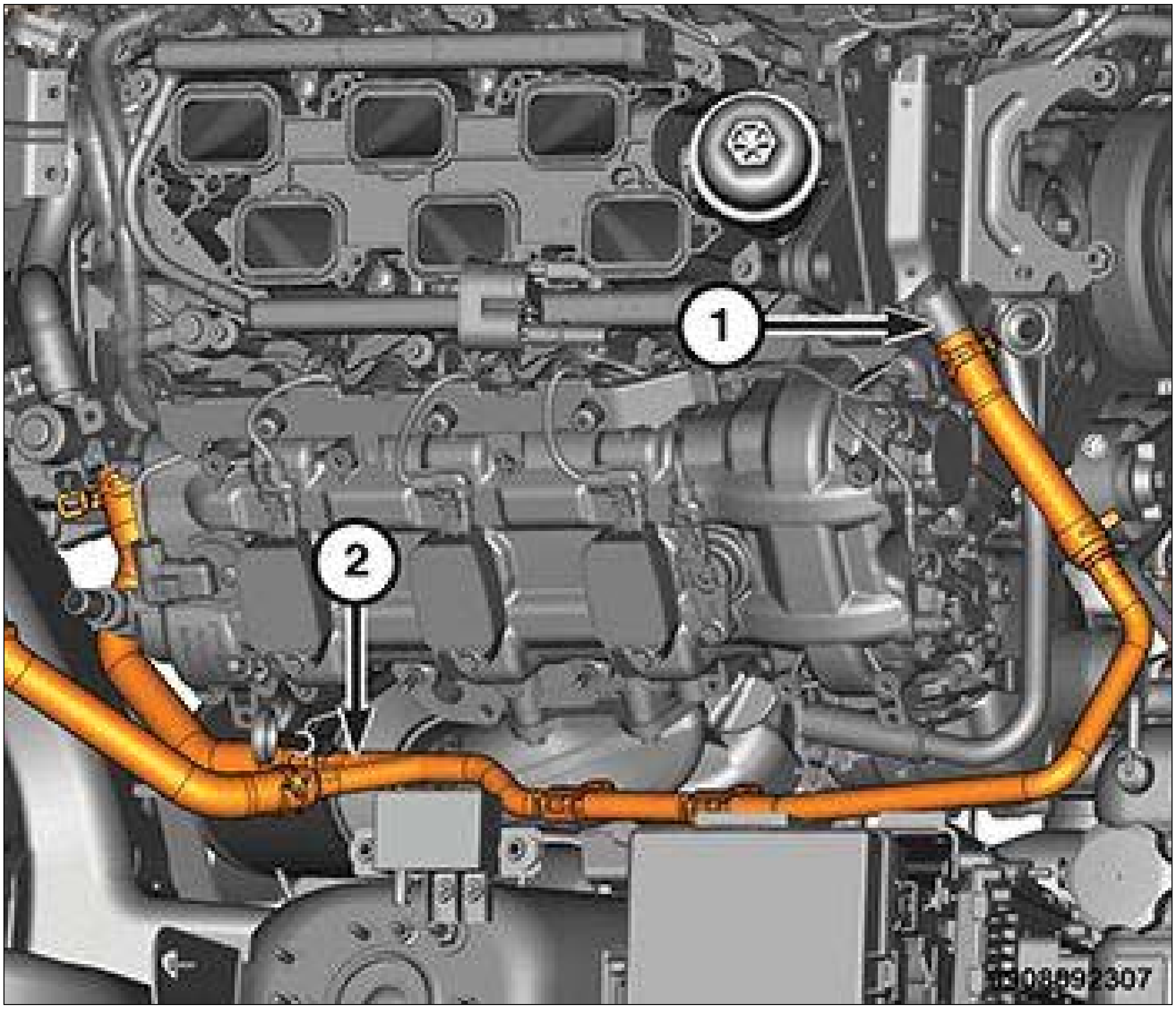
15. Remove the heater core return hose from the water pump bypass (1).
16. Remove the retaining bolts from the engine block (2) and cylinder head (3).
17. Disconnect the return hose from the engine oil cooler and position the tube assembly aside.

Fig 3: Heater Inlet Hose At Coolant Crossover & Heater Inlet Tube Assembly



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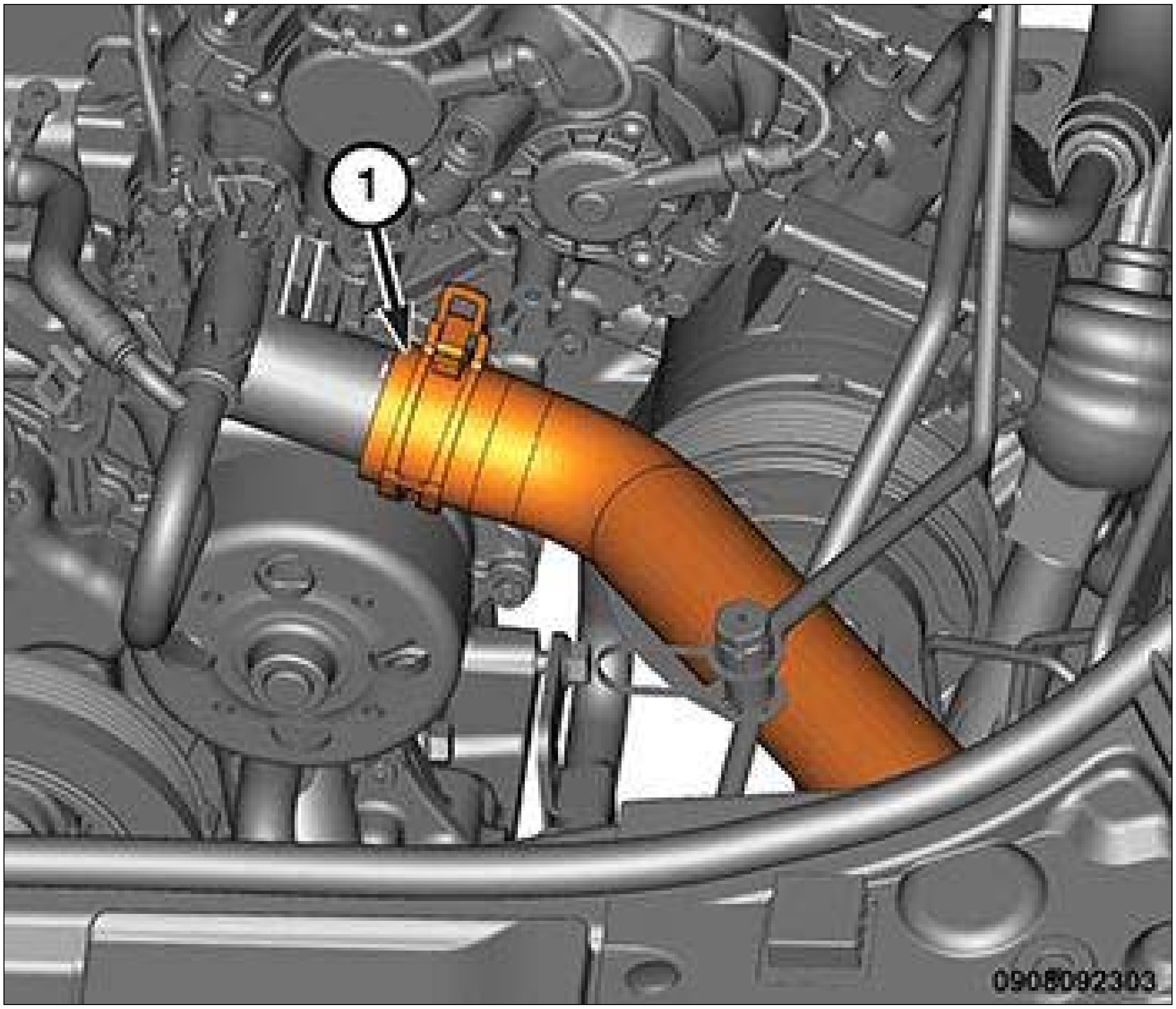
18. Remove the heater inlet hose from the coolant crossover (1) and position the heater inlet tube assembly (2) aside.

Fig 4: Upper Radiator Hose



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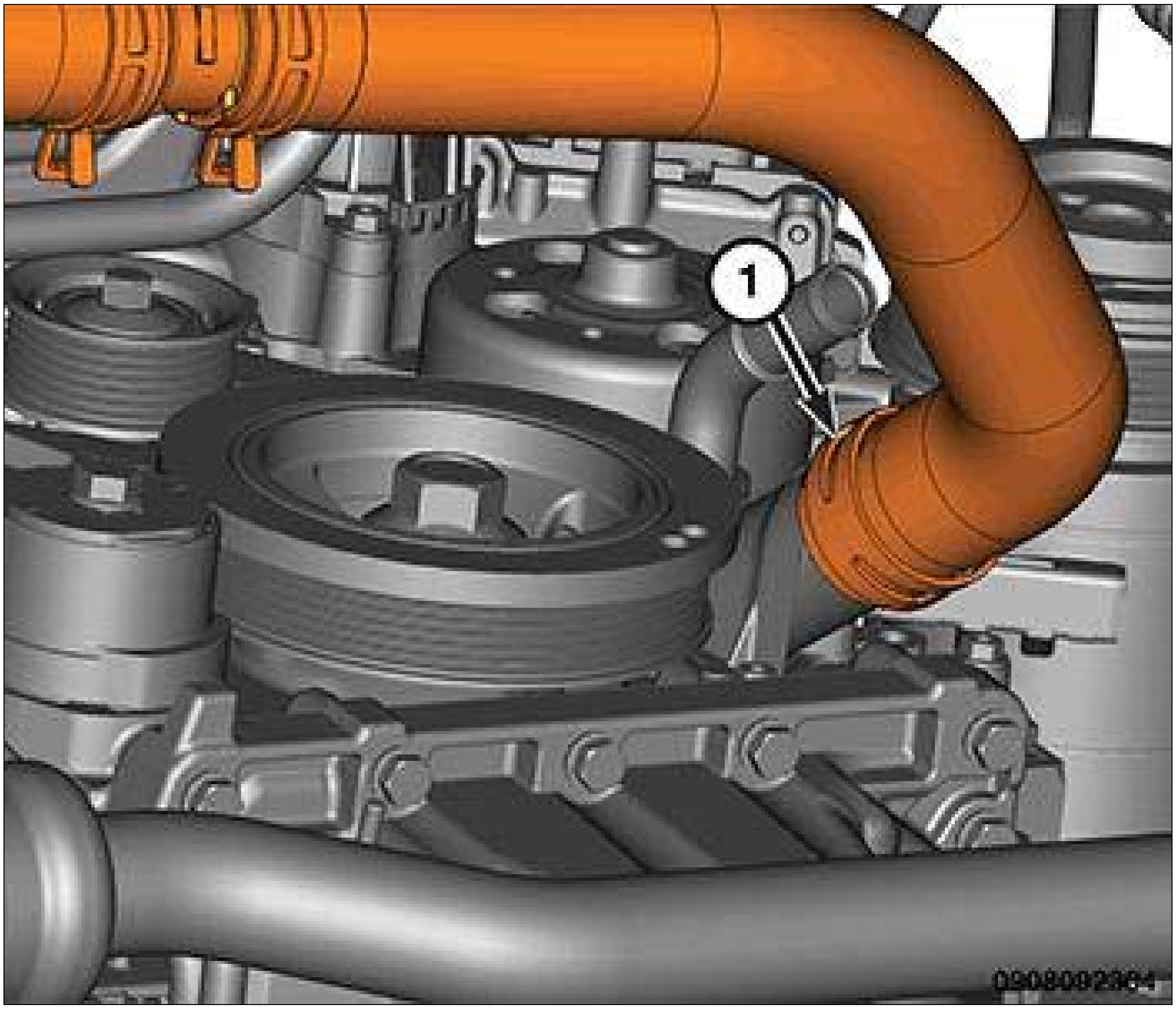
19. Remove the upper radiator hose (1).

Fig 5: Lower Radiator Hose



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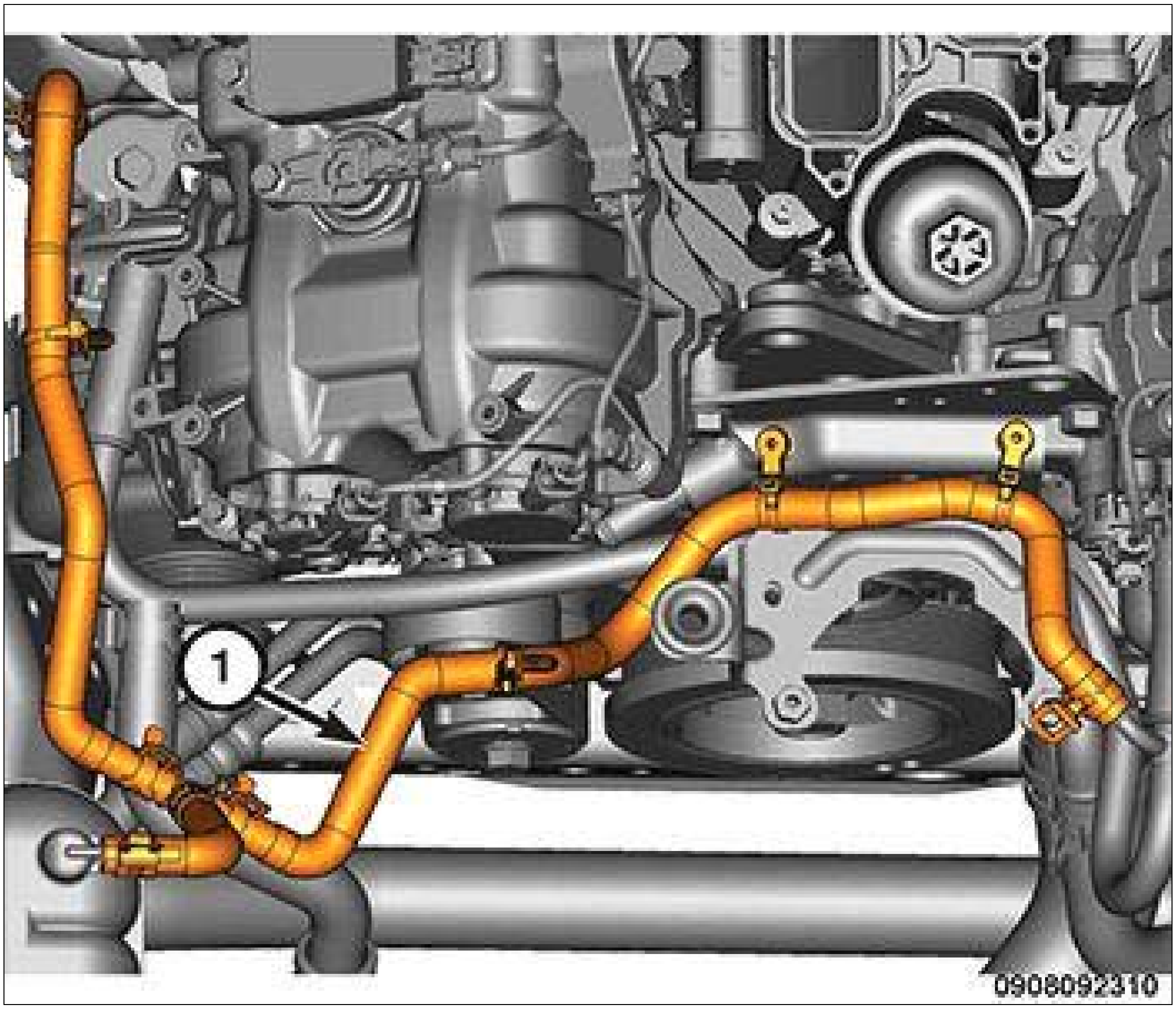
20. Remove the lower radiator hose (1).

Fig 6: Coolant Bottle Inlet Hose



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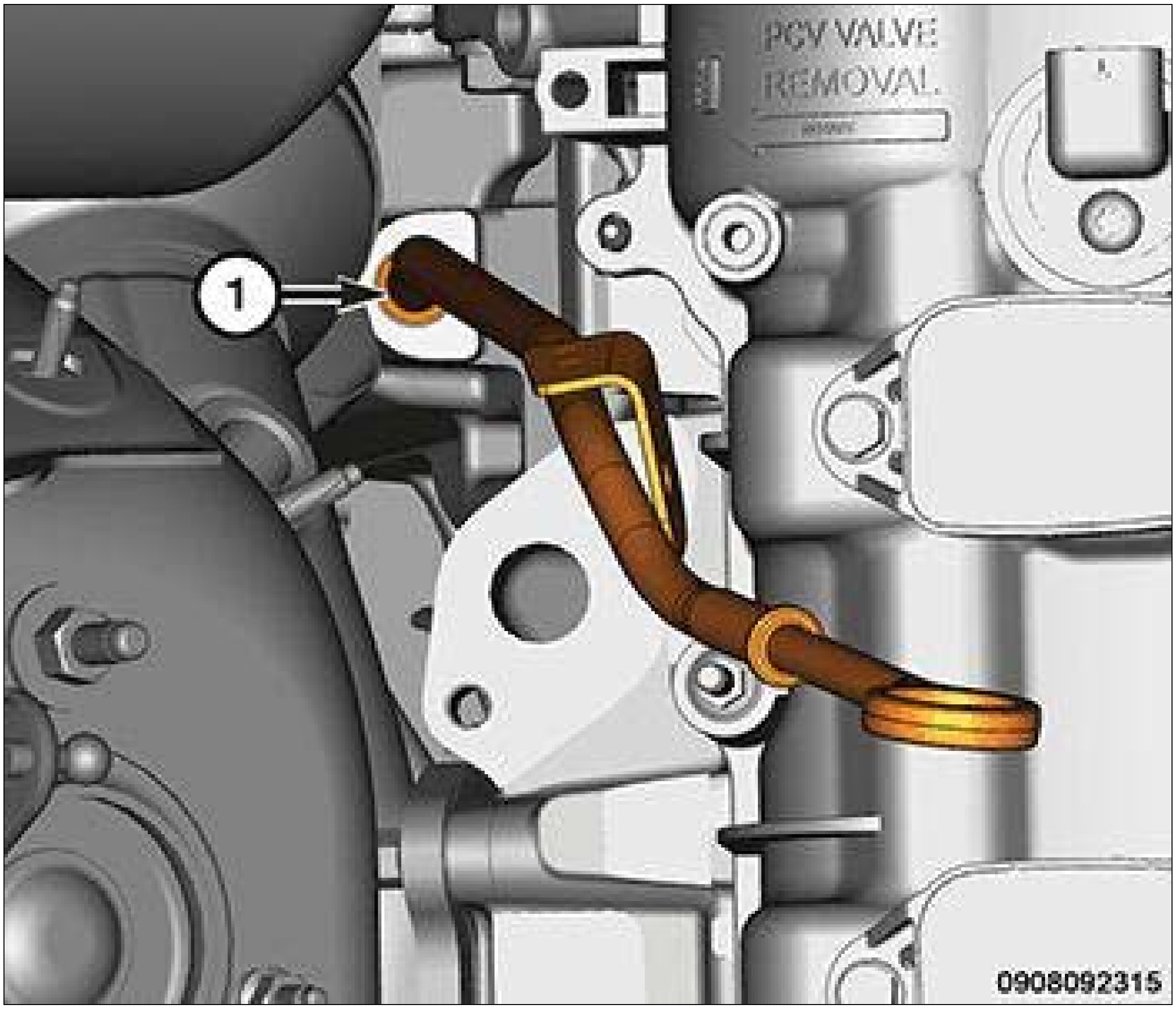
21. Remove the coolant bottle inlet hose (1).
22. Remove the pressurized coolant bottle. Refer to BOTTLE, PRESSURIZED COOLANT, REMOVAL .
23. Remove the cooling fan module. Refer to FAN, COOLING, REMOVAL .

Fig 7: Oil Dipstick & Tube



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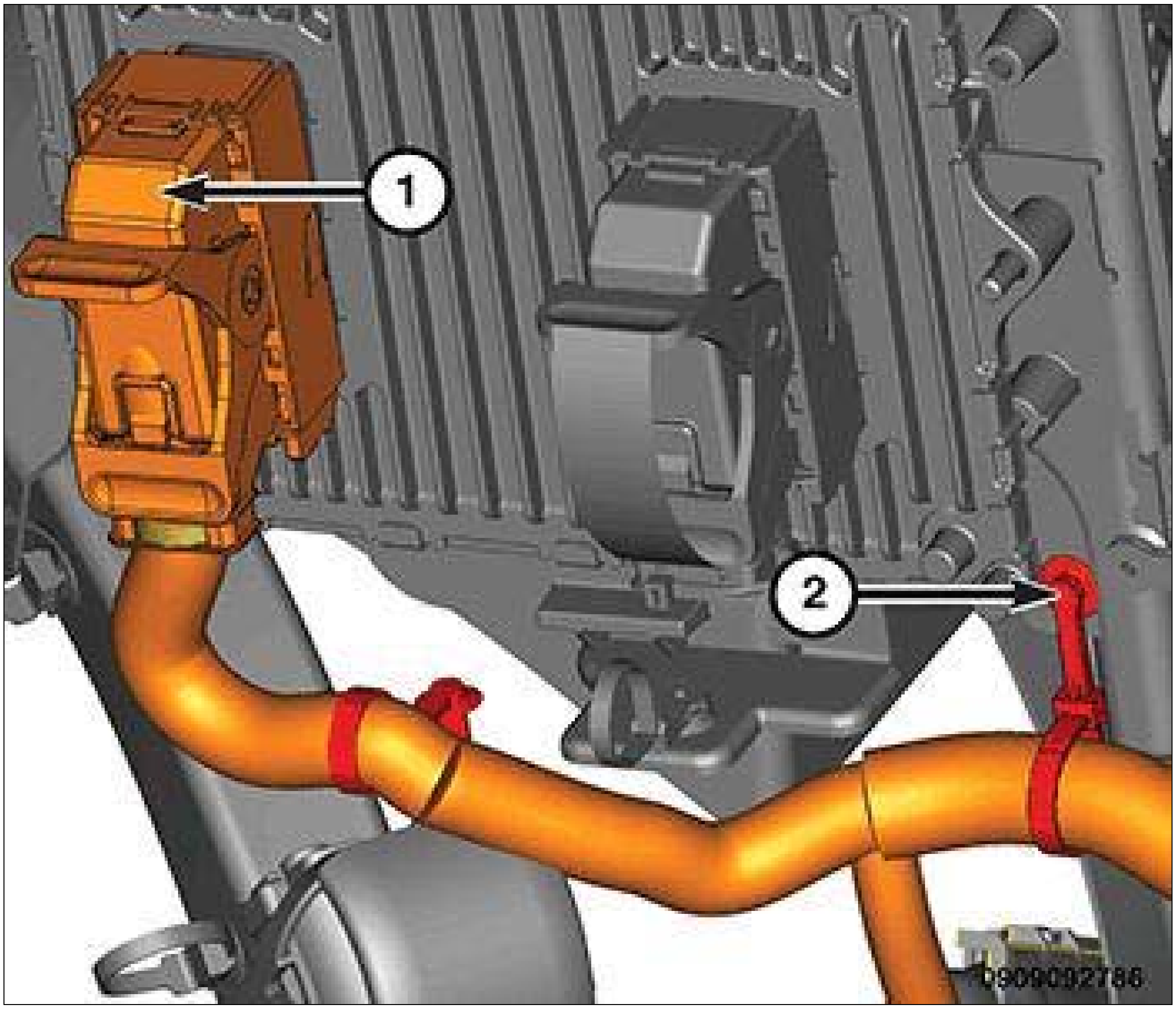
24. Remove the oil dipstick and tube.

Fig 8: PCM Wire Harness Connector & Wire Harness Retaining Clips



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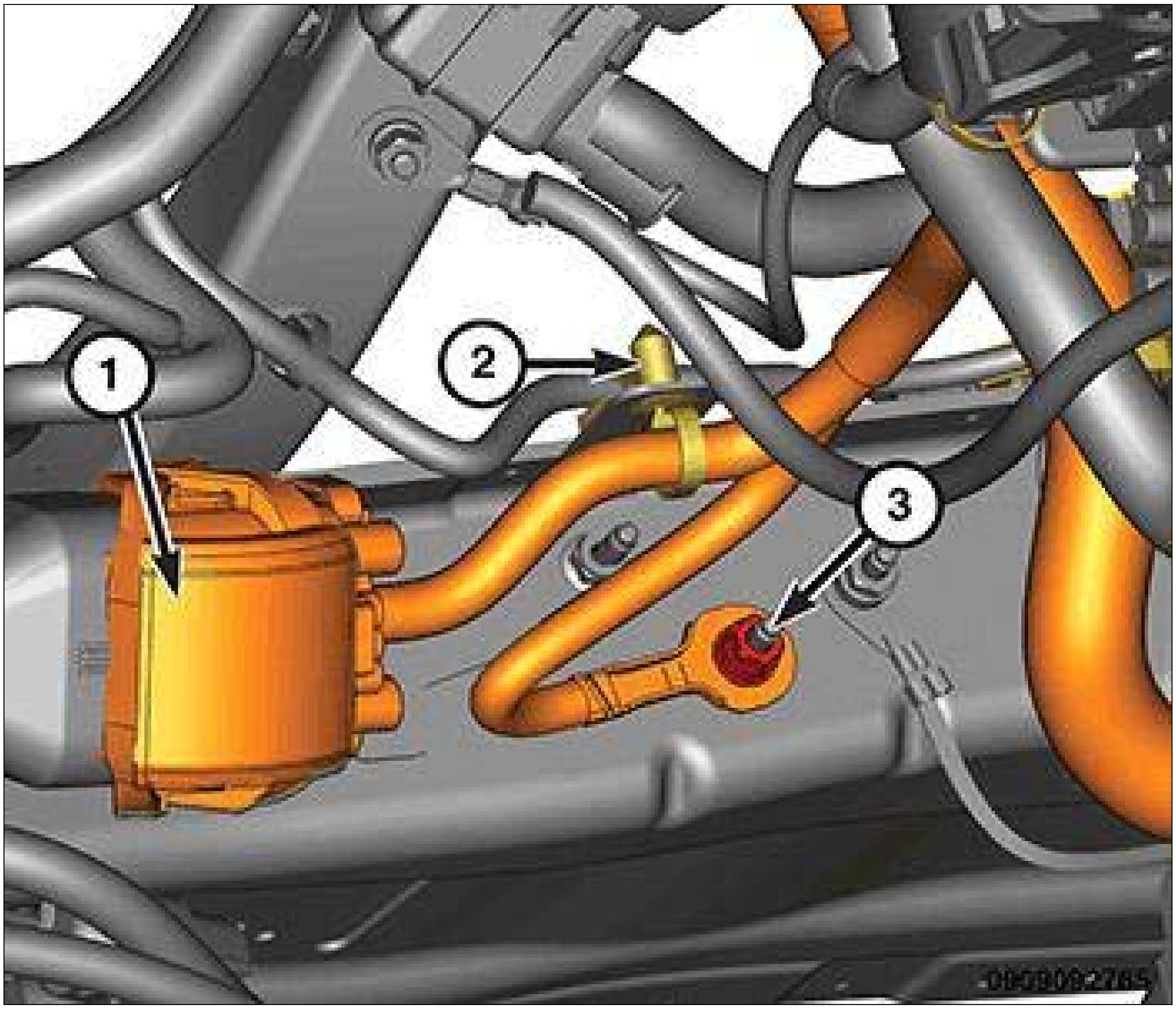
25. Disconnect the wire harness connector (1) from the Powertrain Control Module (PCM).
26. Disengage the wire harness retaining clips (2).

Fig 9: Wire Harness Connector, Wire Harness Retaining Clips & Nut



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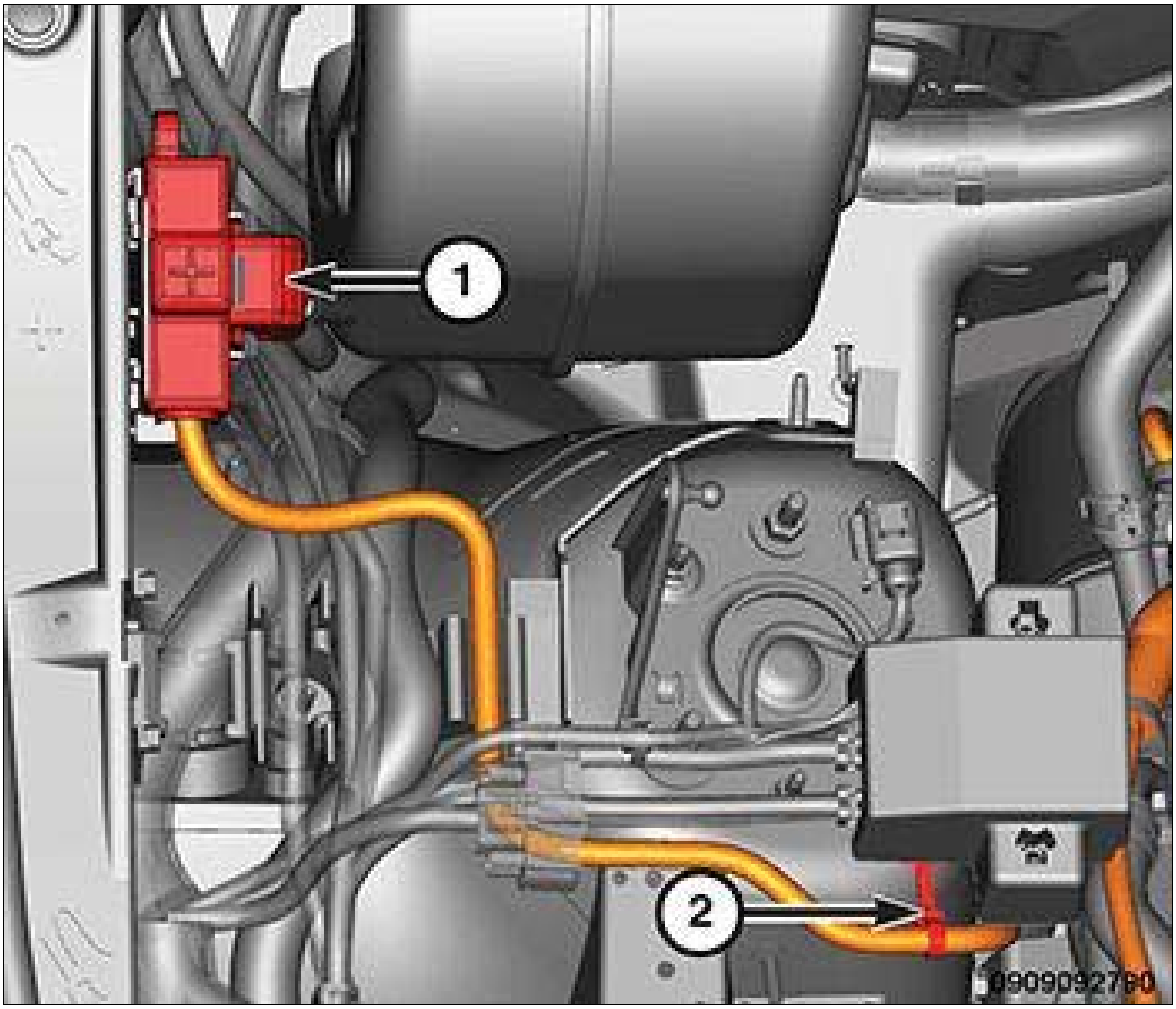
27. Disconnect the wire harness connector (1) just below the PCM, on the right side frame rail.
28. Remove the nut (3) and remove the ground cable.
29. Disengage the wire harness retaining clips (2) and position the harness with the engine.

Fig 10: Positive Starter And Alternator Cable & Wire Harness Retaining Clips



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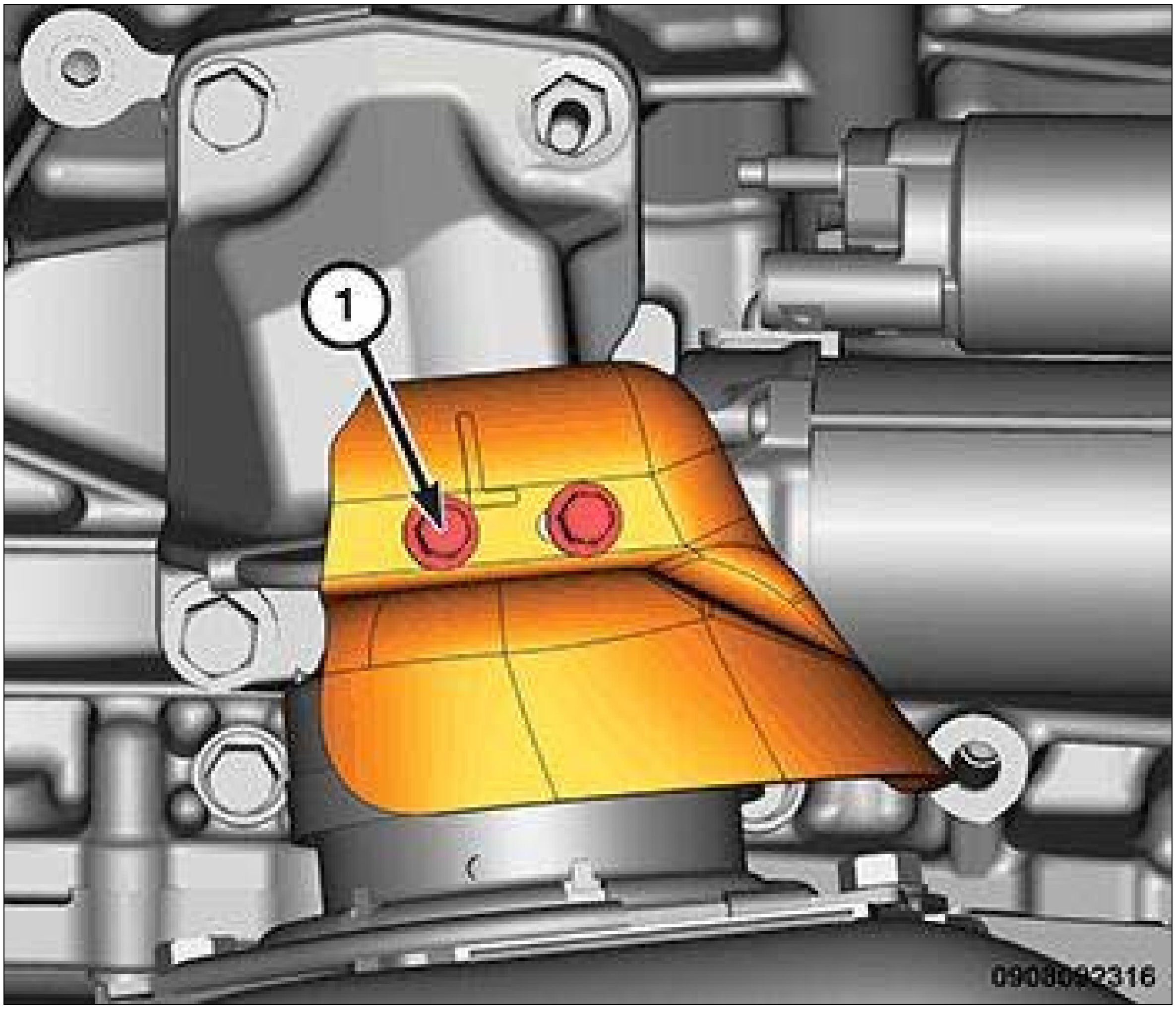
30. Disconnect the positive (1) starter and alternator cable.
31. Disengage the wire harness from the retaining clips (2) and position with the engine.
32. Remove the right and left catalytic converters. Refer to CONVERTER, CATALYTIC, REMOVAL .
33. If equipped with AWD, remove the front axle. Refer to REMOVAL .
34. Remove the starter. Refer to STARTER, REMOVAL .

Fig 11: Left Engine Mount Heat Shield Bolts



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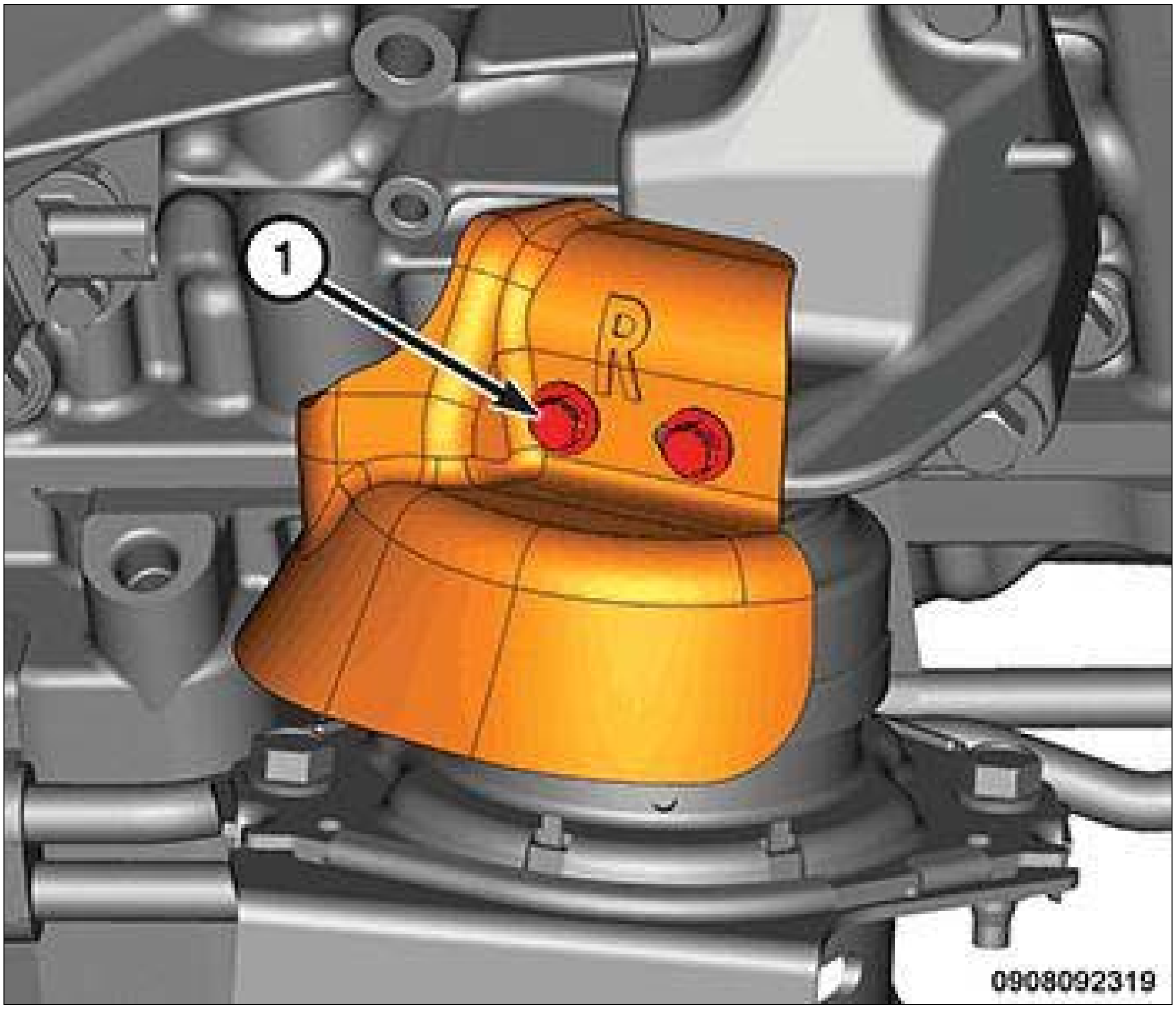
35. Remove the bolts (1) and the engine mount heat shield from the left engine mount.

Fig 12: Right Engine Mount Heat Shield Bolts



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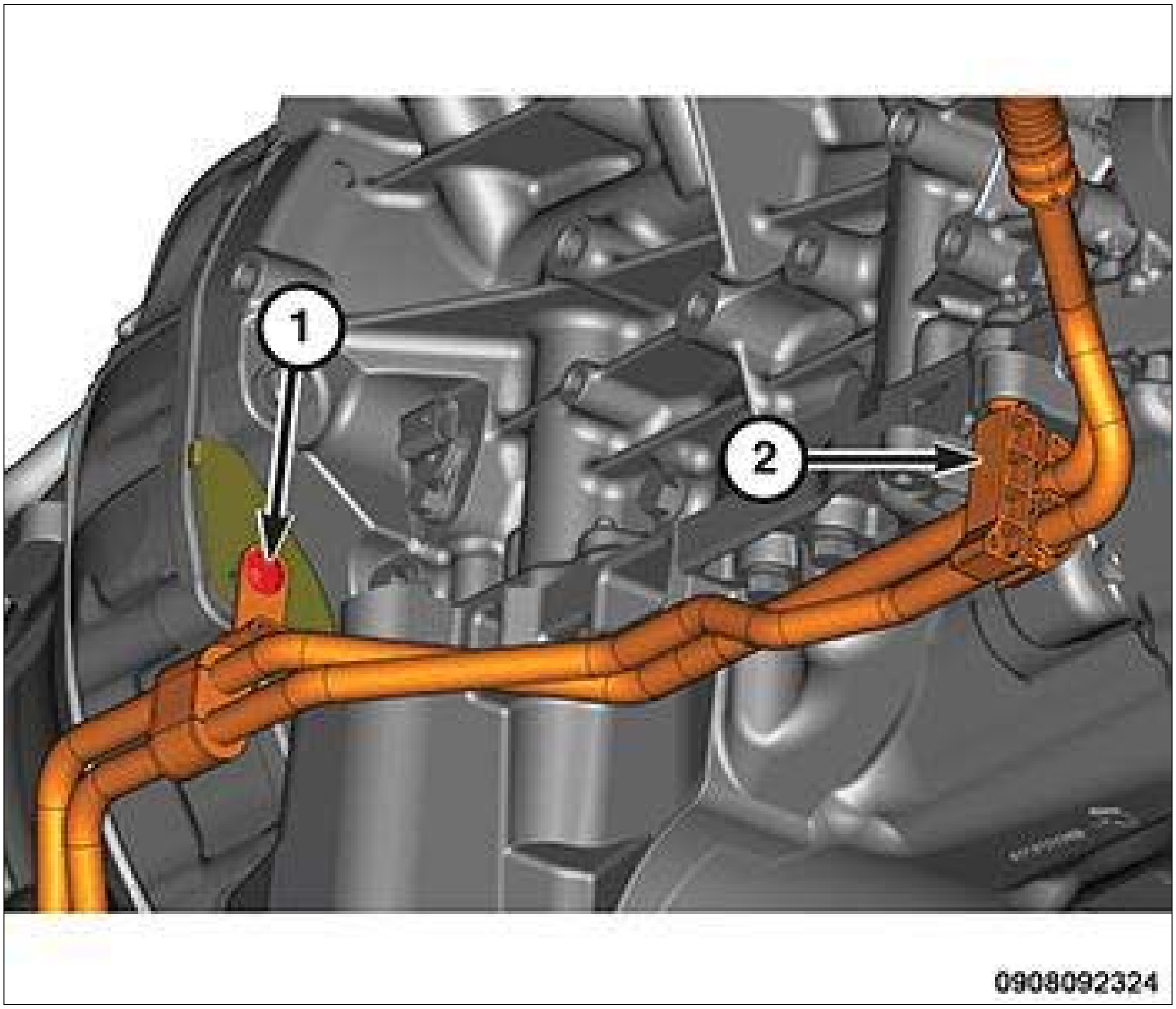
36. Remove the bolts (1) and the engine mount heat shield from the right engine mount.

37. Remove the ground strap from the right engine mount bracket.

Fig 13: Transmission Cooler Line Fastener & Retainer



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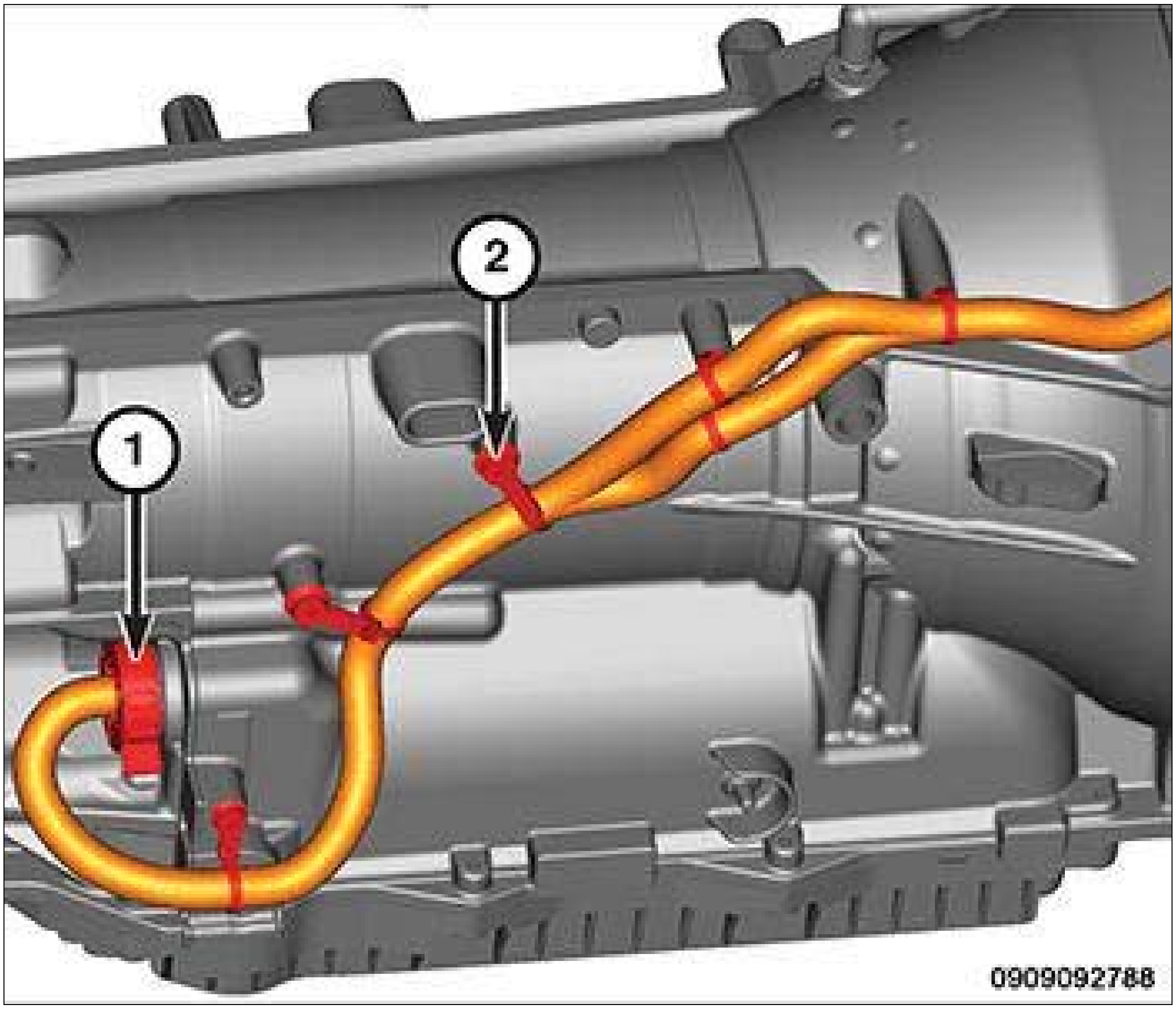
38. Remove the transmission cooler line fastener from the transmission (1) and disengage the retainer (2) from the upper oil pan flange and position lines aside.

Fig 14: Wire Harness Connector & Retainers



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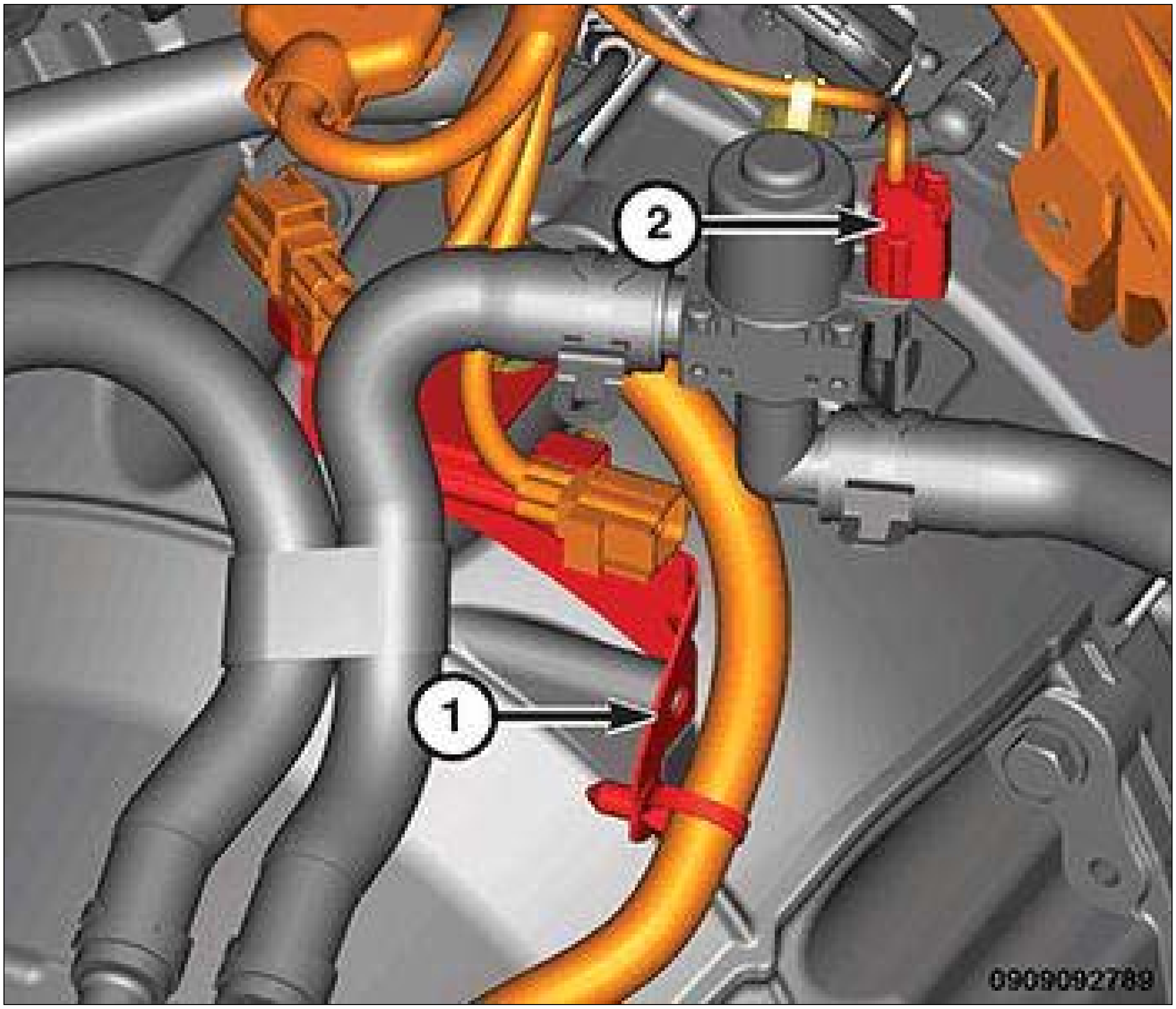
39. Disconnect the wire harness connector (1) from the transmission.
40. Disengage the wire harness retainers from the transmission (2).

Fig 15: O2 Sensor Wire Harness Bracket & Coolant Shut Off Valve Wire Harness Connector



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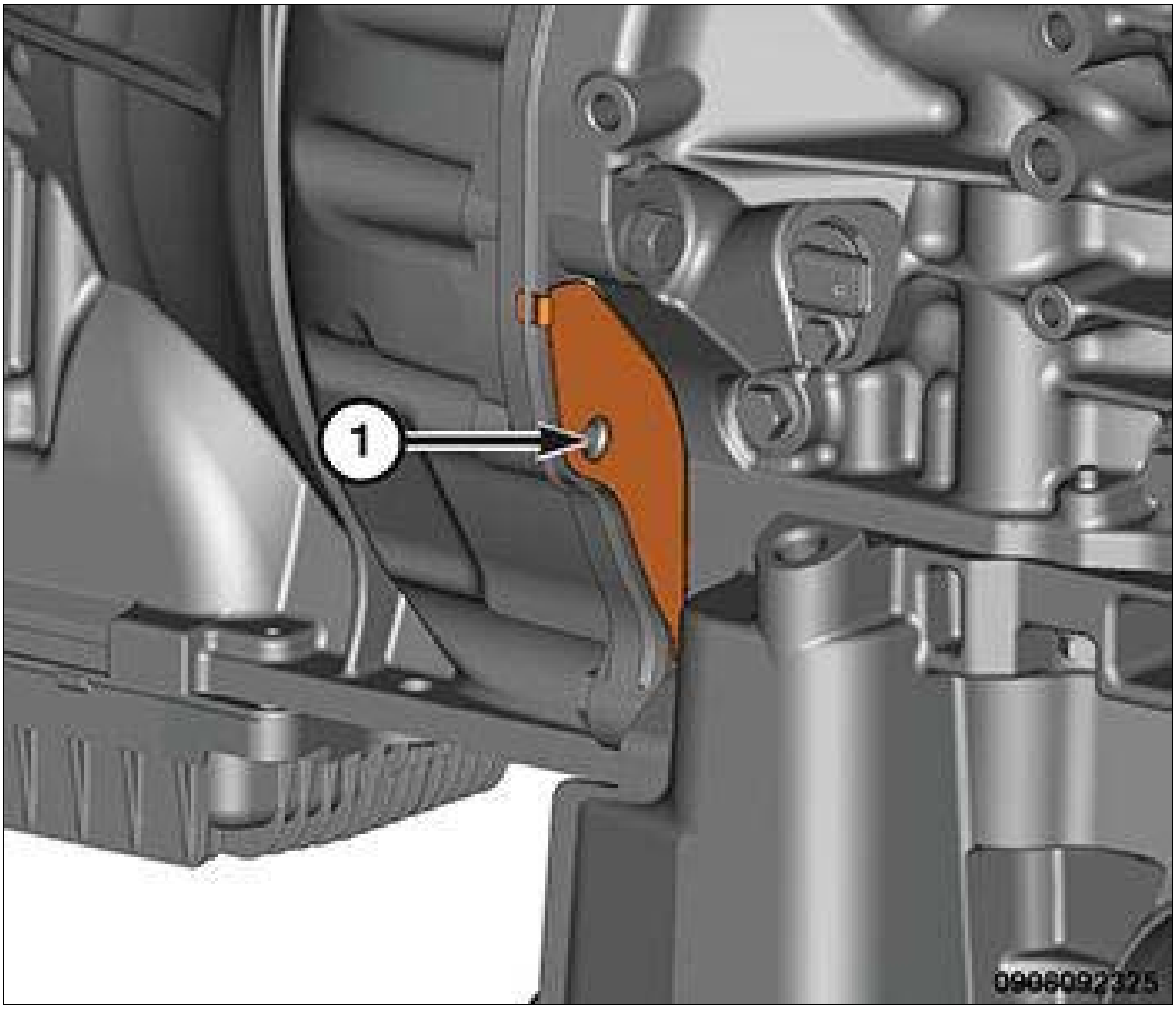
41. Disconnect the wire harness connector from the coolant shut off valve (2).
42. Remove the oxygen sensor wire harness bracket (1) and position the harness with the engine.
43. Verify that all wire harness connections and retainers have been disconnected between the engine, transmission and body.

Fig 16: Torque Converter Dust Shield & Fastener



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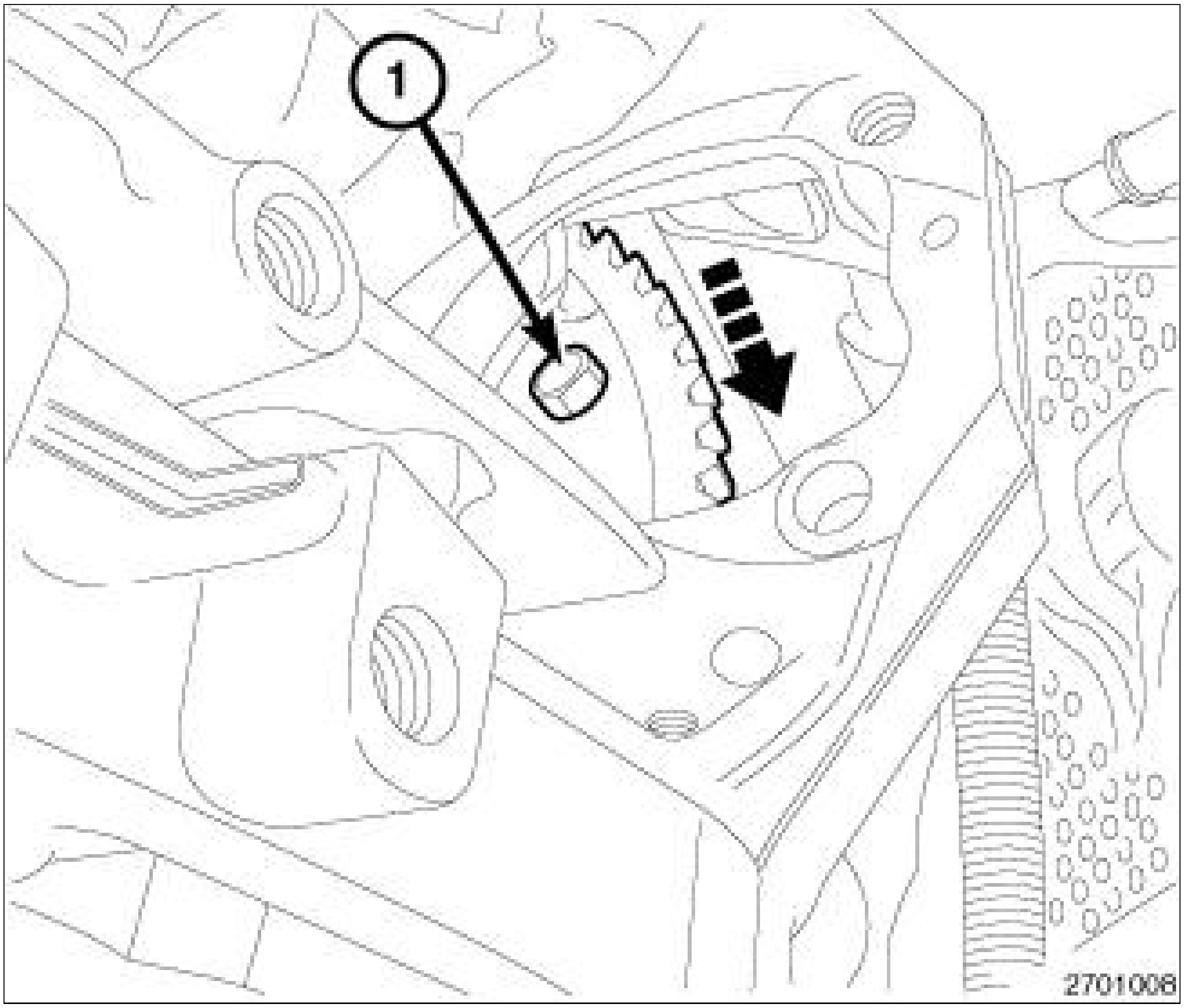
44. Remove the fastener and the torque converter dust shield (1).
45. Disconnect and reposition the power cord from the engine block heater (if equipped).

Fig 17: Torque Converter Bolt



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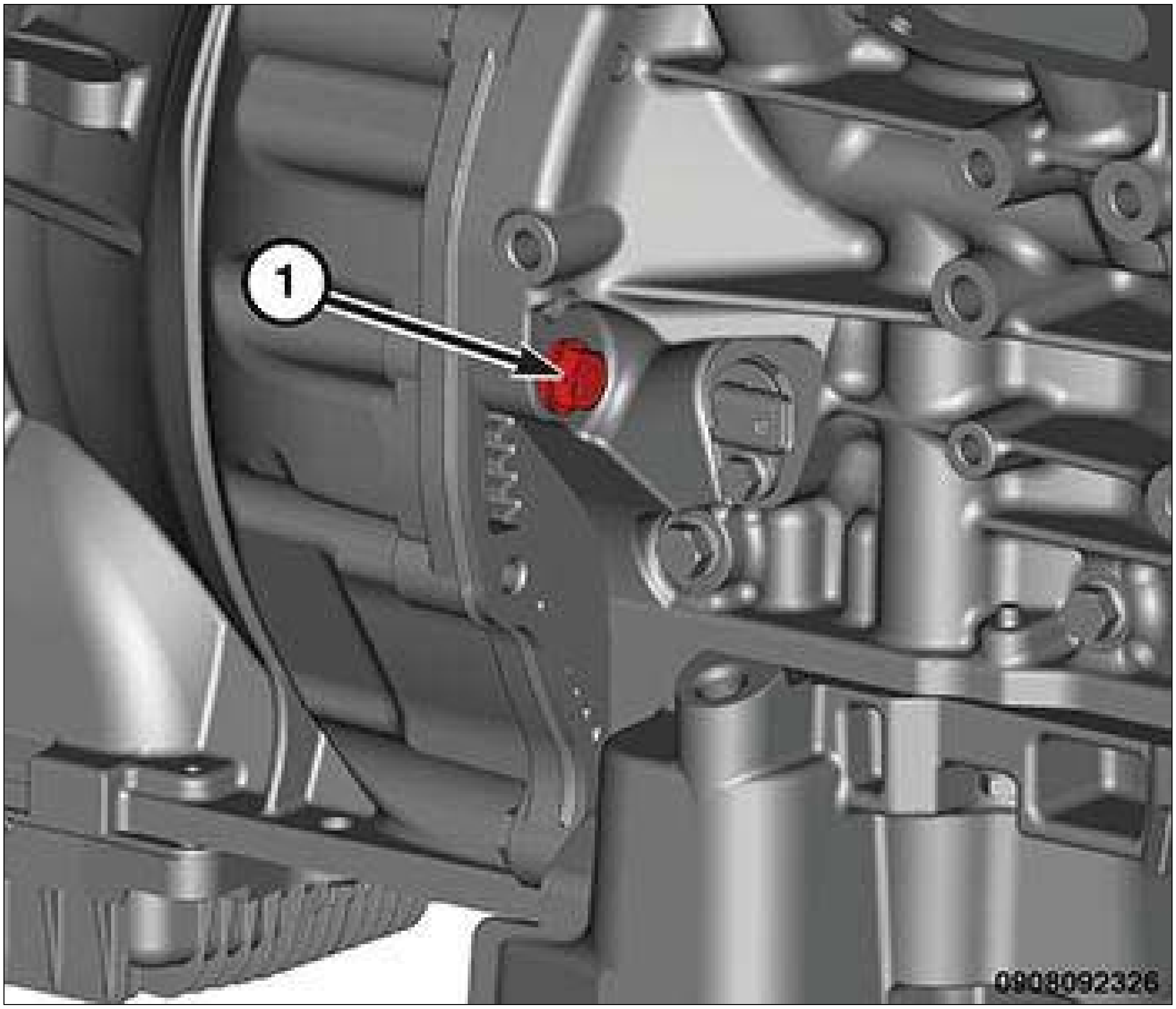
46. Rotate the crankshaft in a clockwise direction until the torque converter bolts (1) are accessible through the starter mounting. Remove the six torque converter bolts (1).

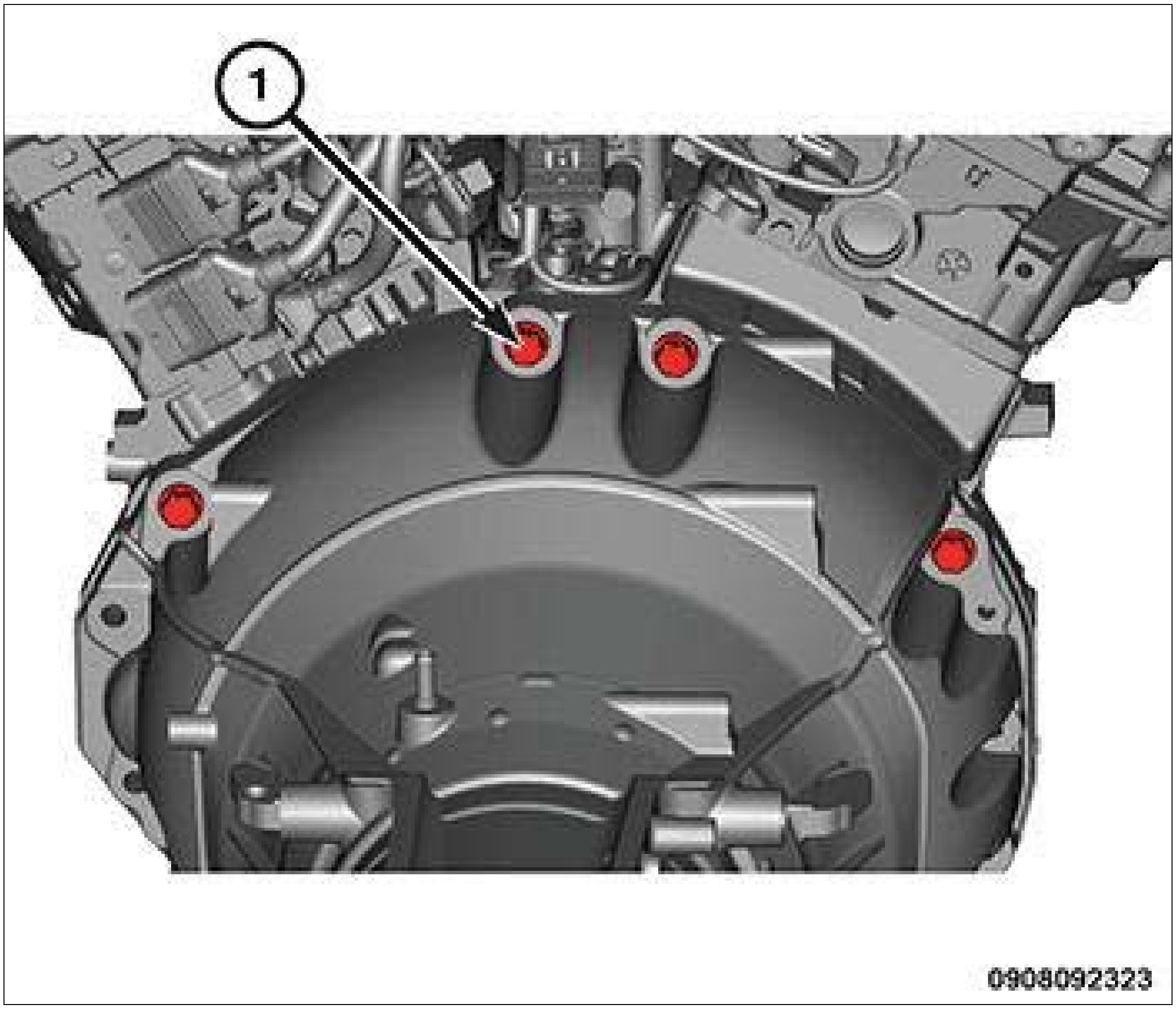
Fig 18: Side Engine To Transmission Bolt



Courtesy of CHRYSLER GROUP, LLC

47. Remove the side engine to transmission bolt (1).

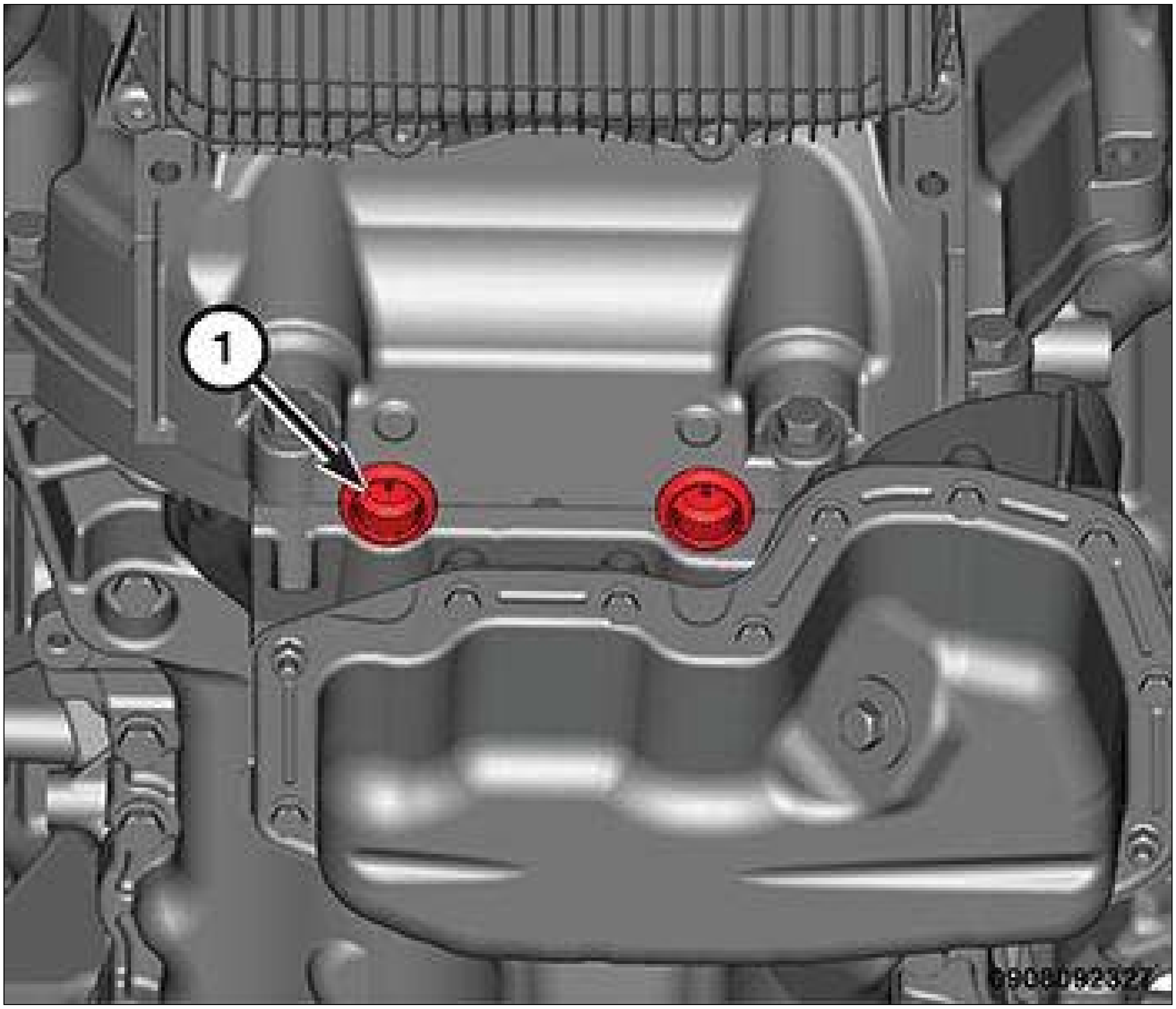
Fig 19: Upper Transmission To Engine Bolts



Courtesy of CHRYSLER GROUP, LLC

48. Remove four upper transmission to engine bolts (1).

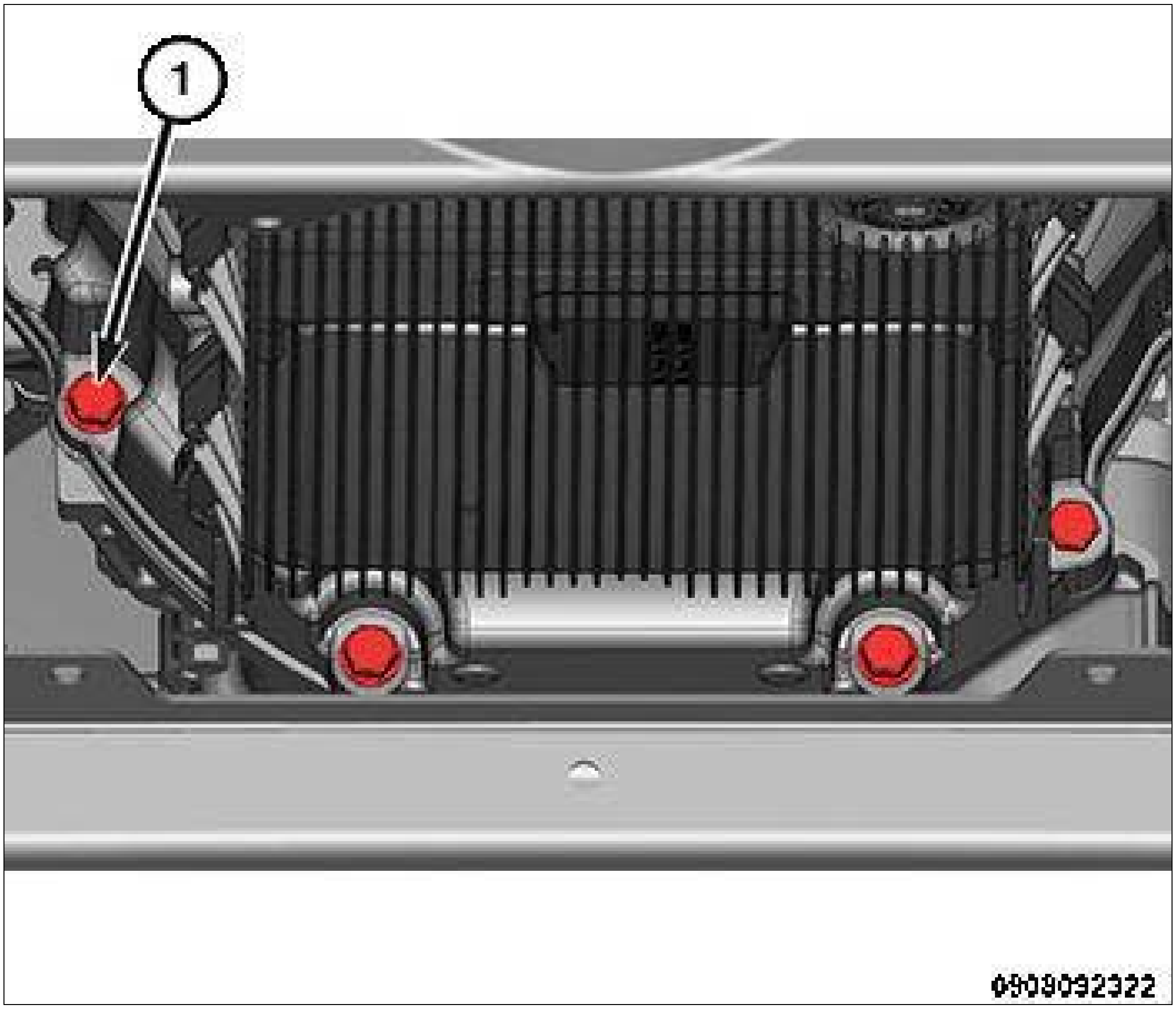
Fig 20: Rubber Plugs Covering Rear Oil Seal Retainer Flange Bolts



Courtesy of CHRYSLER GROUP, LLC

49. Remove two rubber plugs (1) covering the rear oil seal retainer flange bolts.

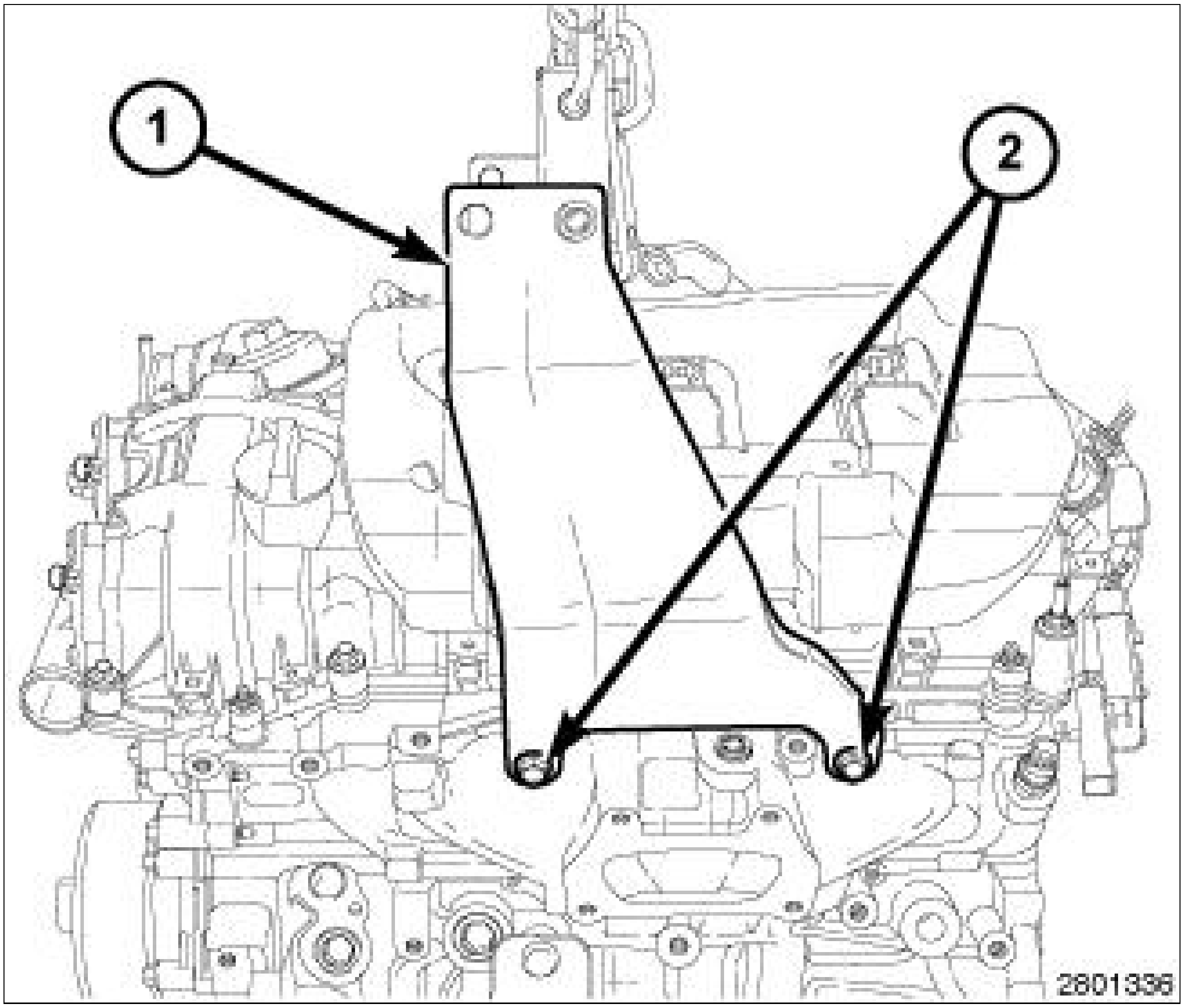
Fig 21: Transmission To Engine Oil Pan Bolts



Courtesy of CHRYSLER GROUP, LLC

50. Remove four transmission to the engine oil pan bolts (1).
51. Lower the vehicle.

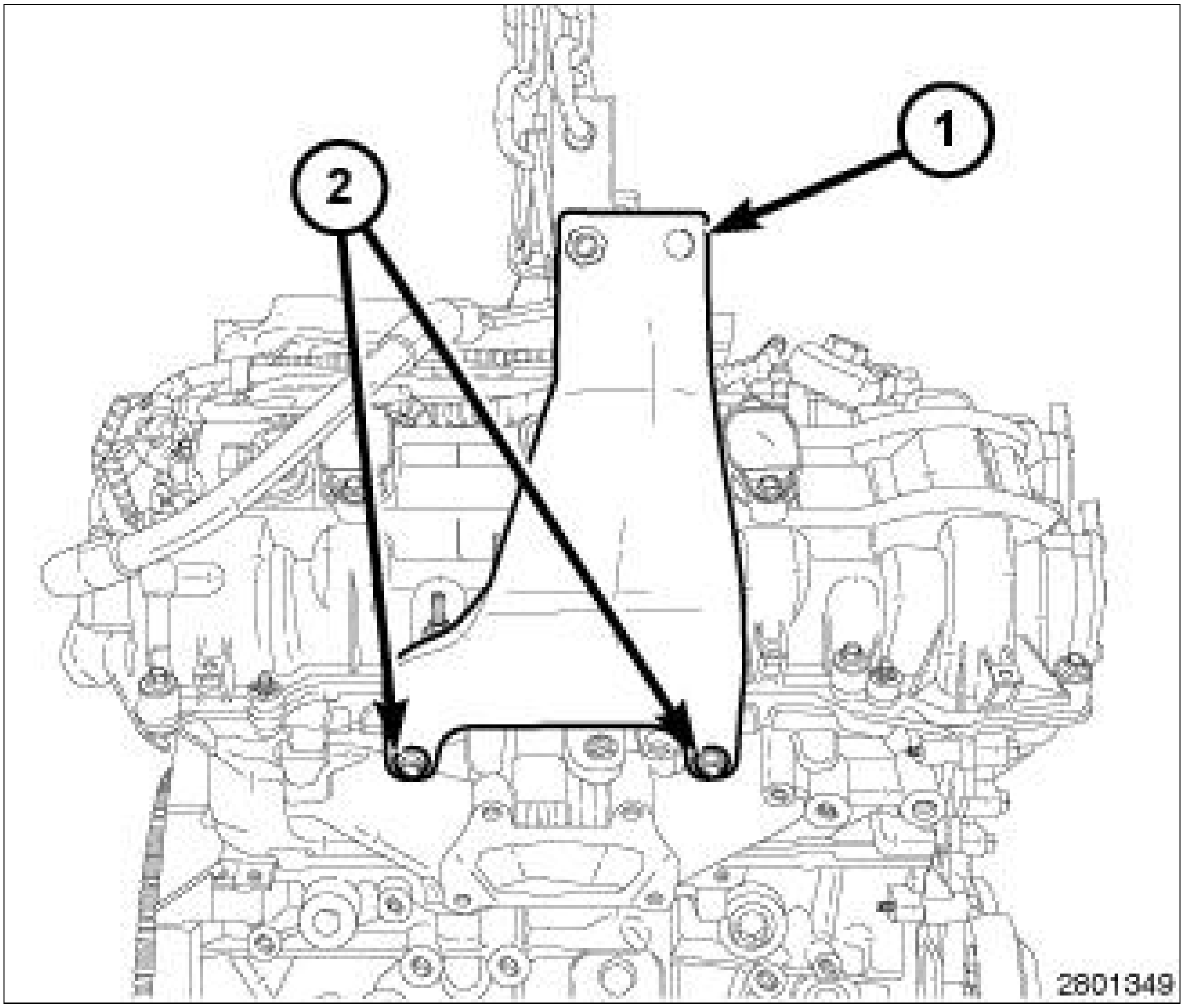
Fig 22: Driver Side Engine Lifting Bracket & Bolts



Courtesy of CHRYSLER GROUP, LLC

52. Install the (special tool #2028010090, Lift Bracket, Engine-Left) (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.).

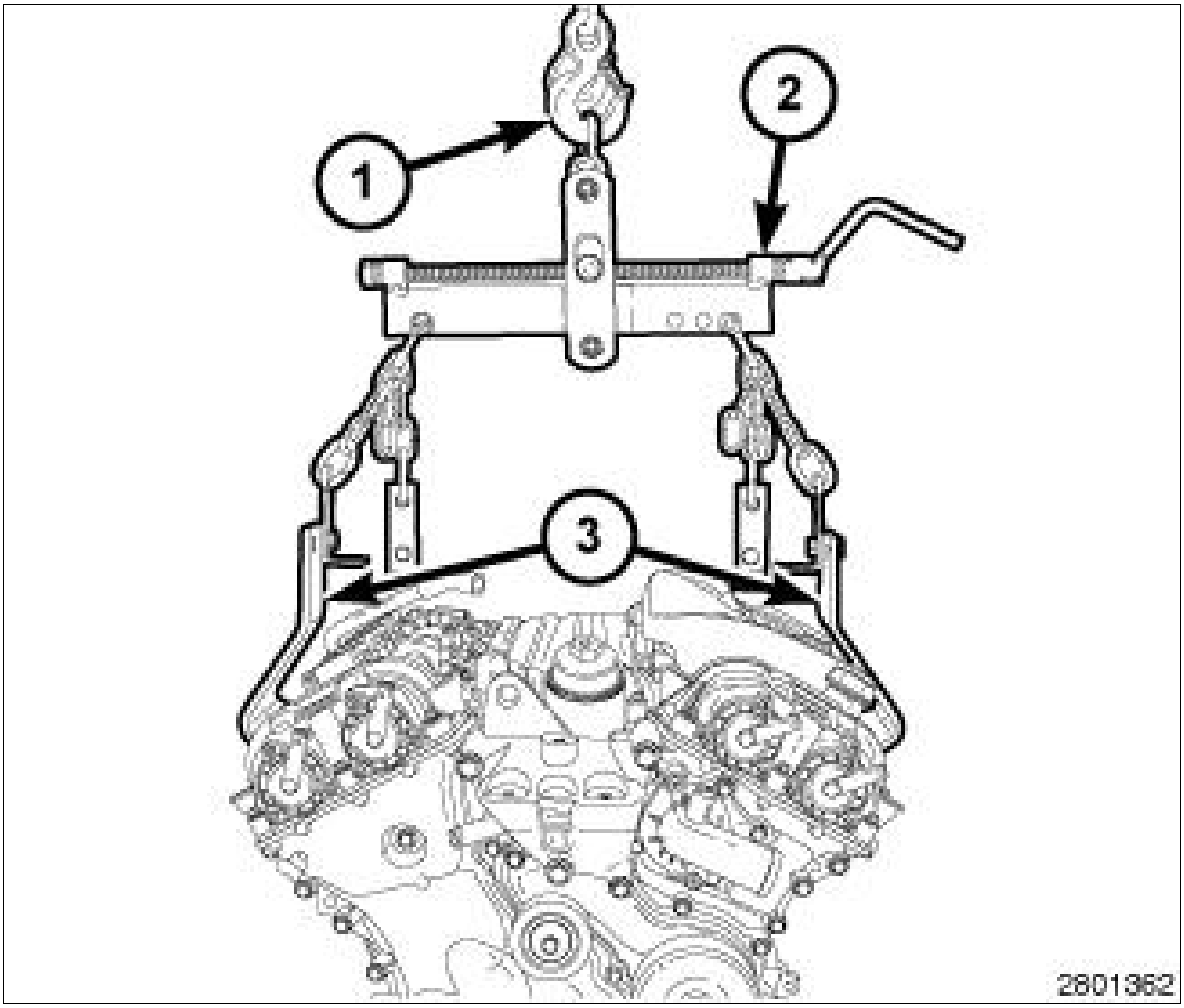
Fig 23: Passenger Side Engine Lifting Bracket & Bolts



Courtesy of CHRYSLER GROUP, LLC

53. Install the (special tool #2028020090, Lift Bracket, Engine-Right) (1) on the RH cylinder head with bolts (2) provided with the Engine Lifting Bracket. Tighten the bolts to 21 N.m (15 ft. lbs.).

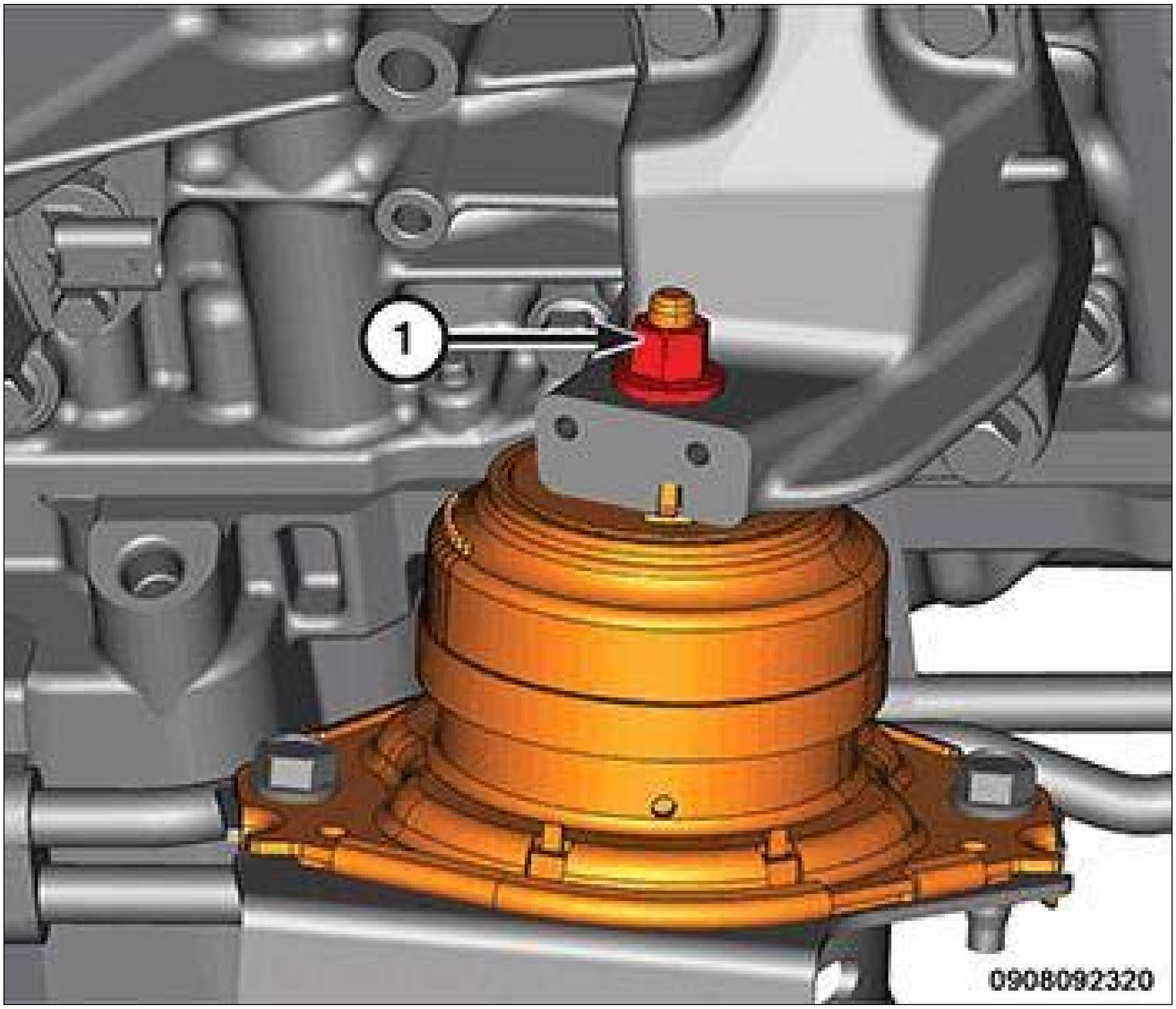
Fig 24: Lifting Sling, Engine Lifting Brackets & Engine Hoist



Courtesy of CHRYSLER GROUP, LLC

54. 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).
55. Support the transmission with a suitable jack.

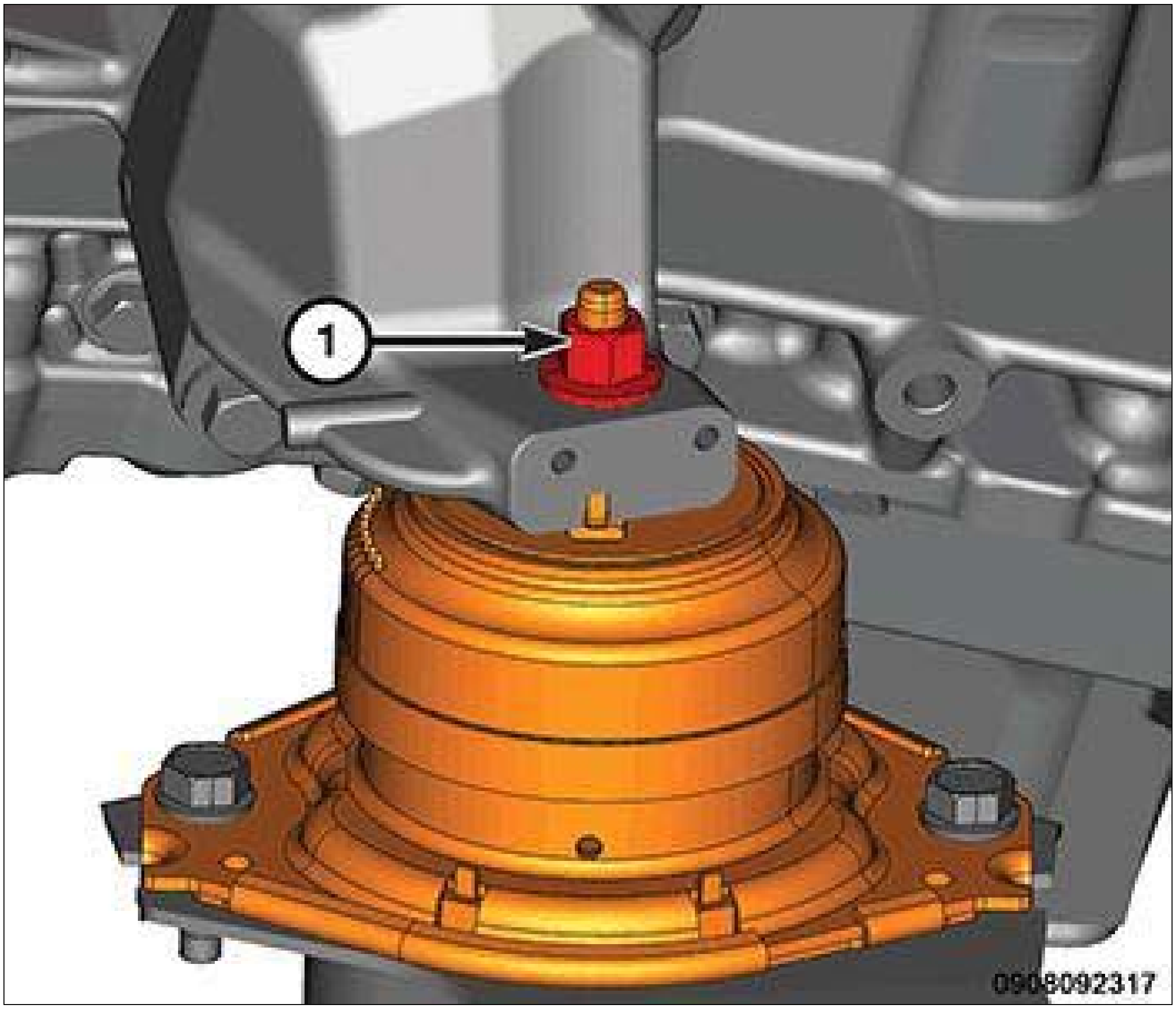
Fig 25: Right Engine Mount Nut



Courtesy of CHRYSLER GROUP, LLC

56. Remove the right engine mount nut (1).

Fig 26: Left Engine Mount Nut



Courtesy of CHRYSLER GROUP, LLC

57. Remove the left engine mount nut (1).

> ⚠ *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.*

58. Carefully remove the engine from the engine bay area.

59. If required, remove the necessary components for installation onto the replacement engine.

INSTALLATION > INSTALLATION

> ⚠ *CAUTION:*

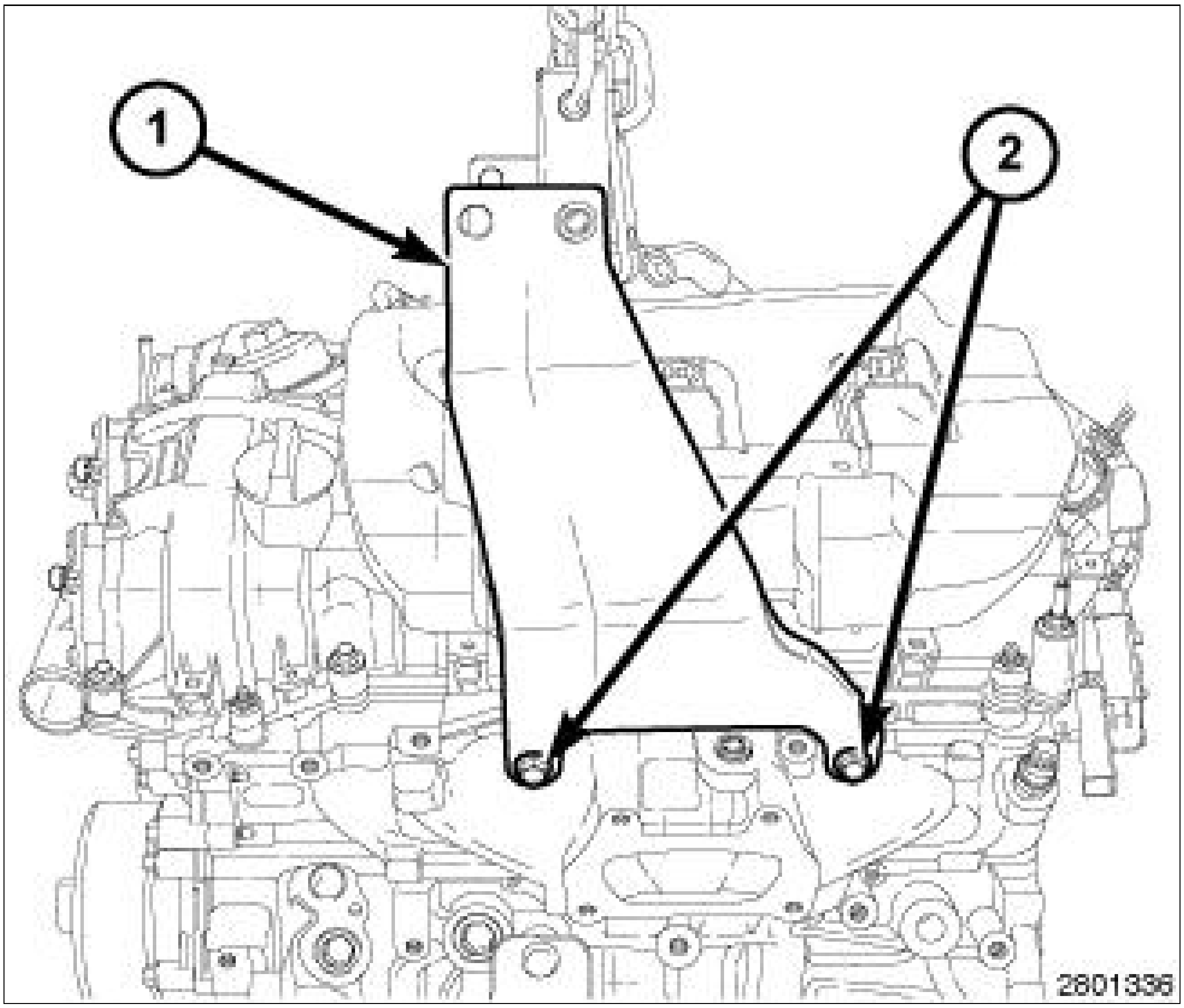
If the original engine has experienced a catastrophic failure or an individual failure with the piston, cylinder bore, engine block, valve or valve seat, the intake manifold MUST be replaced with a new manifold.

NOTE:

If installing a replacement engine, transfer any necessary components such as engine mount brackets, block heater, accessories, and wiring harness to the replacement engine.

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

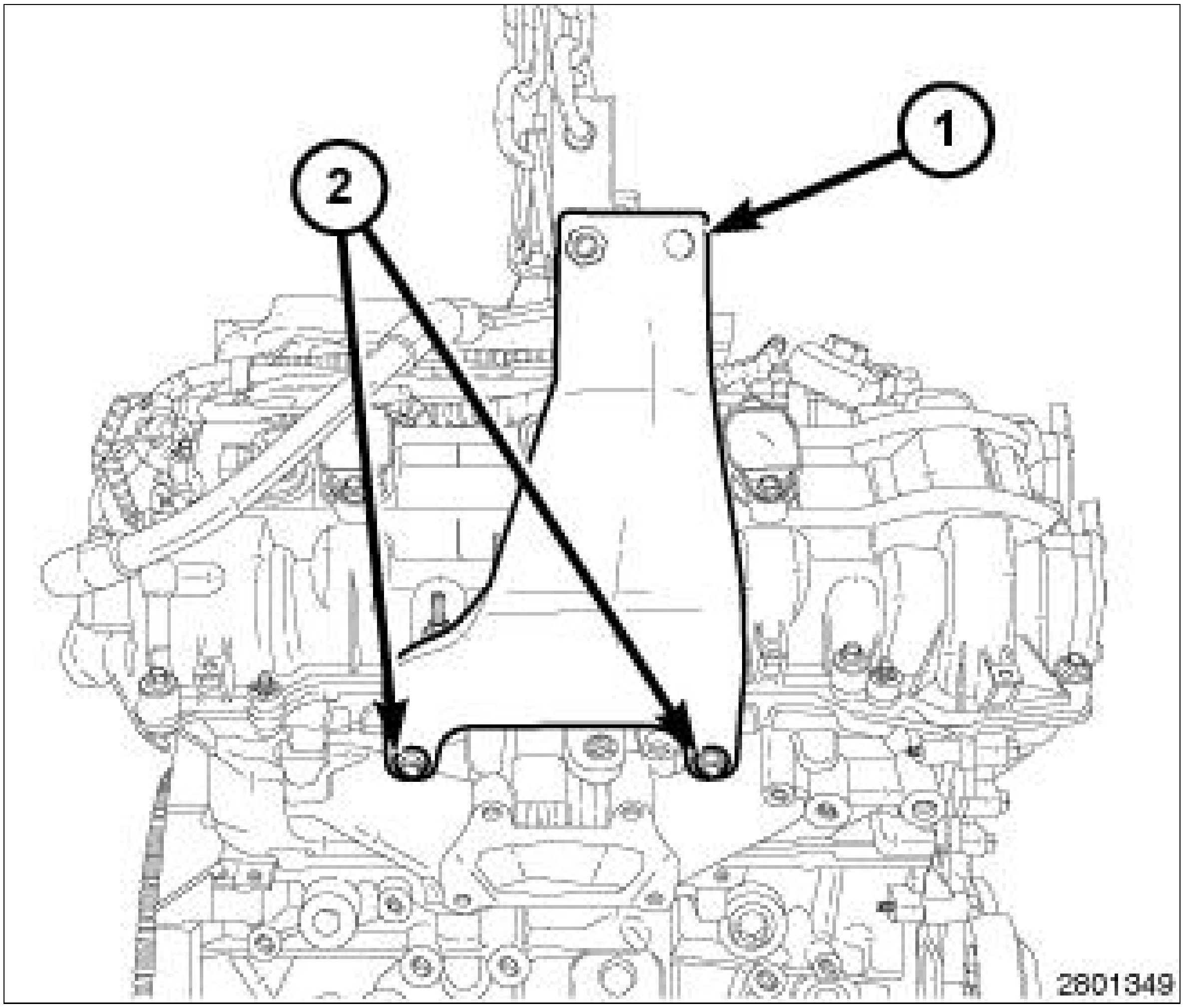
Fig 1: Driver Side Engine Lifting Bracket & Bolts



Courtesy of CHRYSLER GROUP, LLC

2. Install the (special tool #2028010090, Lift Bracket, Engine-Left) (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.).

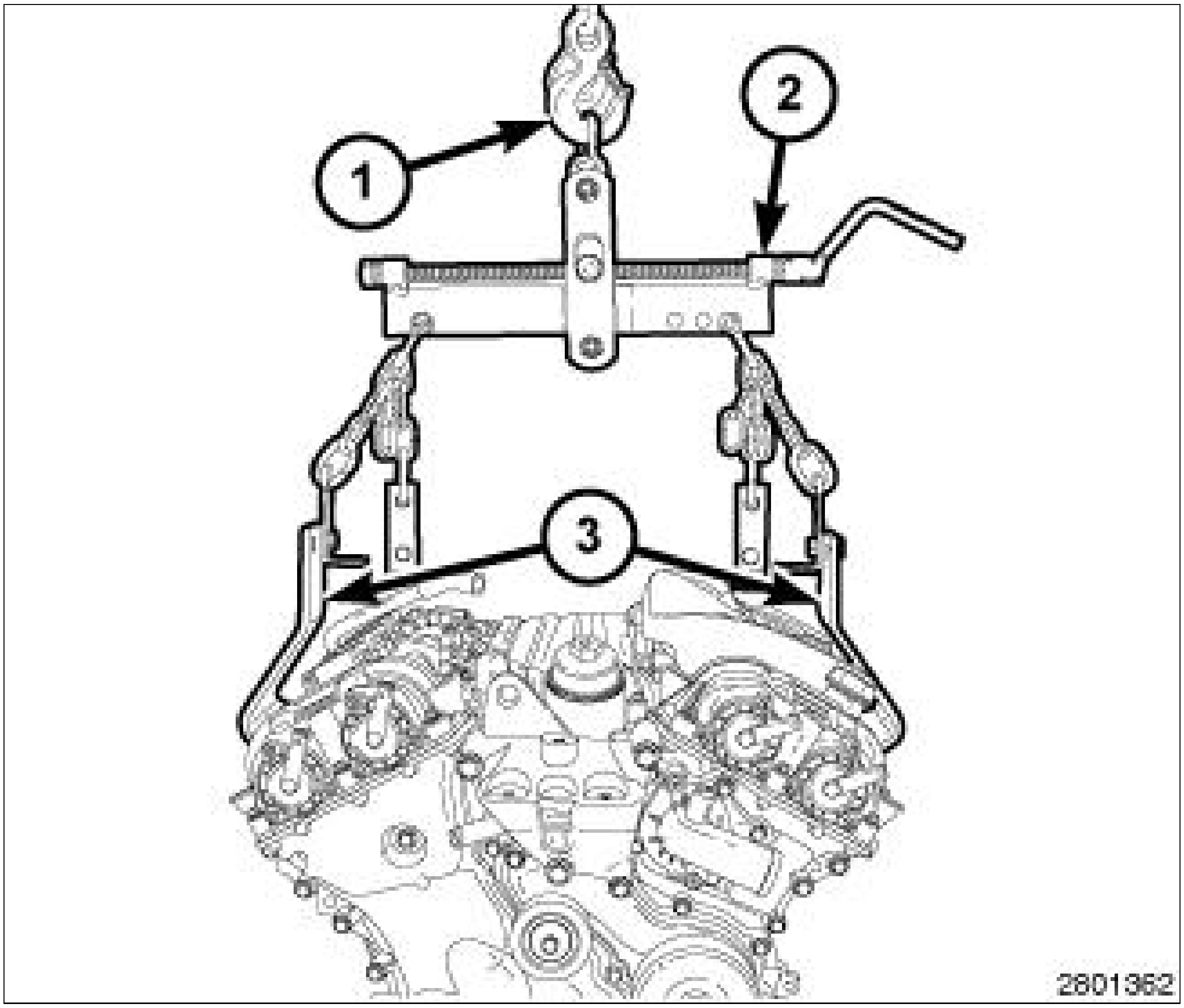
Fig 2: Passenger Side Engine Lifting Bracket & Bolts



Courtesy of CHRYSLER GROUP, LLC

3. Install the (special tool #2028020090, Lift Bracket, Engine-Right) (1) on the RH cylinder head with bolts (2) provided with the Engine Lifting Bracket. Tighten the bolts to 21 N.m (15 ft. lbs.).

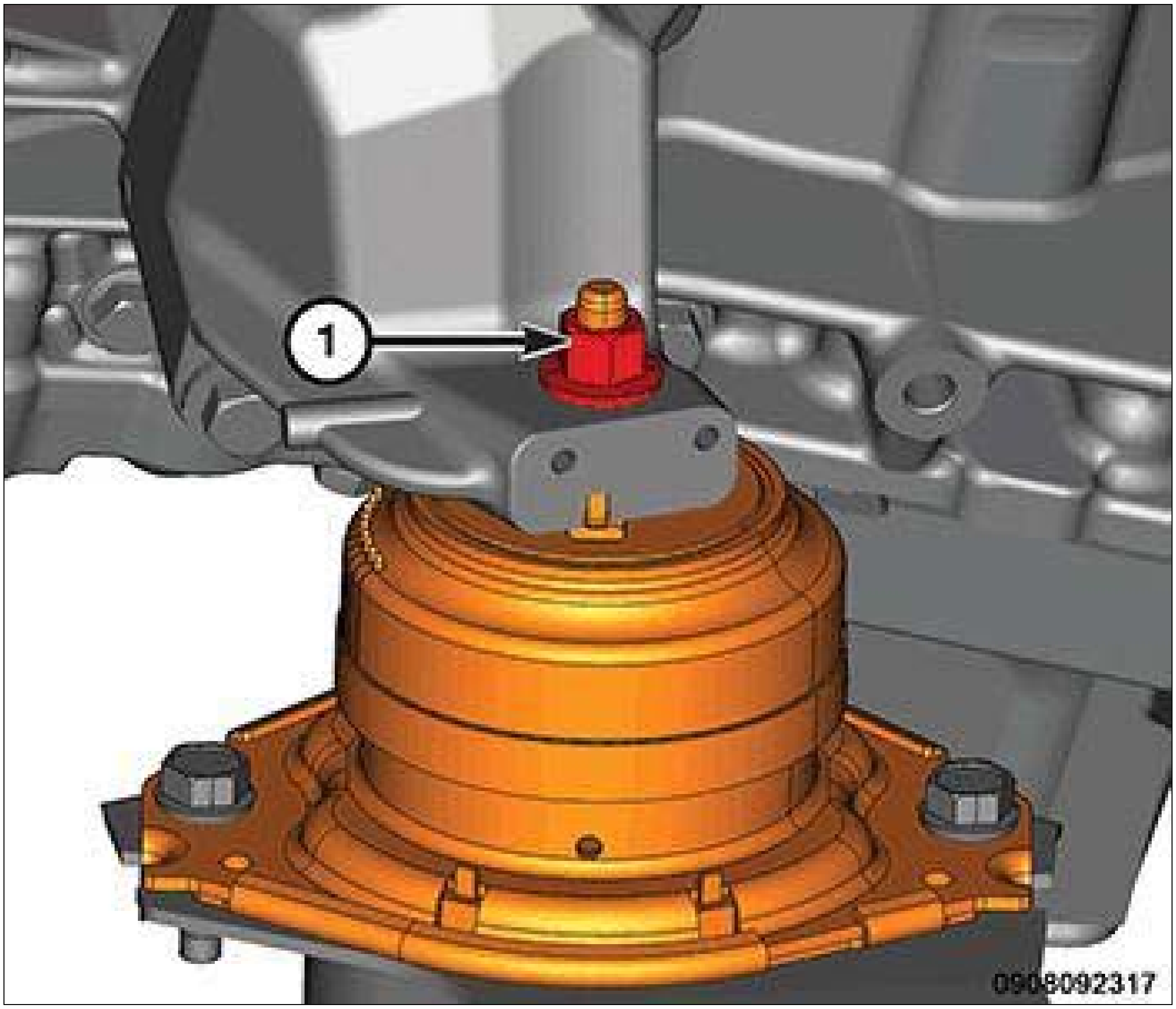
Fig 3: Lifting Sling, Engine Lifting Brackets & Engine Hoist



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. Position the engine in the vehicle while aligning the two locator dowels into the transmission housing.

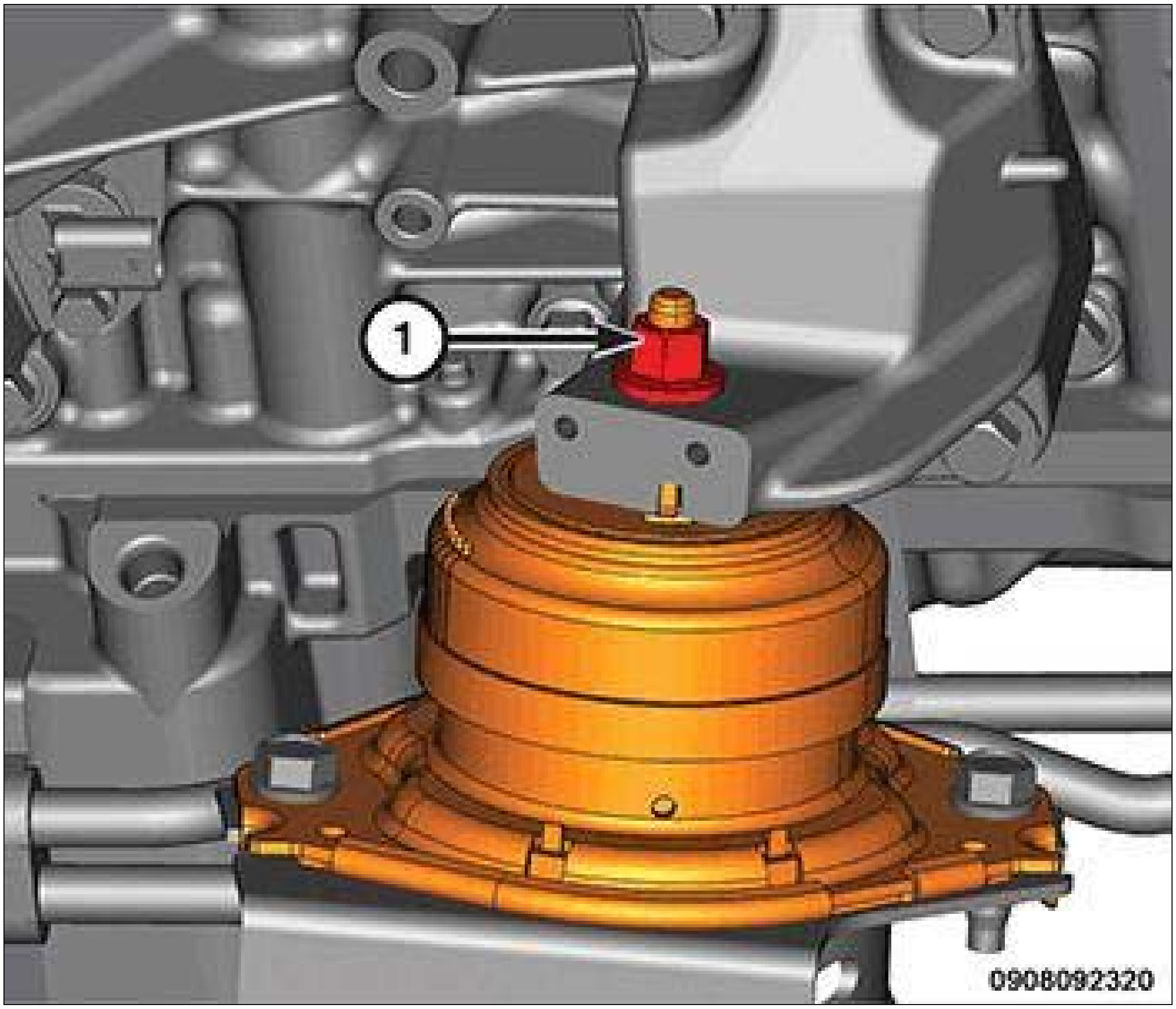
Fig 4: Left Engine Mount Nut



Courtesy of CHRYSLER GROUP, LLC

6. Align the tab on the isolators with the notch in the engine mount brackets and lower the engine so the weight is resting on the isolators.
7. Install the left engine mount nut (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

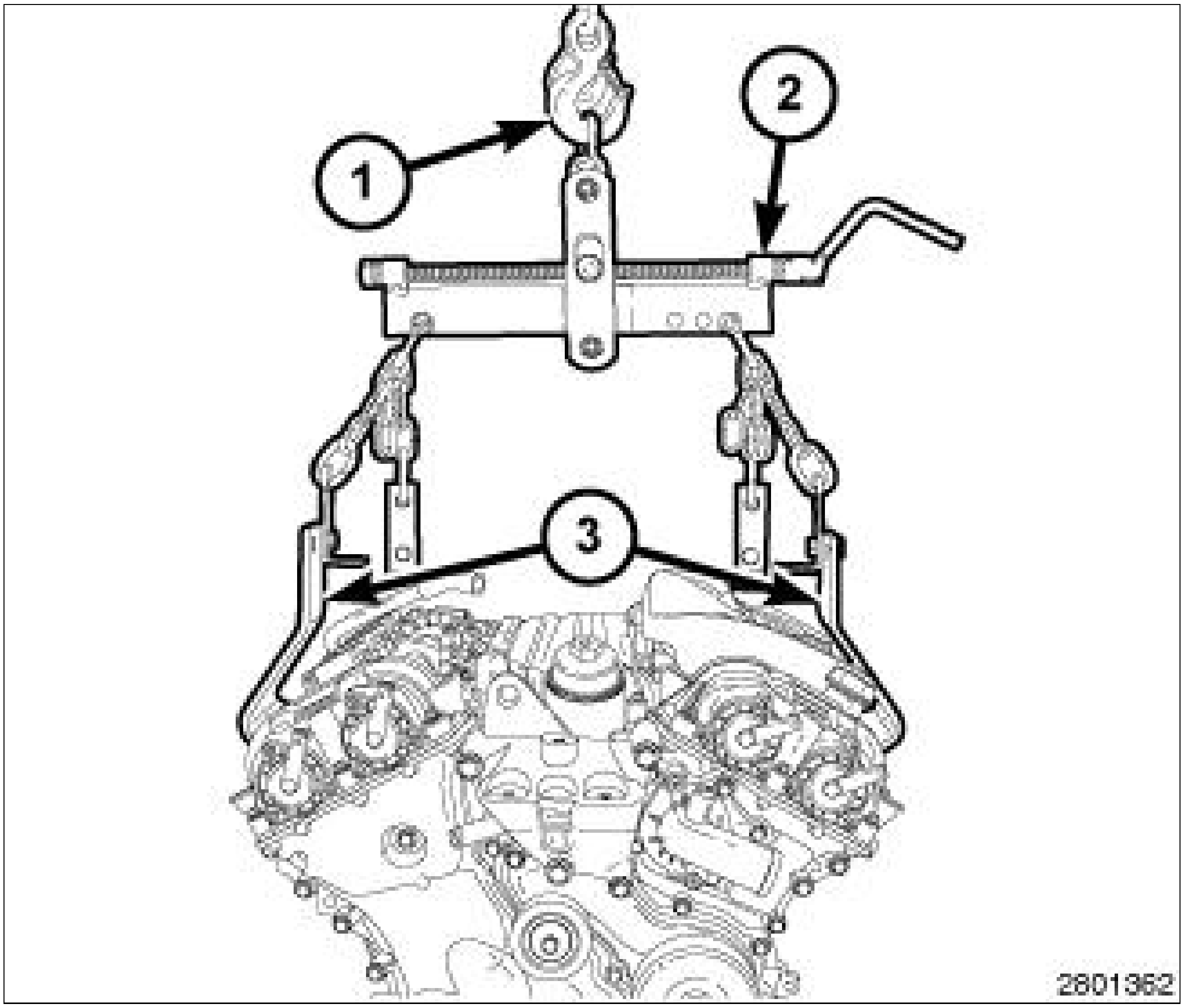
Fig 5: Right Engine Mount Nut



Courtesy of CHRYSLER GROUP, LLC

8. Install the right engine mount nut (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

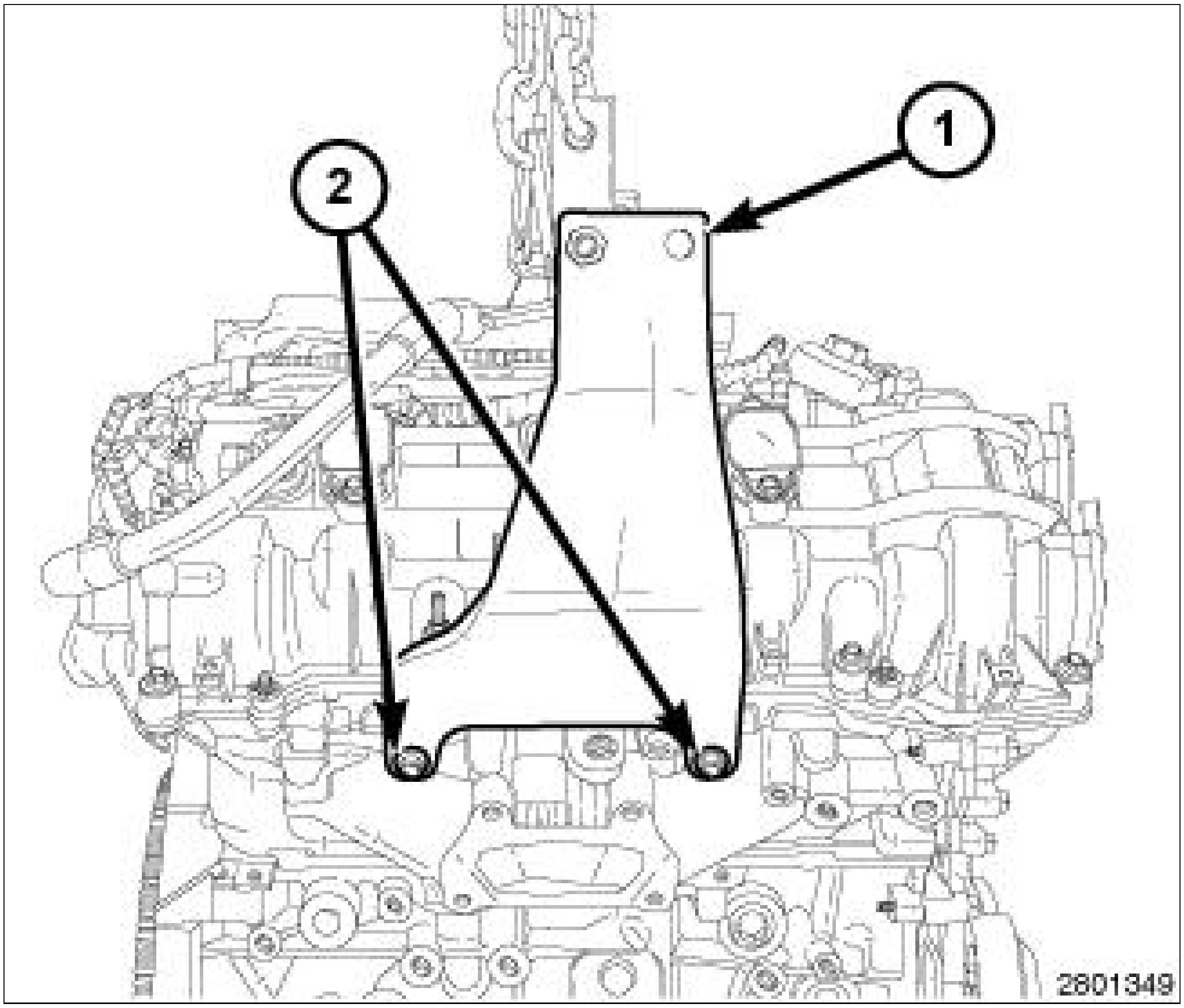
Fig 6: Lifting Sling, Engine Lifting Brackets & Engine Hoist



Courtesy of CHRYSLER GROUP, LLC

9. Remove the load-leveling lifting sling (2), such as OTC® 4305 Engine Load Leveler or equivalent, from the engine lifting brackets (3) and the engine hoist (1).

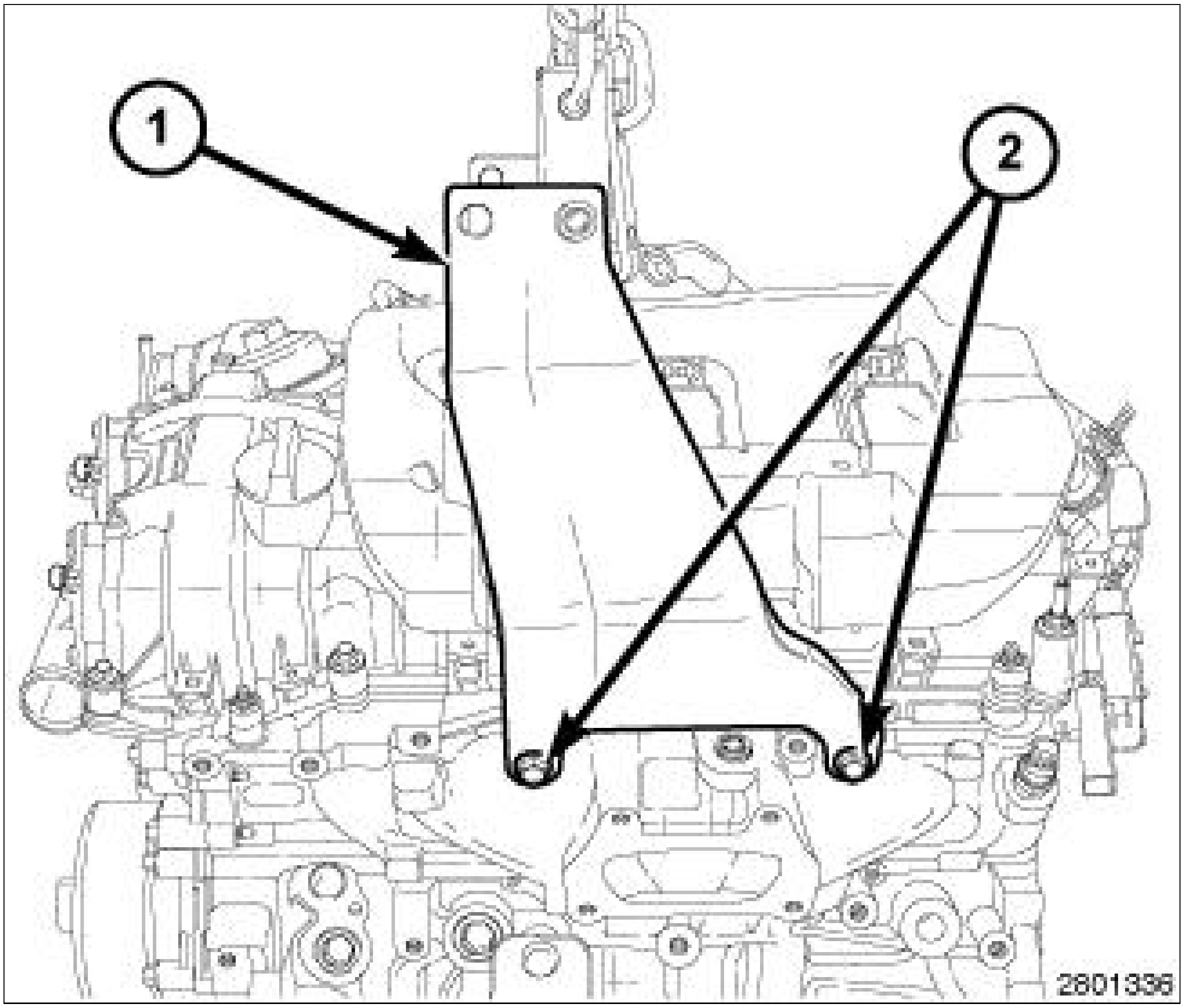
Fig 7: Passenger Side Engine Lifting Bracket & Bolts



Courtesy of CHRYSLER GROUP, LLC

10. Remove the passenger side engine lifting bracket bolts (2) from the RH cylinder head and remove the lift bracket (1).

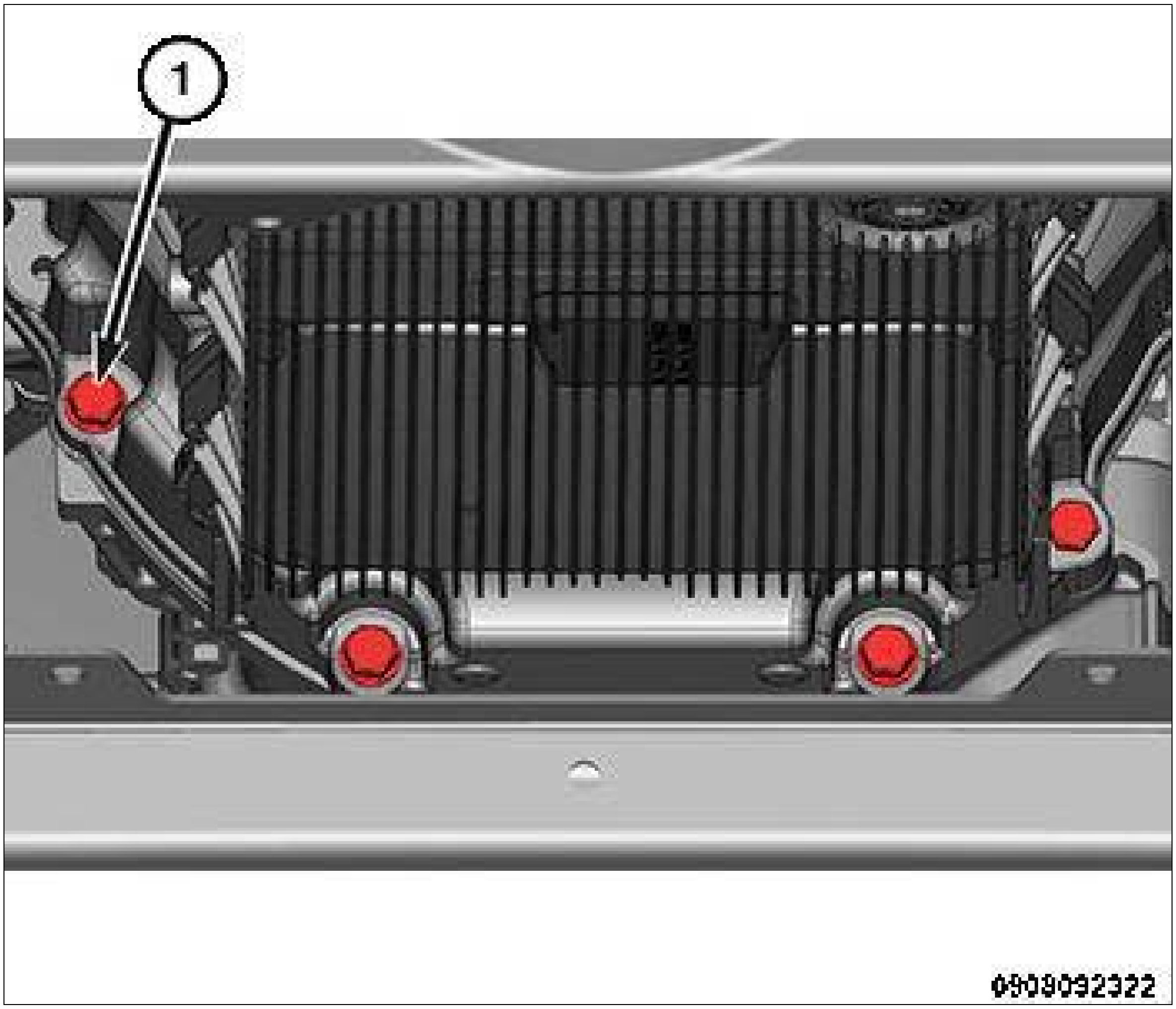
Fig 8: Driver Side Engine Lifting Bracket & Bolts



Courtesy of CHRYSLER GROUP, LLC

11. Remove the driver side engine lifting bracket bolts (2) and remove the lift bracket (1).

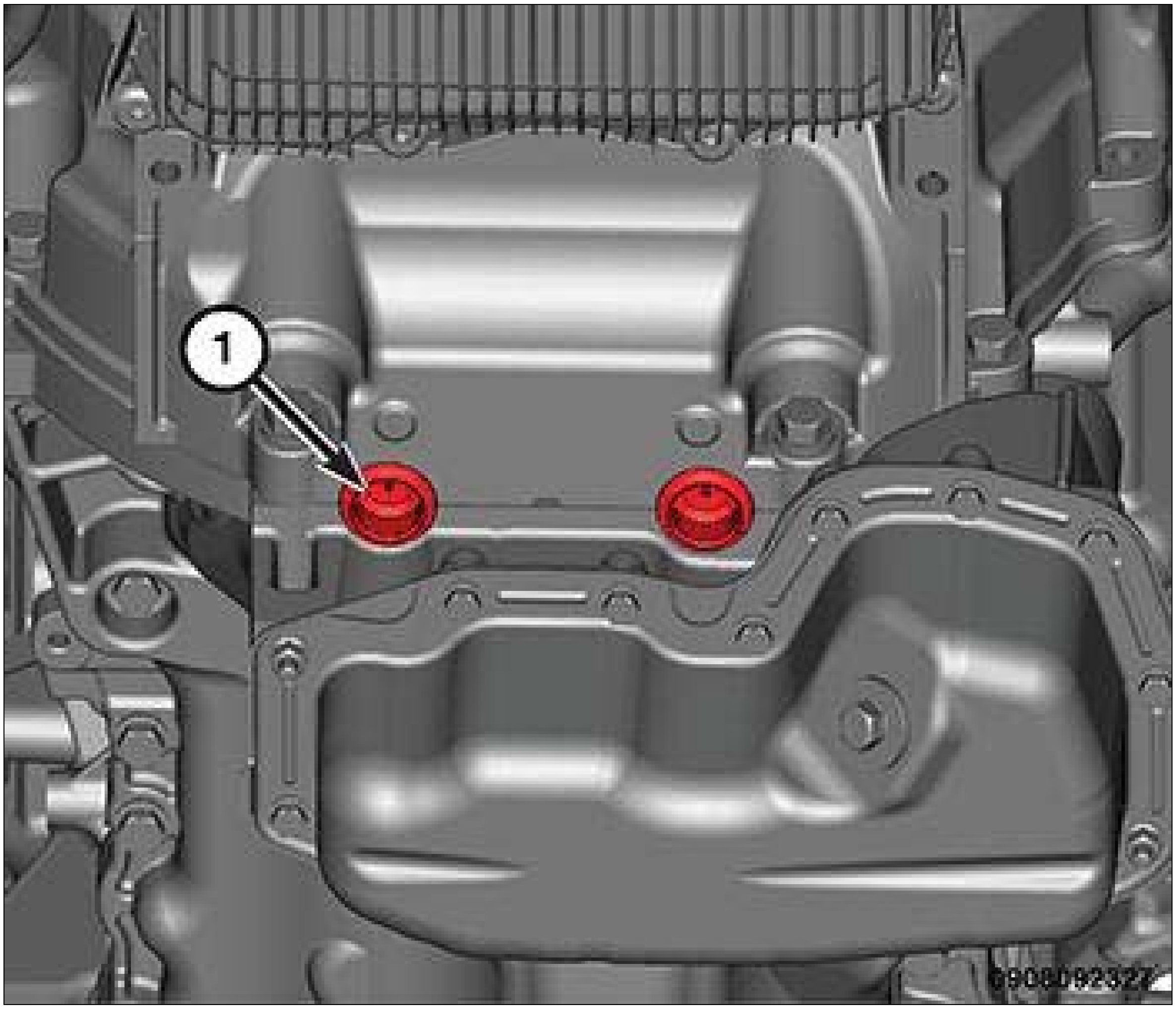
Fig 9: Transmission To Engine Oil Pan Bolts



Courtesy of CHRYSLER GROUP, LLC

12. Install four transmission to engine oil pan bolts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

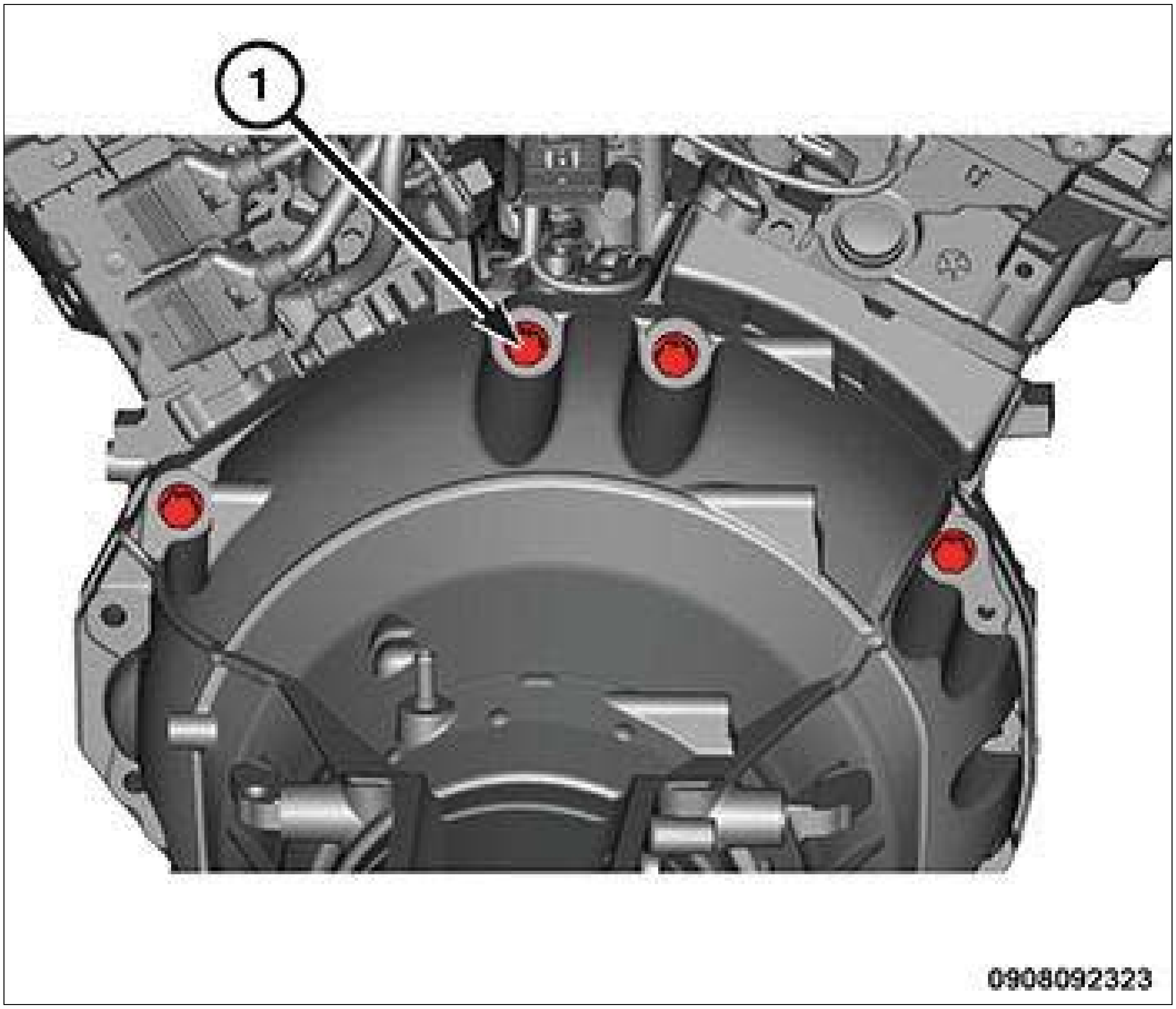
Fig 10: Rubber Plugs Covering Rear Oil Seal Retainer Flange Bolts



Courtesy of CHRYSLER GROUP, LLC

13. Install two rubber plugs (1) covering the rear oil seal retainer flange bolts.

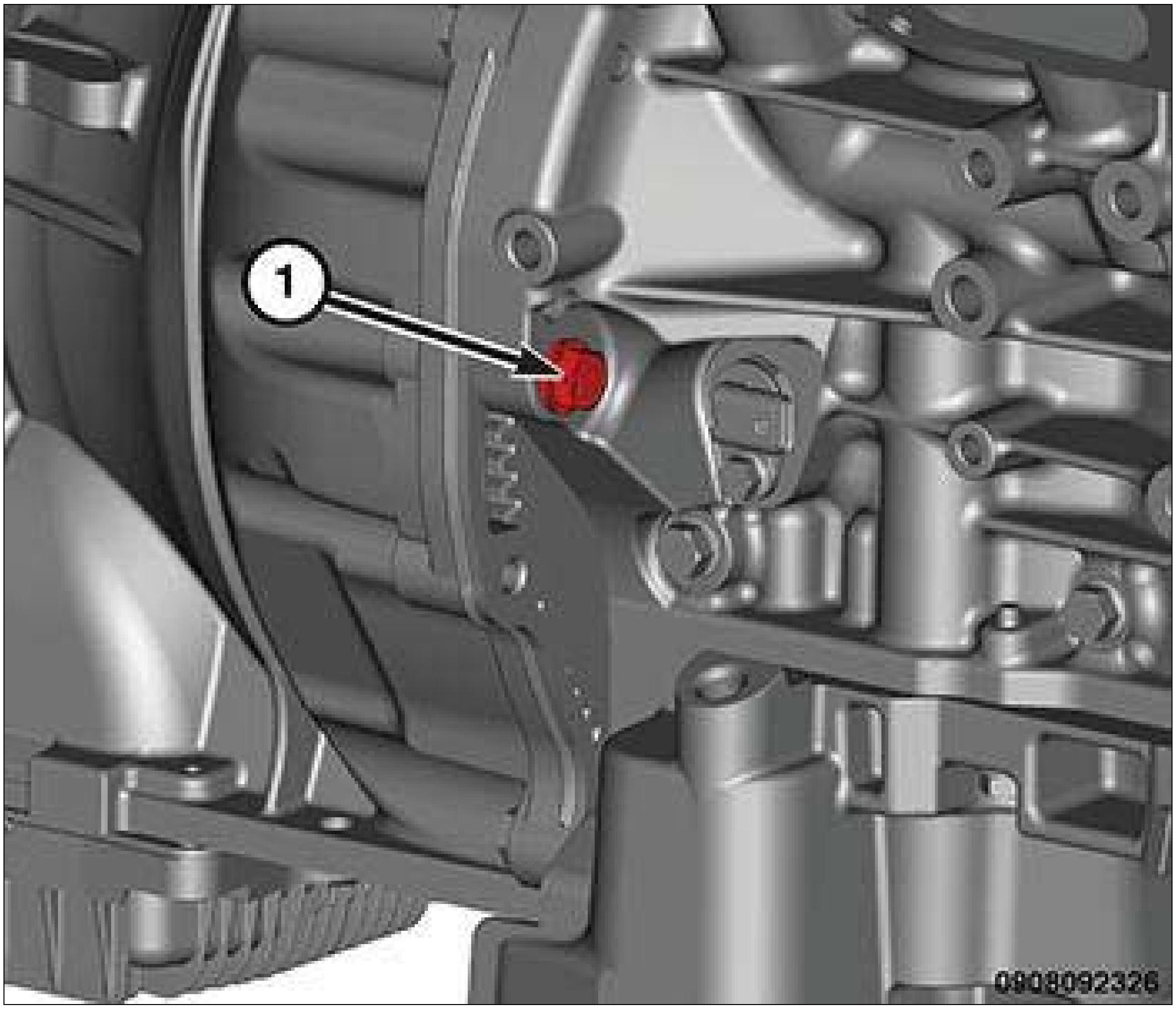
Fig 11: Upper Transmission To Engine Bolts



Courtesy of CHRYSLER GROUP, LLC

14. Install the four upper transmission to engine bolts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

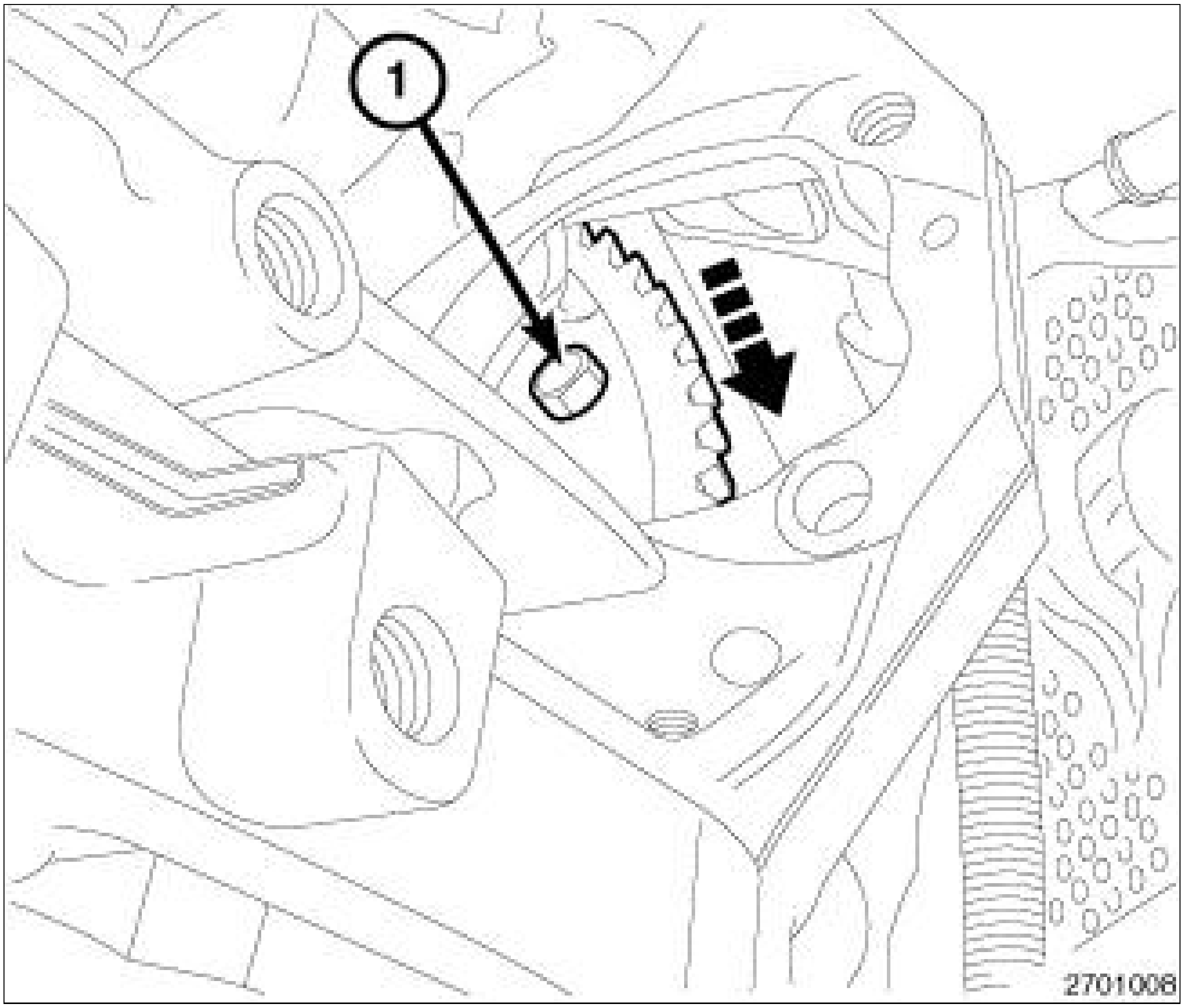
Fig 12: Side Engine To Transmission Bolt



Courtesy of CHRYSLER GROUP, LLC

15. Install the side engine to transmission bolt (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

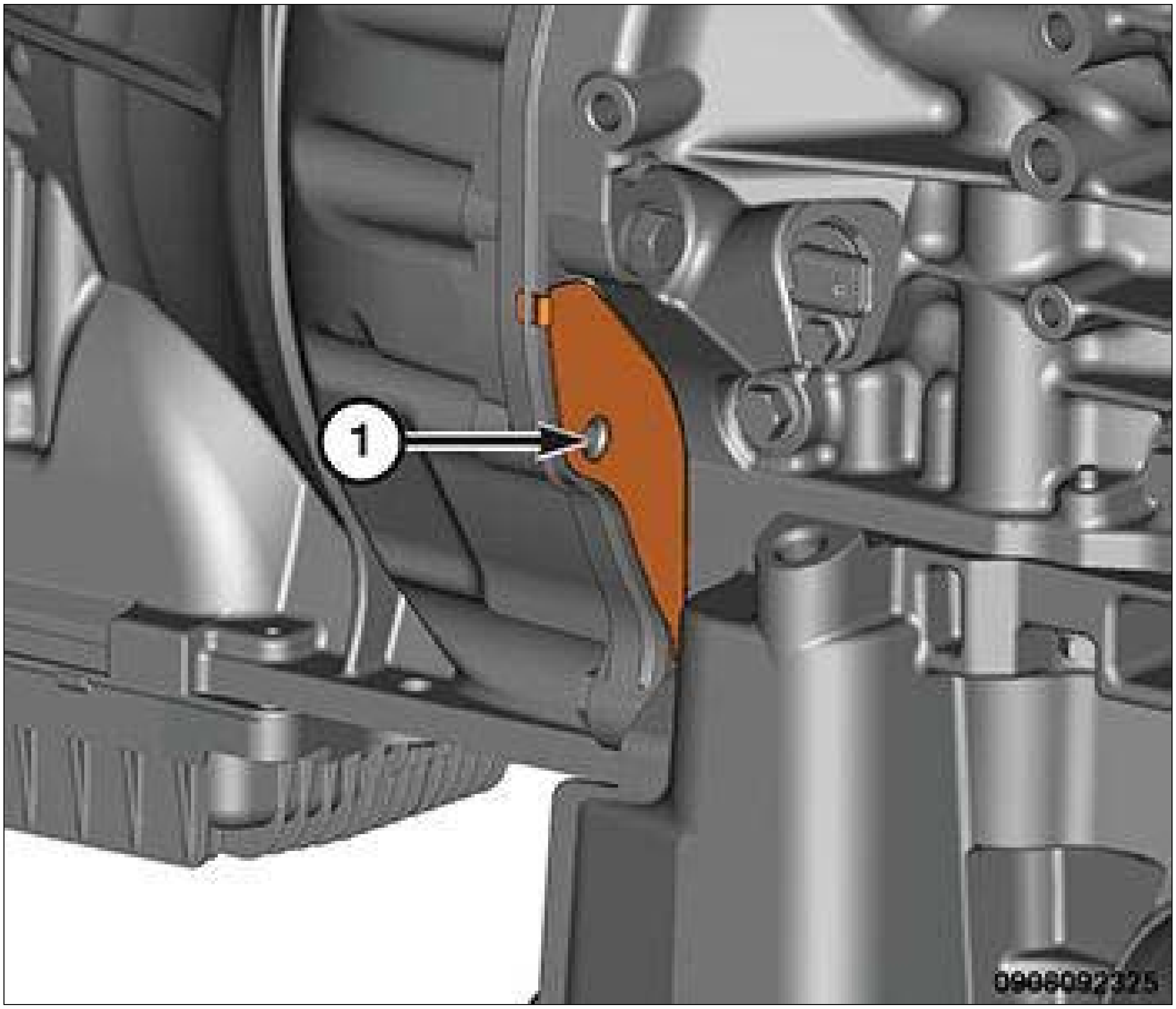
Fig 13: Torque Converter Bolt



Courtesy of CHRYSLER GROUP, LLC

16. Rotate the crankshaft in a clockwise direction and install the six torque converter bolts (1) through the starter mounting and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

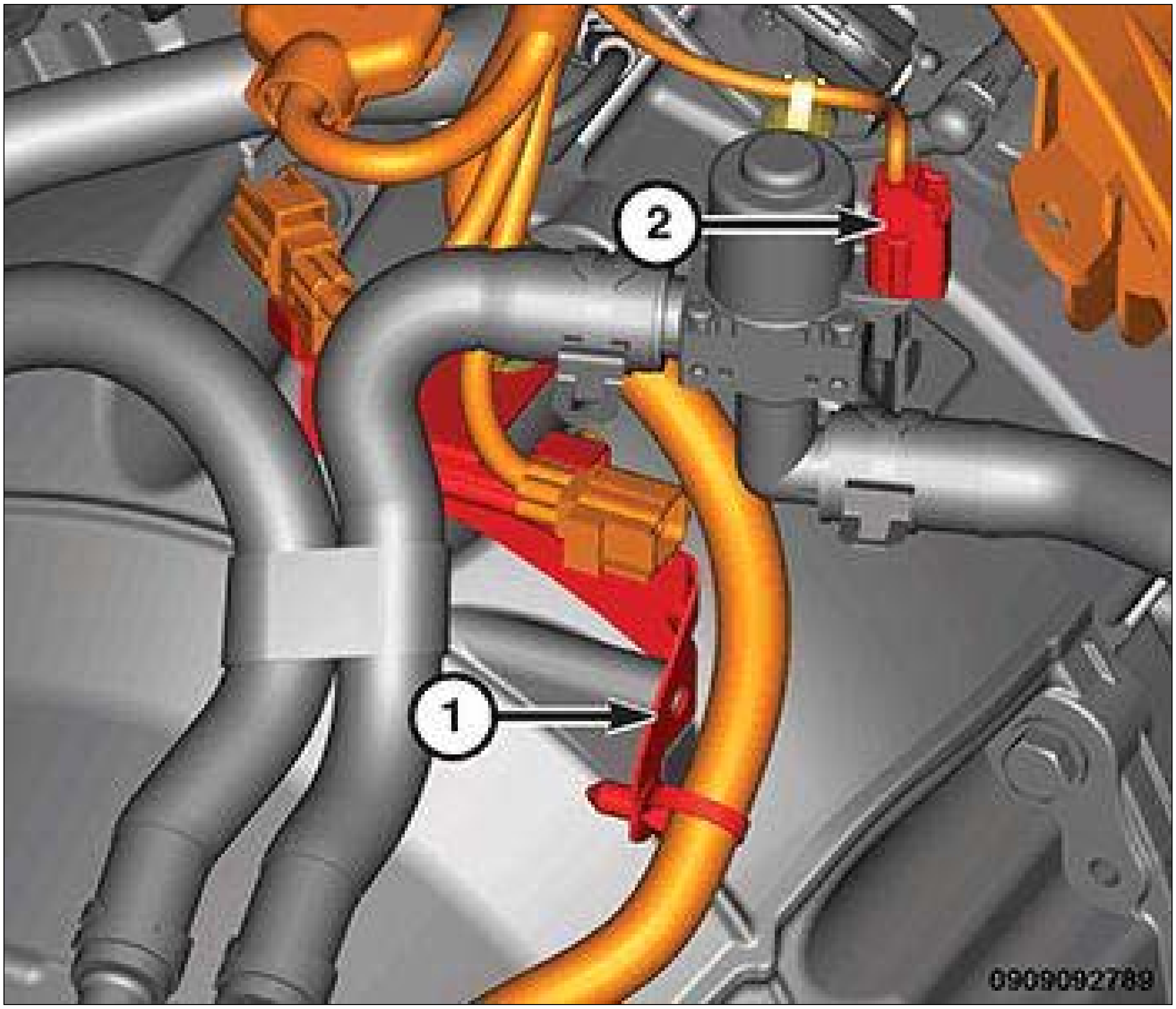
Fig 14: Torque Converter Dust Shield & Fastener



Courtesy of CHRYSLER GROUP, LLC

17. Install the torque converter dust shield (1) with the bolt and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
18. Connect the power cord to the engine block heater (if equipped).

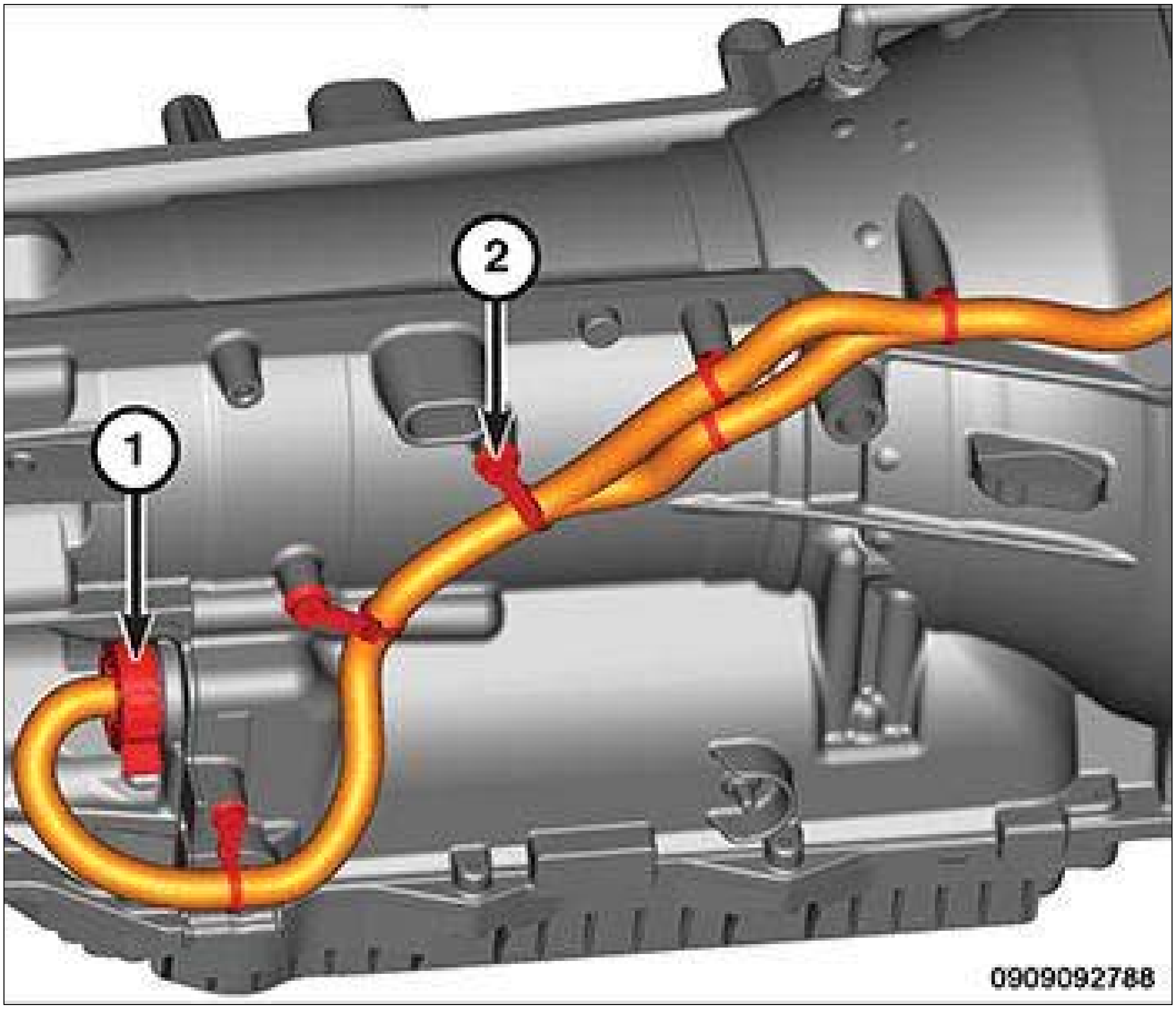
Fig 15: O2 Sensor Wire Harness Bracket & Coolant Shut Off Valve Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

19. Install the oxygen sensor wire harness bracket (1) and position the harness with the engine.
20. Connect the wire harness connector to the coolant shut off valve (2).

Fig 16: Wire Harness Connector & Retainers

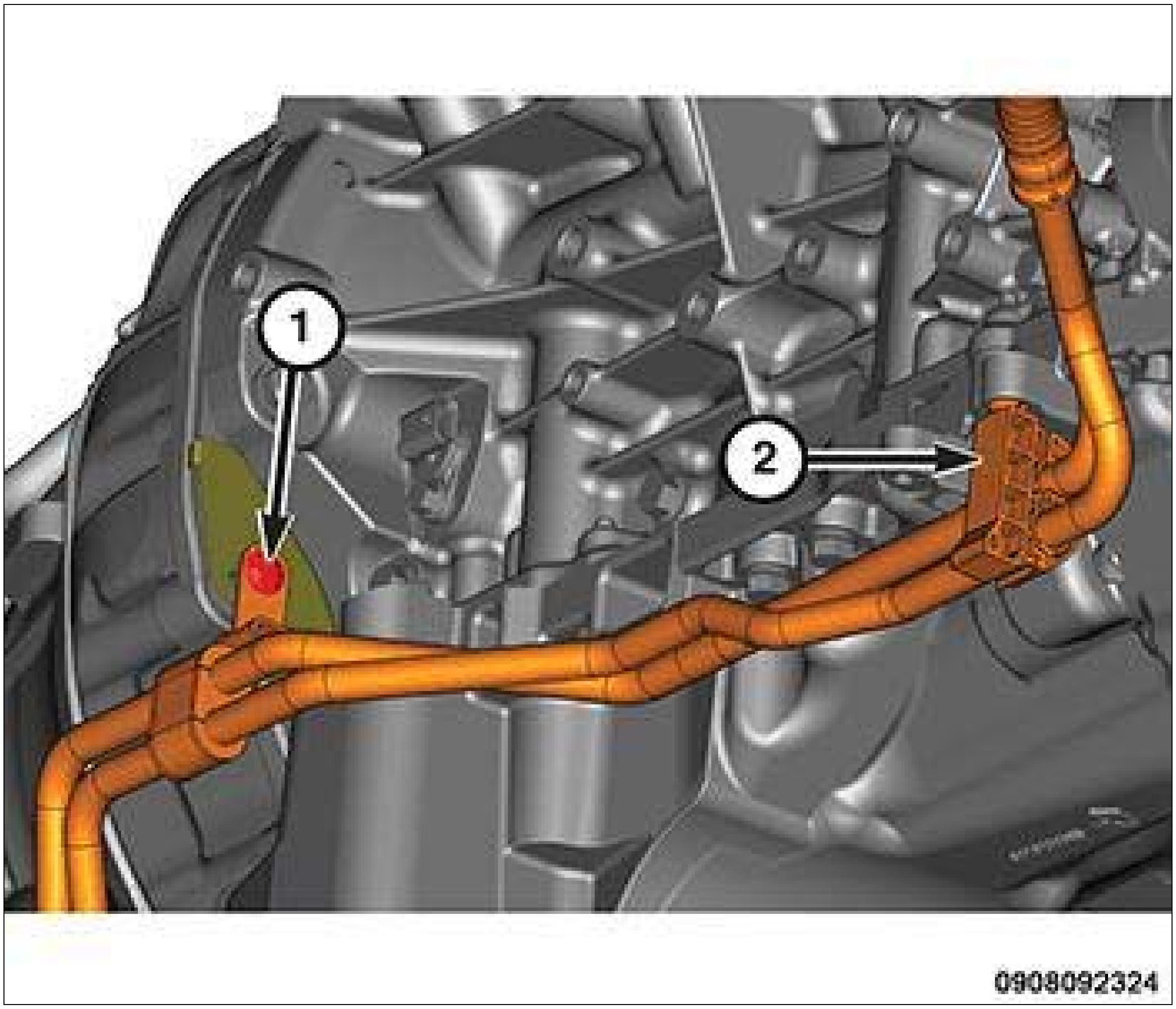


Courtesy of CHRYSLER GROUP, LLC

21. Engage the wire harness retainers onto the transmission (2).

22. Connect the wire harness connector (1) to the transmission.

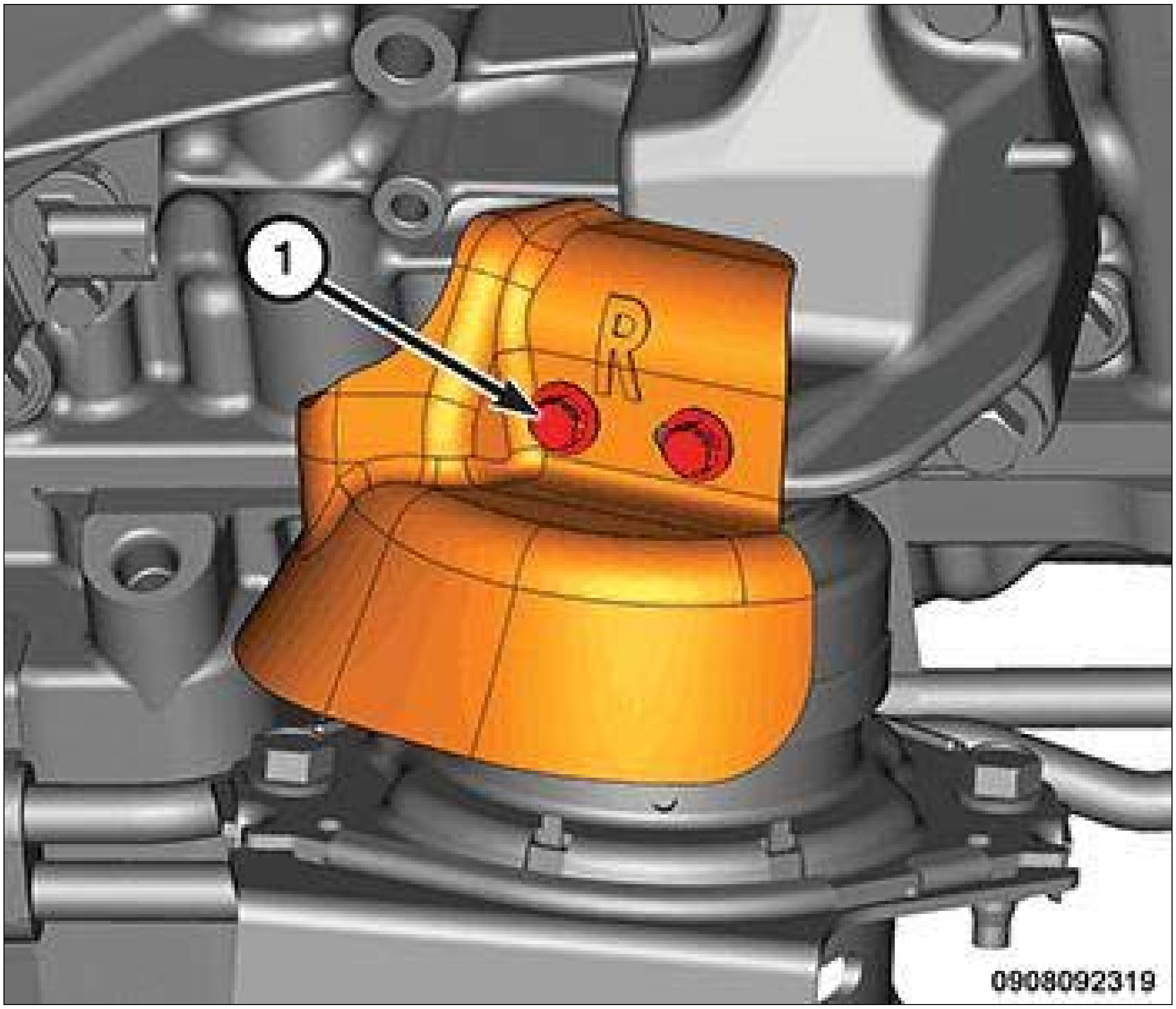
Fig 17: Transmission Cooler Line Fastener & Retainer



Courtesy of CHRYSLER GROUP, LLC

23. Install the transmission cooler line fastener to the transmission (1) and engage the retainer (2) to the upper oil pan flange.

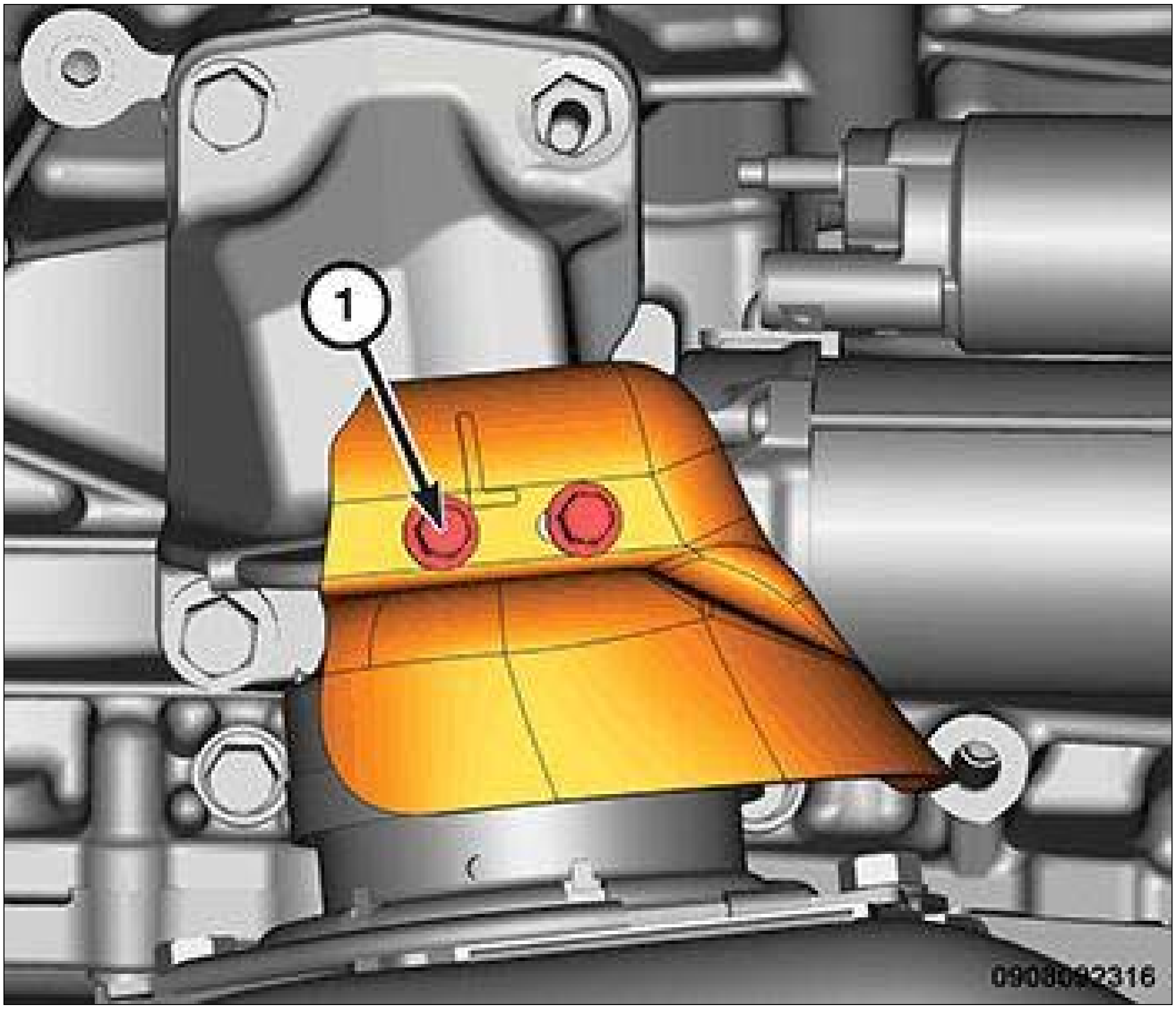
Fig 18: Right Engine Mount Heat Shield Bolts



Courtesy of CHRYSLER GROUP, LLC

24. Install the bolts (1) and the engine mount heat shield onto the right engine mount then tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
25. Install the ground strap to the right engine mount bracket.

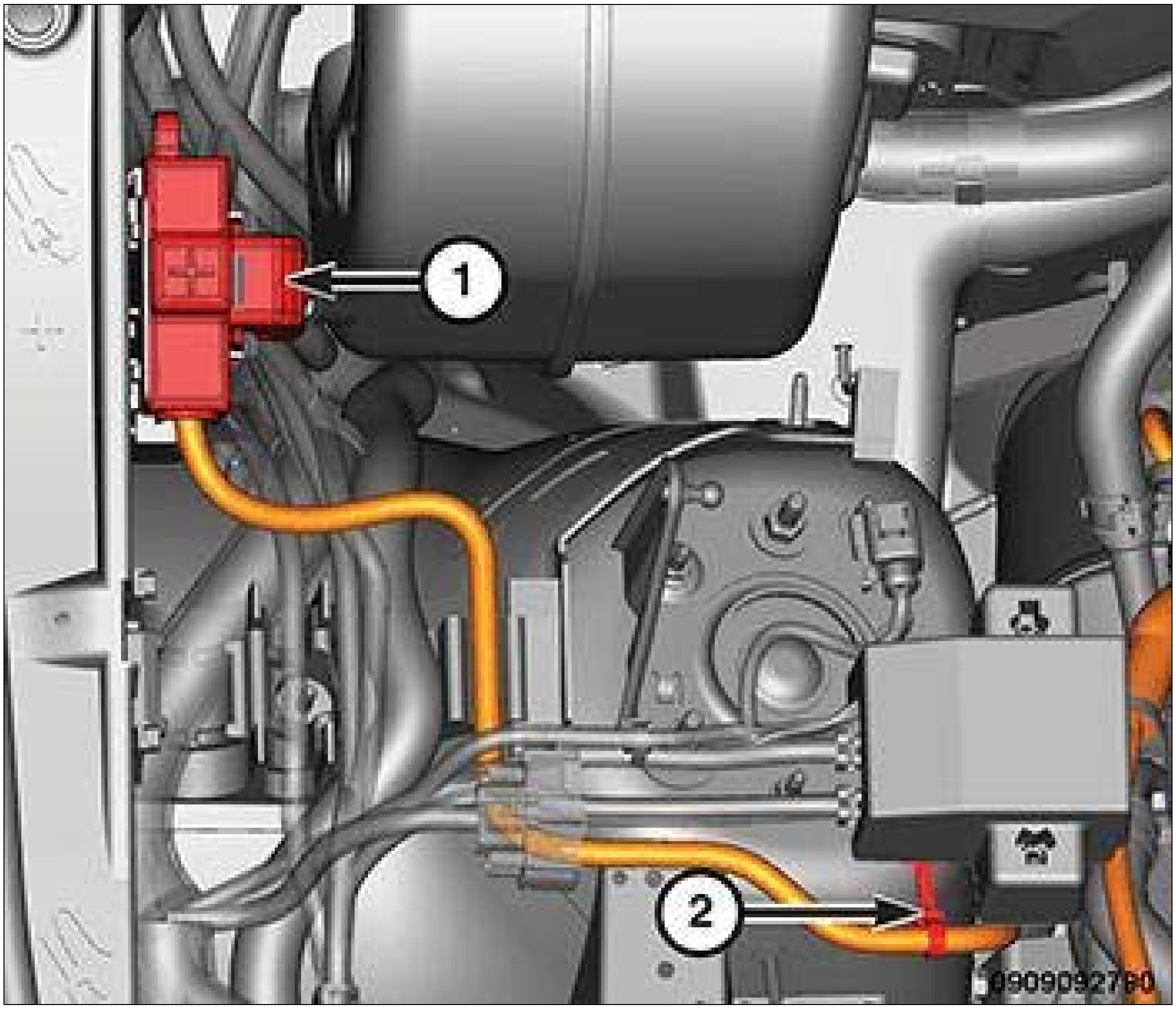
Fig 19: Left Engine Mount Heat Shield Bolts



Courtesy of CHRYSLER GROUP, LLC

26. Install the bolts (1) and the engine mount heat shield onto the left engine mount then tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
27. Install the starter. Refer to STARTER, INSTALLATION .
28. If equipped with AWD, install the front axle. Refer to INSTALLATION .
29. Install both left and right catalytic converters. Refer to CONVERTER, CATALYTIC, INSTALLATION .

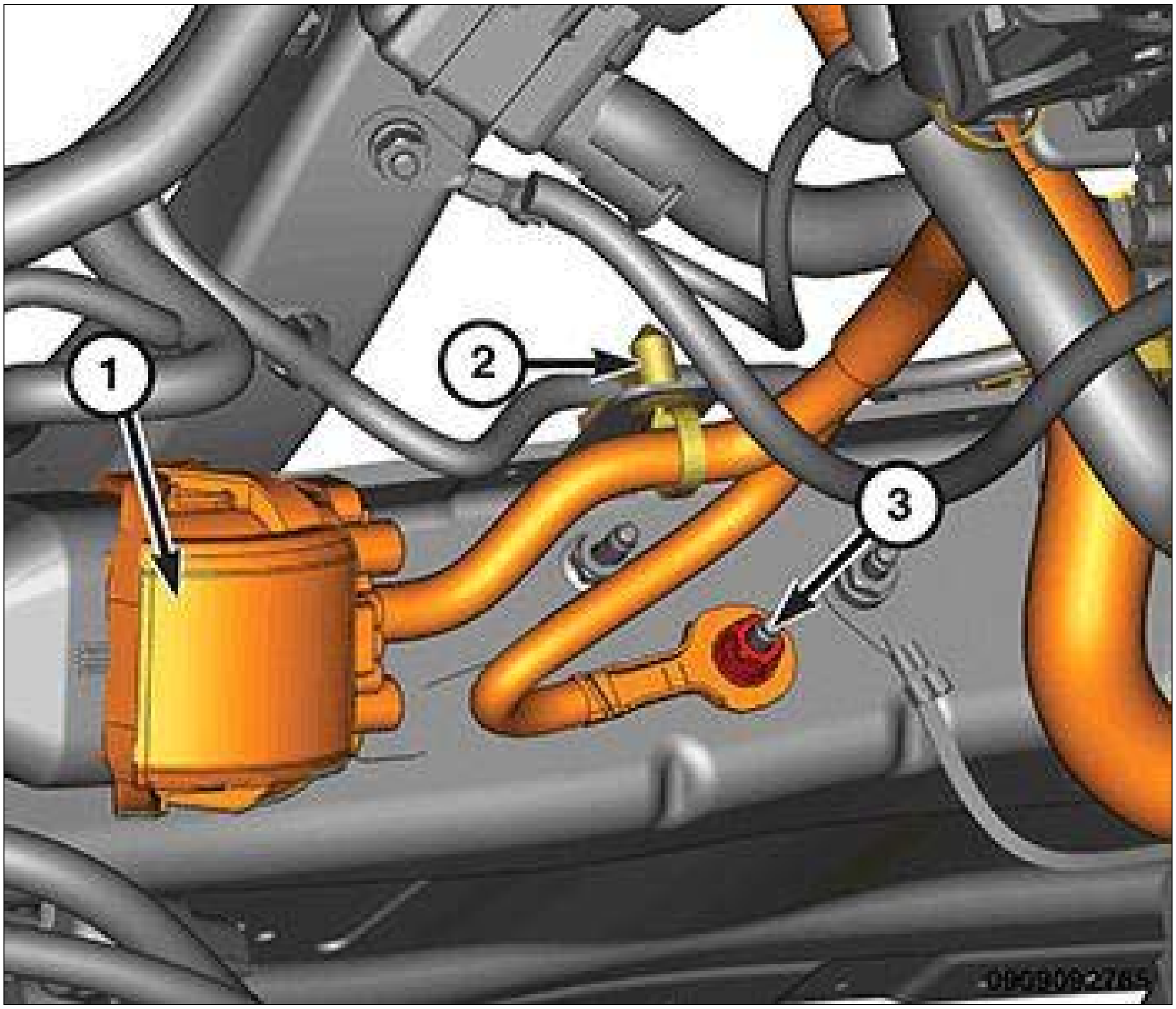
Fig 20: Positive Starter And Alternator Cable & Wire Harness Retaining Clips



Courtesy of CHRYSLER GROUP, LLC

30. Position the wire harness and engage the wire harness retaining clips (2).
31. Connect the positive (1) starter and alternator cable.

Fig 21: Wire Harness Connector, Wire Harness Retaining Clips & Nut



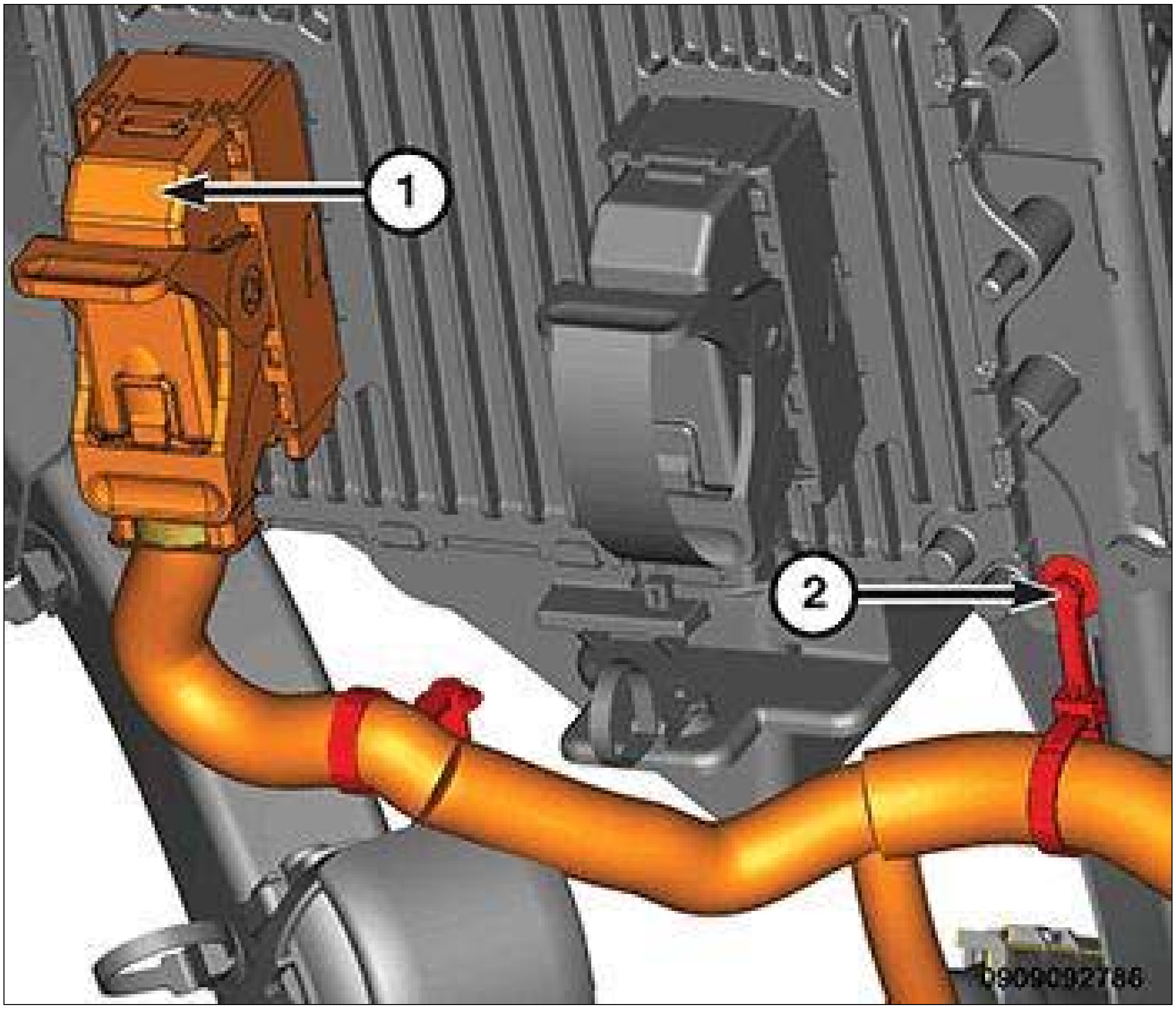
Courtesy of CHRYSLER GROUP, LLC

32. Position the wire harness just below the PCM, on the right side frame rail and engage the wire harness retaining clips (2).

33. Install the ground cable nut (3) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

34. Connect the wire harness connector (1).

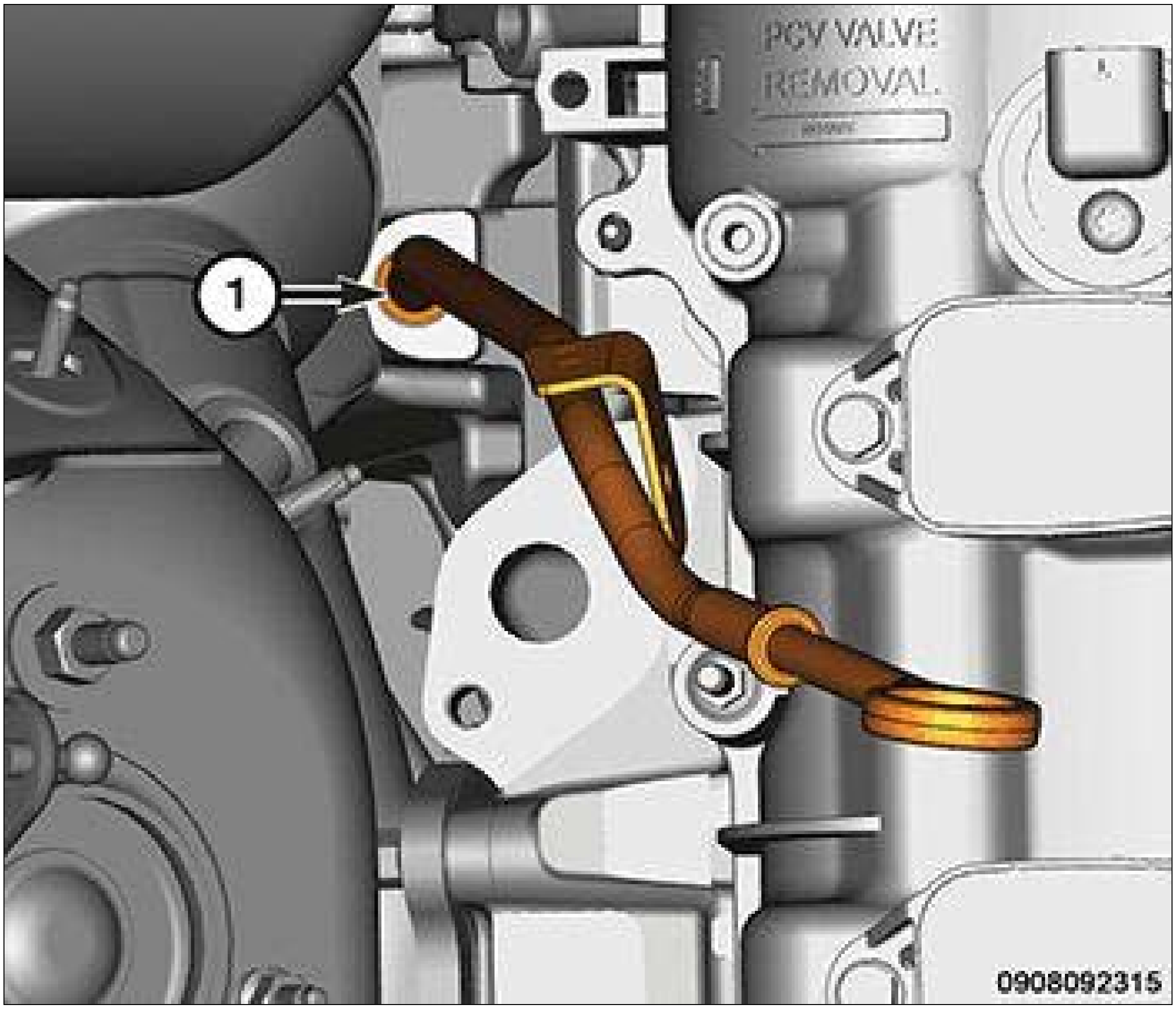
Fig 22: PCM Wire Harness Connector & Wire Harness Retaining Clips



Courtesy of CHRYSLER GROUP, LLC

35. Connect the wire harness connector (1) to the Powertrain Control Module (PCM).
36. Engage the wire harness retaining clips (2).

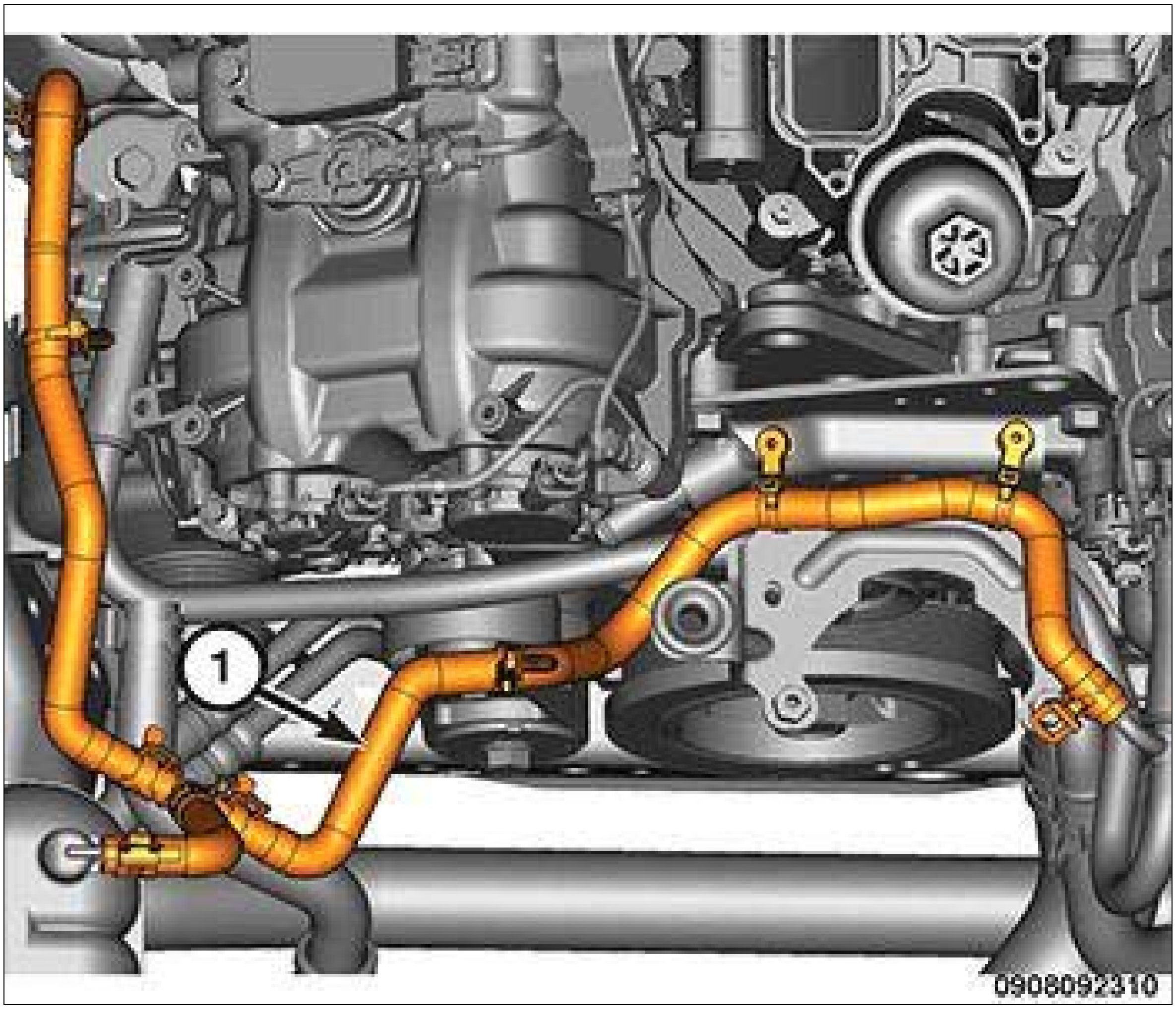
Fig 23: Oil Dipstick & Tube



Courtesy of CHRYSLER GROUP, LLC

37. Install the oil level indicator (1).
38. Install the cooling fan module. Refer to FAN, COOLING, INSTALLATION .
39. Install the pressurized coolant bottle. Refer to BOTTLE, PRESSURIZED COOLANT, INSTALLATION .

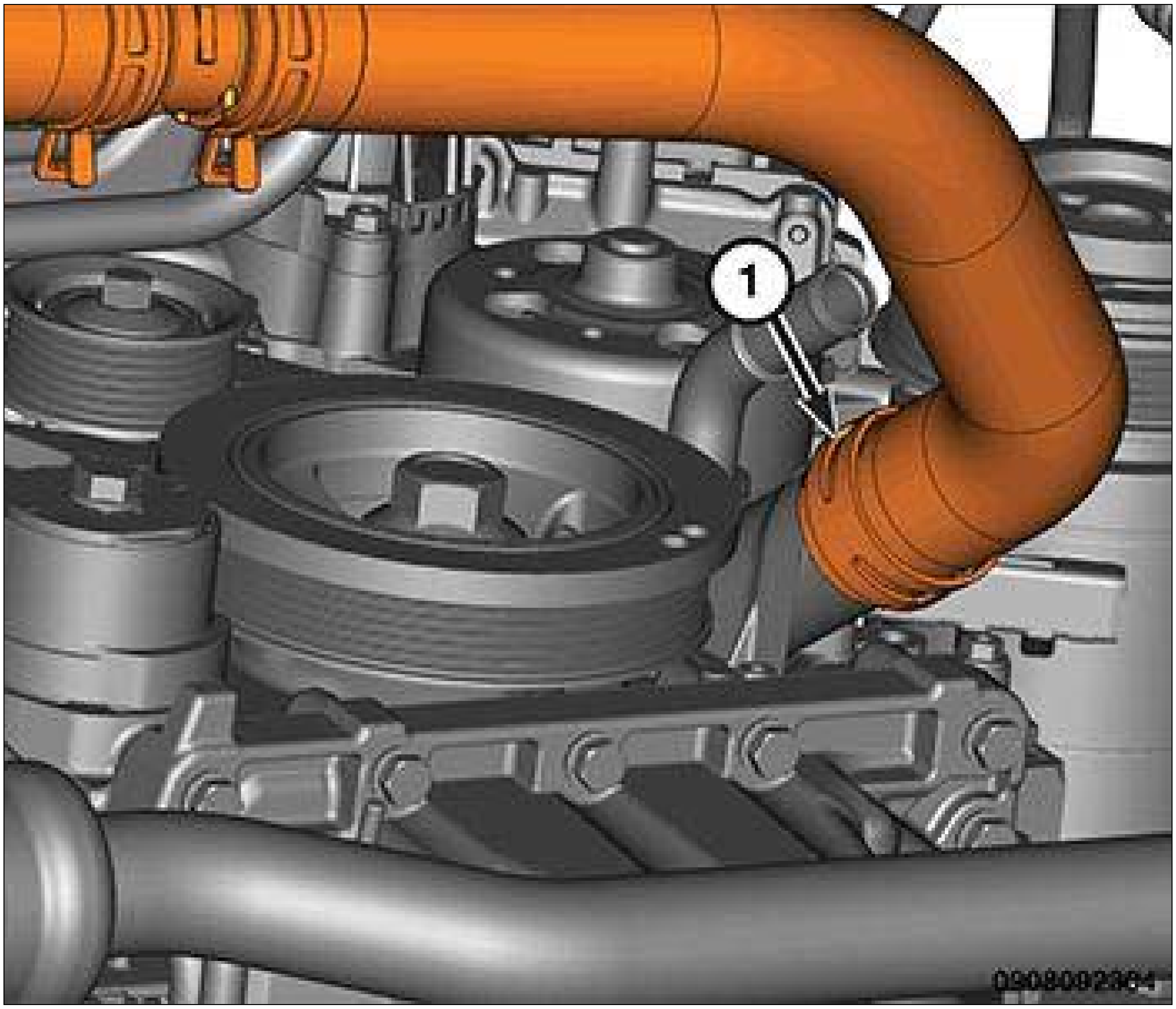
Fig 24: Coolant Bottle Inlet Hose



Courtesy of CHRYSLER GROUP, LLC

40. Remove the coolant bottle inlet hose (1).

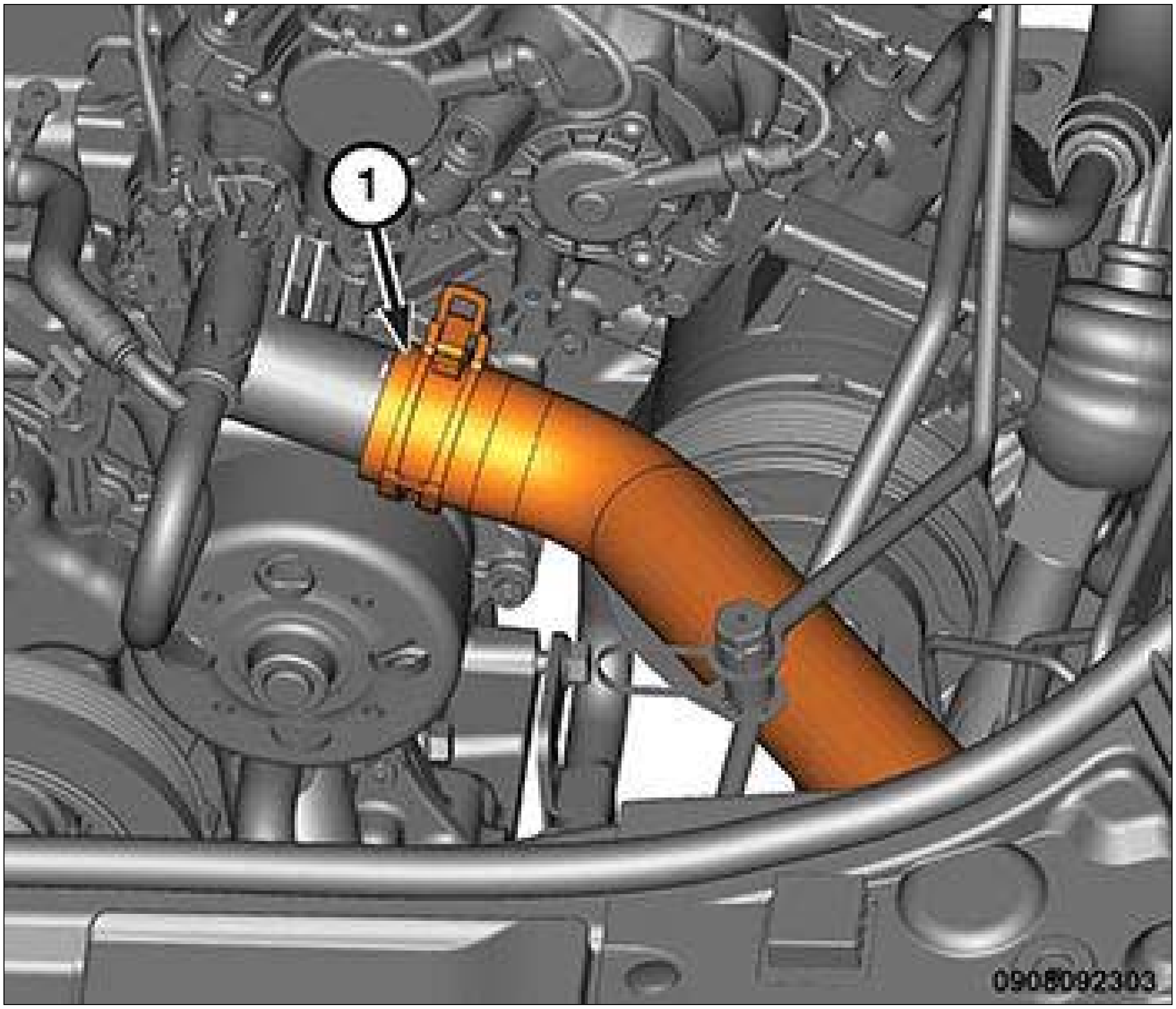
Fig 25: Lower Radiator Hose



Courtesy of CHRYSLER GROUP, LLC

41. Install the lower radiator hose (1) to the engine coolant pump housing.

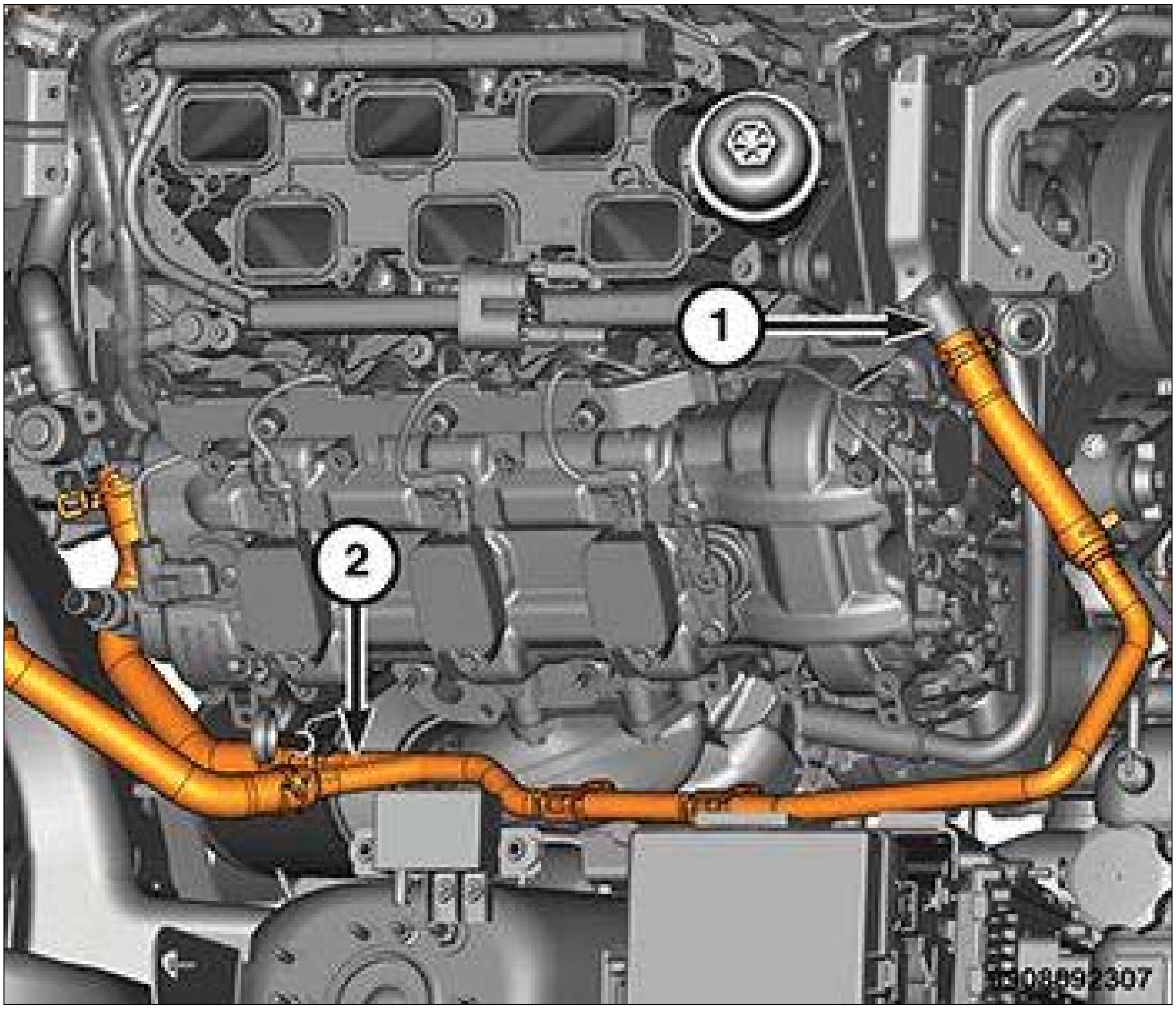
Fig 26: Upper Radiator Hose



Courtesy of CHRYSLER GROUP, LLC

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

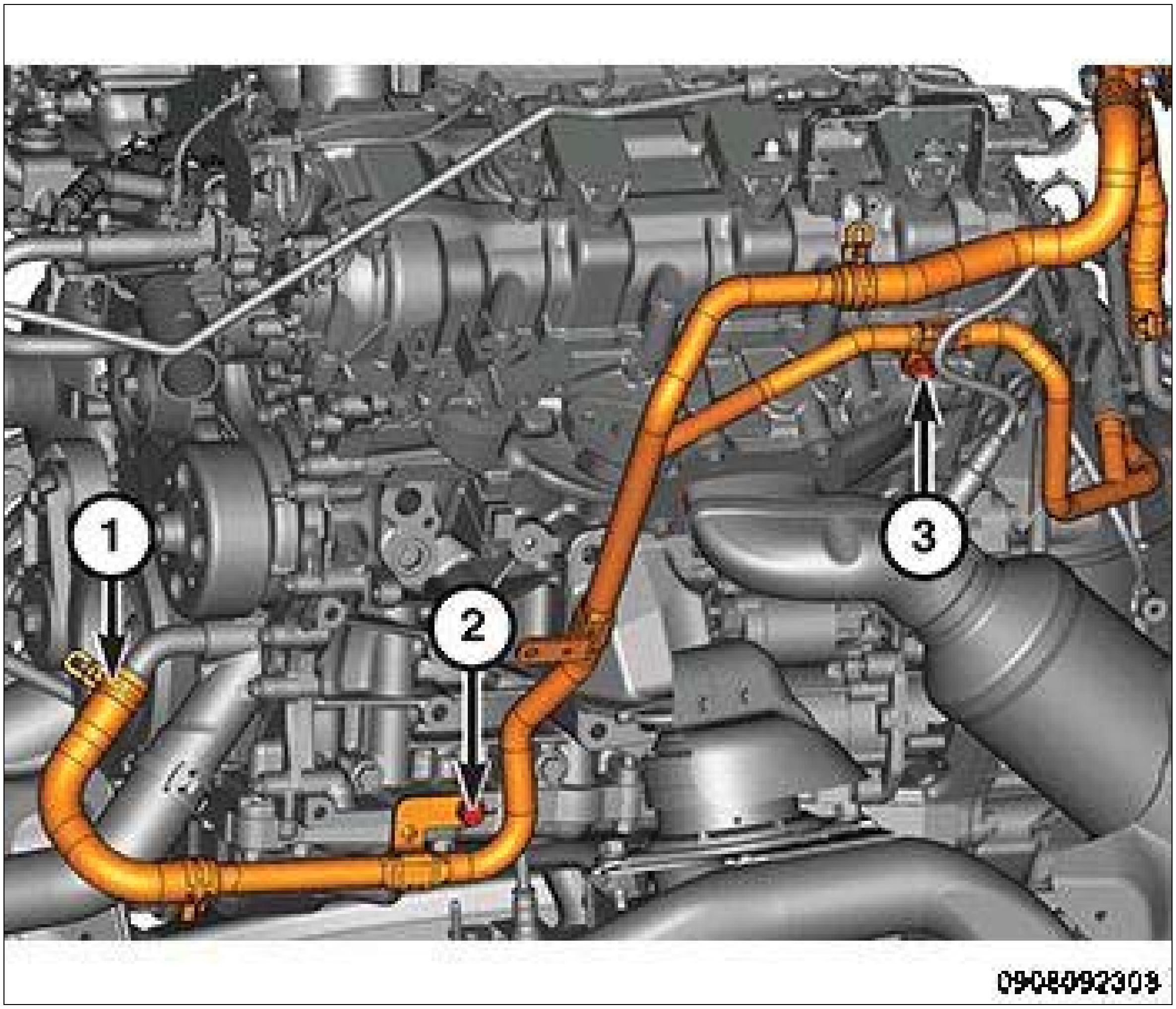
Fig 27: Heater Inlet Hose At Coolant Crossover & Heater Inlet Tube Assembly



Courtesy of CHRYSLER GROUP, LLC

43. Install the heater inlet hose onto the coolant crossover (1) and position the heater inlet tube assembly (2).

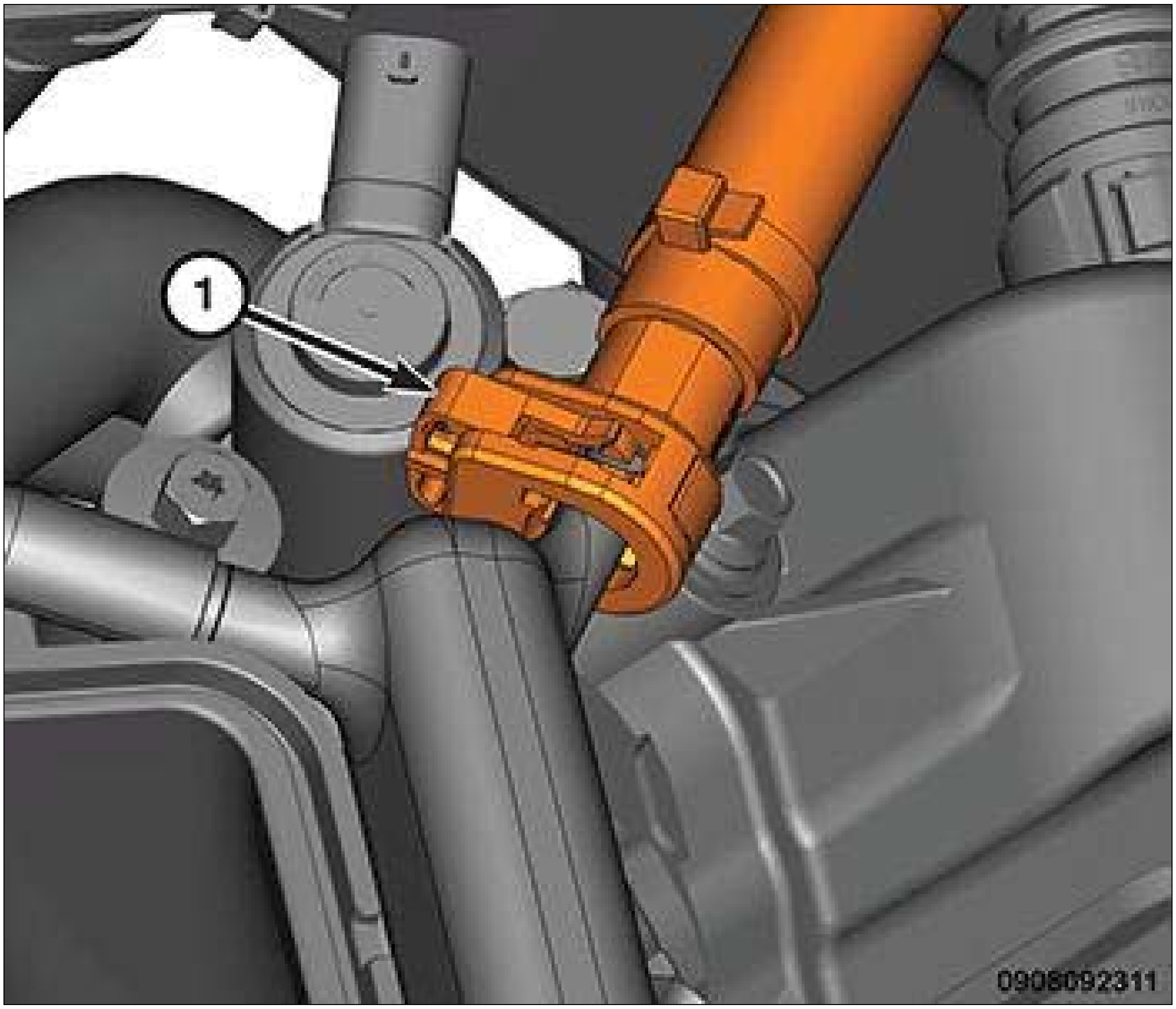
Fig 28: Heater Core Return Hose At Water Pump Bypass, Retaining Bolts At Engine Block & Cylinder Head



Courtesy of CHRYSLER GROUP, LLC

44. Connect the return hose to the engine oil cooler and position the tube assembly to the engine.
45. Install the retaining bolts to the engine block (2) and cylinder head (3) then tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
46. Install the heater core return hose to the water pump bypass (1).

Fig 29: Fuel Supply Hose At Fuel Rail



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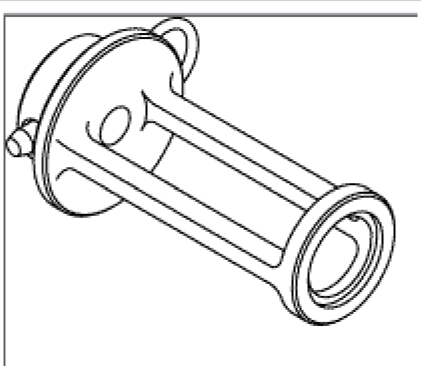
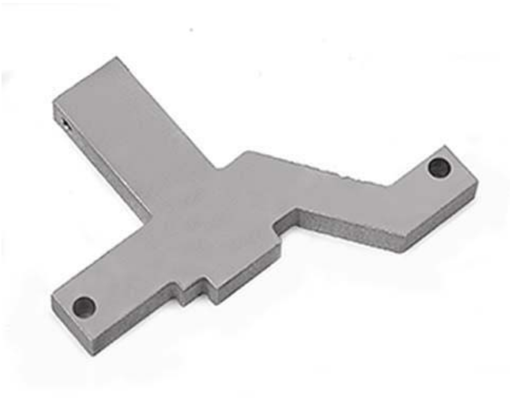
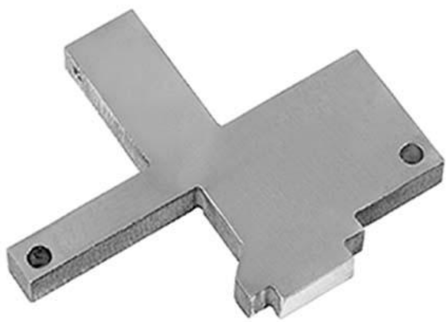
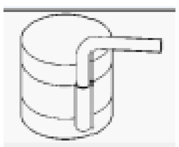
47. Connect the fuel supply hose to the fuel rail. Refer to FITTING, QUICK CONNECT .
48. Install the A/C compressor. Refer to COMPRESSOR, A/C, INSTALLATION .
49. Install the electric vacuum pump and mounting bracket. Refer to PUMP, ELECTRIC VACUUM, INSTALLATION .
50. Install the Exhaust Gas Recirculation (EGR) cooler. Refer to COOLER, EXHAUST GAS RECIRCULATION (EGR), INSTALLATION .
51. Install the upper intake manifold and insulator. Refer to MANIFOLD, INTAKE, INSTALLATION .
52. Install the resonator and the air cleaner body Refer to BODY, AIR CLEANER, INSTALLATION .
53. If equipped, install the transfer case skid plate, the transmission skid plate, the front suspension skid plate and the front skid plate. Refer to PLATE, SKID, FRONT, INSTALLATION , PLATE, SKID, FRONT SUSPENSION, INSTALLATION , PLATE, SKID, FUEL TANK, INSTALLATION , PLATE, SKID, TRANSMISSION, INSTALLATION and PLATE, SKID, TRANSFER CASE, INSTALLATION .
54. Install the cowl extension panel. Refer to SILENCER, COWL EXTENSION, INSTALLATION .

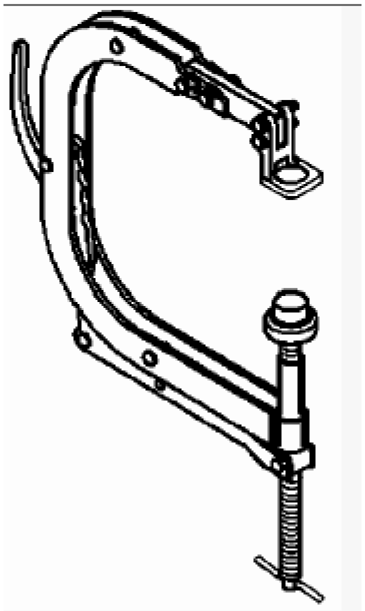
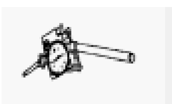
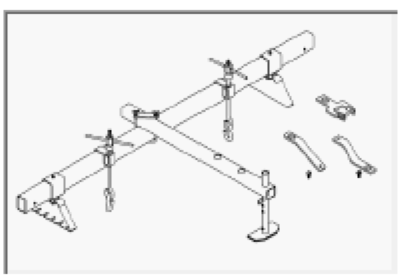
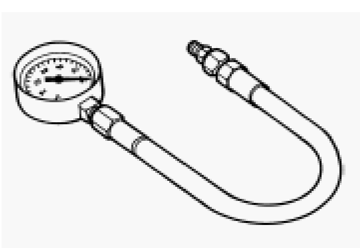
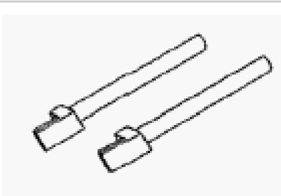
55. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
56. Fill the cooling system. Refer to STANDARD PROCEDURE .
57. Install the hood. Refer to HOOD, INSTALLATION .
58. Connect the negative battery cable.
59. Run the 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.*

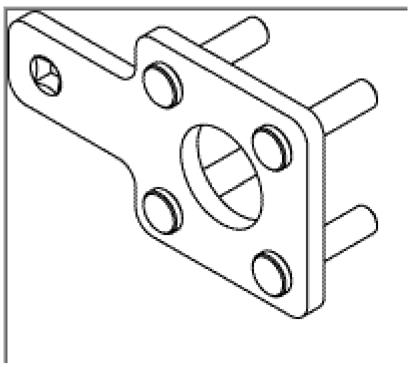
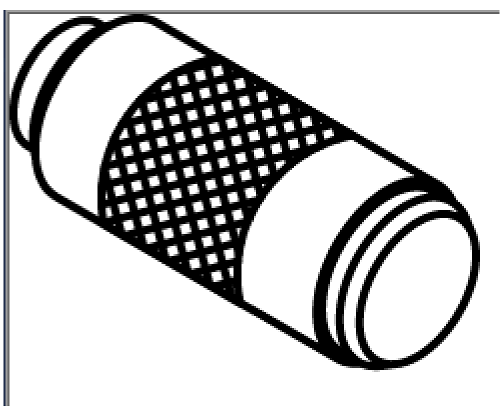
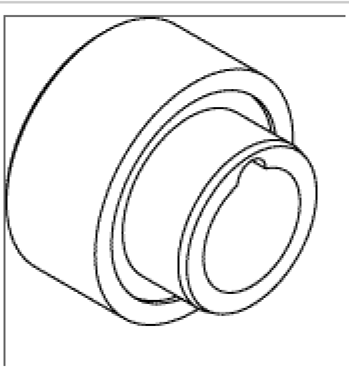
SPECIAL TOOLS > SPECIAL TOOLS

	2021500090 - Adapter, Late Version 3.6L Oil Pressure Test
	10224 - Adapter, Valve Spring (Originally Shipped In Kit Number(s) 10223.)
	C-3685-A - Bloc-Chek Kit

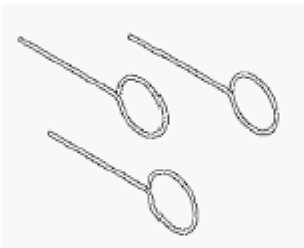
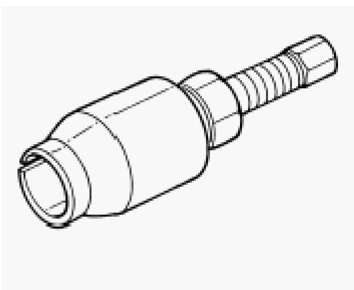
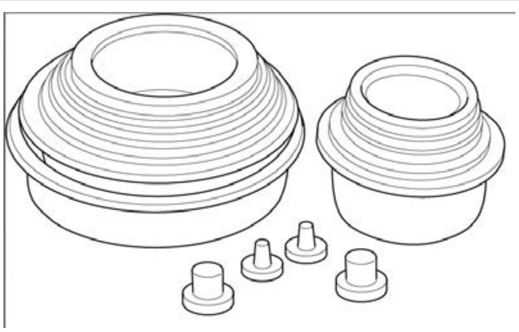
	2027902090 - Check Tool, Tone Wheel Right
	2027901090 - Check Tool, Tone Wheel Left
	C-385 - Compressor, Piston
	MD998772A - Compressor, Valve Spring (Originally Shipped In Kit Number(s) 8678, 8853, 8854.)

	C-3422-D - Compressor, Valve Spring
	C-119 - Cylinder Indicator
	8875A - Disconnect, Transmission Cooler Line (Originally Shipped In Kit Number(s) 9202, 9328, 9328-CAN, 9329, 9516, 9575.)
	8534B - Fixture, Driveline Support (Originally Shipped In Kit Number(s) 8534, 8534B, 8849, 9565.)
	C-3292A - Gauge, Pressure
	8189 - Guide Pins (Originally Shipped In Kit Number(s) 8180, 8180CC, 8263, 8263CC.)

	2025200090 - Holder, Camshaft
	2025102090 - Holder, Camshaft Phaser - Right-Rear Cyl Head
	2025101090 - Holder, Camshaft Phaser - Left-Front Cyl Head
	2025001090 - Holder, Timing Chain Tensioner, Left-Front

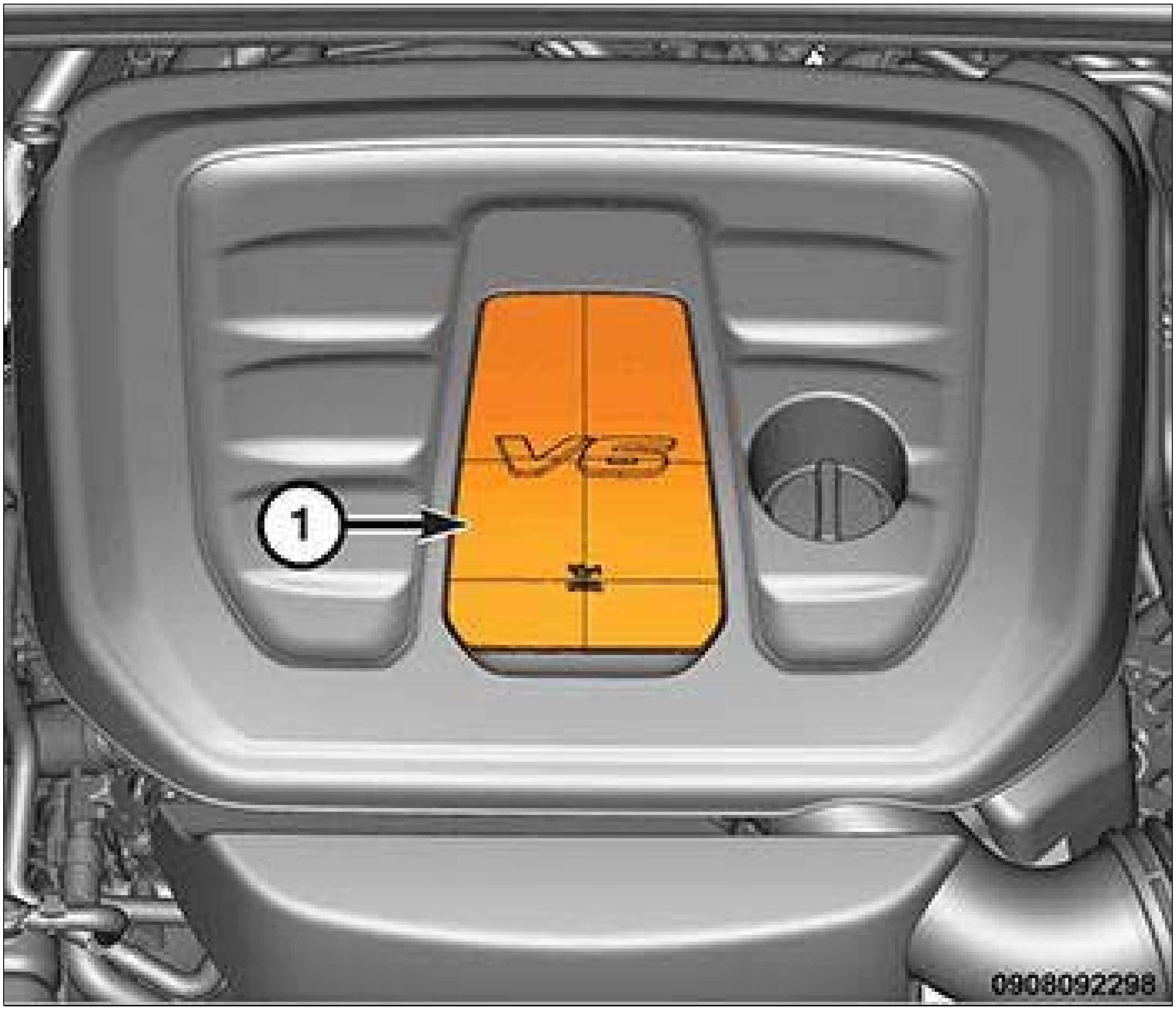
	2025002090 - Holder, Timing Chain Tensioner, Right-Rear
	10198 - Holder, Vibration Damper (Originally Shipped In Kit Number(s) 10223.)
	10256 - Installer, Cam Installer, Cam Sensor/Spark Plug Tube Seal (Originally Shipped In Kit Number(s) 10256.)
	10199 - Installer, Crankshaft Front Oil Seal (Originally Shipped In Kit Number(s) 10223.)

	2024900090 - Installer, Spark Plug Tube
	2027300090 - Kit, VVL Adapters
	2028020090 - Lift Bracket, Engine-Right
	2028010090 - Lift Bracket, Engine-Left

	2025003090 - Pin, Chain Tensioner
	8514 - Pins, Tensioner (Originally Shipped In Kit Number(s) 8283, 8283CC, 8527, 8527CC, 8575, 8575CC, 9975.)
	8511 - Remover, Seal (Originally Shipped In Kit Number(s) 8283, 8283CC, 8527, 8527CC, 8575, 8575CC, 9975.)
	C-3339A - Set, Dial Indicator (Originally Shipped In Kit Number(s) 9202.)
	10368 - Set, Universal Protective Cap
	7700-A - Tester, Cooling System

COVER, ENGINE > REMOVAL > REMOVAL

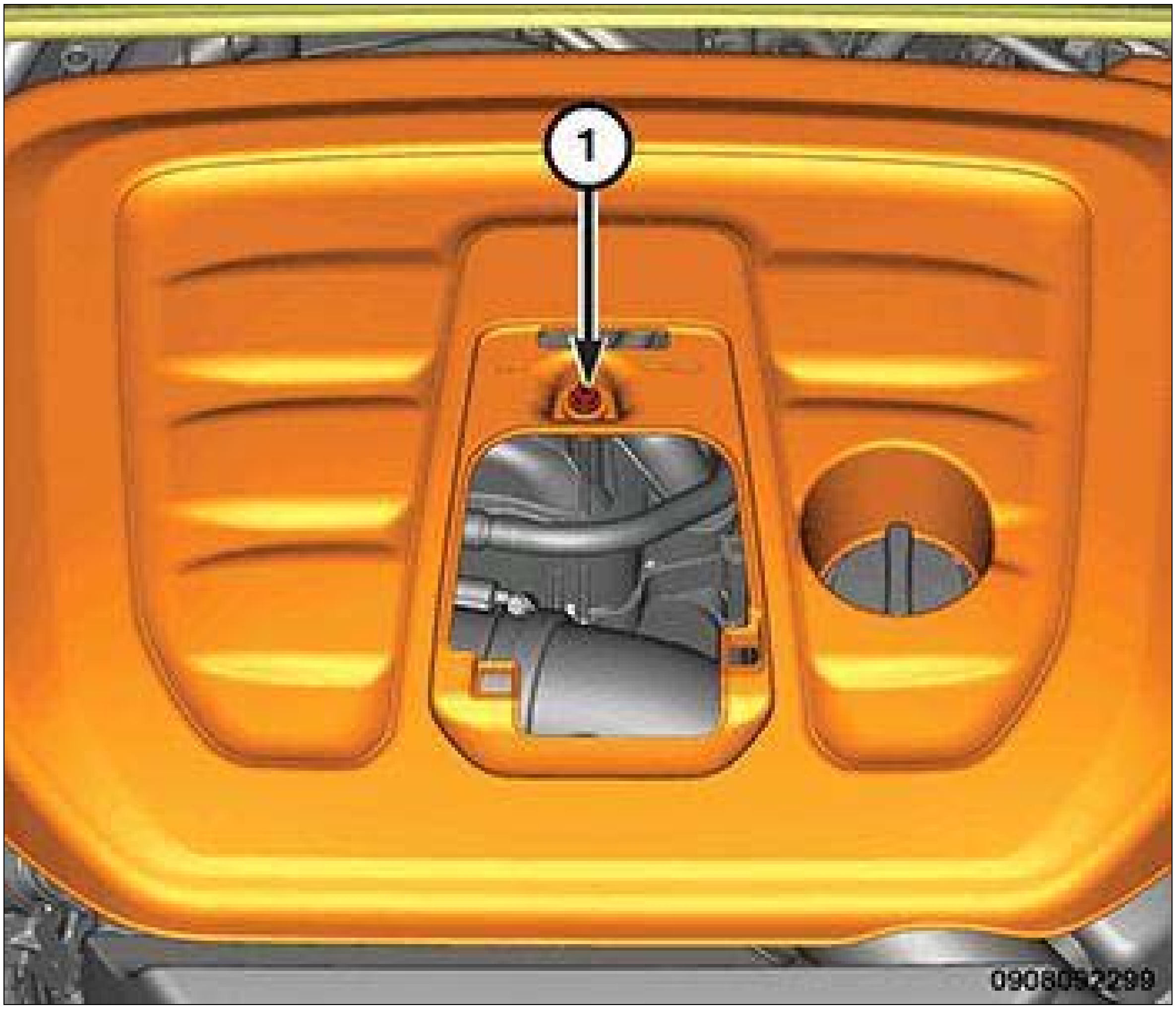
Fig 1: Oil Filter Access Cover



Courtesy of CHRYSLER GROUP, LLC

1. Remove the oil filter access cover (1).

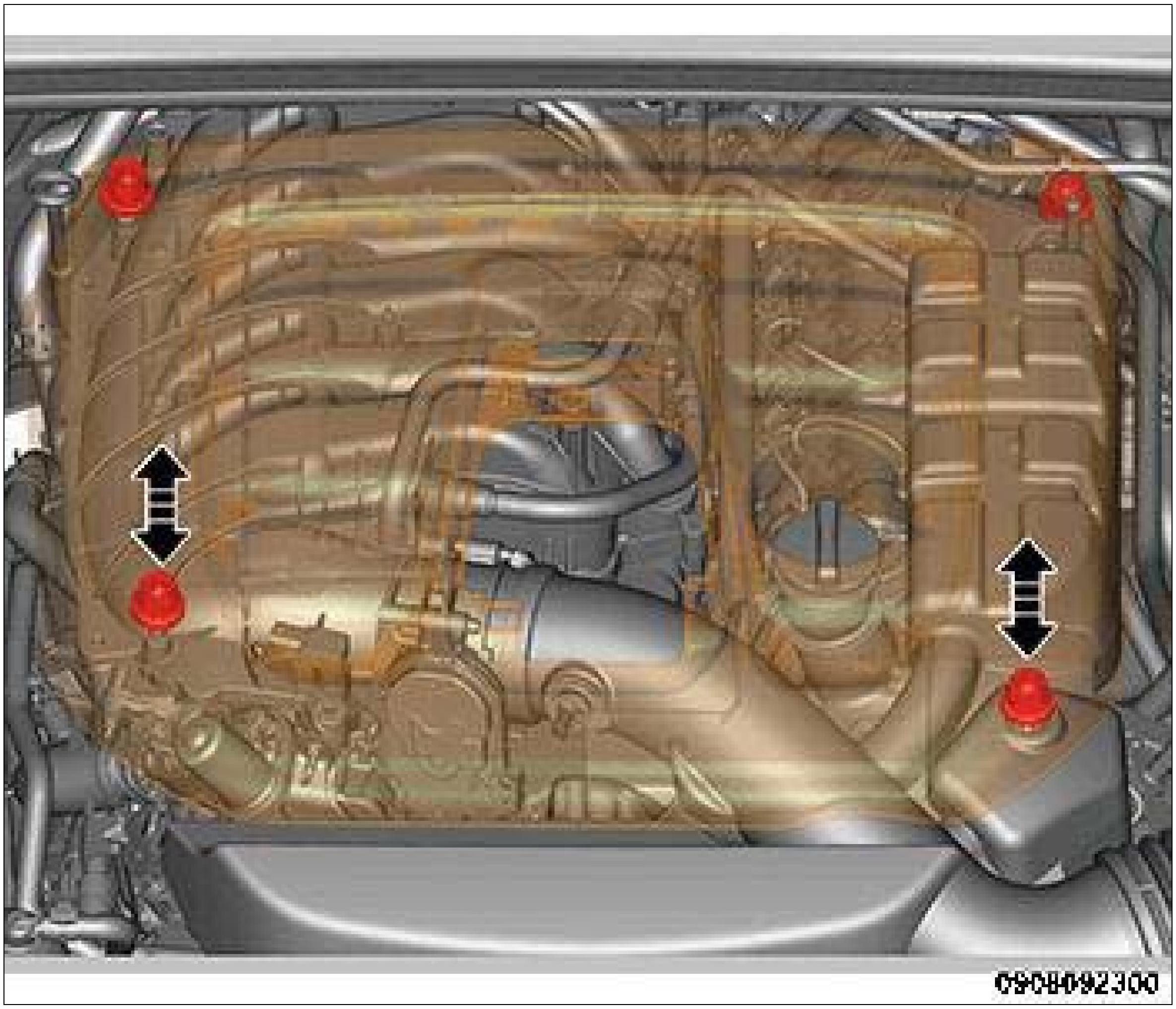
Fig 2: Engine Cover Fastener



Courtesy of CHRYSLER GROUP, LLC

2. Remove the engine cover fastener (1).

Fig 3: Locating Engine Cover Grommets



Courtesy of CHRYSLER GROUP, LLC

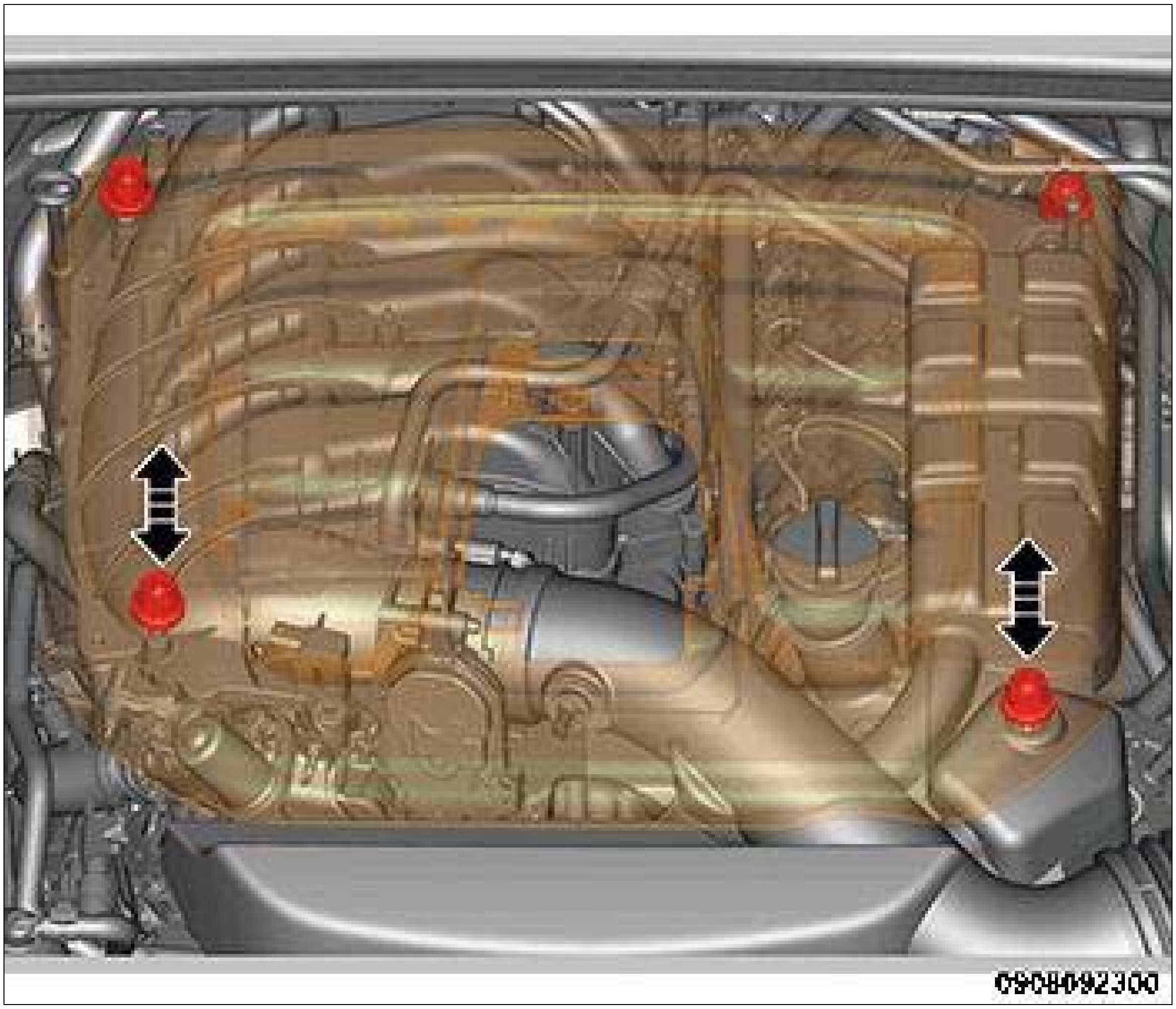
3. Gently lift vertically to disengage the engine cover grommets.
4. Place the engine cover outside of the vehicle in an easy to find location.

> *NOTE:*
>
> *Place the cover with the appearance surface upward to prevent damage and scratches.*

COVER, ENGINE > INSTALLATION > INSTALLATION

1. Locate the engine cover.

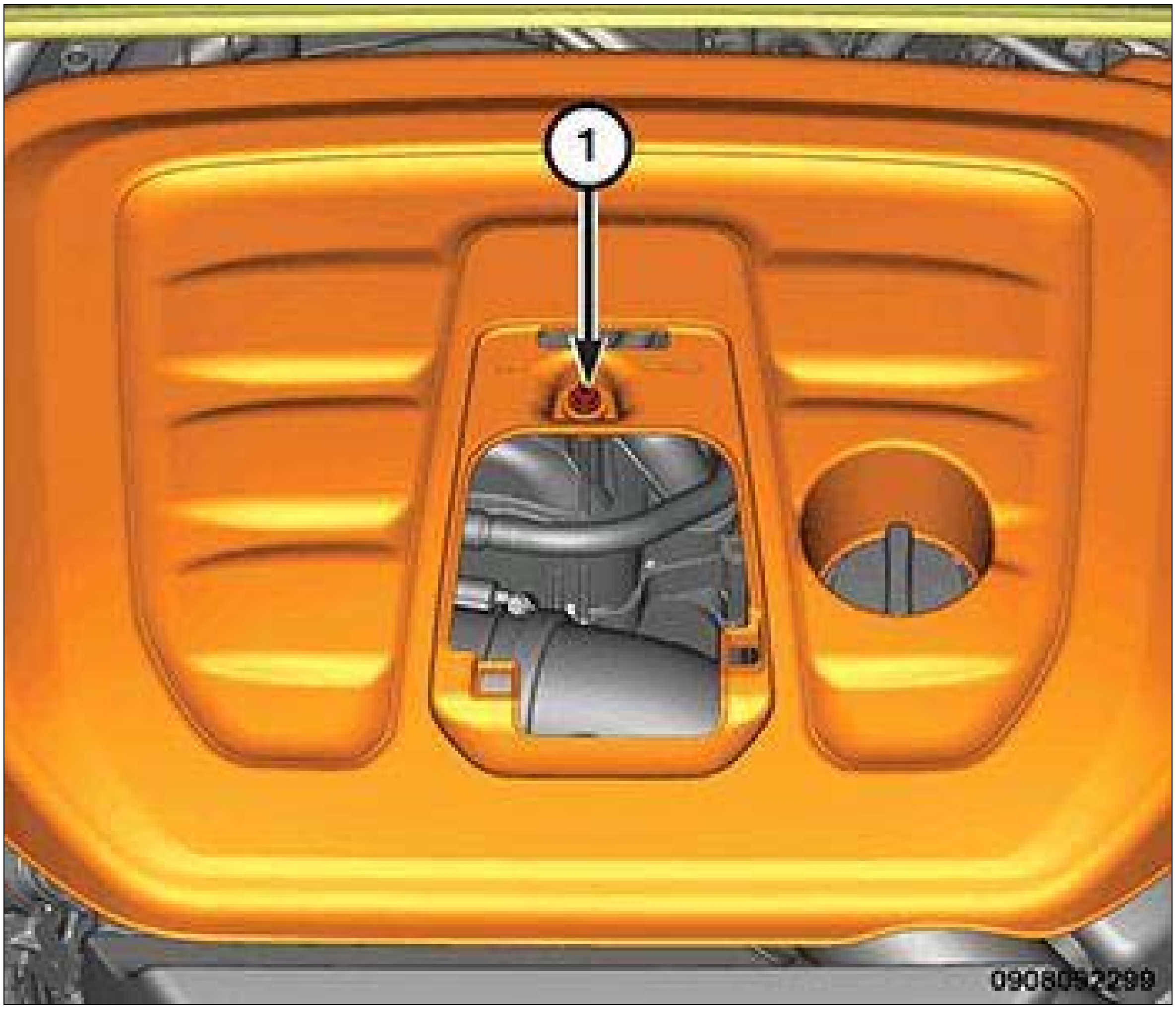
Fig 1: Locating Engine Cover Grommets



Courtesy of CHRYSLER GROUP, LLC

2. Using your hands, gently push down until you feel the grommet and ball stud engage, ensuring grommet and ball stud retention.
3. Using your hands, lightly lift up around the edges of the engine cover to ensure that the cover is not loose and that all of the grommets are engaged.

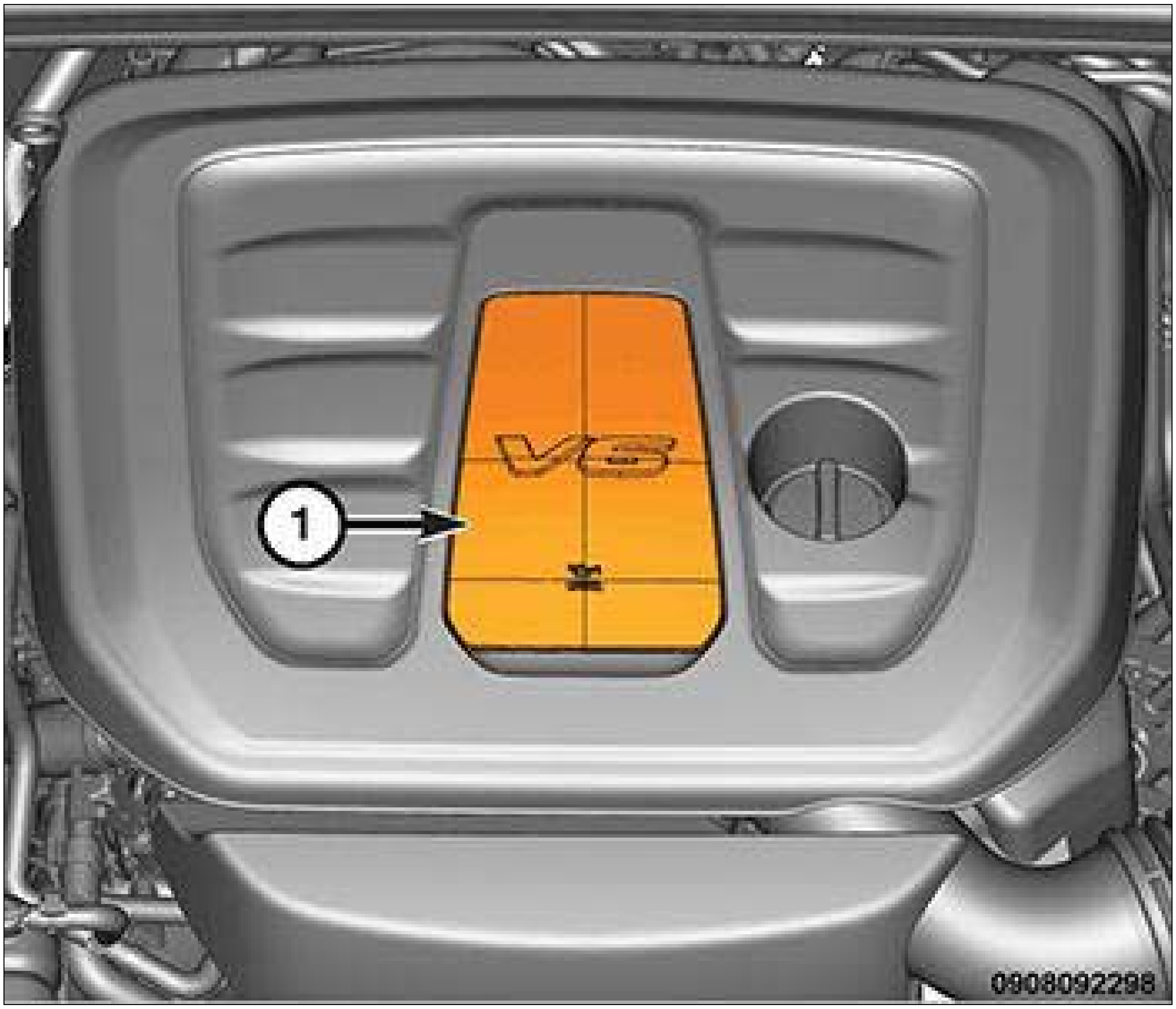
Fig 2: Engine Cover Fastener



Courtesy of CHRYSLER GROUP, LLC

4. Install and securely tighten the engine cover fastener (1).

Fig 3: Oil Filter Access Cover

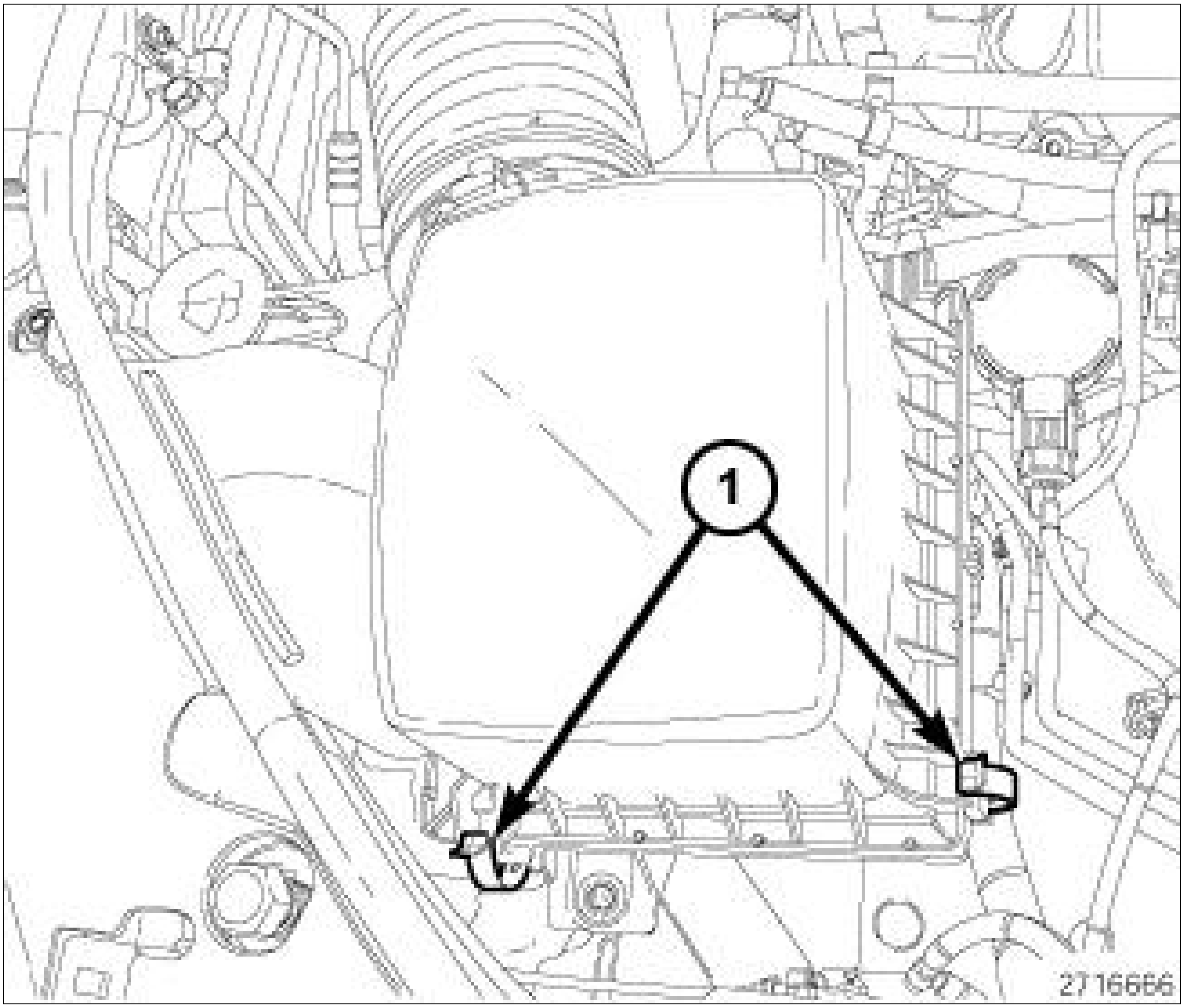


Courtesy of CHRYSLER GROUP, LLC

5. Install the oil filter access cover (1).

AIR INTAKE SYSTEM > AIR CLEANER > REMOVAL > REMOVAL

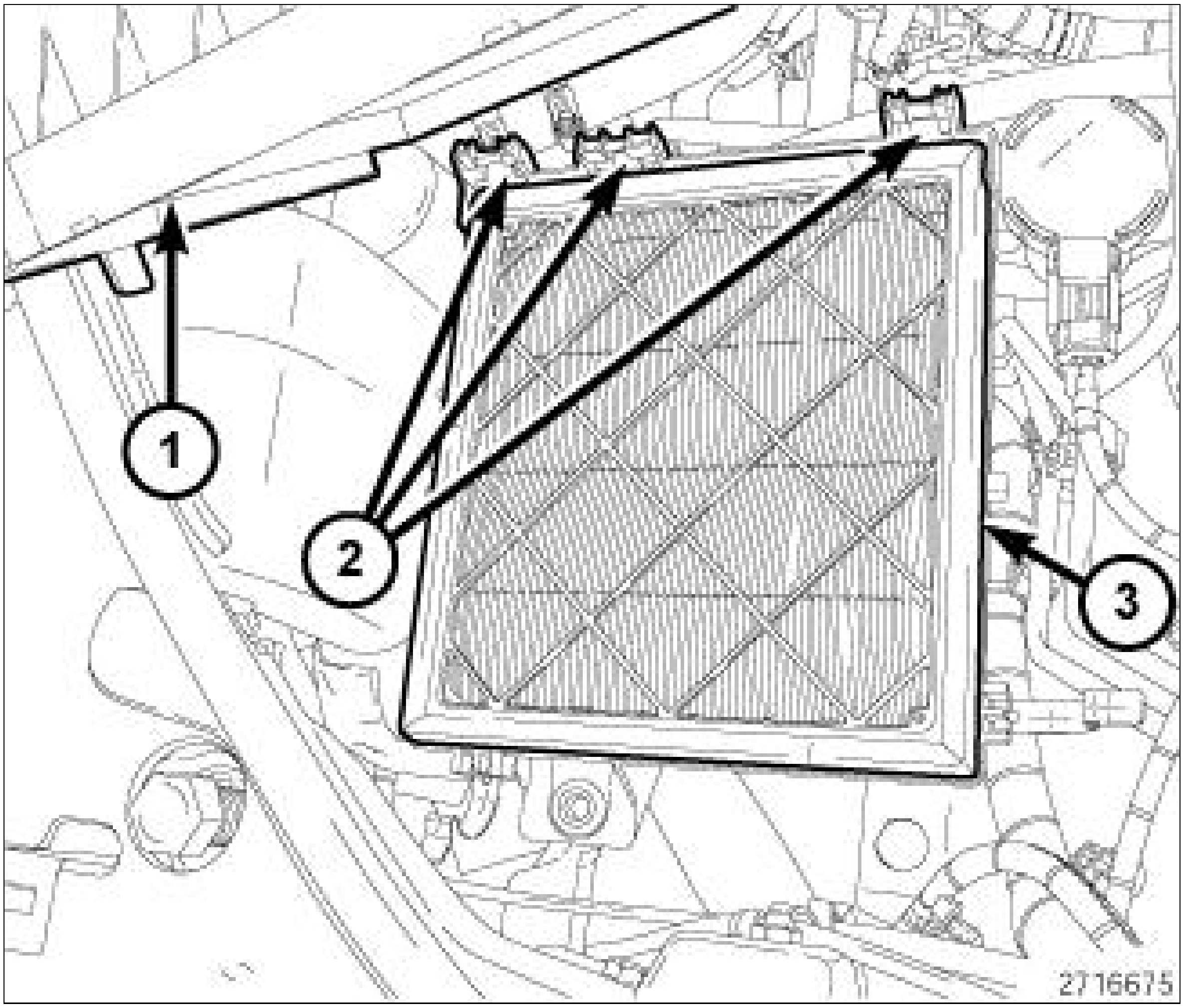
Fig 1: Air Cleaner Housing Cover Latches



Courtesy of CHRYSLER GROUP, LLC

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

Fig 2: Air Cleaner Housing Cover, Tabs & Air Cleaner Element



Courtesy of CHRYSLER GROUP, LLC

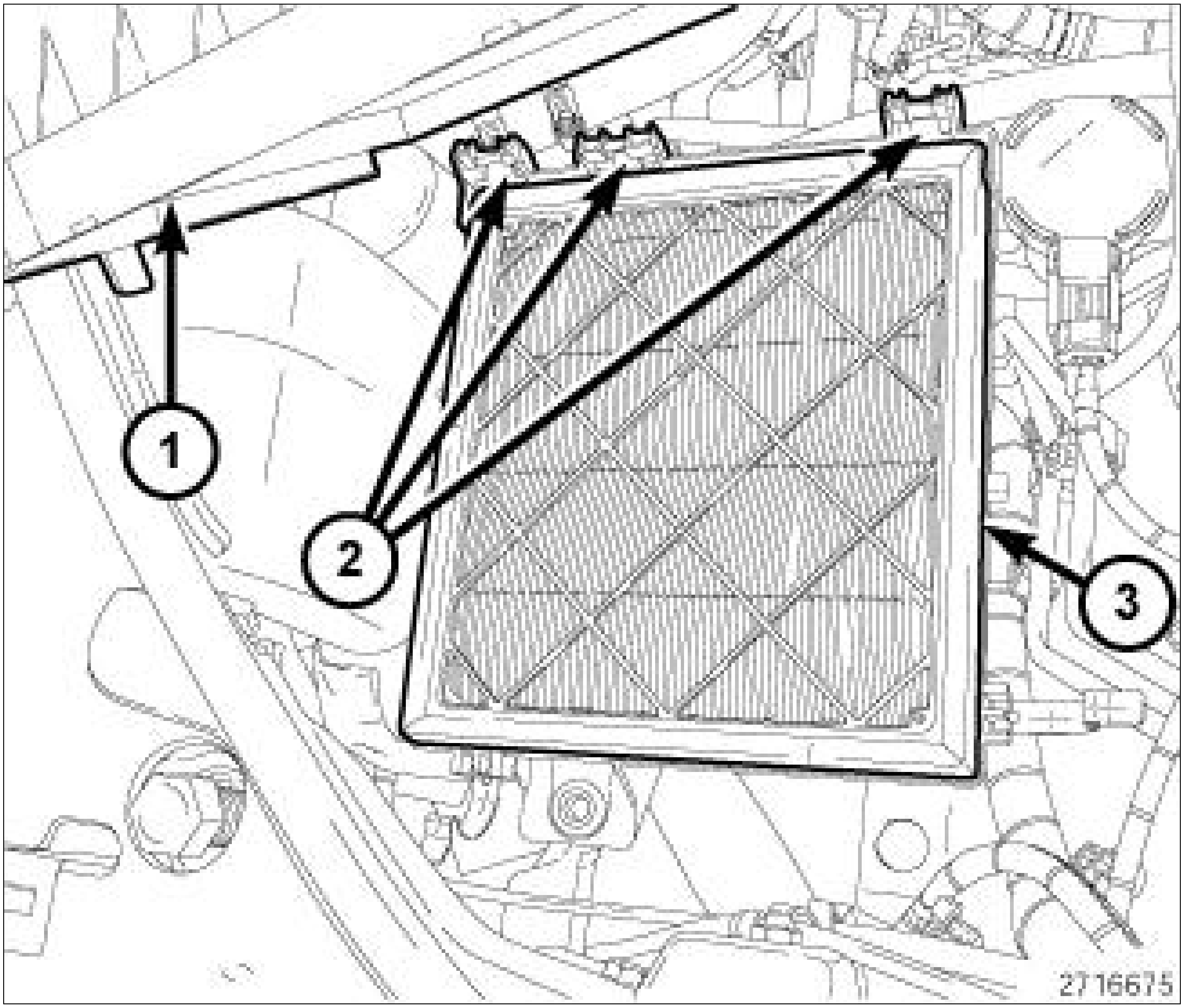
2. Lift the cover (1) and release the cover to housing alignment tabs (2).
3. Remove the air cleaner element (3).

> ⚠ *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.

AIR INTAKE SYSTEM > AIR CLEANER > INSTALLATION > INSTALLATION

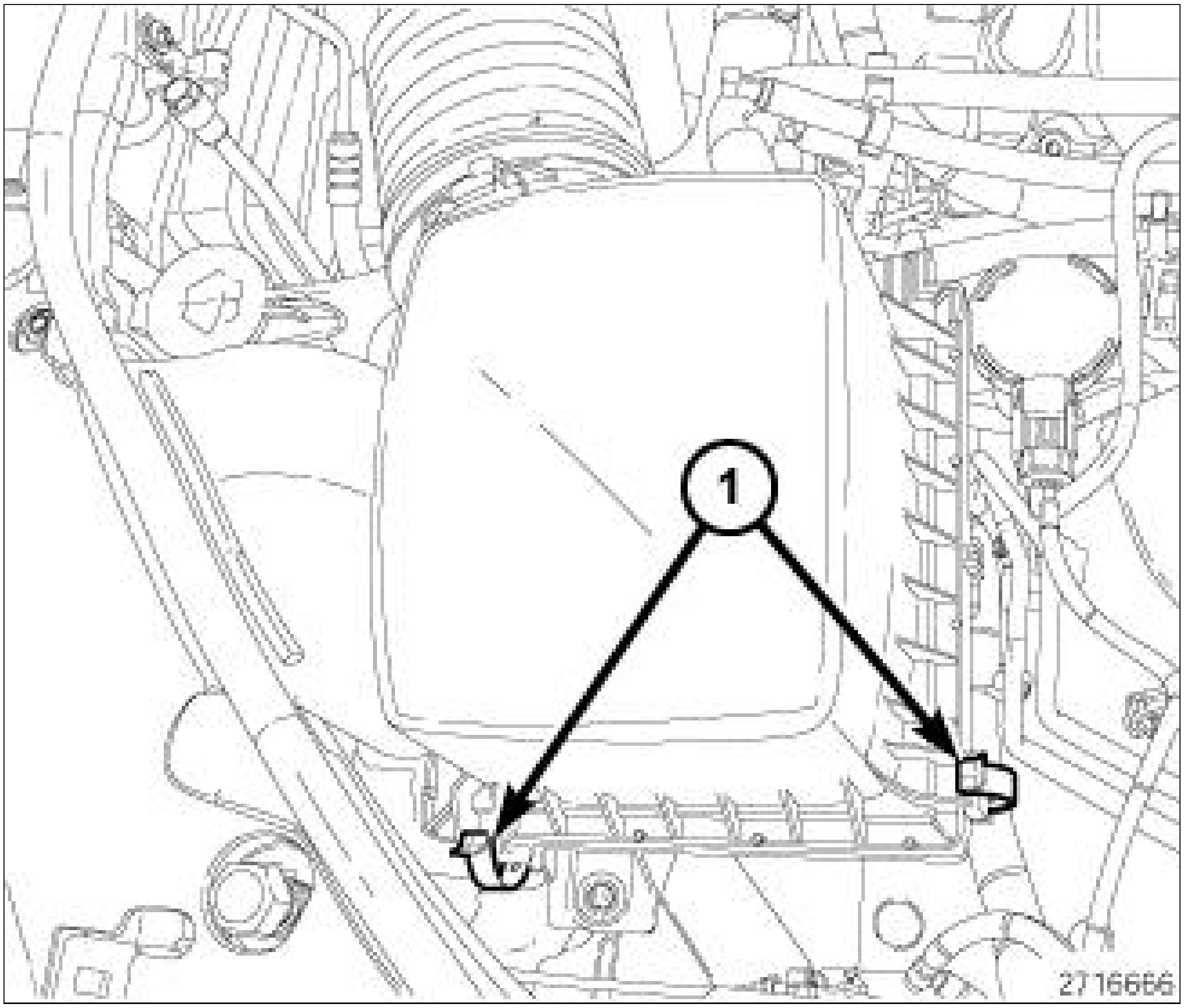
Fig 1: Air Cleaner Housing Cover, Tabs & Air Cleaner Element



Courtesy of CHRYSLER GROUP, LLC

1. Install the air cleaner element (3) into the air cleaner housing.
2. Position the cover (1) so that the alignment tabs insert into the lower housing (2).

Fig 2: Air Cleaner Housing Cover Latches



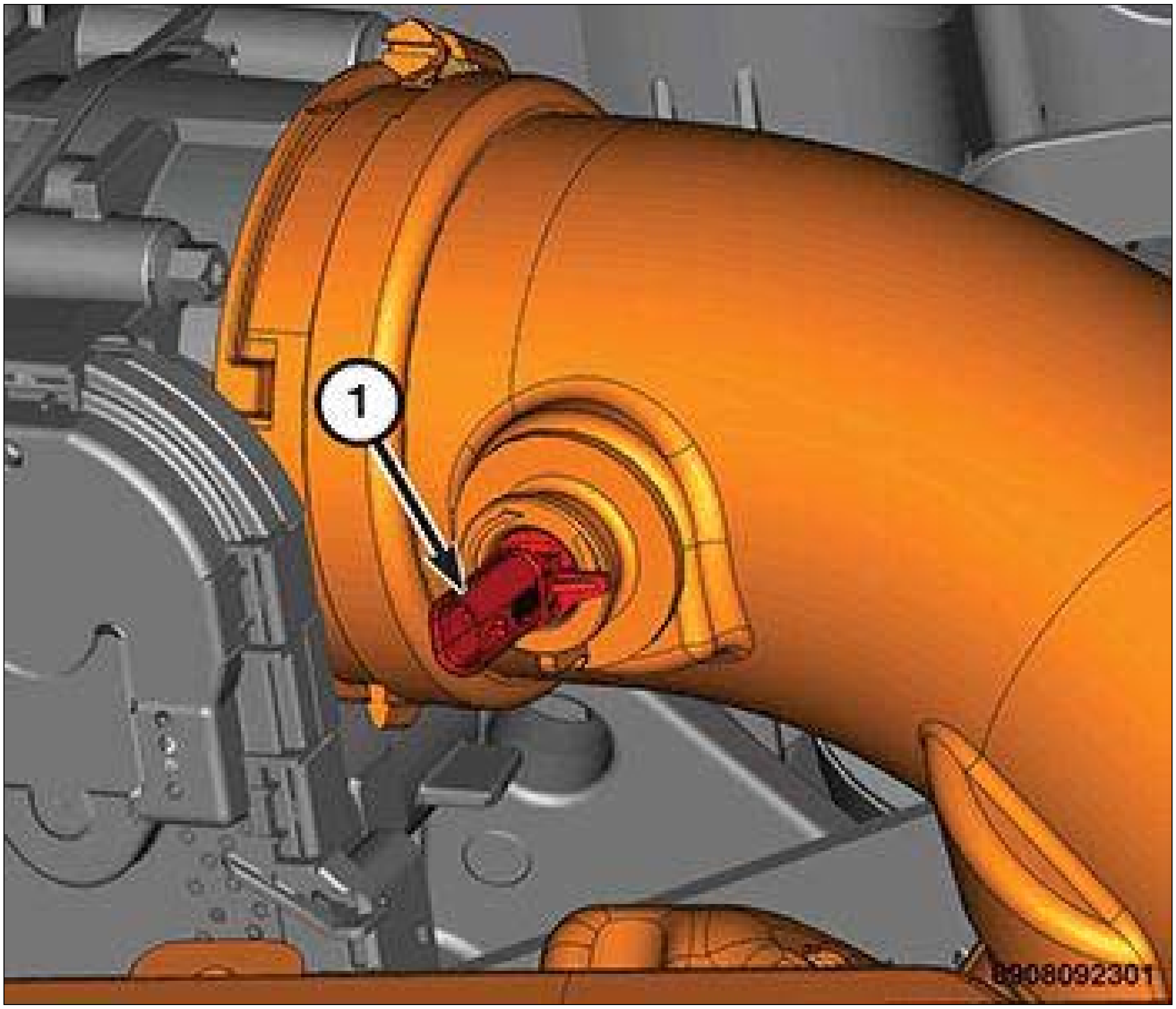
Courtesy of CHRYSLER GROUP, LLC

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

AIR INTAKE SYSTEM > BODY, AIR CLEANER > REMOVAL > REMOVAL

1. Disconnect and isolate the negative battery cable.
2. Remove the engine cover. Refer to COVER, ENGINE, REMOVAL .

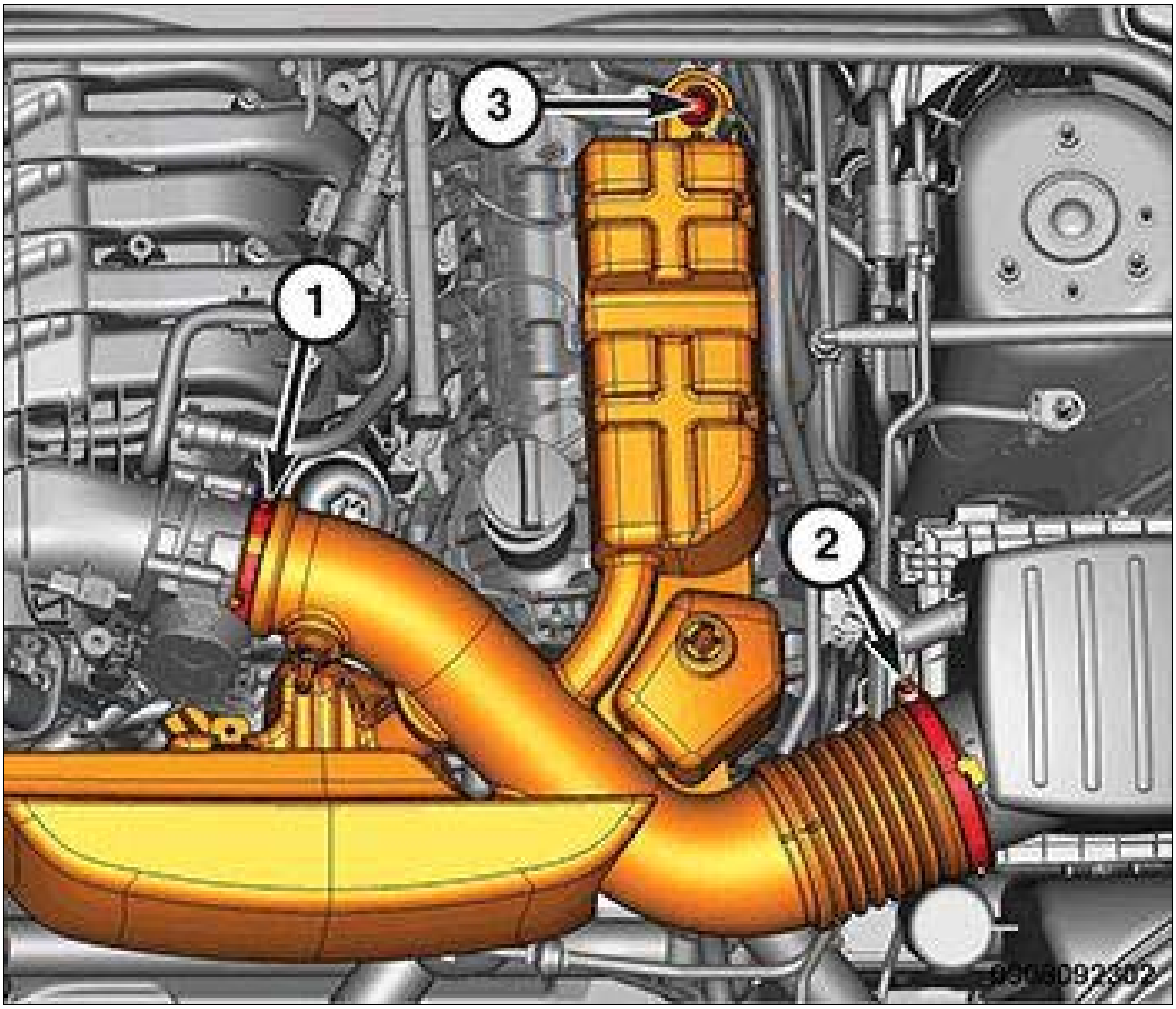
Fig 1: IAT Sensor



Courtesy of CHRYSLER GROUP, LLC

3. Disconnect the electrical connector from the Inlet Air Temperature (IAT) sensor (1).

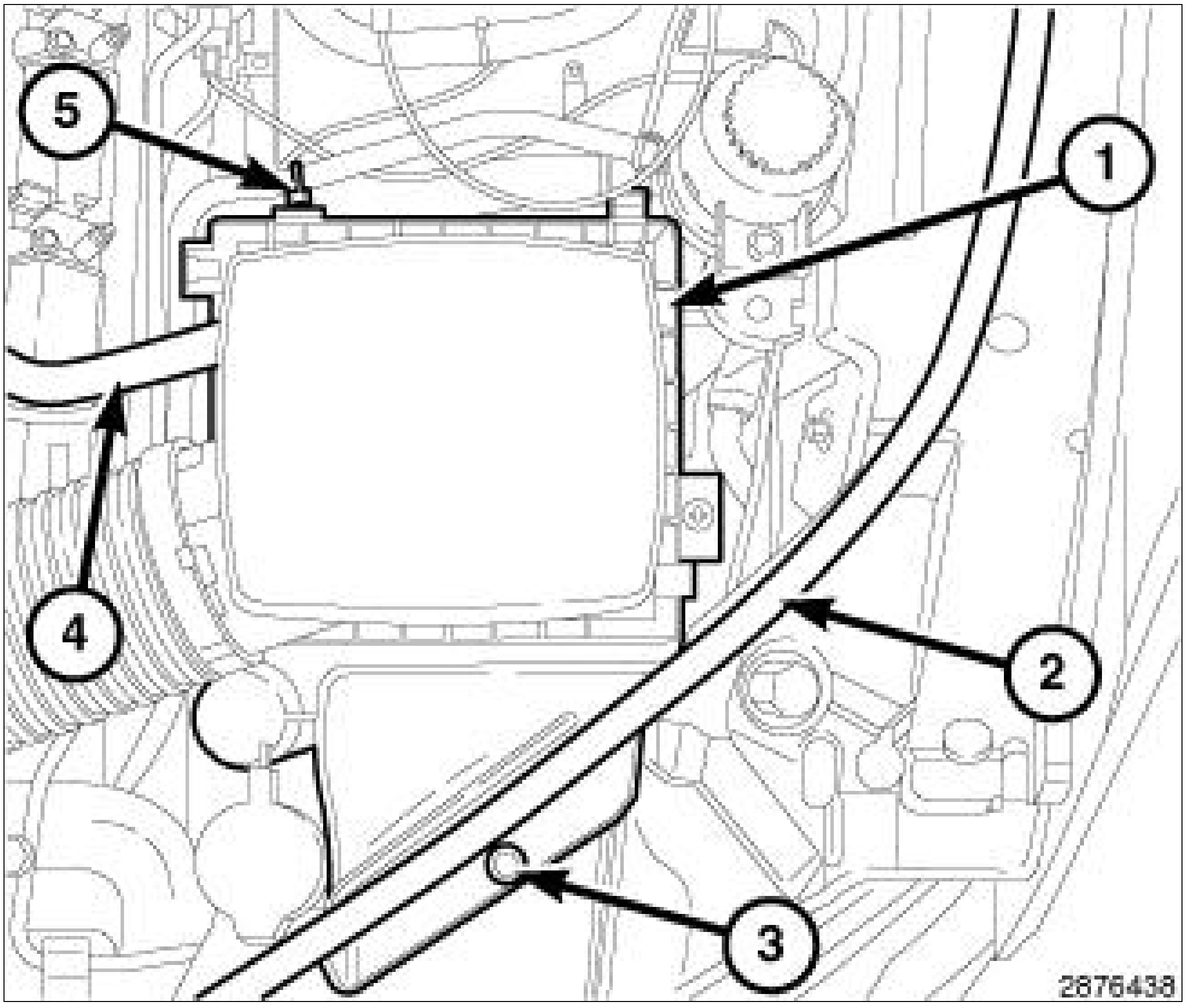
Fig 2: Throttle Body Clamp, Air Cleaner Body Clamp & Air Cleaner Assembly Rubber Grommets



Courtesy of CHRYSLER GROUP, LLC

4. Loosen the clamp (1) at the throttle body.
5. Loosen the clamp (2) at the air cleaner body.
6. Disengage the air cleaner assembly from the rubber grommets (2).
7. Remove the resonator.

Fig 3: Air Cleaner Body, Hood Seal, Push Pin, Air Makeup Hose & Hose Retainer

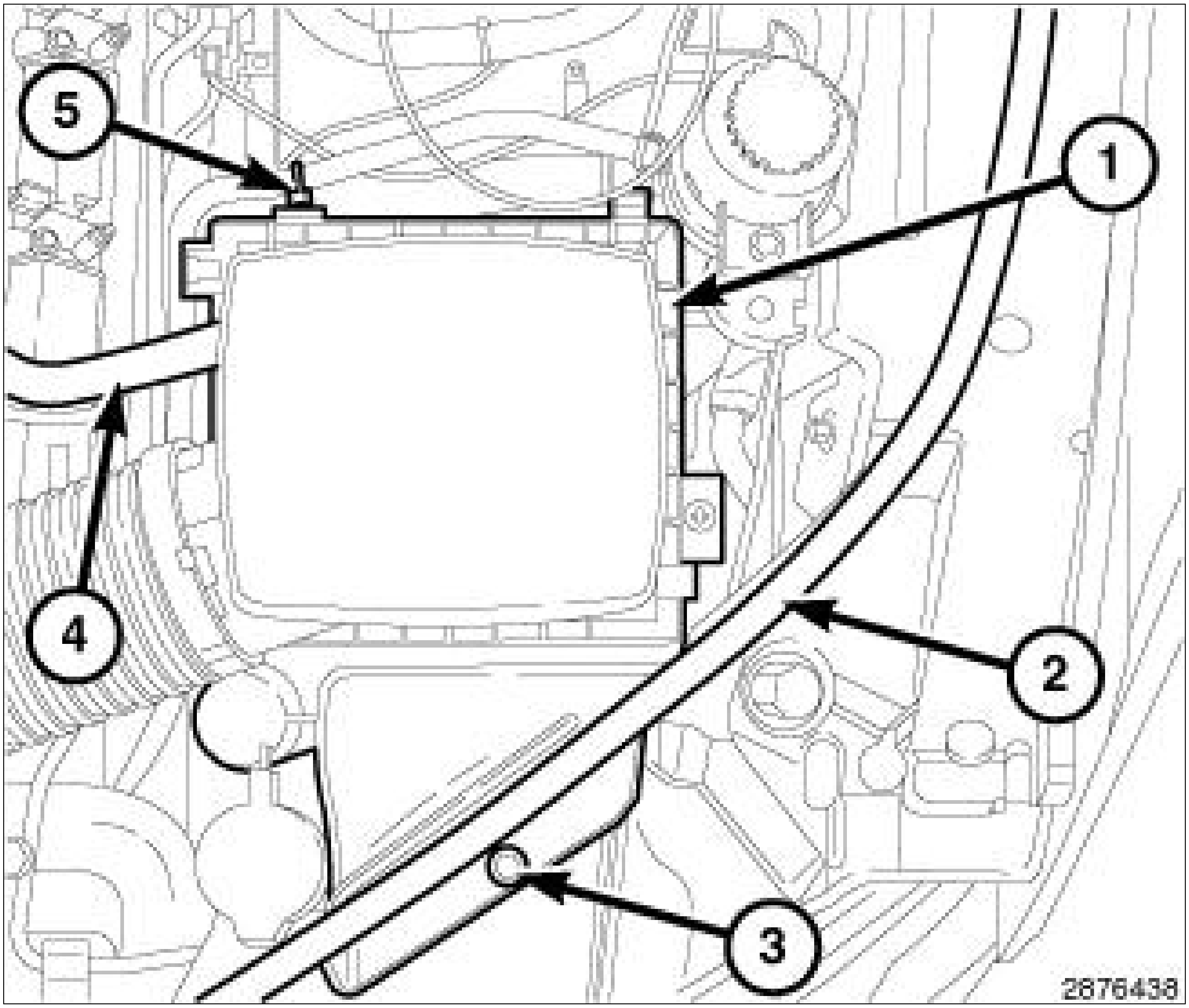


Courtesy of CHRYSLER GROUP, LLC

8. Disconnect the fresh air makeup hose (4) from the air cleaner body.
9. Disengage the hose retainer (5) from the air cleaner body.
10. Remove the push pin (3).
11. Reposition the hood seal (2) and pull the air cleaner body (1) straight up off of the locating pins.

AIR INTAKE SYSTEM > BODY, AIR CLEANER > INSTALLATION > INSTALLATION

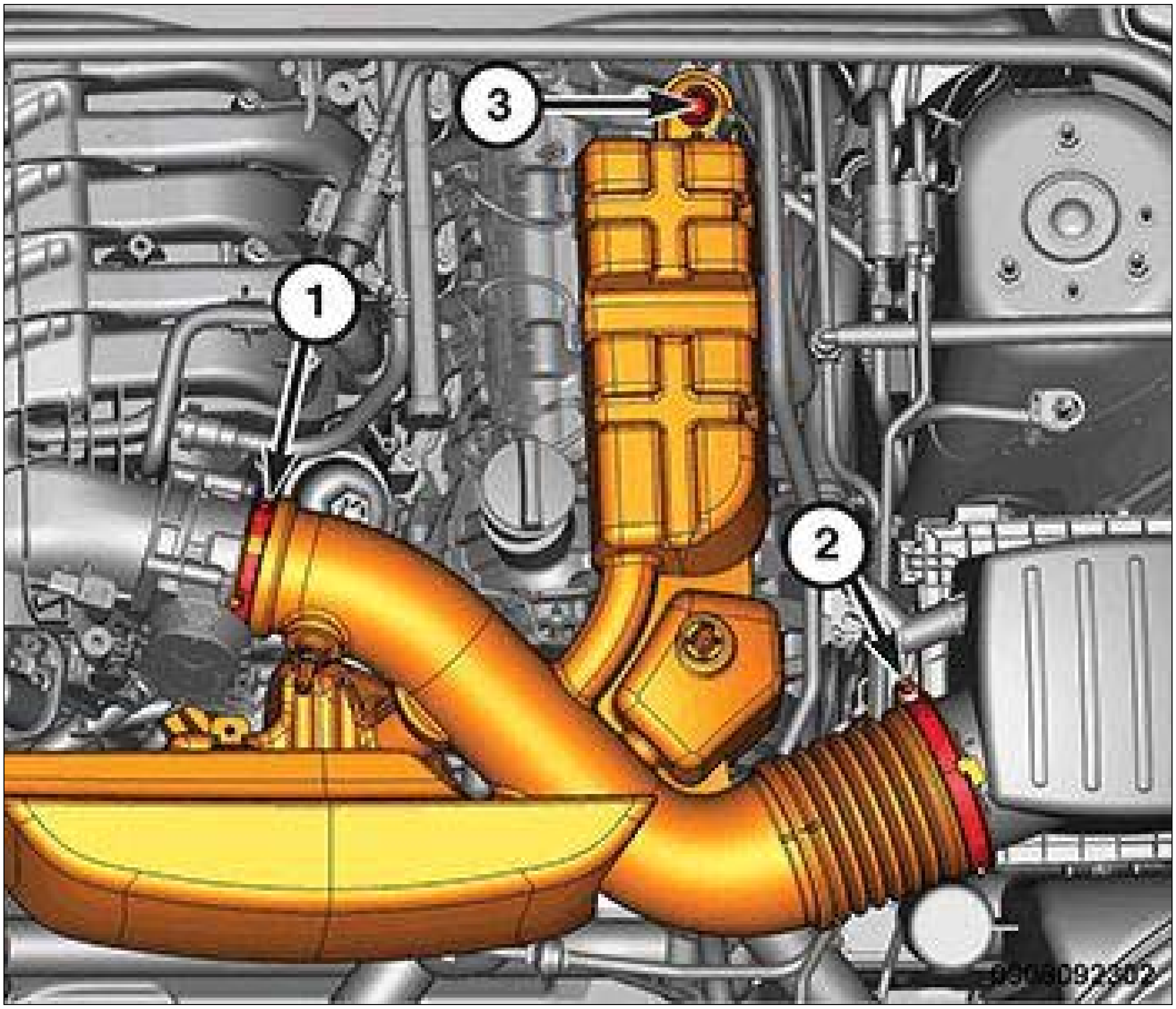
Fig 1: Air Cleaner Body, Hood Seal, Push Pin, Air Makeup Hose & Hose Retainer



Courtesy of CHRYSLER GROUP, LLC

1. Install the air cleaner body (1) straight down on the locating pins while routing the air inlet under the hood seal (2).
2. Install the push pin (3).
3. Engage the hose retainer (5) to the air cleaner body.
4. Install the fresh air makeup hose (4) to the air cleaner body.

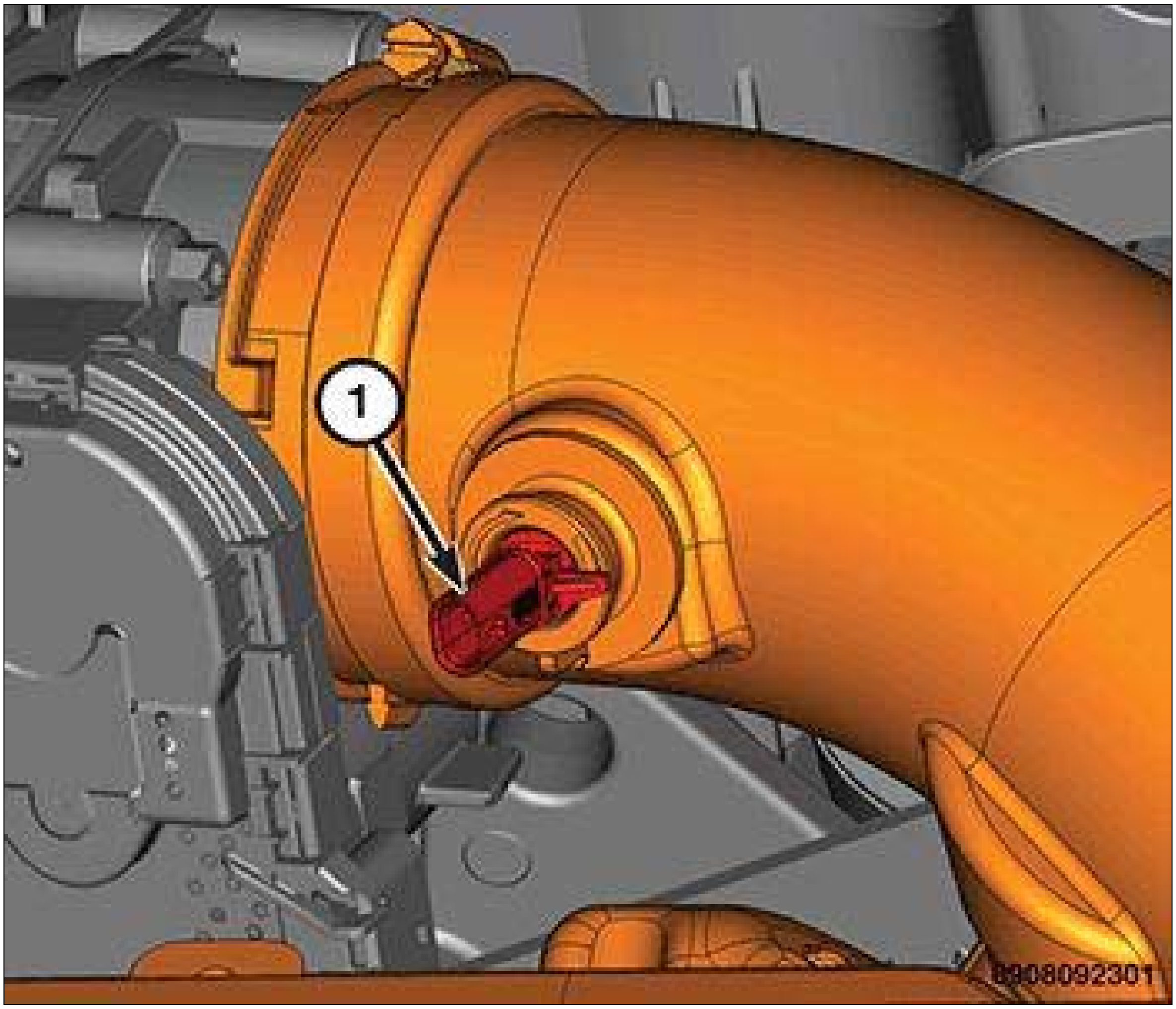
Fig 2: Throttle Body Clamp, Air Cleaner Body Clamp & Air Cleaner Assembly Rubber Grommets



Courtesy of CHRYSLER GROUP, LLC

5. Install the resonator to the air cleaner body and the throttle body engaging the rubber grommets (3).
6. Tighten the clamp at the throttle body (1) and the air cleaner body (2) to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 3: IAT Sensor



Courtesy of CHRYSLER GROUP, LLC

7. Connect the electrical connector (1) to the Inlet Air Temperature (IAT) sensor.
8. Install the engine cover. Refer to COVER, ENGINE, INSTALLATION .
9. Connect the negative battery cable.

CYLINDER HEAD > 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 HEAD > DIAGNOSIS AND TESTING > CYLINDER HEAD GASKET > CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between the cylinders located next to each other, follow the procedures in Cylinder Compression Pressure Test. Refer to CYLINDER COMPRESSION TEST . An engine cylinder head gasket leaking between the cylinders will result in approximately a 50 - 70% reduction in compression pressure.

