

SECTION 6A5B

V8 ENGINES

5.0L (305 CID) RPO L03, VIN H

5.7L (350 CID) RPO L05, VIN K

7.4L (454 CID) RPO L19, VIN N

CAUTION: On vehicles equipped with Supplemental Inflatable Restraint (SIR), refer to CAUTIONS in Section 9J under "ON-VEHICLE SERVICE" and the SIR Component and Wiring Location view in Section 9J before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

NOTICE: Always use the correct fastener in the correct location. Use the correct fastener part number to replace a fastener. If the correct fastener part number is not available, a fastener of equal size and strength may be used. Do not use a fastener that is stronger when the correct fastener part number is not available in the following applications:

- Some bolts are designed to permanently stretch, and if a stronger fastener is used, the part will not be tightened correctly. These permanently stretching bolts will be called out. The correct part number fasteners must be used to replace this type of fastener because there is no available equivalent.
- Other bolts are designed to break if over tightened to prevent part damage. Using a stronger fastener may cause part damage to occur. Fasteners that need to be replaced when removed will be called out. The correct tightening specification and sequence must be used when installing fasteners. Part or system damage may occur if the above instructions are not followed.

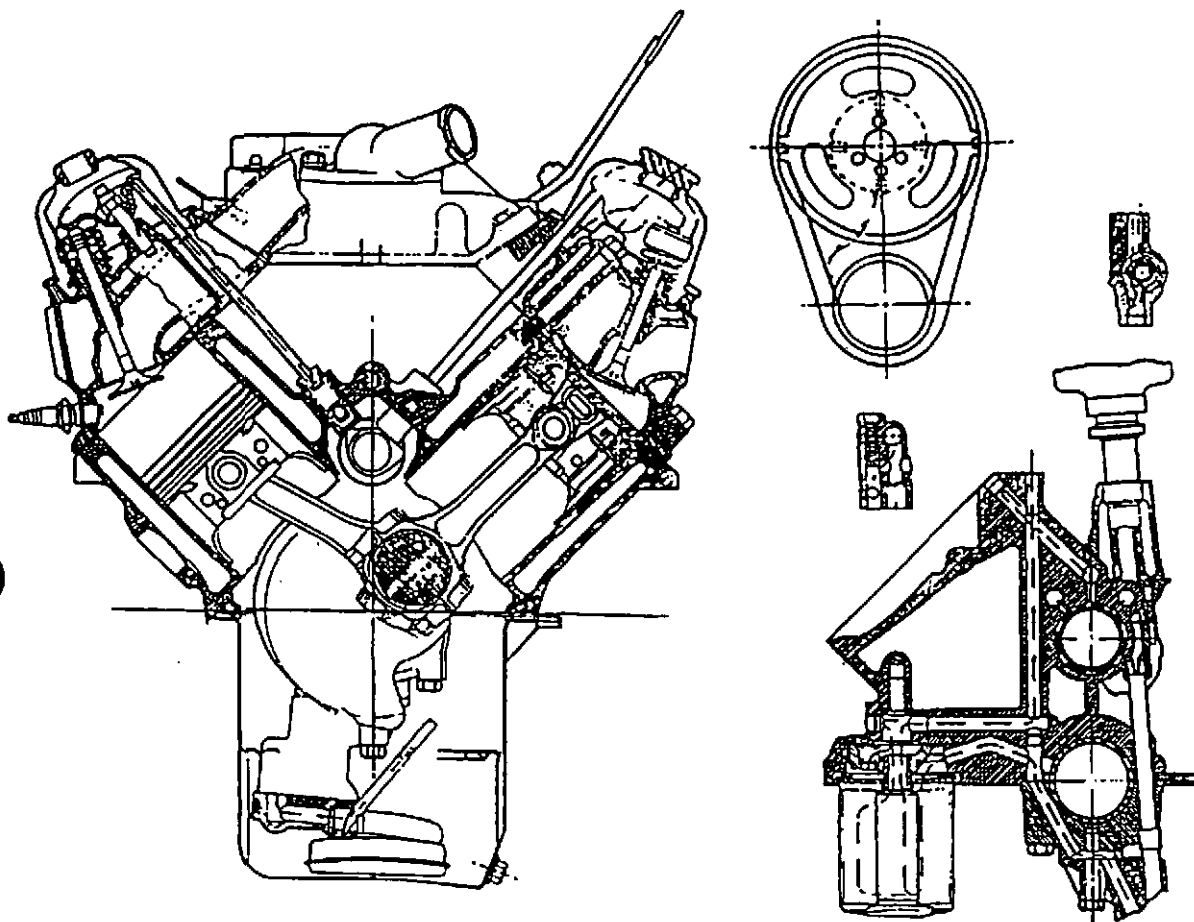
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Figure 2—Lubrication Diagram (5.0L and 5.7L Engines)

GENERAL DESCRIPTION

The engines covered in this section are 90-degree V8 type, overhead valve, liquid cooled, with cast iron block and cylinder heads.

The camshaft is supported by five plain type bearings and is chain driven. Motion from the camshaft is transmitted to the valves by hydraulic lifters, pushrods, and ball-pivot type rocker arms. Heavy Duty 5.7L exhaust valve guides and all 7.4L valve guides are pressed in.

The crankshaft is supported by five precision insert type bearings, with crankshaft thrust taken at the number five (rear) bearing.

The connecting rods are forged steel, with precision insert type crankpin bearings. The piston pins are a press fit in the connecting rods.

The pistons are cast aluminum alloy. The piston pins are a floating fit in the pistons.

The gear-type oil pump is driven through an extension shaft from the distributor driveshaft which is gear driven from the camshaft. The oil is drawn from the engine oil pan through a pickup screen and tube. Pres-

surized oil is delivered through internal passages to the camshaft and crankshaft to lubricate the bearings. Oil under pressure flows from the hydraulic lifters through the pushrod to lubricate the rocker arm and ball pivot. This provides valve lash take-up from the lifters. Lubrication diagrams are shown in figures 1, 2, and 3.

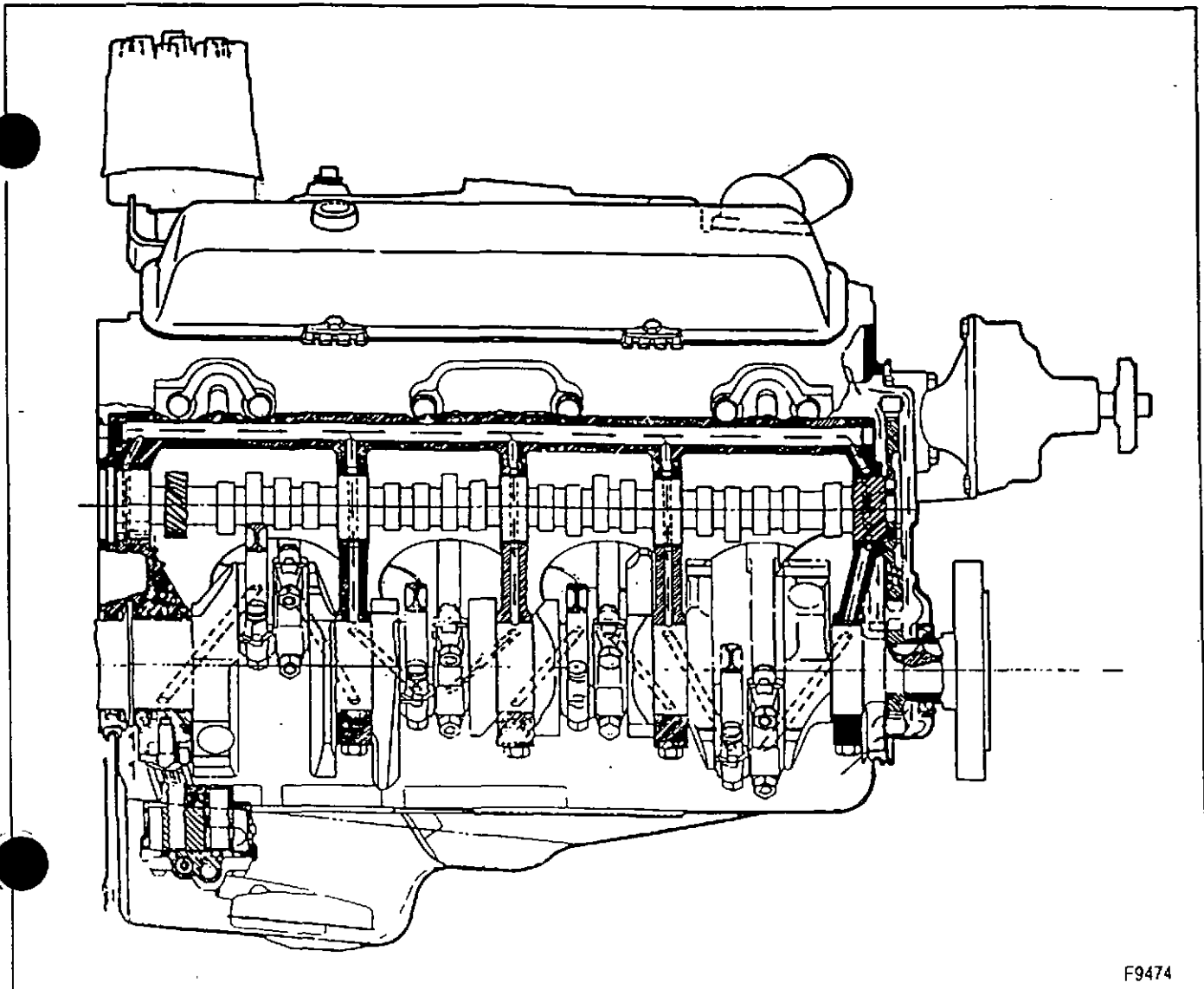
ENGINE IDENTIFICATION

Two basic types of engines, with three different displacements, are covered in this section.

The first type is the "small block" engine, which is available in 5.0L (305 CID) and 5.7L (350 CID) displacements.

The second type is the 7.4L (454 CID) engine, which is sometimes referred to as the "Mark" engine.

To determine the displacement of the engine, use the vehicle identification number (VIN) of the vehicle the engine was removed from. Refer to "Engine Specifications" at the end of this section. If the VIN is not avail-



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Figure 1—Lubrication Diagram (5.0L and 5.7L Engines)

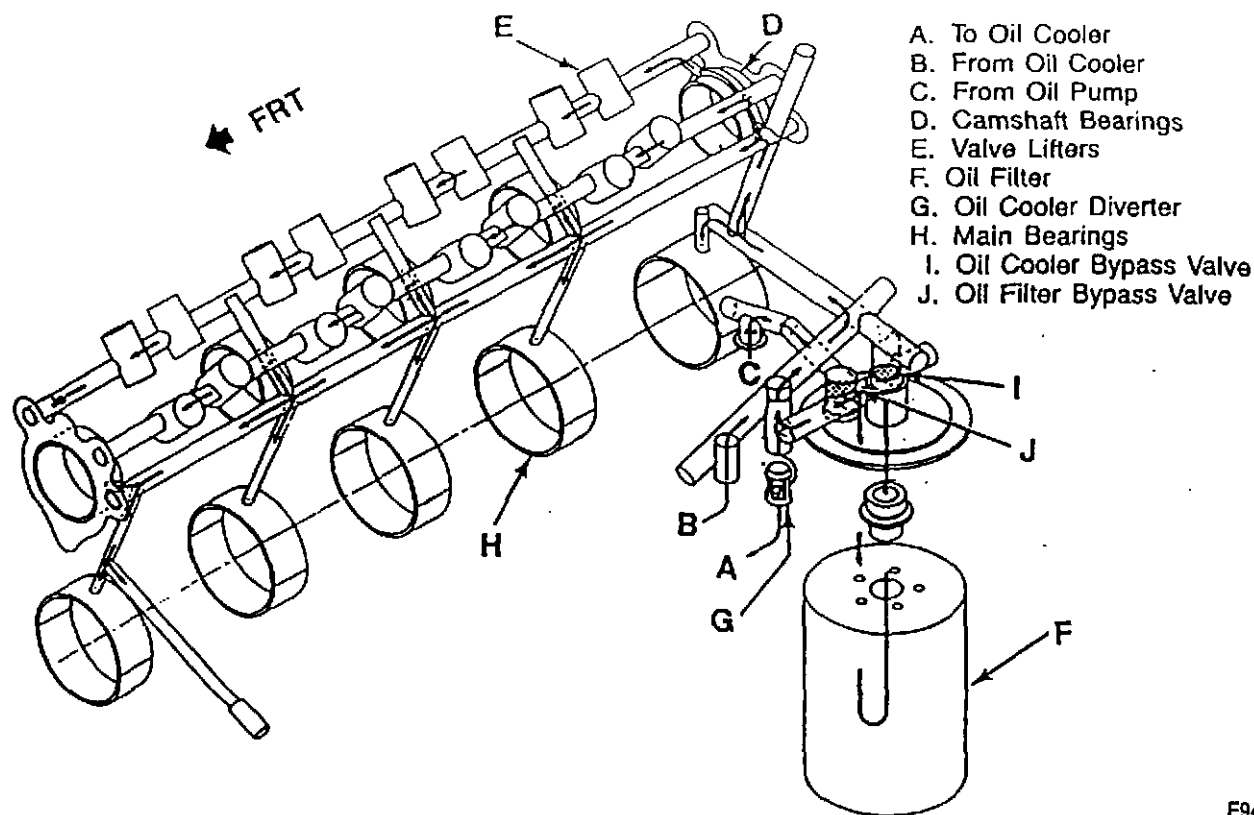
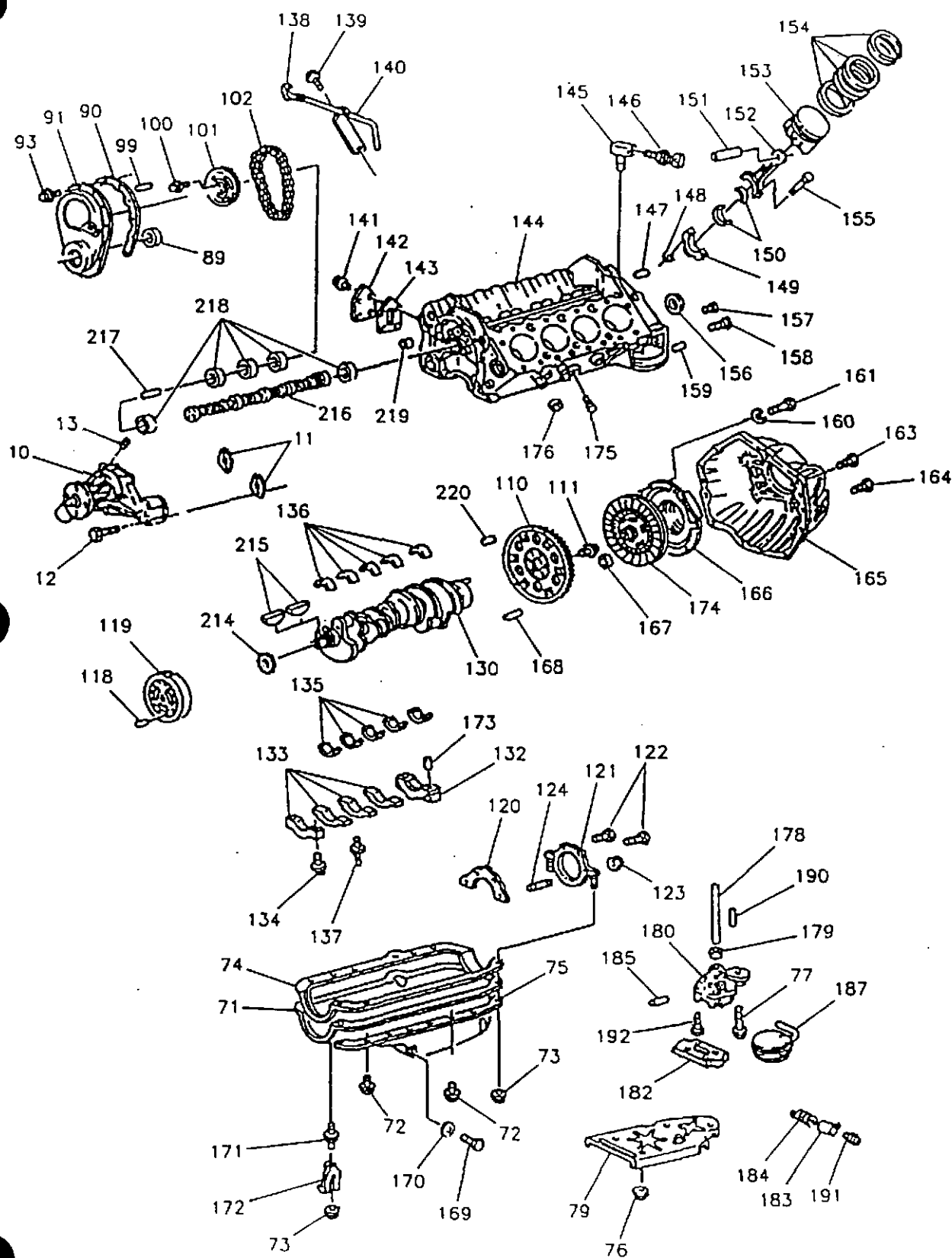


Figure 3—Lubrication Diagram (7.4L Engines)

able, the bore and stroke of the engine involved can be measured and compared against "Engine Specifications" to determine the engine model; or, with "Mark" engines, the engine displacement (in liters) is cast into each side of the cylinder block.

Refer to Section 0A in the proper on-vehicle Truck Service Manual identification information. Refer to figures 4 through 11 for engine component identification.

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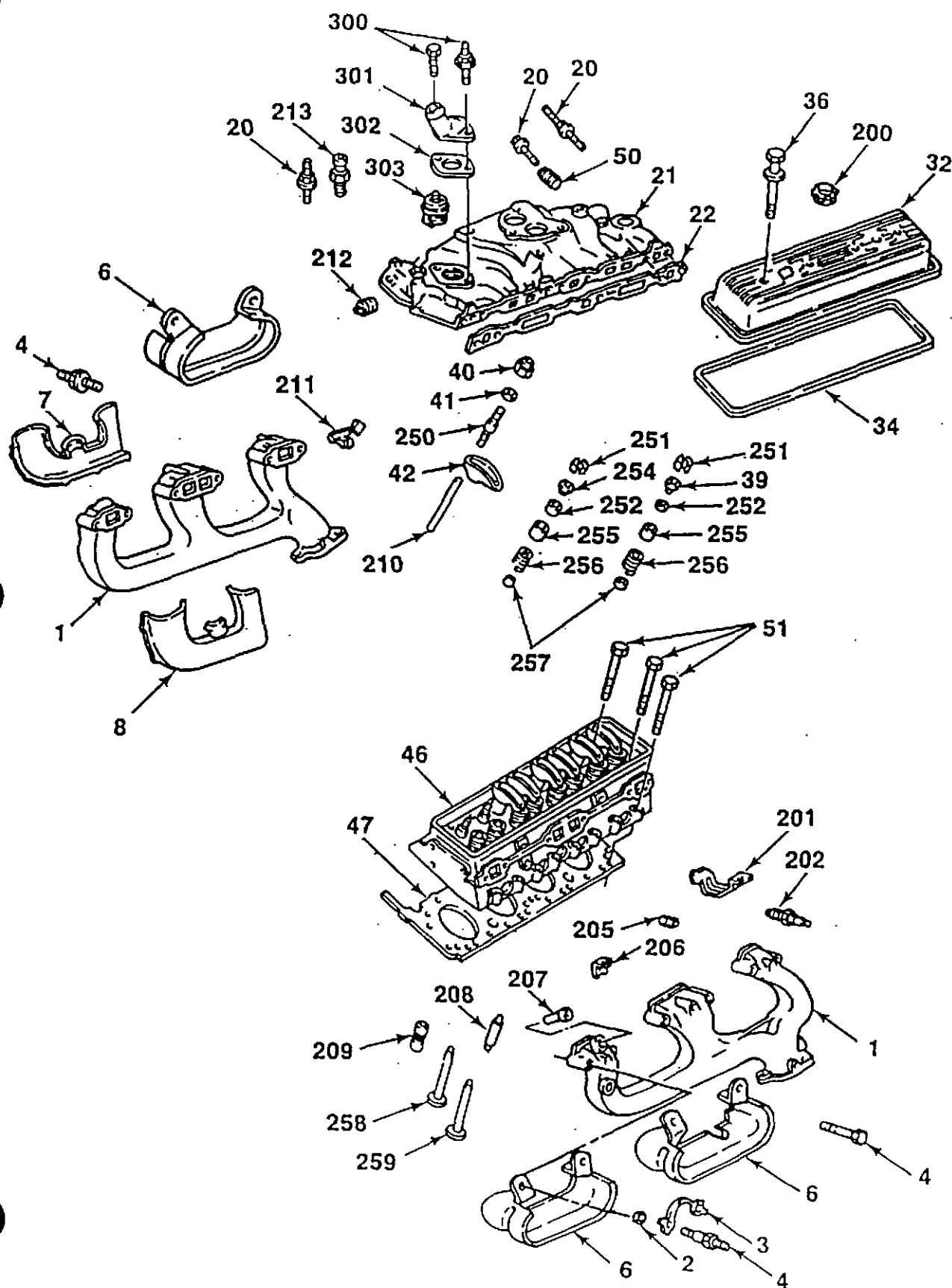
Figure 4—Cylinder Block and Components (5.0L and 5.7L Engines)

10 COOLANT PUMP	148 NUT
11 COOLANT PUMP GASKET	149 CONNECTING ROD BEARING CAP
12 COOLANT PUMP BOLT	150 CONNECTING ROD BEARING
13 PLUG	151 PISTON PIN
71 OIL PAN	152 CONNECTING ROD
72 BOLT	153 PISTON
73 NUT	154 PISTON RINGS
74 OIL PAN GASKET	155 CONNECTING ROD BOLT
75 REINFORCEMENT	156 EXPANSION CUP PLUG
76 OIL PAN DEFLECTOR	157 PLUG
77 OIL PUMP BOLT	158 DRAIN PLUG
79 OIL PAN DEFLECTOR	159 DOWEL PIN
89 CRANKSHAFT FRONT OIL SEAL	160 LOCK WASHER
90 FRONT COVER GASKET	161 CLUTCH COVER AND PRESSURE PLATE BOLT
91 FRONT COVER	163 BOLT
93 FRONT COVER BOLT	164 CLUTCH FORK BALL STUD
99 PIN	165 CLUTCH HOUSING
100 CAMSHAFT SPROCKET BOLT	166 CLUTCH PRESSURE PLATE COVER
101 CAMSHAFT SPROCKET	167 CLUTCH PILOT BEARING
102 TIMING CHAIN	168 FLYWHEEL DOWER PIN
110 FLYWHEEL	169 OIL PAN DRAIN PLUG
111 FLYWHEEL BOLT	170 GASKET
118 GROOVE PIN	171 OIL PAN STUD
119 TORSIONAL DAMPER	172 CLAMP (AUTOMATIC TRANSMISSION ONLY)
120 REAR SEAL RETAINER GASKET	173 SPRING PIN
121 CRANKSHAFT REAR SEAL RETAINER	174 CLUTCH DRIVEN PLATE
122 REAR SEAL RETAINER SCREW	175 PLUG
123 REAR SEAL RETAINER NUT	176 EXPANSION CUP PLUG
124 REAR SEAL RETAINER STUD	178 OIL PUMP DRIVE SHAFT
130 CRANKSHAFT	179 RETAINER
132 REAR MAIN BEARING CAP	180 OIL PUMP
133 MAIN BEARING CAP	182 OIL PUMP COVER
134 MAIN BEARING CAP BOLT	183 OIL PRESSURE REGULATOR VALVE
135 LOWER MAIN BEARING INSERT	184 REGULATOR VALVE SPRING
136 UPPER MAIN BEARING INSERT	185 SPRING STOP RETAINING PIN
137 MAIN BEARING CAP STUD	187 PICK-UP SCREEN AND PIPE
138 OIL LEVEL INDICATOR	190 PIN
139 BOLT	191 REGULATOR VALVE SPRING STOP PLUG
140 OIL LEVEL INDICATOR TUBE	192 BOLT
141 BOLT	214 CRANKSHAFT SPROCKET
142 FUEL PUMP OPENING COVER	215 WOODRUFF KEY
143 FUEL PUMP OPENING COVER GASKET	216 CAMSHAFT
144 ENGINE BLOCK	217 PIN
145 FITTING	218 CAMSHAFT BEARINGS
146 OIL PRESSURE AND FUEL PUMP SWITCH SENSOR	219 OIL PRESSURE PLUG
147 PLUG	220 GROOVE PIN

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Figure 5—Cylinder Block and Components (5.0L and 5.7L Engines) - Legend

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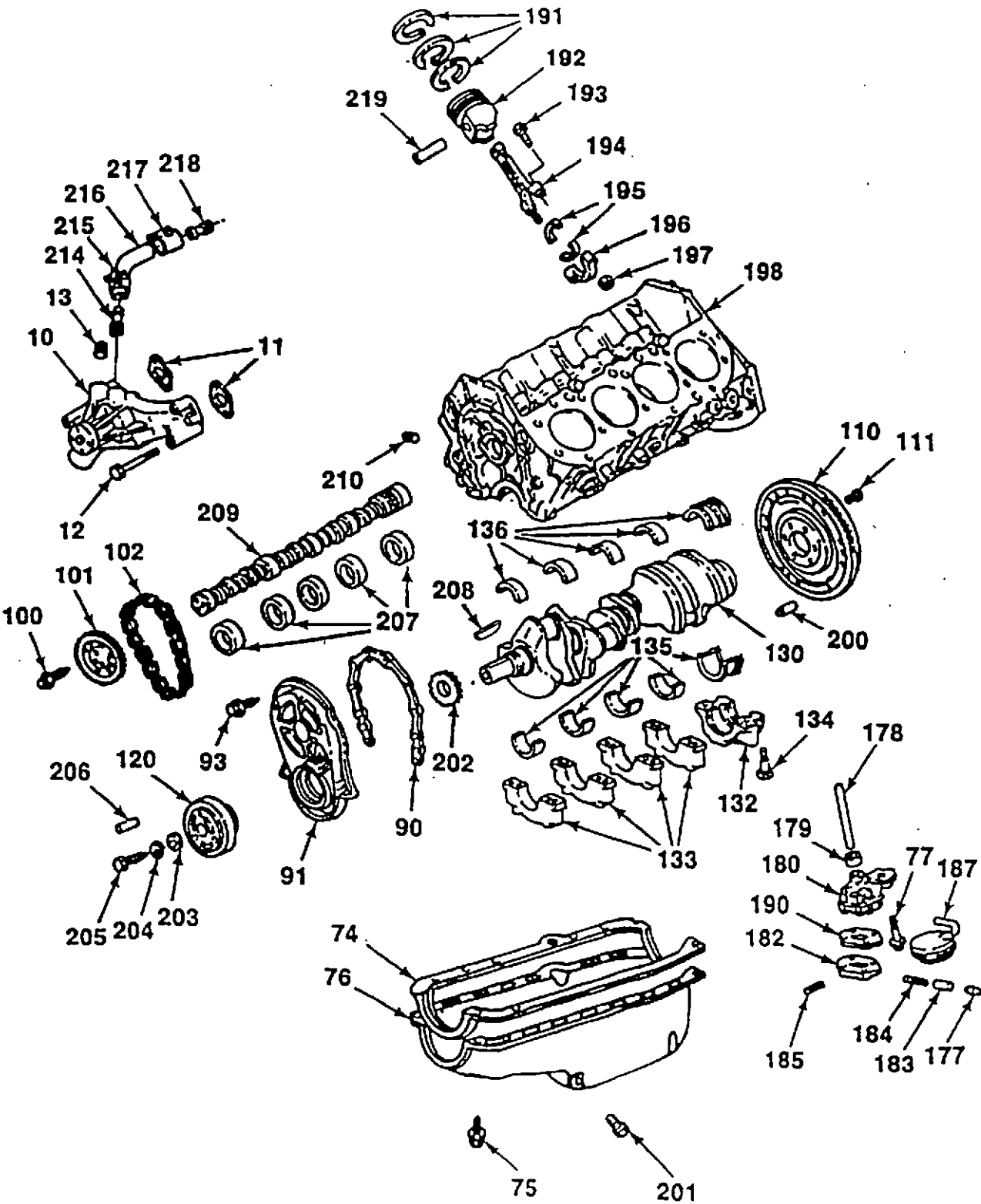
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Figure 6—Cylinder Head, Manifolds, and Components (5.0L and 5.7L Engines)

- | | |
|---------------------------------------|---------------------------------------|
| 1. Exhaust Manifold | 202. Spark Plug |
| 2. Washer | 205. Plug |
| 3. Exhaust Manifold Lock | 206. Spark Plug Wire Support |
| 4. Bolt/Stud | 207. Air Injection Pipe Extension |
| 6. Heat Shield | 208. Dowel Pin |
| 7. Outer Heat Stove | 209. Valve Lifter |
| 8. Inner Heat Stove | 210. Pushrod |
| 20. Bolt/Stud | 211. Spark Plug Wire Retainer Support |
| 21. Intake Manifold | 212. Drain Plug |
| 22. Intake Manifold Gasket | 213. Coolant Temperature Sensor |
| 32. Rocker Arm Cover | 250. Rocker Arm Stud |
| 34. Rocker Arm Cover Gasket | 251. Valve Stem Key |
| 36. Rocker Arm Cover Bolt | 252. Valve Stem Oil Seal (O-Ring) |
| 39. Inlet Valve Spring Cap | 254. Exhaust Valve Rotator |
| 40. Rocker Arm Nut | 255. Valve Stem Oil Shield |
| 41. Rocker Arm Ball | 256. Valve Spring with Damper |
| 42. Rocker Arm | 257. Valve Stem Oil Seal |
| 46. Cylinder Head | 258. Exhaust Valve |
| 47. Cylinder Head Gasket | 259. Inlet Valve |
| 50. Plug | 300. Bolt/Stud |
| 51. Cylinder Head Bolts | 301. Coolant Outlet |
| 200. Oil Filler Cap | 302. Gasket |
| 201. Spark Plug Wire Retainer Support | 303. Thermostat |

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Figure 7—Cylinder Head, Manifolds, and Components (5.0L and 5.7L Engines) - Legend



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Figure 8—Cylinder Block and Components (7.4L Engine)

- | | |
|--------------------------------------|--|
| 10. Coolant Pump | 184. Oil Pressure Regulator Valve Spring |
| 11. Coolant Pump Gasket | 185. Spring Retaining Pin |
| 12. Coolant Pump Bolt | 187. Pick-up Screen and Pipe |
| 13. Coolant Pump Plug | 190. Gasket |
| 74. Oil Pan Gasket | 191. Piston Rings |
| 75. Oil Pan Bolt | 192. Piston |
| 76. Oil Pan | 193. Connecting Rod Bolt |
| 77. Oil Pump Bolt | 194. Connecting Rod |
| 90. Front Cover Gasket | 195. Connecting Rod Bearing |
| 91. Front Cover | 196. Connecting Rod Bearing Cap |
| 93. Front Cover Bolt | 197. Connecting Rod Nut |
| 100. Camshaft Sprocket Bolt | 198. Engine Block |
| 101. Camshaft Sprocket | 200. Engine Balance Groove Pin |
| 102. Timing Chain | 201. Oil Pan Drain Plug |
| 110. Flywheel | 202. Crankshaft Sprocket |
| 111. Flywheel Bolt | 203. Washer |
| 120. Torsional Damper | 204. Spring Lock Washer |
| 130. Crankshaft | 205. Bolt |
| 132. Rear Main Bearing Cap | 206. Engine Balance Groove Pin |
| 133. Main Bearing Cap | 207. Camshaft Bearings |
| 134. Main Bearing Cap Bolt | 208. Woodruff Key |
| 135. Lower Main Bearing Insert | 209. Camshaft |
| 136. Upper Main Bearing Insert | 210. Drain Plug |
| 177. Regulator Valve Spring Retainer | 214. Nipple |
| 178. Oil Pump Driveshaft | 215. Clamp |
| 179. Connector | 216. Hose |
| 180. Oil Pump Body | 217. Clamp |
| 182. Oil Pump Cover | 218. Nipple |
| 183. Oil Pressure Regulator Valve | 219. Piston Pin |

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Figure 9—Cylinder Block and Components (7.4L Engine) - Legend

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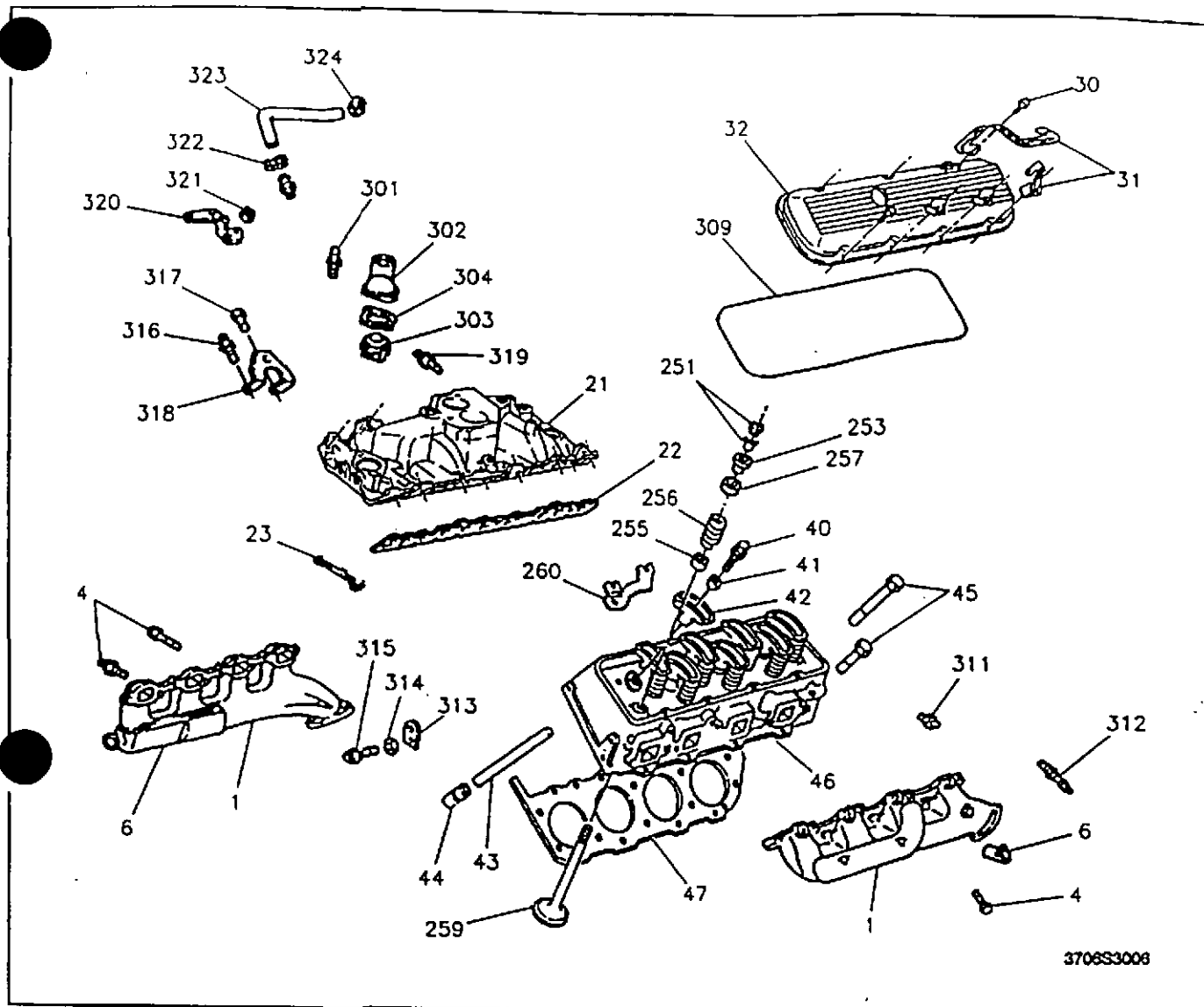


Figure 10—Cylinder Head, Manifolds, and Components (7.4L Engine)

1 EXHAUST MANIFOLD	260 PUSHROD GUIDE
4 BOLT/STUD	301 STUD
6 HEAT SHIELD ASSEMBLY	302 COOLANT OUTLET
21 INTAKE MANIFOLD	303 THERMOSTAT
22 INTAKE MANIFOLD GASKET	304 GASKET
23 INTAKE MANIFOLD SEAL	309 ROCKER COVER GASKET
30 ROCKER COVER BOLT	311 COOLANT TEMPERATURE SENSOR
31 SUPPORT, SPARK PLUG WIRES	312 SPARK PLUG
32 ROCKER ARM COVER	313 ENGINE LIFT BRACKET
40 ROCKER ARM BOLT	314 SPRING LOCK WASHER
41 ROCKER ARM BALL	315 BOLT
42 ROCKER ARM	316 STUD
44 HYDRAULIC LIFTER	317 BOLT
45 CYLINDER HEAD BOLT	318 ENGINE LIFT BRACKET
46 CYLINDER HEAD	319 STUD
47 CYLINDER HEAD GASKET	320 EGR ELECTRONIC VACUUM REGULATOR SOLENOID VALVE BRACKET
251 VALVE STEM KEY	321 NUT
253 VALVE SPRING CAP	322 CLAMP
255 VALVE SPRING ROTATOR	323 HOSE
256 VALVE SPRING	324 CLAMP
257 VALVE STEM OIL SEAL	325 NIPPLE
259 INTAKE VALVE	

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Figure 11—Cylinder Head, Manifolds, and Components (7.4L Engine) - Legend

DISASSEMBLY OF THE ENGINE

TOOLS AND SHOP EQUIPMENT

A clean, well lit work area should be available. Other necessary equipment includes: a suitable parts cleaning tank, compressed air supply, trays to keep parts and fasteners organized, and an adequate set of hand tools. An approved engine repair stand will help prevent personal injury or damage to engine components.

Special tools are illustrated throughout this section and listed at its end. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these tools will also minimize possible damage to engine components.

Some precision measuring tools are required for inspection of certain critical components. Torque wrenches will be necessary for correct assembly of various parts.

ACCESSORY REMOVAL

This manual assumes that the engine accessories have been removed. These accessories may include or more of the following:

- Power Steering Pump
- Distributor
- AIR System Pump
- Generator
- Air Conditioning Compressor
- EGR Valve and Emission Control Equipment
- Cooling Fan

It is beyond the scope of this section to detail the many different accessory installations. Refer to the proper on-vehicle Truck Service Manual for this information.

Diagrams of emission and vacuum hose routings, wiring harness routing, accessory drive belt layout, etc., should be made before removing accessories.

CLEANING

Remove the engine accessories before cleaning to provide better access to the engine's exterior surfaces. After removing the TBI unit, distributor, etc., cover the openings with tape to prevent the entry of coolant, solvent, and dirt.

Methods used to clean the engine will depend on what equipment is available. Steam cleaning, pressure washing, or solvent cleaning are some acceptable methods. Allow the engine to dry before beginning the work.

It is important that the engine be as clean as possible to prevent dirt from entering critical areas during disassembly.

DRAINING THE ENGINE



Remove or Disconnect

1. Oil pan drain plug. Allow the oil pan to drain.
2. Oil filter.

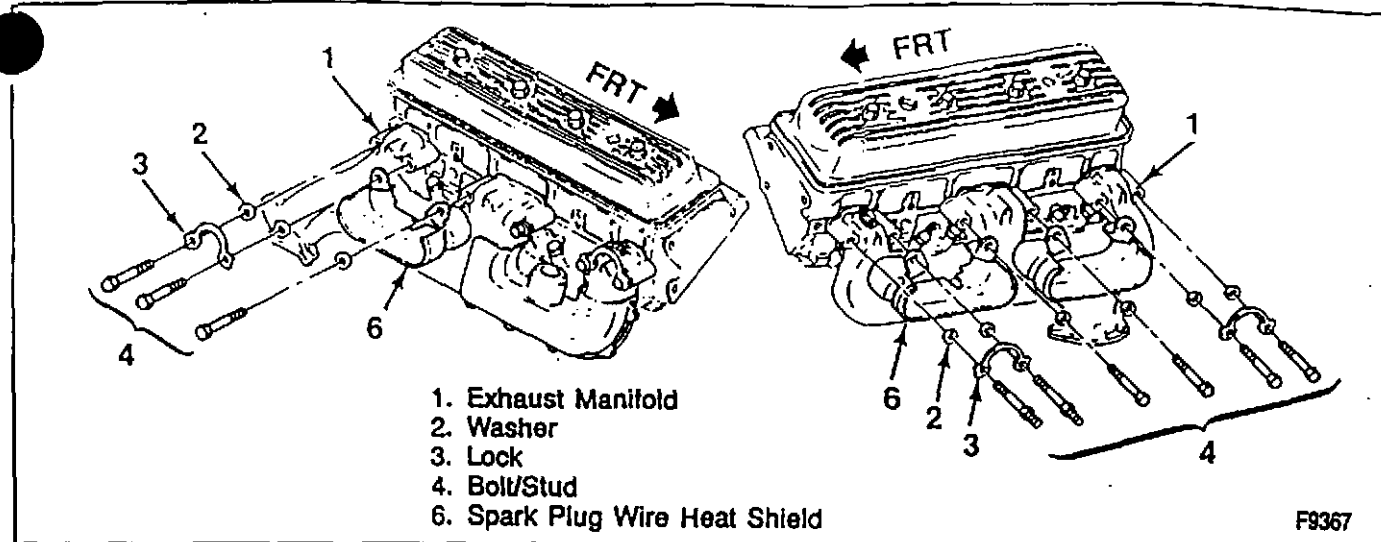


Figure 12—Exhaust Manifold (5.0L and 5.7L Engines)

3. Block drain plugs. Allow the coolant to drain.

Install or Connect

NOTICE: For steps 1 and 2, refer to "Notice" on page 6A5B-1.

Oil pan drain plug.

Tighten

- Oil pan drain plug to 22 N-m (16 lbs. ft.) (5.0L/5.7L Engines).
- Oil pan drain plug to 28 N-m (20 lbs. ft.) (7.4L Engines).

2. Block drain plugs.

Tighten

- Block drain plugs to 22 N-m (16 lbs. ft.) (5.0L/5.7L Engines).
- Block drain plugs to 12 N-m (112 lbs. in.) (7.4L Engine).

EXHAUST MANIFOLD REMOVAL

Remove or Disconnect (Figures 12 and 13)

- Oil dipstick tube.
 - On 5.0L and 5.7L engines, bend back the tab washers (3).
- Bolts and studs (4).
- Tab washers (3) and washers (2).
- Heat shields (6).
- Exhaust manifold (1). Use care not to damage the AIR system injection tubes (if used).

COOLANT PUMP REMOVAL

Remove or Disconnect (Figures 14 and 15)

- Bolts (12).

2. Coolant pump (10).

3. Gaskets (11).

4. Bypass hose and clamps (7.4L engines).

INTAKE MANIFOLD REMOVAL

Remove or Disconnect (Figures 16 and 17)

- Bolts (19) and studs (20).
- Intake manifold (21).

- Pull the intake manifold up.

NOTICE: Do not attempt to loosen the manifold by prying under the gasket surface with any tool.

3. Gaskets (22).

4. Seals (23) (7.4L engines).

ROCKER ARM COVER REMOVAL

Remove or Disconnect (Figures 18 and 19)

- Bolts (30 or 36).
- Rocker arm covers (32). If the rocker arm cover sticks to the cylinder head, try bumping the end of the cover with a rubber mallet. If the cover will not come loose, carefully pry until loose. DO NOT DISTORT THE SEALING FLANGE.
- Gaskets (34).

VALVE TRAIN COMPONENT REMOVAL

Remove or Disconnect (Figures 20 through 26)

Tools Required:

J 3049-A Valve Lifter Remover (Plier Type)

J 9290-01 Valve Lifter Remover (Slide Hammer Type)

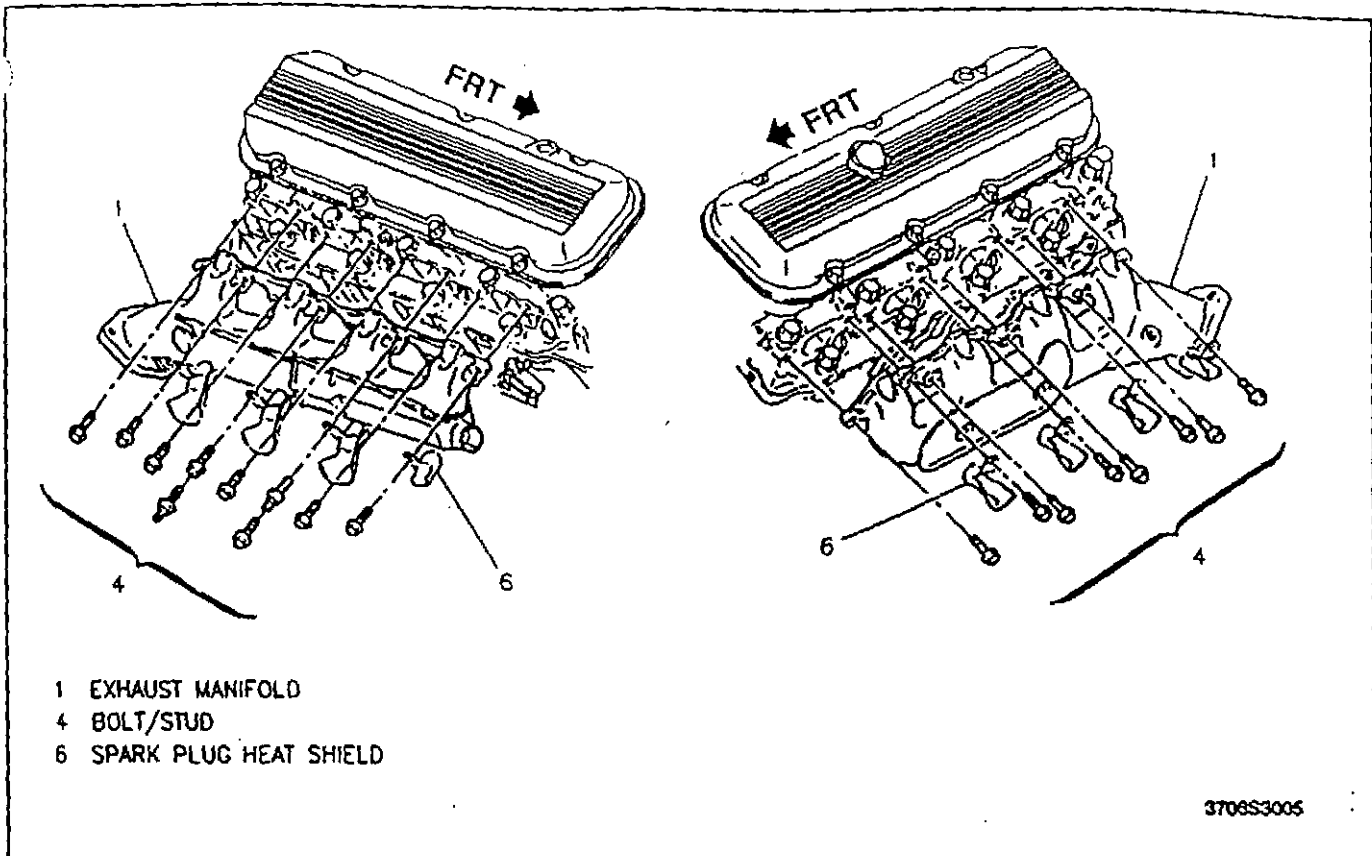


Figure 13—Exhaust Manifold (7.4L Engines)

1. Nuts (40) (5.0L and 5.7L engines) or bolts (40) (7.4L engines), balls (41), rocker arms (42), and pushrods (43 or 210).

- On 7.4L engines, the exhaust valve pushrods are longer than the intake valve pushrods.
- Every effort should be made to ensure that these mating parts are installed in their original locations during assembly. A simple valve train component organizer rack can be made from a piece of wood, as shown in figure 24.

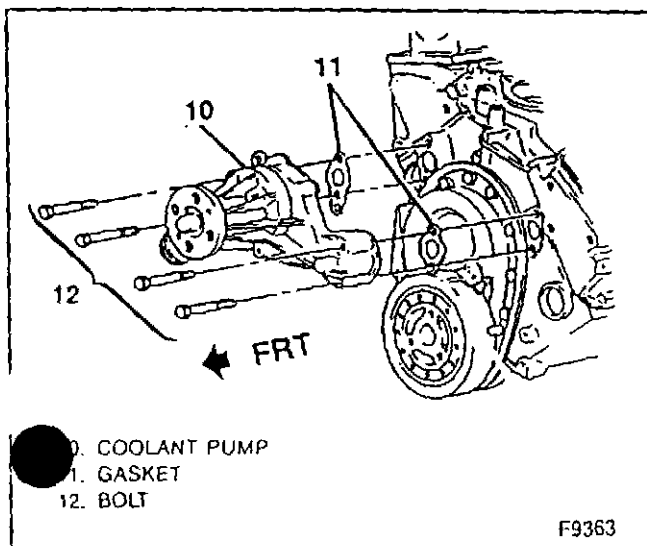


Figure 14—Coolant Pump (5.0L and 5.7L Engines)

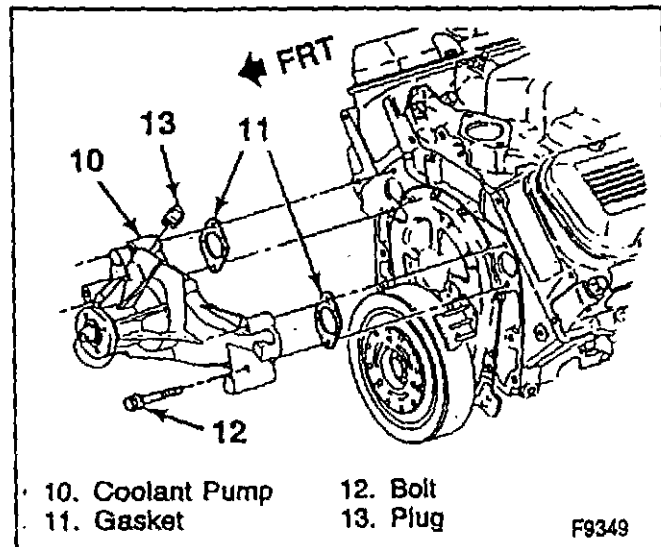
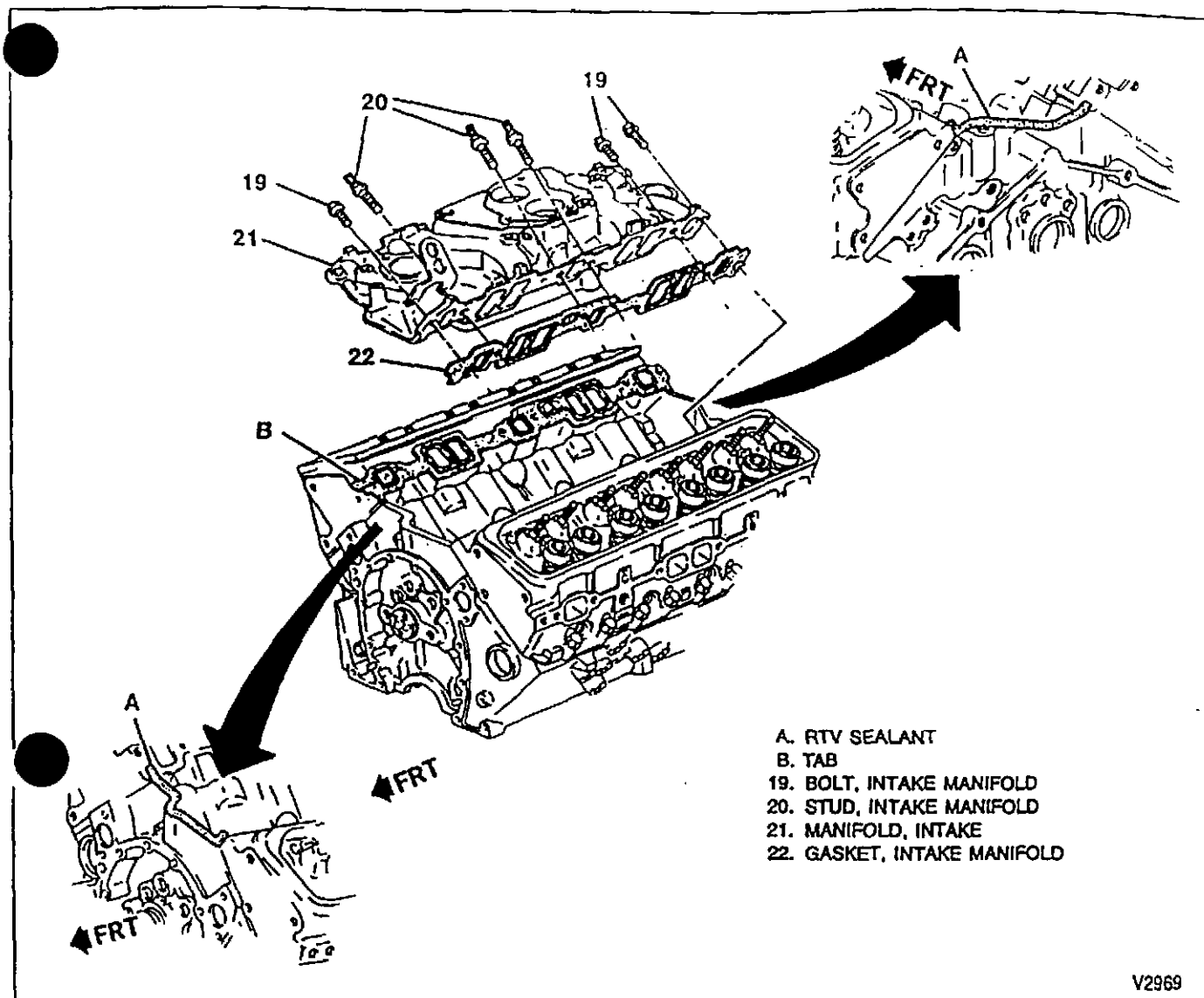


Figure 15—Coolant Pump (7.4L Engines)

2. Hydraulic lifters (44 or 209).

- Remove the lifters one at a time using a magnet. Place the lifters in the organizer rack, or tag them in some way to ensure they can be returned to the valve lifter bore from which they were removed.
- Some lifters may be stuck in their bores due to gum or varnish deposits. These lifters can be removed using either J 3049-A (figure 25) or J 9290-01 (figure 26).



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Figure 16—Intake Manifold (5.0L and 5.7L Engines)

CYLINDER HEAD REMOVAL

- ↔ Remove or Disconnect (Figures 20 through 23)

1. Bolts (45 or 51).
2. Cylinder heads (46). Use care when handling the cylinder heads, to prevent damage to the gasket sealing surfaces.
3. Gaskets (47).

TORSIONAL DAMPER REMOVAL

- ↔ Remove or Disconnect (Figure 27)

Tool Required:

J 39046 Torsional Damper Puller and Installer

1. Crankshaft pulley.
2. Torsional damper retaining bolt and washer.
3. Torsional damper. Use J 39046 (figure 27).

OIL PAN REMOVAL

- ↔ Remove or Disconnect (Figures 28, 29, and 30)

1. Oil pan bolts (72 or 75), nuts (73, 5.0L and 5.7L only), and clips.
2. Oil pan (71 or 76).
3. Gasket (74).
4. Oil pan deflector nuts (76) (figure 29).

OIL PUMP REMOVAL

- ↔ Remove or Disconnect (Figures 28 and 30)

1. Bolts.
2. Oil pump, with drive shaft and connector.

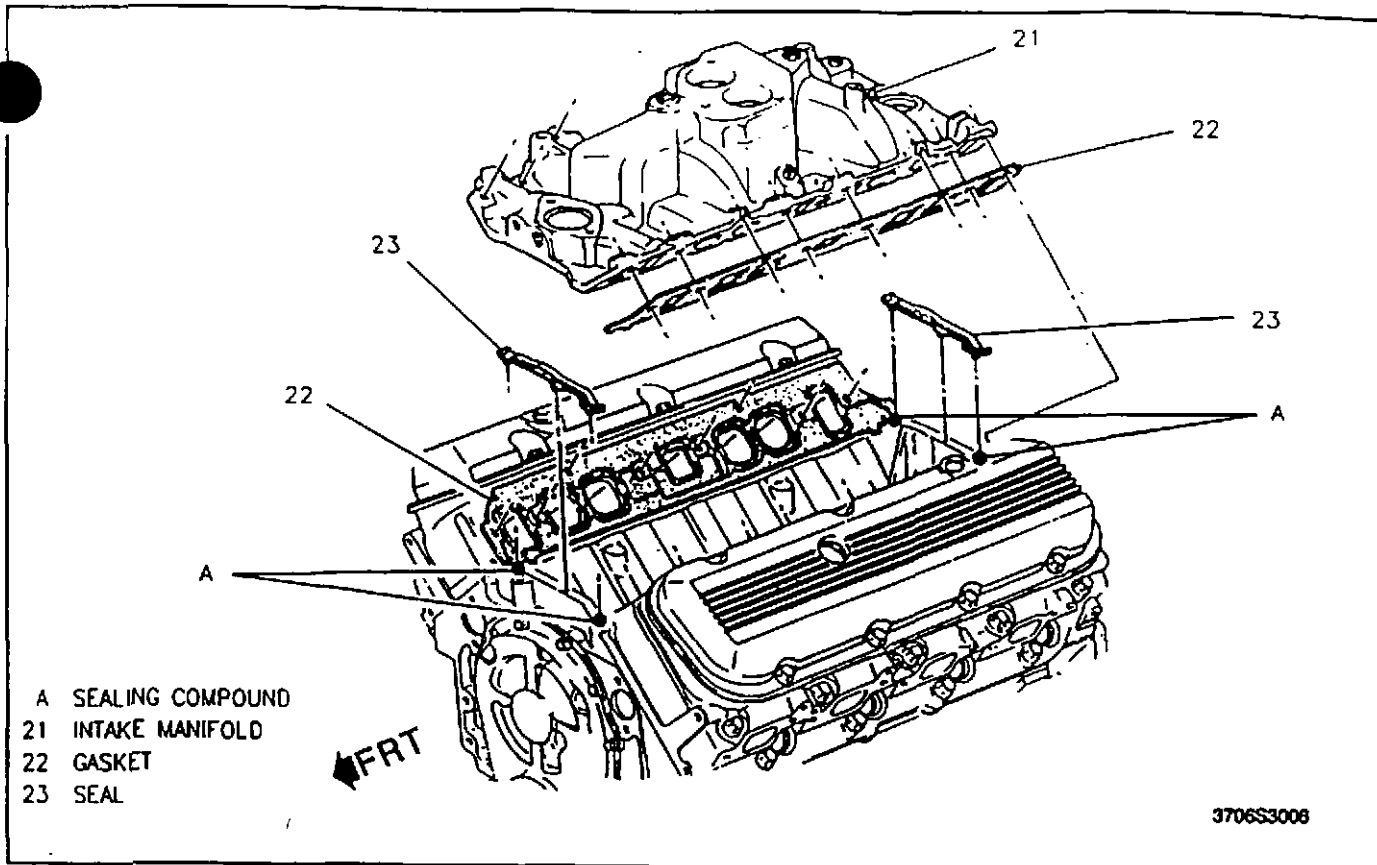


Figure 17—Intake Manifold (7.4L Engines)

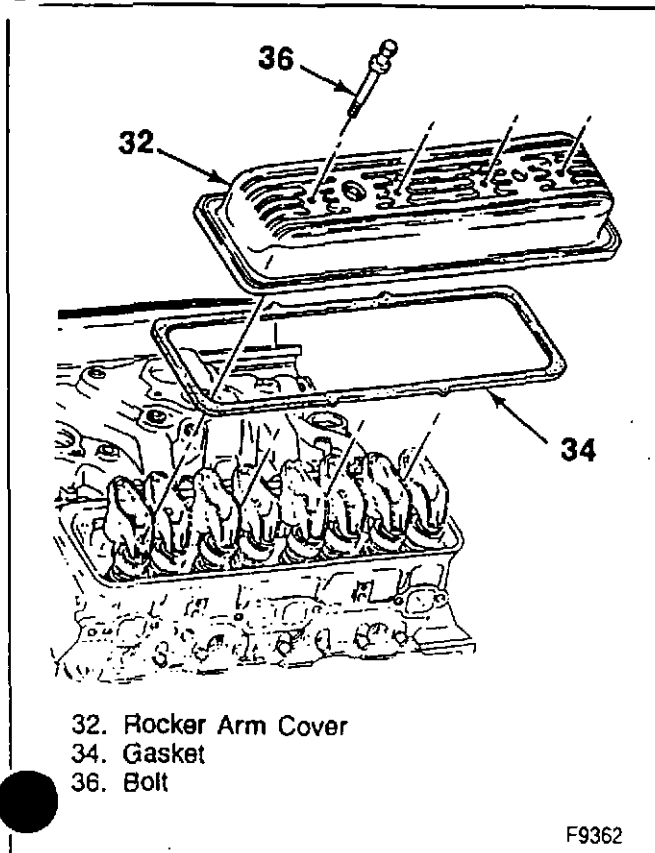


Figure 18—Rocker Arm Cover (5.0L and 5.7L Engines)

FRONT COVER REMOVAL

↔ Remove or Disconnect (Figure 31)

1. Bolts (93).
2. Front cover (91).
3. Gasket (90).

TIMING CHAIN AND CAMSHAFT SPROCKET REMOVAL

↔ Remove or Disconnect (Figure 32)

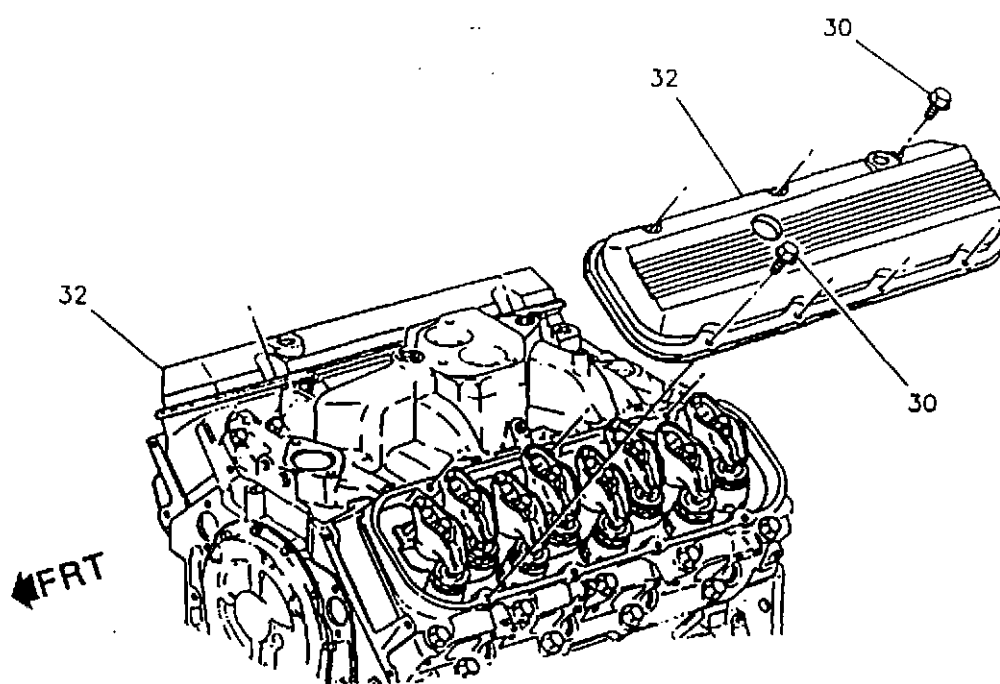
- Timing chain free play. If the chain can be moved back and forth in excess of 16 mm (5/8 inch), make a note that the timing chain should be replaced during assembly (figure 32).

1. Bolts (100).
2. Camshaft sprocket (101) and timing chain (102) together.

CAMSHAFT REMOVAL

↔ Remove or Disconnect (Figure 33)

- Camshaft.
 - A. Install three 5/16-18 bolts 100-125 mm (4-5 inches) long into the camshaft tapped holes. Use these bolts to handle the camshaft.
 - B. Pull the camshaft from the block.
 - C. Use care to prevent damage to the camshaft and bearings.

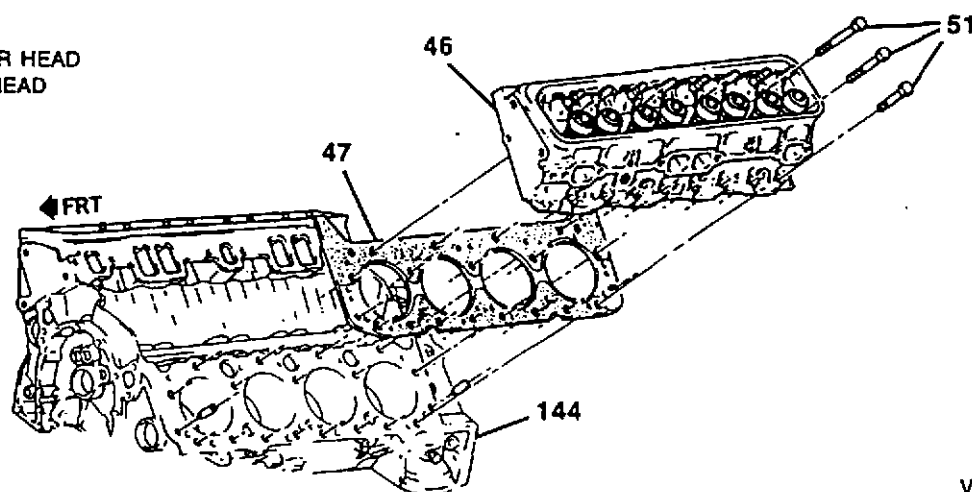


- 30 BOLT
- 32 ROCKER ARM COVER

3706S3013

Figure 19—Rocker Arm Cover (7.4L Engines)

- 46. HEAD, CYLINDER
- 47. GASKET, CYLINDER HEAD
- 51. BOLT, CYLINDER HEAD
- 144. BLOCK, ENGINE



V2880

Figure 20—Cylinder Head (5.0L and 5.7L Engines)

PISTON AND CONNECTING ROD REMOVAL



Remove or Disconnect (Figures 34 and 35)

Tool Required:

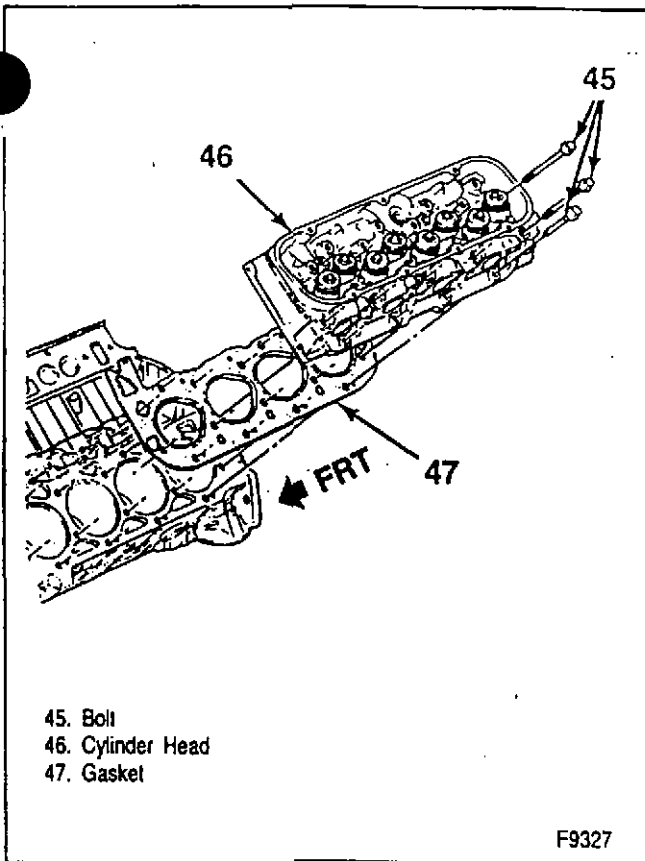
J 5239 Connecting Rod Guide Set

1. Ridge (or deposits) at the top of the cylinder as follows:

- A. Turn the crankshaft until one piston is at the bottom of its stroke. Place a soft cloth on top of the piston.
- B. Using the manufacturer's directions, install a ridge reamer into the top of the cylinder (figure 34). Perform the cutting operation.
- C. After the ridge and/or deposits are removed, remove the ridge reamer. Turn the crankshaft until the piston is at the top of its stroke. Remove the cloth and cuttings.
- D. Repeat this procedure for each piston.

2. Connecting rod caps as follows:

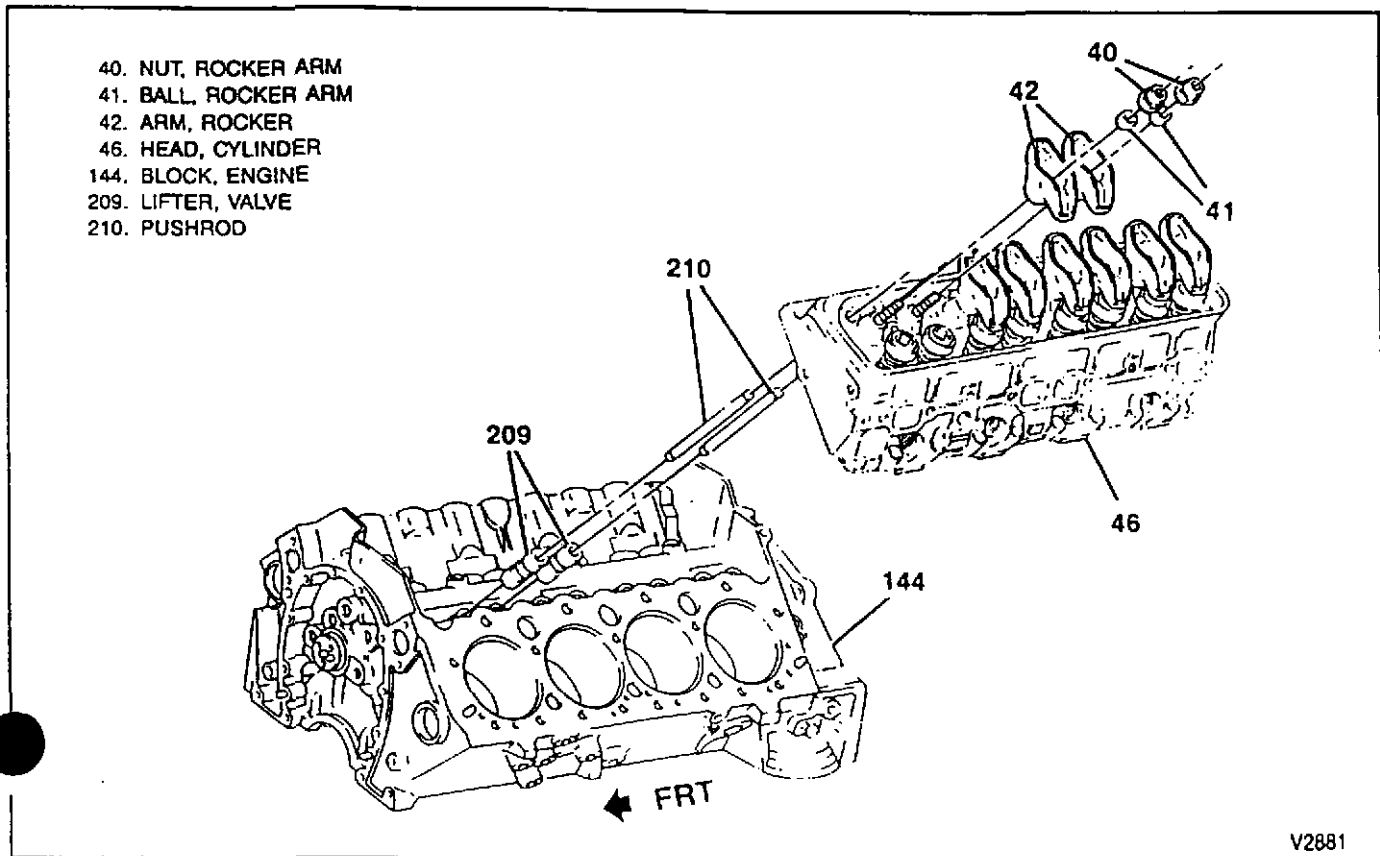
- A. Make note of the arrangement of the connecting rod markings, to ensure they will be returned to their proper position during assembly. Mark the connecting rods with a scratch awl if necessary.
- B. Remove the connecting rod bolt nuts.
- C. To avoid mismatching the connecting rods and connecting rod caps, remove only one connecting rod cap at a time. Place the piston at the bottom of its stroke.



- 45. Bolt
- 46. Cylinder Head
- 47. Gasket

F9327

Figure 21—Cylinder Head (7.4L Engines)

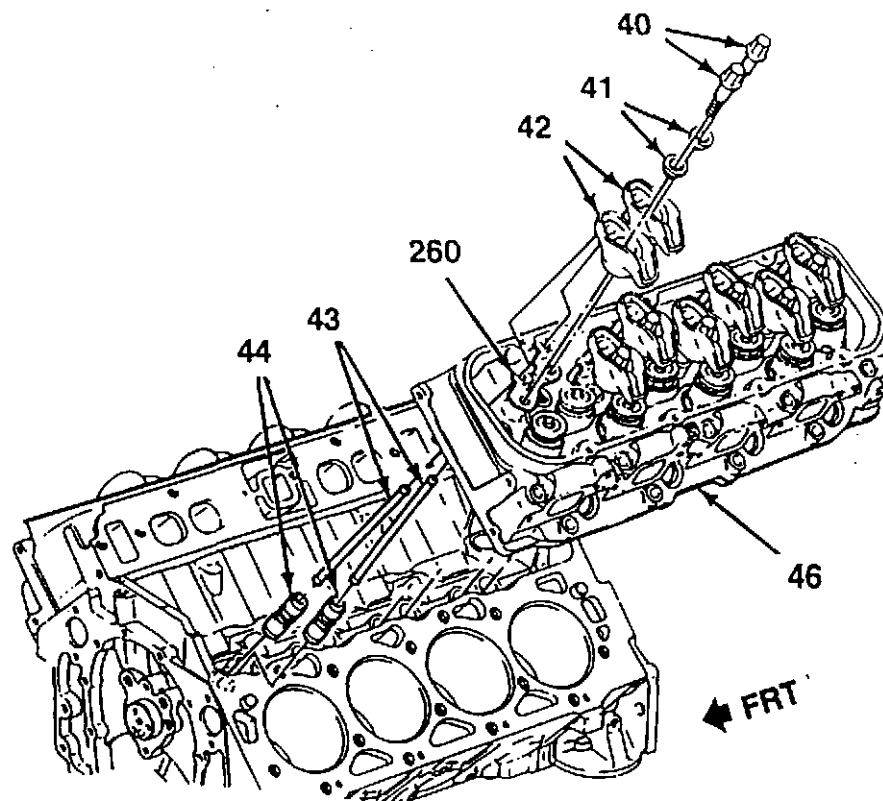


- 40. NUT, ROCKER ARM
- 41. BALL, ROCKER ARM
- 42. ARM, ROCKER
- 46. HEAD, CYLINDER
- 144. BLOCK, ENGINE
- 209. LIFTER, VALVE
- 210. PUSHROD

V2881

Figure 22—Valve Train Components (5.0L and 5.7L Engines)

- 40. Bolt
- 41. Ball
- 42. Rocker Arm
- 43. Pushrod
- 44. Hydraulic Lifter
- 46. Cylinder Head
- 260. Pushrod Guide



F9325

Figure 23—Valve Train Components (7.4L Engines)

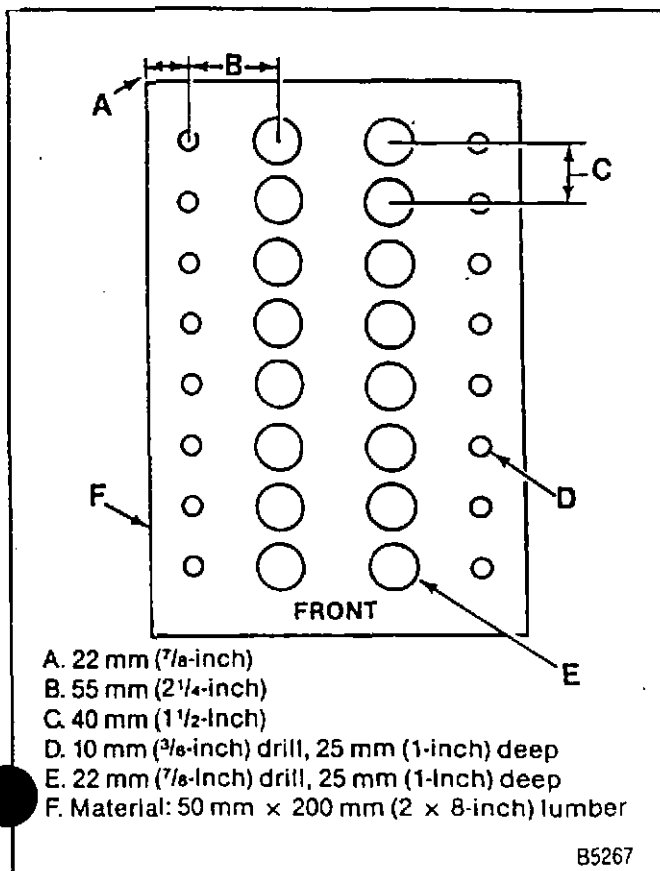


Figure 24—Valve Train Component Organizer

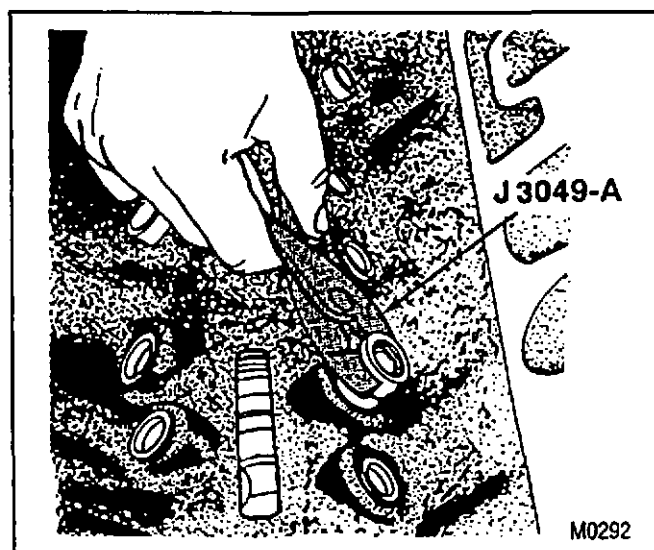


Figure 25—Removing the Hydraulic Lifter

- D. Remove the connecting rod cap.
- E. Install J 5239 onto the connecting rod bolts. Use of the specified guide set will prevent the connecting rod from scratching the bore or crankshaft journal during the removal process. The tool will also prevent the rod bearing half from falling out of the connecting rod during removal.

3. Connecting rod and piston from the block:

- A. Push on the guide rod (item A, figure 35) to push the piston and connecting rod out.

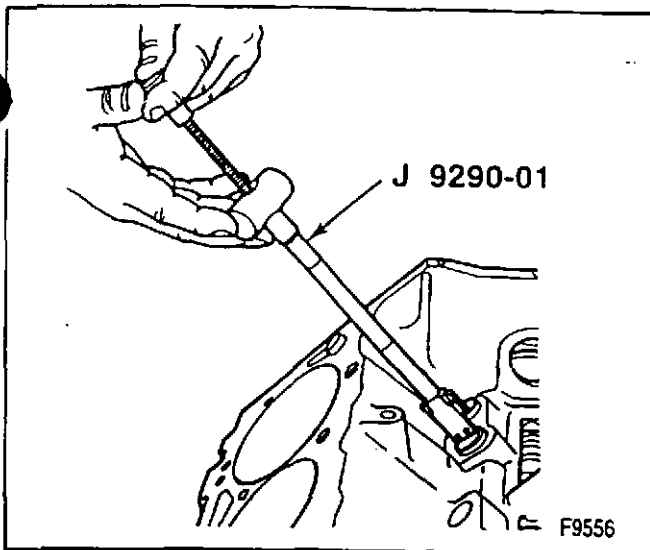


Figure 26—Removing the Hydraulic Lifter

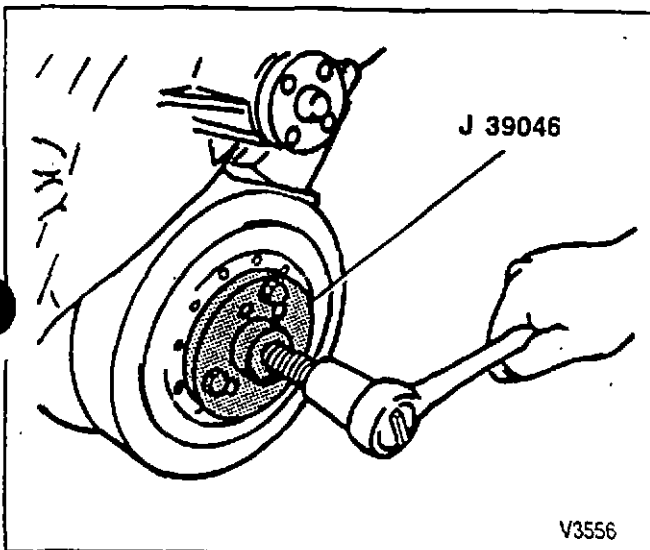


Figure 27—Removing the Torsional Damper

- B. Use the guide rod to prevent the connecting rod from scoring the cylinder bore.
- C. Install the connecting rod cap onto the connecting rod. Do not tighten.
- D. Repeat this procedure on the remaining piston and connecting rod assemblies.

FLYWHEEL REMOVAL

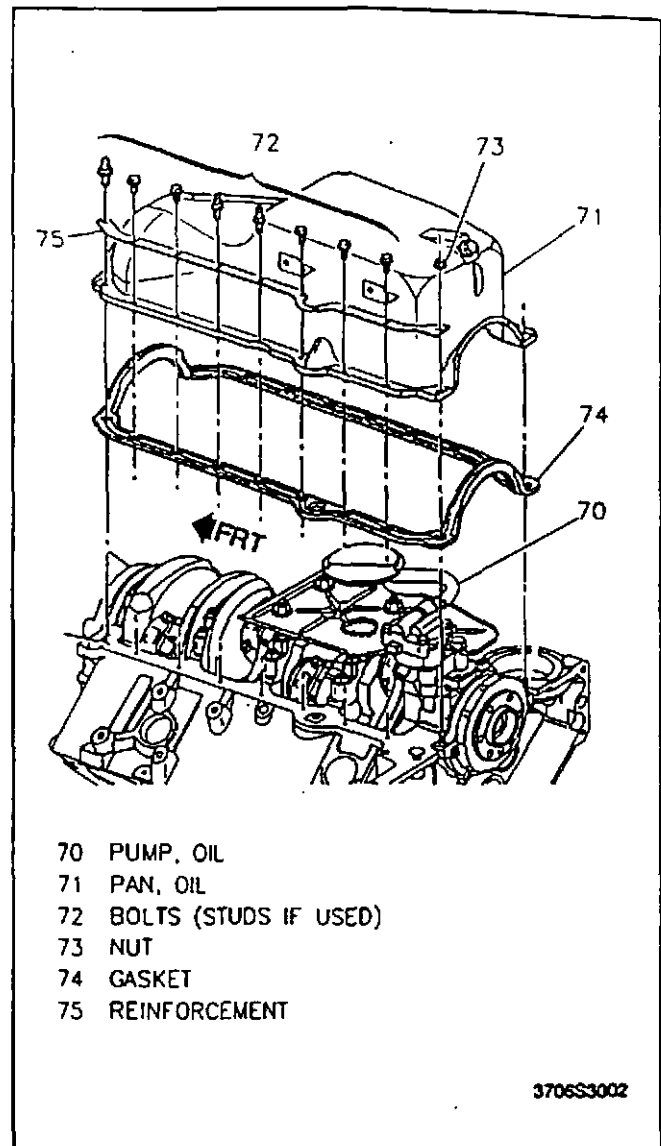
↔ Remove or Disconnect (Figures 36 and 37)

1. Bolts (111).
2. Flywheel (110A or 110B).

CRANKSHAFT REAR OIL SEAL RETAINER REMOVAL (5.0L and 5.7L ENGINES)

↔ Remove or Disconnect (Figure 38)

1. Screws (80) and nuts (81).
2. Seal retainer (82).
3. Gasket (84).



- 70 PUMP, OIL
- 71 PAN, OIL
- 72 BOLTS (STUDS IF USED)
- 73 NUT
- 74 GASKET
- 75 REINFORCEMENT

Figure 28—Oil Pan (5.0L and 5.7L Engines)

CRANKSHAFT REMOVAL

↔ Remove or Disconnect (Figure 39)

- Check the main bearing caps for location markings. Mark the caps if necessary. The caps must be returned to their original locations with the orientation arrow pointing forward during assembly.

1. Bolts (134).
2. Main bearing caps (132 and 133).
3. Crankshaft. Lift the crankshaft straight up. Use care to avoid damage to the crankshaft journals and thrust flange surfaces.
4. Rear seal (131).
5. Main bearing inserts (135 and 136). If the main bearings are to be reused, mark them to ensure they are installed in their original positions before removal.

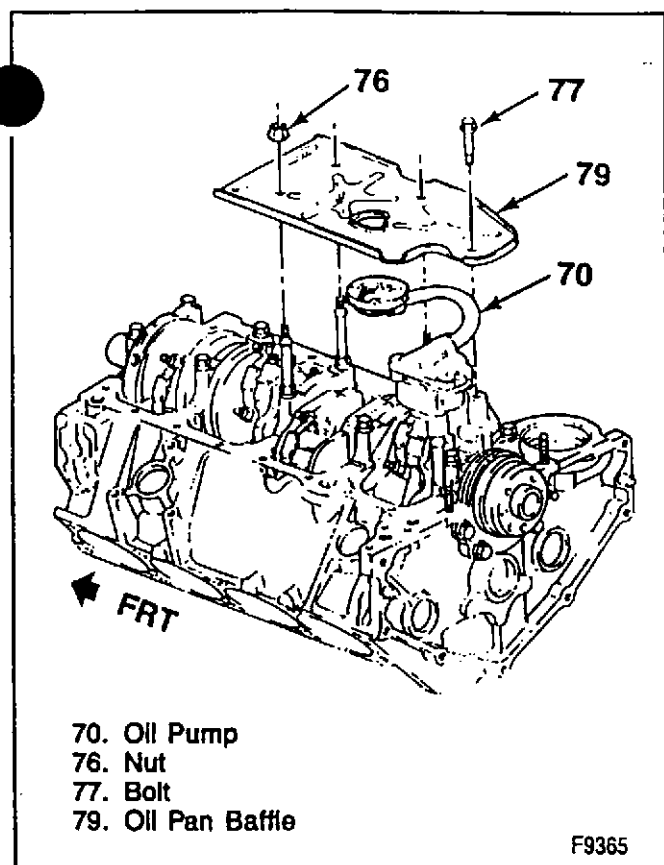


Figure 29—Oil Pan Deflector (5.0L and 5.7L Engines)

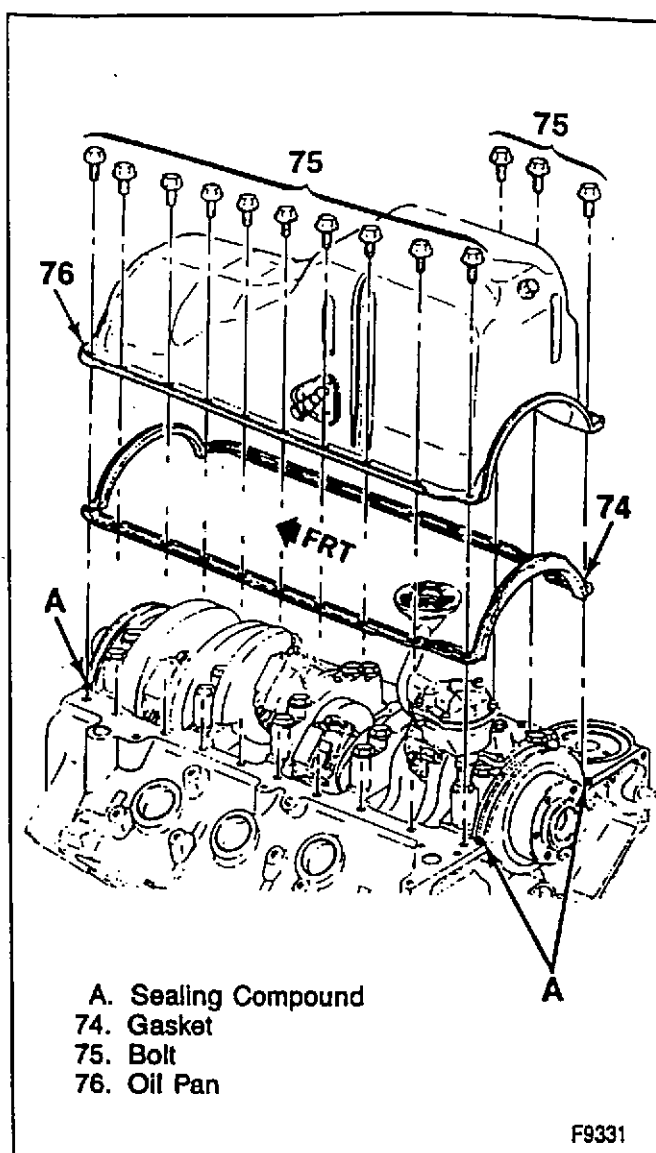


Figure 30—Oil Pan (7.4L Engines)

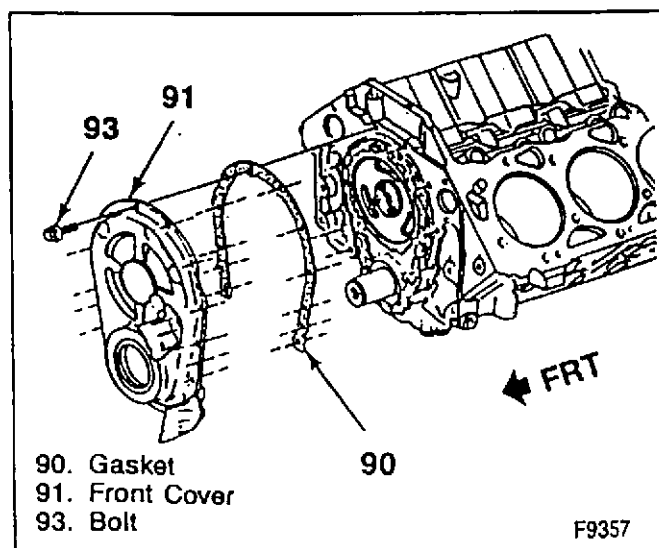


Figure 31—Front Cover

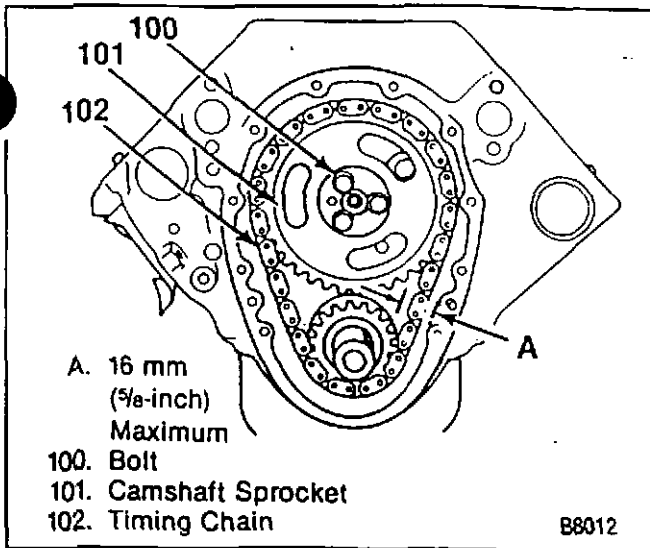


Figure 32—Timing Chain and Sprockets

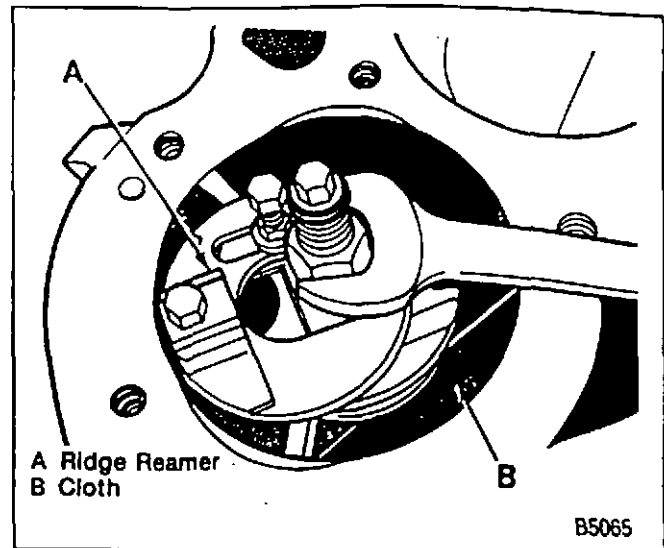


Figure 34—Removing the Cylinder Ridge

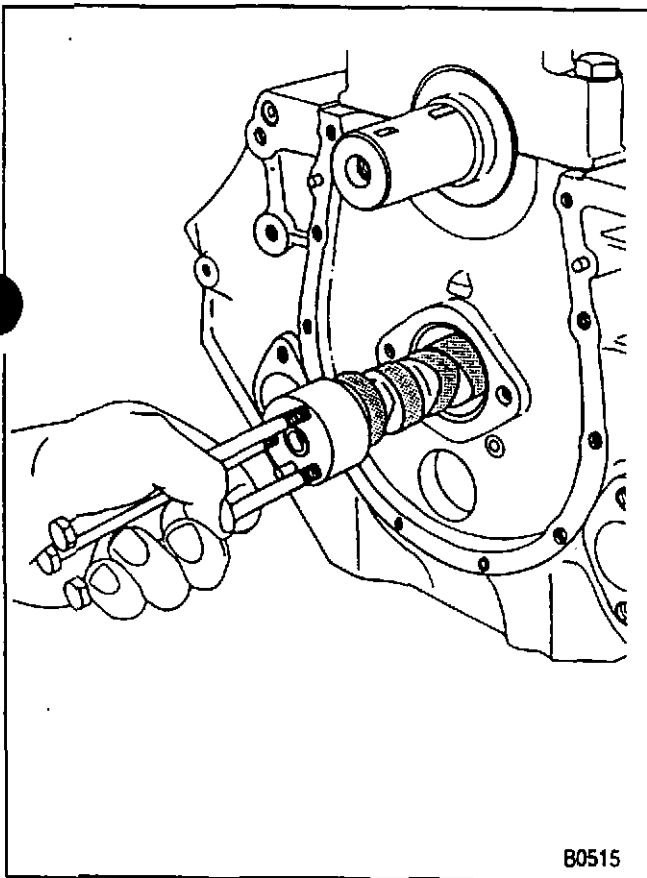


Figure 33—Removing the Camshaft

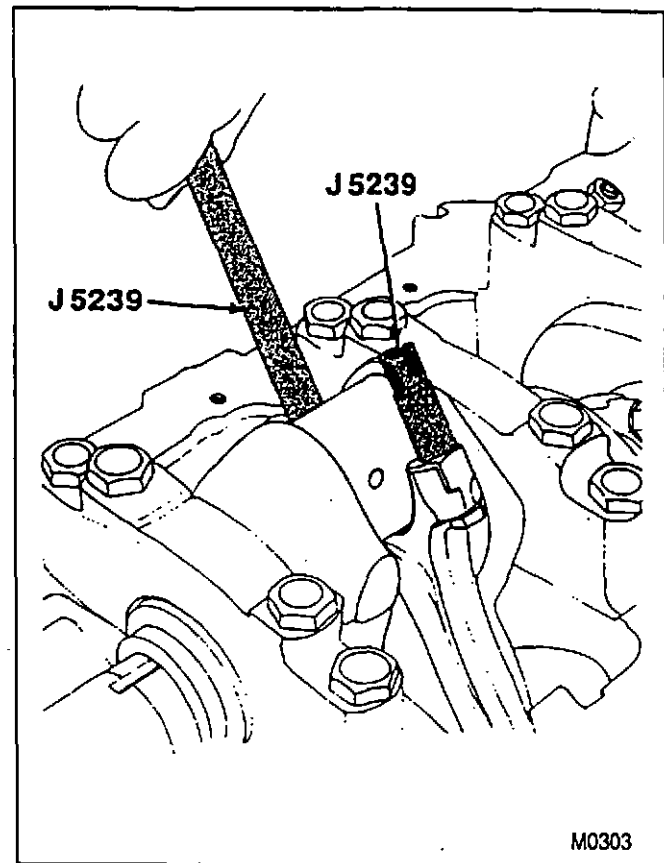


Figure 35—Removing the Piston and Connecting Rod

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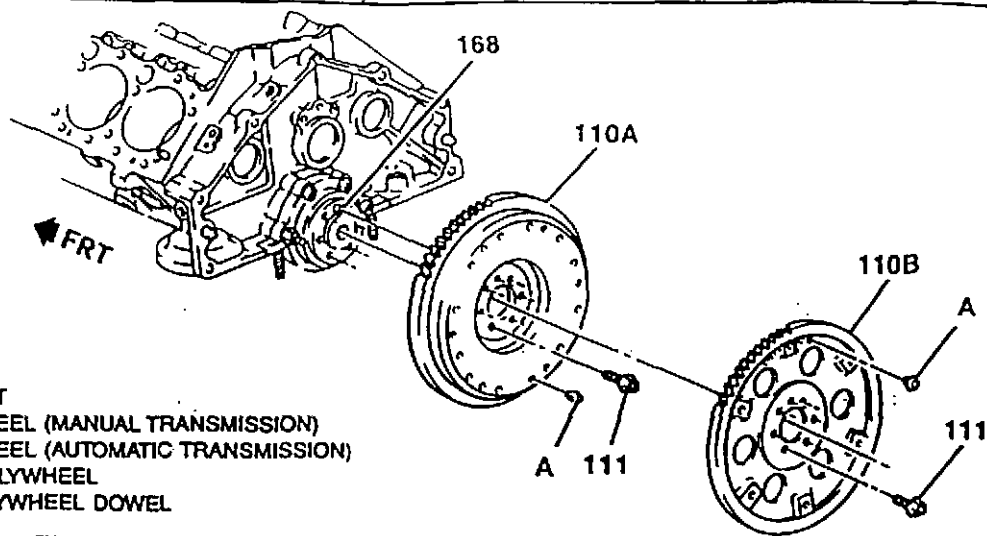


Figure 36—Flywheel (5.0L and 5.7L Engines)

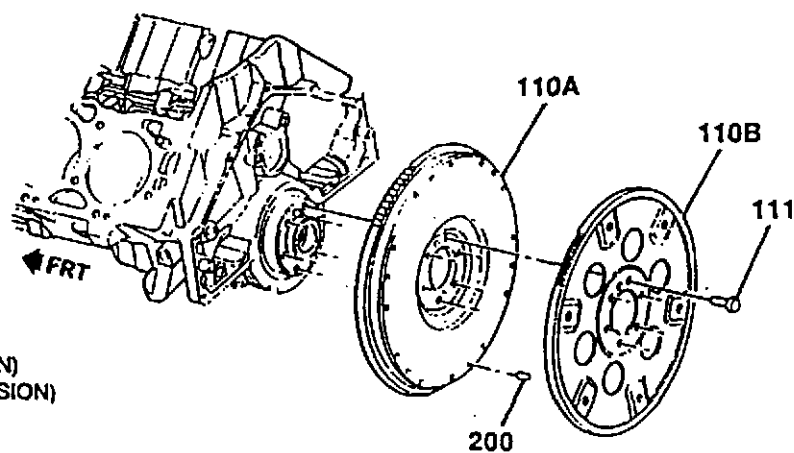


Figure 37—Flywheel (7.4L Engines)

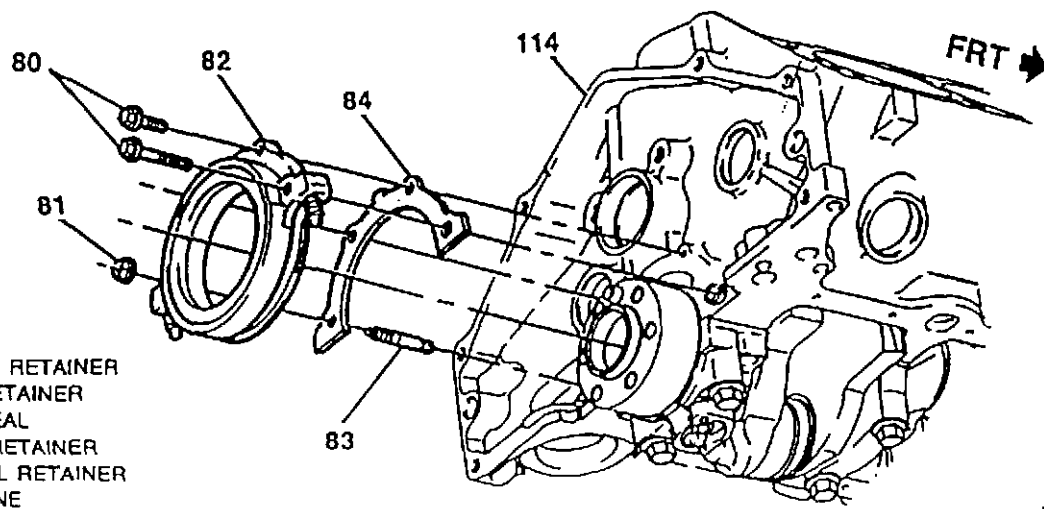


Figure 38—Crankshaft Rear Oil Seal Retainer (5.0L and 5.7L Engines)

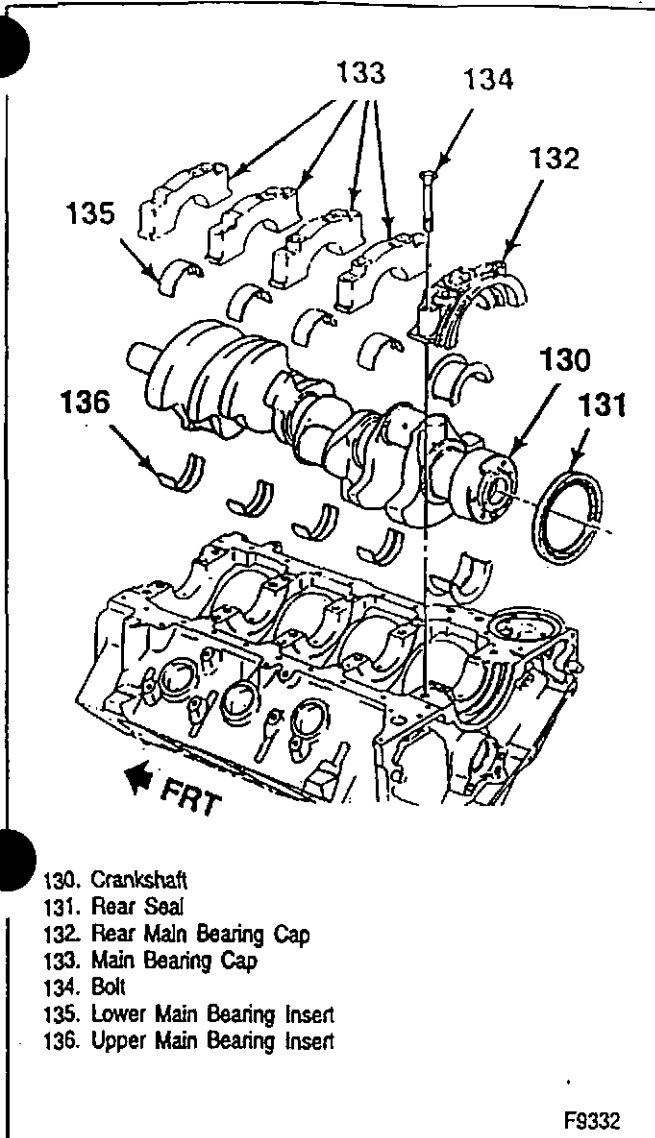


Figure 39—Crankshaft and Components (7.4L Engines)

CLEANING, INSPECTION, AND REPAIR

A solvent tank large enough to hold the larger engine parts will be needed along with various bristle brushes and a gasket scraper. A source of compressed air will be helpful in the cleaning operations.

Precision measuring tools will be required for the inspection procedure. These include: micrometers, cylinder bore gage, feeler gages, dial indicator set, etc. The inspection work, performed with the proper methods and tools, is most important. The rebuilt engine cannot be expected to perform properly if parts worn beyond acceptable limits are reused.

NOTICE: The following is recommended gasket cleaning procedure for General Motors engine components. Carefully remove all gasket material from the part using a plastic or wood scraper. Use Loctite brand "Chisel Gasket Remover" (P/N 4MA) or equivalent. Do not use any other method or technique to remove gasket material from a part. Do not use abrasive pads, sand paper or power tools to clean gasket surfaces. These methods of cleaning can damage the part. Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil. This grit is abrasive and has been known to cause internal engine damage.

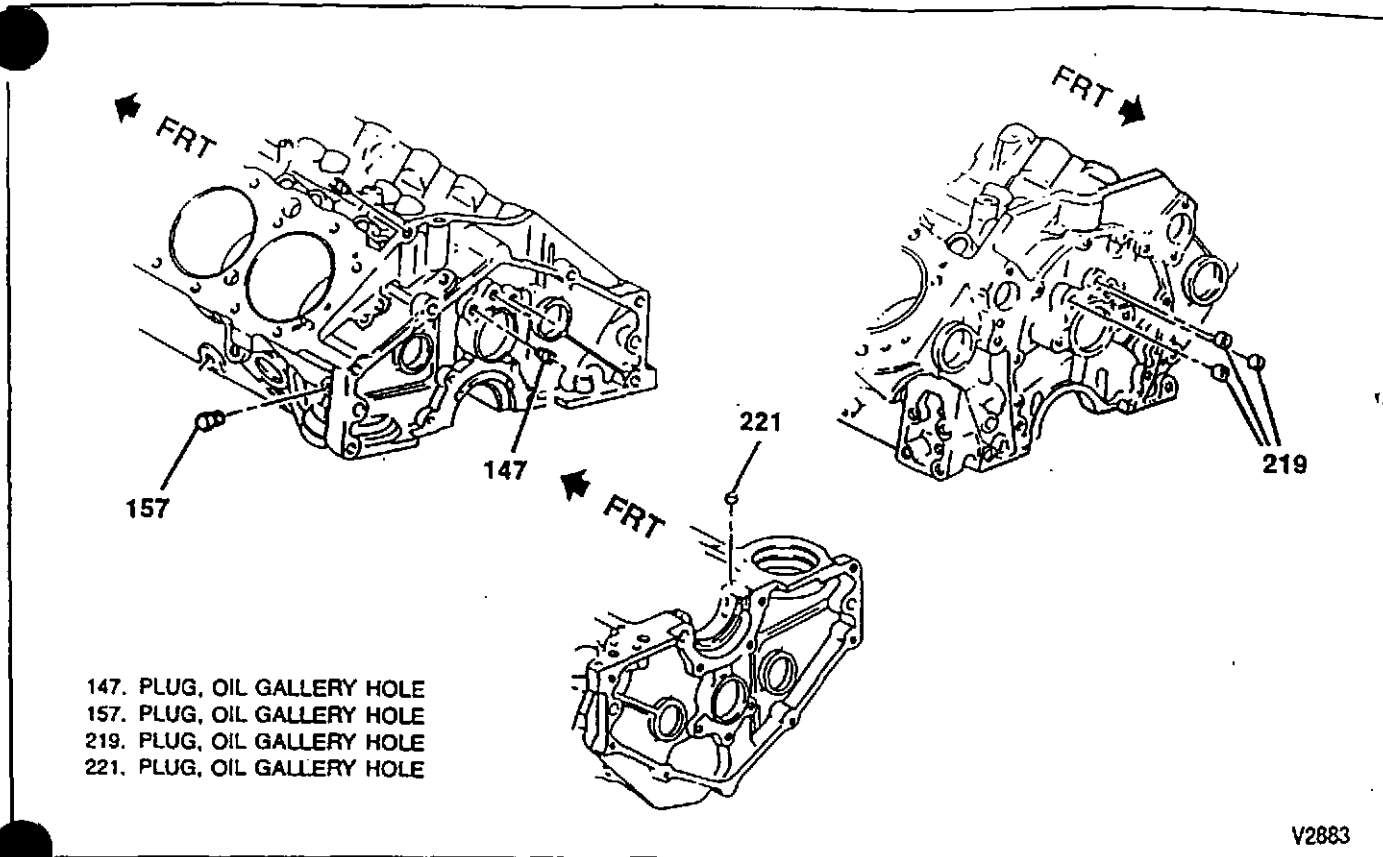


Figure 40—Engine Block Oil Gallery Hole Plugs (5.0L and 5.7L Engines)

NOTICE: If the engine is damaged internally and needs to be rebuilt, make sure all foreign material is completely flushed out of the cooling system. Vehicles equipped with an oil cooler should also be flushed out. Failure to rid the oil or cooling system of debris can result in engine damage to the rebuilt engine.

