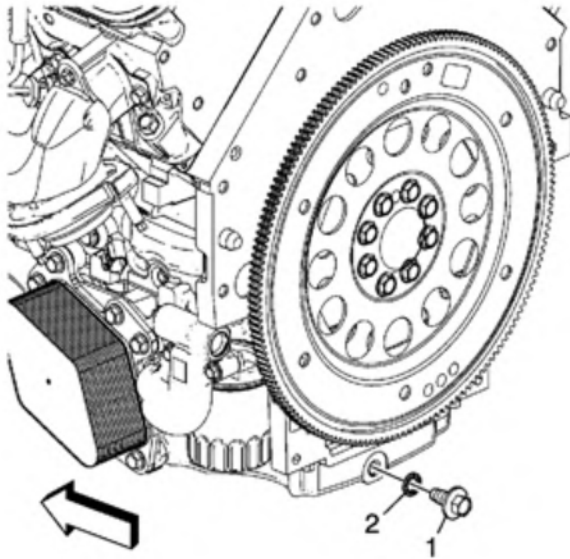
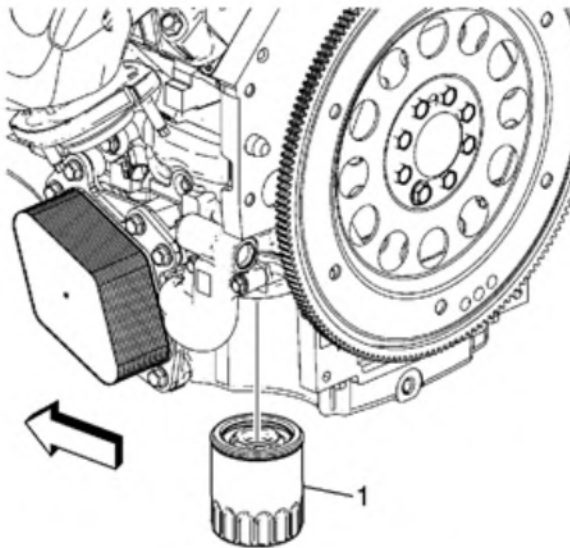


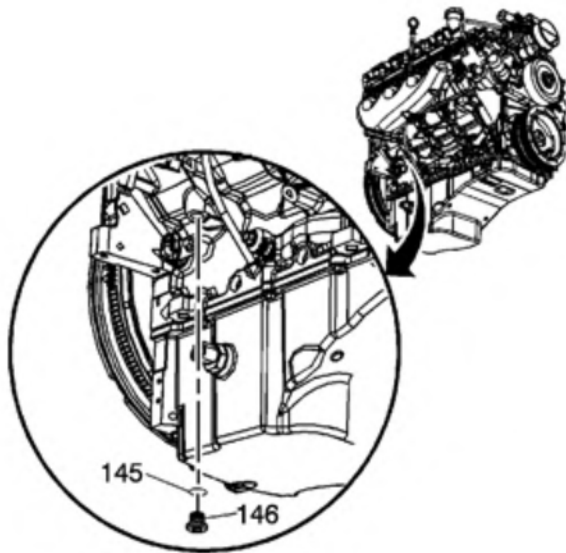
Draining Fluids and Oil Filter Removal



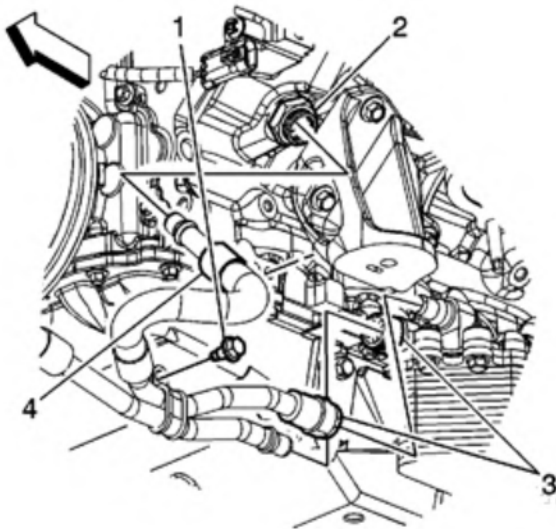
1. Remove the oil pan drain plug (1) with O-ring (2).



2. Remove the engine oil filter (1).



3. Remove the right side rear engine block coolant drain hole plug (146) with washer (145).



4. Disconnect the engine oil cooler hose/pipe (1) in order to drain coolant from the left side of block.

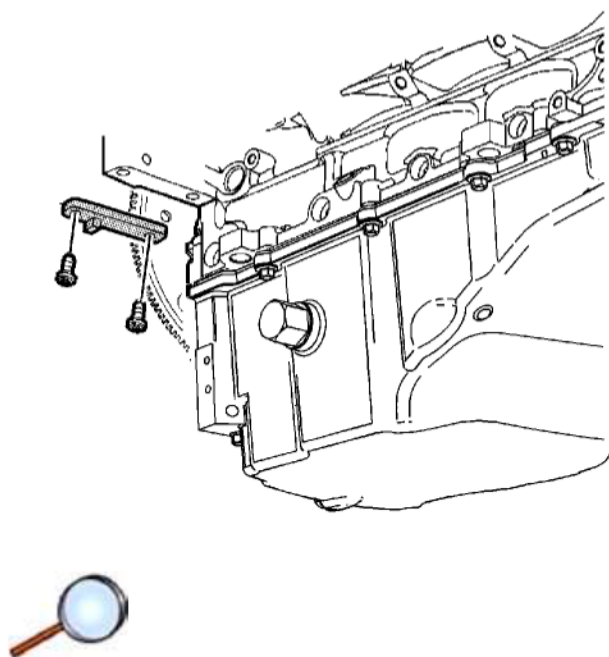
Crankshaft Balancer Removal

Special Tools

- J 41816-A Crankshaft Balancer Remover
- J 41816-2 Crankshaft End Protector
- J 42386-A Flywheel Holding Tool

For equivalent regional tools, refer to [Special Tools](#).

Caution: Refer to [Fastener Caution](#) in the Preface section.

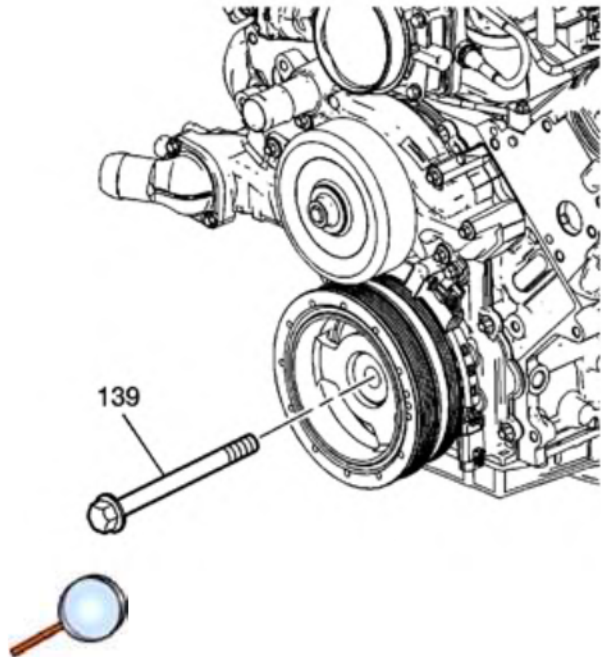


Note:

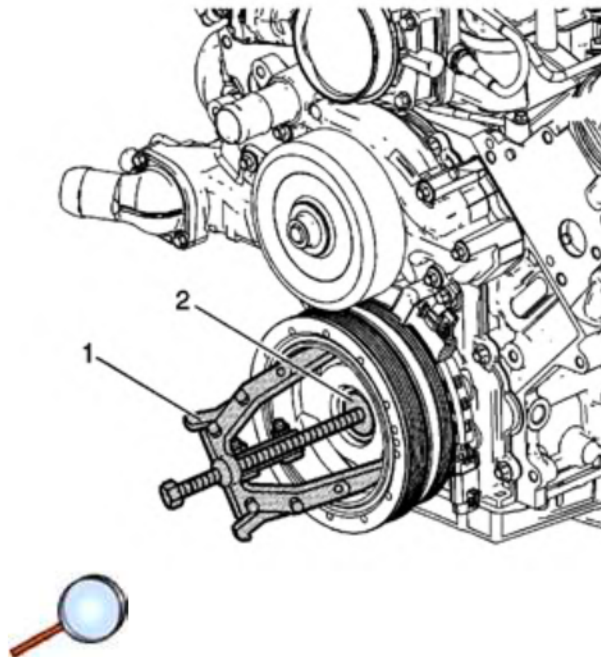
- If replacing the crankshaft balancer on manual transmission applications, note the location of any existing balance weights, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to [Engine Balancing](#).
- Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the J 42386-A tool and bolts.

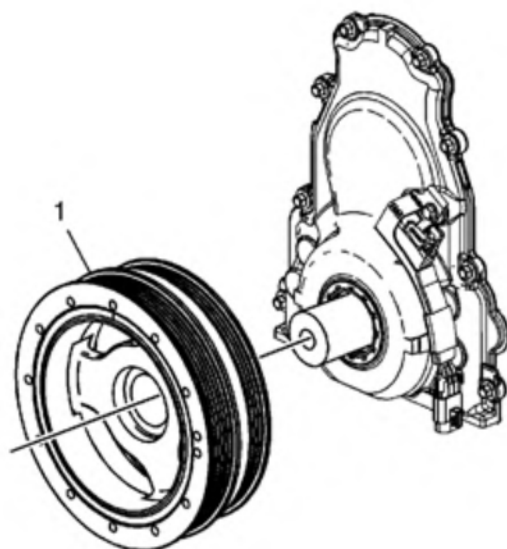
Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation and tighten the J 42386-A tool bolts to **50 N·m (37 lb ft)**.



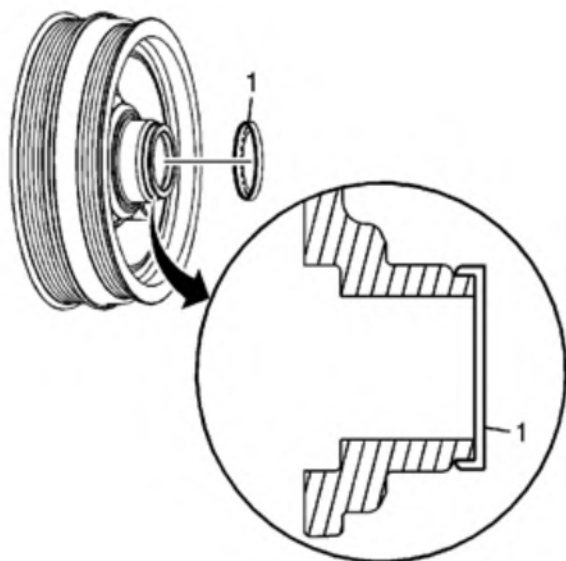
2. Remove the crankshaft balancer bolt (139).



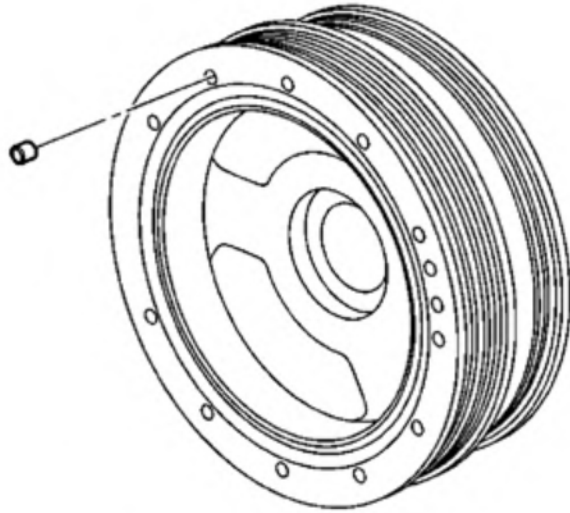
3. Use the *J 41816-A* remover (1) and the *J 41816-2* protector (2) in order to remove the crankshaft balancer.



4. Remove the crankshaft balancer (1).

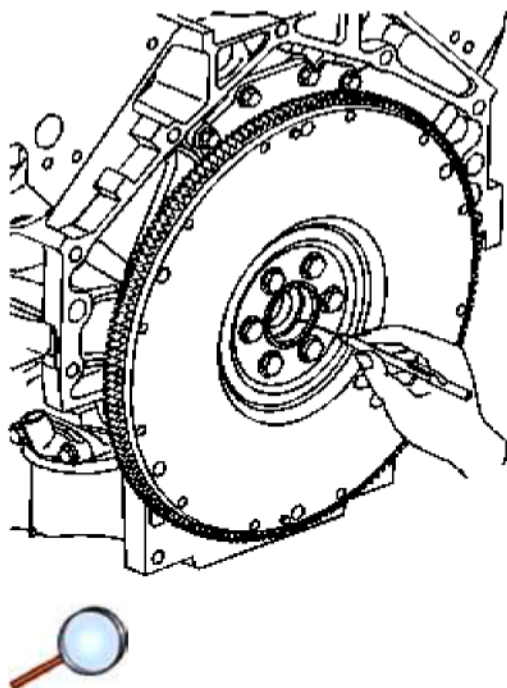


5. Remove the crankshaft balancer washer (1) from the balancer, as required.



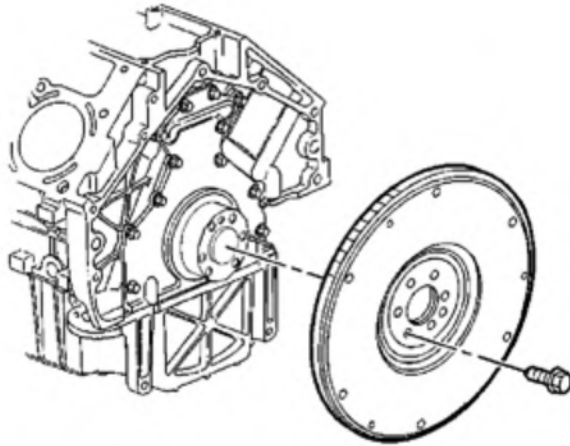
6. Note the position of the crankshaft balance weights, if applicable for manual transmission applications. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).

Engine Flywheel Removal

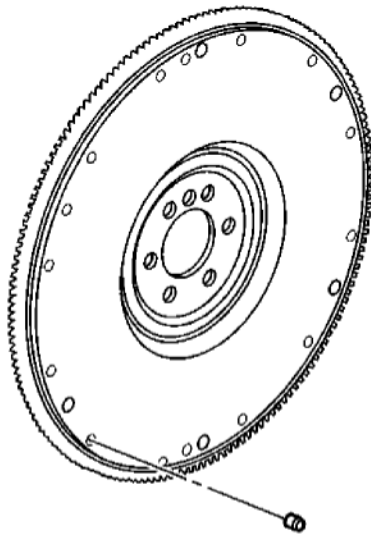


Note: For manual transmission applications, note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction. The engine flywheel will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a 3 stage tightening process.

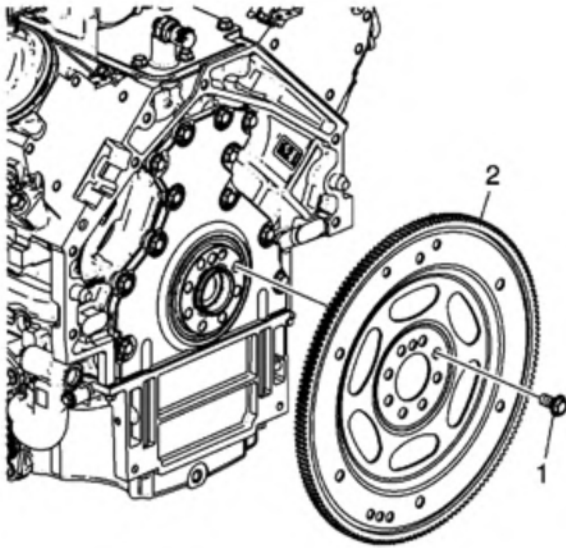
1. Mark or scribe the end of the crankshaft and the manual transmission flywheel. Refer to [Engine Balancing](#).



2. Remove the flywheel bolts.
3. Remove the manual transmission flywheel.

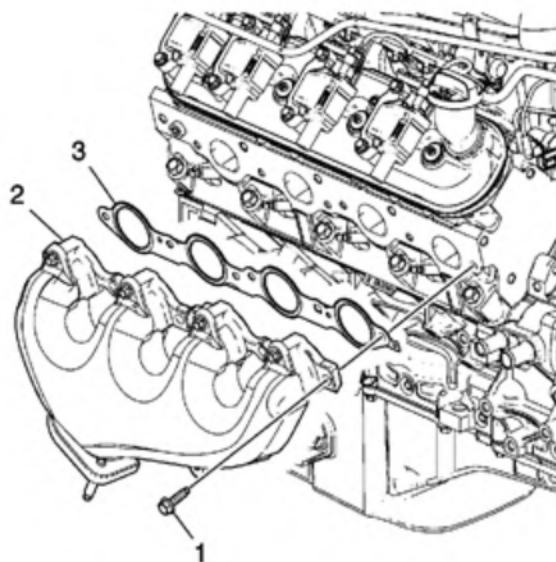


4. Note the location of the manual transmission flywheel balance weights, if applicable. Refer to [Engine Balancing](#).

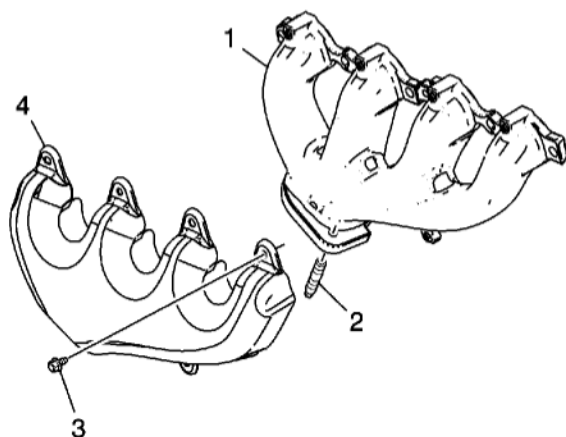


5. Remove the automatic transmission flex plate bolts (1).
6. Remove the automatic transmission flex plate (2).

Exhaust Manifold Removal - Right Side

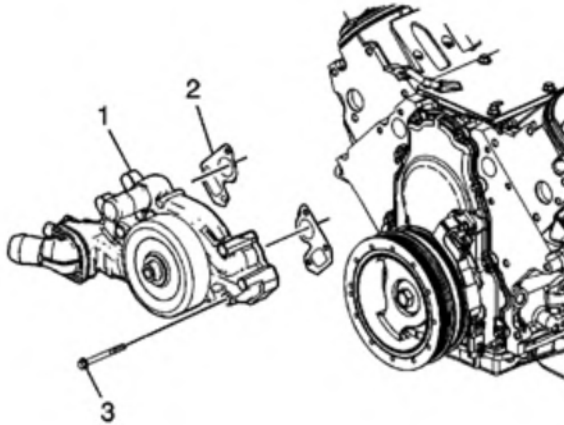


1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (2), bolts (1), and gasket (3).
3. Discard the gasket.



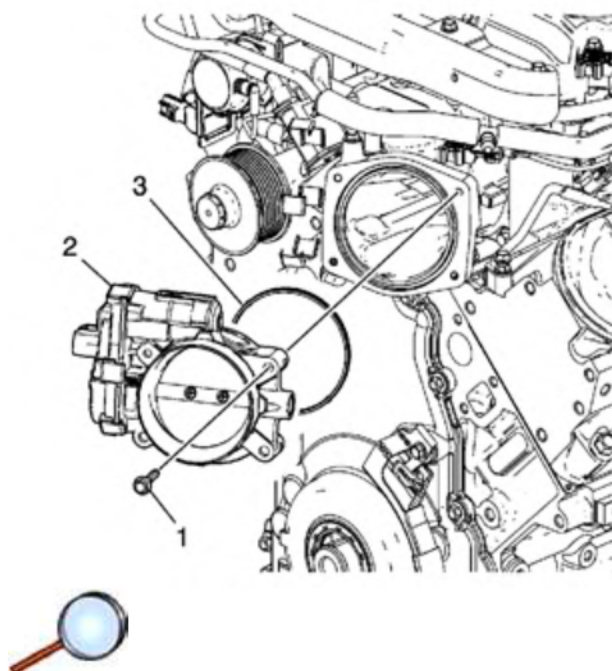
4. Remove the heat shield (4) and bolts (3) from the manifold (1), as required.
5. Remove the studs (2), as required.

Water Pump Removal



1. Remove the water pump bolts (3).
2. Remove the water pump (1) and gaskets (2).
3. Discard the water pump gaskets.

Throttle Body Removal

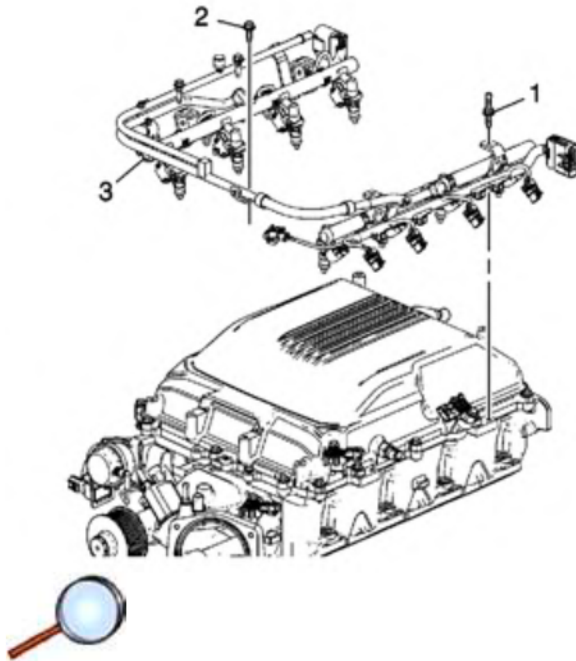


Caution: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

Note: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body bolts (1).
2. Remove the throttle body (2).
3. Remove the throttle body seal (3).
4. Discard the seal.

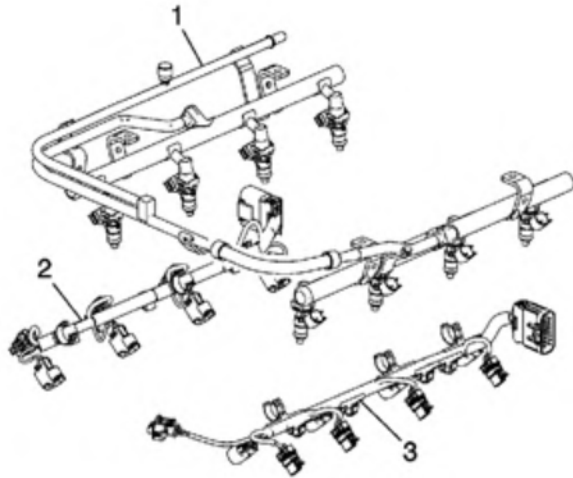
Fuel Rail and Injectors Removal (6.2L)



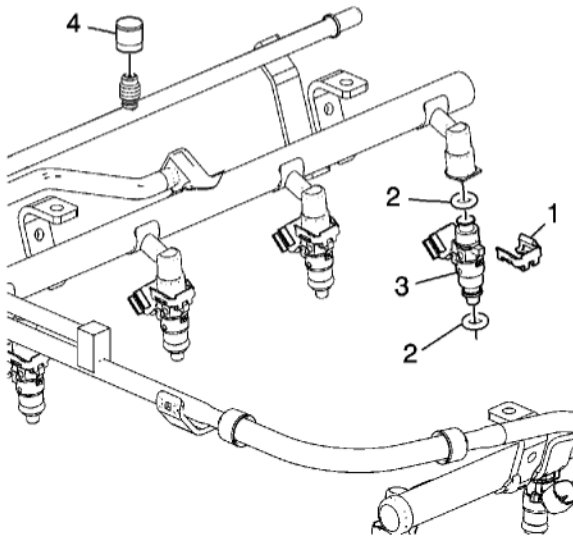
Note:

- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Do not separate the fuel injectors from the fuel rail, unless component service is required.
- Use cleanliness and care when handling the fuel system components. Do not allow dirt or debris to enter the fuel injectors or fuel rail components. Cap ends as necessary.

1. Remove the studs (1), bolt (2) and fuel rail (3). Remove the left side of the fuel rail with flex-hose first, then remove the right side of the fuel rail until all injectors have left their bores.



2. Remove the wiring harnesses (2) and (3) from the fuel rail (1).



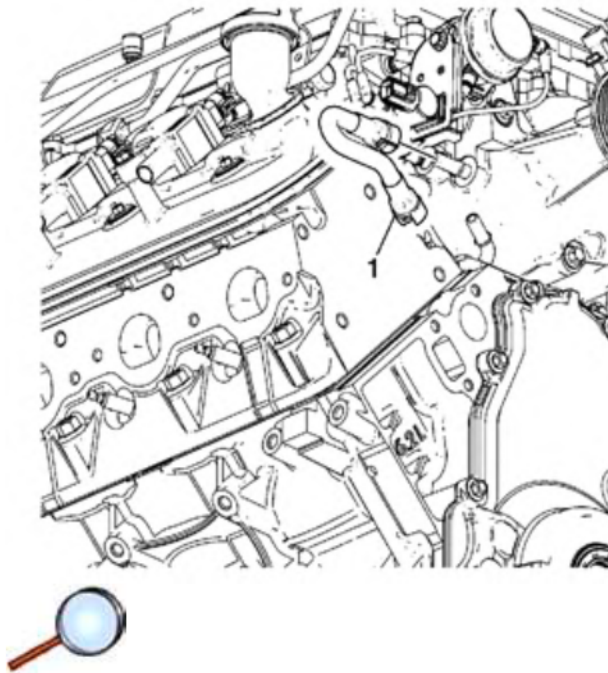
3. Remove the retainers (1) and fuel injectors (3).
4. Remove the O-rings (2), as required.
5. Remove the service port cap (4), as required.

Supercharger Removal

Special Tools

EN 48898 Supercharger Lift Fixture

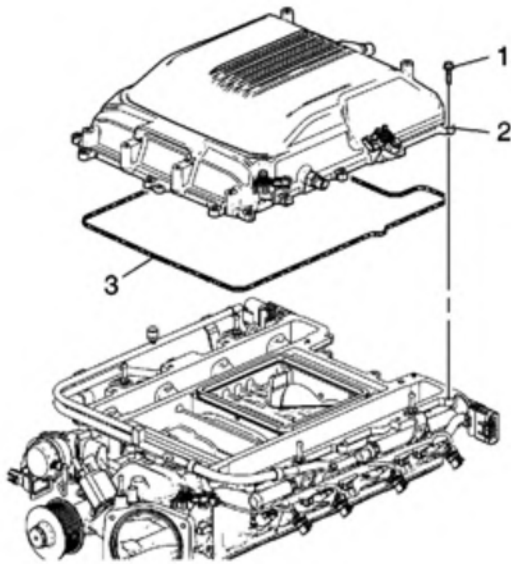
For equivalent regional tools, refer to [Special Tools](#)



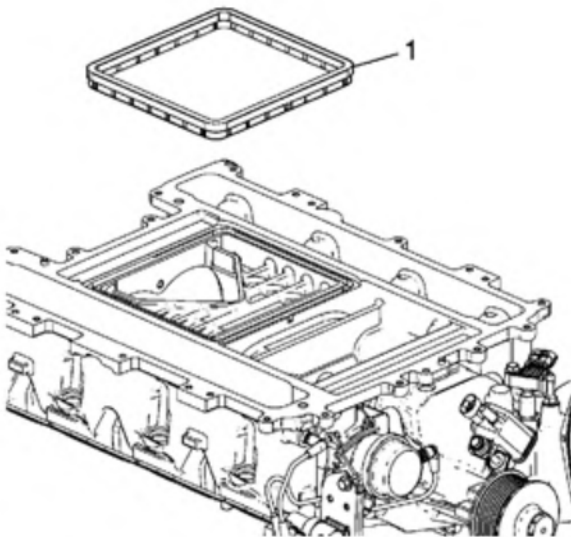
Note:

- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the inlet area of the supercharger (1) to prevent dirt or debris contamination onto the rotors.

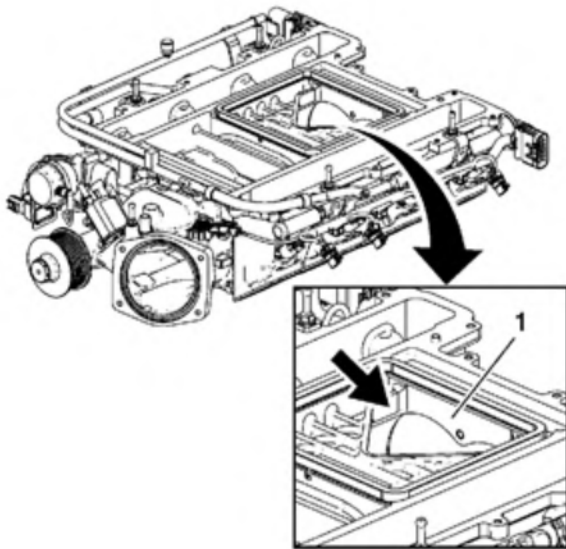
1. Remove the positive crankcase ventilation (PCV) - dirty air hose (1) from the valley cover and supercharger.



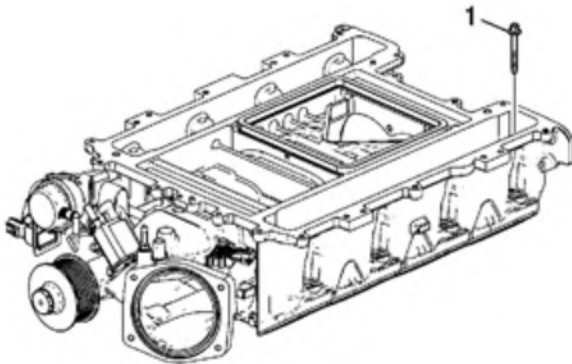
2. Remove the supercharger cover bolts (1) and the supercharger cover (2).
3. Remove the supercharger cover seal (3).



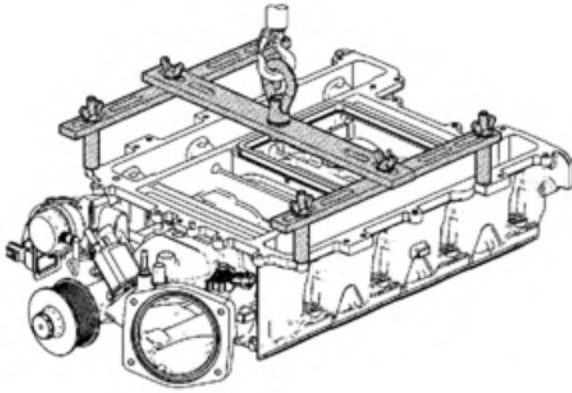
4. Remove the charge air cooler insulator (1).



5. Cover the supercharger rotors area (1) to prevent dirt or debris contamination onto the rotors.

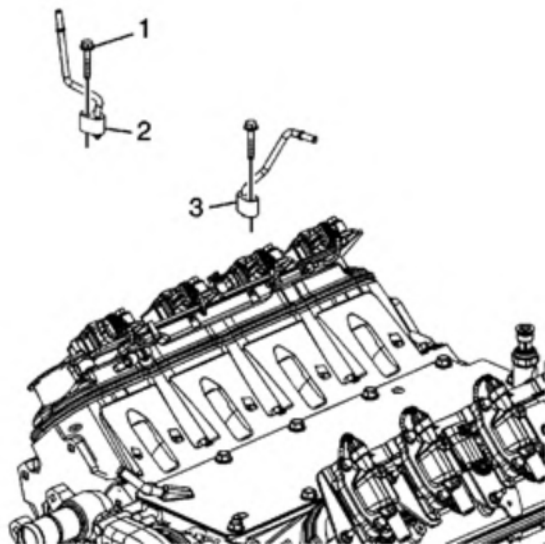


6. Remove the supercharger bolts (1).

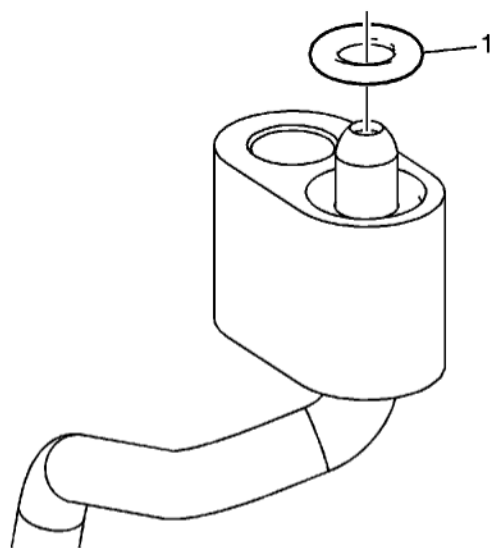


7. Install the *EN 48898* fixture to the supercharger (1) and tighten the *EN 48898* fixture studs and nuts until snug.
8. Using a lifting device, remove the supercharger from the engine.

Engine Coolant Air Bleed Pipe and Hole Cover Removal

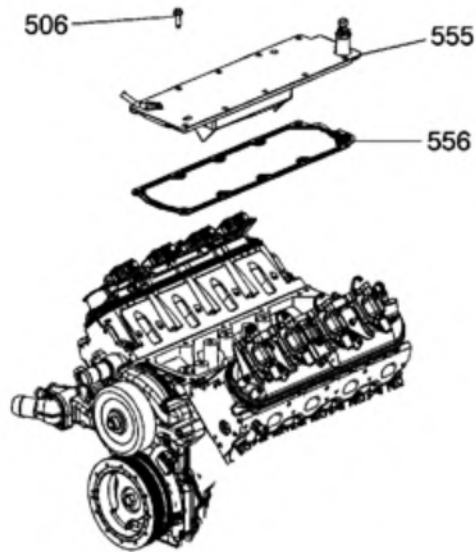


1. Remove the engine coolant air bleed pipe bolts (1).
2. Remove the pipes (2 and 3).

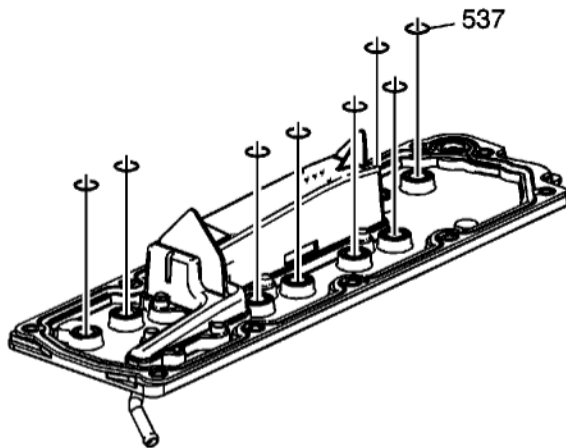


3. Remove the seals (1) from the pipes.
4. Discard the seals.

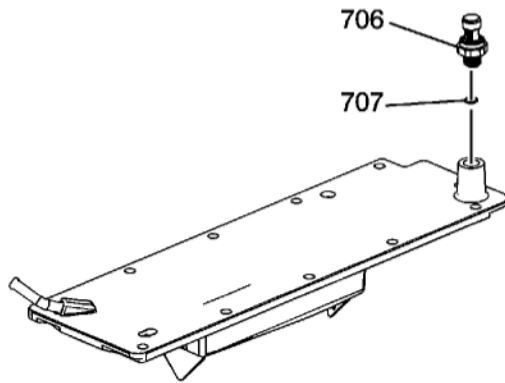
Engine Block Valley Cover Removal (6.2L)



1. Remove the engine block valley cover bolts (506).
2. Remove the valley cover (555) and gasket (556).

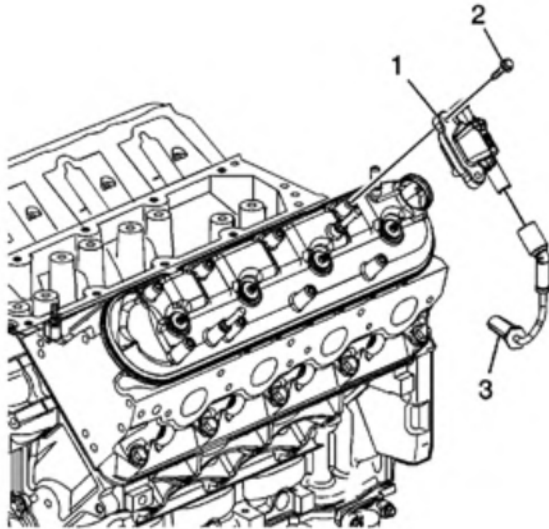


3. Remove the seals (537) from the cover.

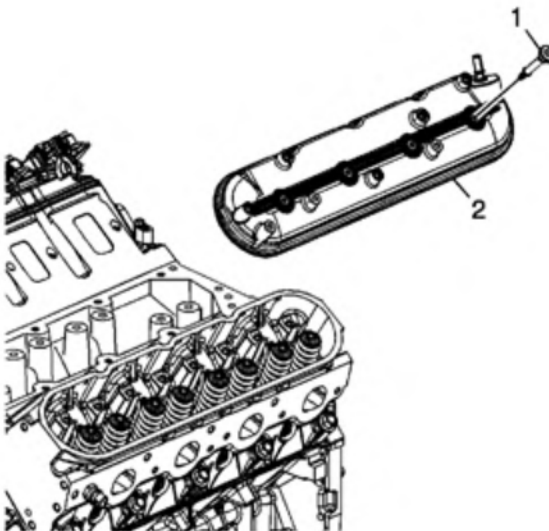


4. Remove the engine oil pressure sensor (706) and seal (707), as required.

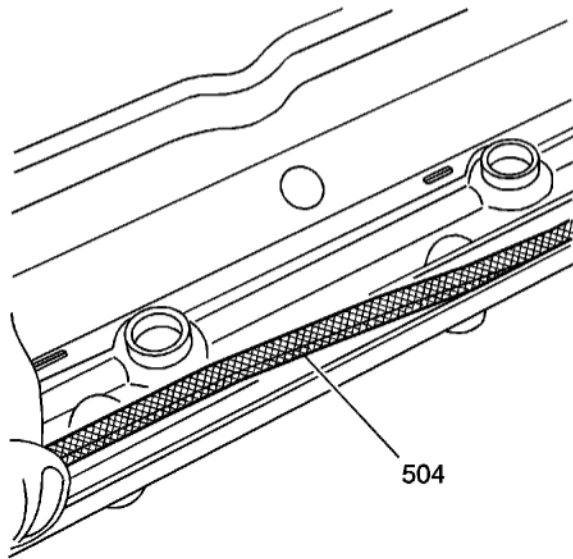
Valve Rocker Arm Cover Removal - Left Side



1. Remove the spark plug wires (3), as required.
2. Remove the ignition coil bolts (2) and ignition coils (1).

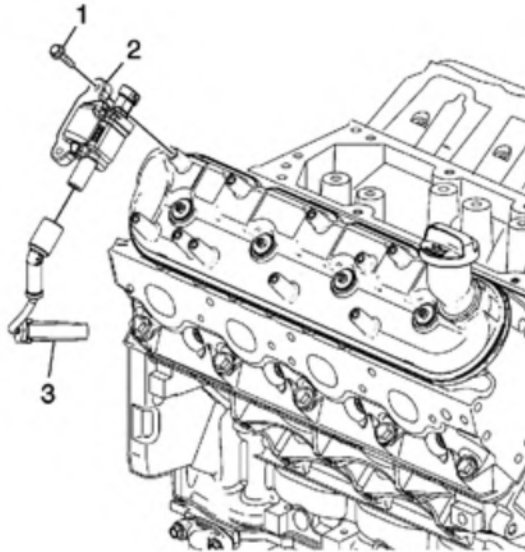


3. Remove the valve rocker arm cover bolts (1) and cover (2).
4. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.



5. Remove the gasket (504) from the cover.

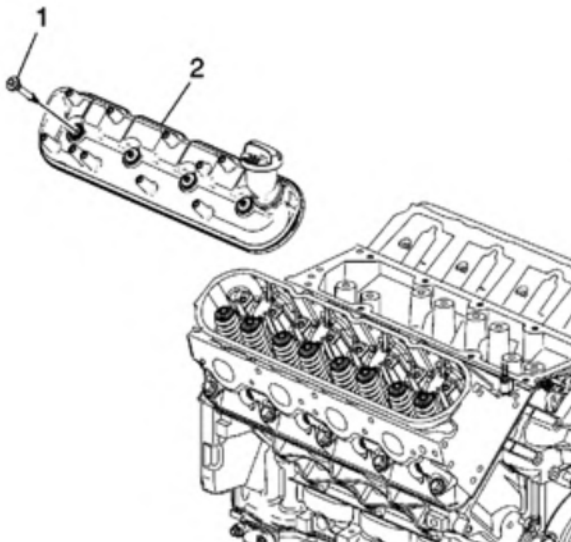
Valve Rocker Arm Cover Removal - Right Side



Note: Do not remove the oil cap from the cover, unless service is required. If the oil cap has been removed from the cover, the locking features of the cap will be damaged and no longer functional.

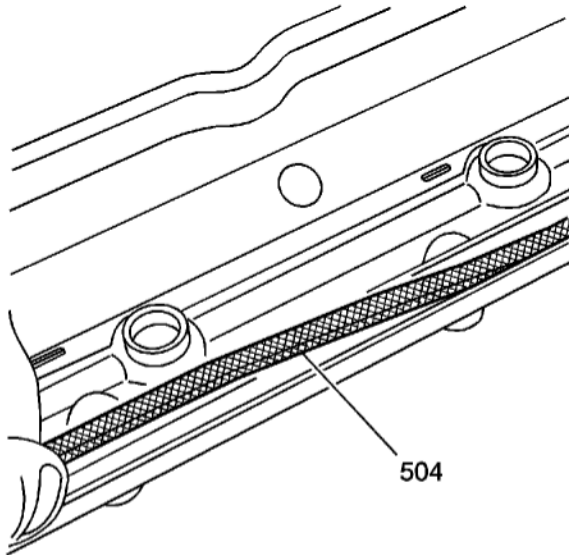
If the cap has been removed, install a NEW cap during assembly.

1. Remove the spark plug wires (3), as required.
2. Remove the ignition coil bolts (1) and ignition coils (2).

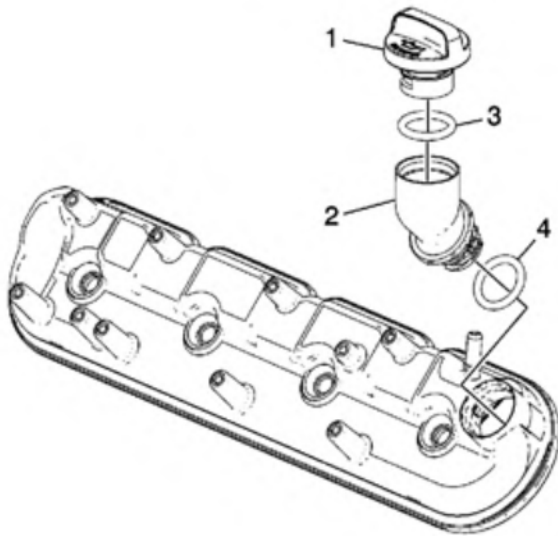




3. Remove the valve rocker arm cover bolts (1) and cover (2).
4. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

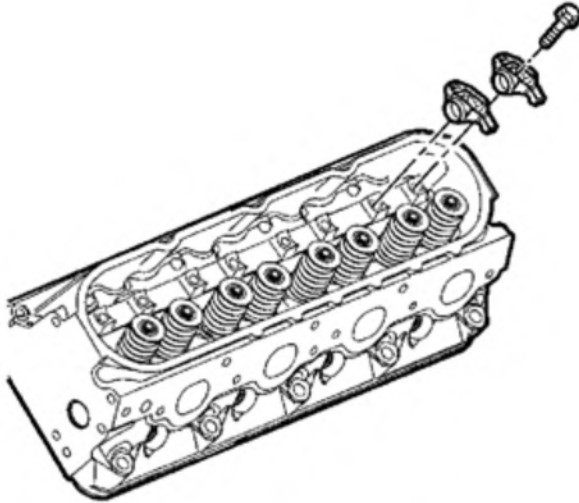


5. Remove the gasket (504) from the cover.



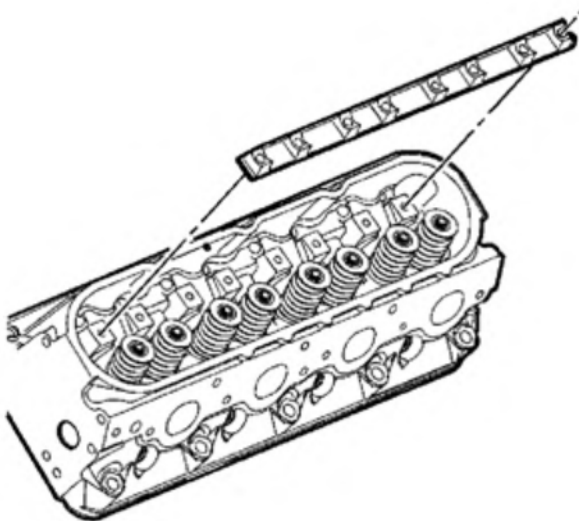
6. Remove the oil cap (1), oil fill tube (2) and seals (3, 4) from the cover, as required.

Valve Rocker Arm and Push Rod Removal

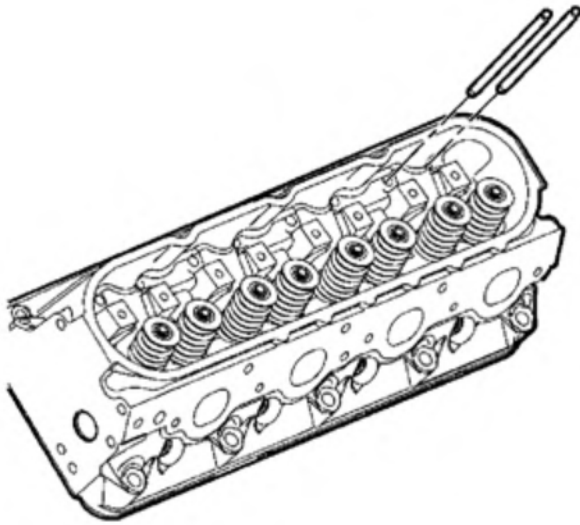


Note: Place the valve rocker arms, valve pushrods, and pivot support in a rack so they can be installed in the same location from which they were removed.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arms.

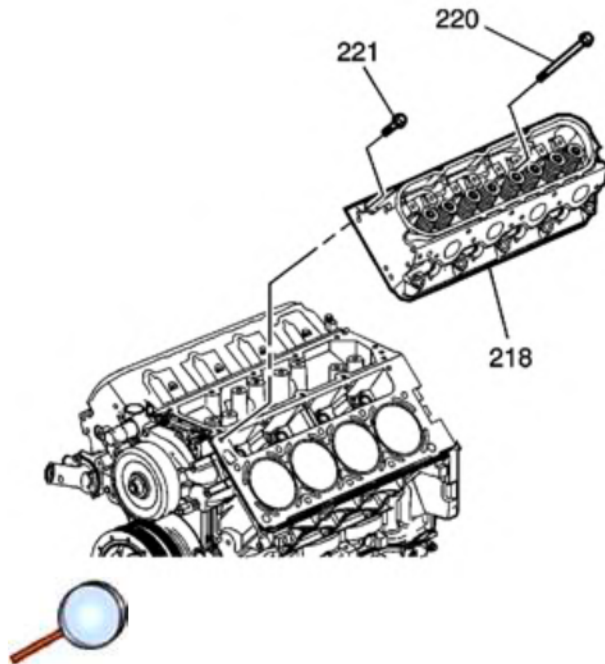


3. Remove the valve rocker arm pivot support.



4. Remove the pushrods.

Cylinder Head Removal - Left Side

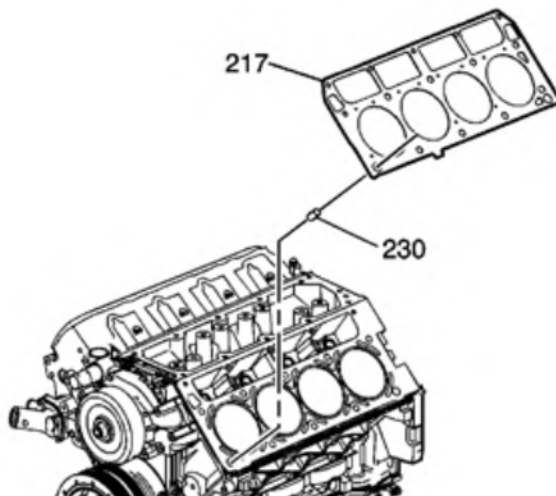


Note: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

1. Remove the cylinder head bolts (220, 221).

Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

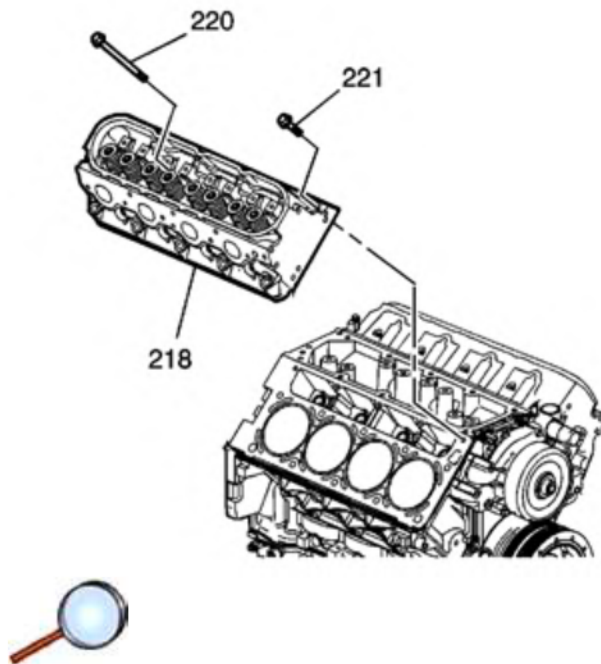
2. Remove the cylinder head (218).





3. Remove the gasket (217) and locating pins (230).
4. Discard the gasket and cylinder head bolts.

Cylinder Head Removal - Right Side

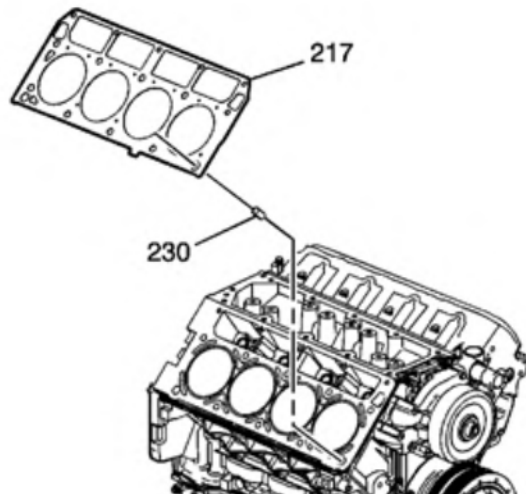


Note: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

1. Remove the cylinder head bolts (220, 221).

Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

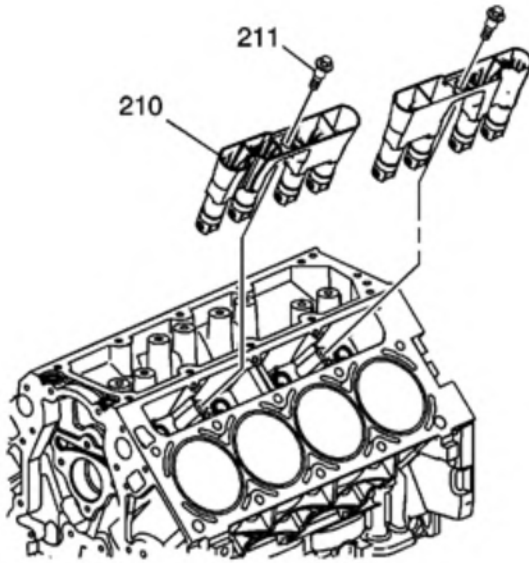
2. Remove the cylinder head (218).





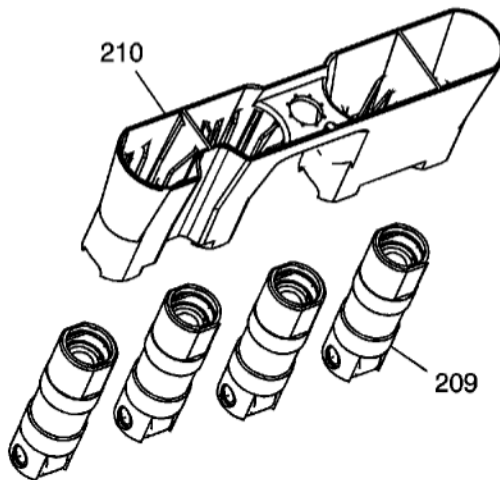
3. Remove the gasket (217) and locating pins (230).
4. Discard the gasket and cylinder head bolts.

Valve Lifter Removal



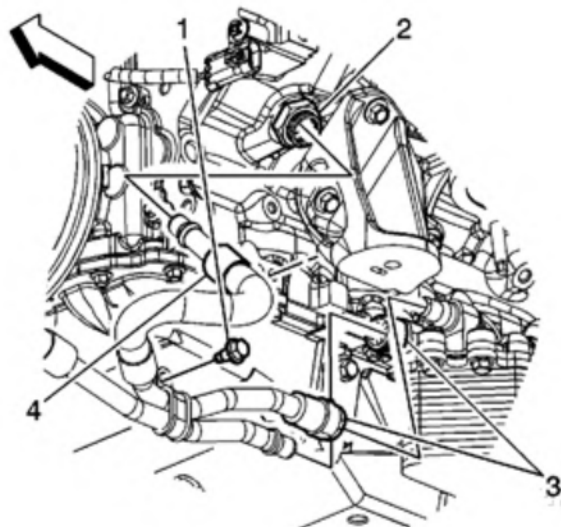
1. Remove the guide bolts (211).
2. Remove the guides (210) with lifters.

Note the installed position of the guides. The notched area of the guide is to align with the locating tab on the block.

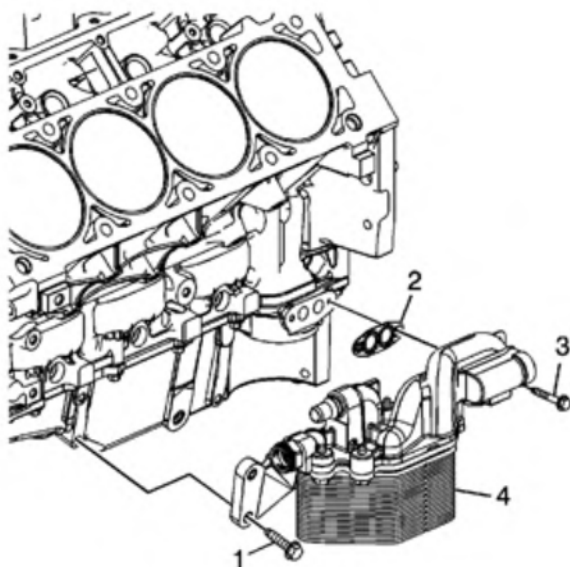


3. Remove the valve lifters (209) from the guide (210).
4. Organize or mark the components so they can be installed in the same location from which they were removed. Refer to [Separating Parts](#).

Engine Oil Cooler Removal

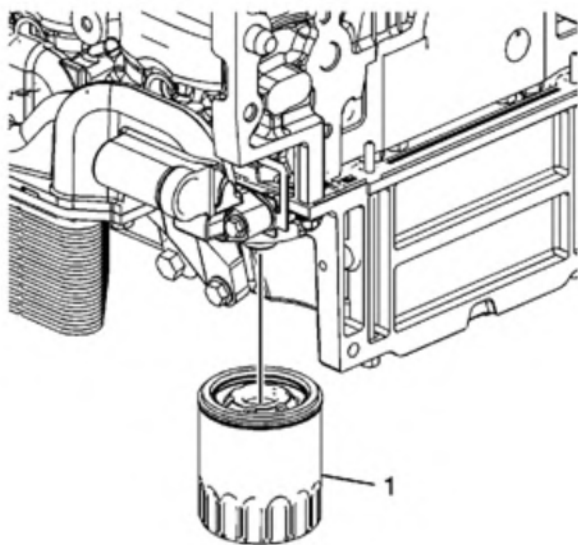


1. Remove the engine oil cooler coolant hose/pipe bolt (1).
2. Disconnect the hose/pipe (4) from the engine block coolant fitting (2) and oil cooler (3).
3. Remove the hose/pipe.

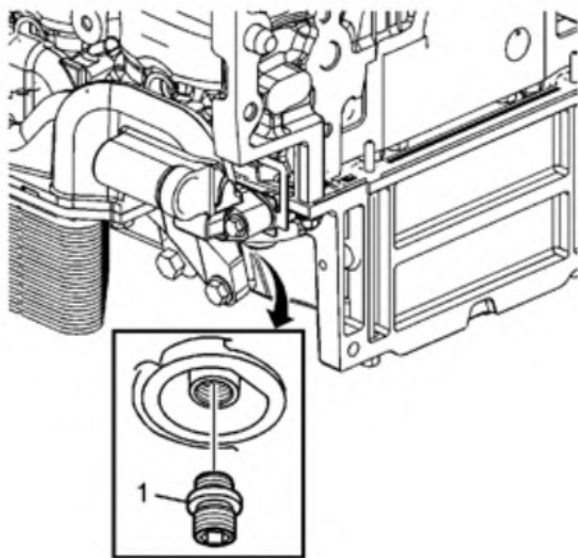


4. Remove the oil cooler M8 (1) and M6 (3) bolts.
5. Remove the oil cooler (4).
6. Remove the oil cooler gasket (2).

Oil Filter Removal

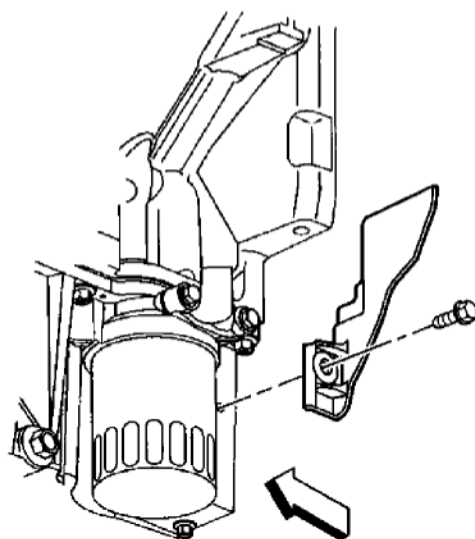


1. Remove the oil filter (1).



2. Remove the oil filter fitting (1), as required.

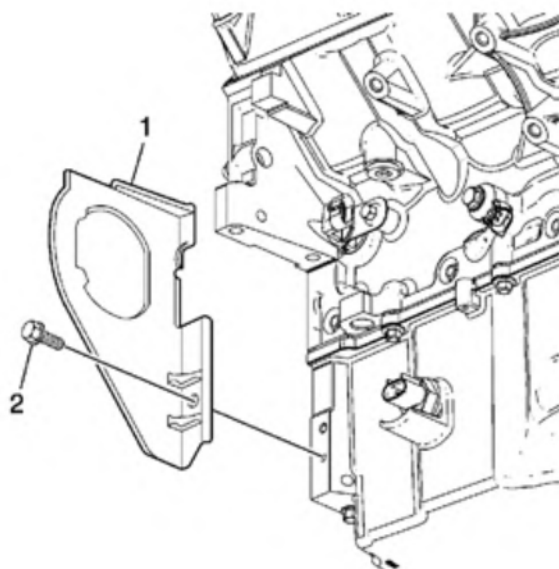
Oil Pan Removal



Note:

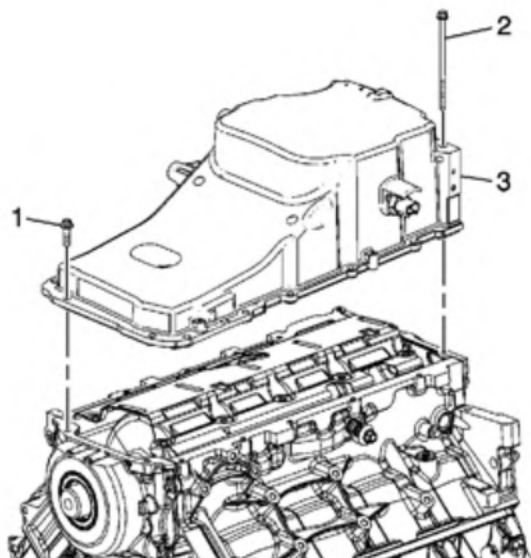
- The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.
- DO NOT use the oil pan gasket again. When installing the oil pan, install a NEW oil pan gasket.