CYLINDER HEAD > DIAGNOSIS AND TESTING > CYLINDER HEAD GASKET > CYLINDER-TO-WATER JACKET LEAKAGE TEST

WARNING:

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

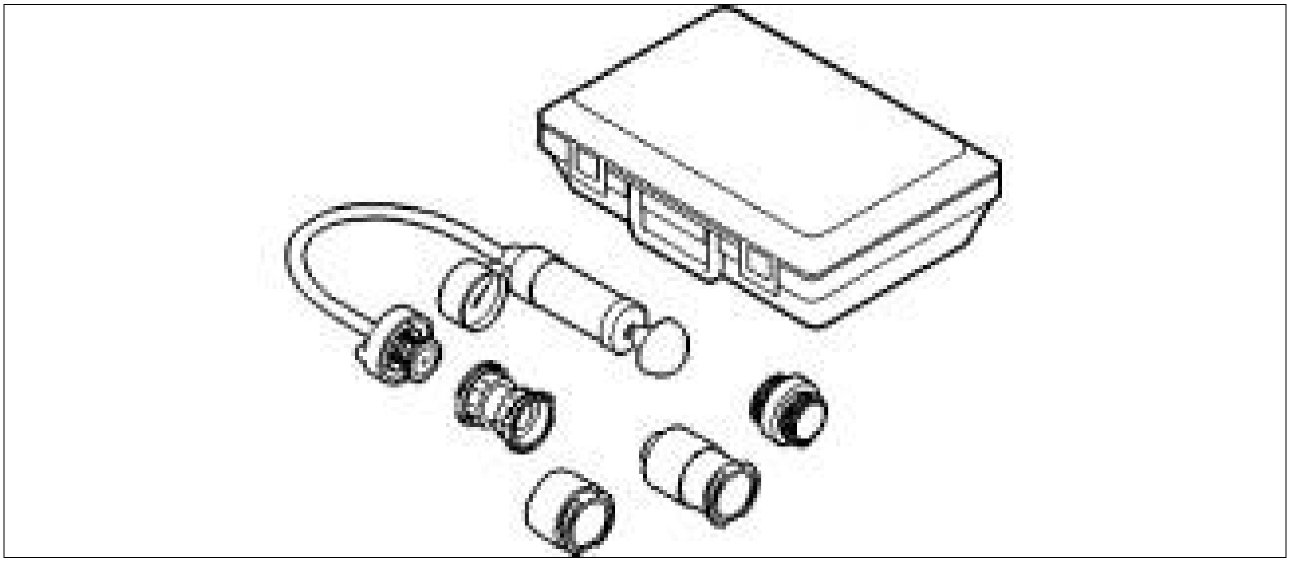
CYLINDER HEAD > DIAGNOSIS AND TESTING > CYLINDER HEAD GASKET > CYLINDER-TO-WATER JACKET LEAKAGE TEST > VISUAL TEST METHOD

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.

CYLINDER HEAD > DIAGNOSIS AND TESTING > CYLINDER HEAD GASKET > CYLINDER-TO-WATER JACKET LEAKAGE TEST > COOLING SYSTEM TESTER METHOD

Fig 1: Cooling System Pressure Tester - 7700a



Courtesy of CHRYSLER GROUP, LLC

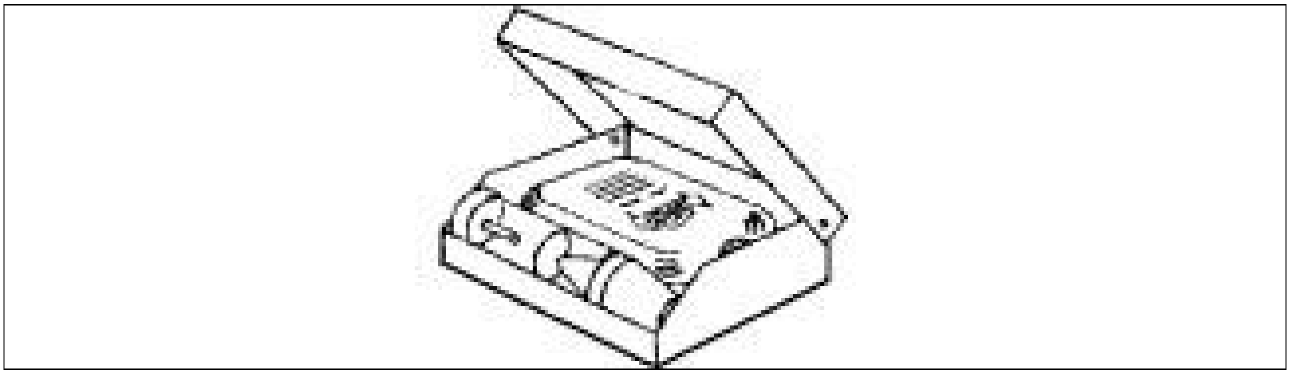
WARNING:

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

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

CYLINDER HEAD > DIAGNOSIS AND TESTING > CYLINDER HEAD GASKET > CYLINDER-TO-WATER JACKET LEAKAGE TEST > CHEMICAL TEST METHOD

Fig 1: Bloc-Chek-Kit - C-3685-A



Courtesy of CHRYSLER GROUP, LLC

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

CYLINDER HEAD > DIAGNOSIS AND TESTING > HYDRAULIC LASH ADJUSTER

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

1. Engine oil level too high or too low. This may cause aerated oil to enter the adjusters and cause them to be spongy.
2. Insufficient running time after rebuilding the cylinder head. Low speed running up to 1 hour may be required.
3. Turn the engine off and let set for a few minutes before restarting. Repeat this several times after the engine has reached normal operating temperature.
4. Low oil pressure.
5. The oil restricter 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.

The internal check balls on the exhaust hydraulic lash adjusters are reversed. For more information, refer to DESCRIPTION .

NOTE:

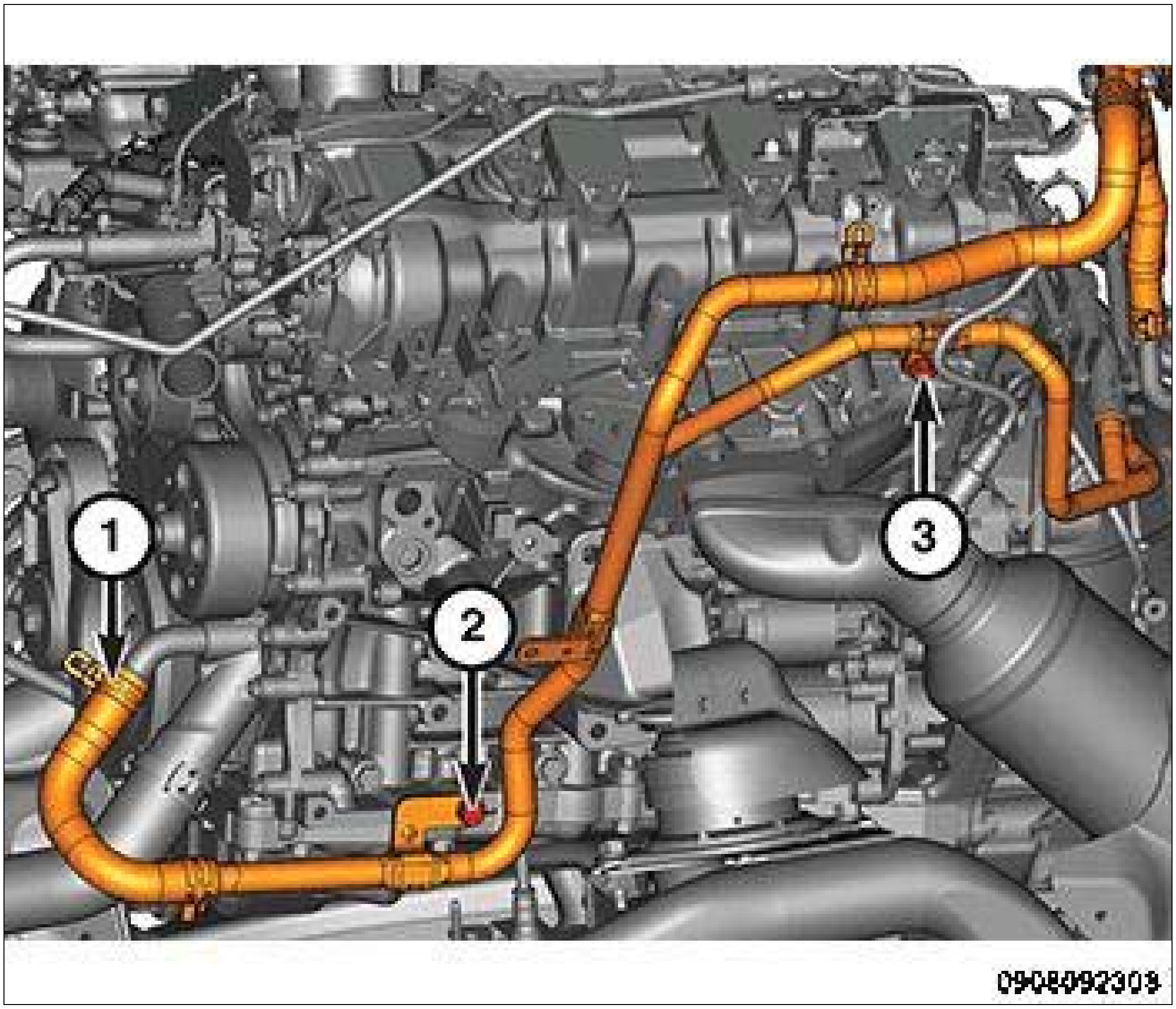
The exhaust hydraulic lifter must never be interchanged with any other hydraulic lifter than what is specifically designated for this vehicle. The internal check ball is reversed and could cause engine damage if an incorrect part is installed.

CYLINDER HEAD > REMOVAL > LEFT

1. Perform the fuel pressure release procedure. Refer to FUEL SYSTEM PRESSURE RELEASE .
2. Disconnect and isolate the negative battery cable.
3. Raise and support the vehicle. Refer to HOISTING, STANDARD PROCEDURE .

4. Drain the cooling system. Refer to STANDARD PROCEDURE .
5. Drain the engine oil. Refer to STANDARD PROCEDURE .
6. Remove the upper and lower intake manifolds and insulator. Refer to MANIFOLD, INTAKE, REMOVAL .

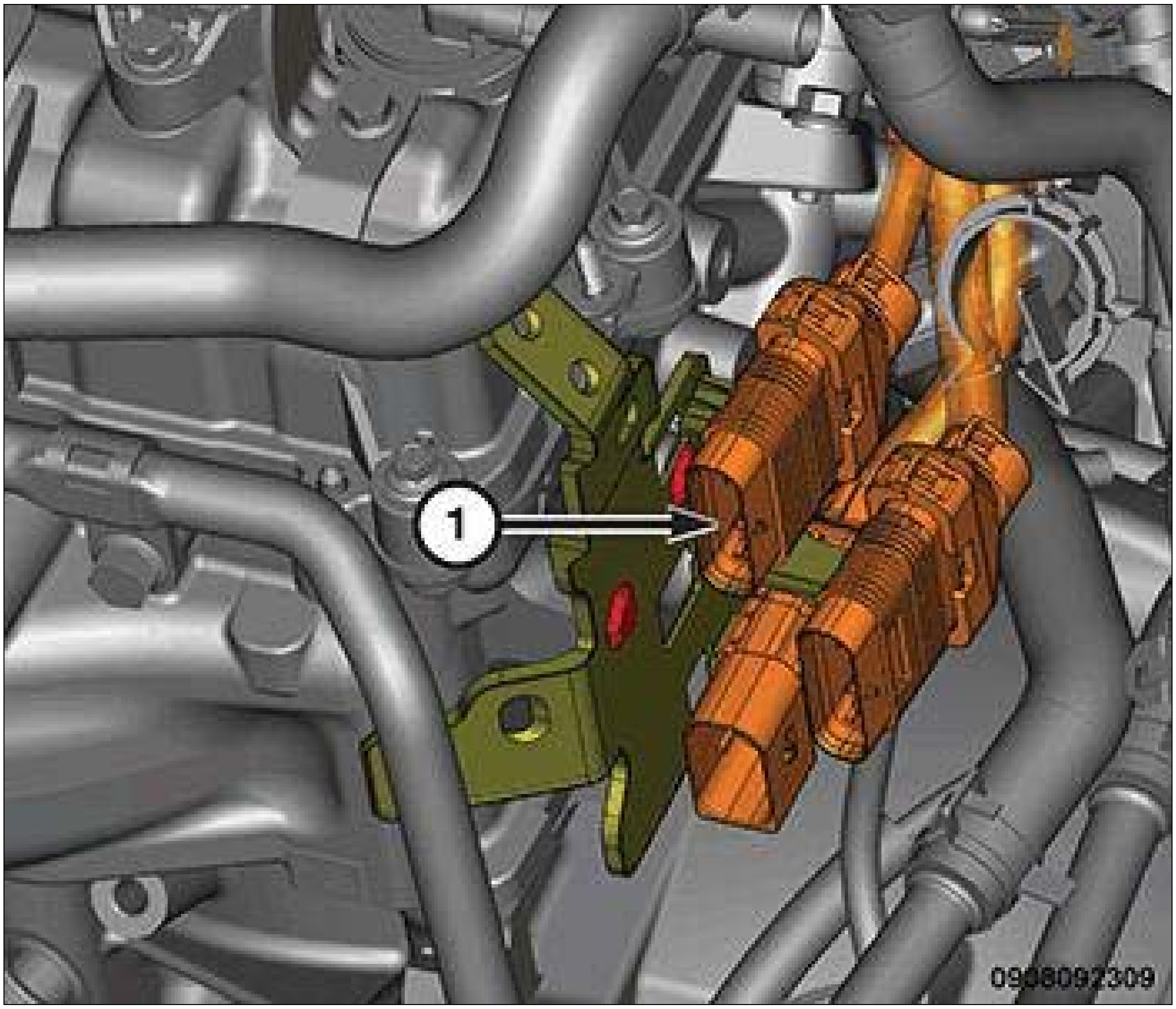
Fig 1: Heater Core Return Hose At Water Pump Bypass, Retaining Bolts At Engine Block & Cylinder Head



Courtesy of CHRYSLER GROUP, LLC

7. Remove the heater core return hose from the water pump bypass (1).
8. Remove the retaining bolts from the engine block (2) and cylinder head (3).
9. Remove the A/C compressor and position aside. Refer to COMPRESSOR, A/C, REMOVAL .
10. Remove the left catalytic converter from the cylinder head and position aside. Refer to CONVERTER, CATALYTIC, REMOVAL .

Fig 2: O2 Sensor Harness Connector Retainer Bracket



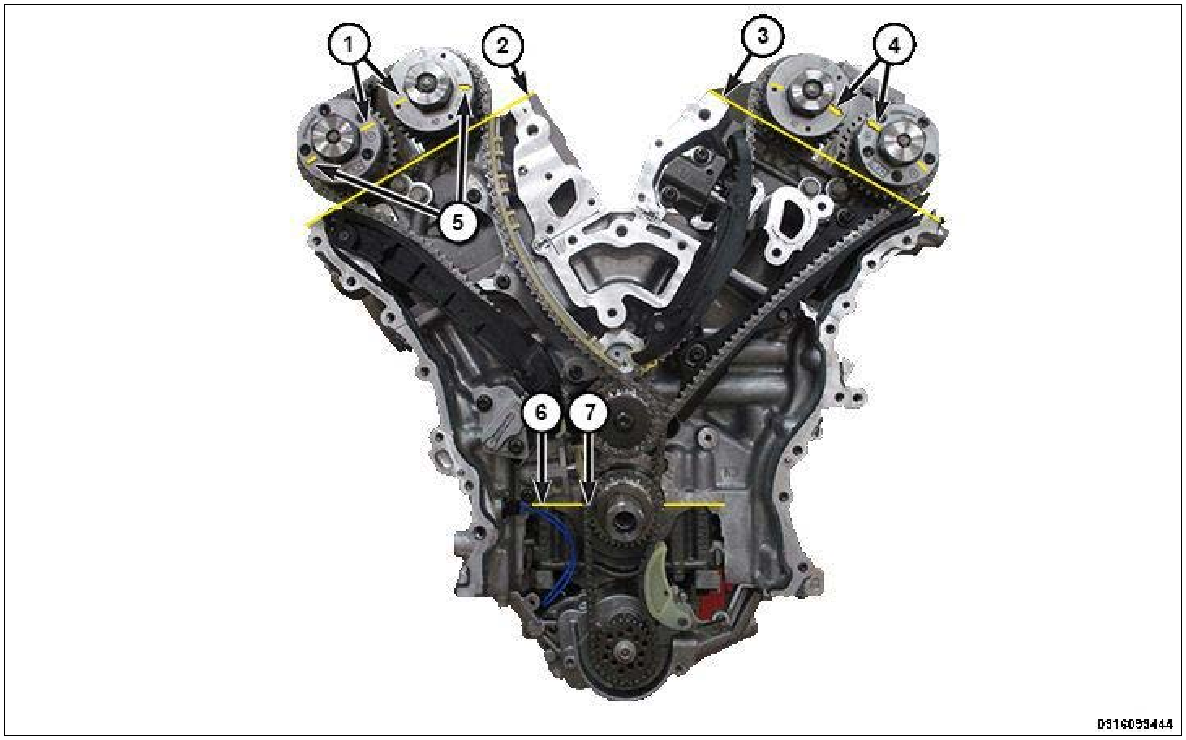
Courtesy of CHRYSLER GROUP, LLC

11. Disconnect the ignition coil capacitor electrical connector.
12. Disengage the injection/ignition harness connector and the oxygen sensor harness connector from the retainer bracket (1) on the rear of the left cylinder head.
13. Disengage one main wire harness bracket from the left cylinder head.
14. Remove the spark plugs. Refer to SPARK PLUG, REMOVAL .
15. Remove the cylinder head covers, lower and upper oil pans, 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 STANDARD PROCEDURE .*

16. Lower the vehicle.

Fig 3: Scribe Lines, Valve Cover Sealing Surfaces, Cam Phaser Arrows, Block/Bearing Cap Junction & Dimple



Courtesy of CHRYSLER GROUP, LLC

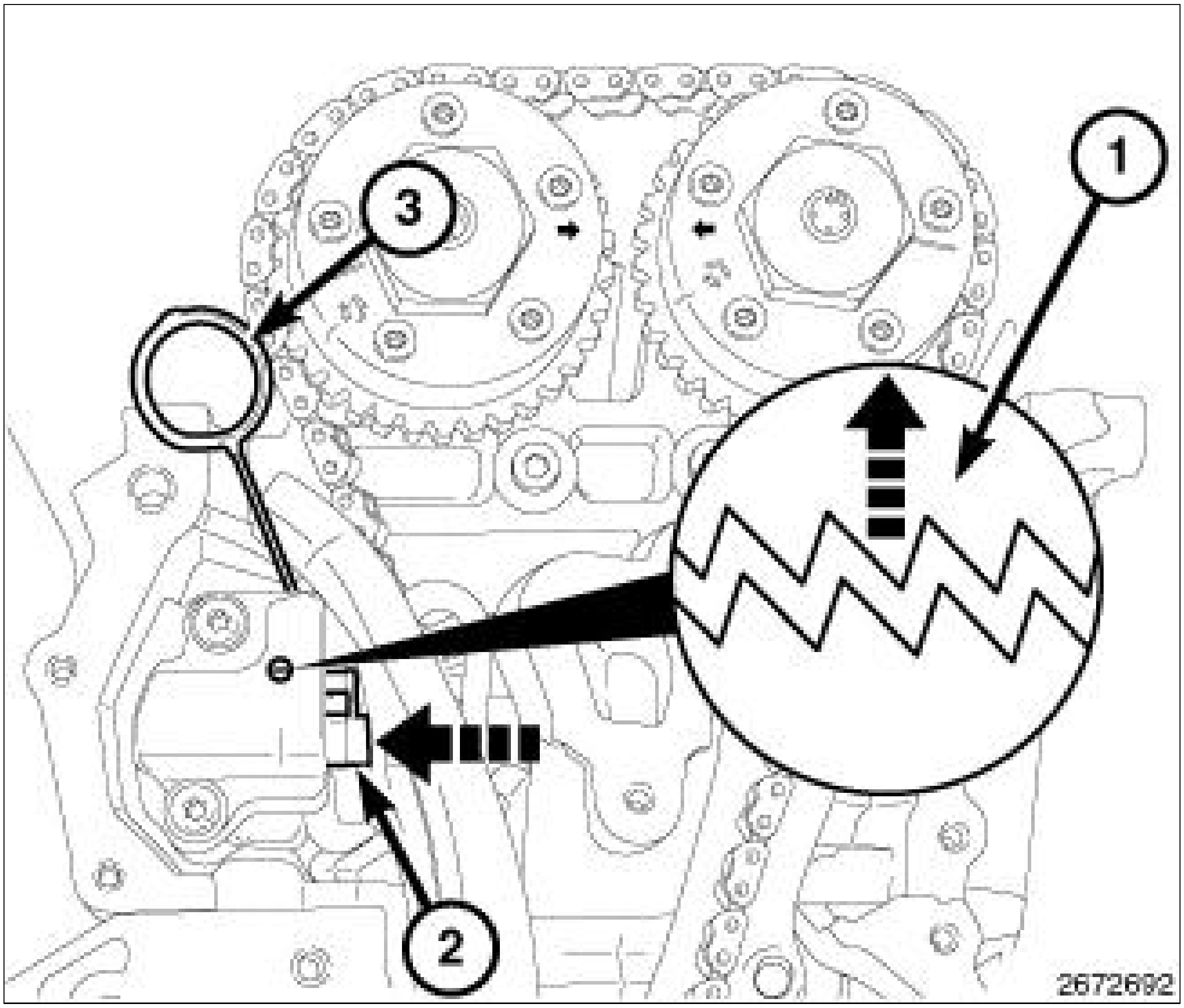
> ⚠ *CAUTION:*
>
> *When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.*

17. Rotate the crankshaft CW to place the number one piston at TDC on the exhaust stroke by aligning the dimple (7) on the crankshaft with the block/bearing cap junction (6). The left side cam phaser arrows (4) should point toward each other and be parallel to the valve cover sealing surface (3). The right side cam phaser arrows (5) should point away from each other and the scribe lines (1) should be parallel to the valve cover sealing surface (2).

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

Fig 4: Resetting Left Cam Chain Tensioner By Lifting Pawl, Pushing Back Piston & Installing Tensioner Pin



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.

19. 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 STANDARD PROCEDURE .

20. Remove the left side camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL .

NOTE:

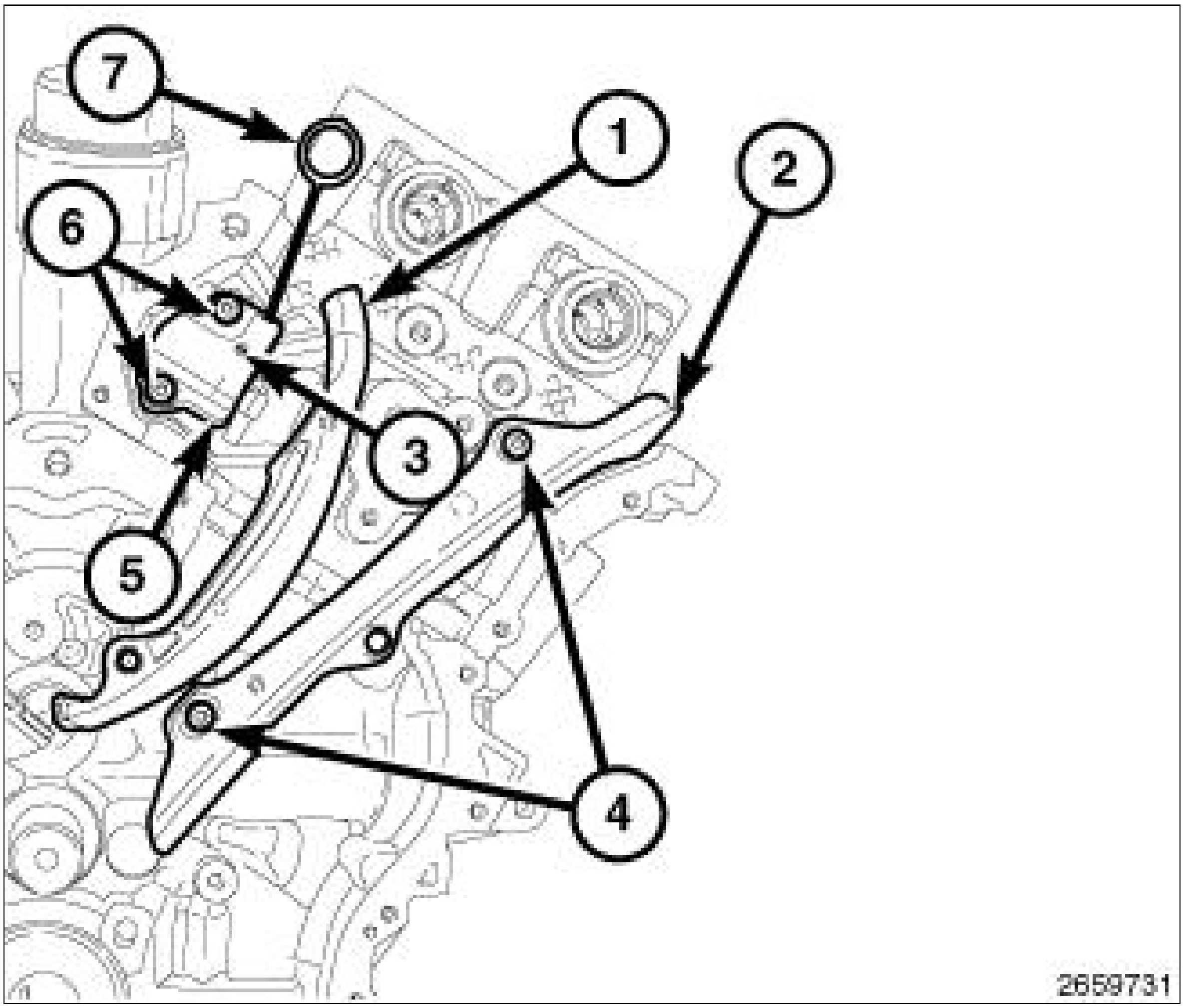
If the rocker arms are to be reused, identify their positions so that they can be *reassembled into their original locations.*

21. 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.*

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

Fig 5: Left Cam Chain Tensioner, Arm, Guide & Bolts



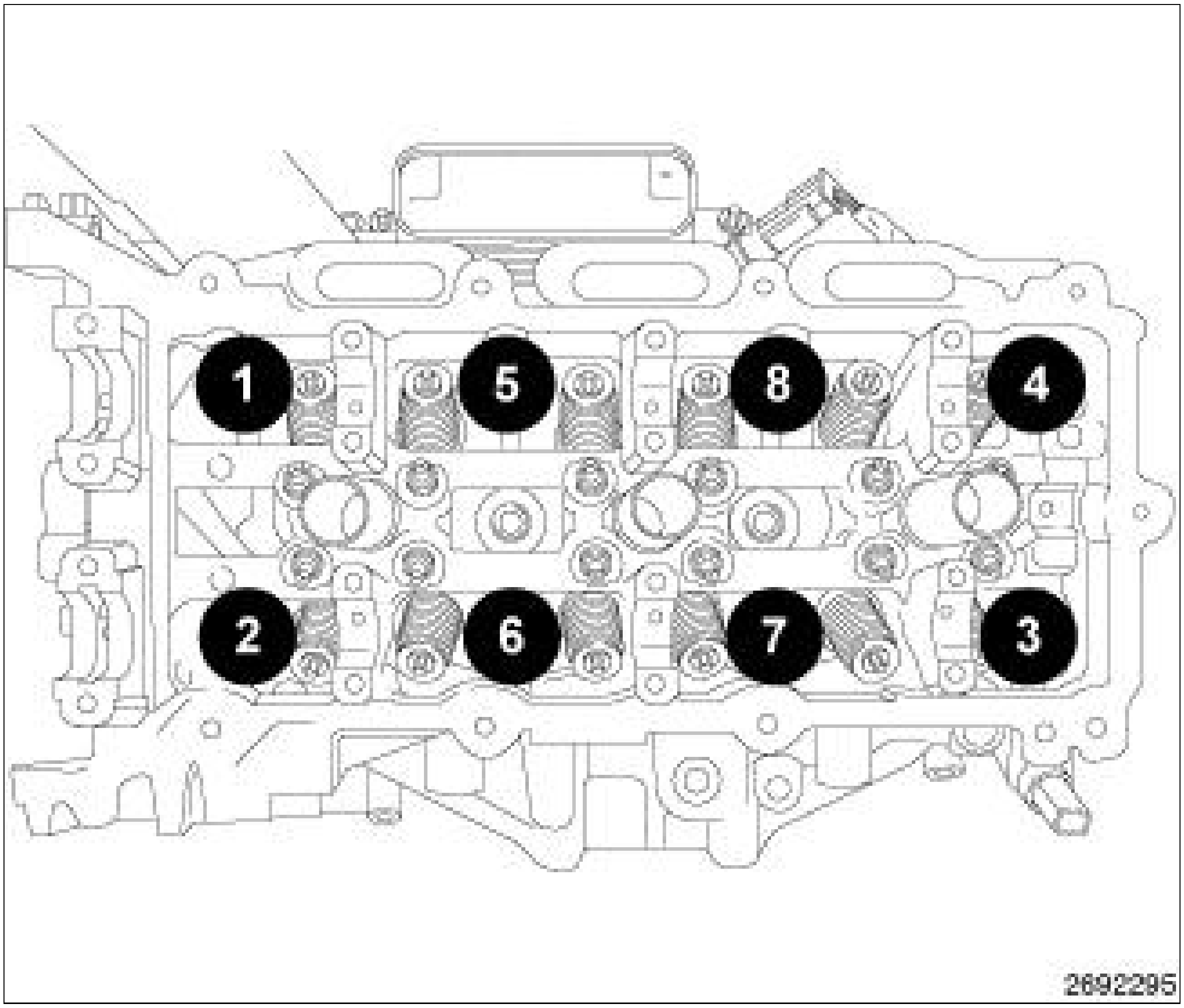
Courtesy of CHRYSLER GROUP, LLC

23. Remove the LH cam chain tensioner arm (1).

24. Remove two bolts (6) and the LH cam chain tensioner (5).

25. Remove two bolts (4) and the LH cam chain guide (2).

Fig 6: Cylinder Head Retaining Bolt Removal Sequence - Left



Courtesy of CHRYSLER GROUP, LLC

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

Fig 7: Head Gasket, Locating Dowels & Identifying Mark

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.

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

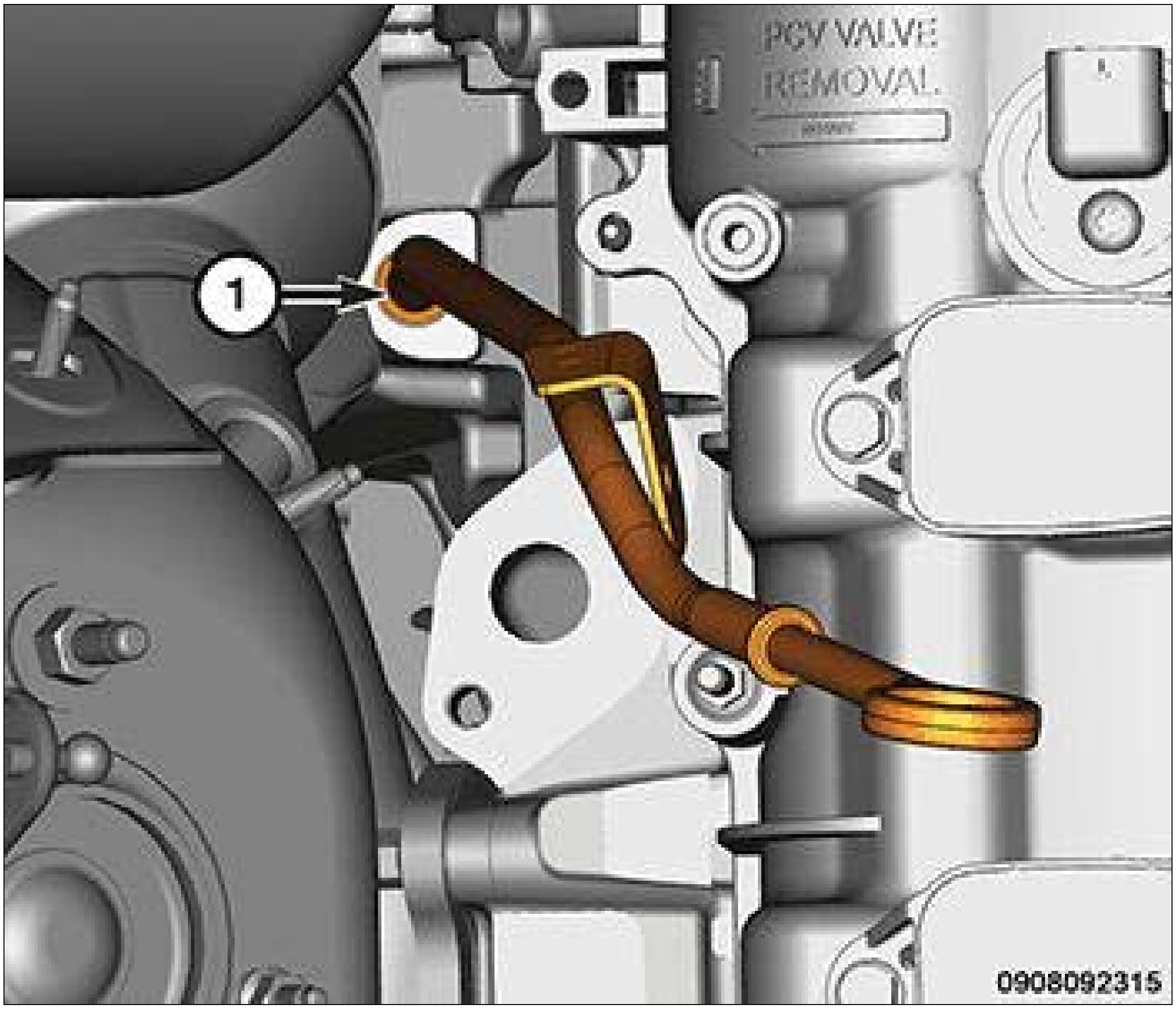
CAUTION:

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.

CYLINDER HEAD > REMOVAL > RIGHT

1. Perform the fuel pressure release procedure. Refer to FUEL SYSTEM PRESSURE RELEASE .
2. Disconnect and isolate the negative battery cable.
3. Remove the upper and lower intake manifolds and insulator. Refer to MANIFOLD, INTAKE, REMOVAL .
4. Remove the Exhaust Gas Recirculation (EGR) cooler and upper intake manifold support bracket. Refer to COOLER, EXHAUST GAS RECIRCULATION (EGR), REMOVAL .
5. Raise and support the vehicle. Refer to HOISTING, STANDARD PROCEDURE .
6. Drain the engine oil. Refer to STANDARD PROCEDURE .
7. Remove the right side catalytic converter and position aside. Refer to CONVERTER, CATALYTIC, REMOVAL .

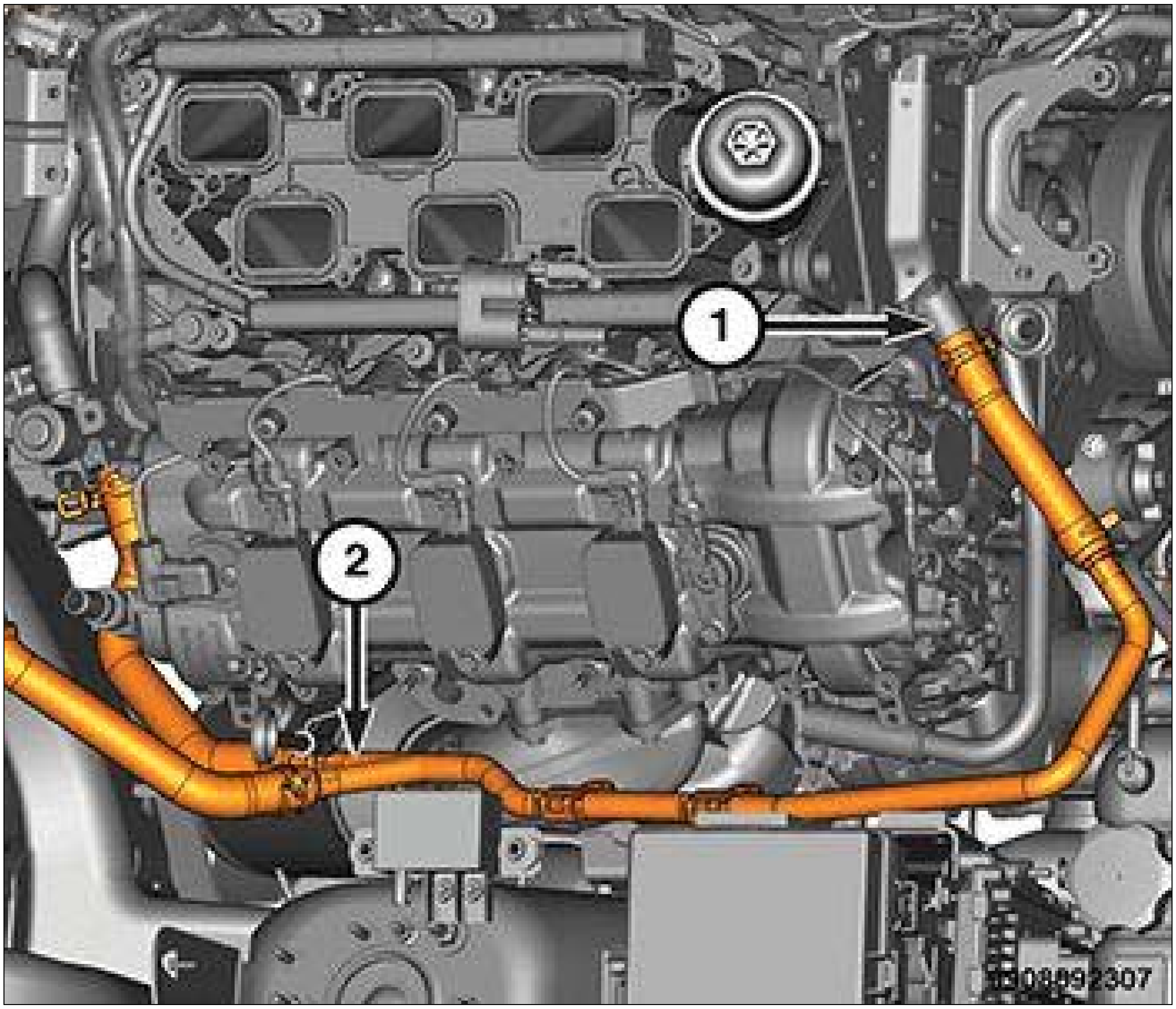
Fig 1: Oil Dipstick & Tube



Courtesy of CHRYSLER GROUP, LLC

8. Remove the oil level indicator (1).

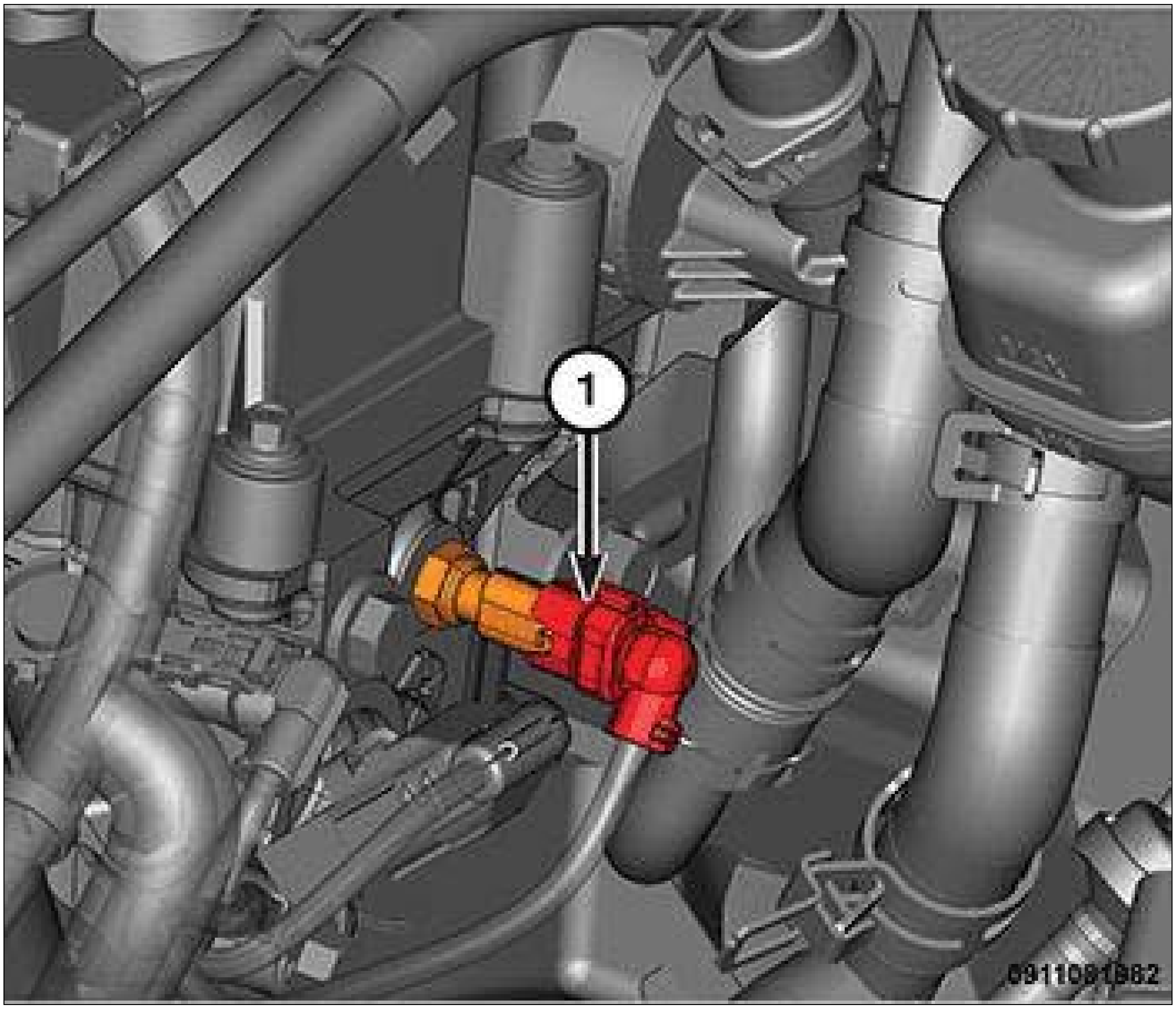
Fig 2: Heater Inlet Hose At Coolant Crossover & Heater Inlet Tube Assembly



Courtesy of CHRYSLER GROUP, LLC

9. Remove the bolt (2) and the heater core supply tube (1).

Fig 3: Oil Temperature Sensor Wire Harness Connector



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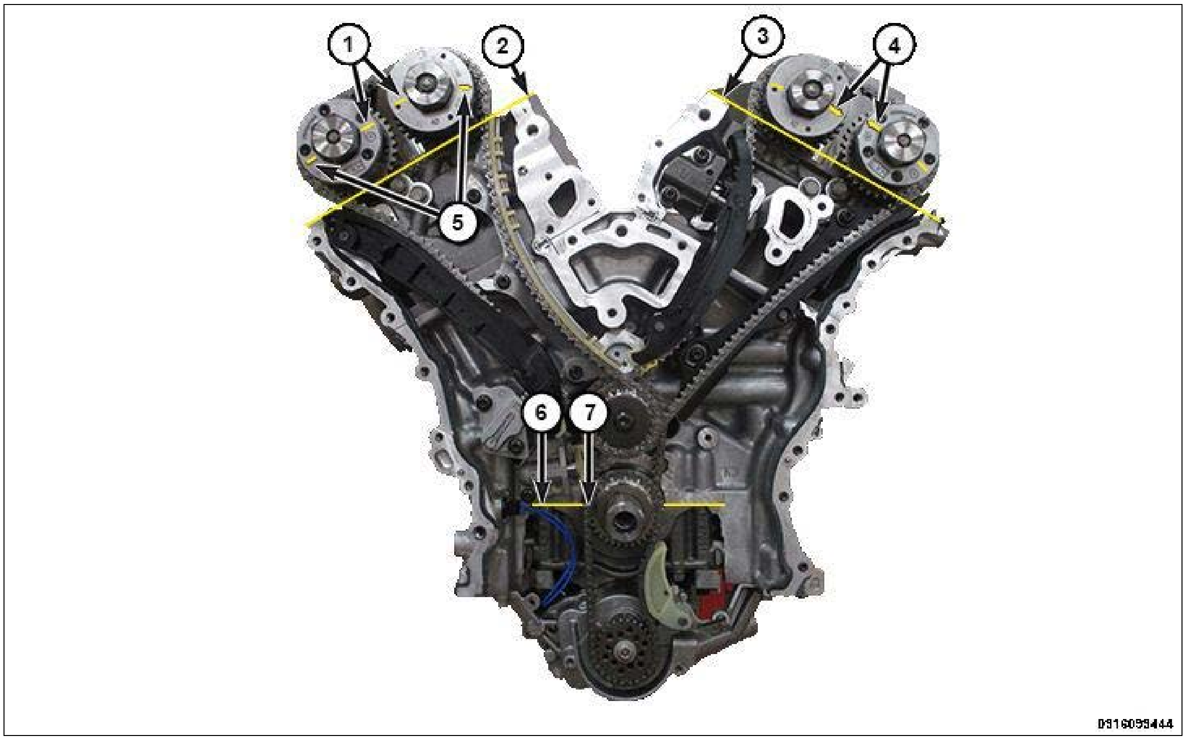
10. Disconnect the oil temperature sensor wire harness connector (1).
11. Disconnect the ignition coil capacitor electrical connector.
12. Remove the spark plugs. Refer to SPARK PLUG, REMOVAL .
13. Remove the cylinder head covers, lower and upper oil pans, crankshaft vibration damper and engine timing cover. Refer to COVER(S), ENGINE TIMING, REMOVAL .

NOTE:

Take this opportunity to measure timing chain wear. Refer to STANDARD PROCEDURE .

Fig 4: Scribe Lines, Valve Cover Sealing Surfaces, Cam Phaser Arrows, Block/Bearing Cap Junction & Dimple



Courtesy of CHRYSLER GROUP, LLC

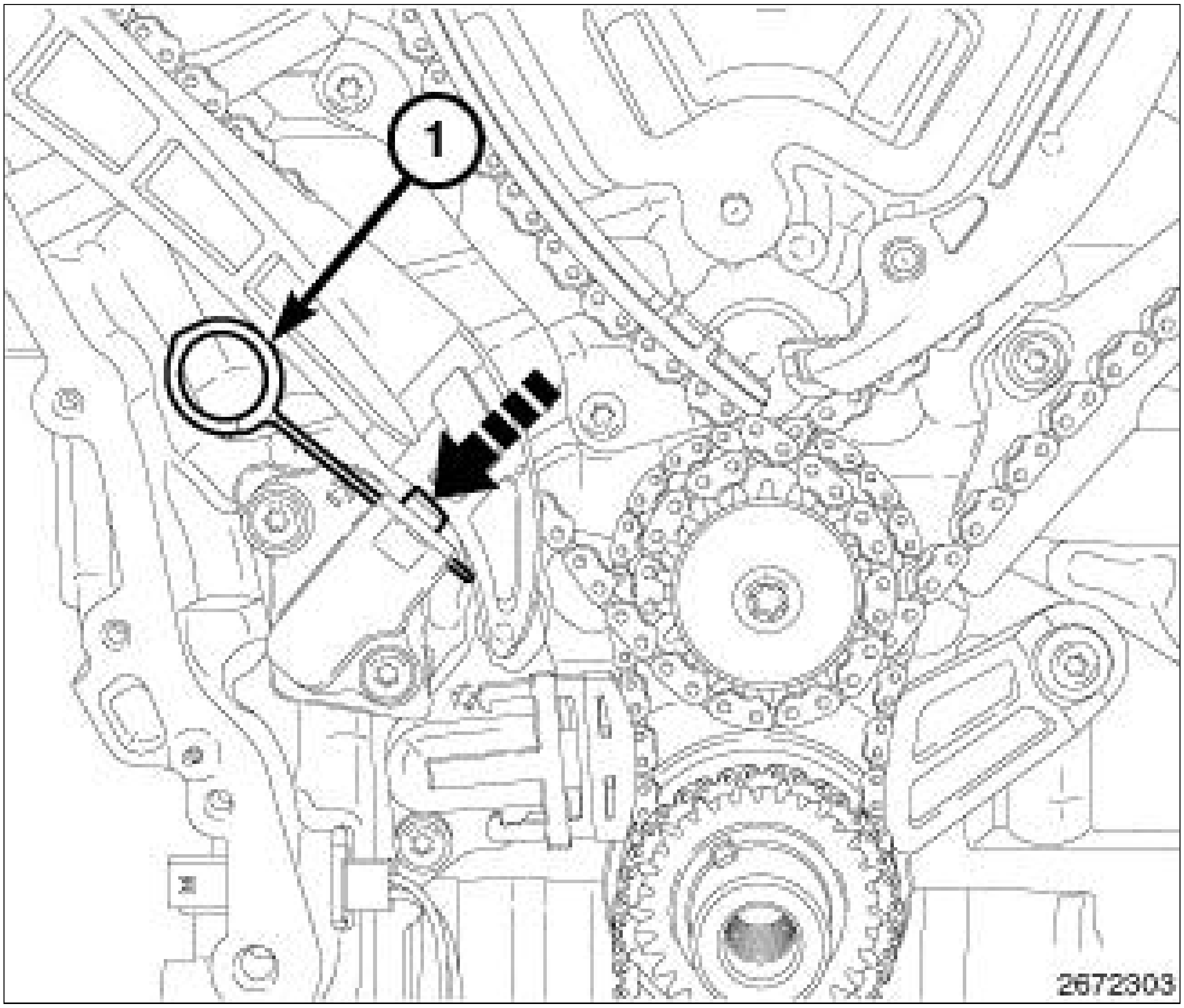
> ⚠ *CAUTION:*
>
> *When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.*

14. Rotate the crankshaft clockwise to place the number one piston at Top Dead Center (TDC) on the exhaust stroke by aligning the dimple (7) on the crankshaft with the block/bearing cap junction (6). The left side cam phaser arrows (4) should point toward each other and be parallel to the valve cover sealing surface (3). The right side cam phaser arrows (5) should point away from each other and the scribe lines (1) should be parallel to the valve cover sealing surface (2).

> ⚠ *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.*

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

Fig 5: Resetting Right Cam Chain Tensioner By Pushing Back Tensioner Piston & Installing Tensioner Pin



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.

16. Reset the RH cam chain tensioner by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (1).
17. Remove the right camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL .

NOTE:

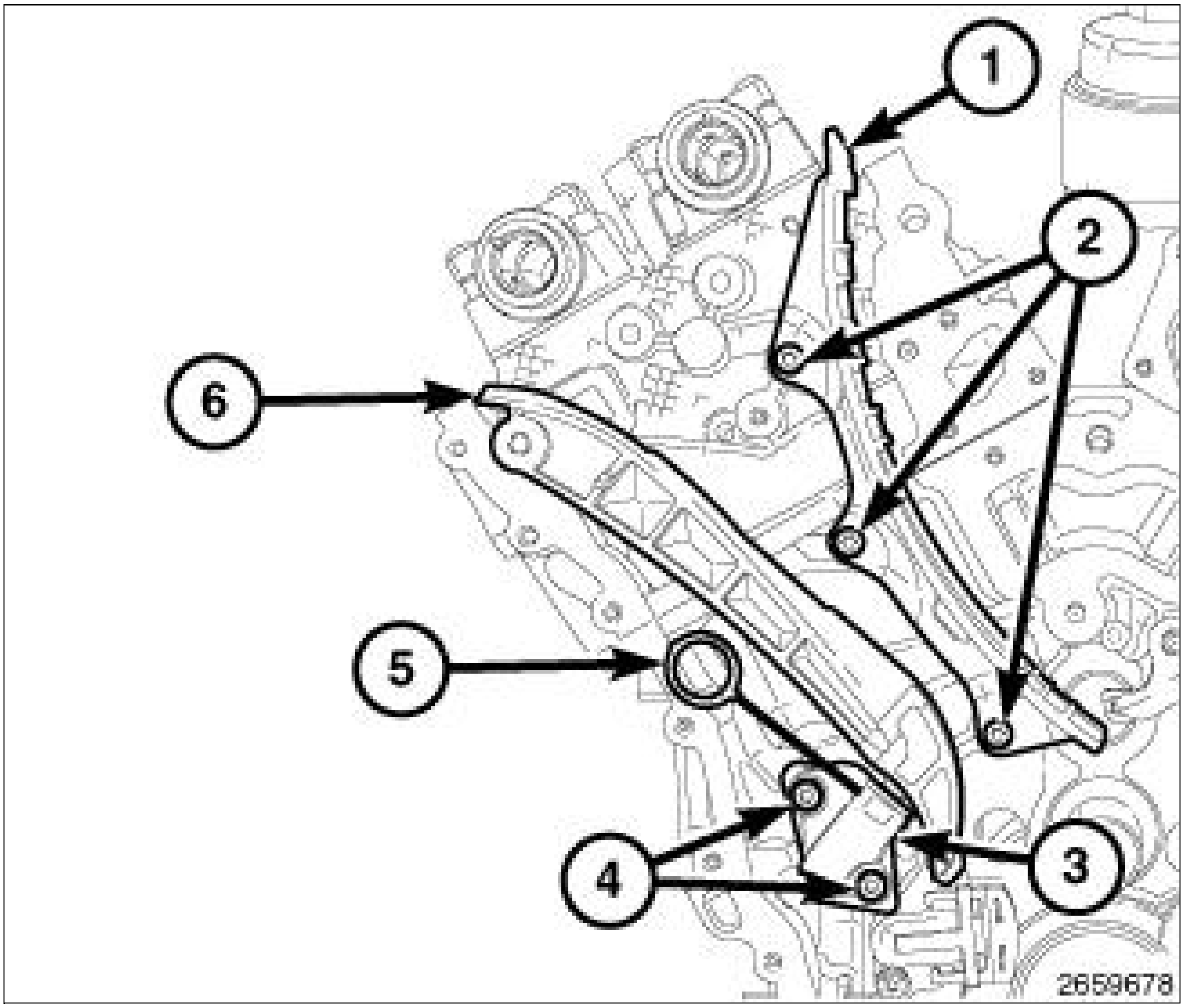
If the rocker arms are to be reused, identify their positions so that they can be reassembled into their original locations.

18. 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.*

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

Fig 6: Right Cam Chain Tensioner, Arm, Guide & Bolts



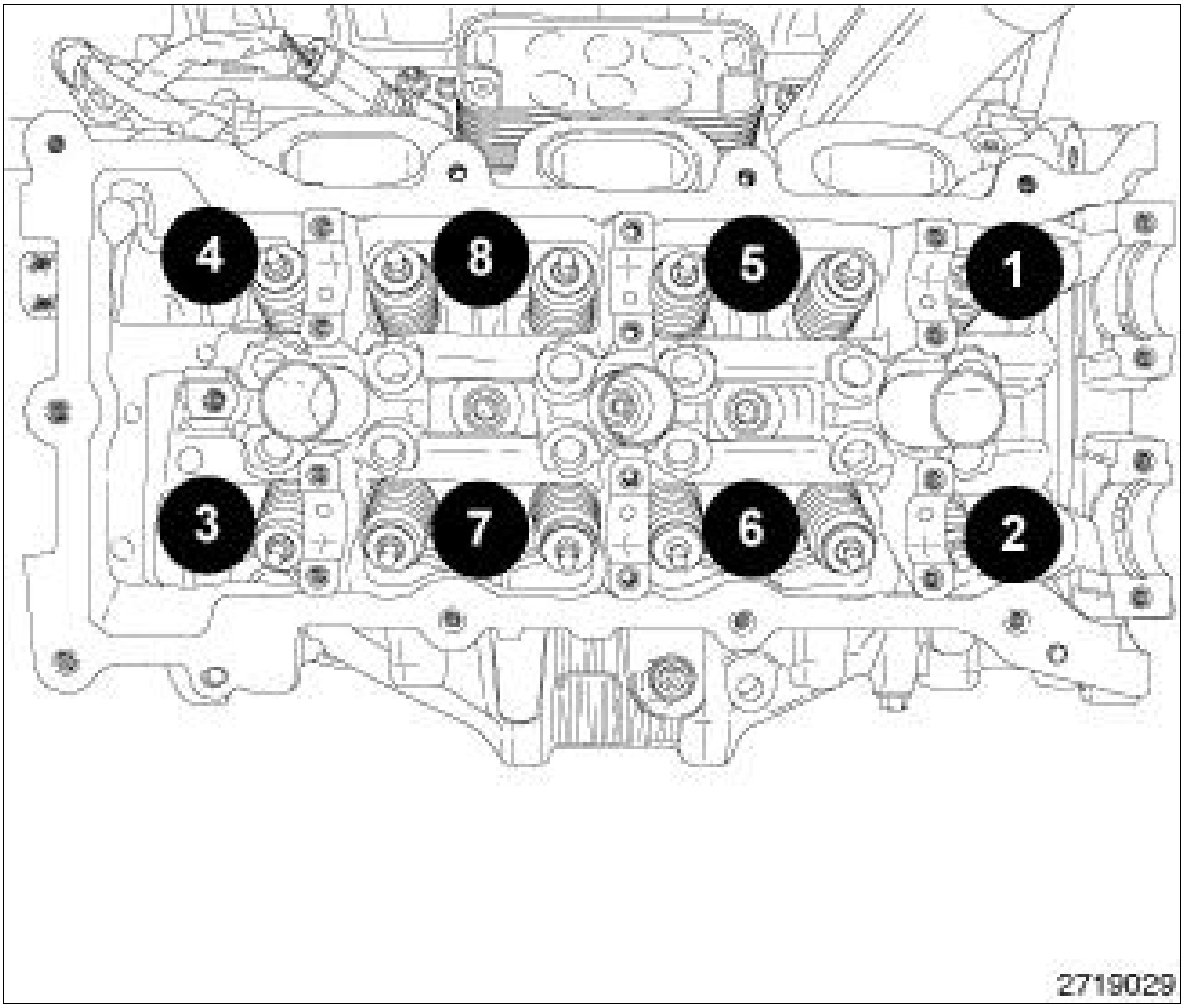
Courtesy of CHRYSLER GROUP, LLC

20. Remove the RH cam chain tensioner arm (6).

21. Remove the two bolts (4) and the RH cam chain tensioner (3).

22. Remove the three bolts (2) and the RH cam chain guide (1).

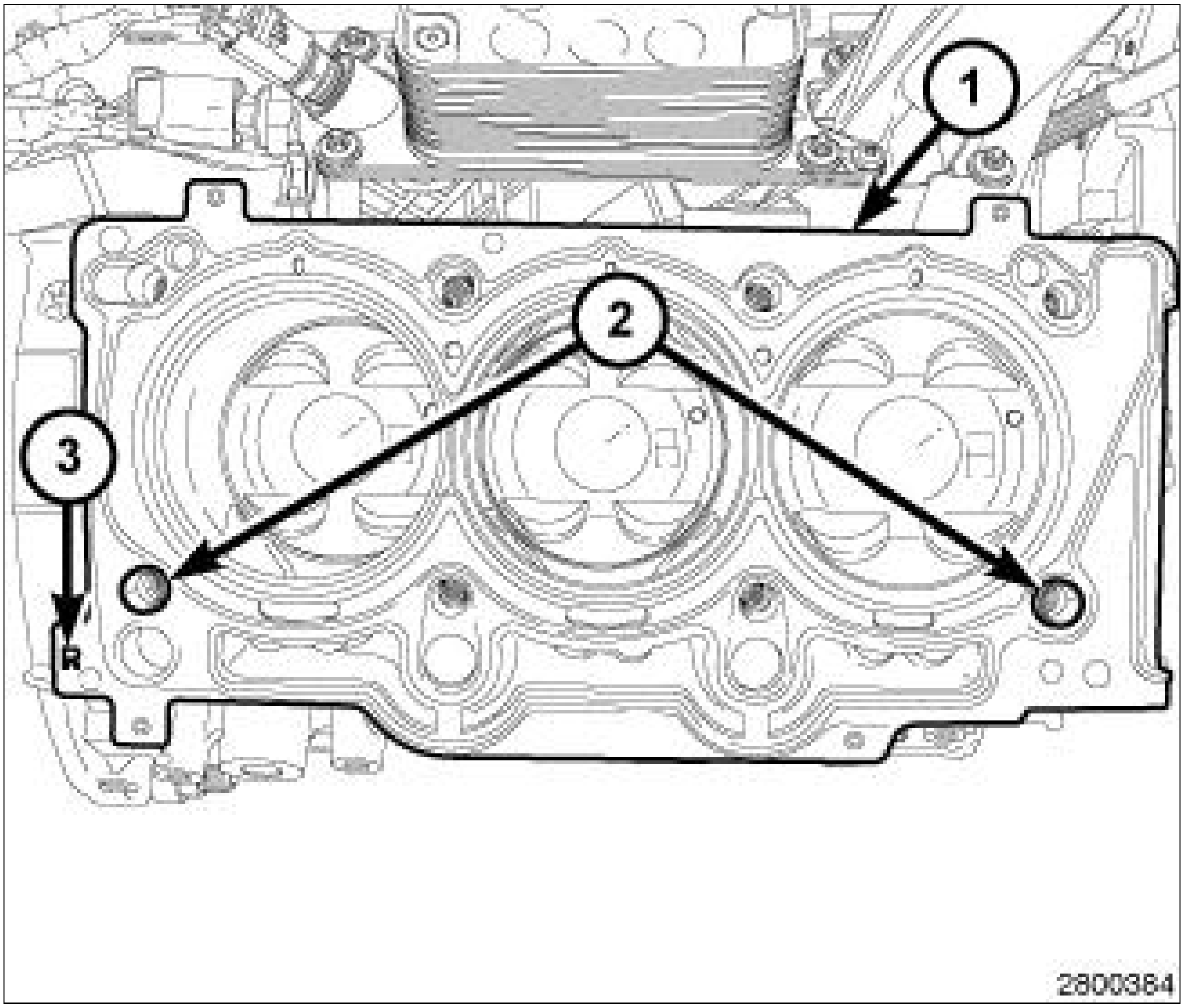
Fig 7: Cylinder Head Retaining Bolt Removal Sequence - Right



Courtesy of CHRYSLER GROUP, LLC

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

Fig 8: 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:

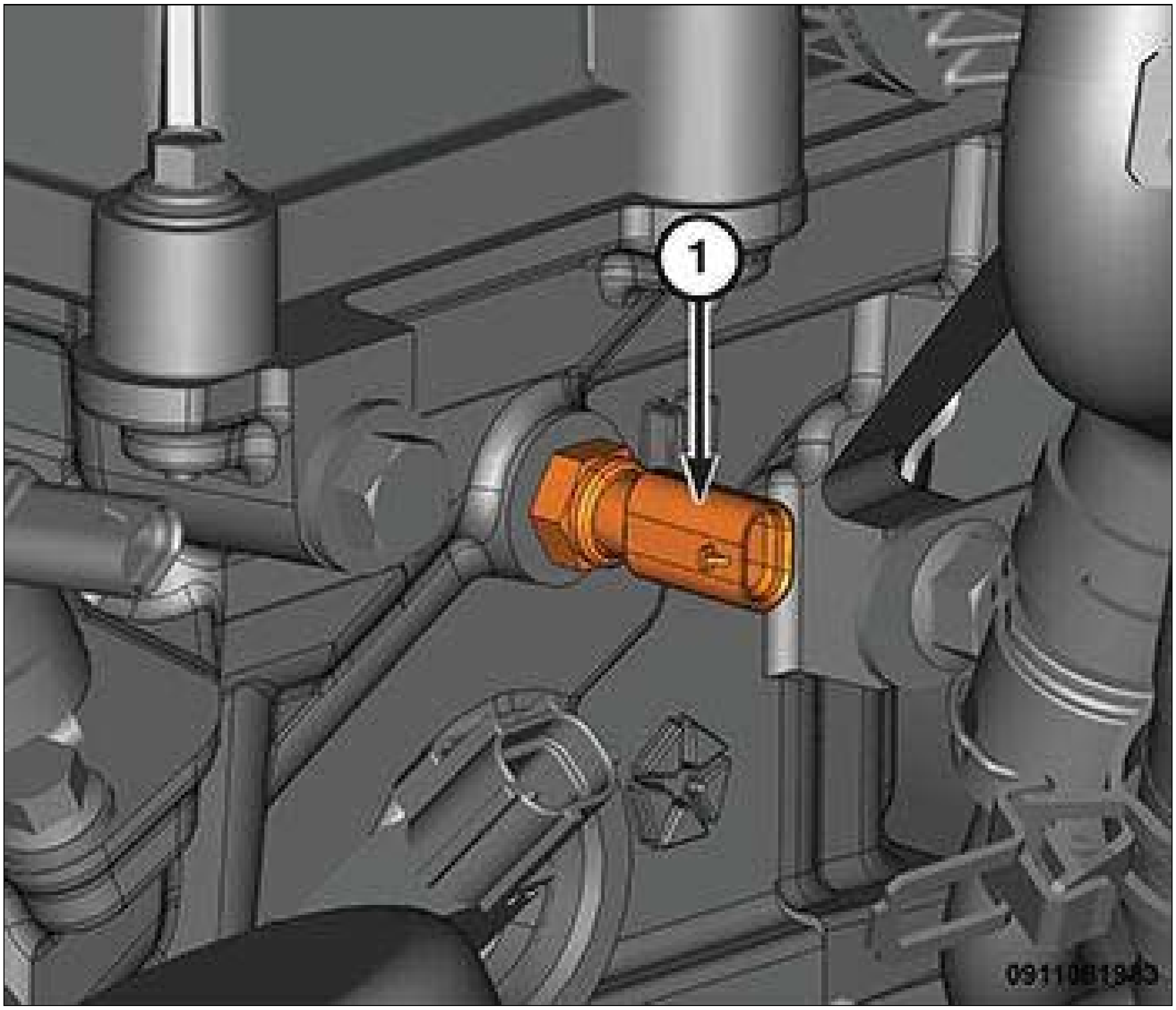
The head gasket (1) crimps the locating dowels (2) and the dowels may pull out of the engine block when the head gasket is removed.

24. 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 9: Oil Temperature Sensor



Courtesy of CHRYSLER GROUP, LLC

25. If required, remove the oil temperature sensor (1) and the ignition coil capacitor.

CYLINDER HEAD > 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 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 GASKET SURFACE PREPARATION . Be careful not to gouge or scratch the aluminum head sealing surface.
2. Clean all engine oil passages.

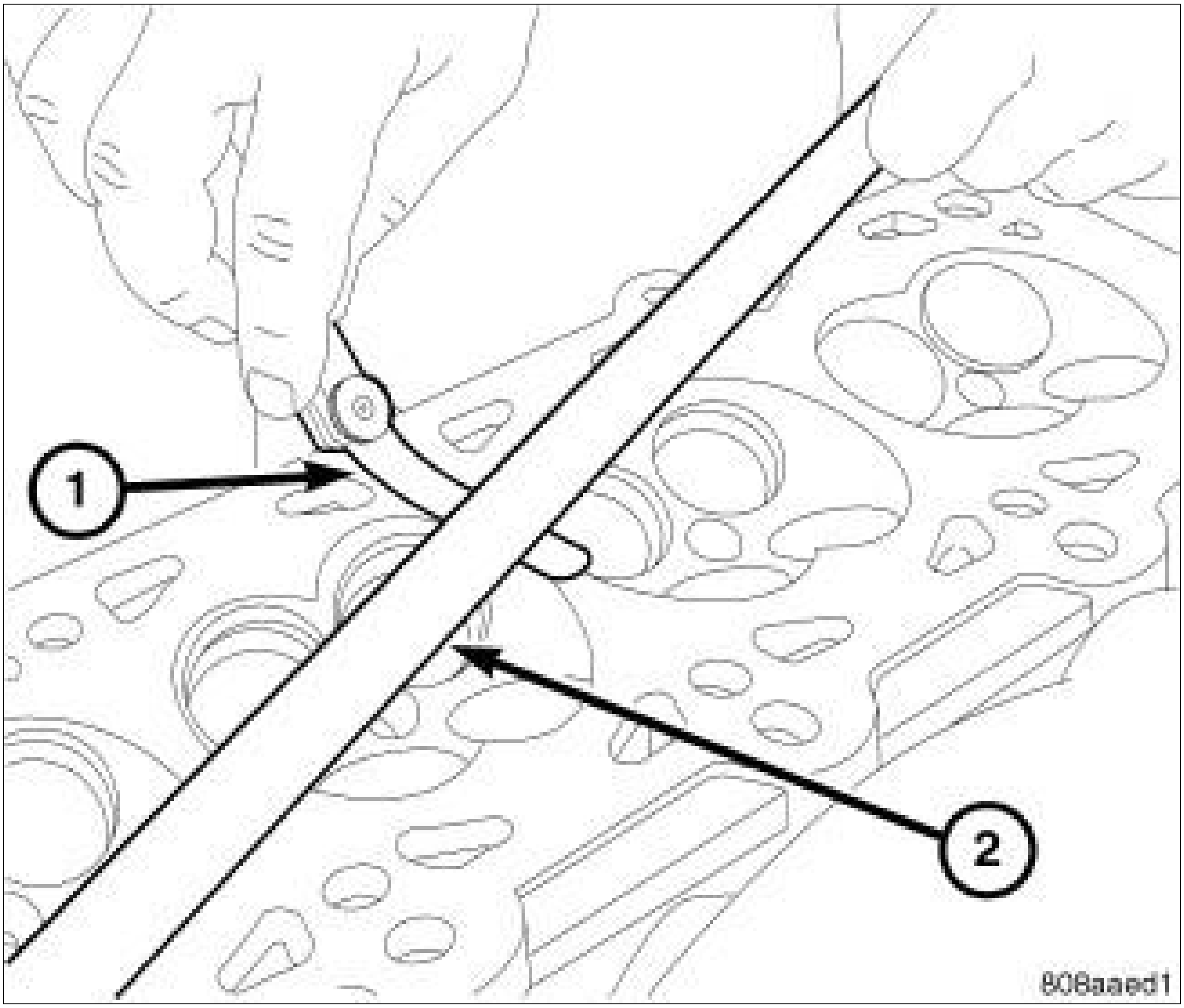
   > *CAUTION:*
   >
   > *Non-compressible debris such as oil, coolant or RTV sealants that are not removed from bolt holes can cause the aluminum casting to crack when tightening the bolts.*

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

   DO NOT USE any adhesives when installing the MLS head gaskets. The use of adhesives may cause the gasket not to seal properly and may leak. MLS gaskets are to be installed on a surface free of debris and oils.

CYLINDER HEAD > INSPECTION > INSPECTION

Fig 1: Checking Cylinder Head Flatness



Courtesy of CHRYSLER GROUP, LLC

1. Check the cylinder head for warping 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 .
    1. Camshafts
    2. Valve Tappets
    3. Springs
    4. Valve Seats

5. Valve Guides

6. Valves

CYLINDER HEAD > INSTALLATION > LEFT

1. If removed, install the ignition coil capacitor and the engine wire harness retainer bracket, then tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

   Fig 1: Head Gasket, Locating Dowels & Identifying Mark

Courtesy of CHRYSLER GROUP, LLC

2. Clean and prepare the gasket sealing surfaces of the cylinder head and block. Refer to ENGINE GASKET SURFACE PREPARATION .

> *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.*

> ⚠ *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.*

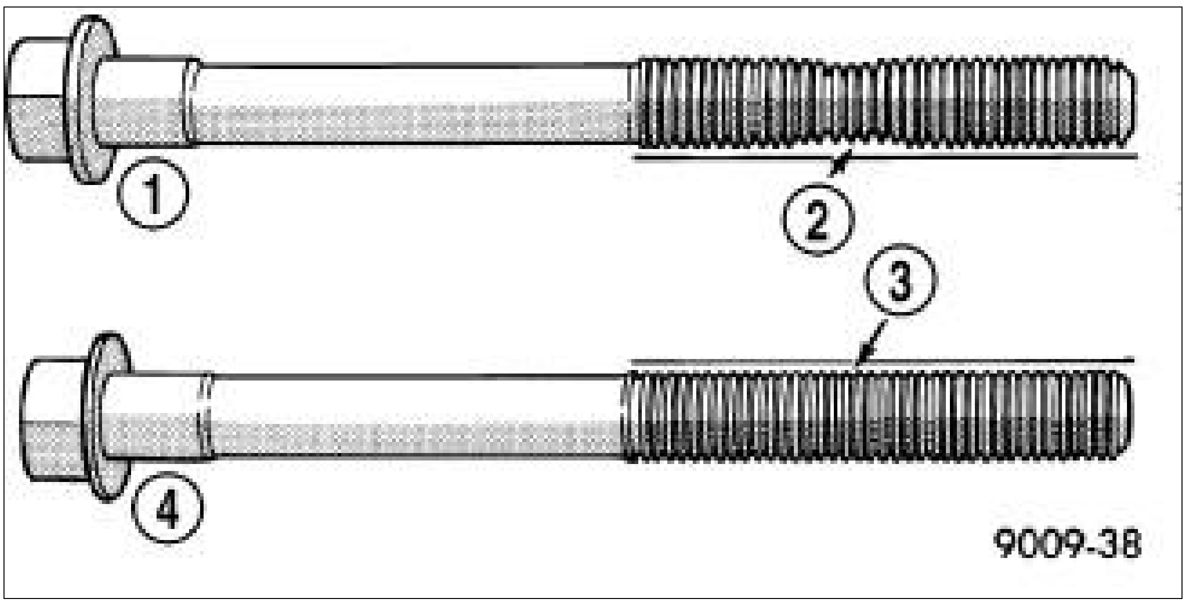
3. Clean out the cylinder head bolt holes in the engine block.

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

> ⚠ *CAUTION:*
>
> *The installation of the cylinder head gaskets are not interchangeable between the left and right cylinder heads. They are clearly marked (3) with "R" for right and "L" for left. They must be applied on a dry surface, without the use of any adhesives.*

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

Fig 2: Checking Cylinder Head Bolts For Stretching (Necking)



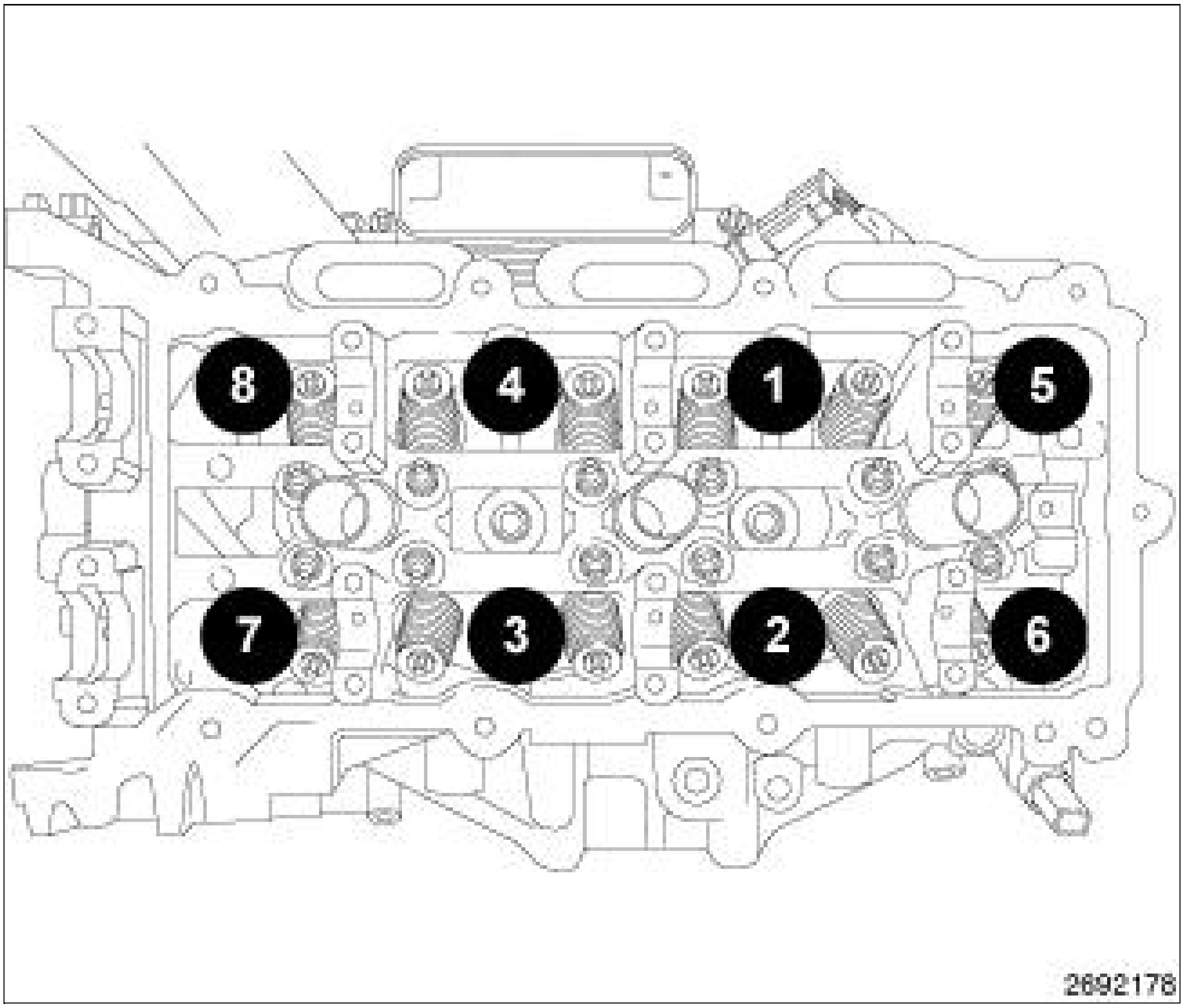
Courtesy of CHRYSLER GROUP, LLC

> ⚠ *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.

5. 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 3: Cylinder Head Retaining Bolt Tightening Sequence - Left



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.

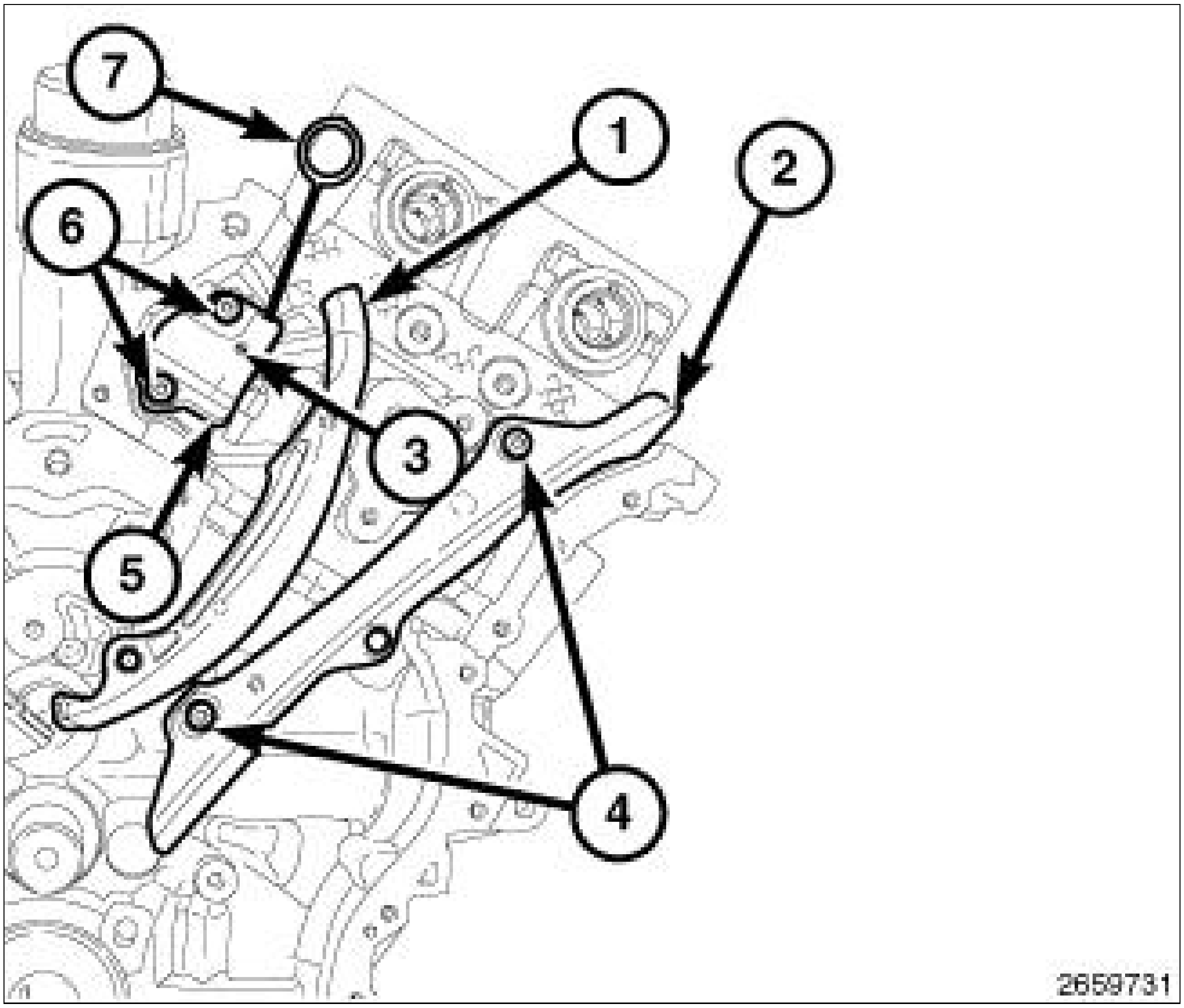
8. Tighten the cylinder head bolts in the sequence shown in illustration, following this 9 step torque plus angle method. The torque sequence must be used for each step. Tighten according to the following torque values:

1. Step 1: All to 30 N.m (22 ft. lbs.)
2. Step 2: All to 45 N.m (33 ft. lbs.)
3. Step 3: Retighten all to 45 N.m (33 ft. lbs.)
4. Step 4: All + 125° Turn (optional angle if 125° rotation cannot be accomplished in one motion; tighten all by turning 35° followed by tightening all by turning 90°) **Do not use a torque wrench for this step.**
5. Step 5: Loosen all fasteners in reverse of sequence shown in illustration
6. Step 6: All to 30 N.m (22 ft. lbs.)
7. Step 7: All to 45 N.m (33 ft. lbs.)
8. Step 8: Retighten all to 45 N.m (33 ft. lbs.)
9. Step 9: All + 130° Turn (optional angle if 130° rotation cannot be accomplished in one motion; tighten all by turning 40° followed by tightening all by turning 90°) **Do not use a torque wrench for this step.**

NOTE:

For engine builds using a new block follow steps 1-9. For engine rebuilds (reuse block) follow step 6-9.

Fig 4: Left Cam Chain Tensioner, Arm, Guide & Bolts

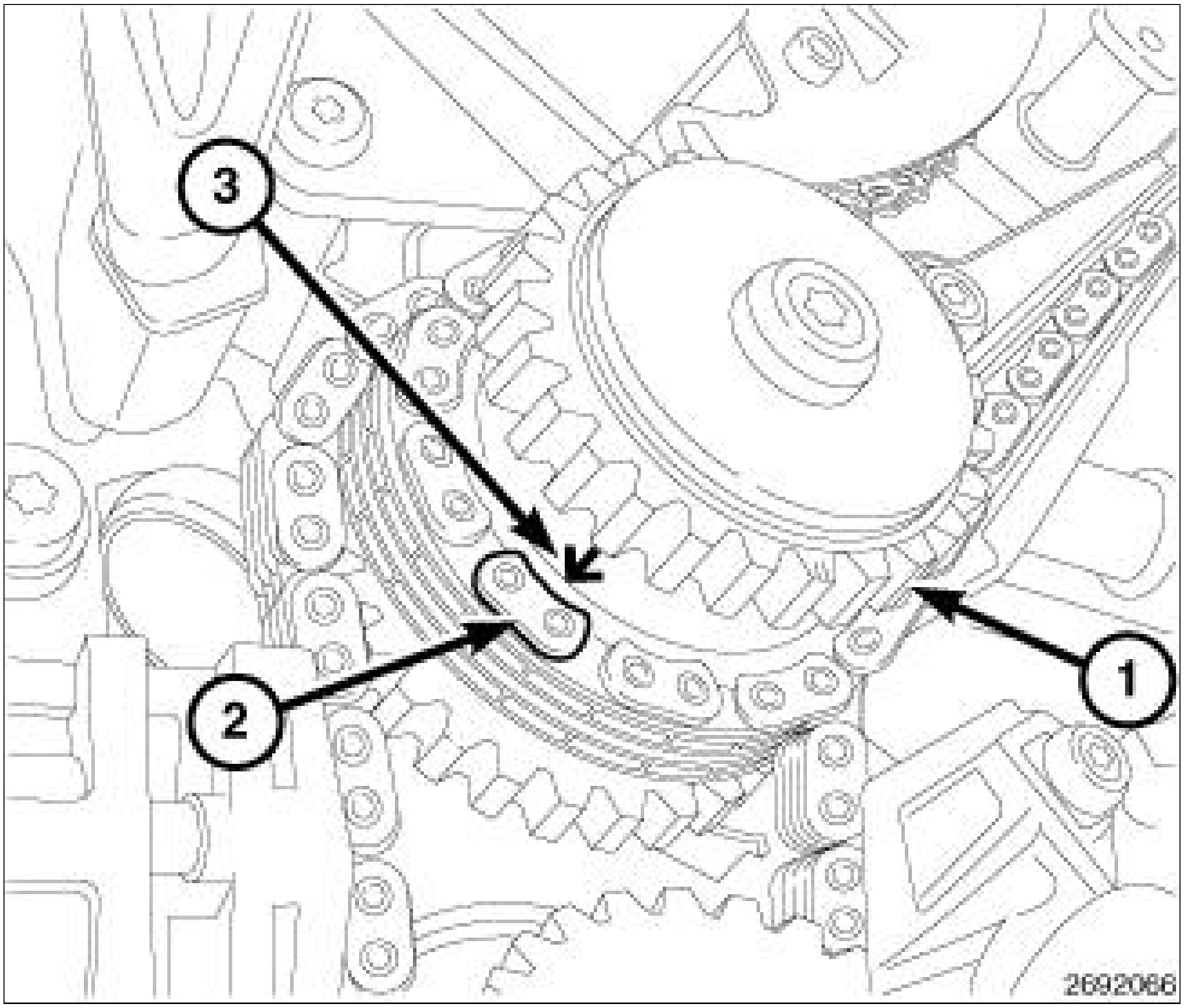


Courtesy of CHRYSLER GROUP, LLC

9. Install the LH cam chain guide (2) with two bolts (4) and tighten the bolts (4) to the proper specification. Refer to COMPRESSOR, A/C, REMOVAL .
10. Install the LH cam chain tensioner (5) to the cylinder head with two bolts (6) and tighten the bolts (6) to the proper specification. Refer to COMPRESSOR, A/C, REMOVAL .
11. 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 STANDARD PROCEDURE .
12. Install the LH tensioner arm (1).

Fig 5: Idler Sprocket, Plated Link & Arrow



Courtesy of CHRYSLER GROUP, LLC

13. Drape the left side cam chain onto the idler sprocket (1) so that the arrow (3) is aligned with the plated link (2) on the cam 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.*

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

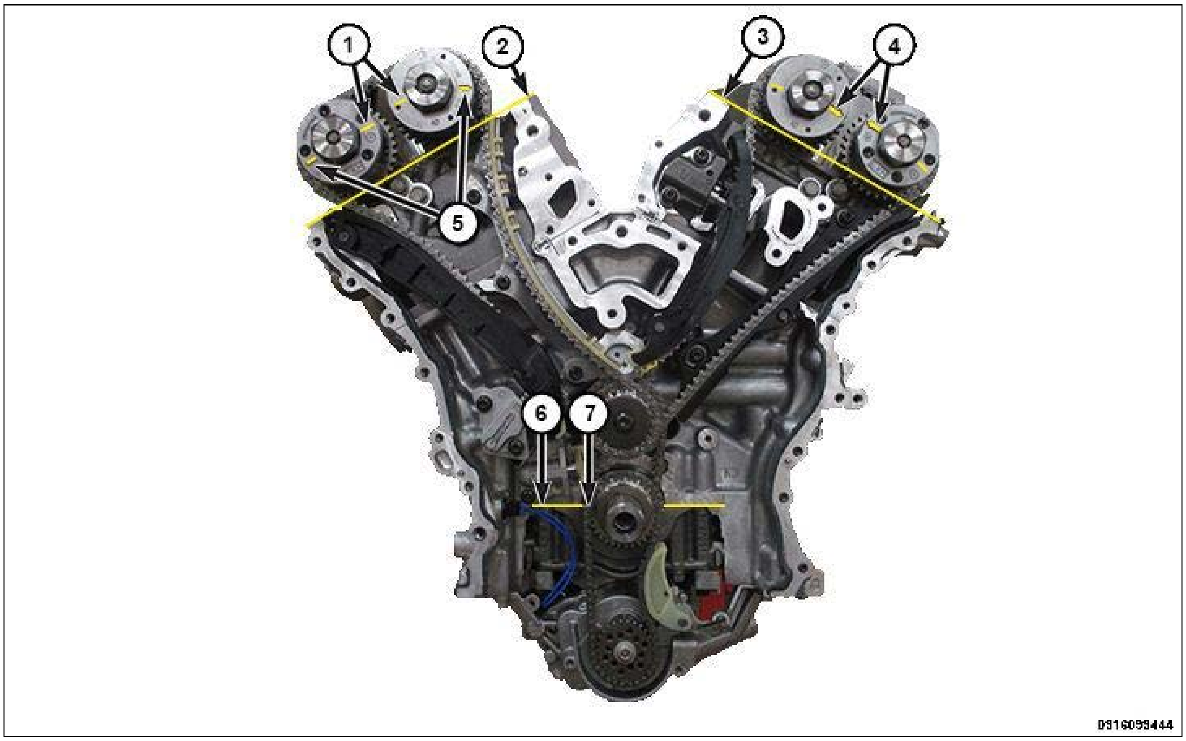
> *NOTE:*
>
> *If the rocker arms and hydraulic are being reused, reassemble them into their original locations.*

15. 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.*

16. Remove the Tensioner Pin (special tool #8514, Pins, Tensioner) from the LH cam chain tensioner.

Fig 6: Scribe Lines, Valve Cover Sealing Surfaces, Cam Phaser Arrows, Block/Bearing Cap Junction & Dimple

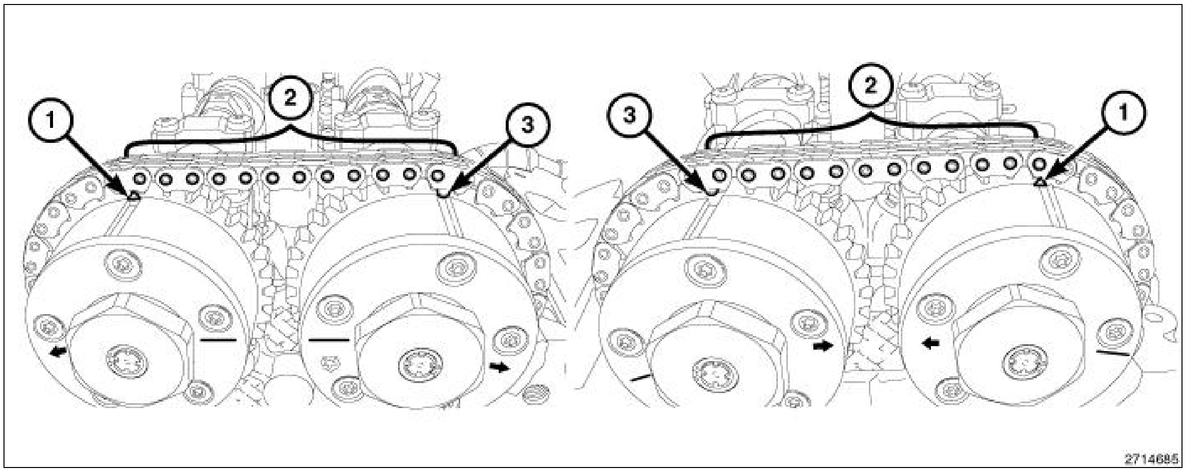


Courtesy of CHRYSLER GROUP, LLC

17. Rotate the crankshaft clockwise two complete revolutions stopping when the dimple (7) on the crankshaft is aligned the with the block/bearing cap junction (6).

18. While maintaining this alignment, verify that the arrows on the left side cam phasers (4) point toward each other and are parallel to the valve cover sealing surface (3) and that the right side cam phaser arrows (5) point away from each other and the scribe lines (5) are parallel to the valve cover sealing surface (2).

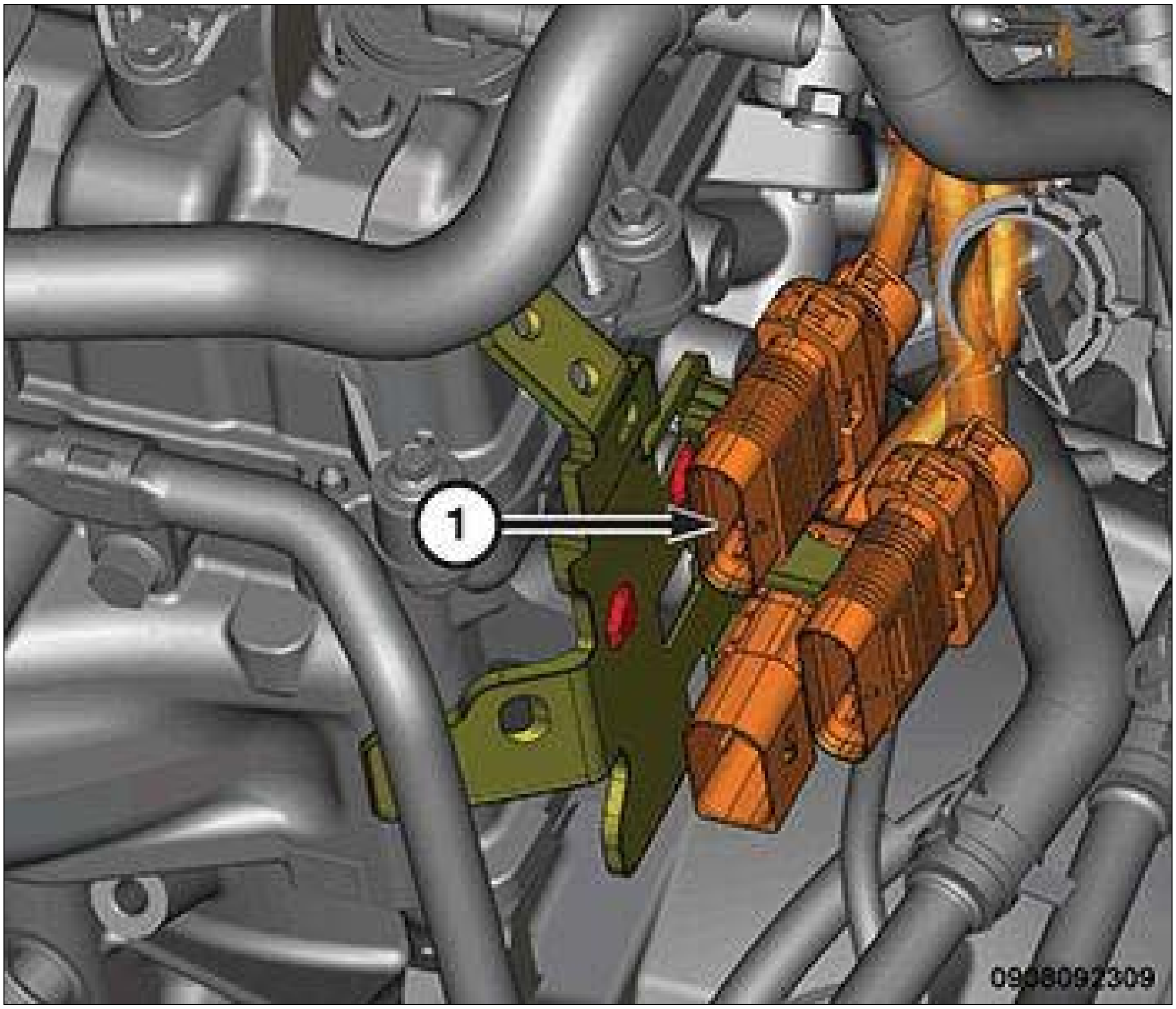
Fig 7: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking



Courtesy of CHRYSLER GROUP, LLC

19. There should be 12 chain pins (2) between the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3).
20. If the engine timing is not correct, refer to CHAIN AND SPROCKETS, TIMING, INSTALLATION .
21. Install the engine timing cover, crankshaft vibration damper, upper and lower oil pans and cylinder head covers. Refer to COVER(S), ENGINE TIMING, INSTALLATION .
22. Install the spark plugs. Refer to SPARK PLUG, INSTALLATION .

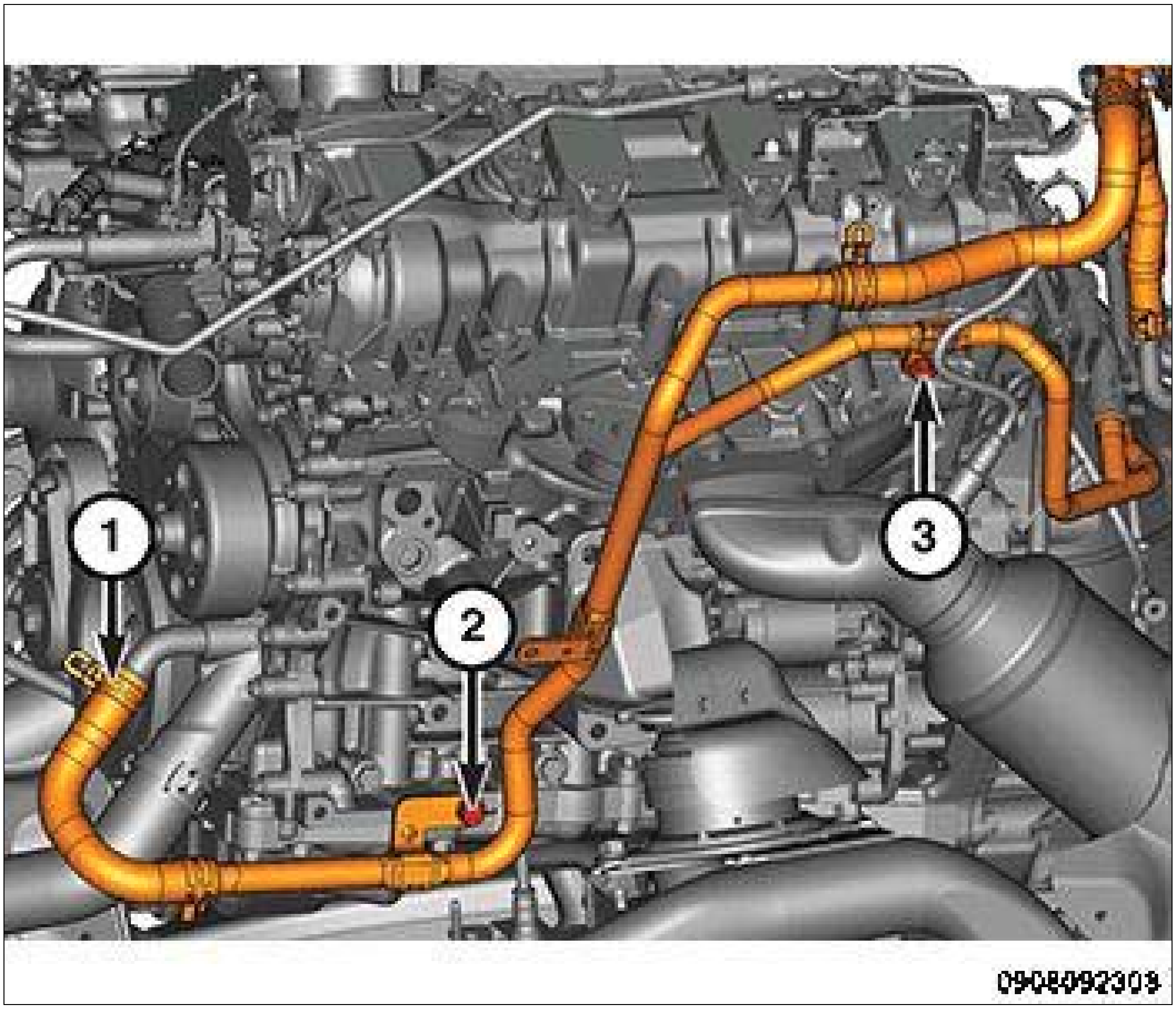
Fig 8: O2 Sensor Harness Connector Retainer Bracket



Courtesy of CHRYSLER GROUP, LLC

23. Connect the ignition coil capacitor and oxygen sensor wire harness connector.
24. Engage the injection/ignition wire harness connector (1) to the retainer bracket on the rear of the left cylinder head.
25. Install the left side catalytic converter. Refer to CONVERTER, CATALYTIC, INSTALLATION .
26. Install the A/C compressor. Refer to COMPRESSOR, A/C, INSTALLATION .

Fig 9: Heater Core Return Hose At Water Pump Bypass, Retaining Bolts At Engine Block & Cylinder Head



Courtesy of CHRYSLER GROUP, LLC

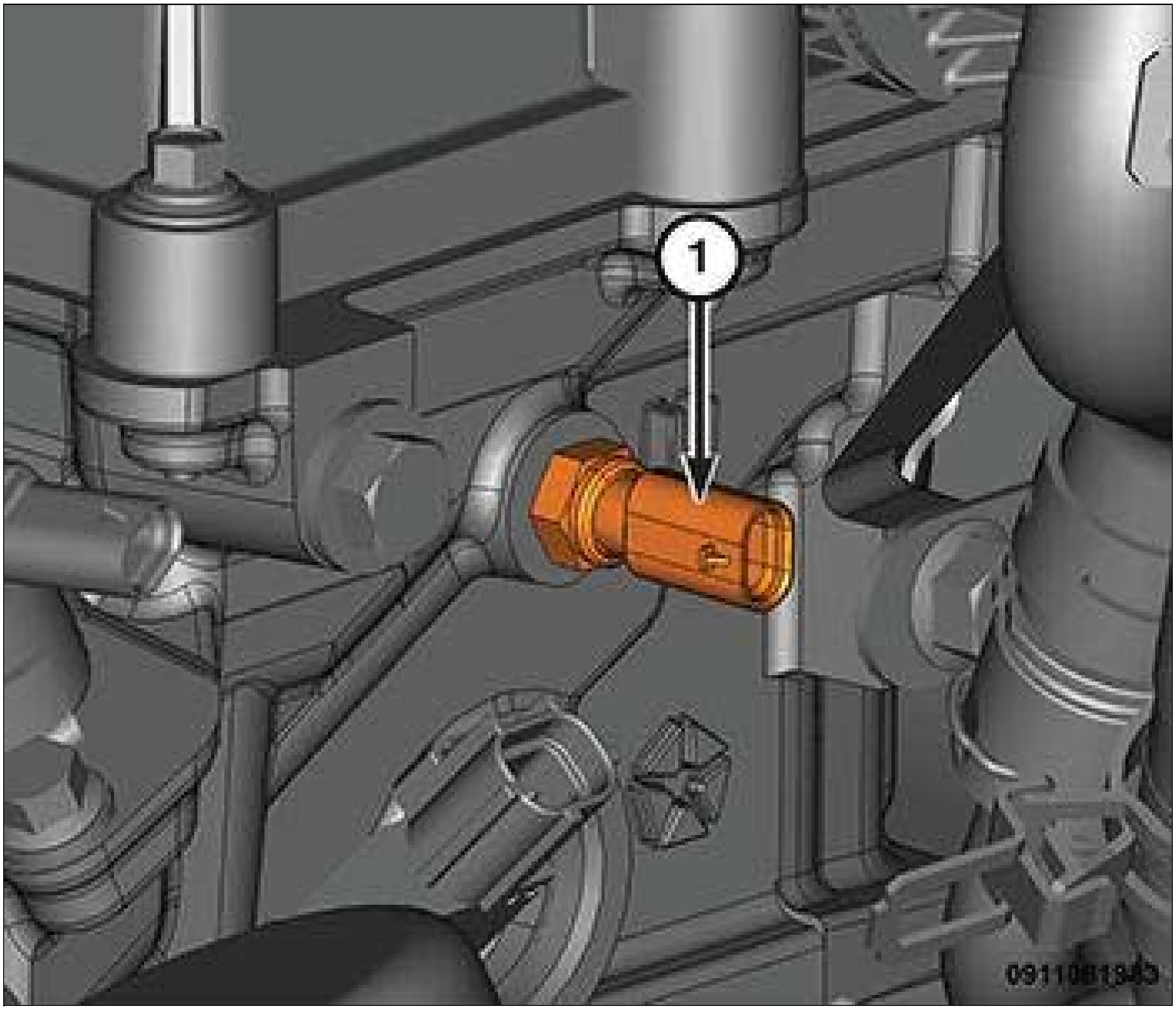
27. Install the heater core return hose onto the water pump bypass (1).
28. Install the heater tube retaining bolts to the engine block (2) and cylinder head (3) and tighten to the proper specification. Refer to COMPRESSOR, A/C, REMOVAL .
29. Install the upper and lower intake manifolds. Refer to MANIFOLD, INTAKE, INSTALLATION .
30. Install a new oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
31. Fill the cooling system. Refer to STANDARD PROCEDURE .
32. Connect the negative battery cable.
33. 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.

CYLINDER HEAD > INSTALLATION > RIGHT

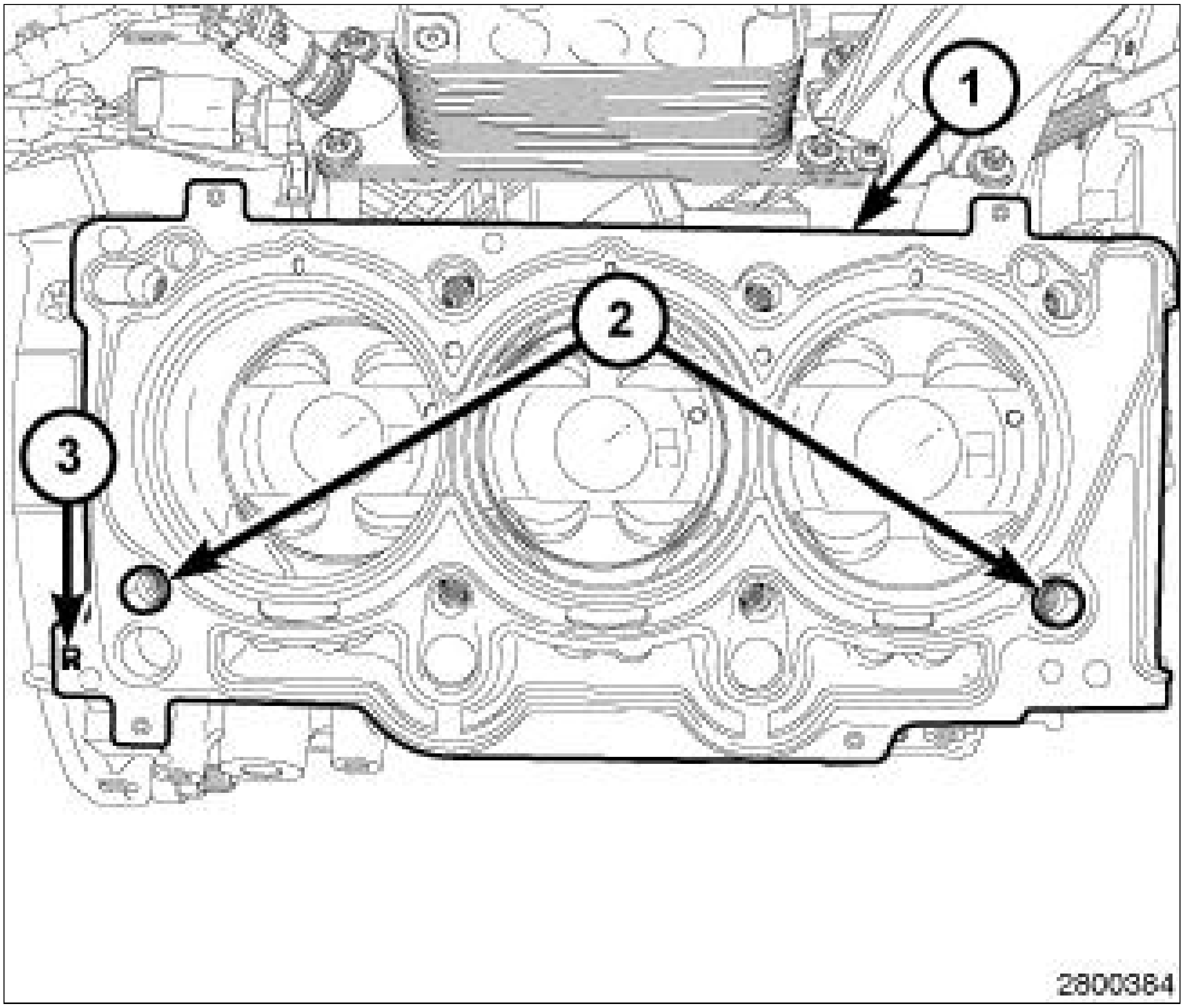
Fig 1: Oil Temperature Sensor



Courtesy of CHRYSLER GROUP, LLC

1. If removed, install the oil temperature sensor (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
2. If removed, install the ignition coil capacitor and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 2: Head Gasket & Locating Dowels



Courtesy of CHRYSLER GROUP, LLC

3. Clean and prepare the gasket sealing surfaces of the cylinder head and block. Refer to ENGINE GASKET SURFACE PREPARATION .

> *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.*

> *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 out the cylinder head bolt holes in the engine block.

WARNING:

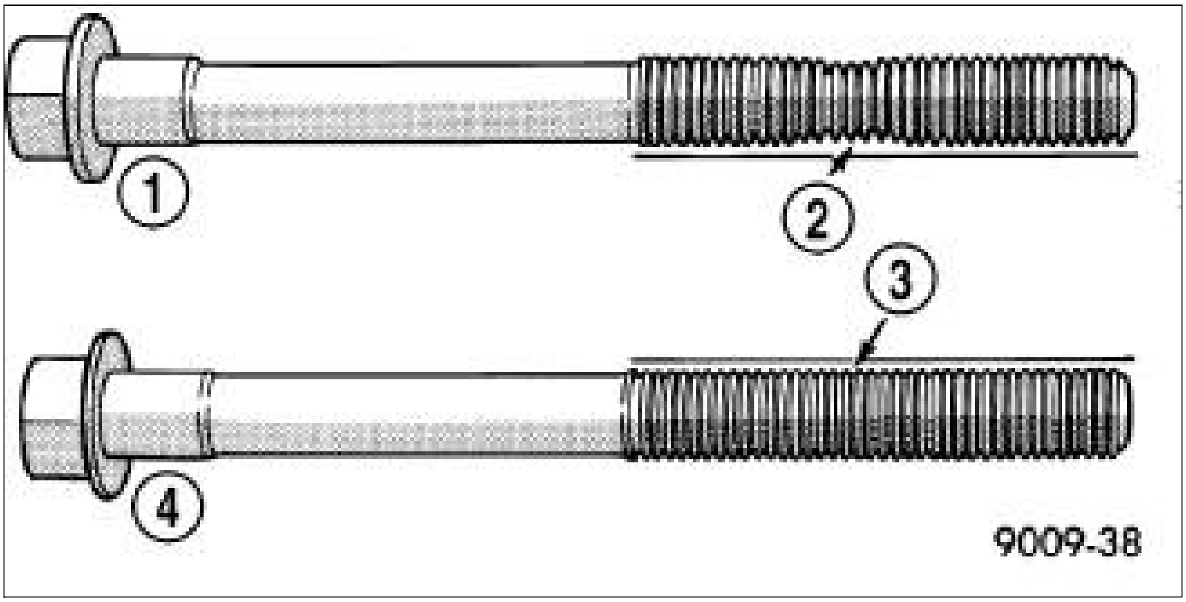
The multi-layered steel head gaskets have very sharp edges that could cause personal injury if not handled carefully.

CAUTION:

The installation of the cylinder head gaskets are not interchangeable between the left and right cylinder heads. They are clearly marked (3) with "R" for right and "L" for left. They must be applied on a dry surface, without the use of any adhesives.

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

Fig 3: Checking Cylinder Head Bolts For Stretching (Necking)



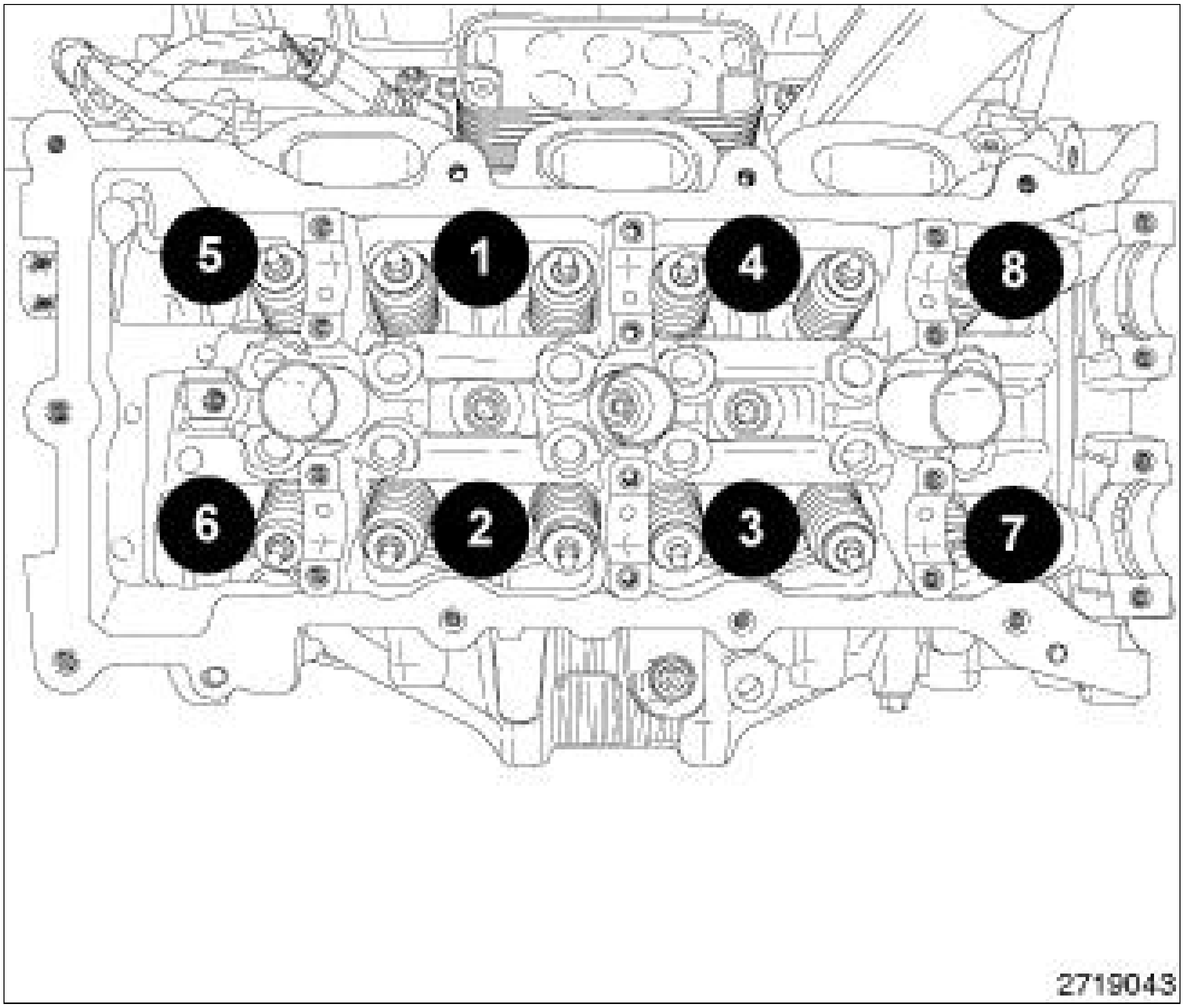
Courtesy of CHRYSLER GROUP, LLC

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.

6. 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 4: Cylinder Head Retaining Bolt Tightening Sequence - Right



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 **NEW** head bolts finger tight.

9. Tighten the cylinder head bolts in the sequence shown in illustration, following this 9 step torque plus angle method. The torque sequence must be used for each step. Tighten according to the following torque values:

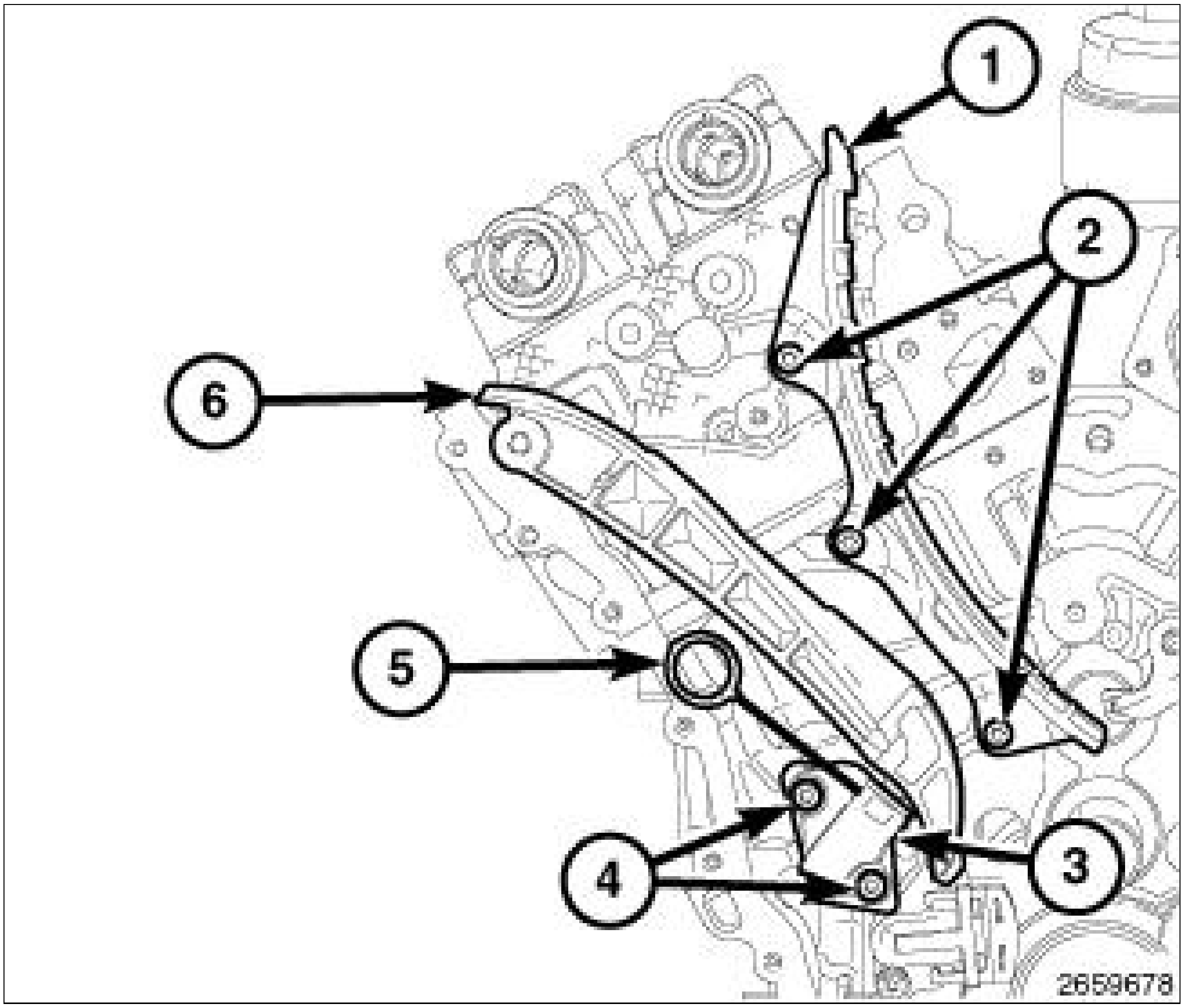
    1. Step 1: All to 30 N.m (22 ft. lbs.)
    2. Step 2: All to 45 N.m (33 ft. lbs.)
    3. Step 3: Retighten all to 45 N.m (33 ft. lbs.)

4. Step 4: All + 125° Turn (optional angle if 125° rotation cannot be accomplished in one motion; tighten all by turning 35° followed by tightening all by turning 90°) **Do not use a torque wrench for this step.**
5. Step 5: Loosen all fasteners in reverse of sequence shown in illustration
6. Step 6: All to 30 N.m (22 ft. lbs.)
7. Step 7: All to 45 N.m (33 ft. lbs.)
8. Step 8: Retighten all to 45 N.m (33 ft. lbs.)
9. Step 9: All + 130° Turn (optional angle if 130° rotation cannot be accomplished in one motion; tighten all by turning 40° followed by tightening all by turning 90°) **Do not use a torque wrench for this step.**

NOTE:

For engine builds using a new block follow steps 1-9. For engine rebuilds (reuse block) follow step 6-9.

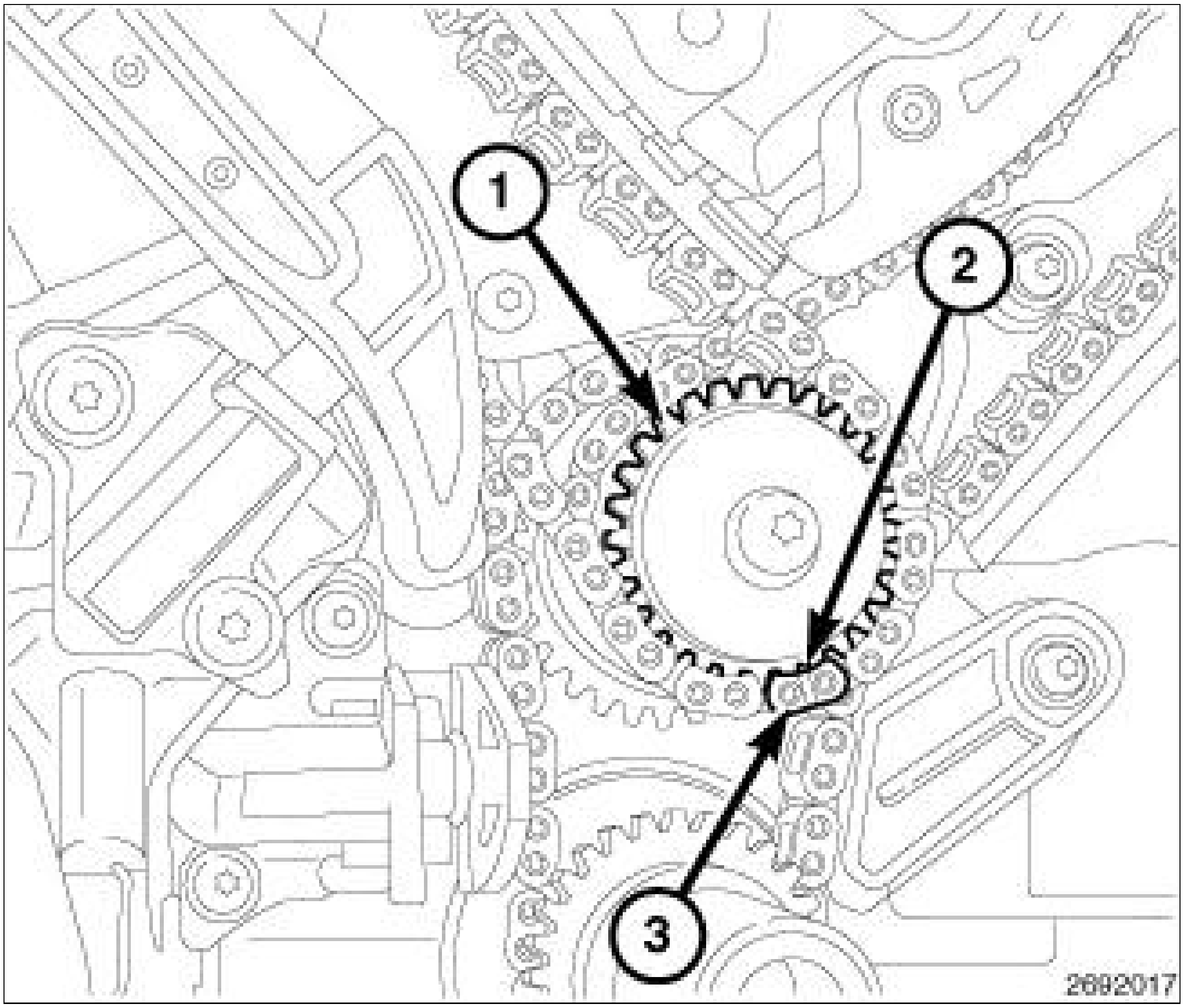
Fig 5: Right Cam Chain Tensioner, Arm, Guide & Bolts



Courtesy of CHRYSLER GROUP, LLC

10. Install the RH cam chain guide (1) with three bolts (2) and tighten the bolts (2) to the proper specification. Refer to TORQUE SPECIFICATIONS .
11. Install the RH cam chain tensioner (3) to the engine block with two bolts (4) and tighten the bolts (4) to the proper specification. Refer to TORQUE SPECIFICATIONS .
12. Reset the RH cam chain tensioner (3) by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (5).
13. Install the RH tensioner arm (6).

Fig 6: Idler Sprocket, Dimple & Plated Link



Courtesy of CHRYSLER GROUP, LLC

14. Drape the right side cam chain onto the idler sprocket (1) so that the dimple (2) is aligned with the plated link (3) on the cam 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.*

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

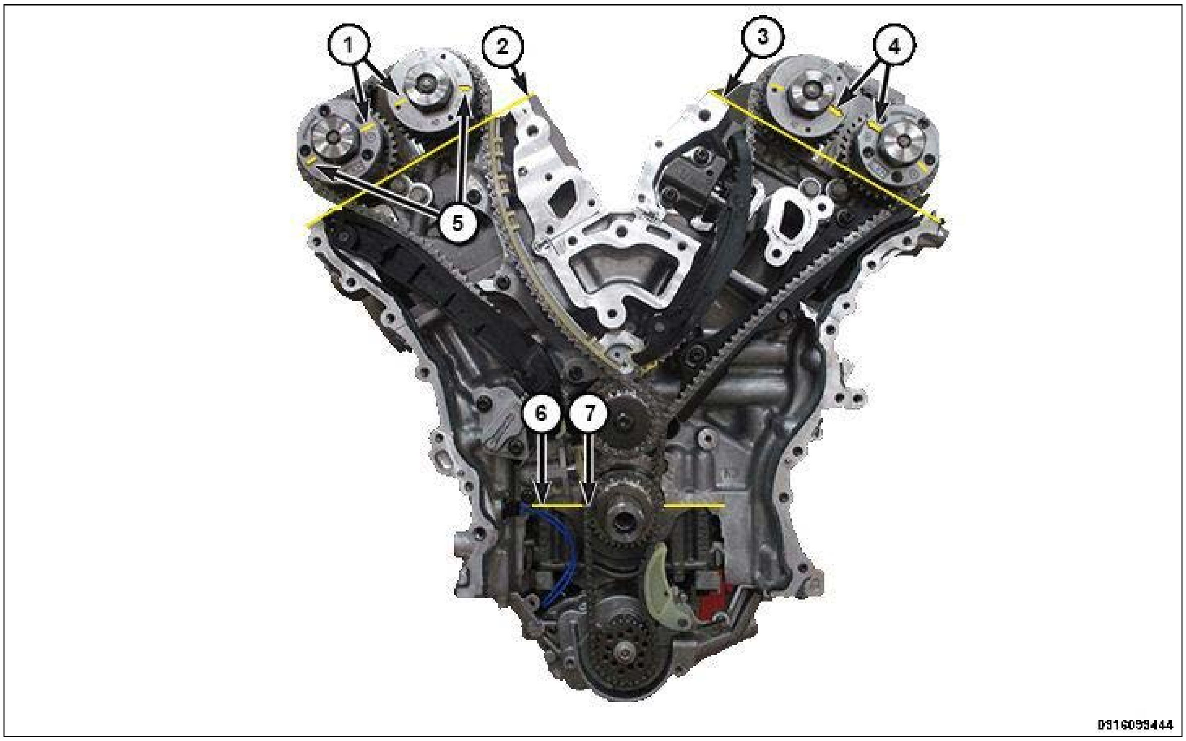
> NOTE:
>
> *If the rocker arms and hydraulic lifters are being reused, reassemble them into their original locations.*

16. 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.*

17. Remove the Tensioner Pin (special tool #8514, Pins, Tensioner) from the RH cam chain tensioner.

Fig 7: Scribe Lines, Valve Cover Sealing Surfaces, Cam Phaser Arrows, Block/Bearing Cap Junction & Dimple

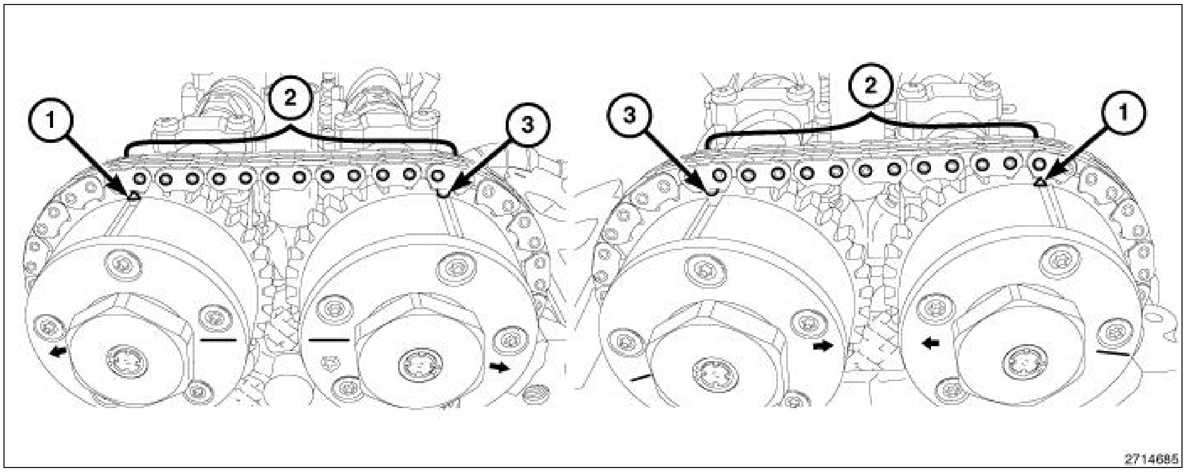


Courtesy of CHRYSLER GROUP, LLC

18. Rotate the crankshaft clockwise two complete revolutions stopping when the dimple (4) on the crankshaft is aligned the with the block/bearing cap junction (5).

19. Rotate the crankshaft clockwise to place the number one piston at Top Dead Center (TDC) on the exhaust stroke by aligning the dimple (7) on the crankshaft with the block/bearing cap junction (6). The left side cam phaser arrows (4) should point toward each other and be parallel to the valve cover sealing surface (3). The right side cam phaser arrows (5) should point away from each other and the scribe lines (1) should be parallel to the valve cover sealing surface (2).

Fig 8: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking



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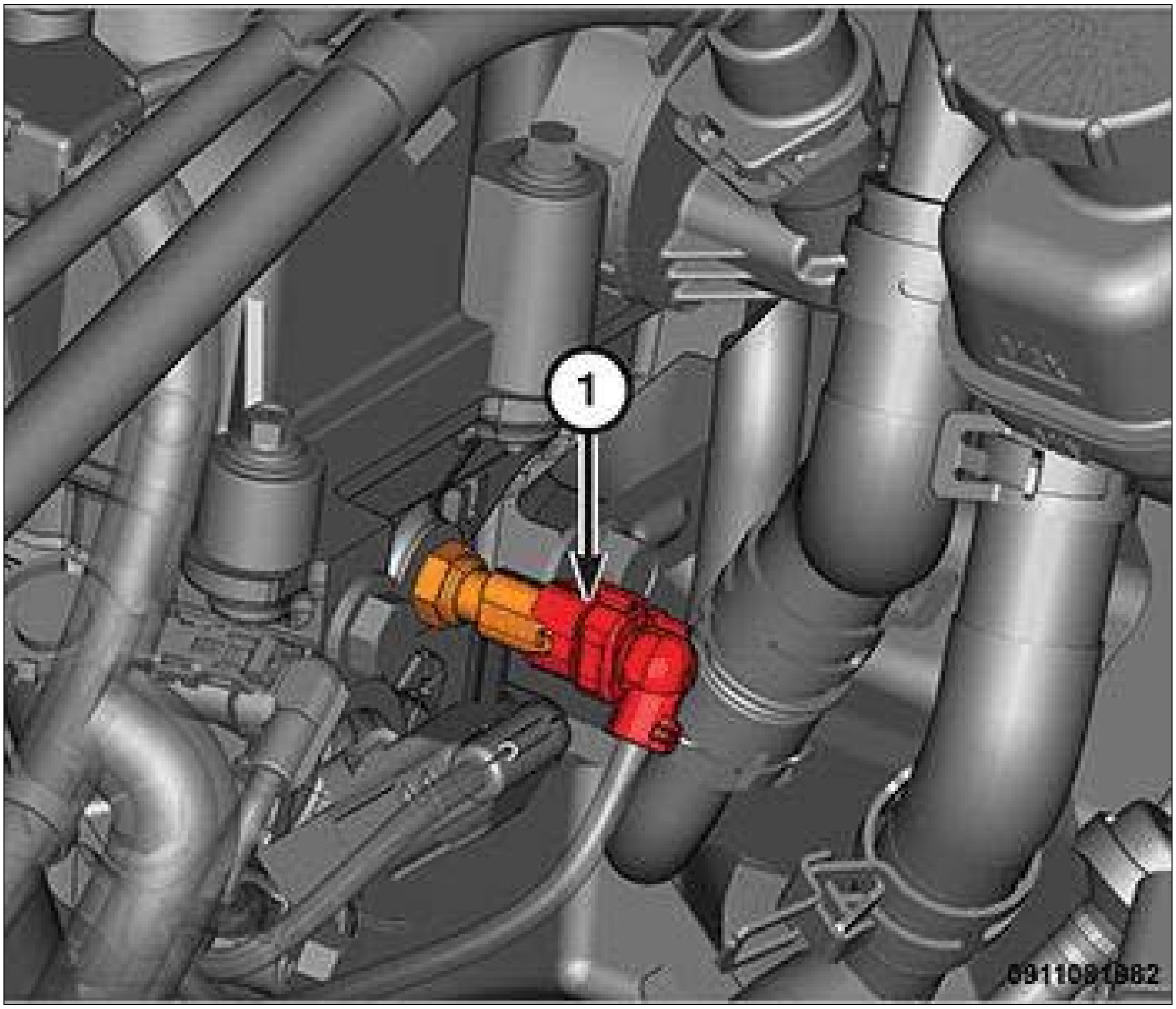
20. There should be 12 chain pins (2) between the exhaust cam phaser triangle marking (1) and the intake cam phaser circle marking (3).
21. If the engine timing is not correct, refer to CHAIN AND SPROCKETS, TIMING, INSTALLATION .
22. Install the engine timing cover, crankshaft vibration damper, upper and lower oil pans and cylinder head covers. Refer to COVER(S), ENGINE TIMING, INSTALLATION .
23. Install the spark plugs. Refer to SPARK PLUG, INSTALLATION .

Fig 9: Oil Temperature Sensor Wire Harness Connector



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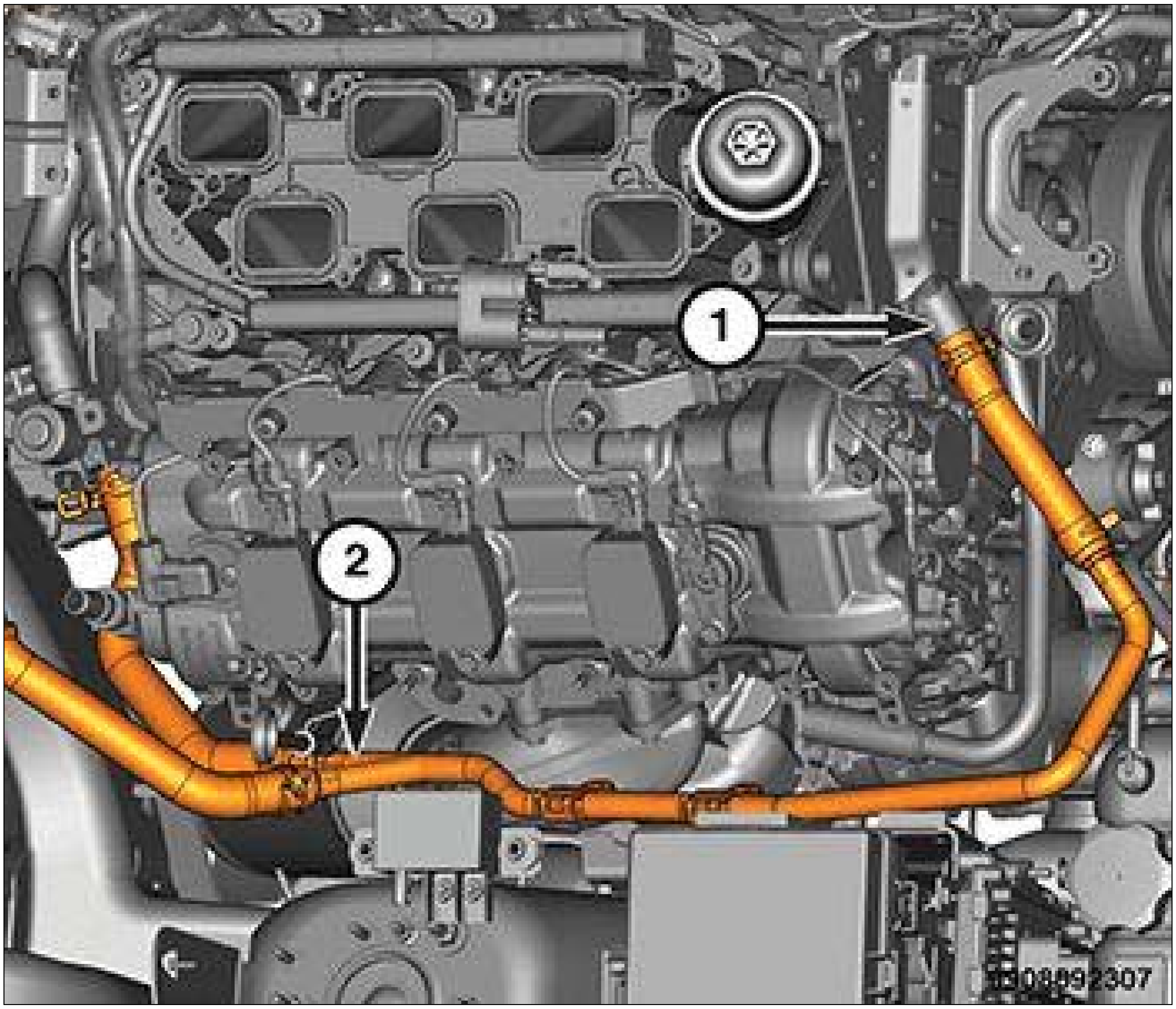
24. Connect the oil temperature sensor wire harness connector (1).
25. Connect the ignition coil capacitor electrical connector.

Fig 10: Heater Inlet Hose At Coolant Crossover & Heater Inlet Tube Assembly



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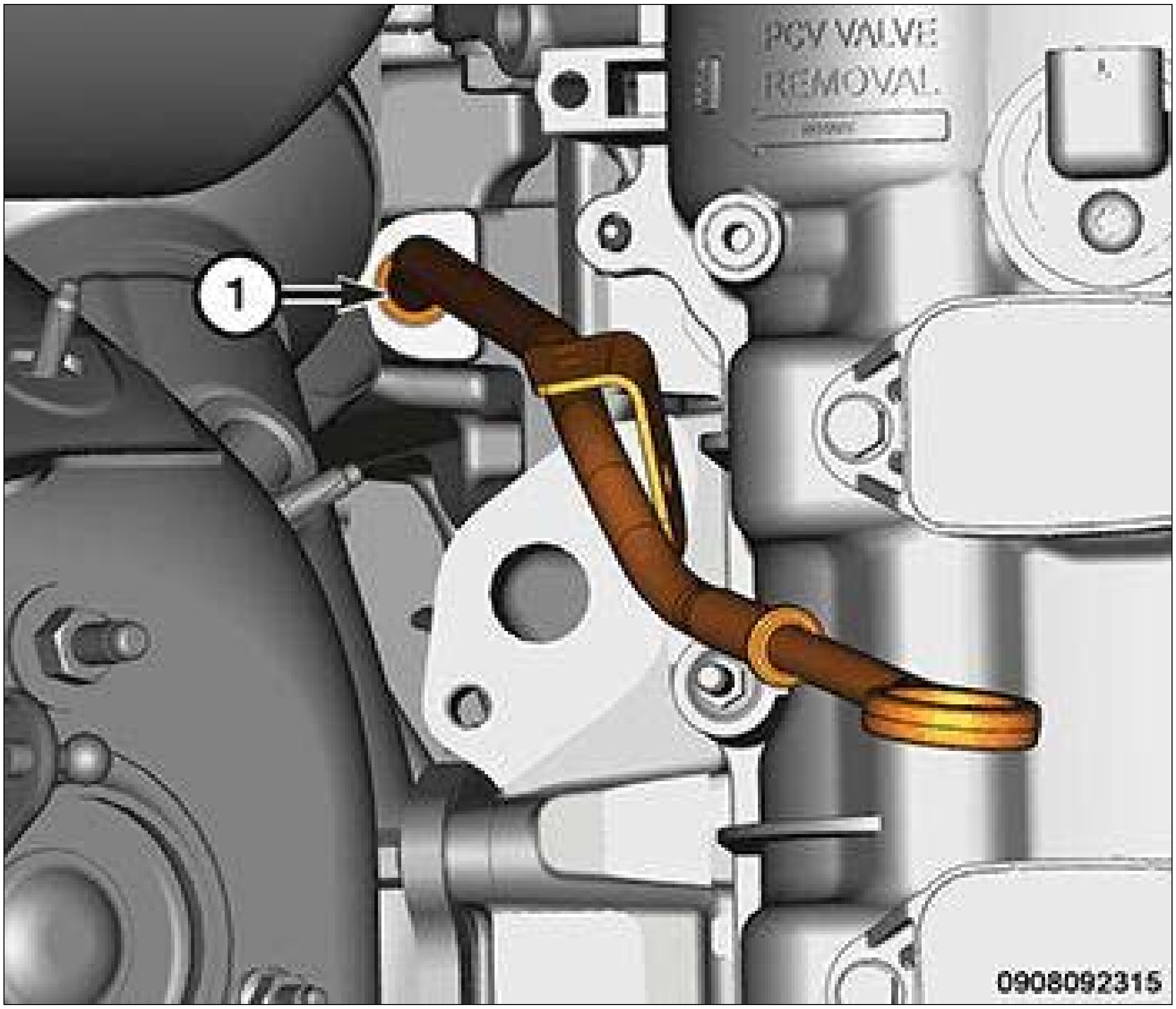
26. Install the heater core supply tube (2).

Fig 11: Oil Dipstick & Tube



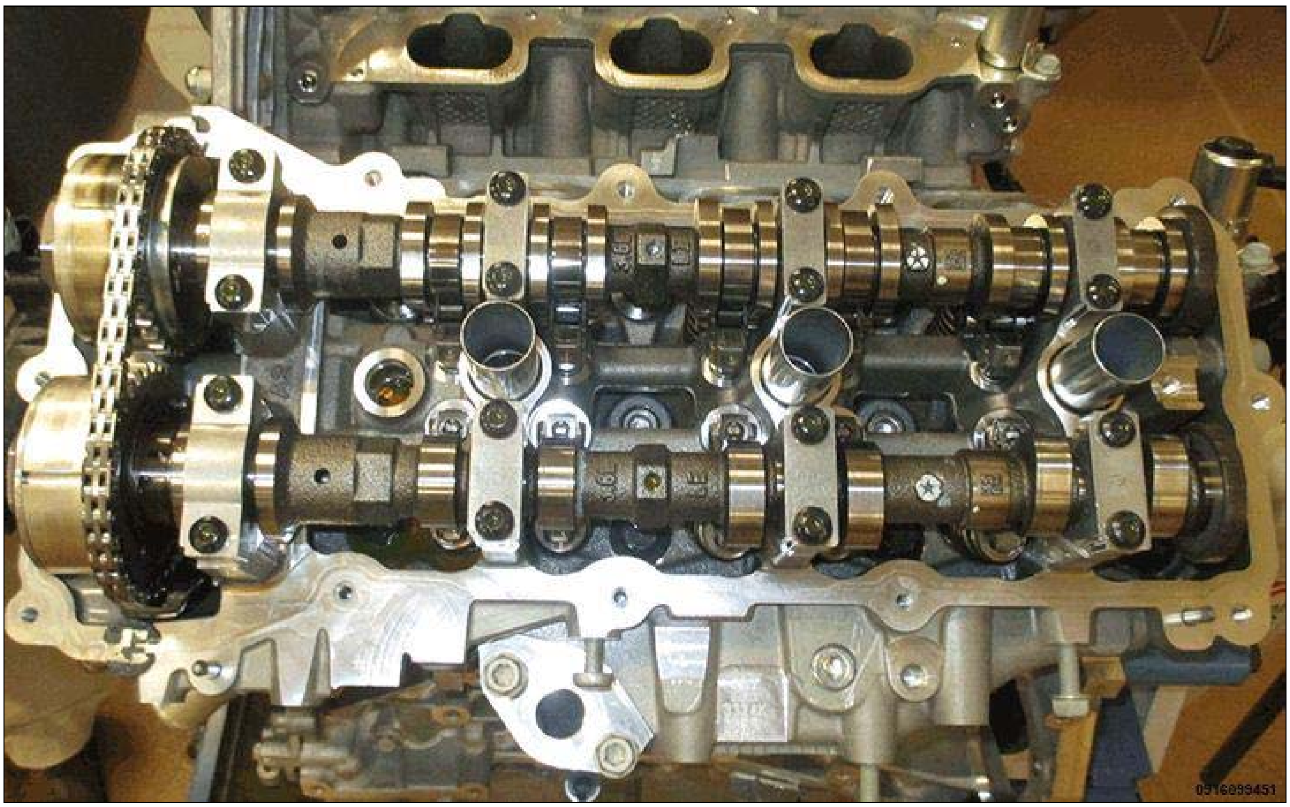
Courtesy of CHRYSLER GROUP, LLC

27. Install the oil level indicator (1).
28. Install the right side catalytic converter. Refer to CONVERTER, CATALYTIC, INSTALLATION .
29. Connect the right upstream oxygen sensor connectors to the main wire harness.
30. Install the Exhaust Gas Recirculation (EGR) cooler and attach the upper intake manifold support bracket with the lower bolt. Refer to COOLER, EXHAUST GAS RECIRCULATION (EGR), INSTALLATION .
31. Install the upper and lower intake manifolds. Refer to MANIFOLD, INTAKE, INSTALLATION .
32. Install a new oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
33. Fill the cooling system. Refer to STANDARD PROCEDURE .
34. Connect the negative battery cable.
35. 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.*

CYLINDER HEAD > CAMSHAFT, ENGINE > DESCRIPTION > DESCRIPTION

Fig 1: Dual Over Head Camshaft (DOHC) Configuration



Courtesy of CHRYSLER GROUP, LLC

The Pentastar engine uses a Dual Over Head Camshaft (DOHC) configuration designed to work with the two-step Variable Valve Lift (VVL) system.

- The camshafts are a nodular cast iron design.
- Each camshaft has a pressed on magnetic timing wheel that is magnetically 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.

Intake Camshafts

- Intake valve lift centerlines: 146° (high lift), 104° (low lift).

- Tri-lobe design for two-step switchable roller finger follower.
- Gun drilled for weight reduction.

Exhaust Camshafts

- Valve lift centerline: 123°.
- Refined double-polish surface finish on journals
- Gun drilled for weight reduction.

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.

For more information on the VVL system, refer to SOLENOID, VARIABLE VALVE LIFT, DESCRIPTION .

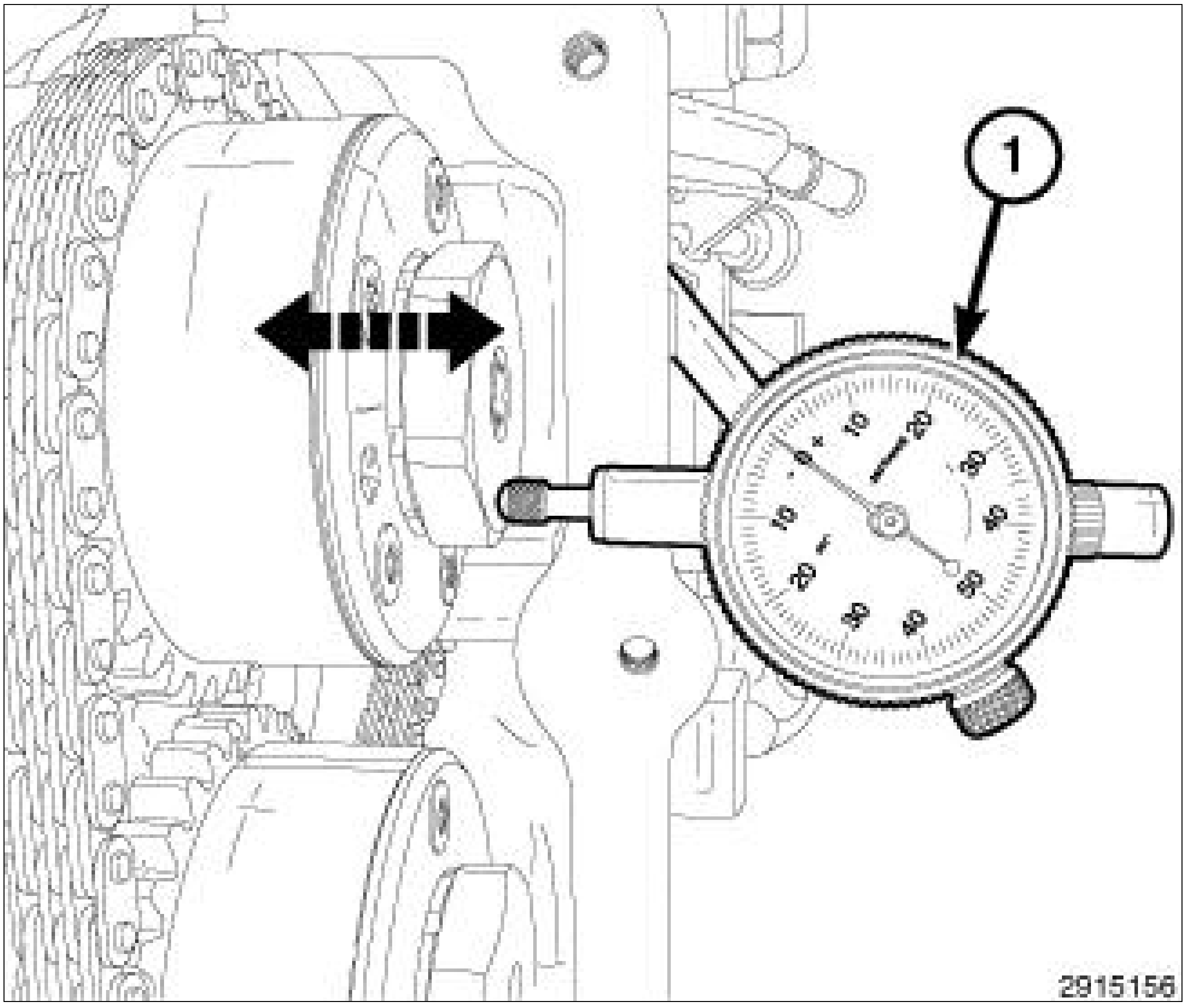
CYLINDER HEAD > CAMSHAFT, ENGINE > STANDARD PROCEDURE > CAMSHAFT END PLAY

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

> *NOTE:*
>
> *Cylinder #1 or #4 must be used when checking for Top Dead Center (TDC).*

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

Fig 1: Mount Dial Indicator Set To A Stationary Point At Front Of Engine



Courtesy of CHRYSLER GROUP, LLC

2. Mount the Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) (1) to a stationary point at the front of the engine. Place the probe perpendicular against the Oil Control Valve (OCV) 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 .

CYLINDER HEAD > CAMSHAFT, ENGINE > REMOVAL > LEFT

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:

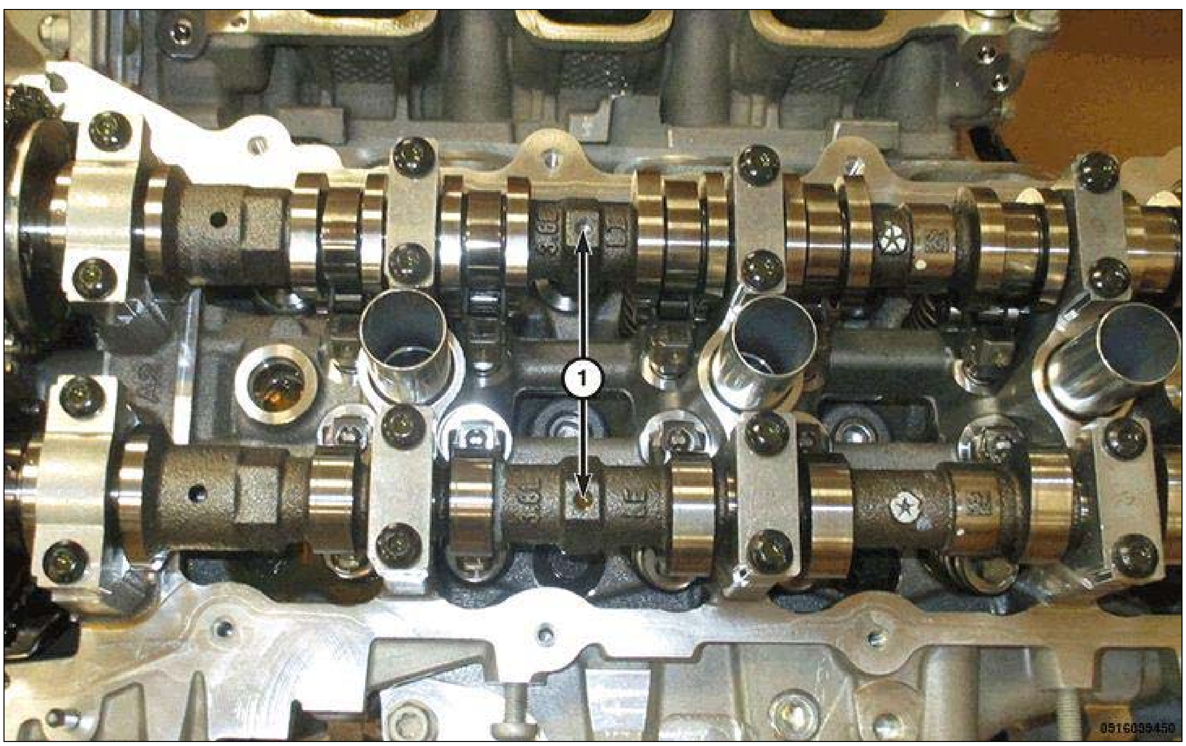
DO NOT STAMP OR STRIKE THE CAMSHAFT BEARING CAPS. SEVERE DAMAGE WILL OCCUR TO THE BEARING CAPS.

1. Remove the variable valve timing assembly. 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.

Fig 1: Positioning Alignment Holes On Camshafts

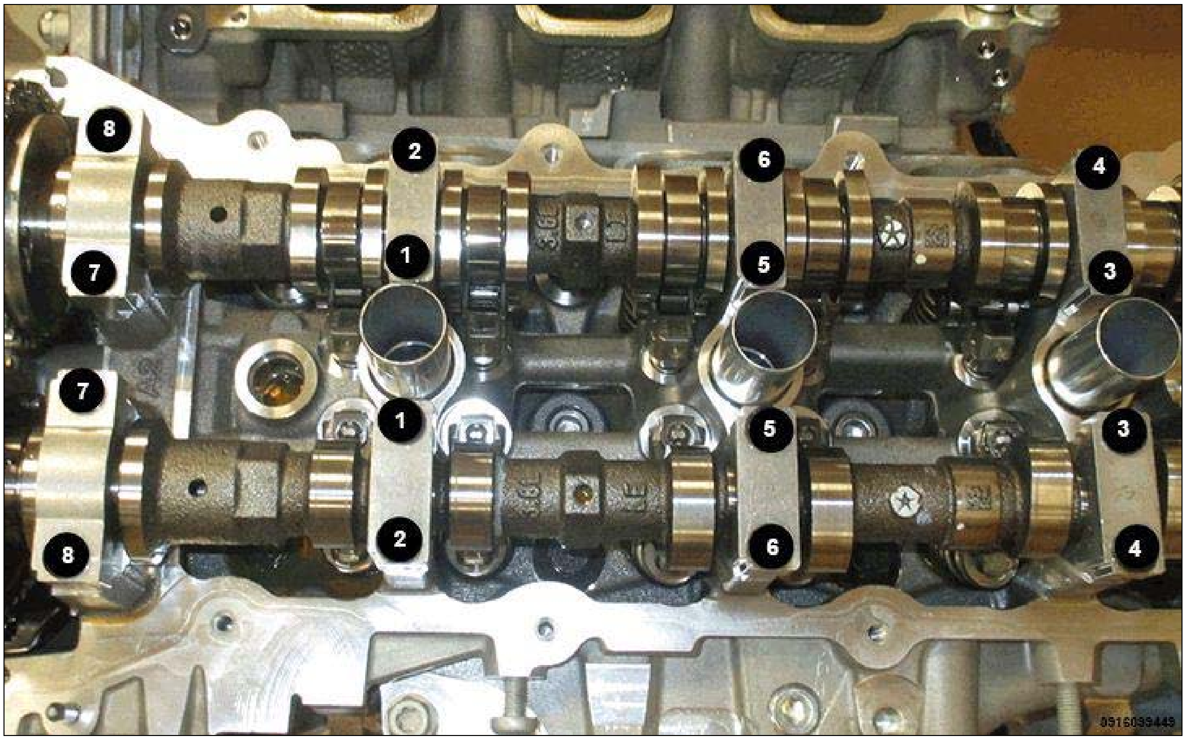


Courtesy of CHRYSLER GROUP, LLC

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).

Fig 2: Camshaft Bearing Cap Bolts Removal & Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

3. Loosen the camshaft bearing cap bolts reversing the sequence shown in illustration, starting at 8 and ending with 1.

> *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.

CYLINDER HEAD > CAMSHAFT, ENGINE > REMOVAL > RIGHT

> *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 variable valve timing assembly. Refer to ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE, REMOVAL .

NOTE:

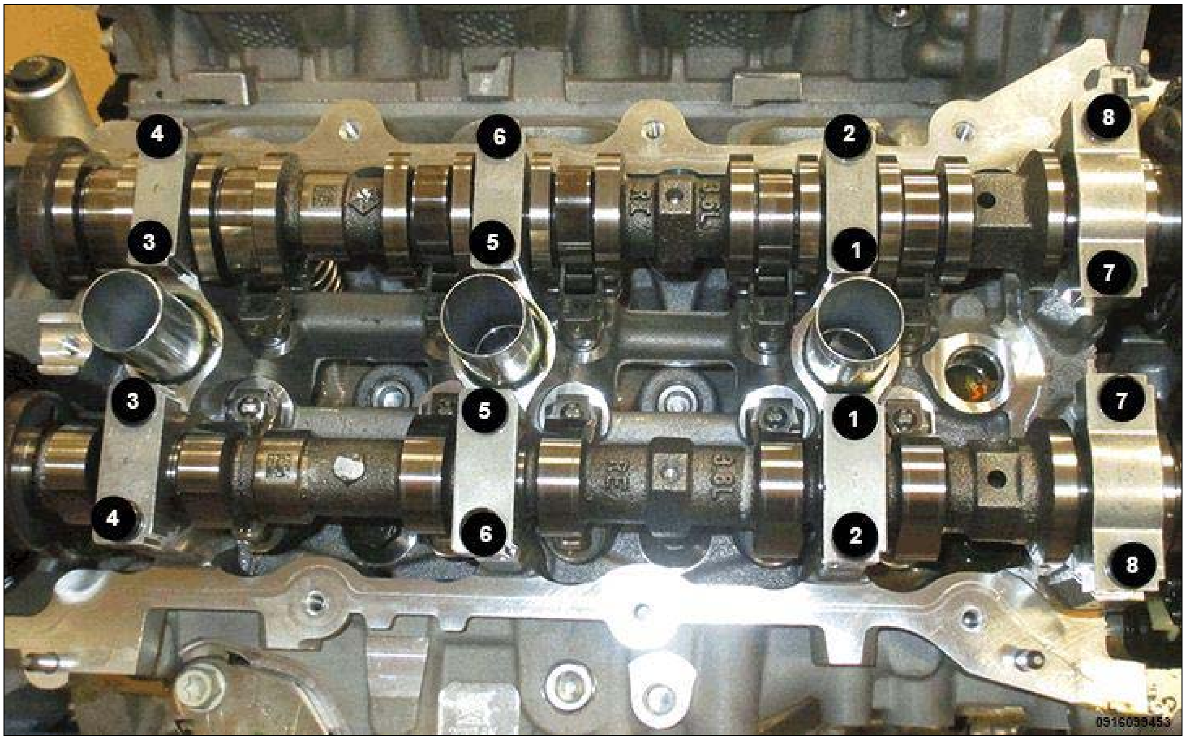
Camshaft bearing caps should have been marked during engine manufacturing. For example, the number one exhaust camshaft bearing cap is marked "1E->". The caps should be installed with the notch forward.

Fig 1: Positioning Alignment Holes On Camshafts

Courtesy of CHRYSLER GROUP, LLC

2. Rotate the camshafts counterclockwise to position the alignment holes (1) at top-dead-center.

Fig 2: Camshaft Bearing Cap Bolts Removal & Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

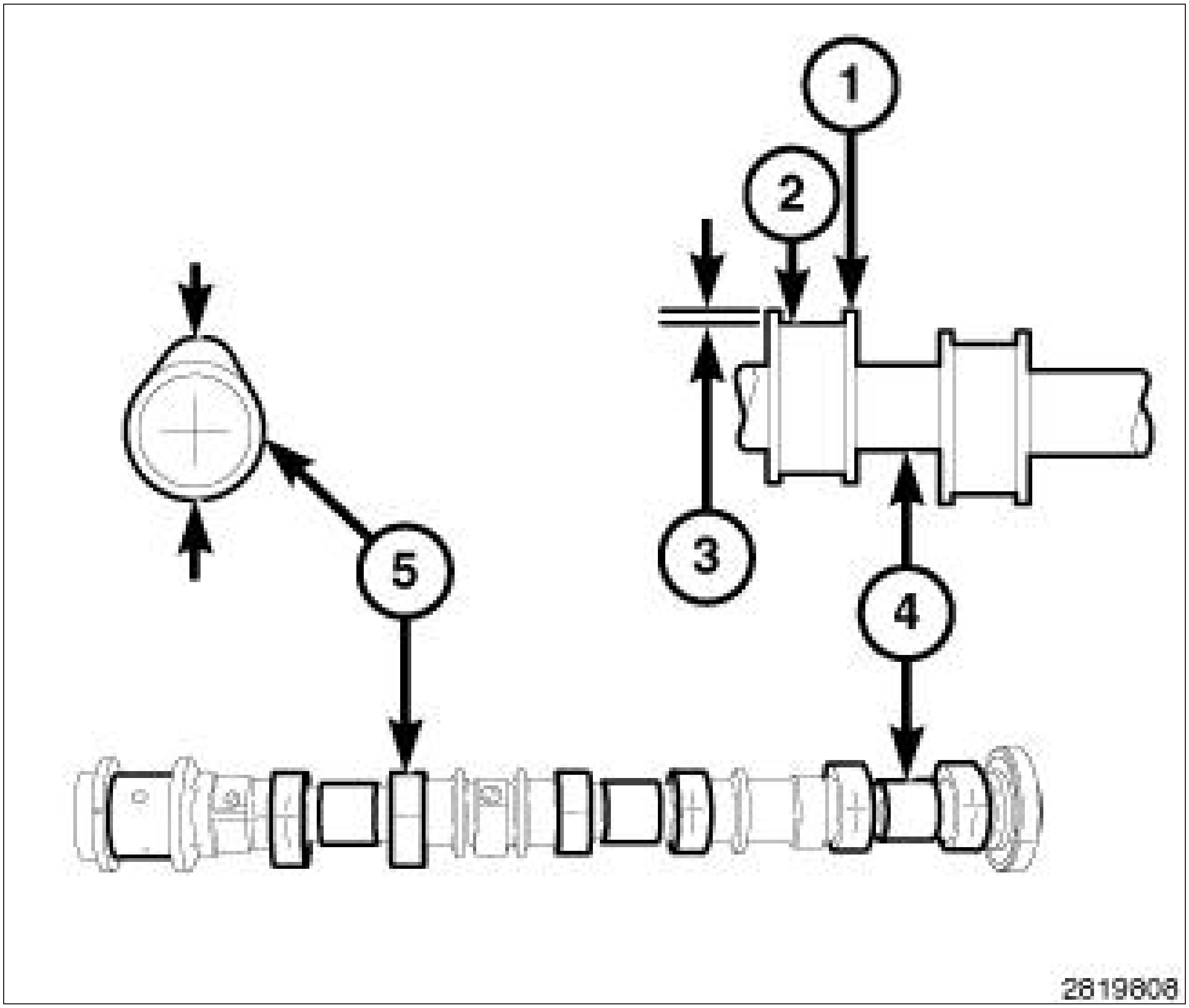
3. Loosen the camshaft bearing cap bolts reversing the sequence shown in illustration, starting at 8 and ending with 1.

> *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.

CYLINDER HEAD > CAMSHAFT, ENGINE > INSPECTION > INSPECTION

Fig 1: Inspecting Camshaft Bearing Journals & Cam Lobes



Courtesy of CHRYSLER GROUP, LLC

NOTE:

RH intake camshaft shown in illustration, other camshafts similar.

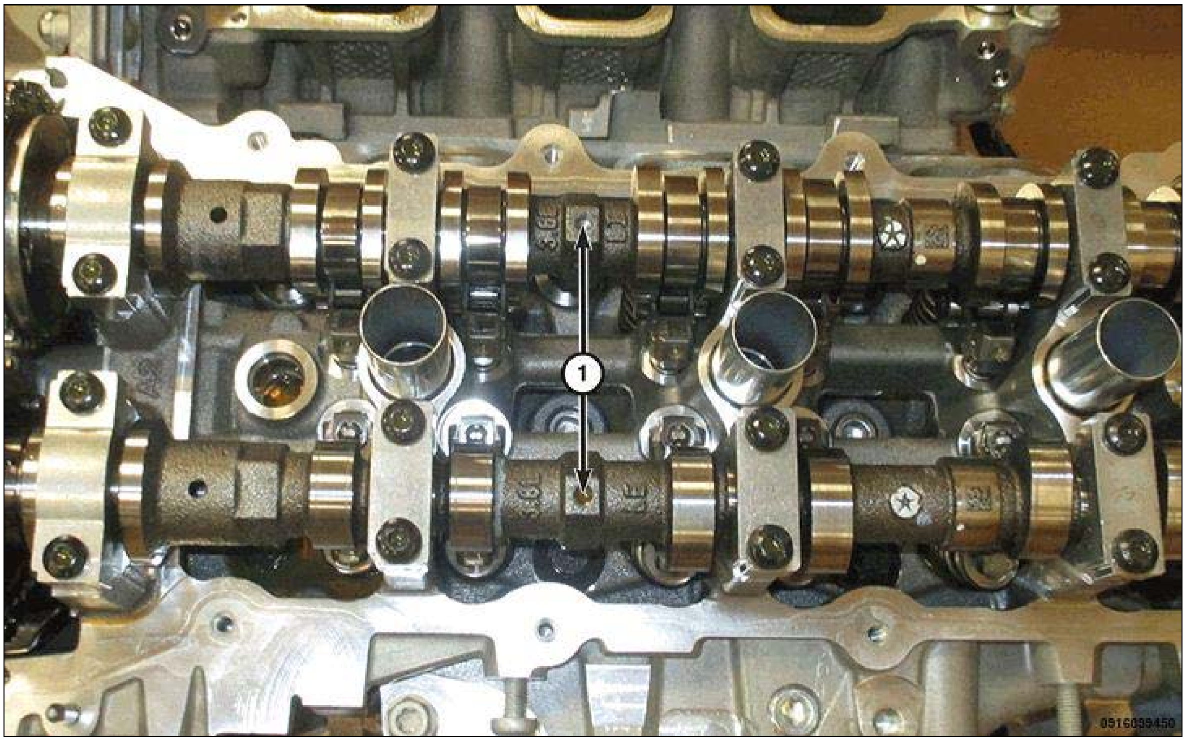
1. Inspect camshaft bearing journals (4) for damage and binding. If journals are binding, check the cylinder head for damage. Also check cylinder head oil holes for clogging.
2. Check the surface of the cam lobes (5) for abnormal wear (3). Measure and compare the unworn area (1) to the worn area (2).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

CYLINDER HEAD > CAMSHAFT, ENGINE > INSTALLATION > LEFT

1. Lubricate the camshaft journals with clean engine oil.

> 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.*

Fig 1: Positioning Alignment Holes On Camshafts



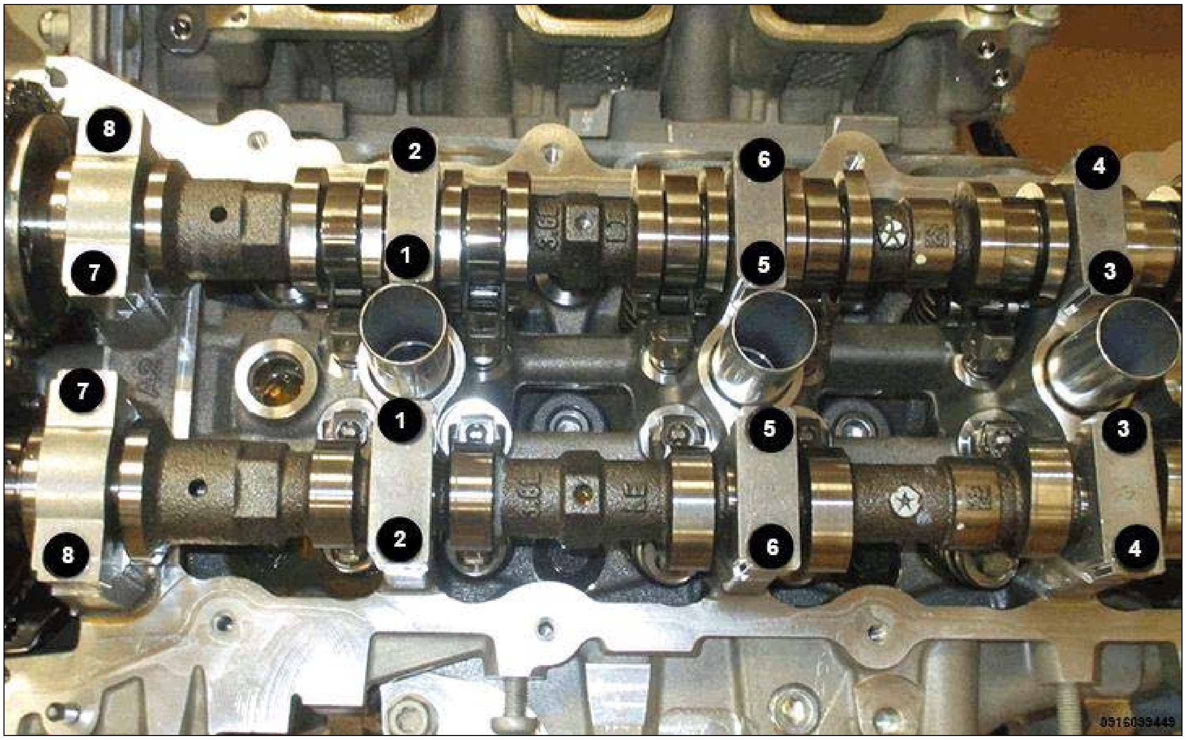
Courtesy of CHRYSLER GROUP, LLC

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.

   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.

3. Verify the rocker arms are aligned to the cam lobe. Refer to ROCKER ARM, VALVE, INSTALLATION .

Fig 2: Camshaft Bearing Cap Bolts Removal & Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

4. Install the camshaft bearing caps and tighten the bolts finger tight.
5. Using the tightening sequence shown in illustration, tighten the bearing cap bolts to 10 N.m (89 in. lbs.).
6. Rotate the camshafts clockwise to top-dead-center by positioning the alignment holes vertically.
7. Install the variable valve timing assembly. 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.

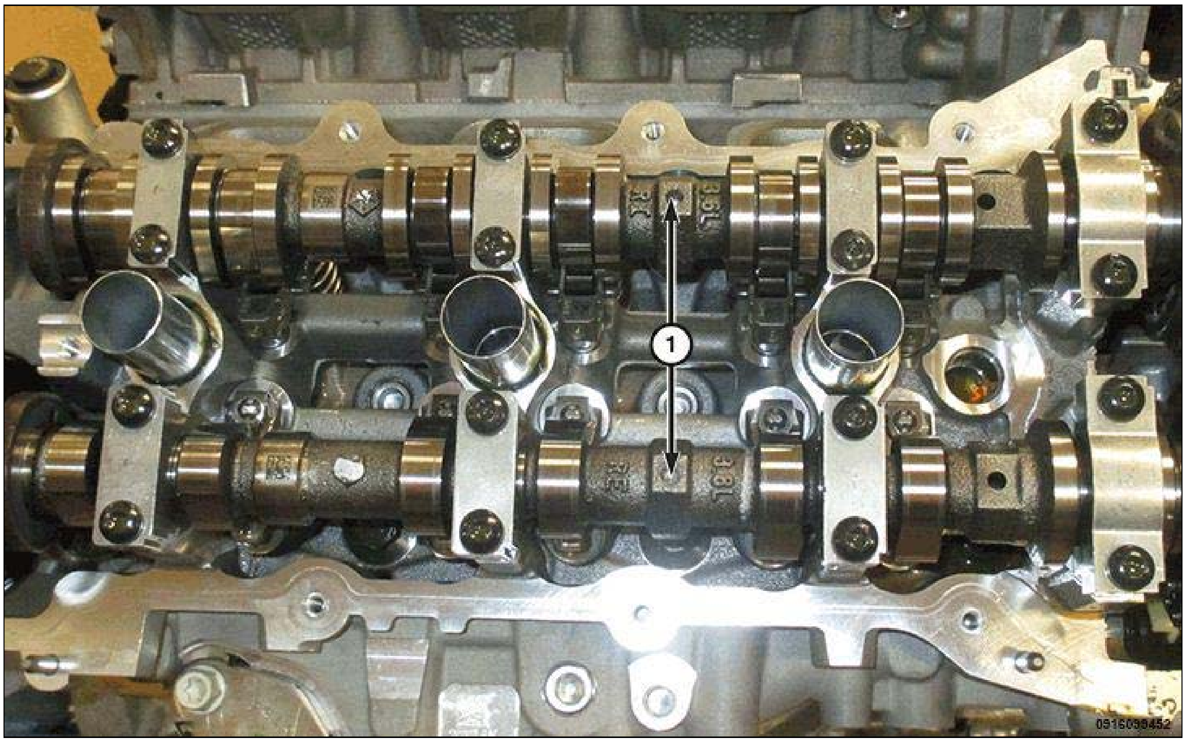
CYLINDER HEAD > CAMSHAFT, ENGINE > INSTALLATION > RIGHT

1. Lubricate camshaft journals with clean engine oil.

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.

Fig 1: Positioning Alignment Holes On Camshafts



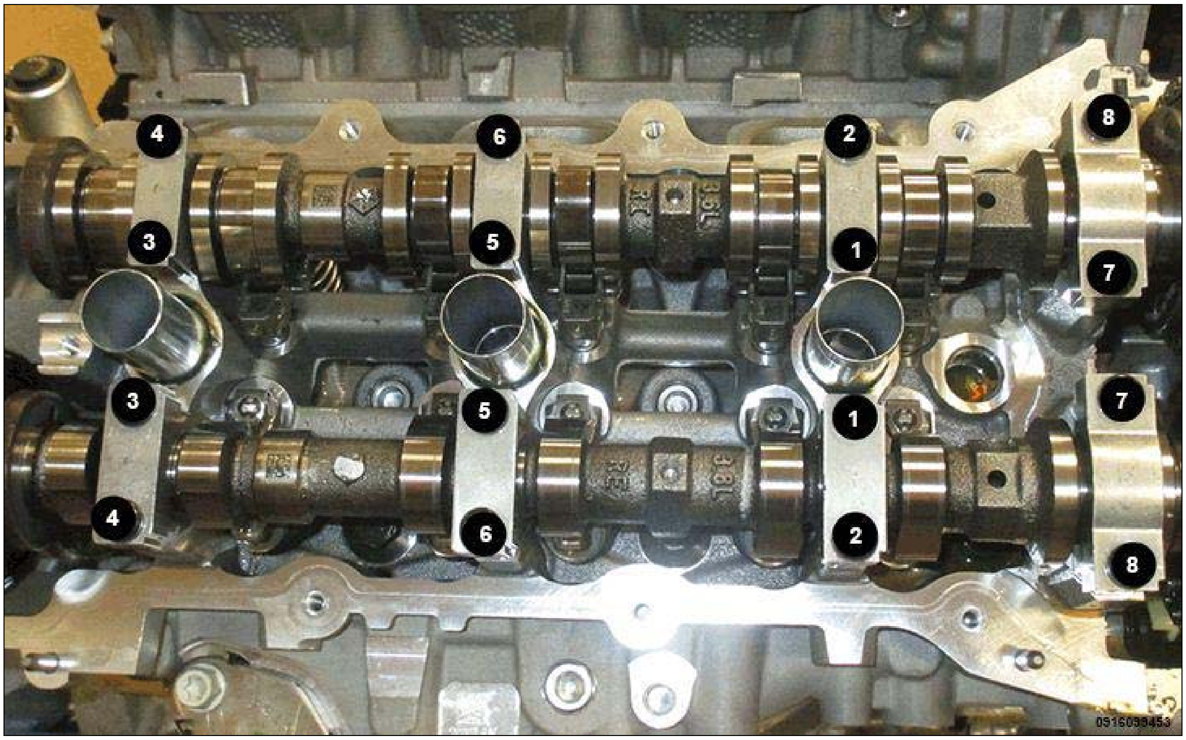
Courtesy of CHRYSLER GROUP, LLC

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.

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.

Fig 2: Camshaft Bearing Cap Bolts Removal & Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

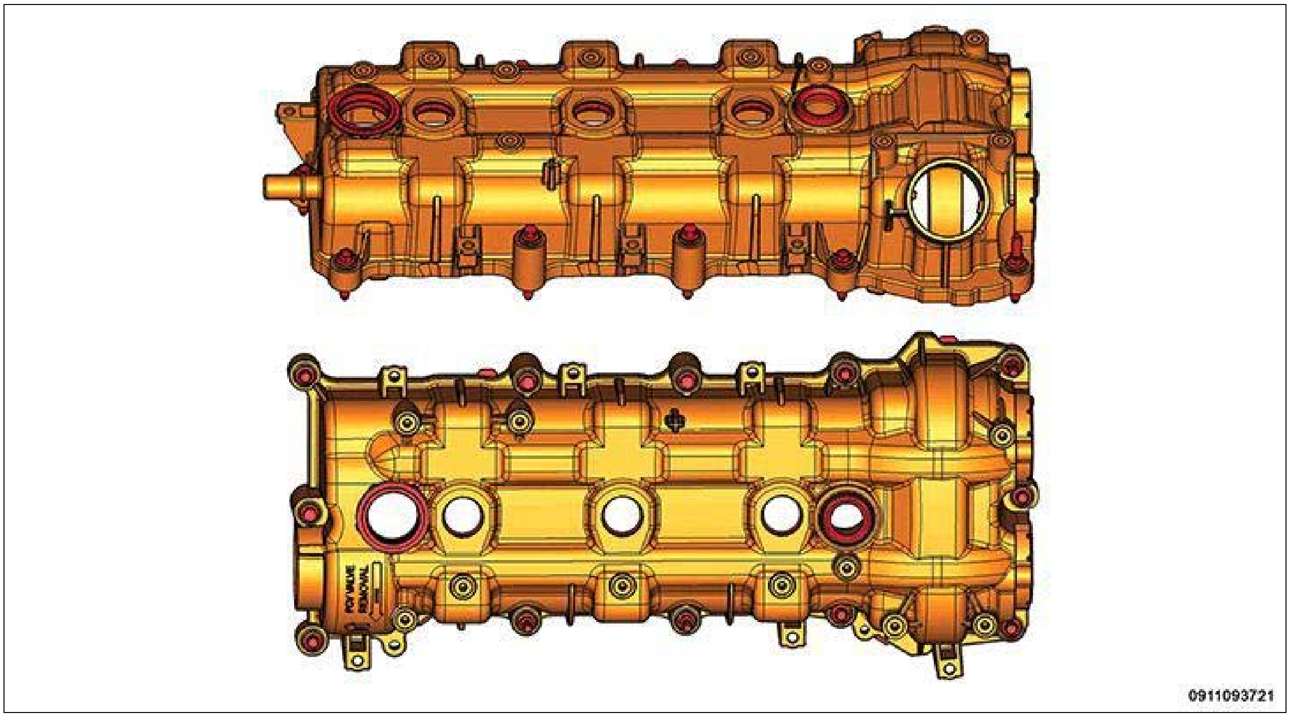
3. Install the camshaft bearing caps and tighten the bolts finger tight.
4. Verify the rocker arms are aligned to the cam lobe.

   Refer to ROCKER ARM, VALVE, INSTALLATION .
5. Using the sequence shown in illustration, tighten the bearing cap bolts to the proper specification. Refer to TORQUE SPECIFICATIONS .
6. Rotate the camshaft clockwise to the top-dead-center by positioning the alignment holes vertically.
7. Install the variable valve timing assembly. 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.*

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

Fig 1: 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 Noise Vibration and Harshness (NVH).
- There are two dowel pins on the outboard side of the cover flange to locate the cover to holes in the cylinder head.
- Room Temperature Vulcanizing silicone (RTV) is used to seal the T-joint at the timing cover, cylinder head and cylinder head cover.

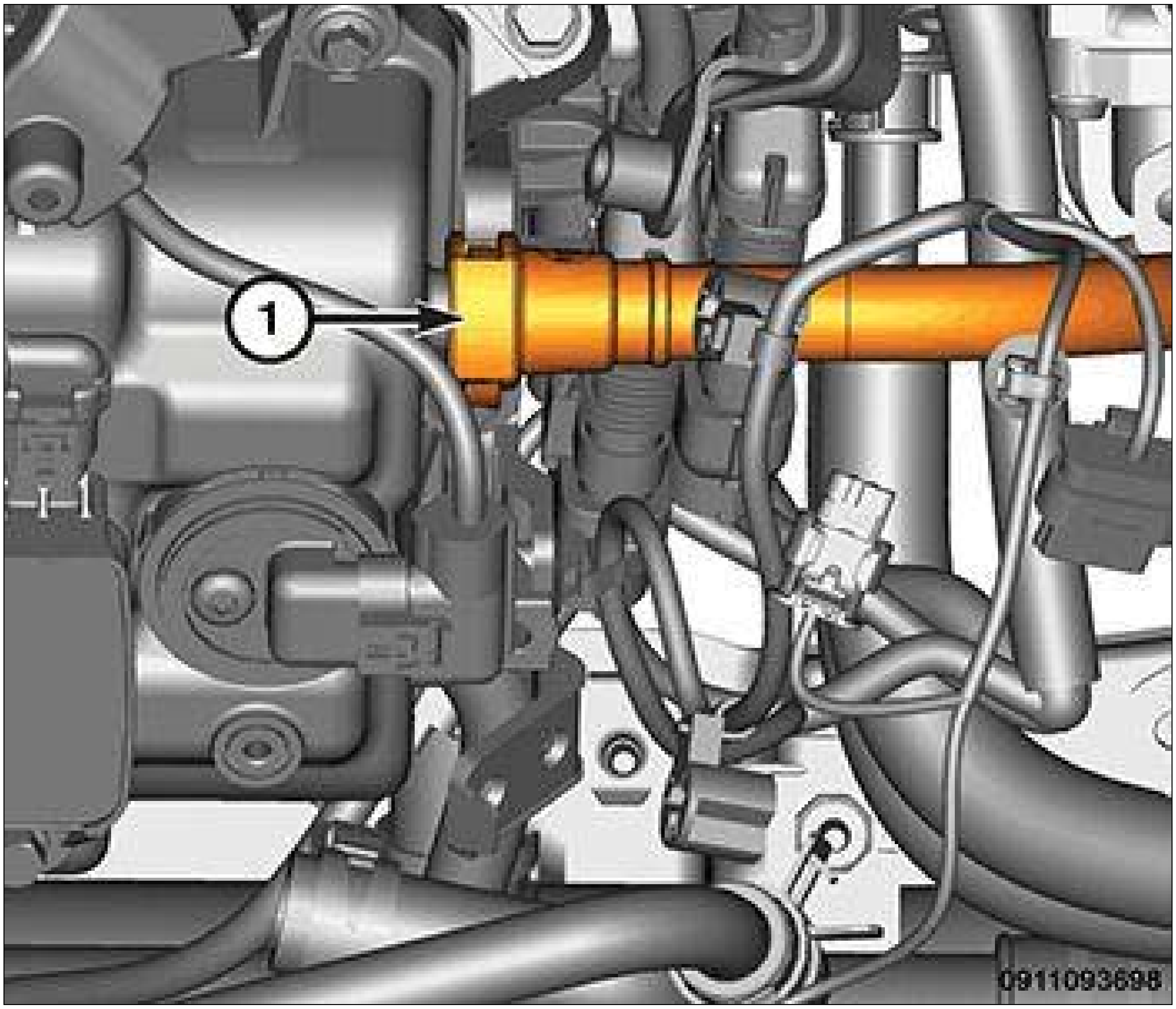
CYLINDER HEAD > COVER(S), CYLINDER HEAD > REMOVAL > LEFT

NOTE:

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

1. Disconnect and isolate the negative battery cable.
2. Remove the air cleaner body. Refer to BODY, AIR CLEANER, REMOVAL .

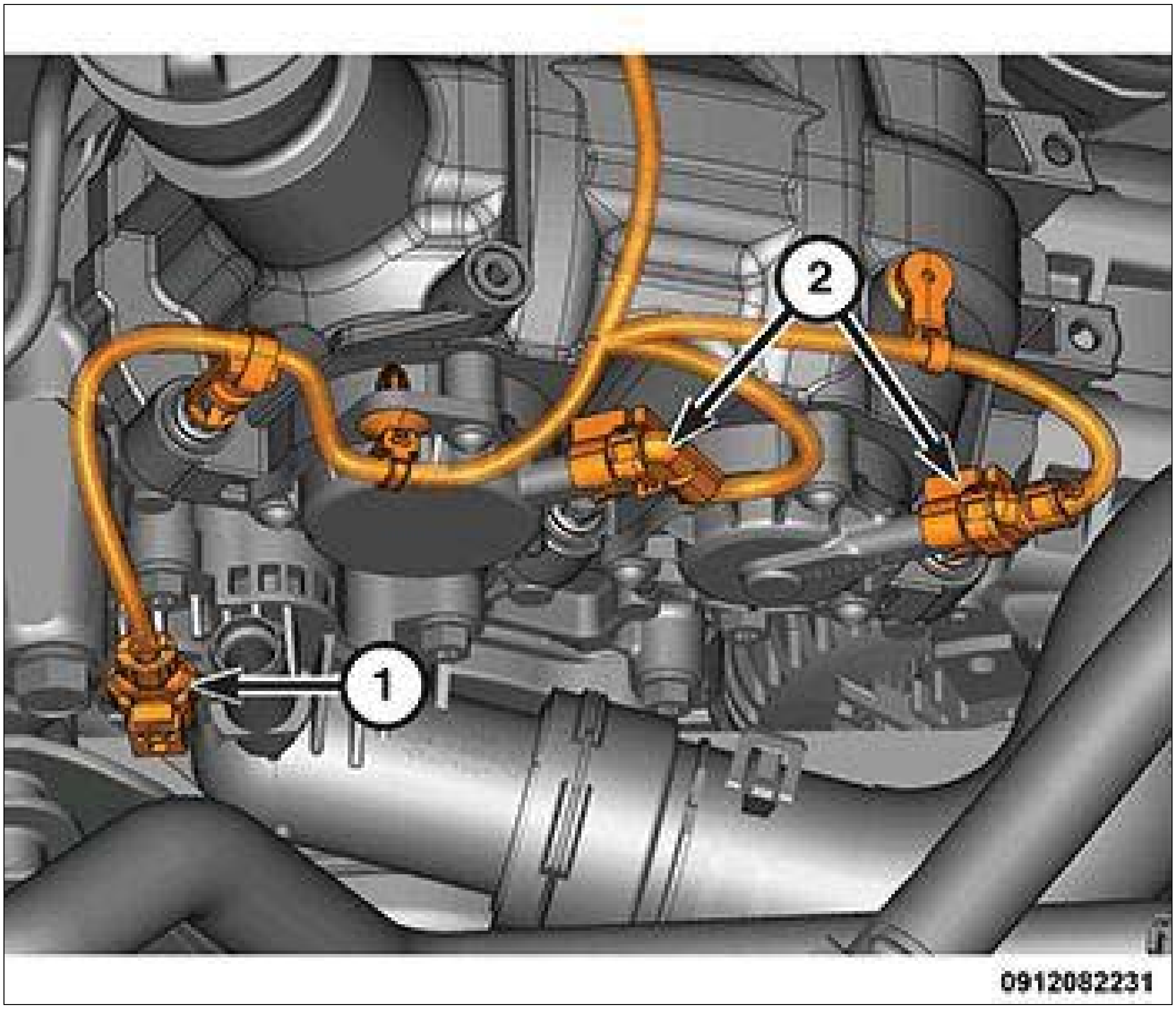
Fig 1: Fresh Air Makeup Hose



Courtesy of CHRYSLER GROUP, LLC

3. Disconnect the fresh air makeup hose (1).
4. Partially drain the engine cooling system. Refer to STANDARD PROCEDURE .

Fig 2: Variable Valve Timing Solenoids Wire Harness Connectors & Coolant Temperature Sensor Wire Harness Connector



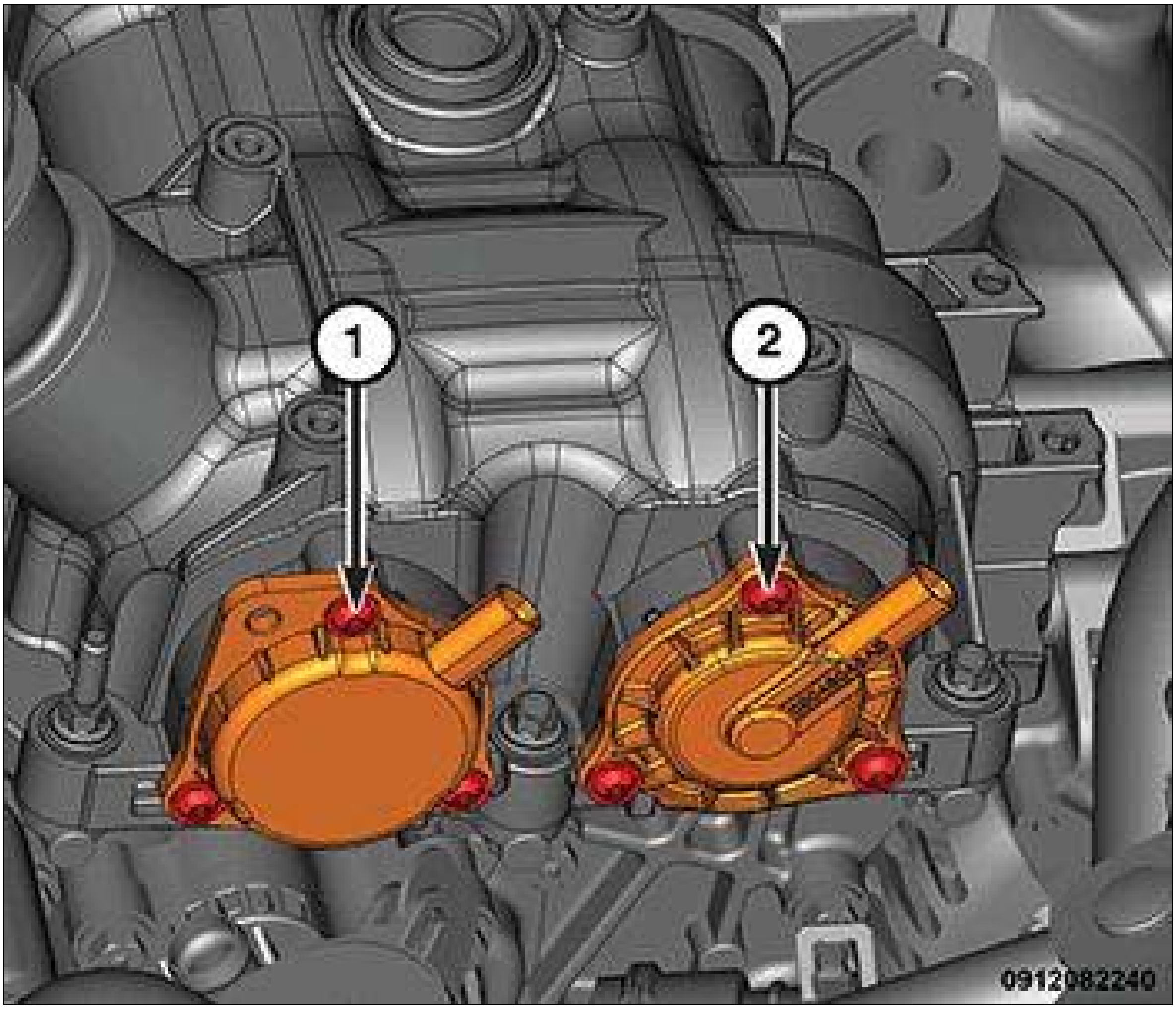
Courtesy of CHRYSLER GROUP, LLC

5. Disconnect the wire harness connectors (2) from the variable valve timing solenoids on the left cylinder head cover.

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

6. Disconnect the coolant temperature sensor wire harness connector (1).
7. Disengage the wire harness retainers from the left cylinder head cover.

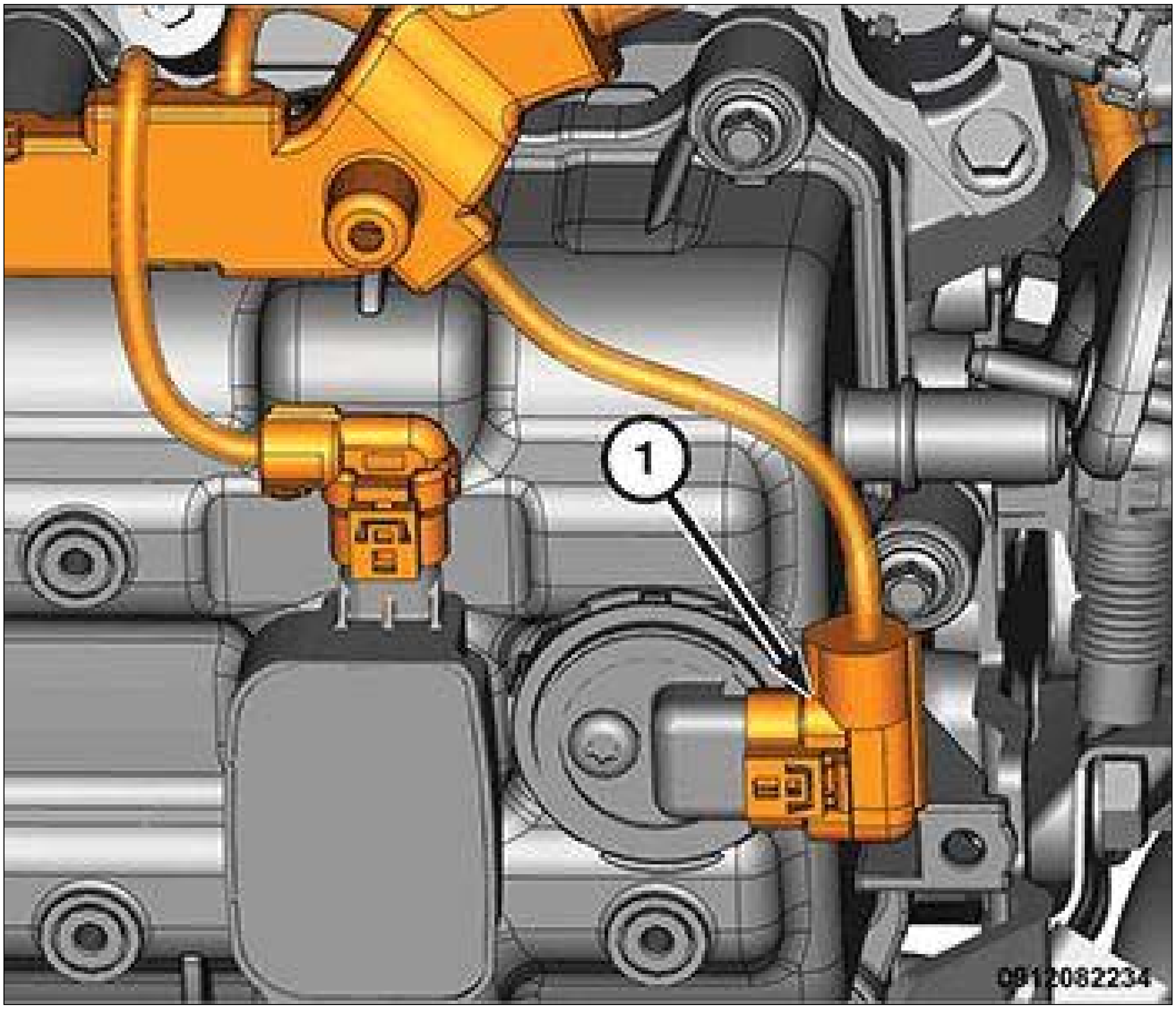
Fig 3: Variable Valve Timing Solenoids



Courtesy of CHRYSLER GROUP, LLC

8. Mark the variable valve timing solenoids (1 and 2) with a paint pen or equivalent so that they may be reinstalled in their original locations.
9. Remove the variable valve timing solenoids. Refer to SOLENOID, VARIABLE VALVE TIMING, REMOVAL .

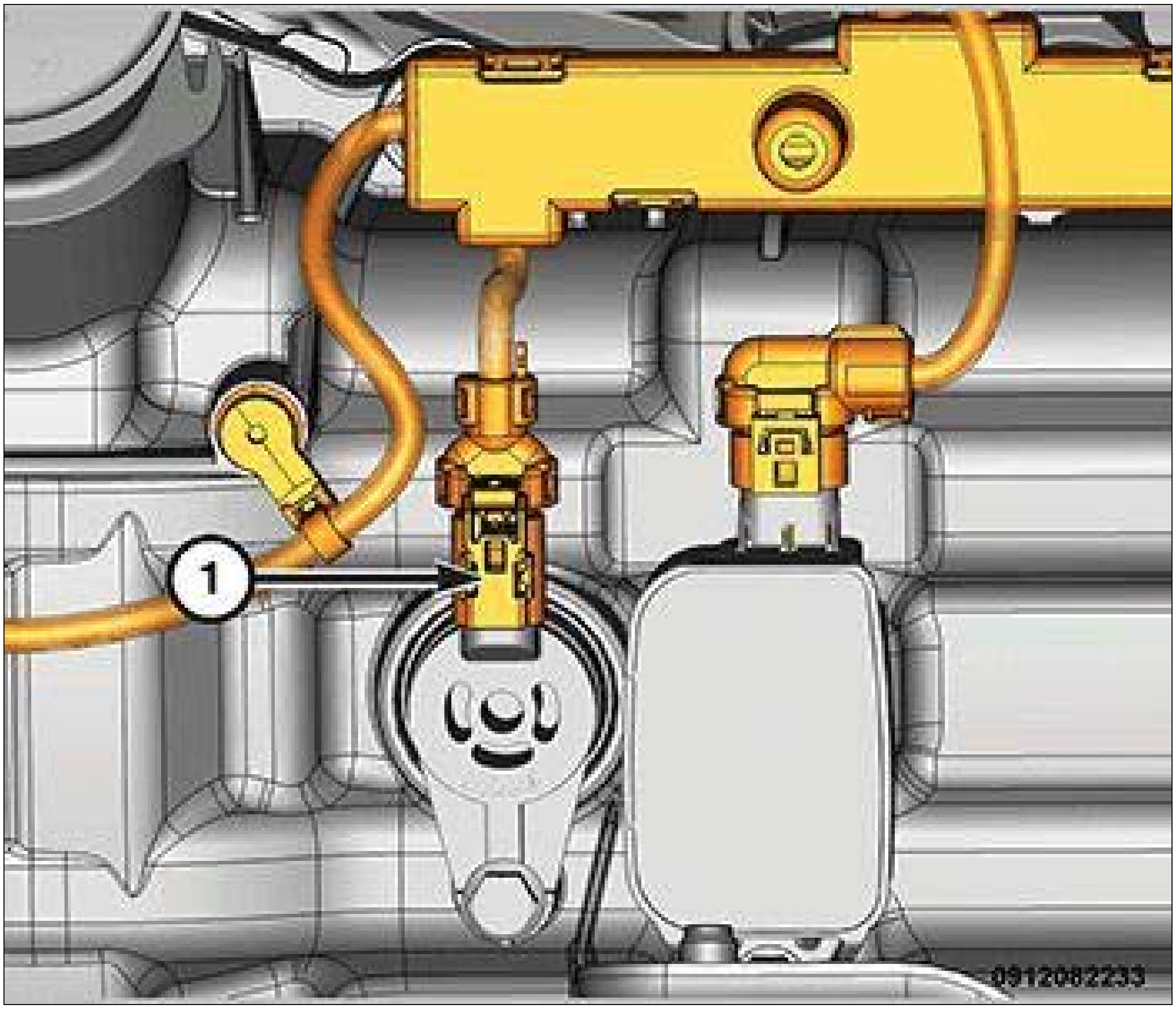
Fig 4: Left Camshaft Position (CMP) Sensor Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

10. Disconnect the left Camshaft Position (CMP) sensor (1) wire harness connector.

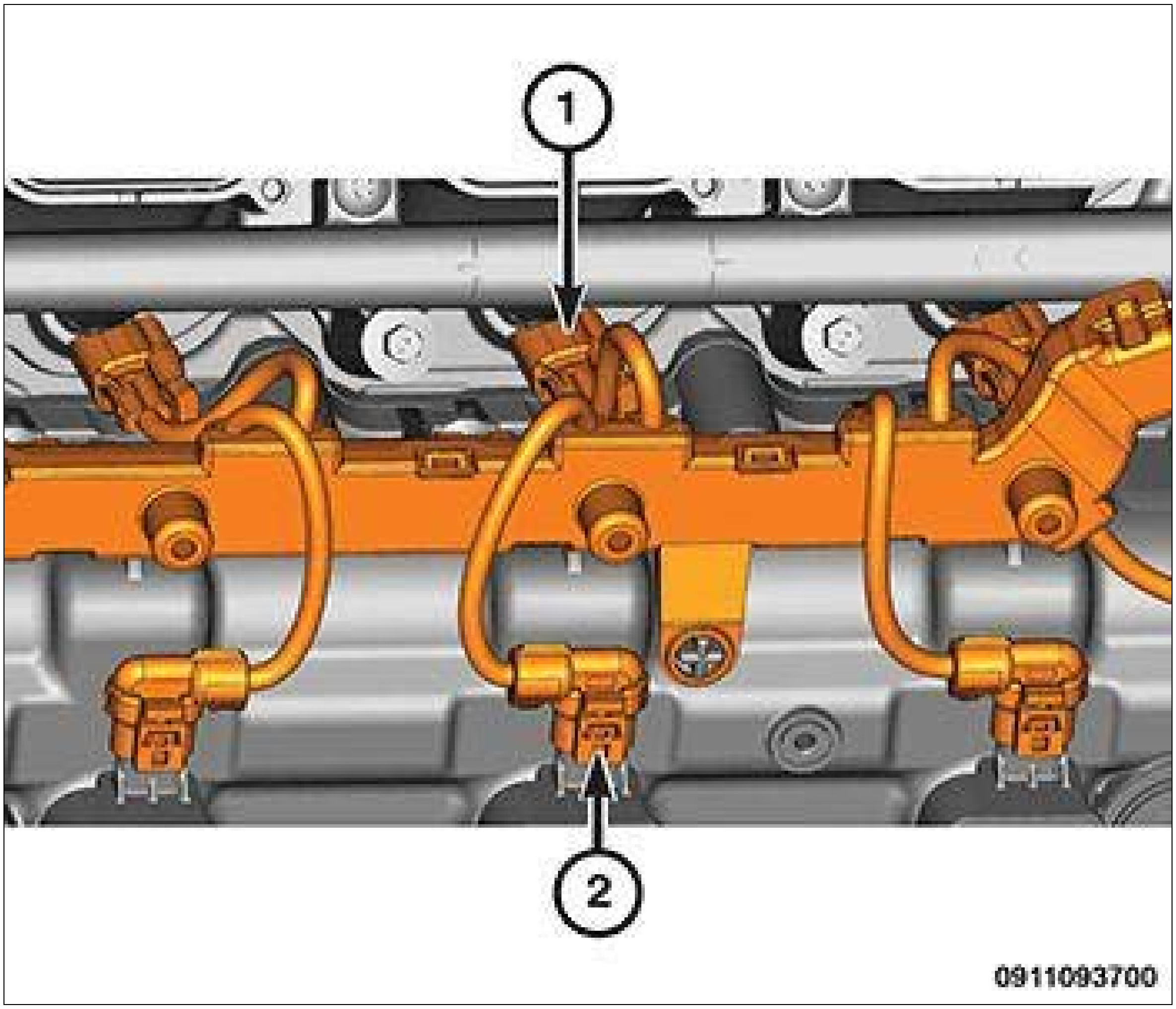
Fig 5: Variable Valve Lift (VVL) Solenoid Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

11. Disconnect the Variable Valve Lift (VVL) solenoid wire harness connector (1).

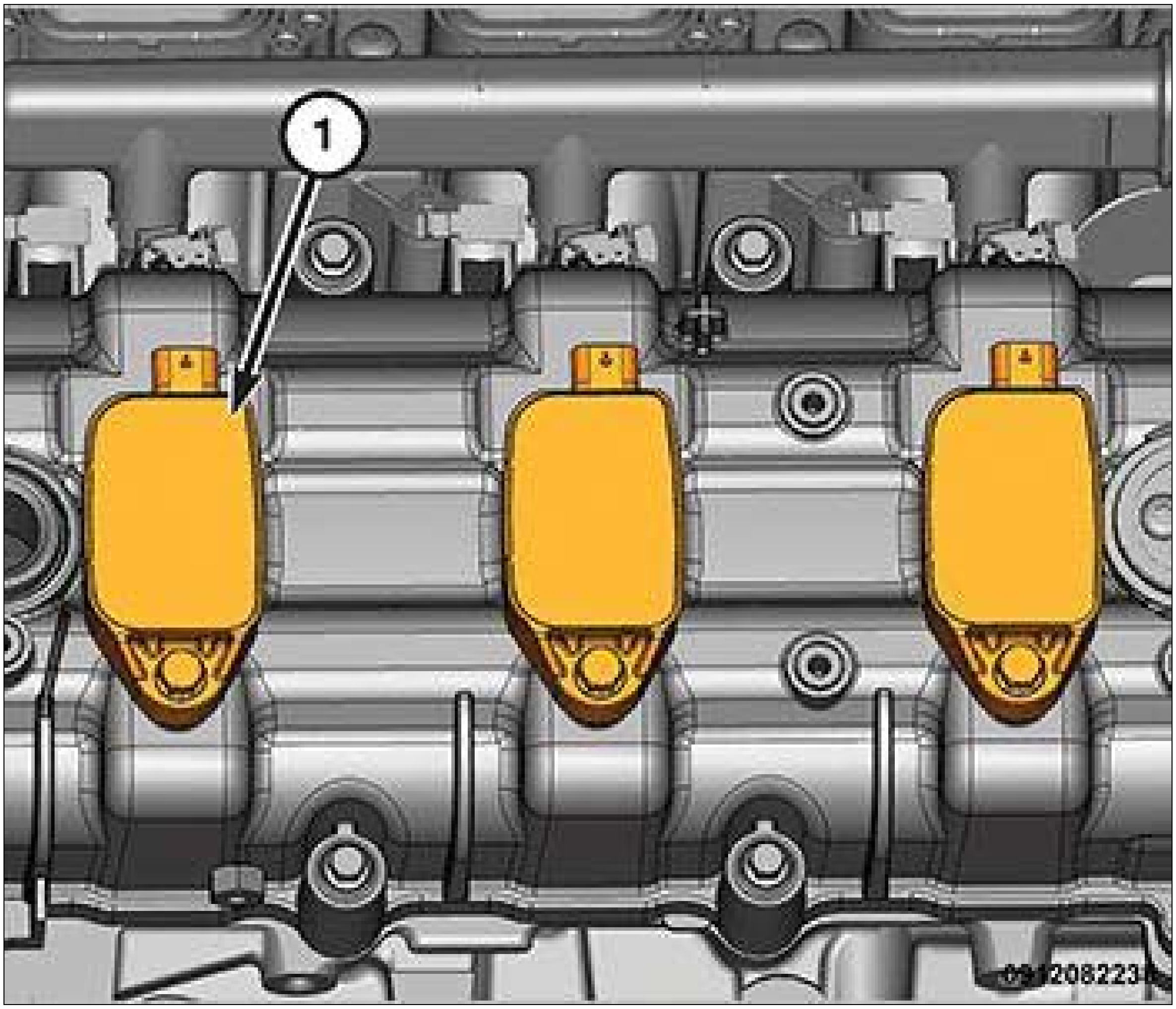
Fig 6: Fuel Injectors & Ignition Coils Wire Harness Connectors



Courtesy of CHRYSLER GROUP, LLC

12. Disconnect the wire harness connectors from fuel injectors (1) and ignition coils (2).
13. Remove the wire harness assembly from the left side cylinder head cover and position aside.

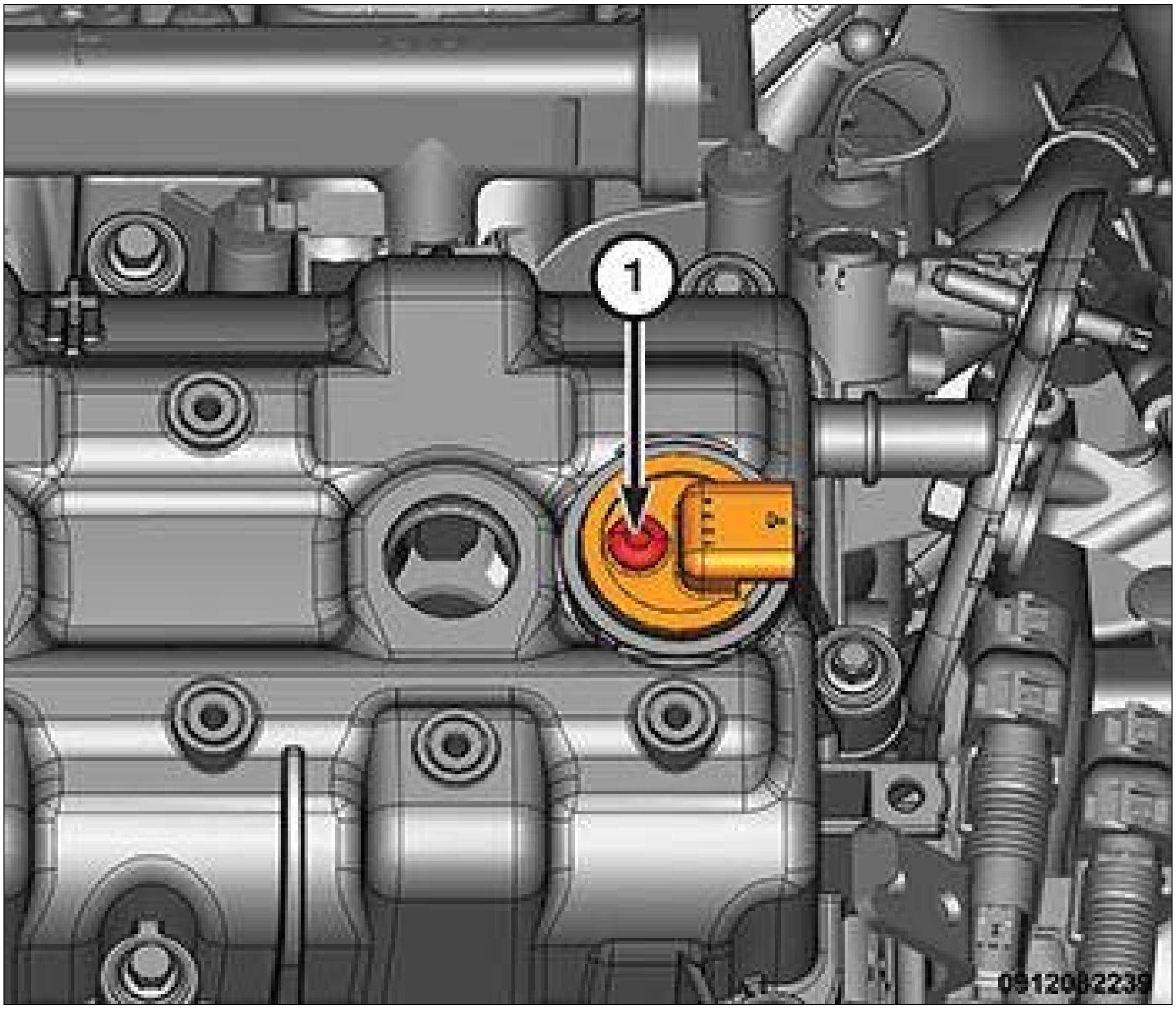
Fig 7: Left Side Ignition Coils



Courtesy of CHRYSLER GROUP, LLC

14. Remove the left side ignition coils (1). Refer to COIL, IGNITION, REMOVAL .

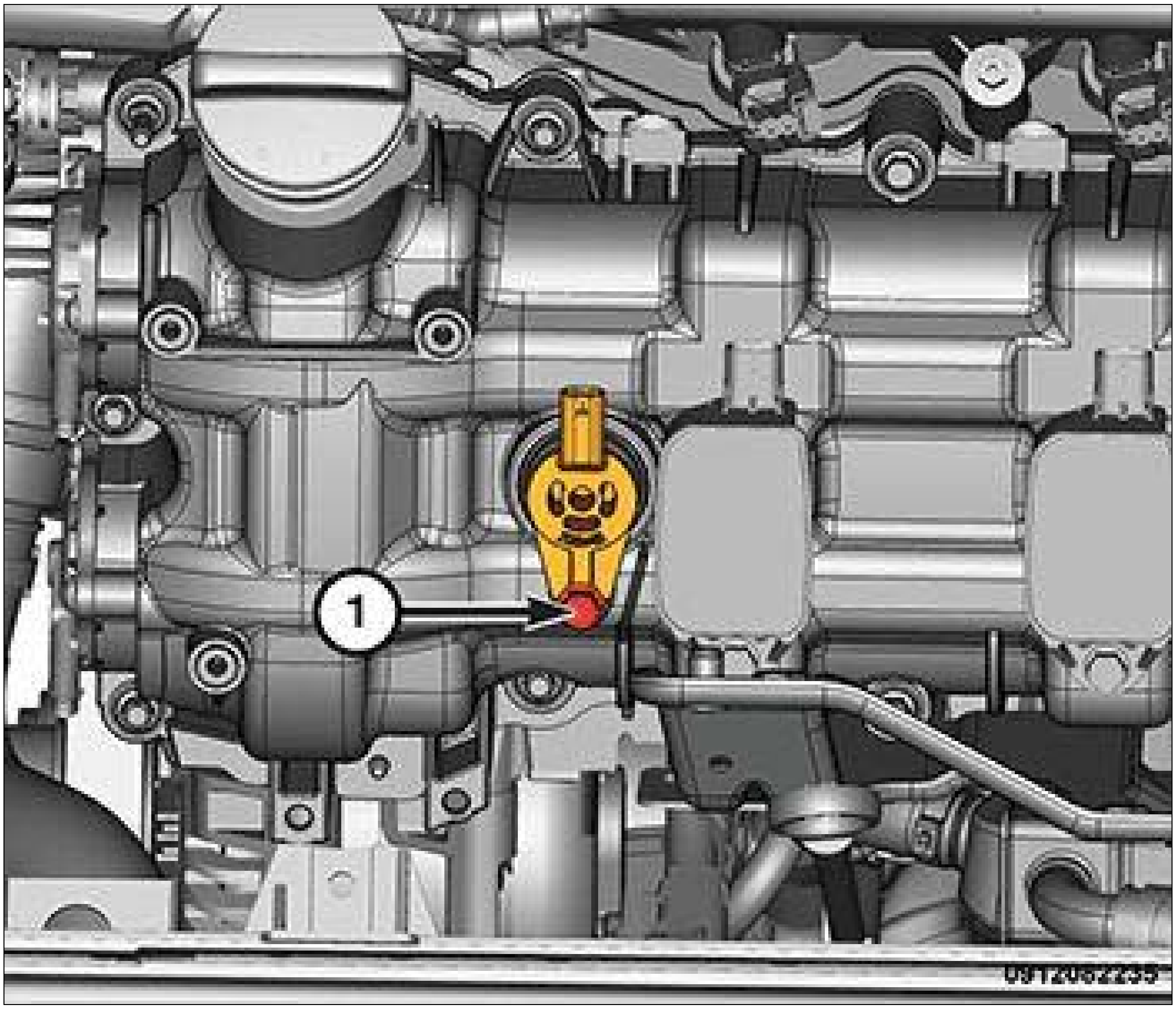
Fig 8: Camshaft Position (CMP) Sensor At Left Cylinder Head Cover



Courtesy of CHRYSLER GROUP, LLC

15. Remove the camshaft position sensor from the left cylinder head cover. Refer to SENSOR, CAMSHAFT POSITION, REMOVAL .

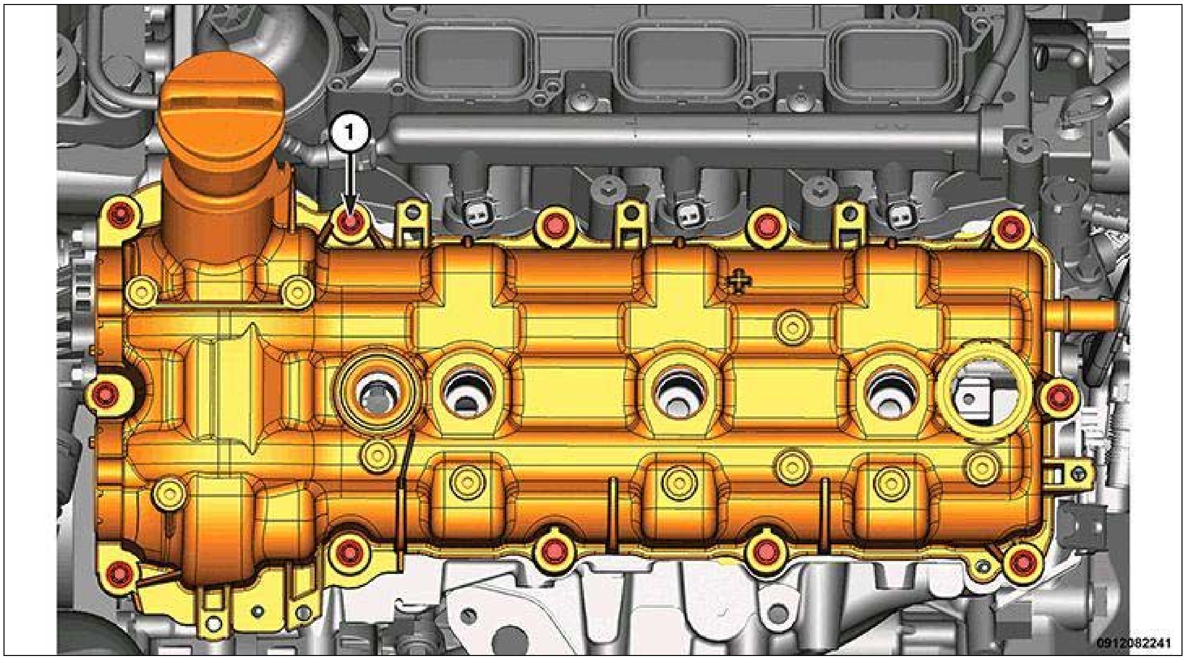
Fig 9: VVL Solenoid At Left Cylinder Head Cover



Courtesy of CHRYSLER GROUP, LLC

16. Remove the VVL solenoid (1) from the left cylinder head cover. Refer to SOLENOID, VARIABLE VALVE LIFT, REMOVAL .

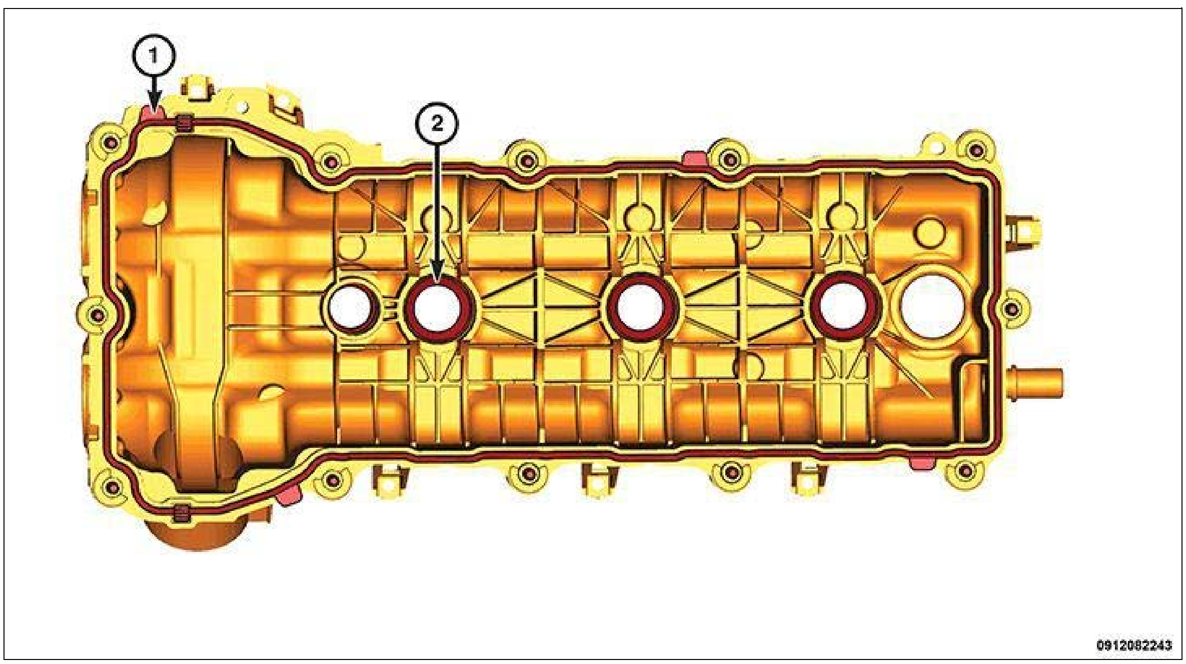
Fig 10: Cylinder Head Cover Mounting Fasteners



Courtesy of CHRYSLER GROUP, LLC

17. Loosen ten cylinder head cover mounting fasteners (1) and remove the cylinder head cover.

Fig 11: 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.

⚠ *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 from the cylinder head, timing chain cover and cylinder head cover mating surfaces. Refer to ENGINE GASKET SURFACE PREPARATION .

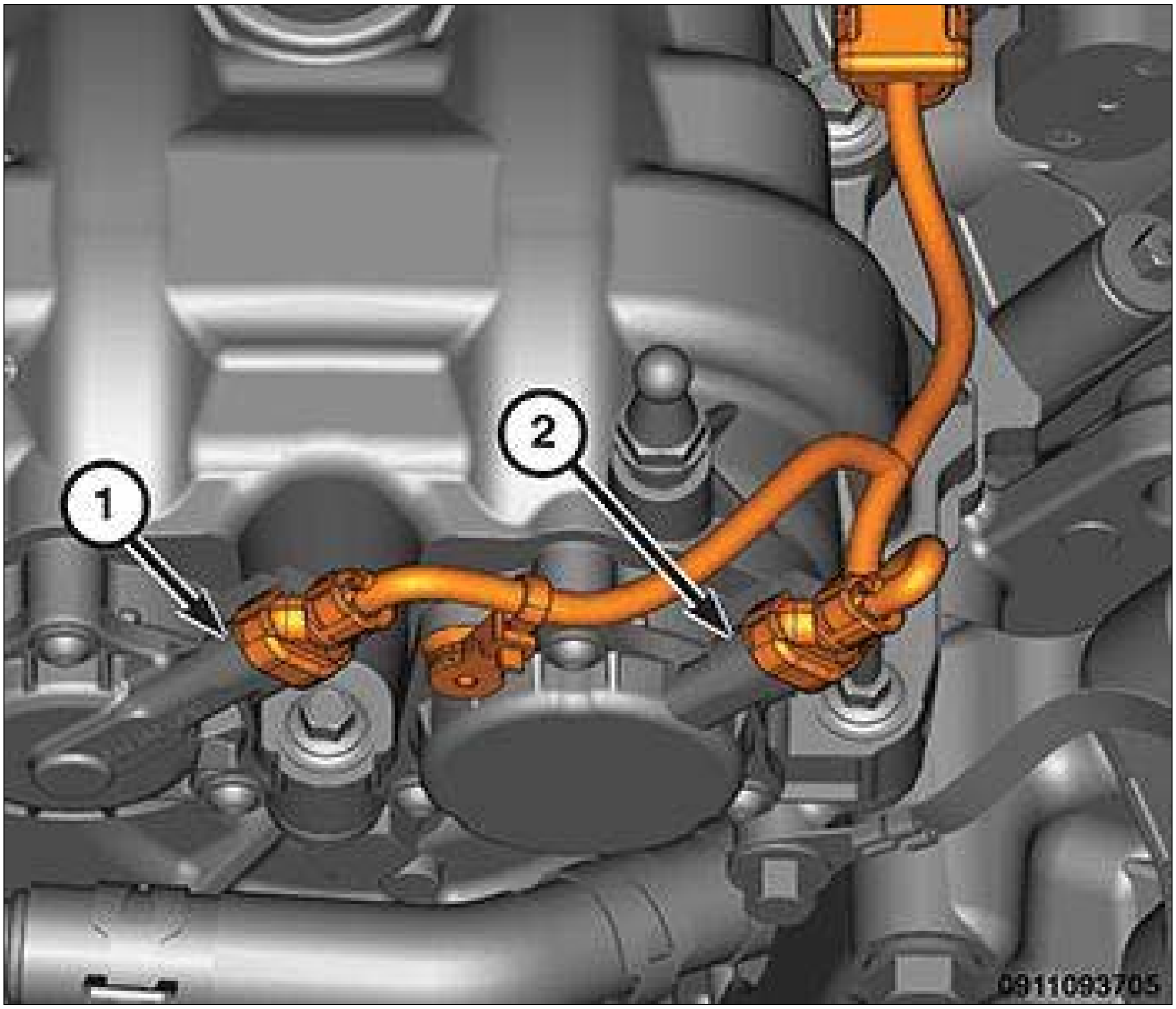
CYLINDER HEAD > COVER(S), CYLINDER HEAD > REMOVAL > RIGHT

NOTE:

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

1. Disconnect and isolate the negative battery cable.
2. Remove the upper intake manifold. Refer to MANIFOLD, INTAKE, REMOVAL .
3. Cover the open intake ports to prevent debris from entering the engine.

Fig 1: Variable Valve Timing Solenoids Wire Harness Connectors At Right Cylinder Head Cover



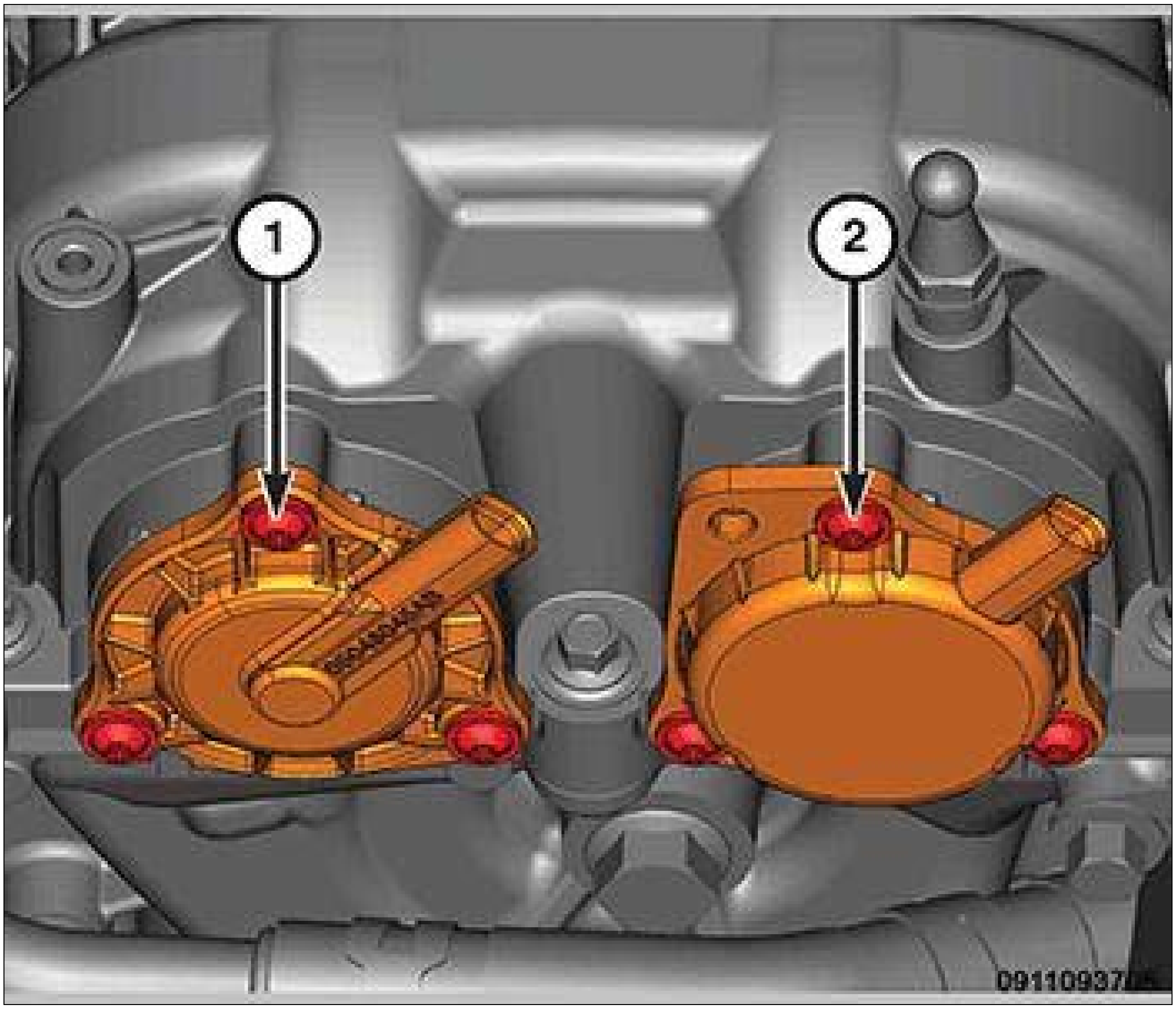
Courtesy of CHRYSLER GROUP, LLC

4. Disconnect the wire harness connectors (1 and 2) from the variable valve timing solenoids on the right cylinder head cover.

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

5. Disengage the wire harness retainers from the right cylinder head cover.

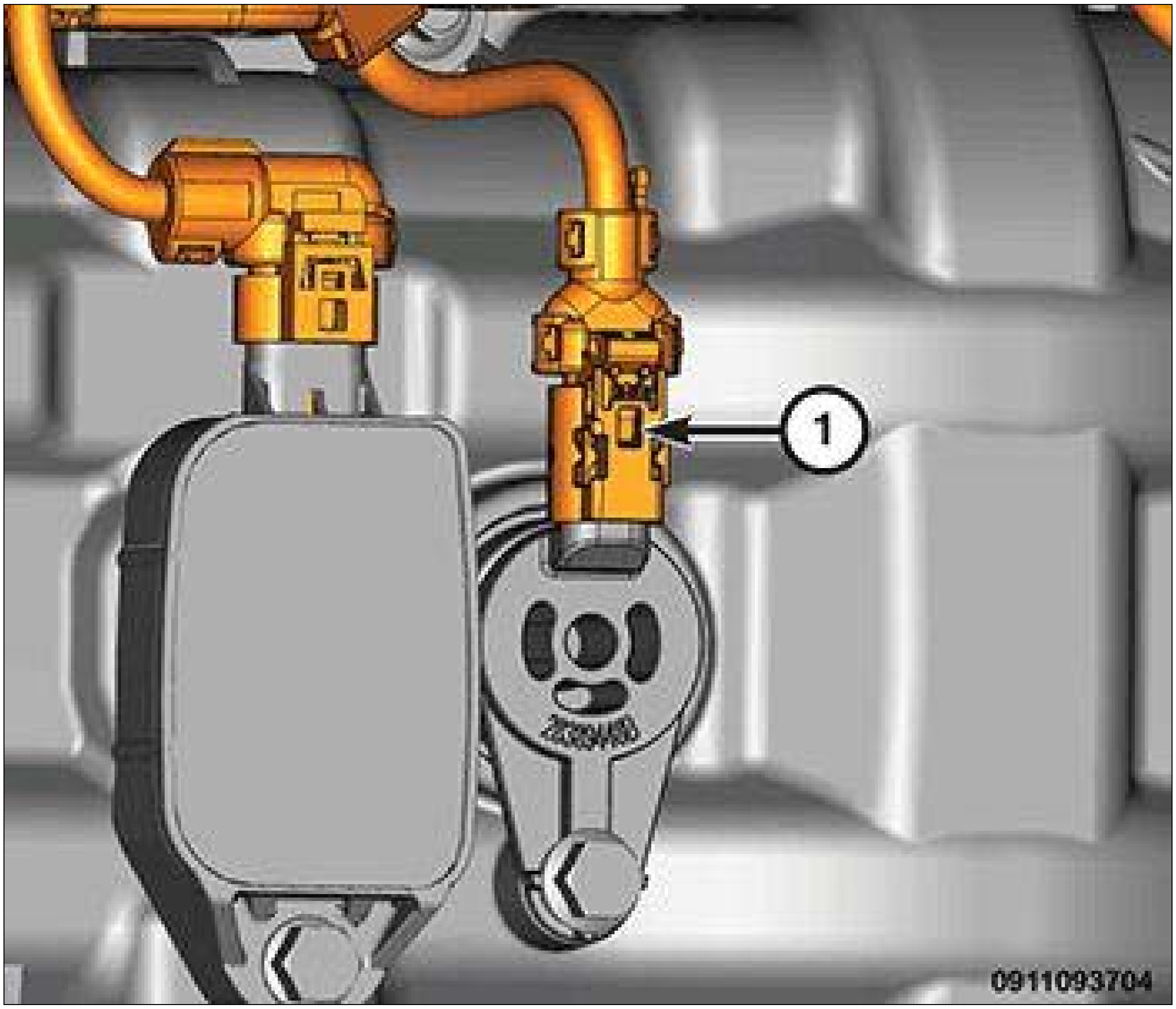
Fig 2: Variable Valve Timing Solenoids



Courtesy of CHRYSLER GROUP, LLC

6. Mark the variable valve timing solenoids (1 and 2) with a paint pen or equivalent so that they may be reinstalled in their original locations.
7. Remove the variable valve timing solenoids. Refer to SOLENOID, VARIABLE VALVE TIMING, REMOVAL .

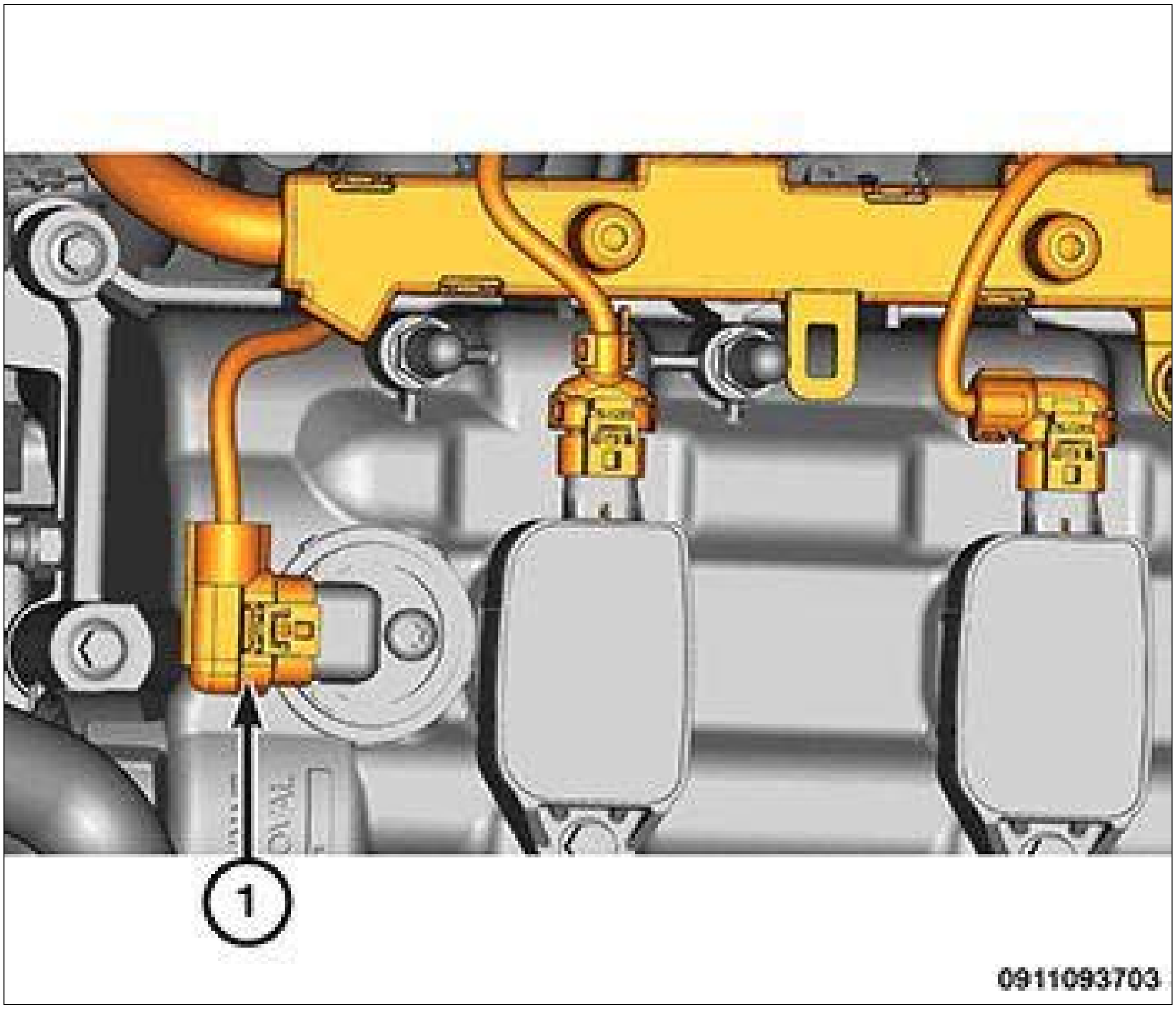
Fig 3: Variable Valve Lift (VVL) Solenoid Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

8. Disconnect the Variable Valve Lift (VVL) solenoid wire harness connector (1).

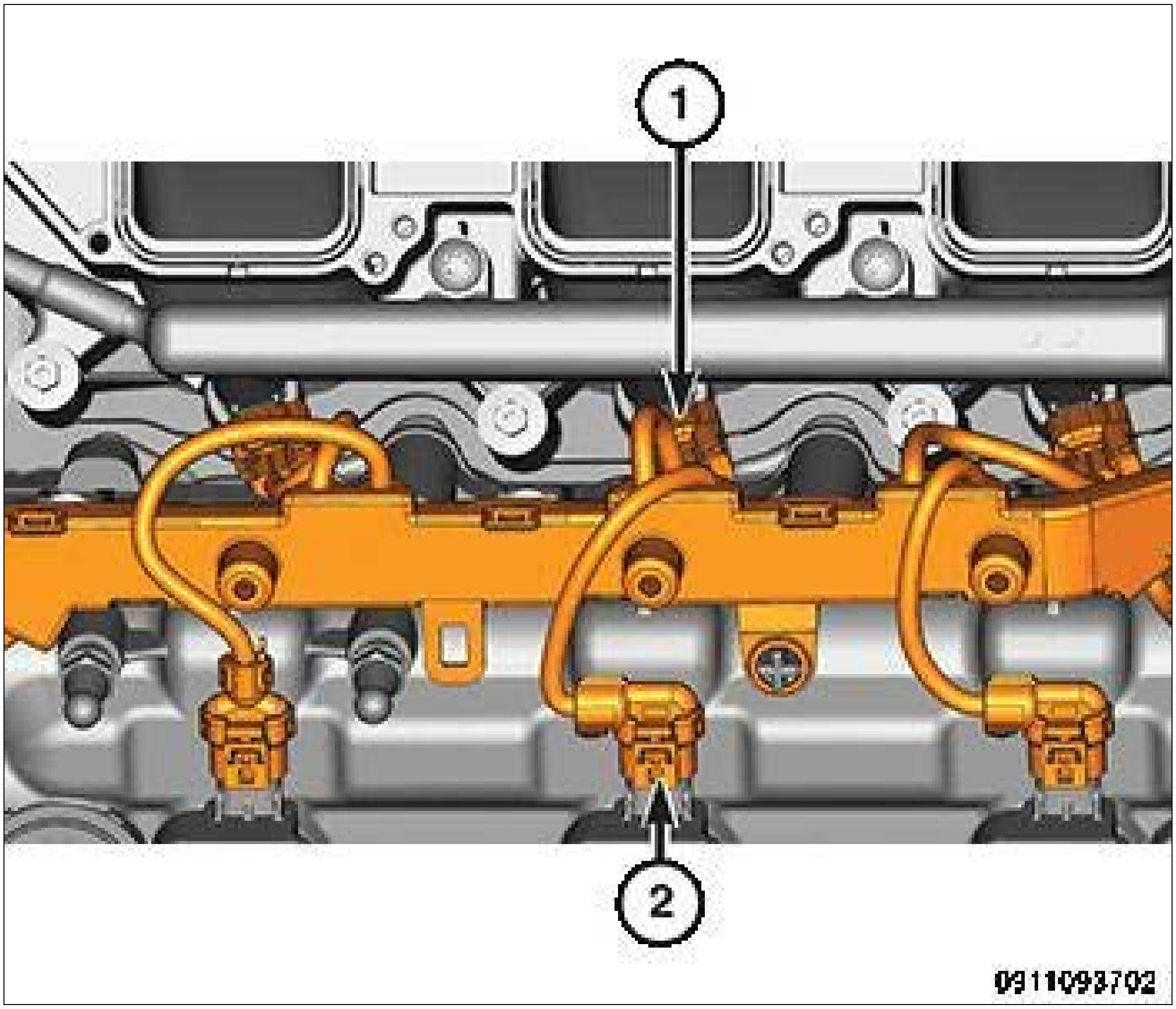
Fig 4: Right Side Camshaft Position (CMP) Sensor Wire Harness Connectors



Courtesy of CHRYSLER GROUP, LLC

9. Disconnect the wire harness connector (1) from the right side Camshaft Position (CMP) sensor.

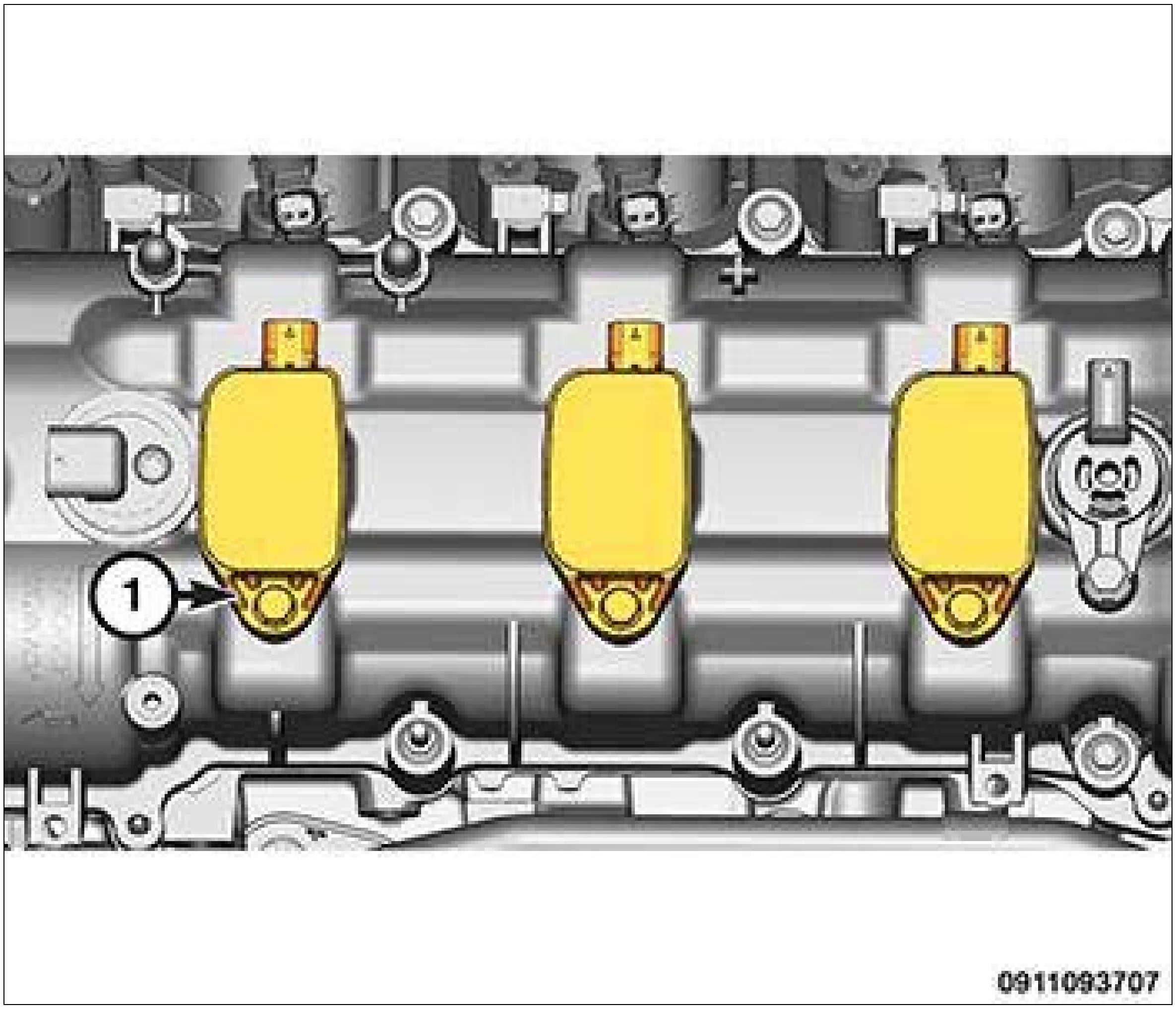
Fig 5: Injector & Ignition Wire Harness Retainers



Courtesy of CHRYSLER GROUP, LLC

10. Disconnect the injector (1) and ignition (2) wire harness retainers and position the wire harness aside.

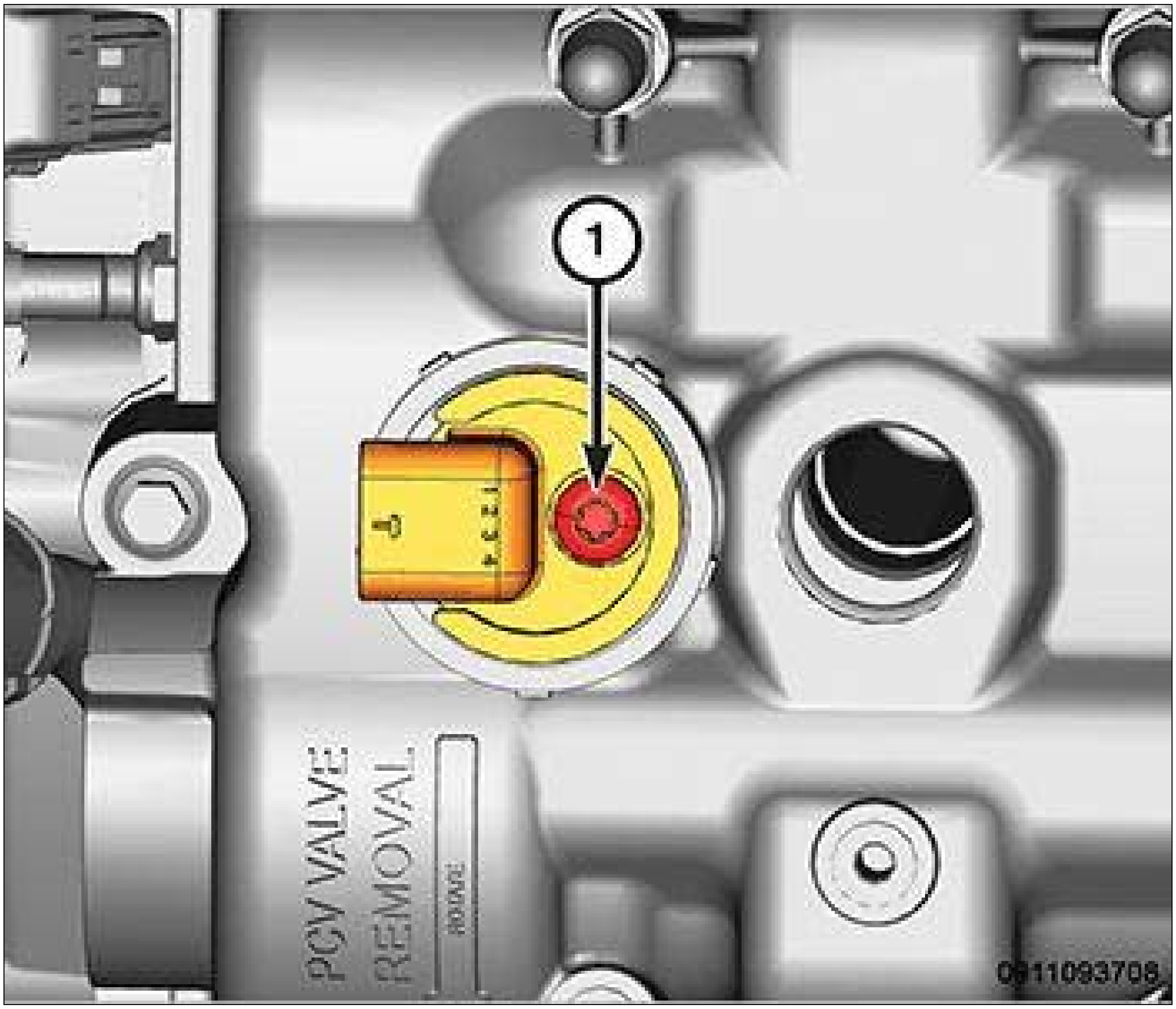
Fig 6: Right Side Ignition Coils



Courtesy of CHRYSLER GROUP, LLC

11. Remove the right side ignition coils (1). Refer to COIL, IGNITION, REMOVAL .

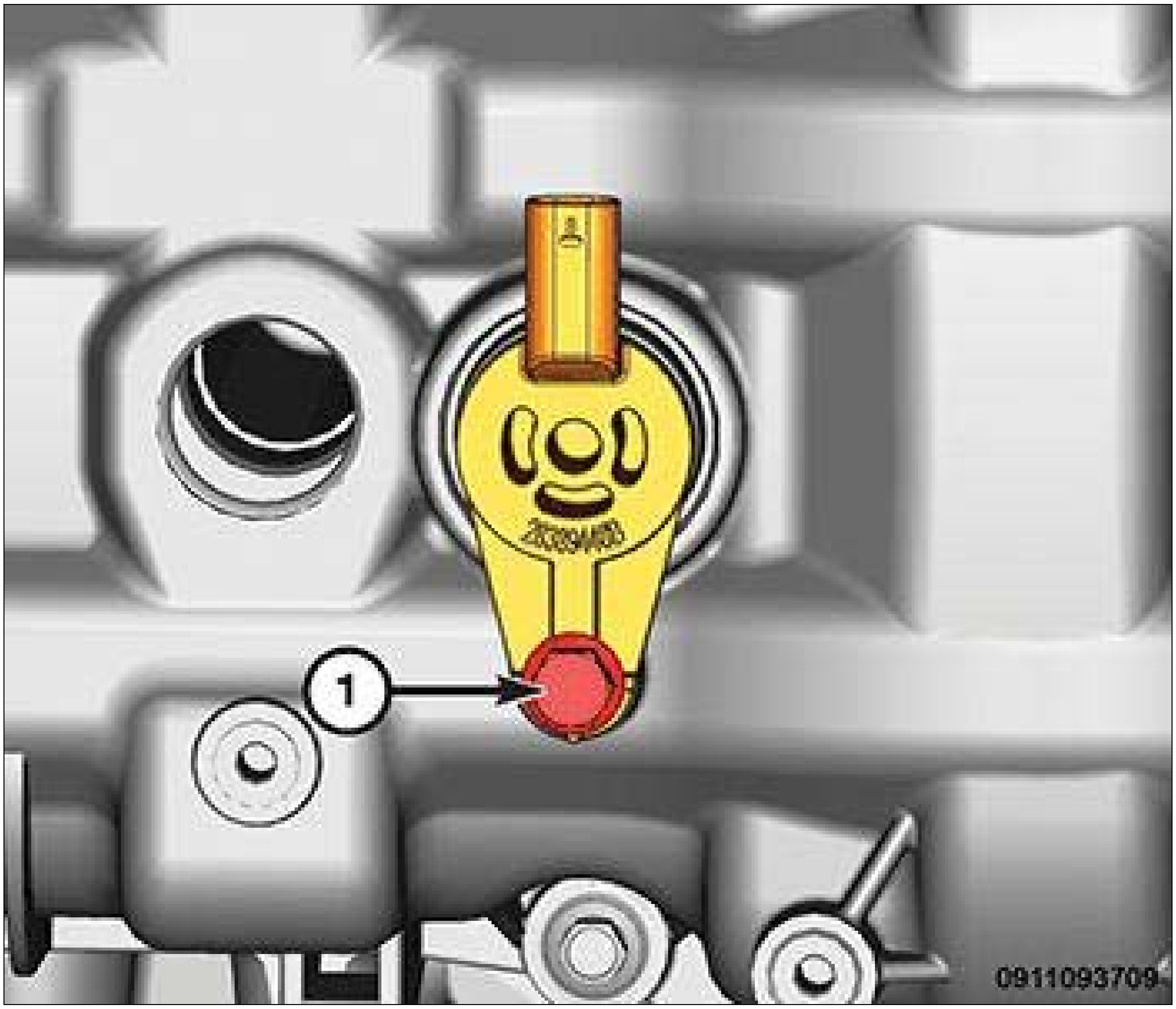
Fig 7: Camshaft Position Sensor



Courtesy of CHRYSLER GROUP, LLC

12. Remove the camshaft position sensor (1). Refer to SENSOR, CAMSHAFT POSITION, REMOVAL .

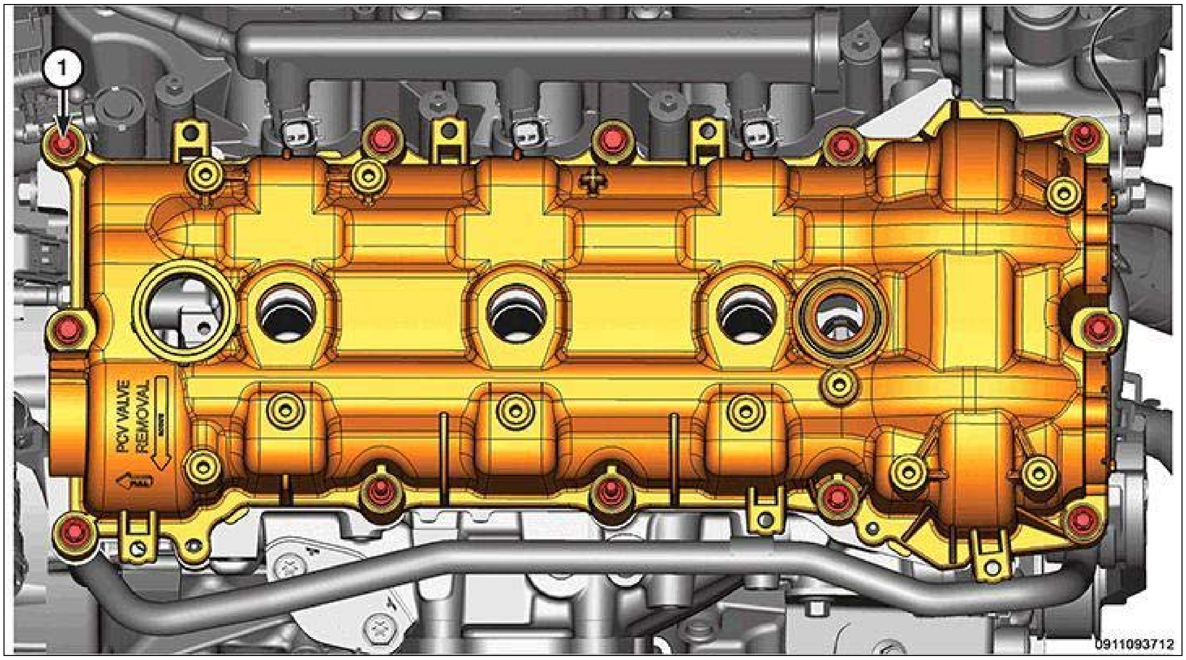
Fig 8: VVL Solenoid At Right Cylinder Head Cover



Courtesy of CHRYSLER GROUP, LLC

13. Remove the VVL solenoid (1) from the right cylinder head cover.
14. Remove the PCV valve. Refer to VALVE, POSITIVE CRANKCASE VENTILATION (PCV), 3.6L, REMOVAL .

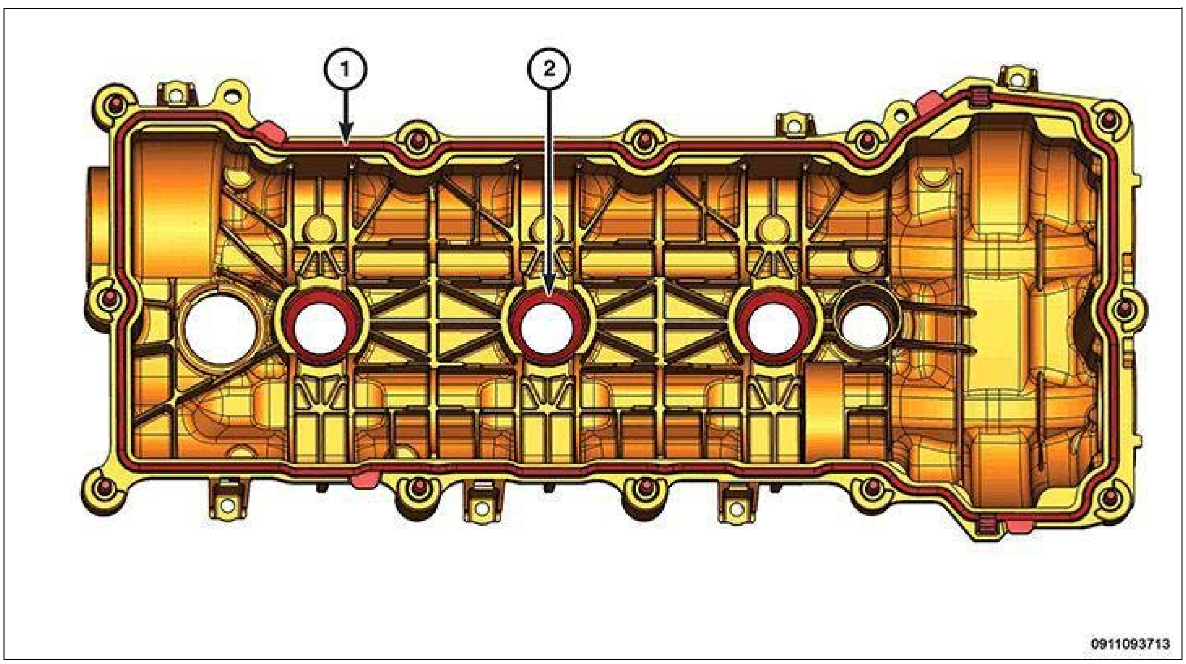
Fig 9: Cylinder Head Cover Mounting Bolts



Courtesy of CHRYSLER GROUP, LLC

15. Loosen the cylinder head cover mounting bolts (1) and remove the cylinder head cover.

Fig 10: Cylinder Head Cover Gasket & Spark Plug Tube Seals



Courtesy of CHRYSLER GROUP, LLC

16. Remove and discard the cylinder head cover gasket (1).

17. The spark plug tube seals (2) can be reused if not damaged.

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.

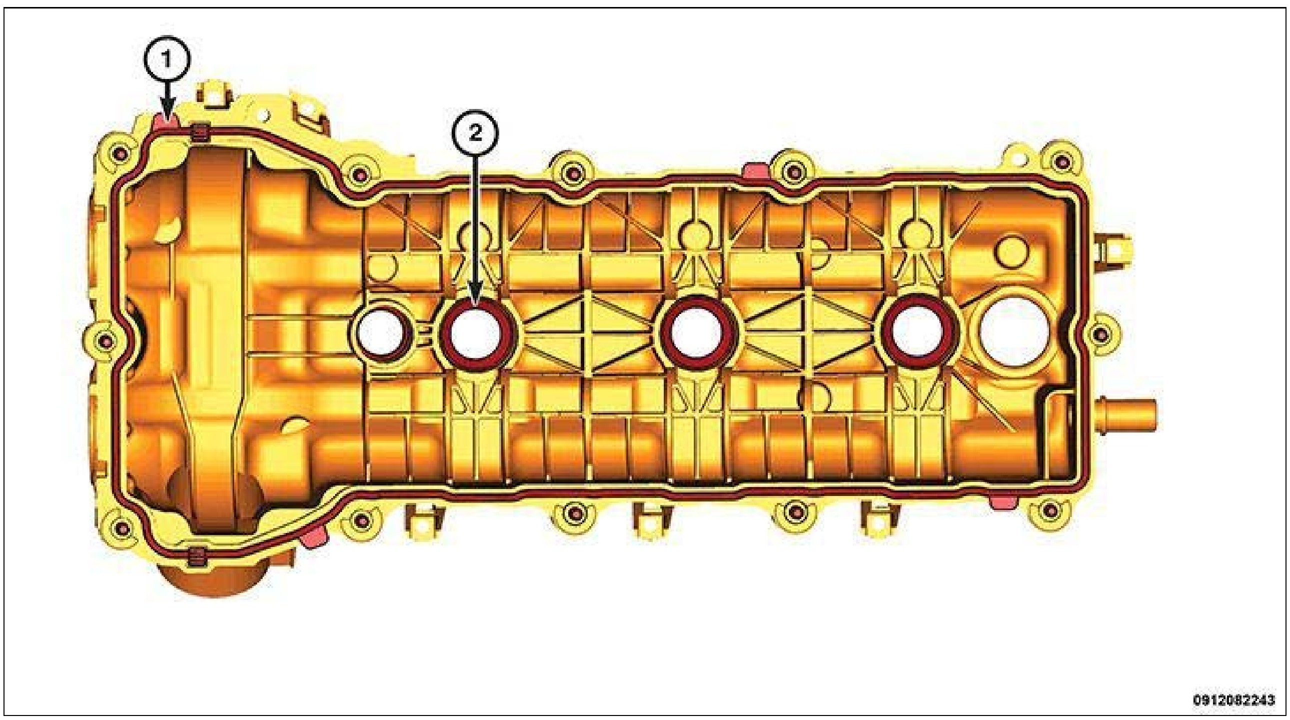
18. Remove all residual sealant from the cylinder head, timing chain cover and cylinder head cover mating surfaces. Refer to ENGINE GASKET SURFACE PREPARATION .

CYLINDER HEAD > COVER(S), CYLINDER HEAD > INSTALLATION > LEFT

NOTE:

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

Fig 1: Cylinder Head Cover Gasket & Spark Plug Tube Seals



Courtesy of CHRYSLER GROUP, LLC

1. Install the **NEW** cylinder head cover gasket (1).
2. The spark plug tube seals (2) can be reused if not damaged.
3. If required, install new spark plug tube seals, in the cylinder head cover.
4. Clean the timing engine timing cover, cylinder head and cylinder head cover mating surfaces

with isopropyl alcohol in preparation for sealant application.

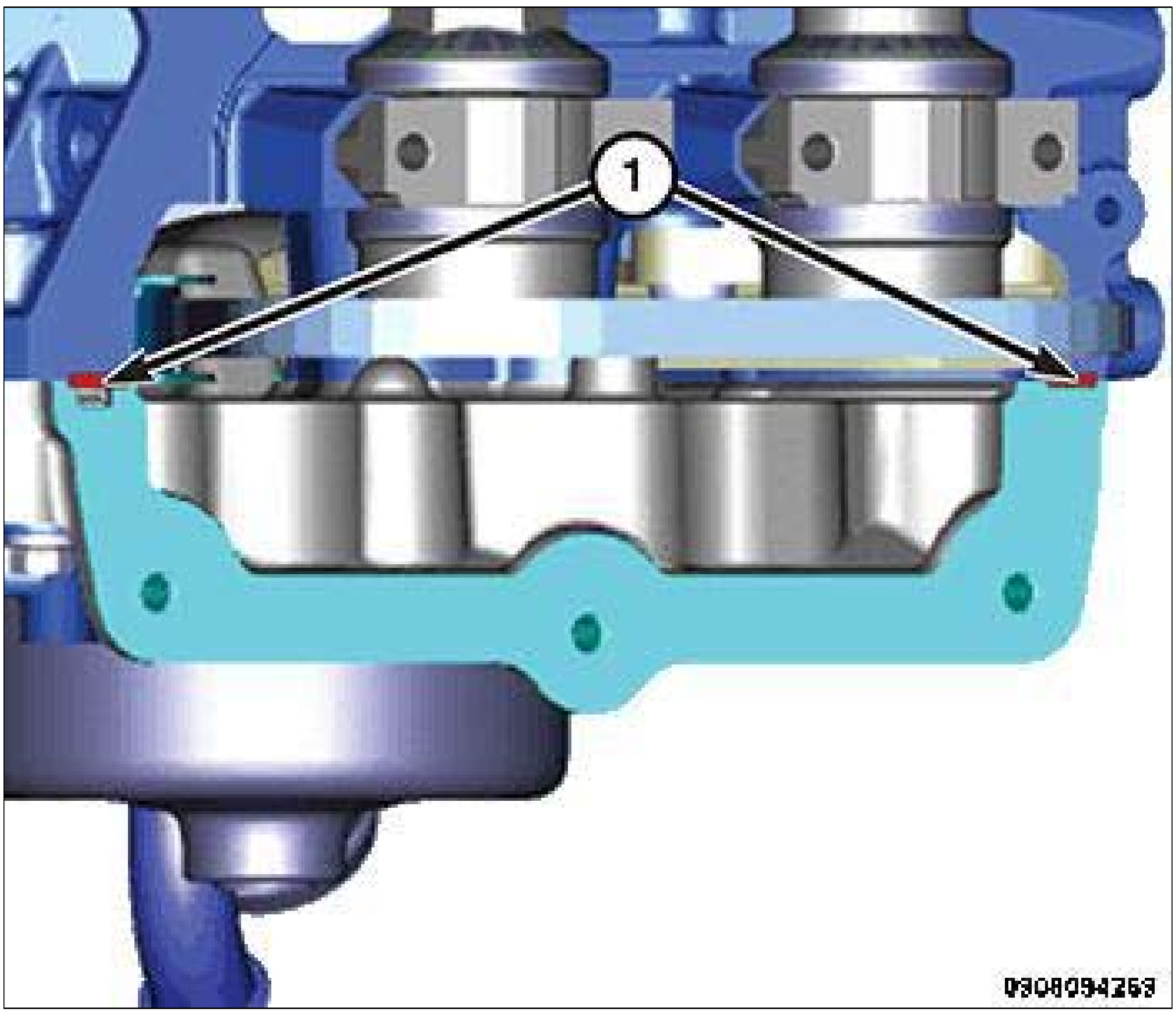
CAUTION:

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.

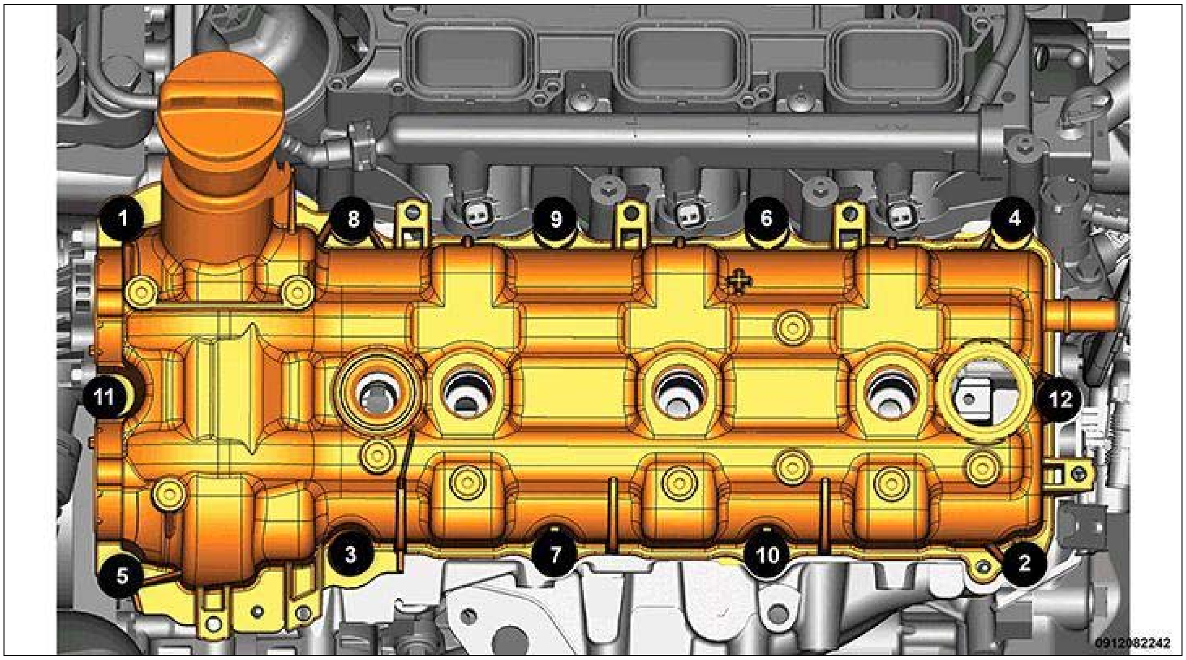
Fig 2: Applying Sealant At Engine Timing Cover To Cylinder Head T-Joints



Courtesy of CHRYSLER GROUP, LLC

5. Apply a 11 mm dollop of Mopar® Threebond Engine RTV Sealant to the two engine timing cover to cylinder head T-joints (1).

Fig 3: Cylinder Head Cover Bolts & Studs Tightening Sequence

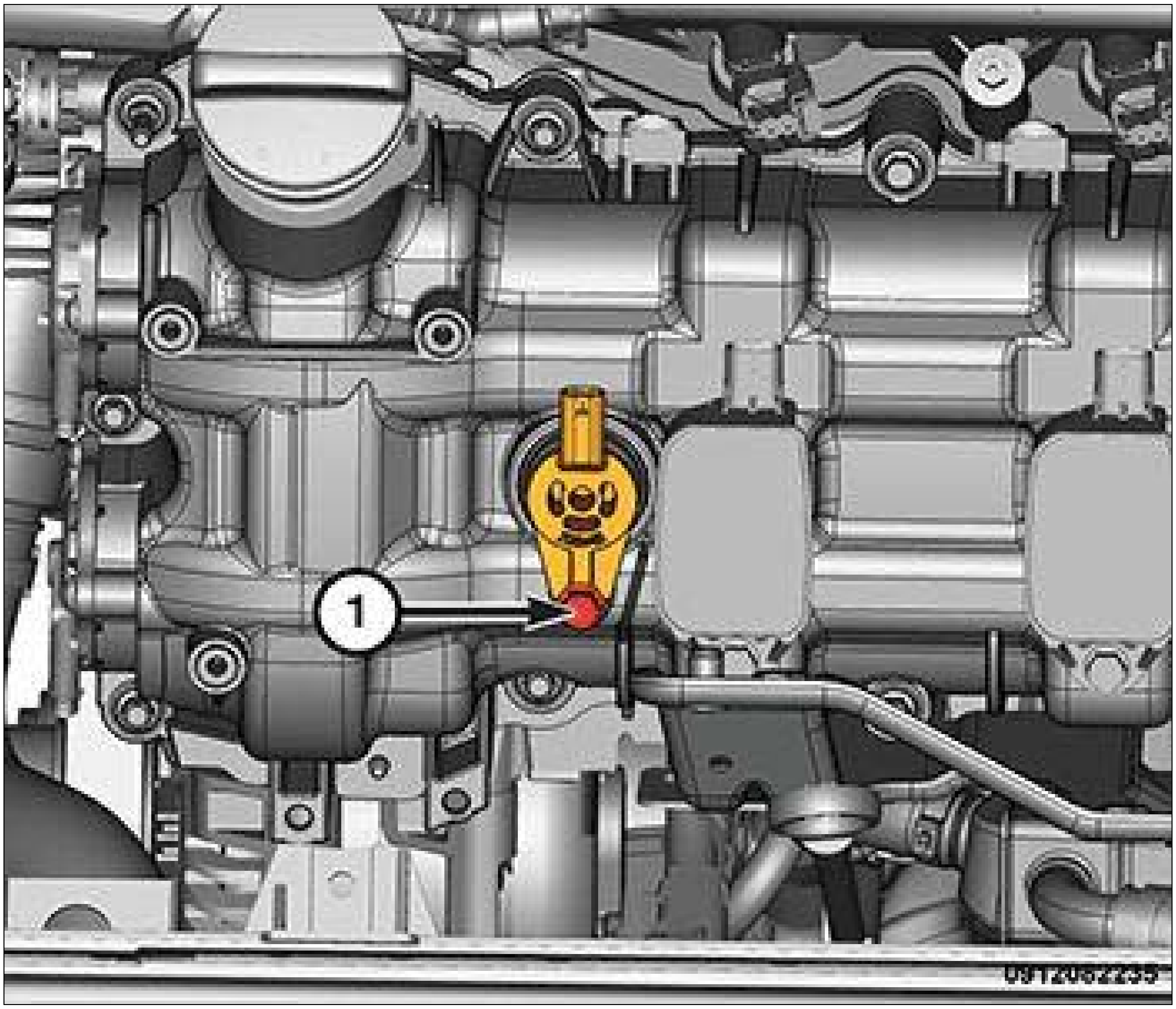


Courtesy of CHRYSLER GROUP, LLC

6. Align the locator pins 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.).

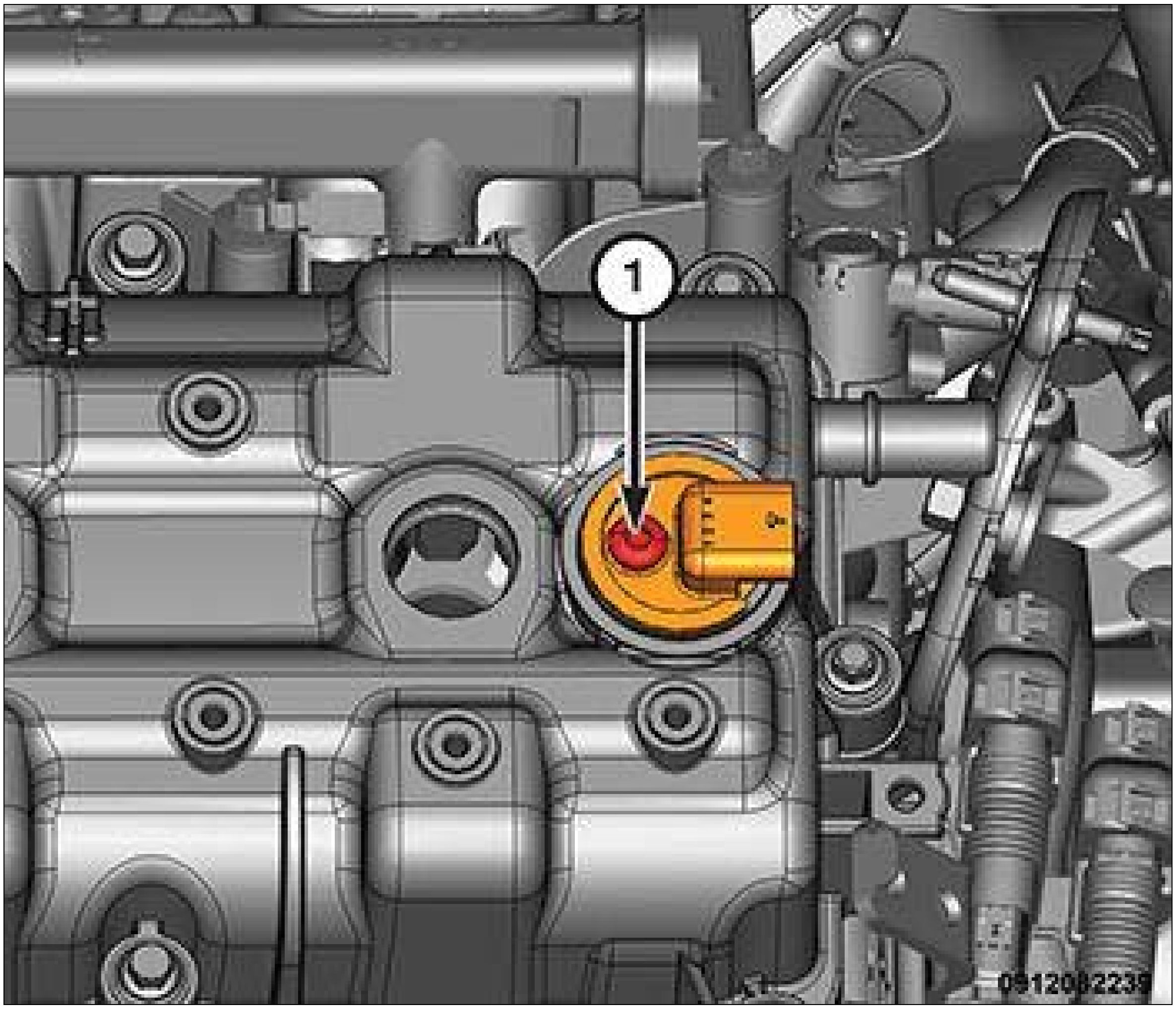
Fig 4: VVL Solenoid At Left Cylinder Head Cover



Courtesy of CHRYSLER GROUP, LLC

8. Install the VVL solenoid (1) into the left cylinder head cover. Refer to SOLENOID, VARIABLE VALVE LIFT, INSTALLATION .

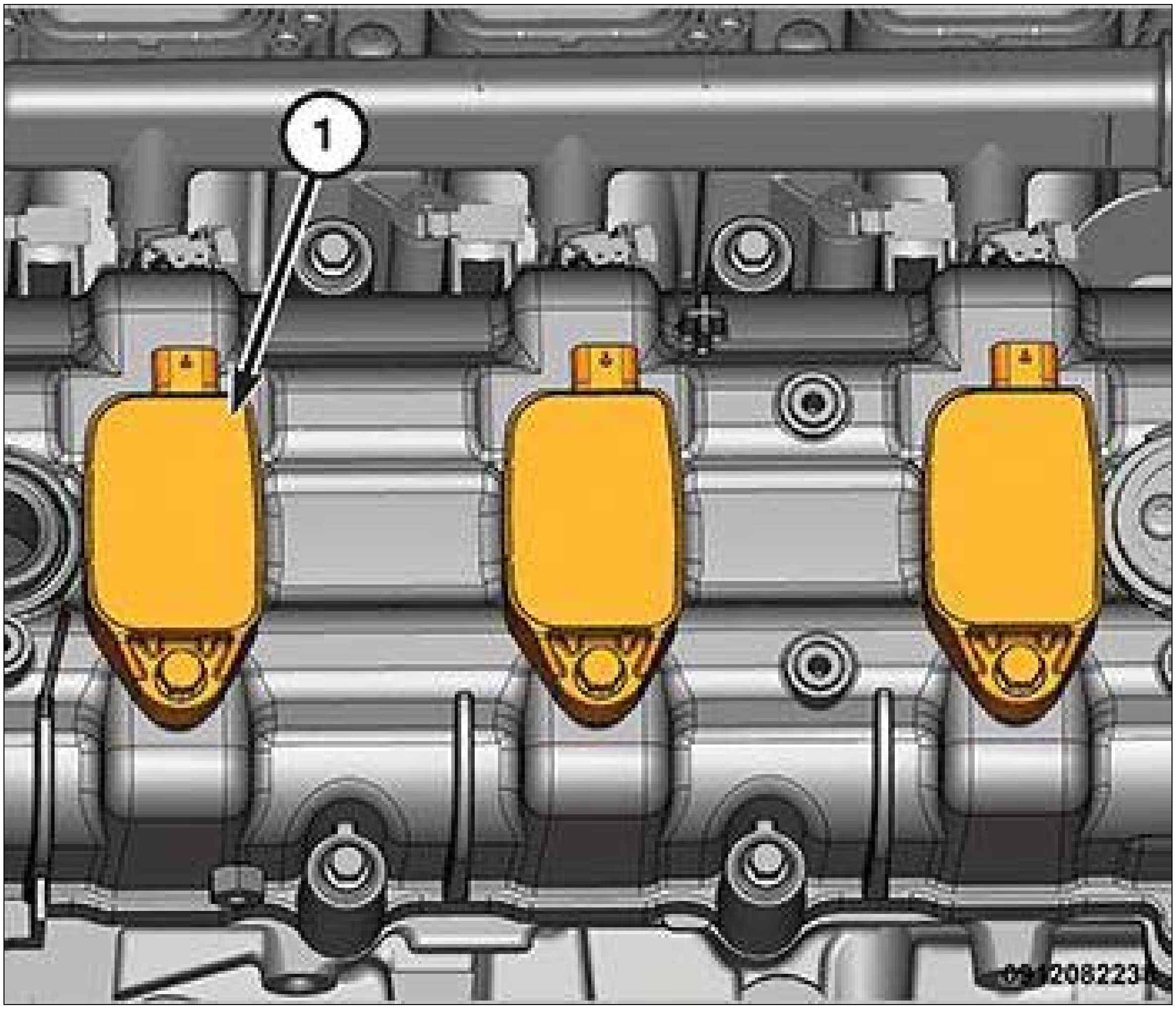
Fig 5: Camshaft Position (CMP) Sensor At Left Cylinder Head Cover



Courtesy of CHRYSLER GROUP, LLC

9. Install the Camshaft Position (CMP) sensor (1) into the left cylinder head cover. Refer to SENSOR, CAMSHAFT POSITION, INSTALLATION .