CYLINDER BLOCK



Clean (Figures 40, 41, and 42)



Disassemble

• Cooling jacket plugs.

1. Obtain a suitable self-threading screw.
2. Drill a hole into the plug.
3. Install the self-threading screw.
4. Remove jacket plugs.

• Oil gallery screw plugs.



Clean (Figures 40, 41, and 42)

Sealing material from mating surfaces.

Boil cylinder block in caustic solution.

— Flush with clean water or steam.

- Cylinder bores.
- Oil galleries and passages (figures 40 and 42).
- Scale deposits from the coolant passages.
- Spray or wipe cylinder bores and machined surfaces with engine oil.

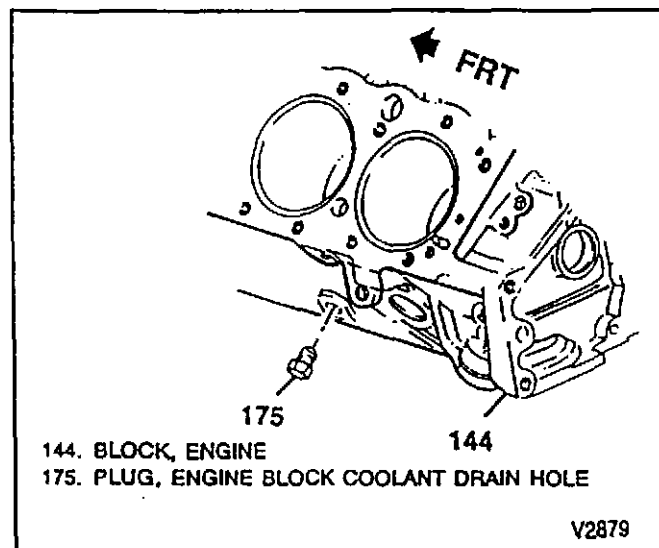
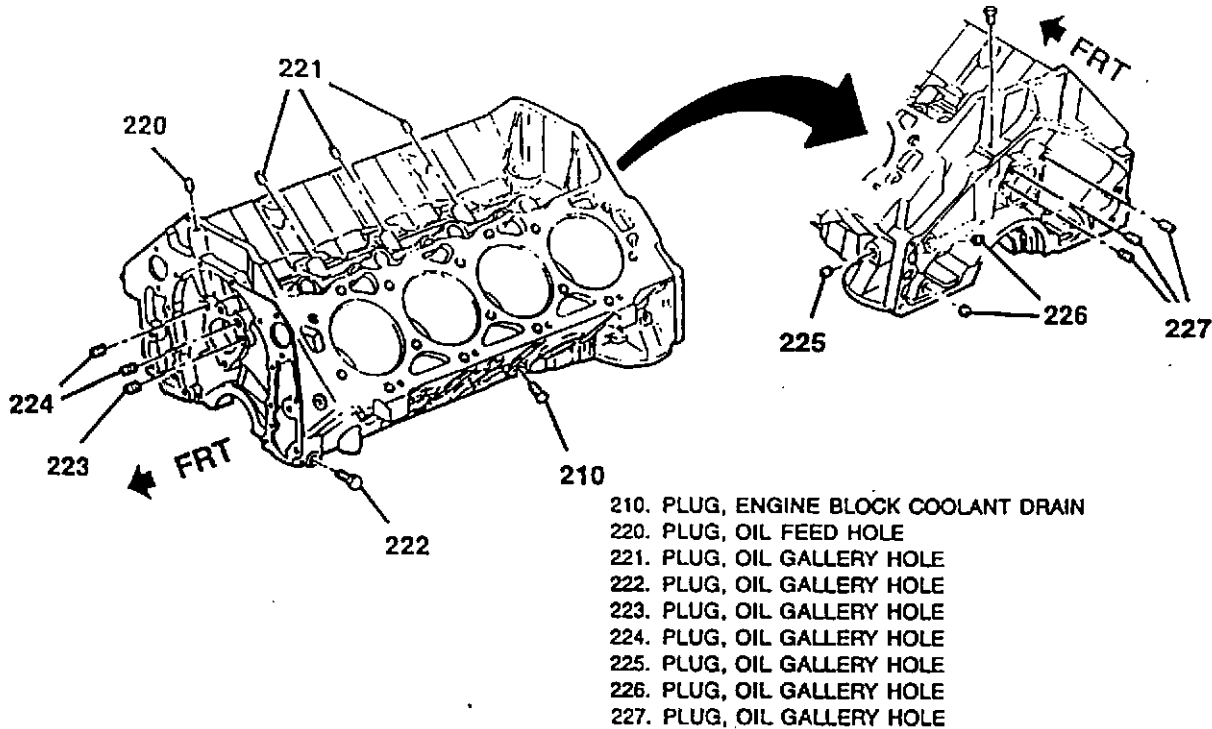


Figure 41—Engine Block Coolant Drain Hole Plug (5.0L and 5.7L Engines)



Inspect

1. All expansion plugs for poor fit or leakage.
2. Hydraulic lifter bores for deep scratches and varnish deposits.
3. Block for cracks.
 - Cylinder walls.
 - Coolant jackets.
 - Main bearing webs.
 - Engine mount bosses.
4. Main bearing bores and main bearing caps.



V2888

Figure 42—Engine Block Oil Gallery Hole and Coolant Drain Hole Plugs (7.4L Engines)



Measure (Figure 43)

- Head gasket surface distortion. Use a straight edge and feeler gage to check for flatness of the milled surface at the top of the cylinder block. The surface must be flat (within 0.10 mm (0.004 inch)) to ensure proper head gasket sealing.

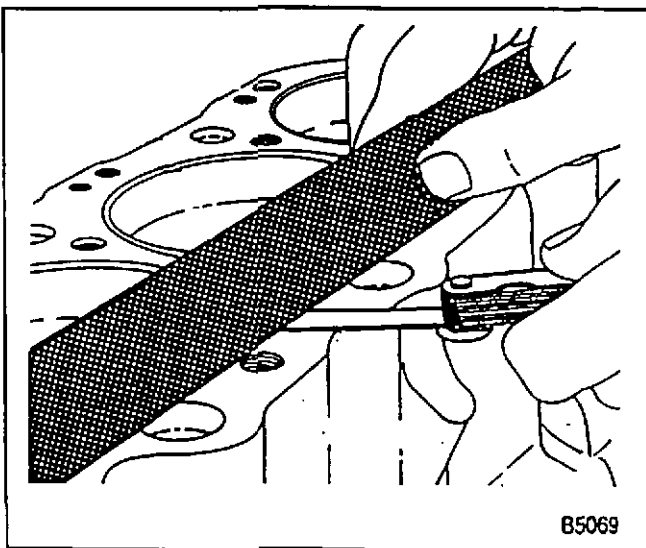


Figure 43—Checking the Block Gasket Surface

- All main bearing bores should be round and uniform in inside diameter (ID) at all bearing supports.
- The area where the main bearing inserts contact the main bearing bore should be smooth.
- If a main bearing cap is damaged and requires replacement, replace it as outlined later.

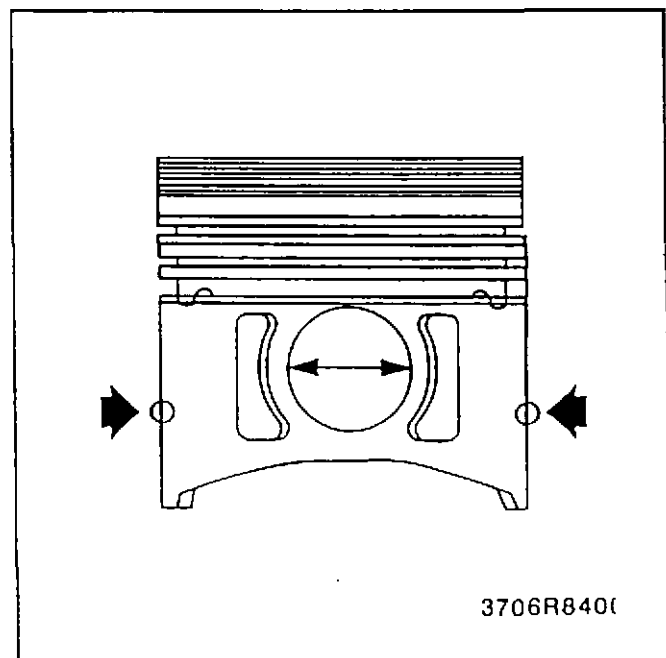


Figure 44—Piston Diameter Measurement

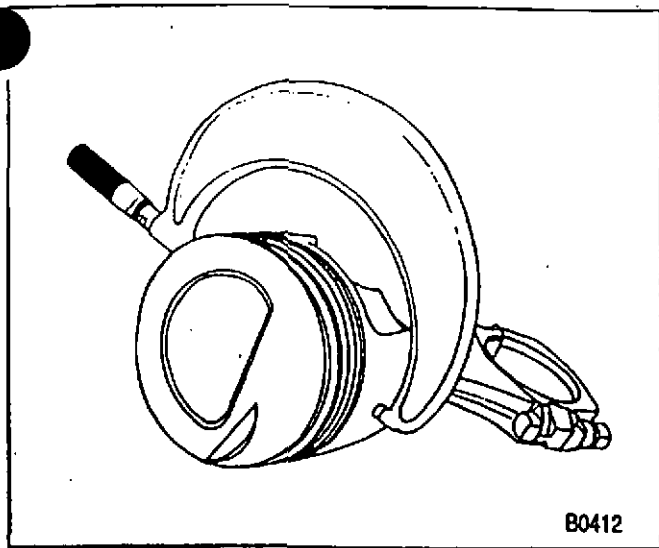


Figure 45—Measuring Piston Diameter

MAIN BEARING CAP REPLACEMENT

 Install or Connect

1. New main bearing cap. The arrow on the main bearing cap faces the front of the engine (opposite the flywheel).

NOTICE: Refer to "Notice" on page 6A5B-1.

2. Main bearing cap bolts.

 Tighten

- Bolts to "Specifications."

 Measure

- Main bearing vertical ID (inside diameter). Use an inside micrometer.
- This dimension should be the same as the other main bearing bore vertical diameters.

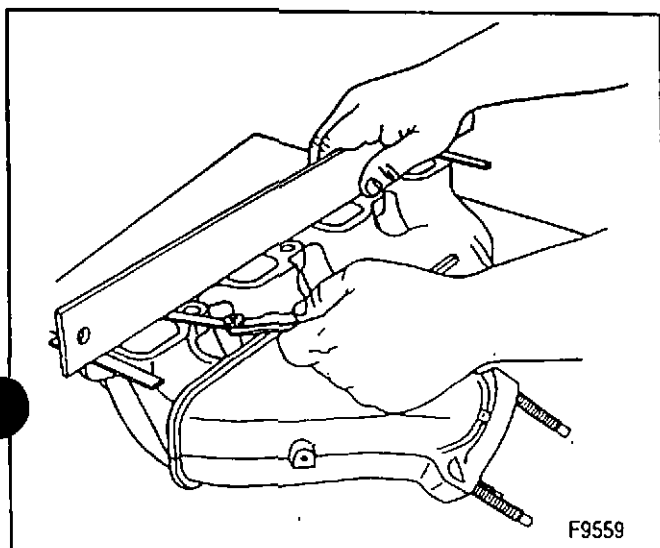


Figure 46—Checking Alignment of Manifold Flanges

CYLINDER BORES

 Inspect

- Cylinder bores for scoring and other damage.

 Measure

- Cylinder out of round and taper. Refer to SECTION 6A.

Cylinder Bore Reconditioning

Refer to SECTION 6A.

PISTON AND CONNECTING ROD ASSEMBLIES

For disassembly, cleaning, inspection, and assembly of these components, refer to SECTION 6A.

 Measure (Figures 44 and 45)

- Piston pin diameter and pin to piston clearance.
- Piston to bore clearance and fit pistons as outlined.

PISTON SELECTION

1. Check the used piston to cylinder bore clearance, as follows:

- A. Cylinder bore diameter. Use a telescoping bore gage, located 65 mm (2 1/2 inches) below the top of the cylinder bore (figure 44).
- B. Piston diameter. Measure the skirt at a right angle to the piston pin hole (figure 45).

 Important

- Measure piston diameter at 20° C (70° F).
- C. Subtract the piston diameter from the cylinder bore diameter to determine piston to bore clearance.
- D. Locate the piston to bore clearance refer to "Engine Specifications." Determine if the piston to bore clearance is in the acceptable range.

 Important

- Each connecting rod and bearing cap should be marked, beginning at the front of the engine. Cylinders 1, 3, 5, and 7 are the right bank and 2, 4, 6, and 8 are the left bank (when viewed from the front of the engine). The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new connecting rod bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number. On 7.4L engines the rod is not symmetrical and the outside always faces out.

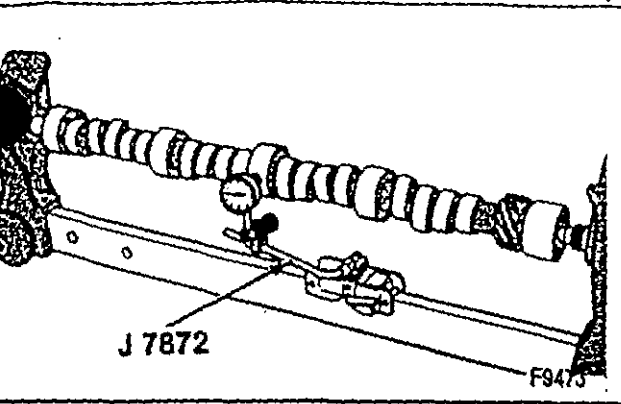


Figure 47—Measuring Camshaft Run-Out

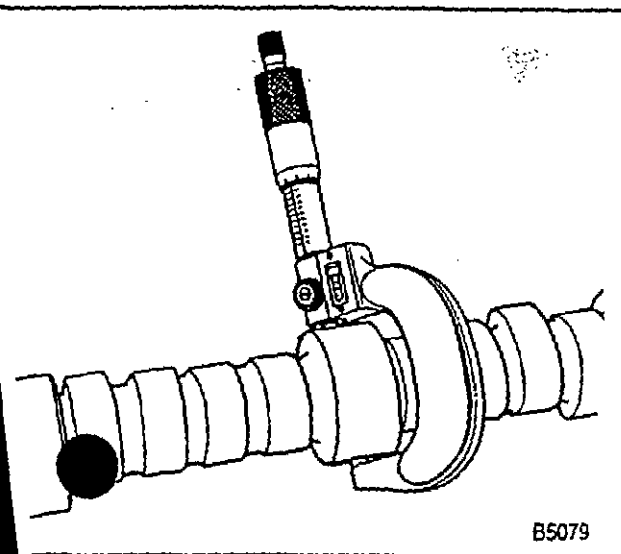


Figure 48—Checking the Camshaft Journals

Measure

Ring end gap and ring clearance. Refer to Section A.

Inspect

Ring fit. Refer to Section 6A.

INTAKE AND EXHAUST MANIFOLD

Remove

Remove pieces of gasket from the gasket surfaces. Remove excessive carbon build-up in the exhaust passages of the intake manifold.

Remove and deposits from the coolant passages of the intake manifold. Remove passage (if used) of excessive carbon deposits.

Inspect (Figure 46)

Check for cracks, broken flanges, and gasket damage.

- Alignment of exhaust manifold flanges. Use a straight edge and feeler gage (figure 46). If the flanges do not align, the manifold is warped and should be replaced or resurfaced.
- AIR system injection tubes for damage. Replace as needed.

CAMSHAFT

? Important

- Do not attempt to repair the camshaft. Replace it if damaged.
- Whenever the camshaft needs to be replaced, a new set of valve lifters must also be installed.

6 Inspect

- Camshaft distributor gear teeth.
- Bearing surfaces and lobes for wear.
- Sprocket.
- Keyway and threads.
- Galling
- Gouges
- Overheating (Discoloration)

Measure (Figures 47 and 48)

Tool Required:

J 7872 Dial Indicator (or equivalent)

- Camshaft runout (figure 47). Mount the camshaft in V-blocks or between centers. Using J 7872, check the intermediate camshaft journal. If runout on 5.0/5.7L engines exceeds 0.0254 mm (0.002 inch) and on 7.4L engines 0.0635 mm (0.0025 inch), the camshaft is excessively bent and should be replaced along with the camshaft bearings.
- Camshaft journal out-of-round. Use a micrometer (figure 46). If the journals are more than 0.00254 mm (0.001 inch) out-of-round, replace the camshaft.
- Camshaft journal diameter. Use a micrometer (figure 48). The proper diameter is listed in "Engine Specifications."

CAMSHAFT BEARINGS

Refer to SECTION 6A for replacement procedures.

TIMING CHAIN AND SPROCKETS

6 Inspect

- Sprockets for chipped teeth and wear.
- Timing chain for damage.
- It should be noted that excessively worn sprockets will rapidly wear a new chain. Likewise, an excessively worn chain will rapidly wear a new set of sprockets.

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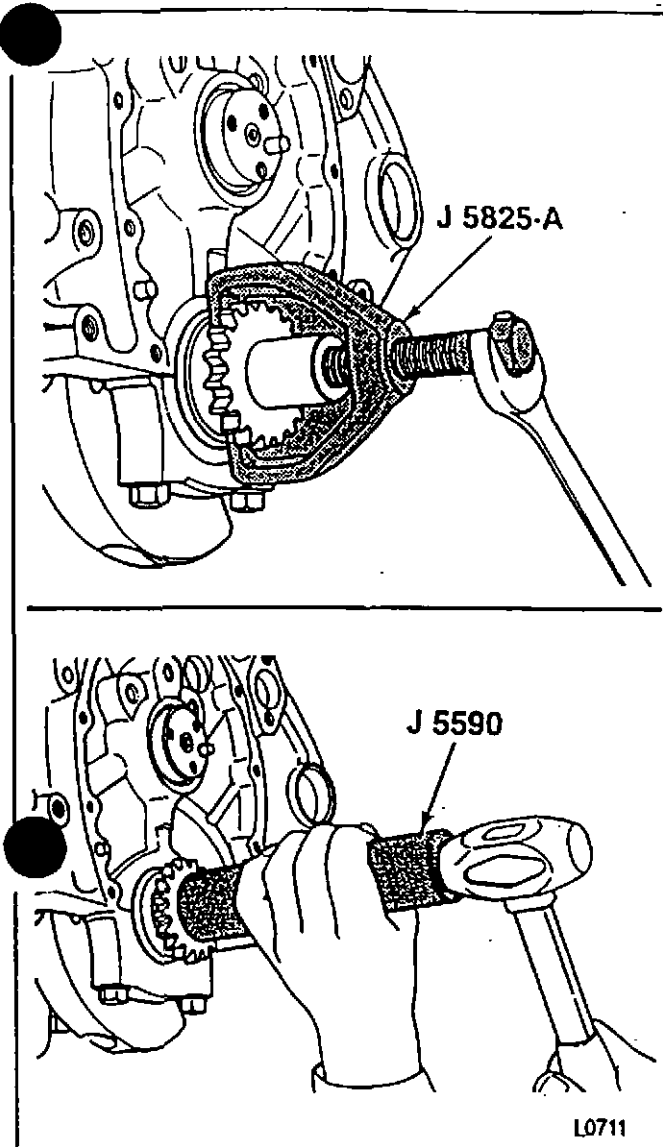


Figure 49—Crankshaft Sprocket Replacement (5.0L and 5.7L Engines)

CRANKSHAFT SPROCKET REPLACEMENT

Disassemble (Figures 49 and 50)

Tools Required:

- J 5825 Crankshaft Sprocket Puller
- J 28509-A Crankshaft Sprocket Puller

1. Crankshaft sprocket. On 5.0L and 5.7L engines, use J 5825 (figure 49). On 7.4L engines, use J 28509-A (figure 50).
2. Key, if necessary.

Assemble (Figures 49 and 50)

Tools Required:

- J 5590 Crankshaft Sprocket Installer
- J 22102 Crankshaft Sprocket Installer

1. Key, if removed.
2. Crankshaft sprocket. Use J 5590 (5.0L and 5.7L engines) or J 22102 (7.4L engines). Make sure the timing mark faces outside.

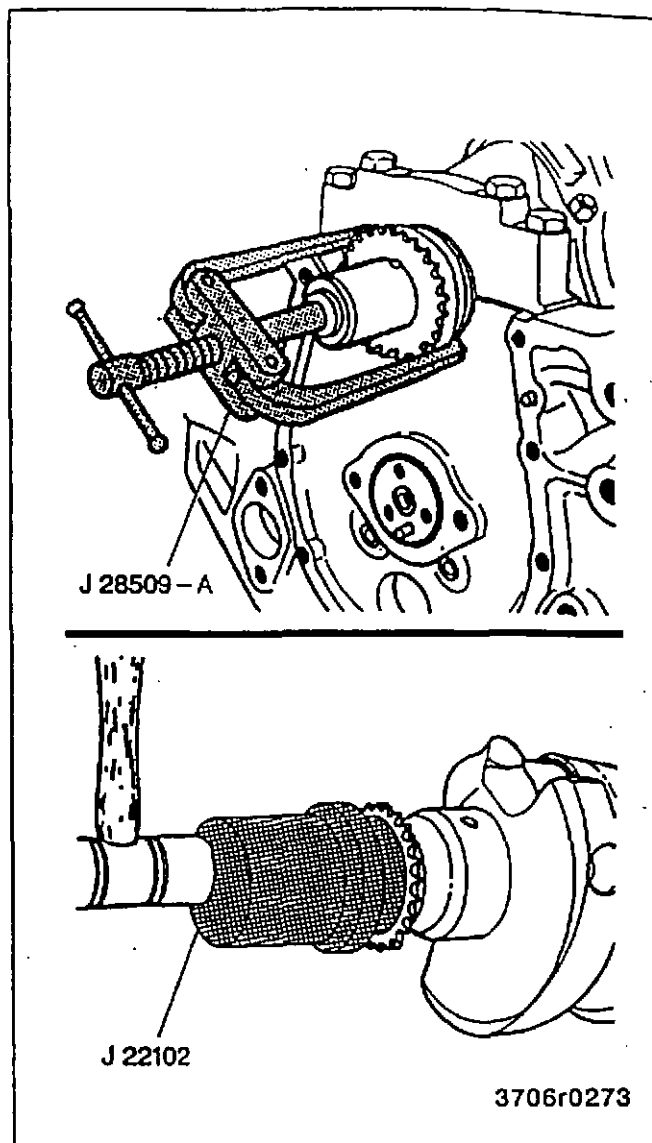


Figure 50—Crankshaft Sprocket Replacement (7.4L Engines)

FRONT COVER

Clean

- Old gasket from the gasket surfaces.

Inspect

- Timing marker for damage.
- Front cover for damage, dents, or cracks.

Disassemble

- Crankshaft front seal. Pry the seal out with a screwdriver. If the front cover is off the engine, push the seal out by hitting it with a screwdriver from the inside of the cover to the outside.



Assemble

1. Crankshaft front seal. Use J 35468 (5.0L and 5.7L engines) or J 22102 (7.4L engines) (figure 51). The open end of the seal must be facing the inside of the front cover.
2. Lightly coat the seal lips with grease.

COOLANT PUMP



Clean

- All gasket mating surfaces. Be sure old gasket material is removed and free of oil or other foreign materials.

NOTICE: Do not immerse the pump in solvent. The solvent may enter the pump's permanently lubricated bearings and cause premature bearing failure.



Inspect

- Coolant pump shaft for rotation and end play. The shaft and fan hub should turn straight and smoothly. If the hub wobbles or the shaft is noisy or feels "lumpy" when turned, replace the coolant pump. If the shaft end play exceeds 0.381 mm (0.015 inch), replace the coolant pump.
- Coolant pump body at the drain (weep) hole. Slight staining around the weep hole is normal. Replace the coolant pump only if coolant is dripping from the weep hole while the engine is running or while the system is pressurized.

OIL PAN AND ROCKER ARM COVERS



Clean

- Parts in solvent. Remove all sludge and varnish.
- Old gaskets from the gasket surfaces.



Inspect

- Gasket flanges for bending or damage.
- Rubber grommets and parts on the rocker arm cover for deterioration.
- Oil pan for rock damage or cracks.
- Oil pan deflector for lack of fit.
- Drain plug threads for stripping.

OIL PUMP



Disassemble (Figures 52 and 53)

1. Oil pump driveshaft (178) and connector (179).
2. Cover screws (186).
3. Cover (182) and gasket (190) (7.4L engines).
 - Mark the gear teeth so the pump gears can be installed with the same gear teeth indexed.
4. Drive gear and shaft (181).
5. Idler gear (188).

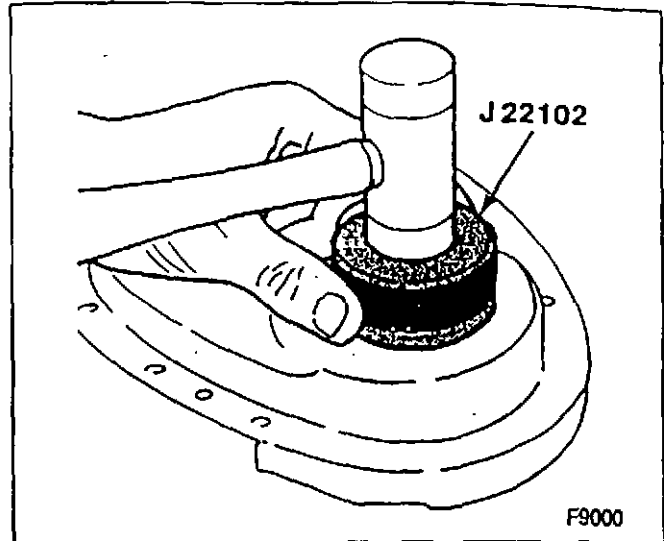


Figure 51—Installing the Crankshaft Front Seal

6. Spring retaining pin (185).
7. Spring (184).
8. Pressure relief valve (183).
9. Pickup screen and pipe (187).

- Do not remove the pickup screen and pipe unless replacement is required. The 7.4L engine uses a pickup pipe and screen that are welded to the oil pump assembly and must be ground off for replacement.
- The pickup pipe is press fit in the pump body to seal it and welded to retain it (7.4L engines only).
- Do not try to remove the screen from the pipe. The pickup screen and pipe are only serviced as an assembly.



Clean

- All parts in clean solvent and blow dry with compressed air.

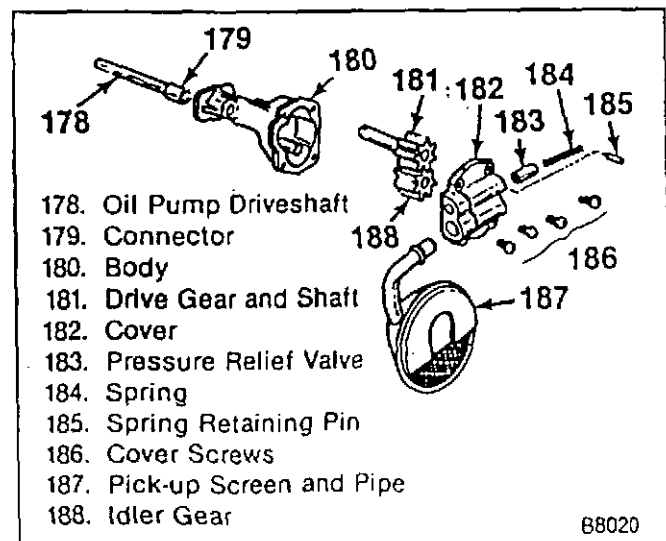
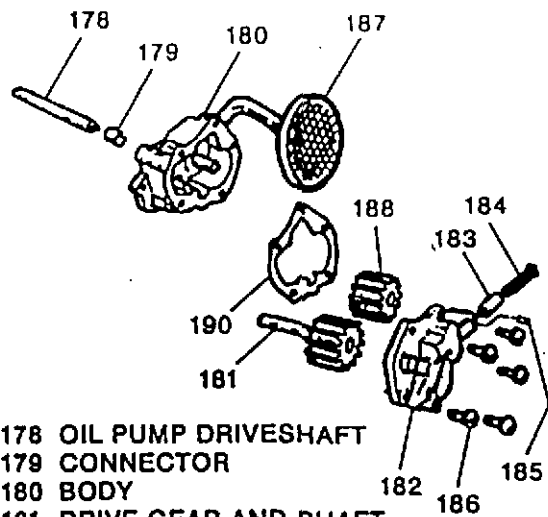


Figure 52—Oil Pump Components (5.0L and 5.7L Engines)

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- 178 OIL PUMP DRIVESHAFT
- 179 CONNECTOR
- 180 BODY
- 181 DRIVE GEAR AND SHAFT
- 182 COVER
- 183 PRESSURE RELIEF VALVE
- 184 SPRING
- 185 SPRING RETAINING PIN
- 186 COVER SCREWS
- 187 PICK-UP SCREEN AND PIPE
- 188 IDLER GEAR
- 190 GASKET

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Figure 53—Oil Pump Components (7.4L Engines)

Inspect

- Pump body (180) and cover (182) for cracks or other damage.
- Gears (181 and 188) for wear.
- Drive gear and shaft (181) for lack of fit in the pump body (180).
- Inside of the cover (182) for wear that would permit oil to leak past the ends of the gears. The pump

gears, cover, and body are not serviced separately. If the parts are damaged or worn, replace the entire oil pump assembly.

- Pressure relief valve (183) for fit. The regulator valve should slide freely in its bore without sticking or binding (figures 52 and 53).



Assemble (Figures 52, 53, and 54)

Tool Required:

J 21882 Pickup Tube and Screen Installer
(5.0L and 5.7L engines)

1. Pressure relief valve (183).
2. Spring (184).
3. Spring retaining pin (185).
4. Drive gear and shaft (181).
5. Idler gear (188) in the pump body (180) with the smooth side of the gear toward the pump cover opening. Index the marks made during disassembly.

NOTICE: Refer to "Notice" on page 6A5B-1.

6. Cover (182), gasket (190) (7.4L engines), and screws (186).



Tighten

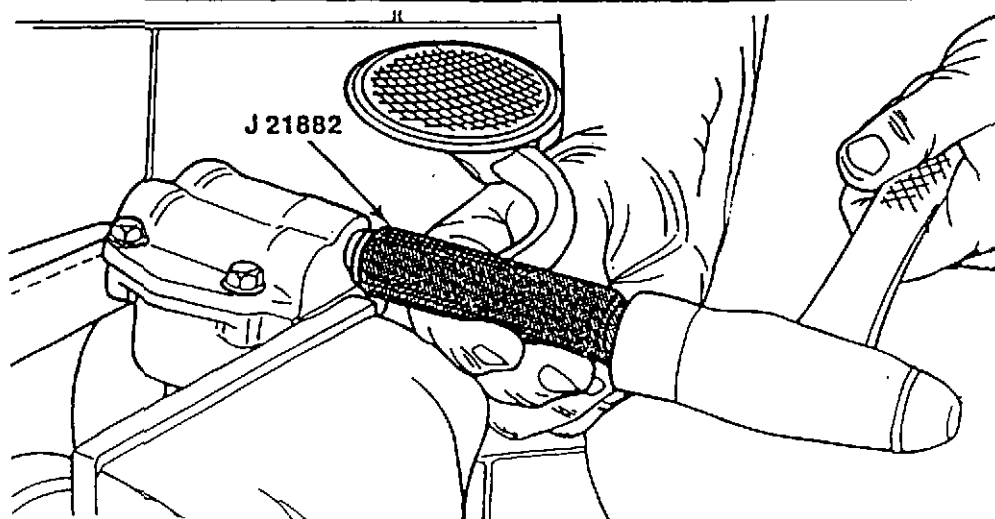
- Screws (186) to 12 N·m (106 lbs. in.).
- Turn the driveshaft by hand to check for smooth operation.

NOTICE: Be careful of twisting, shearing, or collapsing the pipe while installing it in the pump.

7. Pickup screen and pipe (187) (if removed) (figure 54).

A. If the pickup screen and pipe assembly was removed, it should be replaced with a new part. Loss of press fit condition could result in an air leak and loss of oil pressure.

B. Mount the oil pump in a soft jawed vise.



F9471

Figure 54—Installing the Oil Pump Pickup Tube and Screen (5.0L and 5.7L Engines)

- C. Apply sealer to the end of the pipe.
- D. Tap the pickup screen and pipe into place, using J 21882 (5.0L and 5.7L engines), and a hammer.
- E. The pump screen must be parallel with the bottom of the oil pan. The screen of the oil pump is about 1/4 inch from the bottom of the pan.
8. Oil pump driveshaft (178) and connector (179).

VALVE TRAIN COMPONENTS

PUSHRODS, ROCKER ARMS, BALLS, AND NUTS



Clean

- Parts in solvent. Blow dry with compressed air.
- Make sure the oil passages in the pushrods are clear.
- Rocker arms and balls at their mating surfaces. These surfaces should be smooth and free from scoring or other damage.
- Rocker arm areas that contact the valve stems and the sockets that contact the pushrods. These areas should be smooth and free of damage and wear.
- Rocker arm nuts or bolts.
 - The 5.0L and 5.7L engines use prevailing torque nuts. At least 6.2 N·m (55 lbs. in.) of torque should be required to thread the nuts onto the rocker arm studs. If not, it is possible that the nut(s) could back off during engine operation causing a loss of lash and valve train noise.
 - The 7.4L engine uses a bolt to retain the rocker arm, ball, and pushrod guide to the cylinder head. Inspect rocker arm bolts for signs of cracking at the bolt shoulder. Replace if necessary.
- Check pushrods for bending. Roll the pushrod on a flat surface to determine if it is bent. Replace if necessary.
- Check ends of the pushrods for scoring or roughness.

HYDRAULIC LIFTERS

Refer to SECTION 6A.

CYLINDER HEAD

DISASSEMBLY

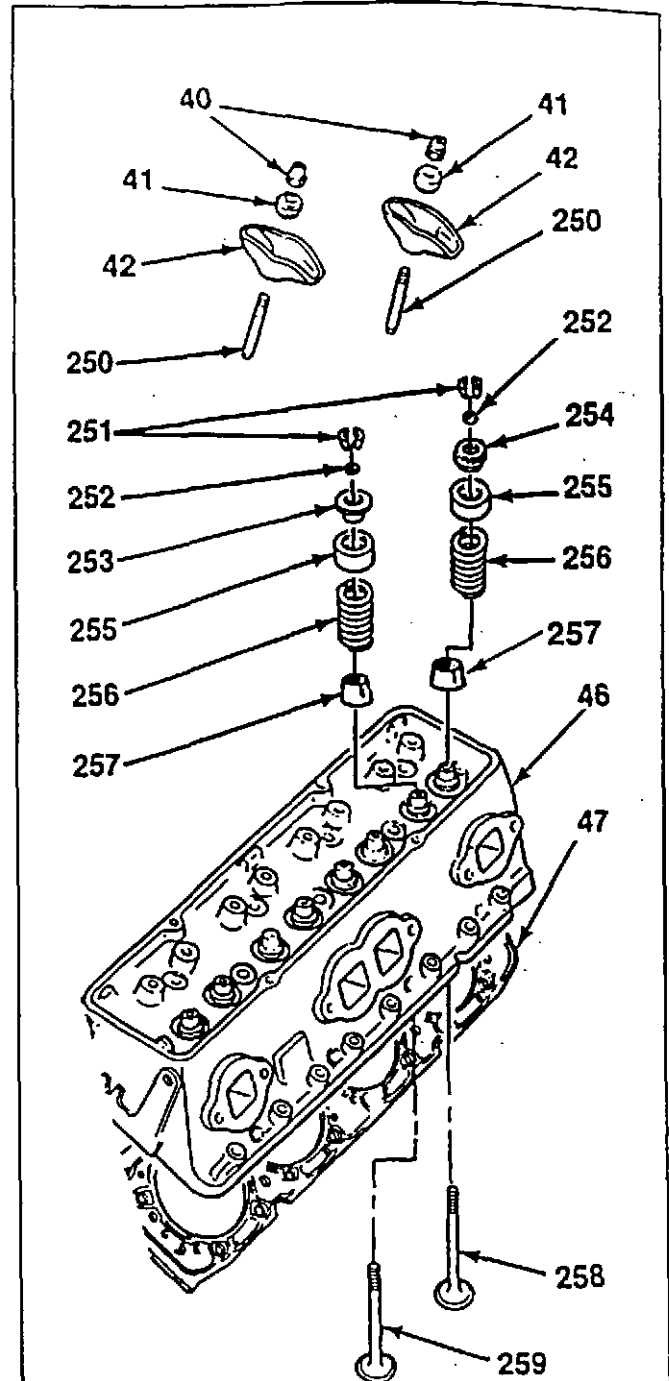


Disassemble (Figures 55, 56, and 57)

Tool Required:

J 8062 Valve Spring Compressor

1. Valve keepers (251).
 - A. Compress the springs (256) with J 8062 (figure 57).
 - B. Remove the valve keepers (251).
 - C. Remove J 8062.
2. Caps (253), shields (255), springs with dampers (256), and rotators (254).
3. O-ring seals (252) (if used) and seals (257).
4. Valves (258 and 259). Place them in a rack so they can be returned to their original position at assembly.



- | | |
|----------------------|-------------------------|
| 40. Nut | 253. Cap |
| 41. Ball | 254. Rotator |
| 42. Rocker Arm | 255. Shield |
| 46. Cylinder Head | 256. Spring with Damper |
| 47. Gasket | 257. Seal |
| 250. Rocker Arm Stud | 258. Exhaust Valve |
| 251. Valve Keeper | 259. Intake Valve |
| 252. O-Ring Seal | |

F9470

Figure 55—Cylinder Head and Components (5.0L and 5.7L Engines)

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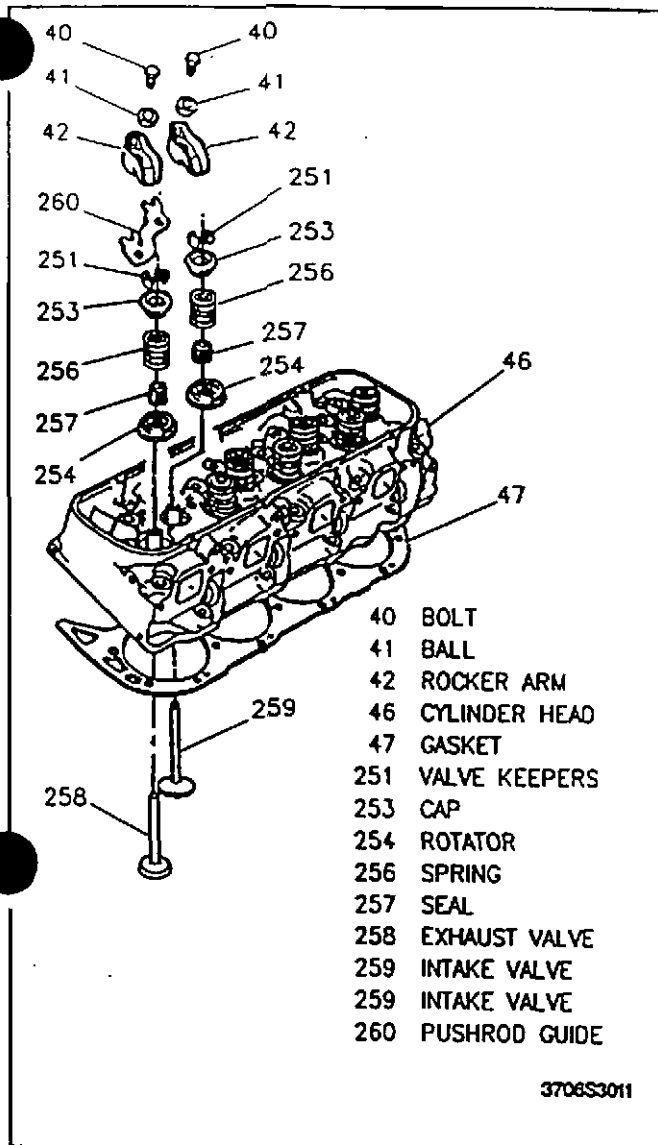


Figure 56—Cylinder Head and Components (7.4L Engines)

CLEANING AND INSPECTION

Refer to SECTION 6A and perform the following:



Measure

- Valve stem clearance.
 - Valve spring tension and free length.
- Other information outlined includes:
- Valve and seat grinding.
 - Valve guide reaming.

ROCKER ARM STUD REPLACEMENT (5.0L AND 5.7L ENGINES)

Tools Required:

- J 5802-01 Stud Remover
- J 5715 Reamer (0.0762 mm (0.003-inch) over-size) or
- J 6036 Reamer (0.3302 mm (0.013-inch) over-size)
- J 6880 Stud Installer

Rocker arm studs that have damaged threads or are loose in cylinder heads should be replaced. New studs are available in 0.003-inch and 0.013-inch oversize.

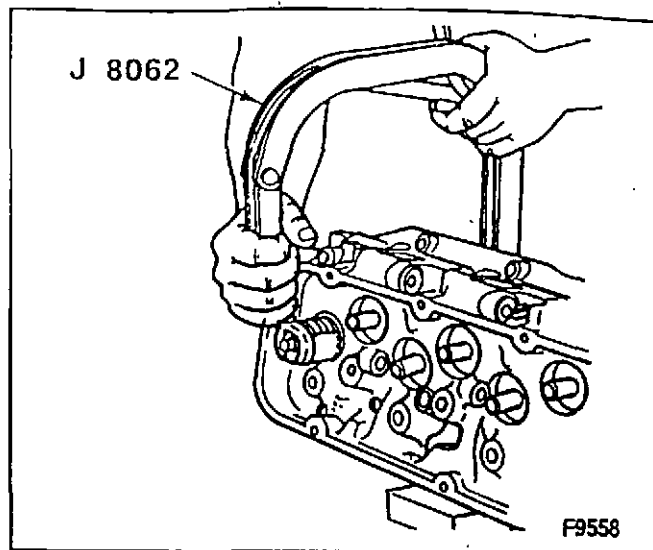


Figure 57—Compressing the Valve Springs

1. Place J 5802-01 over the stud to be removed. Install a nut and flat washer. Remove the stud by turning the nut (figure 58).
2. Ream the hole to the proper size for the replacement oversize stud. Use J 5715 for 0.0762 mm (0.003-inch) oversize studs; J 6036 for 0.3302 mm (0.013-inch) oversize studs (figure 59).
3. Coat lower end (press-fit area) of stud with hypoid axle lubricant. Drive the stud into place with a hammer and J 6880. Stud is installed to proper depth when the tool bottoms on the cylinder head (figure 60).

ASSEMBLY (5.0L AND 5.7L ENGINES)



Assemble (Figures 55 and 61)

Tools Required:

- J 8062 Valve Spring Compressor
- J 23738-A Valve Seal Leak Detector

1. Valves (258 and 259).
 - Lubricate the valve stems with engine oil.
 - Insert the valves into the proper guides.
2. Seals (257). Install the seals over the valve stems and seat them against the head.
3. Springs with dampers (256).
4. Shields (255).
5. Caps (253) (intake valves only).
6. Rotators (254) (intake and exhaust valves on 5.7L H.D. and exhaust valve only on 5.0L and 5.7L engines).
 - Compress the valve spring, using J 8062 (figure 55). Compress the spring enough so the lower valve stem groove can be clearly seen.
7. O-ring seals (252) and valve keepers (251).
 - A. Push a new O-ring seal onto the valve stem. The seal must be installed on the stem's lower groove. Make sure the seal is flat and not twisted.
 - B. Apply a small amount of grease to the area of the upper valve stem groove. Assemble the two valve keepers using the grease to hold the keys in place. Make sure the keepers seat properly in the groove.

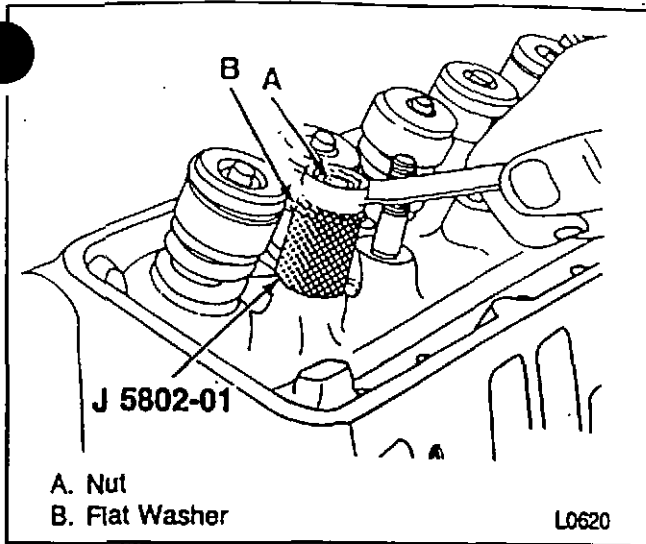


Figure 58—Removing the Rocker Arm Stud (5.0L and 5.7L Engines)

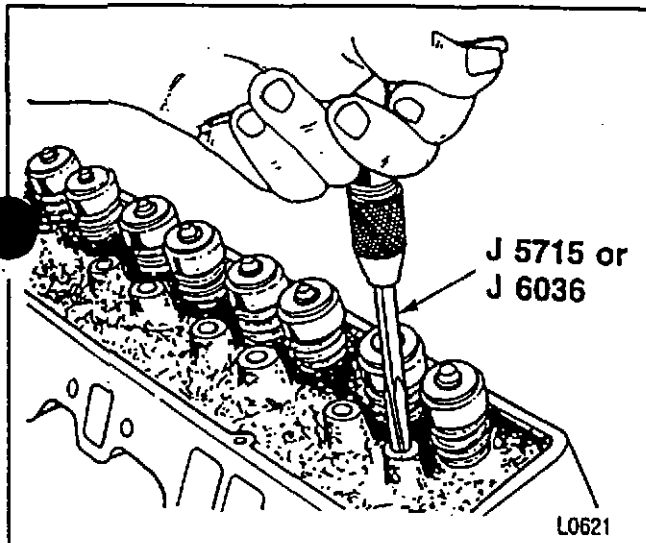


Figure 59—Reaming the Rocker Arm Stud Bore (5.0L and 5.7L Engines)

- C. Release the compressor tool. Make sure the valve keepers stay in place.
- D. Repeat the preceding steps on the remaining valves.
- E. Check each seal, using J 23738-A (figure 61). Place the adapter cup over the shield. Operate the vacuum pump. Observe the vacuum pump gage. No air should be able to leak past the seal. If the seal will not hold a vacuum, it may have been damaged or improperly installed.



Measure (Figures 62 and 63)

Valve spring installed height of each valve spring as follows:

1. Use a narrow, thin scale. A cutaway scale (figure 62) may be helpful.

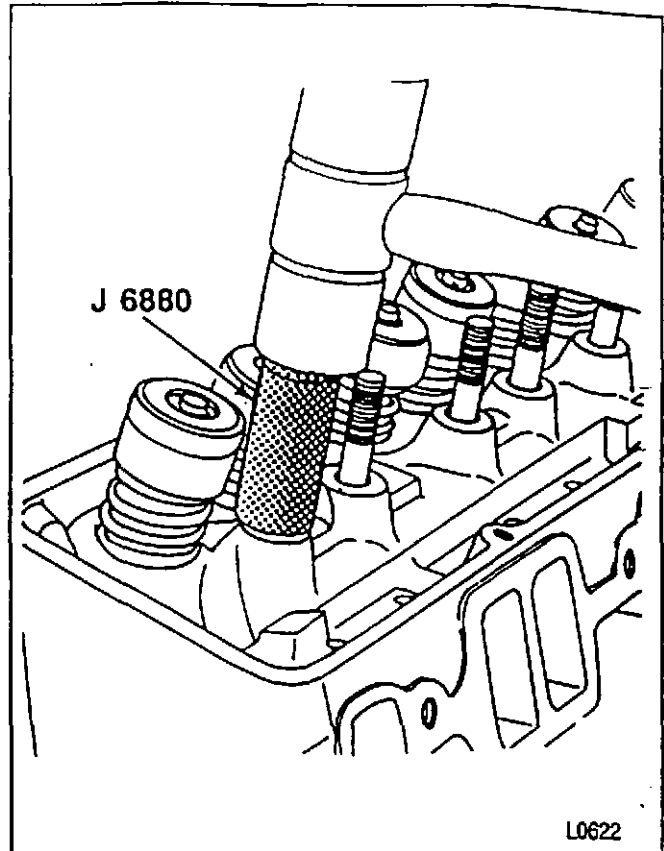


Figure 60—Installing the Rocker Arm Stud (5.0L and 5.7L Engines)

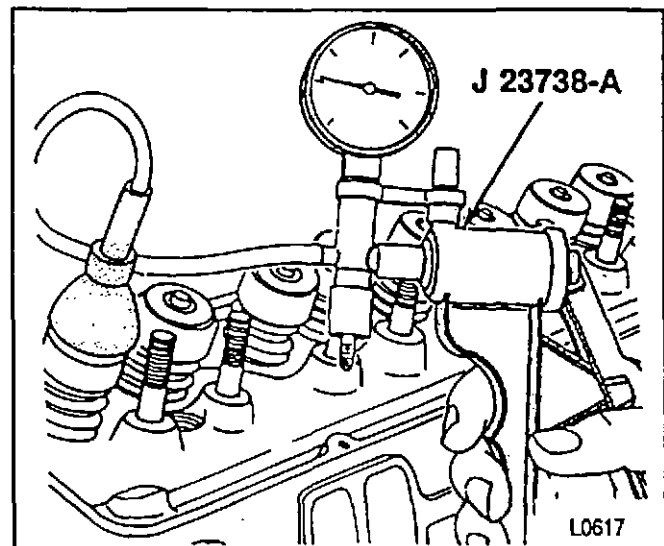


Figure 61—Checking the Valve Seal (5.0L and 5.7L Engines)

2. Measure from the valve shim or spring seat to the top of the shield (255) (figure 63).
3. If this measurement exceeds the amount given in "Engine Specifications," install valve spring seat shims of sufficient thickness (between the spring and cylinder head) to give the desired measurement. NEVER shim the spring so as to give an installed height under the specified amount.

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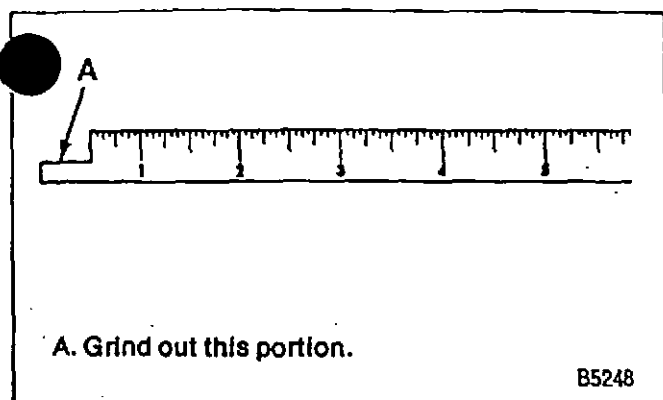


Figure 62—Cutaway Scale

ASSEMBLY (7.4L ENGINES)

Assemble (Figures 56 and 57)

Tool Required:

J 8062 Valve Spring Compressor

1. Valves (258 and 259).

A. Lubricate the valve stems with engine oil.

B. Insert the valve into the proper guide.

2. Rotators (254).

3. Seals (257).

A. Lubricate the seals with engine oil.

B. Push the seals into place.

Valve springs with dampers (256).

Keepers (253).

Valve keepers (251).

A. Compress the valve spring using J 8062 (figure 57). Compress the spring until the valve stem groove can be seen.

B. Apply a small amount of grease to the area of the valve stem groove.

C. Assemble the valve keepers, using the grease to hold the keys in place. Make sure the keepers seat properly in the groove.

D. Release the compressor tools. Make sure the valve keepers stay in place.

E. Repeat this procedure on the remaining valves.

Measure (Figures 62 and 63)

• Valve spring installed height of each valve spring.

1. Use a narrow, thin scale. A cutaway scale (figure 62) may be helpful.

2. Measure from the spring seat to the top of the valve spring (figure 63).

3. If this measurement exceeds the amount given in "Engine Specifications," install valve spring seat shims of sufficient thickness (between the spring and cylinder head) to give the desired measurement. NEVER shim the spring so as to give an installed height under the specified amount.

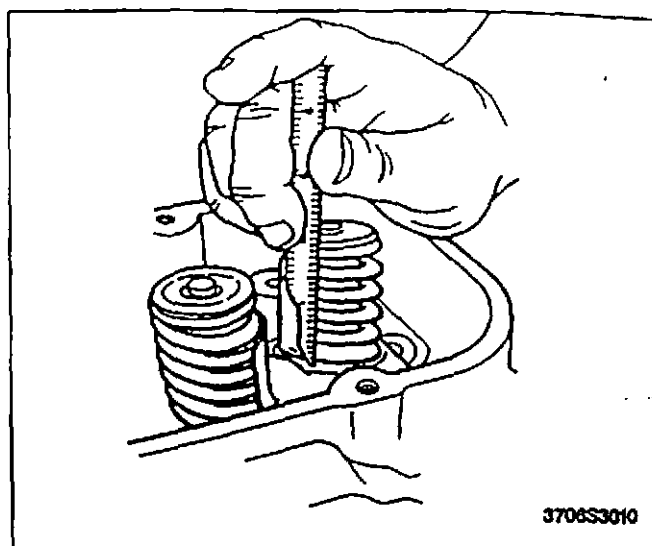
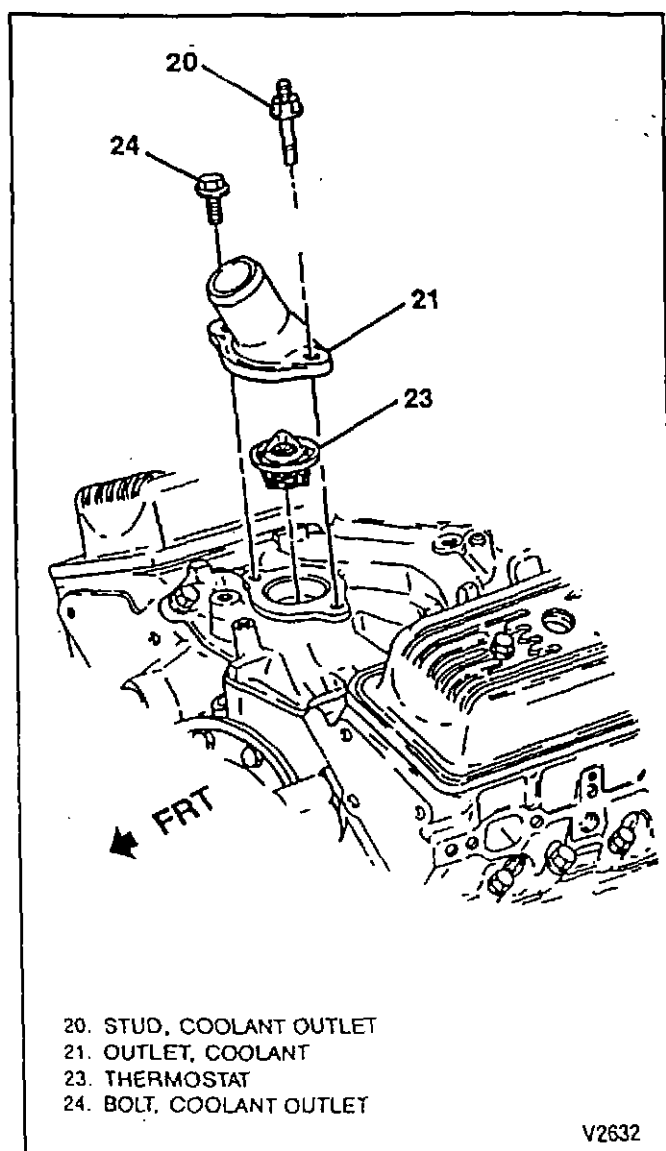


Figure 63—Measuring Valve Spring Installed Height



- 20. STUD, COOLANT OUTLET
- 21. OUTLET, COOLANT
- 23. THERMOSTAT
- 24. BOLT, COOLANT OUTLET

Figure 64—Thermostat and Components (5.0L and 5.7L Engines)

HERMOSTAT AND COOLANT OUTLET

Disassemble (Figures 64 and 65)

1. Bolts (24) or studs (20).

2. Coolant outlet (21).

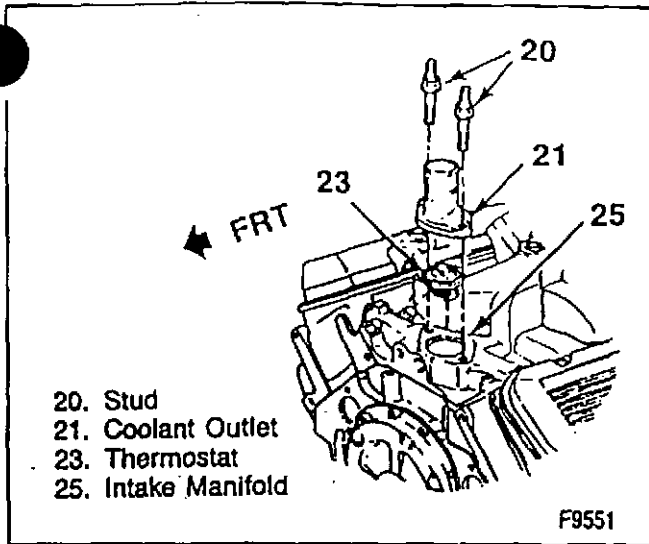


Figure 65—Thermostat and Components (7.4L Engines)

3. Thermostat (23).

Inspect

- Coolant outlet for cracks.

Thermostat Check

Refer to SECTION 6B1 in the proper on-vehicle Light Truck Service Manual.

Install or Connect (Figures 64 and 65)

NOTICE: Do not install thermostat assembly without rubber O-ring. Omitting rubber O-ring may result in poor engine warm-up and reduced heater performance.

1. Thermostat (23) with rubber O-ring.
2. Coolant outlet (21).

NOTICE: Refer to "Notice" on page 6A5B-1.

3. Bolts (24) or studs (20).

Tighten

- Bolts (24) or studs (20) to specifications.
 - 5.0L and 5.7L engines: 28 N·m (21 lbs. ft.).
 - 7.4L engines: 40 N·m (30 lbs. ft.).

TORSIONAL DAMPER

Inspect

- Torsional damper weight for signs of shifting on the hub. Replace as needed.
- Area of the torsional damper hub shaft which contacts the crankshaft front seal for roughness or nicks. Replace the damper if this condition exists.

CRANKSHAFT AND BEARINGS

Clean

- Crankshaft with solvent.
- Blow all sludge from the oil passages with compressed air.
- Main bearing inserts. Wipe free of oil with a soft cloth.
- Seal running surfaces with a non-abrasive cleaner.

Inspect

- Crankshaft for cracks. Use the magnaflux method, if available.
- Crankpins, main bearing journals, and thrust surfaces for scoring, nicks, or damage caused by lack of lubrication.
- Main bearing inserts for scoring or other damage.

In general, the lower inserts (except the #1 bearing) show greater wear and the most distress from fatigue. If, upon inspection, the lower insert is suitable for use, it can be assumed that the upper insert is also satisfactory. If the lower insert shows evidence of wear or damage, both the upper and lower inserts must be replaced.

Measure (Figures 66 and 67)

- Main bearing and connecting rod journal diameters (figure 66). Compare with "Engine Specifications." Grind or replace the crankshaft if necessary.
- Main bearing and connecting rod journals for taper and out-of-round (figure 66). If the journals are tapered or out-of-round more than 0.0254 mm (0.001 inch), grind or replace the crankshaft.
- Crankshaft run-out (figure 67).
 - A. Mount the crankshaft in V-blocks on main journals 1 and 5.
 - B. Use a dial indicator to measure the crankshaft runout, as shown in figure 67.
 - C. If the main journals are misaligned, the crankshaft is bent and must be replaced, along with the main bearings.

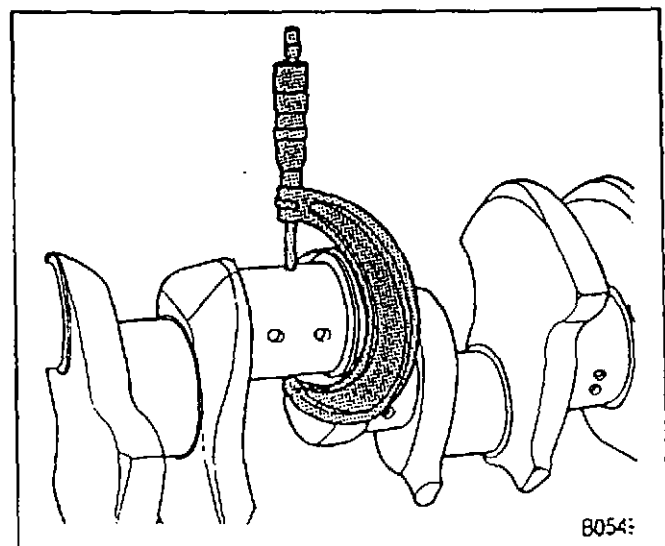


Figure 66—Measuring the Crankshaft Journals

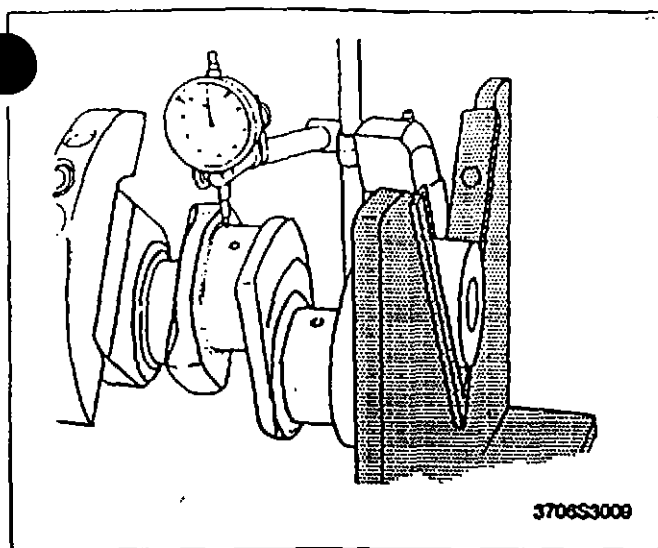


Figure 67—Checking Crankshaft Run-Out

Crankshaft Bearing Availability

Crankshaft main and connecting rod bearings are available in 0.0254 mm (0.001 inch), 0.0508 mm (0.002 inch), 0.2540 mm (0.010 inch), and 0.5080 mm (0.020-inch) undersizes.

CRANKSHAFT REAR OIL SEAL RETAINER (5.0L AND 5.7L ENGINES)



Disassemble (Figure 68)

- Crankshaft rear oil seal. Insert a screwdriver into the notches provided in the seal retainer and pry the seal out (figure 68).

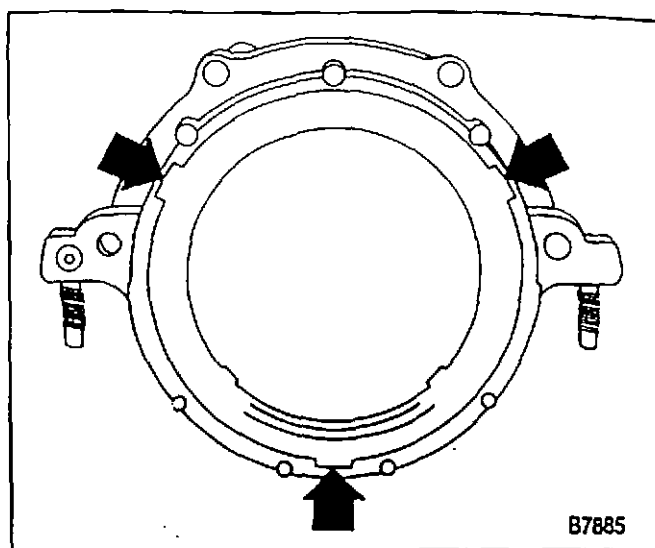


Figure 68—Seal Removal Notches (5.0 and 5.7L Engines)



Clean

- All traces of old gasket from the retainer.



Inspect

- Retainer for cracks, porosity, and damage to the sealing surfaces.



Important

- Install the new crankshaft rear oil seal with the proper tool after the retainer is assembled to the engine, as outlined later.

ASSEMBLY OF THE ENGINE

PRIOR TO ASSEMBLY

The importance of cleanliness during the assembly procedure cannot be overstressed. Dirt will cause premature wear of the rebuilt engine.

Lubricate all moving parts lightly with engine oil or engine assembly lubricant (unless specified otherwise) during assembly. This will provide initial lubrication when the engine is started.

CRANKSHAFT AND MAIN BEARING INSTALLATION

Main bearings are the precision insert type and do not use shims for adjustment. If clearances are excessive, a new bearing will be required. Service bearings are available in standard size and 0.0254 mm (0.001 inch), 0.0508 mm (0.002 inch), 0.2540 mm (0.010 inch), and 0.5080 mm (0.020 inch) undersize. 0.2286 mm (0.009 inch) is available for 5.0L and 5.7L engines only.

Selective fitting of both rod and main bearing inserts is necessary to obtain close tolerances. For this reason you may use, for example, one half of a 0.0254-mm (0.001-inch) undersize insert which will decrease the

clearance 0.0127 mm (0.0005-inch) from using a full standard bearing.

UNDERSIZE MAIN JOURNALS (5.0L AND 5.7L ENGINES)

- On 5.0L and 5.7L engines, when a production crankshaft cannot be precision fit by the method described previously, it is then ground 0.2286-mm (0.009-inch) undersize **ON ONLY THOSE MAIN JOURNALS THAT CANNOT BE PROPERLY FITTED. ALL JOURNALS WILL NOT NECESSARILY BE GROUND.** A 0.2286-mm (0.009-inch) undersize bearing or 0.2540-mm (0.010-inch) undersize bearing will then be used for precision fitting in the same manner as previously described.

OVERSIZE REAR MAIN BEARING THRUST FACES (5.0L AND 5.7L ENGINES)

- Some 5.0L and 5.7L production engines may have rear main bearings that are 0.2032 mm (0.008-inch) wider than standard across the thrust faces.
- The crankshaft on these engines can be identified by ".008" stamped on the rear counterweight.

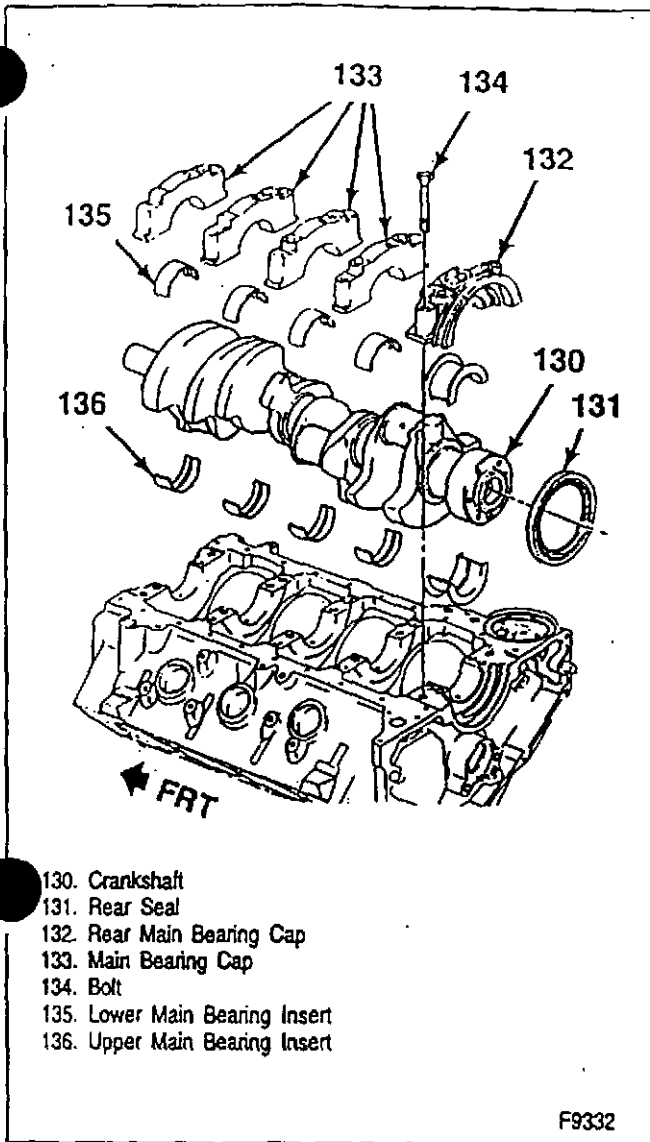


Figure 69—Crankshaft and Components (7.4L Engines)

- If the rear main bearings are replaced, they must have the proper distance between thrust faces to obtain correct crankshaft end play.

Install or Connect (Figures 69, 70, and 71)

NOTICE: For steps 4 and 5, refer to "Notice" on page 6A5B-1.

1. Upper main bearing inserts to the block.

Important

- If any undersized bearings are used, make sure they are fitted to the proper journals.

1. Crankshaft.

Lower main bearing inserts to the main bearing caps.

Measure

- Main bearing clearance. Refer to SECTION 6A.
- Apply engine oil to the main bearing inserts.

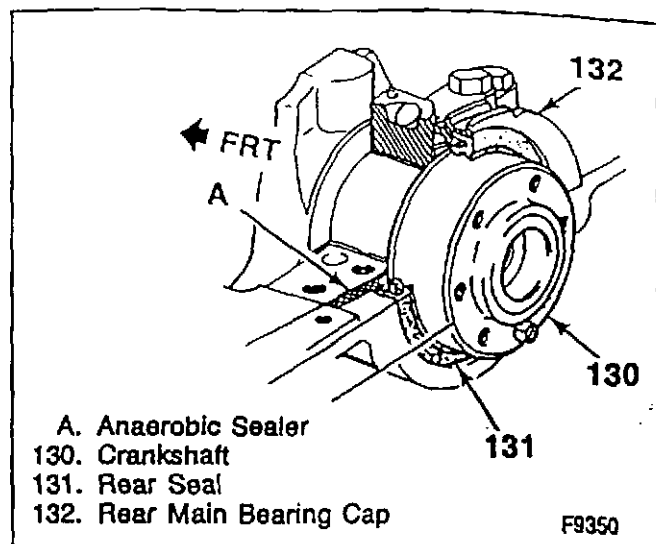


Figure 70—Applying Sealant to the Block (7.4L Engines)

3. Main bearing caps (except rear cap) and bolts to the block.

Tighten

- Main bearing cap bolts to specifications.

— 5.0L and 5.7L engines:

- Outer bolts on #2, #3, and #4 main bearing caps: 95 N·m (70 lbs. ft.).
- All others: 110 N·m (80 lbs. ft.).

— 7.4L engines: 135 N·m (100 lbs. ft.).

4. Rear main bearing cap and bolts to the block.

- On 7.4L engines, apply anaerobic sealing compound to the rear bearing cap sealing face or to the rear bearing cap channel of the engine block, from the corner of the rear thrust bearing pocket to the edge of the channel as shown in figure 70. Do not allow any sealant on either crankshaft or rear oil seal.

Tighten

- Rear main bearing cap bolts temporarily to 4 N·m (35 lbs. in.).

Measure (Figure 71)

- Crankshaft end play, as follows:

- A. Firmly thrust the crankshaft first rearward then forward. This will line up the rear main bearing and crankshaft thrust surfaces.

NOTICE: Refer to "Notice" on page 6A5B-1.

Tighten

- Rear main bearing cap bolts to specifications:
 - 5.0L and 5.7L engines: 110 N·m (80 lbs. ft.).
 - 7.4L engines: 135 N·m (100 lbs. ft.).

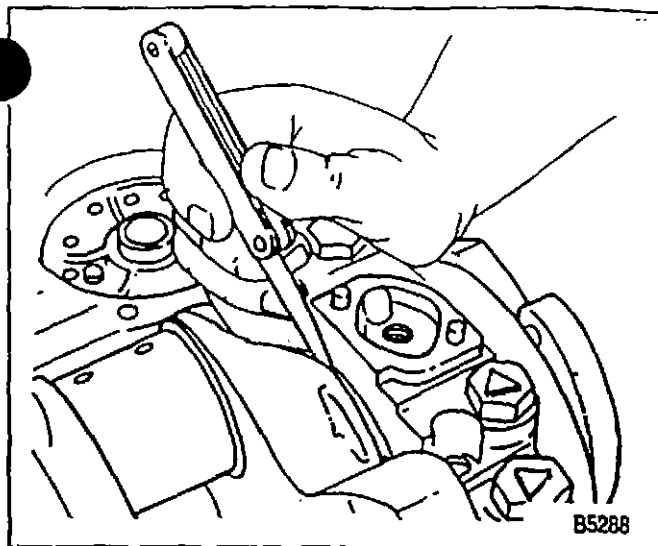


Figure 71—Measuring Crankshaft End Play

B. With the crankshaft wedged forward, measure at the front end of the rear main bearing with a feeler gage (figure 71). The proper clearance is 0.0508-0.1524 mm (0.002-0.006-inch) (5.0L and 5.7L engines) or 0.0508-0.2540 mm (0.002-0.010-inch) (7.4L engines).

C. On 5.0L and 5.7L engines, if correct end play cannot be obtained, make sure the correct size rear main bearing has been installed. Production engines may have rear main bearings that are 0.2032 mm (0.008 inch) wider across the thrust faces than standard, as explained previously.

Inspect

- Crankshaft for binding. Try turning the crankshaft to check for binding. If the crankshaft does not turn freely, loosen the main bearing cap bolts on one cap at a time until the tight bearing is located. Burrs on the bearing cap, foreign matter between the insert and the block or the bearing cap, or a

faulty insert could cause a lack of clearance at the bearing.

— A bent crankshaft could cause binding. Make sure the steps outlined above have been performed before suspecting a bent crankshaft.

CRANKSHAFT REAR OIL SEAL INSTALLATION (7.4L ENGINES)

Install or Connect

Tool Required:

J 38841 Seal Installer

• Crankshaft rear oil seal.

- Make sure the crankshaft rear chamfer is free of grit, loose rust, and burrs. Correct as needed.
- Lubricate the inner and outer diameter of the seal with engine oil.
- Install the seal on J 38841.
- Position J 38841 against the crankshaft. Thread the attaching screws into the tapped holes in the crankshaft.
- Tighten the screws securely with a screwdriver. This will ensure the seal is installed squarely over the crankshaft.
- Turn the handle until it bottoms.
- Remove J 38841.

CRANKSHAFT REAR OIL SEAL AND RETAINER INSTALLATION (5.0L AND 5.7L ENGINES)

Install or Connect (Figures 72 and 73)

Tool Required:

J 35621 Seal Installer

- Whenever the seal retainer is removed, a new retainer gasket and crankshaft rear oil seal must be installed.
- Gasket (84) to the block. It is not necessary to use sealant to hold the gasket in place.
 - Seal retainer (82).

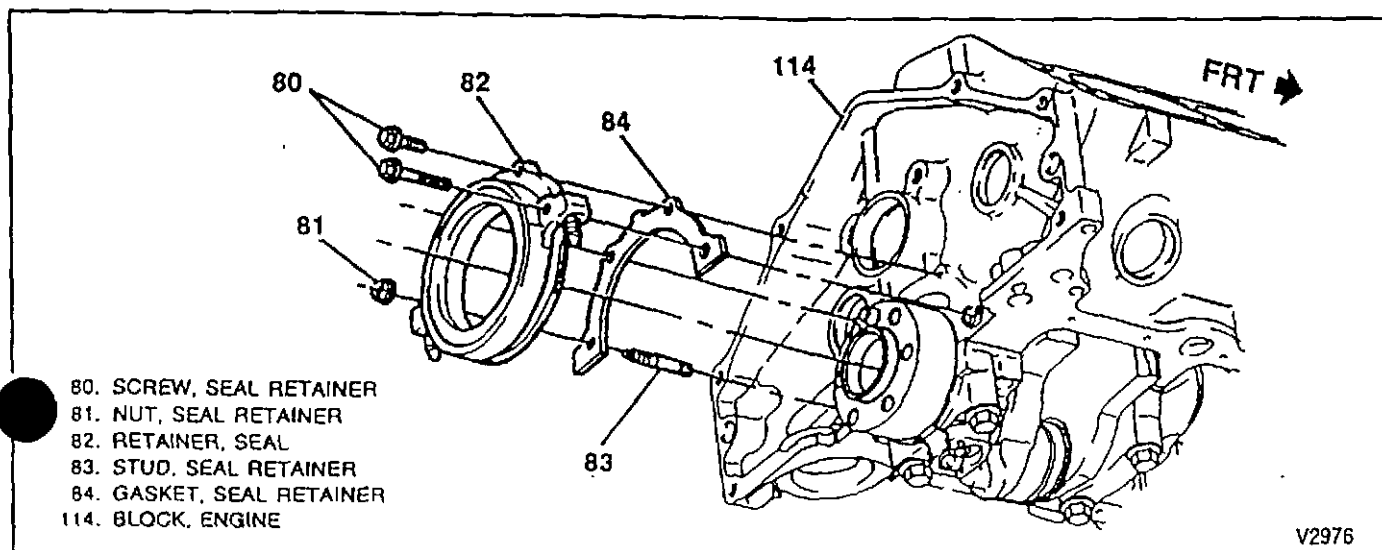


Figure 72—Crankshaft Rear Oil Seal Retainer (5.0L and 5.7L Engines)

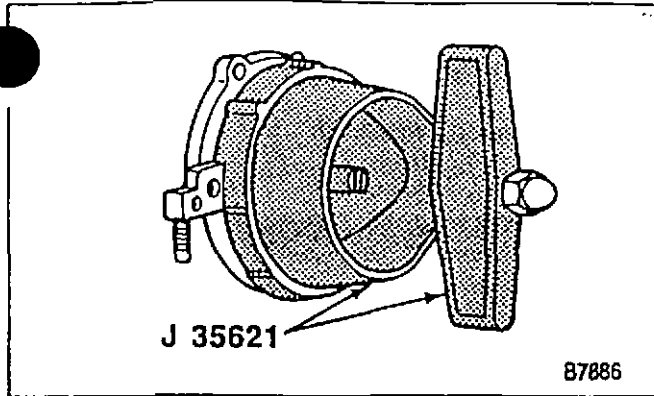


Figure 73—Installing the Crankshaft Rear Oil Seal (5.0L and 5.7L Engines)

NOTICE: Refer to "Notice" on page 6A5B-1.

3. Screws (80) and nuts (81).



Tighten

- Screws (80) and nuts (81) to 15 N·m (11 lbs. ft.).

4. Crankshaft rear oil seal (figure 73).

- A. Make sure the crankshaft rear chamfer is free of grit, loose rust, and burrs. Correct as needed.
- B. Lubricate the inner and outer diameter of the seal with engine oil.
- C. Install the seal on J 35621.
- D. Position J 35621 against the crankshaft. Thread the attaching screws into the tapped holes in the crankshaft.
- E. Tighten the screws securely with a screwdriver. This will ensure the seal is installed squarely over the crankshaft.
- F. Turn the handle until it bottoms.
- G. Remove J 35621.

CAMSHAFT, TIMING CHAIN, AND SPROCKET INSTALLATION



Install or Connect (Figures 74 and 75)

- Coat the camshaft lobes and journals with Engine Oil Supplement (GM P/N 1052367) or equivalent.

1. Camshaft (figure 74).

- Use three 5/16-18 bolts 100-125 mm (4-5 inches) long threaded into the camshaft's tapped holes to handle the camshaft.
- Use care to avoid damaging the camshaft bearings.
- Remove the three bolts after installation.

2. Timing chain to the camshaft sprocket.

3. Camshaft sprocket and timing chain to the engine.



Important

- Align the timing marks on the camshaft sprocket and crankshaft sprocket (figure 75).

4. Camshaft sprocket bolts. Use the bolts to draw the camshaft sprocket onto the camshaft. **DO NOT ATTEMPT TO HAMMER THE CAMSHAFT SPROCKET ONTO THE CAMSHAFT. DOING SO MAY DISLodge THE REAR CAMSHAFT PLUG.**

NOTICE: Refer to "Notice" on page 6A5B-1.



Tighten

- Camshaft sprocket bolts to specifications.
 - 5.0L and 5.7L engines: 28 N·m (21 lbs. ft.).
 - 7.4L engines: 26 N·m (20 lbs. ft.).



Measure

- Timing chain free play. The free play should not exceed 16 mm (5/8 inch).

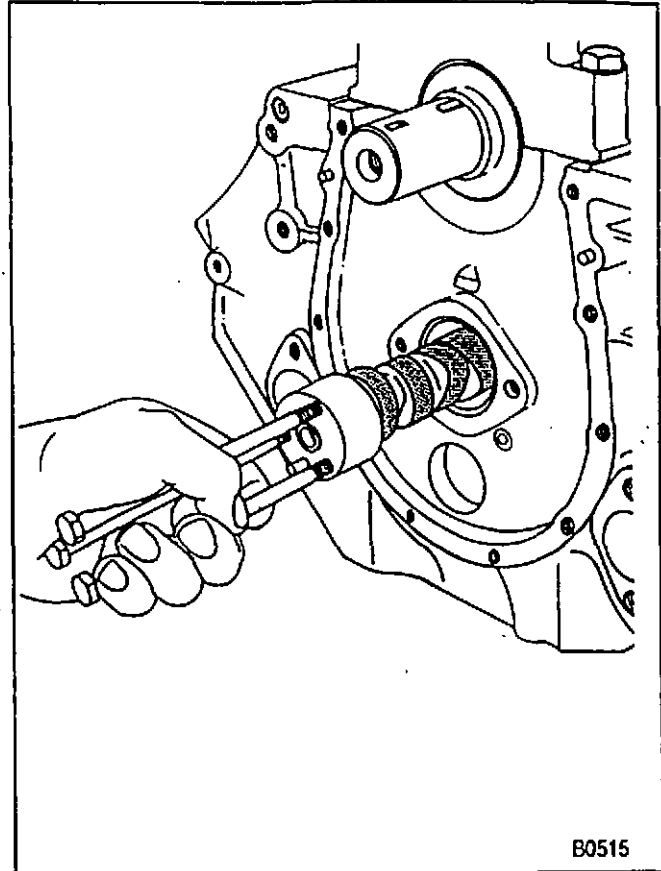
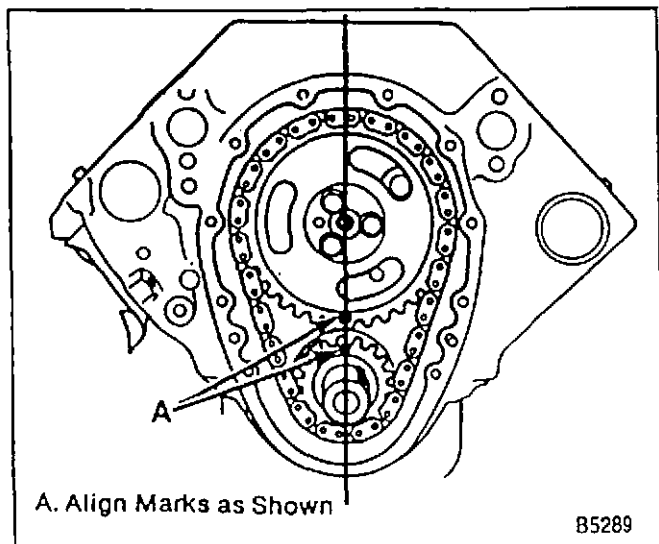


Figure 74—Installing the Camshaft



A. Align Marks as Shown

Figure 75—Camshaft-to-Crankshaft Timing Marks

FRONT COVER INSTALLATION

Install or Connect (Figure 76)

- Lubricate the lips of the crankshaft front oil seal with engine oil.

1. Gasket (90).
2. Front cover (91).

NOTICE: Refer to "Notice" on page 6A5B-1.

3. Bolts (93).

 Tighten

- Bolts (93) to specifications:
 - 5.0L and 5.7L engines: 11 N.m (97 lbs. in.).
 - 7.4L engines: 11 N.m (97 lbs. in.).

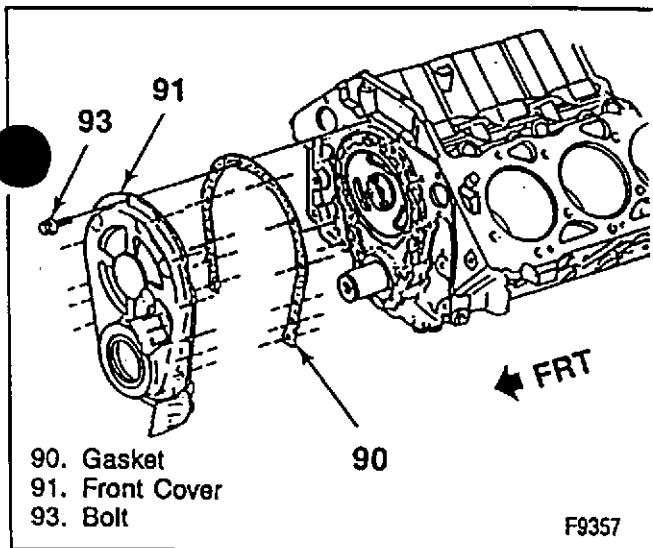


Figure 76—Front Cover

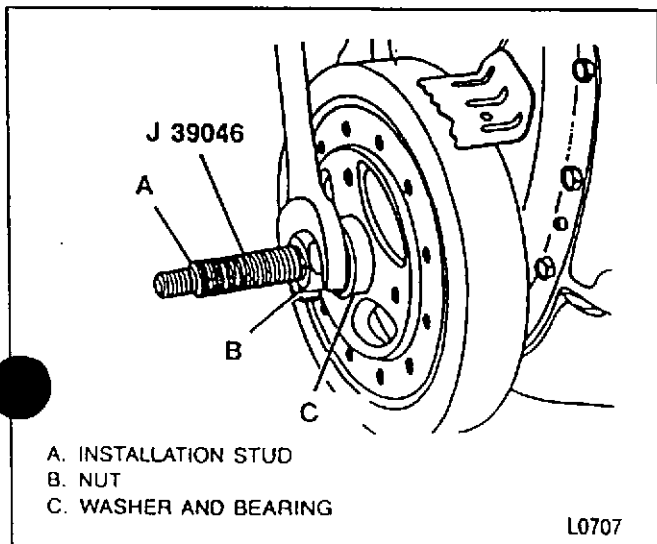


Figure 77—Installing the Torsional Damper

TORSIONAL DAMPER INSTALLATION

Install or Connect (Figure 77)

Tools Required:

J 39046 Torsional Damper Puller and Installer

1. Crankshaft key.

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the torsional damper.

2. Stud (item A, figure 77) to the crankshaft. Thread the stud fully into the tapped hole in the crankshaft.
3. Torsional damper over the end of the stud. Align the keyway in the torsional damper shaft with the crankshaft key.

- Use a small amount of RTV sealant to seal the keyway to crankshaft joint.

4. Bearing, washer, and nut (figure 77).

- A. Turn the nut to pull the torsional damper into place.
- B. Remove the tool.

NOTICE: Refer to "Notice" on page 6A5B-1.

5. Torsional damper bolt and washer.

 Tighten

- Bolt to specifications.
 - 5.0L and 5.7L engines: 95 N.m (70 lbs. ft.).
 - 7.4L engines: 149 N.m (110 lbs. ft.).

PISTON AND CONNECTING ROD INSTALLATION

CONNECTING ROD BEARING SELECTION

Connecting rod bearings are the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are excessive, install a new bearing. Service bearings are available in standard size and 0.0254-mm (0.001-inch) and 0.0508-mm (0.002-inch) undersize for use with new and used standard size crankshafts, and in 0.2540-mm (0.010-inch) and 0.020-inch undersize for use with reconditioned crankshafts.

On production 5.0L and 5.7L engines, it is possible to find a 0.2540-mm (0.010-inch) undersize bearing. These are used in manufacturing for selective fitting.

Selective fitting of both rod and main bearing inserts is necessary to obtain close tolerances. For this reason you may use, for example, one half of a standard insert with one half of a 0.2504-mm (0.001-inch) undersize insert which will decrease the clearance 0.0127 mm (0.0005-inch) from using a full standard bearing.

Install or Connect (Figures 78 through 81)

Tools Required:

J 5239 Connecting Rod Guide Set

J 8037 Ring Compressor

- Lubricate the cylinder walls lightly with engine oil.
- Make sure the piston is installed in its matching cylinder.

1. Connecting rod bearing inserts.

- Make sure the inserts are the proper size.
- Install the inserts in the connecting rod and connecting rod cap.

2. Piston and connecting rod to the proper bore.

- With the connecting rod cap removed, install J 5239 onto the connecting rod bolts.
- Locate the piston ring end gaps as shown in figure 78 (5.0L and 5.7L engines) or figure 79 (7.4L engines).
- Lubricate the piston and rings with engine oil.
- Without disturbing the ring end gap location, install J 8037 over the piston (figure 80).
- Use a hammer handle to tap the piston down into its matching bore.
 - On 5.0L and 5.7L engines, the notch in the piston crown (figure 78) must face the front of the engine.
 - On 7.4L engines, the dimple must face the front of the block (figure 81).

- While tapping the piston into its bore, guide the connecting rod into position on the crankpin, using J 5239. Hold the ring compressor against the block until all rings have entered the cylinder bore.

Important

- Each connecting rod and bearing cap should be marked, beginning at the front of the engine. Cylinder 1, 3, 5 and 7 are the right bank and 2, 4, 6, and 8 are the left bank (when viewed from the front of the engine). The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. (If a connecting rod is ever transposed from one block or cylinder to another, new connecting rod bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.)

NOTICE: Refer to "Notice" on page 6A5B-1.

3. Connecting rod cap with bearing insert and nut.

Measure

- Connecting rod bearing clearance. Refer to SECTION 6A. Then apply engine oil to the connecting rod bearing.

Tighten

- Connecting rod bolt nuts to specifications.
 - 5.0L and 5.7L engines: 61 N.m (45 lbs. ft.).
 - 7.4L engines: 61 N.m (45 lbs. ft.).

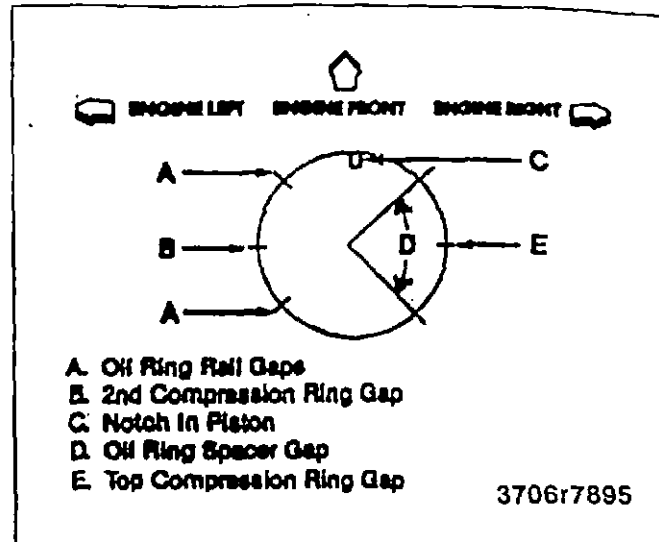


Figure 78—Piston Ring End Gap Location (5.0L and 5.7L Engines)

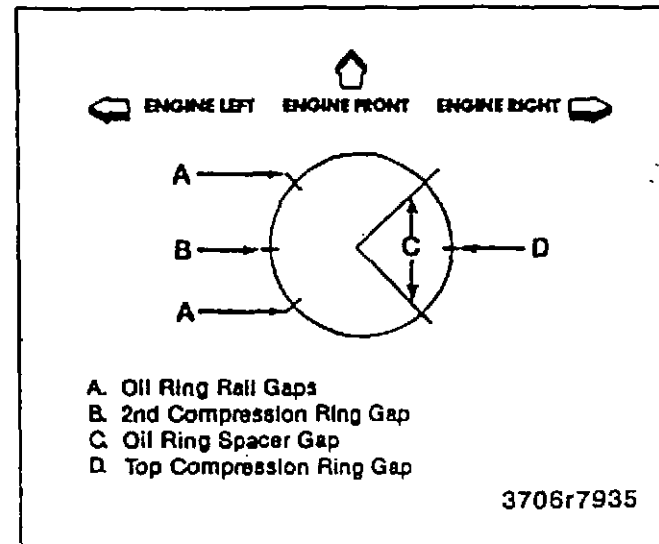


Figure 79—Piston Ring End Gap Location (7.4L Engines)

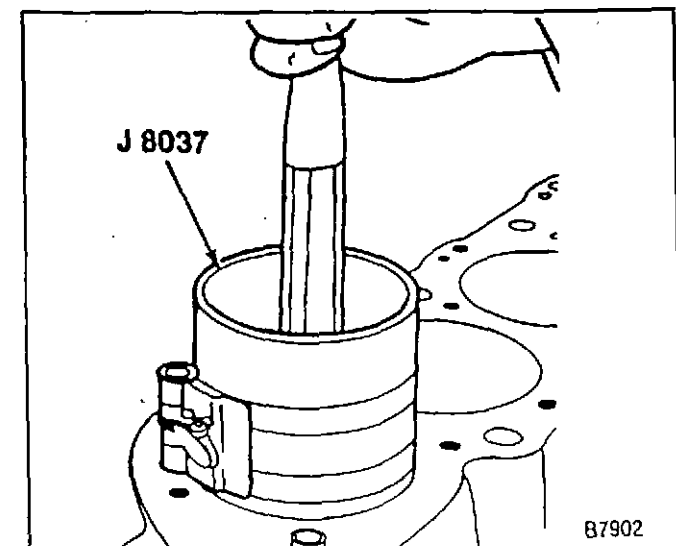


Figure 80—Installing the Piston

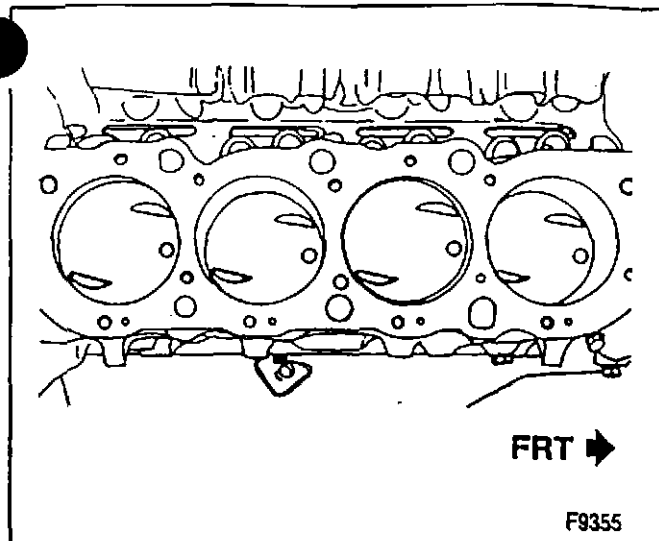


Figure 81—Piston Installed (7.4L Engines)

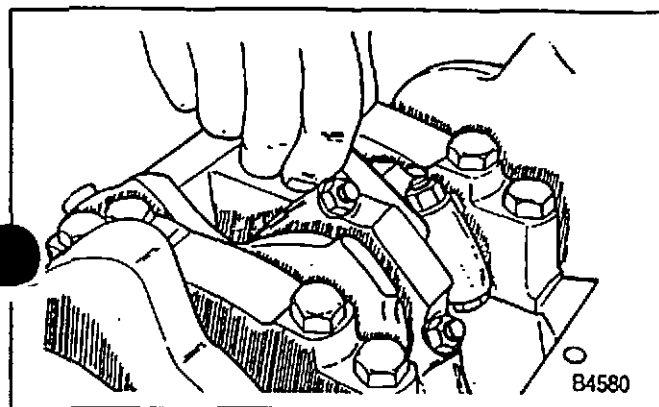


Figure 82—Measuring Connecting Rod Side Clearance

Measure (Figure 82)

- Connecting rod side clearance. Use a feeler gage between the connecting rods (figure 82). The proper clearance is as follows:

- 5.0L and 5.7L engines: 0.1524-0.3556-mm (0.006-0.014-inch).
- 7.4L engines: 0.3302-0.5842-mm (0.013-0.023-inch).

OIL PUMP INSTALLATION

Install or Connect

1. Oil pump with connector and oil pump driveshaft.

NOTICE: Refer to "Notice" on page 6A5B-1.

2. Oil pump to main bearing cap bolt.

Tighten

- Bolt to 90 N·m (65 lbs. ft.).

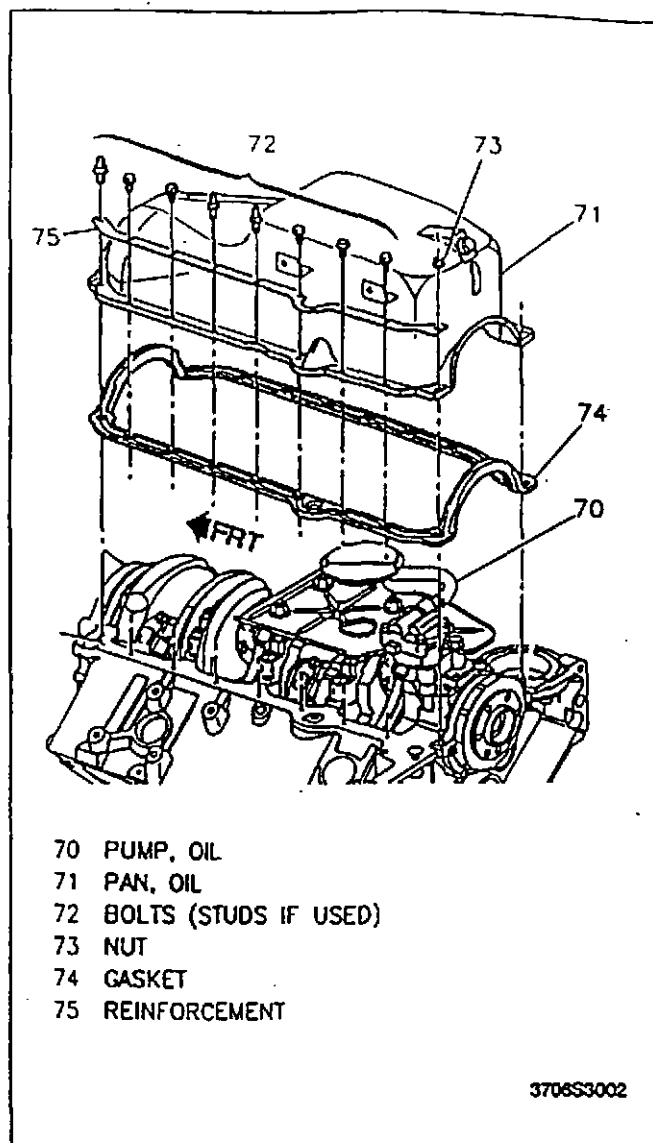


Figure 83—Oil Pan (5.0L and 5.7L Engines)

OIL PAN INSTALLATION

5.0L AND 5.7L ENGINES

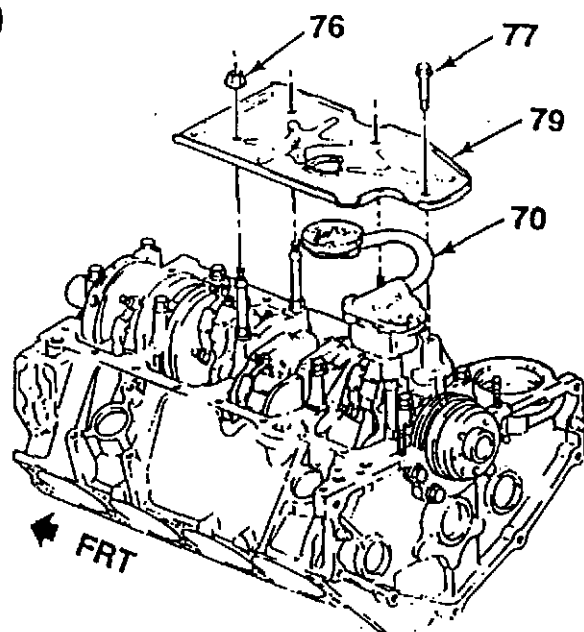
Install or Connect (Figures 83 and 84)

- Apply RTV sealer (GM P/N 12346141) or equivalent to the front cover to block joint and crankshaft rear seal retainer to block joint.

1. Oil pan gasket (74) to the oil pan (71).
2. Oil pan deflector nuts (76) (figure 84).
3. Oil pan (71) to the engine.
4. Oil pan bolts (72), nuts (73), and reinforcements (75).

Tighten

- Oil pan bolts (72) to 11 N·m (97 lbs. in.).
- Oil pan nuts (73) to 22 N·m (16 lbs. ft.).
- Oil pan deflector nuts (76) to 36 N·m (27 lbs. ft.).



- 70. Oil Pump
- 76. Nut
- 77. Bolt
- 79. Oil Pan Baffle

F9365

Figure 84—Oil Pan Deflector (5.0L and 5.7L Engines)

7.4L ENGINES

Install or Connect (Figure 85)

- Apply RTV sealer (GM P/N 12346141) or equivalent in four places where the front and rear main bearing caps meet the engine block as shown in figure 85.

1. Gasket (74) to the block.
2. Oil pan (76). Make sure the gasket stays in place.

NOTICE: Refer to "Notice" on page 6A5B-1.

3. Bolts (75).



Tighten

- Bolts to 22 N.m (16 lbs. ft.).

CYLINDER HEAD INSTALLATION



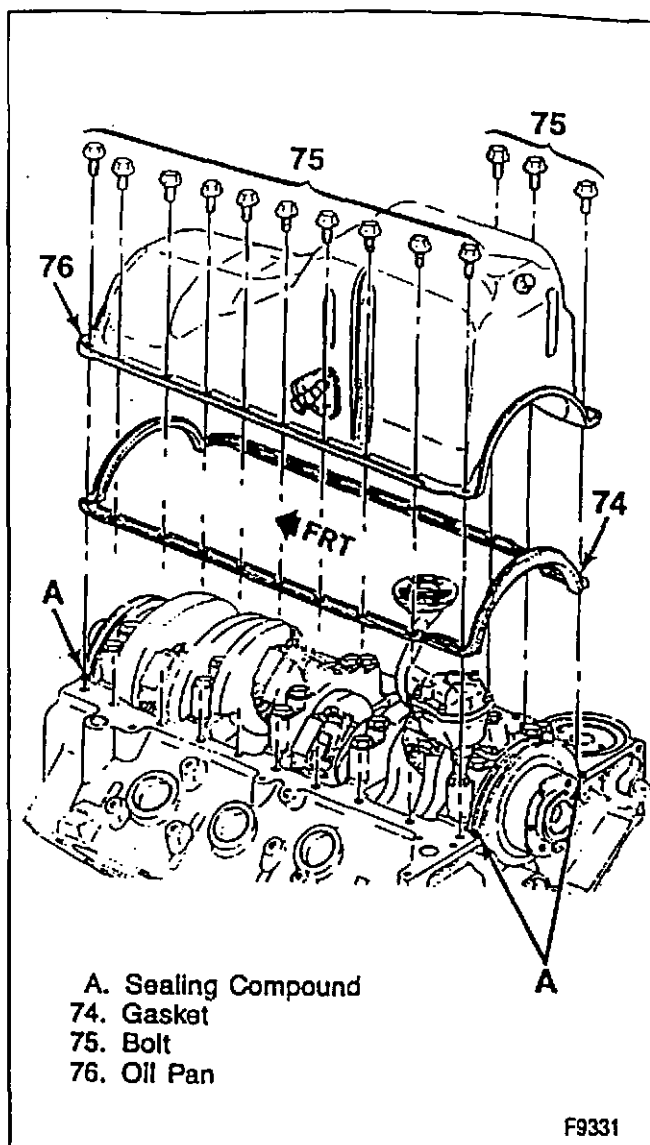
Clean

- Gasket surfaces on block and cylinder head.

Install or Connect (Figures 86 through 91)

1. Head gasket.

- Use no sealer on engines using a composition gasket.
- Place the gasket in position over the dowel pins with the bead up.



- A. Sealing Compound
- 74. Gasket
- 75. Bolt
- 76. Oil Pan

F9331

Figure 85—Oil Pan (7.4L Engines)

2. Cylinder head. Carefully guide the cylinder head into place over the dowel pins and head gaskets.
3. Cylinder head bolts. Coat the threads of the bolts with sealing compound (Loctite #592 or equivalent) and install finger tight.



Tighten

- Bolts in three steps using the sequence shown in figures 90 or 91 until the proper torque is reached:

— 5.0L and 5.7L engines:

- A. The first sequence to 35 N.m (25 lbs. ft.).
- B. The second sequence to 60 N.m (45 ft. lbs.).
- C. The final torque sequence to 90 N.m (65 lbs. ft.).

— 7.4L engines:

- A. The first sequence to 40 N.m (30 lbs. ft.).
- B. The second sequence to 80 N.m (60 ft. lbs.).
- C. The final torque sequence to 115 N.m (85 lbs. ft.).

- 46. HEAD, CYLINDER
- 47. GASKET, CYLINDER HEAD
- 51. BOLT, CYLINDER HEAD
- 144. BLOCK, ENGINE

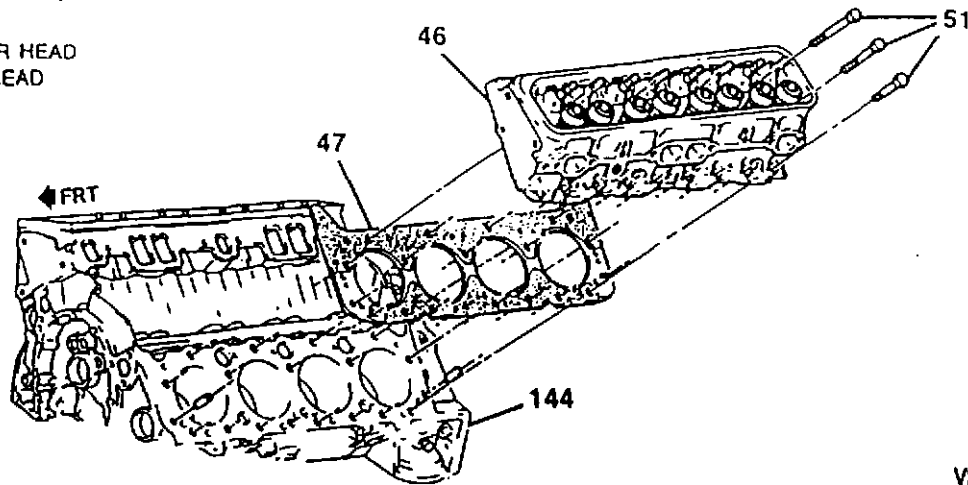


Figure 86—Cylinder Head (5.0L and 5.7L Engines)

VALVE TRAIN COMPONENT INSTALLATION

! Important

- Replace all hydraulic lifters if a new camshaft is installed.
- Install or Connect (Figures 88 and 89)
- Lubricate the hydraulic lifter bodies with Engine Oil Supplement (GM P/N 1052367) or equivalent.

- Lubricate the feet of the lifters with "Moly Kote."
- 1. Hydraulic lifters (44 or 209) to the block.
- 2. Pushrods (43 or 210). Seat the pushrods into the socket in the hydraulic lifters.
 - The 7.4L engine uses different length intake and exhaust pushrods. The exhaust valve pushrods are longer than the intake valve pushrods.
- Coat the mating surfaces of the rocker arms (42) and balls (41) with "Moly Kote" or equivalent.
- 3. Pushrod guides (260), 7.4L engines only.
- 4. Rocker arms (42).
- 5. Balls (41).