1. Remove the left closeout cover and bolt.

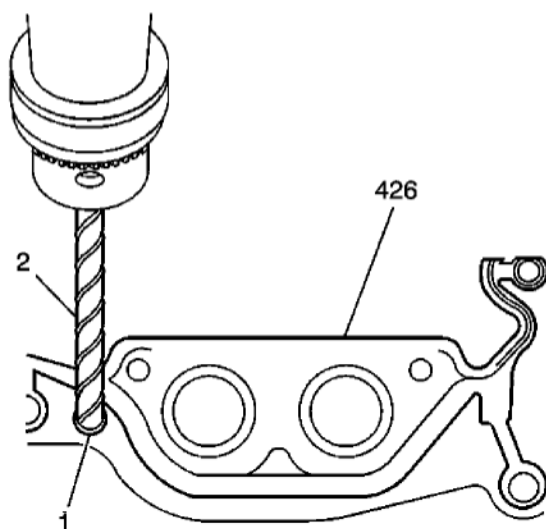




2. Remove the right closeout cover (1) and bolt (2).



3. Remove the oil pan bolts (1, 2).
4. Remove the oil pan (3).



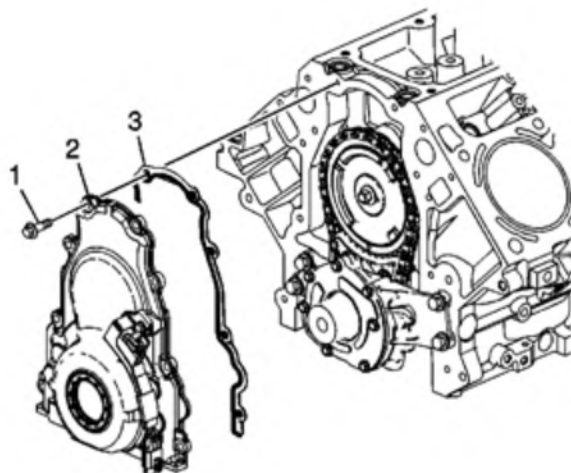
Note:

- DO NOT allow foreign material to enter the oil passages of the oil pan. Cap or cover the openings, as required.
- Use care not to gouge, score, or damage the oil pan sealing surface.

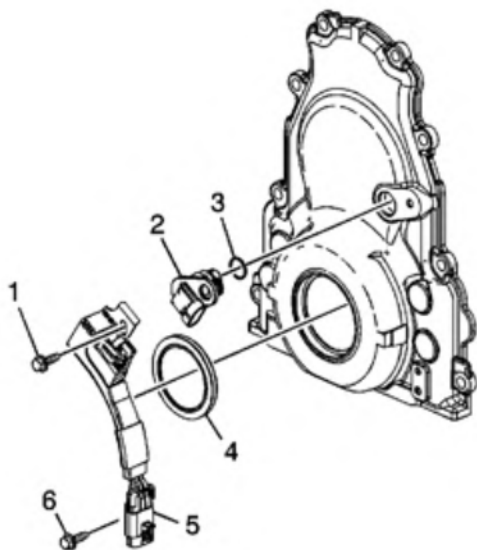
5. Drill (2) out the oil pan gasket retaining rivets (1), if required.

6. Remove the gasket (426) from the pan.
7. Discard the gasket and rivets.

Engine Front Cover Removal (6.2L)

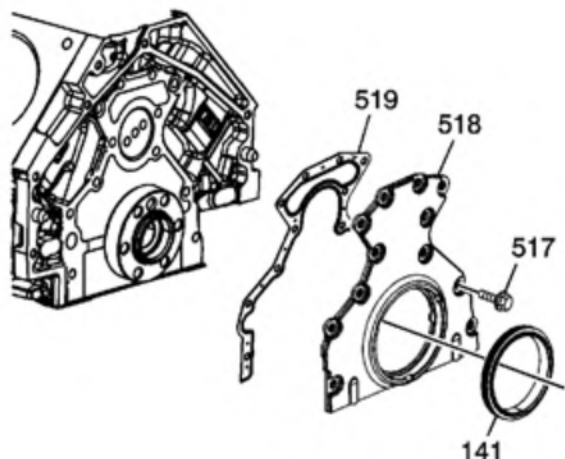


1. Remove the front cover bolts (1).
2. Remove the front cover (2) and gasket (3).
3. Discard the front cover gasket.



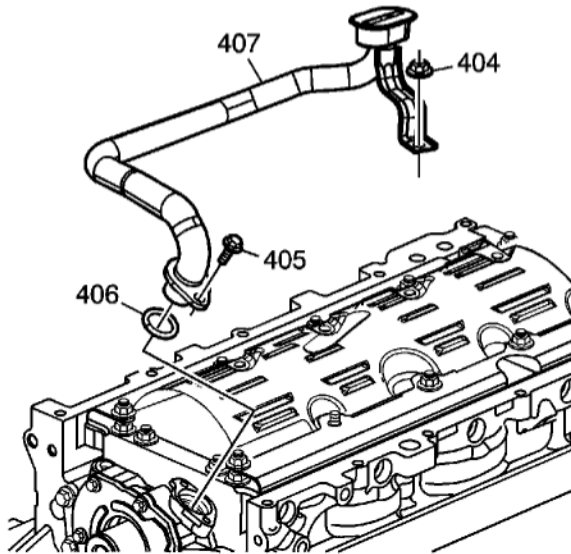
4. Remove the oil seal (4).
5. Remove the bolts (1, 6), camshaft position (CMP) sensor (2), and wire harness (5).
6. Remove the O-ring (3) from the sensor, as required.

Crankshaft Rear Oil Seal Housing Removal

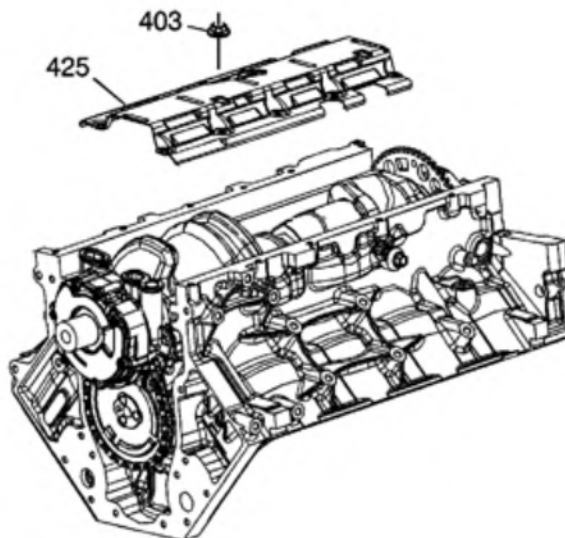


1. Remove the rear oil seal housing bolts (517).
2. Remove the housing (518) and gasket (519).
3. Remove the rear oil seal (141).

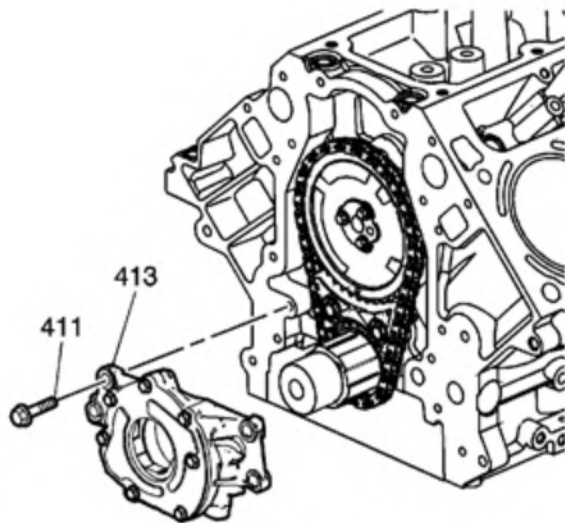
Oil Pump, Screen and Crankshaft Oil Deflector Removal



1. Remove the oil pump screen bolt (405) and nut (404).
2. Remove the oil pump screen (407) with O-ring seal.
3. Remove the O-ring seal (406) from the pump screen.
4. Discard the O-ring seal.



5. Remove the crankshaft oil deflector nuts (403).
6. Remove the crankshaft oil deflector (425).



7. Remove the oil pump bolts (411).

Note: Do not allow dirt or debris to enter the oil pump assembly. Cap ends, as necessary.

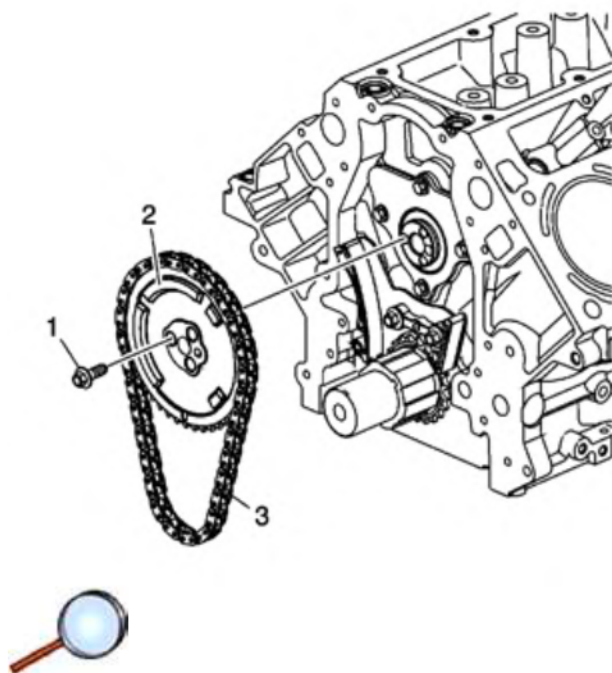
8. Remove the oil pump (413).

Timing Chain and Sprocket Removal

Special Tools

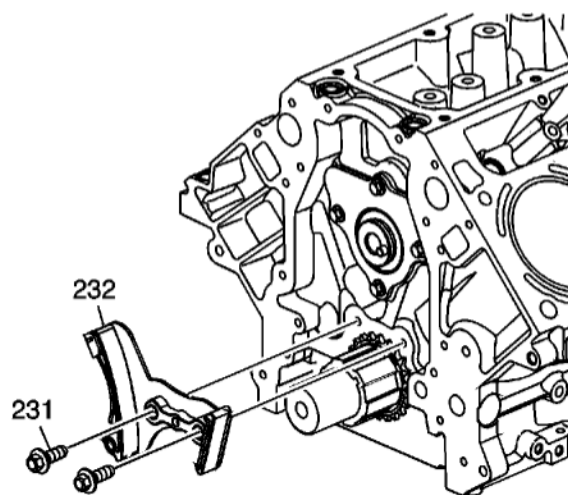
- J 8433 Two Jaw Puller
- J 41558 Crankshaft Sprocket Remover
- J 41816-2 Crankshaft End Protector

For equivalent regional tools refer to [Special Tools](#)

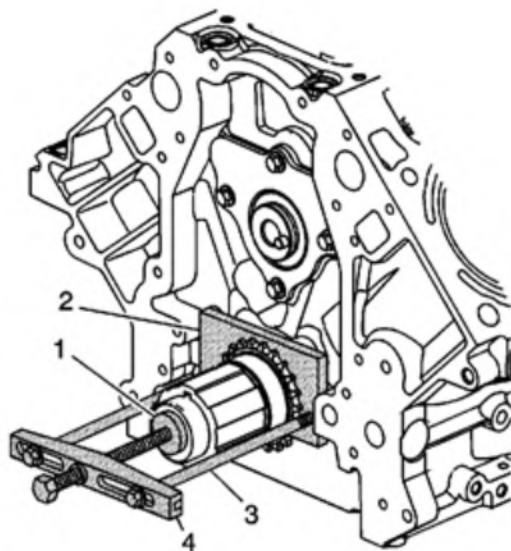


Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

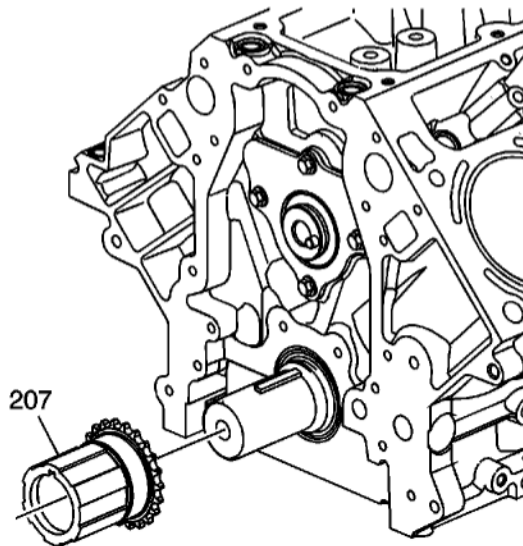
1. Remove the camshaft sprocket bolts (1).
2. Remove the camshaft sprocket (2) and timing chain (3).



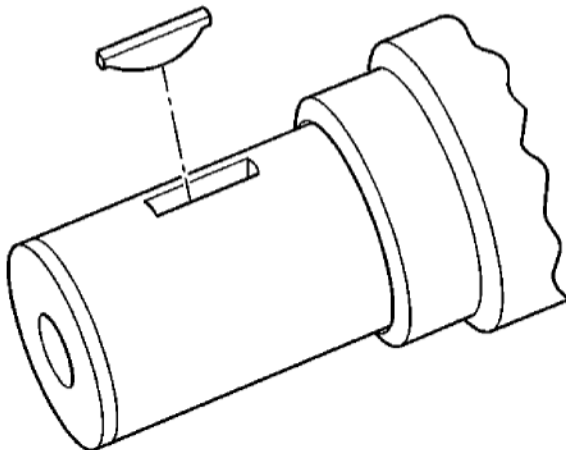
3. Remove the bolts (231) and timing chain tensioner (232).



4. Use the *J 41816-2* protector (1), the *J 41558* remover (2), bolts (3), and the *J 8433* puller (4) in order to remove the crankshaft sprocket.

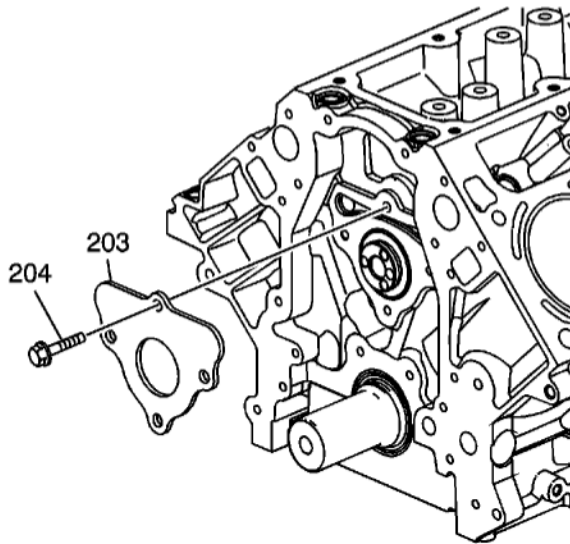


5. Remove the crankshaft sprocket (207).

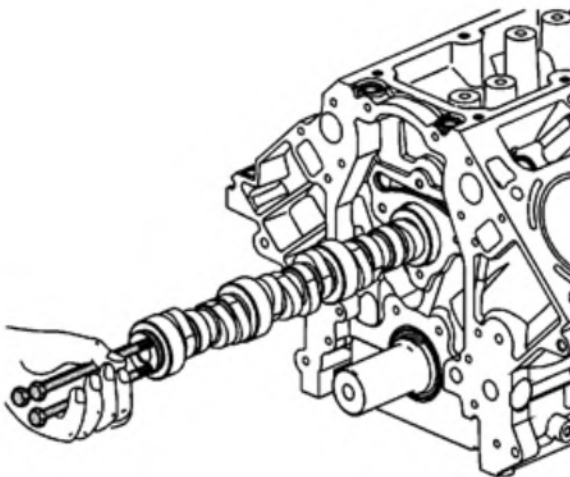


6. Remove the crankshaft sprocket key, as required.

Camshaft Removal



1. Remove the camshaft retainer bolts (204) and retainer (203).



Caution: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

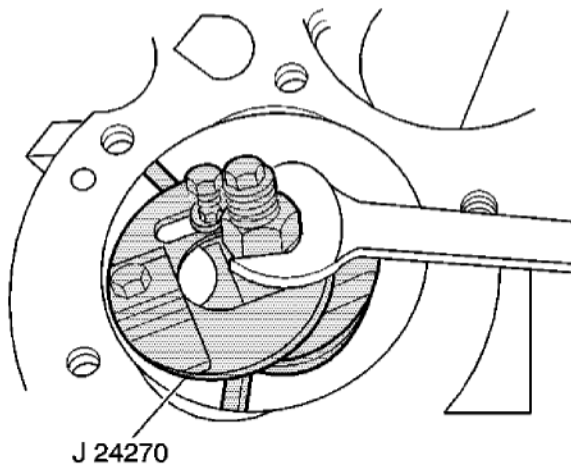
2. Remove the camshaft.
 - 2.1. Install the 3 M8-1.25 x 100 mm bolts into the camshaft front bolt holes.

- 2.2. Using the bolts as a handle, carefully rotate and pull the camshaft out of the engine block.
- 2.3. Remove the bolts from the front of the camshaft.

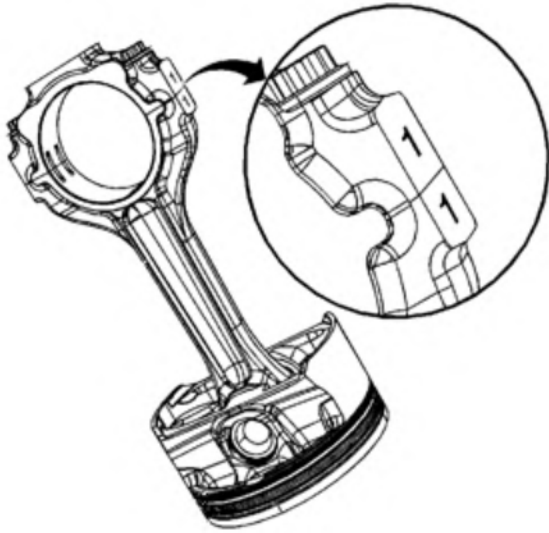
Piston, Connecting Rod, and Bearing Removal

Tools Required

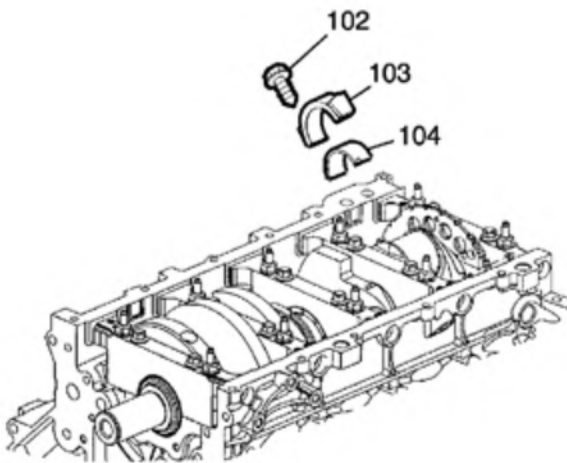
- [J 24270](#) Cylinder Bore Ridge Reamer
- [J 41556](#) Connecting Rod Guide



1. Use the [J 24270](#) in order to remove the cylinder bore ring ridge, if required.
 - 1.1. Turn the crankshaft until the piston is at the bottom of the stroke.
 - 1.2. Place a cloth on top of the piston.
 - 1.3. Use the [J 24270](#) , or equivalent, in order to remove a cylinder ring ridge.
 - 1.4. Turn the crankshaft so the piston is at the top of the stroke.
 - 1.5. Remove the cloth.
 - 1.6. Remove the cutting debris from the cylinder and piston.

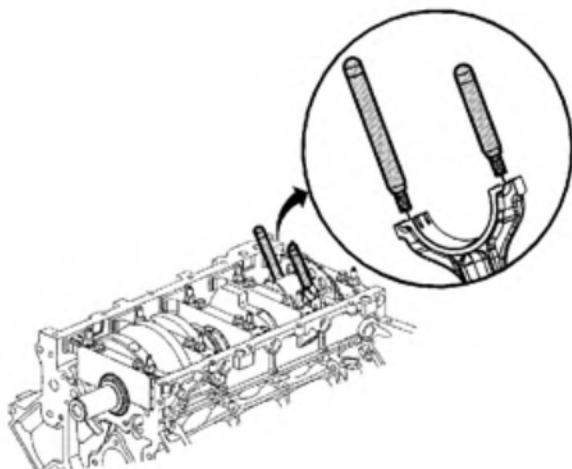


2. Using a paint stick or etching tool, place matchmarks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps **MUST** be assembled to their original position and direction.
 - A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.
 - Mark the top of the piston to the specific cylinder bore.

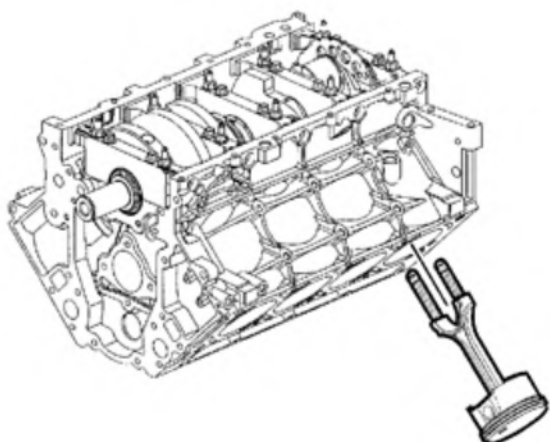


Important: Mark, sort, or organize the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are **NOT** interchangeable. Refer to [Separating Parts](#) .

3. Remove the connecting rod bolts (102), cap (103) and bearing (104).



4. Install the [J 41556](#) to the connecting rod.



5. Using a hammer, tap lightly on the end of the [J 41556](#) in order to remove the piston and connecting rod assembly from the cylinder bore.
6. Remove the [J 41556](#).



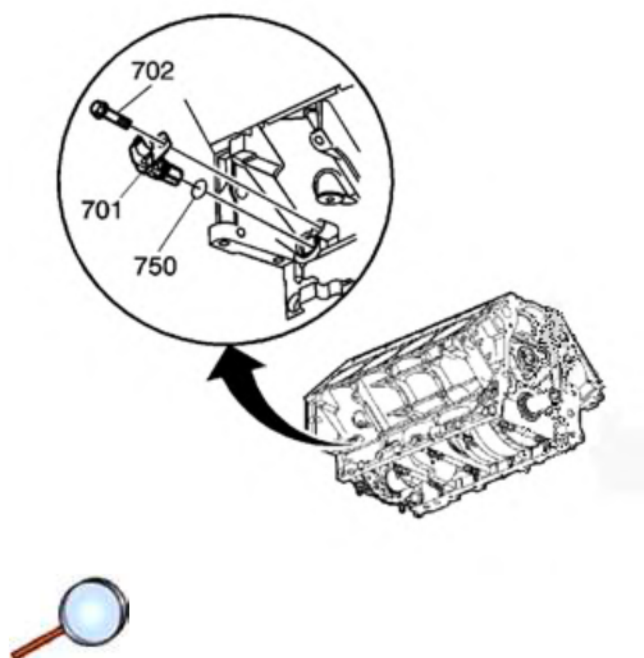
7. Upon removal of the piston and connecting rod assembly, assemble the connecting rod cap and bolts onto the matching connecting rod.

Crankshaft and Bearing Removal

Special Tools

- J 6125-1B Slide Hammer
- J 41818 Crankshaft Bearing Cap Remover

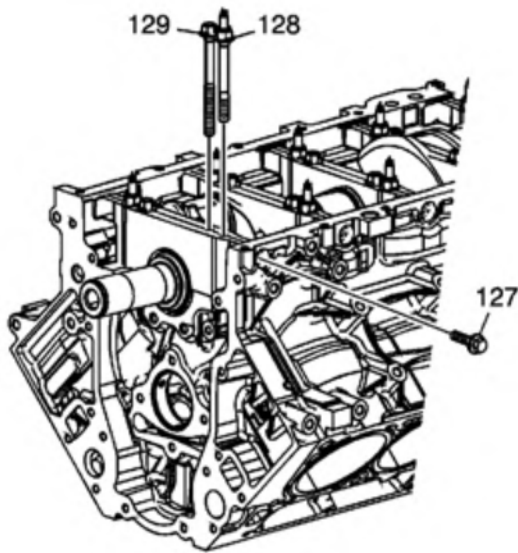
For equivalent regional tools, refer to [Special Tools](#).



Note:

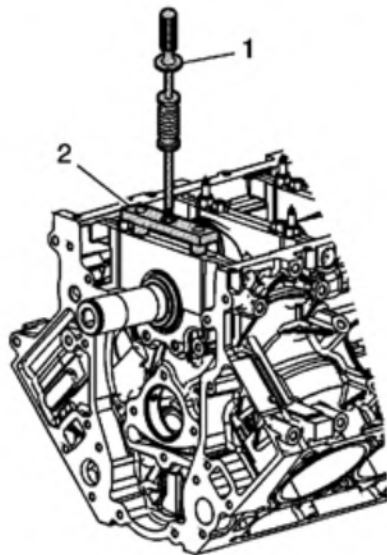
- The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps **MUST** be installed to their original position and direction.
- Do not use the bearing cap M8 side bolts again.

1. Remove the crankshaft position (CKP) sensor bolt (702).
2. Remove the CKP sensor (701).
3. Remove the O-ring (750) from the sensor, as required.

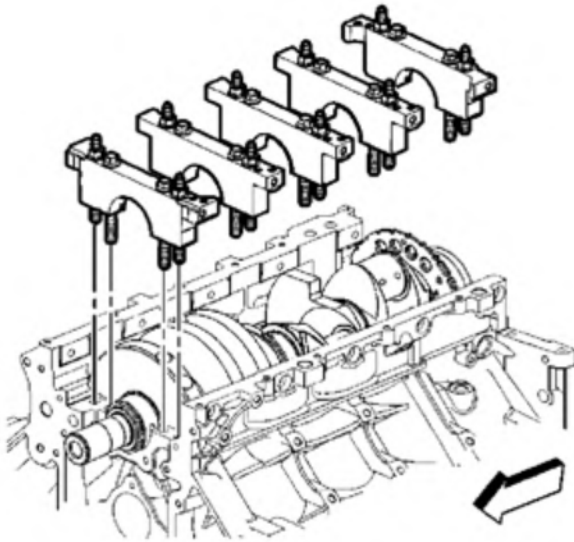


4. Remove the crankshaft bearing cap M8 bolts (127).
5. Remove the bearing cap M10 bolts (129) and studs (128).

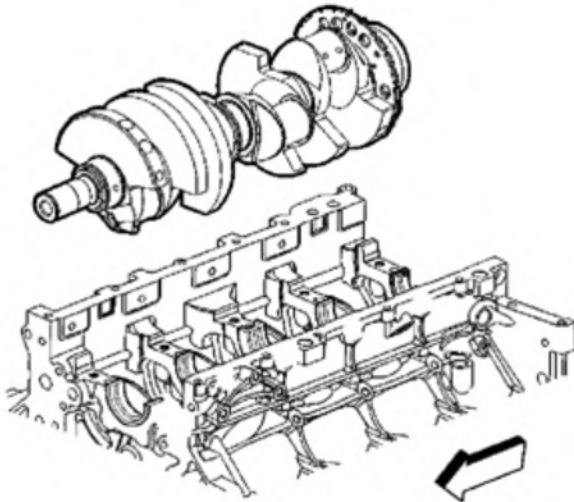
Caution: Refer to [Fastener Caution](#) in the Preface section.



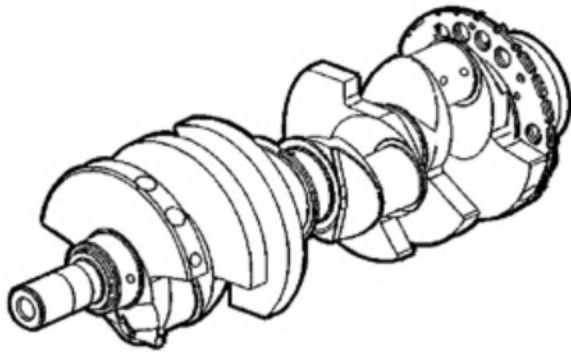
6. Install the *J 41818* remover (2). Tighten the *J 41818* remover (2) bolts to **11 N·m (100 lb in)**.
7. Install the *J 6125-1B* hammer (1) to the *J 41818* remover (2) in order to remove the crankshaft bearing caps.



8. Remove the bearing caps.

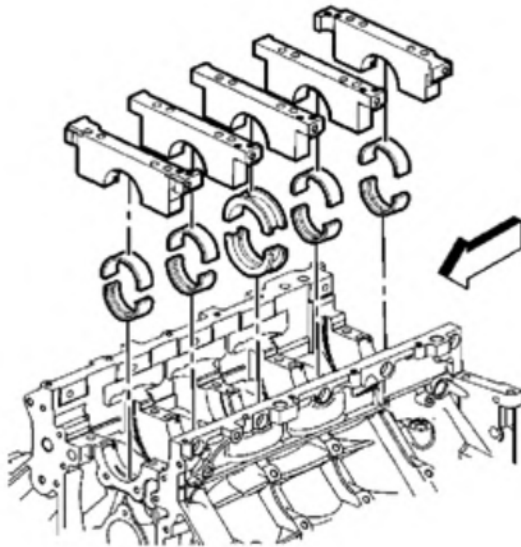


9. Remove the crankshaft.



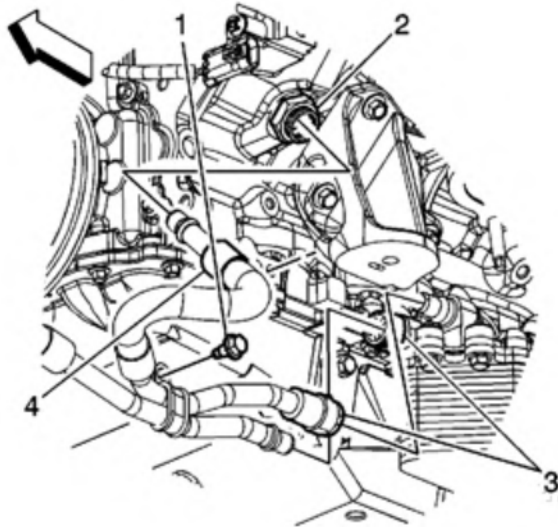
Note: Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may affect on-board diagnostics (OBD) II system performance.

10. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.

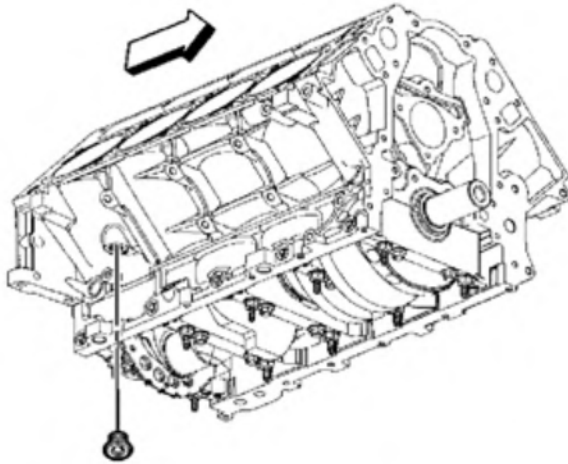


11. Remove the crankshaft bearings from the bearing caps and the engine block.
12. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to [Separating Parts](#).

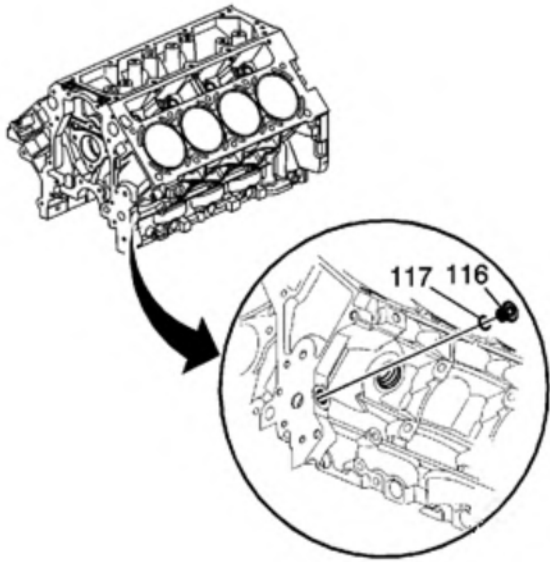
Engine Block Plug Removal



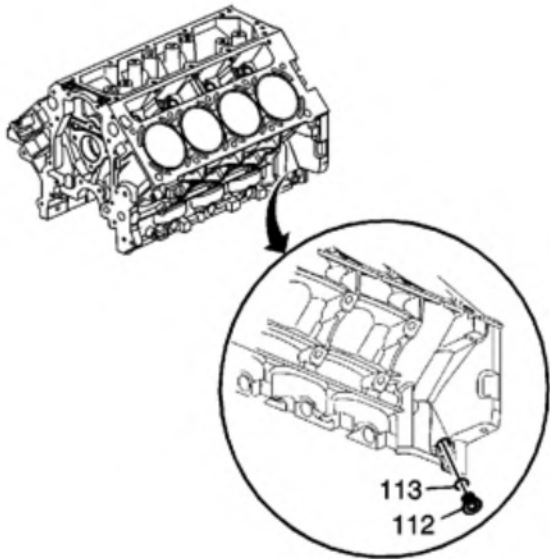
1. Remove the engine oil cooler coolant fitting (2).



2. Remove the engine block right rear coolant drain hole plug and seal.

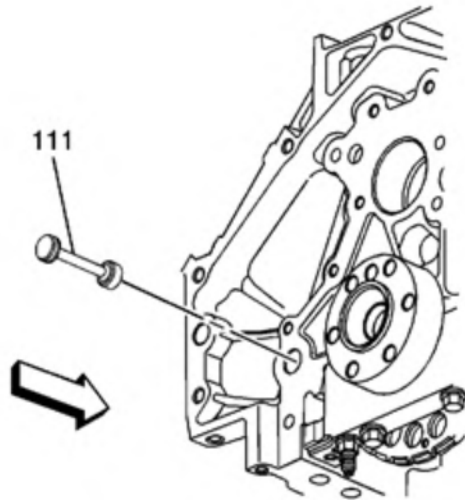


3. Remove the engine block left front oil gallery plug (116) and seal (117).



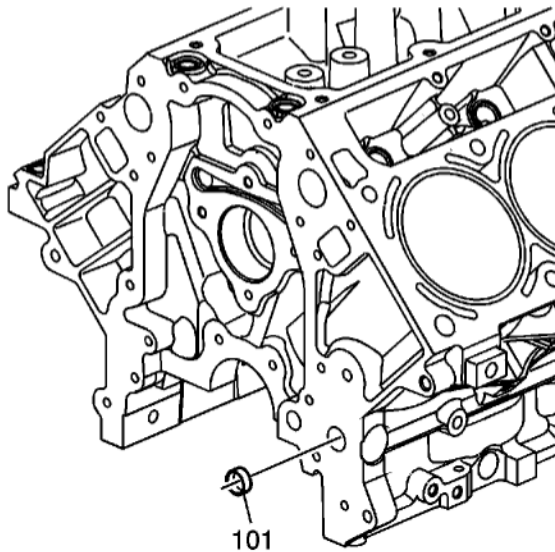
4. Remove the engine block left rear oil gallery plug (112) and seal (113).

If the block plug and coolant heater sealing washers are not damaged, they may be used during assembly.



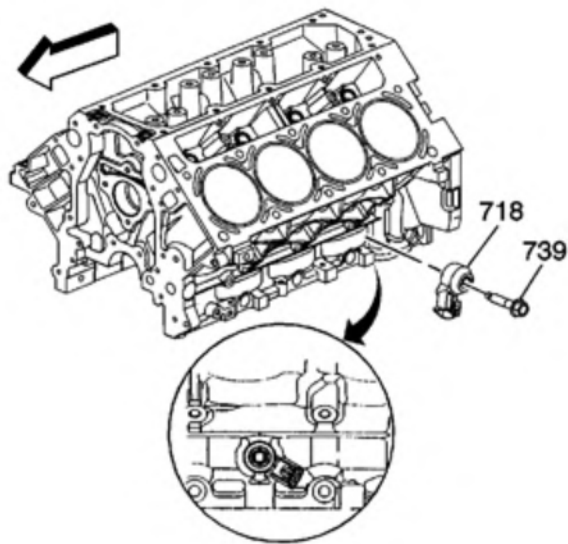
5. Remove the engine block rear oil gallery plug (111) and seal.
6. Inspect the O-ring seal of the rear oil gallery plug.

If the O-ring seal is not cut or damaged, the plug and O-ring seal may be used during assembly.

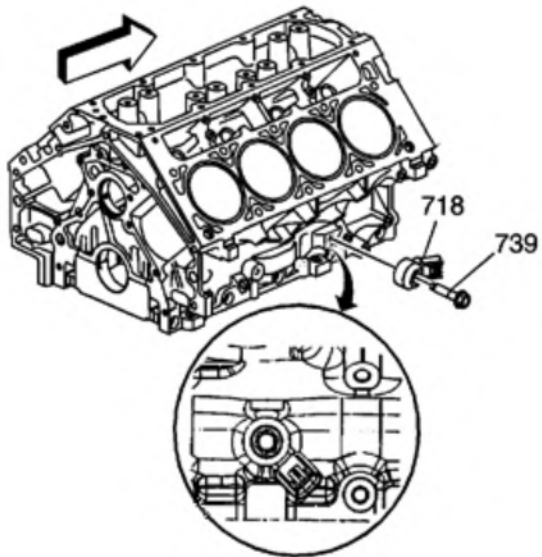


Note: Remove the front oil gallery plug, only if service is required. If the front oil gallery plug is removed, a NEW oil gallery plug must be installed.

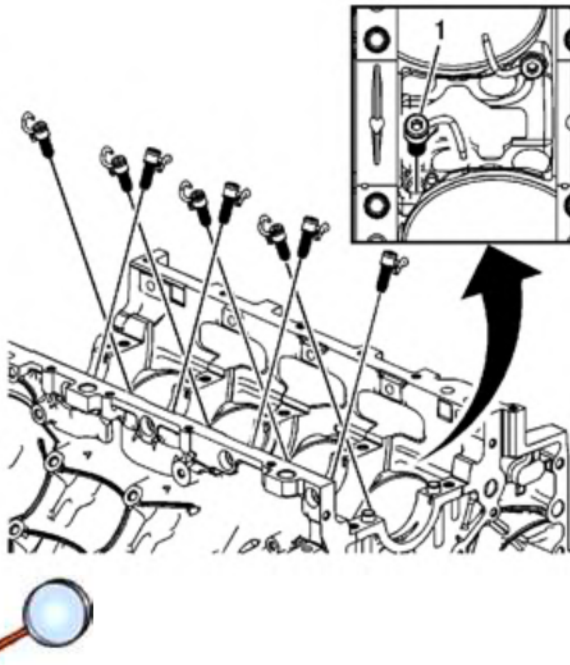
7. Remove the engine block front oil gallery plug (101).



8. Remove the left side knock sensor (718) and bolt (739).



9. Remove the right side knock sensor (718) and bolt (739).



10. Remove the piston oil nozzles (1) from the block - 6.2L LS9/LSA.

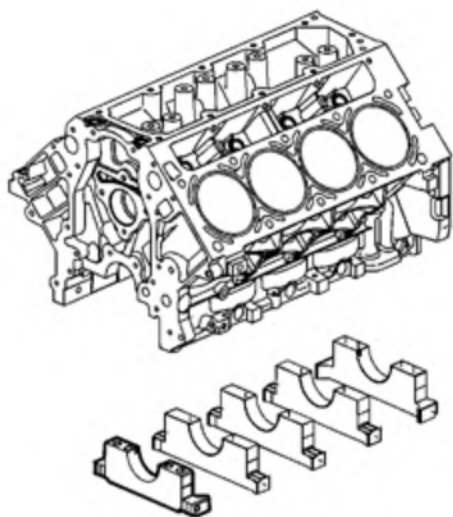
Engine Block Cleaning and Inspection

Special Tools

- J 8087 Cylinder Bore Gage
- J 42385-100 Head/Main Bolt Thread Repair Kit

For equivalent regional tools, refer to [Special Tools](#)

Cleaning Procedure



Caution: Do not use a caustic solution to clean the aluminum engine block.

Note: When cleaning the engine block in a thermal type oven, do not exceed 232°C (450°F).

Clean the following components:

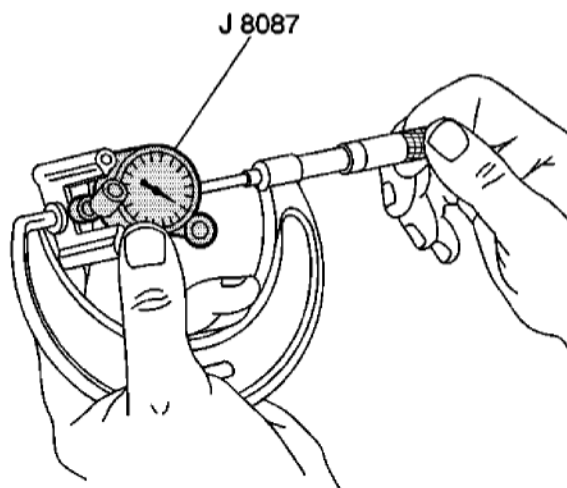
- Remove all sludge, dirt, or debris using a cleaning solvent or thermal type oven. Refer to [Cleanliness and Care](#).
- Gasket surfaces
Refer to [Replacing Engine Gaskets](#).
- Coolant passages
- Oil galleries
- Main bearing caps

- Cylinder head bolt holes to remove threadlocking material
Thread repair tool J 42385-107 may be used to clean the threads of any residual threadlocking material.

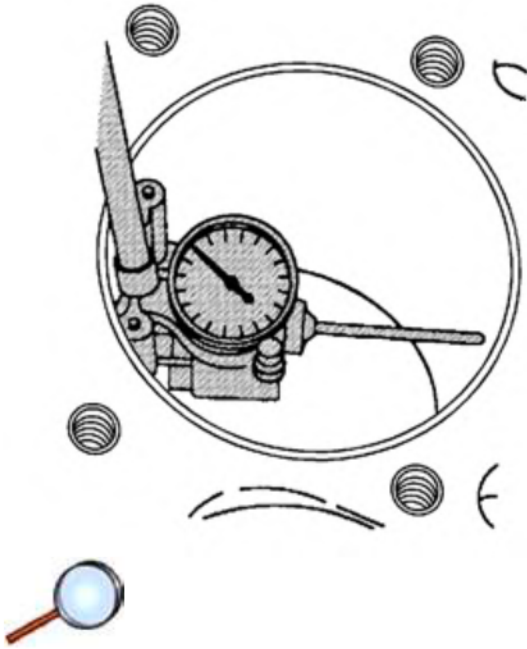
Inspection Procedure

1. Inspect the following components:
 - Cylinder walls for excessive scratches, gouging, or ring ridge
 - Cylinder bores for excessive ring ridge at the top of the cylinder
 - Coolant jacket for cracks
 - Valve lifter bores for excessive scoring or wear
 - Crankshaft bearing webs for cracks
 - Gasket sealing surfaces for excessive scratches or gouging
Refer to [Replacing Engine Gaskets](#).
 - Oil galleries for restrictions
 - Threaded bolt holes for damaged threads
 - Cylinder bores for excessive ring ridge at the top of the cylinder
2. Measure the cylinder bores for an oversize condition:

Measuring the Cylinder for Oversize



1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to [Engine Mechanical Specifications](#).
2. Insert the J 8087 gage into the micrometer and zero the bore gage dial.



3. Using the J 8087 gage , measure the cylinder bore for oversize.

Slide the bore gage up and down throughout the length of the cylinder bore. Measure the bore, both parallel and perpendicular to the centerline of the crankshaft, at the top, center, and bottom of the bore. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to [Engine Mechanical Specifications](#).

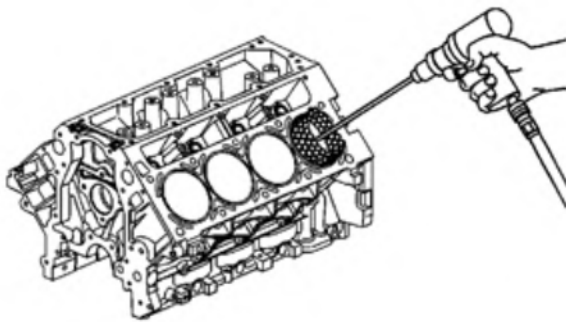
Cylinder Boring and Honing

Boring Procedure

Note: A 0.5 mm (0.02 in) oversize service piston and a piston ring set are available.

1. Measure all pistons with a micrometer to determine the cylinder bore diameter.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure



1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.
2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.

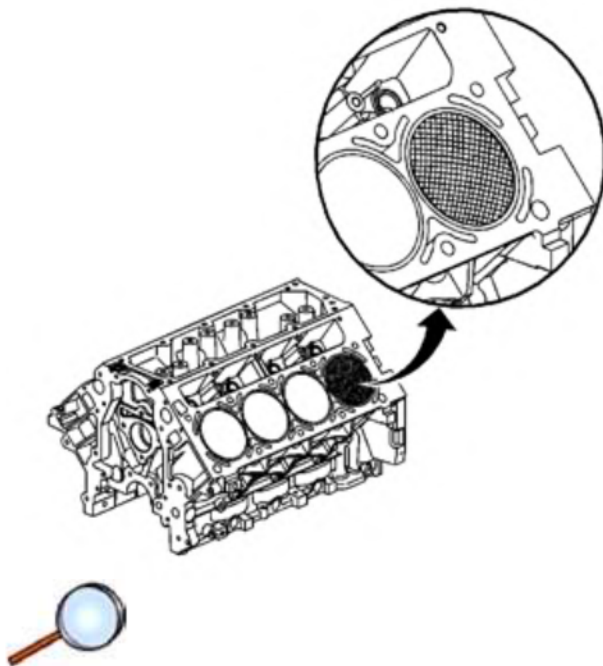
All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.

3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.
4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
7. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.
8. Perform final measurements of the piston and the cylinder bore.
9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure



Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide, or equivalent, material when performing the deglazing procedure.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

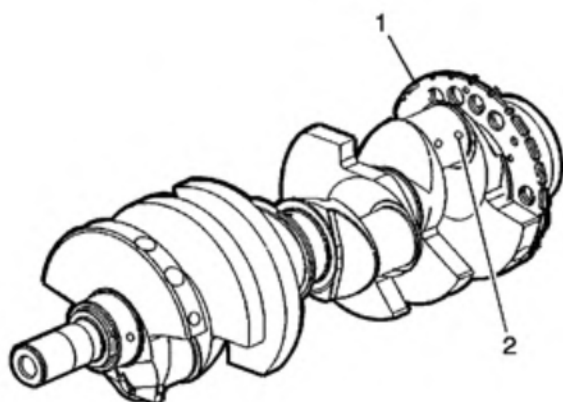
Crankshaft and Bearing Cleaning and Inspection

Special Tools

- [J 7872](#) Magnetic Base Dial Indicator Set
- [J 43690](#) Rod Bearing Checking Tool
- [J 43690-100](#) Rod Bearing Checking Tool - Adapter Kit

For equivalent regional tools, refer to [Special Tools](#)

Cleaning Procedure



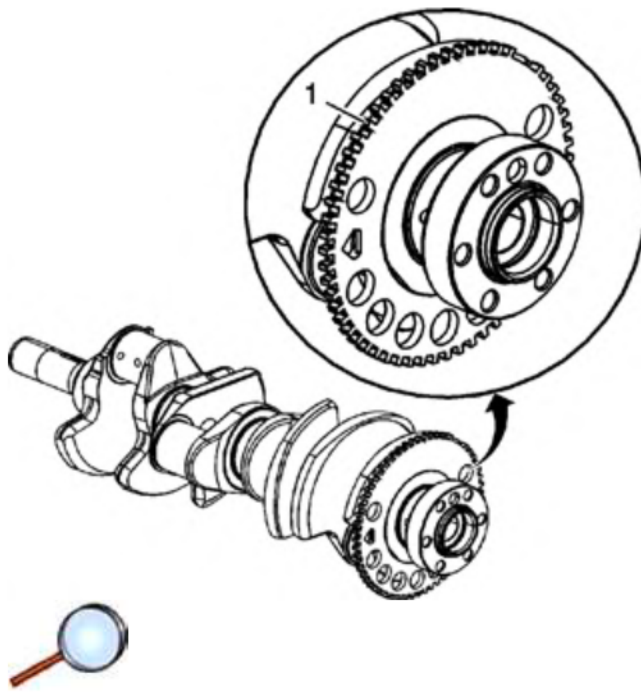
Note: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

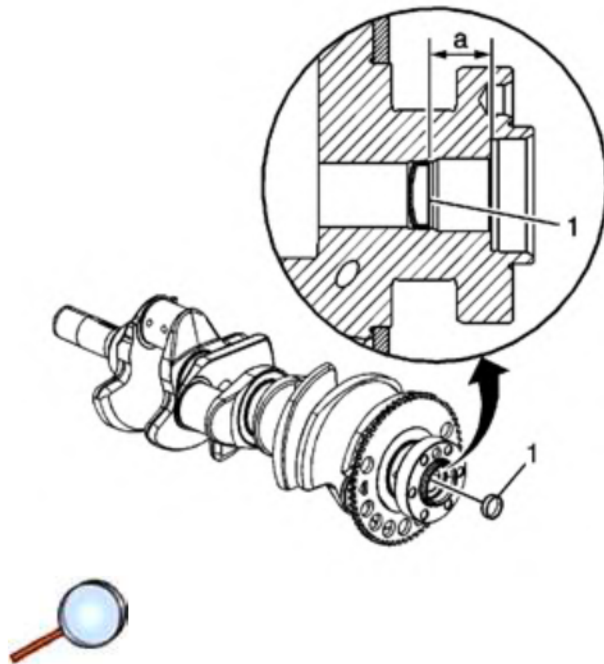
3. Dry the crankshaft with compressed air.

Inspection Procedure



Note: The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may affect OBD II system performance.

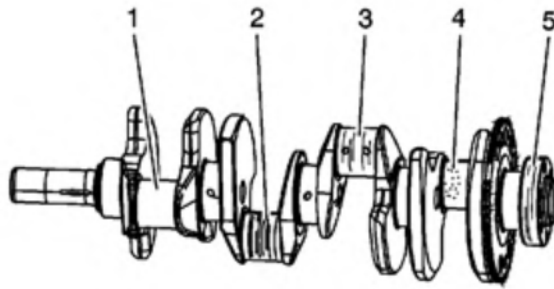
1. Inspect the CKP reluctor ring teeth (1) for damage.



2. Inspect the rear cup plug (1) for leakage, if applicable.

Note: If a new plug is required, apply sealant GM P/N 89021297 (Canadian P/N 10953488) to the side of the plug prior to installation.

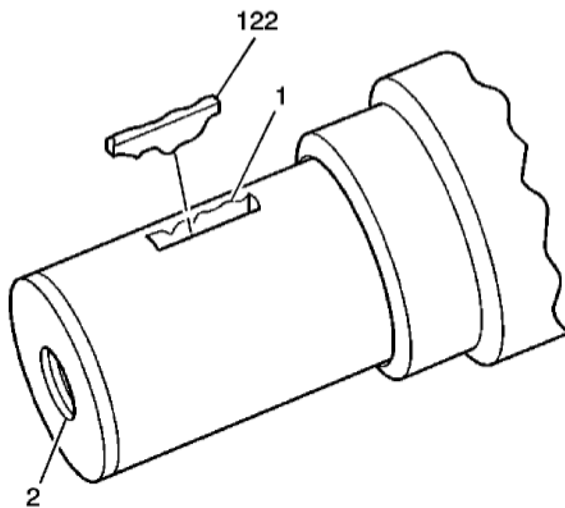
3. Install the rear cup plug (1) to a depth of 24.4 mm (0.96 in) (a).



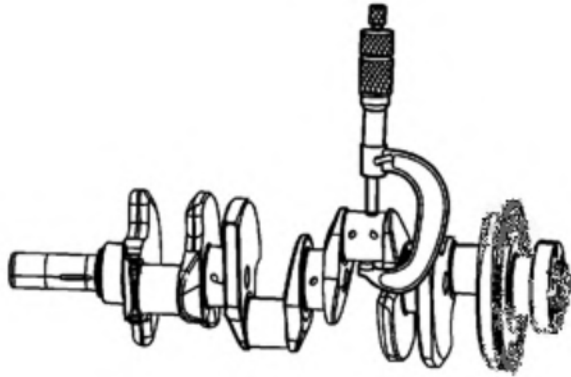
4. Inspect the crankshaft journals for wear.

Journals should be smooth (1) with no signs of scoring, wear, or damage.

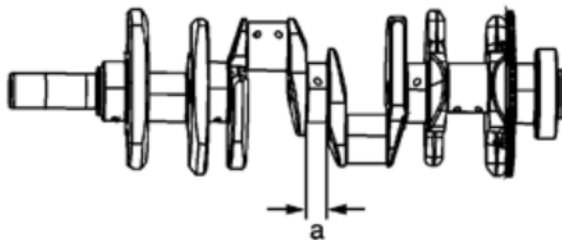
5. Inspect the crankshaft journals for grooves or scoring (2).
6. Inspect the crankshaft journals for scratches or wear (3).
7. Inspect the crankshaft journals for pitting or imbedded bearing material (4).
8. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.



9. Inspect the crankshaft key (122), keyway (1), and threaded hole (2) for damage.

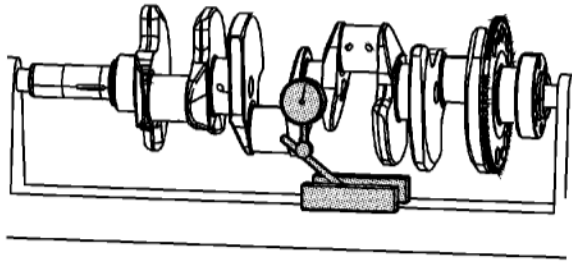


10. Measure the connecting rod journals for out-of-round and taper.



11. Measure the crankshaft thrust wall width.

A crankshaft with a thrust wall width in excess of 26.2 mm (1.0315 in) (a) must be replaced.

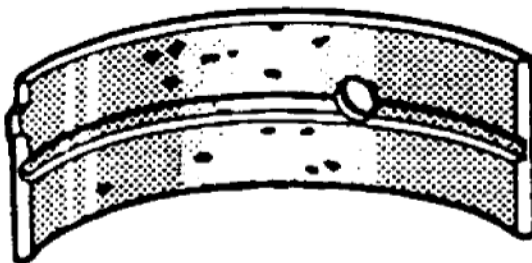


12. Measure the crankshaft runout.

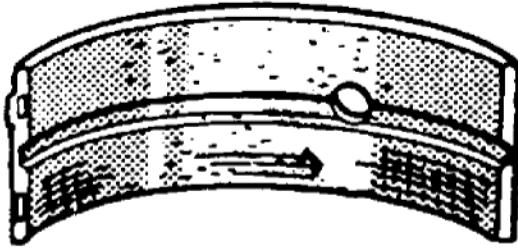
Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.

13. Use the [J 7872](#) in order to measure the crankshaft runout at the front and rear intermediate journals.
14. Use the [J 7872](#) in order to measure the runout of the crankshaft rear flange.
15. Use the [J 7872](#) in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.

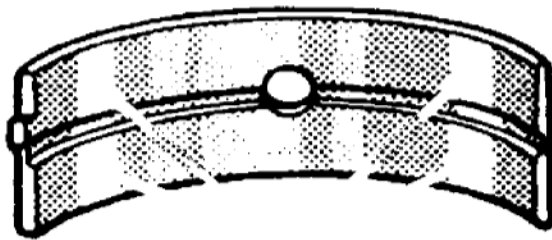
If the reluctor ring has runout in excess of 0.7 mm (0.028 in), replace the crankshaft.



16. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.