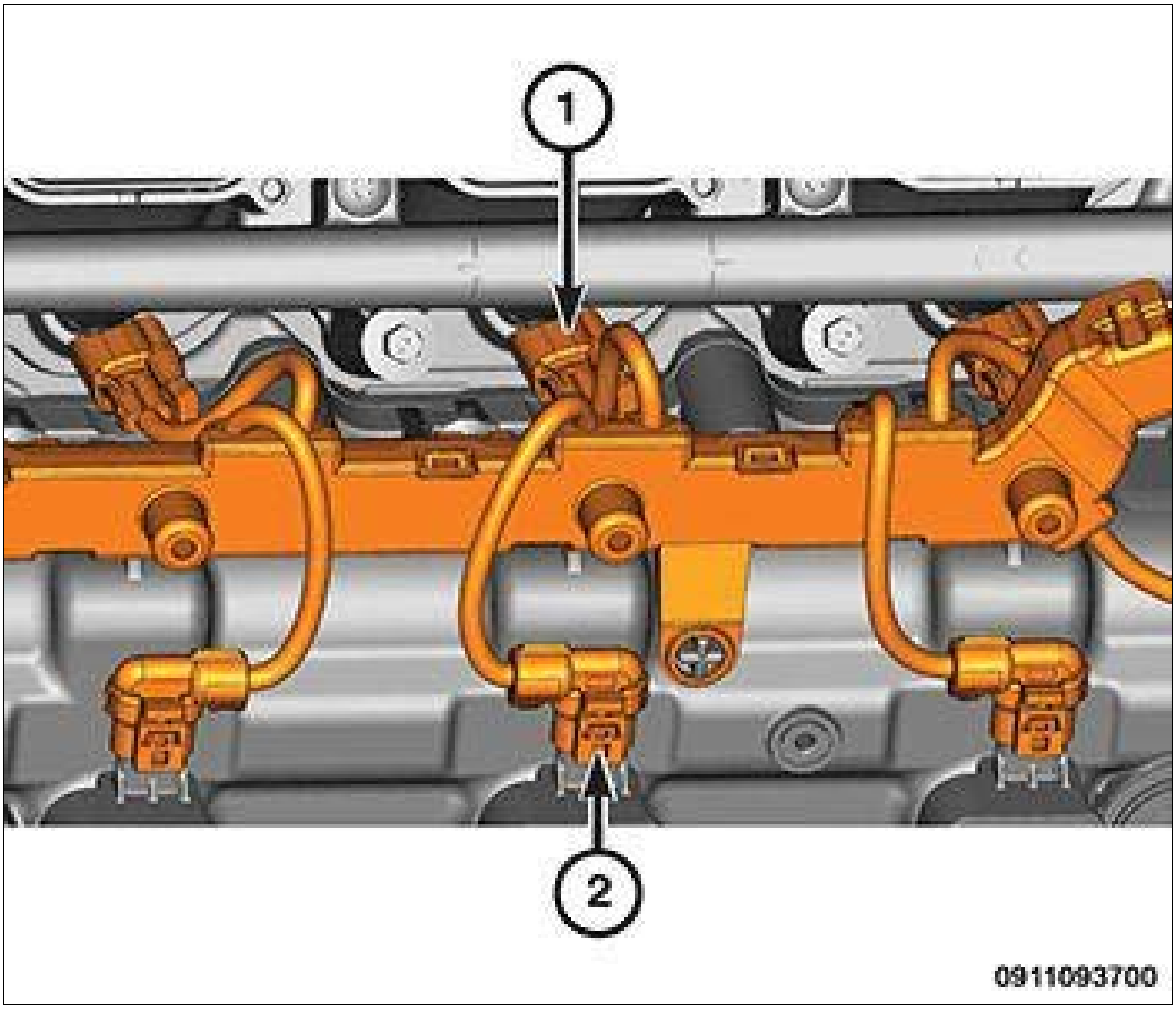
Fig 6: Left Side Ignition Coils



Courtesy of CHRYSLER GROUP, LLC

10. Install the left side ignition coils (1). Refer to COIL, IGNITION, INSTALLATION .

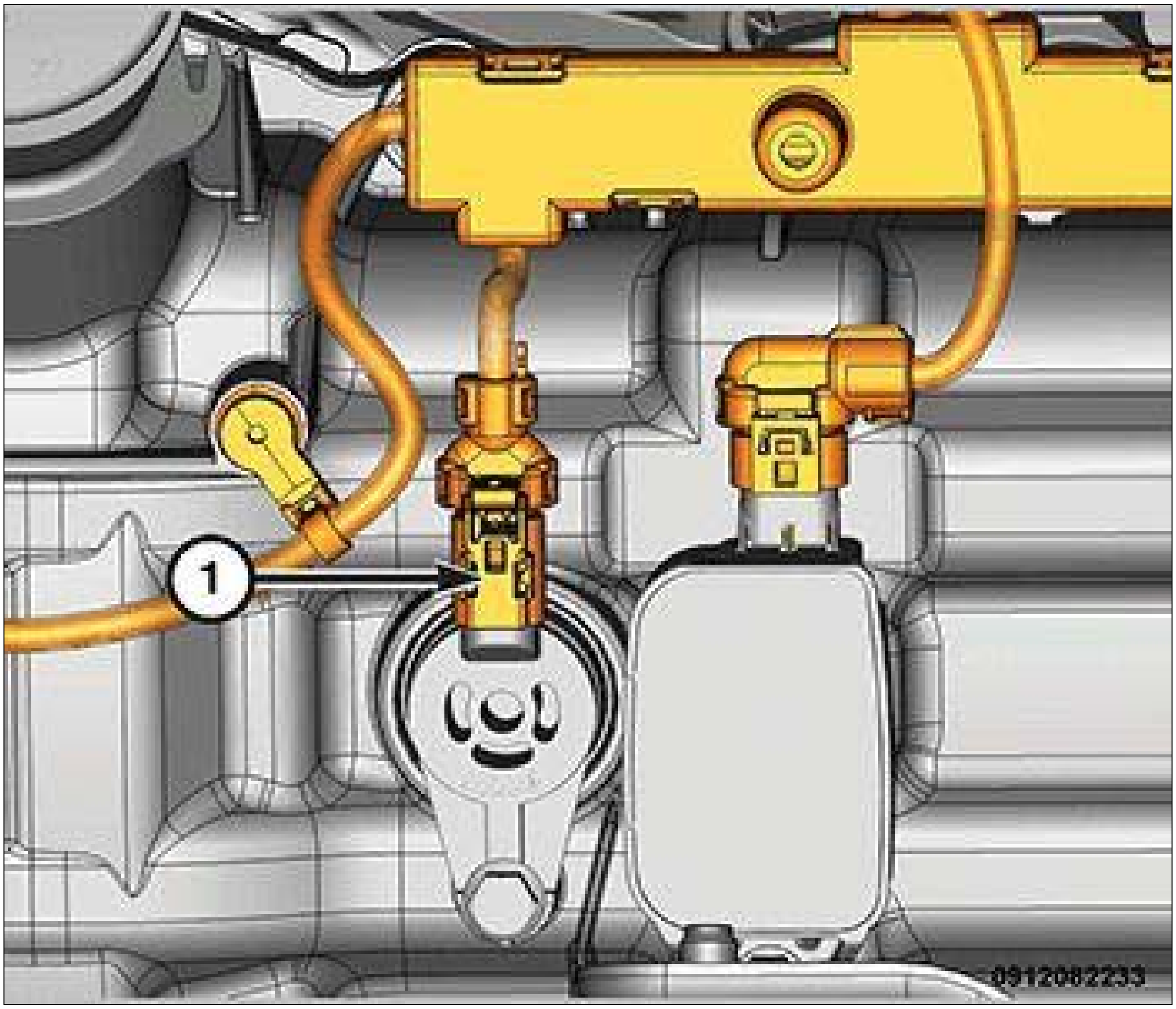
Fig 7: Fuel Injectors & Ignition Coils Wire Harness Connectors



Courtesy of CHRYSLER GROUP, LLC

11. Install the wire harness assembly onto the left side cylinder head cover.
12. Connect the wire harness connectors to the fuel injectors (1) and ignition coils (2).

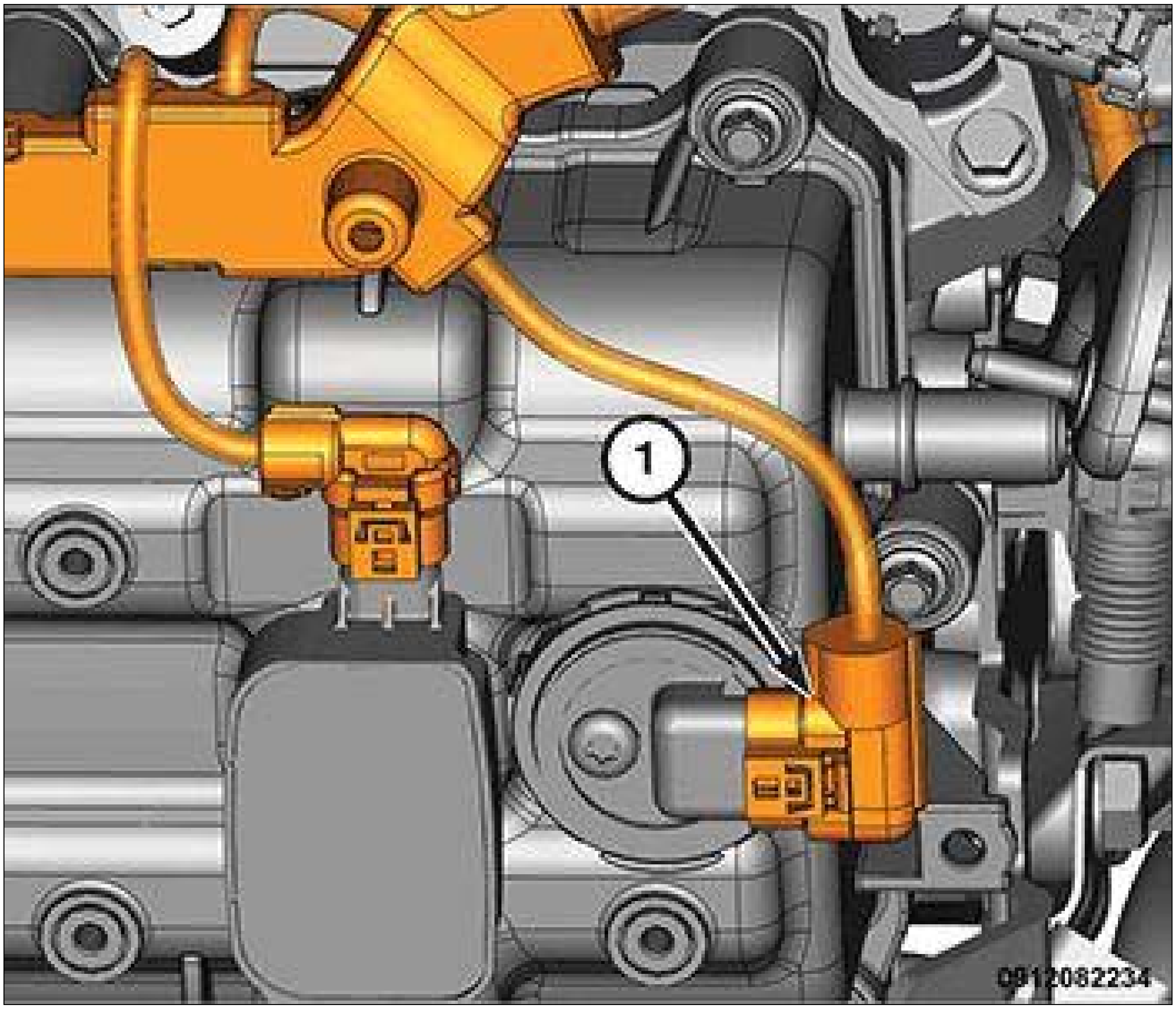
Fig 8: Variable Valve Lift (VVL) Solenoid Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

13. Connect the Variable Valve Lift (VVL) solenoid wire harness connector (1).

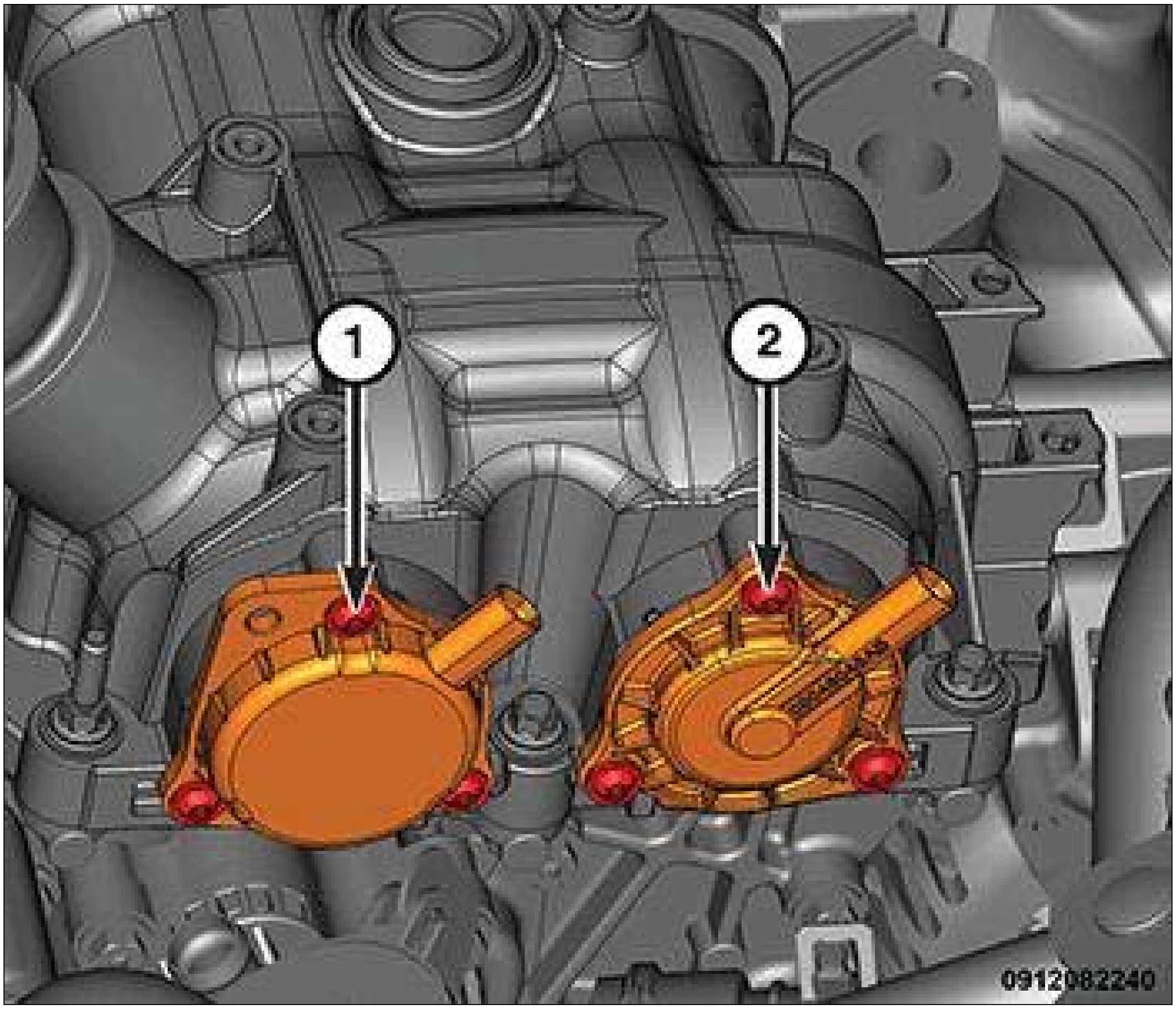
Fig 9: Left Camshaft Position (CMP) Sensor Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

14. Connect the wire harness connector (1) to the left Camshaft Position (CMP) sensor.

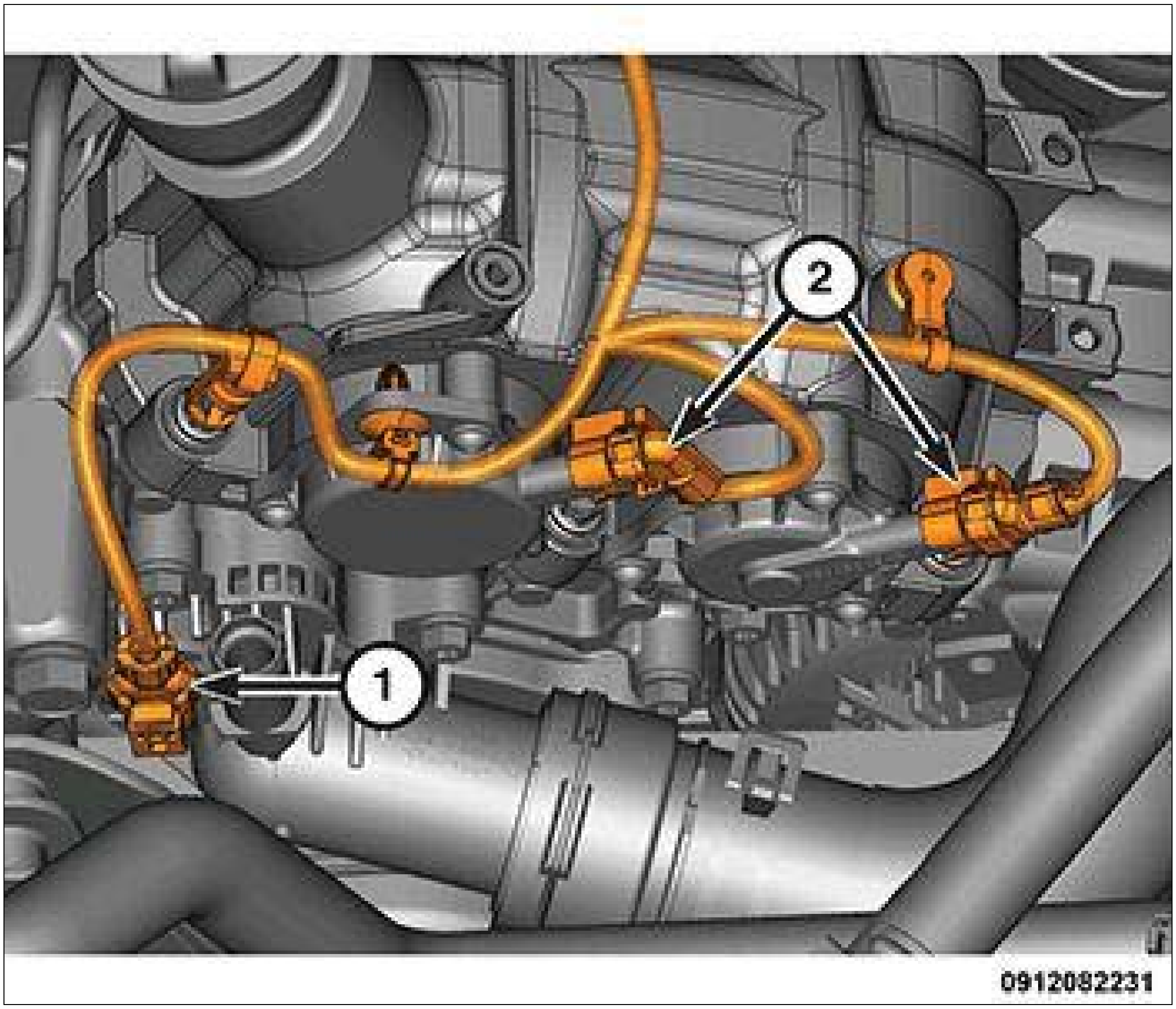
Fig 10: Variable Valve Timing Solenoids



Courtesy of CHRYSLER GROUP, LLC

15. Refer to the markings made at disassembly and install the variable valve timing solenoids (1 and 2) in their original locations. Refer to SOLENOID, VARIABLE VALVE TIMING, INSTALLATION .

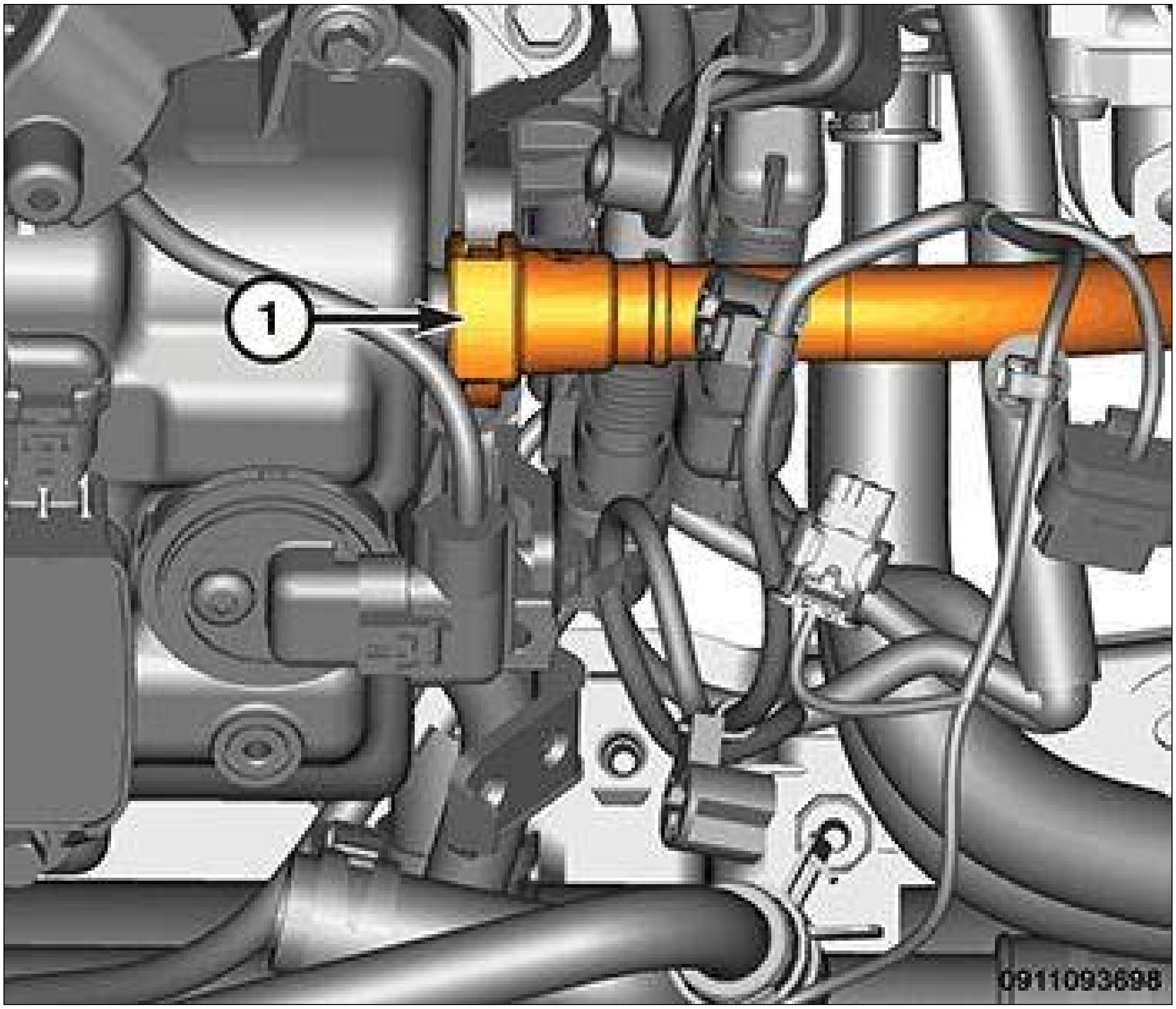
Fig 11: Variable Valve Timing Solenoids Wire Harness Connectors & Coolant Temperature Sensor Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

16. Engage the wire harness retainers to the left cylinder head cover.
17. Connect the wire harness connectors (2) to the left variable valve timing solenoids.
18. Connect the wire harness connector to the coolant temperature sensor (1)
19. Install the air cleaner body. Refer to BODY, AIR CLEANER, INSTALLATION .

Fig 12: Fresh Air Makeup Hose



Courtesy of CHRYSLER GROUP, LLC

20. Install the fresh air makeup hose (1).
21. Fill the engine cooling system. Refer to STANDARD PROCEDURE .
22. Connect the negative battery cable.

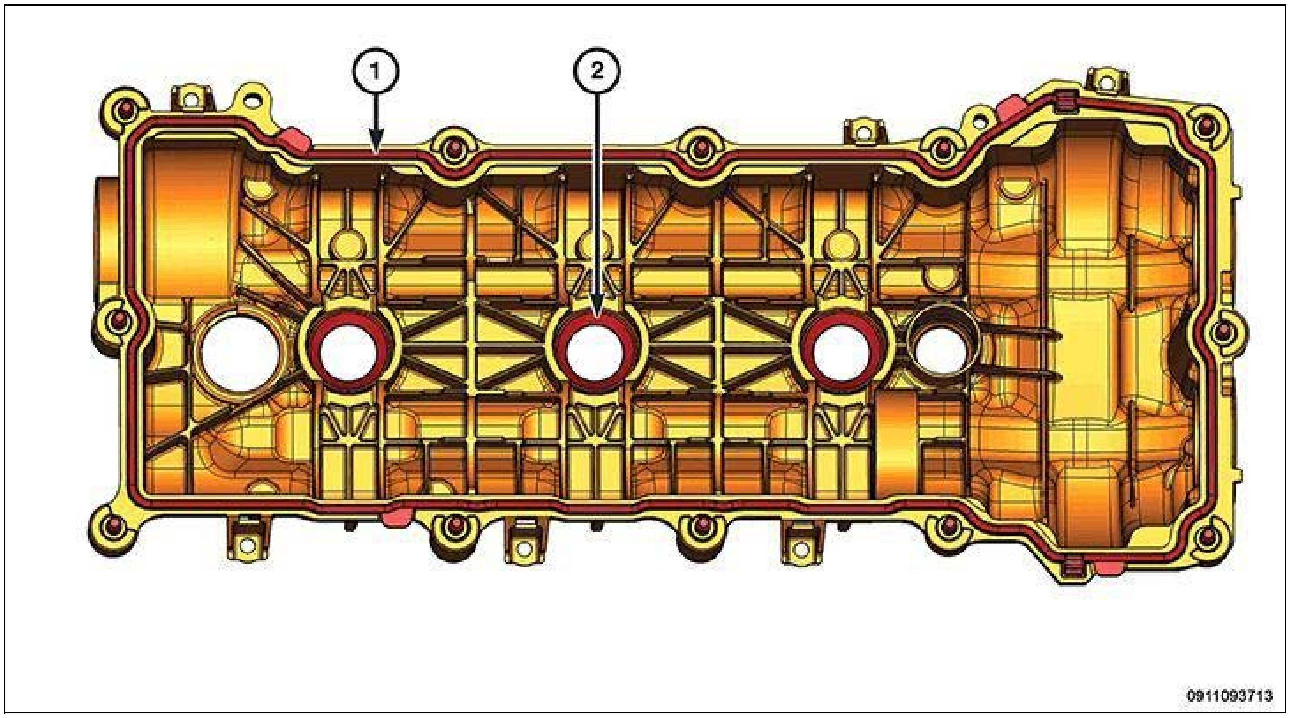
> *NOTE:*
>
> *The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system. For example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components.*

CYLINDER HEAD > COVER(S), CYLINDER HEAD > INSTALLATION > RIGHT

> *NOTE:*

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

Fig 1: Cylinder Head Cover Gasket & Spark Plug Tube Seals



Courtesy of CHRYSLER GROUP, LLC

1. Install the **NEW** cylinder head cover gasket (1).
2. If required, install new spark plug tube seals (2), in the cylinder head cover.
3. Clean the engine timing cover, cylinder head and cylinder head cover mating surfaces with isopropyl alcohol in preparation for sealant application.

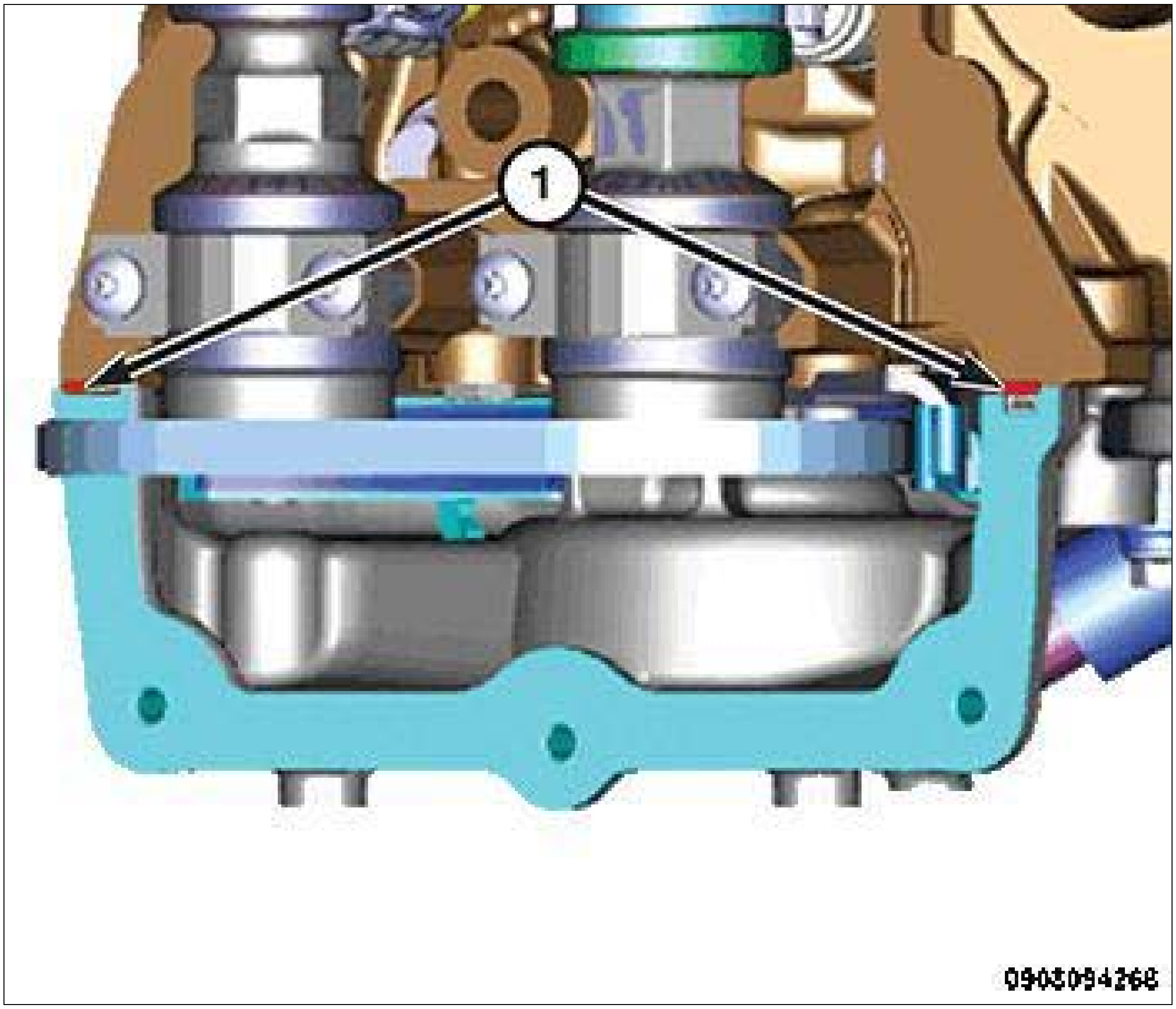
CAUTION:

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.

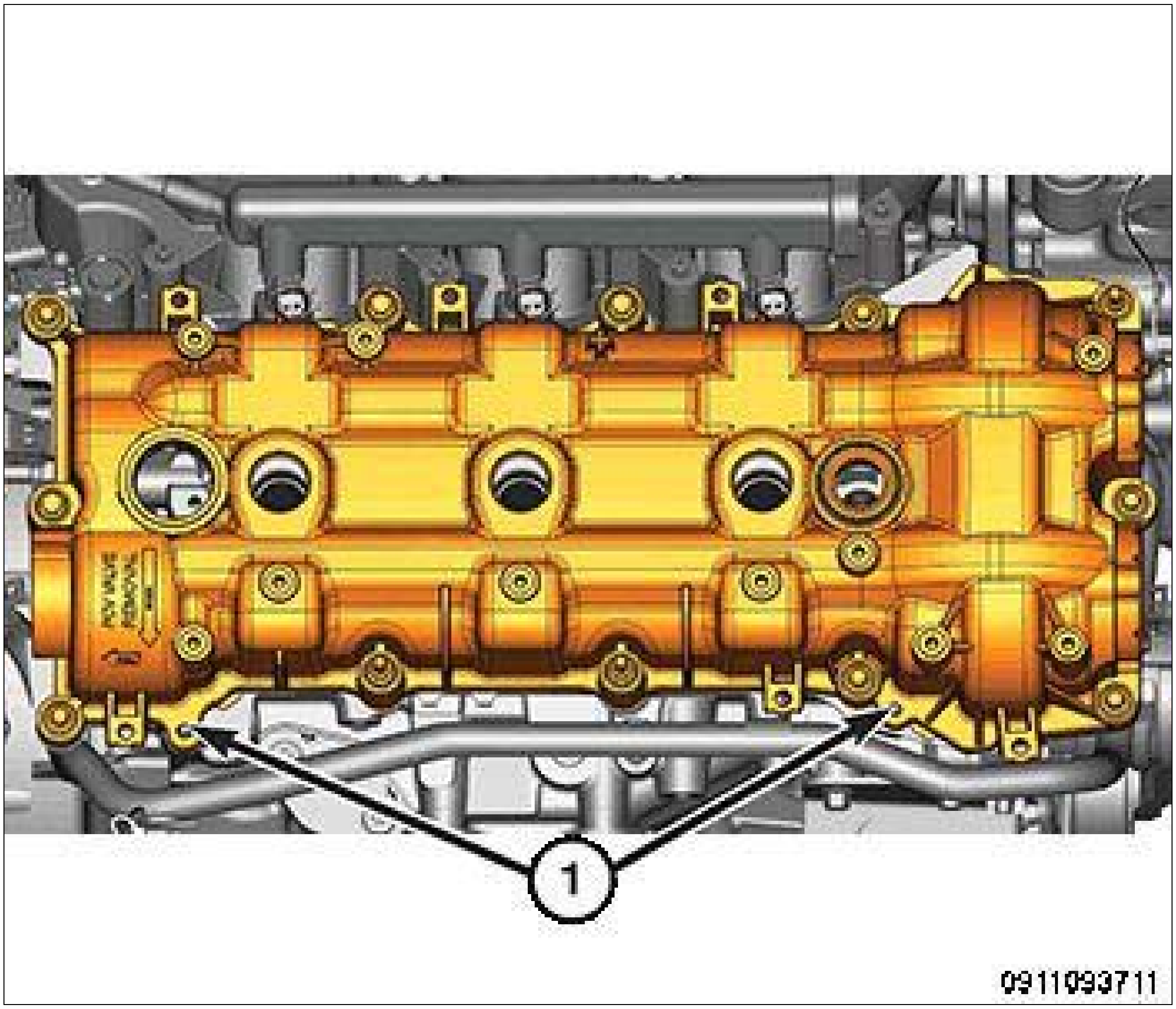
Fig 2: Applying Sealant At Engine Timing Cover To Cylinder Head T-Joints



Courtesy of CHRYSLER GROUP, LLC

4. Apply a 11 mm dollop of Mopar® Threebond Engine RTV Sealant to the two engine timing cover to cylinder head T-joints (1).

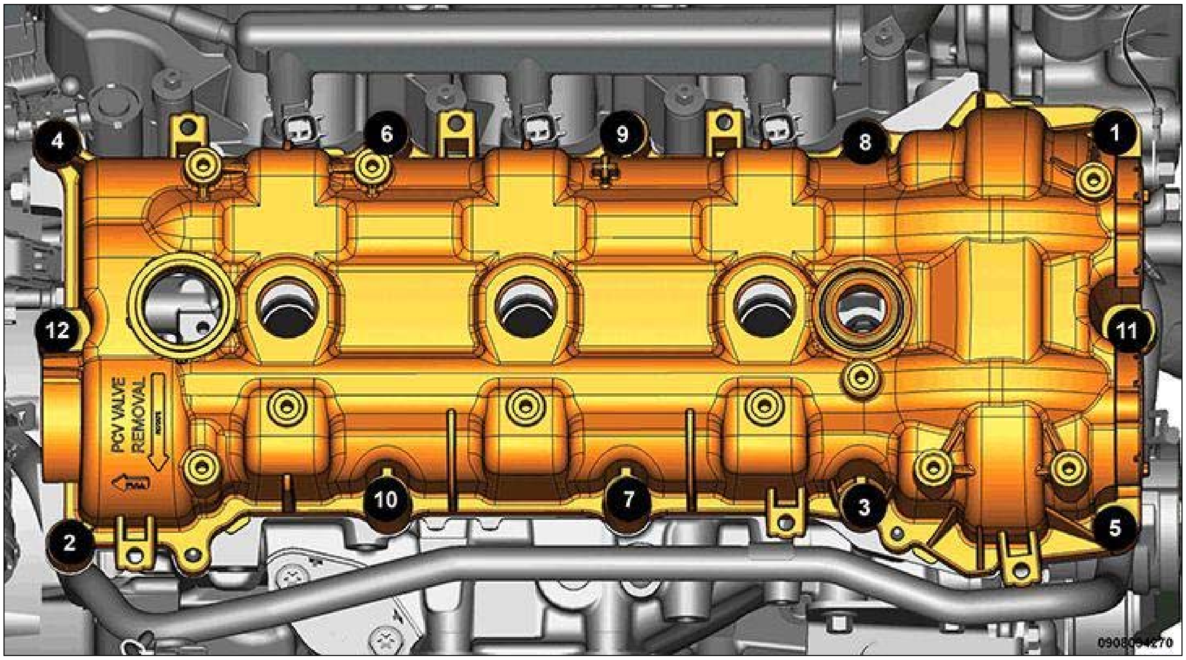
Fig 3: Locator Pins



Courtesy of CHRYSLER GROUP, LLC

5. Align the locator pins (1) to the cylinder head and install the cylinder head cover.

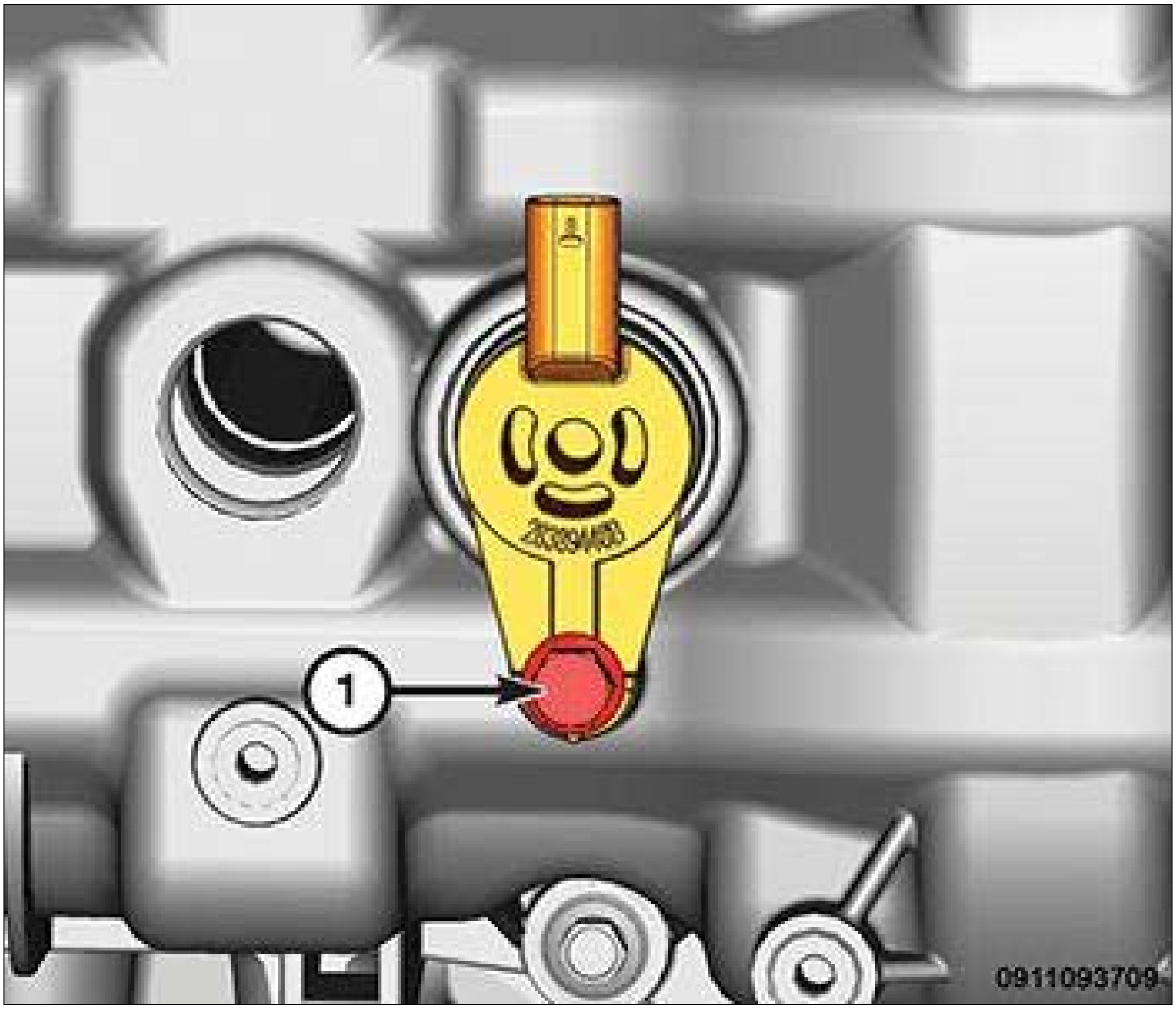
Fig 4: Cylinder Head Cover Bolts & Studs Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

6. Tighten the cylinder head cover bolts and double ended studs in the sequence shown in illustration to 12 N.m (106 in. lbs.).
7. Install the PCV valve. Refer to VALVE, POSITIVE CRANKCASE VENTILATION (PCV), 3.6L, INSTALLATION .

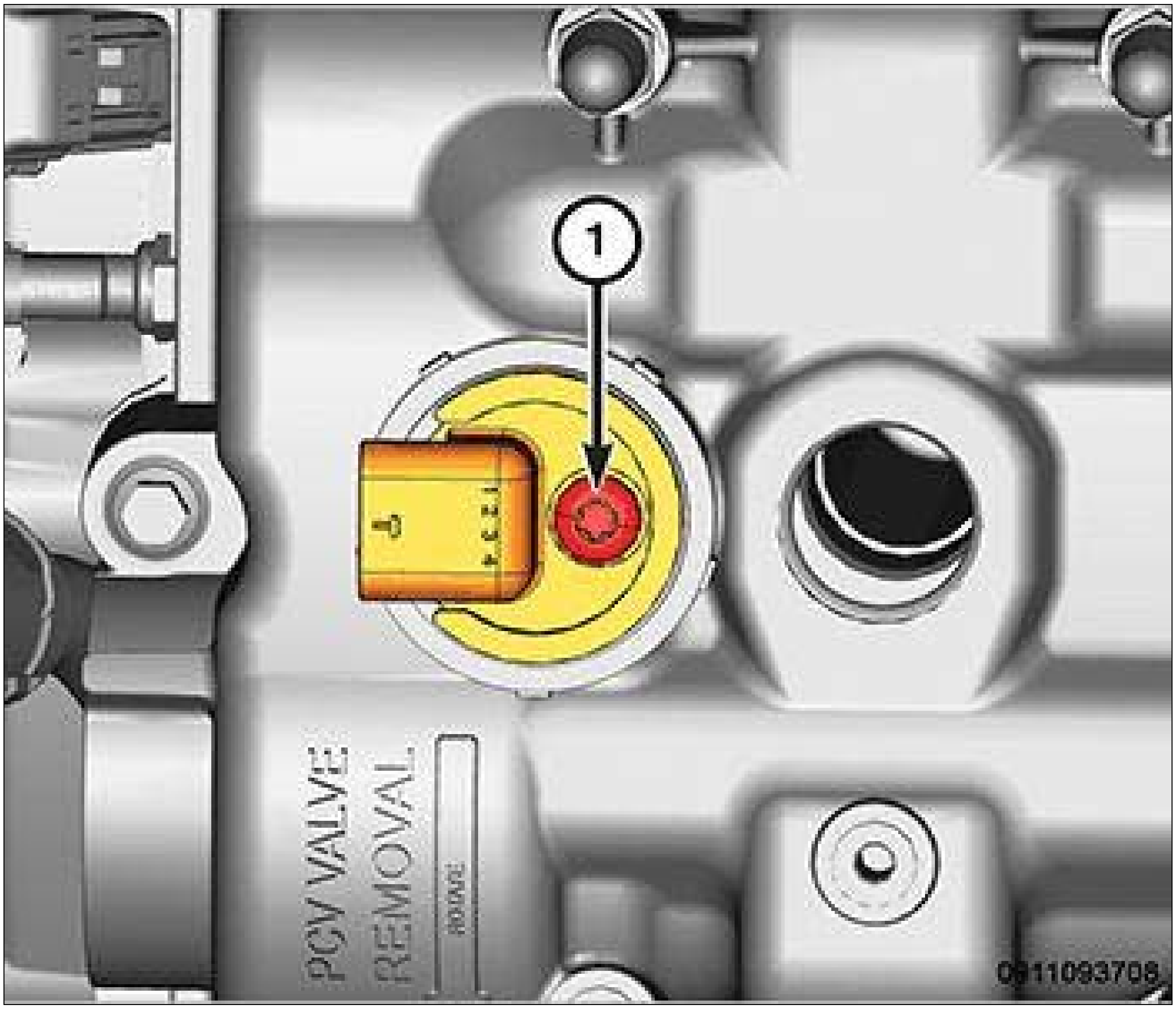
Fig 5: VVL Solenoid At Right Cylinder Head Cover



Courtesy of CHRYSLER GROUP, LLC

8. Install the Variable Valve Lift (VVL) solenoid (1) into right cylinder head cover. Refer to SOLENOID, VARIABLE VALVE LIFT, INSTALLATION .

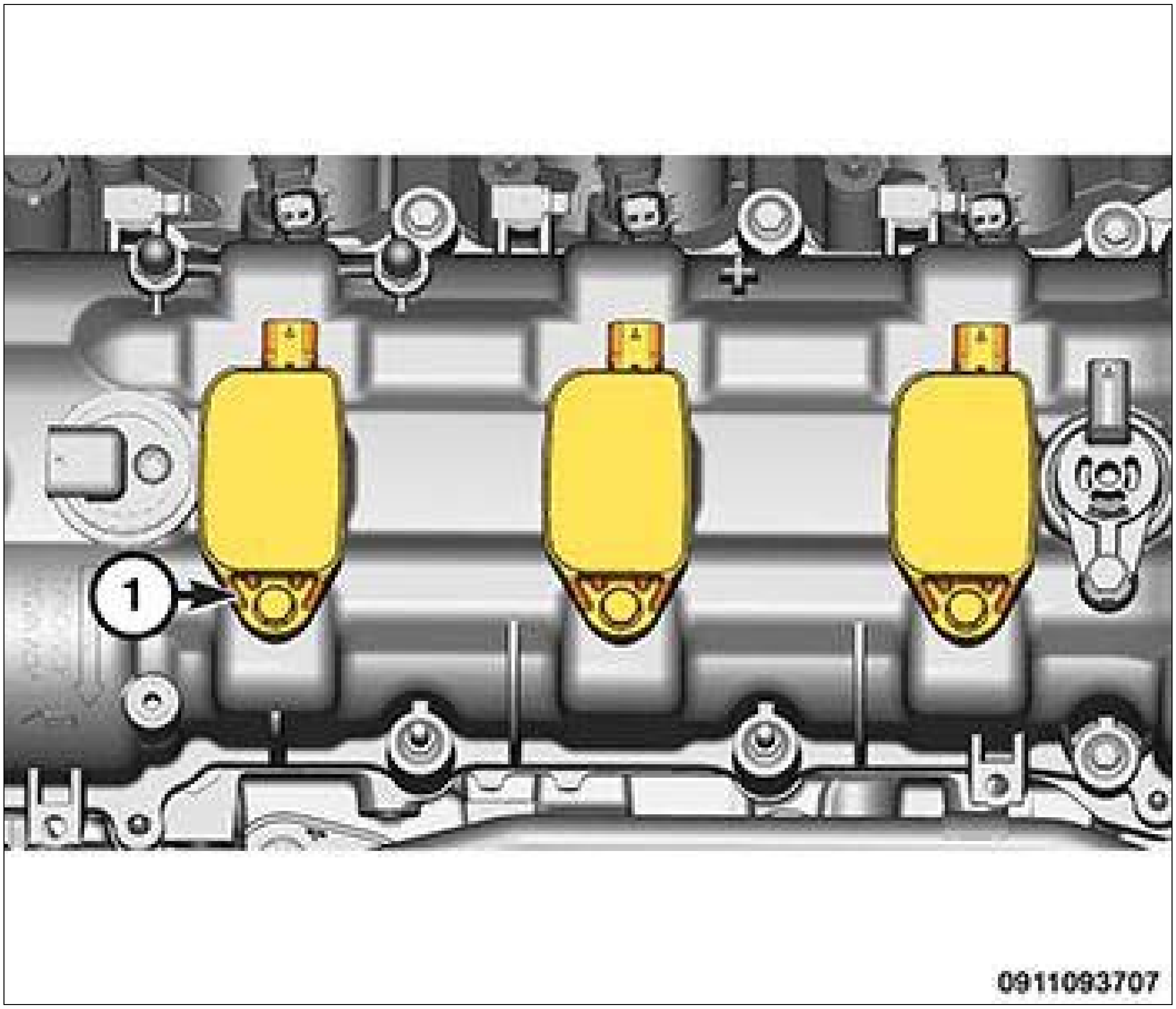
Fig 6: Camshaft Position Sensor



Courtesy of CHRYSLER GROUP, LLC

9. Install the Camshaft Position (CMP) sensor (1). Refer to SENSOR, CAMSHAFT POSITION, INSTALLATION .

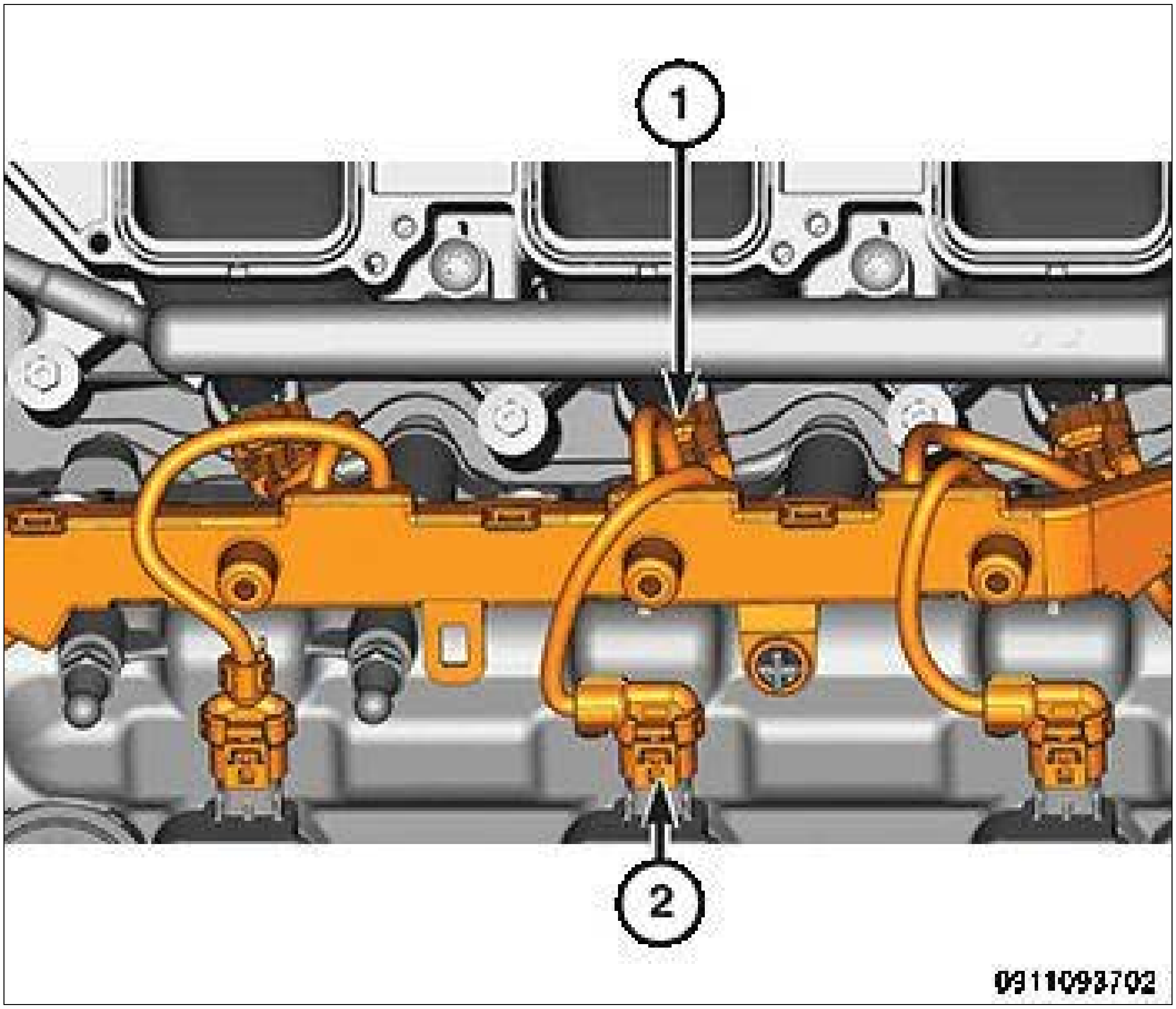
Fig 7: Right Side Ignition Coils



Courtesy of CHRYSLER GROUP, LLC

10. If removed, install the spark plugs. Refer to SPARK PLUG, INSTALLATION .
11. Install the right side ignition coils (1). Refer to COIL, IGNITION, INSTALLATION .

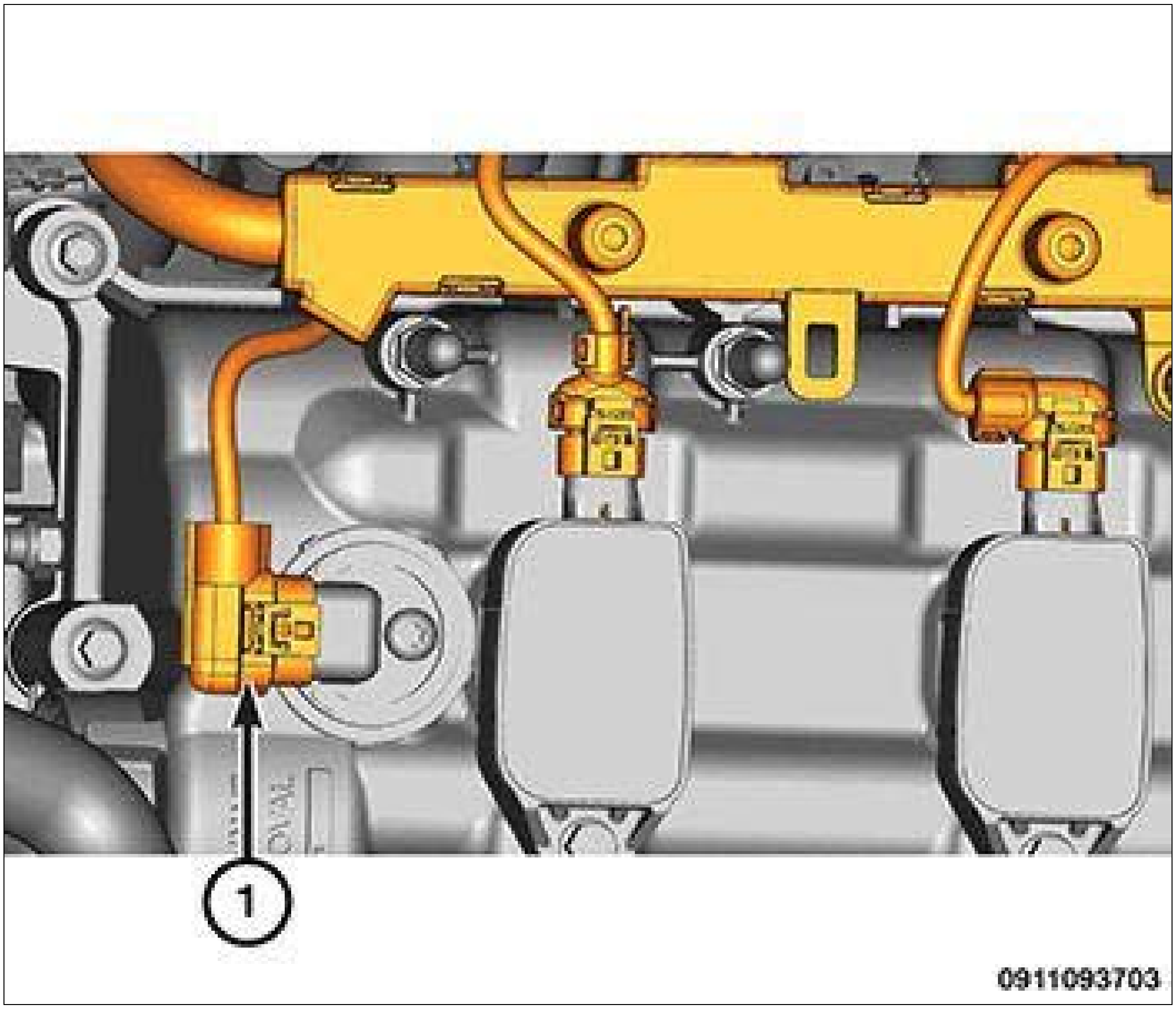
Fig 8: Injector & Ignition Wire Harness Retainers



Courtesy of CHRYSLER GROUP, LLC

12. Install the injector (1) and ignition (2) wire harness retainers and position the wire harness to the cylinder head cover.

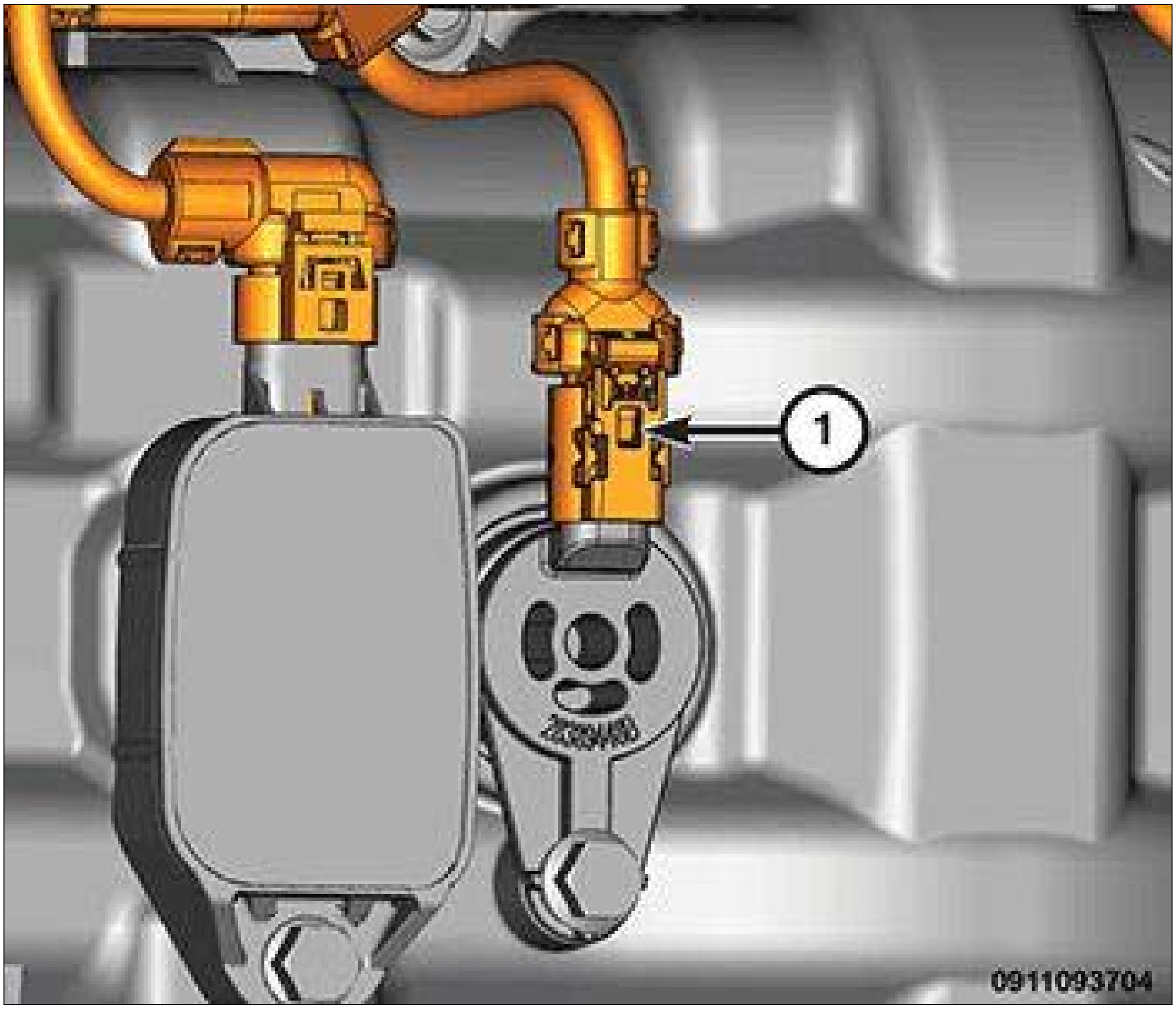
Fig 9: Right Side Camshaft Position (CMP) Sensor Wire Harness Connectors



Courtesy of CHRYSLER GROUP, LLC

13. Connect the wire harness connector (1) to the right side camshaft position sensor.

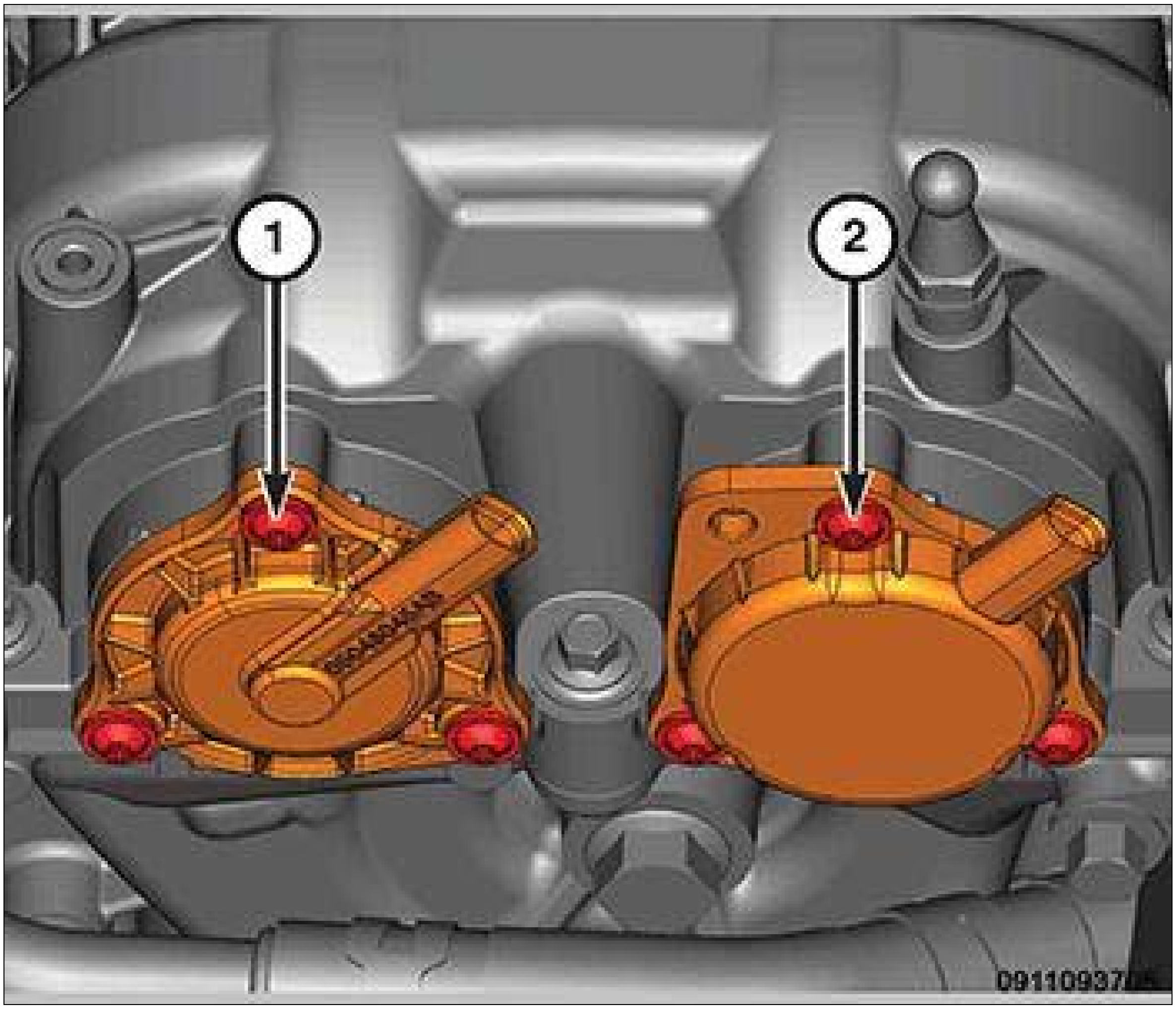
Fig 10: Variable Valve Lift (VVL) Solenoid Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

14. Connect the VVL solenoid wire harness connector (1).

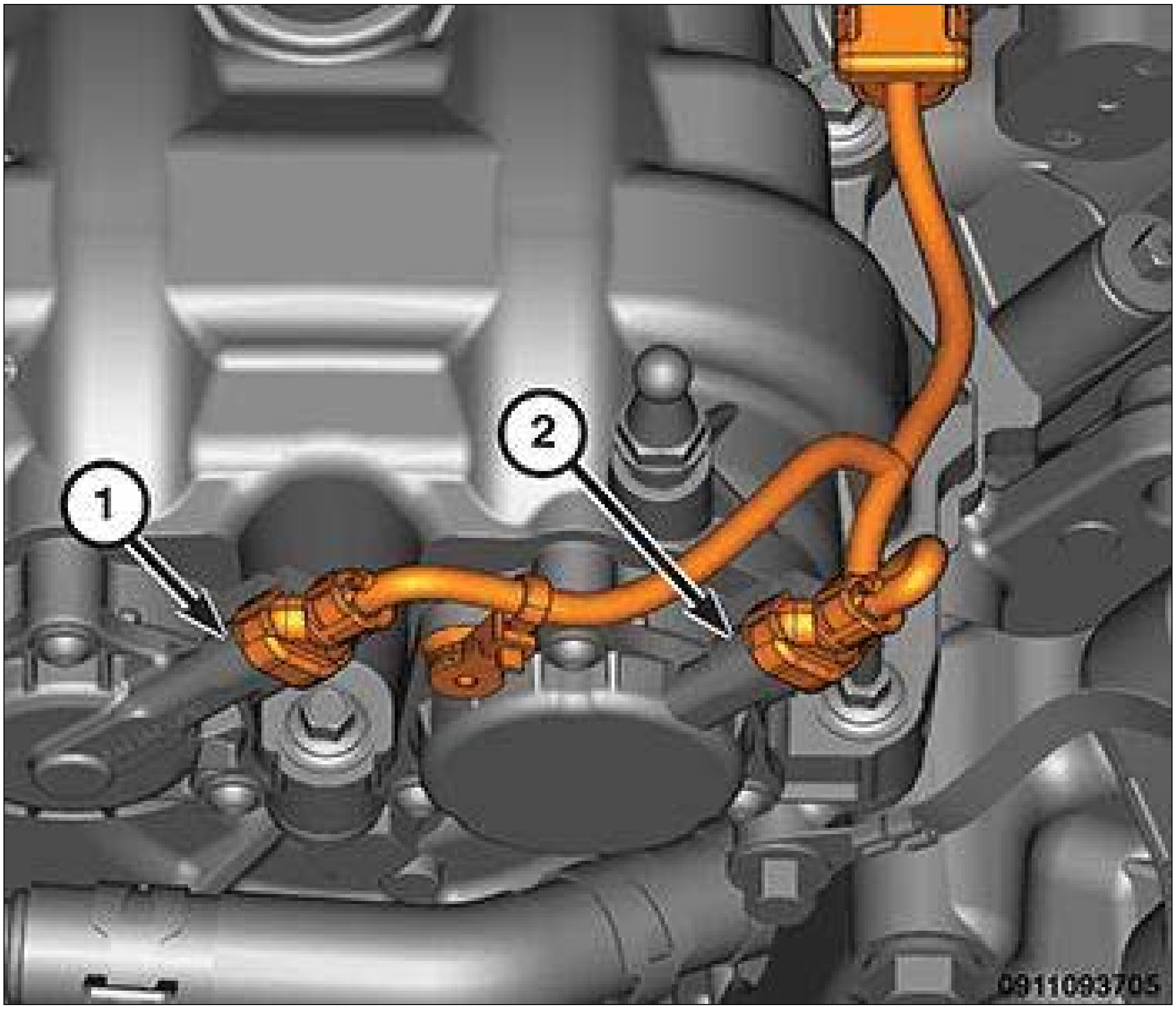
Fig 11: Variable Valve Timing Solenoids



Courtesy of CHRYSLER GROUP, LLC

15. Refer to the markings made at disassembly and install the variable valve timing solenoids (1 and 2) in their original locations. Refer to SOLENOID, VARIABLE VALVE TIMING, INSTALLATION .

Fig 12: Variable Valve Timing Solenoids Wire Harness Connectors At Right Cylinder Head Cover



Courtesy of CHRYSLER GROUP, LLC

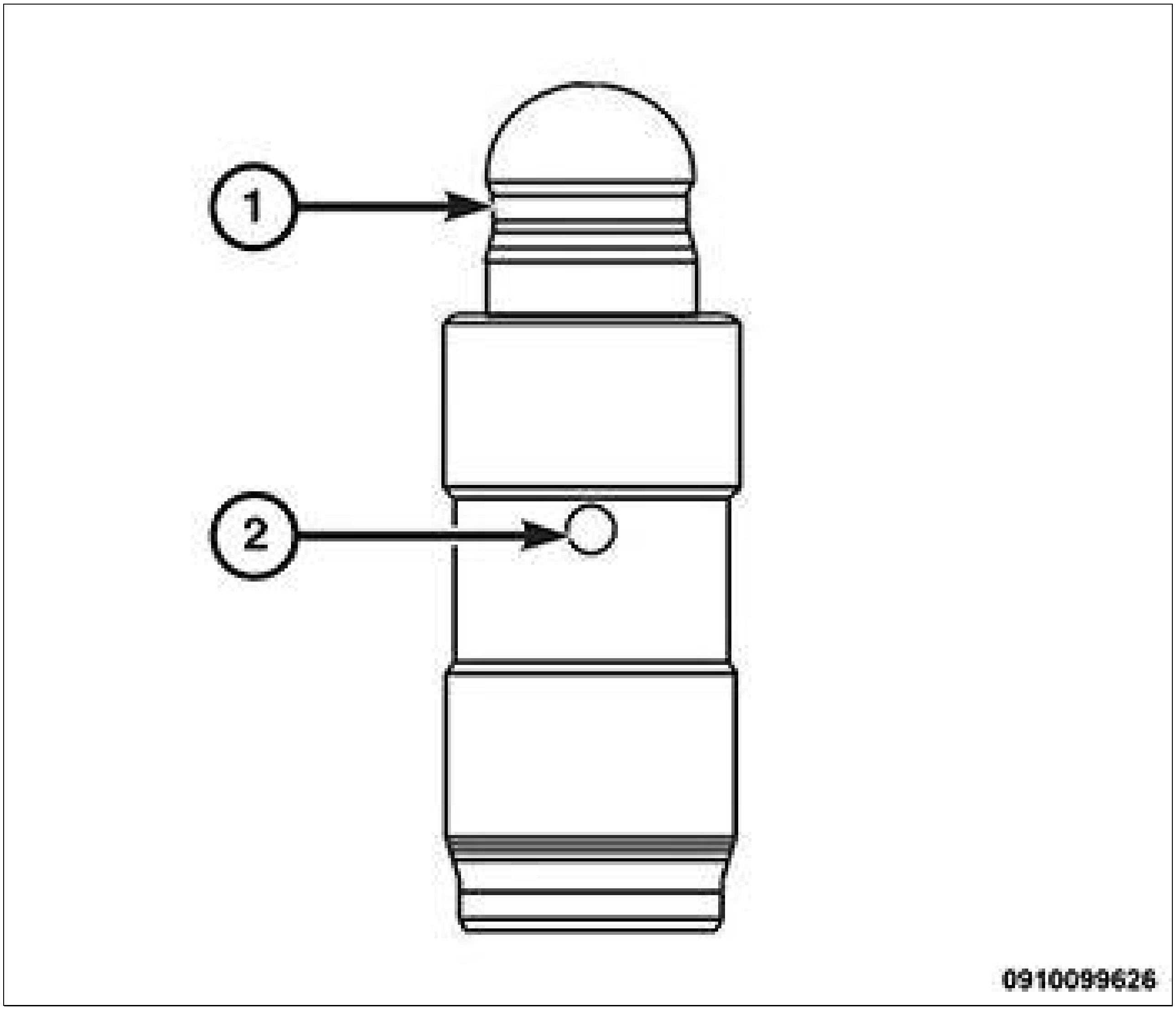
16. Connect the wire harness connectors (1 and 2) to the variable valve timing solenoids on the right cylinder head.
17. Engage the wire harness retainers to the right cylinder head cover.
18. Install the upper intake manifold. Refer to MANIFOLD, INTAKE, INSTALLATION .
19. Connect the negative battery cable.

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.

CYLINDER HEAD > LIFTER(S), HYDRAULIC > DESCRIPTION > DESCRIPTION

Fig 1: Exhaust Hydraulic Lifter & Retaining Clip



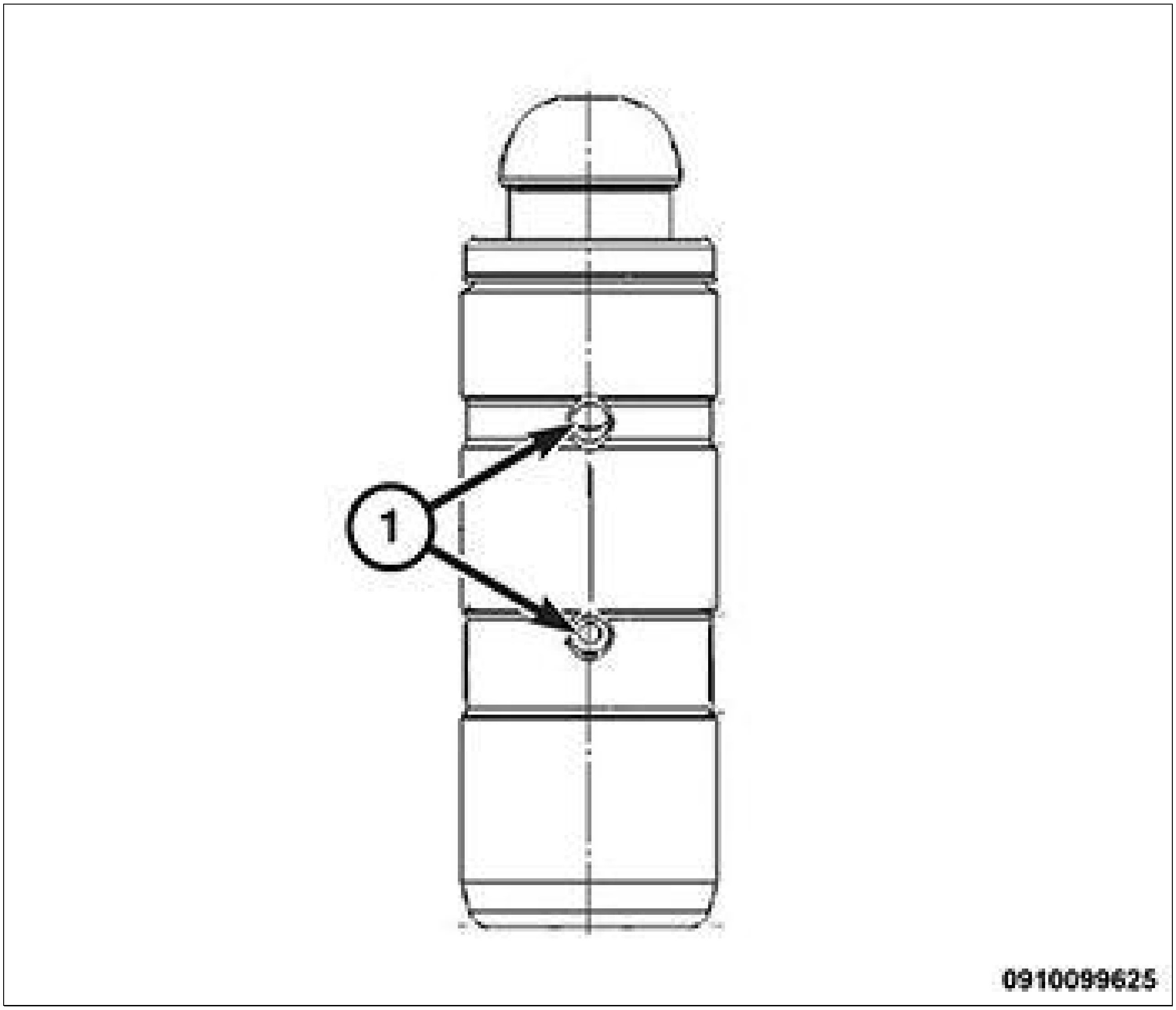
Courtesy of CHRYSLER GROUP, LLC

The exhaust hydraulic lifter is attached to the exhaust roller rocker arm with a retaining clip (1). The internal check ball is reversed, compared to previous model years.

NOTE:

The exhaust hydraulic lifter must never be interchanged with any other hydraulic lifter than what is specifically designated for this vehicle. The internal check ball is reversed and could cause engine damage if an incorrect part is installed.

Fig 2: Intake Hydraulic Lifter Dual Feed Feature



Courtesy of CHRYSLER GROUP, LLC

The intake hydraulic lifter has a dual feed feature (1) to accommodate the two-step Variable Valve Lift (VVL) system. For more information on the VVL system, refer to SOLENOID, VARIABLE VALVE LIFT, DESCRIPTION .

CYLINDER HEAD > 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 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 the lash adjusters for sponginess while installed in the cylinder head. Press down on the rocker arm in a manner that could collapse the lash 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 LIFTER(S), HYDRAULIC, REMOVAL .
4. Low oil pressure.	4. See below:
	(a) Check and correct the engine oil level.
	(b) Check the engine oil pressure. Refer to DIAGNOSIS AND TESTING .
	(c) Check for excessive main bearing clearance and correct specification. Refer to STANDARD PROCEDURE .
	(d) Check for a worn oil pump. Refer to INSPECTION .
	Check the camshaft journals and the bearing bores for abnormal wear patterns, scoring, grooving, fatigue, pitting or a foreign material. Refer to CAMSHAFT, ENGINE, REMOVAL .
5. A plugged oil restrictor in the oil passages to the cylinder head(s).	5. Check the cylinder head oil passages for blockage. Clean or replace as necessary.
6. Worn valve guide(s).	6. Measure the valve stem-to-guide clearance. Refer to INSPECTION .
7. Rocker arm loose, adjuster stuck or at maximum extension and still leaves lash in the system.	7. See below:
-	(a) Check the camshaft journal and lobe for abnormal wear patterns, scoring, grooving, fatigue, pitting or a foreign material. Refer to CAMSHAFT, ENGINE, REMOVAL .

-	(b) Check the rocker arm(s) for proper alignment to the camshaft lobe(s) and valve stem(s). Refer to ROCKER ARM, VALVE, REMOVAL .
-	(c) Check the lash adjuster(s) for proper operation and replace as necessary. Refer to LIFTER(S), HYDRAULIC, REMOVAL .
8. Air ingested into the engine oil due to a broken or cracked oil pump pickup tube.	8. Check the pickup tube and replace as necessary. Refer to PICK-UP, OIL PUMP, REMOVAL .
9. Faulty lash adjuster.	9. Replace the lash adjuster(s). Refer to LIFTER(S), HYDRAULIC, REMOVAL .

CYLINDER HEAD > LIFTER(S), HYDRAULIC > REMOVAL > REMOVAL

NOTE:

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

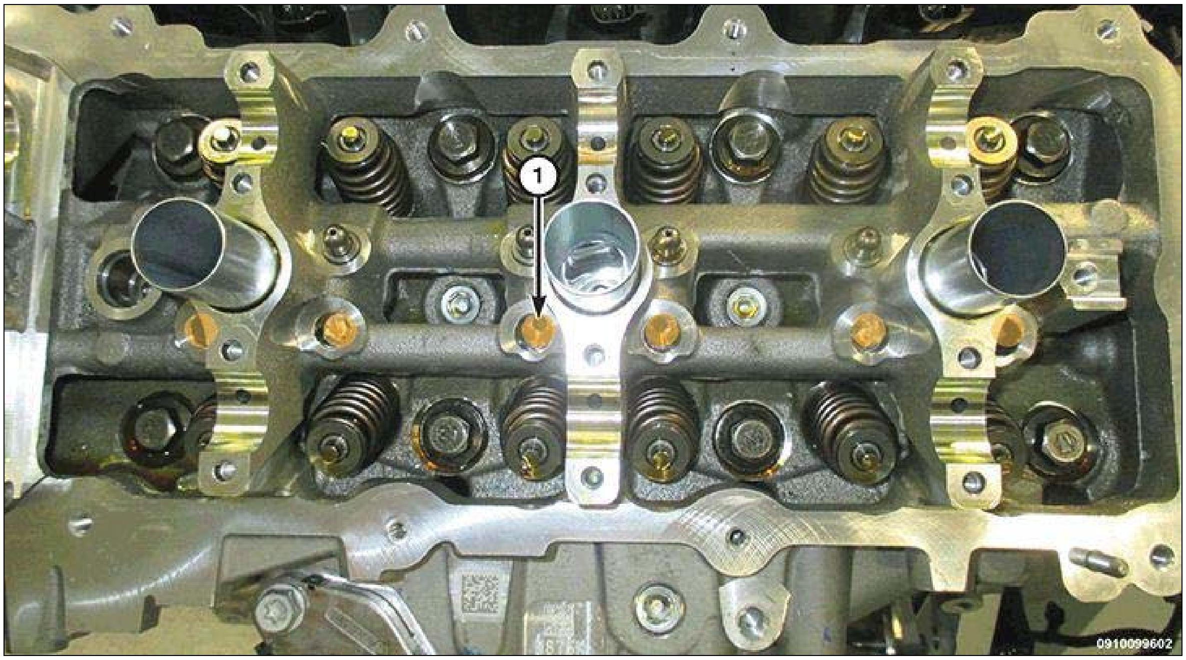
1. Remove the camshaft(s). Refer to CAMSHAFT, ENGINE, REMOVAL .

   NOTE:

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

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

Fig 1: Locating Exhaust Hydraulic Lifters



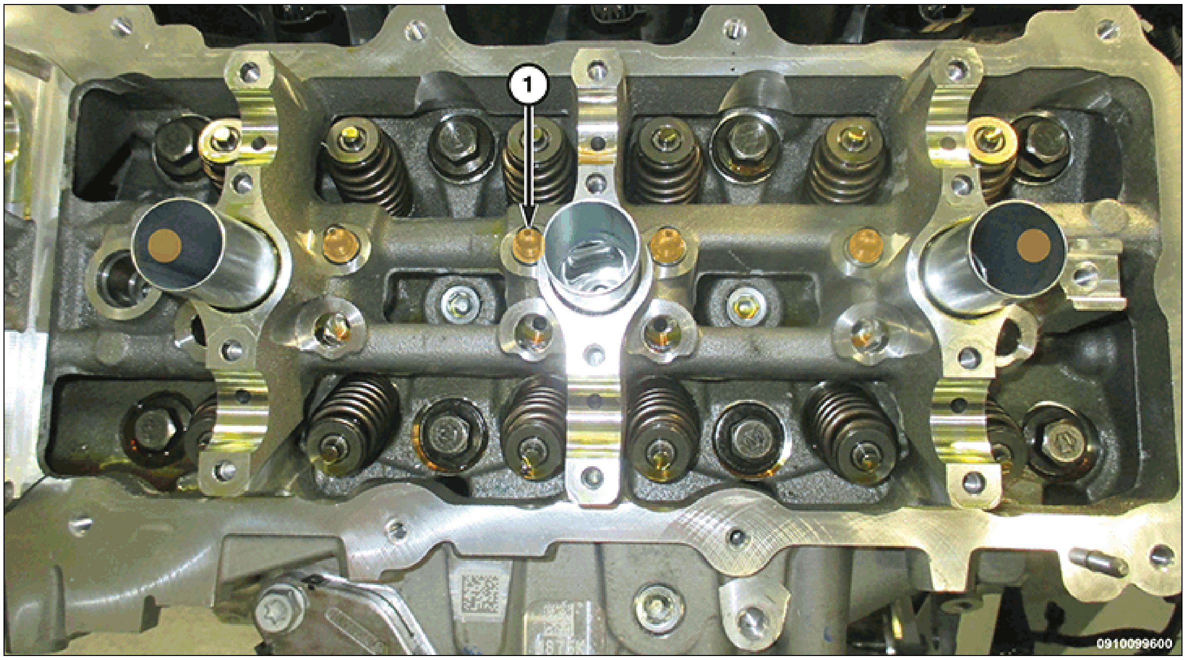
Courtesy of CHRYSLER GROUP, LLC

NOTE:

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

3. The exhaust hydraulic lifters should have been removed (1) with the rockers arms, as they are attached with a retaining clip.

Fig 2: Locating Intake Hydraulic Lifter(s)

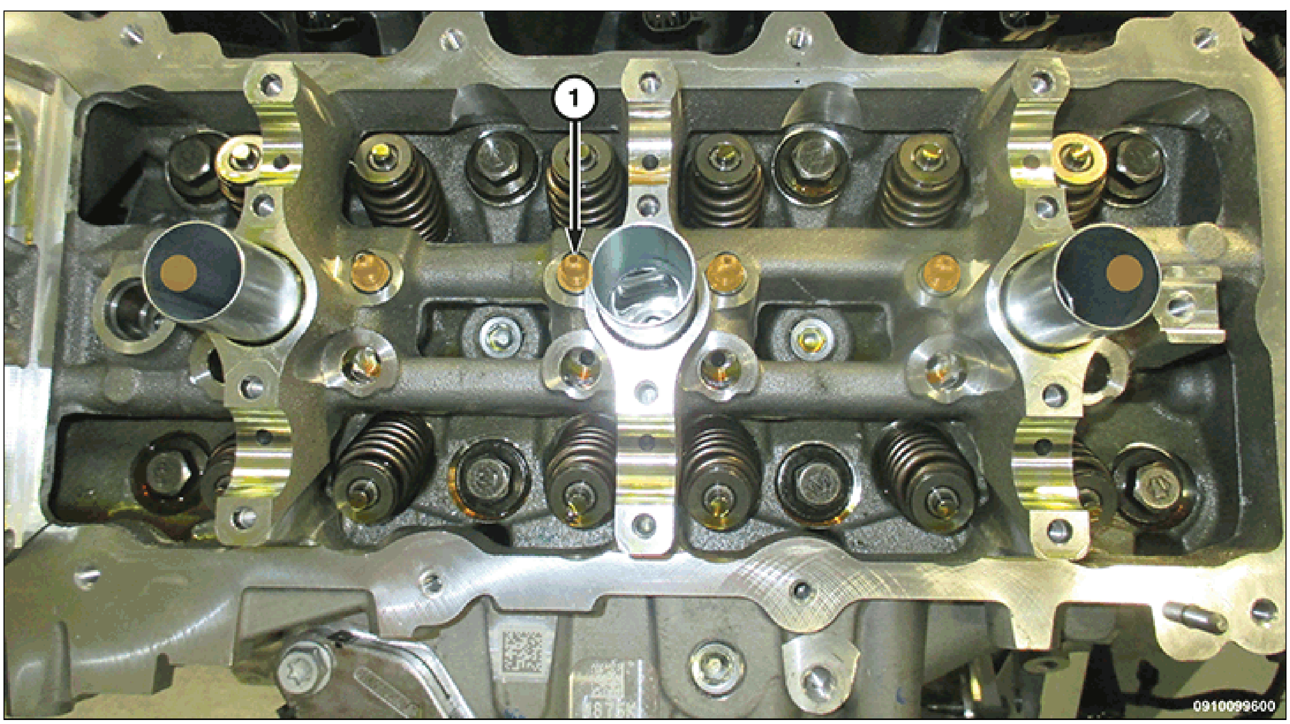


Courtesy of CHRYSLER GROUP, LLC

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

CYLINDER HEAD > LIFTER(S), HYDRAULIC > INSTALLATION > INSTALLATION

Fig 1: Locating Intake Hydraulic Lifter(s)



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.

NOTE:

The exhaust hydraulic lifter must never be interchanged with any other hydraulic lifter than what is specifically designated for this vehicle. The internal check ball is reversed and could cause engine damage if an incorrect part is installed.

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 intake hydraulic lifter(s) (1).

NOTE:

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

Fig 2: Locating Exhaust Hydraulic Lifters

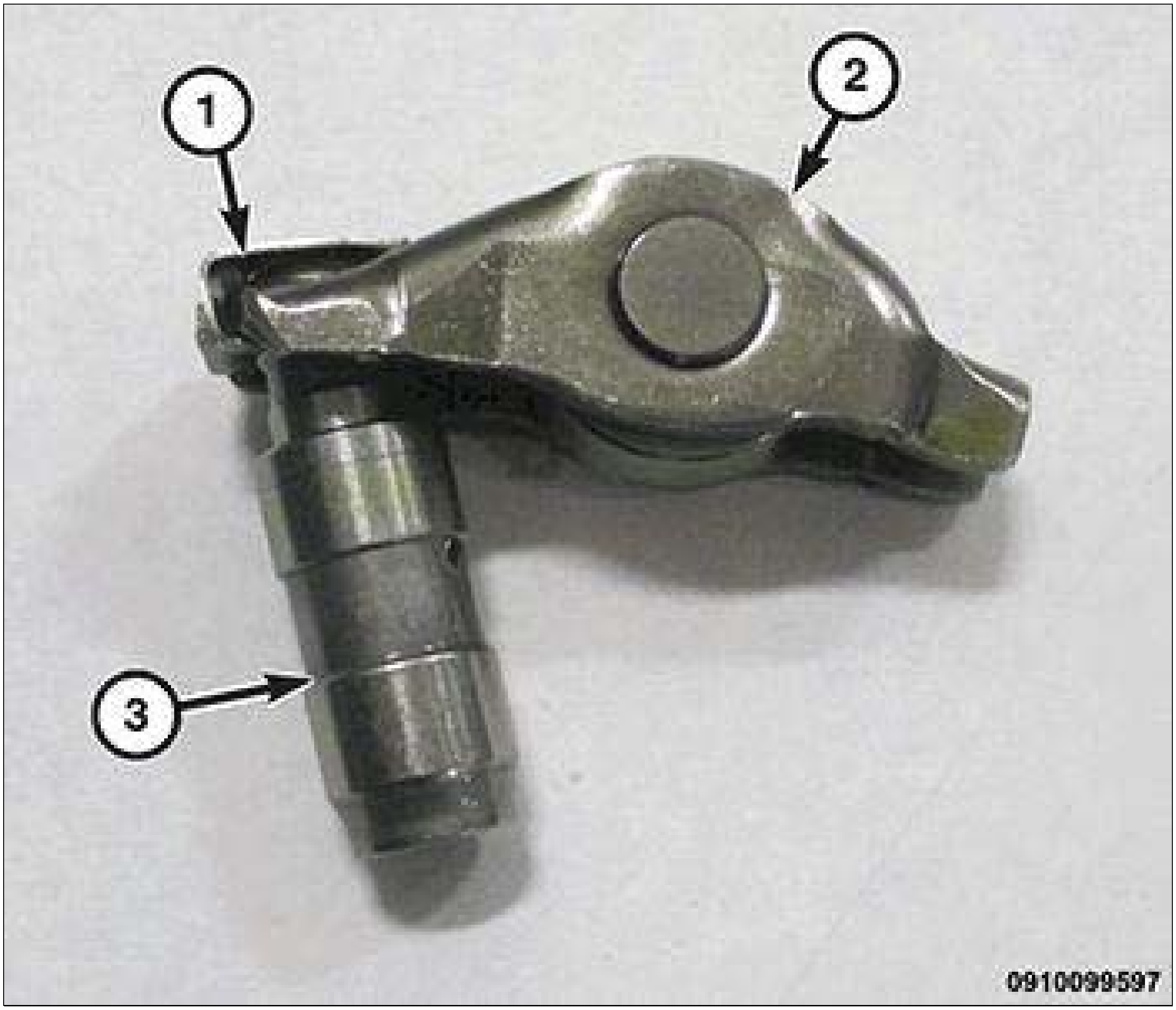
Courtesy of CHRYSLER GROUP, LLC

3. The exhaust hydraulic lifters are installed with the rocker arms, as they are attached to the rocker arm with a clip.

4. Install the rocker arm(s). Refer to ROCKER ARM, VALVE, INSTALLATION .
5. Install the camshaft(s), phasers, cylinder head cover(s) and upper intake manifold. Refer to CAMSHAFT, ENGINE, INSTALLATION .

CYLINDER HEAD > ROCKER ARM, VALVE > DESCRIPTION > DESCRIPTION

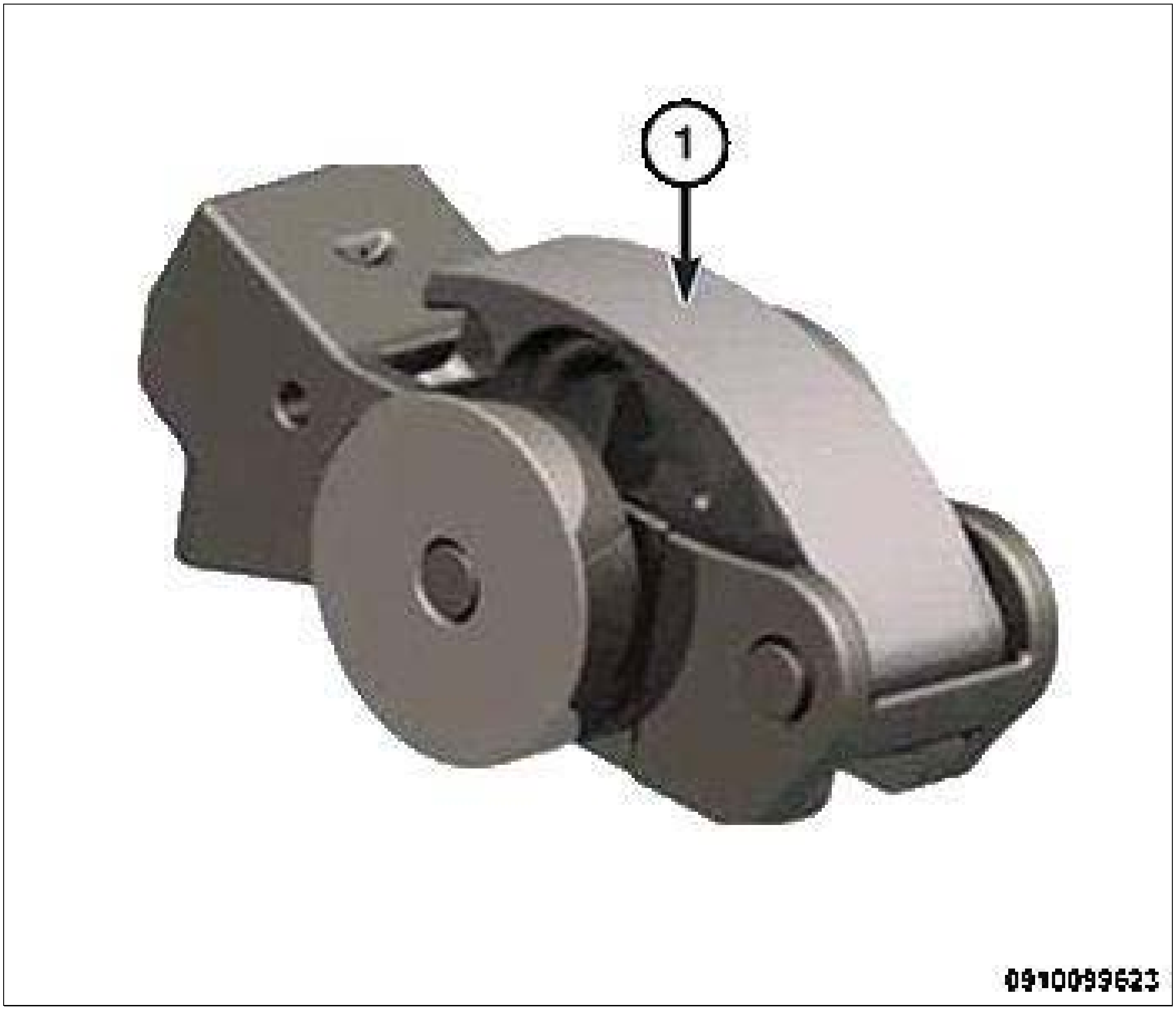
Fig 1: Retaining Clip, Exhaust Roller Rocker Arms & Hydraulic Lifters



Courtesy of CHRYSLER GROUP, LLC

The exhaust roller rocker arms (2) are stamped steel with an integral roller bearing. The exhaust rocker arms are attached to the hydraulic lifters (3) with a retaining clip (1).

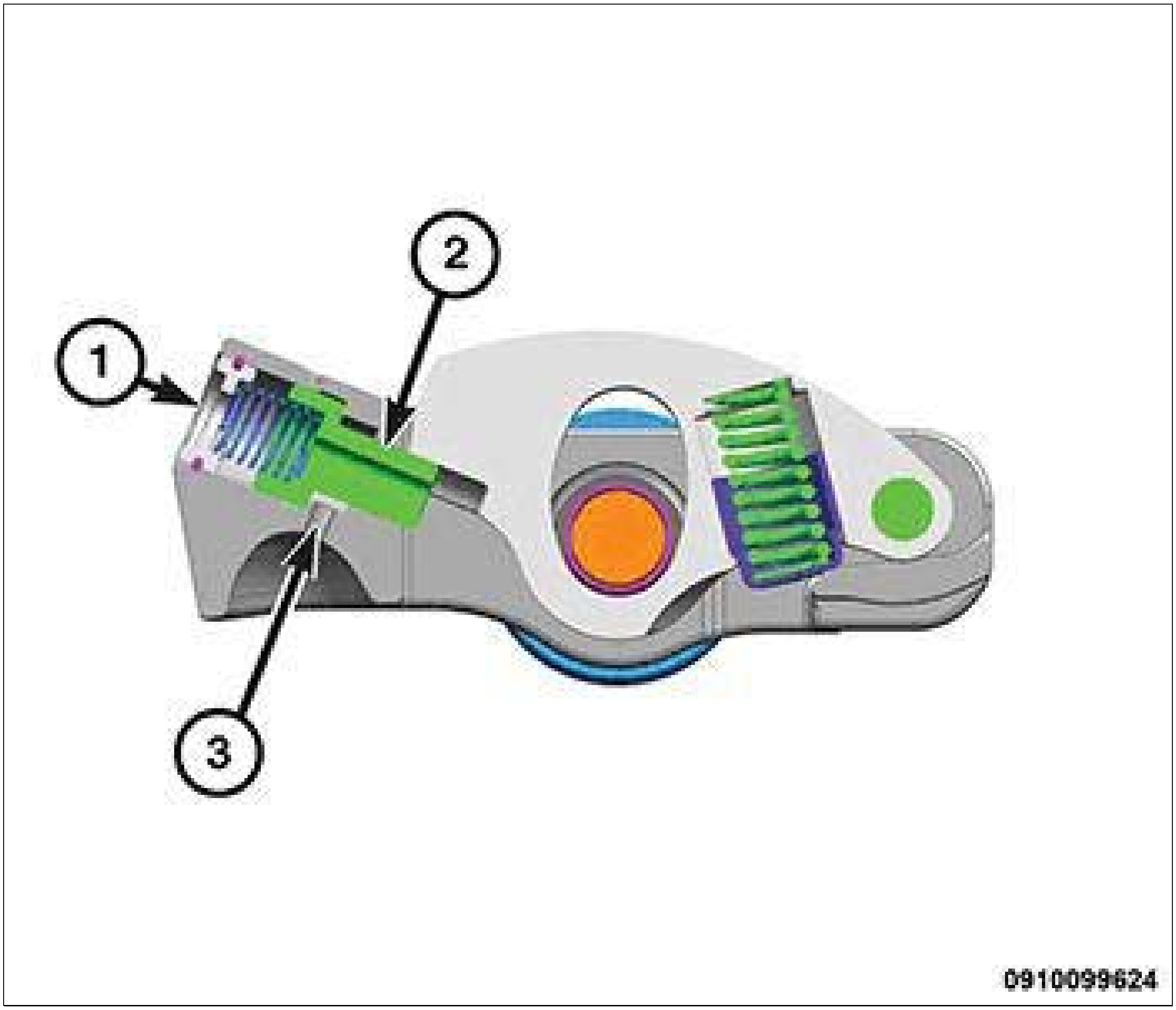
Fig 2: Intake Two-Step Roller Rocker Arms



Courtesy of CHRYSLER GROUP, LLC

The intake two-step roller rocker arms (1) use oil pressure to control high or low intake valve lift depending on configuration.

Fig 3: Intake Two-Step Roller Rocker Arms Low Lift Position, High Lift Position & Oil Pressure From Two-Stop Solenoid



Courtesy of CHRYSLER GROUP, LLC

Configuration is controlled by the Powertrain Control Module (PCM).

- Low lift position (1) - Pin Retracted
- High lift position (2) - Pin Extended
- Oil Pressure from the two-stop solenoid (3)

For more information on the Variable Valve Lift (VVL) solenoids, refer to SOLENOID, VARIABLE VALVE LIFT, DESCRIPTION .

CYLINDER HEAD > ROCKER ARM, VALVE > REMOVAL > REMOVAL

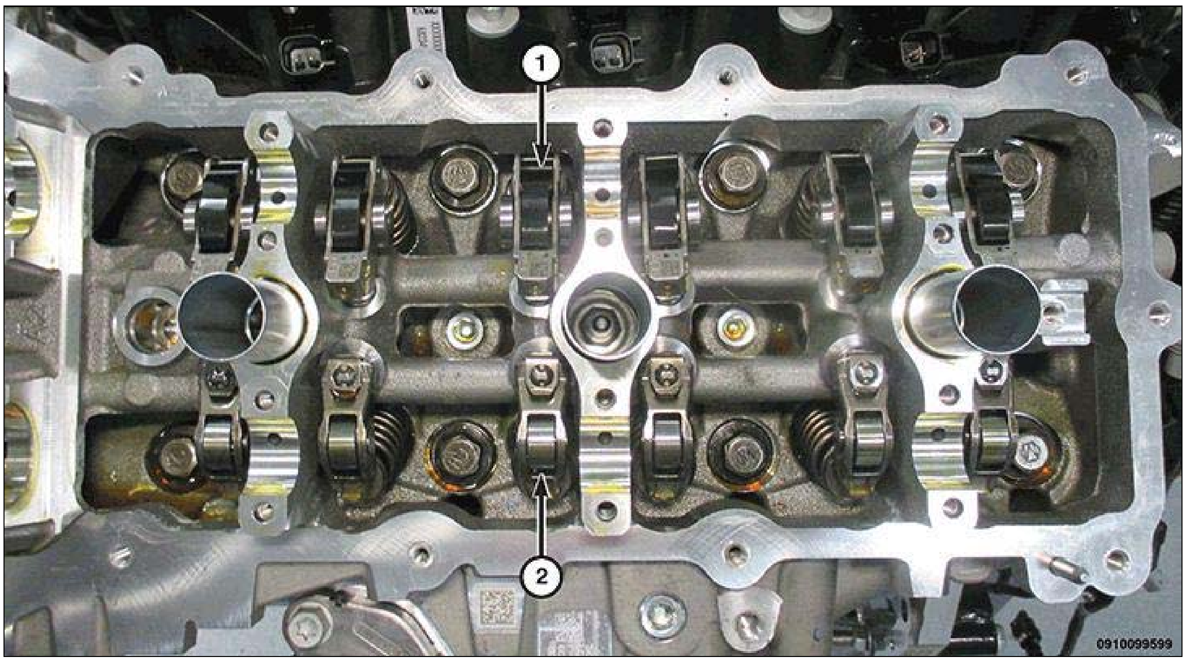
NOTE:

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

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

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

Fig 1: Intake Rocker Arm(s) & Exhaust Rocker Arm And Hydraulic Lifter Assembly

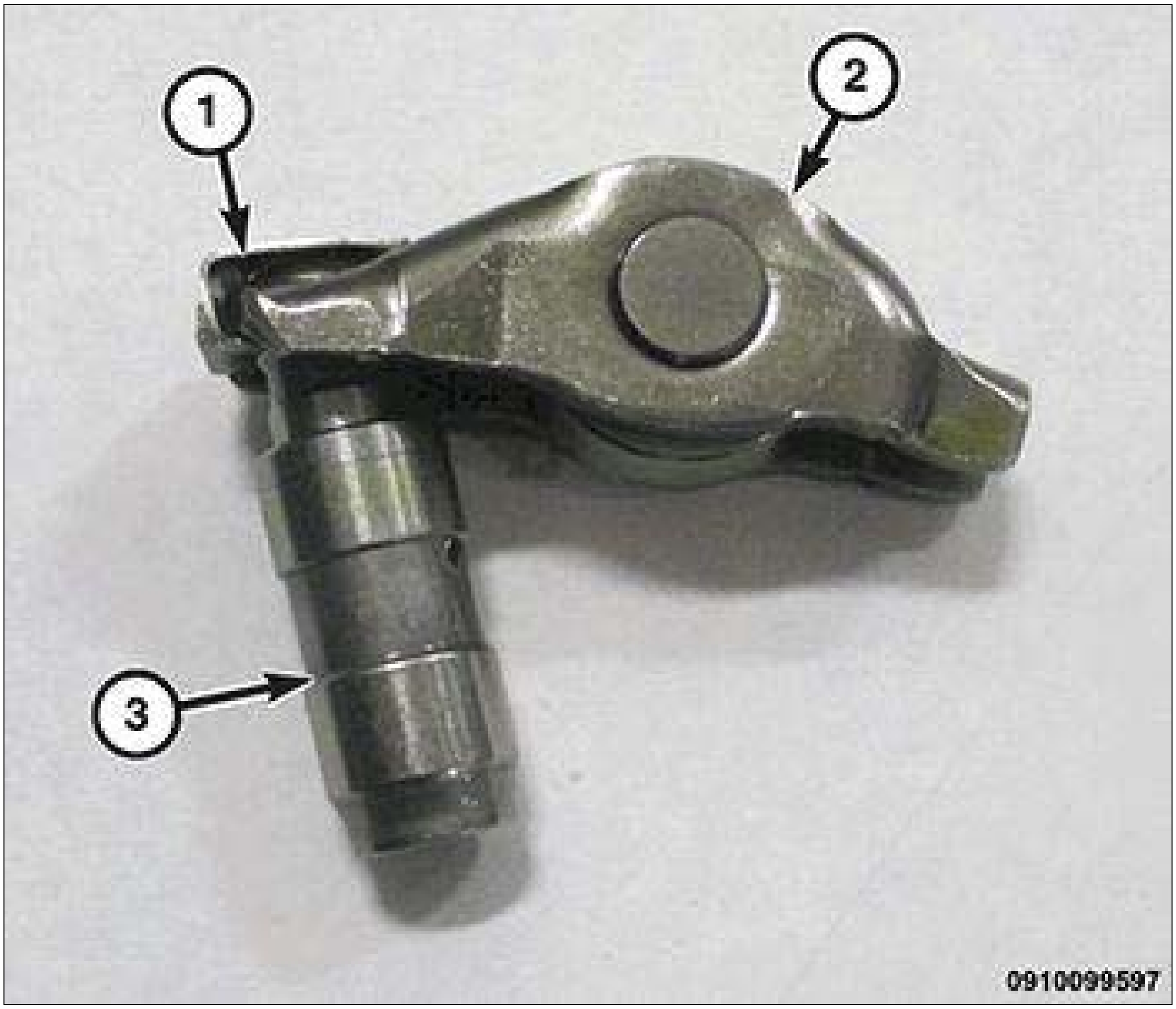


Courtesy of CHRYSLER GROUP, LLC

2. Remove the intake rocker arm(s) (1).

3. Remove the exhaust rocker arm and hydraulic lifter assembly (2).

Fig 2: Retaining Clip, Exhaust Roller Rocker Arms & Hydraulic Lifters

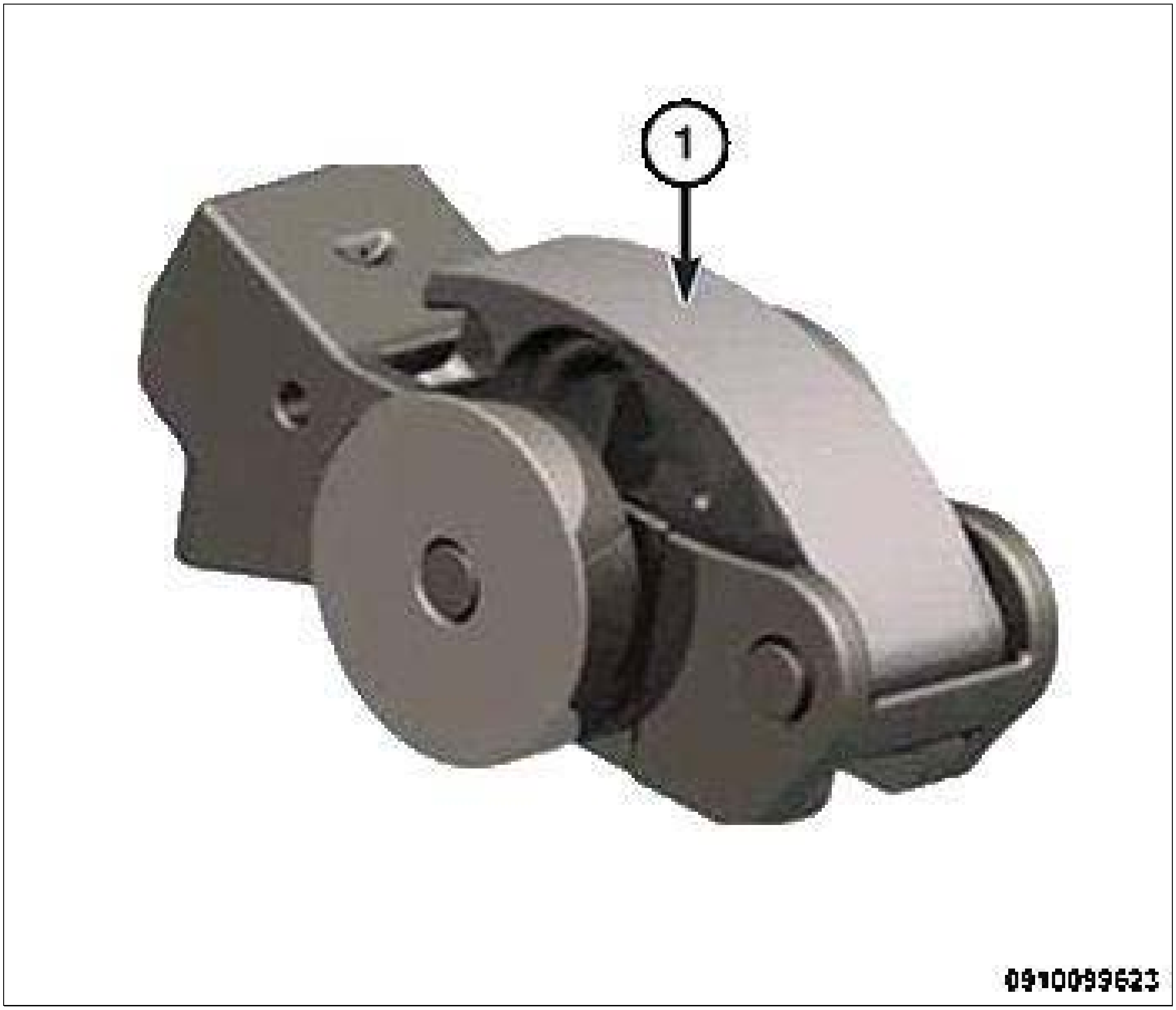


Courtesy of CHRYSLER GROUP, LLC

4. The exhaust rocker arm (2) will come out as an assembly with the hydraulic lifter (3), as it is attached with a retaining clip (1).

CYLINDER HEAD > ROCKER ARM, VALVE > INSPECTION > INSPECTION

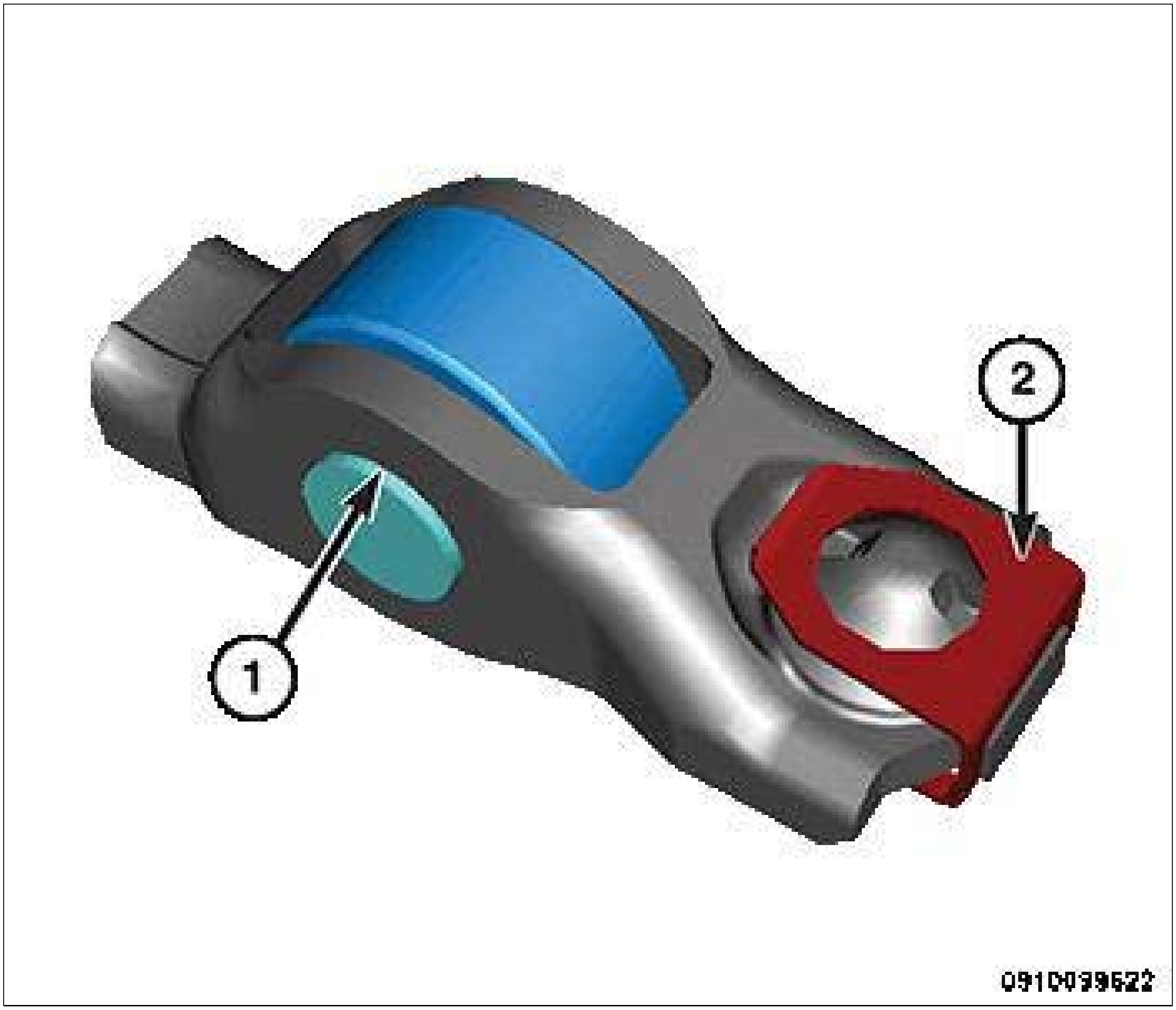
Fig 1: Intake Two-Step Roller Rocker Arms



Courtesy of CHRYSLER GROUP, LLC

Inspect the intake rocker arm assembly (1) for wear or damage. Replace as necessary.

Fig 2: Exhaust Rocker Arm Assembly



Courtesy of CHRYSLER GROUP, LLC

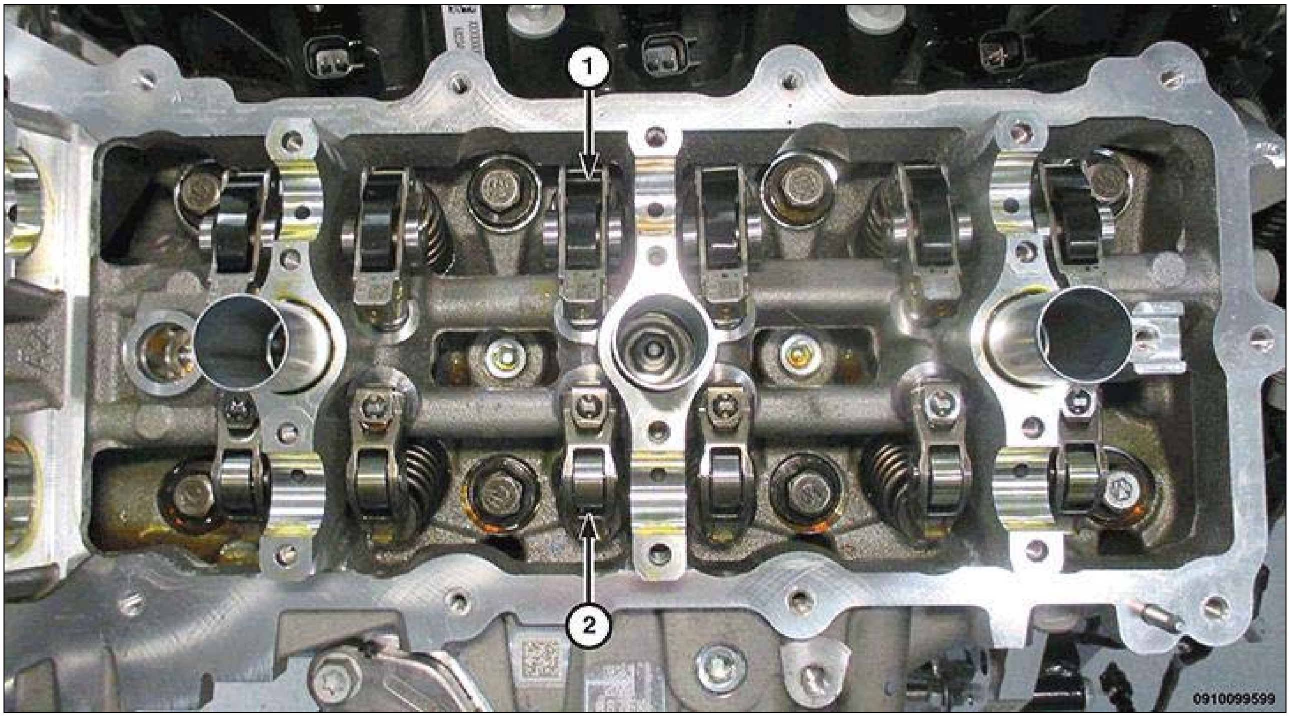
Inspect the exhaust rocker arm assembly (1) for wear or damage. Replace as necessary.

CYLINDER HEAD > ROCKER ARM, VALVE > INSTALLATION > INSTALLATION

CAUTION:

Proper inspection of the rocker arms is required to ensure proper installation. Inspection from the top and also side view is critical to verify the proper seated position of each and every rocker arm. Failure to install the rocker arms correctly may cause severe engine damage.

Fig 1: Intake Rocker Arm(s) & Exhaust Rocker Arm And Hydraulic Lifter Assembly



Courtesy of CHRYSLER GROUP, LLC

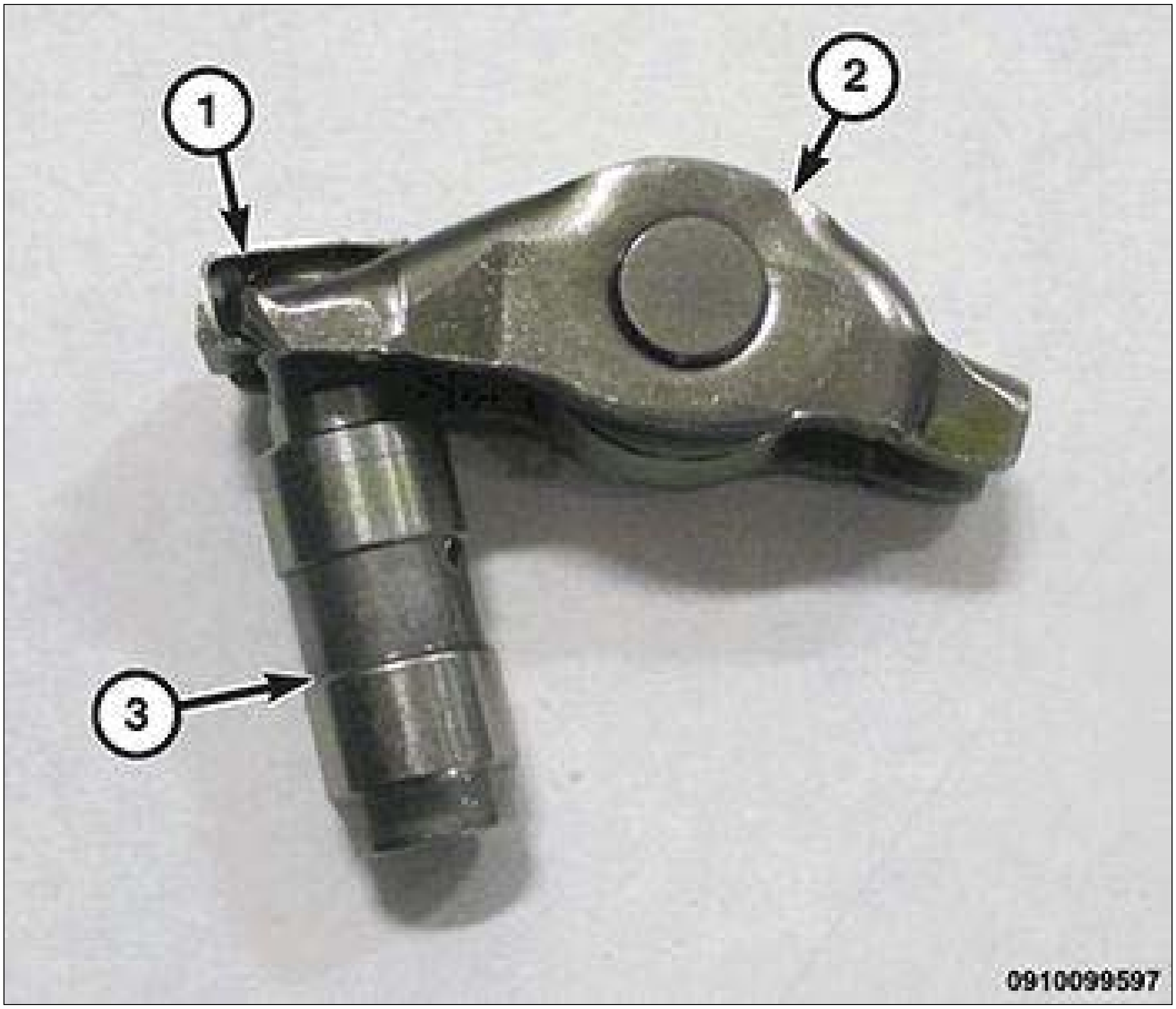
> *NOTE:*
>
> *The LH cylinder head rocker arms are shown in illustration, the RH cylinder head rocker arms are similar. If the rocker arms are being reused, reassemble them into their original locations.*

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

   > *NOTE:*
   >
   > *When placing the rocker arms. The valve stem should fit securely into the rocker arm guides.*

2. Position the intake rocker arm(s) (1) onto the lifter(s) and valve stem(s).
3. Install the exhaust rocker arm(s) (2) and hydraulic lifter(s).

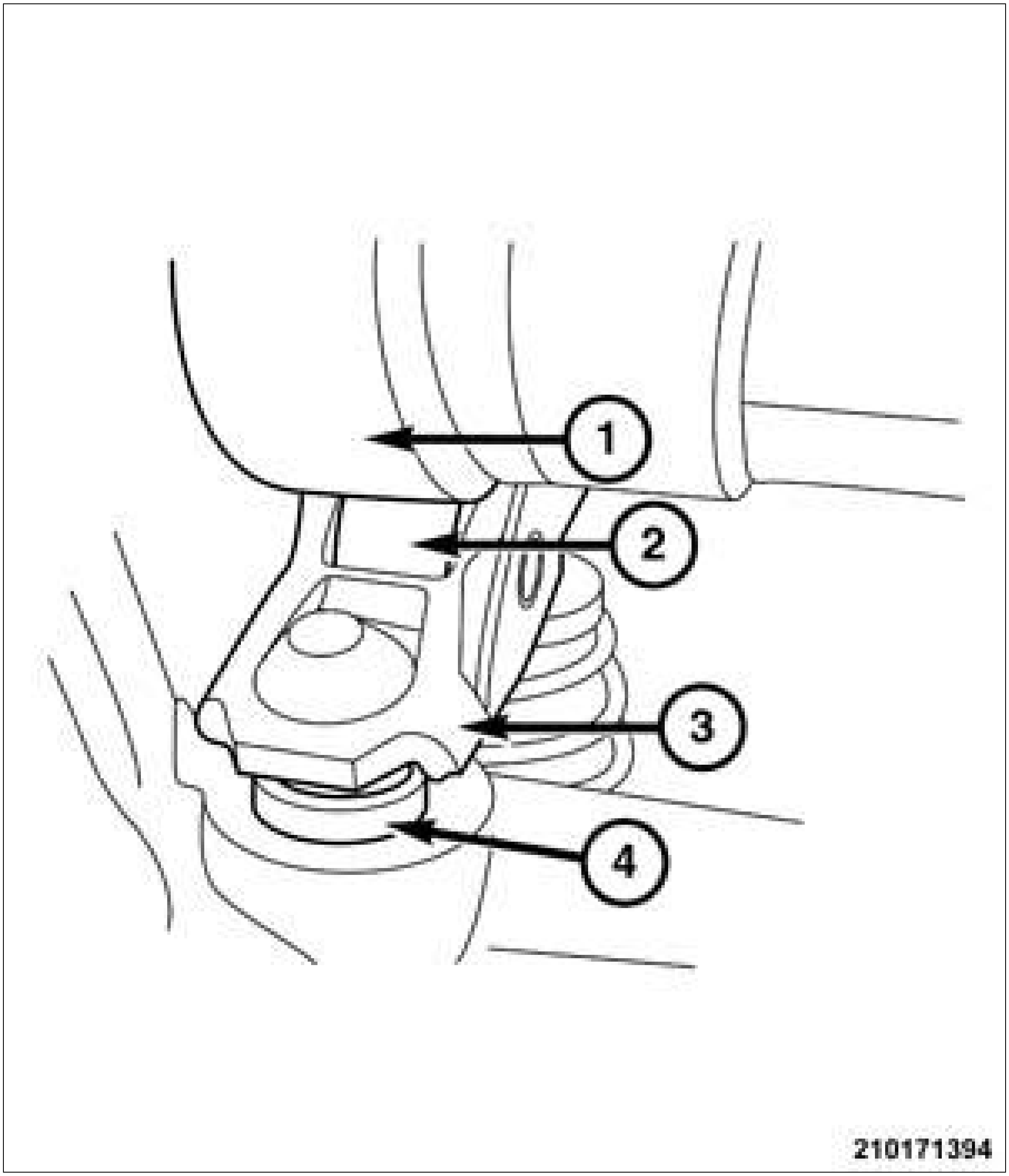
Fig 2: Retaining Clip, Exhaust Roller Rocker Arms & Hydraulic Lifters



Courtesy of CHRYSLER GROUP, LLC

4. The exhaust rocker arm(s) (2) are attached to the hydraulic lifter (3) with a retaining clip (1).

Fig 3: Rocker Arm & Lifter



Courtesy of CHRYSLER GROUP, LLC

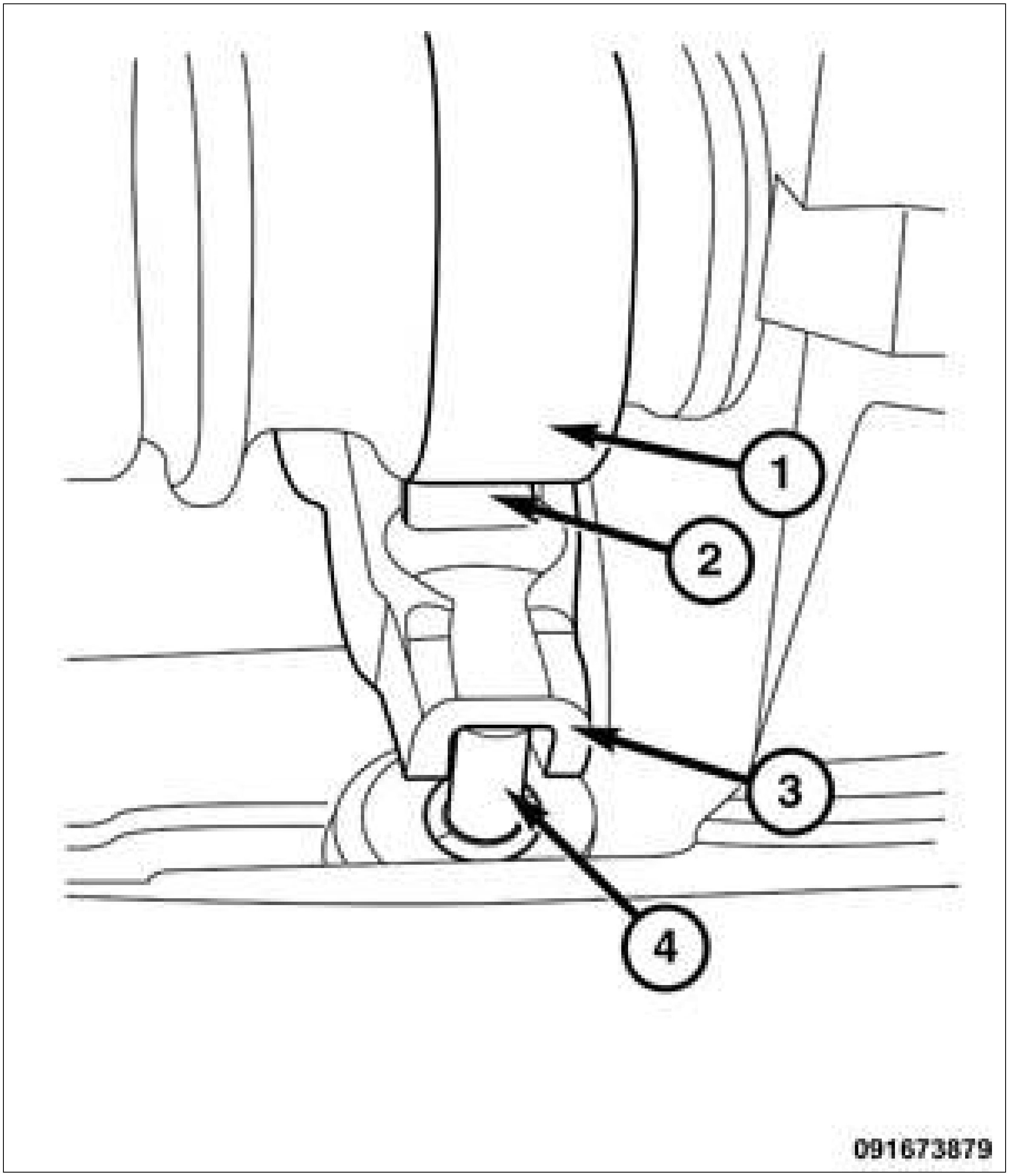
5. Install the camshaft(s). Refer to CAMSHAFT, ENGINE, INSTALLATION .

> *NOTE:*
>
> *If any of the rocker arms are not installed properly. Loosen the bearing caps and reposition the rocker arms.*

6. Verify that the rocker arm (3) is positioned over the lifter (4).

7. Verify that the rocker arm roller (2) is seated to the camshaft lobe (1).

Fig 4: Camshaft Lobe, Rocker Arm Roller, Rocker Arm Guide & Valve Stem



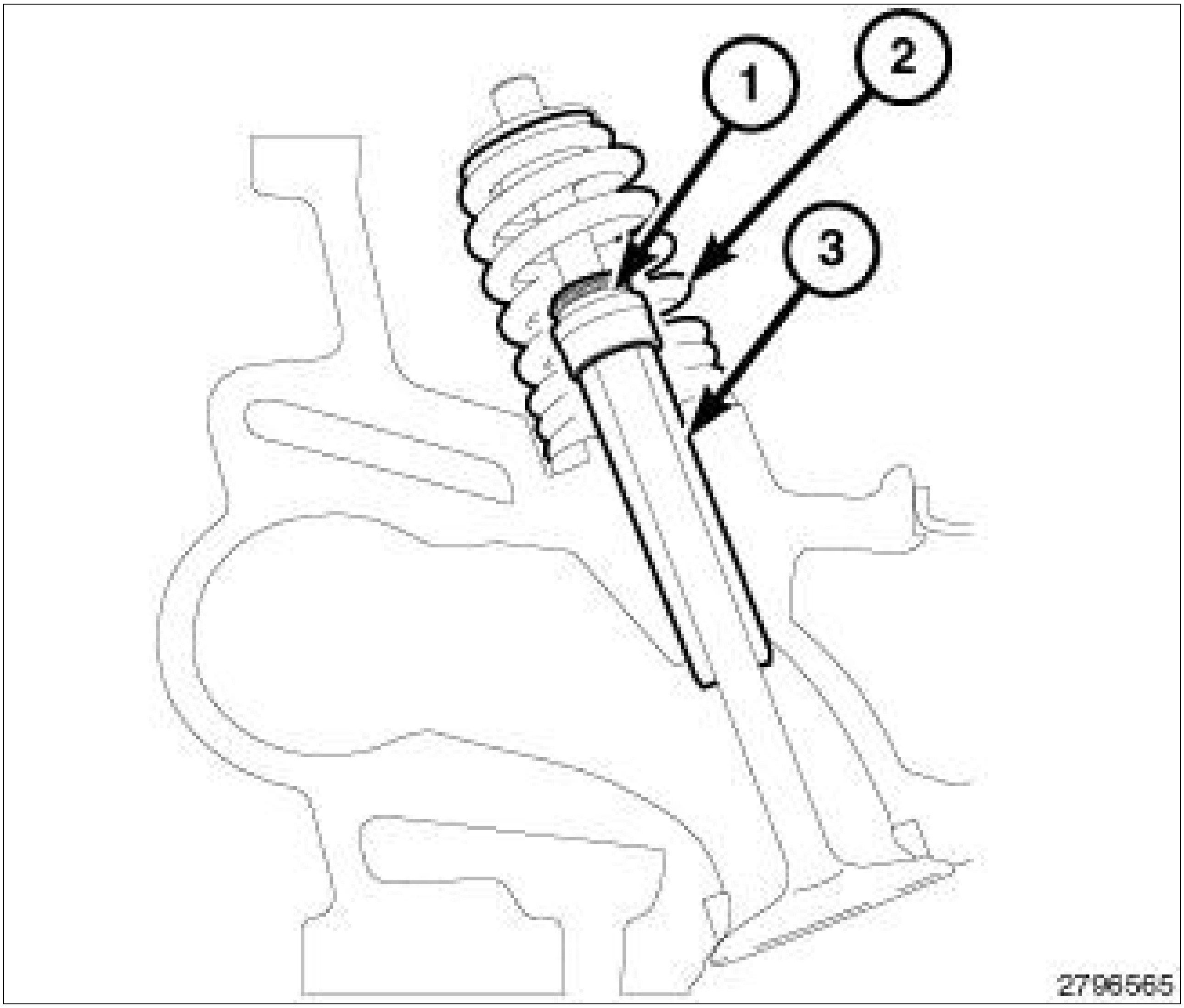
Courtesy of CHRYSLER GROUP, LLC

8. Use a mirror to verify the valve stem (4) is centered between the rocker arm guides (3).

9. Verify the camshaft lobe (1) is centered over the rocker arm roller (2).

CYLINDER HEAD > SEAL(S), VALVE GUIDE > DESCRIPTION > DESCRIPTION

Fig 1: 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.

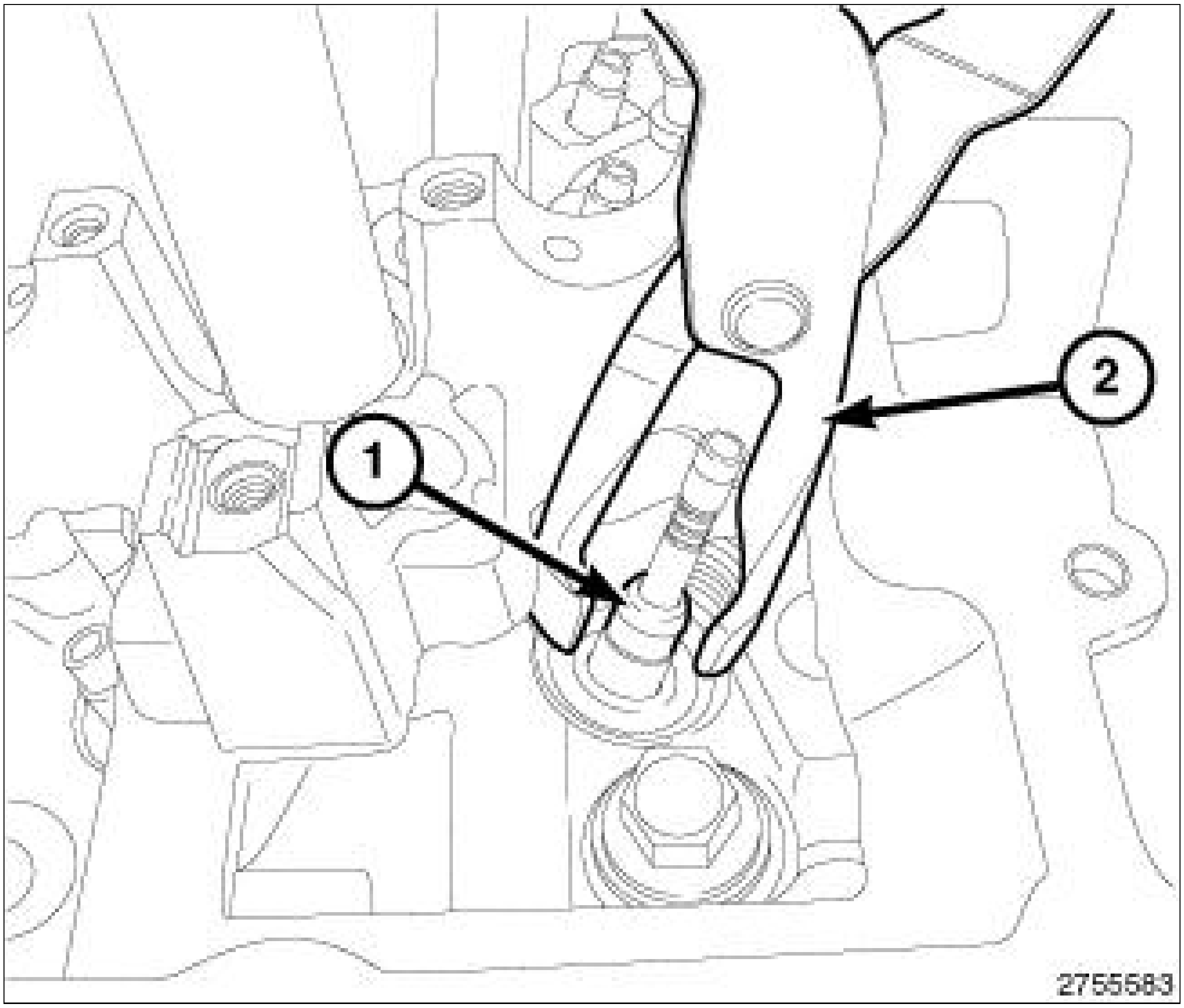
CYLINDER HEAD > SEAL(S), VALVE GUIDE > REMOVAL > REMOVAL

NOTE:

If the springs are to be reused, identify their positions so that they can be reassembled into their original locations.

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

Fig 1: Valve Guide Seal & Valve Seal Tool



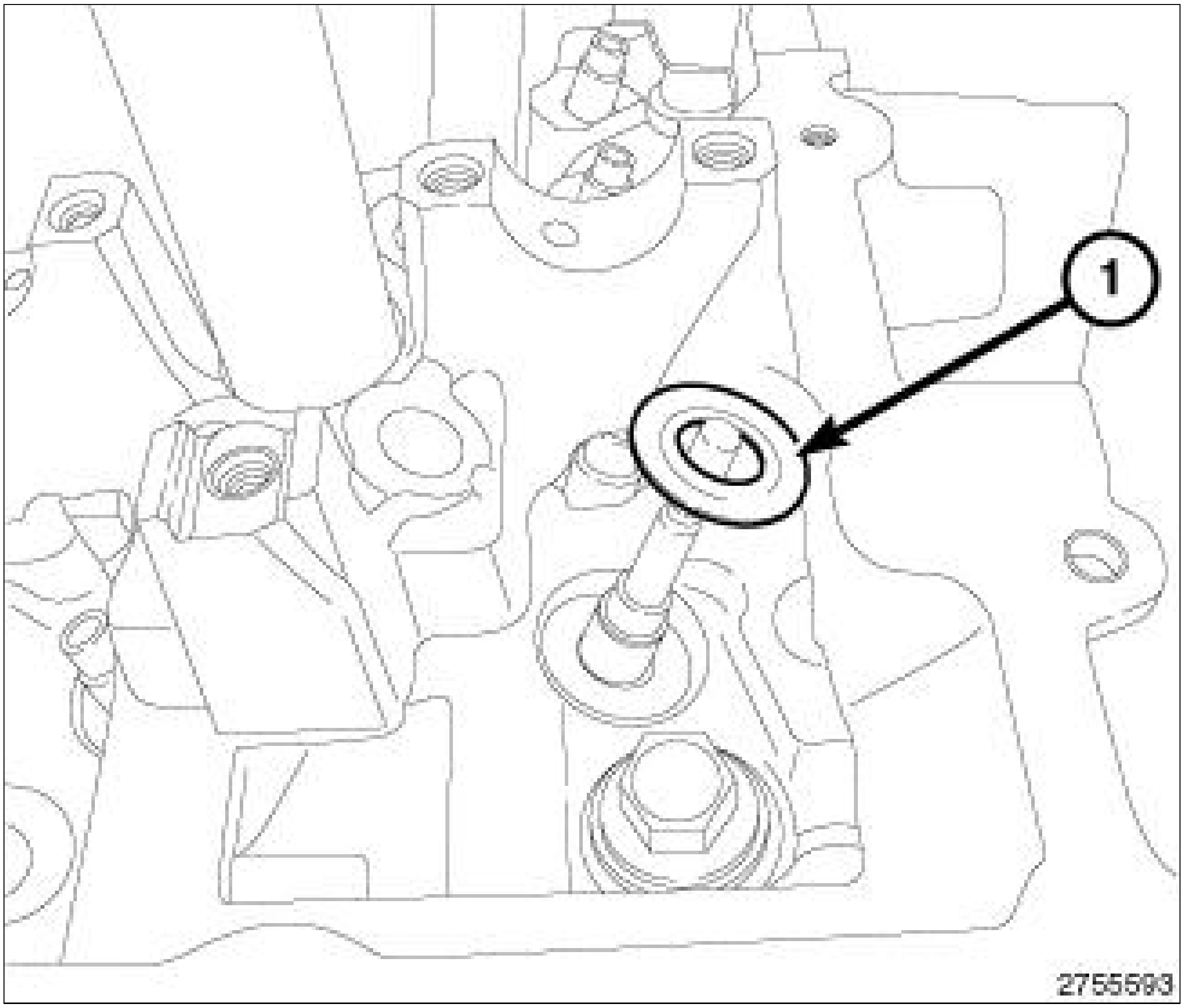
Courtesy of CHRYSLER GROUP, LLC

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 2: Valve Spring Seat



Courtesy of CHRYSLER GROUP, LLC

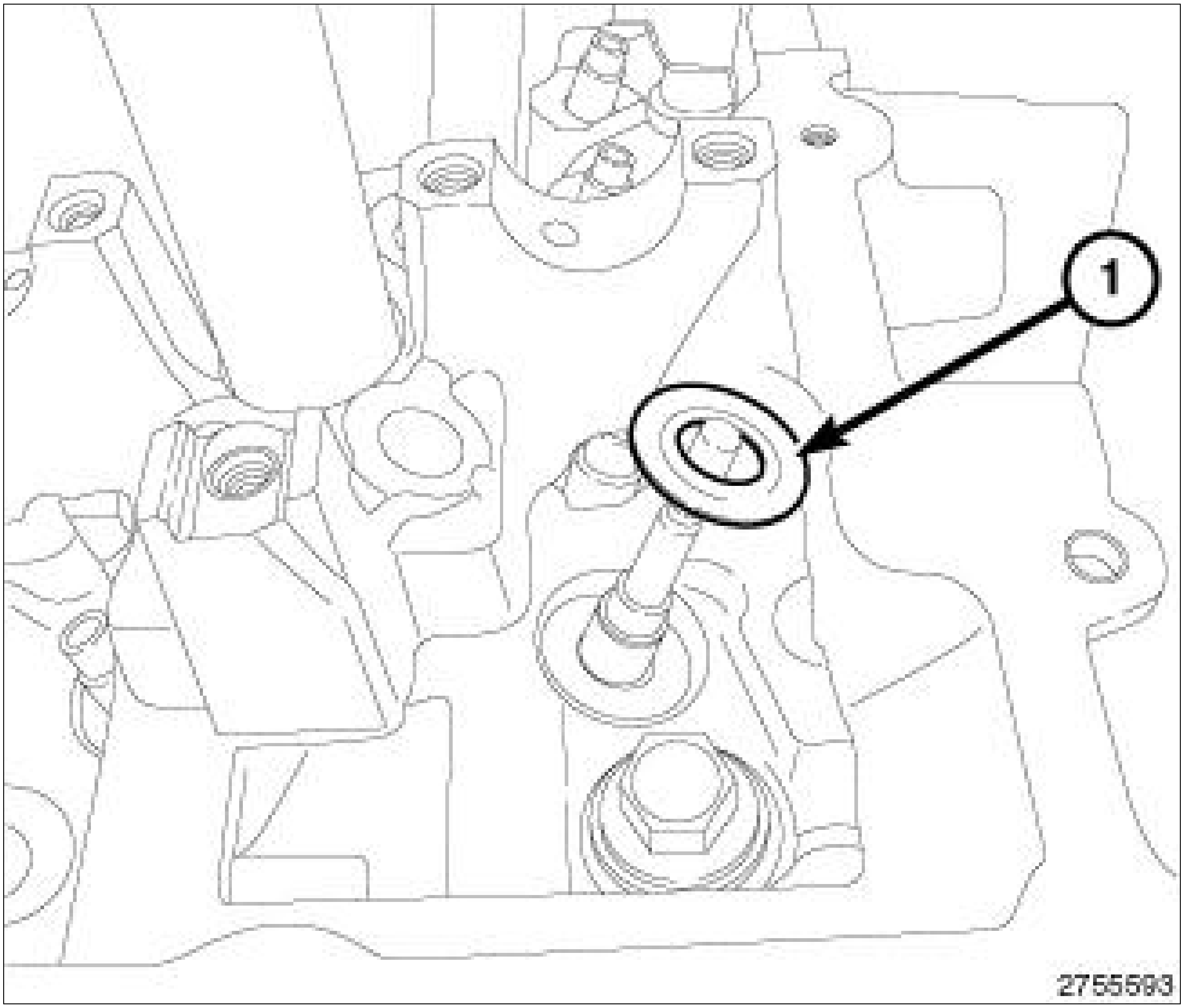
NOTE:

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 .

CYLINDER HEAD > SEAL(S), VALVE GUIDE > INSTALLATION > INSTALLATION

Fig 1: Valve Spring Seat



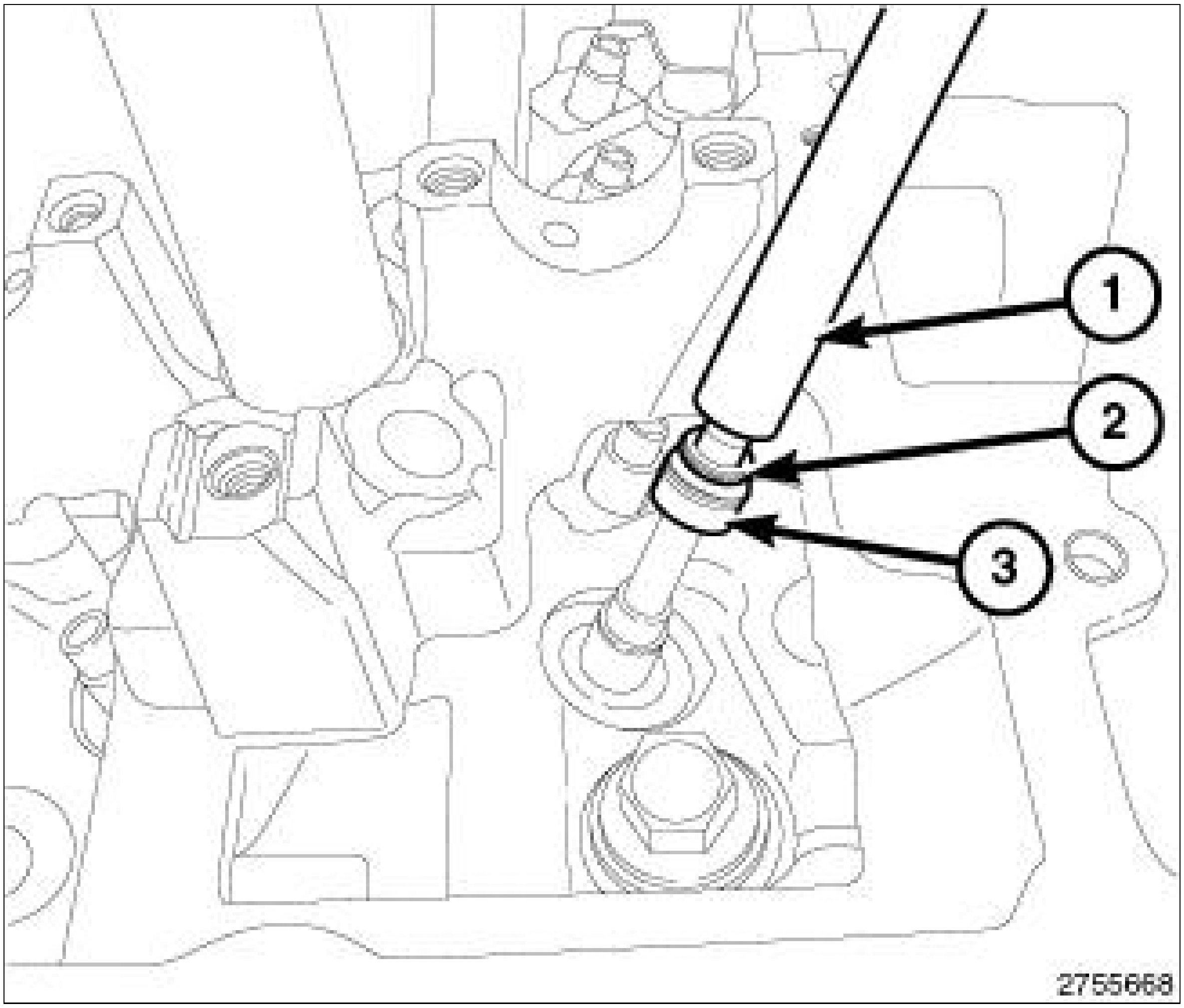
Courtesy of CHRYSLER GROUP, LLC

NOTE:

Reassemble the valves into their original locations. If the valves or valve seats have been refinished, verify that the valve stem tip height is within specification. Refer to ENGINE SPECIFICATIONS . Number 5 cylinder exhaust valve shown in illustration, all other valves similar.

1. If removed, install the valve(s). Refer to VALVES, INTAKE AND EXHAUST, INSTALLATION .
2. If removed, install the spring seat (1) over the valve guide.

Fig 2: Installing Valve Guide Seal



Courtesy of CHRYSLER GROUP, LLC

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.

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:

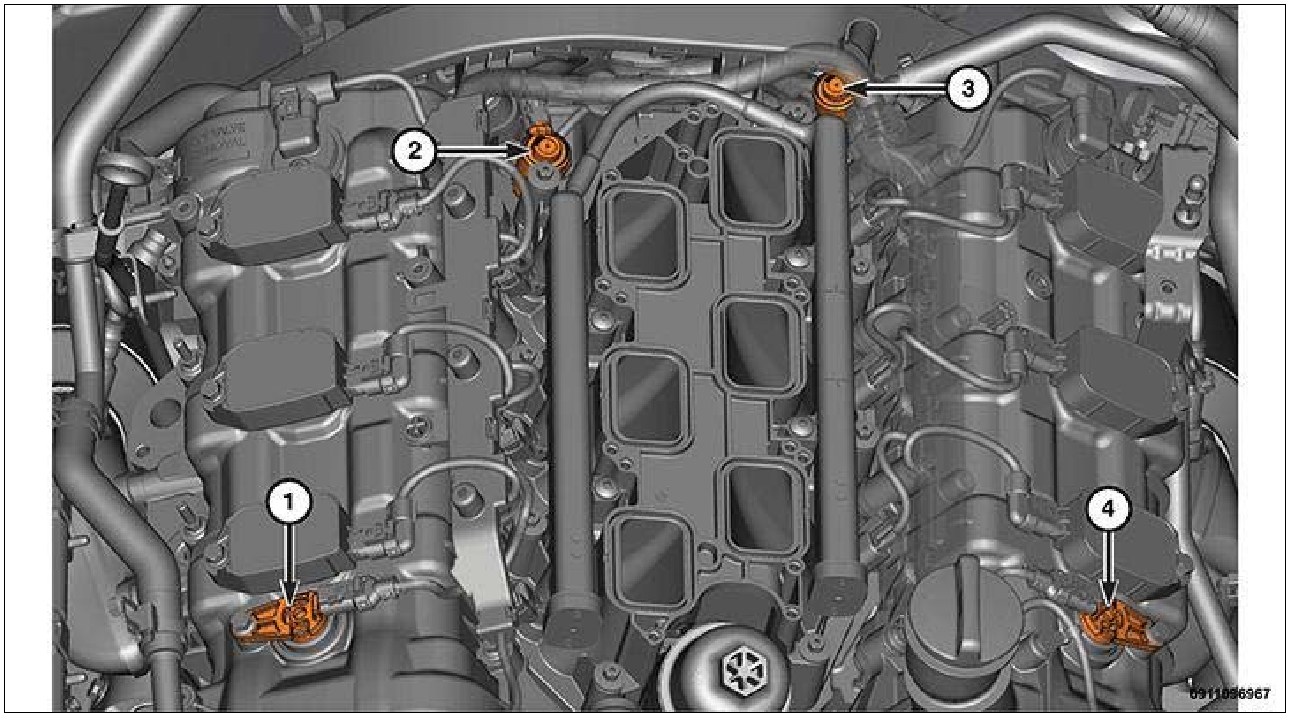
If the valve springs are being reused, reassemble them into their original locations.

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

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > DESCRIPTION > DESCRIPTION AND OPERATION

There are four Variable Valve Lift (VVL) solenoids that control the operation of the Intake rocker arms for all six cylinders. See the figure and chart below for the VVL Solenoid locations and cylinder control:

Fig 1: Locating Variable Valve Lift (VVL) Solenoids



Courtesy of CHRYSLER GROUP, LLC

VVL SOLENOID	PHYSICAL LOCATION	CYLINDERS CONTROLLED
VVL SOLENOID 1/1	BANK 1 FRONT SOLENOID (1)	CYLINDER 1 INTAKE VALVES
VVL SOLENOID 1/2	BANK 1 REAR SOLENOID (2)	CYLINDERS 3 AND 5 INTAKE VALVES
VVL SOLENOID 2/1	BANK 2 FRONT SOLENOID (4)	CYLINDER 2 INTAKE VALVES
VVL SOLENOID 2/2	BANK 2 REAR SOLENOID (3)	CYLINDERS 4 AND 6 INTAKE VALVES

The Variable Valve Lift (VVL) system is designed to vary the lift and duration of the intake valves, to maximize efficiency and engine torque, depending on engine operation. The VVL system consists of 2 step intake rocker arms that are capable of operating in High Lift or Low Lift mode. The four VVL solenoids control the rocker arm modes using engine oil pressure.

- **Low Lift Mode:** The Powertrain Control Module (PCM) commands the VVL Solenoids on, which supplies 12.0 volts to the VVL solenoids and allows engine oil pressure to pass through the solenoids to the rocker arms. This in turn pushes the lock pins back which allows the center of the rocker arms to move down freely, allowing the rocker arms to operate in Low Lift Mode. It takes approximately 20.0 psi of engine oil pressure at the rocker arms to move the lock pins.

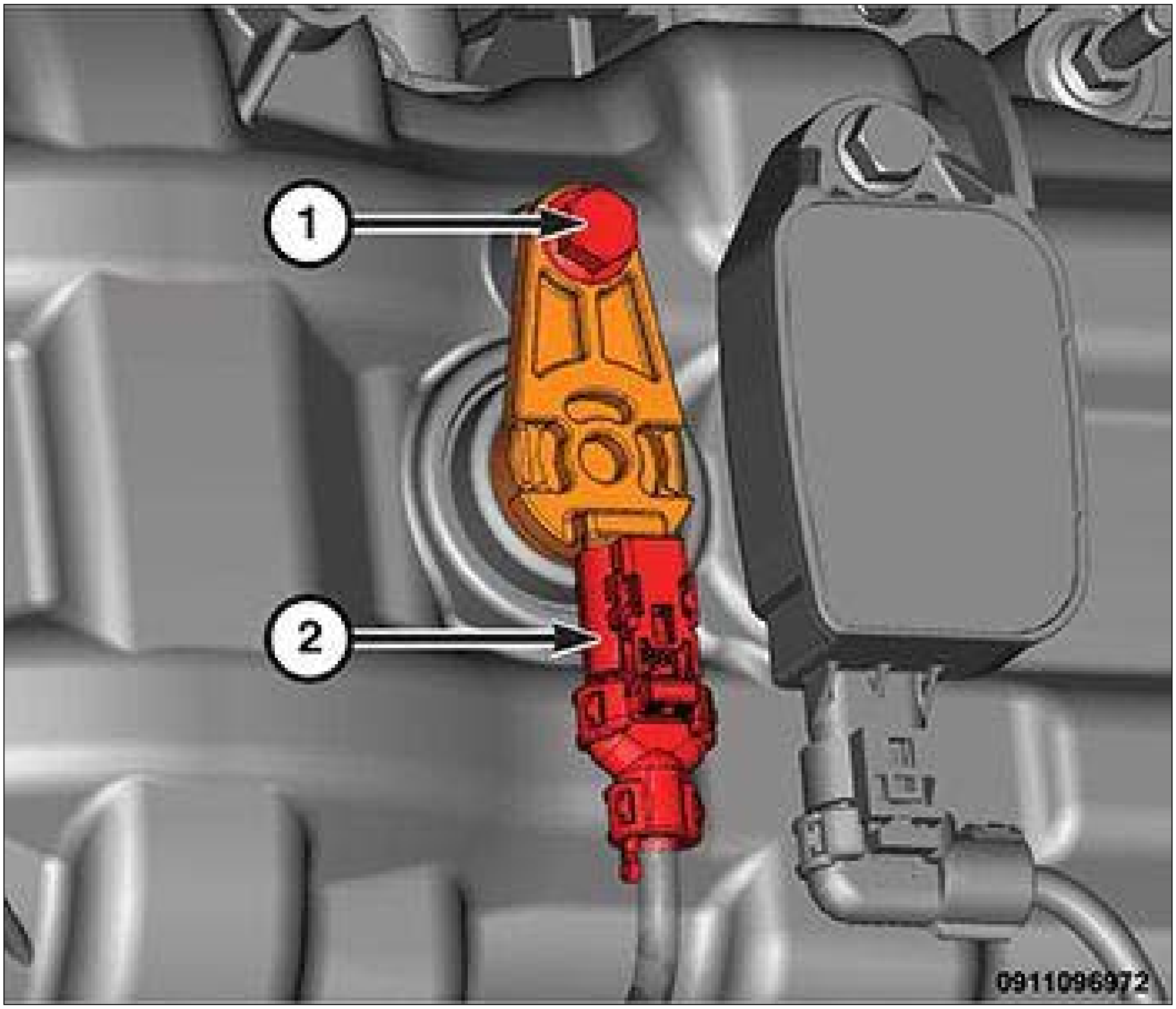
- **High Lift Mode:** The rocker arms default to High Lift mode when no oil pressure is present. This is accomplished with a spring loaded lock pin that keeps the center of the rocker arms in the High Lift position. The PCM commands the VVL Solenoids off when High Lift Mode is desired.

The PCM performs a diagnostic check on each VVL Solenoid High Side Driver Circuit for an open or short in the circuitry. If no circuit faults are detected, the PCM runs a rationality diagnostic to check for any rocker arms that are stuck in the High Lift or Low Lift positions. The PCM can determine this by monitoring for an erratic MAP Sensor signal along with the misfire, knock and Individual Cylinder Fuel Control (ICFC) monitors to detect a rocker arm that is stuck in an incorrect position for a given cylinder. This diagnostic can also detect the mechanical failure of a solenoid or an oil pressure issue to one or more of the rocker arms. When a fault is detected for a rocker arm, the PCM will begin to record **in field** data for diagnostic purposes until the PCM defaults the VVL system to High Lift or Low Lift mode. If the condition goes away during the drive cycle the data collected will also be cleared.

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > REMOVAL > BANK 1 SOLENOID 1

1. Remove the upper intake manifold. Refer to MANIFOLD, INTAKE, REMOVAL .

Fig 1: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



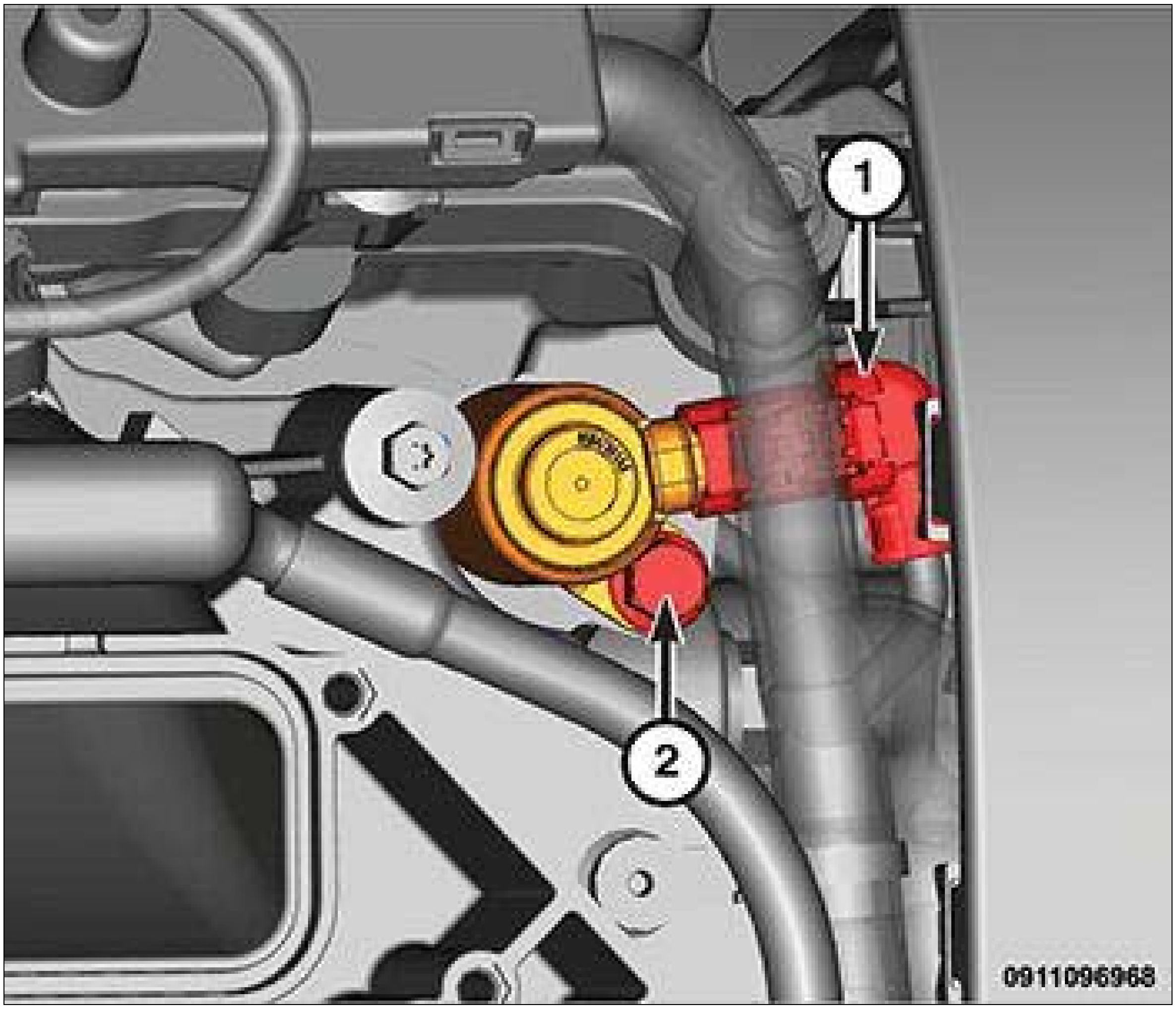
Courtesy of CHRYSLER GROUP, LLC

2. Disconnect the wire harness connector (2) from the Variable Valve Lift (VVL) solenoid.
3. Remove the retaining bolt (1) from the VVL solenoid.
4. Remove the VVL solenoid from the cylinder head cover.
5. The O-ring seal can be reused if not damaged.

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > REMOVAL > BANK 1 SOLENOID 2

1. Remove the upper intake manifold. Refer to MANIFOLD, INTAKE, REMOVAL .

Fig 1: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



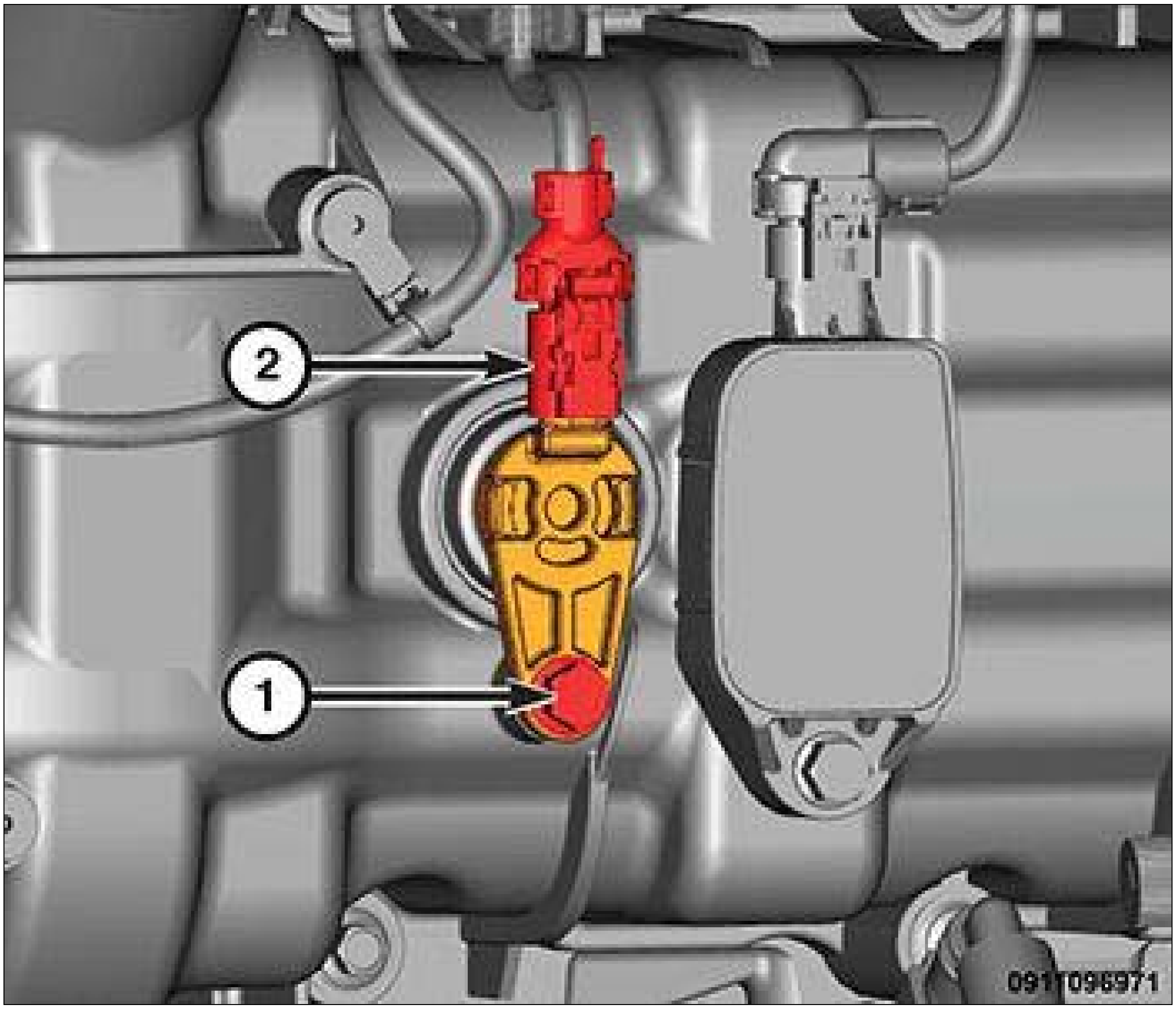
Courtesy of CHRYSLER GROUP, LLC

2. Disconnect the wire harness connector (1) from the Variable Valve Lift (VVL) solenoid.
3. Remove the VVL solenoid retaining bolt (2).
4. Remove the VVL solenoid from the cylinder head.
5. The O-ring seal can be reused if not damaged.

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > REMOVAL > BANK 2 SOLENOID 1

1. Remove the air cleaner body. Refer to BODY, AIR CLEANER, REMOVAL .
2. Disconnect and isolate the negative battery cable.

Fig 1: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



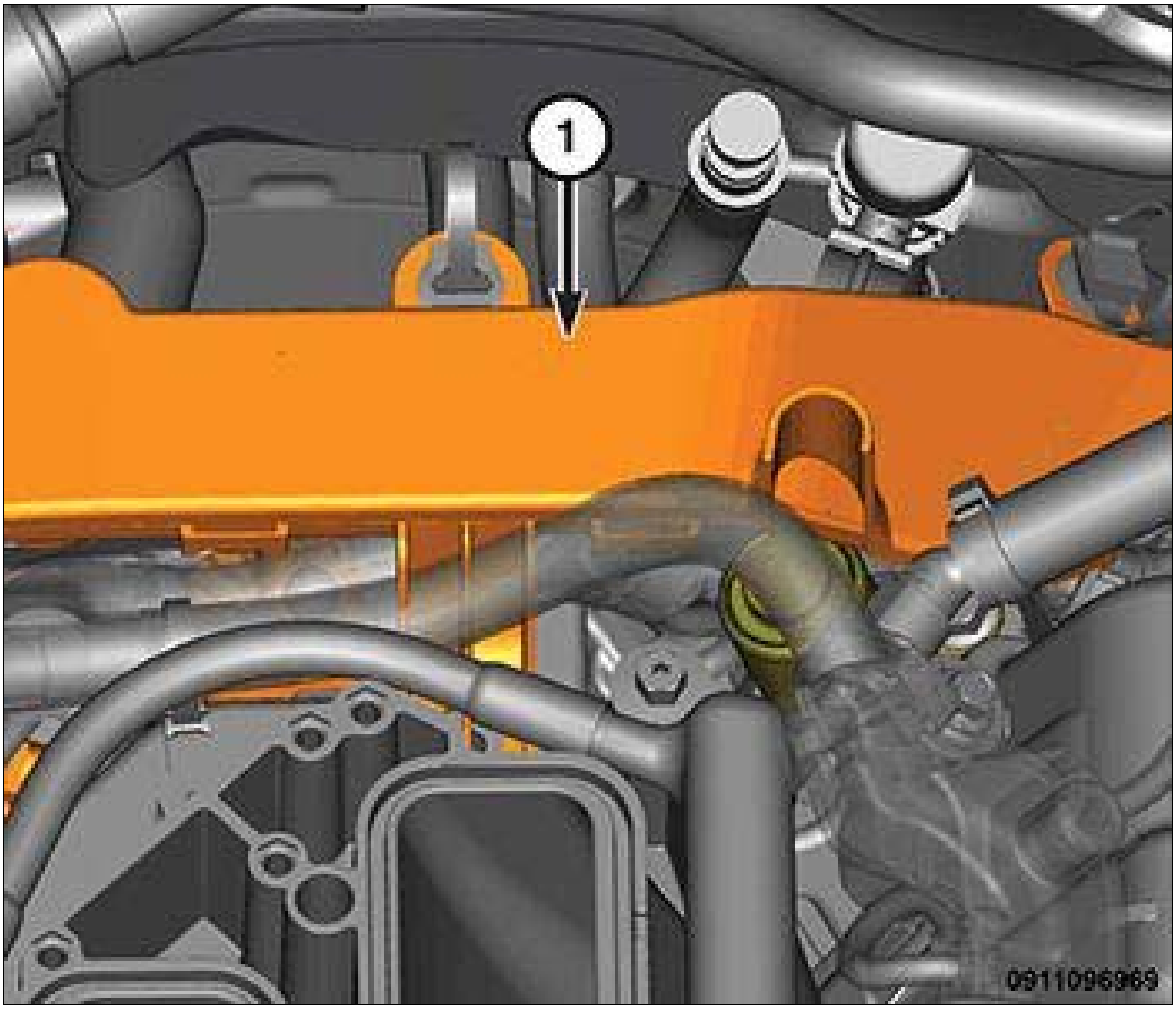
Courtesy of CHRYSLER GROUP, LLC

3. Disconnect the wire harness connector (2) from the Variable Valve Lift (VVL) solenoid.
4. Remove the retaining bolt (1) from the VVL solenoid.
5. Remove the VVL solenoid from the cylinder head cover.
6. The O-ring seal can be reused if not damaged.

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > REMOVAL > BANK 2 SOLENOID 2

1. Disconnect and isolate the negative battery cable.
2. Remove the cowl extension. Refer to SILENCER, COWL EXTENSION, REMOVAL .

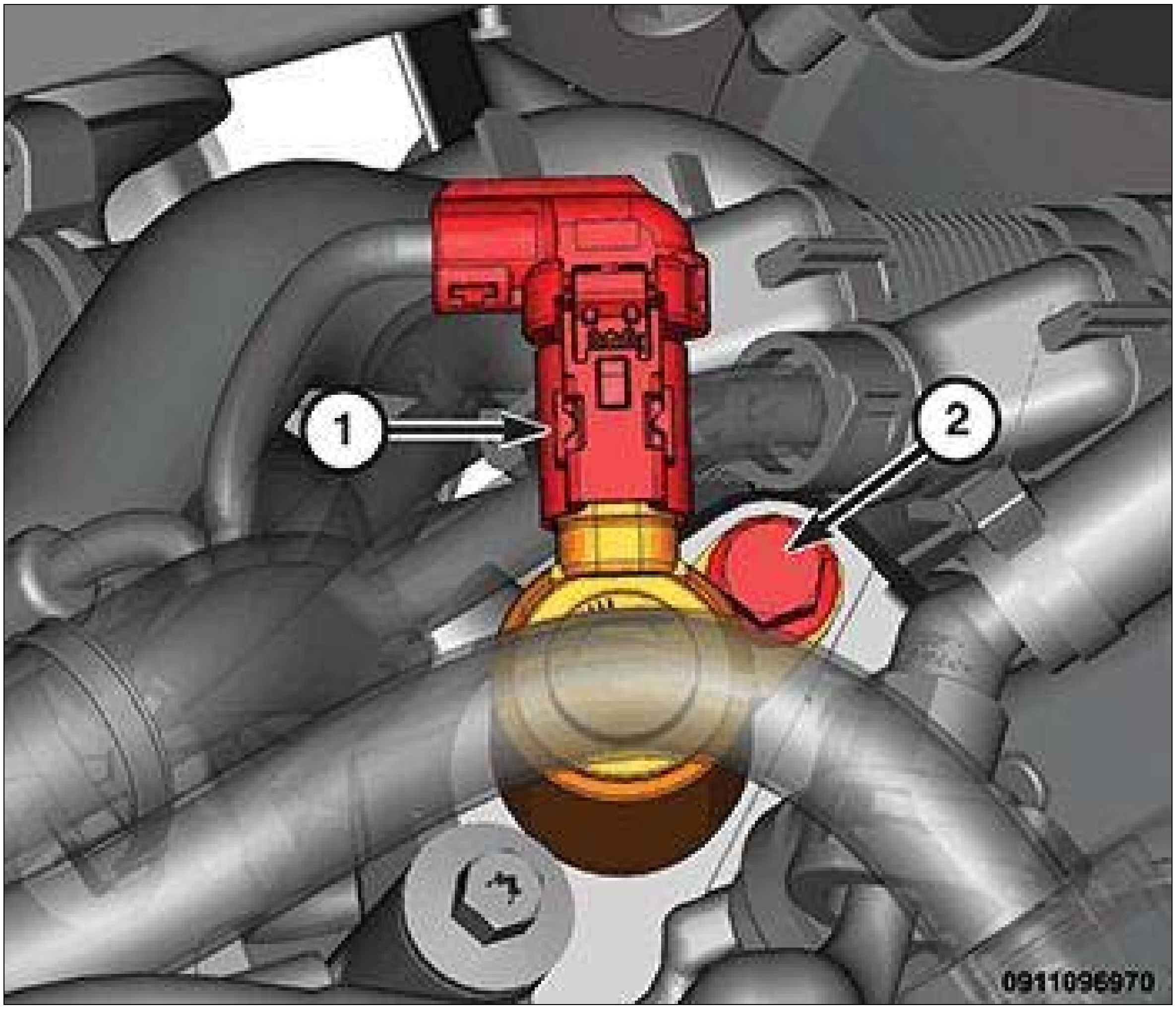
Fig 1: Rear Engine Wire Harness



Courtesy of CHRYSLER GROUP, LLC

3. Position the rear engine wire harness (1) aside.

Fig 2: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



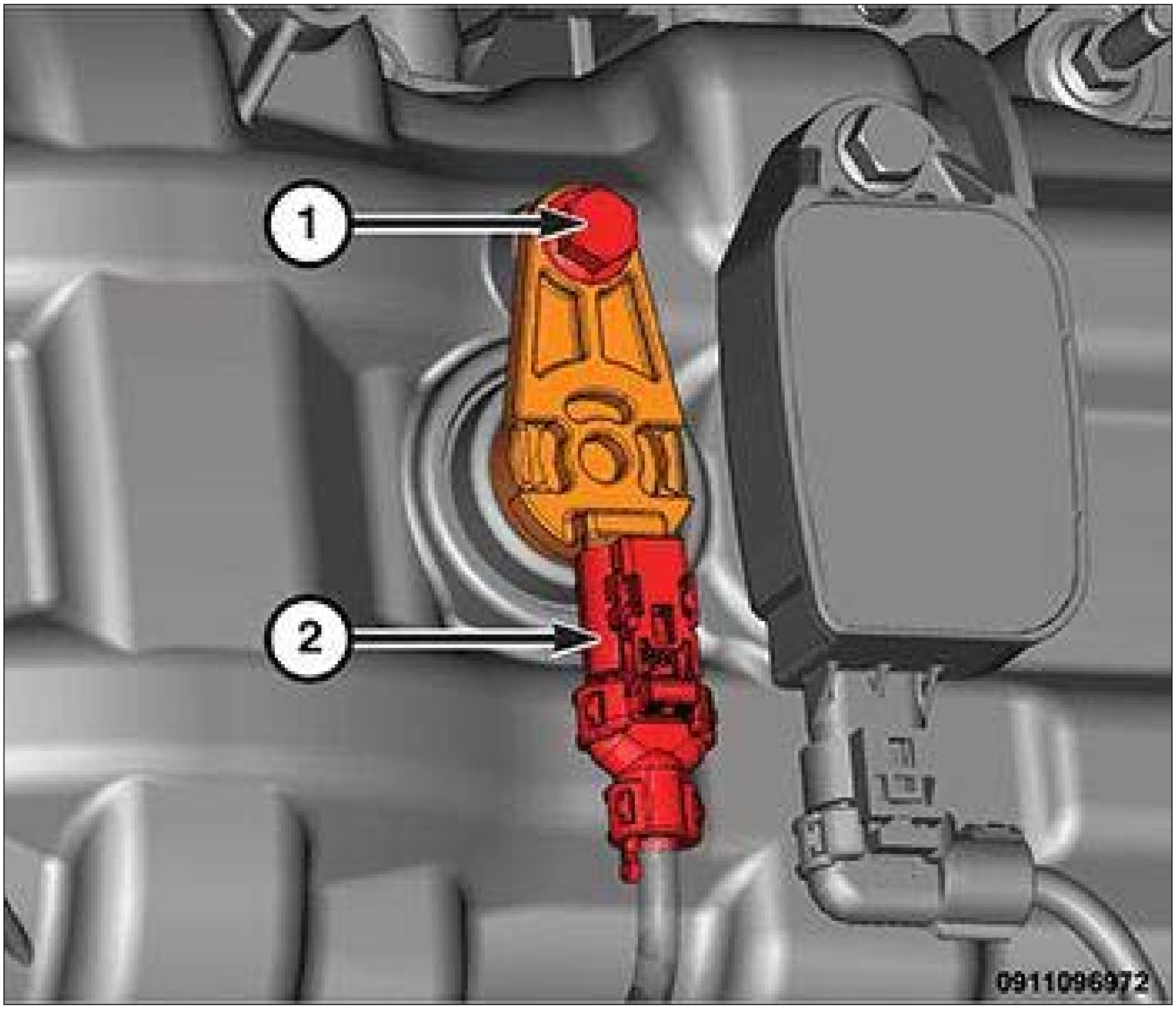
Courtesy of CHRYSLER GROUP, LLC

4. Disconnect the wire harness connector (1) from the Variable Valve Lift (VVL) solenoid.
5. Remove the VVL solenoid retaining bolt (2).
6. Remove the VVL solenoid from the cylinder head.
7. The O-ring seal can be reused if not damaged.

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > INSTALLATION > BANK 1 SOLENOID 1

1. Inspect the Variable Valve Lift (VVL) solenoid O-ring seal and replace if necessary.

Fig 1: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



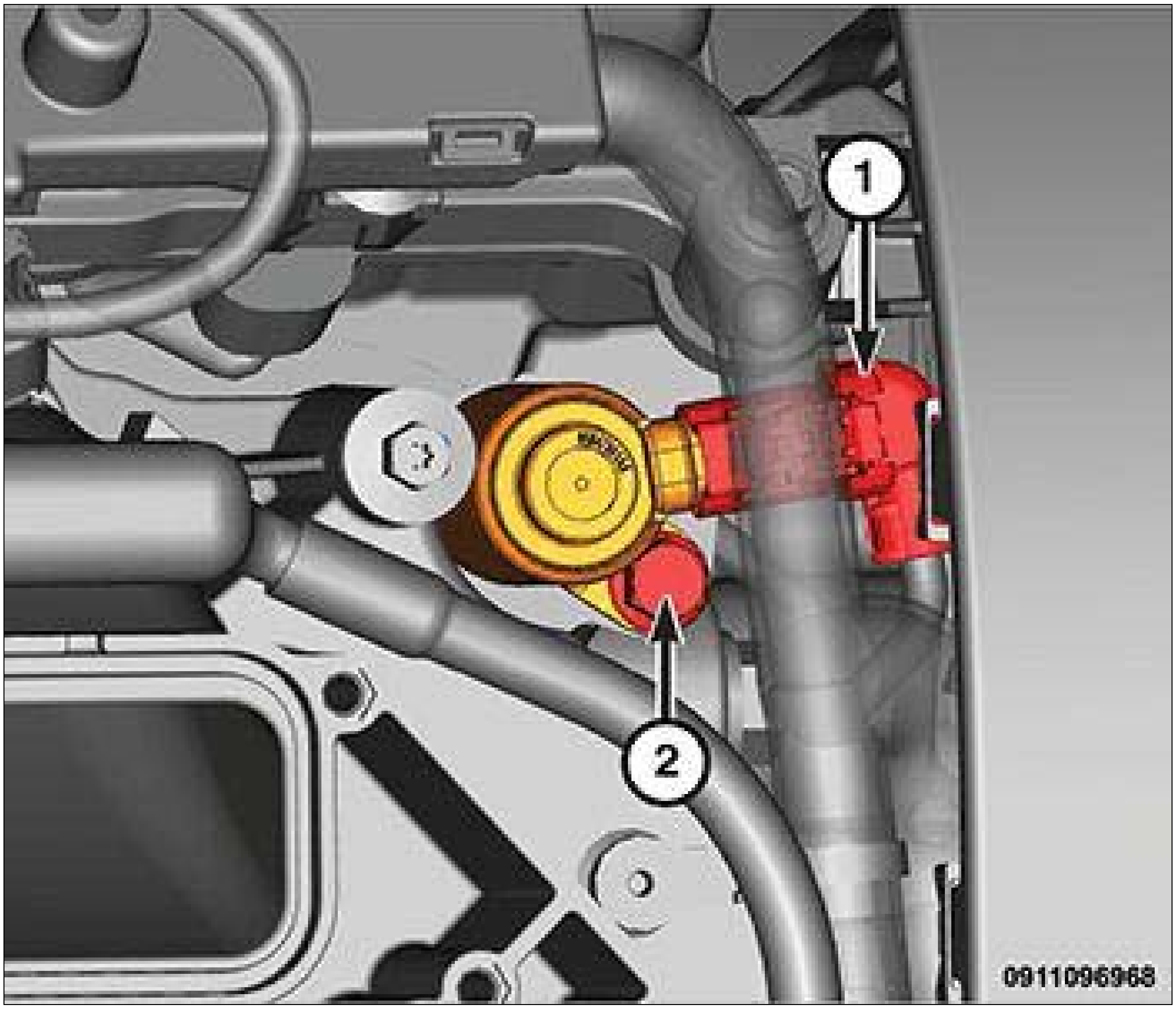
Courtesy of CHRYSLER GROUP, LLC

2. Insert the VVL solenoid into the cylinder head cover.
3. Install the retaining bolt (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
4. Connect the wire harness connector (2) to the VVL solenoid.
5. Install the upper intake manifold. Refer to MANIFOLD, INTAKE, INSTALLATION .

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > INSTALLATION > BANK 1 SOLENOID 2

1. Inspect the Variable Valve Lift (VVL) solenoid O-ring seal and replace if necessary.

Fig 1: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



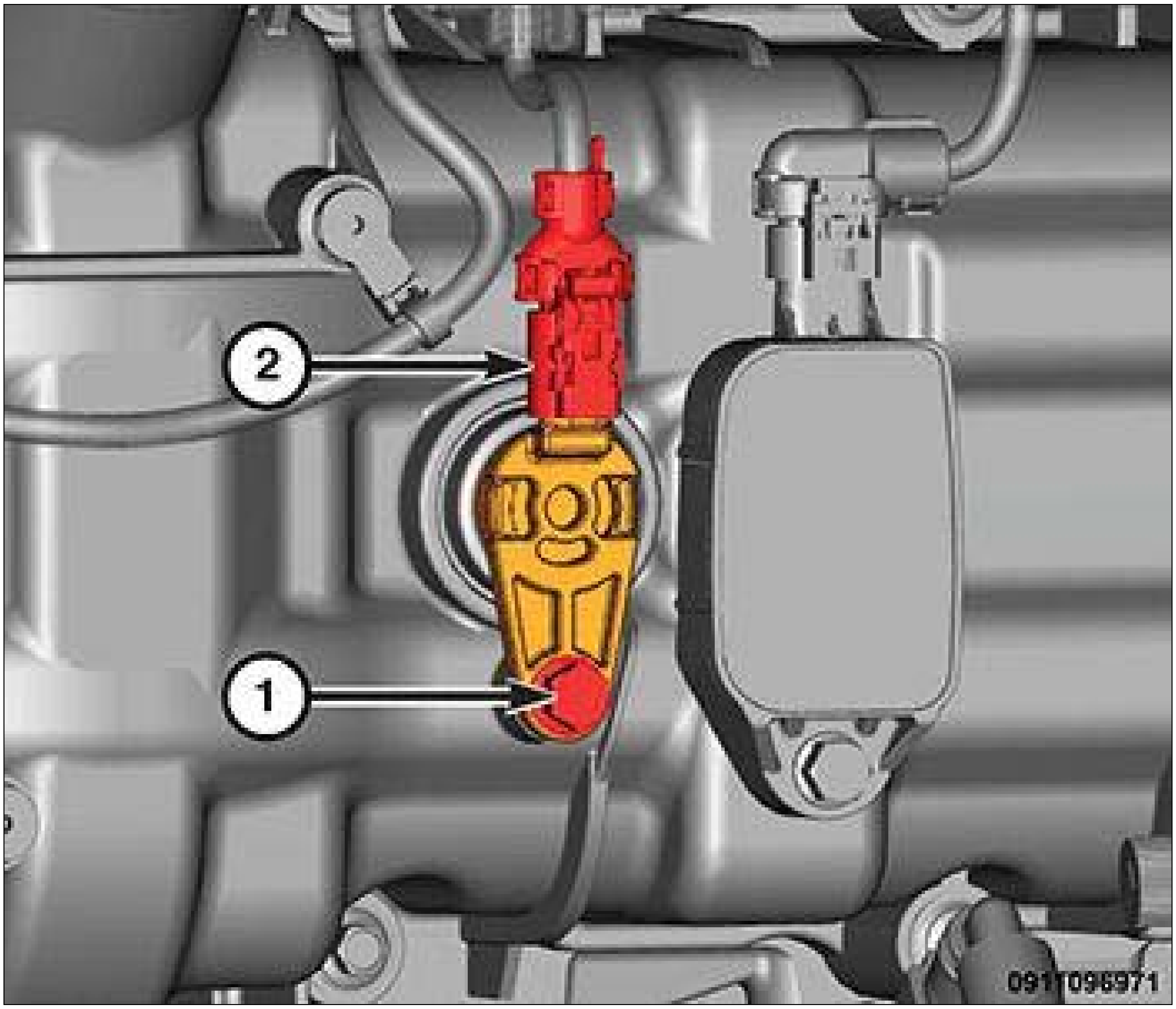
Courtesy of CHRYSLER GROUP, LLC

2. Insert the VVL solenoid into the cylinder head.
3. Install the retaining bolt (2) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
4. Connect the wire harness connector (1) to the VVL solenoid.
5. Install the upper intake manifold. Refer to MANIFOLD, INTAKE, INSTALLATION .

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > INSTALLATION > BANK 2 SOLENOID 1

1. Inspect the Variable Valve Lift (VVL) solenoid O-ring seal and replace if necessary.

Fig 1: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



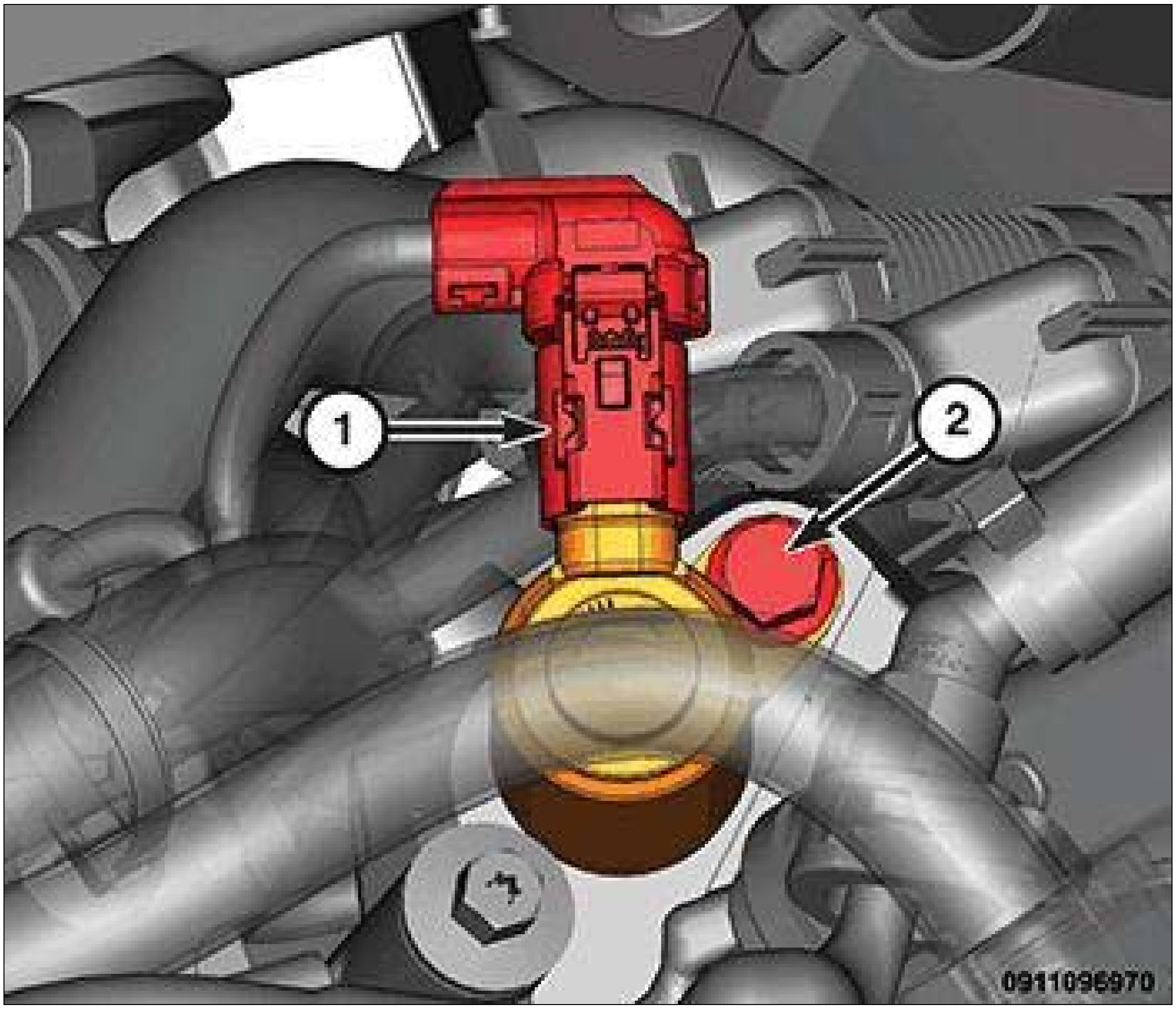
Courtesy of CHRYSLER GROUP, LLC

2. Insert the VVL solenoid into the cylinder head cover.
3. Install the retaining bolt (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
4. Connect the wire harness connector (2) to the VVL solenoid.
5. Connect the negative battery cable.
6. Install the air cleaner body. Refer to BODY, AIR CLEANER, INSTALLATION .

CYLINDER HEAD > SOLENOID, VARIABLE VALVE LIFT > INSTALLATION > BANK 2 SOLENOID 2

1. Inspect the Variable Valve Lift (VVL) solenoid O-ring seal and replace if necessary.

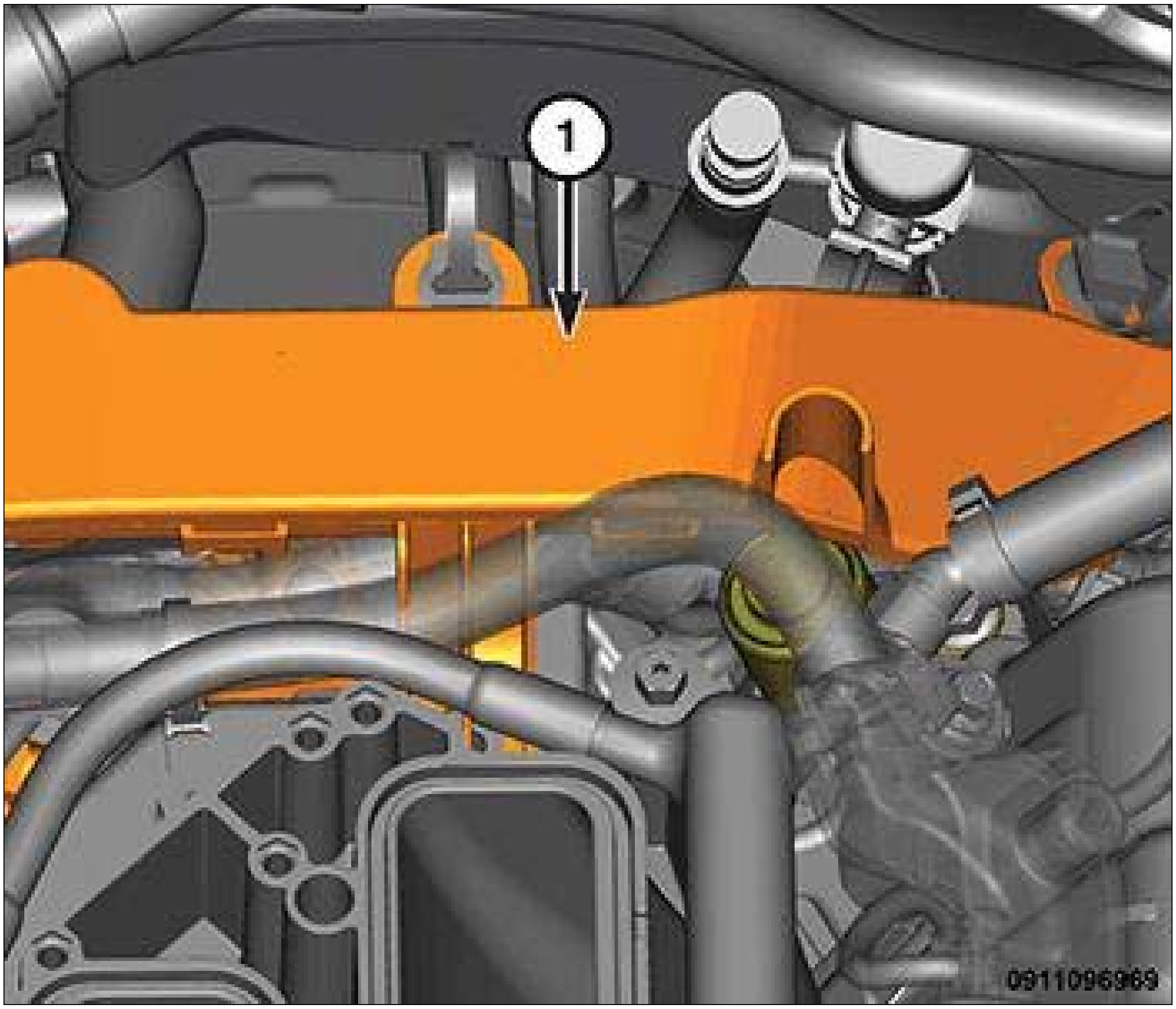
Fig 1: Variable Valve Lift (VVL) Solenoid Wire Harness Connector & Retaining Bolt



Courtesy of CHRYSLER GROUP, LLC

2. Insert the VVL solenoid into the cylinder head.
3. Install the retaining bolt (2) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
4. Connect the wire harness connector (1) to the VVL solenoid.

Fig 2: Rear Engine Wire Harness

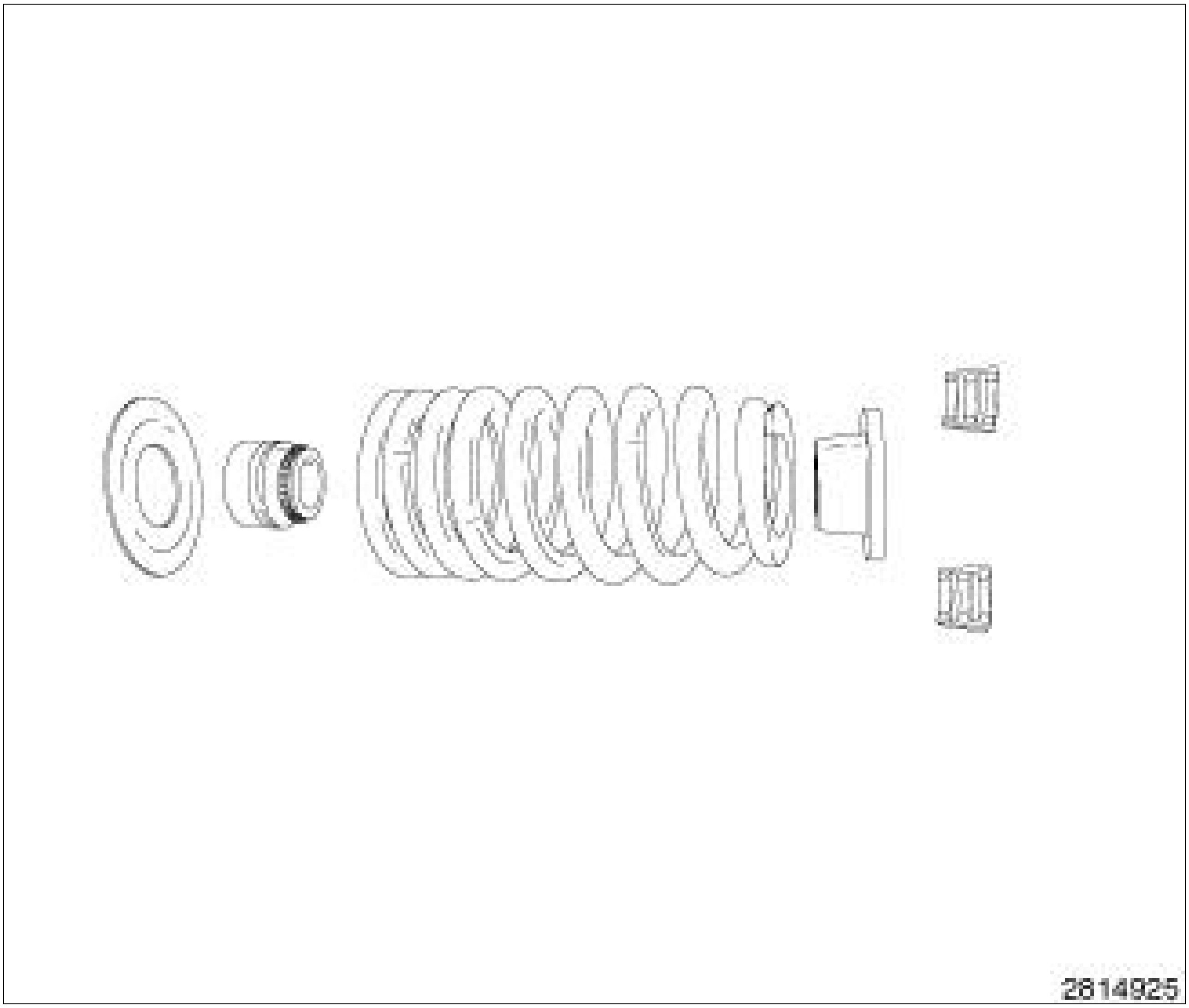


Courtesy of CHRYSLER GROUP, LLC

5. Install the rear engine wire harness.
6. Install the cowl extension. Refer to SILENCER, COWL EXTENSION, INSTALLATION .
7. Connect the negative battery cable.

CYLINDER HEAD > SPRING(S), VALVE > DESCRIPTION > DESCRIPTION

Fig 1: 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.

CYLINDER HEAD > SPRING(S), VALVE > REMOVAL > ON VEHICLE

1. Remove both cylinder head covers. Refer to COVER(S), CYLINDER HEAD, REMOVAL .

NOTE:

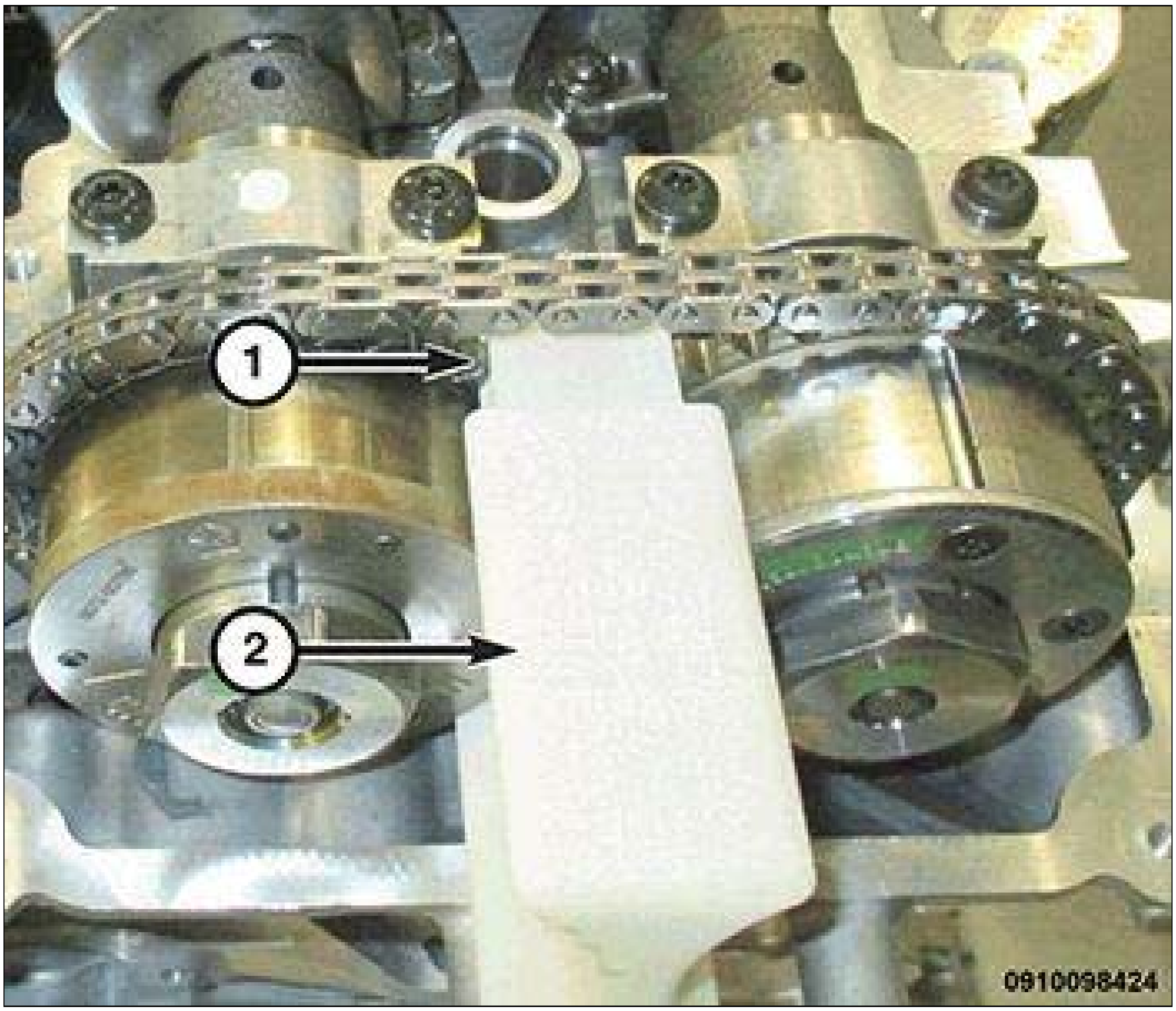
Only remove the camshafts from one head at a time. The opposite head must remain assembled in order to lock the crankshaft against rotation.

NOTE:

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

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

Fig 1: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



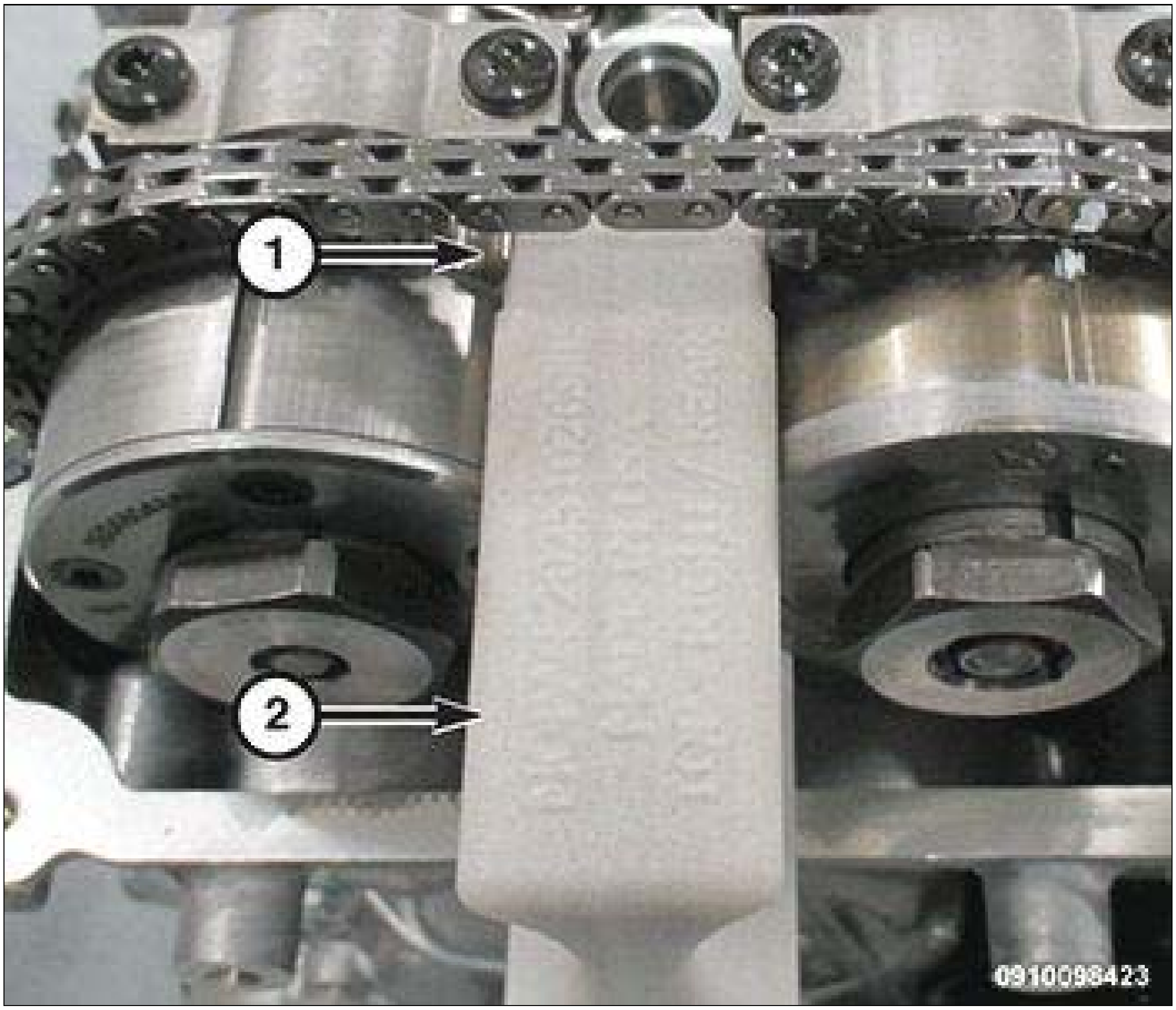
Courtesy of CHRYSLER GROUP, LLC

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.

3. If removing the RH camshafts, install the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head) (2) to lock the crankshaft against rotation.

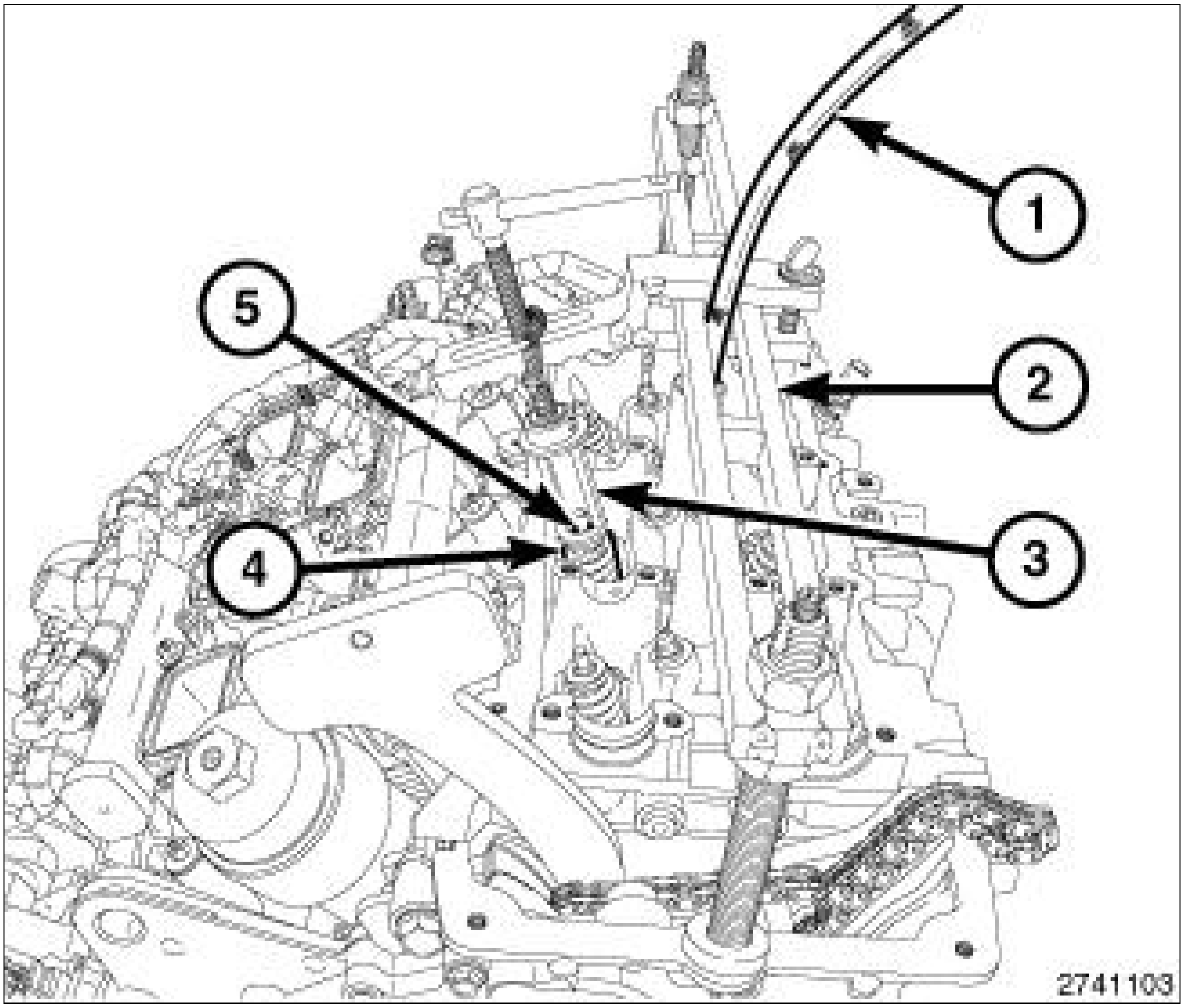
   Fig 2: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

4. If removing the LH camshafts, install the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (2) to lock the crankshaft against rotation.

Fig 3: 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.

5. Remove the spark plug. Refer to SPARK PLUG, REMOVAL .
6. Install Valve Spring Compressor (special tool #MD998772A, Compressor, Valve Spring) (2) onto the cylinder head.

CAUTION:

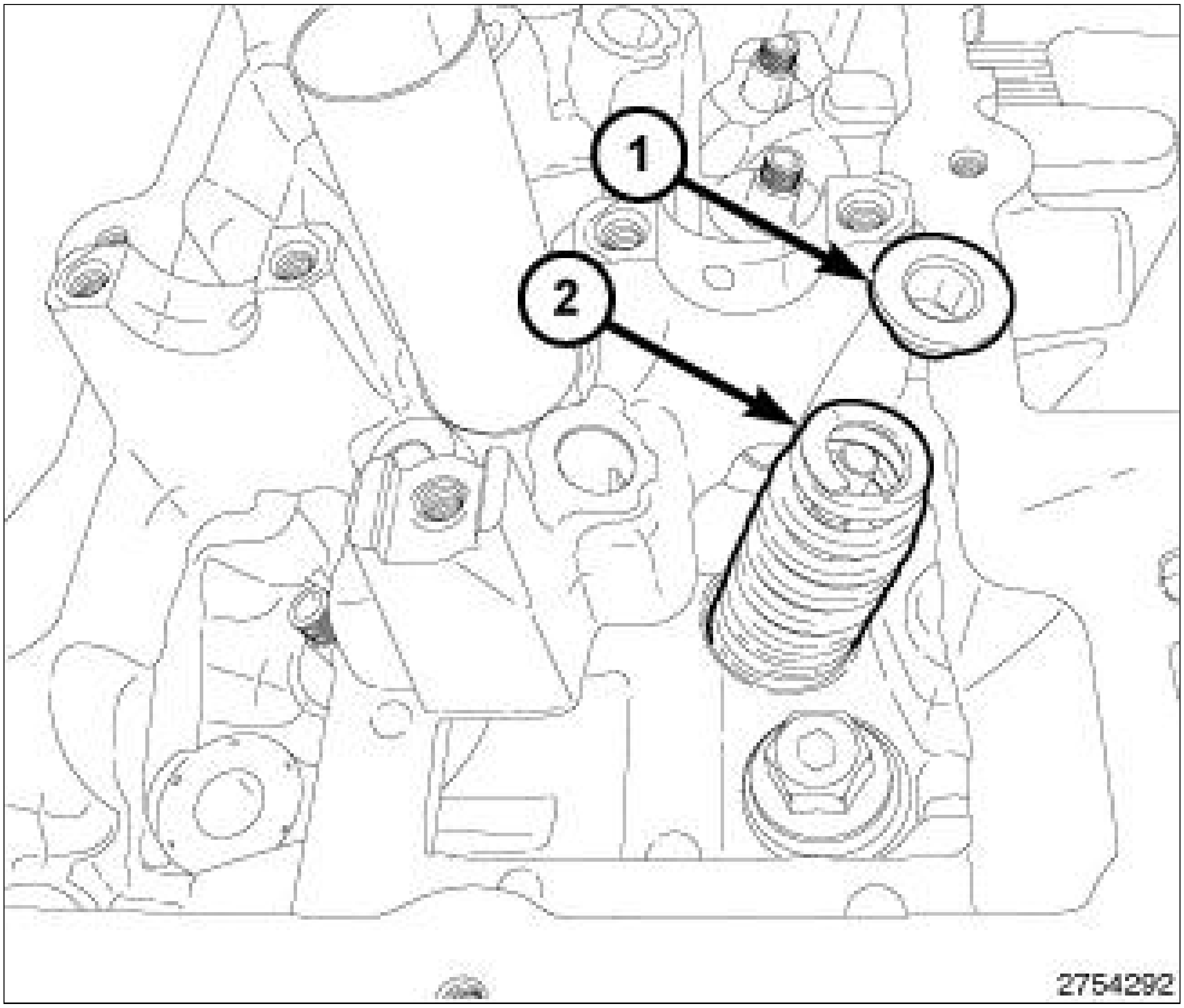
Air pressure must be maintained as long as the valve springs are removed to prevent the valves from dropping into the cylinders.

7. 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.

8. Using Valve Spring Compressor Adapter (special tool #10224, Adapter, Valve Spring) (3), compress valve spring (4) and remove valve retaining locks (5).

Fig 4: 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.*

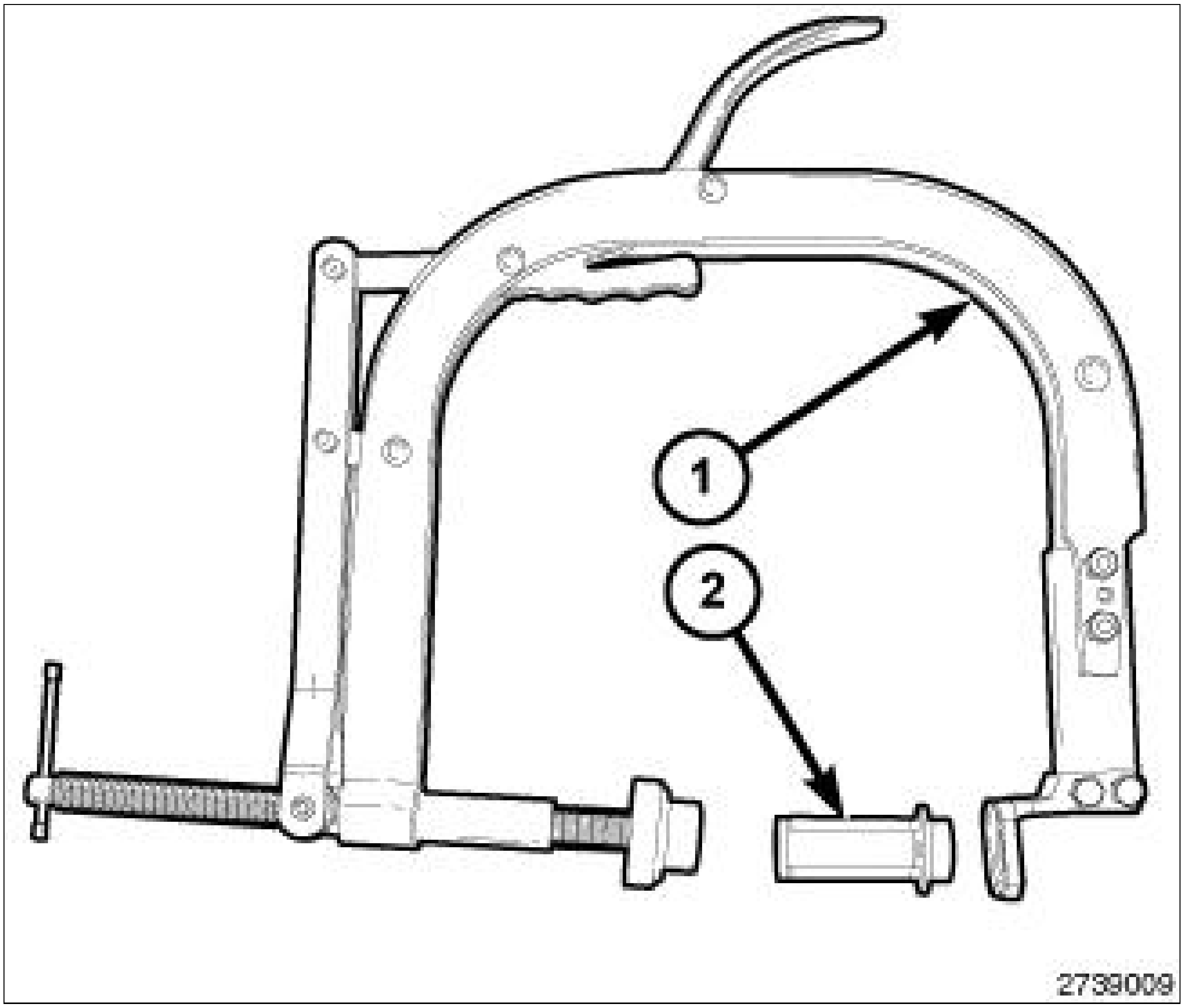
9. Release the valve spring compressor and remove the valve spring retainer (1) and valve spring (2).

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

CYLINDER HEAD > SPRING(S), VALVE > REMOVAL > OFF VEHICLE

1. Remove the cylinder head(s). Refer to CYLINDER HEAD, REMOVAL .

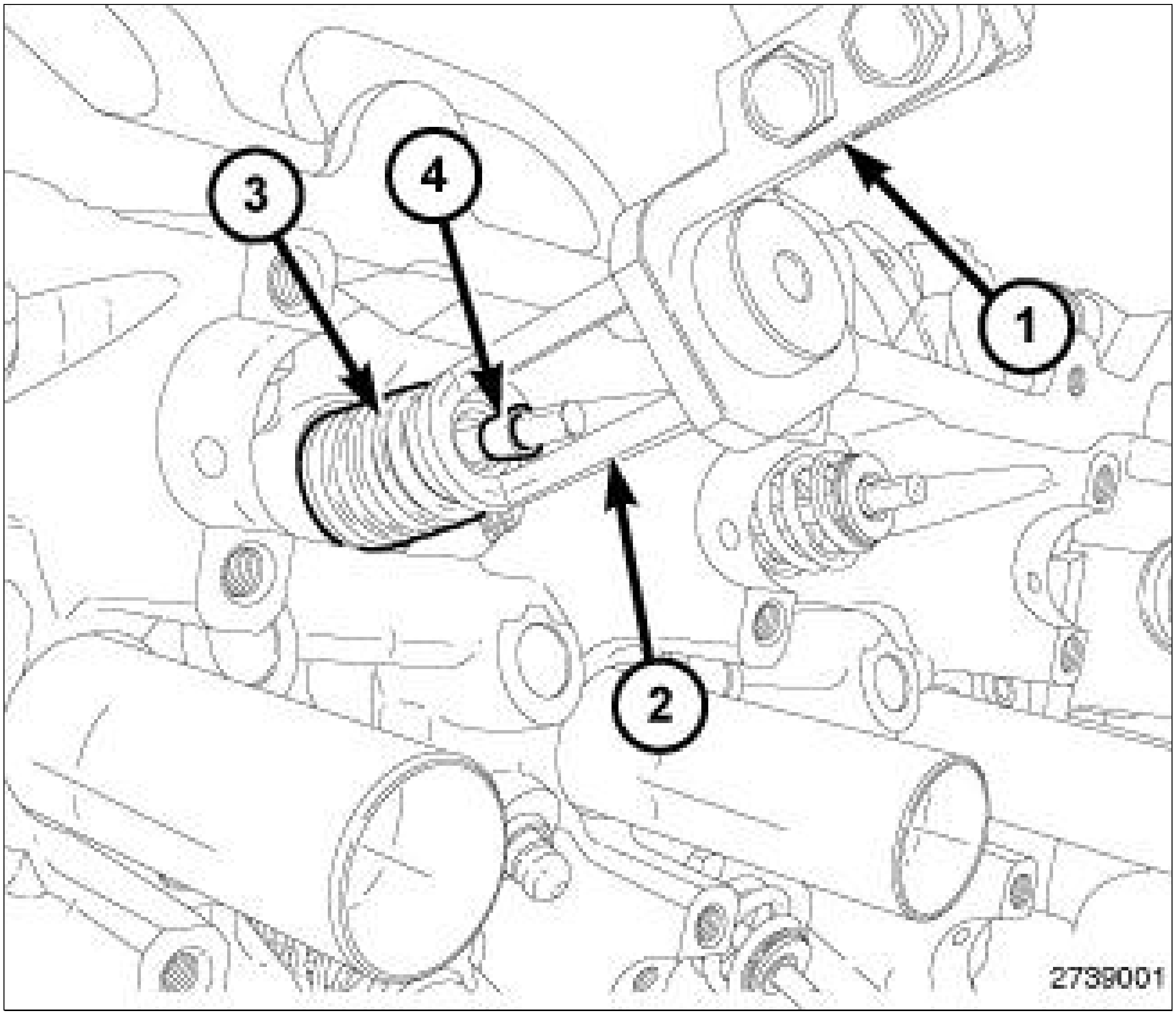
   Fig 1: Valve Spring Compressor Components

   Courtesy of CHRYSLER GROUP, LLC

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 2: Compressing Valve Spring & Locating Valve Retaining Locks



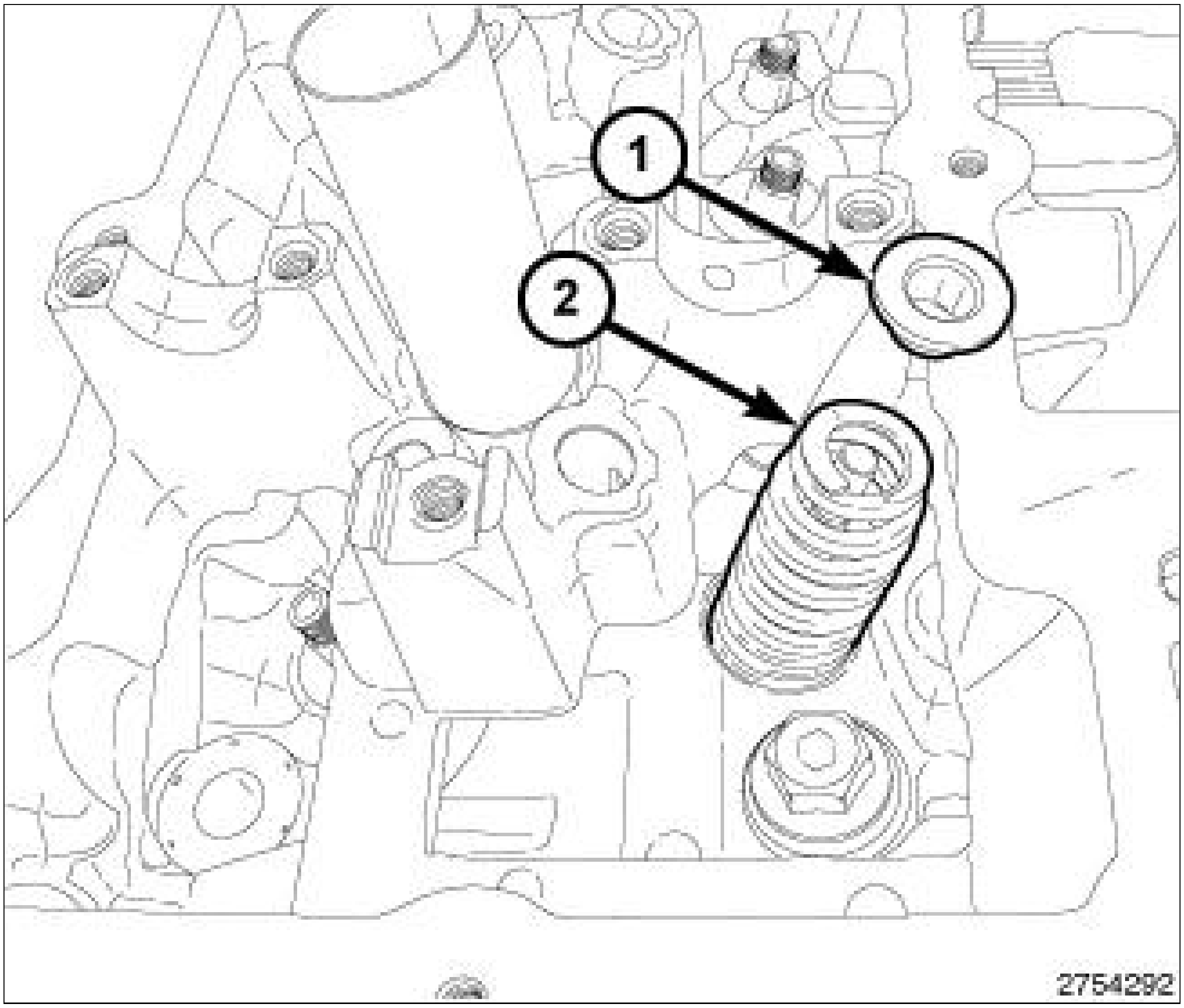
Courtesy of CHRYSLER GROUP, LLC

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 3: Valve Spring & Valve Spring Retainer



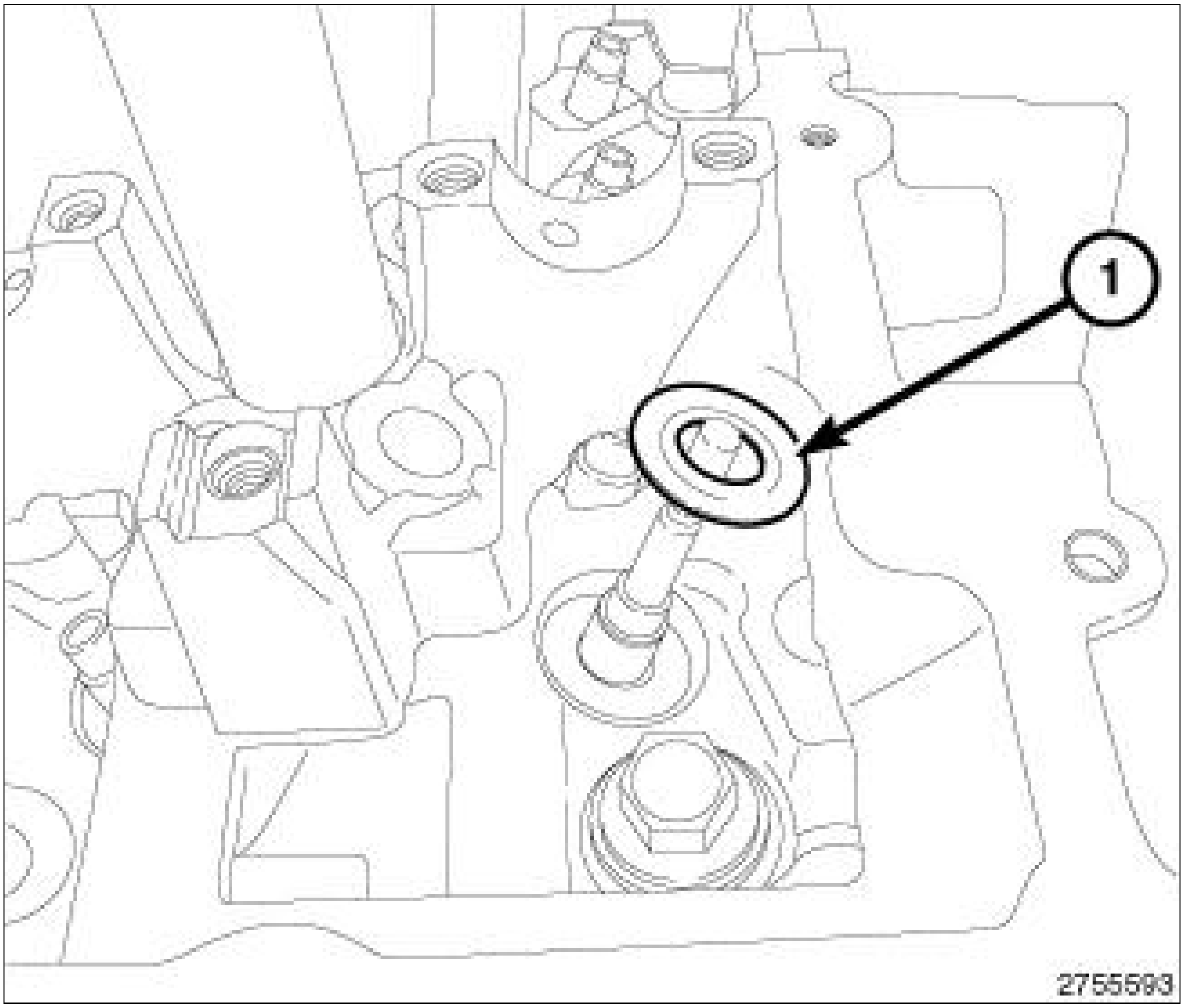
Courtesy of CHRYSLER GROUP, LLC

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 compressor and remove the valve spring retainer (1) and valve spring (2).

Fig 4: Valve Spring Seat

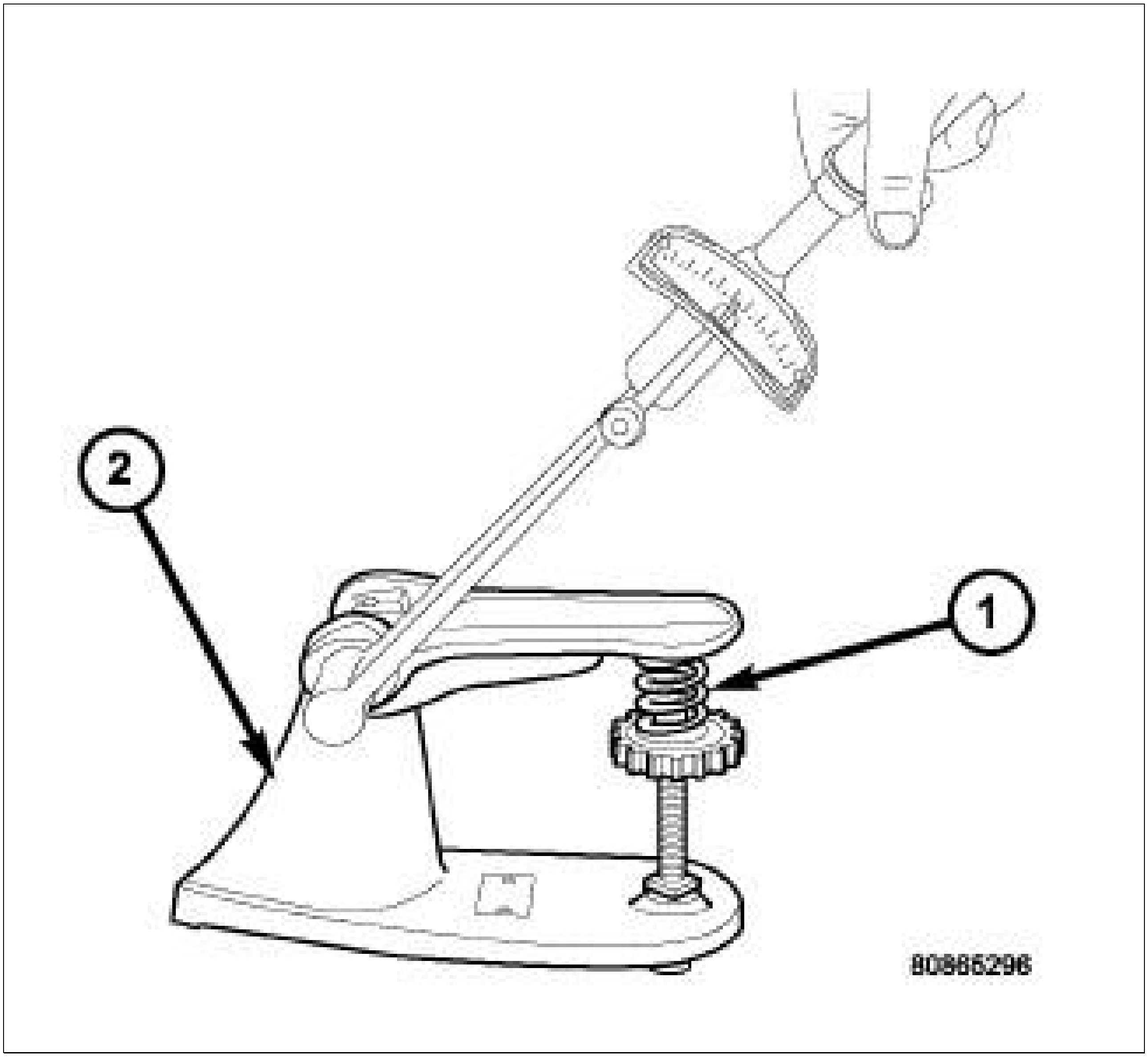


Courtesy of CHRYSLER GROUP, LLC

5. Remove the spring seat (1).

CYLINDER HEAD > SPRING(S), VALVE > INSPECTION > INSPECTION

Fig 1: Testing Valve Spring

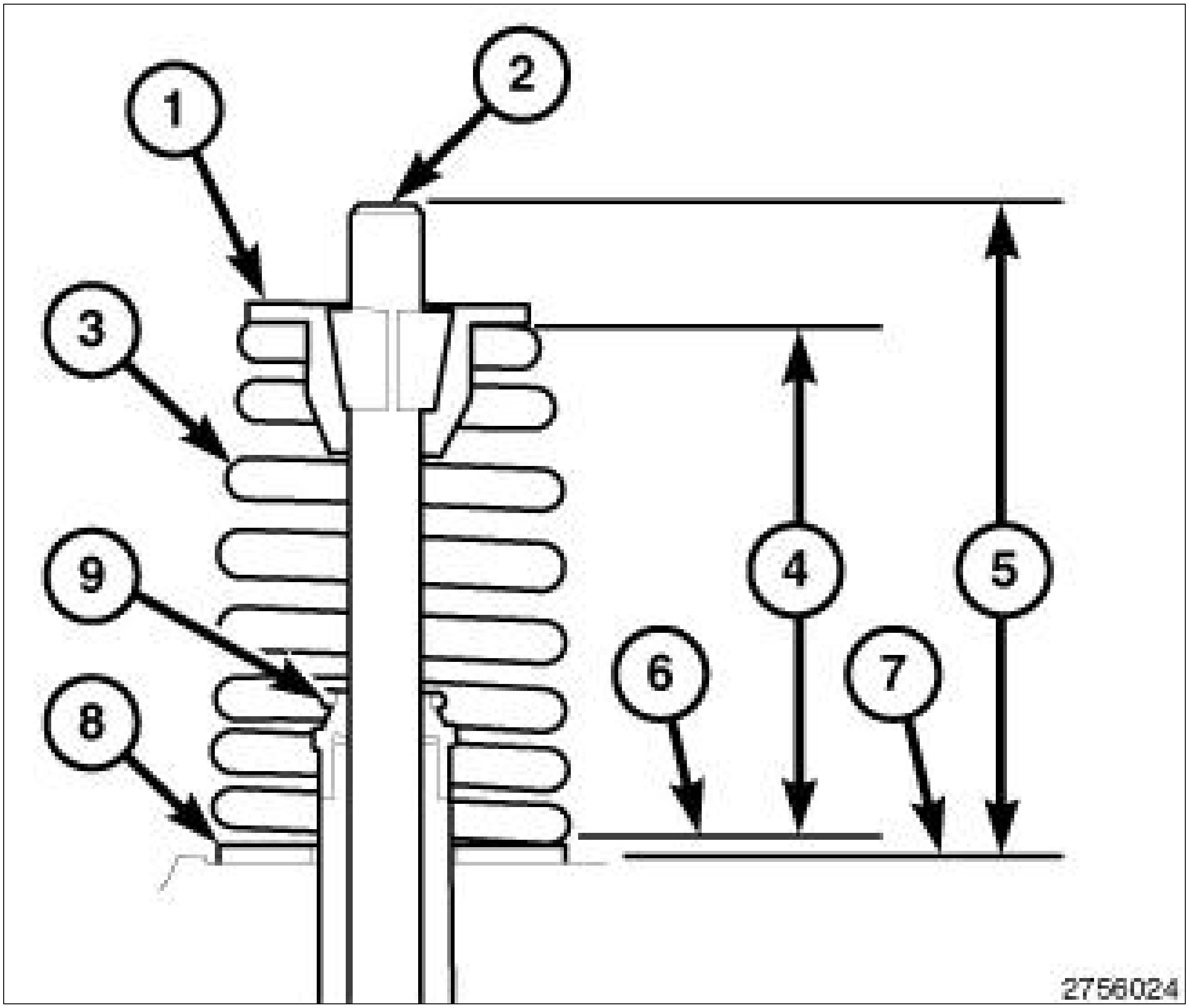


Courtesy of CHRYSLER GROUP, LLC

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

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

Fig 2: 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.

If the valves or valve seats have been refinished and the installed valve spring height (4) is greater than 41.0 mm (1.61 in.). Install a second spring seat (8) in the head counter bore under the original valve spring seat to bring the spring height within specification. Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1).

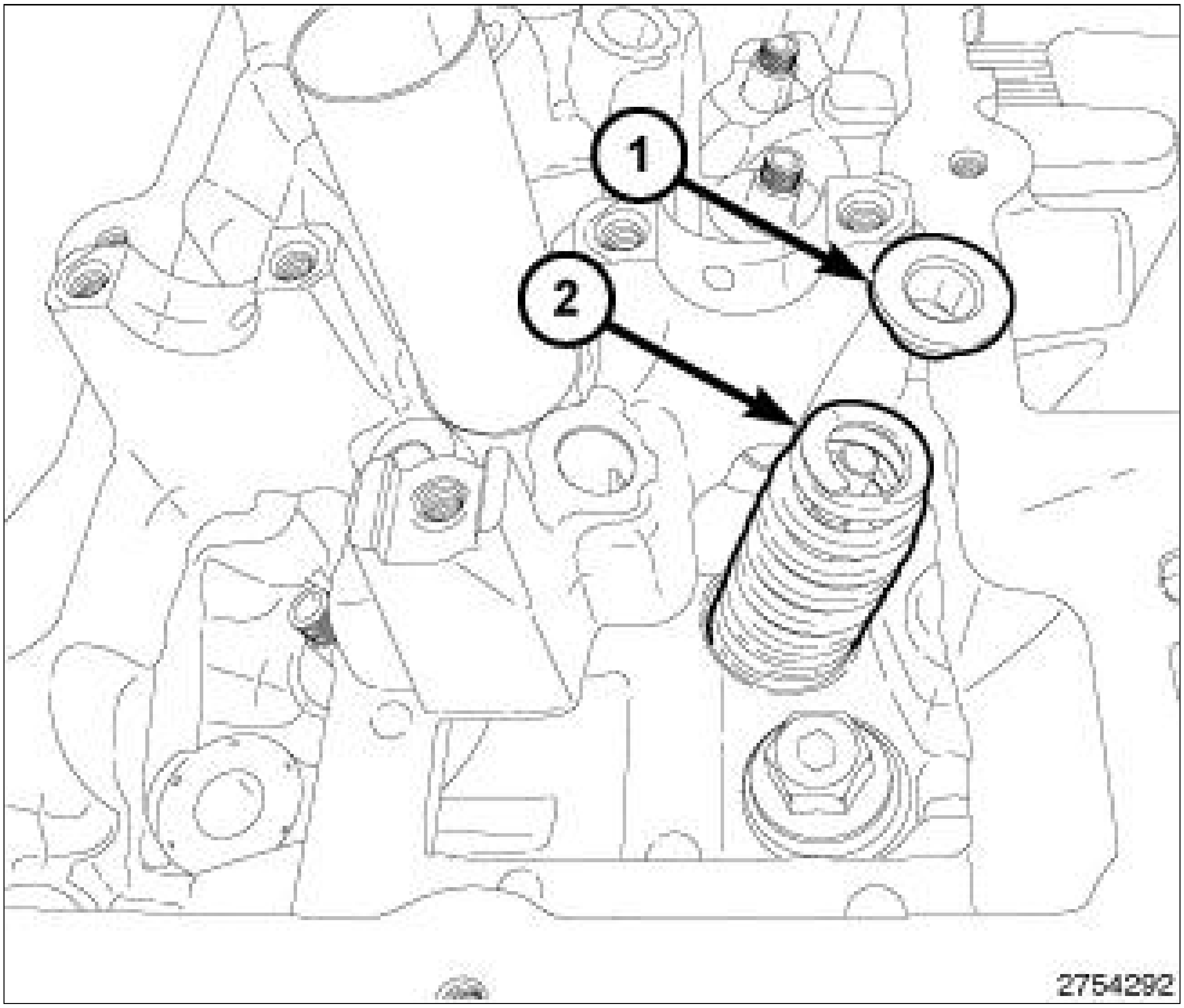
CYLINDER HEAD > SPRING(S), VALVE > INSTALLATION > ON VEHICLE

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

NOTE:

Make sure that the valve spring is intact around the top of the valve guide seal.

Fig 1: Valve Spring & Valve Spring Retainer



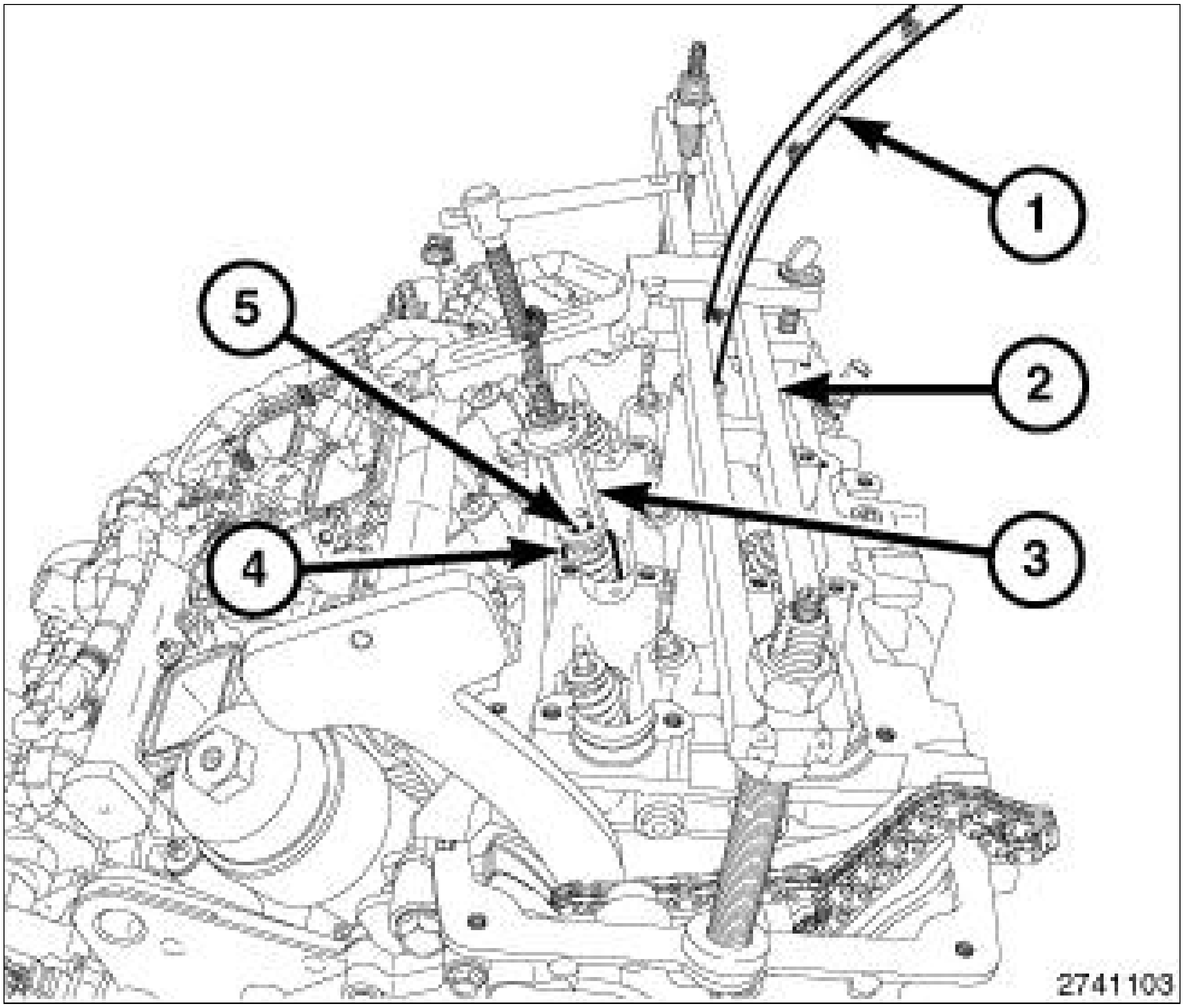
Courtesy of CHRYSLER GROUP, LLC

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 2: 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.

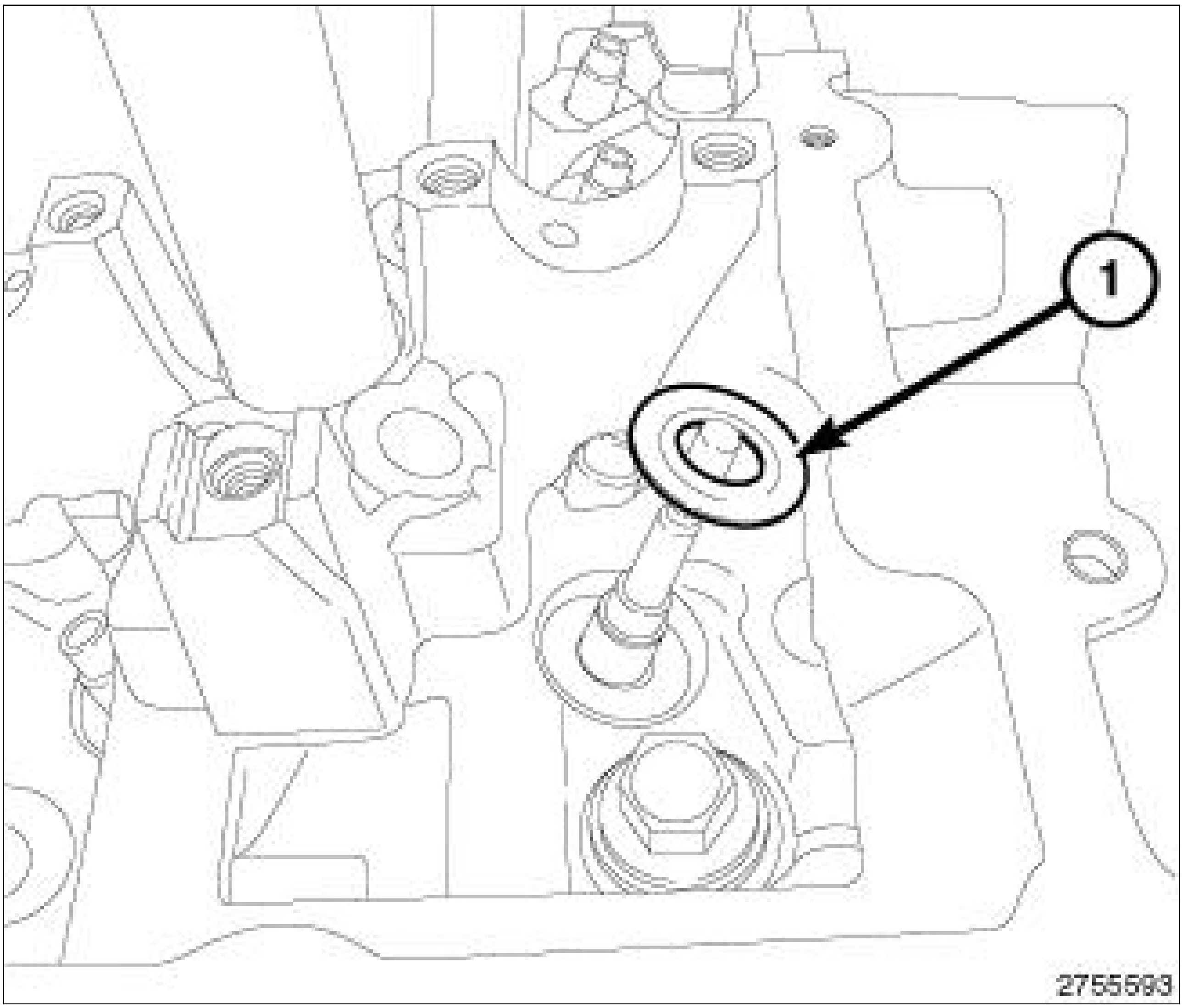
3. Compress the valve springs (4) with the (special tool #10224, Adapter, Valve Spring) (3) mounted in the (special tool #MD998772A, Compressor, Valve Spring) (2).
4. Install the valve retaining locks (5) and release the valve spring compressor.
5. Relieve the air pressure from the combustion chamber and remove the spark plug adapter (1).
6. Install the spark plug. Refer to SPARK PLUG, INSTALLATION .

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

7. Install the rocker arm(s). Refer to ROCKER ARM, VALVE, INSTALLATION .
8. Remove the Camshaft Phaser Holder.
9. Install the cylinder head covers. Refer to COVER(S), CYLINDER HEAD, INSTALLATION .

CYLINDER HEAD > SPRING(S), VALVE > INSTALLATION > OFF VEHICLE

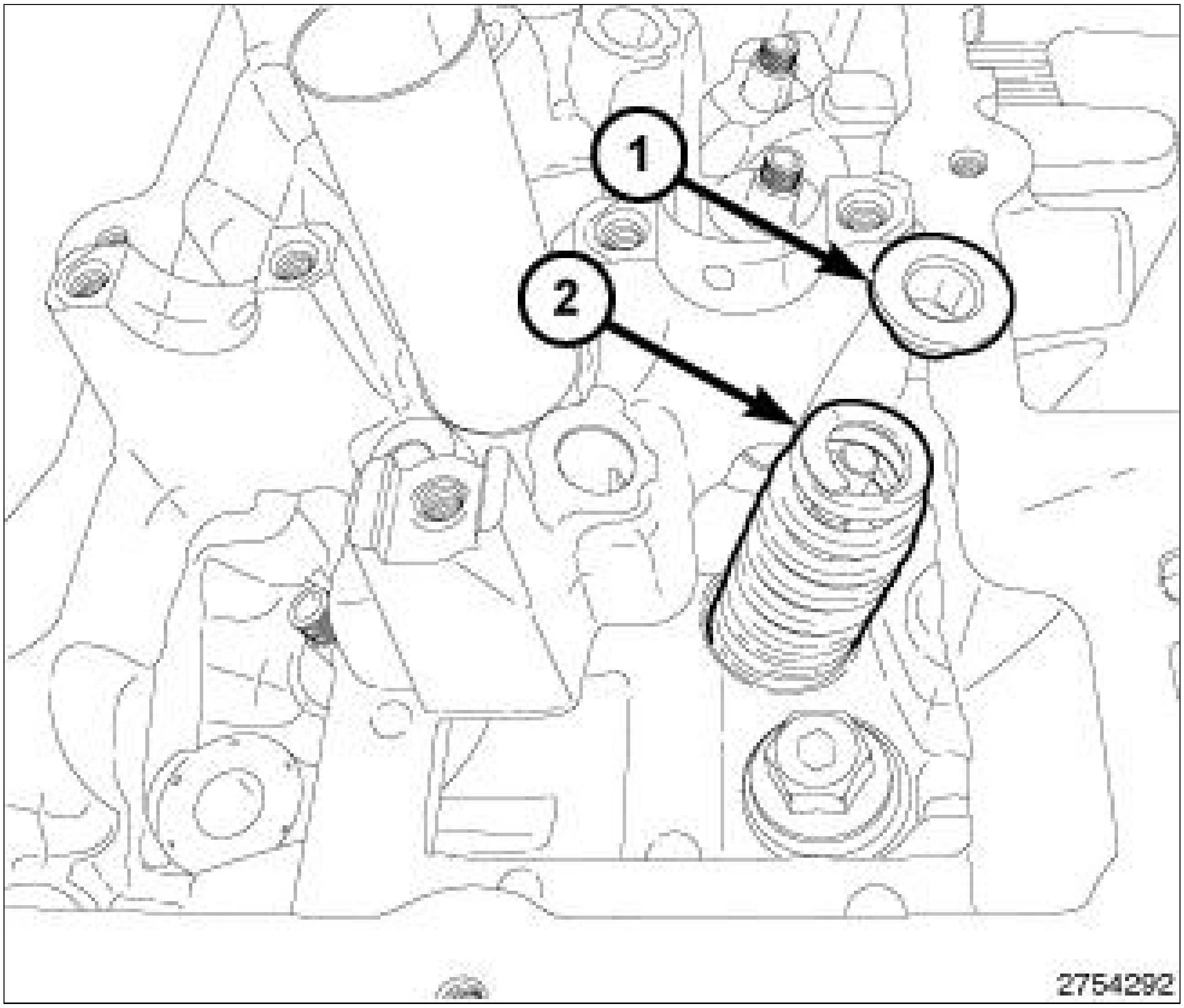
Fig 1: Valve Spring Seat



Courtesy of CHRYSLER GROUP, LLC

1. Install the spring seat (1).

Fig 2: Valve Spring & Valve Spring Retainer



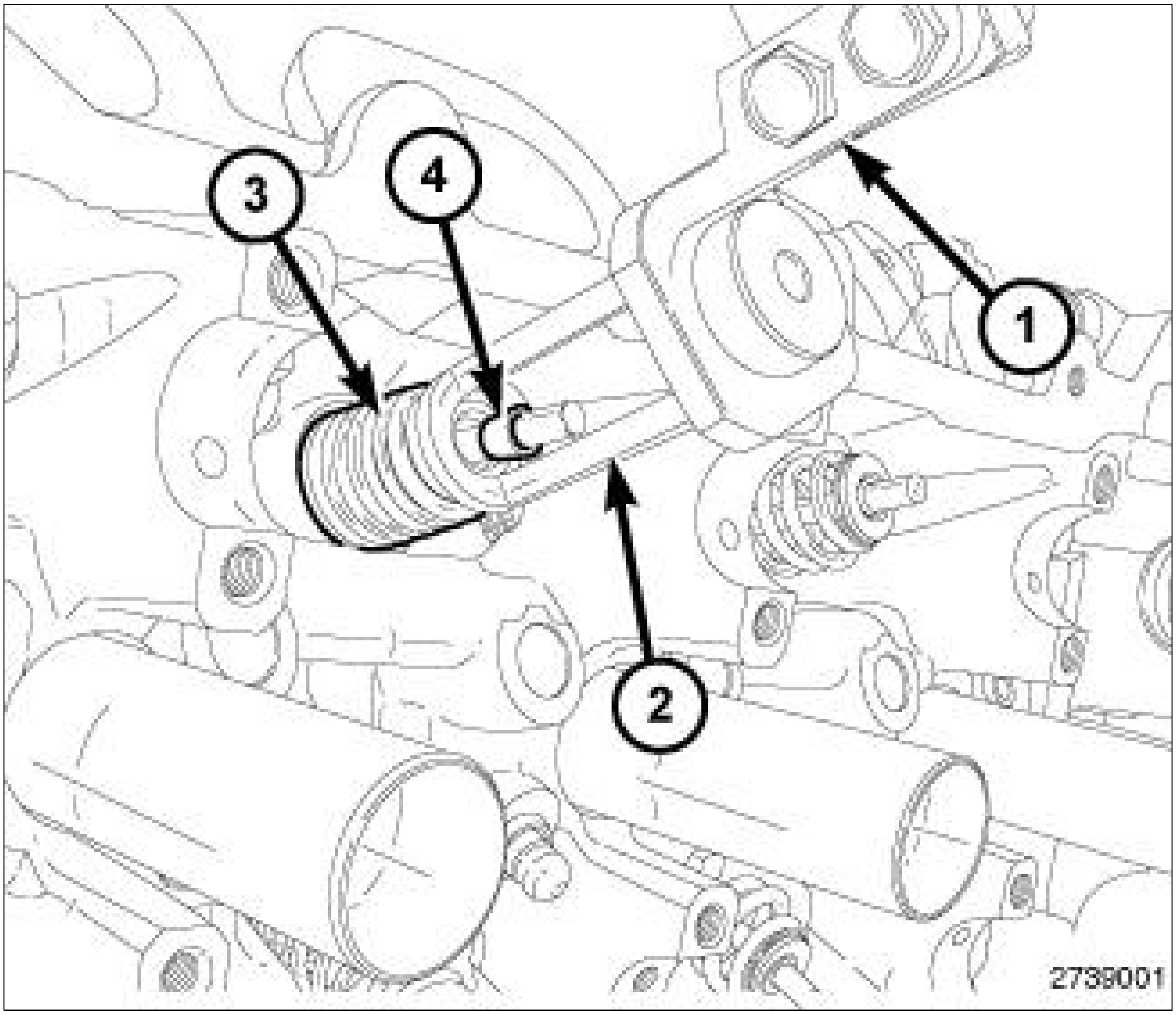
Courtesy of CHRYSLER GROUP, LLC

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 3: Compressing Valve Spring & Locating Valve Retaining Locks



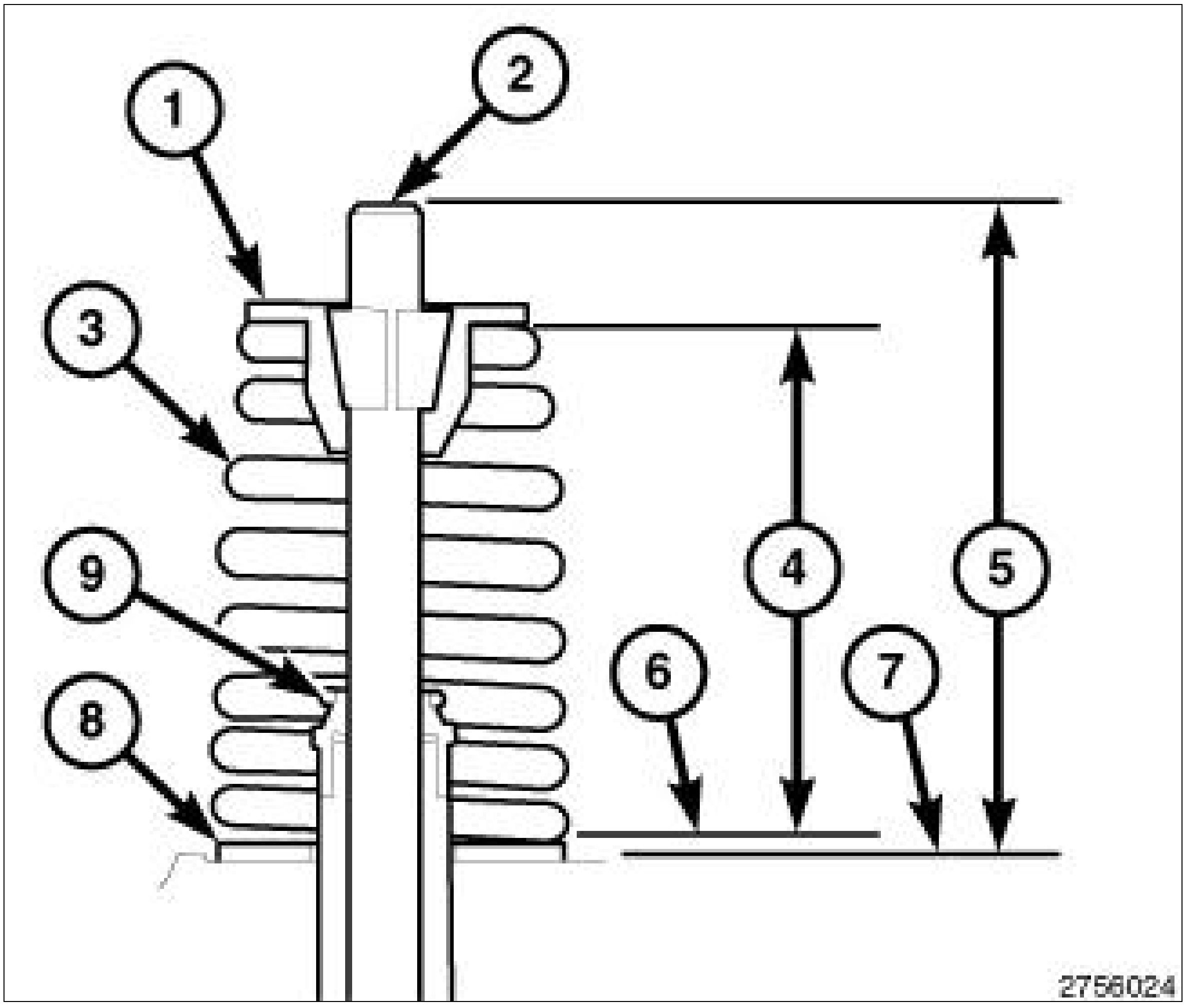
Courtesy of CHRYSLER GROUP, LLC

NOTE:

Number 3 cylinder intake valve spring compression shown in illustration, all other valves similar.

3. Compress 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 4: Checking Valve Spring Installed Height

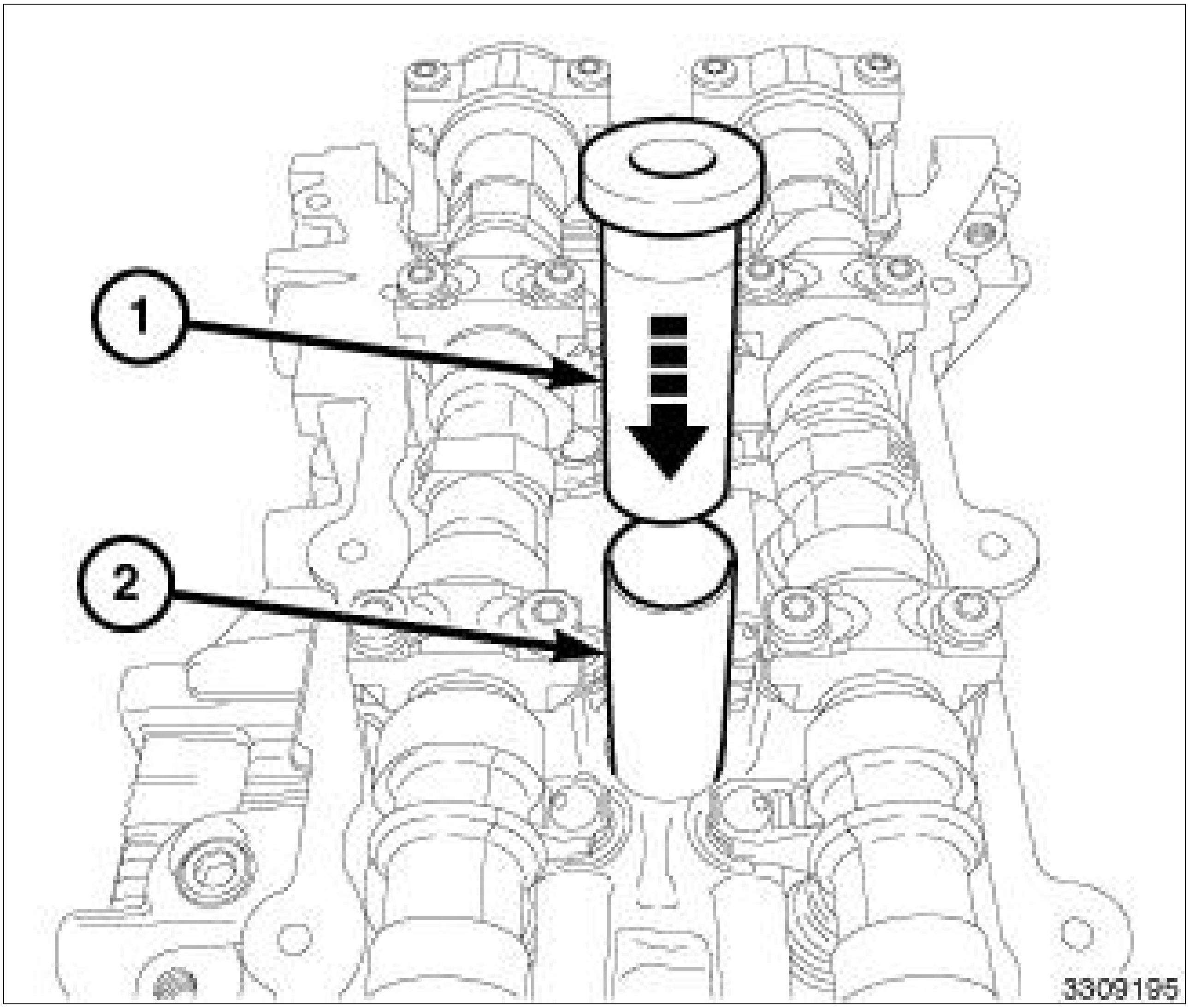


Courtesy of CHRYSLER GROUP, LLC

4. 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).
5. Install the cylinder head(s). Refer to CYLINDER HEAD, INSTALLATION .

CYLINDER HEAD > TUBE, SPARK PLUG > REMOVAL > REMOVAL

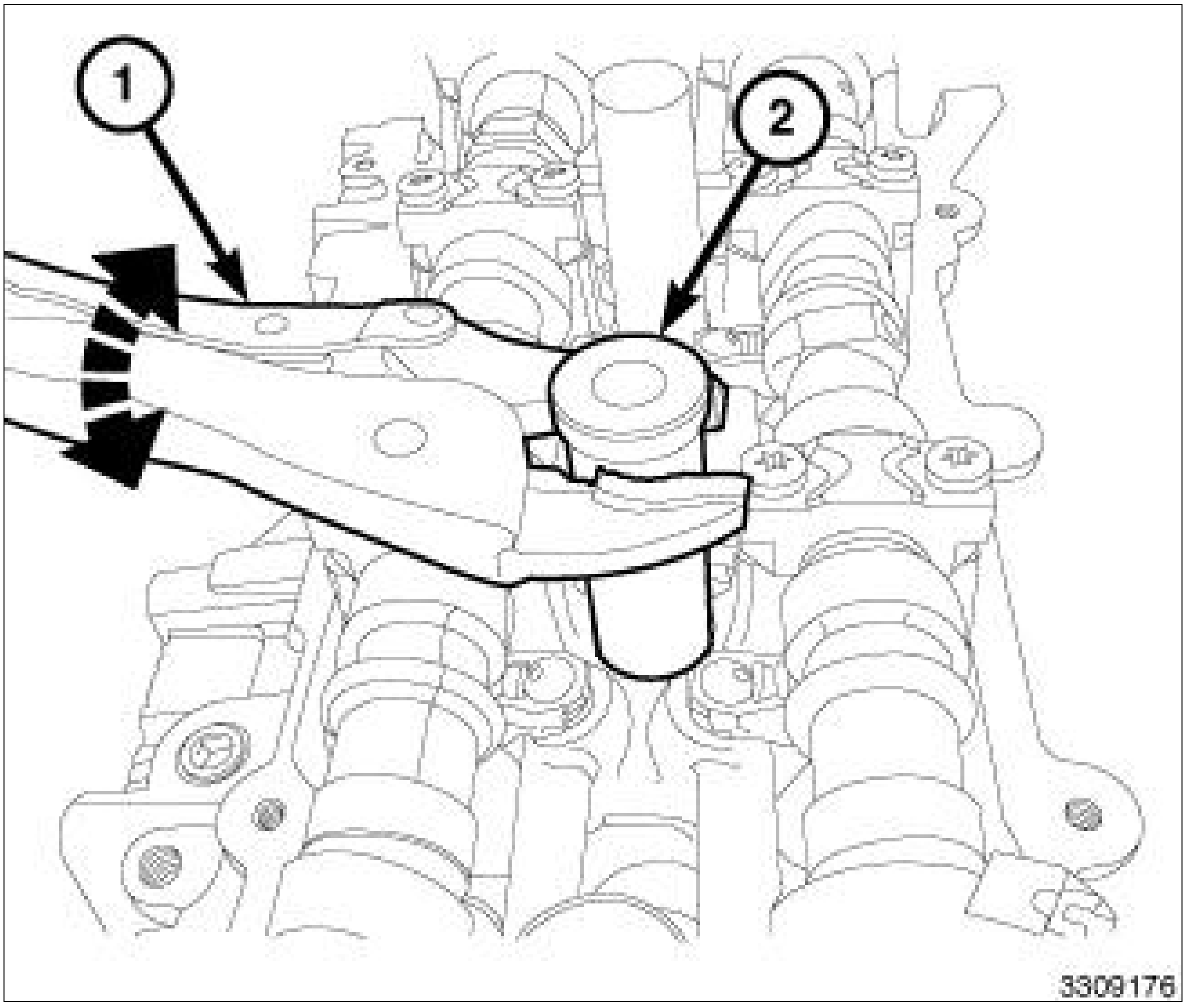
Fig 1: Spark Plug Tube Installer & Spark Plug Tube



Courtesy of CHRYSLER GROUP, LLC

1. Remove the ignition coils. Refer to COIL, IGNITION, REMOVAL .
2. Using compressed air, blow out any dirt or contaminates from around the top of the spark plugs.
3. Remove the cylinder head cover(s). Refer to COVER(S), CYLINDER HEAD, REMOVAL .
4. Install the top half of the (special tool #2024900090, Installer, Spark Plug Tube) (1) into the spark plug tube to be removed (2).

Fig 2: Locking Pliers & Spark Plug Tube

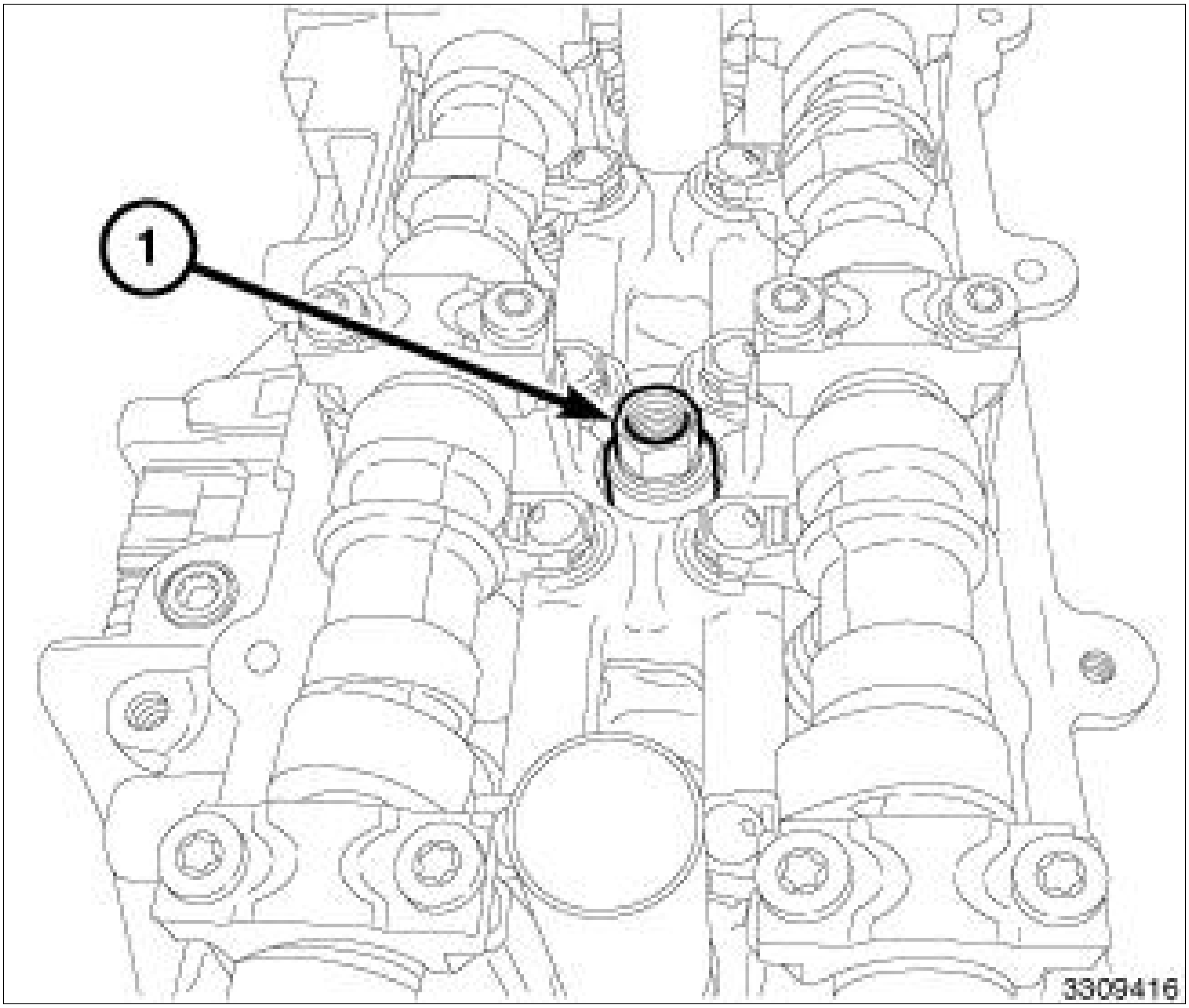


Courtesy of CHRYSLER GROUP, LLC

5. Using suitable locking pliers (1), remove the spark plug tube (2) from the cylinder head and discard the tube.
6. Clean the area around the spark plug tube mounting with Mopar® Parts Cleaner or equivalent.