NOTICE: Refer to "Notice" on page 6A5B-1.

6. Nuts (40), on 5.0L and 5.7L engines or bolts (40) on 7.4L engines.

Tighten

- Bolts (40) to 54 N.m (40 lbs. ft.), 7.4L engines only.

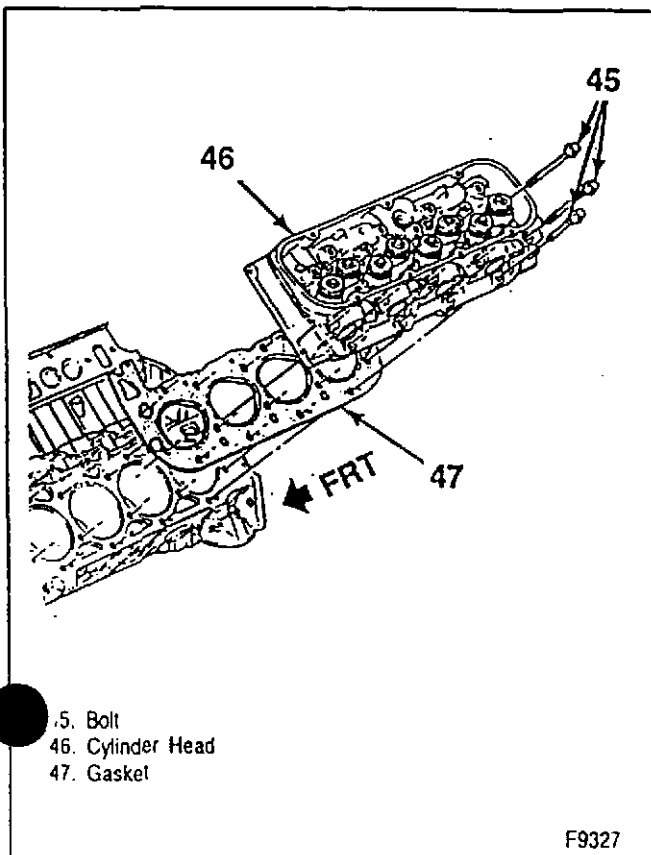
Adjust

- Valves (5.0L and 5.7L engines only).
- No valve adjustment is required for 7.4L engines after tightening the rocker arm bolts to 54 N.m (40 lbs. ft.).

VALVE ADJUSTMENT

5.0L and 5.7L ENGINES

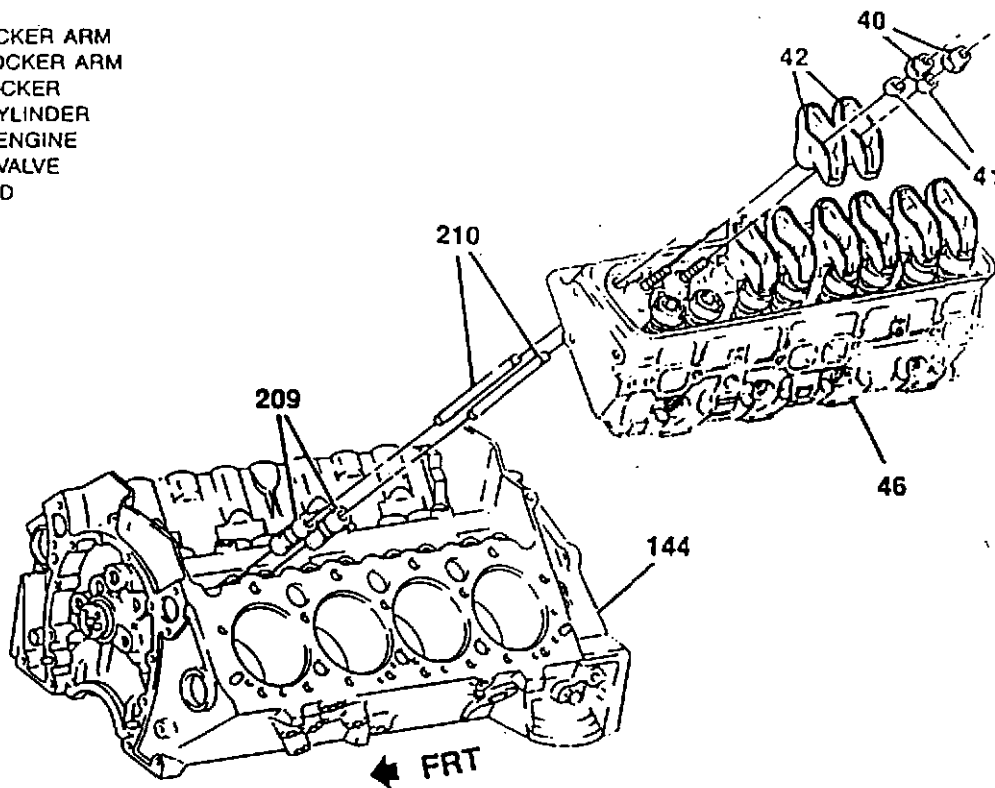
1. Remove the rocker arm covers.
2. Crank the engine until the mark on the torsional damper lines up with the center or "0" mark on the timing tab (figure 92). The engine must be in the number one firing position. This may be determined by placing fingers on the number one cylinder's valves as the mark on the damper comes near the "0" mark on the crankcase front cover. If the valves



- 45. Bolt
- 46. Cylinder Head
- 47. Gasket

Figure 87—Cylinder Head (7.4L Engines)

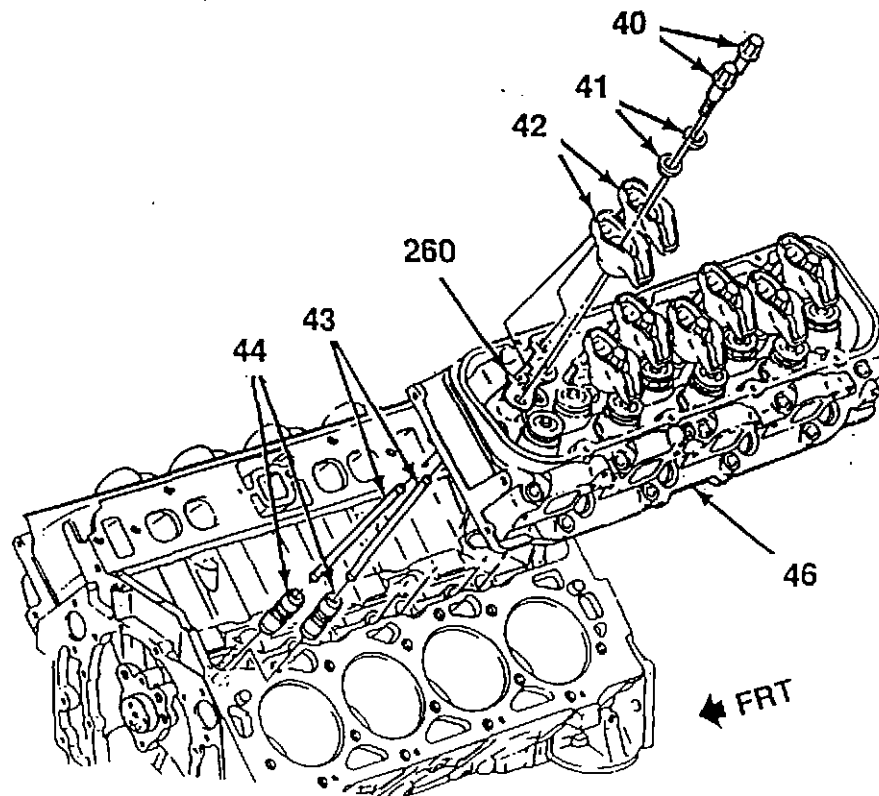
- 40. NUT, ROCKER ARM
- 41. BALL, ROCKER ARM
- 42. ARM, ROCKER
- 46. HEAD, CYLINDER
- 144. BLOCK, ENGINE
- 209. LIFTER, VALVE
- 210. PUSHROD



V2881

Figure 88—Valve Train Components (5.0L and 5.7L Engines)

- 40. Bolt
- 41. Ball
- 42. Rocker Arm
- 43. Pushrod
- 44. Hydraulic Lifter
- 46. Cylinder Head
- 260. Pushrod Guide



F9325

Figure 89—Valve Train Components (7.4L Engines)

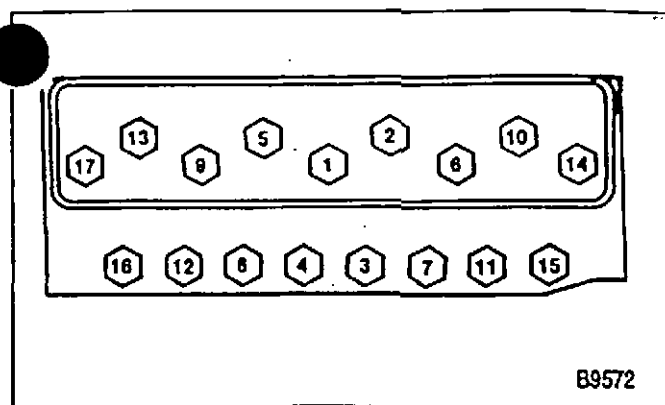


Figure 90—Cylinder Head Bolt Tightening Sequence (5.0L and 5.7L Engines)

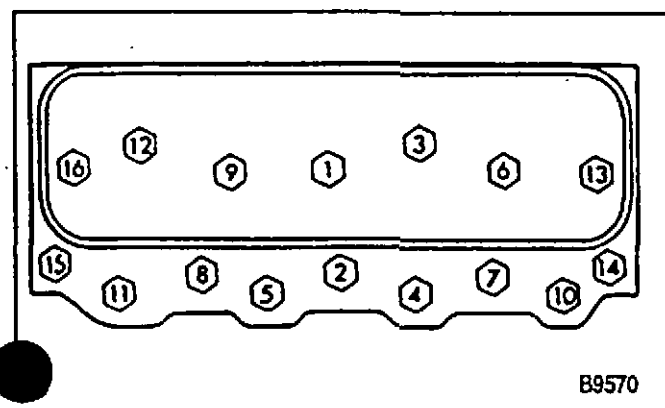


Figure 91—Cylinder Head Bolt Tightening Sequence (7.4L Engines)

are not moving, the engine is in the number one firing position. If the valves move as the mark comes up to the timing tab, the engine is in the number six firing position and should be turned over one more time to reach the number one position.

3. With the engine in the number one firing position as determined above, the following valves may be adjusted:

- Exhaust - 1, 3, 4, 8
- Intake - 1, 2, 5, 7

(Even numbered cylinders are the left bank; odd numbered cylinders are the right bank, when viewed from the front of the engine.)

4. Back out the adjusting nut until lash is felt at the pushrod then turn in the adjusting nut until all lash is removed. This can be determined by rotating the pushrod while turning the adjusting nut (figure 93). When the play has been removed, turn the adjusting nut in as follows:

- 5.0L and 5.7L engines: One full turn.

Crank the engine one revolution until the pointer "0" mark and torsional damper mark are again in alignment. This is the number six firing position. With the engine in this position the following valves may be adjusted:

- Exhaust - 2, 5, 6, 7
- Intake - 3, 4, 6, 8

INTAKE MANIFOLD INSTALLATION

5.0L AND 5.7L ENGINES



Install or Connect (Figures 94 and 95)

1. Gaskets (22) to the cylinder heads.
 - Make sure the tab and/or arrow faces the front of the engine. The side stamped "This Side Down" must face the cylinder head.
2. RTV sealant to the front and rear intake manifold sealing surfaces on the block as follows:
 - Refer to figure 94.
 - Apply a 5 mm (3/16-inch) bead of RTV sealer (GM P/N 1052289 or equivalent) on the front and rear of the block. Extend the bead 13 mm (1/2 inch) up each cylinder head to seal and retain the gaskets.
3. Intake manifold (21) to the engine.

NOTICE: Refer to "Notice" on page 6A5B-1.

4. Intake manifold bolts (19) and studs (20).



Tighten

- Bolts (19) and studs (20) to 47 N.m (35 lbs. ft.) using the tightening sequence shown in figure 95.

7.4L ENGINES



Install or Connect (Figures 96 and 97)

1. Gaskets (22) to the cylinder heads.
 - Apply a 5 mm (3/16-inch) spot of RTV sealer (GM P/N 1052289 or equivalent) on the front and rear of the block in four places as shown in figure 96.
2. Seals (23) to the block.

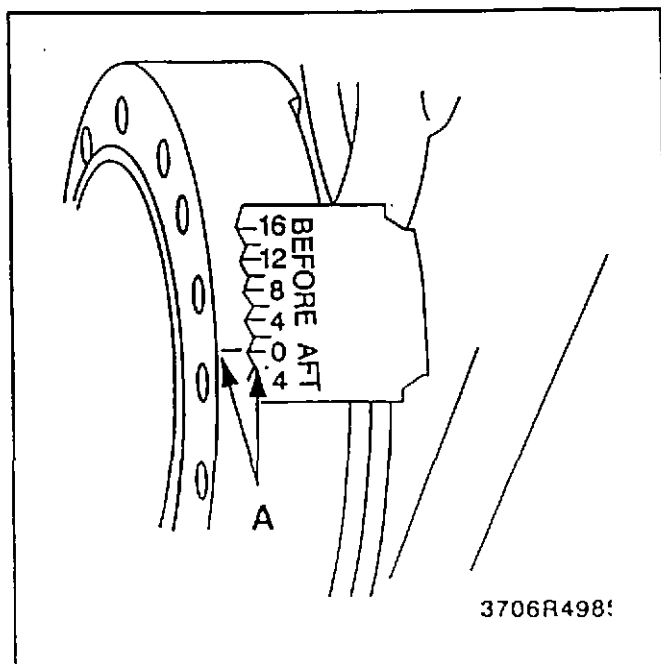


Figure 92—Timing Marks

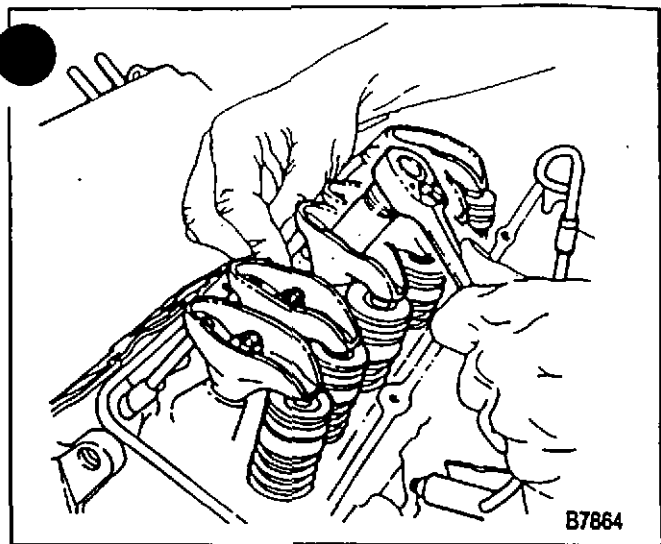


Figure 93—Adjusting the Valves (5.0L and 5.7L Engines)

3. Intake manifold (21).

NOTICE: Refer to "Notice" on page 6A5B-1.

4. Bolts (20).



Tighten

- Bolts (20) to 40 N.m (30 lbs. ft.). Use the tightening sequence shown in figure 97.

ROCKER ARM COVER INSTALLATION



Install or Connect (Figures 98 and 99)

1. Gaskets (34).
2. Rocker arm covers (32).

NOTICE: Refer to "Notice" on page 6A5B-1.

3. Bolts.

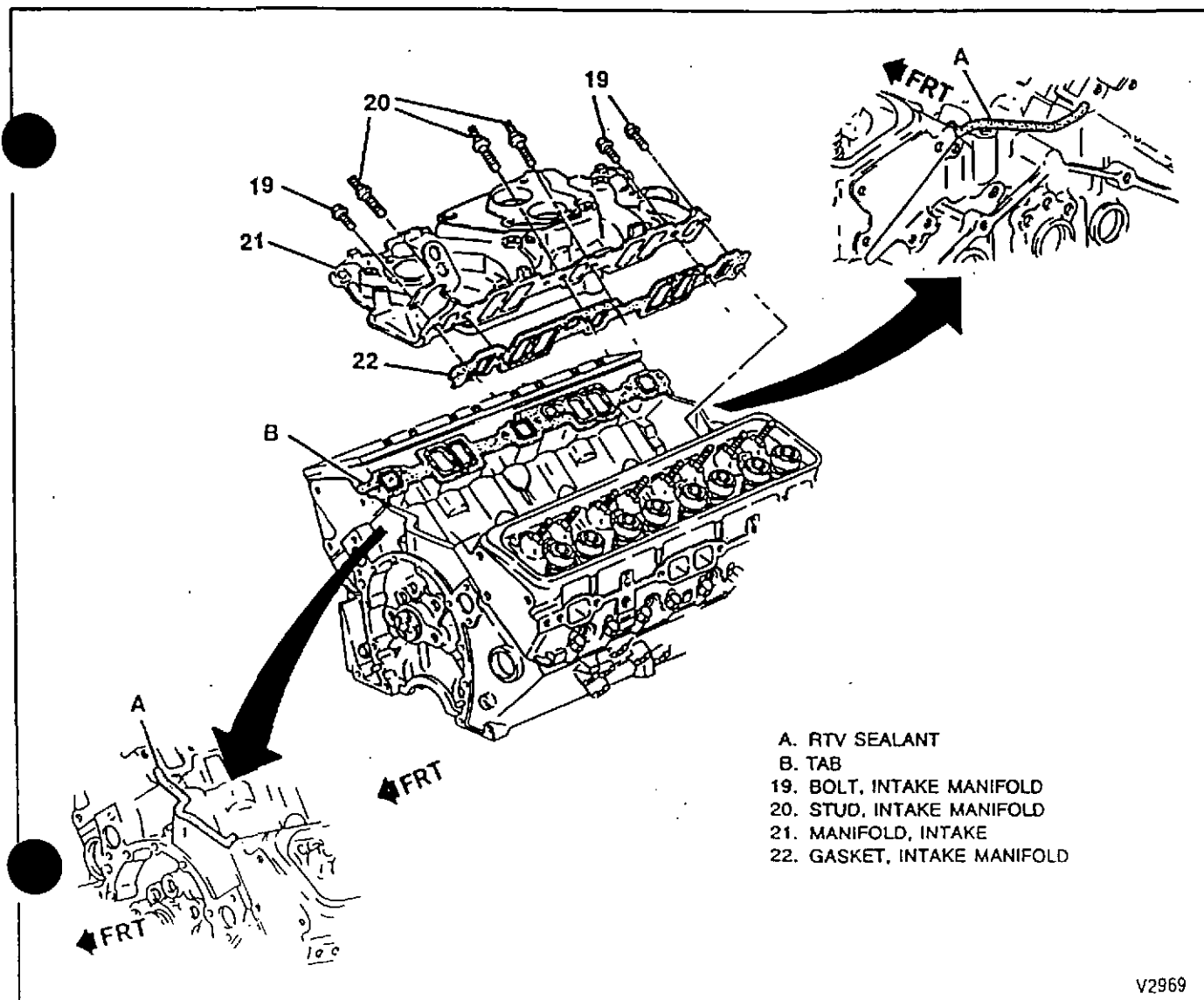


Figure 94—Intake Manifold (5.0L and 5.7L Engines)

6A5B-50 V8 ENGINES

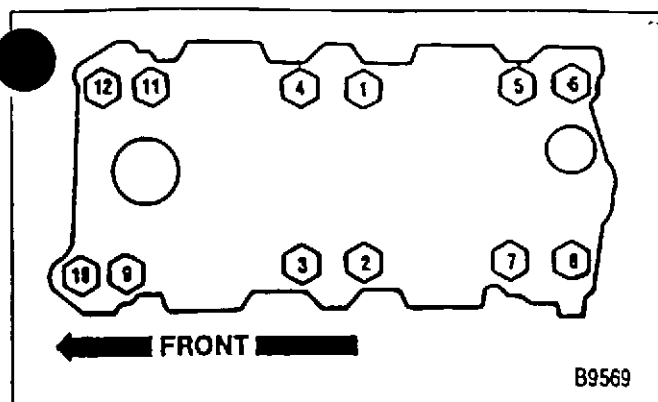


Figure 95—Intake Manifold Bolt Tightening Sequence (5.0L and 5.7L Engines)

Tighten

- Bolts to specification:
 - 5.0L and 5.7L engines: 10 N.m (89 lbs. in.).
 - 7.4L engines: 8 N.m (70 lbs. in.).

EXHAUST MANIFOLD INSTALLATION

Install or Connect (Figures 100 and 101)

- Exhaust manifold (1).
- Spark plug wire heat shields (6).

NOTICE: Refer to "Notice" on page 6A5B-1.

- Washers (2), tab washers (3), (5.0L and 5.7L engines), and bolts/studs (4).

Tighten

- Bolts/studs to specifications:
 - 5.0L and 5.7L engines:
 - Two center bolts: 36 N.m (26 lbs. ft.).
 - Outside bolts: 28 N.m (20 lbs. ft.).
 - Bend the tab washers against the bolt heads.
 - 7.4L engines: 54 N.m (40 lbs. ft.).

COOLANT PUMP INSTALLATION

Install or Connect (Figures 102 and 103)

- Gaskets (11).
- Coolant pump (10).

NOTICE: Refer to "Notice" on page 6A5B-1.

- Bolts (12).

Tighten

- Bolts (12) to 40 N.m (30 lbs. ft.).
- 4. Bypass hose and clamps (7.4L engine).

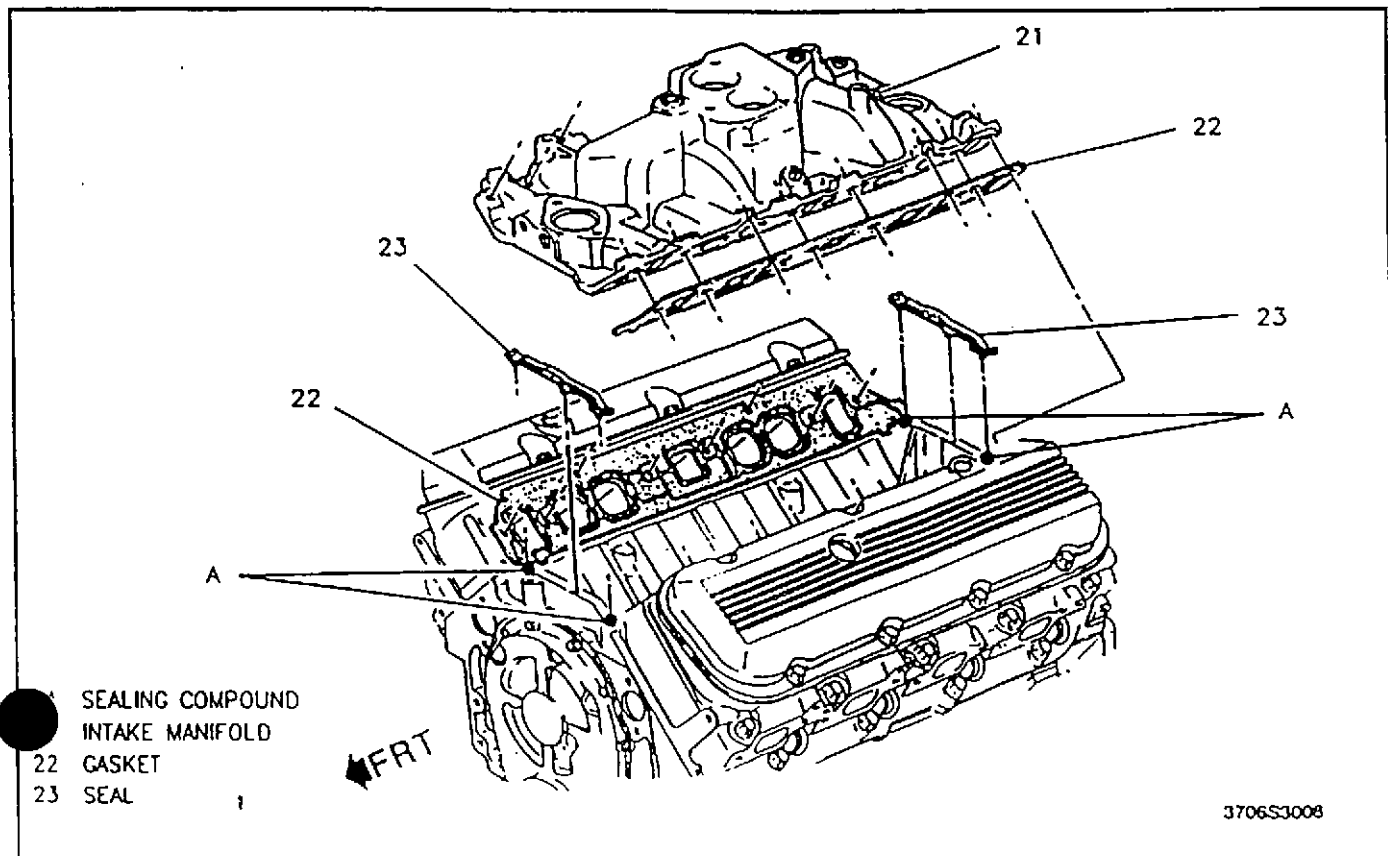


Figure 96—Intake Manifold (7.4L Engines)

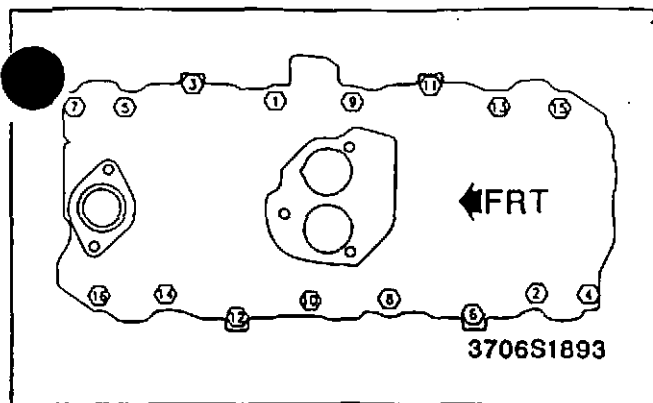


Figure 97—Intake Manifold Tightening Sequence (7.4L Engines)

FLYWHEEL INSTALLATION

➡➡ Install or Connect (Figure 36 and 37)

1. Flywheel (110A or 110B).

NOTICE: Refer to "Notice" on page 6A2B-1.

2. Flywheel bolts (111).

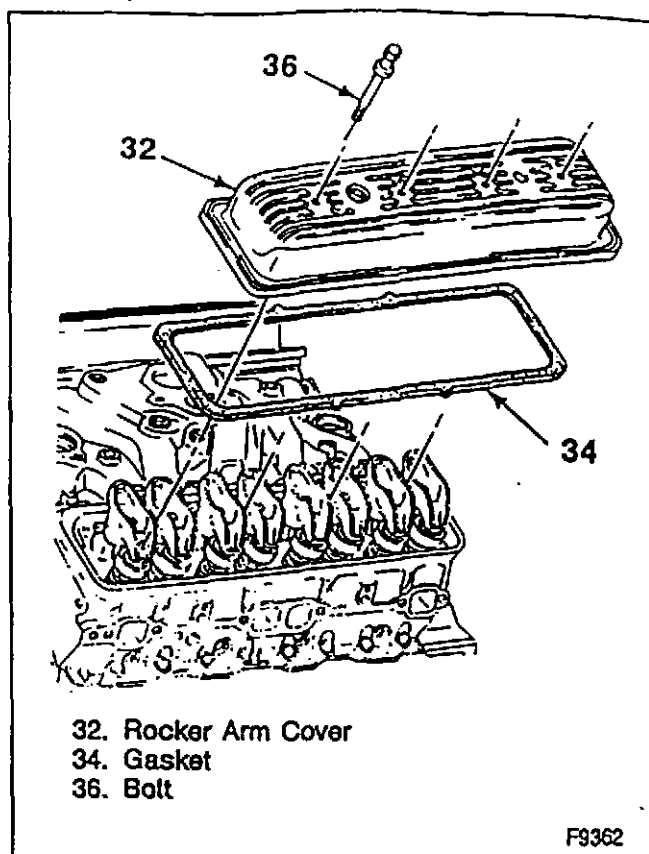


Figure 98—Rocker Arm Cover Installation (5.0L and 5.7L Engines)

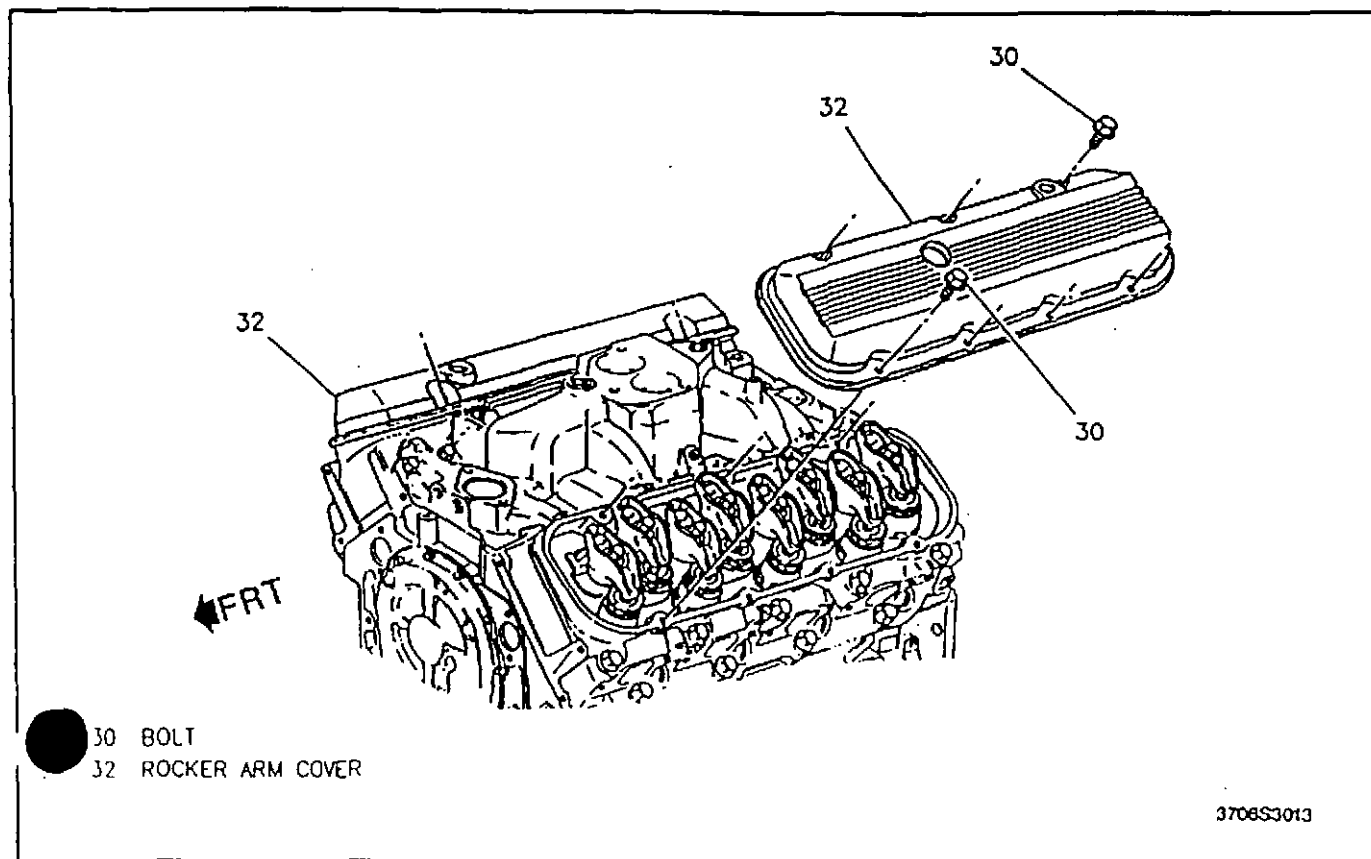


Figure 99—Rocker Arm Cover Installation (7.4L Engines)

6A5B-52 V8 ENGINES

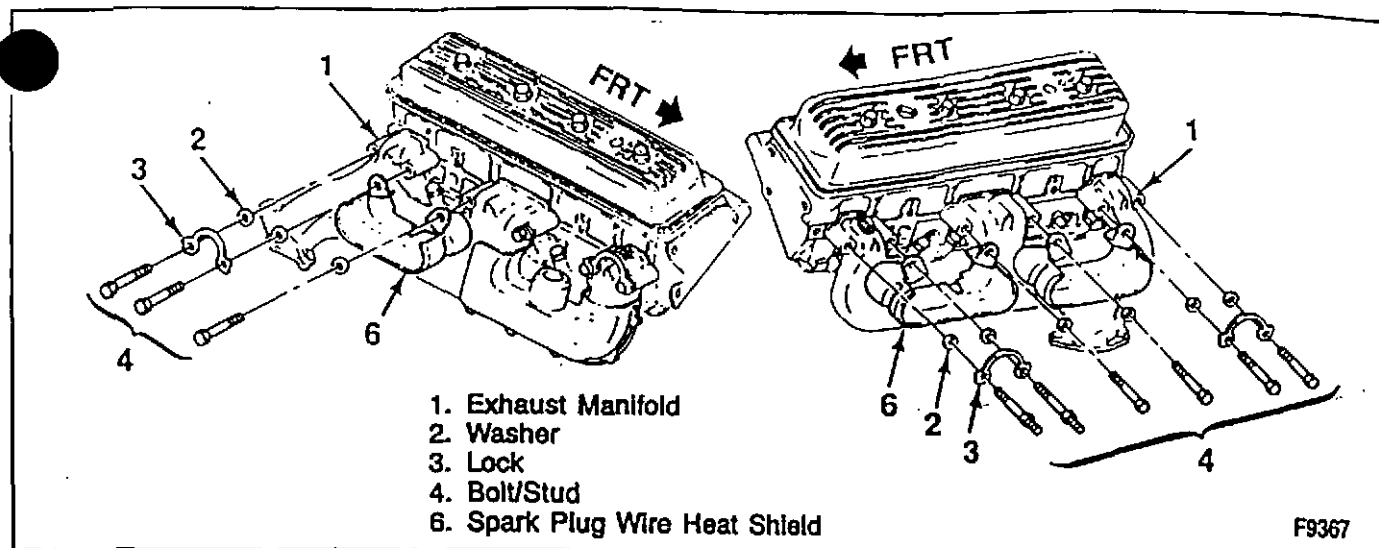


Figure 100—Exhaust Manifold (5.0L and 5.7L Engines)

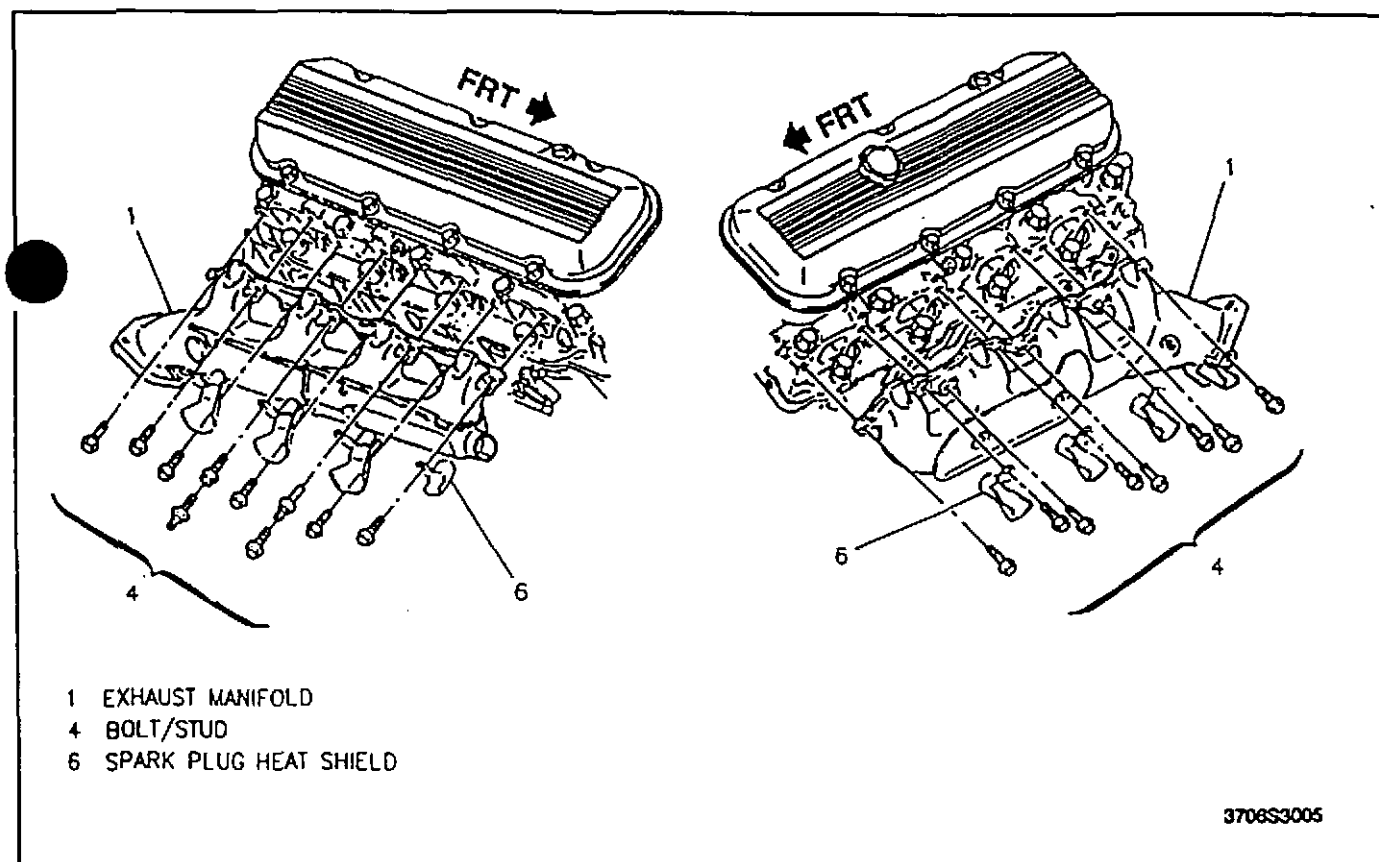
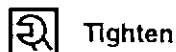


Figure 101—Exhaust Manifold (7.4L Engines)



- Bolts (111) to 100 N.m (74 lbs. ft.) (5.0L/5.7L Engines).
- Bolts (111) to 90 N.m (66 lbs. ft.) (7.4L Engines).

ENGINE ACCESSORY INSTALLATION

Install the engine accessories (TBI unit, distributor, oil filter, generator, etc.) as directed in the proper on-vehicle Truck Service Manual. Connect all vacuum hoses and electrical equipment the same way as removed.

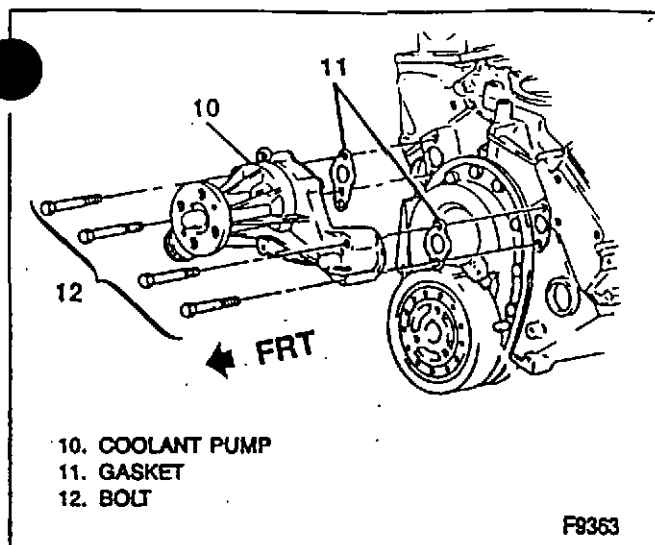


Figure 102—Coolant Pump (5.0L and 5.7L Engines)

ENGINE SET-UP AND TESTING

- After overhaul, the engine should be tested before installation in the vehicle. If a suitable test stand is not available, the following procedure can be used after the engine is installed in the vehicle.

1. Fill the crankcase with the proper quantity and grade of oil.

! Important

- If a new camshaft or hydraulic lifters was installed, add Engine Oil Supplement (GM P/N 1052367) or equivalent to the engine oil.
2. Fill the coolant system with the proper coolant. Refer to SECTION 6B1.

! Important

- Whenever the cooling system is serviced or drained for service procedures, 2 coolant sealant pellets, (GM P/N 3634621) or equivalent, must be added to the cooling system.

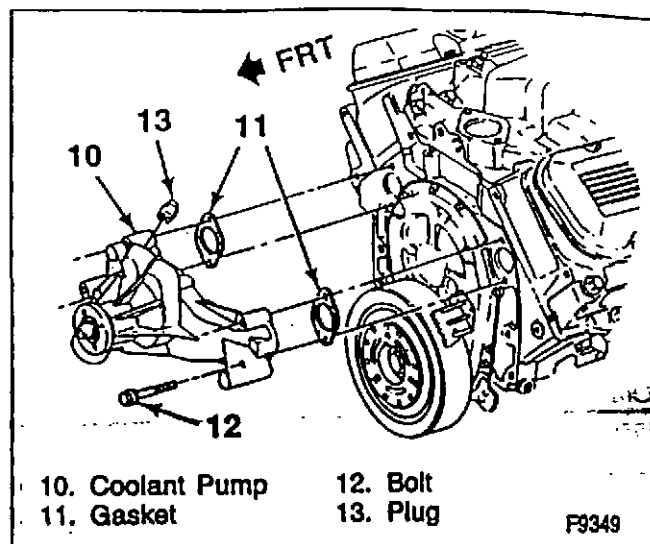


Figure 103—Coolant Pump (7.4L Engines)

- The pellets must be added to the radiator or the pressurized coolant reservoir. **list2**—Pellets must be crushed prior to installation.
 - Do not place pellets into a non-pressurized coolant recovery reservoir. On these systems, the pellets must be added to the radiator.
 - The sealant pellets may leave a film on the sides of pressurized and non-pressurized coolant recovery reservoirs. This film is normal.
3. With the ignition "OFF," or disconnected, crank the engine several times. Listen for any unusual noises or evidence that any parts are binding.
 4. Start the engine and listen for unusual noises.
 5. Run the engine speed at about 1000 rpm until the engine is at operating temperature.
 6. Listen for improperly adjusted valves or sticking lifters, and other unusual noises.
 7. Check for oil and coolant leaks while the engine is running.
 8. Use the proper on-vehicle Truck Service Manual or Emission Control Label for adjustment of the ignition timing.

SPECIFICATIONS

ENGINE SPECIFICATIONS (5.0L/5.7L)

All Specifications are in INCHES unless otherwise noted.

GENERAL DATA:				
Type		V8		
Displacement		5.0L (305 CID)	5.7L (350 CID)	
RPO (VIN Code)		L03 (H)	L05 (K)	
Bore		3.736	4.00	
Stroke		3.480		
Compression Ratio		9.1:1	.	
Firing Order		1-8-4-3-6-5-7-2		
Oil Pressure (Minimum)		6 PSI @ 1000 RPM; 18 PSI @ 2000 RPM; 24 PSI @ 4000 RPM		
CYLINDER BORE:				
Diameter		3.7350-3.7385	3.9995-4.0025	
Out Of Round	Production		0.001 (Maximum)	
	Service		0.002 (Maximum)	
Taper	Production	Thrust Side	0.0005 (Maximum)	
		Relief Side	0.001 (Maximum)	
	Service		0.001 (Maximum)	
PISTON:				
Clearance	Production		0.0007-0.0021	
	Service Limit		0.0027 (Maximum)	
PISTON RING:				
P A S S E N G E R	Groove Clearance	Production	Top	0.0012-0.0032
			2nd	
	Service Limit		Hi Limit Production $\pm$ 0.001	
	Gap	Production	Top	0.010-0.020
			2nd	0.018-0.026
		Service Limit		Hi Limit Production $\pm$ 0.010
O I L	Groove Clearance	Production	0.002-0.007	
		Service Limit	Hi Limit Production $\pm$ 0.001	
	Gap	Production	0.010-0.030	
		Service Limit	Hi Limit Production $\pm$ 0.010	
PISTON PIN:				
Diameter		0.9270-0.09271		
Clearance In Piston	Production		0.0004-0.0008	
	Service Limit		0.001 (Maximum)	
Fit In Rod		0.0008-0.0016 Interference		

*8.3:1 (Over 8500-lb. GVW)

9.1:1 (Under 8500-lb. GVW)

T2368

SPECIFICATIONS

ENGINE SPECIFICATIONS (5.0L/5.7L) (Cont.)

All specifications are in INCHES unless otherwise noted.

DISPLACEMENT:			5.0L (305 Cu. In.)	5.7L (350 Cu. In.)
CRANKSHAFT:				
Main Journal	Diameter	#1	2.4484-2.4493	
		#2, #3, #4	2.4481-2.4490	
		#5	2.4479-2.4488	
	Taper	Production	0.0002 (Maximum)	
		Service Limit	0.001 (Maximum)	
	Out Of Round	Production	0.0002 (Maximum)	
Service Limit		0.001 (Maximum)		
Main Bearing Clearance	Production	#1	0.0008-0.0020	
		#2, #3, #4	0.0011-0.0023	
		#5	0.0017-0.0032	
	Service Limit	#1	0.0010-0.0015	
		#2, #3, #4	0.0010-0.0025	
		#5	0.0025-0.0035	
Crankshaft End Play			0.002-0.006	
Crankpin	Diameter		2.0988-2.0998	
	Taper	Production	0.0005 (Maximum)	
		Service Limit	0.001 (Maximum)	
	Out Of Round	Production	0.0005 (Maximum)	
		Service Limit	0.001 (Maximum)	
Rod Bearing Clearance	Production		0.0013-0.0035	
	Service Limit		0.003 (Maximum)	
Rod Side Clearance			0.006-0.014	
CAMSHAFT:				
Lobe Lift ± 0.002	Intake		0.2336	0.2565
	Exhaust		0.2565	0.2690
Journal Diameter			1.8682-1.8692	
VALVE SYSTEM:				
Lifter			Hydraulic	
Rocker Arm Ratio			1.50:1	
Valve Lash	Intake		One Turn Down From Zero Lash	
	Exhaust			
Face Angle (Intake & Exhaust)			45°	
Seat Angle (Intake & Exhaust)			46°	
Seat Runout (Intake & Exhaust)			0.002 (Maximum)	
Seat Width	Intake		1/32-1/16	
	Exhaust		1/16-3/32	
Stem Clearance	Production	Intake	0.0010-0.0027	
		Exhaust	0.0010-0.0027	
	Service	Intake	High Limit Production +0.001	
		Exhaust	High Limit Production +0.002	
Valve Spring (Outer)	Free Length		2.03	
	Pressure lbs. @ in.	Closed	76-84 lbs. @ 1.70"	
		Open	194-206 lbs. @ 1.25"	
	Installed Height $\pm 1/32$ "		1 23/32	
Valve Spring Damper	Free Length		1.86	
	Approx. # of Coils		4	

T2369

SPECIFICATIONS

ENGINE SPECIFICATIONS (7.4L)

All Specifications are in INCHES unless otherwise noted.

GENERAL DATA:				
Type			V8	
Displacement			7.4L (454 CID)	
RPO			L19	
Bore			4.25	
Stroke			4.00	
Compression Ratio			7.9:1	
Firing Order			1-8-4-3-6-5-7-2	
Oil Pressure (Minimum)*			10 psi @ 600 RPM Minimum; 25 psi @ 2000 RPM	
CYLINDER BORE:				
Diameter			4.2500-4.2507	
Out Of Round	Production		0.001 (Maximum)	
	Service		0.002 (Maximum)	
Taper	Production	Thrust Side	0.0005 (Maximum)	
		Relief Side	0.001 (Maximum)	
	Service		0.001 (Maximum)	
PISTON:				
Clearance	Production		0.0018-0.0030	
	Service Limit		0.0036 (Maximum)	
PISTON RING:				
C O M M I S S I O N	Groove Clearance	Production	Top	0.0012-0.0029
			2nd	0.0012-0.0029
		Service Limit		Hi Limit Production +0.001
	Gap	Production	Top	0.010-0.018
			2nd	0.016-0.024
		Service Limit		Hi Limit Production + 0.010
O I L	Groove Clearance	Production		0.0050-0.0065
		Service Limit		Hi Limit Production + 0.001
	Gap	Production		0.010-0.030
		Service Limit		Hi Limit Production + 0.010
PISTON PIN:				
Diameter			0.98945-0.98965	
Clearance In Piston	Production		0.0002-0.0007	
	Service Limit		0.001 (Maximum)	
Fit In Rod			0.0031-0.0021 Interference	

*Measure on a "Warm Engine." Pressures will be higher on a cold engine.

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SPECIFICATIONS**ENGINE SPECIFICATIONS (7.4 L) (CONT.)**

All Specifications are in INCHES unless otherwise noted.

DISPLACEMENT:			7.4L
CRANKSHAFT:			
Main Journal	Diameter	#1, #2, #3, #4, #5	2.7482-2.7489
	Taper	Production	0.0004 (Maximum)
		Service Limit	0.001 (Maximum)
	Out Of Round	Production	0.0004 (Maximum)
		Service Limit	0.001 (Maximum)
Main Bearing Clearance	Production	#1, #2, #3, #4	0.0017-0.0030
		#5	0.0025-0.0038
	Service Limit	#1, #2, #3, #4	0.0010-0.0030
		#5	0.0025-0.0040
Crankshaft End Play			0.005-0.011
Crankpin	Diameter		2.1990-2.1996
	Taper	Production	0.0005
		Service Limit	0.001
	Out Of Round	Production	0.0005
		Service Limit	0.001
Rod Bearing Clearance	Production		0.0011-0.0029
	Service Limit		0.003 (Maximum)
Rod Side Clearance			0.0013-0.023
CAMSHAFT:			
Lobe Lift ± 0.002	Intake		0.2487
	Exhaust		0.2537
Journal Diameter			1.9477-1.9497
VALVE SYSTEM:			
Lifter			Hydraulic
Rocker Arm Ratio			1.70:1
Valve Lash	Intake		Net Lash
	Exhaust		
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			0.002 (Maximum)
Seat Width	Intake		1/32-1/16
	Exhaust		1/16-3/32
Stem Clearance	Production	Intake	0.0010-0.0027
		Exhaust	0.0012-0.0029
	Service	Intake	High Limit Production +0.001
		Exhaust	High Limit Production +0.002
Valve Spring	Free Length		2.15
	Pressure lbs. @ in.	Closed	76-84 lbs. @ 1.838-in.
		Open	205-225 lbs. @ 1.408-in.
	Installed Height $\pm 1/32$ "		1.838 in.

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SPECIFICATIONS (CONT.)

FASTENER TIGHTENING SPECIFICATIONS (5.0L AND 5.7L ENGINES)

Item	N·m	Lbs. Ft.	Lbs. In.
Camshaft Sprocket Bolts	28	21	—
Connecting Rod Bolt Nuts	61	45	—
Coolant Outlet Bolts	28	21	—
Coolant Pump Bolts	40	30	—
Crankshaft Rear Oil Seal Retainer Screws and Nuts	15	11	—
Cylinder Head Bolts (In Sequence)	90	65	—
Engine Block Drain Plug	22	16	—
Exhaust Manifold Bolts			
Center Two Bolts	36	26	—
All Other Bolts	28	20	—
Flywheel Bolts	100	74	—
Flywheel Housing Bolts	44	32	—
Front Cover Bolts	11	—	97
Intake Manifold Bolts (In Sequence)	47	35	—
Main Bearing Cap Bolts			
Outer Bolts on #2, #3, and #4 Caps	95	70	—
All Others	110	80	—
Oil Filter Bypass Valve Bolts	26	20	—
Oil Pan Baffle Nuts (H.D. 5.7L Only)	36	27	—
Oil Pan Bolts	11	—	97
Oil Pan Drain Plug	22	16	—
Oil Pan Nuts	22	16	—
Oil Pan Studs to Oil Seal Retainer or Engine Block	2	—	15
Oil Pump Bolt	90	65	—
Oil Pump Cover Bolts	12	—	106
Rocker Arm Cover Bolts	10	—	89
Torsional Damper Bolt	95	70	—

(7.4L ENGINES)

Item	N·m	Lbs. Ft.	Lbs. In.
Camshaft Sprocket Bolts	26	20	—
Connecting Rod Bolt Nuts	61	45	—
Coolant Outlet Bolts	40	30	—
Coolant Pump Bolts	40	30	—
Cylinder Head Bolts (In Sequence)	115	85	—
Engine Block Drain Plug	12	—	112
Exhaust Manifold Bolts	54	40	—
Flywheel Bolts	90	66	—
Flywheel Housing Bolts	40	30	—
Front Cover Bolts	12	—	106
Intake Manifold Bolts (In Sequence)	40	30	—
Main Bearing Cap Bolts	135	100	—
Oil Pan Bolts	22	16	—
Oil Pan Drain Plug	28	20	—
Oil Pump Bolt	90	65	—
Oil Pump Cover Bolts	12	—	106
Rocker Arm Bolts	54	40	—
Rocker Arm Cover Bolts	8	—	70
Torsional Damper Bolt	149	110	—

T2525

SPECIAL TOOLS



1.

J 39046



2.

J 8062



3.

J 21882



4.

J 35468

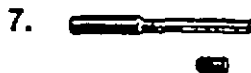
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J 22102



6.

J 8037



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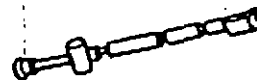
J 5239

8.



J 23738-A

9.



J 9290-01

10.



J 3049-A

11.



J 5802-01

12.

13.



J 5715

J 6036

14.



J 6880

15.



J 5825-A

16.



J 5590

17.

18.



J 35621

J 38841

19.



J 28509-A

1. TORSIONAL DAMPER REMOVER AND INSTALLER
2. VALVE SPRING COMPRESSOR
3. OIL PUMP PICK-UP TUBE INSTALLER
(5.0 AND 5.7L ENGINES)
4. CRANKSHAFT SEAL INSTALLER (5.0L AND 5.7L ENGINES)
5. CRANKSHAFT SEAL INSTALLER (7.4L ENGINE)
6. PISTON RING COMPRESSOR
7. GUIDE SET
8. VACUUM PUMP
9. HYDRAULIC LIFTER REMOVER (SLIDE HAMMER TYPE)
10. HYDRAULIC LIFTER REMOVER (PLIER TYPE)
11. STUD REMOVER (5.0L AND 5.7L ENGINES)
12. REAMER (0.003-INCH OVERSIZE)
13. REAMER (0.013-INCH OVERSIZE)
14. STUD INSTALLER (5.0L AND 5.7L ENGINES)
15. CRANKSHAFT SPROCKET PULLER
(5.0L AND 5.7L ENGINES)
16. CRANKSHAFT SPROCKET INSTALLER
17. CRANKSHAFT REAR OIL SEAL INSTALLER
(5.0L AND 5.7L ENGINES)
18. CRANKSHAFT REAR OIL SEAL INSTALLER (7.4L ENGINE)
19. CRANKSHAFT SPROCKET PULLER (7.4L ENGINE)

Engine Mechanical - 5.0L, 5.7L

Specifications

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Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Control Cable Bracket Bolt and Nut	12 N.m	106 lb in
Air Conditioning (A/C) Compressor Mounting Bolt	50 N.m	37 lb ft
Belt Idler Pulley Bolt	50 N.m	37 lb ft
Camshaft Retainer Bolt	12 N.m	106 lb in
Camshaft Sprocket Bolt	25 N.m	18 lb ft
Connecting Rod Nut		
First Pass	27 N.m	20 lb ft
Final Pass	55 degrees	
Crankshaft Balancer Bolt	95 N.m	70 lb ft
Crankshaft Bearing Cap Bolt and Stud (Preferred Method)		
First Pass (Two Bolt Type Bearing Cap)	20 N.m	15 lb ft
Final Pass (Two Bolt Type Bearing Cap)	73 degrees	
First Pass (Four Bolt Type Bearing Cap)	20 N.m	15 lb ft
Final Pass Outboard Bolt (Four Bolt Type Bearing Cap)	43 degrees	
Final Pass Inboard Bolt and Stud (Four Bolt Type Bearing Cap)	73 degrees	
Crankshaft Bearing Cap Bolt and Stud (Optional Strategy)		
Two Bolt Type Bearing Cap	105 N.m	77 lb ft
Inboard Bolt and Stud (Four Bolt Type Bearing Cap)	105 N.m	77 lb ft
Outboard Bolt (Four Bolt Type Bearing Cap)	90 N.m	66 lb ft
Crankshaft Oil Deflector Nut	40 N.m	29 lb ft
Crankshaft Position Sensor Bolt	9 N.m	80 lb in
Crankshaft Pulley Bolt	58 N.m	43 lb ft
Crankshaft Rear Oil Seal Housing Nut and Bolt	12 N.m	106 lb in
Crankshaft Rear Oil Seal Housing Retainer Stud	6 N.m	53 lb in
Cylinder Head Bolt (Preferred Method)		
All Bolts First Pass in Sequence	30 N.m	22 lb ft
Long Bolt Final Pass in Sequence	75 degrees	
Medium Bolt Final Pass in Sequence	65 degrees	
Short Bolt Final Pass in Sequence	55 degrees	
Cylinder Head Bolt (Optional On-Vehicle Strategy)		
First Pass in Sequence	35 N.m	26 lb ft
Second Pass in Sequence	60 N.m	44 lb ft
Final Pass in Sequence	90 N.m	66 lb ft
Cylinder Head Core Hole Plug	20 N.m	15 lb ft
Distributor Cap Bolt	2.4 N.m	21 lb in
Distributor Clamp Bolt	25 N.m	18 lb ft
Drive Belt Tensioner Bolt	50 N.m	37 lb ft
EGR Valve Bolt		
First Pass	10 N.m	88 lb in

Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Final Pass	30 N.m	22 lb ft
EGR Valve Pipe Nut at Intake Manifold	25 N.m	18 lb ft
EGR Valve Pipe Nut at Exhaust Manifold	30 N.m	22 lb ft
EGR Valve Pipe Clamp Bracket Bolt	25 N.m	18 lb ft
Engine Block Coolant Drain Hole Plug	20 N.m	15 lb ft
Engine Block Oil Gallery Plug	20 N.m	15 lb ft
Engine Coolant Temperature (ECT) Gauge Sensor	20 N.m	15 lb ft
Engine Flywheel Bolt	100 N.m	74 lb ft
Engine Front Cover Bolt	12 N.m	106 lb in
Engine Lift Bracket Bolt (Special Tool J 41427)	15 N.m	11 lb ft
Engine Lift Front Bracket Stud	35 N.m	27 lb ft
Engine Mount Bracket Bolt	51 N.m	38 lb ft
Engine Mount Through-bolt	68 N.m	50 lb ft
Engine Oil Pressure Gauge Sensor	30 N.m	22 lb ft
Engine Oil Pressure Gauge Sensor Fitting (Plus Required Angle)	15 N.m	11 lb ft
Engine Wiring Harness Bracket Nut	12 N.m	106 lb in
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Stud	10 N.m	88 lb in
Exhaust Manifold Bolt		
First Pass	15 N.m	11 lb ft
Final Pass	30 N.m	22 lb ft
Fan and Water Pump Pulley Bolt	25 N.m	18 lb ft
Fuel Pipe Bracket Bolt	6 N.m	53 lb in
Fuel Pipe Retainer Nut	3 N.m	27 lb in
Generator and Drive Belt Tensioner Bracket Bolt and Nut to Engine	41 N.m	30 lb ft
Generator and Drive Belt Tensioner Bracket Stud to Engine	20 N.m	15 lb ft
Generator Mounting Bolt	50 N.m	37 lb ft
Generator Mounting Rear Bracket Bolt to Generator and Drive Belt Tensioner Bracket	50 N.m	37 lb ft
Ignition Coil Stud	12 N.m	106 lb in
Knock Sensor	20 N.m	15 lb ft
Lower Intake Manifold Bolt		
First Pass in Sequence	3 N.m	27 lb in
Second Pass in Sequence	12 N.m	106 lb in
Final Pass in Sequence	15 N.m	11 lb ft
Oil Filter	37 N.m	27 lb ft
Oil Filter Adapter Bolt	25 N.m	18 lb ft
Oil Filter Fitting	35 N.m	26 lb ft
Oil Level Indicator Tube Bolt	12 N.m	106 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan Stud (Front)	6 N.m	53 lb in
Oil Pan Stud Nut	25 N.m	18 lb ft
Oil Pan Bolt or Stud Bolt	12 N.m	106 lb in
Oil Pump Bolt to Rear Crankshaft Bearing Cap	90 N.m	66 lb ft
Oil Pump Cover Bolt	12 N.m	106 lb in

Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Power Steering Pump Bracket Bolt to Engine	41 N·m	30 lb·ft
Power Steering Pump Bracket Stud to Engine	20 N·m	15 lb·ft
Power Steering Pump Bracket Stud Nut	41 N·m	30 lb·ft
Power Steering Pump Bolt	50 N·m	37 lb·ft
Power Steering Pump Nut to Engine	41 N·m	30 lb·ft
Power Steering Pump Rear Bracket Nut	50 N·m	37 lb·ft
Spark Plug		
Initial Installation (New Cylinder Head)	30 N·m	22 lb·ft
All Subsequent Installations	15 N·m	11 lb·ft
Spark Plug Wire Support Bolt	12 N·m	106 lb·in
Square Socket Plug (Engine Block Oil Gallery)	20 N·m	15 lb·ft
Starter Motor Bolt	40 N·m	29 lb·ft
Transmission Cover Bolt	12 N·m	106 lb·in
Upper Intake Manifold Stud		
First Pass	5 N·m	44 lb·in
Final Pass	10 N·m	88 lb·in
Valve Lifter Guide Retainer Bolt	25 N·m	18 lb·ft
Valve Rocker Arm Cover Bolt	12 N·m	106 lb·in
Water Outlet Stud	25 N·m	18 lb·ft
Water Pump Bolt	45 N·m	33 lb·ft

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Engine Mechanical Specifications (L30 (VIN M))

Application	Specification	
	Metric	English
General Data		
Engine Type	V8	
Displacement	5.0L	305 CID
RPO (VIN Code)	L30 (M)	
Bore	94.89 mm	3.736 in
Stroke	88.39 mm	3.480 in
Compression Ratio	9.4:1	
Firing Order	1-8-4-3-6-5-7-2	
Spark Plug Gap	1.52 mm	0.060 in
Oil Pressure (Minimum Hot)	41.4 kpa at 1,000 RPM	6.0 psig at 1,000 RPM
Oil Pressure (Minimum Hot)	124.1 kpa at 2,000 RPM	18.0 psig at 2,000 RPM
Oil Pressure (Minimum Hot)	165.5 kpa at 4,000 RPM	24.0 psig at 4,000 RPM
Camshaft		
End Play	0.11-0.30 mm	0.004-0.012 in
Journal Diameter	47.440-47.490 mm	1.8677-1.8697 in
Lobe Lift (Exhaust)	7.20-7.30 mm	0.283-0.287 in
Lobe Lift (Intake)	6.97-7.07 mm	0.274-0.278 in
Connecting Rod		

Engine Mechanical Specifications (L30 (VIN M)) (cont'd)

Application	Specification	
	Metric	English
Connecting Rod Bearing Clearance (Production)	0.033–0.078 mm	0.0013–0.0031 in
Connecting Rod Bearing Clearance (Service)	0.025–0.063 mm	0.0010–0.0025 in
Connecting Rod Journal Diameter	53.304–53.334 mm	2.0986–2.0998 in
Connecting Rod Journal Taper (Production)	0.007 mm Maximum	0.0003 in Maximum
Connecting Rod Journal Taper (Service)	0.025 mm Maximum	0.0010 in Maximum
Connecting Rod Journal Out-of-Round (Production)	0.007 mm Maximum	0.0003 in Maximum
Connecting Rod Journal Out-of-Round (Service)	0.025 mm Maximum	0.0010 in Maximum
Connecting Rod Side Clearance	0.15–0.68 mm	0.006–0.027 in
Crankshaft		
Crankshaft Bearing Clearance #1 (Production)	0.018–0.053 mm	0.0007–0.0021 in
Crankshaft Bearing Clearance #2, #3, and #4 (Production)	0.030–0.068 mm	0.0012–0.0027 in
Crankshaft Bearing Clearance #5 (Production)	0.020–0.060 mm	0.0008–0.0024 in
Crankshaft Bearing Clearance #1 (Service)	0.025–0.051 mm	0.0010–0.0020 in
Crankshaft Bearing Clearance #2, #3, and #4 (Service)	0.025–0.064 mm	0.0010–0.0025 in
Crankshaft Bearing Clearance Service #5	0.038–0.063 mm	0.0015–0.0025 in
Crankshaft End Play	0.05–0.20 mm	0.002–0.008 in
Crankshaft Journal Diameter #1	62.189–62.212 mm	2.4484–2.4493 in
Crankshaft Journal Diameter #2, #3, and #4	62.181–62.207 mm	2.4481–2.4491 in
Crankshaft Journal Diameter #5	62.181–62.212 mm	2.4481–2.4493 in
Crankshaft Journal Taper (Production)	0.005 mm Maximum	0.0002 in Maximum
Crankshaft Journal Out-of-Round (Production)	0.005 mm Maximum	0.0002 in Maximum
Crankshaft Runout at Rear Flange	0.038 mm	0.0015 in
Cylinder Bore		
Diameter	94.876–94.929 mm	3.7353–3.7374 in
Out-of-Round (Production)	0.025 mm	0.001 in
Out-of-Round (Service)	0.05 mm	0.002 in
Taper (Production—Relief Side)	0.025 mm	0.0010 in
Taper (Production—Thrust Side)	0.012 mm	0.0005 in
Service Limit	0.025 mm	0.0010 in
Cylinder Head		
Surface Flatness (Engine Block Deck)	0.10 mm	0.004 in
Surface Flatness (Exhaust Manifold Deck)	0.05 mm	0.002 in
Surface Flatness (Intake Manifold Deck)	0.10 mm	0.004 in
Piston		
Piston Bore Clearance (Production)	0.018–0.053 mm	0.0007–0.002 in
Piston Bore Clearance (Service)	0.018–0.068 mm	0.0007–0.0026 in
Piston Pin		
Clearance in Piston (Production)	0.010–0.020 mm	0.0004–0.0008 in
Clearance in Piston (Service)	0.013–0.025 mm	0.0005–0.0010 in
Diameter	23.545–23.548 mm	0.9270–0.9271 in
Interference Fit in Connecting Rod	0.021–0.040 mm	0.0008–0.0016 in
Piston Rings (End Gaps Measured in Cylinder Bore)		
Piston Compression Ring Groove Clearance (Production—Top Groove)	0.030–0.070 mm	0.0012–0.0027 in

Engine Mechanical Specifications (L30 (VIN M)) (cont'd)

Application	Specification	
	Metric	English
Piston Compression Ring Groove Clearance (Production—2nd Groove)	0.040–0.080 mm	0.0015–0.003 in
Piston Compression Ring Groove Clearance (Service Limit—Top Groove)	0.030–0.090 mm	0.0012–0.0035 in
Piston Compression Ring Groove Clearance (Service Limit—2nd Groove)	0.040–0.100 mm	0.0015–0.0040 in
Piston Compression Ring Gap (Production—Top Groove)	0.25–0.51 mm	0.010–0.020 in
Piston Compression Ring Gap (Production—2nd Groove)	0.46–0.66 mm	0.018–0.026 in
Piston Compression Ring Gap (Service—Top Groove)	0.25–0.65 mm	0.010–0.025 in
Piston Compression Ring Gap (Service—2nd Groove)	0.46–0.90 mm	0.018–0.035 in
Piston Oil Ring Groove Clearance (Production)	0.051–0.17 mm	0.002–0.006 in
Piston Oil Ring Groove Clearance (Service)	0.051–0.22 mm	0.002–0.009 in
Piston Oil Ring Gap (Production)	0.25–0.76 mm	0.010–0.030 in
Piston Oil Ring Gap (Service)	0.25–0.89 mm	0.010–0.035 in
Valve System		
Valve Lifter	Hydraulic Roller	
Valve Rocker Arm Ratio	1.5:1	
Valve Lash	Rotate the Valve Rocker Arm Nut Clockwise 360 degrees (1 Turn) from Zero Lash	
Valve Face Angle	—	45 degrees
Valve Seat Angle	—	46 degrees
Valve Seat Runout	0.05 mm Maximum	0.002 in Maximum
Valve Seat Width (Exhaust)	1.65–2.49 mm	0.065–0.098 in
Valve Seat Width (Intake)	1.14–1.78 mm	0.045–0.070 in
Valve Spring Free Length	51.3 mm	2.02 in
Valve Spring Installed Height (Exhaust)	42.92–43.43 mm	1.67–1.70 in
Valve Spring Installed Height (Intake)	42.92–43.43 mm	1.67–1.70 in
Valve Spring Pressure (Closed)	338–374 N at 43.2	76–84 lb at 1.70
Valve Spring Pressure (Open)	832–903 N at 32.3	187–203 lb at 1.27
Valve Stem Clearance Exhaust (Production)	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance Intake (Production)	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance Exhaust (Service)	0.025–0.094 mm	0.0010–0.0037 in
Valve Stem Clearance Intake (Service)	0.025–0.094 mm	0.0010–0.0037 in

SIE-ID = 69804

Engine Mechanical Specifications (L31 (VIN R))

Application	Specification	
	Metric	English
General Data		
Engine Type	V8	
Displacement	5.7L	350 CID
RPO (VIN Code)	L31 (R)	
Bore	101.63 mm	4.0012 in
Stroke	88.39 mm	3.480 in

Engine Mechanical Specifications (L31 (VIN R)) (cont'd)

Application	Specification	
	Metric	English
Compression Ratio	9.4:1	
Firing Order	1-8-4-3-6-5-7-2	
Spark Plug Gap	1.52 mm	0.060 in
Oil Pressure (Minimum Hot)	41.4 kpa at 1,000 RPM	6.0 psig at 1,000 RPM
Oil Pressure (Minimum Hot)	124.1 kpa at 2,000 RPM	18.0 psig at 2,000 RPM
Oil Pressure (Minimum Hot)	165.5 kpa at 4,000 RPM	24.0 psig at 4,000 RPM
Camshaft		
End Play	0.11-0.30 mm	0.004-0.012 in
Journal Diameter	47.440-47.490 mm	1.8677-1.8697 in
Lobe Lift (Exhaust)	7.20-7.30 mm	0.283-0.287 in
Lobe Lift (Intake)	6.97-7.07 mm	0.274-0.278 in
Connecting Rod		
Connecting Rod Bearing Clearance (Production)	0.033-0.078 mm	0.0013-0.0031 in
Connecting Rod Bearing Clearance (Service)	0.025-0.063 mm	0.0010-0.0025 in
Connecting Rod Journal Diameter	53.304-53.334 mm	2.0986-2.0998 in
Connecting Rod Journal Taper (Production)	0.007 mm Maximum	0.0003 in Maximum
Connecting Rod Journal Taper (Service)	0.025 mm Maximum	0.0010 in Maximum
Connecting Rod Journal Out-of-Round (Production)	0.007 mm Maximum	0.0003 in Maximum
Connecting Rod Journal Out-of-Round (Service)	0.025 mm Maximum	0.0010 in Maximum
Connecting Rod Side Clearance	0.15-0.68 mm	0.006-0.027 in
Crankshaft		
Crankshaft Bearing Clearance #1 (Production)	0.018-0.053 mm	0.0007-0.0021 in
Crankshaft Bearing Clearance #2, #3, and #4 (Production)	0.030-0.068 mm	0.0012-0.0027 in
Crankshaft Bearing Clearance #5 (Production)	0.020-0.060 mm	0.0008-0.0024 in
Crankshaft Bearing Clearance #1 (Service)	0.025-0.051 mm	0.0010-0.0020 in
Crankshaft Bearing Clearance #2, #3, and #4 (Service)	0.025-0.064 mm	0.0010-0.0025 in
Crankshaft Bearing Clearance Service #5	0.038-0.063 mm	0.0015-0.0025 in
Crankshaft End Play	0.05-0.20 mm	0.002-0.008 in
Crankshaft Journal Diameter #1	62.189-62.212 mm	2.4484-2.4493 in
Crankshaft Journal Diameter #2, #3, and #4	62.181-62.207 mm	2.4481-2.4491 in
Crankshaft Journal Diameter #5	62.181-62.212 mm	2.4481-2.4493 in
Crankshaft Journal Taper (Production)	0.005 mm Maximum	0.0002 in Maximum
Crankshaft Journal Out-of-Round (Production)	0.005 mm Maximum	0.0002 in Maximum
Crankshaft Runout at Rear Flange	0.038 mm	0.0015 in
Cylinder Bore		
Diameter	101.618-101.643 mm	4.0007-4.0017 in
Out-of-Round (Production)	0.025 mm	0.001 in
Out-of-Round (Service)	0.05 mm	0.002 in
Taper (Production—Relief Side)	0.025 mm	0.0010 in
Taper (Production—Thrust Side)	0.012 mm	0.0005 in
Service Limit	0.025 mm	0.0010 in
Cylinder Head		
Surface Flatness (Engine Block Deck)	0.10 mm	0.004 in
Surface Flatness (Exhaust Manifold Deck)	0.05 mm	0.002 in

Engine Mechanical Specifications (L31 (VIN R)) (cont'd)

Application	Specification	
	Metric	English
Surface Flatness (Intake Manifold Deck)	0.10 mm	0.004 in
Piston		
Piston Bore Clearance (Production)	0.018–0.053 mm	0.0007–0.002 in
Piston Bore Clearance (Service)	0.018–0.068 mm	0.0007–0.0026 in
Piston Pin		
Clearance in Piston (Production)	0.013–0.023 mm	0.0005–0.0009 in
Clearance in Piston (Service)	0.013–0.025 mm	0.0005–0.0010 in
Diameter	23.545–23.548 mm	0.9270–0.9271 in
Interference Fit in Connecting Rod	0.021–0.040 mm	0.0008–0.0016 in
Piston Rings (End Gaps Measured in Cylinder Bore)		
Piston Compression Ring Groove Clearance (Production—Top Groove)	0.030–0.070 mm	0.0012–0.0027 in
Piston Compression Ring Groove Clearance (Production—2nd Groove)	0.040–0.080 mm	0.0015–0.003 in
Piston Compression Ring Groove Clearance (Service Limit—Top Groove)	0.030–0.090 mm	0.0012–0.0035 in
Piston Compression Ring Groove Clearance (Service Limit—2nd Groove)	0.040–0.100 mm	0.0015–0.0040 in
Piston Compression Ring Gap (Production—Top Groove)	0.25–0.40 mm	0.098–0.015 in
Piston Compression Ring Gap (Production—2nd Groove)	0.46–0.66 mm	0.018–0.025 in
Piston Compression Ring Gap (Service—Top Groove)	0.25–0.50 mm	0.009–0.019 in
Piston Compression Ring Gap (Service—2nd Groove)	0.46–0.80 mm	0.018–0.031 in
Piston Oil Ring Groove Clearance (Production)	0.046–0.096 mm	0.0018–0.0037 in
Piston Oil Ring Groove Clearance (Service)	0.046–0.100 mm	0.0018–0.0039 in
Piston Oil Ring Gap (Production)	0.25–0.76 mm	0.009–0.029 in
Piston Oil Ring Gap (Service)	0.25–0.90 mm	0.009–0.035 in
Valve System		
Valve Lifter	Hydraulic Roller	
Valve Rocker Arm Ratio	1.5:1	
Valve Lash	Rotate the Valve Rocker Arm Nut Clockwise 360 degrees (1 Turn) from Zero Lash	
Valve Face Angle	—	45 degrees
Valve Seat Angle	—	46 degrees
Valve Seat Runout	0.05 mm Maximum	0.002 in Maximum
Valve Seat Width (Exhaust—Heavy Duty)	1.50–2.56 mm	0.059–0.101 in
Valve Seat Width (Exhaust—Light Duty)	1.65–2.49 mm	0.065–0.098 in
Valve Seat Width (Intake)	1.02–1.65 mm	0.040–0.065 in
Valve Spring Free Length	51.3 mm	2.02 in
Valve Spring Installed Height (Exhaust)	42.92–43.43 mm	1.67–1.70 in
Valve Spring Installed Height (Intake)	42.92–43.43 mm	1.67–1.70 in
Valve Spring Pressure (Closed)	338–374 N at 43.2	76–84 lb at 1.70
Valve Spring Pressure (Open)	832–903 N at 32.3	187–203 lb at 1.27
Valve Stem Clearance Exhaust (Production)	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance Intake (Production)	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance Exhaust (Service)	0.025–0.094 mm	0.0010–0.0037 in

Engine Mechanical Specifications (L31 (VIN R)) (cont'd)

Application	Specification	
	Metric	English
Valve Stem Clearance Intake (Service)	0.025-0.094 mm	0.0010-0.0037 in.

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GM SPO Group Numbers

Application	GM SPO Group Number
Accelerator Control Cable Bracket	3.454
Belt Idler Pulley (Grooved)	1.062
Belt Idler Pulley (Smooth)	1.062
Camshaft Bearing	0.539
Camshaft Retainer	0.529
Camshaft Sprocket	0.736
Camshaft Sprocket Locator Pin	0.738
Camshaft Timing Chain	0.724
Clutch Pilot Bearing	0.649
Connecting Rod	0.603
Connecting Rod Bearing Kit	0.616
Coolant Radiator	1.219
Crankshaft Balancer	0.659
Crankshaft Bearing Kit	0.096
Crankshaft Front Oil Seal	0.213
Crankshaft Oil Deflector	1.430
Crankshaft Rear Oil Seal	0.137
Crankshaft Rear Oil Seal Housing	0.137
Crankshaft Rear Oil Seal Housing Retainer Stud	0.137
Crankshaft Rear Oil Seal Housing Gasket	0.137
Crankshaft Rear Oil Seal Retainer Stud	0.137
Crankshaft Position Sensor	2.383
Crankshaft Position Sensor Reluctor Ring	2.383
Crankshaft Position Sensor Seal (O-ring)	2.383
Crankshaft Pulley	0.659
Crankshaft Sprocket	0.728
Cylinder Head	0.269
Cylinder Head Gasket	0.289
Distributor	2.361
Distributor Cap	2.367
Distributor Clamp	2.363
Distributor Gasket	2.363
Dowel Pin (Cylinder Head Locator)	8.939
Dowel Straight Pin (Transmission Locator)	8.939
Drive Belt Tensioner	1.060
EGR Valve	3.670
EGR Valve Gasket	3.680
EGR Valve Pipe	3.675

GM SPO Group Numbers (cont'd)

Application	GM SPO Group Number
EGR Valve Pipe Fitting	3.680
Evaporative Emission Canister Purge Solenoid Valve	3.130
Evaporative Emission Canister Purge Solenoid Valve Harness	3.145
Engine Block	N.S.
Engine Block Core Hole Plug	0.034
Engine Block Oil Gallery Plug	1.531
Engine Camshaft	0.519
Engine Coolant Heater	1.152
Engine Coolant Temperature Sensor	1.150
Engine Coolant Temperature Gauge Sensor	1.150
Engine Coolant Thermostat	1.246
Engine Coolant Thermostat Seal (O-ring)	1.252
Engine Crankshaft	0.646
Engine Flywheel	0.666
Engine Front Cover	0.206
Engine Mount Bracket	0.029
Engine Mount Bracket Spacer	0.029
Engine Oil Pressure Gauge Sensor	1.800
Engine Oil Pressure Gauge Sensor Fitting	1.800
Engine Piston Kit (Piston and Piston Pin)	0.629
Engine Wiring Harness Bracket	2.559
Exhaust Manifold	3.601
Exhaust Manifold Gasket	3.270
Exhaust Valve	0.297
Expansion Cup Plug (Camshaft Rear Bearing Hole)	8.970
Fan & Water Pump & A/C Compressor & Generator & Power Steering Pump Belt	1.066
Fan & Water Pump & Generator & Power Steering Pump Belt	1.066
Fan and Water Pump Pulley	1.062
Flywheel Locator Pin	0.669
Front Groove Pin (Crankshaft Balancer)	8.940
Fuel Pipe (Included in Fuel Injection Feed and Return Pipe Kit only)	3.163
Fuel Pipe Retainer Bracket (Included in Fuel Injection Feed and Return Pipe Kit only)	3.163
Fuel Injector (O-ring) Seal Kit	3.331
Generator and Drive Belt Tensioner Bracket	1.060
Ignition Coil	2.170
Ignition Coil Wire Harness	2.240
Intake Valve	0.296
Knock Sensor	2.383
Lower Intake Manifold (Included in Lower Intake Manifold Kit only)	3.265
Lower Intake Manifold Gasket Kit	3.270
MAP Sensor	3.682
MAP Sensor Seal (O-ring)	3.682
Oil Fill Cap	1.758
Oil Filter	1.836
Oil Filter Adapter	1.840

GM SPO Group Numbers (cont'd)

Application	GM SPO Group Number
Oil Filter Adapter Gasket	1.840
Oil Filter Adapter Seal (O-ring)	1.844
Oil Filter Bypass Valve	1.837
Oil Filter Fitting	1.855
Oil Level Indicator	1.516
Oil Level Indicator Tube	1.516
Oil Pan Drain Plug	1.453
Oil Pan Drain Plug Seal (O-ring)	1.456
Oil Pan Gasket	1.429
Oil Pan Kit with Gasket	1.426
Oil Pan Reinforcement	1.426
Oil Pump	1.652
Oil Pump Cover	1.723
Oil Pump Drive Shaft	1.639
Oil Pump Drive Shaft Retainer	1.639
Oil Pump Pressure Relief Valve	1.609
Oil Pump Pressure Relief Valve Spring	1.609
Oil Pump Pressure Relief Valve Spring Bore Plug	1.609
Oil Pump Pressure Relief Valve Spring Straight Pin	1.609
Oil Pump Screen	1.656
PCV Tube	1.762
PCV Valve	1.745
PCV Valve Cover	1.745
PCV Valve Elbow	1.762
PCV Valve Grommet	1.745
PCV Valve Hose	1.762
Pin (Oil Pump Locator)	1.723
Piston (with Pin)	0.629
Piston Ring Kit	0.643
Power Steering Pump Bracket	6.606
Radiator Air Deflector	1.272
Radiator Fan Shroud	1.277
Radiator Outlet Hose	1.173
Radiator Surge Tank	1.240
Secondary Air Injection (AIR) Check Valve (Crossover) Pipe	3.675
Secondary Air Injection (AIR) Pipe	3.675
Spark Plug	2.270
Spark Plug Wire	2.240
Spark Plug Wire Retainer	2.251
Spark Plug Wire Shield	2.251
Spark Plug Wire Support	2.251
Spring Type S Pin (Crankshaft Rear Oil Seal Housing Locator)	8.940
Square Socket Plug (Engine Block Oil Gallery)	8.971
Starter Motor	2.041
TBI Fuel Meter	3.734

GM SPO Group Numbers (cont'd)

Application	GM SPO Group Number
Throttle Body	3.335
Throttle Body to Upper Manifold Gasket (Included in Service Kits only)	N.S.
Upper Intake Manifold (included in Intake Manifold Seal Kit)	3.625
Upper Intake Manifold to Lower Intake Manifold Gasket (Included in Intake Manifold Seal Kit)	3.270
Valve Lifter	0.459
Valve Lifter Guide	0.439
Valve Lifter Guide Retainer	0.439
Valve Pushrod	0.426
Valve Rocker Arm (Included in Valve Rocker Arm Kit only)	N.S.
Valve Rocker Arm Ball (Included in Valve Rocker Arm Kit only)	N.S.
Valve Rocker Arm Ball Stud	0.429
Valve Rocker Arm Cover	0.386
Valve Rocker Arm Cover Gasket	0.423
Valve Rocker Arm Kit (Valve Rocker Arm, Ball, Nut)	0.333
Valve Rocker Arm Nut	0.429
Valve Spring	0.303
Valve Spring Cap	0.309
Valve Stem Key	0.310
Valve Stem Oil Seal	0.308
Water Outlet	1.153
Water Pump Gasket	1.079
Water Pump Inlet Hose	1.097
Water Pump Kit (with Gaskets)	1.069
Woodruff Key (Crankshaft Balancer)	8.960

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Sealers, Adhesives, and Lubricants

Application	Type of Material	GM Part Number
Coolant Sealing Pellets	Sealant	3634621
Crankshaft Balancer Keyway	Adhesive	12346141
Cylinder Head Bolt Threads	Sealant	12346004
Engine Block Coolant Drain Hole Plug	Sealant	12346004
Engine Block to Crankshaft Rear Oil Seal Housing Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141
Engine Block to Engine Front Cover Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141
Engine Block at the Lower Intake Manifold Sealing Surfaces	Adhesive	12346141
Engine Block Oil Gallery Plug	Sealant	12346004
Engine Coolant Sensor Threads	Sealant	12346004
Engine Coolant Temperature (ECT) Gauge Sensor	Sealant	12346004
Engine Oil	SAE 5W-30 Oil	12345610
Engine Oil Pressure Gauge Sensor	Sealant	12346004
Engine Oil Pressure Gauge Sensor Fitting Threads	Sealant	12346004

Sealers, Adhesives, and Lubricants (cont'd)

Application	Type of Material	GM Part Number
Engine Oil Supplement	Lubricant	1052367
Exhaust Manifold Bolt Threads	Threadlock	12345493
Expansion Cup Plug (Camshaft Rear Bearing Hole Plug)	Sealant	12346004
Expansion Cup Plug (Engine Block Core Hole)	Sealant	12346004
Knock Sensor Threads	Sealant	12346004
Lower Intake Manifold Bolt Threads	Threadlock	12345382
Oil Level Indicator Tube	Sealant	12346004
Oil Pump Screen Tube	Sealant	12346004
Valve Rocker Arm Ball Stud	Lubricant	1052271
Valve Train Component Prelube	Lubricant	12345501
Water Pump Bolt Threads	Sealant	12346004

Diagnostic Information and Procedures

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Base Engine Misfire Diagnosis

Checks	Action
Engine performance diagnosis procedures are covered in Engine Controls and should be consulted for diagnosis of any Driveability, Emissions, or Malfunctioning Indicator Lamp (MIL) concerns. The following diagnosis covers common concerns and possible causes. When the proper diagnosis is made, the concern should be corrected by adjustment, repair or replacement as required. Refer to the appropriate section of the service manual for each specific procedure. This diagnostic table will assist in engine misfire diagnosis due to a mechanical concern such as a faulty engine camshaft, worn or damaged bearings or bent valve pushrod. This table will not isolate a crossed fuel injector wire, faulty fuel injector or any other driveability component failure that may cause a misfire. The Powertrain On-Board Diagnostic System checks must be performed first. When using this table to make a Base Engine Misfire diagnosis, begin with the preliminary information below and then proceed to the specific category.	
Preliminary	1. Perform DTC P0300 before proceeding with Base Engine Misfire Diagnosis information. DTC P0300 will assist in determining which cylinder or cylinders are misfiring. 2. Perform a visual inspection of the following: • A loose or improperly installed engine flywheel or crankshaft balancer • Worn, damaged or misaligned accessory drive system components 3. Listen to the engine for any abnormal internal engine noises. 4. Inspect the engine for acceptable oil pressure. 5. Verify if the engine has excessive oil consumption. 6. Verify if the engine has excessive coolant consumption. 7. Perform a compression test on the engine.
Intake Manifold Leaks	An intake manifold that has a vacuum leak may cause a misfire. Inspect for the following: • Improperly installed or damaged vacuum hoses • Faulty or improperly installed lower intake manifold and/or gaskets • Cracked or damaged lower intake manifold • Improperly installed MAP sensor • The sealing grommet of the MAP sensor should not be torn or damaged • Improperly installed throttle body or damaged gasket • Warped intake manifold • Warped or damaged cylinder head sealing surface
Coolant Consumption	Coolant consumption may or may not cause the engine to overheat. Inspect for the following: • External coolant leaks • Faulty cylinder head gasket • Warped cylinder head • Cracked cylinder head • Damaged engine block

Base Engine Misfire Diagnosis (cont'd)

Checks	Action
Oil Consumption	Oil consumption may or may not cause the engine to misfire. 1. Remove the spark plugs and inspect for an oil fouled spark plug. 2. Perform a cylinder compression test. 3. If the compression test indicates worn valves or valve guides, inspect the following: • Worn, brittle, or improperly installed valve stem oil seals • Worn valve guides • Worn valve stems • Worn or burnt valves or valve seats 4. If the compression test indicates worn or damaged piston rings, inspect the following: • Broken or improperly seated piston rings • Excessive piston ring end gap • Excessive cylinder bore wear or taper • Cylinder damage • Piston damage
Abnormal Internal Engine Noises	1. Start the engine and determine if the noise is timed to the engine camshaft speed or the crankshaft speed. 2. Using a timing light, two knocks per flash is the crankshaft speed and one knock per flash is the engine camshaft speed. 3. If the noise is timed to the engine camshaft speed, inspect the following: • Missing or loose valve train components • Worn or loose valve rocker arms • Worn or bent valve pushrods • Faulty valve springs • Bent or burnt valves • Worn engine camshaft lobes • Worn or damaged camshaft timing chain and/or sprockets Important: A slight COLD knock or piston slapping noise could be considered normal if not present after the engine has reached normal operating temperatures. 4. If the knock is timed to the crankshaft speed, inspect the following: • Worn crankshaft or connecting rod bearings • Piston or cylinder damage • Worn piston or piston pin • Faulty connecting rod • Excessive carbon build-up on the top of the piston
No Abnormal Internal Engine Noise	1. Inspect for a worn or improperly installed camshaft timing chain and/or sprockets. 2. Remove the valve rocker arm cover on the side of the engine with the cylinder that is misfiring. 3. Inspect for the following: • Loose valve rocker arm studs • Bent valve push rods • Faulty valve springs • Faulty valve lifters (bleeding down) • Worn or improperly seated valves • Worn engine camshaft lobes

Engine Noise Diagnosis

Symptom	Cause
When diagnosing engine noise complaints use the following steps to isolate the source of the engine noise: - Determine the type of noise For example, is the noise a light rattle/tapping or a low rumble/knocking? - The exact operating condition under which the noise exists Note factors such as the ambient temperature, the amount of engine warm-up time, the engine temperature, the engine RPM, and other specifics. - At what rate the noise occurs, and at what location in the engine Engine noises are generally synchronized to either engine speed (crankshaft, engine flywheel, connecting rods, crankshaft balancer, or pistons and related components) or one-half engine speed (valve train noise such as valve rocker arms, valve lifters, and camshaft timing chain). Determine the rate at which the noise is occurring. - Compare the engine sounds to other engines, and make sure you are not trying to correct a normal condition.	
Noise on Start-Up but Only Lasts a Few Seconds	- Improper oil viscosity. Install the recommended oil viscosity for the expected temperatures. - Worn or dirty valve lifters - Excessive piston-to-cylinder bore clearance - Excessive piston pin-to-bore clearance - Excessive crankshaft bearing clearance
Knocks Cold and Continues for 1 to 2 Minutes	- Loose or broken crankshaft balancer or accessory drive components - Excessive piston-to-bore clearance A cold piston knock which disappears in 1.5 minutes should be considered acceptable. - A cold engine knock usually disappears when the specific cylinders secondary ignition circuit is grounded out.
Intermittent Noise on Idle, Disappearing When Engine Speed is Increased	- Improper oil viscosity. Install the recommended oil viscosity for the expected temperatures. - Lower than specified oil pressure Install an oil pressure gauge and measure the engine oil pressure. - Dirty or worn valve lifter
Valve Train Noise (Rattle/Tapping)	The following conditions may cause valve train noise: - Lower than specified oil pressure - Worn or faulty oil pump - Loose oil pump-to-engine block bolt - Loose valve rocker arm attachments - Worn valve rocker arms and/or valve pushrods - Broken valve spring - Sticking valves - Worn, dirty, or faulty valve lifters - Worn engine camshaft lobes - Worn valve guides or valve stems - Bent, broken, or damaged timing chain sprocket teeth

Test Procedure

1. Disconnect the positive ignition coil wire plug from ignition coil.
2. Disconnect the fuel injector electrical connector.
3. Remove all the spark plugs.
4. Block the throttle plate wide open.
5. Charge the battery if the battery is not fully charged.
6. Start with the compression gauge at zero. Then *crank the engine through four compression strokes (four puffs).*
7. Make the compression check the same for each cylinder. Record the reading.

The minimum compression in any one cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any one cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1035 \times 70\% = 725$) ($150 \times 70\% = 105$).

8. If some cylinders have low compression, inject approximately 15 ml (one tablespoon) of engine oil into the combustion chamber through the spark plug hole.
 - Normal — Compression builds up quickly and evenly to the specified compression for each cylinder.
 - Piston Rings Leaking — Compression is low on the first stroke. Then compression builds up with the following strokes but does not reach normal. Compression improves considerably when you add oil.
 - Valves Leaking — Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
 - If two adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the two cylinders.

Engine Noise Diagnosis (cont'd)

Symptom	Cause
Knocks Hot at Idle (Rumble/Knocking)	The following conditions may cause a knocking noise: • Malfunctioning accessory drive system components • Loose or broken crankshaft balancer • Detonation or spark knock Check for proper operation of the cooling, knock, and ignition control components. Refer to diagnostic information in Engine Controls. • Excessive connecting rod bearing clearance • Excessive piston pin-to-bore clearance • Bent connecting rod • Excessive crankshaft bearing clearance • Loose torque converter bolts (if equipped) • Cracked or damaged engine flywheel • Exhaust leak at the exhaust manifold • Combustion chamber deposits
Exhaust System Noise and/or Leakage	Exhaust system noise and/or leakage may be caused by the following conditions: • Improperly installed or misaligned exhaust system components • A cracked or broken exhaust manifold • Damaged or worn exhaust manifold gaskets and/or seals • Burnt or rusted out exhaust system components • Broken or loose exhaust clamps and/or brackets

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Valve Train Diagnosis

General Information

Symptom	Cause
• A light tapping noise at 1/2 engine speed, or any varying frequency, may indicate a valve train problem. • Tapping noises will typically increase with increased engine speed. • Before attempting to diagnose a valve train noise, check for the proper engine oil level and then allow the engine to obtain normal operating temperature. Following this procedure will bring all engine components to a normal state of expansion. • Sit in the driver's seat, then operate the engine at various speeds and listen for any abnormal engine noise.	

General Information (cont'd)

Symptom	Cause
Valve Train Noise	• Low engine oil pressure • A worn or faulty oil pump • A loose or plugged oil pump screen • Loose valve rocker arm attachments (causing excessive valve lash) • A worn or damaged valve rocker arm ball • A worn valve rocker arm and/or valve pushrod • A broken valve spring • Sticking valves • Valve lifters worn, dirty, or faulty • A broken valve lifter guide • Engine camshaft lobes worn • Worn valve guides or valve stems • Worn or damaged valve stem keys • Bent valve pushrods • Excessive play in the camshaft timing chain • Bent, broken, or damaged camshaft sprocket teeth

Diagnostic Table

Step	Action	Value(s)	Yes	No
DEFINITION: A light tapping noise at 1/2 engine speed, or any varying frequency.				
1	Is there valve train noise?	—	Go to Step 2	System OK
2	Check for a high engine oil level. An engine with the engine oil level above the FULL mark on the oil level indicator allows the crankshaft counterweights to churn the engine oil into foam. When the foamy engine oil is pumped into the valve lifters, the valve lifters become noisy. A solid column of engine oil ensures proper valve lifter operation. Is the engine oil level too high?	—	Go to Step 3	Go to Step 4
3	Drain the engine oil to the proper level. Is the tapping noise gone?	—	System OK	Go to Step 6
4	Check for a low engine oil level. An engine with the engine oil level below the ADD mark on the oil level indicator may allow the oil pump to pump air at high engine RPM. Is the engine oil level below the ADD mark on the oil level indicator?	—	Go to Step 5	Go to Step 6
5	Add the engine oil as required. Is the tapping noise gone?	—	System OK	Go to Step 6
6	Check for the proper engine oil pressure. Refer to <i>Engine Mechanical Specifications (L31 (VIN R))</i> and <i>Oil Pressure Diagnosis and Testing</i> . Is the engine oil pressure within specifications?	41.4 kPa (6 psi)	Go to Step 11	Go to Step 7
7	Check the oil pump screen for damage or a loose fit to the oil pump. Is the oil pump screen loose or is the oil pump screen damaged?	—	Go to Step 8	Go to Step 9
8	Repair as required. Is the tapping noise gone?	—	System OK	Go to Step 9

Diagnostic Table (cont'd)

Step	Action	Value(s)	Yes	No
9	Check for a damaged oil pump or loose bolts. Refer to <i>Oil Pump Clean and Inspect</i> . Is the oil pump damaged or are the bolts loose?	—	Go to Step 10	Go to Step 11
10	Repair as required. Is the tapping noise gone?	—	System OK	Go to Step 11
11	Remove and inspect the valve lifters, the valve rocker arms, and the valve pushrods. Refer to <i>Valve Rocker Arm and Push Rods Clean and Inspect</i> and <i>Valve Lifters and Guides Clean and Inspect</i> . Are the components worn or damaged?	—	Go to Step 12	Go to Step 13
12	Replace the components as required. Is the tapping noise gone?	—	System OK	Go to Step 13
13	Perform an engine camshaft lobe lift test. Refer to <i>Camshaft and Bearings Clean and Inspect</i> . Is the engine camshaft lobes within specifications?	—	Go to Step 15	Go to Step 14
14	Replace the engine camshaft and valve lifters. Is the tapping noise gone?	—	System OK	Go to Step 15
15	Remove the engine front cover and inspect the camshaft timing chain and sprockets for excessive wear or damage. Refer to <i>Timing Chain and Sprockets Clean and Inspect</i> . Are the components worn or damaged?	—	Go to Step 17	Go to Step 16
16	Replace the components as required. Is the tapping noise gone?	—	System OK	Go to Step 17
17	Perform a complete disassembly of the engine and inspect all components. Are the components worn or damaged?	—	Go to Step 18	System OK
18	Replace the components as required. Did you complete the worn or damaged component replacement?	—	System OK	—

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Oil Consumption Diagnosis

Excessive oil consumption (not due to leaks) is the use of 1.9 liters (2 quarts) of engine oil within 3 200 kilometers (2,000 miles). However, during initial engine break-in periods 4 828–6 437 kilometers (3,000–4,000 miles) oil consumption may exceed 1.9 liters (2 quarts) or more. The causes of excessive oil consumption include the following conditions:

- External oil leaks. Tighten the bolts and/or replace gaskets and oil seals as necessary.
- Incorrect oil level or improper reading of oil level indicator. With the vehicle on a level surface, allow adequate drain down time and check for the correct oil level.
- Improper oil viscosity. Use recommended SAE viscosity for the prevailing temperatures.
- Continuous high speed driving and/or severe usage.
- Crankcase ventilation system restrictions or malfunctioning components.

- Valve guides and/or valve stem oil seals worn, or the seal omitted. Ream the valve guides and install oversize service valves and/or new valve stem oil seals.
- Piston rings broken, improperly installed, worn, or not seated properly. Allow adequate time for the piston rings to seat. Replace broken or worn piston rings as necessary.
- Piston improperly installed or miss-fitted.

SIE-ID - 23360

Oil Pressure Diagnosis and Testing

1. With the vehicle on a level surface, allow adequate drain down time (2–3 minutes) and measure for a low engine oil level.

Add the recommended grade engine oil, and fill the crankcase until the oil level measures FULL on the oil level indicator.

2. Operate the engine and verify low or no oil pressure on the vehicle oil pressure gauge or the oil indicator light.

Listen for a noisy valve train or a knocking noise.

3. Inspect for the following:
 - Engine oil diluted by moisture or unburned fuel mixtures
 - Improper engine oil viscosity for the expected temperature
 - Incorrect or faulty oil pressure gauge sensor
 - Incorrect or faulty oil pressure gauge
 - Plugged oil filter
 - Malfunctioning oil filter bypass valve
4. Remove the oil pressure gauge sensor or another engine block oil gallery plug.
5. Install an oil pressure gauge and then measure the engine oil pressure.
6. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
 - Oil pump worn or dirty
 - Malfunctioning oil pump pressure relief valve
 - Oil pump screen loose, plugged, or damaged
 - Excessive bearing clearance
 - Cracked, porous or restricted oil galleries
 - Engine block oil gallery plugs missing or incorrectly installed
 - Broken valve lifters

SIE-ID - 204344

Oil Leak Diagnosis

Step	Action	Value(s)	Yes	No
DEFINITION: You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.				
1	1. Operate the vehicle until it reaches normal operating temperature. Refer to <i>Engine Mechanical Specifications</i> . 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait (15 minutes). 4. Check for drippings. 5. Are drippings present?	—	Go to Step 2	Go to Step 3
2	1. Identify the type of fluid and the approximate location of the leak. 2. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 3
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 4

Oil Leak Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait (15 minutes). 5. Identify the type of fluid, and the approximate location of the leak. 6. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 5
5	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 6
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder (baby powder, foot powder, etc.) to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. 5. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 7
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 8
8	1. Using the J 28428-E, Dye and Light Kit, identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. 2. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 12

Oil Leak Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
10	1. Check for the following conditions: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Is there mechanical damage to the engine?	—	Go to Step 11	—
11	Repair or replace all damaged components.	—	Go to Step 1	—
12	System OK.	—	—	—

SIE-ID - 371679

Drive Belt Diagnosis

Definitions

The following are symptomatic noises of the drive belt system:

Chirping

The following items are indications of chirping:

- A high pitched noise that is usually heard once per revolution of a pulley or a belt.
- It is most common on cold, damp mornings.
- Verify this condition by squirting water onto the belt. The noise will momentarily stop.

Squeal

The following items are indications of squeal:

- A loud screeching noise that is caused by a slipping belt (this is unusual for a belt with multiple ribs).
- The noise occurs when a heavy load is applied to the belt, such as an air conditioning compressor engagement, snapping the throttle, or slipping on a seized pulley.

Whine

A high pitched continuous noise that may be caused by a failed bearing.

Faint Cycle Rumbling

A low frequency noise heard once per revolution of the drive belt.

Pilling

The following items are indications of pilling:

- The random accumulation of rubber dust in the bottom of the multi-ribbed belt grooves.
- A small amount of pilling is normal.
- Operation of the drive belt system will not be effected unless the buildup exceeds one third (1/3) of the belt groove depth.

Multiple-ribbed type drive belts wear evenly with their

pulleys. Unusual wear indicates a correction is needed. The following diagnostic tables will aid in diagnosing drive belt system conditions.

Drive Belt Diagnosis

Step	Action	Value(s)	Yes	No
1	Check for misalignment of the pulleys. Are any of the pulleys misaligned?	—	Go to Step 2	Go to Step 3
2	Replace any misaligned pulleys. Is the chirp still present?	—	Go to Step 3	System OK
3	Check for bent or cracked brackets. Are there any bent or cracked brackets?	—	Go to Step 4	Go to Step 5
4	Replace any bent or cracked brackets. Is the chirp still present?	—	Go to Step 5	System OK
5	Check for any loose or missing fasteners. Are there any loose or missing fasteners?	—	Go to Step 6	Go to Step 7
6	Tighten any loose fasteners and properly install any missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . Is the chirp still present?	—	Go to Step 7	System OK
7	Check for a bent pulley flange. Is the pulley flange bent?	—	Go to Step 8	Go to Step 9
8	Replace the pulley flange. Is the chirp still present?	—	Go to Step 9	System OK
9	Check for severe pilling, exceeding 1/3 of the belt groove depth. Is there severe pilling?	—	Go to Step 10	—
10	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> . Is the chirp still present?	—	—	System OK

Drive Belt Squeal

Step	Action	Value(s)	Yes	No
11	Check for a misaligned pulley. Is there a pulley misaligned?	—	Go to Step 13	Go to Step 12
12	Check for incorrect belt length. Refer to <i>Drive Belt Replacement</i> . Is the belt length correct?	—	Go to Step 14	Go to Step 15
13	Repair or install new parts as necessary. Is the repair complete?	—	System OK	—
14	Check for a malfunctioning drive belt tensioner. Refer to <i>Drive Belt Tensioner Diagnosis</i> . Is the tensioner malfunctioning?	—	Go to Step 13	Go to Step 15
15	Check for correct pulley size. Are the pulleys the correct size?	—	Go to Step 16	Go to Step 13
16	Check for seized bearings. Is there a seized bearing?	—	Go to Step 13	System OK

Drive Belt Whine

Step	Action	Value	Yes	No
17	Check for a worn accessory component bearing. Is a bearing making the noise?	—	Go to Step 18	System OK
18	Install new parts as necessary. Is the repair complete?	—	System OK	—

Drive Belt Rumbling

Step	Action	Value(s)	Yes	No
19	Check for severe pilling. Is there severe pilling of more than 1/3 of the rib depth?	—	Go to Step 19	System OK
20	Clean the drive belt pulleys. Are the drive belt pulleys clean?	—	Go to Step 20	Go to Step 21
21	Install a new drive belt. Is the repair complete?	—	System OK	—

Drive Belt Vibration

Step	Action	Value(s)	Yes	No
22	Check for loose or missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . Are there loose or missing fasteners?	—	Go to Step 22	Go to Step 24
23	Re-tighten or replace as necessary. Is the repair complete?	—	System OK	—
24	Check for damaged fan blades. Are there damaged fan blades?	—	Go to Step 25	Go to Step 26
25	Replace as necessary. Refer to Fan Blade Replacement in Engine Cooling. Is the replacement complete?	—	System OK	—
26	Check for a bent fan clutch or coolant pump shaft. Is the fan clutch or coolant pump shaft bent?	—	Go to Step 27	Go to Step 28
27	Replace as necessary. Refer to Water Pump Replacement in Engine Cooling. Is the repair complete?	—	System OK	—
28	Check for bent or cracked brackets. Are there bent or cracked brackets?	—	Go to Step 29	System OK
29	Replace the brackets as necessary. Is the repair complete?	—	System OK	—

Drive Belt Falls Off

Step	Action	Value(s)	Yes	No
30	Check for a misaligned or a bent pulley. Are the pulleys misaligned?	—	Go to Step 31	Go to Step 32
31	Replace any misaligned or bent pulleys. Does the drive belt continue to fall off?	—	Go to Step 32	System OK
32	Check for a bent or a cracked bracket. Are any of the brackets bent or cracked?	—	Go to Step 33	Go to Step 34
33	Replace the damaged brackets. Does the drive belt continue to fall off?	—	Go to Step 34	System OK
34	Check for loose or missing fasteners. Are there any loose or missing fasteners?	—	Go to Step 35	Go to Step 36
35	Replace any missing fasteners and tighten to specifications. Refer to <i>Fastener Tightening Specifications</i> . Does the drive belt continue to fall off?	—	Go to Step 36	System OK
36	Check for a misaligned power steering pump pulley. Is the power steering pump pulley misaligned?	—	Go to Step 37	Go to Step 38

Drive Belt Falls Off (cont'd)

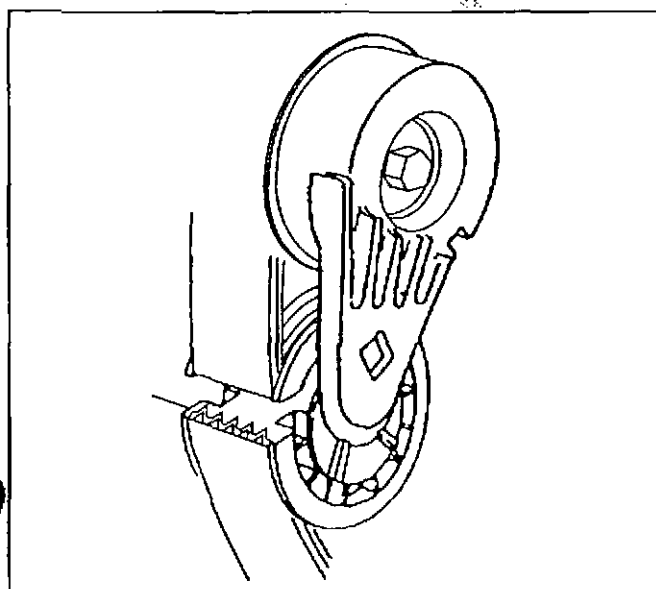
Step	Action	Value(s)	Yes	No
37	Realign or replace the power steering pump pulley. Refer to <i>Power Steering Pump Replacement in Power Steering</i> . Does the drive belt continue to fall off?	—	Go to Step 38	System OK
38	Check for a damaged drive belt. Is the drive belt damaged?	—	Go to Step 39	Go to Step 40
39	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> . Does the drive belt continue to fall off?	—	Go to Step 40	System OK
40	Check for a malfunctioning drive belt tensioner. Is the drive belt tensioner malfunctioning?	—	Go to Step 41	Go to Step 42
41	Replace the drive belt tensioner. Does the drive belt continue to fall off?	—	Go to Step 42	System OK
42	Check for worn idler or tensioner pulley bearings. Are the idler or tensioner pulley bearings worn?	—	Go to Step 43	—
43	Replace the worn bearings. Does the drive belt continue to fall off?	—	—	System OK

Drive Belt Diagnosis

Step	Action	Value(s)	Yes	No
44	Check to see if the ribs in the drive belt do not match the grooves in the pulley. Do the ribs in the drive belt match the grooves in the pulley?	—	—	Go to Step 45
45	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> . Is there still excessive wear in either outside groove of the drive belt?	—	—	System OK

General Instructions

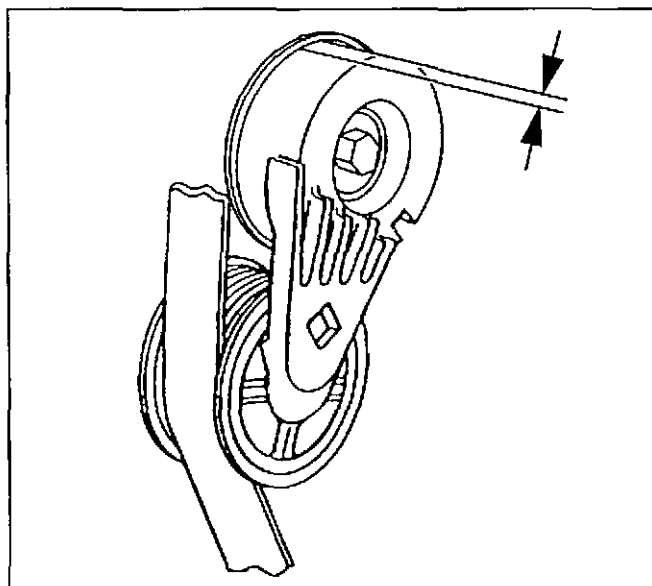
The following graphics illustrate the correct way to route the drive belt over the pulleys, and some examples of incorrect belt placement.