17. Inspect the crankshaft bearings for excessive scoring or discoloration.
18. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

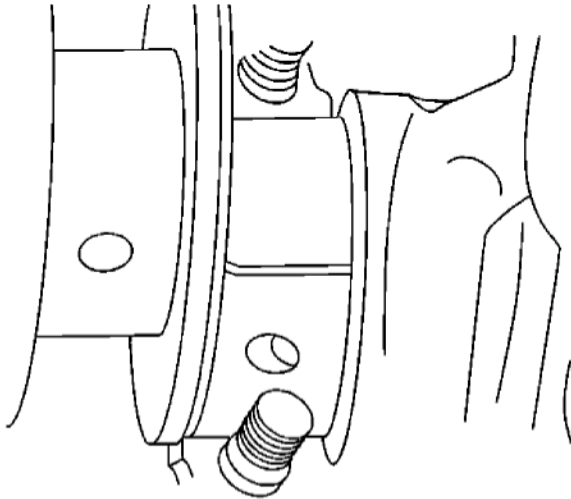


19. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

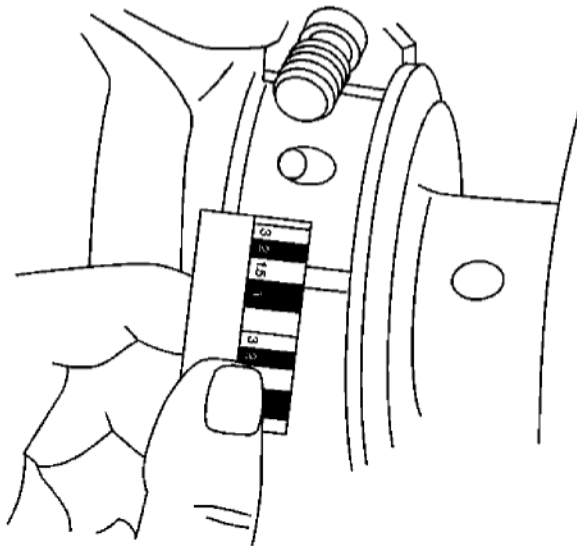
Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

Measuring Main Bearing Clearance - Gaging Plastic Method

**Note:**

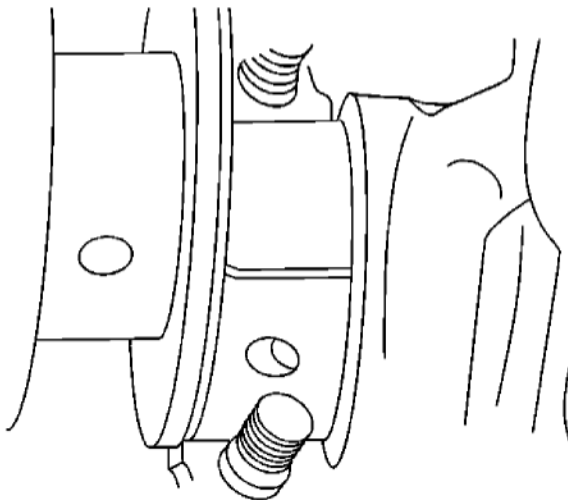
- The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance, and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.
- Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.
- The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect on-board diagnostics (OBD) II system operation.
- Remove the bearing cap side bolts prior to cap removal.

1. Remove the bearing caps, bearing half, and bolts. Refer to [Crankshaft and Bearing Removal](#).
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half, and bolts. Refer to [Crankshaft and Bearing Installation](#).
4. Remove the bearing caps, bearing half, and bolts. Refer to [Crankshaft and Bearing Removal](#).



5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.
 - If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
 - If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to [Engine Mechanical Specifications](#).

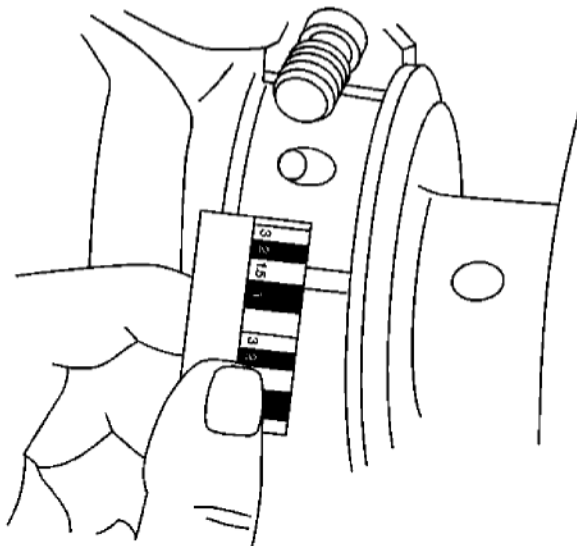
Measuring Connecting Rod Bearing Clearance - Gaging Plastic Method



Note:

- Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.
- Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.

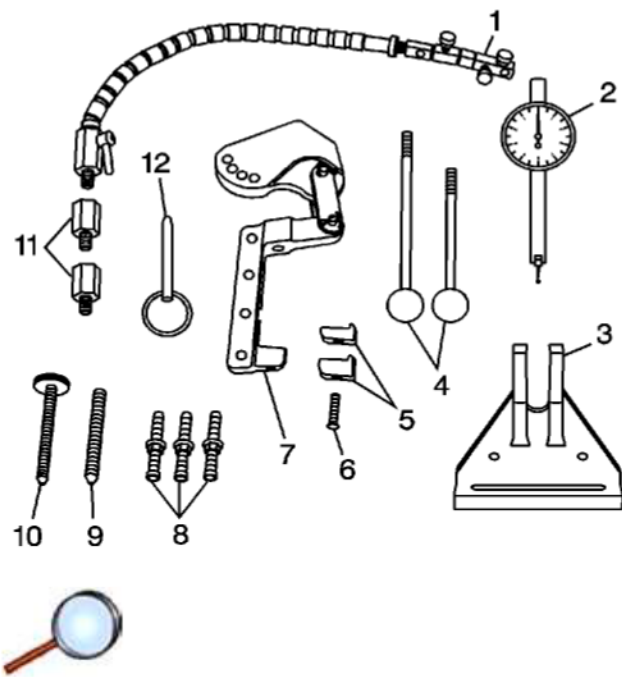
1. Remove the bearing cap, bearing half, and bolts. Refer to [Piston, Connecting Rod, and Bearing Removal](#).
2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
3. Install the bearing cap, bearing half, and bolts. Refer to [Piston, Connecting Rod, and Bearing Installation](#).
4. Remove the bearing cap, bearing half, and bolts. Refer to [Piston, Connecting Rod, and Bearing Removal](#).



5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to [Engine Mechanical Specifications](#).

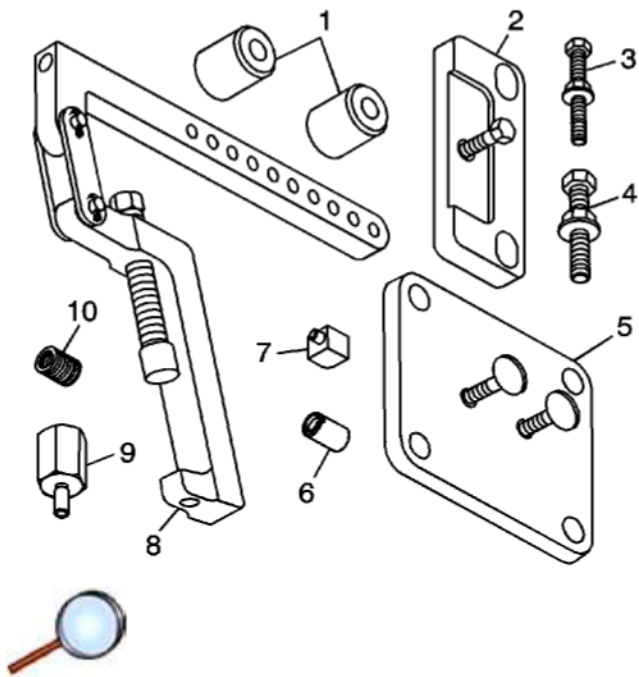
Measuring Connecting Rod Bearing Clearance - Using J 43690 / J 43690-100

[J 43690](#) and [J 43690-100](#) have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.



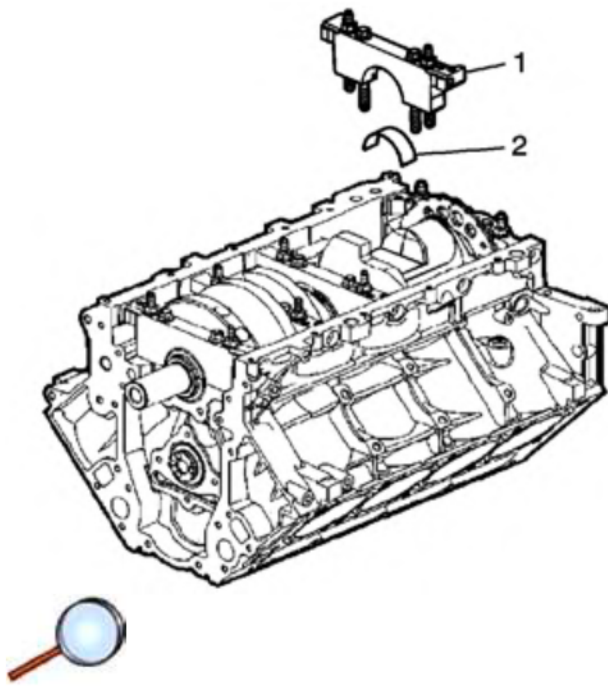
J 43690 Rod Bearing Checking Tool

- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, J 43690-18 Adapter (11)
- 280310 Pin (12)



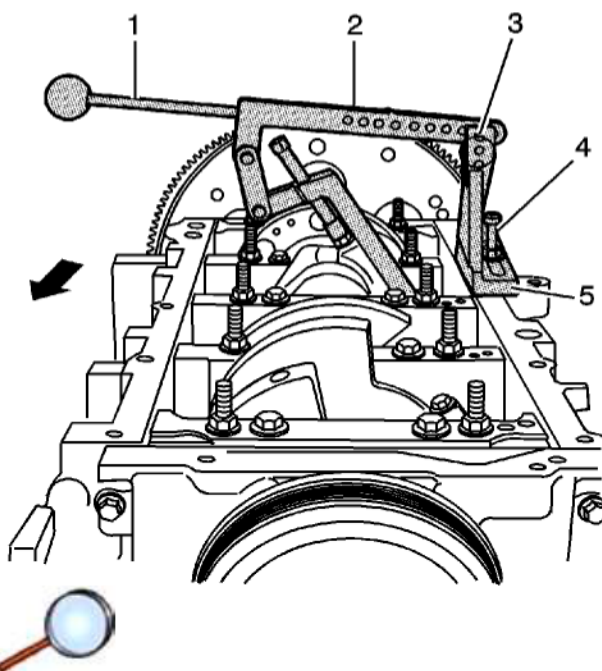
J 43690-100 Rod Bearing Checking Tool - Adapter Kit

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)
- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)



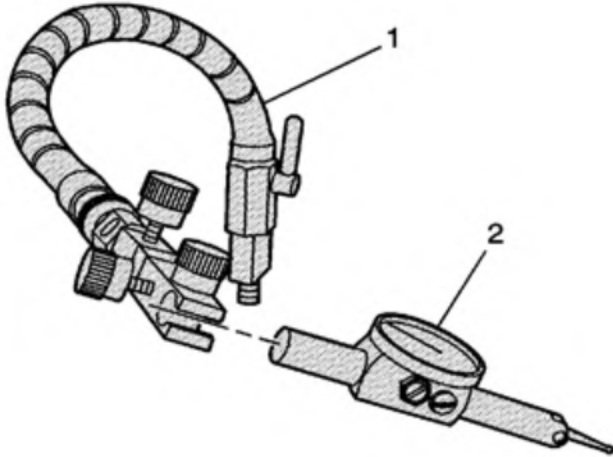
Note: The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.

1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.
2. Remove a bearing cap and bolts (1).
3. Remove the bearing half (2).
4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to [Fastener Tightening Specifications](#).



6. Install the following:
 - 6.1. J 43690-2 (5)

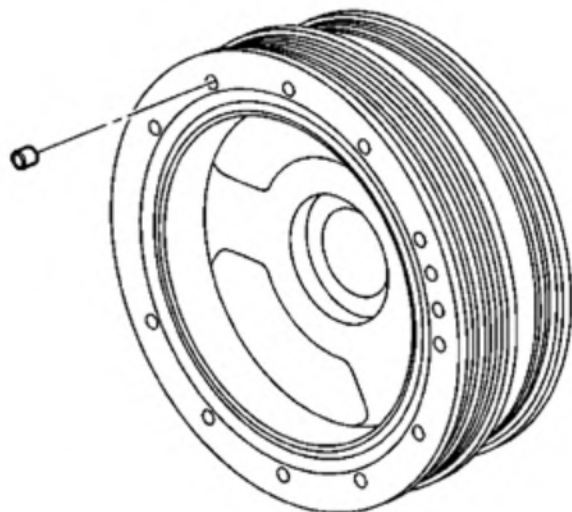
- 6.2. J 43690-3 (4)
- 6.3. J 43690-101 (2)
- 6.4. 280310 (3)
- 6.5. J 43690-5 (1)



- 7. Install the swivel base (1) and dial indicator (2).
- 8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.

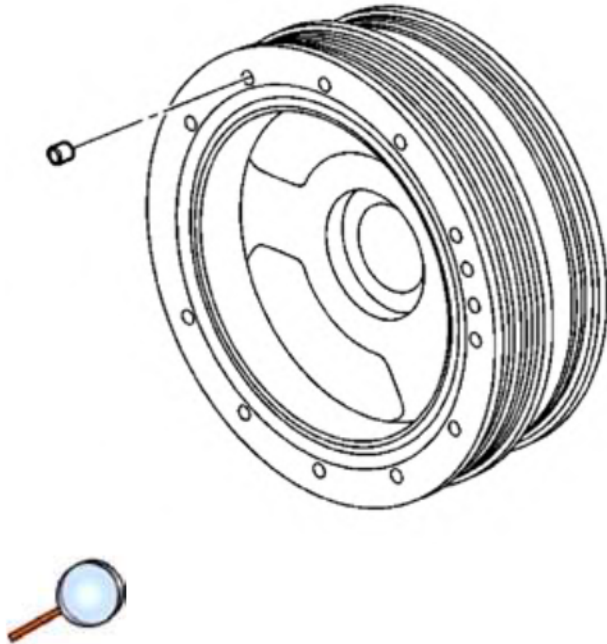
A connecting rod with a clearance in excess of 0.076 mm (0.003 in) is considered excessive. Service components, as required.

Crankshaft Balancer Cleaning and Inspection



1. Clean the crankshaft balancer in solvent.
 2. Using a wire brush, clean the belt grooves of all dirt and debris.
 3. Dry the crankshaft balancer with compressed air.
 4. Inspect the crankshaft balancer for the following conditions:
 - Loose or improperly installed balance weights - manual transmission applications.
A properly installed balance weight should be installed flush or below flush with the face of the balancer.
 - Worn, grooved, or damaged hub seal surface
A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.
Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.
- Note:** In order for the belt to track properly, the belt grooves should be free of all dirt and debris.
- Dirty or damaged belt grooves
The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.
Minor imperfections may be removed with a fine file.
 - Worn, chunking or deteriorated rubber between the hub and pulley

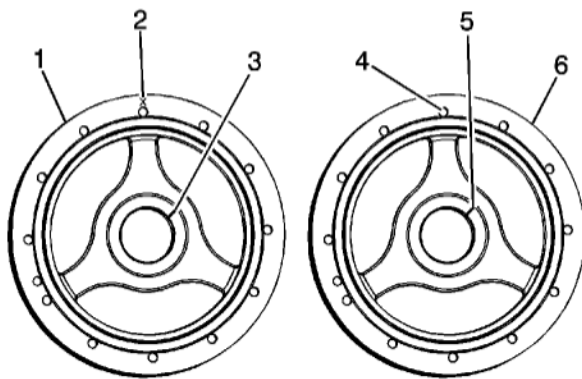
Replacing the Crankshaft Balancer and Balance Weights



Note: If replacing the crankshaft balancer on manual transmission applications, note the location of any existing balance weights, if applicable. Crankshaft balancer weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight is flush or below flush with the face of the balancer.

1. Inspect the crankshaft balancer weight holes for any existing balance weights.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.



2. Using a punch, position the balance weights in the old balancer (1) to the bottom of the

weight holes.

3. With a marking crayon, note the weight holes (2) containing balance weights, if applicable.
4. Lay the old crankshaft balancer (1) on a bench or flat table.

Rotate the old balancer until 1 of the marked balance weight holes (2) is in the 12 o'clock position.

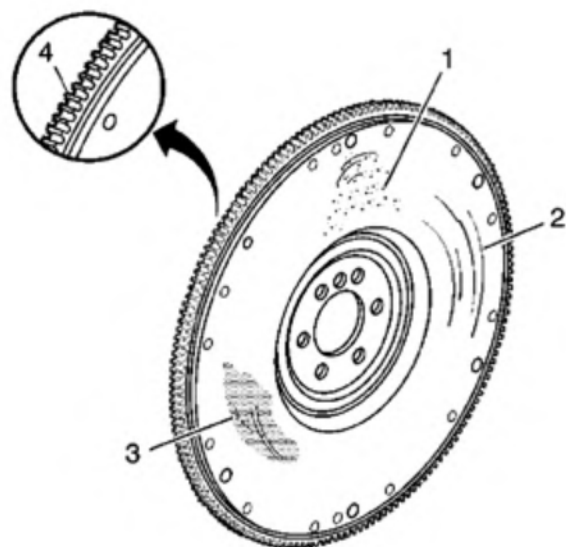
5. Lay the new crankshaft balancer (6) on the bench next to the old balancer.

Rotate the new balancer until 1 of the balance weight holes (4) is in the 12 o'clock position.

6. With a marking crayon, mark the new balancer weight hole (4) located in the 12 o'clock position.
7. Viewing the old balancer, note the position of the crankshaft-to-balancer alignment mark (3).
8. Mark the new balancer in the same location (5).
9. Measure the distance from the top of the balance weights to the face of the old crankshaft balancer.
10. Record the readings.
11. Determine the proper balance weight size for the new balancer. Balance weights are available in 3 different sizes.
 - A balance weight hole depth that measures 13.0 mm (0.512 in), has a short balance weight in the hole. A short balance weight measures 12.7 mm (0.5 in) in length.
 - A balance weight hole depth that measures 6.69 mm (0.263 in), has a medium balance weight in the hole. A medium balance weight measures 19.0 mm (0.75 in) in length.
 - A balance weight hole depth that measures 0.29 mm (0.011 in), has a long balance weight in the hole. A long balance weight measures 25.4 mm (1.0 in) in length.
12. Insert new crankshaft balance weights of the proper size into the new balancer in the same location as the old balancer.

A properly installed balance weight is flush or below flush with the face of the balancer.

Engine Flywheel Cleaning and Inspection



Note: In order to maintain the proper component balance, contact surface taper, and heat transfer, manual transmission flywheels are NOT to be machined.

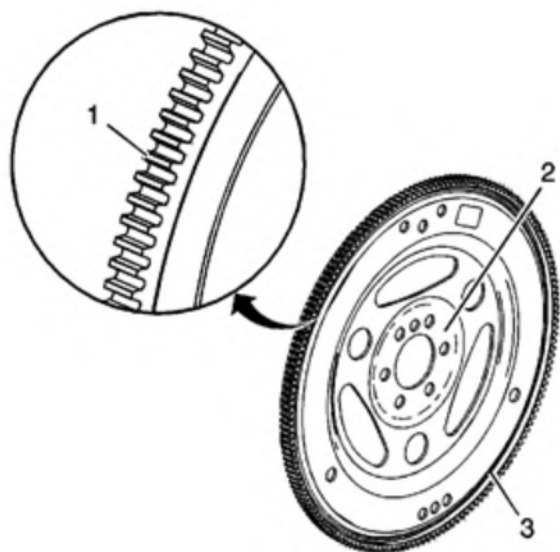
Inspect the manual transmission flywheel for the following conditions:

- Pitted surface (1)
- Grooved or scored surface (2)
- Rusted surface (3)
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

The ring gear has an interference fit onto the flywheel and should be positioned completely against the flange of the flywheel.

- Missing, bent or damaged pressure plate locating pins

Automatic Transmission Flex Plate Cleaning and Inspection



1. Clean the flex plate in solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#) in the Preface section.

2. Dry the flex plate with compressed air.
3. Inspect the flex plate for the following conditions:
 - Damaged ring gear teeth (1)
 - Stress cracks around the flex plate-to-crankshaft bolt hole locations (2)

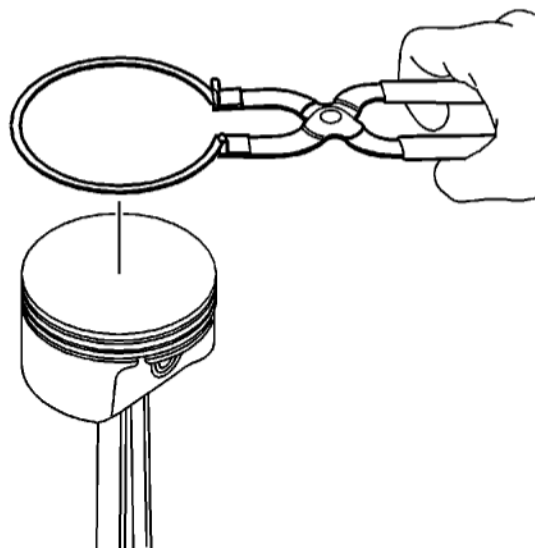
Note: Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate.

- Welded areas (3) that retain the ring gear onto the flex plate for cracking

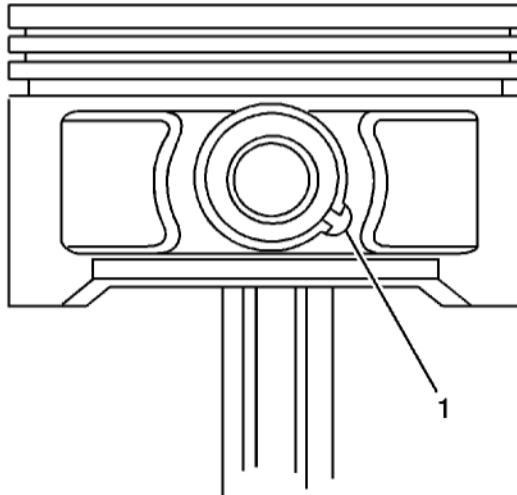
Piston and Connecting Rod Disassemble



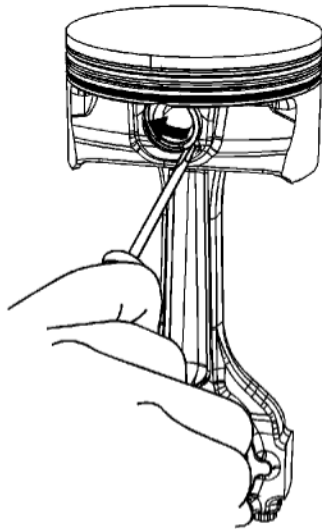
1. Remove the connecting rod bearings from the rod and cap.



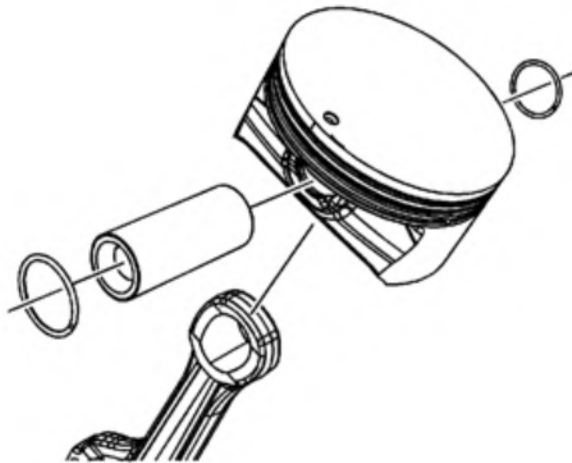
2. Using piston ring pliers, remove the piston rings from the piston.



3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.



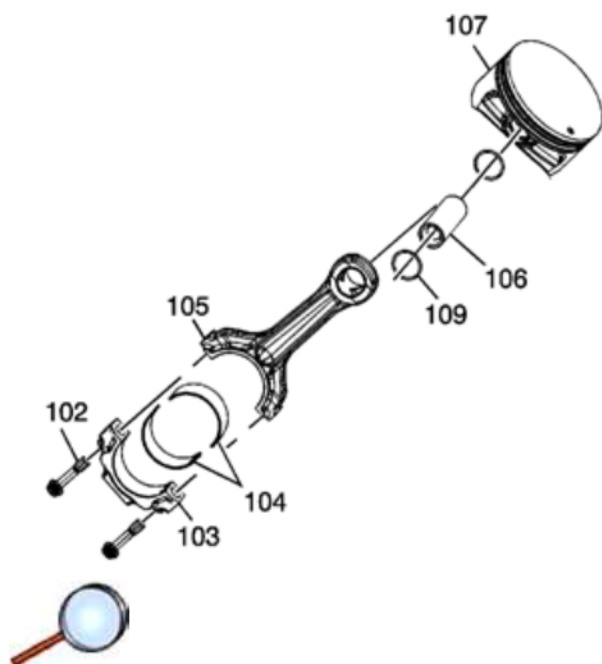
4. Remove the retainers starting in the cutout area of the pin bore.



5. Remove the pin from the piston and connecting rod.
6. Mark, sort, or organize the piston and the matching piston pin.

Piston, Connecting Rod, and Bearing Cleaning and Inspection (6.2L)

Piston, Pin, and Piston Rings



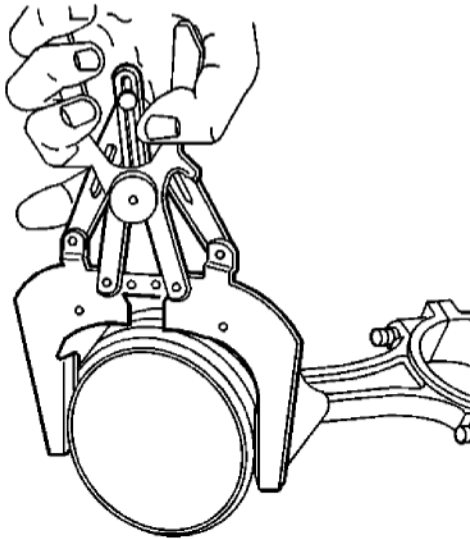
Note:

- Replace pistons, pins, and connecting rods that are damaged or show signs of excessive wear.
- The piston and pin are to be serviced as an assembly.
- Do not wire brush any part of the piston.
- Measurement of the components should be taken with the components at normal room temperature.

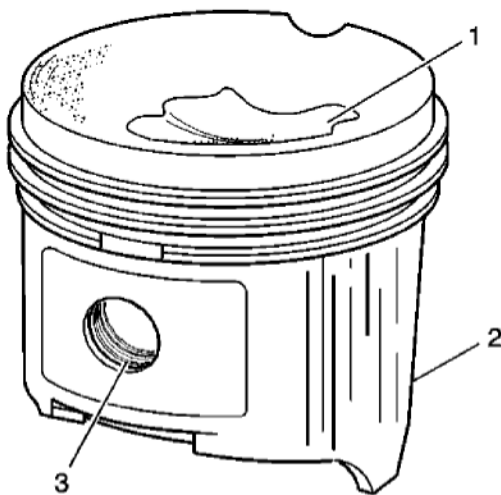
1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

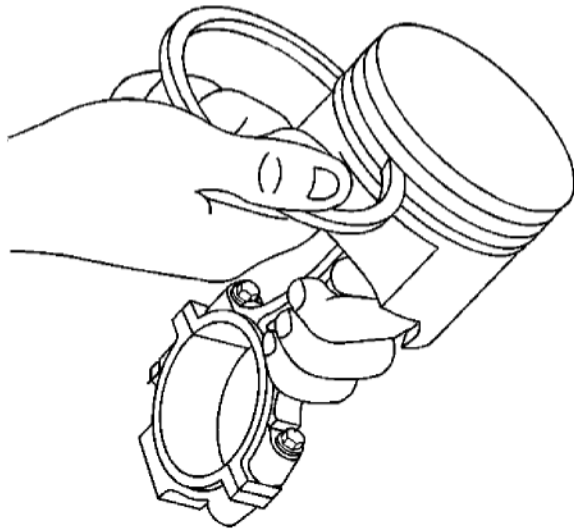
2. Dry the components with compressed air.



3. Clean the piston ring grooves with a suitable ring groove cleaning tool.
4. Clean the oil lubrication holes and slots.

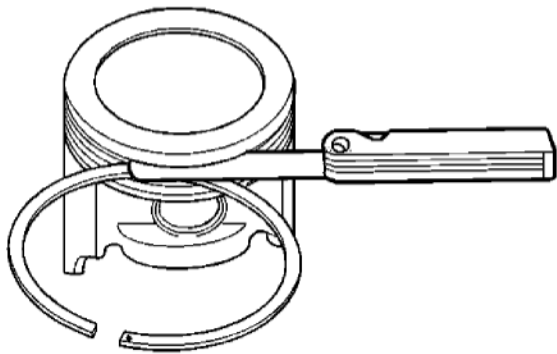


5. Inspect the piston for the following conditions:
 - Cracks in the piston ring lands, the piston skirt, or pin bosses
 - Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind
MINOR imperfections may be removed from the piston with a fine file.
 - Eroded areas at the top of the piston (1)
 - Scuffed or damaged skirts (2)
 - Scoring to the piston pin bore (3) or piston pin

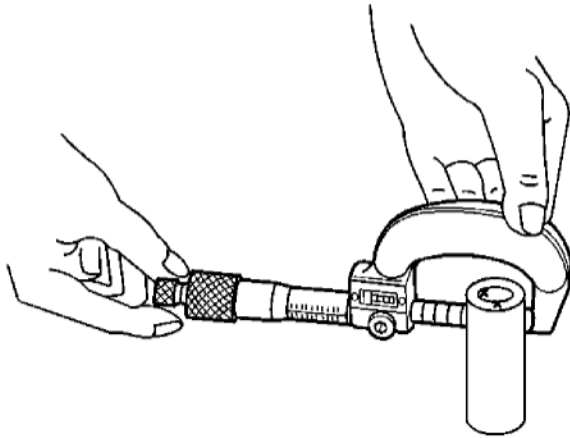


6. Insert the edge of the piston ring into the piston ring groove.

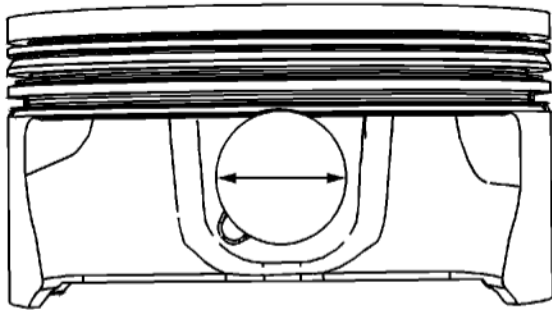
Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the rings, as required.



7. Measure the piston ring side clearance with a feeler gage. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to [Engine Mechanical Specifications](#).

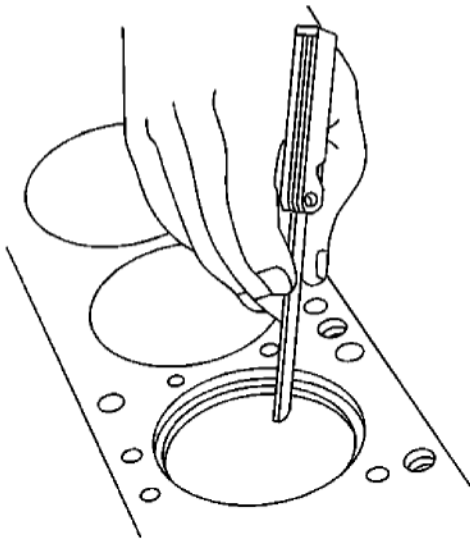


8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).



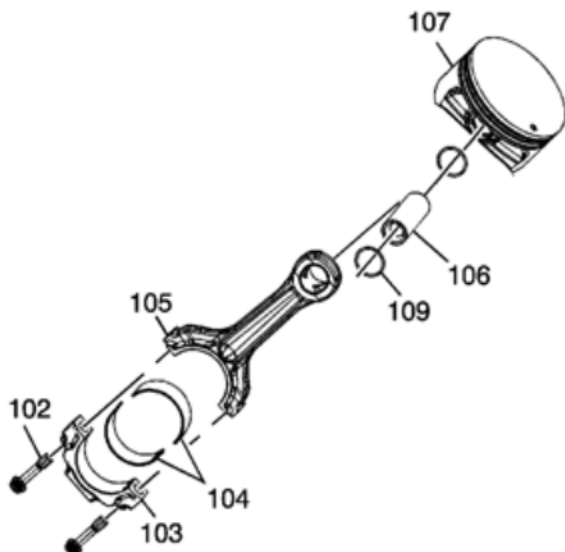
9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to [Engine Mechanical Specifications](#).

Measuring Piston Ring End Gap

**Note:**

- Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.
 - Measure the piston ring in the cylinder in which it will be used.
1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
 2. Insert a feeler gage and measure the piston ring end gap. Refer to [Engine Mechanical Specifications](#).

Connecting Rod and Bearings



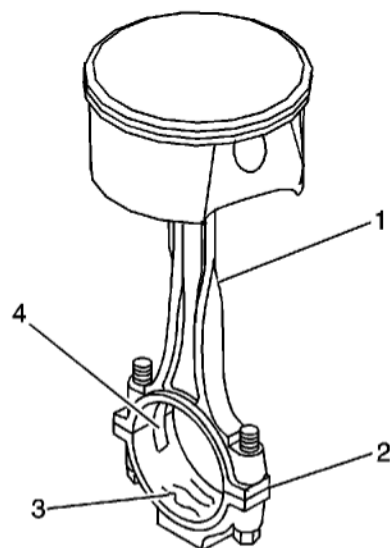
**Note:**

- The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.
- Do not attempt to repair the bolt hole threads of the connecting rod.

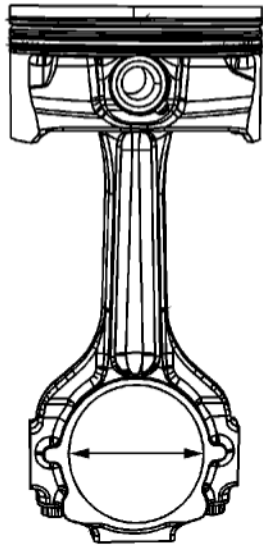
1. Clean the connecting rod (105) and cap (103) in solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

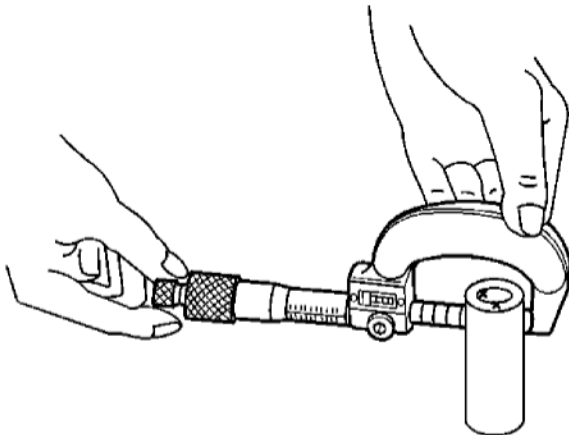
2. Dry the components with compressed air.



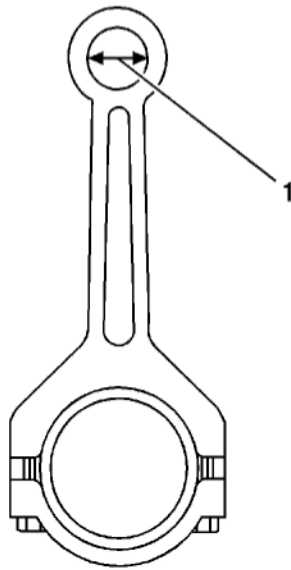
3. Inspect the connecting rod for the following conditions:
 - Twisting (1)
 - Proper fit of the connecting rod and cap mating surfaces (2)
 - Nicks or gouges in the bearing bore (3)
 - Damage to the bearing locating slots (4)



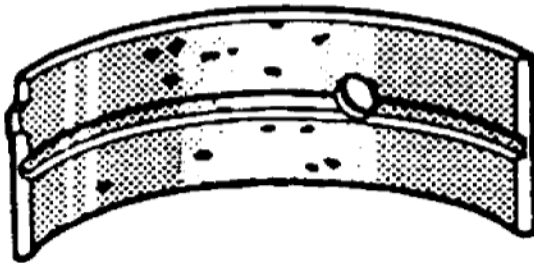
4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to [Engine Mechanical Specifications](#).



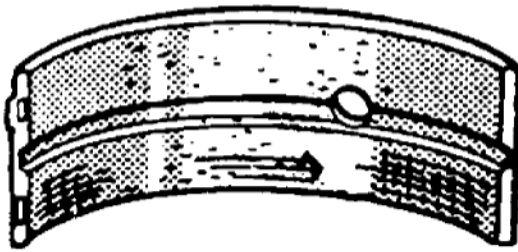
5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.



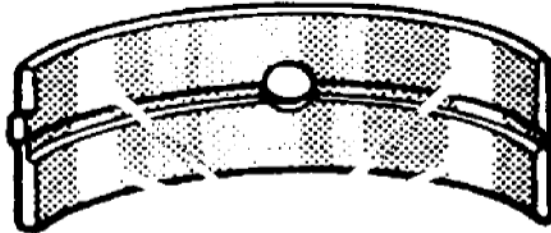
6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine pin-to-bore clearance. Refer to [Engine Mechanical Specifications](#).



8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.

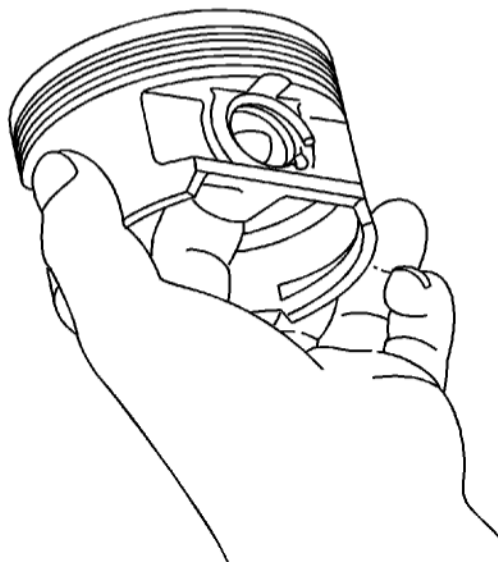


9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.

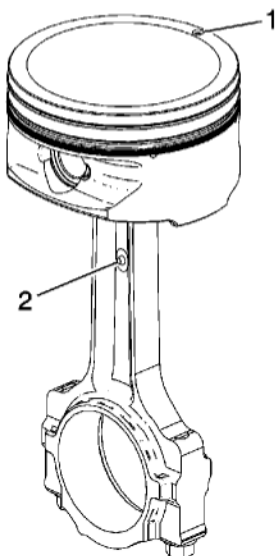


11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.
12. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore ID.
13. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to [Engine Mechanical Specifications](#).

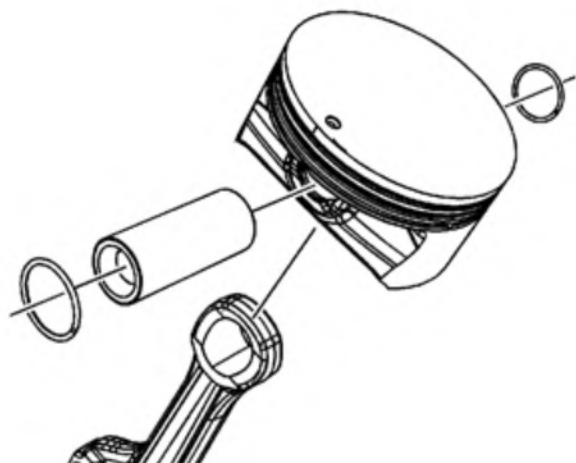
Piston and Connecting Rod Assemble



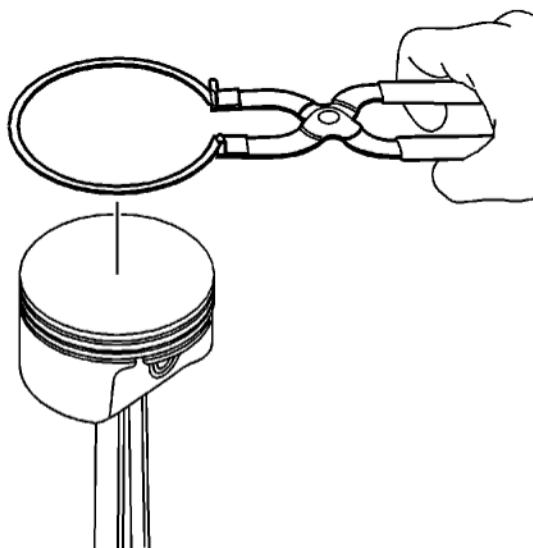
1. Install the retainer. The retainer should be seated in the groove of the pin bore.



2. Assemble the piston and connecting rod. The mark (1) on the top of the piston and the dimple (2) on the connecting rod should be facing the opposite direction.



3. Install the piston pin to the piston and connecting rod.
4. Install the retainers. The retainers should be seated in the groove of the pin bore.



Note: When installing piston rings, use a ring expander plier type tool. Do not roll the rings into the grooves of the piston. Use caution and care to expand the rings only slightly larger than the outside diameter (OD) of the piston.

5. Using piston ring pliers, install the piston rings onto the piston. The dimple or mark on the piston ring should face the top of the piston. If no dimple or mark can be found on the top compression ring, it may be installed in either direction.
6. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
7. Position the compression ring end gaps 180 degrees opposite each other.

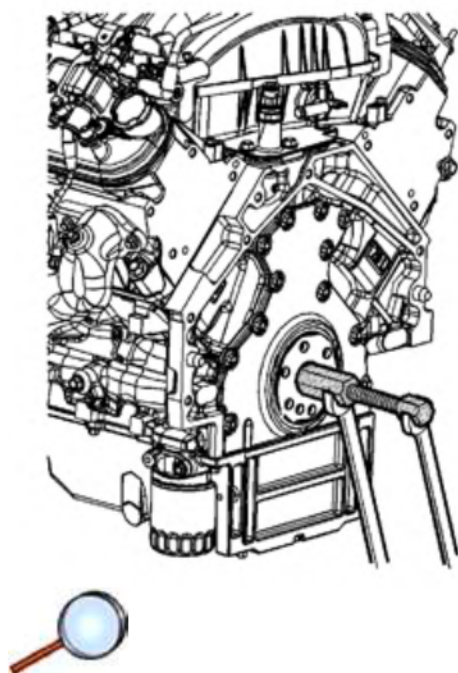


8. Install the connecting rod bearings to the rod and cap.

Clutch Pilot Bearing Removal

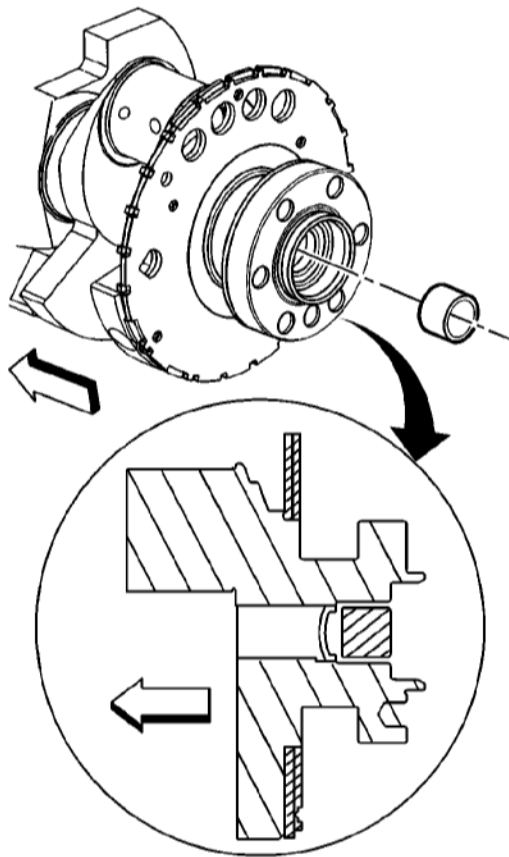
Tools Required

[J 43276](#) Clutch Pilot Bearing Remover



Caution: When using the J 43276 Clutch Pilot Bearing Remover, always secure the J 43276-1 Clutch Pilot Bearing Remover tool body using a wrench. Do not allow the J 43276-1 tool body to rotate. Failing to do so causes damage to the J 43276-1 tool body.

1. Remove the clutch pilot bearing using the [J 43276](#).
 - 1.1. Install the J 43276-1 into the clutch pilot bearing.
 - 1.2. Using a wrench, secure the J 43276-1.
 - 1.3. Insert the J 43276-2 into the J 43276-1.
 - 1.4. Rotate the J 43276-2 clockwise into the J 43276-1 until the clutch pilot bearing is completely removed from the crankshaft.
 - 1.5. Rotate the J 43276-2 counterclockwise to remove the J 43276-2 from the J 43276-1.
 - 1.6. Remove the J 43276-1 from the tool body.

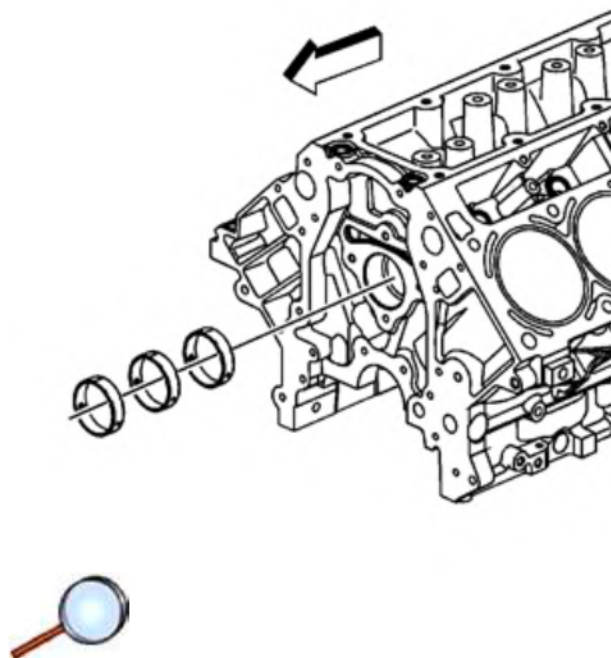


2. Discard the pilot bearing.

Camshaft Bearing Removal

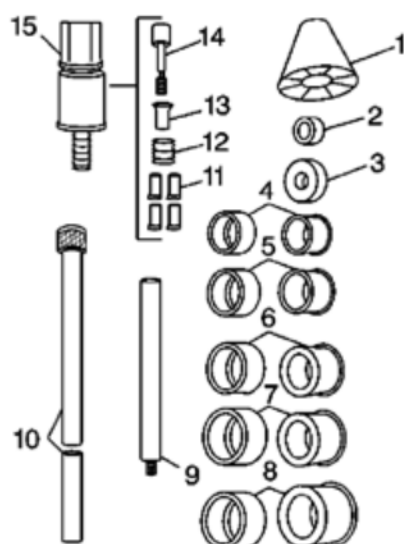
Tools Required

[J 33049](#) Camshaft Bearing Service Set

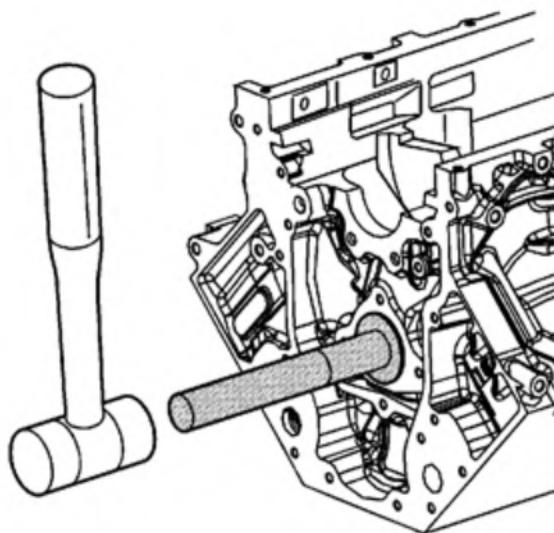


Important: A loose camshaft bearing may be caused by an enlarged, out of round, or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to [Camshaft and Bearings Cleaning and Inspection](#) .
2. Repair or replace the components, as required.



3. Select the expanding driver (4-8) and washer (2 or 3) from the [J 33049](#) .
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.



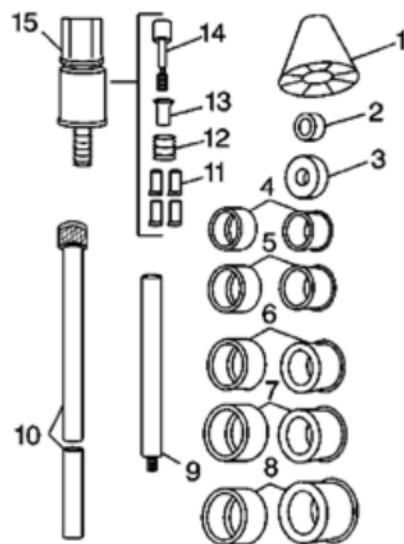
8. Drive the bearing from the block bore.

Important: In order to remove the front camshaft bearing, operate the tool from the rear of the block, using the guide cone in the rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

Tool Usage Information

Bearing, Expander, and Expander Driver Information



- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4-8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).
- Expander bearing driver number 1 inside diameter is 28.575-37.465 mm (1.125-1.475 in) and is used with the expander assembly and the small washer.
- Expander bearing driver number 2 inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used with number 1 expanding driver and the small washer.
- Expander bearing driver number 3 inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with number 2 expanding driver and the large washer.
- Expander bearing driver number 4 inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with number 3 expanding driver and the large washer.
- Expander bearing driver number 5 inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with number 4 expanding driver and the large washer.
- Expander bearing driver number 6 inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with number 5 expanding driver and the large washer.

Tool Assembly and Operation

1. Select the proper expanding driver and washer from the expanding driver and washer information.

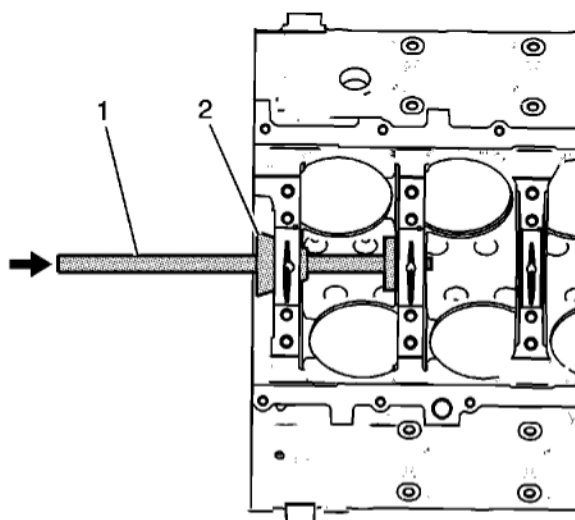
Important: To install or remove the expanding driver, always push on or pull from the ends.

Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.

4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

For removal of the inner bearings, it may be necessary to install the driver bar extension.

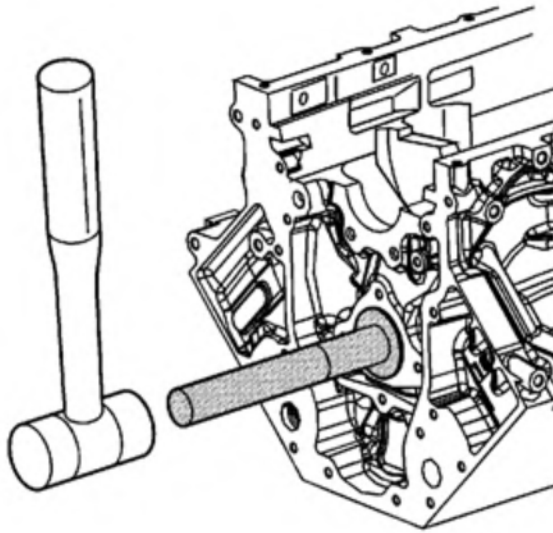


7. Insert the tool (1) into an inner camshaft bearing and tighten until snug.

Operate the tool from the front or rear of the engine block.

On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.

8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.



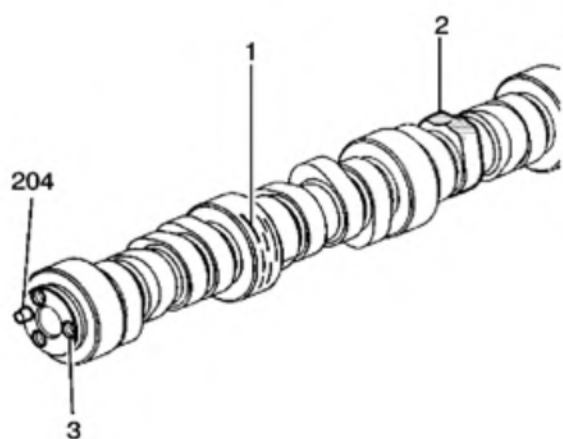
11. For the 2 end bearings, front and rear, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

Camshaft and Bearings Cleaning and Inspection (6.2L)

Special Tools

- J 7872 Magnetic Base Dial Indicator Set
- J 8520 Camshaft Lobe Lift Indicator

For equivalent regional tools, refer to [Special Tools](#).

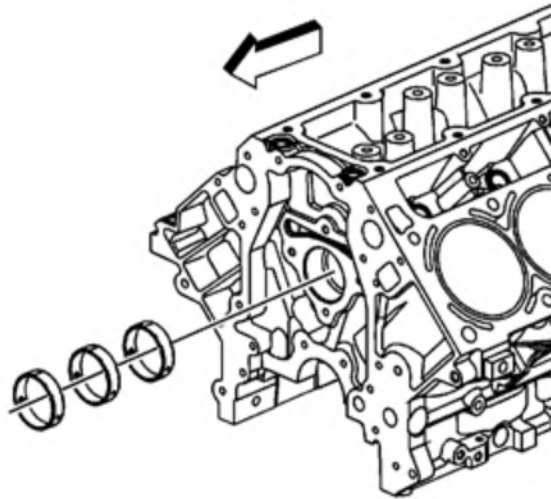


1. Clean the components in solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the threaded bolt holes (3) in the front of the camshaft for damaged threads or debris.
6. Inspect the camshaft sprocket pin (204) for damage.
7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

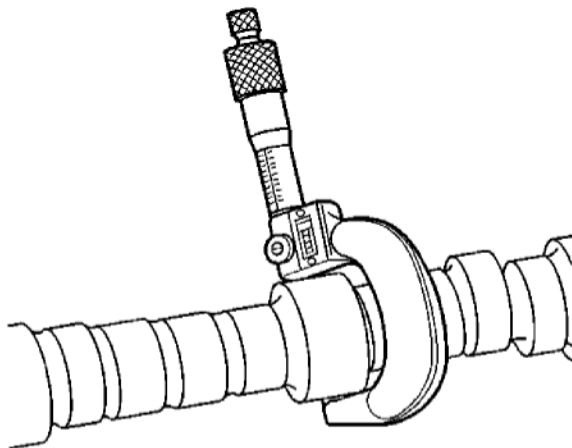
If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.



8. Inspect the camshaft bearings for the following:

- Excessive wear or scoring. The presence of the copper color bearing material should be considered normal and not a guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to [Engine Mechanical Specifications](#).
- Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
- Oil lubrication hole plugged by debris.

Bearings with excessive wear or scoring must be replaced.

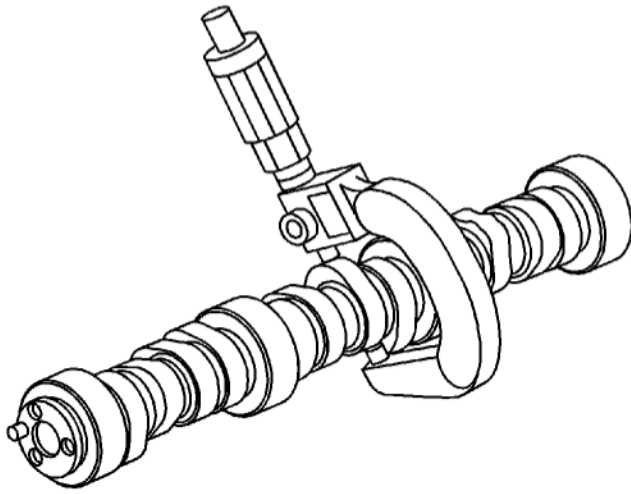


9. Using a micrometer, measure the camshaft journals for wear and out-of-round.

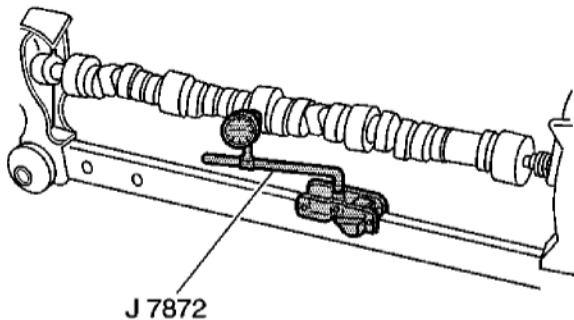
- If the camshaft bearing journals are greater than 0.025 mm (0.001 in) out-of-round,

replace the camshaft.

- If the camshaft bearing journal diameter is less than 54.99 mm (2.164 in), replace the camshaft.

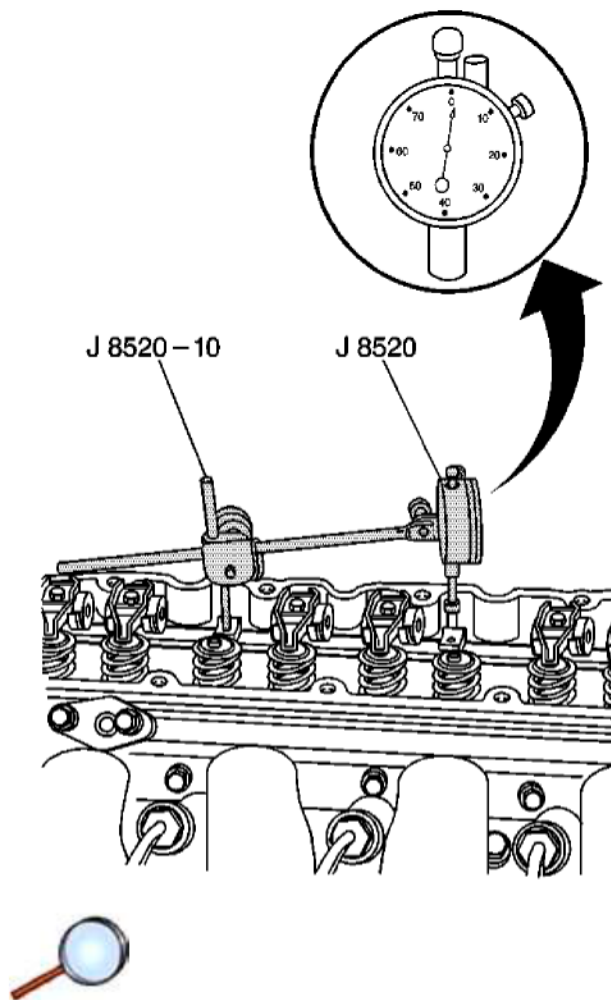


10. Using a micrometer, measure the camshaft lobes for wear. Refer to [Engine Mechanical Specifications](#)



11. Measure the camshaft runout.
 - 11.1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
 - 11.2. Using the J 7872 indicator set , measure the runout of the intermediate camshaft bearing journals.
 - 11.3. If camshaft runout exceeds 0.05 mm (0.002 in), the camshaft is bent and should be replaced.