CYLINDER HEAD > TUBE, SPARK PLUG > INSTALLATION > INSTALLATION

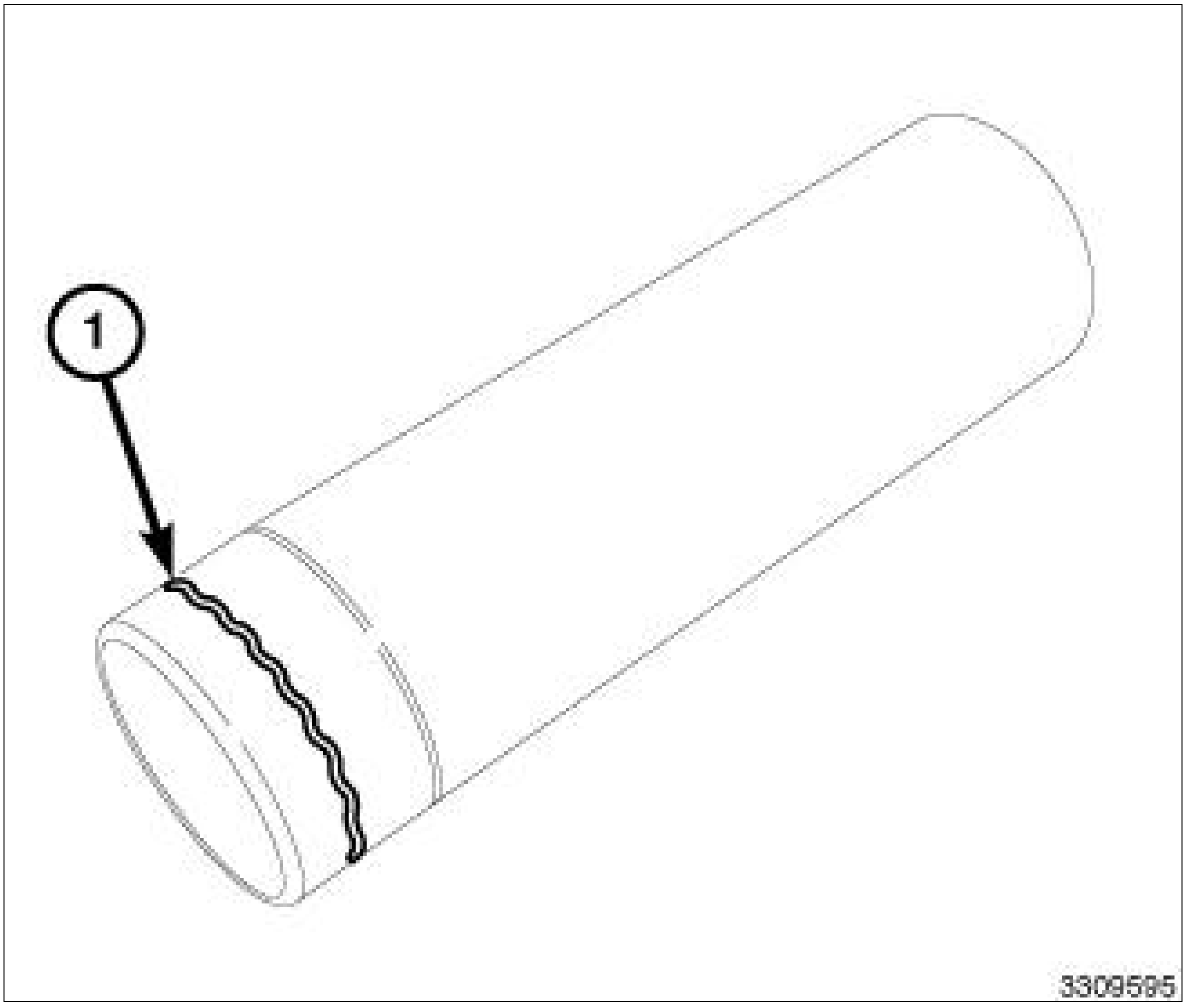
Fig 1: Spark Plug Tube Installer



Courtesy of CHRYSLER GROUP, LLC

1. Remove the spark plug. Refer to SPARK PLUG, REMOVAL .
2. Install the lower half of the (special tool #2024900090, Installer, Spark Plug Tube) (1) into the cylinder head and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

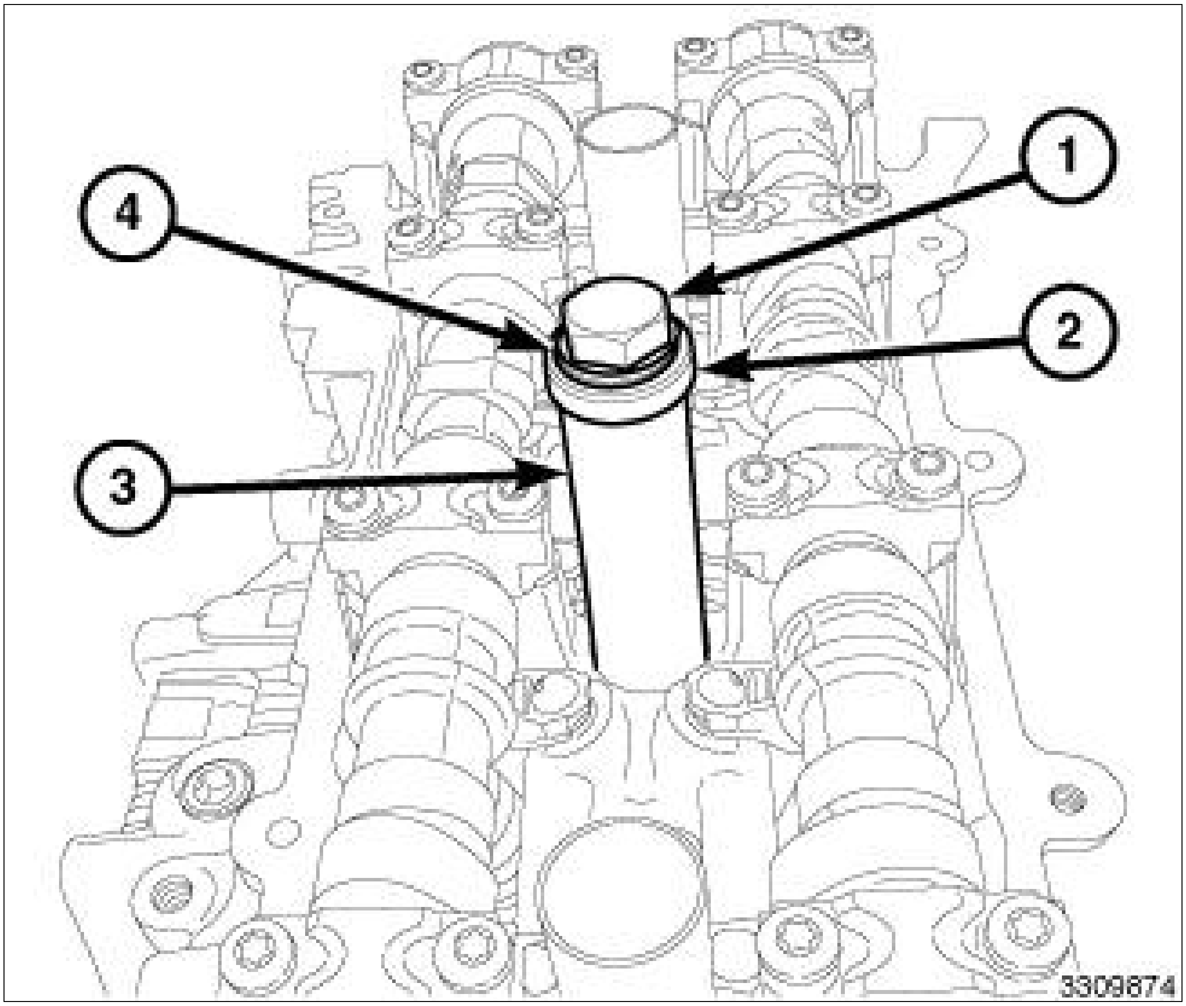
Fig 2: Applying Stud & Bearing Mount Bead To Spark Plug Tube



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 3: Spark Plug Tube, Thrust Washers, Spark Plug Tube Installer & Bolt



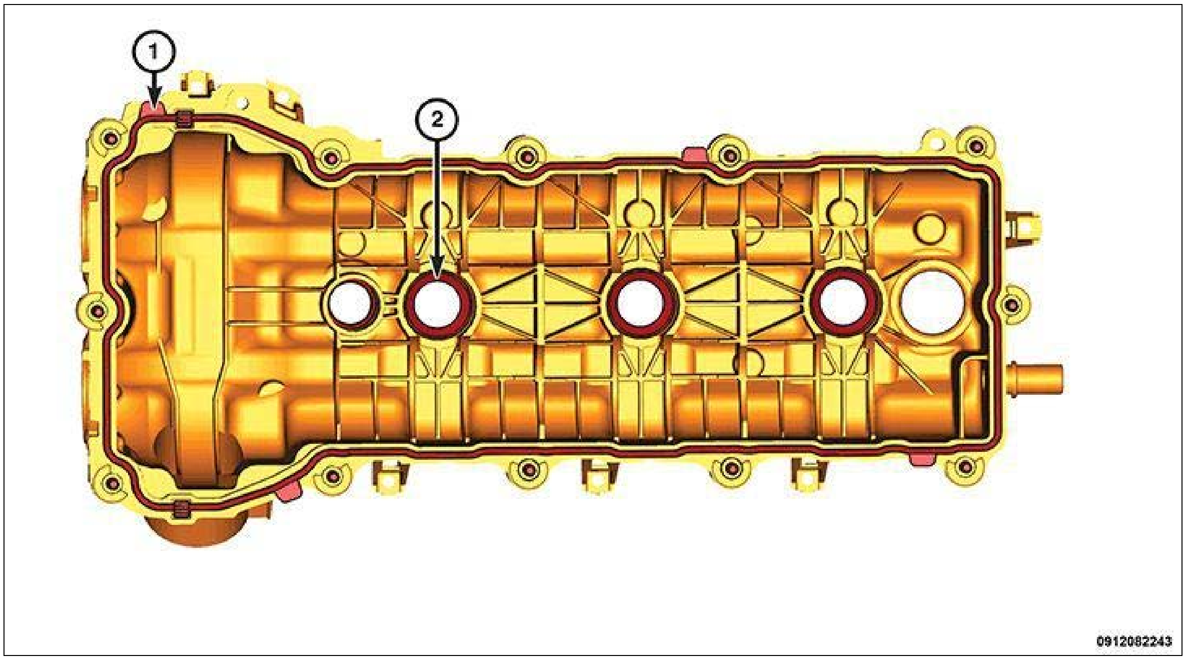
Courtesy of CHRYSLER GROUP, LLC

4. Position the spark plug tube (3) on the top half of the (special tool #2024900090, 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 4: Cylinder Head Cover Gasket & Spark Plug Tube Seals



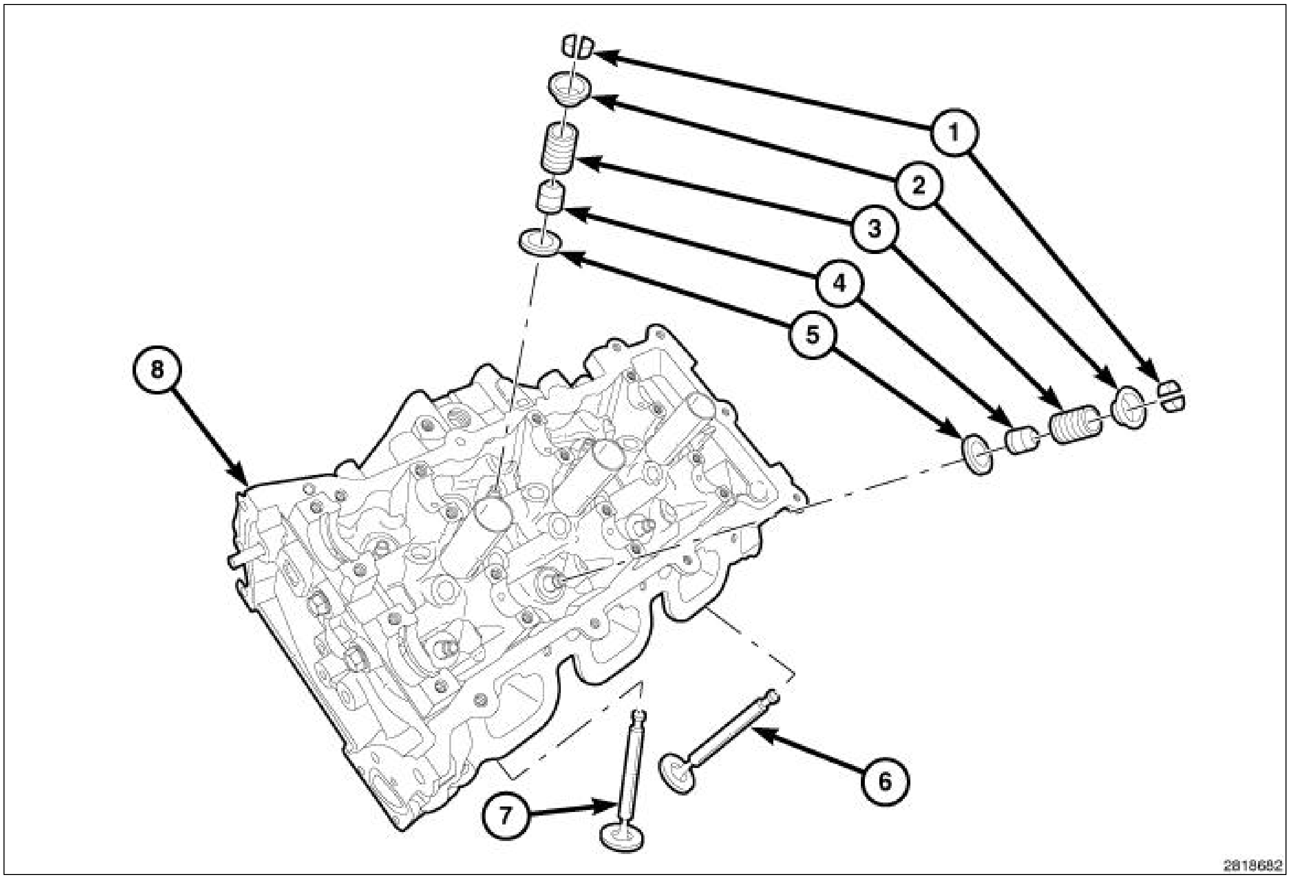
Courtesy of CHRYSLER GROUP, LLC

> *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. Refer to SPARK PLUG, INSTALLATION .
7. If required, install a new spark plug tube seal (2).
8. Install the cylinder head cover(s). Refer to COVER(S), CYLINDER HEAD, INSTALLATION .

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > DESCRIPTION > DESCRIPTION

Fig 1: Intake Valve & Exhaust Valve Component Configuration

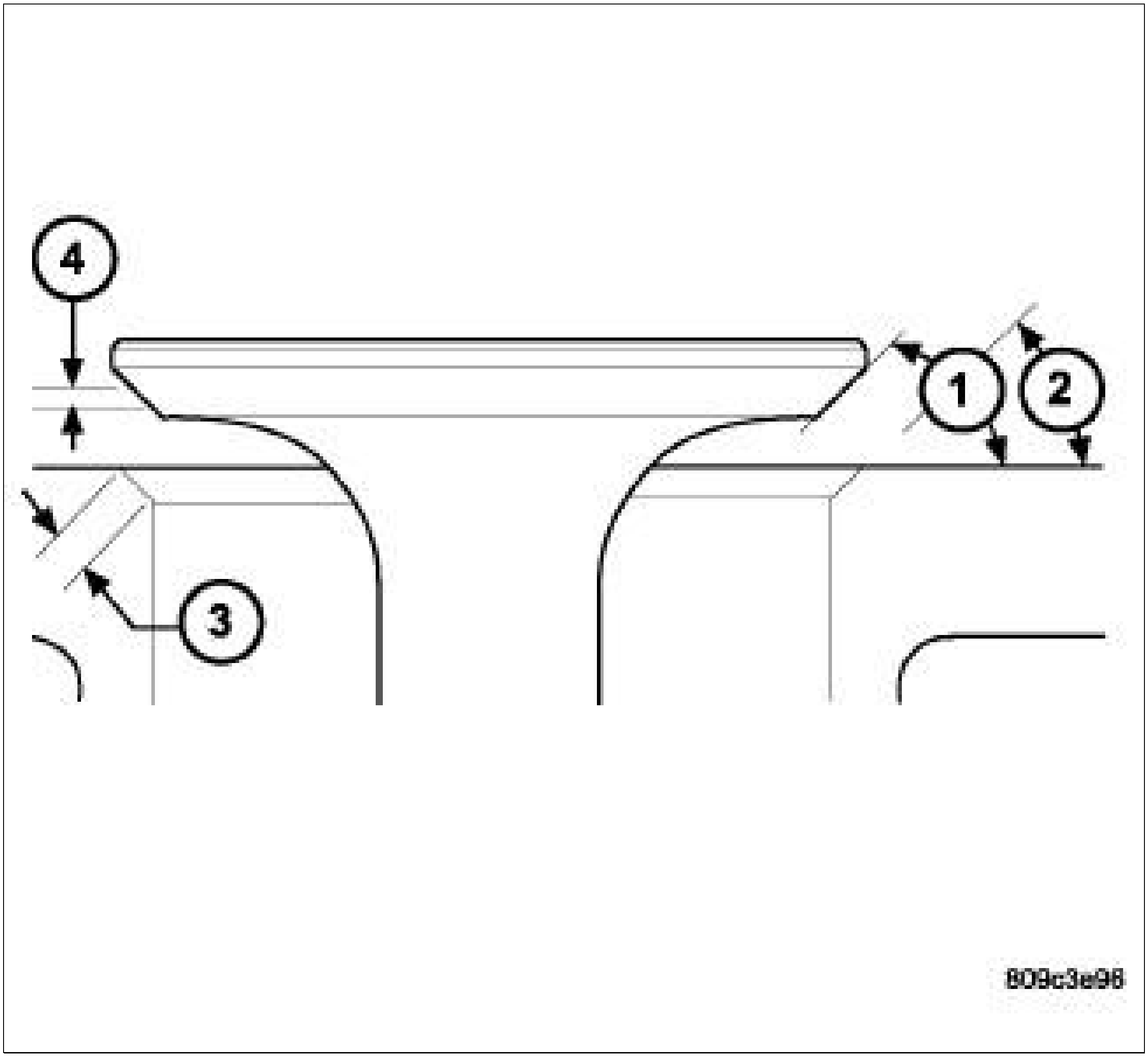


Courtesy of CHRYSLER GROUP, LLC

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.

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > STANDARD PROCEDURE > REFACING INTAKE AND EXHAUST VALVES

Fig 1: Valve Face & Seat



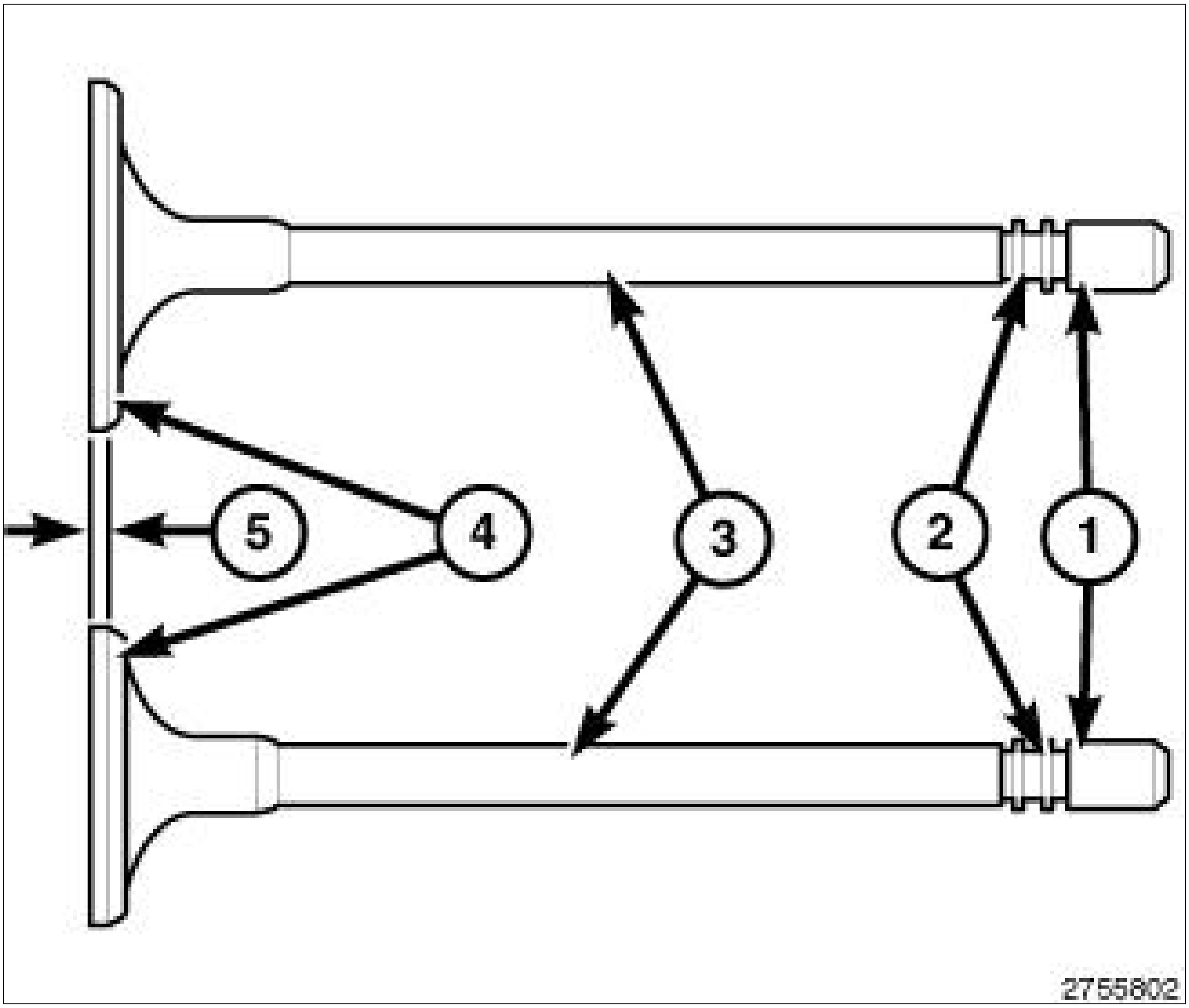
Courtesy of CHRYSLER GROUP, LLC

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

The intake and exhaust valves have a 45.25 ± 0.25 degree face angle (1). The valve seats (2) have a 44.75 ± 0.25 degree face angle.

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > STANDARD PROCEDURE > REFACING INTAKE AND EXHAUST VALVES > VALVES

Fig 1: Inspecting Valve Margin

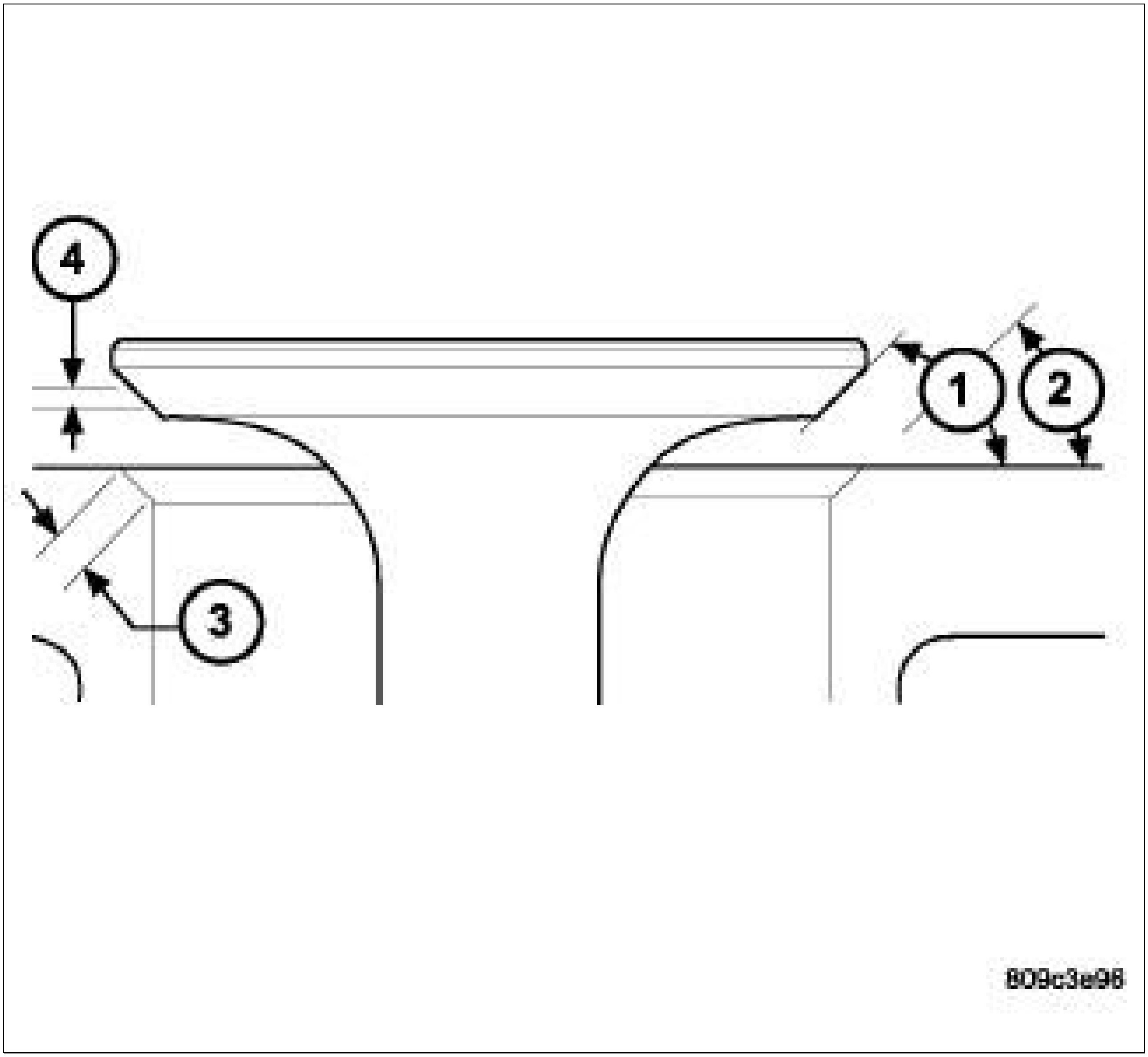


Courtesy of CHRYSLER GROUP, LLC

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

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > STANDARD PROCEDURE > REFACING INTAKE AND EXHAUST VALVES > VALVE SEATS

Fig 1: 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.

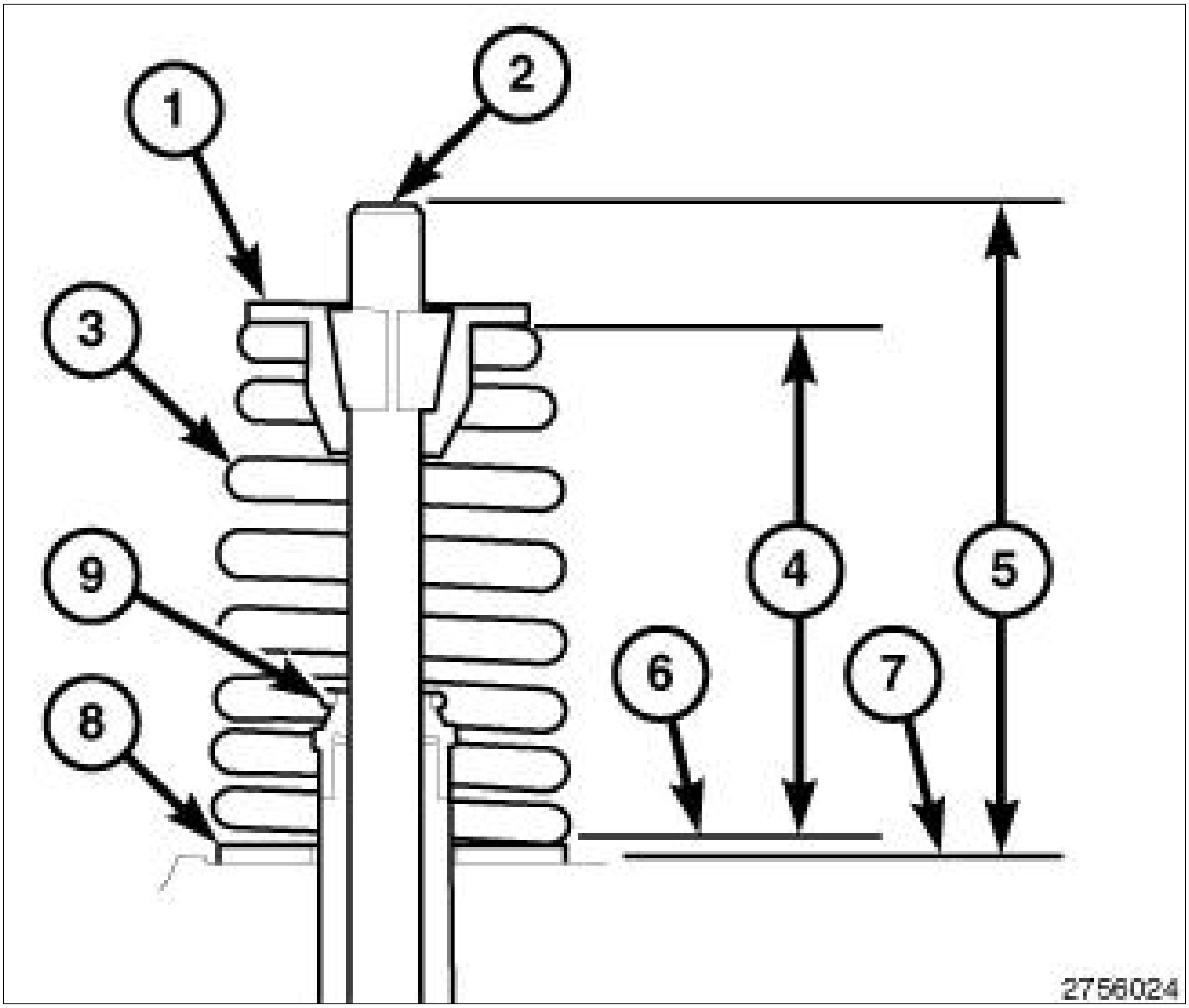
1. Measure the concentricity of the valve seat using a dial indicator. Total runout should not exceed 0.050 mm (0.002 inch.) total indicator reading.

> *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.*

2. Check the sealing of the valve(s) to the valve seat(s) on the cylinder head(s):
    1. Coat the valve seat (3) **LIGHTLY** with Prussian blue.
    2. Install the valve into the cylinder head.
    3. Rotate the valve onto the valve seat using light pressure.
    4. Using care not to wipe the Prussian blue. Remove the valve from the cylinder head.
    5. If the blue is transferred to the center of the valve face (4), contact is within specifications.
    6. If the blue is transferred to the top edge of the valve face, then lower the valve seat with a 15 degree stone.
    7. If the blue is transferred to the bottom edge of the valve face, then raise the valve seat with a 65 degree stone.
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.).

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > STANDARD PROCEDURE > REFACING INTAKE AND EXHAUST VALVES > VALVE AND SPRING INSTALLED HEIGHT

Fig 1: Checking Valve Spring Installed Height



Courtesy of CHRYSLER GROUP, LLC

NOTE:

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

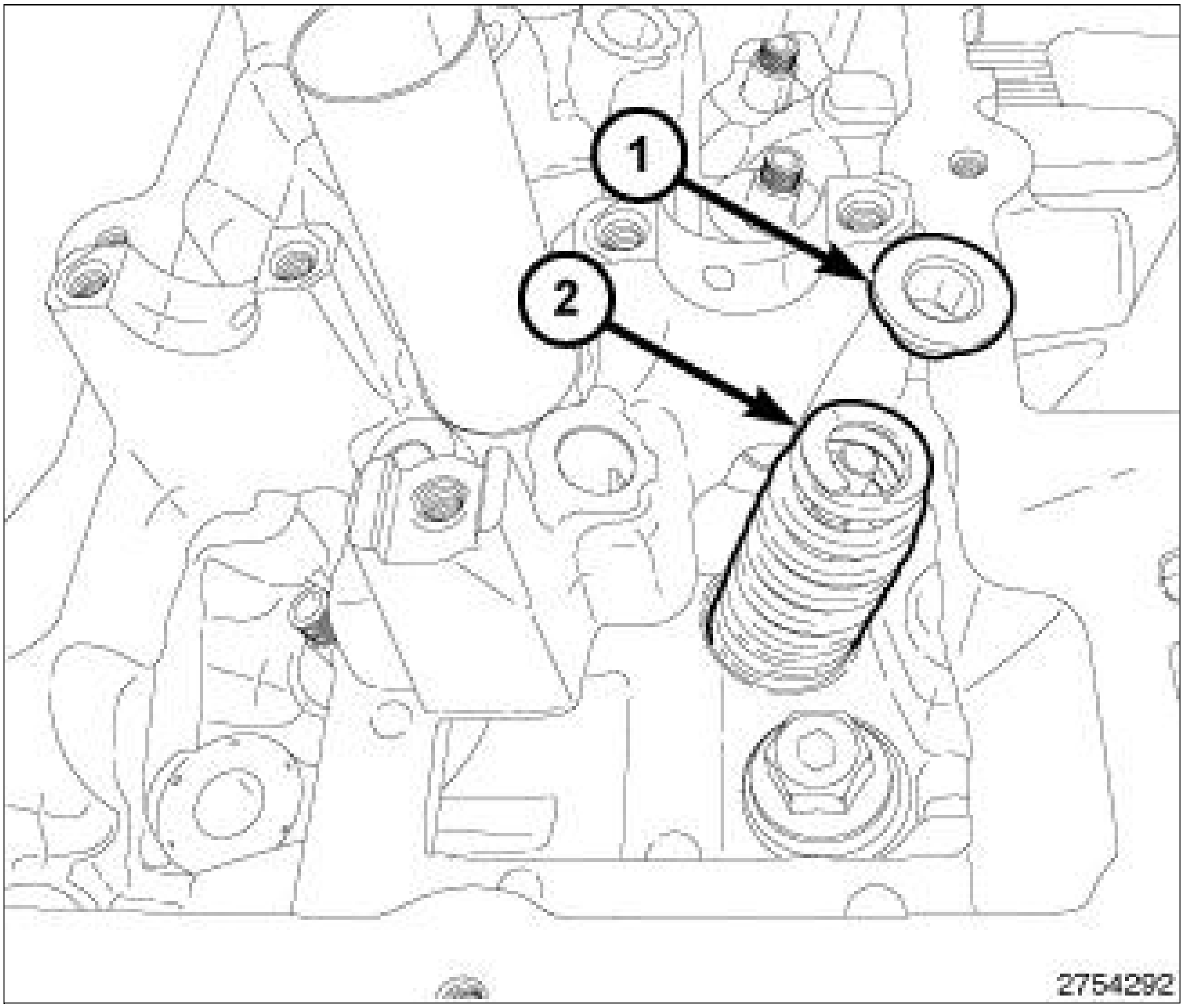
1. Coat the valve stems (2) with clean engine oil and install the valves onto the cylinder head.
2. If the valves or valve seats have been refinished, check the valve tip height (5). If the valve tip height (5) exceeds the specification, grind the valve tip until it is within specification. Refer to ENGINE SPECIFICATIONS . Make sure the measurement is taken from the cylinder head surface (7) to the top of the valve stem (2).

NOTE:

Make sure that the garter spring is intact around the top of the valve guide seal.

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

Fig 2: Valve Spring & Valve Spring Retainer



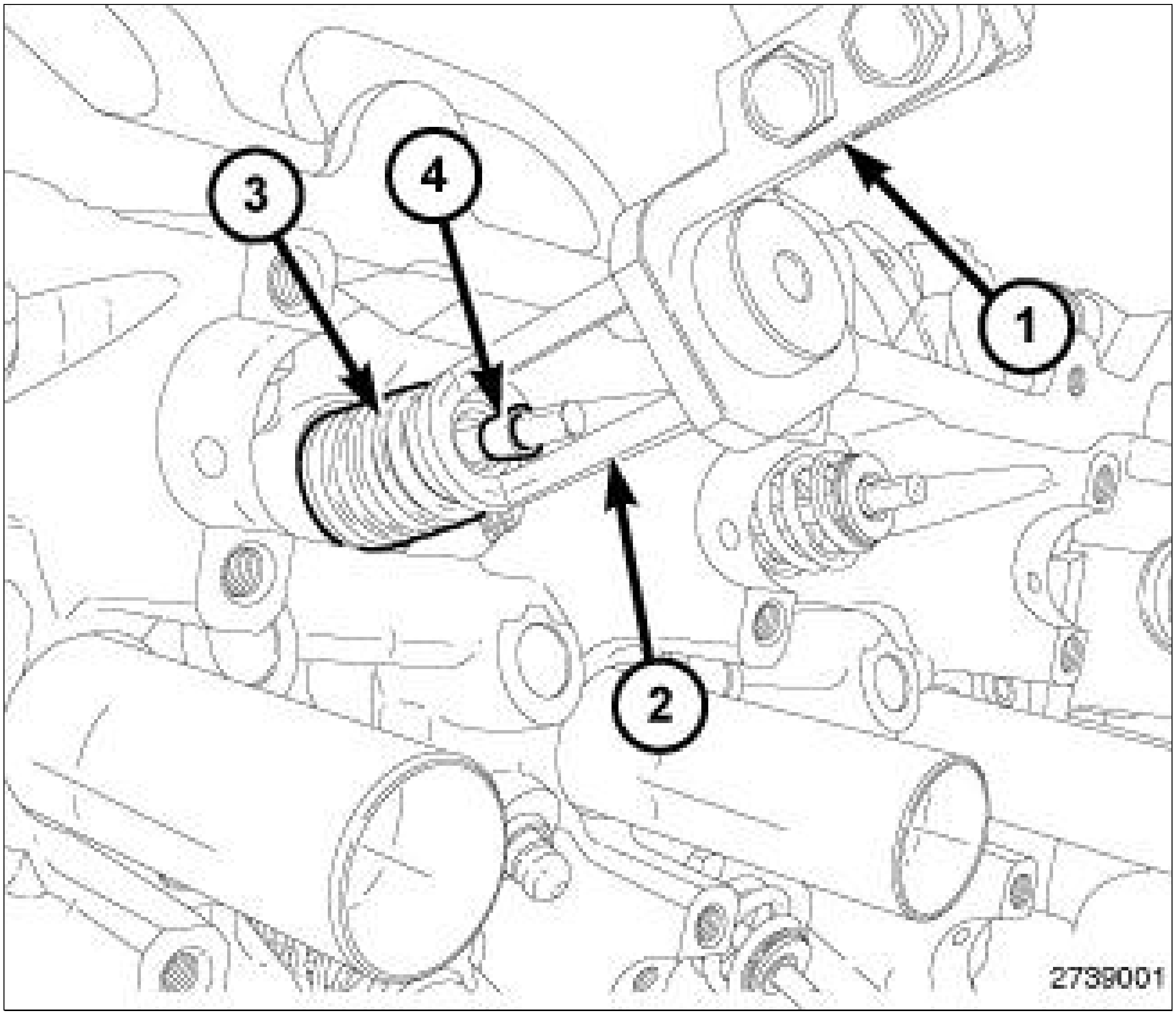
Courtesy of CHRYSLER GROUP, LLC

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 3: Compressing Valve Spring & Locating Valve Retaining Locks



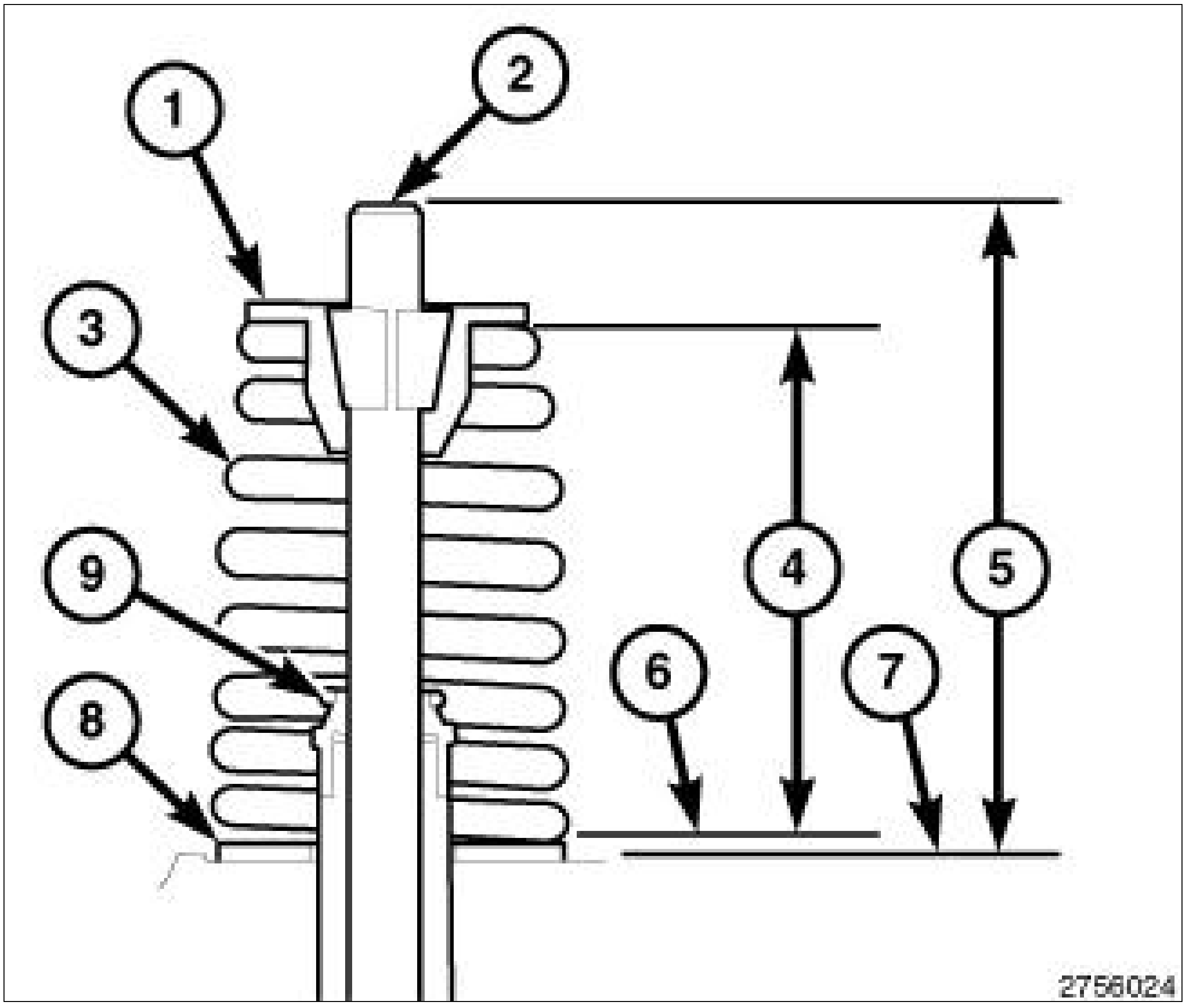
Courtesy of CHRYSLER GROUP, LLC

NOTE:

Number 3 cylinder intake valve spring compression shown in illustration, all other valves similar.

5. Compress the valve spring (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 compressor.

Fig 4: Checking Valve Spring Installed Height



Courtesy of CHRYSLER GROUP, LLC

6. 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 a second spring seat (8) in the head counter bore under the original valve spring seat to bring the spring height within specification. Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1).

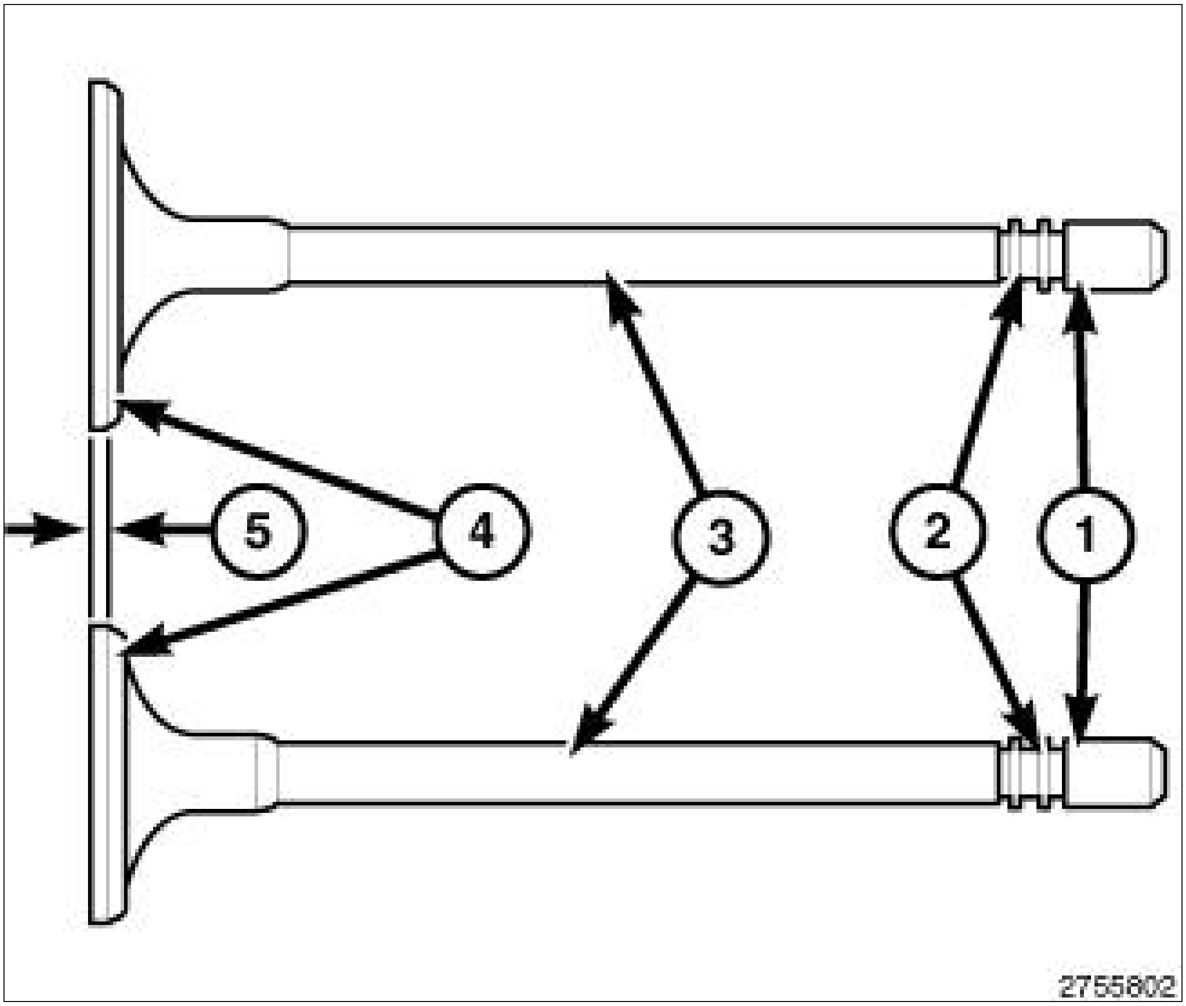
CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > REMOVAL > REMOVAL

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.*

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

Fig 1: Inspecting Valve Margin



Courtesy of CHRYSLER GROUP, LLC

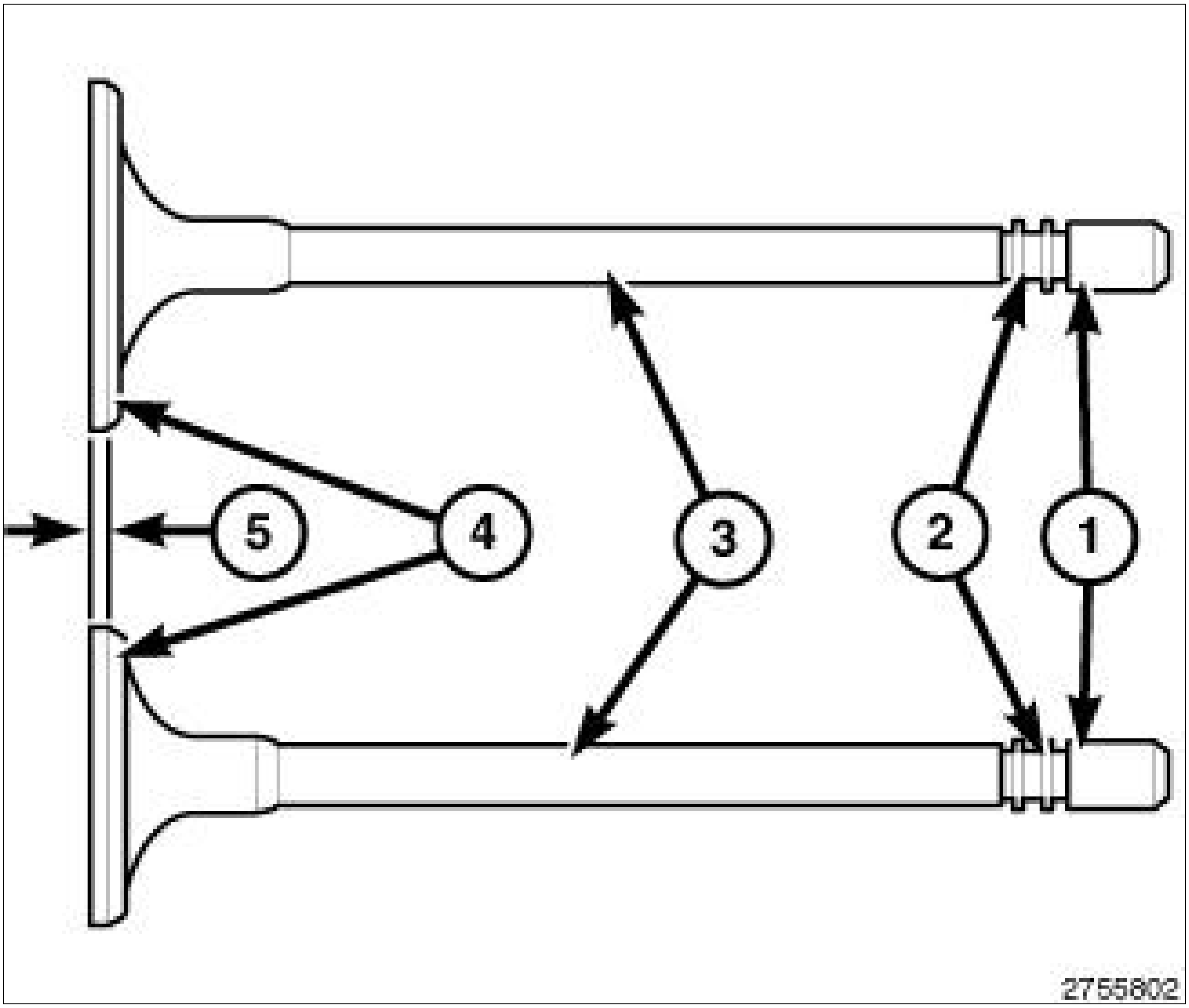
CAUTION:

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

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > INSPECTION > INSPECTION > VALVES

Fig 1: Inspecting Valve Margin

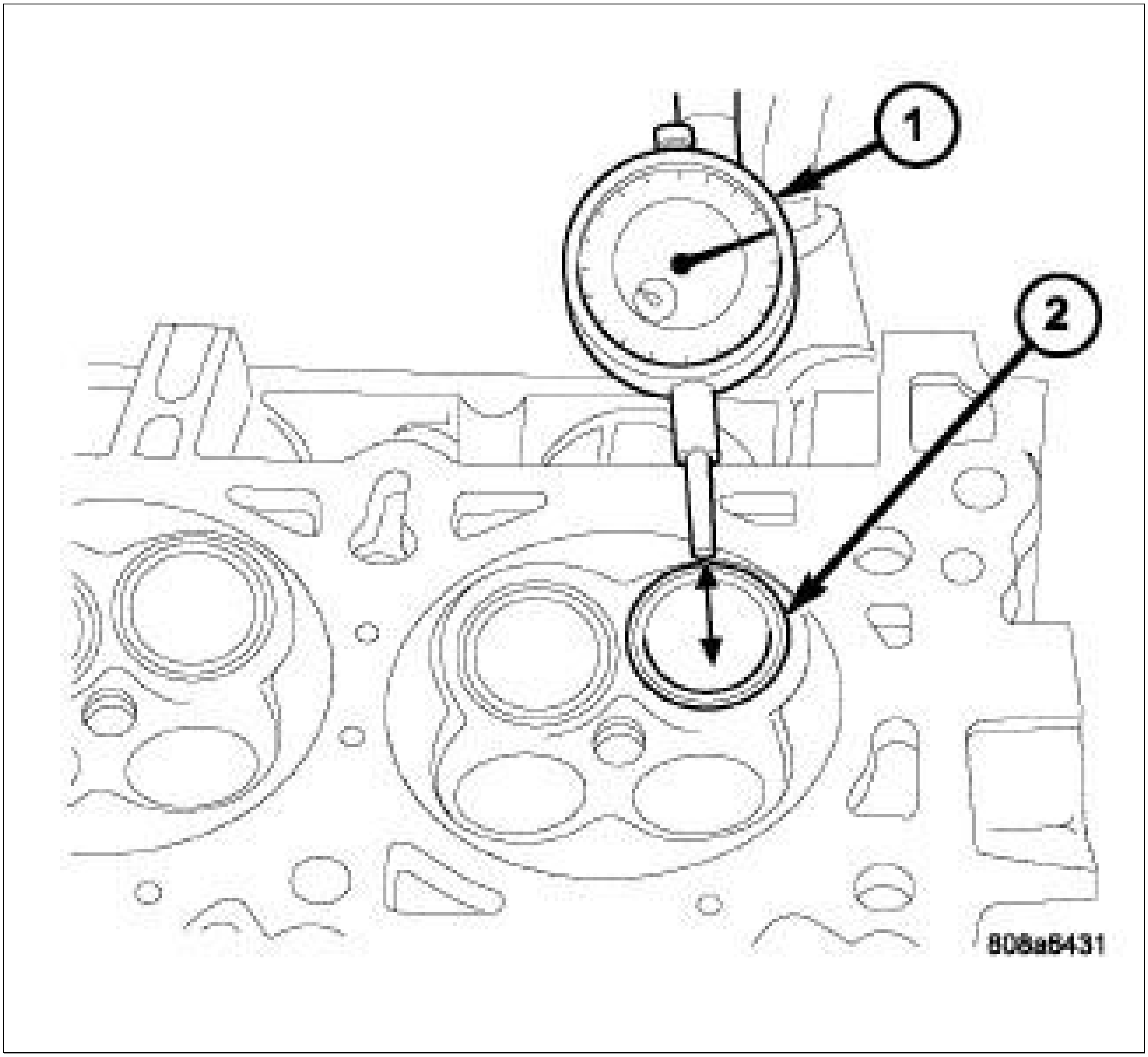


Courtesy of CHRYSLER GROUP, LLC

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 .

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > INSPECTION > INSPECTION > VALVE GUIDES

Fig 1: Measuring Valve Guide Wear - Typical



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.

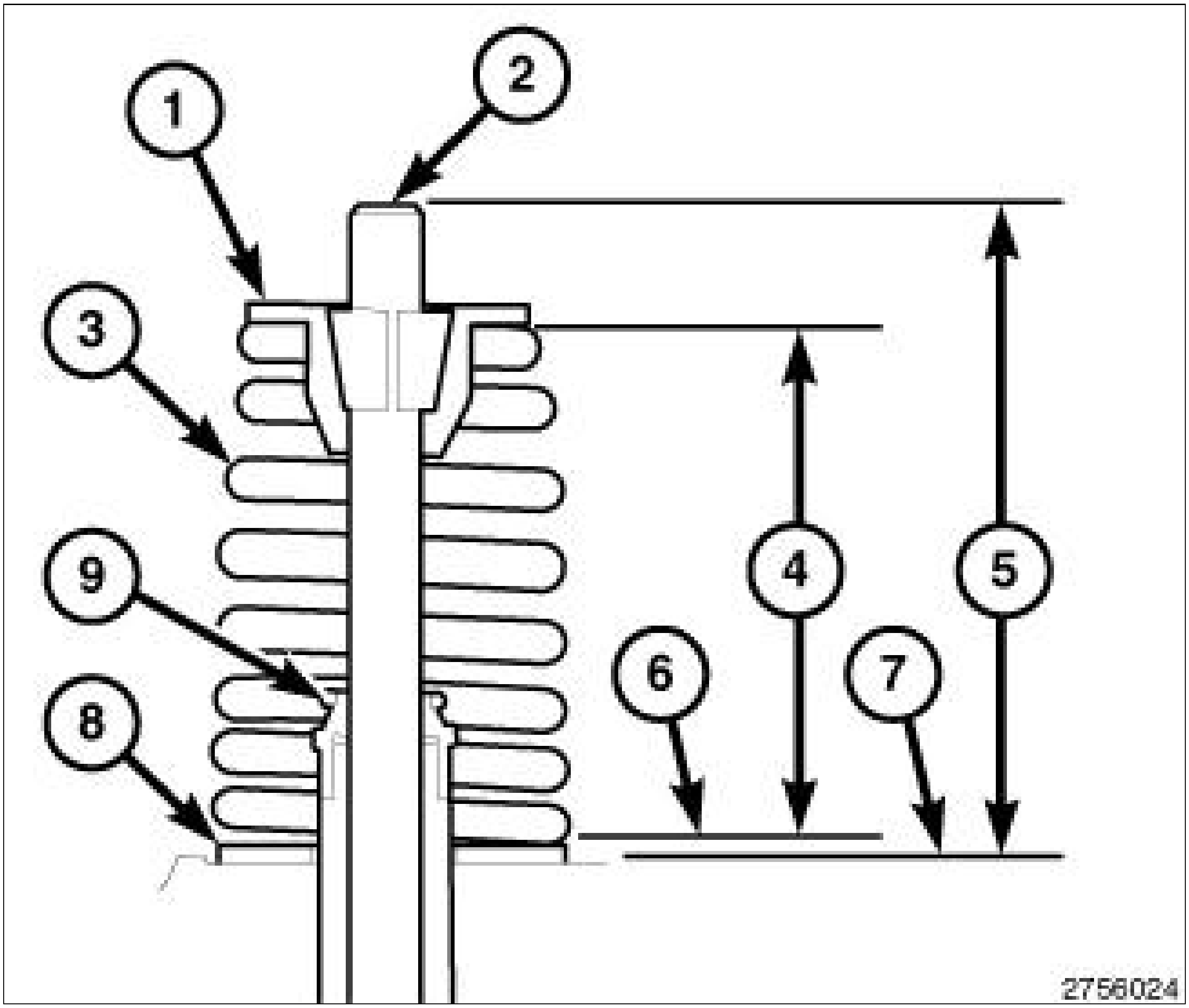
> *NOTE:*
>
> *If stem-to-guide clearance exceeds specifications, you must measure the valve stem. If the valve stem is within specification or if the valve guide is loose in the*

cylinder head, replace the cylinder head.*

5. Move the valve to and from the indicator. Compare this reading to the specification. Refer to ENGINE SPECIFICATIONS .

CYLINDER HEAD > VALVES, INTAKE AND EXHAUST > INSTALLATION > INSTALLATION

Fig 1: 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).
3. If removed, install the spring seat and valve guide seal over the valve guide. Refer to SEAL(S), VALVE GUIDE, INSTALLATION .

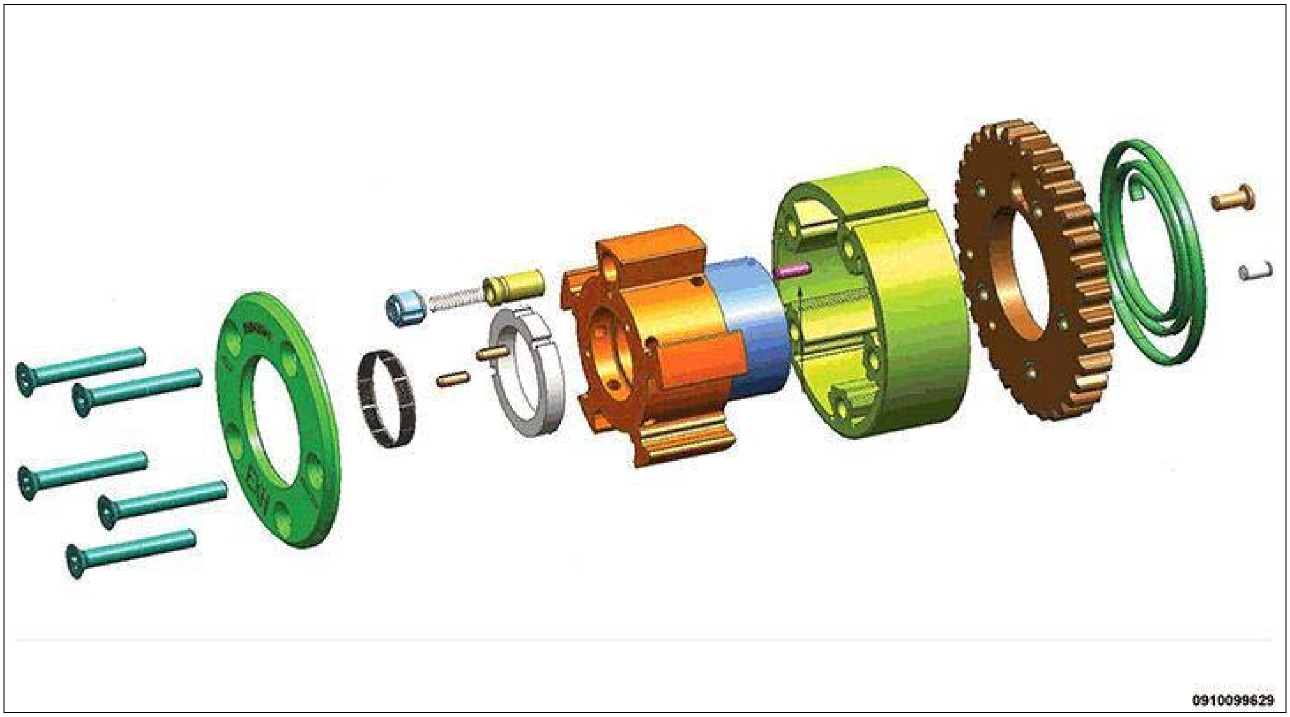
> *NOTE:*
>
> *Reassemble the valves springs into their original locations. If the valves or valve seats have been refinished, verify that the valve spring installed height is within specification. Refer to ENGINE SPECIFICATIONS .*

4. Install the valve spring(s). Refer to SPRING(S), VALVE, INSTALLATION .
5. Install the cylinder head(s). Refer to CYLINDER HEAD, INSTALLATION .

CYLINDER HEAD > ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE > DESCRIPTION > DESCRIPTION

Exhaust Phaser

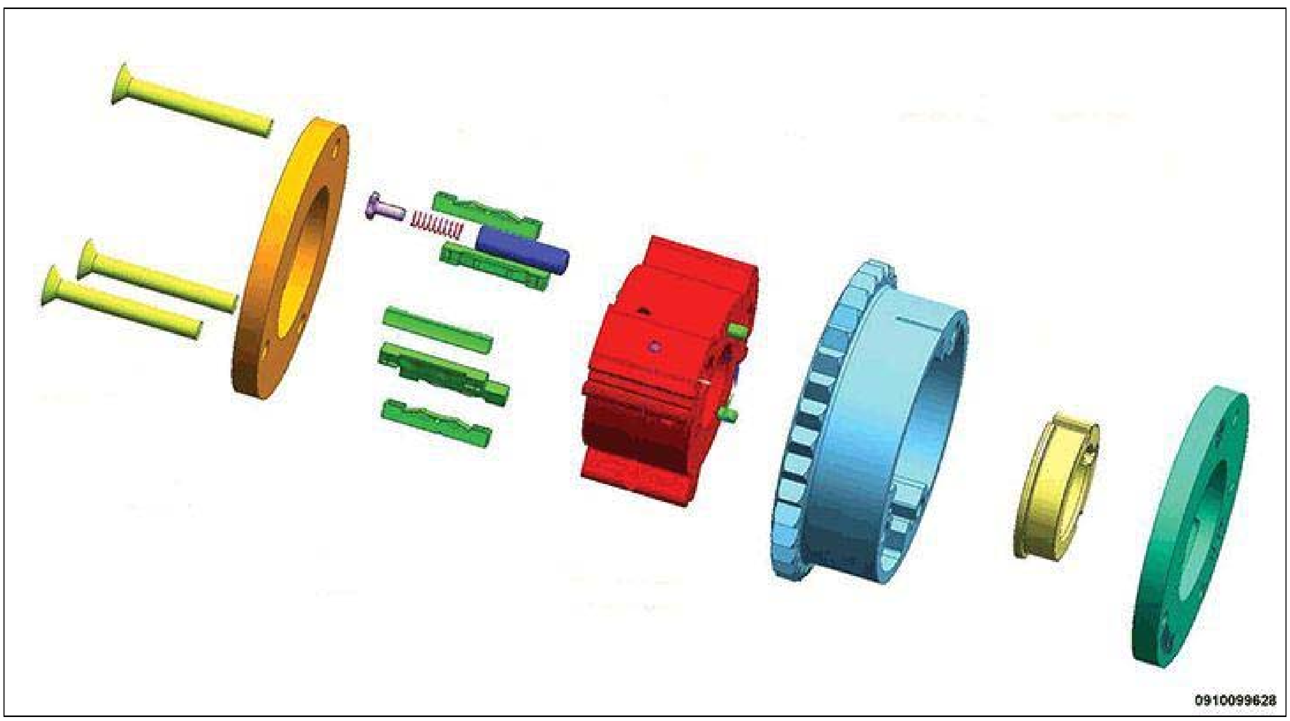
Fig 1: Exhaust Phaser Components



Courtesy of CHRYSLER GROUP, LLC

Intake Phaser

Fig 2: Intake Phaser Components

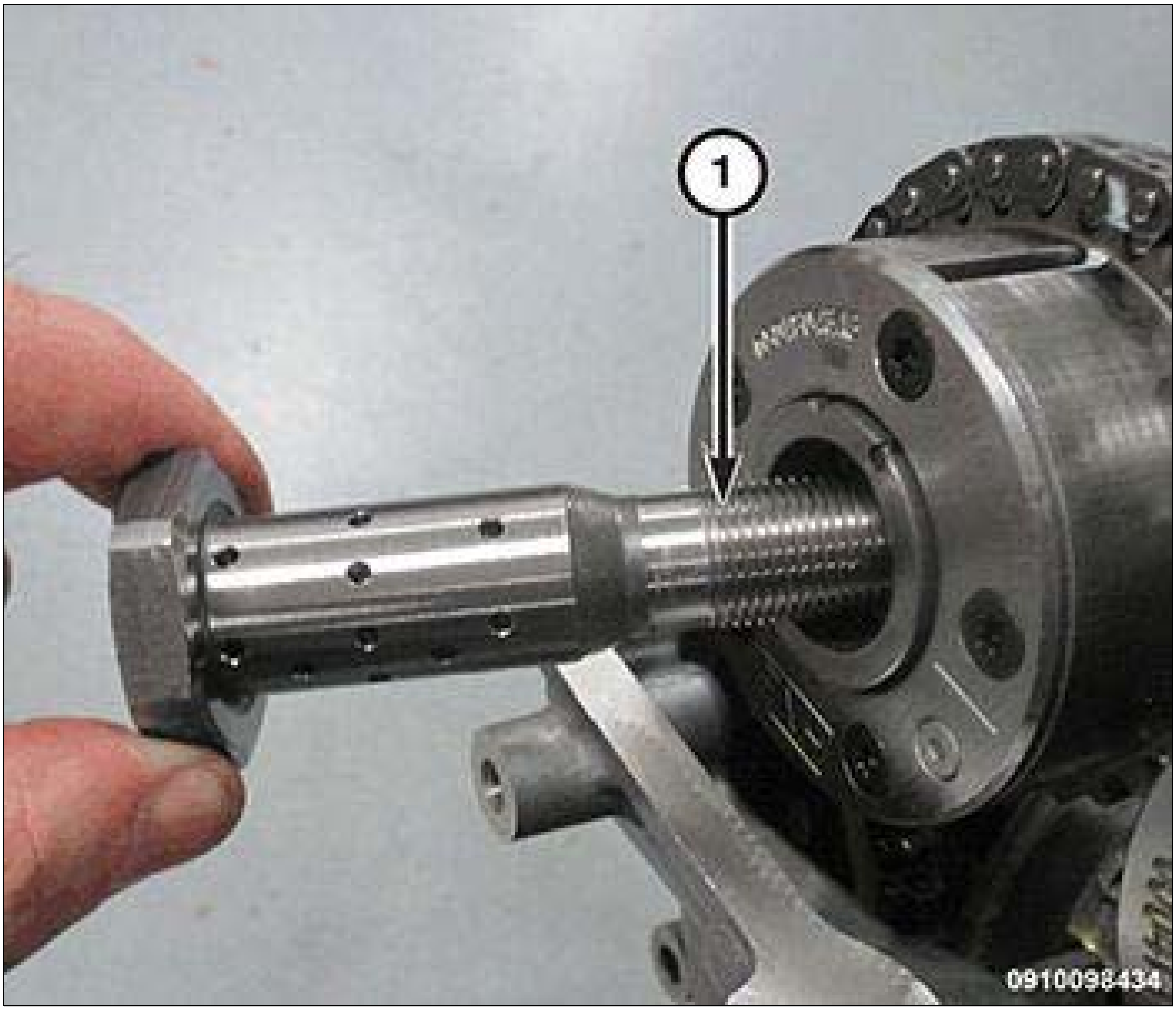


Courtesy of CHRYSLER GROUP, LLC

The 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 four phasers are located on the front of the camshafts, behind the VVT solenoids, inside of the engine timing cover.

- 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 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.

Fig 3: Oil Control Valve (OCV)

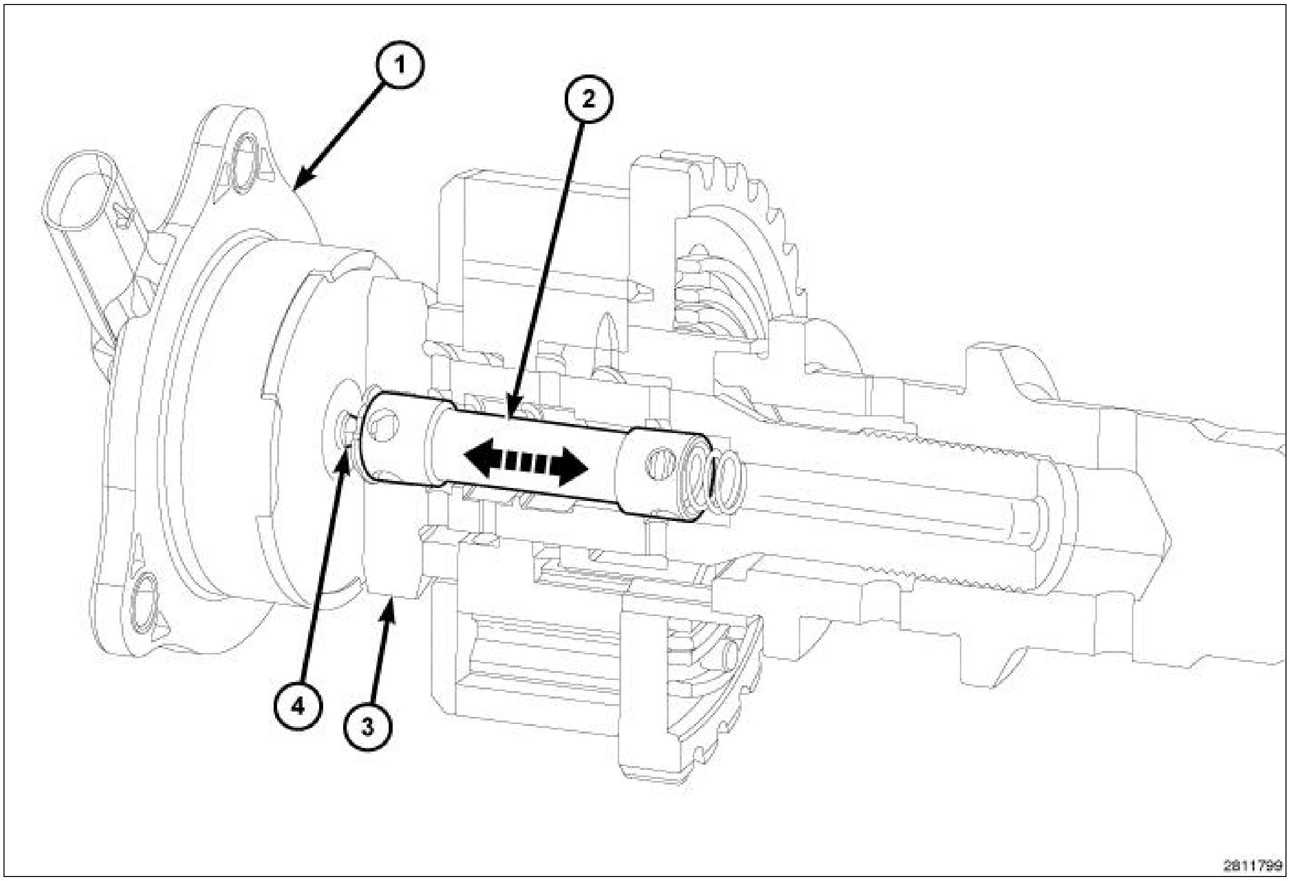


Courtesy of CHRYSLER GROUP, LLC

The engine has an Oil Control Valve (OCV) (1) 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.

CYLINDER HEAD > ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE > OPERATION > OPERATION

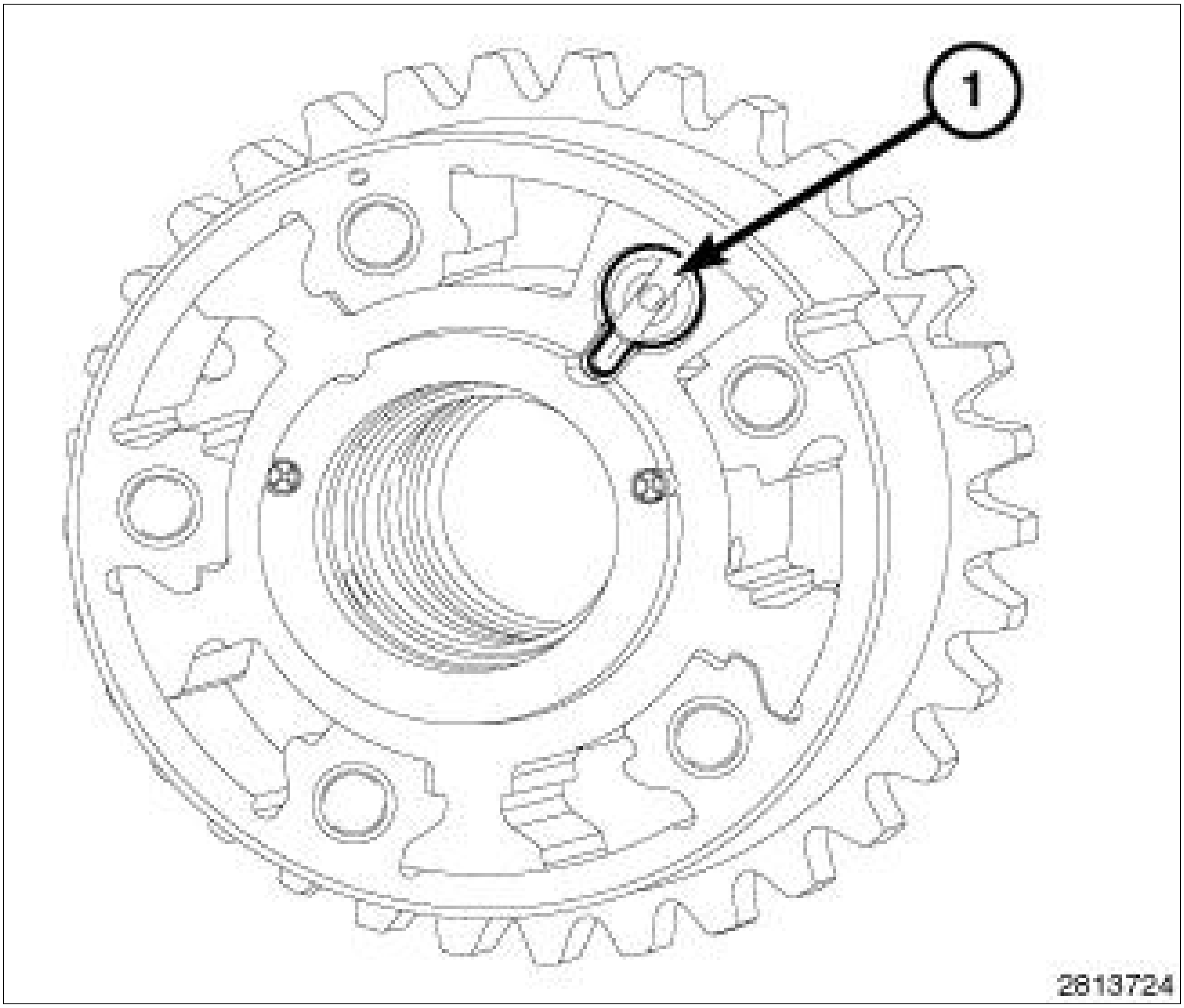
Fig 1: Oil Control Valve (OCV), VVT Solenoid, Solenoid Pintle & Internal Spool Valve



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 Variable Valve Timing (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 forward and backward to direct oil flow.

Fig 2: Phasers In Lock-Pin Position

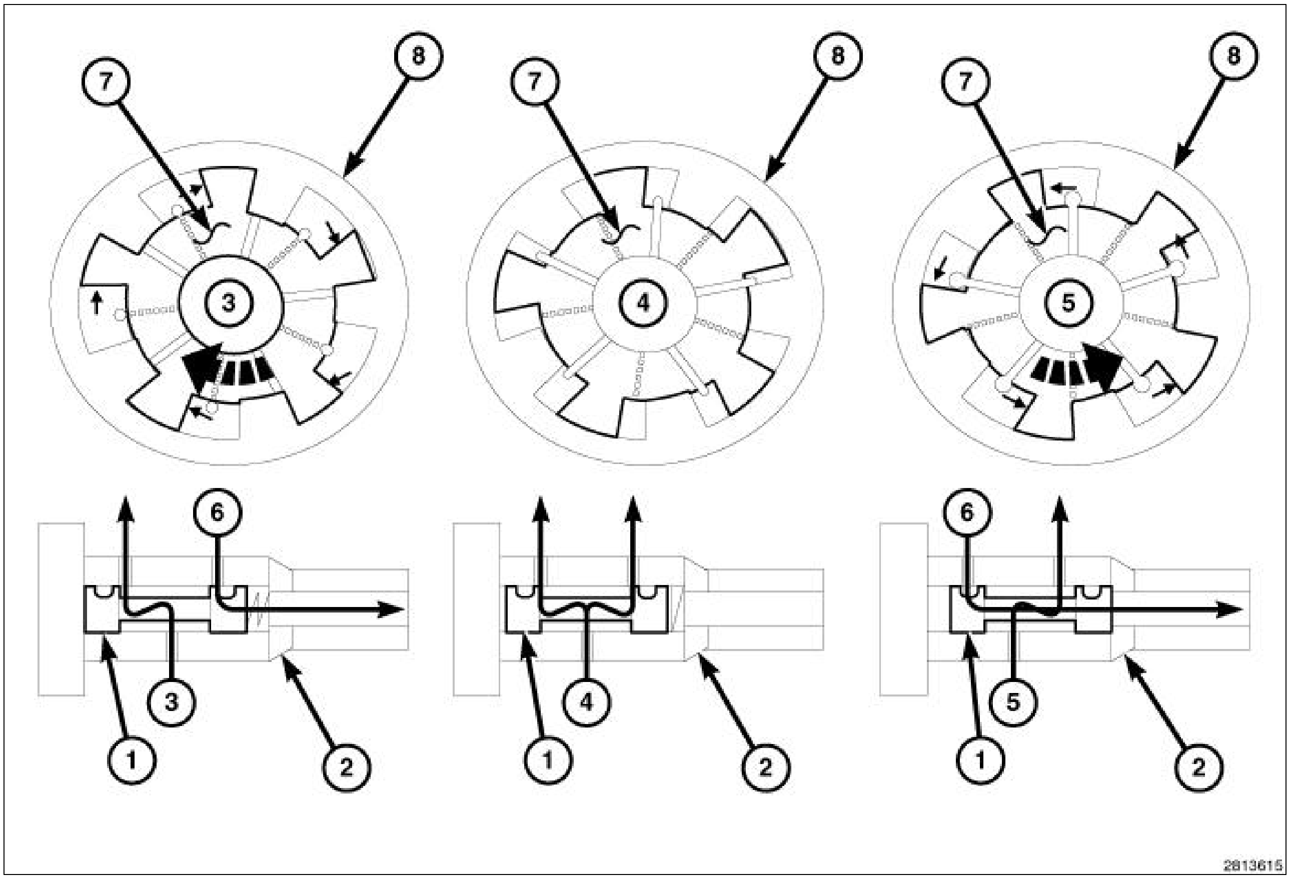


Courtesy of CHRYSLER GROUP, LLC

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.

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.

Fig 3: 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.

CYLINDER HEAD > ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE > REMOVAL > LEFT

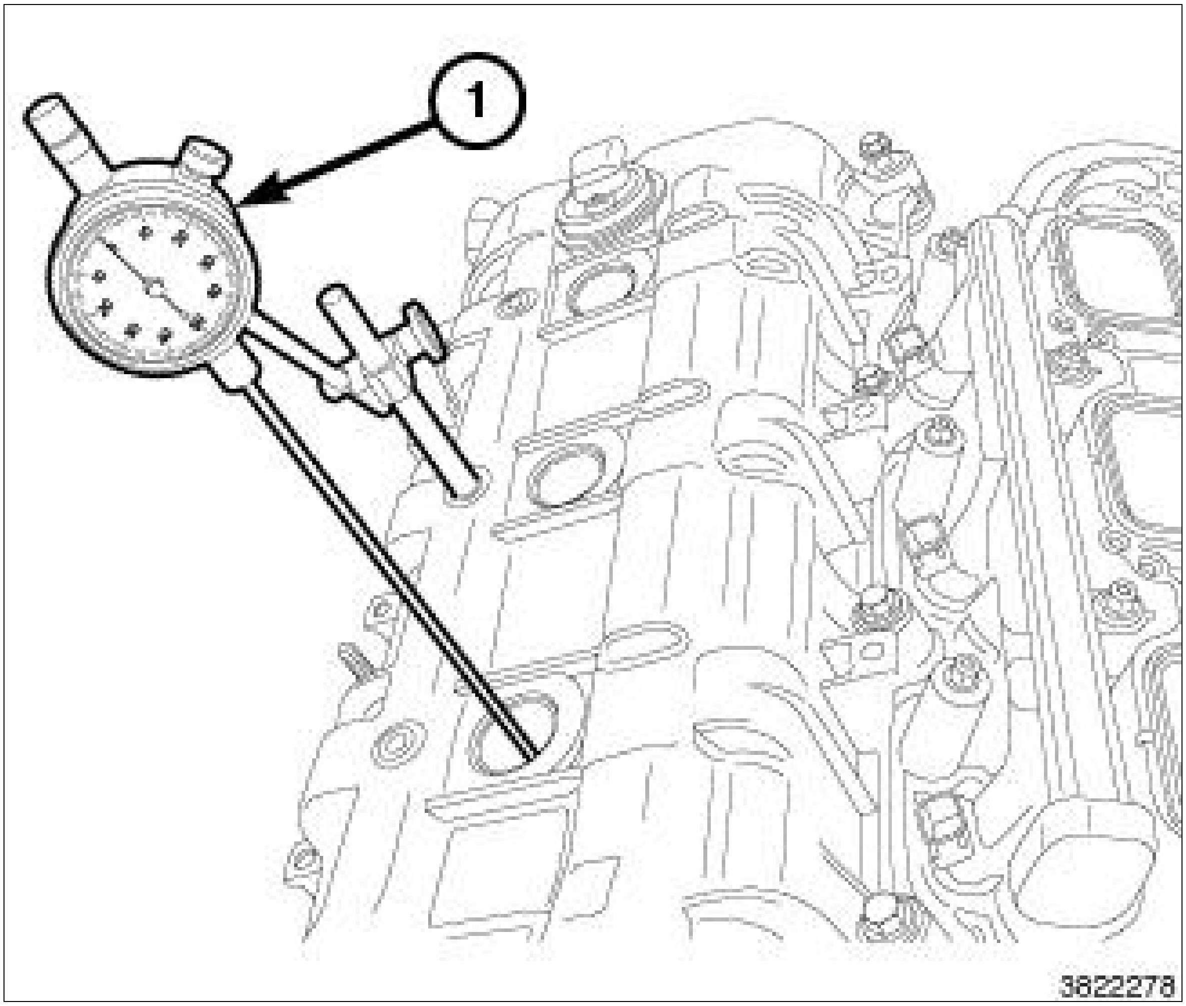
NOTE:

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

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

2. Remove the right side spark plugs. Refer to SPARK PLUG, REMOVAL .

Fig 1: Mount Dial Indicator Set To Stationary Point On Engine

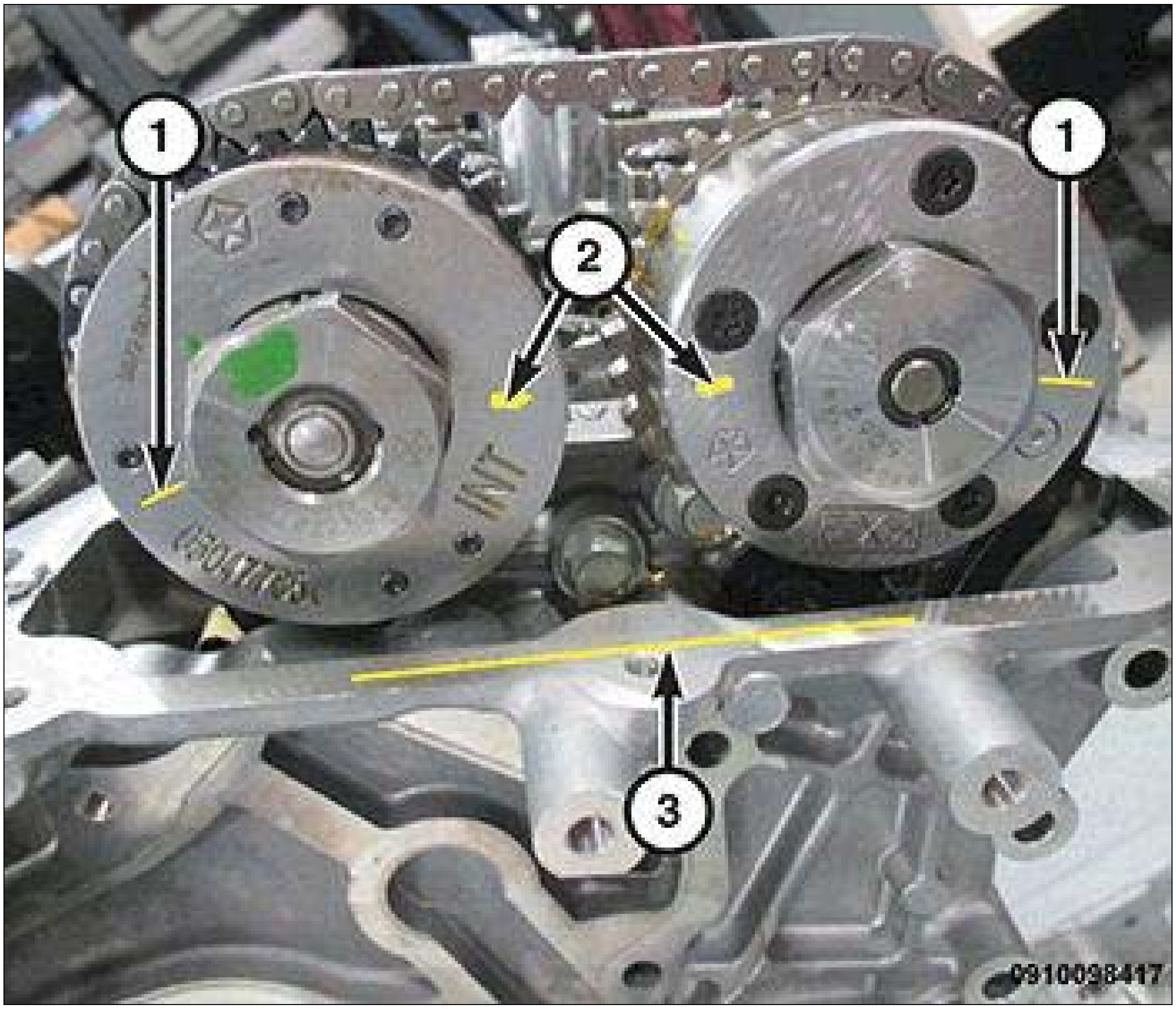


Courtesy of CHRYSLER GROUP, LLC

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

3. Mount the 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.

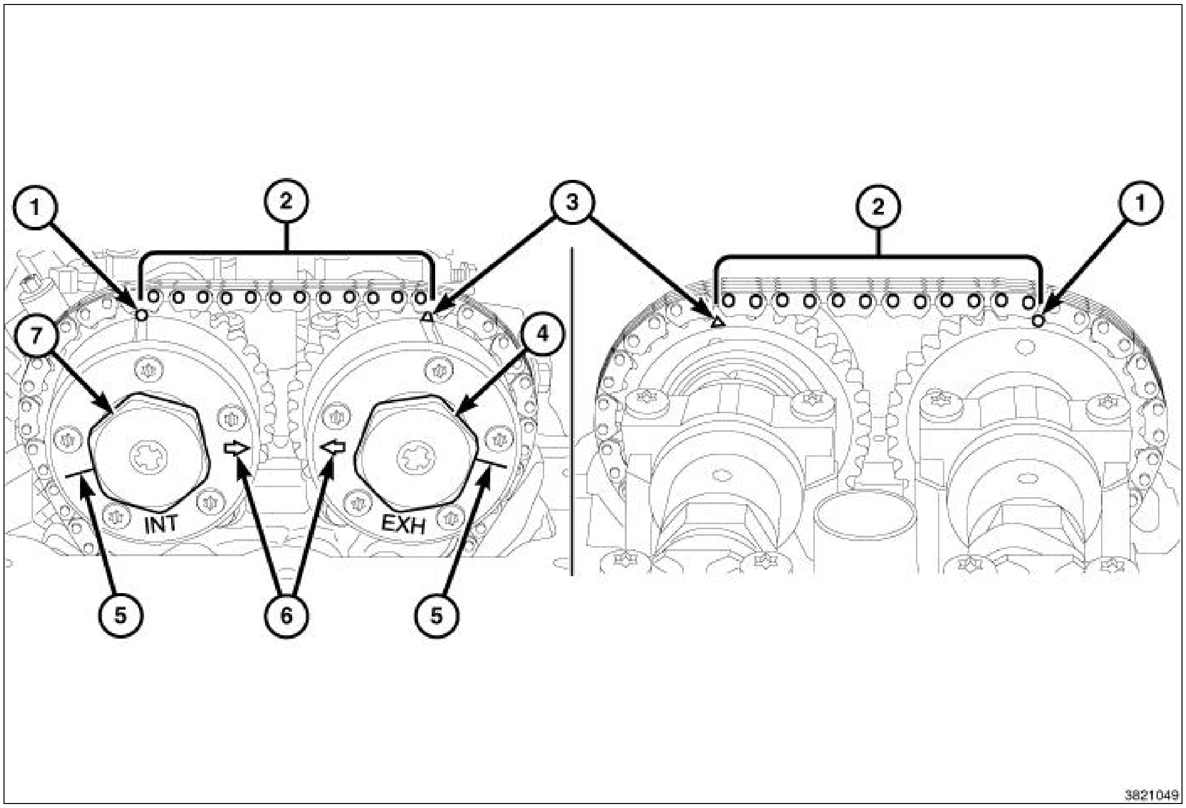
Fig 2: Left Side Cam Phaser Scribe Lines, Arrows & Cylinder Head Cover Mounting Surface



Courtesy of CHRYSLER GROUP, LLC

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

Fig 3: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows



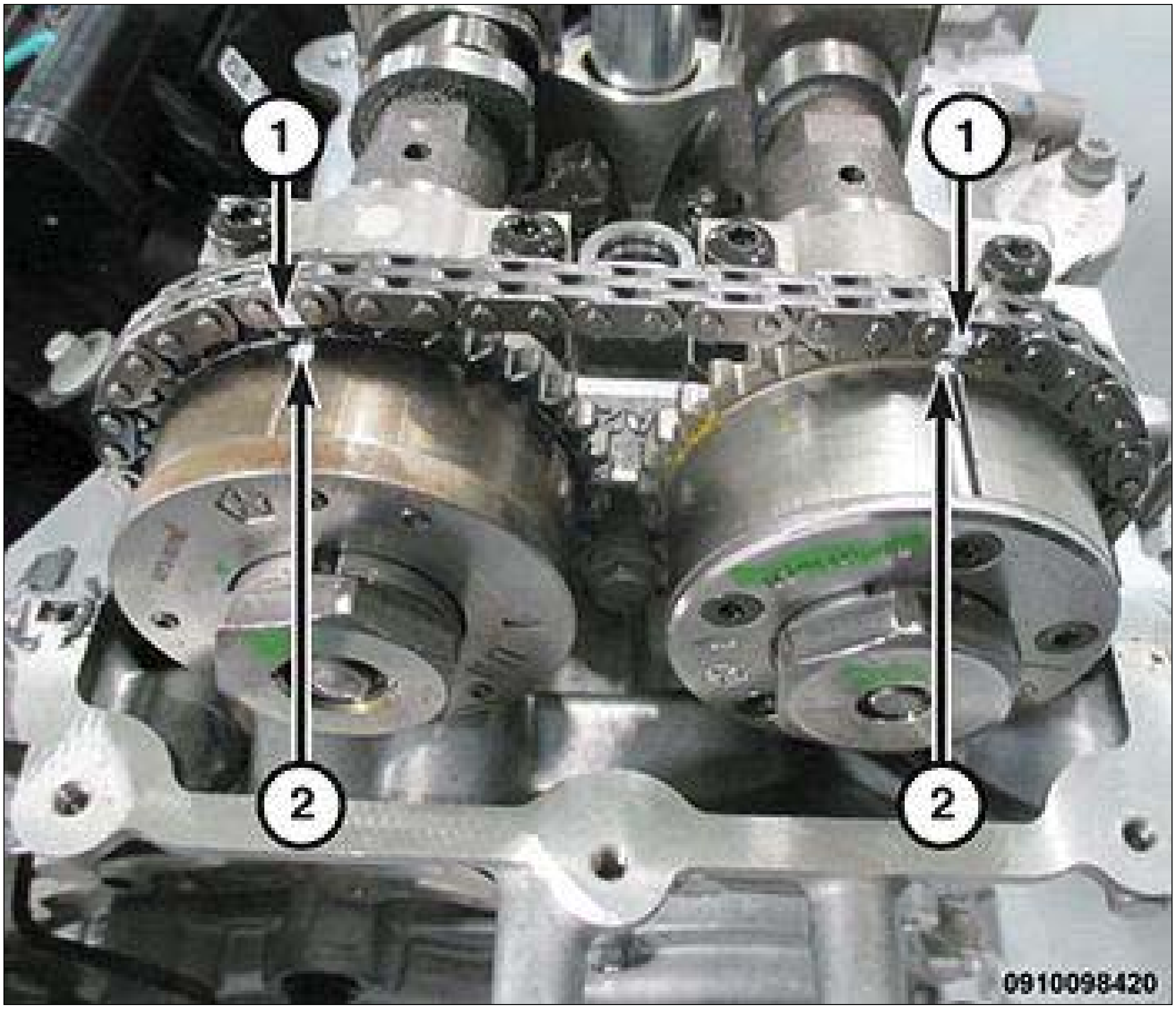
Courtesy of CHRYSLER GROUP, LLC

NOTE:

The cam phaser timing 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 (2) between the markings.

5. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser mark (3) and the intake cam phaser mark (1) as viewed from either the front or rear of the cam phasers.

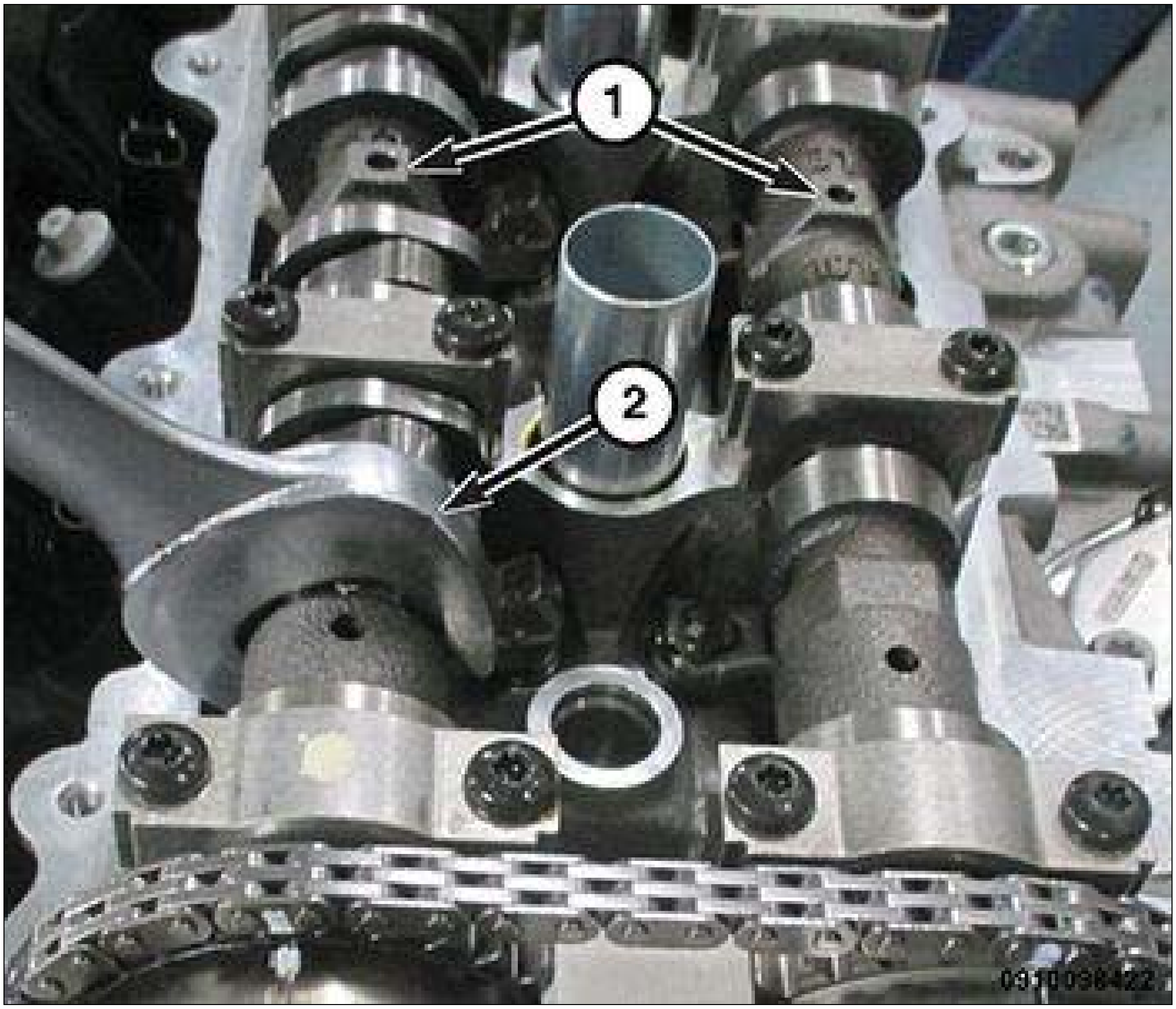
Fig 4: Cam Chain & Phaser Timing Marks



Courtesy of CHRYSLER GROUP, LLC

6. Mark both sides of the cam chain (1) at the phaser timing marks (2) using a paint pen or equivalent to aid in reassembly.

Fig 5: Alignment Holes & Wrench

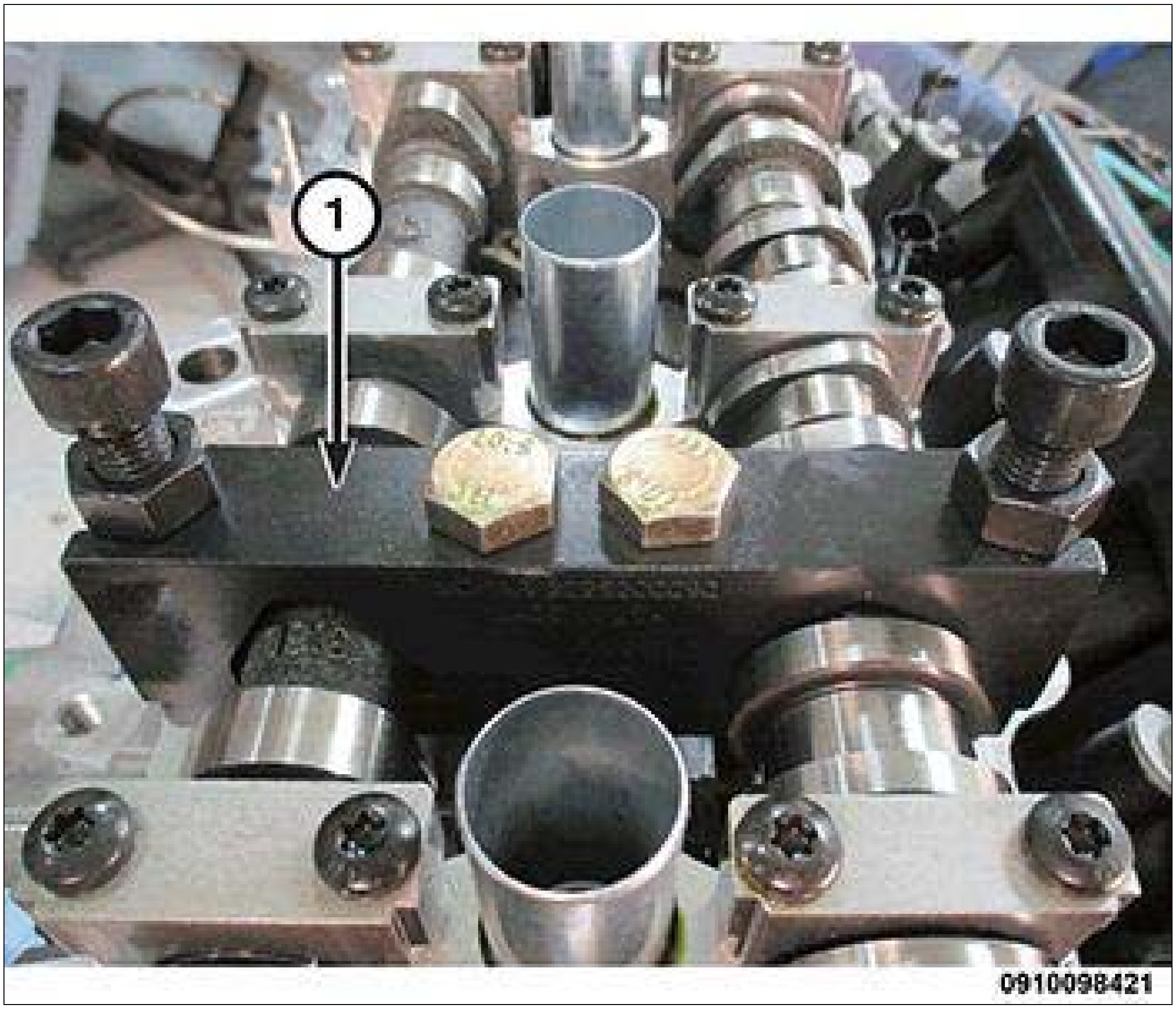


Courtesy of CHRYSLER GROUP, LLC

7. The camshafts should be at top-dead-center, with the alignment holes (1) positioned vertically.

> *NOTE:*
>
> *It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (2) when installing the camshaft holder.*

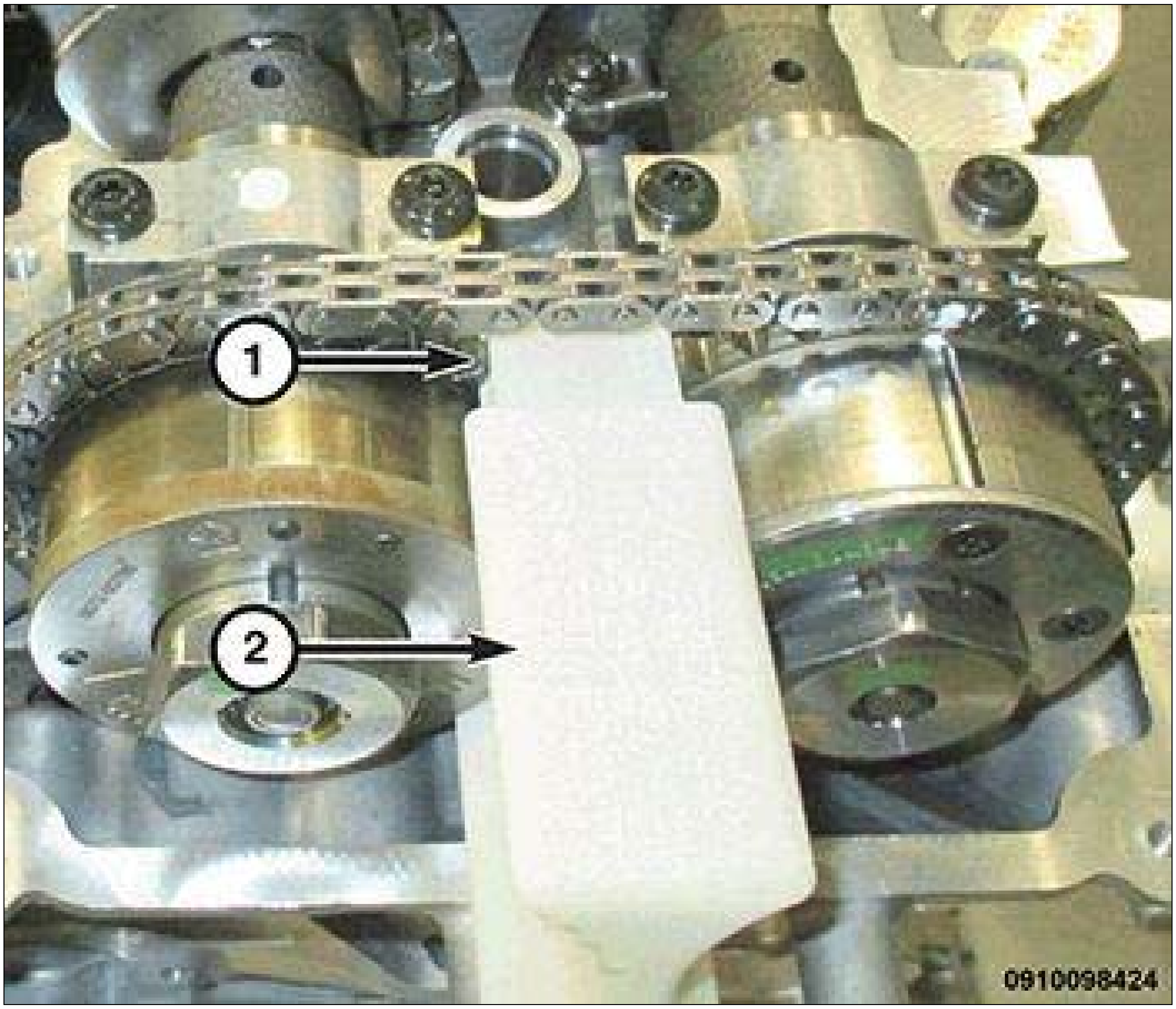
Fig 6: Camshaft Holder



Courtesy of CHRYSLER GROUP, LLC

8. Install the (special tool #2025200090, Holder, Camshaft) (1).

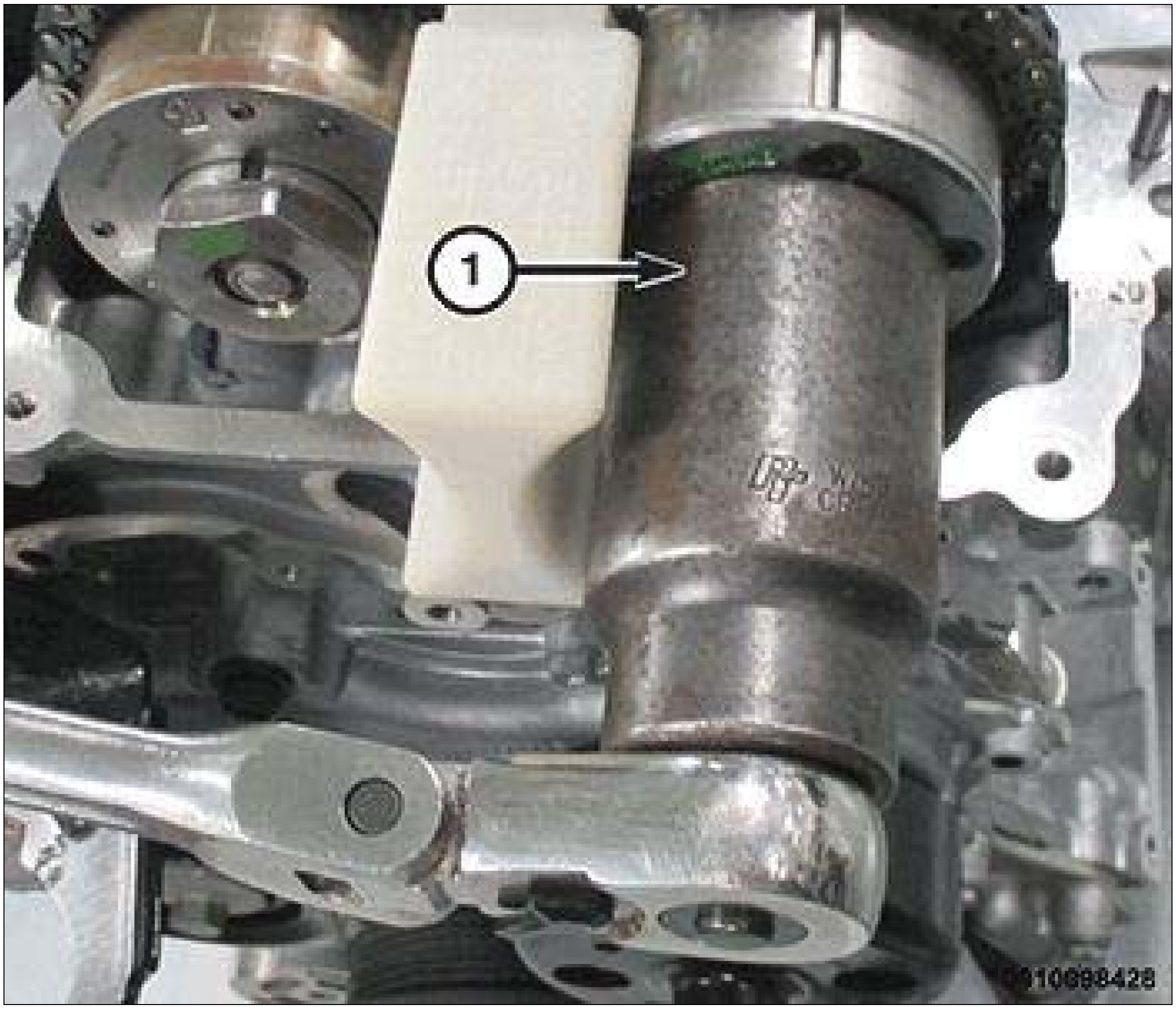
Fig 7: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

9. Install the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head) (2) against the cylinder head cover mounting surface between the intake and exhaust phasers (1), with the tool number facing up.

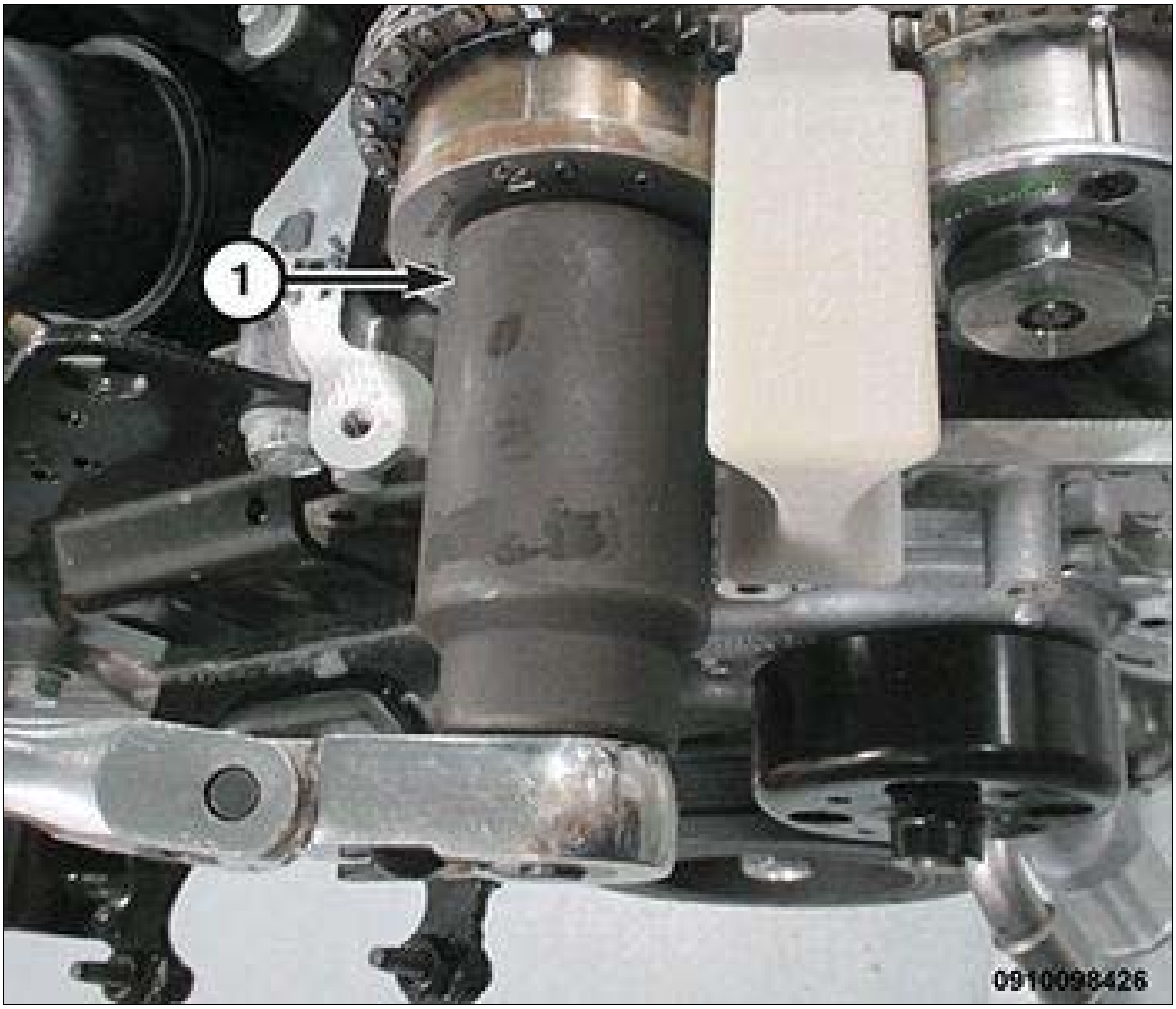
Fig 8: Installing Socket On Exhaust Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

10. Loosen, but do not remove, the exhaust oil control valve (1).

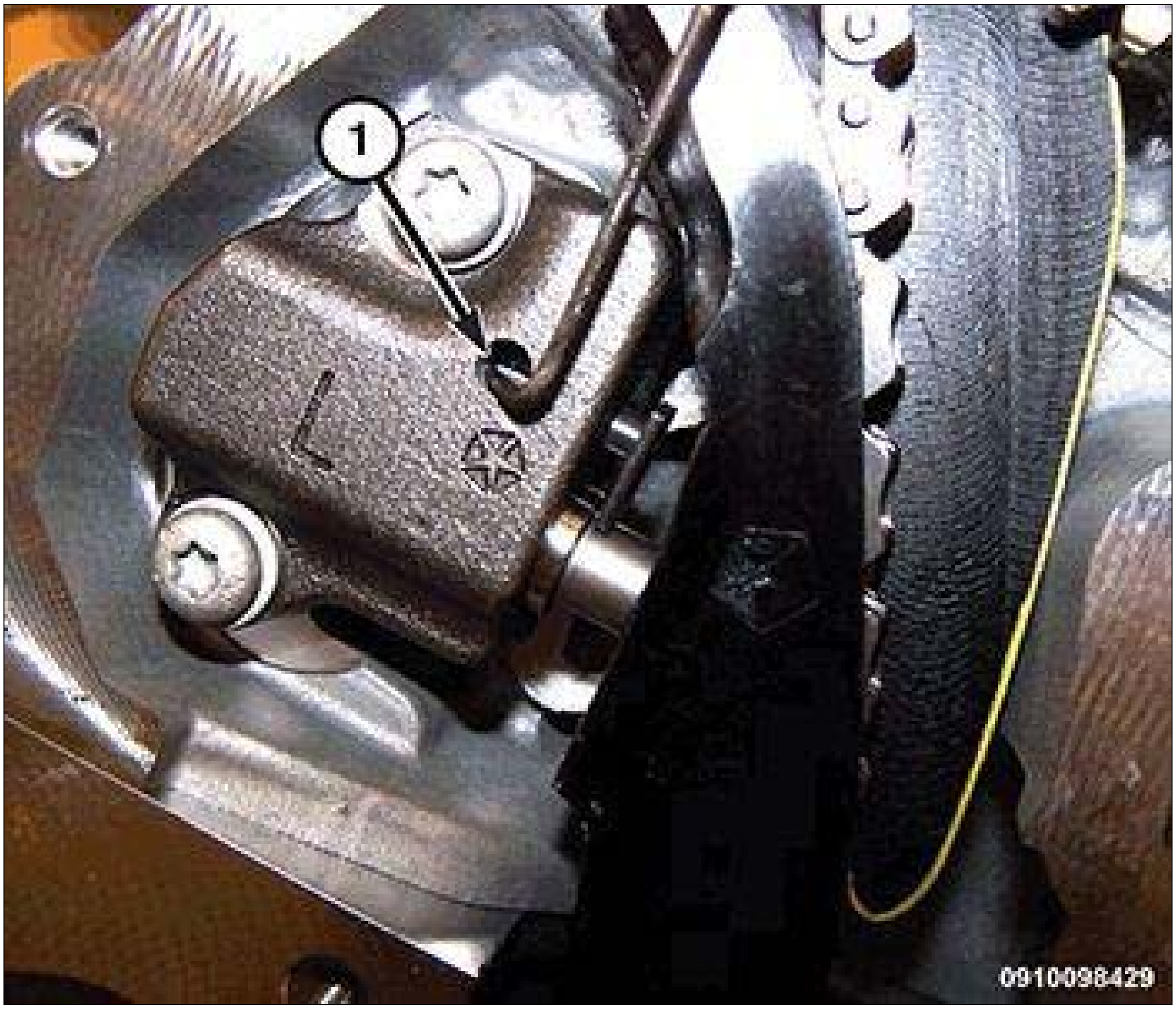
Fig 9: Installing Socket On Intake Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

11. Loosen, but do not remove, the intake oil control valve (1).
12. Remove the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head), leaving the Camshaft Holder in place.

Fig 10: Using Chain Tensioner Pin To Lift Pawl Off Of Rack



Courtesy of CHRYSLER GROUP, LLC

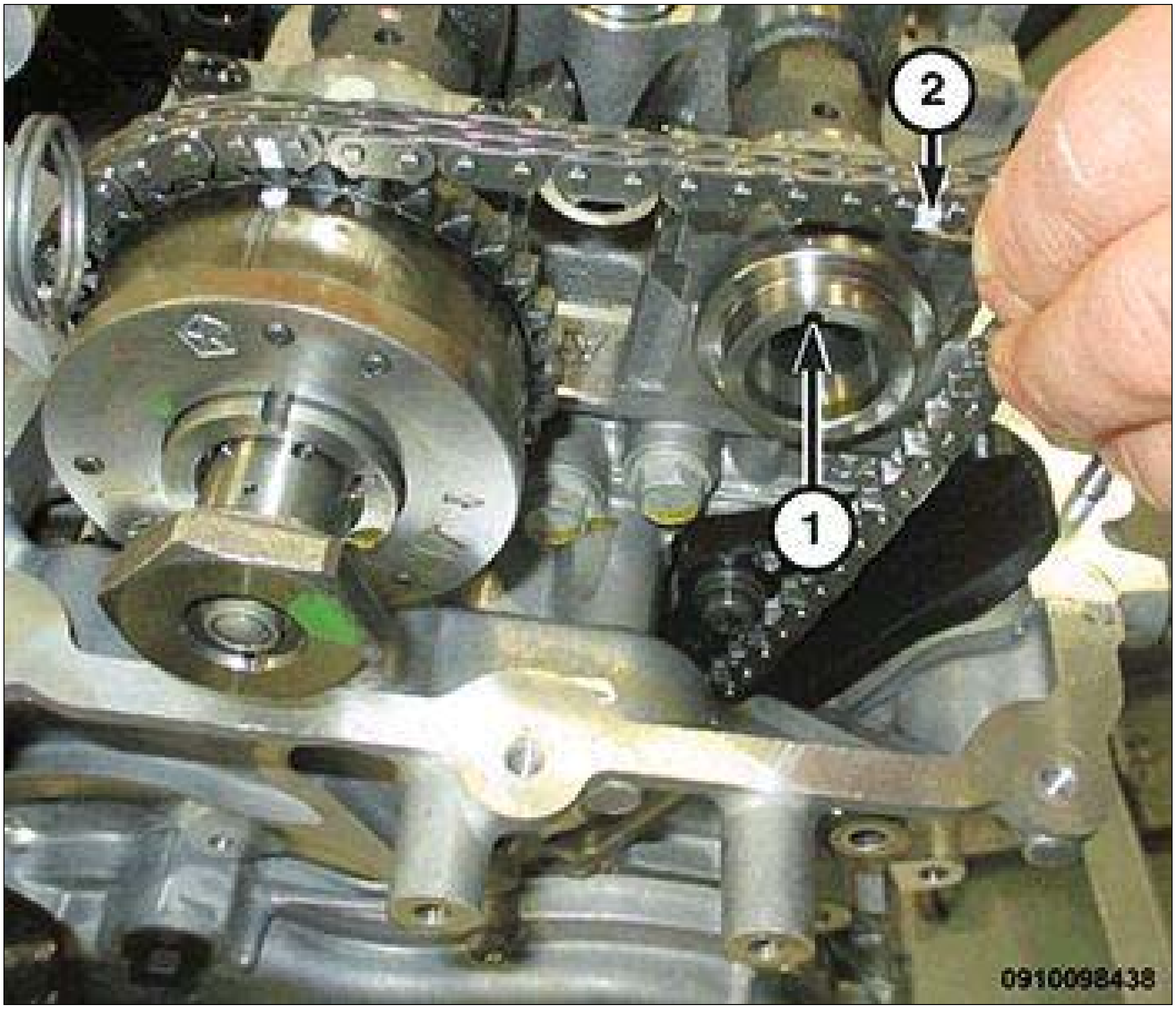
13. Using the (special tool #2025003090, Pin, Chain Tensioner), lift the pawl off of the rack (1).

Fig 11: Holding Pawl Off Rack & Pushing Timing Chain Tensioner Holder Into Place

Courtesy of CHRYSLER GROUP, LLC

14. While holding the pawl off of the rack (2), push the (special tool #2025001090, Holder, Timing Chain Tensioner, Left-Front) (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 STANDARD PROCEDURE .

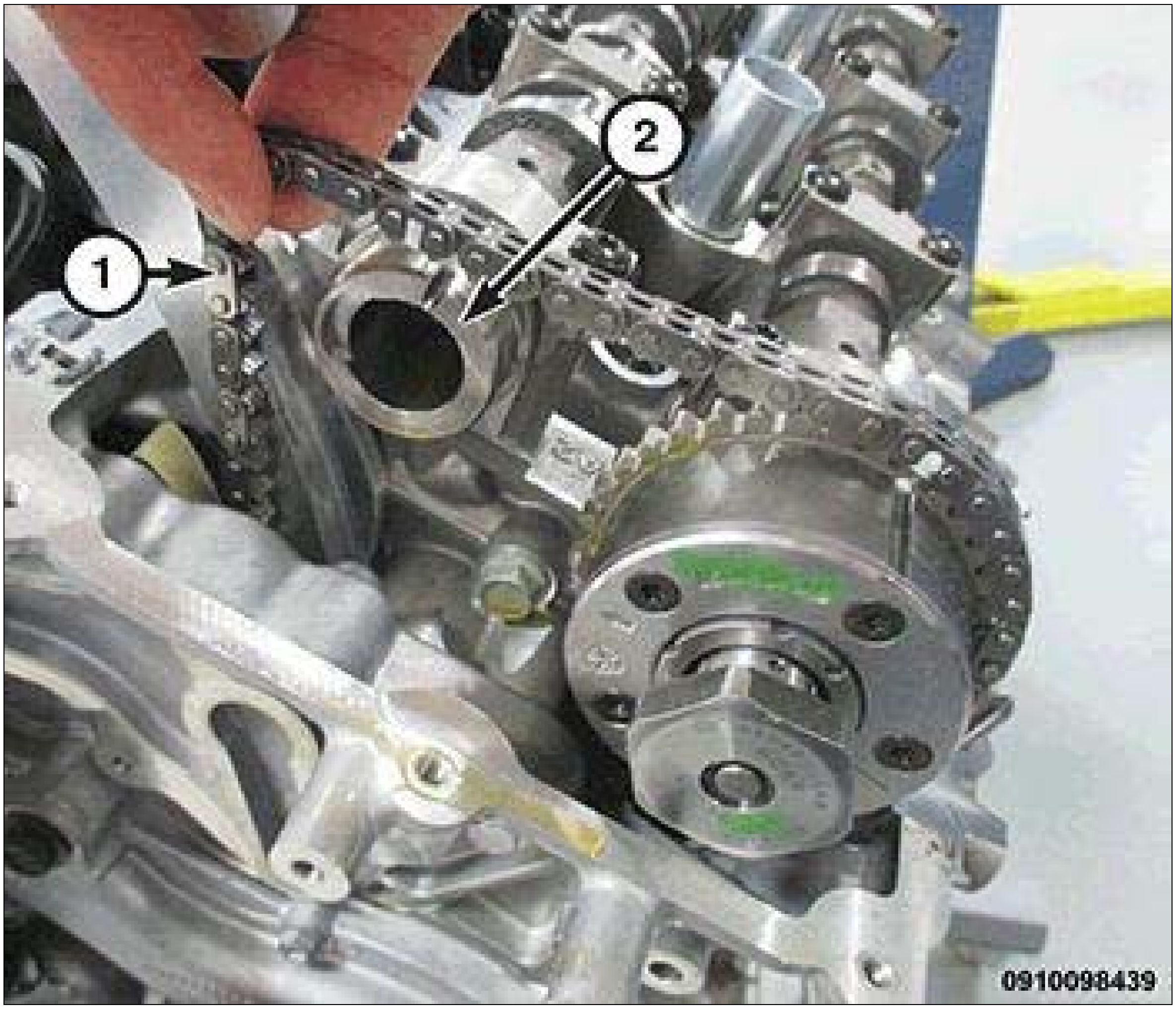
Fig 12: Exhaust Camshaft & Timing Chain



Courtesy of CHRYSLER GROUP, LLC

15. Remove the oil control valve and pull the left side exhaust cam phaser off of the camshaft (1) while supporting the timing chain (2).

Fig 13: Intake Camshaft & Timing Chain



Courtesy of CHRYSLER GROUP, LLC

16. Remove the oil control valve and pull the left side intake cam phaser off of the camshaft (2) while supporting the timing chain (1).

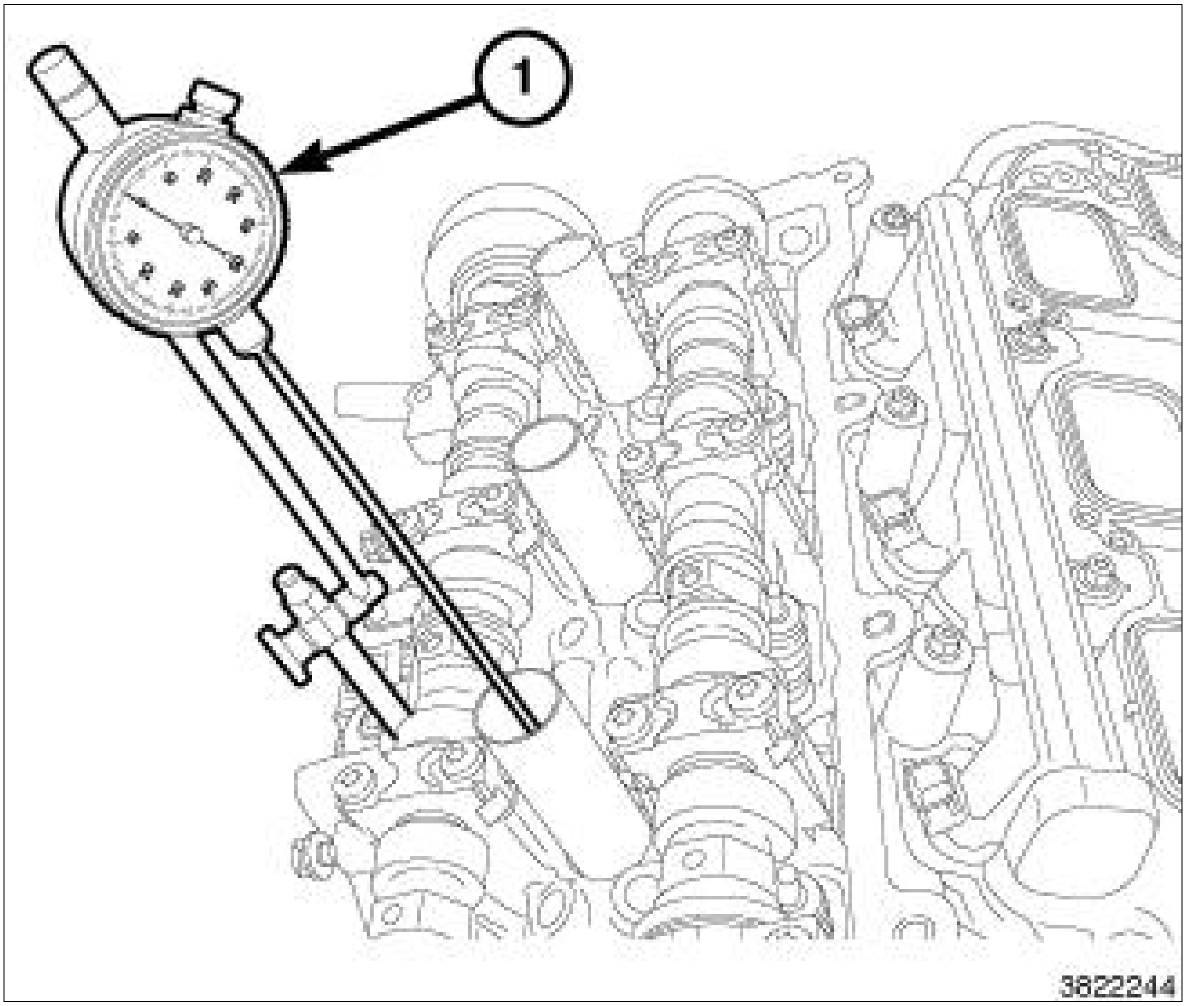
CYLINDER HEAD > ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE > REMOVAL > RIGHT

NOTE:

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

1. Remove the right cylinder head cover. Refer to COVER(S), CYLINDER HEAD, REMOVAL .
2. Remove all the left spark plugs. Refer to SPARK PLUG, REMOVAL .

Fig 1: Mount Dial Indicator Set To Stationary Point On Engine

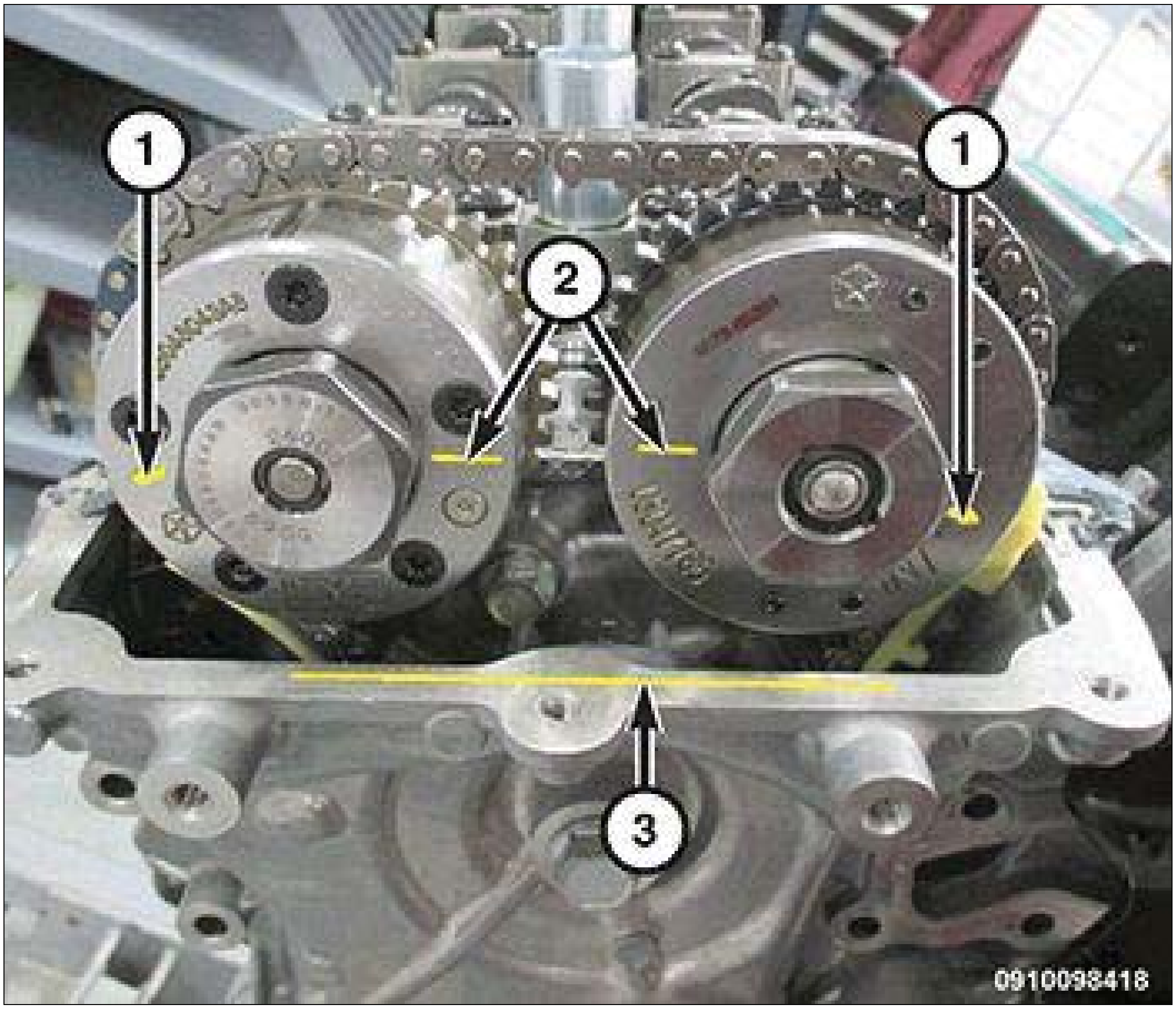


Courtesy of CHRYSLER GROUP, LLC

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

3. Mount the 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.

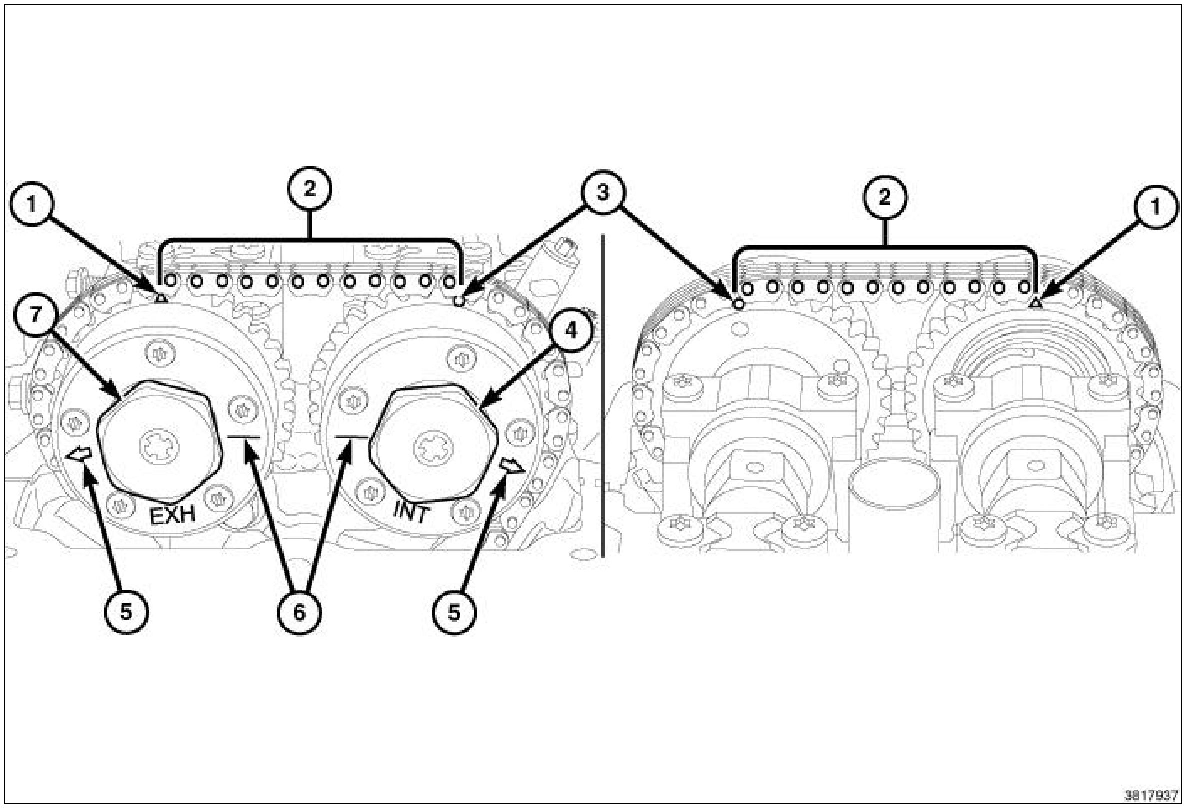
Fig 2: Right Side Cam Phaser Scribe Lines, Arrows & Cylinder Head Cover Mounting Surface



Courtesy of CHRYSLER GROUP, LLC

4. The right side cam phaser **ARROWS** (1) should point away from each other and the **SCRIBE LINES** (2) 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.

Fig 3: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows



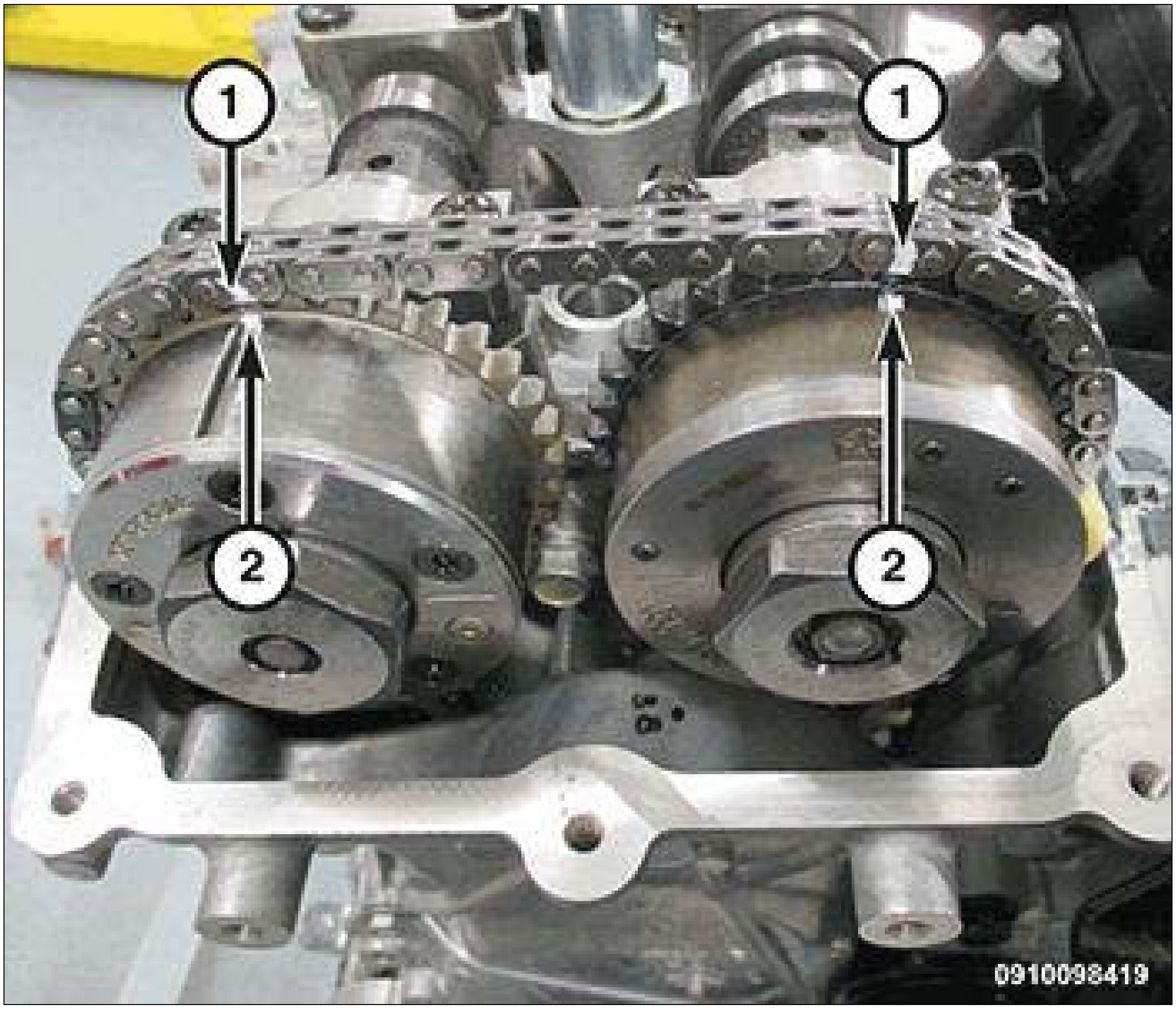
Courtesy of CHRYSLER GROUP, LLC

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 (2) between the markings.

5. There should be twelve chain pins (2) **BETWEEN** the exhaust cam phaser mark (1) and the intake cam phaser mark (3) as viewed from either the front or rear of the cam phasers.

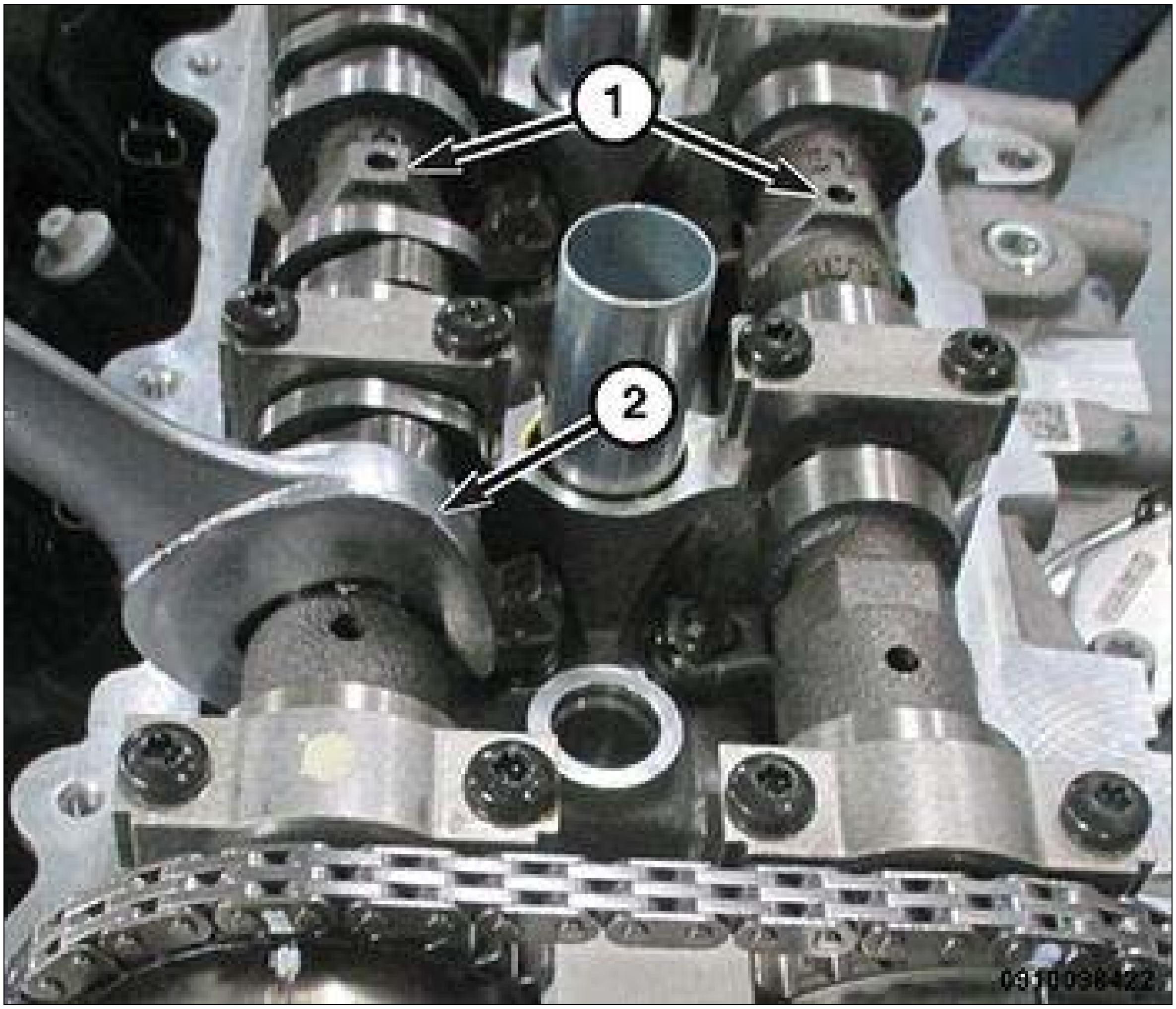
Fig 4: Timing Chain & Phaser Timing Marks



Courtesy of CHRYSLER GROUP, LLC

6. Mark both sides of the timing chain (1) at the phaser timing marks (2) using a paint pen or equivalent to aid in reassembly.

Fig 5: Alignment Holes & Wrench



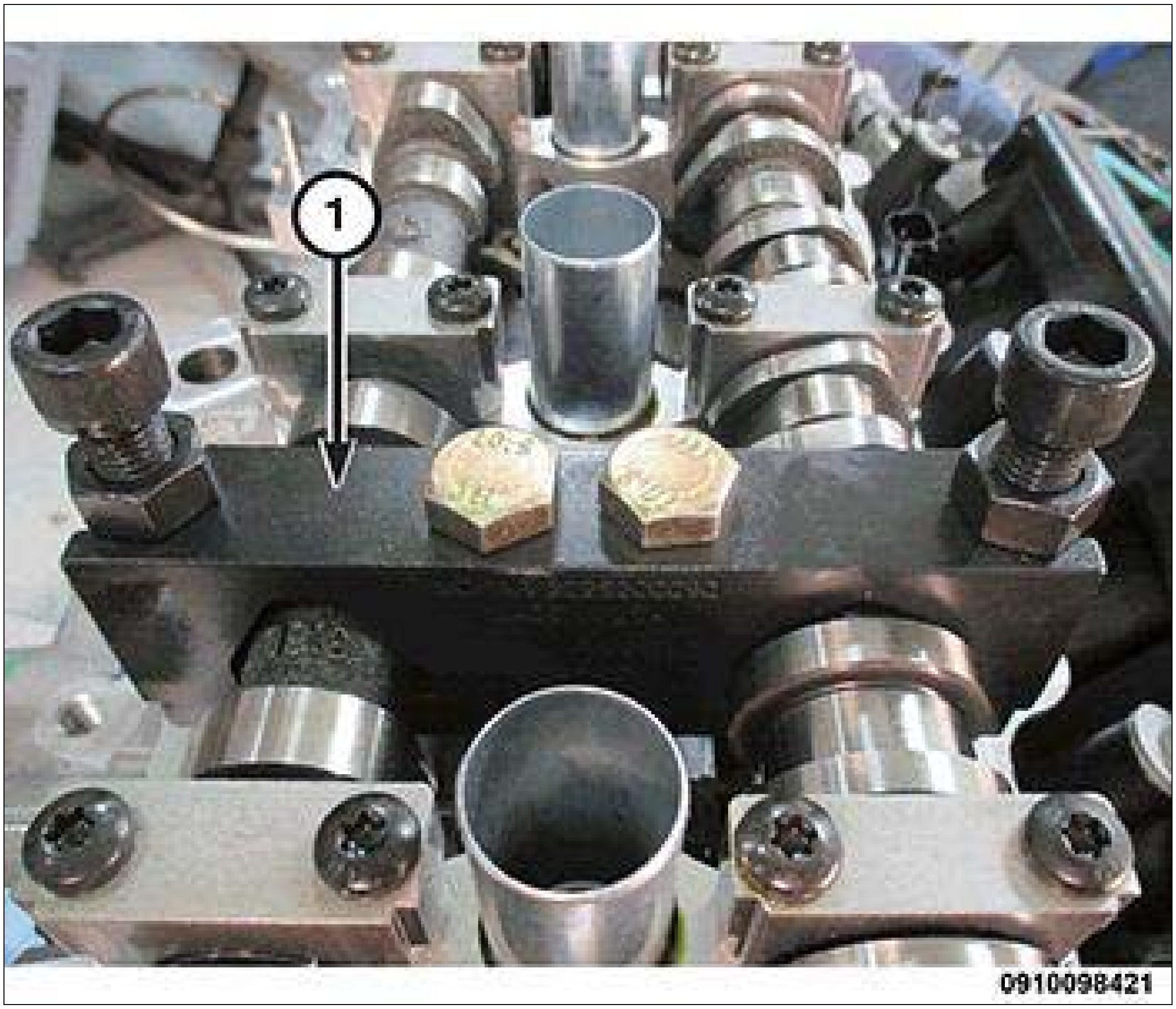
Courtesy of CHRYSLER GROUP, LLC

7. The camshafts should be at top-dead-center, with the alignment holes (1) positioned vertically.

NOTE:

It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (2) when installing the camshaft holder.

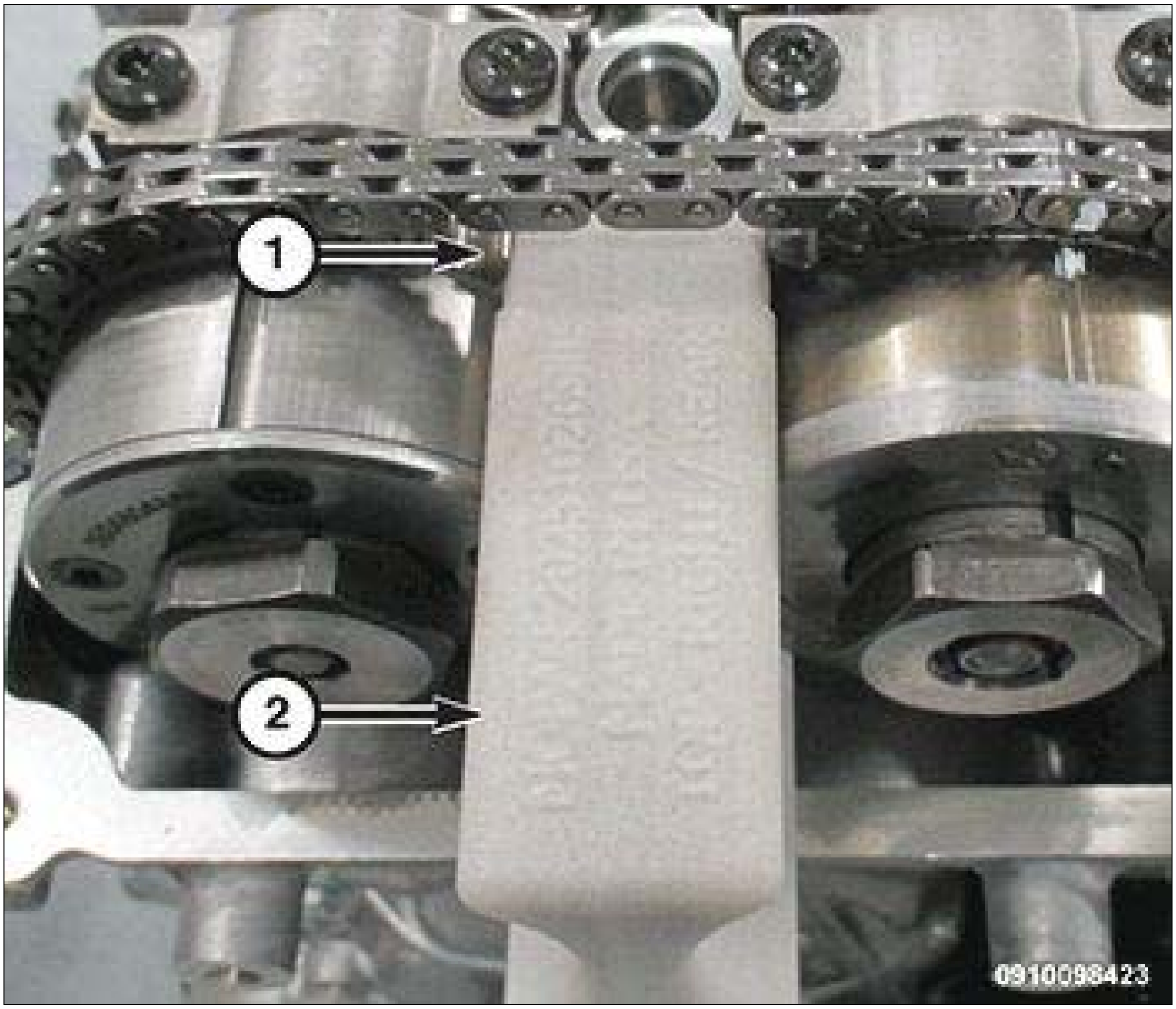
Fig 6: Camshaft Holder



Courtesy of CHRYSLER GROUP, LLC

8. Install the (special tool #2025200090, Holder, Camshaft) (1).

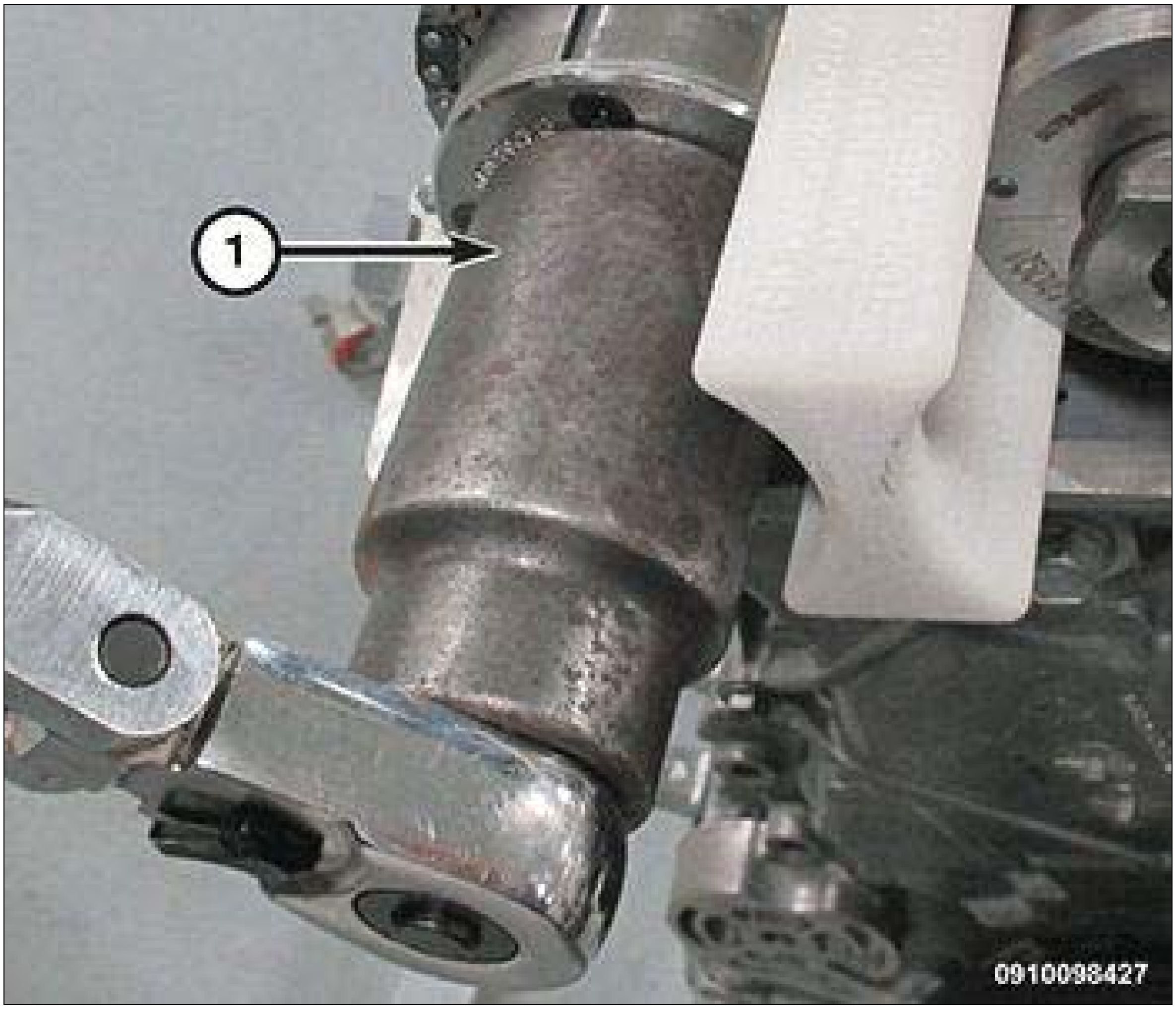
Fig 7: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

9. Install the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (2) against the cylinder head cover mounting surface between the intake and exhaust phasers (1), with the tool number facing up.

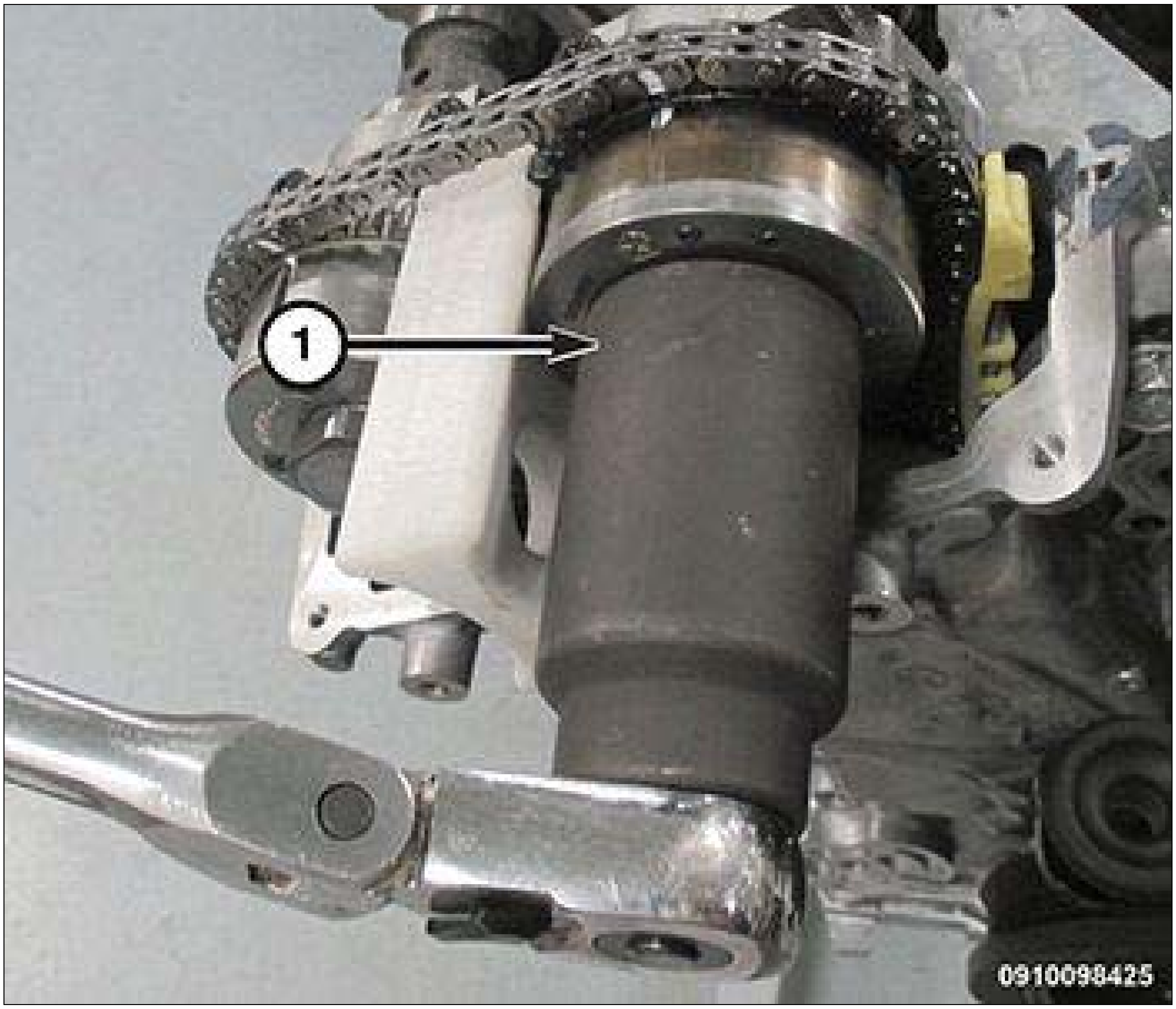
Fig 8: Installing Socket On Exhaust Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

10. Loosen, but do not remove, the exhaust oil control valve (1).

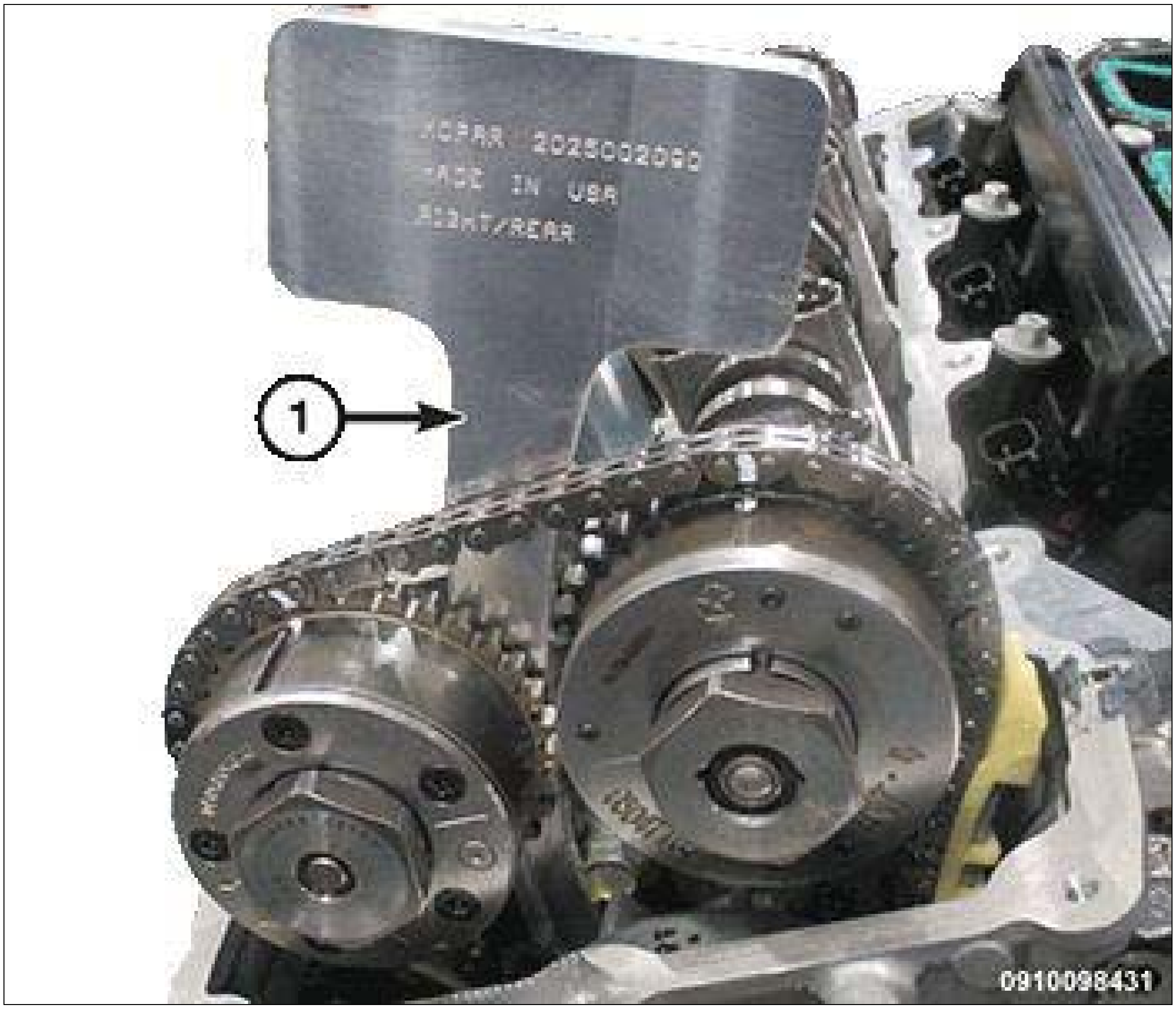
Fig 9: Installing Socket On Intake Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

11. Loosen, but do not remove, the intake oil control valve (1).
12. Remove the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (1).

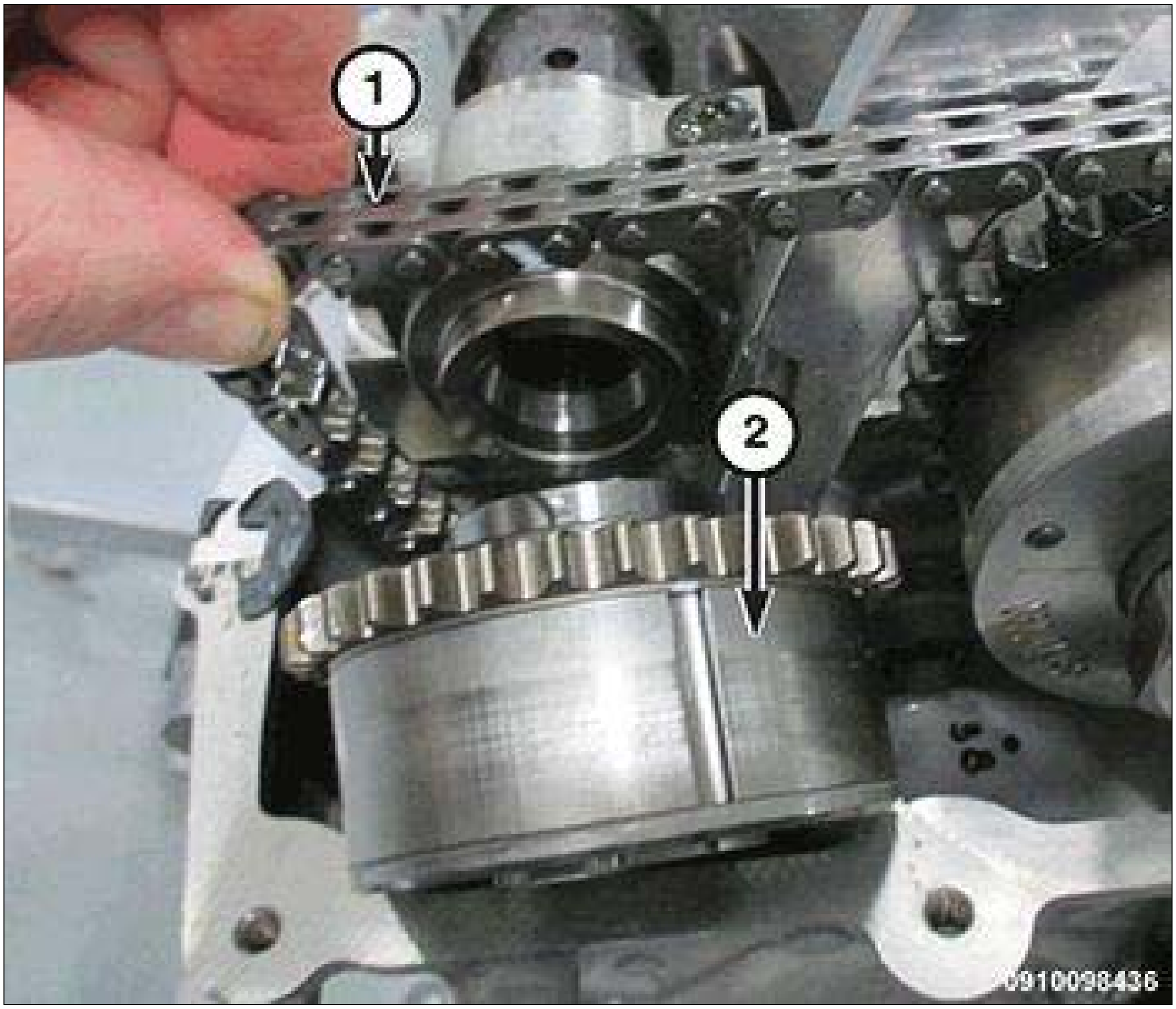
Fig 10: Inserting Timing Chain Tensioner Holder



Courtesy of CHRYSLER GROUP, LLC

13. Insert the (special tool #2025002090, Holder, Timing Chain Tensioner, Right-Rear) (1) into place between the cylinder head boss and the tensioner arm to hold the tensioner in the compressed position. The Timing Chain Tensioner Holder remains in place while the phasers are removed.

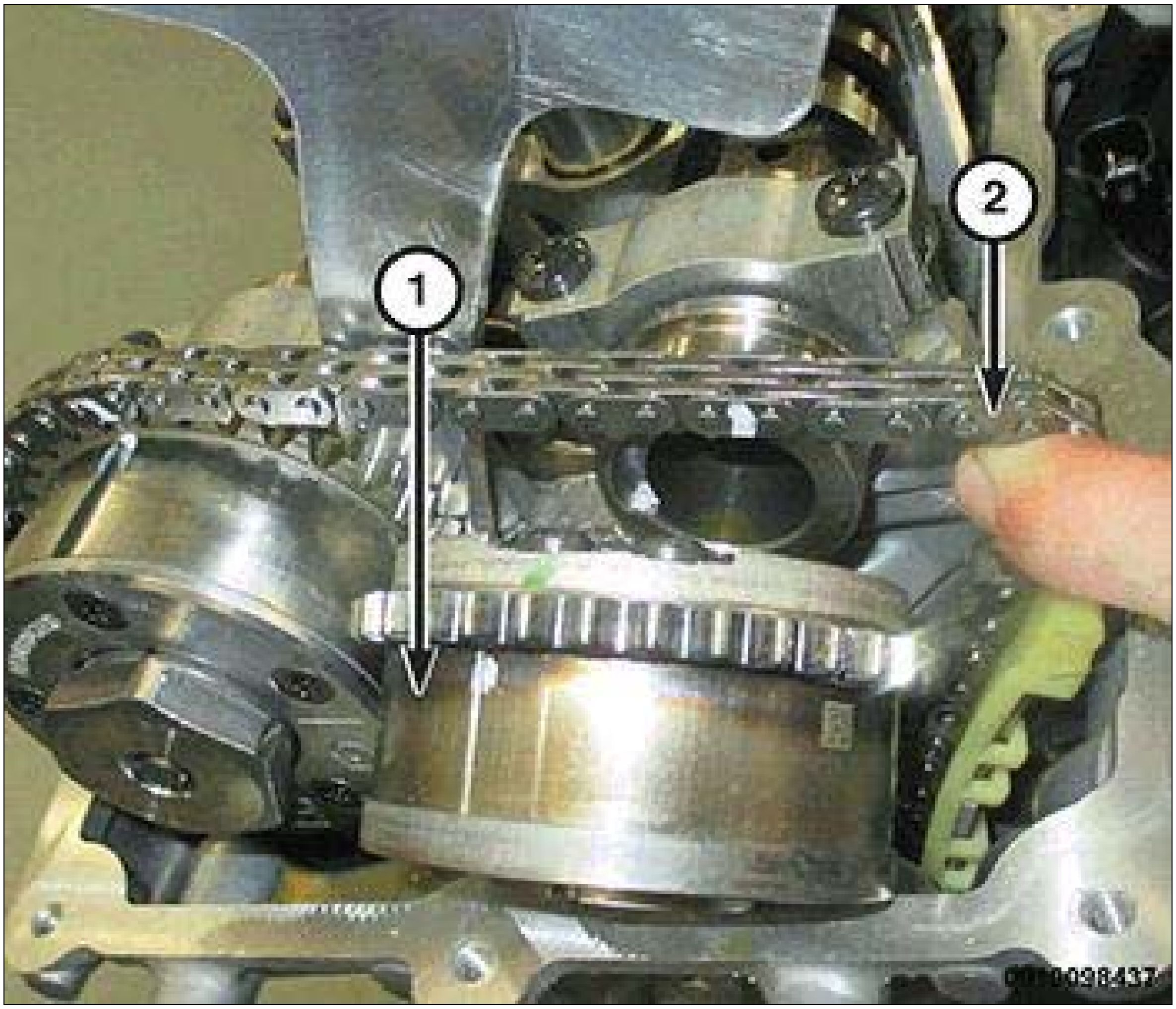
Fig 11: Right Side Exhaust Cam Phaser & Timing Chain



Courtesy of CHRYSLER GROUP, LLC

14. Remove the oil control valve and pull the right side exhaust cam phaser (2) off of the camshaft while supporting the timing chain (1).

Fig 12: Right Side Intake Cam Phaser & Timing Chain

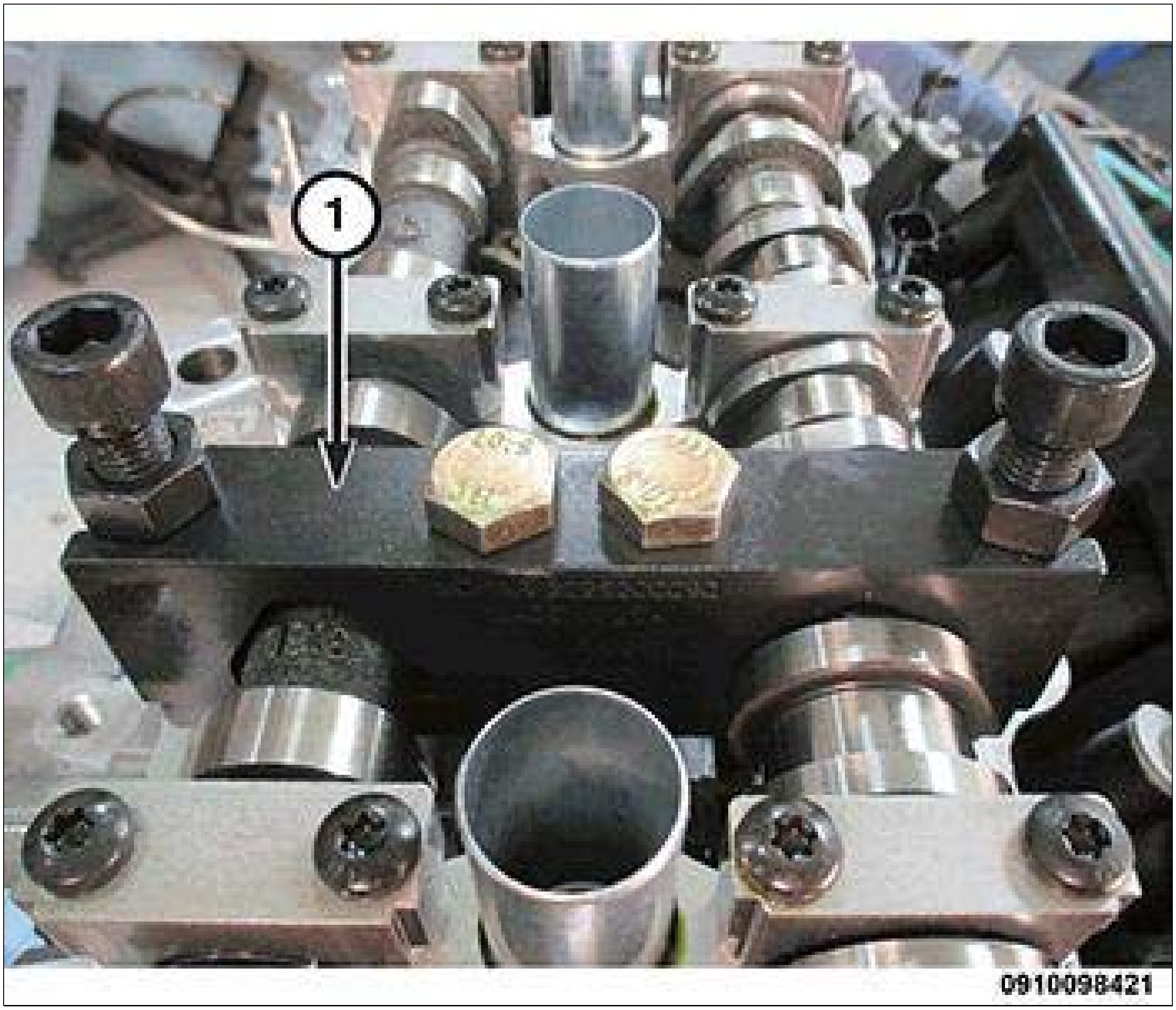


Courtesy of CHRYSLER GROUP, LLC

15. Remove the oil control valve and pull the right side intake cam phaser (1) off of the camshaft while supporting the timing chain (2).

CYLINDER HEAD > ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE > INSTALLATION > LEFT

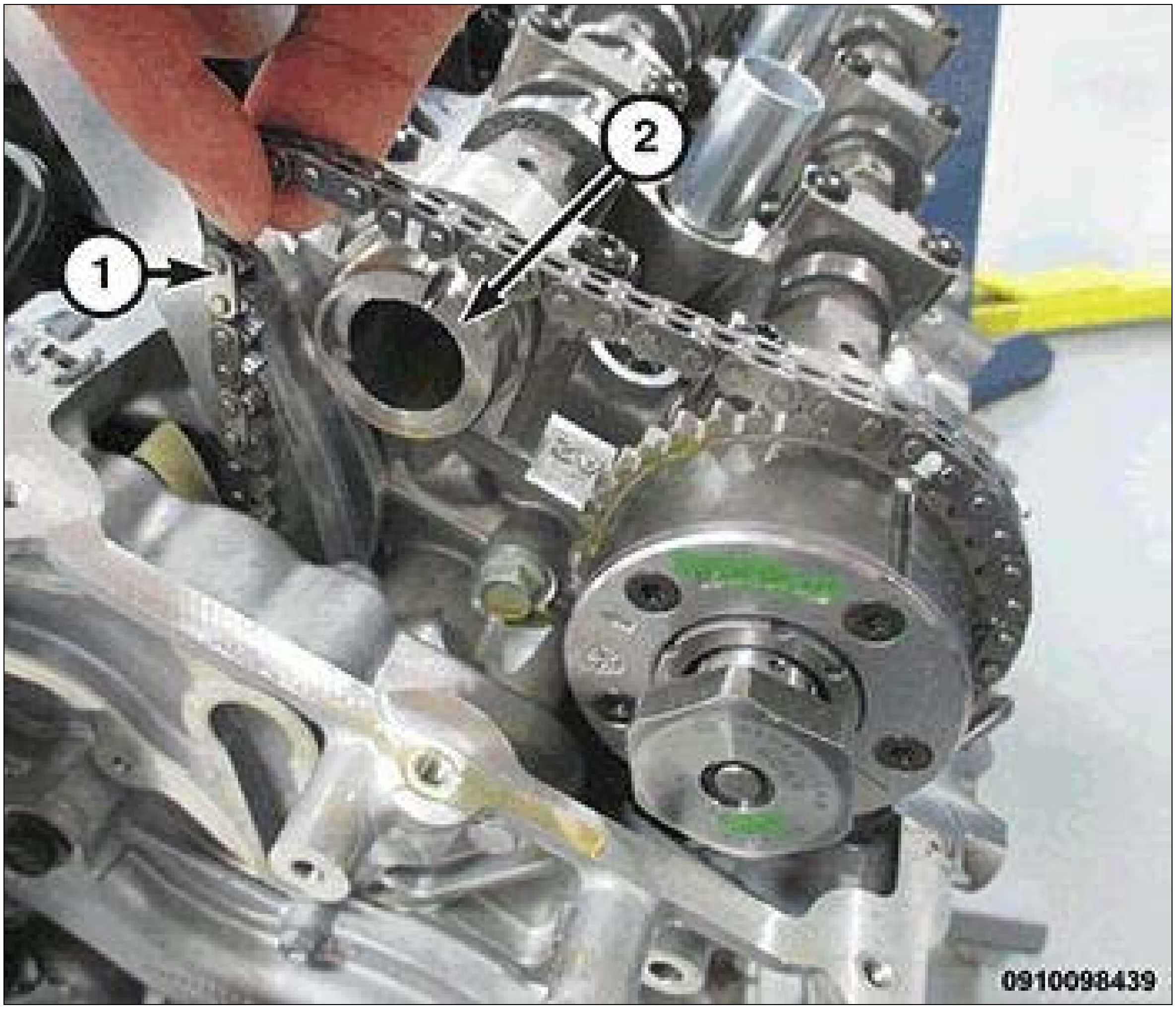
Fig 1: Camshaft Holder



Courtesy of CHRYSLER GROUP, LLC

1. The Timing Chain Tensioner Holder and Camshaft Holder (1) should still be in place as installed during the removal procedure. If required, the Timing Chain Tensioner Holder and Camshaft Holder can be installed by repeating the steps within the removal procedure. Refer to ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE, REMOVAL .

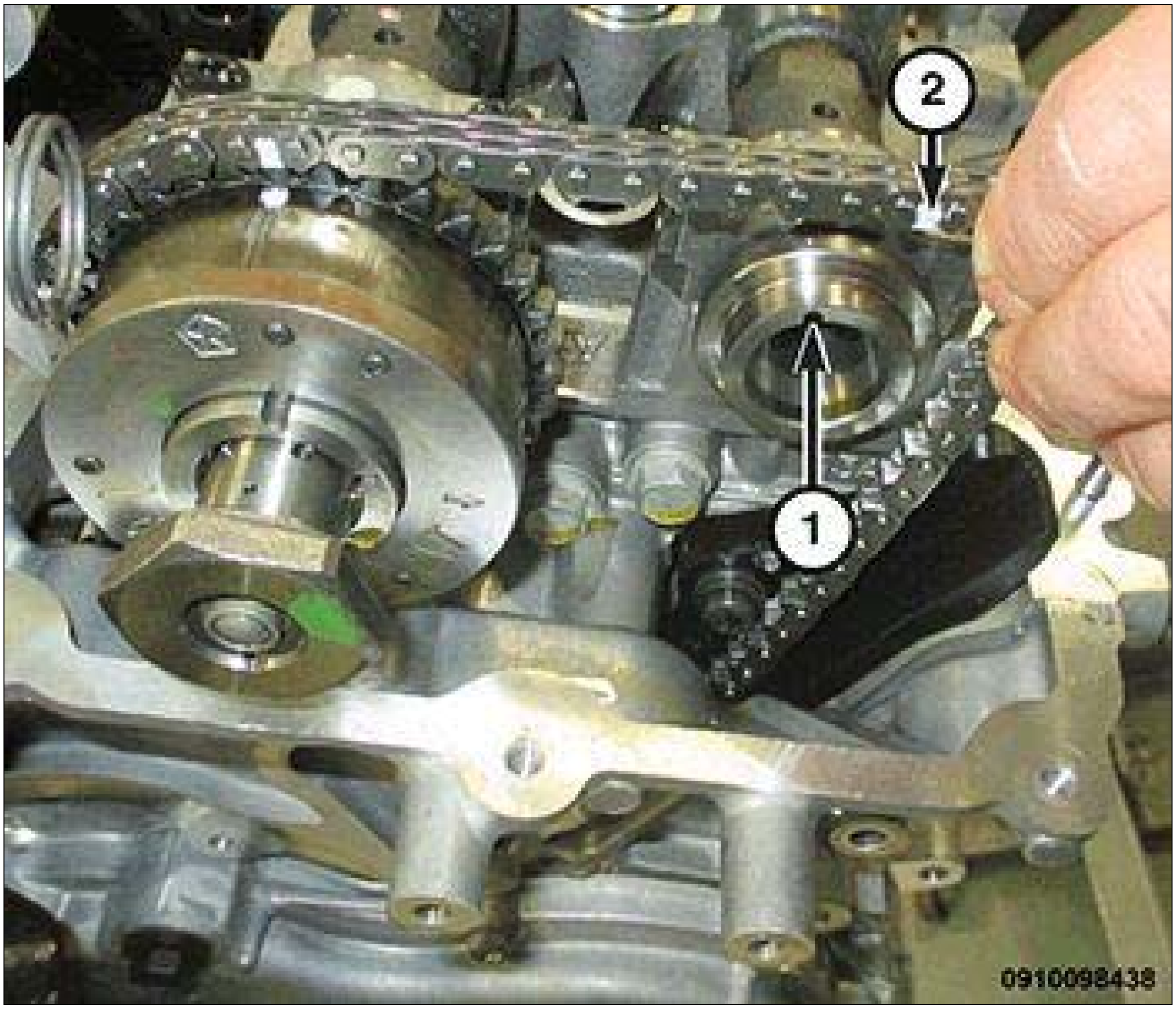
Fig 2: Intake Camshaft & Timing Chain



Courtesy of CHRYSLER GROUP, LLC

2. Route the timing chain (1) around the left intake cam phaser while aligning the paint mark with the phaser timing mark. Press the left intake cam phaser onto the intake camshaft (2). Install and hand tighten the oil control valve.

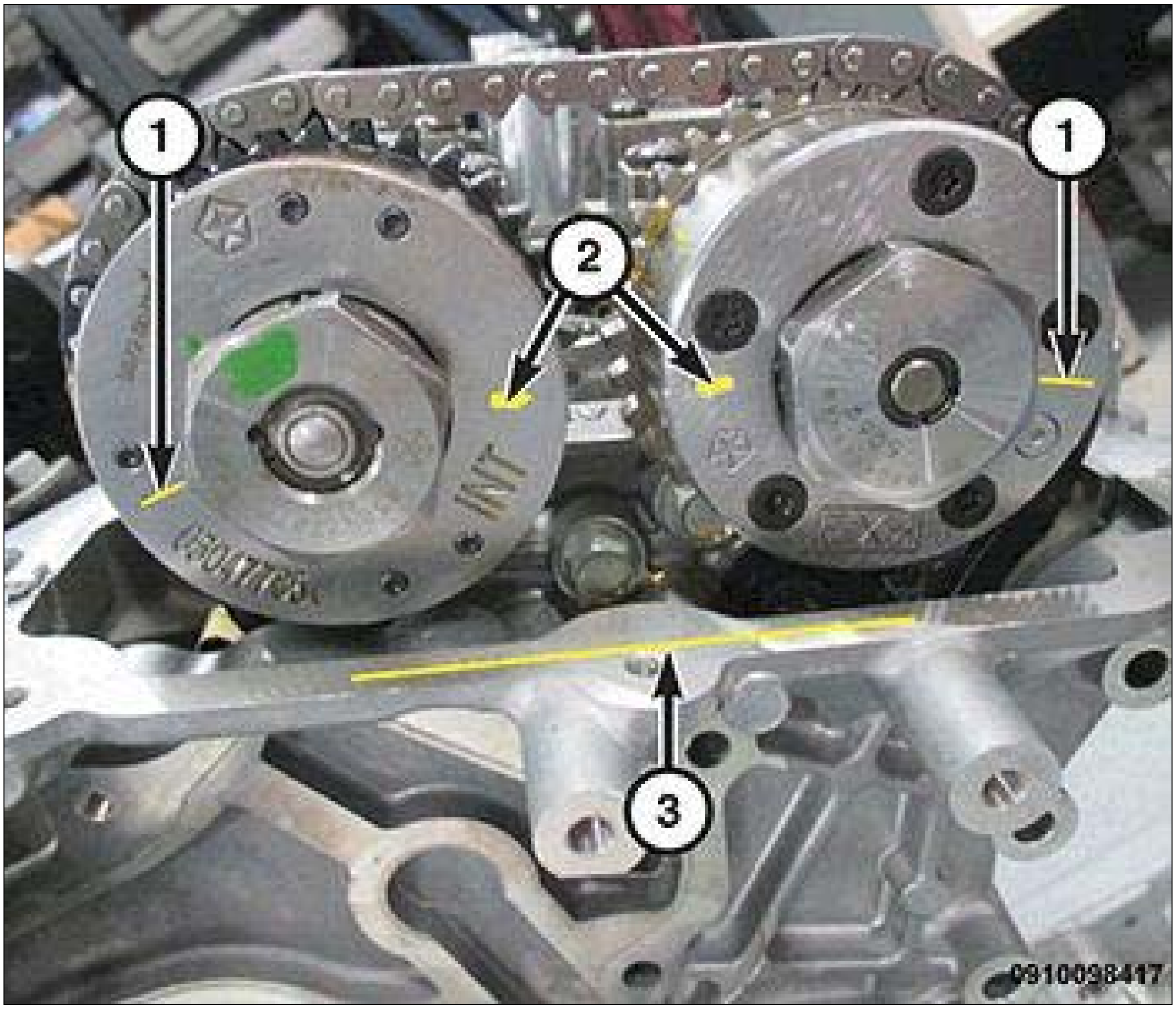
Fig 3: Exhaust Camshaft & Timing Chain



Courtesy of CHRYSLER GROUP, LLC

3. While maintaining this alignment, route the timing chain (2) around the exhaust cam phaser so that the paint mark is aligned with the phaser timing mark. Press the exhaust cam phaser onto the exhaust cam (1), install and hand tighten the oil control valve.

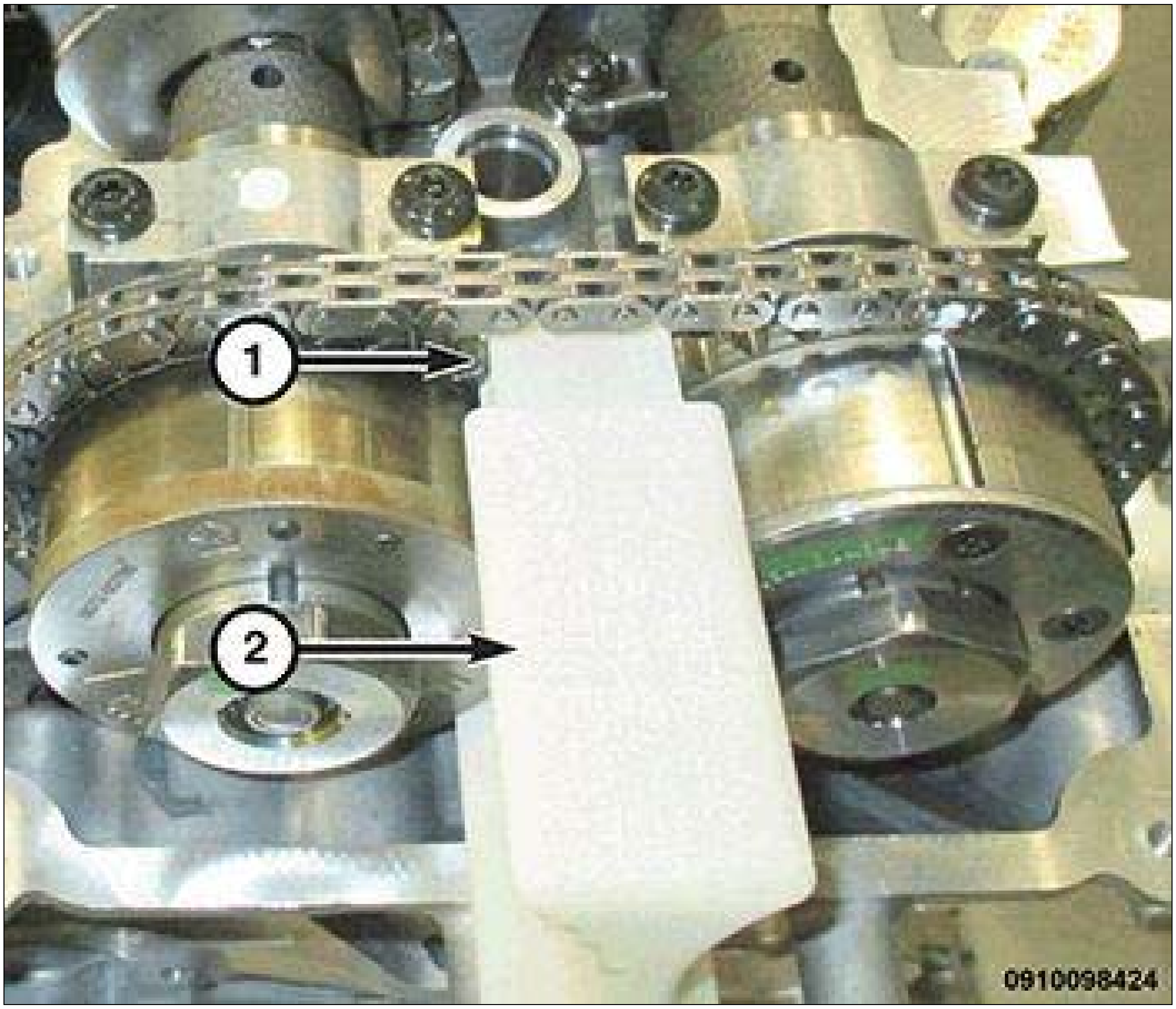
Fig 4: Left Side Cam Phaser Scribe Lines, Arrows & Cylinder Head Cover Mounting Surface



Courtesy of CHRYSLER GROUP, LLC

4. The **SCRIBE LINES** (1) on the cam phasers should face away from each other and the **ARROWS** (2) should point toward each other and be parallel to the cylinder head cover mounting surface (3). There should be twelve chain pins **BETWEEN** the exhaust cam phaser mark and the intake cam phaser mark.

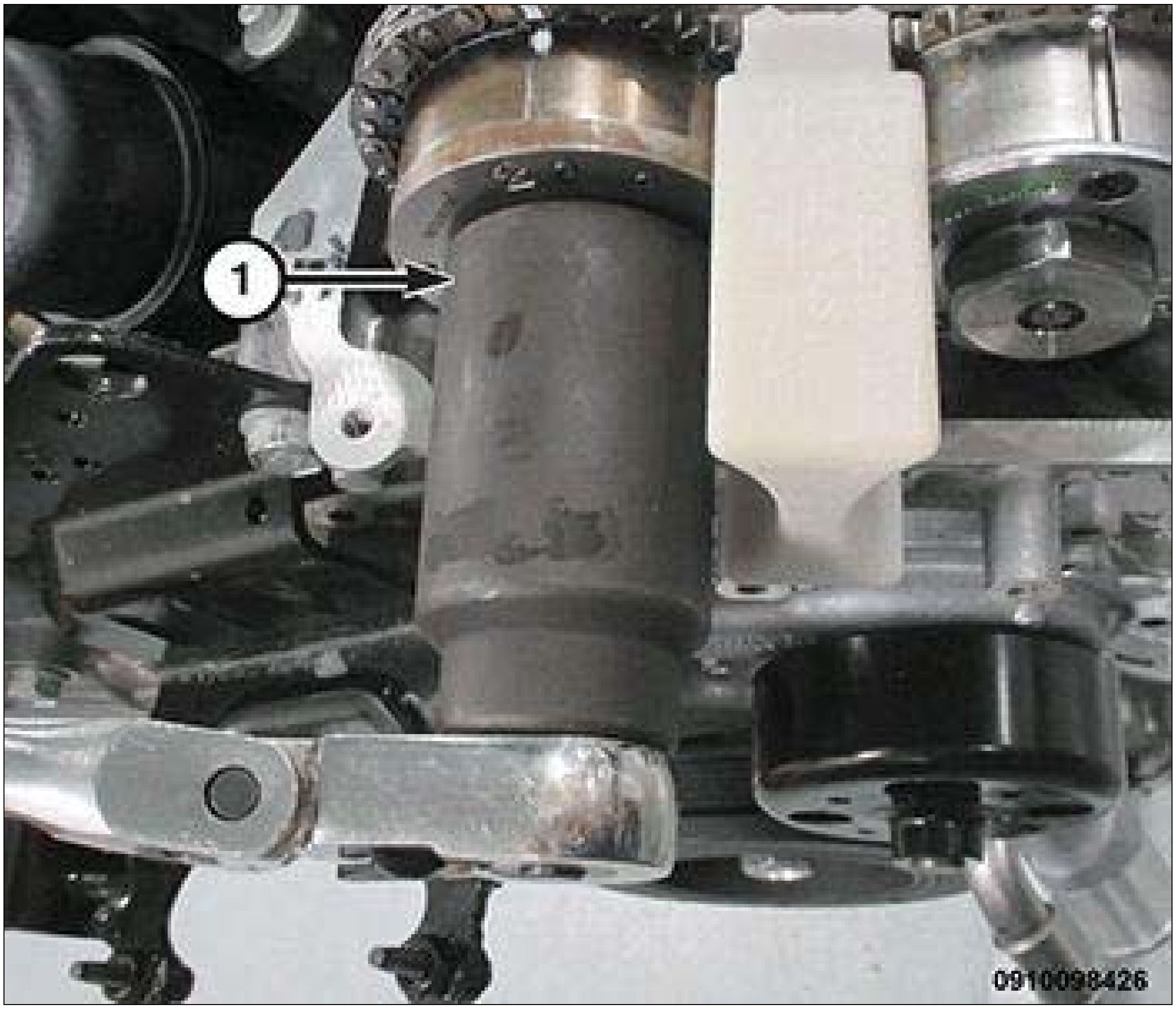
Fig 5: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

5. Install the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head) (2) against the cylinder head cover mounting surface with the tool number facing up, between the intake and exhaust phasers (1).

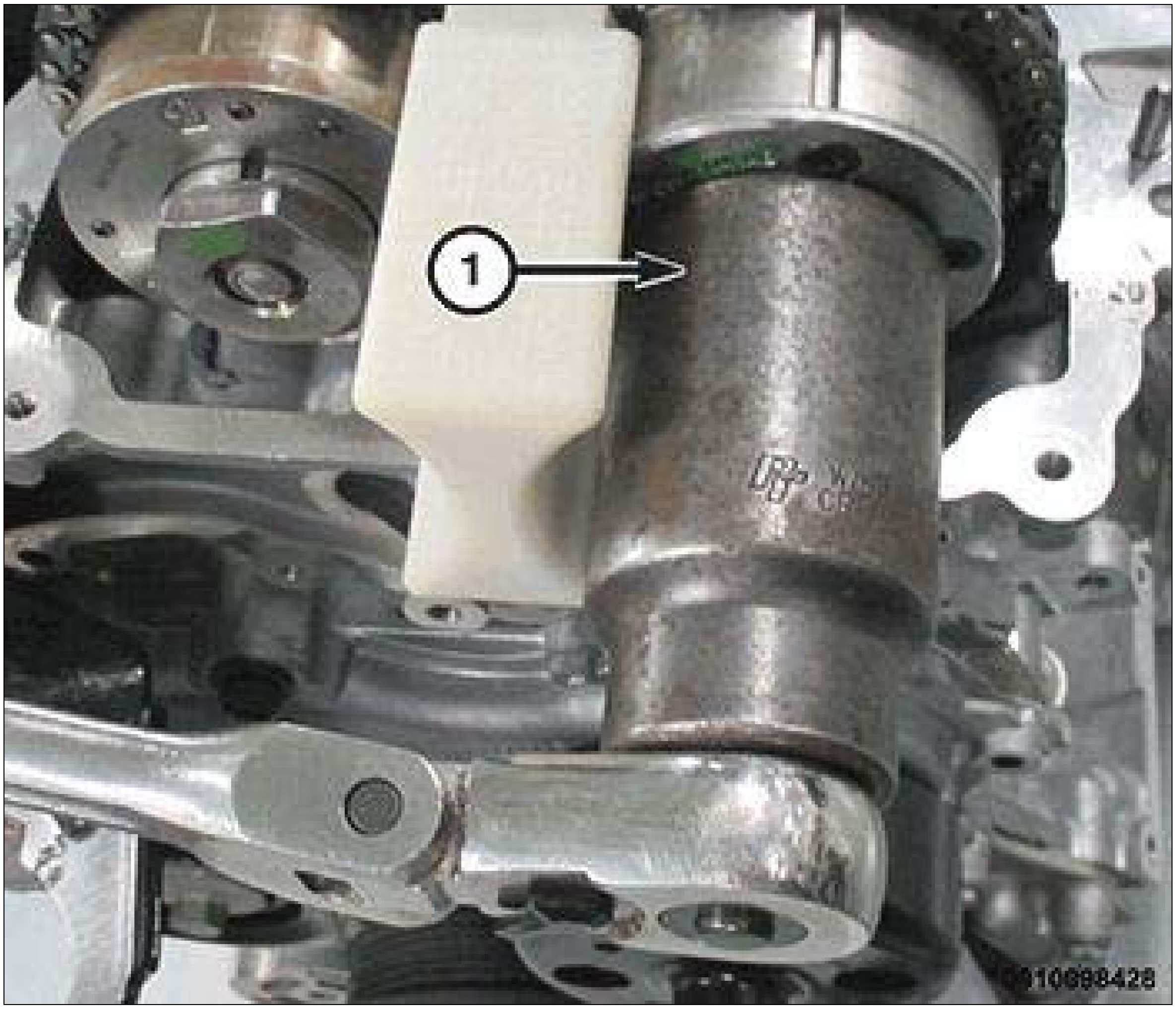
Fig 6: Installing Socket On Intake Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

6. Tighten the intake oil control valve (1) to the proper specification. Refer to TORQUE SPECIFICATIONS .

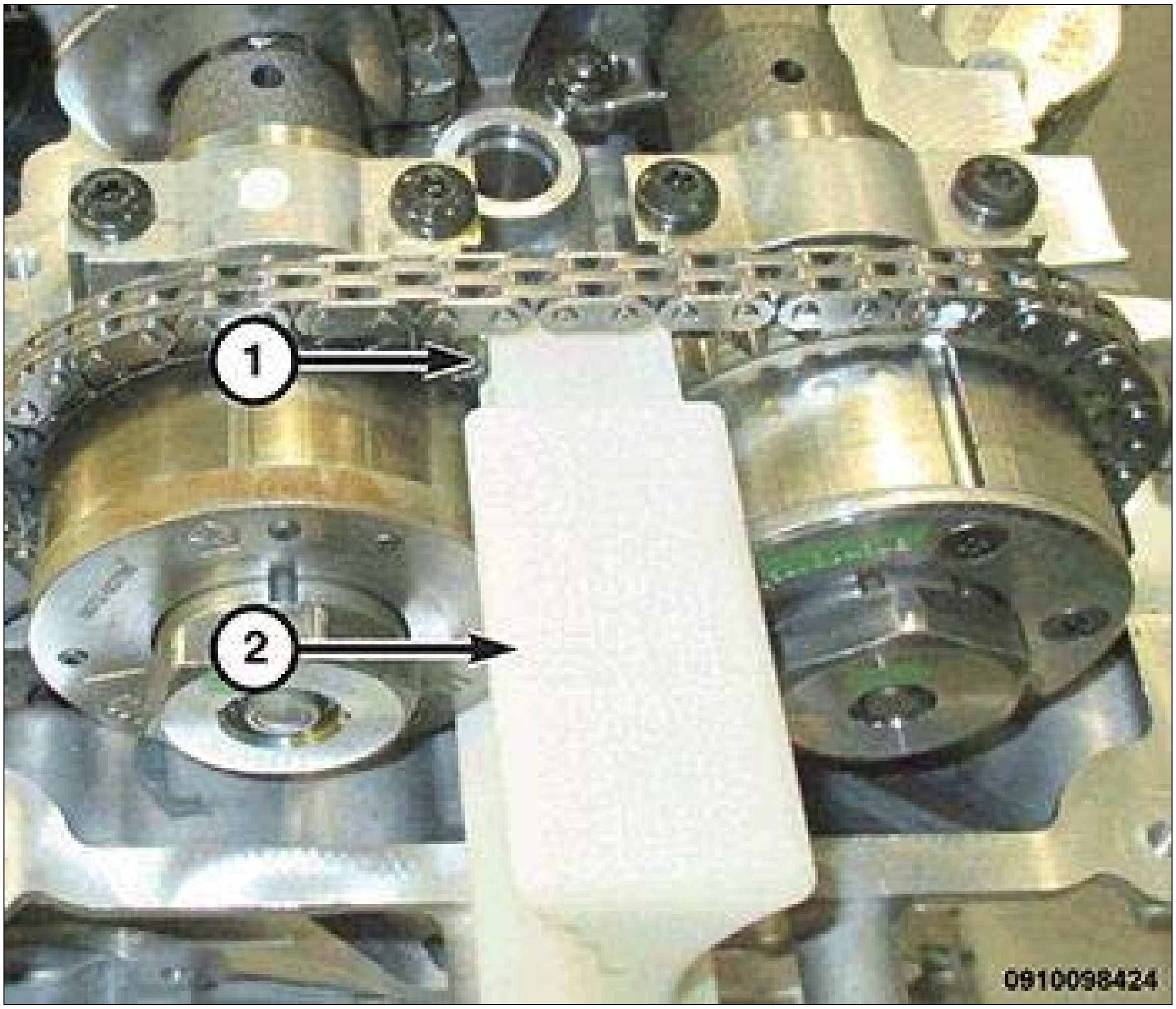
Fig 7: Installing Socket On Exhaust Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

7. Tighten the exhaust oil control valve (1) to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 8: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

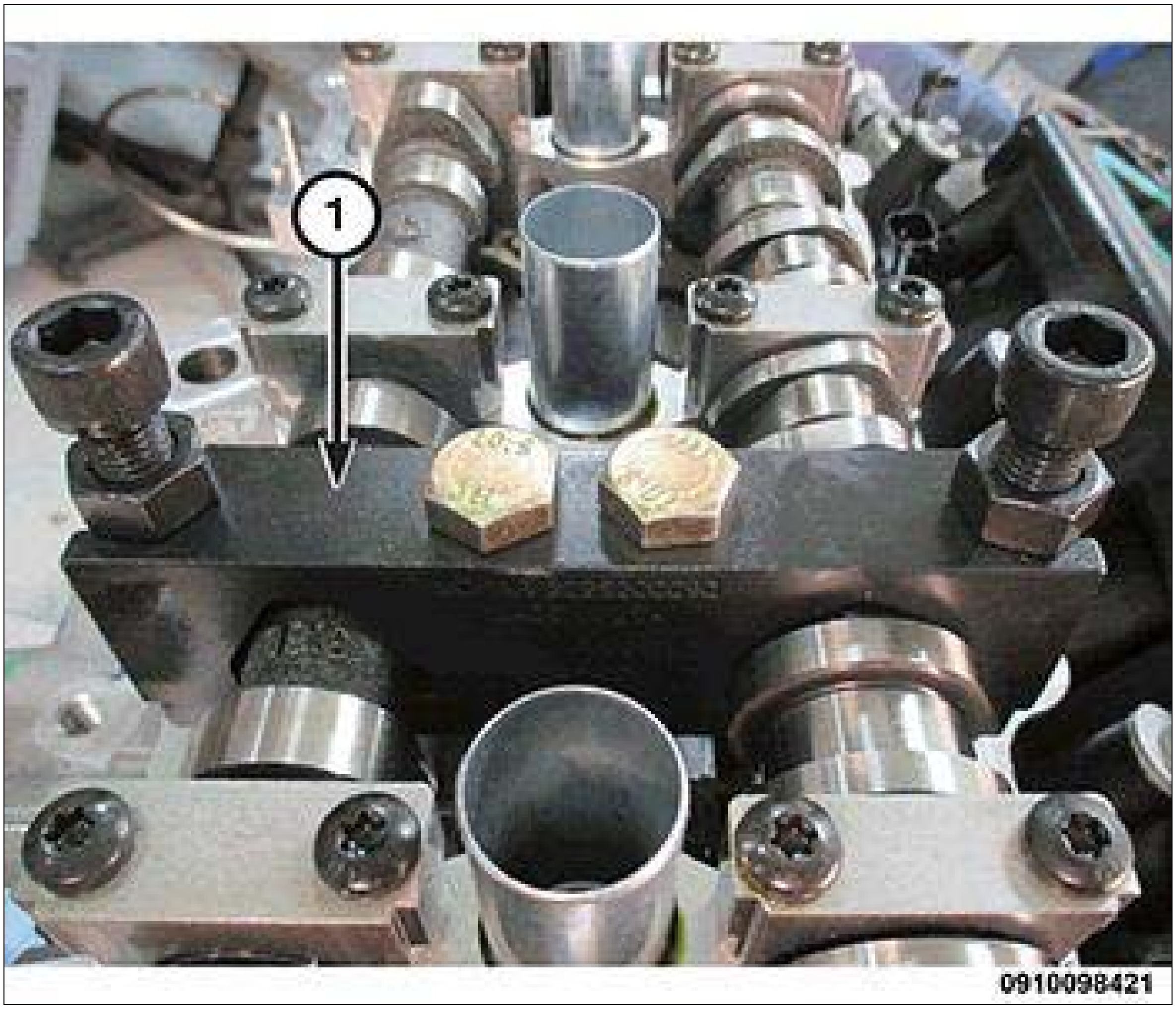
8. Remove the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head) (2).

Fig 9: Holding Pawl Off Rack & Pushing Timing Chain Tensioner Holder Into Place

Courtesy of CHRYSLER GROUP, LLC

9. Remove the (special tool #2025001090, Holder, Timing Chain Tensioner, Left-Front) (1).

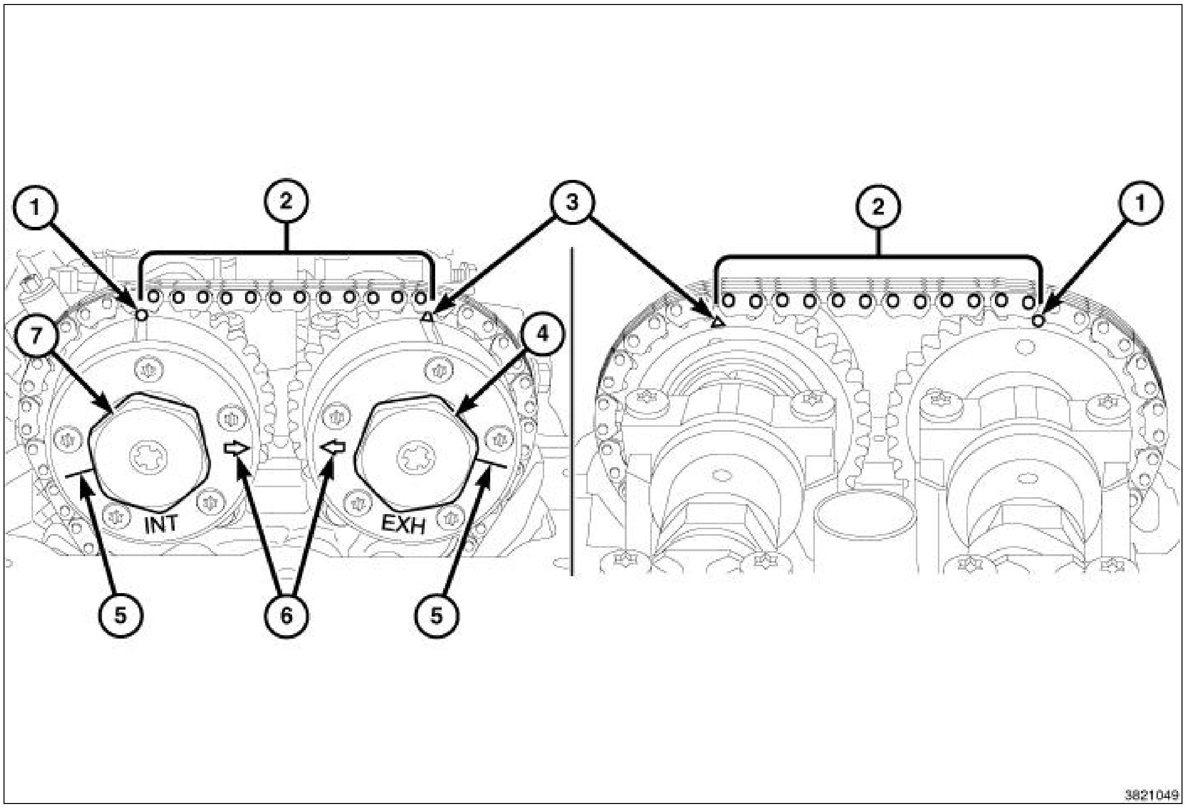
Fig 10: Camshaft Holder



Courtesy of CHRYSLER GROUP, LLC

10. Remove the (special tool #2025200090, Holder, Camshaft) (1).

Fig 11: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows



Courtesy of CHRYSLER GROUP, LLC

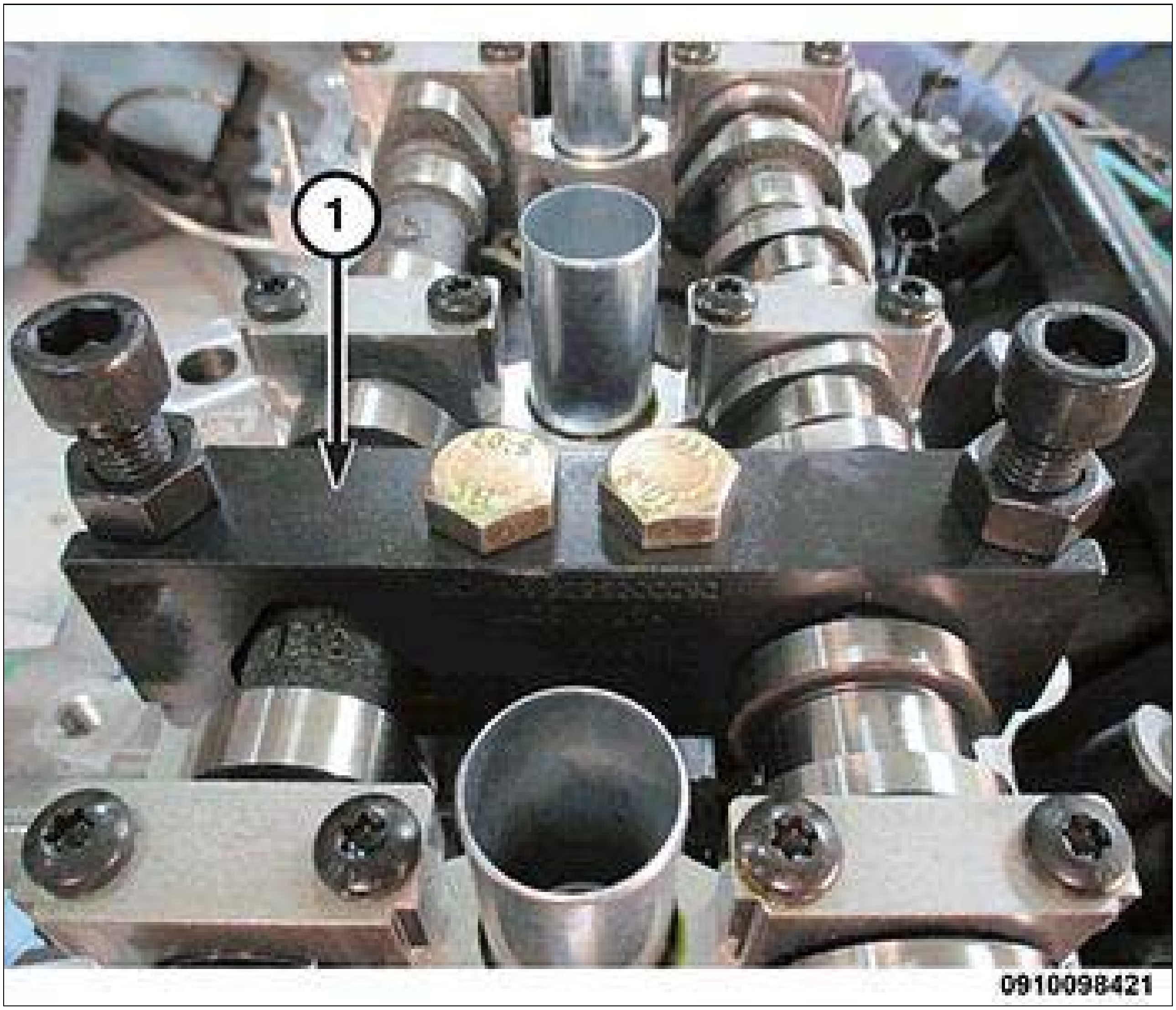
11. Rotate the crankshaft clockwise two complete revolutions stopping when the right side number one cylinder piston is again positioned at top-dead-center on the exhaust stroke. To assure correct engine timing, verify the following;
    1. The indicator dial is set to **ZERO** when the right side number one cylinder piston is positioned at top-dead-center on the exhaust stroke.
    2. The **SCRIBE LINES** (5) on the left side cam phasers face away from each other.
    3. The **ARROWS** (6) on the left side cam phasers point toward each other and are parallel to the cylinder head cover mounting surface.
    4. There are twelve chain pins (2) **BETWEEN** the exhaust cam phaser mark (3) and the intake cam phaser mark (1).
12. If the engine timing is not correct, repeat this procedure.
13. Install the left cylinder head cover. Refer to COVER(S), CYLINDER HEAD, INSTALLATION .
14. Install the right side spark plugs. Refer to SPARK PLUG, INSTALLATION .
15. Connect the negative battery cable.
16. Start the engine and perform the following Powertrain Verification Tests: Refer to appropriate Engine Electrical Diagnostics article.
    1. Cam/Crank Variation Relearn

2. 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 Engine Electrical Diagnostics article.*

CYLINDER HEAD > ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE > INSTALLATION > RIGHT

Fig 1: Camshaft Holder

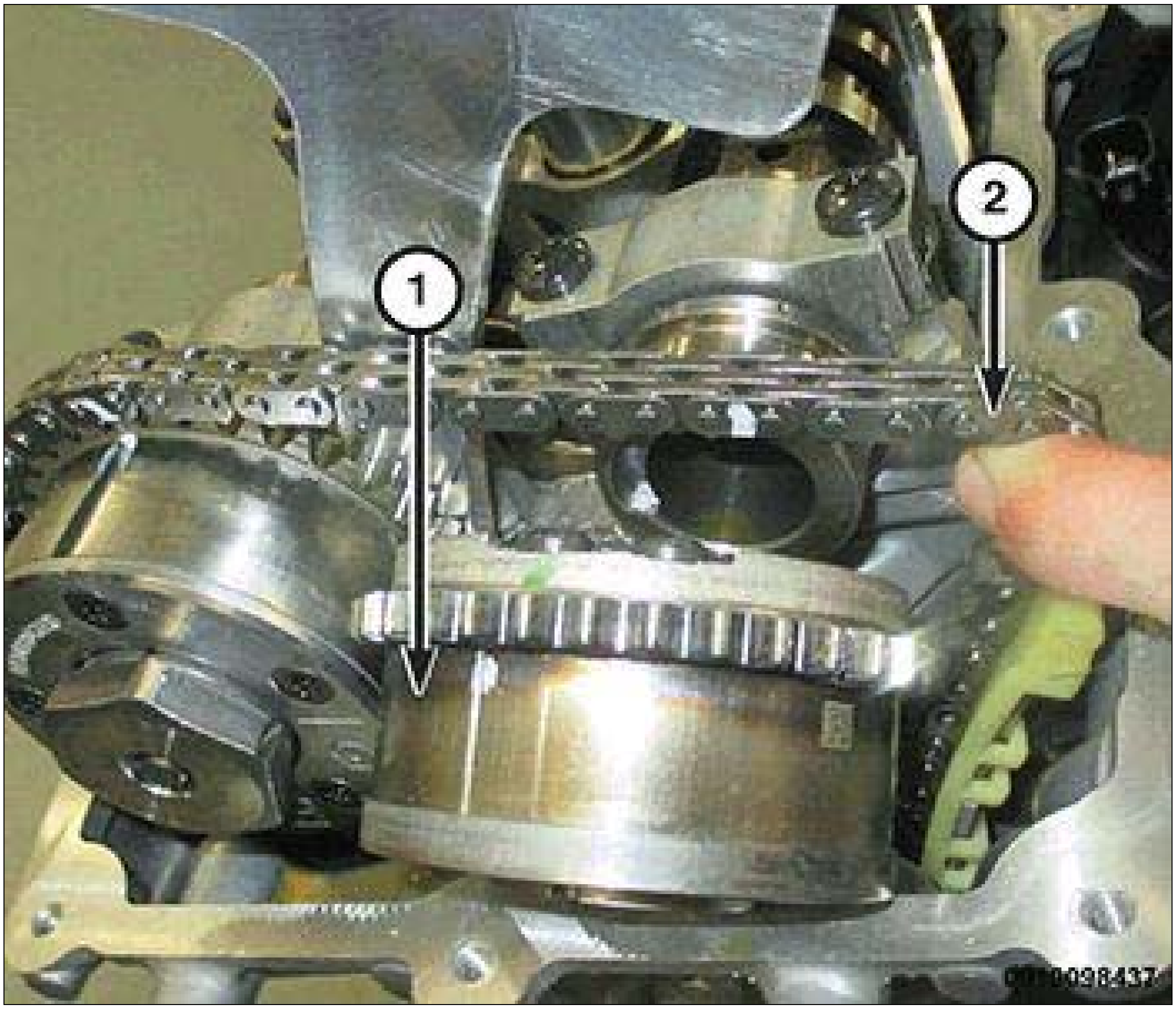


Courtesy of CHRYSLER GROUP, LLC

1. The Timing Chain Tensioner Holder and Camshaft Holder (1) should still be in place as installed during the removal procedure. If required, the Timing Chain Tensioner Holder and Camshaft

Holder can be installed by repeating the steps within the removal procedure. Refer to ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE, REMOVAL .

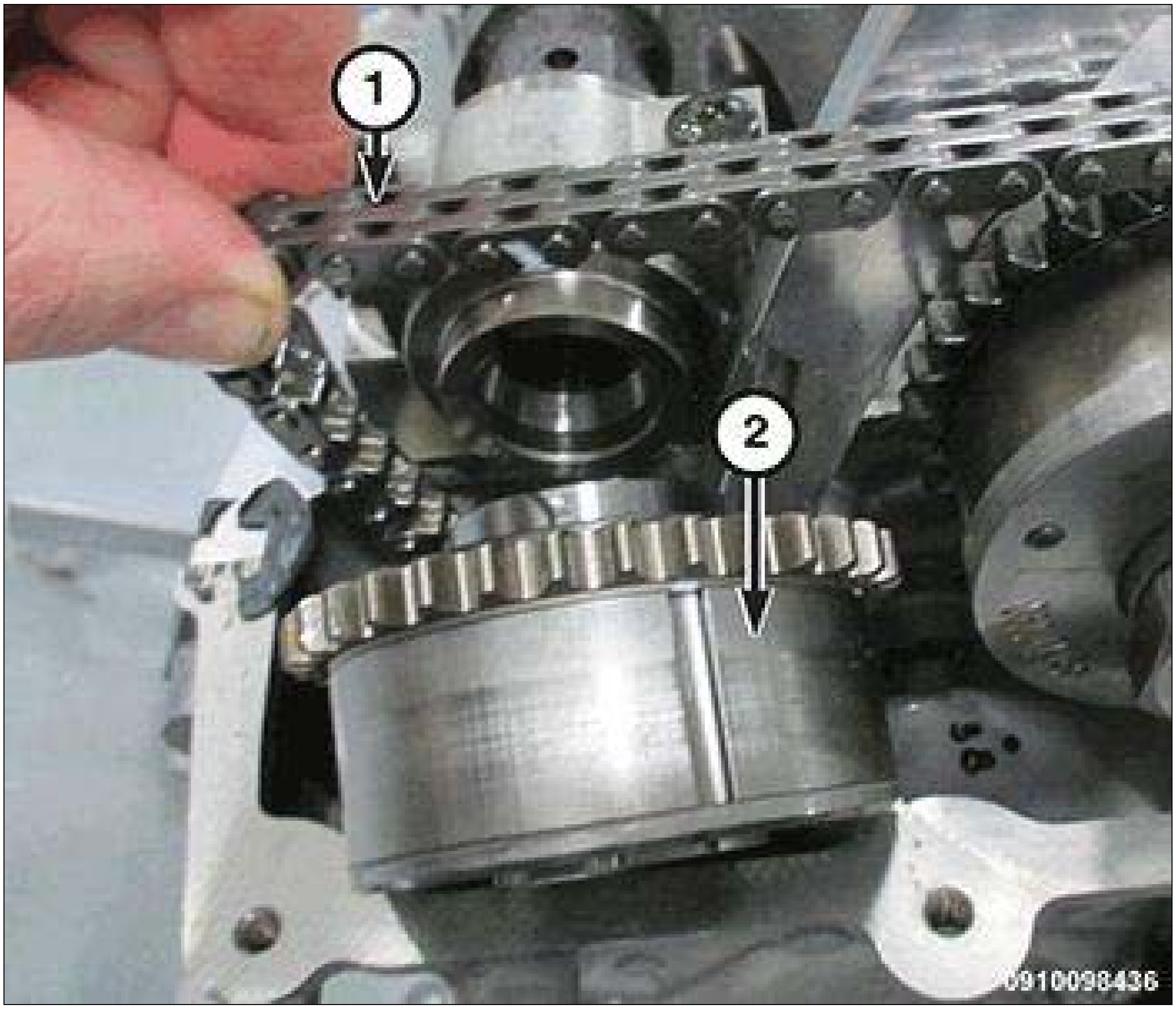
Fig 2: Right Side Intake Cam Phaser & Timing Chain



Courtesy of CHRYSLER GROUP, LLC

2. Route the timing chain (2) around the right intake cam phaser (1) while aligning the paint mark with the phaser timing mark. Press the right intake cam phaser onto the intake camshaft. Install and hand tighten the oil control valve.

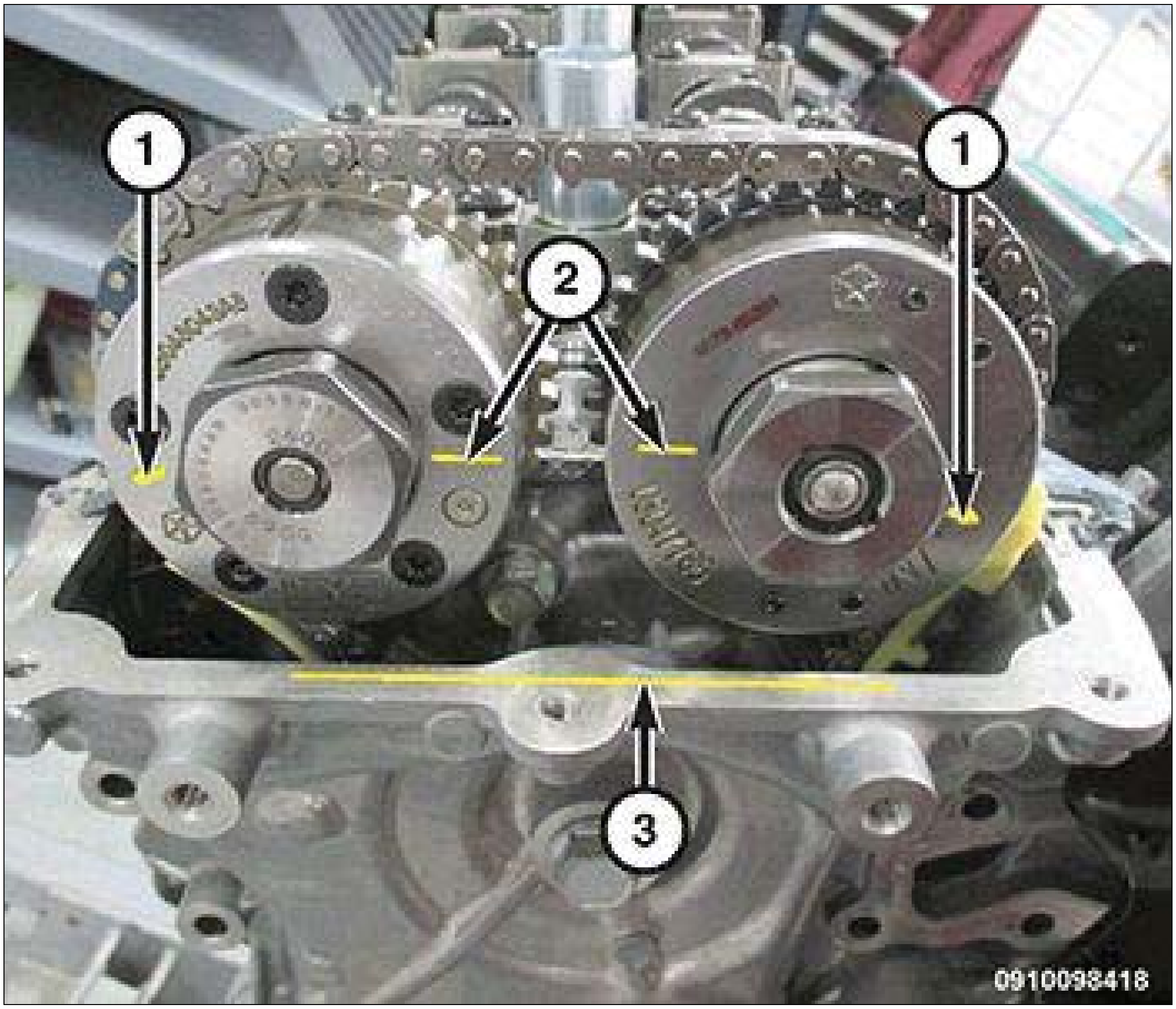
Fig 3: Right Side Exhaust Cam Phaser & Timing Chain



Courtesy of CHRYSLER GROUP, LLC

3. While maintaining this alignment, route the timing chain (1) around the right exhaust cam phaser (2) while aligning the paint mark with the phaser timing mark. Press the right exhaust cam phaser onto the exhaust camshaft. Install and hand tighten the oil control valve.

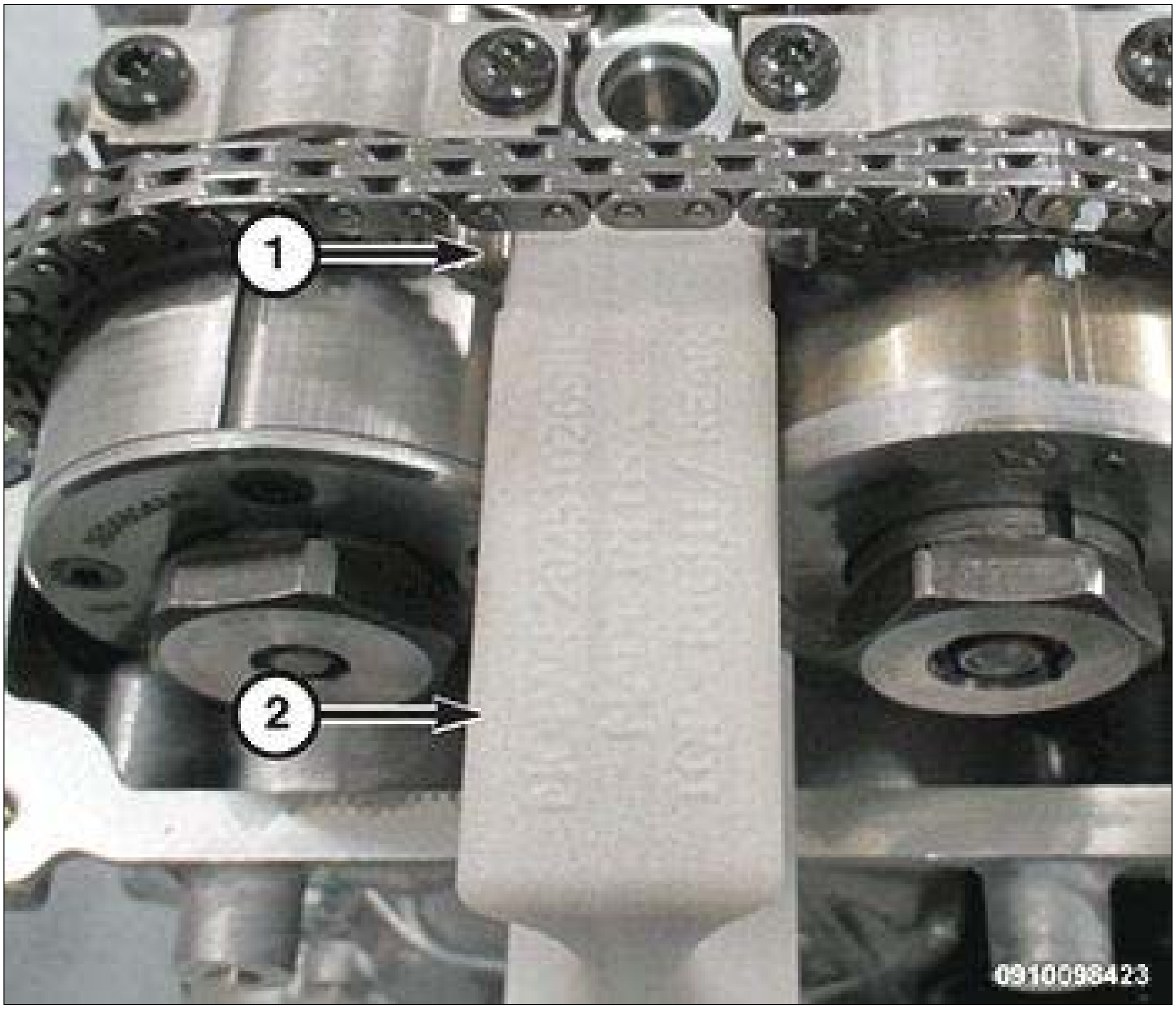
Fig 4: Right Side Cam Phaser Scribe Lines, Arrows & Cylinder Head Cover Mounting Surface



Courtesy of CHRYSLER GROUP, LLC

4. The **ARROWS** (1) on the cam phasers should point away from each other and the **SCRIBE LINES** (2) should be parallel to the cylinder head cover mounting surface (3). There should be twelve chain pins **BETWEEN** the exhaust cam phaser mark and the intake cam phaser mark.

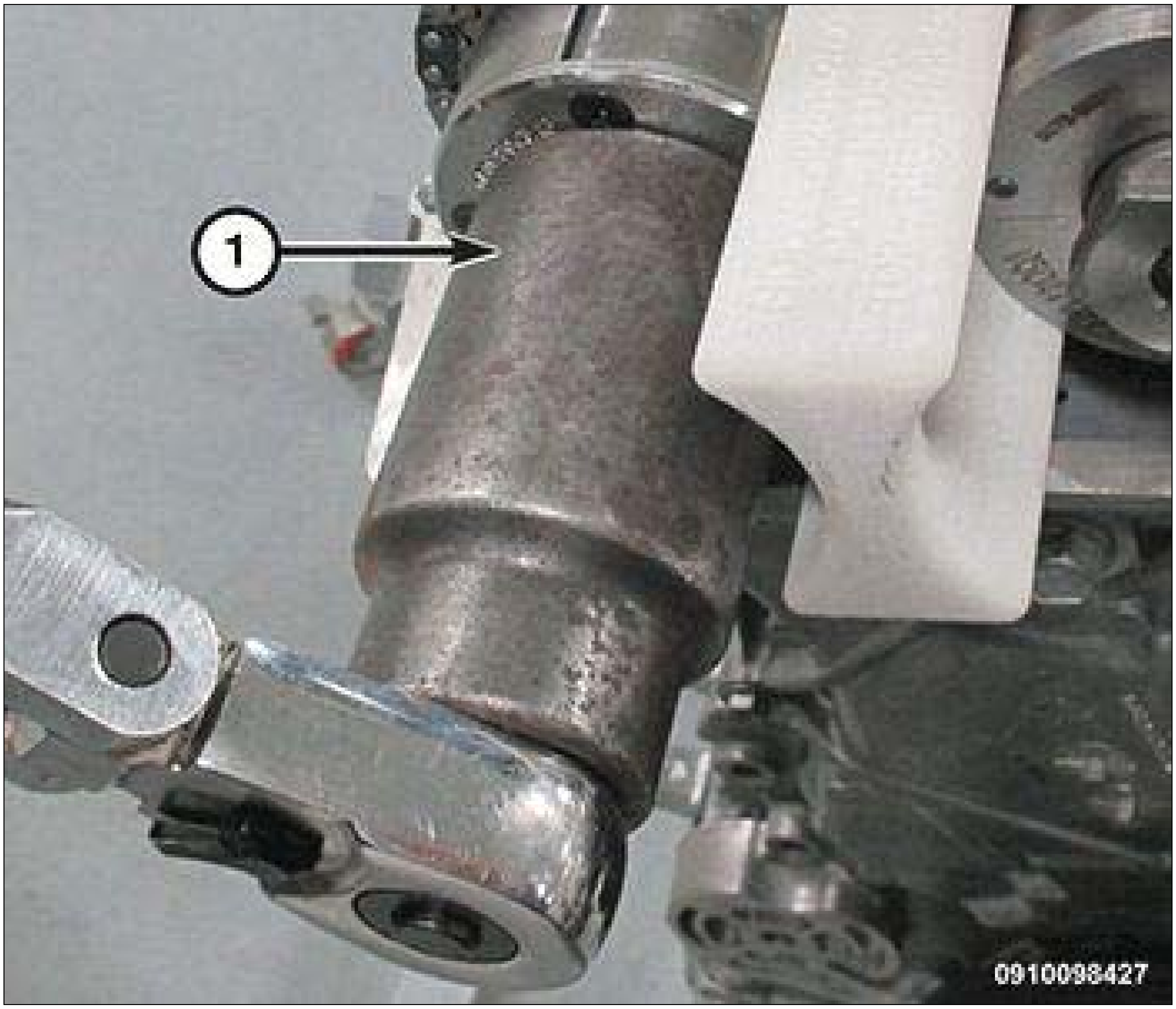
Fig 5: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

5. Install the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (1) against the cylinder head cover mounting surface with the tool number facing up, between the intake and exhaust phasers (1).

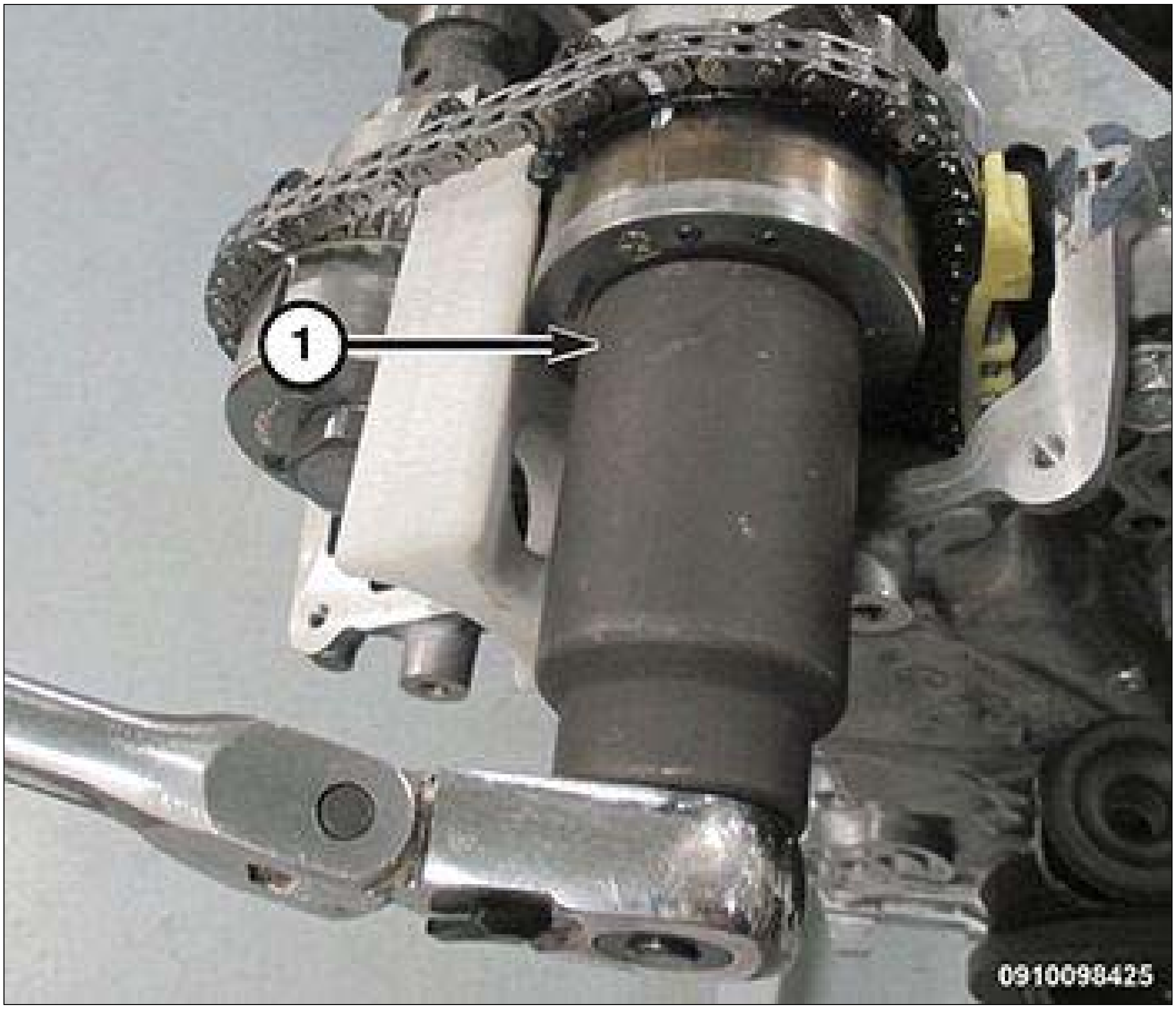
Fig 6: Installing Socket On Exhaust Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

6. Tighten the exhaust oil control valve (1) to the proper specification. Refer to TORQUE SPECIFICATIONS .

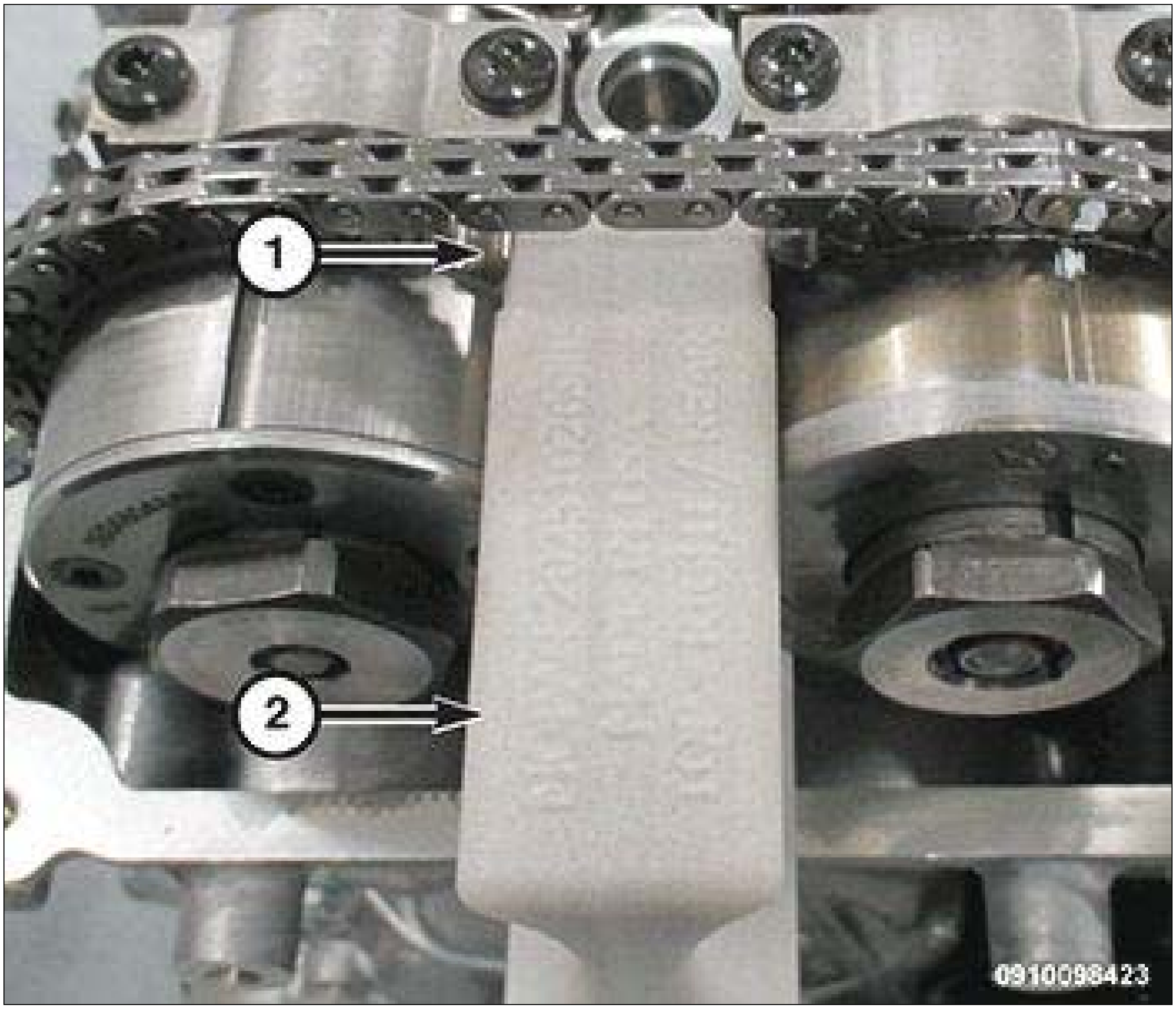
Fig 7: Installing Socket On Intake Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

7. Tighten the intake oil control valve (1) to the proper specification. Refer to TORQUE SPECIFICATIONS .

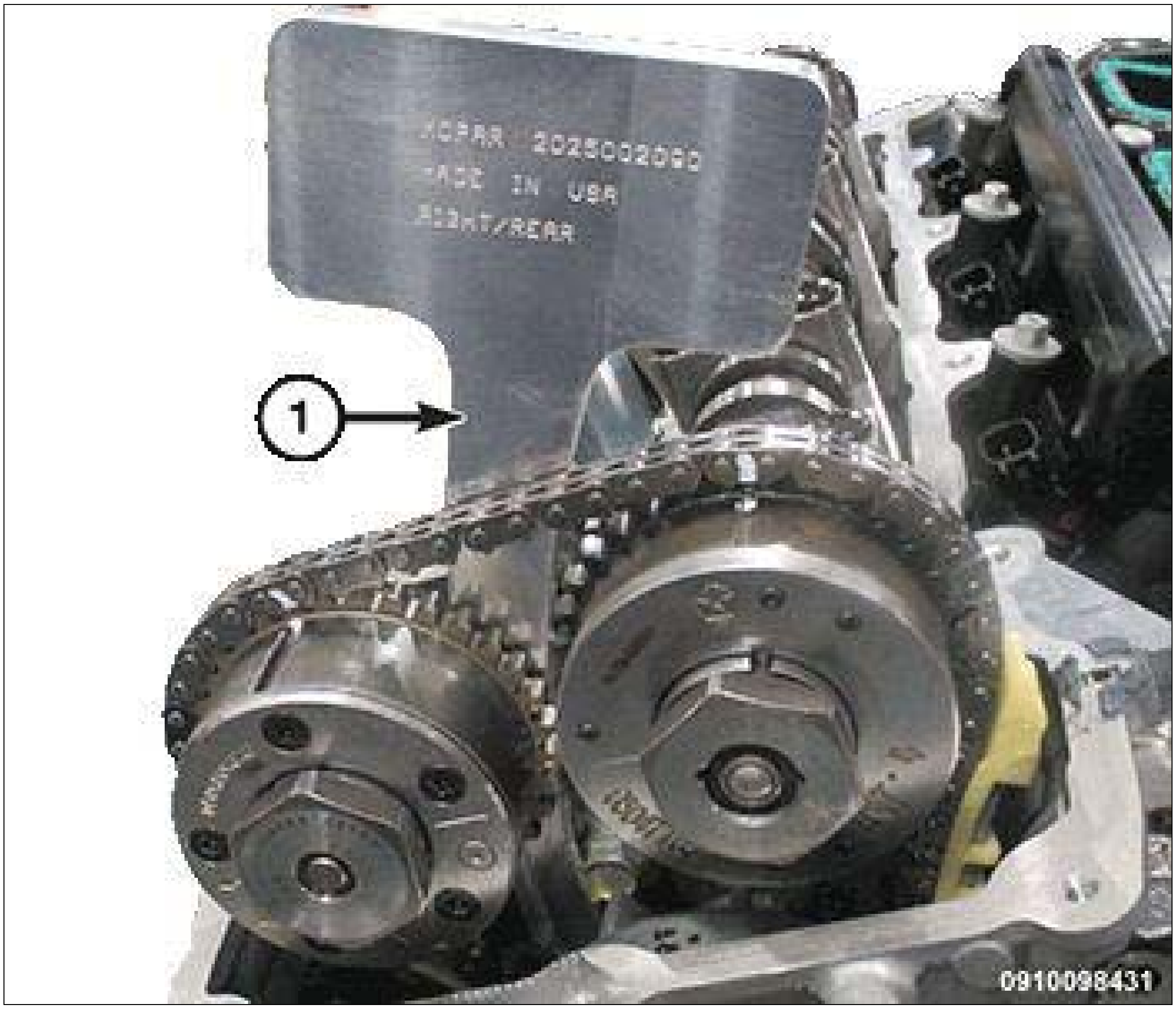
Fig 8: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

8. Remove the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (1).

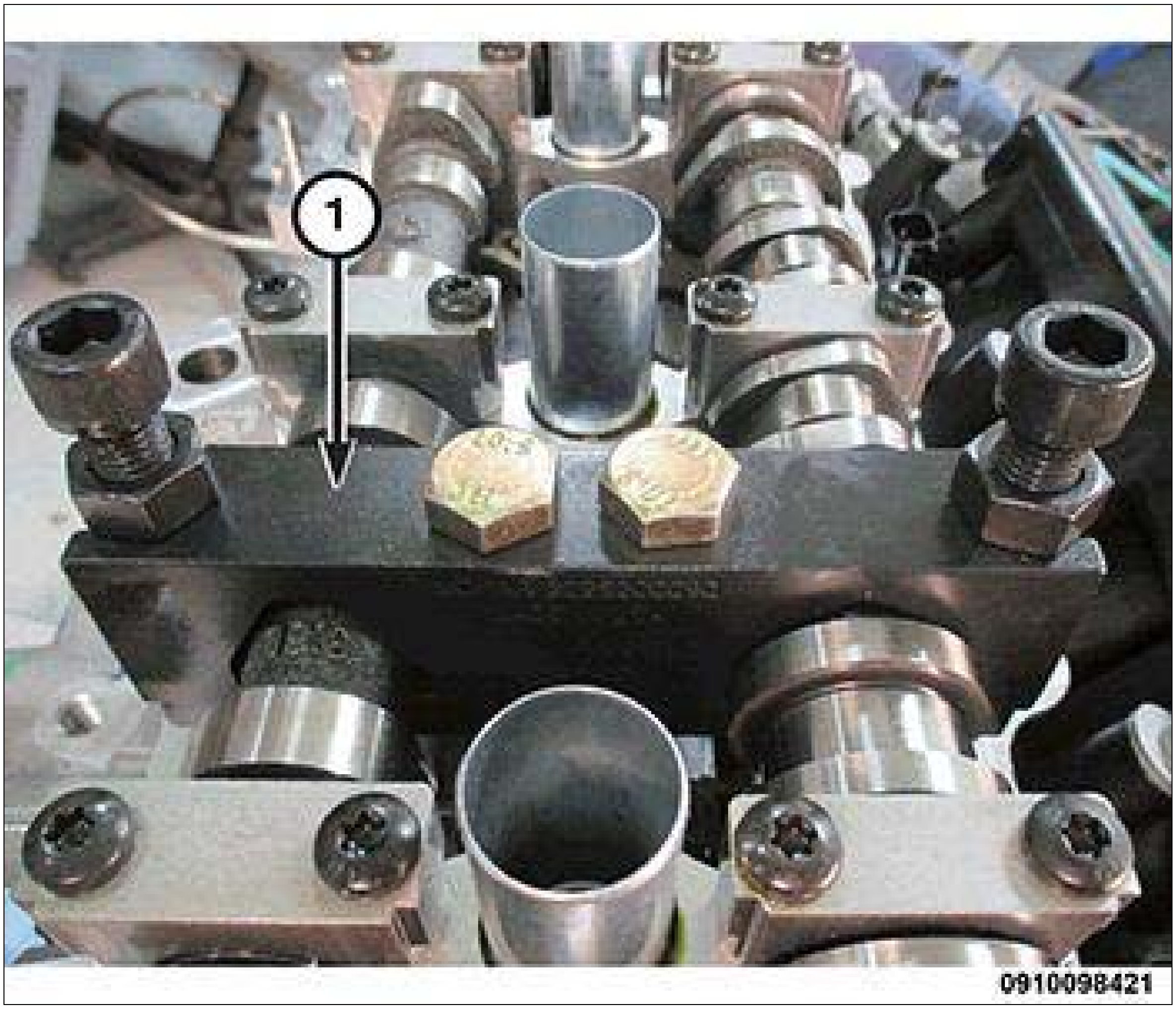
Fig 9: Inserting Timing Chain Tensioner Holder



Courtesy of CHRYSLER GROUP, LLC

9. Remove the (special tool #2025002090, Holder, Timing Chain Tensioner, Right-Rear) (1).

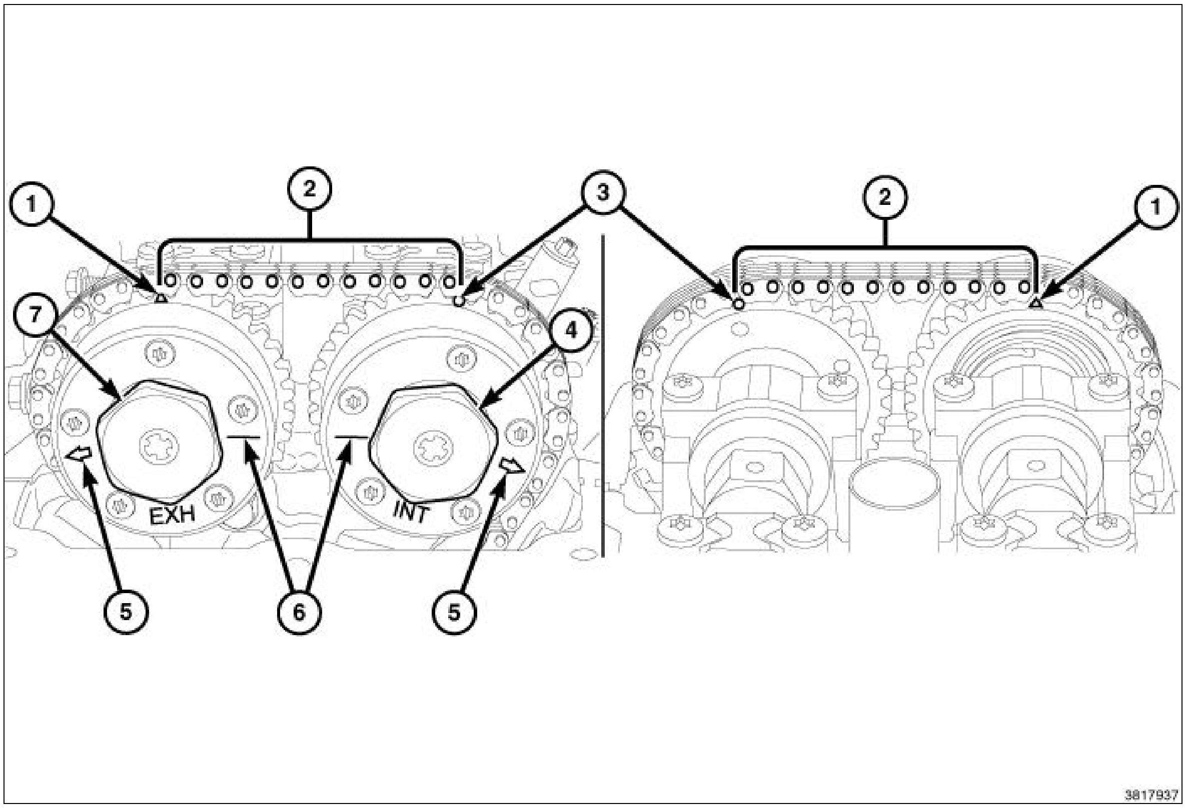
Fig 10: Camshaft Holder



Courtesy of CHRYSLER GROUP, LLC

10. Remove the (special tool #2025200090, Holder, Camshaft) (1).

Fig 11: Phaser Timing Mark, Chain Pins, Exhaust Cam Phaser Triangle Marking, Oil Control Valve, Scribe Lines & Arrows



Courtesy of CHRYSLER GROUP, LLC

11. 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;
    1. 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.
    2. The **ARROWS** (5) on the right side cam phasers point away from each other.
    3. The **SCRIBE LINES** (6) on the right side cam phasers are parallel to the cylinder head cover mounting surface.
    4. There are twelve chain pins (2) **BETWEEN** the exhaust cam phaser mark (1) and the intake cam phaser circle mark (3).
12. If the engine timing is not correct, repeat this procedure.
13. Install the spark plugs. Refer to SPARK PLUG, INSTALLATION .
14. Install the left ignition coils. Refer to COIL, IGNITION, INSTALLATION .
15. Install the right cylinder head cover and right ignition coils. Refer to COVER(S), CYLINDER HEAD, INSTALLATION .
16. Connect the negative battery cable.
17. Start the engine and perform the following Powertrain Verification Tests: Refer to appropriate

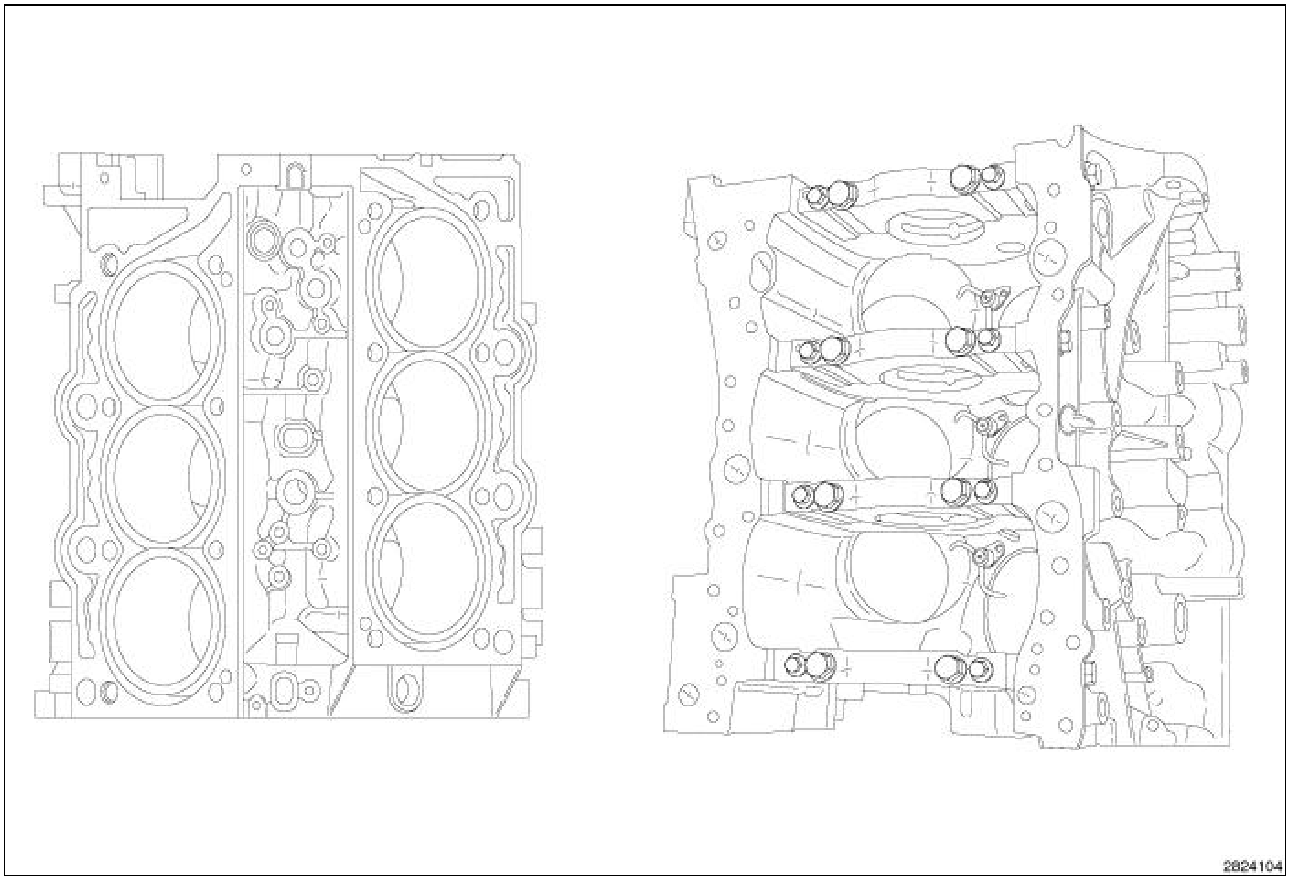
Engine Electrical Diagnostics article.

1. Cam/Crank Variation Relearn
2. 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 Engine Electrical Diagnostics article.*

ENGINE BLOCK > DESCRIPTION > DESCRIPTION

Fig 1: 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 iron 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 groves facing outward.
- The main bearing caps are a six bolt design and cross-bolted for improved lower end strength.
- There are three oil drain back drillings located on each of the cylinder banks.

ENGINE BLOCK > STANDARD PROCEDURE > CYLINDER BORE DEGLAZING

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

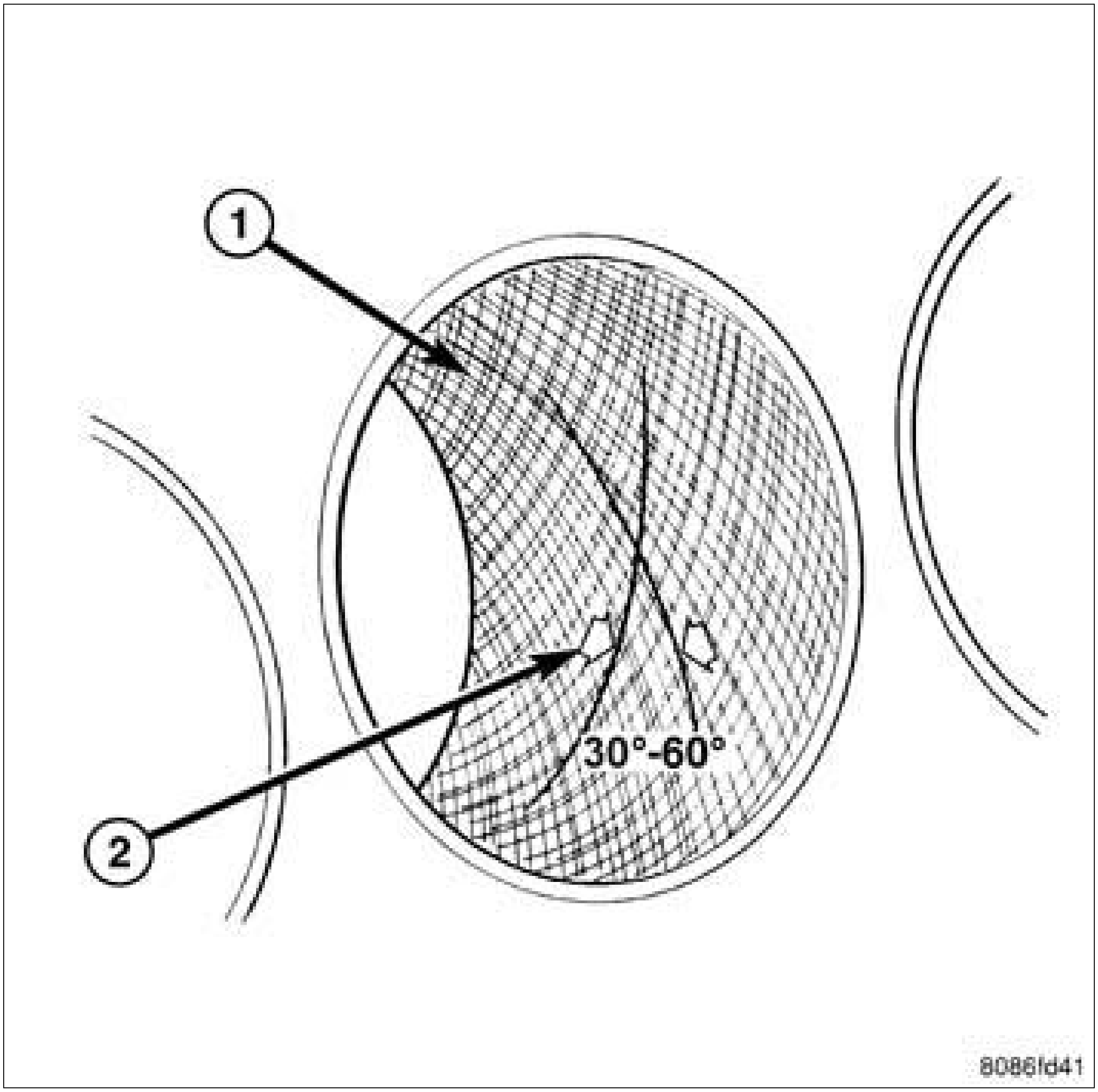
> ⚠ *CAUTION:*
>
> *DO NOT use rigid type hones to remove cylinder wall glaze.*

1. Select an appropriate size flexible ball hone.

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

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

Fig 1: Identifying Cylinder Bore Crosshatch Pattern



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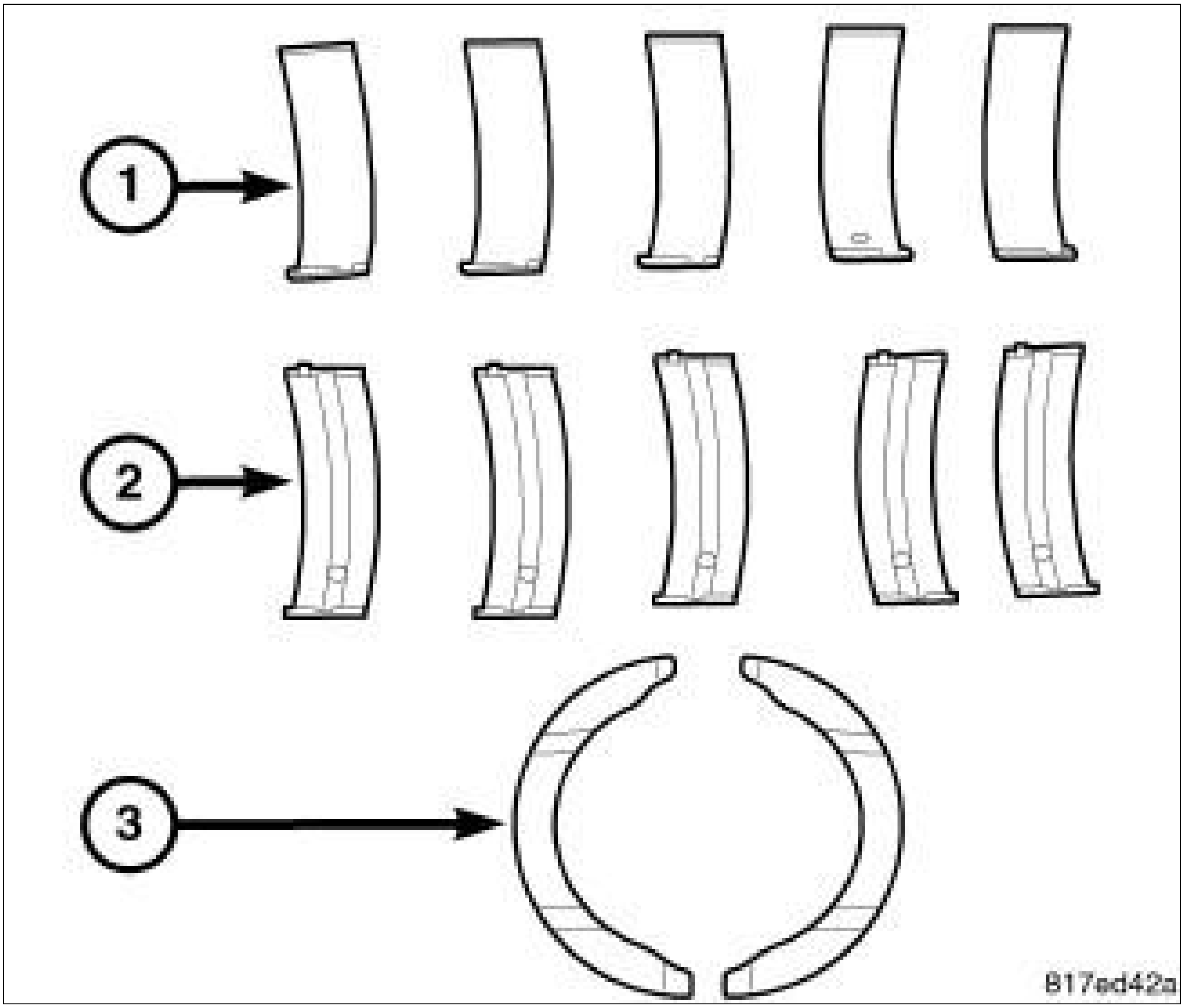
3. Deglazing should be done by moving the hone up and down fast enough to get a crosshatch pattern. The hone marks should intersect at 30° to 60° inclusive angle for proper seating of rings.
4. A controlled hone motor speed between 200 and 300 RPM is necessary to obtain the proper crosshatch angle (1). The number of up and down strokes per minute can be regulated to get the desired 30° to 60° inclusive angle (2). Faster up and down strokes increase the crosshatch angle.
5. After deglazing, it is necessary that the block be cleaned to remove all traces of abrasive. Use a brush to wash parts with a solution of hot water and detergent. Dry parts thoroughly. Use a clean, white, lint-free cloth to check that the bore is clean. Oil the bores after cleaning to prevent rusting. Upon completion, perform a visual inspection of the cylinder block passages to inspect for abrasive debris. If any debris is found, repeat the cleaning process.

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

ENGINE BLOCK > INSPECTION > INSPECTION

Fig 1: Bearing Identification



Courtesy of CHRYSLER GROUP, LLC

1. Wipe the bearing inserts (1, 2) clean.

    1. Inspect the inserts for abnormal wear patterns, scoring, grooving, fatigue, pitting and for metal or other foreign material imbedded in the lining.

2. Inspect the back of the inserts for fractures, scrapes, or irregular wear patterns.

3. Inspect the insert locking tabs for damage.

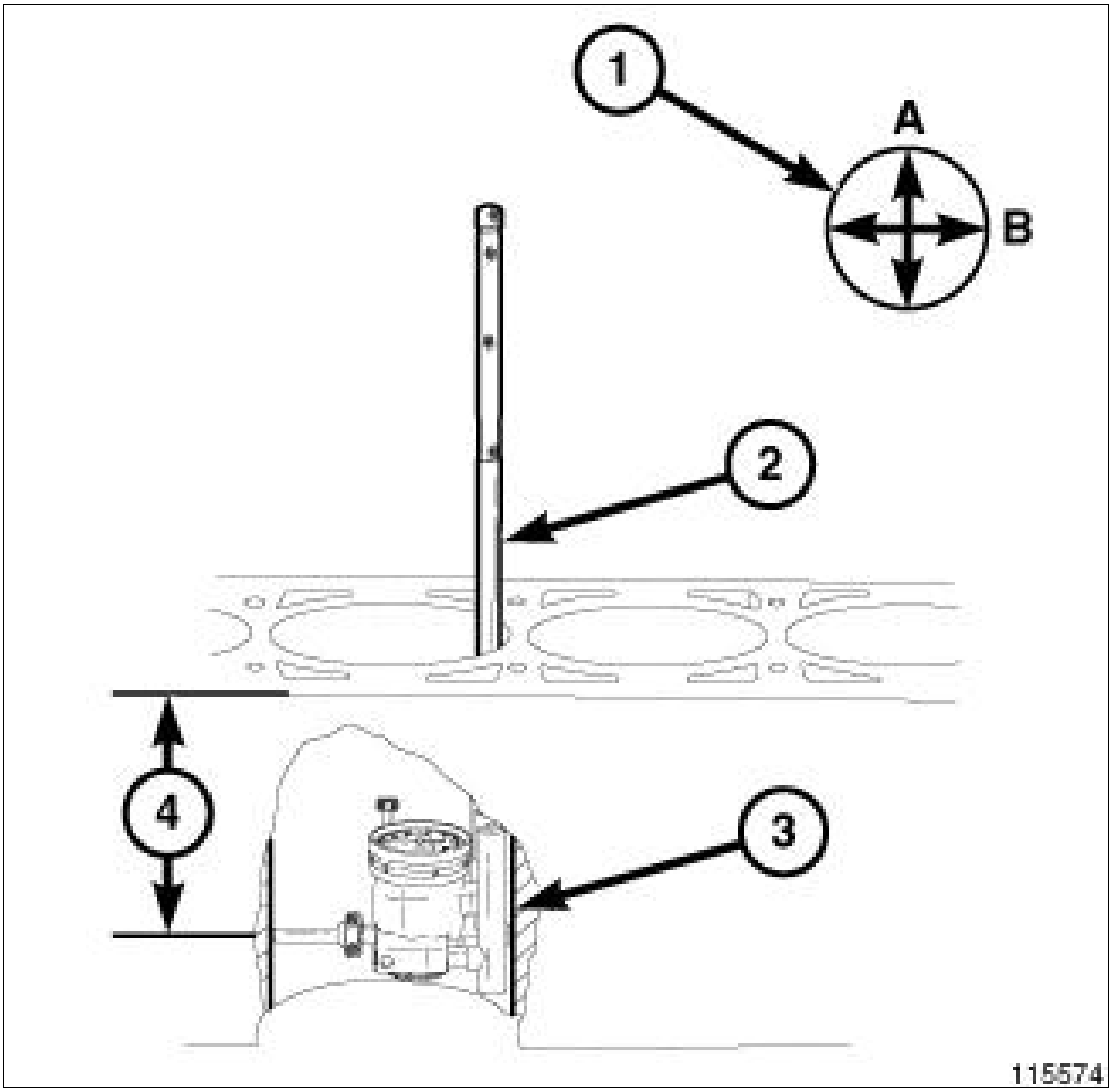
4. Inspect the crankshaft thrust bearings (3) for scoring, scratches, wear or blueing.

2. Replace any bearing that shows abnormal wear. Refer to STANDARD PROCEDURE .

3. Inspect the main bearing bores for signs of scoring, nicks and burrs.

4. If the cylinder block main bearing bores show damage the engine block must be replaced.

Fig 2: Measuring Cylinder Bore Diameter



Courtesy of CHRYSLER GROUP, LLC

5. Use the 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.

6. 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).

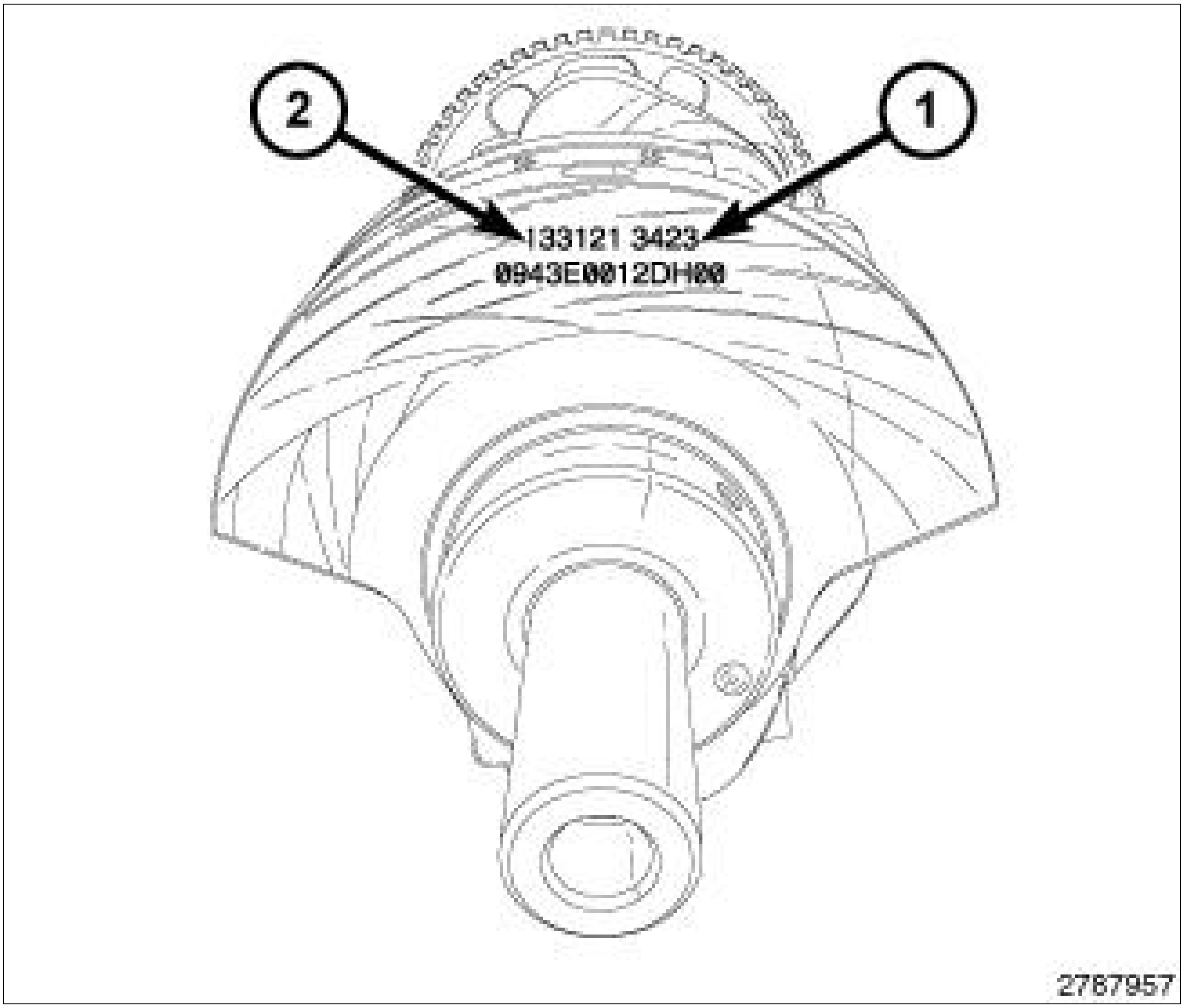
7. Repeat the measurement near the middle of the bore, then repeat the measurement near the bottom of the bore.
8. Determine taper by subtracting the smaller diameter from the larger diameter.
9. Rotate the Cylinder Indicator 90° to point B (1) and repeat the three measurements. Verify that the maximum taper is within specification. Refer to ENGINE SPECIFICATIONS .
10. Determine out-of-roundness by comparing the difference between A and B at each of the three levels. Verify that the maximum out of round is within specification. Refer to ENGINE SPECIFICATIONS .

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

11. If cylinder bore taper and out-of-roundness are within specification, the cylinder bore can be honed. Refer to STANDARD PROCEDURE . If the cylinder bore taper or out-of-round condition exceeds the maximum limits, the cylinder block must be replaced.

ENGINE BLOCK > BEARING(S), CONNECTING ROD > STANDARD PROCEDURE > CONNECTING ROD BEARING FITTING

Fig 1: Crankshaft Main Bearing Journal Diameter Grade Markings & Connecting Rod Bearing Journal Diameter Grade Markings



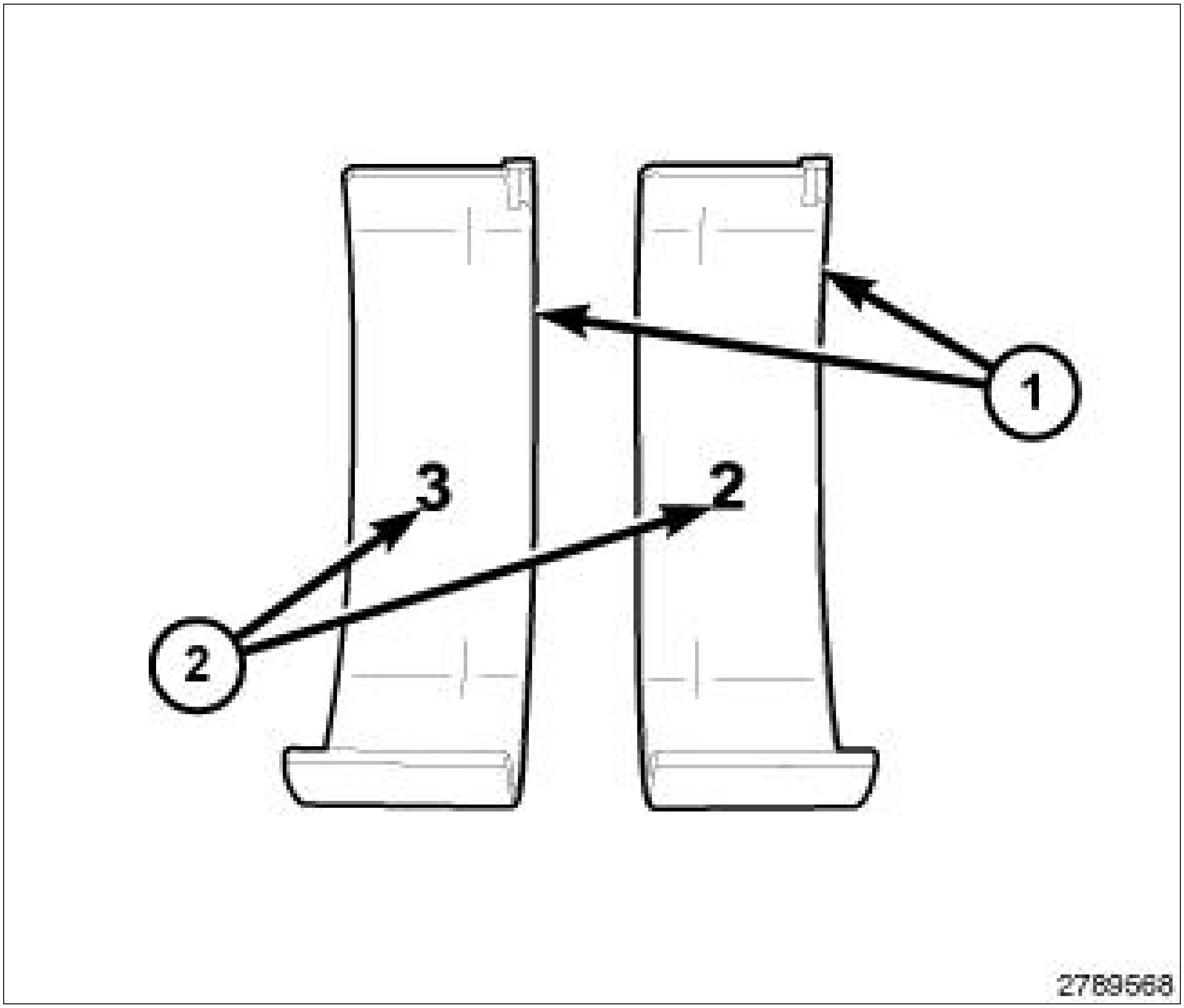
Courtesy of CHRYSLER GROUP, LLC

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	53.9910 - 53.9969 mm (2.1256 - 2.1258 in.)
2	53.9970 - 54.0029 mm (2.1259 - 2.1261 in.)
3	54.0030 - 54.0090 mm (2.1261 - 2.1263 in.)

Fig 2: 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.

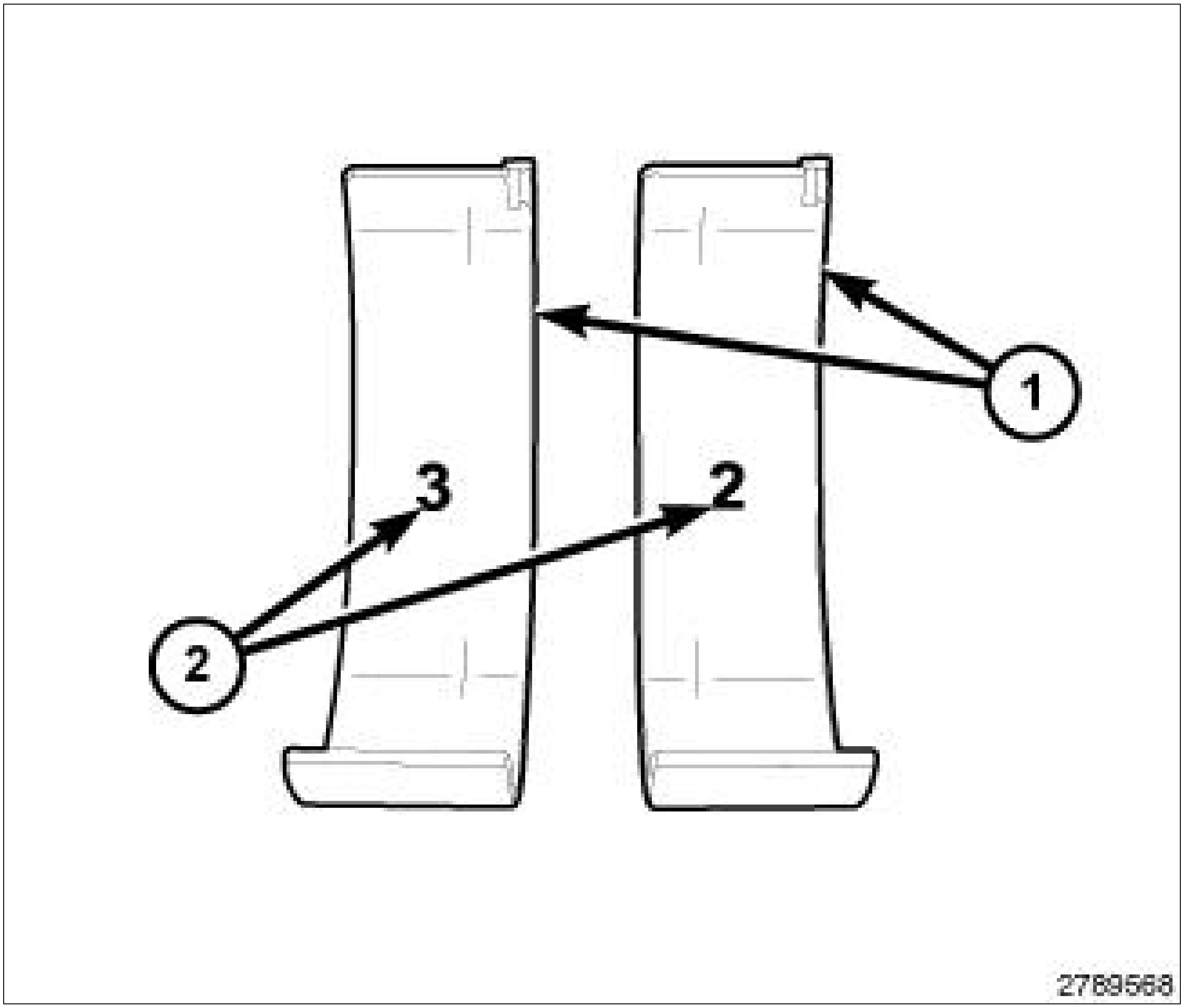
Rod bearing shells are available in three sizes. The chart below identifies the three bearing sizes.

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.)

ENGINE BLOCK > BEARING(S), CONNECTING ROD > STANDARD PROCEDURE > CONNECTING ROD BEARING REPLACEMENT

Fig 1: Connecting Rod Bearing Shells & Bearing Size

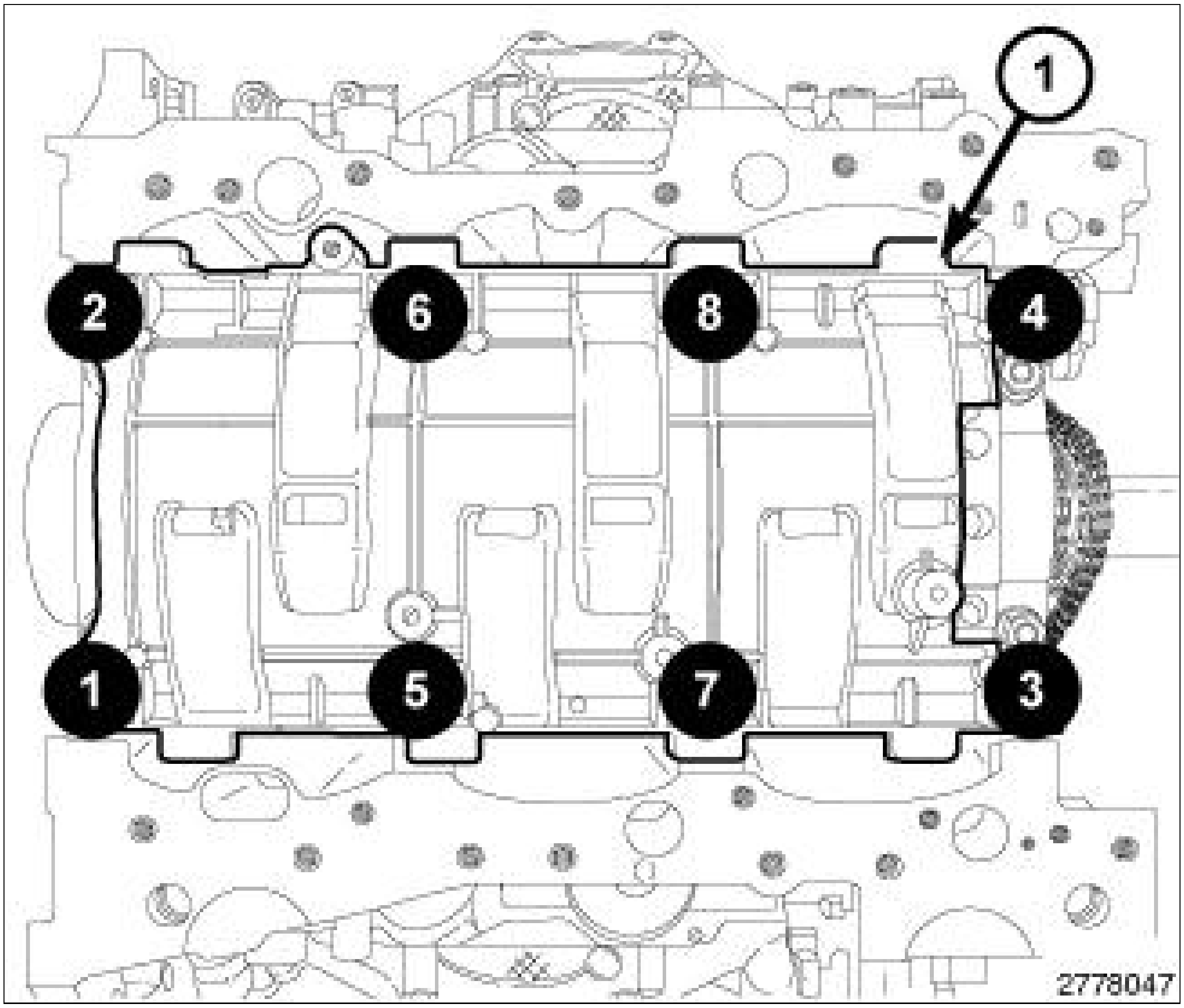


Courtesy of CHRYSLER GROUP, LLC

The connecting rod bearings (1) can be 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 STANDARD PROCEDURE .