172992

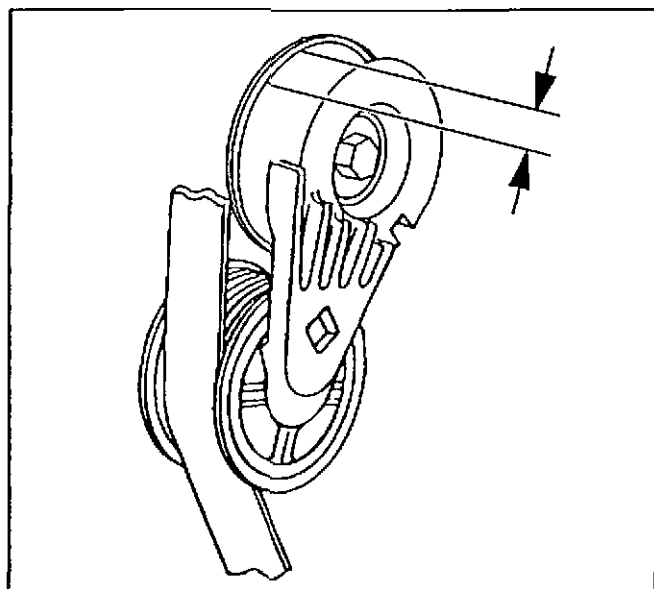
1. Observe the drive belt correctly installed on the

pulley. Each groove on the drive belt rests inside a matching groove in the pulley.



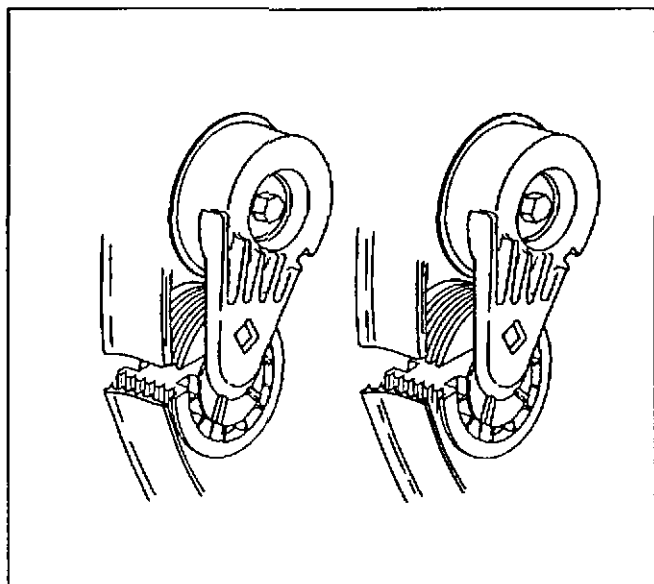
172989

2. When installing a new drive belt, observe the indicator on the tensioner. A new drive belt should fall inside this range.



172991

3. When installing a used drive belt, observe the indicator on the tensioner. A used drive belt should fall inside this range.



172993

4. Observe these incorrectly installed drive belts: Avoid mis-positioning the belt by one or more grooves.

SIE-ID - 332331

Drive Belt Tensioner Diagnosis

Inspection Procedure

Notice: SIO-ID - 3753 Allowing the drive belt tensioner to snap into the free position may result in damage to the tensioner.

1. Remove the drive belt. Refer to *Drive Belt Replacement*.
2. Position a hex-head socket on the belt tensioner pulley bolt head.
3. Move the belt tensioner through it's full travel.
 - The movement should feel smooth.

- There should be no binding.
 - The drive belt tensioner should return freely.
4. If any binding is observed, replace the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement*.
 5. Install the drive belt. Refer to *Drive Belt Replacement*.

Important: Please note that movement of the Drive Belt Tensioner while the engine is operating is considered a normal operating condition. The Drive Belt Tensioner should not be replaced for this normal operating condition.

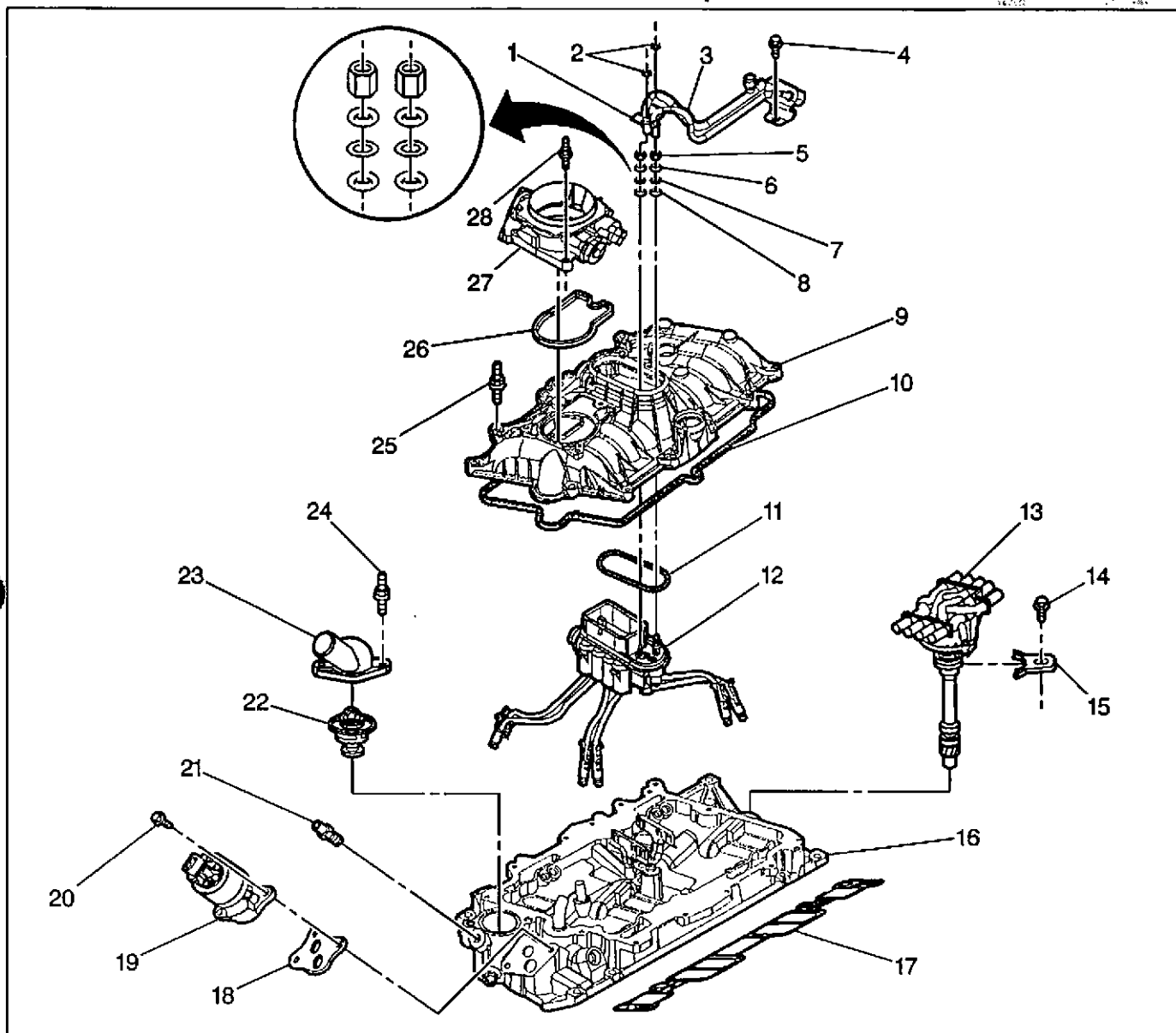
Visual Identification

SIE-ID - 348556

Disassembled Views

SIO-ID - 67224

Intake Manifolds and Components



66997

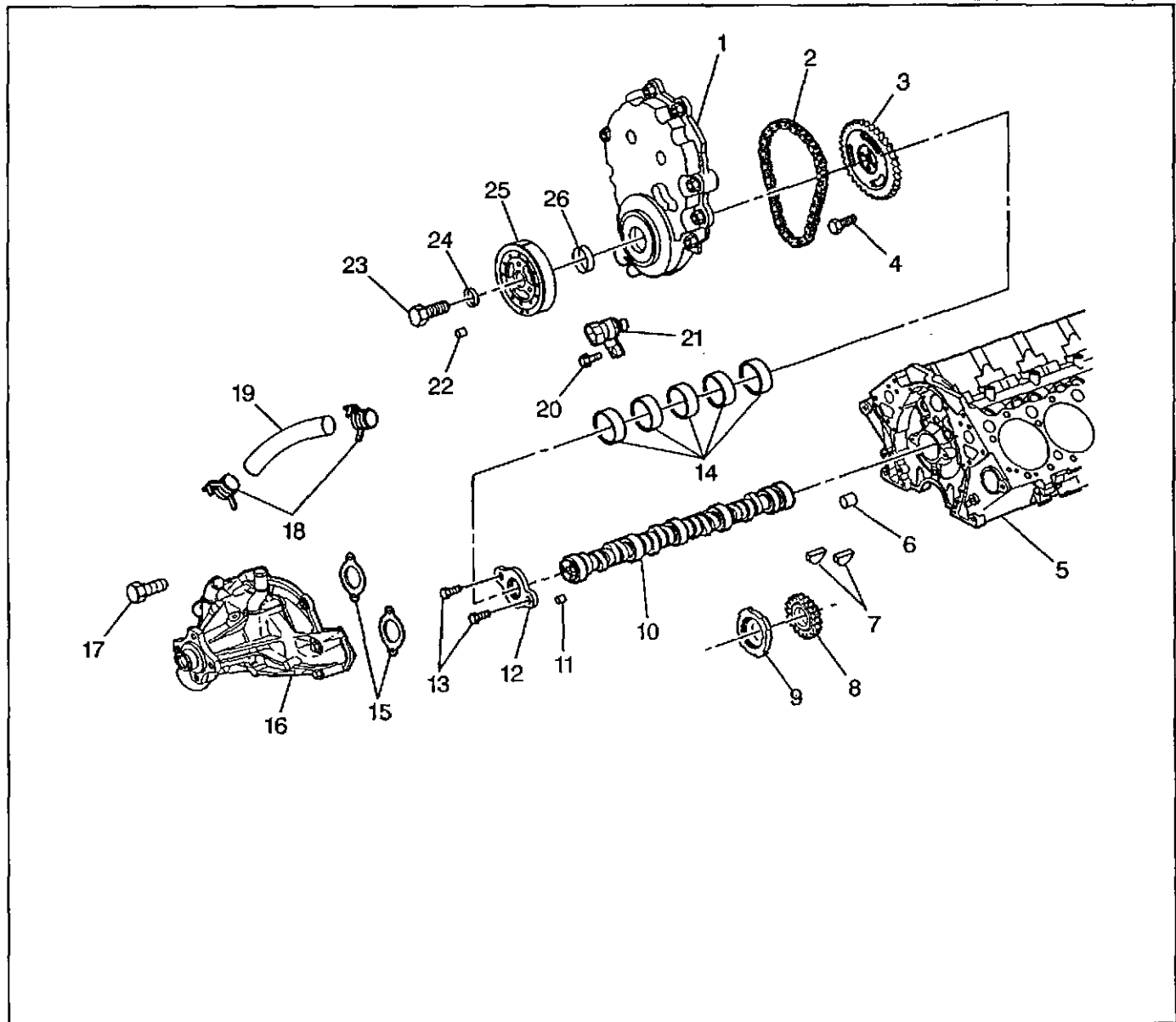
Legend

- | | |
|---|-----------------------------------|
| (1) Fuel Pipe Retainer Bracket | (12) TBI Fuel Meter |
| (2) Fuel Pipe Retainer Bracket Nuts | (13) Distributor |
| (3) Fuel Pipe | (14) Hex Bolt (Distributor Clamp) |
| (4) Fuel Pipe Attachment Screw | (15) Distributor Clamp |
| (5) Fuel Seal Retainer | (16) Lower Intake Manifold |
| (6) Fuel Seal (Yellow O-ring) | (17) Lower Intake Manifold Gasket |
| (7) Spacer Ring (Flat Washer) | (18) EGR Valve Gasket |
| (8) Fuel Seal (Black O-ring) | (19) EGR Valve |
| (9) Upper Intake Manifold | (20) EGR Valve Bolt |
| (10) Upper Intake Manifold to Lower Intake Gasket | (21) Engine Coolant Sensor |
| (11) Fuel Meter Body Seal | (22) Engine Coolant Thermostat |

- (23) Water Outlet
- (24) Water Outlet Stud
- (25) Upper Intake Manifold Stud
- (26) Throttle Body Gasket
- (27) Throttle Body
- (28) Throttle Body Attaching Stud

SIO-ID - 197523

Front of Engine



182828

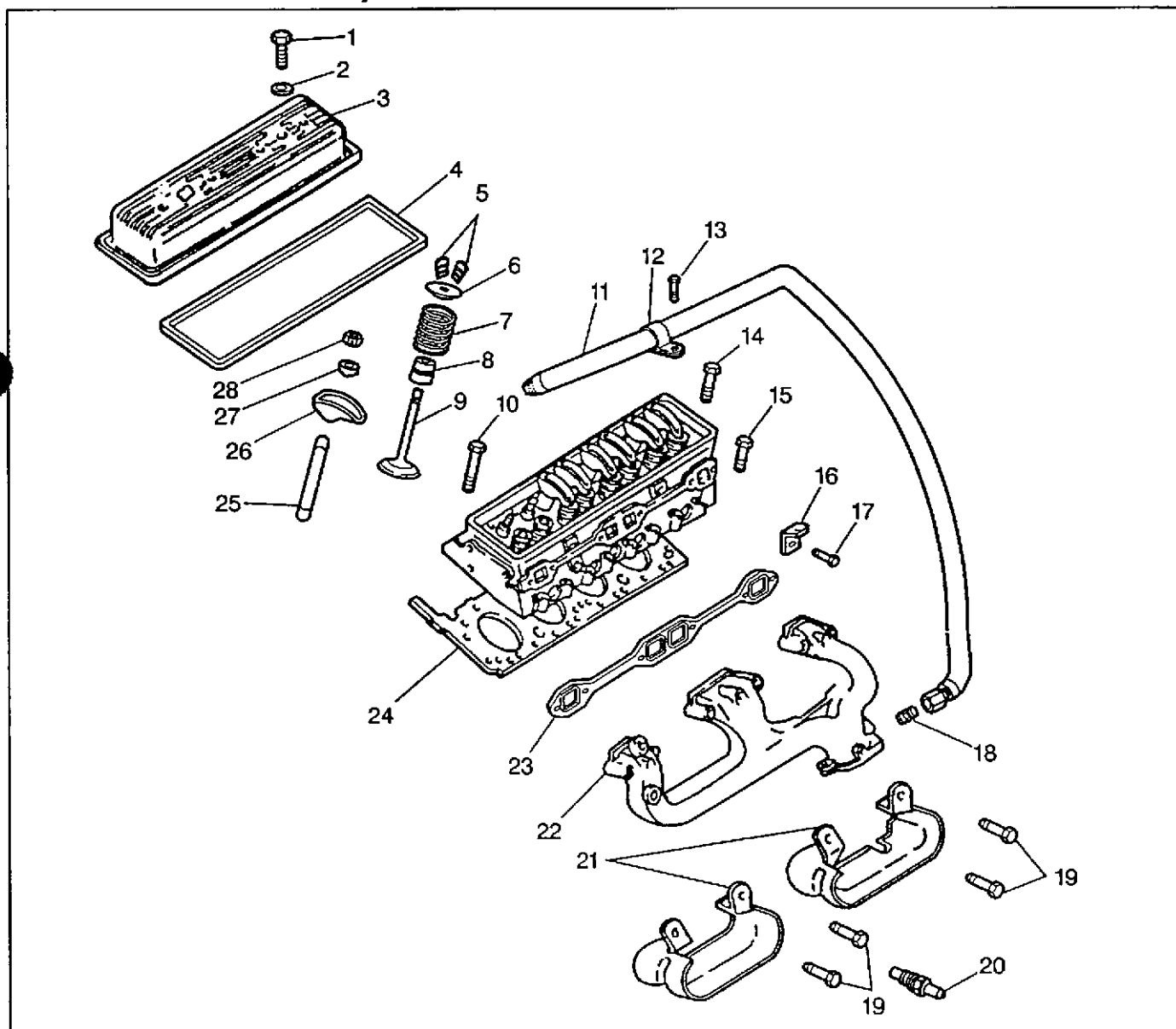
Legend

- | | |
|--|---------------------------------------|
| (1) Engine Front Cover | (9) Crankshaft Position Reluctor Ring |
| (2) Camshaft Timing Chain | (10) Engine Camshaft |
| (3) Camshaft Sprocket | (11) Camshaft Sprocket Locator Pin |
| (4) Camshaft Sprocket Bolt | (12) Camshaft Retainer |
| (5) Engine Block | (13) Camshaft Retainer Bolt |
| (6) Engine Block Oil Gallery Plug | (14) Camshaft Bearings |
| (7) Woodruff Key (Crankshaft Balancer) | (15) Water Pump Gasket |
| (8) Crankshaft Sprocket | (16) Water Pump |

- (17) Water Pump Bolt
- (18) Water Pump Inlet Hose Clamp
- (19) Water Pump Inlet Hose
- (20) Crankshaft Position Sensor Bolt
- (21) Crankshaft Position Sensor
- (22) Front Groove Pin (Crankshaft Balancer)
- (23) Crankshaft Balancer Bolt
- (24) Crankshaft Balancer Bolt Washer
- (25) Crankshaft Balancer
- (26) Crankshaft Front Oil Seal

SIO-ID - 197712

Cylinder Head and Exhaust Manifold Area



182825

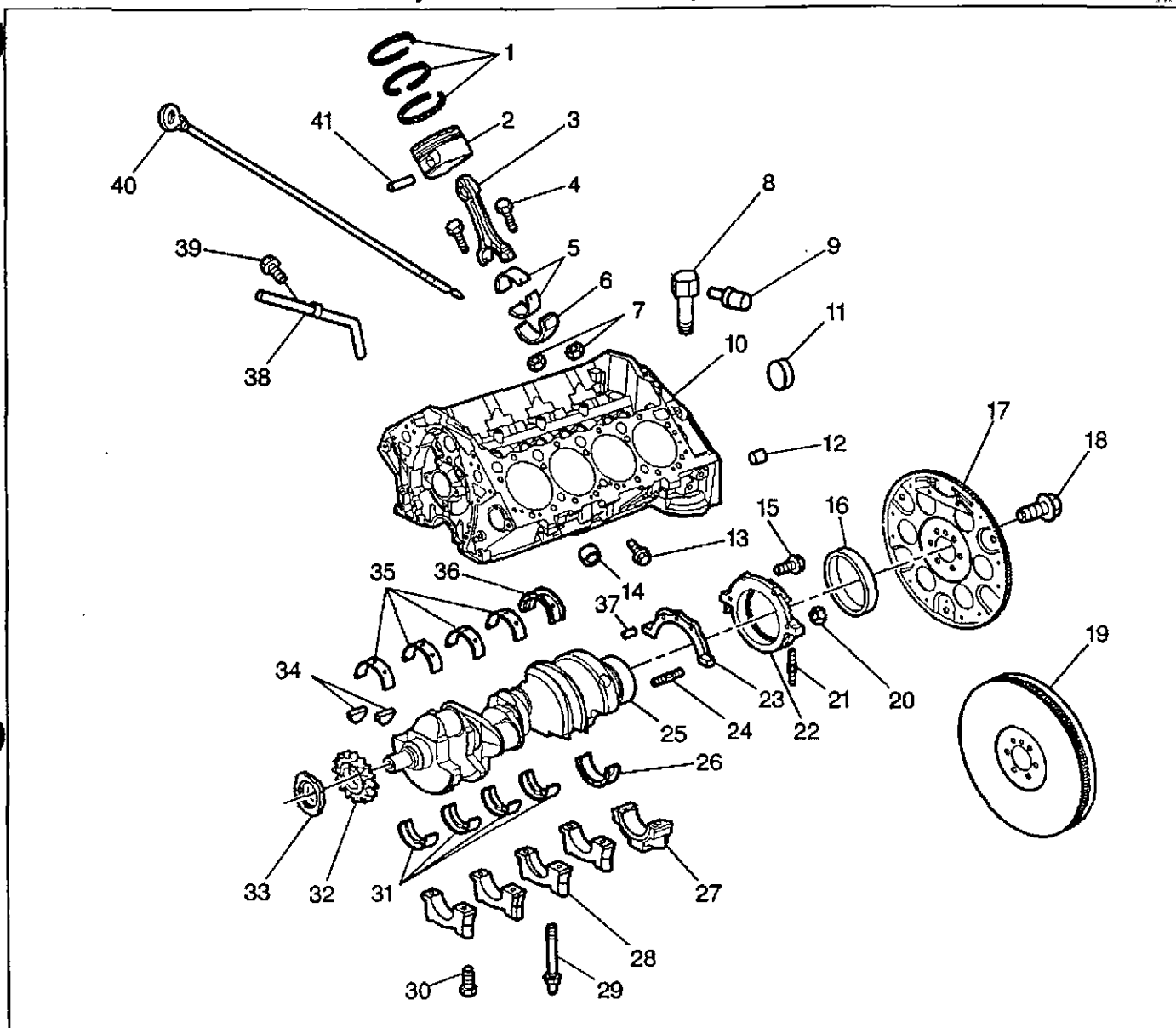
Legend

- | | |
|--|-------------------------|
| (1) Valve Rocker Arm Cover Bolt | (5) Valve Stem Keys |
| (2) Valve Rocker Arm Cover Bolt Washer | (6) Valve Spring Cap |
| (3) Valve Rocker Arm Cover | (7) Valve Spring |
| (4) Valve Rocker Arm Cover Gasket | (8) Valve Stem Oil Seal |

- (9) Valve
- (10) Cylinder Head Bolt (Long)
- (11) EGR Valve Pipe
- (12) EGR Valve Pipe Clamp
- (13) EGR Valve Pipe Clamp Bracket Bolt
- (14) Cylinder Head Bolt (Medium)
- (15) Cylinder Head Bolt (Short)
- (16) Spark Plug Wire Support Bracket
- (17) Spark Plug Wire Support Bracket Bolt
- (18) EGR Valve Pipe Fitting
- (19) Exhaust Manifold Bolts
- (20) Engine Coolant Temperature (ECT) Gauge Sensor
- (21) Spark Plug*Wire Shields
- (22) Exhaust Manifold
- (23) Exhaust Manifold Gasket
- (24) Cylinder Head Gasket
- (25) Valve Pushrod
- (26) Valve Rocker Arm
- (27) Valve Rocker Arm Ball
- (28) Valve Rocker Arm Nut

SIO-ID - 348439

Cylinder Block and Components



317429

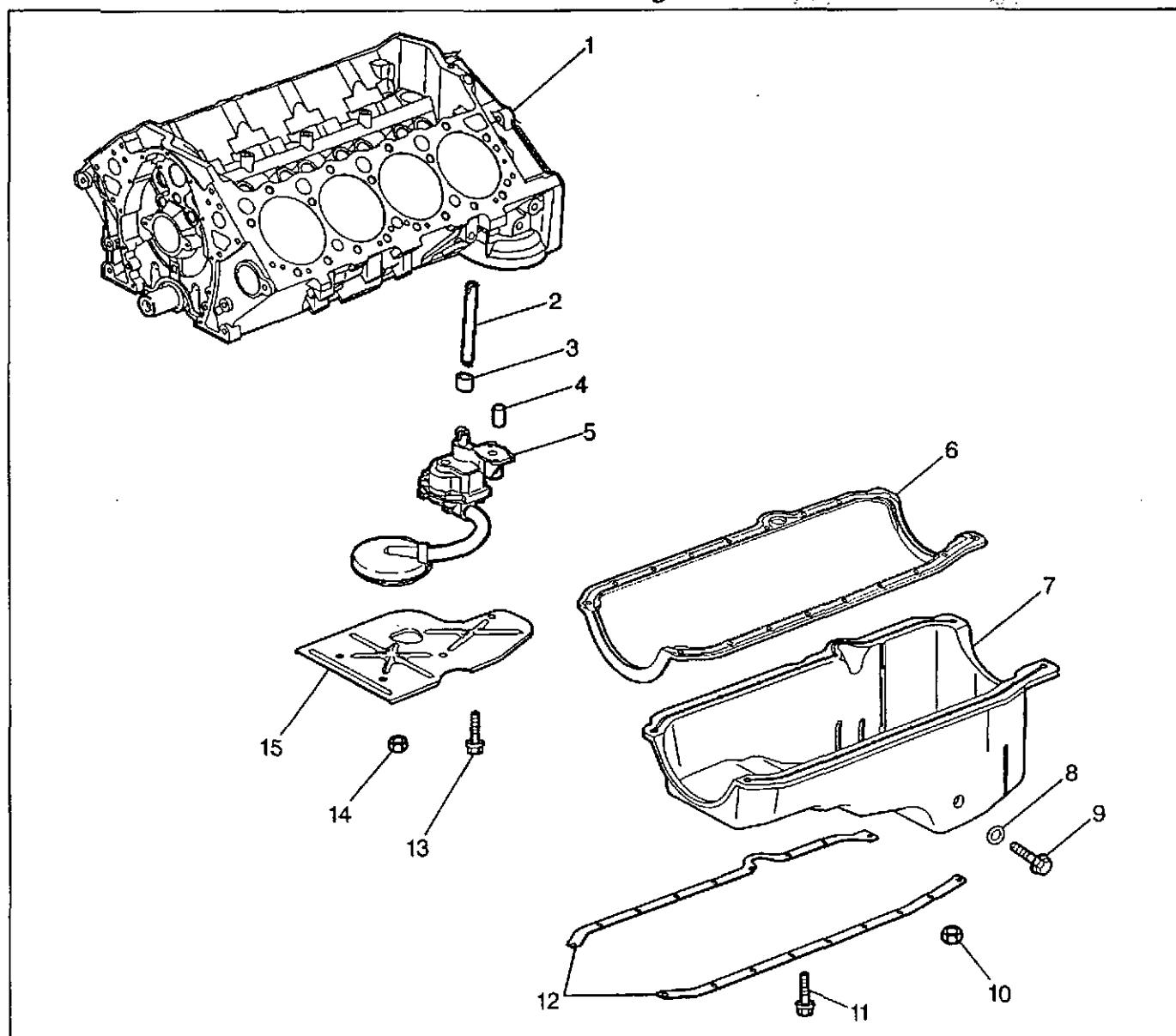
Legend

- | | |
|--|---|
| (1) Piston Ring Kit | (16) Crankshaft Rear Oil Seal |
| (2) Piston | (17) Engine Flywheel (Automatic Transmission) |
| (3) Connecting Rod | (18) Flywheel Bolt |
| (4) Connecting Rod Bolt | (19) Engine Flywheel (Manual Transmission) |
| (5) Connecting Rod Bearings | (20) Crankshaft Rear Oil Seal Housing Nut |
| (6) Connecting Rod Cap | (21) Crankshaft Rear Oil Seal Housing Stud |
| (7) Hex Nut (Connecting Rod) | (22) Crankshaft Rear Oil Seal Housing |
| (8) Engine Oil Pressure Gauge Sensor Fitting | (23) Crankshaft Rear Oil Seal Housing Gasket |
| (9) Engine Oil Pressure Gauge Sensor | (24) Crankshaft Rear Oil Seal Housing Stud |
| (10) Engine Block | (25) Crankshaft |
| (11) Expansion Cup Plug (Camshaft Rear Bearing Hole) | (26) Crankshaft Bearing (Rear Thrust Bearing) |
| (12) Dowel Straight Pin (Transmission Locator) | (27) Crankshaft Bearing Cap (Rear) |
| (13) Engine Block Coolant Drain Hole Plug | (28) Crankshaft Bearing Cap |
| (14) Engine Block Core Hole Plug | (29) Crankshaft Bearing Cap Stud |
| (15) Crankshaft Rear Oil Seal Housing Bolt | (30) Crankshaft Bearing Cap Bolt |
| | (31) Crankshaft Bearings |

- (32) Crankshaft Sprocket
- (33) Crankshaft Position Sensor Reluctor Ring
- (34) Woodruff Keys (Crankshaft Balancer)
- (35) Crankshaft Bearing
- (36) Crankshaft Bearing (Rear Thrust Bearing)
- (37) Spring Type S Pin (Crankshaft Rear Oil Seal Housing Locator)
- (38) Oil Level Indicator Tube
- (39) Oil Level Indicator Tube Bolt
- (40) Oil Level Indicator
- (41) Piston Pin

SIO-10 - 197524

Bottom of Engine

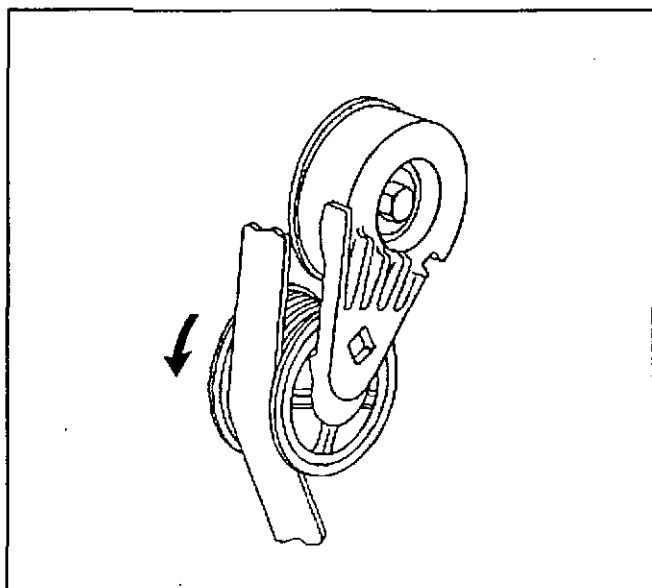


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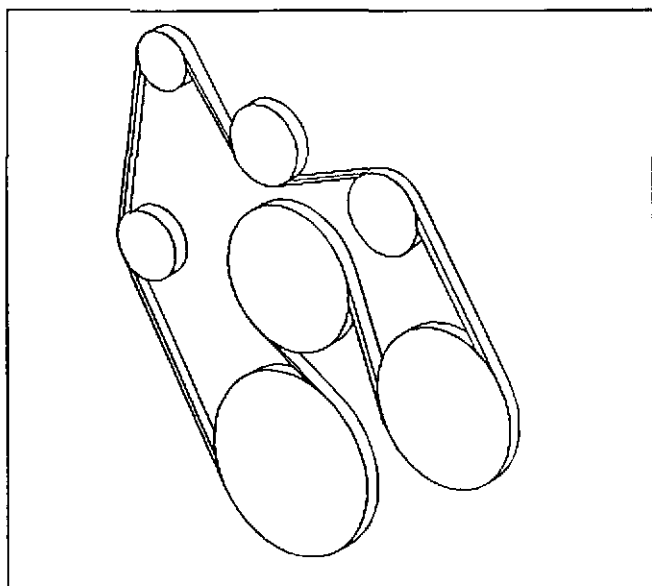
Legend

- | | |
|----------------------------------|--------------------------------------|
| (1) Engine Block | (5) Oil Pump |
| (2) Oil Pump Driveshaft | (6) Oil Pan Gasket |
| (3) Oil Pump Driveshaft Retainer | (7) Oil Pan |
| (4) Pin (Oil Pump Locator) | (8) Oil Pan Drain Plug Seal (O-ring) |

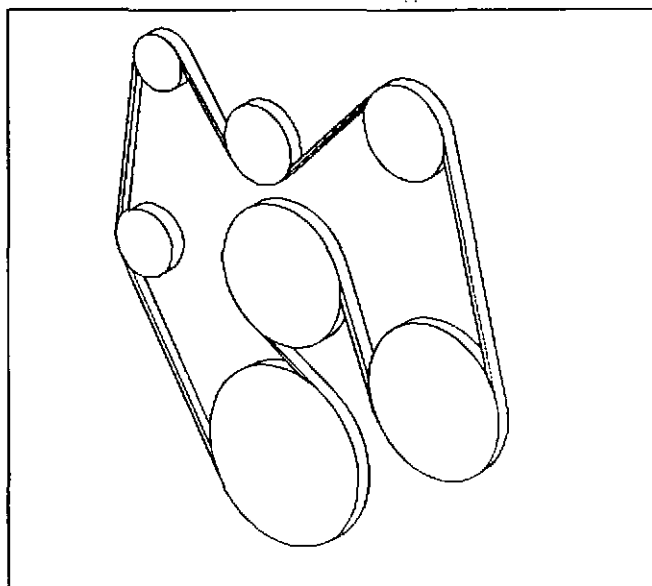
- (9) Oil Pan Drain Plug
 - (10) Oil Pan Nut
 - (11) Oil Pan Bolt
 - (12) Oil Pan Reinforcement
 - (13) Crankshaft Oil Deflector Bolt
 - (14) Crankshaft Oil Deflector Nut
 - (15) Crankshaft Oil Deflector
-



177620



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43859

Repair Instructions

SIE-ID = 332317

Drive Belt Replacement

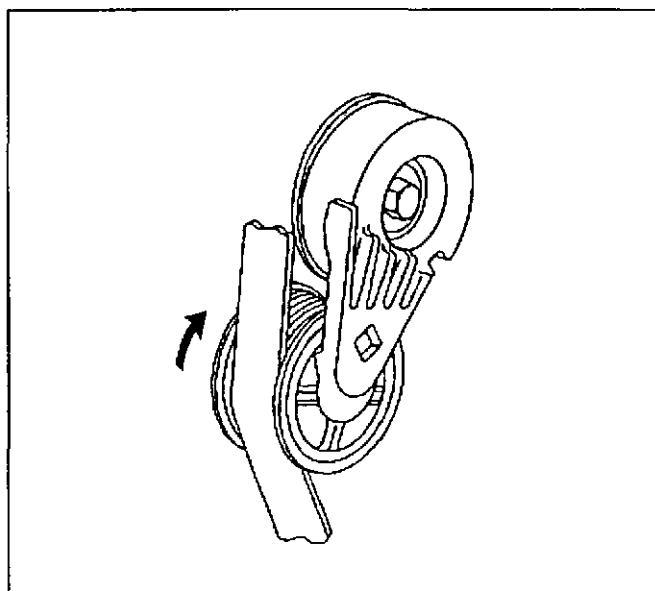
Removal Procedure

1. Install a 3/8 inch drive wrench on the drive belt tensioner and rotate the arm counterclockwise.
2. Remove the drive belt.
3. Slowly release the tension on the drive belt tensioner.

Installation Procedure

1. Route the belt over all the pulleys except the drive belt tensioner.
2. Observe belt routing for vehicles without air conditioning.
3. Observe belt routing for vehicles with air conditioning.

4. Install a 3/8 inch drive wrench on the drive belt tensioner and rotate the arm counterclockwise.
5. Install the belt over the drive belt tensioner pulley.
6. Slowly release the tension on the drive belt tensioner.
7. Confirm that the belt is properly routed.



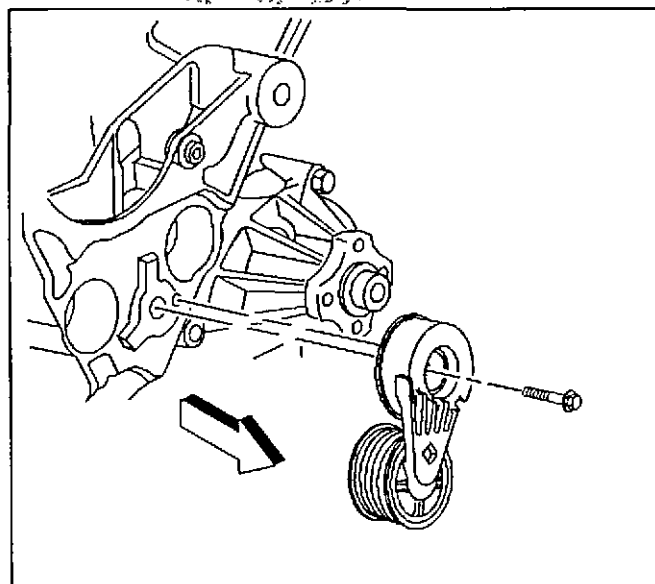
177622

SIE-ID - 332333

Drive Belt Tensioner Replacement

Removal Procedure

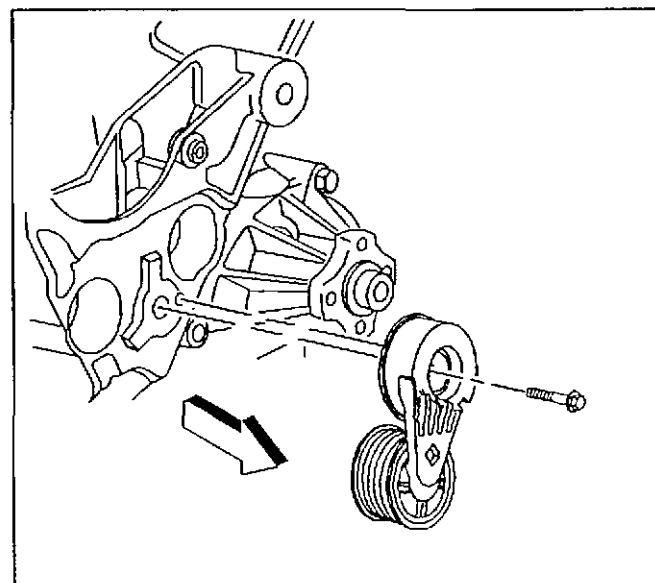
1. Remove the drive belt. Refer to *Drive Belt Replacement*.
2. Remove the bolt.
3. Remove the drive belt tensioner.



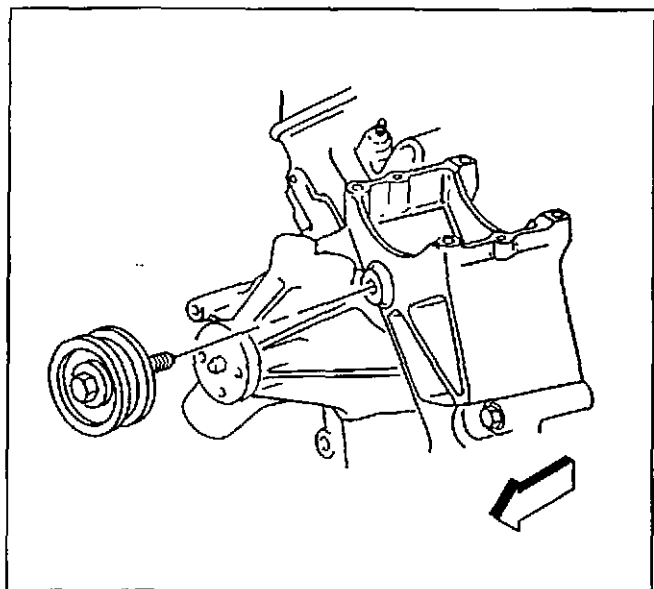
43854

Installation Procedure

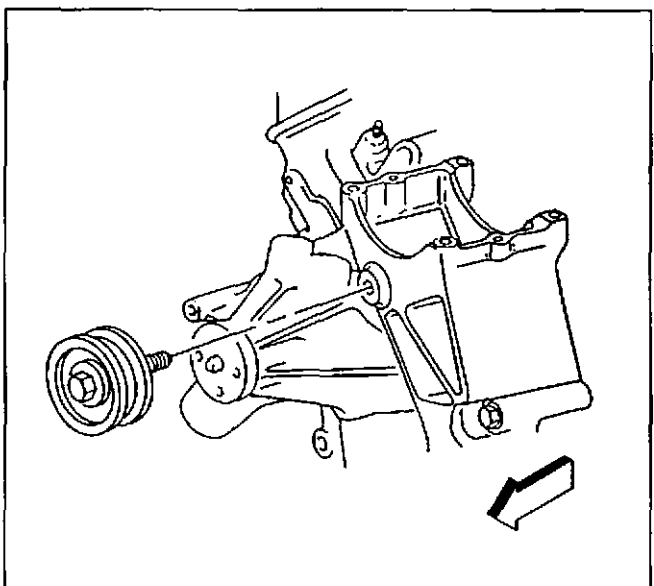
1. Install the belt tensioner assembly.
Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the attaching bolt.
Tighten
 Tighten the drive belt tensioner assembly bolt to 50 N·m (37 lb ft).
3. Install the drive belt. Refer to *Drive Belt Replacement* (ERROR - NOT IN CURRENT PSD).



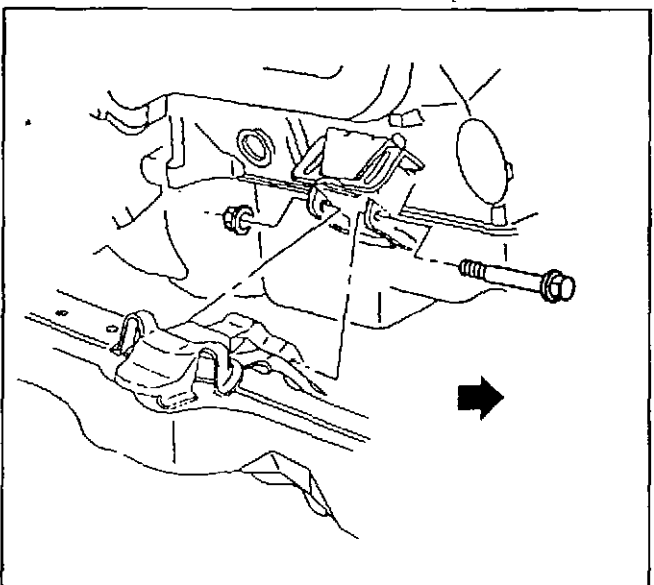
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188927



188927



4564

SIE-ID - 332337

Drive Belt Idler Pulley Replacement

Removal Procedure

1. Remove the drive belt. Refer to *Drive Belt Replacement*.
2. Remove the belt idler pulley bolt.
3. Remove the belt idler pulley.

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the belt idler pulley and bolt to the power steering bracket.

Tighten

Tighten the bolt to 50 N·m (37 lb ft).

2. Install the drive belt. Refer to *Drive Belt Replacement*.

SIE-ID - 332340

Engine Mount Inspection (Front)

Notice: SIO-ID - 5167 Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

Notice: SIO-ID - 221323 When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Lifting the engine in an unapproved manner may cause component damage.

1. Raise the engine in order to complete the following tasks:
 - Remove weight from the mount.
 - Place a slight tension on the rubber cushion.
 - Observe the mount while raising the engine.
2. Replace the mount if the following conditions

exist:

- Heat check cracks cover the hard rubber surface
 - The rubber cushion is separated from the metal plate of the mount
 - There is a split through the rubber cushion.
3. If the mount is loose, lower the engine and tighten the bolts or the nuts to the engine frame or the bracket. Refer to *Fastener Tightening Specifications*.

SIE-ID = 332362

Engine Mount Replacement (Front C Model)

SIO-ID = 67154

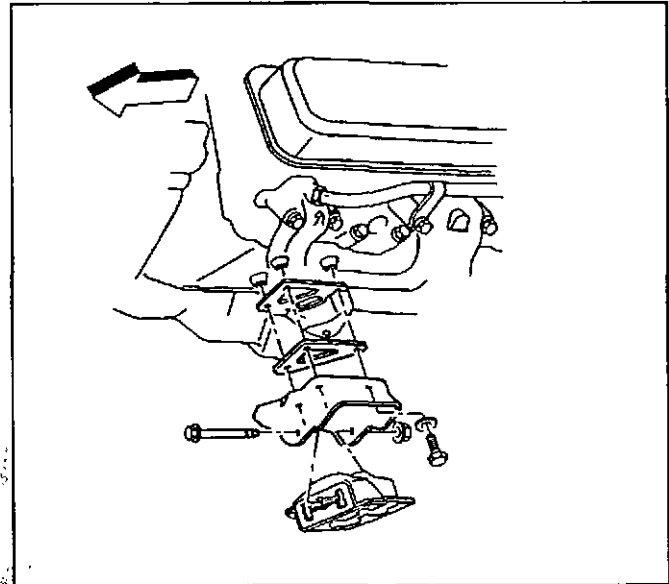
Removal Procedure

Notice: SIO-ID = 16639 When supporting the engine to replace a mounting, raise the engine only to the height required to provide clearance for mounting removal. It may be necessary to drain the cooling system and disconnect hoses to avoid damage when the engine is raised. Be careful that control linkage and wiring are not damaged from raising the engine. When replacing a single front mounting, both mountings, should be detached before attempting to raise the engine. Failure to do this will place excessive stress on the attached mounting when the engine is raised.

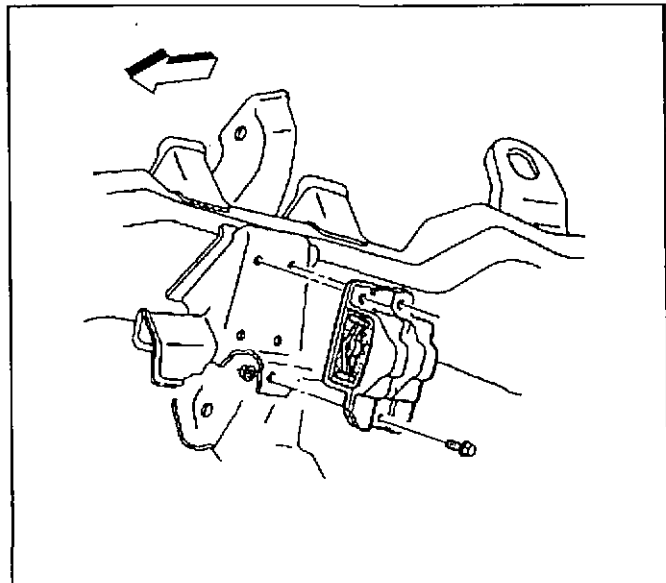
1. Support the engine with a suitable jack. Do not load the engine mounting.

Notice: SIO-ID = 16544 Raise the engine to allow sufficient clearance. Distributor damage results from interference between the rear of the engine and the dash panel.

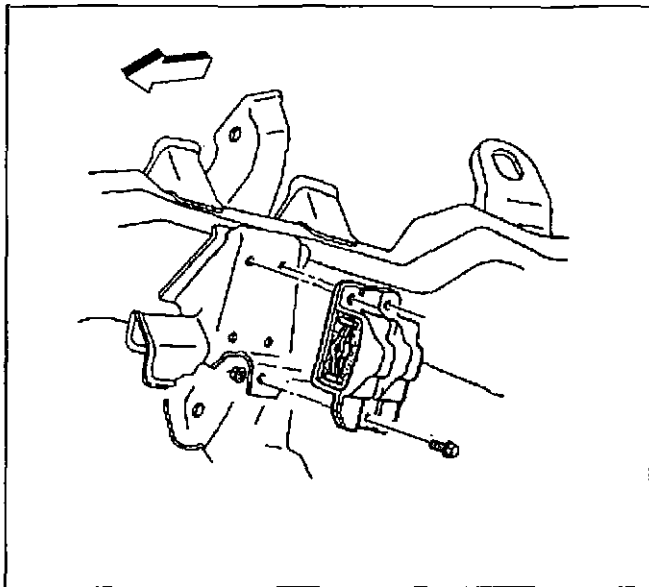
2. Raise the engine only enough in order to permit removal of the engine mounting.
Remove the engine mounting through-bolt and nut.
3. Remove the mounting assembly bolts, nuts, and washers.
4. Remove the mounting assembly.



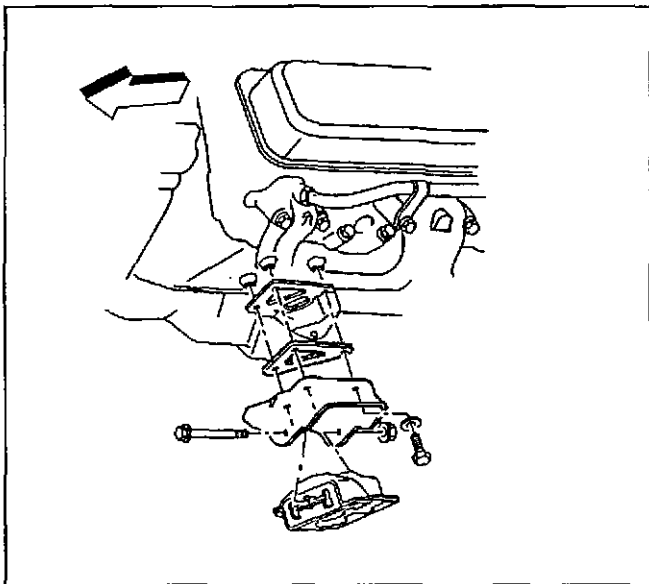
66191



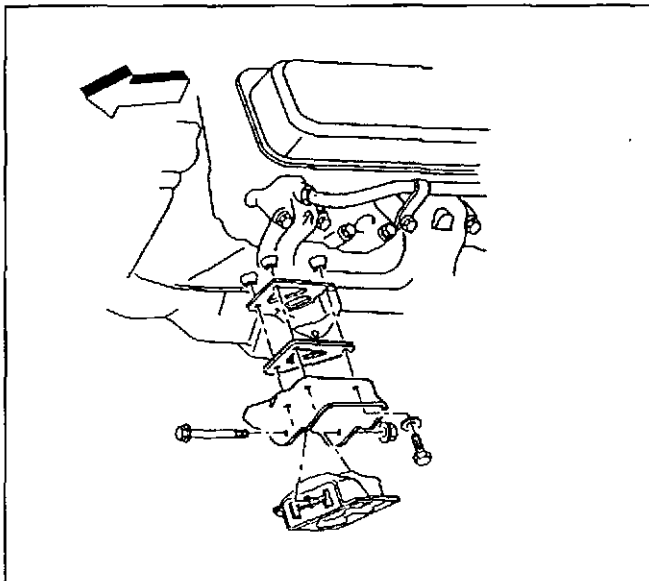
66190



66190



66191



66191

SIO-ID - 67155

Installation Procedure

1. Install the mounting assembly.
2. Install the mounting assembly bolts, nuts, and washers.

Tighten

- Tighten the bolts to 59 N·m (44 lb·ft).
- Tighten the nuts to 45 N·m (33 lb·ft).

Notice: Refer to *Fastener Notice* in General Information.

3. Install the engine mount through-bolt and nut.
- 3.1. Lower the engine until the bolt can be inserted.
- 3.2. Install the through-bolt nut.

Tighten

Tighten the nut to 68 N·m (50 lb·ft).

SIE-ID - 332376

Engine Mount Replacement (Front C Model)

SIO-ID - 67151

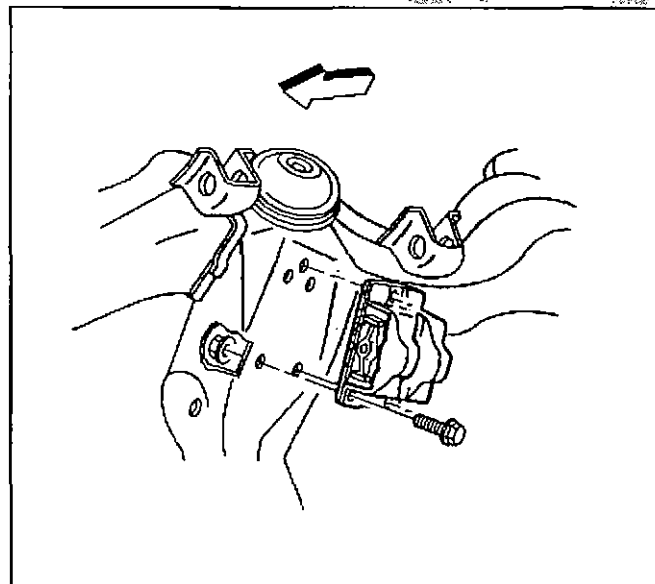
Removal Procedure

Notice: SIO-ID - 18639 When supporting the engine to replace a mounting, raise the engine only to the height required to provide clearance for mounting removal. It may be necessary to drain the cooling system and disconnect hoses to avoid damage when the engine is raised. Be careful that control linkage and wiring are not damaged from raising the engine. When replacing a single front mounting, both mountings should be detached before attempting to raise the engine. Failure to do this will place excessive stress on the attached mounting when the engine is raised.

1. Support the engine with a suitable jack. Do not load the engine mounting.

Notice: SIO-ID - 16544 Raise the engine to allow sufficient clearance. Distributor damage results from interference between the rear of the engine and the dash panel.

2. Raise the engine only enough to permit removal of the engine mounting.
3. Remove the engine mounting through-bolt and the nut.
4. Remove the mounting assembly bolts, nuts, and washers.
5. Remove the mounting assembly.



66189

SIO-ID - 67153

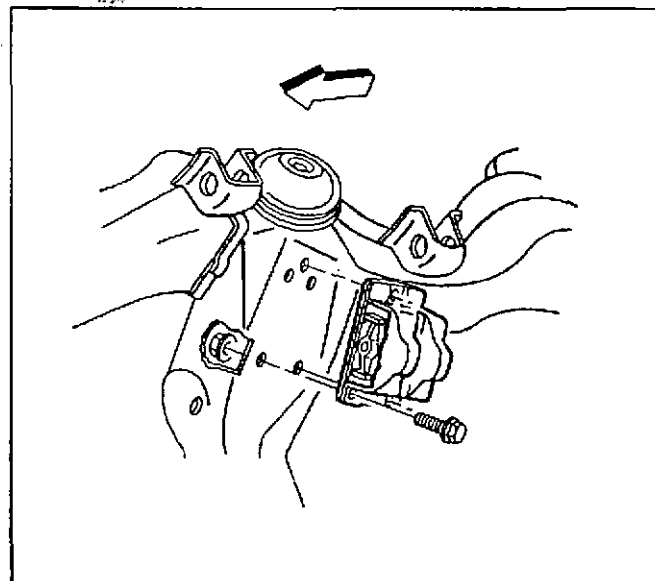
Installation Procedure

1. Install the mounting assembly.
2. Install the mounting assembly bolts, nuts, and washers.

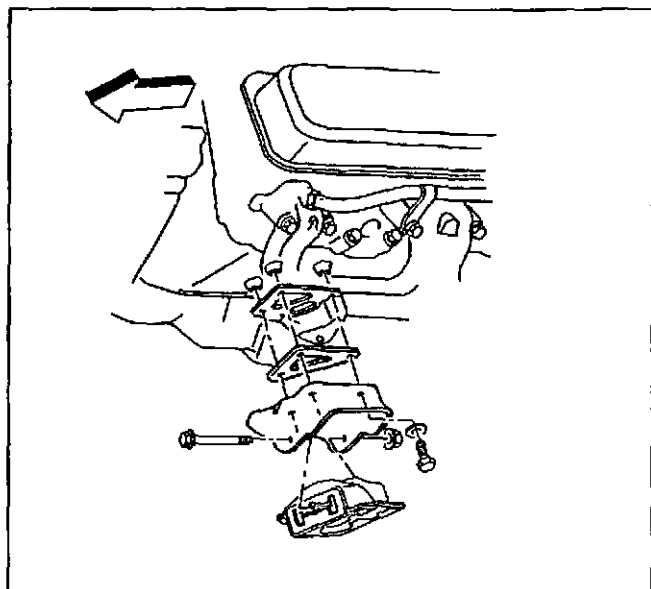
Tighten

- Tighten the bolts to 59 N.m (44 lb ft).
- Tighten the nuts to 45 N.m (33 lb ft).

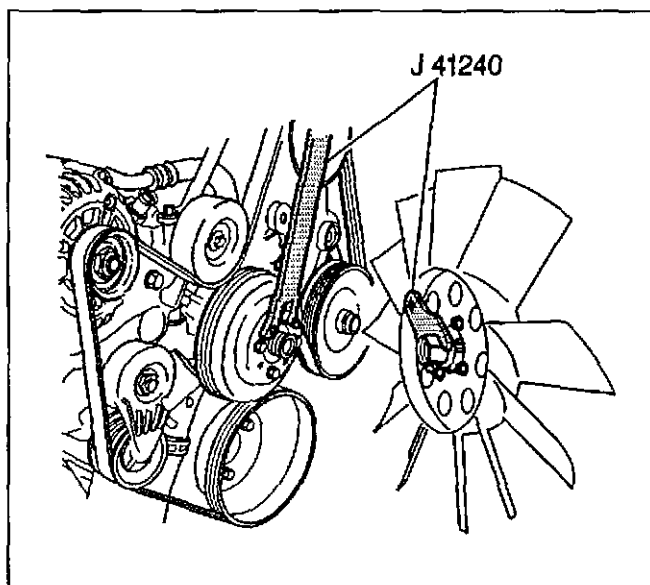
Notice: Refer to *Fastener Notice* in General Information.



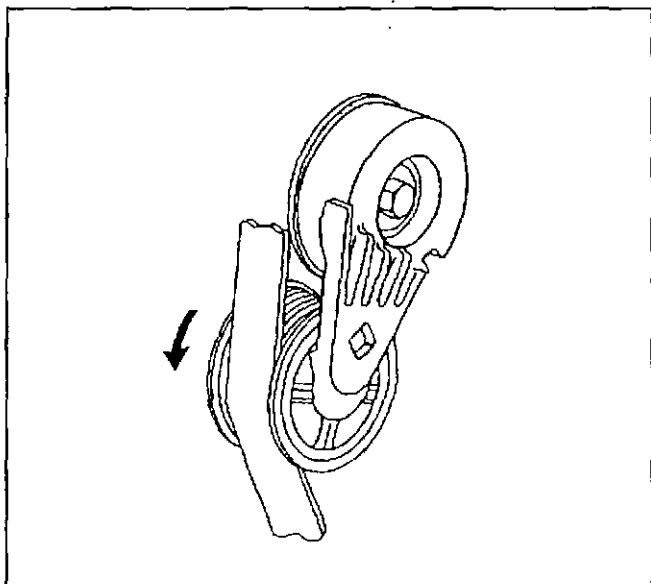
66189



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3. Install the engine mount through-bolt and nut.
 - 3.1. Lower the engine until the bolt can be inserted.
 - 3.2. Install the through-bolt nut.

Tighten

Tighten the nut to 68 N·m (50 lb·ft)

SIE-ID # 358133

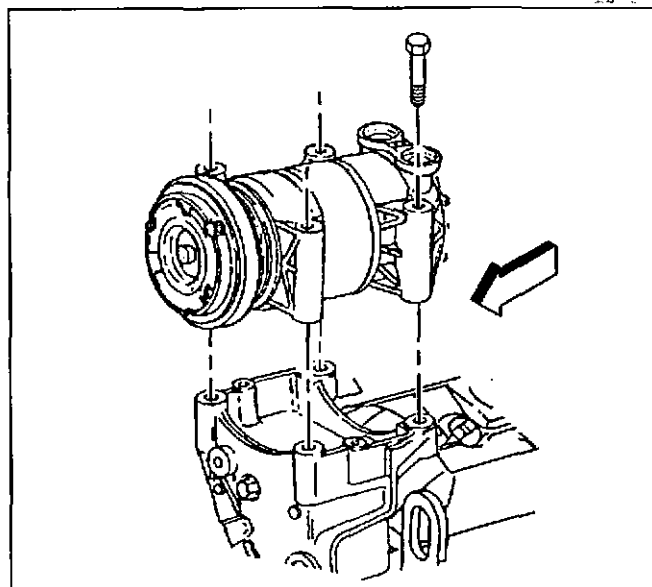
Accessory Mounting Brackets Replacement (AC Equipped)

Removal Procedure

1. Remove the engine cooling fan. Refer to *Fan Clutch Replacement (5.0L, 5.7L and 6.5L)* in Engine Cooling.
2. Remove the drive belt. Refer to *Drive Belt Replacement*.

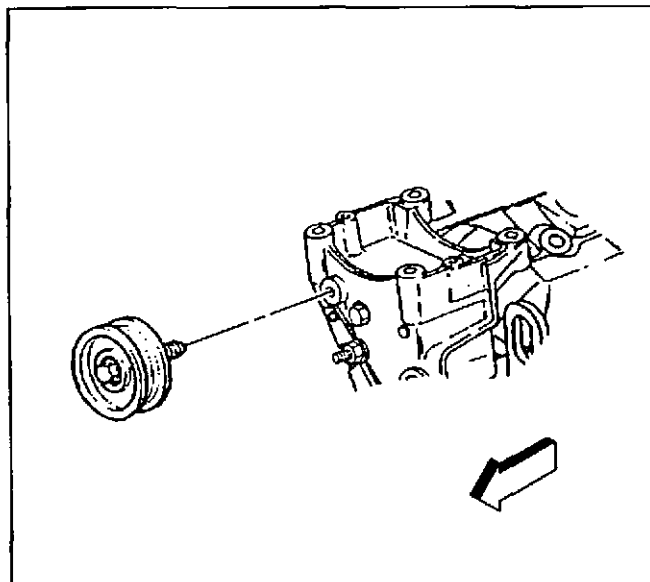
Important: Do not evacuate the air conditioning system.

3. Remove the mounting bolts for the air conditioning compressor, if equipped.
4. Move the air conditioning compressor aside and support.



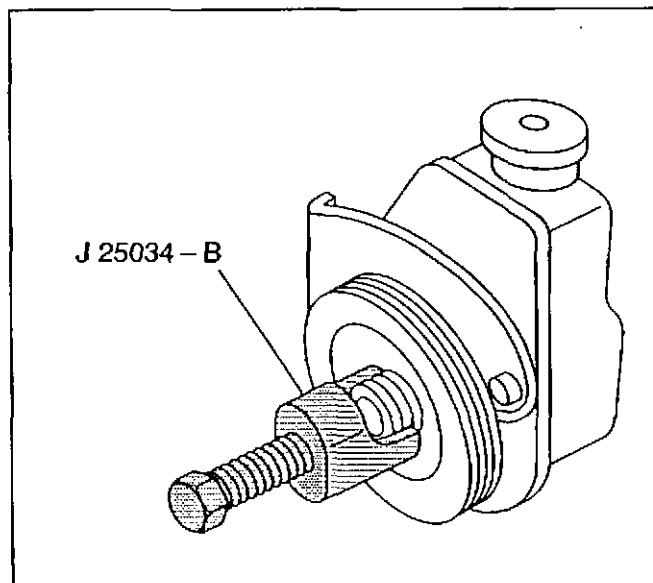
179249

5. Remove the belt idler pulley if not equipped with A/C. Refer to *Drive Belt Idler Pulley Replacement*.

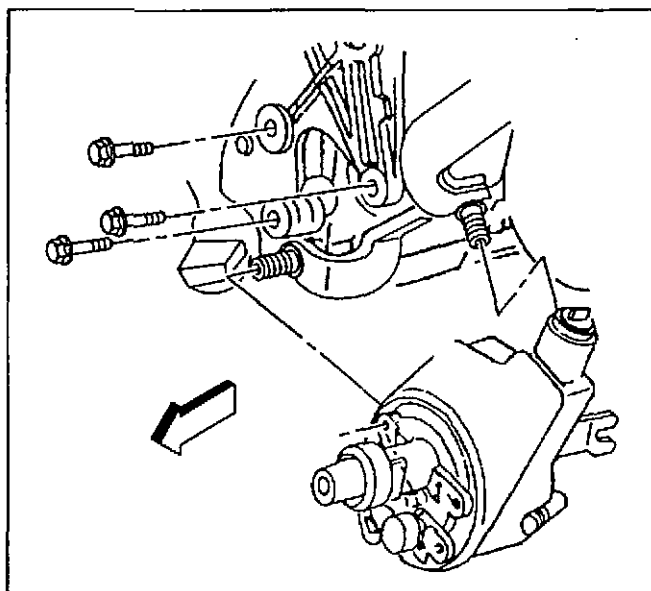


338506

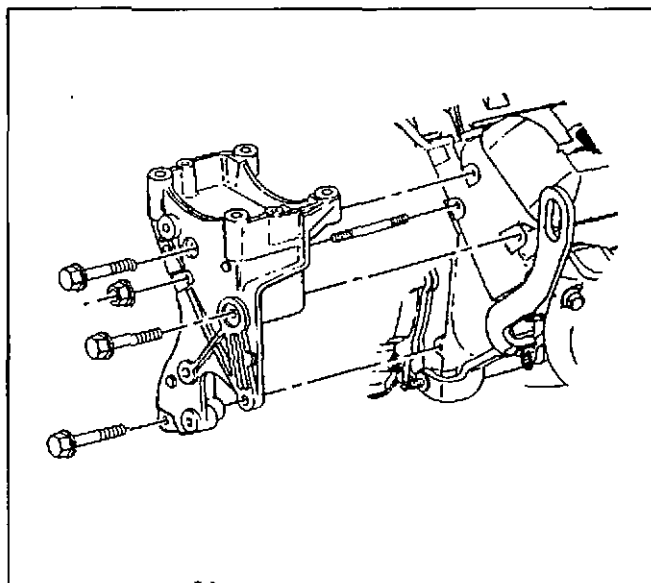
6. Remove the power steering pump pulley.



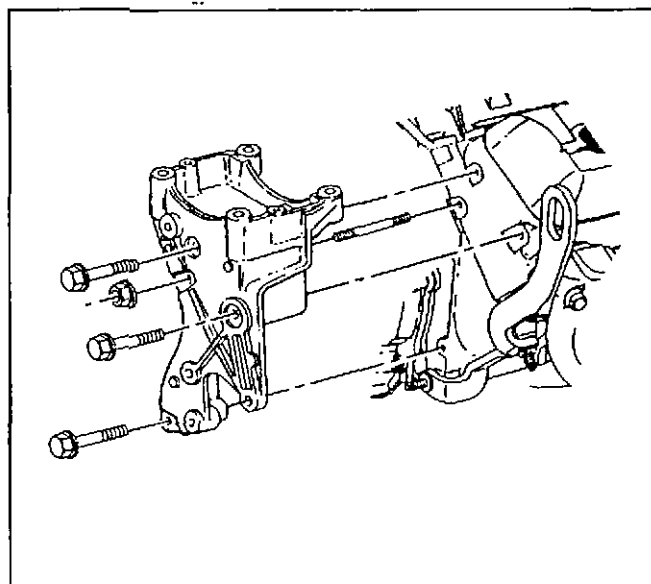
188649



288829



188295



188295

7. Remove the bolts and nuts holding the power steering pump to the accessory mounting bracket.

8. Remove the three bolts and nut holding the accessory mounting bracket to the engine.
9. Slide the accessory mounting bracket off the stud and power steering pump.

Installation Procedure

1. Slide the bracket on the stud and the power steering pump.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the three bolts and the nut.

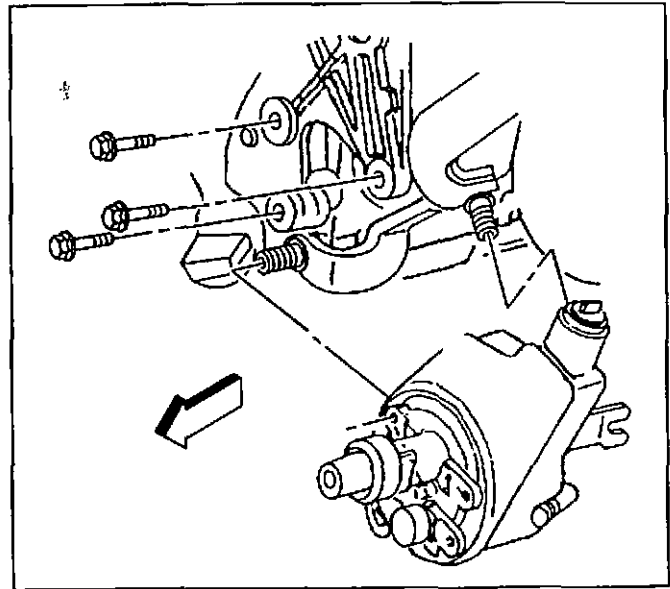
Tighten

Tighten the bolts and nut to 41 N·m (30 lb ft).

3. Install the bolts and nuts for the power steering pump.

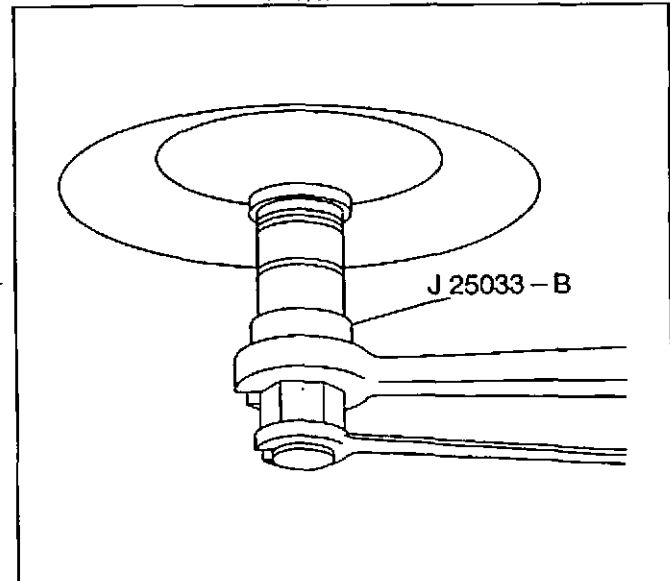
Tighten

Tighten the bolts and nuts to 41 N.m (30 lb ft).



288829

4. Install the power steering pump pulley.

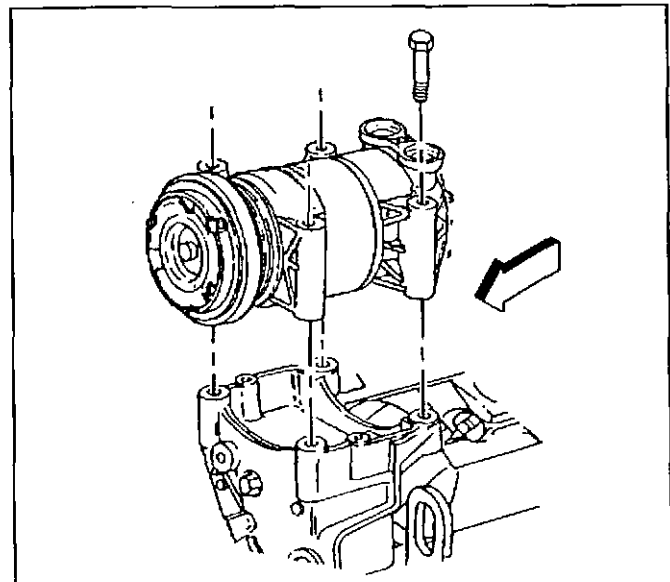


188373

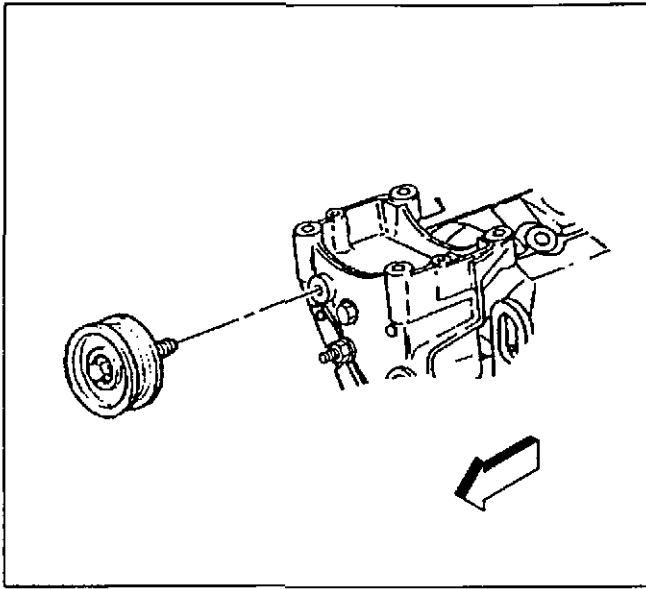
5. Install the air conditioning compressor bolts.

Tighten

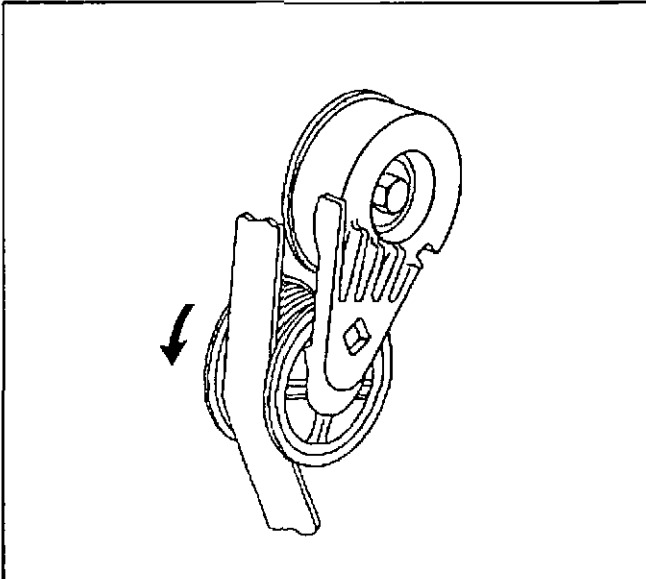
Tighten the bolts to 50 N.m (37 lb ft).



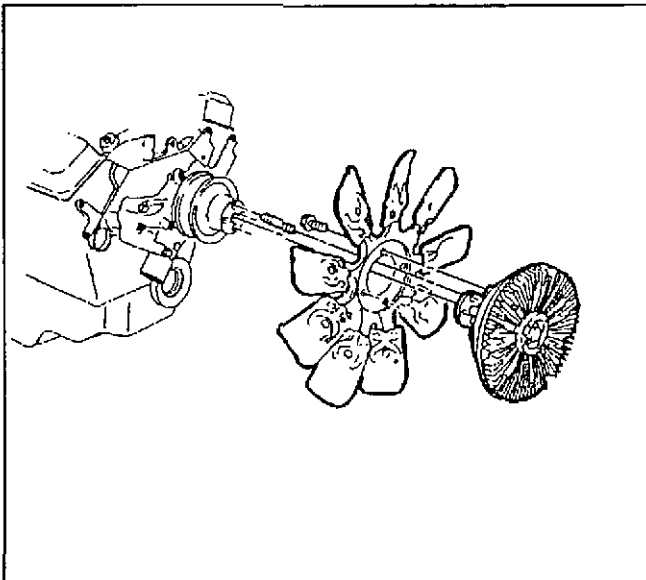
179249



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108015

6. Install the belt idler pulley if not equipped with A/C.

Tighten

Tighten the belt idler pulley bolt to 50 N·m (37 lb ft).

7. Install the drive belt. Refer to *Drive Belt Replacement*.

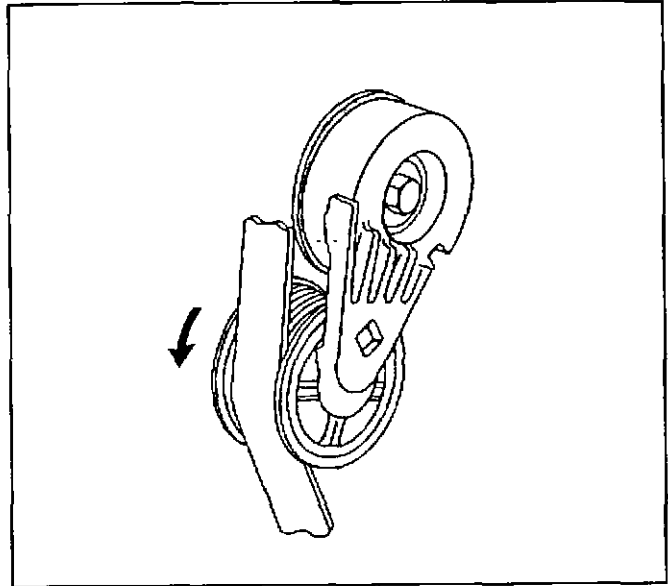
8. Install the engine cooling fan. Refer to *Fan Clutch Replacement (5.0L, 5.7L and 6.5L)* in Engine Cooling.

SIE-ID - 358143

Accessory Mounting Brackets Replacement (Generator)

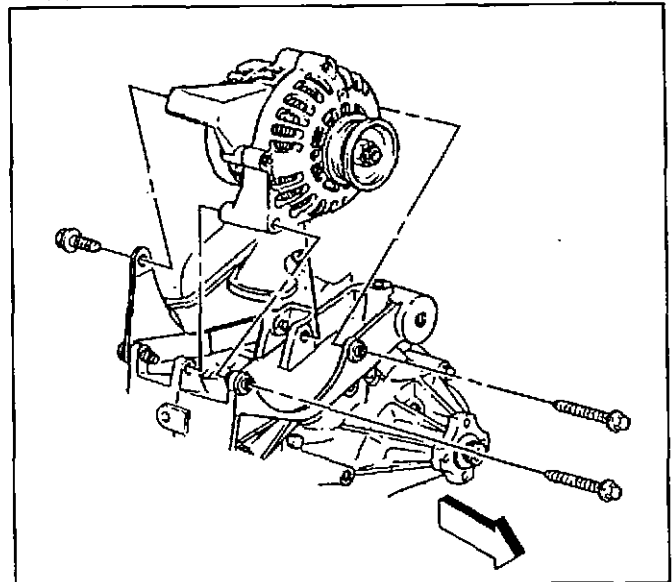
Removal Procedure

1. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the engine cooling fan. Refer to *Fan Clutch Replacement (5.0L, 5.7L and 6.5L)* in Engine Cooling.
3. Remove the drive belt. Refer to *Drive Belt Replacement*.

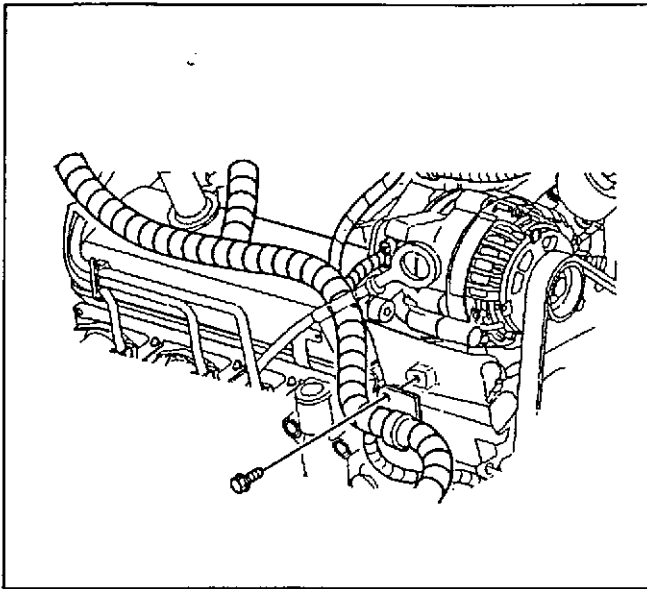


177620

4. Remove the generator. Refer to *Generator Replacement (Gasoline)* in Engine Electrical.

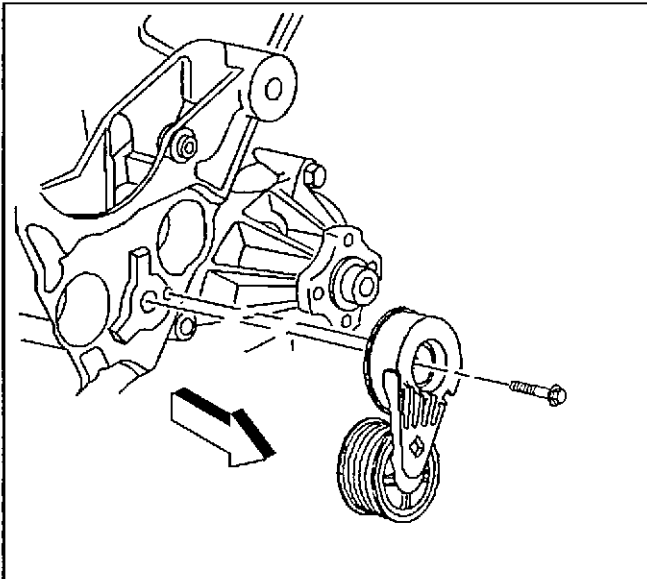


43033



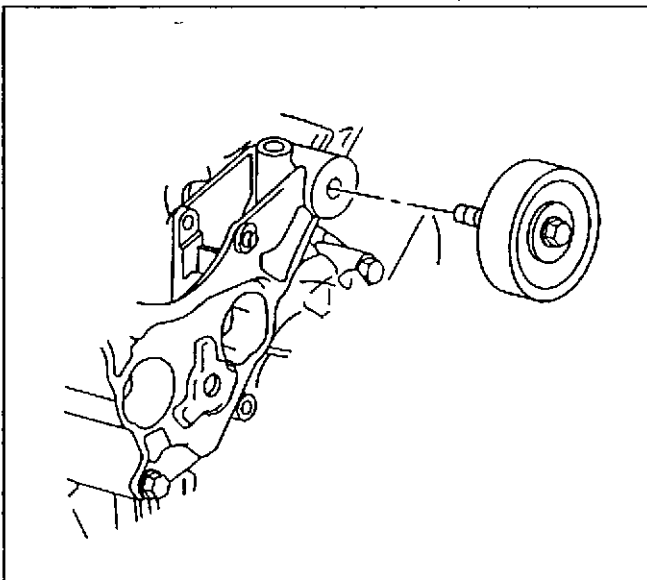
340790

5. Remove the wire harness bracket from the generator and drive belt tensioner bracket.



43854

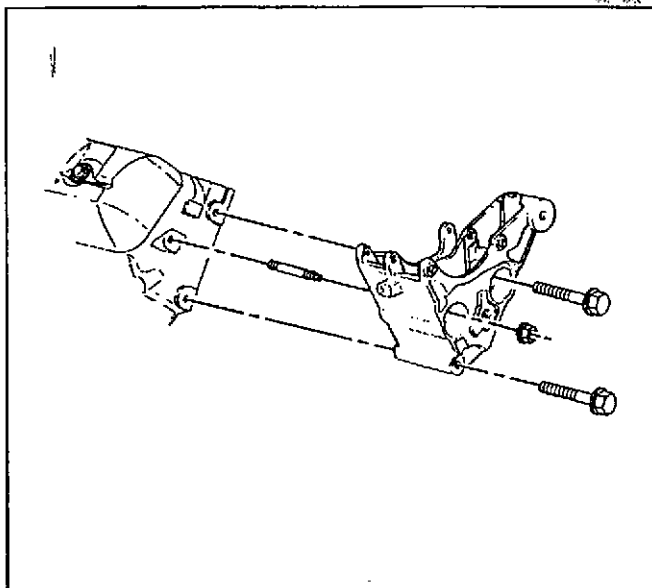
6. Remove the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement*.



310229

7. Remove the belt idler pulley. Refer to *Drive Belt Idler Pulley Replacement*.

8. Remove the three bolts and nut holding the generator and drive belt tensioner to the engine.
9. Slide the accessory mounting bracket off of the stud.



196643

Installation Procedure

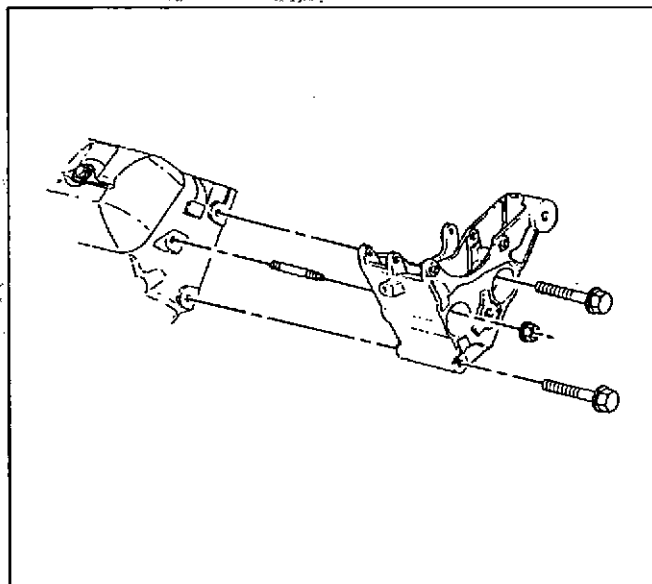
1. Slide the accessory mounting bracket on the stud.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the three bolts and the nut.

Tighten

Tighten the bolts and nut to 41 N·m (30 lb ft).

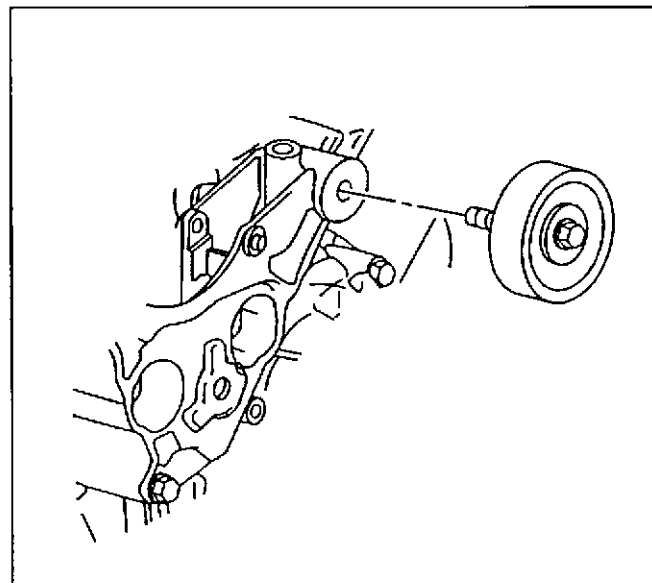


196643

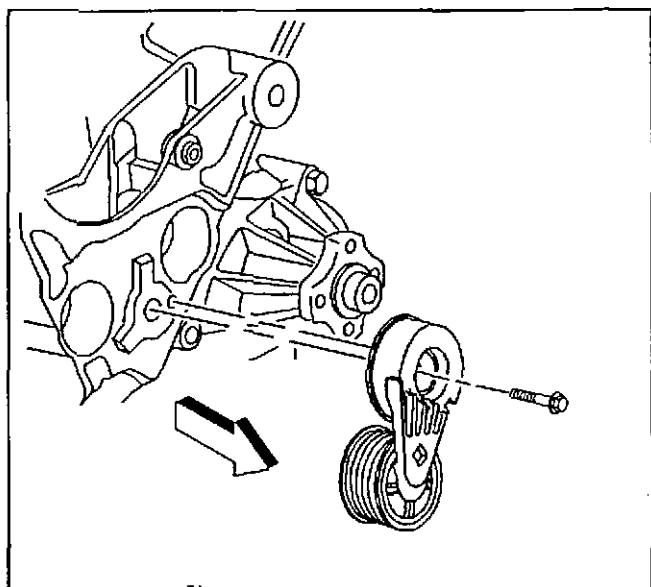
3. Install the belt idler pulley.

Tighten

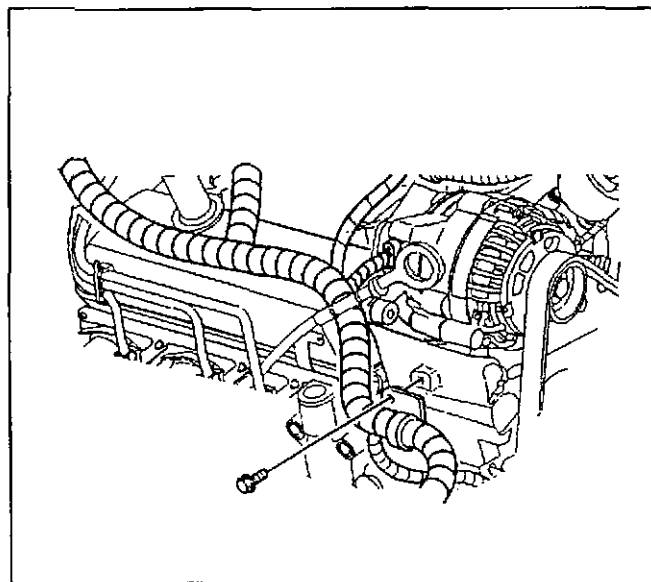
Tighten the belt idler pulley bolt to 50 N·m (37 lb ft).



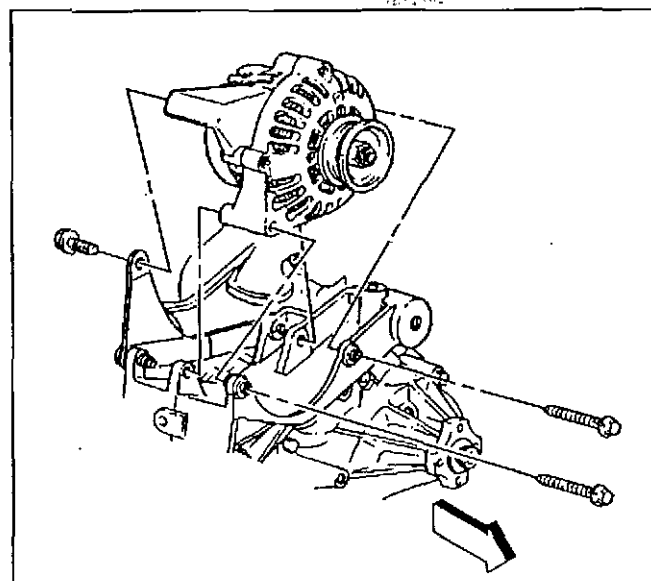
310229



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43033

4. Install the drive belt tensioner.

Tighten

Tighten the drive belt tensioner bolt to 50 N·m (37 lb ft).

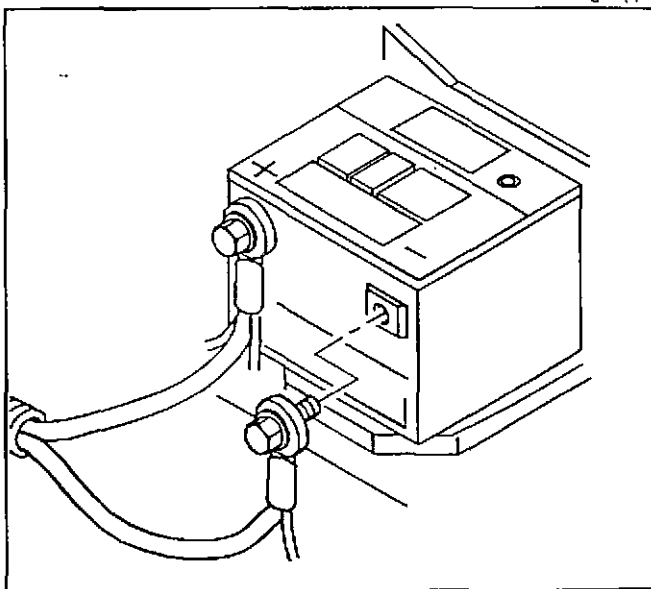
5. Install the wire harness bracket to the generator and drive belt tensioner mounting bracket.

Tighten

Tighten the bolt to 24 N·m (18 lb ft).

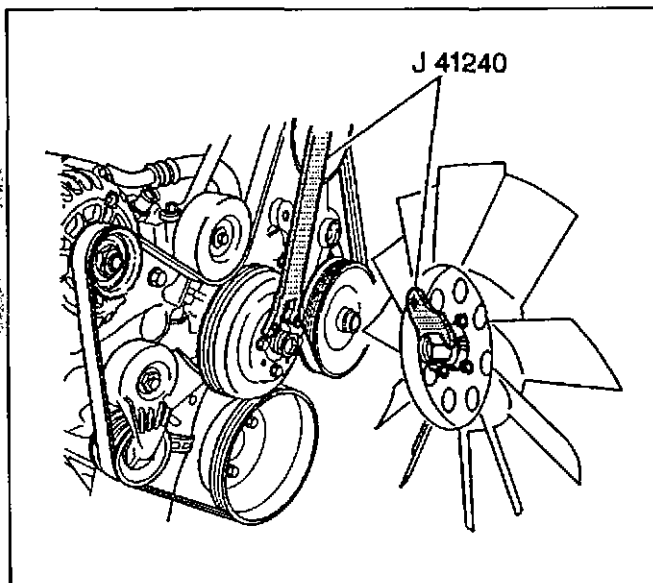
6. Install the generator. Refer to *Generator Replacement (Gasoline)* in Engine Electrical.
7. Install the drive belt. Refer to *Drive Belt Replacement*.

8. Connect the battery negative cable.



38205

9. Install the engine cooling fan. Refer to *Fan Clutch Replacement (5.0L, 5.7L and 6.5L)* in Engine Cooling.



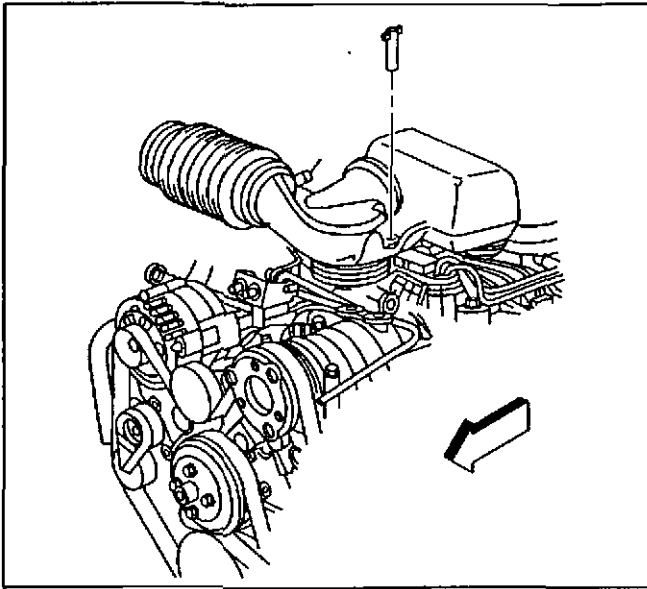
42910

SIE-ID - 332389

Intake Manifold Replacement (Lower)

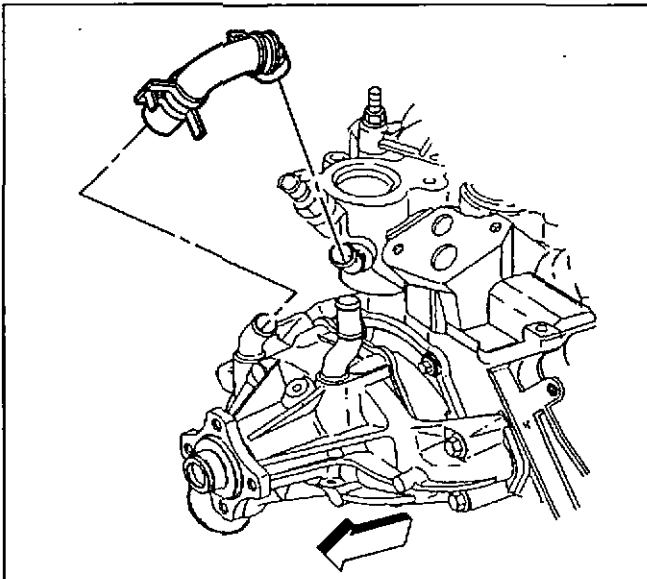
Removal Procedure

1. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in Engine Electrical.
2. Drain the engine coolant. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)*.



308131

3. Remove the air cleaner assembly.

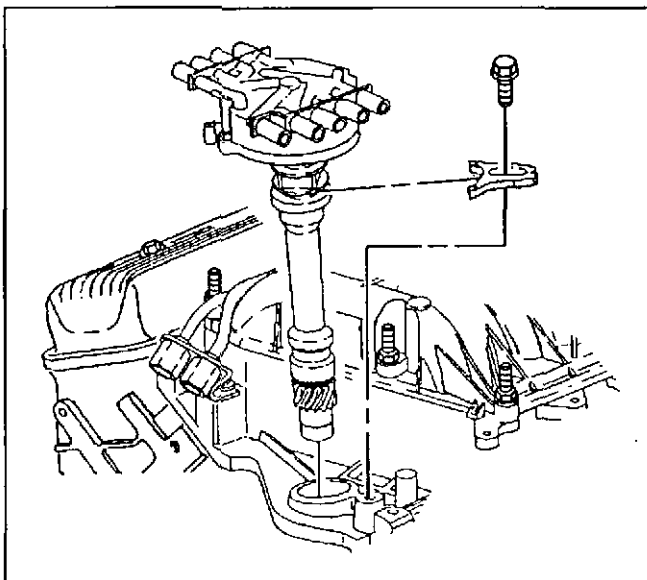


182853

4. Remove the following coolant hoses:

- Upper radiator hose. Refer to *Radiator Hose Replacement (5.0L)*.
- Both heater hoses. Refer to *Heater Hoses Replacement (Outlet Hose - 7.4L)* in Engine Cooling.
- Water pump inlet hose. Refer to *Hot Water Bypass Valve Replacement* in Engine Cooling.

5. Disconnect all electrical connectors and secure out of the way.

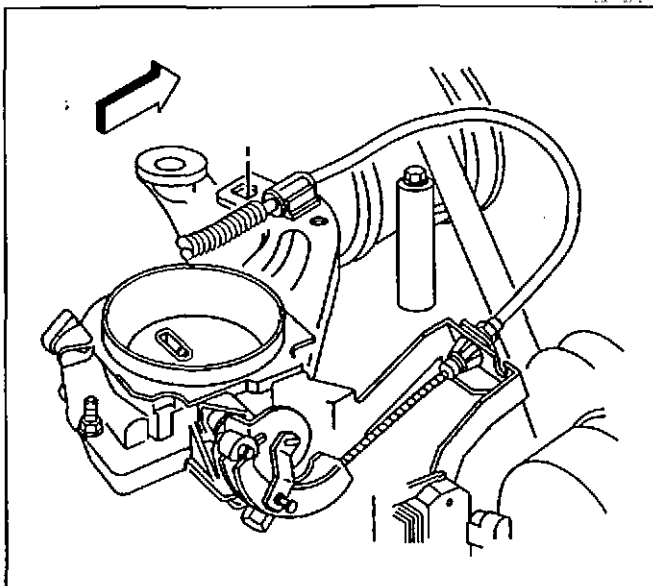


173208

6. Remove the distributor. Refer to *Distributor Replacement (5.0L, 5.7L)* in Engine Electrical.

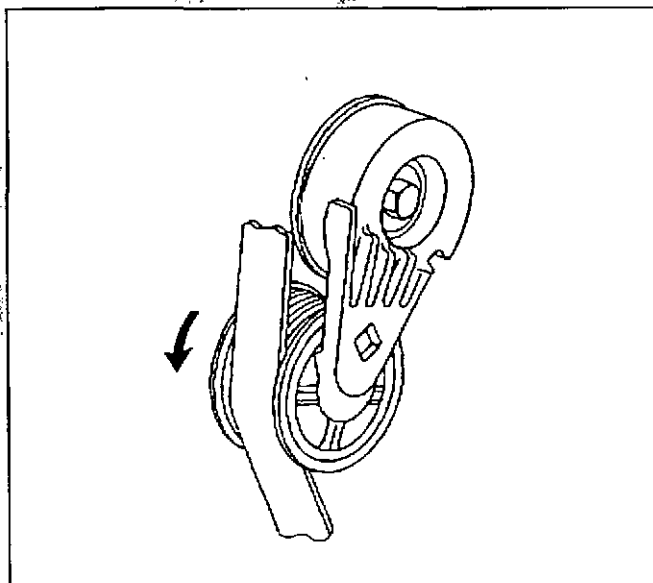
7. Use a twisting motion to remove the vacuum brake booster hose, if equipped.

8. Disconnect the accelerator control cable and the cruise control cable, if equipped. Refer to *Accelerator Controls Cable Replacement* in Engine Controls.



216754

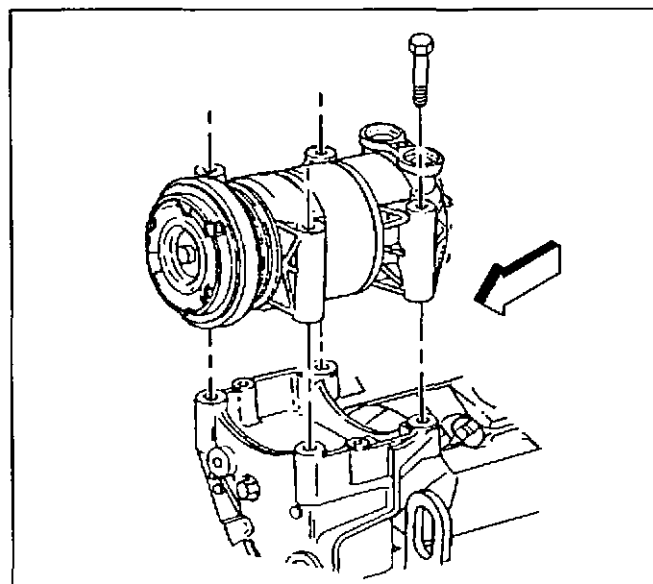
9. Remove the drive belt. Refer to *Drive Belt Replacement*.



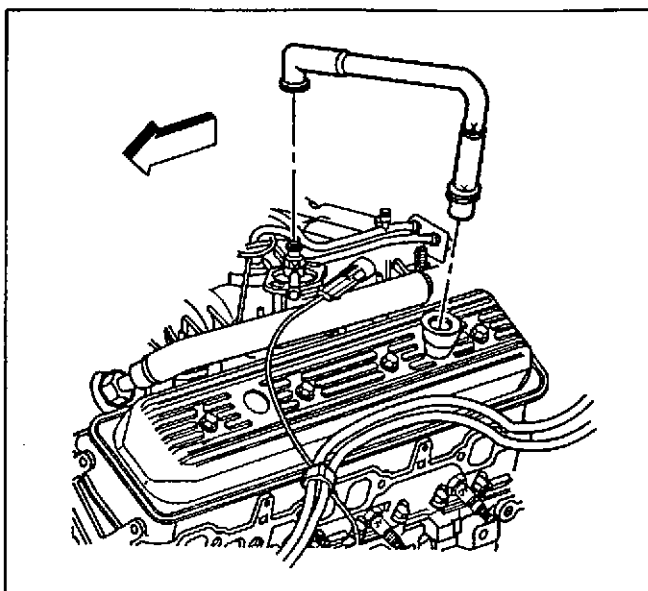
177620

Important: It is not necessary to discharge the A/C refrigerant.

10. Remove the air conditioning (A/C) compressor, if equipped, and set the A/C compressor aside. Refer to *Compressor Replacement (5.0L, 5.7L)*

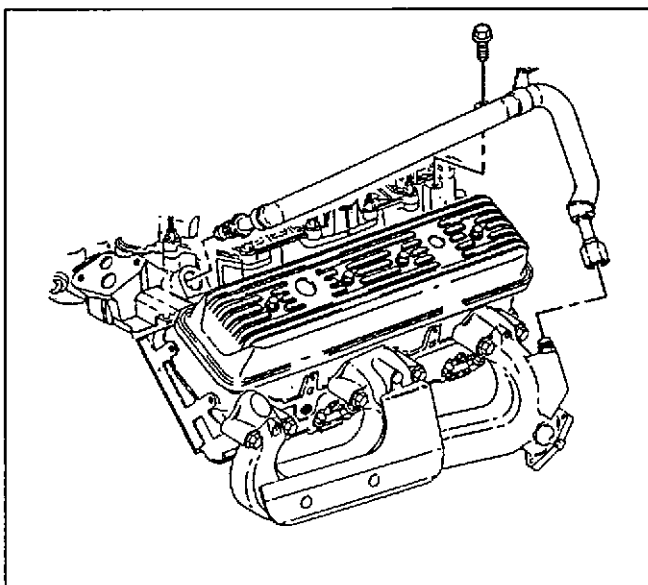


179249



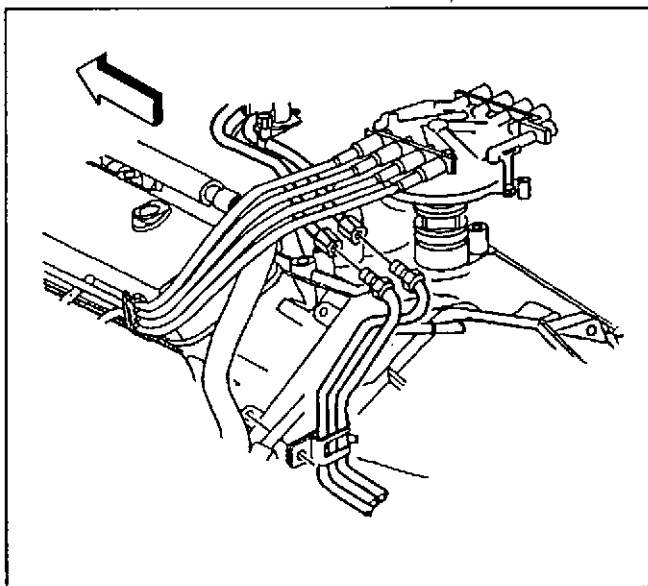
317197

11. Remove the PCV valve.



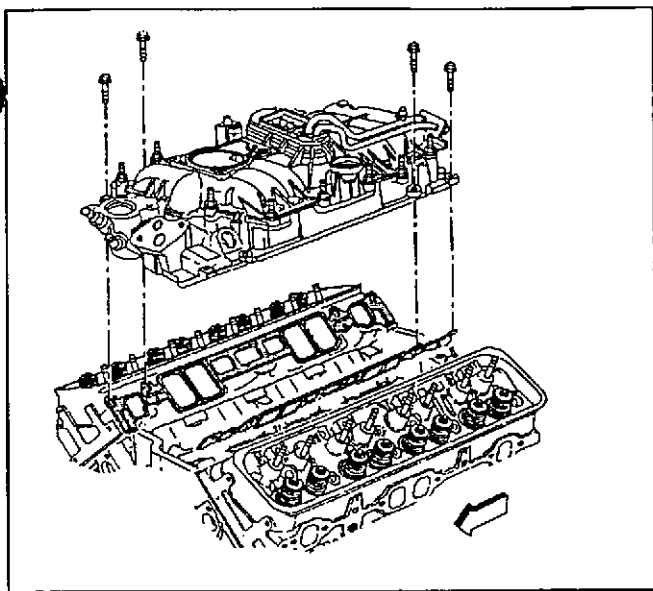
173206

12. Disconnect the exhaust gas recirculation (EGR) pipe from the bracket and the front of the intake manifold. Refer to Engine Controls.