Measuring Camshaft Lobe Lift



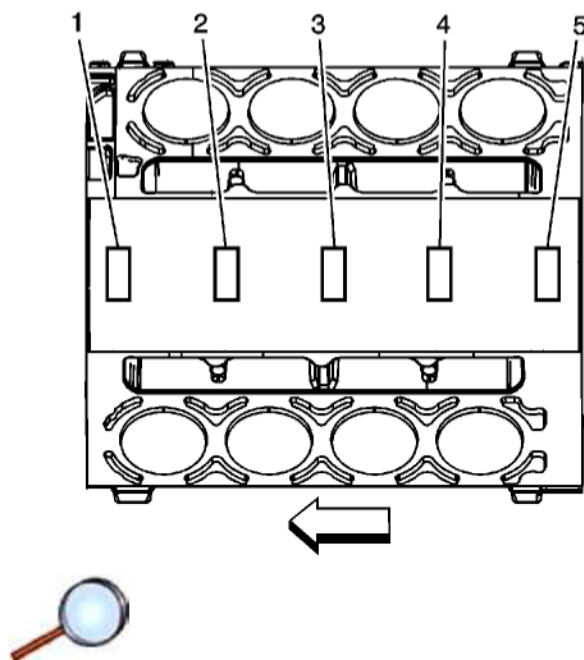
Note: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Using the J 8520 lift indicator , measure camshaft lobe lift.
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the J 8520 lift indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to [Engine Mechanical Specifications](#)

Camshaft Bearing Installation

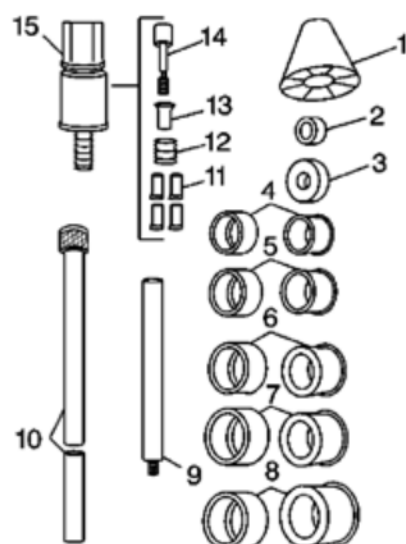
Tools Required

[J 33049](#) Camshaft Bearing Service Set

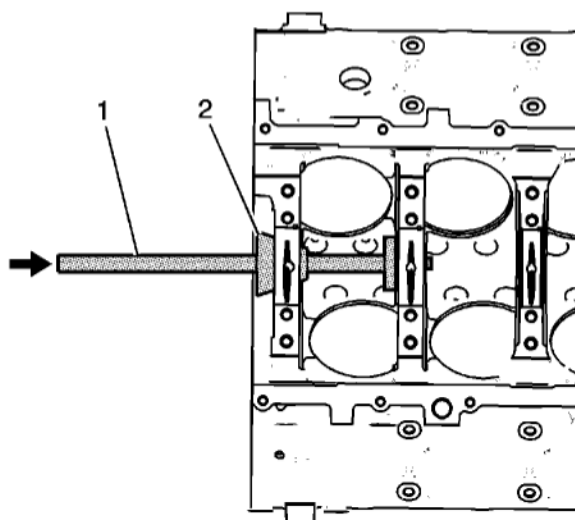


Important: The engine block camshaft bearing bores are machined for 3 different outside diameter (OD) size bearings. Position 1 and 5 are the largest diameter bores. Position 3 is the smallest diameter bore. Position 2 and 4 are the intermediate size bores. The inside diameter (ID) for all camshaft bearings is the same size.

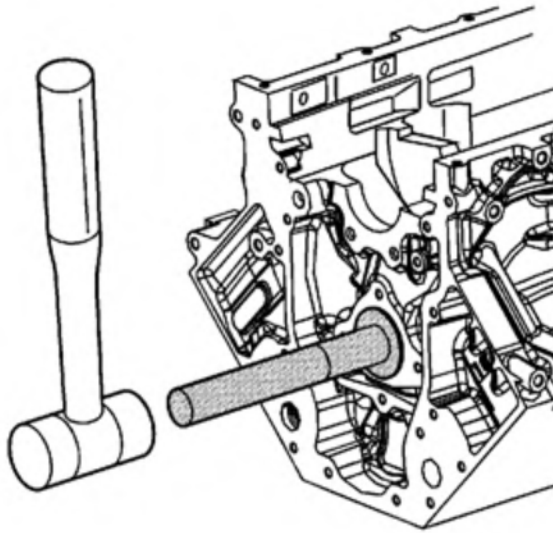
1. Measure the engine block camshaft bearing bores (1-5) in order to identify the correct OD size bearing for each position. Refer to [Engine Mechanical Specifications](#).



2. Select the expanding driver (4-8) and washer (2 or 3) from the [J 33049](#) . Refer to [Piston and Connecting Rod Assemble](#).
3. Assemble the tool.

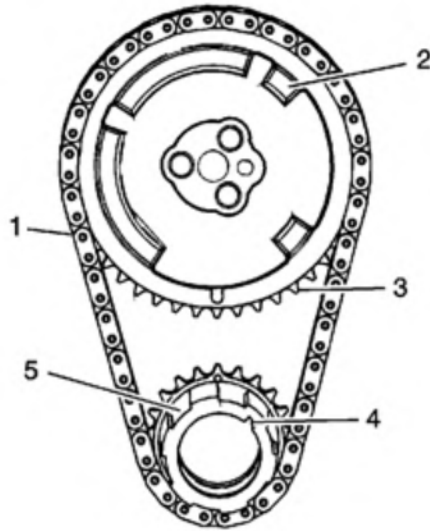


4. Insert the tool (1) through the front of the engine block and into the bearing.
5. Tighten the expander assembly nut until snug.
6. Push the guide cone (2) into the front camshaft bearing in order to align the tool.
7. Drive the bearing into the block bore.



8. Install the front and rear bearings to the block.

Camshaft Timing Chain and Sprocket Cleaning and Inspection

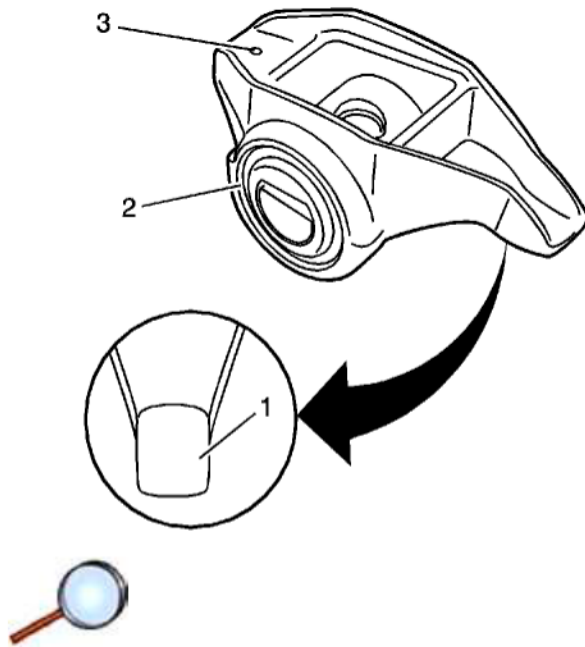


1. Clean the components with cleaning solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

2. Dry the components with compressed air.
3. Inspect the timing chain (1) for binding or wear.
4. Inspect the camshaft position (CMP) sensor raised areas (2) for nicks or damage.
5. Inspect for worn, damaged, or chipped teeth (3).
6. Inspect for a damaged keyway (4).
7. Inspect for worn oil pump drive splines (5).

Valve Rocker Arm and Push Rod Cleaning and Inspection



Note: Parts that are to be used again must be marked, sorted or organized for assembly.

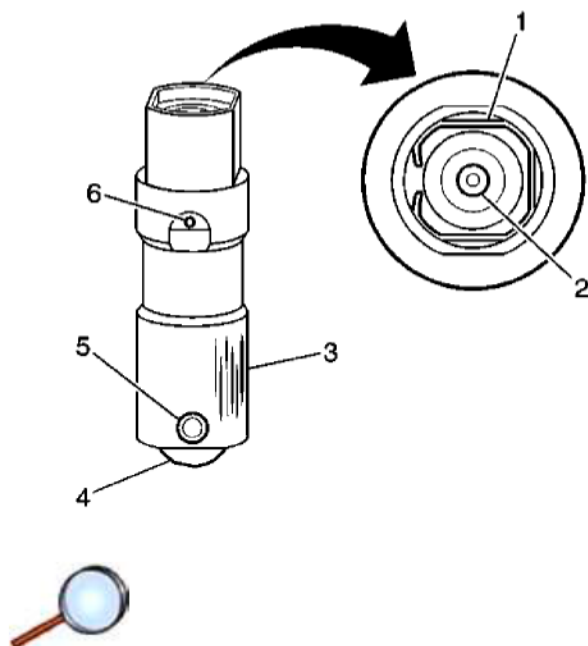
1. Mark, sort, or organize the components for assembly. Refer to [Separating Parts](#).
2. Clean the components with cleaning solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

3. Dry the components with compressed air.
4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.
6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear, or other damage.

Valve Lifter and Guide Cleaning and Inspection

Valve Lifters



Note: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:

- Bent or broken clip (1)
- Worn pushrod socket (2)
- Scuffed or worn sides (3)

If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.

- Flat spots on the roller (4)
- Loose or damaged pin (5)
- Plugged oil hole (6)
- Worn or damaged roller bearing

The roller should rotate freely with no binding or roughness.

Valve Guides

Inspect the valve lifter guides for the following conditions:

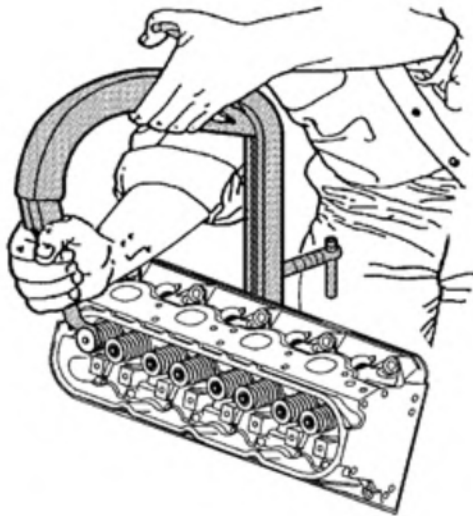
- Cracks or damage
- Excessive wear in the lifter mounting bores

Cylinder Head Disassemble

Special Tools

J 8062 Valve Spring Compressor - Head Off

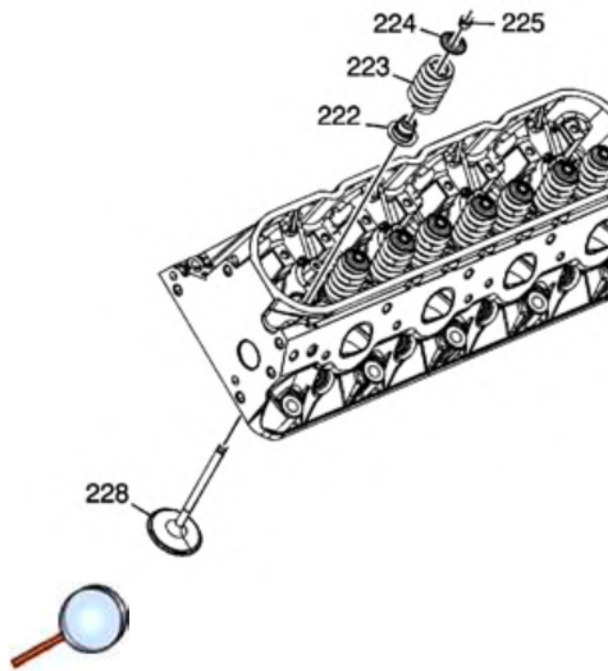
For equivalent regional tools, refer to [Special Tools](#)



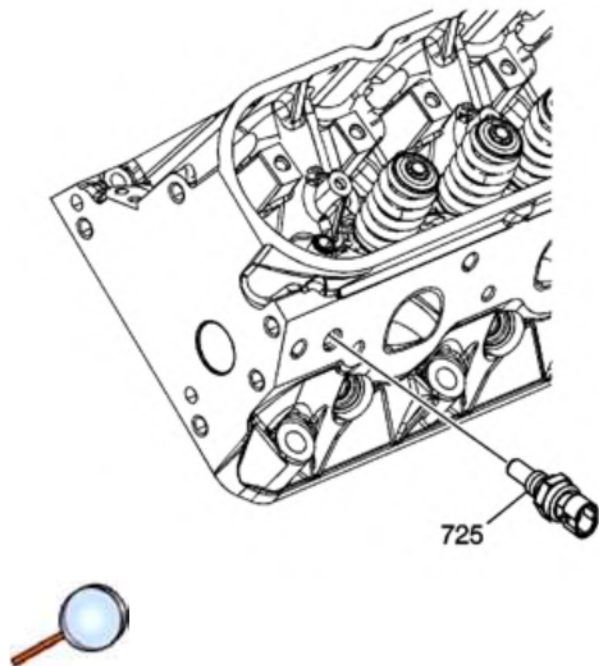
Note:

- With the components at room temperature, remove the spark plugs from the cylinder head.
- Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.

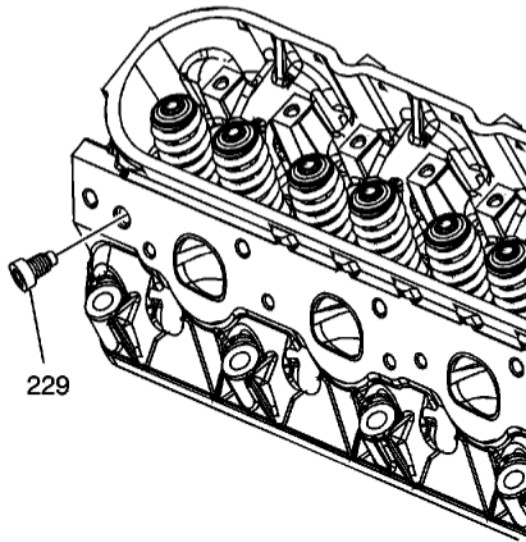
1. Remove the spark plugs from the cylinder heads.
2. Use the *J 8062* Compressor - Head Off in order to compress the valve spring.



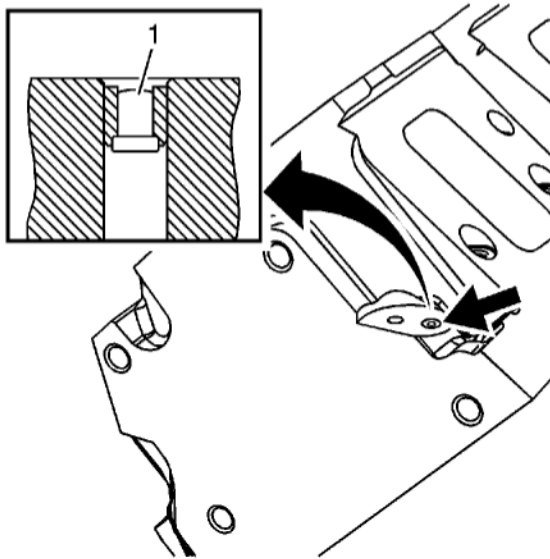
3. Remove the valve stem keys (225).
4. Remove the valve spring cap (224).
5. Remove the valve spring (223).
6. Remove the valves (228).
7. Remove the valve stem oil seal (222). Refer to [Separating Parts](#).



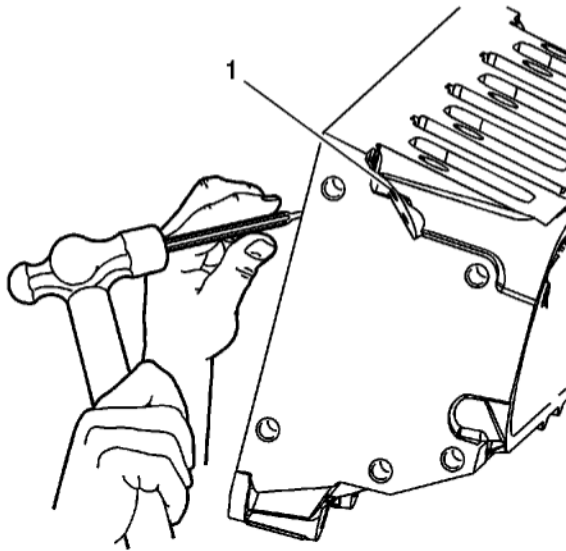
8. Remove the coolant temperature sensor (725) from the left cylinder head.



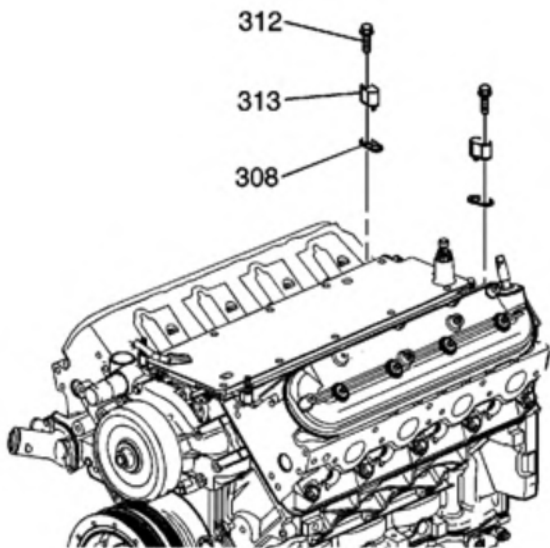
9. Remove the cylinder head plug (229) from the right cylinder head.



10. Inspect for a leaking plug. Production applications use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug.



11. Using a 6.43 mm (0.25 in) or smaller punch, remove the plug assembly from the cylinder head.



12. If plug removal is required, install a first design coolant air bleed cover and bolt to complete the repair.

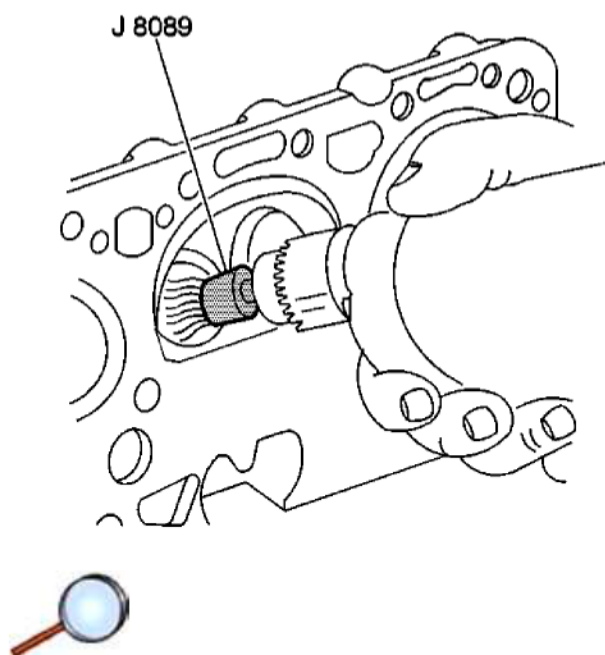
Cylinder Head Cleaning and Inspection

Special Tools

- *J 8089* Carbon Removal Brush
- *J 9666* Valve Spring Tester

For equivalent regional tools, refer to [Special Tools](#)

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.



Note:

- When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).
- Be careful not to scuff the chamber.

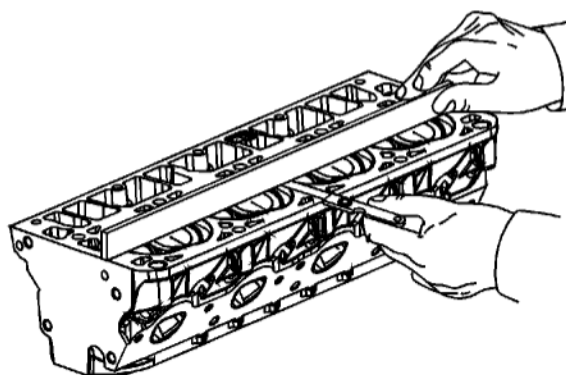
1. Clean the following components:
 - Use the *J 8089* Brush in order to remove the carbon from the combustion chambers.
 - Gasket surfaces
Refer to [Replacing Engine Gaskets](#).
 - Valve stems and heads on a buffing wheel
 - Bolt hole threads
Remove all dirt, debris, or threadlocking material from the bolt holes.
2. Inspect the cylinder head for the following conditions:
 - 2.1. Cracks in the exhaust ports and combustion chambers

- 2.2. External cracks in the water chambers
- 2.3. Gasket surfaces for excessive scratches or gouging

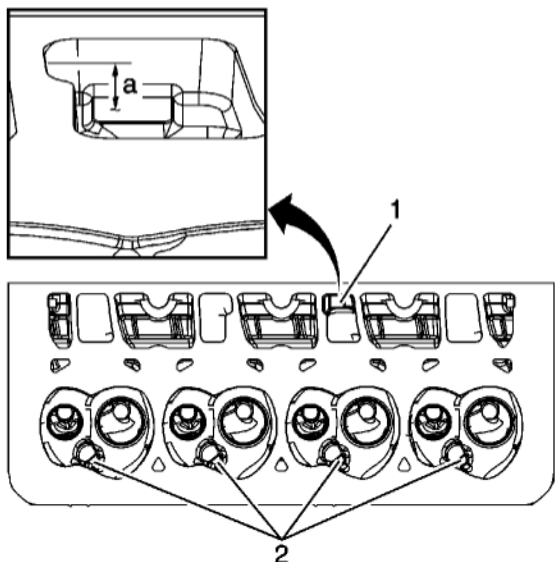
Refer to [Replacing Engine Gaskets](#).

- 2.4. Bolt hole threads for debris or damaged threads

Refer to [Thread Repair](#) or [Thread Repair Specifications](#).

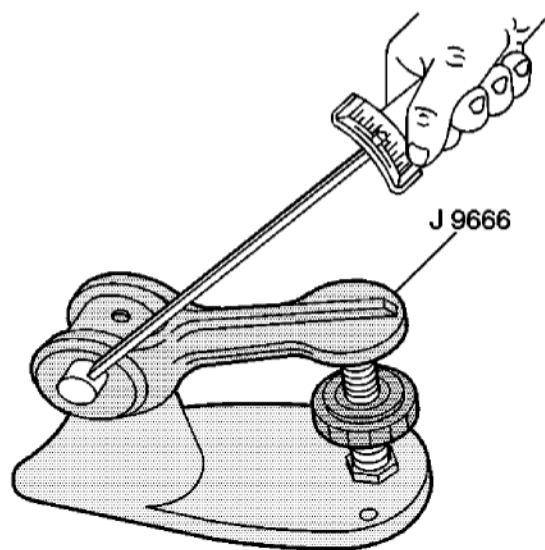


- 3. Inspect the cylinder head for warpage. Refer to [Engine Mechanical Specifications](#).

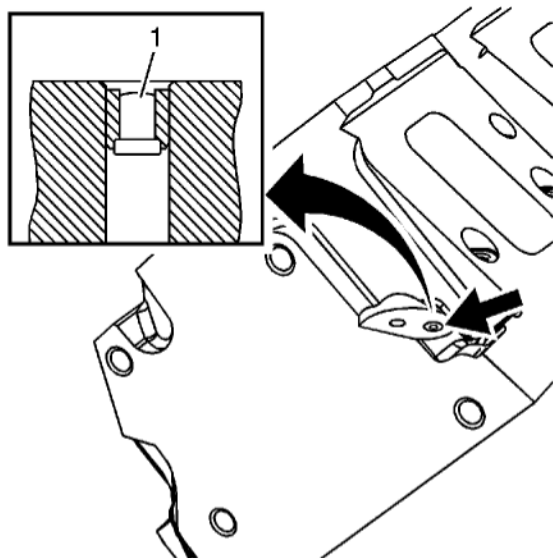


- 4. Cylinder heads that have excessive warpage or a damaged sealing surface can be machined

as required. Determine the cylinder head thickness as measured from the cast in place machining pads (1 and 2) to the head deck sealing surface. A cylinder head that measures less than 6.88-7.12 mm (0.271-0.283 in) (a) cannot be machined and must be replaced.



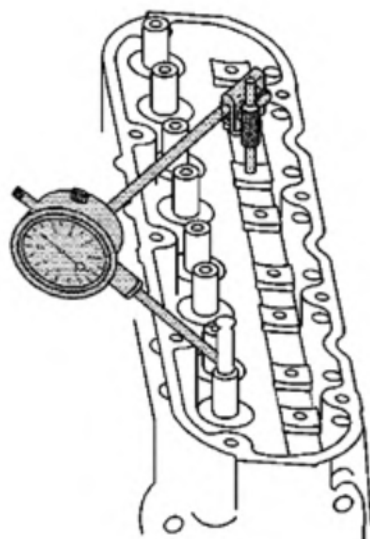
5. Use the *J 9666* Tester in order to measure the valve spring tension. Refer to [Engine Mechanical Specifications](#).



6. Inspect for a leaking plug. Production applications use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to [Cylinder Head Disassemble](#)

Valve Guide Reaming, and Valve and Seat Grinding (6.2L)

Valve Guide Reaming

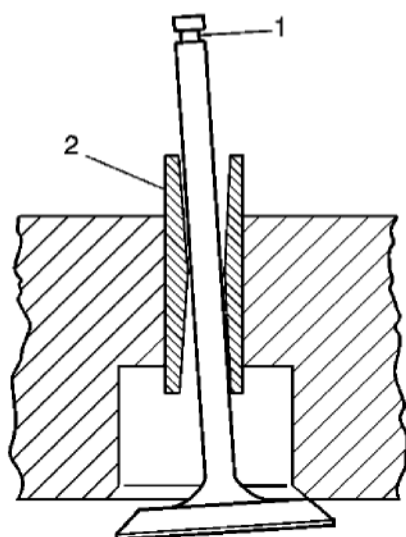


Caution: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

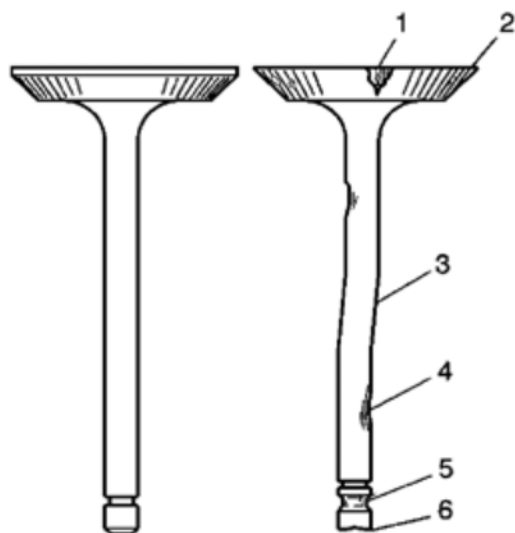
Caution: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using a dial indicator, measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gage to measure the guide bore.



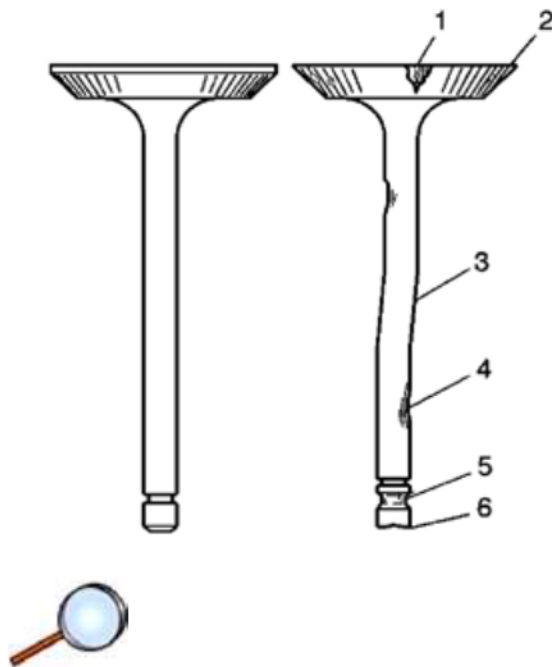
2. A valve stem (1) and guide (2), with excessive clearance, must be replaced or the cylinder head replaced. Refer to [Engine Mechanical Specifications](#).



3. Inspect the valve stems for excessive scoring, wear, or warpage.
 - A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
 - If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.
4. Measure the valve stem diameter. A valve stem with a diameter less than 7.95 mm (0.313 in) must be replaced.

If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

Valve and Seat Grinding



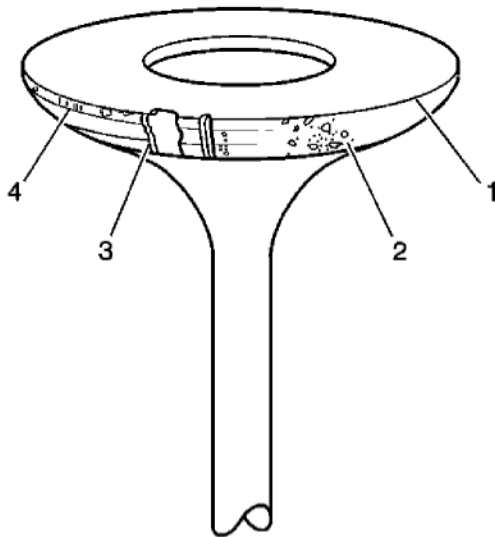
Note:

- Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.
- Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.
- The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.
- Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1.25 mm (0.05 in) after grinding, replace the valve.
- Several different types of equipment are available for refacing valves. The recommendation of the equipment manufacturer should be carefully followed to obtain the proper results.
- DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.

1. Inspect the valve for the following conditions:

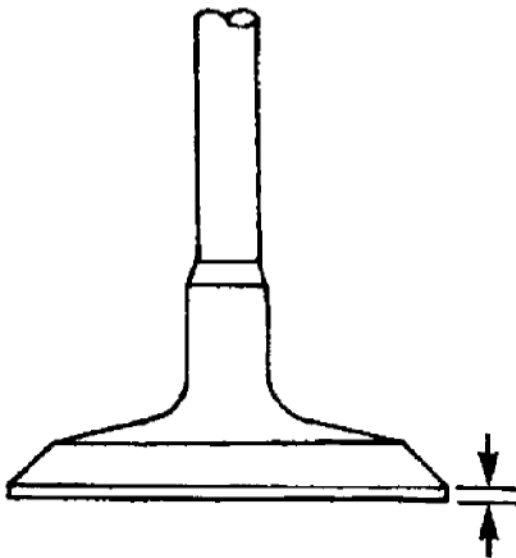
- Burnt or eroded areas (1)
- A worn margin (2)
- A bent stem (3)

- A worn or scored stem (4)
- A worn key groove (5)
- A worn stem tip (6)



2. Inspect the valve face for the following conditions:

- Worn or no margin (1 or 4)
- Pitted surfaces (2)
- Burnt or eroded areas (3)



3. Inspect the valve margin.

The exhaust valve may be refaced if the margin is greater than 1.25 mm (0.05 in) thick before grinding.

4. Reface pitted exhaust valves on a suitable valve refacing machine.
5. Replace the valve if the margin is less than 1.25 mm (0.05 in) thick after grinding.
6. If the valve face has been ground, it may be necessary to shim the valve spring in order to obtain the proper spring installed height. Refer to [Cylinder Head Disassemble](#).
7. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

The valve guide must be clean for the seat grinding tool to obtain proper results.

9. Grind the valve seat.

The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

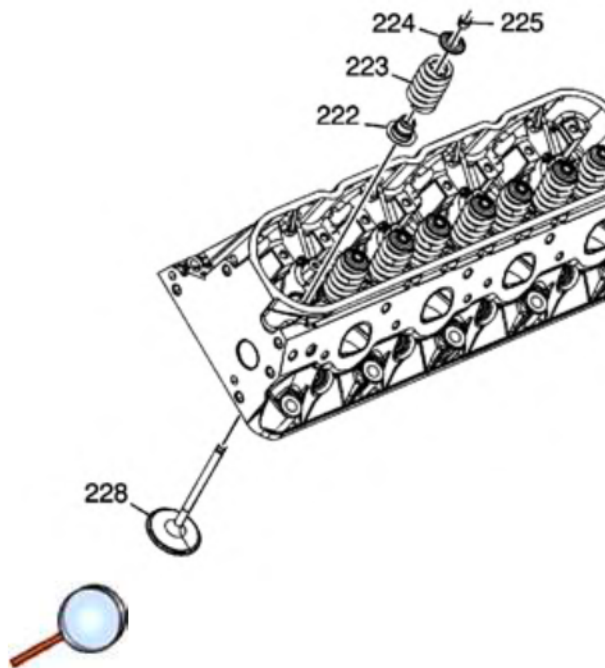
10. Inspect the valve seats.
 - The valve seats should be concentric to within 0.05 mm (0.0021 in) total indicator reading.
 - If the valve seat has been ground, it may be necessary to shim the valve spring in order to attain the proper spring installed height. Refer to [Cylinder Head Disassemble](#).

Cylinder Head Assemble

Special Tools

J 8062 Valve Spring Compressor - Head Off

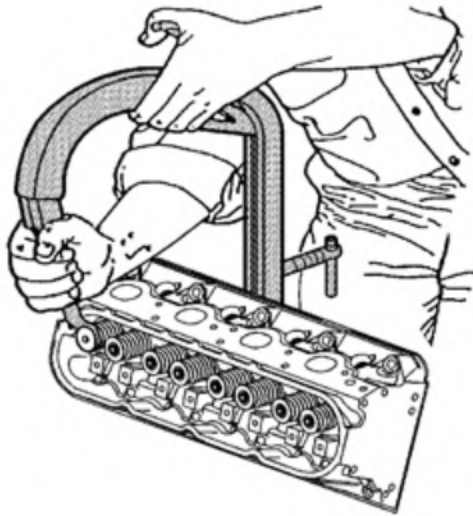
For equivalent regional tools, refer to [Special Tools](#)



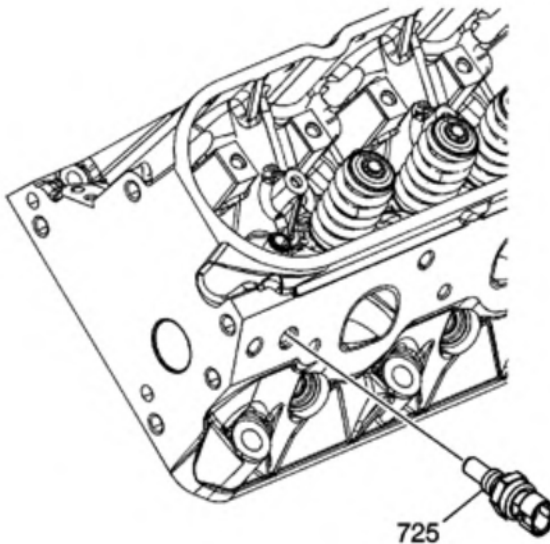
1. Clean the cylinder head valve spring shim area.

Note: When using the valves and related components again, install the parts to their original location.

2. Install the valves (228) into the proper port. Refer to [Separating Parts](#).
3. Install the valve stem oil seal (222).
4. Install the valve spring (223).
5. Install the valve spring cap (224).



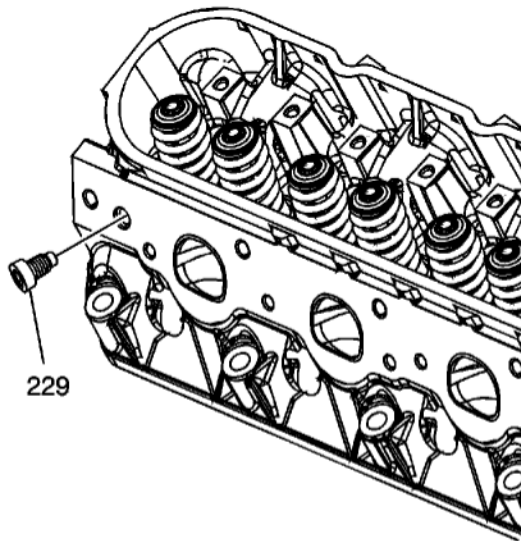
6. Using the *J 8062 Compressor - Head Off* , compress the valve spring.
7. Install the valve stem keys.
 - 7.1. Use grease in order to hold the keys in place and remove the *J 8062 Compressor - Head Off* .
 - 7.2. Ensure the keys seat properly in the groove of the valve stem.
 - 7.3. Tap the end of the valve stem with a plastic face hammer to seat the keys, if necessary.
8. Install the remaining valves, springs, and other components.



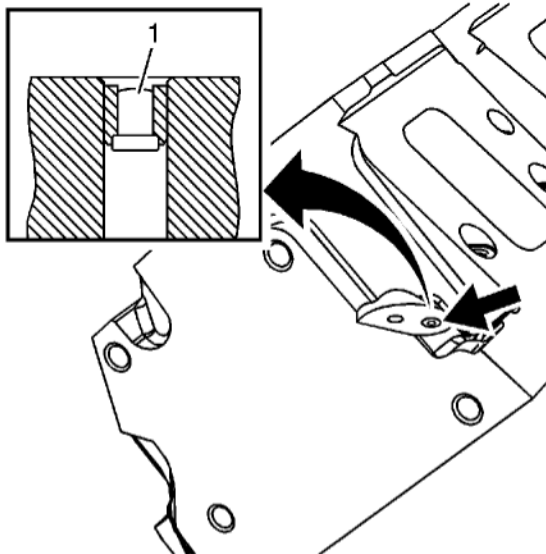
9. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the coolant temperature sensor (725).

Caution: Refer to [Fastener Caution](#) in the Preface section.

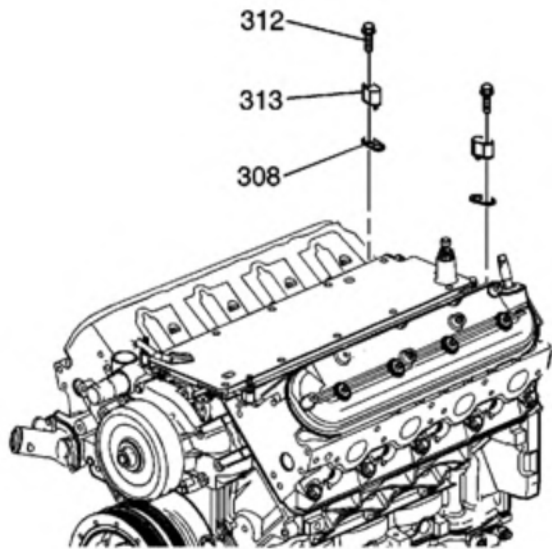
10. Install the coolant temperature sensor into the left cylinder head and tighten to **20 N·m (15 lb ft)**.



11. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the cylinder head plug (229).
12. Install the cylinder head plug to the right cylinder head and tighten to **20 N·m (15 lb ft)**.

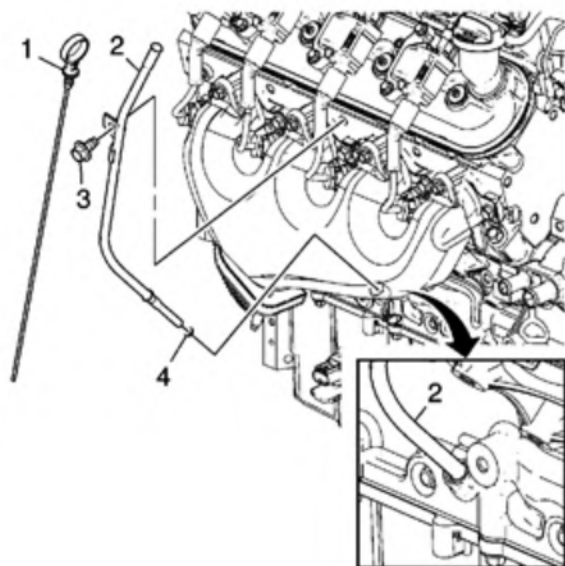


13. Production applications use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to [Cylinder Head Disassemble](#).



14. If plug removal is required, install a first design coolant air bleed cover and bolt to complete the repair.

Oil Level Indicator and Tube Removal

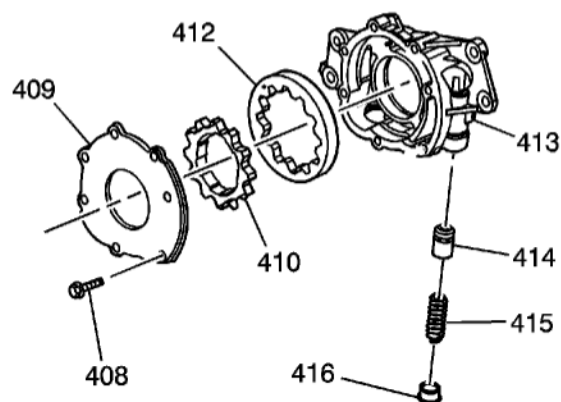


1. Remove the oil level indicator (1) from the tube (2).
2. Remove the oil level indicator tube bolt (3).
3. Remove the oil level indicator tube (2) from the engine block.

Note: Inspect the O-ring for cuts or damage. The O-ring may be used again if it is not cut or damaged.

4. Remove the O-ring (4) from the tube, as required.

Oil Pump Disassemble (6.2L)



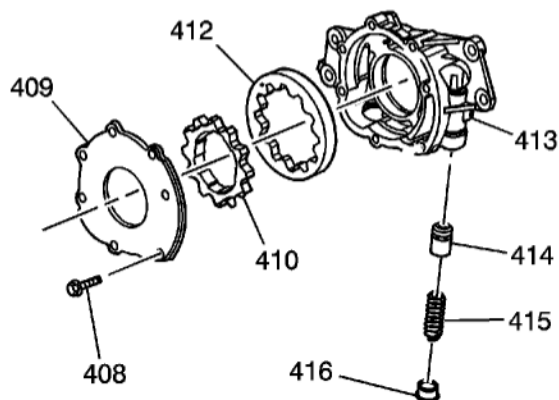
Important: The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.

1. Remove the oil pump cover bolts (408).
2. Remove the oil pump cover (409).

Important: Mark or identify the gears for assembly. Refer to [Separating Parts](#) .

3. Remove the drive gear (410).
4. Remove the driven gear (412).
5. Remove the pressure relief valve plug (416).
6. Remove the pressure relief valve spring (415).
7. Remove the pressure relief valve (414).
8. Inspect the oil pump components. Refer to [Oil Pump Cleaning and Inspection](#) .

Oil Pump Cleaning and Inspection (6.2L)



Note:

- The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.
- The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.

1. Clean the parts in solvent.

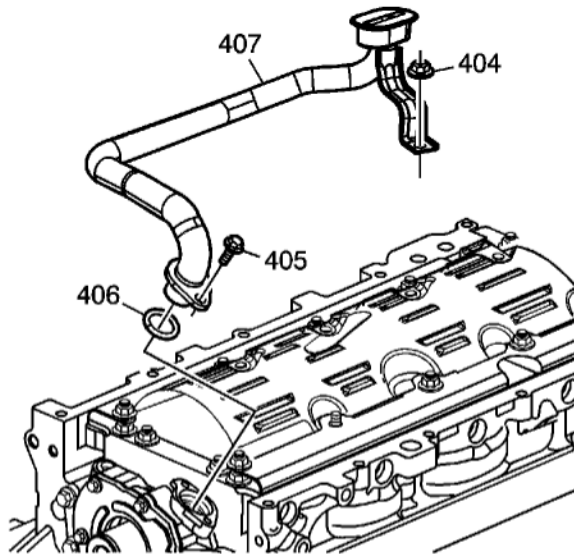
Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

2. Dry the parts with compressed air.
3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.
5. Inspect the oil pump housing for damaged bolt hole threads.
6. Inspect the relief valve plug (416) and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.
8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.

Minor burrs or imperfections on the gears may be removed with a fine oil stone.

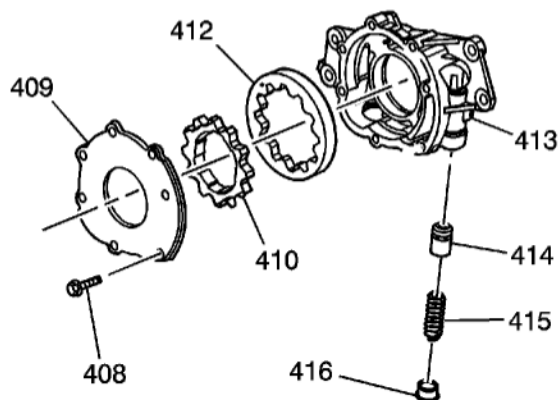
9. Inspect the drive gear splines for excessive wear.
10. Inspect the pressure relief valve (414) and bore for scoring or wear.

The valve must move



11. Inspect the oil pump screen (407) for debris or restrictions.
12. Inspect the oil pump screen for broken or loose wire mesh.

Oil Pump Assemble (6.2L)



Note: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear (412) into the pump housing (413).

Install the driven gear with the orientation mark facing the pump cover.

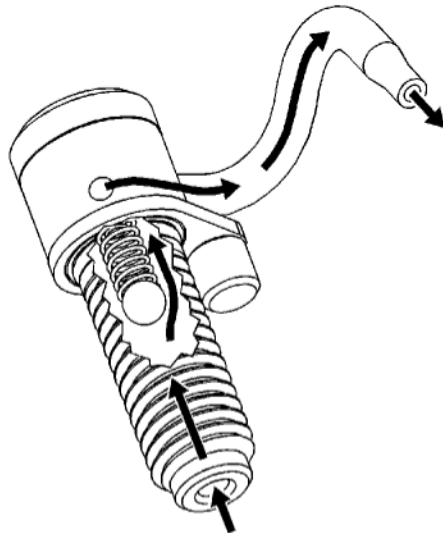
2. Install the drive gear (410) into the pump housing.
3. Install the oil pump cover (409).

Caution: Refer to [Fastener Caution](#) in the Preface section.

4. Install the oil pump cover bolts (408) and tighten to **12 N·m (106 lb in)**.
5. Install the relief valve (414).
6. Install the relief valve spring (415).
7. Install the relief valve plug (416) and tighten to **12 N·m (106 lb in)**.
8. Inspect the oil pump for smooth operation by rotating the drive gear.

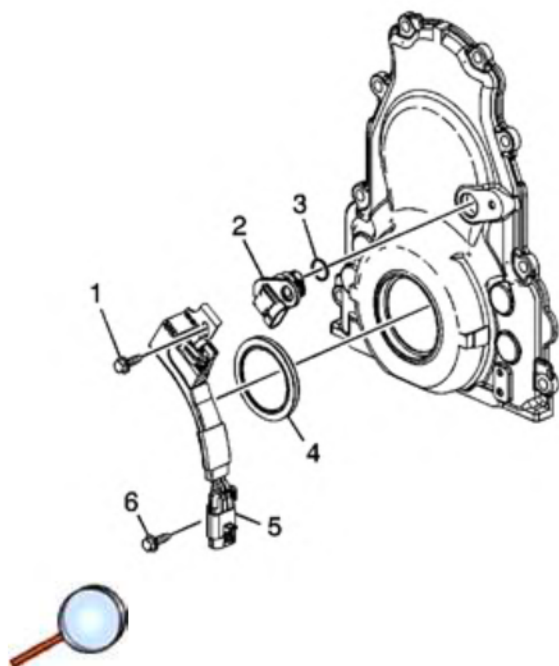
Piston Oil Nozzle Cleaning and Inspection

Note: The piston oil nozzle assembly is designed to provide oil to the bottom side of the piston for cooling purposes. The internal check ball is held in the normally closed position by the spring until system oil pressure exceeds 20.7 kPa (43.5 psi).



1. Clean the nozzle assembly in solution.
2. Inspect the nozzle assembly for the following:
 - damaged bolt threads
 - damaged or cut O-ring seal
 - bent nozzle
 - A restricted or stuck-open nozzle assembly
3. With no oil pressure, the check ball should be seated and not permit flow through the nozzle tube. Using a blow gun, apply air pressure to the inlet portion of the bolt. Air pressure should unseat the check ball and permit flow through and out of the nozzle tube.

Engine Front Cover Cleaning and Inspection (6.2L)



Note:

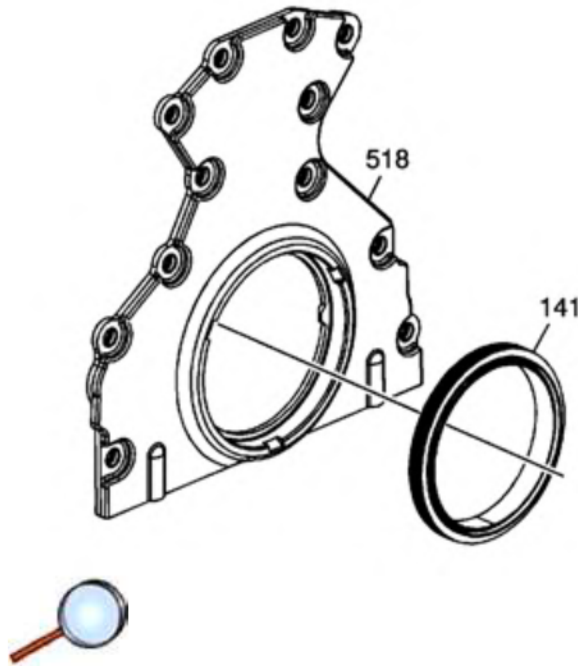
- Do not use the crankshaft oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (4) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to [Replacing Engine Gaskets](#).

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal and camshaft position (CMP) sensor mounting bores for damage.

Crankshaft Rear Oil Seal Housing Cleaning and Inspection



Note:

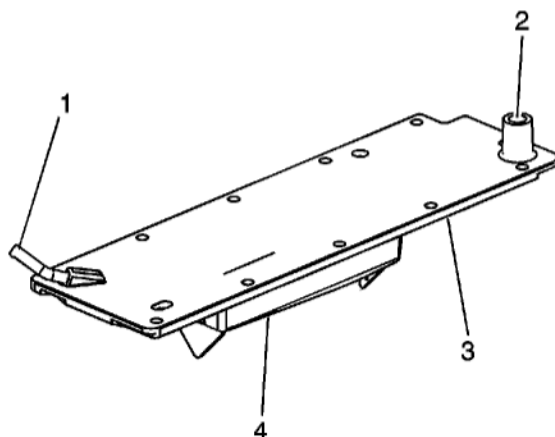
- Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (141) from the rear housing.
2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to [Replacing Engine Gaskets](#).

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

3. Dry the housing with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

Engine Block Valley Cover Cleaning and Inspection

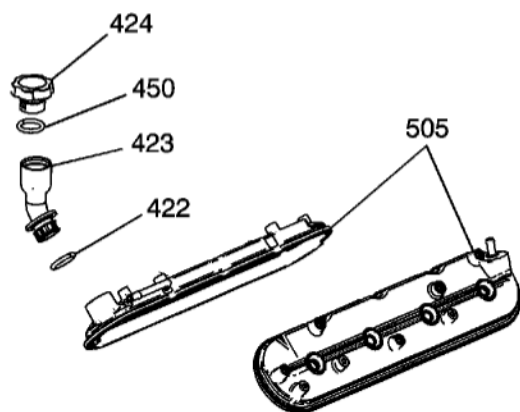


1. Clean the valley cover in solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

2. Dry with compressed air.
3. Inspect for restrictions within the positive crankcase ventilation (PCV) passages (1, 4).
4. Inspect for damaged threads (2) and damaged sealing surfaces (3).

Valve Rocker Arm Cover Cleaning and Inspection (6.2L)

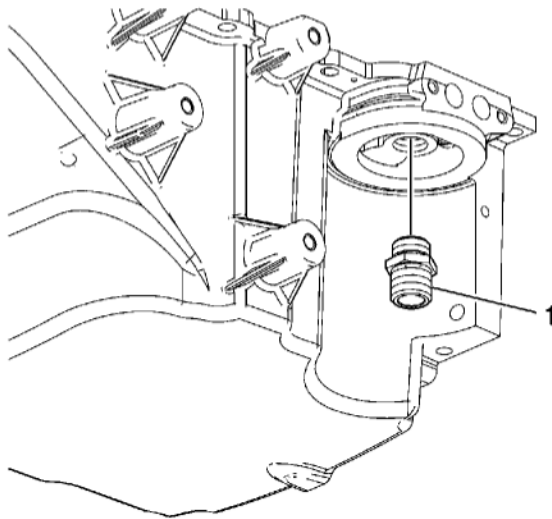


Important:

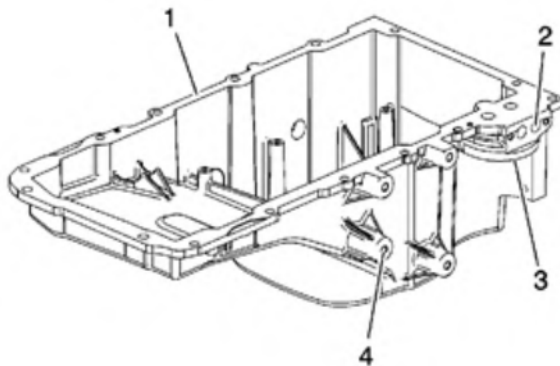
- Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.
- Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.
- Do not remove the oil fill tube from the covers unless service is required. If the tube is removed from the cover, install a NEW tube (423) and seal (422) during assembly.

1. Inspect the oil fill tube (423) for a loose fit or damage.
2. Inspect the covers (505) for the following conditions:
 - Scoring or damage to the gasket surfaces
 - Ventilation system passages for restrictions
 - Threaded bolt holes for damage or debris

Oil Pan Cleaning and Inspection



1. Remove the oil filter fitting (1), as required.



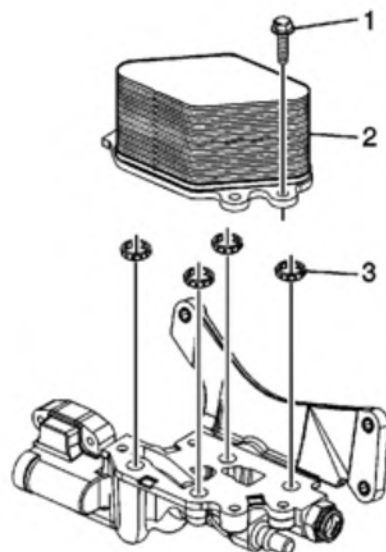
2. Clean the oil pan in solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

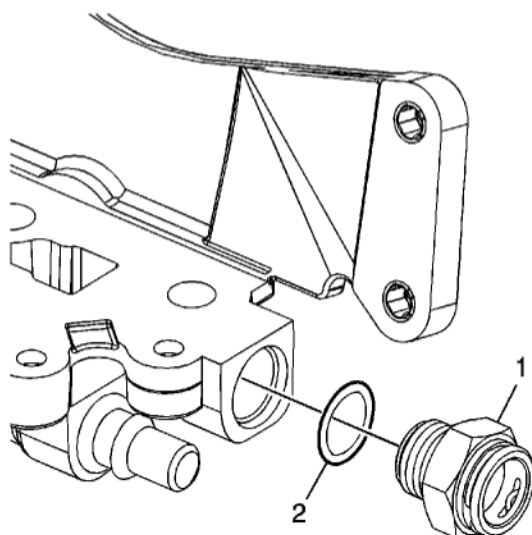
3. Dry the oil pan with compressed air.
4. Inspect the oil pan for the following conditions:

- Damaged gasket surfaces (1)
- Restrictions within the oil passages (2) of the pan
- Damaged oil filter seal surface (3)
- Threaded bolt holes (4) for damage

Engine Oil Cooler Disassemble

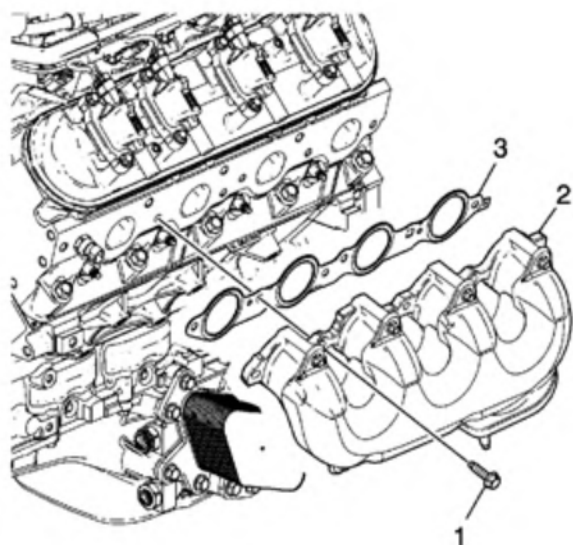


1. Remove the oil cooler core bolts (1).
2. Remove the oil cooler core (2).
3. Remove the oil cooler core seals (3).

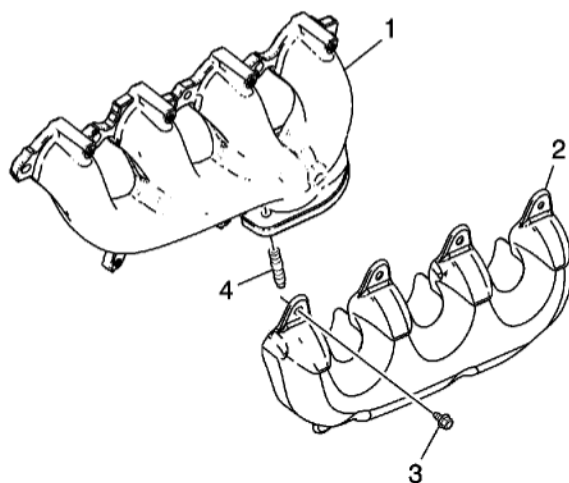


4. Remove the coolant fitting (1), as required.
5. Remove the coolant fitting seal (2).
6. Discard the seal.

Exhaust Manifold Removal - Left Side

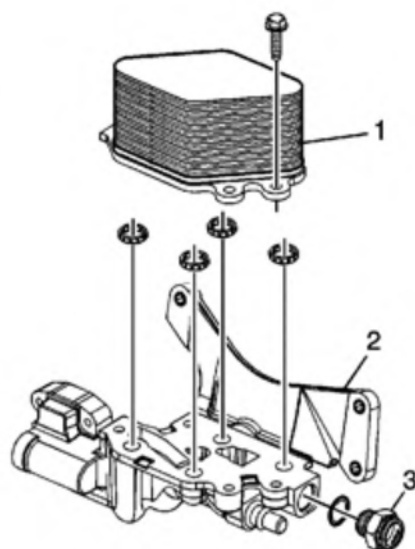


1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (2), bolts (1), and gasket (3).
3. Discard the gasket.



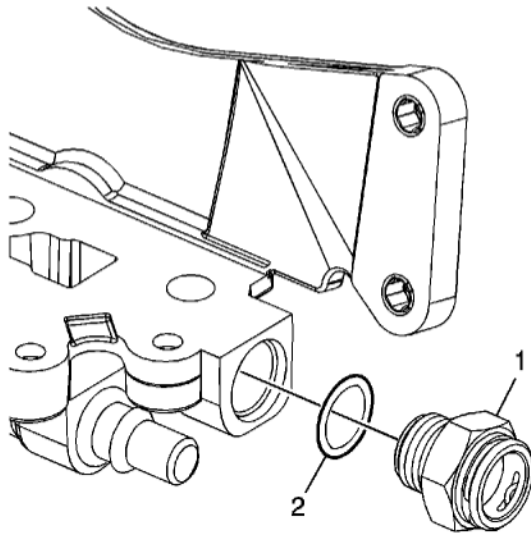
4. Remove the heat shield (2) and bolts (3) from the manifold (1), as required.
5. Remove the studs (4), as required.