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 .

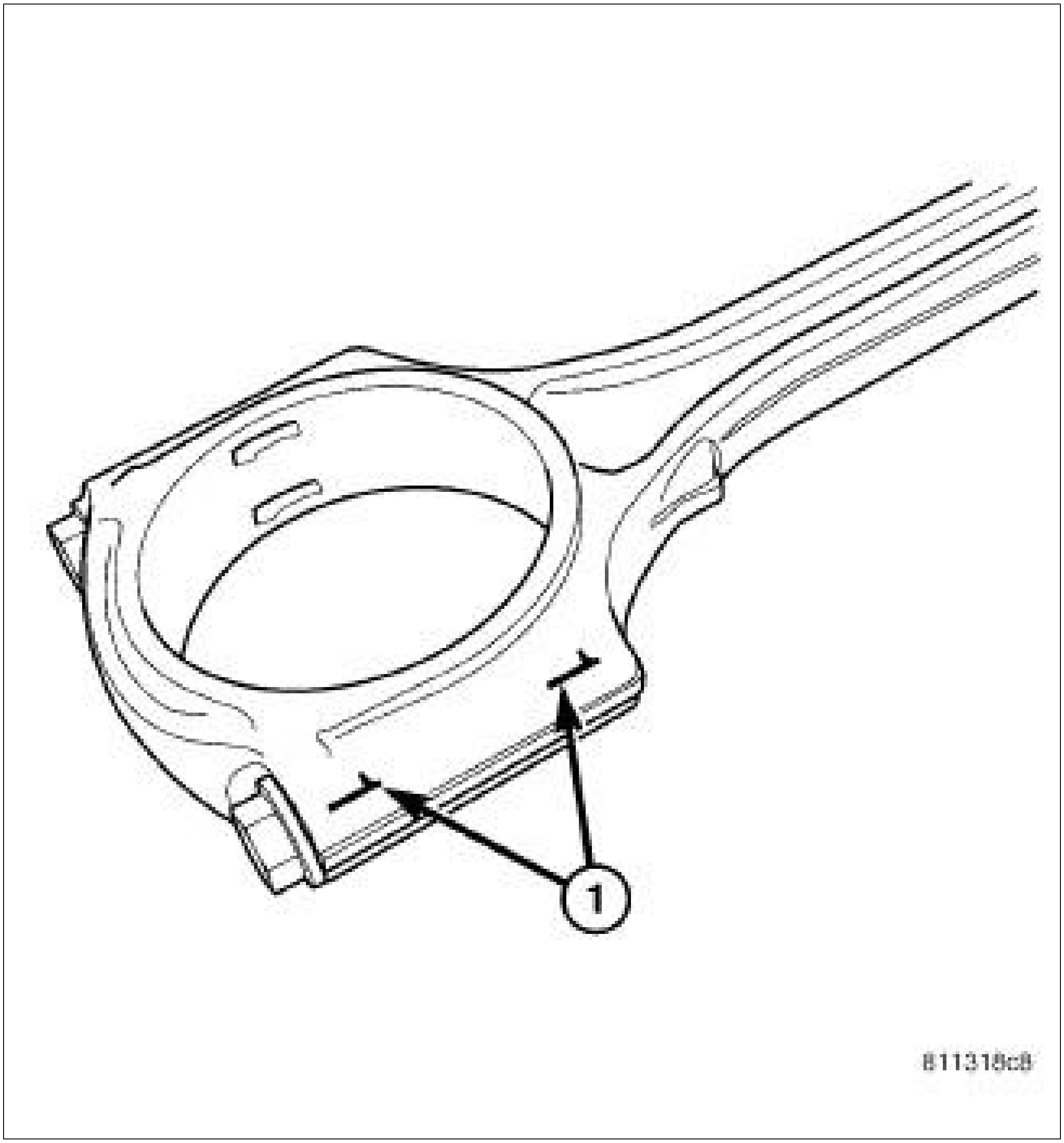
Fig 2: Main Bearing Cap Bolts From Windage Tray Removal Sequence



Courtesy of CHRYSLER GROUP, LLC

4. Remove the eight main bearing cap bolts from the windage tray in the sequence shown in illustration and remove the windage tray (1).

Fig 3: Connecting Rod To Cylinder Identification



Courtesy of CHRYSLER GROUP, LLC

CAUTION:

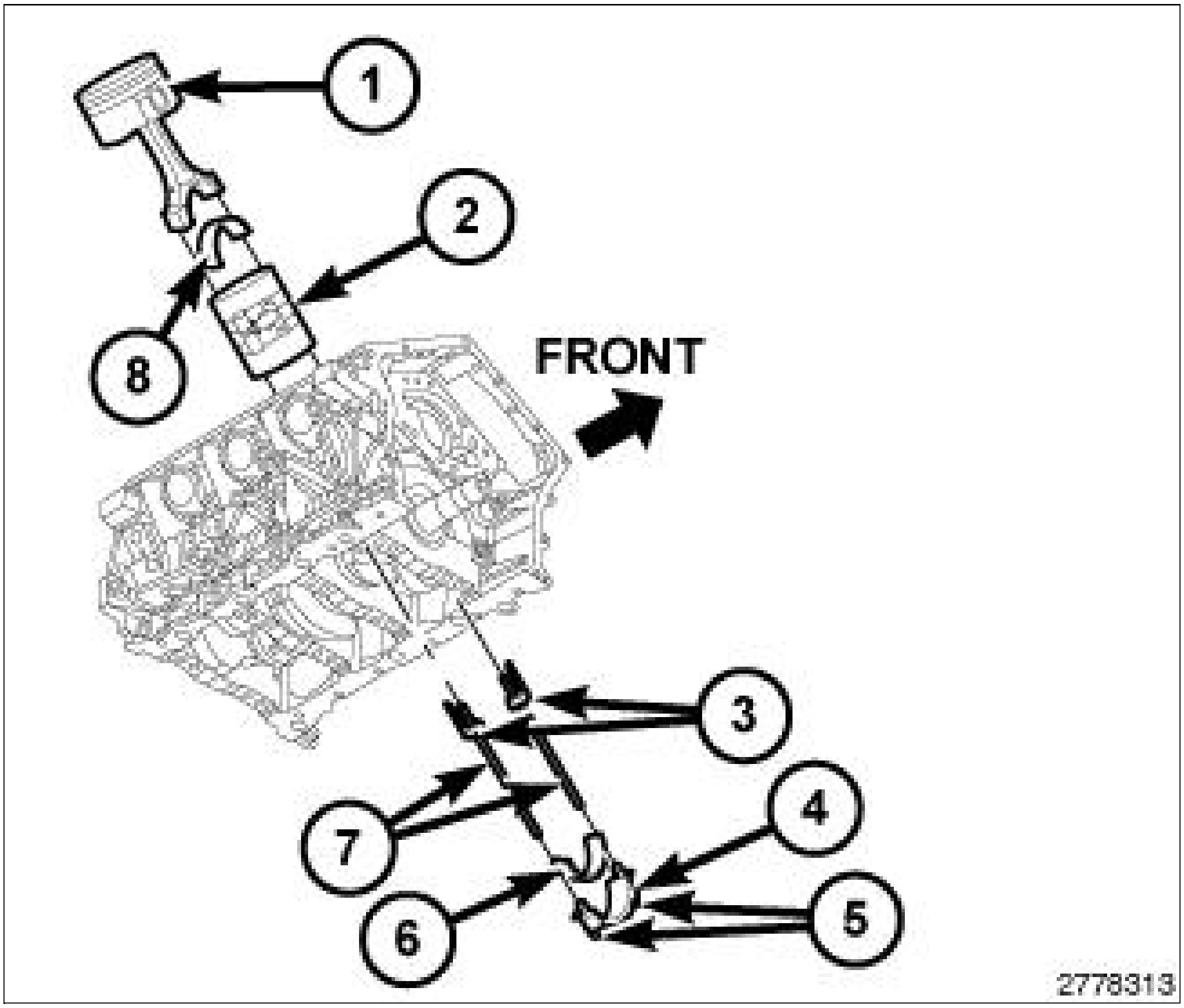
DO NOT use a number stamp or a punch to mark connecting rods or caps, as damage to connecting rods could occur

NOTE:

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

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

Fig 4: 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. Inspect the rods and bearings for abnormal wear patterns, scoring, grooving, fatigue, pitting and for metal or other foreign material imbedded in the lining. Refer to INSPECTION .
10. If required, check the connecting rod bearing clearances by the use of Plastigage or equivalent. Refer to STANDARD PROCEDURE .
11. If required, select and fit new bearings to the connecting rod. Refer to STANDARD PROCEDURE .
12. 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.
13. 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.

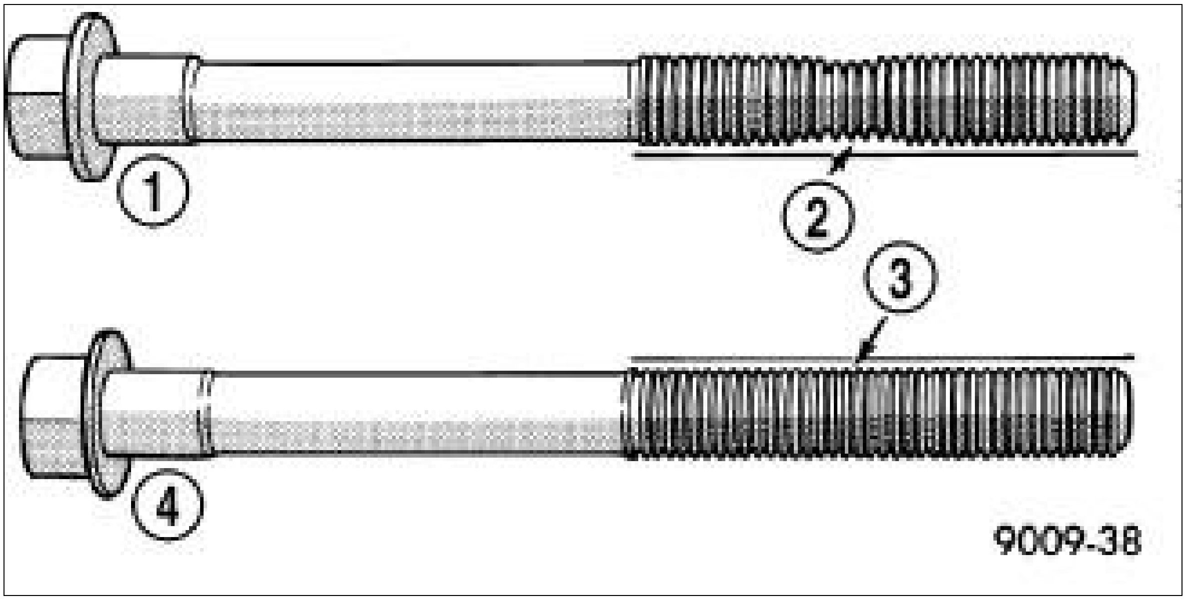
14. Install the bearing shell (6) on the connecting rod cap (4) with the tang inserted into the machined groove in the cap. Lubricate the bearing surface with clean engine oil.

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 the proper specification. Refer to TORQUE SPECIFICATIONS .
16. If required, check the connecting rod side clearance. Refer to STANDARD PROCEDURE .
17. Repeat the previous steps for each connecting rod bearing being replaced.

Fig 5: Checking Cylinder Head Bolts For Stretching (Necking)



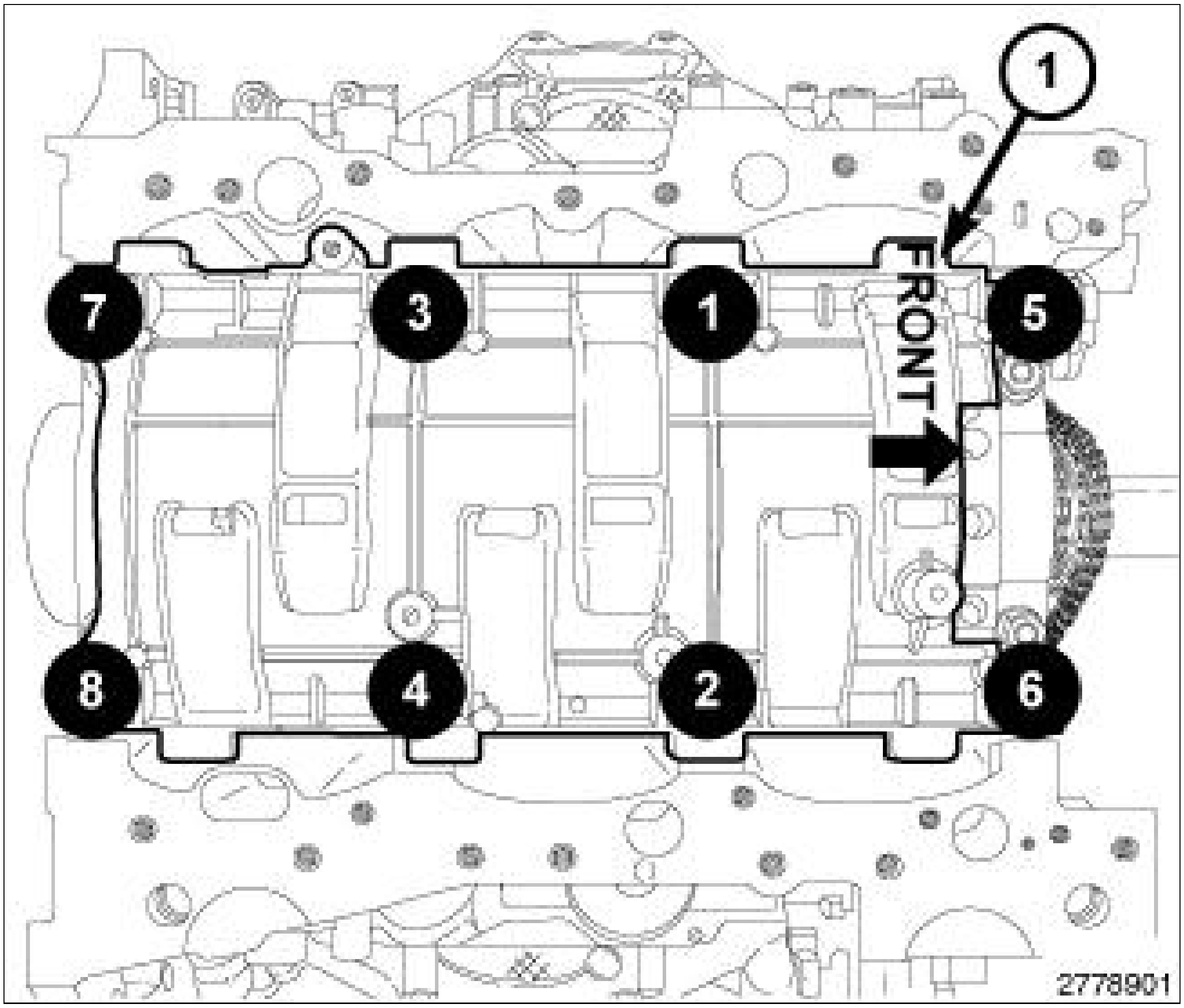
Courtesy of CHRYSLER GROUP, LLC

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 6: Windage Tray With Main Bearing Cap Bolts Installation Sequence



Courtesy of CHRYSLER GROUP, LLC

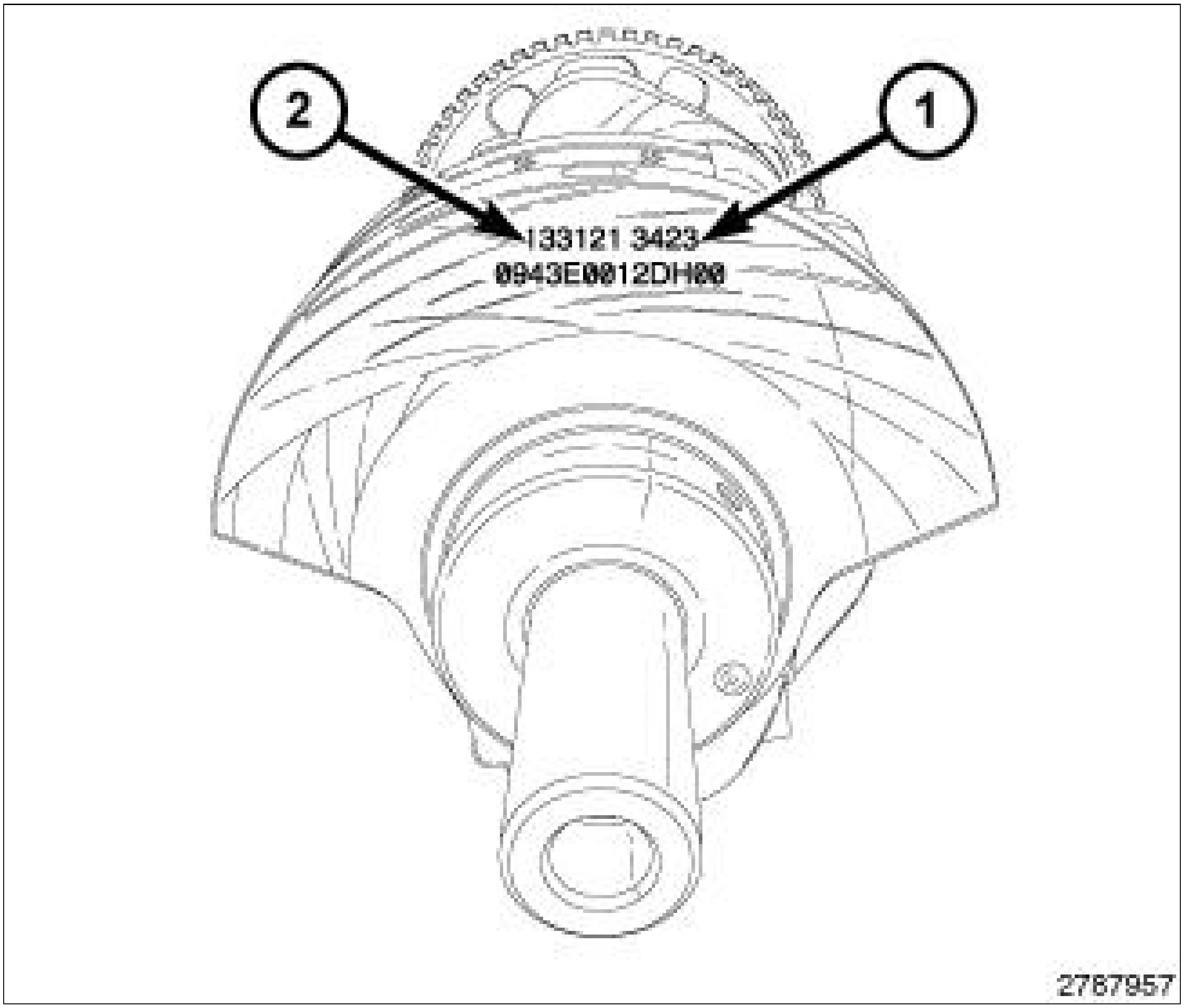
19. Install the windage tray with eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to 21 N.m (16 ft. lbs.) plus an additional 90° turn.
20. Install the engine oil pump, oil pump pick-up and oil pan. Refer to PUMP, ENGINE OIL, INSTALLATION .
21. Install the spark plugs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

ENGINE BLOCK > BEARING(S), CRANKSHAFT, MAIN > STANDARD PROCEDURE > MAIN BEARING FITTING

NOTE:

Crankshaft thrust washers are not selectable and are only available in a single thickness.

Fig 1: Crankshaft Main Bearing Journal Diameter Grade Markings & Connecting Rod Bearing Journal Diameter Grade Markings



Courtesy of CHRYSLER GROUP, LLC

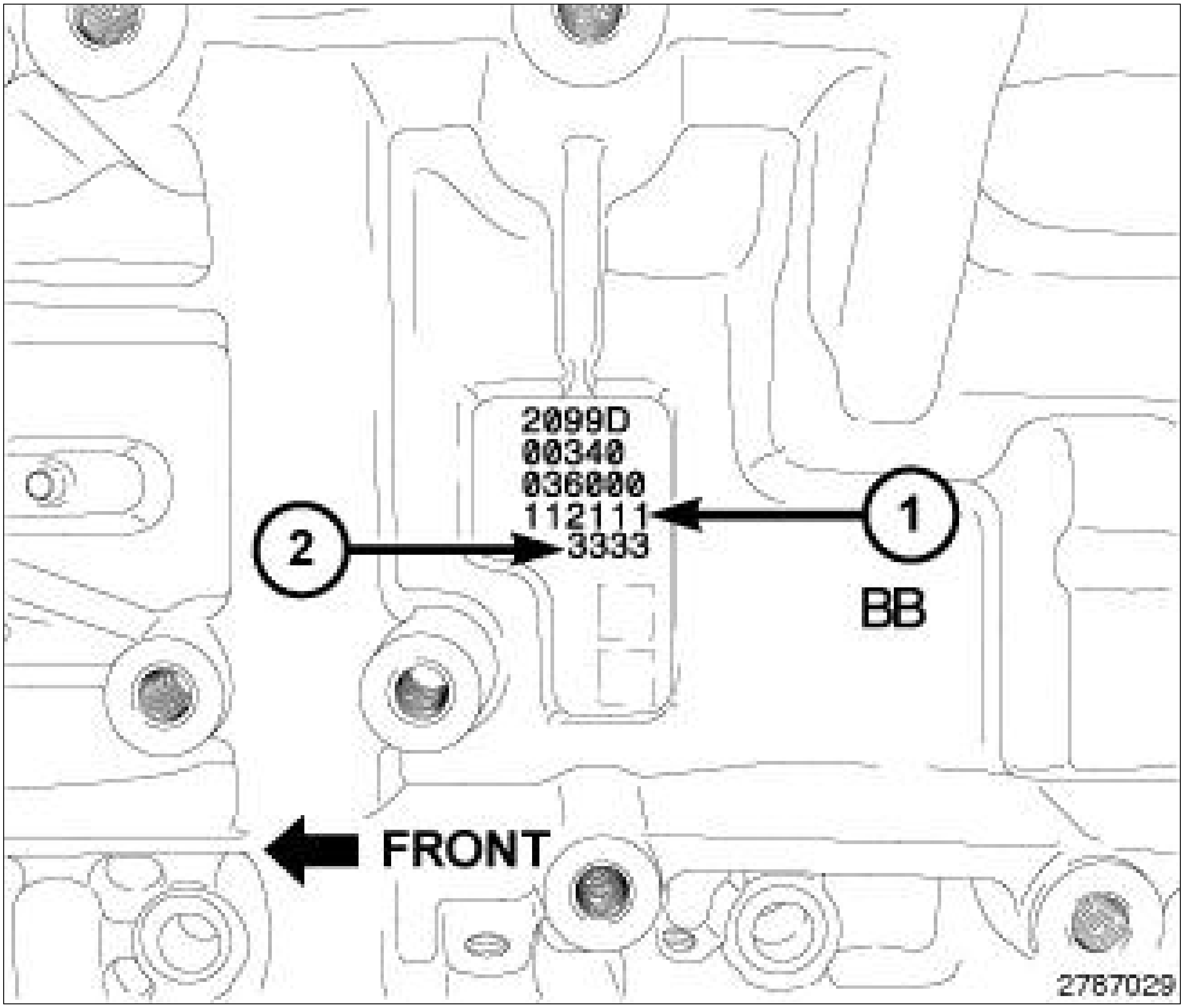
The upper and lower main bearings are "select fit" to achieve proper oil clearances. Crankshaft main bearing journal diameter grade markings (1) are stamped into the front crankshaft counterweight. These marks are read from left to right, corresponding with journal number 1, 2, 3, 4.

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	67.9870 - 67.9905 mm (2.6766 - 2.6767 in.)

2	67.9906 - 67.9941 mm (2.6768 - 2.6769 in.)
3	67.9942 - 67.9977 mm (2.6769 - 2.6771 in.)
4	67.9978 - 68.0013 mm (2.6771 - 2.6772 in.)
5	68.0014 - 68.0050 mm (2.6772 - 2.6773 in.)

Fig 2: 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.

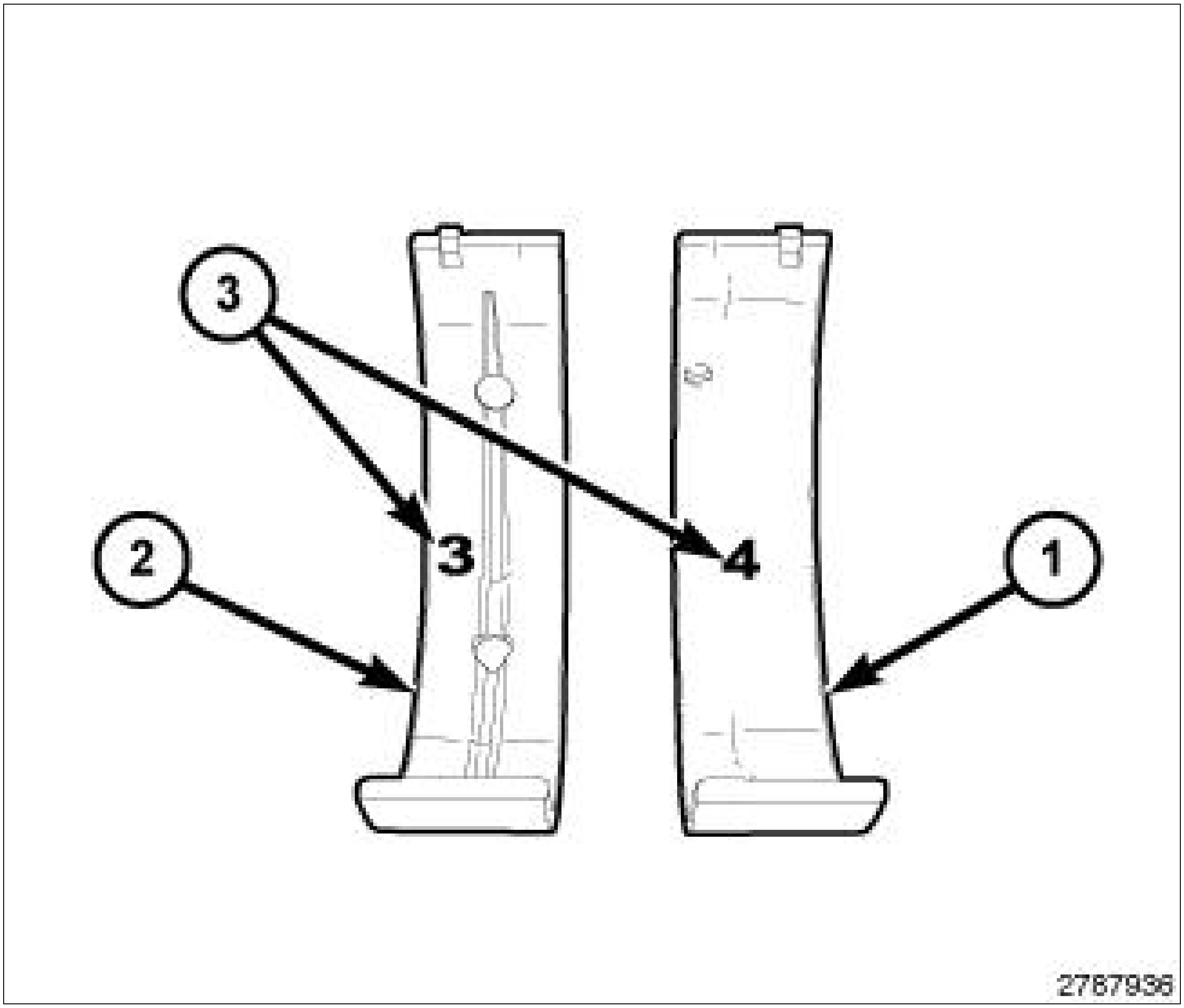
Engine Block Marking	Journal Size mm (in.)
1	73.0055 - 73.0090 mm (2.8742 - 2.8744 in.)
2	73.0019 - 73.0054 mm (2.8741 - 2.8742 in.)

3	72.9983 - 73.0018 mm (2.8739 - 2.8741 in.)
4	72.9947 - 72.9982 mm (2.8738 - 2.8739 in.)
5	72.9910 - 72.9946 mm (2.8736 - 2.8738 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				

Fig 3: Main Bearing Inserts



Courtesy of CHRYSLER GROUP, LLC

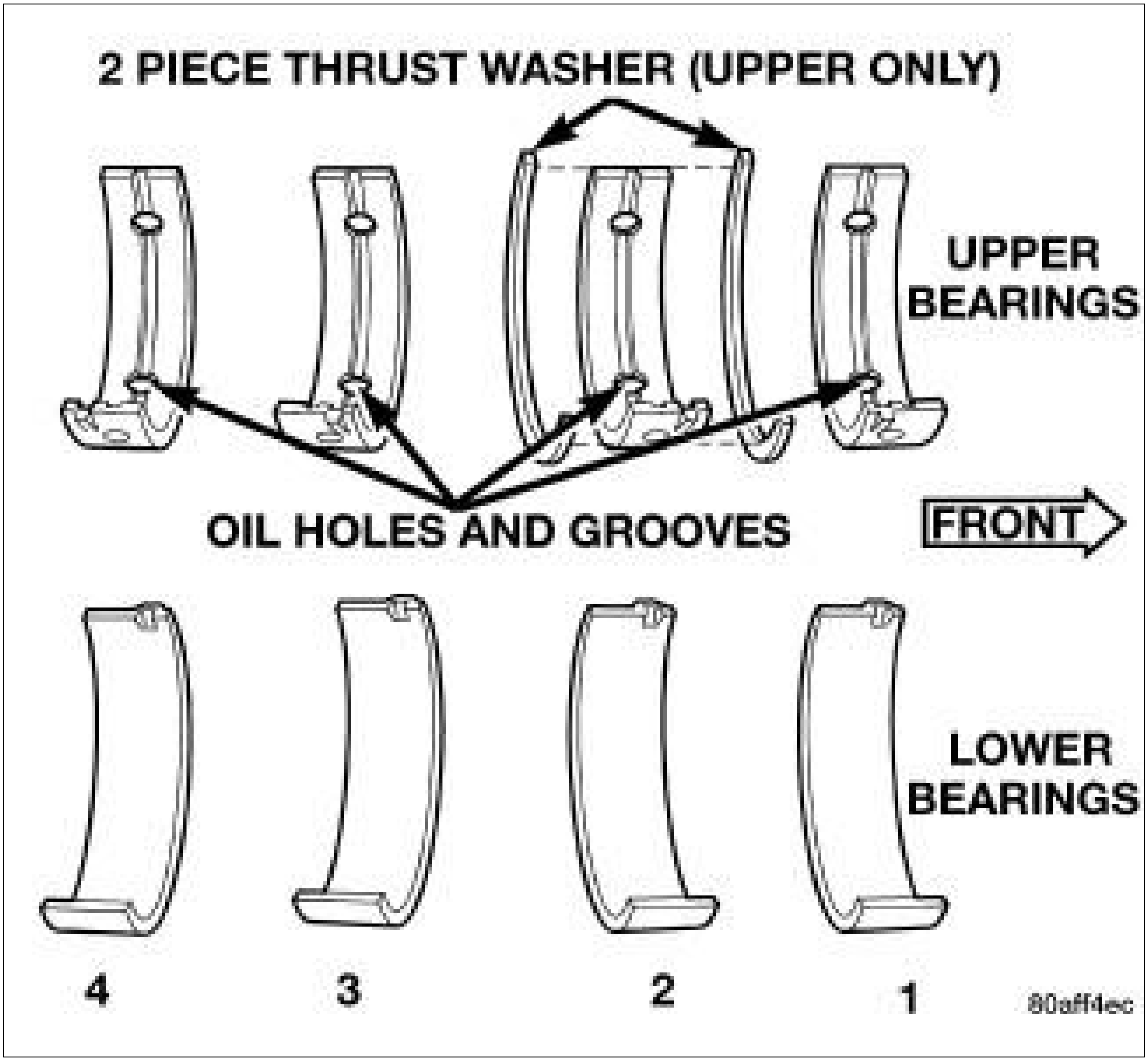
The upper main bearing shell (2) and lower main bearing shell (1) are marked with the bearing size (3) on the bearing lining surface. The upper and lower bearings are available in five different sizes and can be mixed on a journal in order to achieve the proper oil clearance.

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.)

ENGINE BLOCK > BEARING(S), CRANKSHAFT, MAIN > STANDARD PROCEDURE > MAIN BEARING REPLACEMENT

Fig 1: Main Bearing Identification

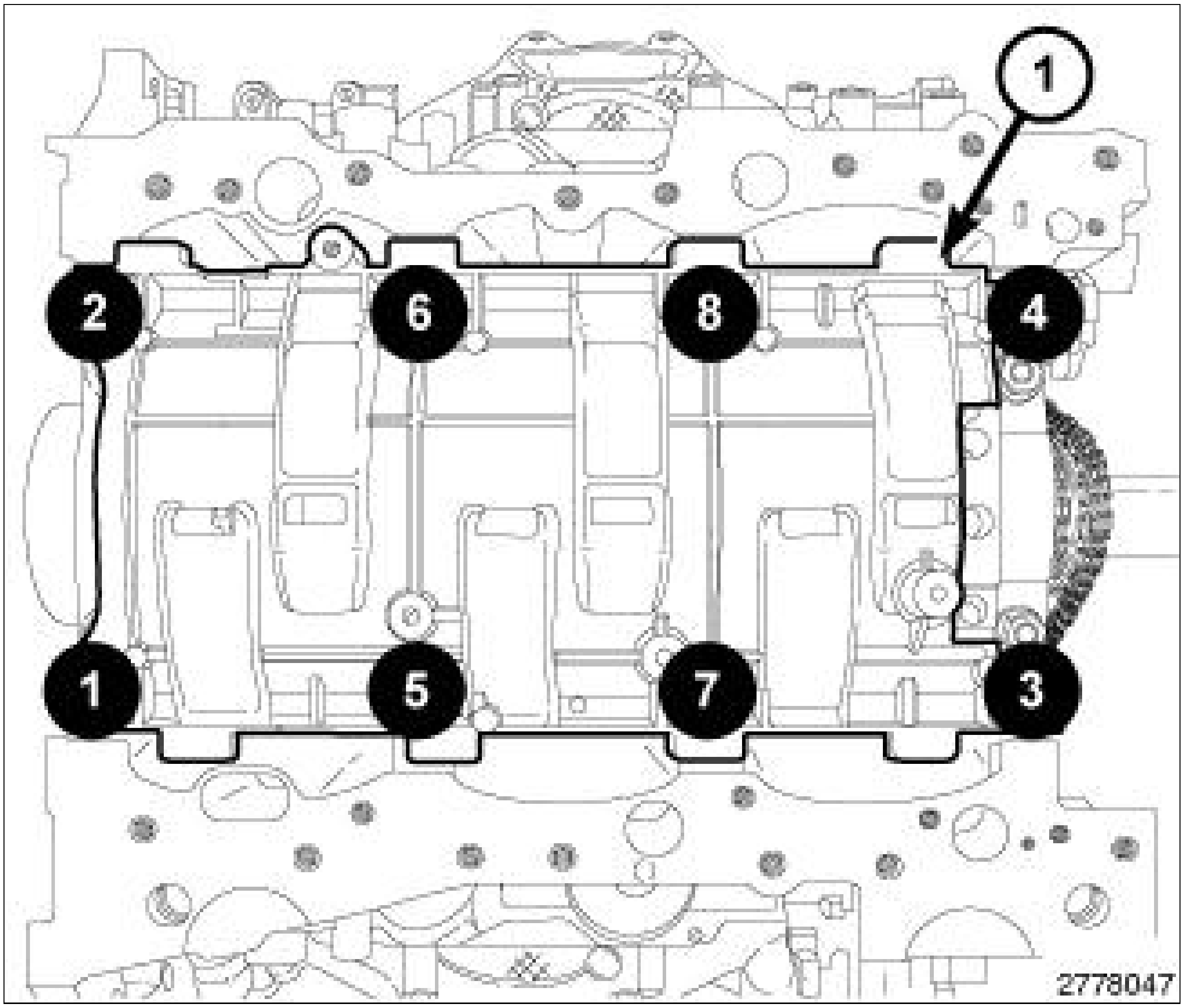


Courtesy of CHRYSLER GROUP, LLC

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 STANDARD PROCEDURE .

1. Disconnect and isolate the negative battery cable.

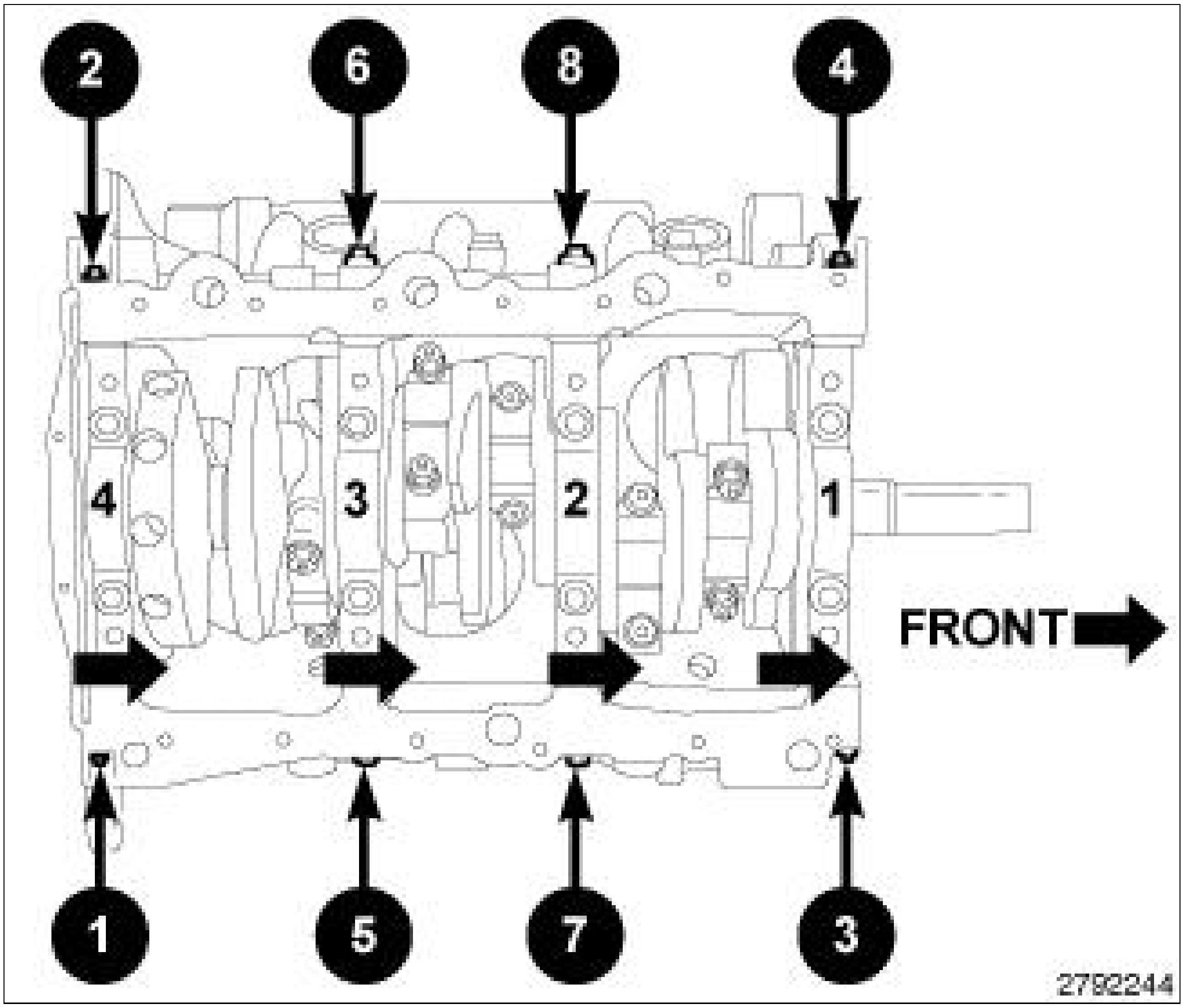
Fig 2: Main Bearing Cap Bolts From Windage Tray Removal Sequence



Courtesy of CHRYSLER GROUP, LLC

2. Remove the oil pan, oil pump pick-up and engine oil pump. Refer to PUMP, ENGINE OIL, REMOVAL .
3. Remove the eight main bearing cap bolts from the windage tray in the sequence shown in illustration and remove the windage tray (1).

Fig 3: Main Bearing Tie Bolts Removal Sequence



Courtesy of CHRYSLER GROUP, LLC

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

4. Remove the eight main bearing tie bolts in the sequence shown in illustration.

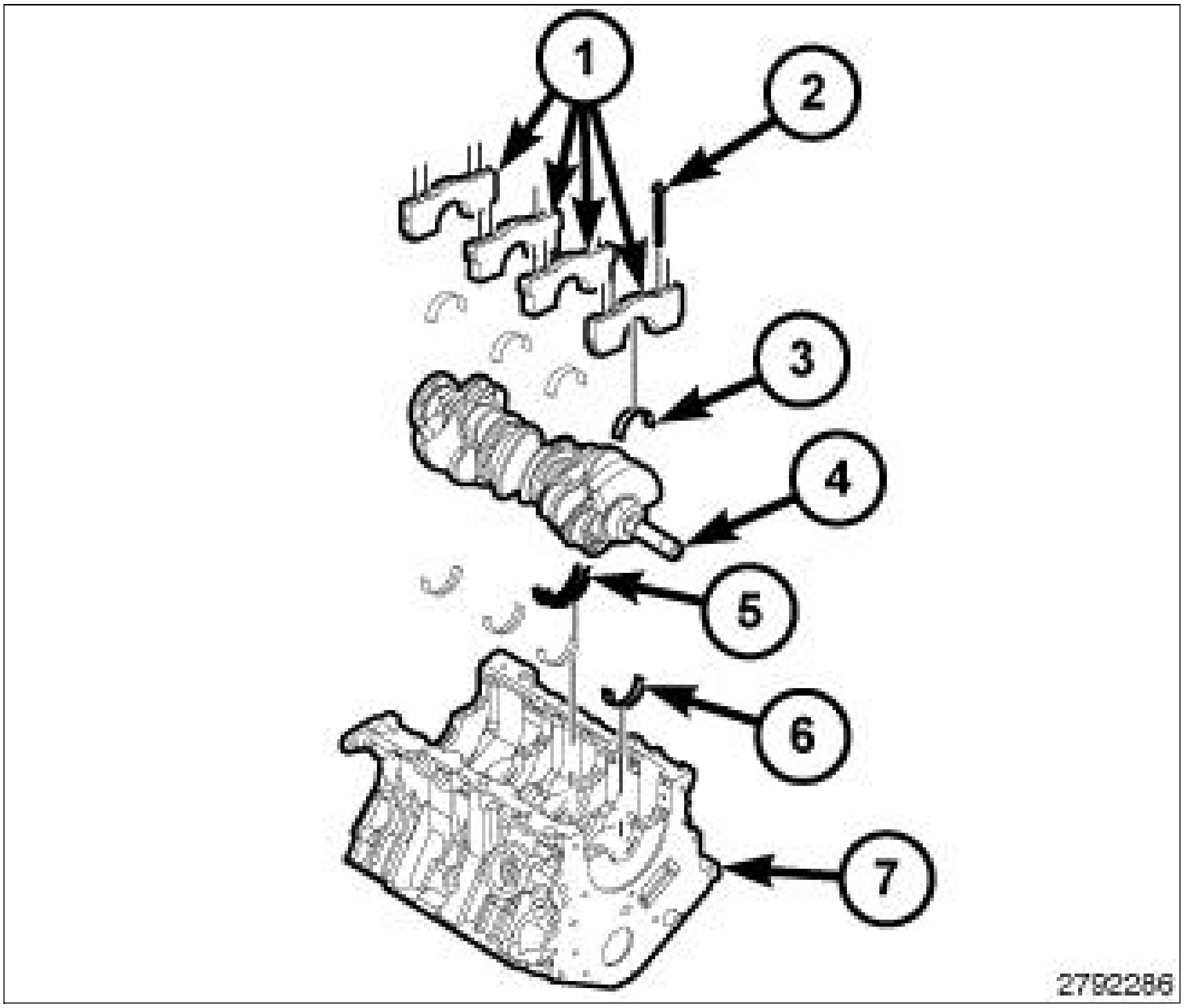
> *CAUTION:*
>
> *DO NOT use a number stamp or a punch to mark main bearing caps, as damage to main bearings could occur.*

NOTE:

Main bearing caps are not interchangeable and are marked to insure correct assembly.

5. Mark the main bearing cap positions using a permanent ink marker or a scribe tool.

Fig 4: Main Bearing Caps, Bolts, Crankshaft & Engine Block



Courtesy of CHRYSLER GROUP, LLC

NOTE:

Typical V6 engine configuration shown in illustration.

CAUTION:

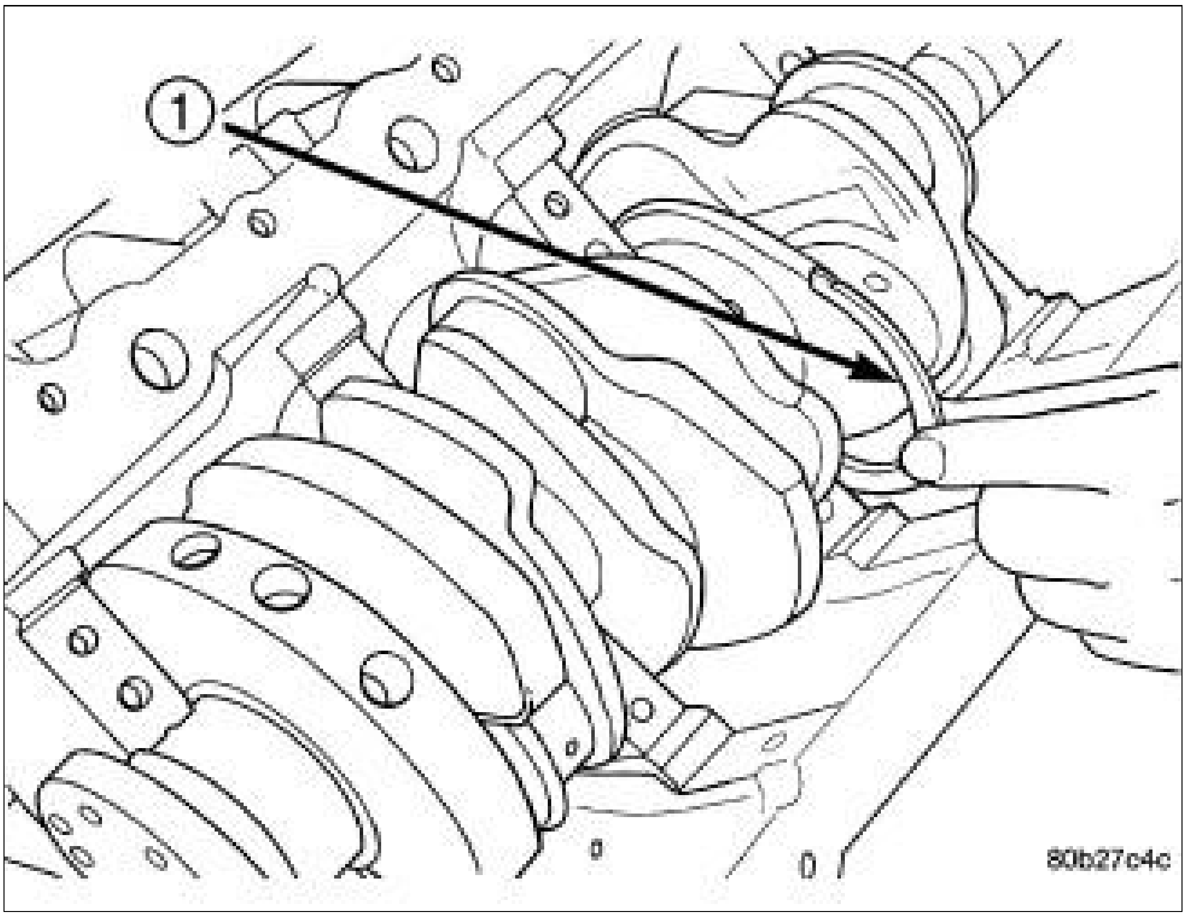
Replace only one main bearing at a time while all other main bearing caps remain properly tightened. If all main bearing caps are removed, the weight of the *unsupported crankshaft will damage the crankshaft oil seals.*

NOTE:

Replace the main bearings in the following order; 2, 3, 1, 4.

6. Remove the two cap bolts (2) and remove the main bearing cap (1).
7. When removing the No. 2 bearing cap, also remove the thrust washers (5).
8. Slide the upper main bearing half (6) out from between the crankshaft and the engine block.
9. If required, select fit new main bearings to the engine block. Refer to STANDARD PROCEDURE .
10. Lubricate the upper main bearing half (6) with clean engine oil and slide the bearing into position.

Fig 5: Thrust Washer Installation



Courtesy of CHRYSLER GROUP, LLC

NOTE:

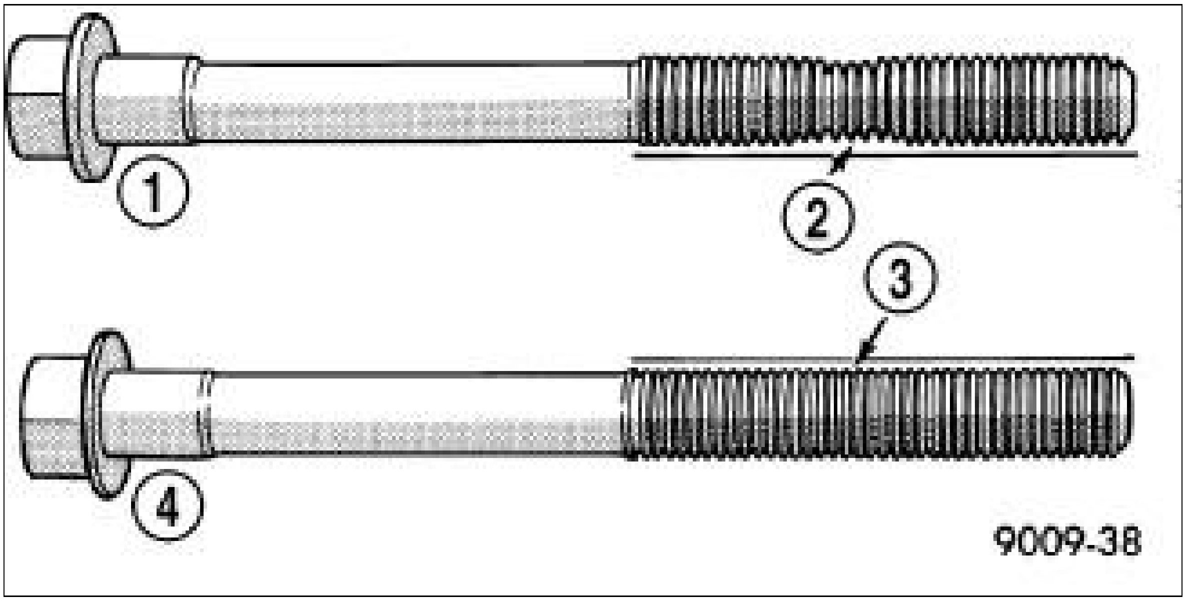
Typical V6 engine configuration shown in illustration.

11. When installing thrust washers (1) at the No. 2 main bearing location, use the following procedure:

    a. 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.

    b. 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 6: Checking Cylinder Head Bolts For Stretching (Necking)



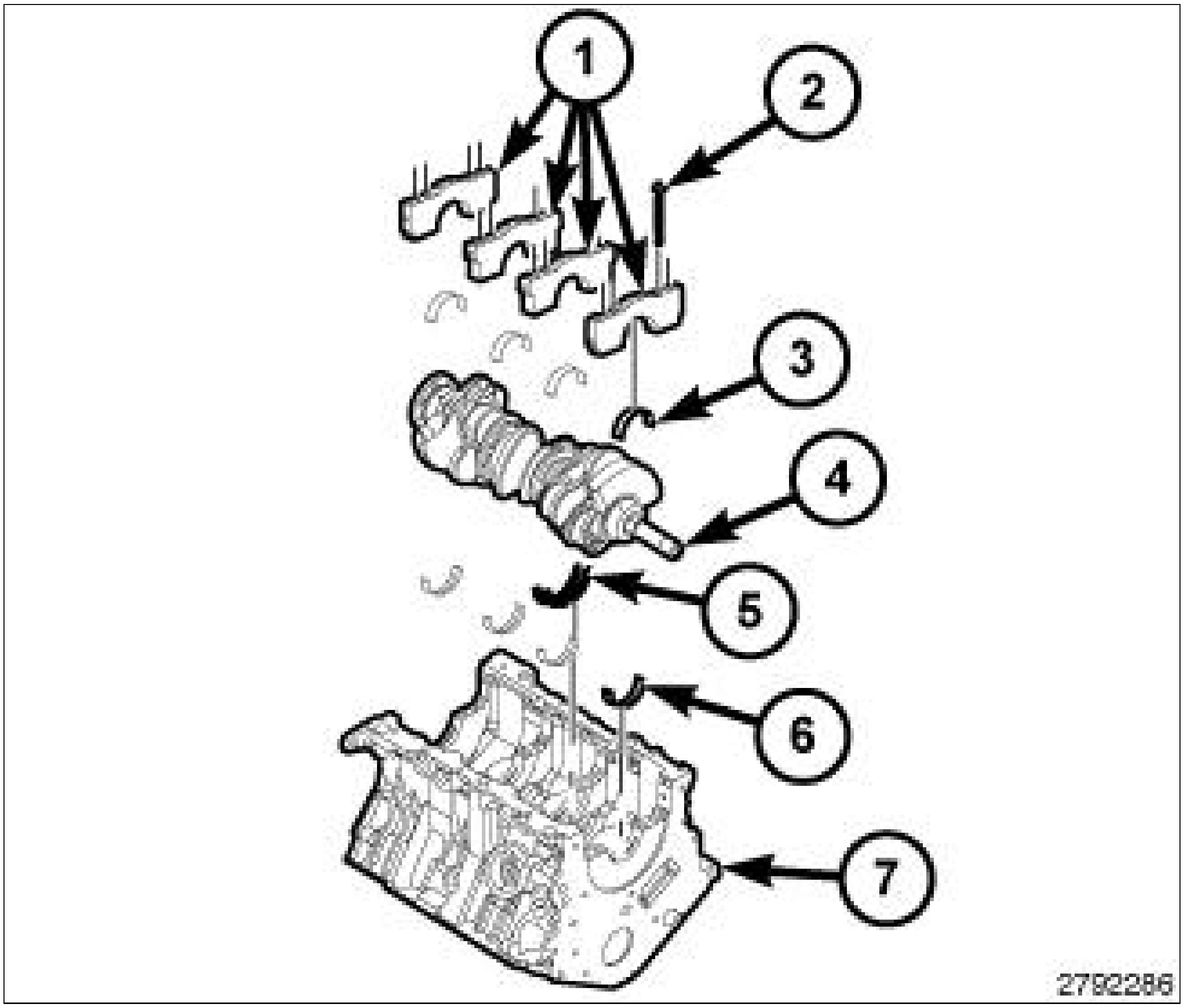
Courtesy of CHRYSLER GROUP, LLC

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.

12. 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 7: Main Bearing Caps, Bolts, Crankshaft & Engine Block

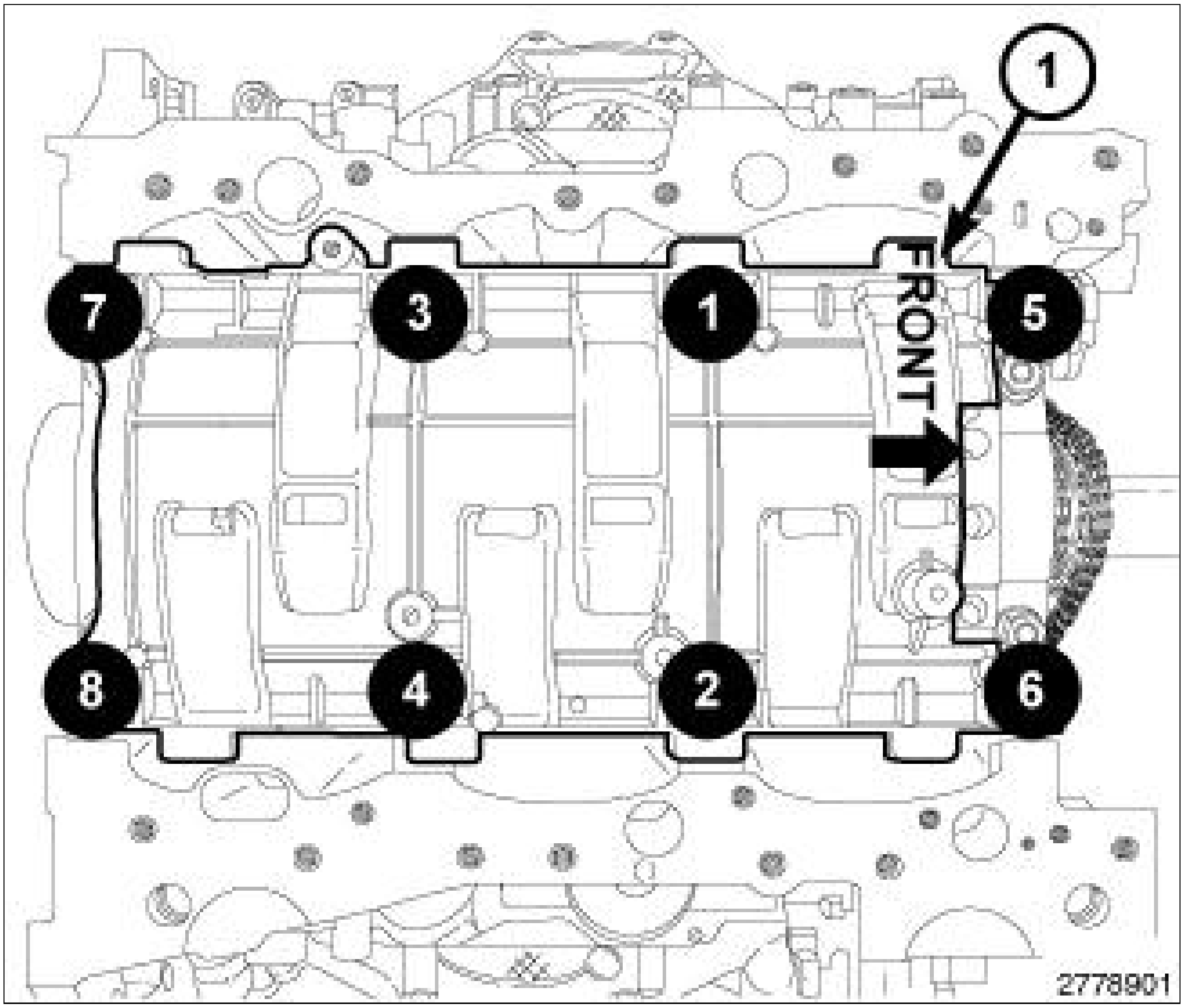


Courtesy of CHRYSLER GROUP, LLC

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

13. Lubricate and install the lower bearing half (3) onto the main cap (1).
14. Install the main bearing cap (1) with two inner main bearing cap bolts (2) tightened to 20 N.m (15 ft. lbs.) plus 90°.
15. Repeat the previous steps for main bearings 3, 1 and 4.
16. Measure crankshaft end play. Refer to STANDARD PROCEDURE .

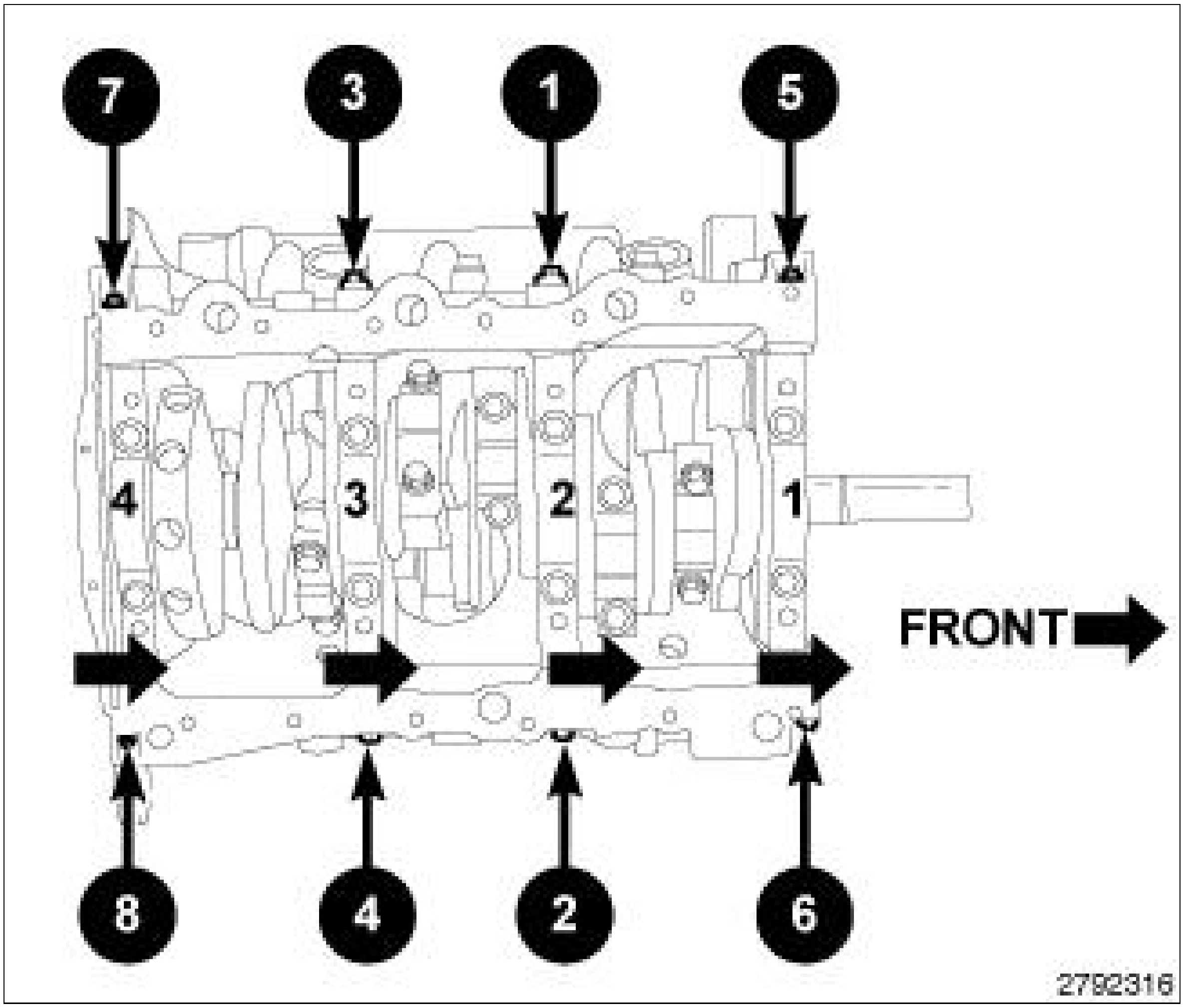
Fig 8: Windage Tray With Main Bearing Cap Bolts Installation Sequence



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°.

Fig 9: Main Bearing Tie Bolts Installation Sequence



Courtesy of CHRYSLER GROUP, LLC

NOTE:

Typical V6 engine configuration shown in illustration.

18. Install the eight main bearing tie bolts. Tighten the bolts in the sequence shown in illustration to 28 N.m (21 ft. lbs.).
19. Install the engine oil pump, oil pump pick-up and oil pan. Refer to PUMP, ENGINE OIL, INSTALLATION .
20. Install the spark plugs and ignition coils. Refer to SPARK PLUG, INSTALLATION .
21. Install a new oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
22. Connect the negative battery cable.
23. Operate the engine until it reaches normal operating temperature.

ENGINE BLOCK > CRANKSHAFT > DESCRIPTION > DESCRIPTION

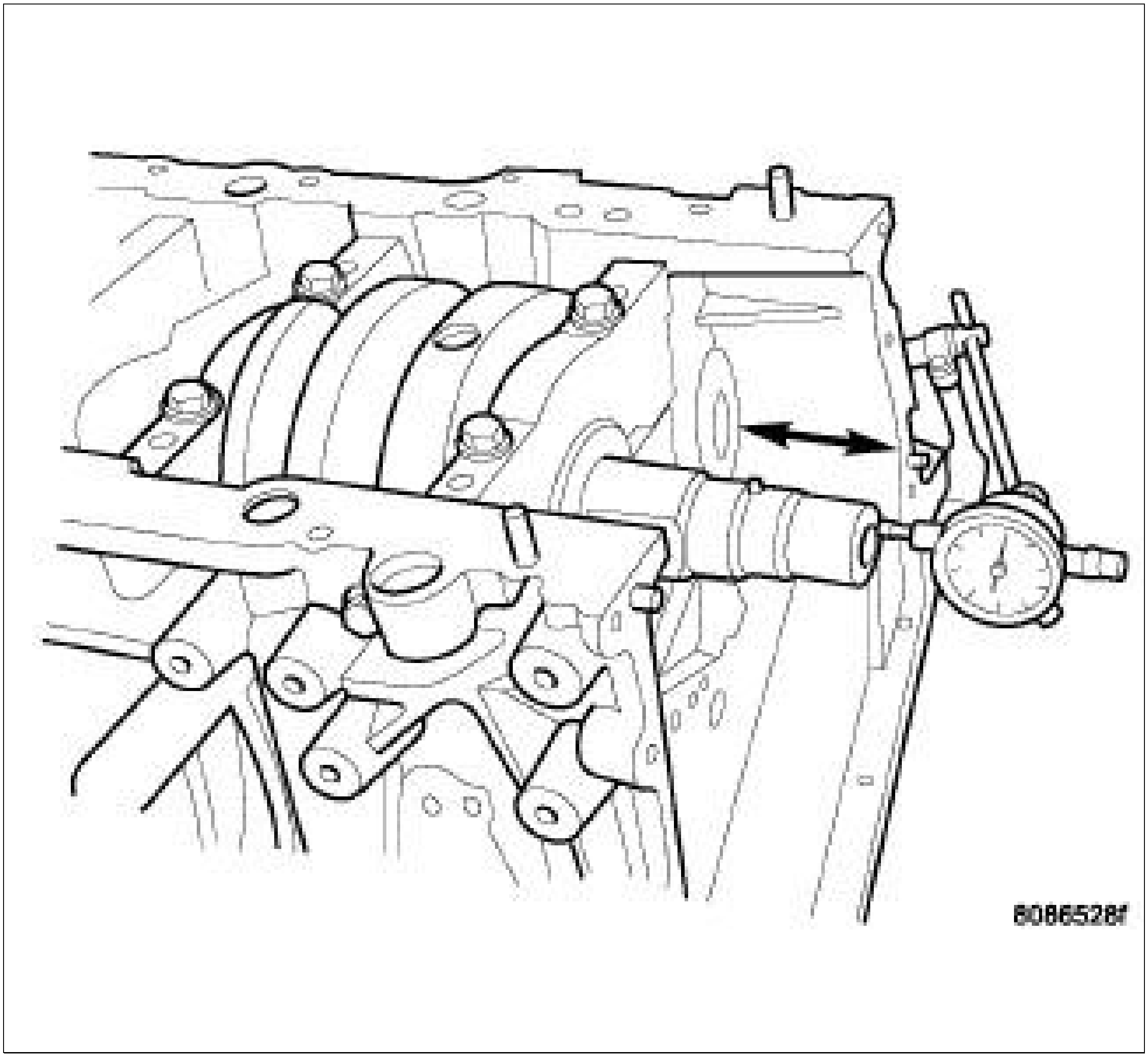
Fig 1: Crankshaft

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 crossed 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.

ENGINE BLOCK > CRANKSHAFT > STANDARD PROCEDURE > STANDARD PROCEDURE - END PLAY

Fig 1: Checking Crankshaft End Play



Courtesy of CHRYSLER GROUP, LLC

NOTE:

Typical V6 engine shown in illustration.

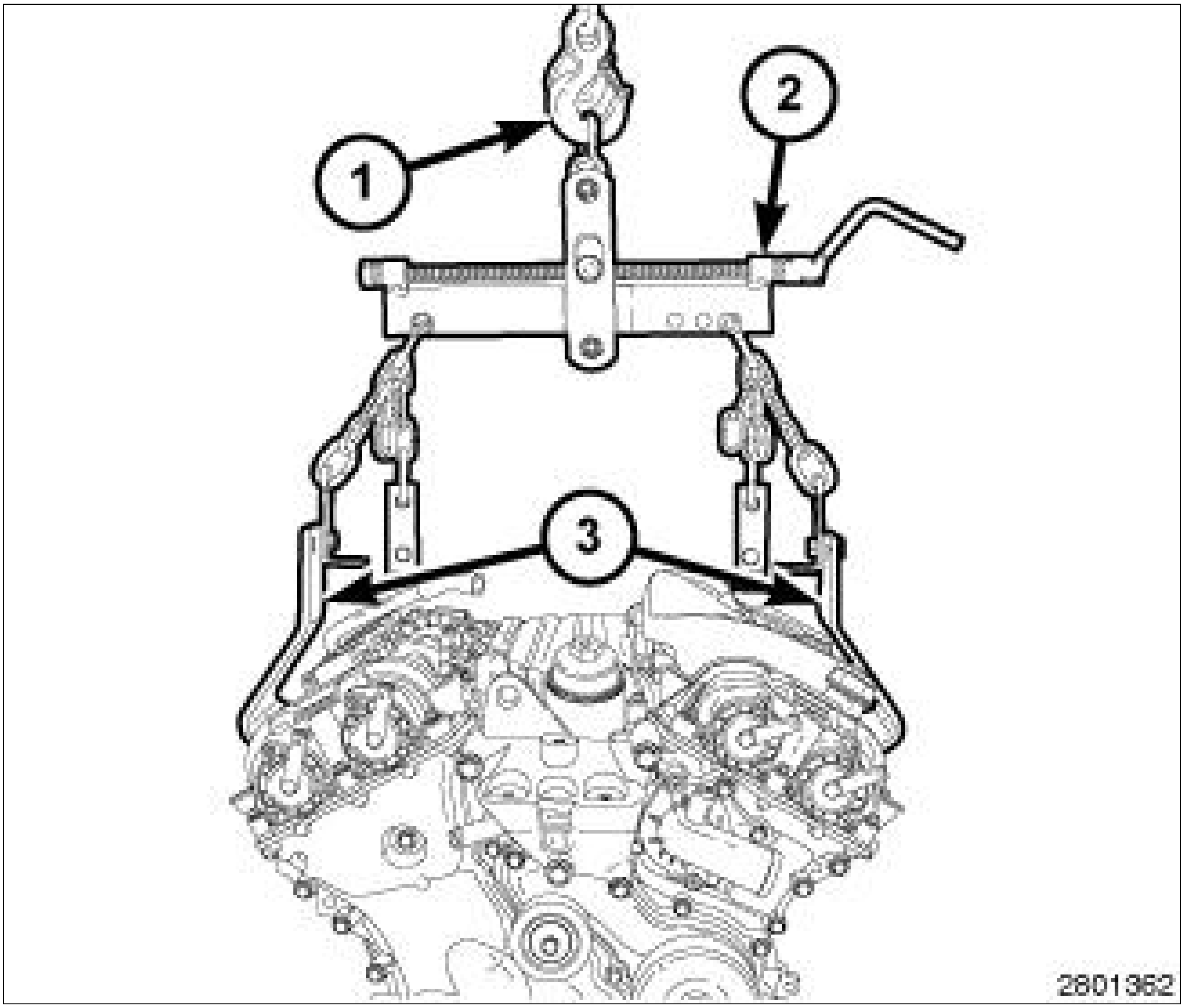
1. Mount Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) to a stationary point at the front of the engine. Locate the probe perpendicular against the nose of the crankshaft.
2. Move the crankshaft all the way to the rear of its travel.
3. Zero the dial indicator.
4. Move the crankshaft 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.

ENGINE BLOCK > CRANKSHAFT > REMOVAL > REMOVAL

Fig 1: Lifting Sling, Engine Lifting Brackets & Engine Hoist



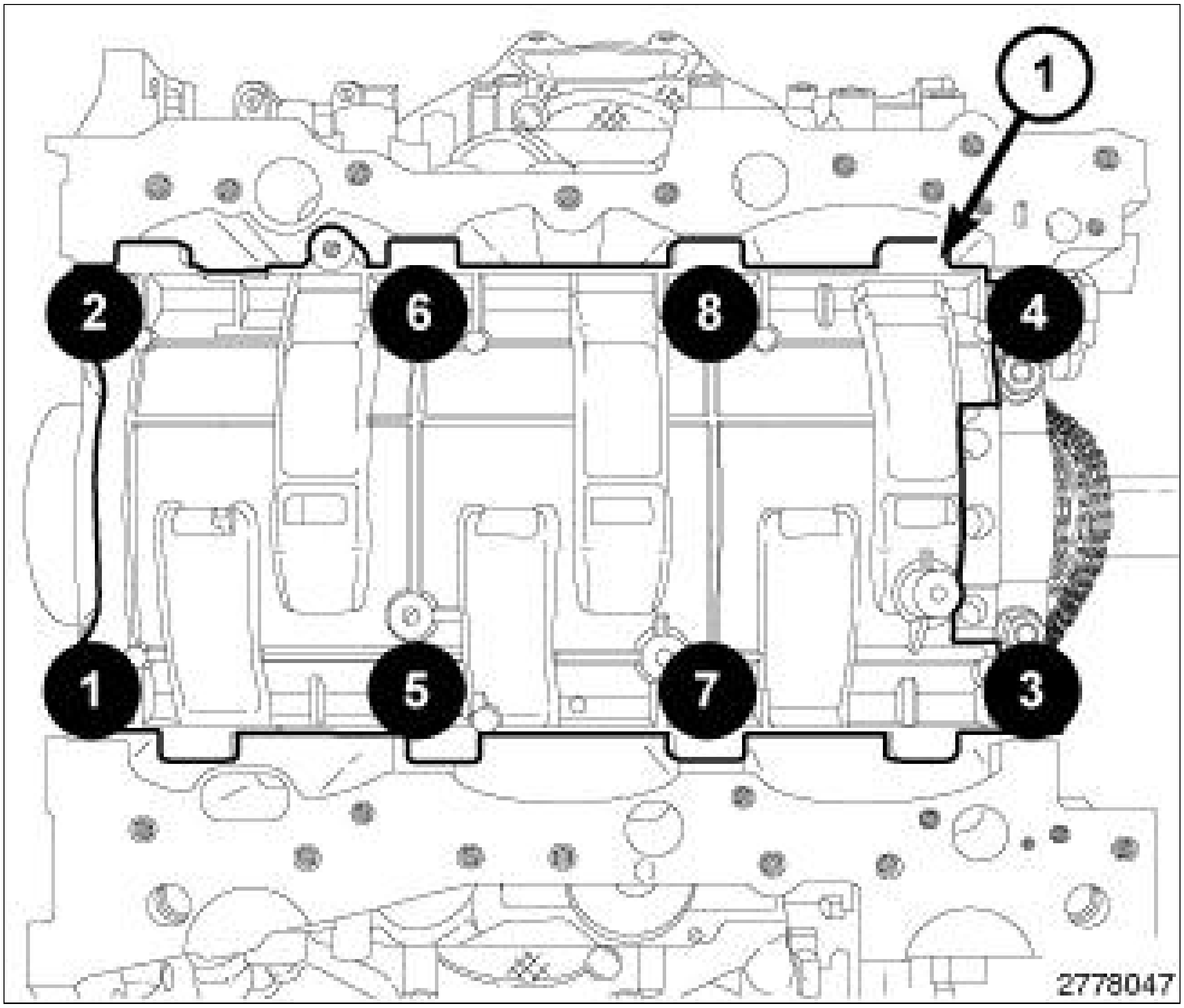
Courtesy of CHRYSLER GROUP, LLC

NOTE:

To remove the crankshaft from the engine, the engine must be removed from the vehicle.

1. Remove the engine. Refer to REMOVAL .

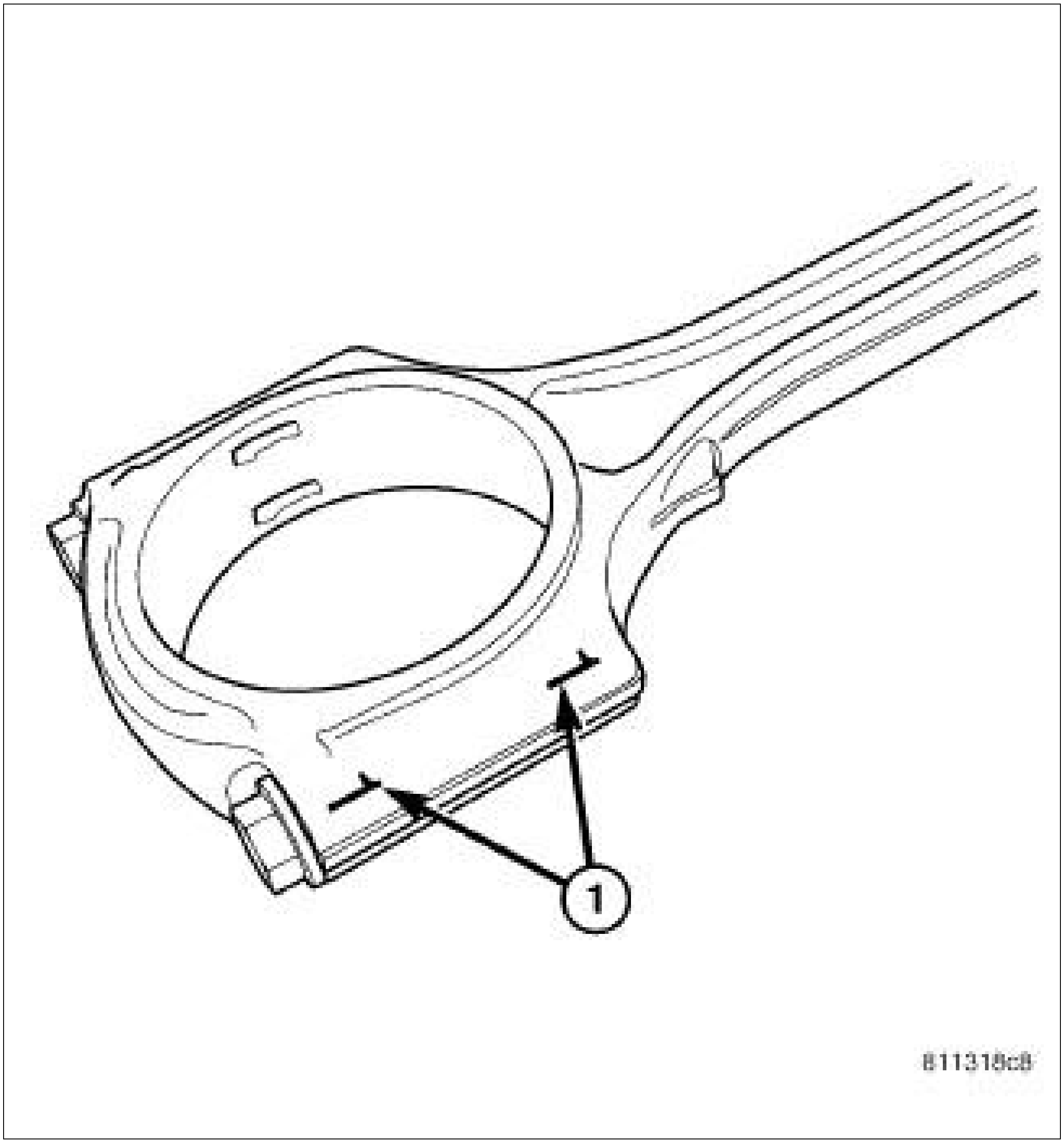
Fig 2: Main Bearing Cap Bolts From Windage Tray Removal Sequence



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).

Fig 3: Connecting Rod To Cylinder Identification



Courtesy of CHRYSLER GROUP, LLC

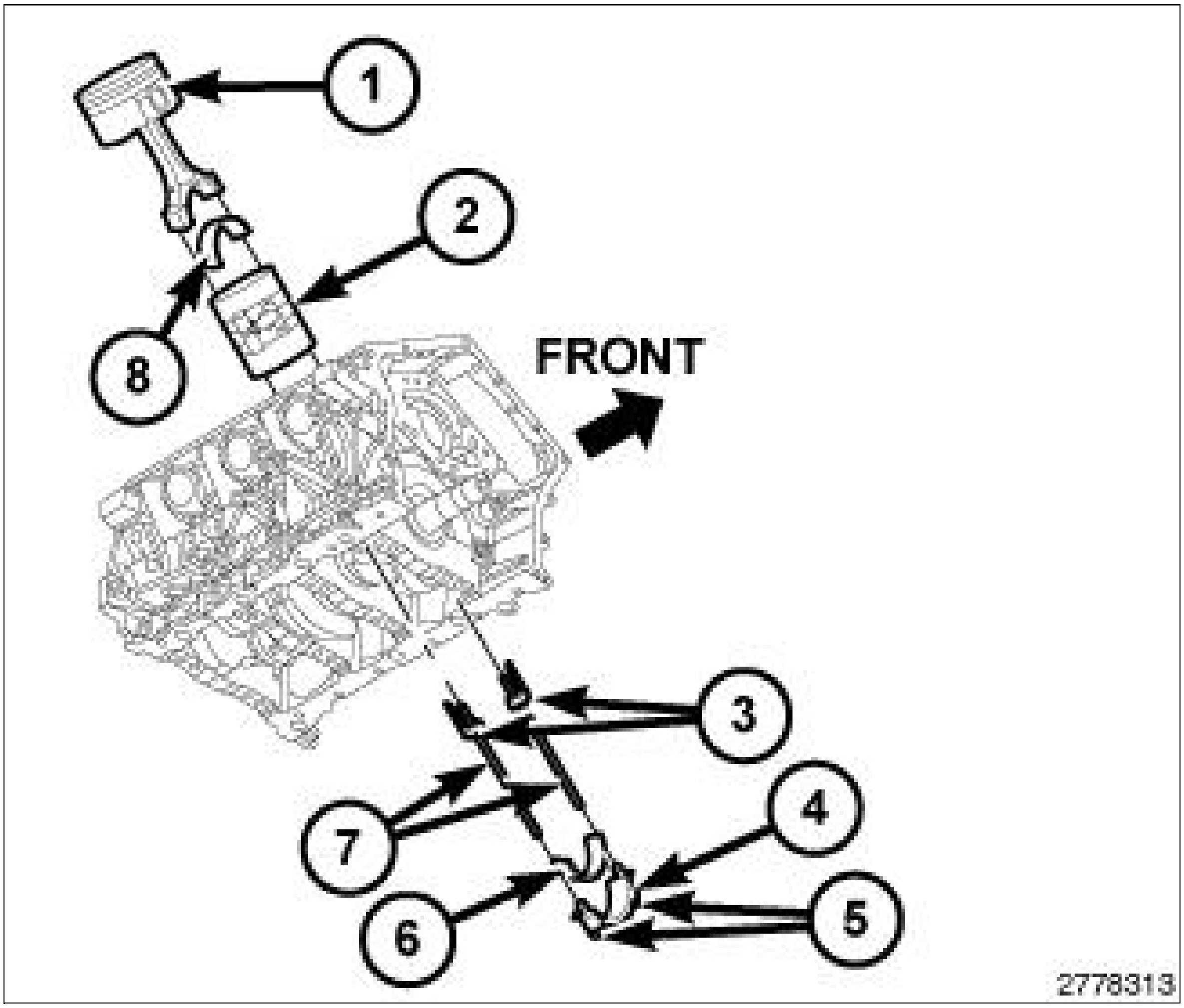
CAUTION:

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 4: 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.

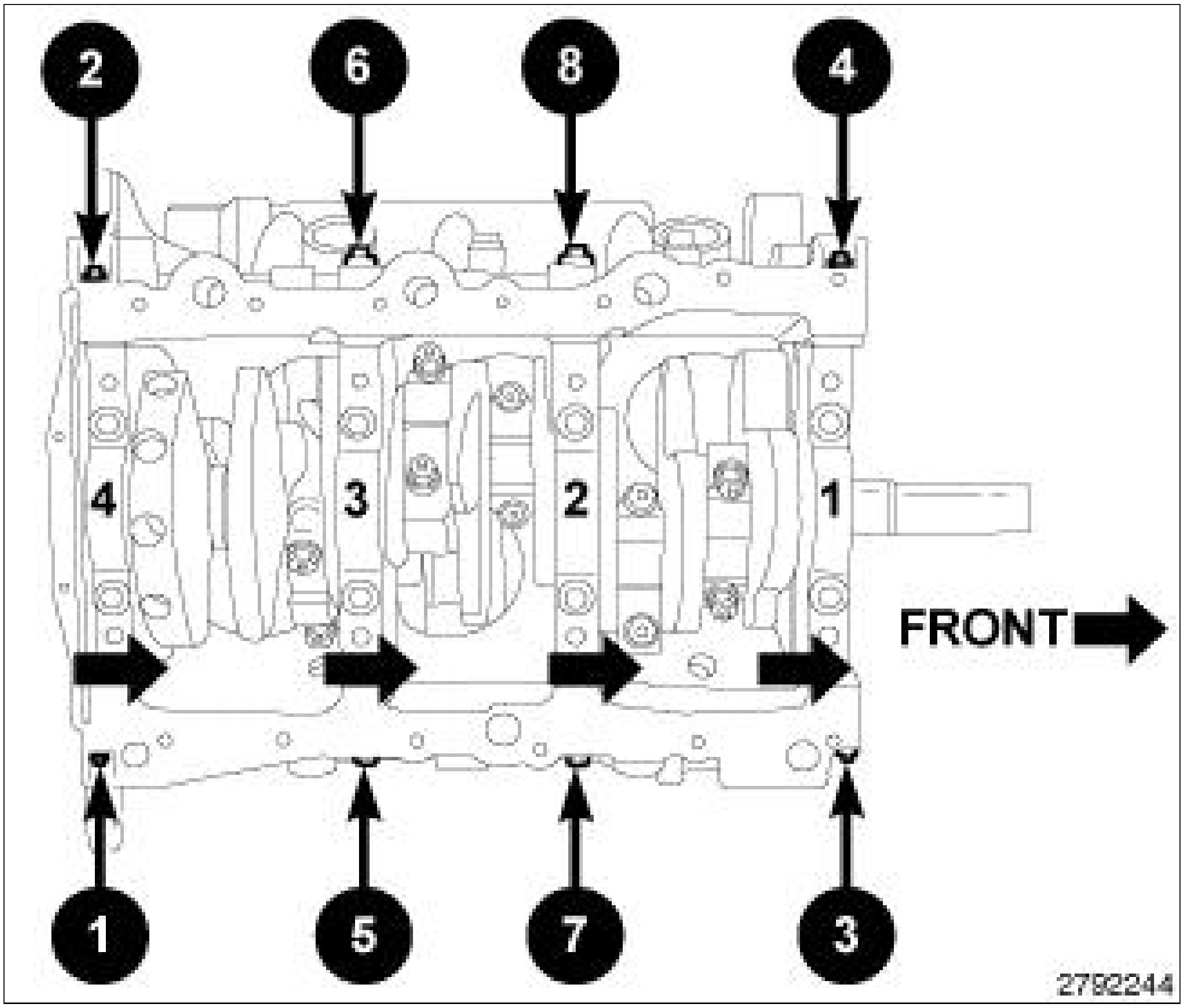
> *CAUTION:*
>
> *Care must be taken not to nick crankshaft journals, as engine damage may occur.*

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 5: 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.

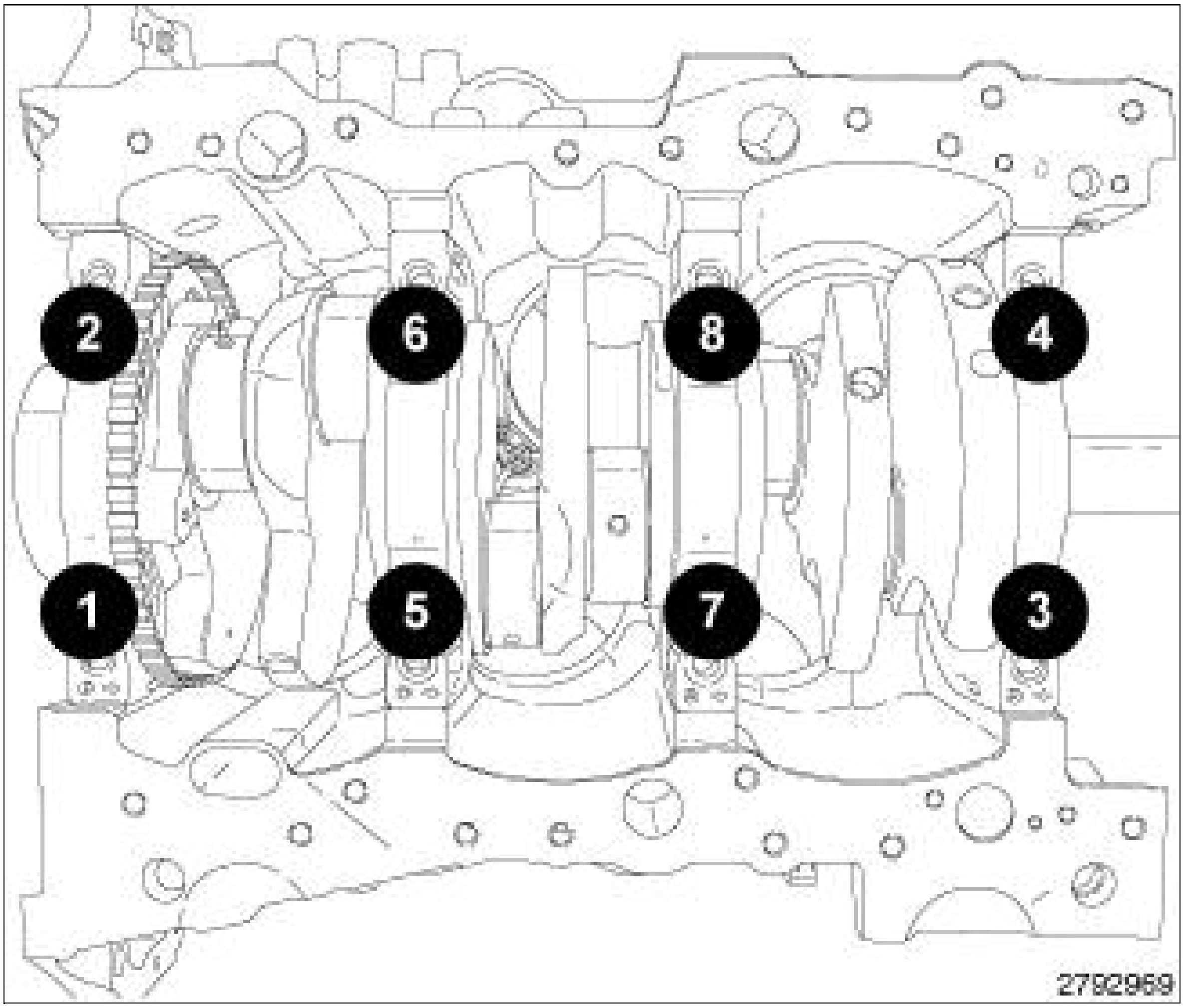
CAUTION:

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.

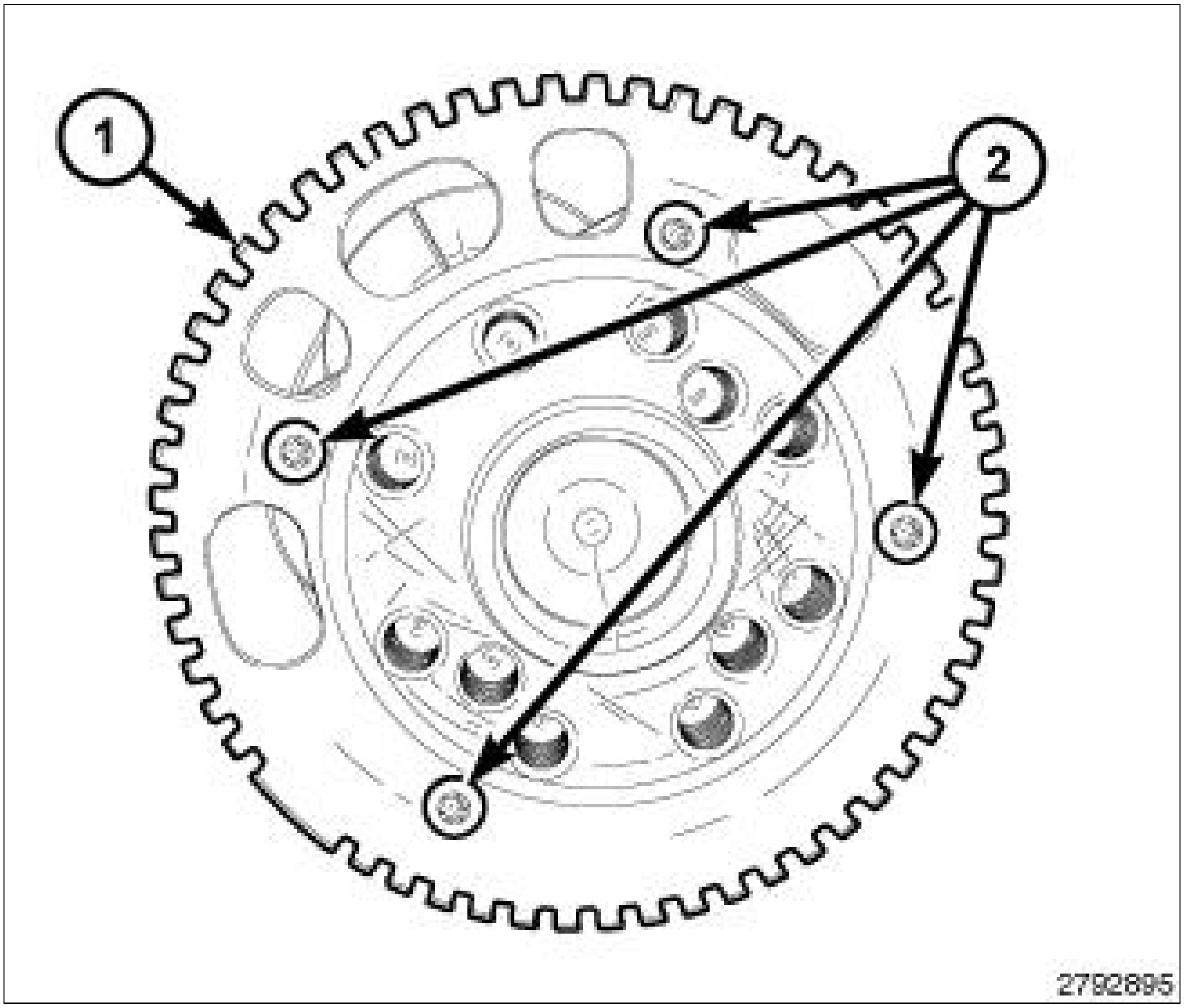
Fig 6: Main Bearing Cap Bolts Removal Sequence



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.

Fig 7: Target Wheel & Bolts



Courtesy of CHRYSLER GROUP, LLC

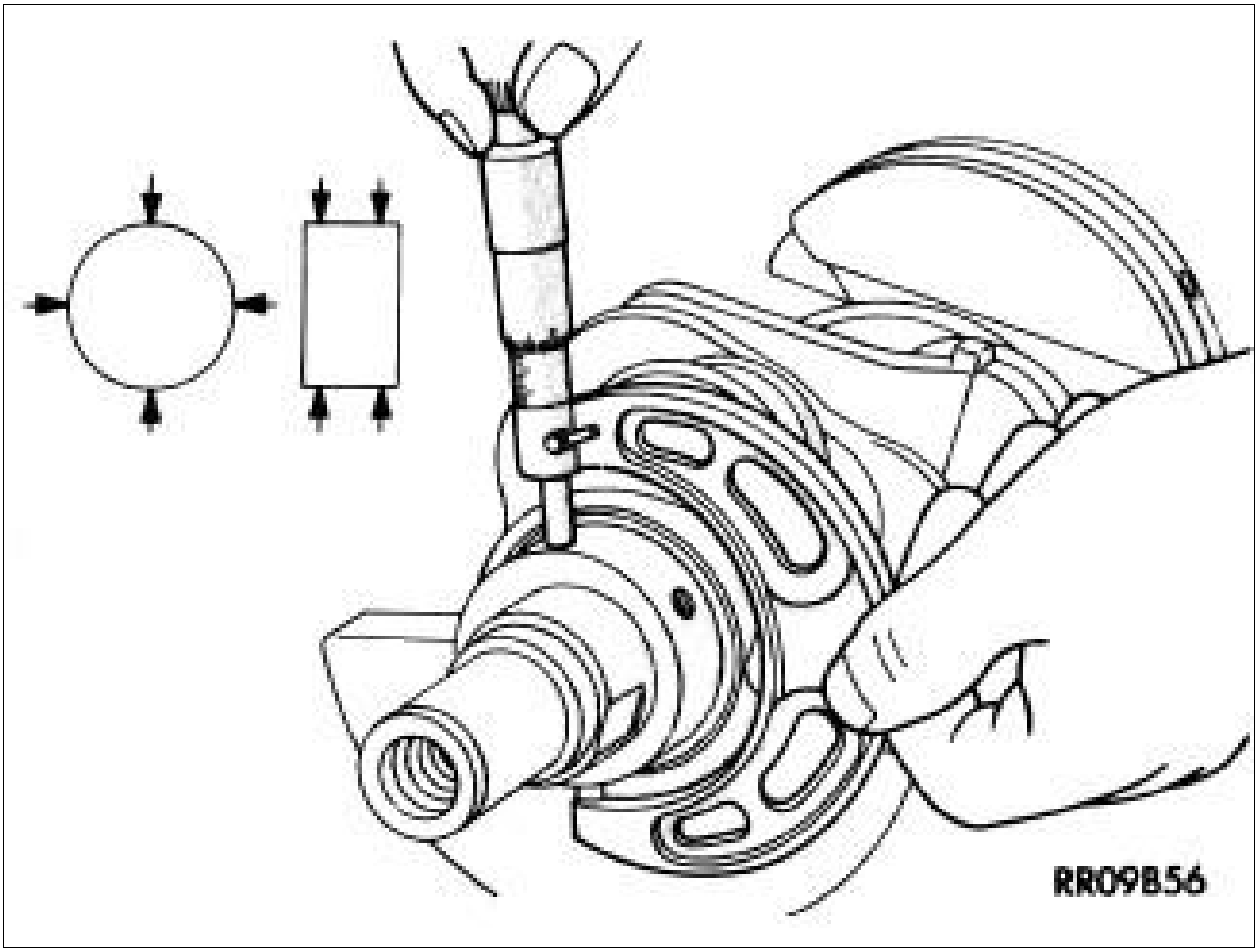
CAUTION:

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.

ENGINE BLOCK > CRANKSHAFT > INSPECTION > INSPECTION

Fig 1: Crankshaft Journal Measurements - Typical



Courtesy of CHRYSLER GROUP, LLC

NOTE:

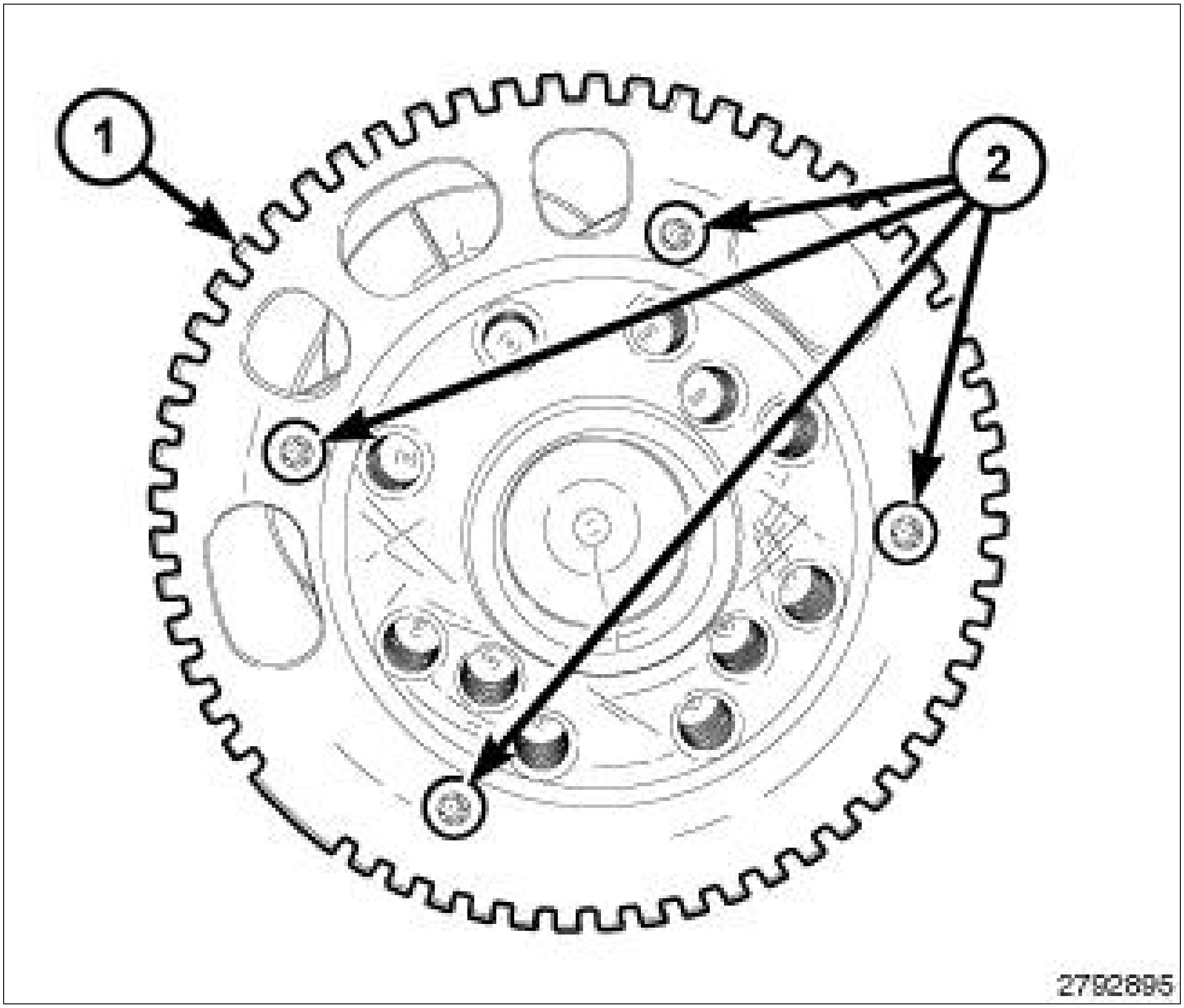
Typical crankshaft journal measurements shown in illustration.

1. Clean the oil off the bearing journals.
2. Determine the maximum diameter of the journals with a micrometer. Measure at two locations 90° apart at each end of the journals.
3. Compare the measured rod journal diameter to the crankshaft connecting rod bearing journal diameter grade marking chart. Refer to STANDARD PROCEDURE . Select the bearing size that corresponds to the crankshaft markings for each rod bearing journal that will provide the proper oil clearance.
4. Compare the measured main bearing journal diameter to the crankshaft main bearing journal diameter grade marking chart. Refer to STANDARD PROCEDURE . Obtain the main bearing journal grade identification marks from the engine block and select the upper and lower main bearing sizes that will provide the proper oil clearance.

5. For connecting rod journals, verify that the maximum taper and maximum out of round are within specifications. Refer to ENGINE SPECIFICATIONS .
6. For main bearing journals, verify that the maximum taper and maximum out of round are within specifications. Refer to ENGINE SPECIFICATIONS .

ENGINE BLOCK > CRANKSHAFT > INSTALLATION > INSTALLATION

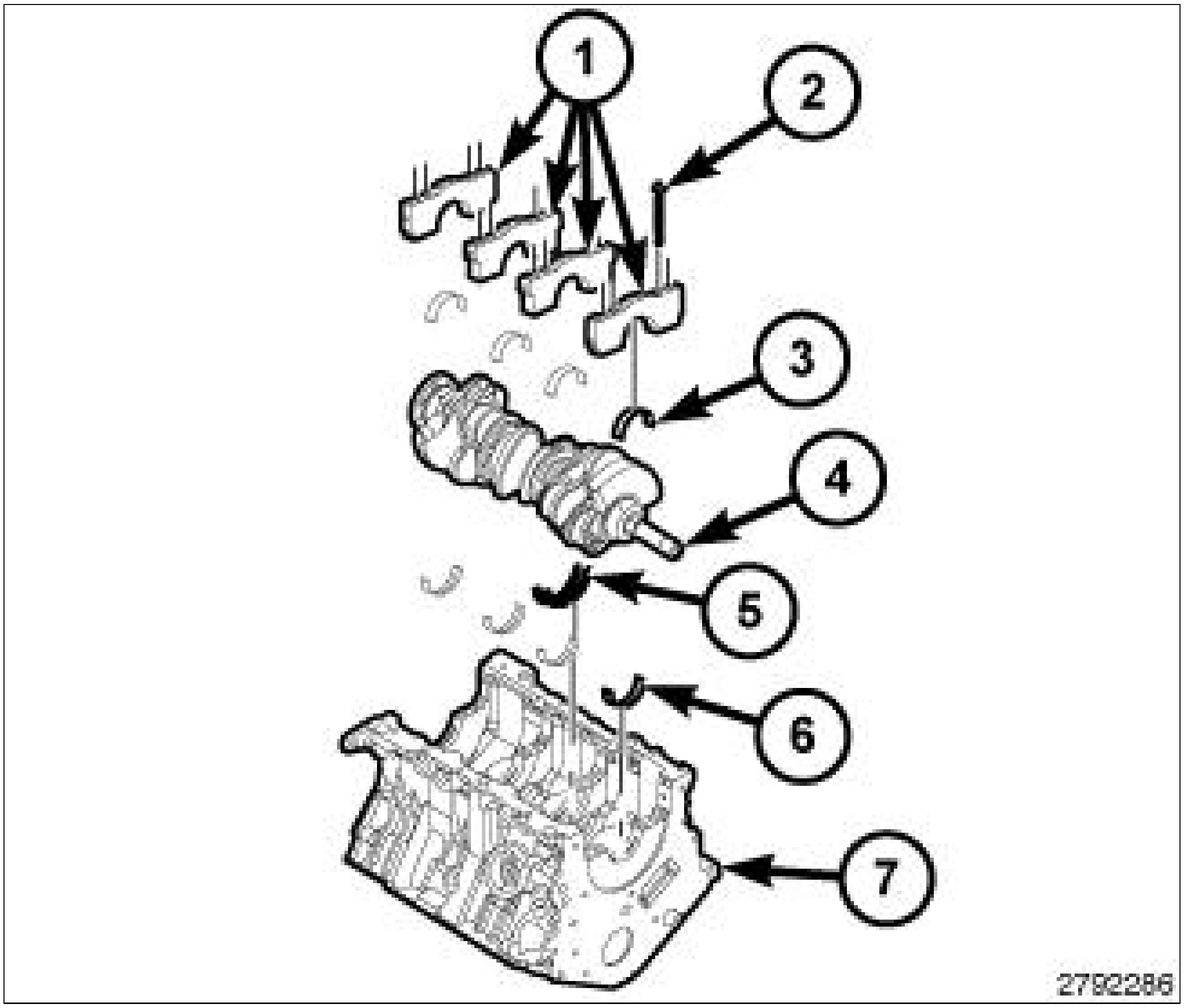
Fig 1: Target Wheel & Bolts



Courtesy of CHRYSLER GROUP, LLC

1. If required, select and fit new crankshaft main bearings to the engine block. Refer to STANDARD PROCEDURE .
2. If required, select and fit new bearings to the connecting rod. Refer to 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 the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 2: Main Bearing Caps, Bolts, Crankshaft & Engine Block



Courtesy of CHRYSLER GROUP, LLC

NOTE:

Typical V6 engine configuration shown in illustration.

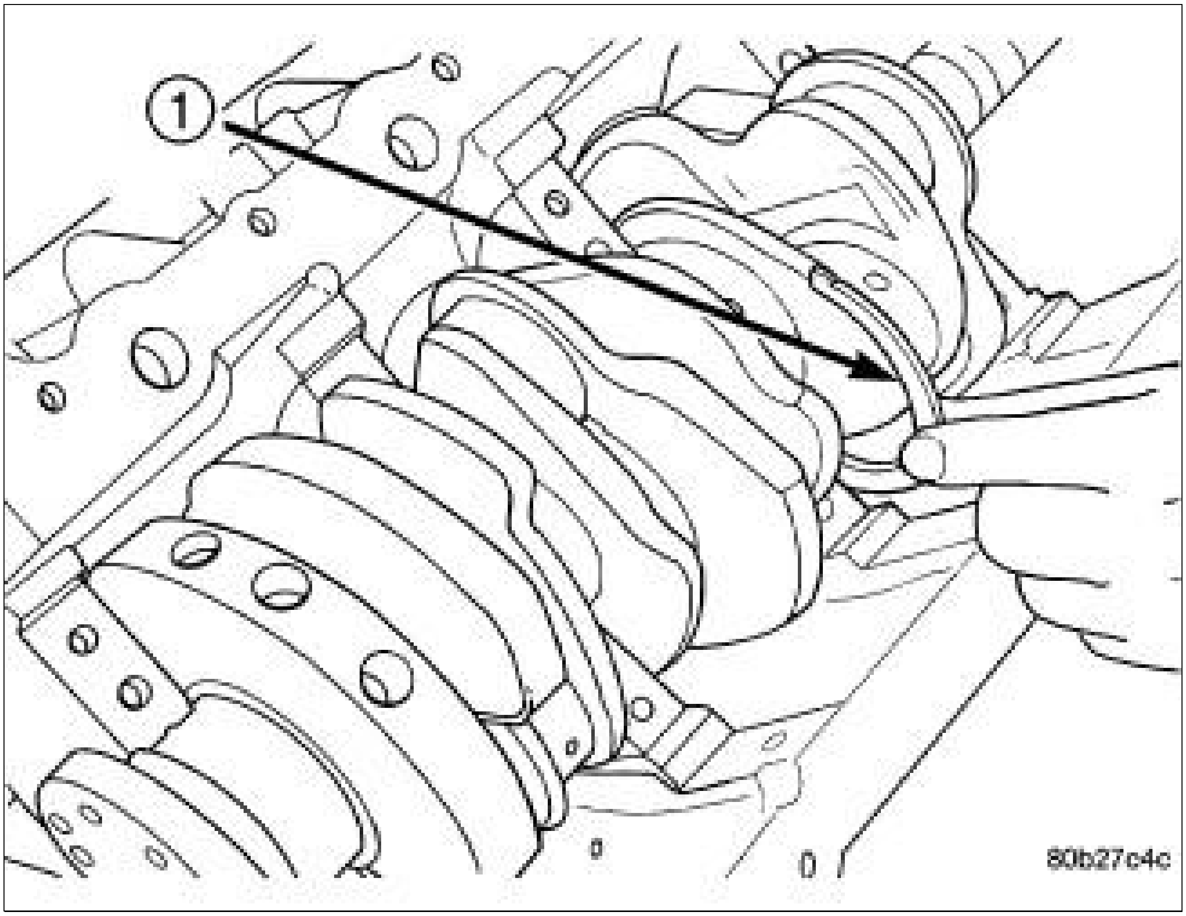
4. If removed, lubricate and install the upper main bearing halves (6) into the engine block (7).

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 3: Thrust Washer Installation



Courtesy of CHRYSLER GROUP, LLC

NOTE:

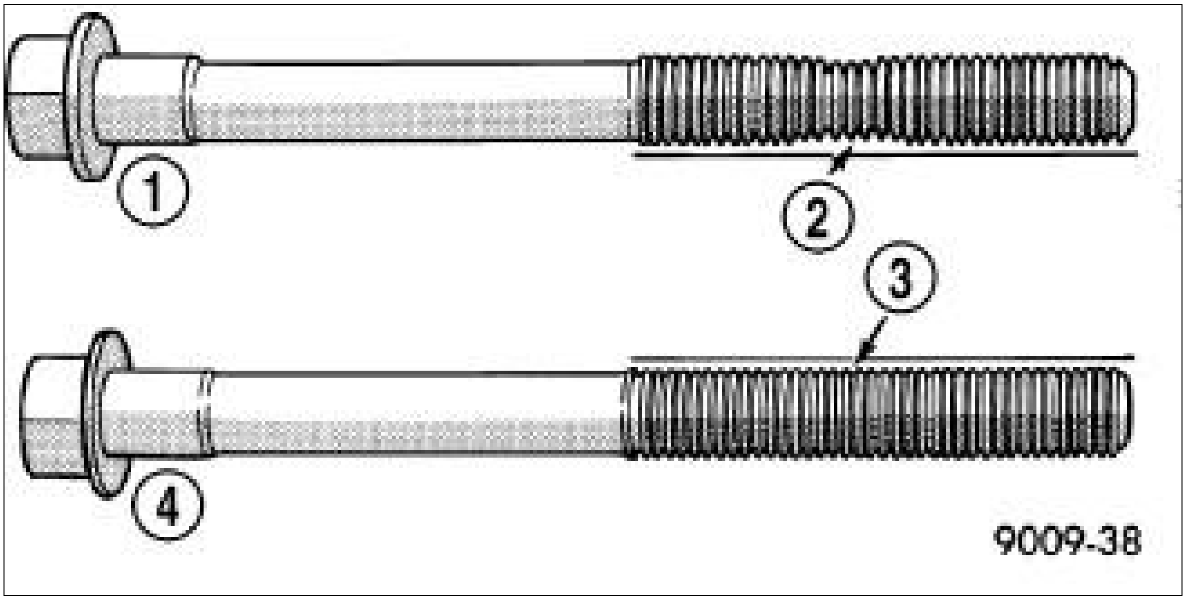
Typical V6 engine configuration shown in illustration.

6. Installing thrust washers (1) at the No. 2 main bearing location, using the following procedure:

    a. 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.

    b. 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 4: Checking Cylinder Head Bolts For Stretching (Necking)



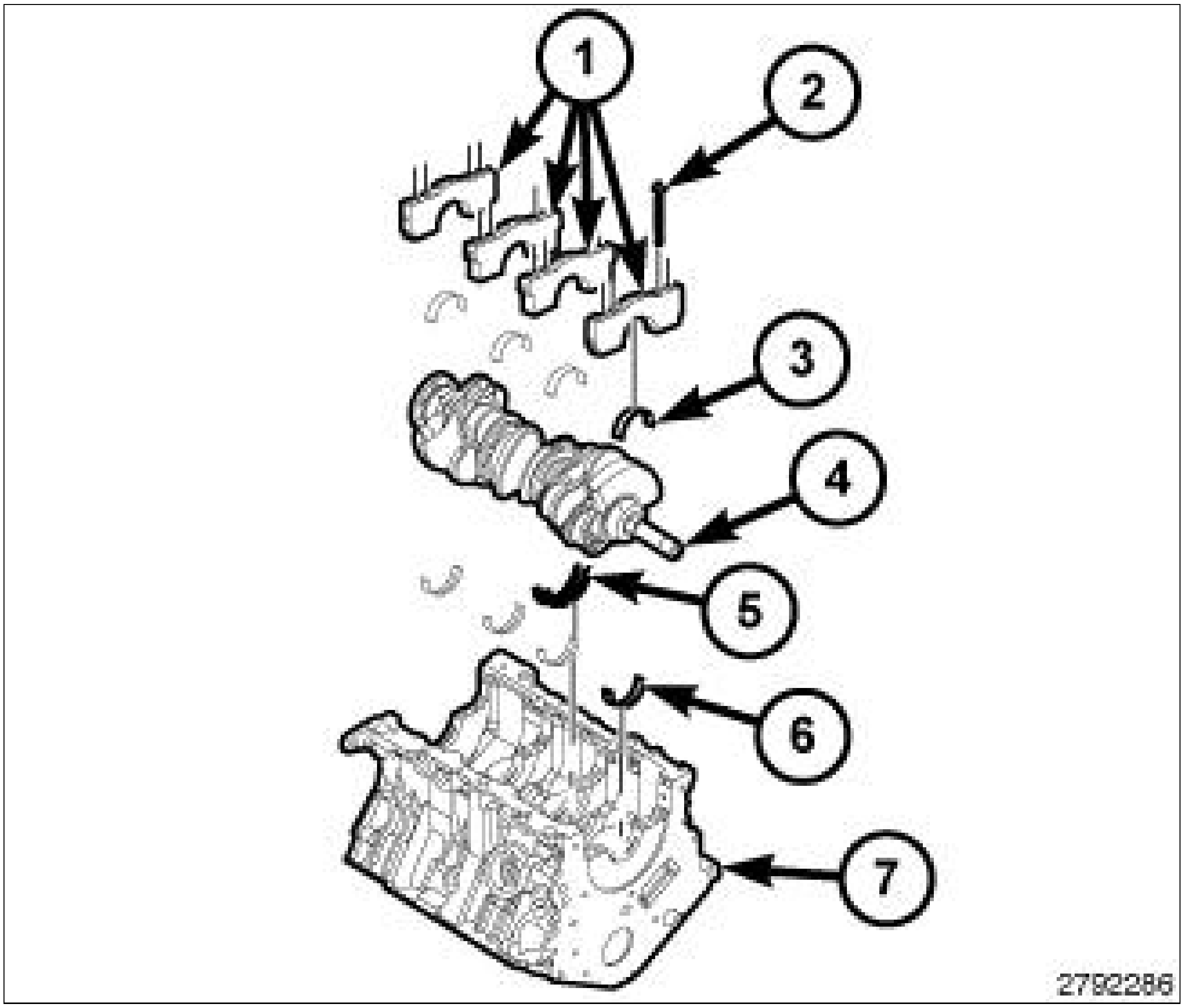
Courtesy of CHRYSLER GROUP, LLC

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.

Fig 5: Main Bearing Caps, Bolts, Crankshaft & Engine Block



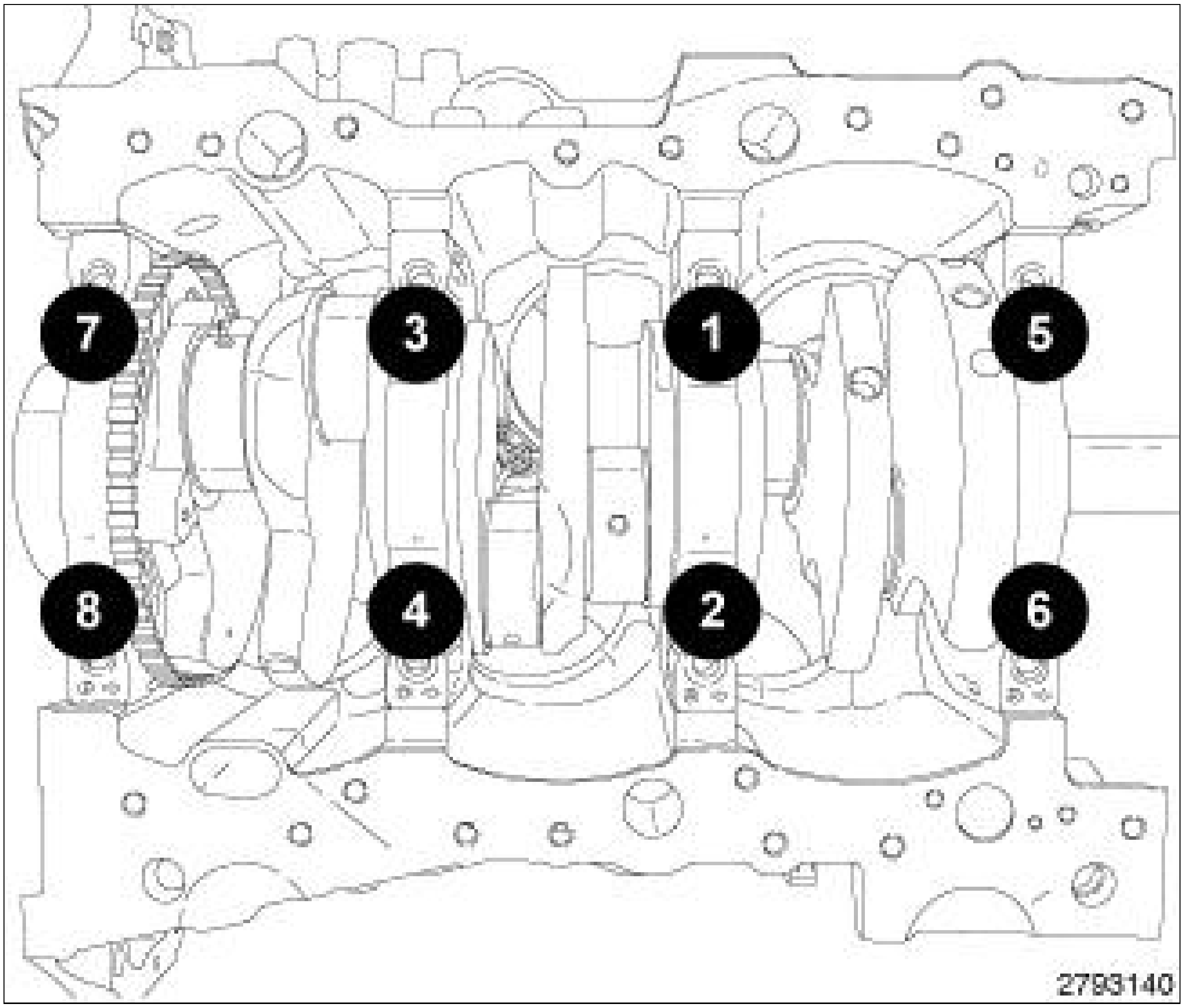
Courtesy of CHRYSLER GROUP, LLC

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).

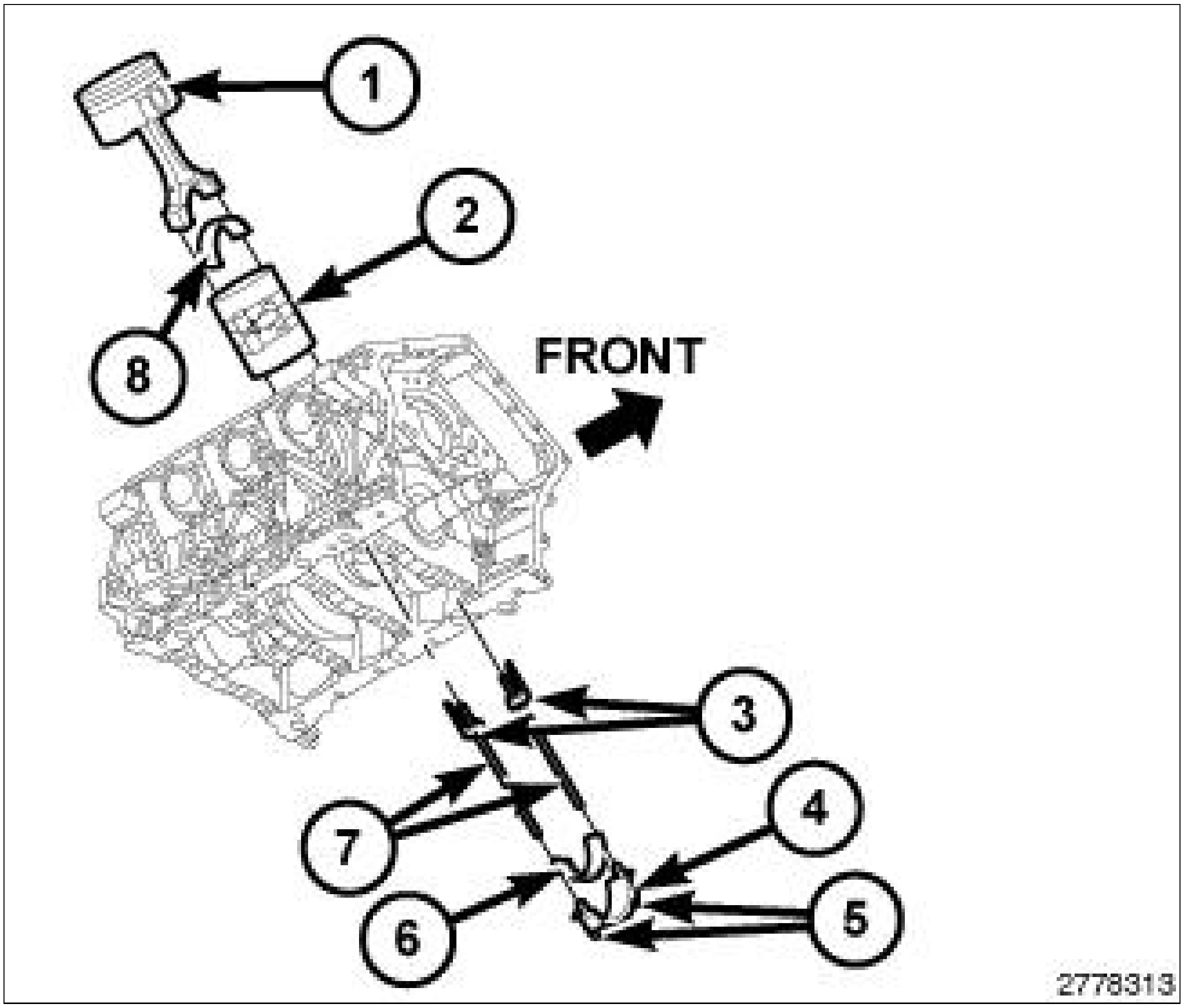
Fig 6: Inner Main Bearing Cap Bolts Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

10. Tighten the inner main bearing cap bolts in the sequence shown in illustration to the proper specification. Refer to TORQUE SPECIFICATIONS .
11. Measure crankshaft end play. Refer to STANDARD PROCEDURE .

Fig 7: 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.

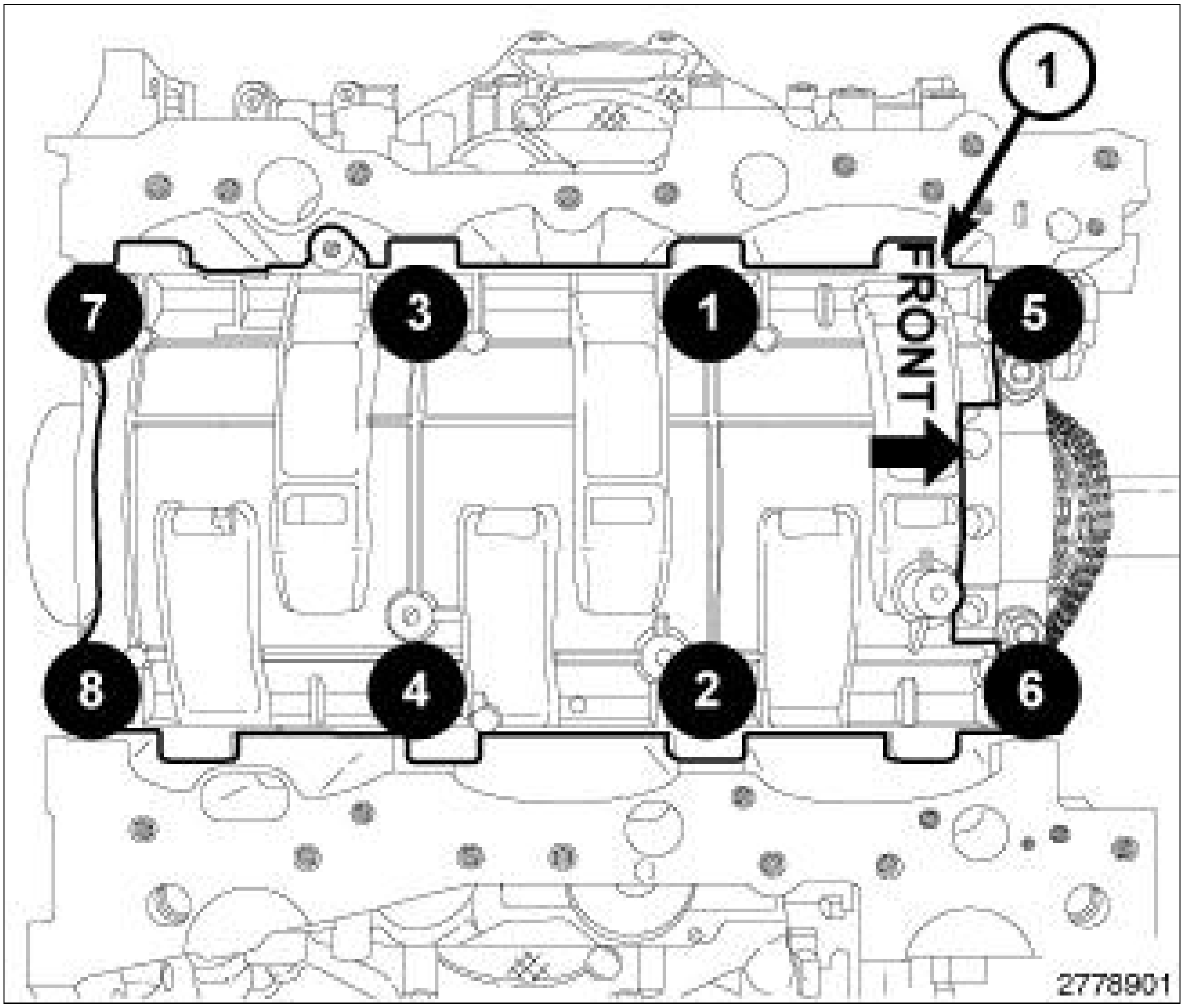
> *CAUTION:*
>
> *The connecting rod bolts must not be reused. Always replace the connecting rod bolts whenever they are loosened or removed.*

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 the proper specification. Refer to TORQUE SPECIFICATIONS .
17. If required, check the connecting rod side clearance. Refer to STANDARD PROCEDURE .
18. Repeat the previous steps for the remaining connecting rods.

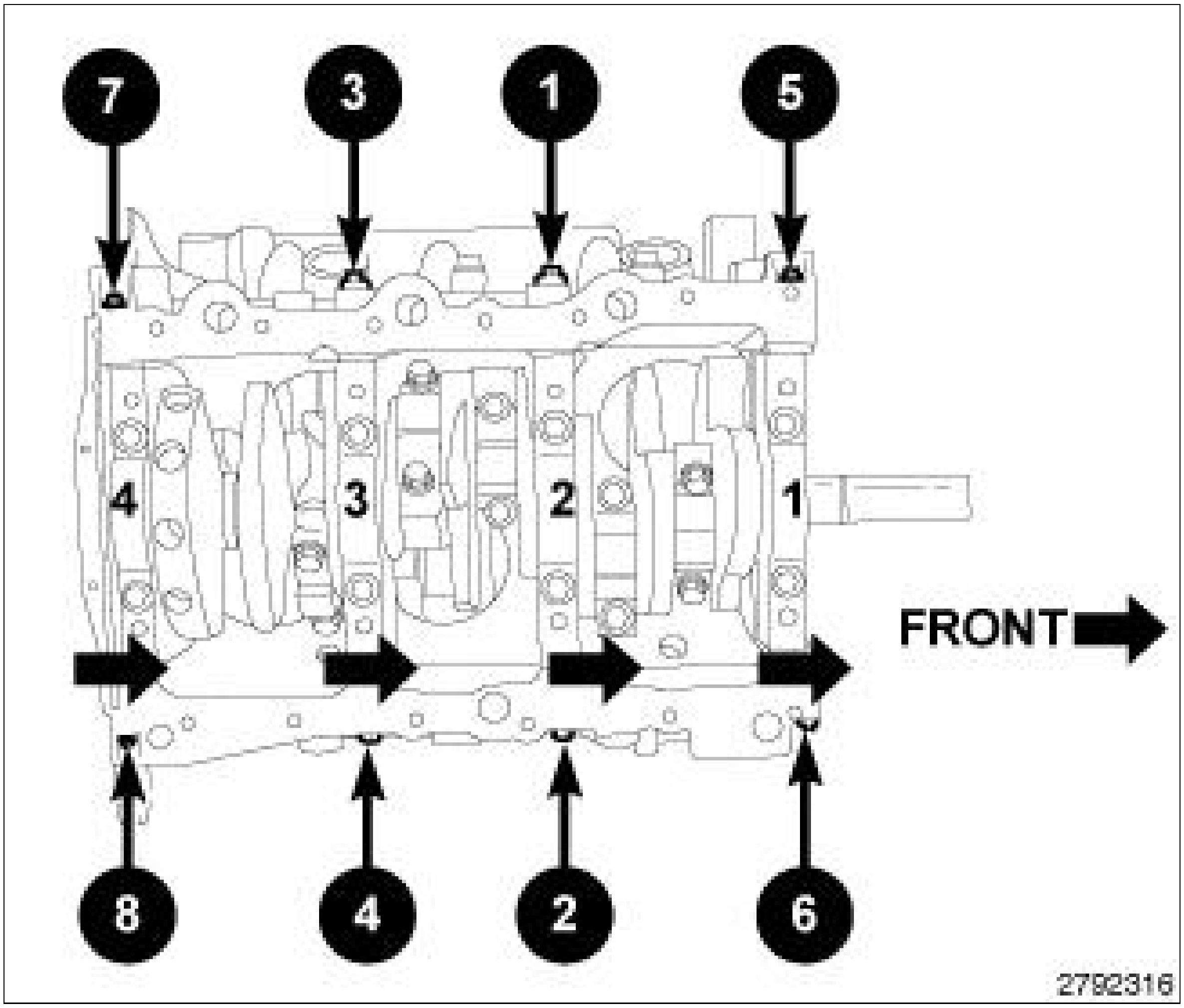
Fig 8: Windage Tray With Main Bearing Cap Bolts Installation Sequence



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 the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 9: Main Bearing Tie Bolts Installation Sequence



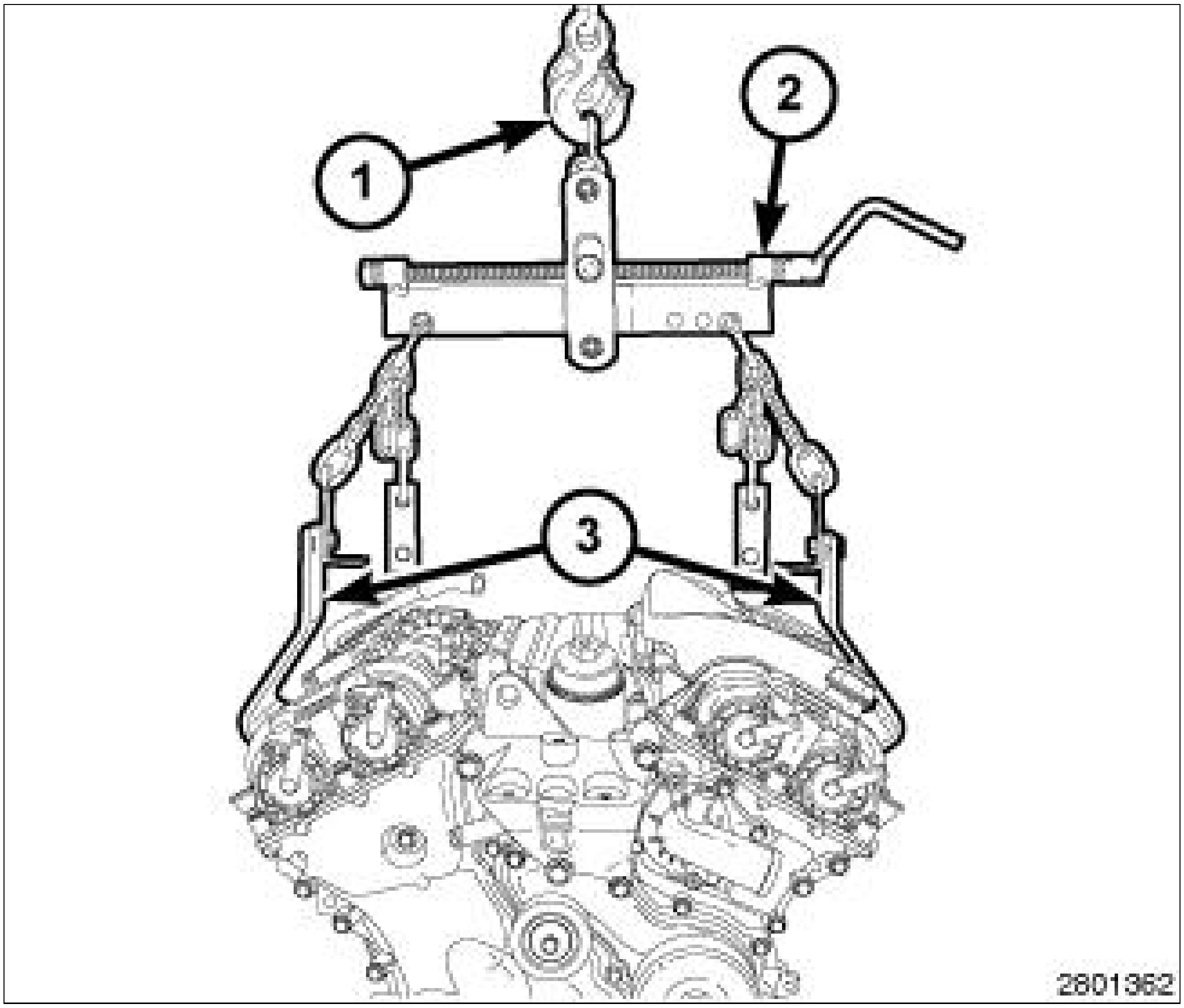
Courtesy of CHRYSLER GROUP, LLC

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 the proper specification. Refer to TORQUE SPECIFICATIONS .
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. Refer to CHAIN AND SPROCKETS, TIMING, INSTALLATION .

Fig 10: Lifting Sling, Engine Lifting Brackets & Engine Hoist



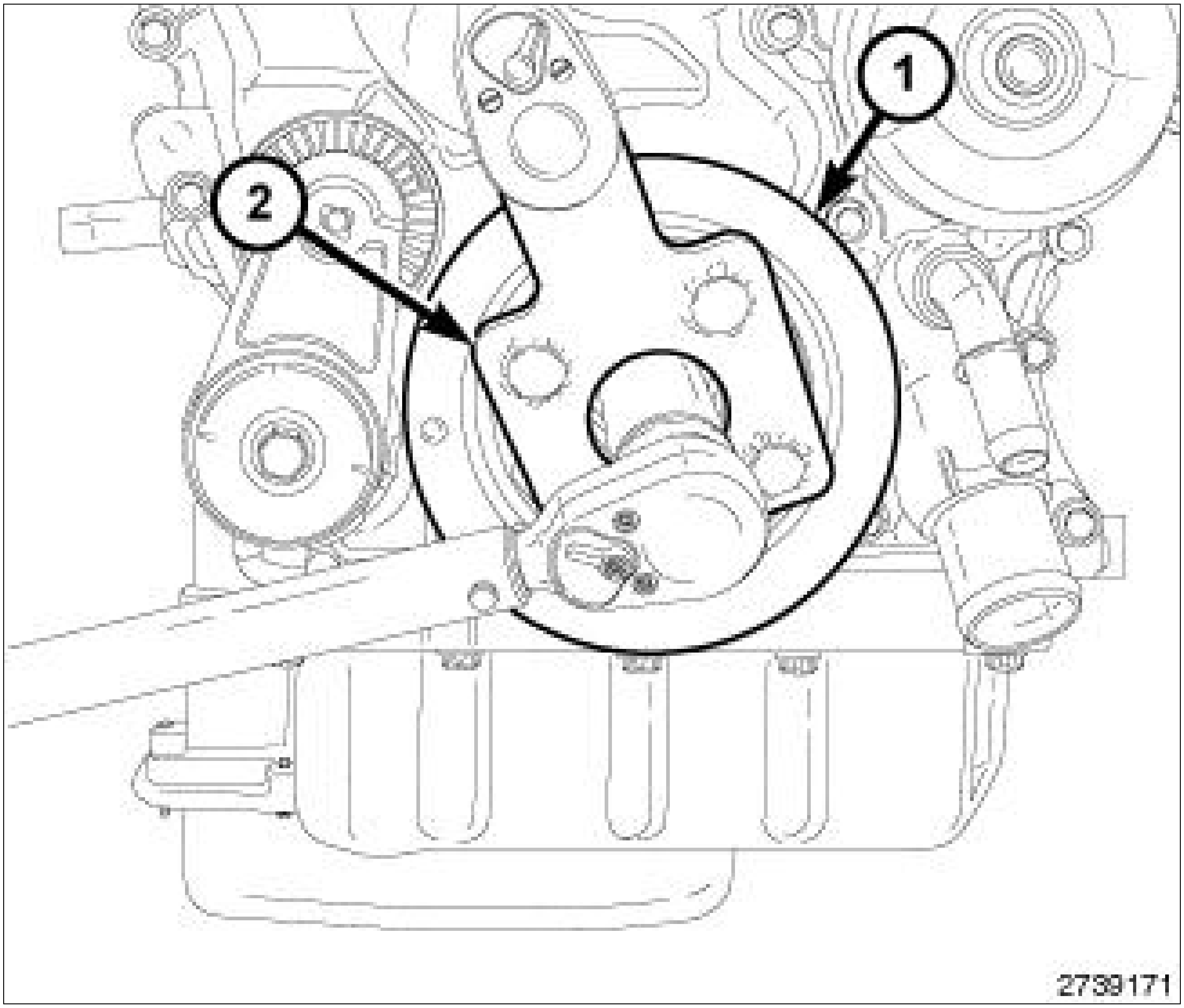
Courtesy of CHRYSLER GROUP, LLC

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 STANDARD PROCEDURE .
26. Connect the negative battery cable.
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.*

ENGINE BLOCK > DAMPER, VIBRATION > REMOVAL > REMOVAL

Fig 1: Crankshaft Vibration Damper & Vibration Damper Holder



Courtesy of CHRYSLER GROUP, LLC

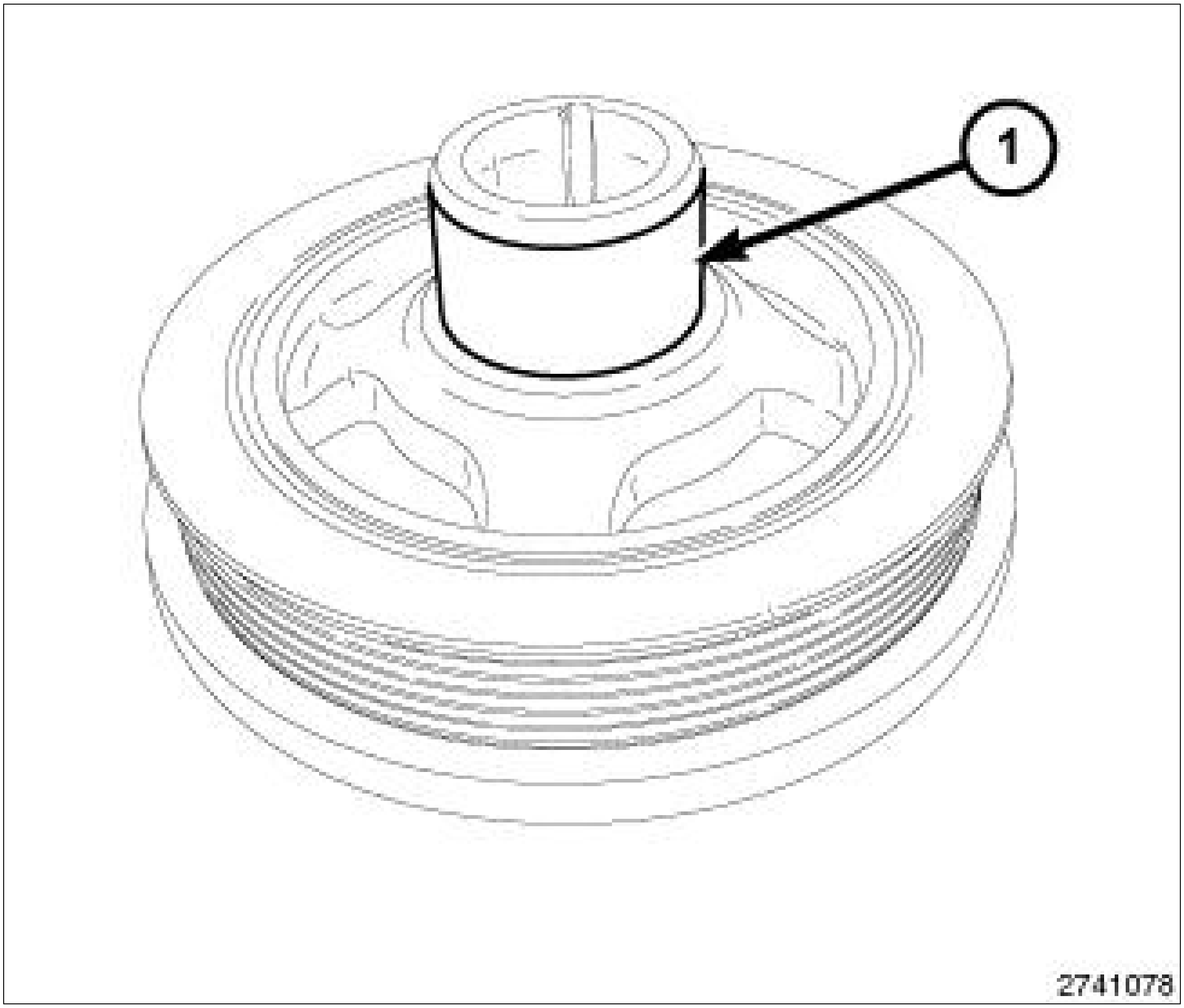
1. Remove the accessory drive belt. Refer to BELT, SERPENTINE, REMOVAL .

> *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.

ENGINE BLOCK > DAMPER, VIBRATION > INSTALLATION > INSTALLATION

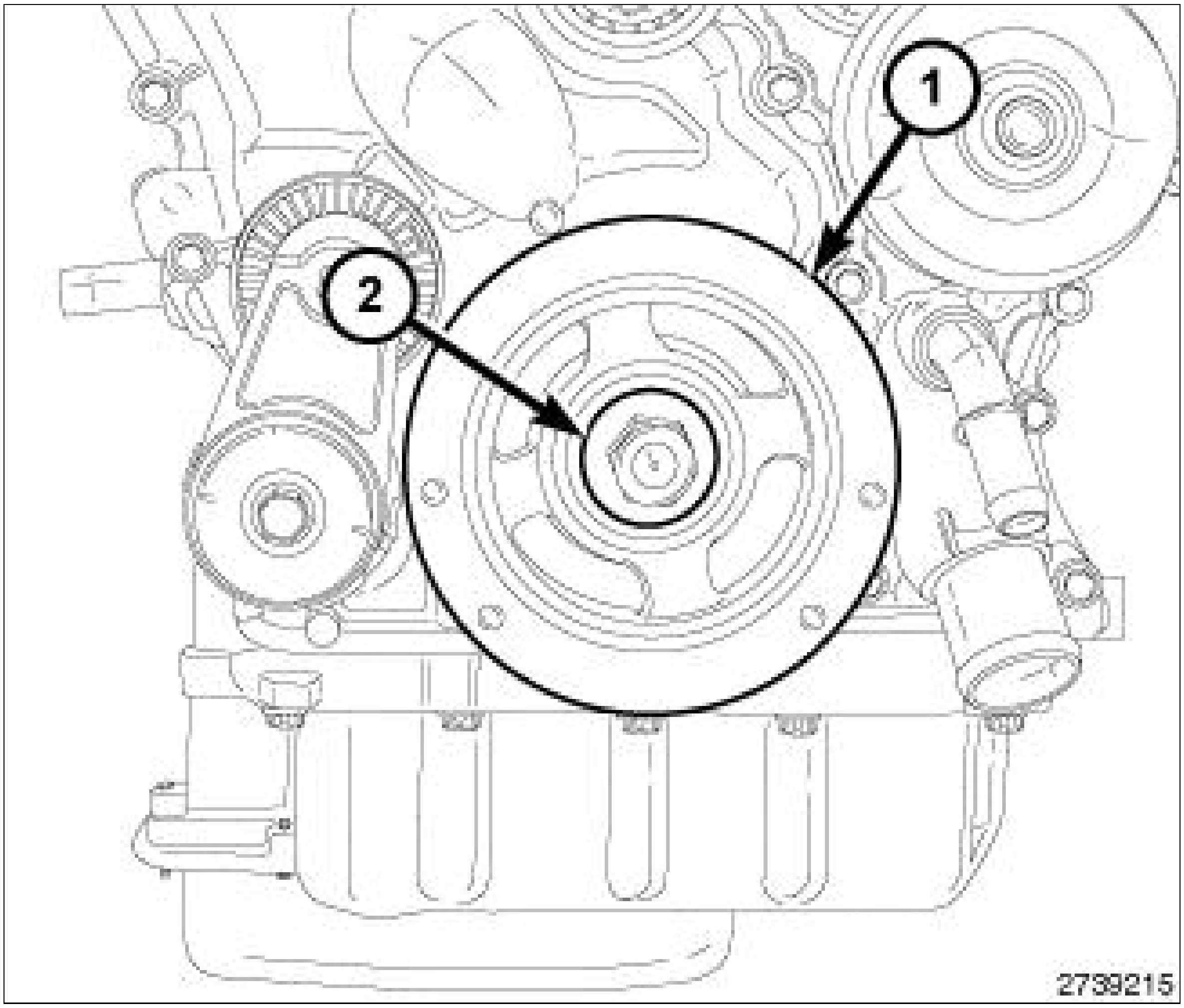
Fig 1: Front Crankshaft Seal Surface



Courtesy of CHRYSLER GROUP, LLC

1. Ensure that the front crankshaft seal surface (1) is clean and free of any dust, dirt, or debris.

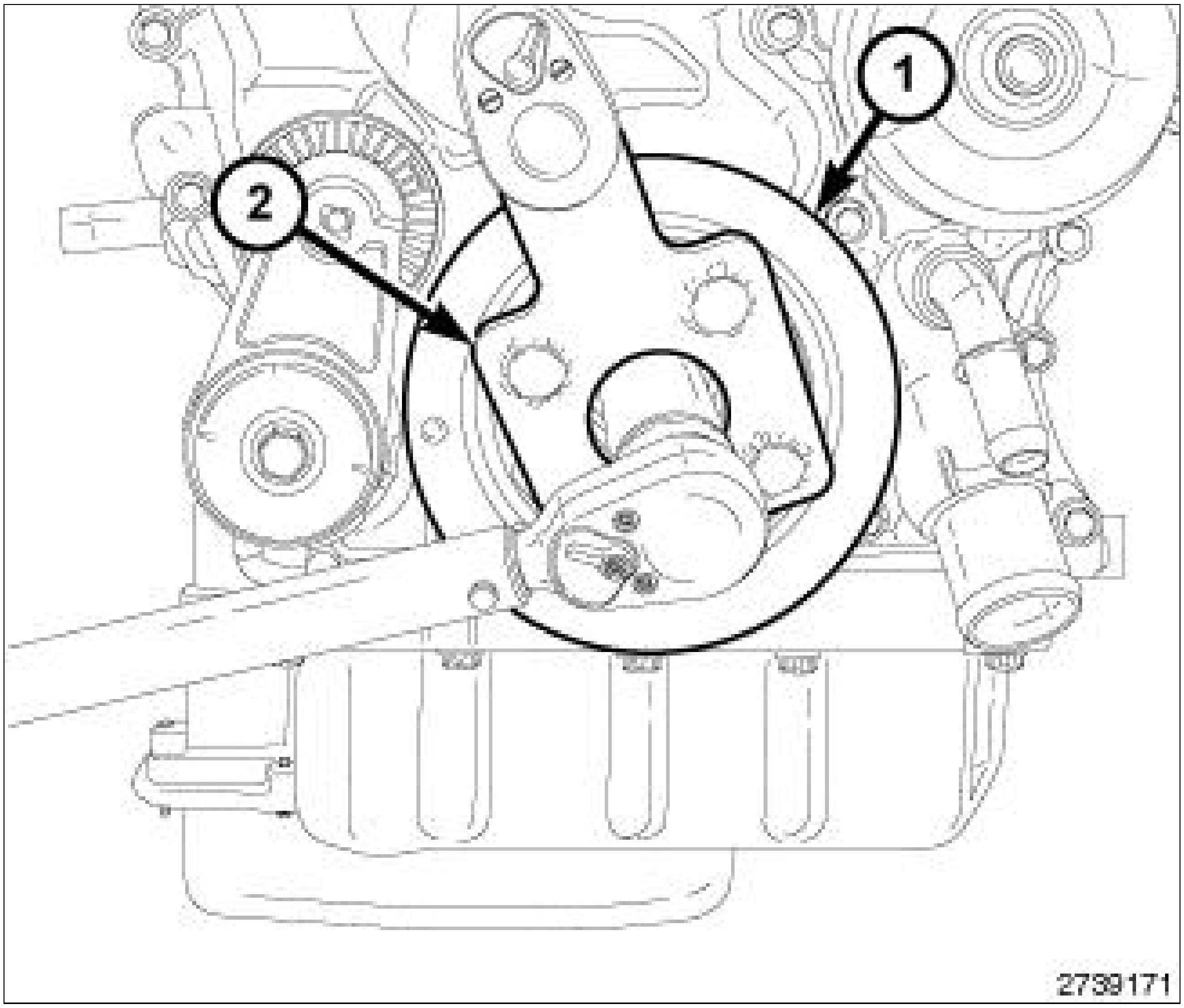
Fig 2: Crankshaft Vibration Damper & Bolt



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 3: Crankshaft Vibration Damper & Vibration Damper Holder



Courtesy of CHRYSLER GROUP, LLC

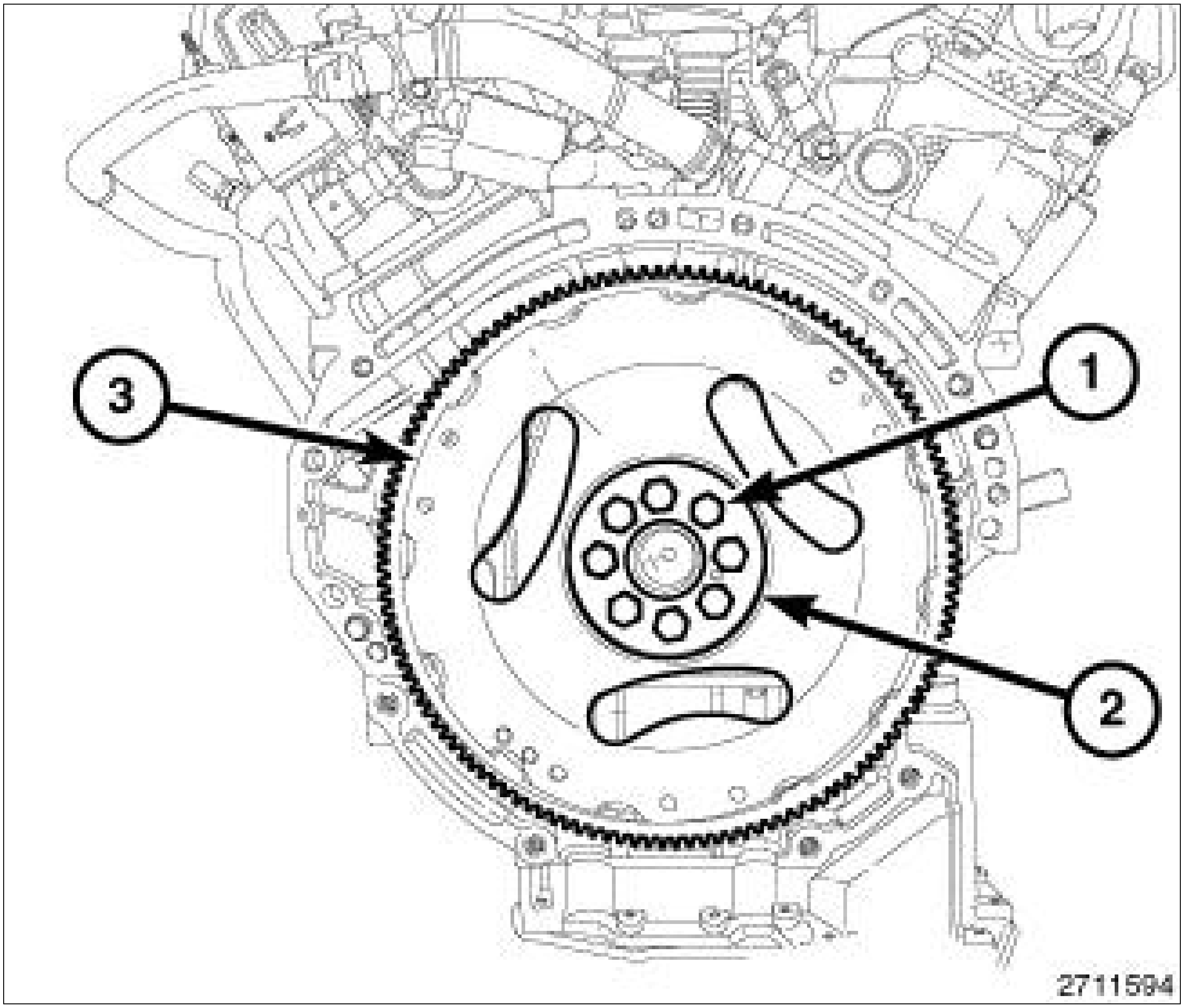
4. Hold the crankshaft vibration damper (1) with Vibration Damper Holder (special tool #10198, Holder, Vibration Damper) (2) and tighten the crankshaft vibration damper bolt to the proper specification.

   Refer to TORQUE SPECIFICATIONS .

5. Install the accessory drive belt. Refer to BELT, SERPENTINE, REMOVAL .

ENGINE BLOCK > FLEXPLATE > REMOVAL > REMOVAL

Fig 1: Flexplate, Spacer Plate & Bolts

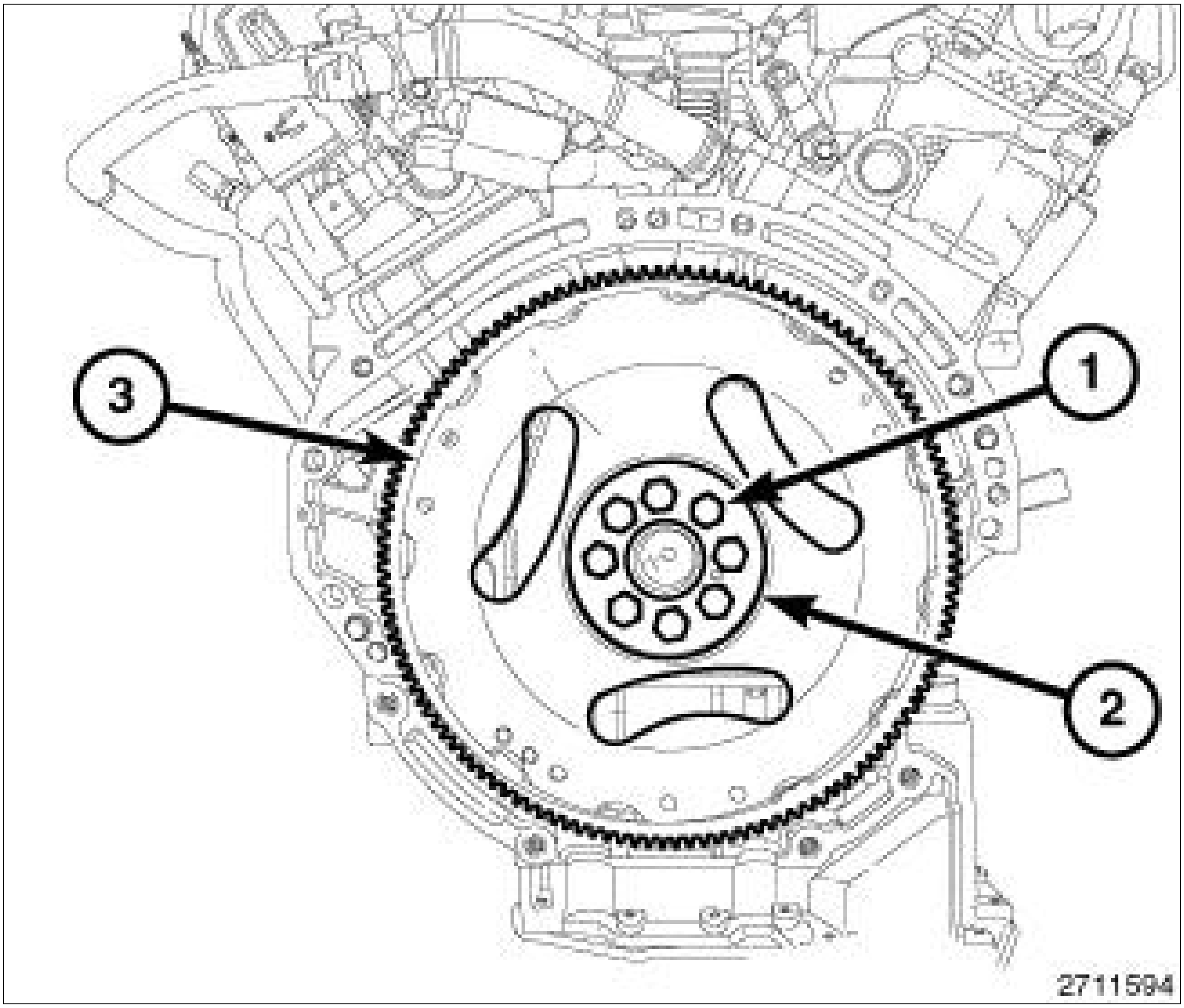


Courtesy of CHRYSLER GROUP, LLC

1. Remove the transmission.
2. Remove the bolts (1).
3. Remove the flexplate (3).

ENGINE BLOCK > FLEXPLATE > INSTALLATION > INSTALLATION

Fig 1: Flexplate, Spacer Plate & Bolts

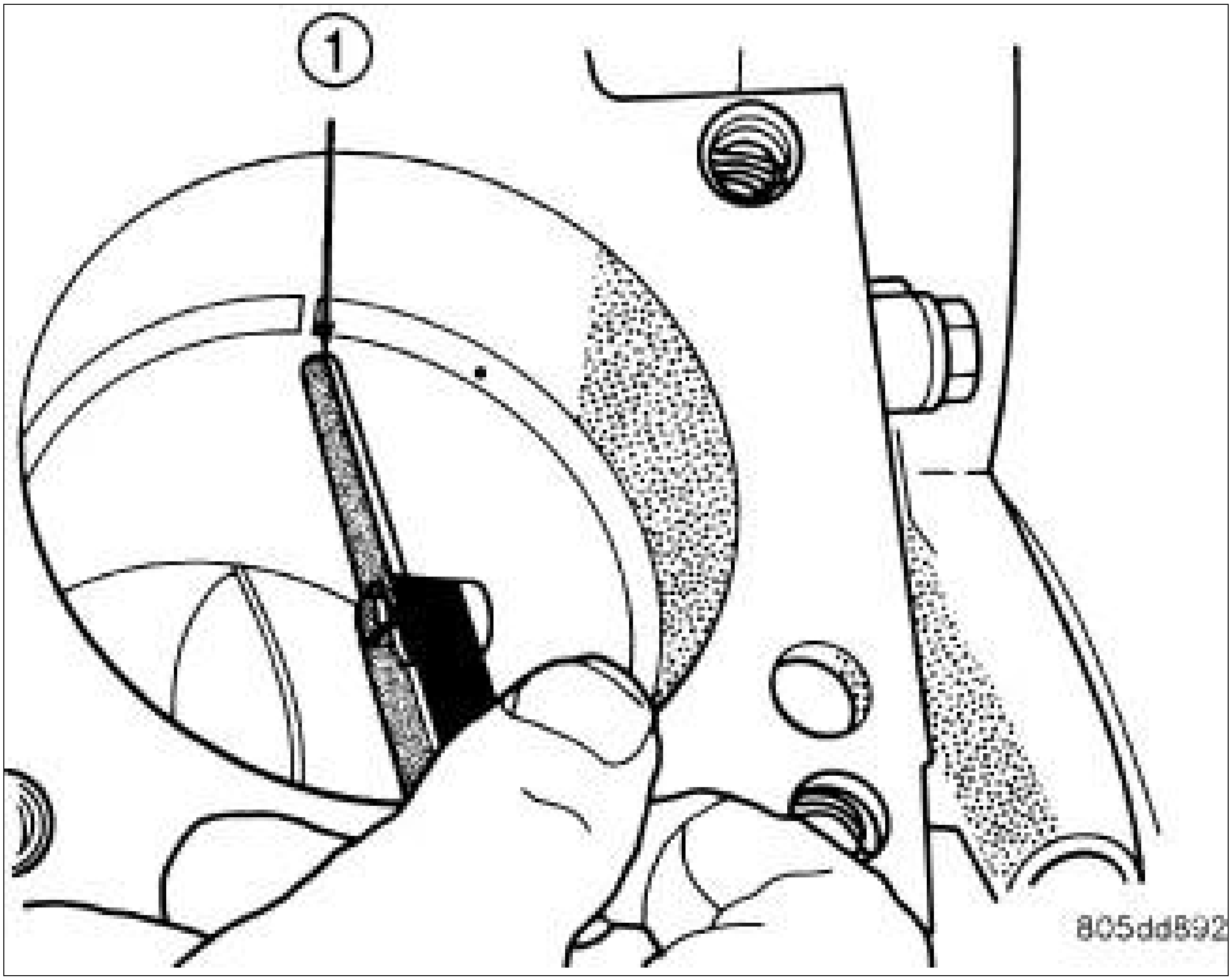


Courtesy of CHRYSLER GROUP, LLC

1. Position the flexplate (3) onto the crankshaft.
2. Install the spacer (2) and the bolts (1) hand tight.
3. Using a crisscross pattern, tighten the flexplate to crankshaft retaining bolts to the proper specification. Refer to TORQUE SPECIFICATIONS .
4. Install the transmission.

ENGINE BLOCK > RING(S), PISTON > STANDARD PROCEDURE > STANDARD PROCEDURE - PISTON RING FITTING

Fig 1: Measuring Piston Ring End Gap

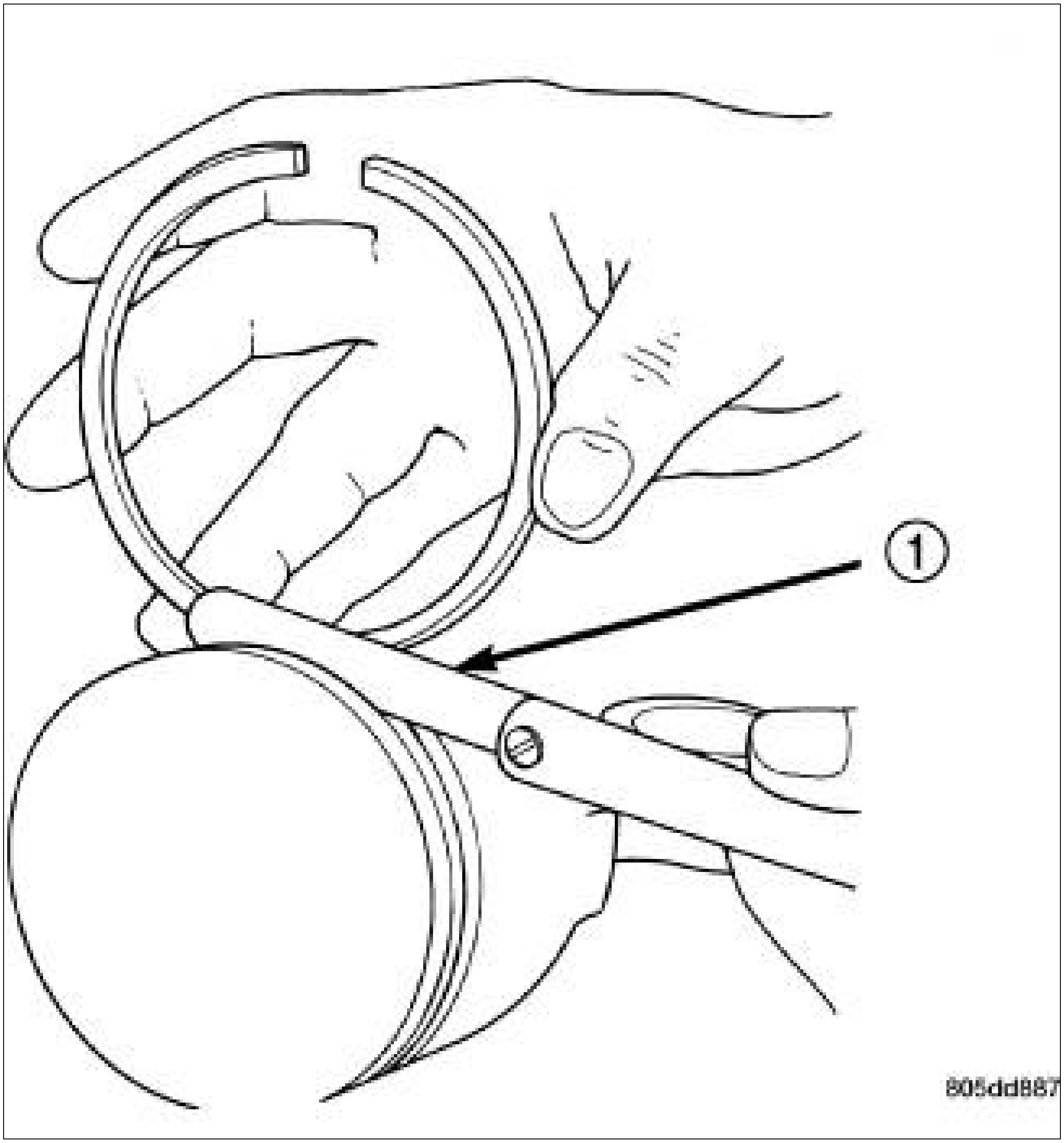


Courtesy of CHRYSLER GROUP, LLC

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 2: Checking Piston Ring Grooves Clearances



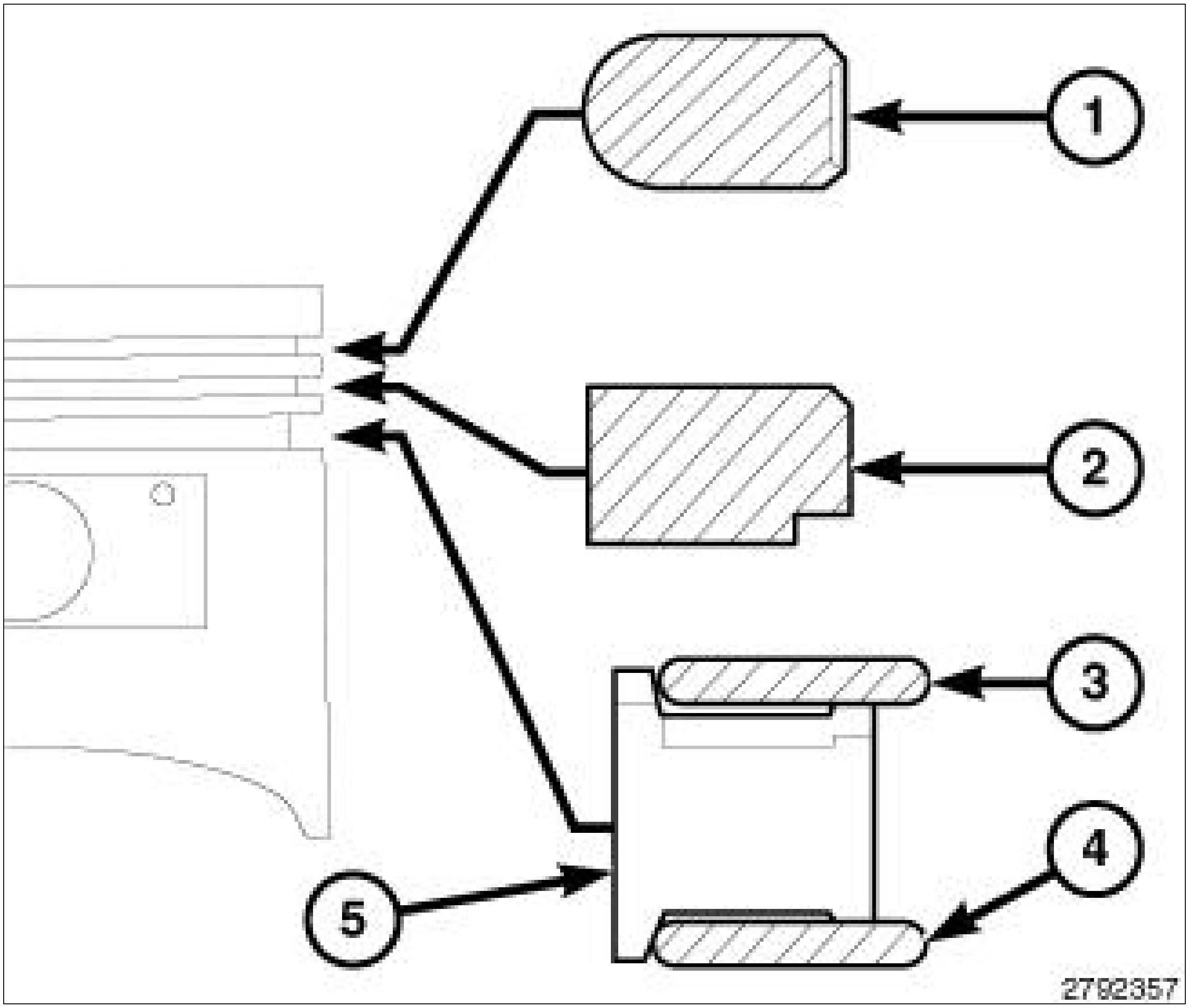
Courtesy of CHRYSLER GROUP, LLC

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.)

ENGINE BLOCK > RING(S), PISTON > REMOVAL > REMOVAL

Fig 1: 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:

1. *No. 1 (upper) piston ring (1)*

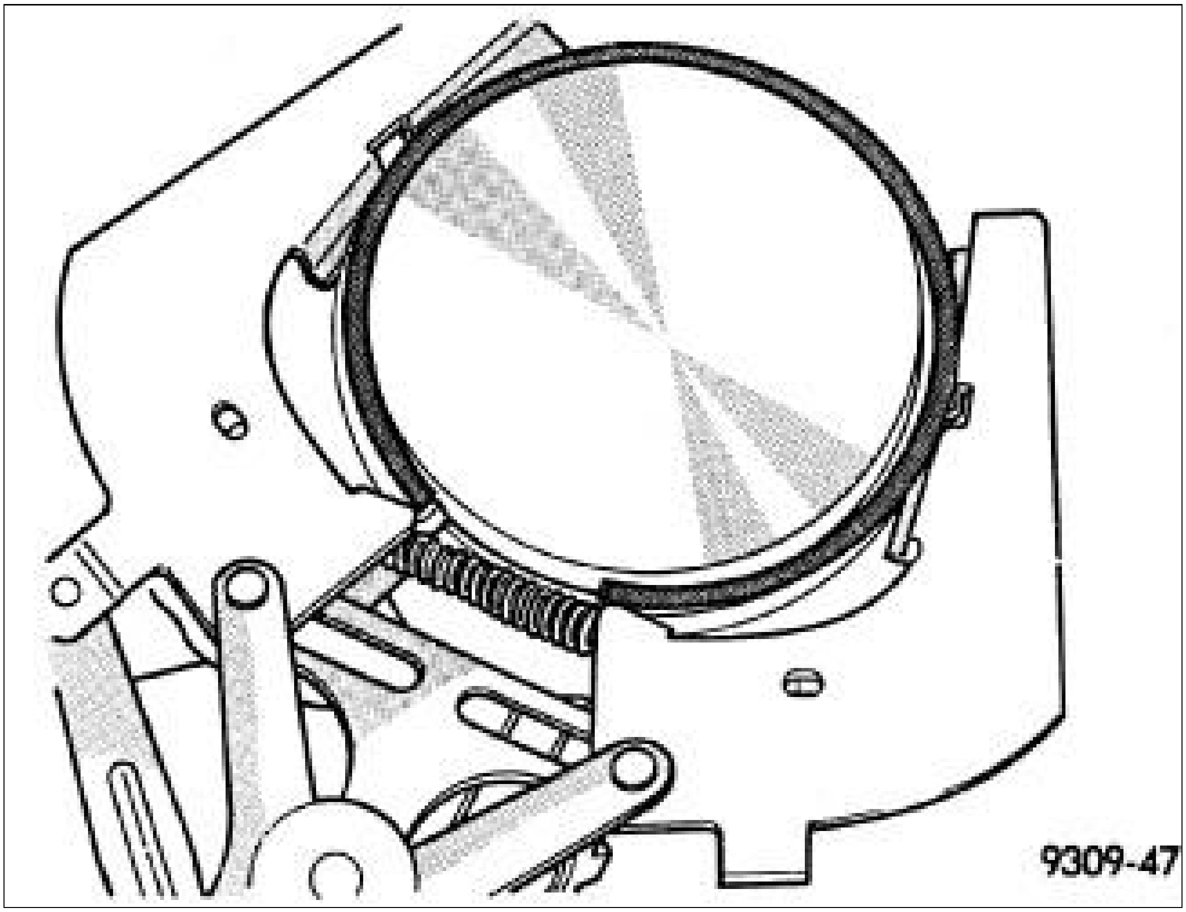
2. No. 2 (intermediate) piston ring (2)

3. Oil ring upper side rail (3)

4. Oil ring lower side rail (4)

5. Oil ring expander (5)

Fig 2: Installing Intermediate Piston Ring

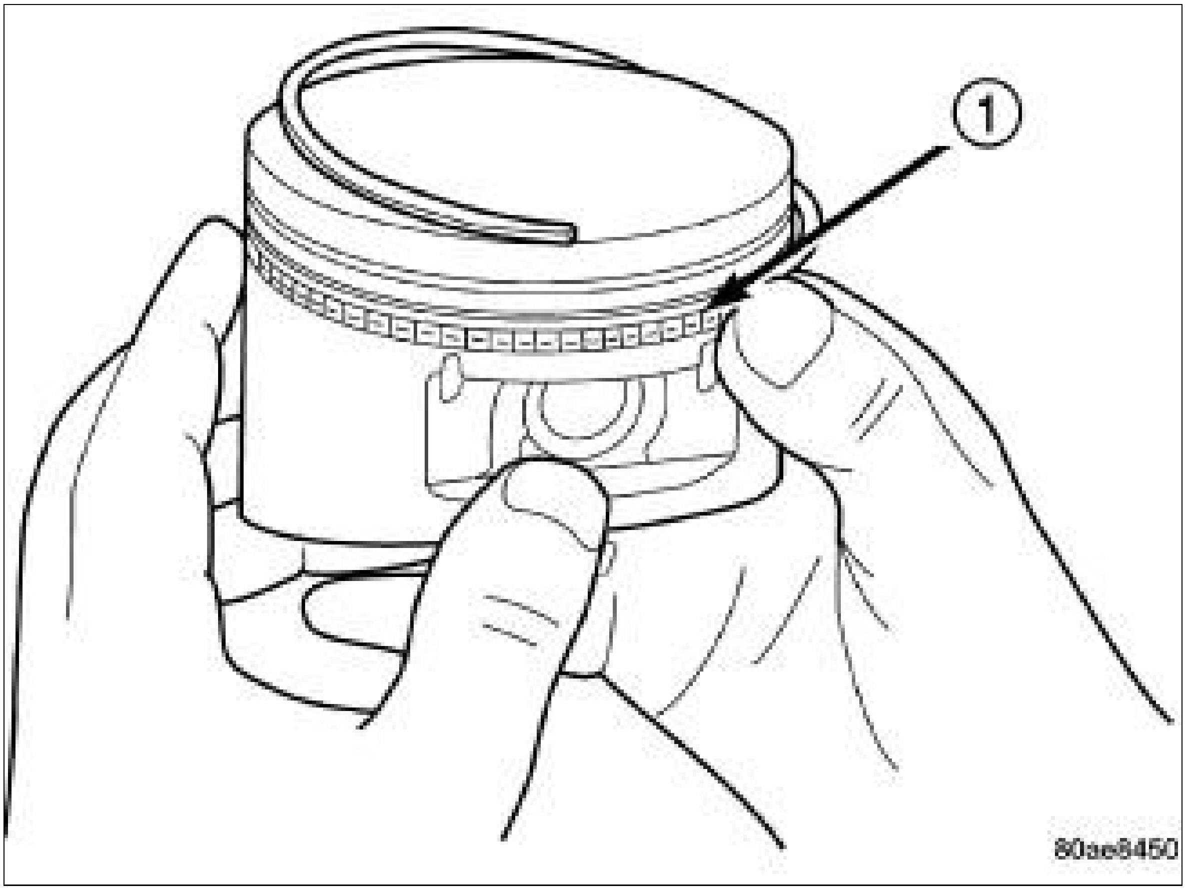


Courtesy of CHRYSLER GROUP, LLC

> *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 3: Installing Piston Ring Side Rail



Courtesy of CHRYSLER GROUP, LLC

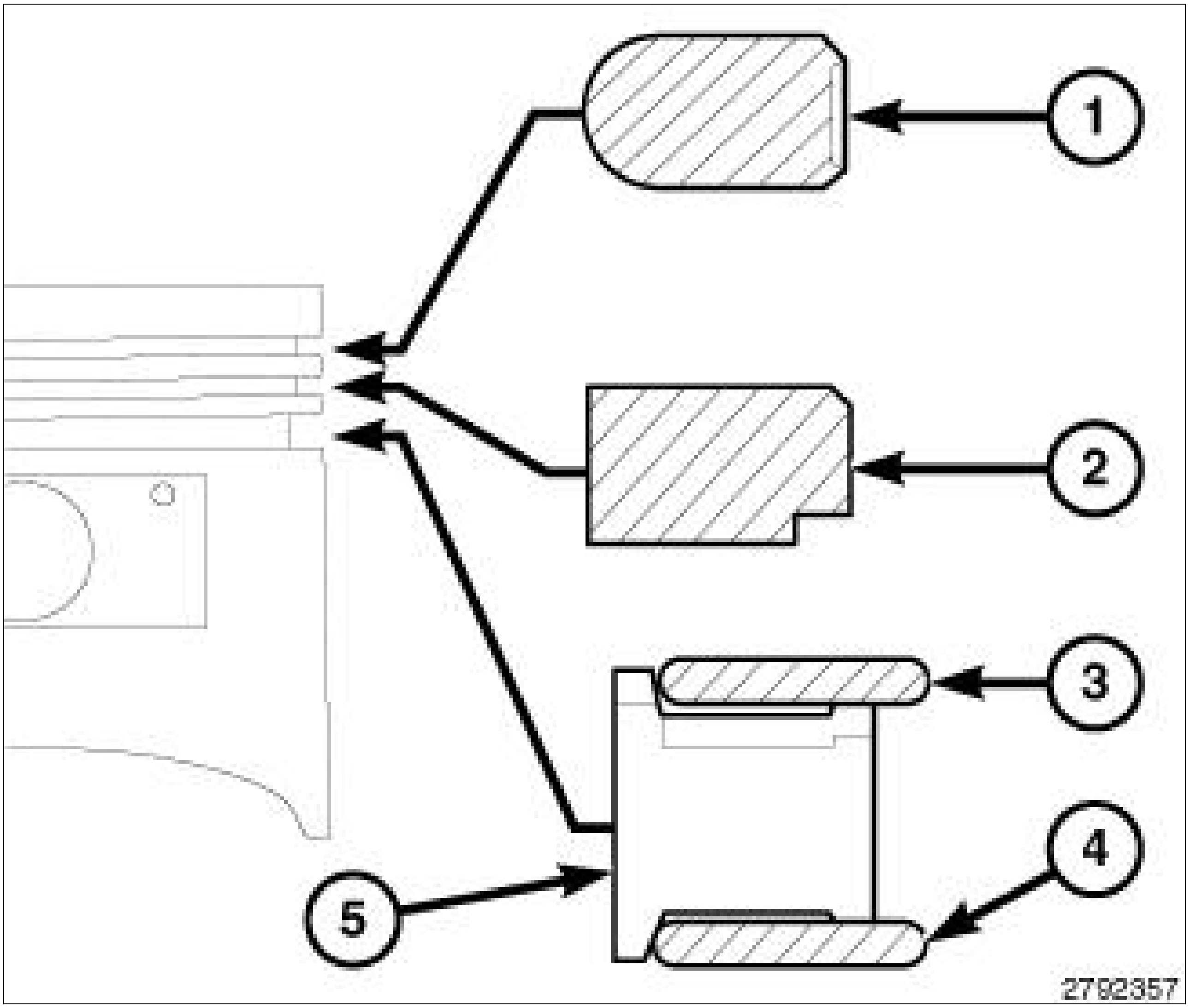
NOTE:

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).

ENGINE BLOCK > RING(S), PISTON > INSTALLATION > INSTALLATION

Fig 1: Piston Ring Removal/Installation Sequence



Courtesy of CHRYSLER GROUP, LLC

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

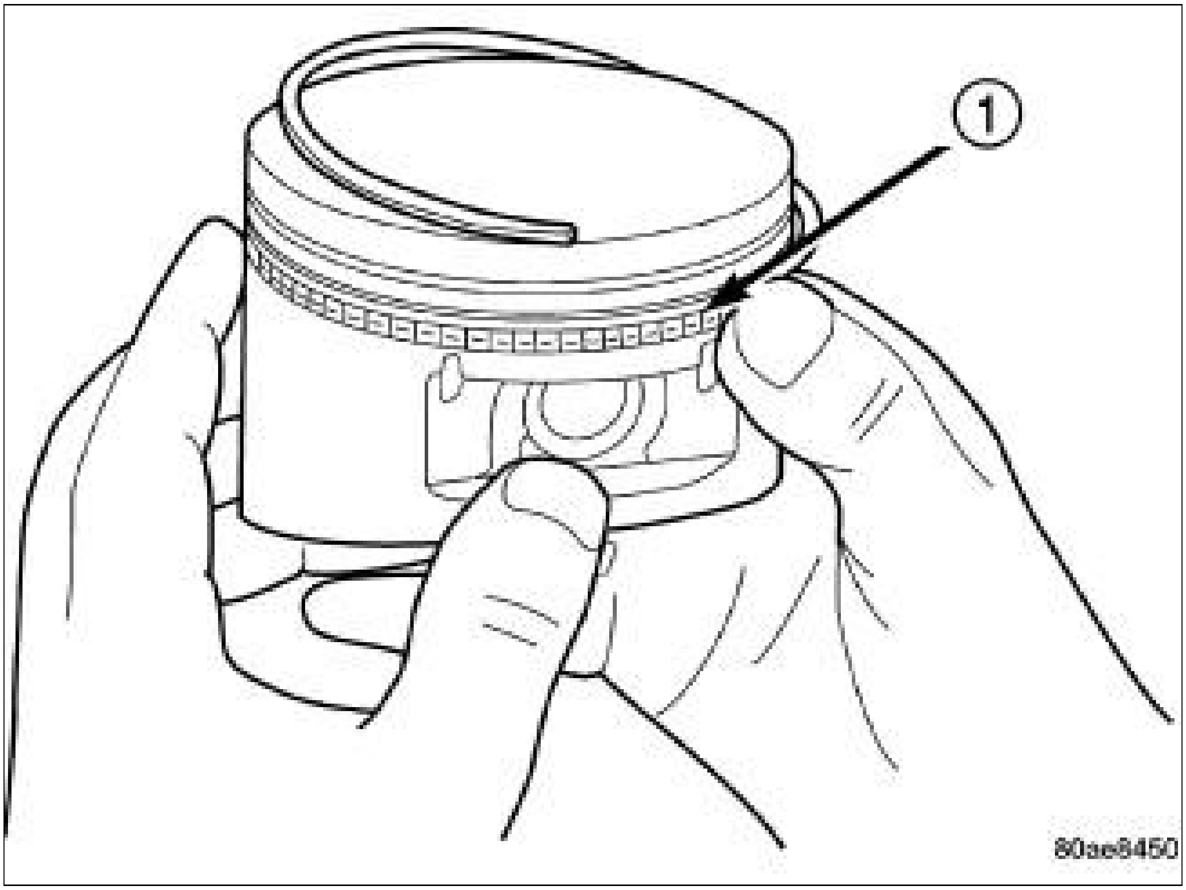
1. If required, fit new rings to the piston. Refer to STANDARD PROCEDURE .

> *CAUTION:*
>
> *To avoid damage to the piston rings, they must be installed in the following order:*
>
> 1. *Oil ring expander (5)*
> 2. *Oil ring lower side rail (4)*
> 3. *Oil ring upper side rail (3)*

4. No. 2 (intermediate) piston ring (2)

5. No. 1 (upper) piston ring (1)

Fig 2: Installing Piston Ring Side Rail



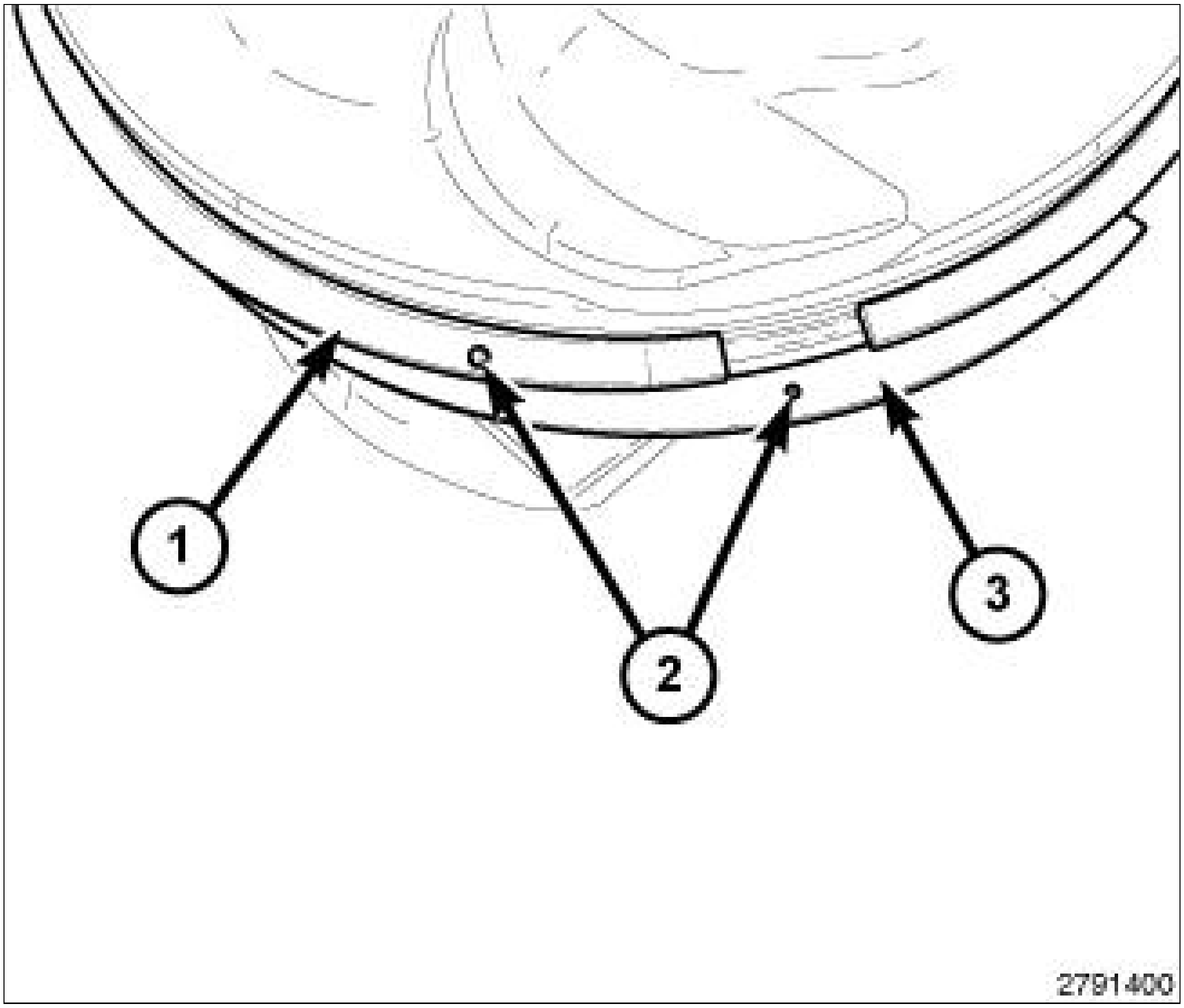
Courtesy of CHRYSLER GROUP, LLC

NOTE:

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

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

Fig 3: Identifying Dot Marks On Piston Rings

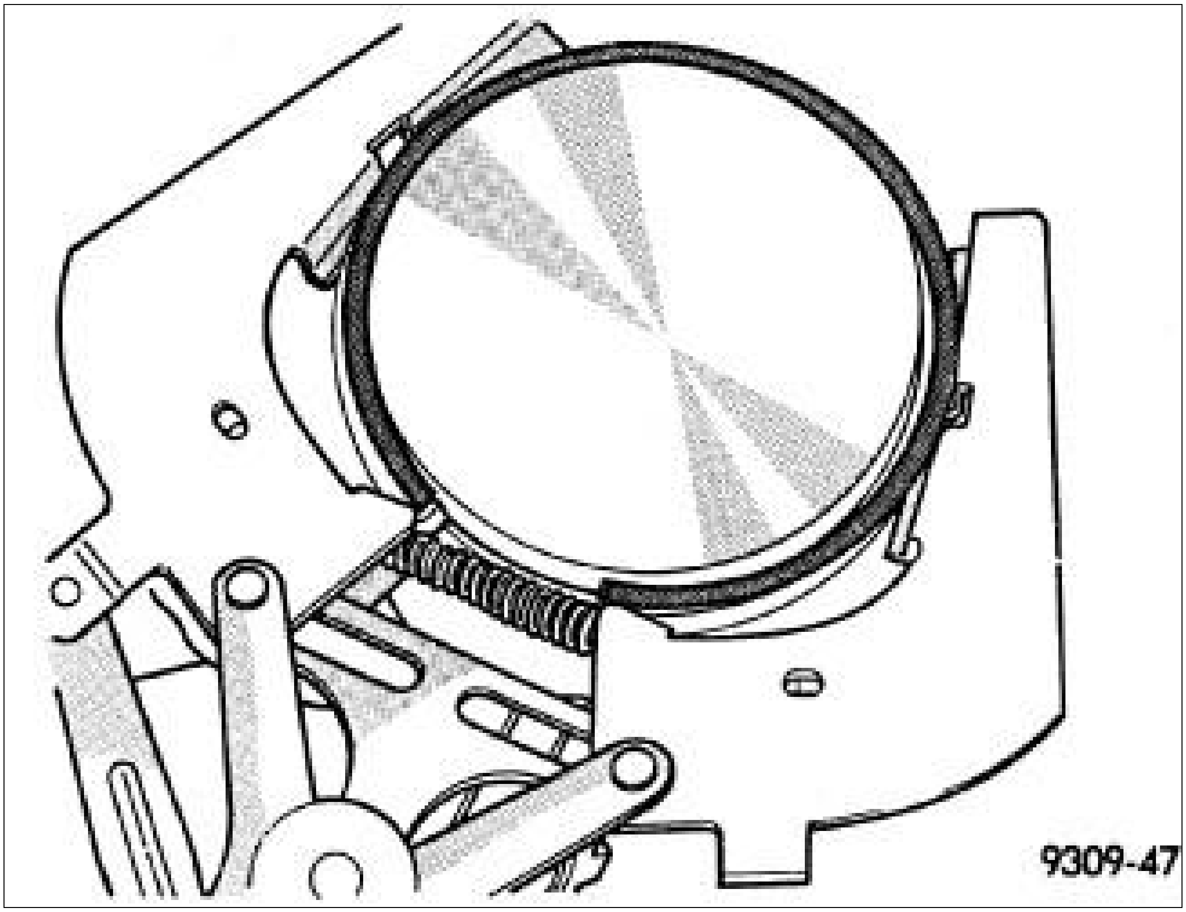


Courtesy of CHRYSLER GROUP, LLC

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 4: Installing Intermediate Piston Ring



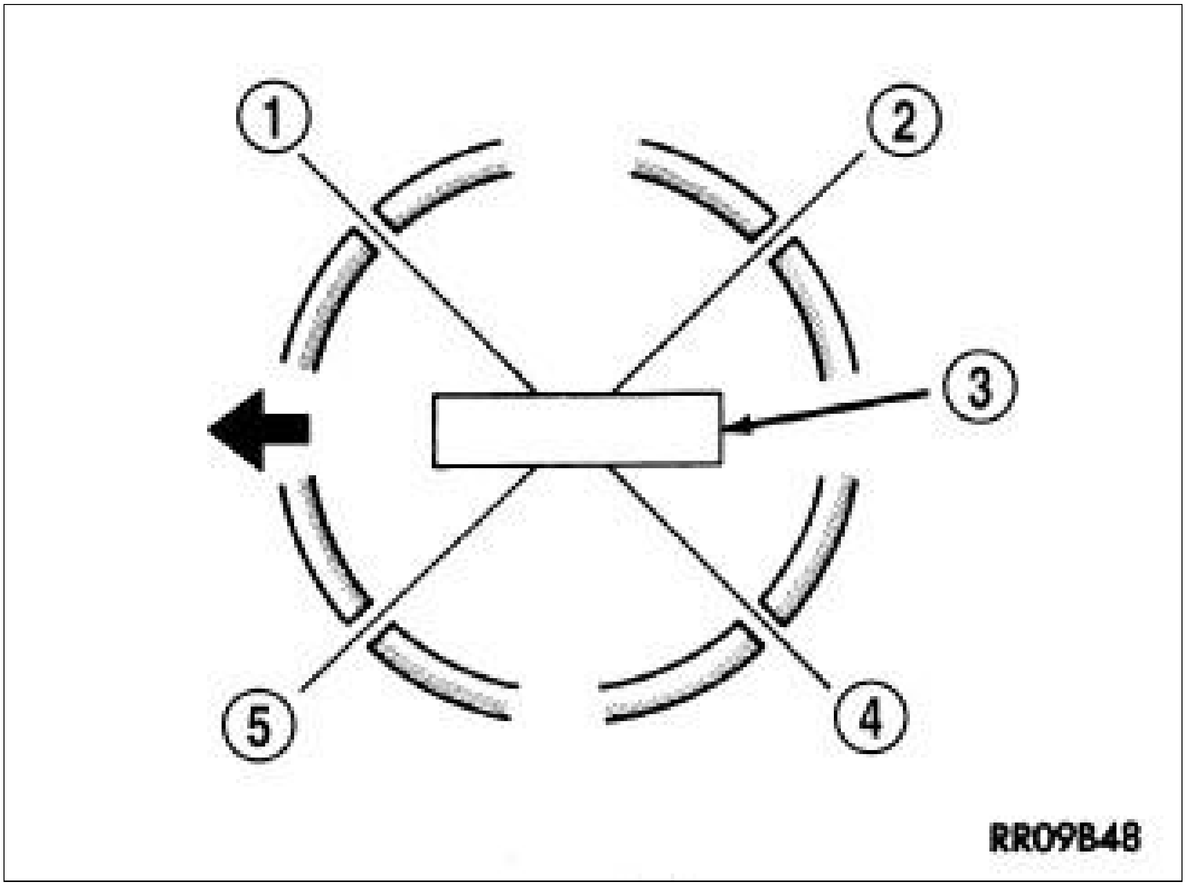
Courtesy of CHRYSLER GROUP, LLC

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 5: Piston Ring End Gap Position

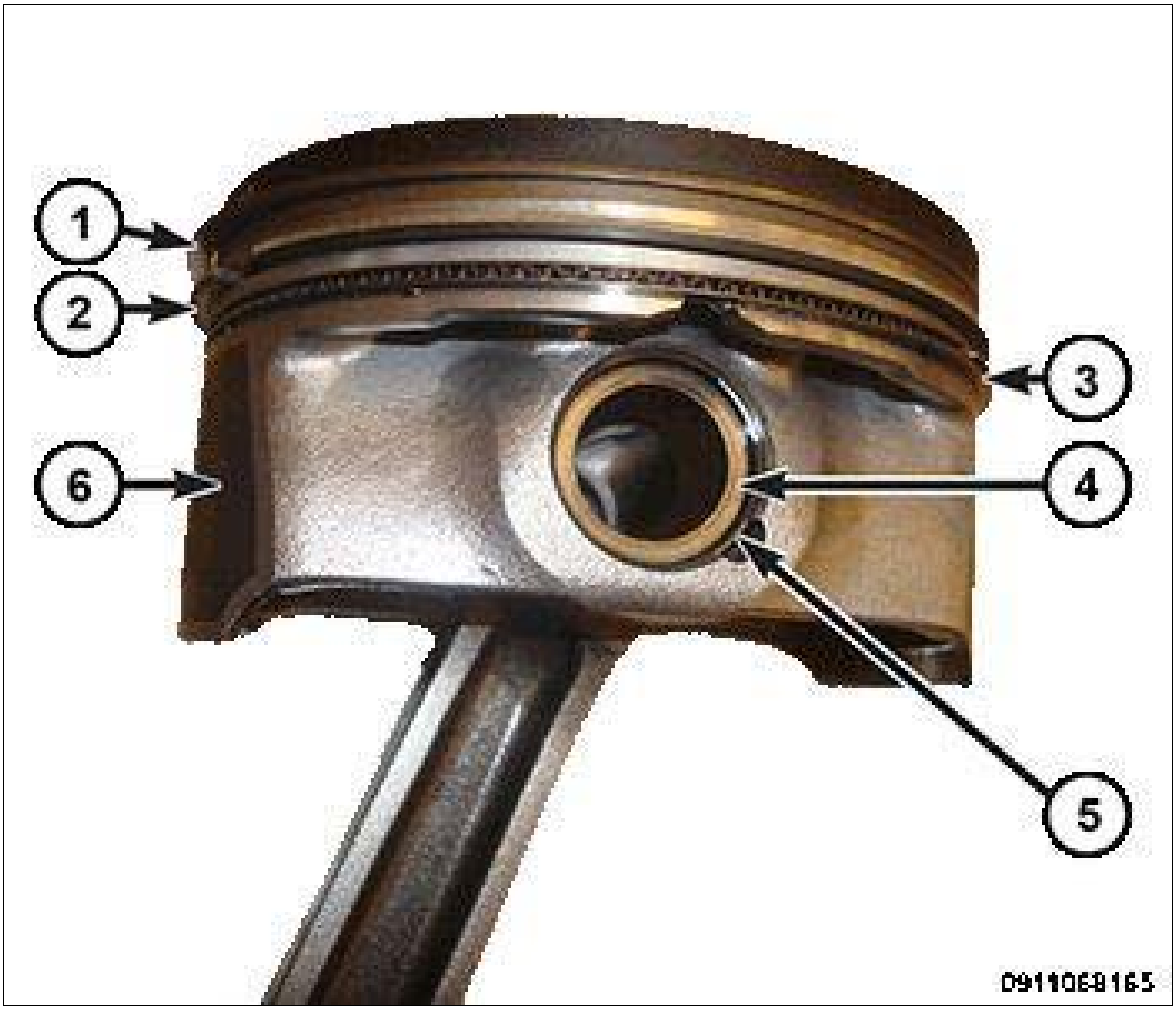


Courtesy of CHRYSLER GROUP, LLC

8. Position the piston ring end gaps as follows:
    1. Oil ring expander gap (5)
    2. Oil ring lower side rail end gap (4)
    3. Oil ring upper side rail end gap (1)
    4. No. 2 (intermediate) ring end gap (5)
    5. No. 1 (upper) ring end gap (2)
9. Install the piston and connecting rod(s). Refer to ROD, PISTON AND CONNECTING, INSTALLATION .

ENGINE BLOCK > ROD, PISTON AND CONNECTING > DESCRIPTION > DESCRIPTION

Fig 1: Piston Components



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.*

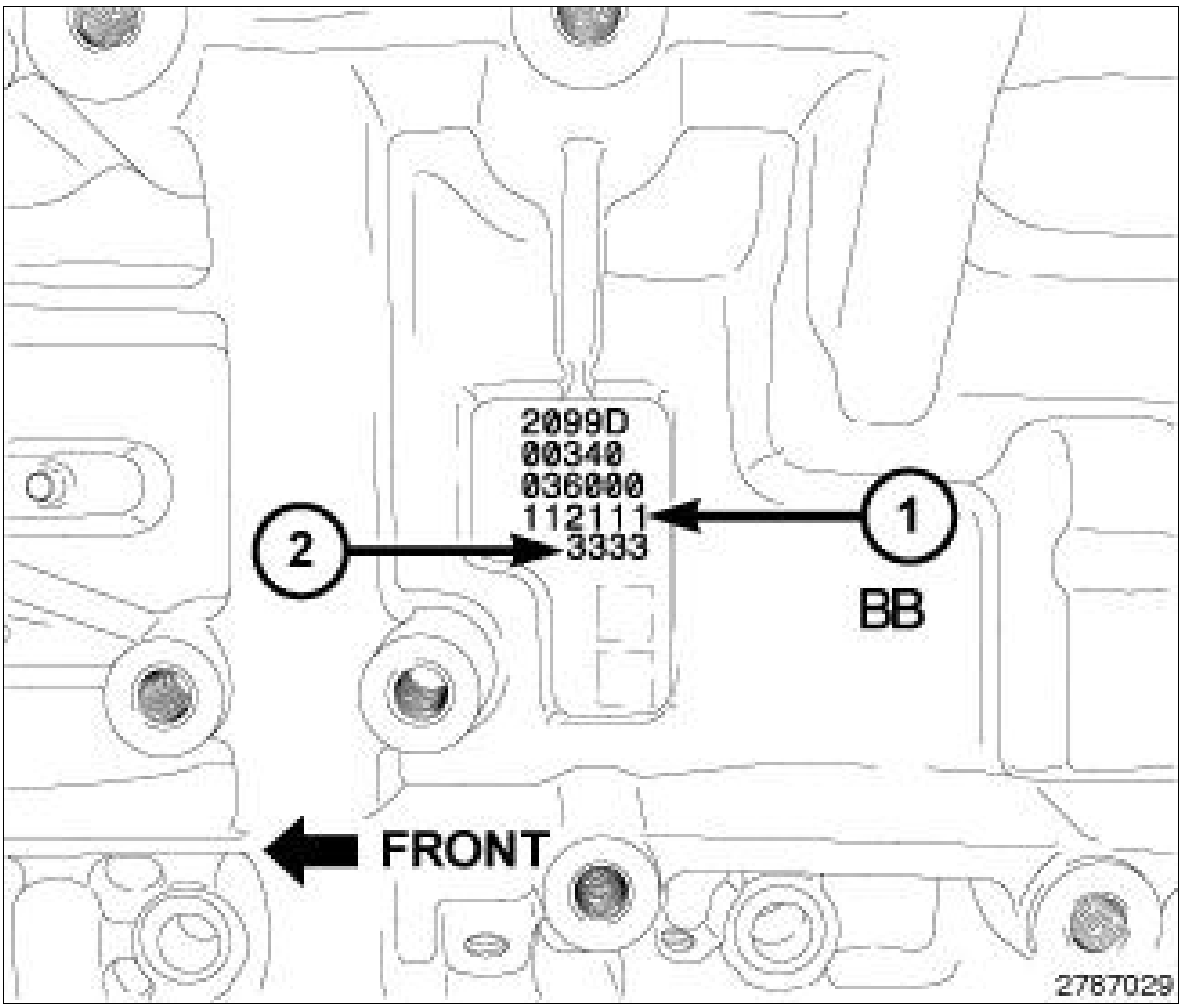
The pistons are a lightweight design with ultra low tension piston rings for improved fuel economy:

- The pistons are made of a high strength aluminum alloy and the piston skirt (6) has a MolyT® coating.
- The top piston ring land has an anodized coating for improved wear performance.
- The piston is connected to the rod using a full floating pin (5) with a locking clip (4) on both sides.
- The connecting rod is powder-forged steel with a bolted cracked cap design. The connecting rod bolts are not reusable.

- Pistons are available in three diameters (A, B and C) with grade markings for each bore indicated on the side of the cylinder block.
- The upper compression ring (1) is a 1.2 mm steel ring with Physical Vapor Deposition (PVD) coating.
- The intermediate compression ring (2) 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 (3) is very thin. Both the rail segments and the expander are nitride steel.

ENGINE BLOCK > ROD, PISTON AND CONNECTING > STANDARD PROCEDURE > PISTON FITTING

Fig 1: Engine Block Main Bearing Journal Diameter Grade Markings



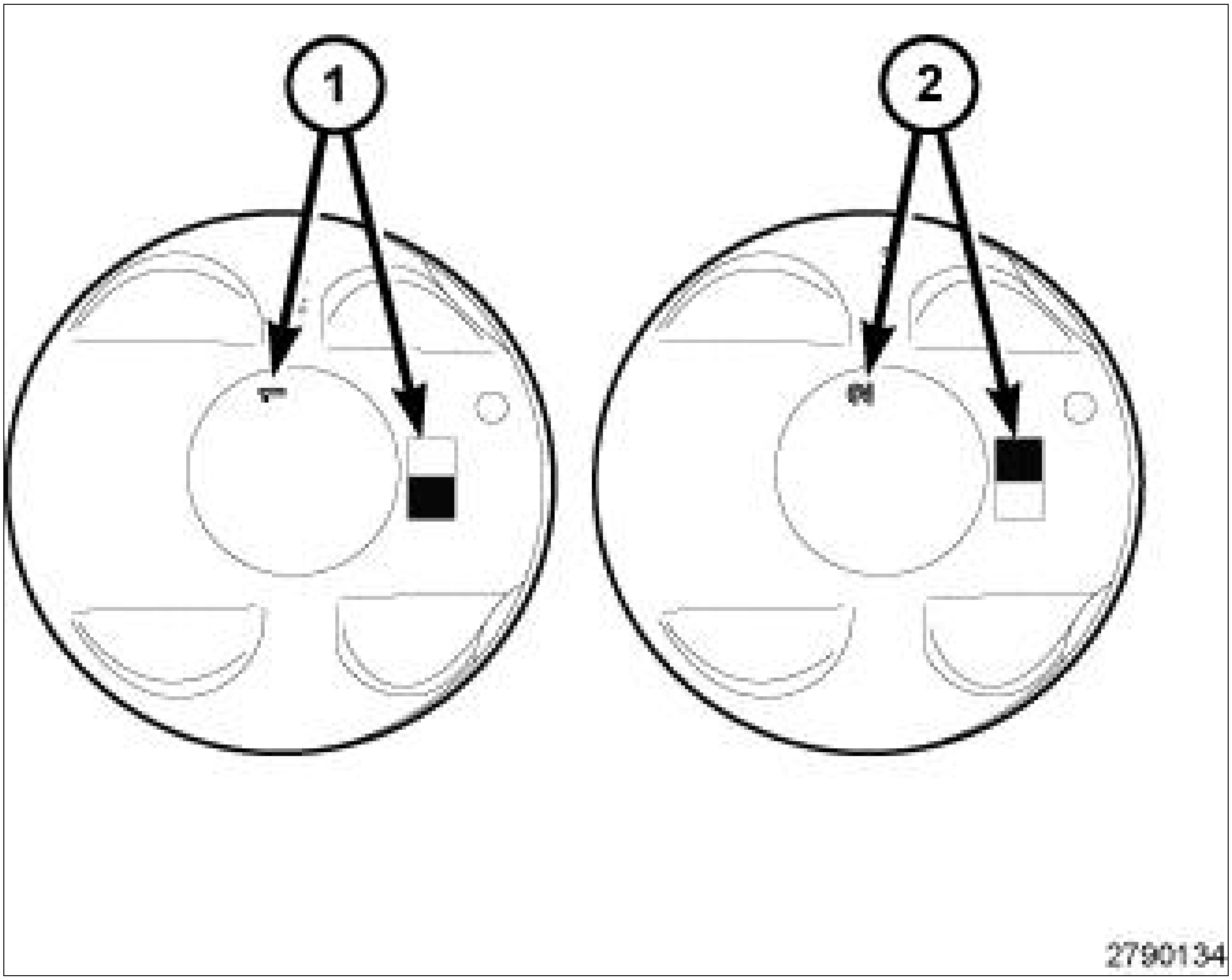
Courtesy of CHRYSLER GROUP, LLC

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.)

Fig 2: Piston Size Located On Piston Crown



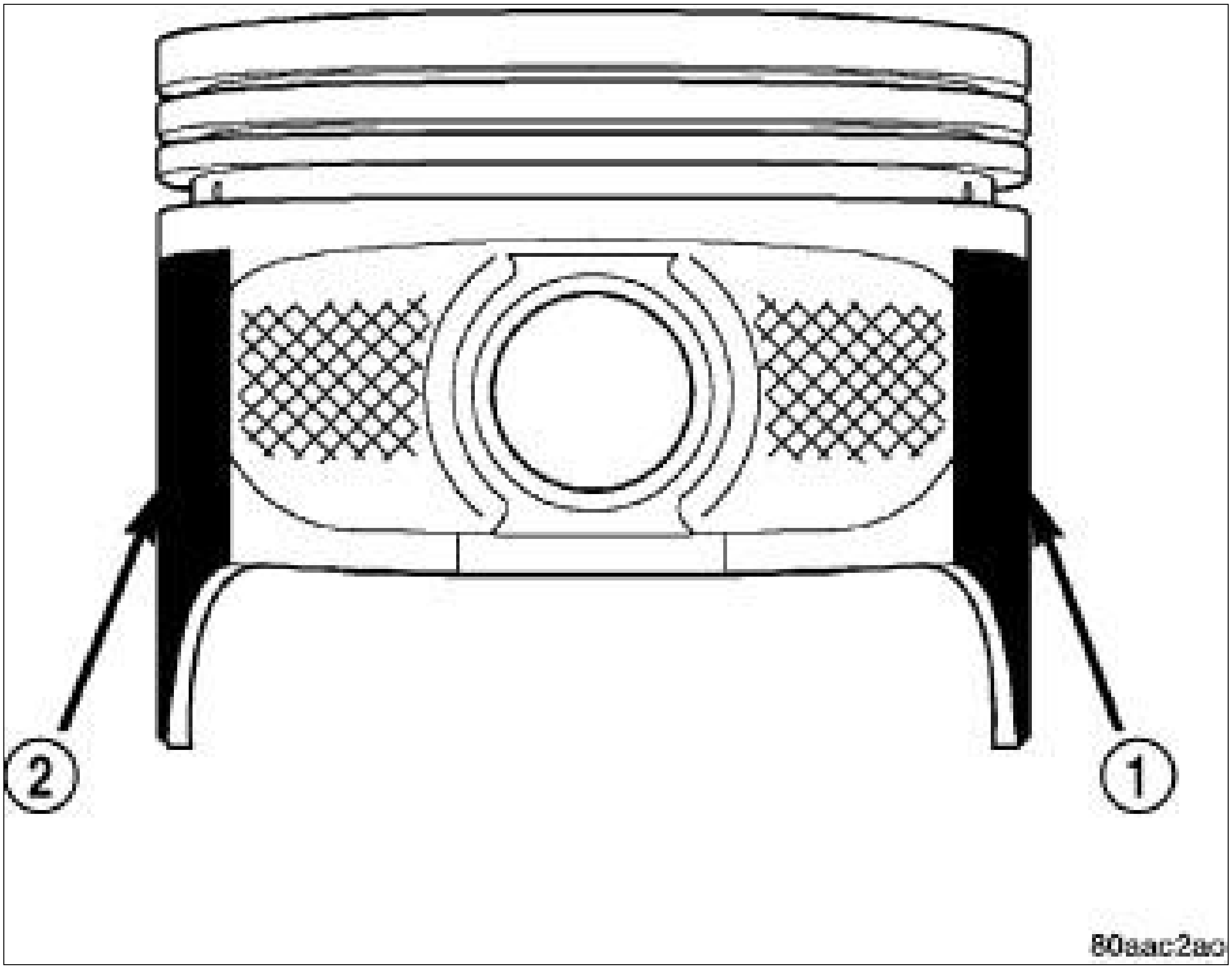
Courtesy of CHRYSLER GROUP, LLC

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.)

Fig 3: Identifying Coating Material On Piston



Courtesy of CHRYSLER GROUP, LLC

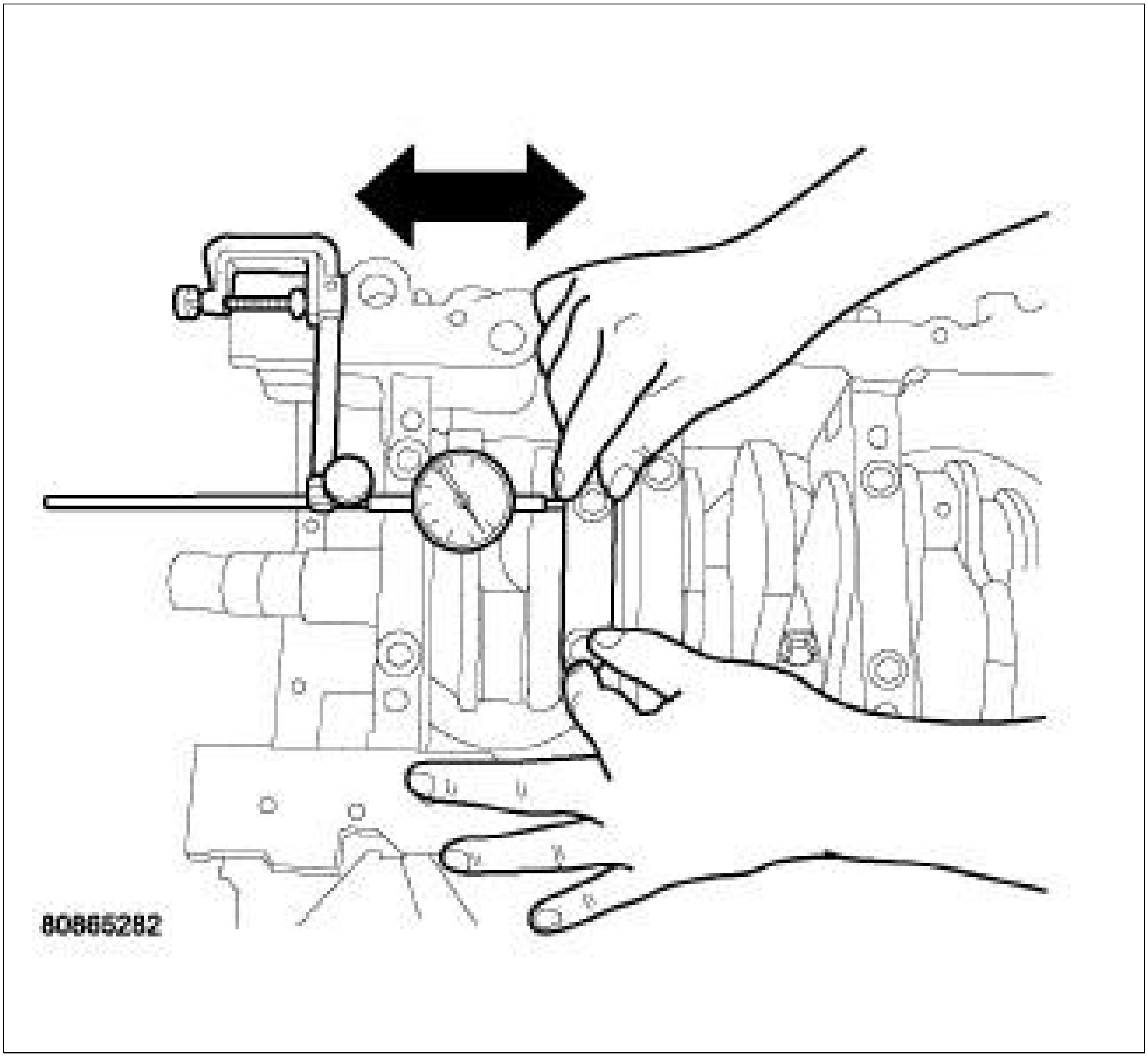
NOTE:

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.

ENGINE BLOCK > ROD, PISTON AND CONNECTING > STANDARD PROCEDURE > CONNECTING ROD SIDE CLEARANCE > DIAL INDICATOR

Fig 1: Measuring Connecting Rod Side Clearance



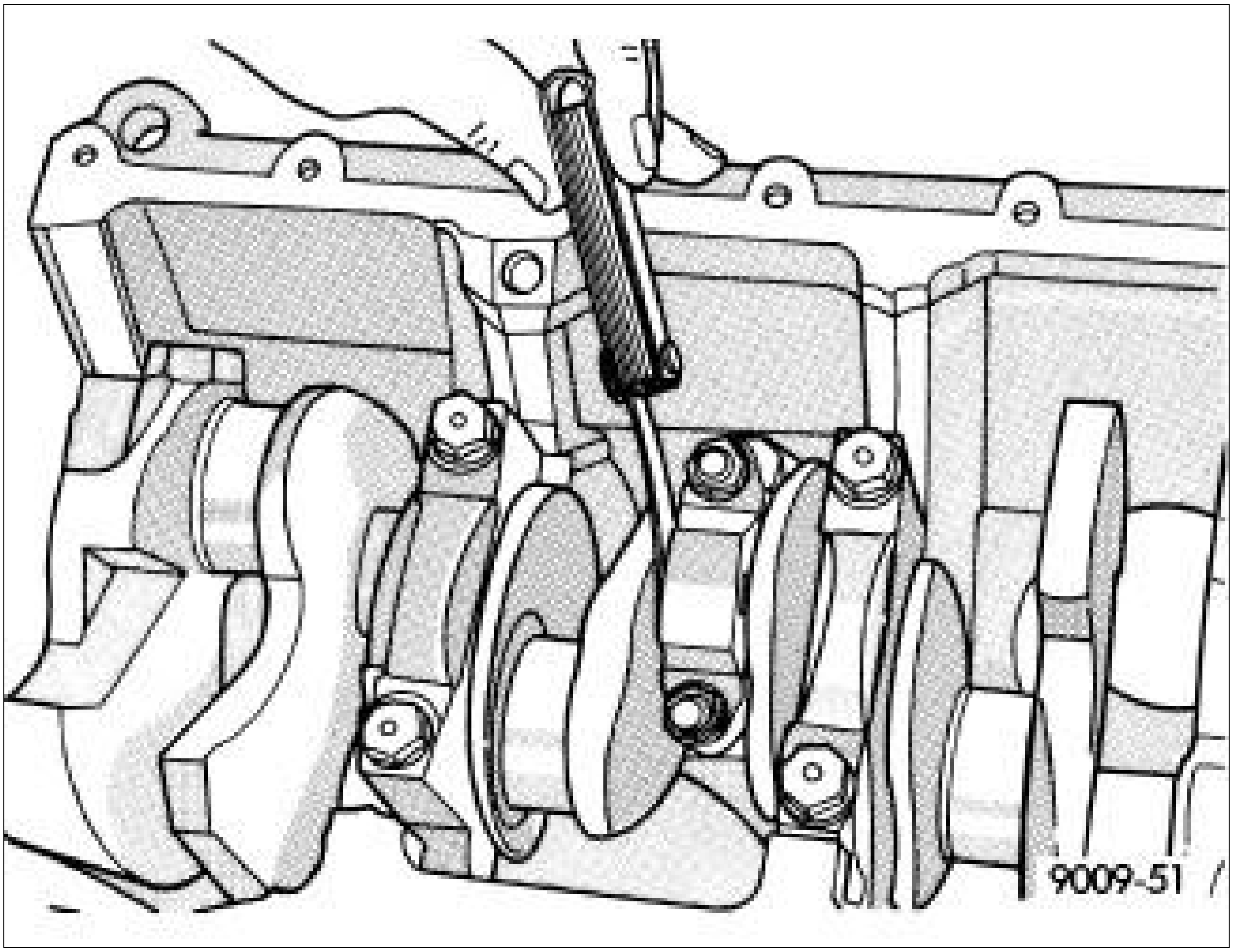
Courtesy of CHRYSLER GROUP, LLC

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.

ENGINE BLOCK > ROD, PISTON AND CONNECTING > STANDARD PROCEDURE > CONNECTING ROD SIDE CLEARANCE > FEELER GAUGE

Fig 1: Measuring Gap Between Connecting Rod & Crankshaft Journal Flange

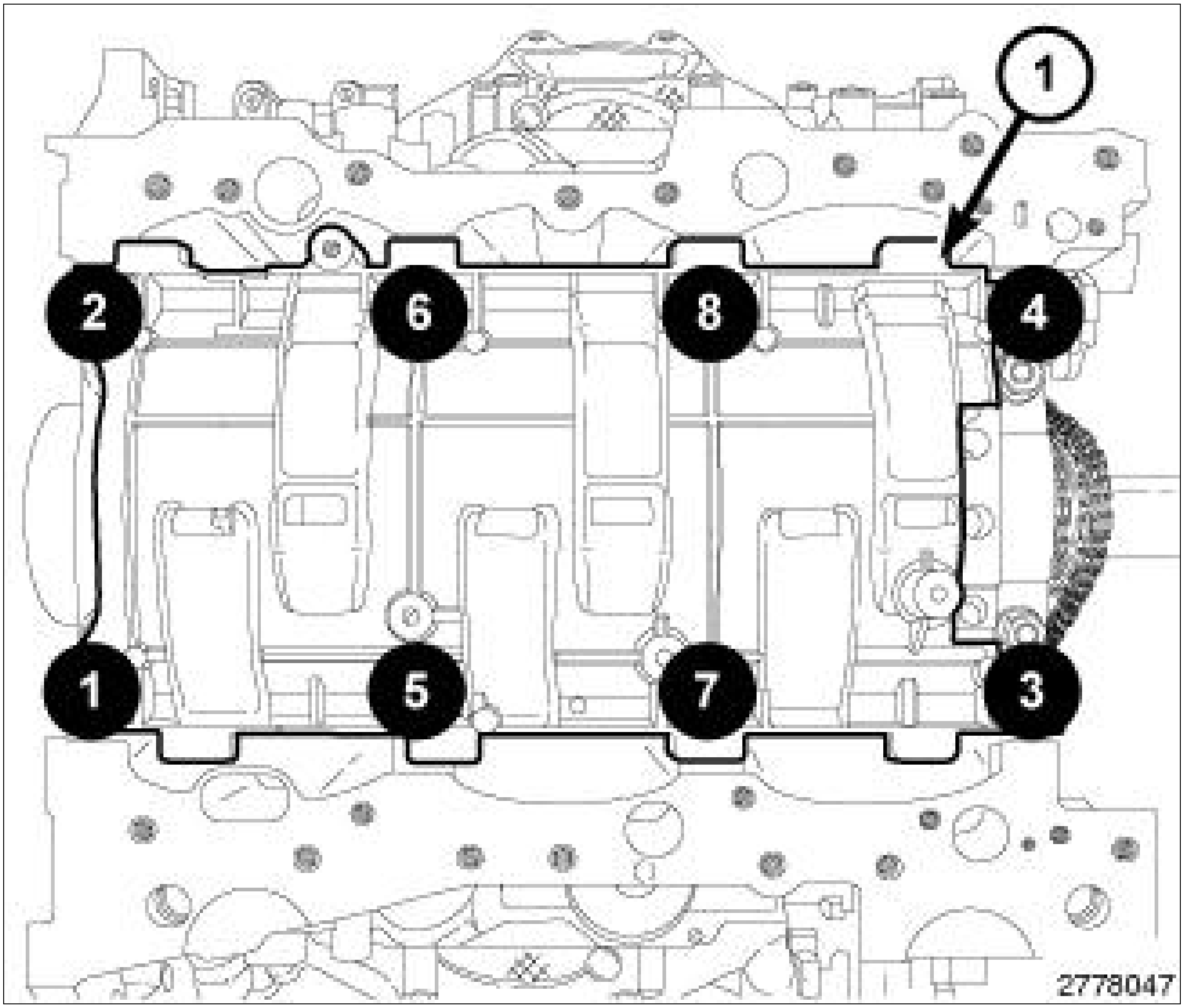


Courtesy of CHRYSLER GROUP, LLC

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.

ENGINE BLOCK > ROD, PISTON AND CONNECTING > REMOVAL > REMOVAL

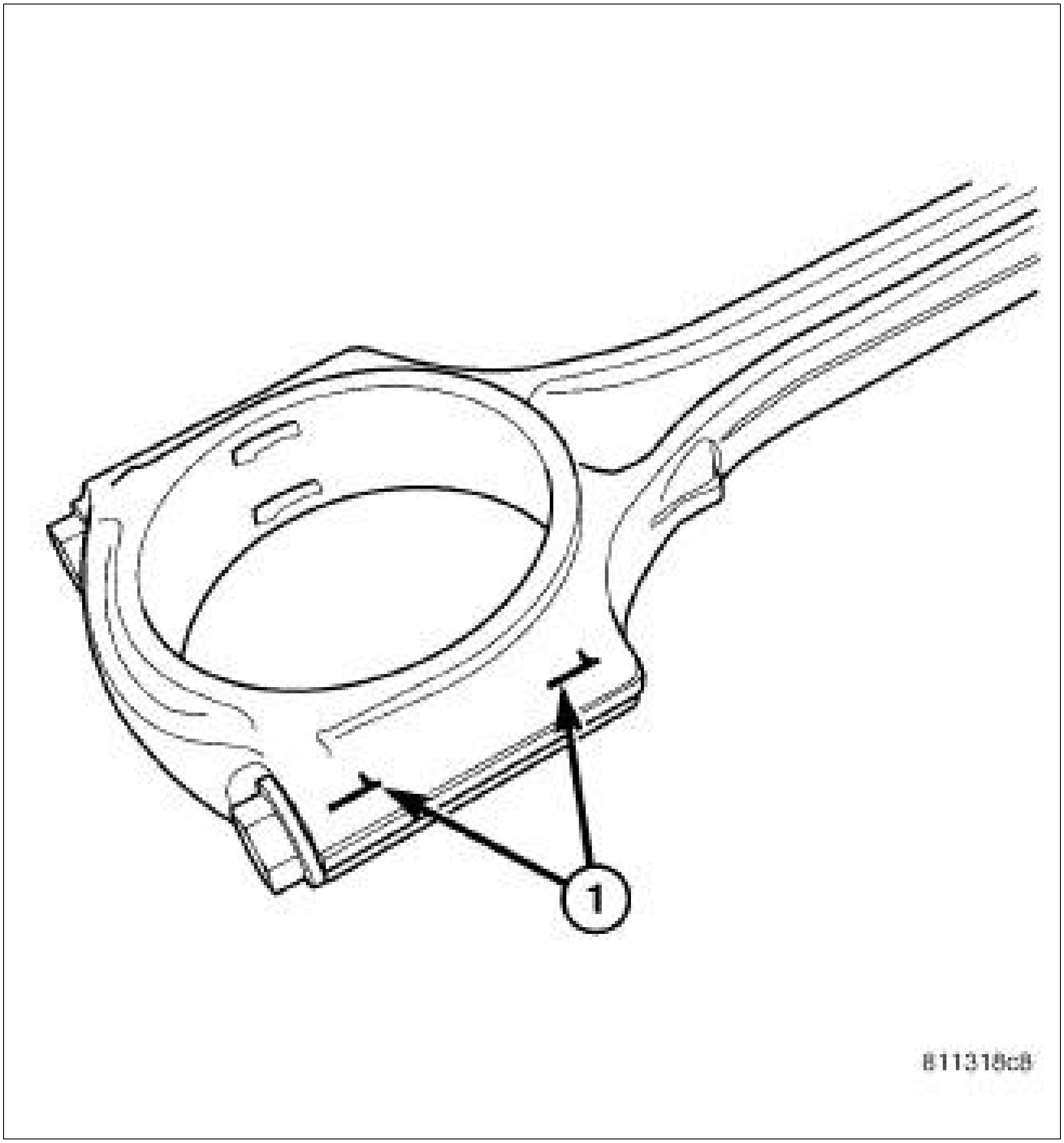
Fig 1: Main Bearing Cap Bolts From Windage Tray Removal Sequence



Courtesy of CHRYSLER GROUP, LLC

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

Fig 2: Connecting Rod To Cylinder Identification



Courtesy of CHRYSLER GROUP, LLC

4. 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 clockwise so that each connecting rod is centered in the cylinder bore.

CAUTION:

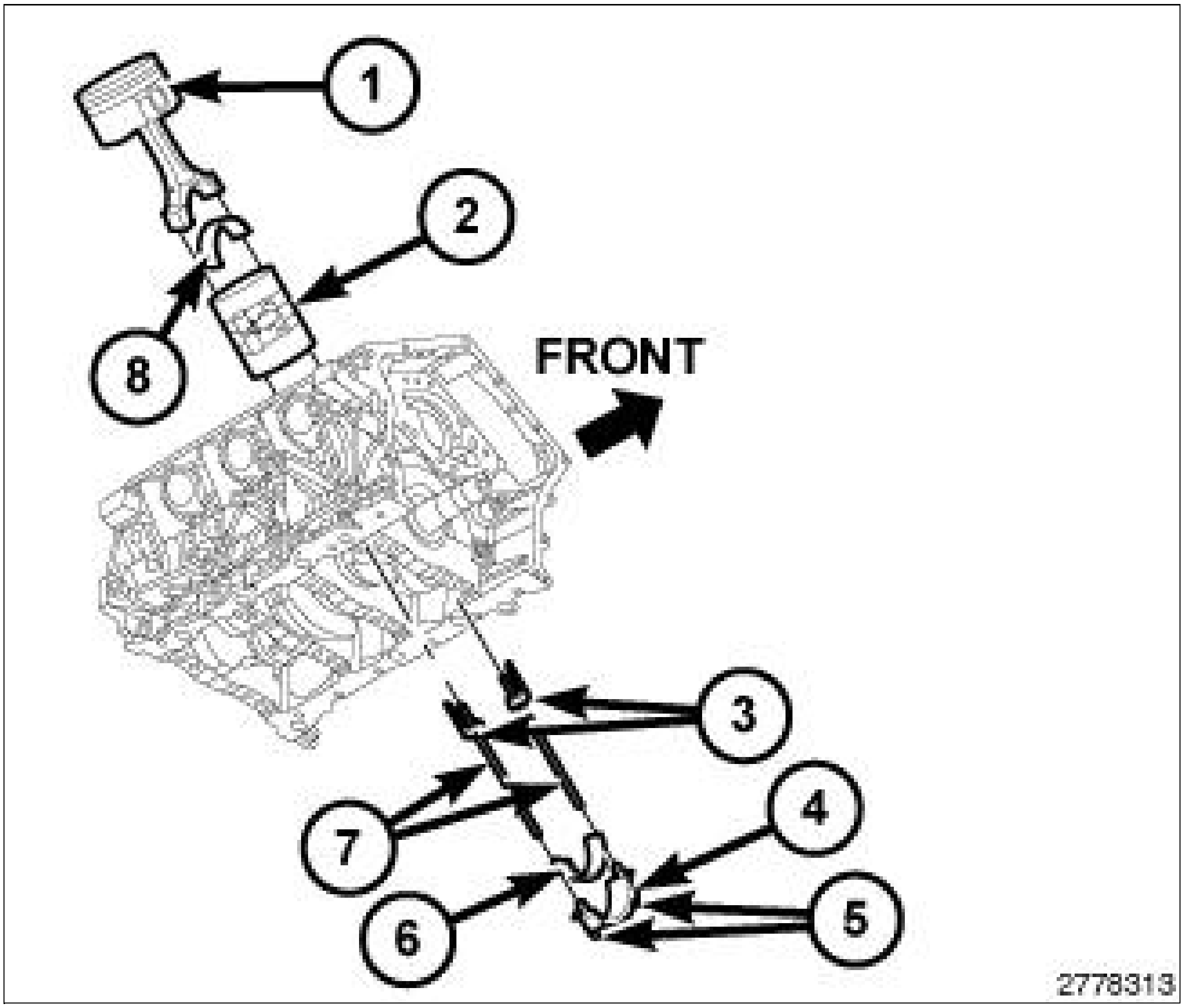
DO NOT use a number stamp or a punch to mark connecting rods or caps, as damage to connecting rods could occur

NOTE:

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

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

Fig 3: 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.*

6. 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.*

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

8. Remove the piston and connecting rod (1) from cylinder bore.
9. Repeat the previous steps for each piston being removed.
10. 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.
11. If required, remove the piston rings. Refer to RING(S), PISTON, REMOVAL .
12. Repeat the previous steps for each piston being removed.

ENGINE BLOCK > ROD, PISTON AND CONNECTING > CLEANING > CLEANING

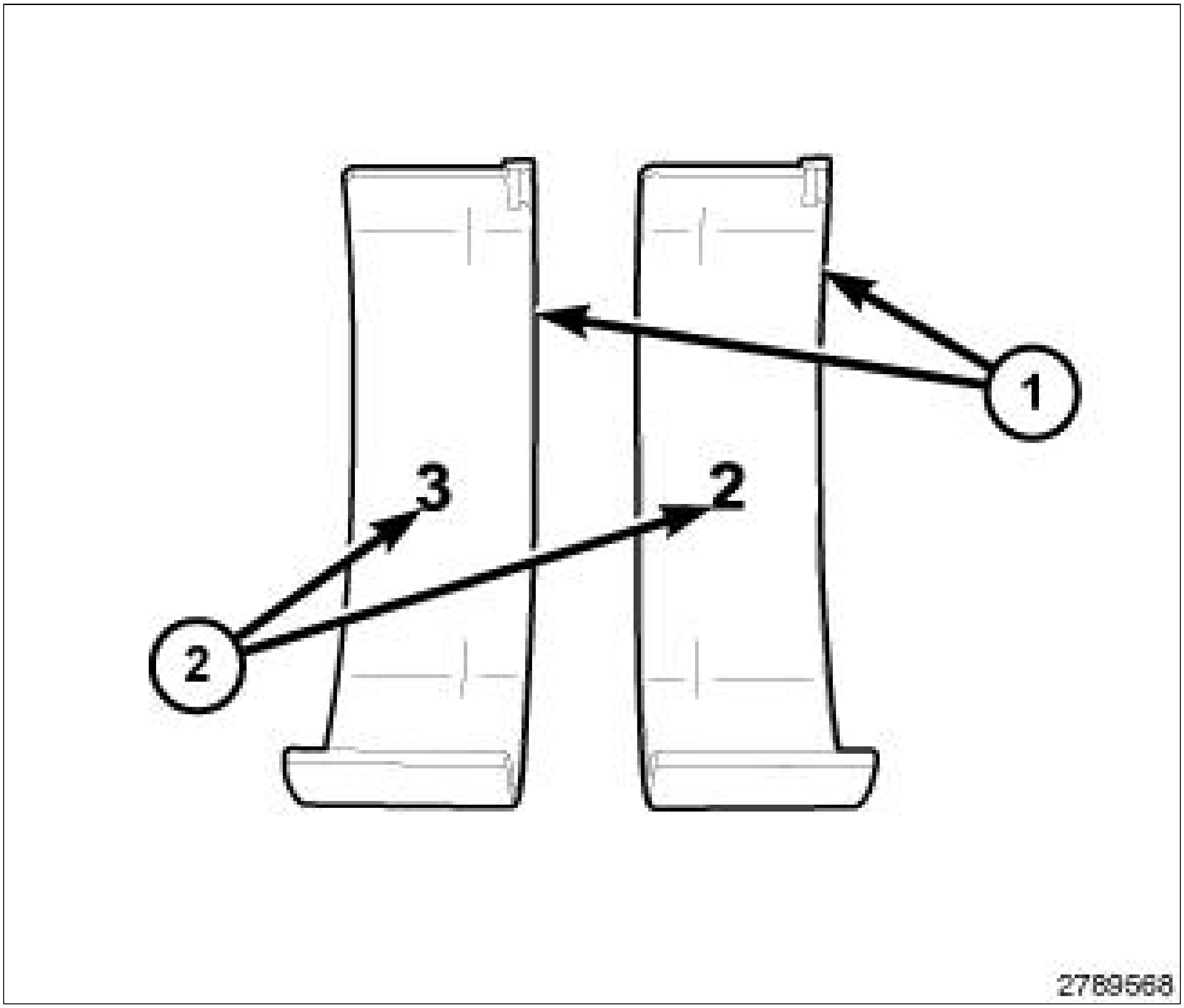
> CAUTION:
>
> *DO NOT use a wire wheel or other abrasive cleaning devise to clean the pistons or connecting rods. The pistons have a Moly coating, this coating must not be damaged.*

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

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

ENGINE BLOCK > ROD, PISTON AND CONNECTING > INSPECTION > INSPECTION

Fig 1: Connecting Rod Bearing Shells & Bearing Size

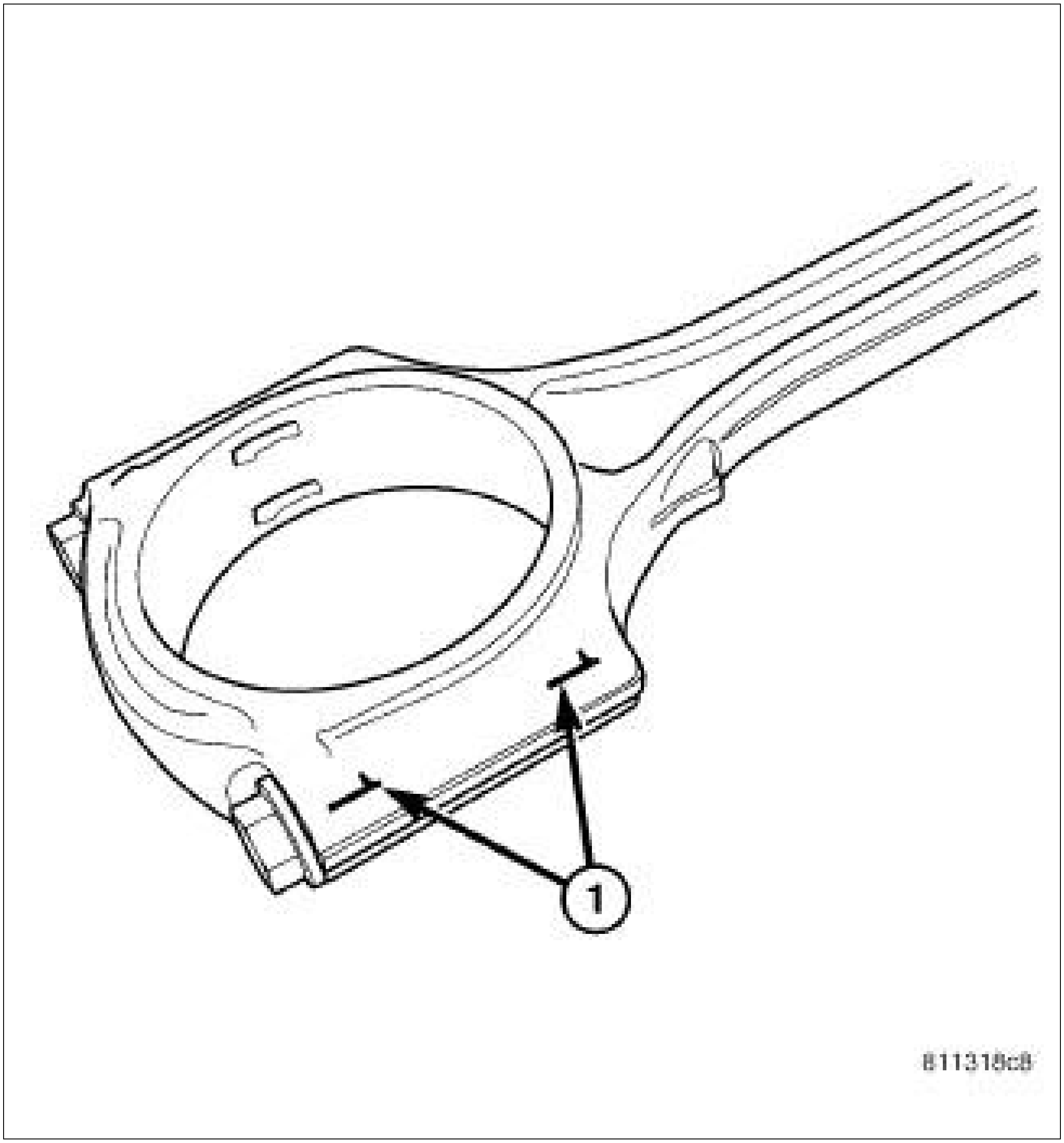


Courtesy of CHRYSLER GROUP, LLC

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 STANDARD PROCEDURE .

Fig 2: Connecting Rod To Cylinder Identification



Courtesy of CHRYSLER GROUP, LLC

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

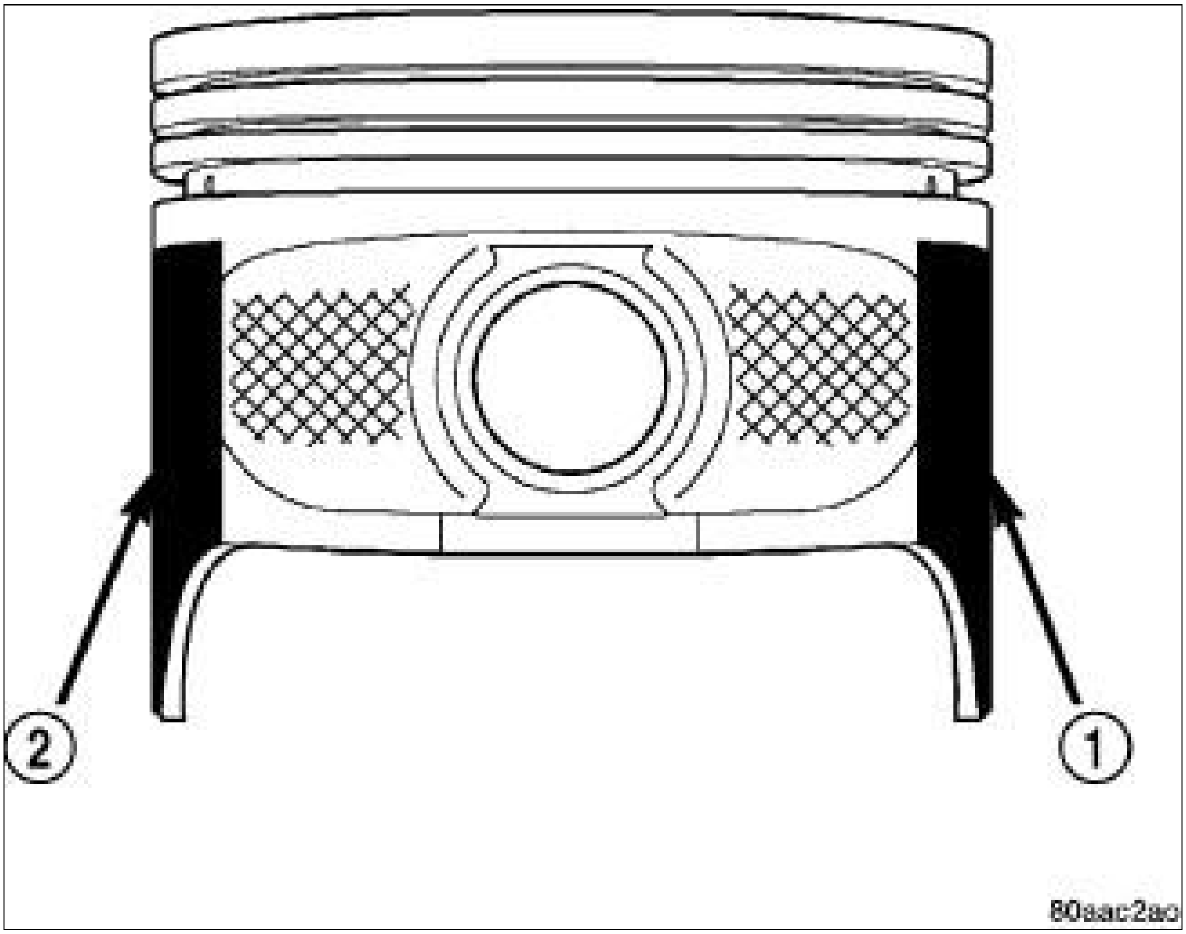
> *NOTE:*
>
> *Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these components indicate the*

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 STANDARD PROCEDURE .*

Fig 3: Identifying 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 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 STANDARD PROCEDURE .

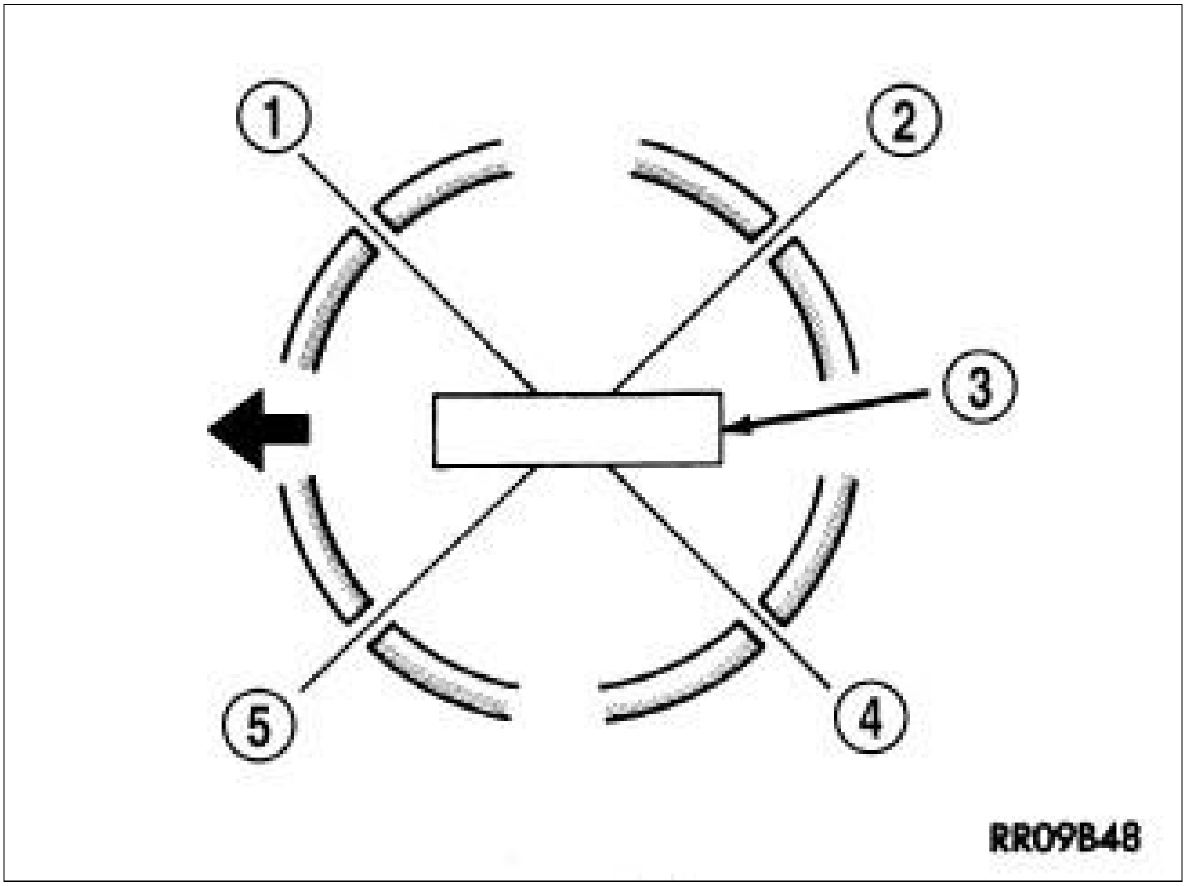
> *NOTE:*
>
> *Piston installation into the cylinder bore requires slightly more pressure than that required for non-coated pistons. The bonded coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.*

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

ENGINE BLOCK > ROD, PISTON AND CONNECTING > INSTALLATION > INSTALLATION

1. If required, select and fit new piston and connecting rod assemblies to the engine block. Refer to STANDARD PROCEDURE .
2. If required, select and fit new bearings to the connecting rod. Refer to STANDARD PROCEDURE .
3. If required, hone the cylinder bores. Refer to STANDARD PROCEDURE .
4. If removed, install the piston rings. Refer to RING(S), PISTON, INSTALLATION .

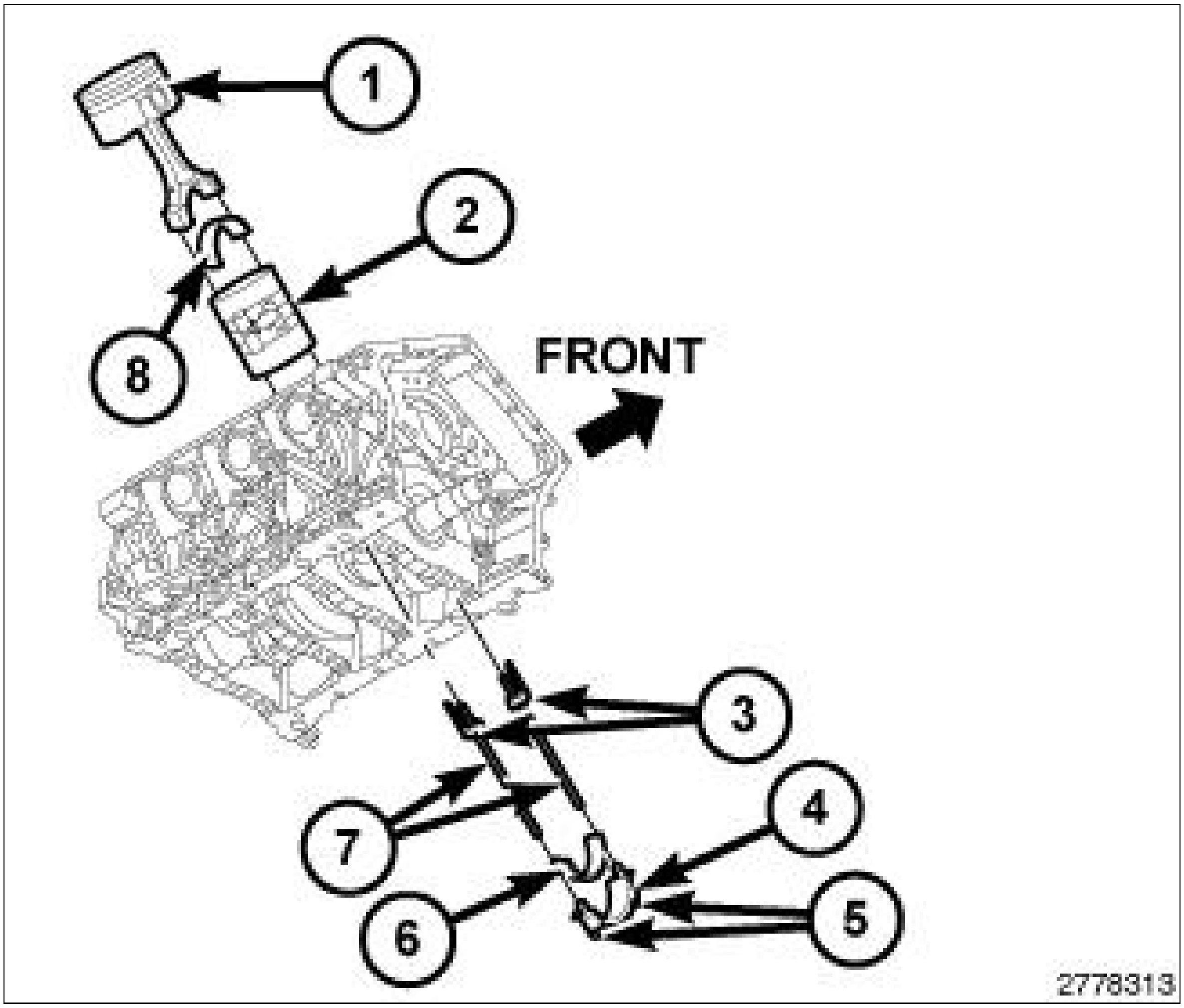
Fig 1: Piston Ring End Gap Position



Courtesy of CHRYSLER GROUP, LLC

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

Fig 2: 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).

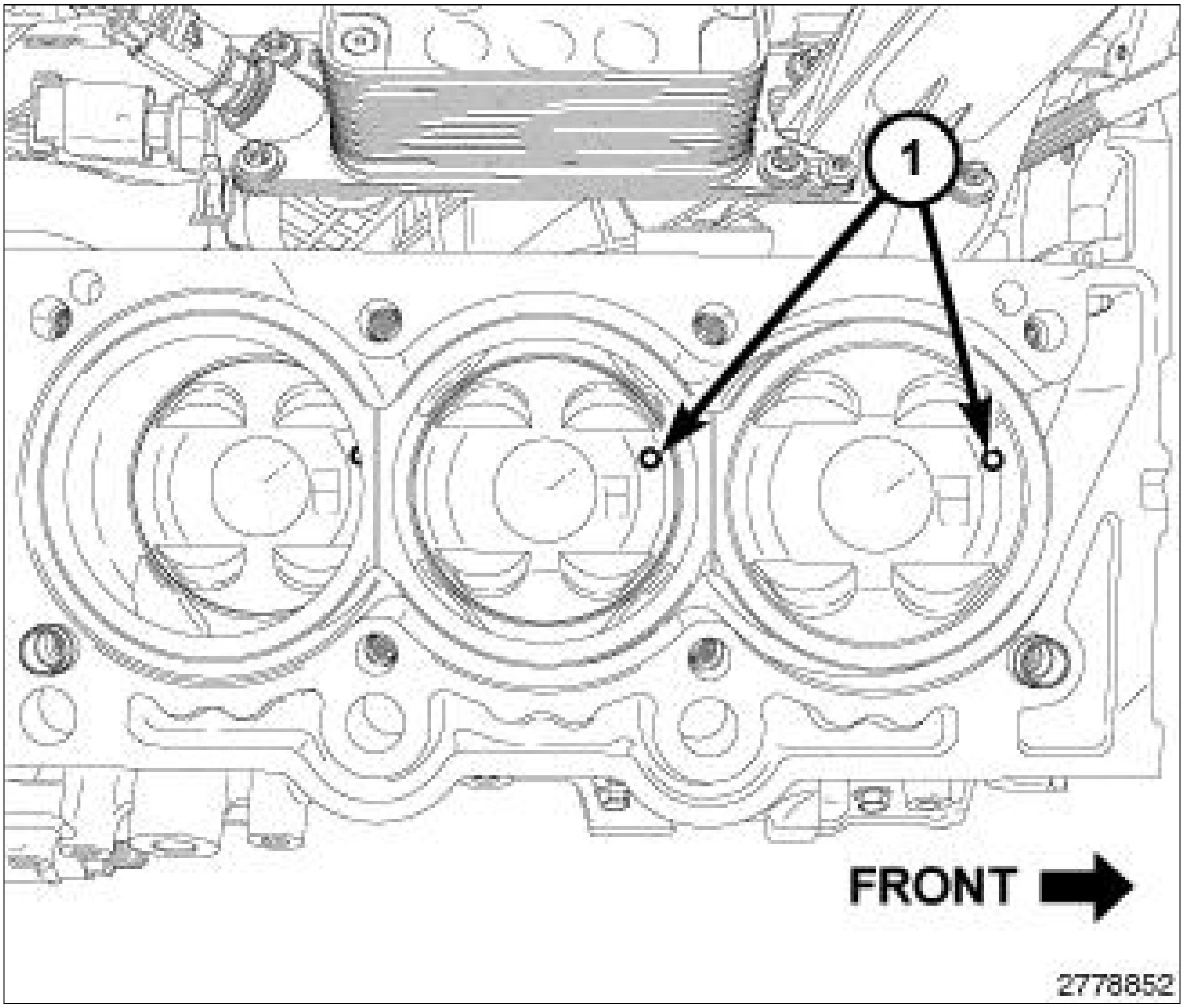
NOTE:

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 3: 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.

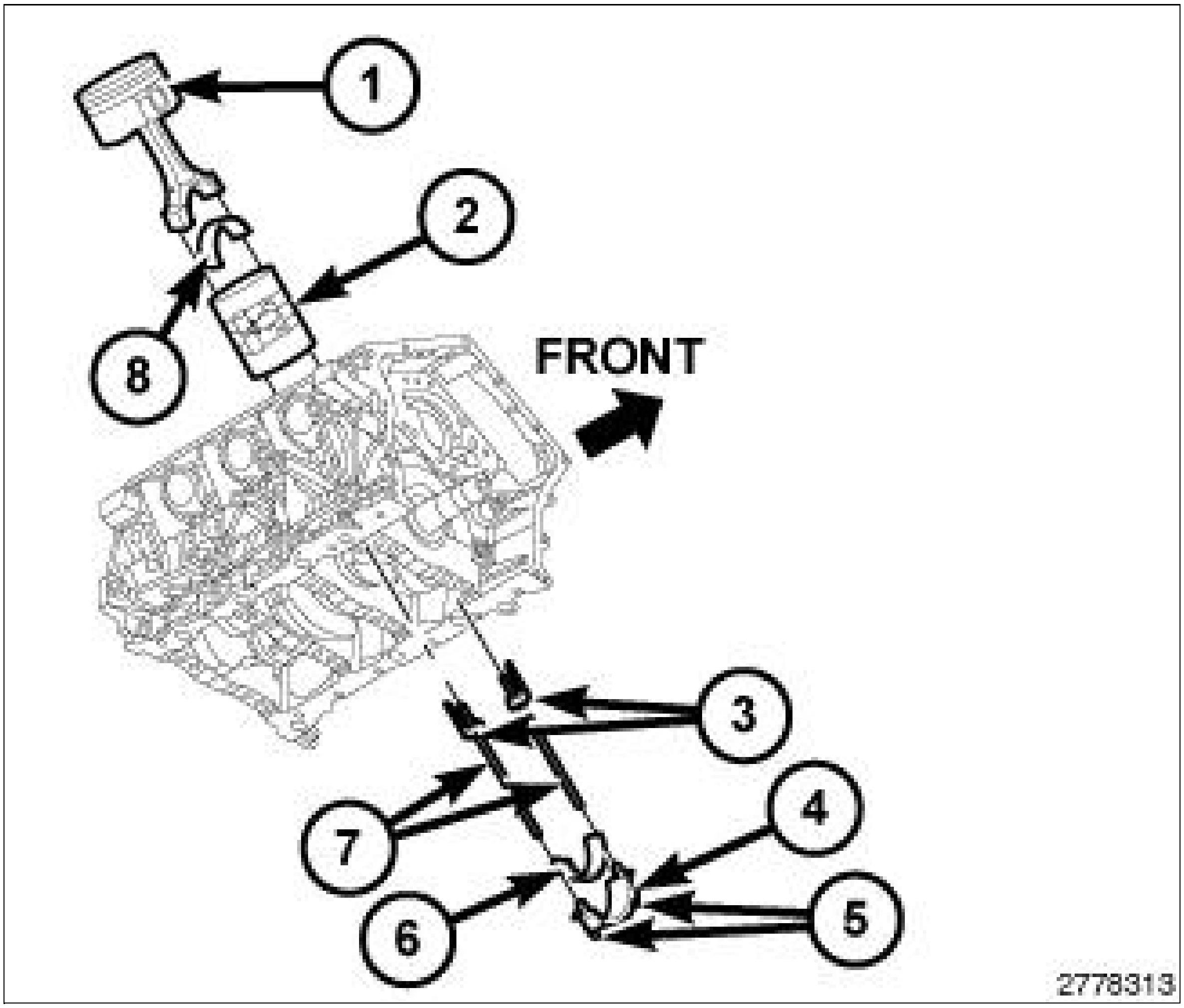
11. Rotate the crankshaft until the connecting rod journal is on the center of cylinder bore.

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 4: 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.

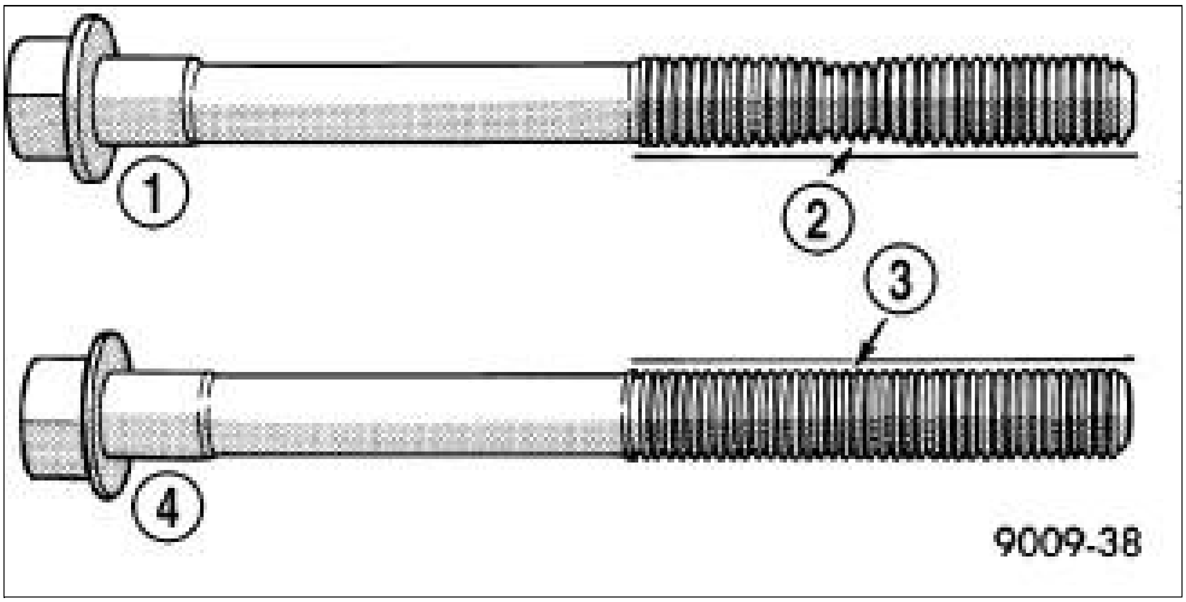
14. Install the bearing shell (6) on the connecting rod cap (4) with the tang inserted into the machined groove in the cap. Lubricate the bearing surface with clean engine oil.

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 the proper specification. Refer to TORQUE SPECIFICATIONS .
16. If required, check the connecting rod side clearance. Refer to STANDARD PROCEDURE .
17. Repeat the previous steps for each piston being installed.

Fig 5: Checking Cylinder Head Bolts For Stretching (Necking)



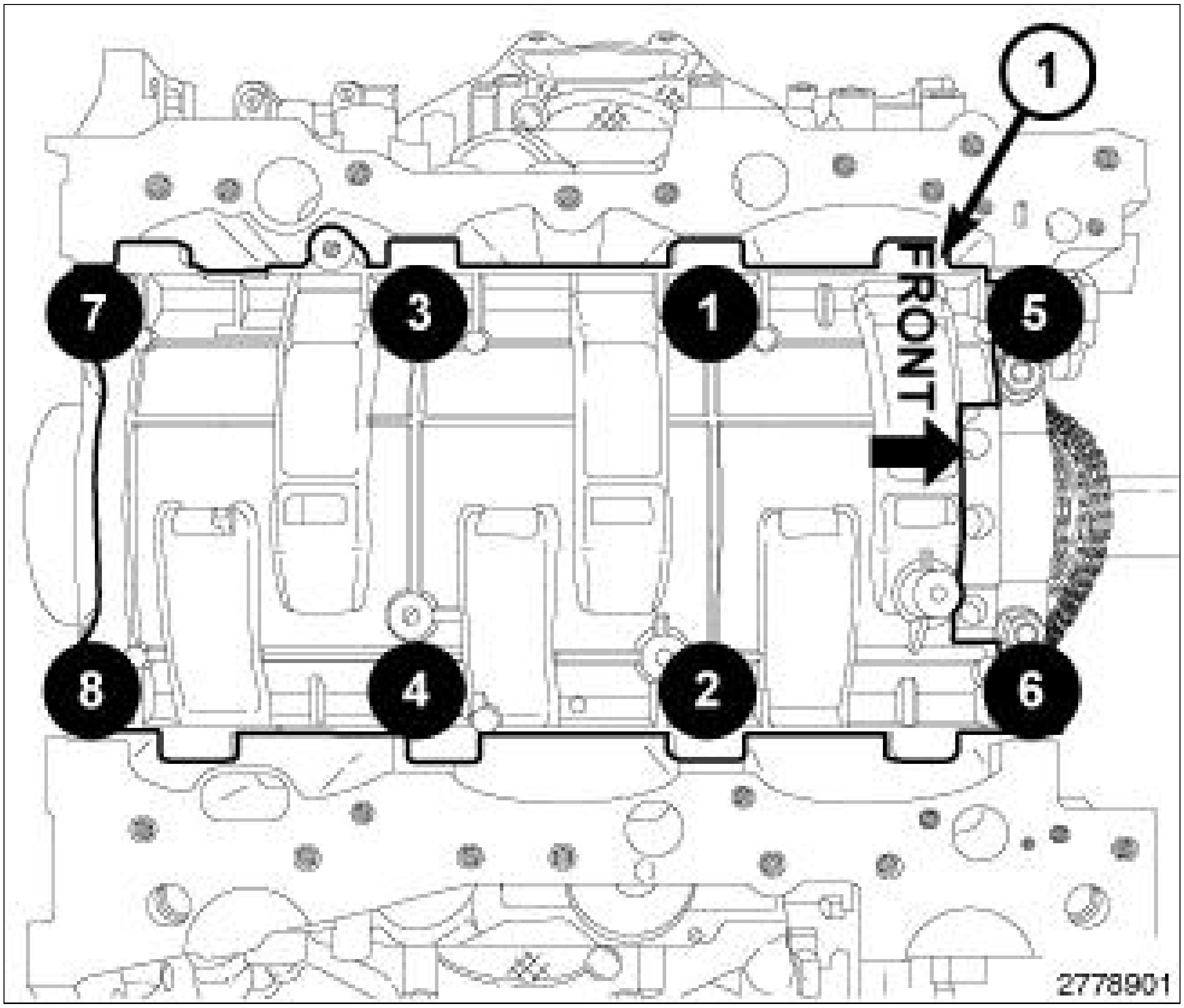
Courtesy of CHRYSLER GROUP, LLC

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 6: Windage Tray With Main Bearing Cap Bolts Installation Sequence

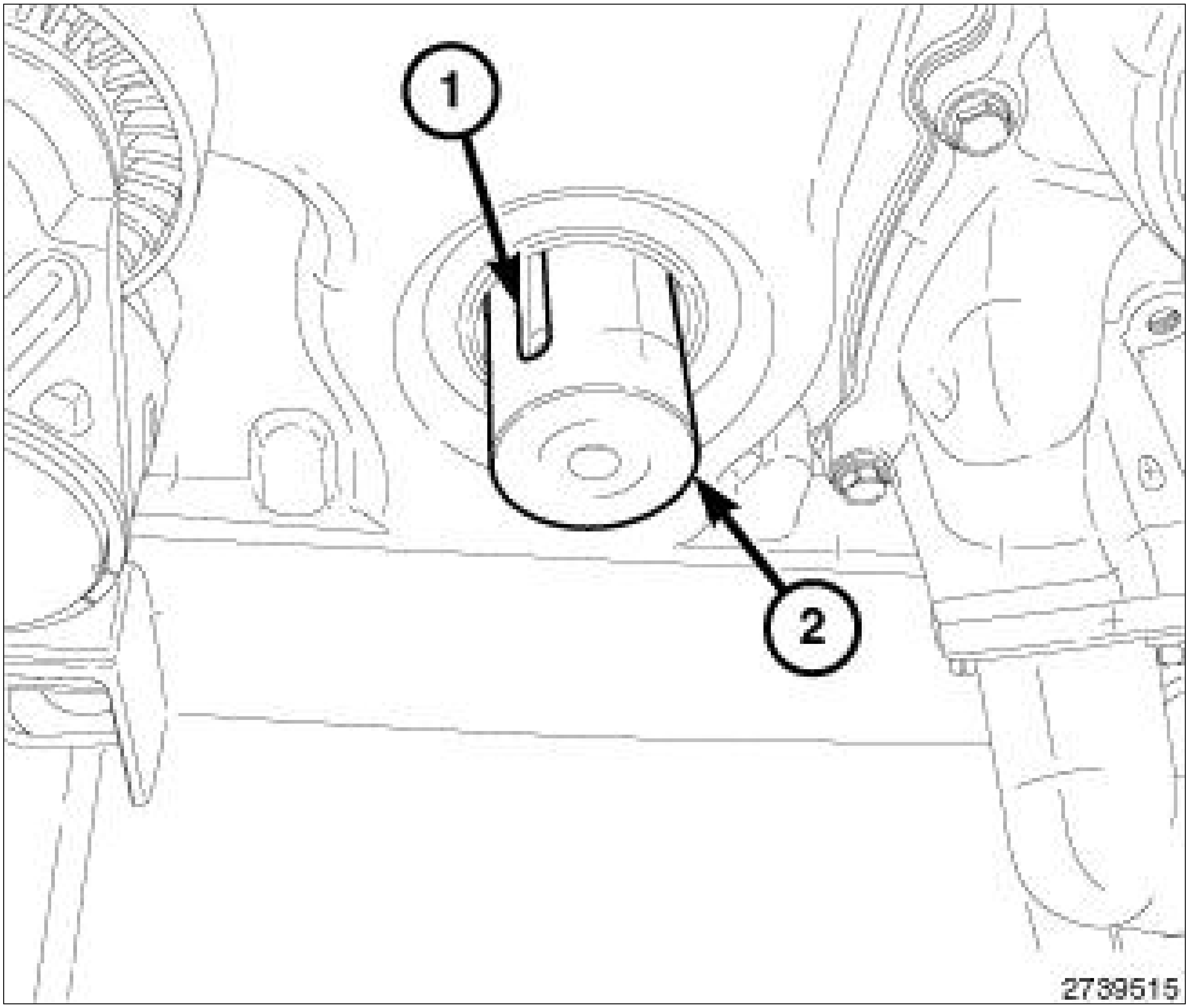


Courtesy of CHRYSLER GROUP, LLC

19. Install the windage tray with eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to the proper specification. Refer to TORQUE SPECIFICATIONS .
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 STANDARD PROCEDURE .
23. Fill the cooling system. Refer to STANDARD PROCEDURE .
24. Operate the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to STANDARD PROCEDURE .

ENGINE BLOCK > SEAL, CRANKSHAFT OIL, FRONT > REMOVAL > REMOVAL

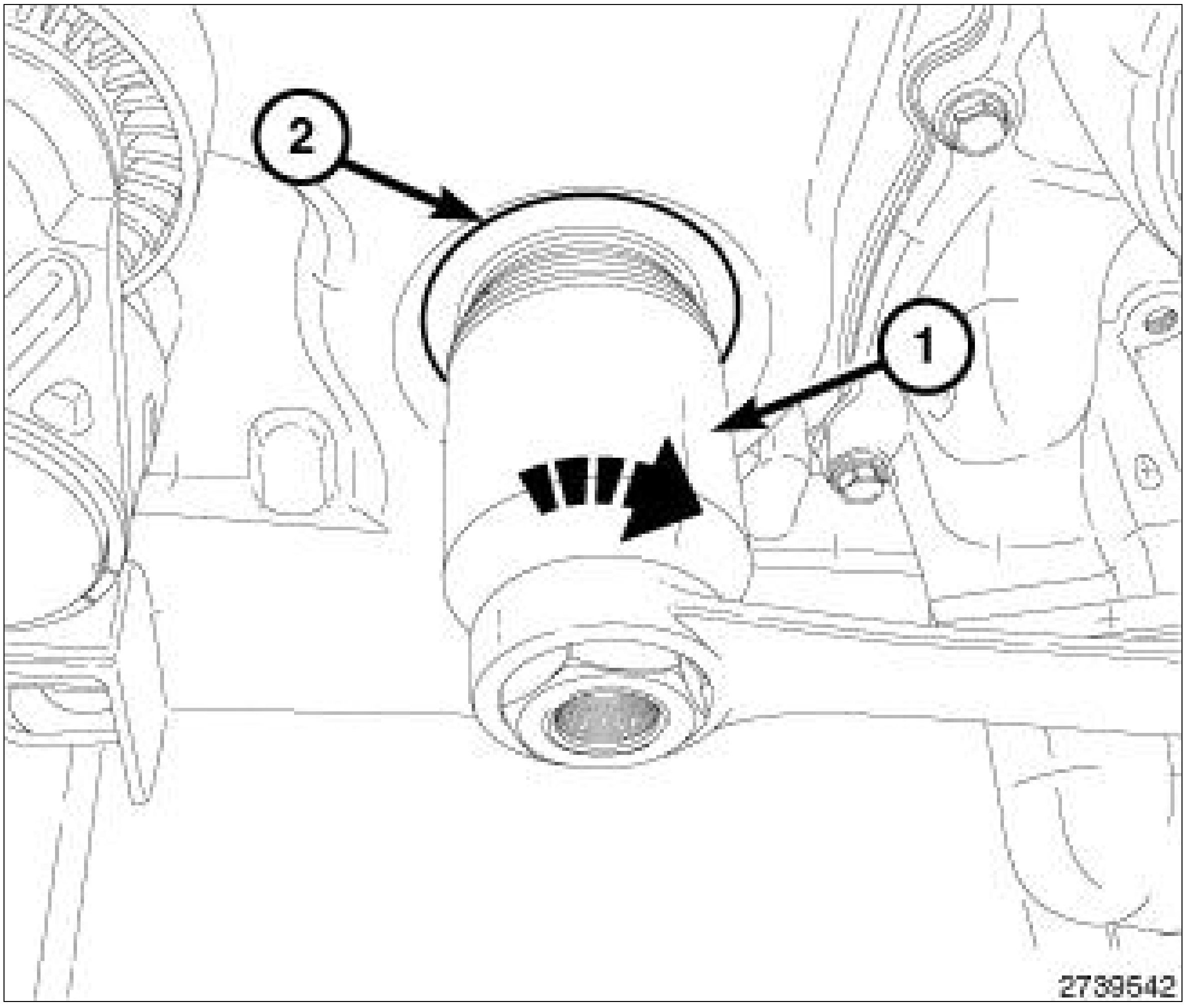
Fig 1: Sleeve & Flywheel Key



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.

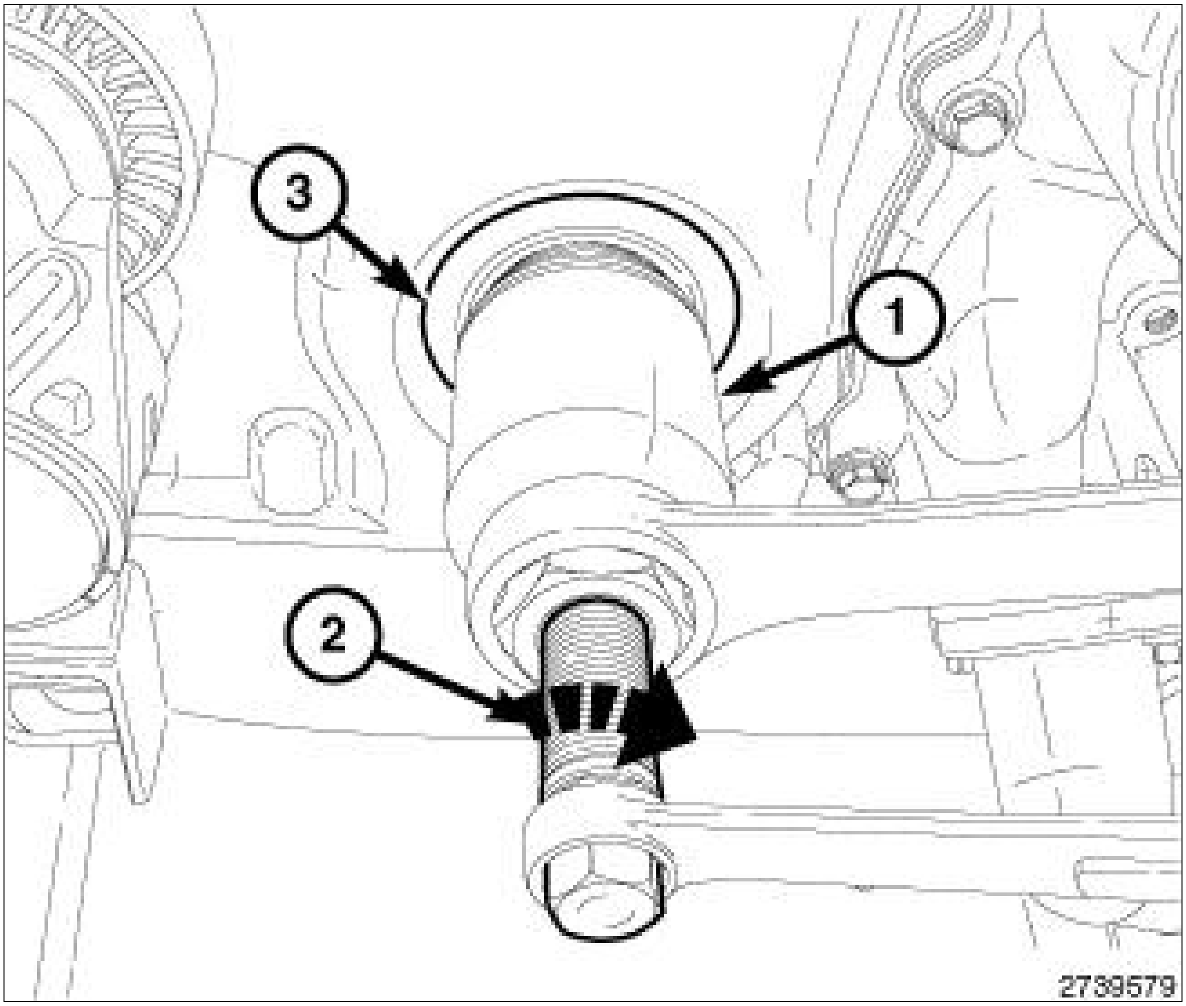
Fig 2: Seal Remover & Front Crankshaft Oil Seal



Courtesy of CHRYSLER GROUP, LLC

3. Screw Seal Remover (special tool #8511, Remover, Seal) (1) into the front crankshaft oil seal (2).

Fig 3: Extractor Screw, Seal Remover & Front Crankshaft Oil Seal

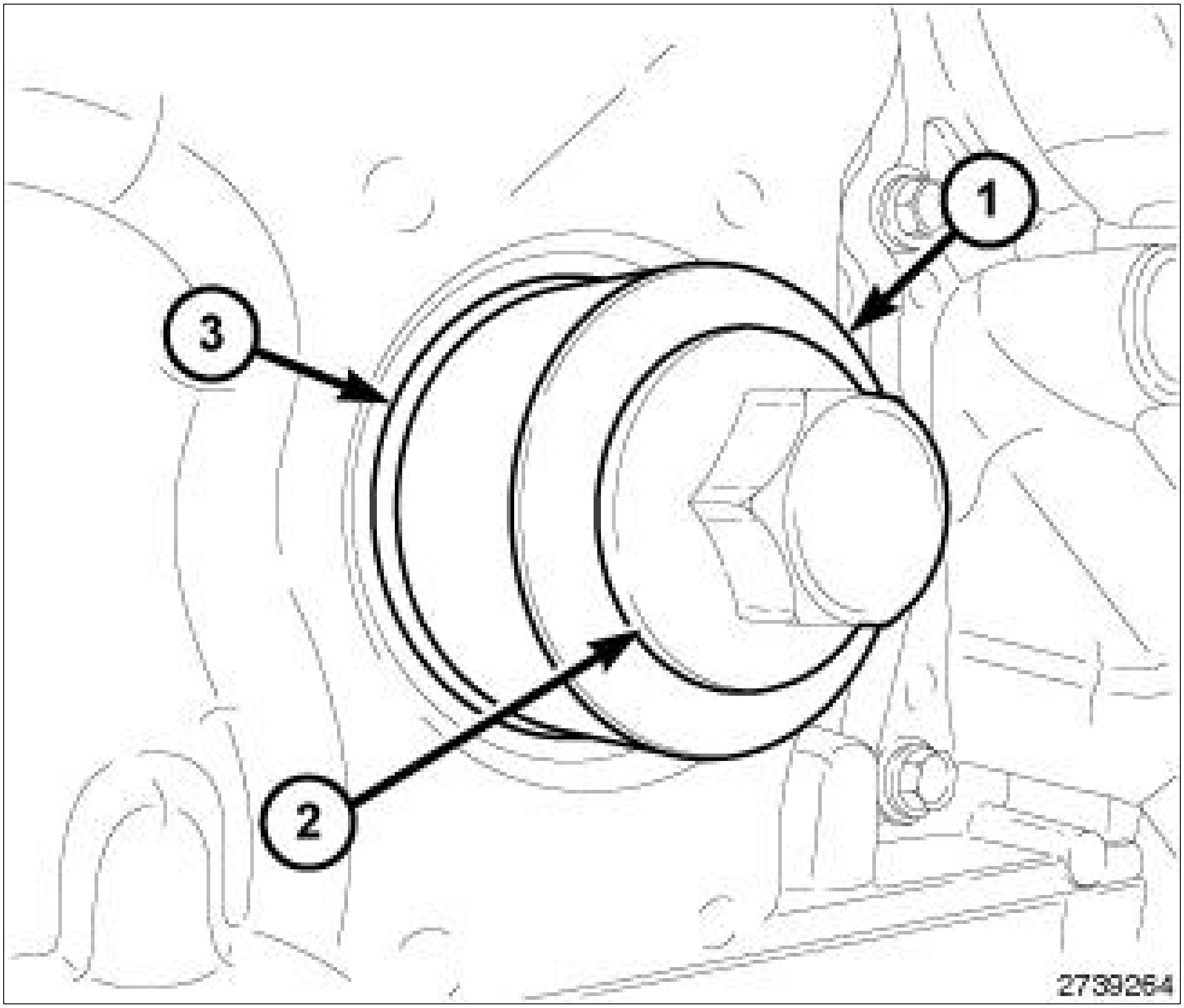


Courtesy of CHRYSLER GROUP, LLC

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.