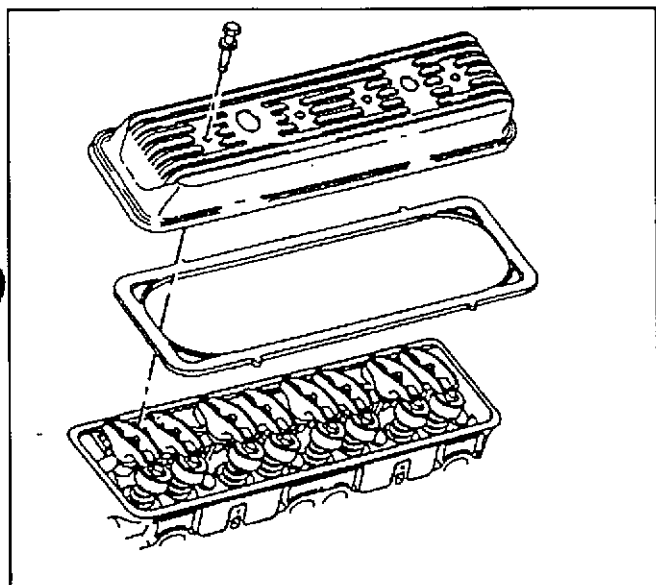


343625

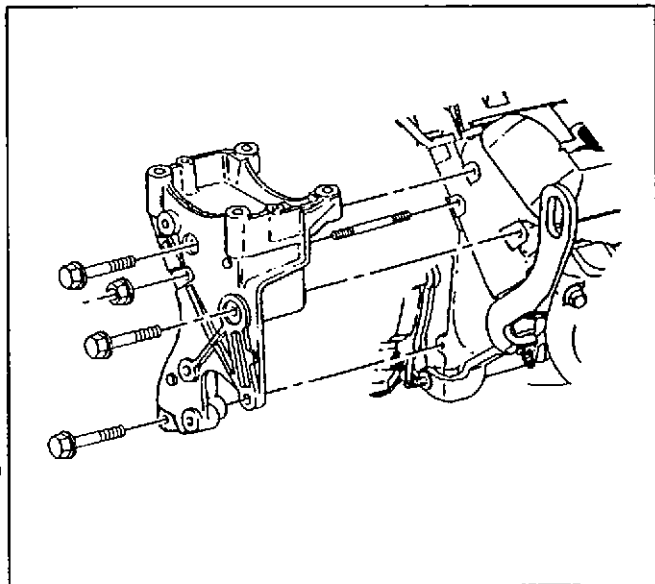
13. Disconnect the fuel pipes from the rear of the intake manifold. Refer to *Fuel Hose/Pipes Assembly Replacement (Fuel Pipes)* in Engine Controls.
14. Disconnect the electrical connector from the power steering pump.



66456



68709



186295

Installation Procedure

1. Install the intake manifold. Refer to *Intake Manifold Installation*.

2. Install the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Installation (Right)* and *Valve Rocker Arm Cover Installation (Left)*.

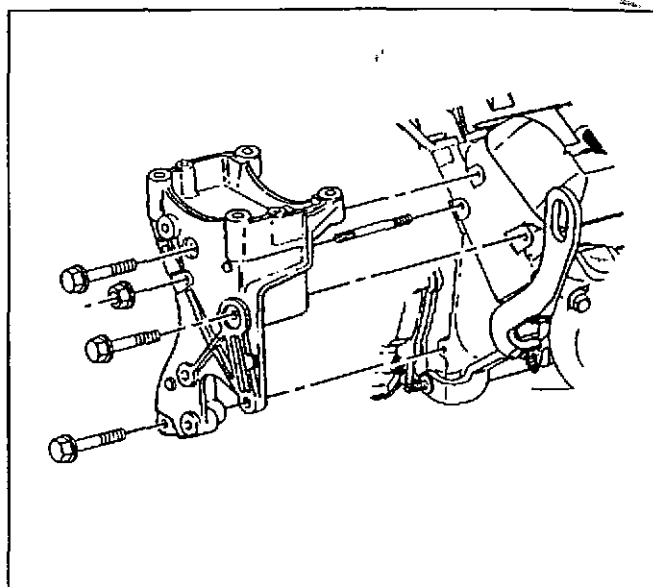
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the power steering bracket using the following procedure:
 - 3.1. Install the power steering bracket onto the stud.
 - 3.2. Install the nut onto the stud finger tight.
 - 3.3. Install the three bolts finger tight.
 - 3.4. Install the two nuts to the back of the power steering pump.

Tighten

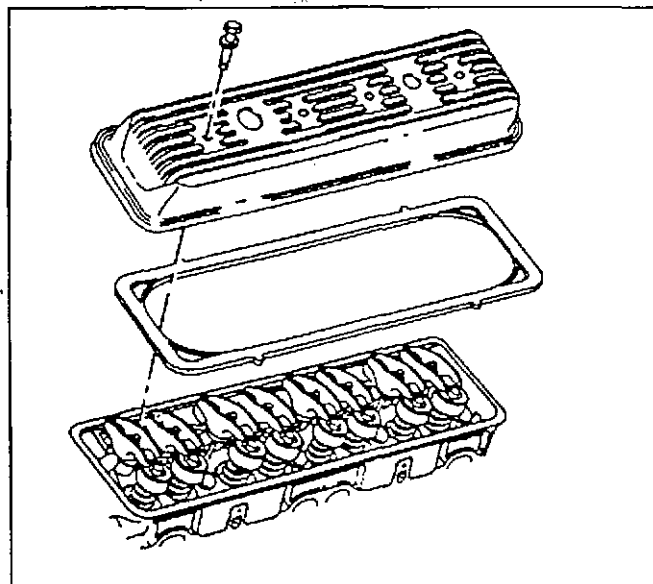
Tighten the nuts and the bolts to 41 N·m (30 lb ft).

15. Remove the power steering bracket using the following procedure:
 - 15.1. Remove the power steering pump pulley.
 - 15.2. Remove the nut, then the bolts.
 - 15.3. Remove two nuts from the back of the power steering pump.
 - 15.4. Slide the power steering bracket forward, with the power steering pump still attached.
16. Disconnect the wiring bracket from the rear of the right cylinder head.



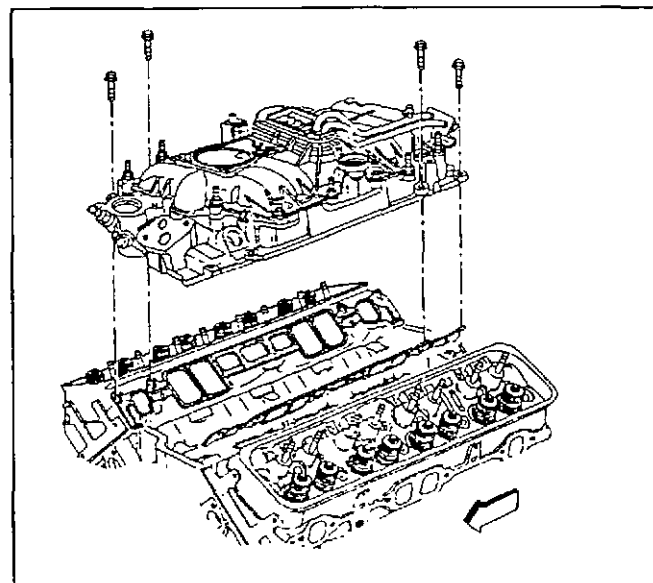
188295

17. Remove one valve rocker arm cover. Refer to *Valve Rocker Arm Cover Replacement*.

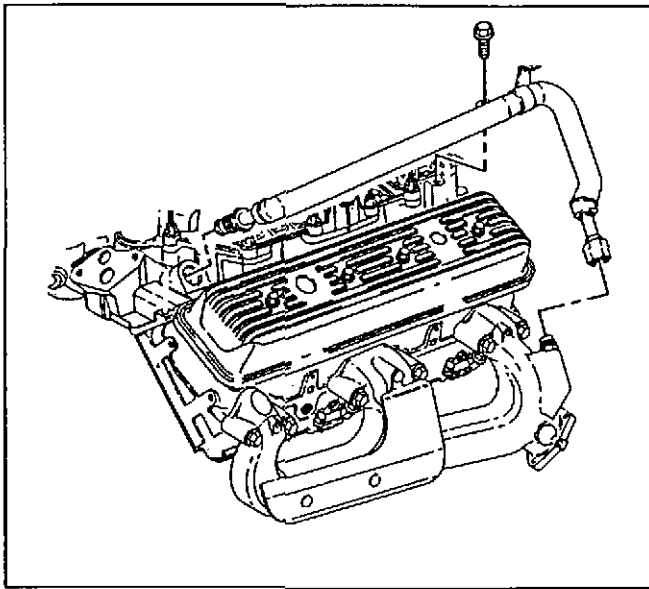


68709

18. Remove the intake manifold bolts.
19. Remove the intake manifold. Refer to *Intake Manifold Removal*.
20. Clean all surfaces. Refer to *Intake Manifold Clean and Inspect*.

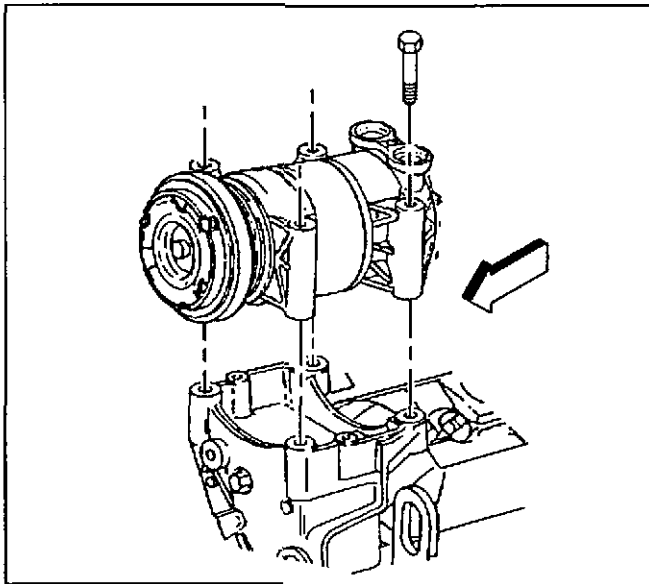


66456



173206

9. Connect the exhaust gas recirculation (EGR) pipe to the bracket and the front of the intake manifold. Refer to Engine Controls.
10. Use a twisting motion to install the vacuum brake booster hose, if equipped.
11. Install AIR check valve (crossover) pipe, if equipped.

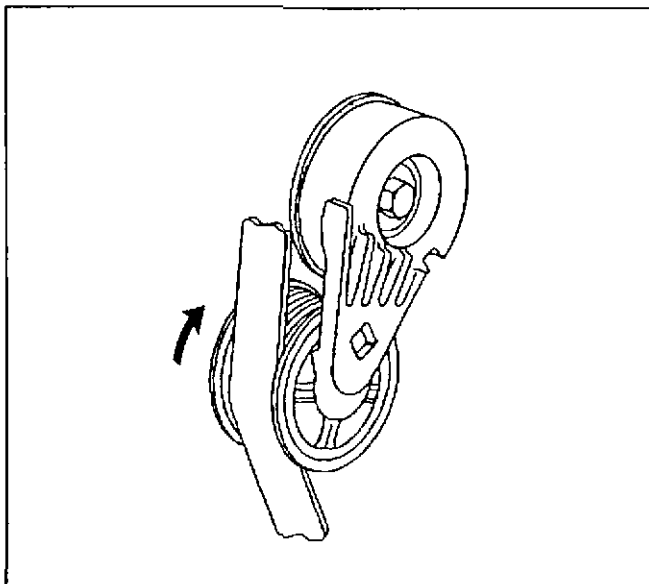


179249

12. Install the air conditioning (A/C) compressor onto the power steering bracket.
13. Install the A/C compressor bolts.

Tighten

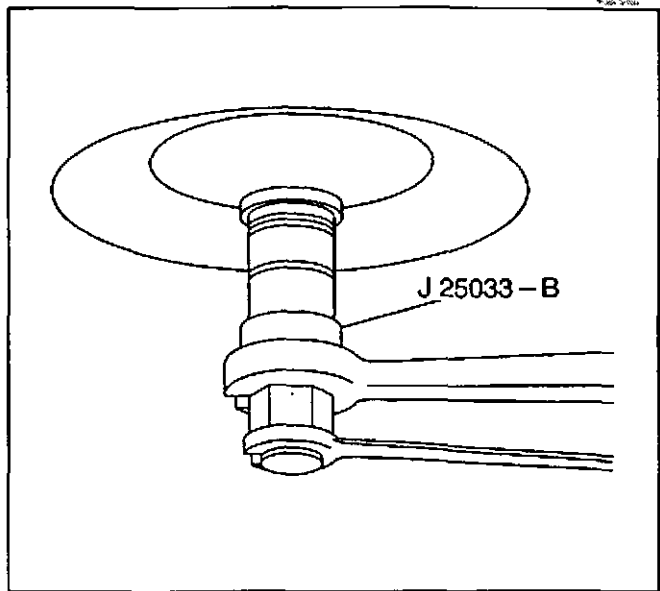
Tighten the bolts to 50 N.m (37 lb ft).



177622

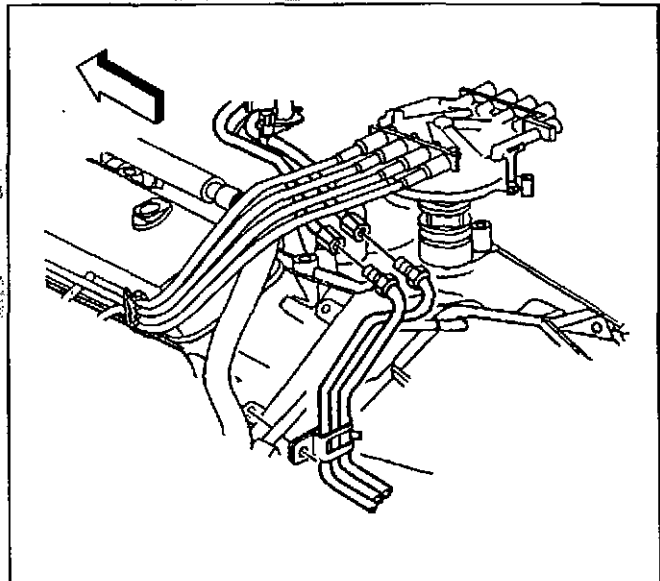
14. Install the drive belt. Refer to *Drive Belt Replacement*.

4. Install the power steering pump pulley.
5. Connect the electrical connector to the power steering pump.



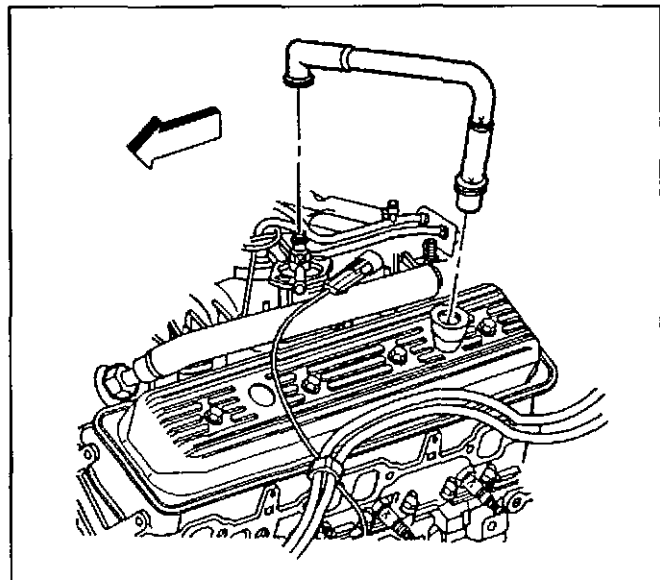
188373

6. Connect the fuel pipes to the rear of the intake manifold. Refer to *Fuel Hose/Pipes Assembly Replacement (Fuel Pipes)* in Engine Controls.
7. Connect the wiring bracket to the rear of the right cylinder head.



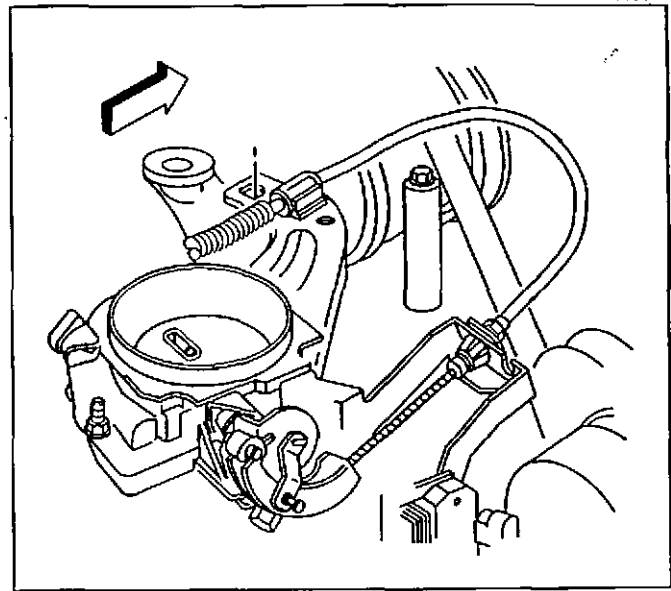
343625

8. Install the PCV valve.



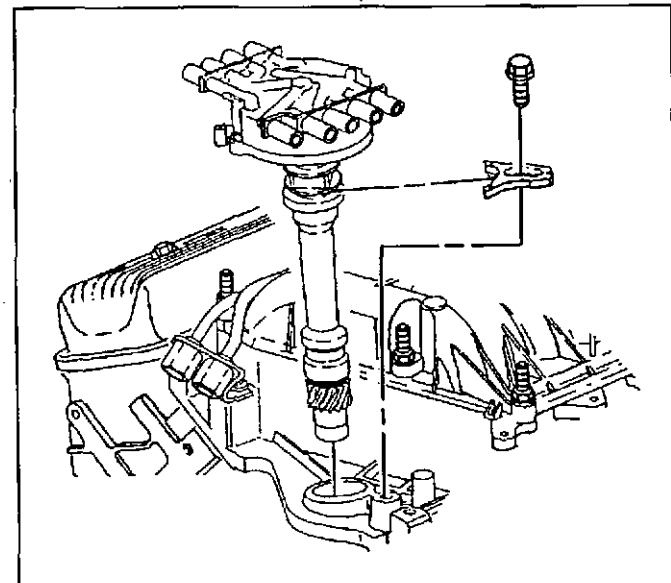
317197

15. Connect the accelerator control cable and the cruise control cable, if equipped. Refer to *Accelerator Controls Cable Replacement* in Engine Controls.



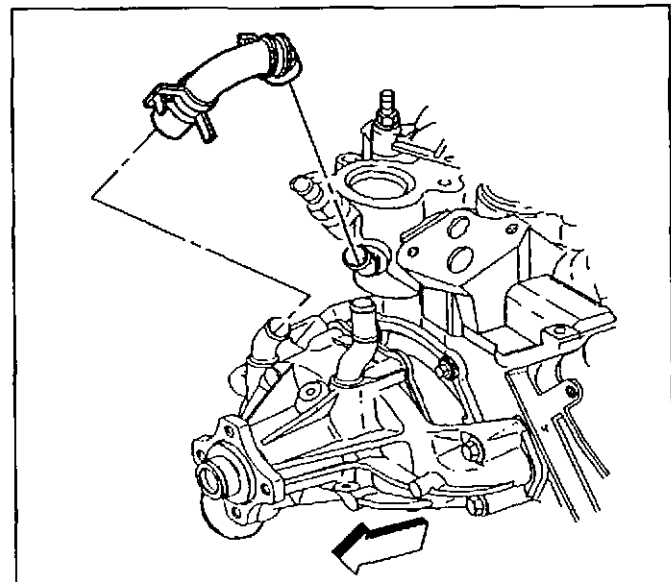
216754

16. Install the distributor. Refer to *Distributor Replacement (ERROR - NOT IN CURRENT PSD)*.
17. Connect all electrical connectors.

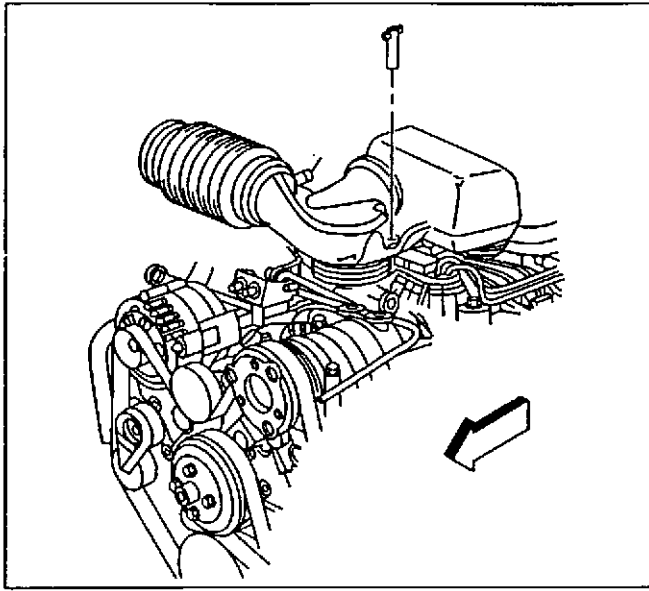


173208

18. Install the following coolant hoses.
 - Upper radiator hose. Refer to *Radiator Hose Replacement (5.0L)* in engine cooling.
 - Both heater hoses. Refer to *Heater Hoses Replacement (Outlet Hose - 7.4L)* in engine cooling.
 - Water pump inlet. Refer to *Hot Water Bypass Valve Replacement* in engine cooling.



182853



308131

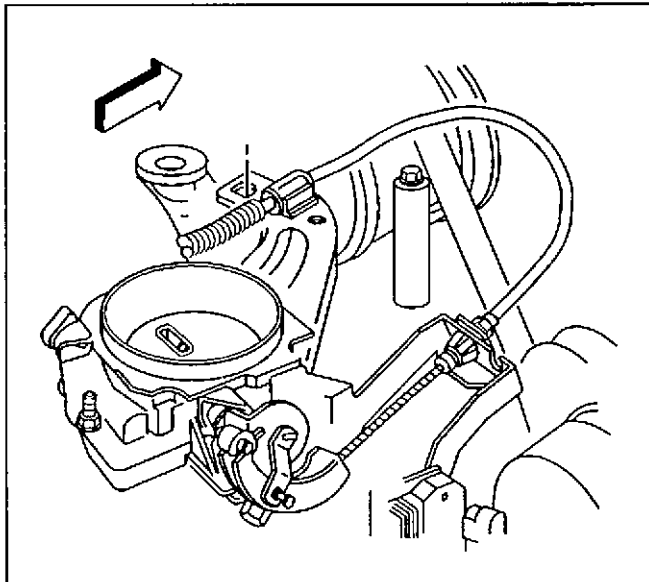
19. Install the air cleaner assembly.
20. Fill the cooling system with coolant. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)*.
21. Connect the battery negative cable.

SIE-ID = 332395

Intake Manifold Replacement (Upper)

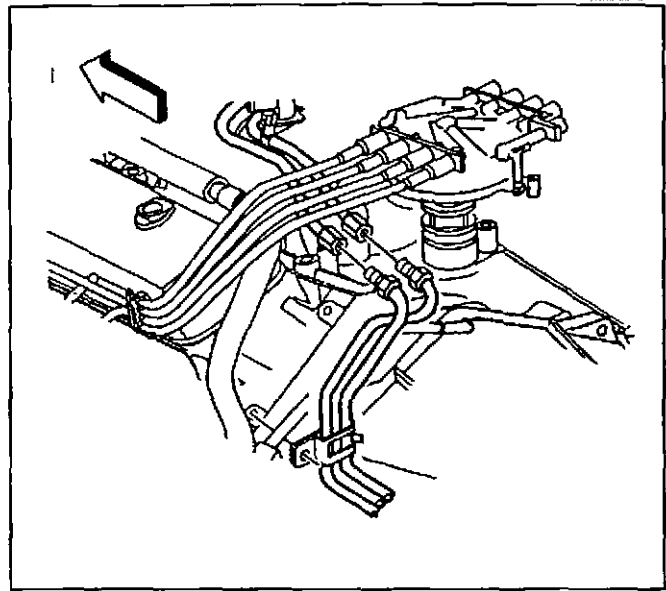
Removal Procedure

1. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in Engine Electrical.
2. Remove the air cleaner assembly. Refer to *Air Cleaner Assembly Replacement* in Engine Controls.
3. Remove the vacuum brake booster hose, if equipped.
4. Disconnect the accelerator control and cruise control cables (if equipped). Refer to *Accelerator Controls Cable Replacement* in Engine Controls.
5. Remove the accelerator control cable bracket and set it aside.
6. Remove the following electrical connectors:
 - The SCPI injector harness connector
 - The EVAP canister purge solenoid valve
 - The ignition coil
 - The ignition control module (ICM)
 - The generator
 - The idle air control (IAC) motor
 - The throttle position (TP) sensor
 - The oxygen (O²) sensor
 - The exhaust gas recirculation (EGR) valve
 - The engine coolant temperature (ECT) sensor
 - The engine oil pressure sensor



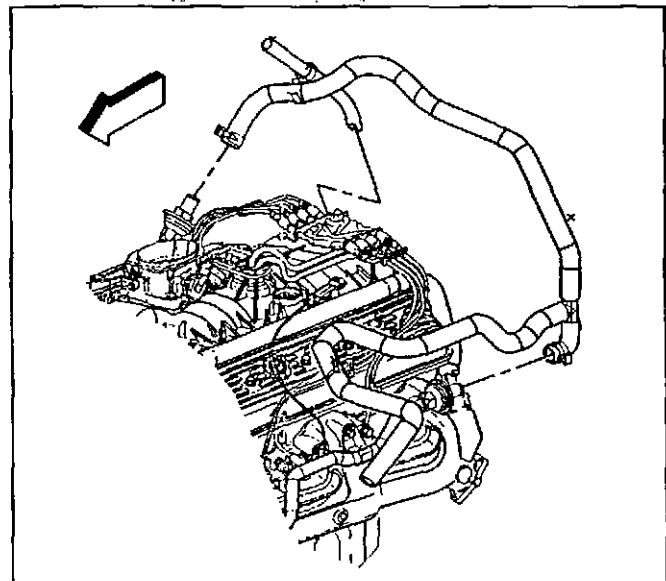
216754

7. Disconnect the fuel pipes from the fuel pipes. Refer to *Fuel Hose/Pipes Assembly Replacement (Fuel Pipes)* in Engine Controls.



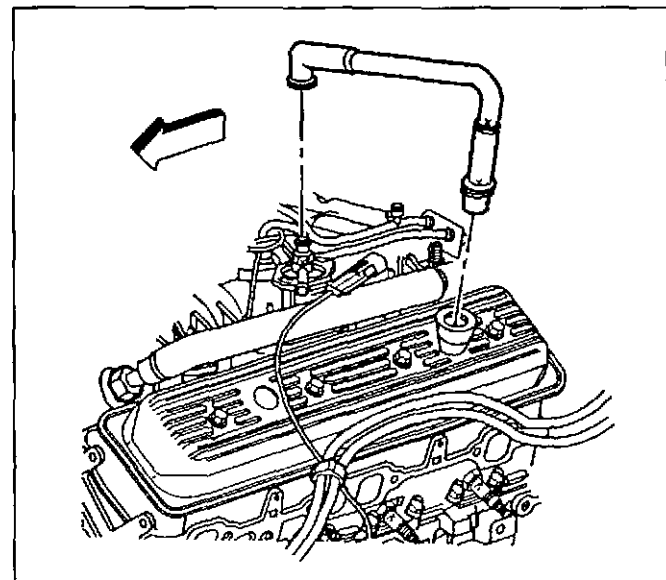
343625

8. Remove the AIR check valve (crossover) pipe, if equipped.
9. Remove the distributor cap and reposition the distributor cap out of the way.

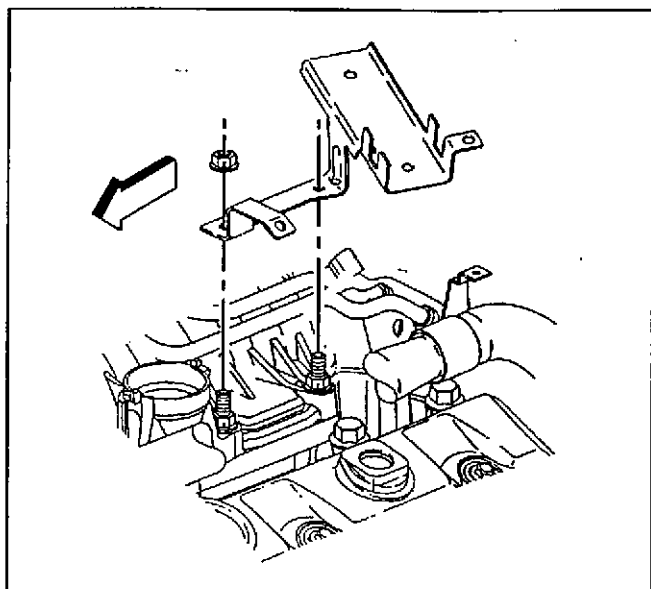


341228

10. Remove the PCV valve hose assembly.

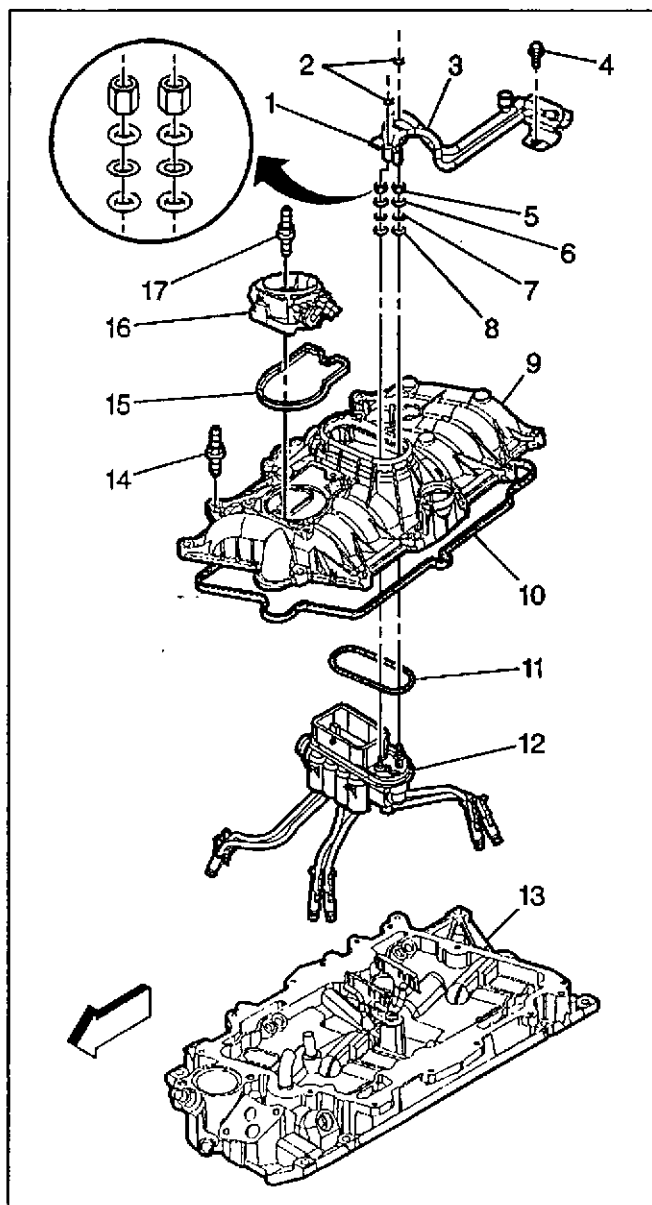


317197



179250

11. Remove the engine wiring harness bracket from the manifold.
12. Remove the EVAP canister purge solenoid valve.

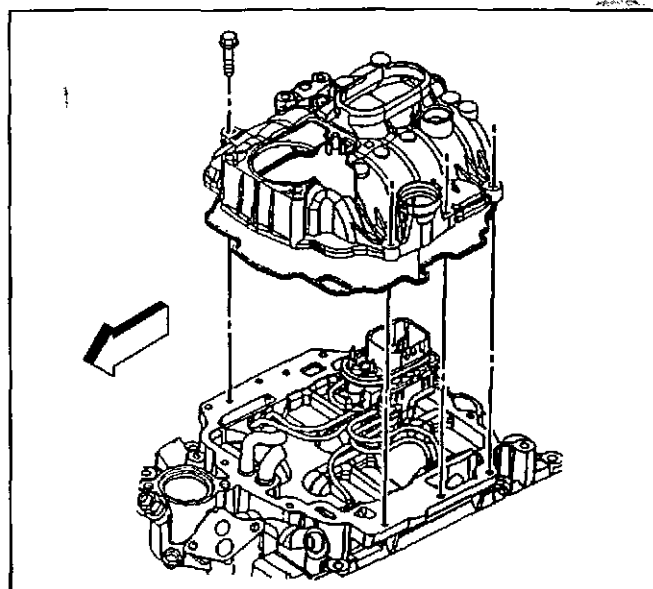


66929

13. Remove the studs holding the upper intake manifold to the lower intake manifold.
14. Remove the upper intake manifold. Refer to *Intake Manifold Disassemble*.
15. Clean all the surfaces. Refer to *Intake Manifold Clean and Inspect*.

Installation Procedure

1. Install the upper intake manifold. Refer to *Intake Manifold Assemble*.
2. Install the EVAP canister purge solenoid valve.



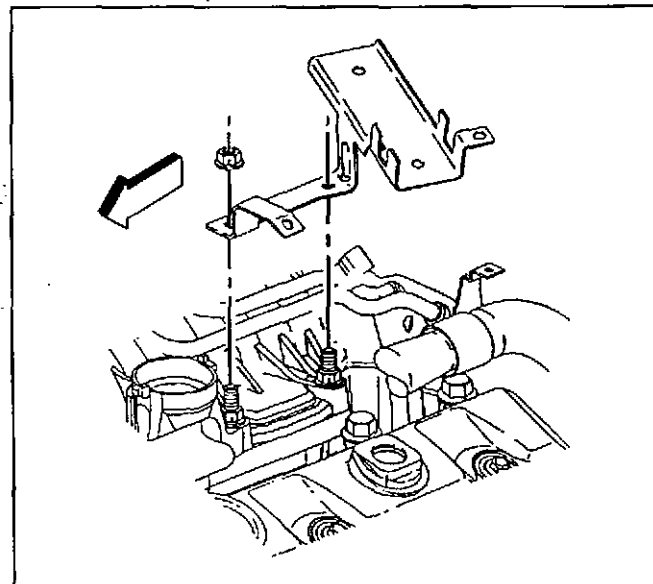
31649

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the engine wiring harness bracket to the upper intake manifold.

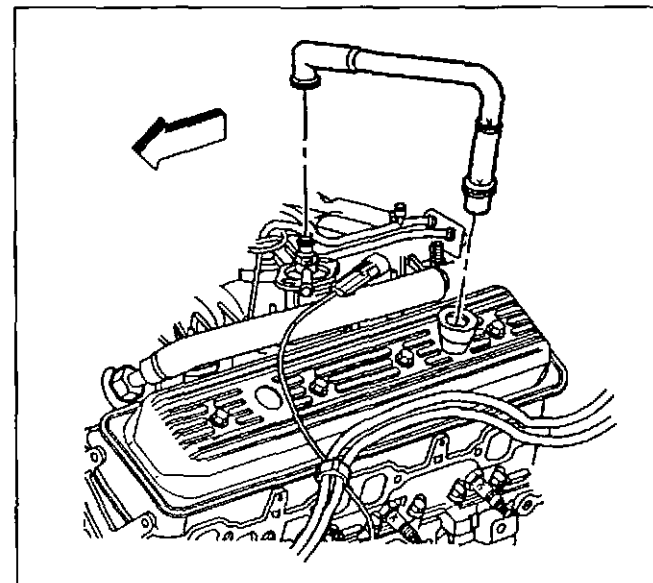
Tighten

Tighten the nut to 12 N.m (106 lb in).

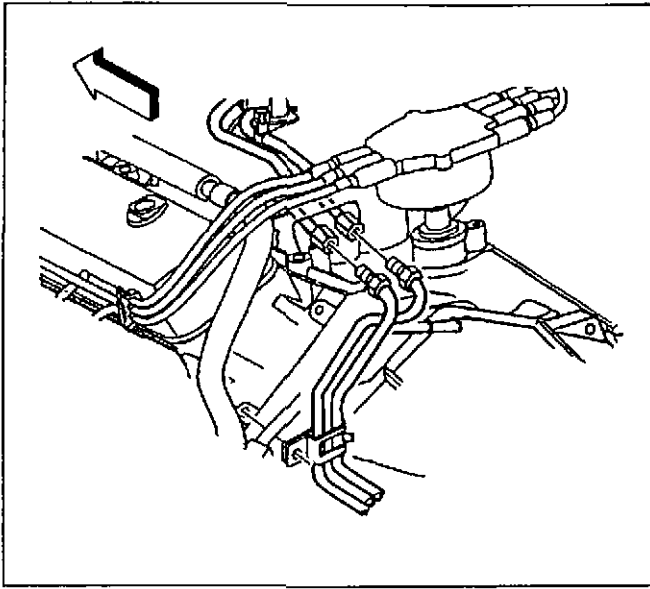


179250

4. Install the PCV valve hose assembly.
5. Install the distributor cap. Refer to *Distributor Replacement (5.0L, 5.7L)* in Engine Electrical.

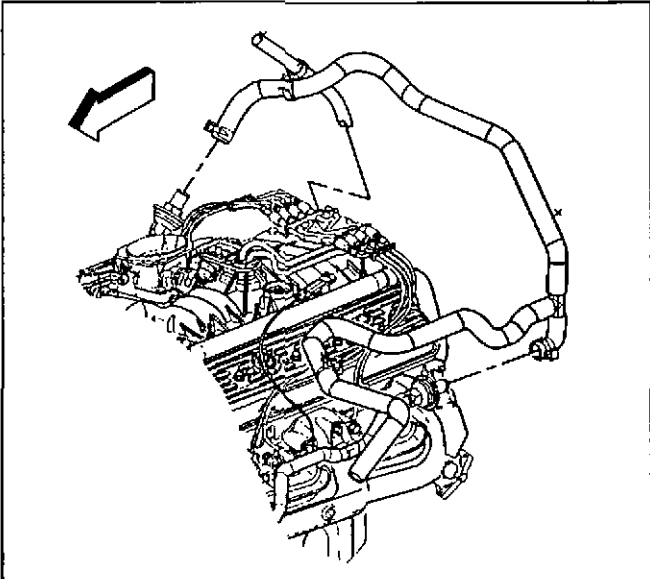


317197



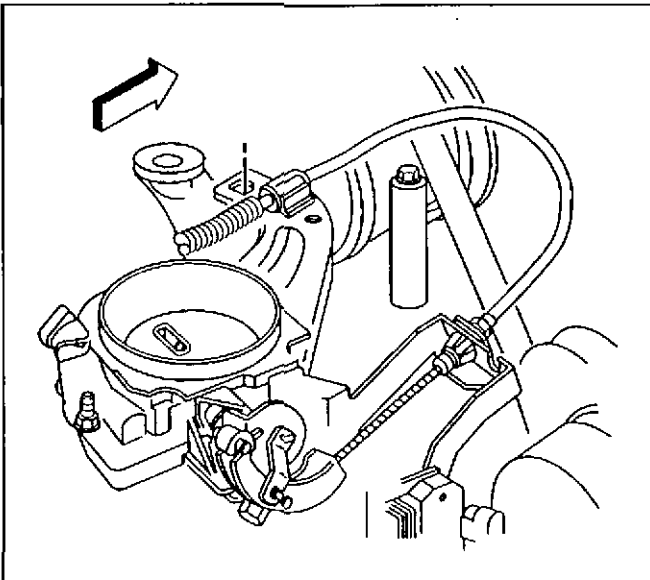
172997

6. Connect the fuel pipes to the rear of the engine. Refer to *Fuel Hose/Pipes Assembly Replacement (Fuel Pipes)* in Engine Controls.



341228

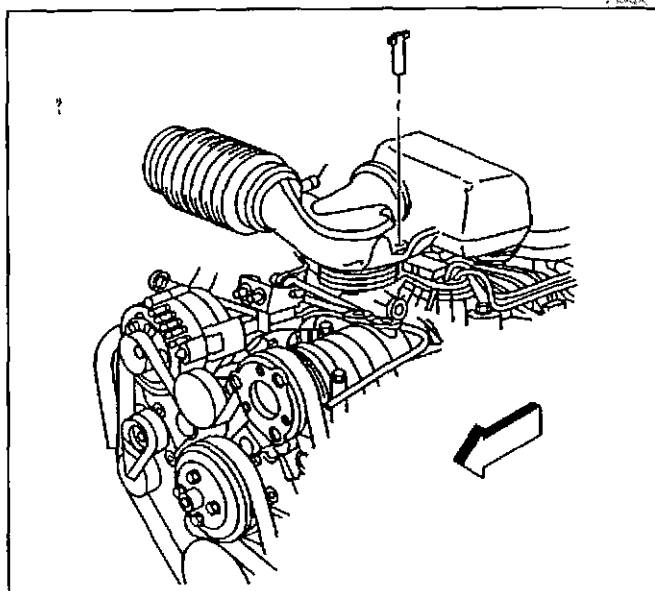
7. Install the AIR check valve (crossover) pipe, if so equipped.
8. Connect the electrical connectors.
9. Install the accelerator control cable bracket.



216754

10. Connect the accelerator control cable and the cruise control cable, if equipped. Refer to *Accelerator Controls Cable Replacement* in Engine Controls.

11. Install the vacuum brake booster hose, if equipped.
12. Install the air cleaner assembly.
13. Connect the battery negative cable.



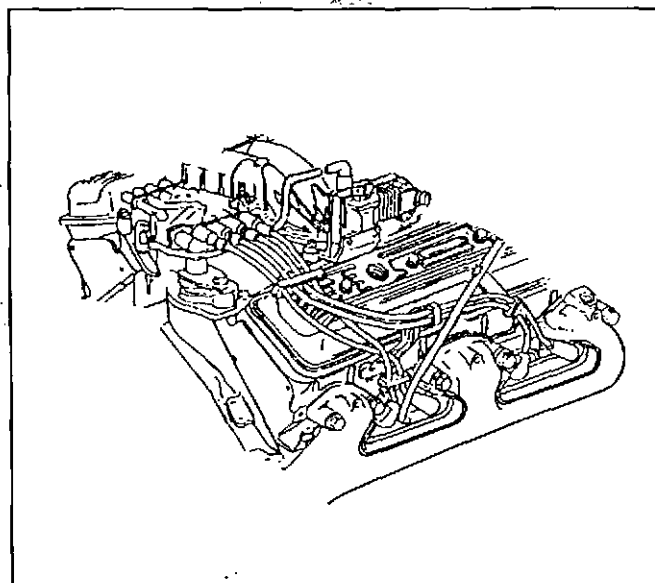
308131

SIE-ID - 332408

Valve Rocker Arm Cover Replacement

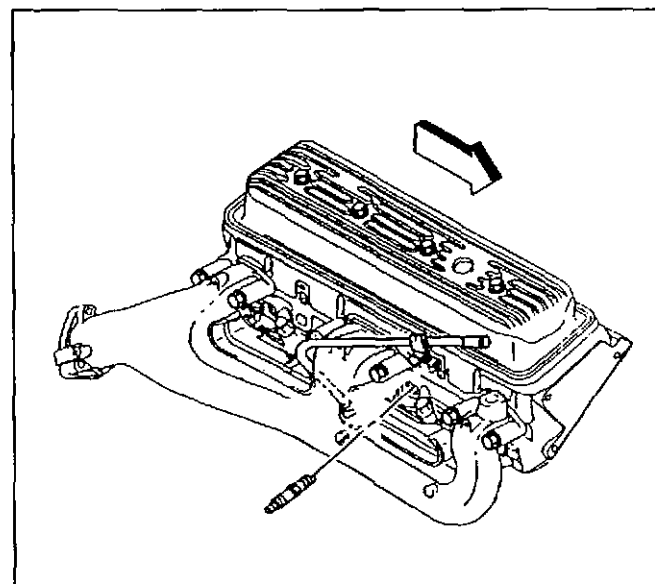
Removal Procedure

1. Disconnect the spark plug wires from the spark plugs. Refer to *Spark Plug Wire Harness Replacement (4.3L)* in Engine Electrical.
2. Disconnect the wiring harness from the clips, and move the harness aside.
3. Remove the air cleaner intake duct for access to the right valve rocker arm cover. Refer to Air Cleaner Assembly in Engine Controls.

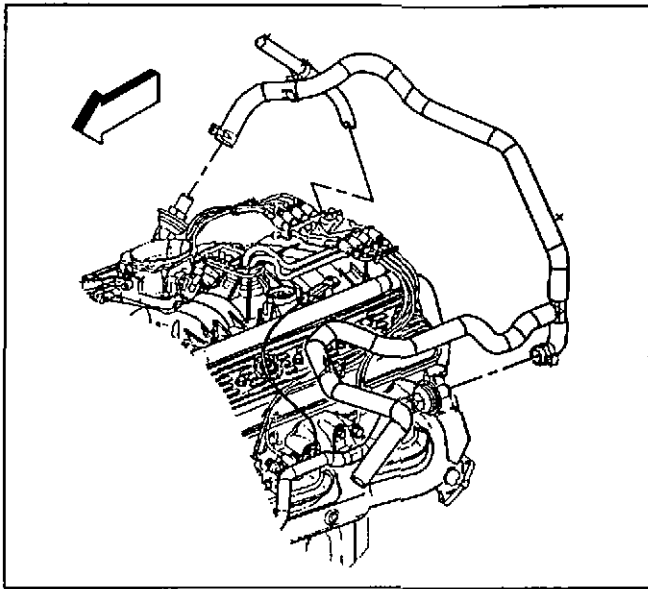


176070

4. Remove the bolts and oil level indicator tube bracket. Refer to *Oil Level Indicator and Tube Replacement*.

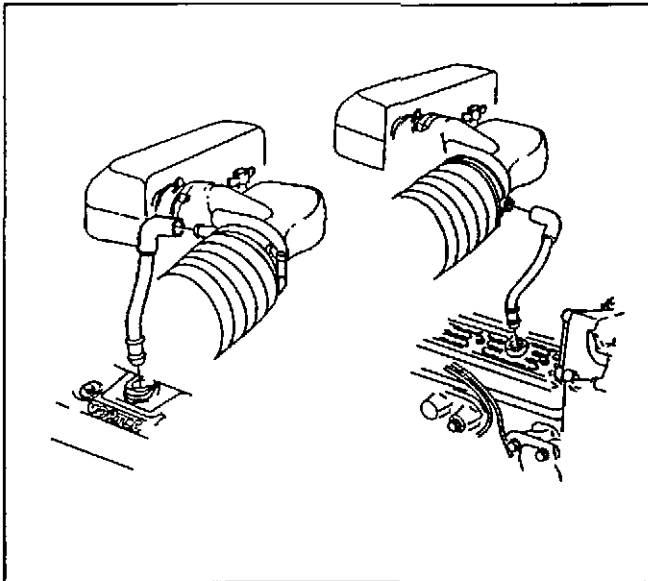


345189



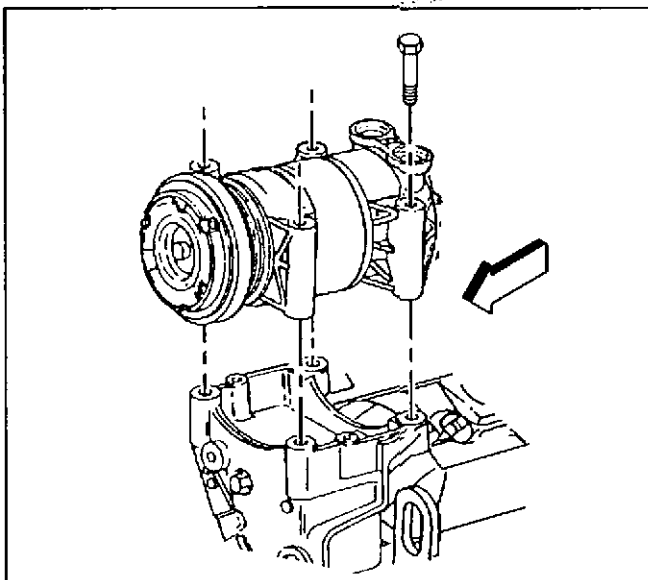
341228

5. Remove the AIR check valve (crossover), if so equipped.



173191

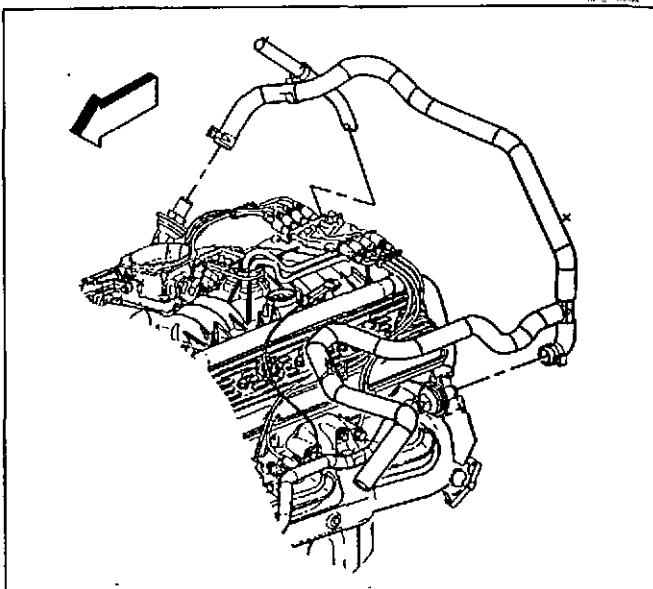
6. Remove the PCV tube.



179249

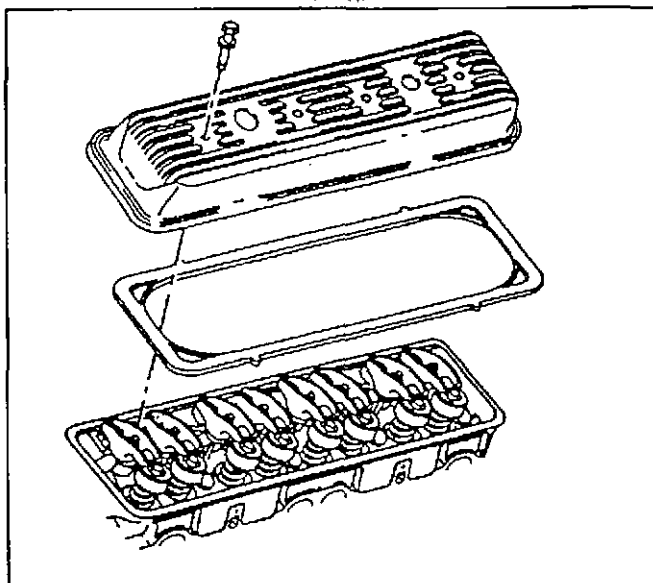
7. Remove the following components for access to the left valve rocker arm cover:
- 7.1. The air conditioning (A/C) compressor, if equipped, and lay the A/C compressor aside. Refer to *Compressor Replacement* (5.0L, 5.7L).
 - 7.2. The EGR valve inlet pipe
 - 7.3. The PCV and the hose
 - 7.4. The vacuum brake booster pipe, if equipped, and move it aside

8. Remove the AIR check valve (crossover) pipe, if so equipped.



341228

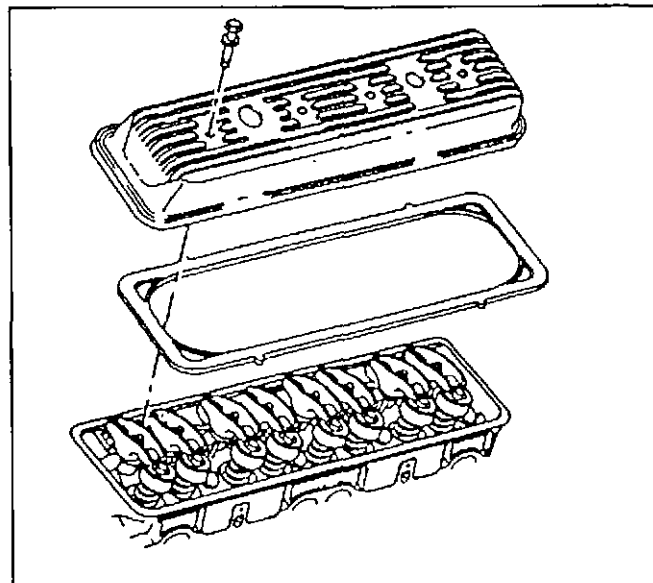
9. Remove the valve rocker arm cover and the gasket. Refer to *Valve Rocker Arm Cover Removal (Right)* and *Valve Rocker Arm Cover Installation (Left)*.
10. Clean all traces of old gasket from the valve rocker arm cover and the cylinder head. Refer to *Valve Rocker Arm Cover Clean and Inspect*.



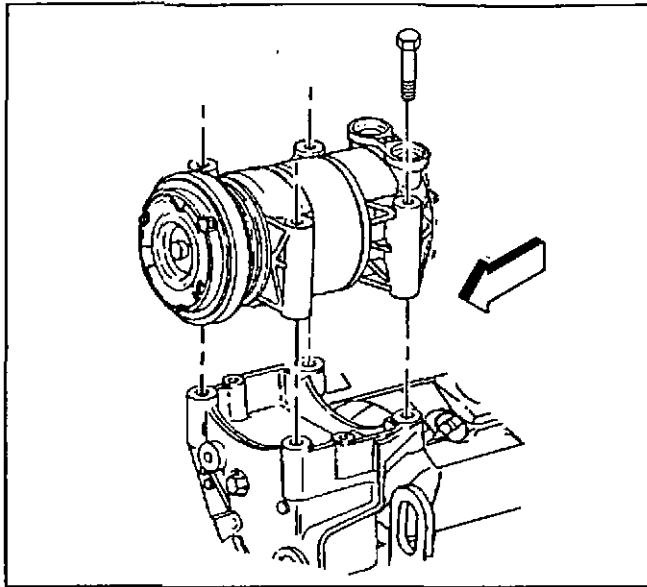
68709

Installation Procedure

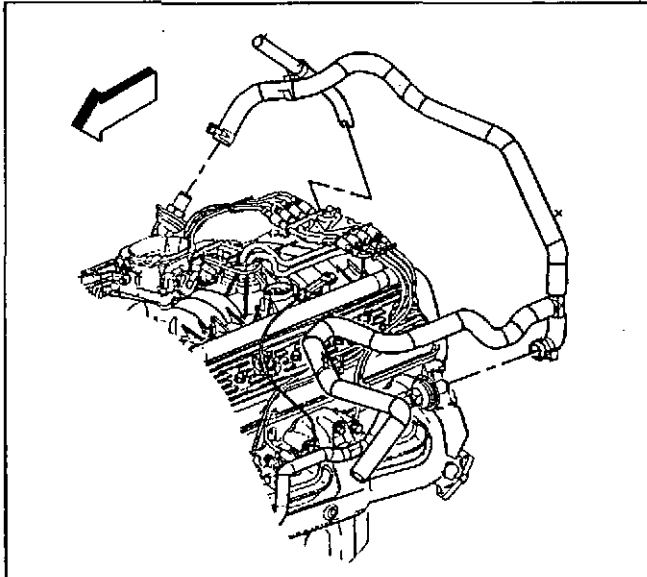
1. Install the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Installation (Left)*.



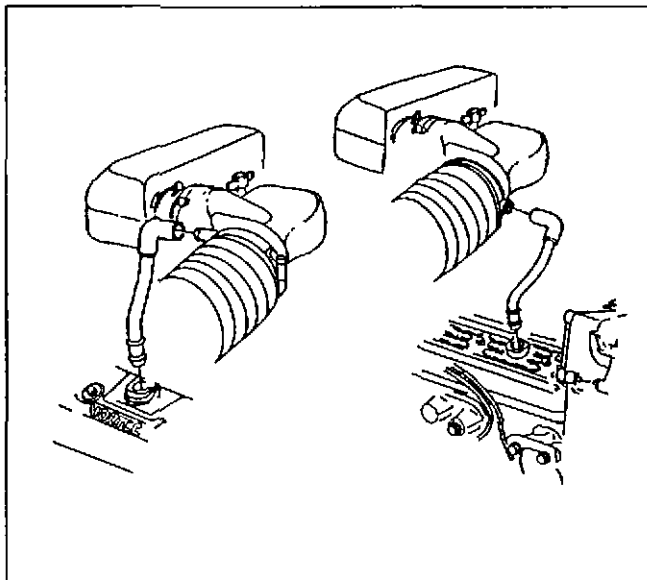
68709



179249



341228



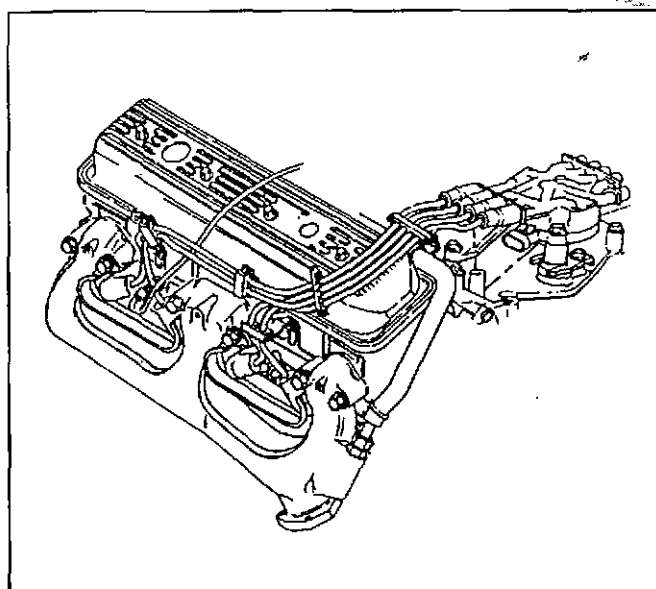
173191

2. Install the components as follows for the left valve rocker arm cover:
 - 2.1. The air conditioning compressor. Refer to *Compressor Replacement (5.0L, 5.7L)*.
 - 2.2. The EGR valve pipe. Refer to *Engine Controls*.
 - 2.3. The PCV and the hose
 - 2.4. The vacuum brake booster pipe

3. The AIR check valve (crossover) pipe, if equipped.

4. Install the components as follows for the right valve rocker arm cover:
 - 4.1. The air cleaner intake duct.
 - 4.2. The crankcase ventilation hose.
 - 4.3. The oil level indicator tube. Refer to *Oil Level Indicator and Tube Replacement*.
5. Install the wiring harnesses to the valve rocker arm cover clips.

6. Install the spark plug wires. Refer to *Spark Plug Wire Harness Replacement (4.3L)* in Engine Electrical.



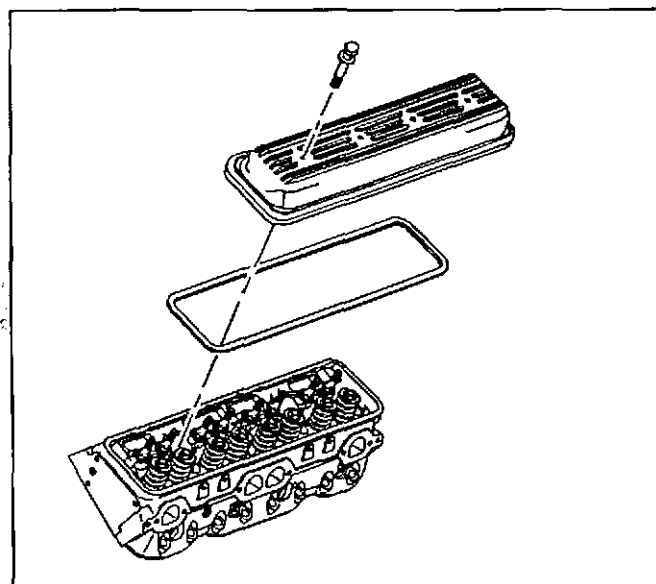
176067

SIE-ID # 332411

Valve Rocker Arm and Push Rod Replacement

Removal Procedure

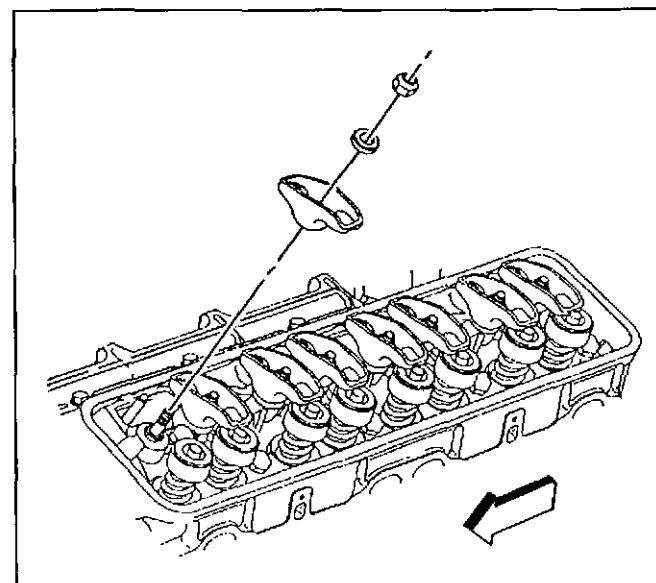
1. Remove the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Replacement*.



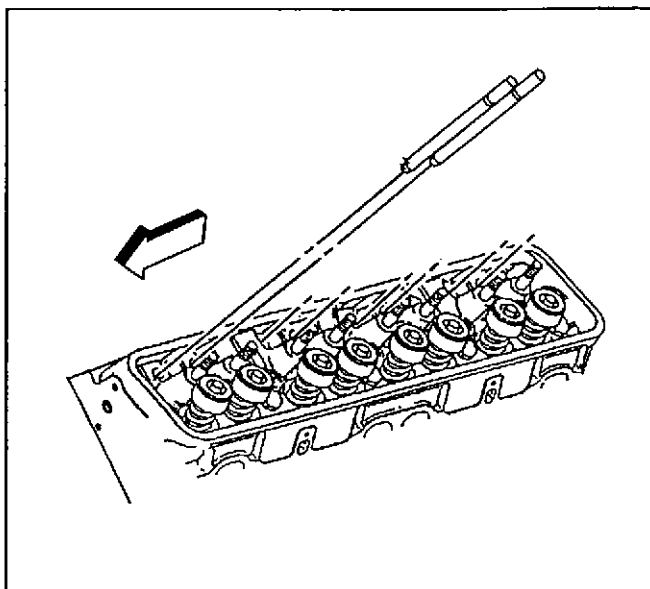
39119

Important: Store used components in order so that they can be reassembled in the same location.

2. Remove the valve rocker arm nut.
 - 2.1. If only the valve pushrod is being replaced, back the valve rocker arm nut off until the valve rocker arm can rotate away from the valve pushrod.
 - 2.2. Then remove the valve pushrod.
3. Remove the valve rocker arm with the valve rocker arm ball.

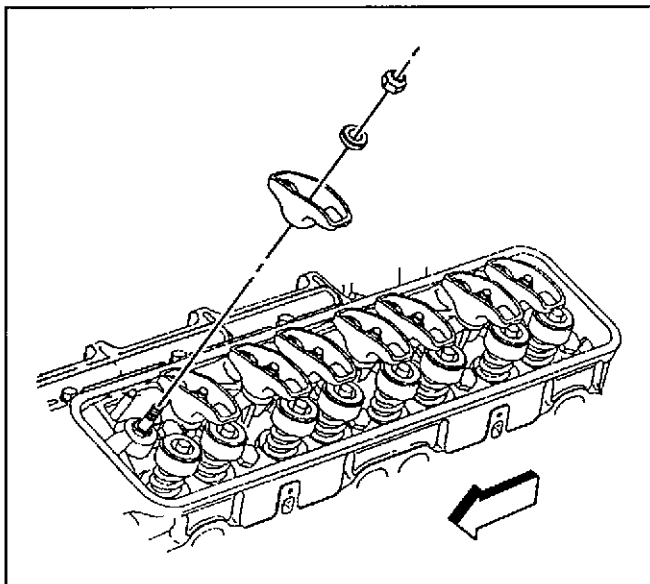


343916



343915

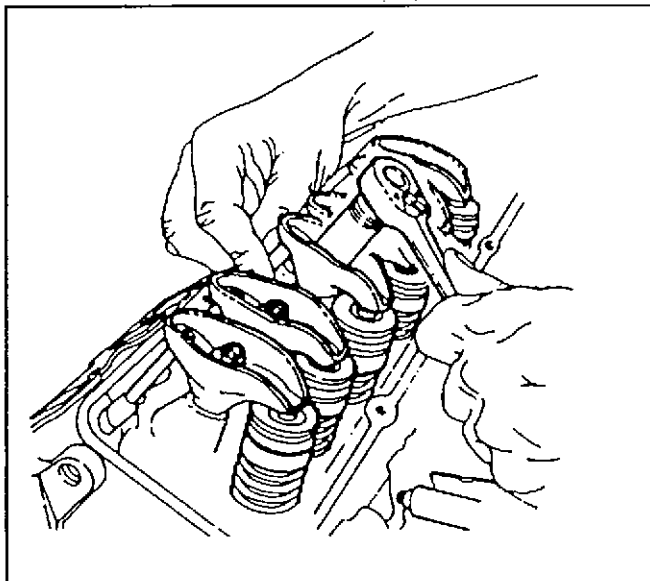
4. Remove the valve pushrod.
5. Clean and inspect all parts. Refer to *Valve Rocker Arm and Push Rods Clean and Inspect*.



343916

Installation Procedure

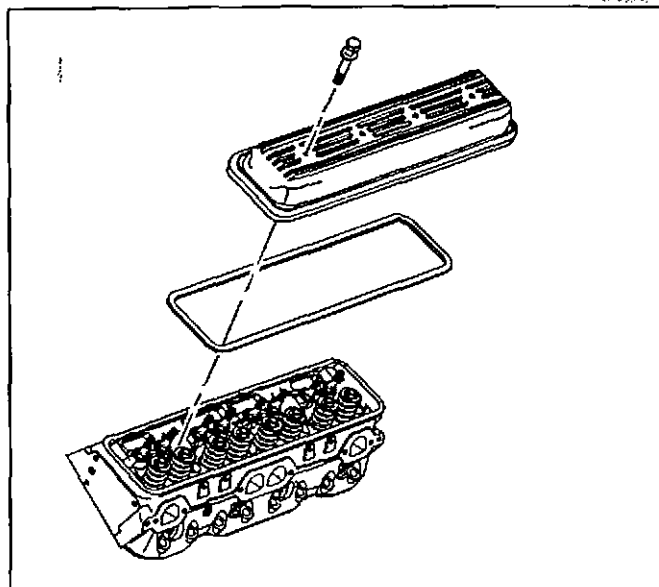
1. Install the valve pushrod. Refer to *Valve Rocker Arm and Push Rod Installation*.



22759

2. Adjust the valve lash. Refer to *Valve Lash Adjustment*.

3. Install the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Replacement*.



39119

SIE-ID - 332413

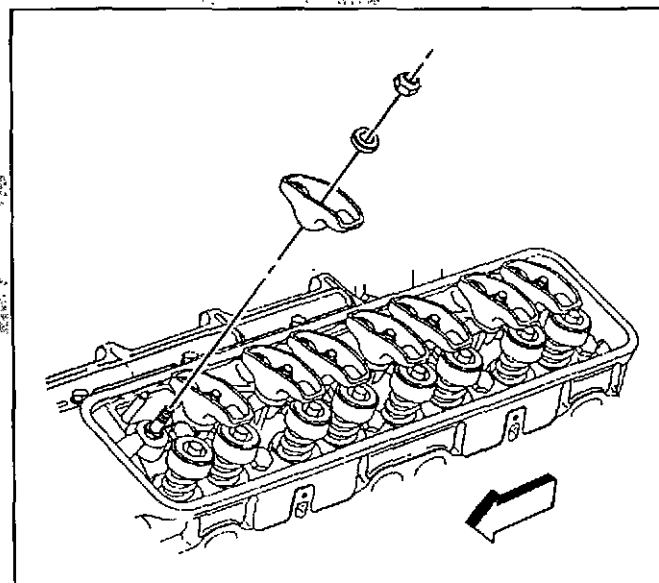
Valve Stem Oil Seal and Valve Spring Replacement

Removal Procedure

Tools Required

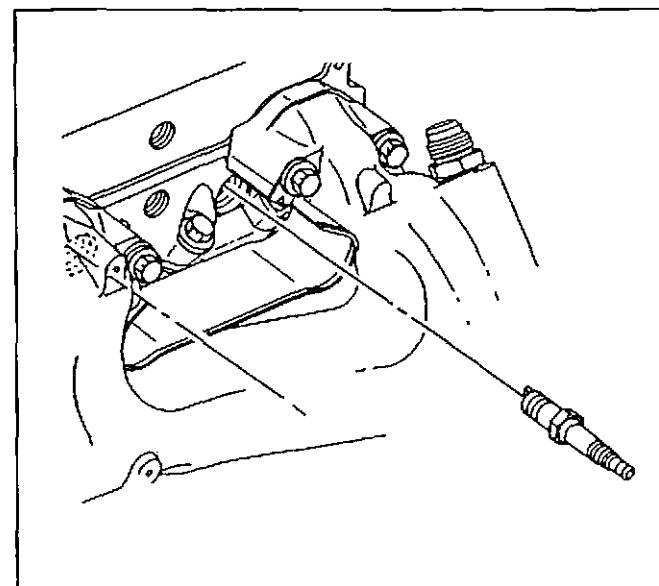
- J 22794 Spark Plug Port Adapter
- J 38606 Valve Spring Compressor
- J 5892-D Valve Spring Compressor

1. Remove the valve rocker arms. Refer to *Valve Rocker Arm and Push Rod Replacement*.

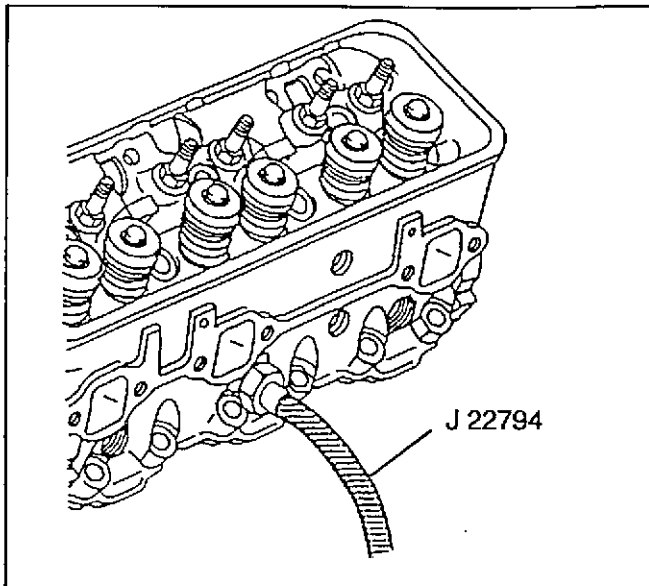


343916

2. Remove the spark plugs. Refer to *Spark Plug Replacement*.



172979

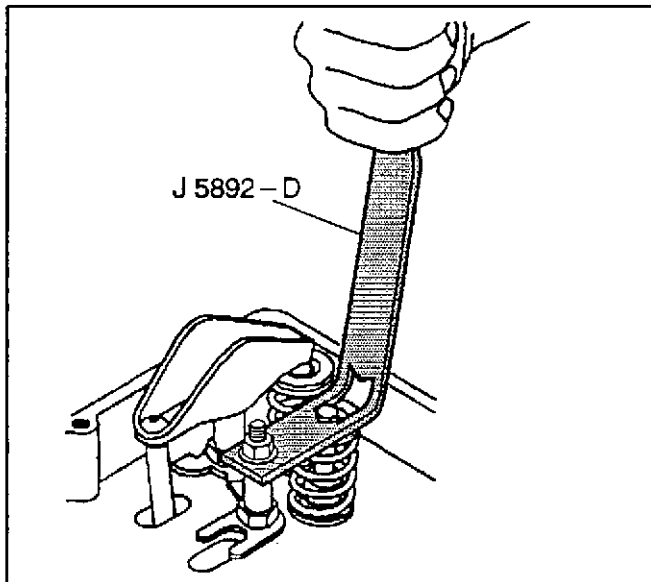


65039

3. Install the J 22794 into the spark plug hole.

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

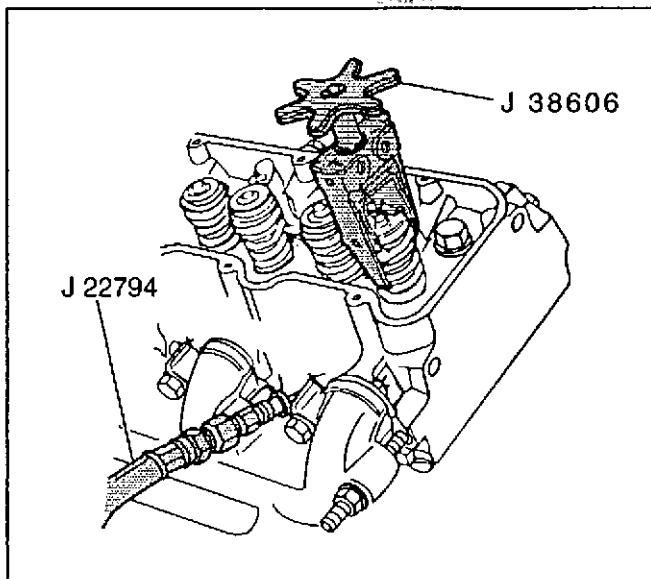
4. Apply compressed air in order to hold the valves in place.



1964

5. Install the valve rocker arm nut.

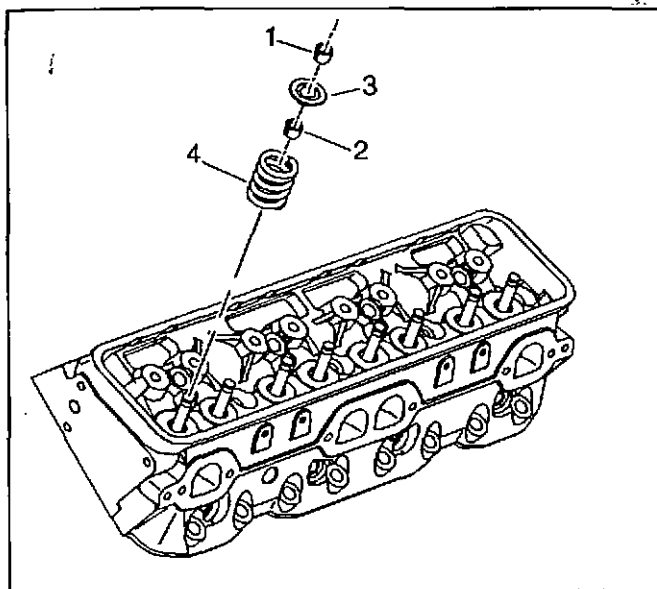
6. Use the J 5892-D in order to compress the valve spring.



218211

7. Use the J 38606 if clearance does not permit use of J 5892-D.

8. Remove the valve stem keys (1).
9. Carefully release the valve spring tension.
10. Remove the *J 5892-D* or the *J 38606*.
11. Remove the valve spring cap and valve spring (4).
12. Remove the valve stem oil seal (2).



69538

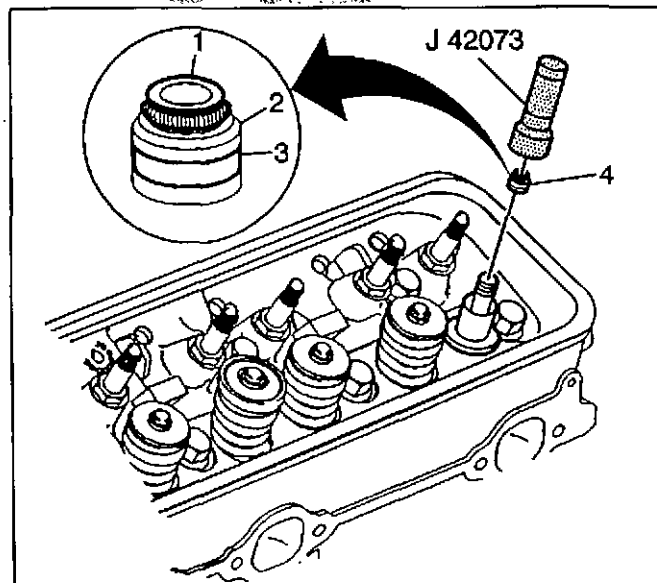
Installation Procedure

Tools Required

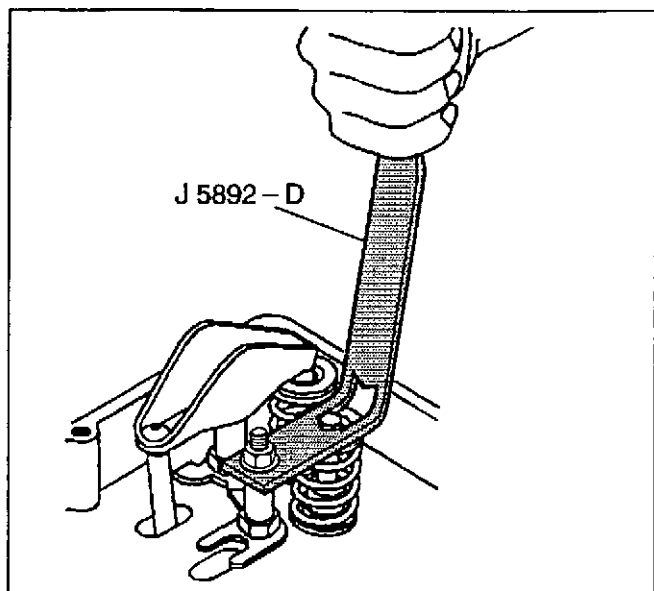
- *J 22794* Spark Plug Port Adapter
- *J 38606* Valve Spring Compressor
- *J 5892-D* Valve Spring Compressor
- *J 42073* Valve Stem Seal Installer

Important: The exhaust valve oil seal has the letters EX (1) molded into the top of the seal. The seal material is brown in color (2) with a white stripe (3) painted on the outside diameter of the seal.

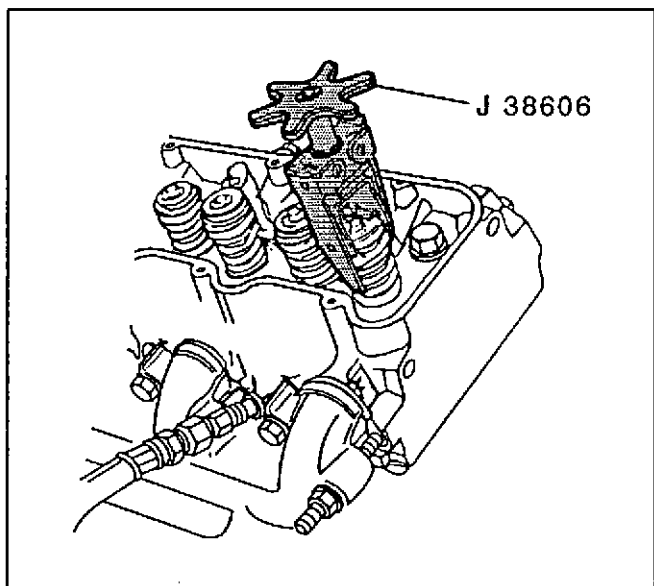
1. Select the proper valve stem oil seal for the specific valve guide.
2. Lubricate the valve stem oil seal and guide with clean engine oil.
The exhaust and intake valve seals are not interchangeable.
3. Assemble the valve stem oil seal onto the valve guide using the *J 42073* and a hammer.
Install the oil seal onto the valve guide until the installation tool bottoms against the valve spring seat.
4. Install the valve spring.



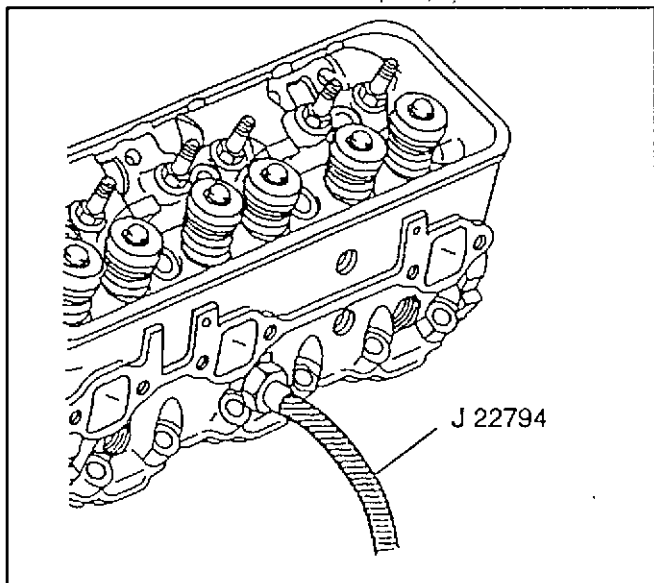
200320



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5. Use the *J 5892-D* in order to compress the valve spring.

6. Use the *J 38606* if clearance does not permit use of *J 5892-D*.

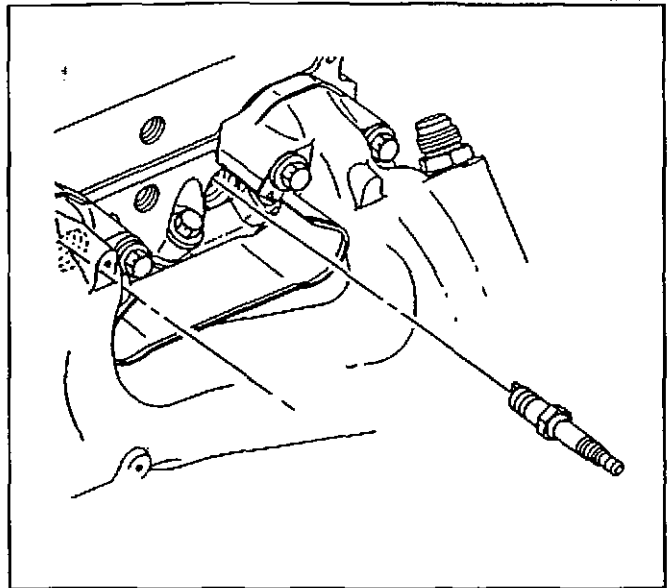
7. Install the valve stem keys (1).

Use grease in order to hold the valve stem keys in place.

8. Carefully release the valve spring pressure, making sure the valve stem keys stay in place.

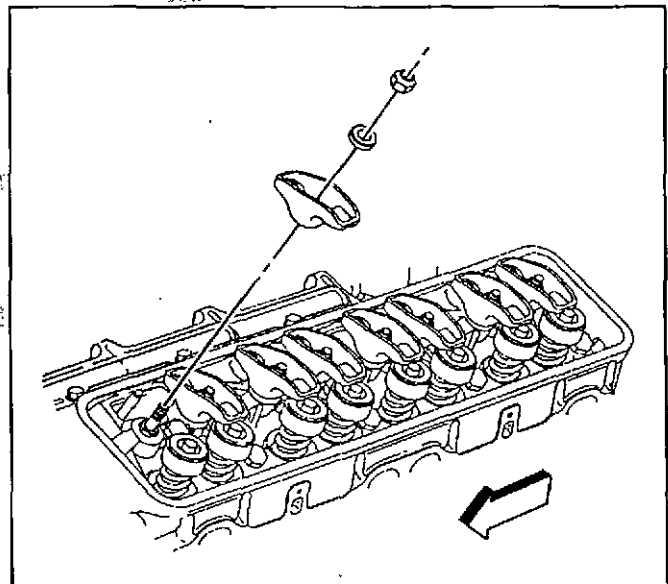
9. Remove the *J 5892-D* or *J 38606* and the *J 22794*.

10. Install the spark plugs. Refer to *Spark Plug Replacement*.



172979

11. Install the valve rocker arms. Refer to *Valve Rocker Arm and Push Rod Replacement*.



343916

SIE-ID - 332418

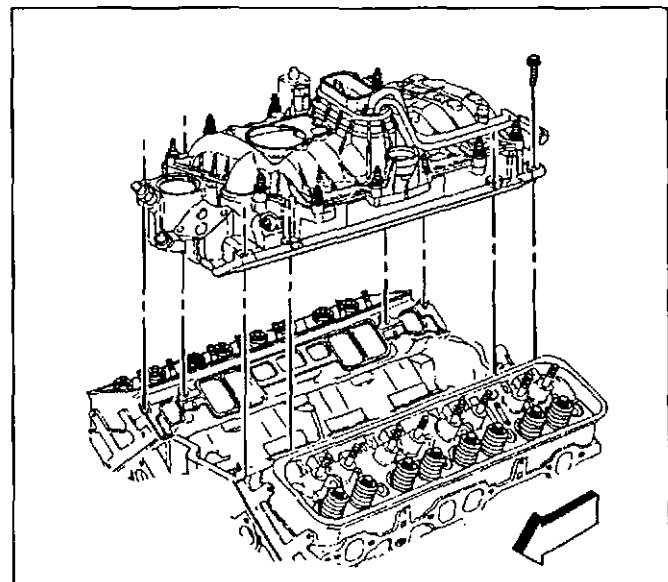
Valve Lifter Replacement

Removal Procedure

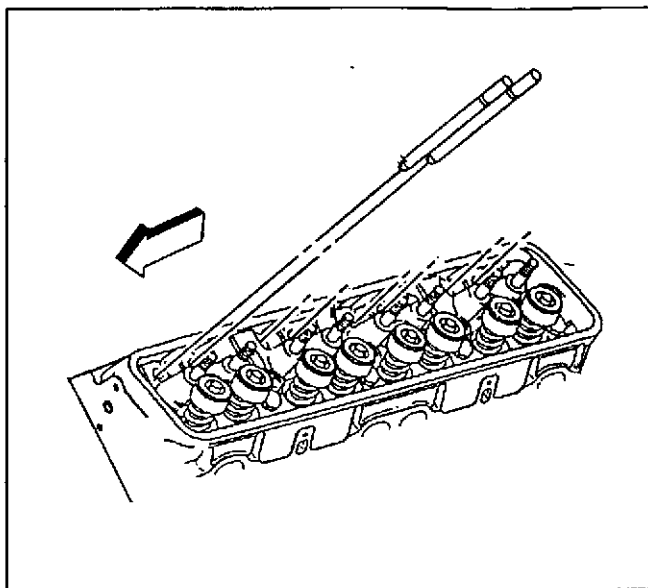
Tools Required

J 3049-A Valve Lifter Remover

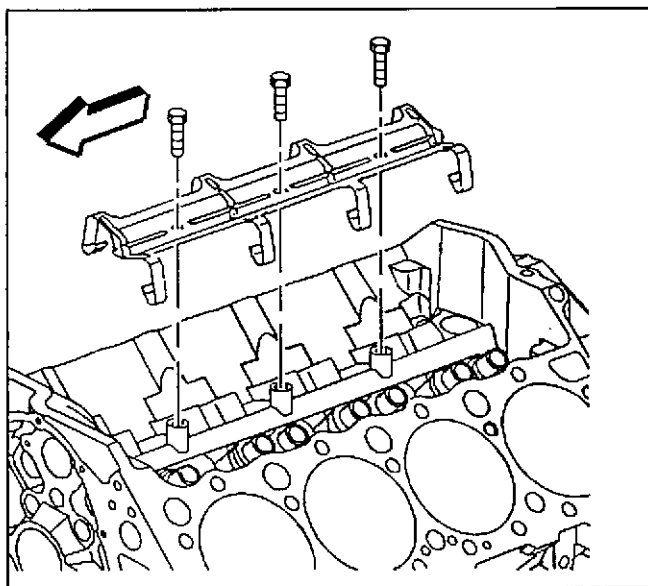
1. Remove the intake manifold. Refer to *Intake Manifold Replacement (Lower)*.



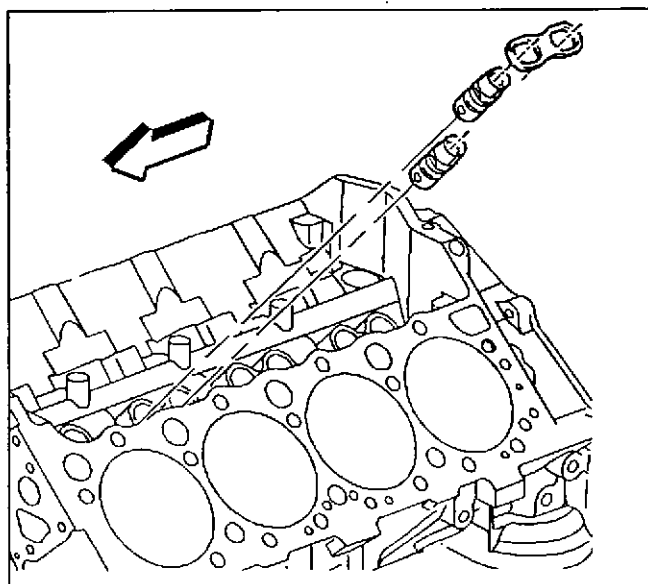
343948



343915



11508



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Important: The valve lifters and valve guides must be installed in the same location from which the valve lifter and valve guides were removed.

2. Remove the valve pushrods. Refer to *Valve Rocker Arm and Push Rod Replacement*

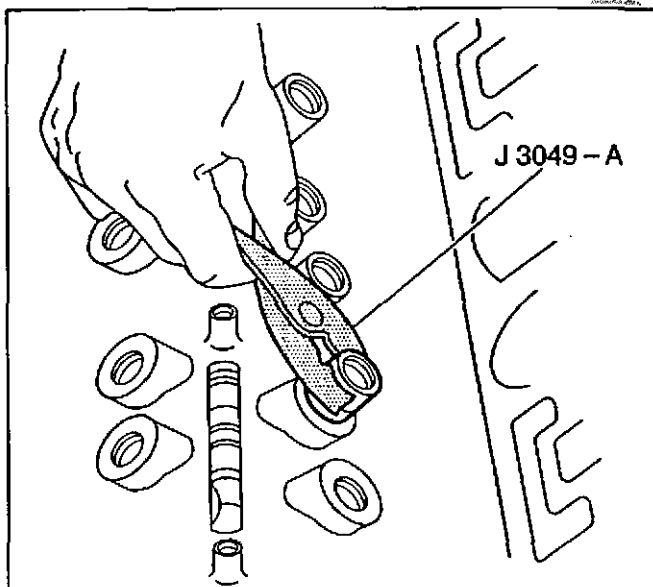
3. Remove the valve lifter guide retainer.

4. Remove the valve lifter guides.

Important: Place the valve lifters in a rack in the upright position in order to maintain the oil inside the valve lifter.

5. Place the lifters and guides in an organizer rack.

6. A stuck valve lifter can be removed using the J 3049-A.
Refer to *Cylinder Head Replacement* to obtain access to the valve lifter.
7. Inspect the valve lifter. Refer to *Valve Lifters and Guides Clean and Inspect*.



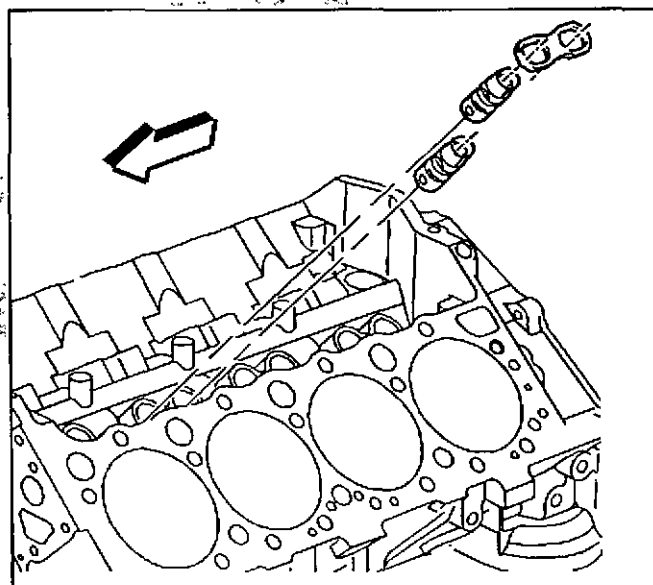
31350

Installation Procedure

Important:

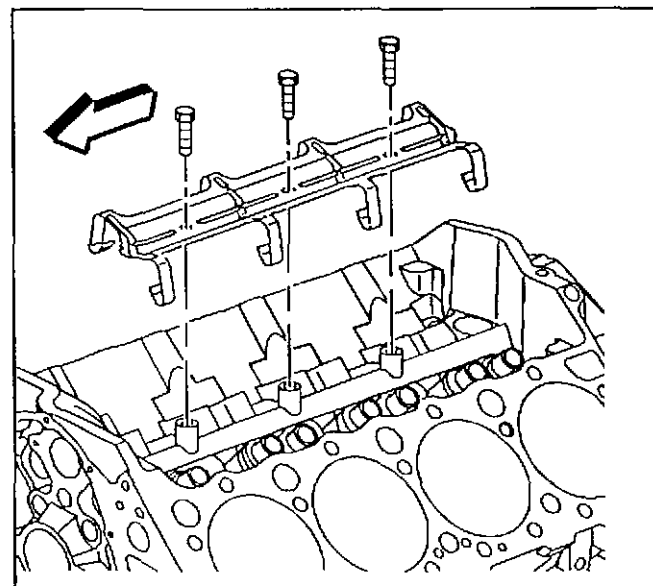
- When the new valve lifters or a new engine camshaft is installed, change the engine oil and the oil filter. Refer to *Engine Oil and Oil Filter Replacement*.
- Add Engine Oil Supplement GM P/N 1051396 or the equivalent to the engine oil.
- Replace the valve lifters as required when a new engine camshaft is installed.

1. Install the valve lifters one at a time.

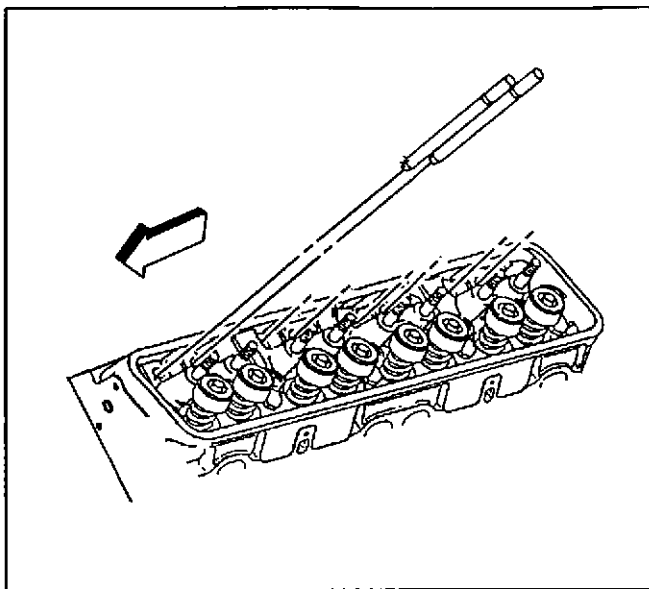


11509

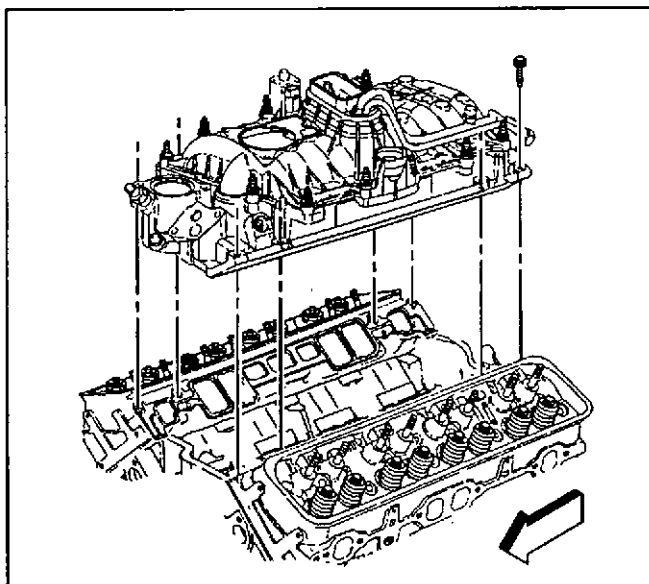
2. Install the valve lifter guide retainer. Refer to *Valve Lifter Installation*.



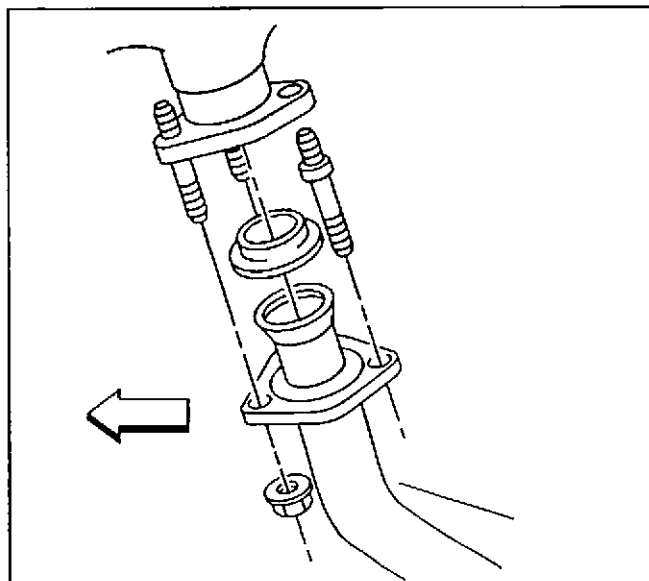
11508



343915



343948



42940

3. Install the pushrods. Refer to *Valve Rocker Arm and Push Rod Installation*.

4. Install the intake manifold. Refer to *Intake Manifold Replacement (Lower)*.

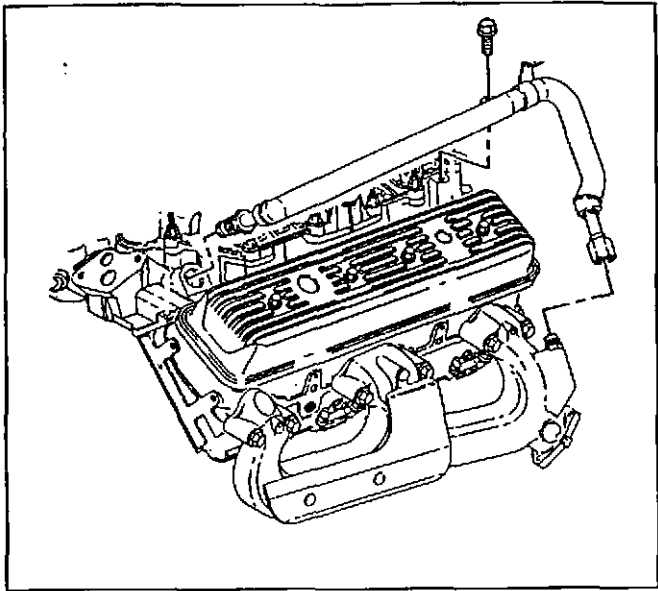
SIE-ID - 332420

Exhaust Manifold Replacement (Left Side)

Removal Procedure

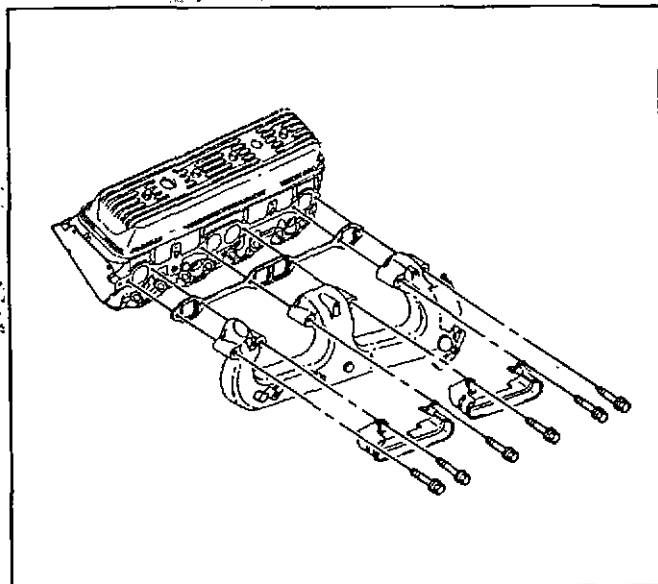
1. Remove the exhaust pipe from the exhaust manifold.
2. Disconnect the oxygen sensor electrical connector.

3. Disconnect the EGR valve pipe from the exhaust manifold.



173206

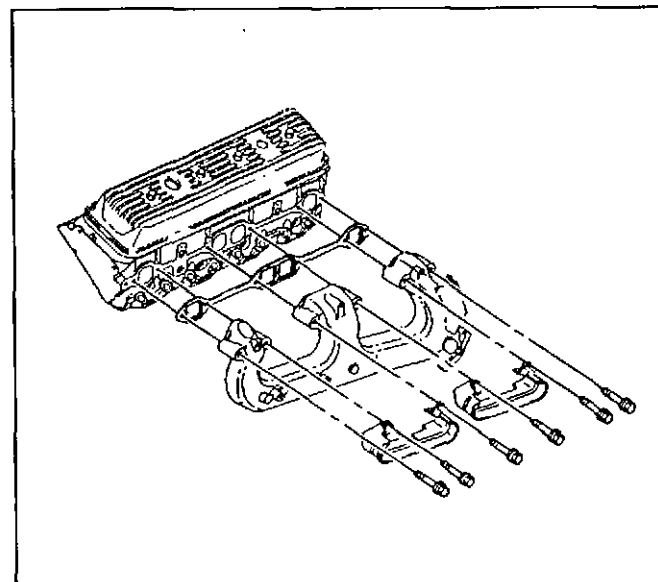
4. Remove the exhaust manifold bolts.
5. Remove the exhaust manifold. Refer to *Exhaust Manifold Removal (Left)*.
6. Clean all sealing surfaces. Refer to *Exhaust Manifold Clean and Inspect*.



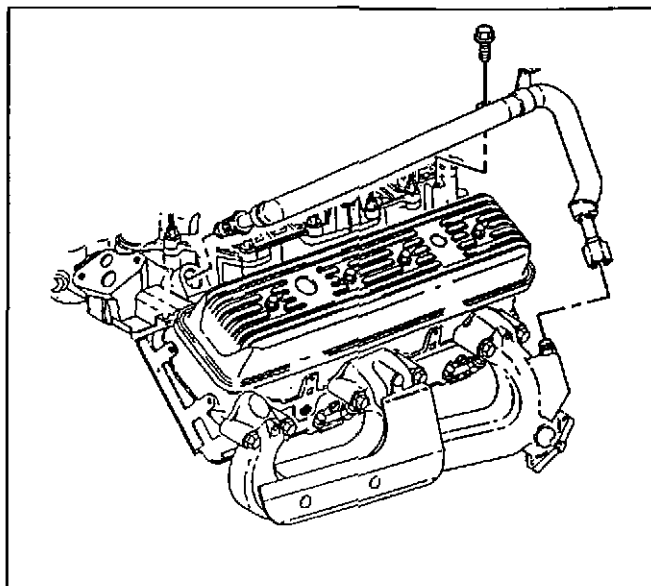
176061

Installation Procedure

1. Install the exhaust manifold. Refer to *Exhaust Manifold Installation (Left)*.



176061



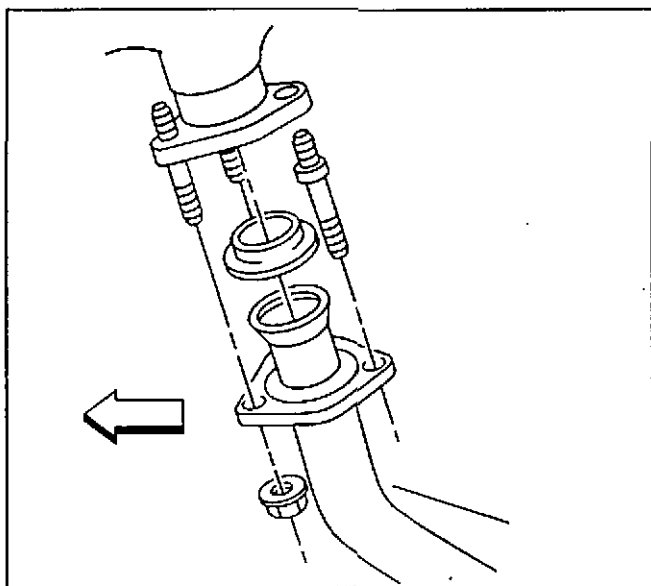
173206

Caution: Refer to *Battery Disconnect Caution* in *Cautions and Notices*.

2. Connect the EGR valve pipe to the exhaust manifold.

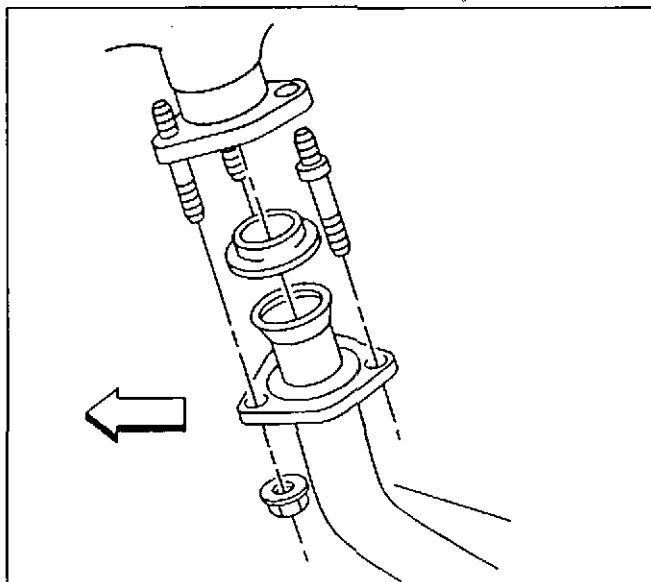
Tighten

Tighten the EGR valve pipe nut to 30 N.m(22 lb ft).



42940

3. Install the exhaust pipe to the exhaust manifold. Refer to *Exhaust Manifold Pipe Replacement (Diesel)* in *Engine Exhaust*.
4. Connect the oxygen sensor electrical connector.



42940

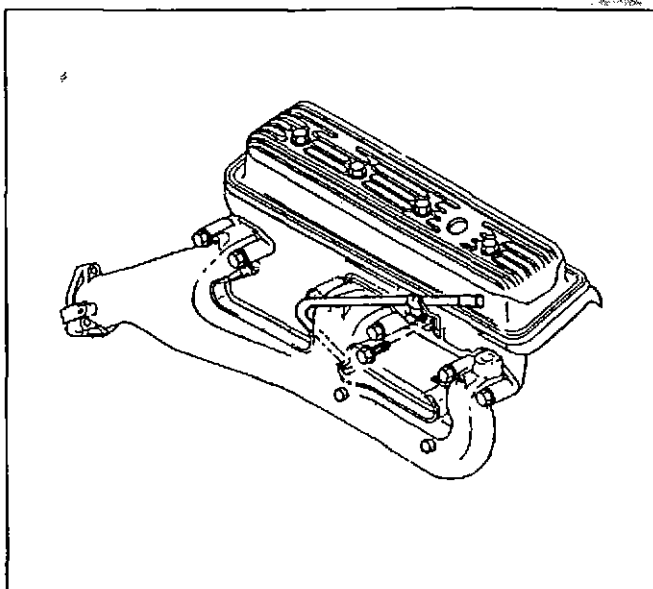
SIE-ID - 332421

Exhaust Manifold Replacement (Right Side)

Removal Procedure

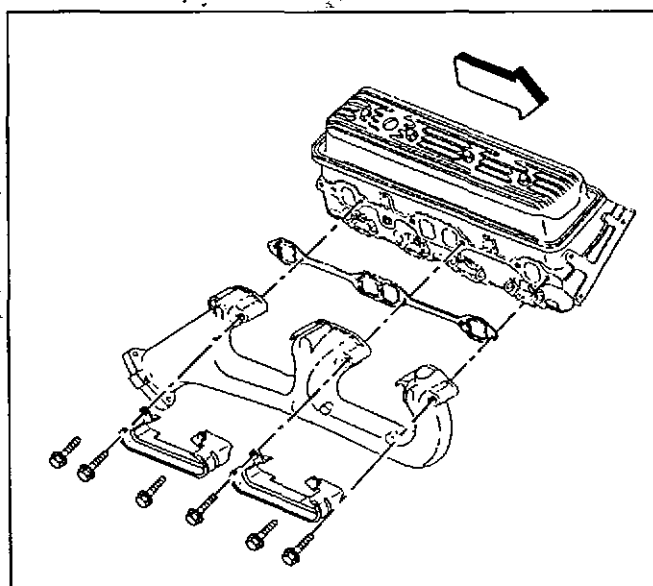
1. Remove the exhaust pipe from the exhaust manifold. Refer to *Exhaust Manifold Pipe Replacement (Diesel)* in *Engine Exhaust*.
2. Disconnect the oxygen sensor electrical connector.