Engine Oil Cooler Cleaning and Inspection



1. Inspect the oil cooler housing (2) and the oil cooler core (1) for cracks or casting imperfections.
2. Inspect the oil cooler housing for damaged bolt hole threads.
3. Inspect the oil cooler housing and core for damaged seal surfaces.
4. Inspect the oil cooler core for damaged or broken cooling fins.
5. Inspect for restrictions within the coolant passages of the core or housing.
6. Inspect for restrictions within the oil passages of the core or housing.
7. Inspect for a leaking coolant hose fitting (3).

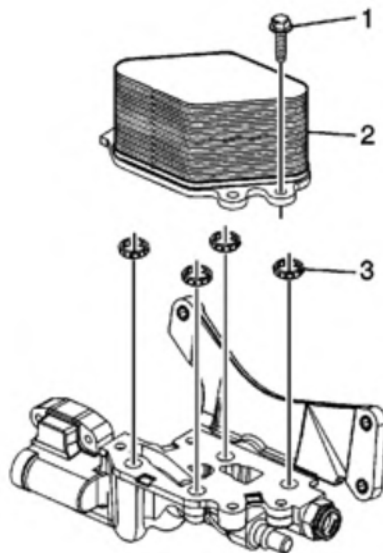
Engine Oil Cooler Assemble



1. Install a NEW coolant fitting seal (2).

Caution: Refer to [Fastener Caution](#) in the Preface section.

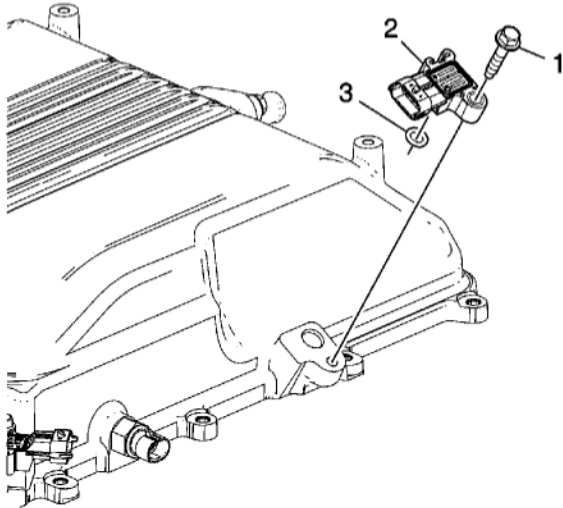
2. Install the coolant fitting (1) and tighten to 35 N·m (27 lb ft).



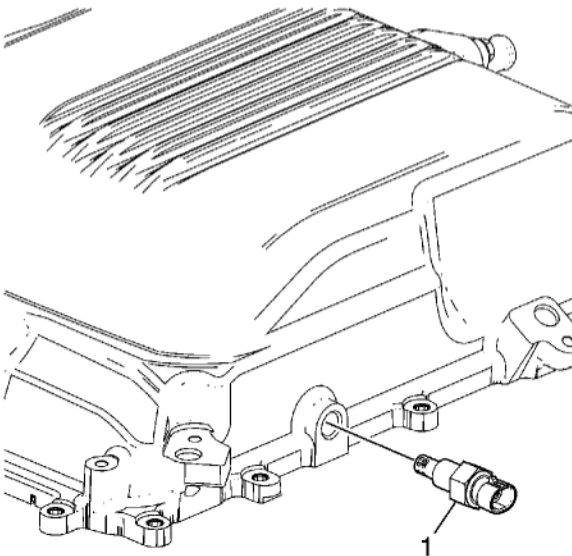
3. Install the NEW oil cooler core seals (3).
4. Install the oil cooler core (2).

5. Install the oil cooler core bolts (1) and tighten to **25 N·m (18 lb ft)**.

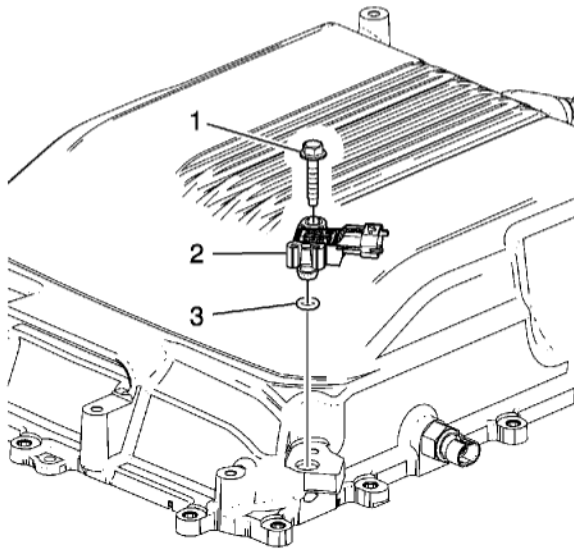
Supercharger Disassemble



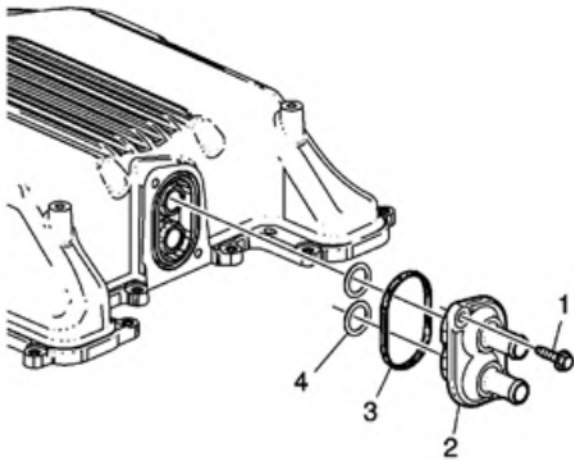
1. Remove the air outlet pressure sensor bolt (1).
2. Remove the sensor (2).
3. Remove the sensor seal (3), as required.



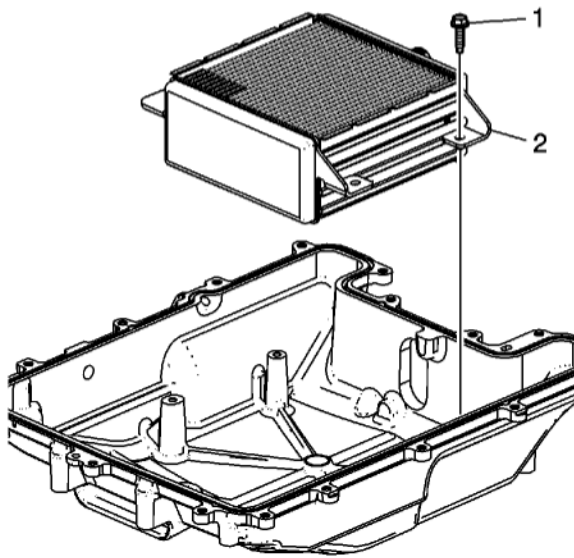
4. Remove the inlet air temperature sensor (1).



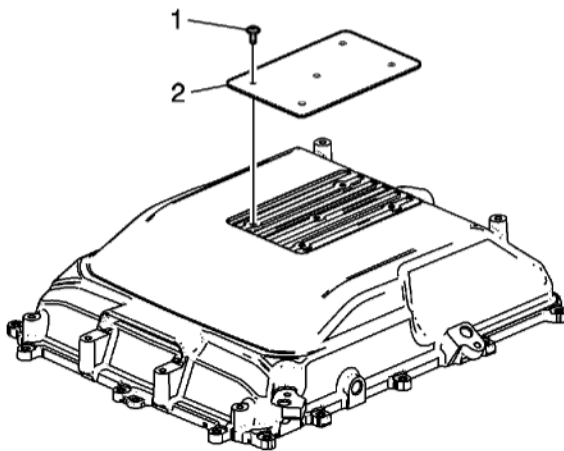
5. Remove the barometric pressure (BARO) sensor bolt (1).
6. Remove the BARO sensor (2).
7. Remove the BARO sensor seal (3), as required.



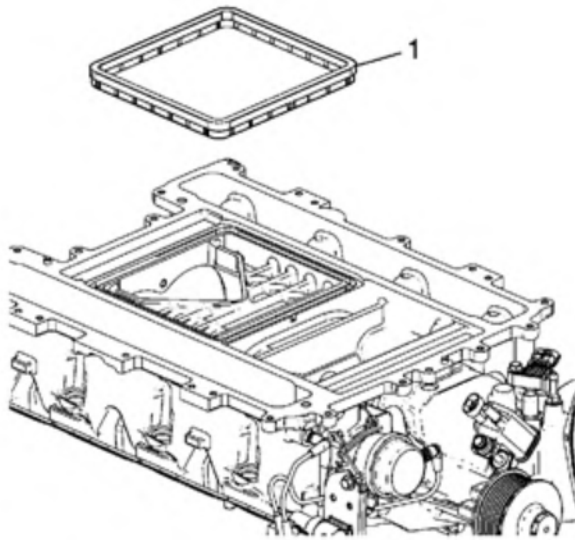
8. Remove the bolts (1), plate (2), seal (3), seals (4) from the cooler.



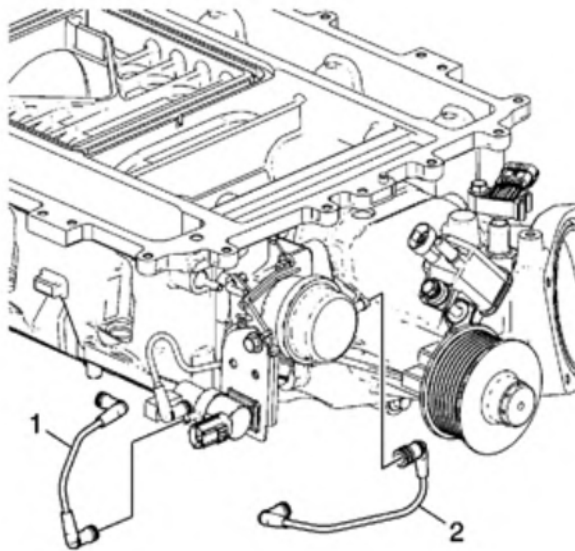
9. Remove the charge air cooler (2) and bolts (1).



10. Remove the isolator pad (2) and bolts (1), as required.

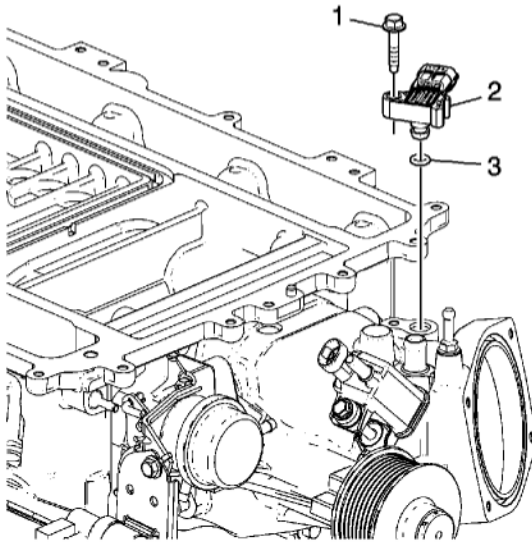


11. Remove the insulator seal (1).

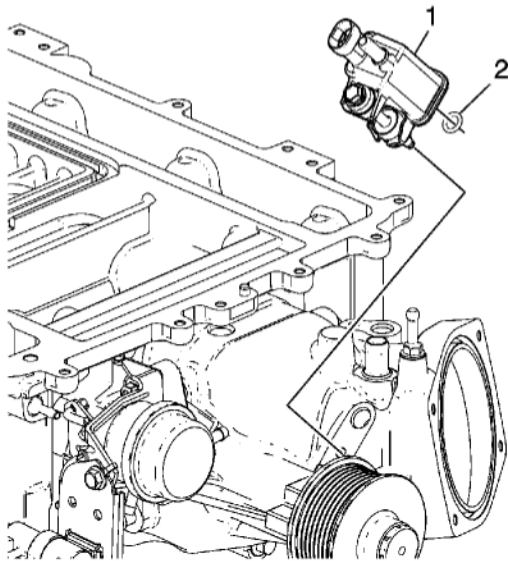


12. Remove the charge air bypass valve tube (1).

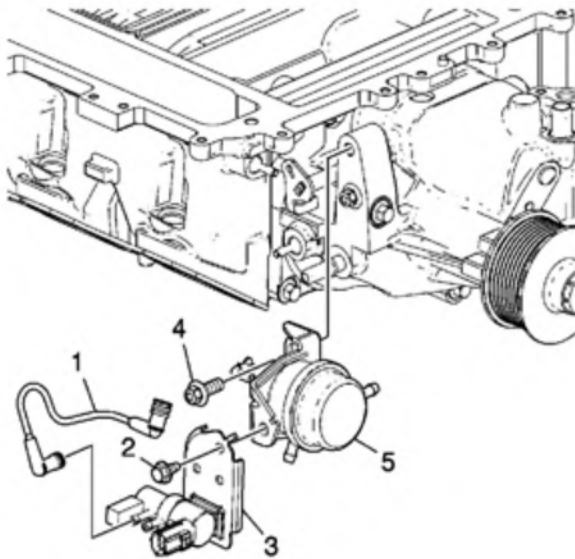
13. Remove the charge air bypass valve vacuum tube (2).



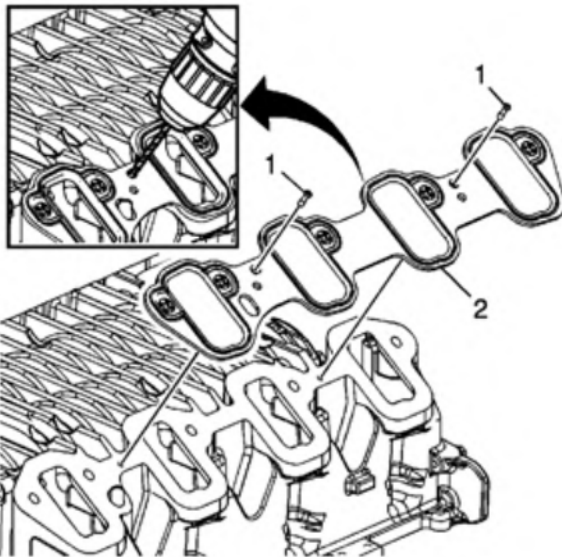
14. Remove the inlet air pressure sensor bolt (1).
15. Remove the inlet air pressure sensor (2).
16. Remove the inlet air pressure sensor seal (3), as required.



17. Loosen the evaporative emissions (EVAP) bolt.
18. Remove the EVAP valve (1).
19. Remove the EVAP valve seal (2), as required.



20. Remove the bypass actuator tube (1).
21. Remove the charge air bypass valve bolt (2).
22. Remove the charge air bypass valve (3).
23. Remove the bypass actuator bolts (4).
24. Rotate the actuator upward and remove the rod from the lever of the supercharger.
25. Remove the bypass actuator (5).



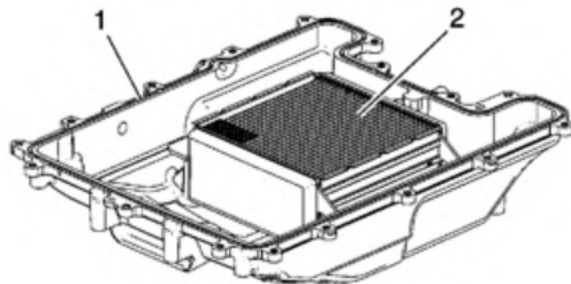
Note:

- Do not allow dirt or debris to enter the passages of the supercharger. Cover the intake ports as required.
- With the manifold positioned upside down on a bench, the lower assembly may be positioned onto the intercooler cover dowel pins. Use care not to reposition or bend the dowel pins.

26. Drill out the gasket rivets (1) using a drill bit with an outside diameter (OD) no larger than 3.2 mm (0.125 in).
27. Remove the gaskets (2).

Supercharger Cleaning and Inspection

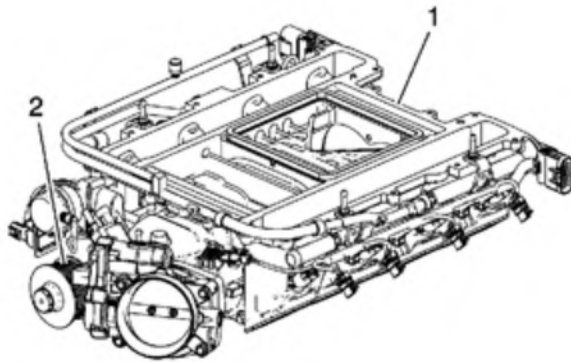
Charge Air Cooler Cover Cleaning and Inspection



Inspect the cover for the following:

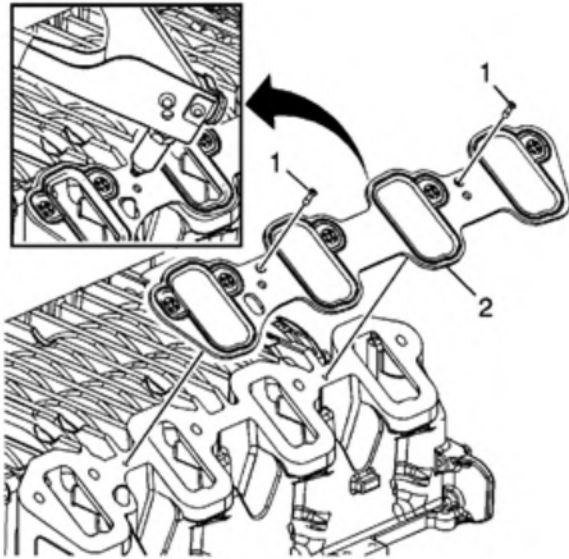
- Damaged seal surfaces (1)
- Leaking, restricted, or damaged charge air cooler (2). Refer to [Supercharger Assemble](#).

Supercharger Cleaning and Inspection

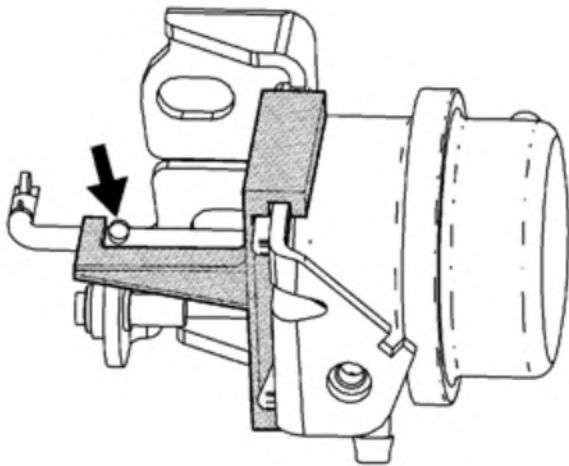


1. Inspect the supercharger for the following:
 - Damaged seal surfaces (1)
 - Worn or damaged belt pulley grooves (2)
2. Rotate the pulley of the supercharger by hand. The pulley and rotors should rotate freely with no binding.
3. Operate the boost bypass valve by hand. The bypass valve should operate within the full range of motion with no sticking or binding.

Supercharger Assemble



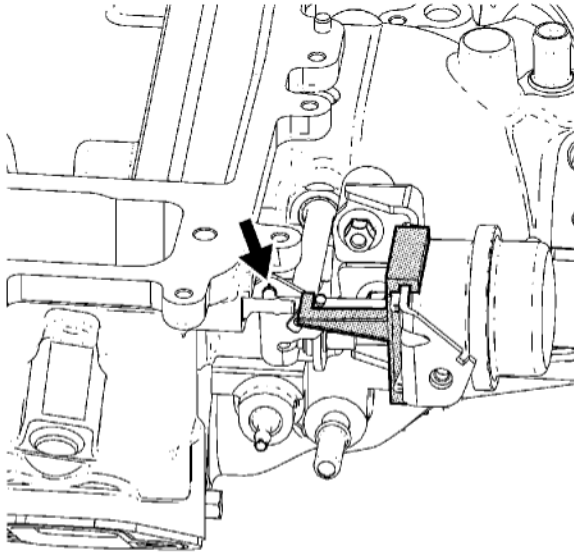
1. Install the NEW gaskets (2).
2. Install NEW gasket rivets (1).



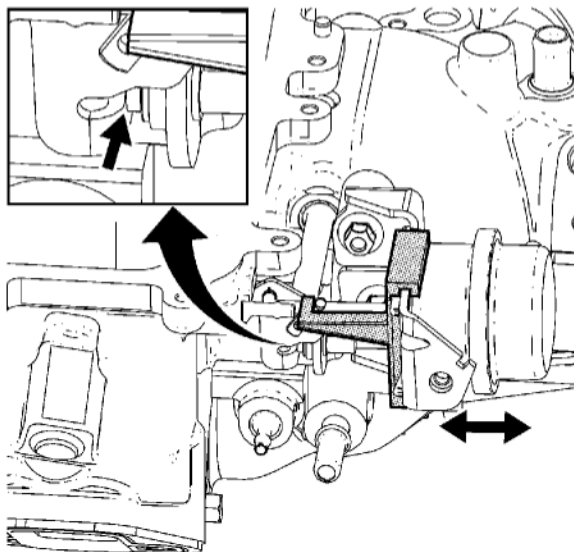
Note: The actuator adjustment tool is provided within the actuator parts kit.

3. Install the actuator adjustment tool onto the actuator. Position the raised portion of the rod

in the proper position.



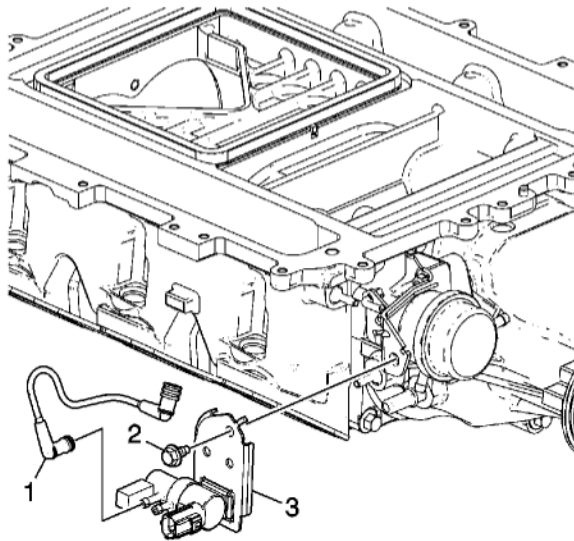
4. Install the rod of the actuator into the lever of the supercharger.
5. Rotate the actuator and install the bolts. Do not tighten the bolts at this time.



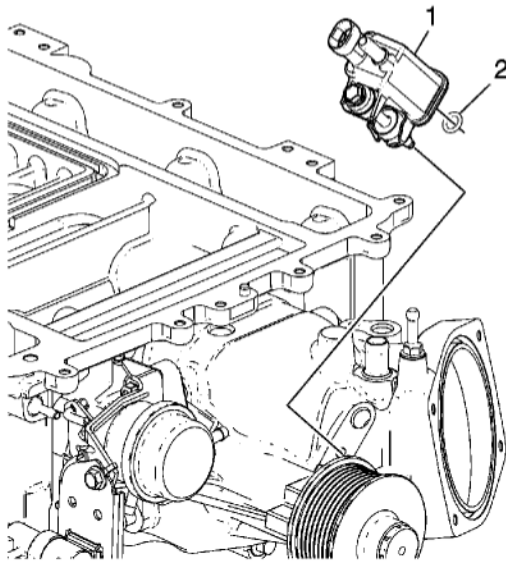
6. Moving the actuator forward or rearward as required, ensure that the supercharger lever is in contact with the adjustment screw on the actuator and that the lever is rotated to the fully closed position.

Caution: Refer to [Fastener Caution](#) in the Preface section.

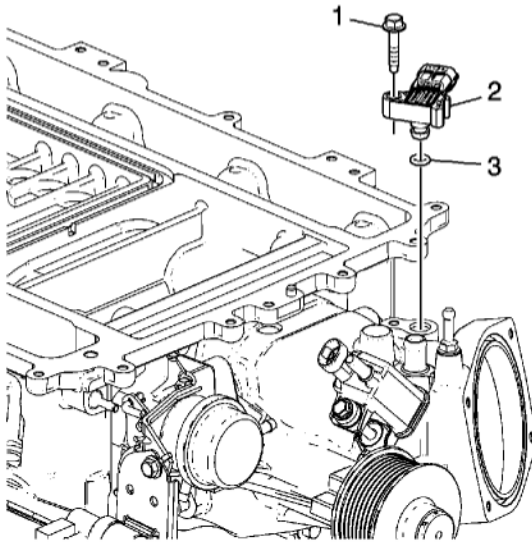
7. Tighten the actuator bolts to **25 N·m (18 lb ft)**.
8. Remove the adjustment tool from the actuator.
9. Rotate the adjustment screw on the actuator clockwise ¼ turn.



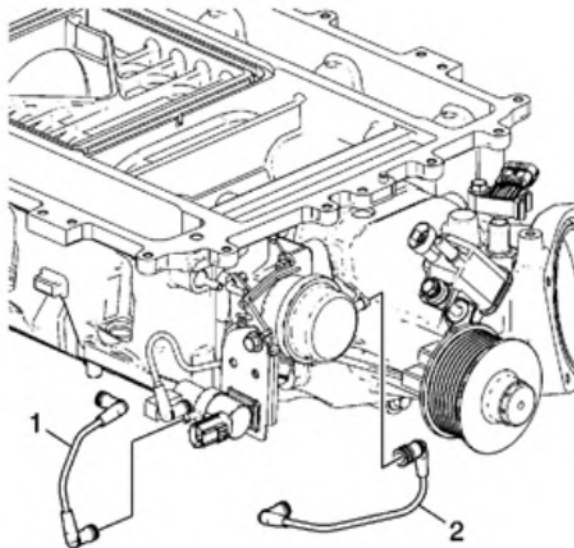
10. Install the charge air bypass valve (3).
11. Install the charge air bypass valve bolt (2) and tighten to **12 N·m (108 lb ft)**.
12. Install the bypass actuator tube (1).



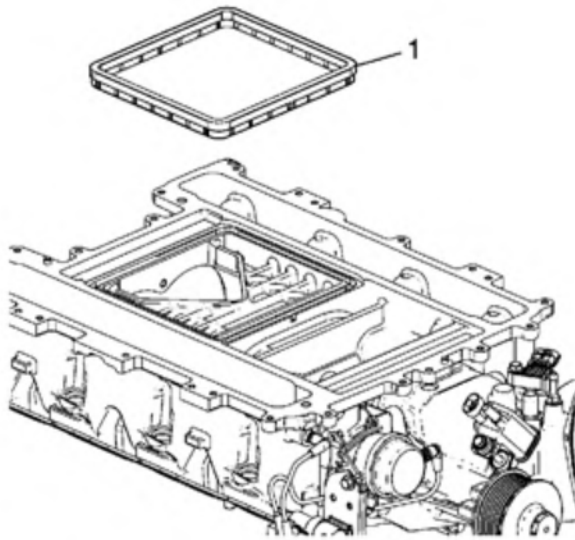
13. Install a **NEW** evaporative emission (EVAP) valve seal (2).
14. Install the EVAP valve (1) and tighten to **10 N·m (89 lb in)**.



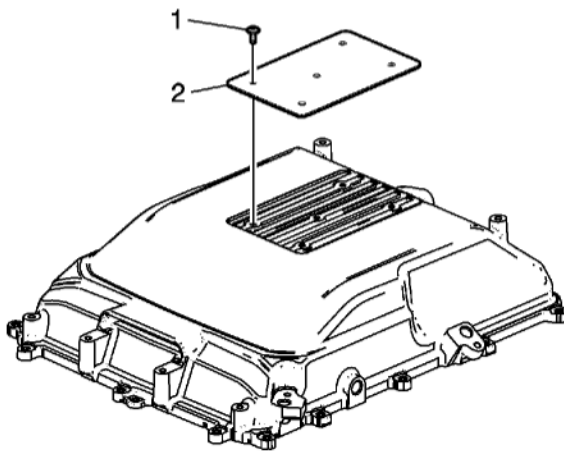
15. Install a NEW inlet air pressure sensor seal (3).
16. Install the inlet air pressure sensor (2).
17. Install the inlet air pressure sensor bolt (1) and tighten to **10 N·m (89 lb in)**.



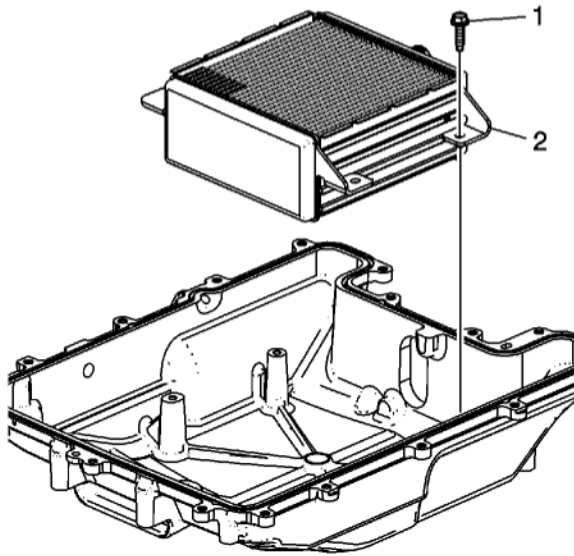
18. Install the bypass valve vacuum tube (2).
19. Install the bypass valve tube (1).



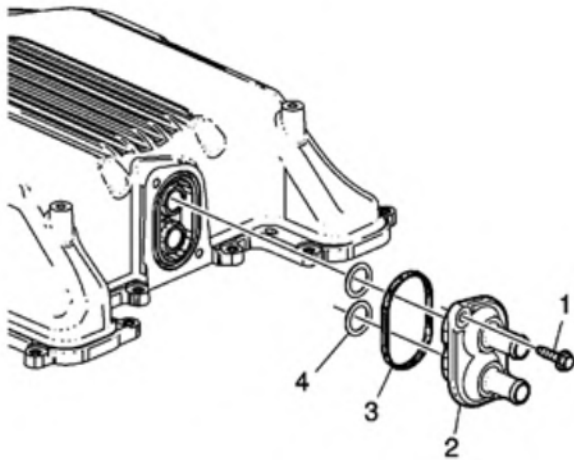
20. Install the NEW insulator seals (1).



21. Install the isolator pad (2) and bolts (1) and tighten to **10 N·m (89 lb in)**.



22. Apply a 5 mm (0.2 in) band of threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the threads of the bolts.
23. Install the charger air cooler (2) and bolts (1) and tighten to **10 N·m (89 lb in)**.

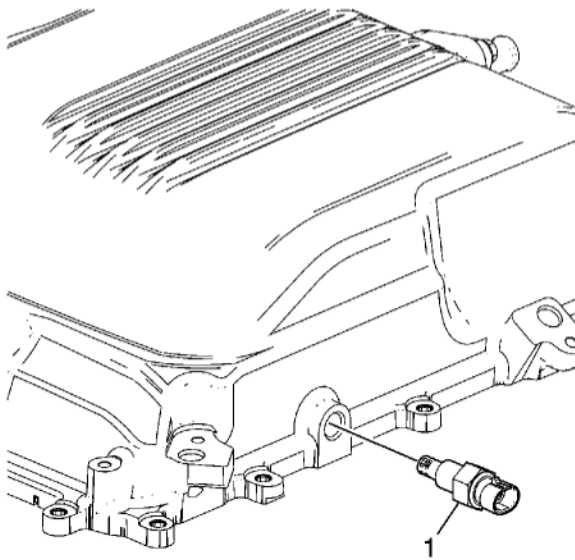


24. Lubricate the seals with clean engine oil.
25. Install the O-ring seals (4), seal (3), plate (2) and bolts (1) and tighten to **10 N·m (89 lb in)**.

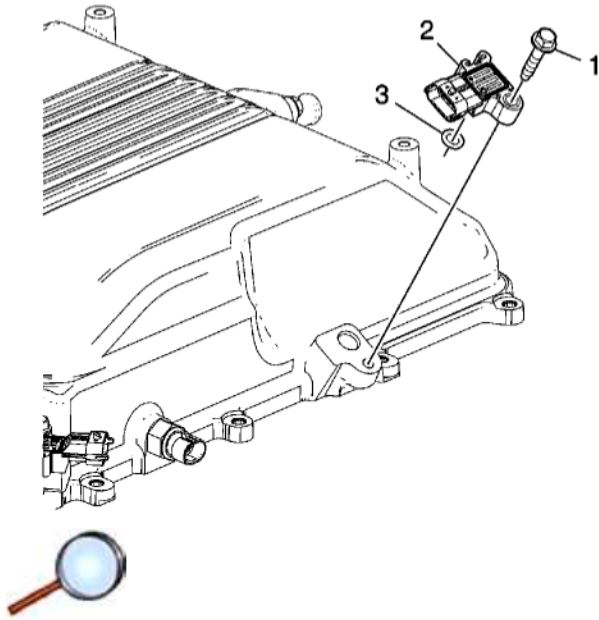
✖ Object Number: 2156822 Size: SH



26. Install a NEW barometric pressure (BARO) sensor seal (3).
27. Install the BARO sensor (2).
28. Install the BARO sensor bolt (1) and tighten to **10 N·m (89 lb in)**.



29. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor (1).
30. Install the IAT sensor (1) and tighten to **20 N·m (15 lb ft)**.



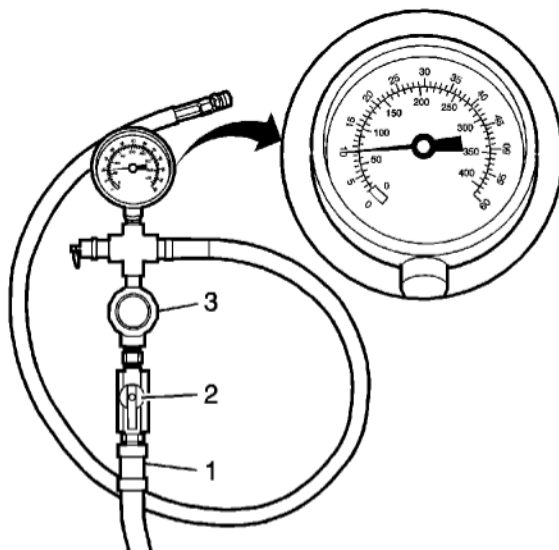
31. Install a NEW manifold absolute pressure (MAP) sensor seal (3).
32. Install the MAP sensor (2).
33. Install the MAP sensor bolt (1) and tighten to **10 N·m (89 lb in)**.

Supercharger Intercooler Pressure Testing

Special Tools

- EN-48974 Adapter Kit
- J 46091 Charge Air Cooler Tester

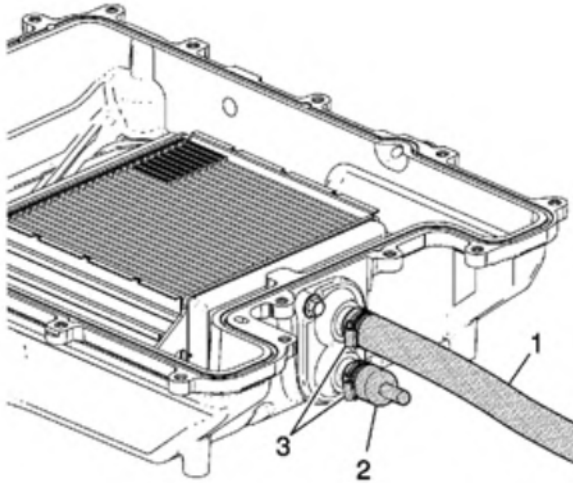
For equivalent regional tools, refer to [Special Tools](#)



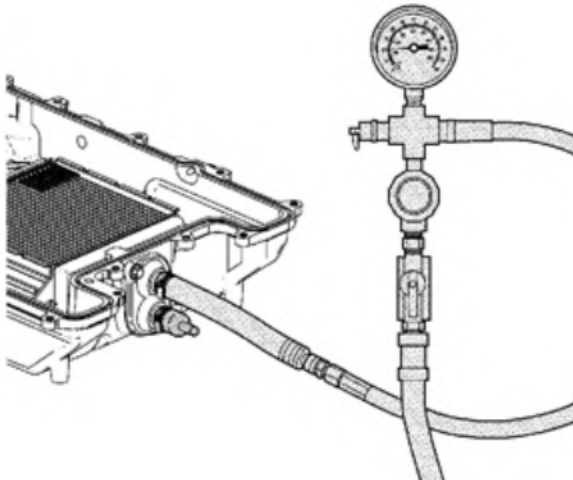


Warning: Do not apply greater than 69 kPa (10 psi) to the supercharger intercooler, this may damage the charge air cooler and other internal components within the intercooler.

1. Rotate the regulator knob (3) counterclockwise until stop to reduce pressure to 0 kPa (0 psi).
2. Connect the J 46091-1 to a shop air source (1).



3. Install the *EN-48974* kit adapter hose (1), cap (2) and clamps (3) to the coolant inlet and outlet connections of the intercooler water manifold. Tighten the clamps until snug.

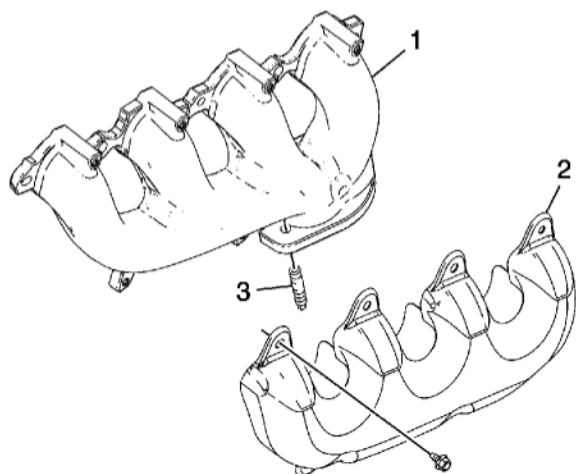


4. Install the J 46091-1 to the *EN-48974* kit adapter hose.
5. Rotate the knob of the regulator slowly clockwise to increase pressure.

Note: The gage value should not exceed 69 kPa (10 psi). Adjust the pressure regulator as required.

6. With the intercooler pressurized to 69 kPa (10 psi) maximum, close the air inlet valve of the J 46091-1.
7. Inspect for a drop in air pressure on the gage.
 - If a drop in pressure is noted, inspect for leaks at the tool connections, the charge air coolers, service bleed ports, assembly plant fill port, and water manifold-to-charge air cooler seal locations.
 - If no drop in pressure is noted, the intercooler can be installed onto the engine assembly.

Exhaust Manifold Cleaning and Inspection

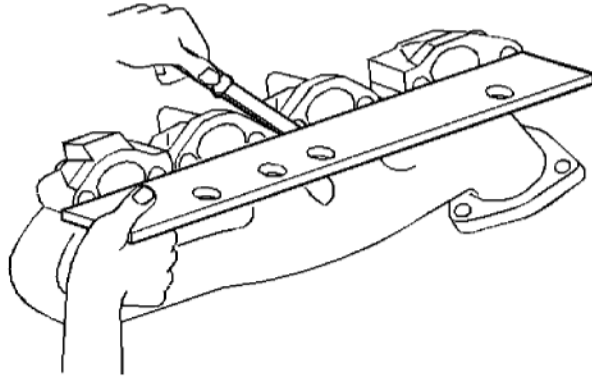


Note: Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may effect on-board diagnostics (OBD) II system performance.

1. Clean the exhaust manifold (1) and heat shield (2) in solvent.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

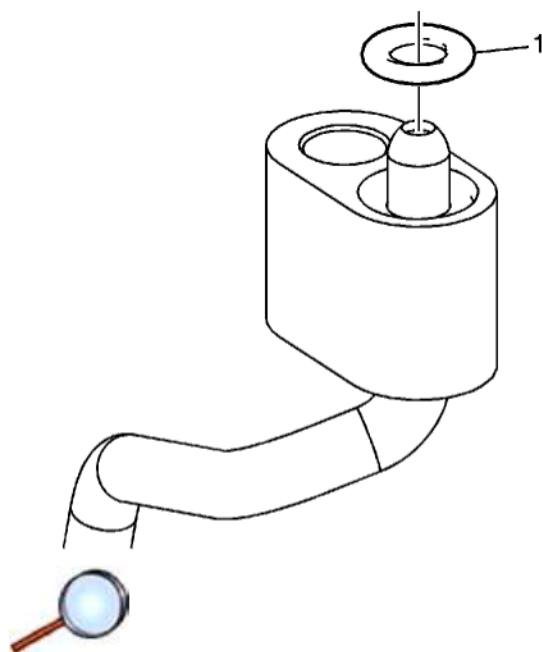
2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shield (2).
5. Inspect the exhaust pipe studs (3) for damaged threads.



6. Use a straight edge and a feeler gage to measure the exhaust manifold cylinder head deck for warpage.

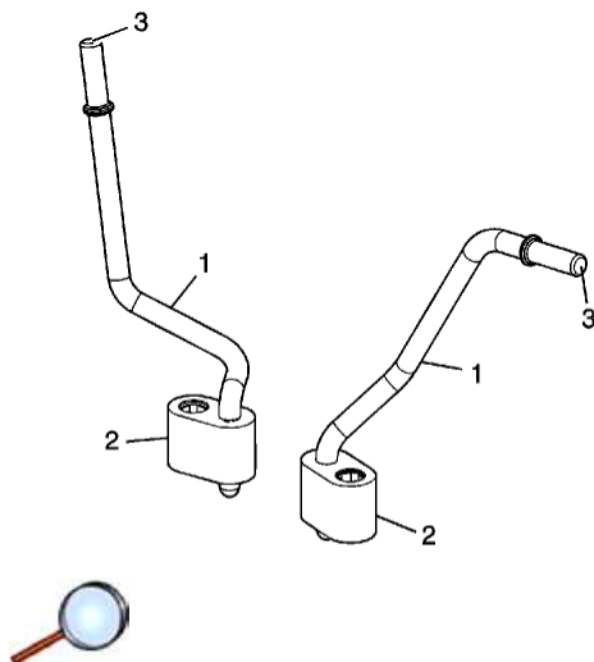
An exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in) within the 2 front or 2 rear runners or 0.5 mm (0.02 in) overall, may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

Engine Coolant Air Bleed Pipe and Hole Cover Cleaning and Inspection



Note: Do not use the engine coolant air bleed pipe seals again. Upon installation of the pipes, install NEW seals.

1. Remove the seals (1) from the pipes.



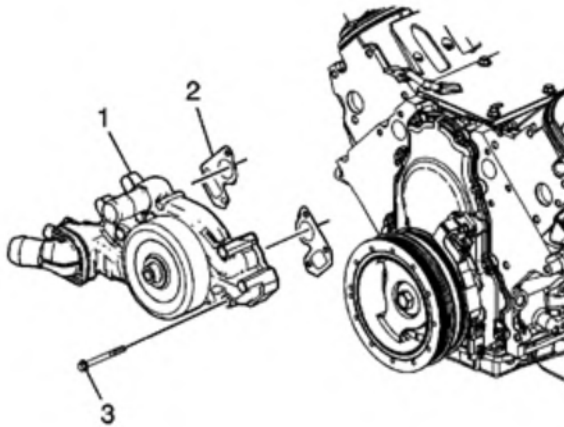
2. Clean the pipes in solvent.

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Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

3. Dry the pipes with compressed air.
4. Inspect the pipes for damaged sealing surfaces (1, 2) or restrictions within the pipe (3).

Water Pump Cleaning and Inspection (6.2L)



1. Remove the old gasket from the water pump sealing surfaces. Refer to [Replacing Engine Gaskets](#).
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump (1) for the following conditions:
 - Gasket and hose sealing surfaces for excessive scratches or gouging
 - Restrictions within the internal coolant passages
 - Excessive side-to-side play in the pulley shaft
 - Leakage at the water outlet housing or rear cover gasket
 - Leakage at the water pump vent hole
 - A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.
 - Wear or damage in the belt tracking area of the pulley

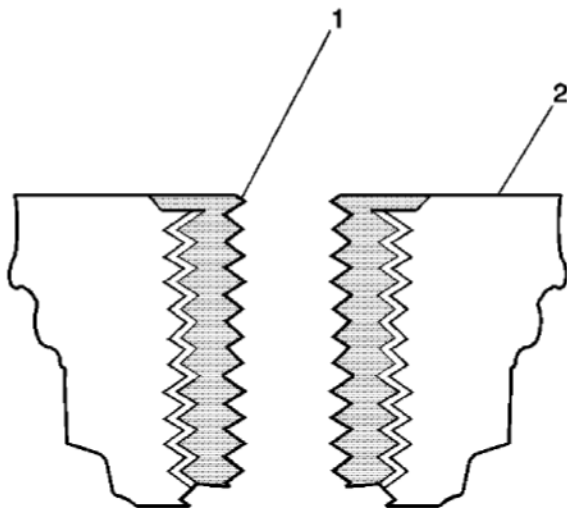
Thread Repair

Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 42385-200 Common Thread Repair Kit
- J 42385-300 Fixtures and Hardware Kit

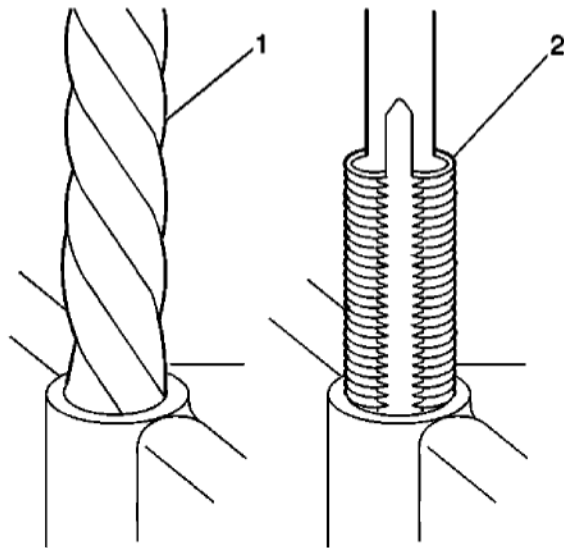
For equivalent regional tools, refer to [Special Tools](#)

General Thread Repair



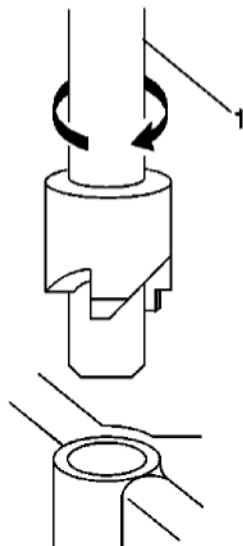
The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

**Note:**

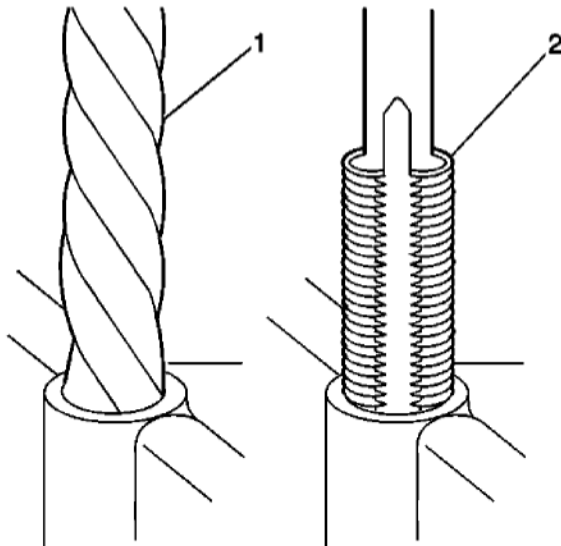
- The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures.
- Driver oil **MUST** be used on the installer driver tool.
- The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Drill out the threads of the damaged hole (1).
 - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
 - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
 - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).
2. Using compressed air, clean out any chips.

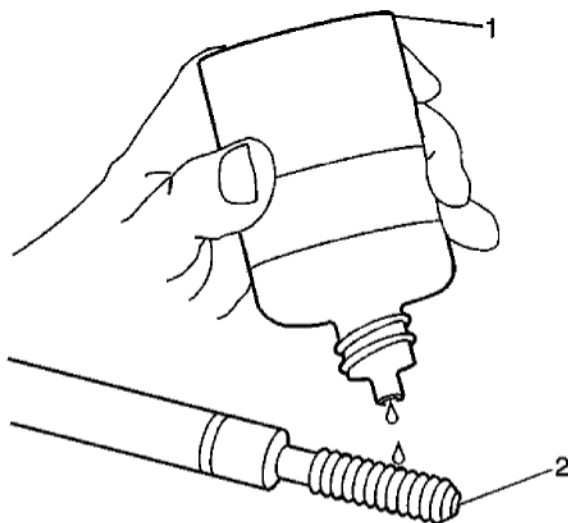




3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

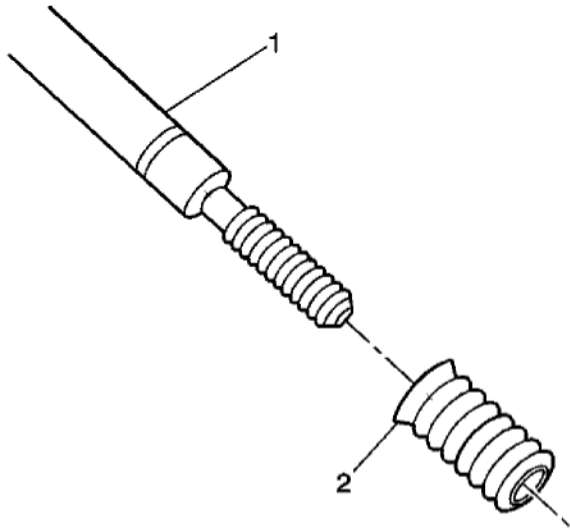


5. Using a tap wrench (2), tap the threads of the drilled hole.
 - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
 - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
 - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).
6. Using compressed air, clean out any chips.
7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.

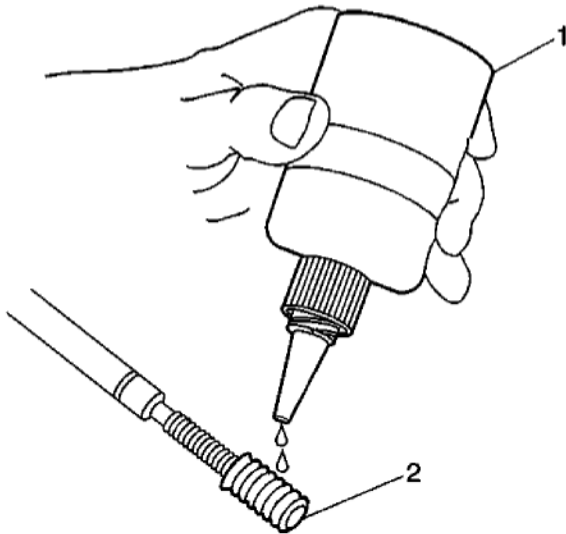


Note: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).



10. Install the insert (2) onto the driver tool (1).



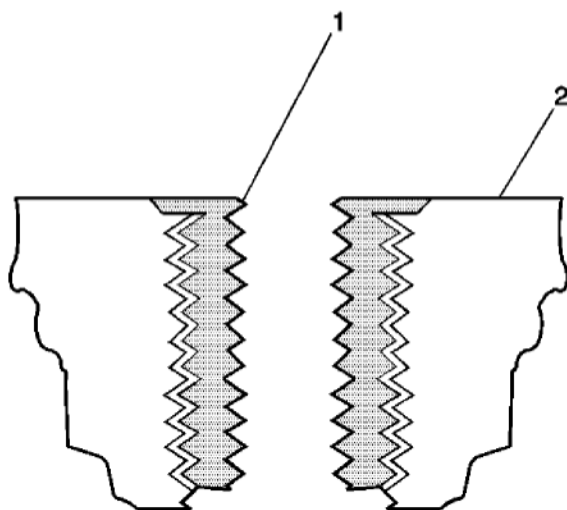
11. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).



12. Install the insert (2) into the hole.

Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

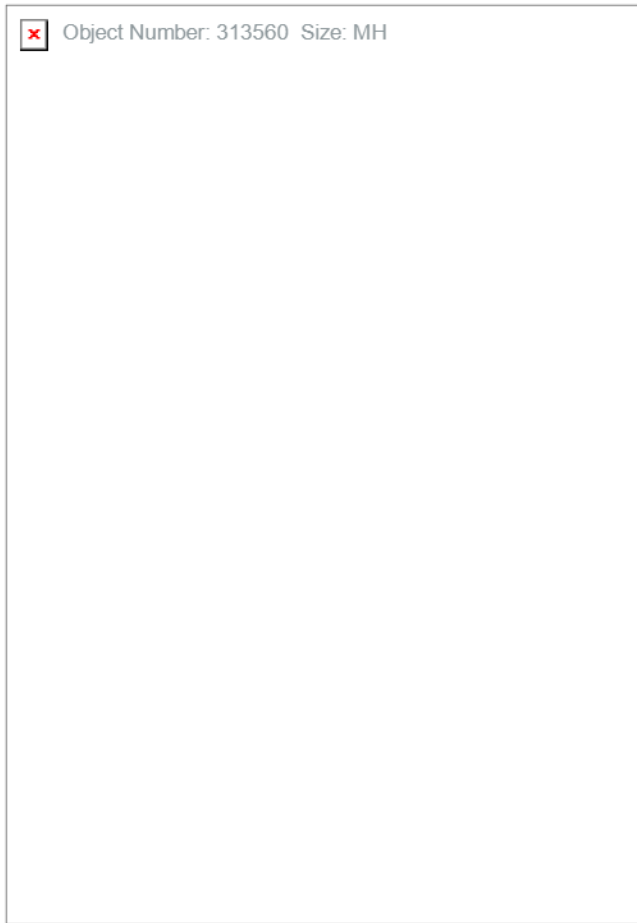


13. Inspect the insert for proper installation into the hole.

A properly installed insert (1) will be either flush or slightly below flush with the surface of

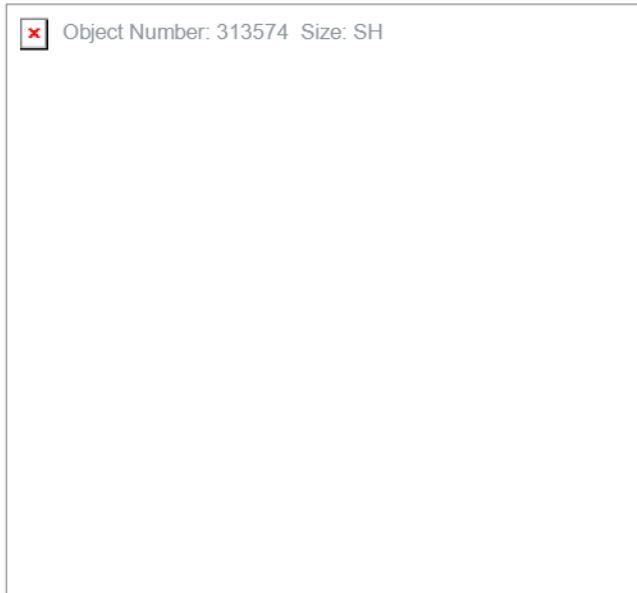
the base material (2).

Cylinder Head Bolt Hole Thread Repair



1. The cylinder head bolt hole thread repair kit consists of the following items:
 - The drill (1)
 - The tap (2)
 - The installer (3)
 - The sleeve (4)
 - The alignment pin (5)
 - The bushing (6)
 - The bolts (7)
 - The fixture plate (8)

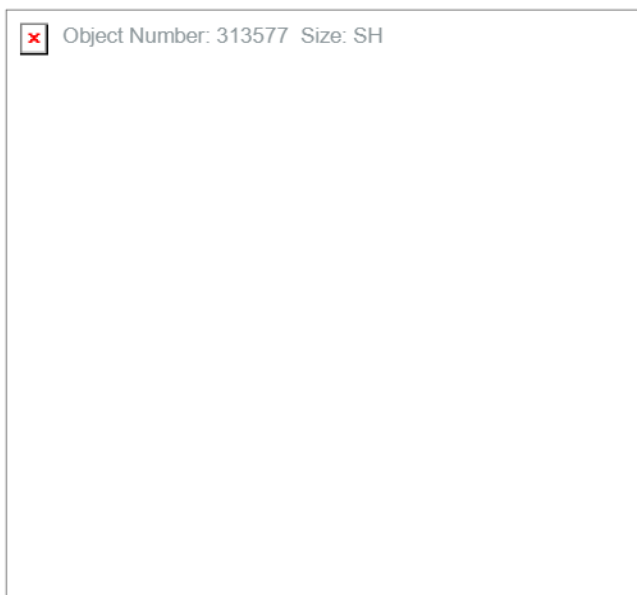
Warning: Refer to [Safety Glasses Warning](#) in the Preface section.

**Note:**

- The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures.
- Driver oil **MUST** be used on the installer driver tool.
- The tool kits are designed for use with either a suitable tap wrench or drill motor.

2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

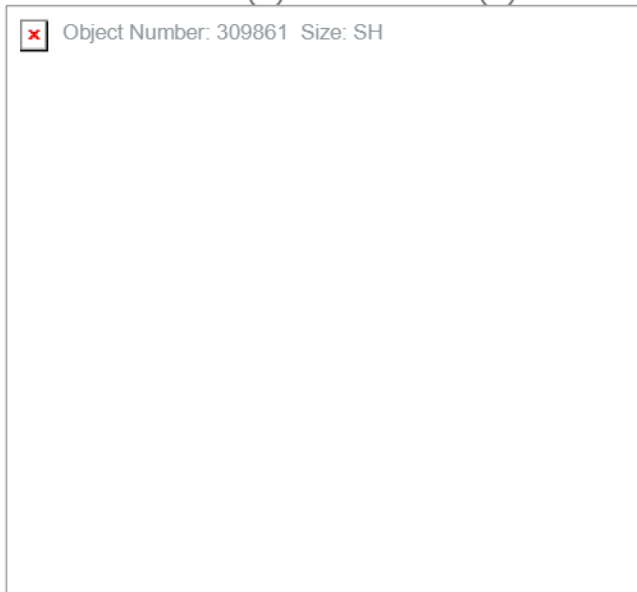
Position the fixture plate and bushing over the hole that is to be repaired (4).



3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.