ENGINE BLOCK > SEAL, CRANKSHAFT OIL, FRONT > INSTALLATION > INSTALLATION

Fig 1: Front Crankshaft Seal Installer & Oil Seal



Courtesy of CHRYSLER GROUP, LLC

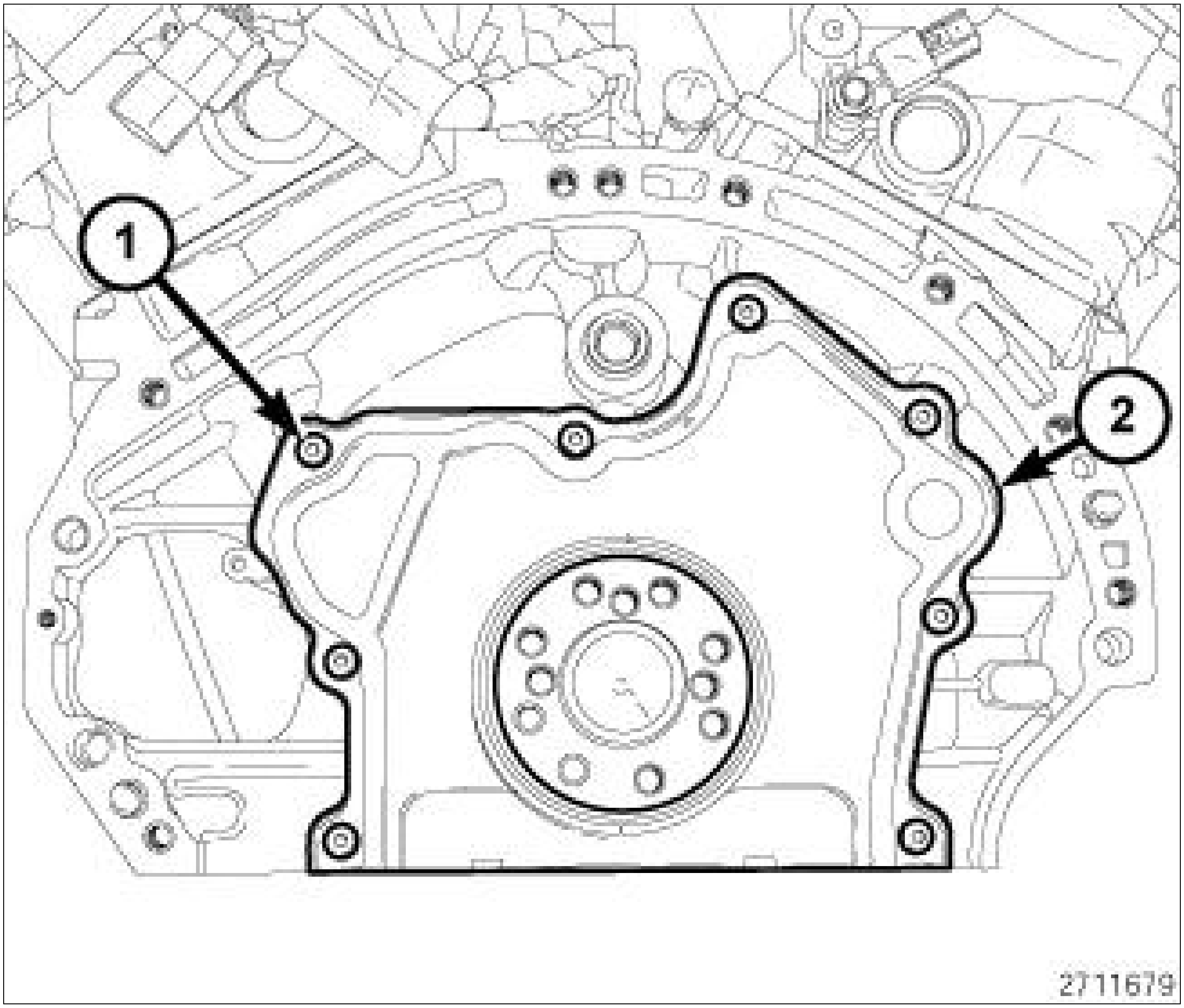
1. Position the front crankshaft oil seal (3) to engine timing cover.
2. Align the Front Crankshaft Seal Installer (special tool #10199, Installer, Crankshaft Front Oil Seal) (1) to the flywheel key on the crankshaft and against the front crankshaft oil seal (3).

> *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. Refer to DAMPER, VIBRATION, INSTALLATION .
5. Install the accessory drive belt. Refer to BELT, SERPENTINE, INSTALLATION .

ENGINE BLOCK > SEAL, CRANKSHAFT OIL, REAR > REMOVAL > REMOVAL

Fig 1: Seal Retainer & Attaching Screws



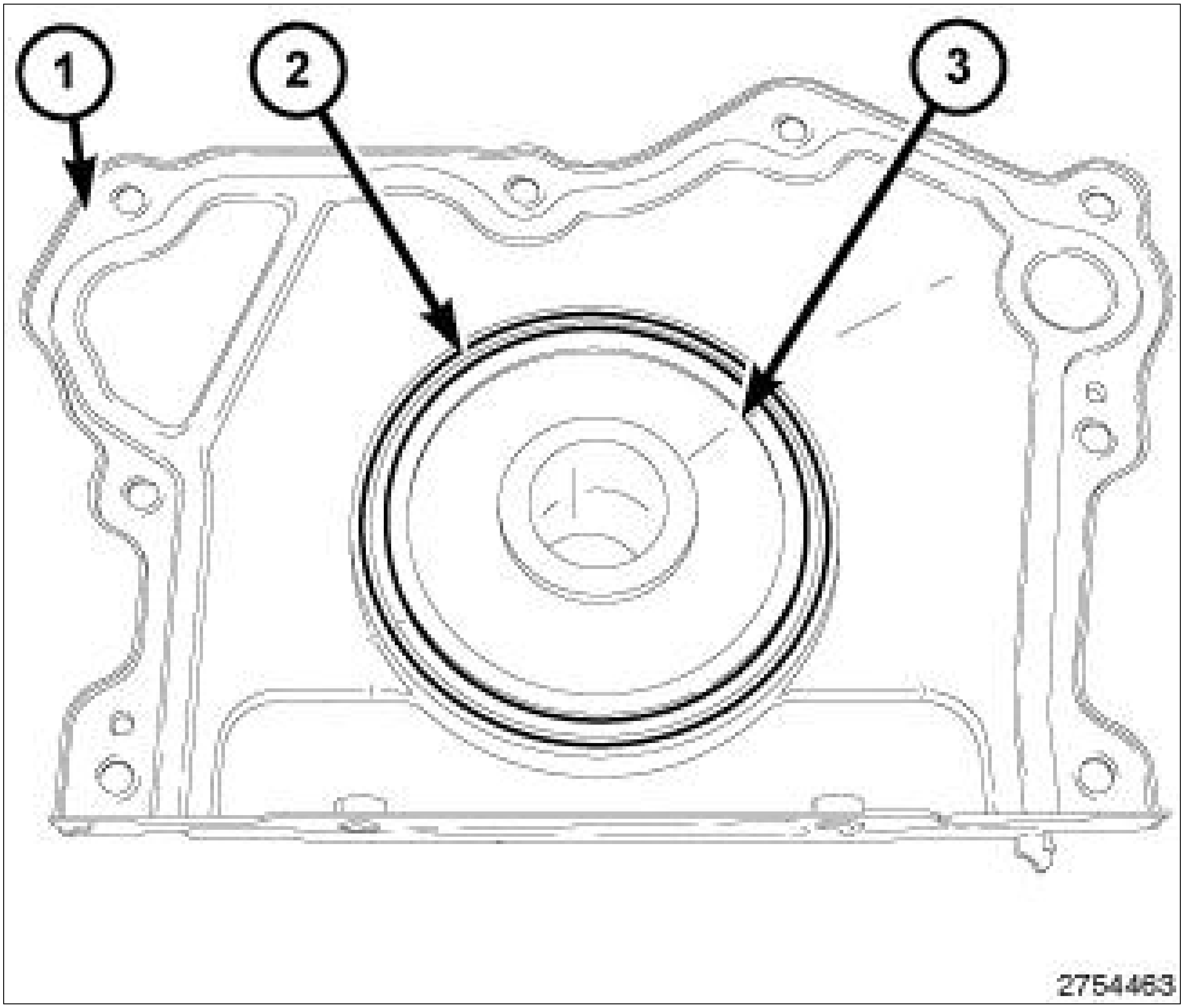
Courtesy of CHRYSLER GROUP, LLC

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 transmission. Refer to REMOVAL .
2. Remove the flexplate. Refer to FLEXPLATE, REMOVAL .
3. Remove the upper oil pan. Refer to PAN, OIL, REMOVAL .
4. Remove the eight seal retainer attaching screws (1).
5. Remove and discard the seal retainer (2).

ENGINE BLOCK > SEAL, CRANKSHAFT OIL, REAR > INSTALLATION > INSTALLATION

Fig 1: Rear Crankshaft Oil Seal, Retainer & Seal Protector



Courtesy of CHRYSLER GROUP, LLC

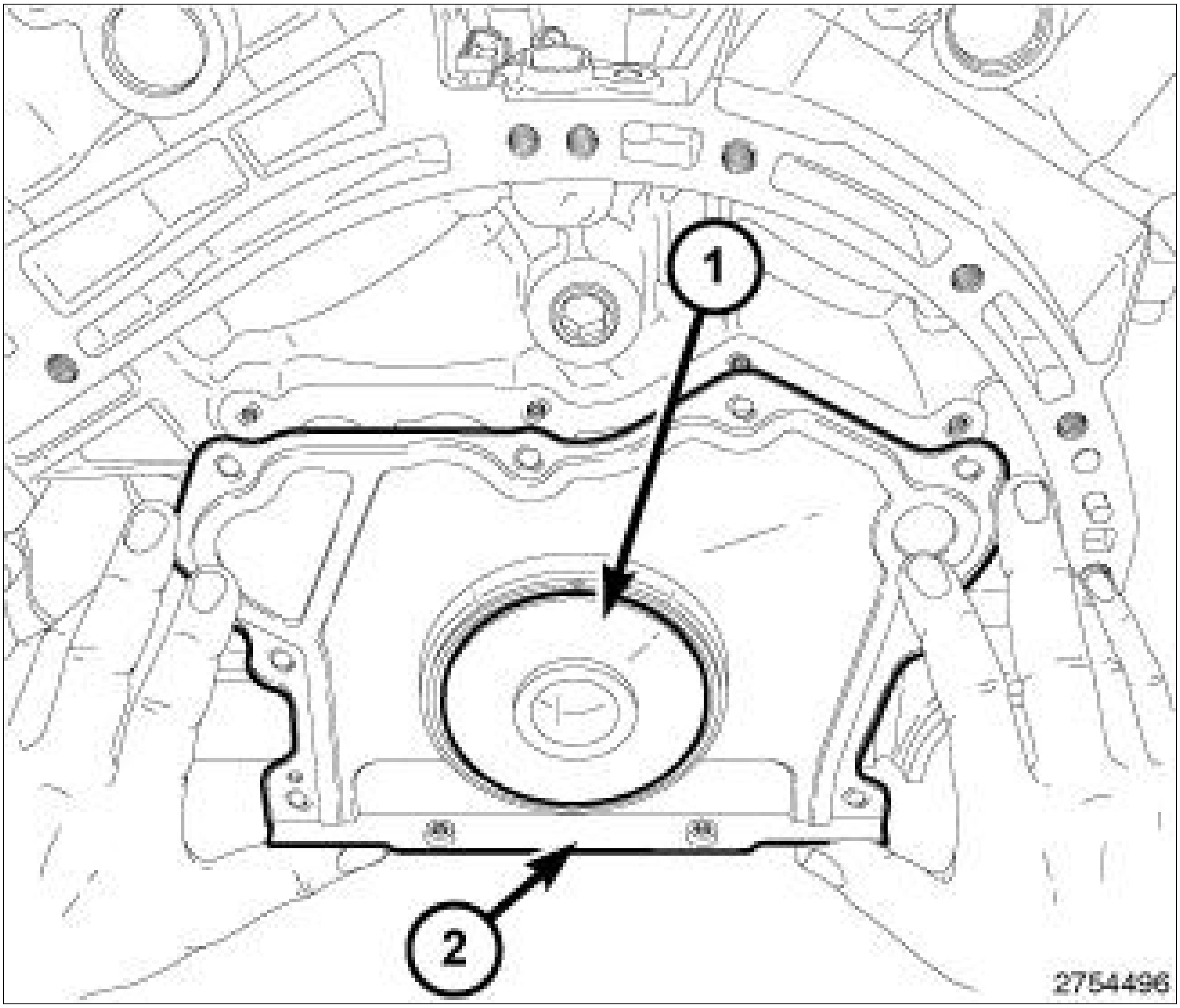
CAUTION:

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.

Fig 2: Oil Seal Retainer Assembly & Seal Protector



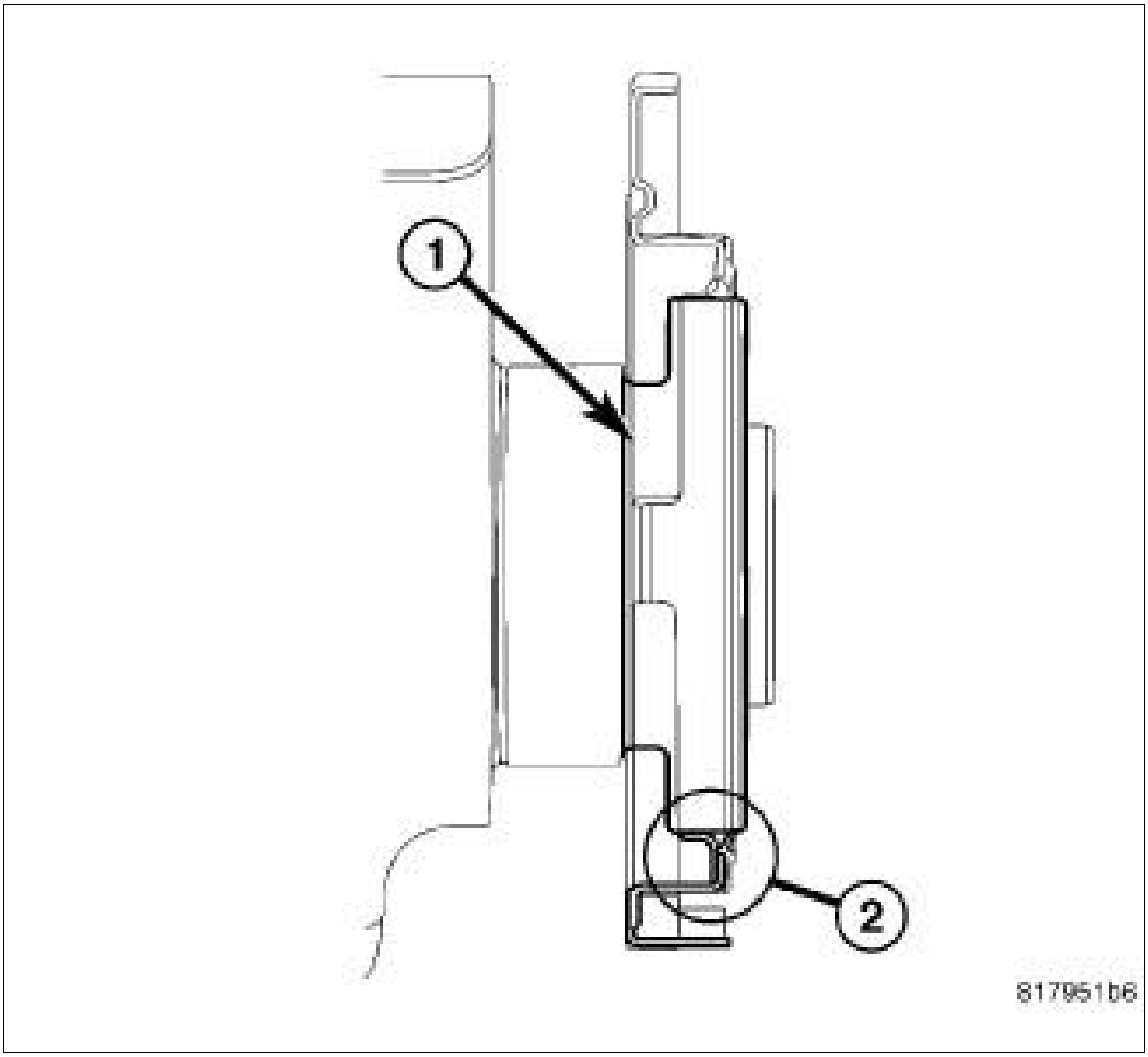
Courtesy of CHRYSLER GROUP, LLC

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).

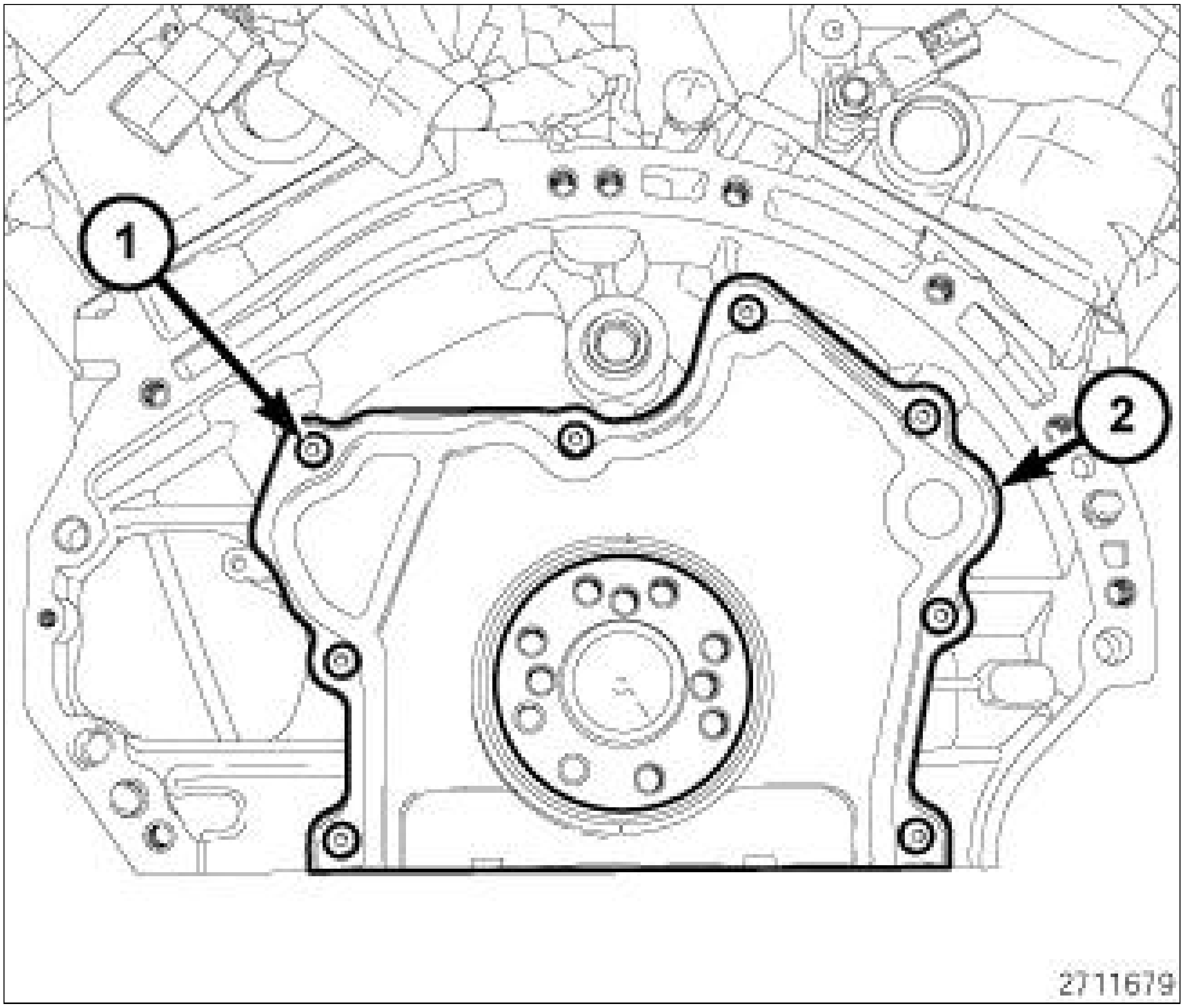
Fig 3: Rear Seal Installed



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).

Fig 4: 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.).

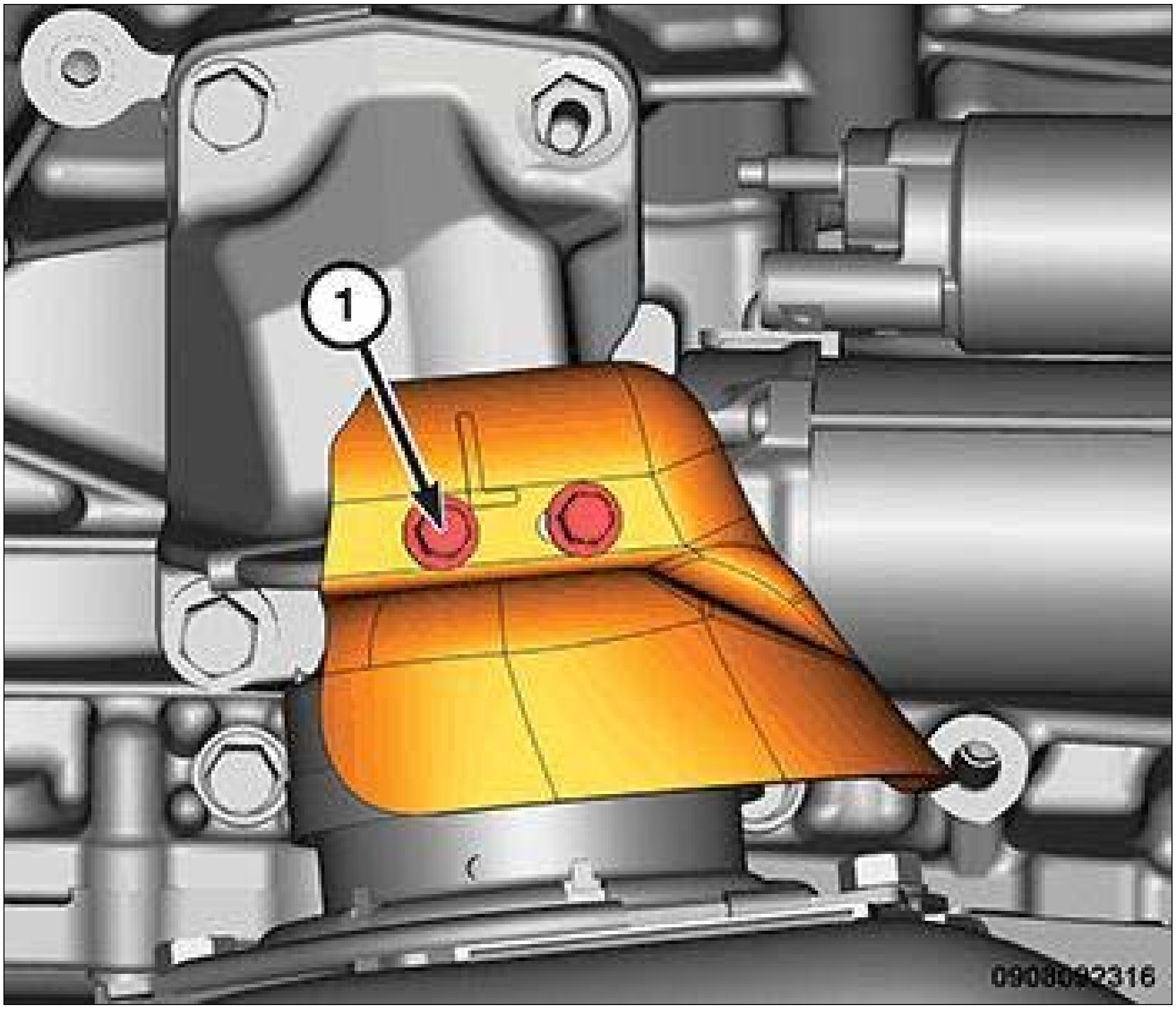
> *NOTE:*
>
> *Make sure that the seal retainer flange is flush with the engine block oil pan sealing surface.*

6. Install the upper oil pan. Refer to PAN, OIL, INSTALLATION .
7. Install the flexplate. Refer to FLEXPLATE, INSTALLATION .
8. Install the transmission. Refer to INSTALLATION .
9. Fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .

ENGINE MOUNTING > INSULATOR, ENGINE MOUNT, LEFT > REMOVAL > REMOVAL

1. Disconnect and isolate the negative battery cable.
2. Remove the upper intake manifold and insulator. Refer to MANIFOLD, INTAKE, REMOVAL .

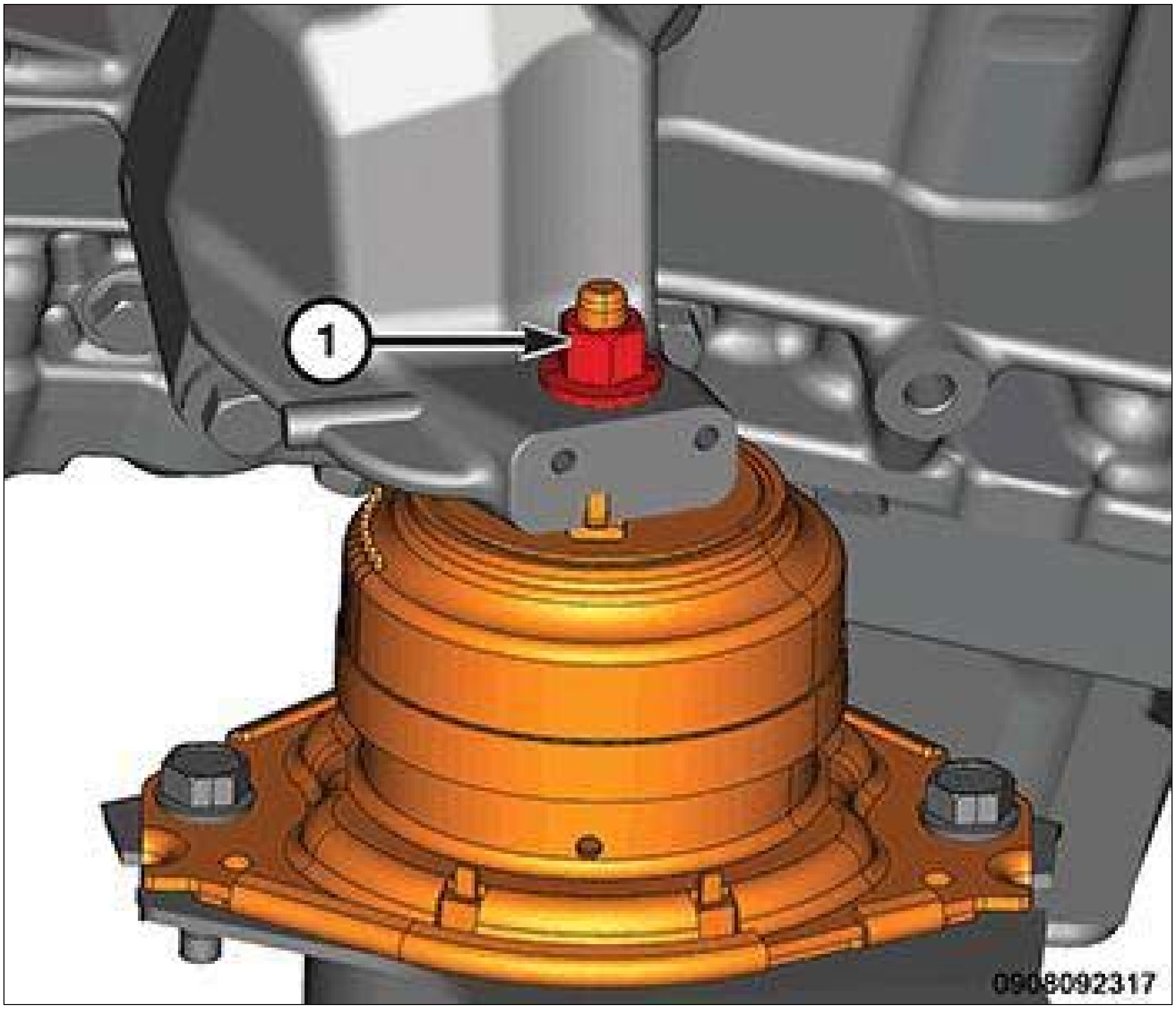
   Fig 1: Left Engine Mount Heat Shield Bolts

   Courtesy of CHRYSLER GROUP, LLC

3. Remove the bolts (1) and the engine mount heat shield from both the left and right engine mounts.

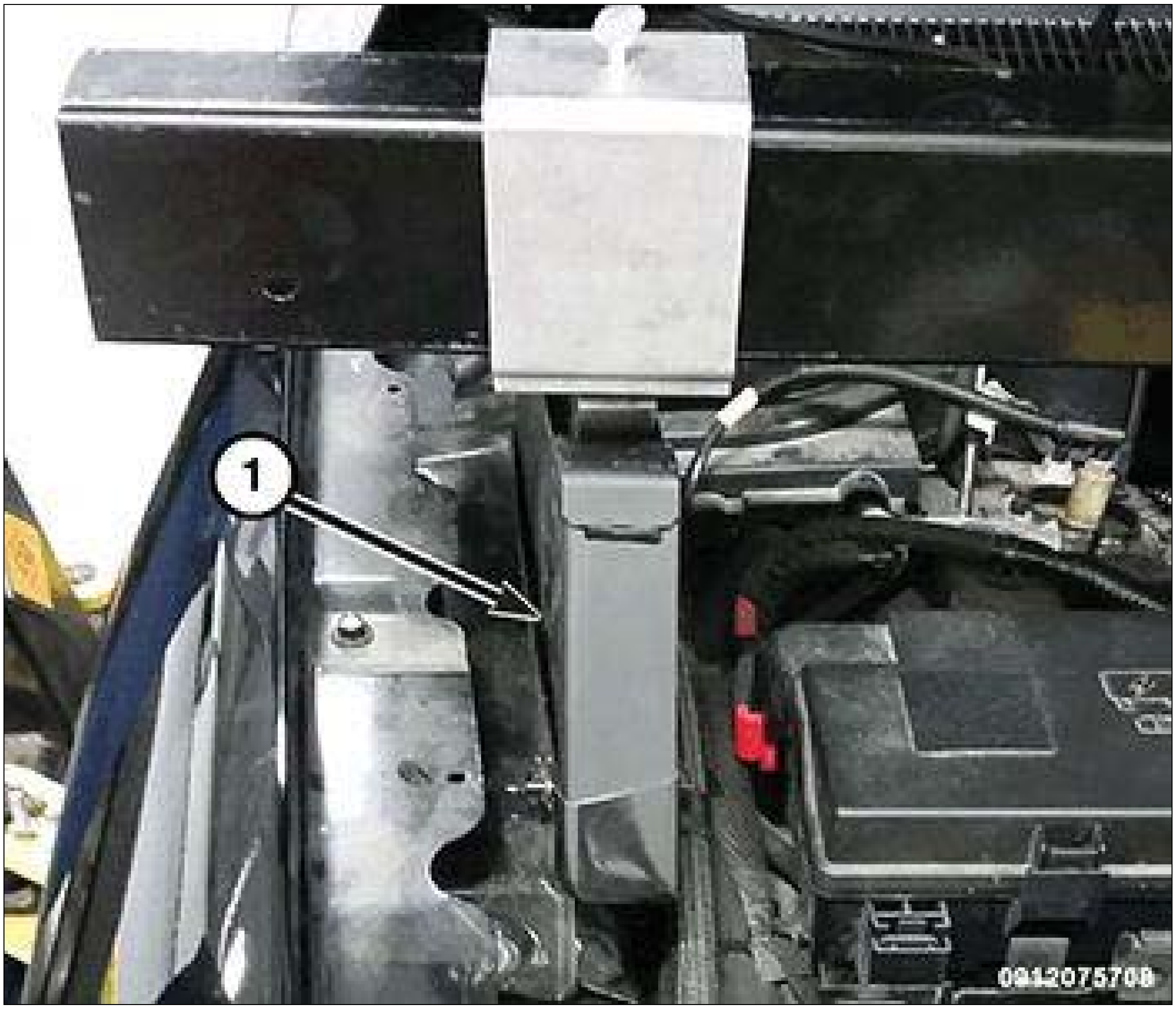
Fig 2: Left Engine Mount Nut



Courtesy of CHRYSLER GROUP, LLC

4. Remove both the left and right engine mount nuts (1).

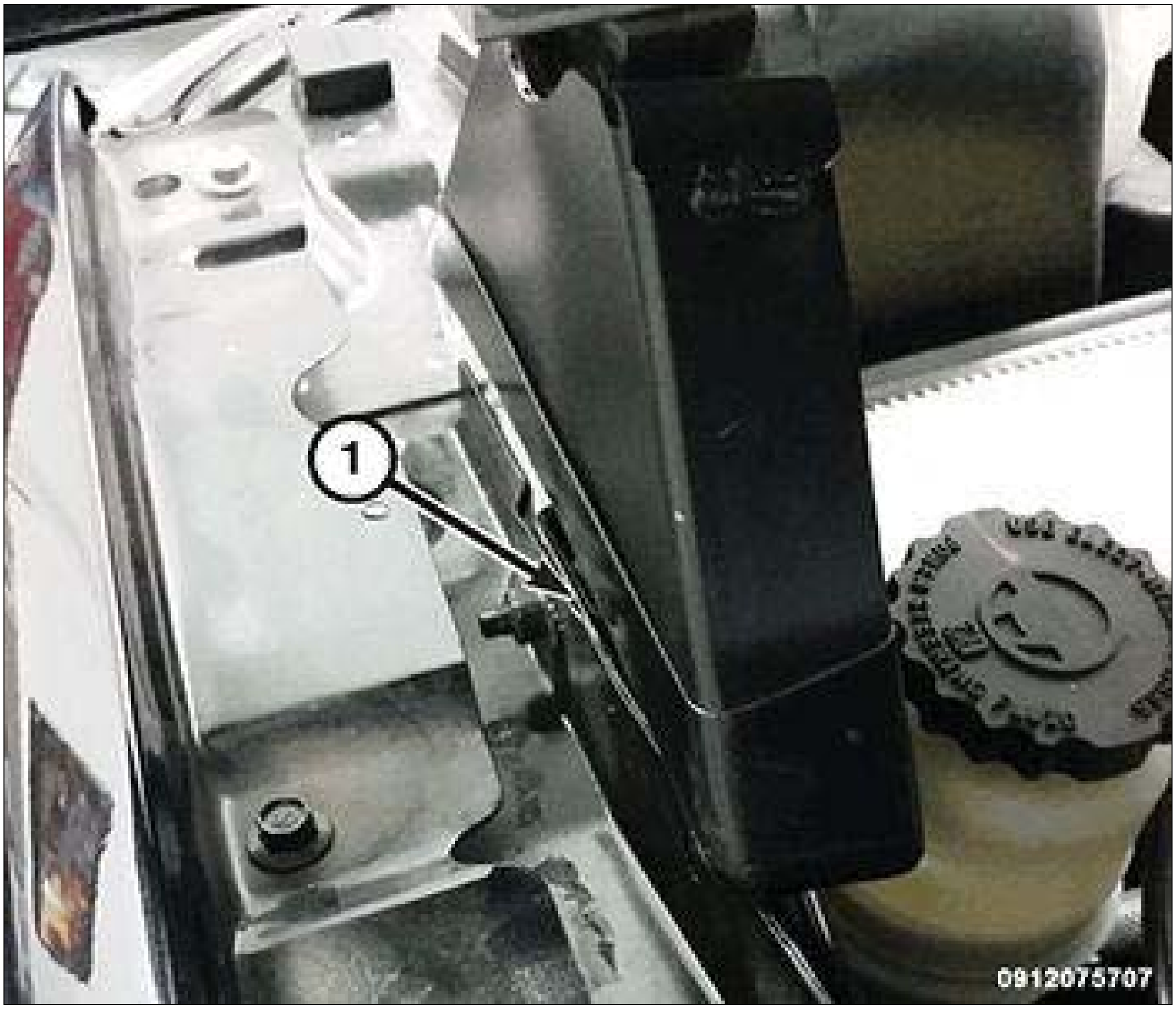
Fig 3: Placing Engine Support Fixture On Right Side Of Inner Body Structure



Courtesy of CHRYSLER GROUP, LLC

5. Remove the closeout panels and place the engine support fixture as shown in illustration on the right side of the inner body structure (1).

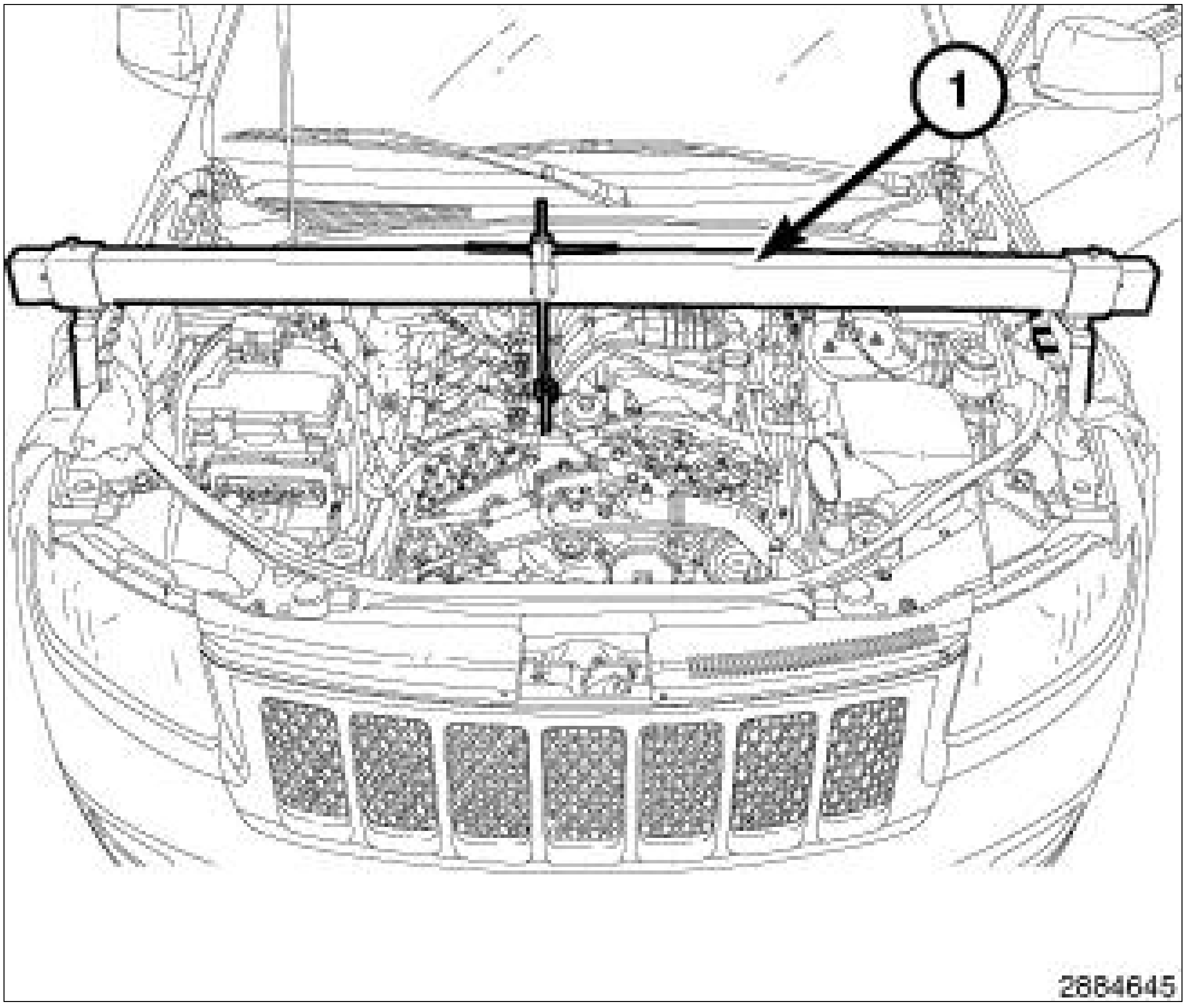
Fig 4: Placing Engine Support Fixture On Left Side Of Inner Body Structure



Courtesy of CHRYSLER GROUP, LLC

6. Remove the closeout panels and place the engine support fixture as shown in illustration on the left side of the inner body structure (1).

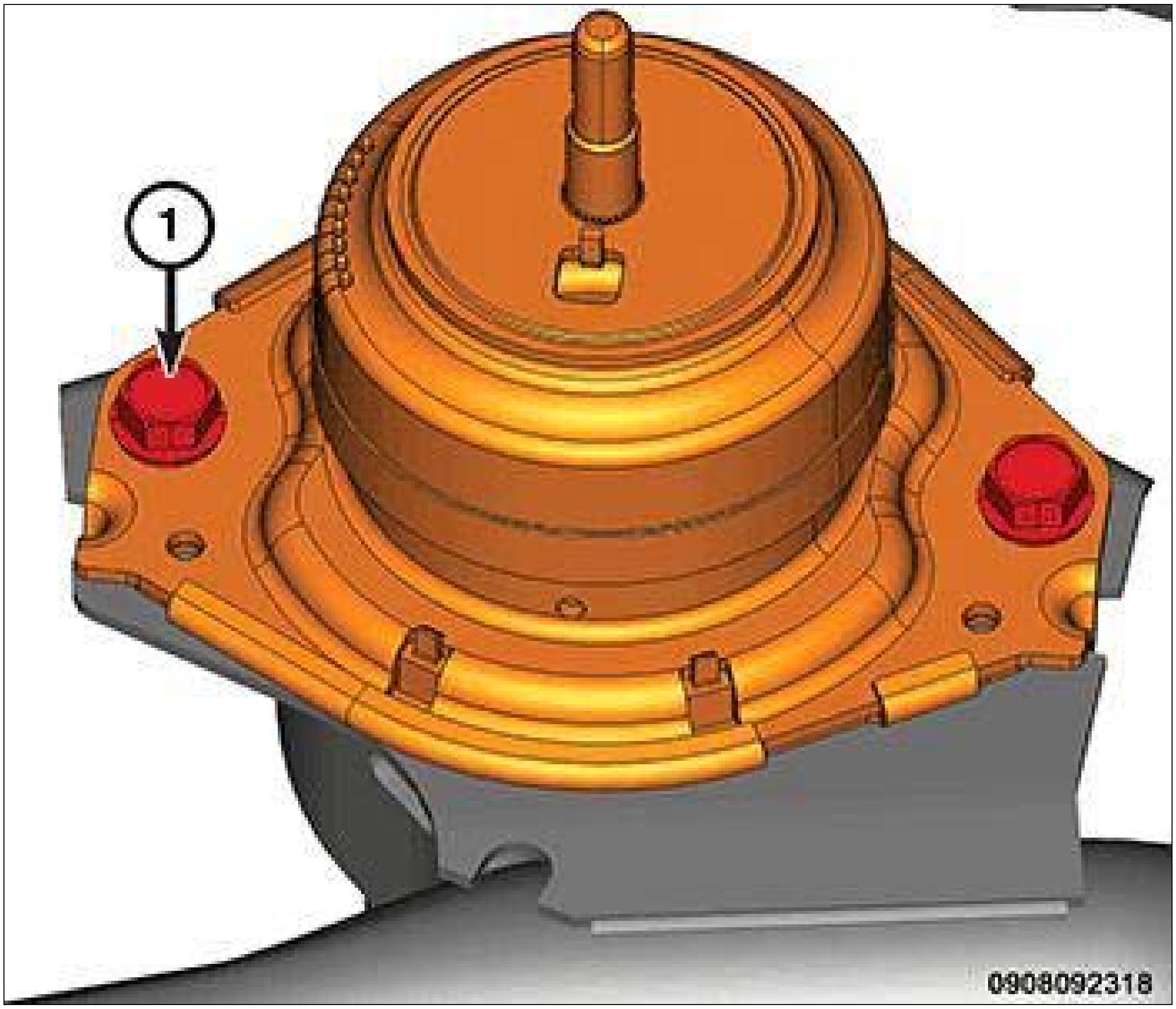
Fig 5: Engine Support Fixture



Courtesy of CHRYSLER GROUP, LLC

7. Install the Engine Support Fixture (1) (special tool #8534B, Fixture, Driveline Support) and carefully lift the engine only high enough to gain enough clearance to remove the mount.

Fig 6: Left Engine Mount Isolator Bolts



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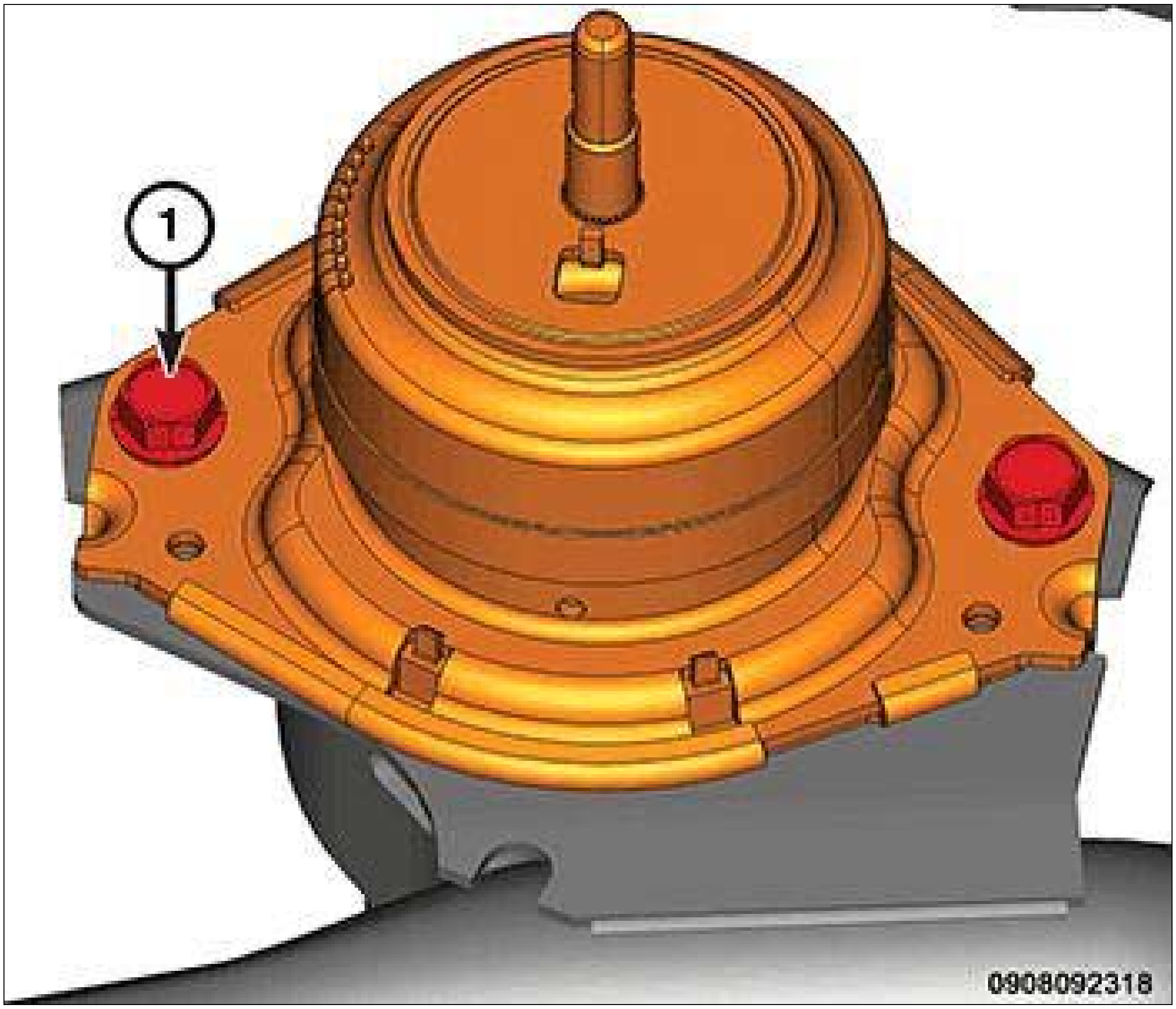
8. Remove the two bolts (1) from the left engine mount isolator.
9. Remove the left engine mount isolator from the vehicle.
10. If required, remove the four bolts from the left engine mount bracket and remove the bracket from the vehicle.

ENGINE MOUNTING > INSULATOR, ENGINE MOUNT, LEFT > INSTALLATION > INSTALLATION

1. If removed, install the left engine mount bracket to the engine block with four bolts and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 1: Left Engine Mount Isolator Bolts



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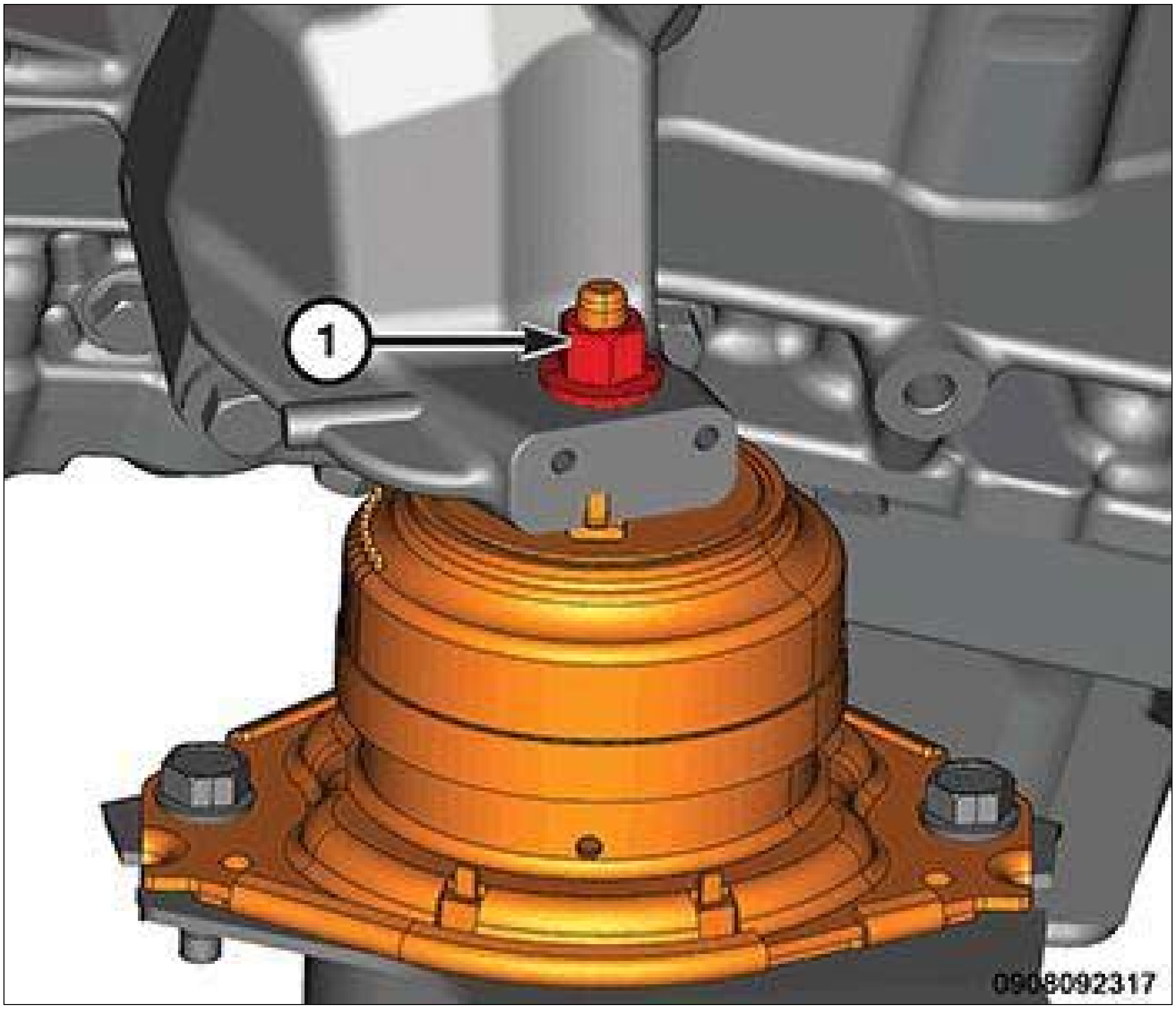
2. Install the left engine mount isolator to the frame with two bolts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

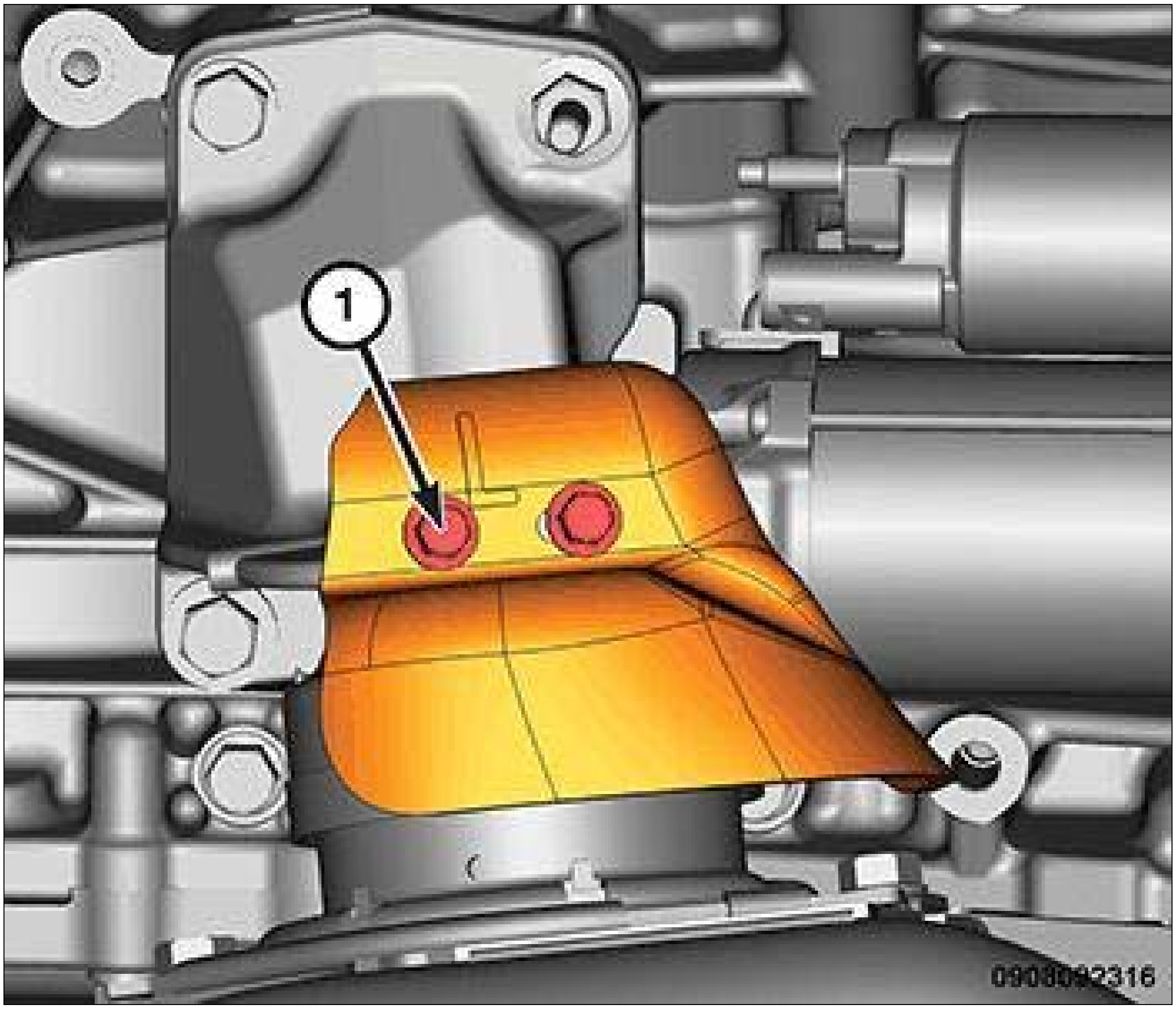
Fig 2: Left Engine Mount Nut



Courtesy of CHRYSLER GROUP, LLC

3. Align the tab on the isolators with the notch in the engine mount brackets and lower the engine so the weight is resting on the isolators.
4. Install the left and right engine mount nuts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 3: Left Engine Mount Heat Shield Bolts



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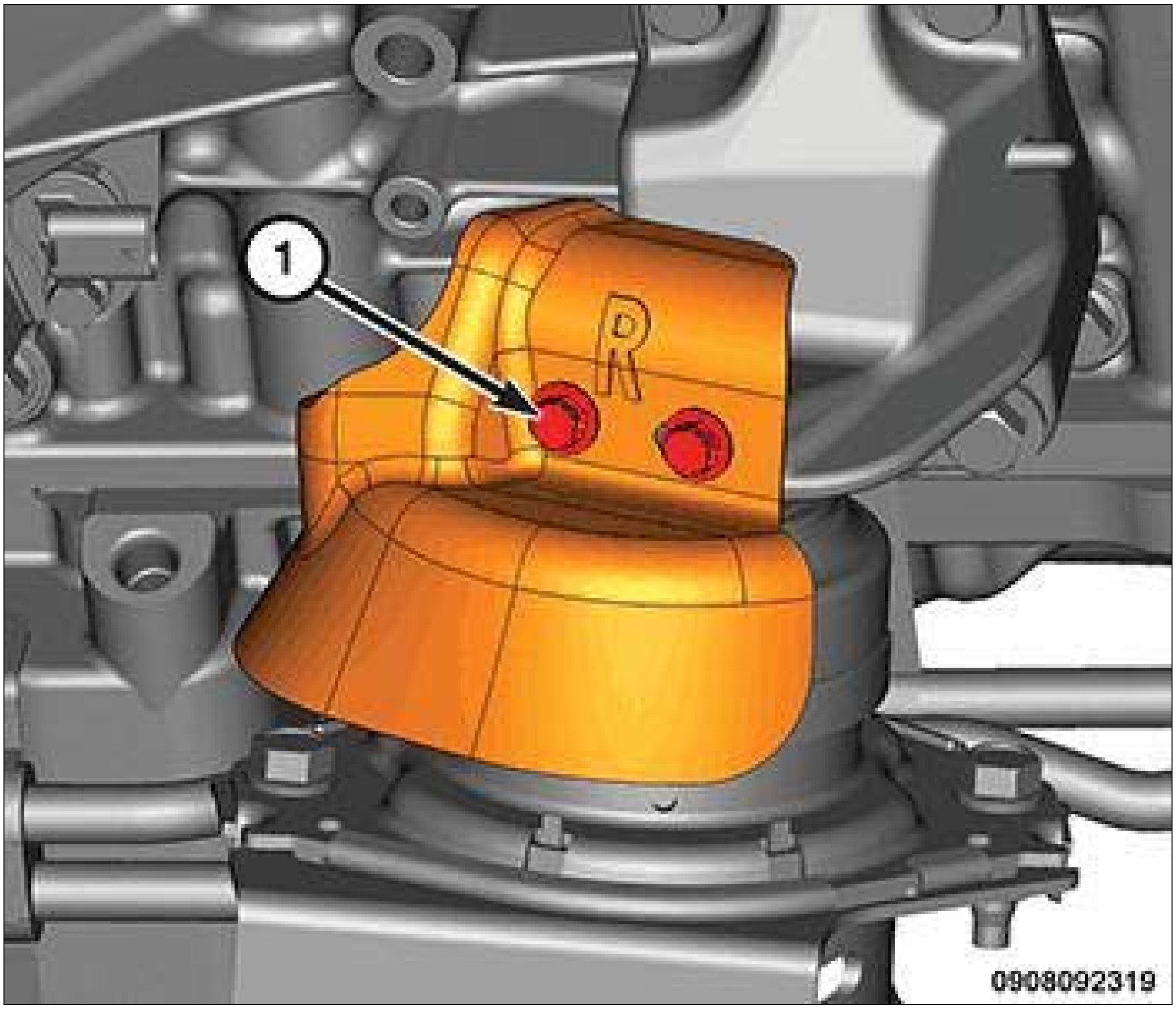
5. Install the engine mount heat shield to both the left and right engine mounts with two bolts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
6. Install the upper intake manifold and insulator. Refer to MANIFOLD, INTAKE, INSTALLATION .
7. Connect the negative battery cable.

ENGINE MOUNTING > INSULATOR, ENGINE MOUNT, RIGHT > REMOVAL > REMOVAL

1. Disconnect and isolate the negative battery cable.
2. Remove the upper intake manifold and insulator. Refer to MANIFOLD, INTAKE, REMOVAL .

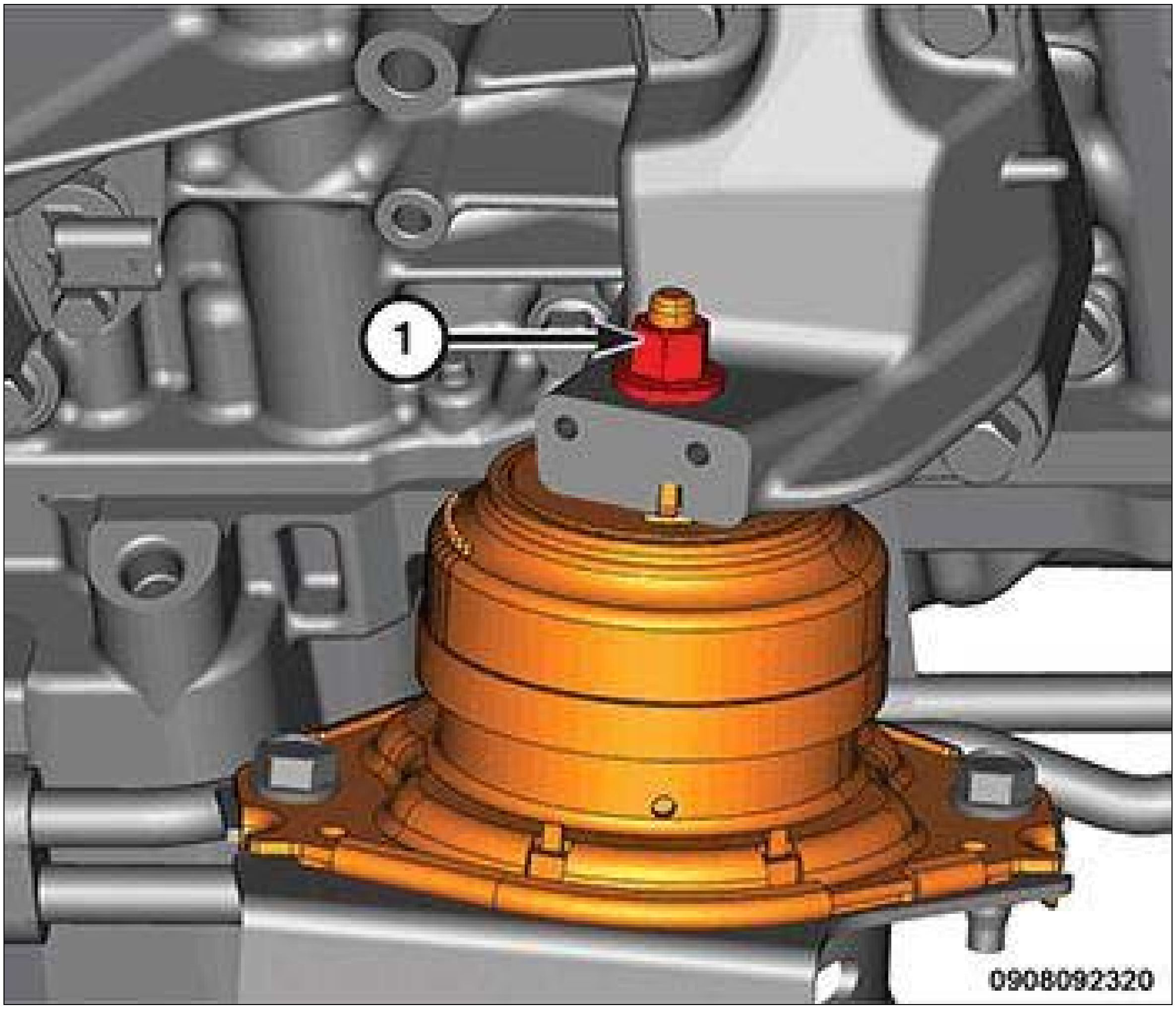
Fig 1: Right Engine Mount Heat Shield Bolts



Courtesy of CHRYSLER GROUP, LLC

3. Remove the bolts (1) and the engine mount heat shield from both the left and right engine mounts.

Fig 2: Right Engine Mount Nut

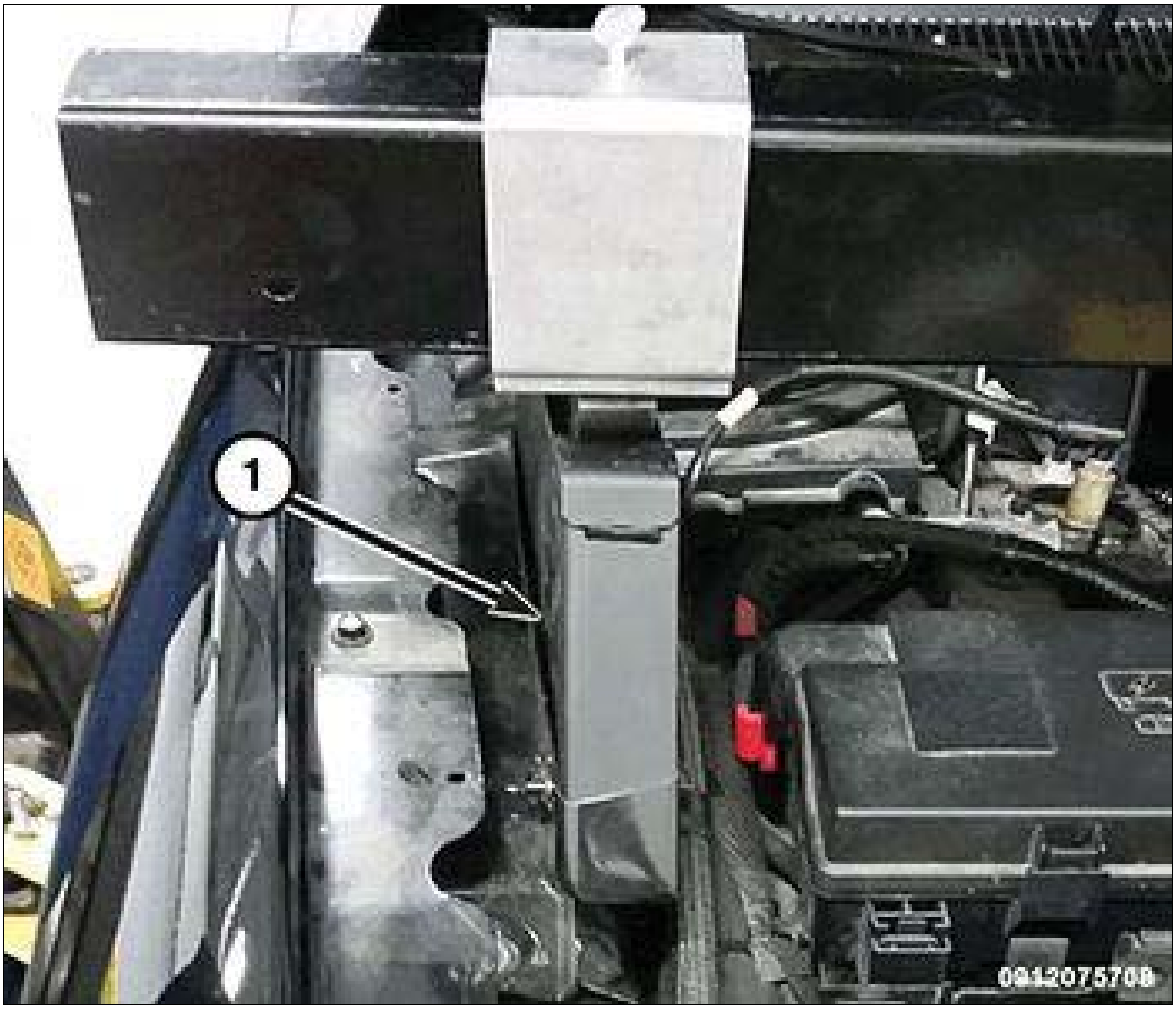


Courtesy of CHRYSLER GROUP, LLC

4. Remove both the left and right engine mount nuts (1).

> *NOTE:*
>
> *Do not place the engine support fixture on the fenders. The engine support fixture must be placed on the inner body structure.*

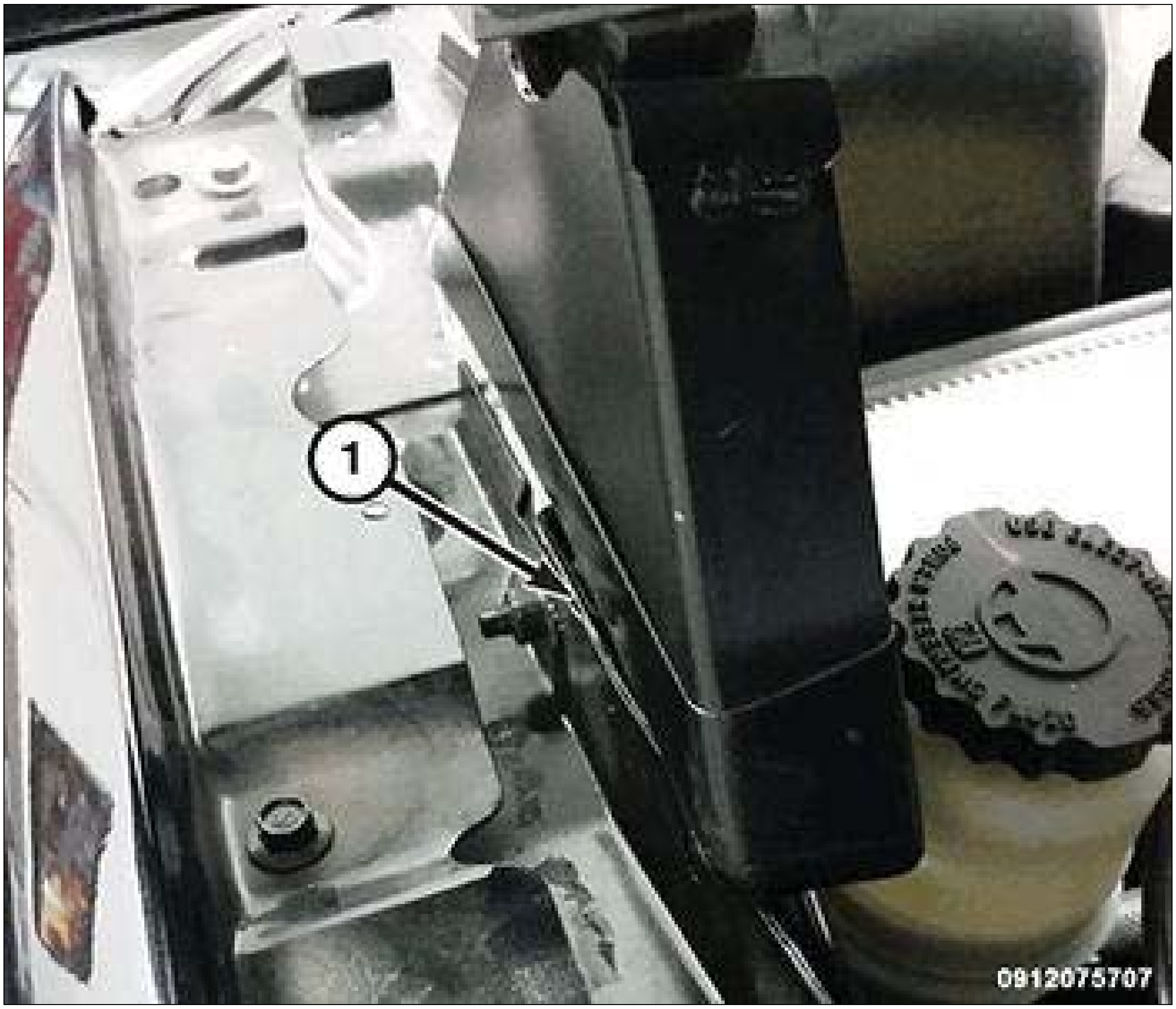
Fig 3: Placing Engine Support Fixture On Right Side Of Inner Body Structure



Courtesy of CHRYSLER GROUP, LLC

5. Remove the closeout panels and place the engine support fixture as shown in illustration on the right side of the inner body structure (1).

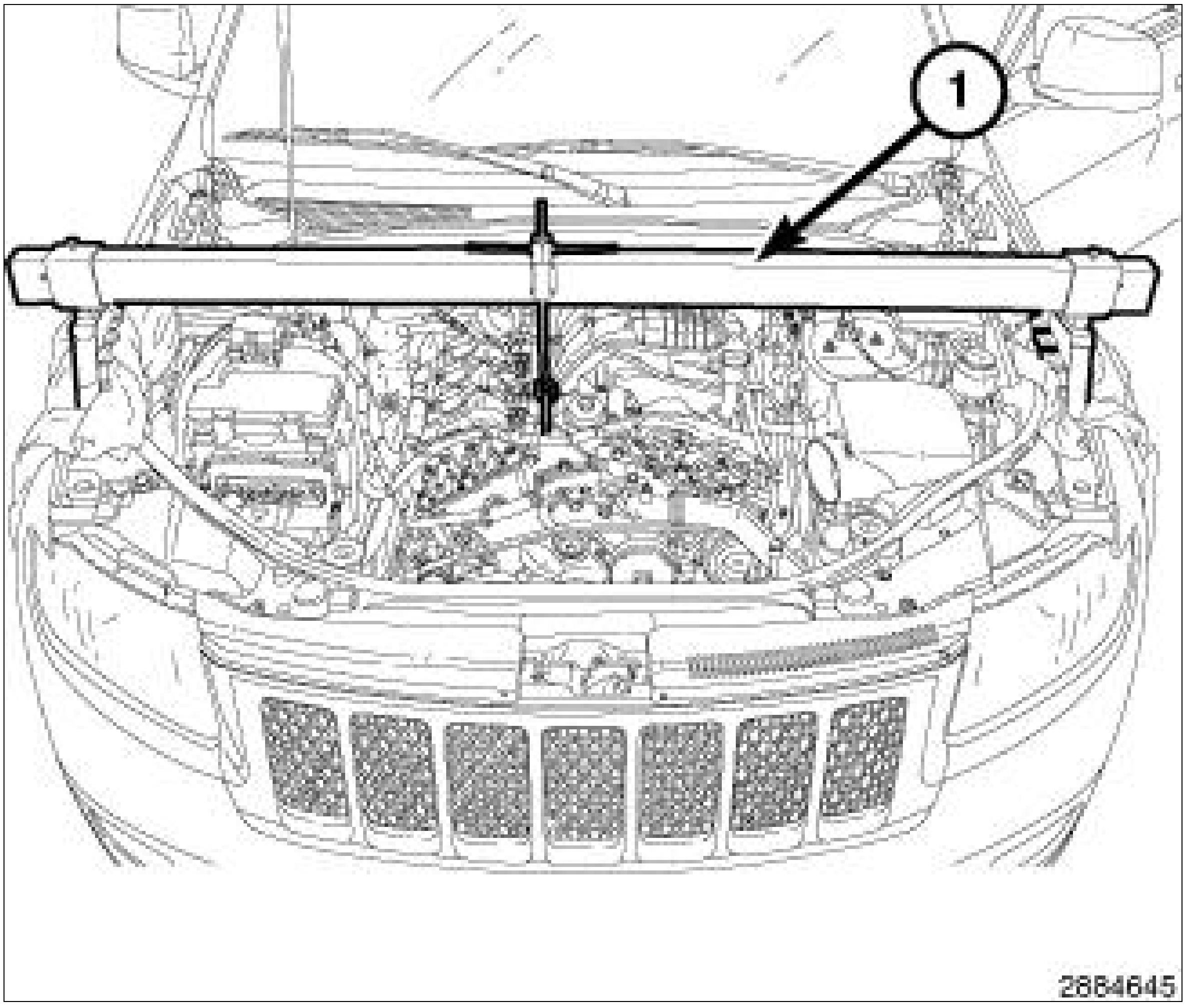
Fig 4: Placing Engine Support Fixture On Left Side Of Inner Body Structure



Courtesy of CHRYSLER GROUP, LLC

6. Remove the closeout panels and place the engine support fixture as shown in illustration on the left side of the inner body structure (1).

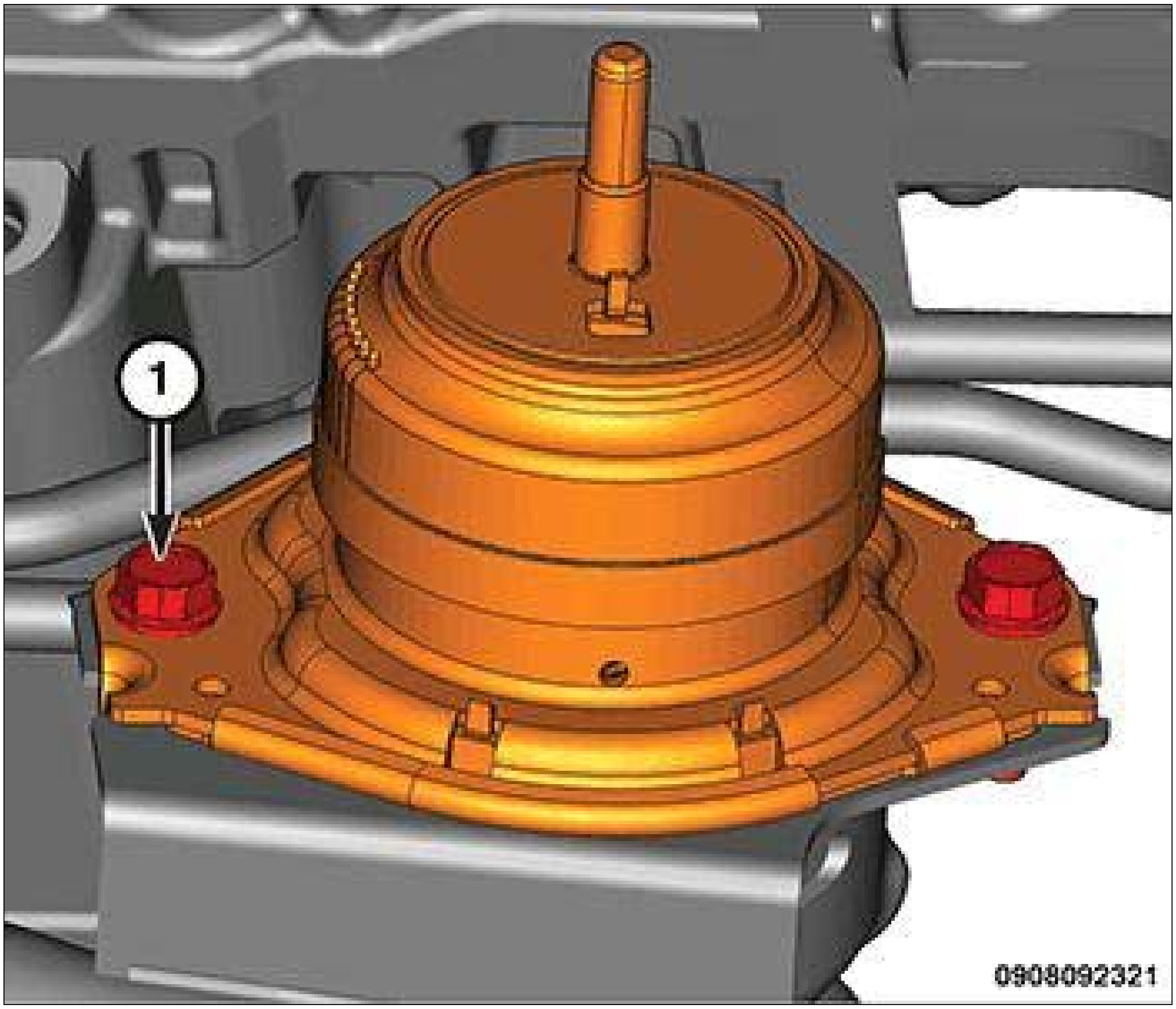
Fig 5: Engine Support Fixture



Courtesy of CHRYSLER GROUP, LLC

7. Install the Engine Support Fixture (1) (special tool #8534B, Fixture, Driveline Support) and carefully lift the engine only high enough to gain enough clearance to remove the mount.

Fig 6: Right Engine Mount Isolator Bolts



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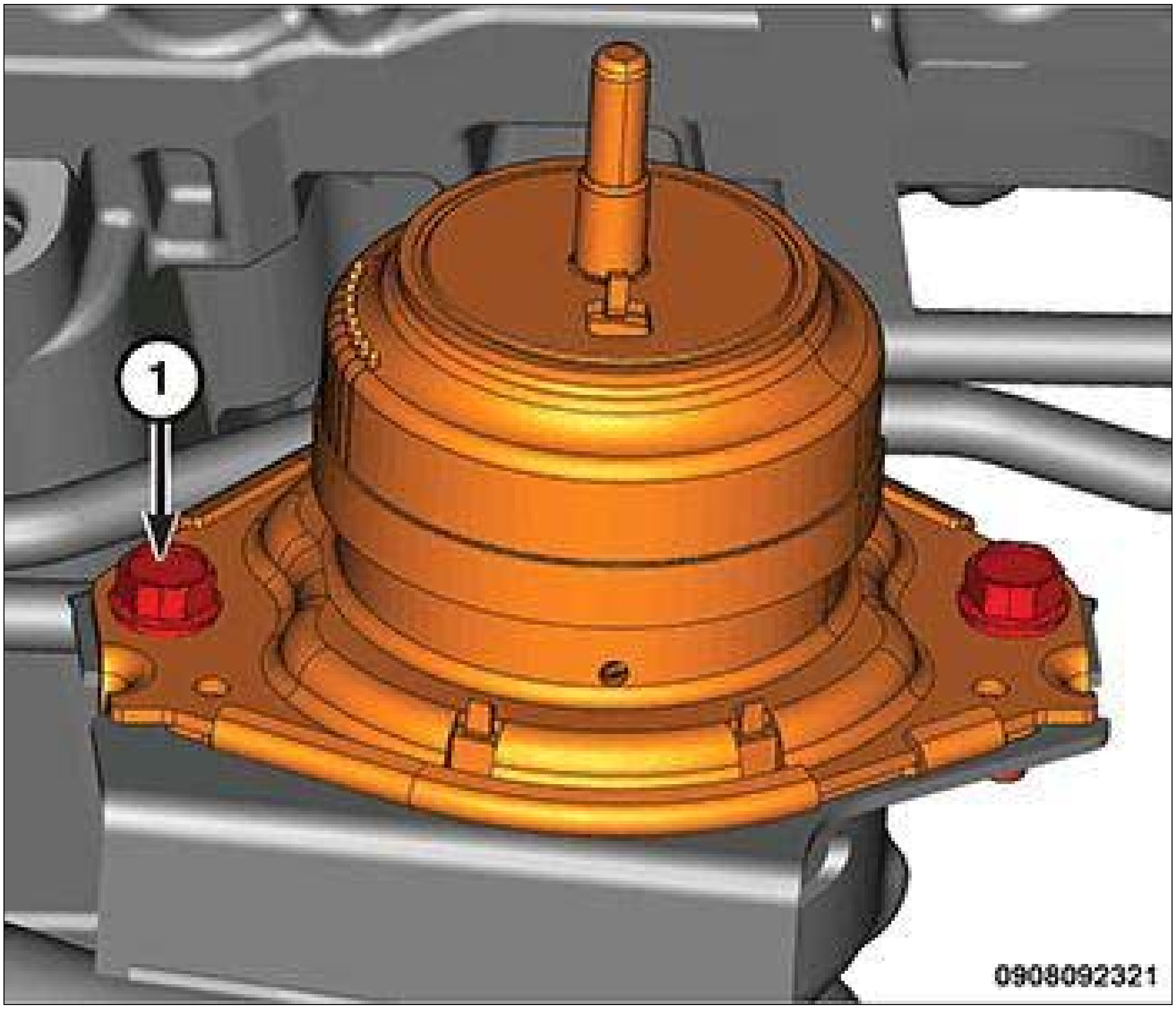
8. Remove the two bolts (1) from the right engine mount isolator and remove the isolator from the vehicle.
9. If required, remove the four bolts from the right engine mount bracket and remove the bracket from the vehicle.

ENGINE MOUNTING > INSULATOR, ENGINE MOUNT, RIGHT > INSTALLATION > INSTALLATION

1. If removed, install the right engine mount bracket (2) to the engine block with four bolts (3) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

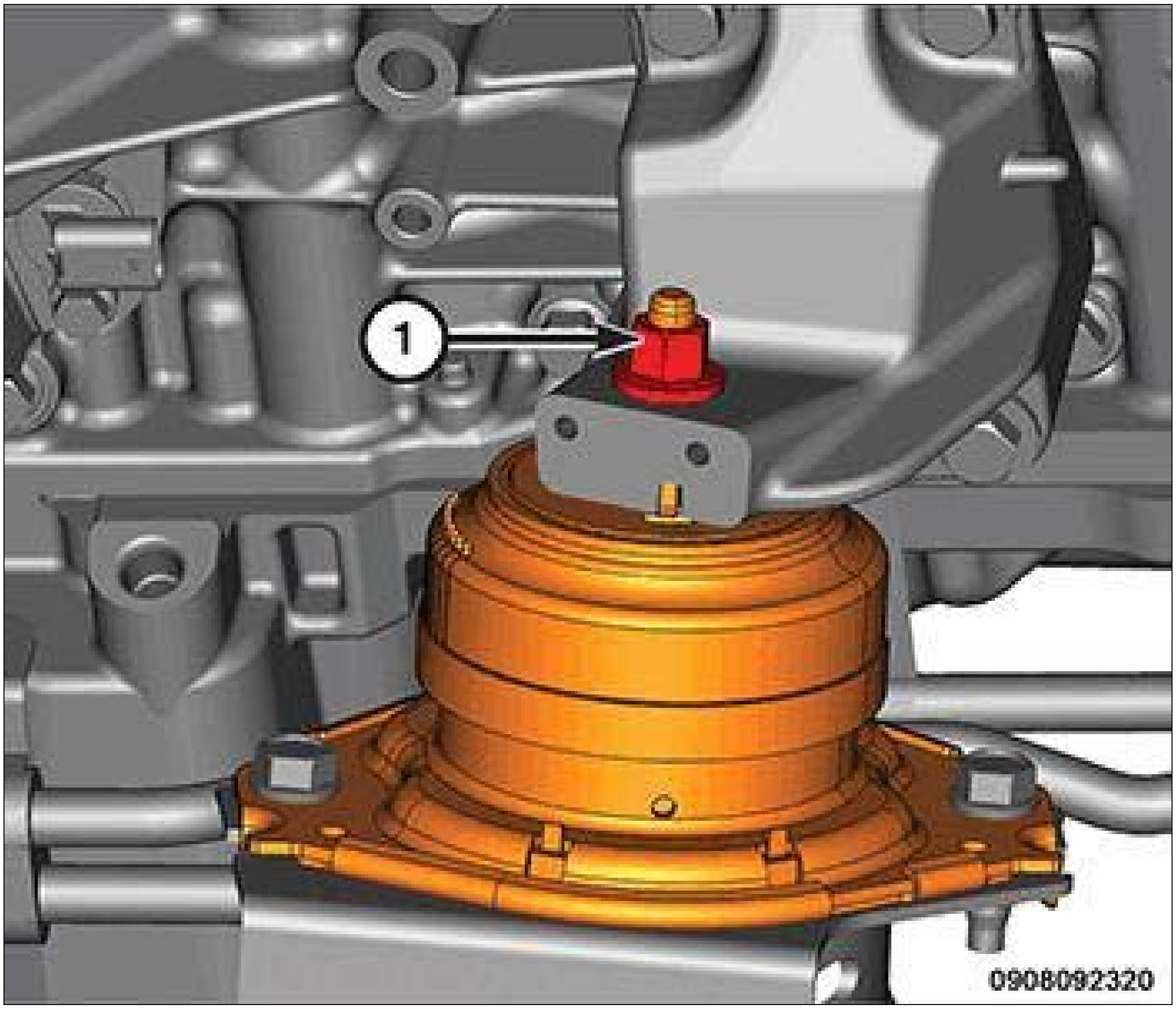
Fig 1: Right Engine Mount Isolator Bolts



Courtesy of CHRYSLER GROUP, LLC

2. Install the right engine mount isolator to the frame with two bolts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

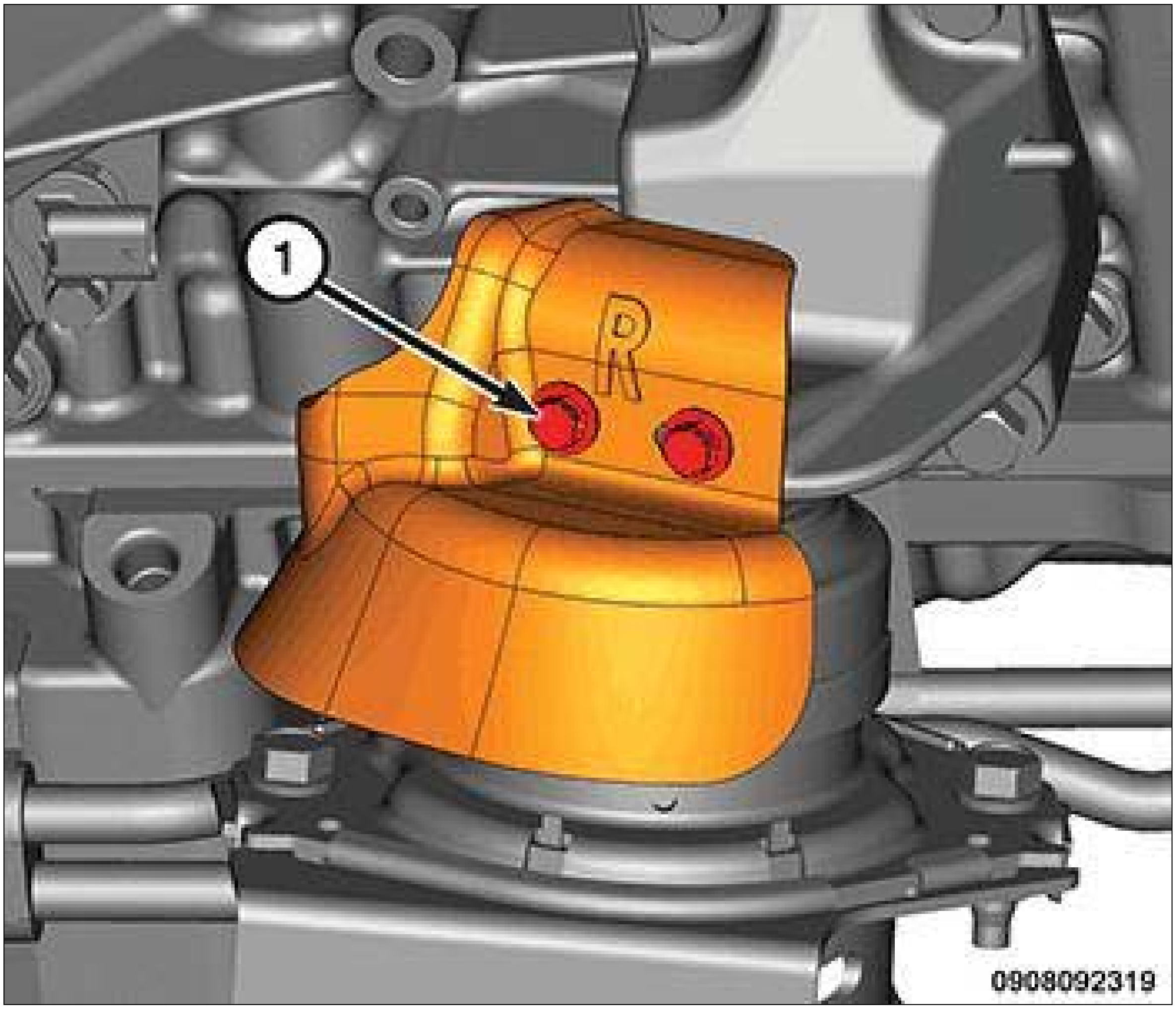
Fig 2: Right Engine Mount Nut



Courtesy of CHRYSLER GROUP, LLC

3. Align the tab on the isolators with the notch in the engine mount brackets and lower the engine so the weight is resting on the isolators.
4. Install the left and right engine mount nuts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 3: Right Engine Mount Heat Shield Bolts

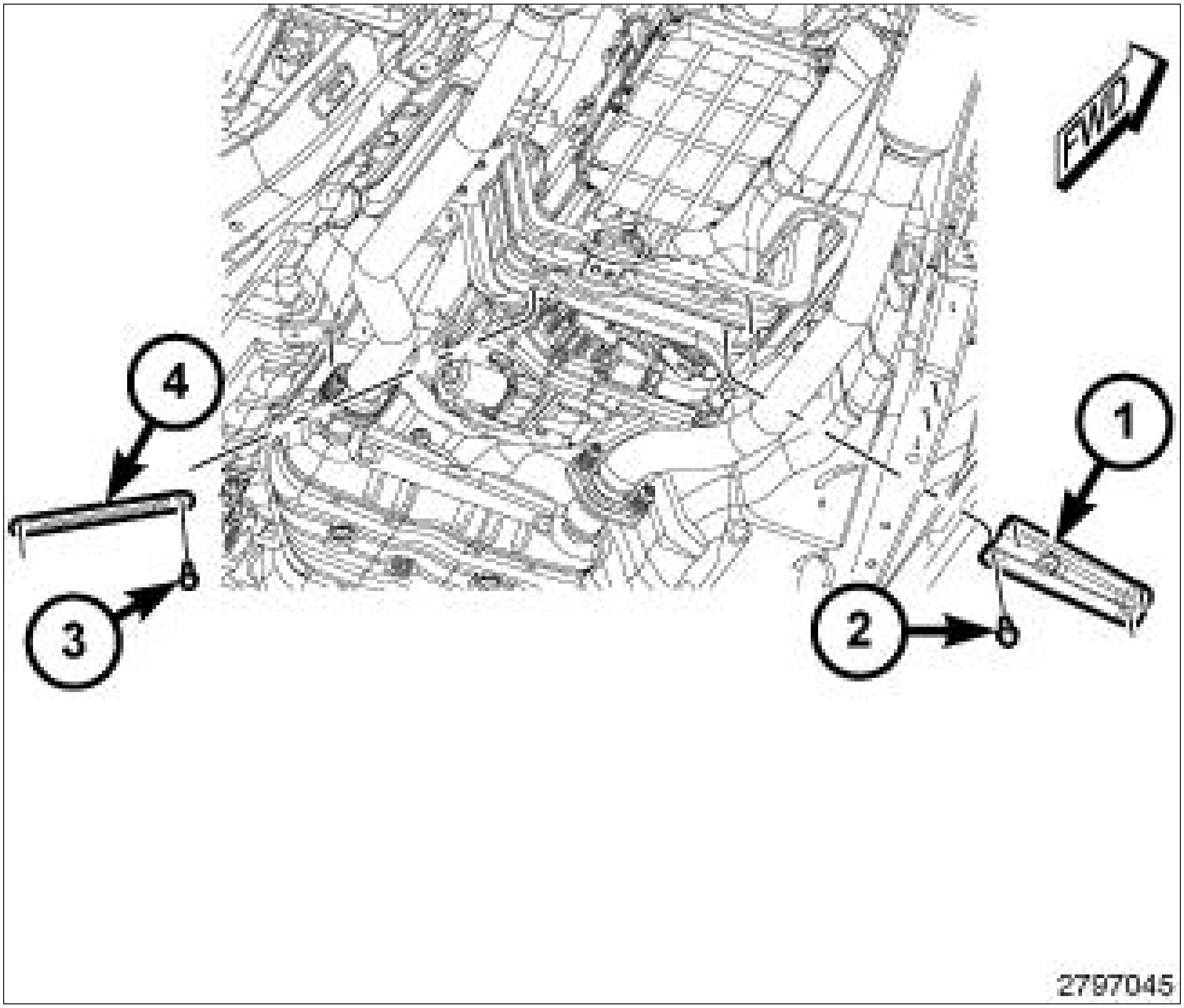


Courtesy of CHRYSLER GROUP, LLC

5. Install the engine mount heat shield to both the left and right engine mounts, then tighten the bolts (1) to the proper specification. Refer to TORQUE SPECIFICATIONS .
6. Install the upper intake manifold and insulator. Refer to MANIFOLD, INTAKE, INSTALLATION .
7. Connect the negative battery.

ENGINE MOUNTING > INSULATOR, ENGINE MOUNT, REAR > REMOVAL > REMOVAL

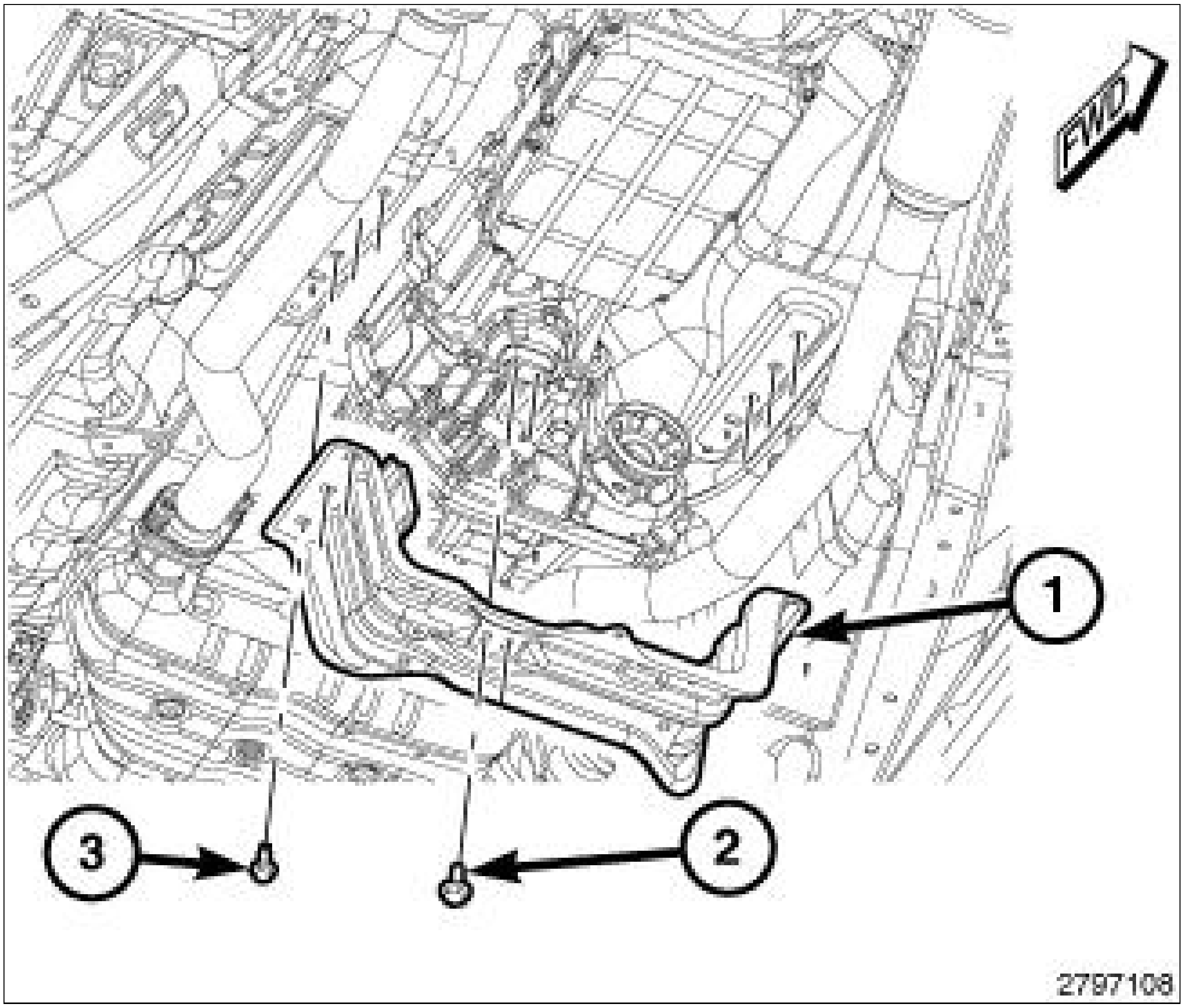
Fig 1: Left & Right Crossmember Brace With Fasteners



Courtesy of CHRYSLER GROUP, LLC

1. Raise and support the vehicle. Refer to HOISTING, STANDARD PROCEDURE .
2. Remove the skid plate, if equipped. Refer to PLATE, SKID, FRONT, REMOVAL , PLATE, SKID, FRONT SUSPENSION, REMOVAL , PLATE, SKID, FUEL TANK, REMOVAL , PLATE, SKID, TRANSMISSION, REMOVAL or PLATE, SKID, TRANSFER CASE, REMOVAL .
3. Remove four bolts (2) and the left crossmember brace (1).
4. Remove two bolts (3) and the right crossmember brace (4).

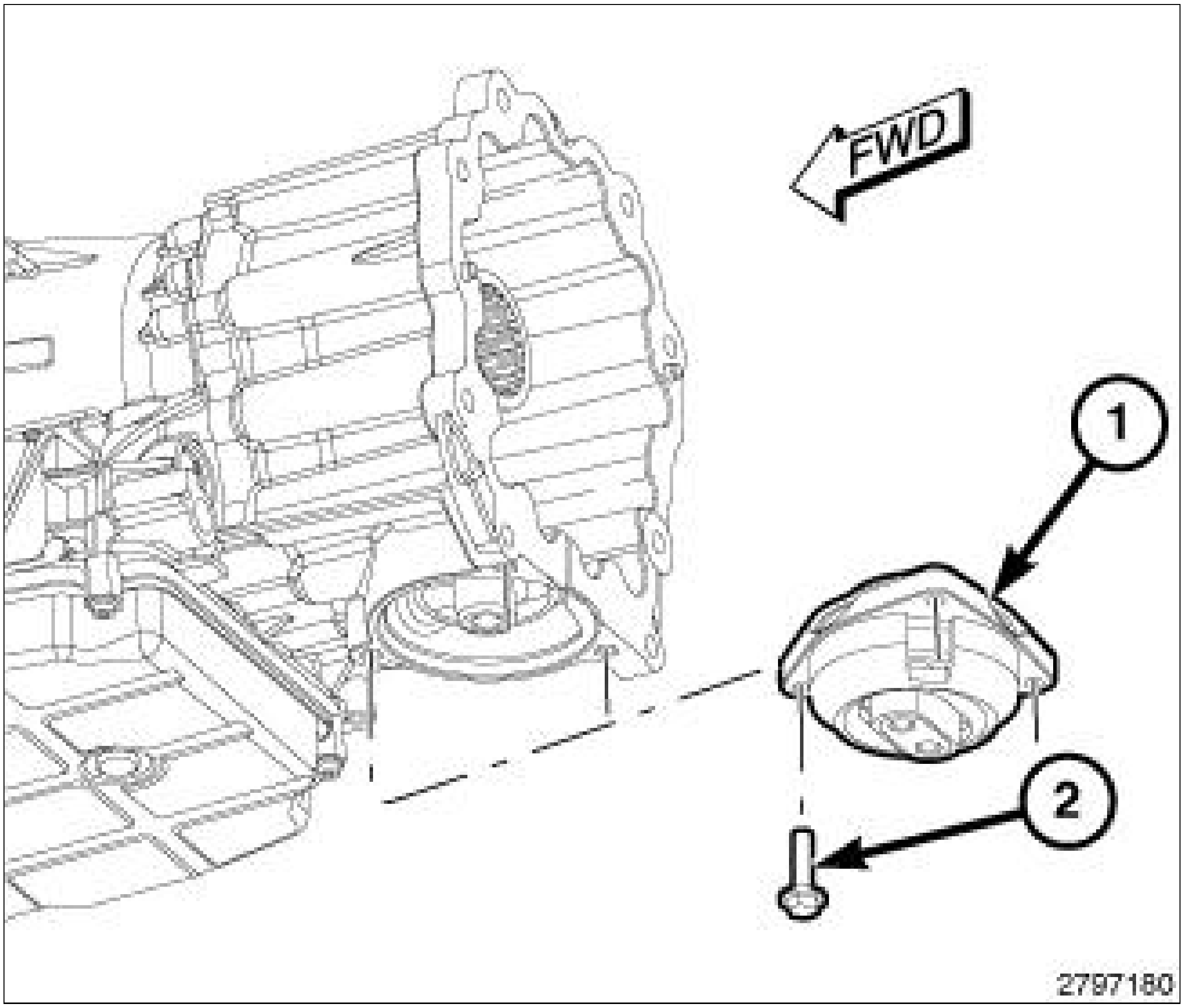
Fig 2: Crossmember & Bolts



Courtesy of CHRYSLER GROUP, LLC

5. Remove the two bolts (2) from the rear engine mount isolator.
6. Using a suitable jack stand and a block of wood positioned under the transmission oil pan, raise the transmission until the weight is off of the isolator (approximately 5 mm).
7. Remove six bolts (3) and the crossmember (1).

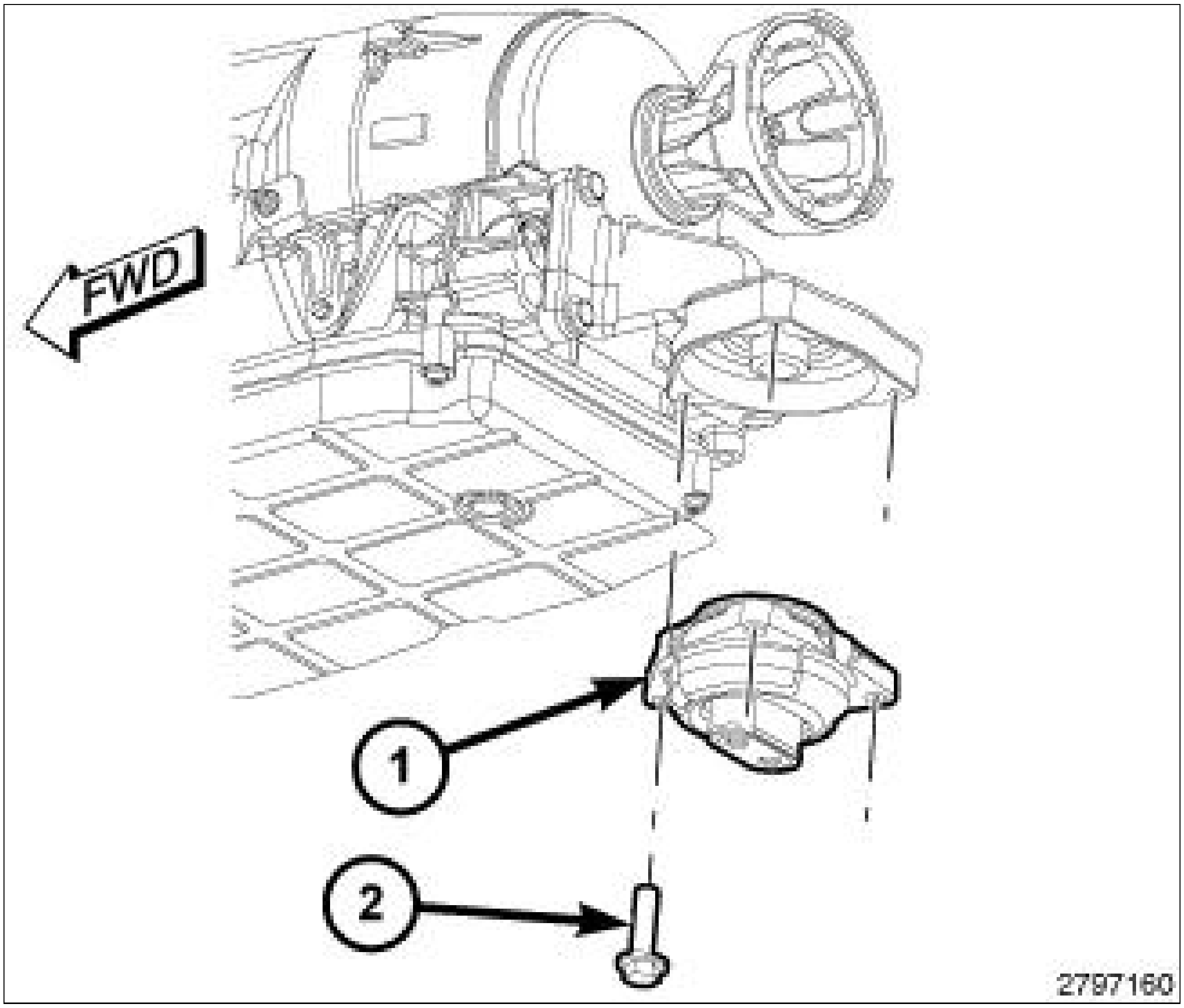
Fig 3: Rear Engine Mount Isolator & Bolts (4x4)



Courtesy of CHRYSLER GROUP, LLC

8. On 4x4 vehicles, remove three bolts (2) and the rear engine mount isolator (1).

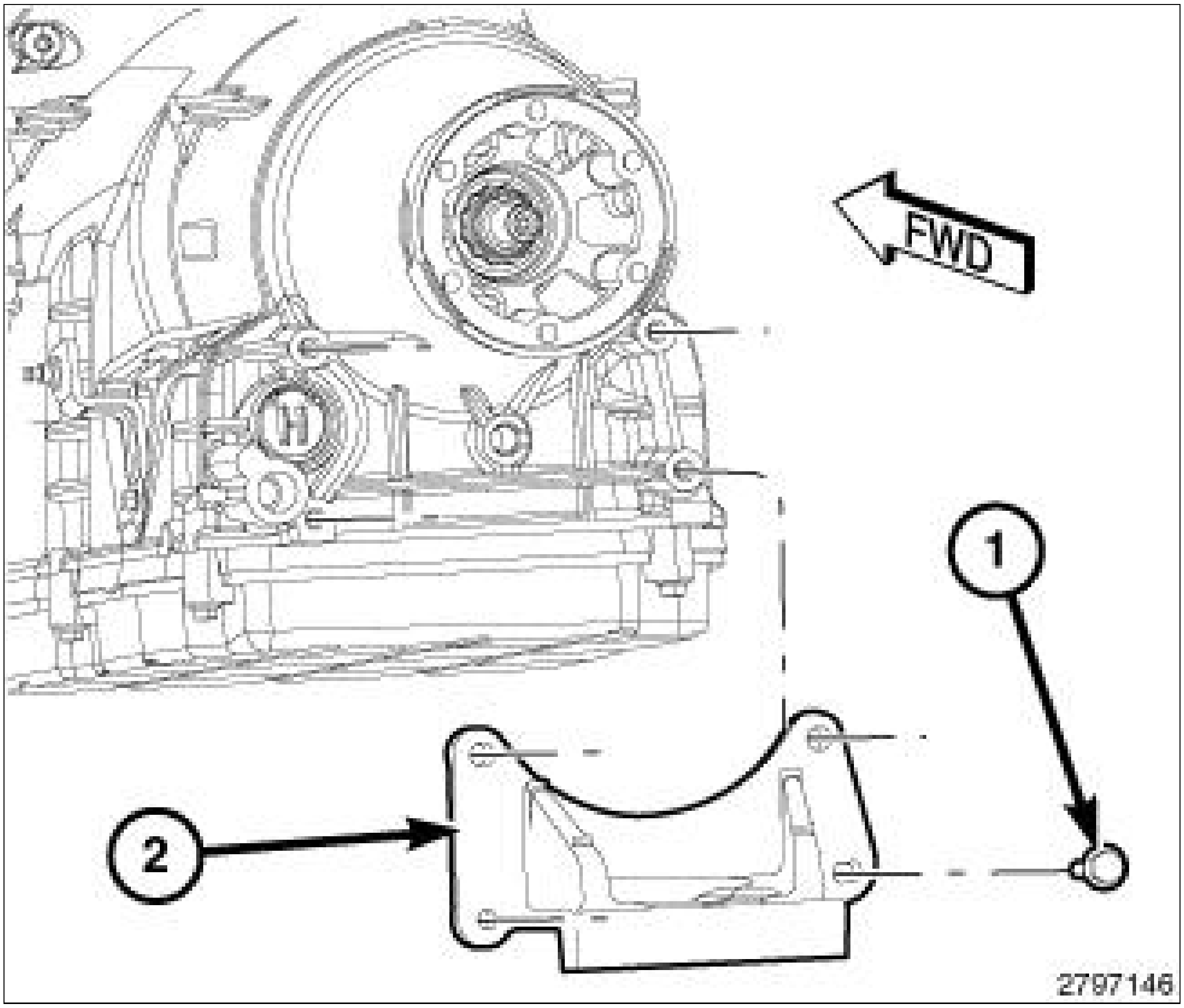
Fig 4: Rear Engine Mount Isolator & Bolts (4x2)



Courtesy of CHRYSLER GROUP, LLC

9. On 4x2 vehicles, remove three bolts (2) and the rear engine mount isolator (1).

Fig 5: Rear Engine Mount Bracket & Bolts (4x2)

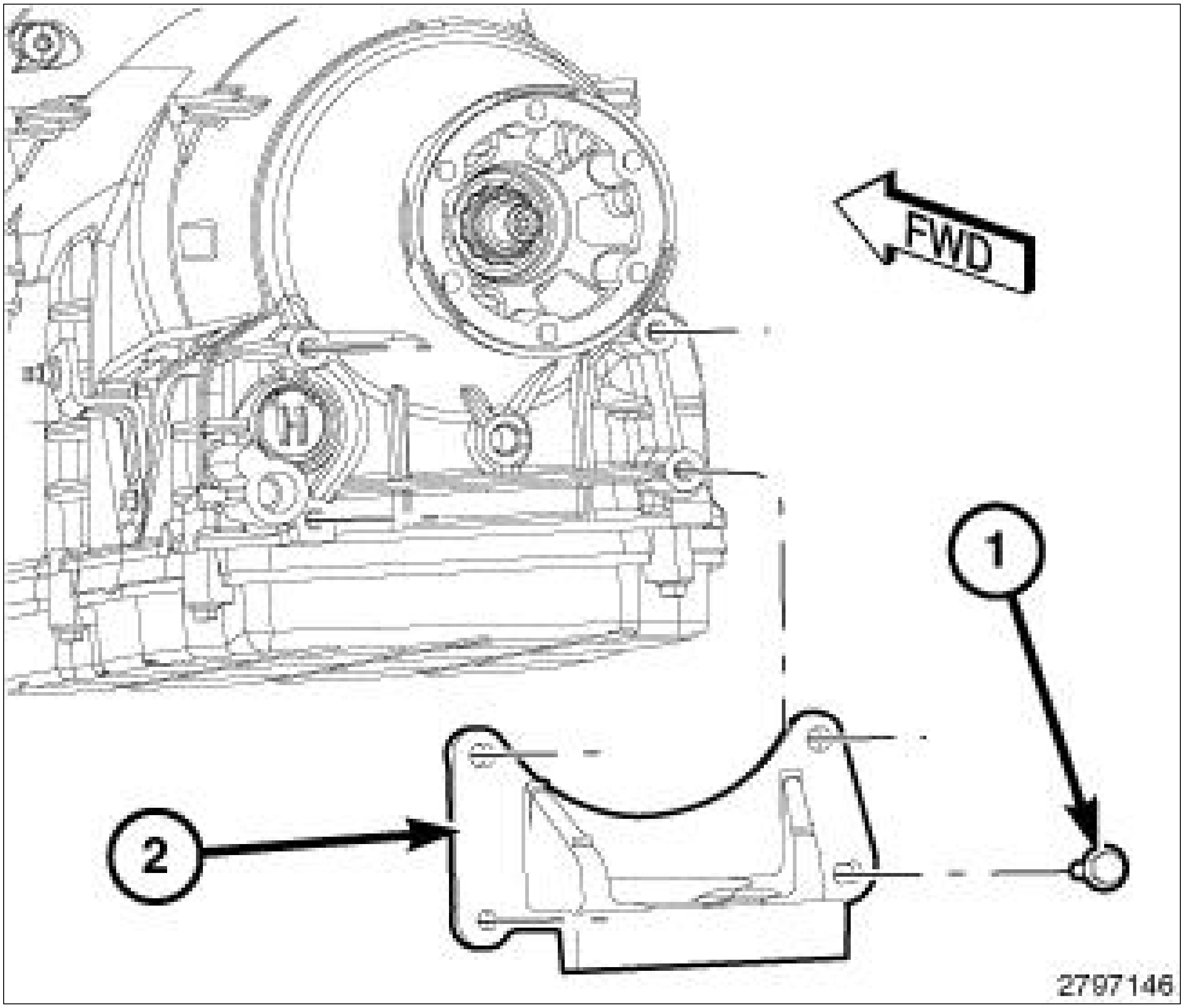


Courtesy of CHRYSLER GROUP, LLC

10. On 4x2 vehicles if required, remove four bolts (1) and the rear engine mount bracket (2).

ENGINE MOUNTING > INSULATOR, ENGINE MOUNT, REAR > INSTALLATION > INSTALLATION

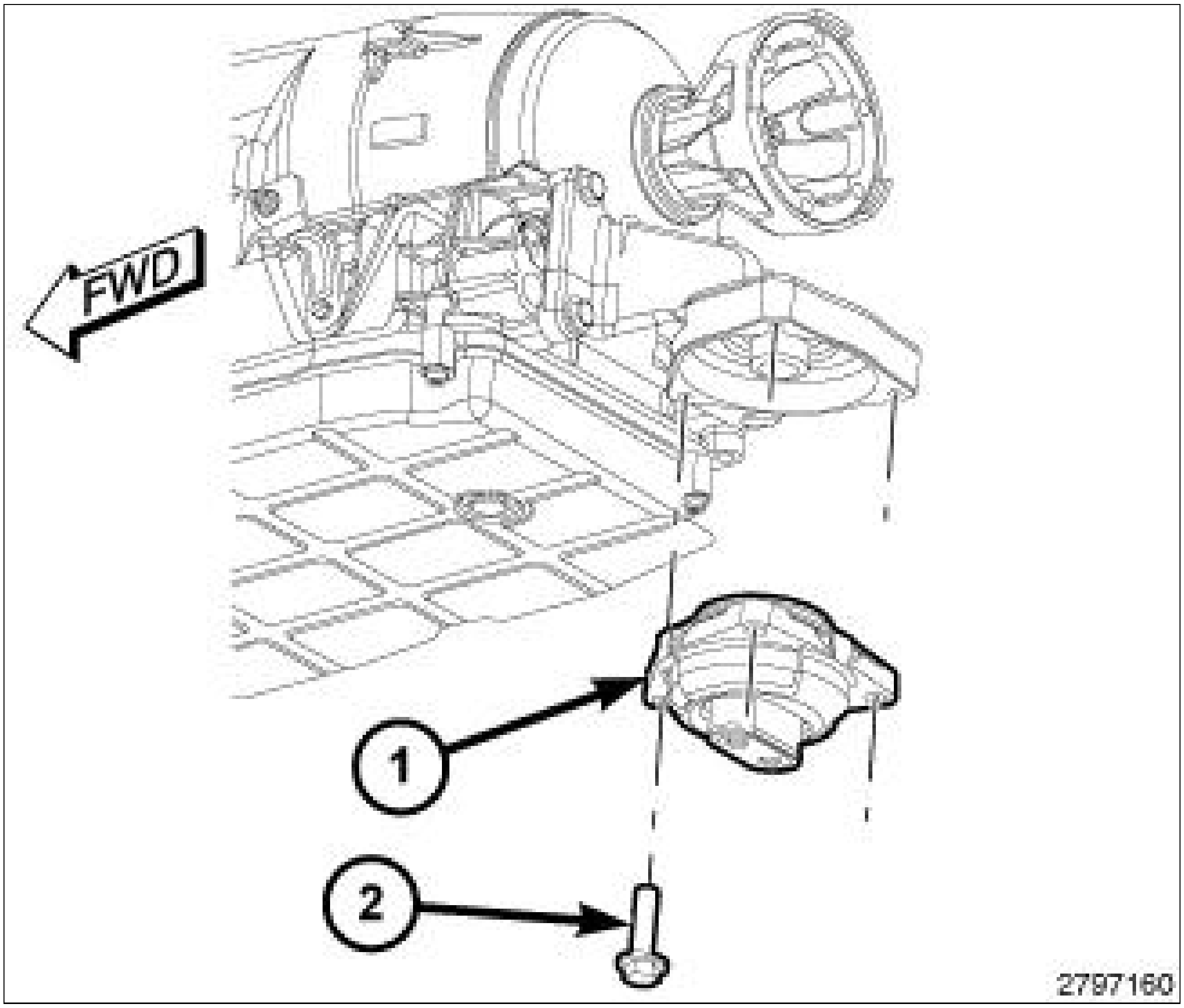
Fig 1: Rear Engine Mount Bracket & Bolts (4x2)



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.).

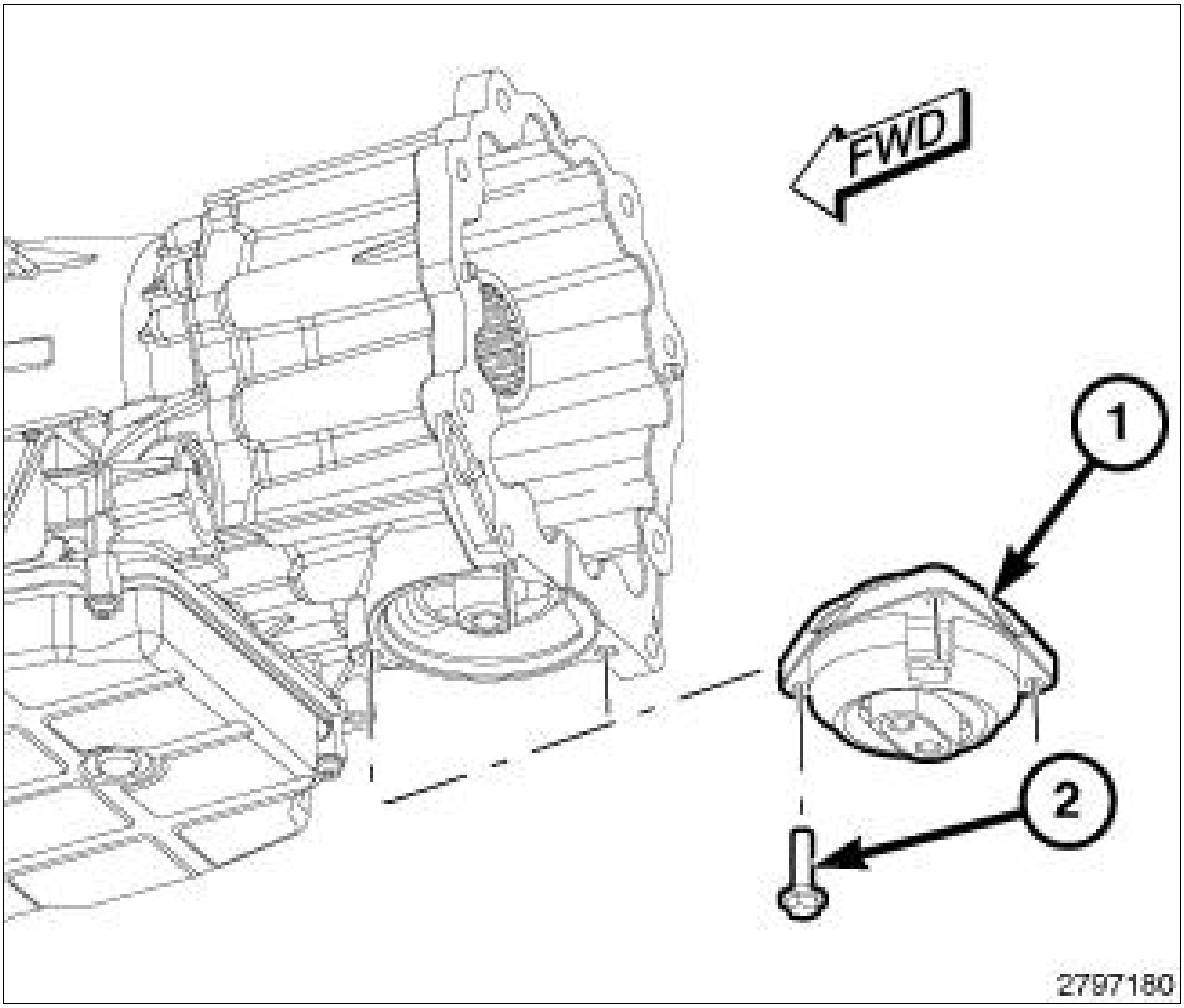
Fig 2: Rear Engine Mount Isolator & Bolts (4x2)



Courtesy of CHRYSLER GROUP, LLC

2. On 4x2 vehicles, install the rear engine mount isolator (1) with three bolts (2) tightened to 61 N.m (45 ft. lbs.).

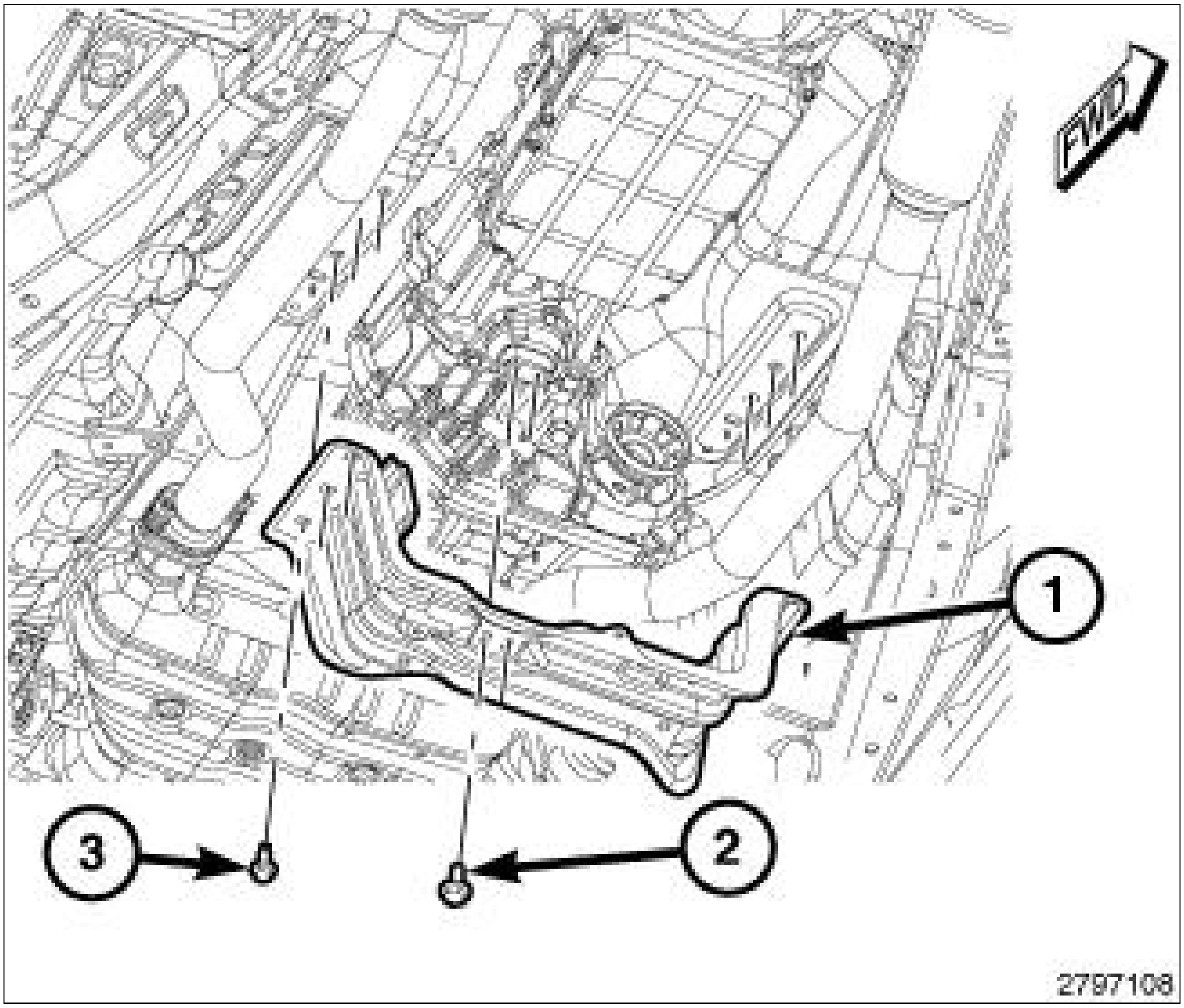
Fig 3: Rear Engine Mount Isolator & Bolts (4x4)



Courtesy of CHRYSLER GROUP, LLC

3. On 4x4 vehicles, install the rear engine mount isolator (1) with three bolts (2) tightened to 61 N.m (45 ft. lbs.).

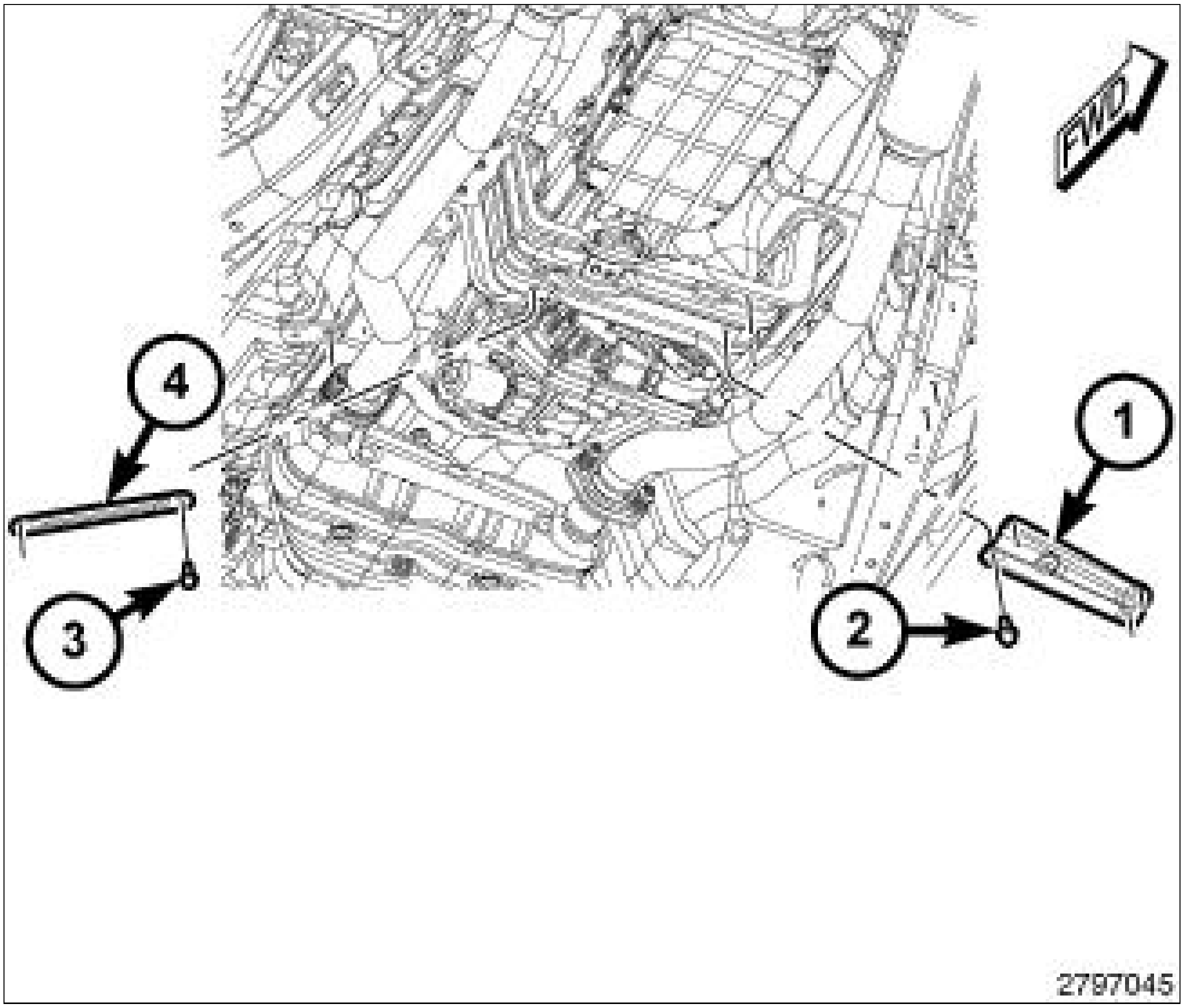
Fig 4: Crossmember & Bolts



Courtesy of CHRYSLER GROUP, LLC

4. Install the crossmember (1) with six bolts (3) tightened to 55 N.m (41 ft. lbs.).
5. Lower the transmission so the weight is resting on the isolator.
6. Install two bolts (2) to the rear engine mount isolator and tighten to 61 N.m (45 ft. lbs.).

Fig 5: Left & Right Crossmember Brace With Fasteners



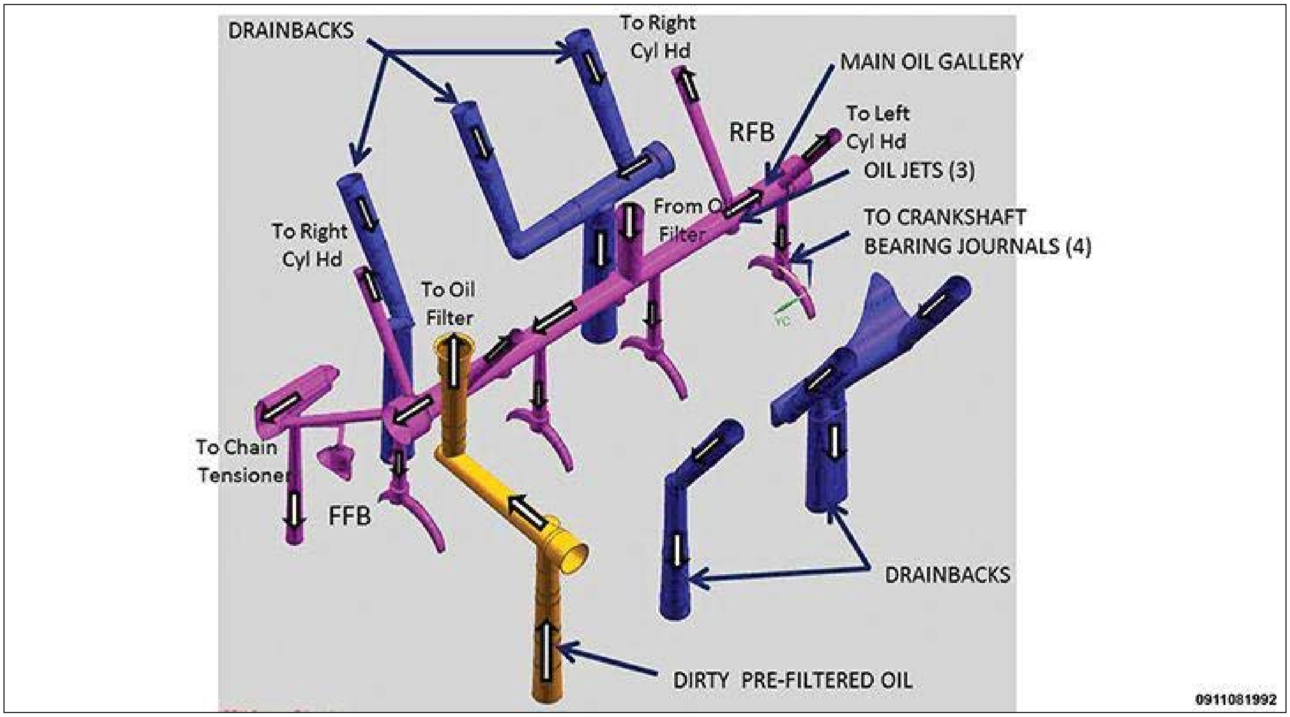
Courtesy of CHRYSLER GROUP, LLC

7. Install the left crossmember brace (1) with four bolts (2) tightened to 55 N.m (41 ft. lbs.).
8. Install the right crossmember brace (4) with two bolts (3) tightened to 55 N.m (41 ft. lbs.).
9. Install the skid plate, if equipped. Refer to PLATE, SKID, FRONT, INSTALLATION , PLATE, SKID, FRONT SUSPENSION, INSTALLATION , PLATE, SKID, FUEL TANK, INSTALLATION , PLATE, SKID, TRANSMISSION, INSTALLATION or PLATE, SKID, TRANSFER CASE, INSTALLATION .
10. Lower the vehicle.

LUBRICATION > DESCRIPTION > DESCRIPTION AND OPERATION

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. 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 is located on the oil filter housing assembly which is mounted to the top of the engine block between the cylinder heads. The oil temperature sensor is mounted on the rear of the right cylinder head. 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.

Fig 1: Engine Lubrication Flow



Courtesy of CHRYSLER GROUP, LLC

Oil Flow:

- 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 the galleys 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
	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

LUBRICATION > 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 in accordance to the Service Information.

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.

LUBRICATION > DIAGNOSIS AND TESTING > ENGINE OIL LEAK > 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 in accordance with the Service Information.

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.

LUBRICATION > DIAGNOSIS AND TESTING > CHECKING ENGINE OIL PRESSURE

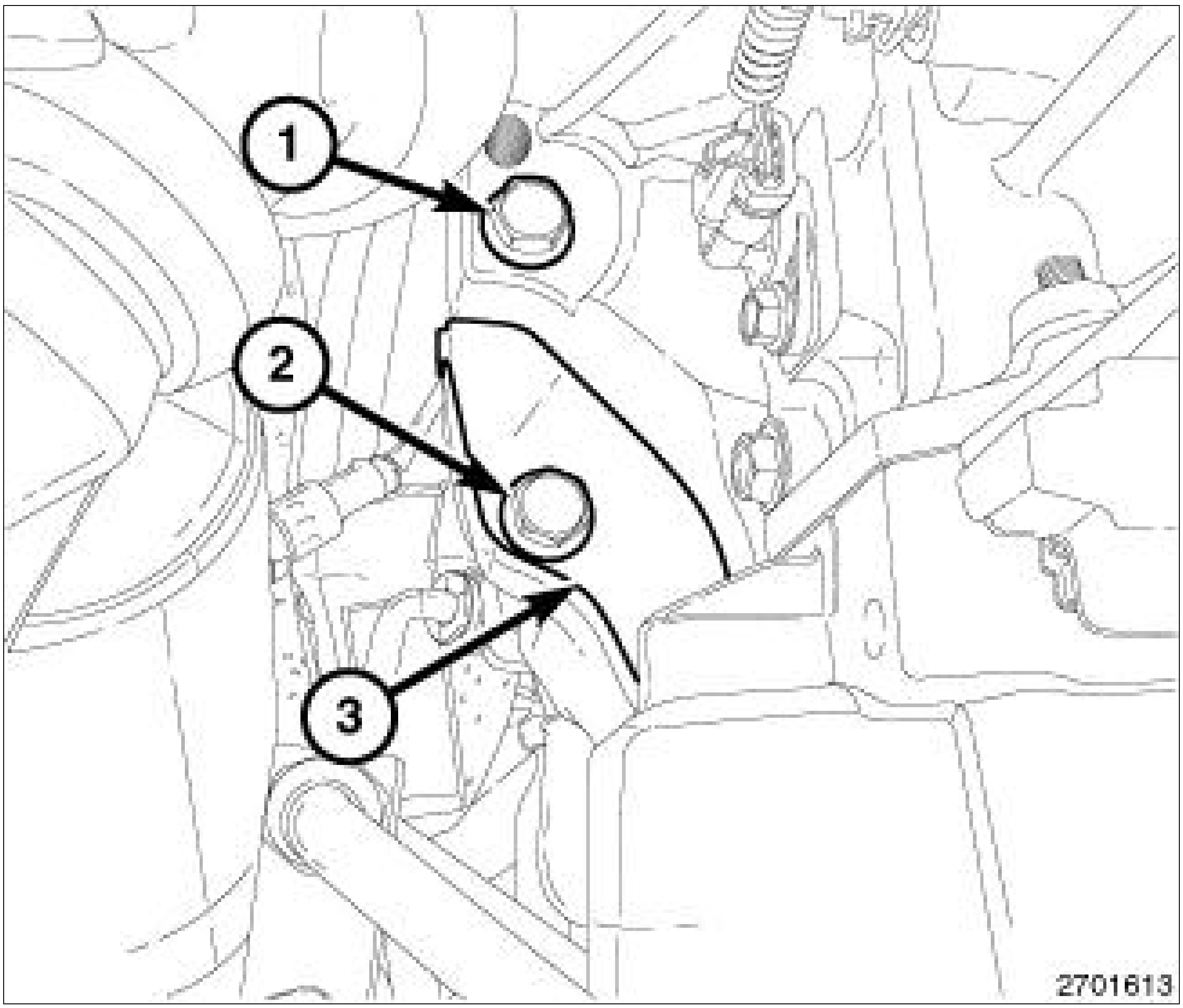
1. Remove the oil filter and cap. Refer to FILTER, ENGINE OIL, REMOVAL .

2. Transfer the oil filter to the (special tool #2021500090, Adapter, Late Version 3.6L Oil Pressure Test).

3. Install Pressure Gauge (special tool #C-3292A, Gauge, Pressure) (1) to the Oil Pressure Test Adapter.
4. Install the Oil Pressure Test Adapter to the engine and securely tighten.
5. 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 .
6. Run the engine until it reaches normal operating temperature.
7. Verify that the engine has acceptable oil pressure. Refer to ENGINE SPECIFICATIONS .

LUBRICATION > DIAGNOSIS AND TESTING > REAR SEAL AREA LEAKS

Fig 1: Side Engine-To-Transmission Bolt, Transmission Dust Shield Retaining Bolt & Dust Shield



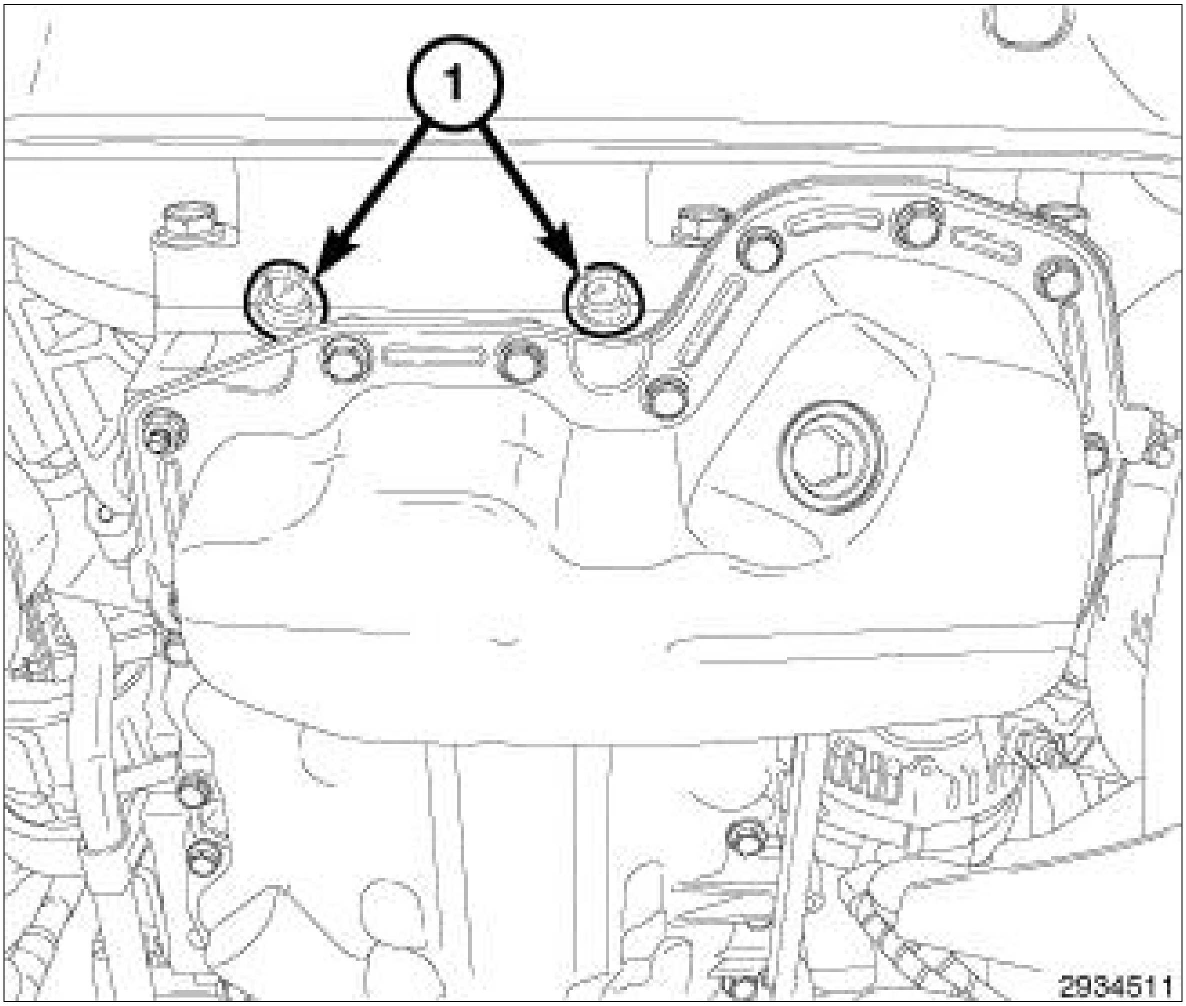
Courtesy of CHRYSLER GROUP, LLC

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 2: 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:
   a. Circular spray pattern generally indicates seal leakage or crankshaft damage.
   b. Where leakage tends to run straight down, possible causes are a porous block, 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 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.

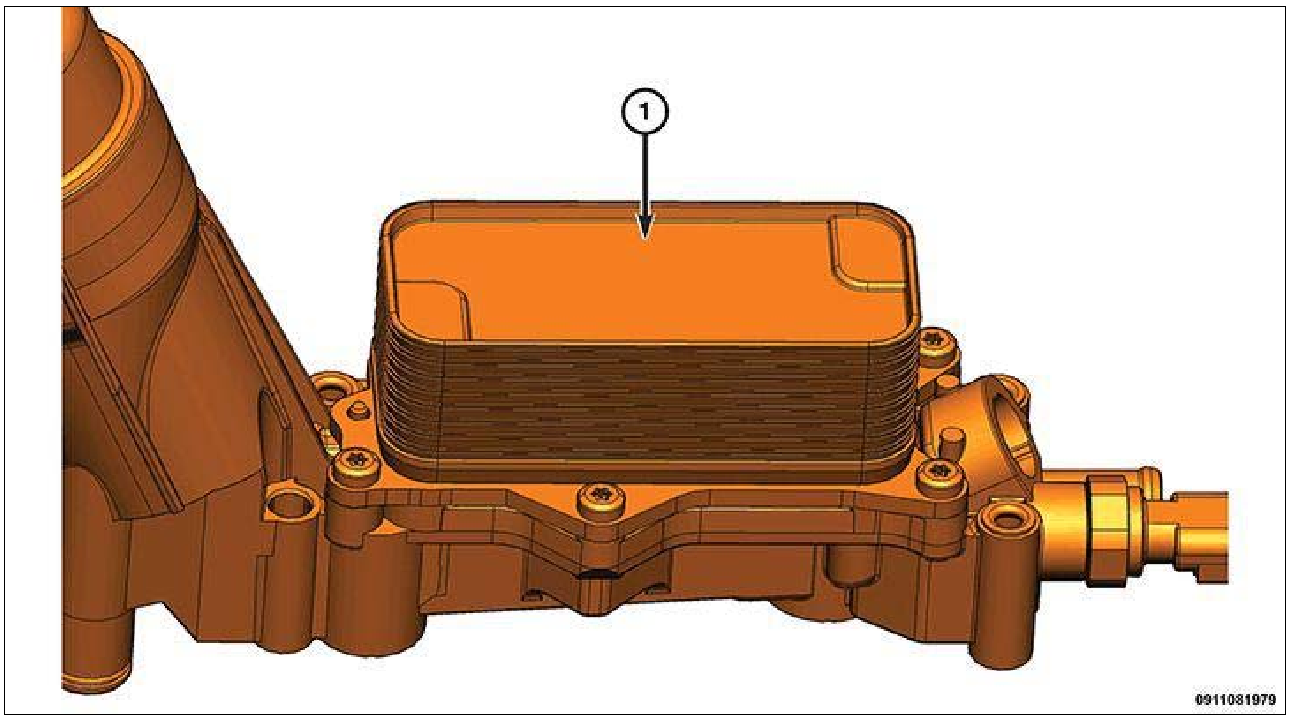
CAUTION:

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 .

LUBRICATION > COOLER, OIL > DESCRIPTION > DESCRIPTION

Fig 1: Oil Cooler & Oil Filter Housing

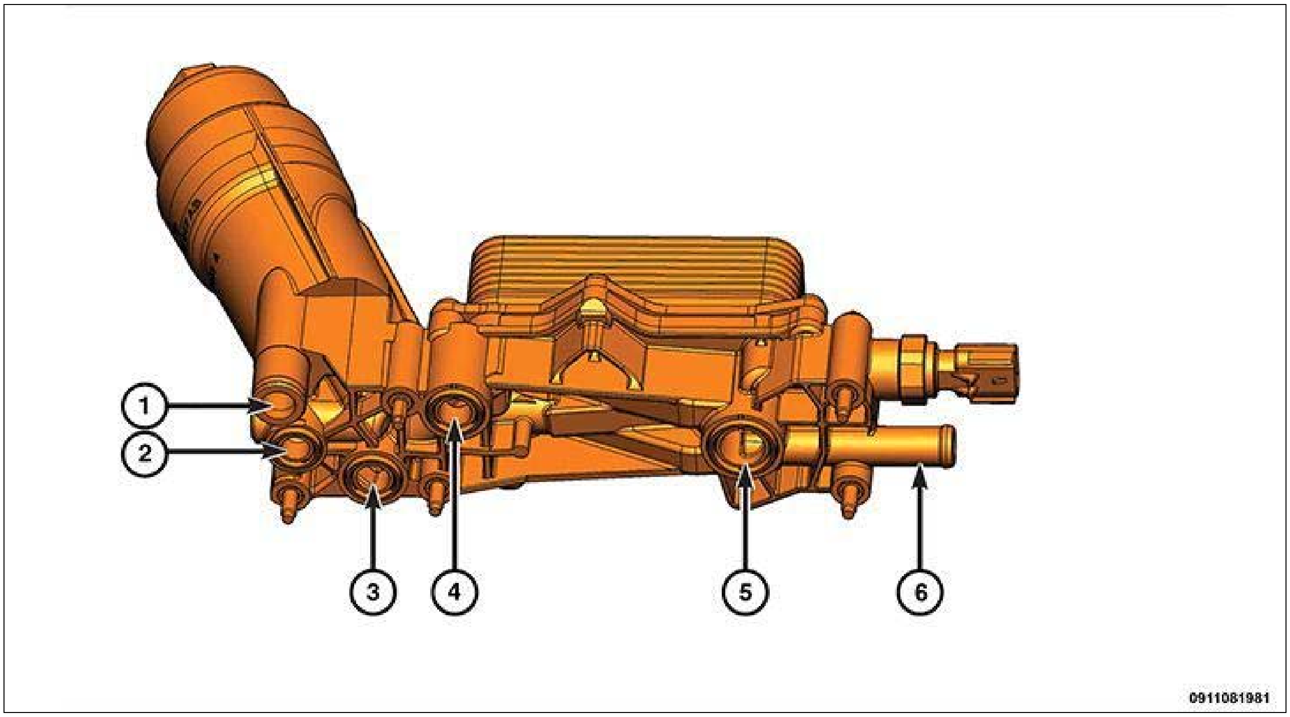


Courtesy of CHRYSLER GROUP, LLC

The oil cooler (1) 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.

LUBRICATION > COOLER, OIL > OPERATION > OPERATION

Fig 1: 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.

LUBRICATION > COOLER, OIL > REMOVAL > REMOVAL

NOTE:

The oil cooler can not be cleaned out. In the event that the engine requires rebuilding or replacement, replace the oil cooler.

NOTE:

The oil cooler is replaced as an assembly with the oil filter housing.

For removal, refer to HOUSING, OIL FILTER, REMOVAL .

LUBRICATION > COOLER, OIL > INSTALLATION > INSTALLATION

NOTE:

The oil cooler is serviced as an assembly with the oil filter housing.

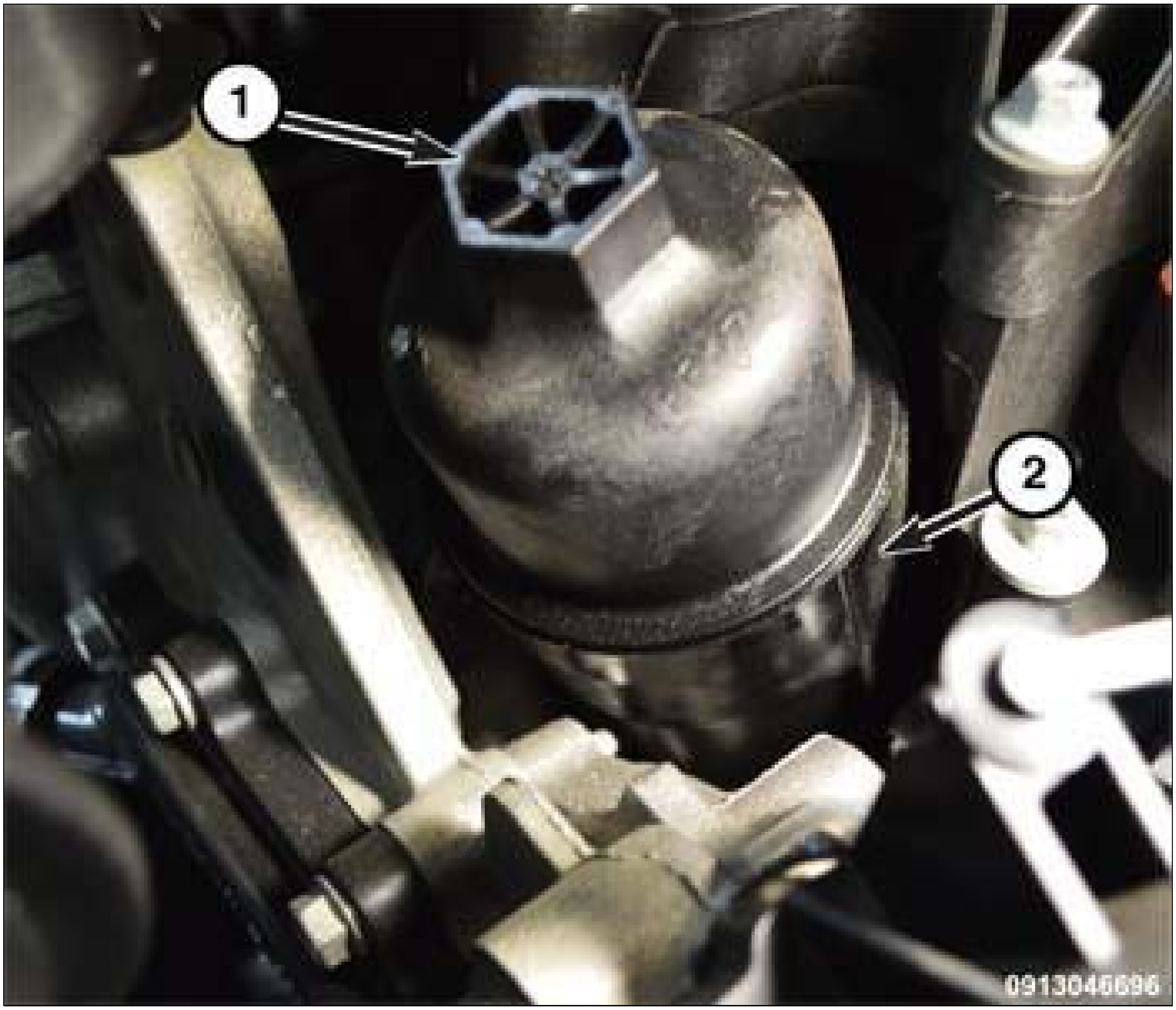
For installation of the oil cooler, refer to HOUSING, OIL FILTER, INSTALLATION .

LUBRICATION > FILTER, ENGINE OIL > REMOVAL > REMOVAL

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.

Fig 1: Oil Filter Cap & Oil Filter Housing



Courtesy of CHRYSLER GROUP, LLC

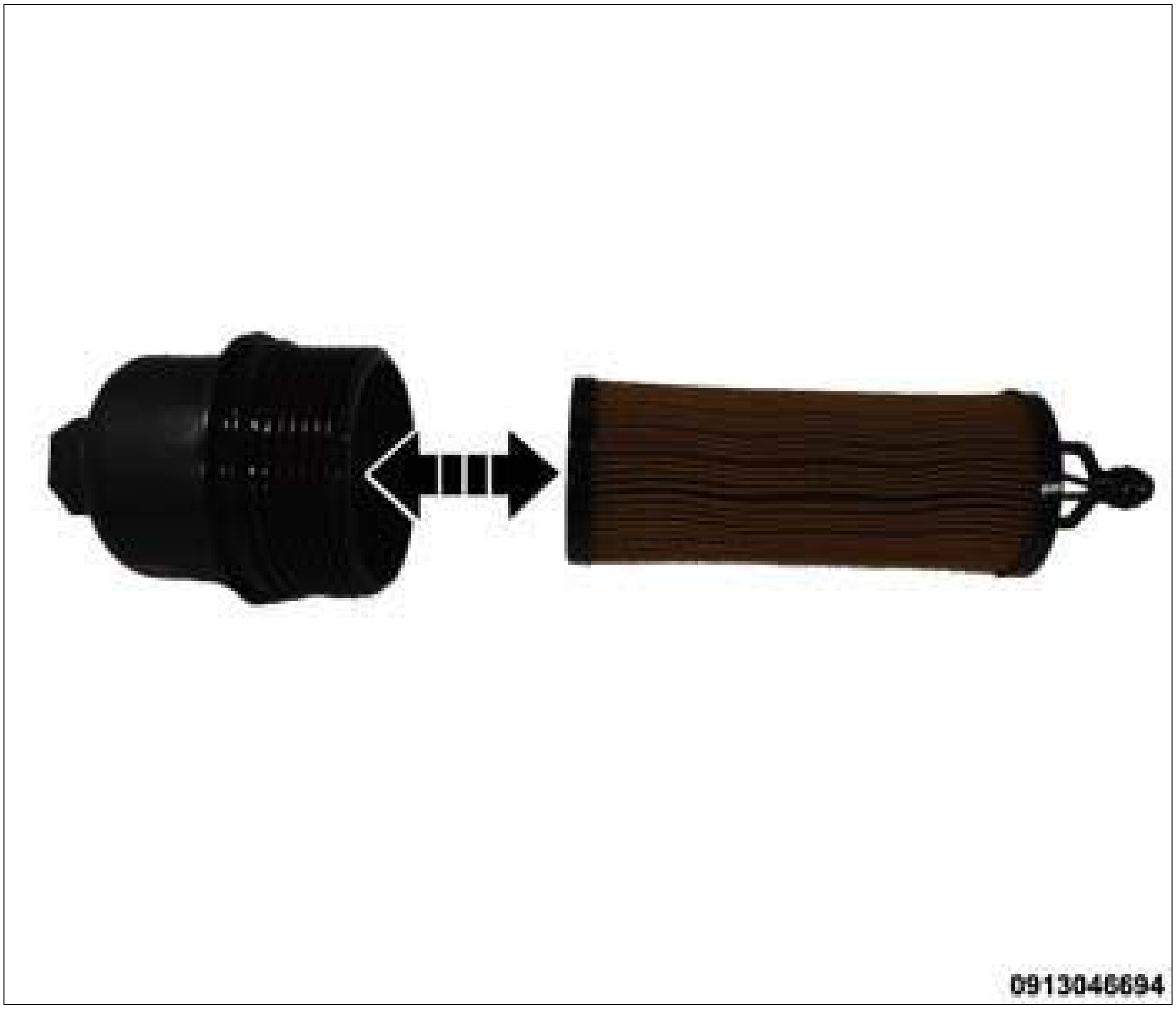
1. Place an oil absorbent cloth around the oil filter housing at the base of the oil filter cap.
2. Rotate the oil filter cap (1) counterclockwise until it is disengaged from the oil filter housing (2).

Fig 2: Remove/Install Oil Filter From/To Housing

Courtesy of CHRYSLER GROUP, LLC

3. Lifting the oil filter cap upward, remove the oil filter from the housing.

Fig 3: Remove/Install Oil Filter From/To Oil Filter Cap



Courtesy of CHRYSLER GROUP, LLC

4. Remove the oil filter from the oil filter cap.

Fig 4: O-Ring Seal

Courtesy of CHRYSLER GROUP, LLC

5. Remove and discard the O-ring seal (1).

LUBRICATION > FILTER, ENGINE OIL > INSTALLATION > INSTALLATION

NOTE:

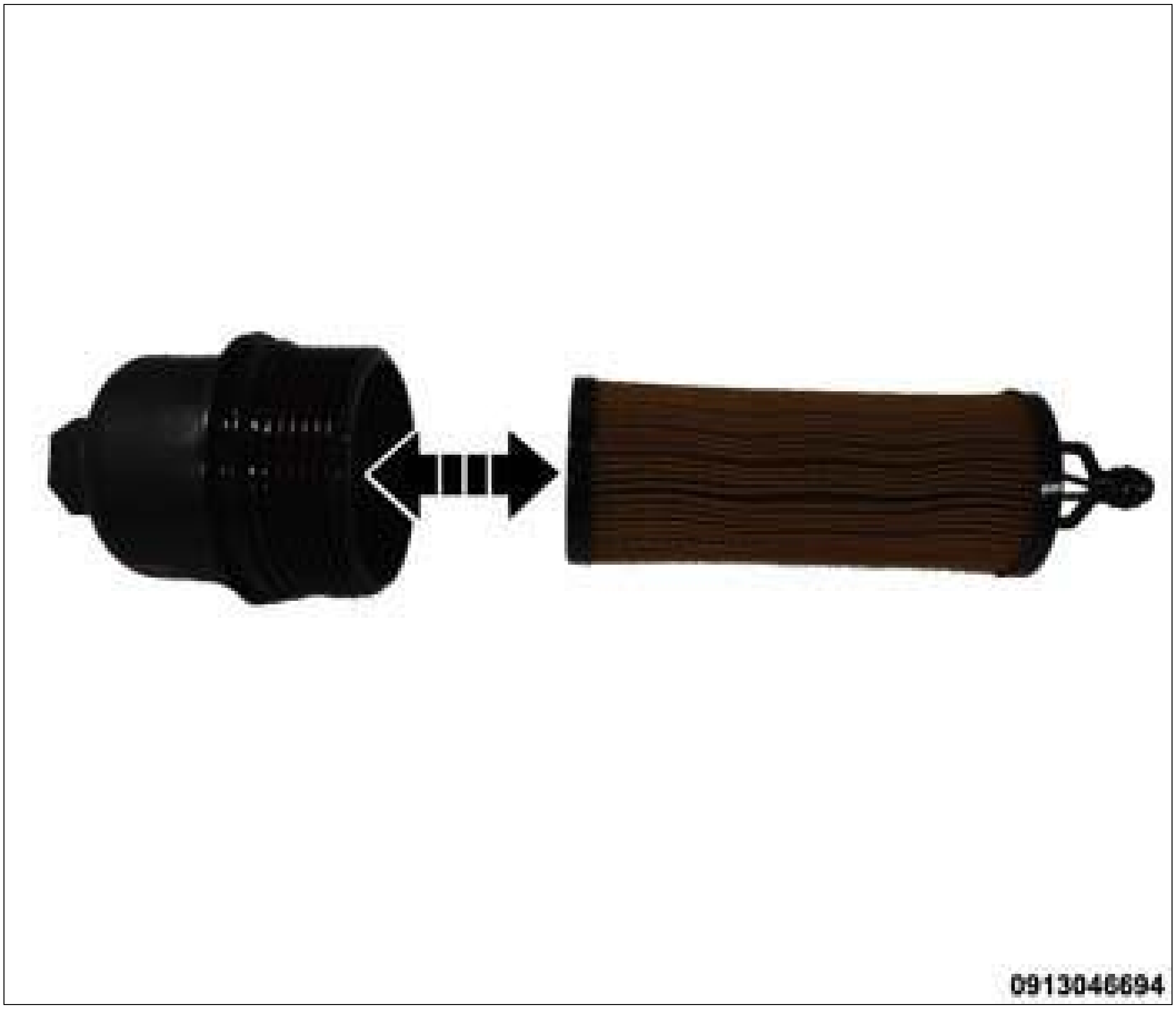
It is not necessary to pre-oil the oil filter or fill the oil filter housing.

Fig 1: O-Ring Seal

Courtesy of CHRYSLER GROUP, LLC

1. Lightly lubricate the new O-ring seal (1) with clean engine oil.
2. Install the O-ring seal on the filter cap.

Fig 2: Remove/Install Oil Filter From/To Oil Filter Cap



Courtesy of CHRYSLER GROUP, LLC

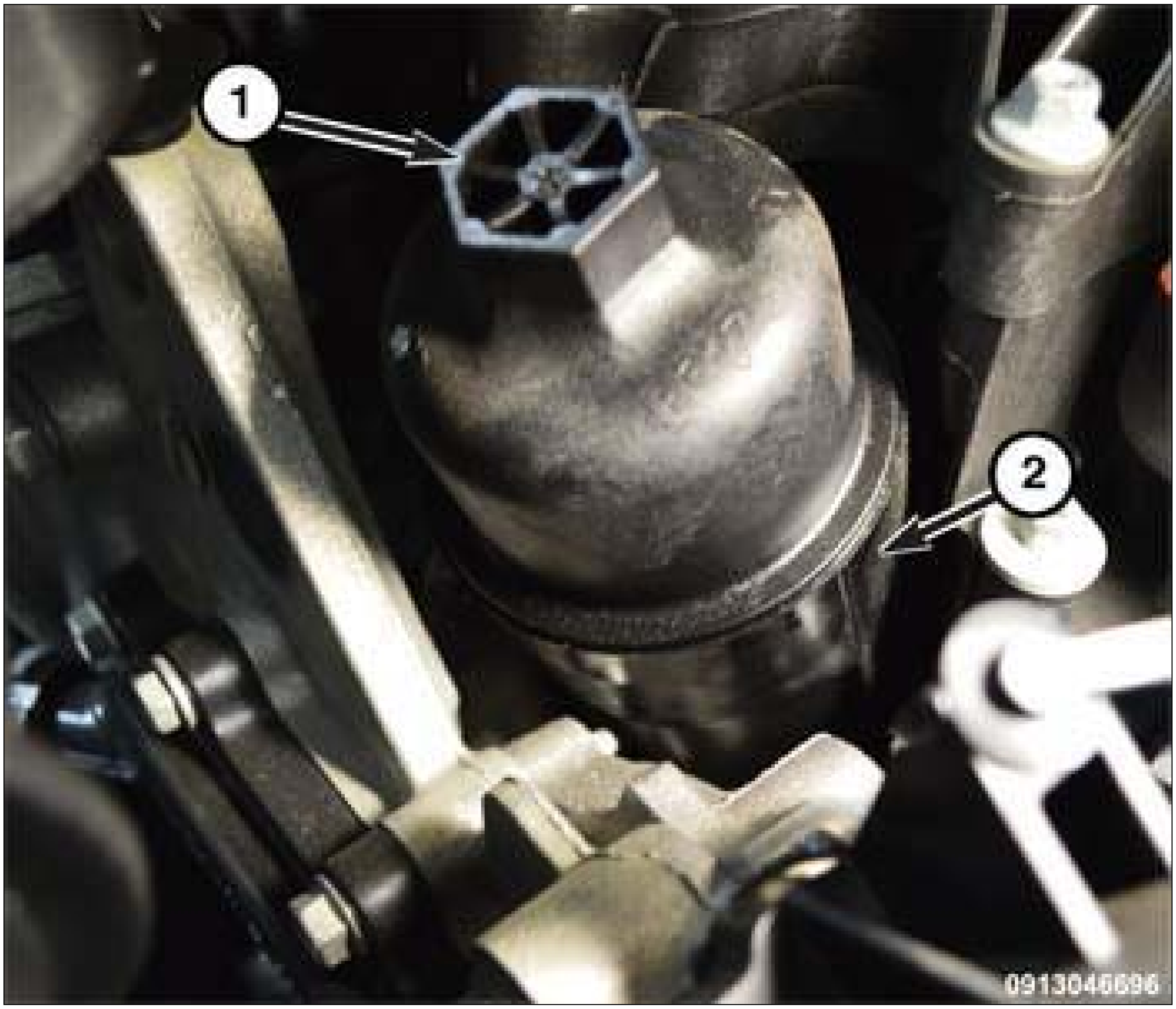
3. Install the new oil filter into the oil filter cap.

Fig 3: Remove/Install Oil Filter From/To Housing

Courtesy of CHRYSLER GROUP, LLC

4. Install the oil filter into oil filter housing.

Fig 4: Oil Filter Cap & Oil Filter Housing

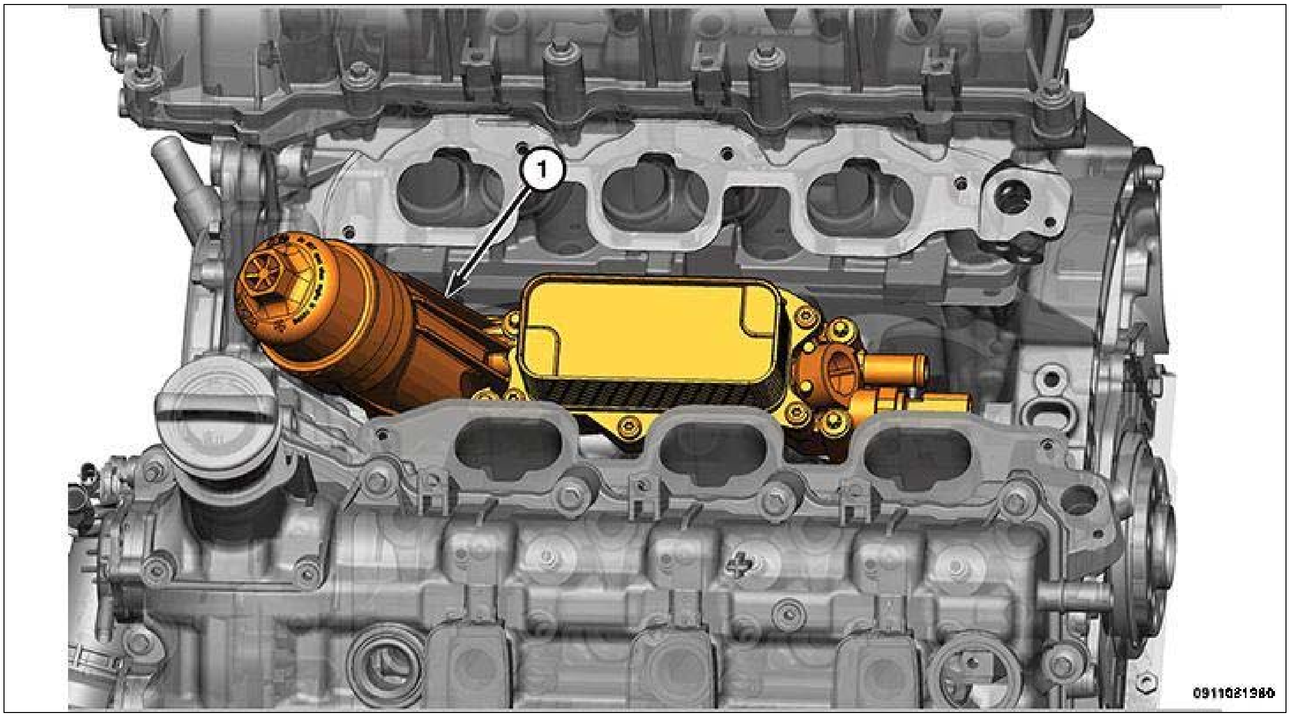


Courtesy of CHRYSLER GROUP, LLC

5. Thread the oil filter cap (1) into the oil filter housing (2) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
6. Add oil, verify crankcase oil level and start engine. Inspect for oil leaks. Refer to STANDARD PROCEDURE .

LUBRICATION > HOUSING, OIL FILTER > DESCRIPTION > DESCRIPTION

Fig 1: Oil Filter Housing & Engine Oil Cooler

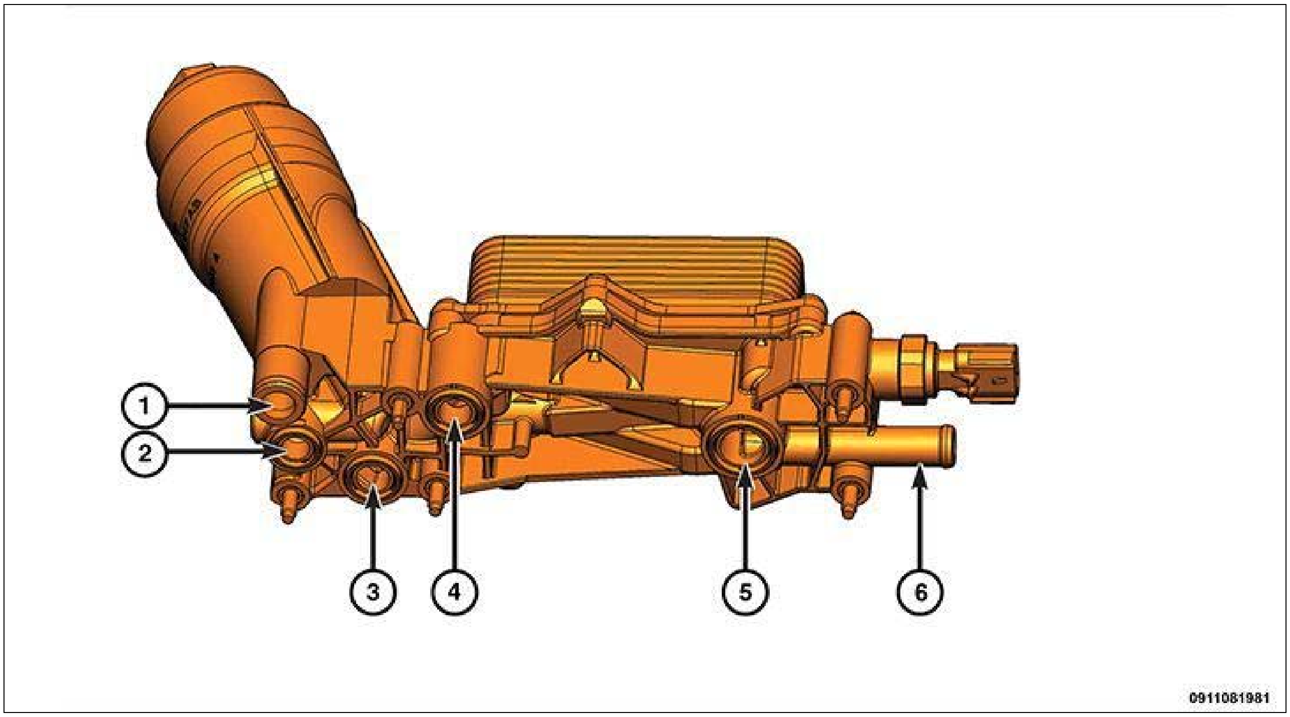


Courtesy of CHRYSLER GROUP, LLC

The oil filter housing (1) 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. The oil pressure sensor is located at the rear of the housing.

LUBRICATION > HOUSING, OIL FILTER > OPERATION > OPERATION

Fig 1: Oil Flow & Coolant Flow Locations



Courtesy of CHRYSLER GROUP, LLC

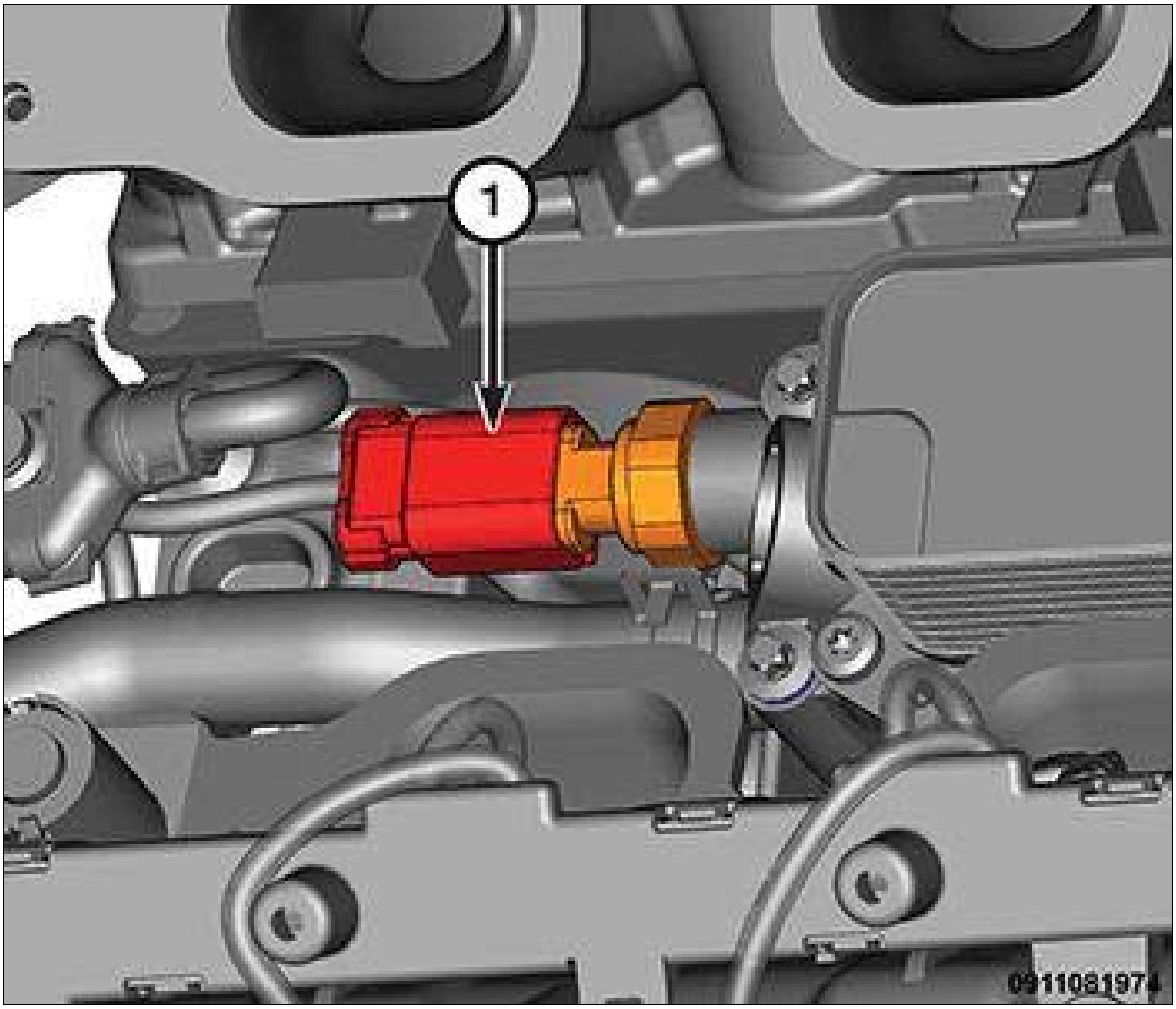
Oil flows from the engine oil pump to the oil filter housing inlet (1) and to the oil filter element located within the oil filter housing. After the oil is filtered and then cooled it travels to the main oil gallery (5). An oil filter by-pass is built into the housing and is not serviceable. Removing 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.

LUBRICATION > HOUSING, OIL FILTER > REMOVAL > REMOVAL

1. Perform the fuel system pressure release procedure. Refer to FUEL SYSTEM PRESSURE RELEASE .
2. Drain the cooling system. Refer to STANDARD PROCEDURE .
3. Remove the lower intake manifold. Refer to MANIFOLD, INTAKE, REMOVAL .

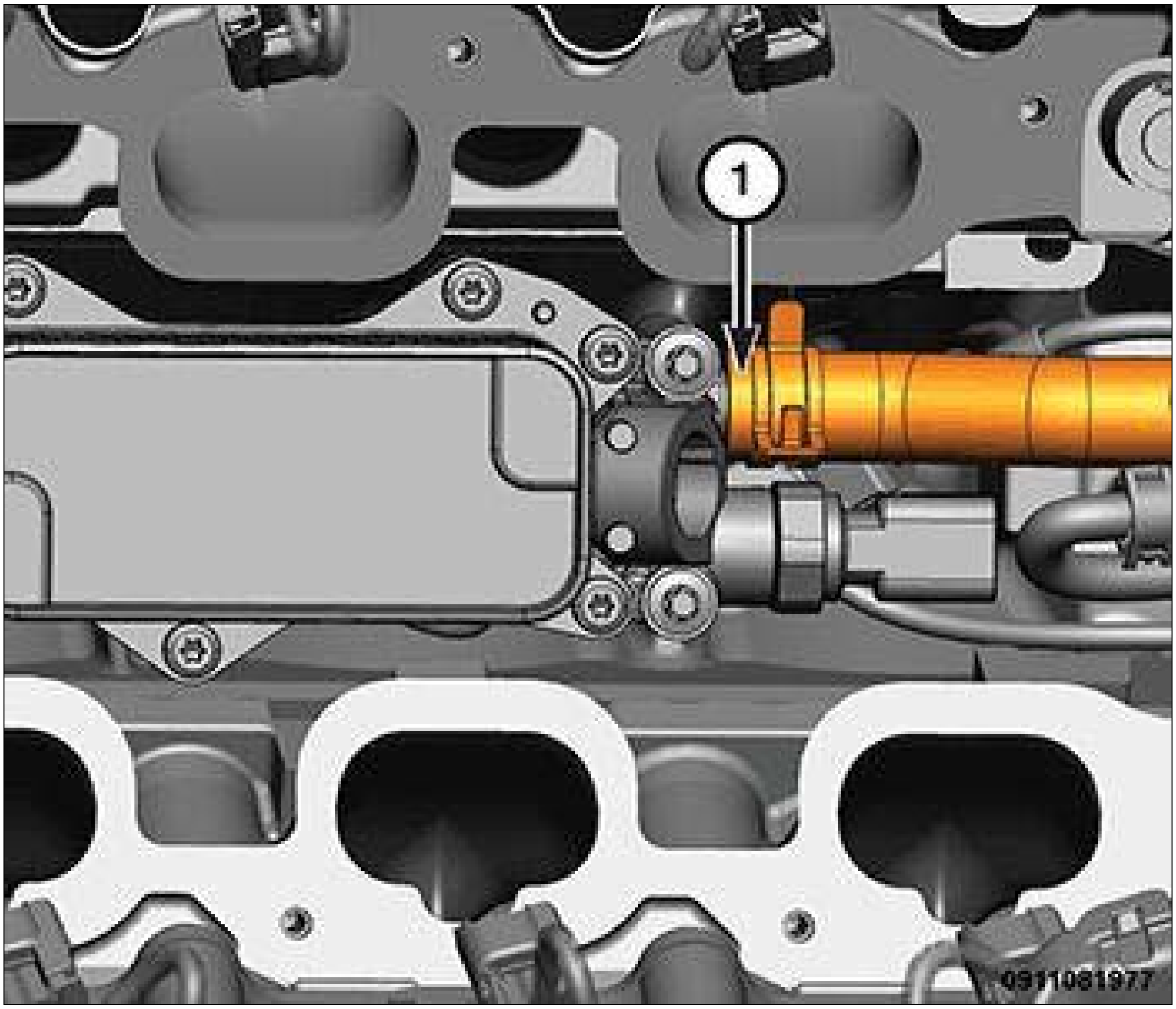
Fig 1: Oil Pressure Sensor Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

4. Disconnect the oil pressure sensor wire harness connectors (1).

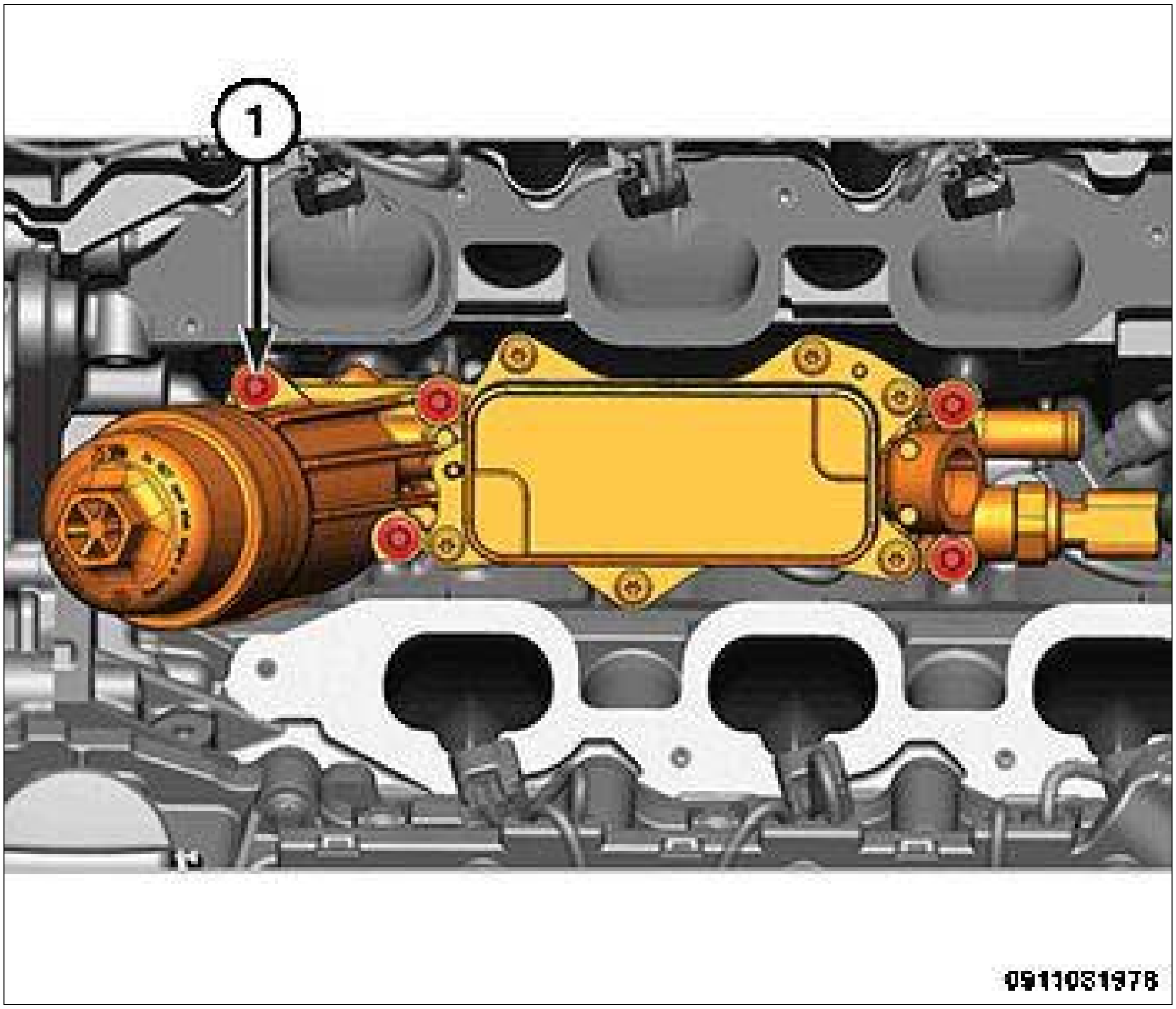
Fig 2: Heater Hose At Oil Filter Housing



Courtesy of CHRYSLER GROUP, LLC

5. Remove the heater hose (1) from the oil filter housing.

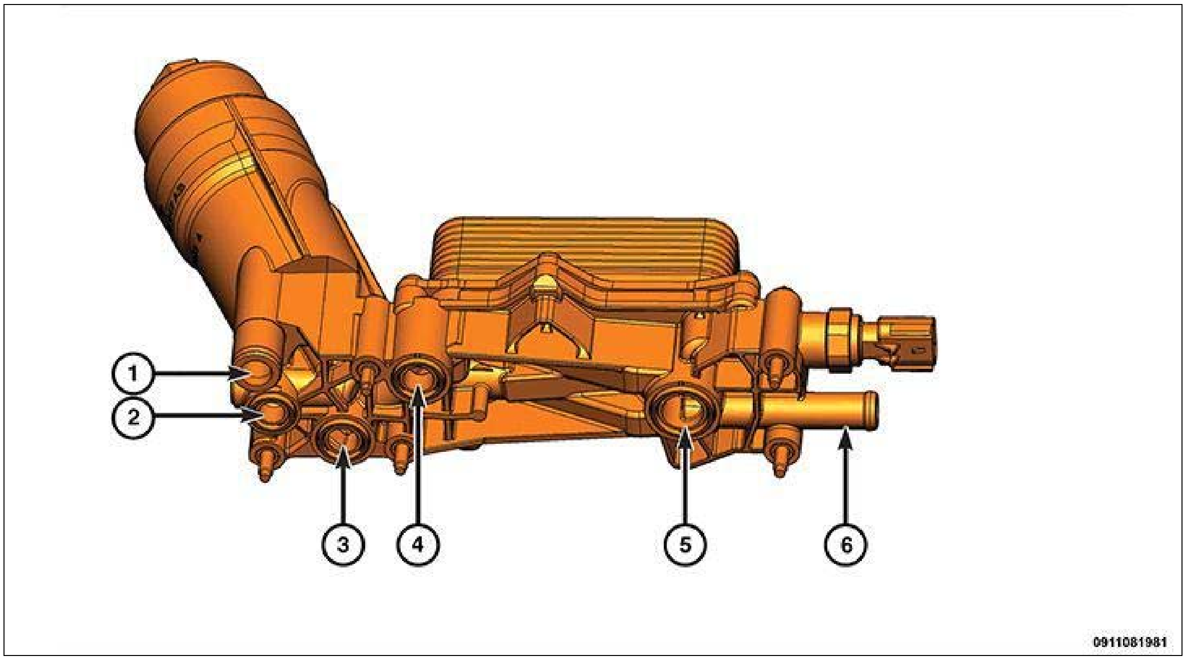
Fig 3: Oil Filter Housing Bolts



Courtesy of CHRYSLER GROUP, LLC

6. Remove five bolts (1) and remove the oil filter housing.

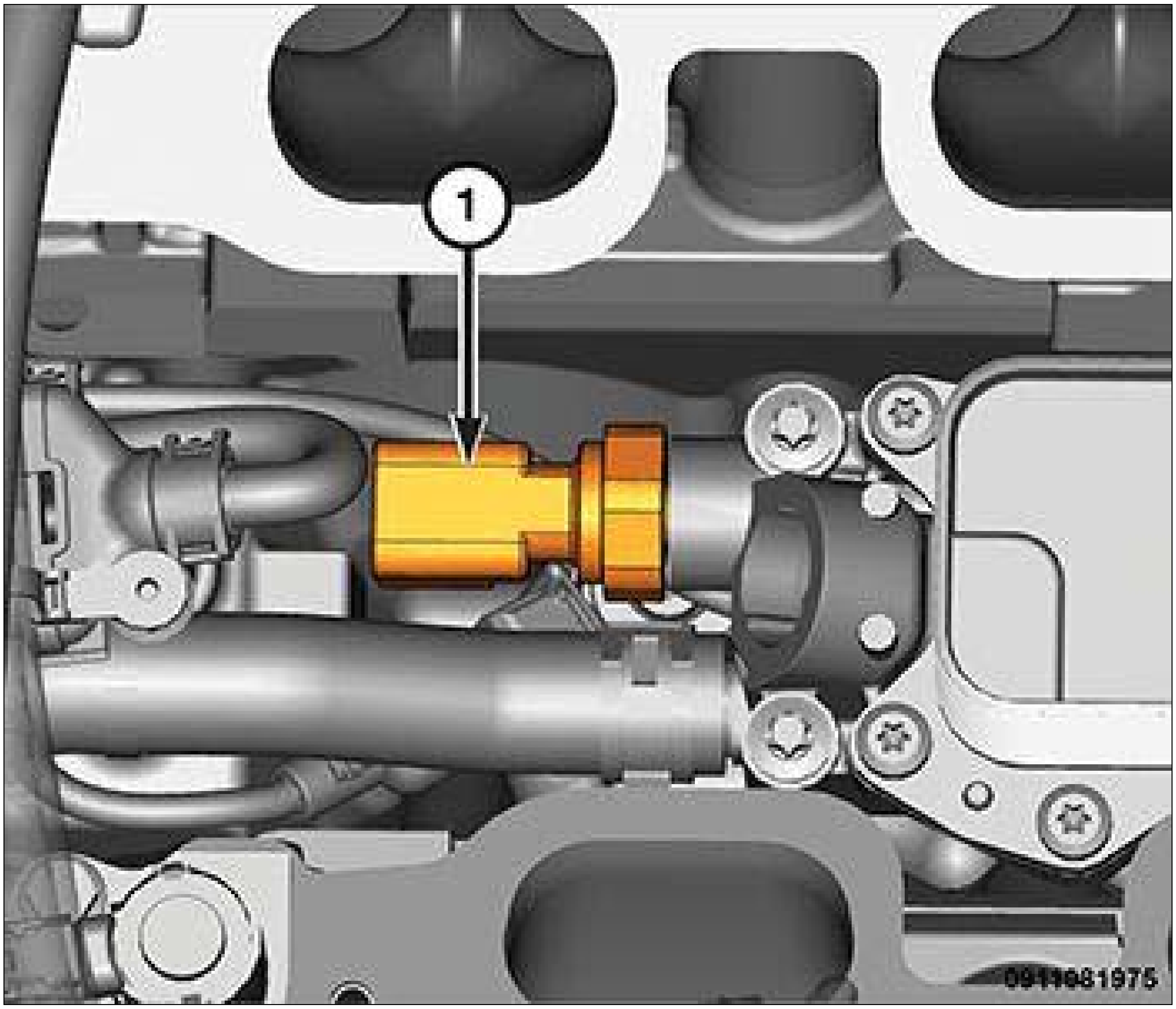
Fig 4: Oil Flow & Coolant Flow Locations



Courtesy of CHRYSLER GROUP, LLC

7. Remove and discard the oil filter housing seals (1-5).

Fig 5: Oil Pressure Sensor

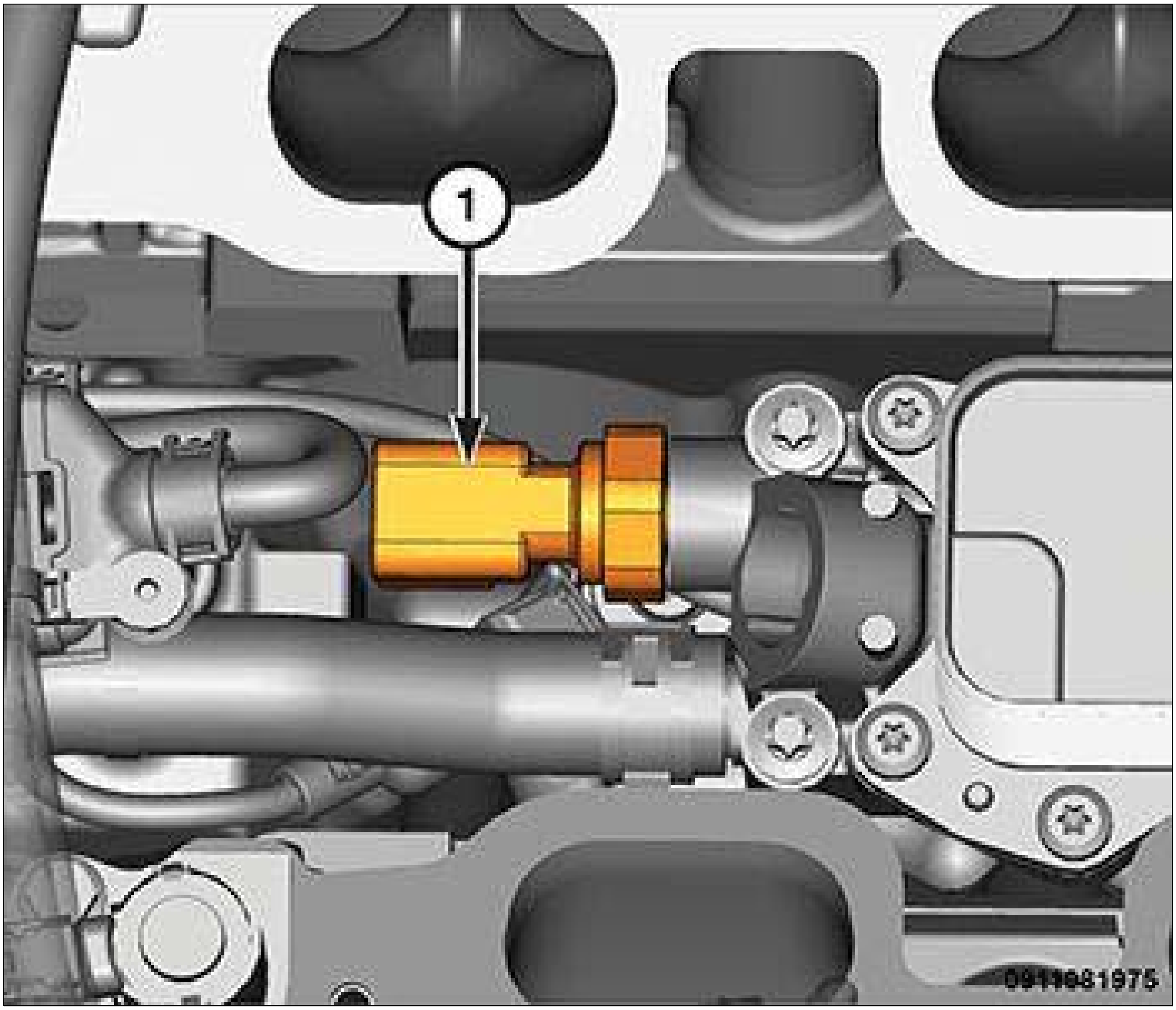


Courtesy of CHRYSLER GROUP, LLC

8. If required, remove the oil pressure sensor (2) from the oil filter housing.

LUBRICATION > HOUSING, OIL FILTER > INSTALLATION > INSTALLATION

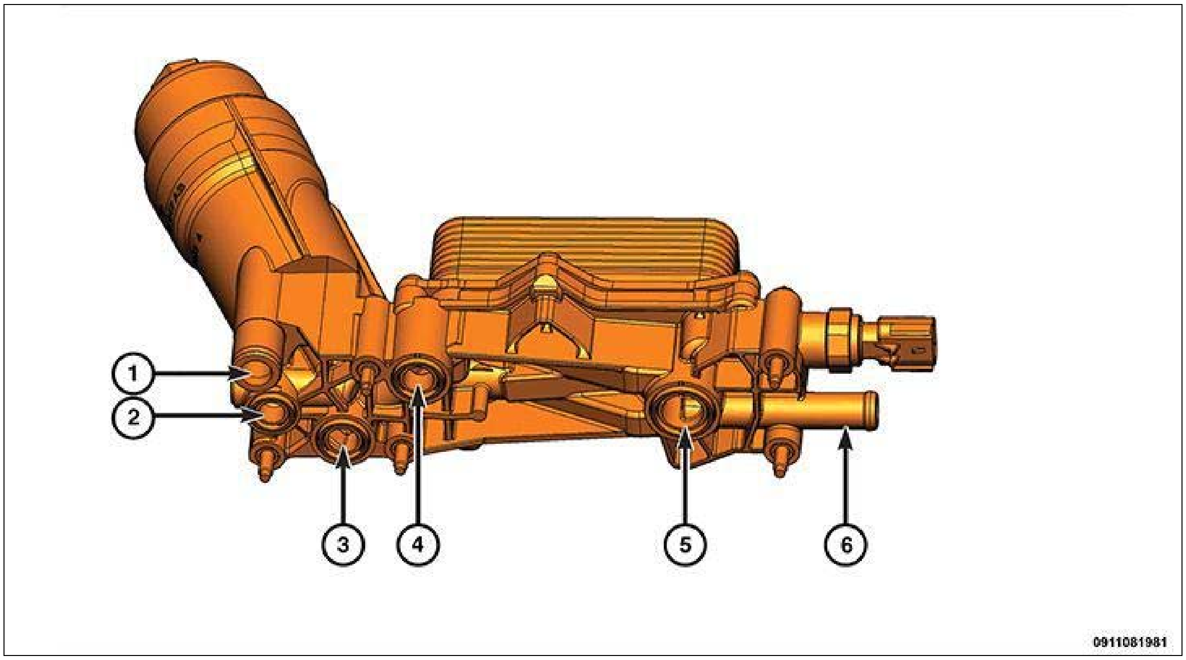
Fig 1: Oil Pressure Sensor



Courtesy of CHRYSLER GROUP, LLC

1. If removed, install the oil pressure sensor (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 2: Oil Flow & Coolant Flow Locations

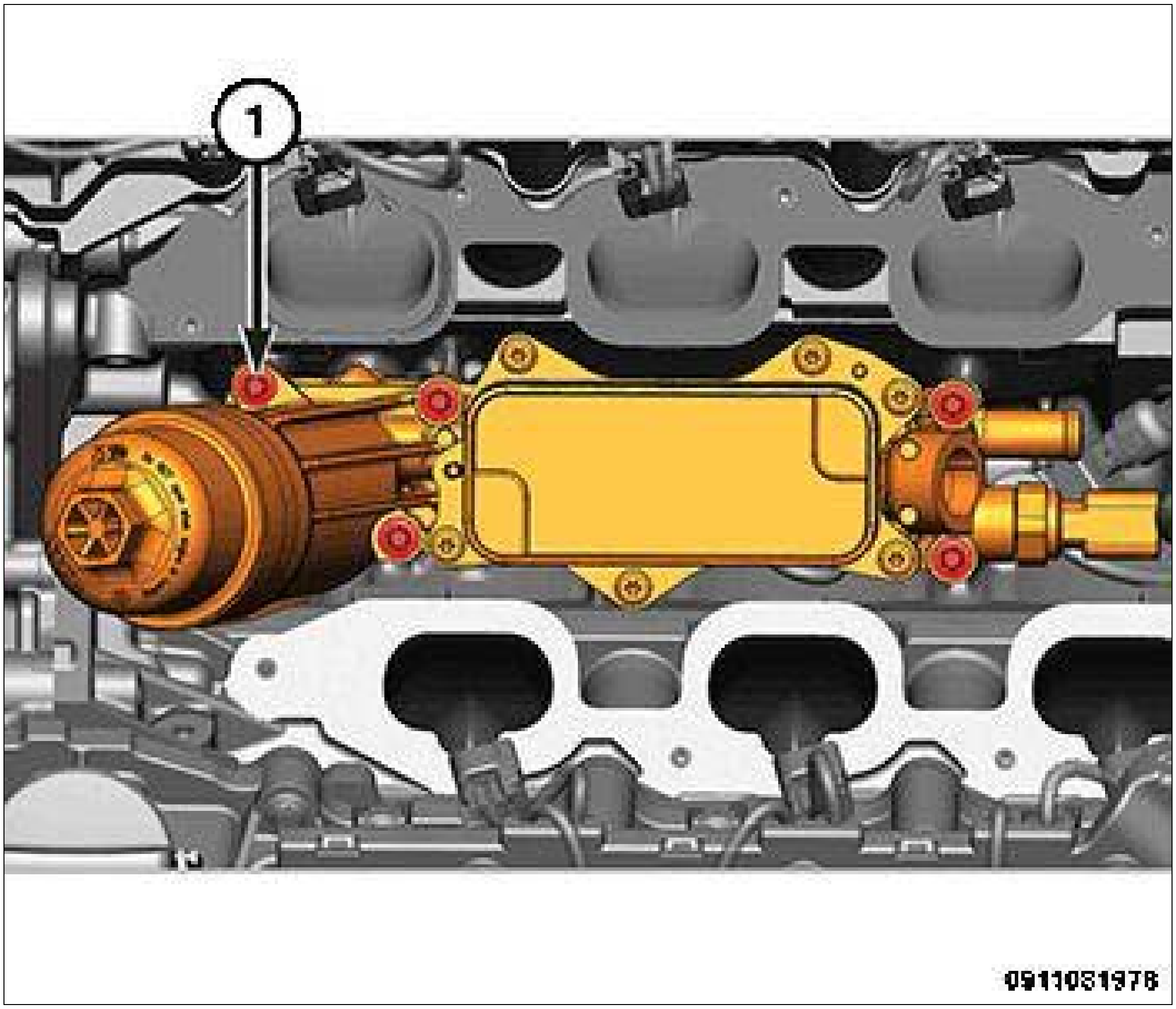


Courtesy of CHRYSLER GROUP, LLC

NOTE:

*Always use **NEW** dry seals when installing the oil filter housing. Lubricate the O-ring seal (1-5) with clean engine oil prior to installation.*

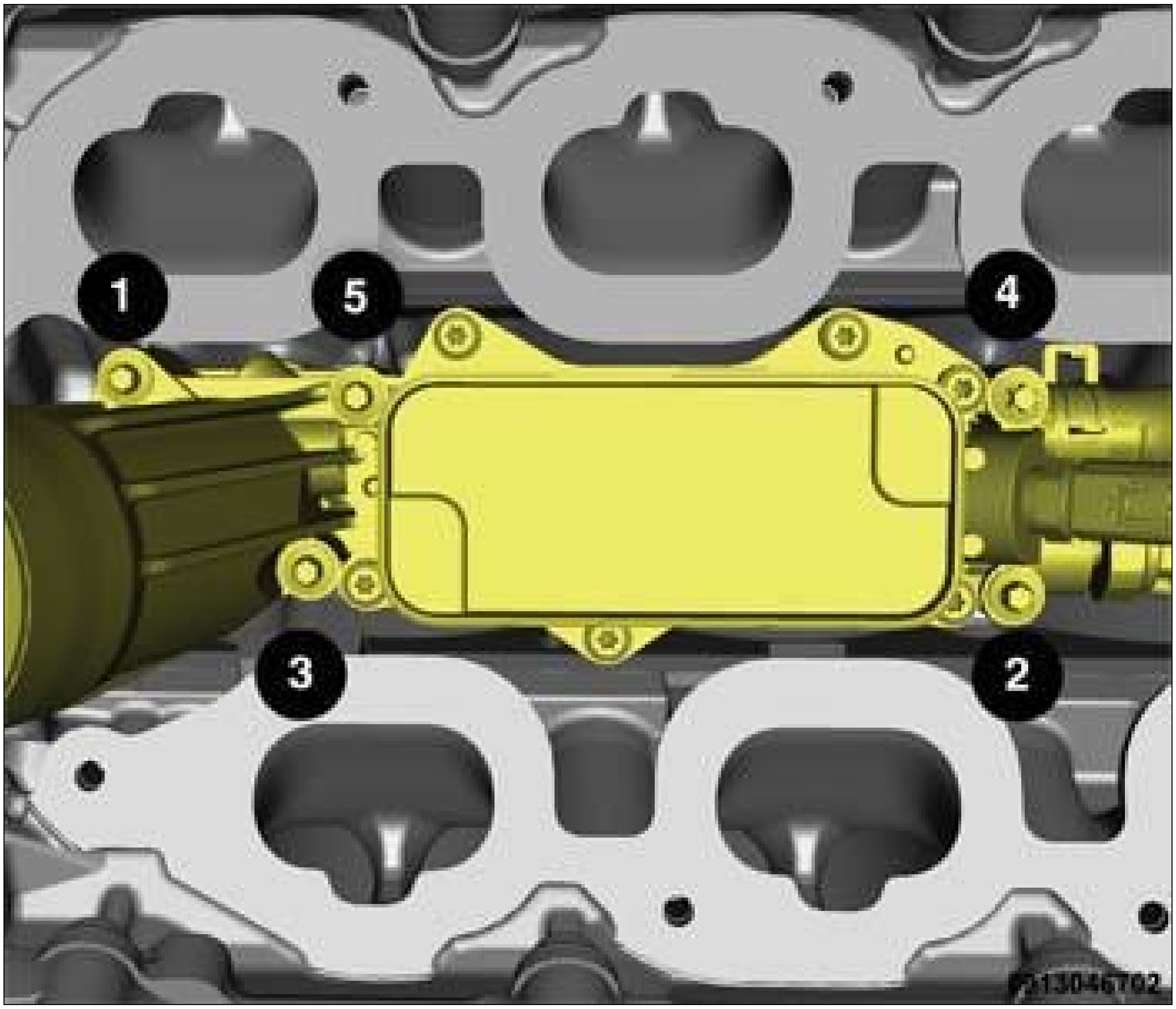
Fig 3: Oil Filter Housing Bolts



Courtesy of CHRYSLER GROUP, LLC

2. Install **NEW** oil filter housing seals onto the oil filter housing.
3. Install the five oil filter housing retaining bolts and tighten finger tight.

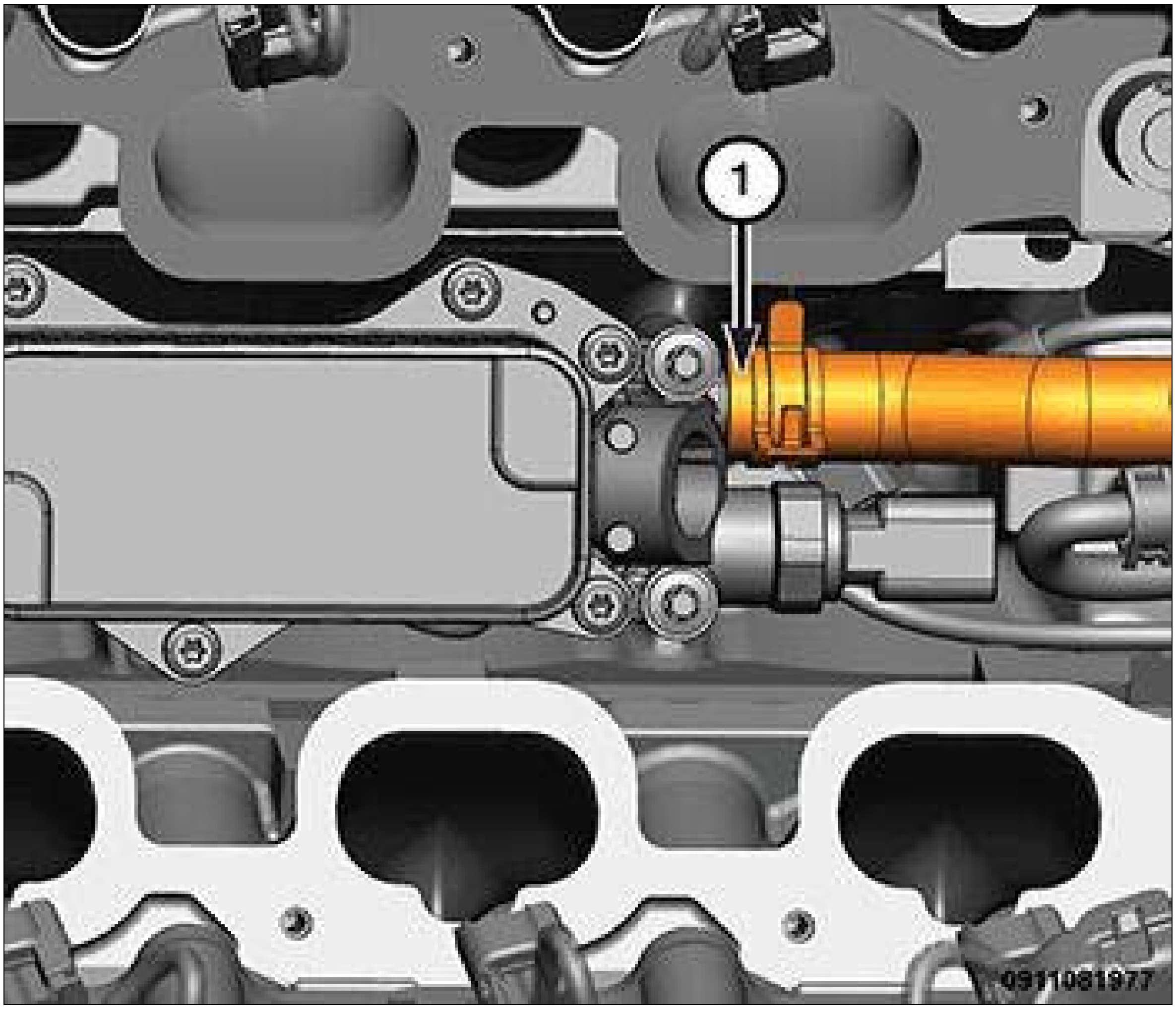
Fig 4: Oil Cooler Screws Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

4. Using the sequence shown in illustration, tighten the oil filter housing bolts to the proper specification. Refer to TORQUE SPECIFICATIONS .

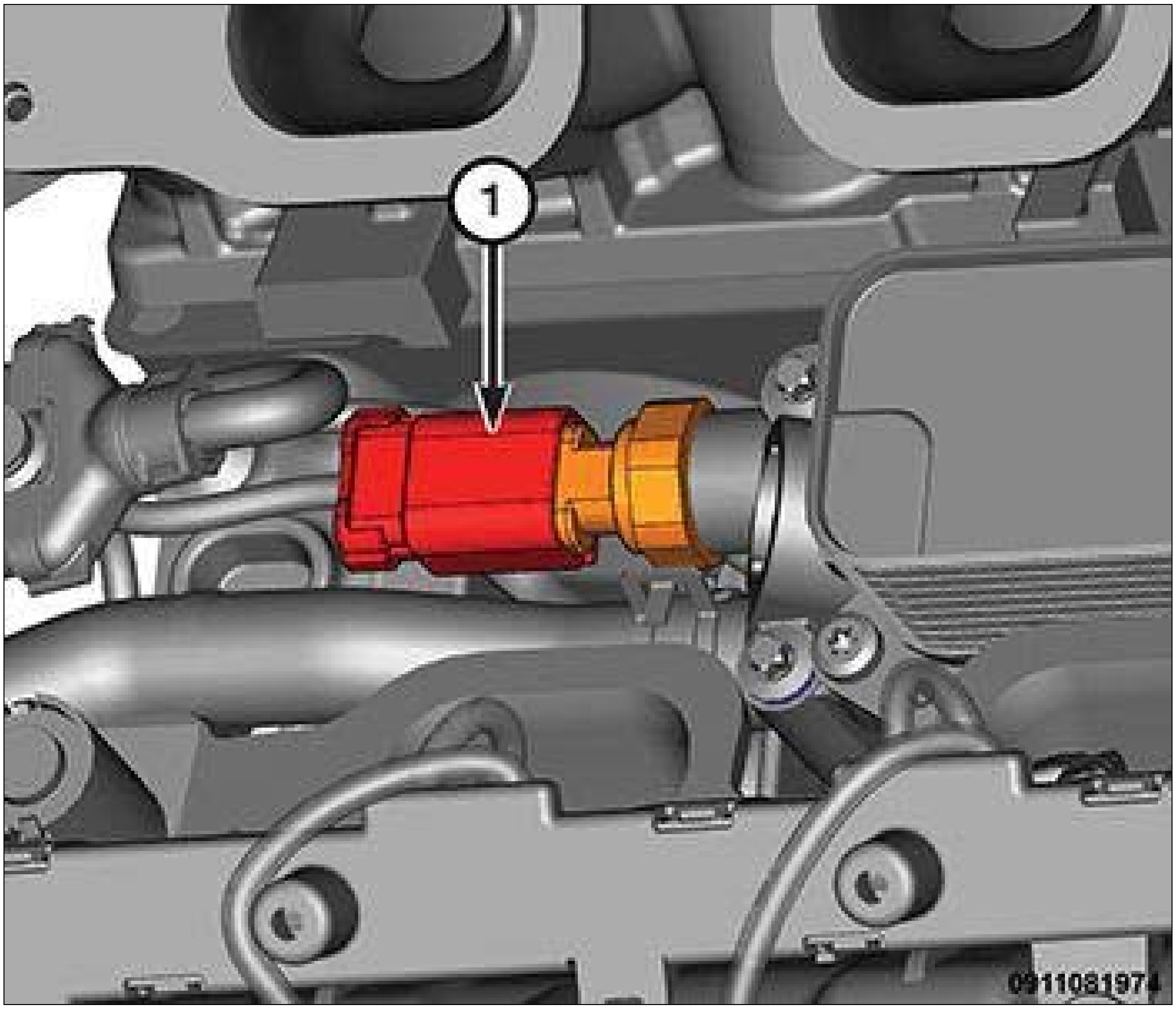
Fig 5: Heater Hose At Oil Filter Housing



Courtesy of CHRYSLER GROUP, LLC

5. Install the heater hose (1) to the oil filter housing.

Fig 6: Oil Pressure Sensor Wire Harness Connector

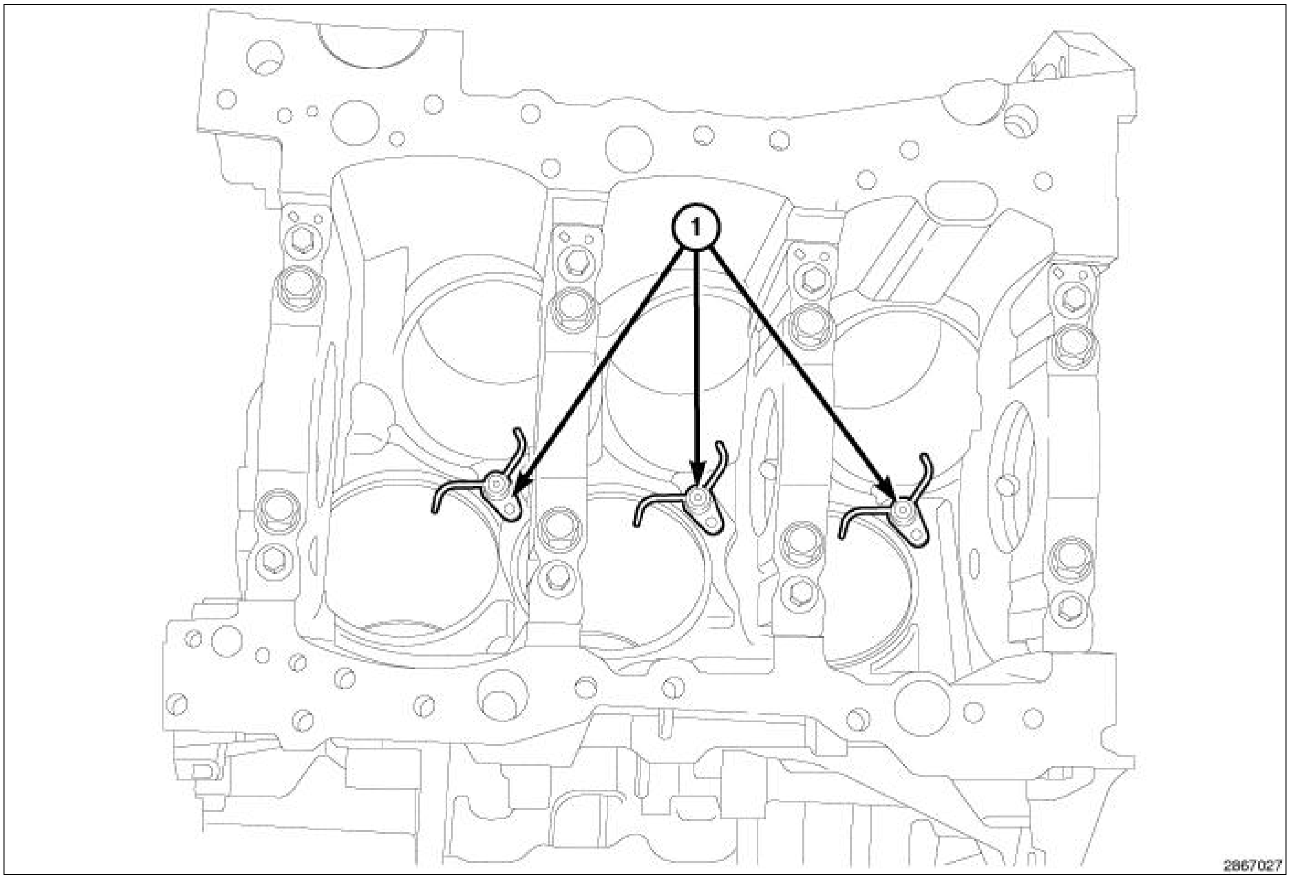


Courtesy of CHRYSLER GROUP, LLC

6. Connect the oil pressure sensor (1) wire harness connector (1).
7. Install the lower intake manifold. Refer to MANIFOLD, INTAKE, INSTALLATION .
8. If required, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
9. Fill the cooling system. Refer to STANDARD PROCEDURE .
10. Operate the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to STANDARD PROCEDURE .

LUBRICATION > JET, PISTON OIL COOLER > DESCRIPTION > DESCRIPTION

Fig 1: Engine Blocked-Mounted Oil Jets



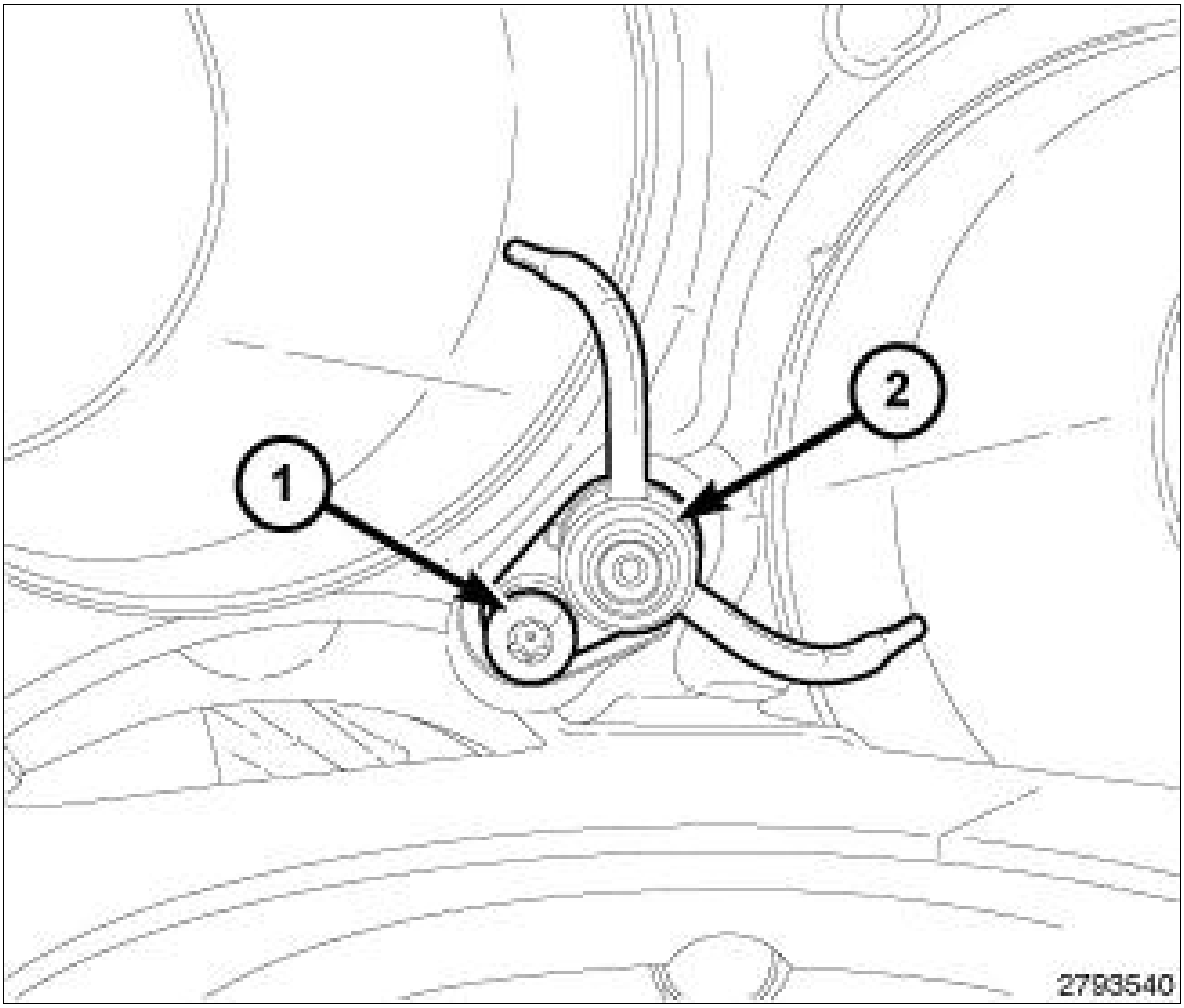
Courtesy of CHRYSLER GROUP, LLC

The Piston Oil Cooler Jet (1) is used to aid in the cooling of the pistons and the cylinder walls. There are three Piston Oil Cooler Jets used. Each jet is supplied oil by the main oil gallery. The oil is sprayed upwards onto the bottom of the pistons and sides of the cylinder walls. A Piston Oil Cooler Jet is mounted to the engine block under each pair of opposing cylinders.

Each jet has a check valve that closes below 241 kPa (35 psi) to maintain ample oil pressure at idle. All three oil jets are identical and seal to the engine block using an O-ring and fastener.

LUBRICATION > JET, PISTON OIL COOLER > REMOVAL > REMOVAL

Fig 1: Piston Oil Cooler Jet & Bolt

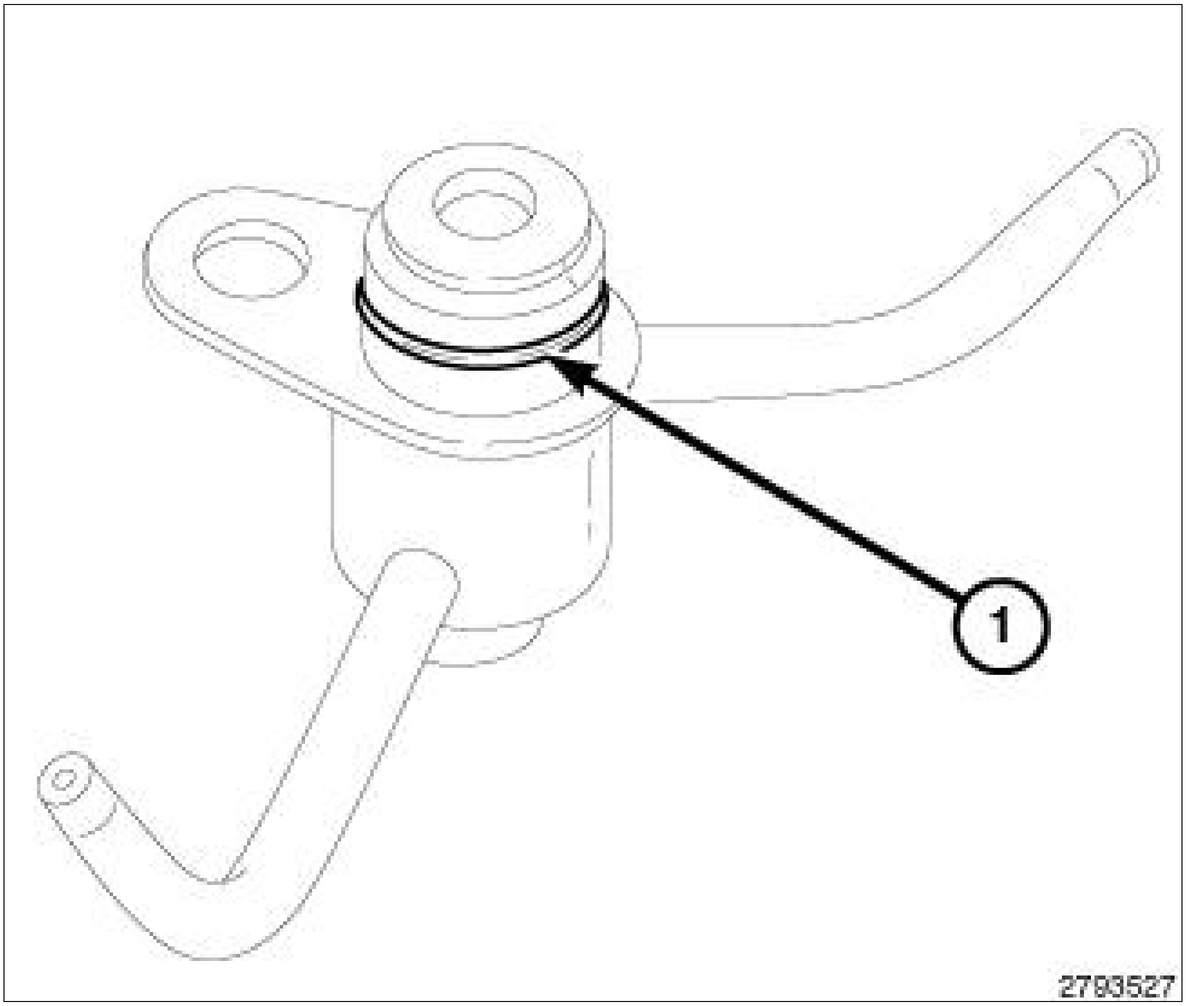


Courtesy of CHRYSLER GROUP, LLC

> *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 2: Piston Oil Cooler Jet O-Ring Seal

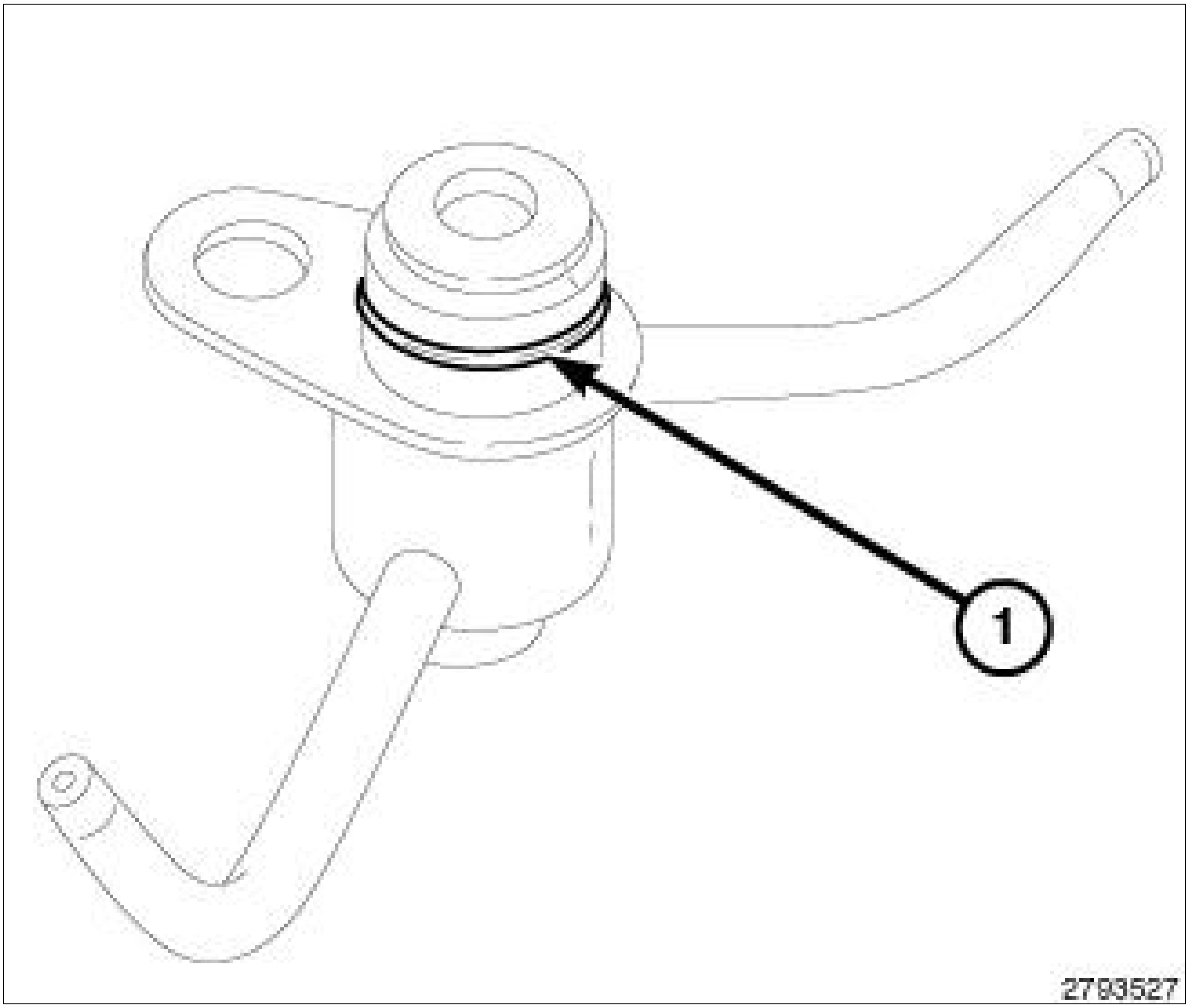


Courtesy of CHRYSLER GROUP, LLC

3. Remove and discard the O-ring seal (1) from the piston oil cooler jet(s).

LUBRICATION > JET, PISTON OIL COOLER > INSTALLATION > INSTALLATION

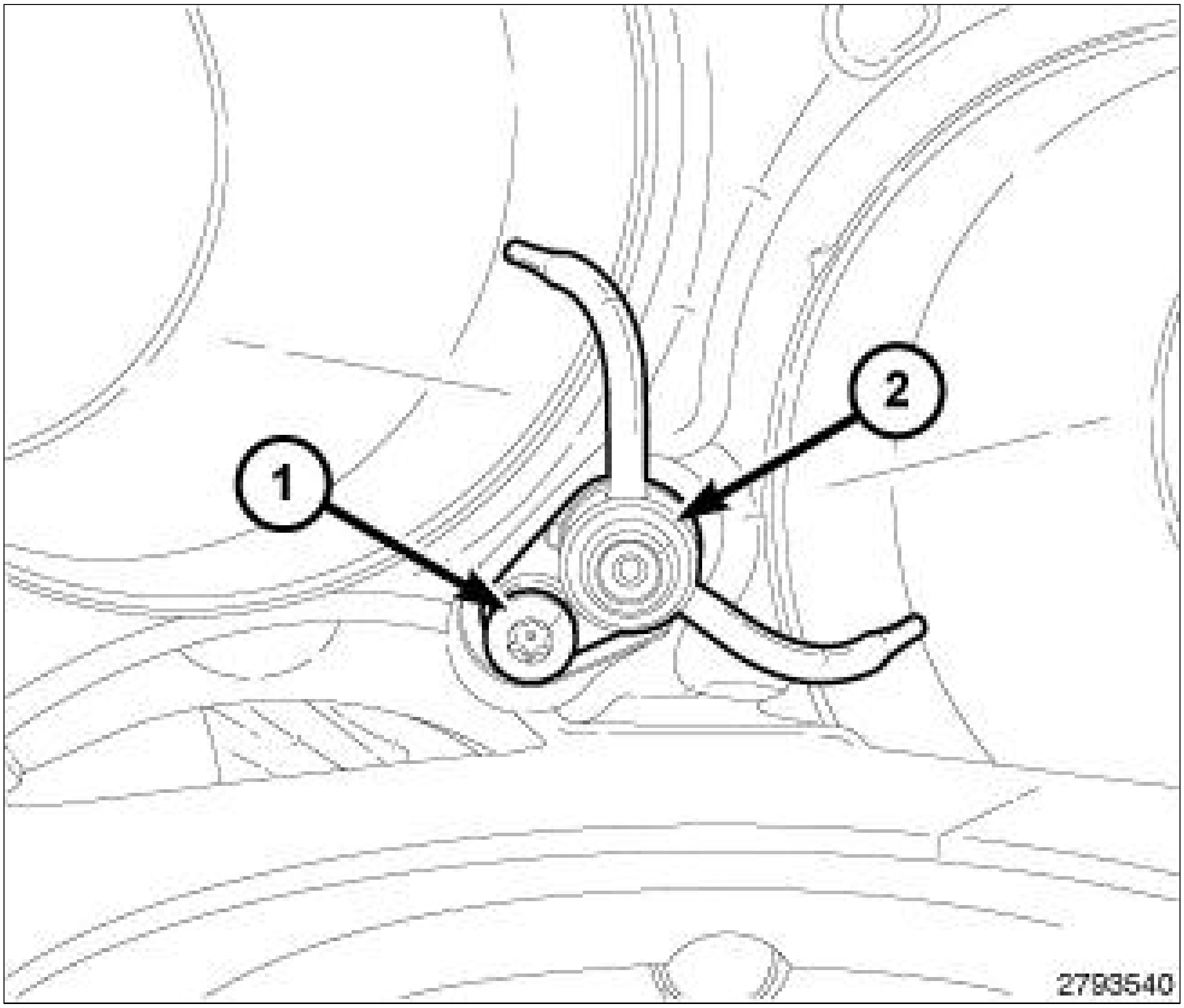
Fig 1: Piston Oil Cooler Jet O-Ring Seal



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 2: 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 the proper specification. Refer to TORQUE SPECIFICATIONS .
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 STANDARD PROCEDURE .
5. Fill the cooling system. Refer to STANDARD PROCEDURE .
6. Connect the negative battery cable and tighten the nut to the proper specification. Refer to SPECIFICATIONS .
7. Run the engine until it reaches normal operating temperature. Check cooling system for correct

fluid level. Refer to STANDARD PROCEDURE .

LUBRICATION > OIL > STANDARD PROCEDURE > STANDARD PROCEDURE - ENGINE OIL AND FILTER CHANGE > ENGINE OIL SERVICE

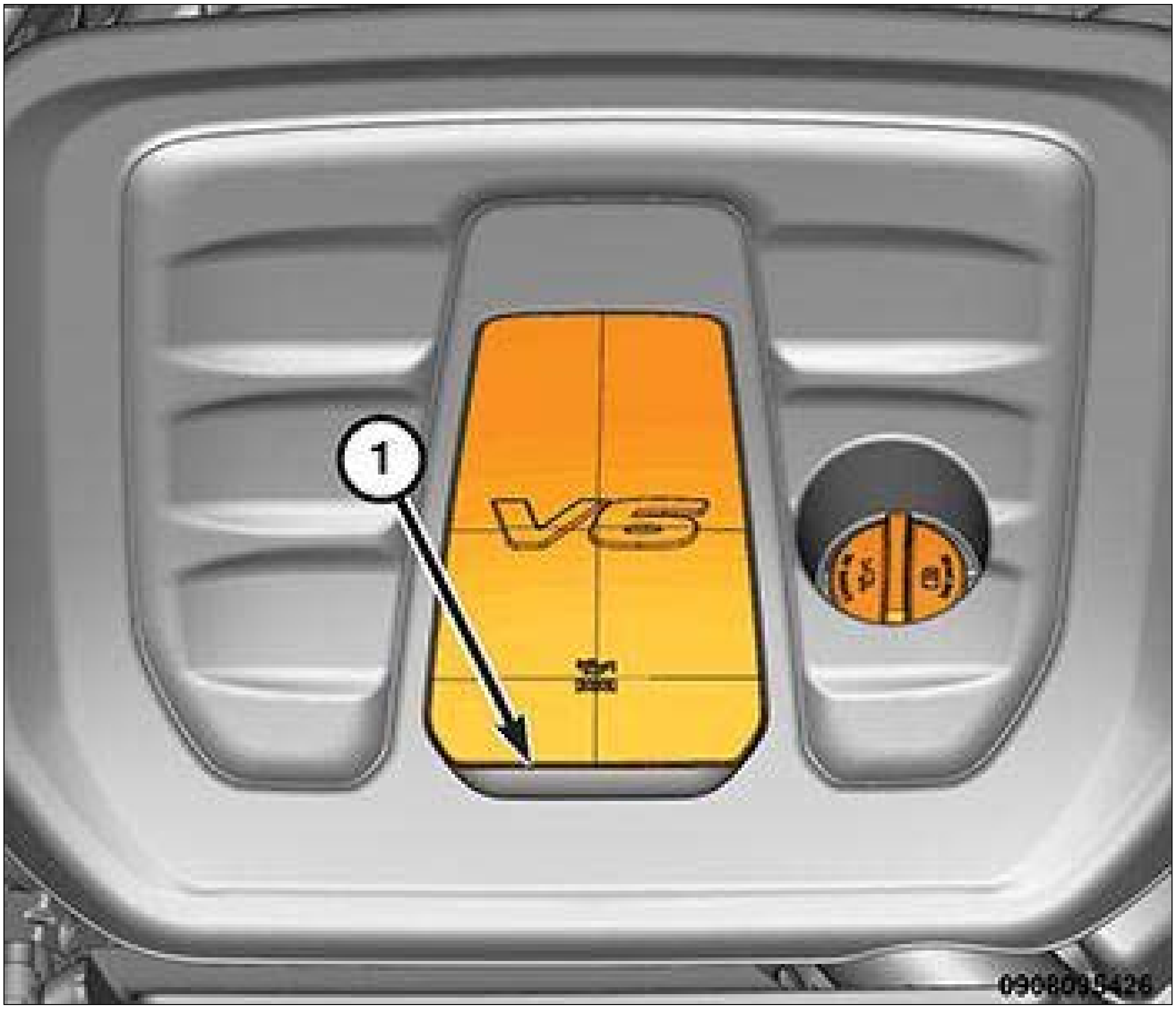
WARNING:

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 .

1. Run the engine until achieving normal operating temperature.
2. Position the vehicle on a level surface and turn the engine off.

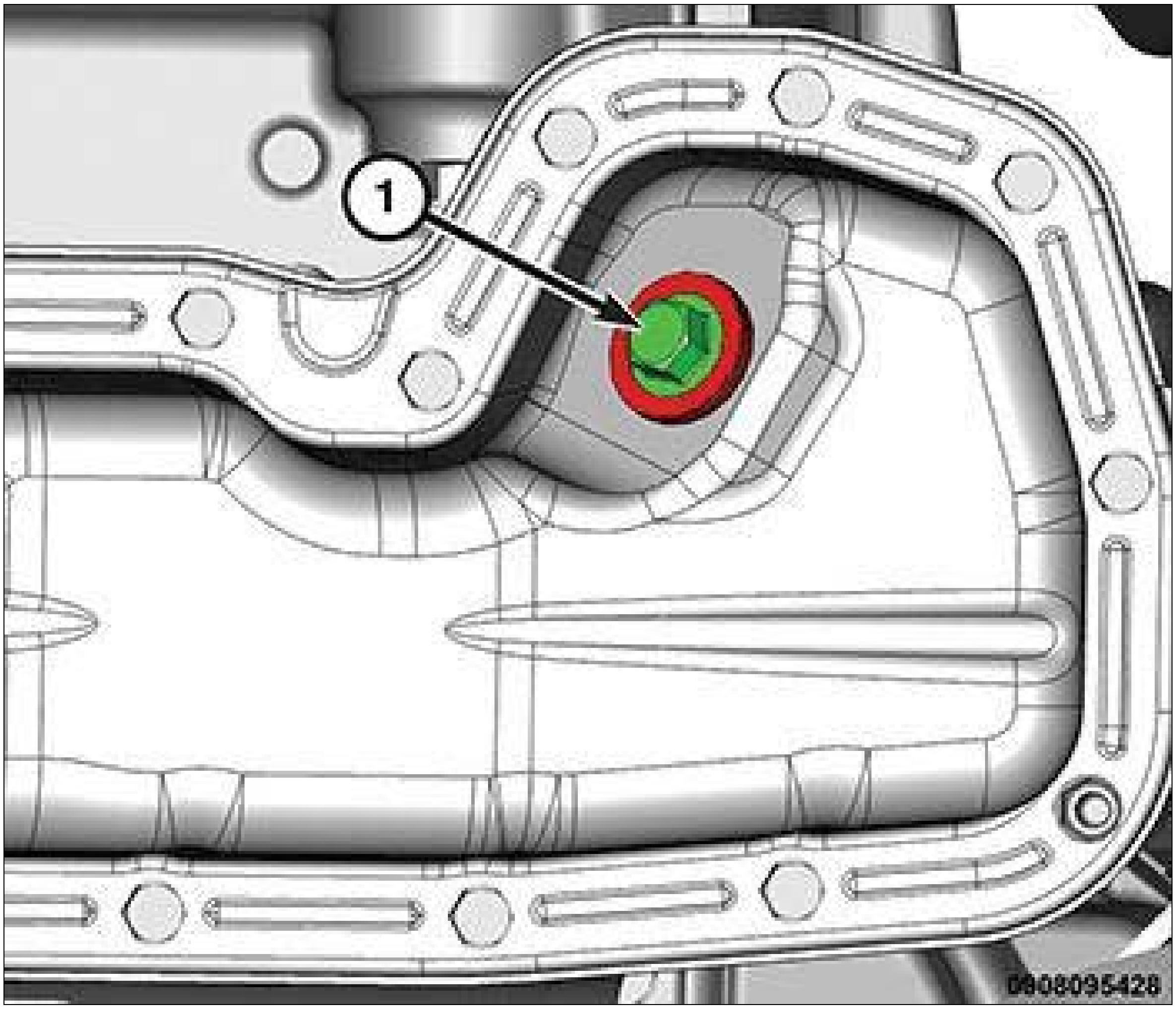
Fig 1: Oil Filter Access Cover



Courtesy of CHRYSLER GROUP, LLC

3. Remove the oil filter access cover (1).
4. Remove the engine oil filter. Refer to FILTER, ENGINE OIL, REMOVAL .

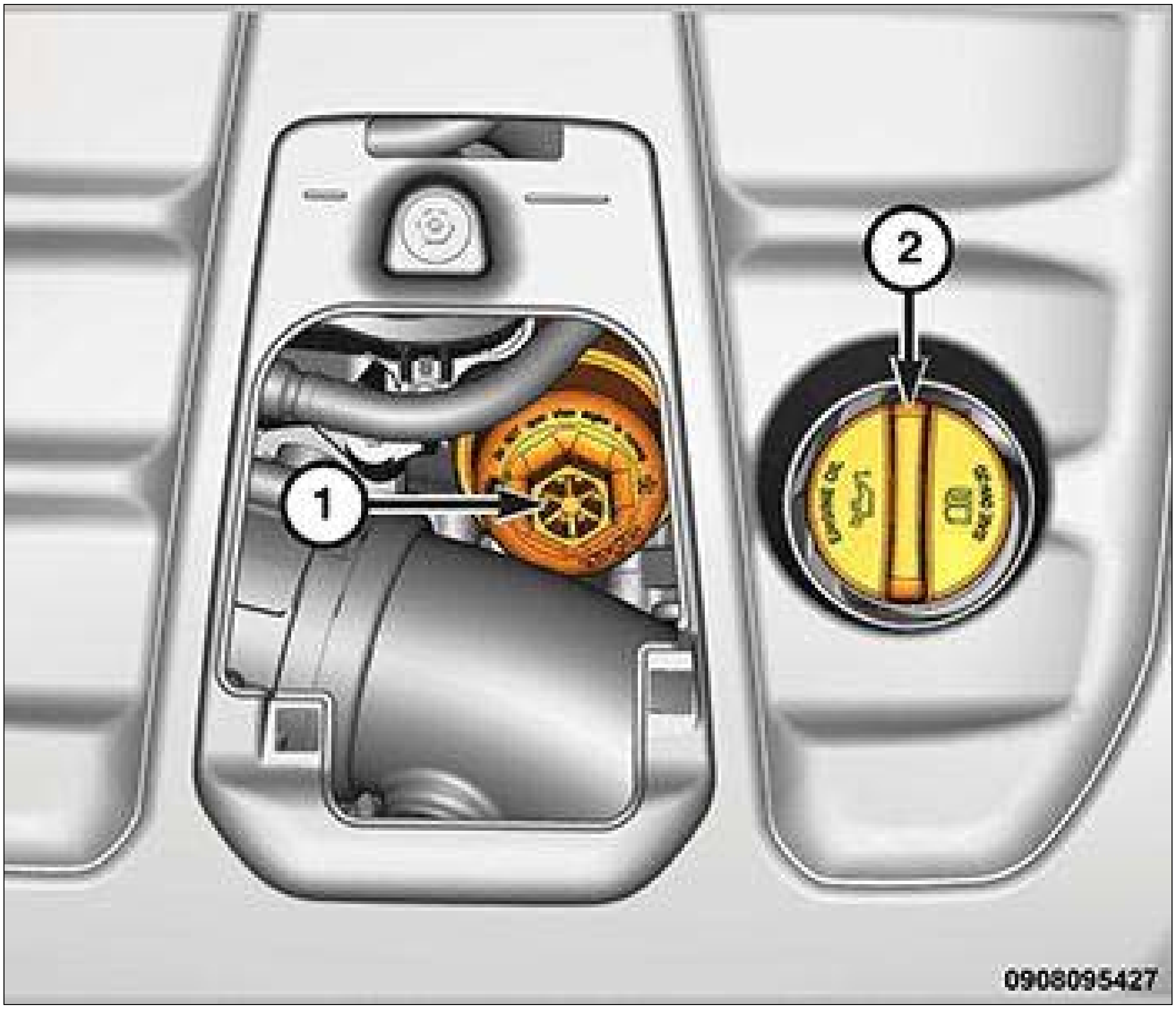
Fig 2: Crankcase Drain Plug



Courtesy of CHRYSLER GROUP, LLC

5. Raise and support the vehicle. Refer to HOISTING, STANDARD PROCEDURE .
6. Place a suitable drain pan under the crankcase drain plug (1).
7. Remove the drain plug 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.
8. Install the drain plug in the oil pan and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .
9. Lower the vehicle.

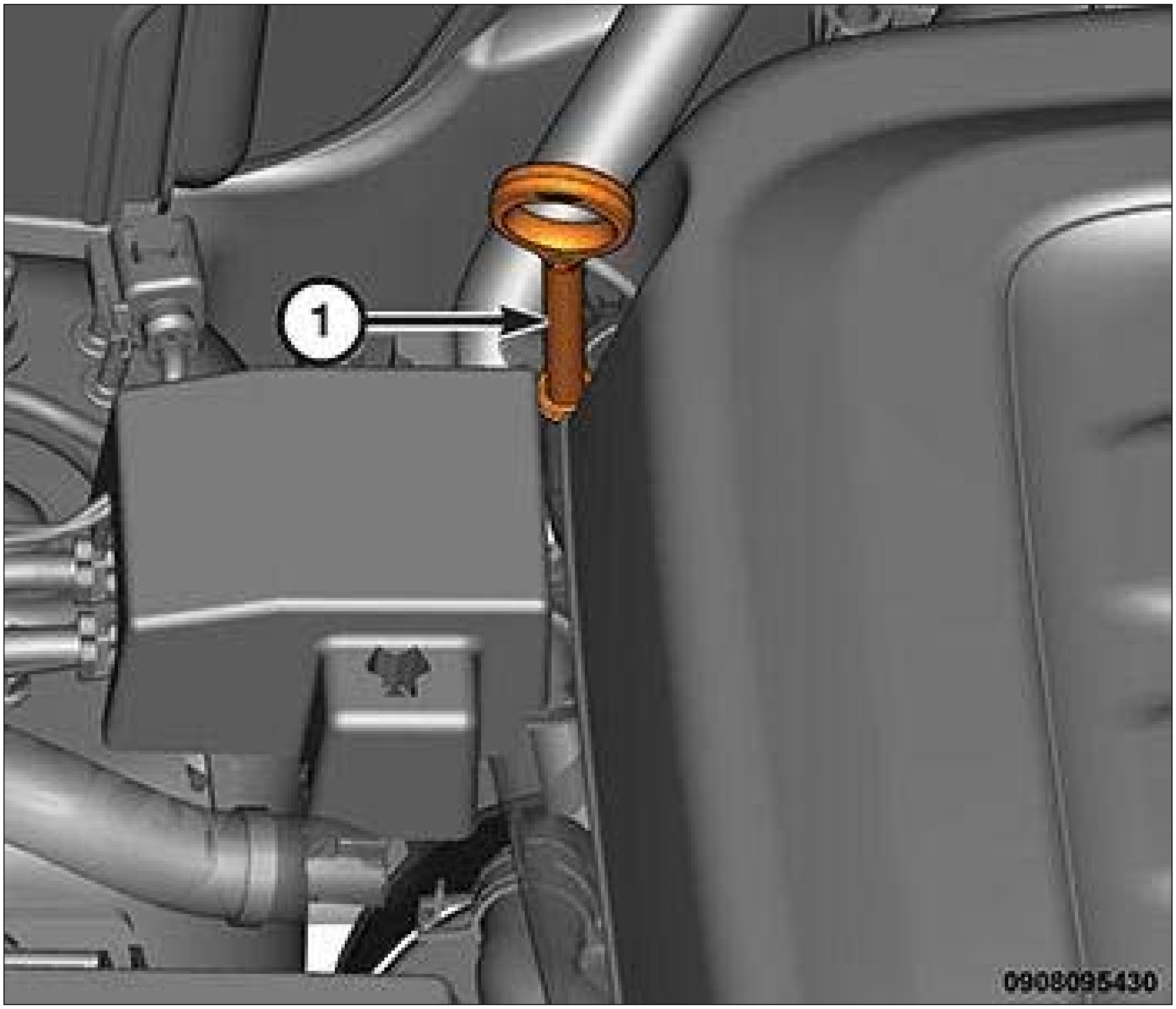
Fig 3: Engine Oil Filter & Oil Fill Cap



Courtesy of CHRYSLER GROUP, LLC

10. Install the engine oil filter (1). Refer to FILTER, ENGINE OIL, INSTALLATION .
11. 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 .
12. Install the oil fill cap.
13. Start the engine and inspect for leaks.

Fig 4: Oil Level Indicator



Courtesy of CHRYSLER GROUP, LLC

14. Stop the engine and check the oil level (1).

LUBRICATION > OIL > STANDARD PROCEDURE > STANDARD PROCEDURE - ENGINE OIL AND FILTER CHANGE > OIL FILTER SPECIFICATION

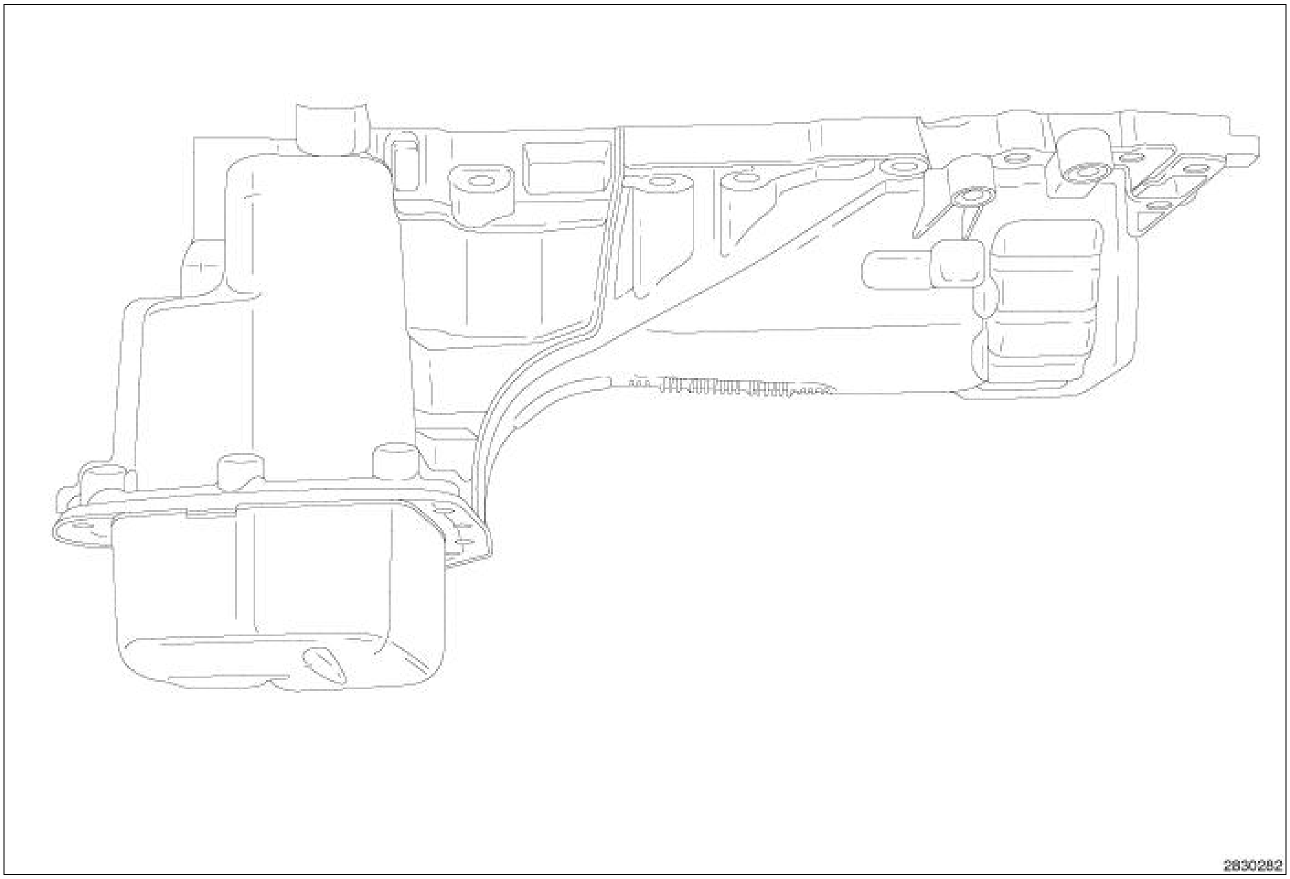
All engines are equipped with a high quality full-flow, disposable type oil filter. When replacing oil filter, use a Mopar® filter or equivalent.

LUBRICATION > OIL > STANDARD PROCEDURE > STANDARD PROCEDURE - ENGINE OIL AND FILTER CHANGE > 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.

LUBRICATION > PAN, OIL > DESCRIPTION > DESCRIPTION

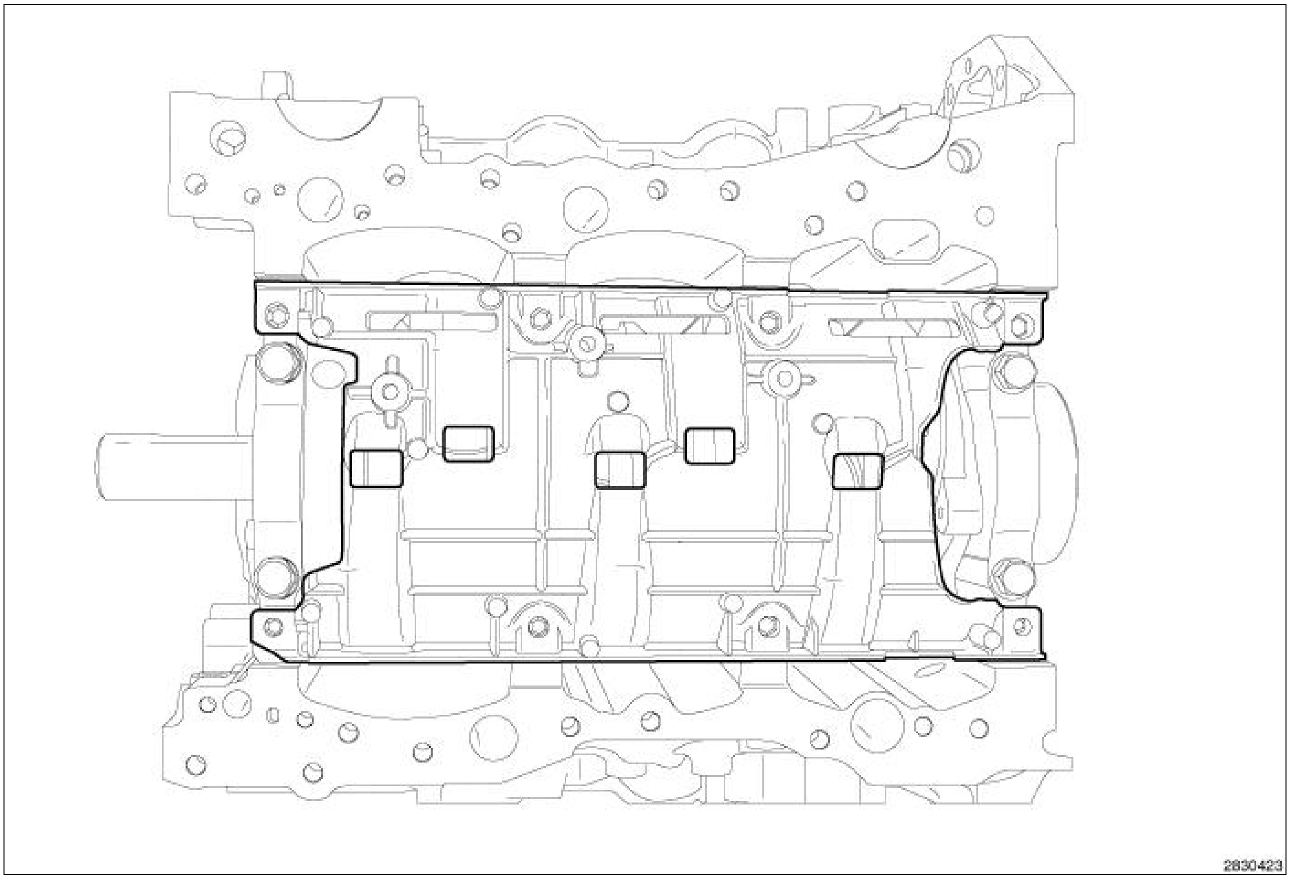
Fig 1: Upper & Lower Oil Pan



Courtesy of CHRYSLER GROUP, LLC

There is an upper and lower oil pan. The upper oil pan is cast aluminum and also serves as the 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. The lower oil pan must be removed in order to access all of the upper oil pan attaching bolts.

Fig 2: 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.

LUBRICATION > PAN, OIL > REMOVAL > LOWER OIL PAN

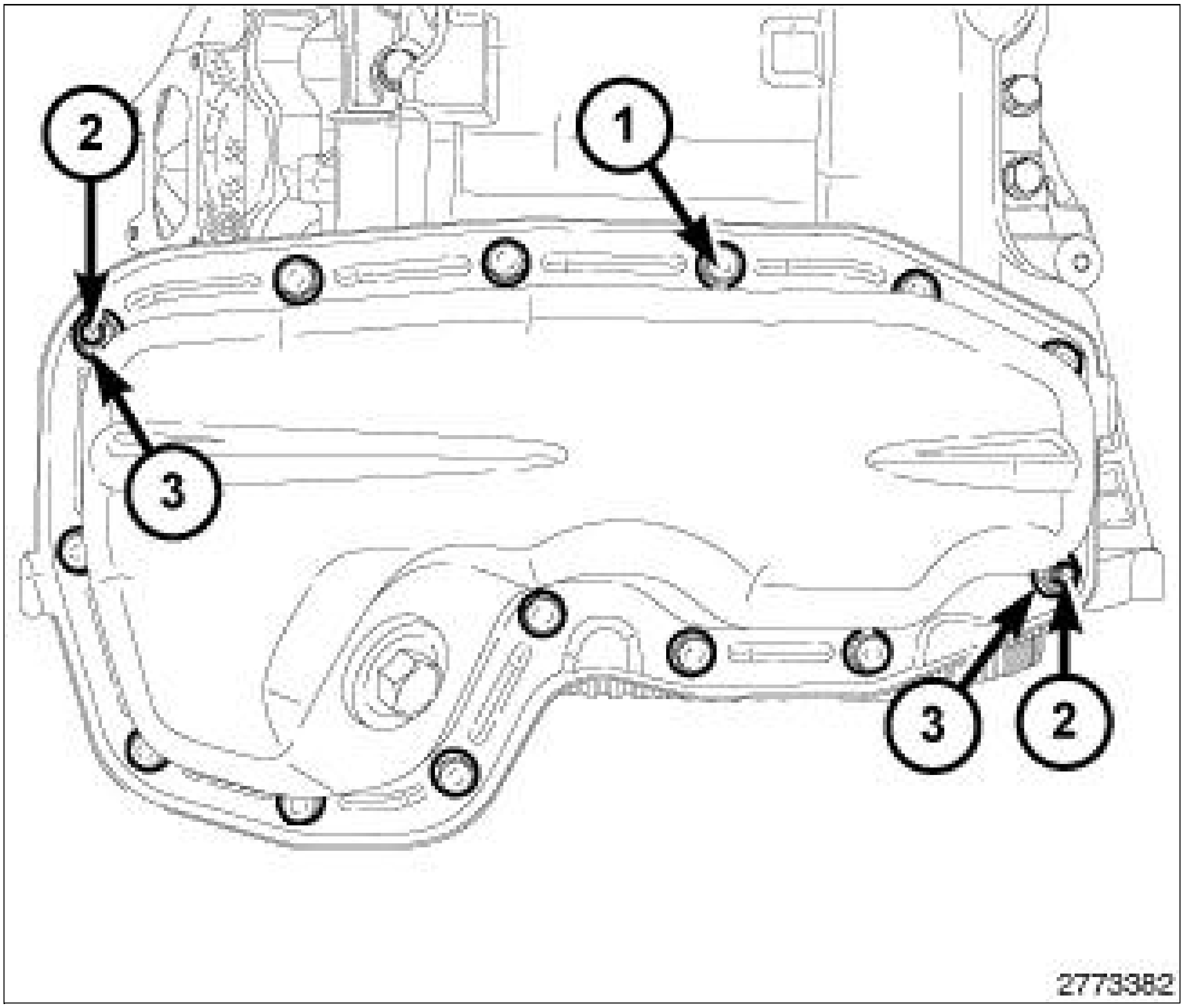
1. Raise and support the vehicle. Refer to HOISTING, STANDARD PROCEDURE .
2. Drain the engine oil. Refer to STANDARD PROCEDURE .
3. Remove the front suspension skid plate, if equipped. Refer to PLATE, SKID, FRONT, REMOVAL , PLATE, SKID, FRONT SUSPENSION, REMOVAL , PLATE, SKID, FUEL TANK, REMOVAL , PLATE, SKID, TRANSMISSION, REMOVAL or PLATE, SKID, TRANSFER CASE,

REMOVAL .

NOTE:

The lower oil pan must be removed to access all of the upper oil pan retaining bolts.

Fig 1: Lower Oil Pan & Fasteners



Courtesy of CHRYSLER GROUP, LLC

4. Remove twelve bolts (1), two nuts (3) and two studs (2) from the flange of the lower oil pan.

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.

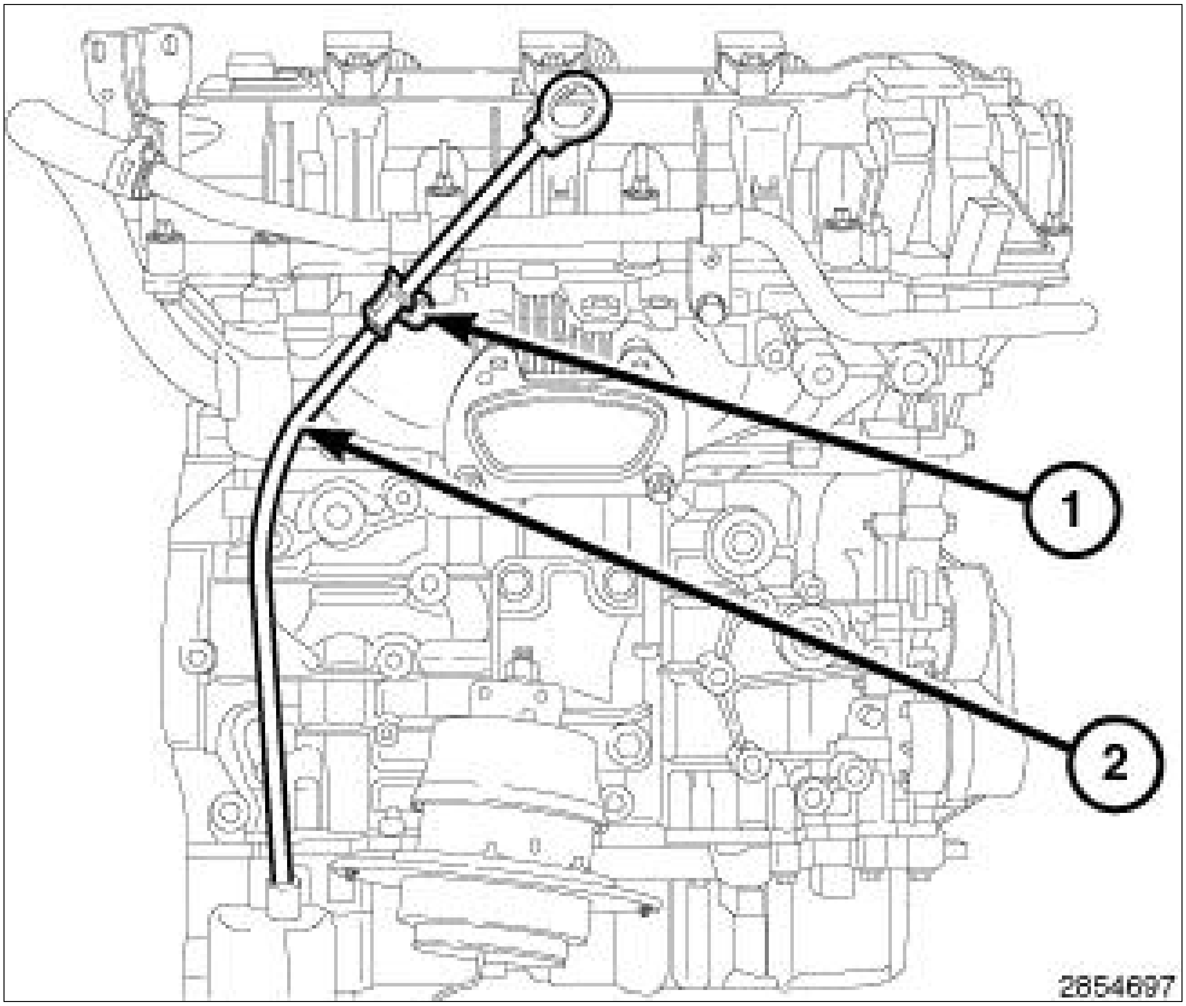
5. Using a gasket scraper or equivalent, loosen the seal around the lower oil pan in order to shear the sealant bond and remove the pan.

6. Remove all residual sealant from the upper and lower oil pans and clean the mating surfaces with isopropyl alcohol in preparation for sealant application. Refer to CLEANING .

LUBRICATION > PAN, OIL > REMOVAL > UPPER

1. Disconnect and isolate the negative battery cable.

Fig 1: Oil Level Indicator & Retaining Bolt



Courtesy of CHRYSLER GROUP, LLC

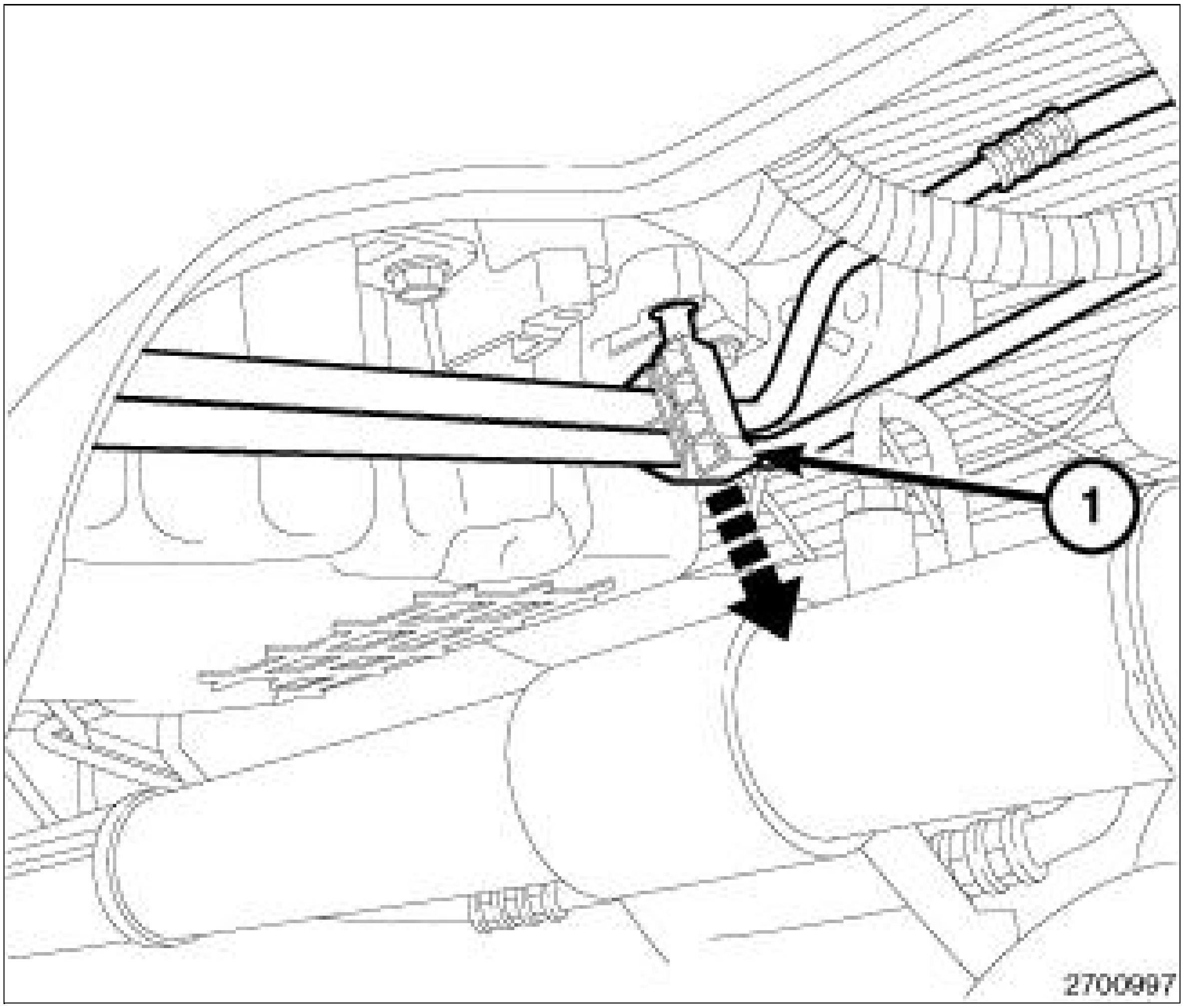
2. Remove the bolt (1) and remove the oil level indicator (2).
3. If equipped, remove the front skid plate and the front suspension skid plate. Refer to PLATE, SKID, FRONT, REMOVAL , PLATE, SKID, FRONT SUSPENSION, REMOVAL , PLATE, SKID, FUEL TANK, REMOVAL , PLATE, SKID, TRANSMISSION, REMOVAL or PLATE, SKID, TRANSFER CASE, REMOVAL .
4. Remove the lower oil pan. Refer to PAN, OIL, REMOVAL .

NOTE:

The lower oil pan must be removed to access all of the upper oil pan retaining bolts.

5. If equipped with AWD, remove the front axle. Refer to REMOVAL .
6. Remove the steering gear. Refer to GEAR, REMOVAL .

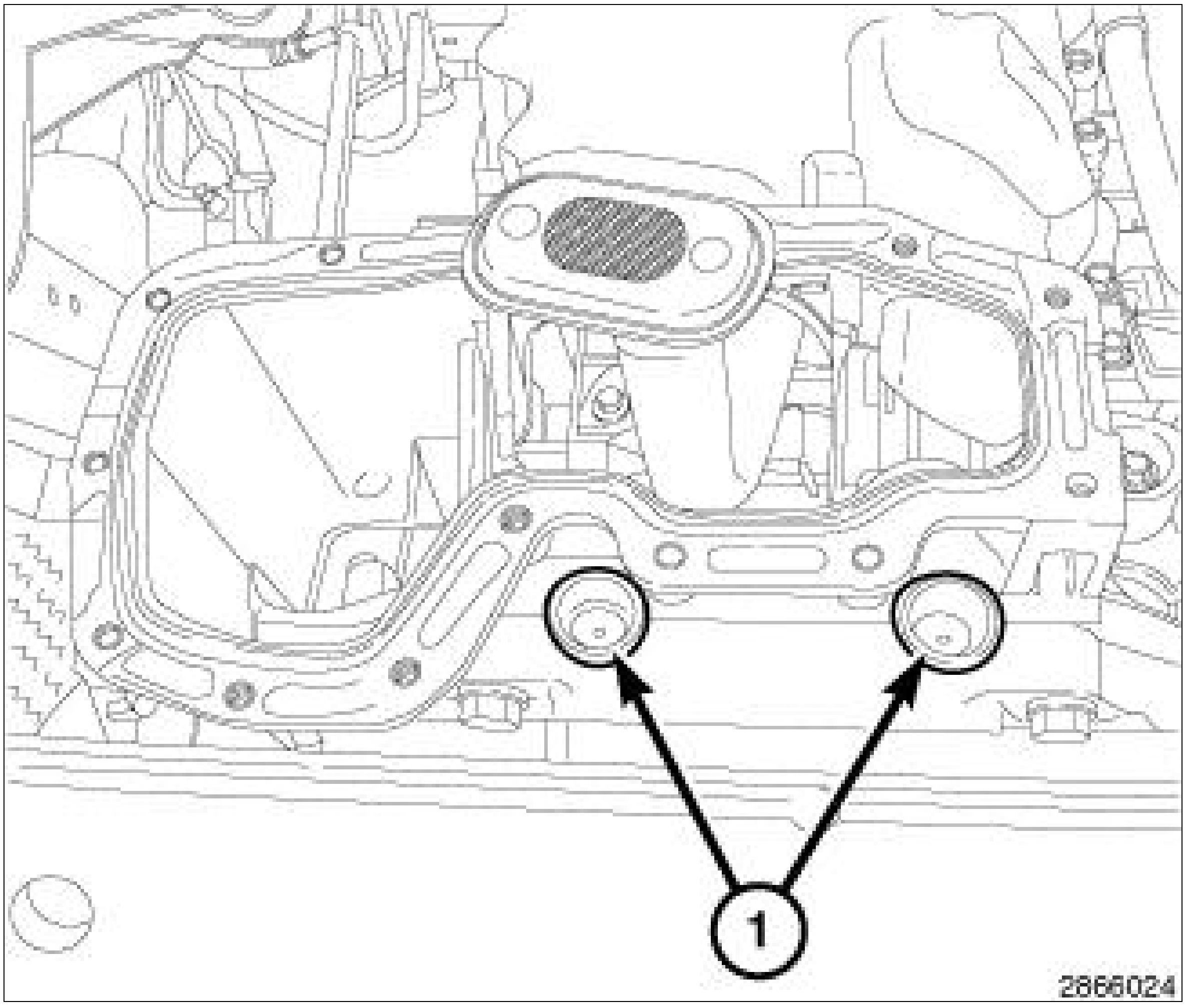
Fig 2: Transmission Cooler Line Retainer



Courtesy of CHRYSLER GROUP, LLC

7. Unclip the transmission cooler line retainer (1) from the oil pan flange.

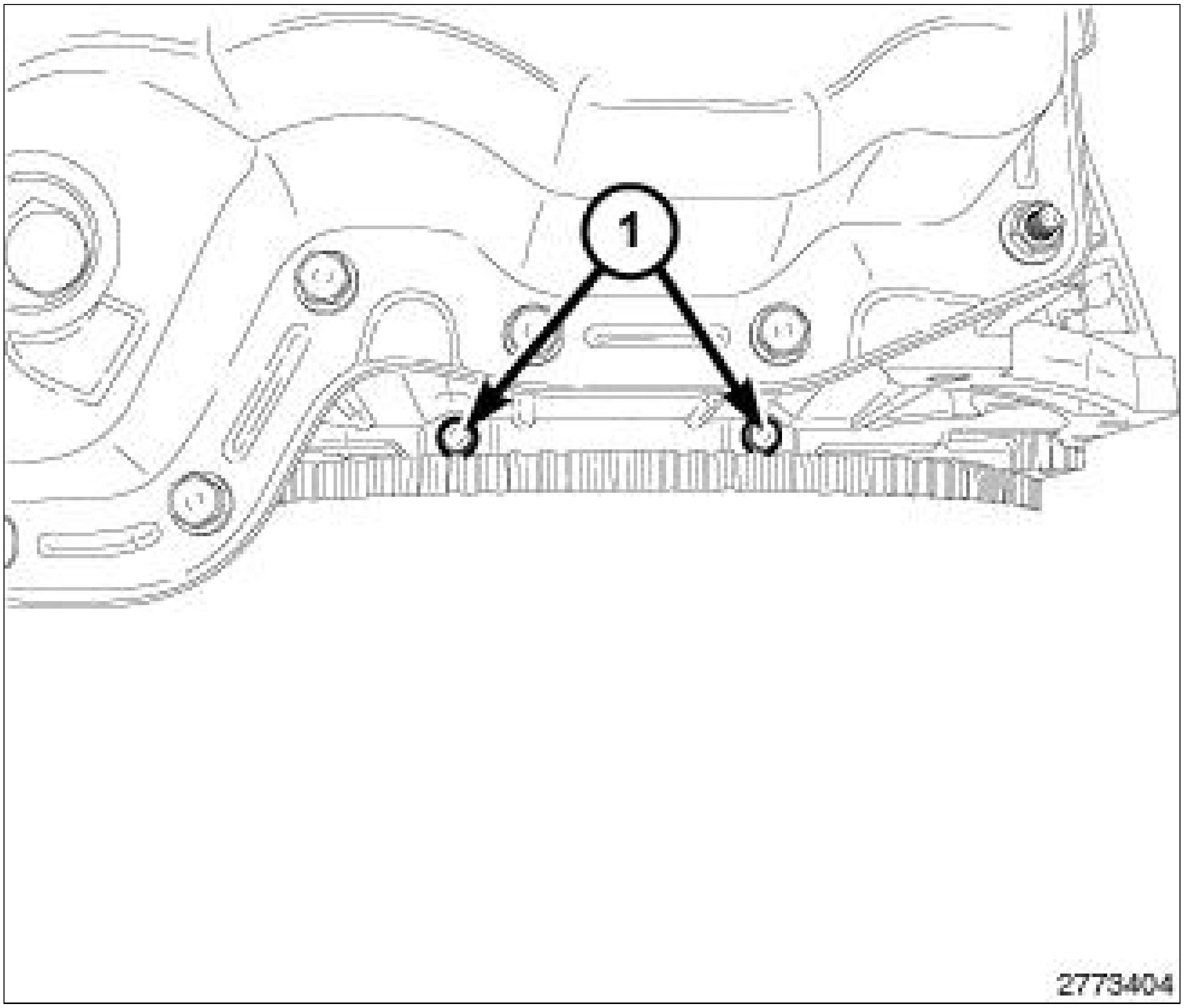
Fig 3: Rubber Plugs



Courtesy of CHRYSLER GROUP, LLC

8. Remove two rubber plugs (1) covering the rear oil seal retainer flange bolts.

Fig 4: Rear Oil Seal Retainer Flange Bolts



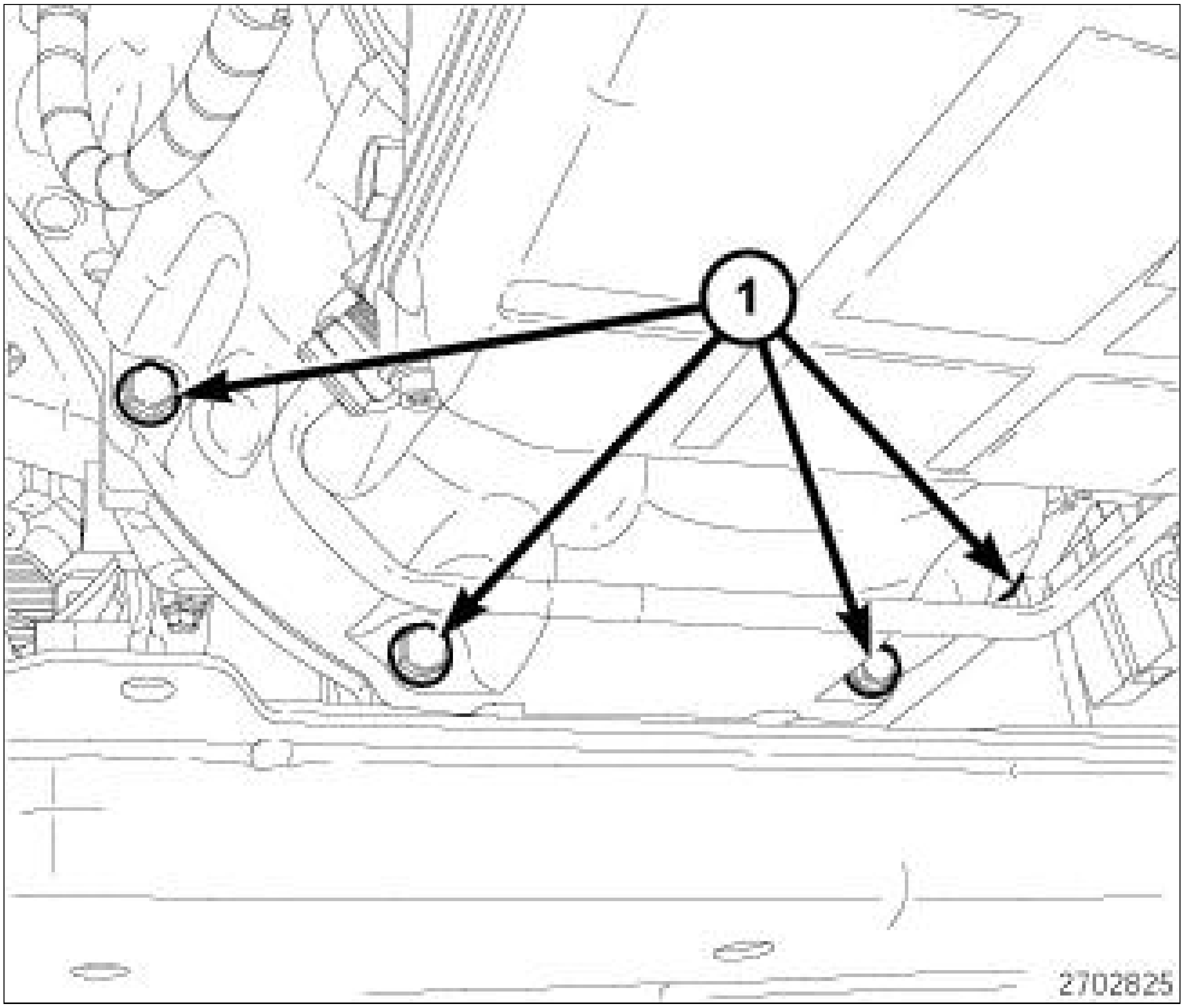
Courtesy of CHRYSLER GROUP, LLC

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.