3. Remove the air cleaner assembly.
4. Remove the bolt for the oil level indicator tube. Refer to *Oil Level Indicator and Tube Replacement*.



173203

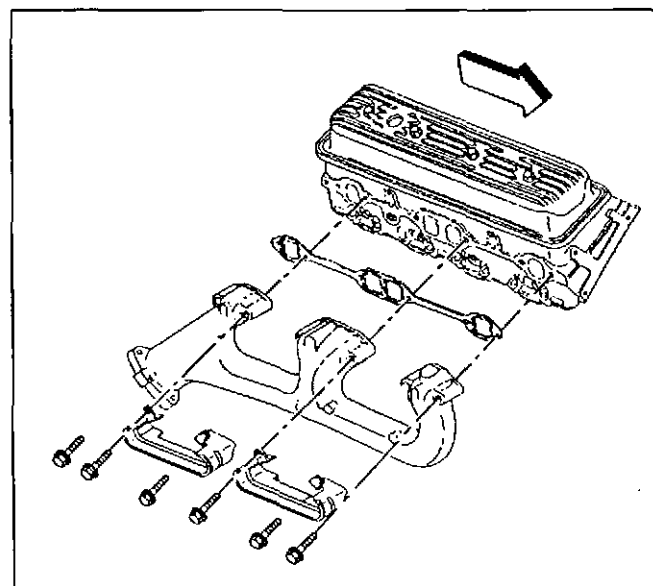
5. Remove the exhaust manifold bolts.
6. Remove the exhaust manifold. Refer to *Exhaust Manifold Removal (Right)*.
7. Clean all sealing surfaces. Refer to *Exhaust Manifold Clean and Inspect*.



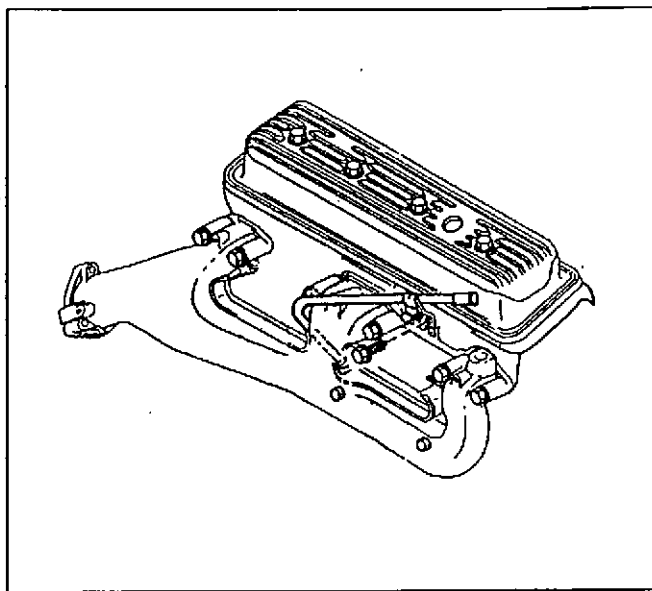
69032

Installation Procedure

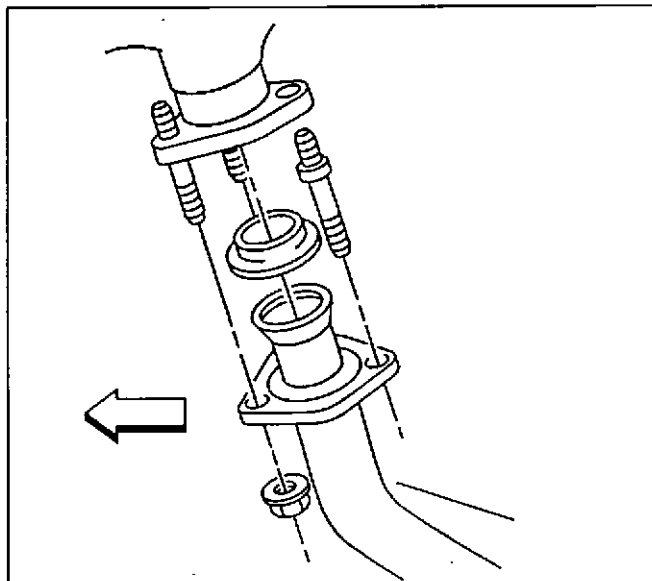
1. Install the exhaust manifold. Refer to *Exhaust Manifold Removal (Right)*.



69032



173203



42940

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the oil level indicator tube. Refer to *Oil Level Indicator and Tube Replacement*.

Tighten

Tighten the bolt to 12 N·m (106 lb in).

3. Install the air cleaner assembly.

4. Install the exhaust pipe to the exhaust manifold. Refer to *Exhaust Manifold Pipe Replacement (Diesel)* in Engine Exhaust.

5. Connect the oxygen sensor electrical connector.

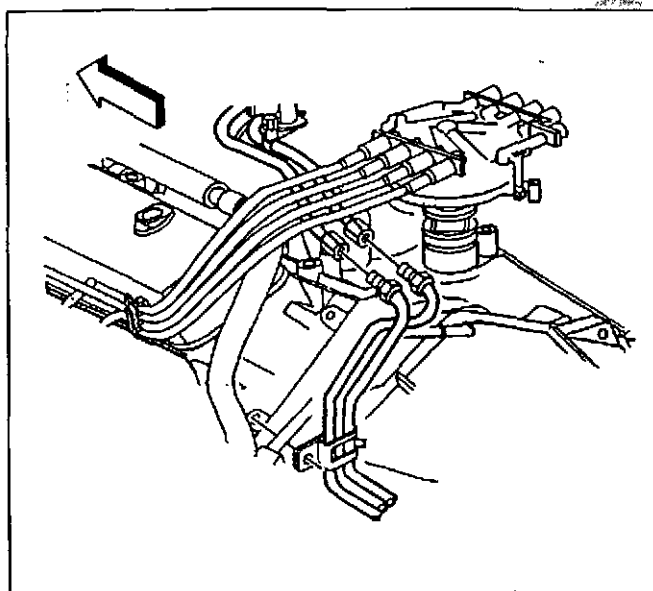
SIE-ID - 332428

Cylinder Head Replacement

Removal Procedure

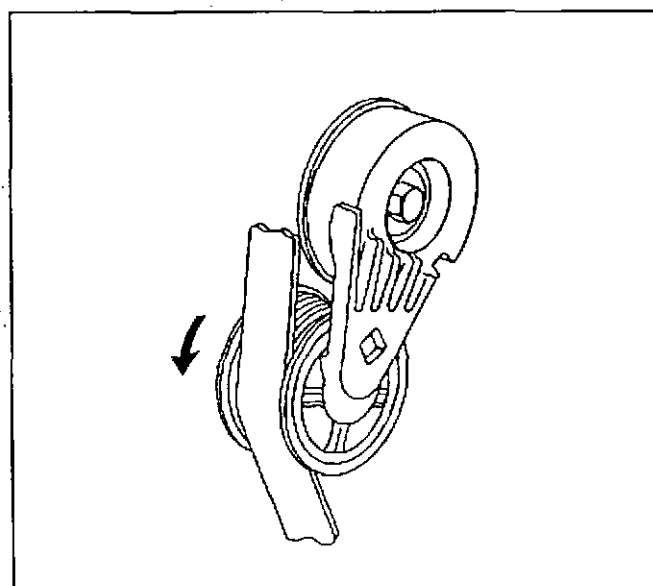
1. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in Engine Electrical.
2. Drain the engine coolant. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)*.
3. Remove the air cleaner assembly.
4. Remove the upper radiator hose. Refer to *Radiator Hose Replacement (5.0L)* in Engine Cooling.
5. Remove both heater hoses. Refer to *Heater Hoses Replacement (Inlet Hose - 5.0L, 5.7L, 7.4L)* and *Heater Hoses Replacement (Outlet Hose - 5.0L, 5.7L)* in Engine Cooling.

6. Disconnect the spark plug wires from the distributor cap.
7. Remove the distributor cap.
8. Remove the water pump inlet hose from the water pump.



343625

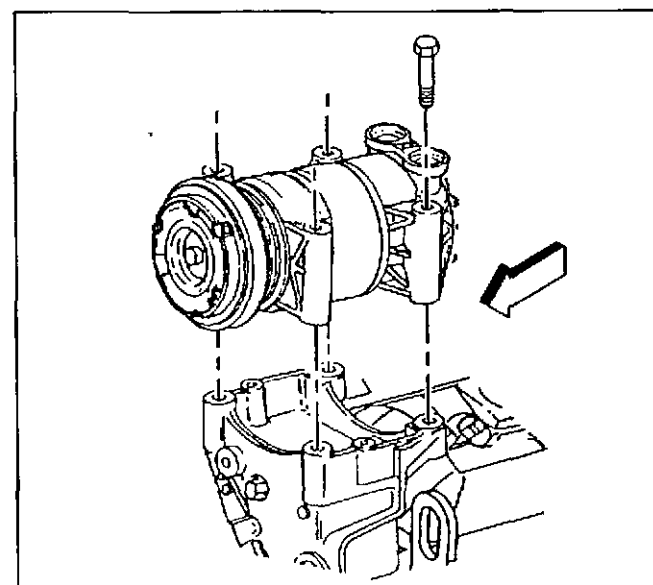
9. Remove the drive belt. Refer to *Drive Belt Replacement*.



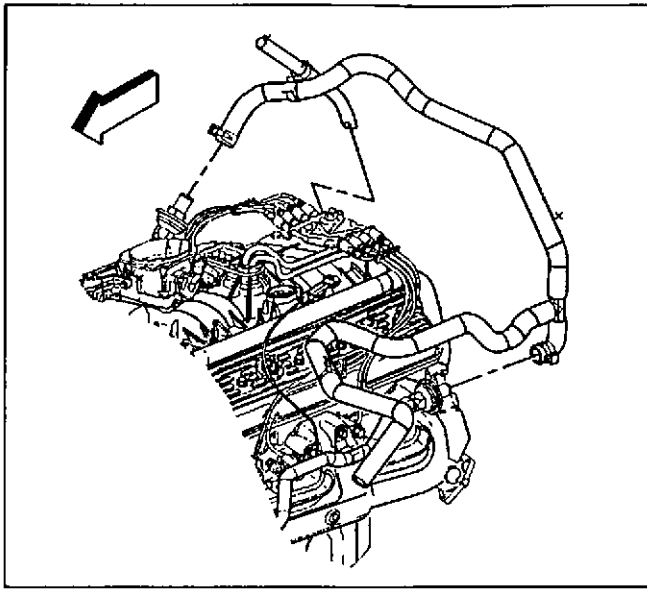
177620

Important: It is not necessary to evacuate the A/C refrigerant.

10. Remove the A/C compressor from the power steering bracket, if equipped, and set it aside.

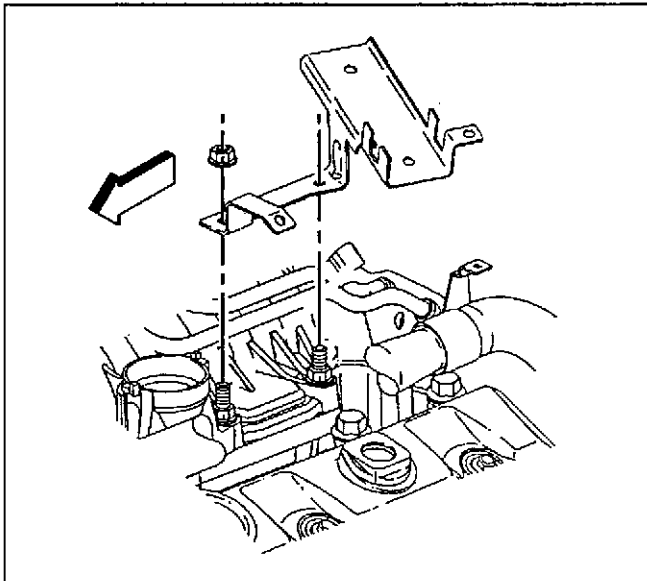


179249



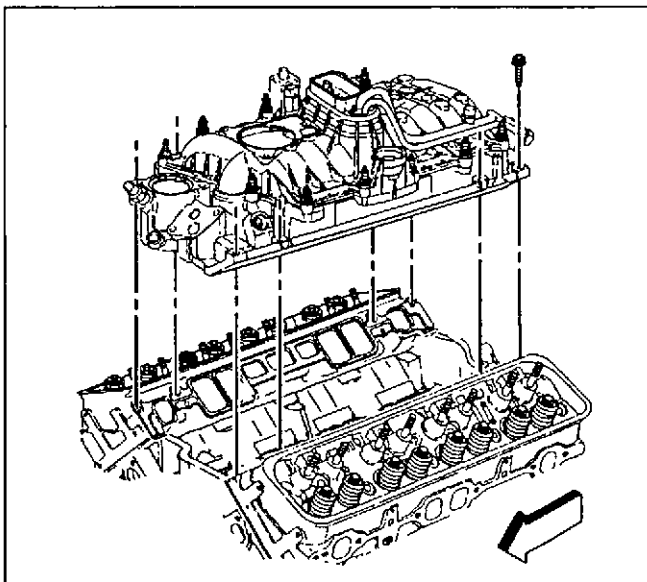
341228

11. Remove AIR check valve (crossover) pipe, if so equipped.



179250

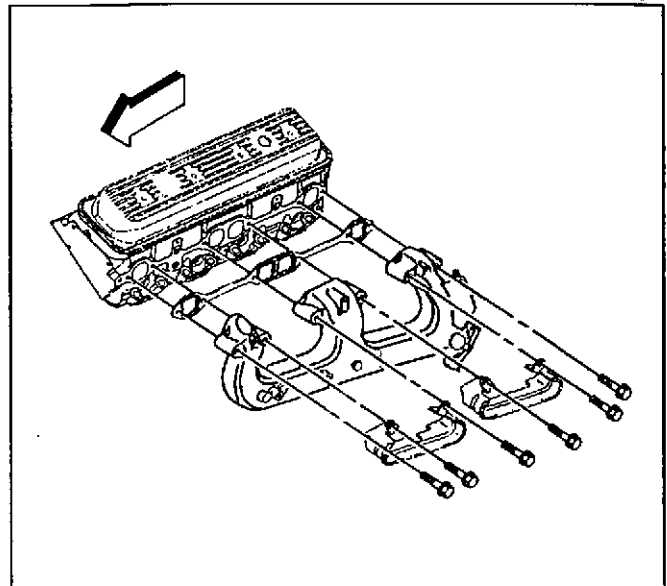
12. Remove the wiring bracket from the rear of the cylinder head.
13. Disconnect the accessory bracket and slide it forward.



343948

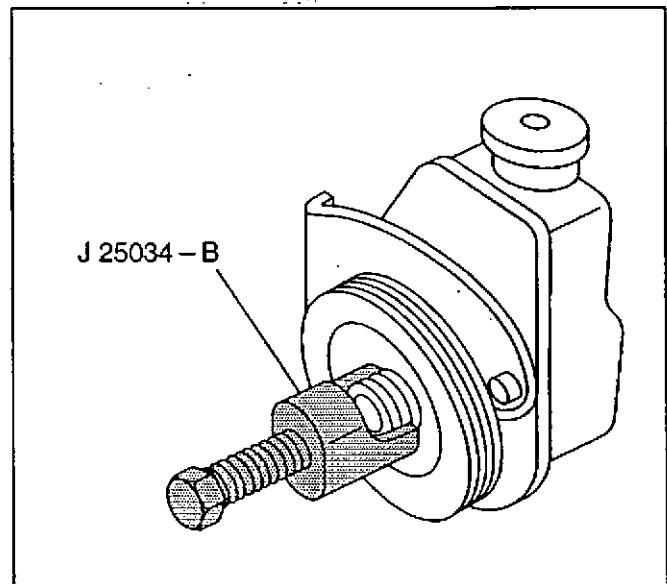
14. Remove the lower intake manifold. Refer to *Intake Manifold Replacement (Lower)*.

15. Remove the exhaust manifold. Refer to *Exhaust Manifold Replacement (Left Side)*.
16. Remove the valve rocker arms and pushrods. Refer to *Valve Rocker Arm and Push Rod Removal*.



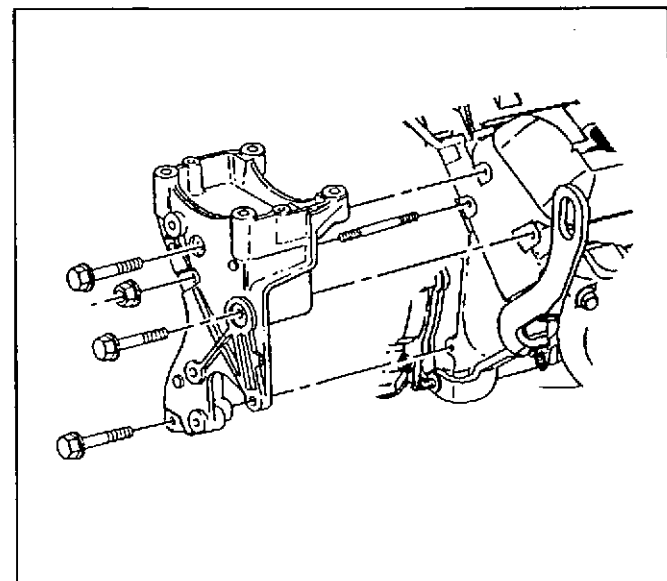
344217

17. Remove the power steering pump pulley.

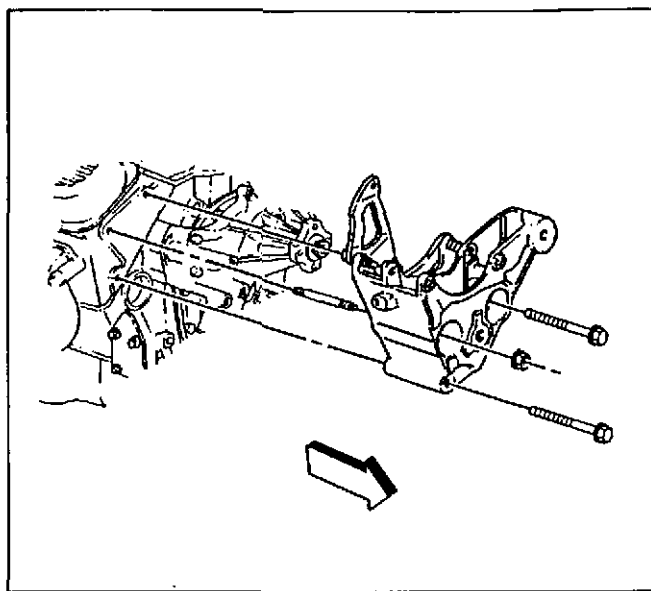


188649

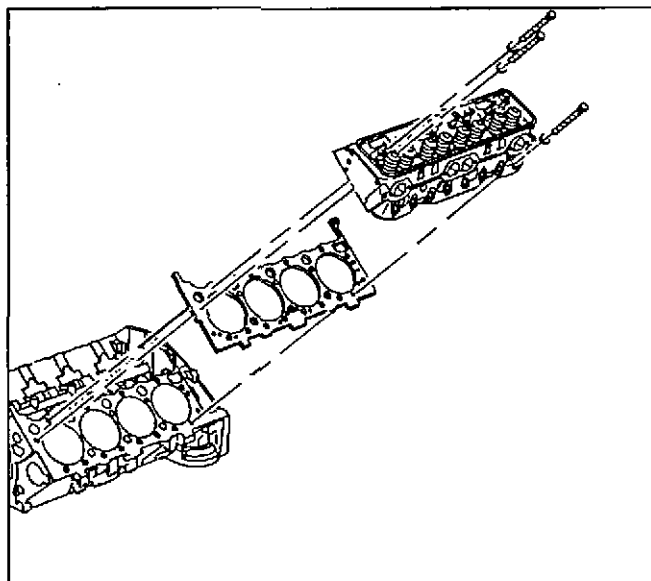
18. Remove the power steering pump mounting bracket using the following procedure:
 - 18.1. Disconnect the electrical connector from the power steering pump.
 - 18.2. Remove the two nuts holding the power steering pump to the engine.
 - 18.3. Remove the power steering pump mounting bracket bolts and the nut.
 - 18.4. Slide the power steering pump mounting bracket forward with the power steering pump still attached.
 - 18.5. Set the power steering pump and the mounting bracket aside.
 - 18.6. Remove the stud.
19. Disconnect the wiring bracket from the rear of the right cylinder head.



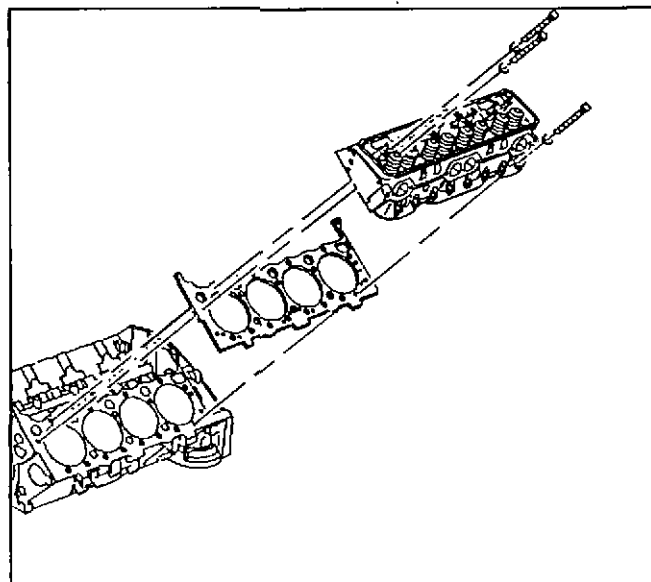
188295



344131



11482



11482

20. For the right side cylinder head, remove the following components:

- Generator. Refer to *Generator Replacement (ERROR - NOT IN CURRENT PSD)*.
- Oil indicator tube bracket bolt.

21. Remove the generator and drive belt tensioner bracket using the following procedure:

- 21.1. Remove the one nut.
- 21.2. Remove the three bolts.
- 21.3. Slide the generator and drive belt tensioner bracket off of the stud.
- 21.4. Remove the stud.

22. Remove the sixteen-cylinder head bolts.

23. Remove the cylinder head and the gasket.

24. Clean all sealing surfaces. Refer to *Cylinder Head Clean and Inspect*.

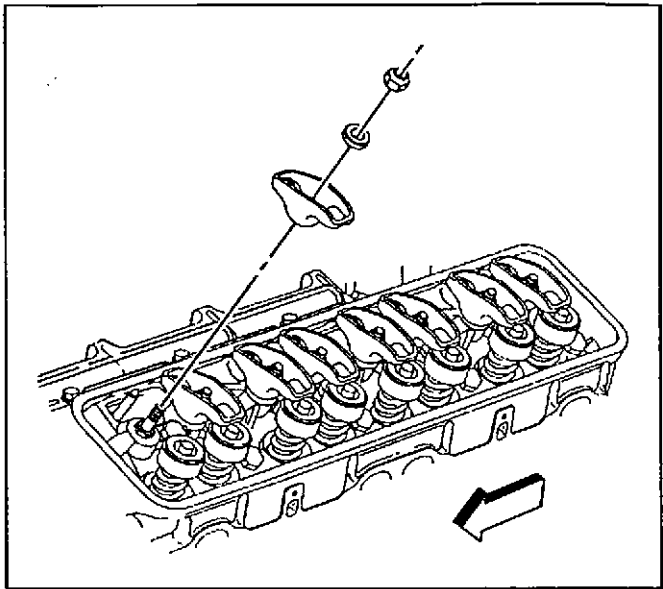
Installation Procedure

Tools Required

J 36660 Torque Angle Meter

1. Install the cylinder head.

2. Install the valve rocker arms and the valve pushrods. Refer to *Valve Rocker Arm and Push Rod Installation*.



343916

3. For the left side cylinder head, install the power steering pump mounting bracket using the following procedure:

Notice: Refer to *Fastener Notice* in Cautions and Notices.

- 3.1. Install the stud to the cylinder head.

Tighten

Tighten the stud to 20 N·m (15 lb ft).

- 3.2. Loosely assemble the mounting bracket over the stud.

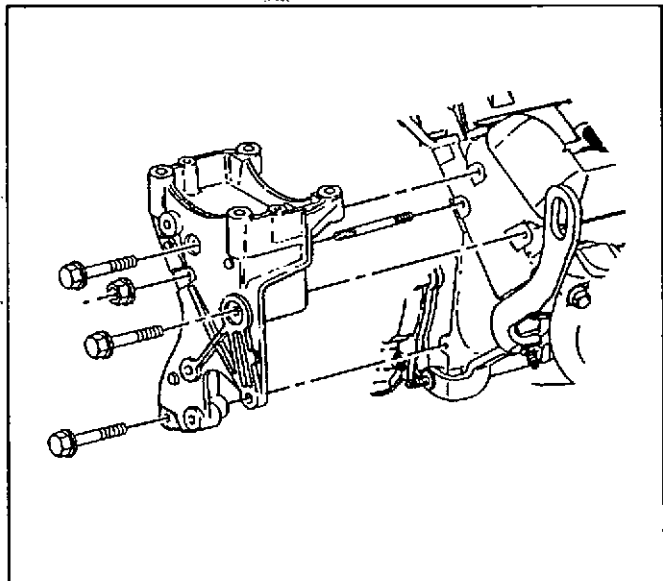
- 3.3. Install a nut to the stud finger tight.

- 3.4. Install the three bolts finger tight.

- 3.5. Install the two nuts to the power steering pump finger tight.

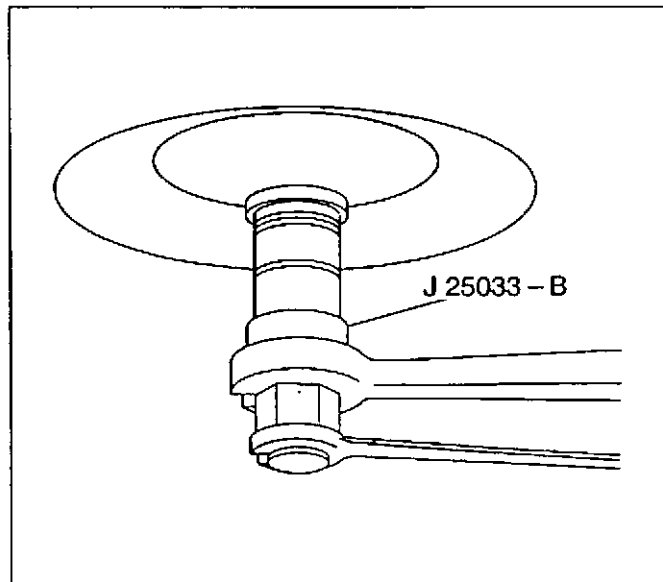
Tighten

Tighten the nuts and bolts to 41 N·m (30 lb ft).

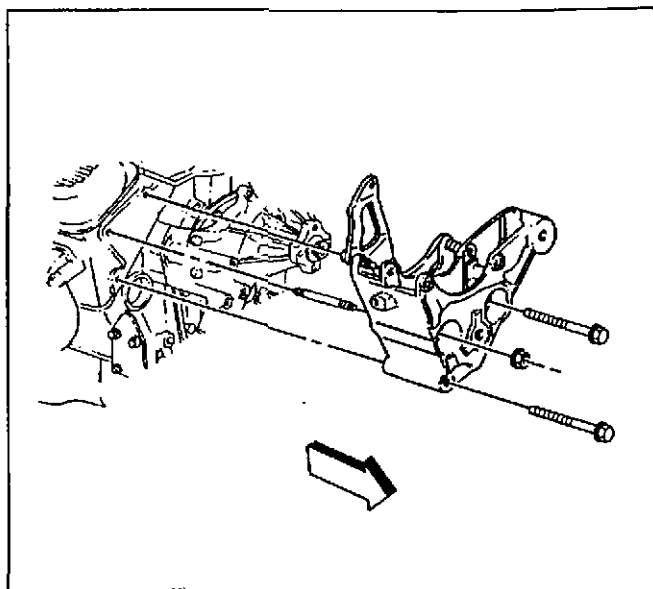


188295

4. Install the power steering pump pulley.
5. Connect the electrical connector to the power steering pump.



188373



344131

6. For the right side cylinder head, install the generator mounting bracket using the following procedure:

- 6.1. Install the stud.

Tighten

Tighten the stud to 20 N·m (15 lb ft).

- 6.2. Loosely assemble the generator mounting bracket over the stud.

- 6.3. Install a nut to the stud finger tight.

- 6.4. Install the three bolts finger tight.

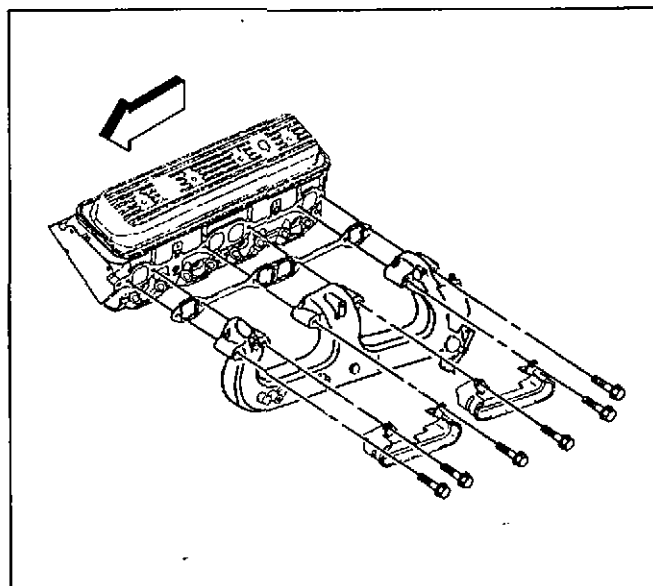
Tighten

Tighten the nuts and bolts to 41 N·m (30 lb ft).

- 6.5. Install the generator. Refer to *Generator Replacement (ERROR - NOT IN CURRENT PSD)*.

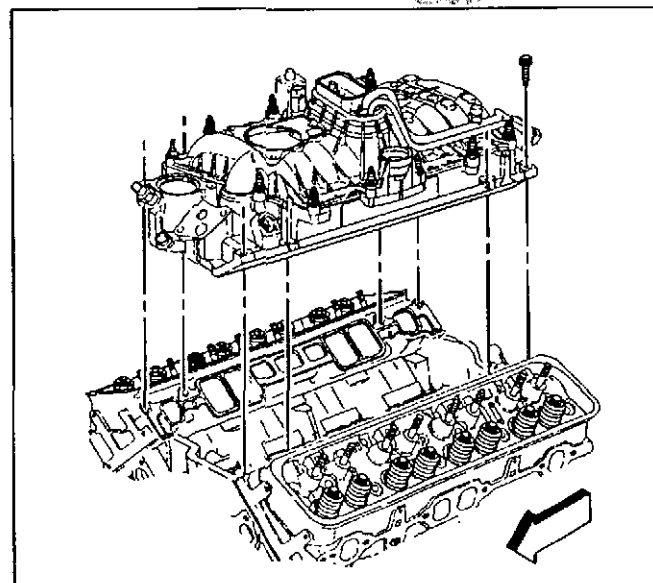
- 6.6. Oil indicator tube bracket bolt. Refer to *Oil Level Indicator and Tube Replacement*.

7. Install the exhaust manifold. Refer to *Exhaust Manifold Replacement (Left Side)*.



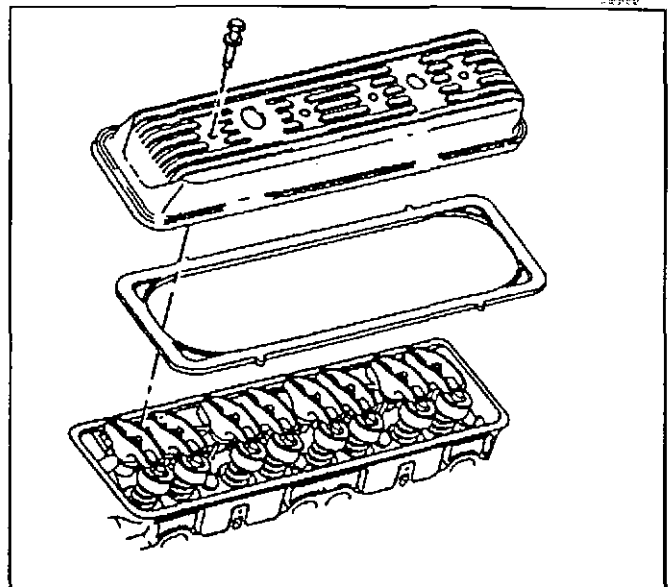
344217

8. Install the lower intake manifold. Refer to *Intake Manifold Replacement (Lower)*.



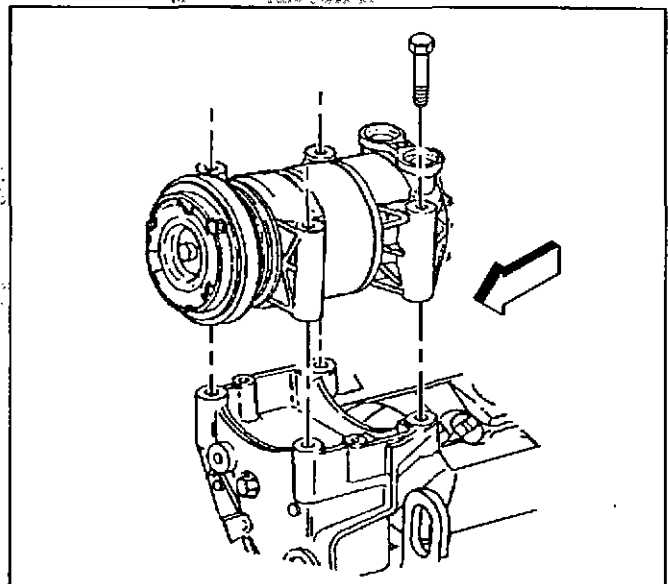
343948

9. Install the valve rocker arm covers. Refer to *Valve Rocker Arm Cover Replacement*.
10. Install the wiring bracket to the rear of the cylinder head.
11. Connect the accessory bracket.



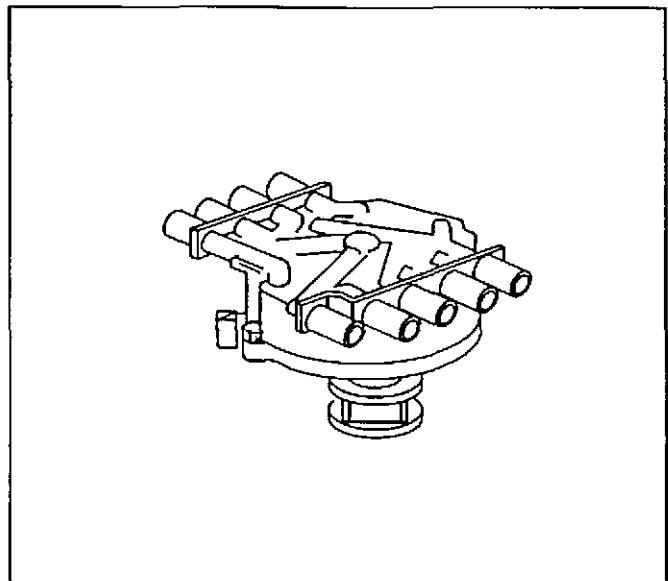
68709

12. Install the A/C compressor, if equipped. Refer to *Compressor Replacement in HVAC*.
13. Install the drive belt. Refer to *Drive Belt Replacement*.



179249

14. Install the distributor cap.
15. Connect the spark plug wires to the distributor cap.
16. Install both heater hoses. Refer to *Heater Hoses Replacement (Outlet Hose - 5.0L, 5.7L)* in HVAC.
17. Install the upper radiator hose. Refer to *Heater Hoses Replacement (Inlet Hose - 5.0L, 5.7L, 7.4L)* in Engine Cooling.
18. Install the air cleaner assembly.
19. Refill the cooling system. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)*.
20. Connect the battery negative cable.



344232

SIE-ID = 332436

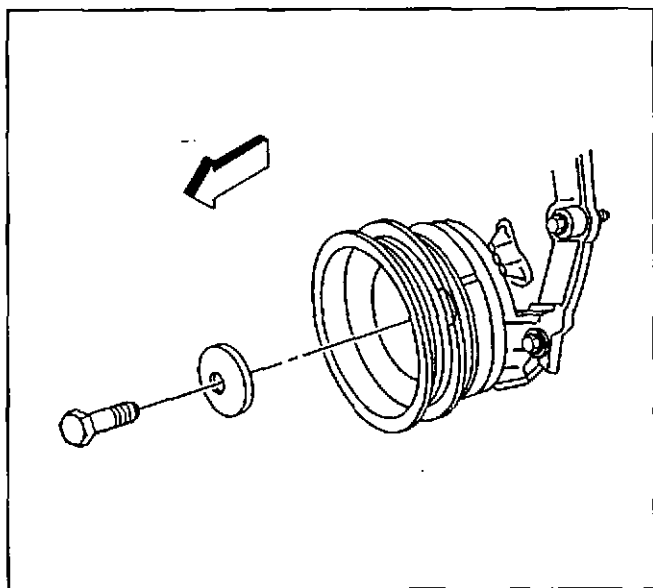
Crankshaft Balancer Replacement

Removal Procedure

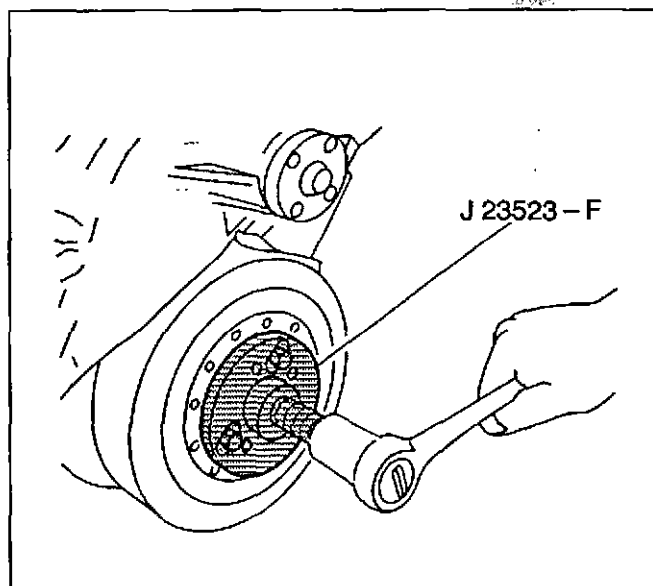
Tools Required

J 23523-F Crankshaft Balancer Remover

1. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in Engine Electrical.
2. Remove the fan shroud assembly. Refer to *Fan Shroud Replacement (Upper)* and *Fan Shroud Replacement (Lower)* in Engine Cooling.
3. Remove the drive belt. Refer to *Drive Belt Replacement*.
4. Remove the crankshaft balancer.
5. Clean and inspect all parts. Refer to *Crankshaft Balancer Clean and Inspect*.



173172



4059

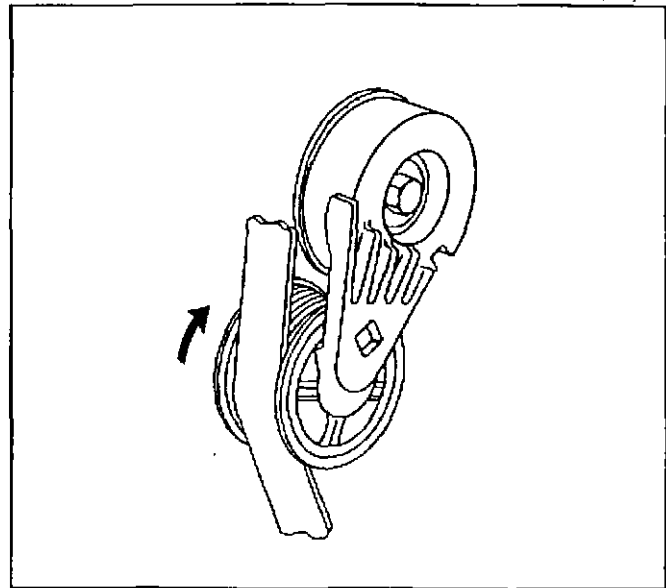
Installation Procedure

Tools Required

J 39046 Crankshaft Balancer Installer

1. Install the crankshaft balancer. Refer to *Crankshaft Balancer Installation*.

2. Install the drive belt. Refer to *Drive Belt Replacement*.
3. Install the fan shroud assembly. Refer to *Fan Shroud Replacement (Upper)* and *Fan Shroud Replacement (Lower)* in Engine Cooling.
4. Connect the battery negative cable.



177622

SIE-ID - 352446

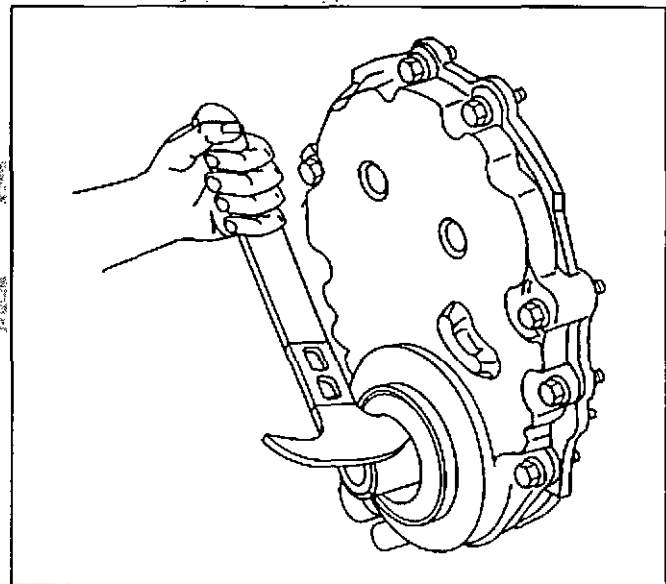
Crankshaft Front Cover Oil Seal Replacement

Removal Procedure

Tools Required

4.3L On Vehicle Front Crankshaft Oil Seal Remov

1. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Replacement*.
2. Use a suitable prying tool to remove the crankshaft front oil seal.
3. Inspect the engine front cover seal bore for damage.
4. Inspect the crankshaft balancer sealing surface for damage. Refer to *Crankshaft Balancer Clean and Inspect*.



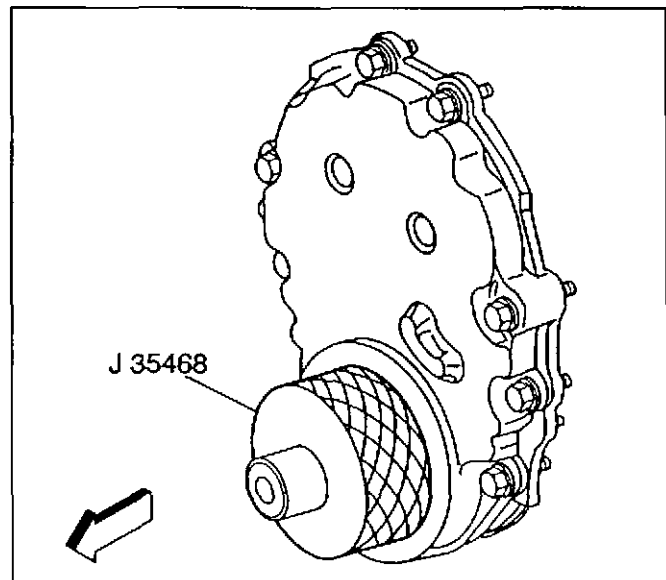
357563

Installation Procedure

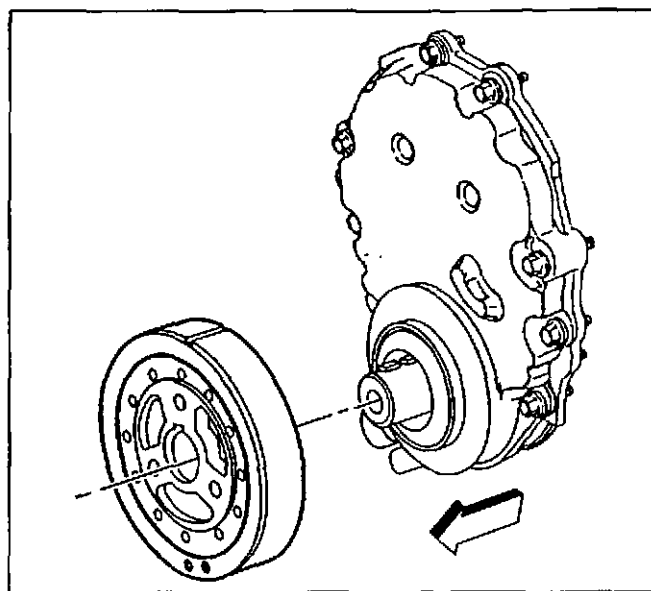
Tools Required

J 35468 Cover Aligner/Seal Installer

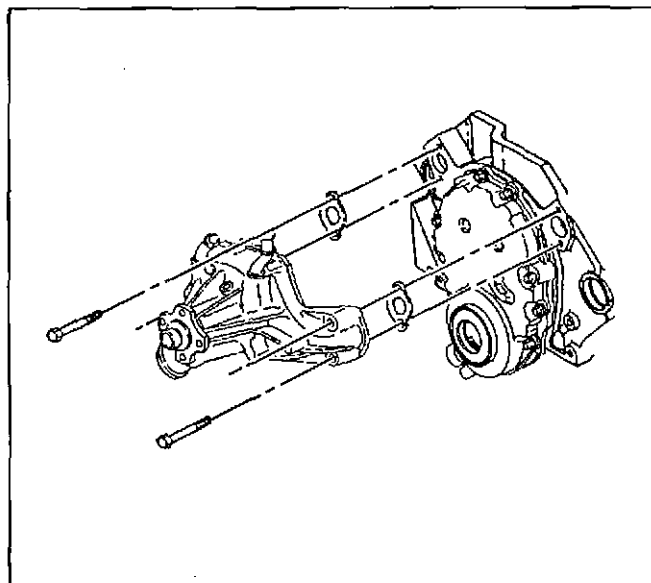
1. Look to ensure that the pre-applied grease on the crankshaft front oil seal is intact.
2. Use the J 35468 Cover Aligner/Seal Installer in order to install the crankshaft front oil seal.
3. Inspect to ensure the crankshaft front oil seal is flush and square to the engine front cover.
4. Install the crankshaft balancer. Refer to *Crankshaft Balancer Replacement*.



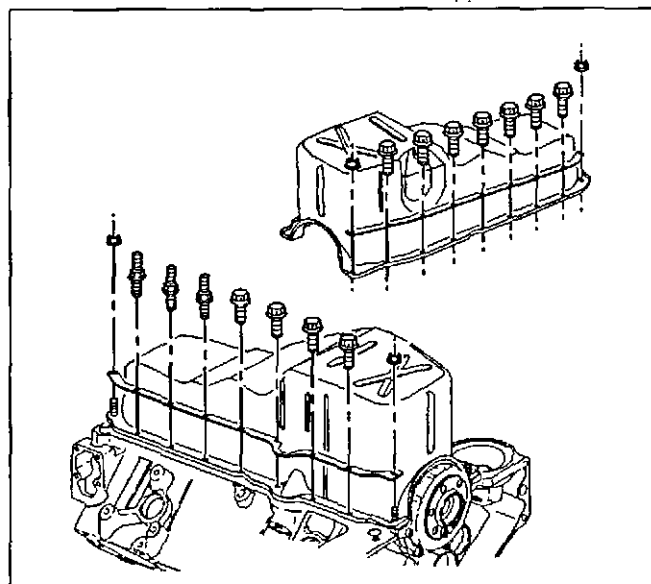
357566



182832



69011



176054

SIE-ID - 332450

Engine Front Cover Replacement

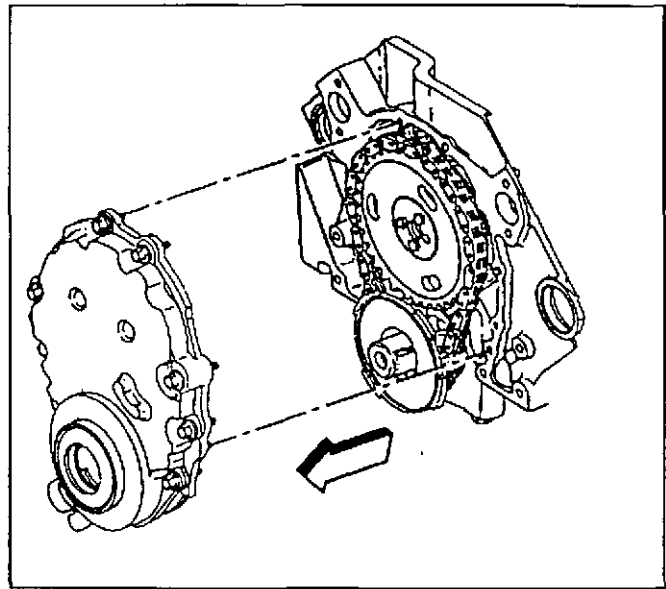
Removal Procedure

1. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Replacement*.

2. Remove the water pump. Refer to *Water Pump Replacement (Diesel)*.

3. Drain the engine oil. Refer to *Engine Oil and Oil Filter Replacement*.
4. Remove all the engine oil pan fasteners except the two nuts at the rear of the engine.
5. Carefully separate the engine oil pan from the engine front cover.
6. Disconnect the crankshaft position (CKP) sensor wire.

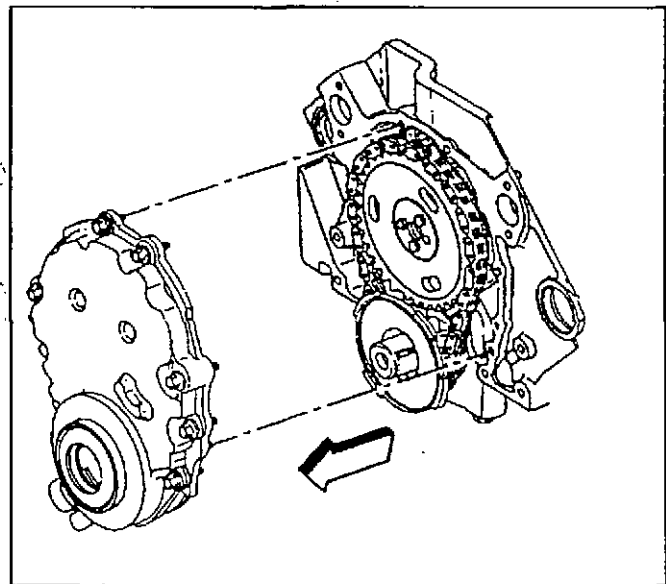
7. Remove the engine front cover and gasket. Refer to *Crankshaft Front Cover Oil Seal Replacement*.



69010

Installation Procedure

1. Install the engine front cover. Refer to *Crankshaft Front Cover Oil Seal Replacement*.

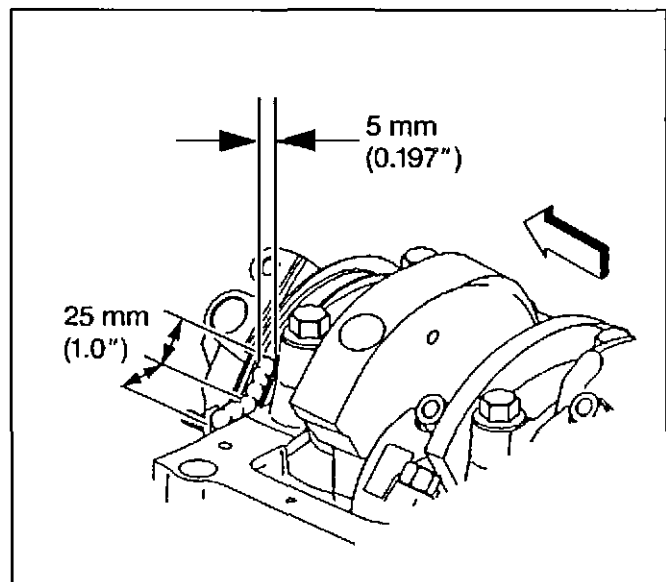


69010

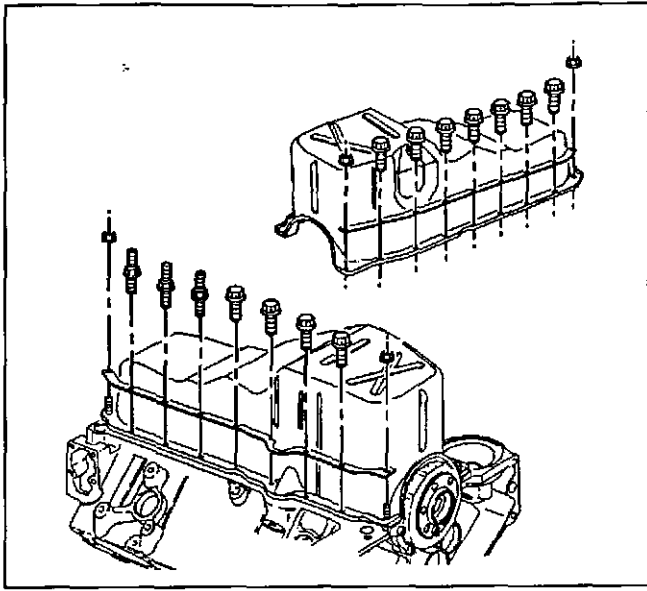
2. Clean all the adhesive from the corners of the oil pan gasket where it meets the engine front cover.

Important: The oil gasket and the oil pan must be installed and the fasteners tightened while the adhesive is still wet to the touch.

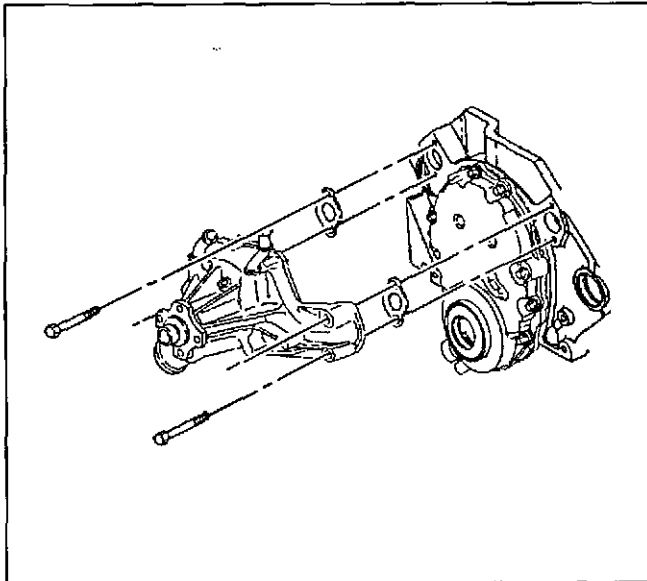
3. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive, GM P/N 12346141 or equivalent, to the engine front cover to engine block junction at the oil pan sealing surfaces.



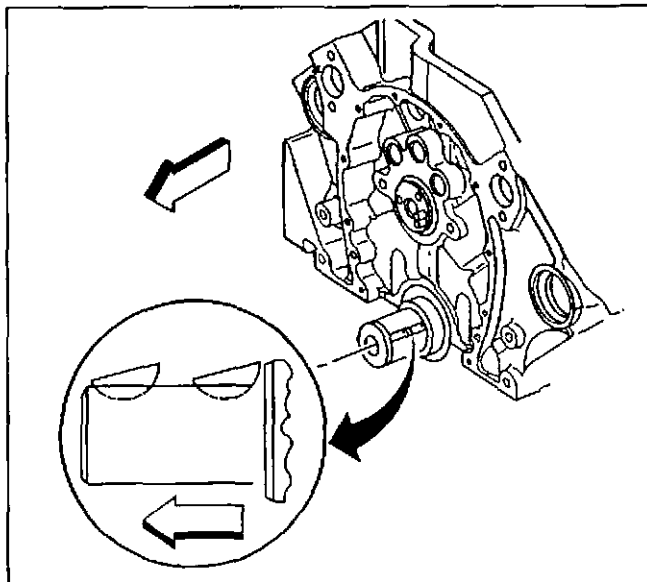
317310



176054



69011



182847

Caution: Refer to *Battery Disconnect Caution* in *Cautions and Notices*.

4. Install the engine oil pannuts and bolts.

Tighten

- 4.1. Tighten the oil pan bolts to 12 N.m (106 lb in).
 4.2. Tighten the oil pan nuts to 25 N.m (10 lb ft).
 5. Connect the crankshaft position (CKP) sensor wire.

6. Install the water pump. Refer to *Water Pump Replacement (Diesel)*.

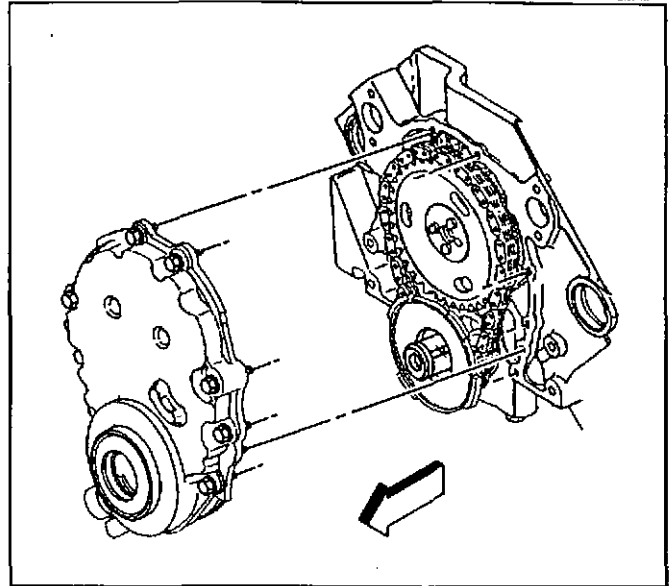
7. Install the crankshaft balancer. Refer to *Crankshaft Balancer Installation*.

SIE-ID - 332452

Crankshaft Position Reluctor Ring Replacement

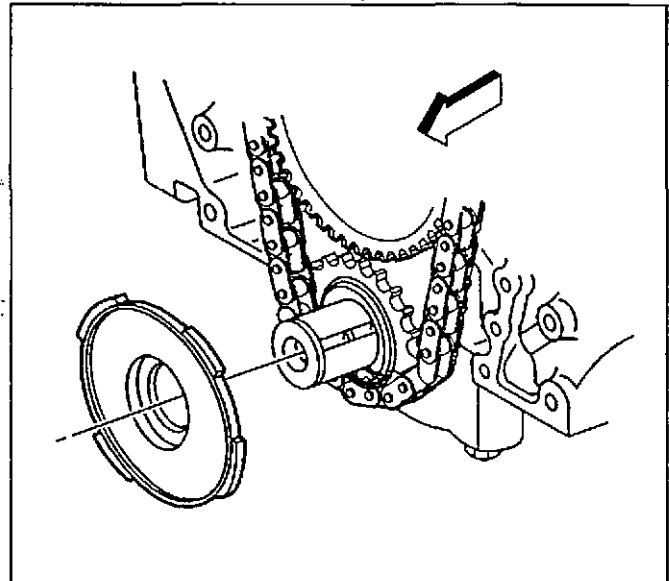
Removal Procedure

1. Remove the engine front cover. Refer to *Engine Front Cover Replacement*.



344274

2. Remove the crankshaft position sensor reluctor ring.



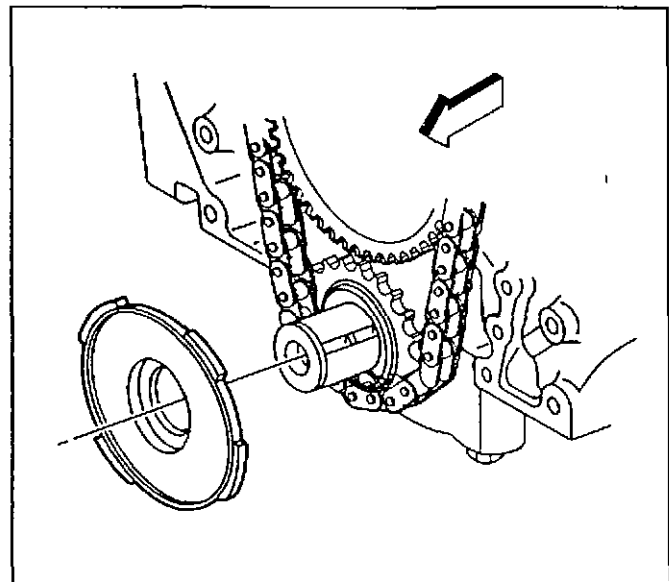
69450

Installation Procedure

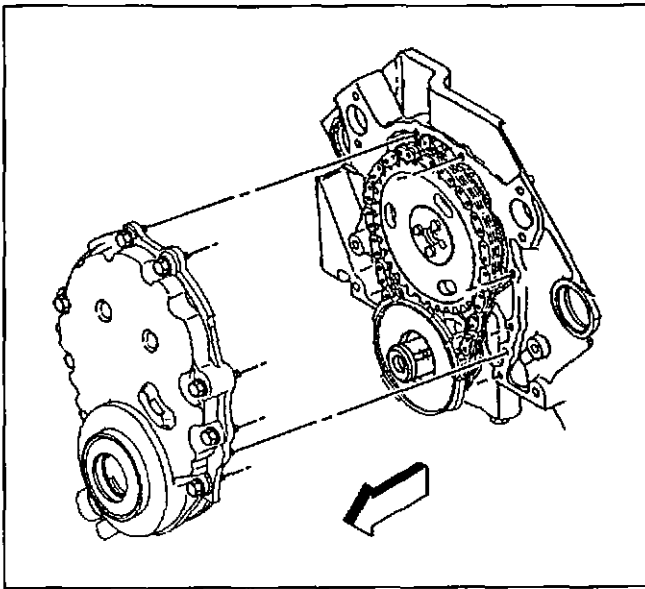
Notice: S10-ID - 23526 Failure to properly align the crankshaft position sensor reluctor ring may result in component damage and effect OBD II system performance.

Important: The reluctor ring is shaped like a dish. The dish must face the engine front cover. Failure to do so will damage the engine front cover and the reluctor ring.

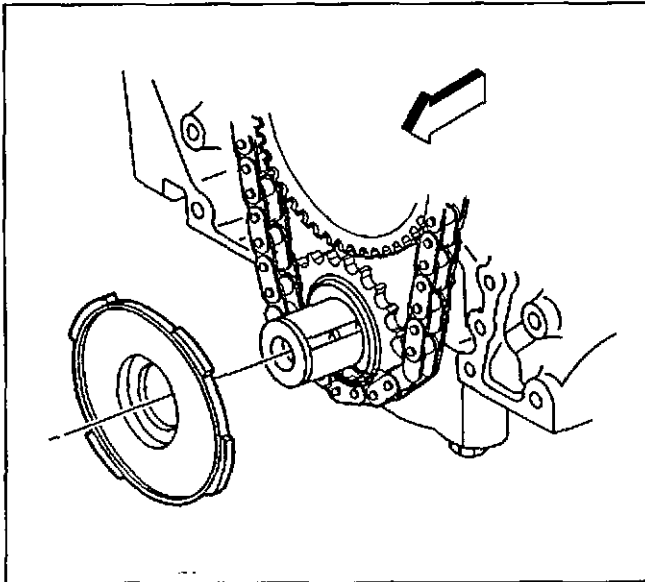
1. Install the crankshaft position sensor reluctor ring.
 - 1.1. Align the keyway on the crankshaft position sensor reluctor ring with the woodruff key (crankshaft balancer) in the crankshaft.
 - 1.2. Push the crankshaft position sensor reluctor ring onto the crankshaft until completely seated against the crankshaft sprocket.



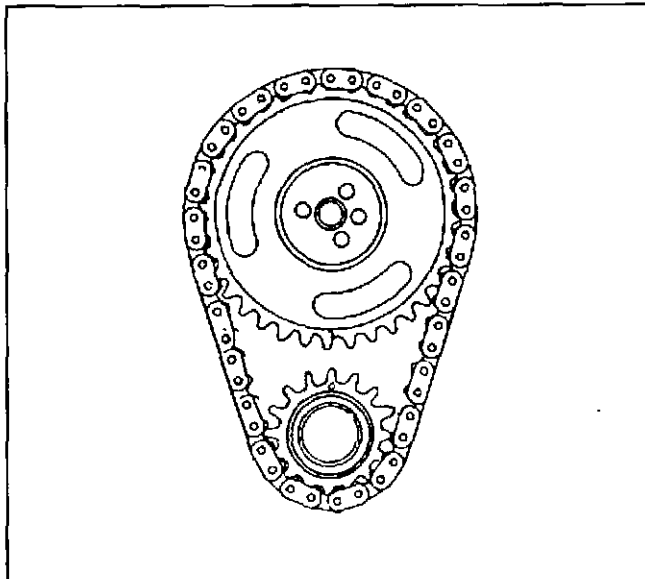
69450



344274



69450



344371

2. Install the engine front cover. Refer to *Engine Front Cover Replacement*.

SIE-ID - 332456

Timing Chain and Sprockets Replacement

Removal Procedure

Tools Required

J 5825-A Crankshaft Gear Remover

1. Remove the engine front cover and the crankshaft position sensor reluctor ring. Refer to *Crankshaft Position Reluctor Ring Replacement*.

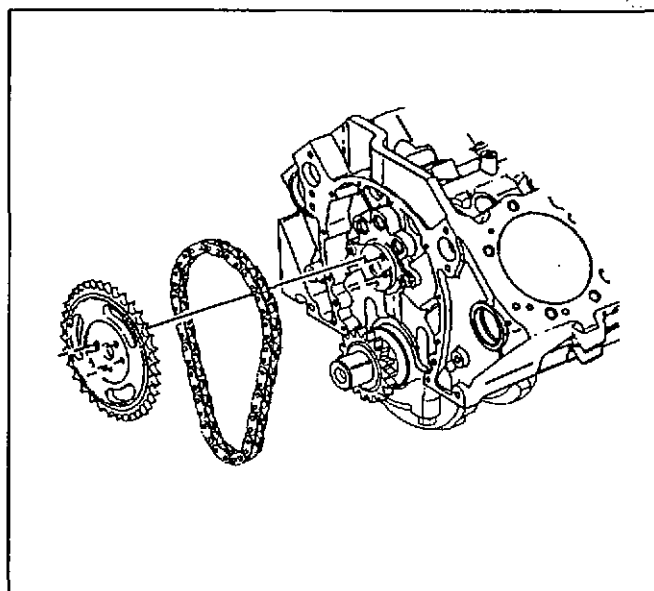
Important: Once the engine front cover is removed, do not re-install it.

Always install a NEW engine front cover.

2. Rotate the crankshaft until:

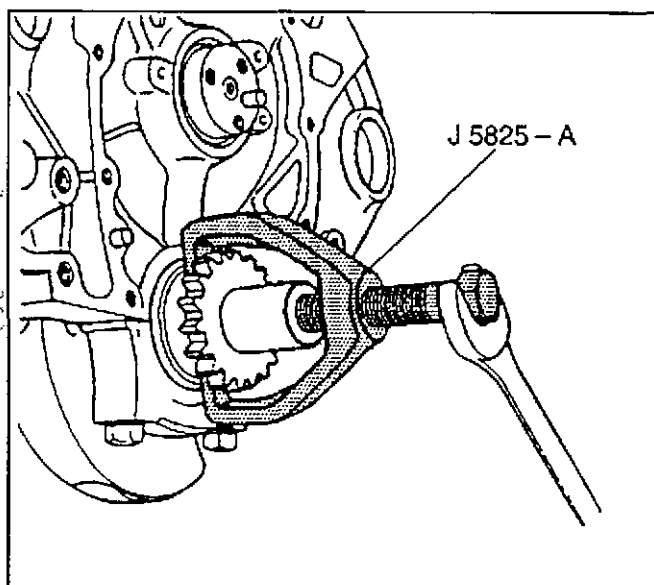
- 2.1. The number one cylinder is at top dead center (TDC) of the compression stroke.
- 2.2. The timing marks on both sprockets line up.

3. Remove the camshaft sprocket bolts.
4. Remove the camshaft sprocket and the camshaft timing chain.



344368

5. Use the J 5825-A in order to remove the crankshaft sprocket.
6. Remove the woodruff key (crankshaft balancer), if necessary.
7. Inspect all parts for wear or damage. Refer to *Timing Chain and Sprockets Clean and Inspect*.



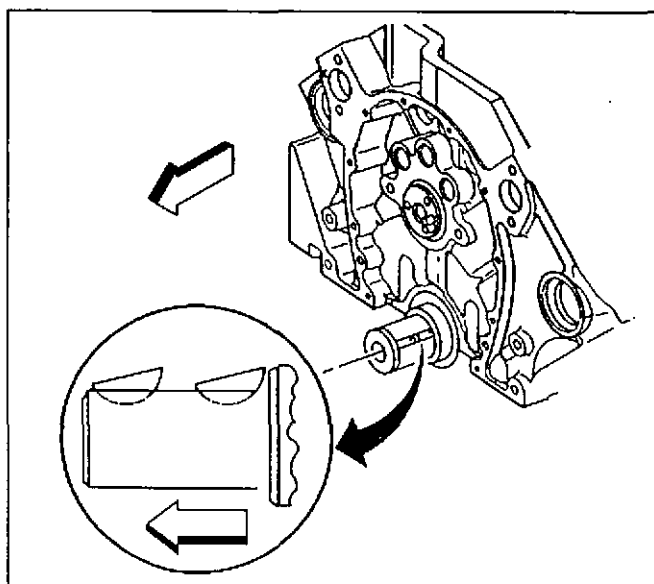
11506

Installation Procedure

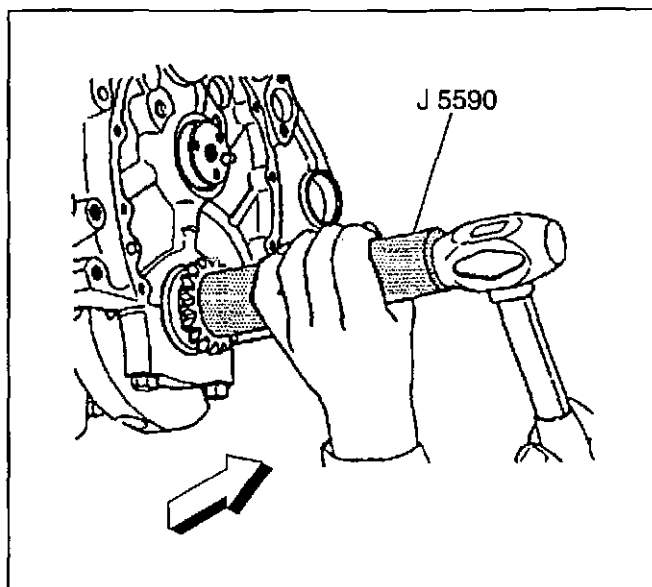
Tools Required

J 5590 Crankshaft Sprocket Installer

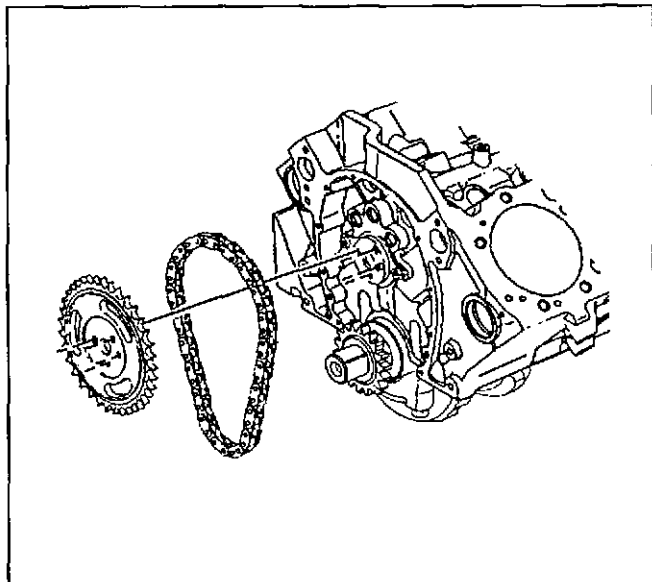
1. Install the woodruff key (crankshaft balancer) into the crankshaft, if removed.



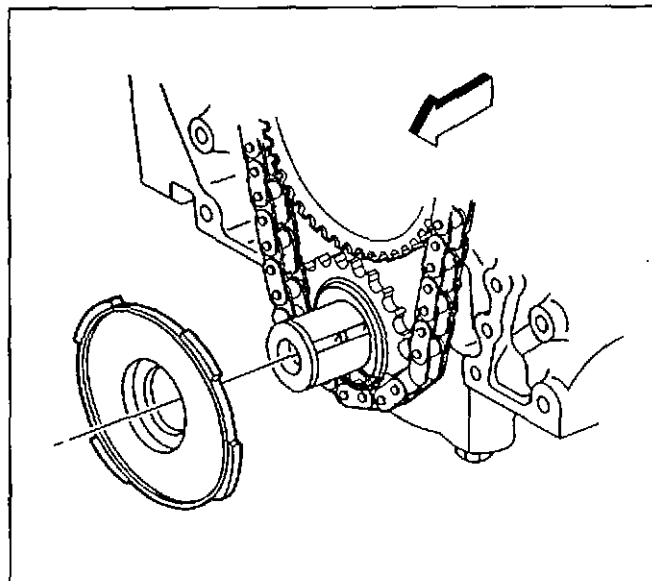
182847



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69450

Caution: SIO-10 - 5011 *Wear safety glasses in order to avoid eye damage.*

2. Align the keyway of the crankshaft sprocket with the woodruff key (crankshaft balancer).
3. Use the J 5590 and a hammer in order to install the crankshaft sprocket.
4. Make sure that the number 1 piston is still at TDC of the compression stroke.
5. Align the timing marks on both sprockets. Look to ensure that the crankshaft sprocket alignment mark is in the 12 o'clock position.

6. Install the camshaft sprocket and the camshaft timing chain. The camshaft sprocket alignment mark must be in the 6 o'clock position.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the camshaft sprocket bolts.

Tighten

Tighten the bolts to 25 N.m (18 lb ft).

8. Look to ensure that the camshaft sprocket and the crankshaft sprocket alignment marks.

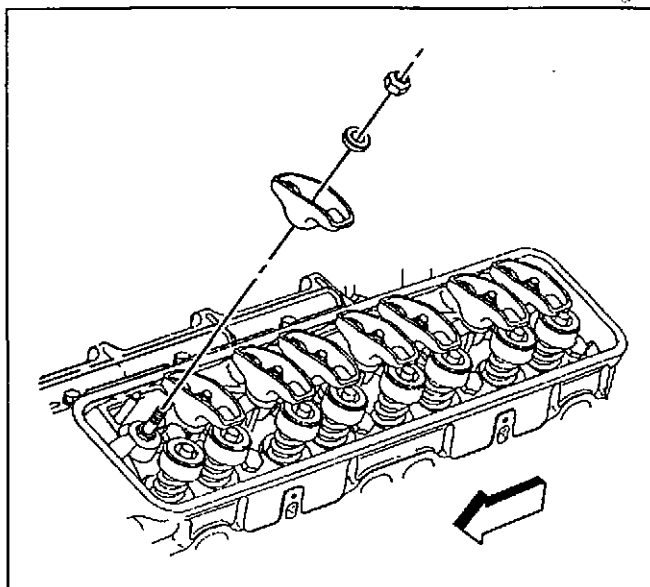
9. Install the crankshaft position sensor reluctor ring and the engine front cover. Refer to *Crankshaft Position Reluctor Ring Replacement*.

SIE-ID - 332464

Camshaft Replacement

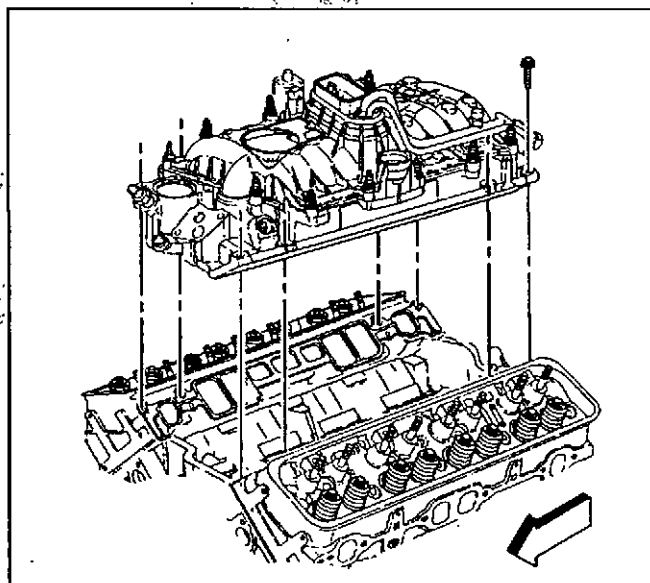
Removal Procedure

1. Evacuate the air conditioning system, if equipped. Refer to *Refrigerant Recovery and Recharging* Recharging the Refrigerant System in HVAC.
2. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in Engine Electrical.
3. Drain the engine oil. Refer to *Engine Oil and Oil Filter Replacement*.
4. Remove the valve rocker arms and valve pushrods. Refer to *Engine Oil and Oil Filter Replacement*.



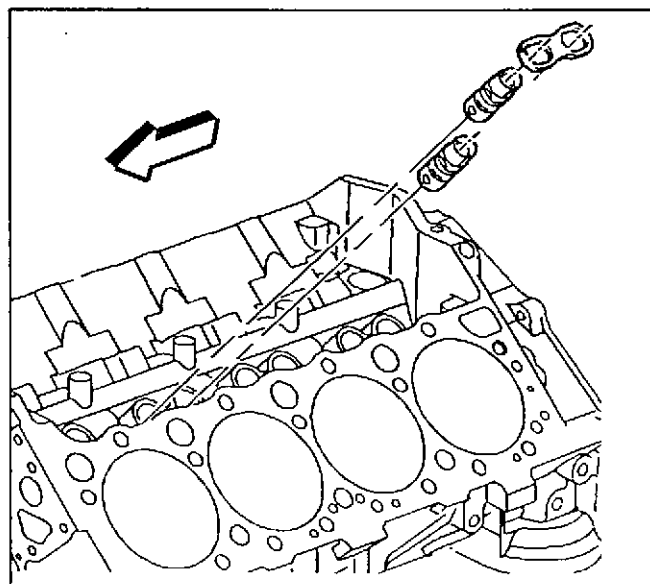
343916

5. Remove the lower intake manifold. Refer to *Intake Manifold Replacement (Lower)*.

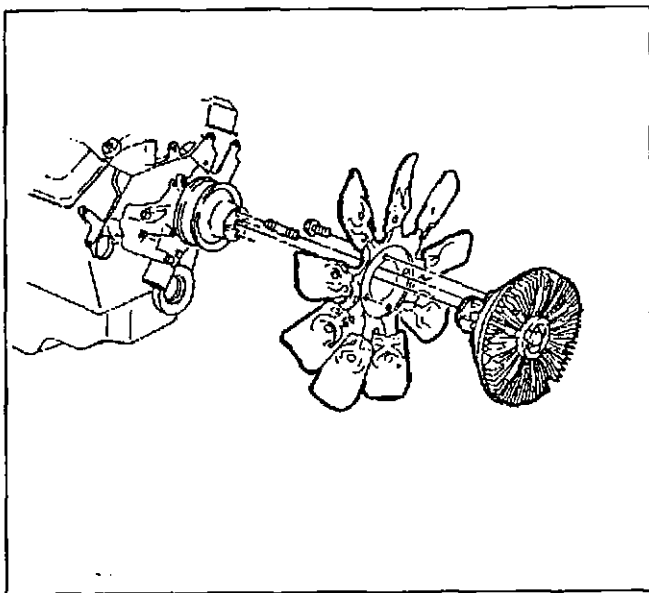


343948

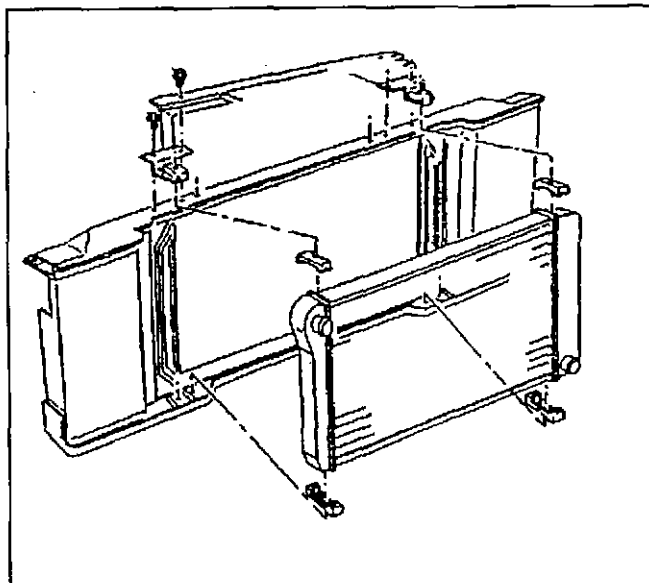
6. Remove the valve lifters. Refer to *Valve Lifter Replacement*.



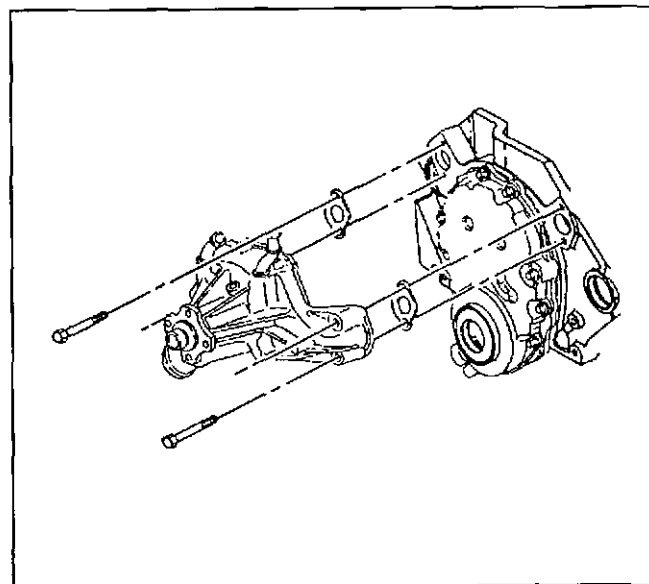
11509



108015



72749



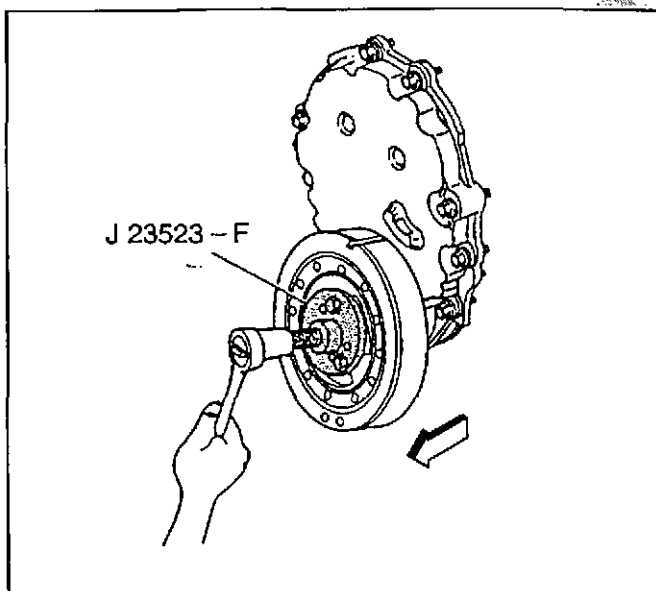
69011

7. Remove the engine cooling fan and the fan shroud. Refer to *Fan Clutch Replacement (5.0L, 5.7L and 6.5L)*.
8. Remove the radiator grille. Refer to *Grille Replacement (Luxury)*.
9. Remove the hood latch bracket. Refer to *Hood Latch Replacement (Primary)*.

10. Remove the radiator. Refer to *Radiator Replacement*.
11. Remove the A/C condenser, if equipped. Refer to *Condenser Replacement*.

12. Remove the water pump. Refer to *Water Pump Replacement (Diesel)*.

13. Remove the three crankshaft pulley bolts and the crankshaft pulley.
14. Use the J 23523-F in order to remove the crankshaft balancer.
Refer to *Crankshaft Balancer Replacement*.

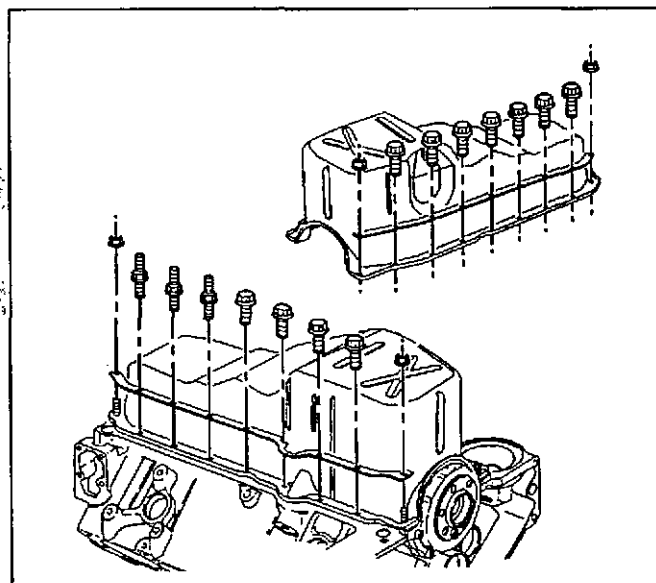


66878

15. Raise the vehicle.
16. Remove the following fasteners from the oil pan:
 - Two nuts at the front of the engine.
 - Eleven screws and three studs.

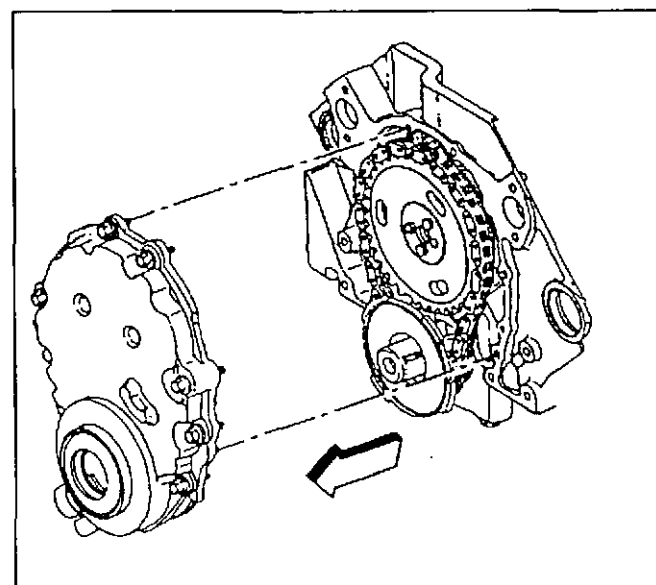
Important: Do not remove the two nuts at the rear of the engine.

17. Lower the vehicle.

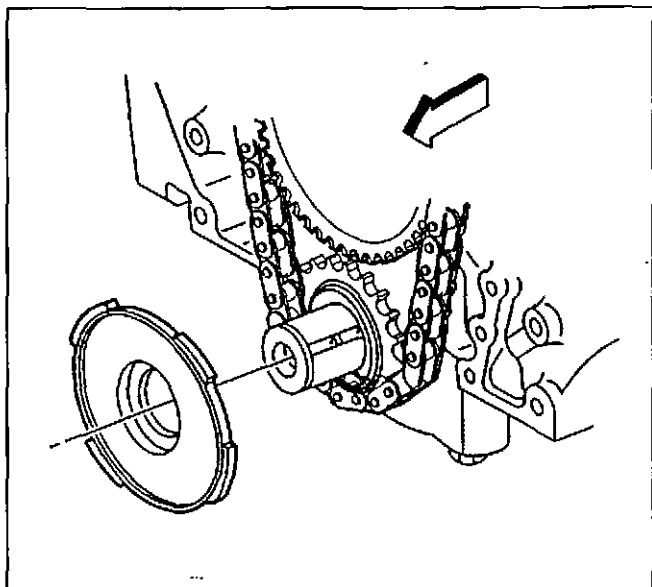


176054

18. Remove the engine front cover. Refer to *Engine Front Cover Replacement*.

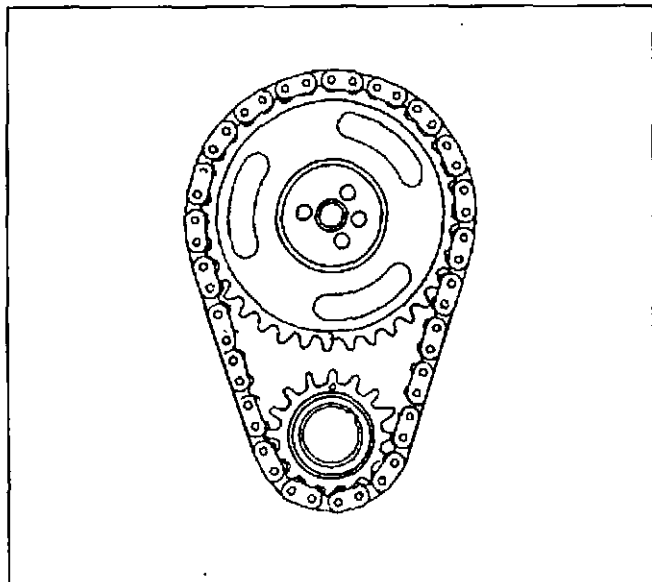


69010



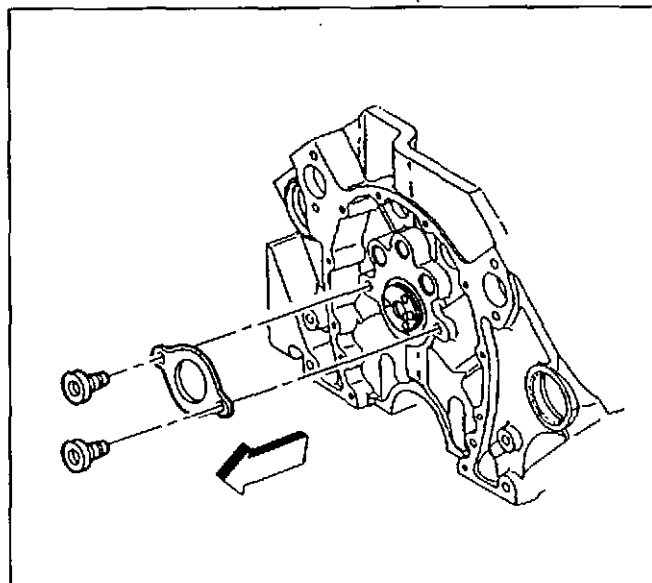
69450

19. Remove the crankshaft position sensor reluctor ring. Refer to *Crankshaft Position Reluctor Ring Replacement*.



344371

20. Rotate the number one piston to Top Dead Center (TDC).
21. Align the timing marks on the camshaft and the crankshaft sprockets.



182636

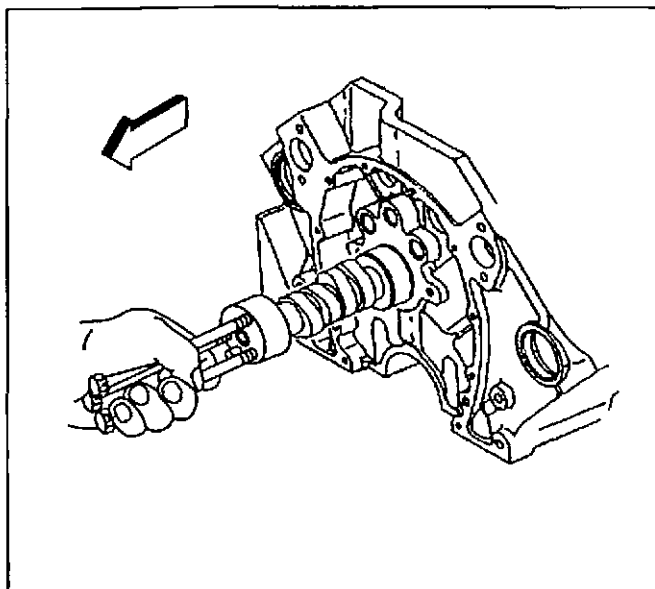
22. Remove the camshaft sprocket bolts.
23. Remove the camshaft sprocket and the timing chain. Refer to *Timing Chain and Sprockets Replacement*.
24. Remove the camshaft retainer plate and bolts using a T-30 TORX® socket.

Notice: S10-ID - 13833 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.

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

25. Remove the engine camshaft.

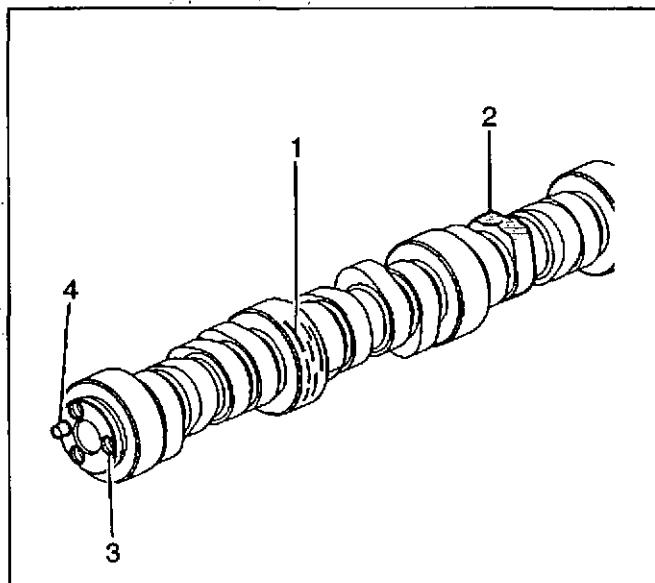
- 25.1. Install the three 5/16-18 x 4.0 in bolts in the engine camshaft front bolt holes.
- 25.2. Using the bolts as a handle, carefully rotate and pull the engine camshaft out of the camshaft bearings.
- 25.3. Remove the bolts from the front of the engine camshaft.



344428

26. Clean all sealing surfaces.

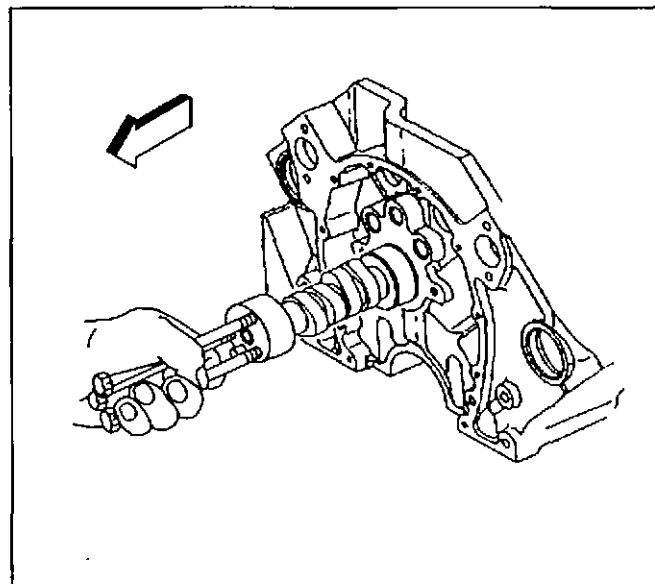
27. Inspect all parts for wear. Refer to *Camshaft and Bearings Clean and Inspect*.



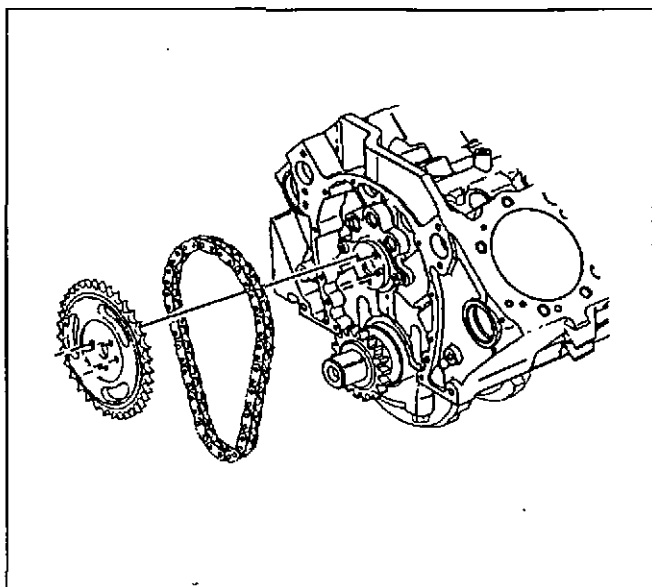
188095

Installation Procedure

1. Install the camshaft. Refer to *Camshaft Installation*.

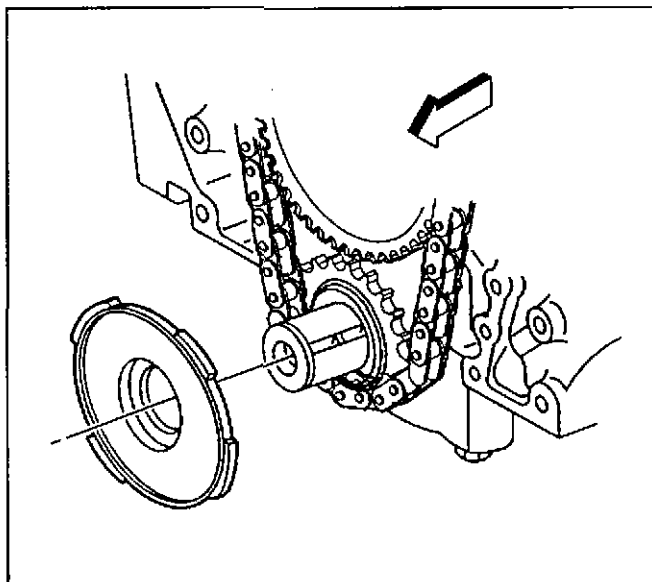


344428



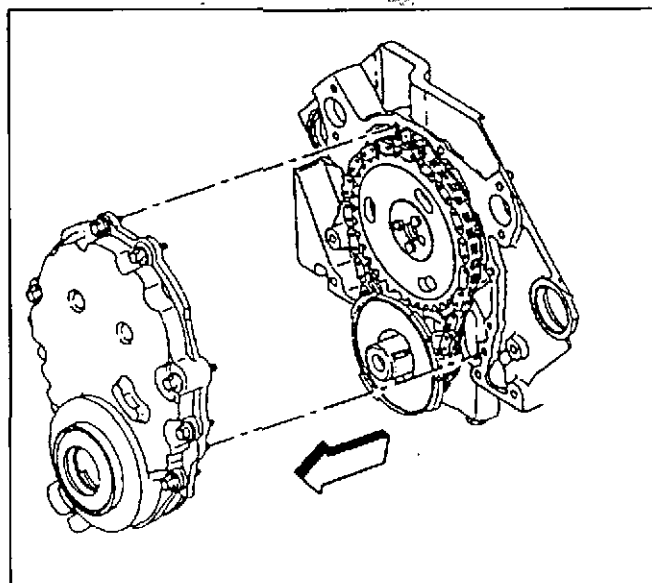
344368

2. Install the components removed from the front of the engine. Refer to *Timing Chain and Sprockets Replacement*.



69450

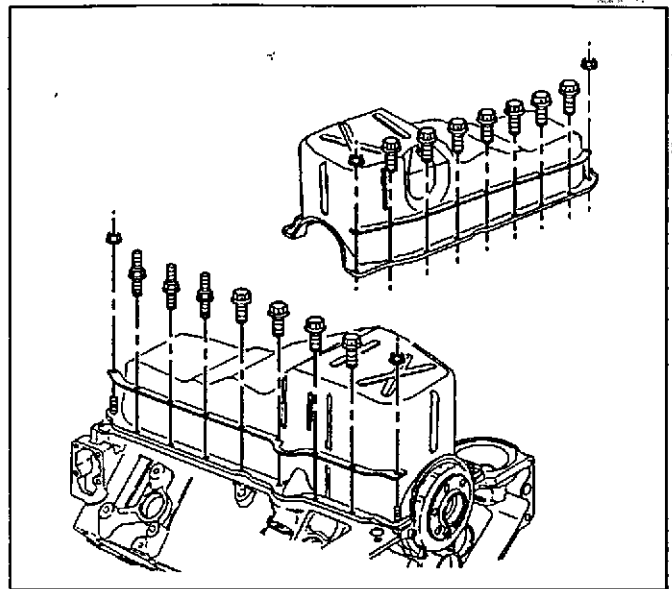
3. Install the crankshaft reluctor ring. Refer to *Crankshaft Position Reluctor Ring Replacement*.



69010

4. Install the engine front cover. Refer to *Engine Front Cover Replacement*.

5. Raise the vehicle.
6. Install the fasteners to the oil pan. Refer to *Oil Pan Installation*.
7. Lower the vehicle.



176054

8. Use *J 23523-F* in order to install the crankshaft balancer. Refer to *Crankshaft Balancer Installation*.

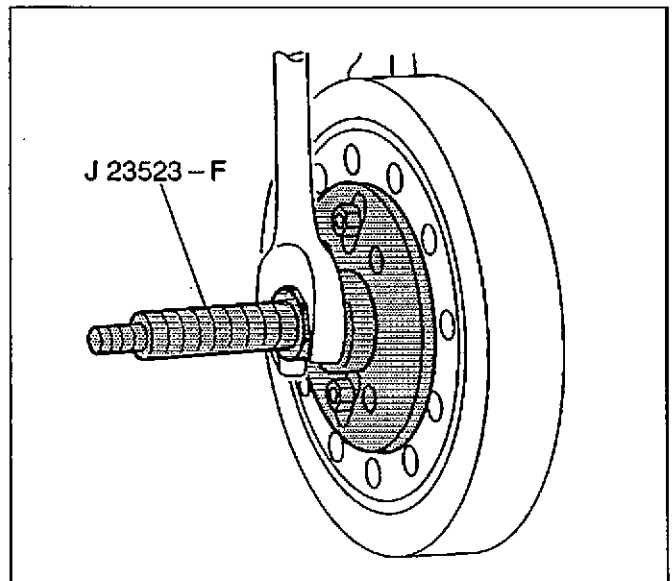
Notice: Refer to *Fastener Notice* in Cautions and Notices.

9. Install the crankshaft pulley in the following manner:

- 9.1. Install the pulley and the three bolts.
- 9.2. Install the crankshaft balancer bolt.

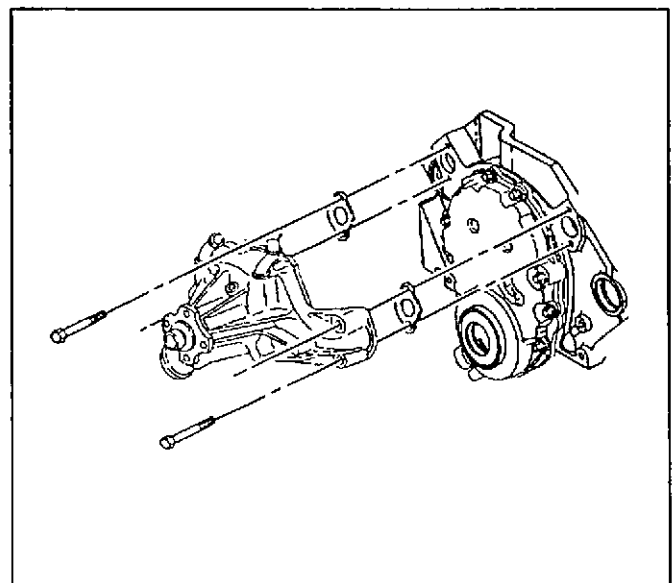
Tighten

- 9.2.1 Tighten the pulley bolts to 58 N·m (43 lb·ft).
- 9.2.2 Tighten the crankshaft balancer bolt to 95 N·m (70 lb·ft).

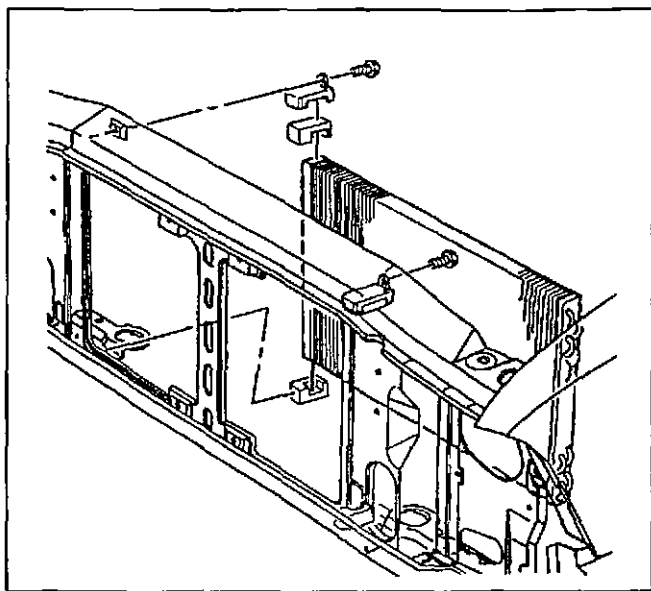


4065

10. Install the water pump. Refer to *Water Pump Replacement (Diesel)*.

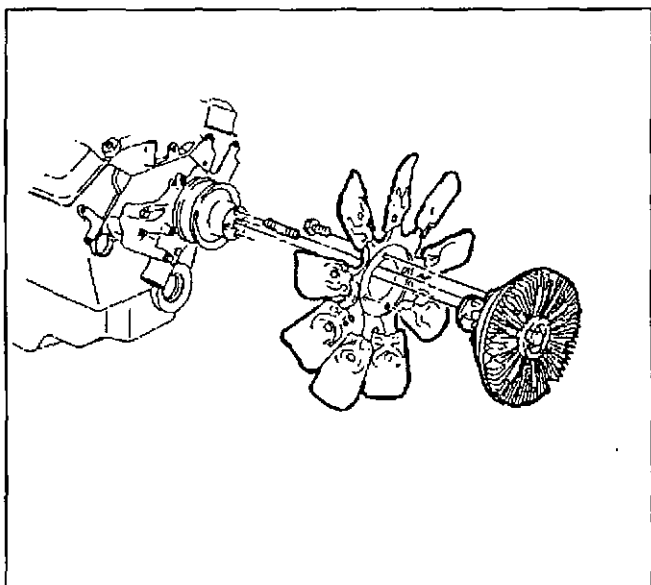


63011



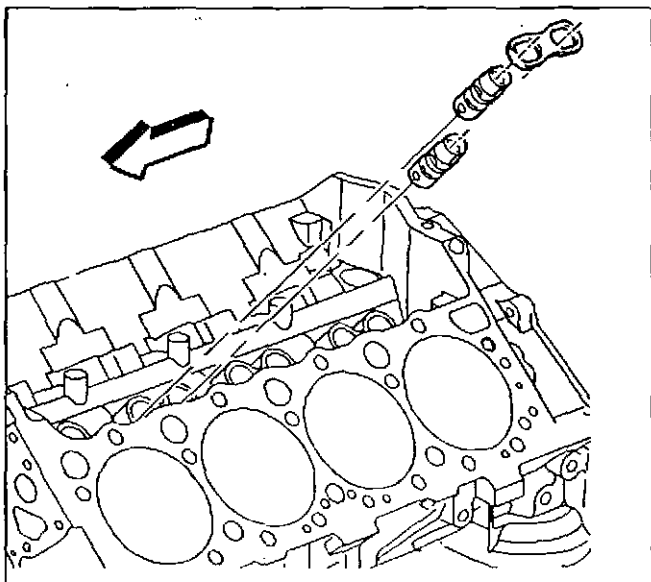
199015

11. Install the A/C condenser, if equipped. Refer to *Condenser Replacement*.
12. Install the radiator. Refer to *Radiator Replacement*.
13. Install the hood latch bracket. Refer to *Hood Latch Replacement (Primary)*.
14. Install the radiator grille. Refer to *Grille Replacement (Luxury)*.