6. Install the sleeve (2) onto the drill (1).



Note: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

8. Using compressed air, clean out any chips.

 Object Number: 320667 Size: SH

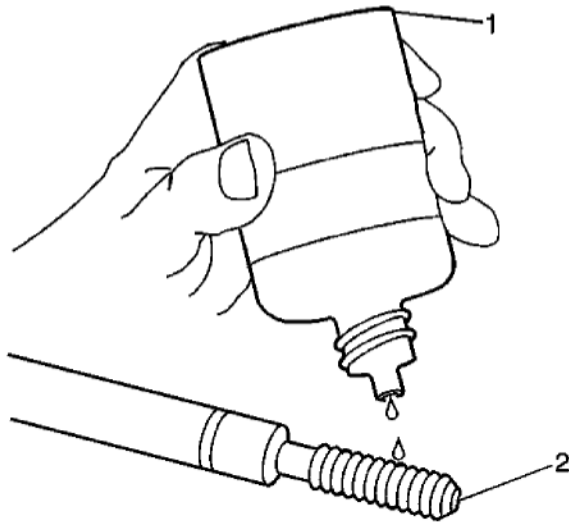


9. Using a tap wrench, tap the threads of the drilled hole.

 Object Number: 377637 Size: SH

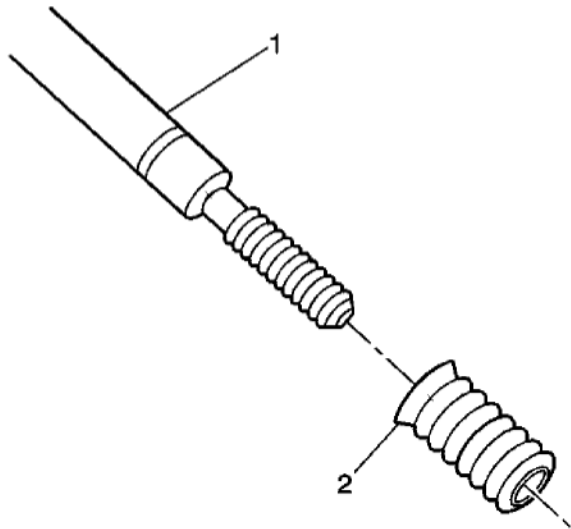


10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).
11. Remove the fixture plate (2), bushing (3), and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
14. Using compressed air, clean any cutting oil and chips out of the hole.

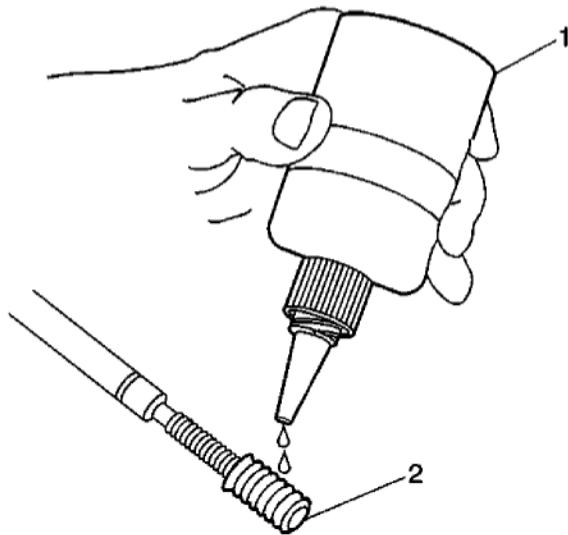


Note: Do not allow oil or foreign material to contact the OD of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).



16. Install the insert (2) onto the driver tool (1).



17. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

 Object Number: 320669 Size: SH

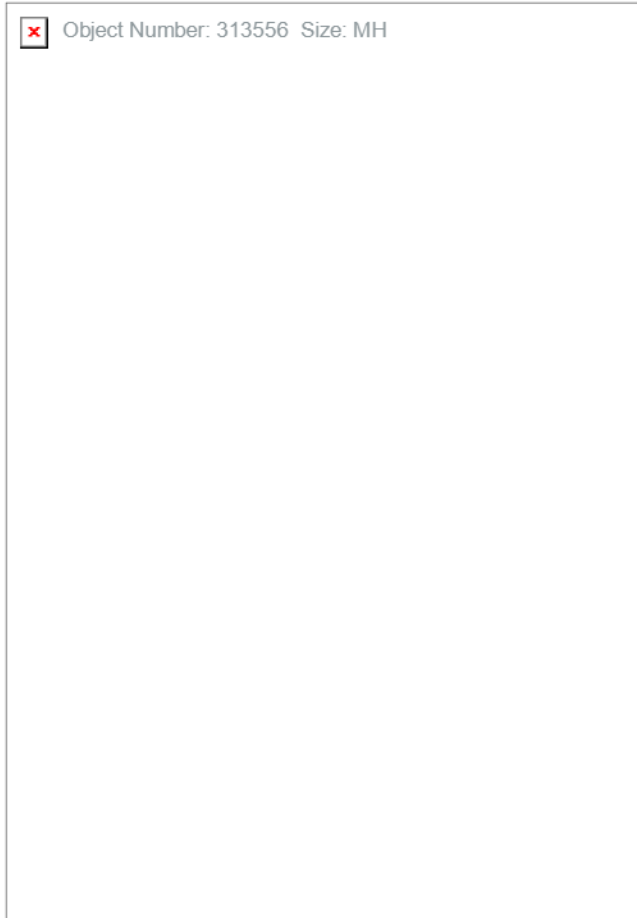


18. Install the insert and driver (1) into the hole.

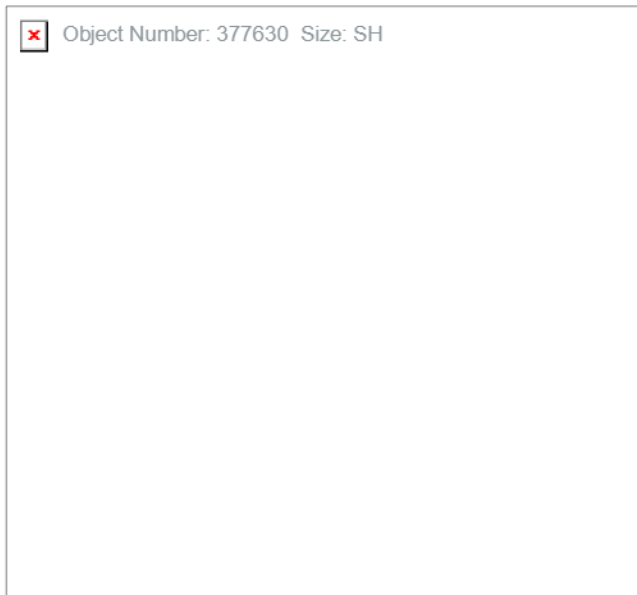
Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Main Cap Bolt Hole Thread Repair



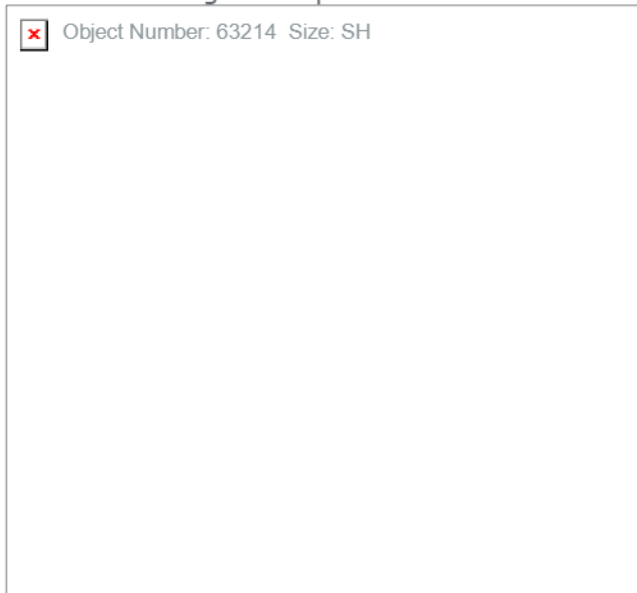
1. The main cap bolt hole thread repair kit consists of the following items:
 - The drill (1)
 - The tap (2)
 - The installer (3)
 - The fixture plate (4)
 - The long bolts (5)
 - The short bolts (6)
 - The alignment pin (7)
 - The bushing (8)



2. Install the fixture plate, bolt, and bushing onto the engine block.

Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.

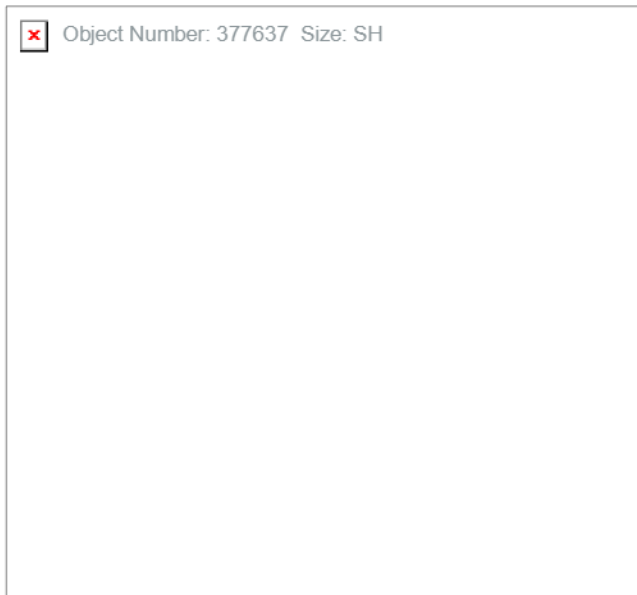


4. Drill out the damaged hole.

The outer bolt hole locations 11-20 have the shallower counterbores. Use sleeve J 42385-316 with the drill.

Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.



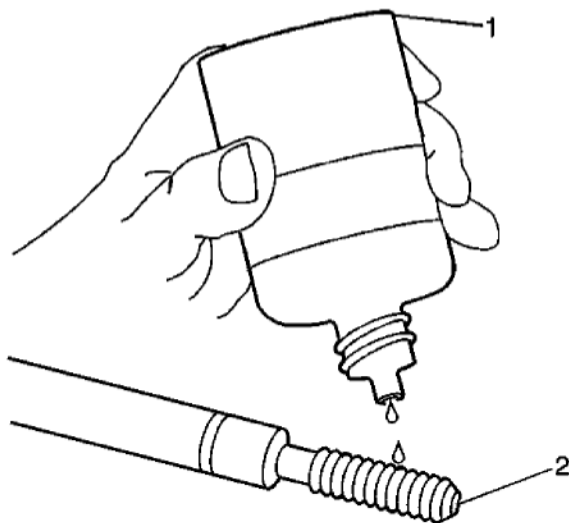
6. Using a tap wrench, tap the threads of the drilled hole.

In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

For the deeper main cap holes 1-10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

For the shallower main cap holes 11-20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

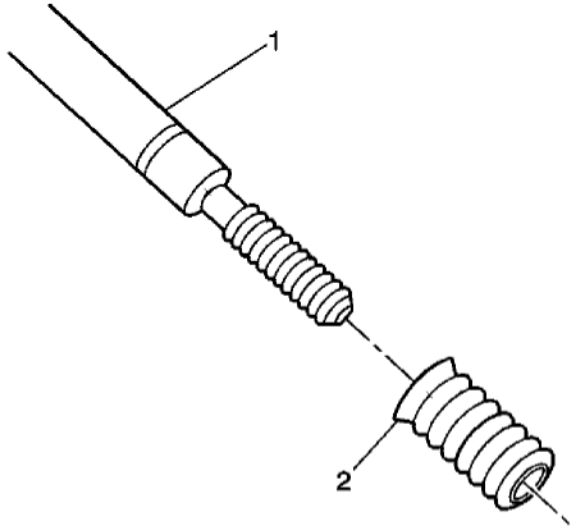
7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.



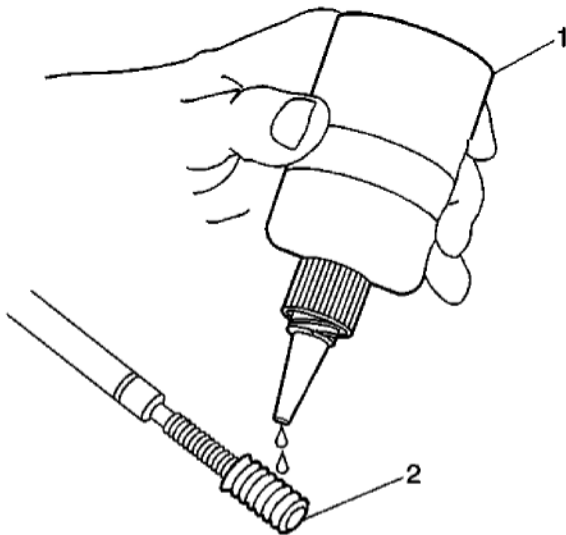


Note: Do not allow oil or foreign material to contact the OD of the insert.

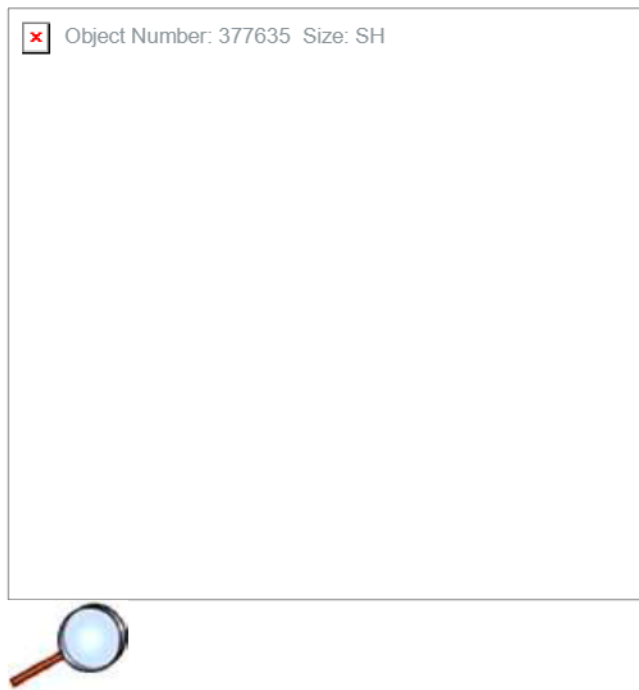
10. Lubricate the threads of the installer tool (2) with the driver oil (1).



11. Install the insert (2) onto the driver tool (1).



12. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).



Note: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

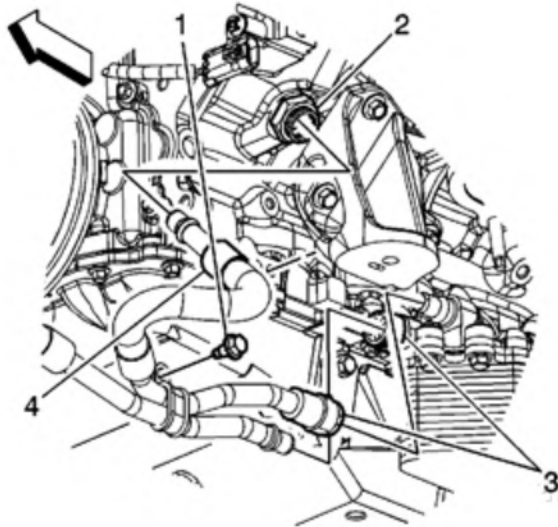
Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Service Prior to Assembly

- Dirt or debris causes premature wear of the rebuilt engine. Clean all components. Refer to [Cleanliness and Care](#).
- Use the proper tools to measure components when inspecting for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are installed into an engine, return the components to their original location, position and direction. Refer to [Separating Parts](#).
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

Engine Block Plug Installation

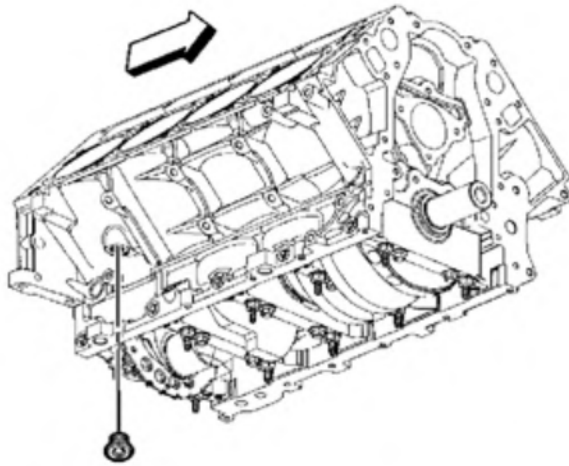


Note: Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged.

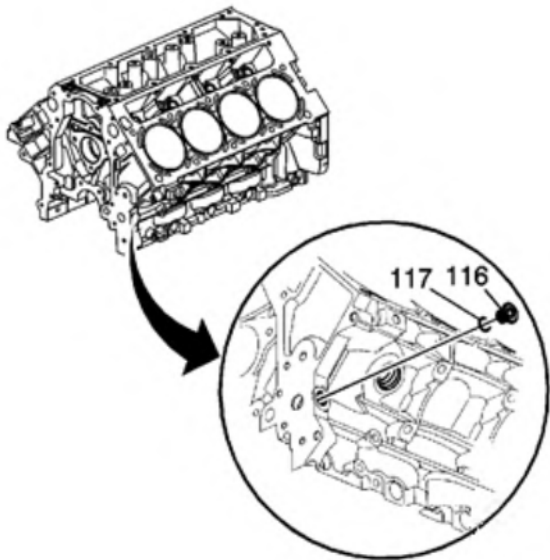
1. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the engine oil cooler coolant fitting (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

Caution: Refer to [Fastener Caution](#) in the Preface section.

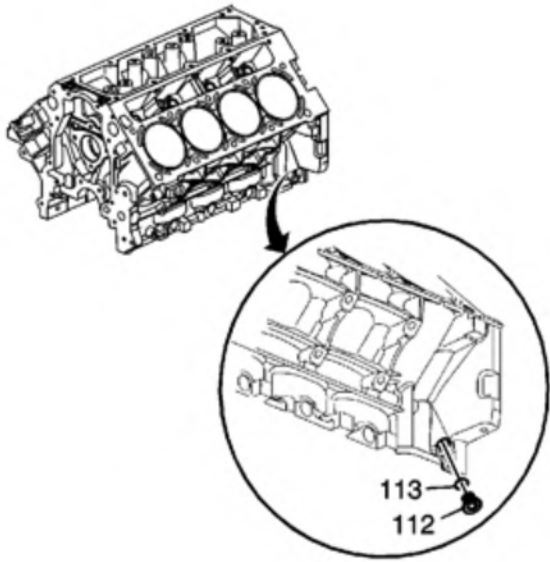
2. Install the engine oil cooler coolant fitting (2) and tighten to **50 N·m (37 lb ft)**.



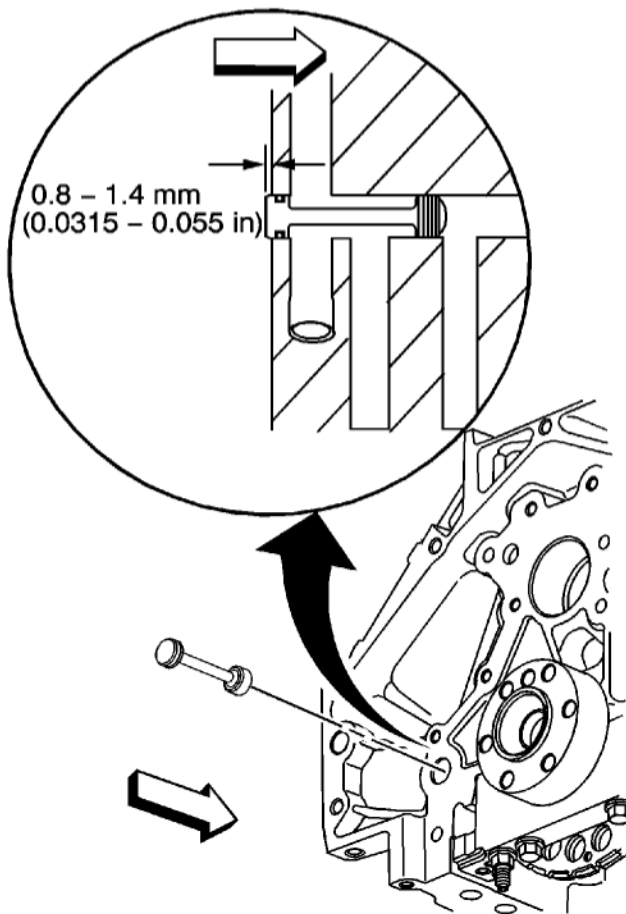
3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block right rear coolant drain hole plug sealing washer.
4. Install the engine block right rear coolant drain hole plug and tighten to **60 N·m (44 lb ft)**.



5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left front oil gallery plug sealing washer (117).
6. Install the engine block left front oil gallery plug (116) and tighten to **60 N·m (44 lb ft)**.



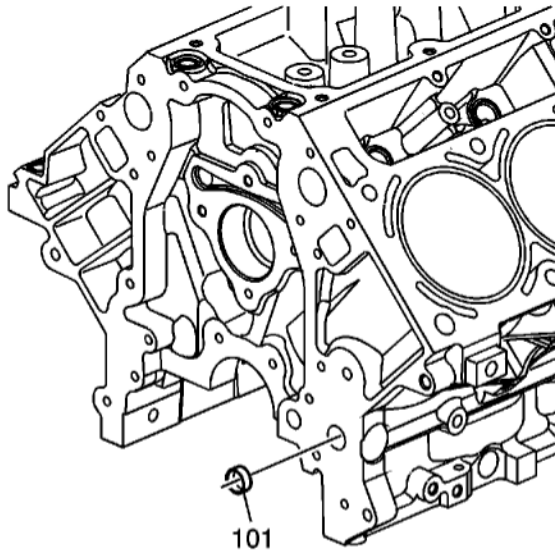
7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left rear oil gallery plug sealing washer (113).
8. Install the engine block left rear oil gallery plug (112) and tighten to **60 N·m (44 lb ft)**.



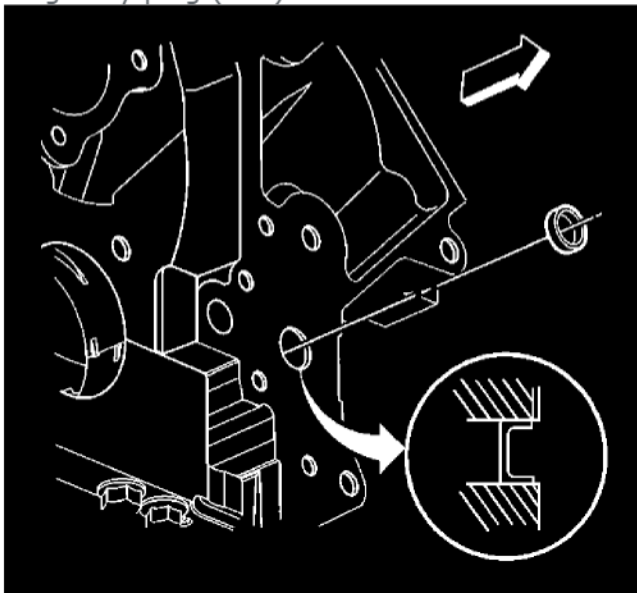
9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is

not cut or damaged, the rear oil gallery plug may be used again.

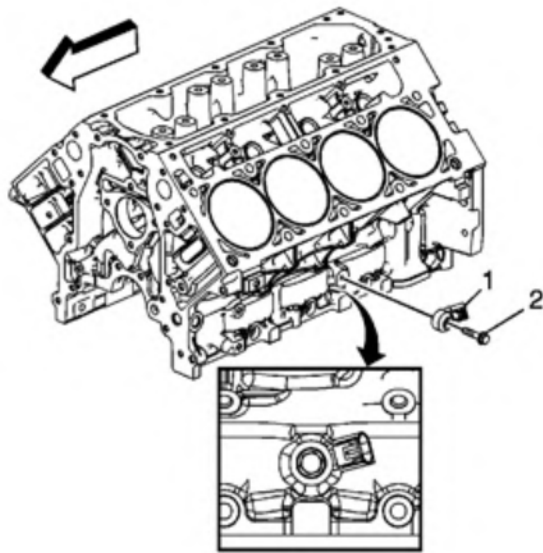
10. Lubricate the O-ring seal with clean engine oil.
11. Install the O-ring seal onto the plug.
12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8-1.4 mm (0.0315-0.055 in) beyond the rear face of the block.



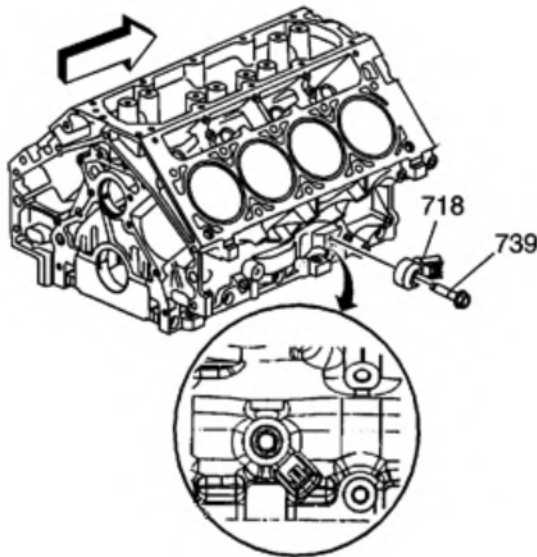
13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the sides of the NEW front oil gallery plug (101).



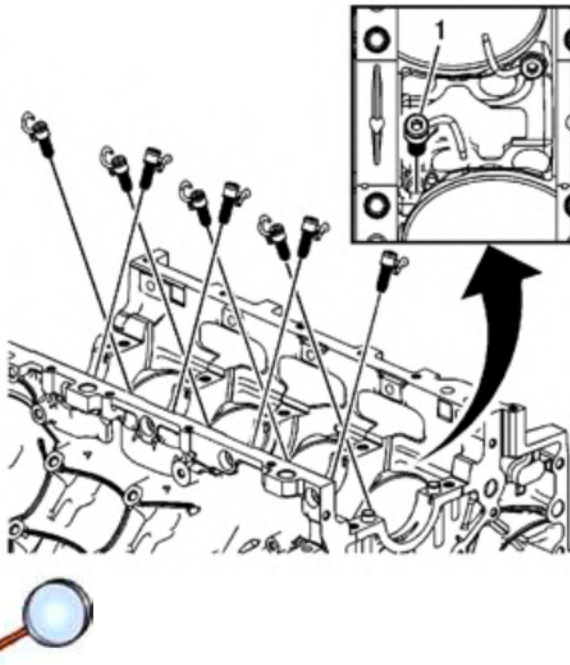
14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore 2.2-2.8 mm (0.0086-0.011 in) below flush.



15. Install the left side knock sensor (1) and bolt (2) and tighten to **25 N·m (18 lb ft)**.



16. Install the right side knock sensor (718) and bolt (739) and tighten to **25 N·m (18 lb ft)**.



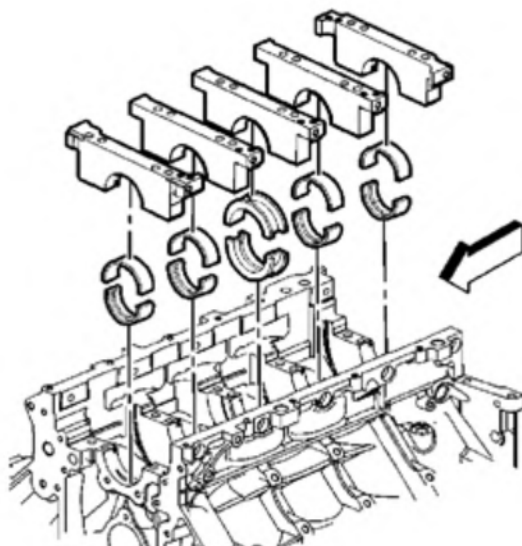
17. Install the piston oil nozzles (1) to the block - 6.2L LS9/LSA.
18. Tighten the bolts to **20 N·m (15 lb ft)**.

Crankshaft and Bearing Installation

Special Tools

J 45059 Angle Meter

For equivalent regional tools, refer to [Special Tools](#)

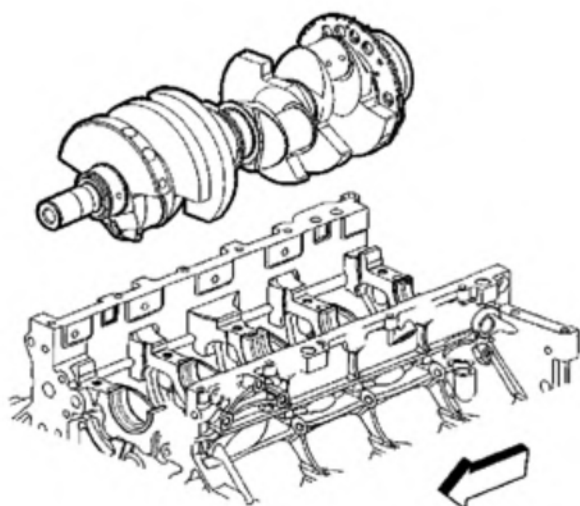


Note:

- Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.
- Crankshaft bearing caps must be installed to the proper location and direction.
- When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.
- Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.
- In order to prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.

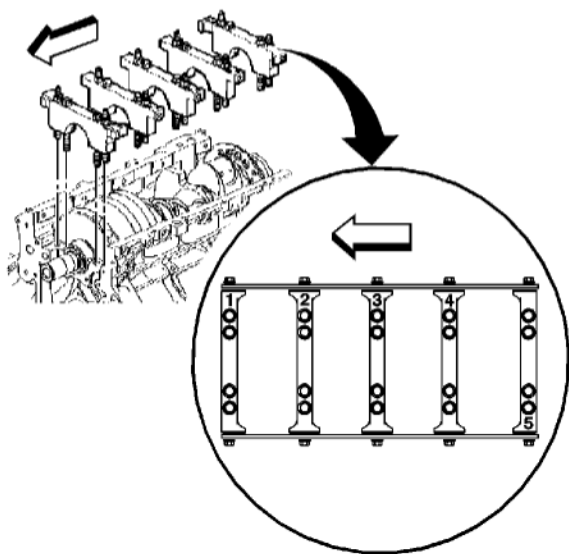
The crankshaft bearing cap M8 side bolts have a pre-applied sealant patch applied to the bolt flange.

1. Install the crankshaft bearings to the engine block and bearing caps. The thrust bearings are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.



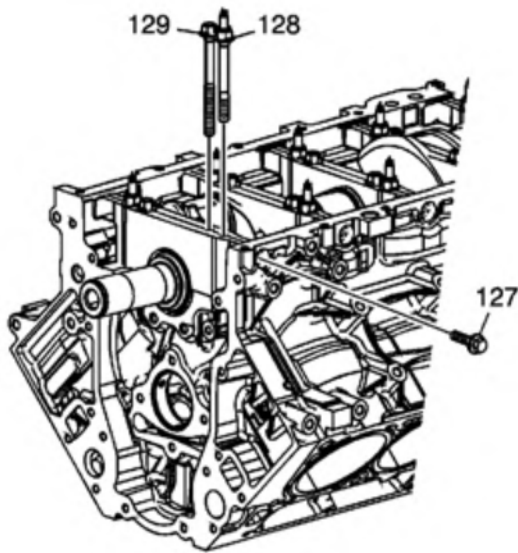
Caution: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft.



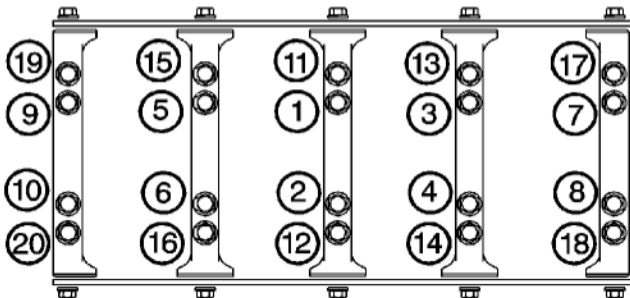
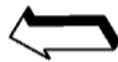
Note: The bearing caps must be installed in the proper location and direction.

4. Install the crankshaft bearing caps, with bearings, into the engine block.



5. Install the M10 bolts (129) and studs (128).
6. Using a plastic-face hammer, tap the bearing caps into place.
7. Install the NEW M8 bearing cap side bolts (127).

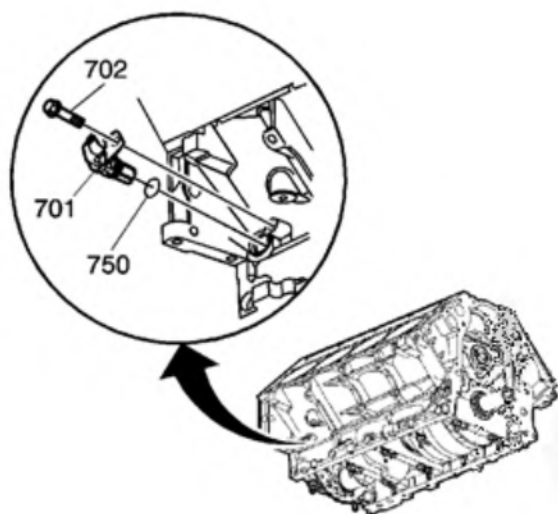
Caution: Refer to [Fastener Caution](#) in the Preface section.



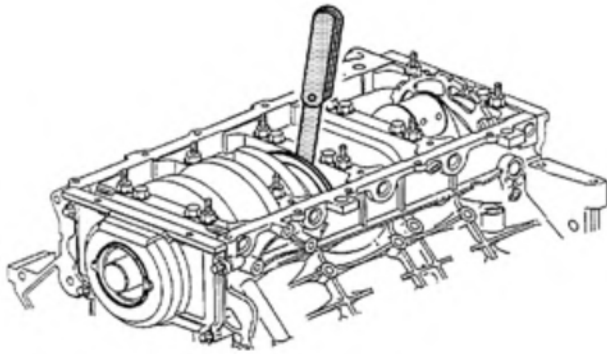
8. Tighten the bearing cap M10 bolts (1-10). Tighten the M10 bearing cap bolts (1-10) a first pass in sequence to **20 N·m (15 lb ft)**.

Note: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft **MUST** be in the forward direction.

9. Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.
- Tighten the M10 bolts (1-10) a final pass in sequence 80 degrees using the *J 45059* meter .
 - Tighten the M10 studs (11-20) a first pass in sequence to **20 N·m (15 lb ft)**.
 - Tighten the M10 studs (11-20) a final pass in sequence 51 degrees using the *J 45059* meter .
 - Tighten the bearing cap side M8 bolts to **25 N·m (18 lb ft)**.
- Tighten the bolt on 1 side of the bearing cap and then tighten the bolt on the opposite side of the same bearing cap.



10. Install the CKP sensor.
- 10.1. Inspect the CKP sensor O-ring seal (750). If the O-ring seal is not cut or damaged, it may be used again.
 - 10.2. Coat the O-ring seal with clean engine oil.
 - 10.3. Install the O-ring onto the sensor.
 - 10.4. Install the sensor (701). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
 - 10.5. Install the sensor bolt (702) and tighten to **25 N·m (18 lb ft)**.



11. Measure the crankshaft end play.
 - 11.1. Thrust the crankshaft forward or rearward.
 - 11.2. Insert a feeler gage between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

The proper crankshaft end play clearance is 0.04-0.2 mm (0.0015-0.0078 in).

- 11.3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

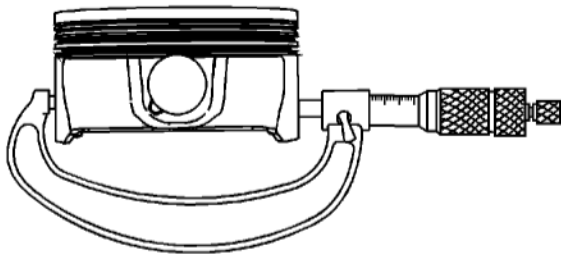
Piston, Connecting Rod, and Bearing Installation (6.2L)

Special Tools

- *J 8037* Piston Ring Compressor
- *J 8087* Cylinder Bore Gage
- *J 41556* Connecting Rod Guide
- *J 45059* Angle Meter

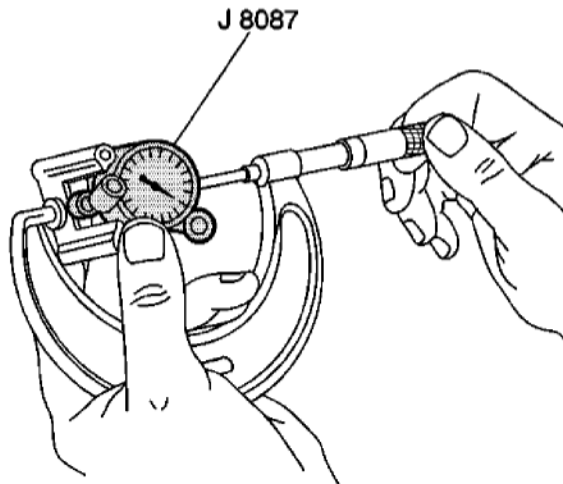
For equivalent regional tools, refer to [Special Tools](#)

Piston Selection

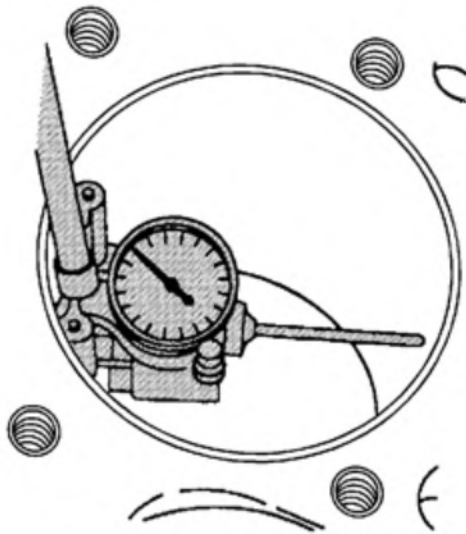


Note: Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to [Engine Mechanical Specifications](#).
2. Record the piston OD.



3. Adjust the micrometer to the recorded piston OD.
4. Insert the *J 8087* gage into the micrometer and zero the gage dial.

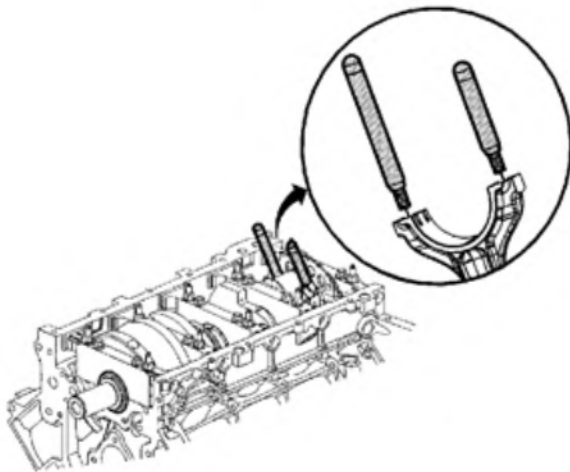


5. Using the *J 8087* gage, measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to [Engine Mechanical Specifications](#).
8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

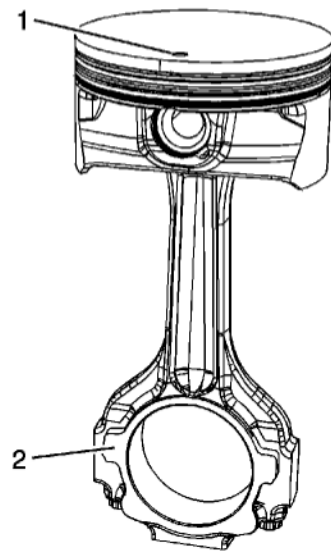
Piston, Pin, and Connecting Rod Installation



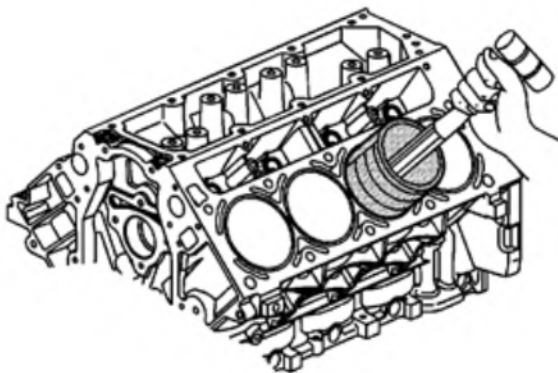
1. Lubricate the following components with clean engine oil:
 - Piston
 - Piston rings
 - Cylinder bore
 - Bearings and bearing surfaces
2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.



5. Install the *J 41556* guide to the connecting rod.



6. Identify the proper installation direction of the piston and connecting rod assembly. When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the tab (2) on the side of the connecting rod should face the front of the engine.

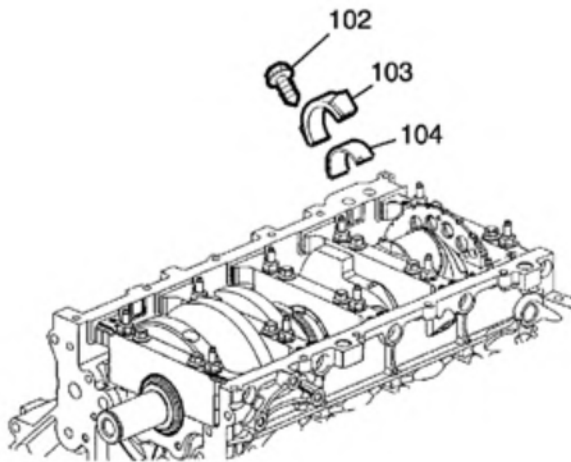


7. Install the *J 8037* compressor onto the piston and compress the piston rings.

Note: The piston alignment mark **MUST** face the front of the engine block.

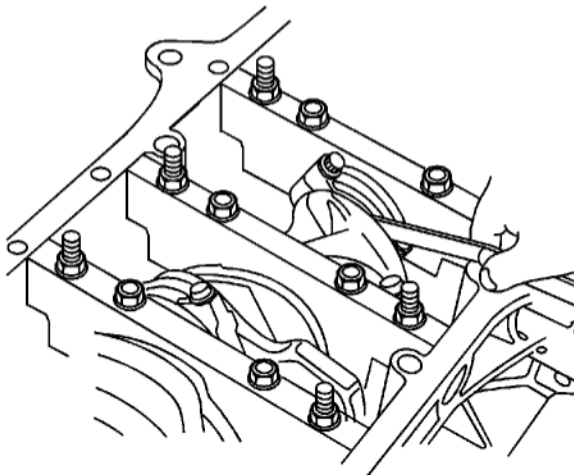
8. Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.
9. Use the *J 41556* guide to guide the connecting rod onto the crankshaft journal.
10. Remove the *J 41556* guide from the connecting rod.

Caution: Refer to [Fastener Caution](#) in the Preface section.



Note: The connecting rod and cap must be assembled with the mating surfaces properly aligned.

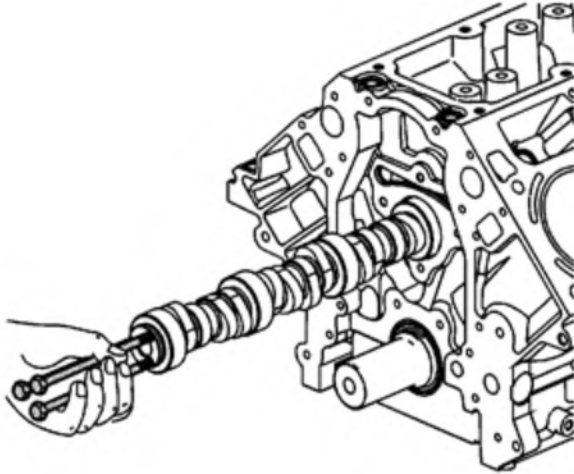
11. Install the bearing cap (103), bearing (104), and bolts (102).
 - 11.1. Tighten the bolts a first pass to **20 N·m (15 lb ft)**.
 - 11.2. Tighten the bolts a final pass to **85 degrees** using the J 45059 meter .



12. Measure the connecting rods for the proper side clearance. Refer to [Engine Mechanical](#)

[Specifications.](#)

Camshaft Installation (6.2L)

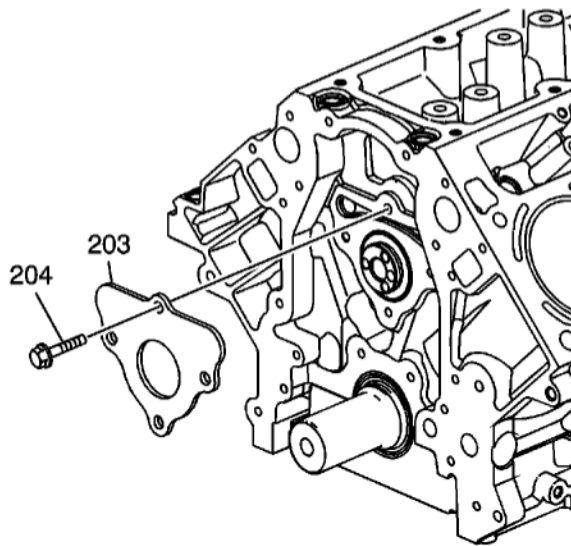


Note: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install 3 M8 - 1.25 x 100 mm (M8 - 1.25 x 4.0 in) bolts into the camshaft front bolt holes.

Caution: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

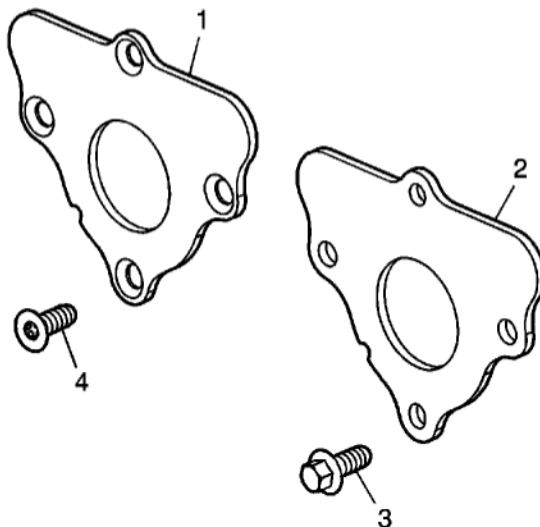
3. Using the bolts as a handle, carefully install the camshaft into the engine block.
4. Remove the 3 bolts from the front of the camshaft.



Note: The gasket surface on the engine block should be clean and free of dirt or debris.

5. Install the camshaft retainer (203) and the bolts (204). Install the retainer with the sealing gasket facing the front of the engine block.

Caution: Refer to [Fastener Caution](#) in the Preface section.



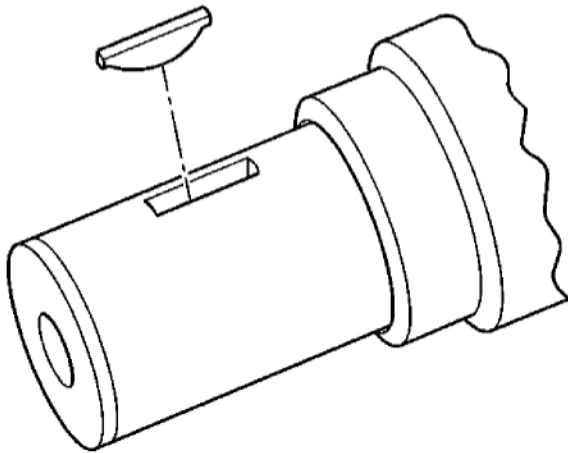
6. Tighten the camshaft retainer bolts.
 - Tighten the first design hex head bolts (3) to **25 N·m (18 lb ft)**.
 - Tighten the second design TORX® head bolts (4) to **15 N·m (11 lb ft)**.

Timing Chain and Sprocket Installation (6.2L)

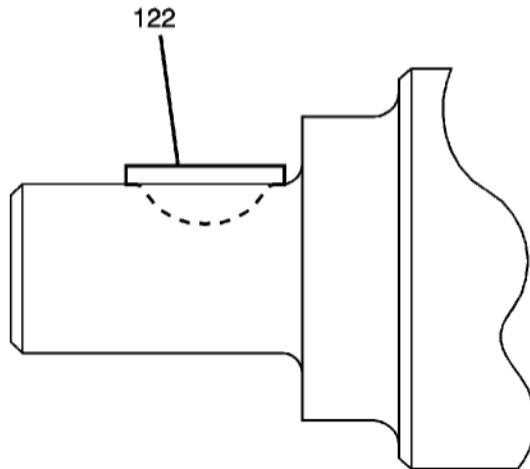
Special Tools

- *EN 46330* Timing Belt Tensioner Retaining Pin
- *J 41478* Crankshaft Front Oil Seal Installer
- *J 41665-1A* Crankshaft Balancer and Sprocket Installer
- *J 42386-A* Flywheel Holding Tool

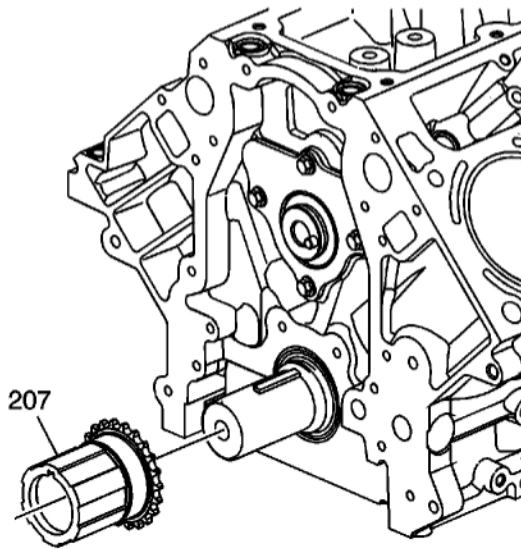
For equivalent regional tools, refer to [Special Tools](#)



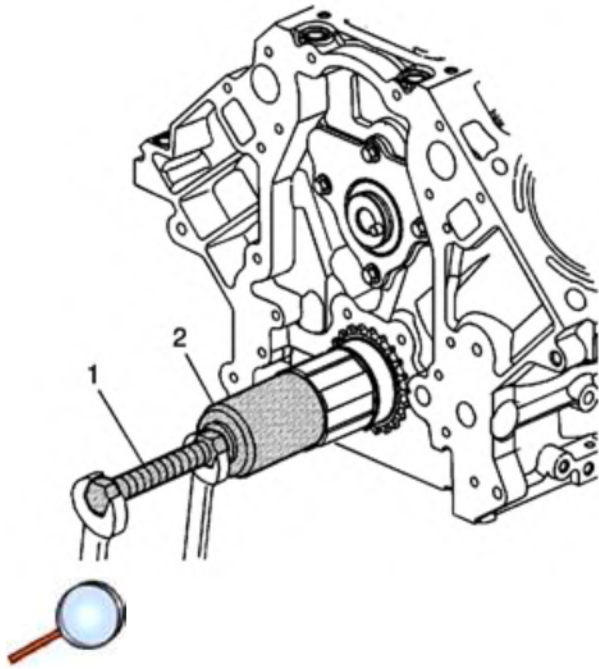
1. Install the key into the crankshaft keyway, if previously removed.



2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.



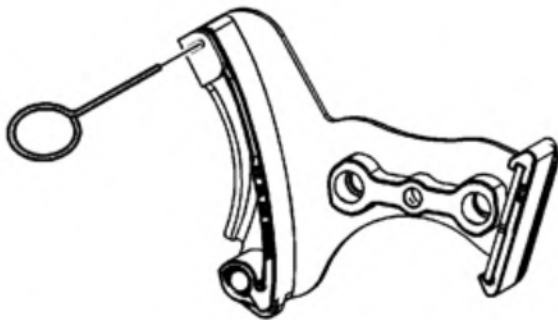
3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.



4. Use the *J 41478* installer (1) and the *J 41665-1A* installer (2) in order to install the crankshaft sprocket.

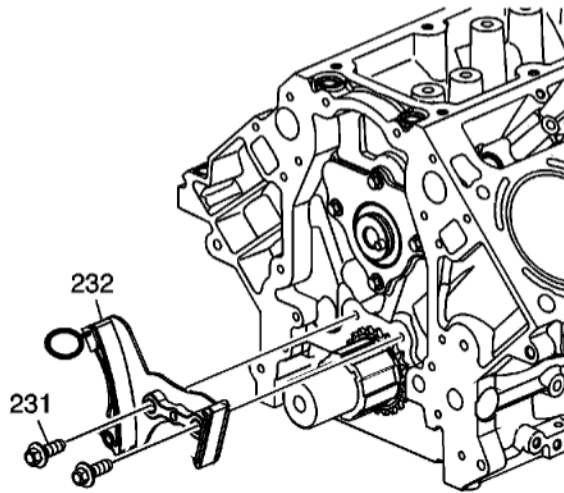
Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

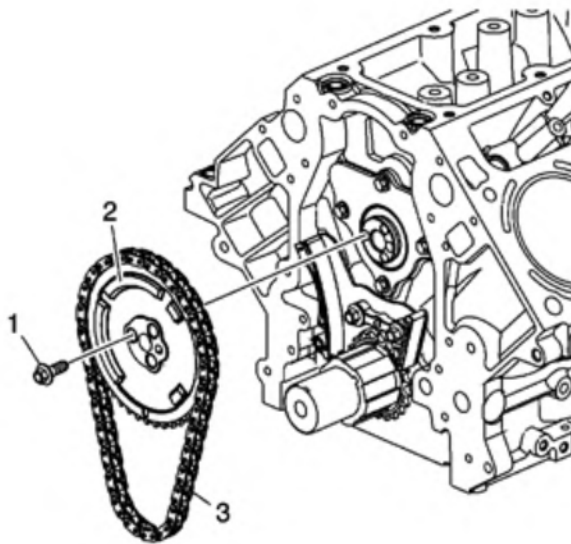


6. Compress the timing chain tensioner guide and install the *EN 46330* pin .

Caution: Refer to [Fastener Caution](#) in the Preface section.



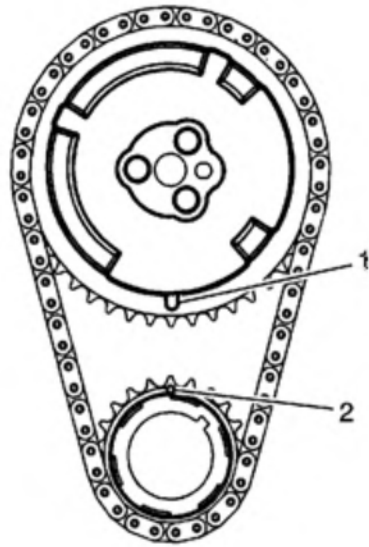
7. Install the timing chain tensioner (232) and bolts (231) and tighten to **25 N·m (18 lb ft)**.



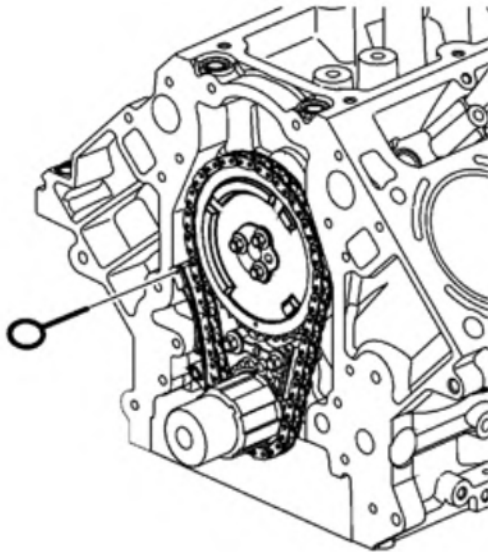
Note:

- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks **MUST** be aligned properly.

8. Install the camshaft sprocket (2), timing chain (3), and bolts (1).



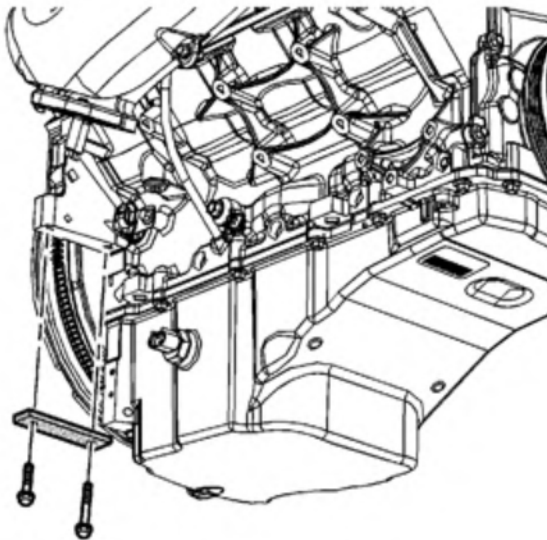
9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



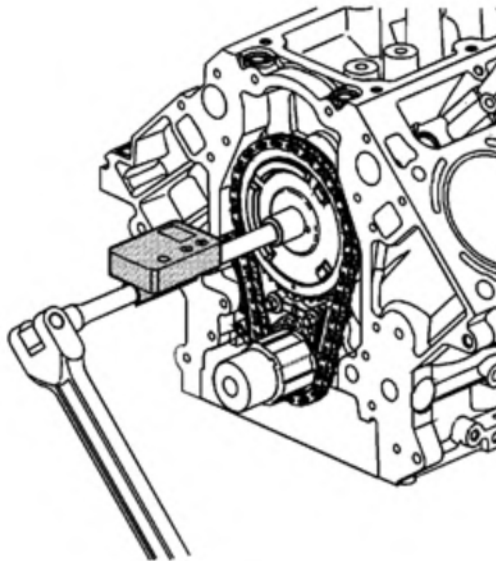
10. Remove the *EN 46330* pin .

Note: Do not apply threadlock to the flex plate bolts at this time.

11. Temporarily install the automatic transmission flex plate or manual transmission flywheel and bolts. Refer to [Engine Flywheel Installation](#).

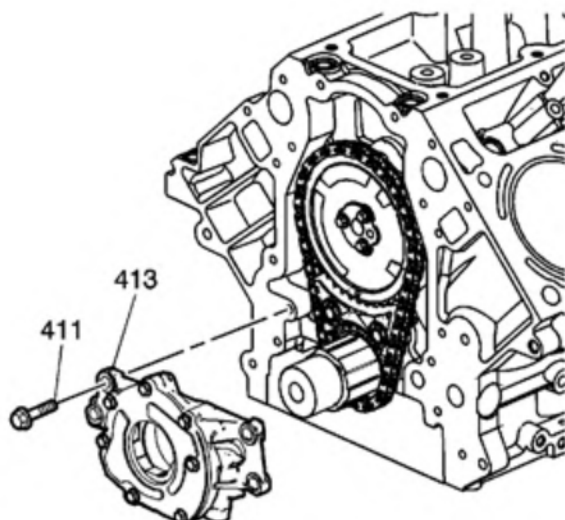


12. Install the *J 42386-A* tool and bolts. Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation. Tighten the *J 42386-A* tool bolts to **50 N·m (37 lb ft)**.



13. Tighten the camshaft sprocket bolts to **30 N·m (22 lb ft)**.
14. Remove the *J 42386-A* tool and bolts.
15. Remove the automatic transmission flex plate or manual transmission flywheel and bolts. Refer to [Engine Flywheel Removal](#).