9. Remove two M6 bolts (1) from the rear oil seal retainer flange.

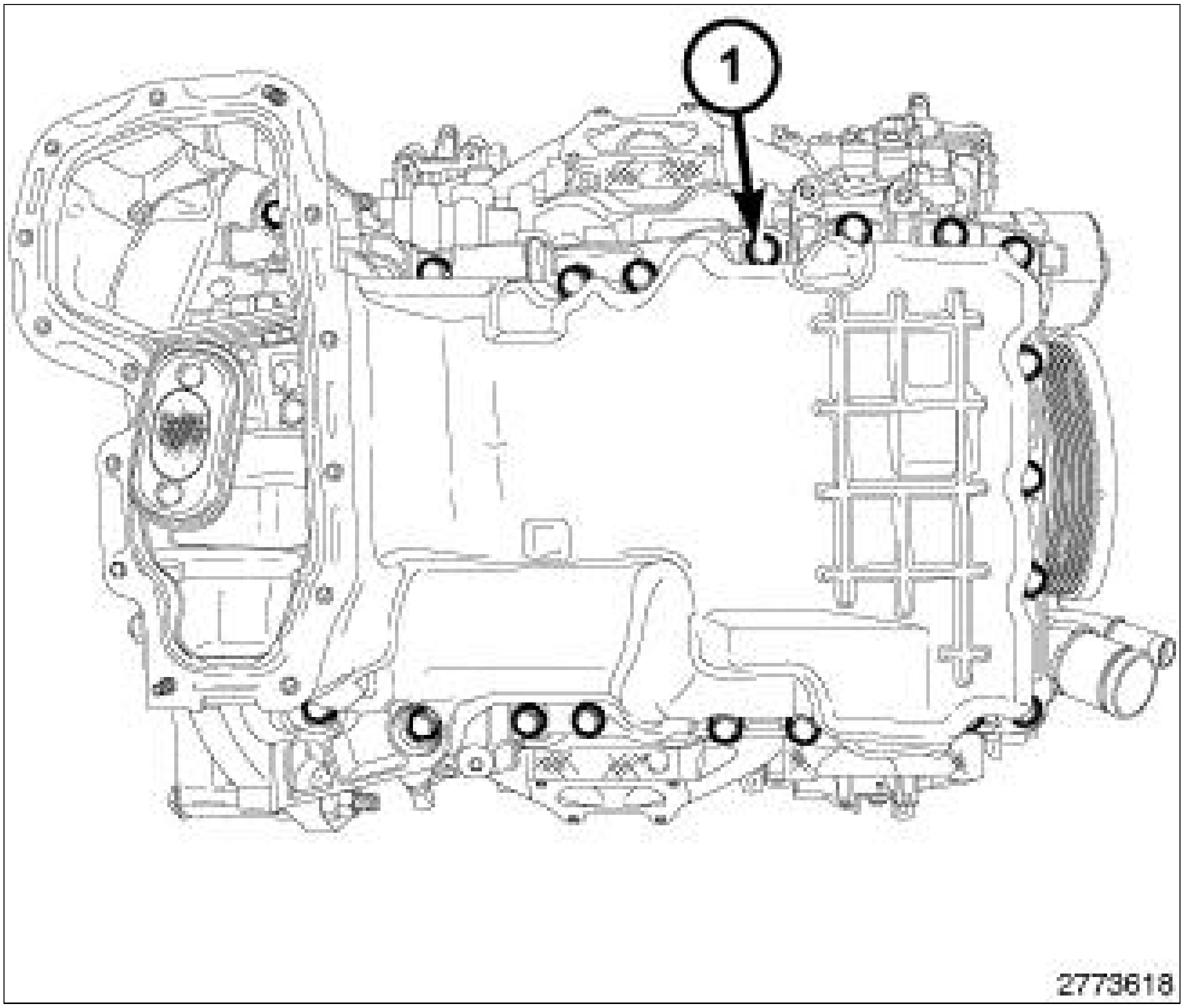
Fig 5: Transmission-To-Engine Oil Pan Bolts



Courtesy of CHRYSLER GROUP, LLC

10. Remove four transmission to the engine oil pan bolts (1).

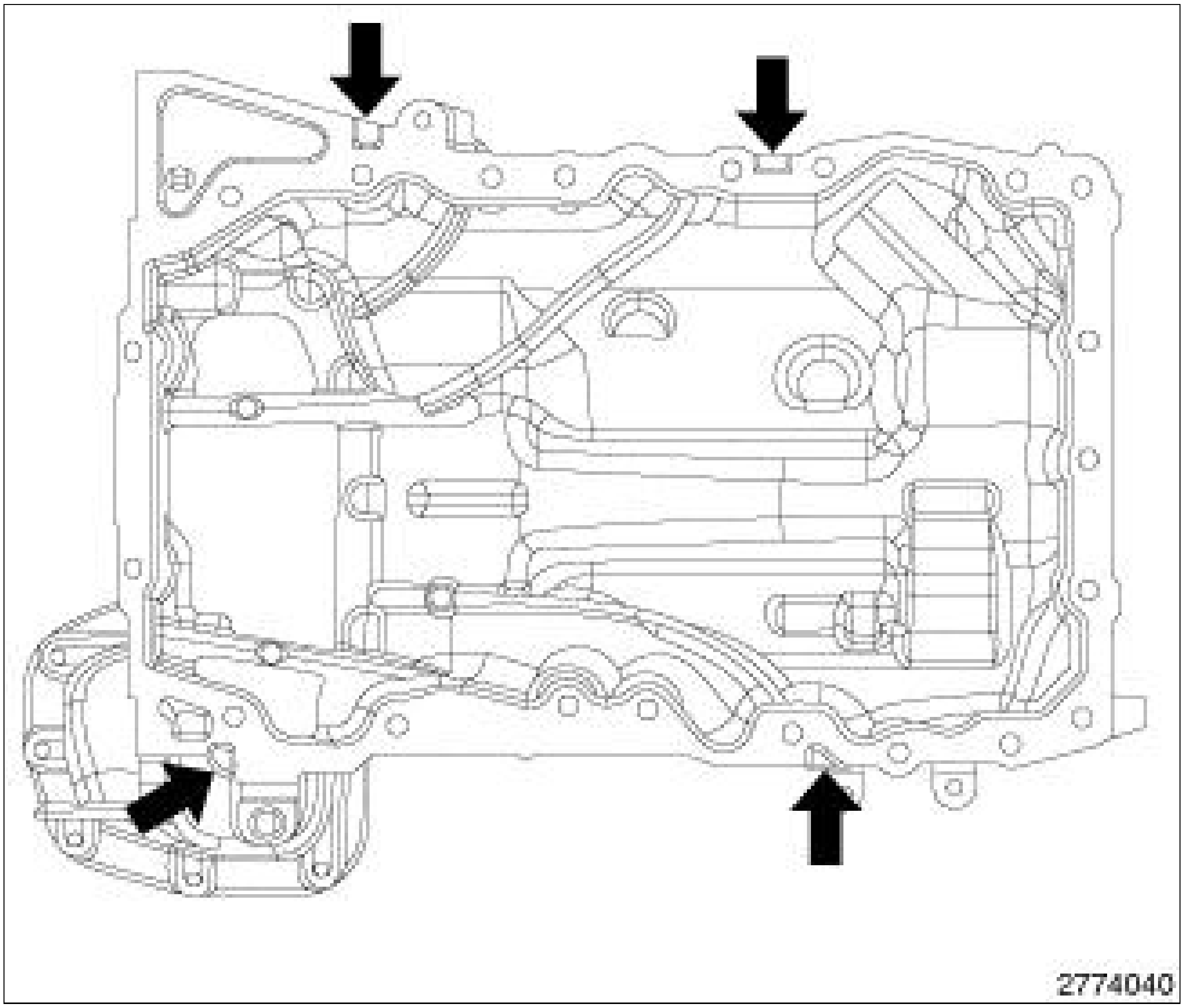
Fig 6: Oil Pan Mounting Bolts



Courtesy of CHRYSLER GROUP, LLC

11. Remove nineteen M8 oil pan mounting bolts (1).

Fig 7: Pry Points



Courtesy of CHRYSLER GROUP, LLC

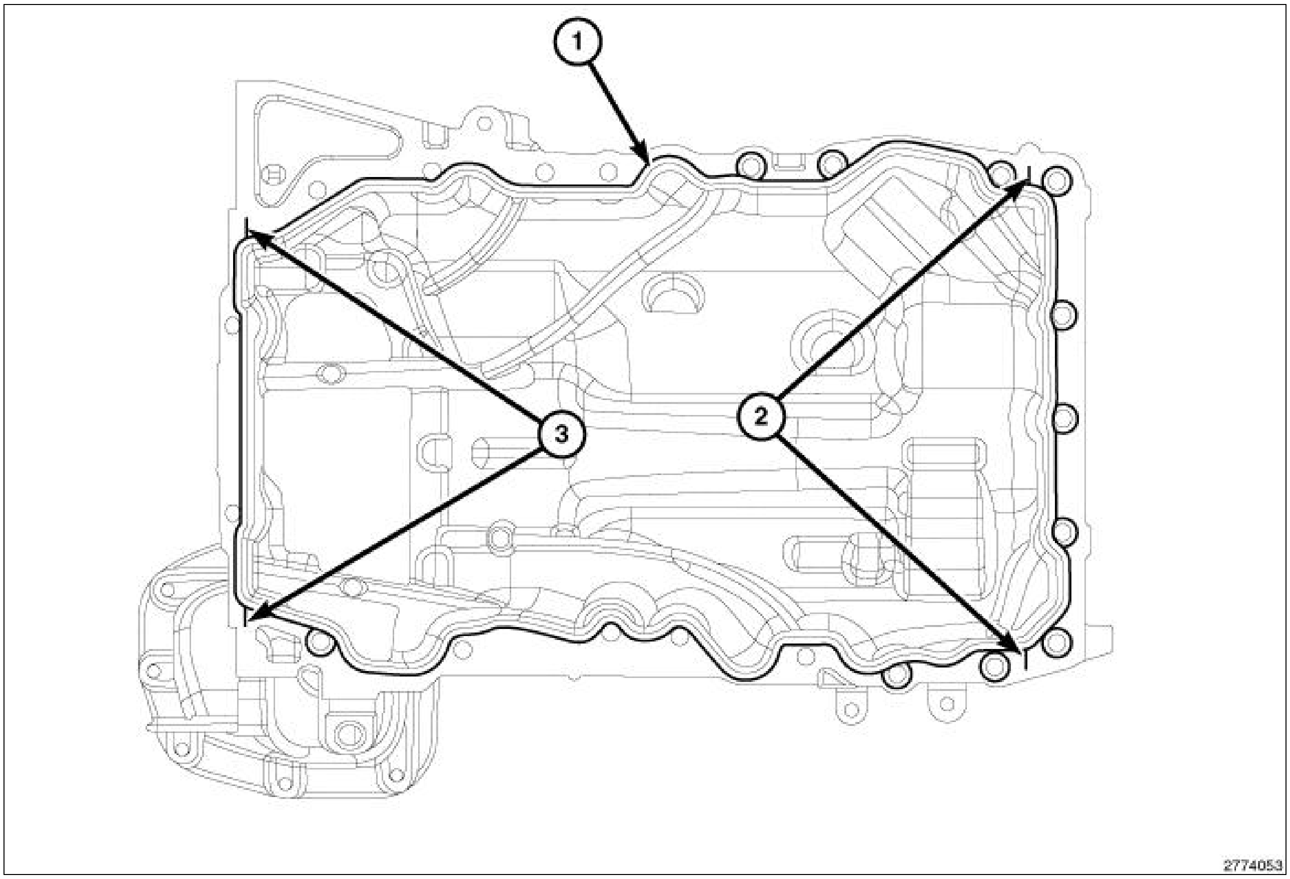
12. Using the four indicated pry points, carefully remove the upper oil pan.
13. Remove all residual sealant from the upper and lower oil pans, timing chain cover, rear seal retainer and engine block mating surfaces. Refer to CLEANING .

LUBRICATION > PAN, OIL > CLEANING > CLEANING

CAUTION:

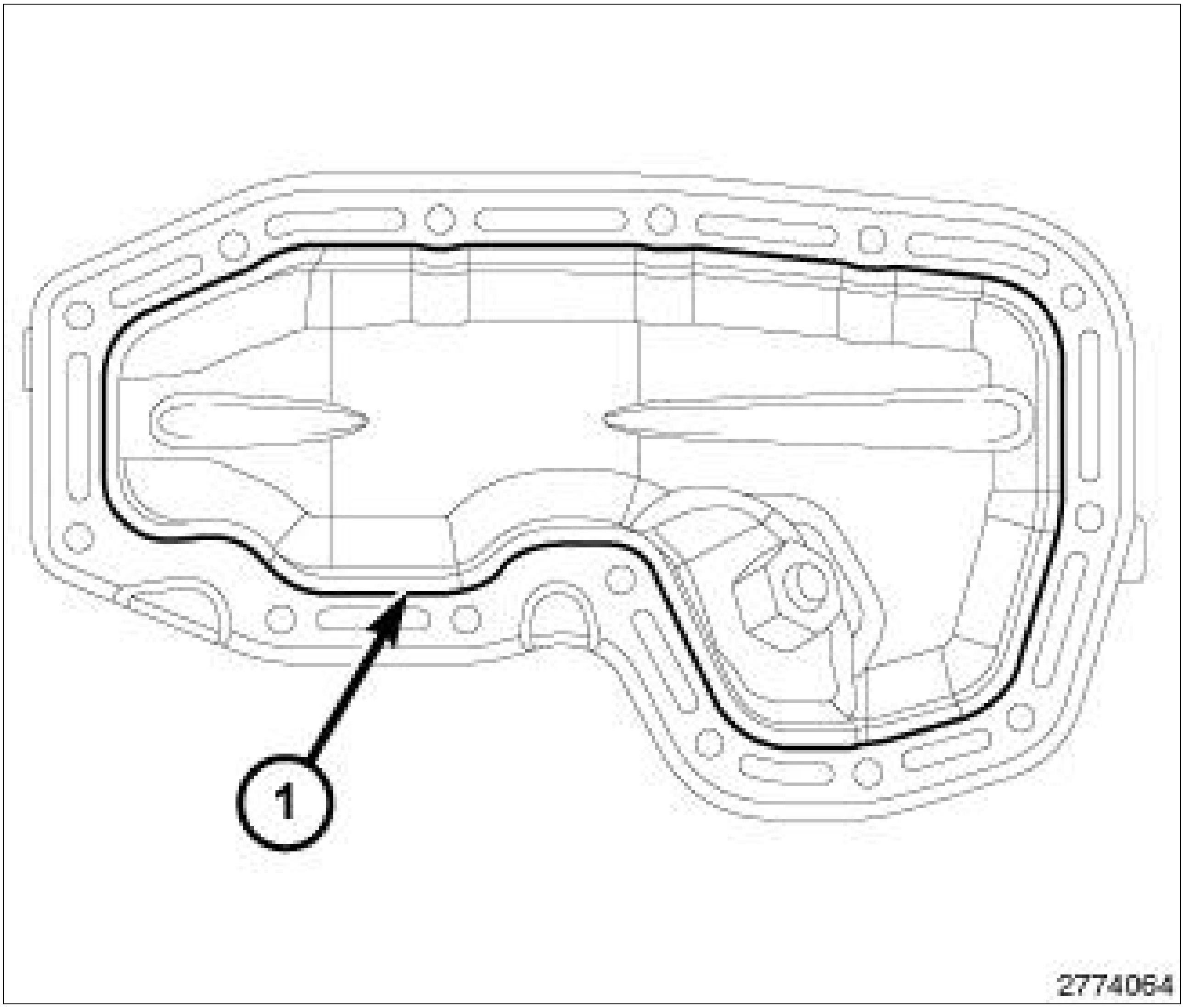
Clean the upper and lower oil pans, timing chain cover, rear seal retainer and engine block mating surfaces thoroughly with isopropyl alcohol in preparation for sealant application. All surfaces that seal with RTV must be oil and contamination free to ensure proper adhesion of the RTV to the mating surface to prevent leaks.

Fig 1: Mopar® Threebond Engine RTV Sealant Locations



Courtesy of CHRYSLER GROUP, LLC

Fig 2: Mopar® Threebond Engine RTV Sealant Location

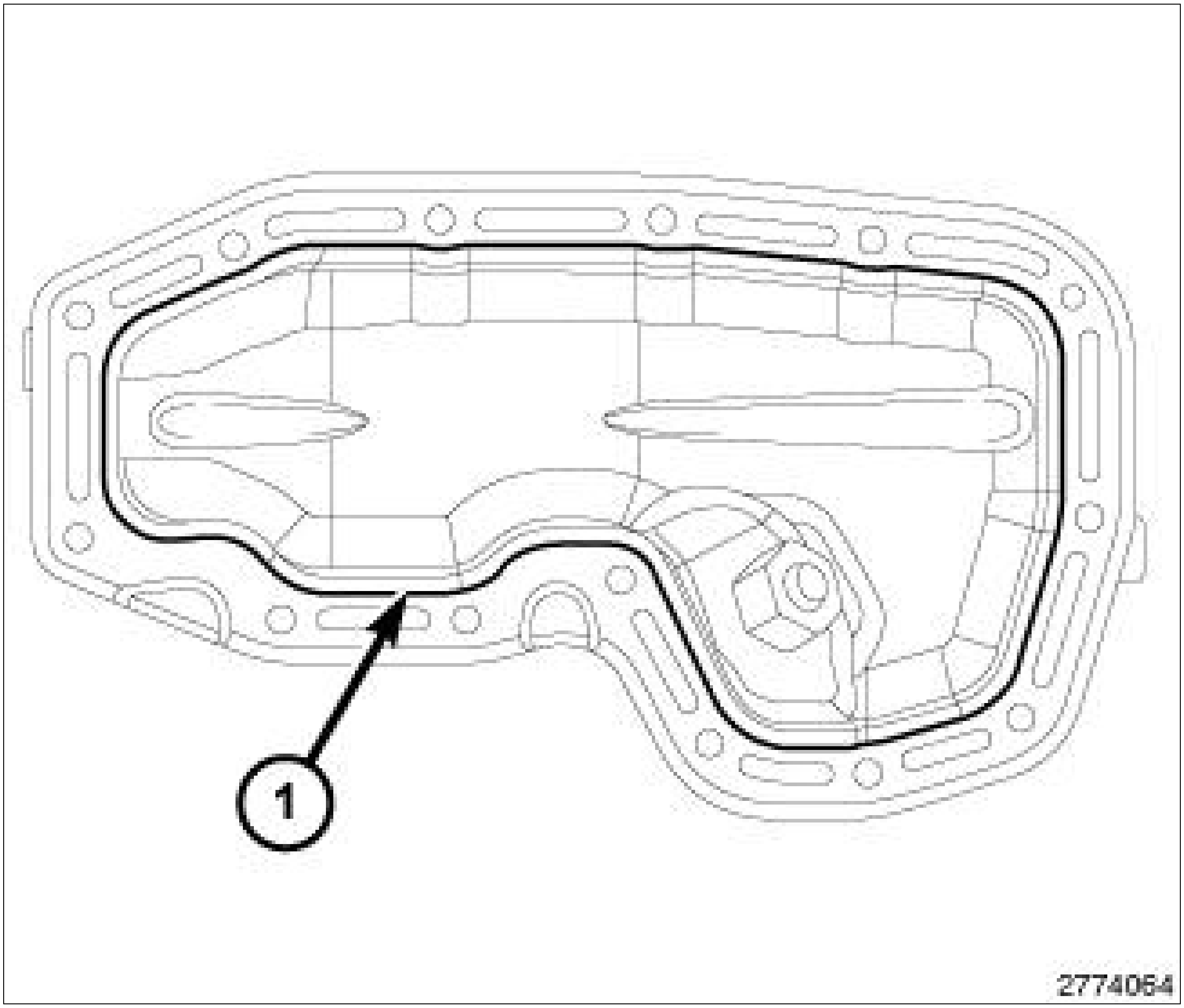


Courtesy of CHRYSLER GROUP, LLC

1. Clean the oil pan in solvent and wipe dry with a clean cloth.
2. Remove all residual sealant (1, 2, 3) from the upper and lower oil pans. Refer to ENGINE GASKET SURFACE PREPARATION .

LUBRICATION > PAN, OIL > INSTALLATION > LOWER OIL PAN

Fig 1: Mopar® Threebond Engine RTV Sealant Location



Courtesy of CHRYSLER GROUP, LLC

1. Clean the upper and lower oil pan mating surfaces with isopropyl alcohol in preparation for sealant application. Refer to CLEANING .

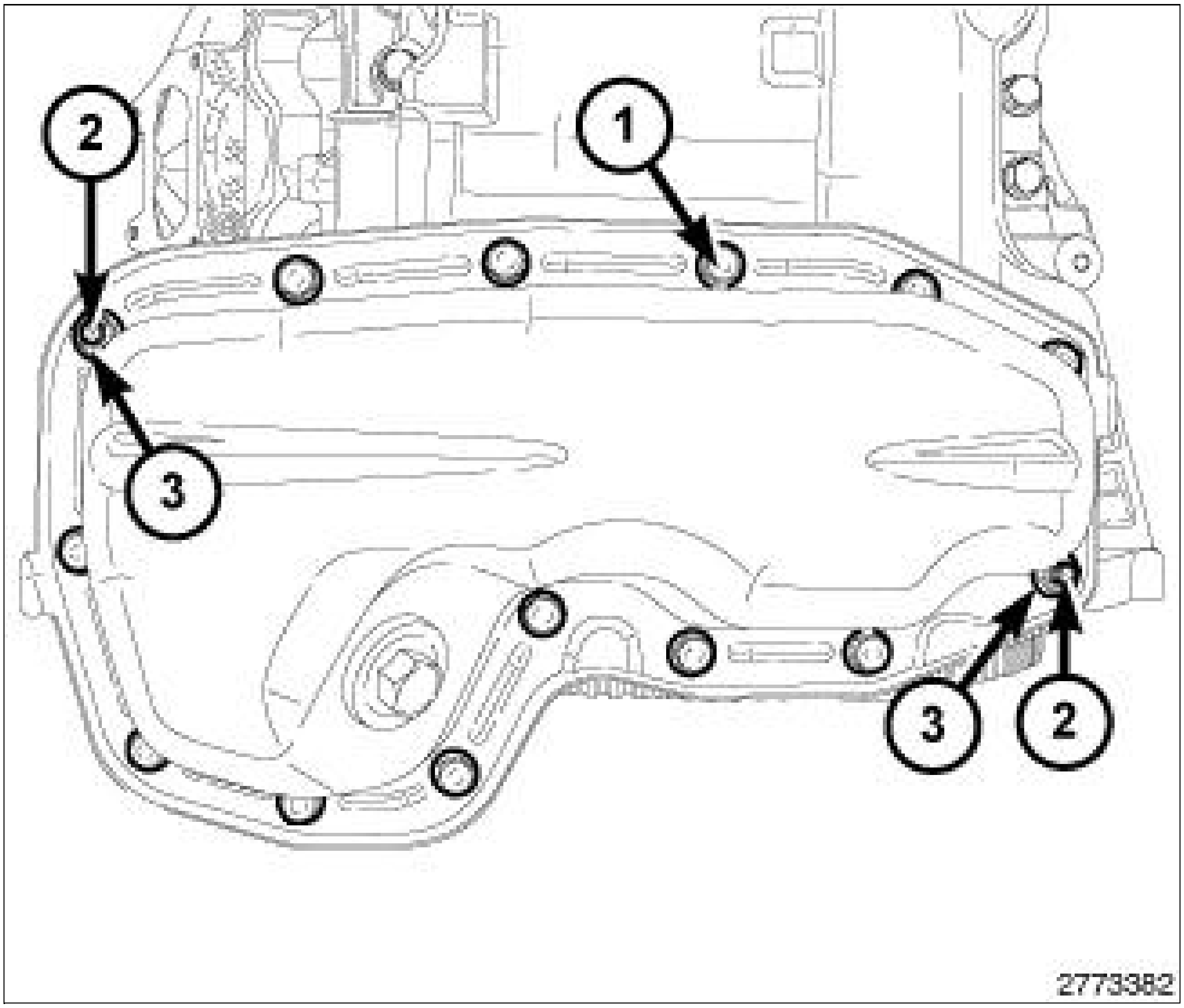
> *CAUTION:*
>
> *Engine assembly requires the use of a unique sealant that is compatible with engine oil. Using a sealant other than Mopar® Threebond Engine RTV Sealant may result in engine fluid leakage.*

> *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 2: 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 to the upper oil pan with twelve bolts (1) and two nuts (3) tightened to 10.5 N.m (93 in. lbs.).

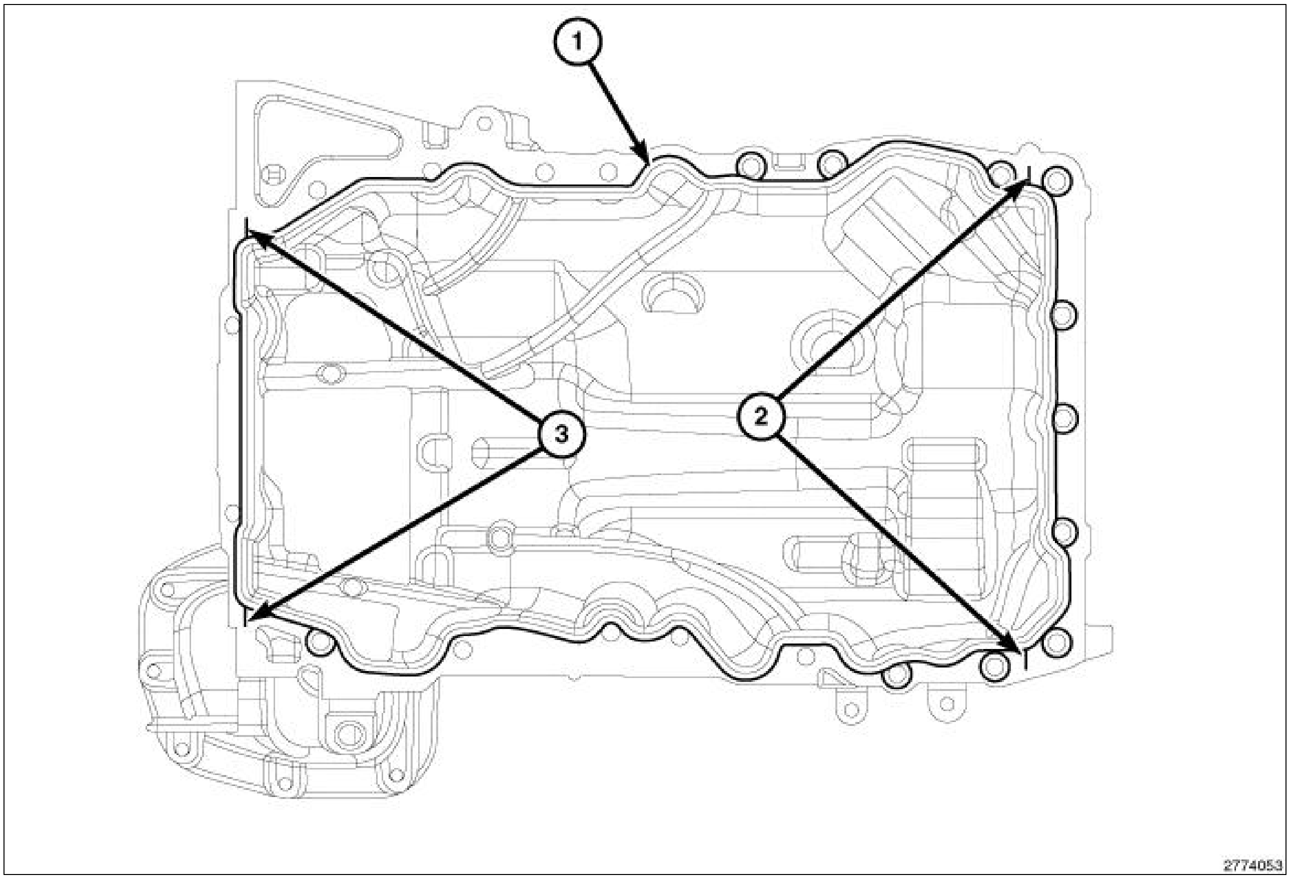
> ⚠ *CAUTION:*
>
> *Following assembly, the Mopar® Threebond Engine RTV Sealant must be allowed to dry for 45 minutes prior to adding oil and engine operation. Premature exposure to oil prior to drying may result in engine fluid leakage.*

5. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .

6. Run the engine until it reaches normal operating temperature.

LUBRICATION > PAN, OIL > INSTALLATION > UPPER

Fig 1: Mopar® Threebond Engine RTV Sealant Locations



Courtesy of CHRYSLER GROUP, LLC

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.

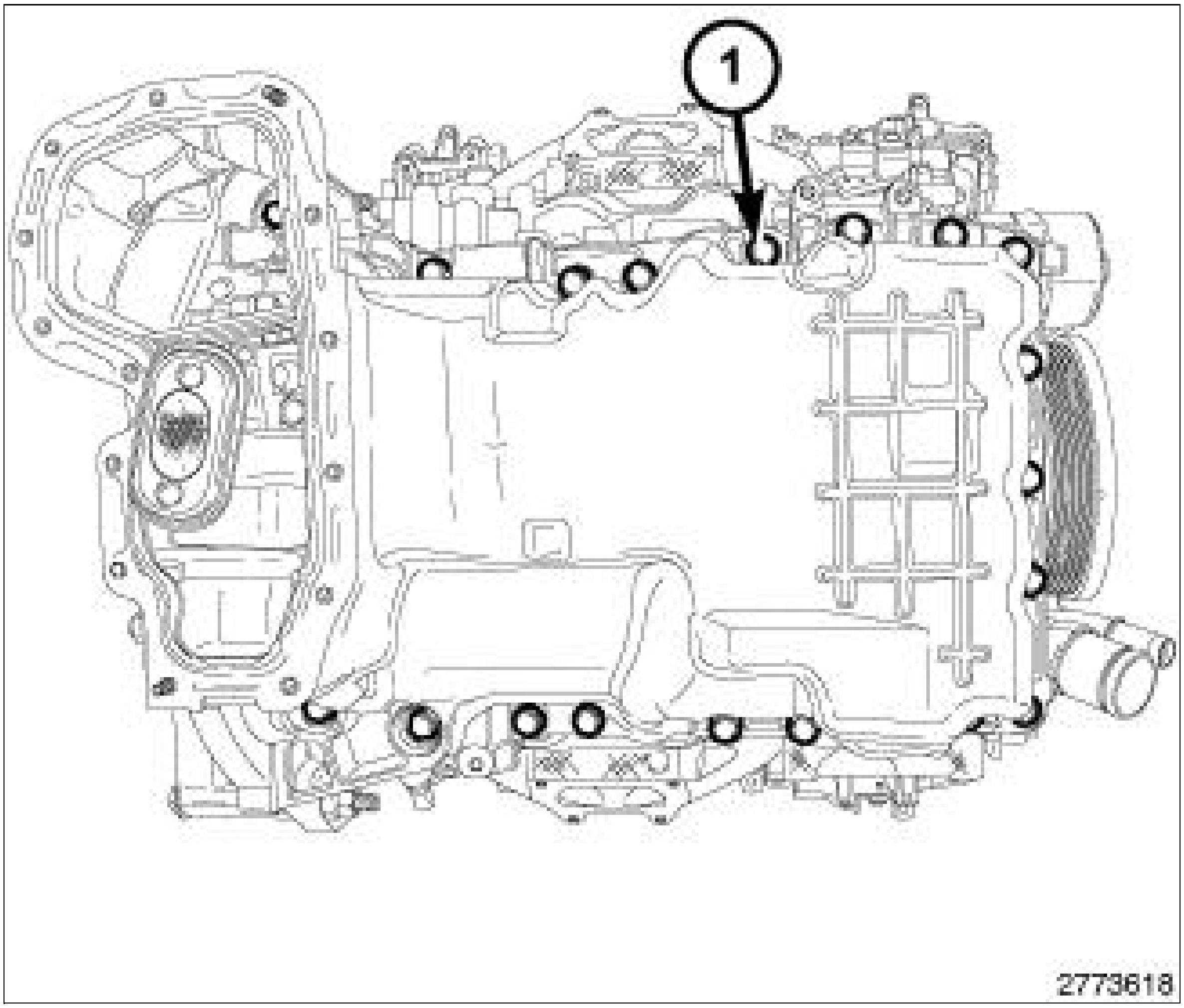
> *CAUTION:*
>
> *Engine assembly requires the use of a unique sealant that is compatible with engine oil. Using a sealant other than Mopar® Threebond Engine RTV Sealant may result in engine fluid leakage.*

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 3 to 4 mm wide bead of Mopar® Threebond Engine RTV Sealant next to the chamfer of the upper oil pan as shown in illustration in the following locations:
    1. Oil pan to engine block flange (1)
    2. Two timing cover to engine block T-joints (2)
    3. Two rear seal retainer to engine block T-joints (3)

Fig 2: Oil Pan Mounting Bolts



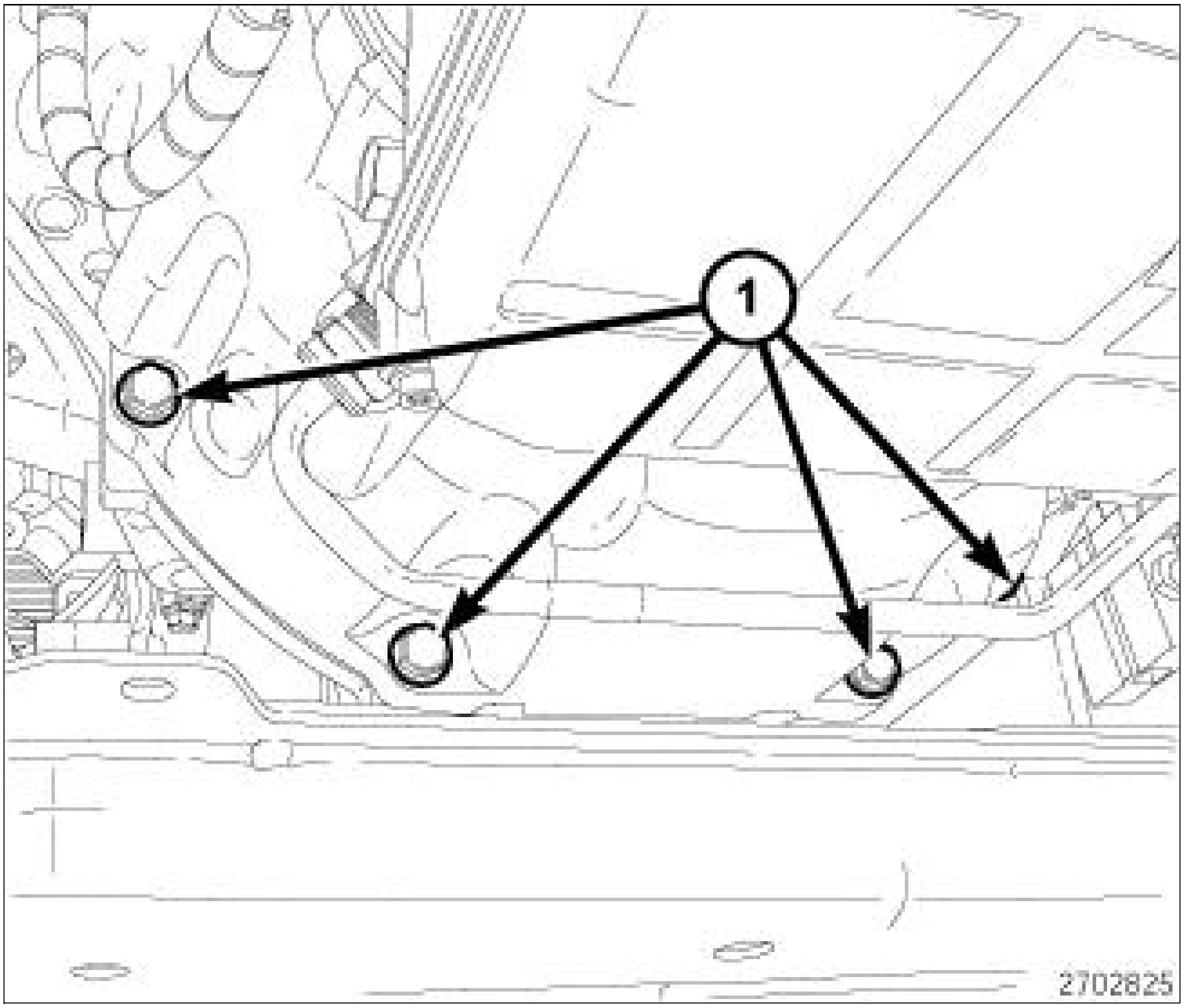
Courtesy of CHRYSLER GROUP, LLC

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.

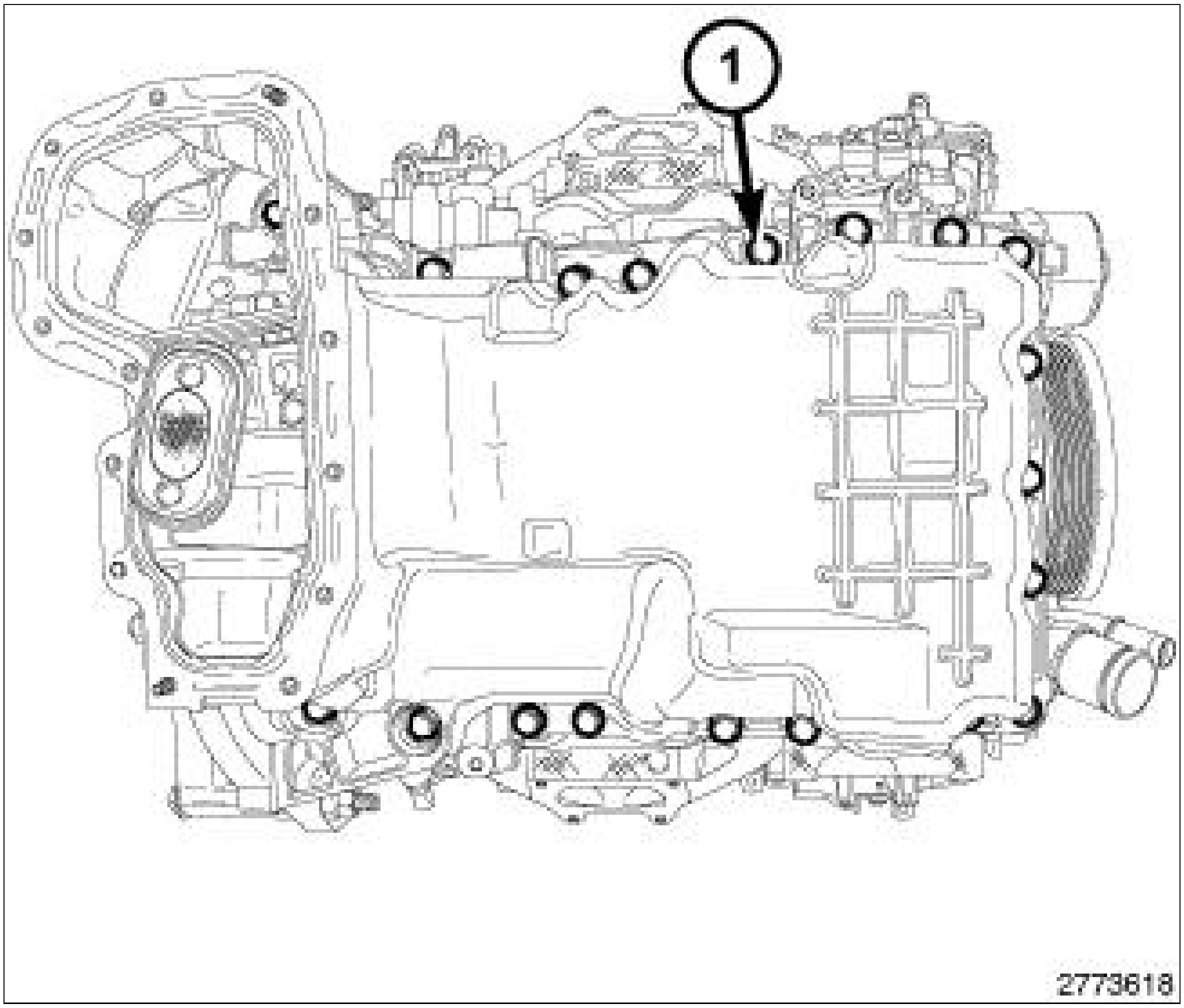
Fig 3: Transmission-To-Engine Oil Pan Bolts



Courtesy of CHRYSLER GROUP, LLC

4. Install four transmission to the engine oil pan bolts (1) and tighten to 55 N.m (41 ft. lbs.).

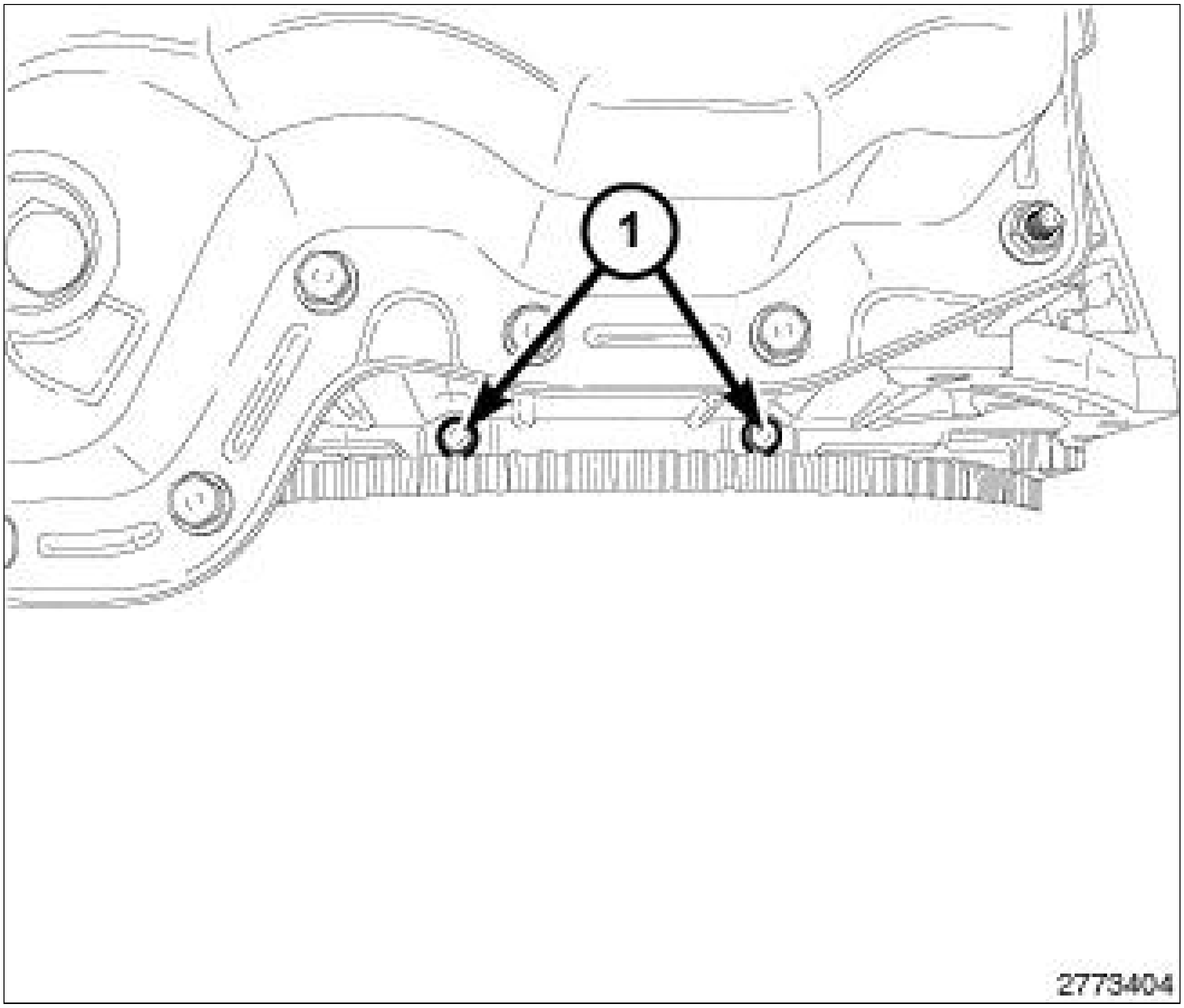
Fig 4: Oil Pan Mounting Bolts



Courtesy of CHRYSLER GROUP, LLC

5. Tighten the nineteen previously installed M8 oil pan mounting bolts (1) to 25 N.m (18 ft. lbs.).

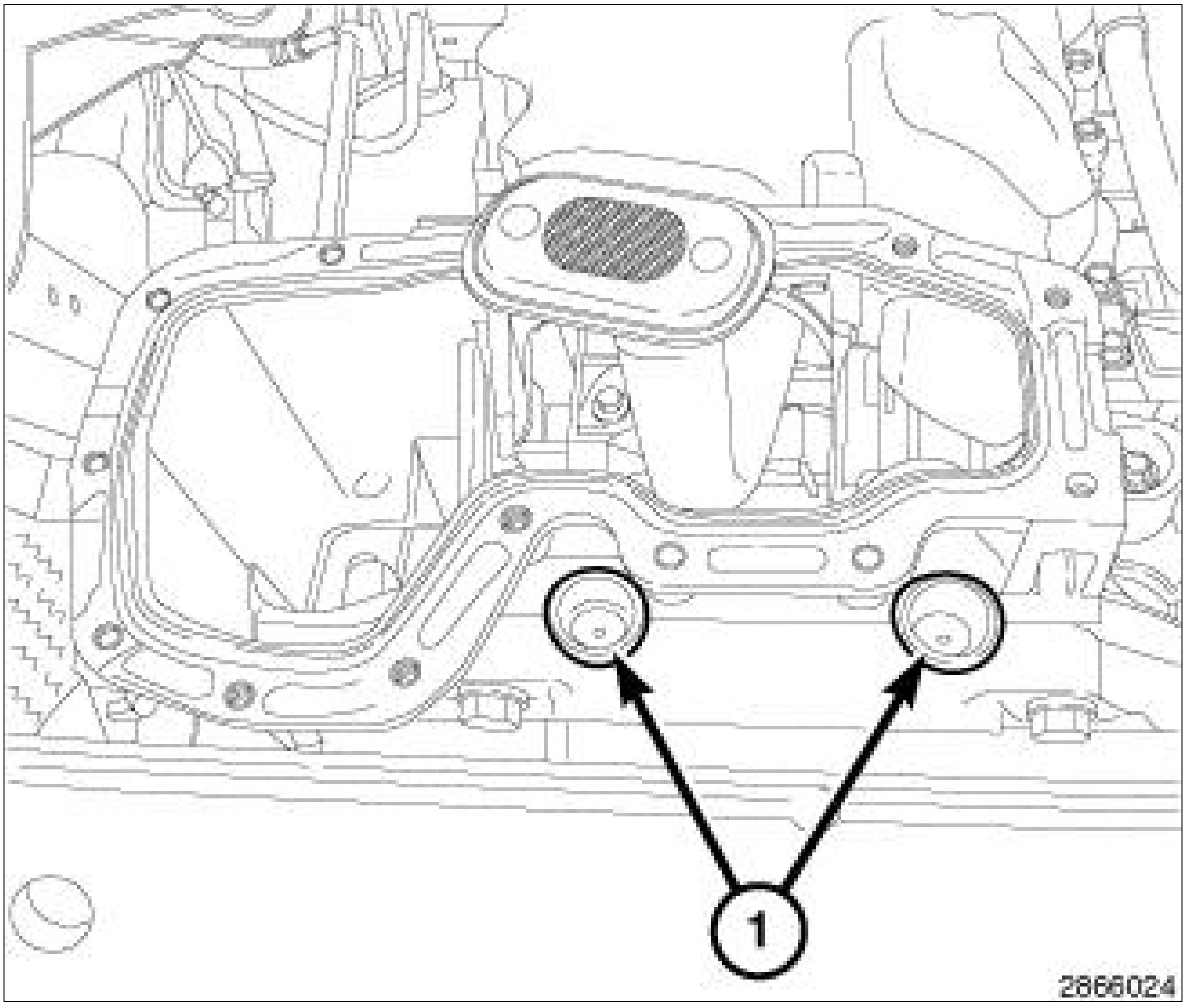
Fig 5: Rear Oil Seal Retainer Flange Bolts



Courtesy of CHRYSLER GROUP, LLC

6. Install two M6 bolts (1) to the rear oil seal retainer flange and tighten to 12 N.m (106 in. lbs.).

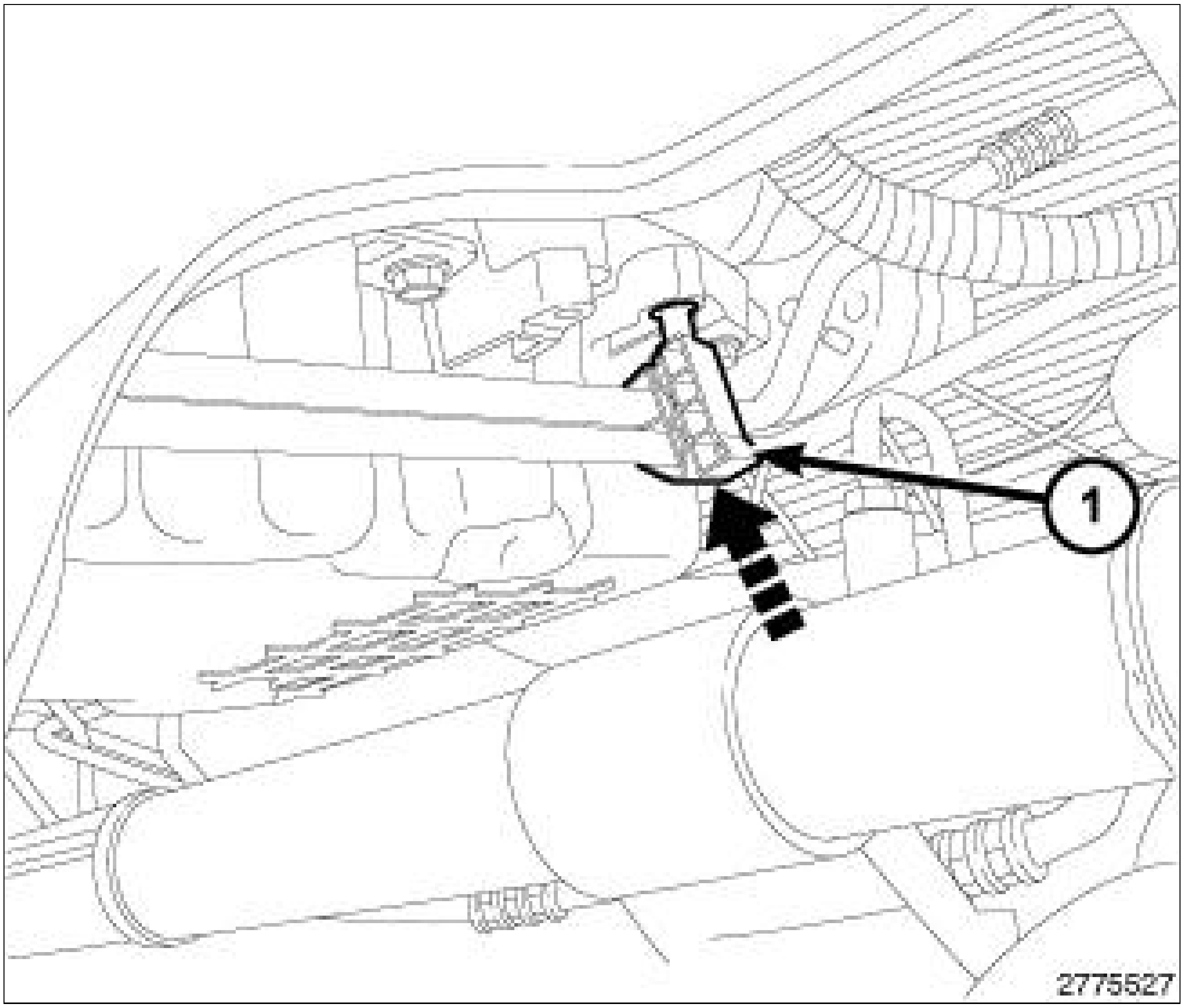
Fig 6: Rubber Plugs



Courtesy of CHRYSLER GROUP, LLC

7. Install two rubber plugs (1) covering the rear oil seal retainer flange bolts.

Fig 7: Transmission Cooler Line Retainer

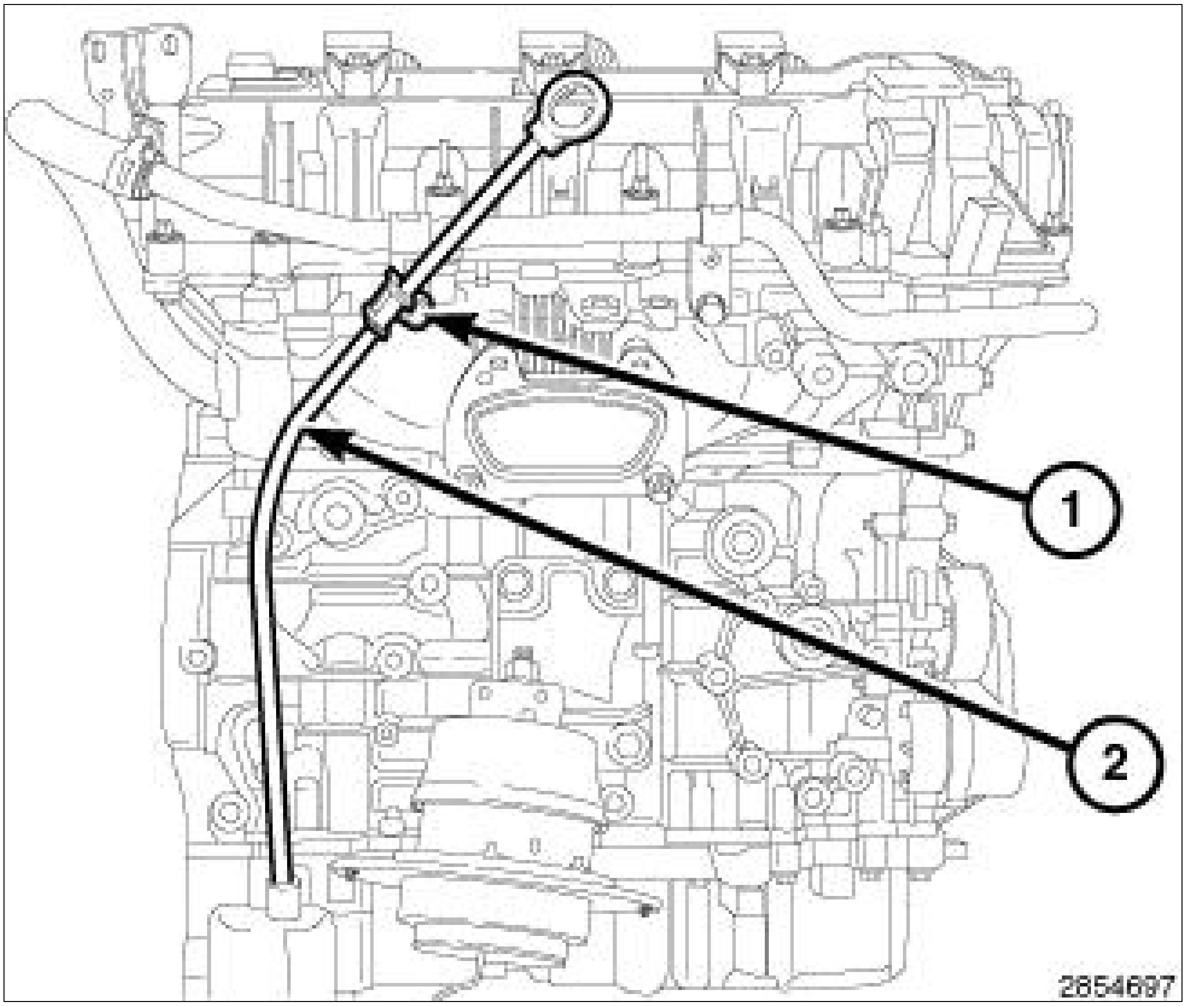


Courtesy of CHRYSLER GROUP, LLC

8. Clip the transmission cooler line retainer (1) to the oil pan flange.
9. Install the steering gear. Refer to GEAR, INSTALLATION .

   If equipped with AWD, install the front axle. Refer to INSTALLATION .
10. Install the lower oil pan. Refer to PAN, OIL, INSTALLATION .
11. Install the front skid plates, if equipped. Refer to PLATE, SKID, FRONT, INSTALLATION , PLATE, SKID, FRONT SUSPENSION, INSTALLATION , PLATE, SKID, FUEL TANK, INSTALLATION , PLATE, SKID, TRANSMISSION, INSTALLATION or PLATE, SKID, TRANSFER CASE, INSTALLATION .

Fig 8: Oil Level Indicator & Retaining Bolt



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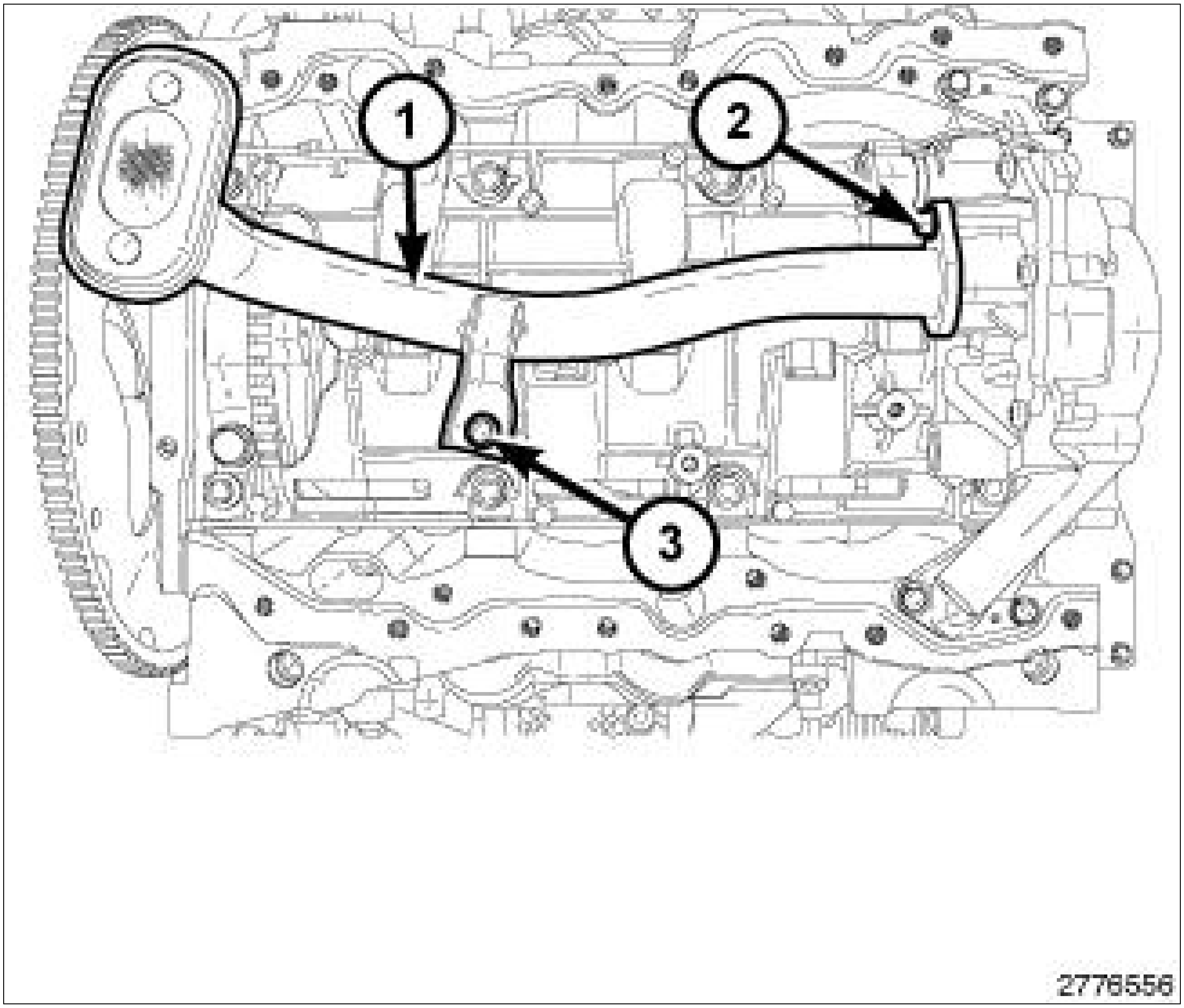
12. Lower the vehicle.
13. Install the oil level indicator (2) with bolt (1) tightened 12 N.m (106 in. lbs.).
14. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
15. Connect the negative battery cable.
16. Run the engine until it reaches normal operating temperature and then check for any leaks.

LUBRICATION > PICK-UP, OIL PUMP > REMOVAL > REMOVAL

Fig 1: Oil Pick-Up Tube & Bolts



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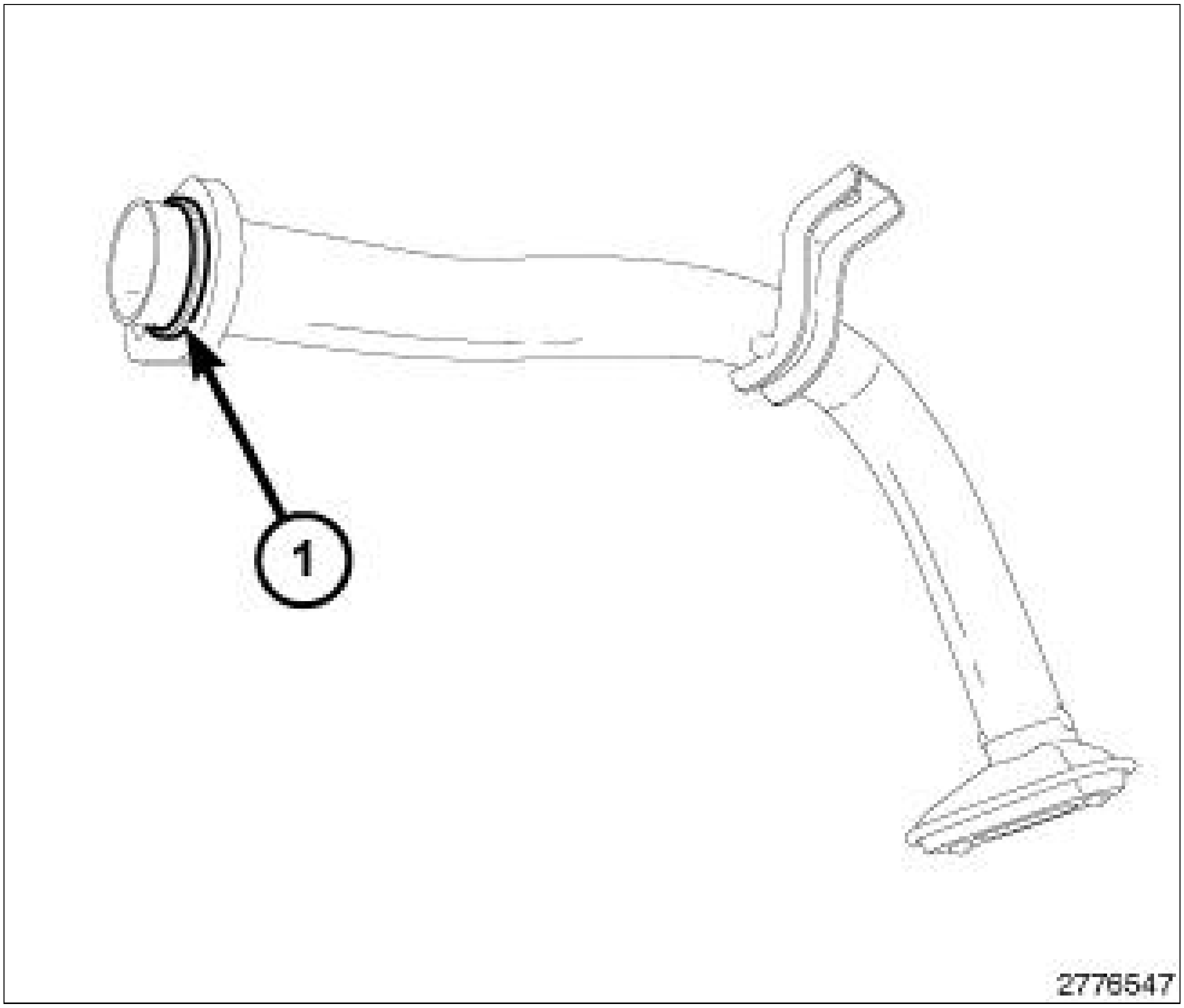
1. Disconnect and isolate the negative battery cable.
2. Remove the oil pan. Refer to PAN, OIL, REMOVAL .
3. Remove the bolt (3) from the oil pump pick-up tube support bracket.
4. Remove the bolt (2) from the oil pick-up tube and remove the oil pick-up tube (1) from the oil pump.

Fig 2: Oil Pick-Up Tube O-Ring Seal

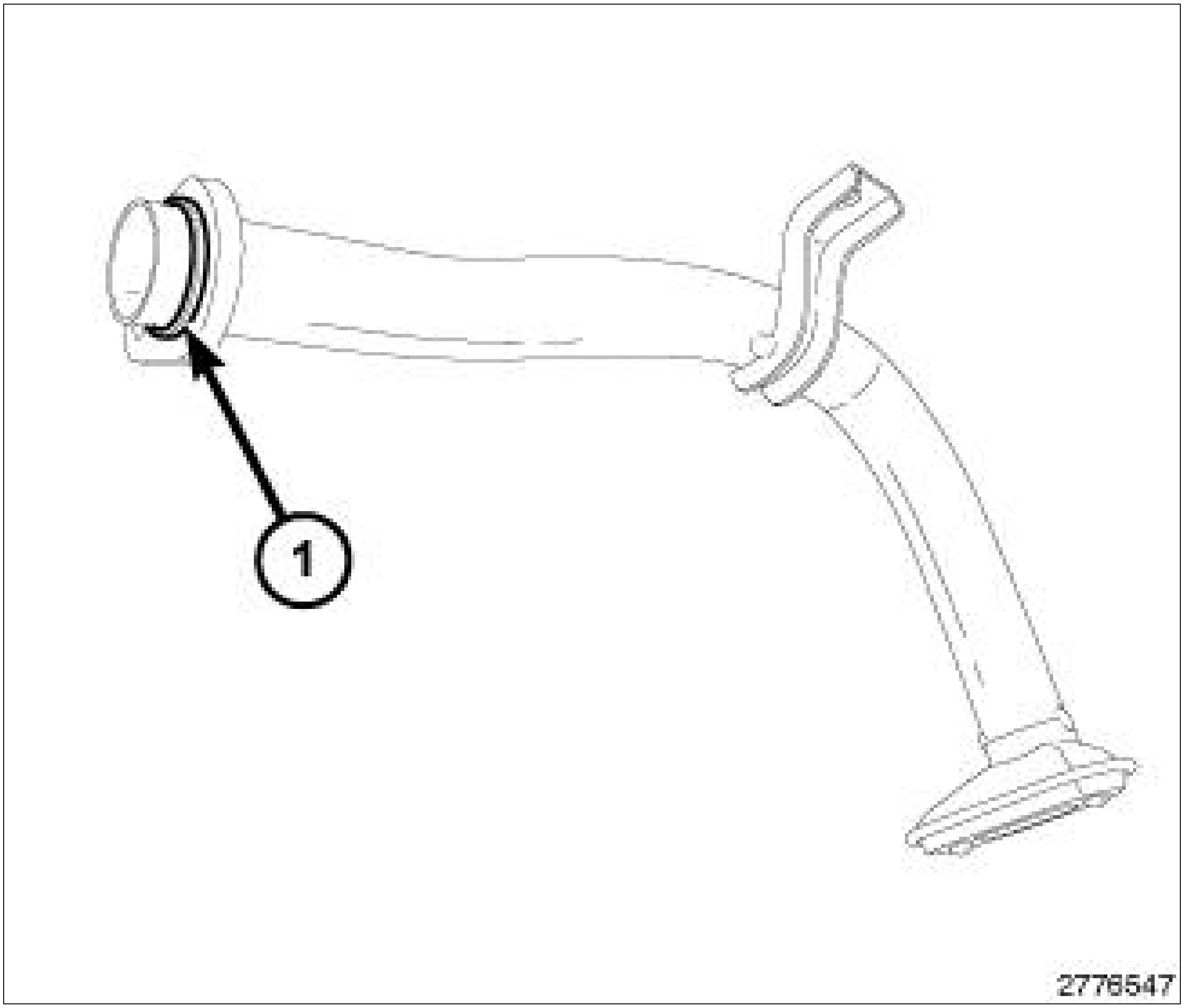


Courtesy of CHRYSLER GROUP, LLC

5. Remove and discard the O-ring seal (1) from the oil pick-up tube.

LUBRICATION > PICK-UP, OIL PUMP > INSTALLATION > INSTALLATION

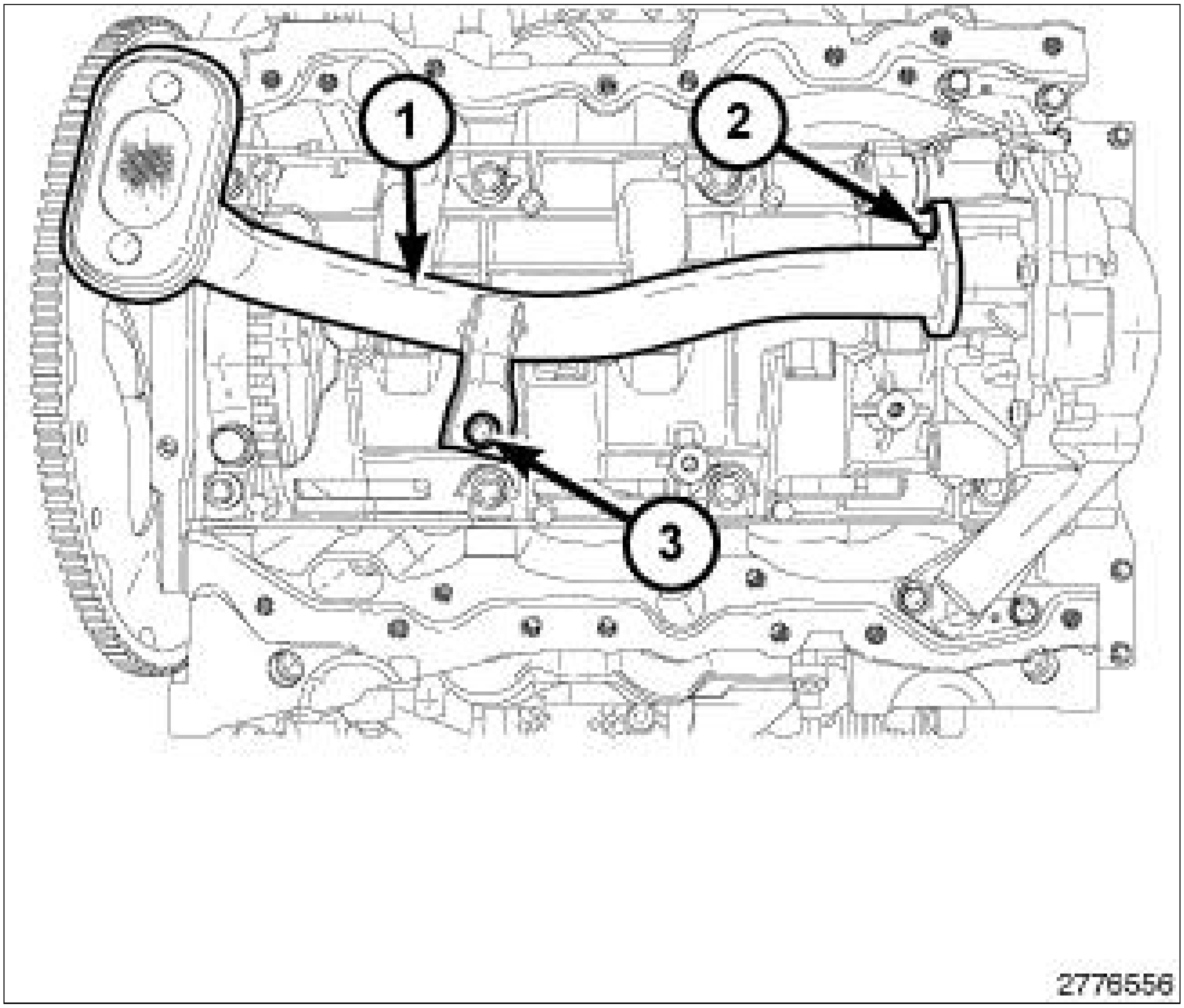
Fig 1: Oil Pick-Up Tube O-Ring Seal



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.

Fig 2: Oil Pick-Up Tube & Bolts

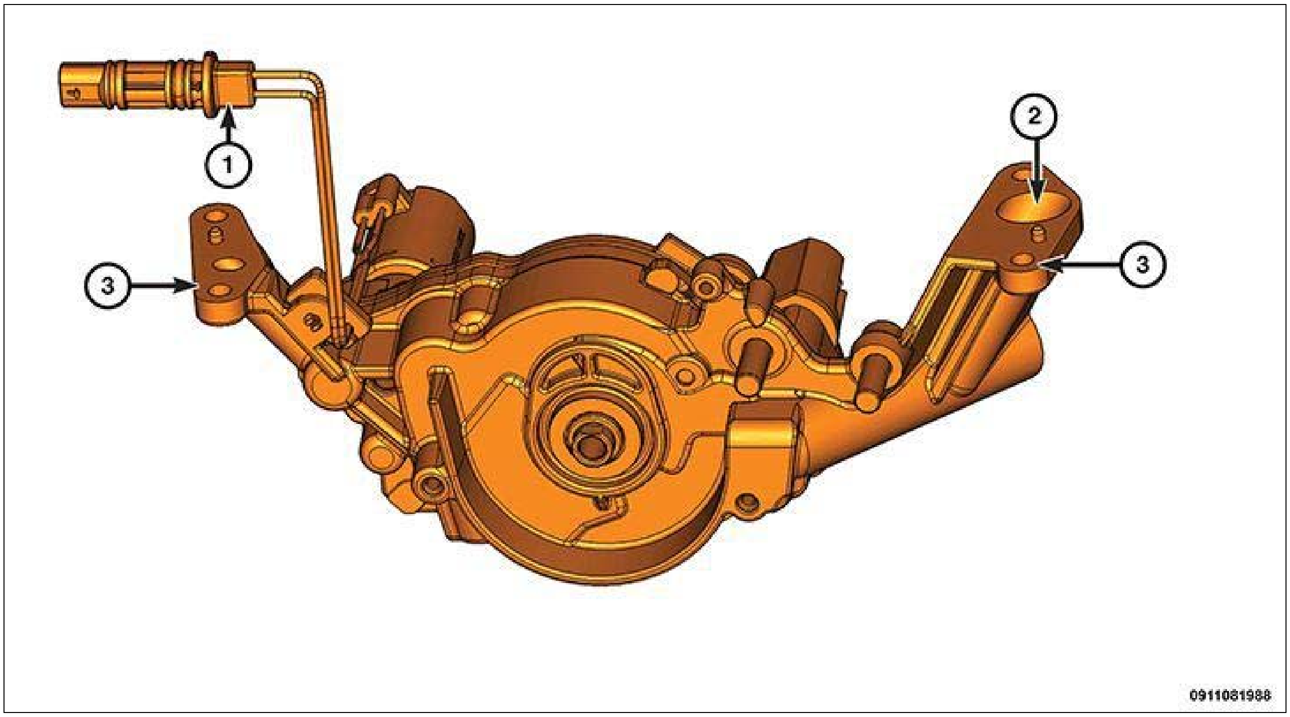


Courtesy of CHRYSLER GROUP, LLC

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 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 STANDARD PROCEDURE .
5. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
6. Run the engine until it reaches normal operating temperature.

LUBRICATION > PUMP, ENGINE OIL > DESCRIPTION > DESCRIPTION

Fig 1: Engine Oil Pump



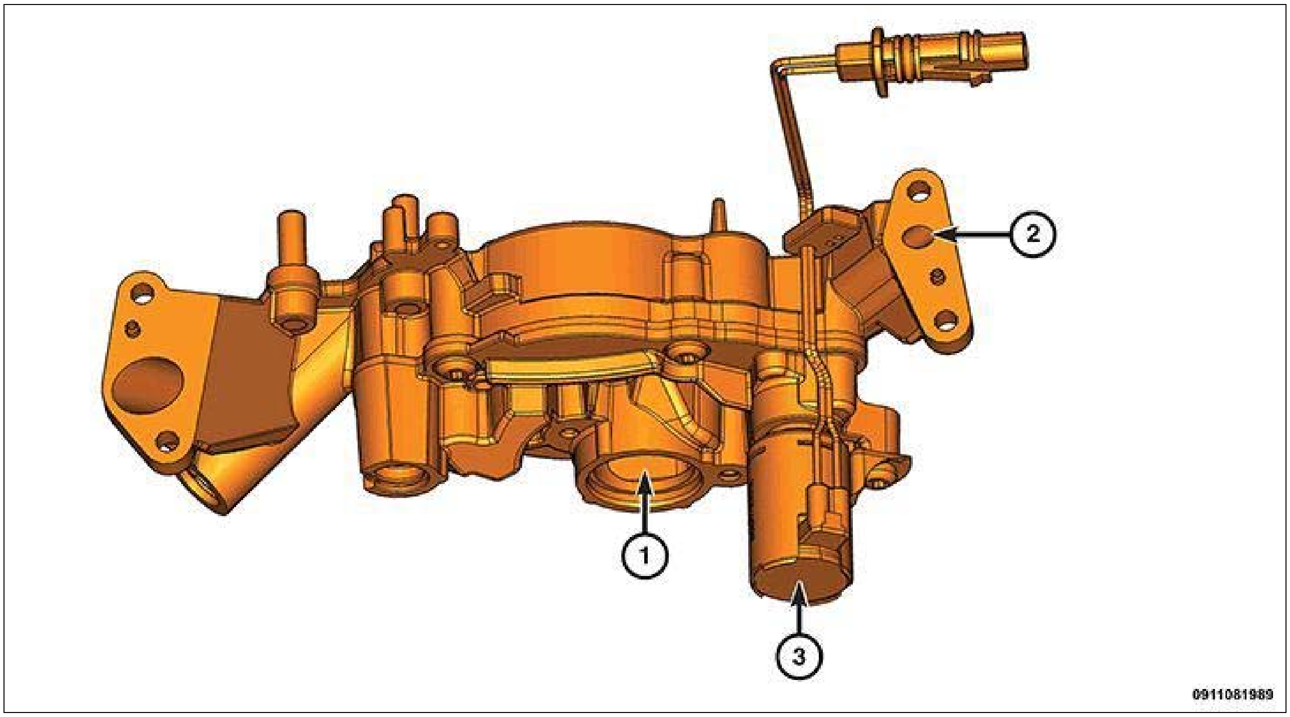
Courtesy of CHRYSLER GROUP, LLC

The vane type engine oil pump (2) is mounted to the underside of the cylinder block (3) and is driven by the oil pump chain off the crankshaft at a 1.15:1 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 components are non-serviceable items and are to be replaced as a complete assembly.

LUBRICATION > PUMP, ENGINE OIL > OPERATION > OPERATION

Fig 1: Engine Oil Pump, Moving Element & On/Off Solenoid



Courtesy of CHRYSLER GROUP, LLC

Oil pump operation as follows:

- The engine oil pump (2) 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 (3).
- 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.
- 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.

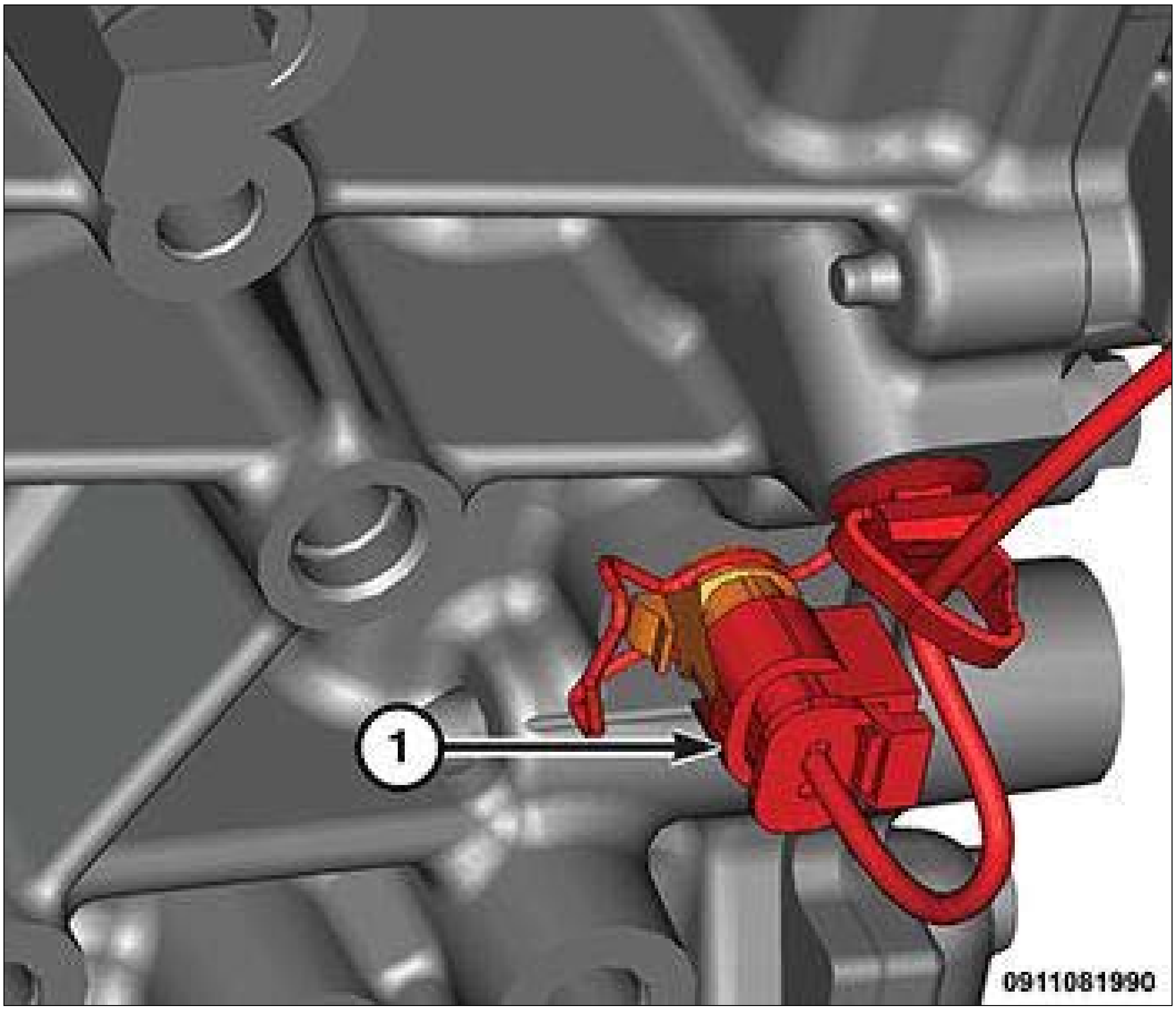
In high pressure mode regulation (solenoid off) main gallery oil pressure is applied to the moving element). The main gallery oil pressure works against spring pressure to move the element to a more concentric location about the pump driveshaft thus reducing displacement and pump output.

In low pressure mode regulation (solenoid on) the energized solenoid changes internal spring position to main gallery oil pressure increasing the force on the spring to further reduce displacement and output pressure.

LUBRICATION > PUMP, ENGINE OIL > REMOVAL > REMOVAL

1. Disconnect and isolate the negative battery cable.
2. Remove the oil pump pick-up. Refer to PICK-UP, OIL PUMP, REMOVAL .

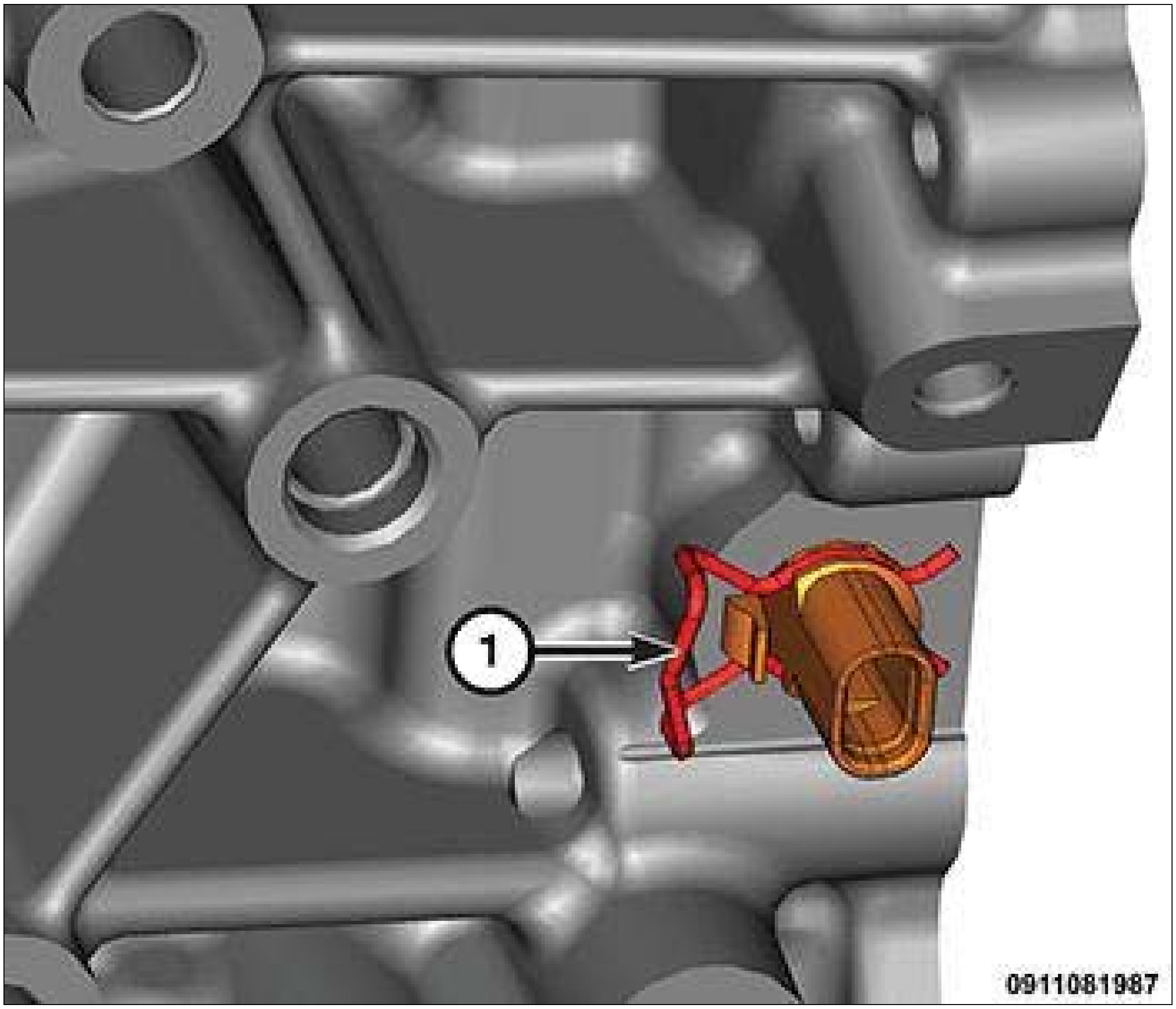
   Fig 1: Oil Pump Solenoid Wire Harness Connector

   Courtesy of CHRYSLER GROUP, LLC

3. Disconnect the engine wire harness from the oil pump solenoid wire harness connector (1).

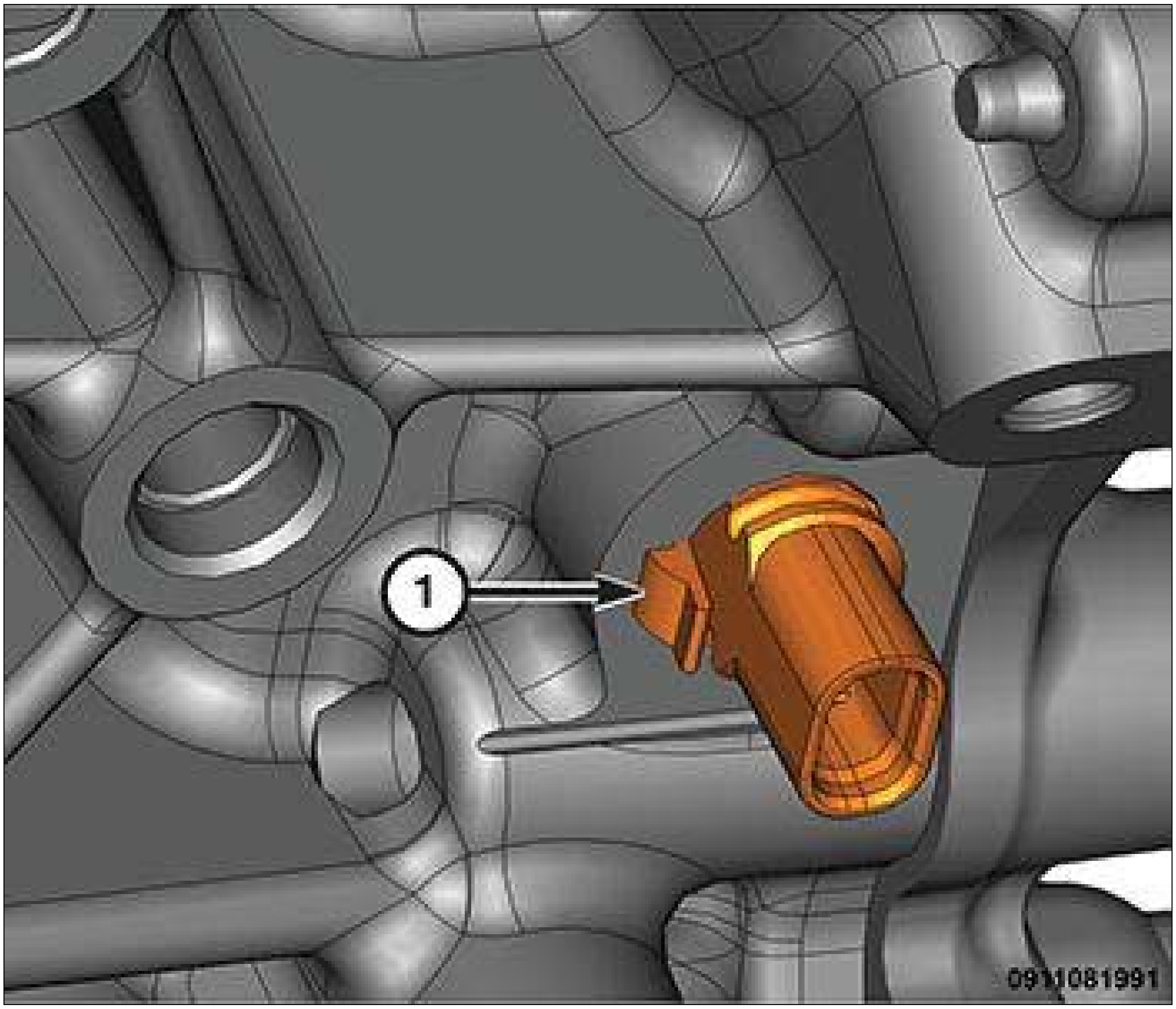
Fig 2: Oil Pump Solenoid Connector Retainer



Courtesy of CHRYSLER GROUP, LLC

4. Remove the oil pump solenoid connector retainer (1).

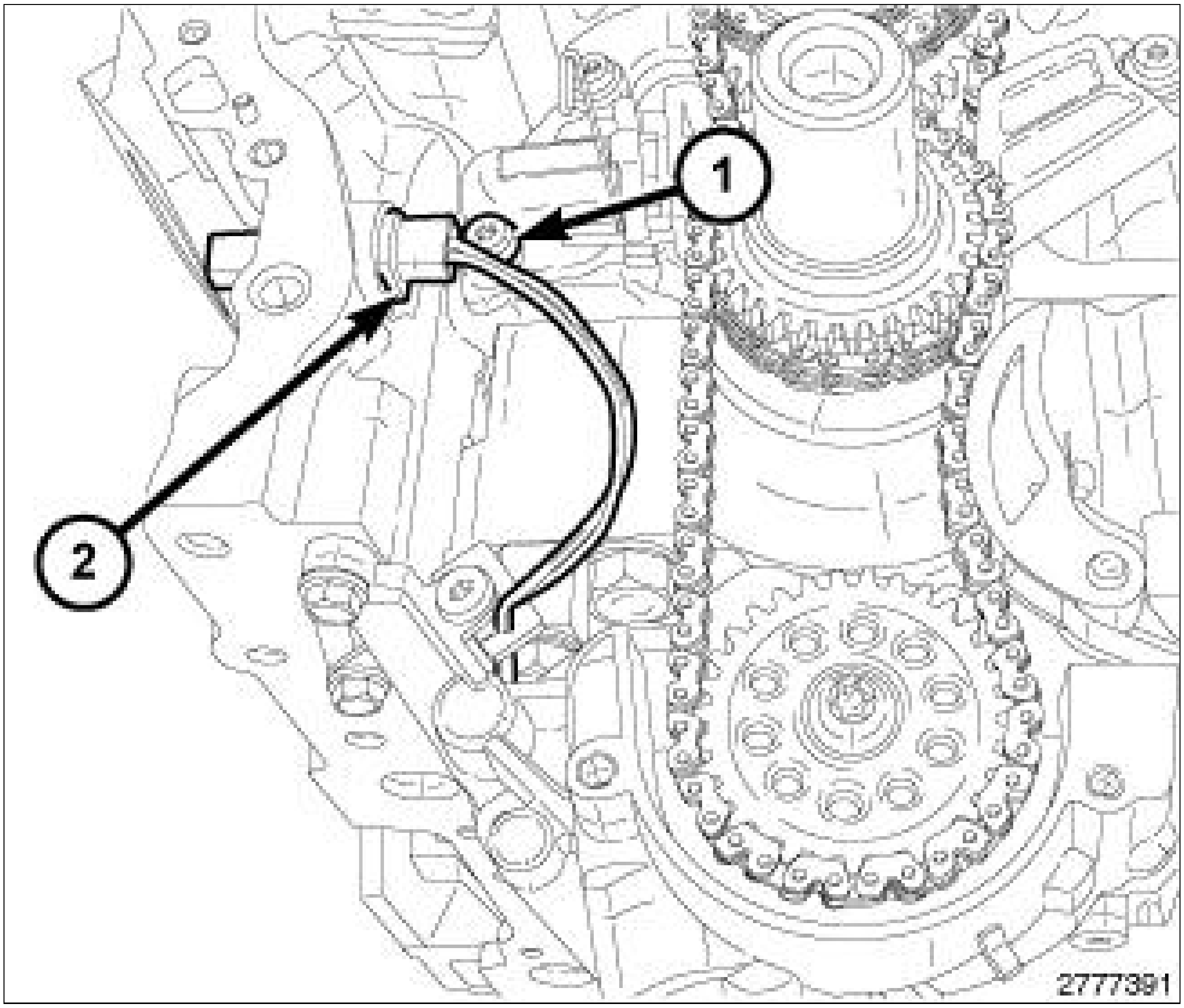
Fig 3: Oil Pump Solenoid Electrical Connector Retention Lock Tab



Courtesy of CHRYSLER GROUP, LLC

5. Depress the connector retention lock tab (1) to disengage the oil pump solenoid electrical connector from the engine block.

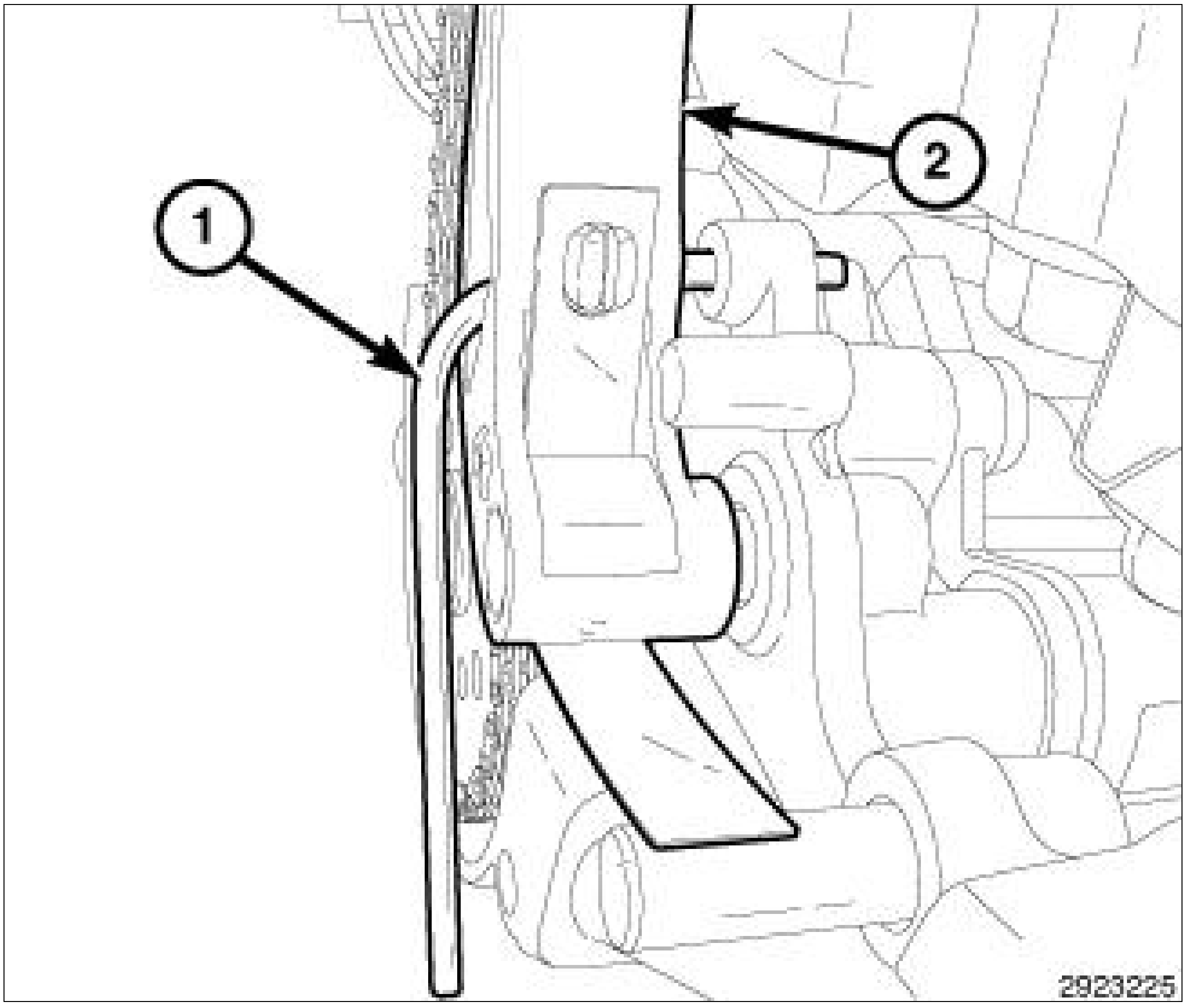
Fig 4: Oil Pump Solenoid Electrical Connector & Primary Chain Tensioner Mounting Bolt



Courtesy of CHRYSLER GROUP, LLC

6. 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.

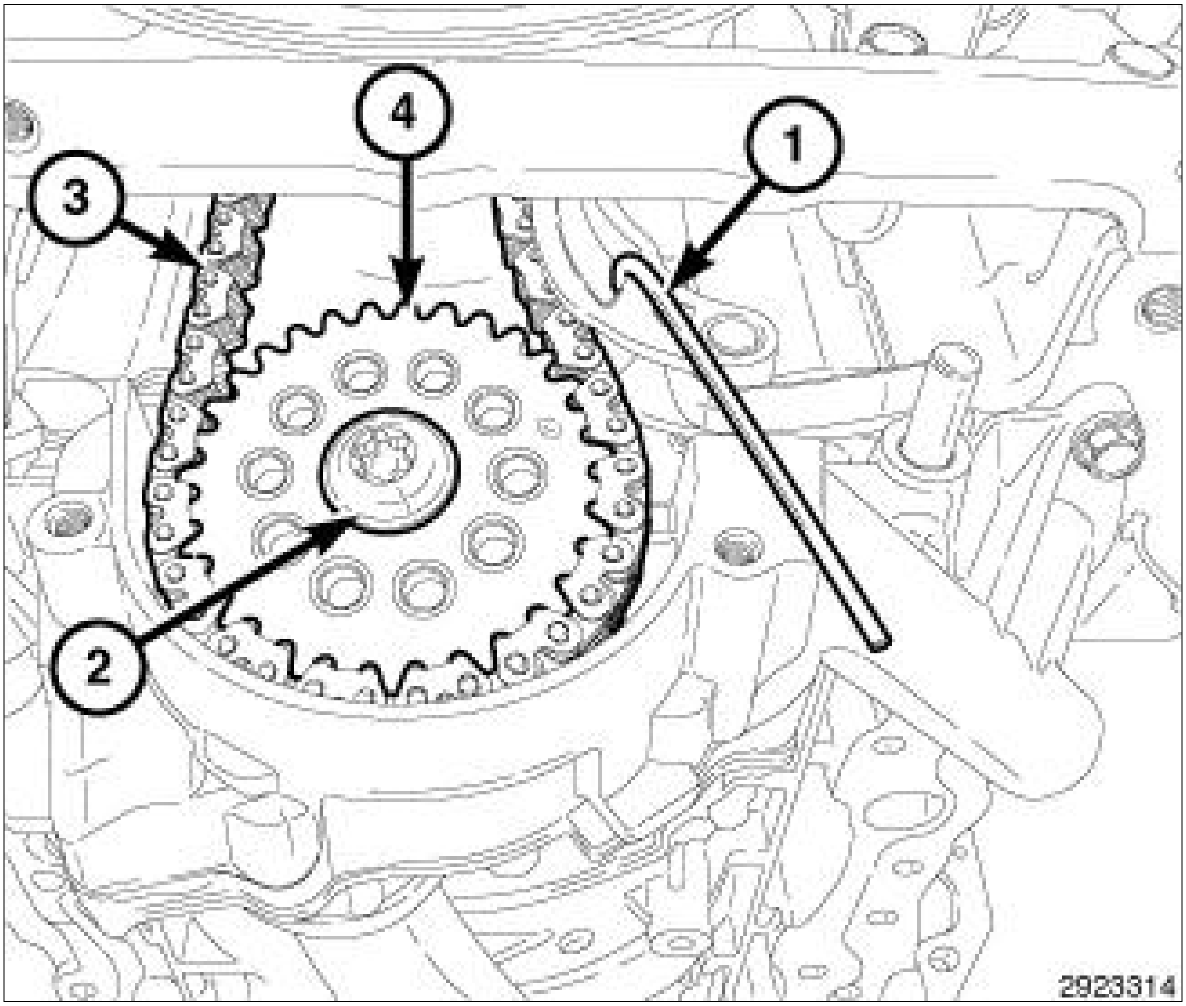
Fig 5: Oil Pump Chain Tensioner & Retaining Pin



Courtesy of CHRYSLER GROUP, LLC

7. Push back the oil pump chain tensioner (2) and insert a suitable retaining pin (1) such as a 3 mm Allen wrench.

Fig 6: 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.

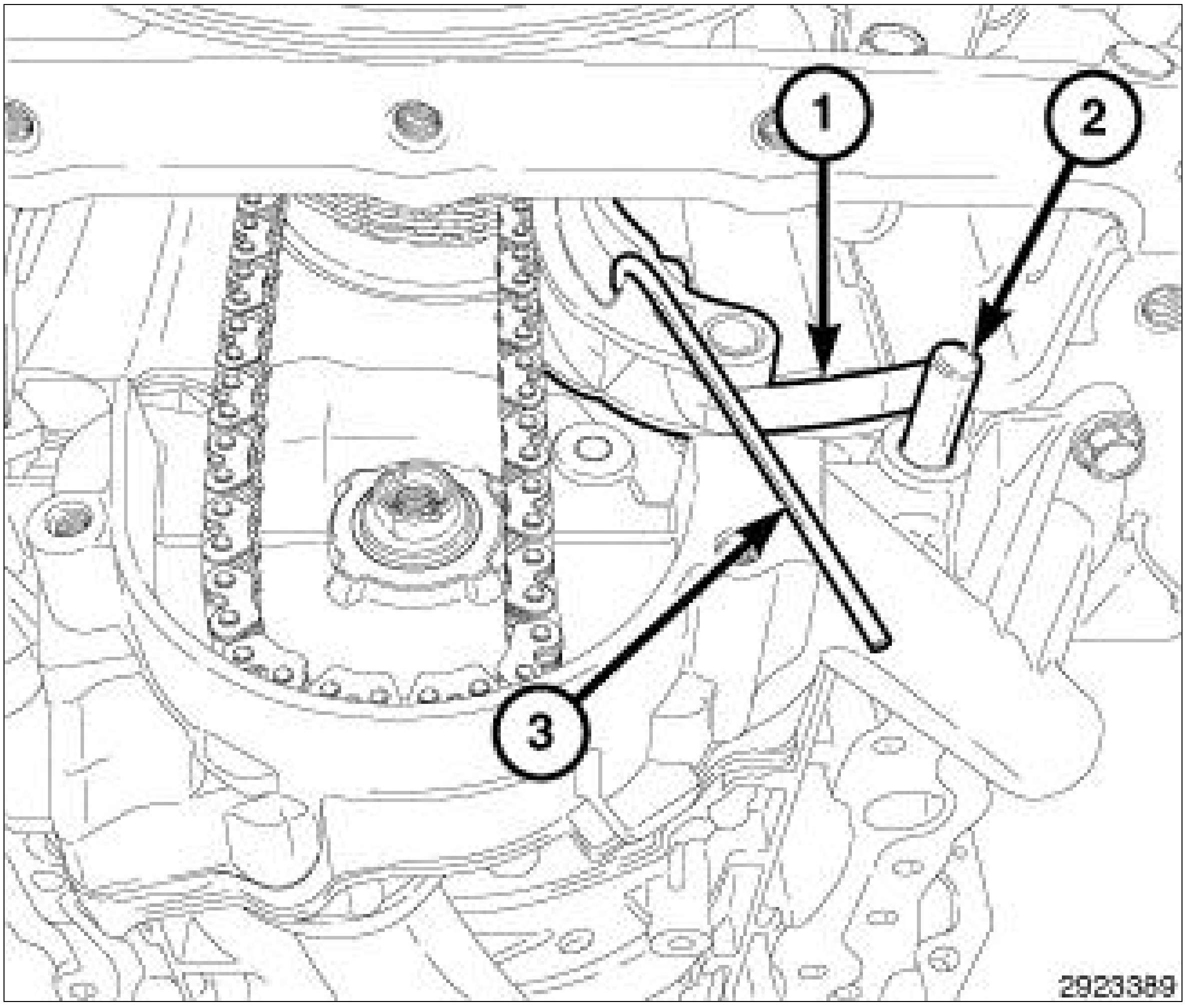
8. Mark the direction of rotation on the oil pump chain (3) and sprocket (4) using a paint pen or equivalent to aid in reassembly.

NOTE:

There are no timing marks on the oil pump gear or chain. Timing of the oil pump is not required.

9. Remove the oil pump sprocket T45 retaining bolt (2) and remove the oil pump sprocket (4).

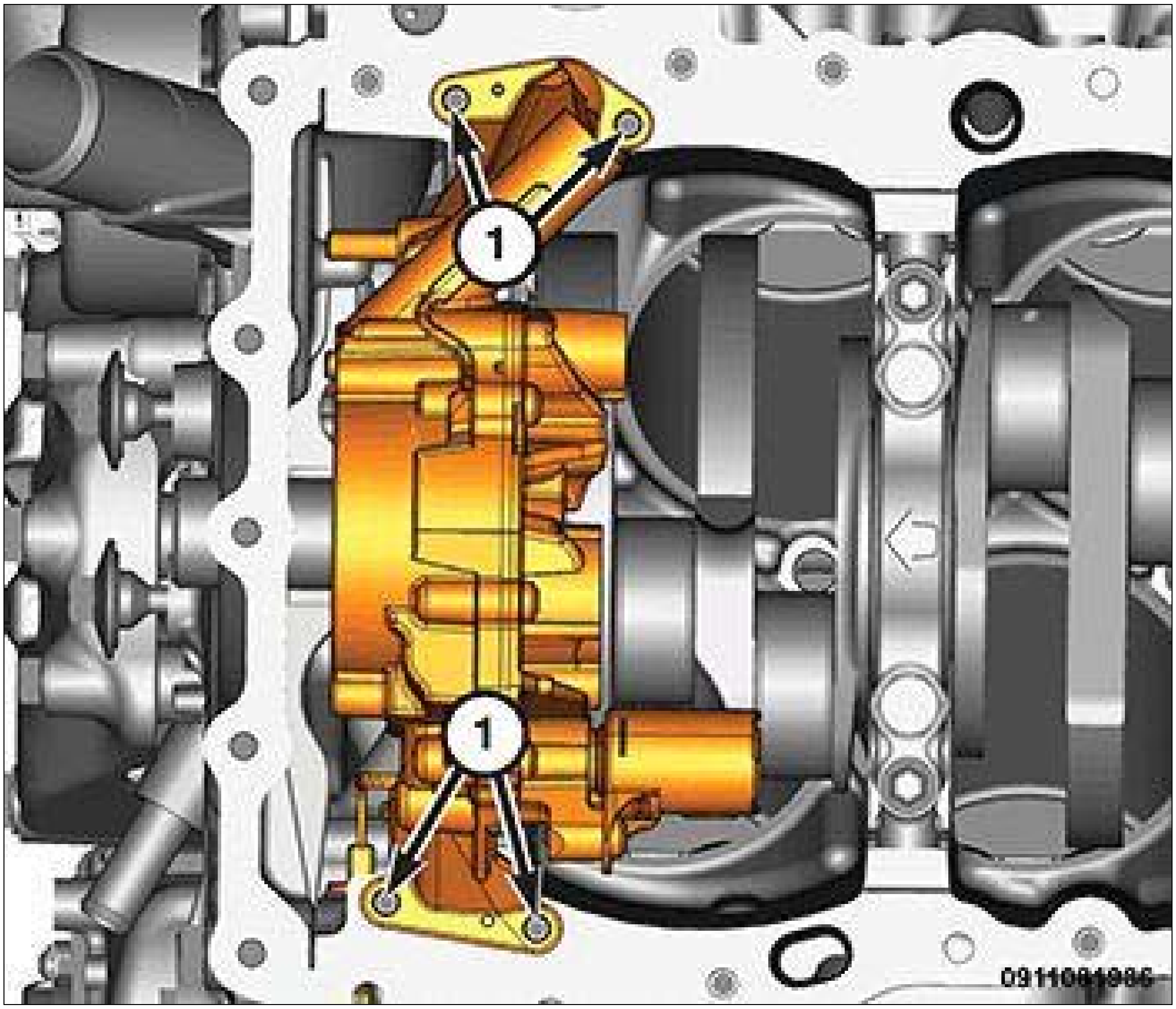
Fig 7: Retaining Pin, Oil Pump Chain Tensioner Spring & Dowel Pin



Courtesy of CHRYSLER GROUP, LLC

10. Remove the retaining pin (3) and disengage the oil pump chain tensioner spring (1) from the dowel pin (2).
11. Remove the oil pump chain tensioner from the oil pump.

Fig 8: Oil Pump Bolts

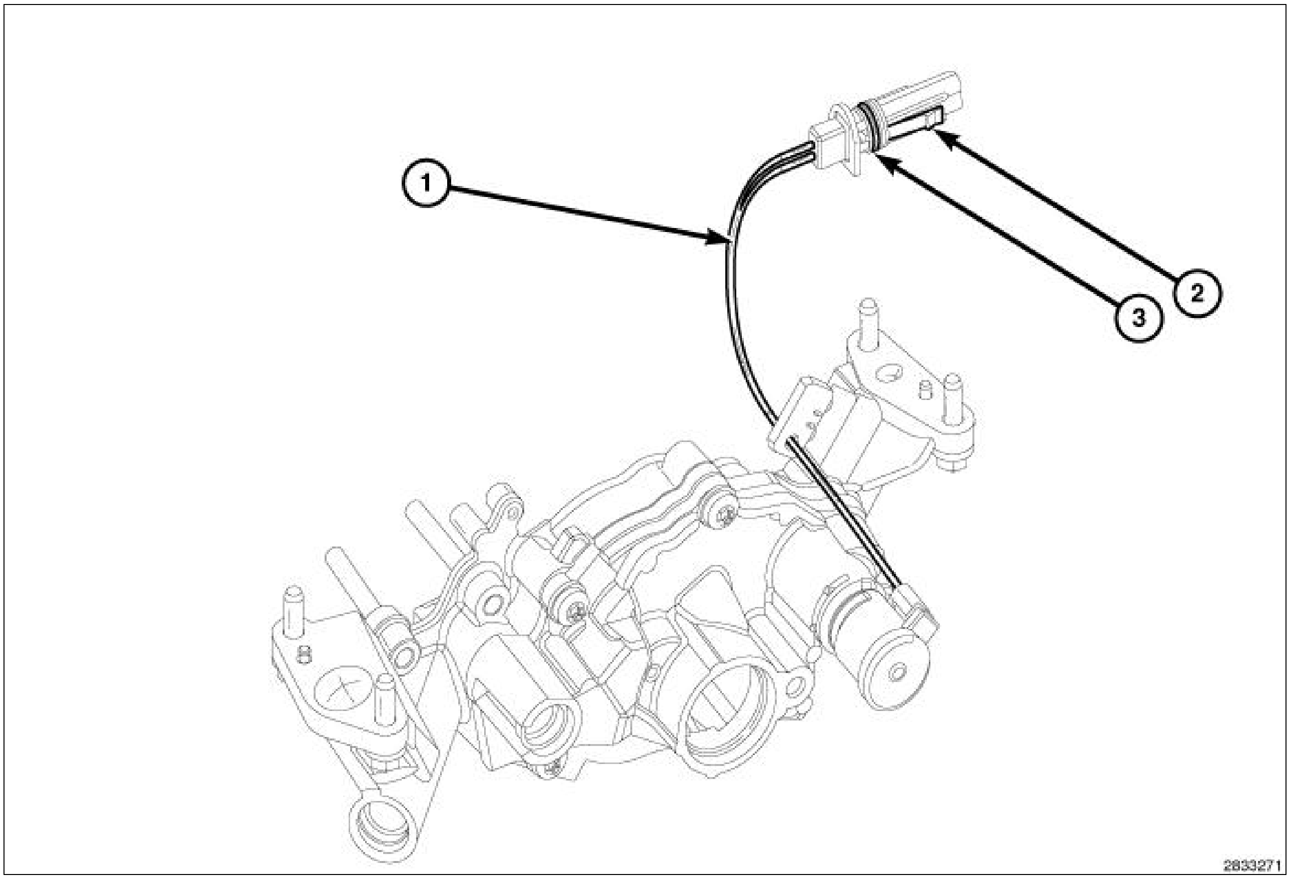


Courtesy of CHRYSLER GROUP, LLC

12. Remove the four oil pump bolts (1) and remove the oil pump.

LUBRICATION > PUMP, ENGINE OIL > INSPECTION > INSPECTION

Fig 1: Solenoid Wires, Connector Retention Lock Tab & O-Ring Seal



Courtesy of CHRYSLER GROUP, LLC

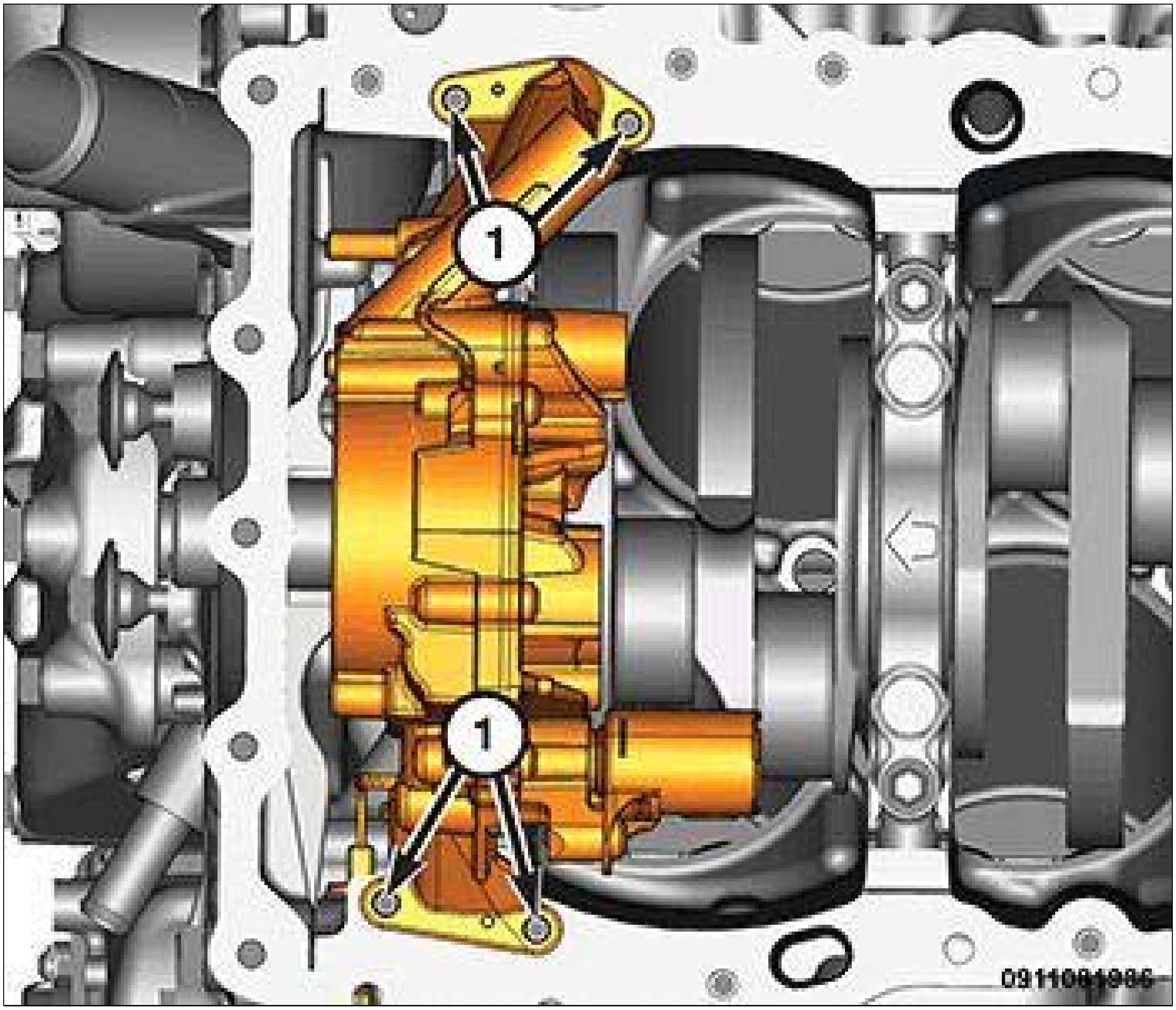
NOTE:

The 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 chafing.
2. Inspect the condition of the connector O-ring seal (3).

LUBRICATION > PUMP, ENGINE OIL > INSTALLATION > INSTALLATION

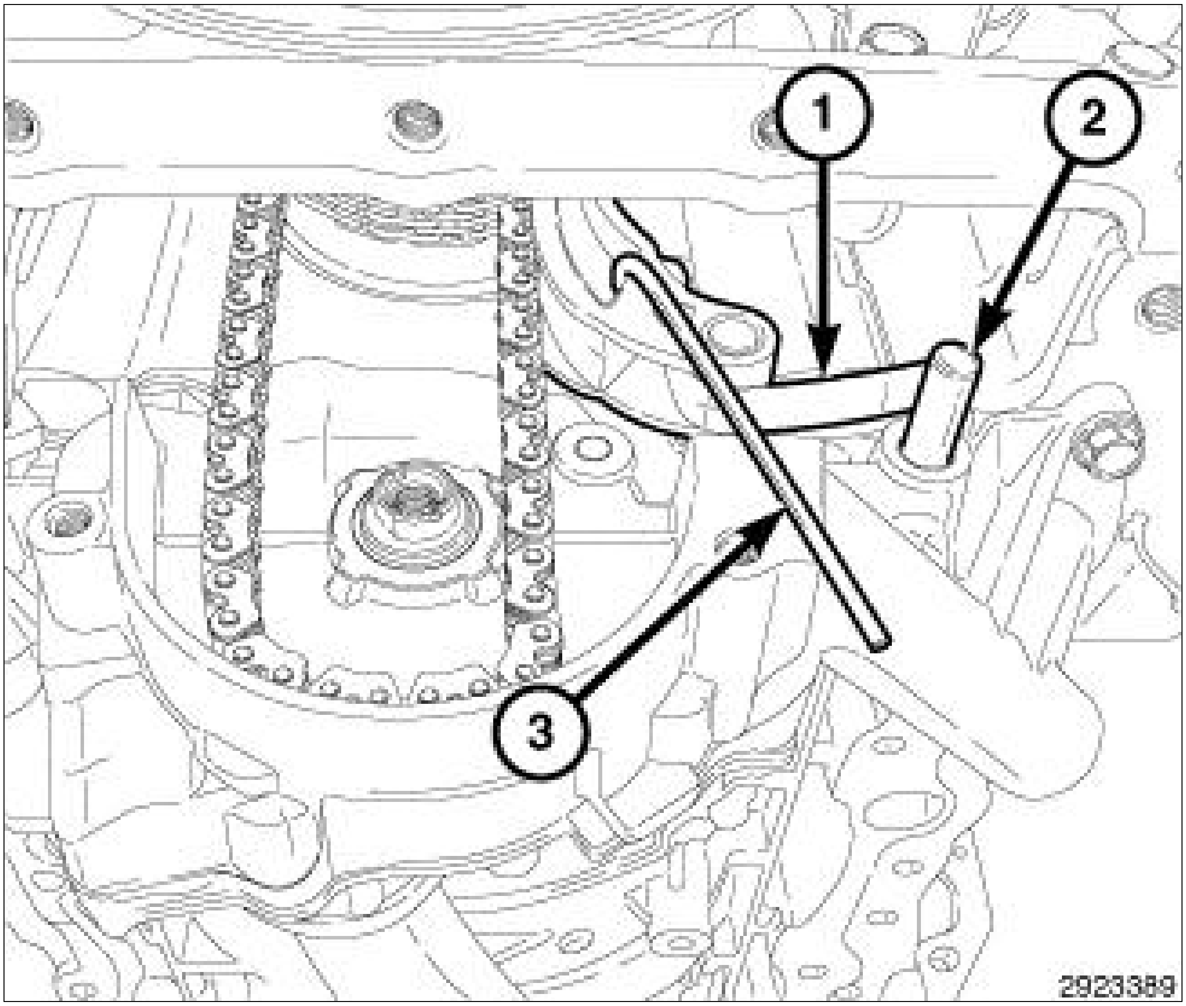
Fig 1: Oil Pump Bolts



Courtesy of CHRYSLER GROUP, LLC

1. Align the locator pins to the engine block and install the oil pump with the four bolts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

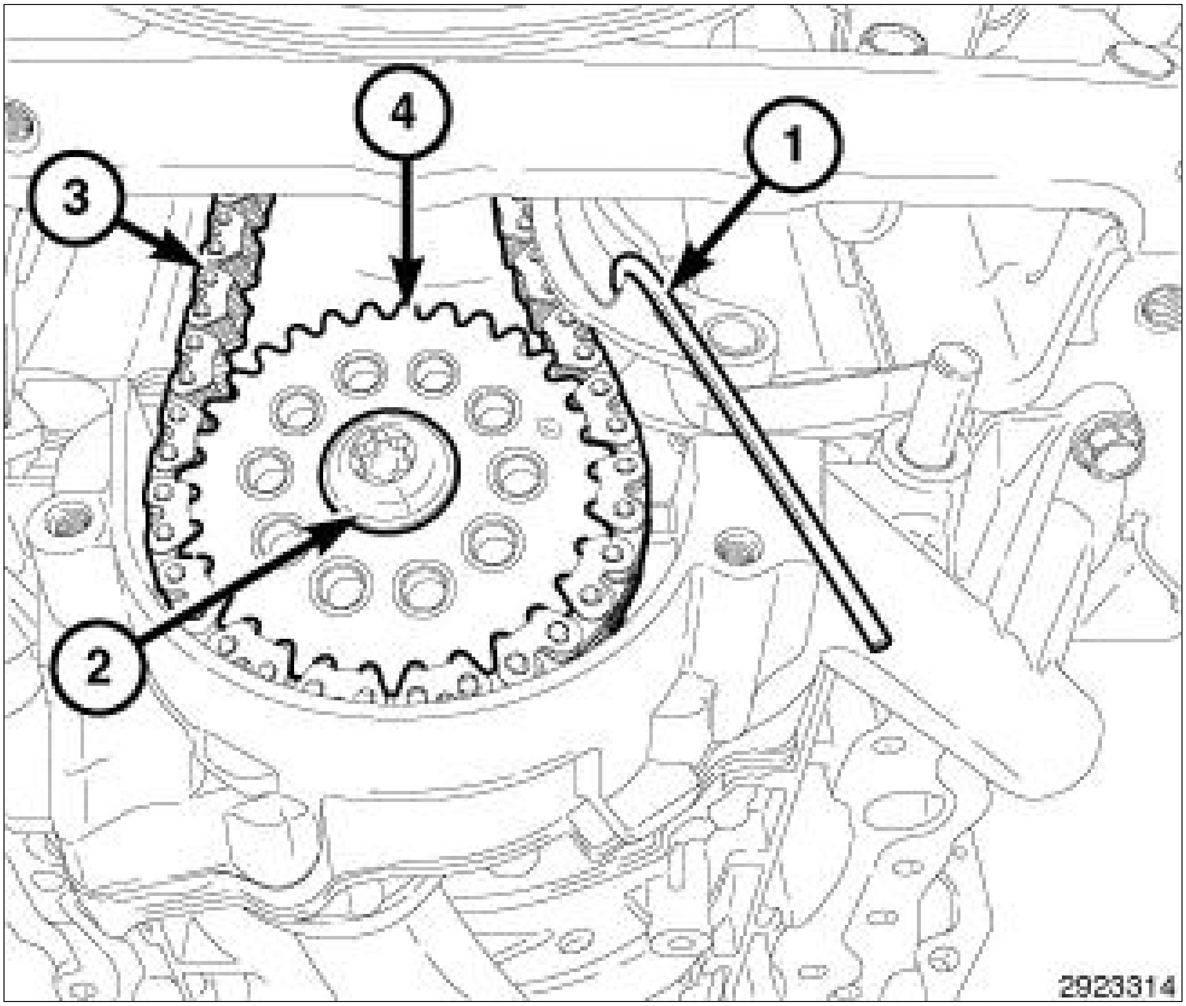
Fig 2: Retaining Pin, Oil Pump Chain Tensioner Spring & Dowel Pin



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 3: 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.

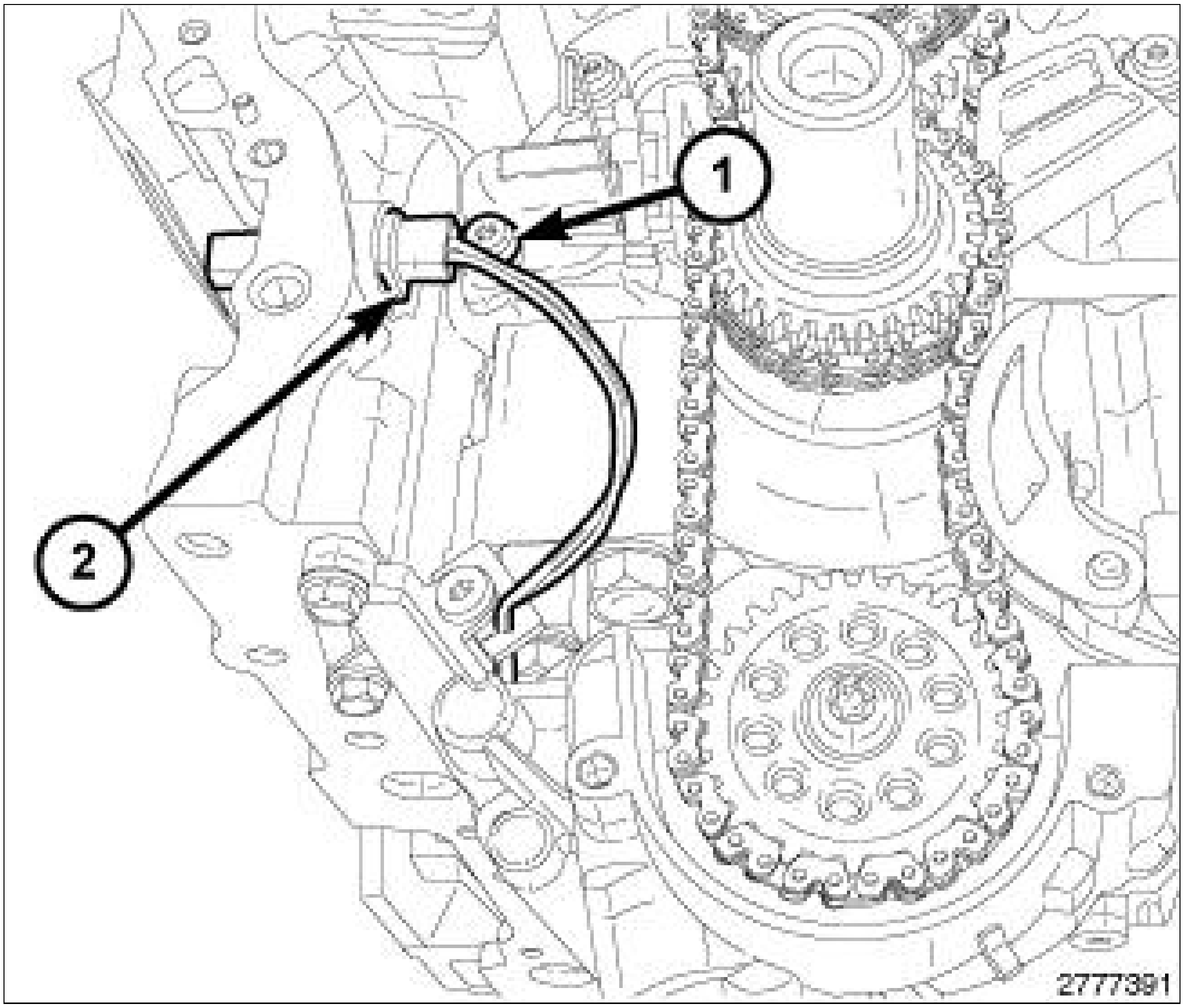
5. Place the oil pump sprocket (4) into the oil pump chain (3). Align the oil pump sprocket with the oil pump shaft and install the sprocket. Install the T45 retaining bolt (2) and tighten the bolts to the proper specification. Refer to TORQUE SPECIFICATIONS .

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.

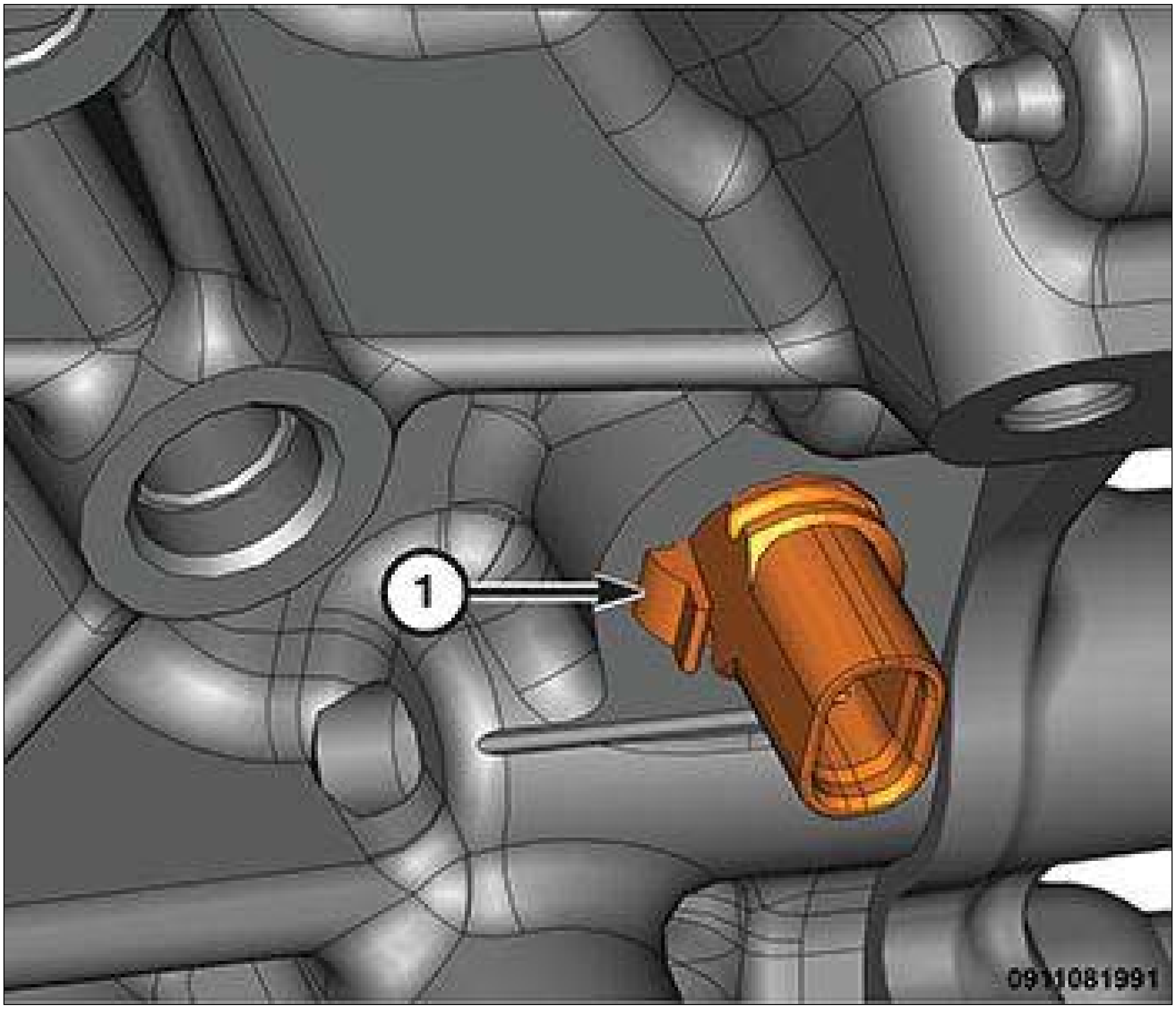
   Fig 4: Oil Pump Solenoid Electrical Connector & Primary Chain Tensioner Mounting Bolt



Courtesy of CHRYSLER GROUP, LLC

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.

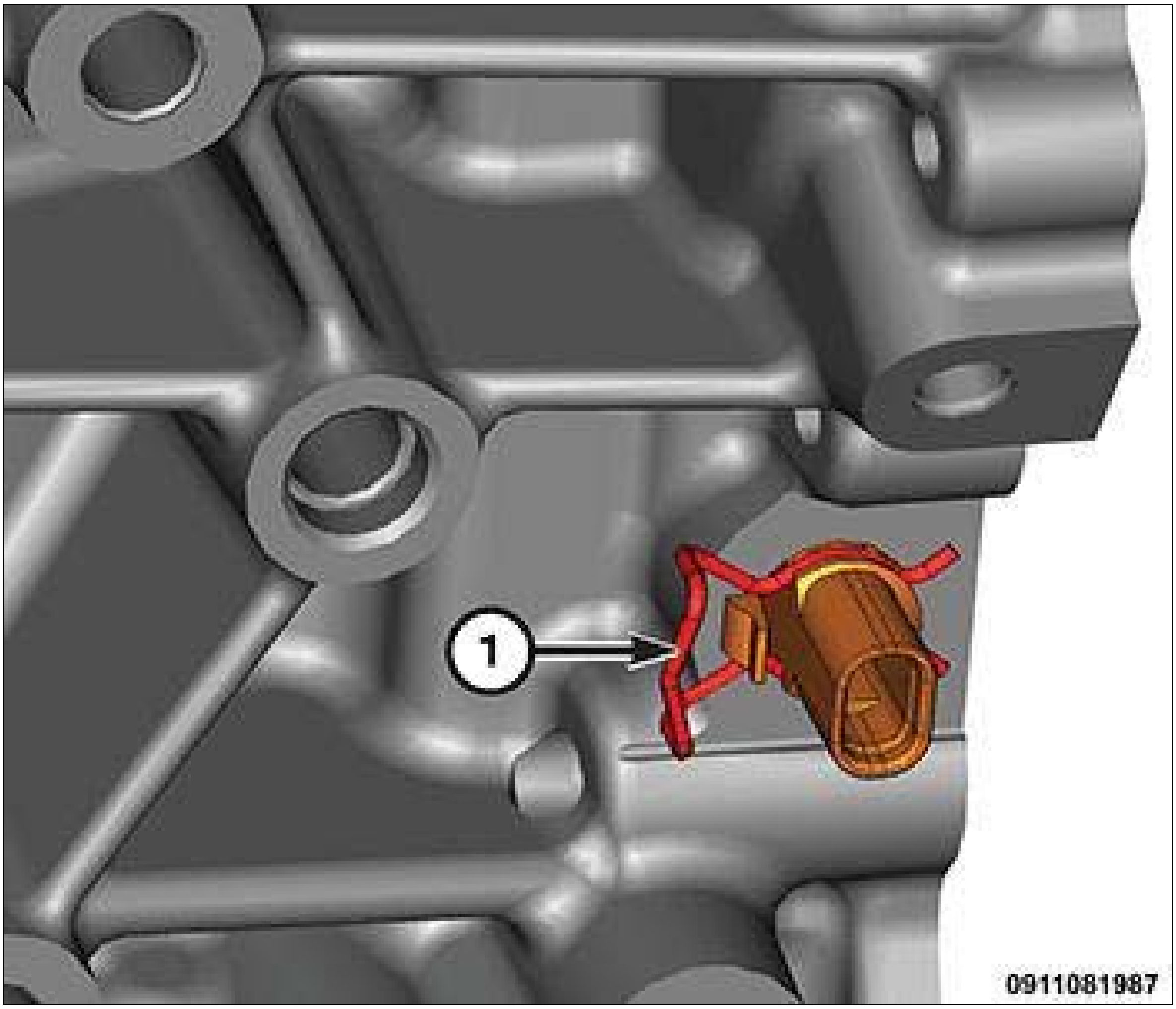
Fig 5: Oil Pump Solenoid Electrical Connector Retention Lock Tab



Courtesy of CHRYSLER GROUP, LLC

9. Verify that the oil pump solenoid electrical connector retention lock tab (1) is engaged to the engine block.

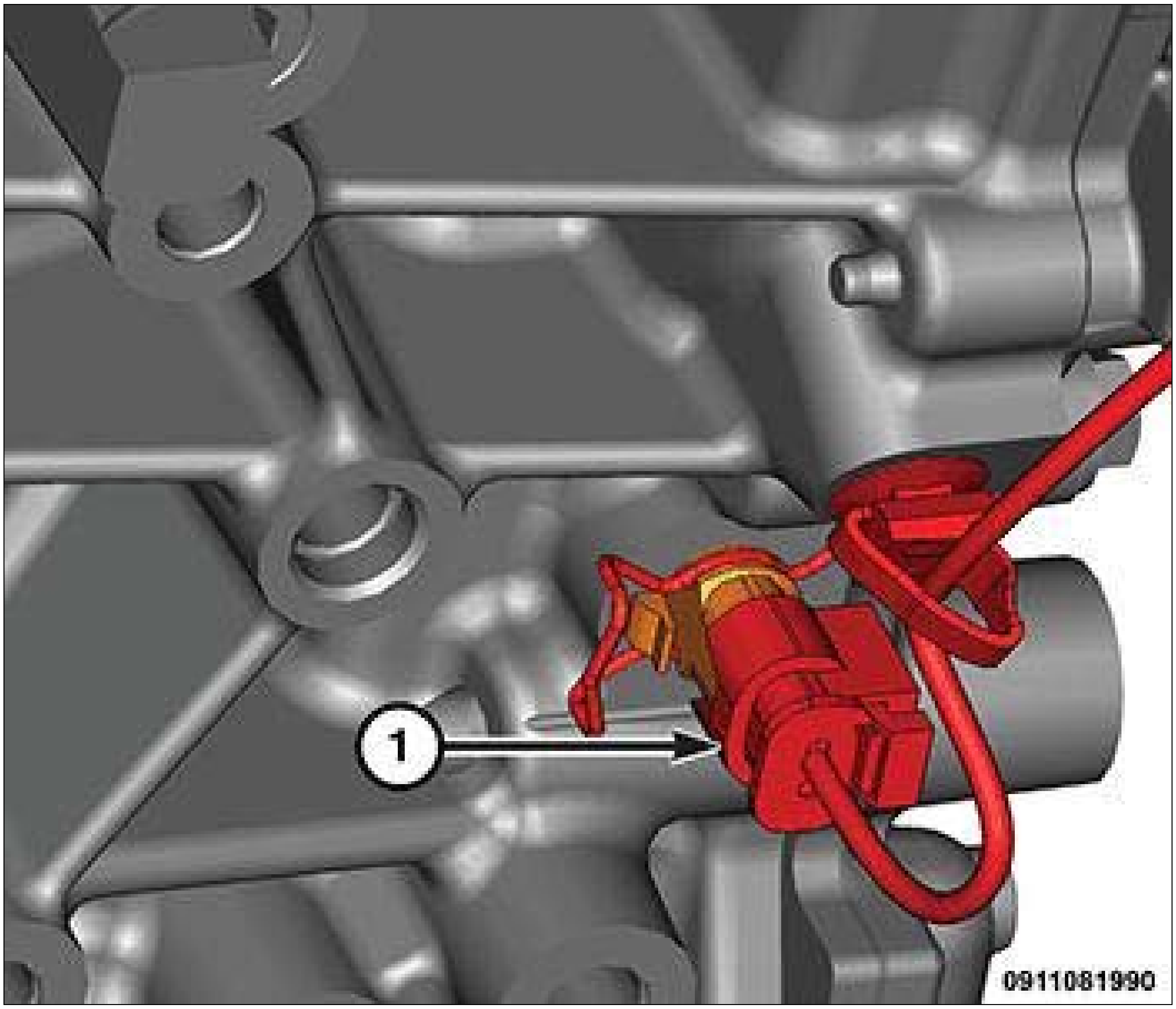
Fig 6: Oil Pump Solenoid Connector Retainer



Courtesy of CHRYSLER GROUP, LLC

10. Install the oil pump solenoid connector retainer (1).

Fig 7: Oil Pump Solenoid Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

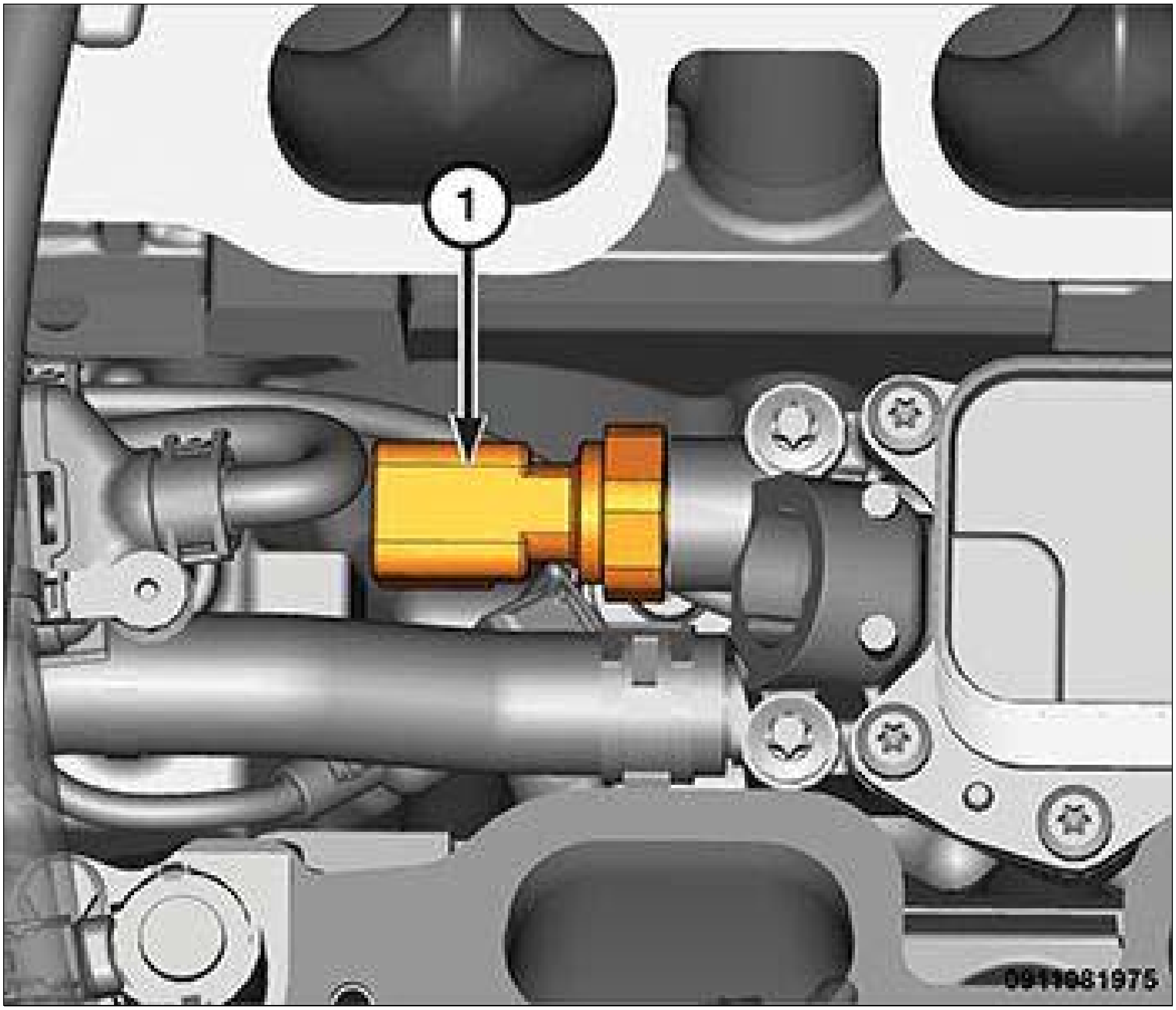
11. Connect the engine wire harness to the oil pump solenoid wire harness connector (1).
12. Install the oil pump pick-up (2). Refer to PICK-UP, OIL PUMP, INSTALLATION .
13. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
14. Connect the negative battery cable.

> ⚠ *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.*

15. Start and run the engine until it reaches normal operating temperature.

LUBRICATION > SENSOR, OIL PRESSURE > DESCRIPTION > DESCRIPTION

Fig 1: Oil Pressure Sensor

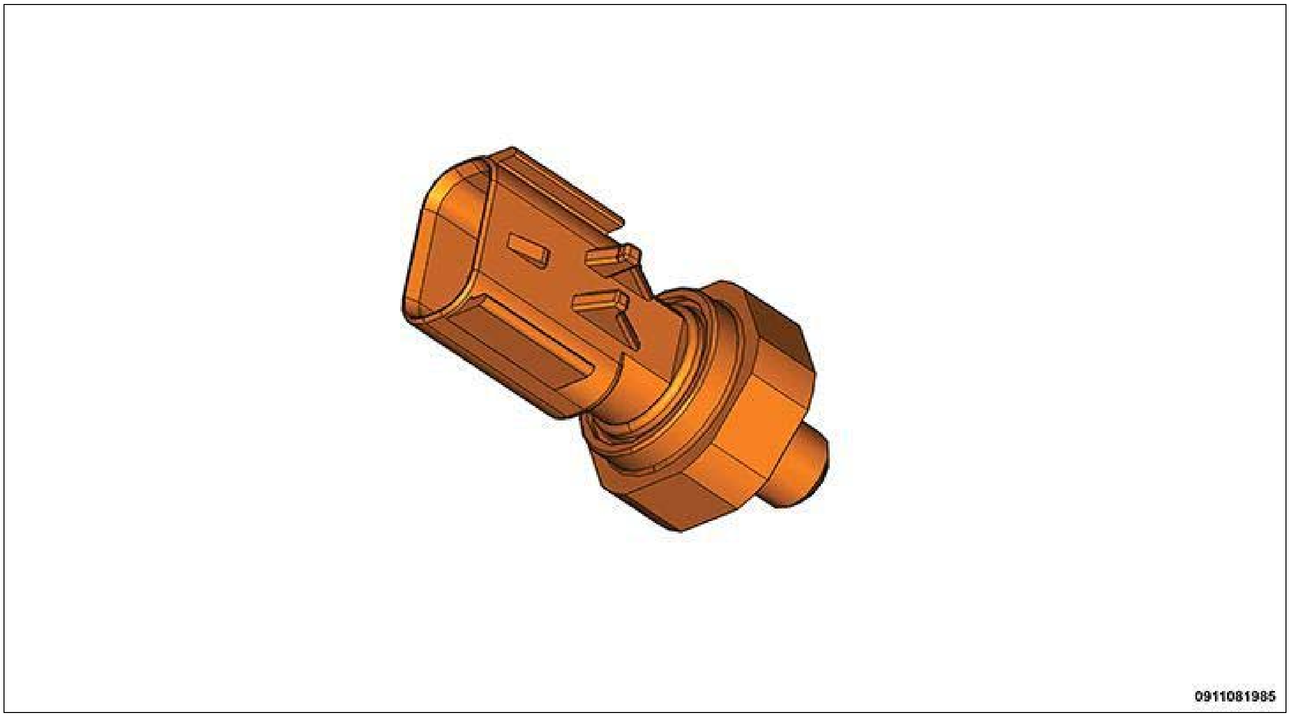


Courtesy of CHRYSLER GROUP, LLC

The oil pressure sensor (1) is located on the oil filter housing. 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.

LUBRICATION > SENSOR, OIL PRESSURE > OPERATION > OPERATION

Fig 1: Oil Pressure Sensor



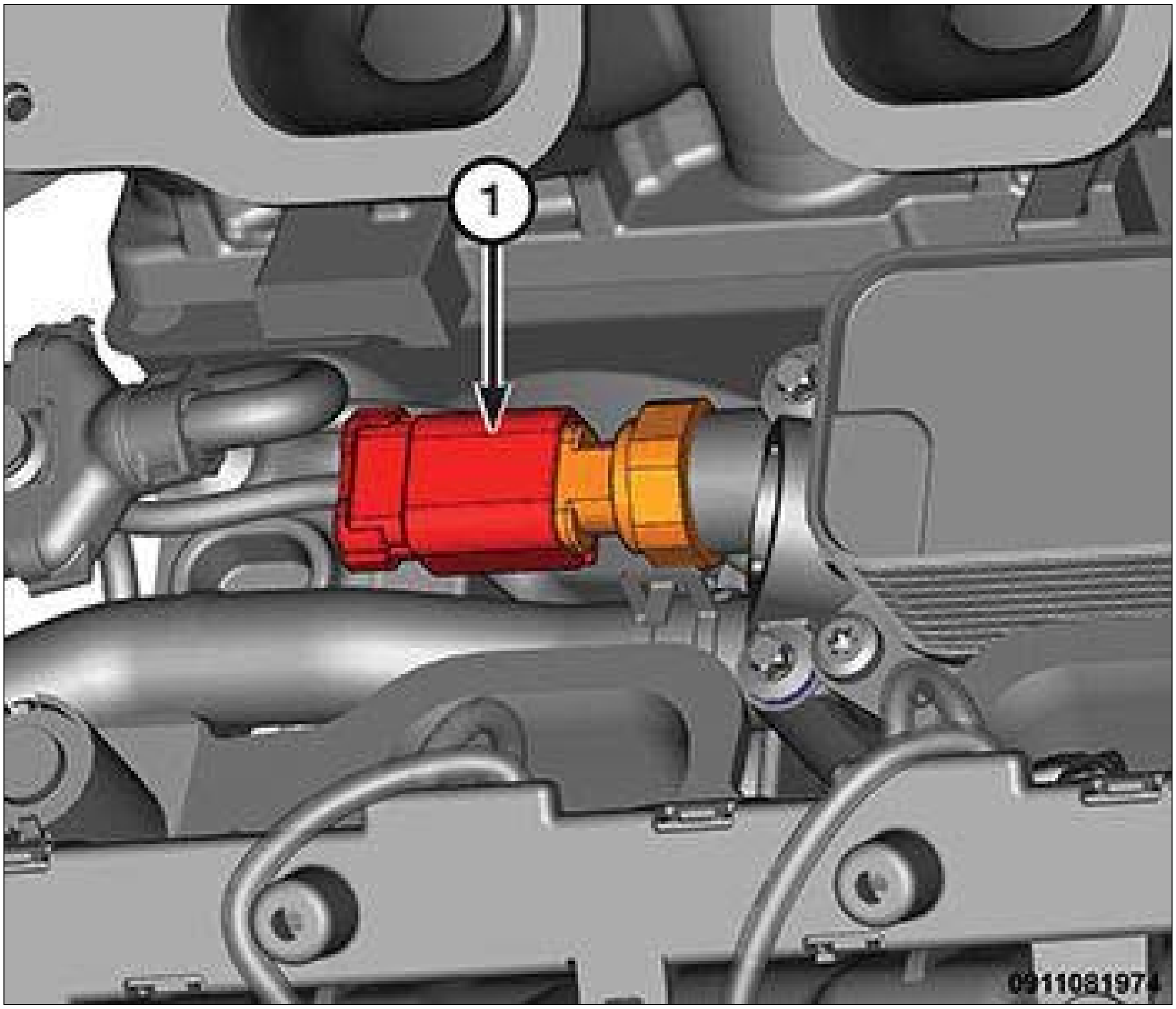
Courtesy of CHRYSLER GROUP, LLC

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.

LUBRICATION > SENSOR, OIL PRESSURE > REMOVAL > REMOVAL

1. Remove the upper intake manifold and lower intake manifold. Refer to MANIFOLD, INTAKE, REMOVAL .

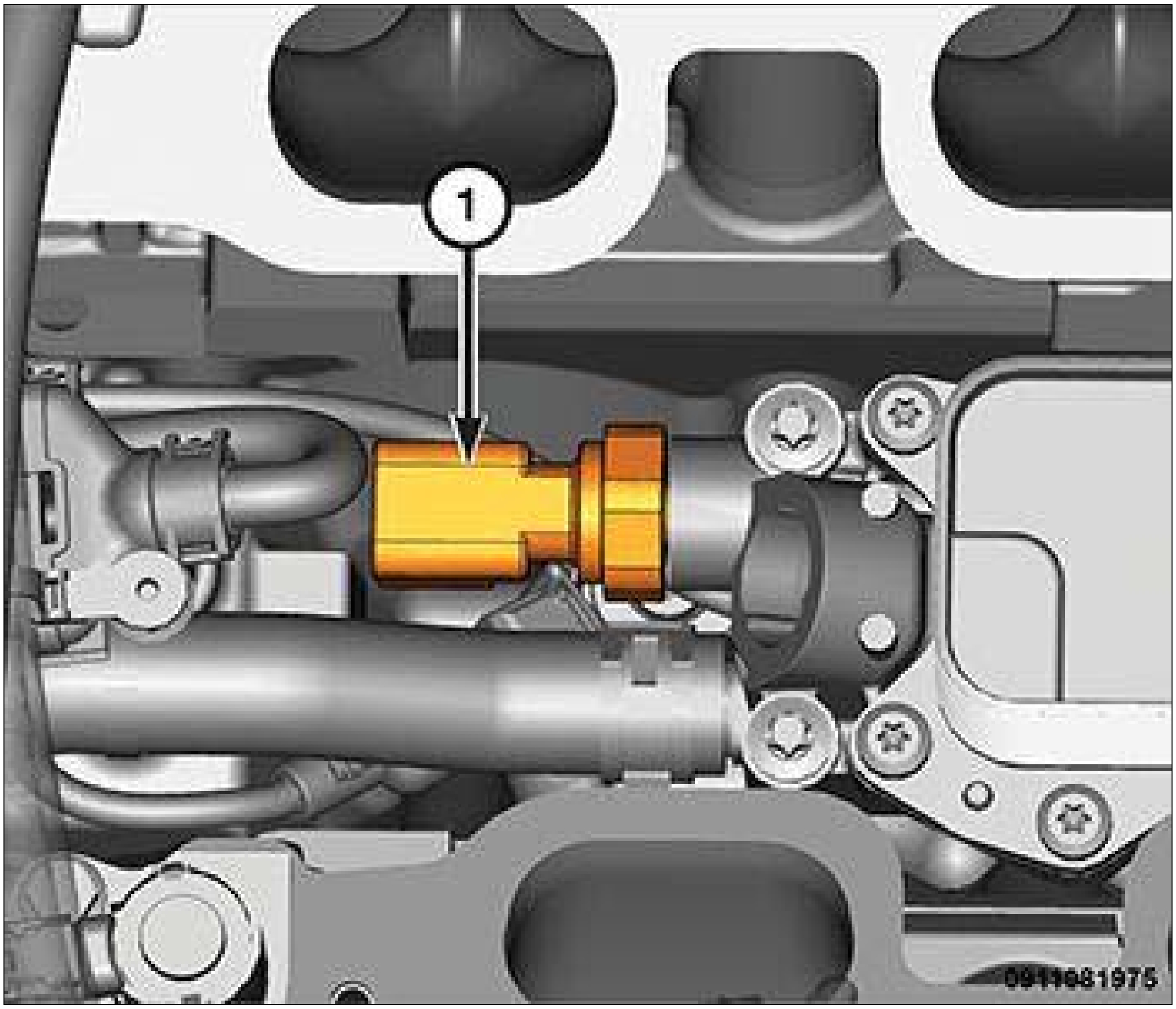
Fig 1: Oil Pressure Sensor Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

2. Disconnect the oil pressure sensor wire harness connector (1).

Fig 2: Oil Pressure Sensor

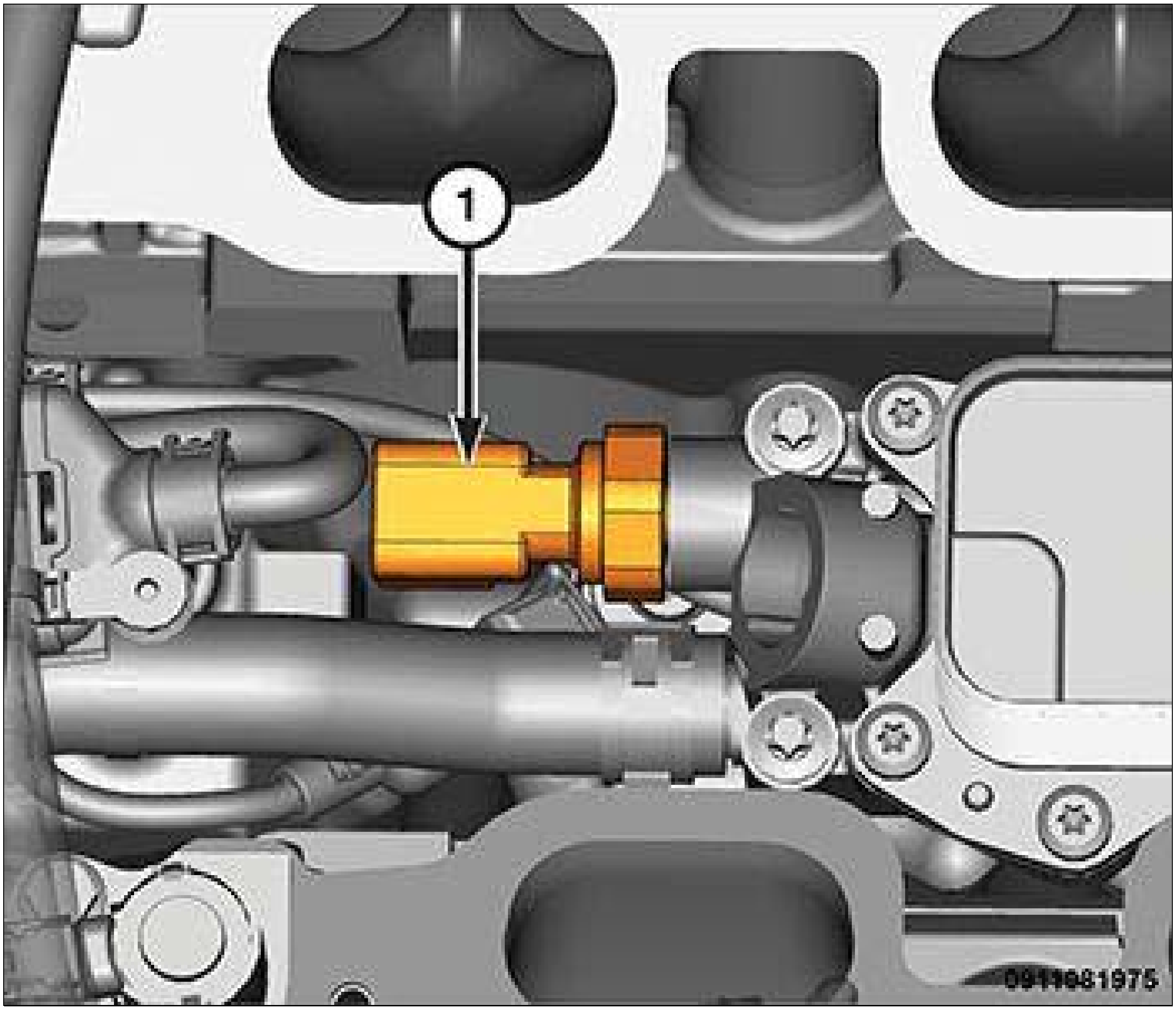


Courtesy of CHRYSLER GROUP, LLC

3. Remove the oil pressure sensor (1) from the oil filter housing.

LUBRICATION > SENSOR, OIL PRESSURE > INSTALLATION > INSTALLATION

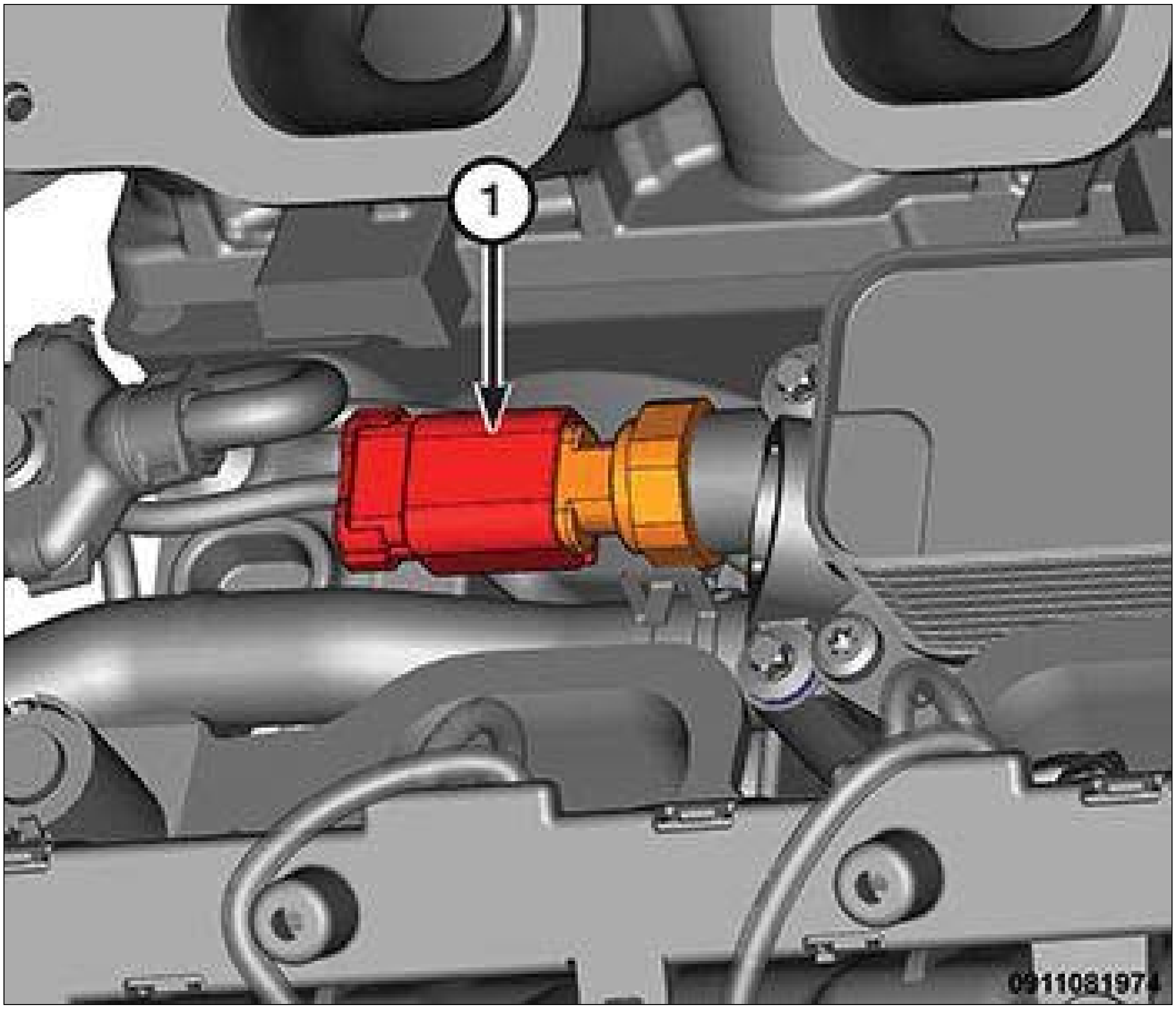
Fig 1: Oil Pressure Sensor



Courtesy of CHRYSLER GROUP, LLC

1. Install the oil pressure sensor (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 2: Oil Pressure Sensor Wire Harness Connector

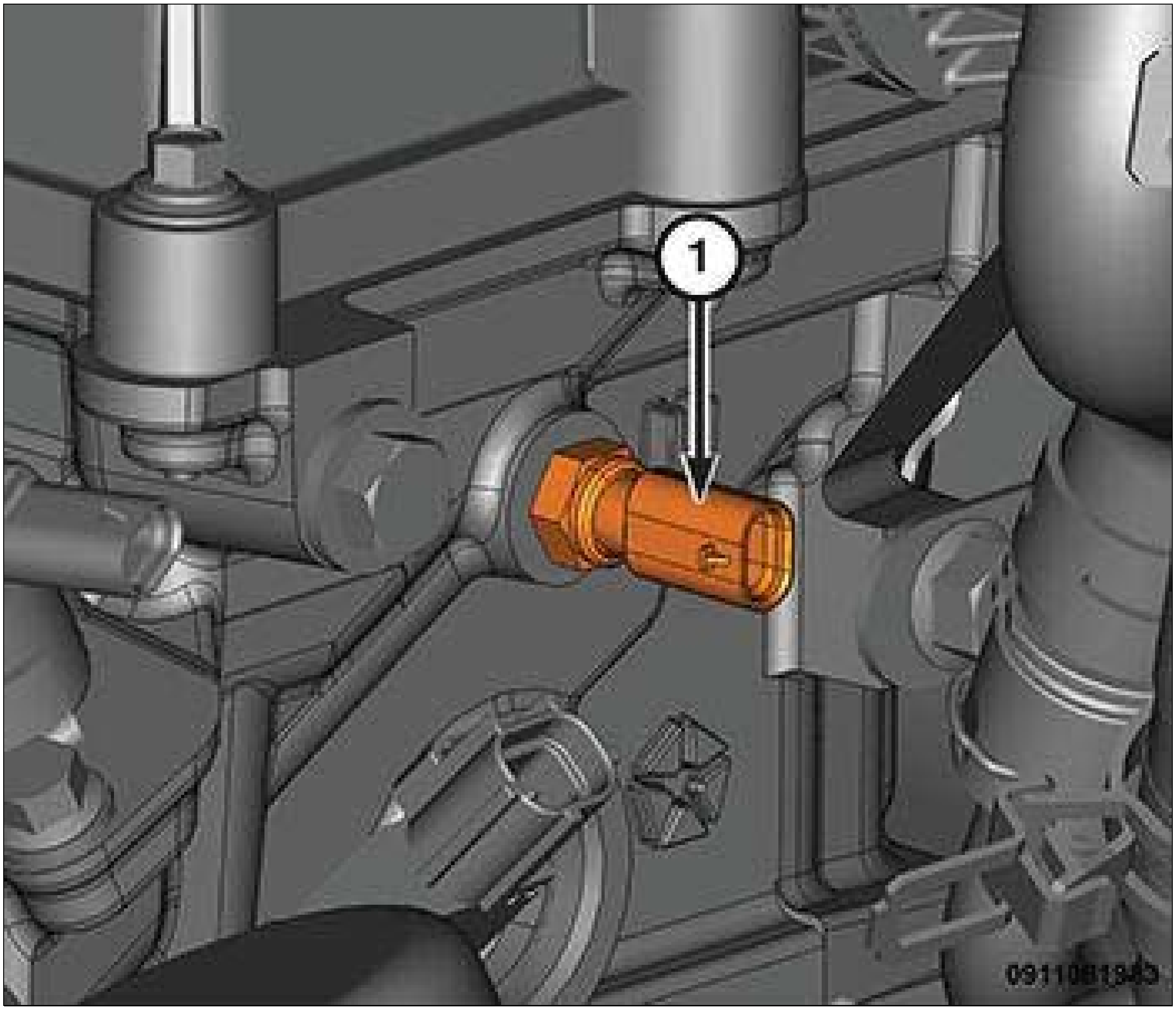


Courtesy of CHRYSLER GROUP, LLC

2. Connect the oil pressure sensor wire harness connector (1).
3. Install the upper and lower intake manifolds. Refer to MANIFOLD, INTAKE, INSTALLATION .

LUBRICATION > SENSOR, OIL TEMPERATURE > DESCRIPTION > DESCRIPTION

Fig 1: Oil Temperature Sensor

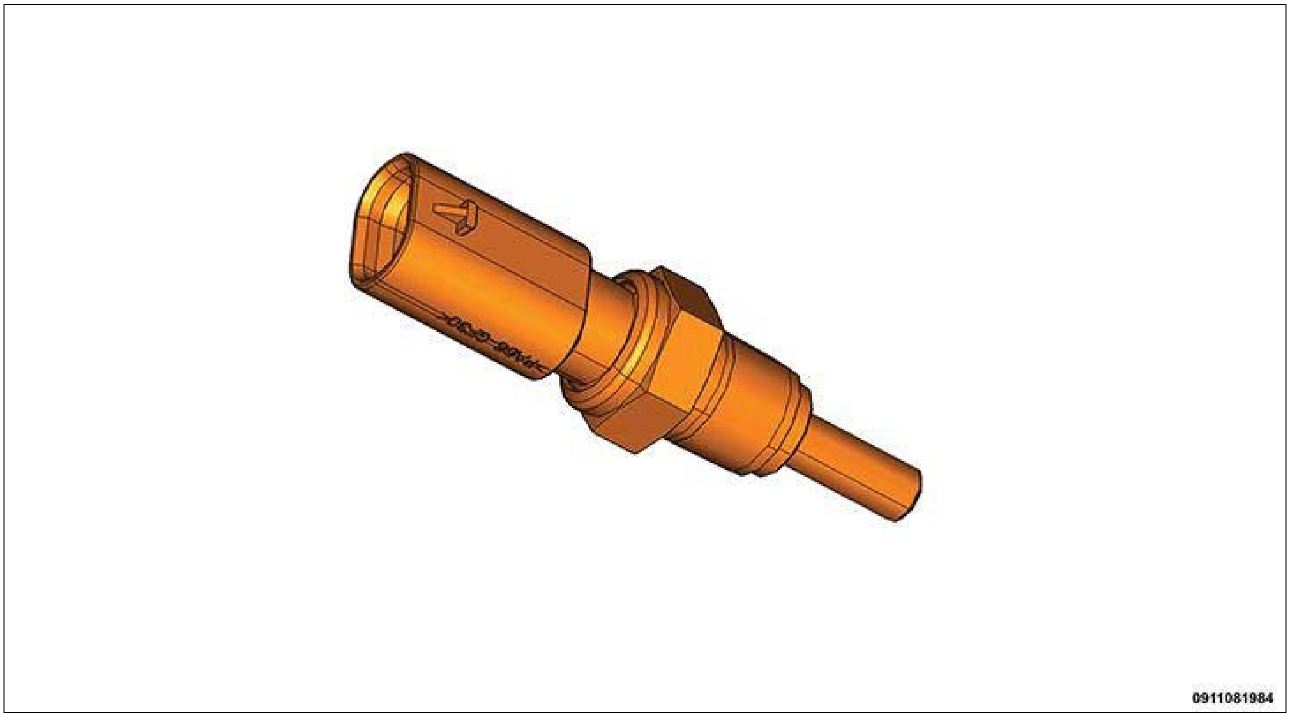


Courtesy of CHRYSLER GROUP, LLC

The oil temperature sensor (1) is located on the back of the right cylinder head. The oil temperature sensor is a two wire sensor with a tapered threaded sensor probe. The sensor probe is mounted to the cylinder head through an access hole. A thread lock patch seals the oil temperature sensor to the cylinder head.

LUBRICATION > SENSOR, OIL TEMPERATURE > OPERATION > OPERATION

Fig 1: Oil Temperature Sensor



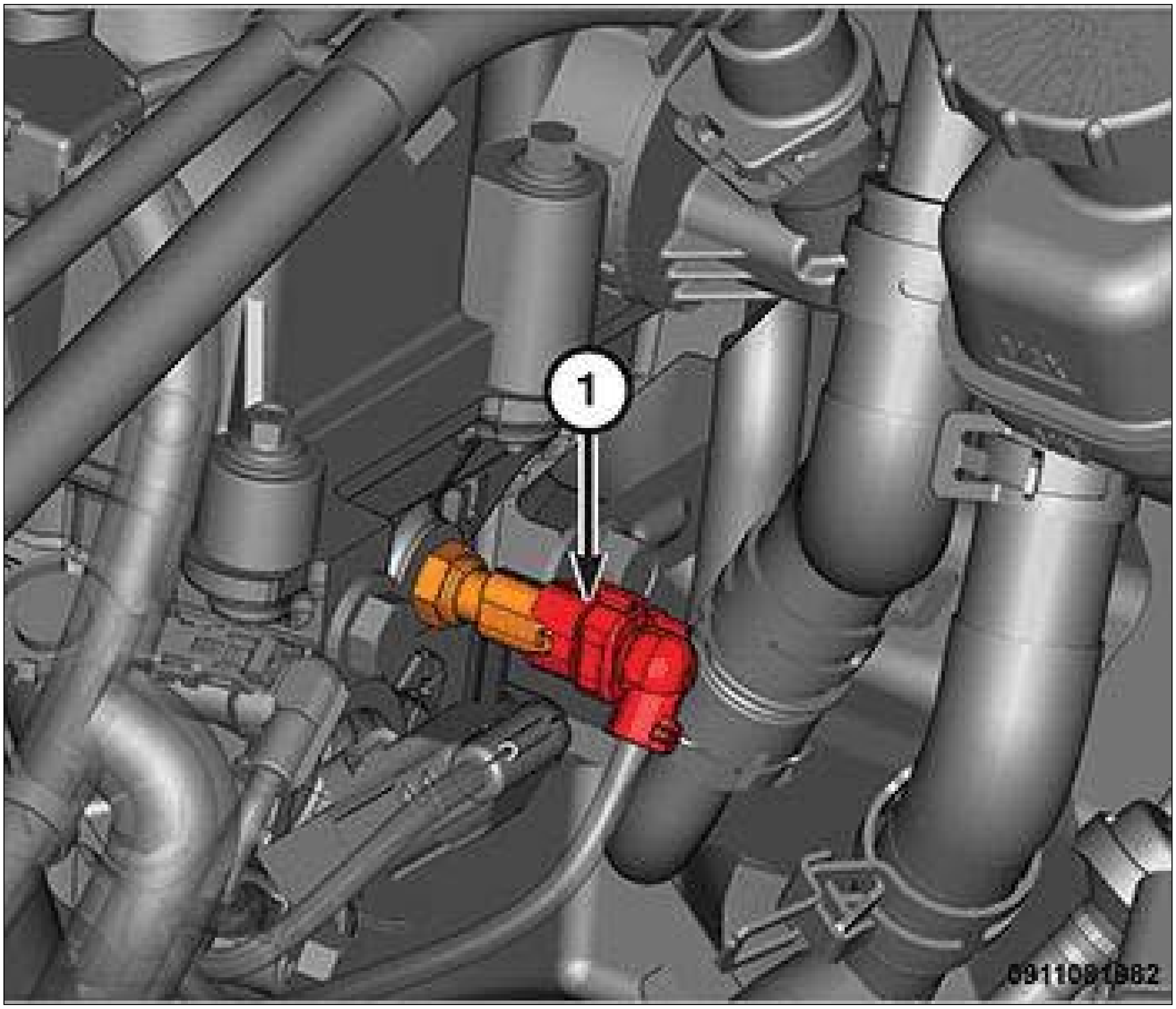
Courtesy of CHRYSLER GROUP, LLC

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.

LUBRICATION > SENSOR, OIL TEMPERATURE > REMOVAL > REMOVAL

1. Disconnect and isolate the negative battery cable.
2. Remove the cowl extension. Refer to SILENCER, COWL EXTENSION, REMOVAL .

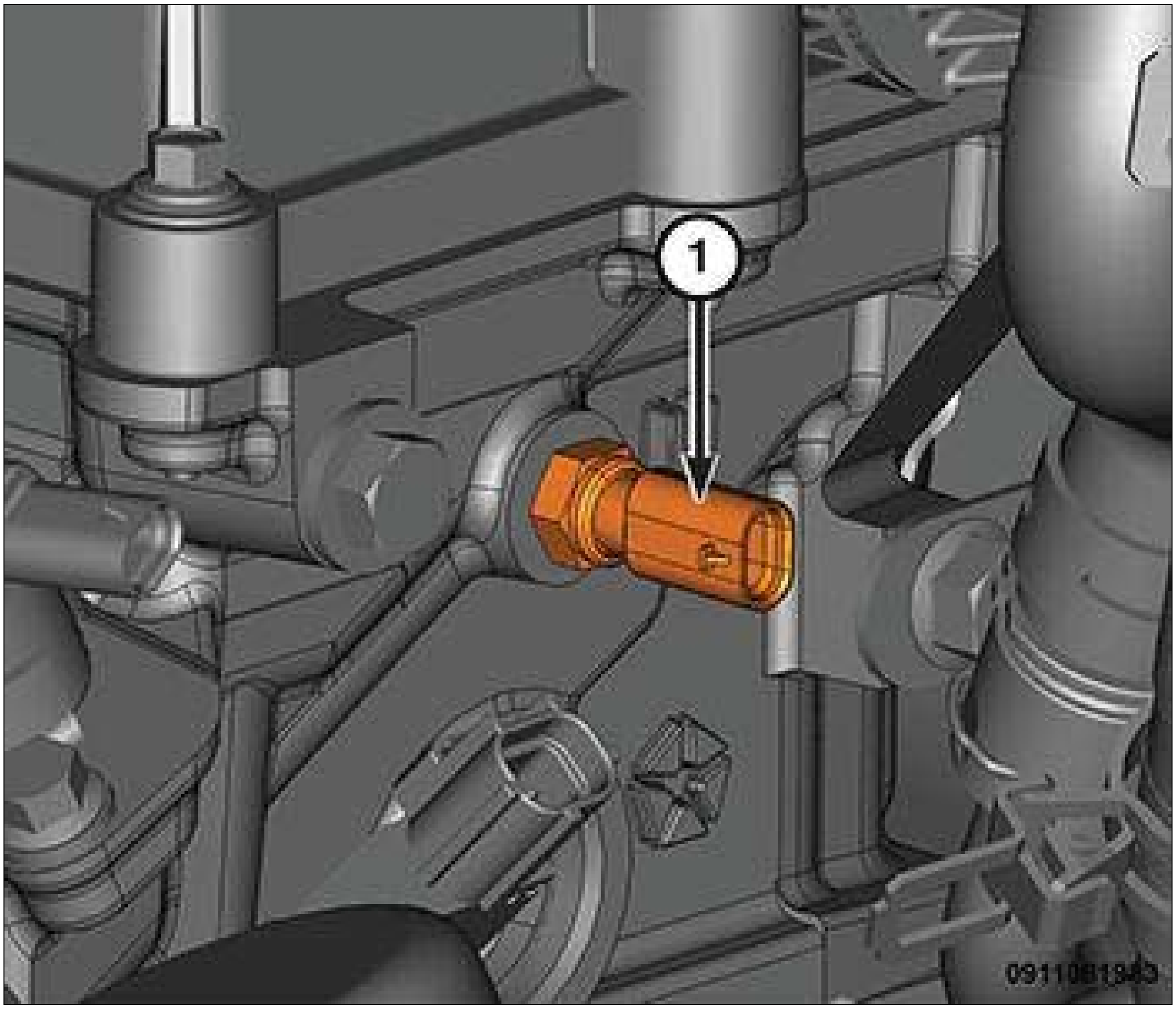
Fig 1: Oil Temperature Sensor Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

3. Disconnect the oil temperature sensor wire harness connector (2).

Fig 2: Oil Temperature Sensor

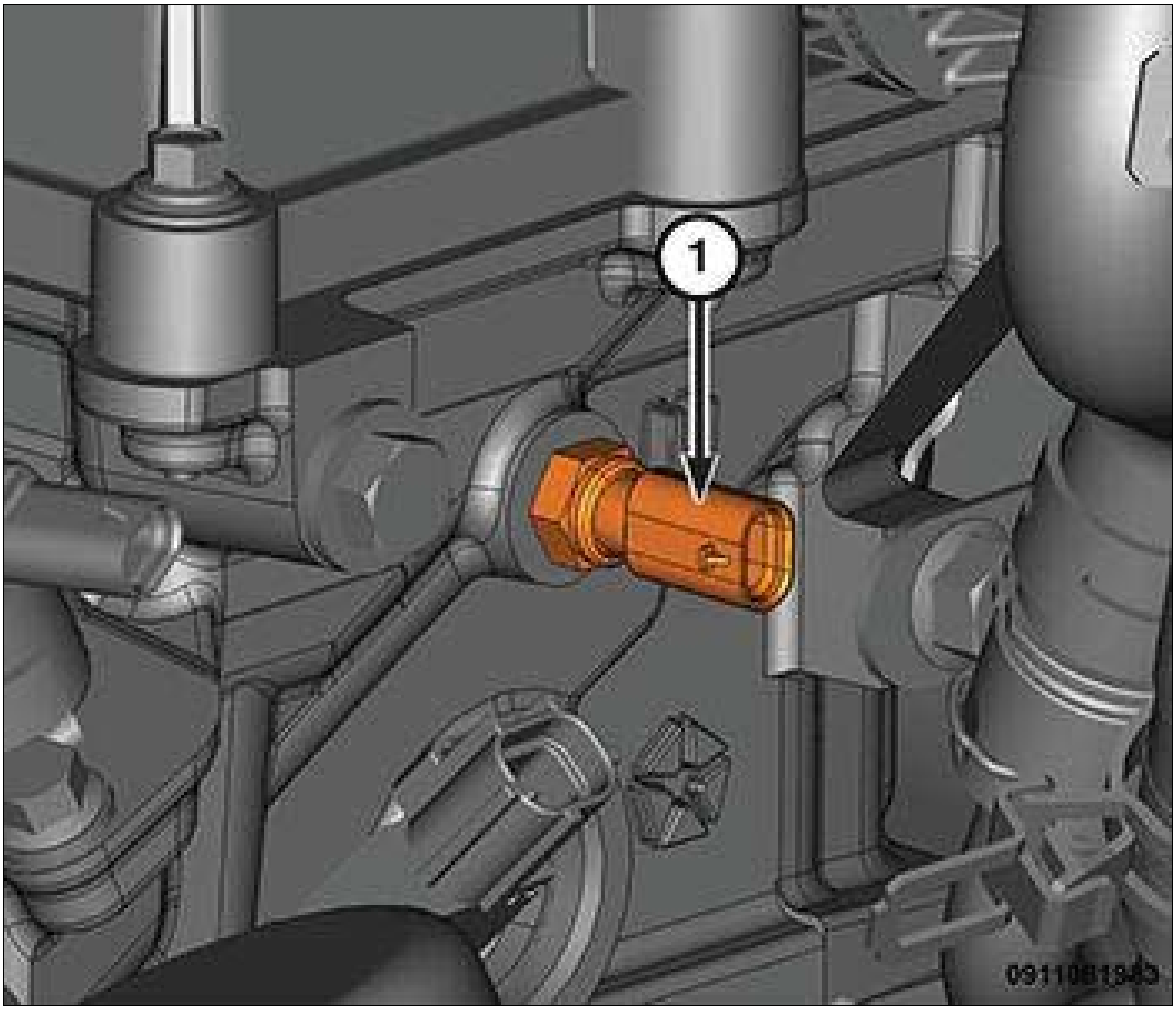


Courtesy of CHRYSLER GROUP, LLC

4. Remove the oil temperature sensor (1) from the cylinder head.

LUBRICATION > SENSOR, OIL TEMPERATURE > INSTALLATION > INSTALLATION

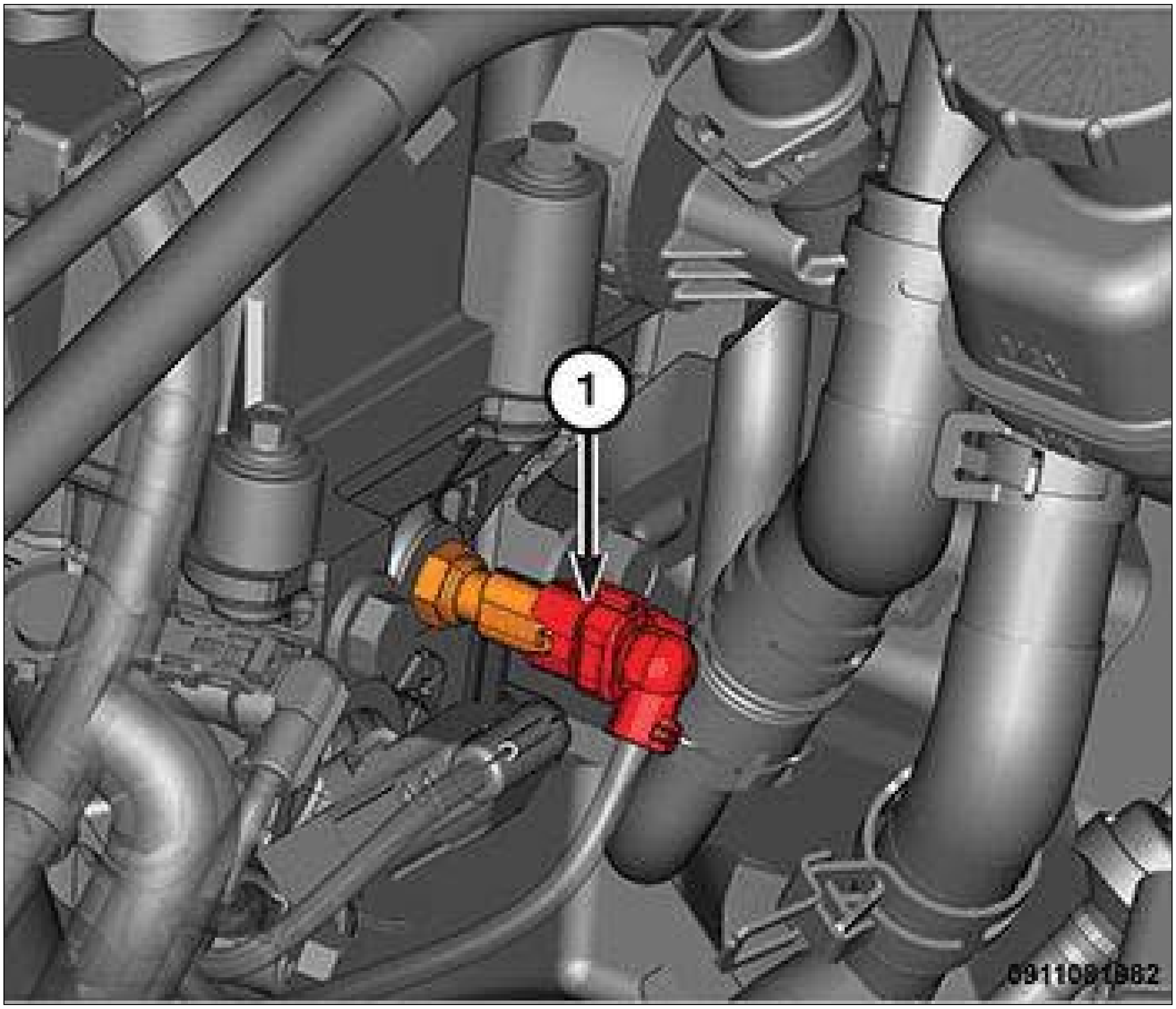
Fig 1: Oil Temperature Sensor



Courtesy of CHRYSLER GROUP, LLC

1. Install the oil temperature sensor (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 2: Oil Temperature Sensor Wire Harness Connector

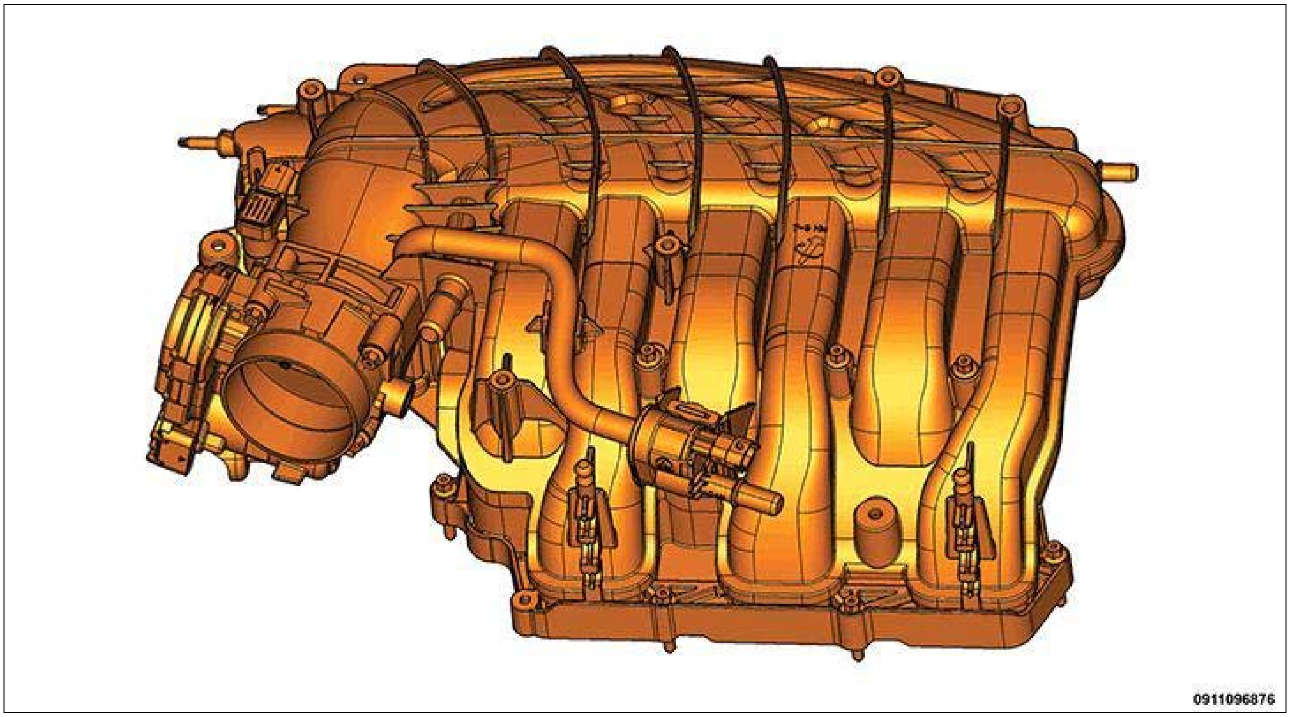


Courtesy of CHRYSLER GROUP, LLC

2. Connect the oil temperature sensor wire harness connector (2).
3. Install the cowl extension. Refer to SILENCER, COWL EXTENSION, INSTALLATION .
4. Connect the negative battery cable.

MANIFOLDS > MANIFOLD, INTAKE > DESCRIPTION > DESCRIPTION > UPPER INTAKE MANIFOLD

Fig 1: Upper Intake Manifold



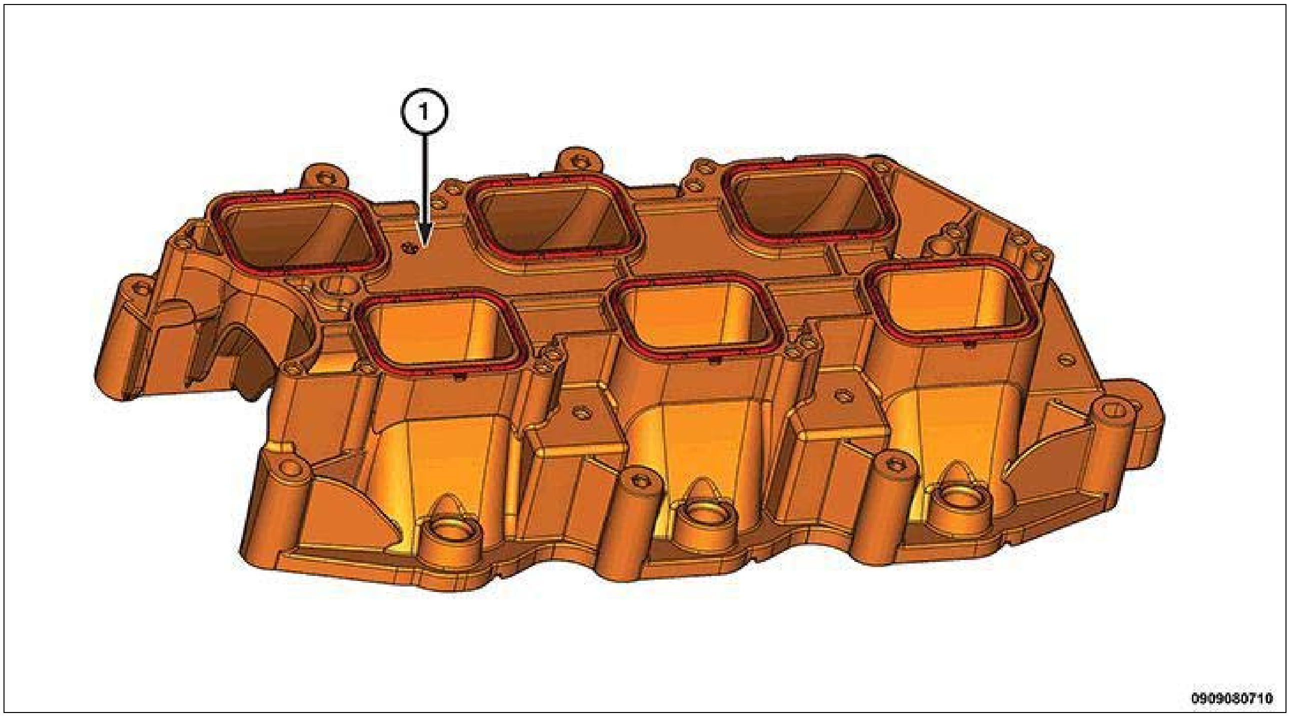
Courtesy of CHRYSLER GROUP, LLC

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 Fluoroelastomer (FKM) gaskets. Inspect the gaskets whenever the upper intake manifold is removed from the engine. The gaskets may be reused if no issues are found. There is a silencer pad positioned 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. The eight 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.

MANIFOLDS > MANIFOLD, INTAKE > DESCRIPTION > DESCRIPTION > LOWER INTAKE MANIFOLD

Fig 1: Lower Intake Manifold



Courtesy of CHRYSLER GROUP, LLC

The lower intake manifold (1) is an injection molded nylon composite design. The lower intake manifold is sealed to the cylinder heads using six individual press-in-place Fluoroelastomer (FKM) gaskets. Inspect the gaskets whenever the lower intake manifold is removed from the engine. The gaskets may be reused if no issues are found. The eight upper intake manifold fasteners thread directly into the composite lower intake manifold and are a self-tapping design.

The four fuel rail fasteners also thread directly into the composite lower intake manifold and are a self-tapping 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.

MANIFOLDS > MANIFOLD, INTAKE > DIAGNOSIS AND TESTING > DIAGNOSIS AND TESTING - INTAKE MANIFOLD LEAKS

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

WARNING:

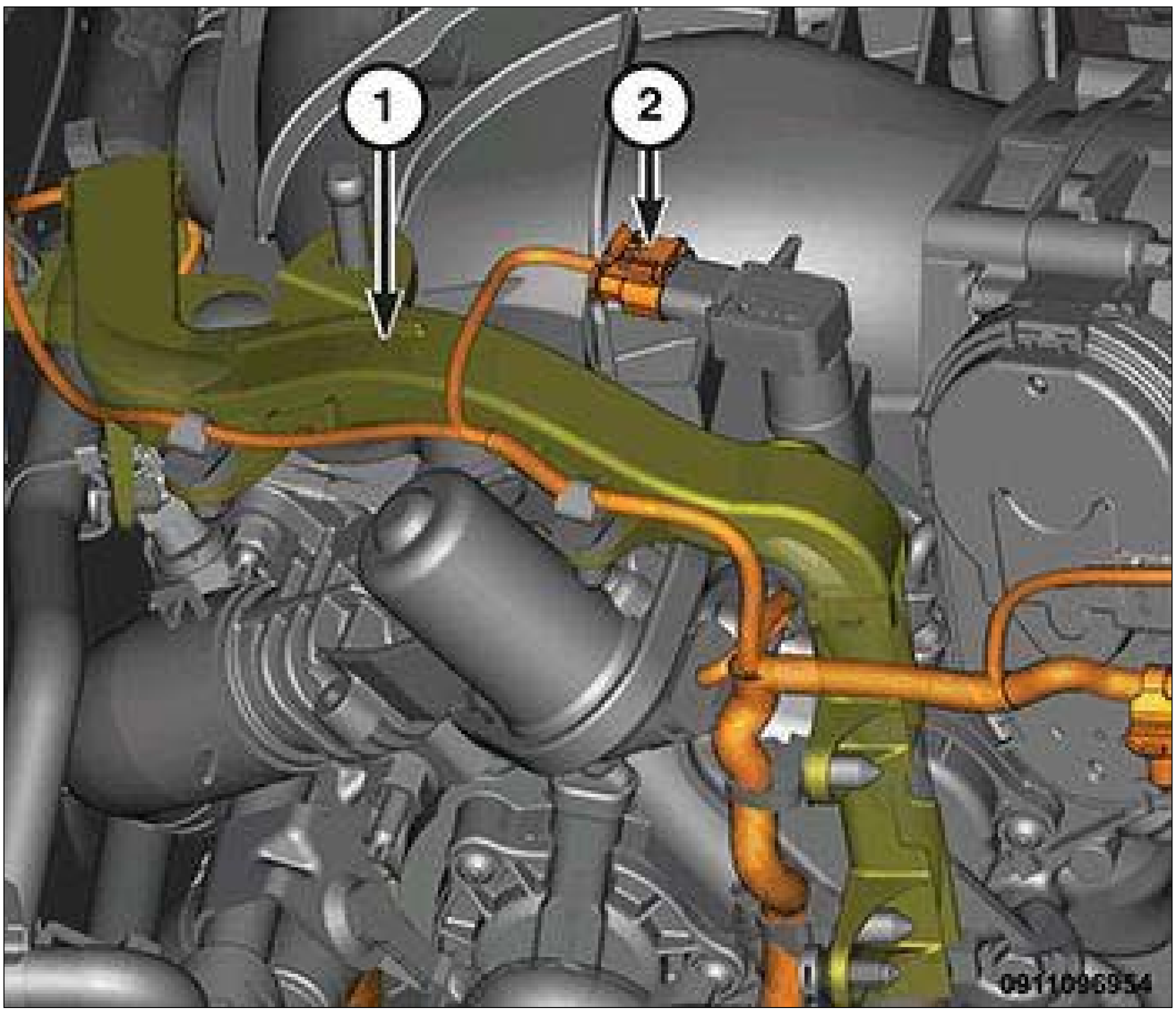
Use extreme caution when the engine is operating. Do not stand in a direct line with the fan. Do not put your hands near the pulleys, belts or the fan. Do not wear loose clothing.

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

MANIFOLDS > MANIFOLD, INTAKE > REMOVAL > UPPER

1. Disconnect and isolate the negative battery cable.
2. Remove the engine cover. Refer to COVER, ENGINE, REMOVAL .
3. Remove the air cleaner body. Refer to BODY, AIR CLEANER, REMOVAL .

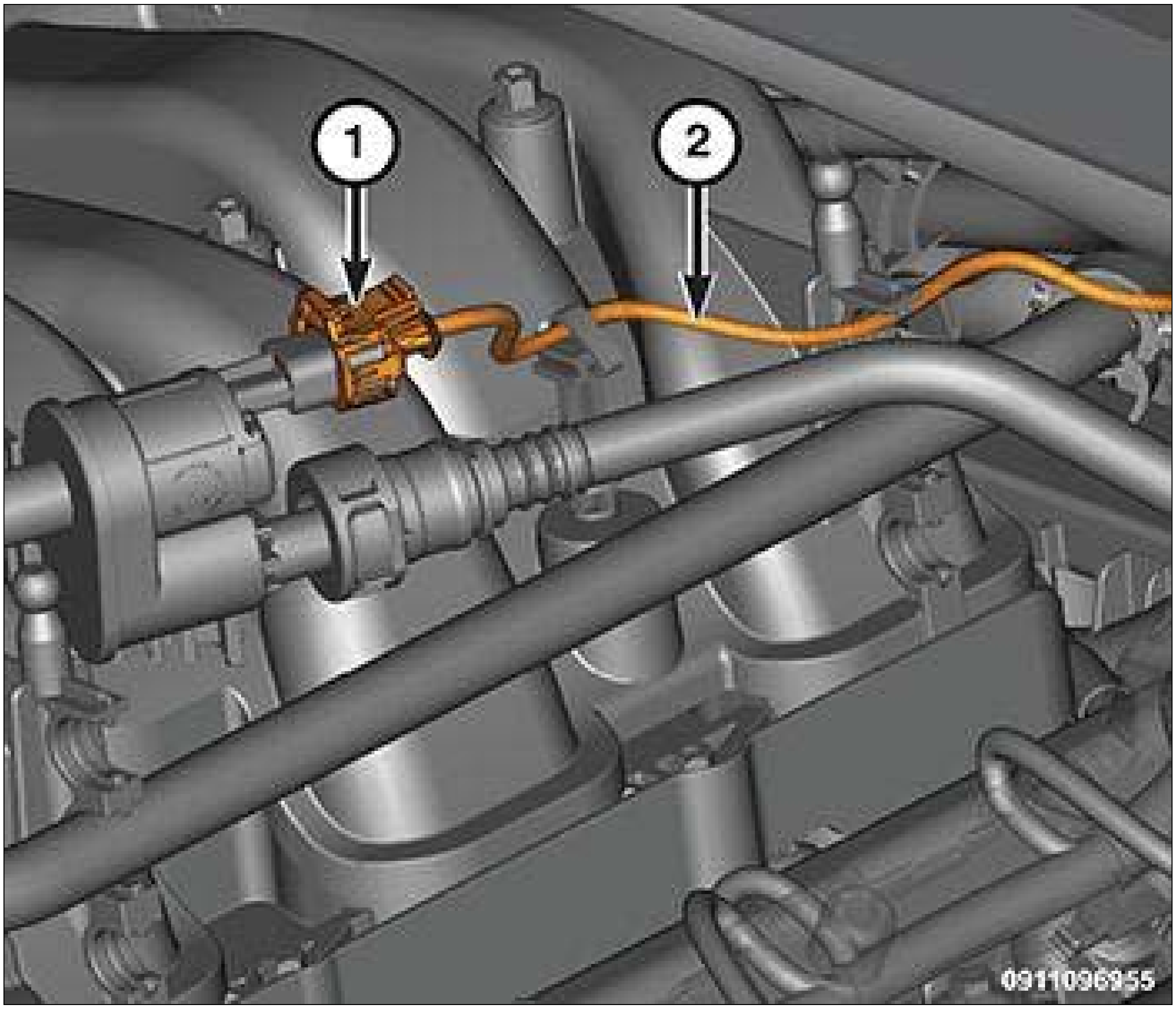
   Fig 1: Wire Harness Retainer & Front Engine Wire Harness Connectors



Courtesy of CHRYSLER GROUP, LLC

4. Disconnect the front engine wire harness connectors (2) and detach the wire harness retainer (1) from the manifold, then position aside.

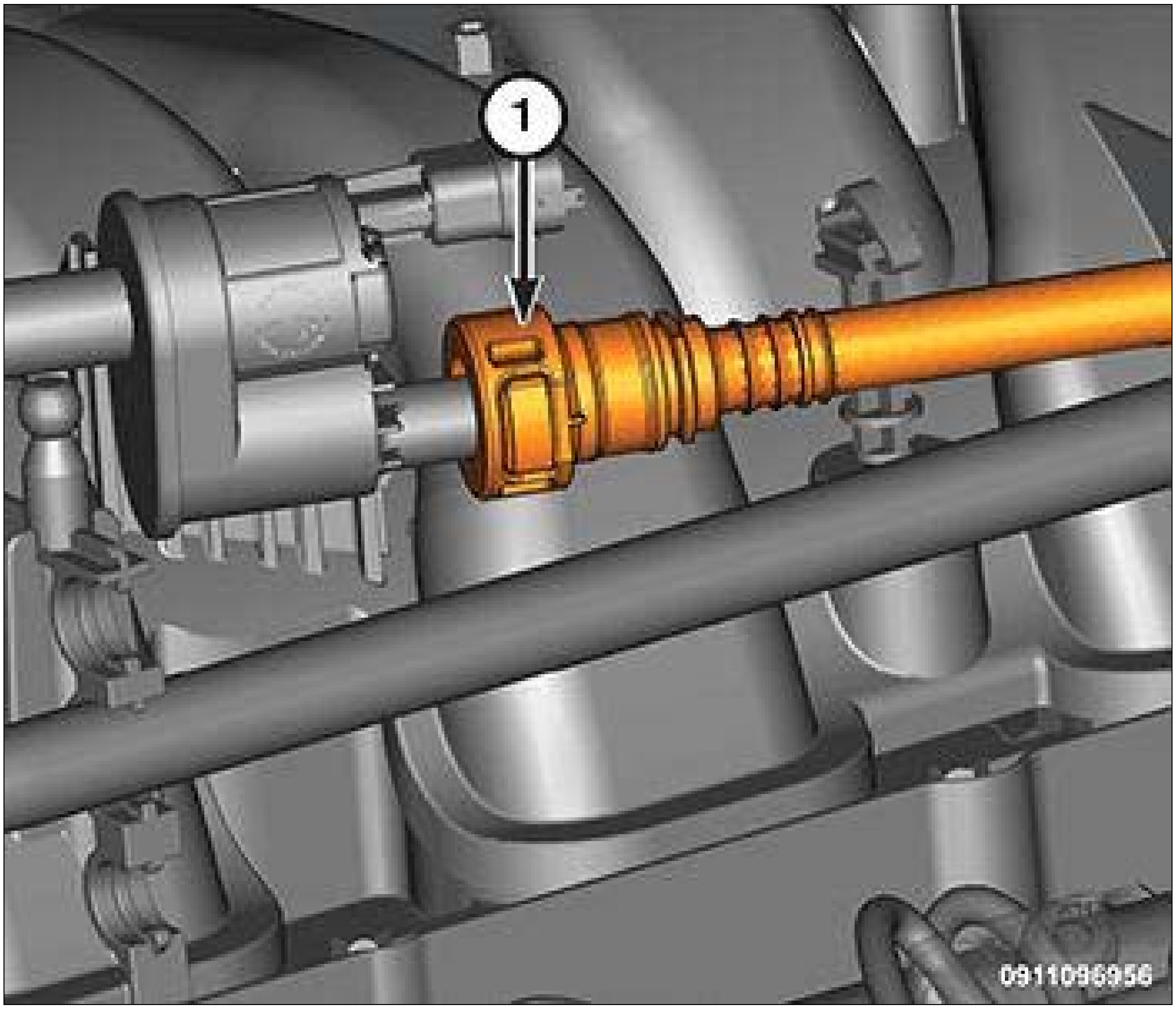
Fig 2: Vapor Purge Line & Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

5. Disconnect the evaporative purge solenoid wire harness connector and detach the wire harness (2) retainer from the manifold.

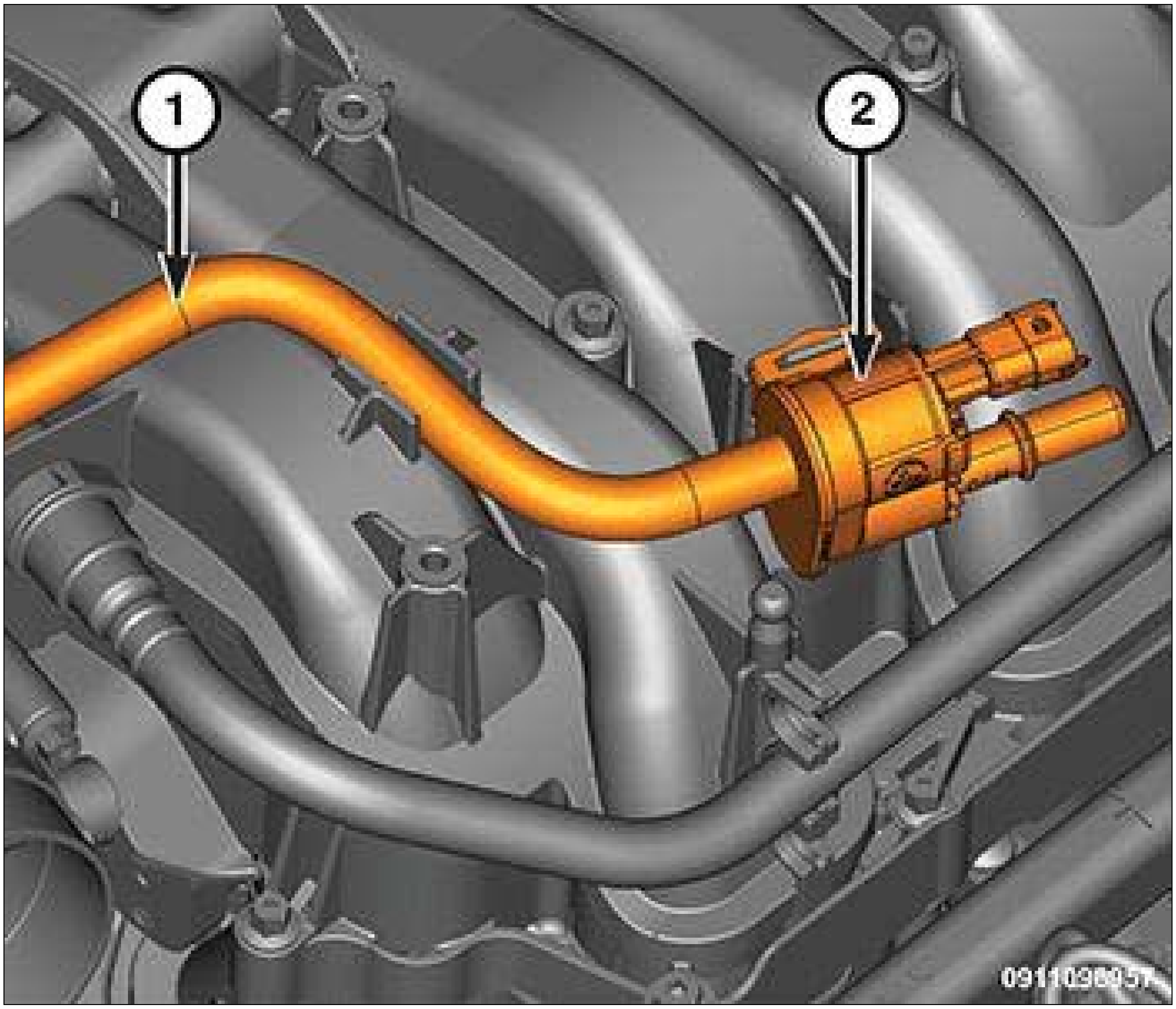
Fig 3: Vapor Purge Line



Courtesy of CHRYSLER GROUP, LLC

6. Disconnect the vapor purge line (1) from the solenoid.

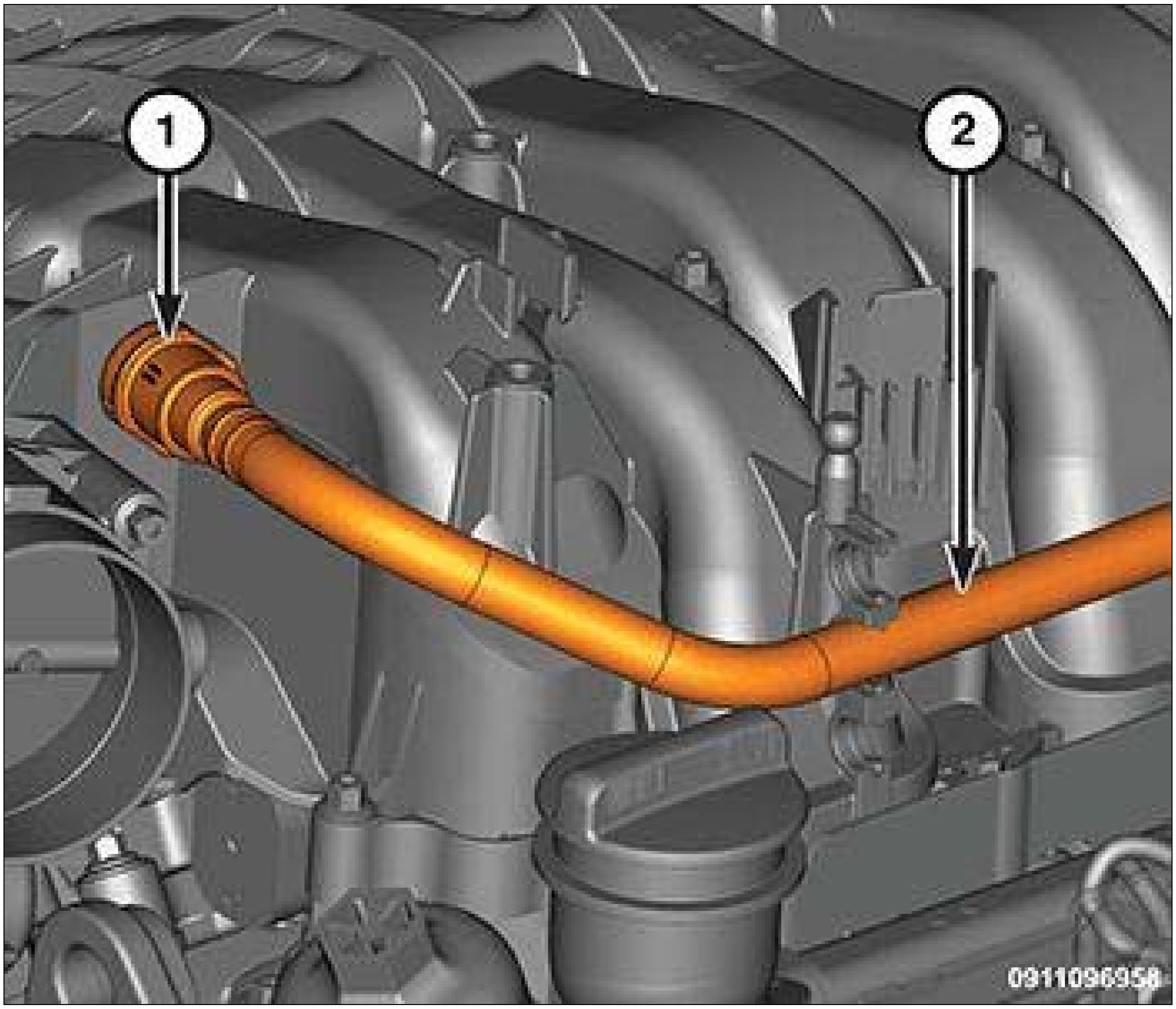
Fig 4: Purge Solenoid Vacuum Hose & Purge Solenoid



Courtesy of CHRYSLER GROUP, LLC

7. If necessary, disengage the evaporative purge solenoid hose (1) and remove the evaporative purge solenoid (2) from the intake manifold.

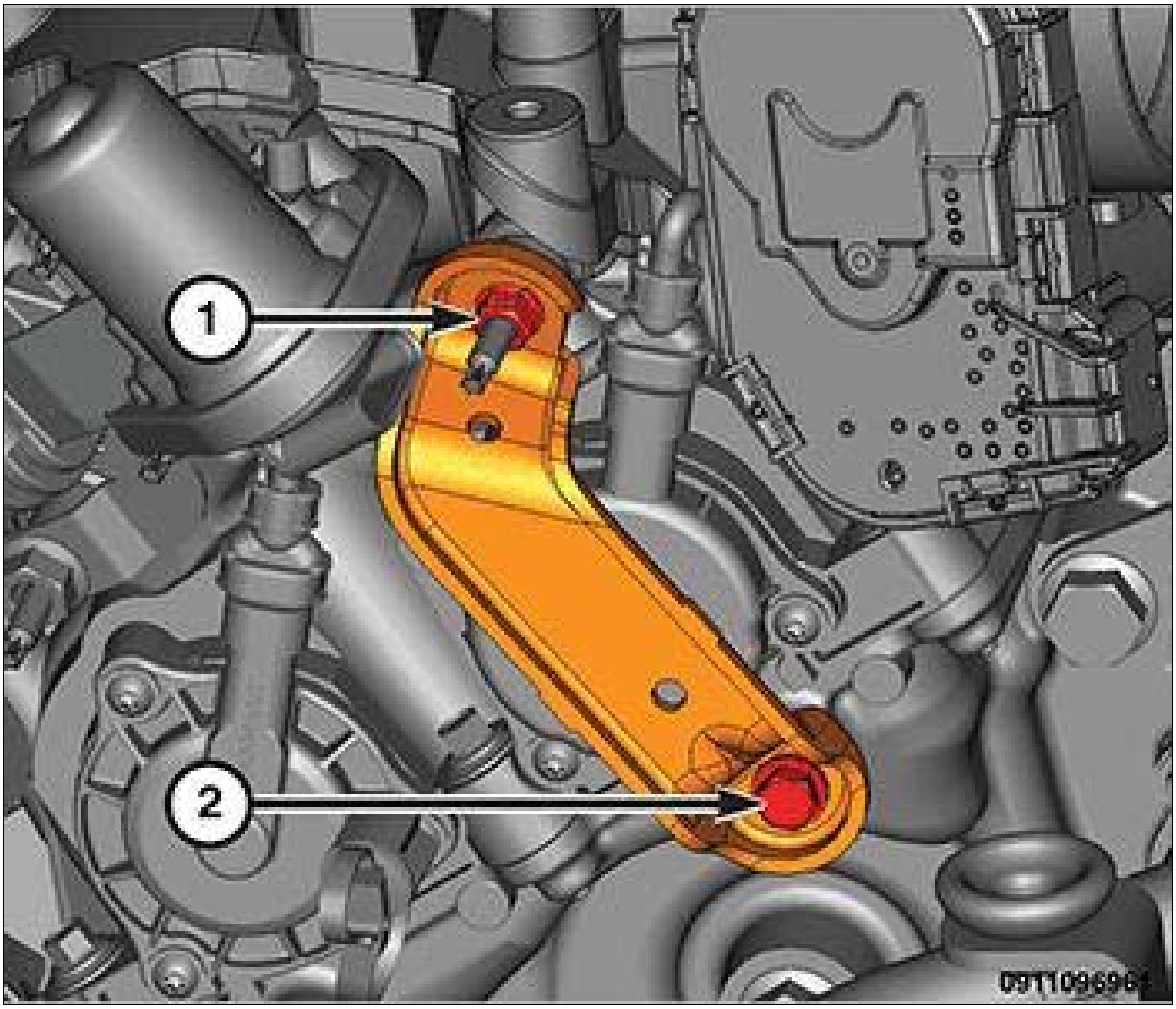
Fig 5: PCV Hose & Retaining Clips



Courtesy of CHRYSLER GROUP, LLC

8. Disconnect the Positive Crankcase Ventilation (PCV) hose (1), then remove the hose from the retaining clips (2) and position aside.

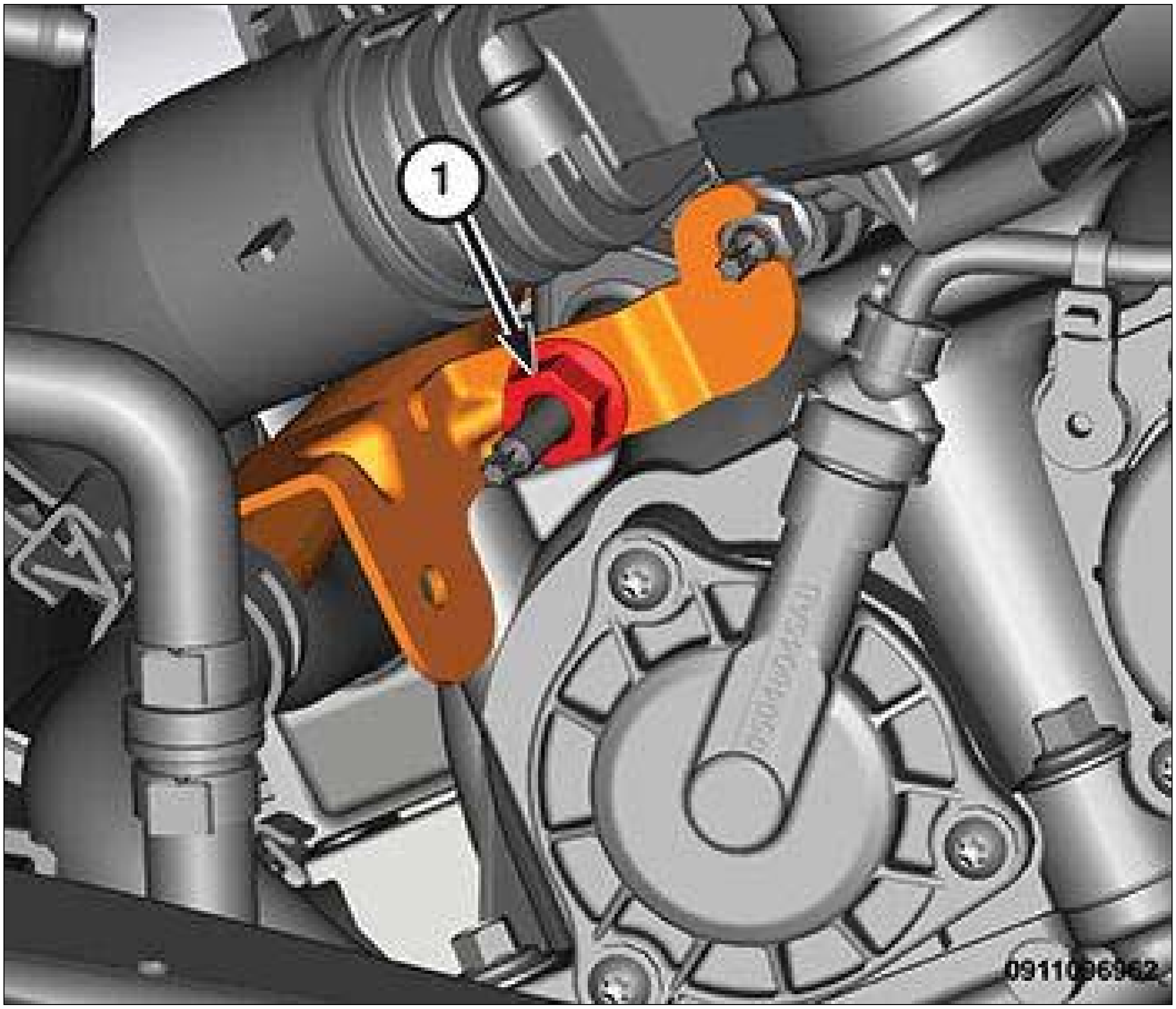
Fig 6: Front Support Bracket, Nut & Bolt



Courtesy of CHRYSLER GROUP, LLC

9. Remove the nut (1) and bolt (2), then remove the front support bracket.

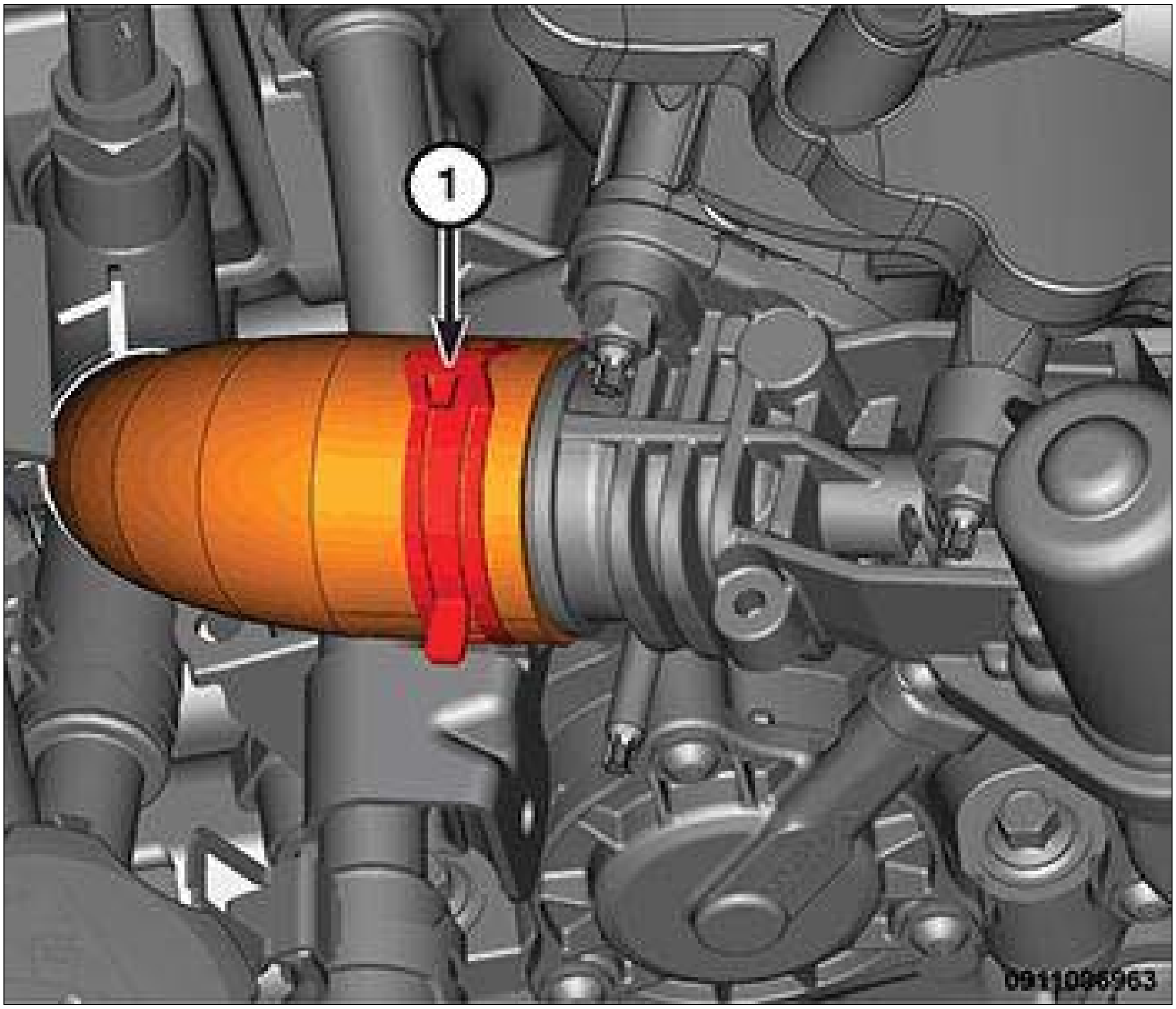
Fig 7: Coolant Tube Bracket Retaining Nut



Courtesy of CHRYSLER GROUP, LLC

10. Remove the coolant tube bracket retaining nut (1) and position tube aside.

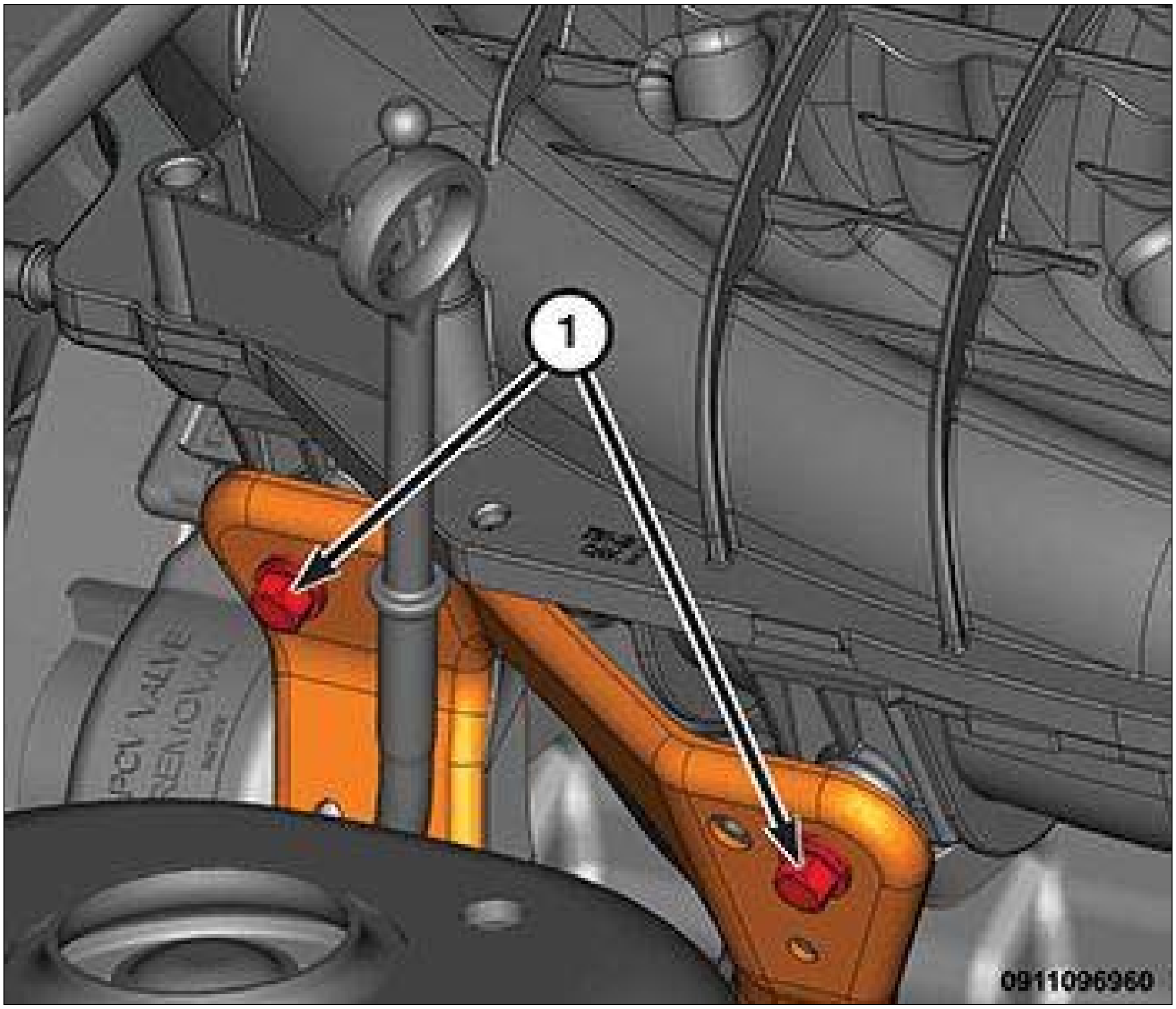
Fig 8: EGR Cooler Hose Clamp



Courtesy of CHRYSLER GROUP, LLC

11. Disconnect the EGR valve wire harness connector.
12. Disconnect the EGR cooler hose (1) from the EGR valve.

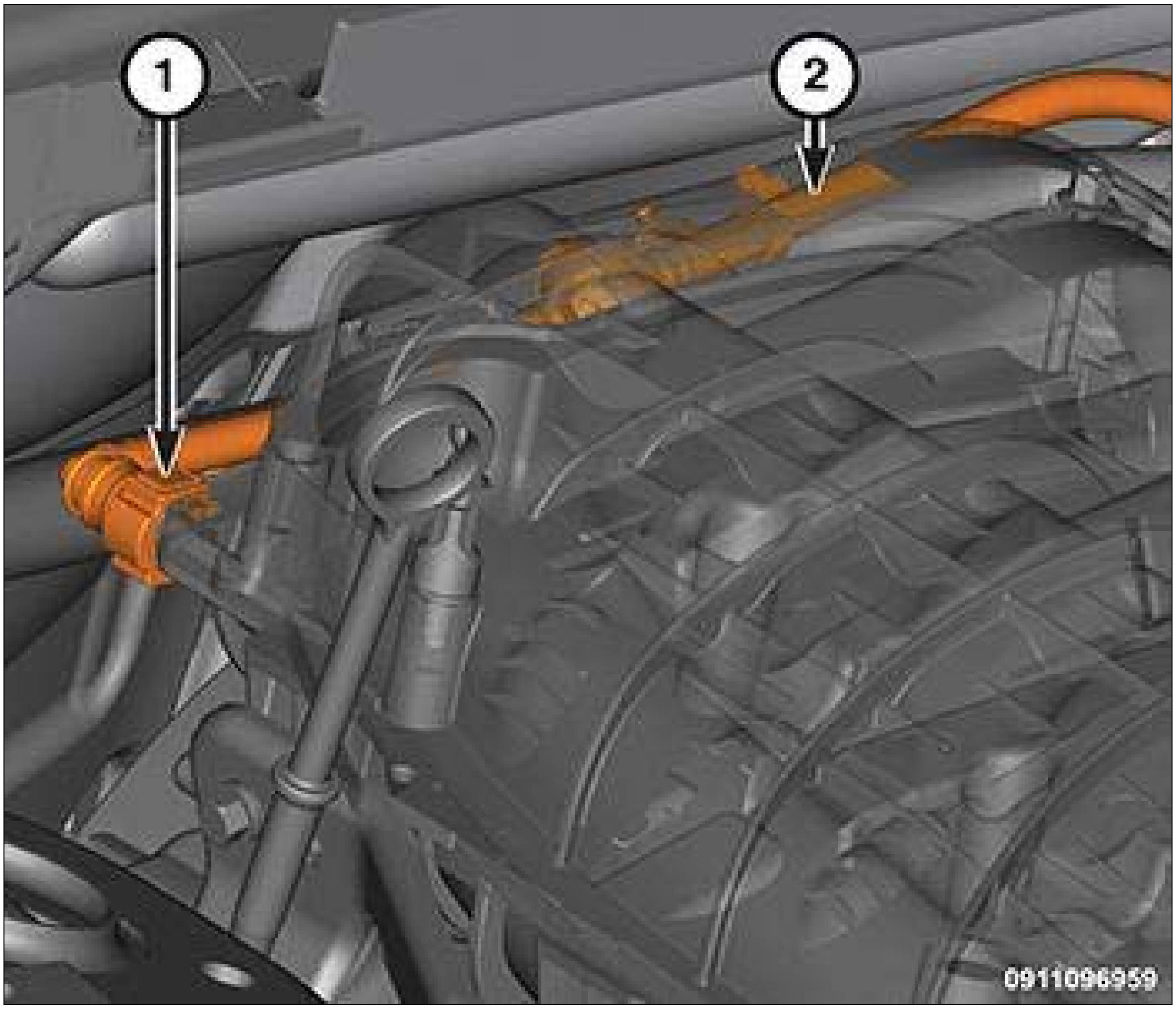
Fig 9: Upper Intake Manifold Support Bracket Bolts



Courtesy of CHRYSLER GROUP, LLC

13. Remove the two upper intake manifold support bracket bolts (1).

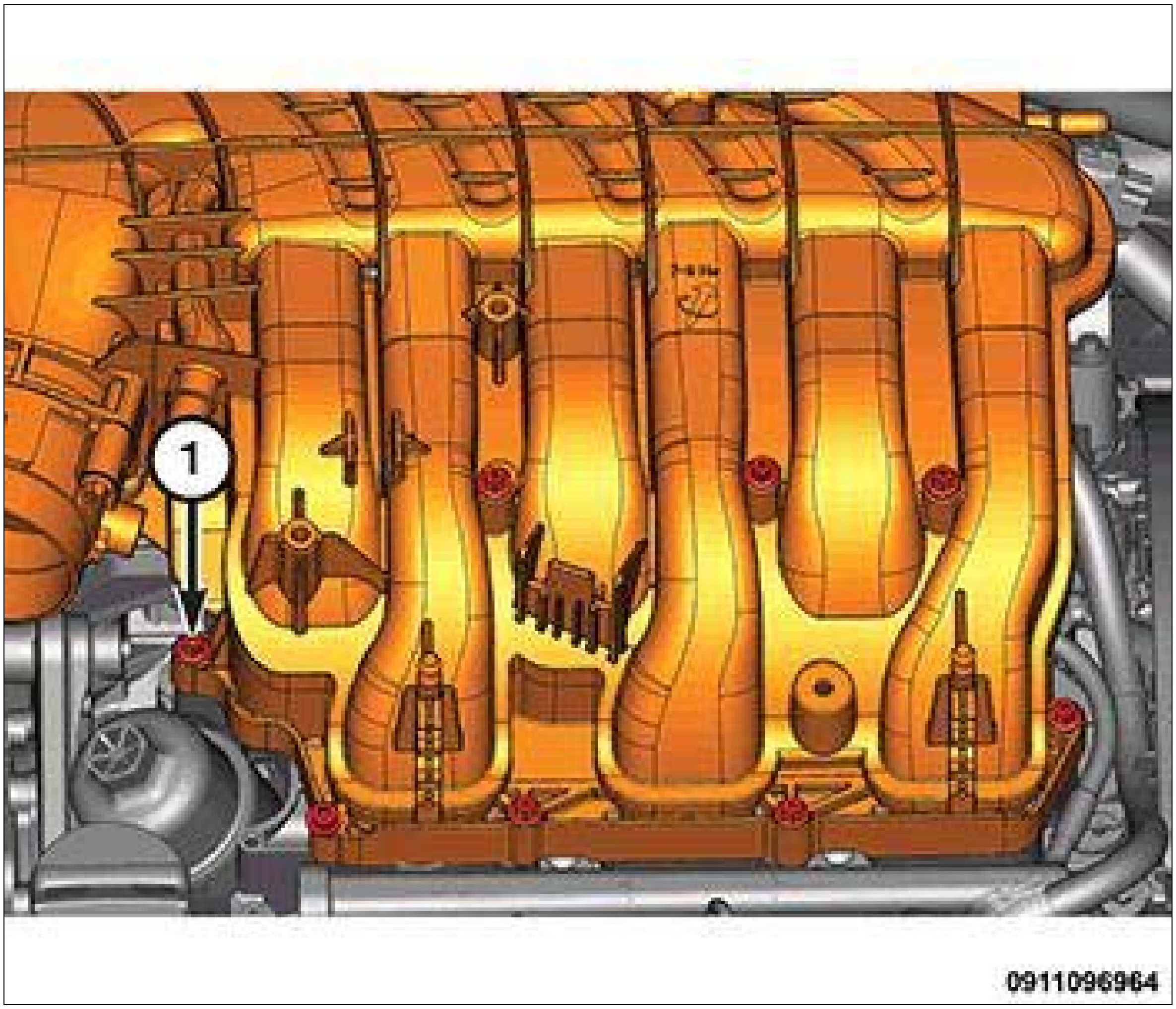
Fig 10: Brake Booster Vacuum Hose



Courtesy of CHRYSLER GROUP, LLC

14. Disconnect the brake booster vacuum hose (1) and position the hose (2) aside.

Fig 11: Upper Intake Manifold Bolts



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 fuel rail attachment bolts that are in close proximity of the upper intake manifold attaching bolts.

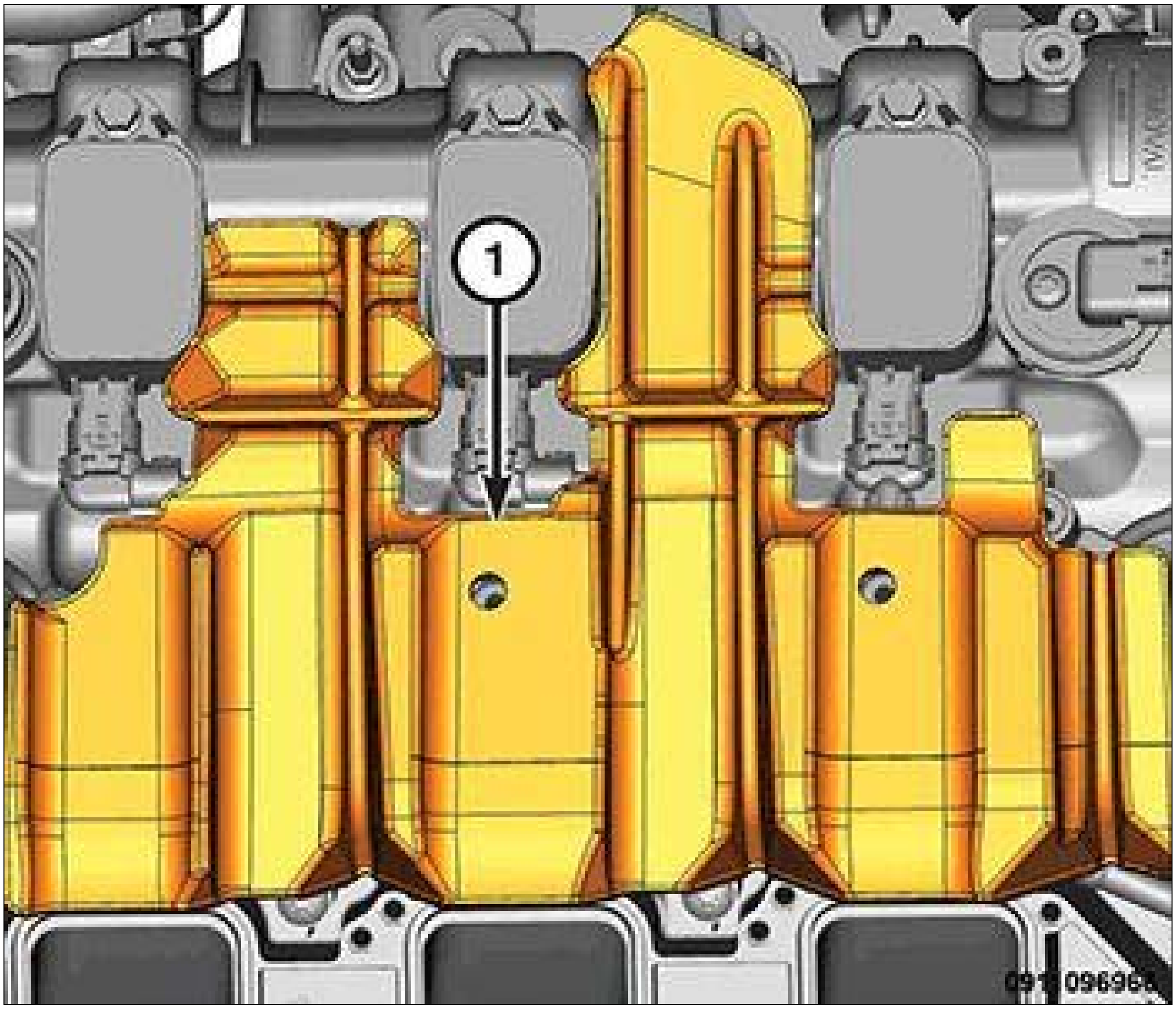
15. Remove the eight bolts (1) and the upper intake manifold.

Fig 12: Upper To Lower Intake Manifold Gaskets

Courtesy of CHRYSLER GROUP, LLC

16. Inspect the six upper to lower intake manifold gaskets, and reuse if no issue are found.
17. Cover the open intake ports to prevent debris from entering the engine.

Fig 13: Insulator



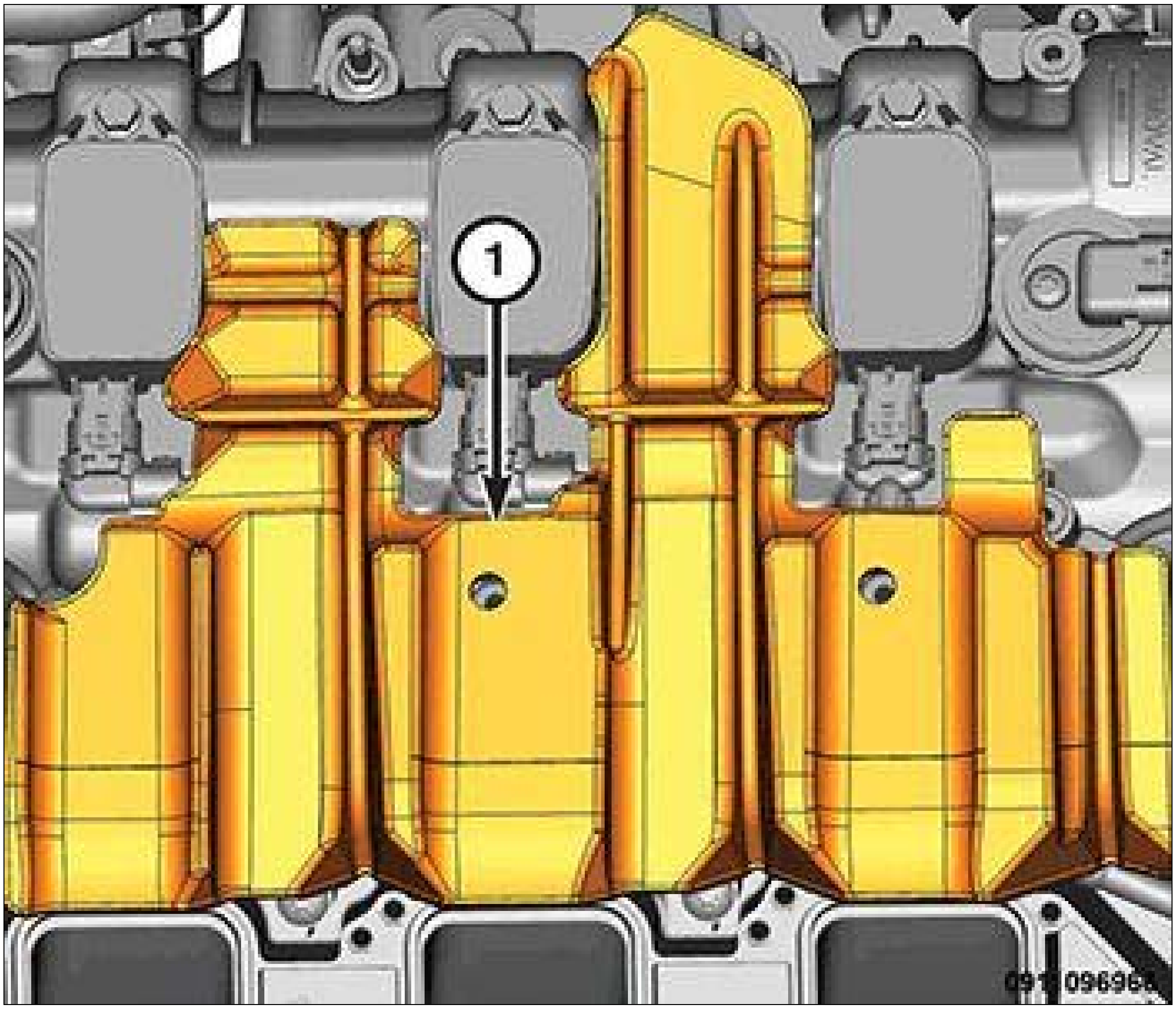
Courtesy of CHRYSLER GROUP, LLC

18. If necessary, remove the insulator (1) from the right cylinder head cover.

MANIFOLDS > MANIFOLD, INTAKE > REMOVAL > LOWER

1. Release the fuel system pressure. Refer to FUEL SYSTEM PRESSURE RELEASE .
2. Remove the upper intake manifold. Refer to MANIFOLD, INTAKE, REMOVAL .

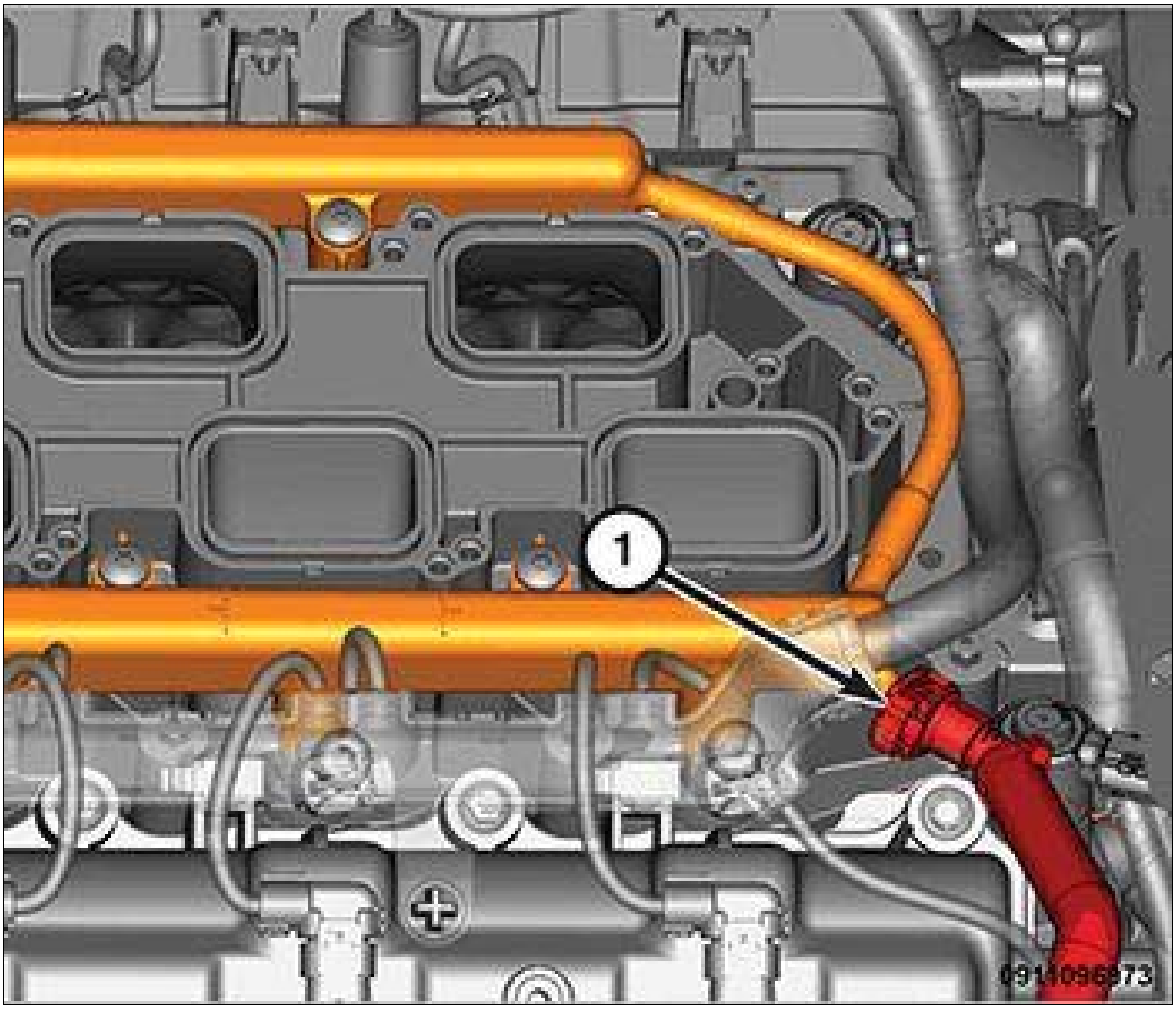
Fig 1: Insulator



Courtesy of CHRYSLER GROUP, LLC

3. Remove the insulator (1) from the right cylinder head cover.

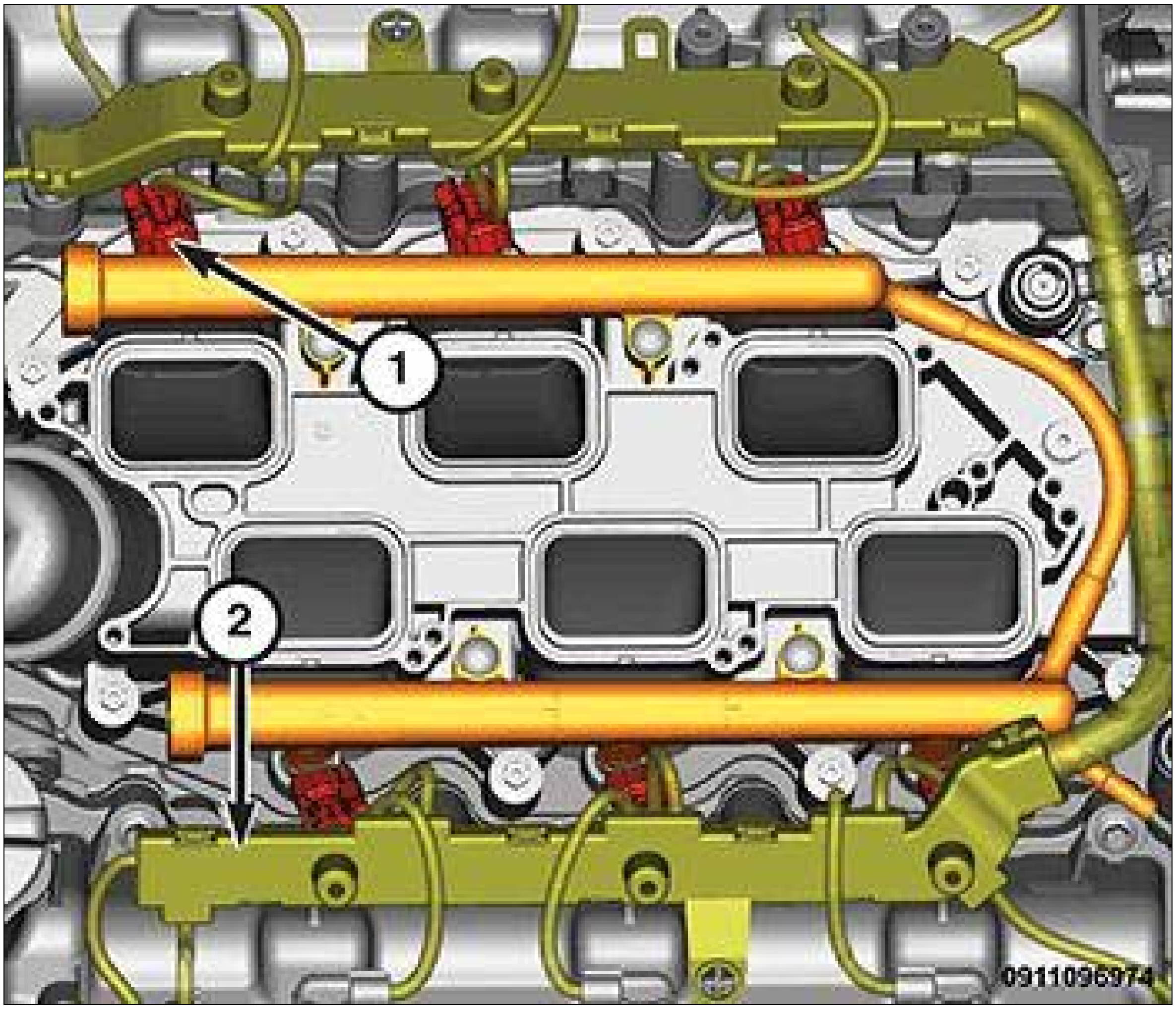
Fig 2: Fuel Supply Hose



Courtesy of CHRYSLER GROUP, LLC

4. Disconnect the fuel supply hose (1) from the fuel rail inlet. Refer to FITTING, QUICK CONNECT .

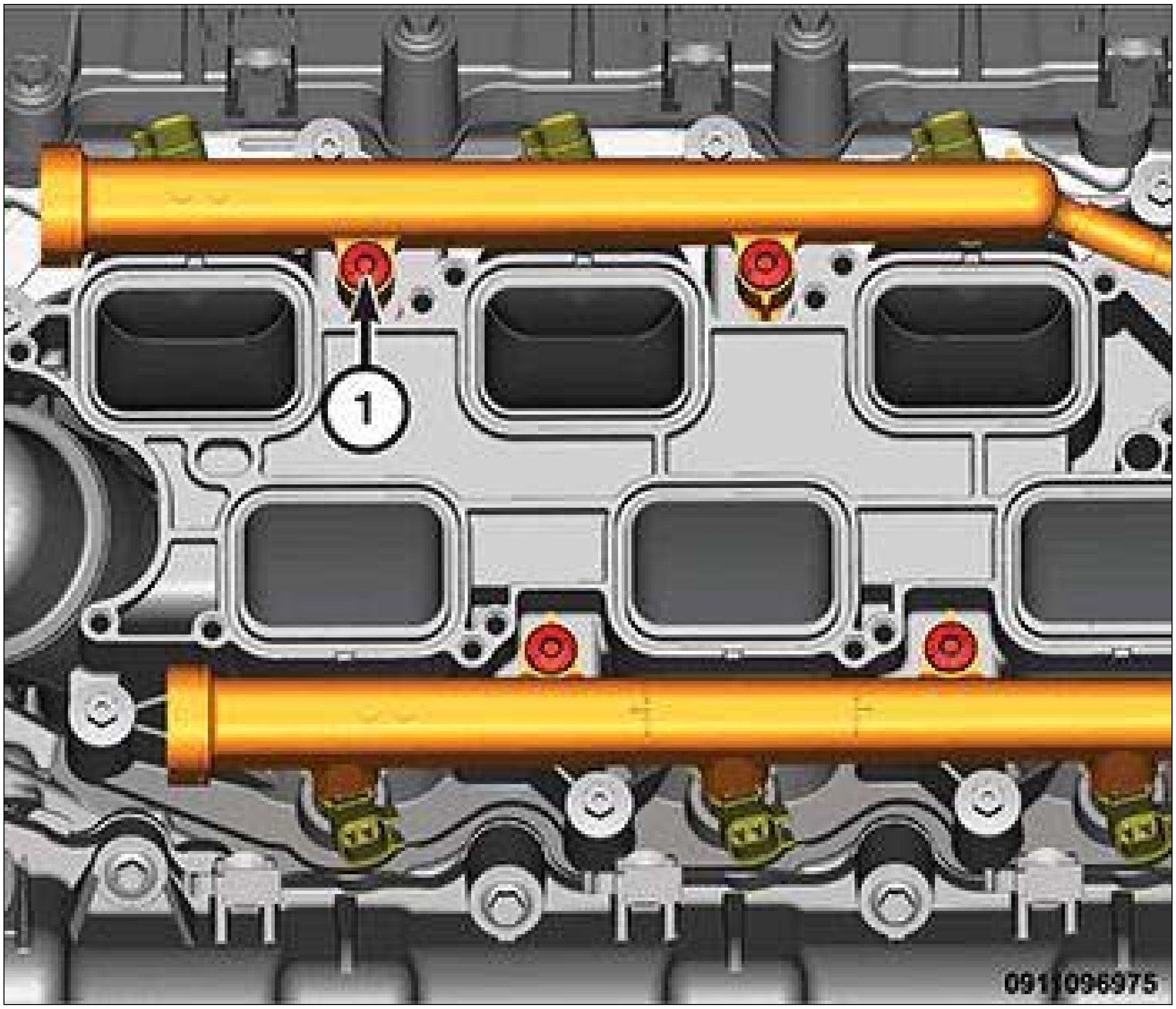
Fig 3: Fuel Injector Wire Harness Connectors & Wire Harness



Courtesy of CHRYSLER GROUP, LLC

5. Disconnect the fuel injector wire harness connectors (1) and position the wire harness (2) aside.

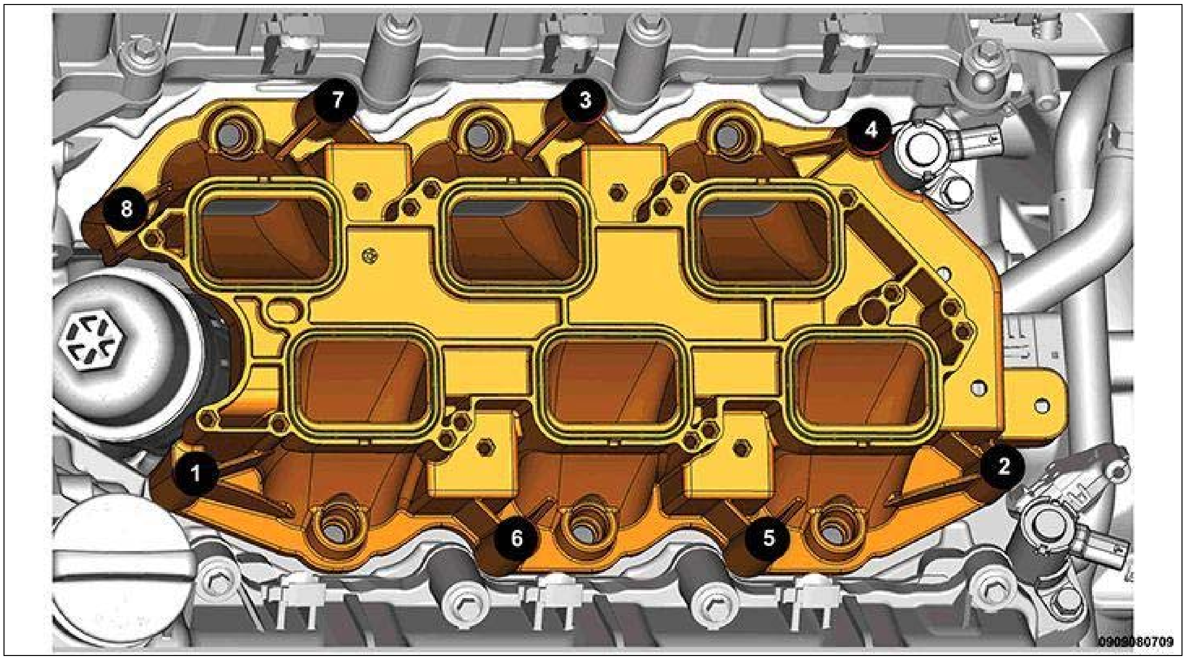
Fig 4: Fuel Rail Bolts



Courtesy of CHRYSLER GROUP, LLC

6. Remove the bolts (1), then lift the fuel rail and fuel injectors from the lower intake manifold.

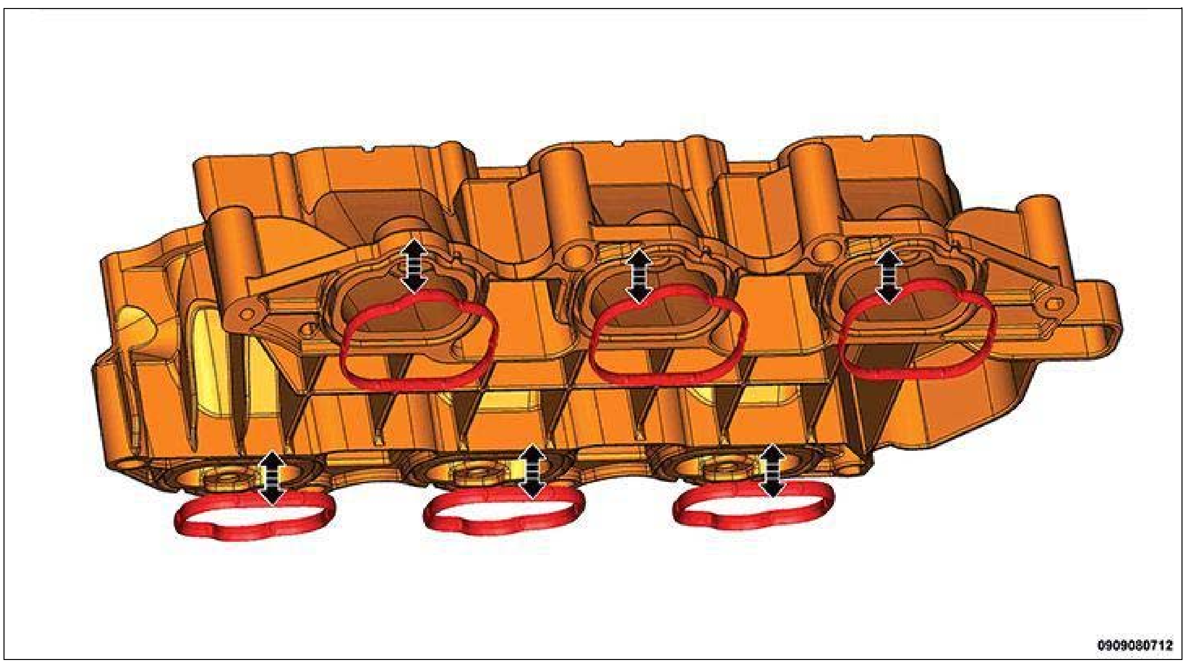
Fig 5: Lower Intake Manifold Bolt Removal & Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

7. Using the sequence shown in illustration, remove the bolts and lower intake manifold.

Fig 6: Lower Intake Manifold To Cylinder Head Gaskets

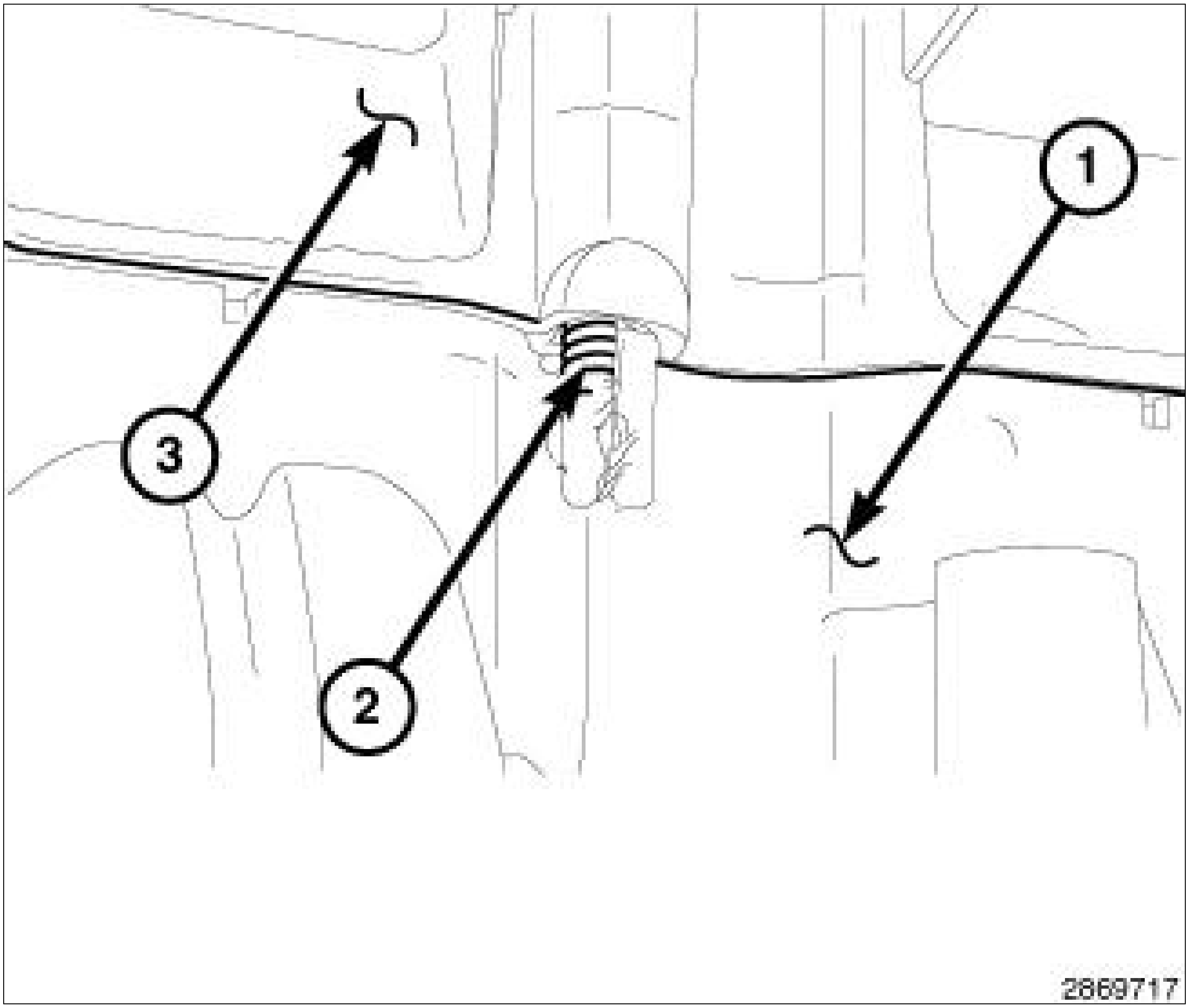


Courtesy of CHRYSLER GROUP, LLC

8. Inspect and reuse the six lower intake manifold to cylinder head gaskets if no issue are found.

MANIFOLDS > MANIFOLD, INTAKE > INSPECTION > INSPECTION

Fig 1: 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

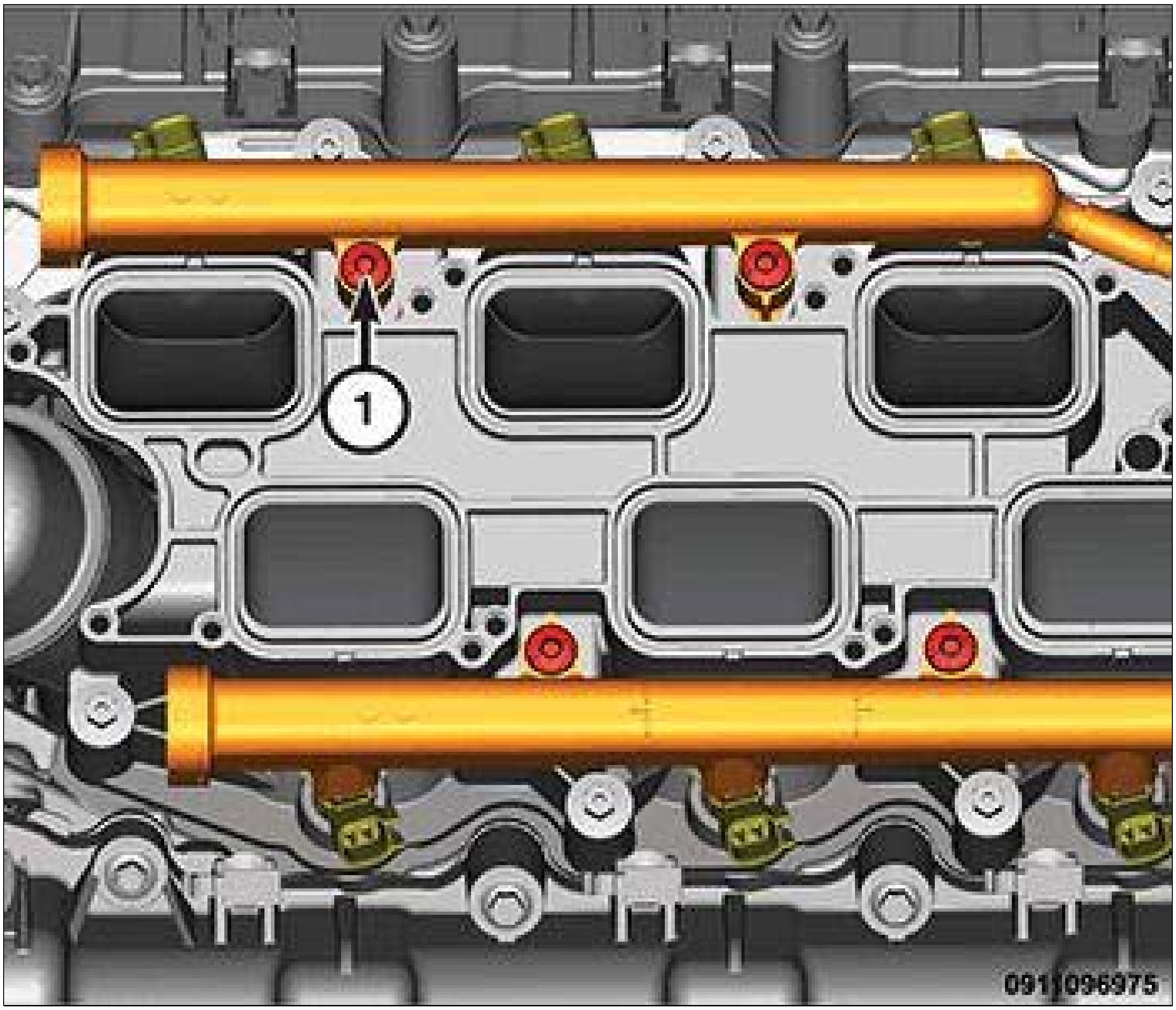
Check the lower intake manifold for:

- Damaged fuel injector ports

If either the upper or lower manifold exhibits any damaged or warped conditions, replace the manifold.

MANIFOLDS > MANIFOLD, INTAKE > INSTALLATION > UPPER

Fig 1: Fuel Rail Bolts



Courtesy of CHRYSLER GROUP, LLC

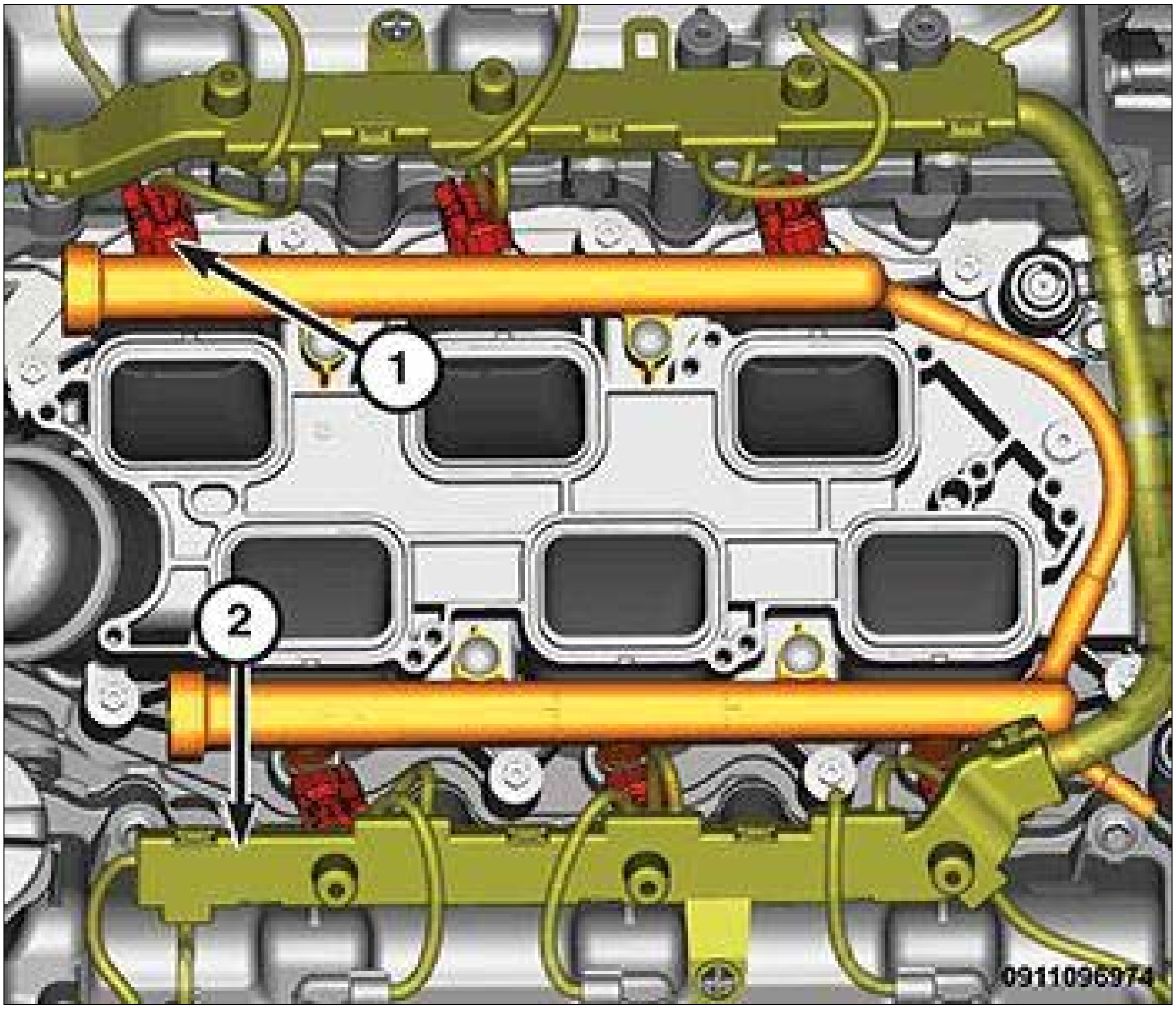
1. Prior to installing the upper intake manifold, verify that the four fuel rail bolts (1) were not inadvertently loosened. If loosened, the bolts must tightened in sequence. Refer to RAIL, FUEL, INSTALLATION .

Fig 2: Upper To Lower Intake Manifold Gaskets

Courtesy of CHRYSLER GROUP, LLC

2. Clean and inspect the sealing surfaces, the gaskets may be reused if no issues are found. Install the upper to lower intake manifold gaskets.

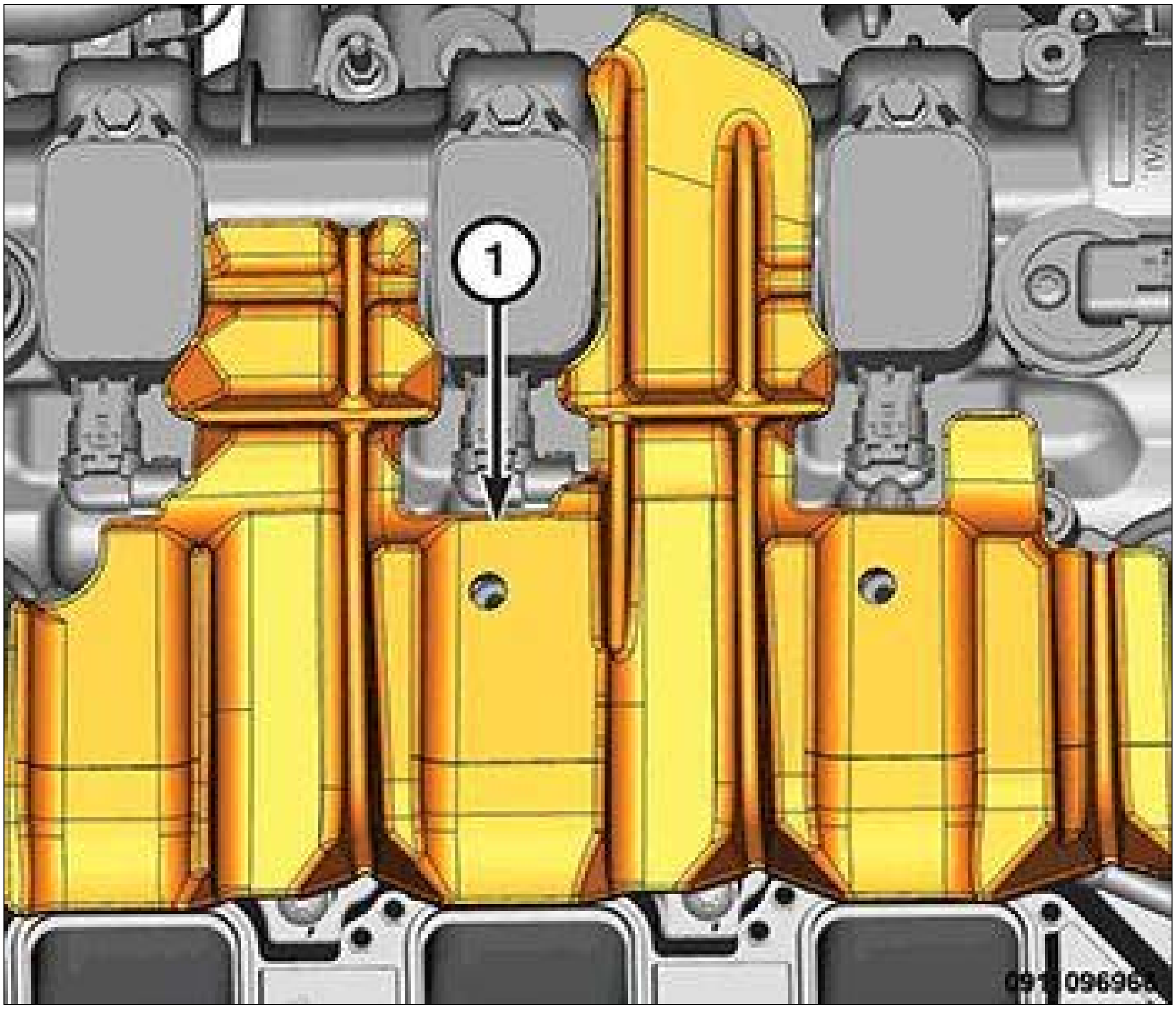
Fig 3: Fuel Injector Wire Harness Connectors & Wire Harness



Courtesy of CHRYSLER GROUP, LLC

3. Make sure the fuel injectors (1) and wiring harnesses (2) are in the correct position so that they don't interfere with the upper intake manifold installation.