108015

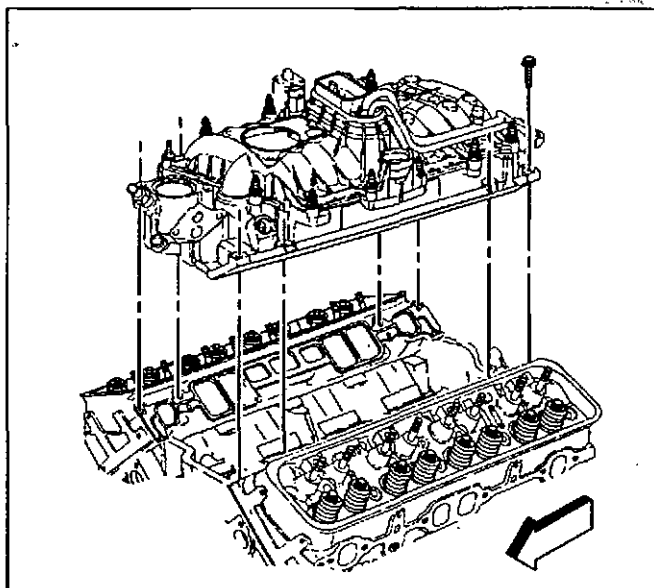
15. Install the engine cooling fan and the upper fan shroud. Refer to *Fan Clutch Replacement (5.0L, 5.7L and 6.5L)*.



11509

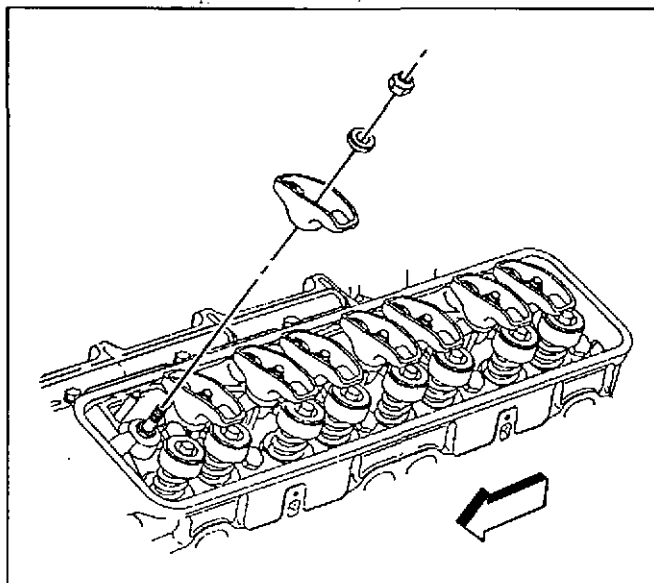
16. Install the components removal from the top of the engine. Refer to *Valve Lifter Replacement*.

17. Install the lower intake manifold. Refer to *Intake Manifold Replacement (Lower)*.



343948

18. Install the valve rocker arms and pushrods. Refer to *Valve Rocker Arm and Push Rod Installation*.
19. Connect the battery negative cable.
20. Recharge the air conditioning system, if equipped. Refer to *Recharging the Refrigerant System in HVAC*.
21. Fill the engine with the proper type and quantity of engine oil.
22. Replace the engine oil filter. Refer to *Engine Oil and Oil Filter Replacement*.



343916

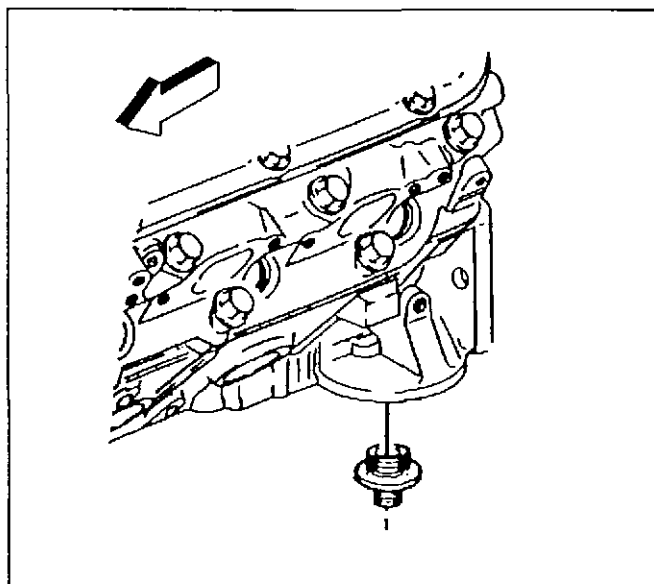
SIE-ID - 332471

Oil Filter Adapter and Valve Assembly Replacement

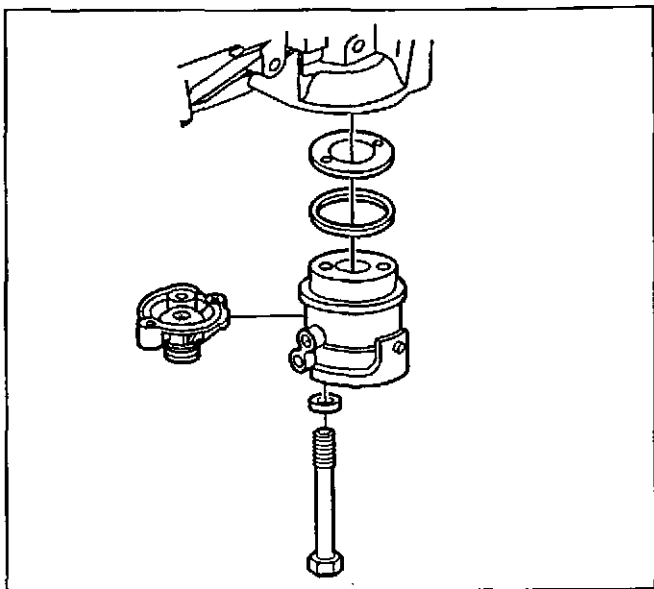
Removal Procedure

Oil Filter Bypass Valve

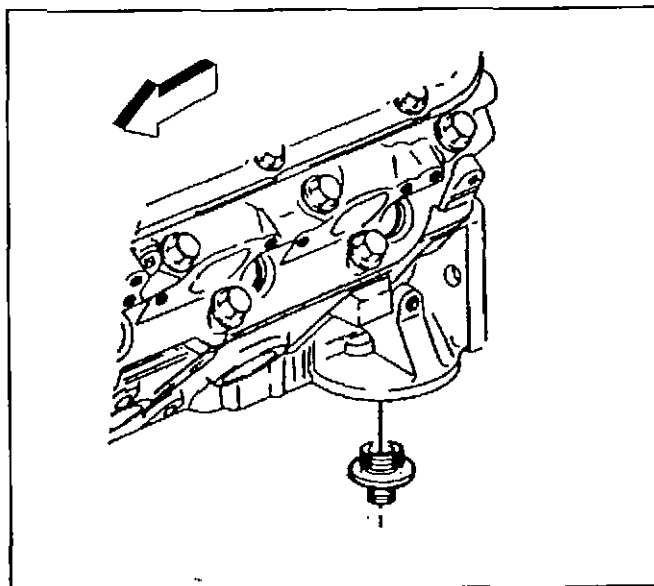
1. Remove the oil filter. Refer to *Engine Oil and Oil Filter Replacement*.
2. Remove the bolts.
3. Remove the oil filter bypass valve.
4. Inspect the bypass valve spring and valve disc for proper operation, cracks, and damage.
Replace the oil filter bypass valve if necessary.
5. Clean the valve chamber in the engine block.



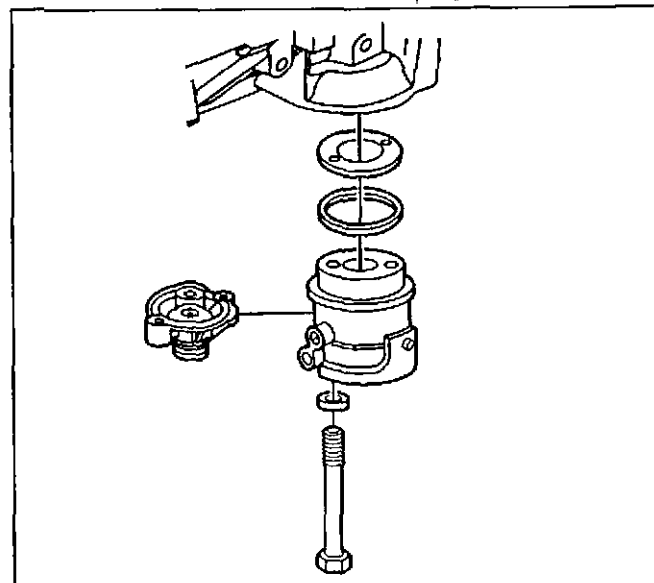
70416



39122



70416



39122

Oil Filter Adapter

1. Remove and discard the oil filter.
Refer to *Engine Oil and Oil Filter Replacement*.
2. Remove the oil cooler pipes.
3. Remove the oil filter adapter.
4. Clean all sealing surfaces.

Installation Procedure**Oil Filter Bypass Valve**

1. Install the oil filter bypass valve and a new gasket.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the bolts finger tight.

Tighten

Tighten the bolts to 25 N.m (18 lb ft).

3. Install the engine oil and the oil filter. Refer to *Engine Oil and Oil Filter Replacement*.

Oil Filter Adapter

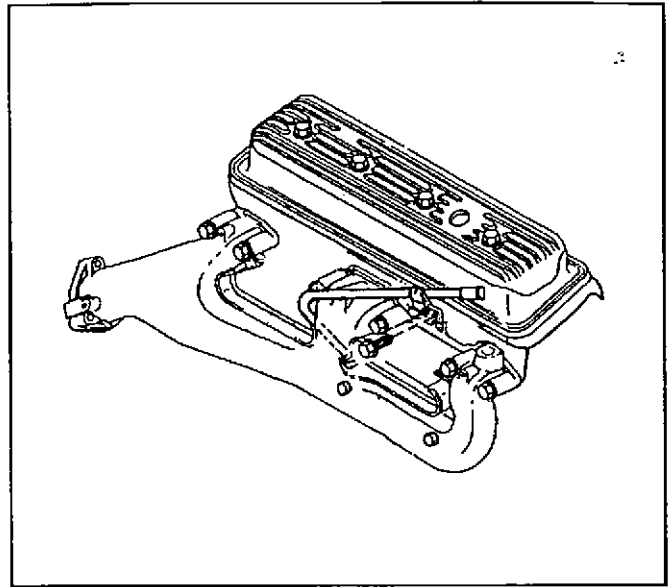
1. Install the oil filter adapter.
2. Install the oil cooler pipes.
3. Install the engine oil and the NEW oil filter.
Refer to *Engine Oil and Oil Filter Replacement*.

SIE-ID = 332474

Oil Pan Replacement

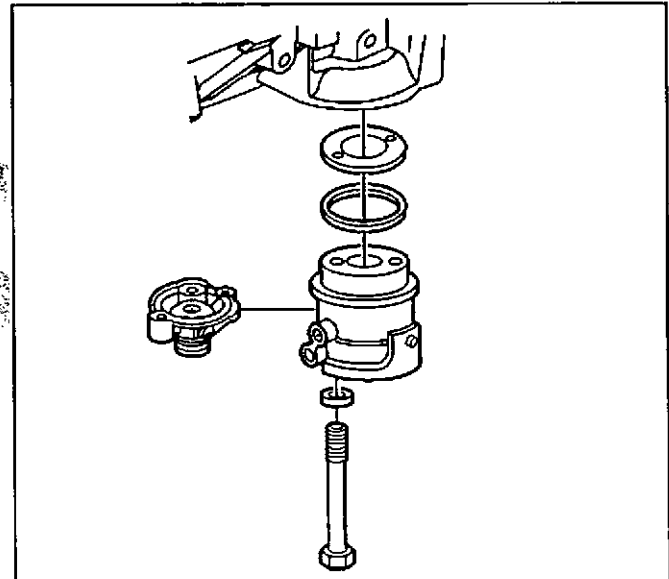
Removal Procedure

1. Remove the oil level indicator tube. Refer to *Oil Level Indicator and Tube Replacement*.



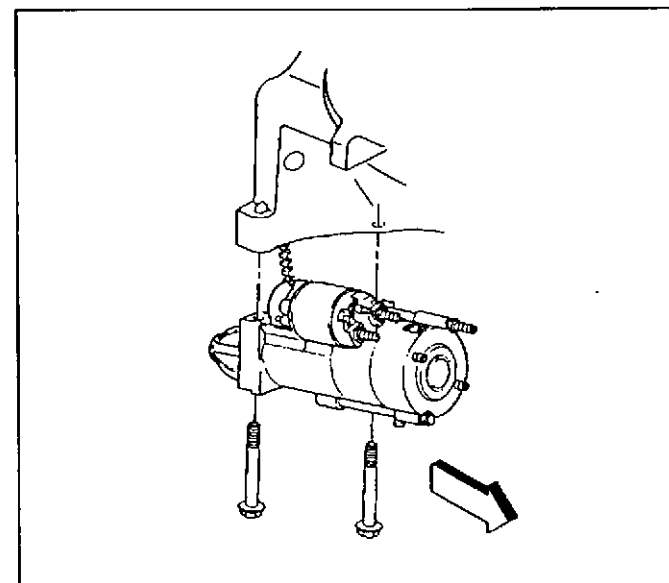
173203

2. Raise the vehicle.
3. Remove the engine oil and the engine oil filter. Refer to *Engine Oil and Oil Filter Replacement*.
4. Remove the oil filter adapter. Refer to *Oil Filter Adapter and Valve Assembly Replacement*.

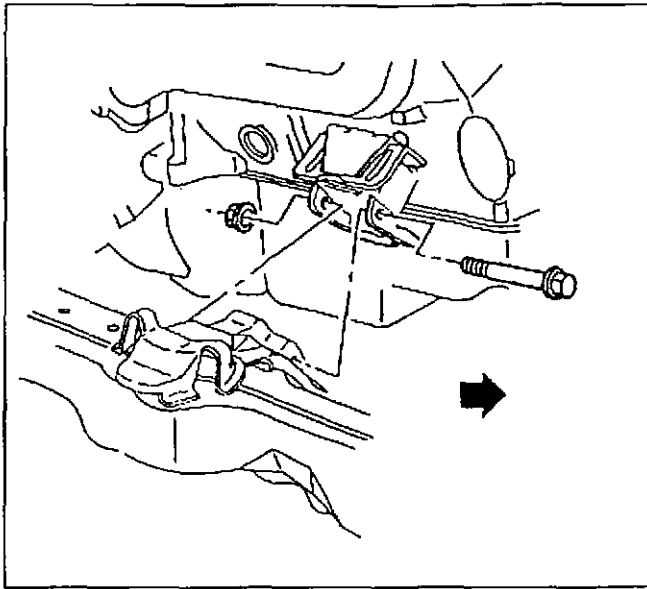


39122

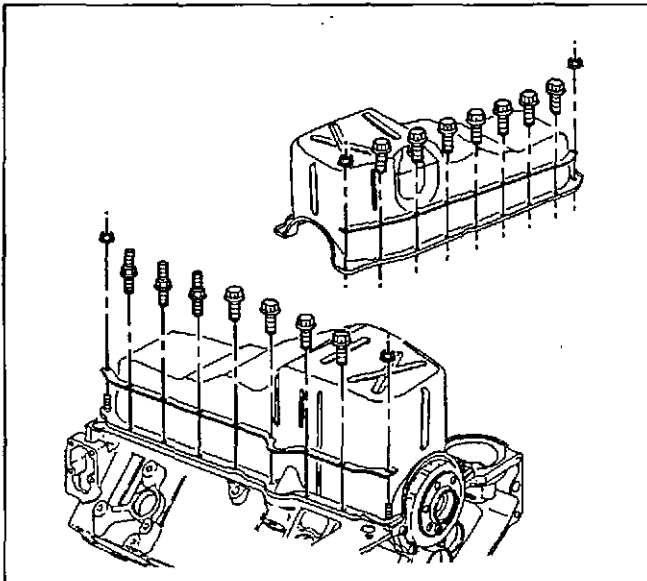
5. Remove the starter. Refer to *Starter Motor Replacement (ERROR - NOT IN CURRENT PSD)*.
6. Remove the flywheel inspection cover.



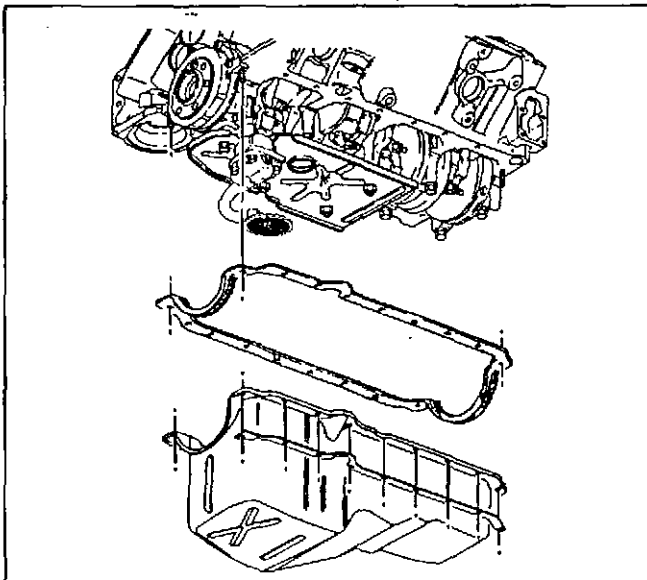
183406



4564



176054



176052

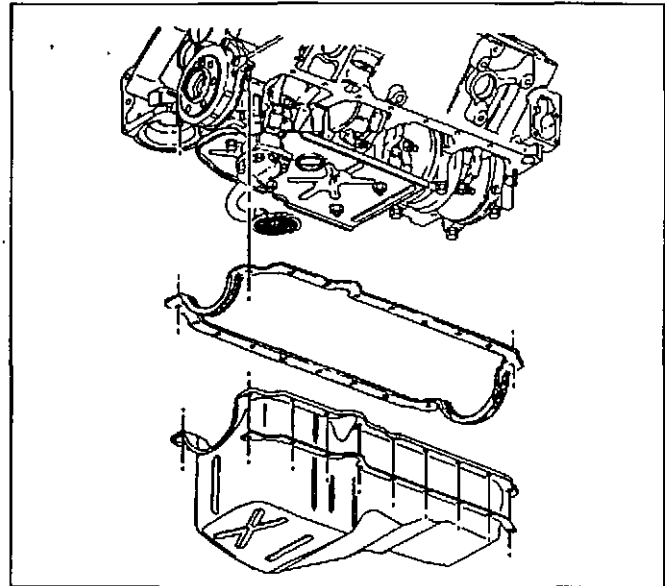
7. Remove the engine mount through bolts. Refer to *Engine Mount Replacement (Front C Model)*.
8. Raise and support the engine.

9. Remove the oil pan nuts and bolts.
Note the location of any studs to assist reassembly.

10. Remove the engine oil pan and the gasket.
11. Clean all the sealing surfaces. Refer to *Oil Pan Clean and Inspect*.

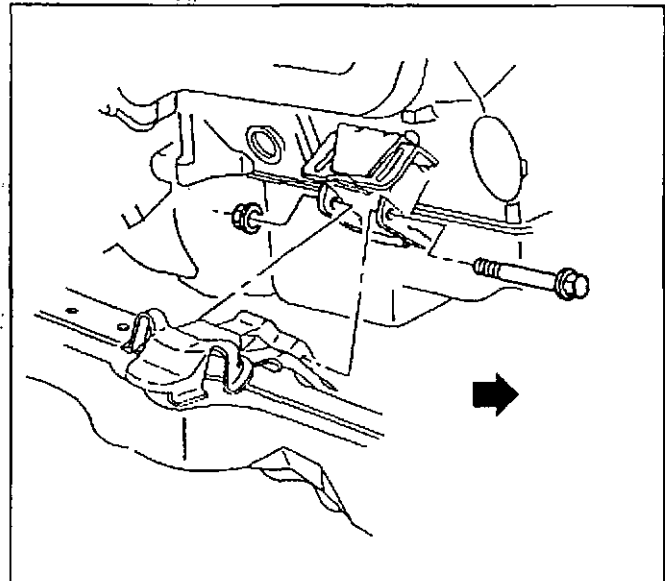
Installation Procedure

1. Install the engine oil pan and a NEW oil pan gasket. Refer to *Oil Pan Installation*.



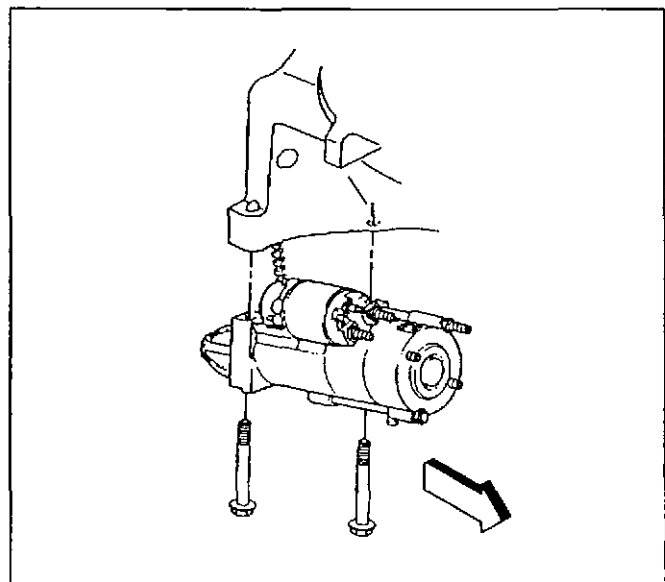
176052

2. Lower the engine onto the engine mounts.
3. Install the engine mount through-bolts. Refer to *Engine Mount Replacement (Front C Model)*.

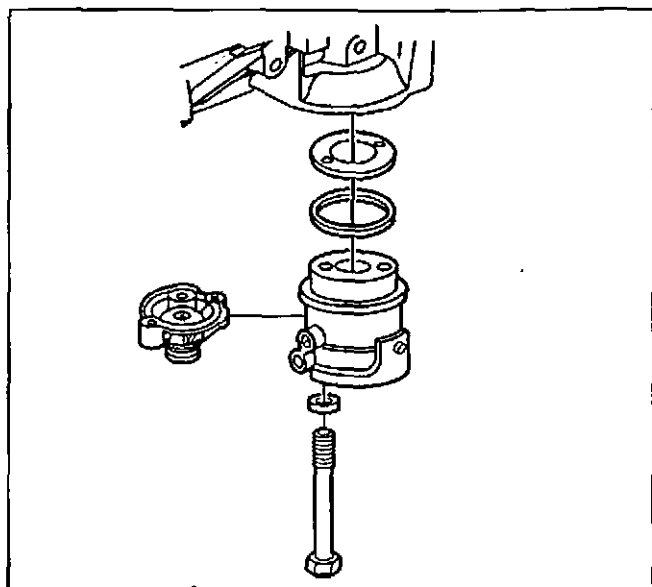


4564

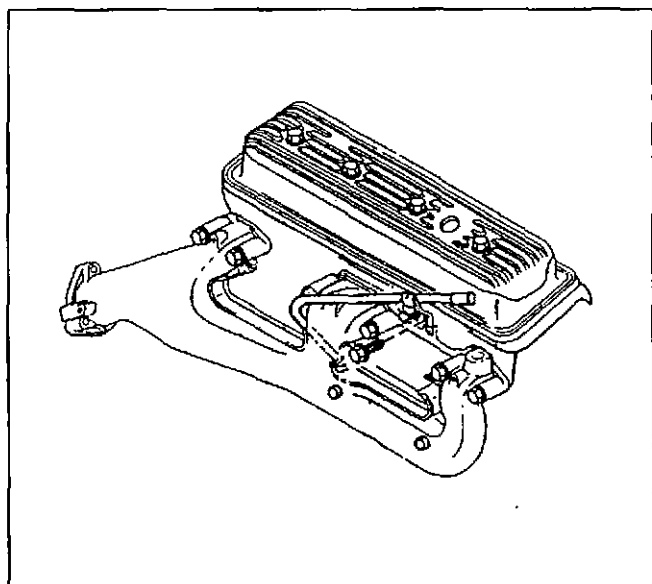
4. Install the starter. Refer to *Starter Motor Replacement (ERROR - NOT IN CURRENT PSD)*.
5. Install the flywheel inspection cover.



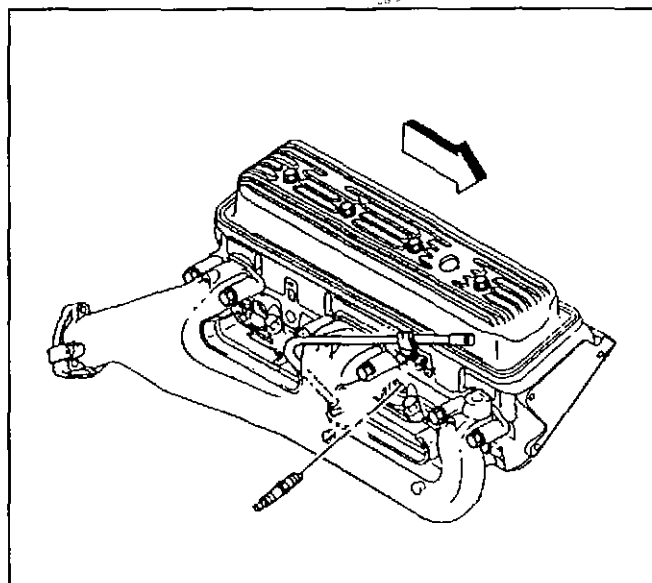
183406



39122



173203



345189

6. Install the oil filter adapter. Refer to *Oil Filter Adapter and Valve Assembly Replacement*.
7. Install the engine oil filter and the engine oil. Refer to *Engine Oil and Oil Filter Replacement*.
8. Lower the vehicle.

9. Install the oil level indicator tube. Refer to *Oil Level Indicator and Tube Replacement*.

SIE-ID = 332475

Oil Level Indicator and Tube Replacement

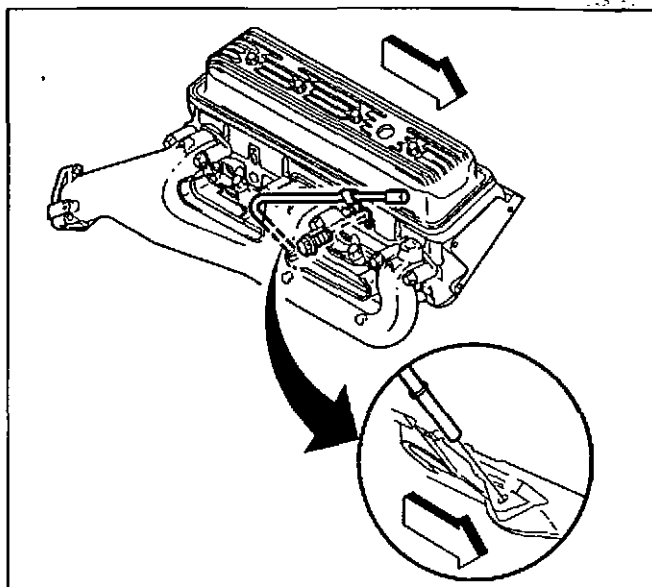
Removal Procedure

1. Remove the air cleaner assembly.

Notice: SIO-ID = 2878 Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

2. Remove the spark plug wire from the cylinder number 4 spark plug
 - 2.1. Rotate the spark plug wire boot 1/2 turn.
 - 2.2. Pull outward on the spark plug wire boot to release from the spark plug.
3. Remove the spark plug for the number 4 cylinder.
4. Remove the oil level indicator from the oil level indicator tube.

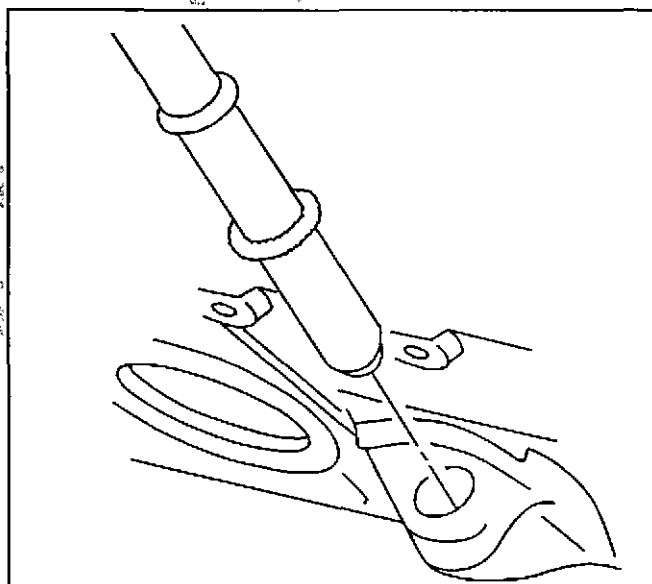
5. Remove the oil level indicator tube bolt.
6. Remove the oil level indicator tube from the engine block using a twisting motion.
7. Clean the old sealer from the oil level indicator tube and the engine block.



182831

Installation Procedure

1. Apply sealant, GM P/N 12346004 or equivalent, around the oil level indicator tube 13 mm (0.5 in) below the tube bead.
2. Install the oil level indicator tube to the engine block. The indicator tube collar must be installed flush to the engine block.
3. Line up the oil level indicator tube with the spark plug retainer.



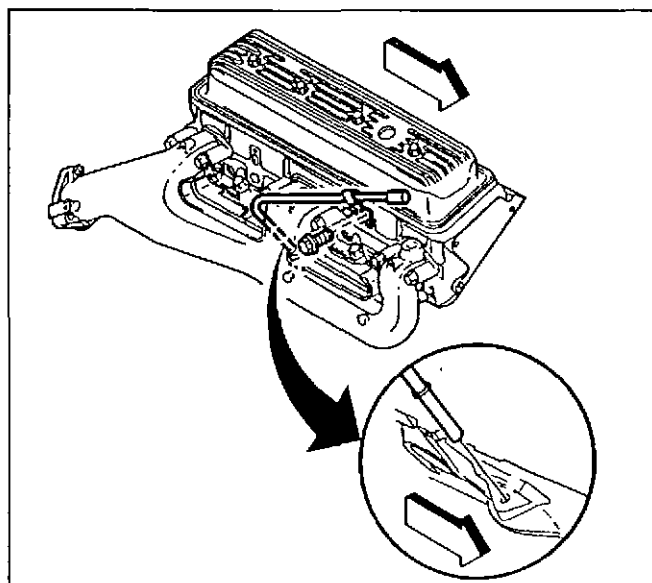
176058

Notice: Refer to *Fastener Notice* in *Cautions and Notices*.

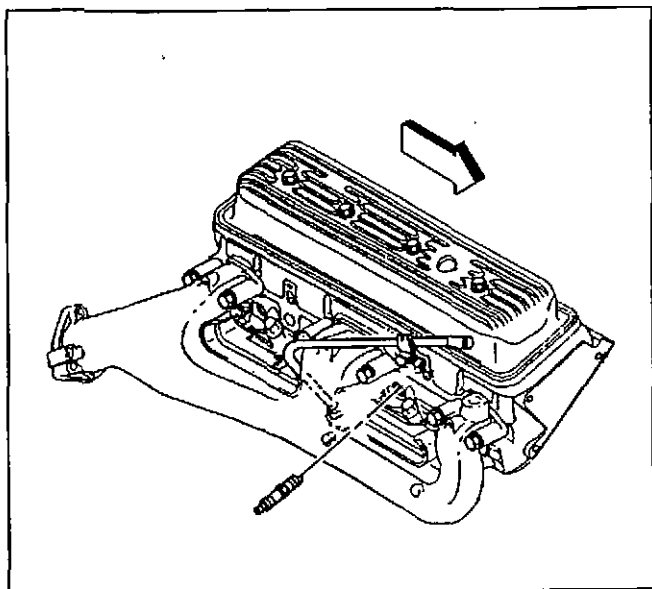
4. Install the bolt.

Tighten

Tighten the oil level indicator tube bolt to 12 N.m (106 lb in).



182831



345189

5. Install the spark plug for the number 4 cylinder.
6. Install the spark plug wire.
- Tighten**
Tighten the spark plug to 20 N.m (15 lb ft).
7. Install the air cleaner assembly.

SIE-10 - 348762

Engine Oil Pressure Sensor/Switch Replacement

Removal Procedure

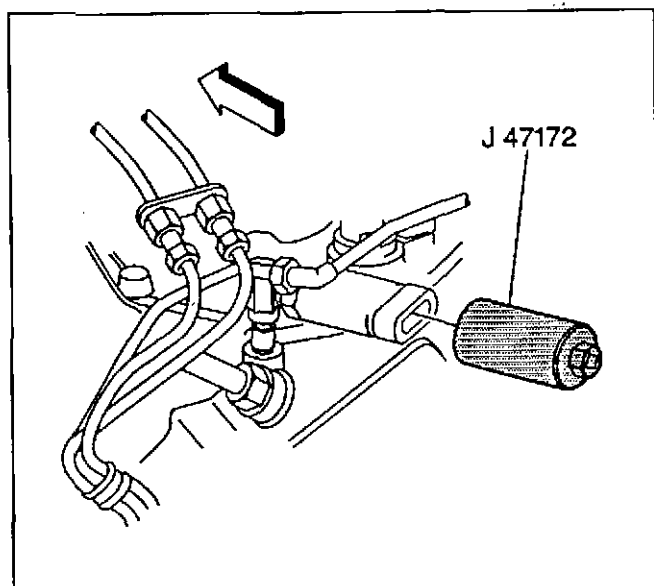
Tools Required

J 25254-10 A Oil Pressure Switch Socket.

1. Remove the Engine Cover. Refer to *Engine Cover Replacement (ERROR - NOT IN CURRENT PSD)* in Interior Trim.
2. Disconnect the electrical connector.
3. Hold the engine oil pressure sensor fitting with a wrench.

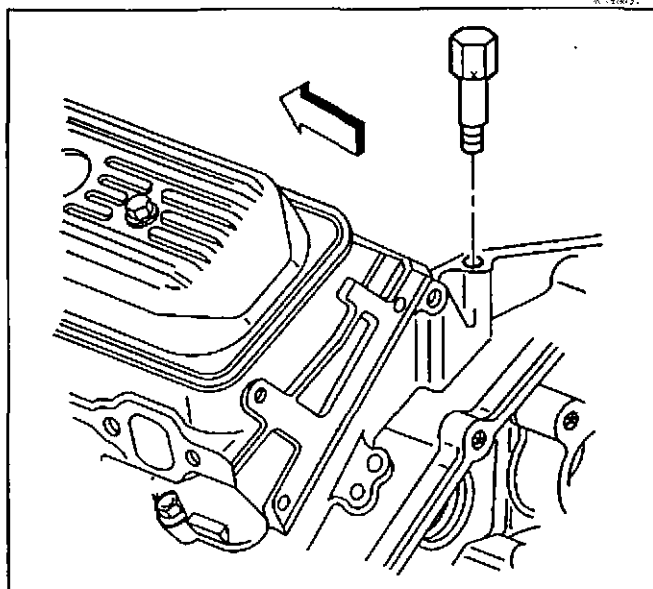
Important: Note the alignment of the oil pressure sensor fitting prior to removal.

4. Remove the engine oil pressure sensor using J 25254-10 A .



348085

5. Remove the engine oil pressure sensor fitting, if necessary.



333652

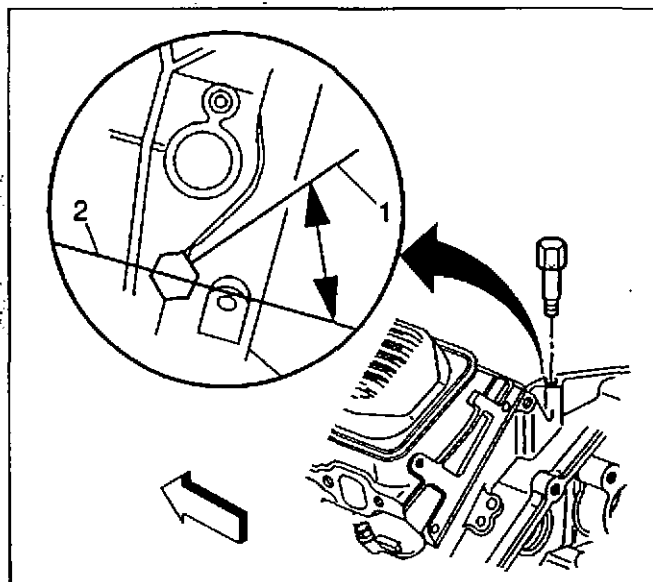
Installation Procedure

Notice: Fastener Notice in Cautions and Notices.

Important: Do not loosen the fitting. Do not tighten more than one turn.

1. Install the oil pressure sensor fitting, if removed.
Tighten

- 1.1. Tighten the engine oil pressure sensor fitting to 15 N.m (11 lb ft).
- 1.2. Tighten the fitting until properly align.



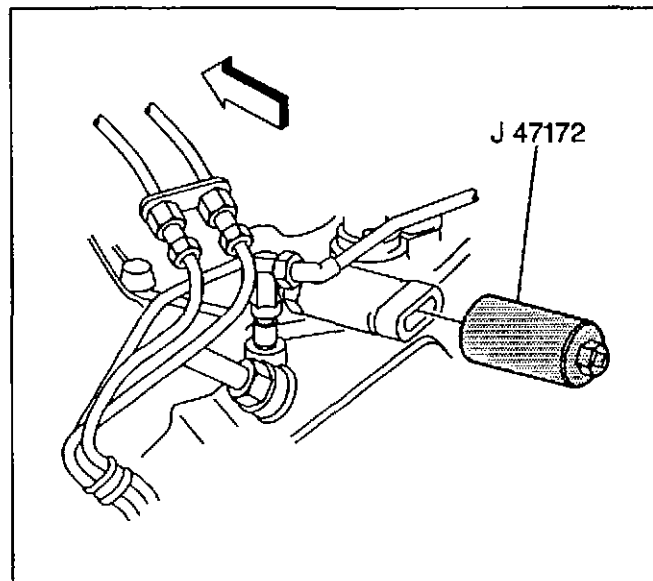
333659

2. Install the oil pressure sensor.
3. Hold the oil pressure sensor fitting with a wrench to prevent from turning.

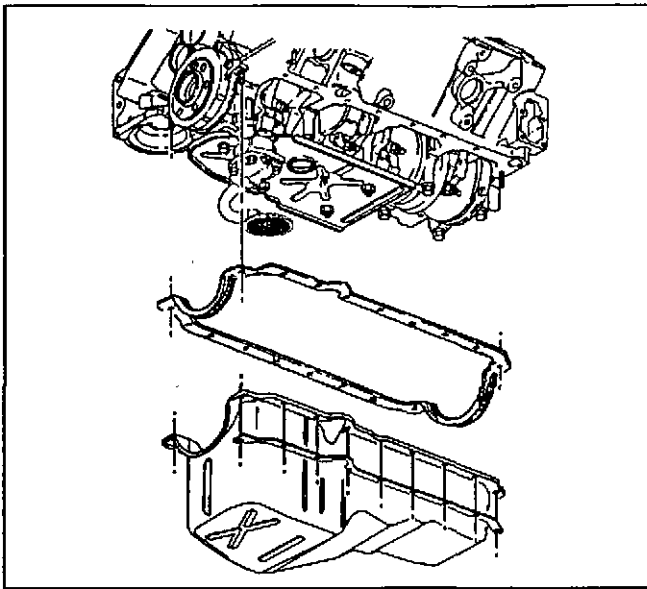
Tighten

Using J 25254-10 A tighten the oil pressure sensor to 30 N.m (22 lb ft).

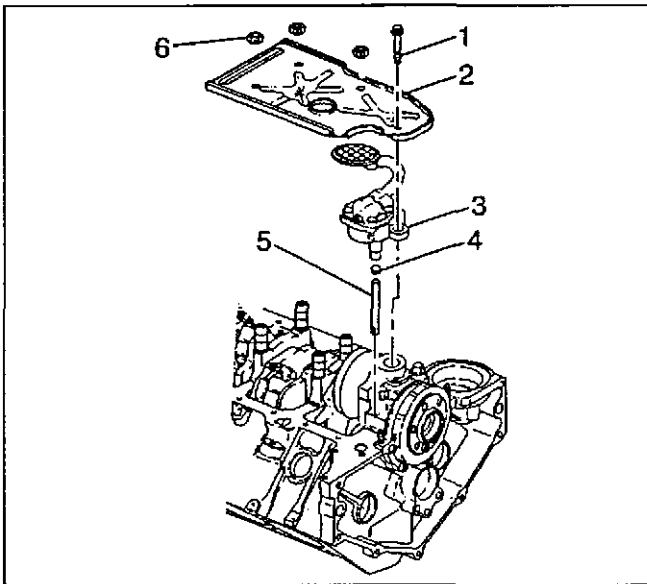
4. Install the electrical connector.
5. Install Engine Cover. Refer to *Engine Cover Replacement (ERROR - NOT IN CURRENT PSD)* in Interior Trim.



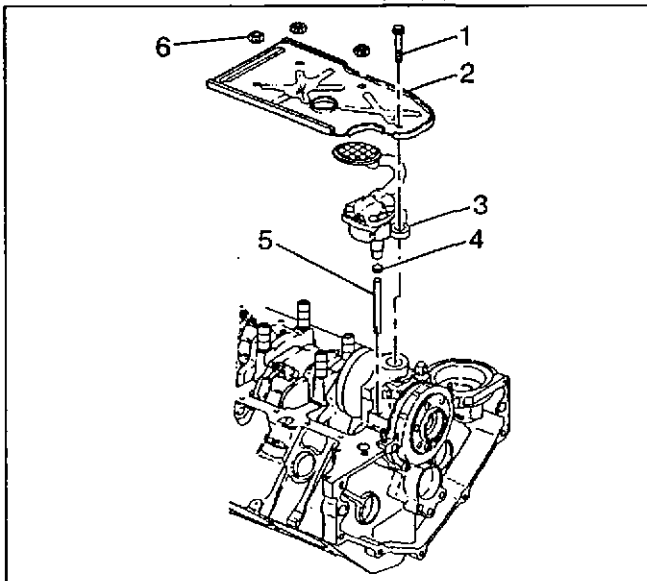
348085



176052



11438



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SIE-ID - 332477

Oil Pump, Pump Screen and Deflector Replacement

Removal Procedure

1. Remove the engine oil pan. Refer to *Oil Filter Adapter and Valve Assembly Replacement*.

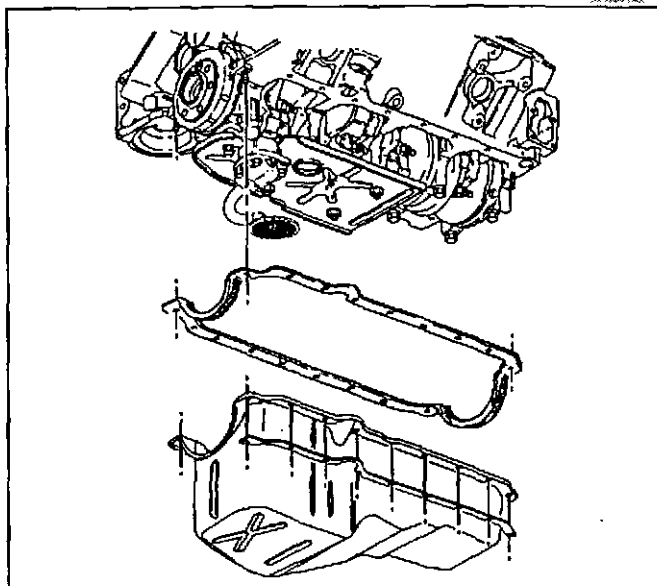
2. Remove the oil pump.

3. A loose screen or pipe assembly can result in an air leak and loss of oil pressure. For more information, refer to *Oil Pump Clean and Inspect*.

Installation Procedure

1. Install the oil pump and the oil deflector.

2. Install the engine oil pan. Refer to *Oil Pan Replacement*.



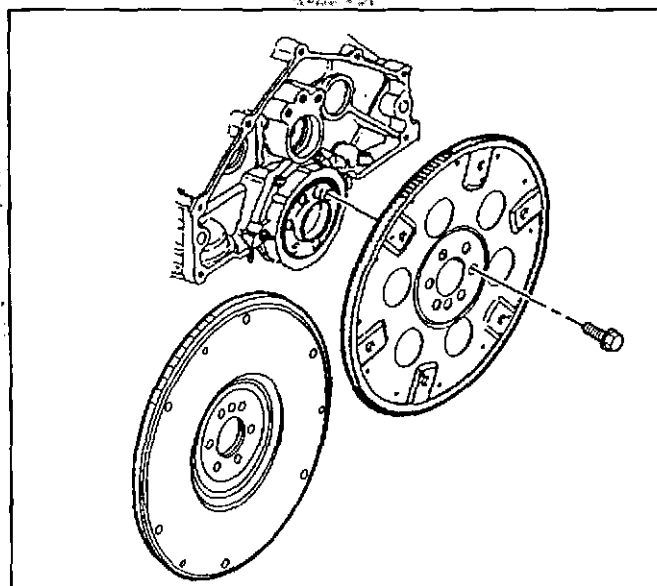
176052

SIE-ID # 332479

Crankshaft Rear Oil Seal and Housing Replacement (Housing)

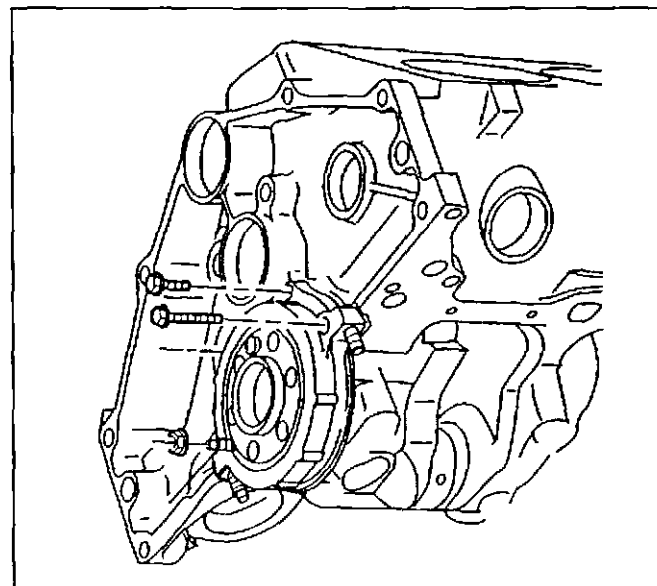
Removal Procedure

1. Remove the transmission assembly and the flywheel. Refer to *Transmission Replacement in Transmission/Transaxle*.

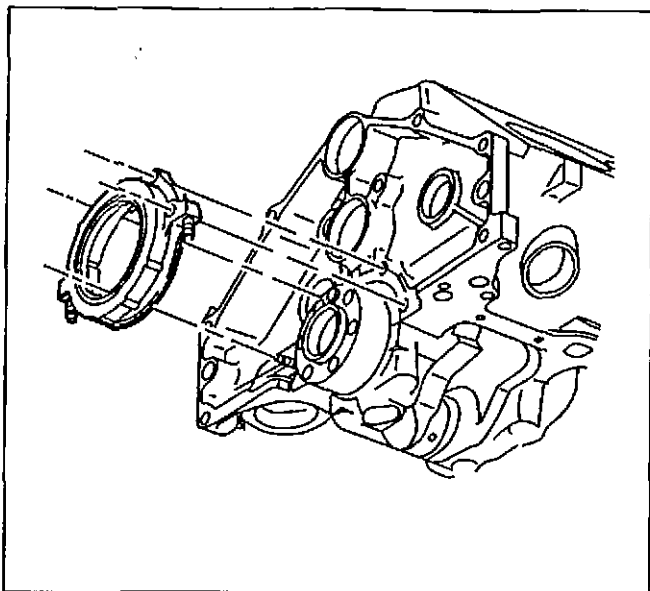


69012

2. Remove the following fasteners from the oil seal housing:
 - Three bolts using a T27 TORX® wrench and one nut.
 - Two lower studs using an E7 TORX® wrench.

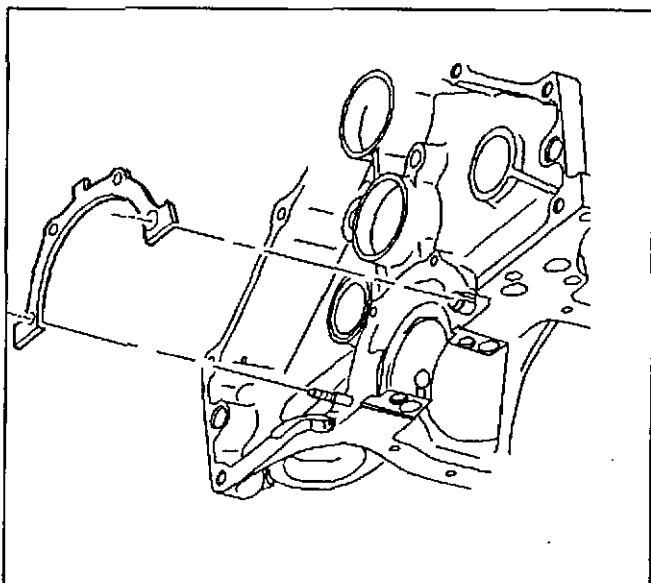


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4072

3. Remove the crankshaft rear oil seal housing. Refer to *Crankshaft Rear Oil Seal and Housing Installation*.

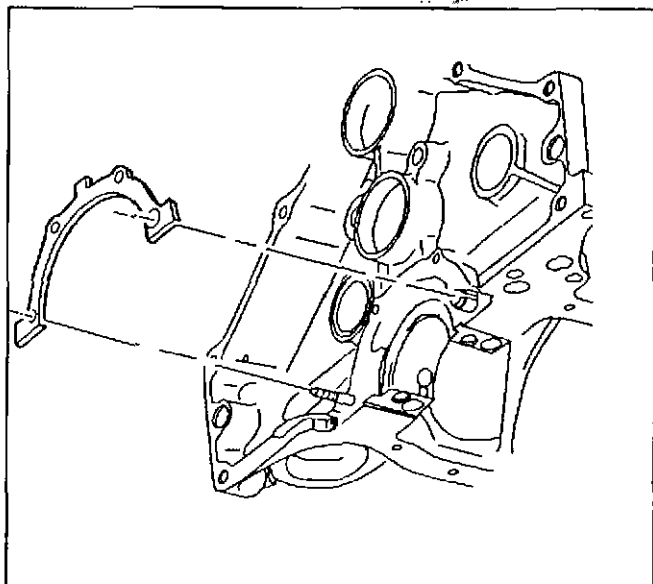


4073

4. Remove the crankshaft rear oil seal housing gasket and discard.
5. Clean all the sealing surfaces.
6. Inspect the crankshaft rear oil seal housing housing for warping, cracks, wear, or damage.

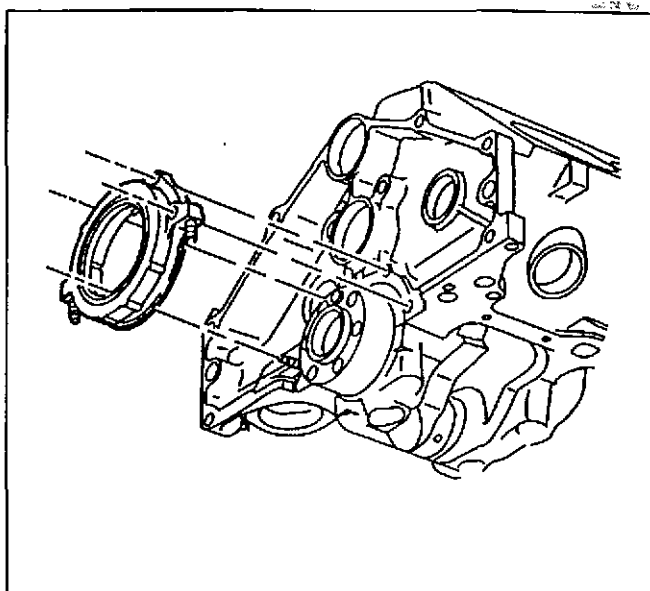
Installation Procedure

1. Install a NEW crankshaft rear oil seal housing gasket.



4073

2. Install the crankshaft rear oil seal housing to the engine block.



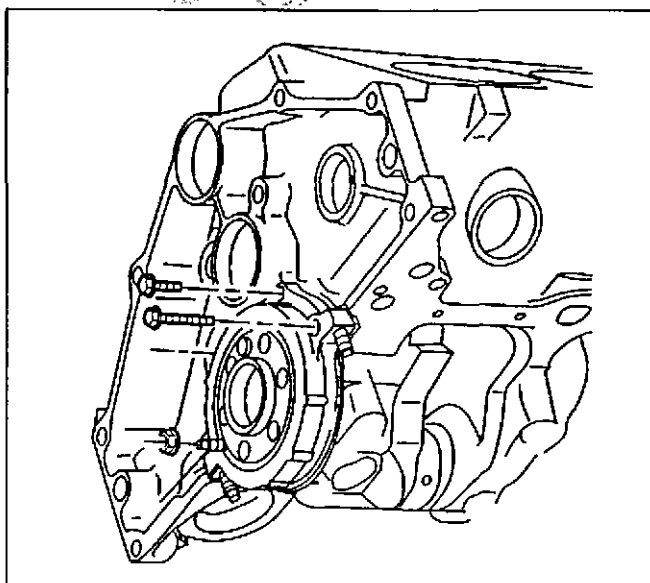
4072

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the following fasteners to the oil seal housing:
 - Three bolts using a T27 TORX® wrench and one nut.
 - Two lower studs using an E7 TORX® wrench, if needed.

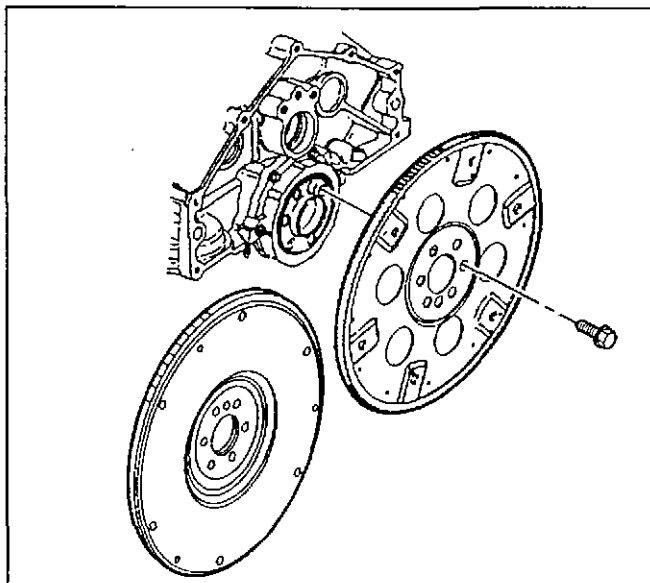
Tighten

- Tighten the crankshaft rear oil seal housing bolts and nut to 12 N.m (106 lb in).
- Tighten the lower studs to 6 N.m (53 lb in), if needed.



4071

4. Install the transmission assembly and the engine flywheel.
Refer to *Transmission Replacement* in Transmission/Transaxle.



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SIE-ID = 332482

Crankshaft Rear Oil Seal and Housing Replacement (Seal)

Removal Procedure

1. Remove the flywheel and transmission assembly. Refer to *Transmission Replacement* in Transmission/Transaxle.

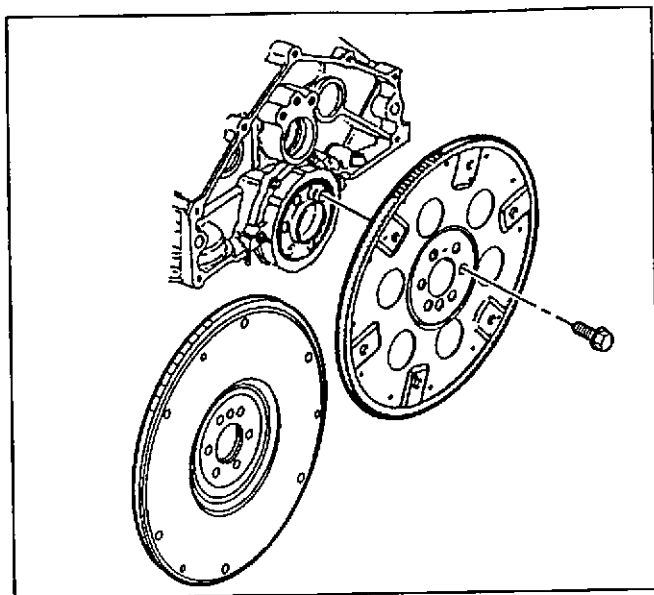
2. Remove the crankshaft rear oil seal from the crankshaft rear oil seal housing. Insert a suitable tool into the access notches and then carefully pry the crankshaft rear oil seal from the crankshaft rear oil seal housing.
3. Discard the crankshaft rear oil seal.

Installation Procedure

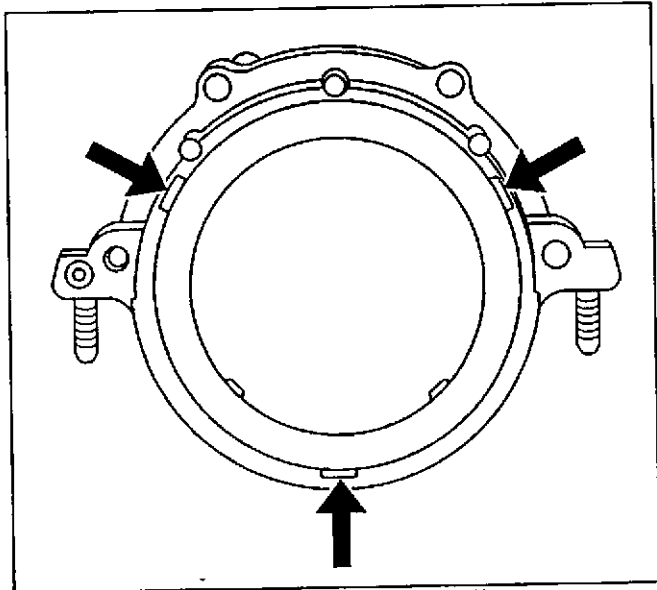
Tools Required

J 35621-A Crankshaft Rear Oil Seal Installer.

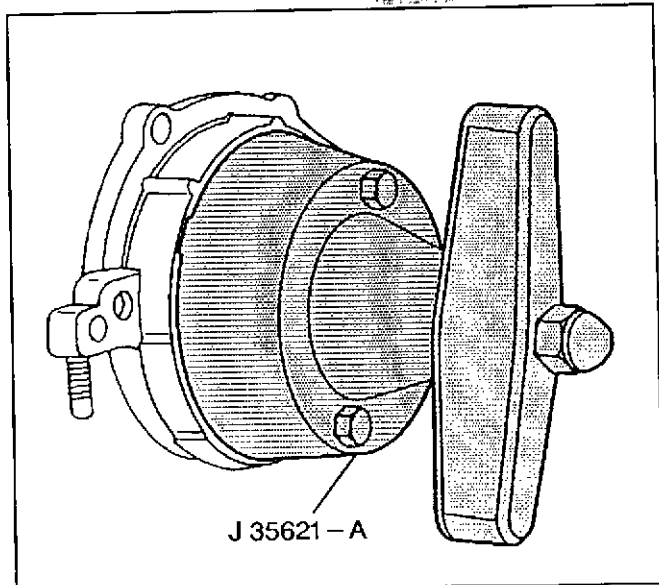
1. Use the *J 35621-A* in order to install the NEW oil seal.



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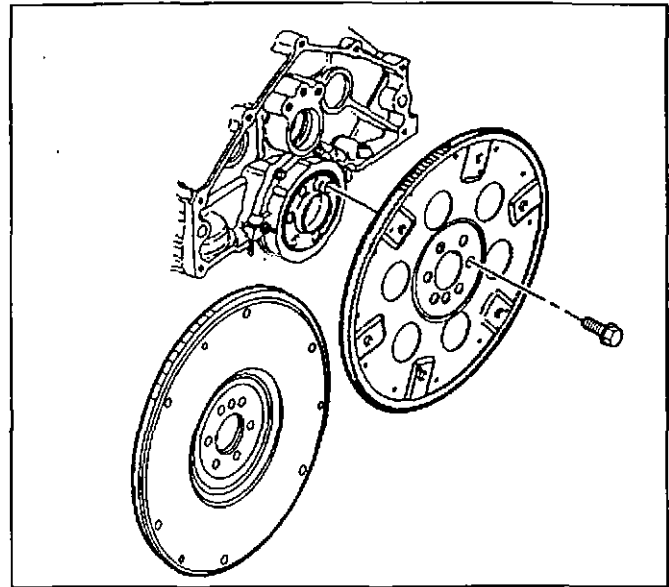


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2. Install the engine flywheel and transmission assembly. Refer to *Transmission Replacement* in *Transmission/Transaxle*.



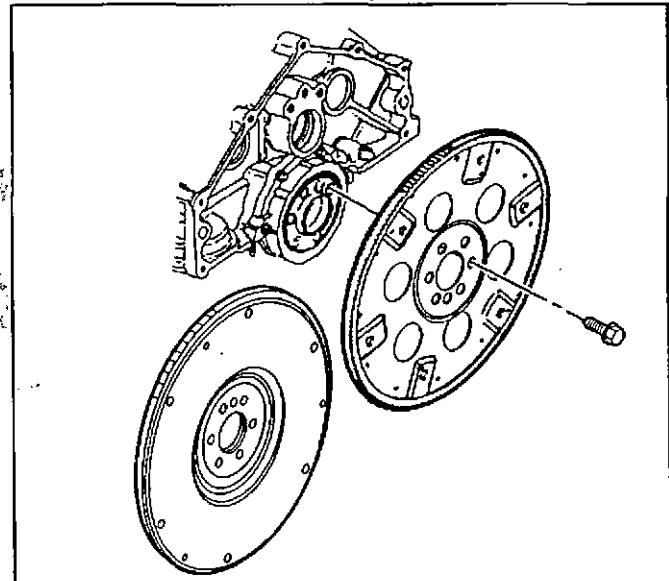
69012

SIE-ID = 332483

Engine Flywheel Replacement (Manual Transmission)

Removal Procedure

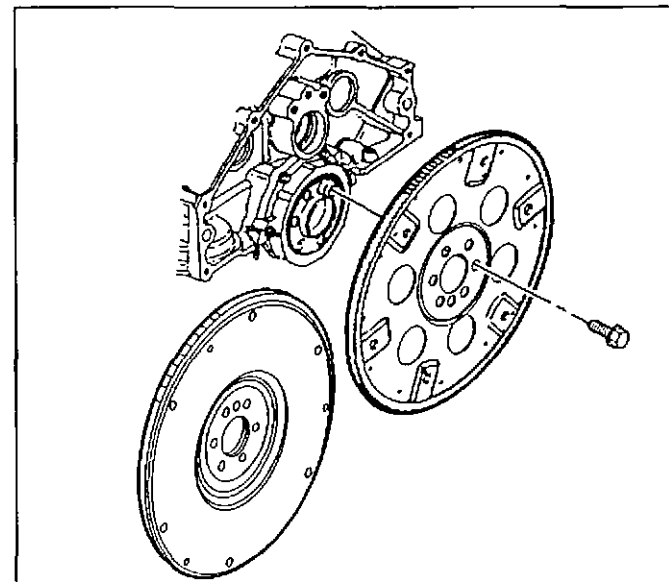
1. Remove the transmission and clutch assembly. Refer to *Transmission Replacement* in *Transmission/Transaxle*.
2. Remove the engine flywheel. Refer to *Engine Flywheel Removal*.
3. Clean and inspect all parts. Refer to *Engine Flywheel Clean and Inspect* (ERROR - NOT IN CURRENT PSD).



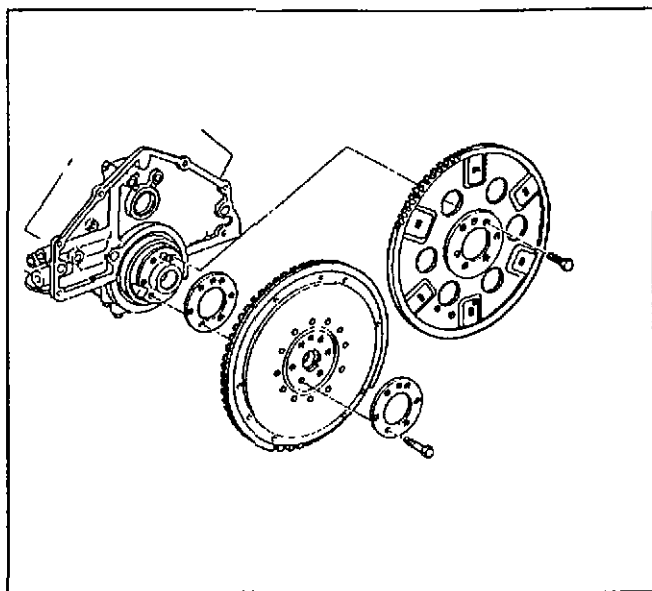
69012

Installation Procedure

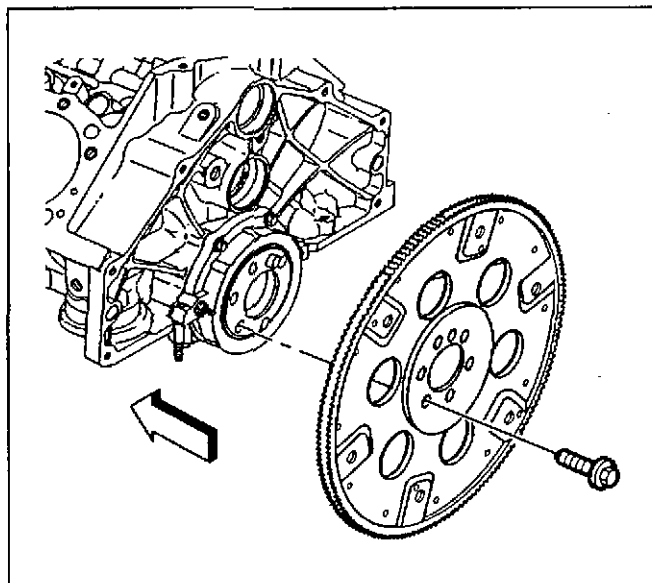
1. Install the engine flywheel.
2. Install the transmission and clutch assemblies. Refer to *Transmission Replacement* in *Transmission/Transaxle*.



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SIE-ID - 332484

Engine Flywheel Replacement (Automatic Transmission)

Removal Procedure

1. Remove the transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.
2. Remove the engine flywheel. Refer to *Engine Flywheel Removal*.
3. Clean and inspect all parts. Refer to *Engine Flywheel Clean and Inspect* (ERROR - NOT IN CURRENT PSD).

Installation Procedure

1. Install the engine flywheel.
2. Install the transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.

SIE-ID - 332486

Engine Replacement

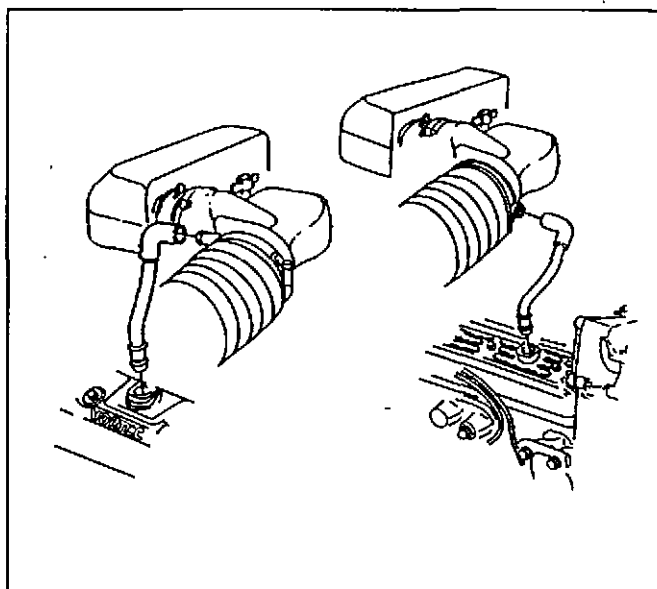
Removal Procedure

Tools Required

J 41427 Engine Lift Brackets

1. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the hood. Refer to *Hood Replacement*.

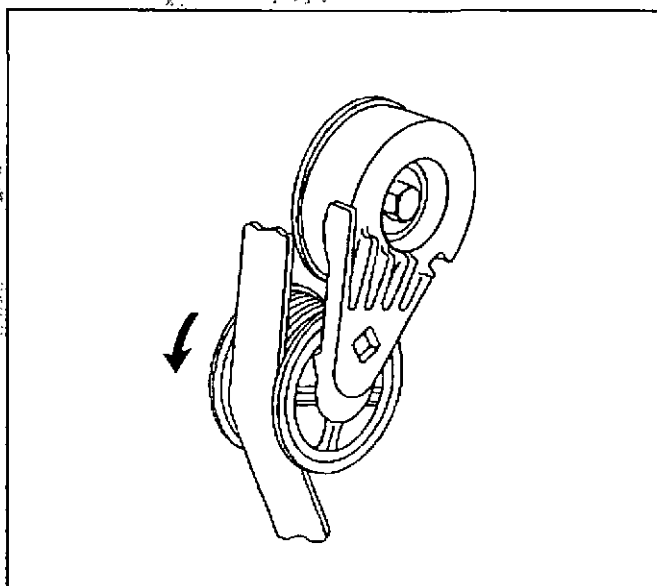
3. Remove the air cleaner assembly.
4. Drain the engine coolant. Refer to *Draining and Filling Cooling System*.
5. Remove the following coolant hoses:
 - Remove the upper radiator hose. Refer to *Radiator Hose Replacement (5.0L)* in Engine Cooling.
 - Remove the lower radiator hose. Refer to *Radiator Hose Replacement (6.5L)* in Engine Cooling.
 - Remove both heater hoses. Refer to *Heater Hoses Replacement (Inlet Hose - 5.0L, 5.7L, 7.4L)* and *Heater Hoses Replacement (Outlet Hose - 5.0L, 5.7L)*.
6. Remove the upper radiator shroud. Refer to *Fan Shroud Replacement (Upper)* and *Fan Shroud Replacement (Lower)* in Engine Cooling.



173191

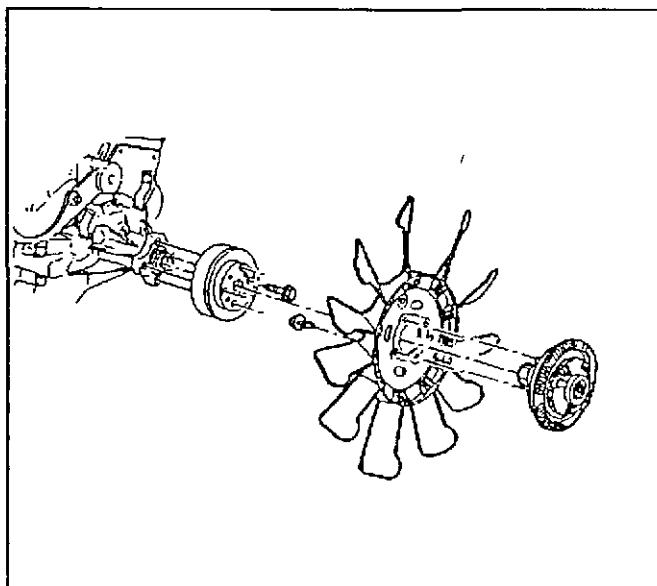
7. Remove the drive belt. Refer to *Drive Belt Replacement*.

Caution: S10-ID - 352518 To help avoid potential personal injury or potential damage to the vehicle due to possible cable damage during service, replace the existing accelerator control cable with a NEW cable when removing or replacing the engine. Position the cruise control cable out of the way to ensure it is not damaged while removing or installing the engine. Do not bend the cruise control cable and cause a kink at the bend. Do not position the cruise control cable where the technician may lean or pry against the cable and cause damage to the cable.

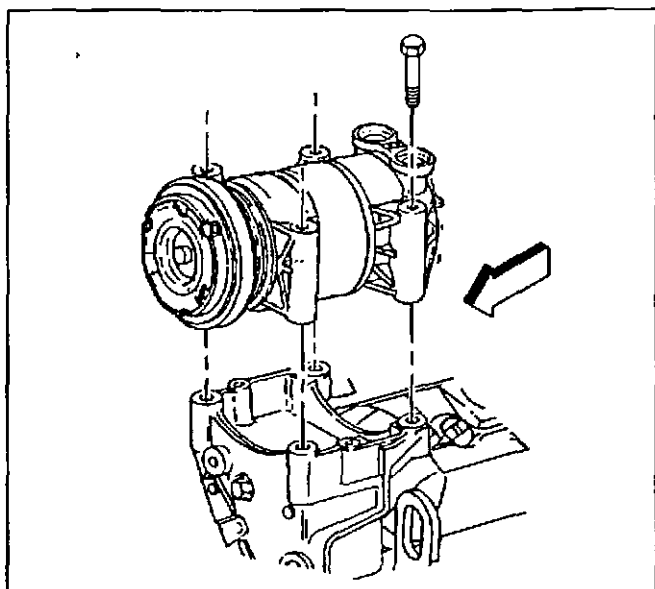


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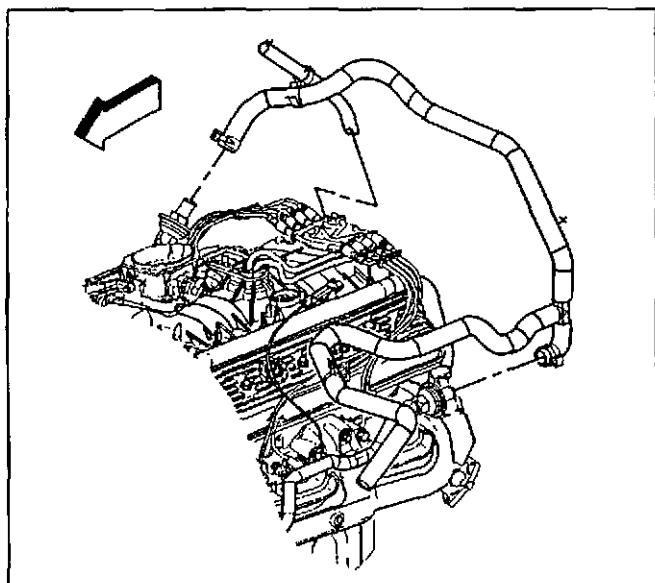
8. Disconnect the accelerator control cable and the cruise control cable, if equipped. Refer to *Accelerator Controls Cable Replacement* in Engine Controls.
9. Remove the engine cooling fan. Refer to *Fan Clutch Replacement (5.0L, 5.7L and 6.5L)*.



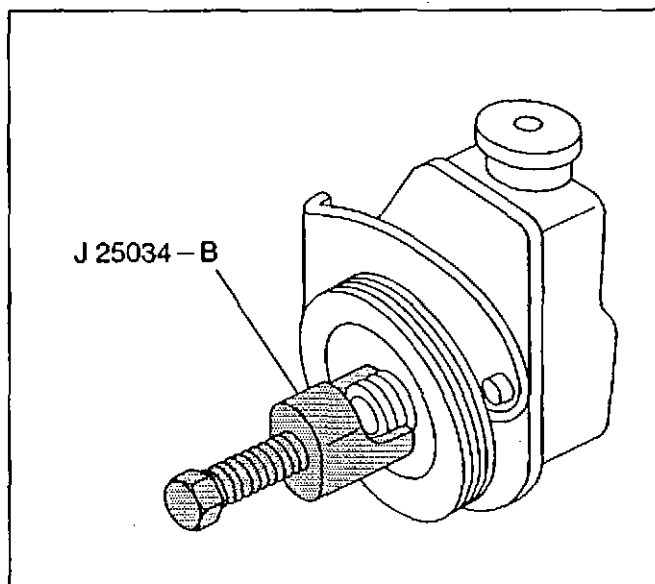
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Important: It is not necessary to discharge the A/C refrigerant.

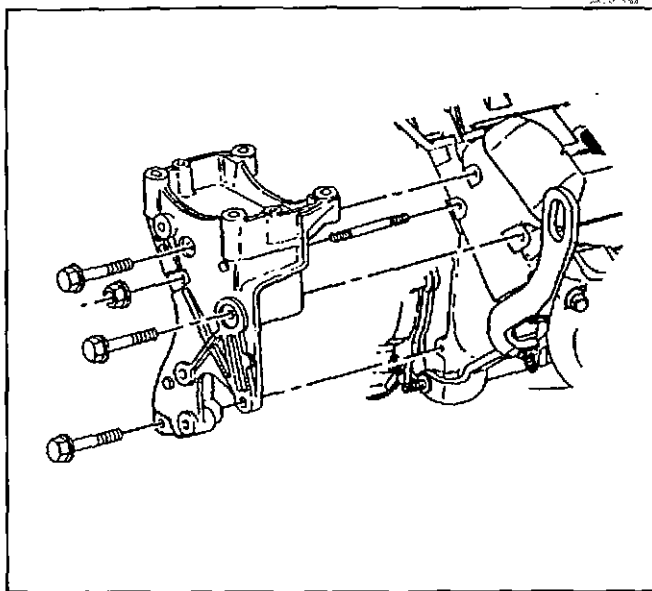
10. Remove the air conditioning compressor, if equipped, and set it aside. Refer to *Compressor Replacement (5.0L, 5.7L)* in HVAC.

11. Remove AIR bypass hose assembly, if so equipped. Refer to *Sec Air Injection Check Valve/Pipe Replacement*.

12. Remove the power steering pump pulley. Refer to *Power Steering Pump Replacement (5.0L, 5.7L)*.

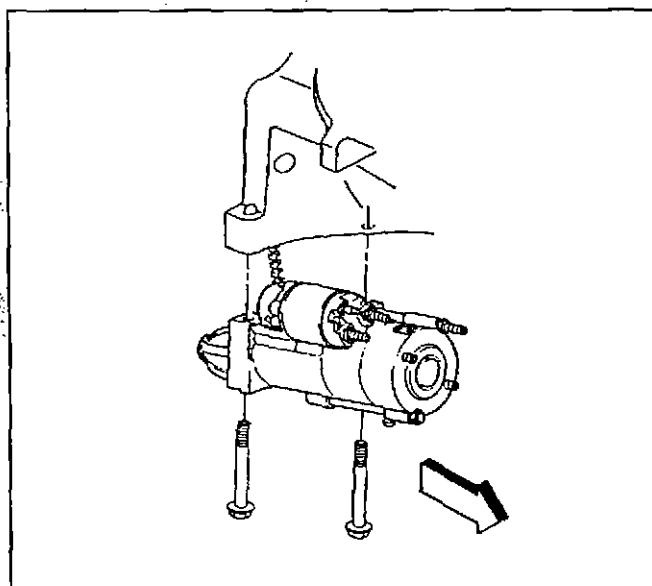
13. Remove the power steering pump mounting bracket using the following procedure:

- 13.1. Disconnect the electrical connector from the power steering pump.
- 13.2. Remove the nuts holding the power steering pump to the engine.
- 13.3. Remove the power steering pump mounting bracket bolts and the nut.
- 13.4. Slide the power steering pump mounting bracket forward with the power steering pump still attached.
- 13.5. Remove the stud from the cylinder head.
- 13.6. Set the power steering pump and the mounting bracket aside.



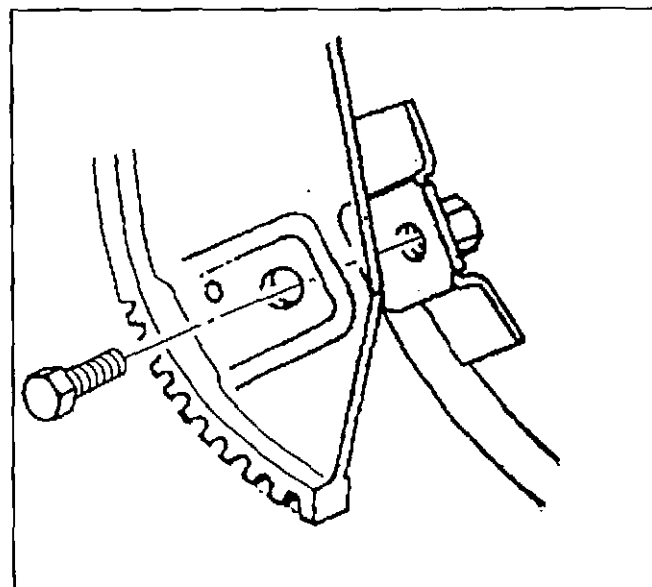
188295

14. Remove the starter motor. Refer to *Starter Motor Replacement (ERROR - NOT IN CURRENT PSD)*.
15. Remove the starter opening cover.
16. Disconnect the electrical connectors on the top of the engine.
17. Disconnect the positive battery cable at the generator.

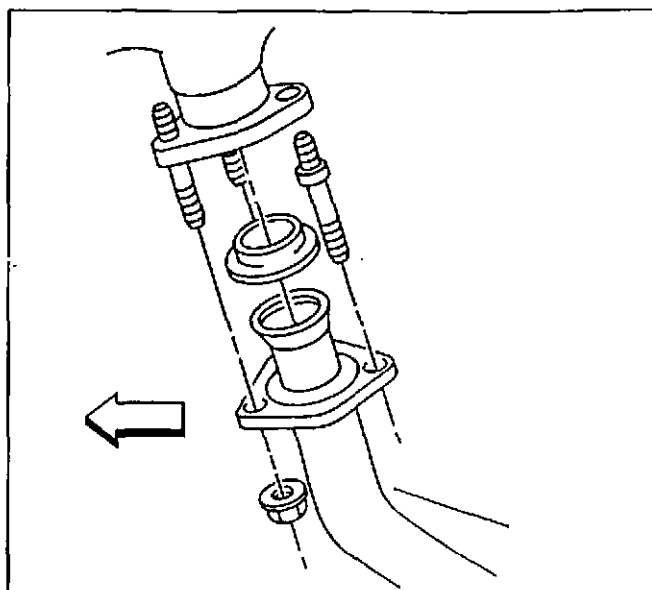


183406

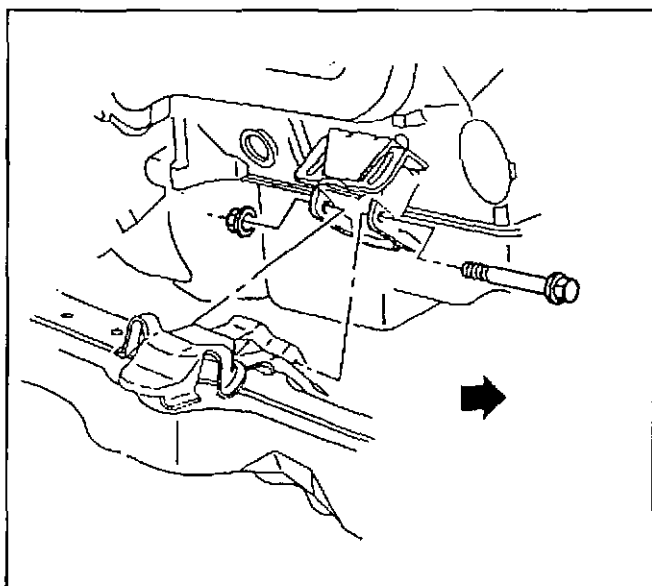
18. Remove the torque converter to flywheel bolts. Refer to *Flywheel to Torque Converter Bolts (ERROR - NOT IN CURRENT PSD)* in automatic transmission, transaxle.
19. Disconnect the transmission cooler pipe bracket from the right side of the oil pan. Refer to *Oil Cooler Line Replacement* in automatic transmission, transaxle.



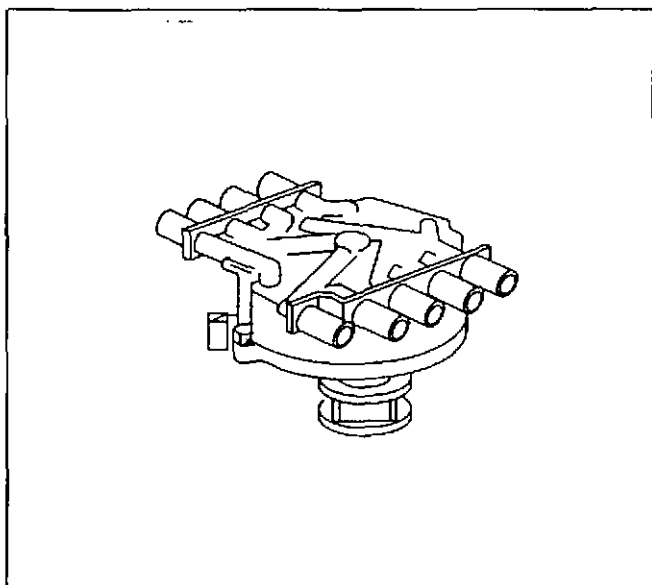
9096



42940



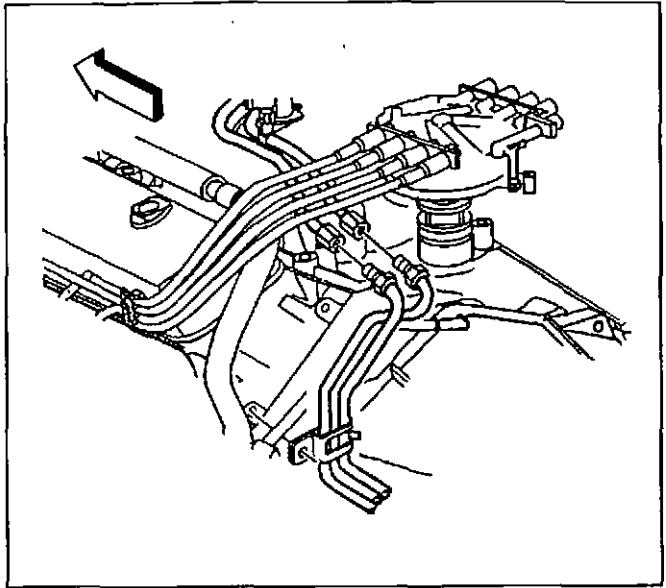
4564



344232

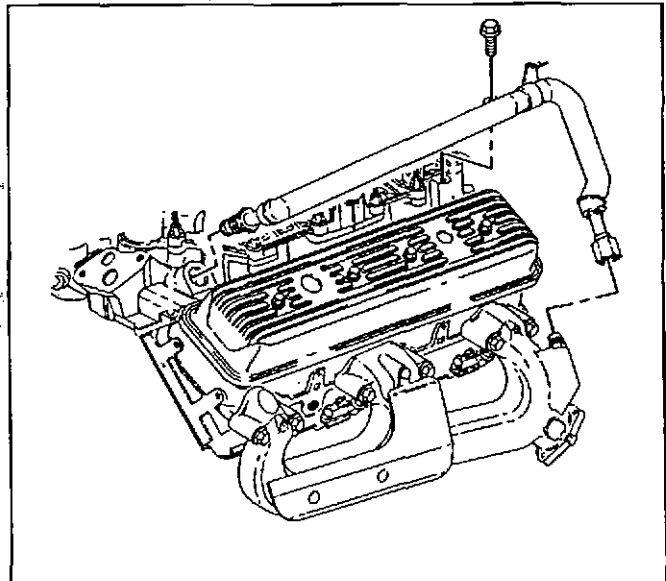
20. Remove the exhaust pipe from the exhaust manifolds. Refer to *Exhaust Manifold Pipe Replacement (Diesel)* in Engine Exhaust.
21. Support the transmission with a suitable strap.
22. Remove the engine oil cooler pipes, if equipped. Refer to *Engine Oil Cooler Line Replacement*.
23. Remove both engine mount through-bolts.
24. Remove seven transmission to engine bolts including the brackets.
25. Lower the vehicle.
26. Disconnect the remaining electrical connectors.
27. Remove the distributor cap. Refer to *Distributor Replacement (ERROR - NOT IN CURRENT PSD)*.
28. Remove the engine harness support.

29. Disconnect the fuel pipes. Refer to *Fuel Hose/Pipes Assembly Replacement (Fuel Pipes)* in Engine Controls.
30. Remove two transmission to engine bolts at the rear top of the engine.



343625

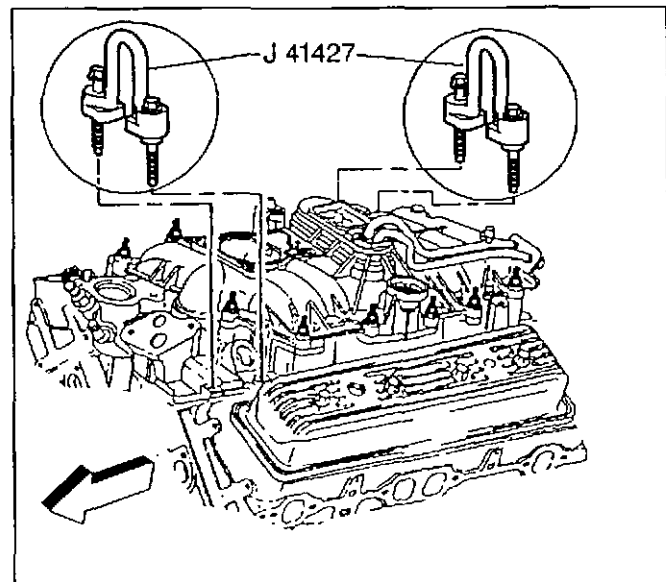
31. Remove the EGR pipe. Refer to *Sec Air Injection Check Valve/Pipe Replacement* in Engine Controls.



173206

Notice: Refer to *Fastener Notice* in Cautions and Notices.

32. Attach the J 41427 to the left front and right rear intake manifold mounting bolts, using the following procedure:
 - 32.1. Remove the right rear lower intake manifold bolts. Refer to *Intake Manifold Replacement (Lower)*.
 - 32.2. Install the J 41427 marked RIGHT REAR.
 - 32.3. Install the retaining bolts.
Tighten
Tighten the bolts to 15 N.m (11 lb ft).
 - 32.4. Remove the left front lower intake manifold bolts.
 - 32.5. Install the J 41427 marked LEFT FRONT with the arrow pointing to the front of the engine.
 - 32.6. Install the retaining bolts.



66496

Tighten

Tighten the bolts to 15 N·m (11 lb ft).

33. Attach a suitable lifting device to the lift brackets.
34. Remove the engine.

Installation Procedure**Tools Required****J 41427 Engine Lift Brackets**

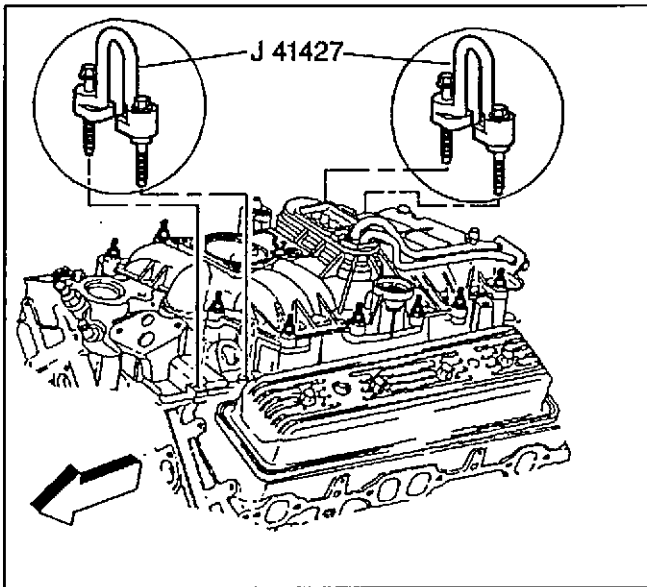
1. Install the engine in the vehicle.
2. Install two top transmission to engine bolts, including the brackets and clips.
3. Remove the J 41427 and the lifting device.
4. Apply thread lock GM P/N 12345382 or equivalent to the threads of the lower intake manifold bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

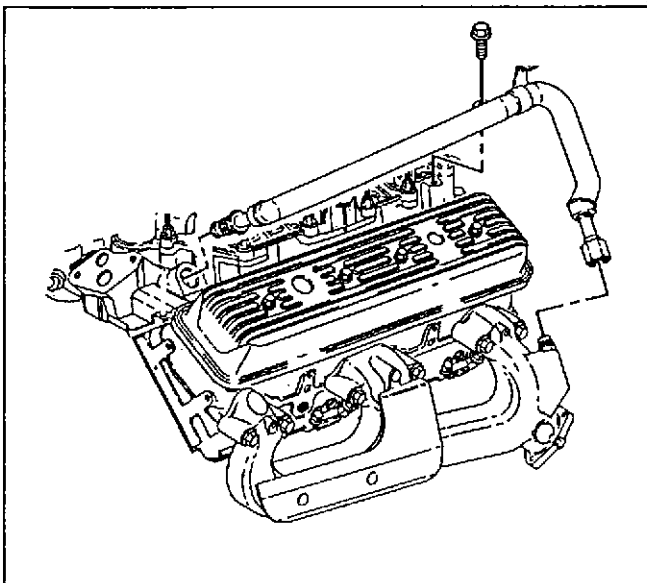
5. Reinstall the intake manifold bolts.

Tighten

- 5.1. Tighten the bolts on the first pass to 3 N·m (27 lb in).
- 5.2. Tighten the bolts on the second pass to 12 N·m (106 lb in).
- 5.3. Tighten the bolts on the third pass to 15 N·m (11 lb ft).
6. Install the EGR valve inlet pipe. Refer to *Sec Air Injection Check Valve/Pipe Replacement* in Engine Controls.

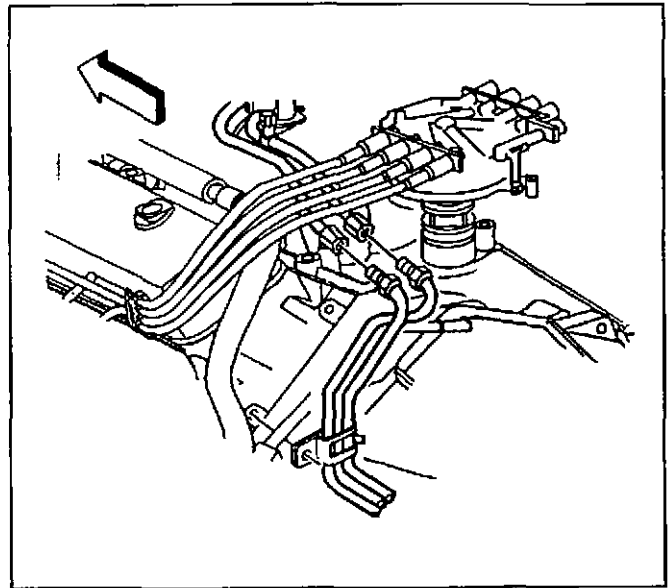


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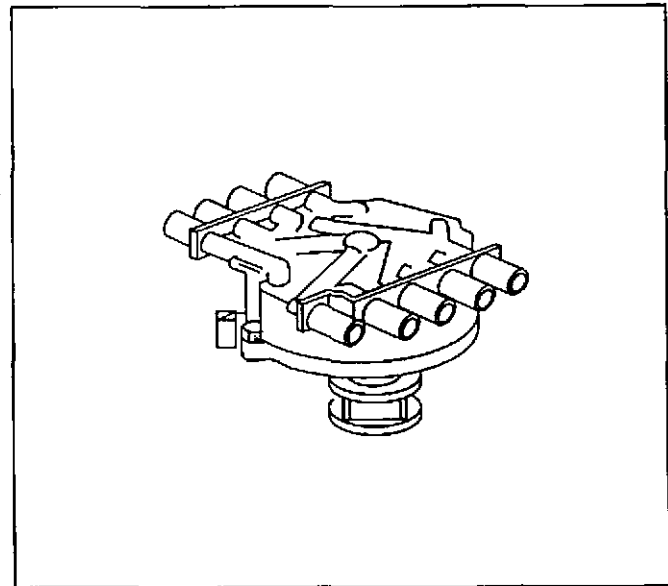
173206

7. Connect the fuel pipes.
Refer to *Fuel Hose/Pipes Assembly Replacement (Fuel Pipes)* in Engine Controls.
8. Install the engine harness support.



343625

9. Install the distributor cap. Refer to *Distributor Replacement (ERROR - NOT IN CURRENT PSD)*.

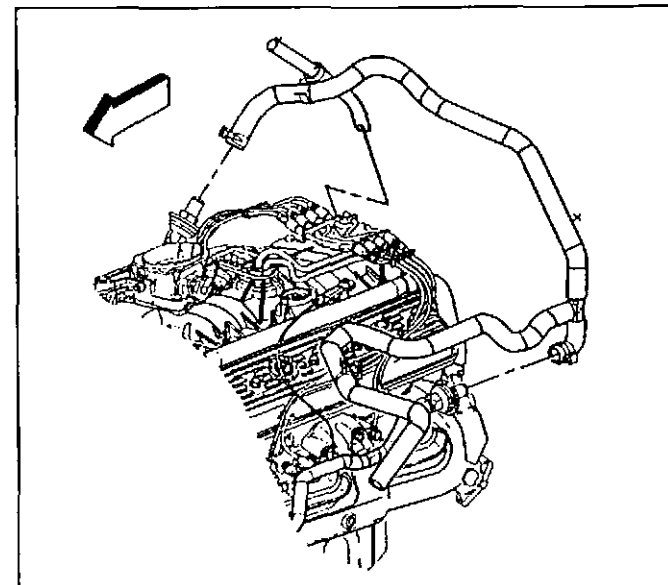


344232

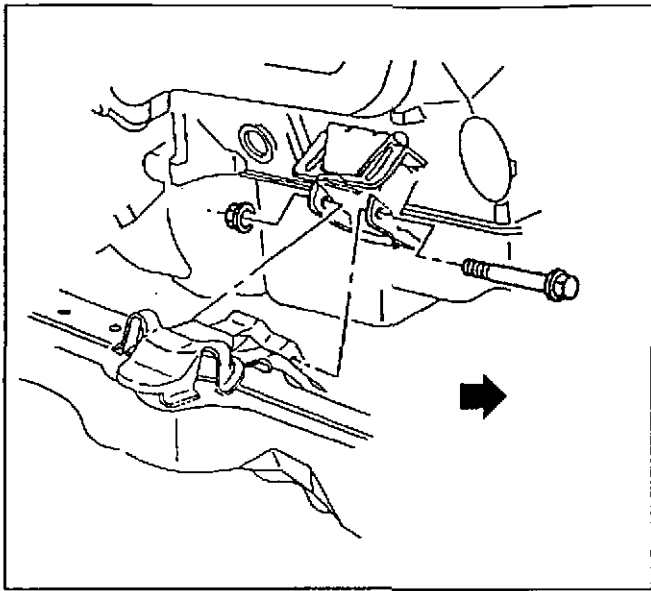
10. Install the AIR bypass hose assembly, if equipped. Refer to *Sec Air Injection Check Valve/Pipe Replacement*.
11. Connect the engine harness.
12. Install the remaining seven transmission to engine bolts.

Tighten

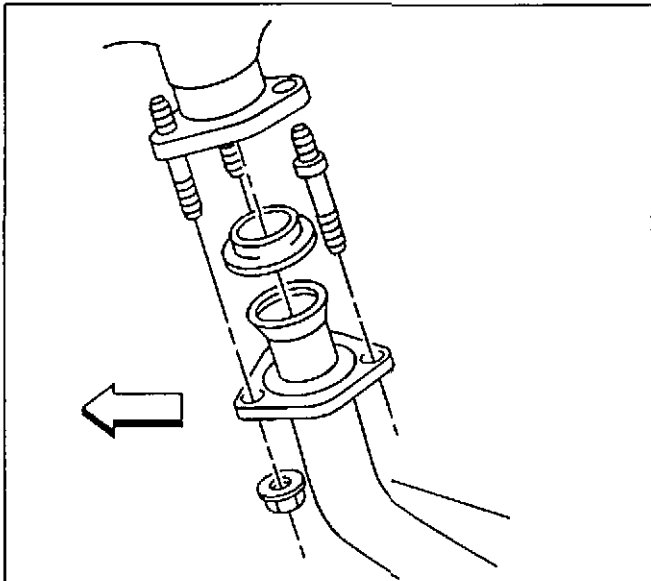
Tighten the bolts to 100 N.m (74 lb ft).



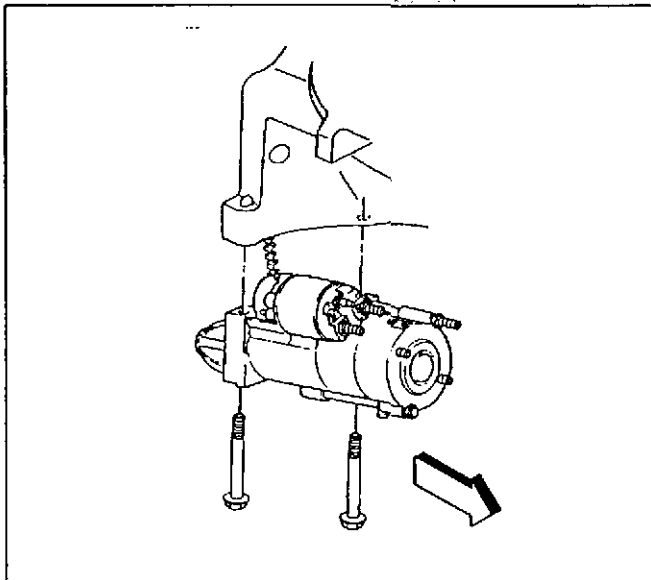
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13. Install both engine mount through-bolts, if equipped. Refer to *Engine Mount Replacement (Front C Model)*.
14. Install the oil cooler pipes, if equipped.
15. Remove the transmission support strap.

16. Install the exhaust pipe to the exhaust manifolds. Refer to *Engine Oil Cooler Line Replacement* in Engine Exhaust.
17. Install the transmission cooler pipe bracket to the right side of the oil pan, if equipped.
18. Install three torque converter to engine flywheel bolts, if equipped.

Tighten

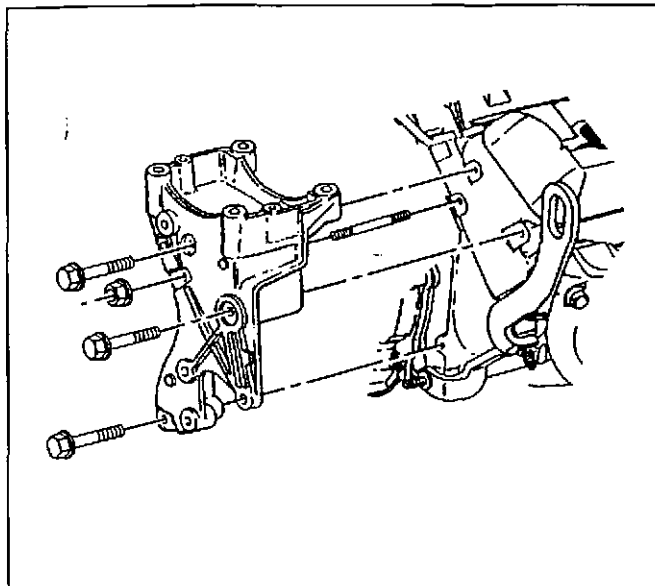
Tighten the bolts to 75 N·m (55 lb ft).

19. Install the starter opening shield.
20. Install the starter motor. Refer to *Starter Motor Replacement (ERROR - NOT IN CURRENT PSD)*.
21. Connect the positive battery cable at the generator.
Tighten
Tighten the nut to 20 N·m (15 lb in).
22. Connect the engine harness to the top of the engine.

23. Install the power steering pump mounting bracket using the following procedure:
 - 23.1. Loosely assemble the mounting bracket over the stud.
 - 23.2. Install a nut to the stud finger tight.
 - 23.3. Install the three bolts finger tight.
 - 23.4. Install the two nuts to the power steering pump finger tight.

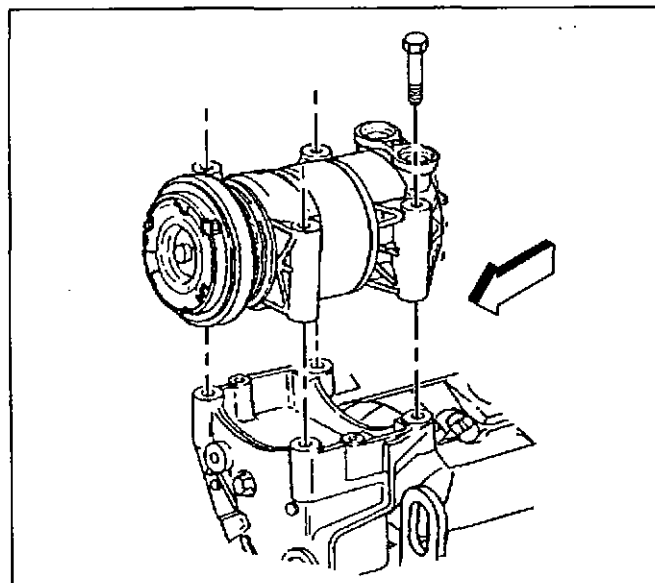
Tighten

Tighten the nuts and bolts to 41 N.m (30 lb ft).



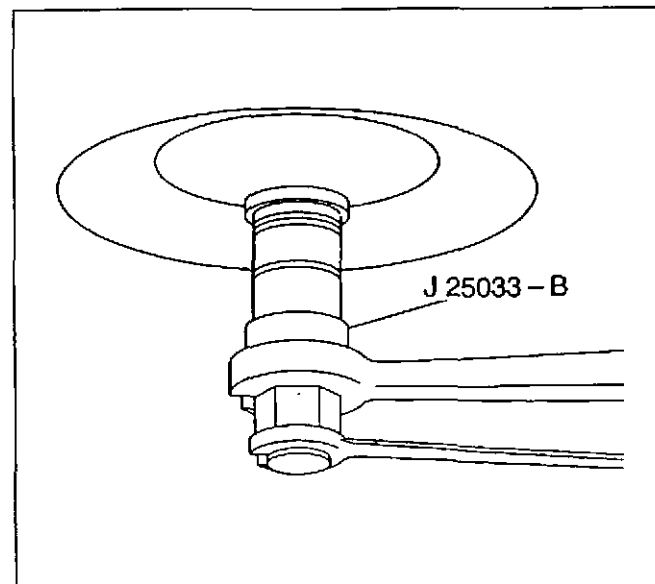
188295

24. Install the air conditioning (A/C) compressor, if equipped. Refer to *Compressor Replacement (5.0L, 5.7L)*.
25. Connect the electrical connector to the power steering pump.

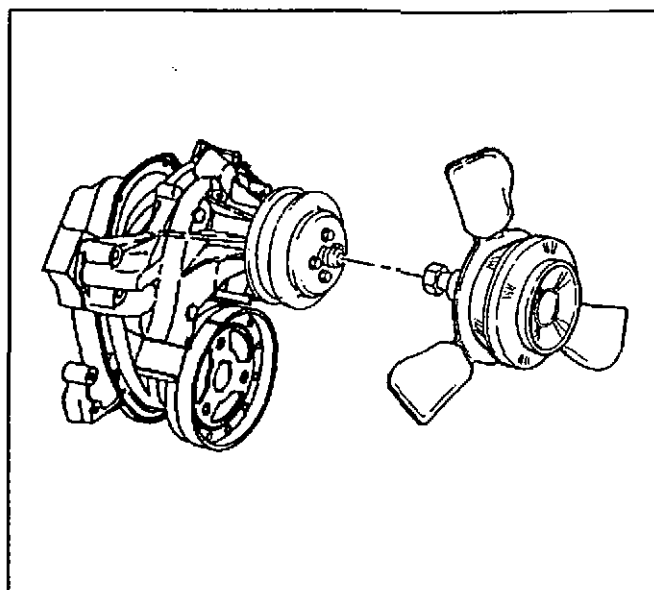


179249

26. Use the J 25033-B in order to install the power steering pump pulley. Refer to *Power Steering Pump Replacement (5.0L, 5.7L)*.