Oil Pump, Screen and Crankshaft Oil Deflector Installation (6.2L)

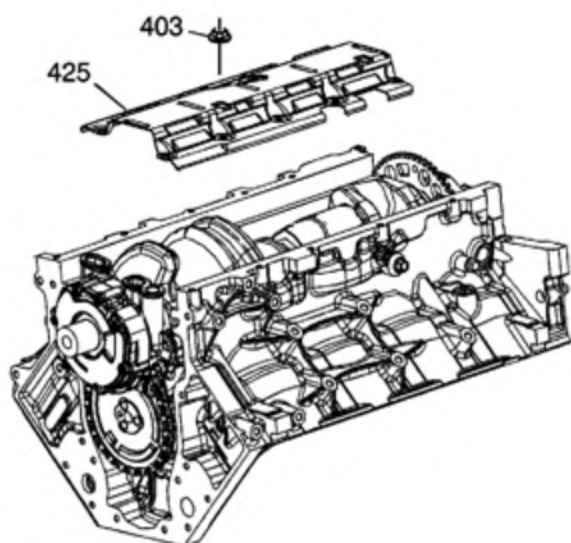


Note: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

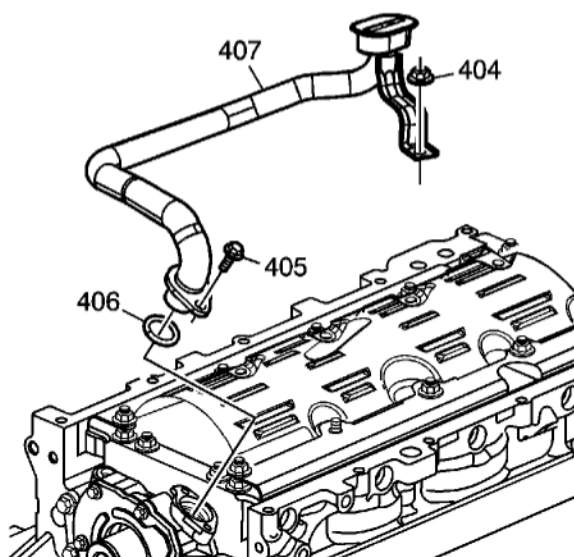
1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

Caution: Refer to [Fastener Caution](#) in the Preface section.

3. Install the oil pump bolts (411) and tighten to **25 N·m (18 lb ft)**.



4. Install the crankshaft oil deflector.



5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

Note:

- Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.
- Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.

7. Install the oil pump screen (407).
8. Install the oil pump screen bolt (405) and the deflector nut (404).

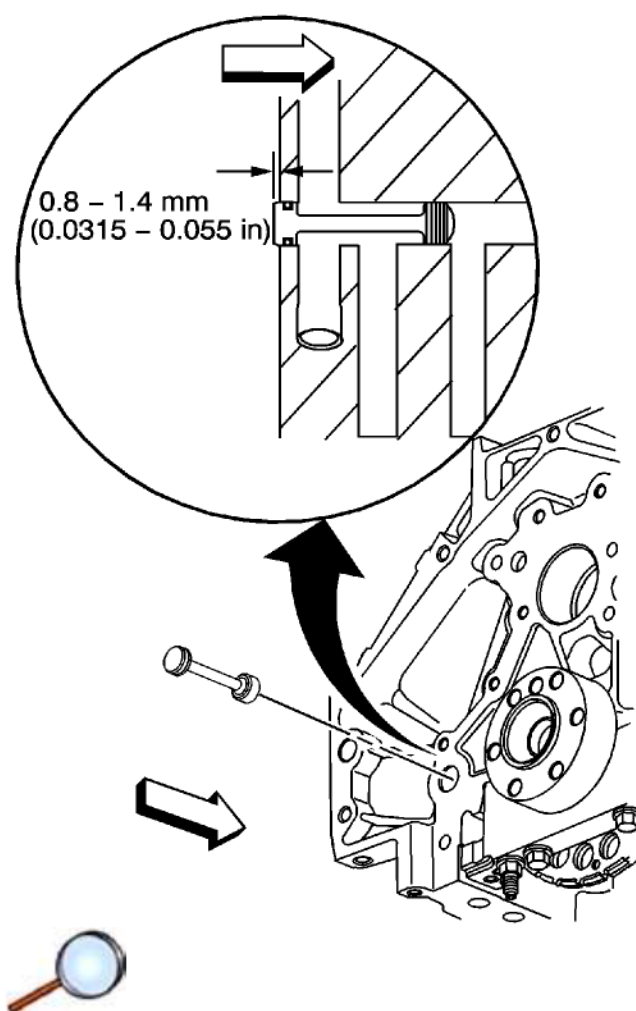
- 8.1. Tighten the oil pump screen bolt to **12 N·m (106 lb in)**.
- 8.2. Tighten the crankshaft oil deflector nut to **25 N·m (18 lb ft)**.

Crankshaft Rear Oil Seal Housing Installation (Without Seal in Housing)

Special Tools

- J 41476 Front and Rear Cover Alignment Tool
- J 41480 Front and Rear Cover Alignment

For equivalent regional tools, refer to [Special Tools](#).



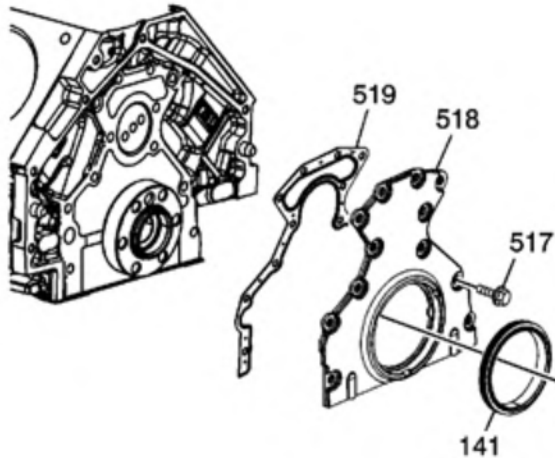
Note:

- Do not use the crankshaft rear oil seal or the engine rear housing gasket again.
- Do not apply any type of sealant to the rear housing gasket, unless specified.
- The special tools in this procedure are used to properly align the engine rear housing at the oil pan surface and to center the crankshaft rear oil seal.
- The crankshaft r sing has been installed

and aligned. Install the rear housing without the crankshaft oil seal.

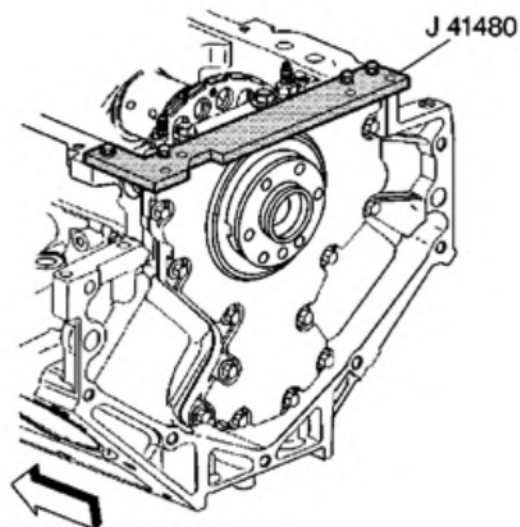
- The crankshaft rear oil seal **MUST** be centered in relation to the crankshaft.
- The oil pan sealing surface at the rear housing, and the engine block, **MUST** be aligned within specifications.
- An improperly aligned rear housing may cause premature rear oil seal wear and/or engine assembly oil leaks.

1. Inspect the rear oil gallery plug for proper installation.



2. Install the rear housing gasket (519), rear housing (518), and bolts (517).
3. Tighten the bolts finger tight. Do not overtighten.

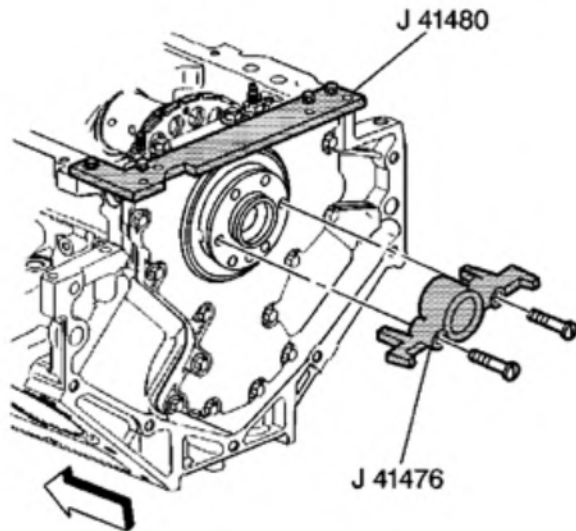
Caution: Refer to [Fastener Caution](#) in the Preface section.





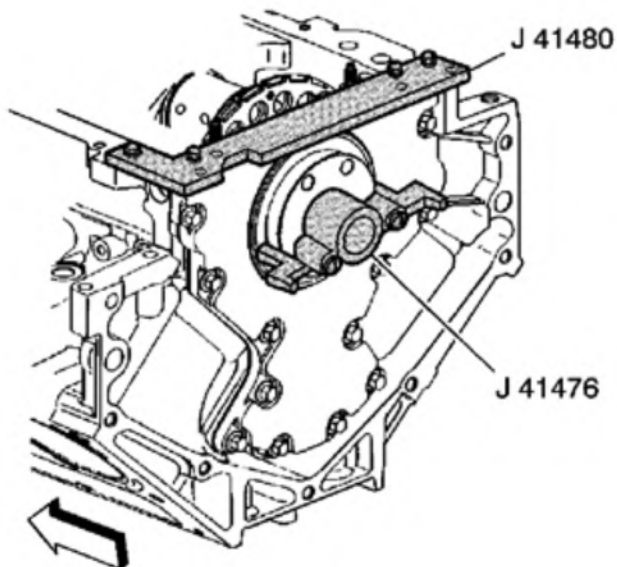
Note: Start the *J 41480* alignment tool-to-rear housing bolts. Do not tighten the bolts at this time.

4. Install the *J 41480* alignment and bolts. Tighten the tool-to-engine block bolts to **25 N·m (18 lb ft)**.



Note: To properly align the rear housing, the *J 41476* tool must be installed onto the rear of the crankshaft with the tool mounting bolts parallel to the oil pan surface.

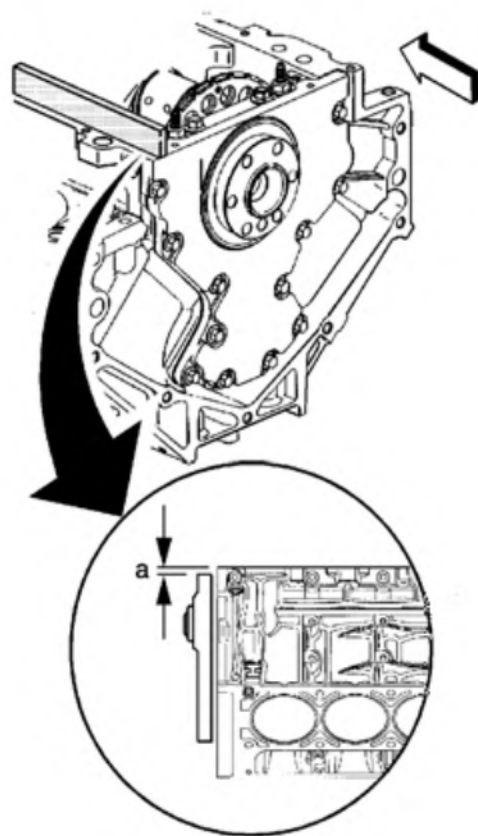
5. Rotate the crankshaft until 2 opposing flywheel bolt holes are parallel to the oil pan surface.





Note: The tapered legs of the alignment tool must enter the rear housing oil seal bore.

6. Install the *J 41476* tool and bolts onto the rear of the crankshaft.
 - 6.1. Tighten the tool mounting bolts until snug. Do not overtighten.
 - 6.2. Tighten the *J 41480* alignment tool-to-rear housing bolts evenly to **12 N·m (106 lb in)**.
 - 6.3. Tighten the rear housing bolts to **30 N·m (22 lb ft)**.
7. Remove the tools.



8. Measure the rear housing-to-engine block oil pan surface for flatness.
 - 8.1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.
 - 8.2. Insert a feeler gage between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.5 mm (0.02 in) below flush (a).
9. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
10. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be

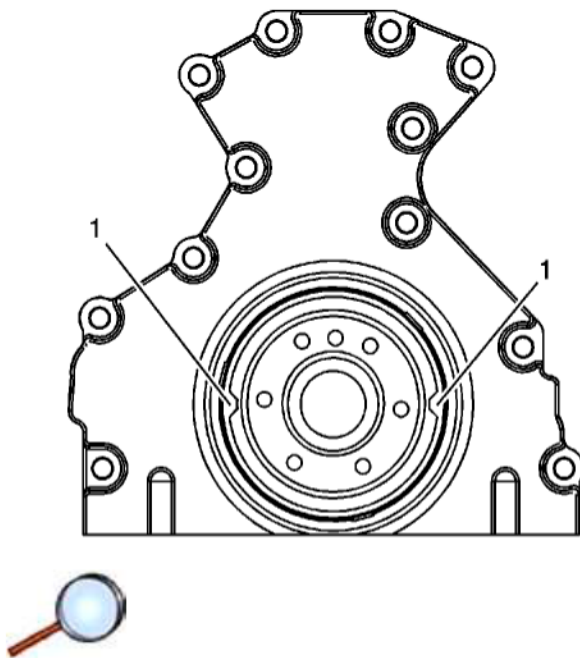
obtained, replace the rear housing.

Crankshaft Rear Oil Seal Housing Installation (With Seal in Housing)

Special Tools

- J 41479-2A Crankshaft Rear Oil Seal Installation Guide
- J 41480 Front and Rear Cover Alignment

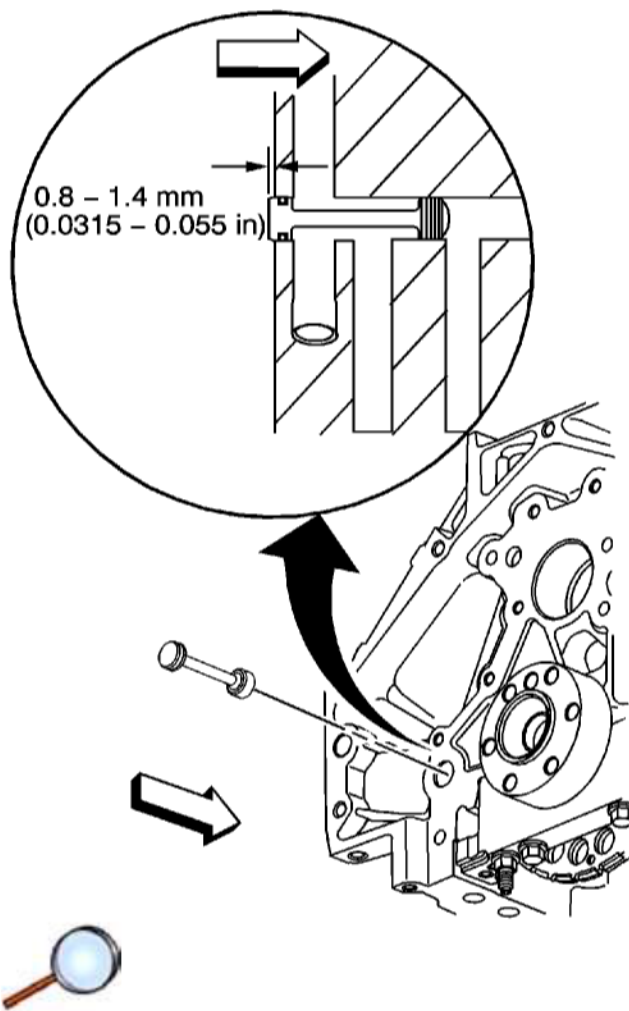
For equivalent regional tools, refer to [Special Tools](#)



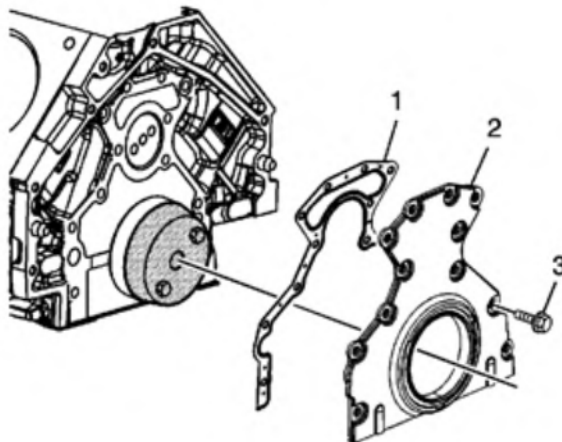
Note:

- Do not use the crankshaft rear oil seal or the engine rear housing gasket again.
- Do not apply any type of sealant to the rear housing gasket, unless specified.
- The special tool in this procedure is used to properly align the engine rear housing at the oil pan surface.
- First design rear housings do not have alignment tabs for alignment of the housing horizontally. J 41476 tool is required to properly align first design rear housings. The rear oil seal must be removed from the housing for proper use of the tool.
- Second design rear housings have alignment tabs for alignment of the housing horizontally. J 41476 tool is not required for proper alignment of second design rear housings. The housing may be installed and aligned with the seal already installed into the housing.

1. Inspect the rear housing to identify for alignment tabs (1).



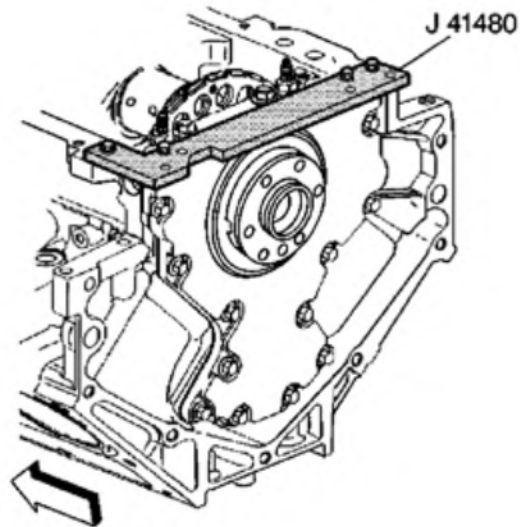
2. Inspect the rear oil gallery plug for proper installation.



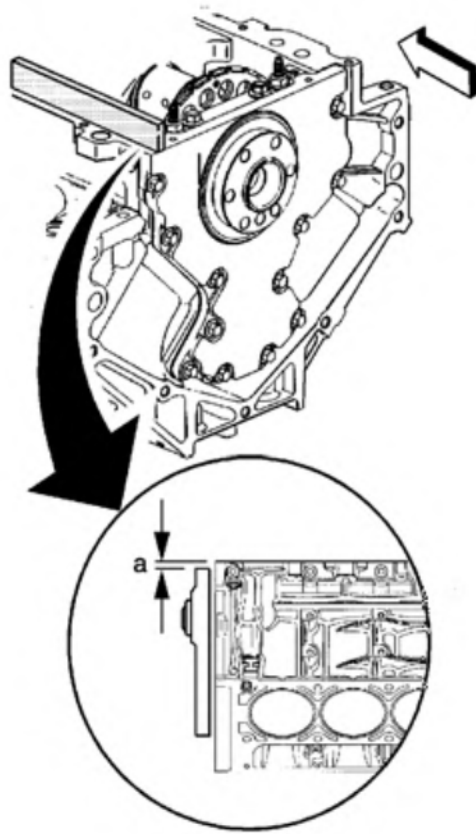
3. Install the J 41479-2A guide cone and bolts onto the rear of the crankshaft.
 4. Tighten the bolts until snug. Do not overtighten.
 5. Install the rear housing gasket (1), rear housing with seal (2), and bolts (3).

6. Tighten the bolts finger tight. Do not overtighten.
7. Remove the *J 41479-2A* guide and bolts.

Caution: Refer to [Fastener Caution](#) in the Preface section.



8. Install the *J 41480* alignment and bolts.
 - 8.1. Tighten the tool-to-engine block bolts to **25 N·m (18 lb ft)**.
 - 8.2. Tighten the *J 41480* alignment tool-to-rear housing bolts evenly to **12 N·m (106 lb in)**.
 - 8.3. Tighten the rear housing-to-engine block bolts to **30 N·m (22 lb ft)**.
9. Remove the *J 41480* alignment and bolts.



10. Measure the rear housing-to-engine block oil pan surface for flatness.
 - 10.1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

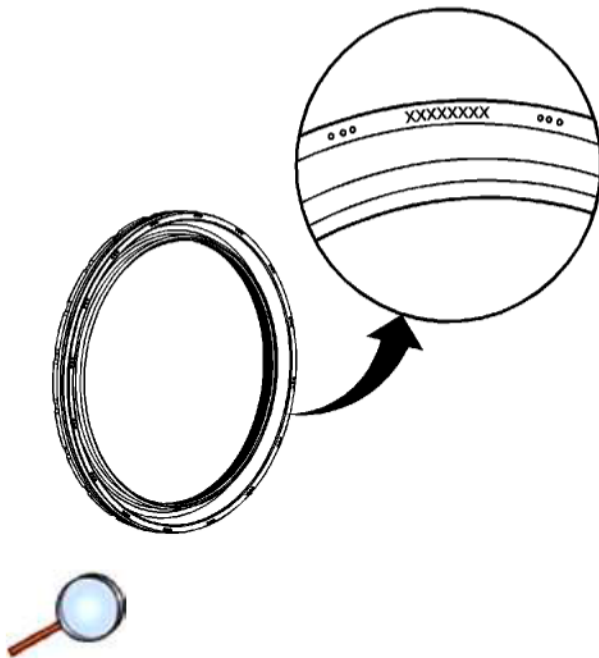
Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

- 10.2. Insert a feeler gage between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.5 mm (0.02 in) (a) below flush.
11. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
12. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

Crankshaft Rear Oil Seal Installation

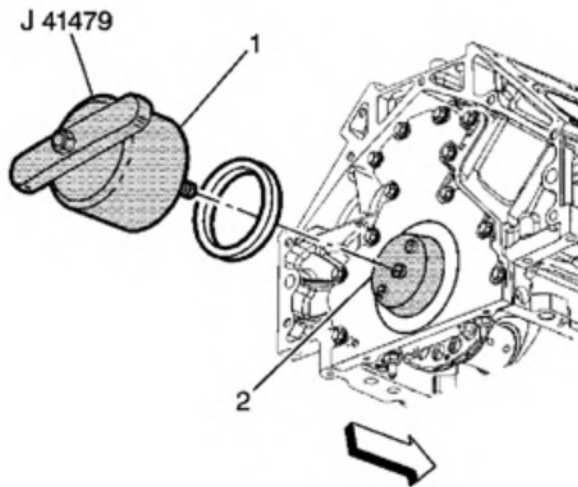
Special Tools

- [J 41479](#) Crankshaft Rear Oil Seal Installer
- [J 41479-2A](#) Crankshaft Rear Oil Seal Installation Guide



Important: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.



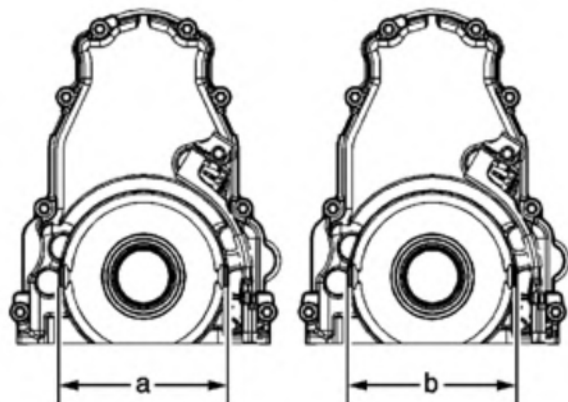
2. Install the [J 41479](#) or the [J 41479-2A](#) cone (2) and bolts onto the rear of the crankshaft. The [J 41479-2A](#) may be required for manual transmission or 5.3L LS4 applications.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the [J 41479](#) threaded rod into the tapered cone until the tool (1) contacts the oil seal.
6. Align the oil seal onto the tool (1).
7. Rotate the handle of the tool (1) clockwise until the seal enters the rear housing and bottoms into the seal bore.
8. Remove the tool.

Engine Front Cover Installation (without Camshaft Position Actuator)

Special Tools

- *EN-48853* Front Cover Alignment Tool
- *J 41480* Front and Rear Cover Alignment

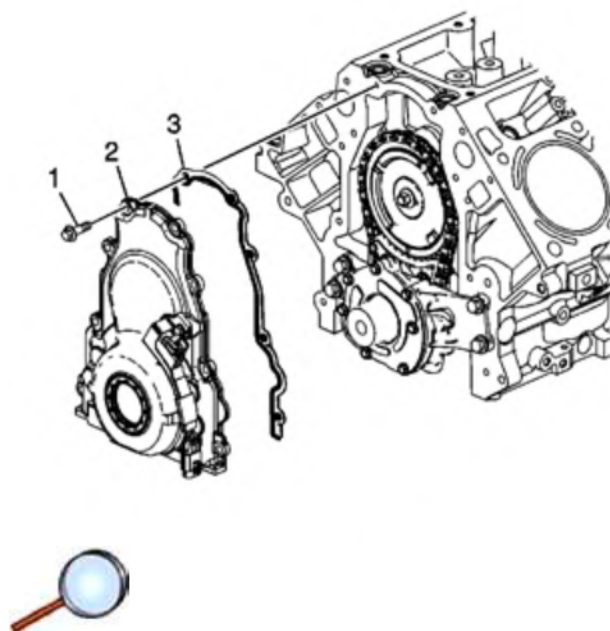
For equivalent regional tools, refer to [Special Tools](#)



1. Measure the alignment tab distance on the front cover.

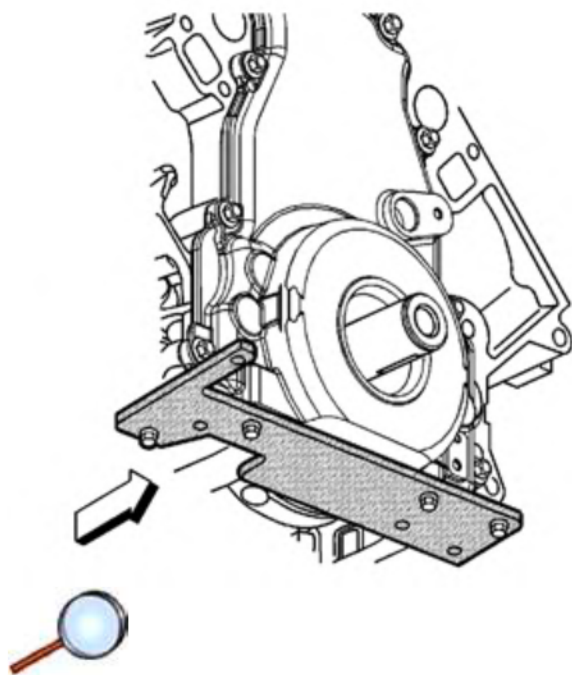
For 2009 model year, the engine front cover may have either a 141 mm (5.55 in) dimension (a) or 159 mm (6.26 in) dimension (b) alignment tab distance. Front cover alignment tool *EN-48853* tool is designed to properly align both front covers. For the 141 mm (5.55 in) cover, adapters *EN 48853-2* must be used.

Caution: Refer to [Fastener Caution](#) in the Preface section.

**Note:**

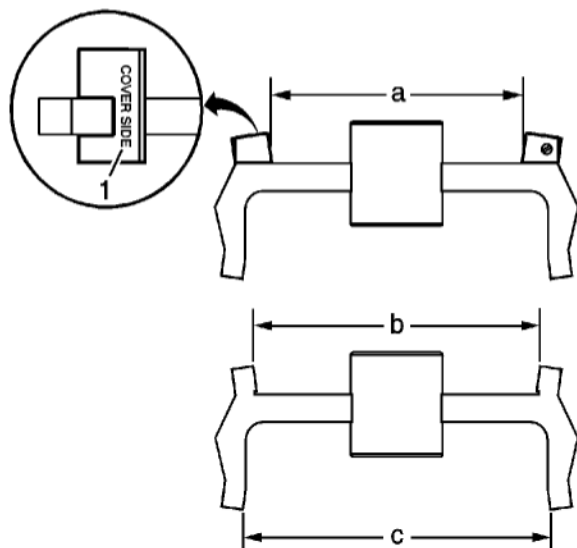
- Do not use the crankshaft oil seal or the engine front cover gasket again.
- Do not apply any type of sealant to the front cover gasket, unless specified.
- The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.
 - All gasket surfaces should be free of oil or other foreign material during assembly.
 - The crankshaft front oil seal **MUST** be centered in relation to the crankshaft.
 - The oil pan sealing surface at the front cover and engine block **MUST** be aligned within specifications.
 - An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.

2. Install the front cover gasket (3), front cover (2), and bolts (1).
3. Tighten the cover bolts finger tight. Do not overtighten.

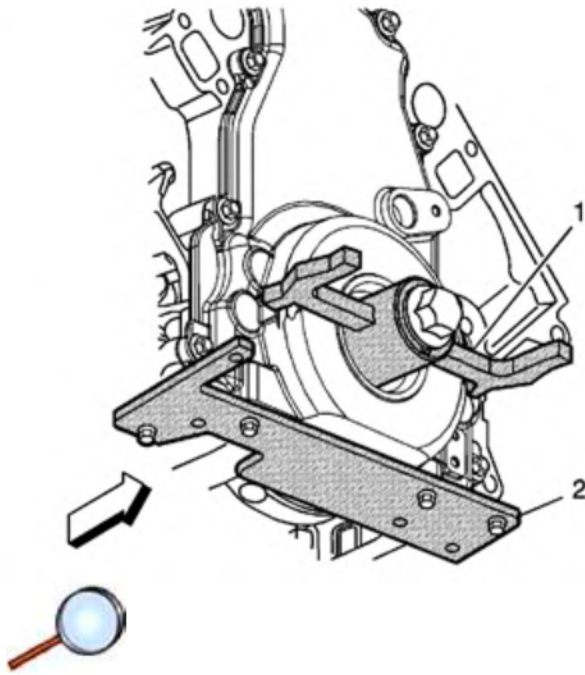


Note: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

4. Install the *J 41480* cover alignment and tighten the tool-to-engine block bolts to **25 N·m (18 lb ft)**.

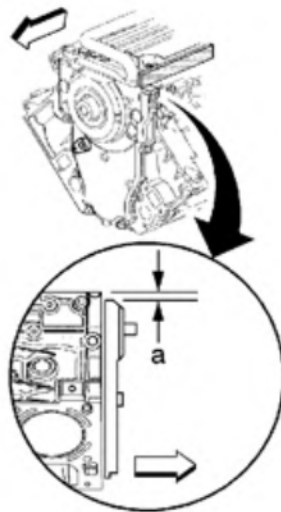


5. Install the EN 48853-2 adapters as required for usage on the 141 mm (5.55 in) dimension (a) front cover. Position the adapters against the legs of the *EN-48853* tool with the words "cover side" (1) facing away from the tool.



Note: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

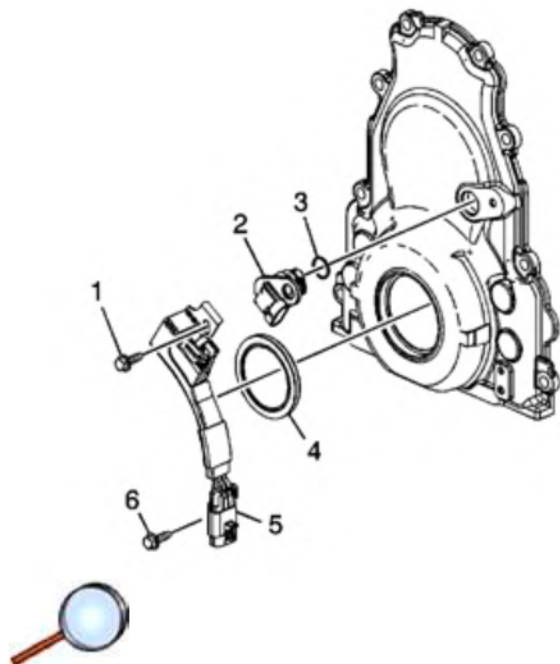
6. Install the *EN-48853* tool (1).
7. Install the crankshaft balancer bolt.
8. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
9. Tighten the *J 41480* alignment (2).
10. Tighten the engine front cover bolts to **25 N·m (18 lb ft)**.
11. Remove the tools.



12. Measure the oil pan surface flatness, front cover-to-engine block.
 - 12.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

- 12.2. Insert a feeler gage between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no greater than 0.5 mm (0.02 in) (a) below flush.
13. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
14. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.



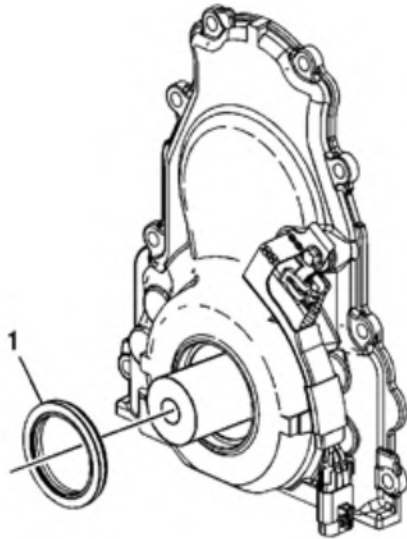
15. Inspect the camshaft position (CMP) sensor O-ring seal (3) for cuts or damage. If the seal is not cut or damaged, it may be used again.
16. Lubricate the O-ring seal with clean engine oil.
17. Install the O-ring seal onto the sensor (2).
18. Install the sensor to the cover.
19. Install the CMP sensor wire harness (5) and bolts (1, 6).

Crankshaft Front Oil Seal Installation

Special Tools

- EN-47812 Installer Bolt
- J 41478 Crankshaft Front Oil Seal Installer
- J 41478-1A Crankshaft Front Oil Seal Installer Cone

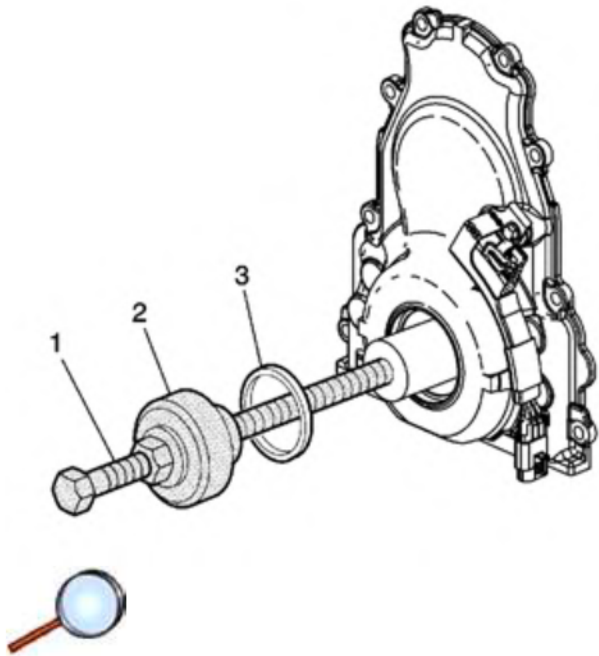
For equivalent regional tools, refer to [Special Tools](#)



Note:

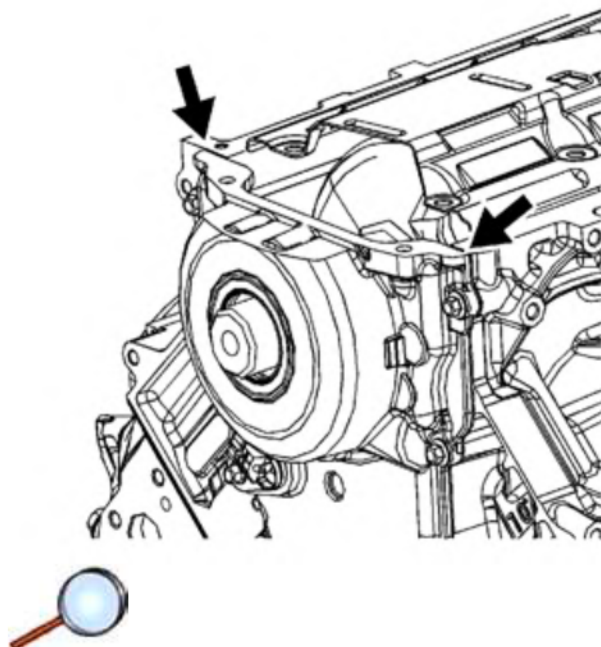
- Do not lubricate the oil seal sealing surface.
- Do not use the crankshaft front oil seal again.

1. Lubricate the outer edge of the oil seal (1) with clean engine oil.
2. Lubricate the front cover oil seal bore with clean engine oil.



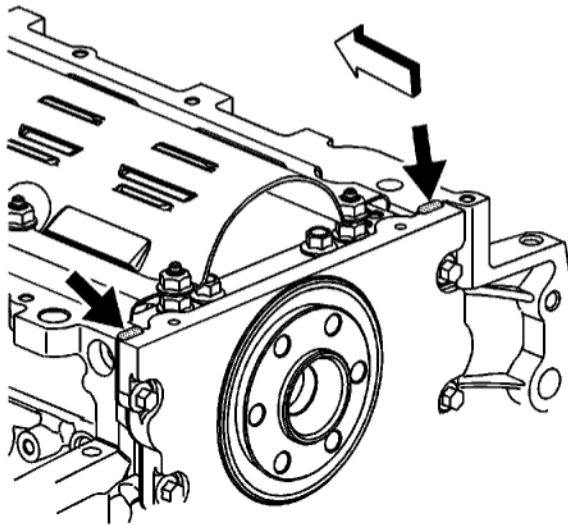
3. Using the *EN-47812* bolt and the *J 41478* installer , install the crankshaft front oil seal.
4. Install the *EN-47812* bolt threaded rod (1), nut, washer, the *J 41478-1A* installer cone (2), and oil seal (3) into the end of the crankshaft.
5. Use the *J 41478* installer in order to install the oil seal into the cover bore.
 - 5.1. Use a wrench and hold the hex on the installer bolt.
 - 5.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
 - 5.3. Remove the tool.
 - 5.4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

Oil Pan Installation

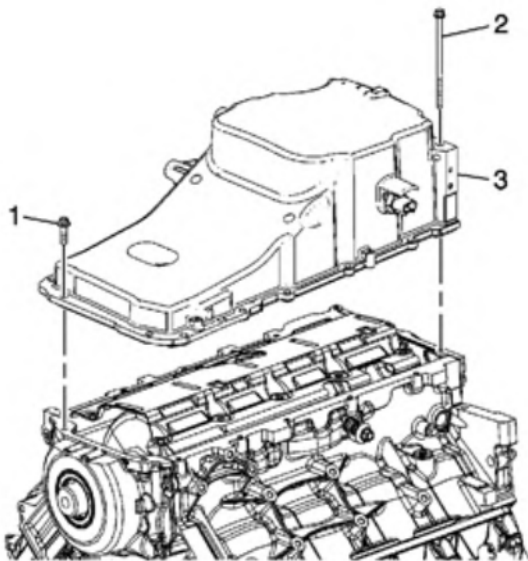


Note:

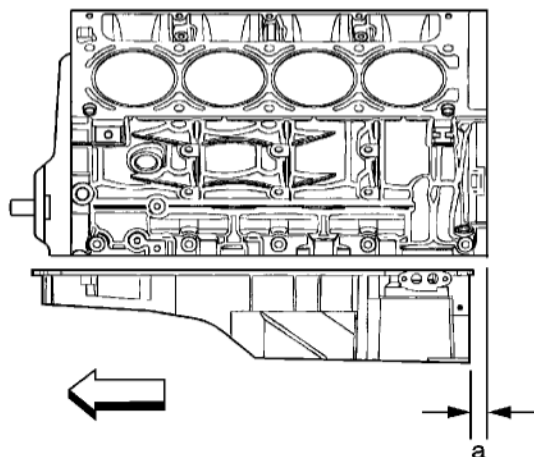
- The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush, or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.
 - Do not use the oil pan gasket again.
 - It is not necessary to rivet the NEW gasket to the oil pan.
1. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).



2. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the rear housing gasket that protrude into the oil pan surface.



3. Pre-assemble the oil pan gasket to the pan.
 - 3.1. Install the gasket onto the oil pan.
 - 3.2. Install the oil pan bolts (1, 2) to the pan and through the gasket.
4. Install the oil pan (3), gasket and bolt to the engine block.
5. Tighten the bolts finger tight. Do not overtighten.



6. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.

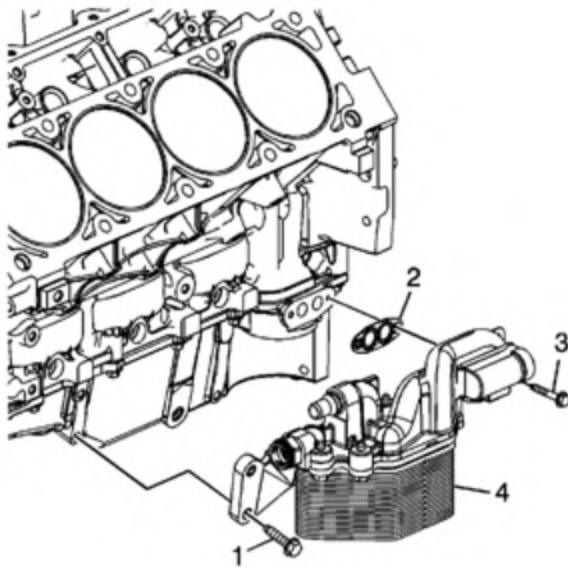
Caution: Refer to [Fastener Caution](#) in the Preface section.

7. Align the oil pan until the rear of the engine block and the rear of the oil pan are flush, or even.
8. Tighten the oil pan-to-block and oil pan-to-front cover bolts to **25 N·m (18 lb ft)**.
9. Tighten the oil pan-to-rear cover bolts to **12 N·m (106 lb in)**.
10. Measure the oil pan-to-engine block alignment.
 - 10.1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

Note: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

- 10.2. Insert a feeler gage between the straight edge and the oil pan transmission housing mounting surface. The rear of oil pan must be flush with the rear face of block or no greater than 0.5 mm (0.02 in) below flush (a).
- 10.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

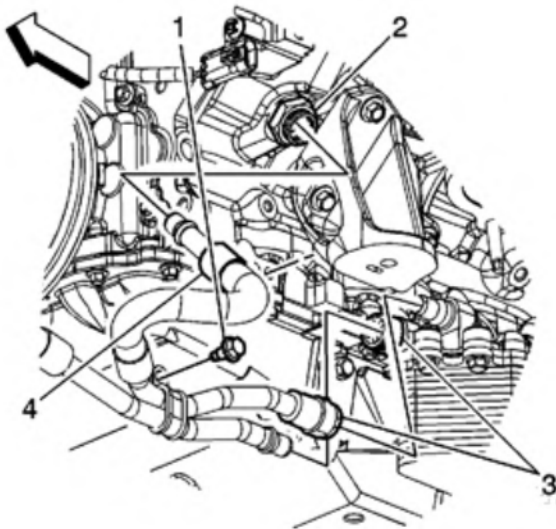
Engine Oil Cooler Installation



1. Install the oil cooler gasket (2).
2. Install the oil cooler (4).

Caution: Refer to [Fastener Caution](#) in the Preface section.

3. Install the oil cooler M8 (1) and M6 (3) bolts.
4. Tighten the M6 bolts to **10 N·m (89 lb in)**.
5. Tighten the M8 bolts to **25 N·m (18 lb ft)**.

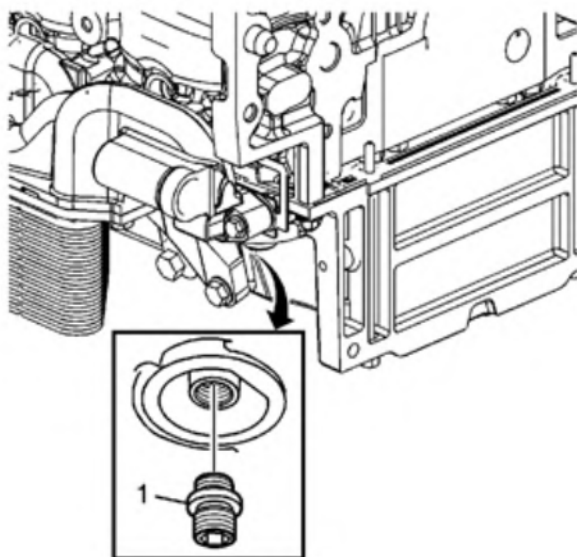




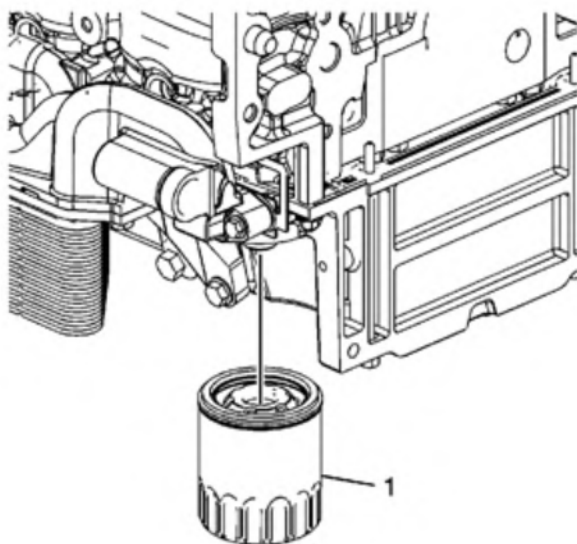
6. Install the engine oil cooler coolant fitting (2) to the block, as required and tighten to **60 N·m (44 lb ft)**.
7. Install the hose/pipe (4) to the fitting (2) and cooler (3).
8. Install the bolt and tighten to **25 N·m (18 lb ft)**.

Oil Filter Installation

Caution: Refer to [Fastener Caution](#) in the Preface section.

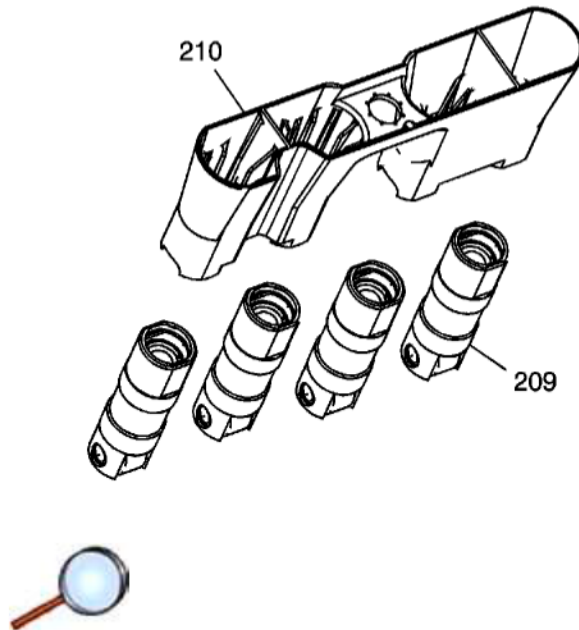


1. Install the oil filter fitting (1) and tighten to **55 N·m (40 lb ft)**.



2. Lubricate the oil filter seal with clean engine oil.
3. Install the oil filter (1) and tighten to **30 N·m (22 lb ft)**.

Valve Lifter Installation

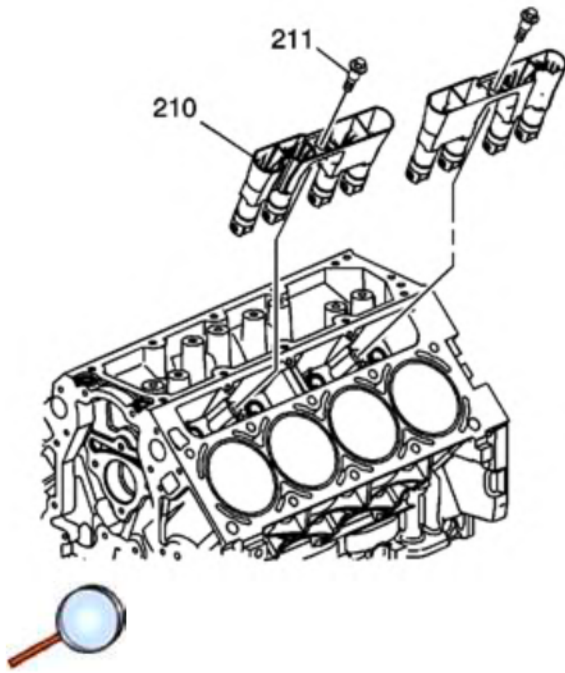


Important:

- When using the valve lifters again, install the lifters to their original locations.
- If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210).

Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.



3. Install the valve lifters and guide assembly (210) to the engine block.

Caution: Refer to [Fastener Caution](#) in the Preface section.

4. Install the valve lifter guide bolts (211).

Tighten

Tighten the valve lifter guide bolts to 12 N·m (106 lb in).

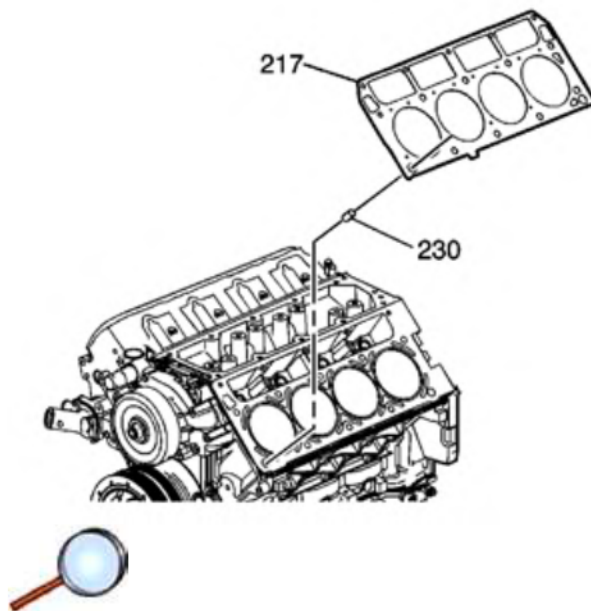
Cylinder Head Installation - Left Side

Special Tools

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter

For equivalent regional tools, refer to [Special Tools](#)

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.



Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

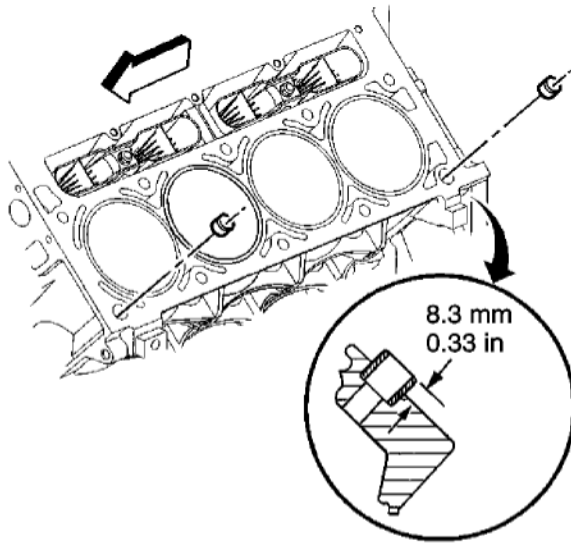
Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets must be installed in the proper direction and position.

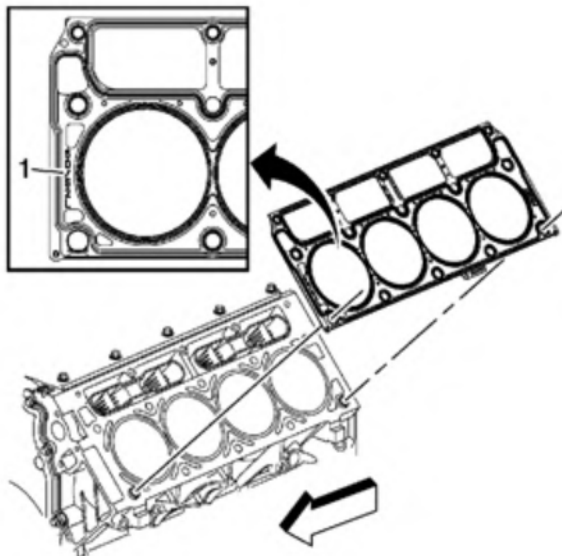
1. Clean the engine block cylinder head bolt holes, if required.

Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

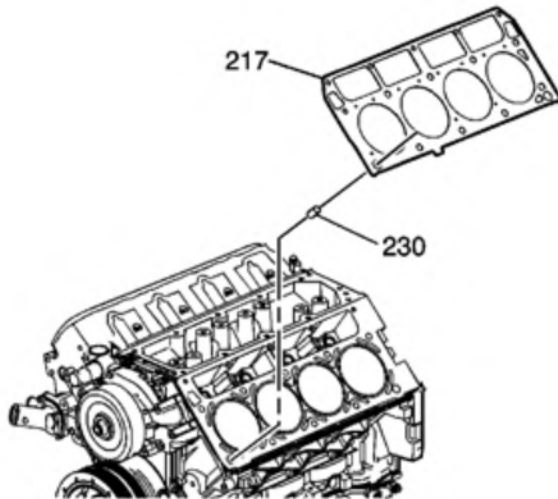
2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).



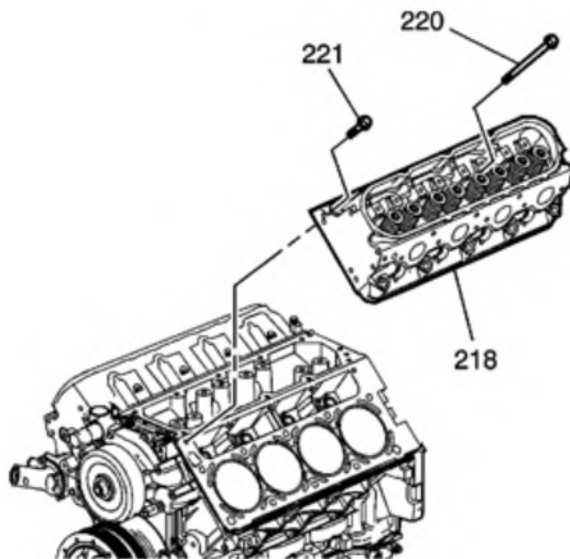
5. Inspect the locating pins for proper installation.



6. Inspect the displacement markings on the gasket for proper usage.

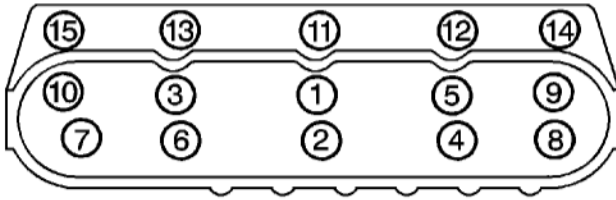


7. Install the NEW cylinder head gasket (217) onto the locating pins.



8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

Caution: Refer to [Fastener Caution](#) in the Preface section.



10. Tighten the cylinder head bolts.
 - 10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **50 N·m (37 lb ft)**.
 - 10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **80 degrees** using the *J 45059* meter .
 - 10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **55 degrees** using the *J 45059* meter .
 - 10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N·m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

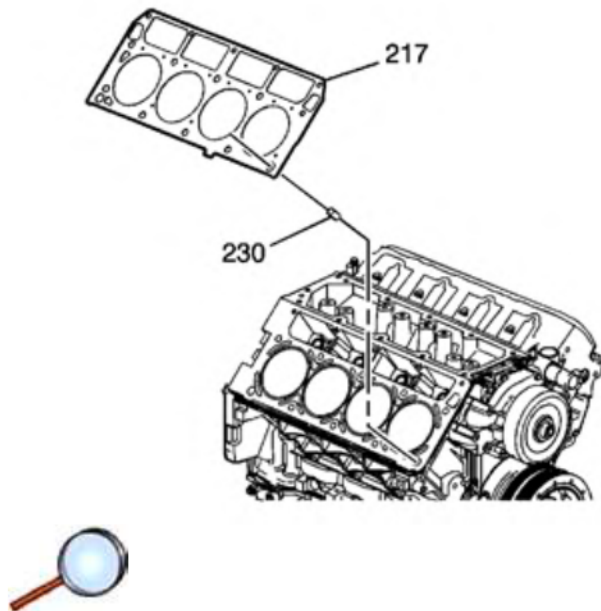
Cylinder Head Installation - Right Side

Special Tools

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter

For equivalent regional tools, refer to [Special Tools](#)

Warning: Refer to [Safety Glasses Warning](#) in the Preface section.



Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

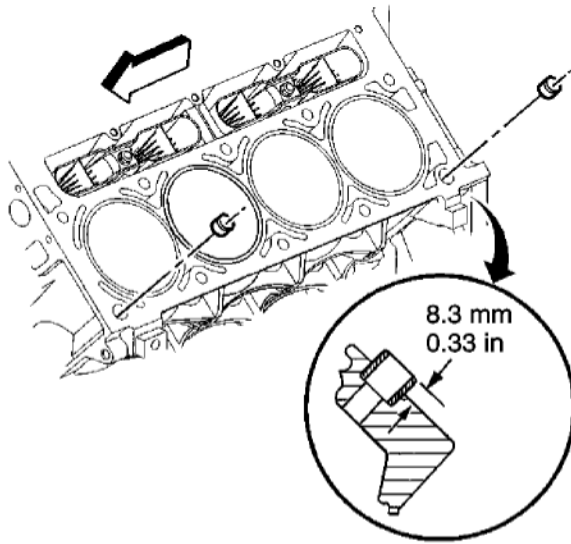
Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets must be installed in the proper direction and position.

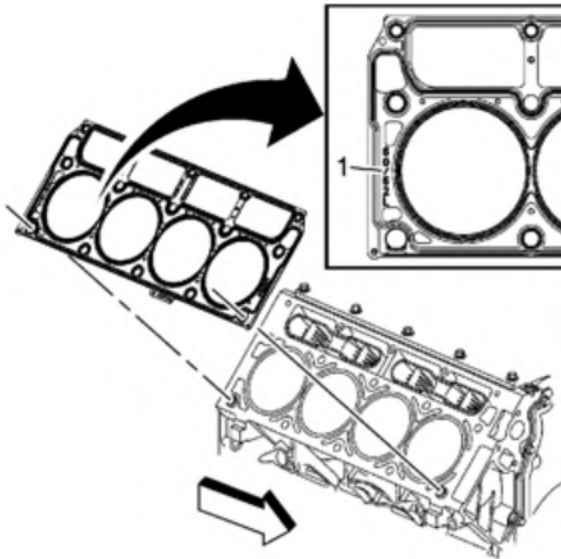
1. Clean the engine block cylinder head bolt holes, if required.

Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

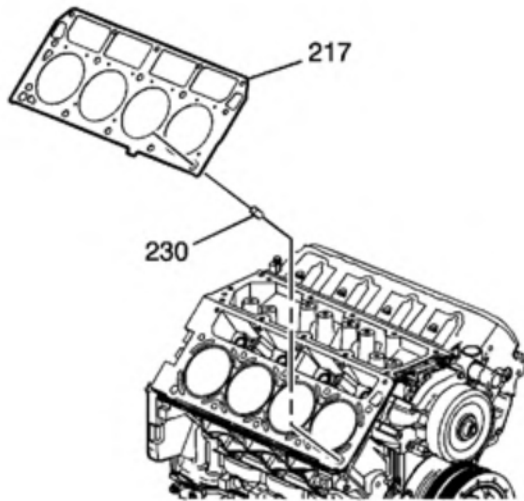
2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).