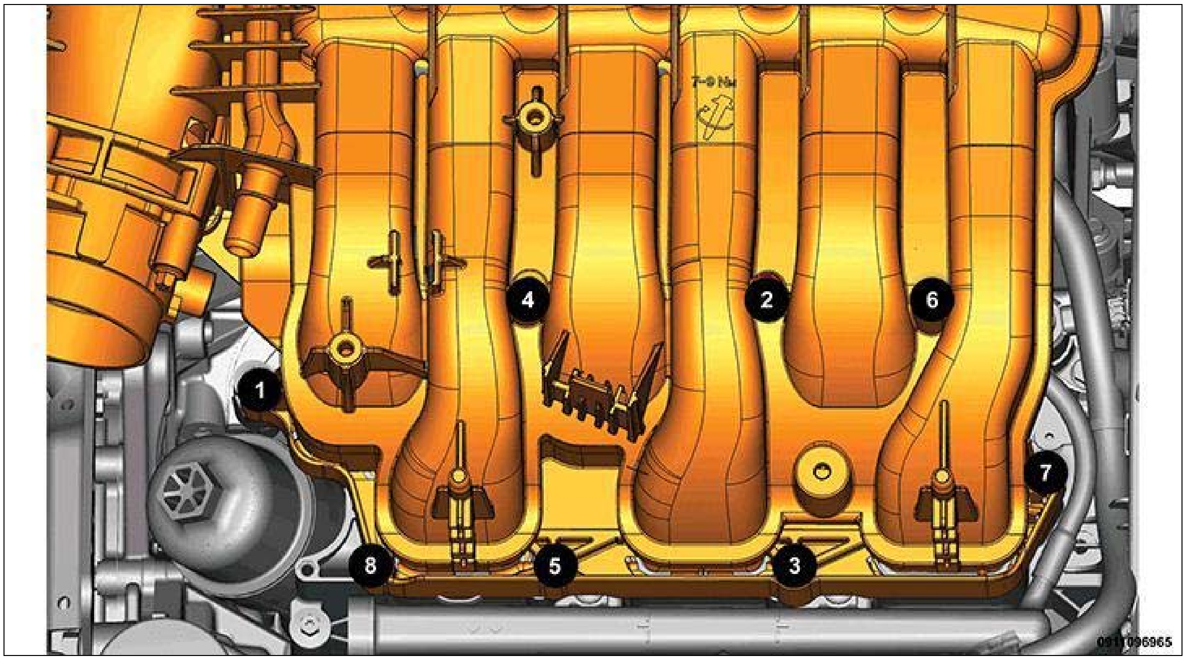
Fig 4: Insulator



Courtesy of CHRYSLER GROUP, LLC

4. If removed, install the insulator (1) on top of the right cylinder head cover.
5. Lift and hold the upper intake attaching bolts 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.

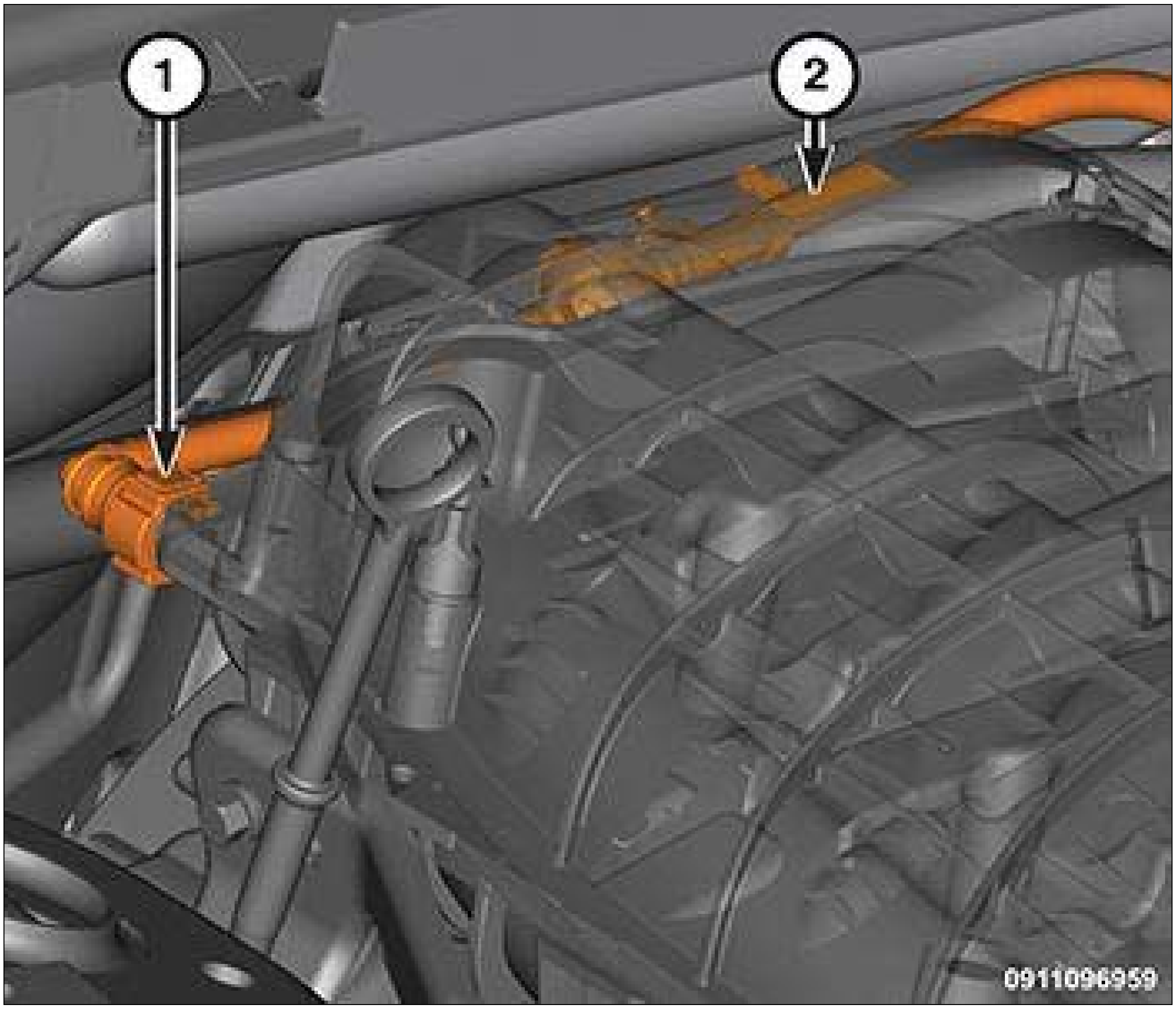
Fig 5: Upper Intake Manifold Bolts Tightening Sequence



Courtesy of CHRYSLER GROUP, LLC

6. Position the upper intake manifold onto the lower intake manifold so that the locating posts on the upper intake manifold align with corresponding holes in the lower intake manifold.
7. Install the eight upper intake manifold attaching bolts. Tighten the bolts in the sequence shown in illustration to the proper specification. Refer to TORQUE SPECIFICATIONS .

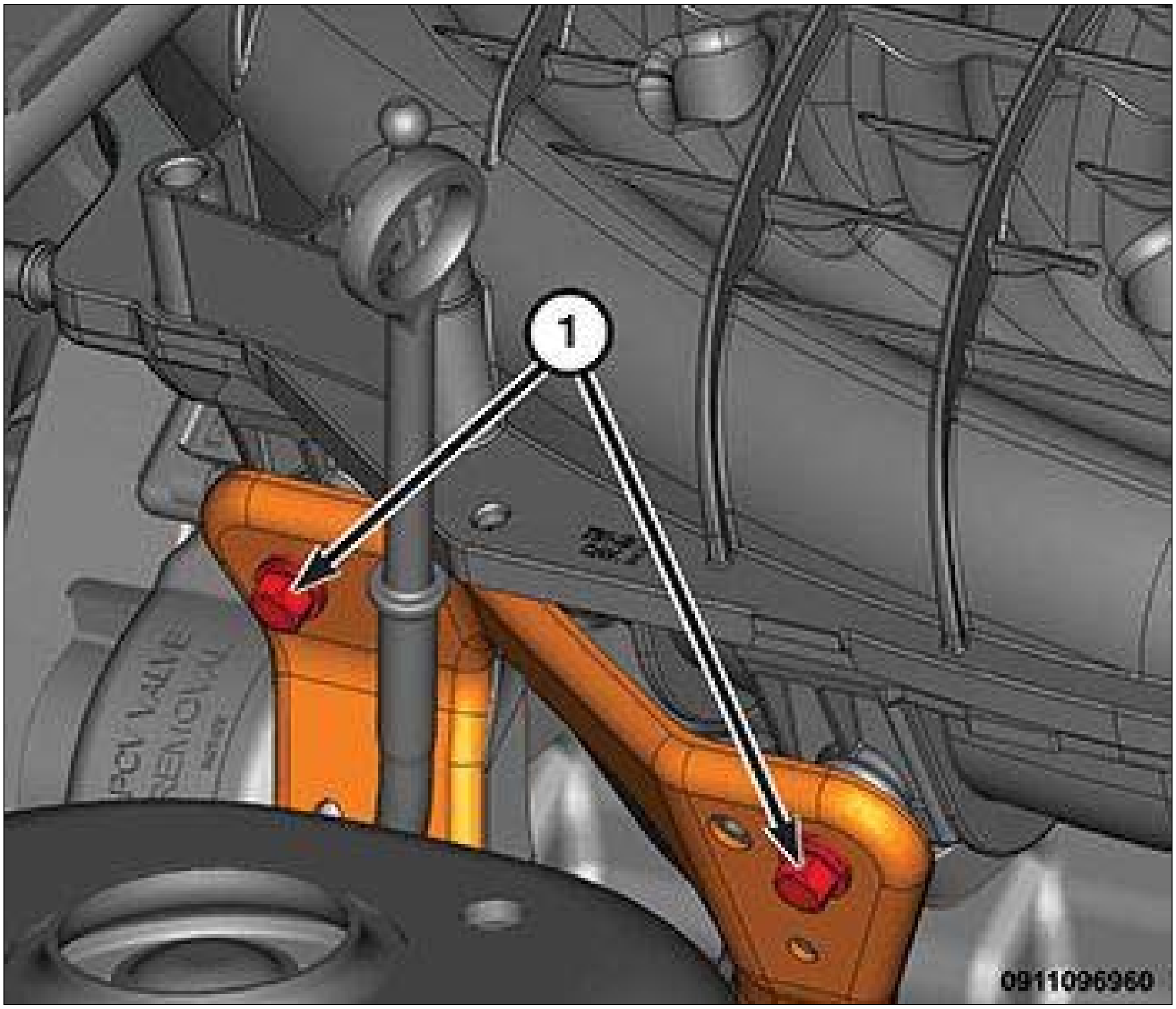
Fig 6: Brake Booster Vacuum Hose



Courtesy of CHRYSLER GROUP, LLC

8. Connect the brake vacuum booster hose (2) to the manifold (1).

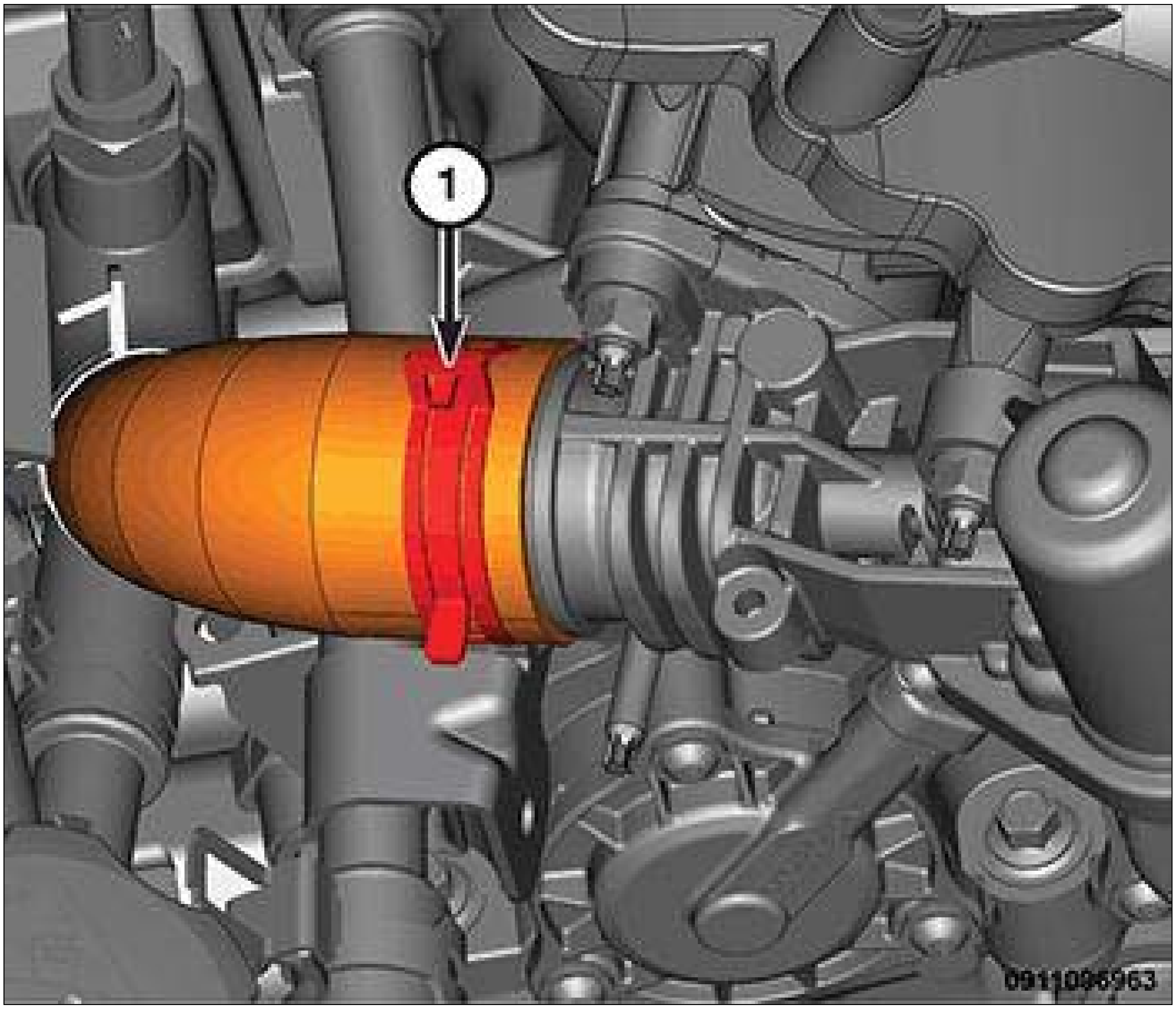
Fig 7: Upper Intake Manifold Support Bracket Bolts



Courtesy of CHRYSLER GROUP, LLC

9. Install the two upper intake manifold support bracket bolts (1) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

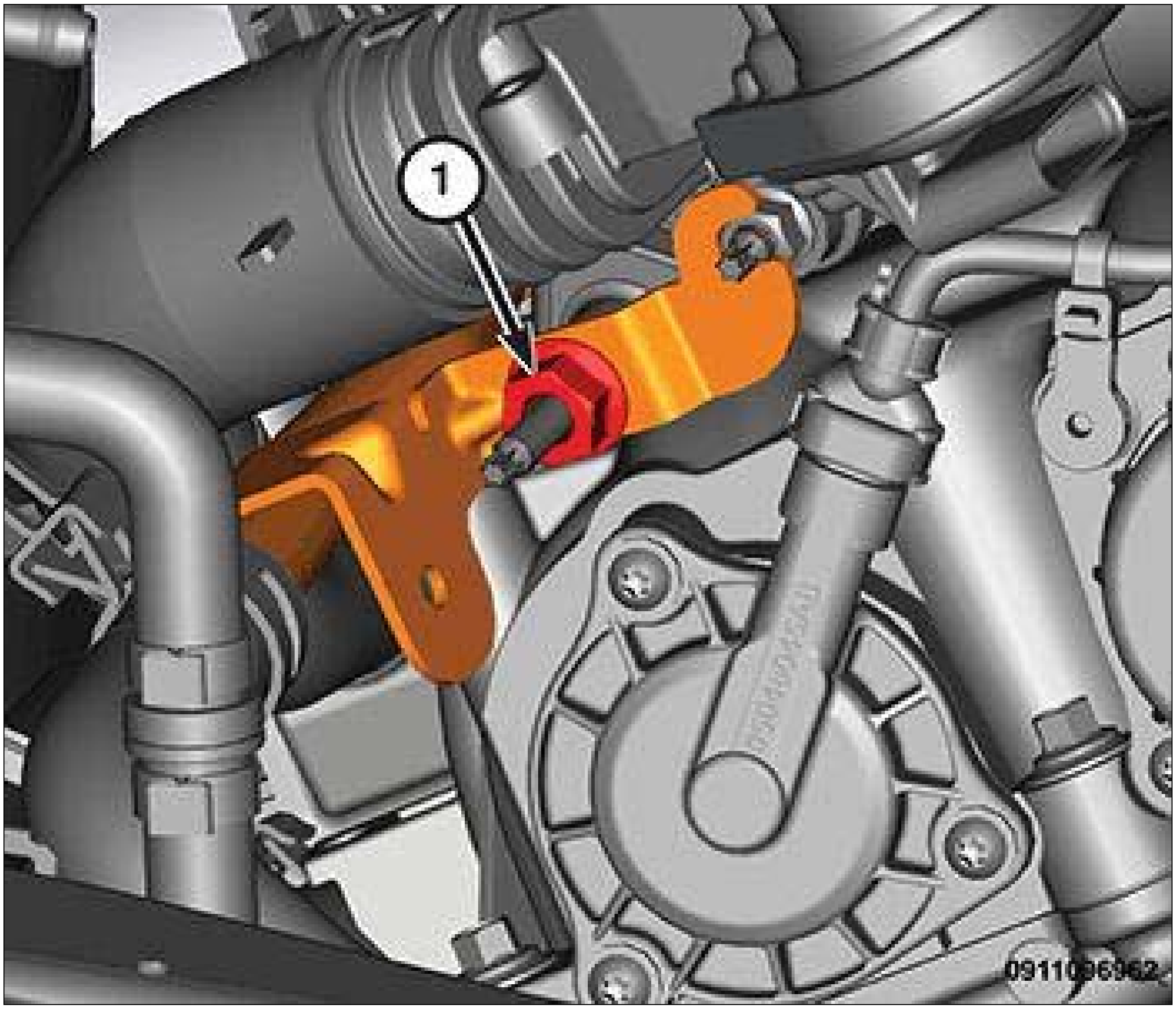
Fig 8: EGR Cooler Hose Clamp



Courtesy of CHRYSLER GROUP, LLC

10. Connect the EGR cooler hose (1) to the EGR valve.
11. Connect the EGR valve wire harness connector.

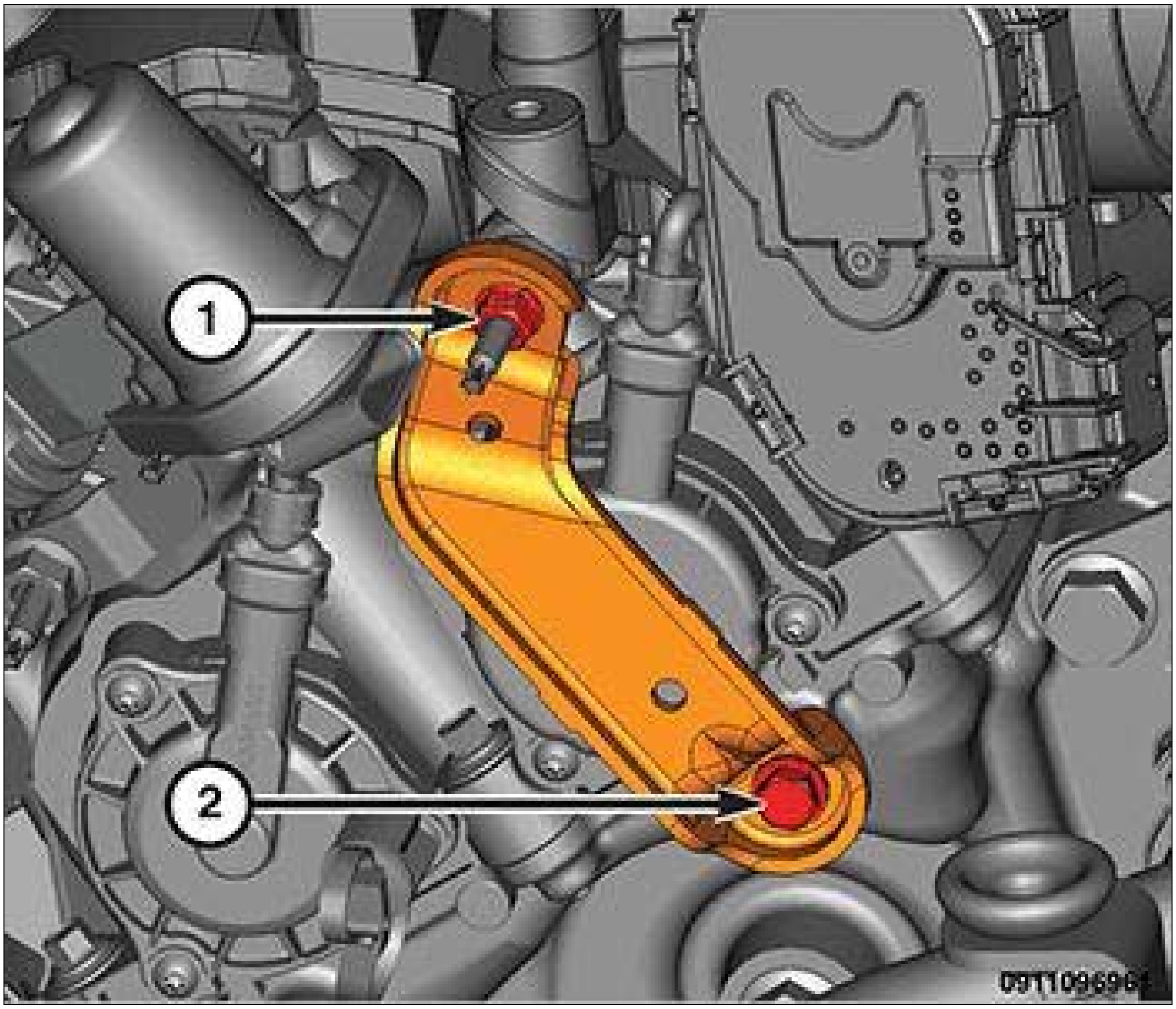
Fig 9: Coolant Tube Bracket Retaining Nut



Courtesy of CHRYSLER GROUP, LLC

12. Install the coolant tube bracket onto the studs and tighten the retaining nut (1) to the proper specification. Refer to TORQUE SPECIFICATIONS .

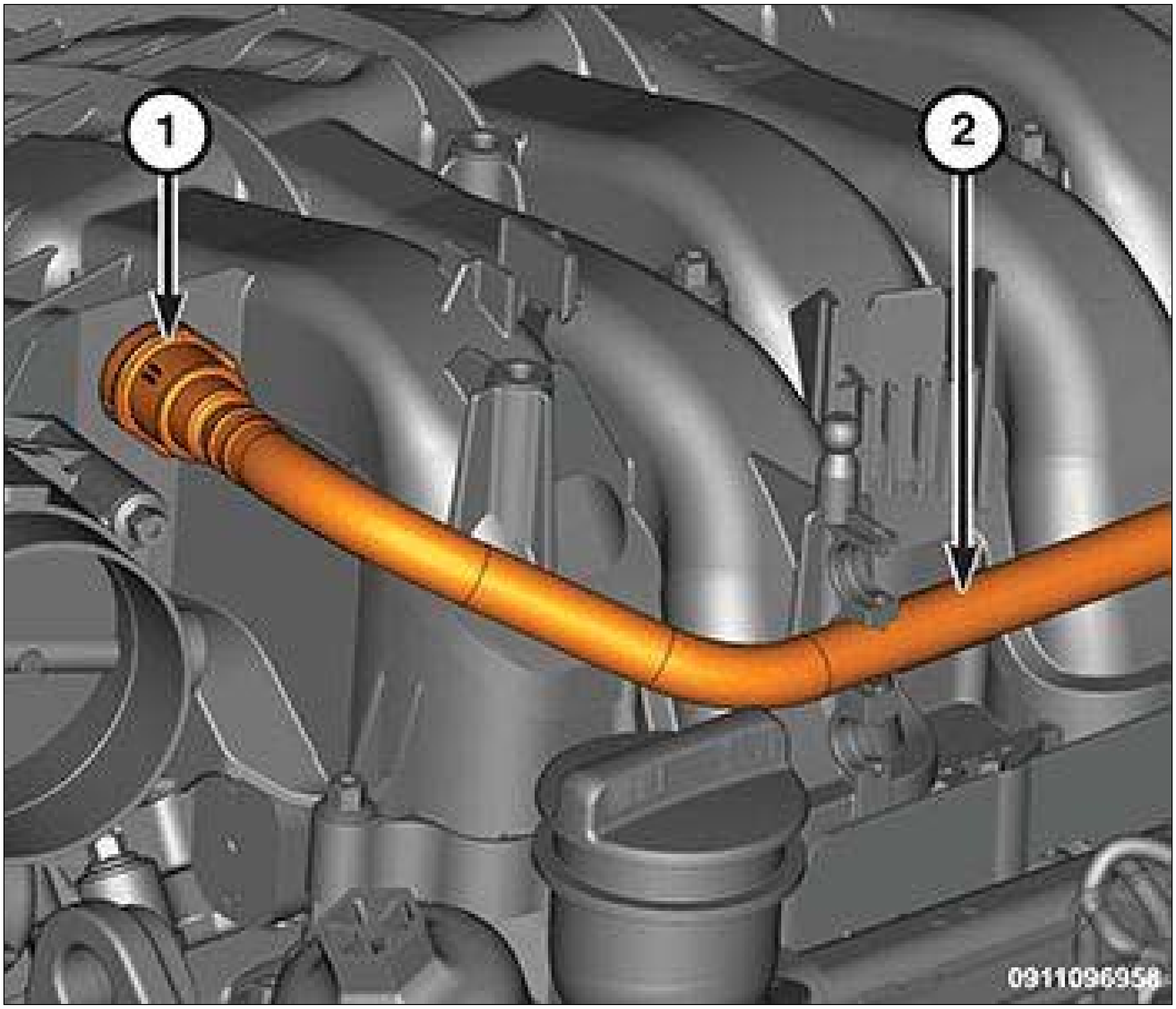
Fig 10: Front Support Bracket, Nut & Bolt



Courtesy of CHRYSLER GROUP, LLC

13. Install the support bracket and tighten the nut (1) and bolt (2) to the proper specification. Refer to TORQUE SPECIFICATIONS .

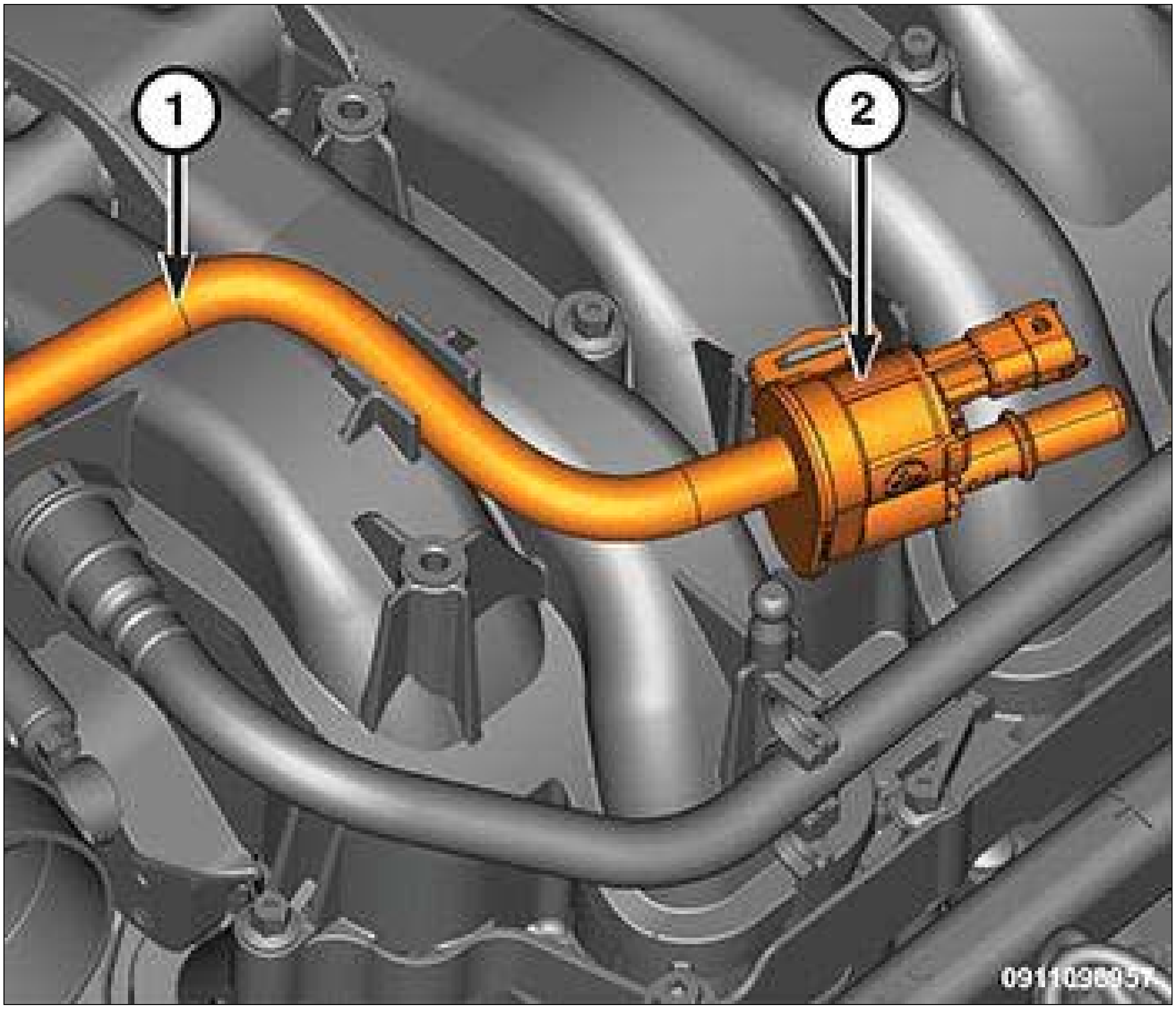
Fig 11: PCV Hose & Retaining Clips



Courtesy of CHRYSLER GROUP, LLC

14. Connect the Positive Crankcase Ventilation (PCV) hose (2) to the intake manifold (1).

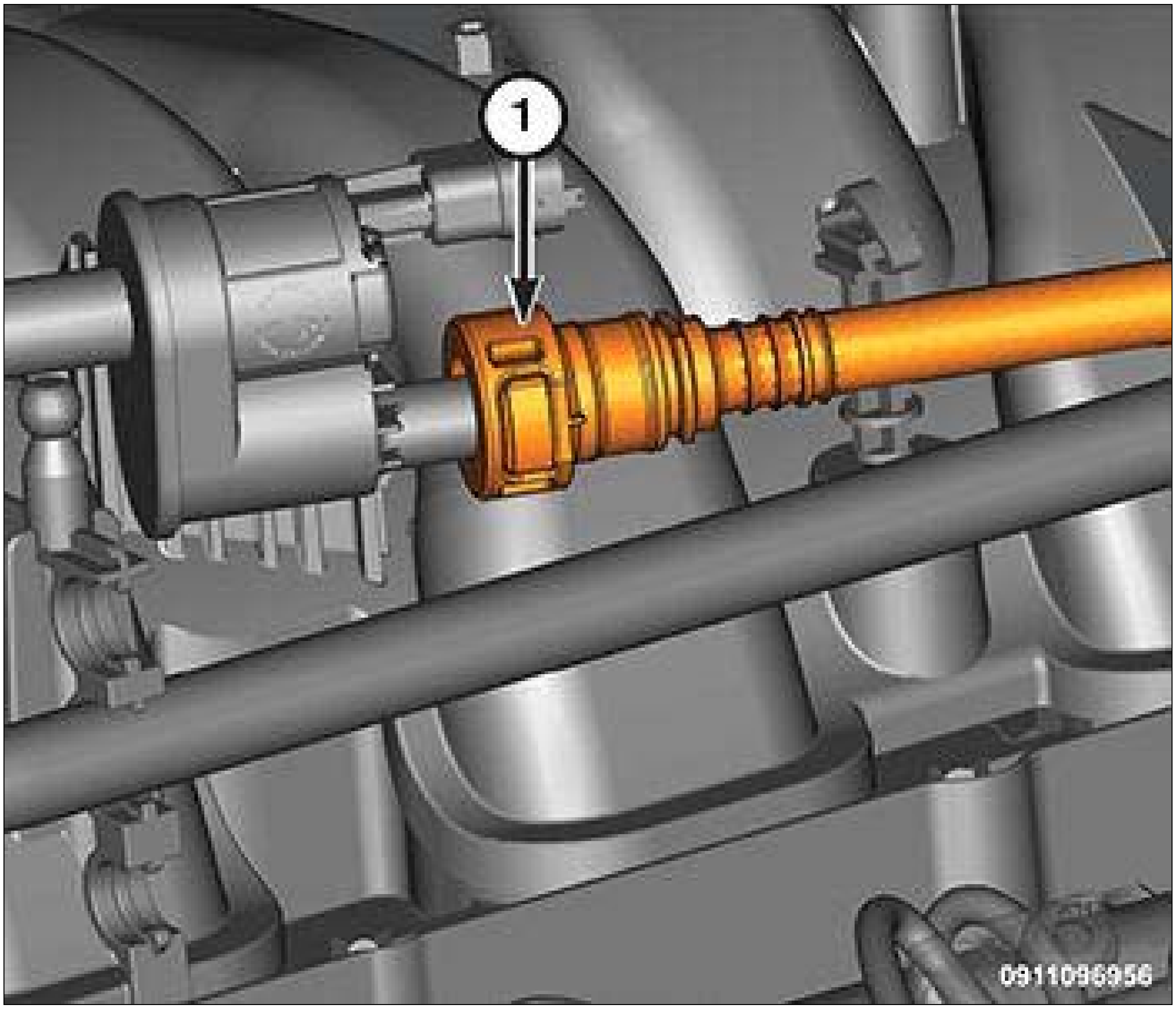
Fig 12: Purge Solenoid Vacuum Hose & Purge Solenoid



Courtesy of CHRYSLER GROUP, LLC

15. If removed, connect the evaporative purge solenoid hose (1) and evaporative purge solenoid (2) to the intake manifold.

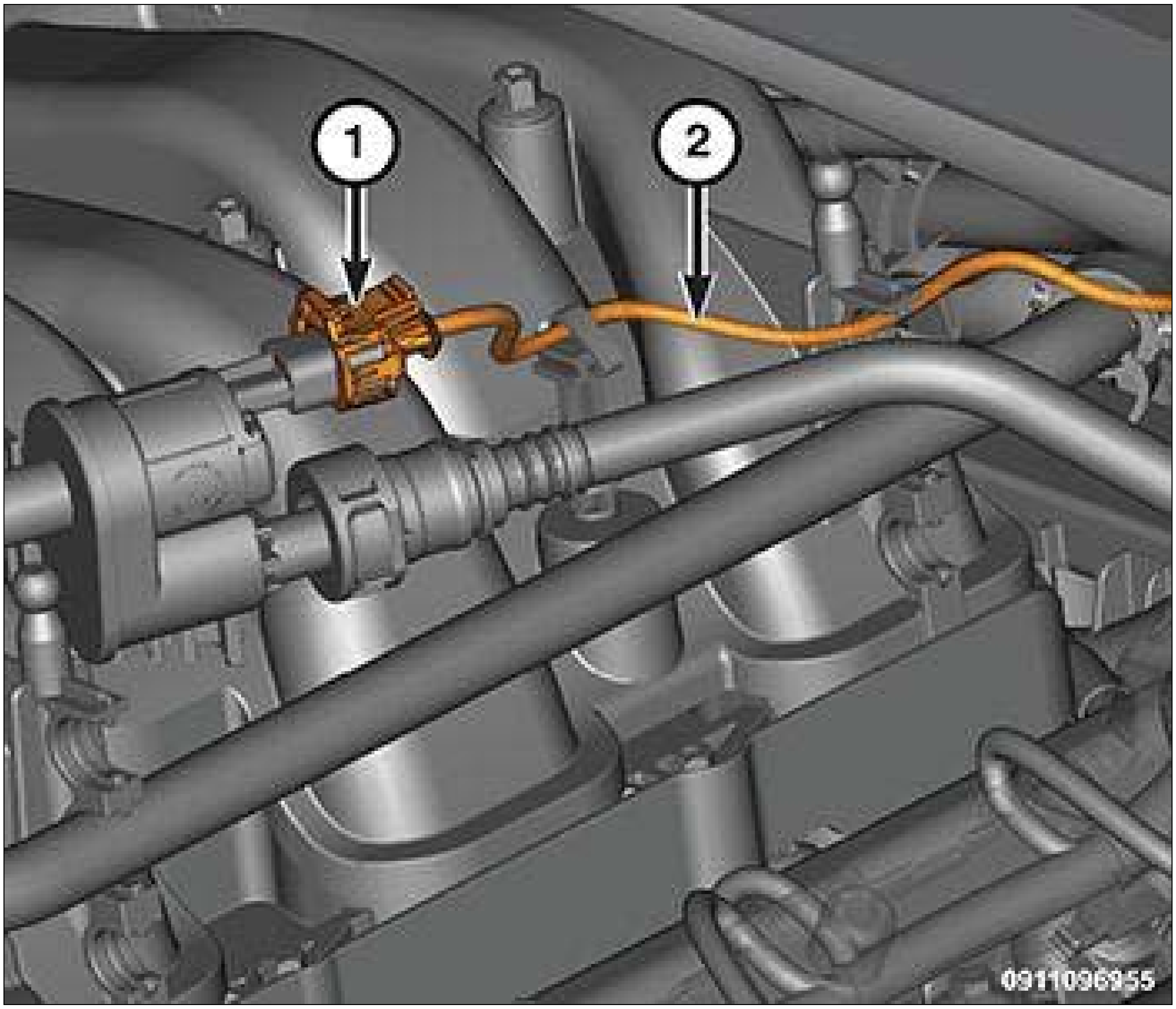
Fig 13: Vapor Purge Line



Courtesy of CHRYSLER GROUP, LLC

16. Connect the vapor purge line (1) to the solenoid.

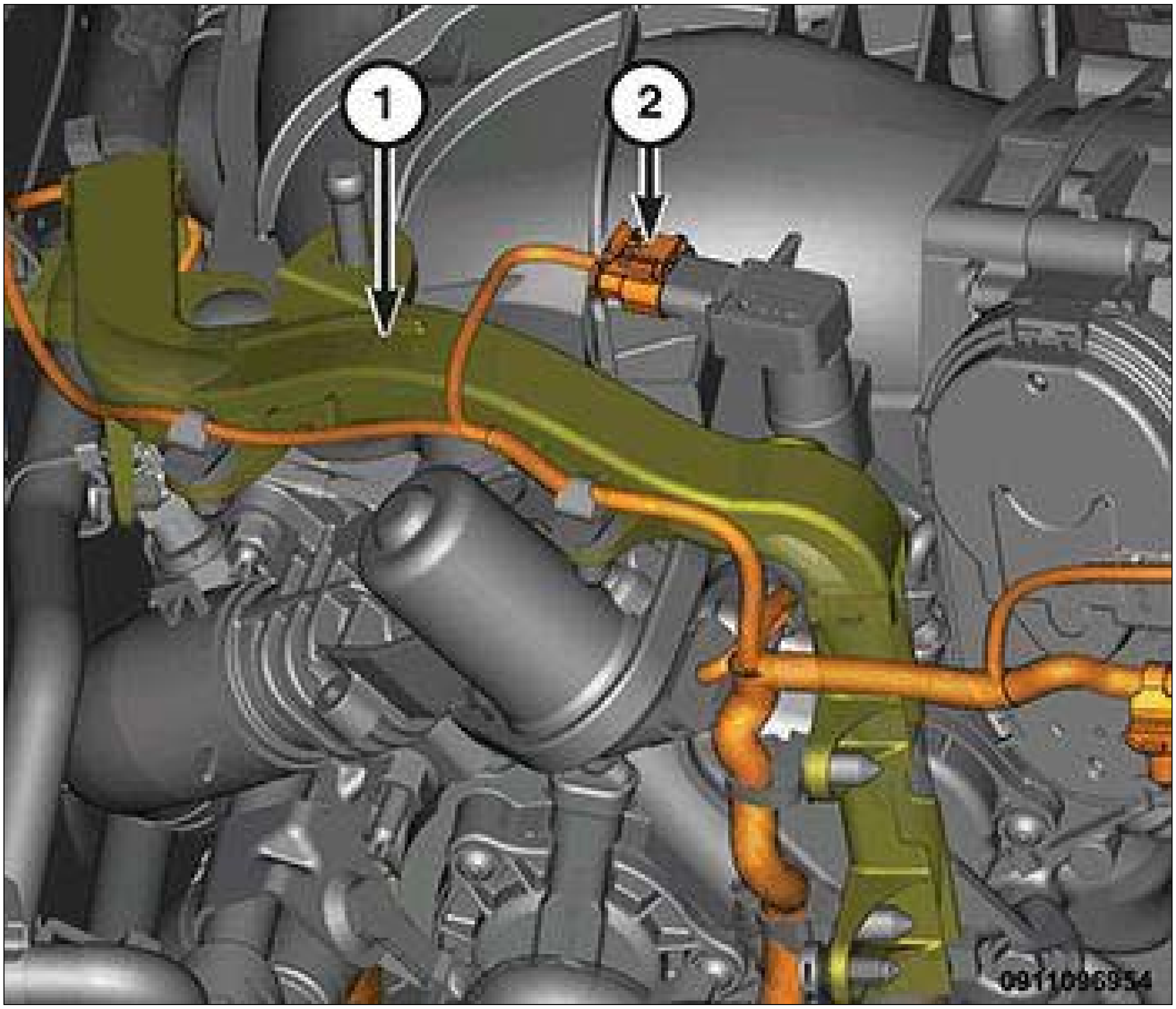
Fig 14: Vapor Purge Line & Wire Harness Connector



Courtesy of CHRYSLER GROUP, LLC

17. Connect the evaporative purge solenoid wire harness connector (1) and attach the wire harness retainer (2) to the manifold.

Fig 15: Wire Harness Retainer & Front Engine Wire Harness Connectors

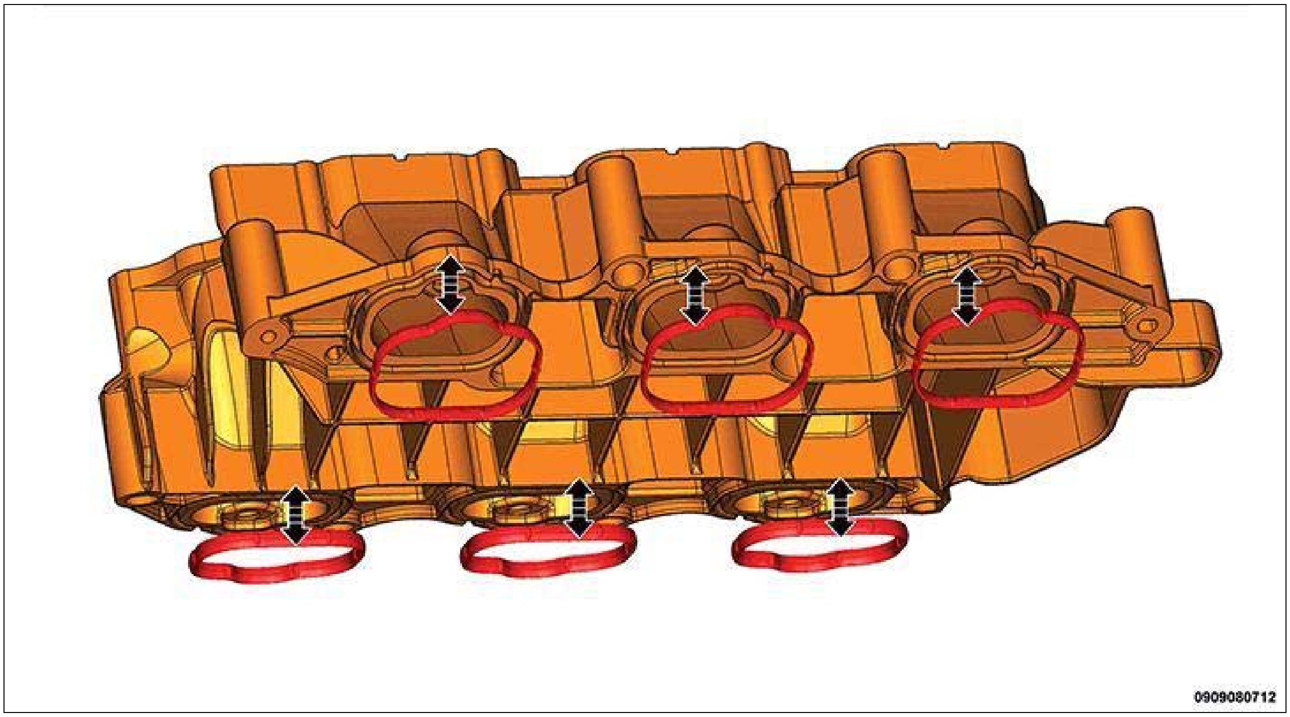


Courtesy of CHRYSLER GROUP, LLC

18. Connect the front engine wire harness connectors (2) and attach the wire harness retainer (1) to the manifold.
19. Install the air cleaner intake body. Refer to BODY, AIR CLEANER, INSTALLATION .
20. Connect the negative battery cable.
21. Install the engine cover. Refer to COVER, ENGINE, INSTALLATION .

MANIFOLDS > MANIFOLD, INTAKE > INSTALLATION > LOWER

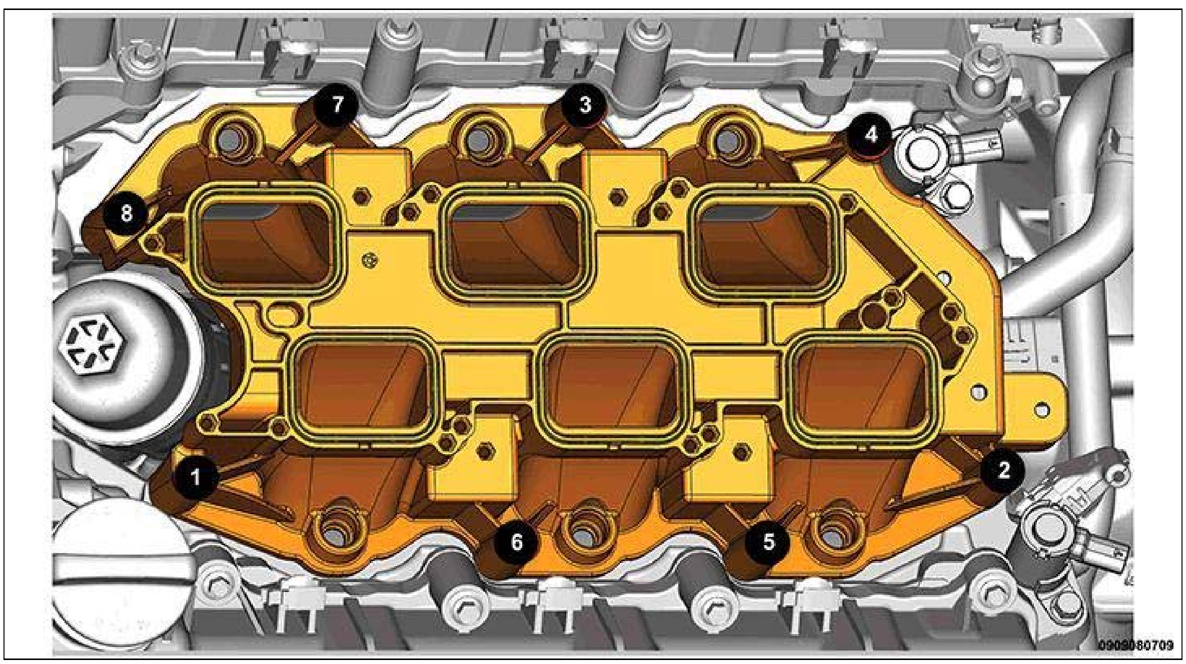
Fig 1: Lower Intake Manifold To Cylinder Head Gaskets



Courtesy of CHRYSLER GROUP, LLC

1. Clean and inspect the sealing surfaces, the gaskets may be reused if no issues are found. Install the lower intake manifold to cylinder head gaskets.

   Fig 2: Lower Intake Manifold Bolt Removal & Tightening Sequence

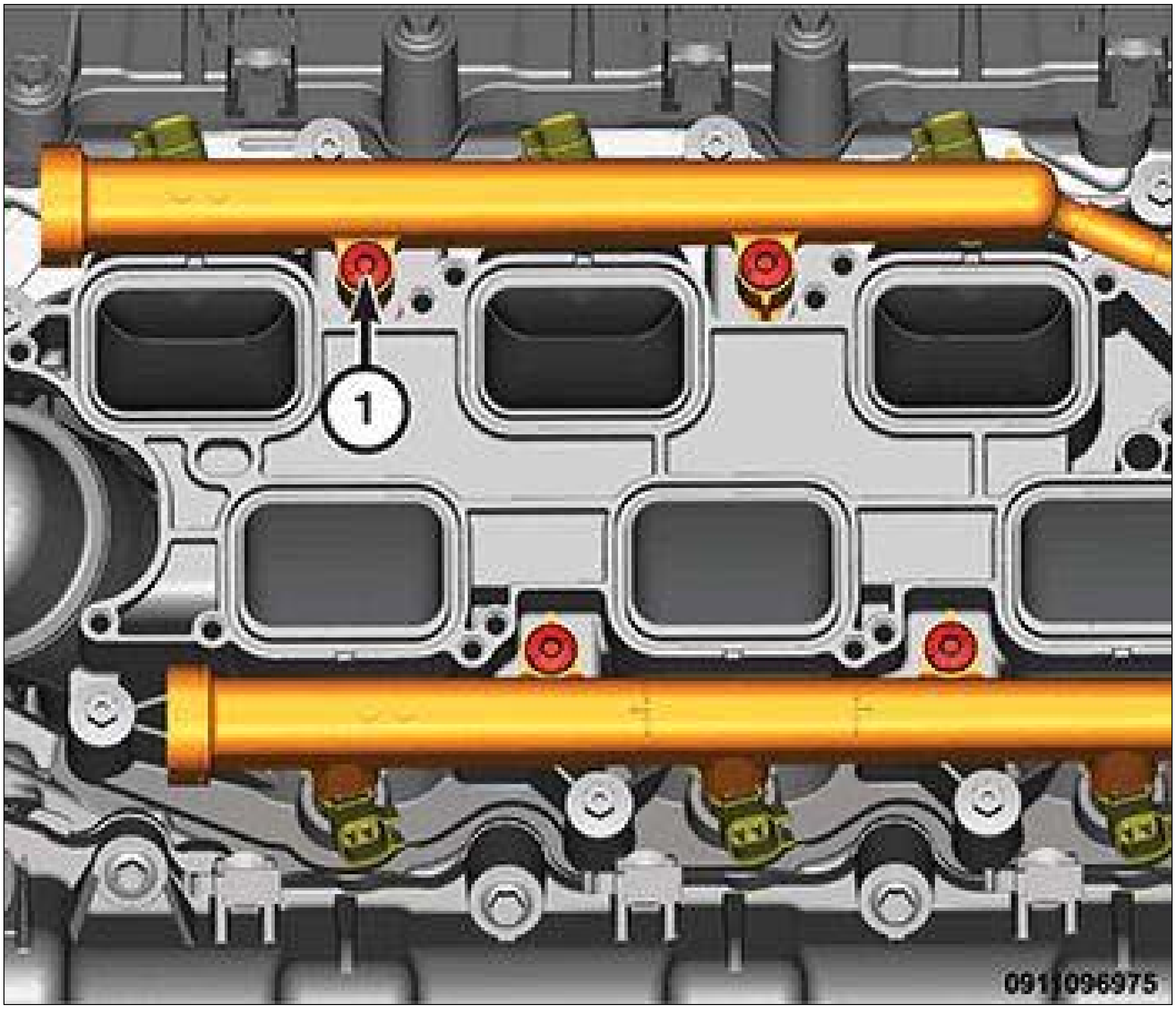
   Courtesy of CHRYSLER GROUP, LLC

2. Position the lower intake manifold on the cylinder head surfaces.

3. Tighten the bolts to the proper specification in the sequence shown in illustration. Refer to

TORQUE SPECIFICATIONS .

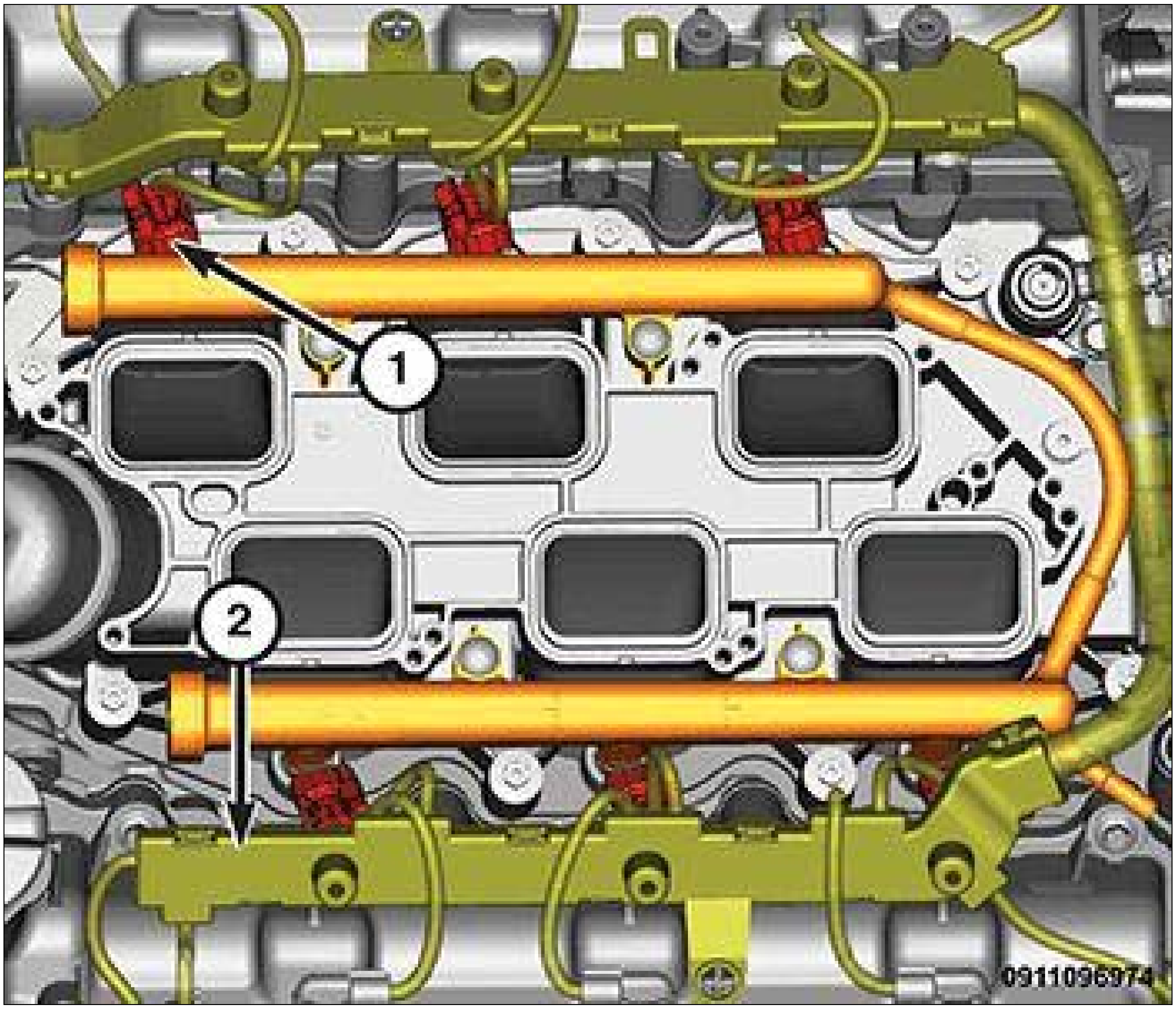
Fig 3: Fuel Rail Bolts



Courtesy of CHRYSLER GROUP, LLC

4. Install the fuel injectors and the fuel rail to the lower intake manifold. Tighten the bolts (1) to the proper specification. Refer to TORQUE SPECIFICATIONS .

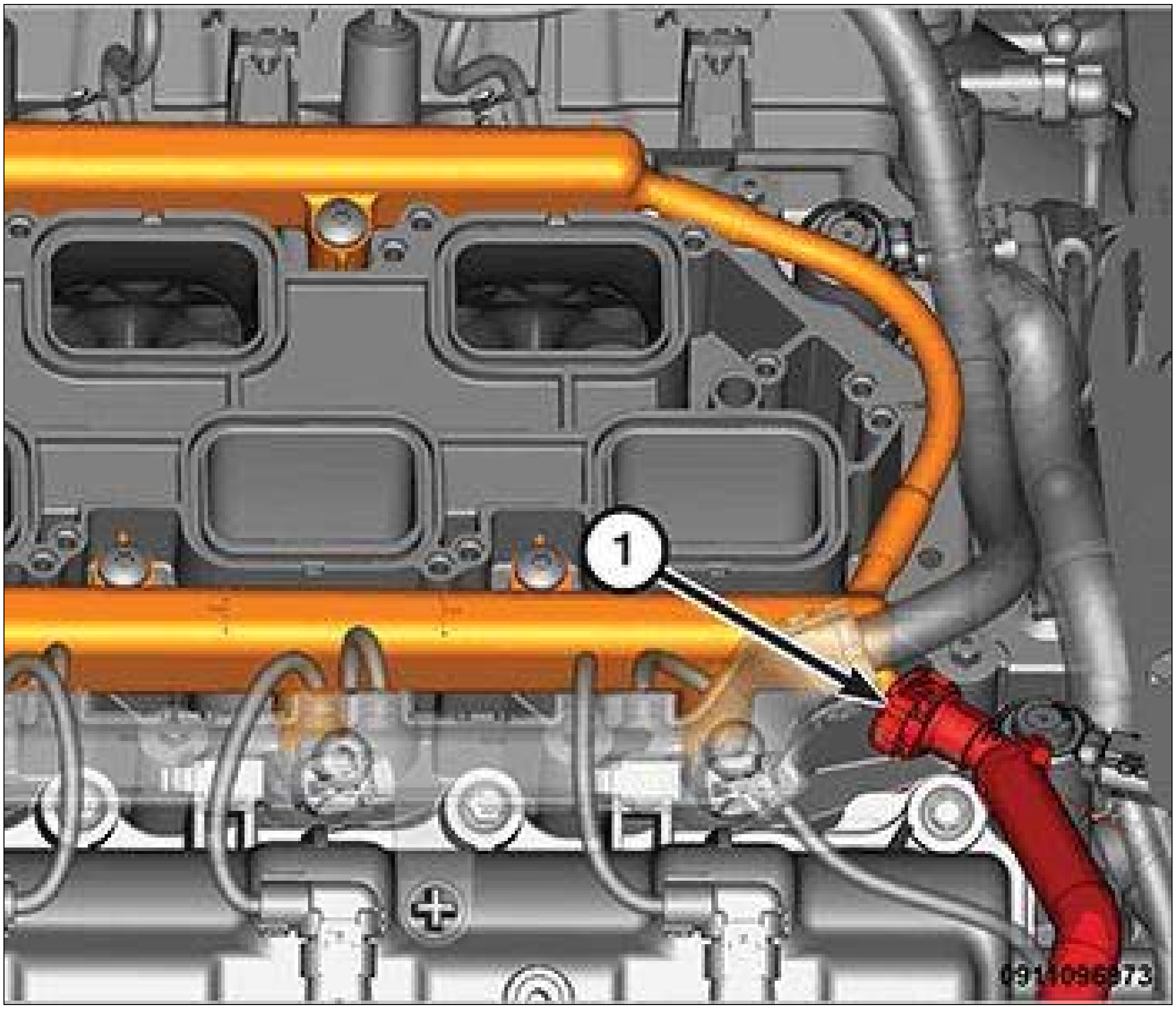
Fig 4: Fuel Injector Wire Harness Connectors & Wire Harness



Courtesy of CHRYSLER GROUP, LLC

5. Position the wire harness (2) and connect the fuel injector wire harness connectors (1).

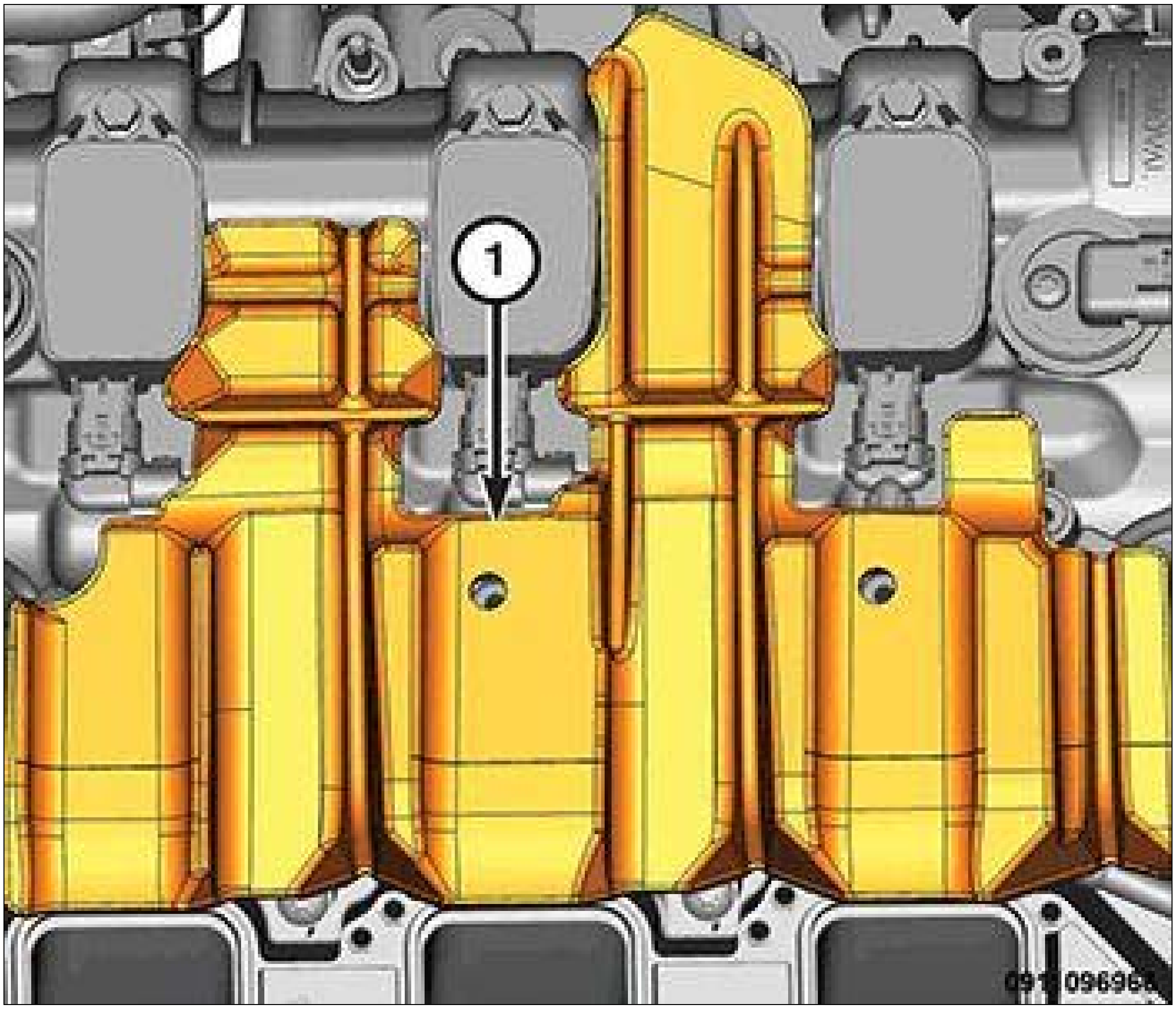
Fig 5: Fuel Supply Hose



Courtesy of CHRYSLER GROUP, LLC

6. Connect the fuel supply hose (1) to the fuel rail. Refer to FITTING, QUICK CONNECT .

Fig 6: Insulator

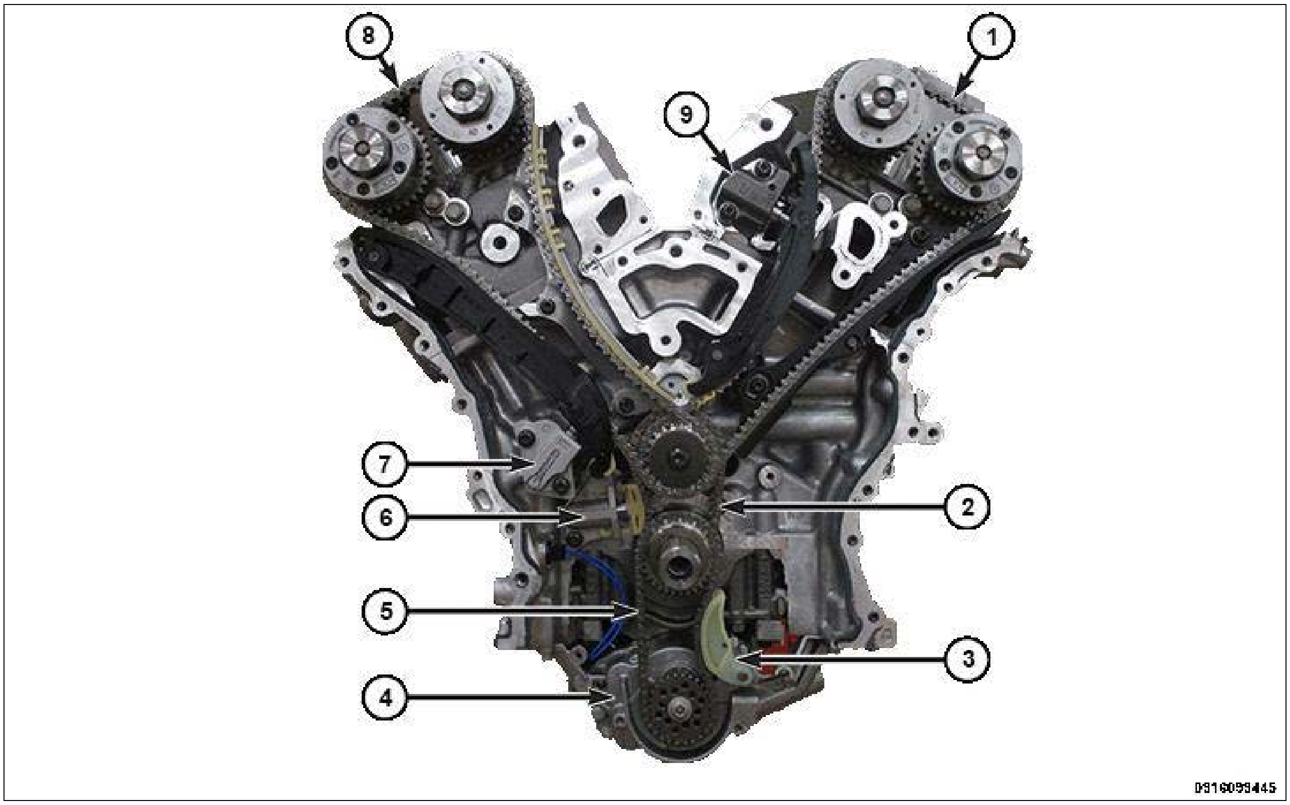


Courtesy of CHRYSLER GROUP, LLC

7. Install the insulator (1) on top of the right cylinder head cover.
8. Install the upper intake manifold. Refer to MANIFOLD, INTAKE, INSTALLATION .
9. Start the engine and check for leaks.

VALVE TIMING > DESCRIPTION > DESCRIPTION

Fig 1: 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.

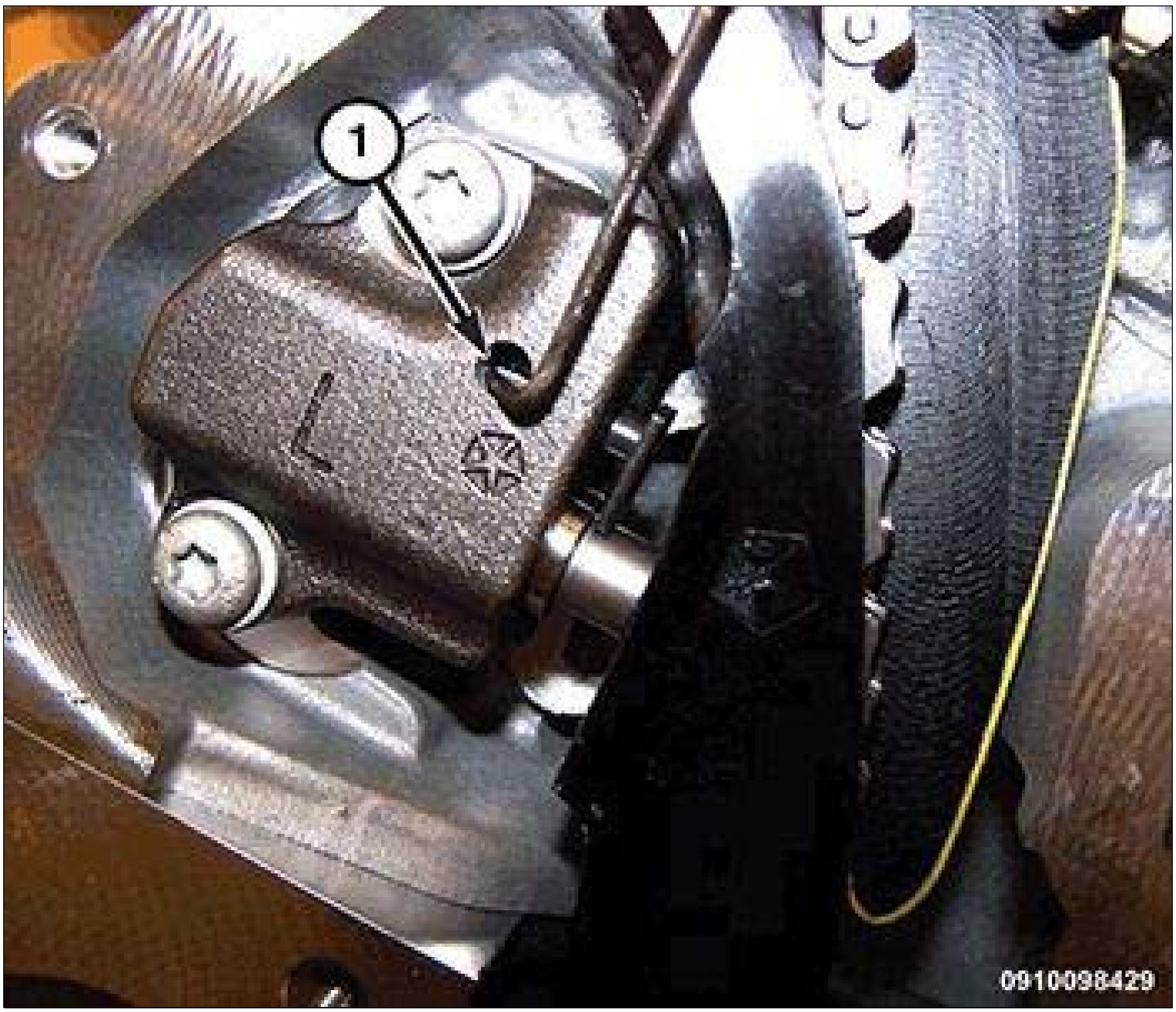
VALVE TIMING > OPERATION > OPERATION

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.

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.

VALVE TIMING > STANDARD PROCEDURE > RESETTING LEFT CAM CHAIN TENSIONER > ENGINE TIMING COVER INSTALLED

Fig 1: Using Chain Tensioner Pin To Lift Pawl Off Of Rack



Courtesy of CHRYSLER GROUP, LLC

1. Using the (special tool #2025003090, Pin, Chain Tensioner), lift the pawl off of the rack (1).

   Fig 2: Holding Pawl Off Rack & Pushing Timing Chain Tensioner Holder Into Place

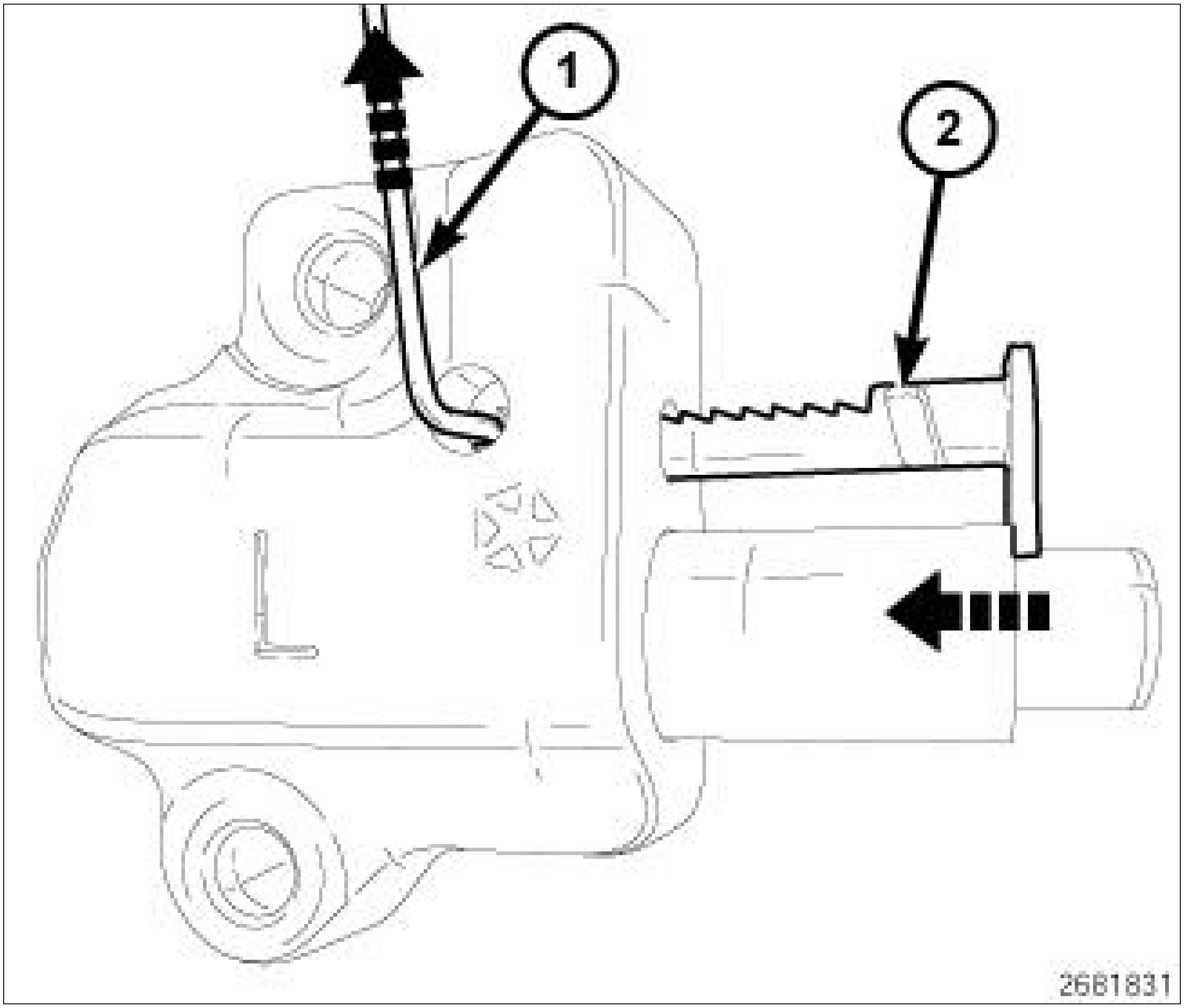
   

   Courtesy of CHRYSLER GROUP, LLC

2. While holding the pawl off of the rack, push (special tool #2025001090, Holder, Timing Chain Tensioner, Left-Front) (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.

VALVE TIMING > STANDARD PROCEDURE > RESETTING LEFT CAM CHAIN TENSIONER > ENGINE TIMING COVER REMOVED

Fig 1: Locating Slot In Rack & Allen Wrench



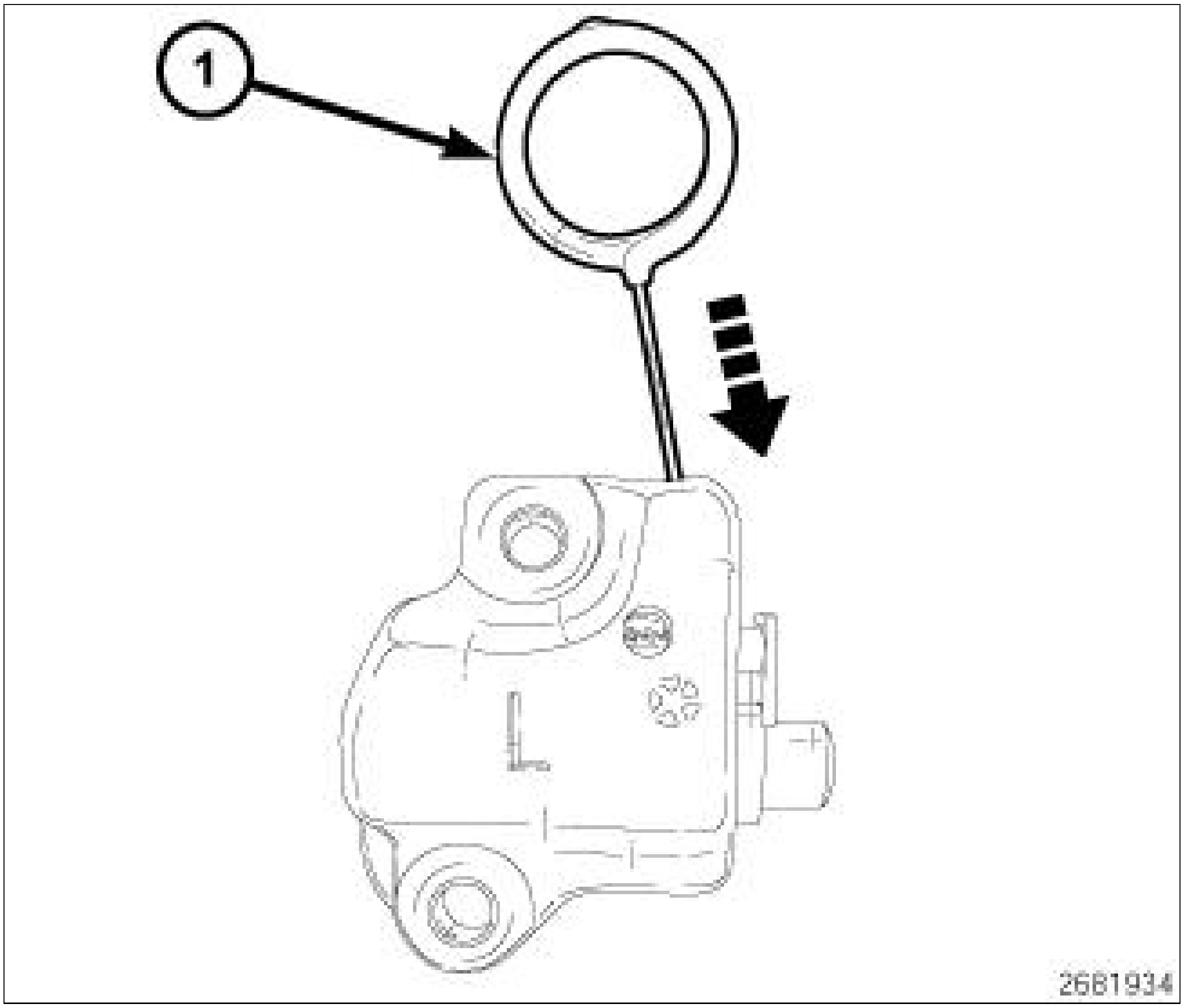
Courtesy of CHRYSLER GROUP, LLC

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.

Fig 2: Inserting Tensioner Pin To Hold Rack & Piston In Retracted Position

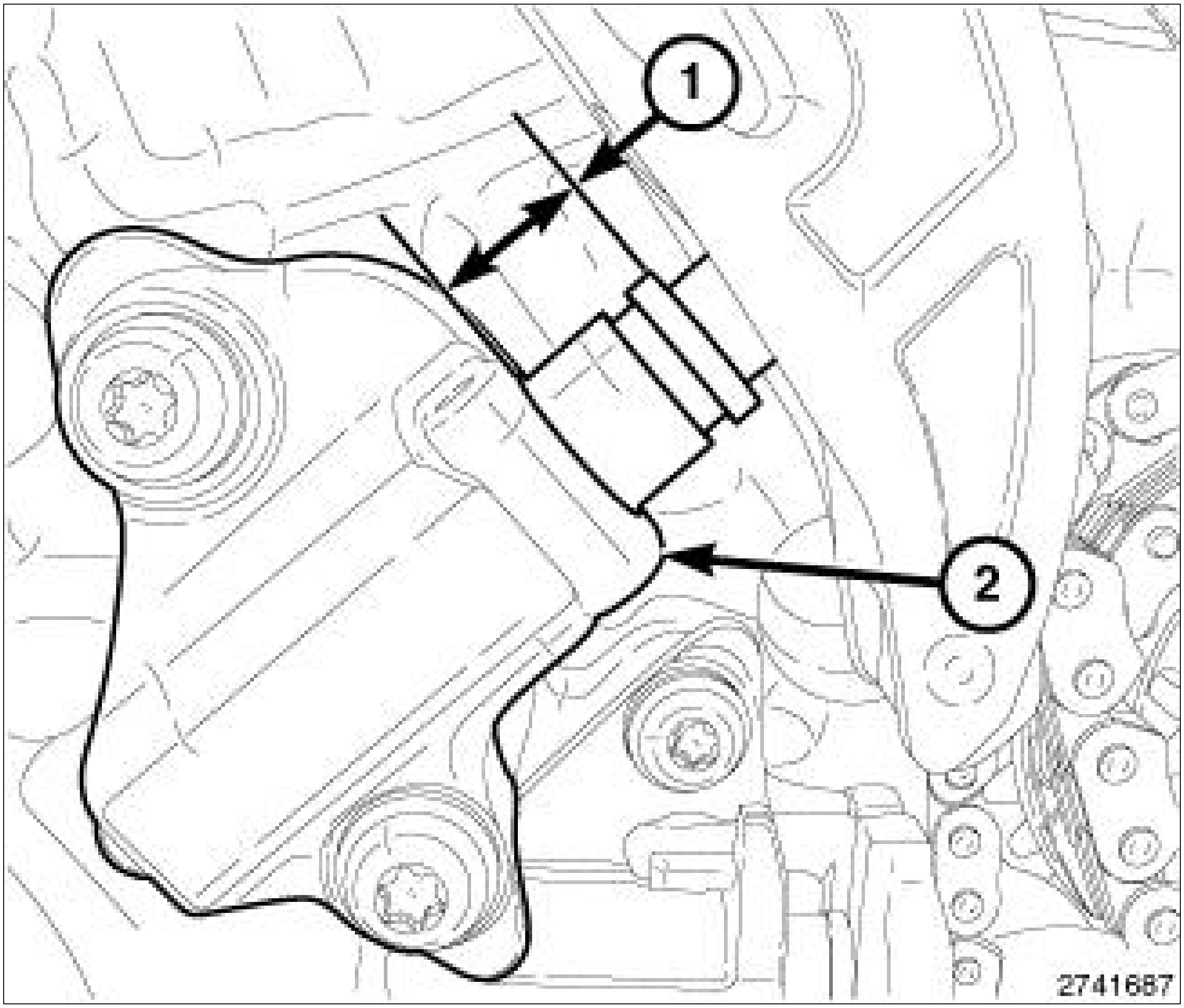


Courtesy of CHRYSLER GROUP, LLC

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.

VALVE TIMING > STANDARD PROCEDURE > MEASURING TIMING CHAIN WEAR

Fig 1: Piston Extension & Right Hand Cam Chain Tensioner



Courtesy of CHRYSLER GROUP, LLC

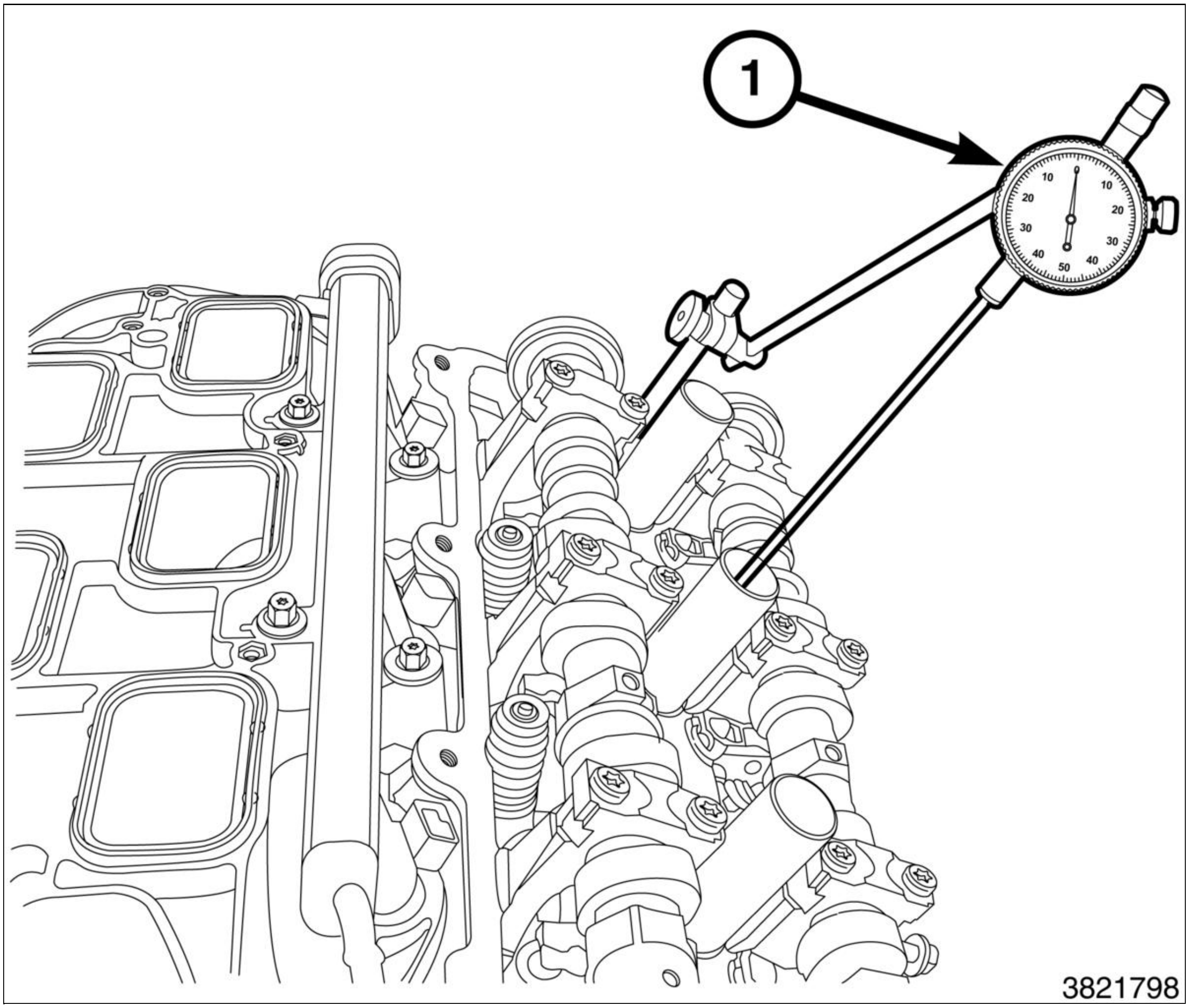
1. Remove the engine timing chain cover. Refer to COVER(S), ENGINE TIMING, REMOVAL .
2. To determine if the timing chains are worn, rotate the crankshaft clockwise until maximum tensioner piston extension (1) is obtained on the RH cam chain tensioner (2). Measure the distance between the secondary timing 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 .

VALVE TIMING > STANDARD PROCEDURE > ENGINE TIMING VERIFICATION

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 1: Positioning Dial Indicator & Setting #4 Cylinder At Top-Dead-Center Compression Stroke



Courtesy of CHRYSLER GROUP, LLC

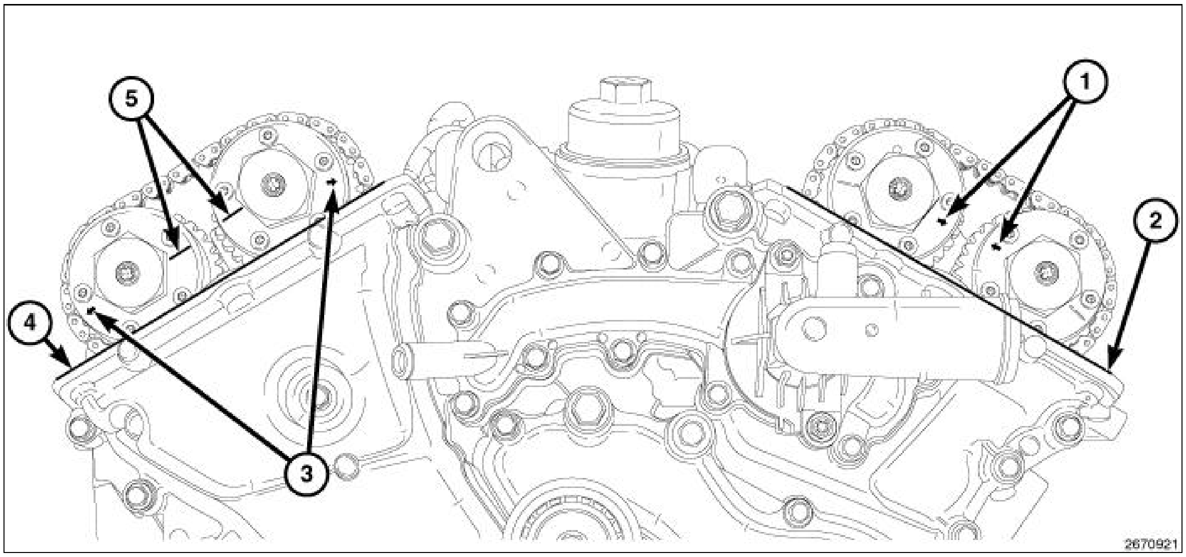
Correct timing is critical for the NON free-wheeling designed, 3.6L engine. Engine timing can be verified by using the following procedures:

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 left camshaft position (CMP) sensor mount. Position the indicator probe into the number four cylinder, rotate the crankshaft clockwise (as viewed from the front) to place the number four cylinder piston at top-dead-center on the compression stroke and set the indicator dial to **ZERO** .

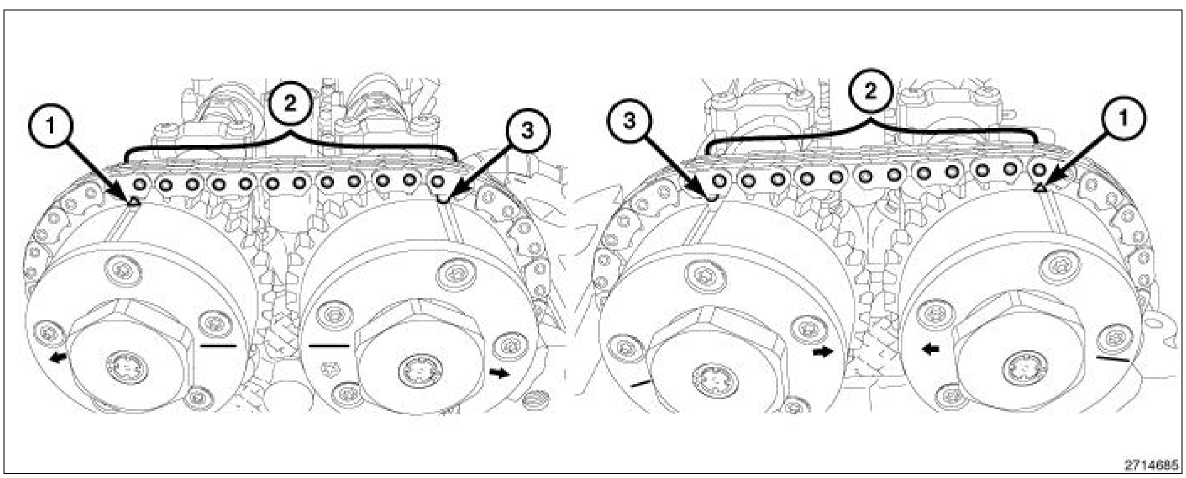
Fig 2: Arrows, Scribe Lines, & Cam Phasers



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).

Fig 3: 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 .

VALVE TIMING > CHAIN AND SPROCKETS, TIMING > REMOVAL > REMOVAL

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.

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:

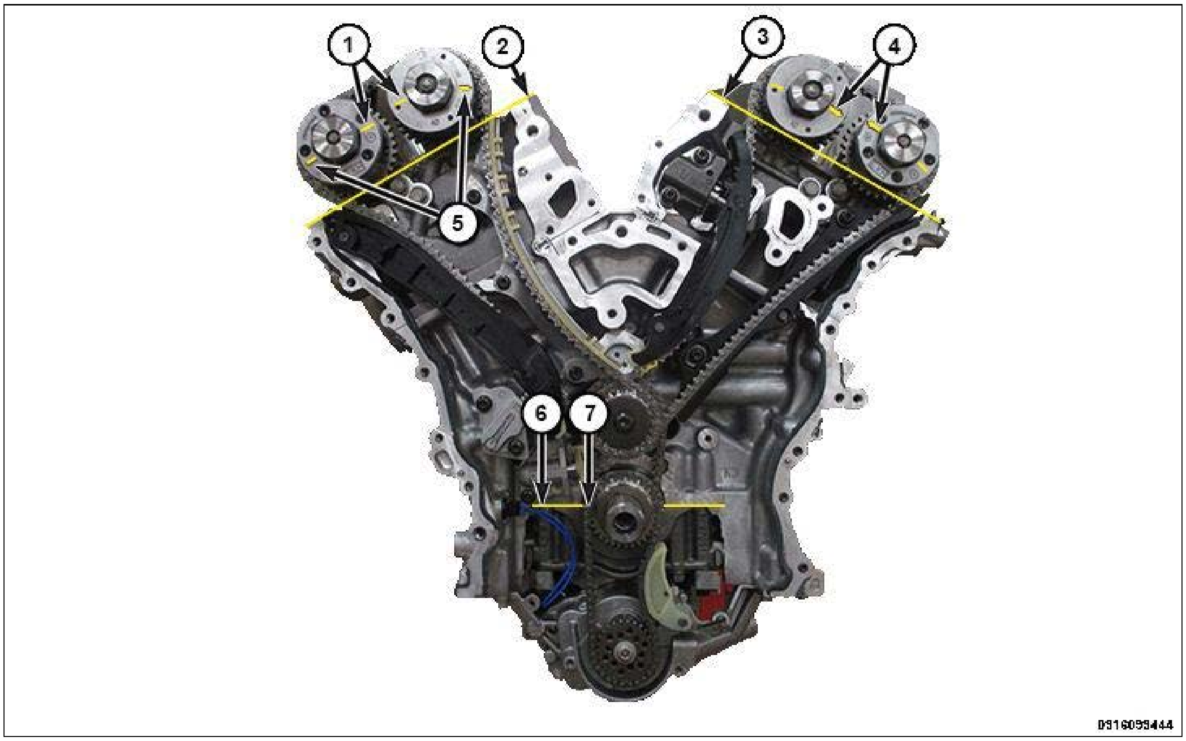
The Variable Valve Timing (VVT) assemblies (Phasers) and Oil Control Valves (OCVs) can be serviced without removing the engine timing cover. Refer to ASSEMBLY, VARIABLE VALVE TIMING, PHASER/OIL CONTROL VALVE, REMOVAL .

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

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

> *NOTE:*
>
> *Take this opportunity to measure timing chain wear. Refer to STANDARD PROCEDURE .*

Fig 1: Scribe Lines, Valve Cover Sealing Surfaces, Cam Phaser Arrows, Block/Bearing Cap Junction & Dimple

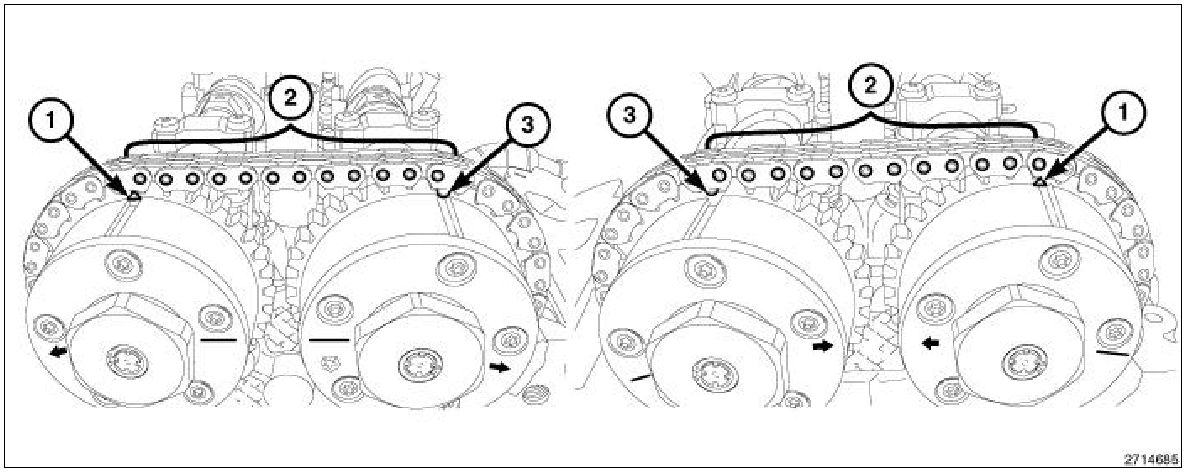


Courtesy of CHRYSLER GROUP, LLC

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

7. 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 (7) on the crankshaft with the block/bearing cap junction (6).
8. While maintaining this alignment, verify that the **ARROWS** (4) 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** (5) point away from each other and the **SCRIBE LINES** (7) are parallel to the cylinder head cover mounting surface (2).

Fig 2: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking



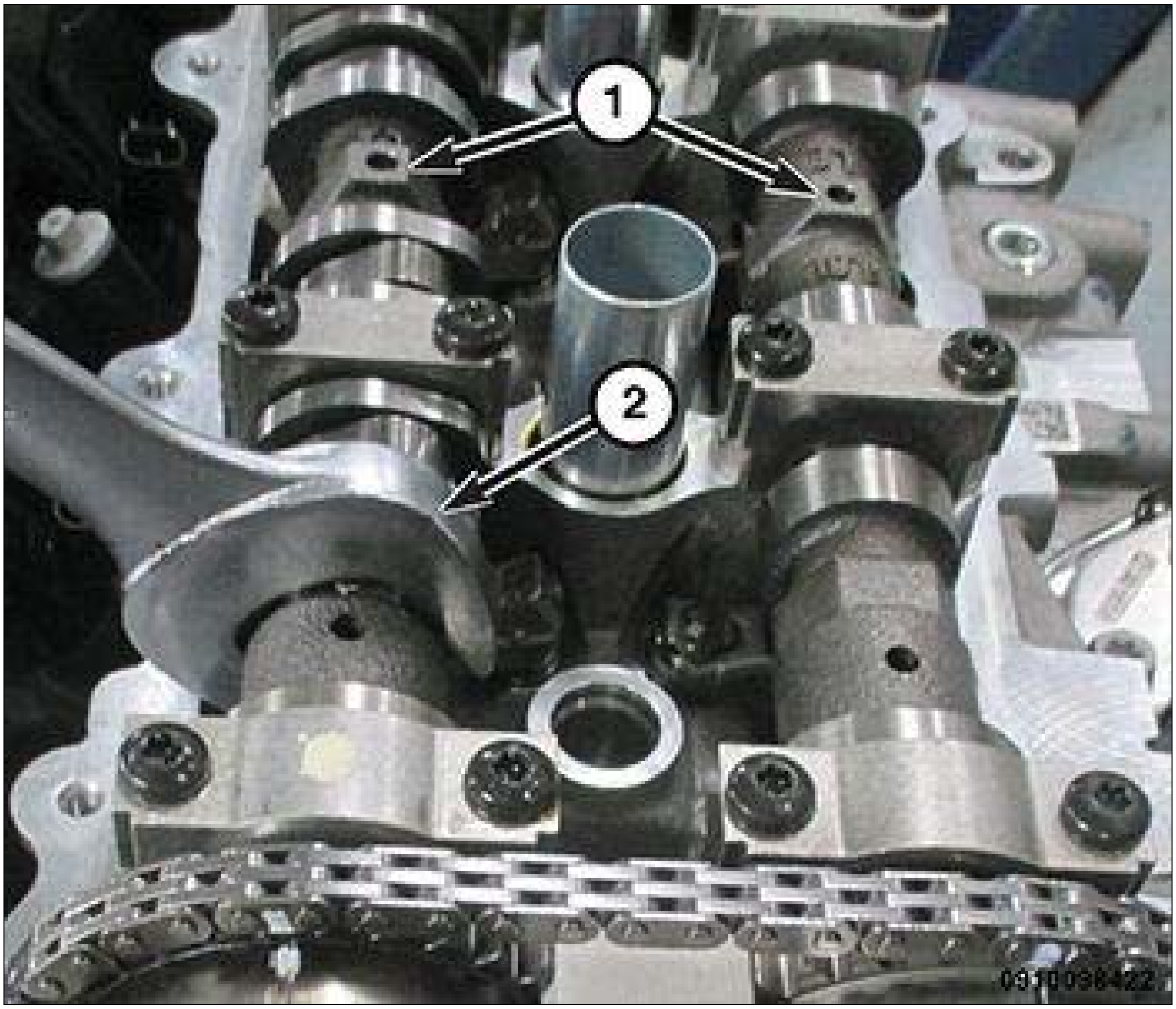
Courtesy of CHRYSLER GROUP, LLC

> *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.*

9. 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.*

Fig 3: Alignment Holes & Wrench

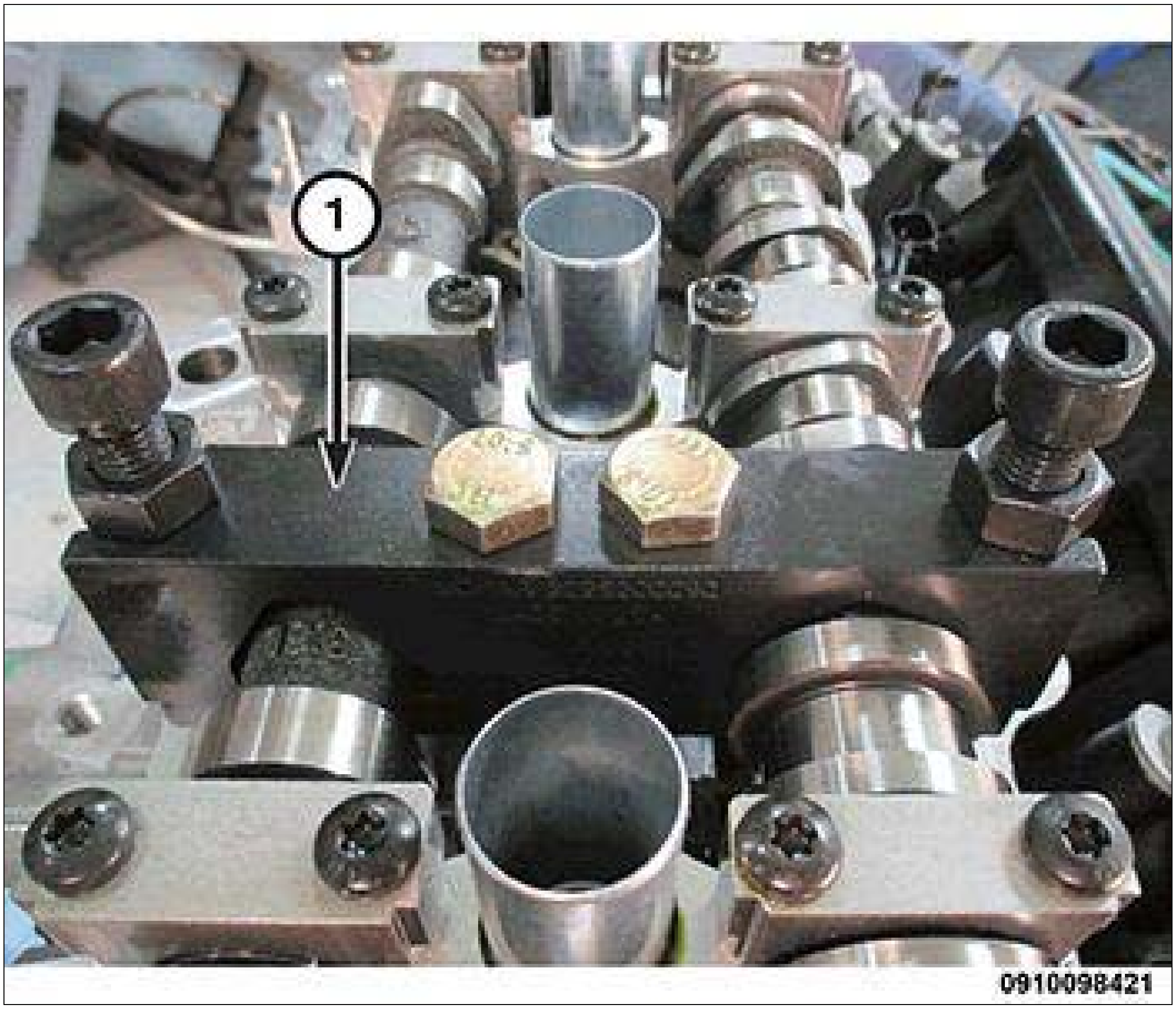


Courtesy of CHRYSLER GROUP, LLC

10. Both left and right side camshafts should be at top-dead-center, with the alignment holes (1) positioned vertically.

> *NOTE:*
>
> *It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (2) when installing the camshaft holder.*

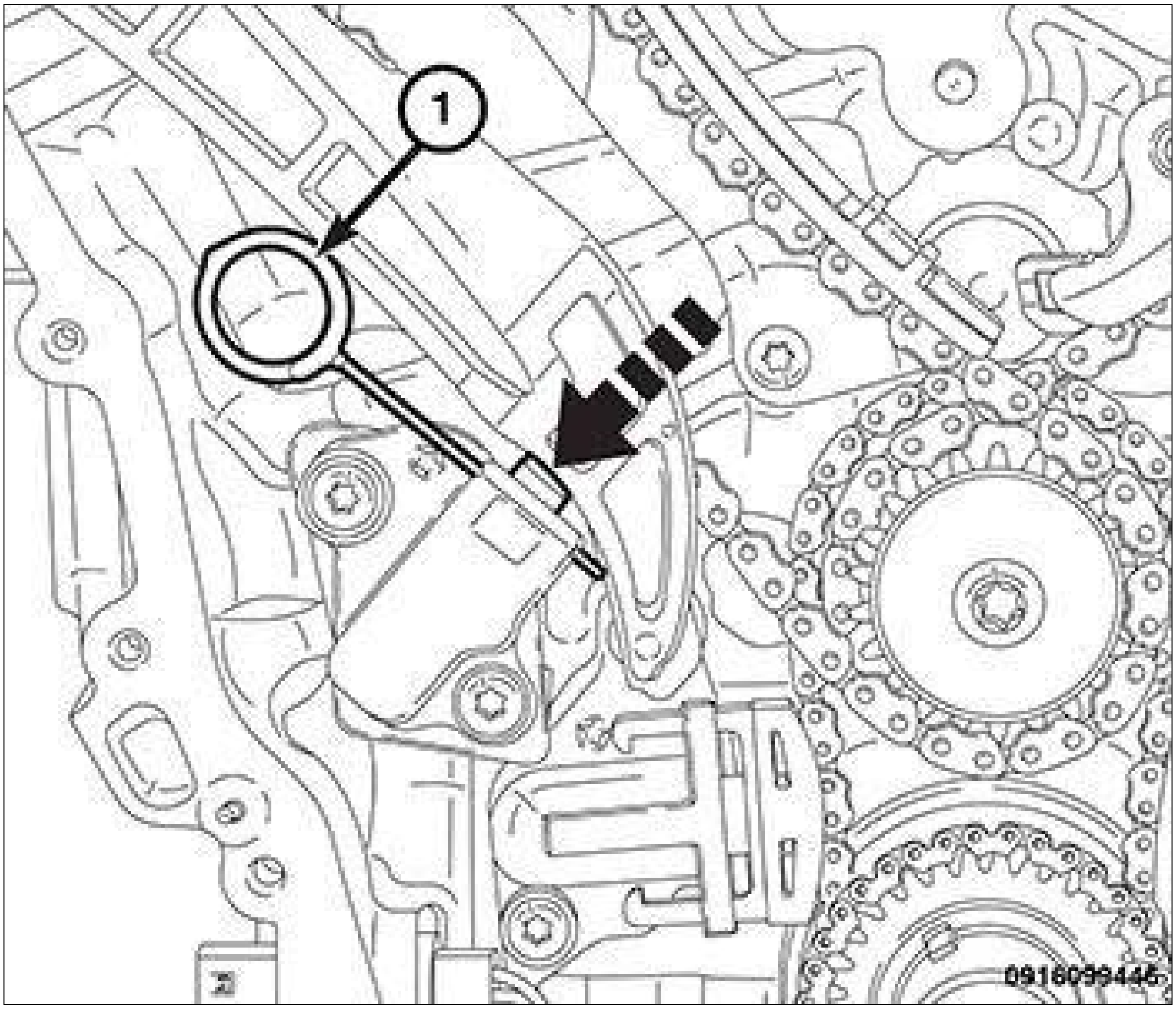
Fig 4: Camshaft Holder



Courtesy of CHRYSLER GROUP, LLC

11. Install the (special tool #2025200090, Holder, Camshaft) (1) on both left and right side camshafts.
12. Mark the direction of rotation on the following timing chains using a paint pen or equivalent to aid in reassembly:
    1. Left side cam chain
    2. Right side cam chain
    3. Oil pump chain
    4. Primary chain

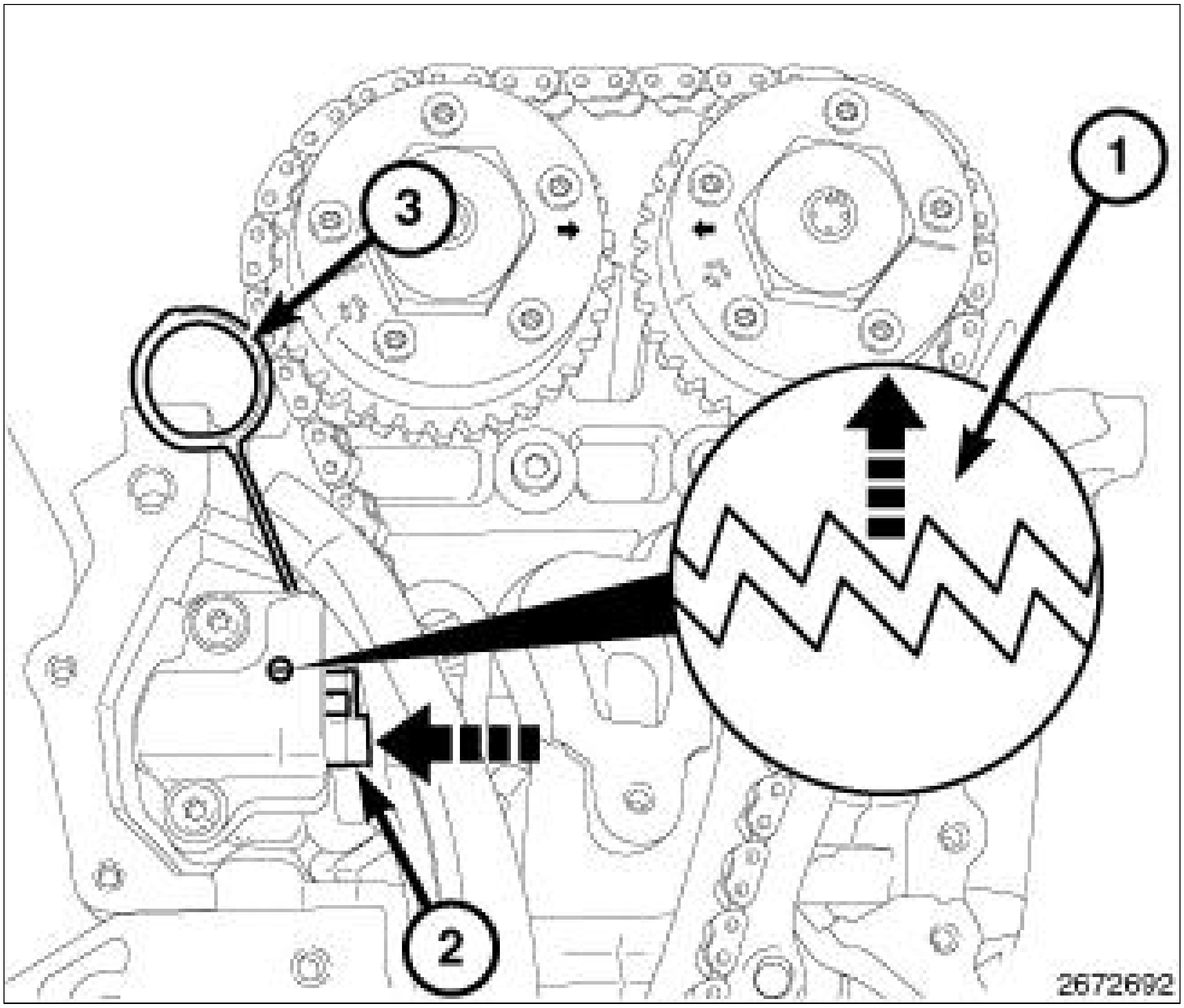
Fig 5: Resetting Right Side Cam Chain Tensioner By Pushing Back Tensioner Piston & Installing Tensioner Pin



Courtesy of CHRYSLER GROUP, LLC

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

Fig 6: Resetting Left Cam Chain Tensioner By Lifting Pawl, Pushing Back Piston & Installing Tensioner Pin

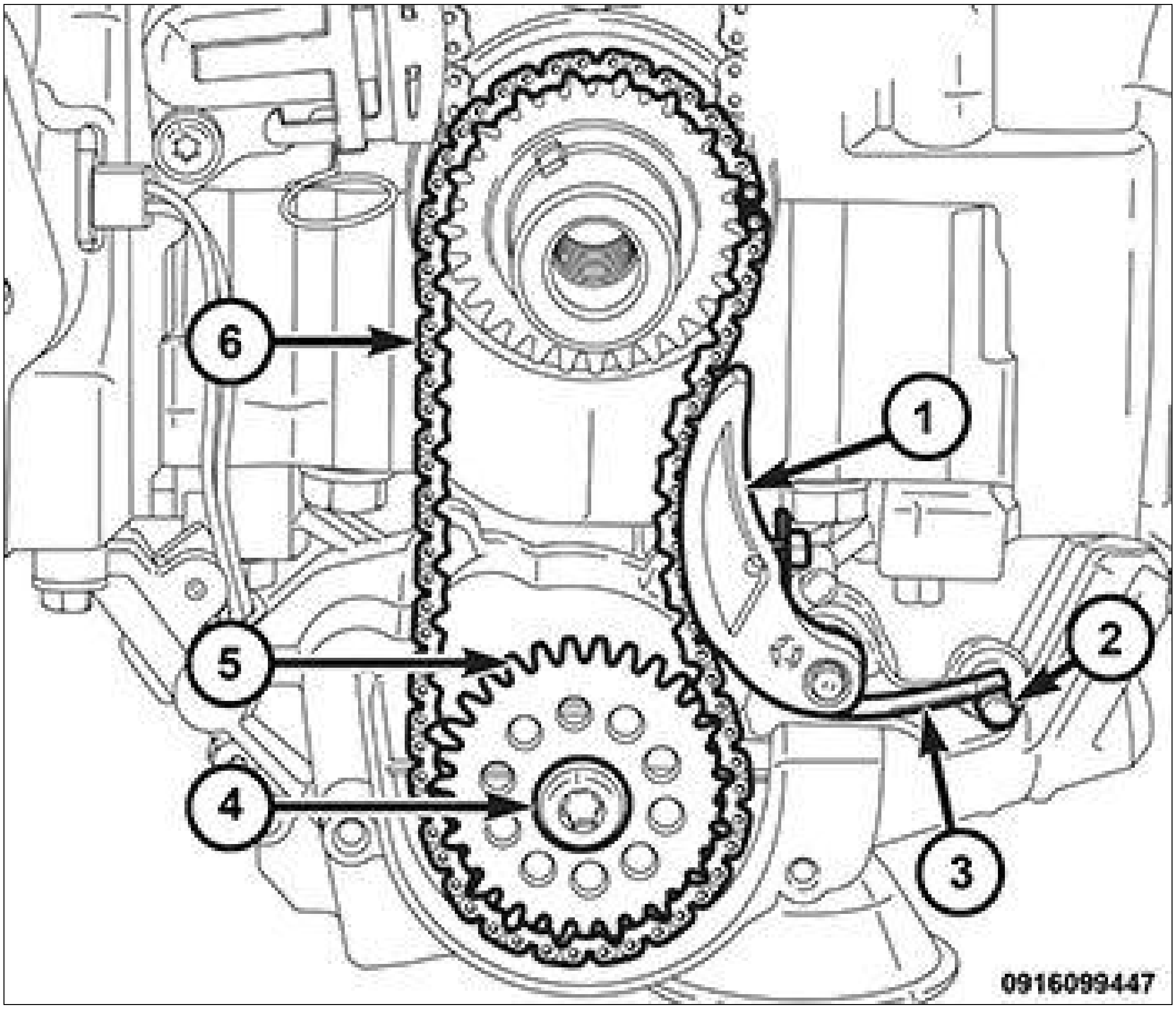


Courtesy of CHRYSLER GROUP, LLC

14. 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 STANDARD PROCEDURE .

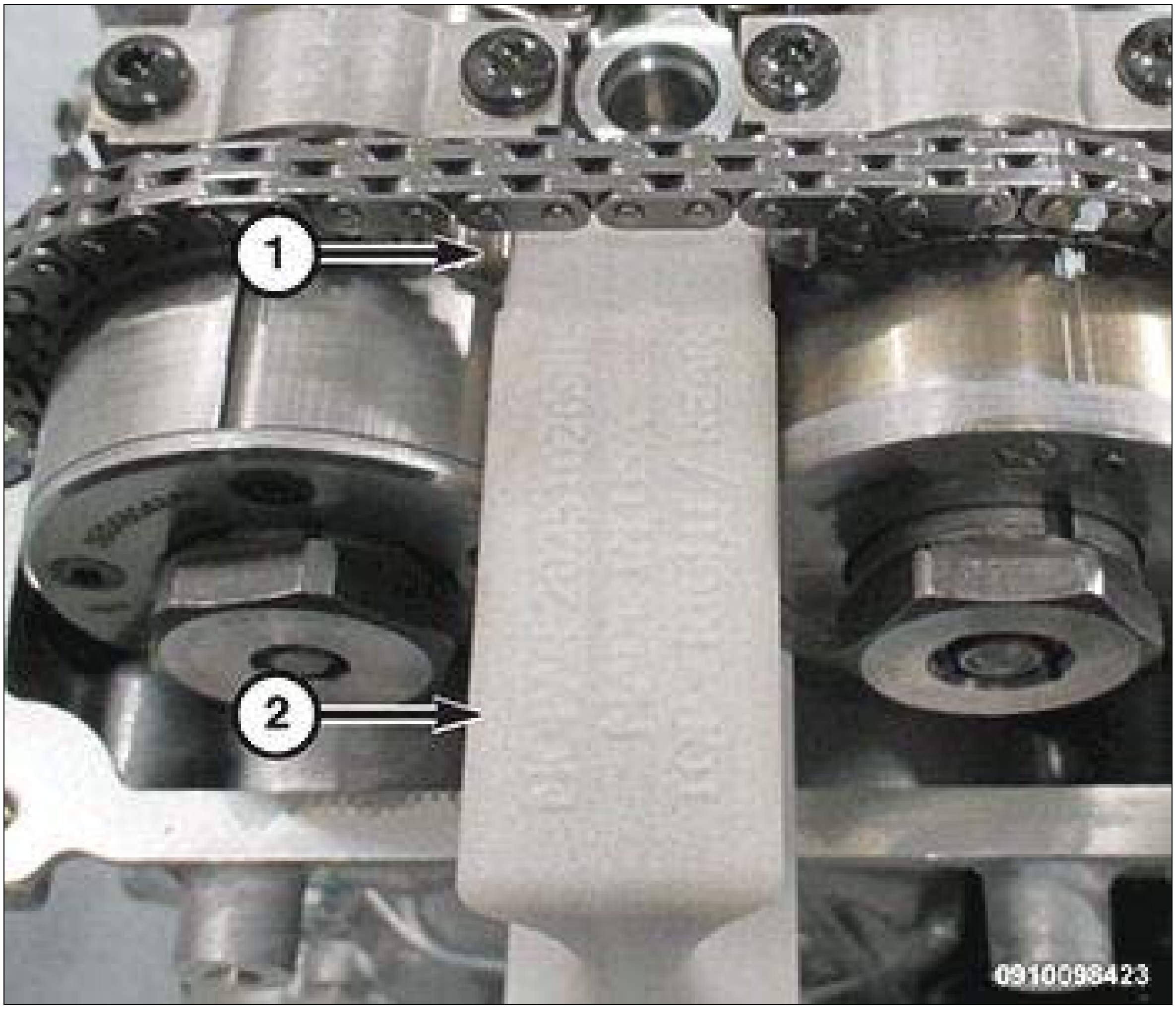
Fig 7: Oil Pump Chain Tensioner Spring, Dowel Pin, Oil Pump Chain Tensioner, Oil Pump Sprocket, Retaining Bolt & Oil Pump Chain



Courtesy of CHRYSLER GROUP, LLC

15. Disengage the oil pump chain tensioner spring (3) from the dowel pin (2) and remove the oil pump chain tensioner (1).
16. Remove the oil pump sprocket retaining bolt (4) and remove the oil pump sprocket (5) and oil pump chain (6).

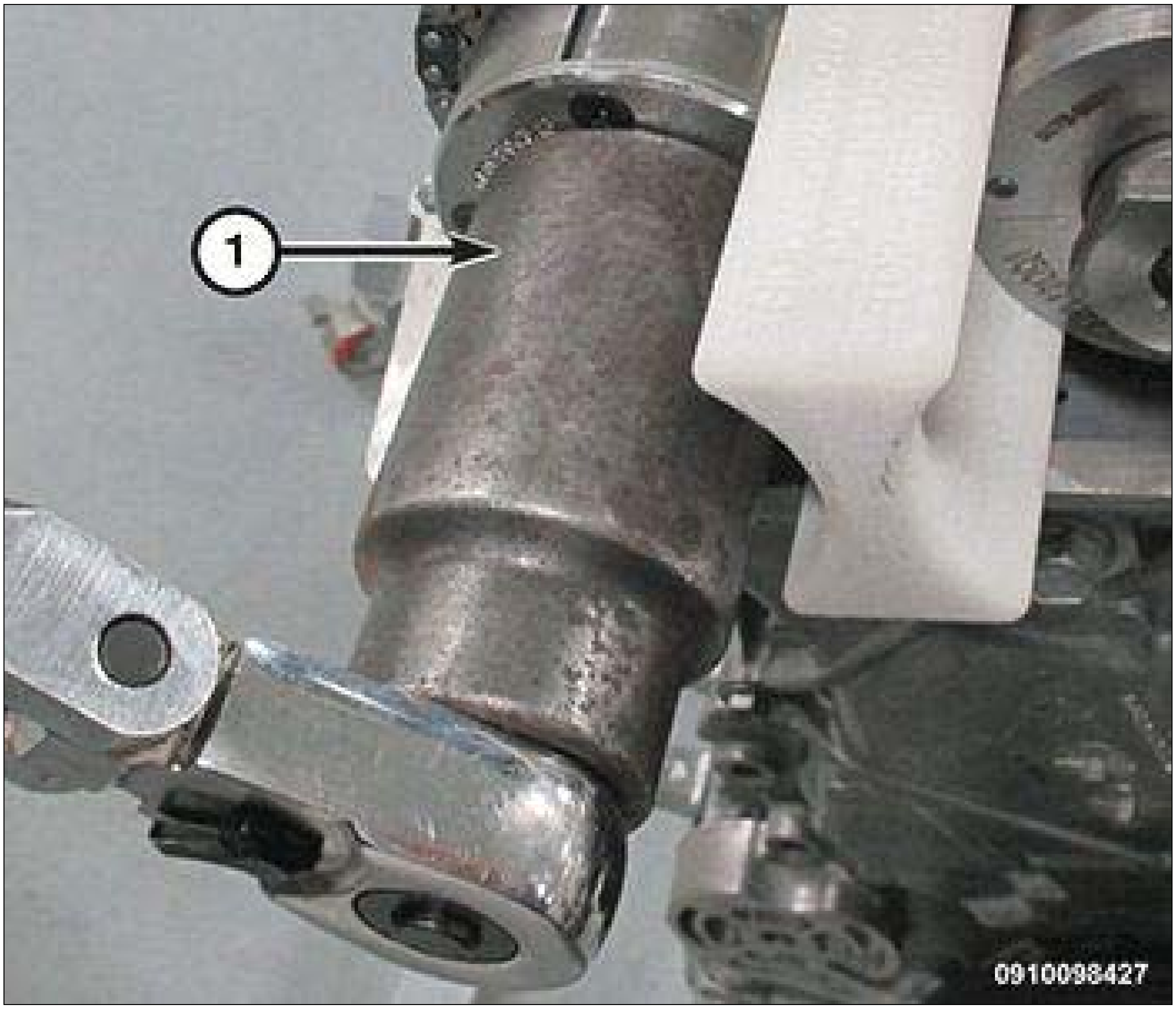
Fig 8: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

17. Install the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (2) between the right side intake and exhaust phasers (1), with the tool number facing up.

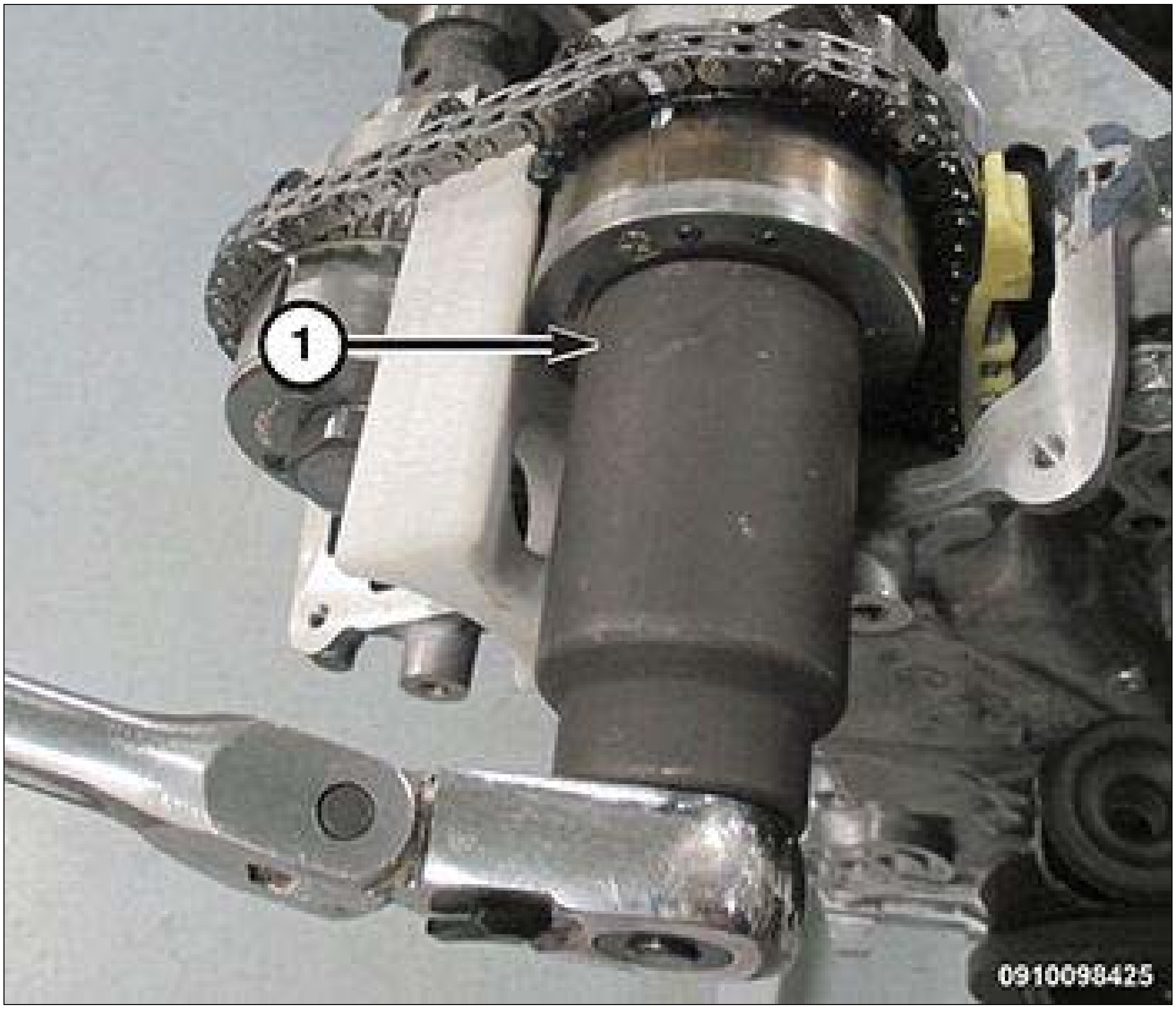
Fig 9: Installing Socket On Exhaust Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

18. Loosen, but do not remove, the right side exhaust oil control valve (1).

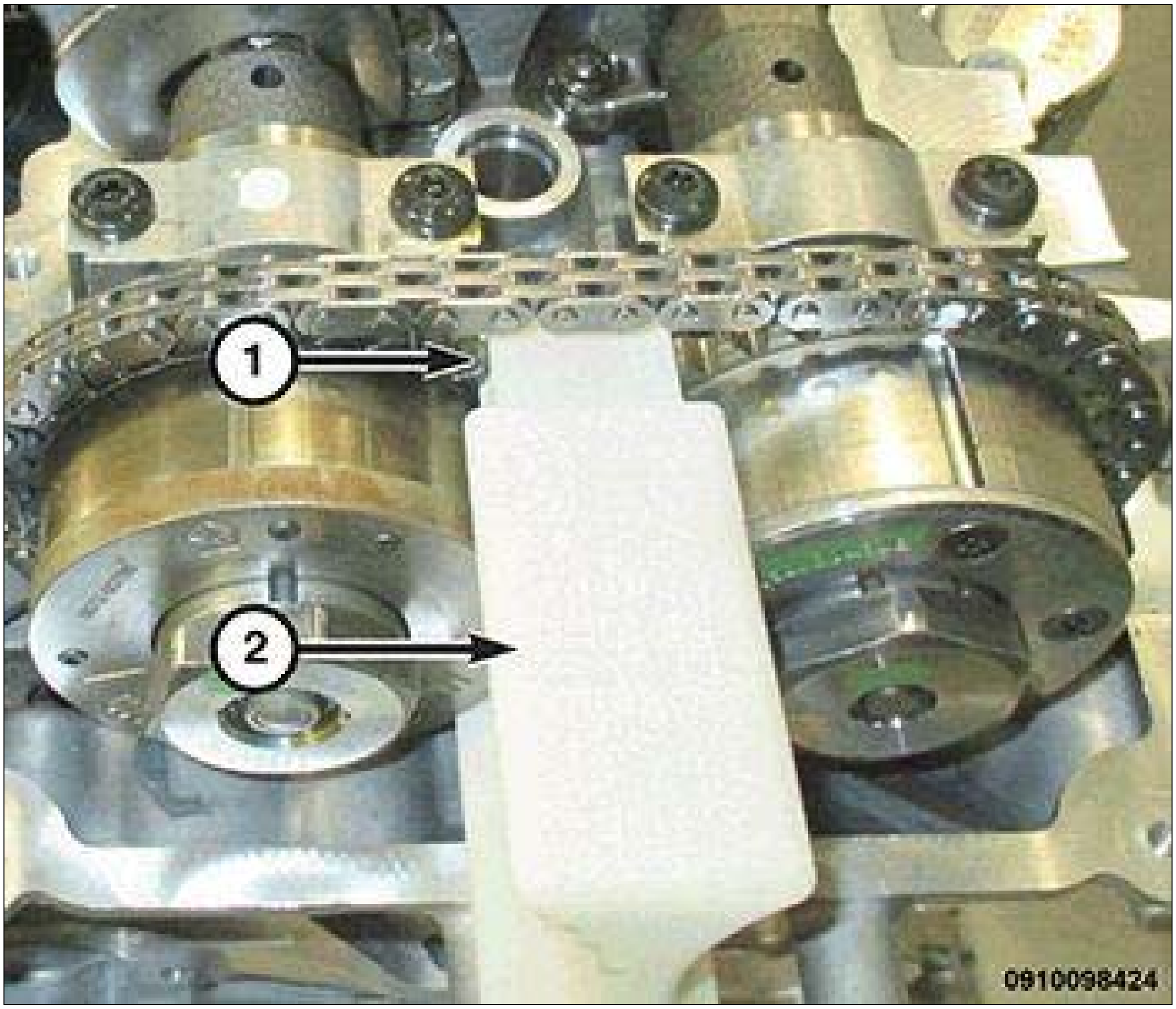
Fig 10: Installing Socket On Intake Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

19. Loosen, but do not remove, the right side intake oil control valve (1).
20. Remove the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (1).
21. Remove the oil control valve from the right side intake cam phaser.
22. Pull the right side intake cam phaser off of the camshaft and remove the right side cam chain.
23. If required, remove the oil control valve and pull the right side exhaust cam phaser off of the camshaft.

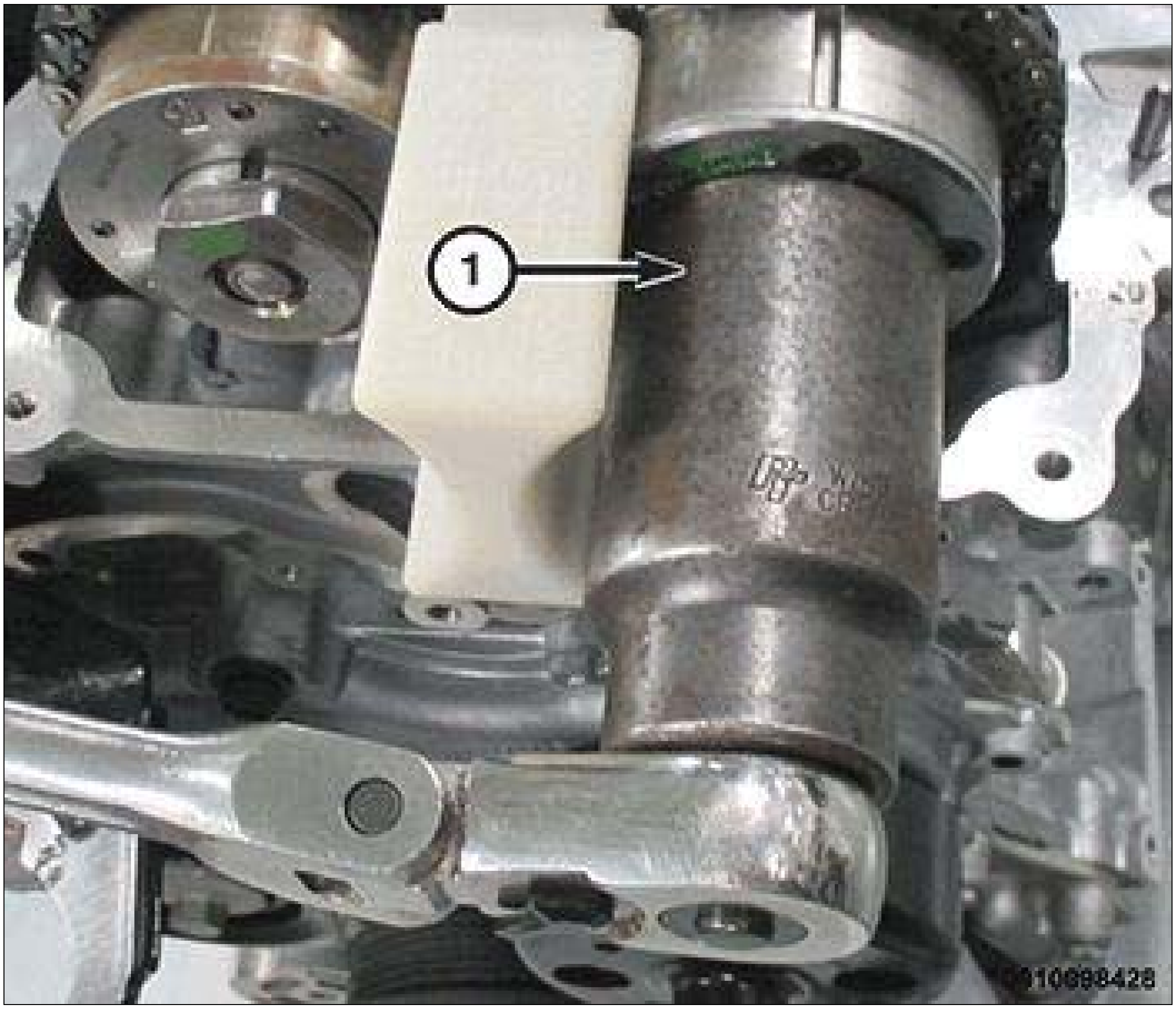
Fig 11: Camshaft Phaser Holder Positioned Against Cylinder Head Cover Mounting Surface Between Intake & Exhaust Phasers



Courtesy of CHRYSLER GROUP, LLC

24. Install the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head) (2) between the intake and exhaust phasers (1), with the tool number facing up.

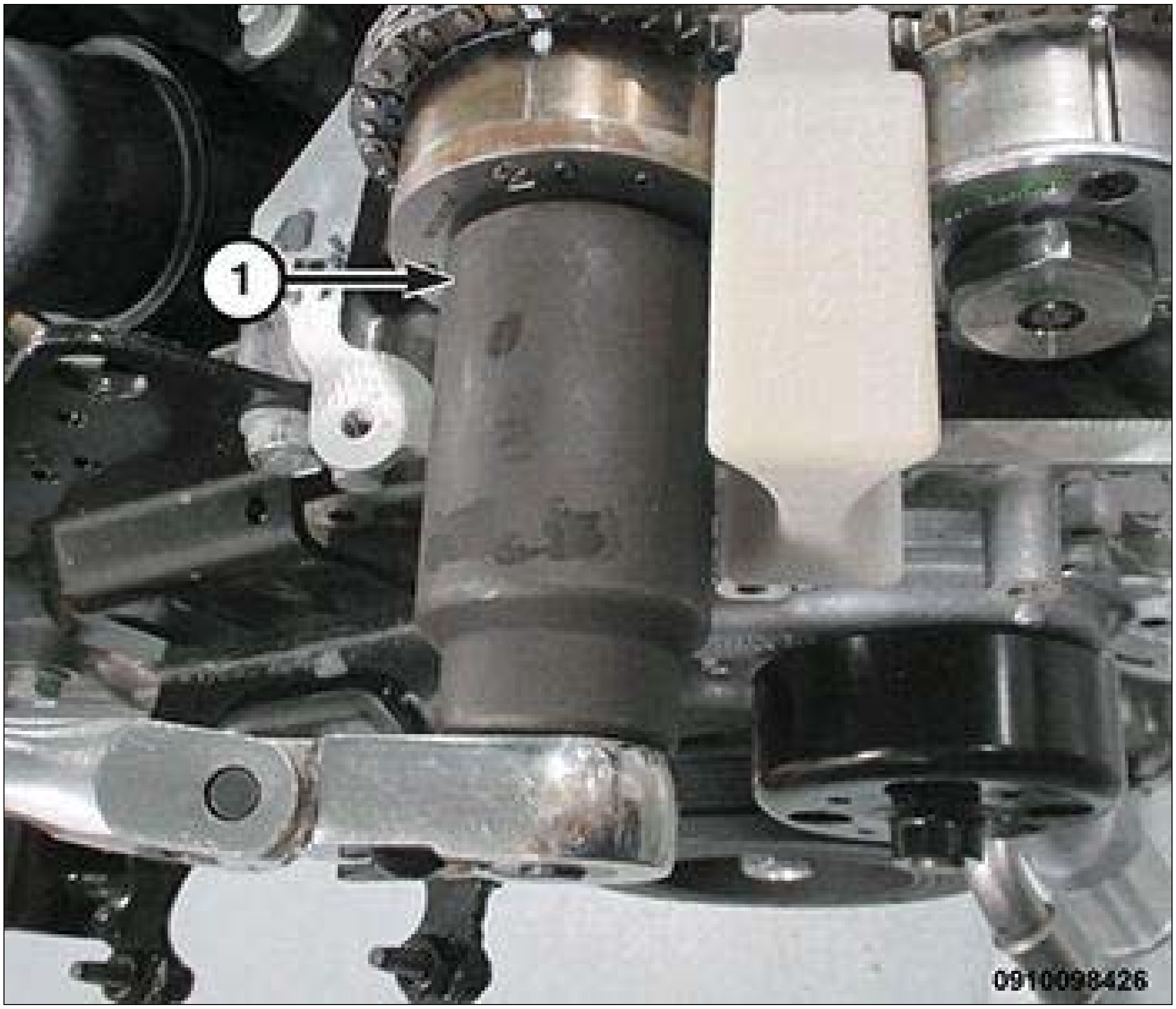
Fig 12: Installing Socket On Exhaust Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

25. Loosen, but do not remove, the left side exhaust oil control valve (1).

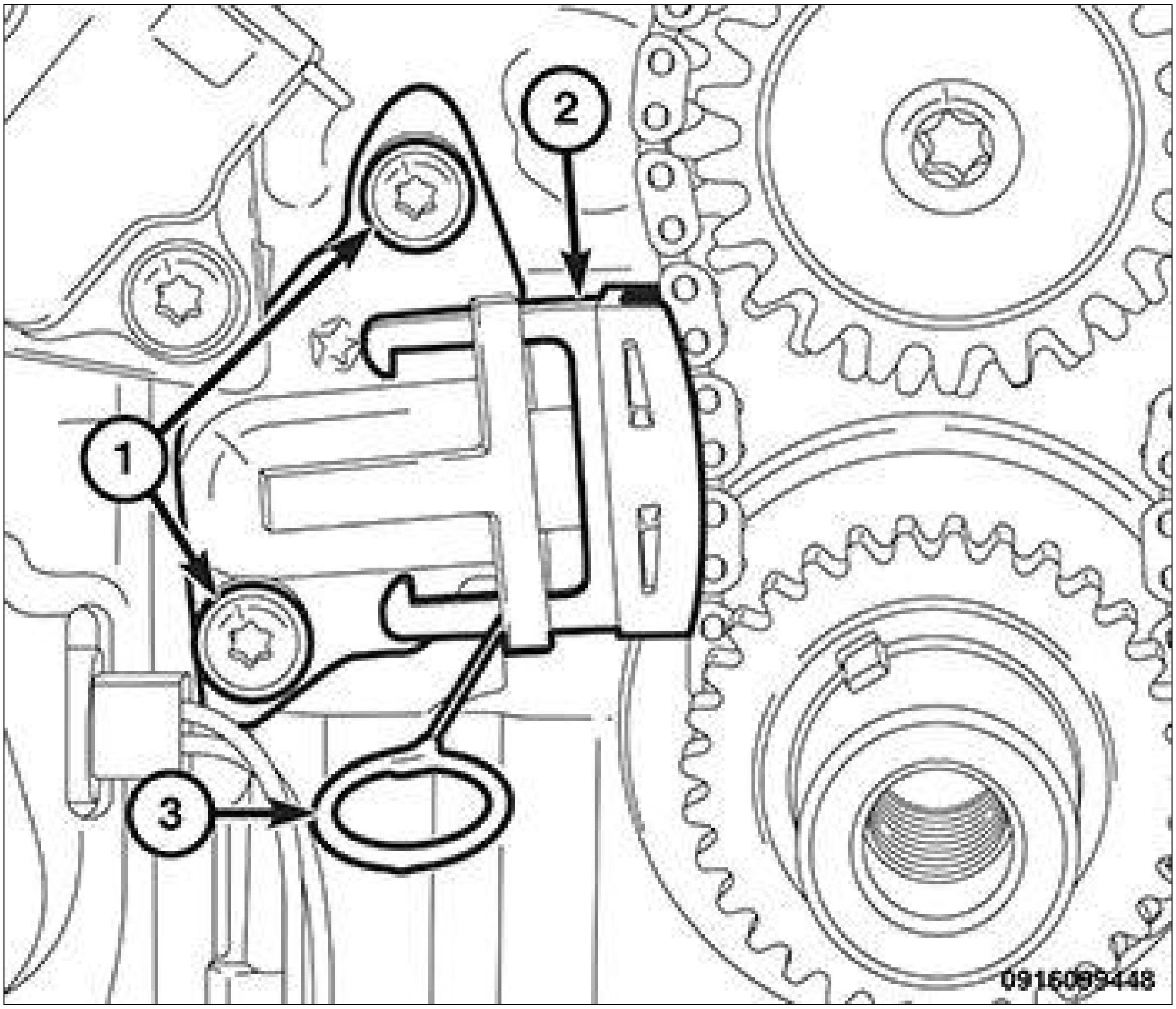
Fig 13: Installing Socket On Intake Oil Control Valve



Courtesy of CHRYSLER GROUP, LLC

26. Loosen, but do not remove, the left side intake oil control valve (1).
27. Remove the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head), leaving the Camshaft Holder in place.
28. Remove the oil control valve (2) from the left side exhaust cam phaser.
29. Pull the left side exhaust cam phaser off of the camshaft and remove the left side cam chain.
30. If required, remove the oil control valve and pull the left side intake cam phaser off of the camshaft.

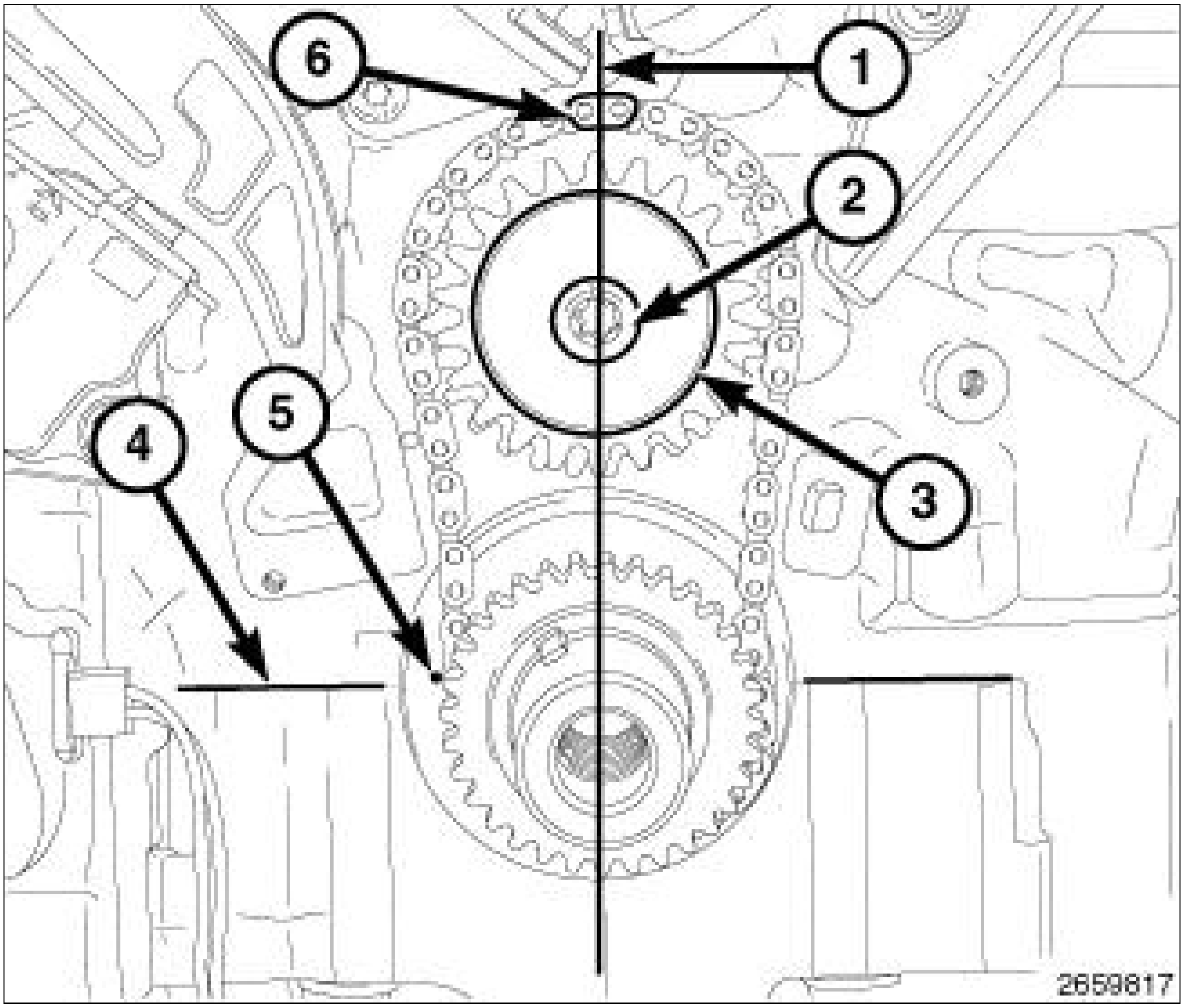
Fig 14: Primary Chain Tensioner & Bolts



Courtesy of CHRYSLER GROUP, LLC

31. Reset the primary chain tensioner (2) by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (3). Remove the two bolts (1) and remove the primary chain tensioner.

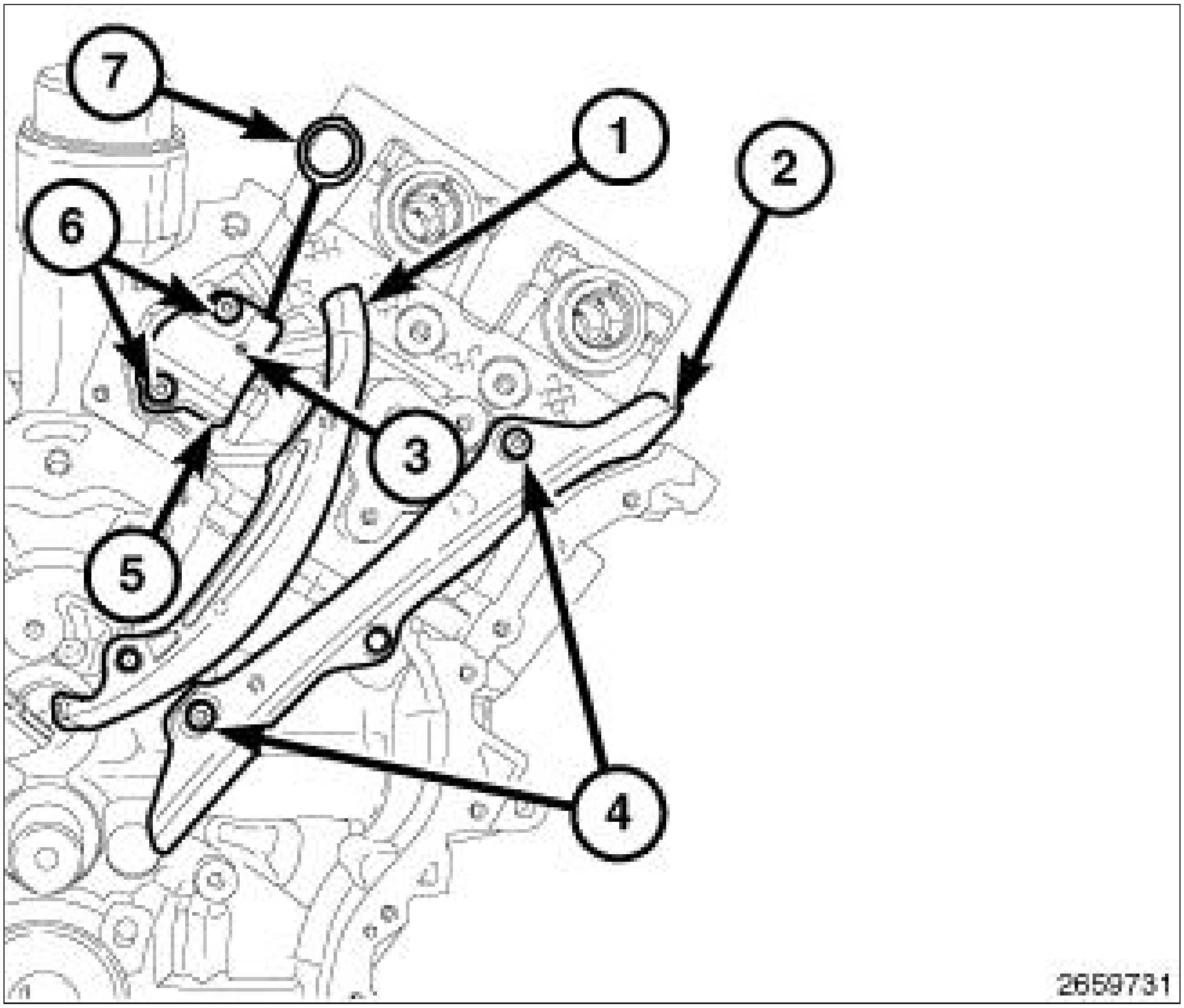
Fig 15: Timing Chain Plated Link At 12 O'Clock, Washer, Retaining Bolt, Block/Bearing Cap Junction & Dimple



Courtesy of CHRYSLER GROUP, LLC

32. Remove the idler sprocket retaining bolt (2) and washer (3).
33. Remove the primary chain, idler sprocket and crankshaft sprocket as an assembly.

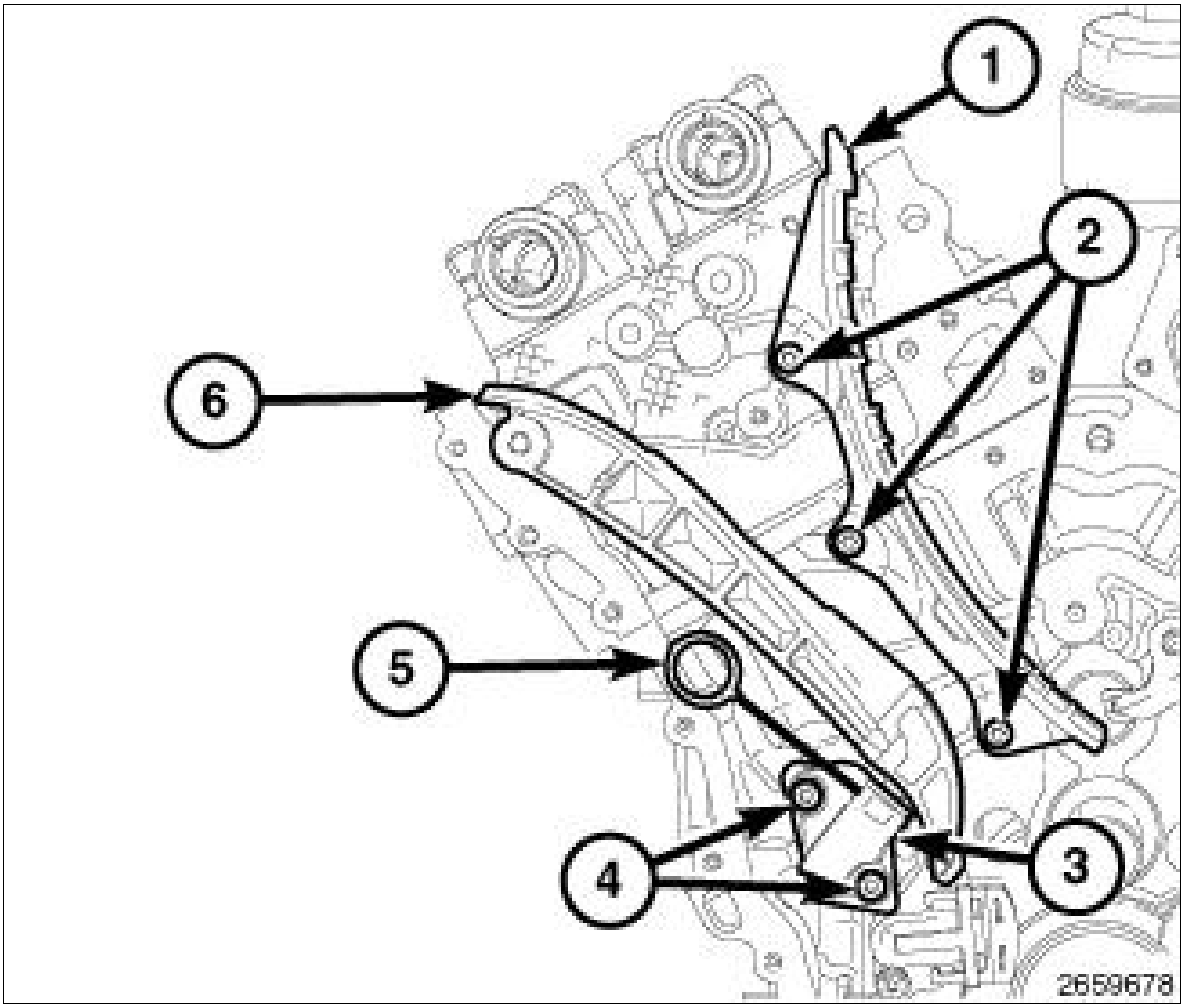
Fig 16: Left Cam Chain Tensioner, Arm, Guide & Bolts



Courtesy of CHRYSLER GROUP, LLC

34. If required, remove the two bolts (6) and the left side cam chain tensioner (5).
35. If required, remove the two bolts (4) and the left side cam chain guide (2) and tensioner arm (1).

Fig 17: Right Cam Chain Tensioner, Arm, Guide & Bolts

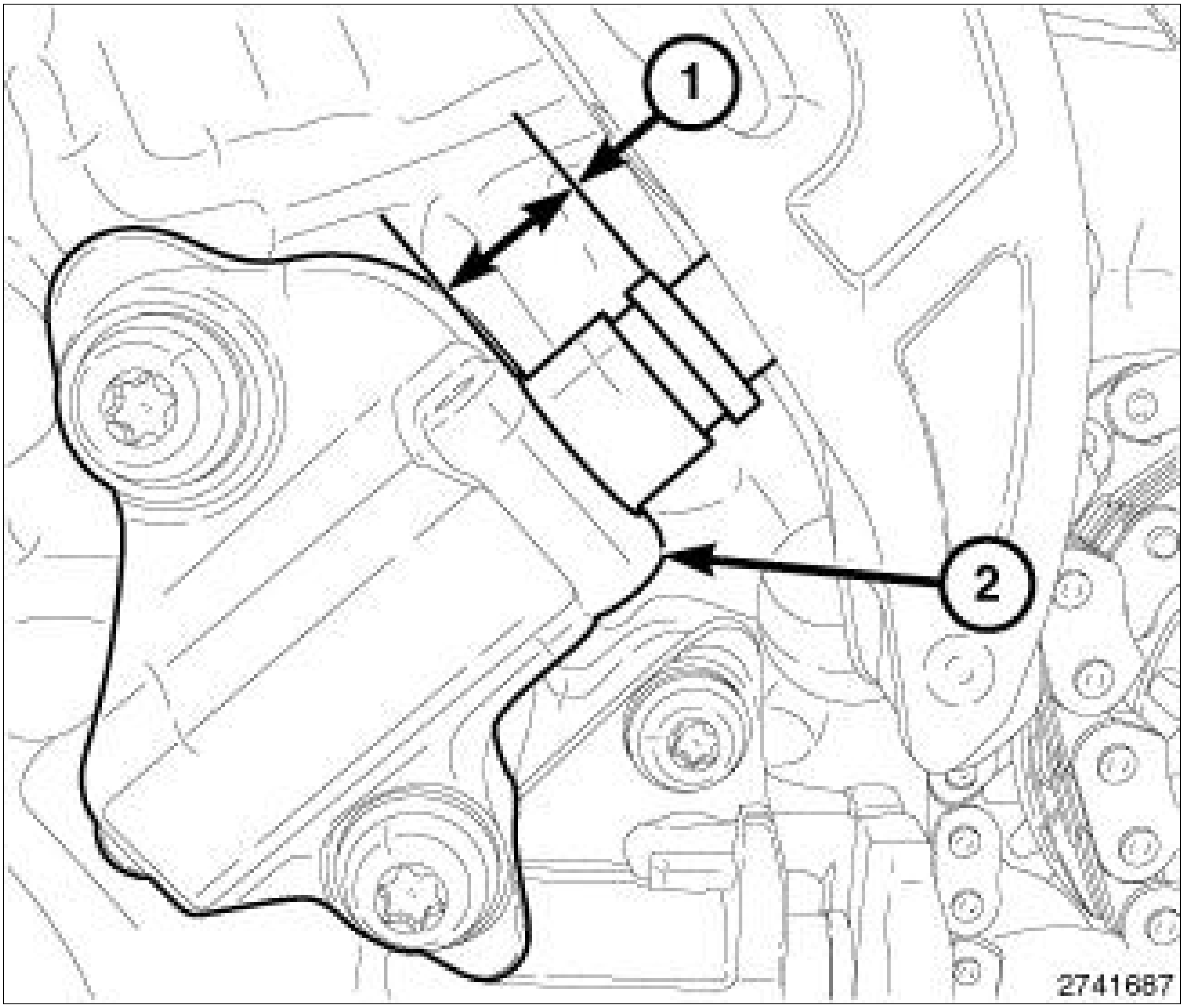


Courtesy of CHRYSLER GROUP, LLC

36. If required, remove the two bolts (4) and the right side cam chain tensioner (3).
37. If required, remove the three bolts (2) and the right side cam chain guide (1) and tensioner arm (6).
38. Inspect all sprockets and chain guides. Replace if damaged.

VALVE TIMING > CHAIN AND SPROCKETS, TIMING > INSPECTION > INSPECTION

Fig 1: Piston Extension & Right Hand 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 STANDARD PROCEDURE .

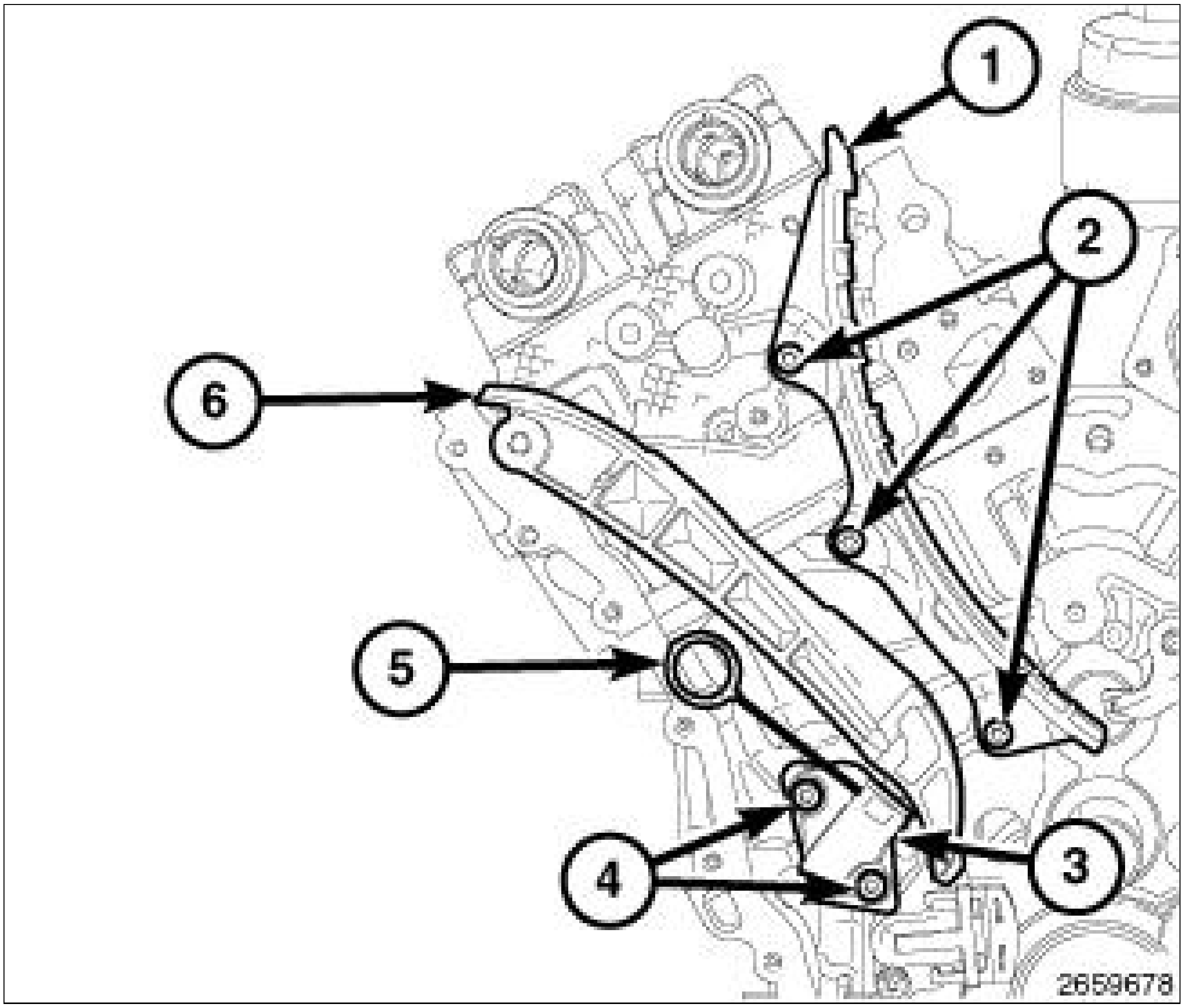
Inspect the following valve timing components:

- 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.

VALVE TIMING > CHAIN AND SPROCKETS, TIMING > INSTALLATION > INSTALLATION

1. Inspect all sprockets and chain guides. Replace if damaged.

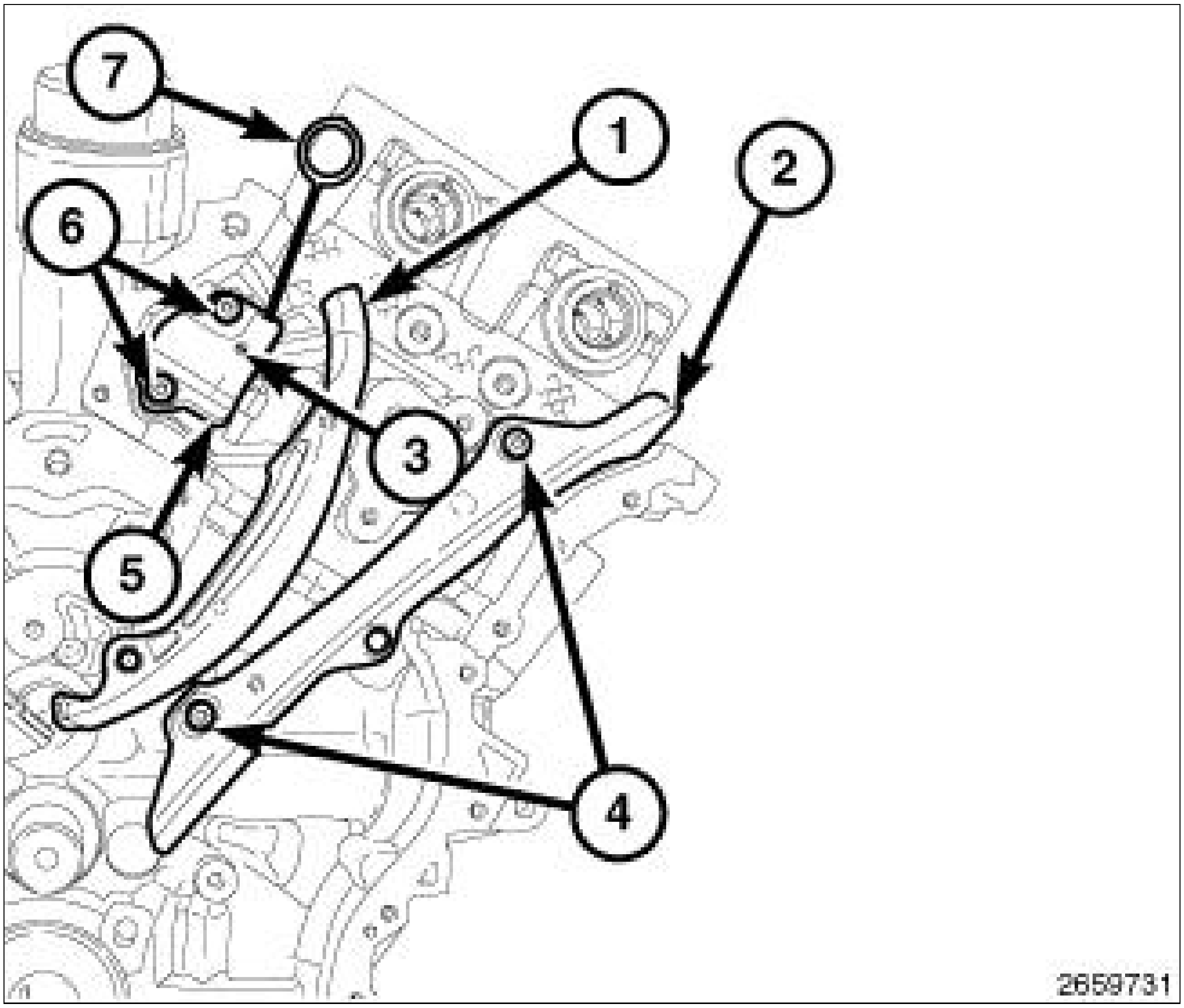
   Fig 1: Right Cam Chain Tensioner, Arm, Guide & Bolts

   Courtesy of CHRYSLER GROUP, LLC

2. If removed, install the right side cam chain guide (1) and tensioner arm (6) and tighten the bolts (2) to the proper specification. Refer to TORQUE SPECIFICATIONS .
3. If removed, install the right side cam chain tensioner (3) to the engine block with two bolts (4) and tighten the bolts (4) to the proper specification. Refer to TORQUE SPECIFICATIONS .
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).

Fig 2: Left Cam Chain Tensioner, Arm, Guide & Bolts

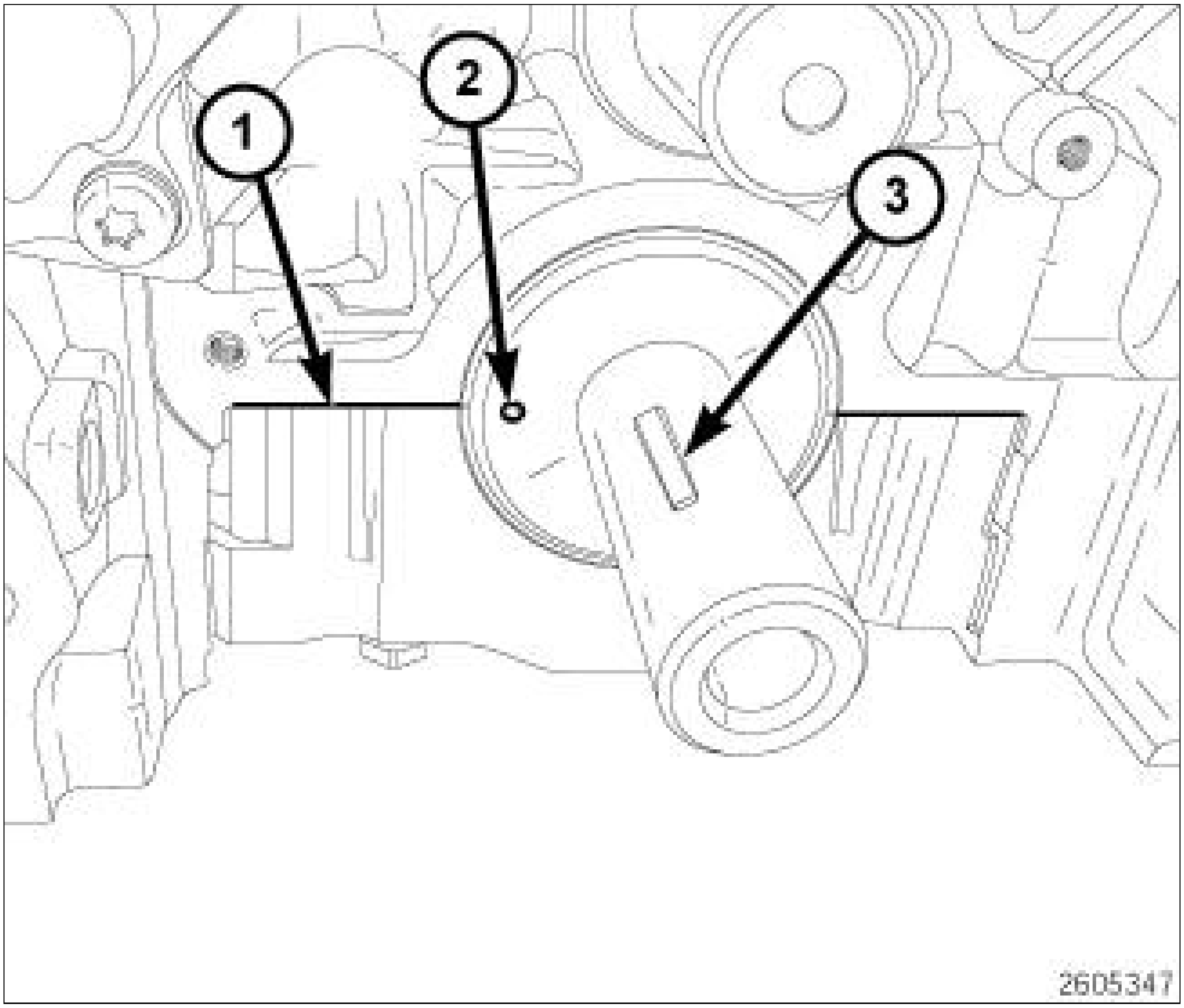


Courtesy of CHRYSLER GROUP, LLC

5. If removed, install the left side cam chain guide (2) and tensioner arm and tighten the bolts (4) to the proper specification. Refer to TORQUE SPECIFICATIONS .
6. If removed, install the left side cam chain tensioner (5) to the cylinder head with two bolts (6) and tighten the bolts (6) to the proper specification. Refer to TORQUE SPECIFICATIONS .
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 STANDARD PROCEDURE .

Fig 3: Crankshaft Key, Dimple & Block/Bearing Cap Junction

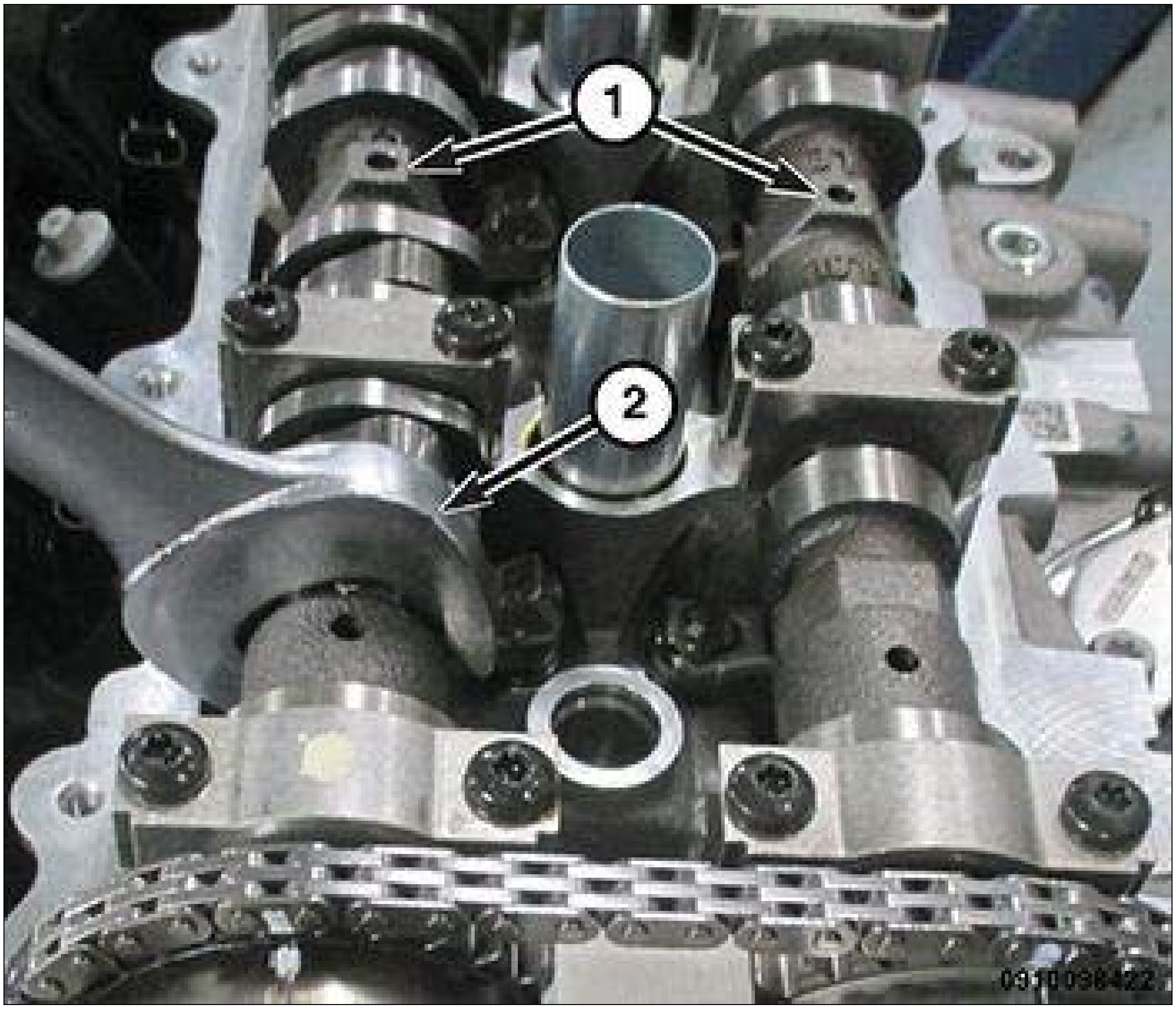


Courtesy of CHRYSLER GROUP, LLC

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.*

Fig 4: Alignment Holes & Wrench



Courtesy of CHRYSLER GROUP, LLC

9. 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).

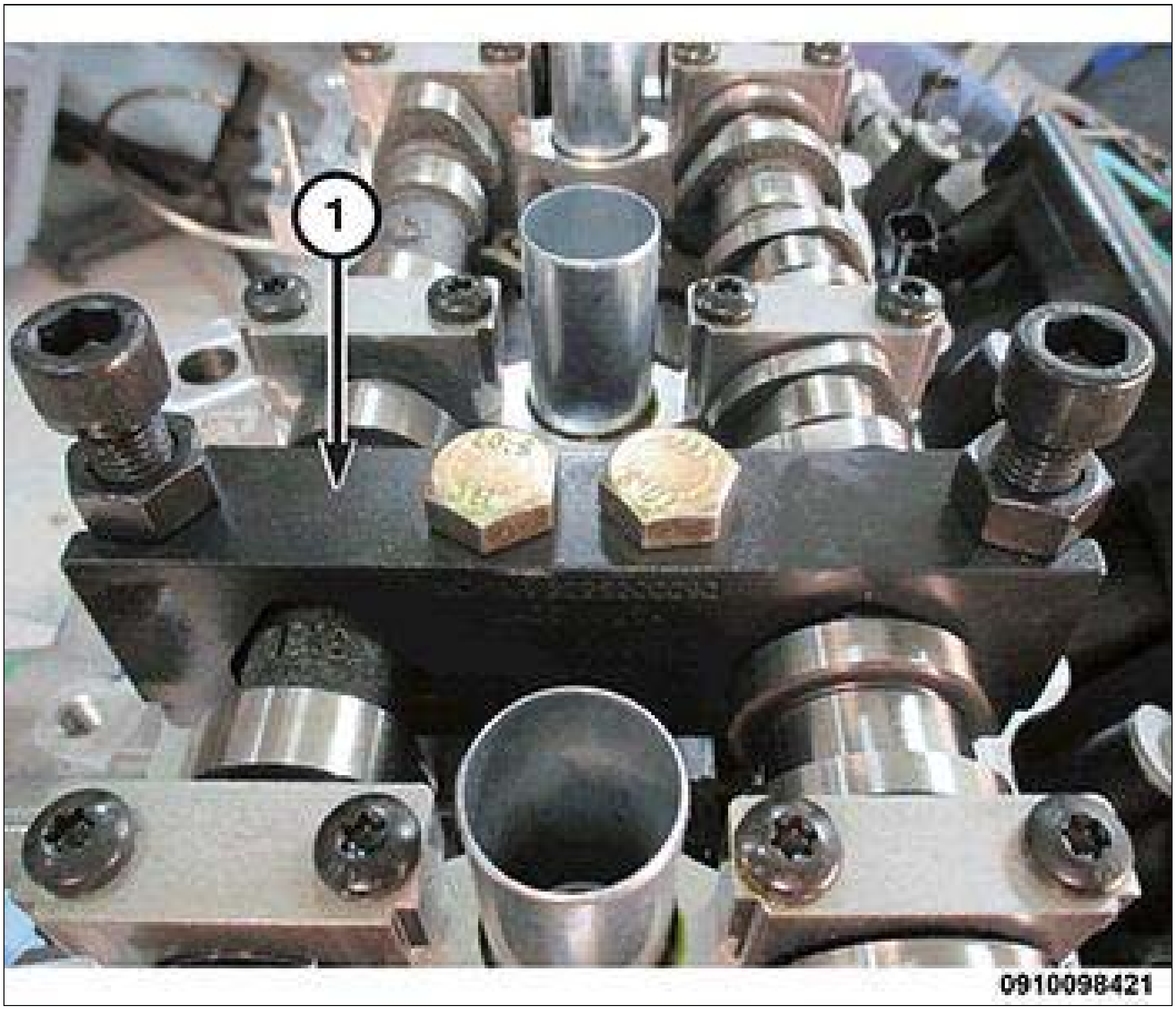
CAUTION:

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.

NOTE:

It may be necessary to rock the camshaft slightly (a few degrees) with a wrench (2) when installing the camshaft holder.

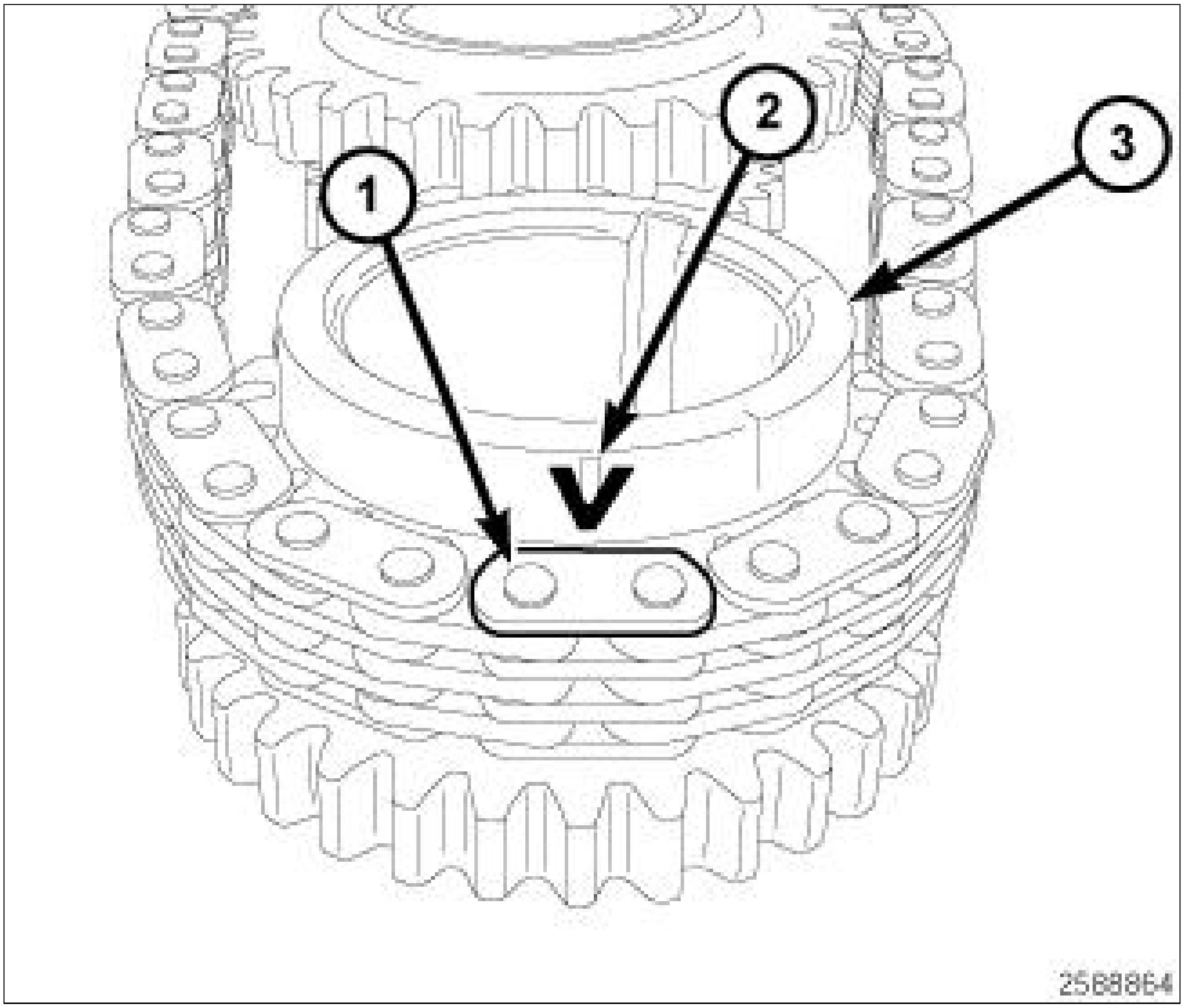
Fig 5: Camshaft Holder



Courtesy of CHRYSLER GROUP, LLC

10. If the Camshaft Holders have been removed, verify that the camshafts are set at top-dead-center by positioning the alignment holes (1) vertically.
11. Install the (special tool #2025200090, Holder, Camshaft) (1) on both left and right side camshafts.

Fig 6: Aligning Arrow With Plated Link On Primary Chain



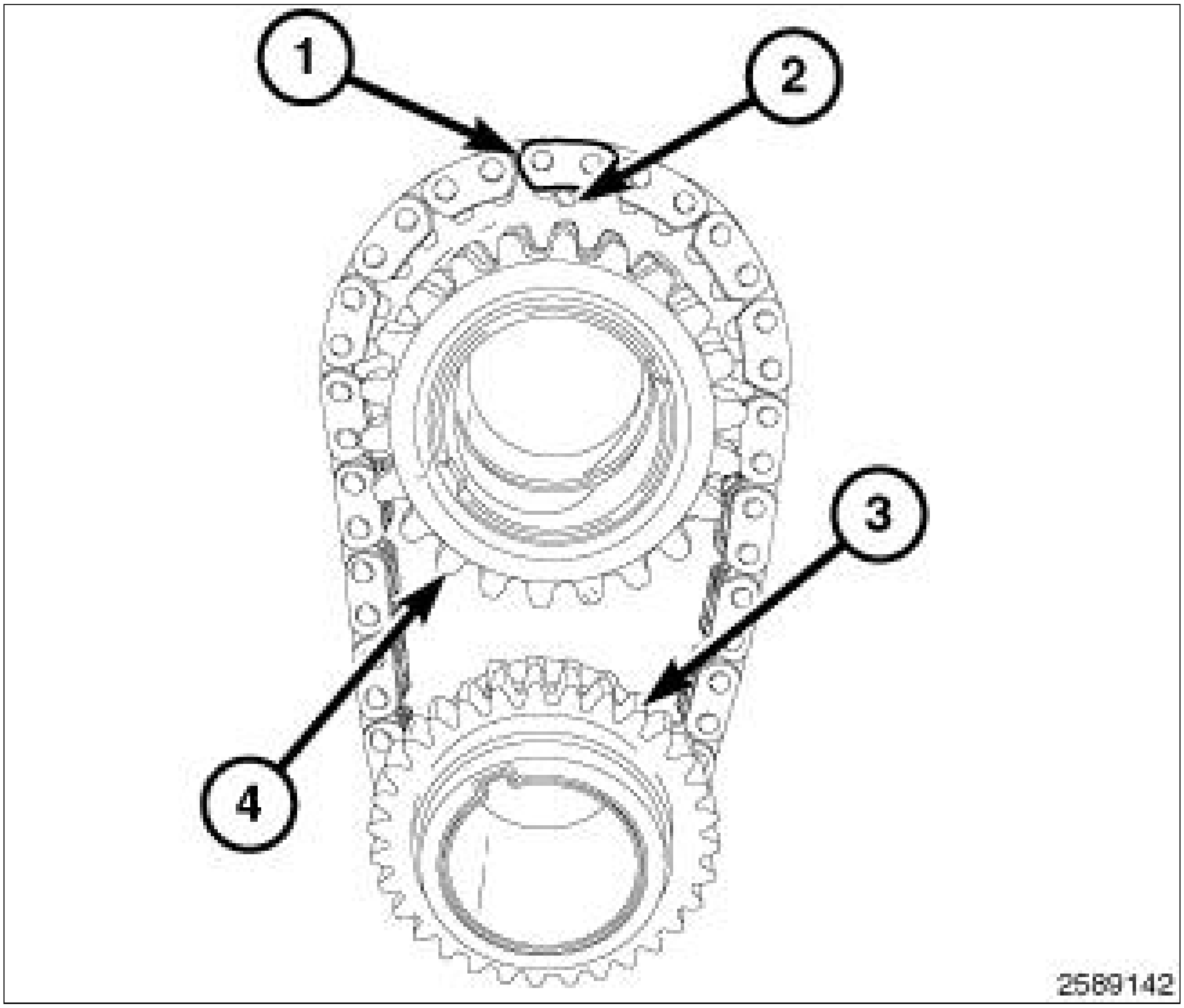
Courtesy of CHRYSLER GROUP, LLC

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.

12. 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.

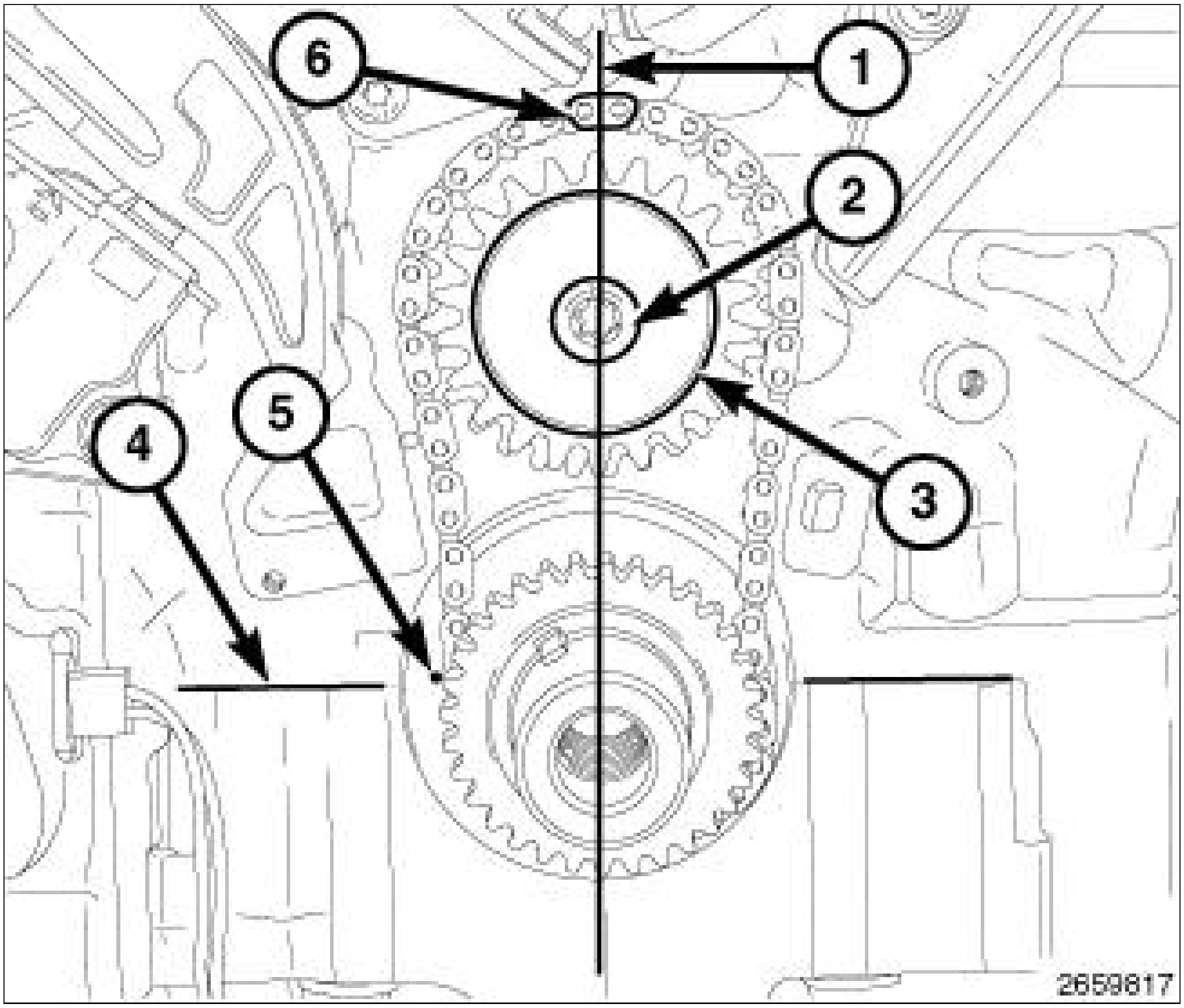
Fig 7: Placing Idler Sprocket Into Timing Chain So That Dimple Is Aligned With Plated Link On Timing Chain



Courtesy of CHRYSLER GROUP, LLC

13. 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.

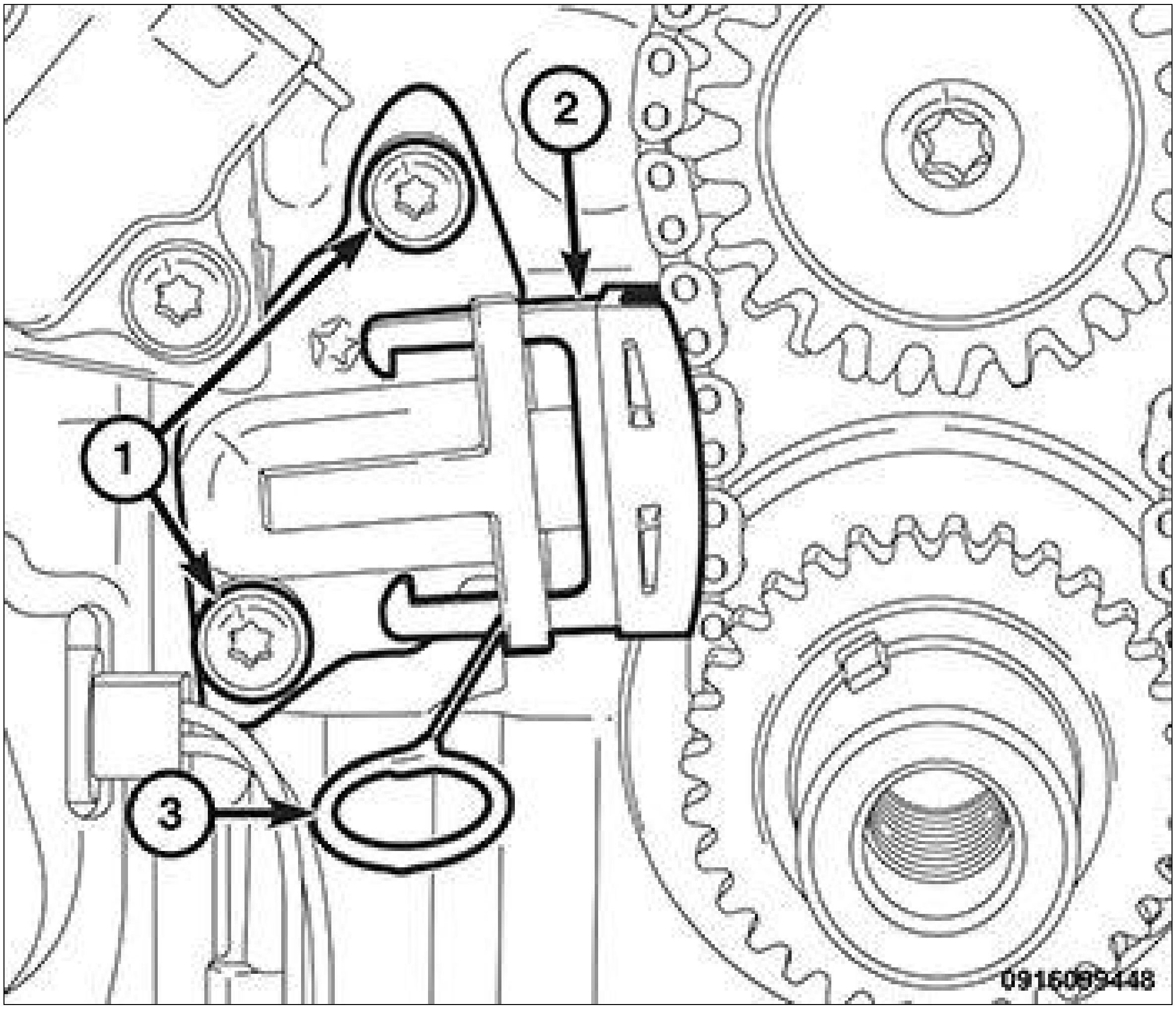
Fig 8: Timing Chain Plated Link At 12 O'Clock, Washer, Retaining Bolt, Block/Bearing Cap Junction & Dimple



Courtesy of CHRYSLER GROUP, LLC

14. 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).
15. Install the idler sprocket retaining bolt (2) and washer (3) and tighten the bolt (2) to the proper specification. Refer to TORQUE SPECIFICATIONS .

Fig 9: Primary Chain Tensioner & Bolts

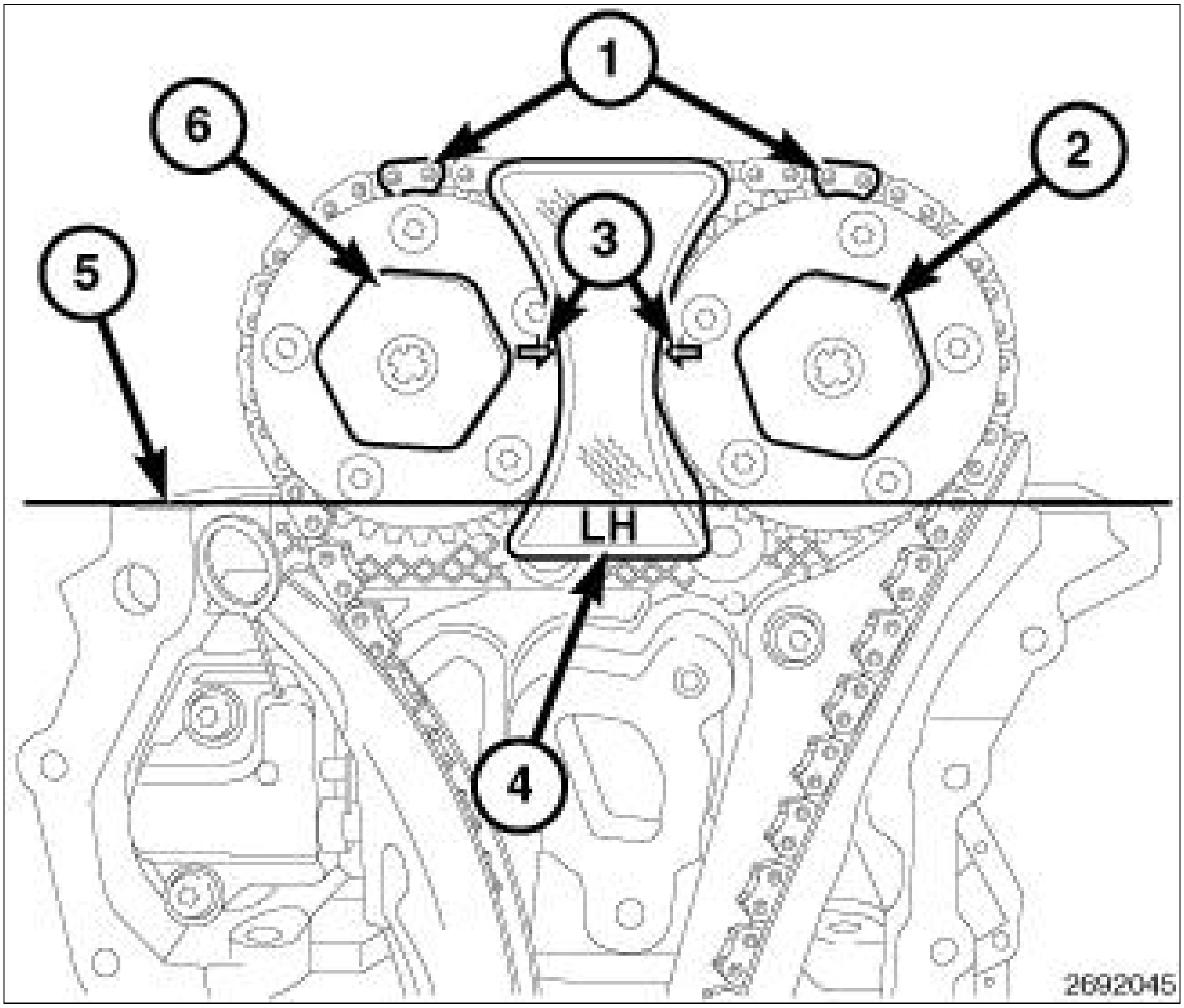


Courtesy of CHRYSLER GROUP, LLC

16. Reset the primary chain tensioner (2) by pushing back the tensioner piston and installing Tensioner Pin (special tool #8514, Pins, Tensioner) (3).
17. Install the primary chain tensioner to the engine block with two bolts (1) and tighten the bolts (1) to the proper specification.

    Refer to TORQUE SPECIFICATIONS .

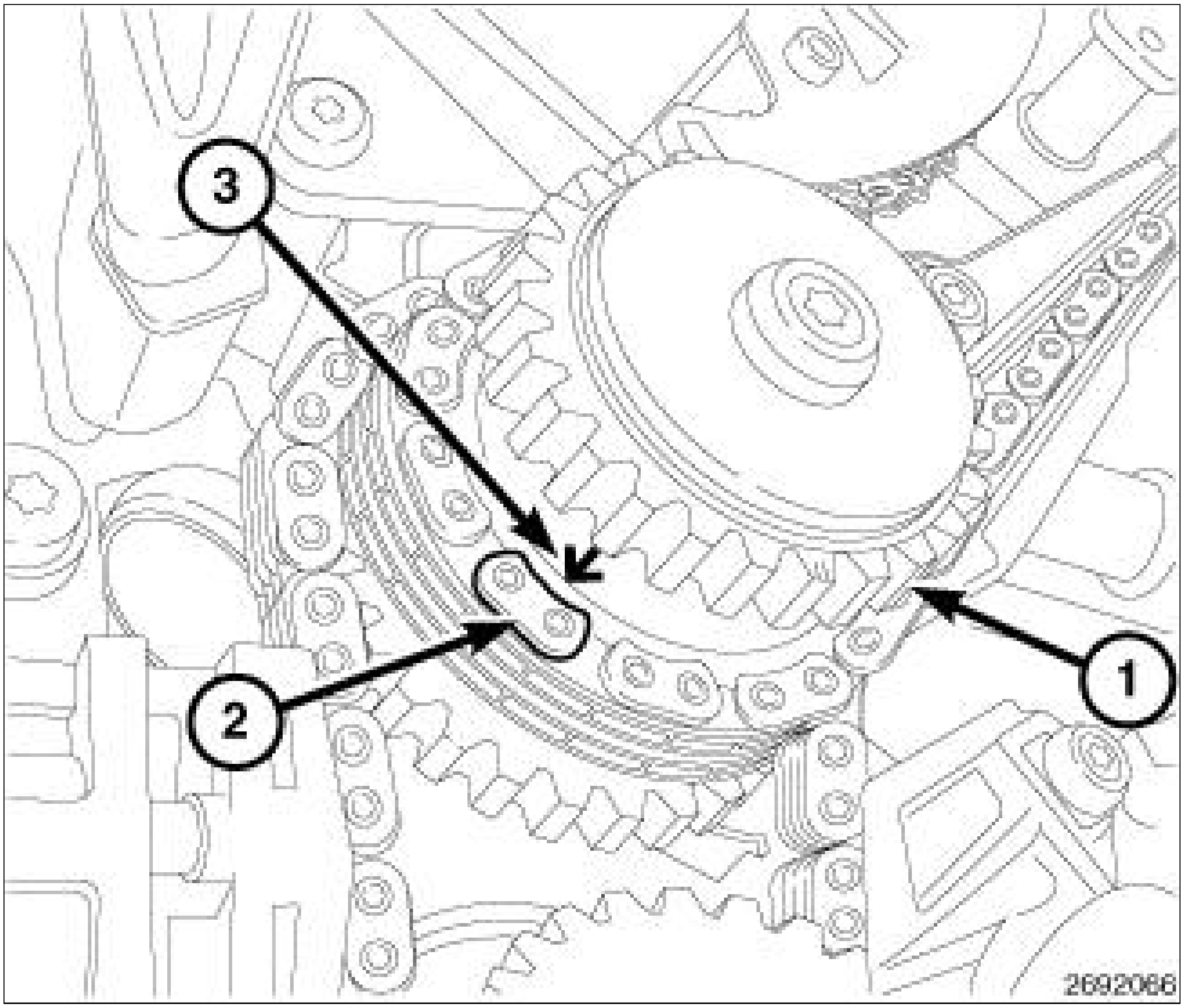
Fig 10: Phaser Timing Marks, Oil Control Valves & LH Camshaft Phaser Lock



Courtesy of CHRYSLER GROUP, LLC

18. Press the left side intake cam phaser onto the intake camshaft. Install and hand tighten the oil control valve (6).

Fig 11: Idler Sprocket, Plated Link & Arrow



Courtesy of CHRYSLER GROUP, LLC

NOTE:

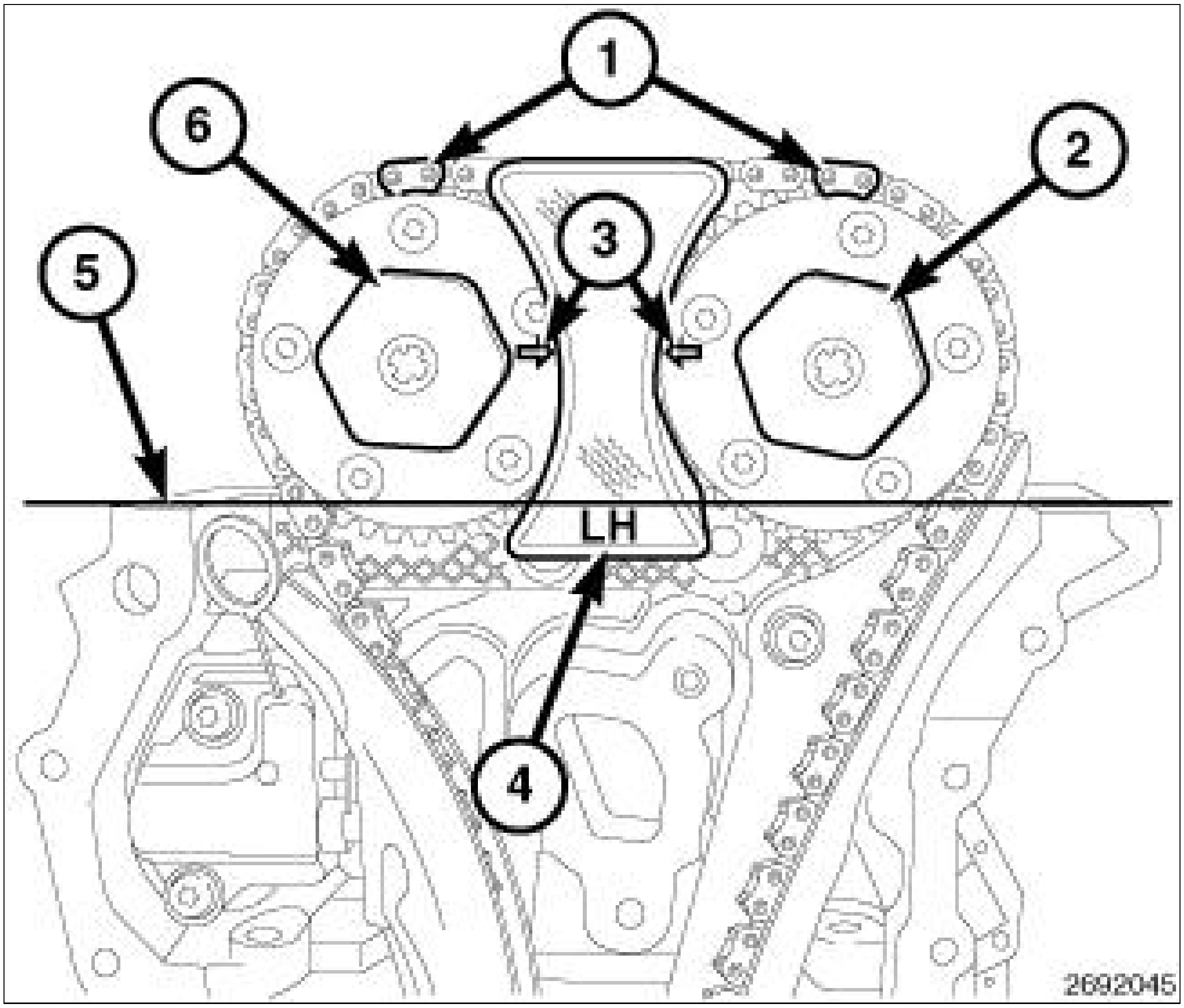
The left side and right side cam chains are identical.

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.

19. 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 12: Phaser Timing Marks, Oil Control Valves & LH Camshaft Phaser Lock



Courtesy of CHRYSLER GROUP, LLC

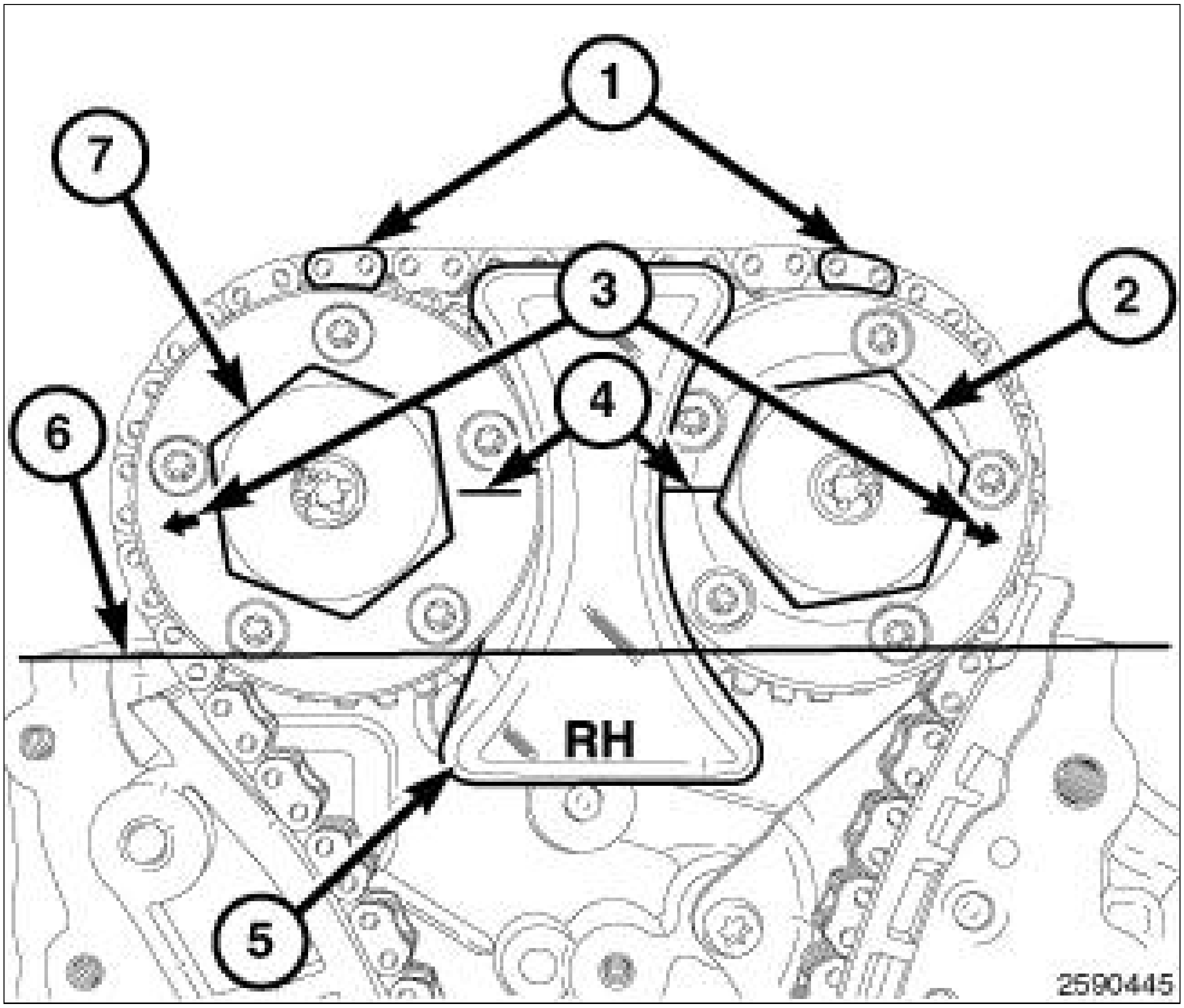
20. While maintaining this alignment, route the cam chain around the exhaust and intake cam phasers so that the plated links are aligned with the phaser timing marks (1). Position the left side cam phasers so that the arrows (3) point toward each other and are parallel to the cylinder head cover mounting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

21. Install the (special tool #2025101090, Holder, Camshaft Phaser - Left-Front Cyl Head) (4) with the tool number facing up.

22. Tighten the oil control valves (2) and (6) to the proper specification. Refer to TORQUE SPECIFICATIONS .

23. Remove the Camshaft Phaser Holder (4).

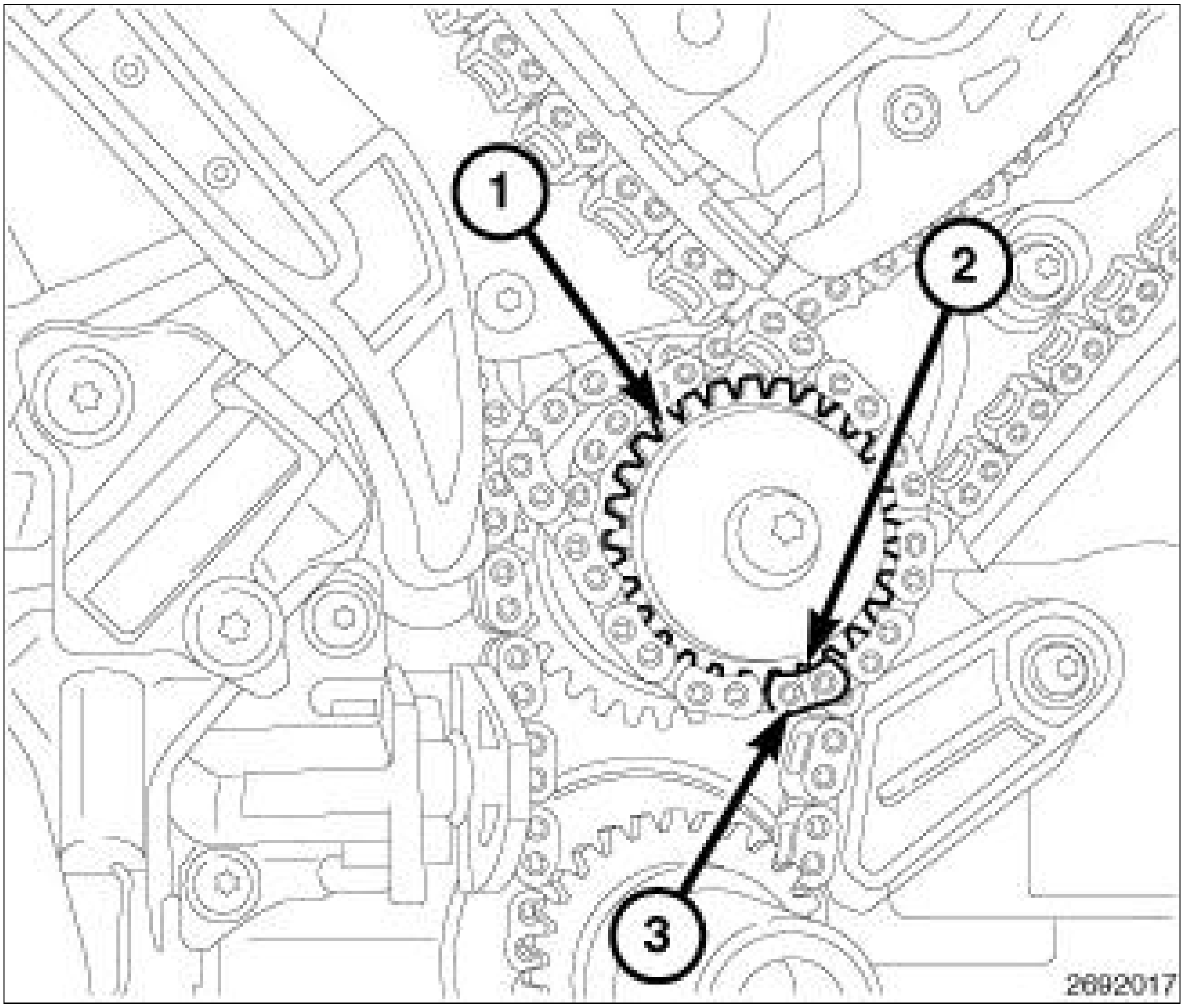
Fig 13: Phaser Timing Marks, Oil Control Valves & RH Camshaft Phaser Lock



Courtesy of CHRYSLER GROUP, LLC

24. Press the right side exhaust cam phaser onto the exhaust camshaft. Install and hand tighten the oil control valve (7).

Fig 14: Idler Sprocket, Dimple & Plated Link



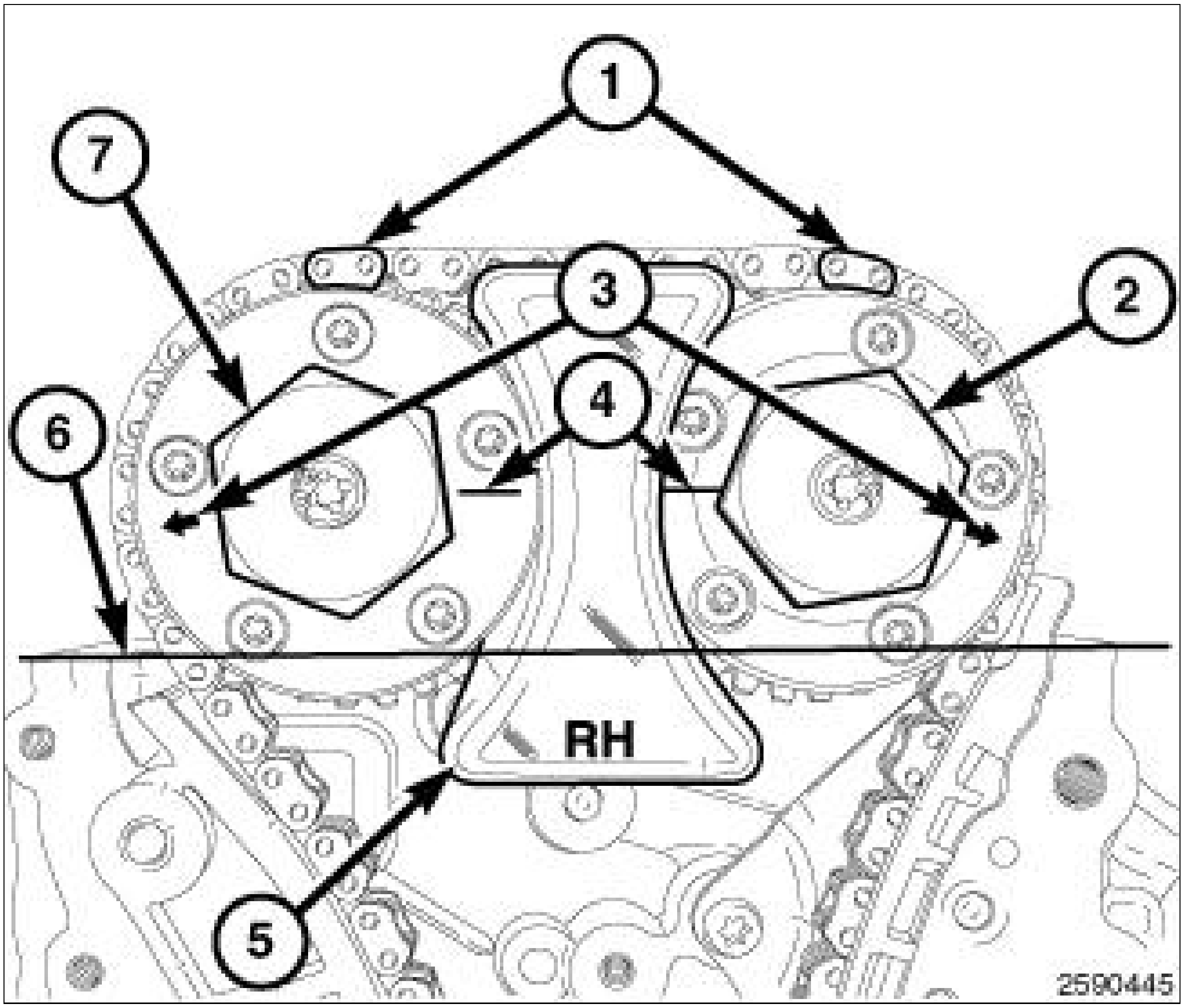
Courtesy of CHRYSLER GROUP, LLC

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.

25. 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.

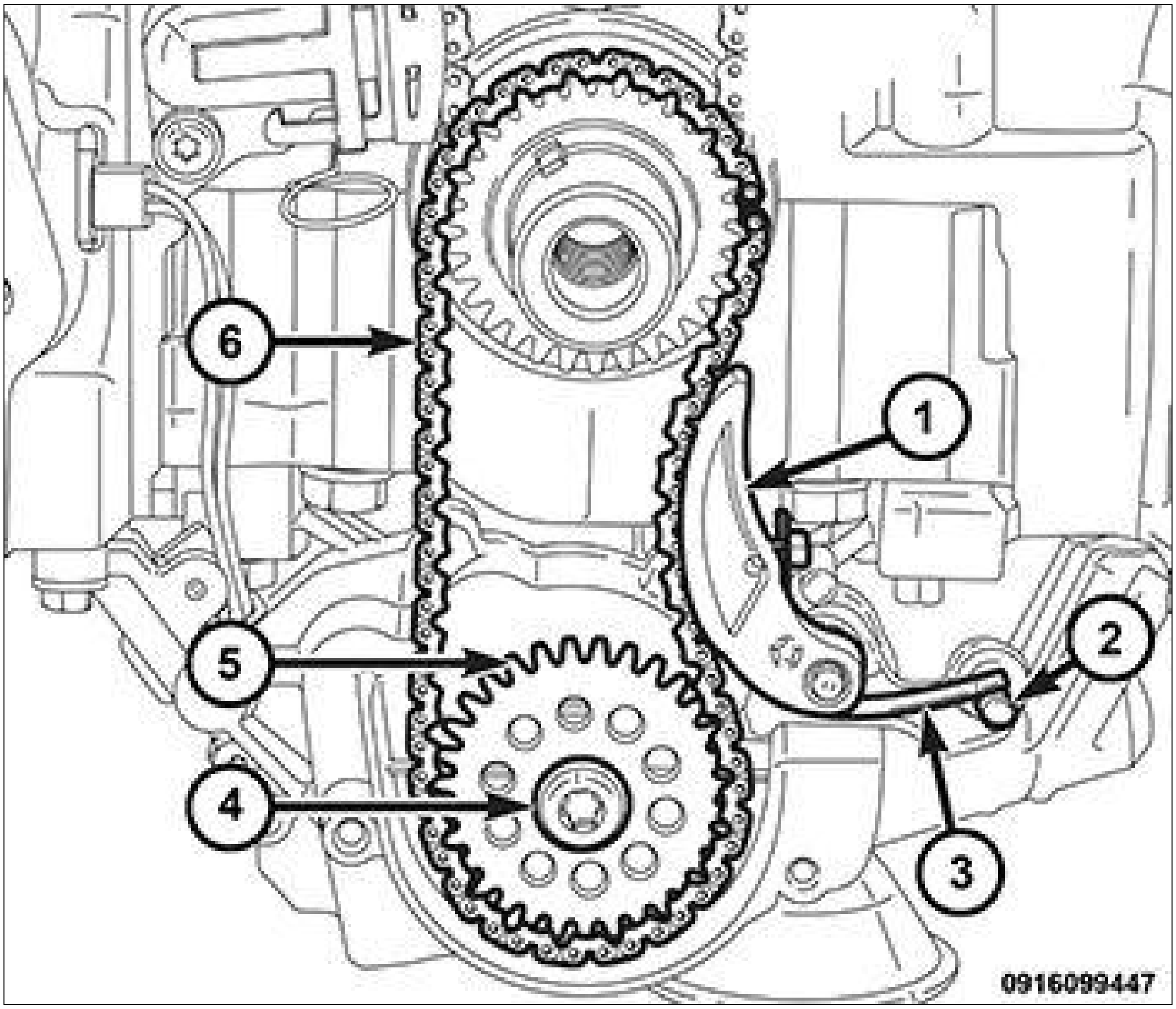
Fig 15: Phaser Timing Marks, Oil Control Valves & RH Camshaft Phaser Lock



Courtesy of CHRYSLER GROUP, LLC

26. 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).
27. Install the (special tool #2025102090, Holder, Camshaft Phaser - Right-Rear Cyl Head) (5) with the tool number facing up.
28. Tighten the oil control valves (2) and (7) to the proper specification. Refer to TORQUE SPECIFICATIONS .
29. Remove the Camshaft Phaser Holder (5).

Fig 16: Oil Pump Chain Tensioner Spring, Dowel Pin, Oil Pump Chain Tensioner, Oil Pump Sprocket, Retaining Bolt & Oil Pump Chain



Courtesy of CHRYSLER GROUP, LLC

NOTE:

There are no timing marks on the oil pump gear or chain.

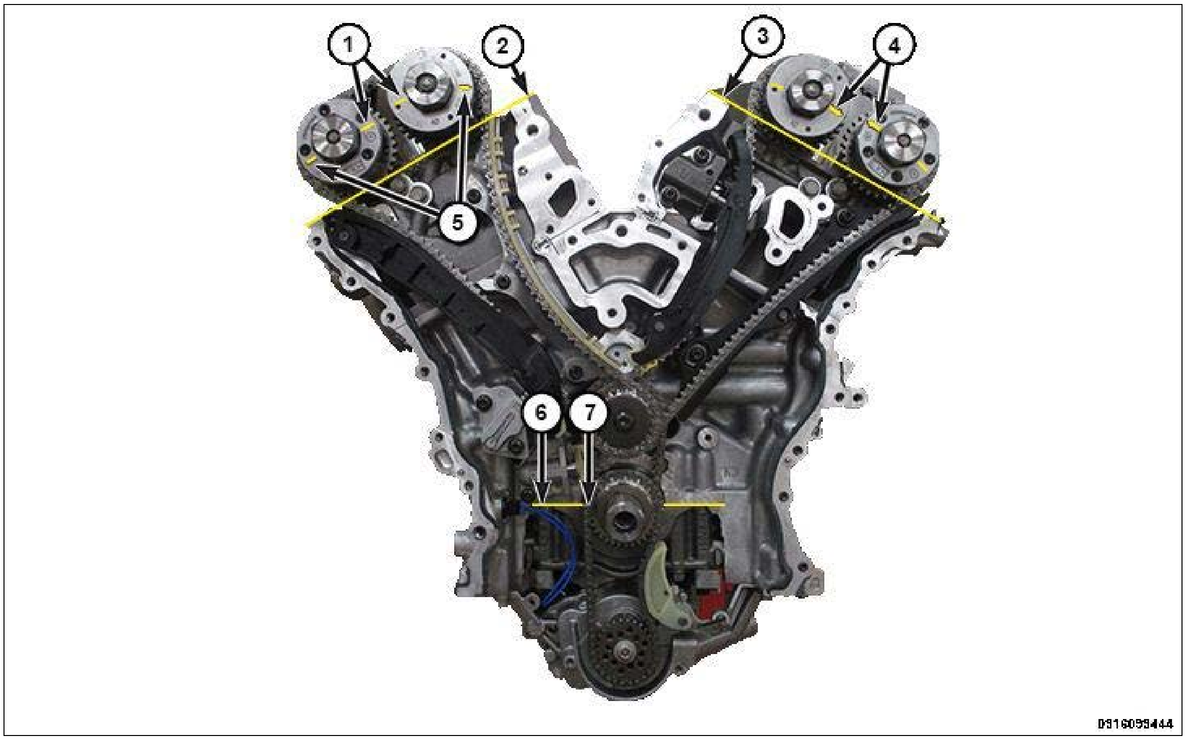
CAUTION:

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.

30. 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 retaining bolt (4) and tighten to the proper specification. Refer to TORQUE SPECIFICATIONS .

31. Install the oil pump chain tensioner (1). Insure that the spring (3) is positioned above the dowel pin (2).

Fig 17: Scribe Lines, Valve Cover Sealing Surfaces, Cam Phaser Arrows, Block/Bearing Cap Junction & Dimple



Courtesy of CHRYSLER GROUP, LLC

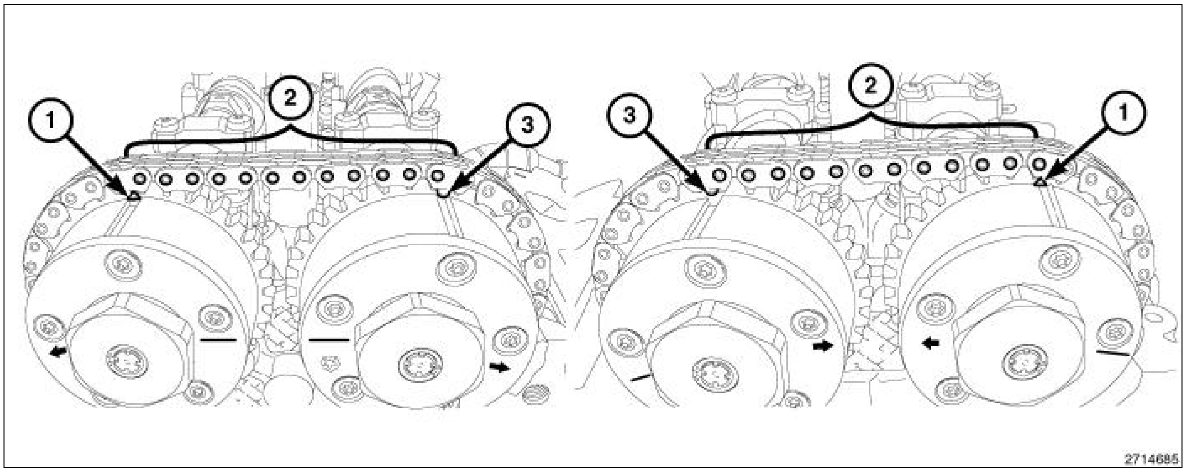
32. Remove the Tensioner Pins (special tool #8514, Pins, Tensioner) from the right side and left side cam chain tensioners.

33. Remove the (special tool #2025200090, Holder, Camshaft) from the camshafts.

34. Rotate the crankshaft clockwise (as viewed from the front) two complete revolutions stopping when the dimple (7) on the crankshaft is aligned with the block/bearing cap junction (6).

35. While maintaining this alignment, verify that the **ARROWS** (4) 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** (5) point away from each other and the **SCRIBE LINES** (1) are parallel to the cylinder head cover mounting surface (2).

Fig 18: Chain Pins, Exhaust Cam Phaser Triangle Marking & Circle Marking



Courtesy of CHRYSLER GROUP, LLC

36. 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.
37. If the engine timing is not correct, repeat this procedure.
38. Install the engine timing cover. Refer to COVER(S), ENGINE TIMING, INSTALLATION .
39. Install the spark plugs. Refer to SPARK PLUG, INSTALLATION .
40. Install the cylinder head covers. Refer to COVER(S), CYLINDER HEAD, INSTALLATION .
41. Fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
42. Connect the negative battery cable.
43. Fill the cooling system. Refer to STANDARD PROCEDURE .
44. Operate the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to STANDARD PROCEDURE .

NOTE:

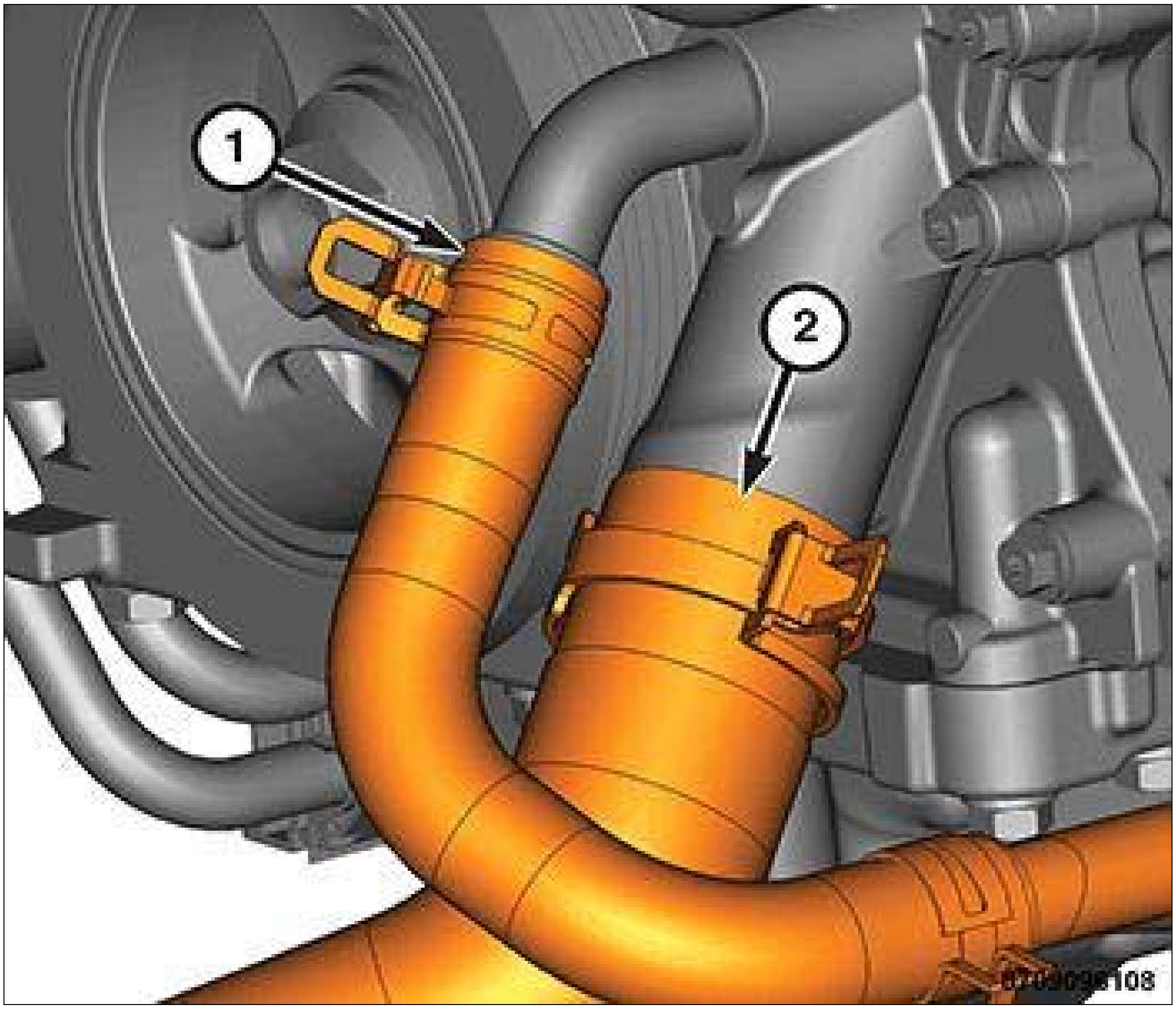
The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system. For example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components.

VALVE TIMING > COVER(S), ENGINE TIMING > REMOVAL > REMOVAL

1. Disconnect and isolate the negative battery cable.
2. Drain the cooling system. Refer to STANDARD PROCEDURE .

3. Remove the electric vacuum pump. Refer to PUMP, ELECTRIC VACUUM, REMOVAL .
4. Remove the upper radiator hose and thermostat housing. Refer to THERMOSTAT, REMOVAL .

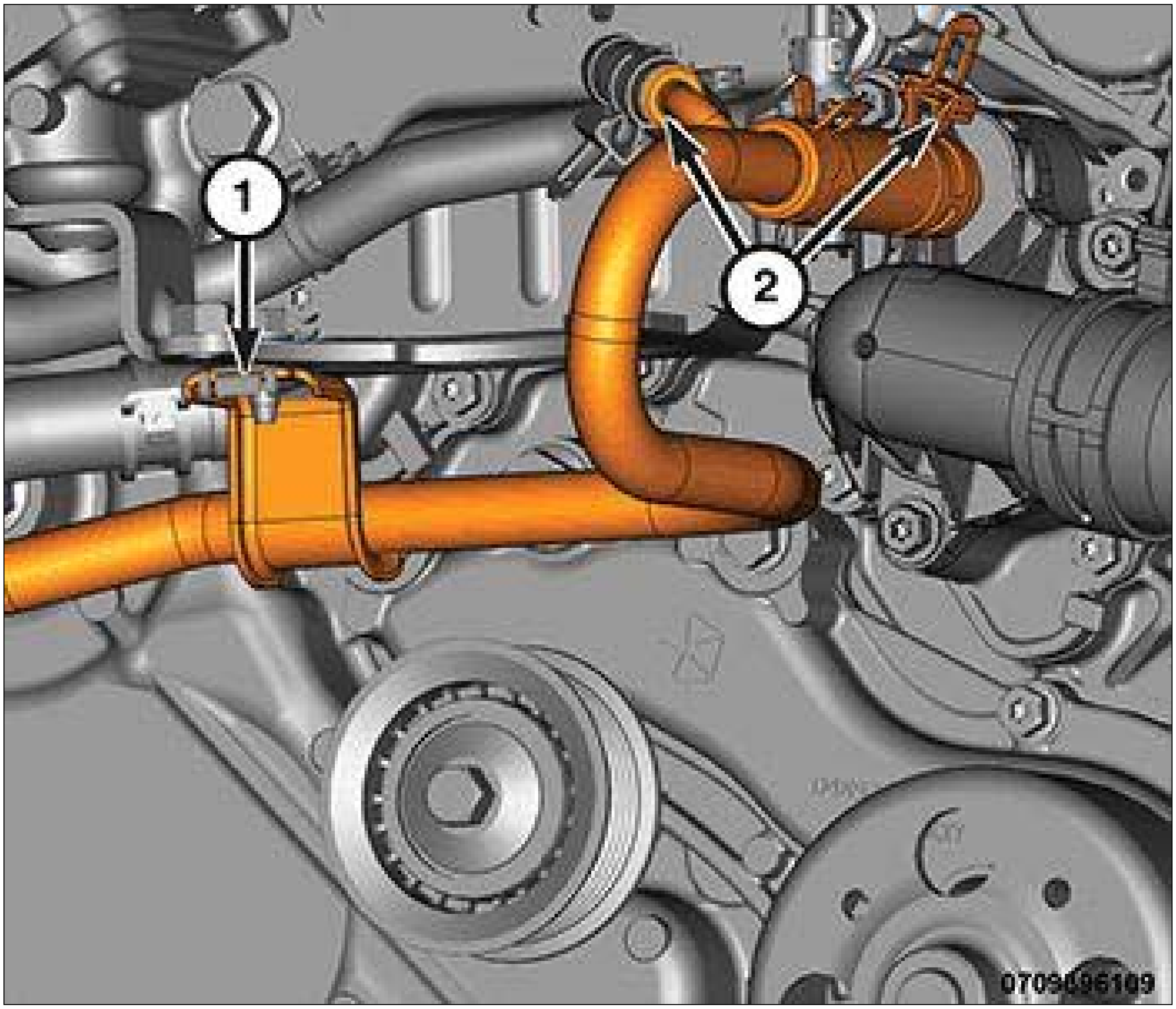
Fig 1: Lower Heater Hose & Lower Radiator Hose



Courtesy of CHRYSLER GROUP, LLC

5. Remove the heater core return hose (1) from the water pump housing.
6. Remove the lower radiator hose (2) from the water pump housing.

Fig 2: Vacuum Pump Bracket & Outlet Hose Clamps

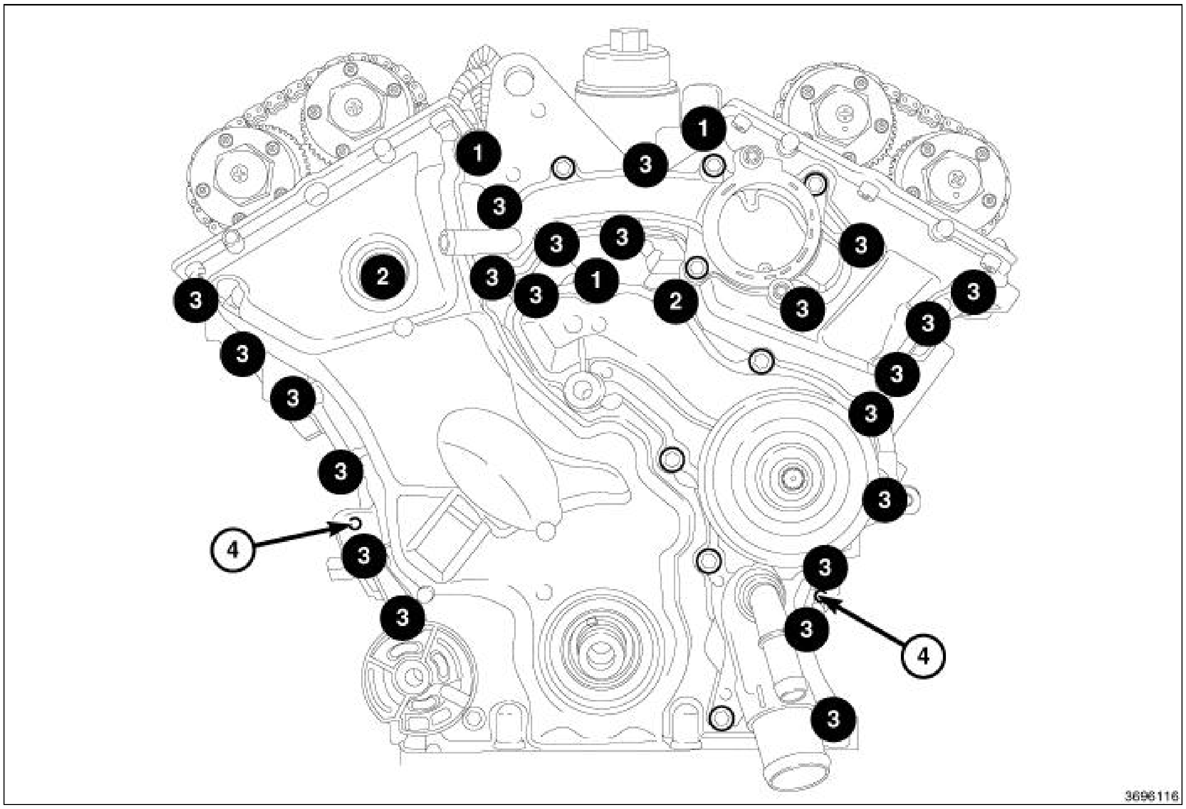


Courtesy of CHRYSLER GROUP, LLC

7. Remove the heater core supply hose from the coolant outlet housing (2).
8. Remove the bolt (1) and reposition the heater core supply tube.
9. Remove the accessory drive belt. Refer to BELT, SERPENTINE, REMOVAL .
10. Remove the accessory drive belt tensioner. Refer to TENSIONER, BELT, REMOVAL .
11. Remove the accessory idler pulley. Refer to PULLEY, IDLER, REMOVAL .
12. Remove the crankshaft vibration damper. Refer to DAMPER, VIBRATION, REMOVAL .
13. Remove the right and left cylinder head covers. Refer to COVER(S), CYLINDER HEAD, REMOVAL .
14. Remove the upper and lower oil pans. Refer to PAN, OIL, REMOVAL .

> NOTE:
>
> *It is not necessary to remove the water pump or the coolant outlet housing for engine timing cover removal.*

Fig 3: Timing Cover Bolts

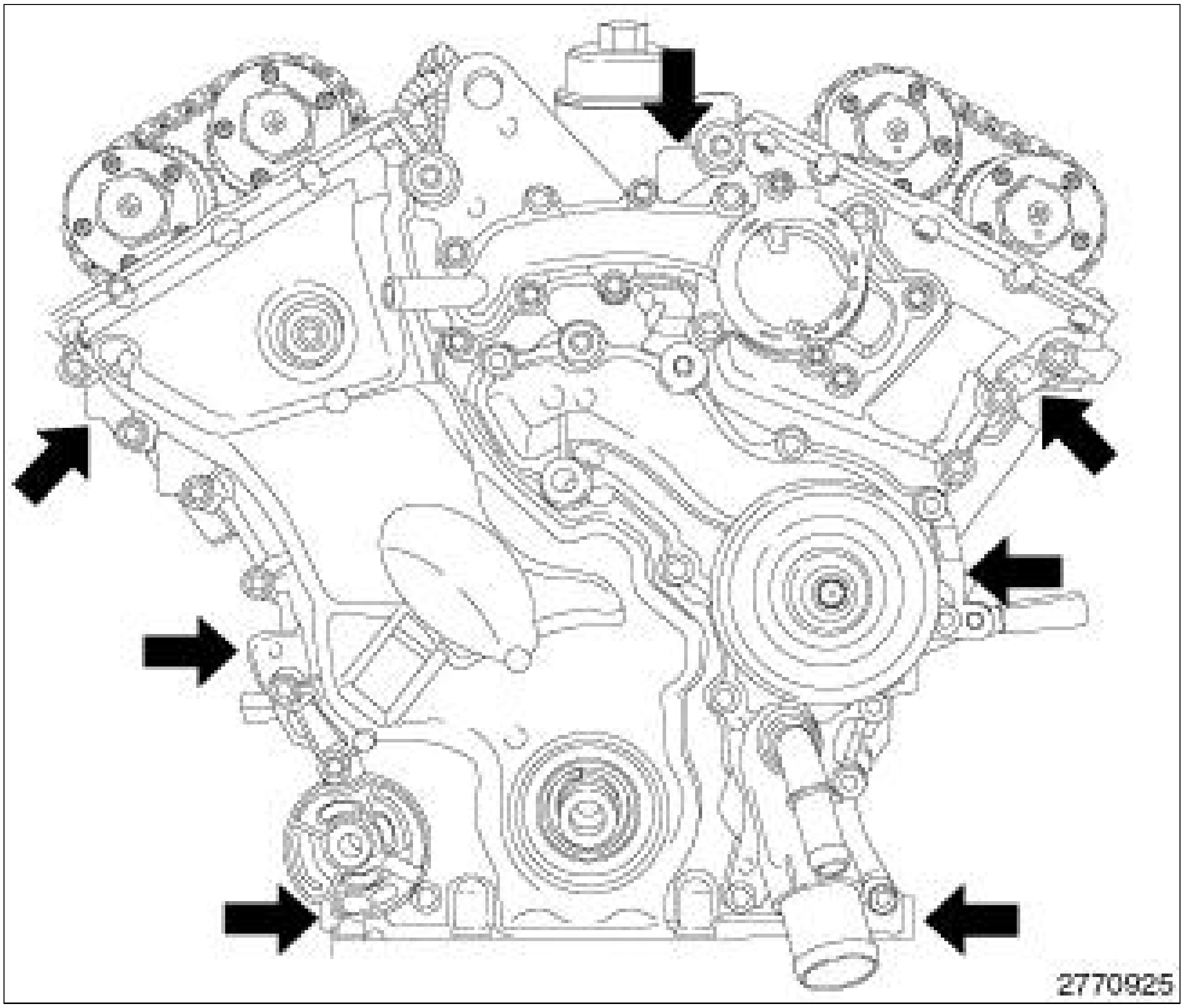


Courtesy of CHRYSLER GROUP, LLC

15. Remove the following timing cover attaching bolts:

    1. Three M10 bolts (1)
    2. Two M8 bolts (2)
    3. Twenty-two M6 bolts (3)

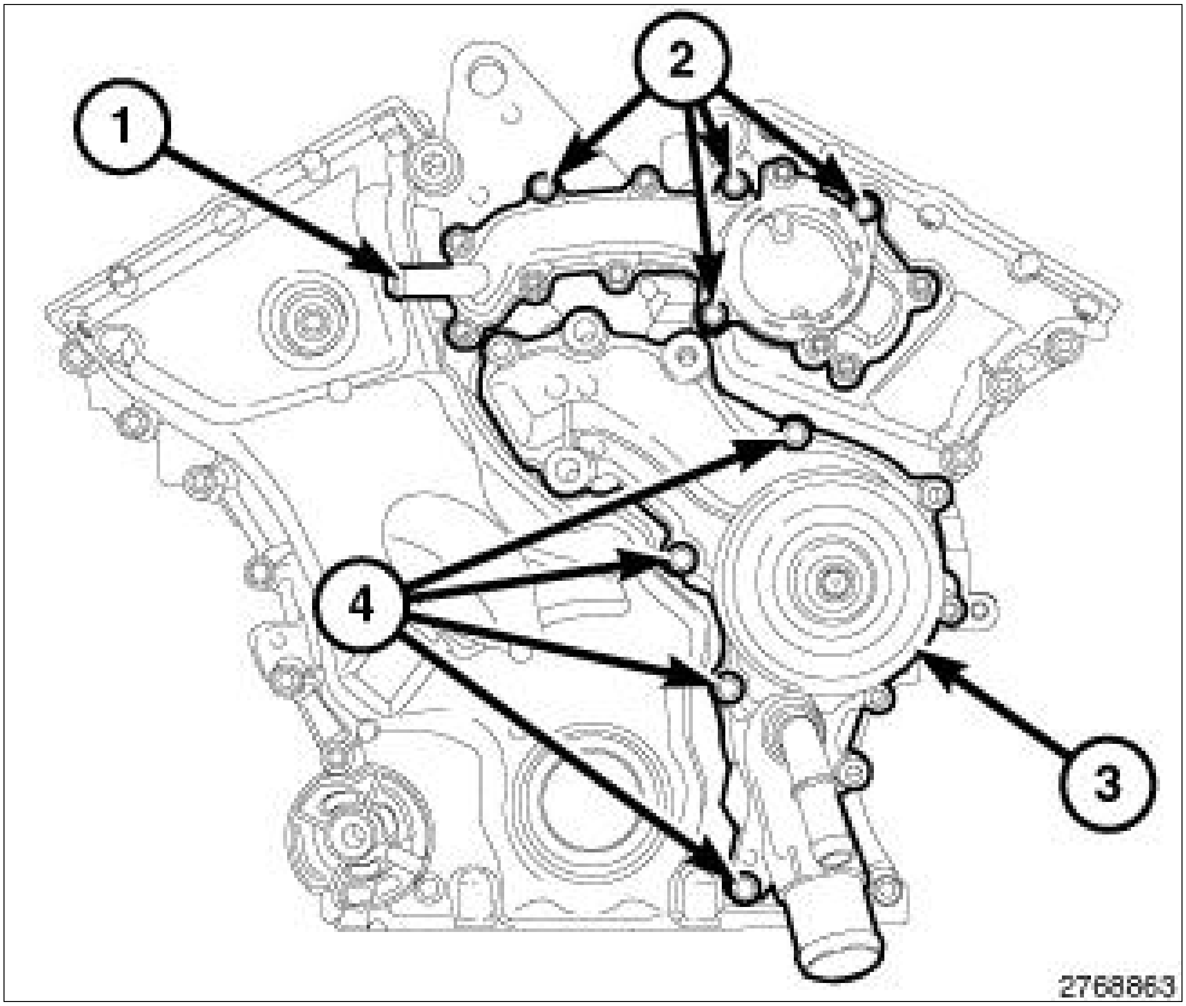
Fig 4: Timing Cover Removal Pry Points



Courtesy of CHRYSLER GROUP, LLC

16. Using the seven indicated pry points, carefully remove the timing cover.

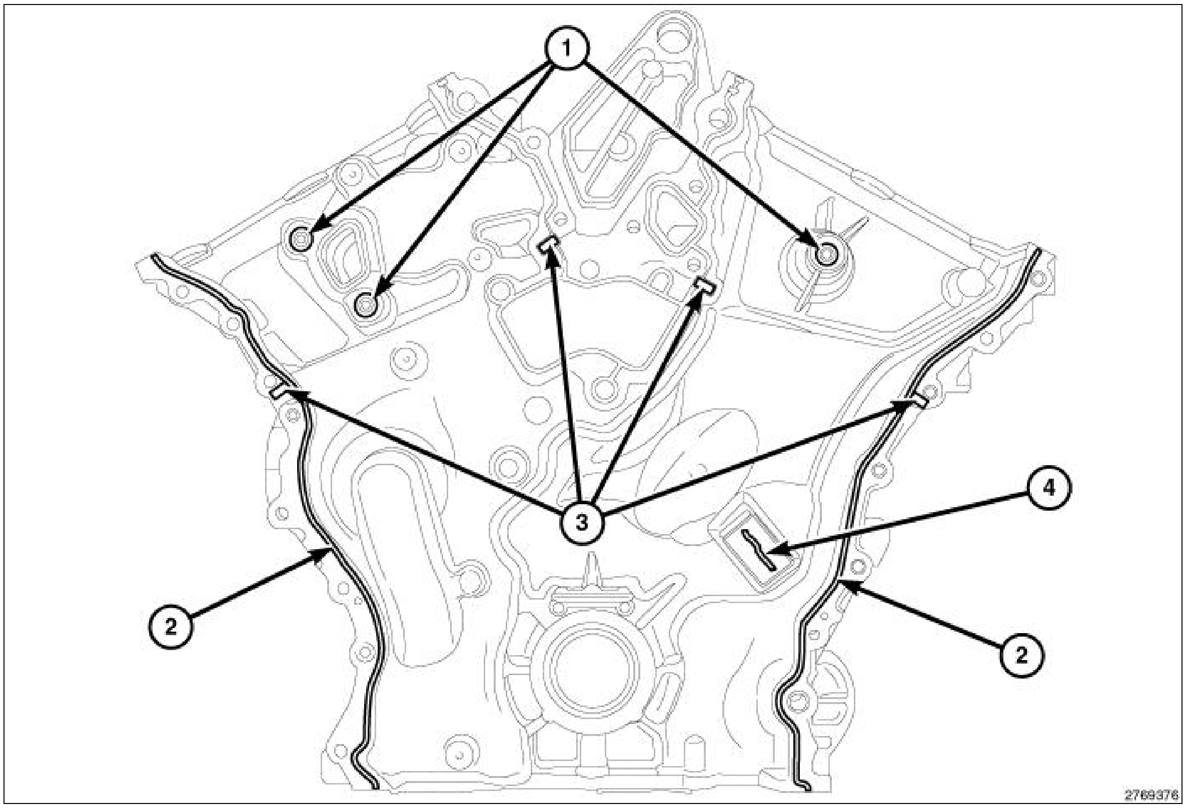
Fig 5: Coolant Outlet Housing, Water Pump & Bolts



Courtesy of CHRYSLER GROUP, LLC

17. If required, remove the remaining four M6 bolts (2) and the coolant outlet housing (1) from the engine timing cover.
18. If required, remove the remaining four M6 bolts (4) and the water pump (3) from the engine timing cover.

Fig 6: Sealant At Cylinder Head Bosses, Right & Left Flanges, Cylinder Head-To-Engine Block T-Joints & Cover To Right Cam Chain Tensioner Gap



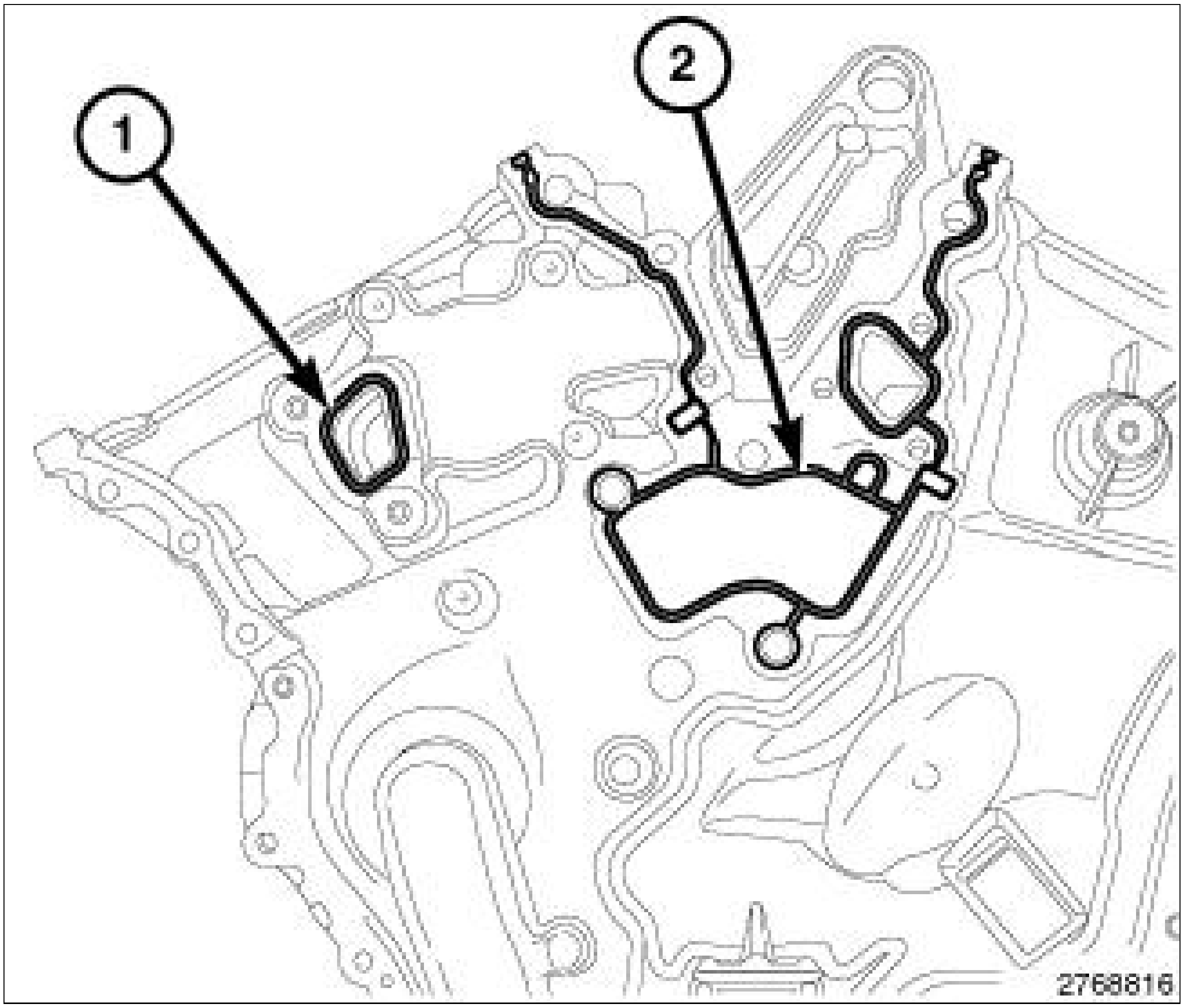
Courtesy of CHRYSLER GROUP, LLC

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.

19. Remove all residual sealant from the timing chain cover, cylinder head and engine block mating surfaces. Refer to ENGINE GASKET SURFACE PREPARATION .

Fig 7: Coolant Outlet Housing Gasket & Water Pump Gasket

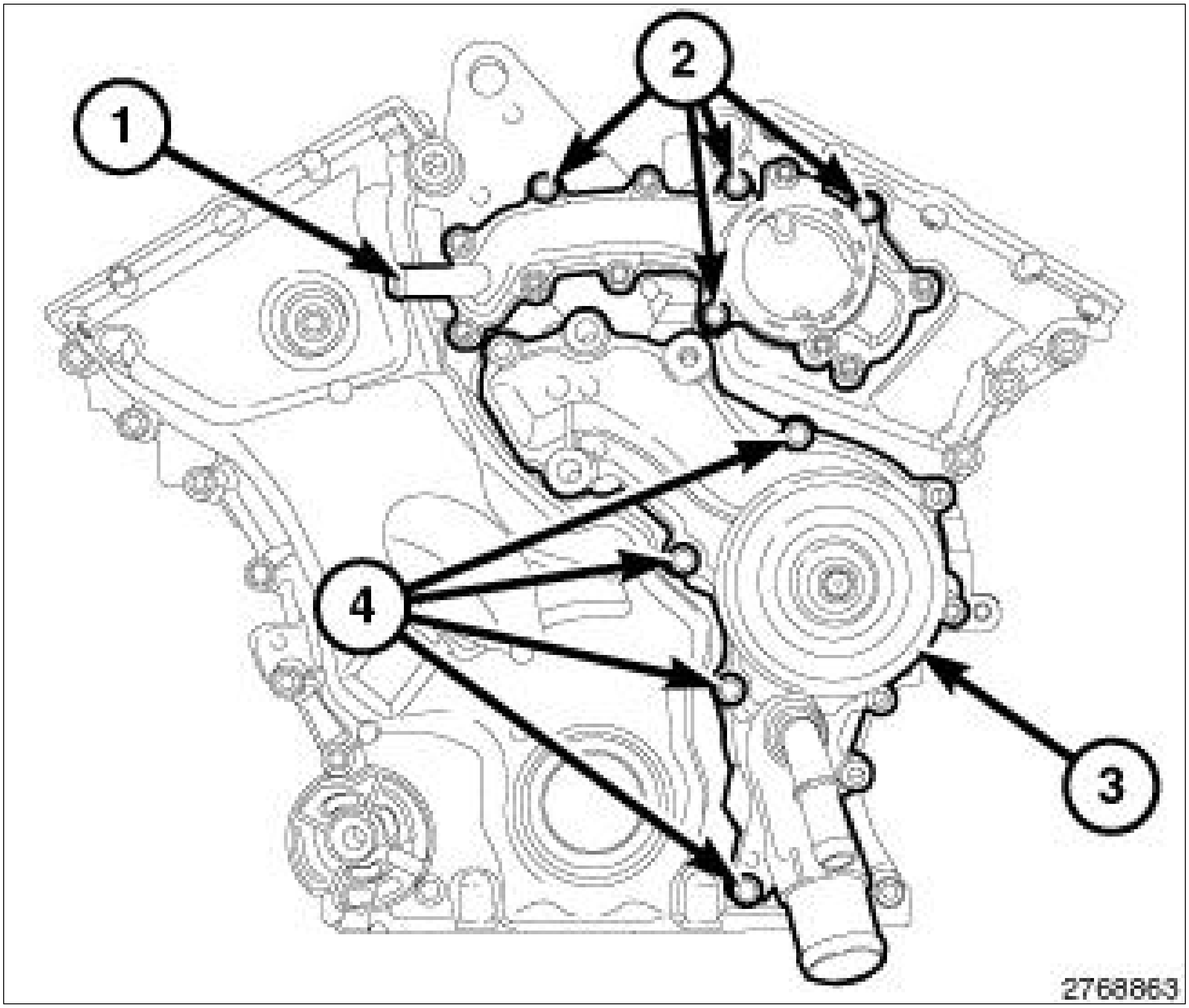


Courtesy of CHRYSLER GROUP, LLC

20. Remove and discard the coolant outlet housing gasket (1) and the water pump gasket (2).

VALVE TIMING > COVER(S), ENGINE TIMING > INSTALLATION > INSTALLATION

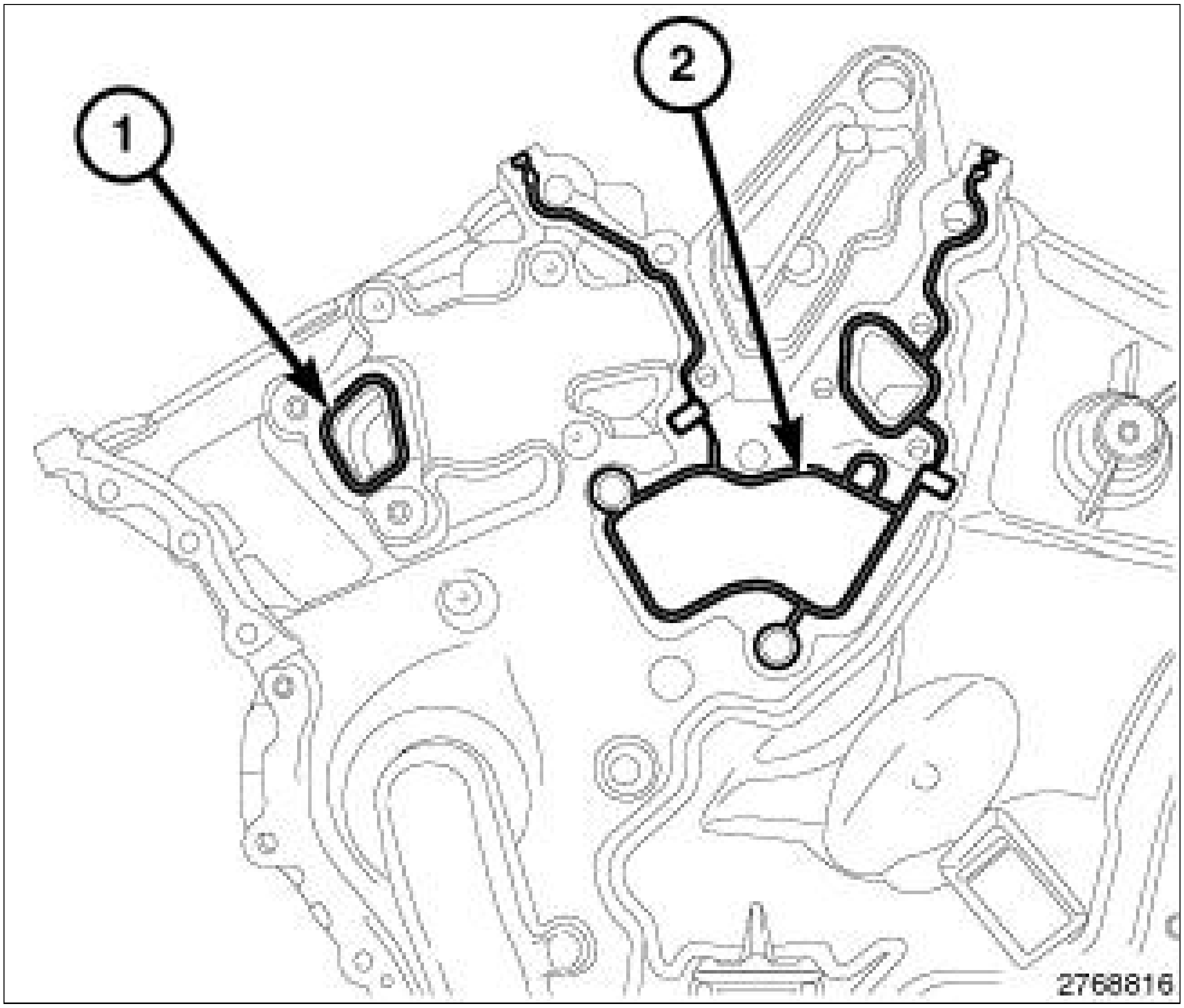
Fig 1: Coolant Outlet Housing, Water Pump & Bolts



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 .

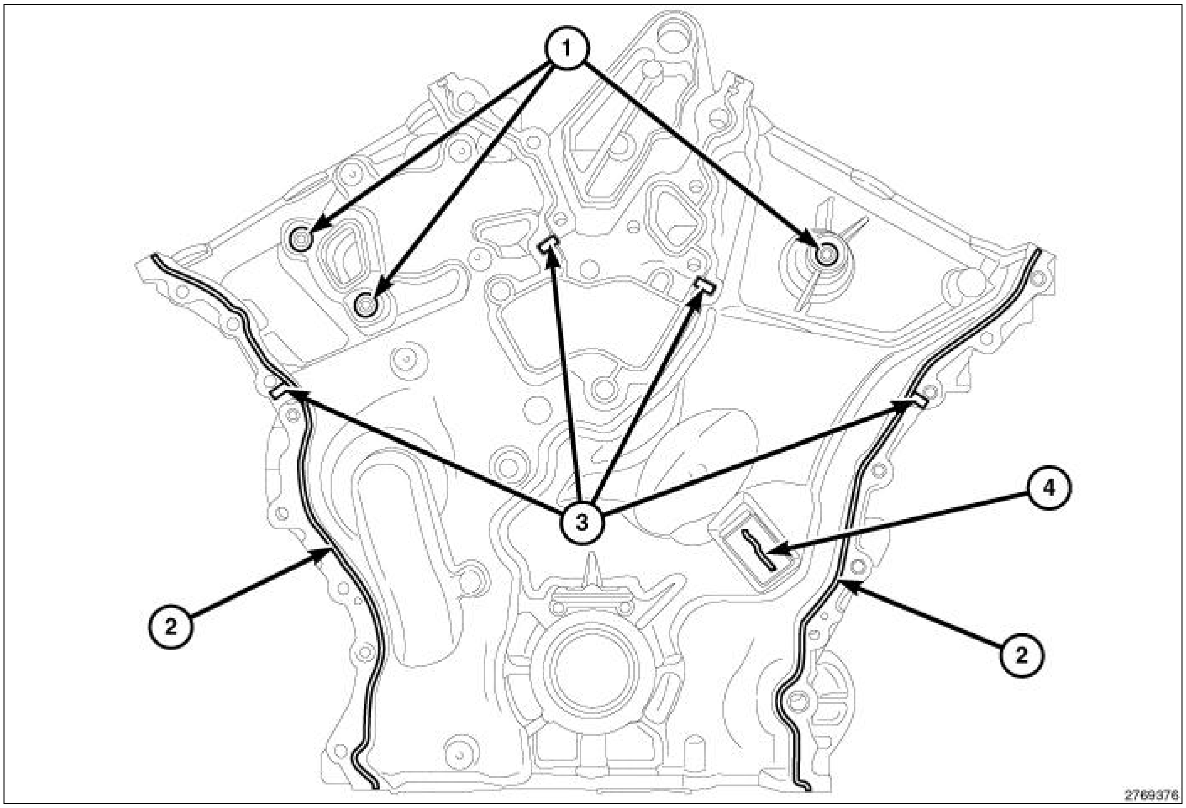
Fig 2: Coolant Outlet Housing Gasket & Water Pump Gasket



Courtesy of CHRYSLER GROUP, LLC

3. Install the coolant outlet housing gasket (1) and the water pump gasket (2).

Fig 3: Sealant At Cylinder Head Bosses, Right & Left Flanges, Cylinder Head-To-Engine Block T-Joints & Cover To Right Cam Chain Tensioner Gap



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. Refer to ENGINE GASKET SURFACE PREPARATION .

> *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:

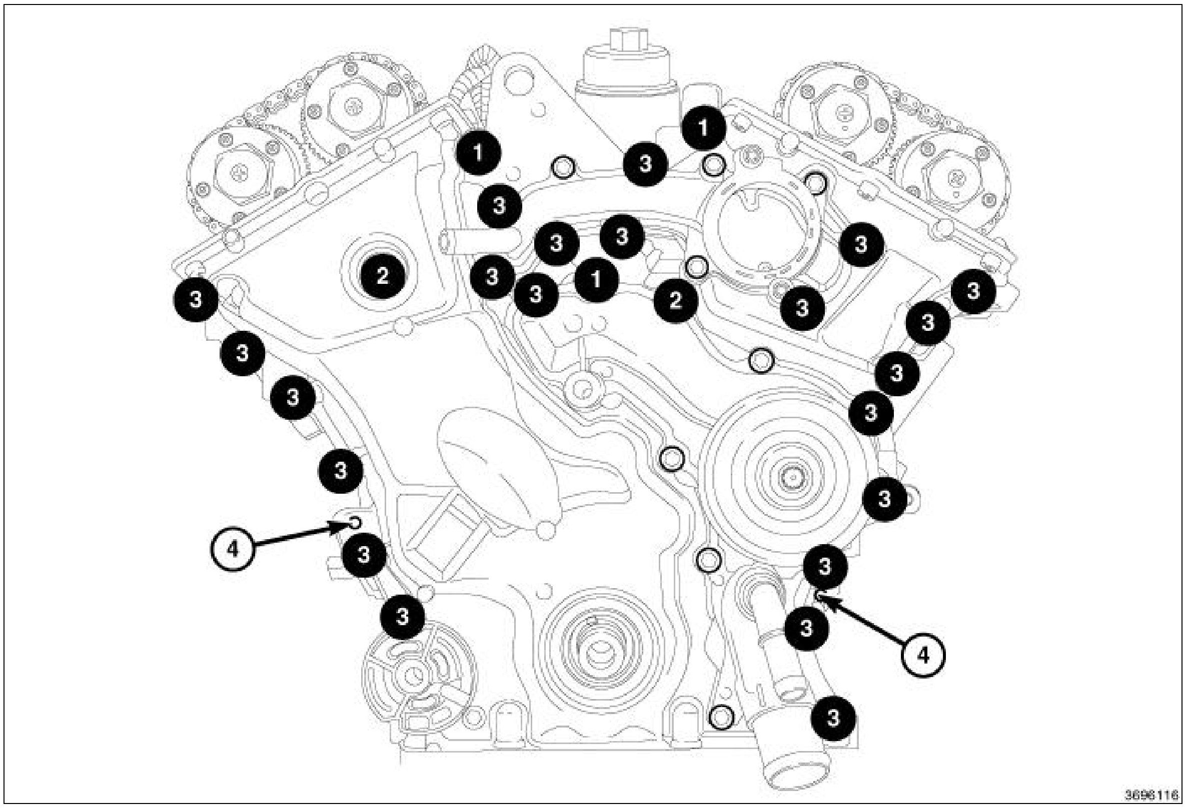
    1. Three cylinder head bosses (1)

2. Right and left flanges (2)

3. Four cylinder head to engine block T-joints (3)

4. Cover to right cam chain tensioner gap (4)

Fig 4: Timing Cover Bolts

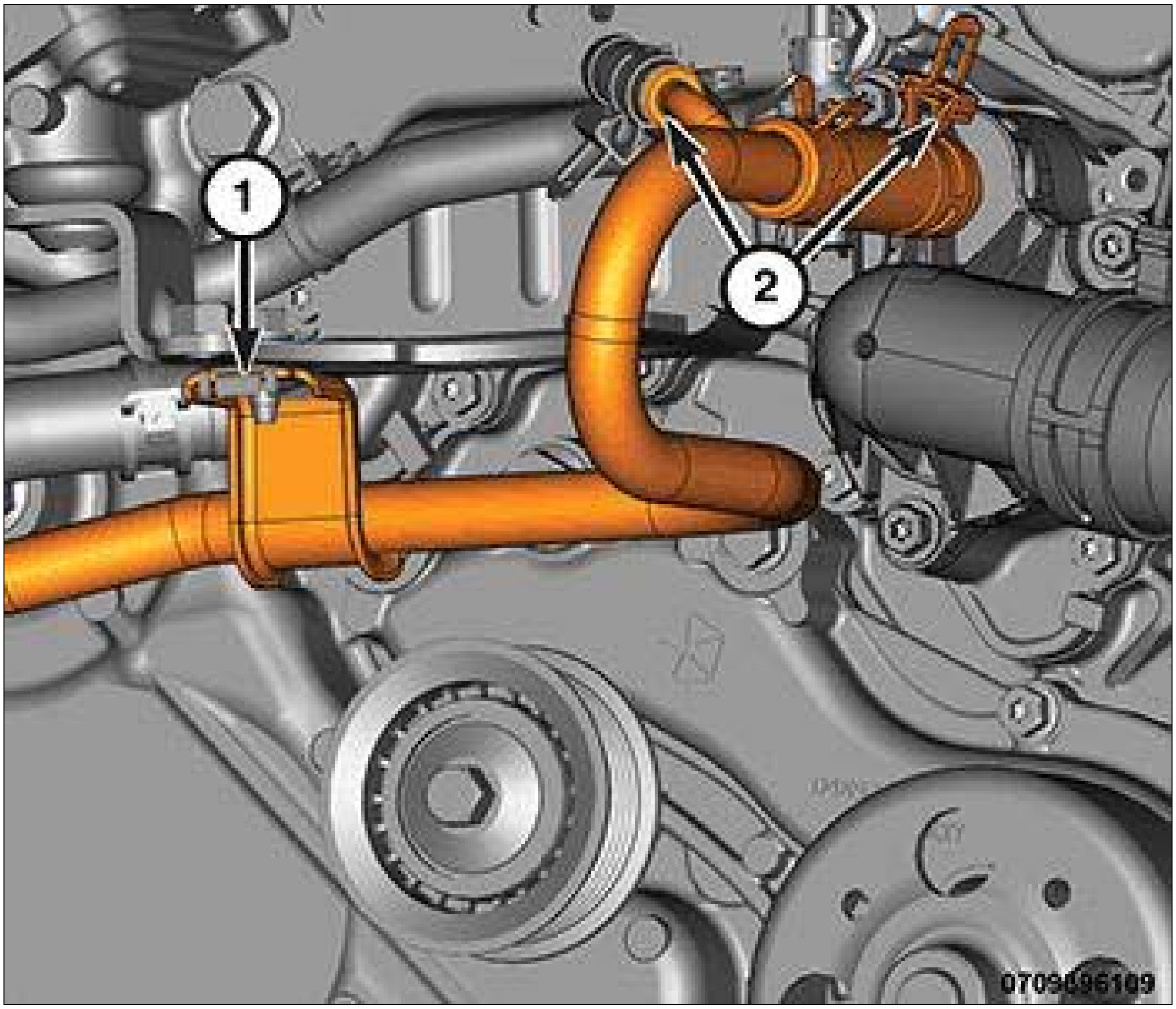


Courtesy of CHRYSLER GROUP, LLC

6. Align the locator pins (4) on the engine block to the engine timing cover and install the cover.
7. Install and tighten the timing cover attaching bolts:
    1. Twenty-two M6 bolts (3) to 12 N.m (106 in. lbs.).
    2. Two M8 bolts (2) to 25 N.m (18 ft. lbs.).
    3. Three M10 bolts (1) to 55 N.m (41 ft. lbs.)
8. Install the upper and lower oil pans. Refer to PAN, OIL, INSTALLATION .
9. Install the right and left cylinder head covers and upper intake manifold. Refer to COVER(S), CYLINDER HEAD, INSTALLATION .
10. Install the crankshaft vibration damper. Refer to DAMPER, VIBRATION, INSTALLATION .
11. Install the accessory idler pulley. Refer to PULLEY, IDLER, INSTALLATION .
12. Install accessory drive belt tensioner. Refer to TENSIONER, BELT, INSTALLATION .
13. Install the thermostat housing and upper radiator hose. Refer to THERMOSTAT, REMOVAL .

14. Install the accessory drive belt. Refer to BELT, SERPENTINE, REMOVAL .

Fig 5: Vacuum Pump Bracket & Outlet Hose Clamps

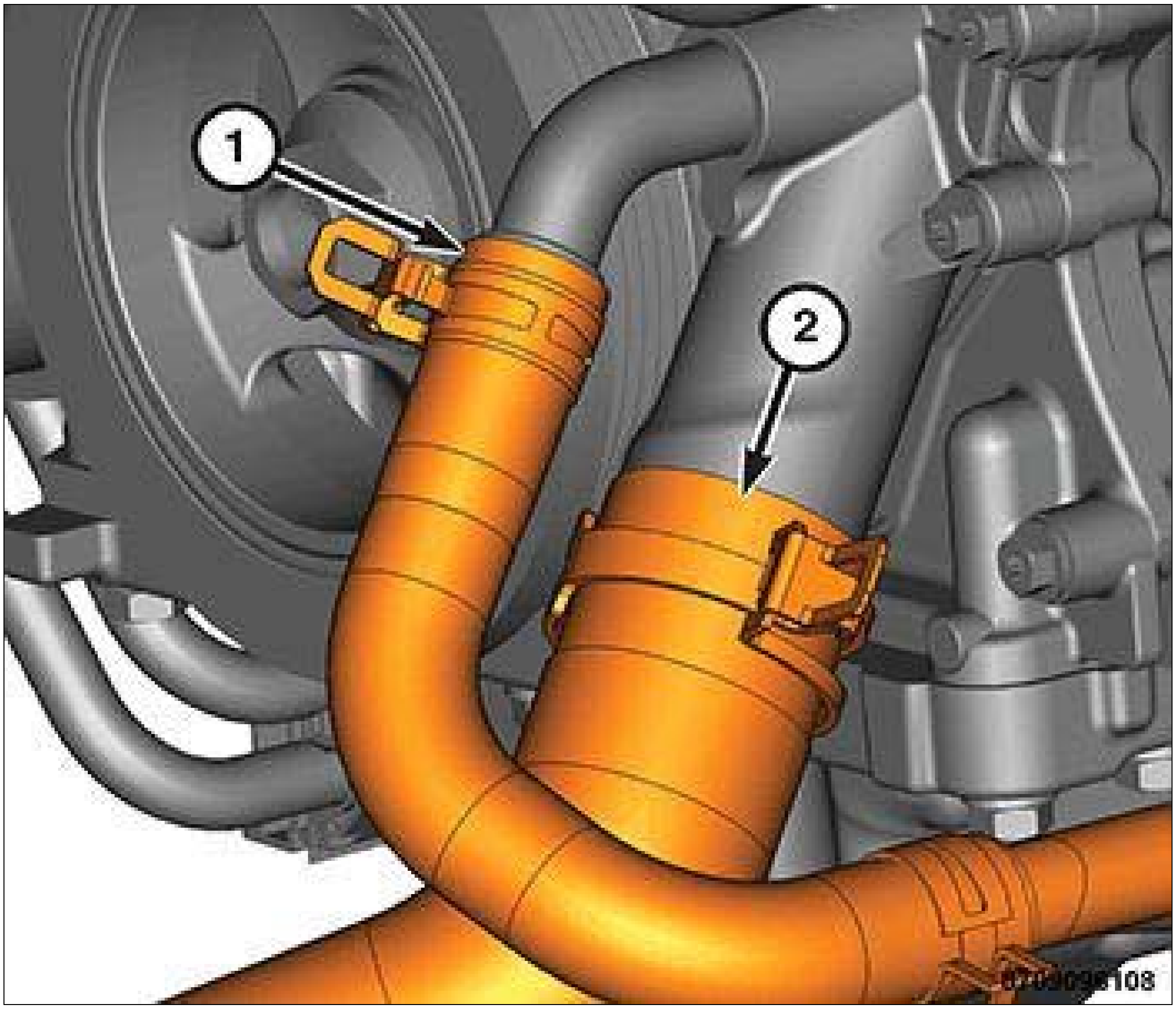


Courtesy of CHRYSLER GROUP, LLC

15. Install the heater core supply tube bolt (1) and tighten to the proper specification. Refer to ENGINE SPECIFICATIONS .

16. Install the heater core supply hose (2) to the coolant outlet housing.

Fig 6: Lower Heater Hose & Lower Radiator Hose



Courtesy of CHRYSLER GROUP, LLC

17. Install the lower radiator hose (2) to the water pump housing.
18. Install the heater core return hose (1) to the water pump housing.
19. Install the electric vacuum pump. Refer to PUMP, ELECTRIC VACUUM, INSTALLATION .
20. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to STANDARD PROCEDURE .
21. Connect the negative battery cable.
22. Fill the cooling system. Refer to STANDARD PROCEDURE .
23. Run the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to STANDARD PROCEDURE .