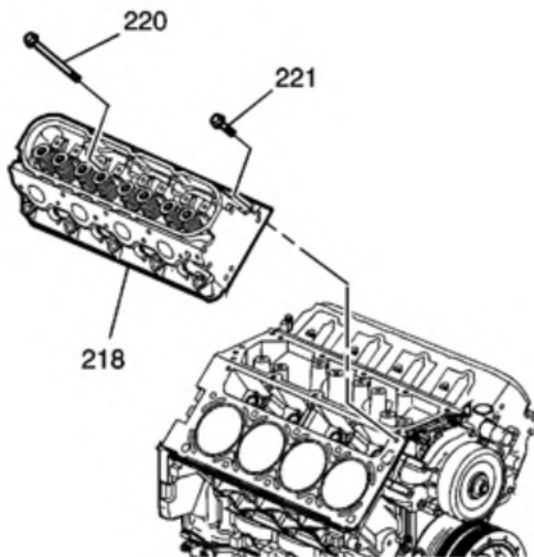
5. Inspect the locating pins for proper installation.



6. Inspect the displacement markings on the gasket for proper usage.

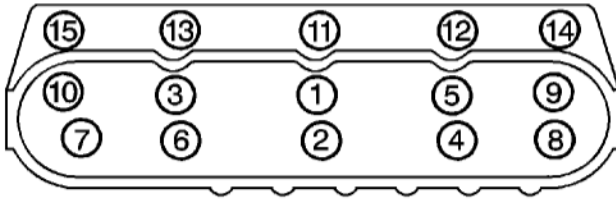


7. Install the NEW cylinder head gasket (217) onto the locating pins.



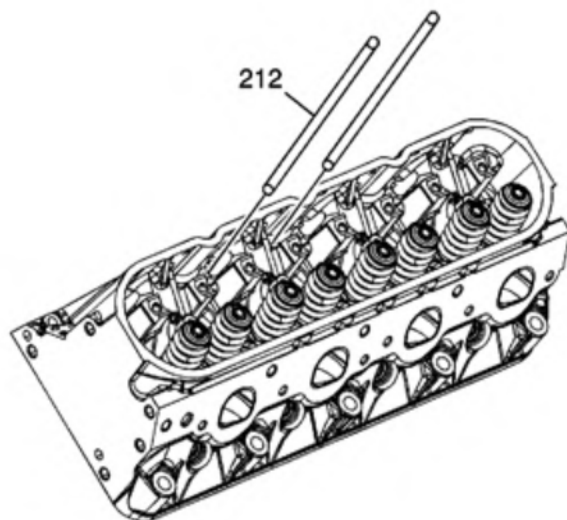
8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

Caution: Refer to [Fastener Caution](#) in the Preface section.



10. Tighten the cylinder head bolts.
 - 10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **50 N·m (37 lb ft)**.
 - 10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **80 degrees** using the *J 45059* meter .
 - 10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **55 degrees** using the *J 45059* meter .
 - 10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N·m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Valve Rocker Arm and Push Rod Installation



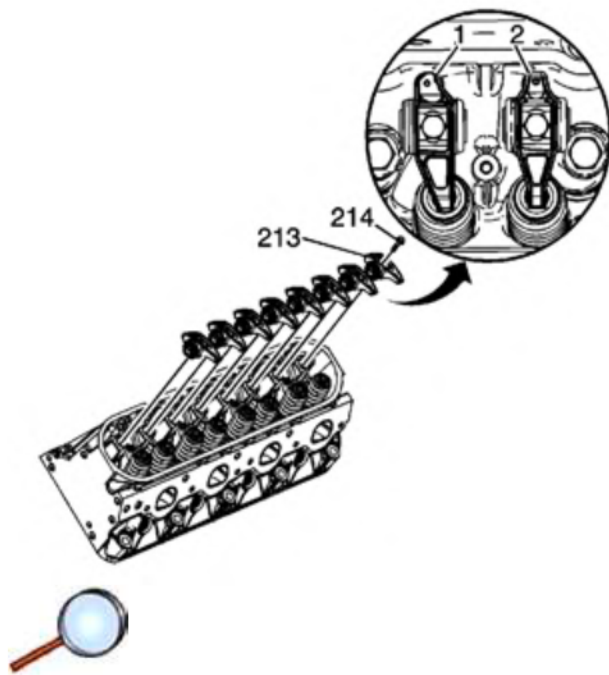
Note:

- When using the valve train components again, always install the components to the original location and position.
- Valve lash is net build, no valve adjustment is required.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.

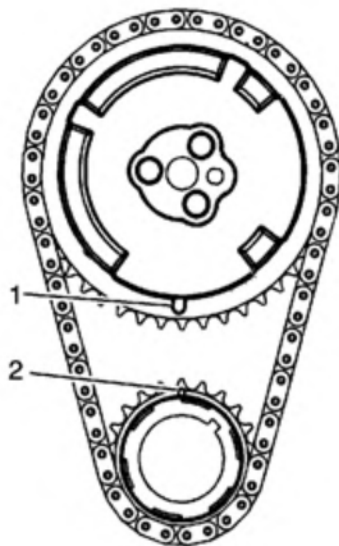
Note: Ensure the pushrods seat properly to the valve lifter sockets.

3. Install the pushrods (212).

**Note:**

- Ensure the pushrods seat properly to the ends of the rocker arms.
- DO NOT tighten the rocker arm bolt at this time.

4. Install the rocker arms (213) and bolts (214). Note the locations of the intake (1) and exhaust (2) valve rocker arms. The intake rocker arms (1) have an offset design.



5. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock positions. If viewing from the rear of the engine, the

additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

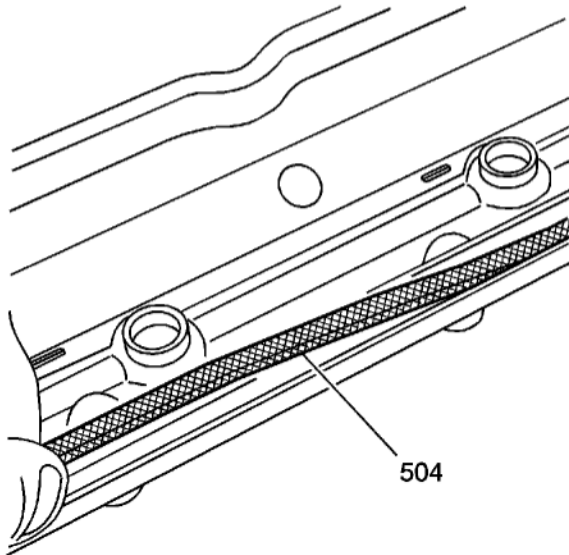
Cylinders 1, 3, 5 and 7 are left bank.

Cylinders 2, 4, 6, and 8 are right bank.

Caution: Refer to [Fastener Caution](#) in the Preface section.

6. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
 - Tighten exhaust valve rocker arm bolts 1, 2, 7, and 8 to **30 N·m (22 lb ft)**.
 - Tighten intake valve rocker arm bolts 1, 3, 4, and 5 to **30 N·m (22 lb ft)**.
7. Rotate the crankshaft 360 degrees.
8. Tighten the following valve rocker arm bolts:
 - Tighten exhaust valve rocker arm bolts 3, 4, 5, and 6 to **30 N·m (22 lb ft)**.
 - Tighten intake valve rocker arm bolts 2, 6, 7, and 8 to **30 N·m (22 lb ft)**.

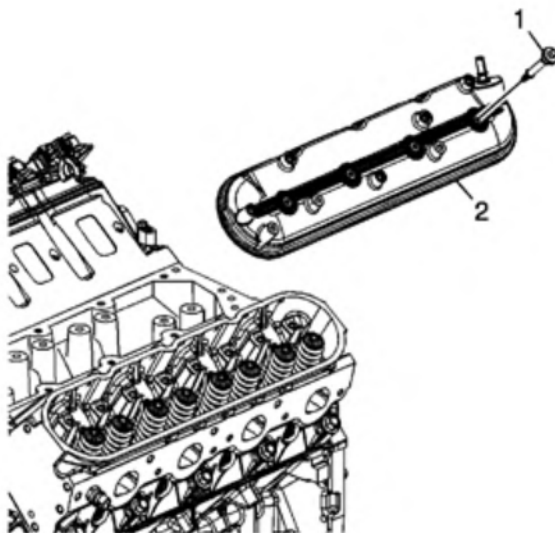
Valve Rocker Arm Cover Installation - Left Side



Note:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.

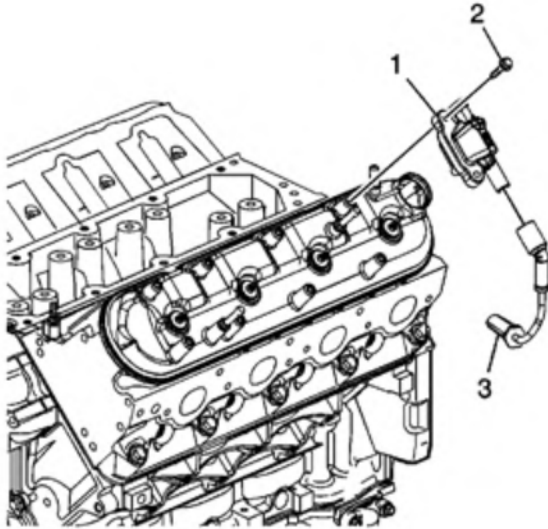




3. Install the valve rocker arm cover (2) onto the cylinder head.

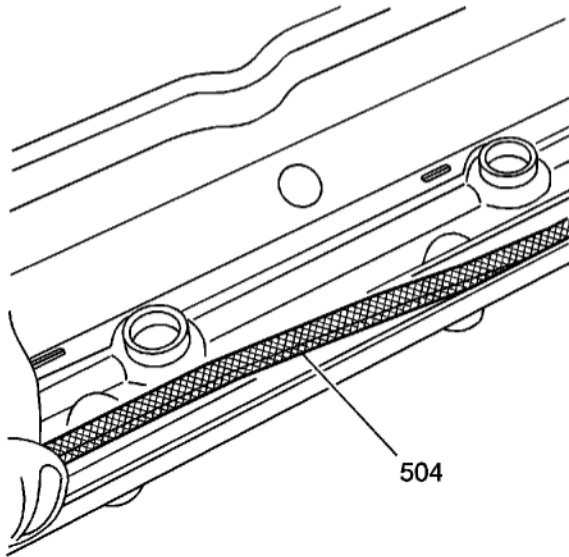
Caution: Refer to [Fastener Caution](#) in the Preface section.

4. Install the cover bolts (1) with grommets and tighten to **12 N·m (106 lb in)**.



5. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (2).
6. Install the ignition coils (1) and bolts (2) and tighten to **12 N·m (106 lb in)**.
7. Install the spark plug wires (3).

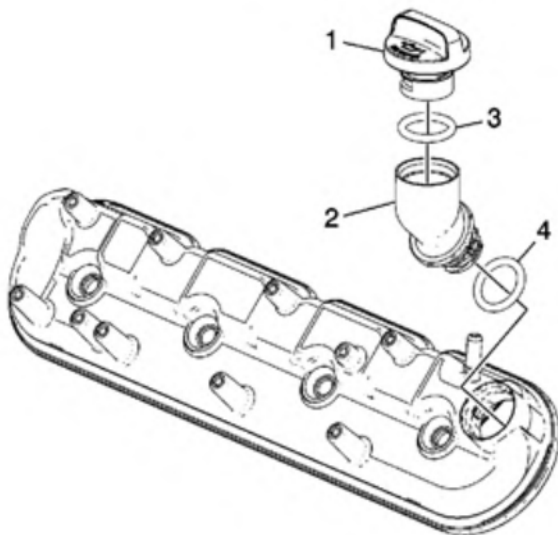
Valve Rocker Arm Cover Installation - Right Side



Note:

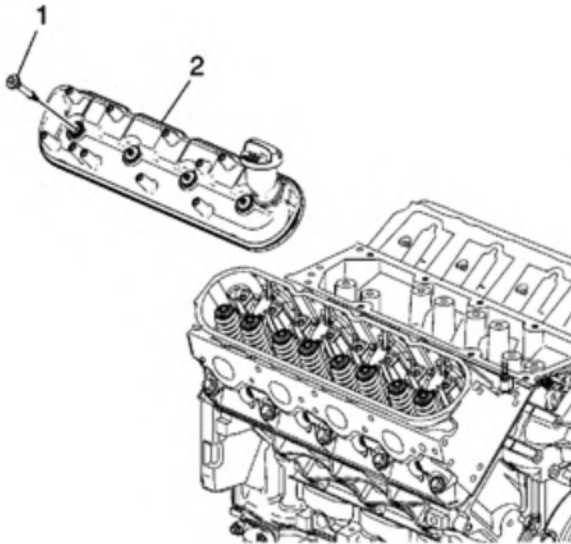
- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.





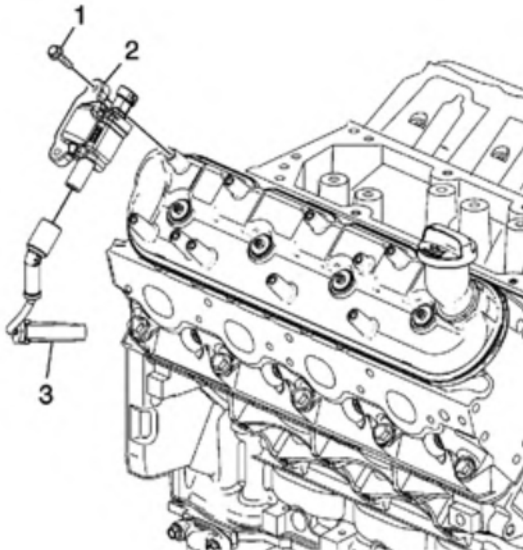
3. Install a NEW oil cap (1), oil fill tube (2) and seals (3, 4) to the valve rocker arm cover, as required.



4. Install the valve rocker arm cover (2) onto the cylinder head.

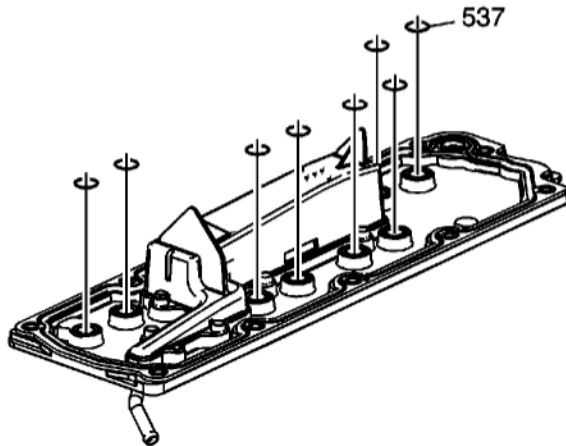
Caution: Refer to [Fastener Caution](#) in the Preface section.

5. Install the cover bolts (1) with NEW grommets and tighten to **12 N·m (106 lb in)**.



6. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (1).
7. Install the ignition coils (2) and bolts (1) and tighten to **12 N·m (106 lb in)**.
8. Install the spark plug wires (3).

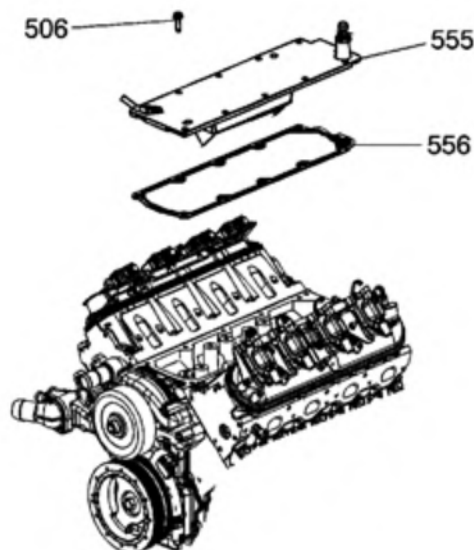
Engine Block Valley Cover Installation (6.2L)



Note: All gasket surfaces should be free of oil or other foreign material during assembly.

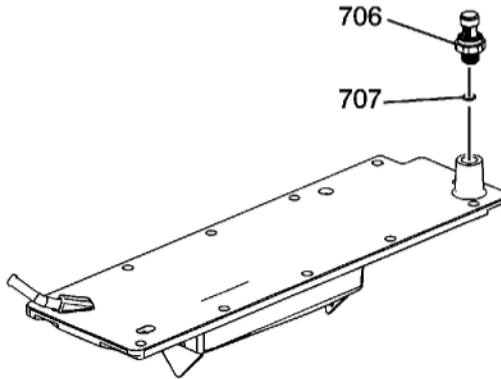
1. Lubricate the O-ring seals (537) with clean engine oil.
2. Install the O-ring seals (537) to the cover.

Caution: Refer to [Fastener Caution](#) in the Preface section.



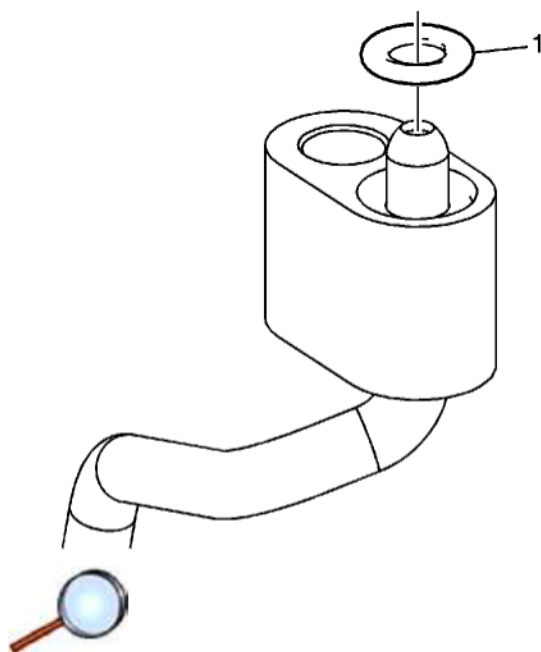


3. Install the cover (555), gasket (556), and bolts (506) and tighten the cover bolts to **25 N·m (18 lb ft)**.



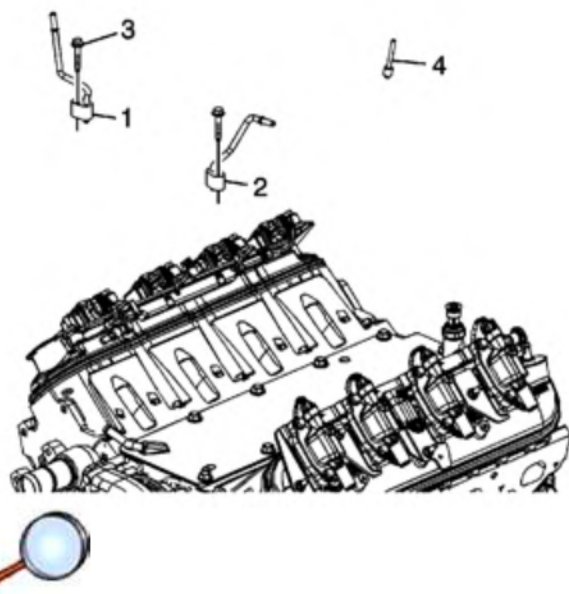
4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor.
5. Install the oil pressure sensor (706) and sealing washer (707) and tighten the sensor to **35 N·m (26 lb ft)**.

Engine Coolant Air Bleed Pipe and Hole Cover Installation



1. Install the seals (1) onto the engine coolant air bleed pipe.

Caution: Refer to [Fastener Caution](#) in the Preface section.



2. Install the pipes (1 and 2) and bolts (3) and tighten to **12 N·m (106 lb in)**.

Supercharger Installation

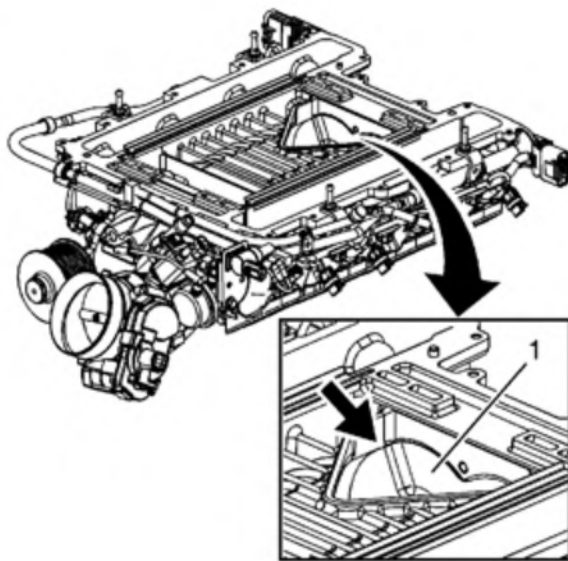
Special Tools

EN 48898 Supercharger Lift Fixture

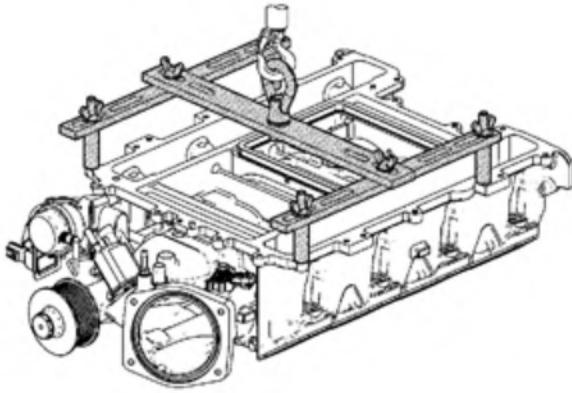
For equivalent regional tools, refer to [Special Tools](#)

Note:

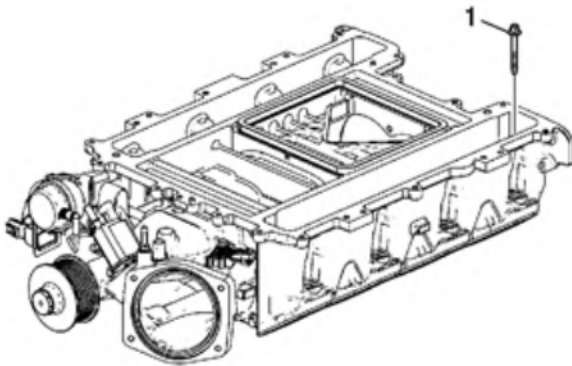
- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the rotors area of the supercharger to prevent dirt or debris contamination onto the rotors.



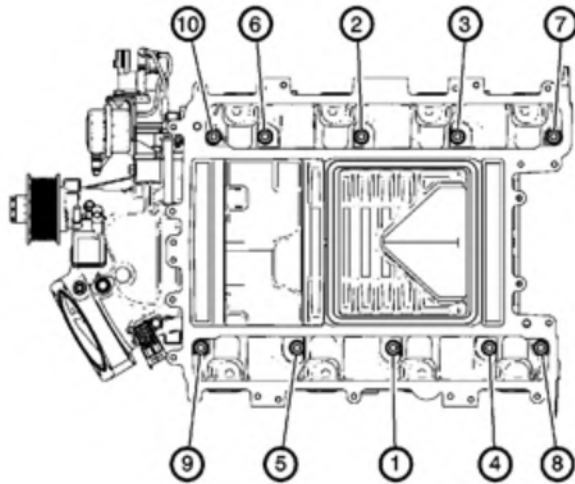
1. Cover the inlet area of the supercharger (1) to prevent dirt or debris contamination onto the rotors.



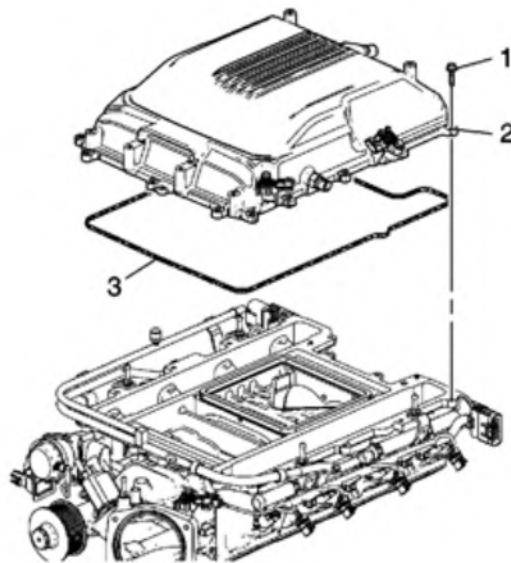
2. Install the *EN 48898* fixture to the supercharger (1).
3. Tighten the *EN 48898* fixture bolts and nuts until snug.
4. Using the lifting device, install the supercharger onto the engine. Align the dowel pin at the right front of the supercharger to the cylinder head.



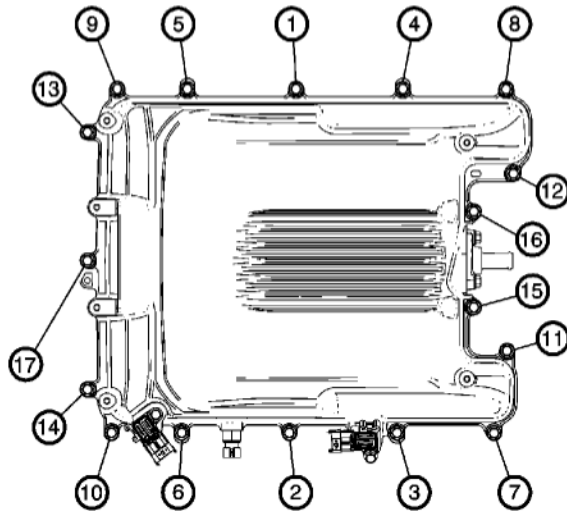
5. Apply a 5 mm (0.2 in) band of threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the threads of the bolts.
6. Install the supercharger bolts (1).



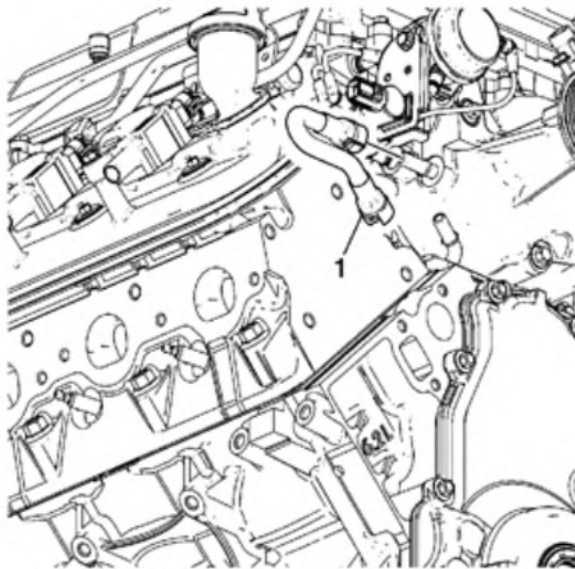
7. Tighten the bolts.
8. Tighten the bolts a first pass in sequence to **5 N·m (44 lb ft)**.
9. Tighten the bolts a final pass in sequence to **10 N·m (89 lb ft)**.



10. Install the supercharger cover seal (3).
11. Install the supercharger cover bolts (1) and the supercharger cover (2).

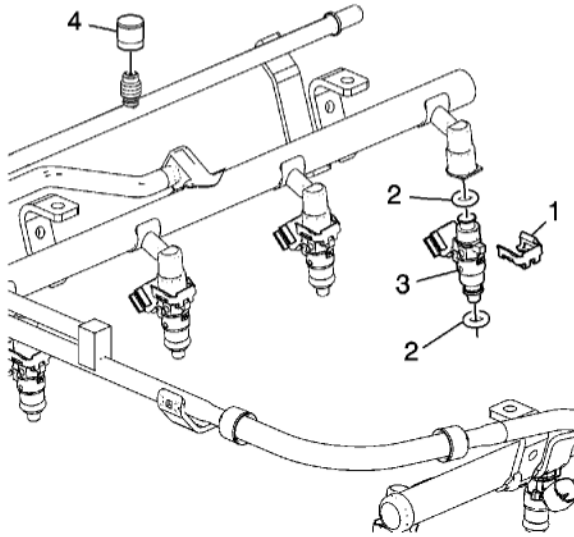


12. Tighten the bolts.
13. Tighten the bolts a first pass in sequence to **5 N·m (44 lb ft)**.
14. Tighten the bolts a final pass in sequence to **10 N·m (89 lb ft)**.
15. Install the fuel rail with injectors as required. Refer to [Fuel Rail and Injectors Installation](#).



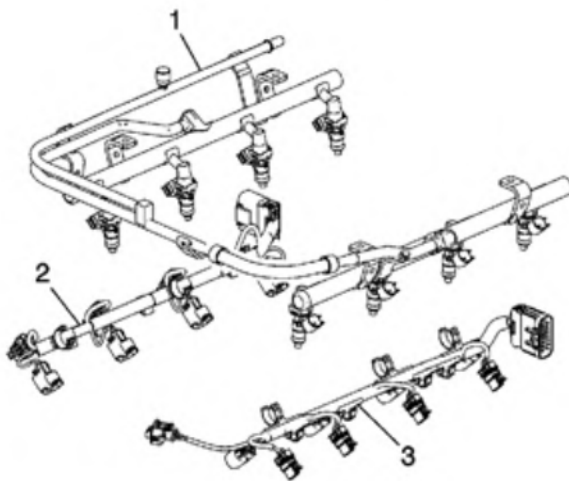
16. Install the positive crankcase ventilation (PCV) - dirty air hose (1) to the valley cover and supercharger.

Fuel Rail and Injectors Installation

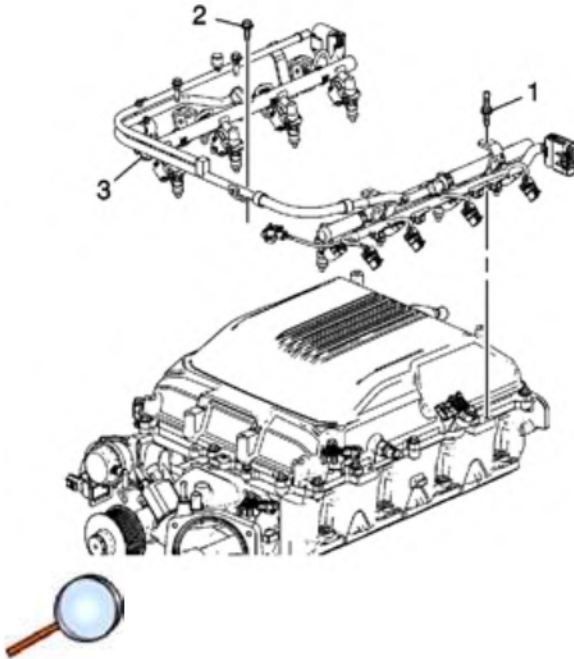


Note: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals (2) with clean engine oil.
2. Install the O-ring seals to the fuel injectors.
3. Install the fuel injectors (3) and retainers (1).



4. Install the wiring harnesses (2) and (3) onto the fuel rail (1).

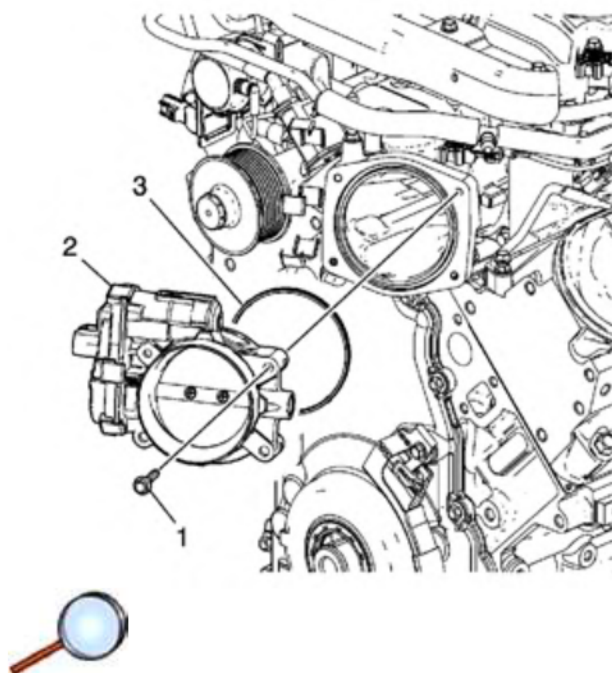


5. Install the fuel rail assembly (3). Install the right side first, then install the left side with flex hose until all injectors have entered their bores.
6. Apply a 5 mm (0.2 in) band of threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the fuel rail studs and bolt. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

Caution: Refer to [Fastener Caution](#) in the Preface section.

7. Install the fuel rail studs (1) and bolt (2) and tighten to **10 N·m (89 lb in)**.

Throttle Body Installation



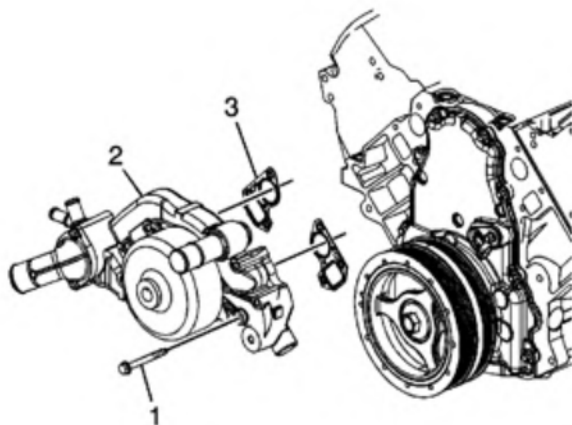
Note: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

1. Install the throttle body gasket (3) to the supercharger.

Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the throttle body (2) and bolts (1) and tighten to **10 N·m (89 lb in)**.

Water Pump Installation



Note: All gasket surfaces are to be free of oil or other foreign material during assembly.

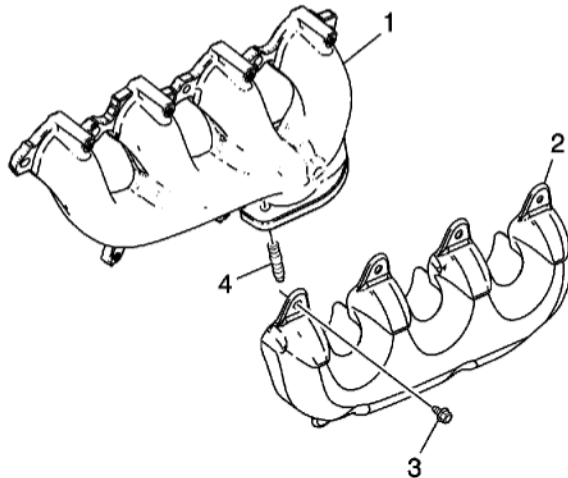
1. Install the water pump (2) and NEW gaskets (3).

Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the water pump bolts (1).
 - 2.1. Tighten the water pump bolts a first pass to **15 N·m (11 lb ft)**.
 - 2.2. Tighten the water pump bolts a final pass to **30 N·m (22 lb ft)**.

Exhaust Manifold Installation - Left Side

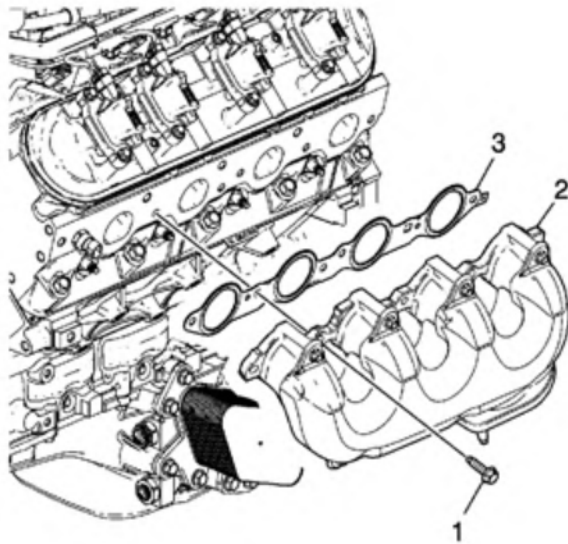
Caution: Refer to [Fastener Caution](#) in the Preface section.



Note:

- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.
- Do not apply sealant to the first 3 threads of the bolt.

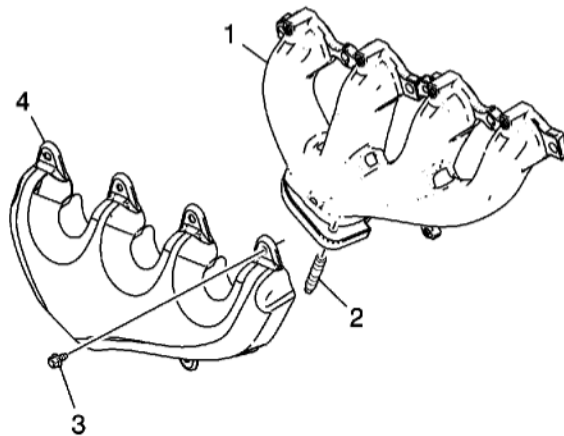
1. Install the heat shield (2) and bolts (3) onto the manifold (1) and tighten to **9 N·m (80 lb in)**.
2. Install the exhaust pipe studs (4) and tighten to **20 N·m (15 lb ft)**.



3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
4. Install the exhaust manifold (2), NEW gasket (3), and bolts (1).
 - 4.1. Tighten the exhaust manifold bolts a first pass to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
 - 4.2. Tighten the exhaust manifold bolts a final pass to 20 N·m (15 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.

Exhaust Manifold Installation - Right Side

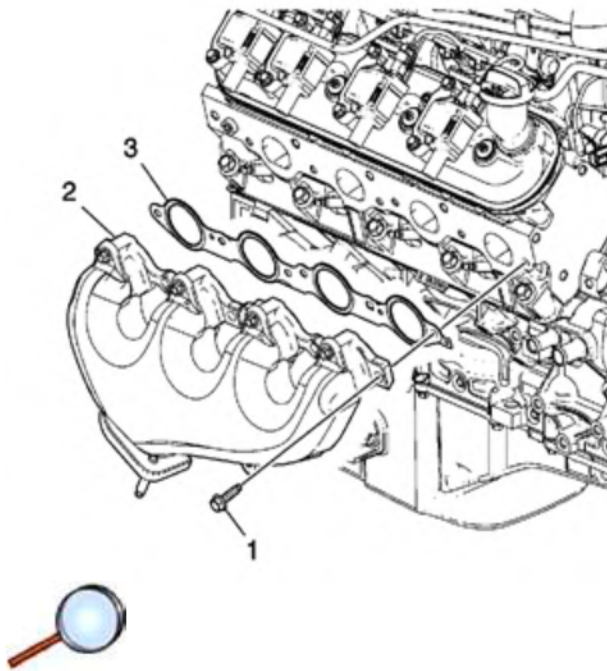
Caution: Refer to [Fastener Caution](#) in the Preface section.



Note:

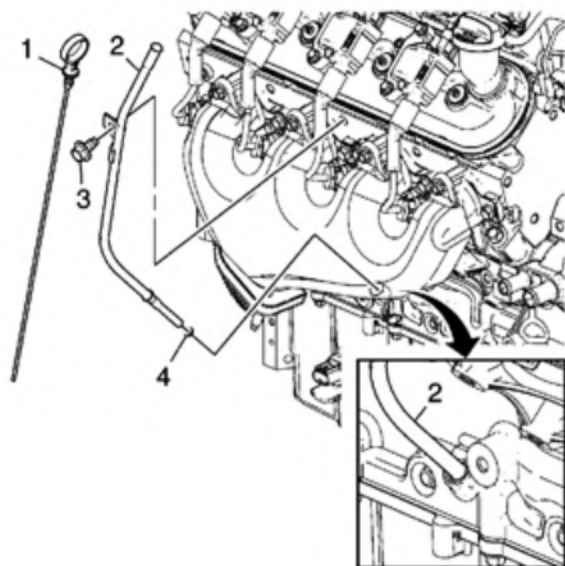
- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.
- Do not apply sealant to the first 3 threads of the bolt.

1. Install the heat shield (4) and bolts (3) onto the manifold (1) and tighten to **9 N·m (80 lb in)**.
2. Install the exhaust pipe studs (2) and tighten to **20 N·m (15 lb ft)**.



3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
4. Install the exhaust manifold (2), NEW gasket (3), and bolts (1).
 - 4.1. Tighten the exhaust manifold bolts a first pass to **15 N·m (11 lb ft)**. Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
 - 4.2. Tighten the exhaust manifold bolts a final pass to **20 N·m (15 lb ft)**. Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.

Oil Level Indicator and Tube Installation



1. Inspect the O-ring seal (4) for cuts or damage. If the oil level indicator tube O-ring seal is not cut or damaged, it may be used again.
2. Lubricate the O-ring seal with clean engine oil.
3. Install the O-ring seal onto the oil level indicator tube (2).
4. Install the oil level indicator tube into the engine block and rotate into proper position.

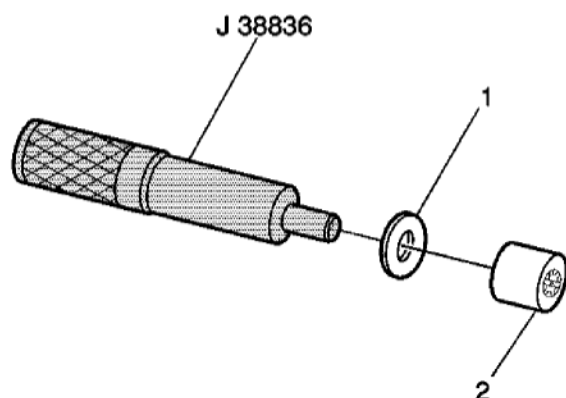
Caution: Refer to [Fastener Caution](#) in the Preface section.

5. Install the tube bolt (3) and tighten the oil level indicator tube bolt to **25 N·m (18 lb ft)**.
6. Install the oil level indicator (1) into the tube.

Clutch Pilot Bearing Installation

Tools Required

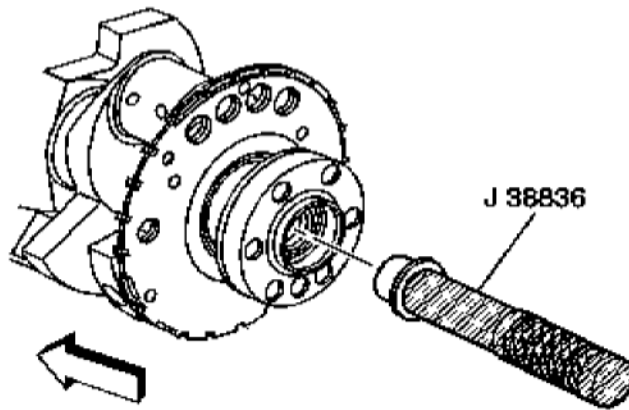
[J 38836](#) Bushing Installer and Clutch Arbor



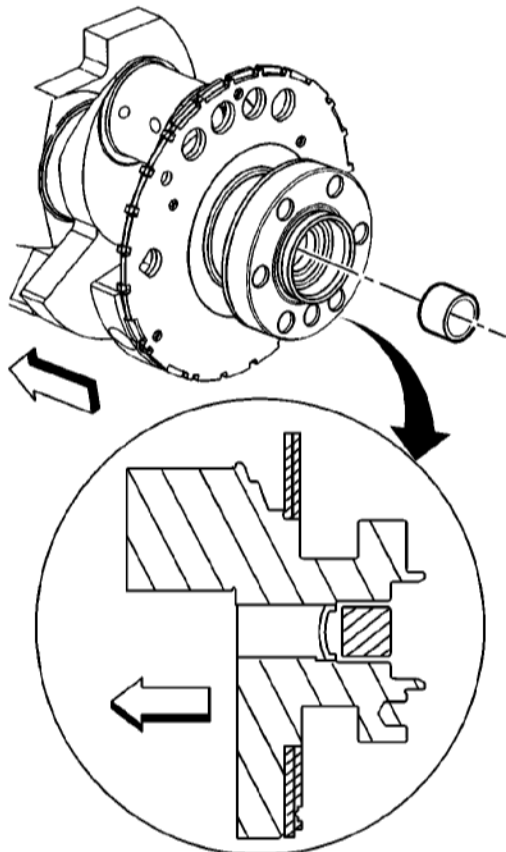
1. Install a 5/8 inch washer (1) onto the [J 38836](#) , or equivalent.

The washer serves as a stop against the crankshaft face and assists in installing the bearing to the proper depth.

2. Install the new pilot bearing (2) onto the tool.



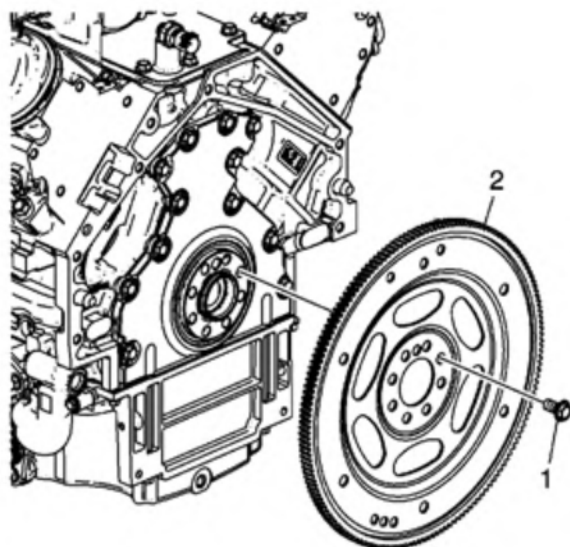
3. Install the new pilot bearing into the crankshaft using the [J 38836](#) .



4. Inspect the clutch pilot bearing for proper installation.

A properly installed clutch pilot bearing will be installed until flush to the rear face of the crankshaft.

Engine Flywheel Installation (6.2L)

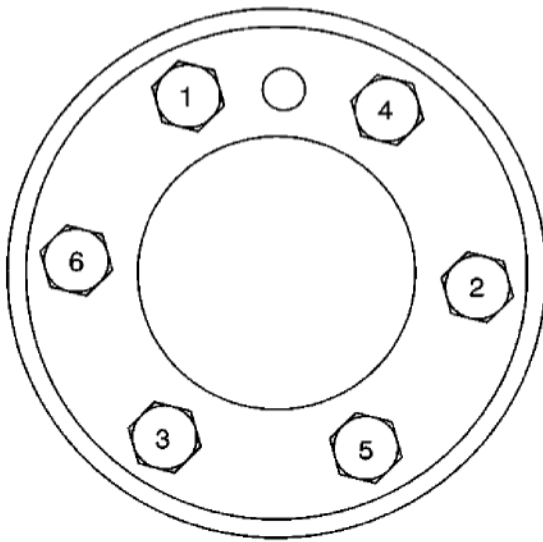


Note:

- For manual transmission applications, note the position and direction of the engine flywheel before removal. Mark or scribe the end of the crankshaft and flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction.
- The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a 3 stage tightening process.

1. Install the automatic transmission flex plate to the crankshaft, if applicable.
2. Install the manual transmission flywheel (2) to the crankshaft, if applicable. Refer to [Engine Balancing](#).
3. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the bolts (1).

Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Install the bolts.
 - 4.1. Tighten the bolts (1-6) a first pass in sequence to **20 N·m (15 lb ft)**.
 - 4.2. Tighten the bolts (1-6) a second pass in sequence to **50 N·m (37 lb ft)**.
 - 4.3. Tighten the bolts (1-6) a final pass in sequence to **100 N·m (74 lb ft)**.

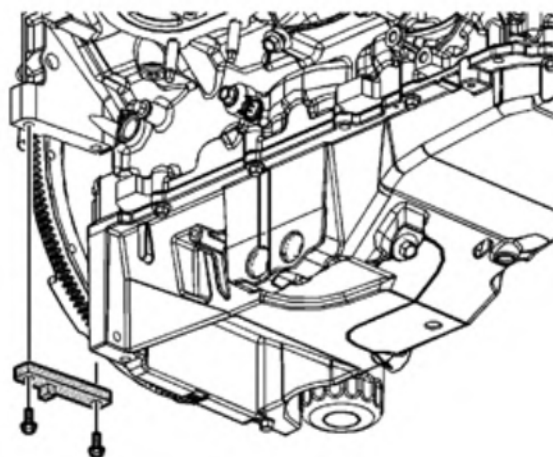
Crankshaft Balancer Installation

Special Tools

- EN-47812 Installer Bolt
- J 41665-A Crankshaft Balancer and Sprocket Installer
- J 42386-A Flywheel Holding Tool
- J 45059 Angle Meter

For equivalent regional tools, refer to [Special Tools](#)

Caution: Refer to [Fastener Caution](#) in the Preface section.

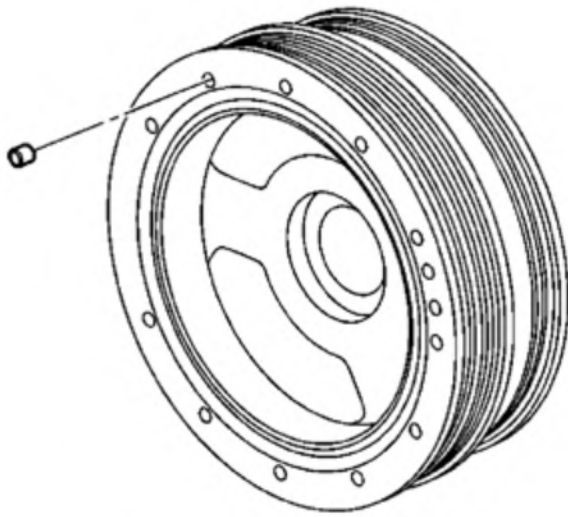


Note:

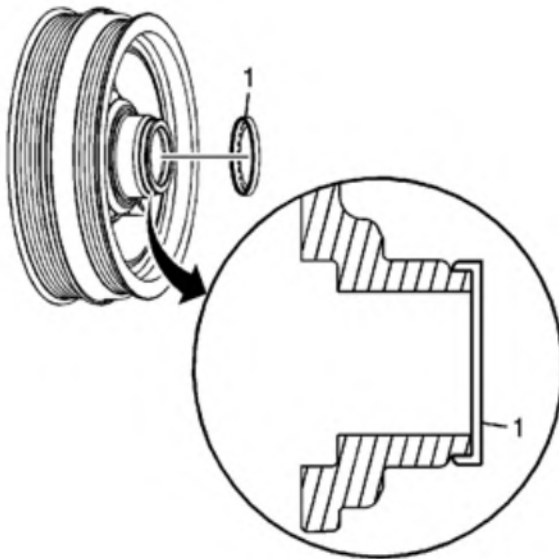
- If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Install new balance weights into the new crankshaft balancer, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).
- The crankshaft balancer installation and bolt tightening involves a 4 step tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the NEW bolt to the proper torque.

1. Install the J 42386-A holding tool and bolts.

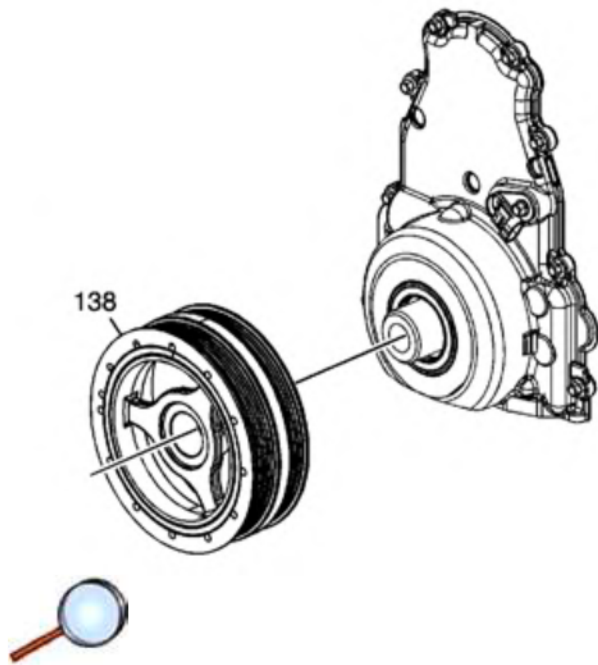
Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation and tighten the J 42386-A holding tool bolts to **50 N·m (37 lb ft)**.



2. Using the old balancer as a reference, mark or scribe the new balancer in the same location, if applicable. Refer to [Crankshaft Balancer Cleaning and Inspection](#).
3. Install balance weights into the new balancer, if applicable.

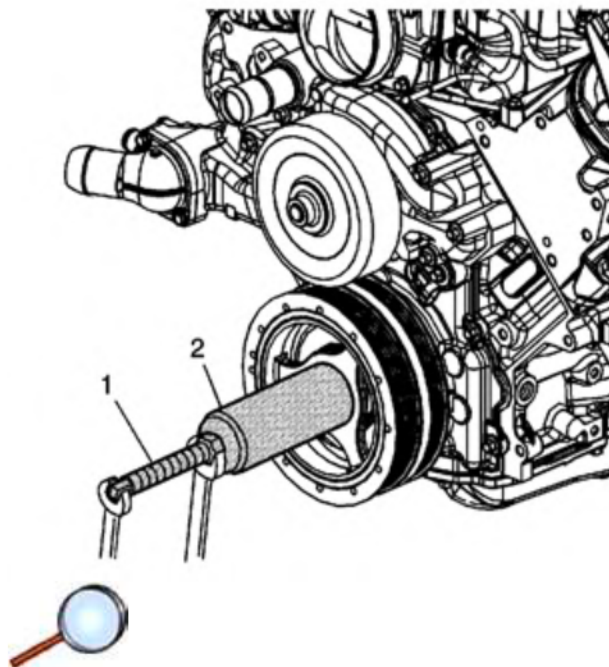


4. Install the crankshaft balancer washer (1) onto the crankshaft balancer.



Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

5. Position the balancer (138) onto the end of the crankshaft.



6. Use the *J 41665-A* installer (2) and the *EN-47812* installer bolt (1) in order to install the balancer.
 - 6.1. Assemble the *EN-47812* installer bolt (1), nut, washer and the *J 41665-A* installer (2).

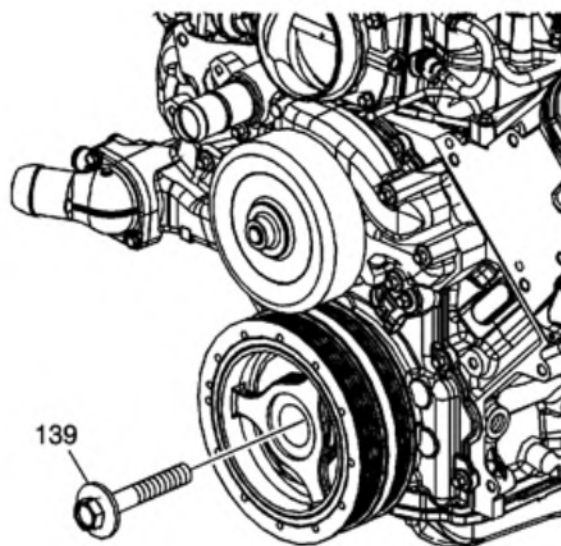
Insert the smaller end of the *J 41665-A* installer (2) into the front of the balancer.

- 6.2. Use a wrench and hold the hex end of the *EN-47812* installer bolt (1).

- 6.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
- 6.4. Remove the *J 41665-A* installer (2) and reverse the installation tool.

Position the larger end of the *J 41665-A* installer (2) against the front of the balancer.

- 6.5. Use a wrench and hold the end of the *EN-47812* installer bolt (1).
- 6.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
- 6.7. Remove the balancer installation tools.



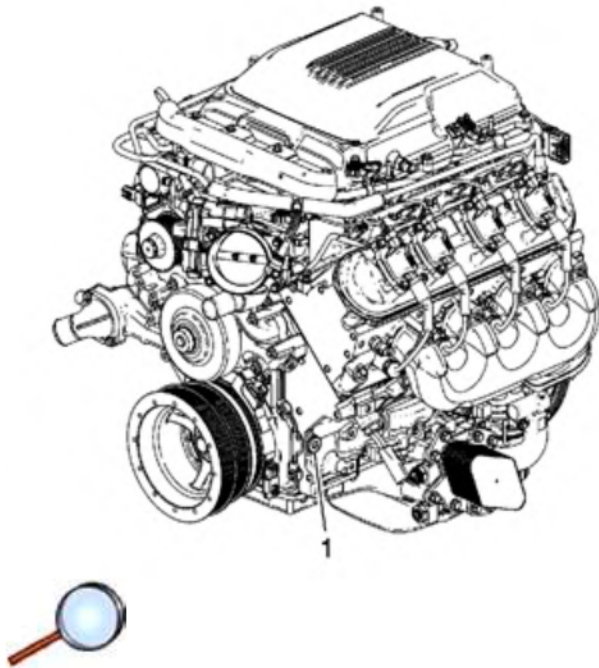
7. Install the NEW crankshaft balancer bolt (139) and:
 - Tighten the crankshaft balancer bolt a first pass to **150 N·m (110 lb ft)**.
 - Loosen the crankshaft balancer bolt a second pass **360 degrees**.
 - Tighten the crankshaft balancer bolt a third pass to **50 N·m (37 lb ft)**.
 - Tighten the crankshaft balancer bolt a final pass to **230 degrees** using the *J 45059* meter .
8. Remove the *J 42386-A* tool .

Engine Prelubing

Special Tools

J 45299 Engine Preluber

For equivalent regional tools, refer to [Special Tools](#)

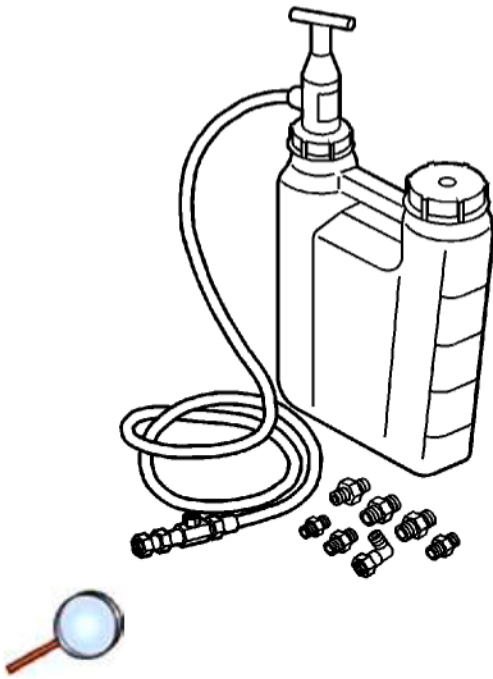


Note: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

1. Remove the engine oil filter, and fill with clean engine oil.

Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the oil filter and tighten to **30 N·m (22 lb ft)**.
3. Locate the engine block left front oil gallery plug (1).
4. Install the M16 x 1.5 adapter P/N 509375.



5. Install the flexible hose to the adapter and open the valve.
6. Pump the handle on the *J 45299* preluber in order to flow a minimum of 1-1.9 liters (1-2 quarts) engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the gallery plug to the engine and tighten to **60 N·m (44 lb ft)**.
9. Top-off the engine oil to the proper level.