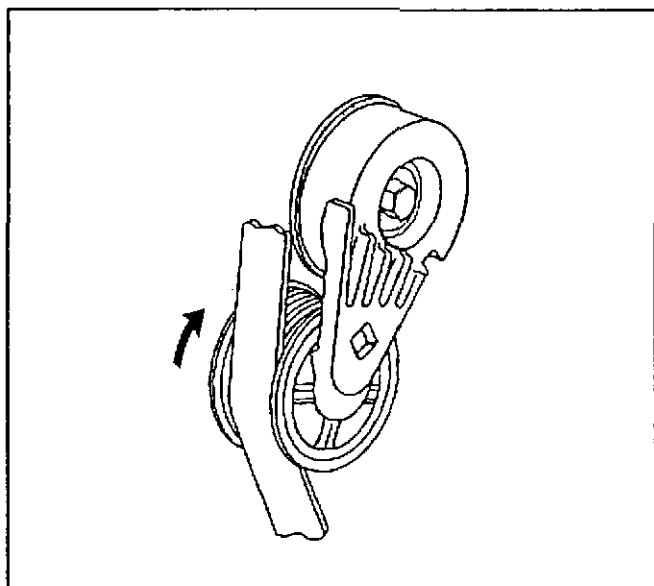


188373



188352

27. Install the engine cooling fan. Refer to *Fan Clutch Replacement (ERROR - NOT IN CURRENT PSD)*.

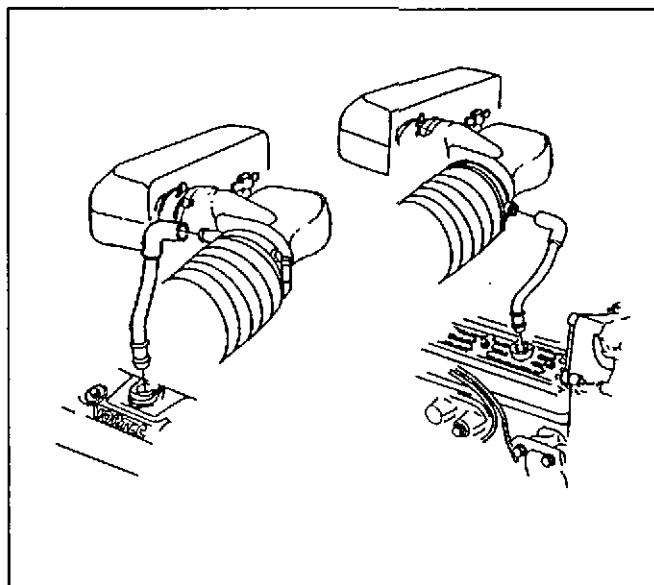


177622

28. Install the drive belt. Refer to *Drive Belt Replacement*.

Caution: S10-10 - 352518 To help avoid potential personal injury or potential damage to the vehicle due to possible cable damage during service, replace the existing accelerator control cable with a NEW cable when removing or replacing the engine. Position the cruise control cable out of the way to ensure it is not damaged while removing or installing the engine. Do not bend the cruise control cable and cause a kink at the bend. Do not position the cruise control cable where the technician may lean or pry against the cable and cause damage to the cable.

29. Connect the NEW accelerator control cable and the cruise control cable, if equipped. Refer to *Accelerator Controls Cable Replacement* in Engine Controls.



173191

30. Install the air cleaner assembly.
31. Install the upper radiator shroud. Refer to *Fan Shroud Replacement (Upper)* and *Fan Shroud Replacement (Lower)* in Engine Cooling.
32. Install the following coolant hoses:
- The upper radiator hose. Refer to *Radiator Hose Replacement (5.0L)* in Engine Cooling.
 - The lower radiator hose. Refer to *Radiator Hose Replacement (6.5L)* in Engine Cooling.
 - Both heater hoses. Refer to *Heater Hoses Replacement (Inlet Hose - 5.0L, 5.7L, 7.4L)* and *Heater Hoses Replacement (Outlet Hose - 5.0L, 5.7L)*.
33. Fill the cooling system with coolant. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)*.
34. Install the hood. Refer to *Hood Replacement*.
35. Connect the battery negative cable. Refer to *Battery Cable (0)* in Engine Electrical.

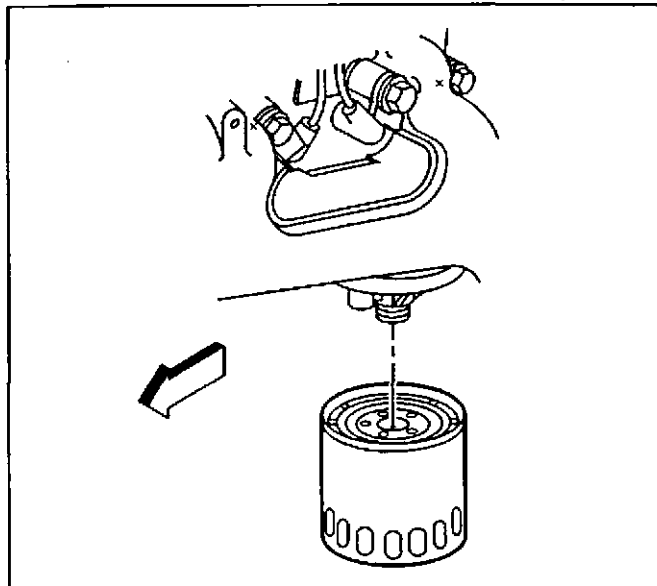
36. Before starting a new engine, or one that has been repaired. Refer to *Engine Set-Up and Testing*.

SIE-ID - 332487

Engine Oil and Oil Filter Replacement

Removal Procedure

1. Open the hood.
2. Raise the vehicle and support with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
3. Remove the oil filter from the engine block.
4. Remove the oil pan drain plug and drain the engine oil into a suitable container.

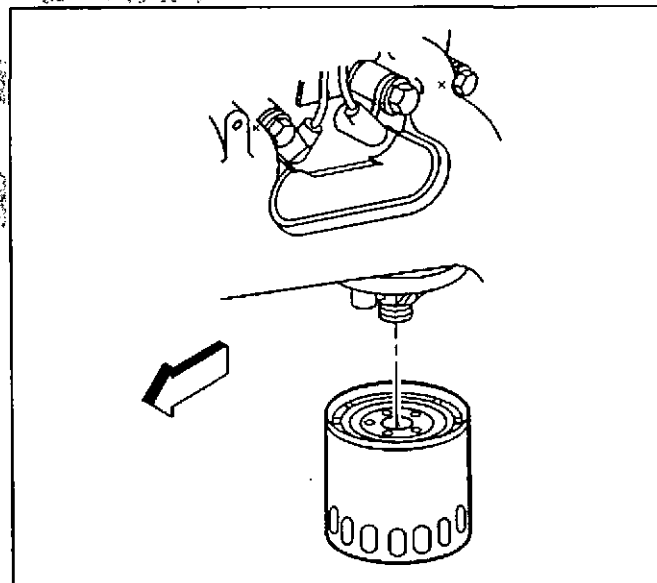


316766

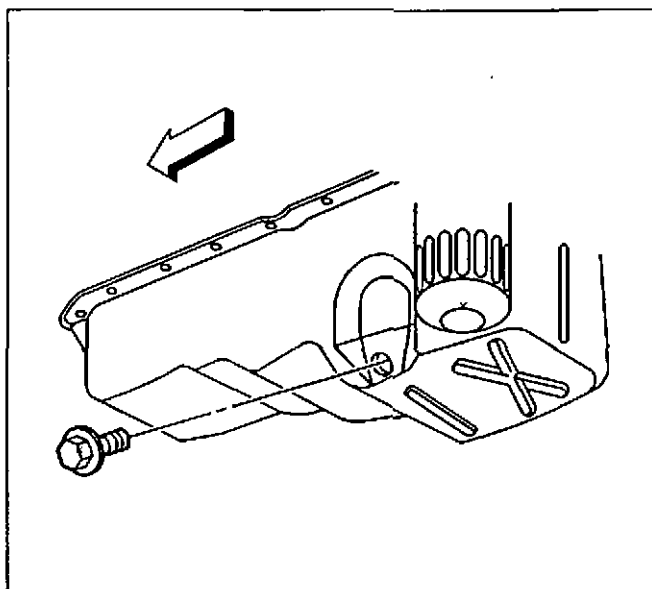
Installation Procedure

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

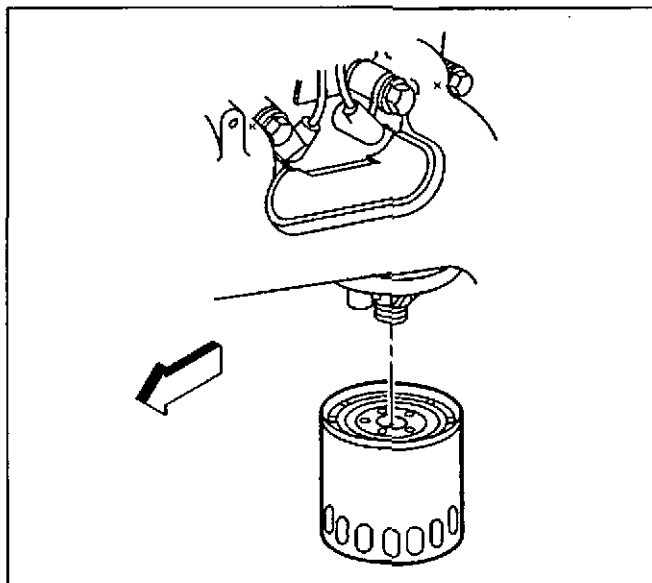
1. Install the NEW oil filter to the engine block.
Tighten
Tighten the oil filter to 37 N.m(27 lb ft).
2. Install the oil pan drain plug to the oil pan.
Tighten
Tighten the oil pan drain plug to 25 N.m(18 lb ft).
3. Remove the safety stands and lower the vehicle. Refer to *Vehicle Lifting and Jacking* in General Information.
4. Fill the crankcase with oil. Refer to *Fluid and Lubricant Recommendations* in General Information.
5. Close the hood.



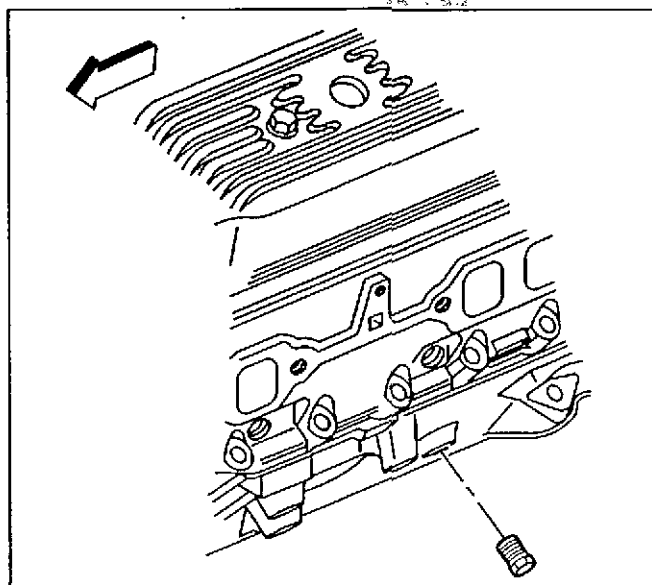
316766



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316798

SIE-10 - 194572

Draining Fluids and Oil Filter Removal

1. Remove the oil pan drain plug. Allow the oil to drain.

2. Remove the oil filter:

3. Remove the engine block coolant drain hole plug.

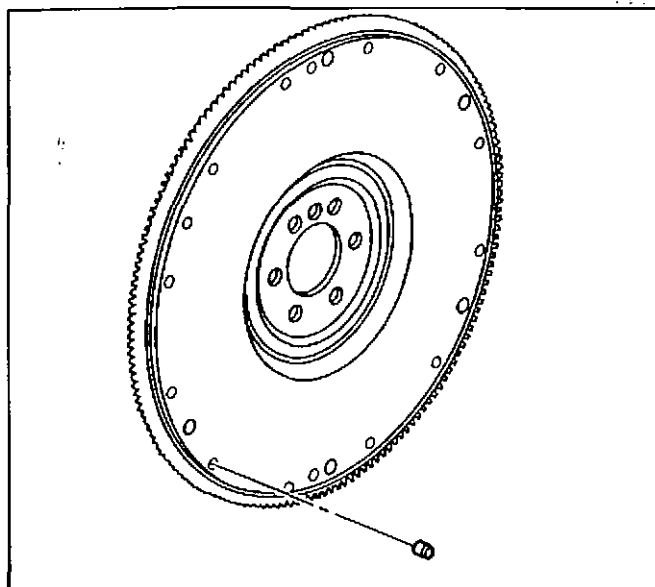
SIE-ID - 66678

Engine Flywheel Removal

SIO-ID - 66954

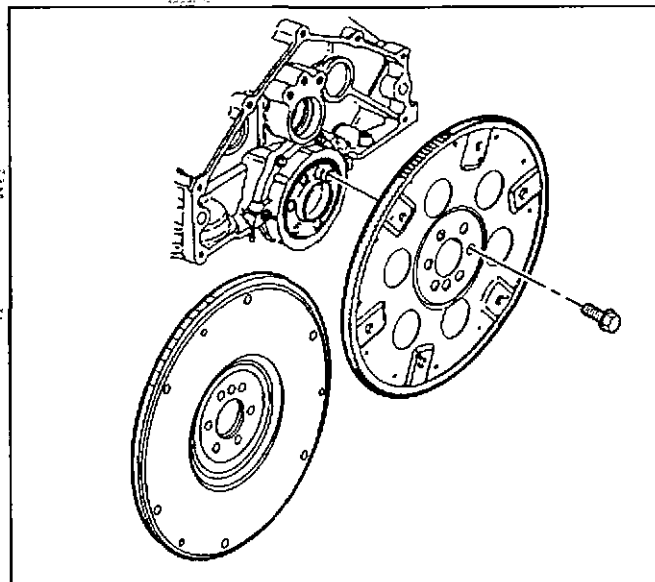
Important: If replacing the manual transmission type engine flywheel, note the location of any existing flywheel weights (if applicable). Install new flywheel weights into the new engine flywheel (if applicable). Flywheel weights must be installed into the new engine flywheel in the same location as the old flywheel weights in the old engine flywheel. A properly installed flywheel weight will be either flush or below flush with the face of the engine flywheel.

1. Note the position and location of the flywheel weights (if applicable).



64126

2. Remove the engine flywheel bolts.
3. Remove the engine flywheel.



69012

SIE-ID - 375497

Clutch Pilot Bearing Removal

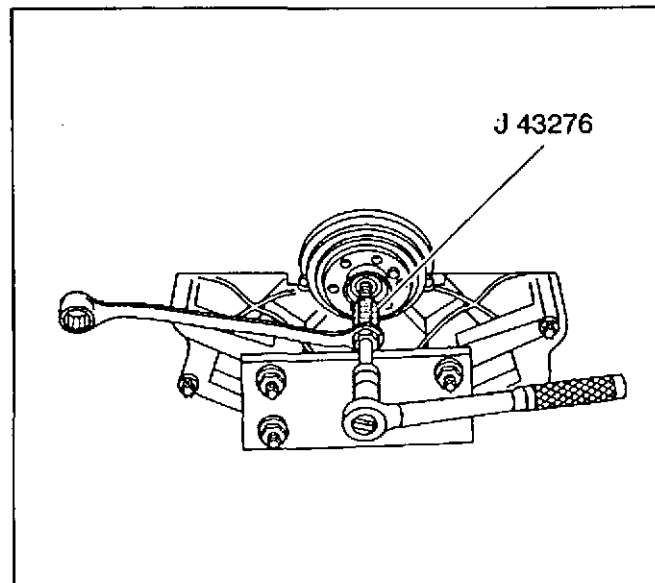
Tools Required

J 43276 Clutch Pilot Bearing Remover

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

Notice: SIO-ID - 352829 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 Clutch Pilot Bearing Remover tool body to rotate. Failing to do so will cause damage to the J 43276-1 Clutch Pilot Bearing Remover tool body.

1. Remove the clutch pilot bearing using the J 43276 .
 - 1.1. Install the J 43276-1 tool body into the clutch pilot bearing.
 - 1.2. Using a wrench secure the J 43276-1 tool body.



373133

- 1.3. Insert the J 43276-2 forcing screw into the J 43276-1 tool body.
- 1.4. Rotate the J 43276-2 forcing screw clockwise into the J 43276-1 tool body until the clutch pilot bearing is completely removed from the crankshaft.
- 1.5. Rotate the J 43276-2 forcing screw counterclockwise to remove the J 43276-2 forcing screw from the J 43276-1 tool body.
- 1.6. Remove the J 43276-1 tool body from the clutch pilot bearing.
2. Discard the clutch pilot bearing.

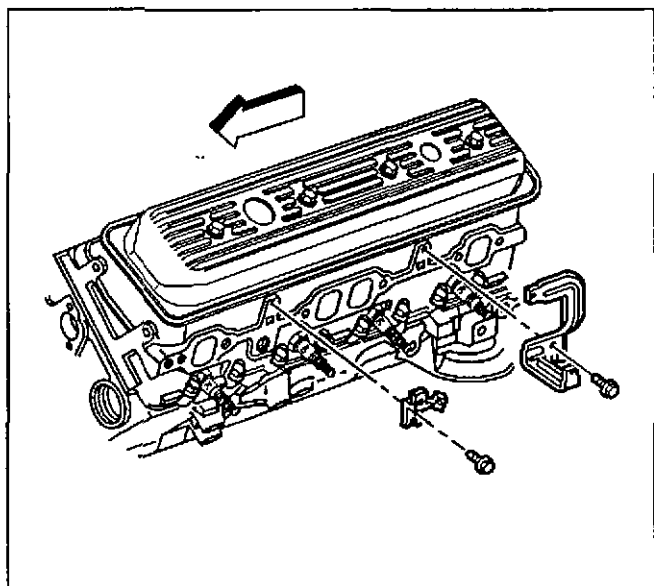
SIE-ID - 67244

Exhaust Manifold Removal (Left)

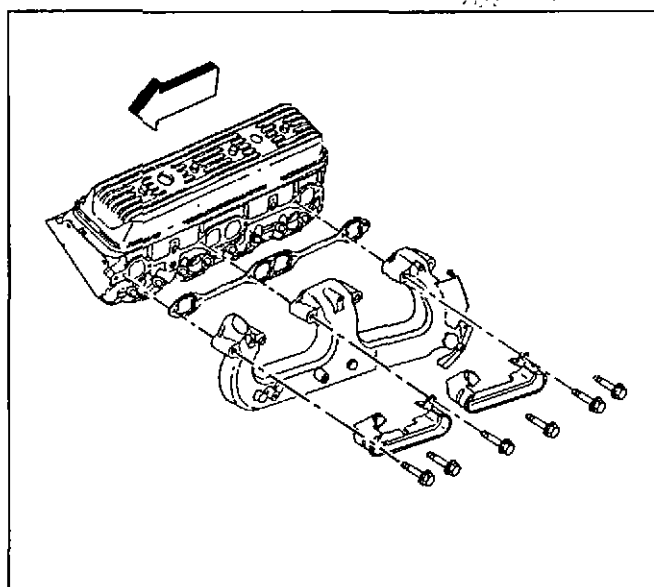
SIO-ID - 66885

Notice: SIO-ID - 2878. Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

1. Remove the spark plug wires from the spark plugs.
 - 1.1. Rotate the spark plug wire boot one half turn.
 - 1.2. Pull outward on the spark plug wire boot to release from the spark plug.
2. Remove the bolts and the spark plug wire supports.
3. Remove the exhaust manifold bolts.
4. Remove the spark plug wire shields.
5. Remove the exhaust manifold.
6. Remove and discard the exhaust manifold gasket.



317185



64925

SIE-ID - 66680

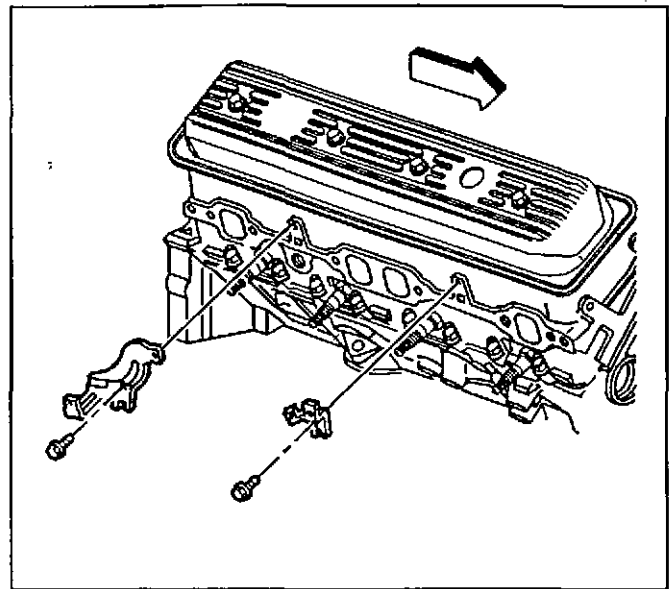
Exhaust Manifold Removal (Right)

SIO-ID - 66884

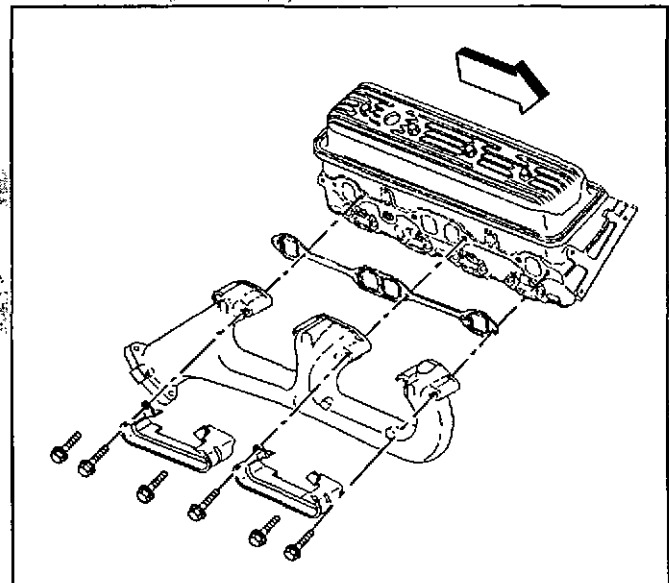
Notice: SIO-ID - 2878 Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

1. Remove the spark plug wires from the spark plugs.
 - 1.1. Rotate the spark plug wire boot one half turn.
 - 1.2. Pull outward on the spark plug wire boot to release from the spark plug.
2. Remove the bolts and the spark plug wire supports.

3. Remove the exhaust manifold bolts.
4. Remove the spark plug wire shields.
5. Remove the exhaust manifold.
6. Remove and discard the exhaust manifold gasket.



317178

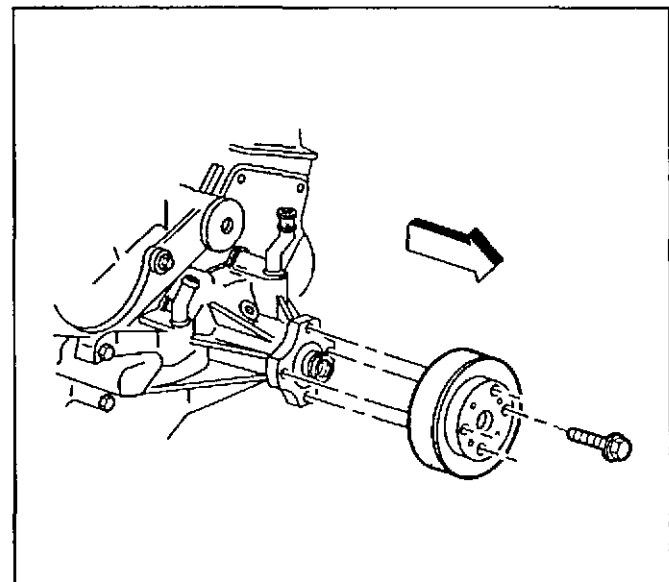


69032

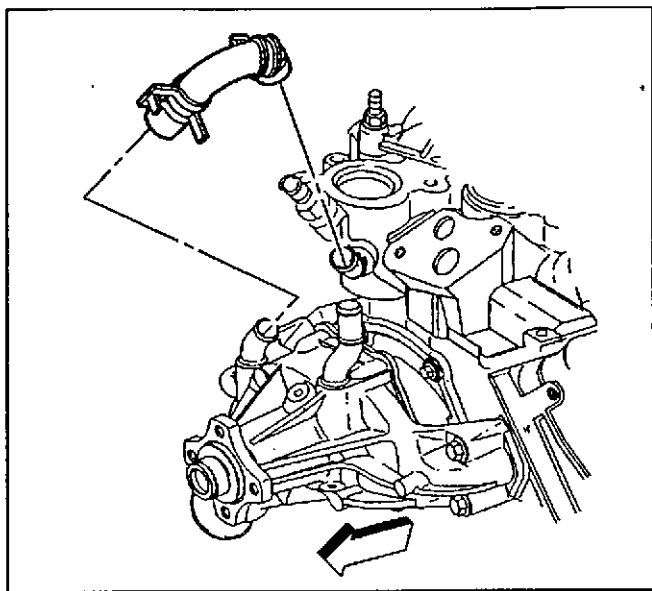
SIE-ID - 69041

Water Pump Removal

1. Remove the bolts and the fan and water pump pulley.

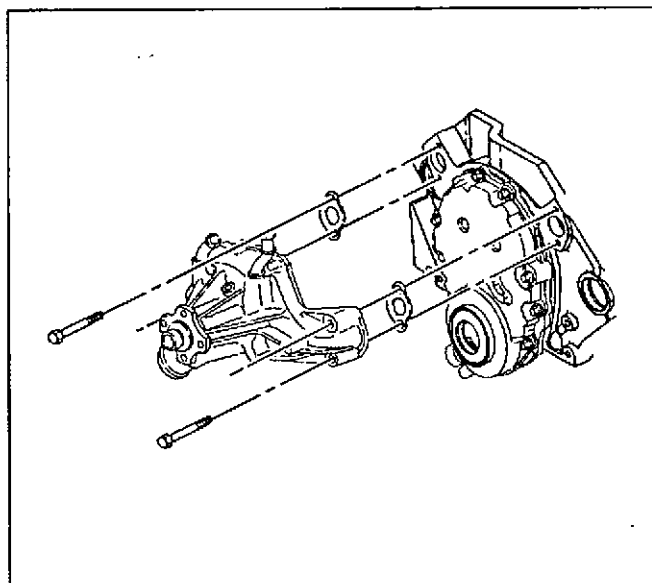


317191



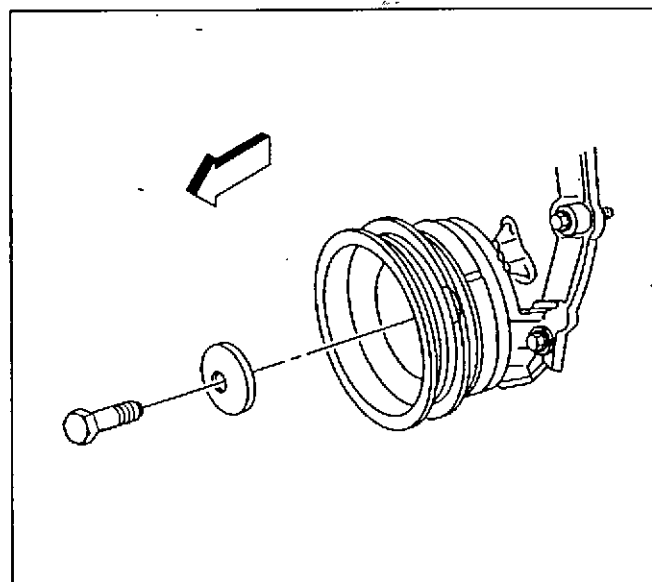
182853

2. Remove the clamps and the water pump inlet hose.



69011

3. Remove the water pump bolts.
4. Remove the water pump.
5. Remove the water pump gaskets.
6. Discard the water pump gaskets.



173172

SIE-ID - 66682

Crankshaft Balancer Removal

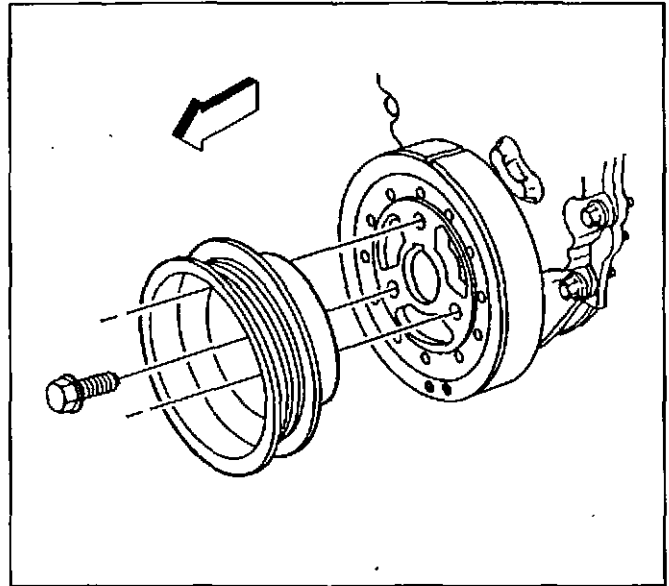
SIO-ID - 66889

Tools Required

J 23523-F Balancer Remover and Installer

1. Remove the crankshaft balancer bolt and washer.

2. Remove the bolts and the crankshaft pulley.

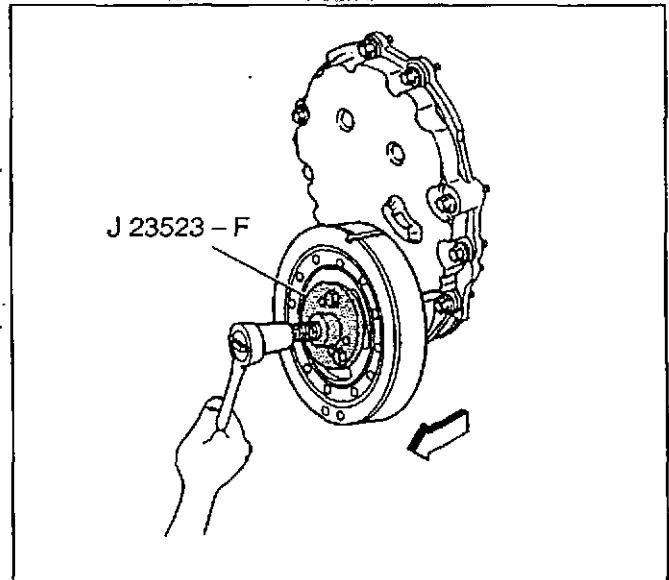


188055

Notice: *SIO-ID - 301560* To prevent damage to the end of the crankshaft when using a crankshaft balancer removal tool install a bolt in the crankshaft. Use a shorter bolt with the same threads as the crankshaft balancer bolt. This bolt will allow a place for the tool to push against. The shorter bolt is to keep from going past the threads in the crankshaft and damaging the crankshaft threads.

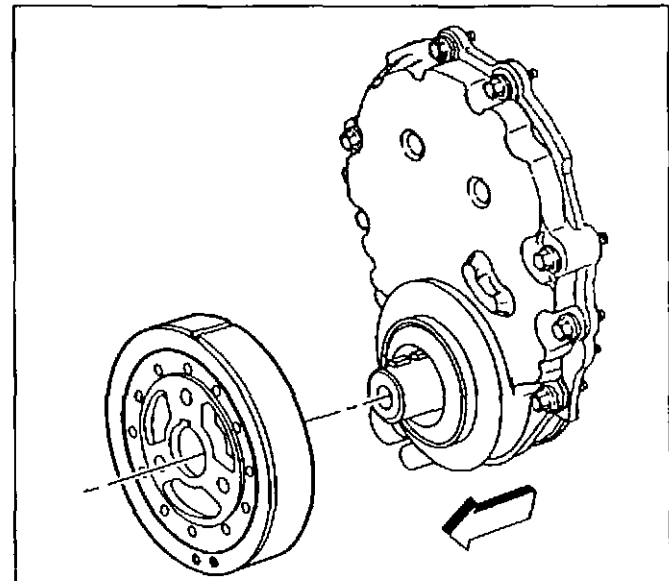
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Use the *J 23523-F* in order to remove the crankshaft balancer.
 - 3.1. Install the *J 23523-F* plate and bolts.
Tighten
Tighten the bolts to 25 N.m (18 lb ft).
 - 3.2. Install the *J 23523-F* forcing screw.
 - 3.3. Rotate the *J 23523-F* forcing screw clockwise in order to remove the crankshaft balancer.

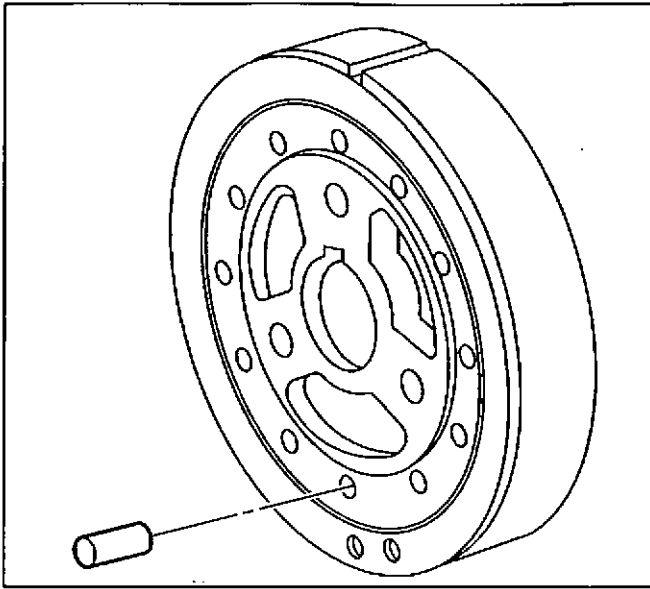


66878

4. Remove the crankshaft balancer.
5. Remove the *J 23523-F* from the crankshaft balancer.



182832



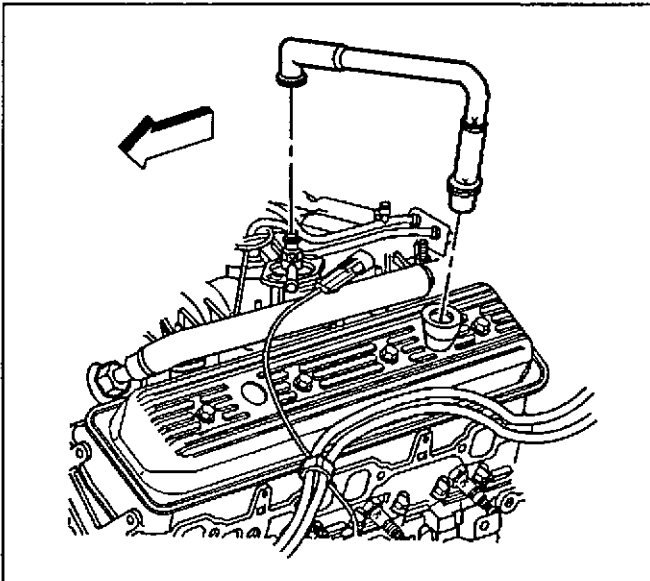
182849

6. Note the position of any front groove pins (crankshaft balancer weights) (if applicable).

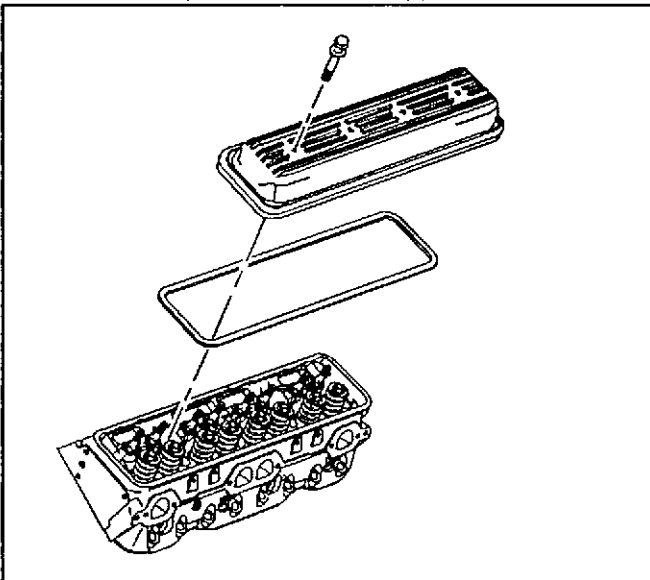
SIE-ID = 39120

Valve Rocker Arm Cover Removal (Left)

1. Remove the PCV valve hose assembly.



317197



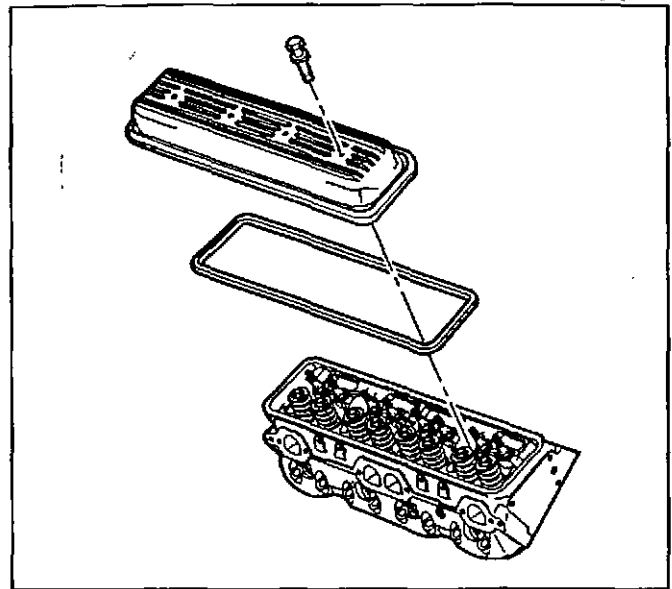
39119

2. Remove the valve rocker arm cover bolts and washers.
3. Remove the valve rocker arm cover.
4. Remove the valve rocker arm cover gasket.
5. Discard the valve rocker arm cover gasket.

SIE-ID = 194614

Valve Rocker Arm Cover Removal (Right)

1. Remove the valve rocker arm cover bolts and washers.
2. Remove the valve rocker arm cover.
3. Remove the valve rocker arm cover gasket.
4. Discard the valve rocker arm cover gasket.

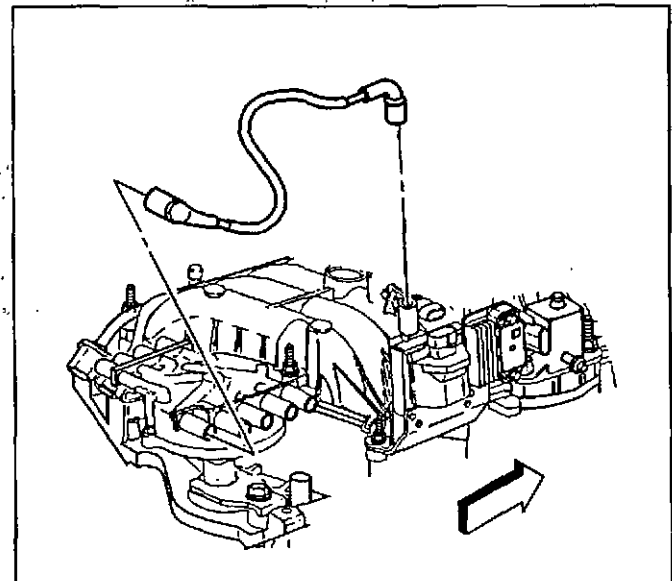


182833

SIE-ID = 69504

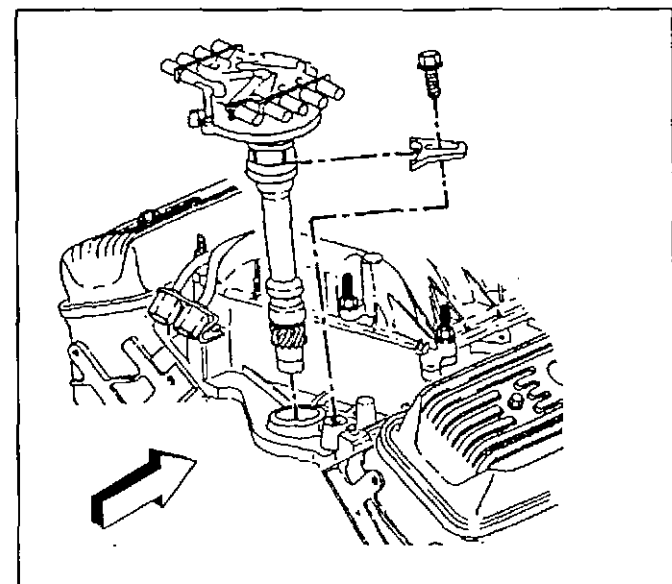
Distributor Removal

1. Remove the ignition coil wire harness from the ignition coil and distributor cap.

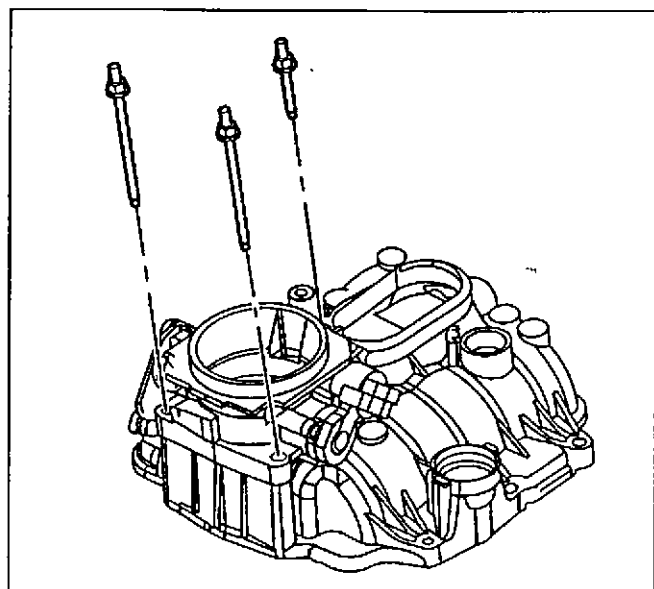


341359

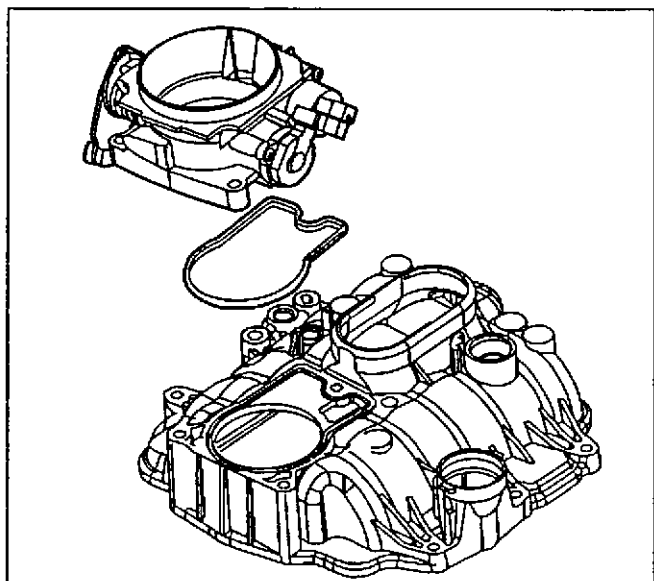
2. Remove the distributor clamp bolt.
3. Remove the distributor clamp.
4. Remove the distributor.



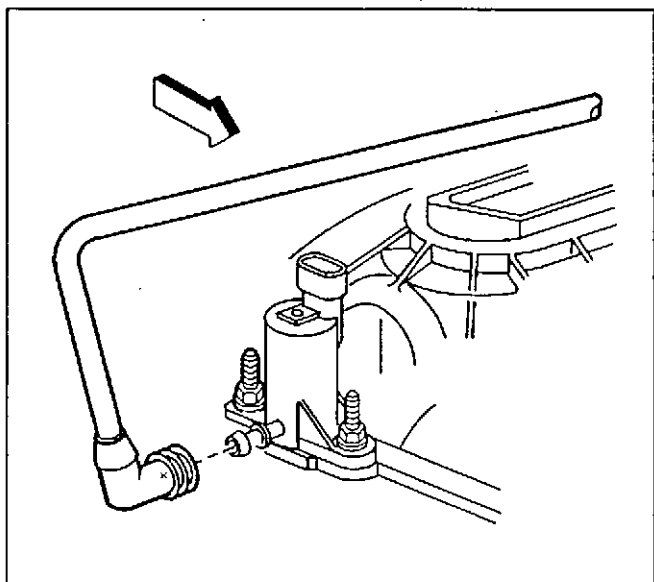
69303



12852



12853



317211

SIE-ID = 194657

Throttle Body Removal

1. Remove the throttle body attaching studs.

2. Remove the throttle body.
3. Remove the throttle body gasket.
4. Discard the throttle body gasket.

SIE-ID = 66685

Intake Manifold Removal

SIO-ID = 67830

1. Remove the evaporative emission canister purge solenoid valve harness.
 - 1.1. Push the quick disconnect clip and hold in place.
 - 1.2. Pull outward on the harness elbow.

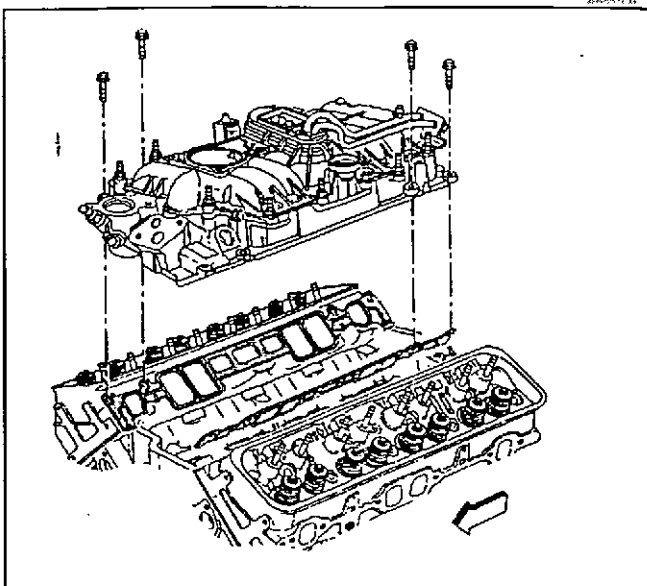
2. Remove the lower intake manifold bolts.

Important: The intake manifold may be removed as an assembly. Do not remove the specific intake manifold components unless component service is required.

Do not allow dirt or debris to enter the fuel system. Ensure that the ends of the fuel system are properly sealed.

Do not disassemble the Central Sequential Fuel Injection (SFI) unit, unless service is required.

3. Remove the intake manifold assembly.
4. Remove and discard the lower intake manifold gaskets.



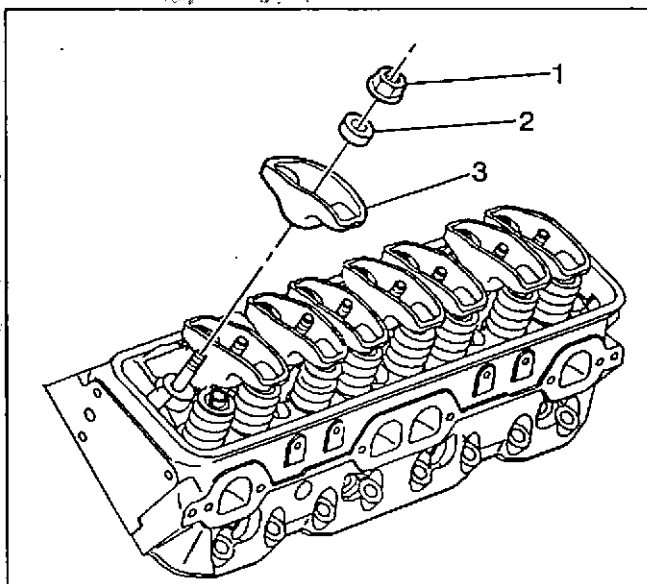
66456

SIE-10 - 66690

Valve Rocker Arm and Push Rod Removal

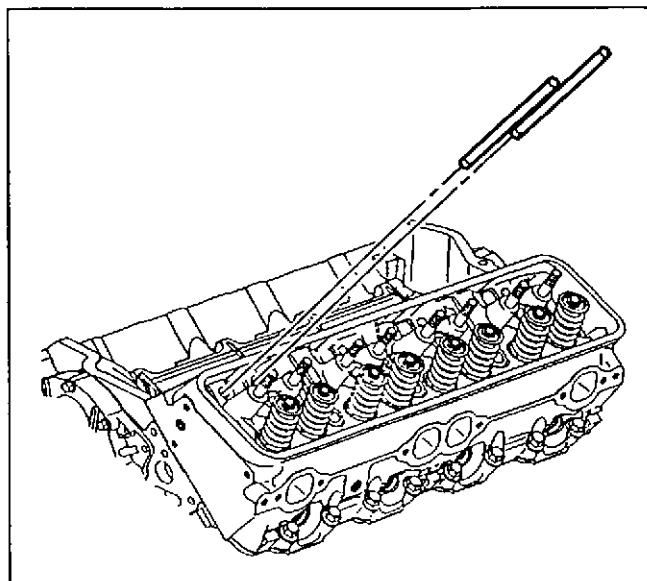
Important: Mark, sort, and organize the components so that the components can be reinstalled to the original location.

1. Remove the following components from the cylinder head:
 - 1.1. The valve rocker arm nuts (1)
 - 1.2. The valve rocker arm balls (2)
 - 1.3. The valve rocker arms (3)

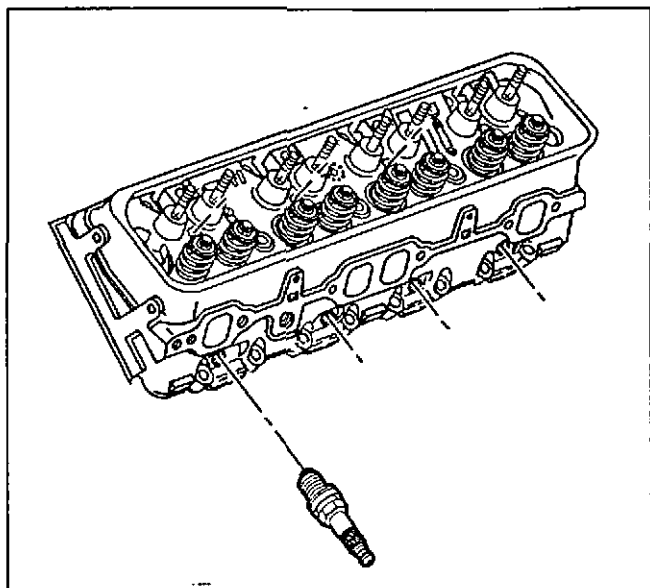


182835

2. Remove the valve pushrods.



22766

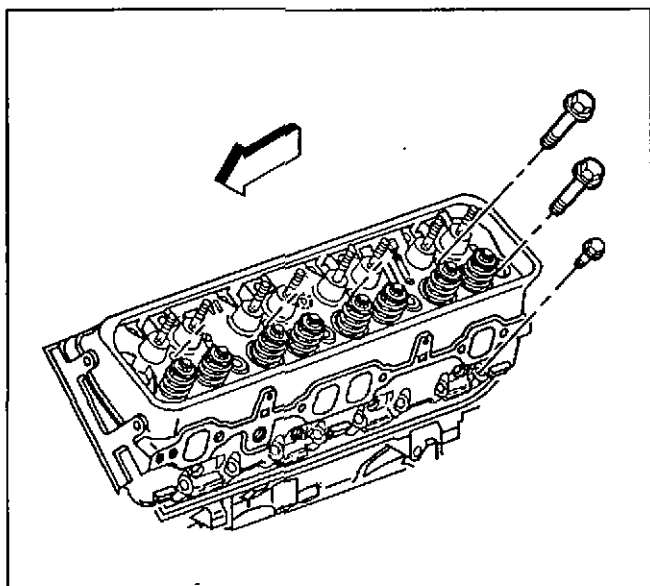


SIE-ID - 66692

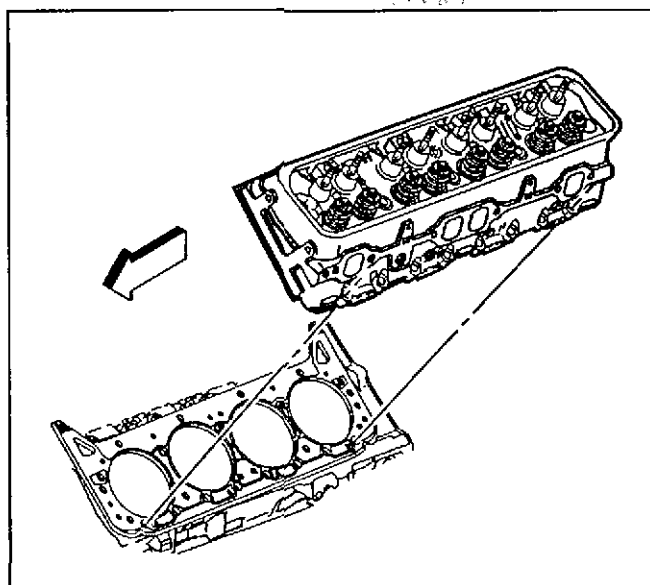
Cylinder Head Removal (Left)

SIO-ID - 66888

1. Remove and discard the spark plugs.



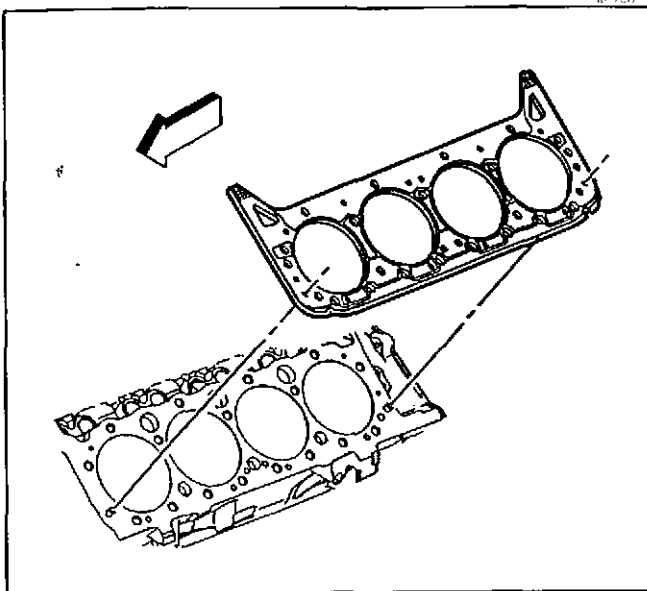
2. Remove the cylinder-head bolts.



Notice: SIO-ID - 13838 After removal, place the cylinder head on two wood blocks to prevent damage.

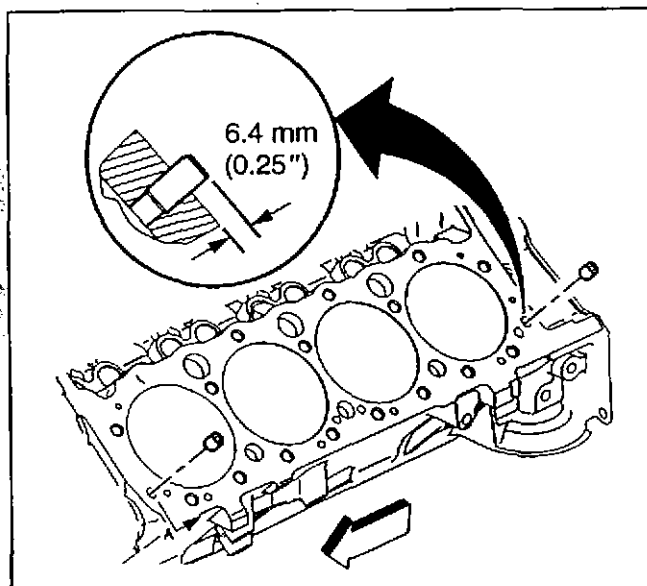
3. Remove the cylinder head.

4. Remove and discard the cylinder head gasket.



317233

5. Remove the dowel pin (cylinder head locator) (if required).

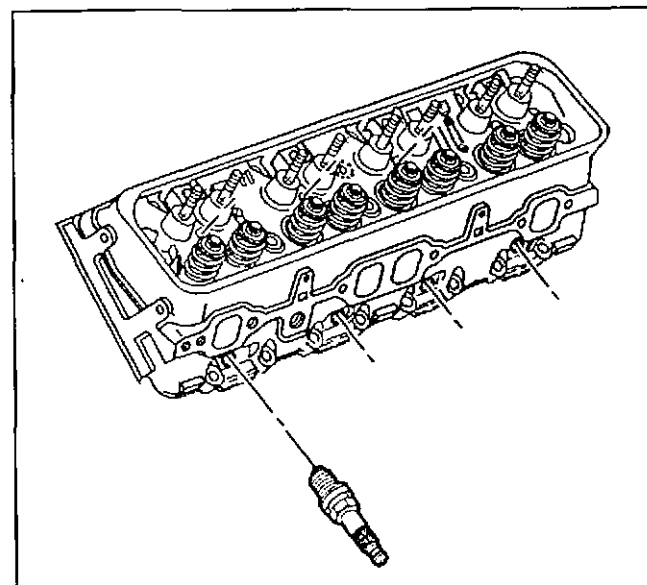


182846

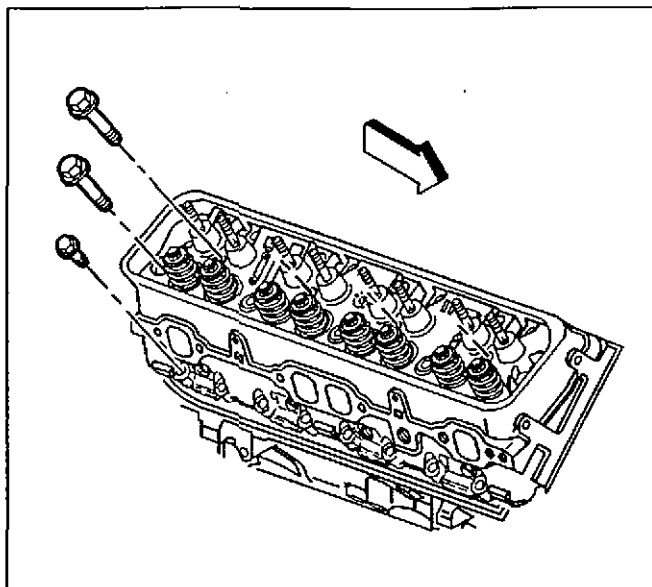
SIE-ID - 195376

Cylinder Head Removal (Right)

1. Remove and discard the spark plugs.

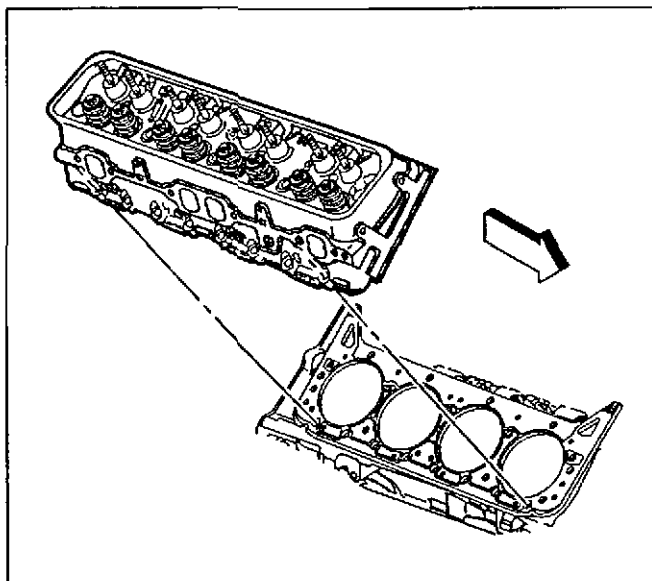


317307



317239

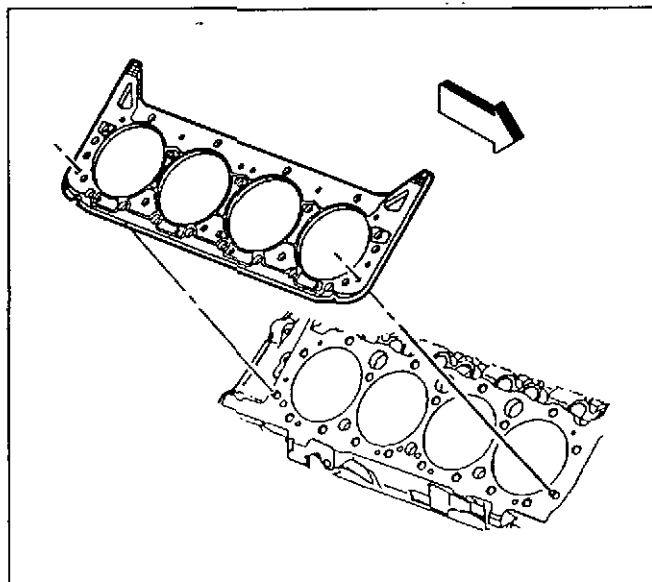
2. Remove the cylinder head bolts.



317246

Notice: SIO-ID - 13838 After removal, place the cylinder head on two wood blocks to prevent damage.

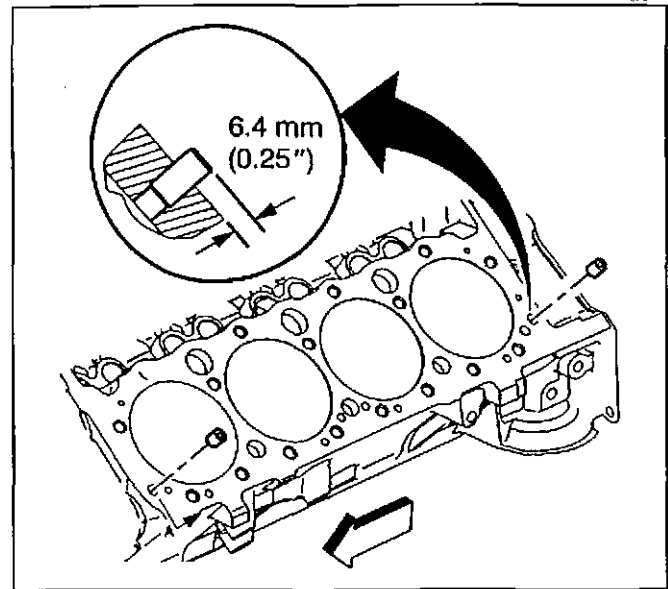
3. Remove the cylinder head.



317255

4. Remove and discard the cylinder head gasket.

5. Remove the dowel pin (cylinder head locator) (if required).



182846

SIE-ID - 24119

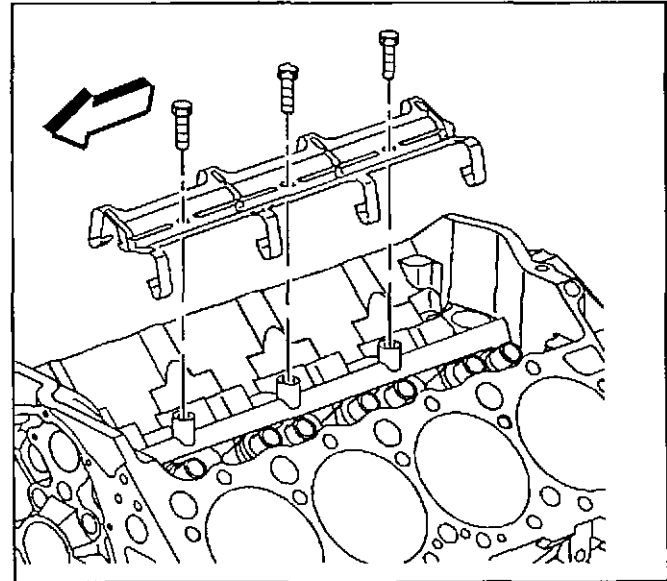
Valve Lifter Removal

SIO-ID - 14197

Tools Required

J 3049-A Valve Lifter Remover

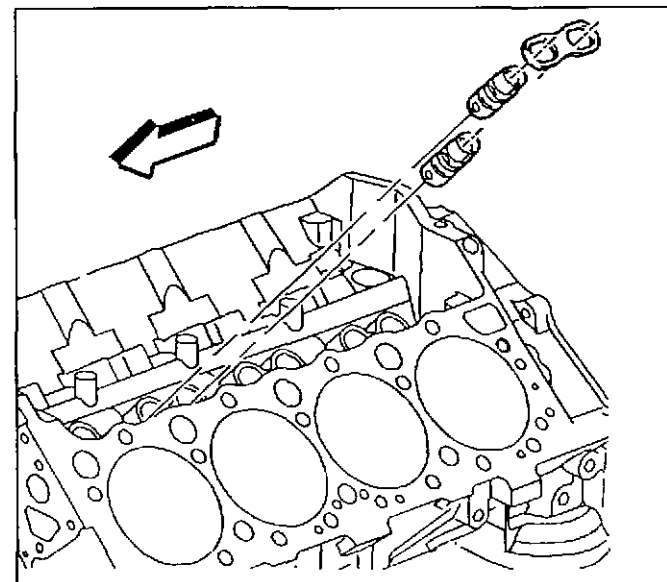
1. Remove the bolts and valve lifter guide retainer.



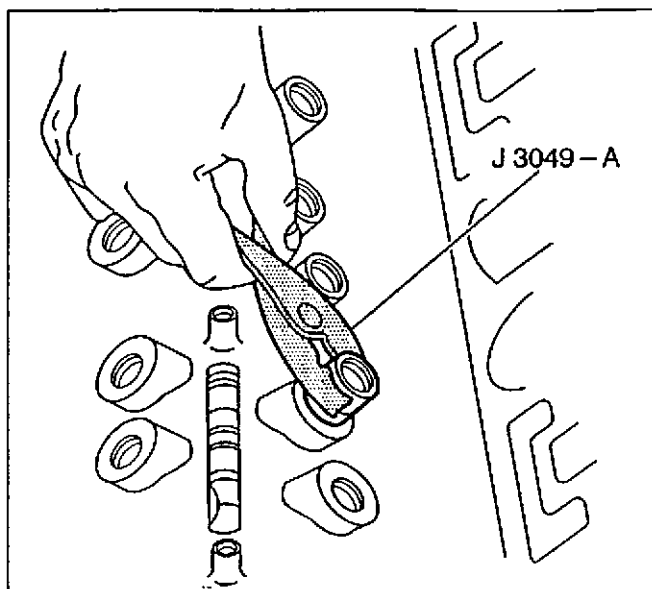
11508

Important: Place the valve lifters in the rack in the upright position in order to maintain the oil inside the valve lifter.

2. Remove the valve lifter guides.
3. Place the components in a rack so that the components can be reinstalled to the original location.



11509



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Important: Some valve lifters may be stuck in the valve lifter bores because of gum or varnish deposits.

4. Use the J 3049-A in order to remove the stuck valve lifters.

SIE-ID = 66836

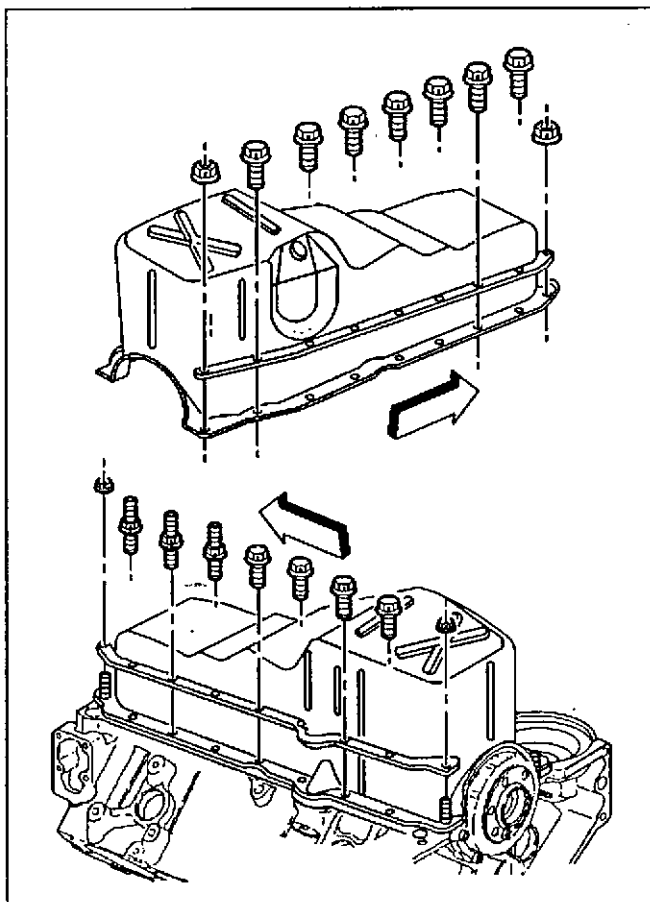
Oil Pan Removal

SIO-ID = 66938

1. Remove the oil pan bolts and nuts.
2. Remove the oil pan reinforcements.
3. Remove the oil pan.
4. Remove and discard the oil pan gasket.

Important: Note the location of the oil pan studs for assembly.

5. Remove the oil pan studs.



182851

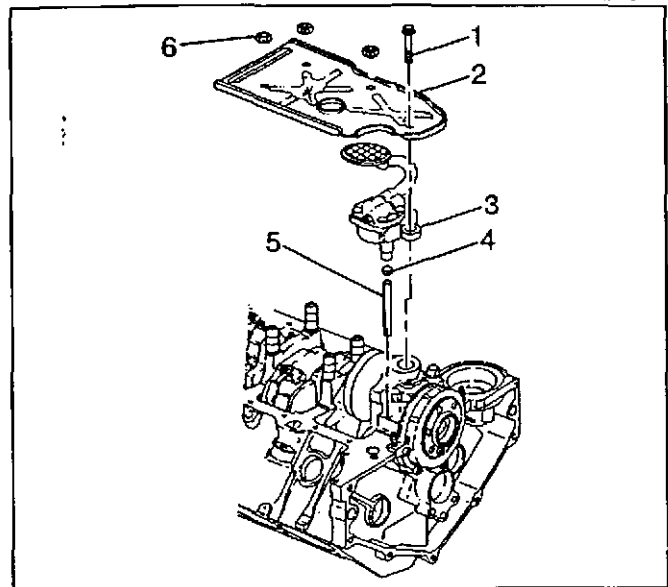
SIE-ID - 195387

Oil Pump, Pump Screen and Deflector Removal

1. Remove the nuts (6) and the crankshaft oil deflector (2).
2. Remove the oil pump bolt (1).
3. Remove the oil pump (3), the oil pump driveshaft (5), and the oil pump driveshaft retainer (4).
4. Separate the oil pump (3), the oil pump driveshaft (5), and the oil pump driveshaft retainer (4).

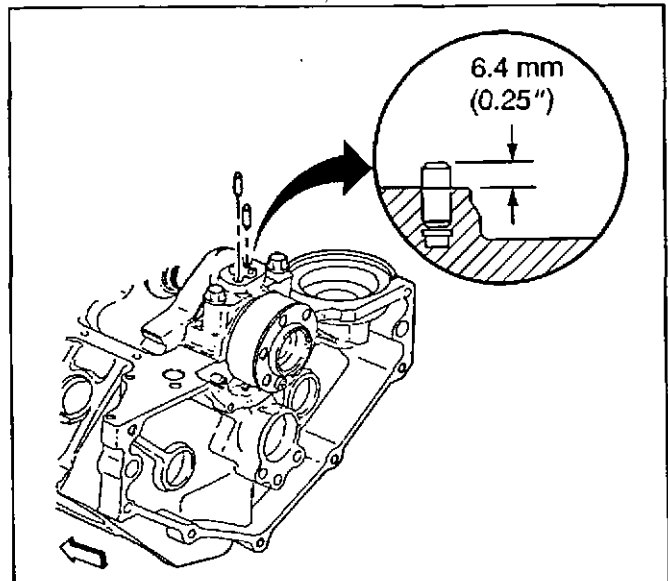
Important: Always install a NEW oil pump driveshaft retainer during assembly.

5. Discard the oil pump driveshaft retainer.



11438

6. Inspect the pins (oil pump locator) for damage, replace the pins if required.

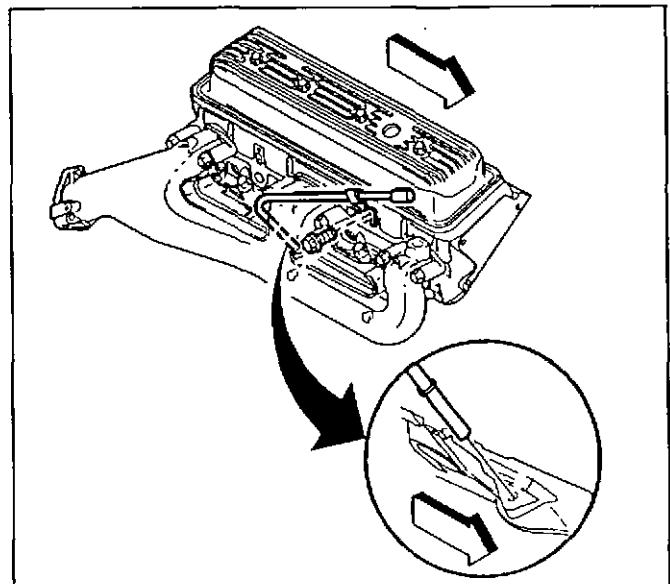


182852

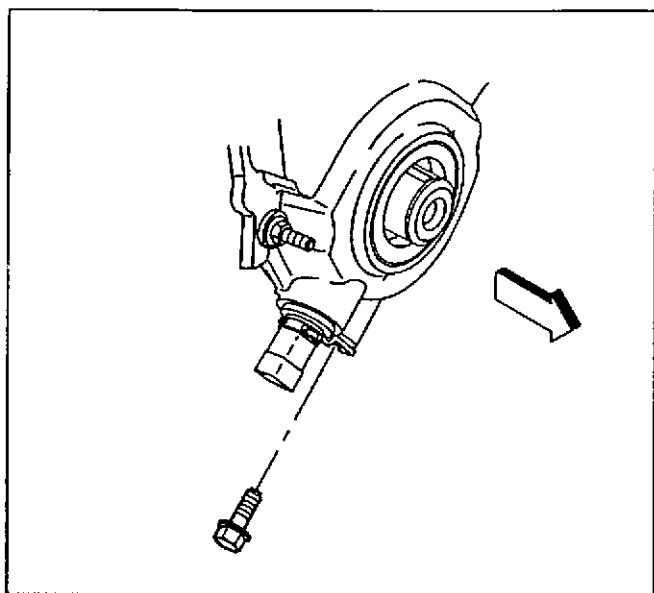
SIE-ID - 32348

Oil Level Indicator and Tube Removal

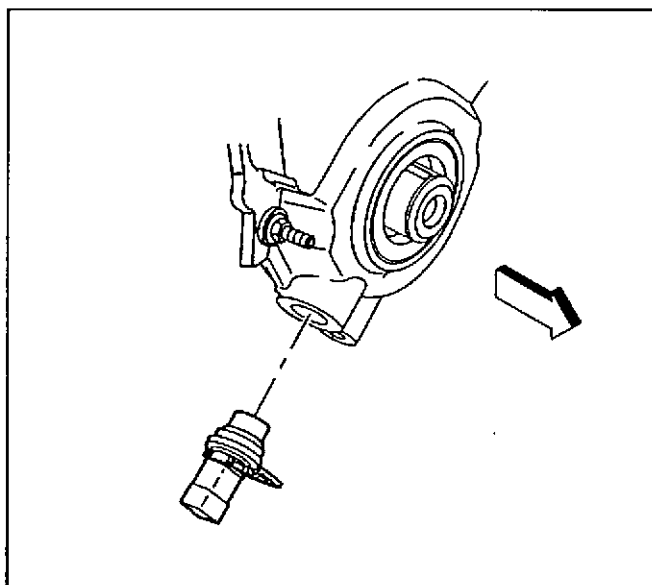
1. Remove the oil level indicator from the oil level indicator tube.
2. Remove the oil level indicator tube bolt.
3. Remove the oil level indicator tube from the engine block.



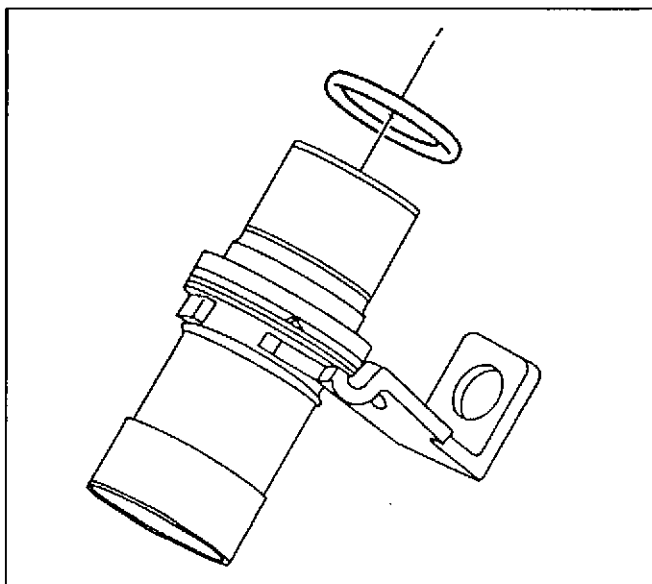
182831



10938



10939



387759

SIE-ID - 195381

Engine Front Cover Removal:

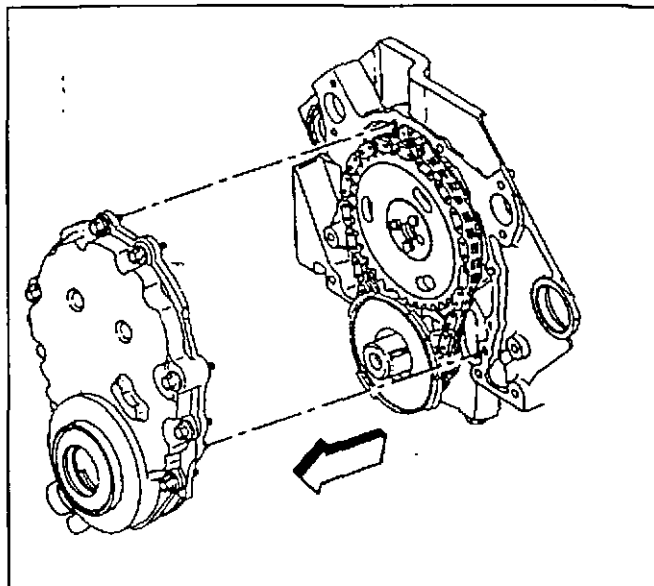
1. Remove the crankshaft position sensor bolt.

2. Remove the crankshaft position sensor.

Important: Always install a NEW crankshaft position sensor seal (O-ring) during assembly.

3. Remove the crankshaft position sensor seal (O-ring).
4. Discard the crankshaft position sensor seal (O-ring).

5. Remove the engine front cover bolts.
6. Remove the engine front cover and gasket.
Important: DO NOT reuse the composite engine front cover and gasket. Always install a NEW engine front cover.
7. Discard the engine front cover and gasket.



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SIE-ID = 66838

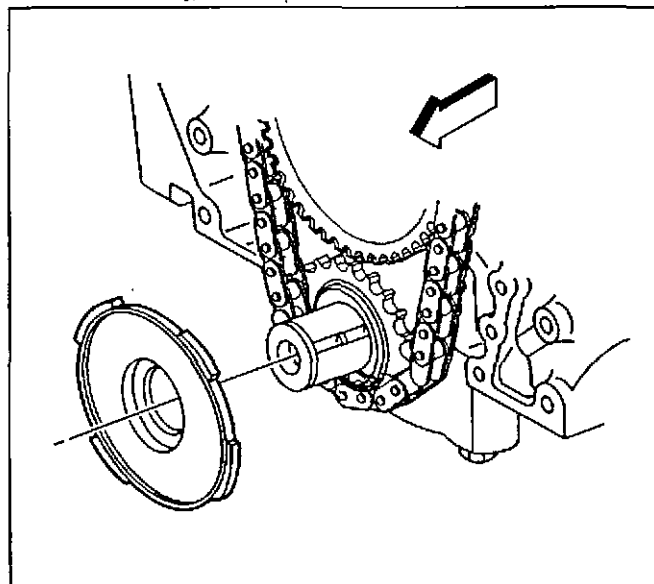
Timing Chain and Sprockets Removal

SIO-ID = 66890

Tools Required

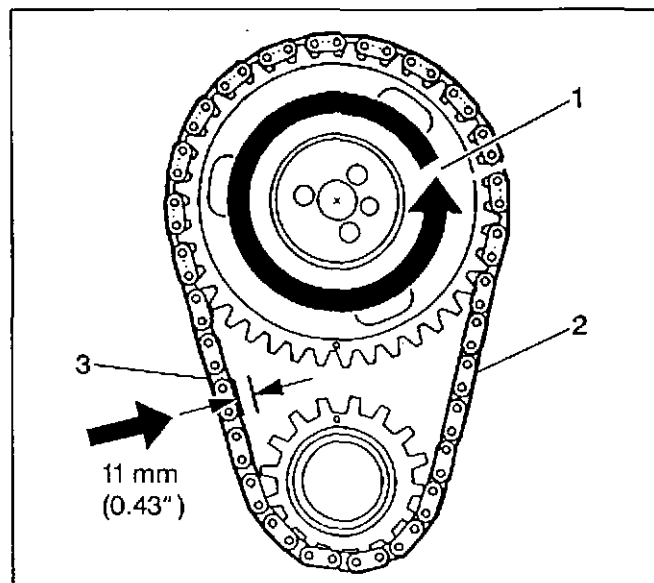
J 5825-A Crankshaft Gear Remover

1. Remove the crankshaft position sensor reluctor ring.

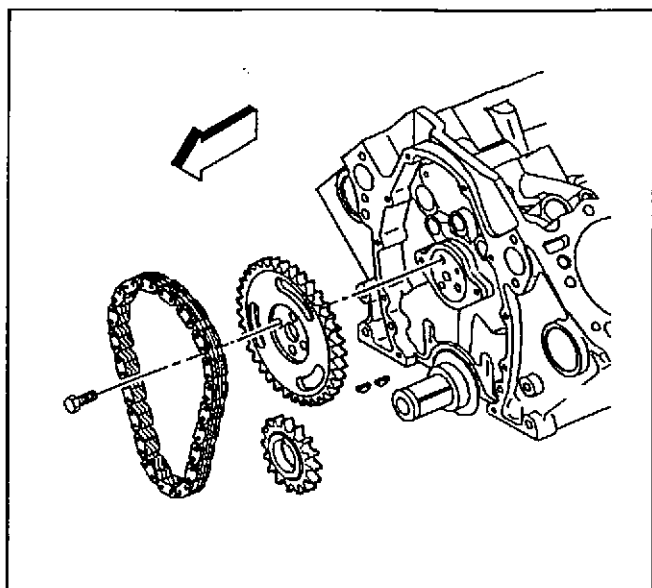


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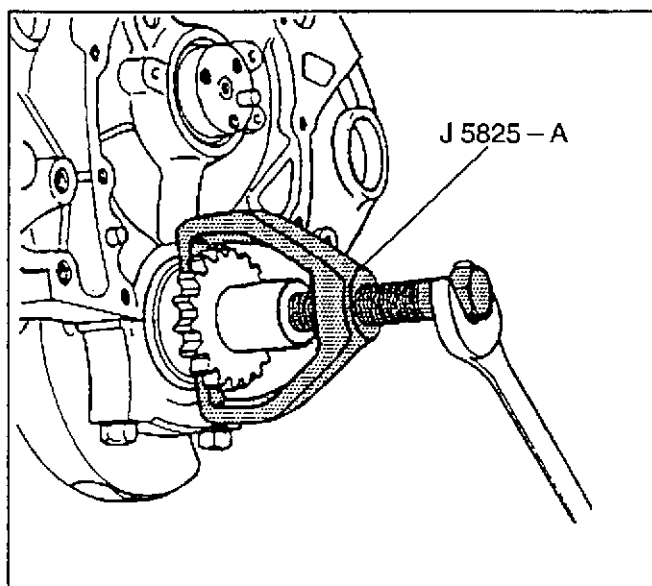
2. Check the camshaft timing chain free play.
If the camshaft timing chain can be moved in excess of 11 mm (0.43 in), replacement of the camshaft timing chain and the sprockets is recommended during assembly.
 - 2.1. Rotate the camshaft sprocket (1) counterclockwise until all slack is removed from the camshaft timing chain (2).
 - 2.2. Measure the free play on the slack side (3) of the camshaft timing chain.



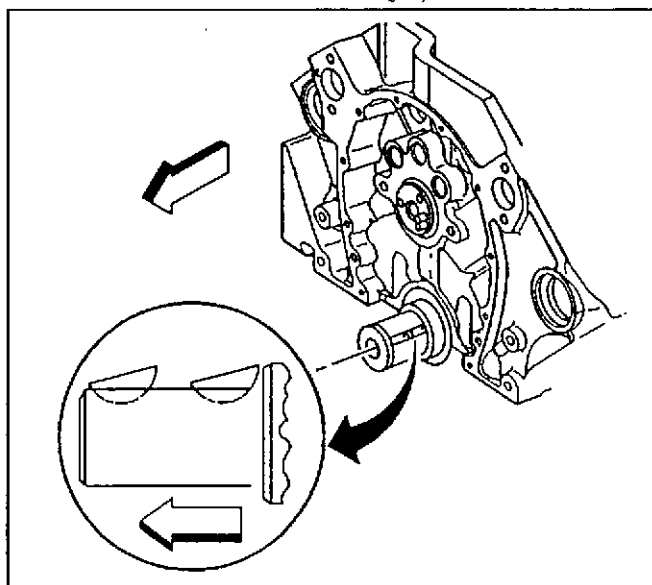
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3. Remove the camshaft sprocket bolts.
4. Remove the camshaft sprocket.
5. Remove the camshaft timing chain.

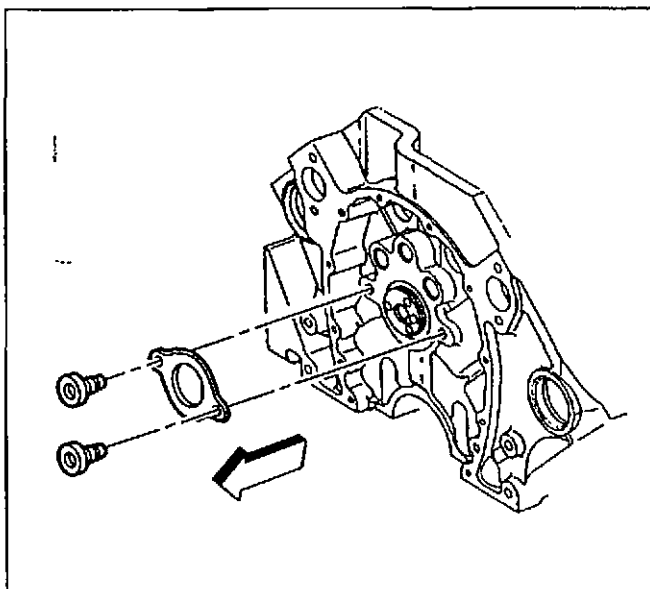
6. Remove the crankshaft sprocket using the J 5825-A.

7. Remove the woodruff keys (crankshaft balancer) (if required).

SIE-ID = 69031

Camshaft Removal

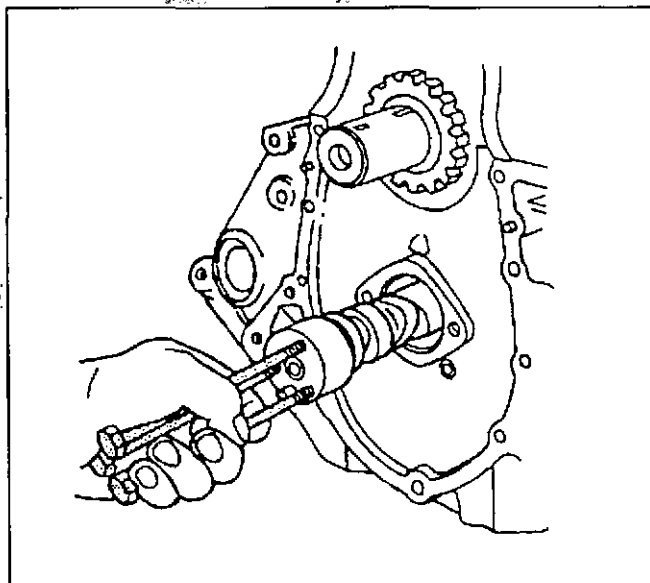
1. Remove the bolts and the camshaft retainer.



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Notice: SIO-ID = 13833 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 engine camshaft.
 - 2.1. Install the three 5/16-18 x 4.0 inch bolts in the engine camshaft front bolt holes.
 - 2.2. Using the bolts as a handle, carefully rotate and pull the engine camshaft out of the camshaft bearings.
 - 2.3. Remove the bolts from the front of the engine camshaft.



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SIE-ID = 24200

Piston, Connecting Rod, and Bearing Removal

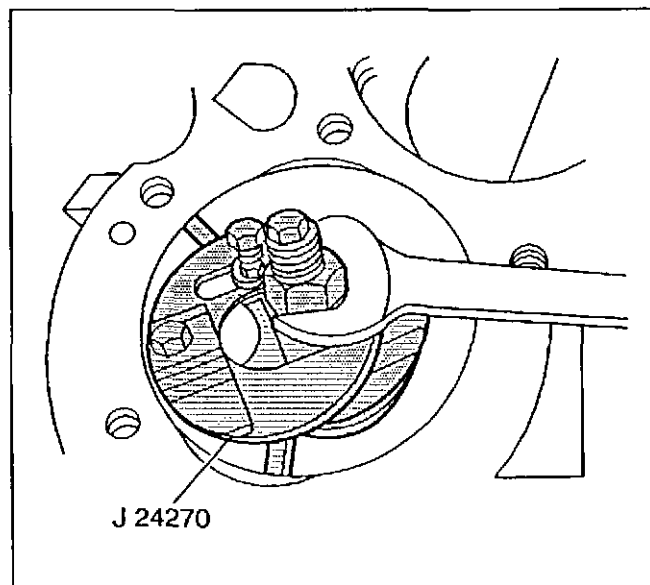
SIO-ID = 14210

Tools Required

- J 5239 Connecting Rod Bolt Guide Set
- J 24270 Cylinder Bore Ridge Reamer

Caution: SIO-ID = 5011 **Wear safety glasses in order to avoid eye damage.**

1. Remove the ring ridge.
 - 1.1. Turn the crankshaft until the piston is at the bottom of the stroke.
 - 1.2. Place a cloth on the top of the piston.
 - 1.3. Use the J 24270 in order to remove cylinder ring ridge.
 - 1.4. Turn the crankshaft so the piston is at the top of the stroke.
 - 1.5. Remove the cloth.

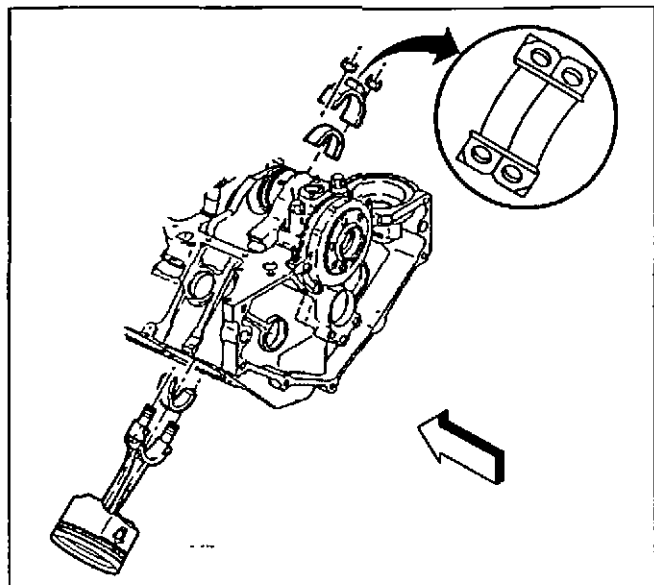


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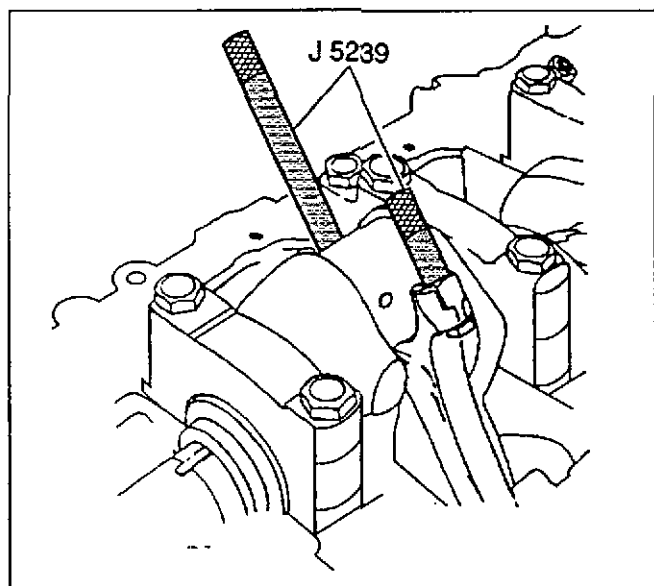
1.6. Remove the cutting debris.

Important: Place matchmarks or numbers on the connecting rods and the connecting rod caps. Assemble the connecting rod caps to the matching connecting rods.

2. Remove the connecting rod nuts.
3. Remove the connecting rod cap.



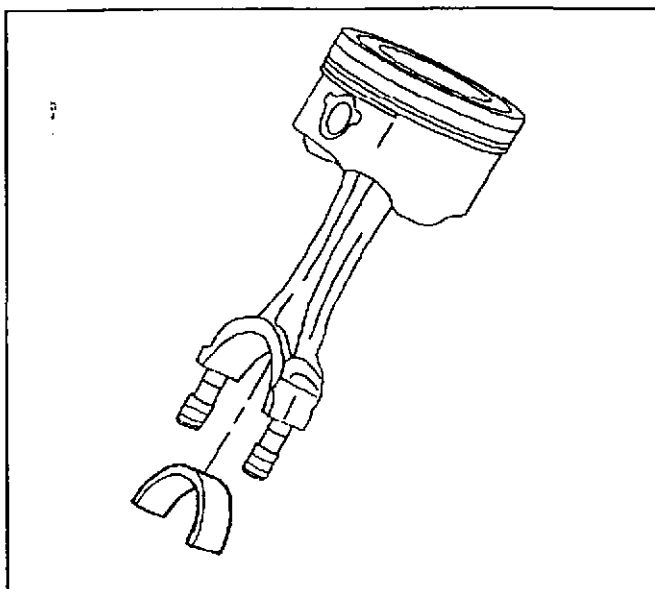
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4. Use the J 5239 in order to protect the crankshaft journals and remove the connecting rod and the piston out of the top of the engine block.

5. Remove the connecting rod bearings.
 - Keep the connecting bearings with the original connecting rod and connecting rod cap.
 - Wipe the oil from the connecting bearings.
 - Wipe the oil from the crankpins.



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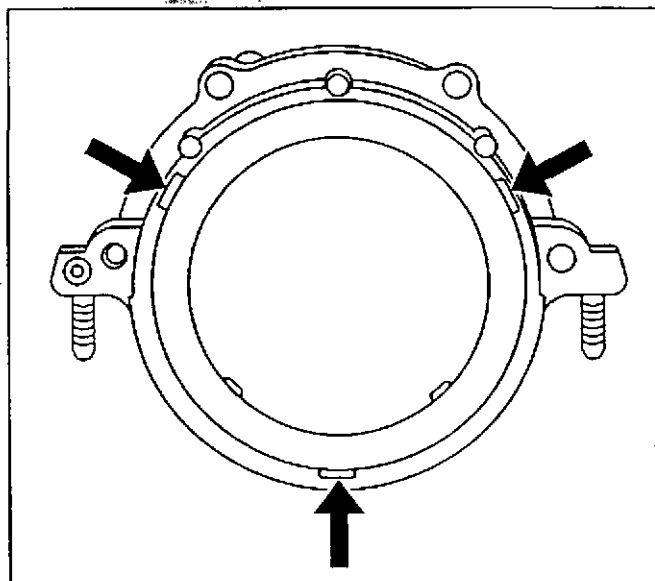
SIE-ID - 24222

Crankshaft Rear Oil Seal and Housing Removal

SIO-ID - 14231

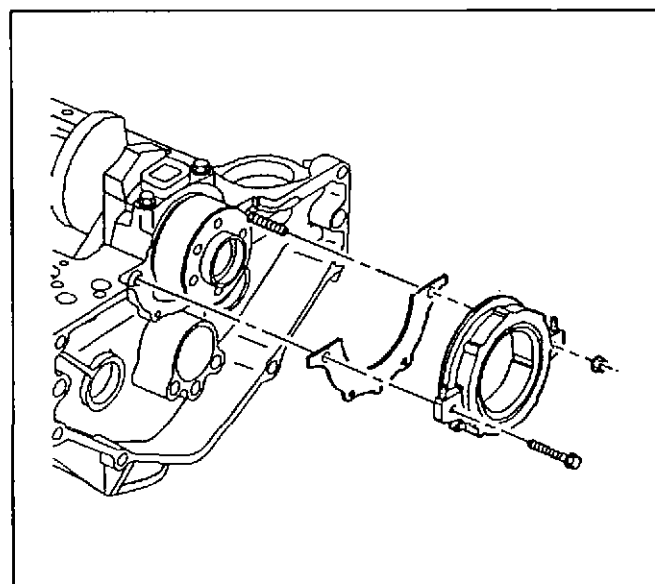
1. Remove the crankshaft rear oil seal from the crankshaft rear oil seal housing.

Insert a suitable tool into the access notches and then carefully pry the crankshaft rear oil seal from the crankshaft rear oil seal housing.
2. Discard the crankshaft rear oil seal.

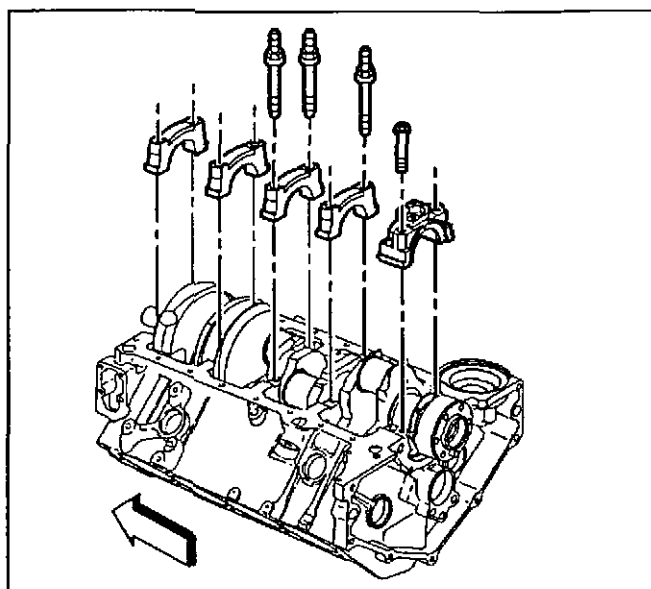


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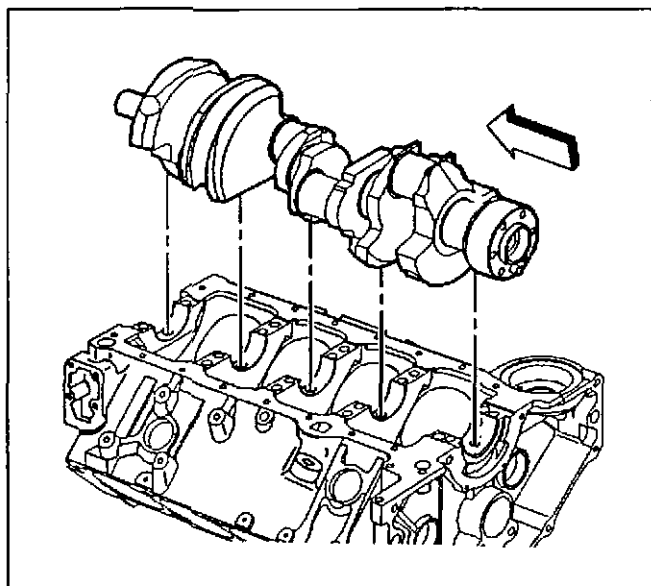
3. Remove the crankshaft rear oil seal housing nut and bolts.
4. Remove the crankshaft rear oil seal housing.
5. Remove the crankshaft rear oil seal housing gasket.
6. Discard the crankshaft rear oil seal housing gasket.
7. Remove the rear oil seal housing retainer stud from the engine block.



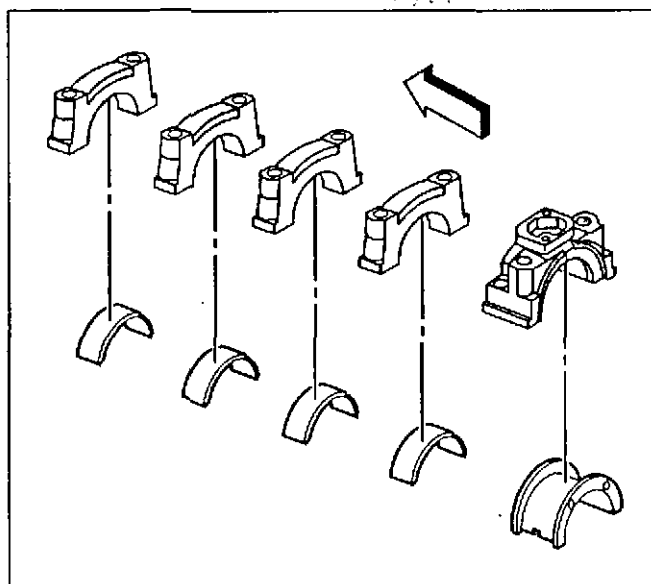
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SIE-ID = 69426

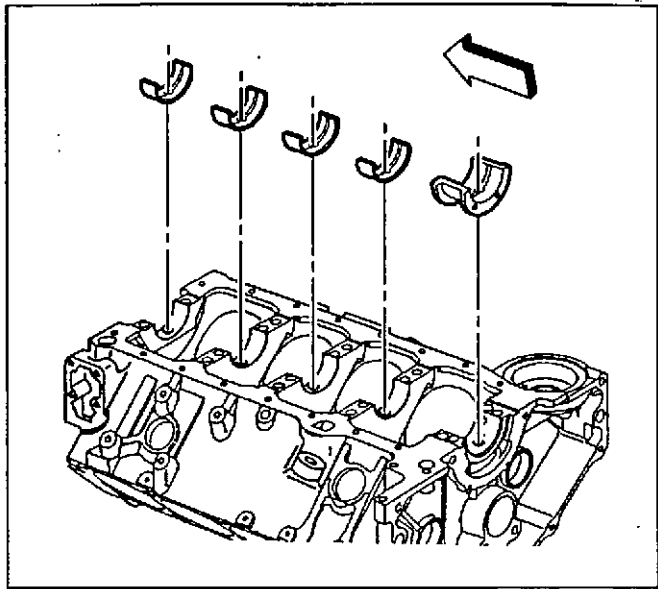
Crankshaft and Bearings Removal

1. Mark or identify the crankshaft bearing cap locations and positions for assembly.
2. Remove the crankshaft bearing cap bolts and studs.
3. Remove the crankshaft bearing caps.

4. Remove the crankshaft.

5. Remove the crankshaft bearings from the crankshaft bearing caps.

6. Remove the crankshaft bearings from the engine block.

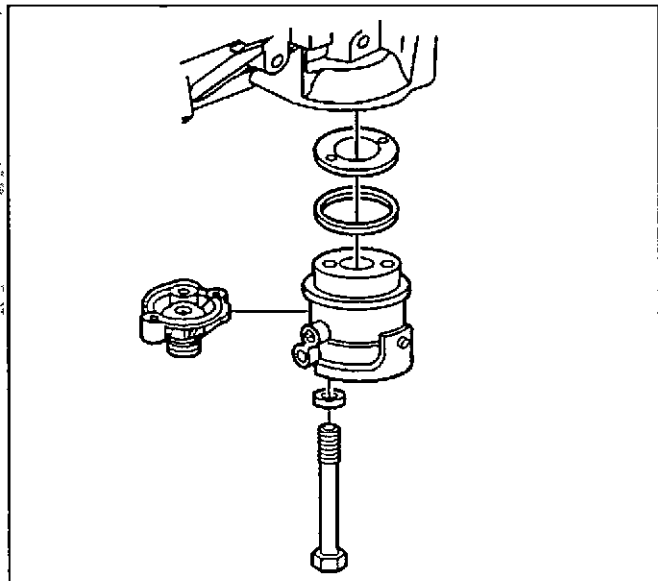


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SIE-ID - 69505

Oil Filter Adapter and Valve Assembly Removal

1. Remove the oil filter adapter bolts and washers (if applicable).
2. Remove the oil filter adapter.
3. Remove the oil filter adapter seal (O-ring), and the oil filter adapter gasket (if applicable).
4. Discard the oil filter adapter seal (O-ring) and the oil filter adapter gasket (if applicable).



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SIO-ID - 348910

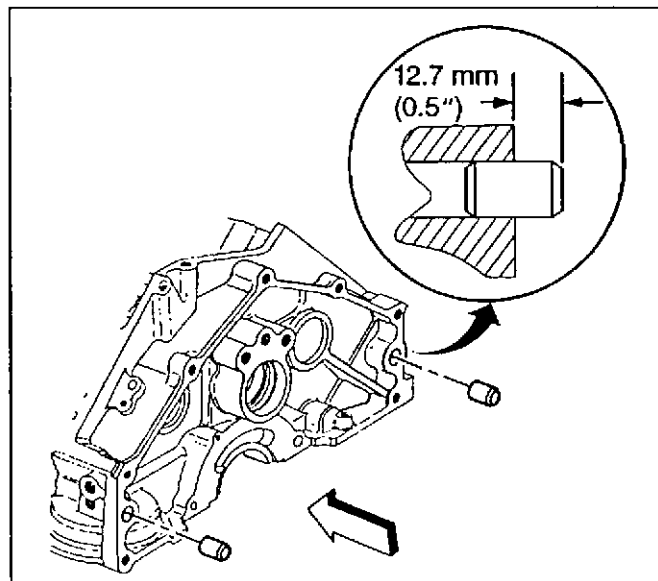
Engine Block Plug Removal

Tools Required

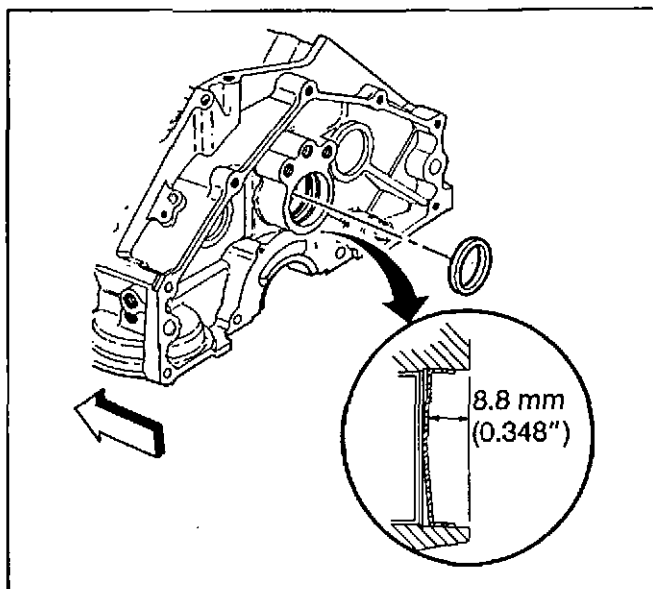
J 41712 Oil Pressure Switch Socket

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

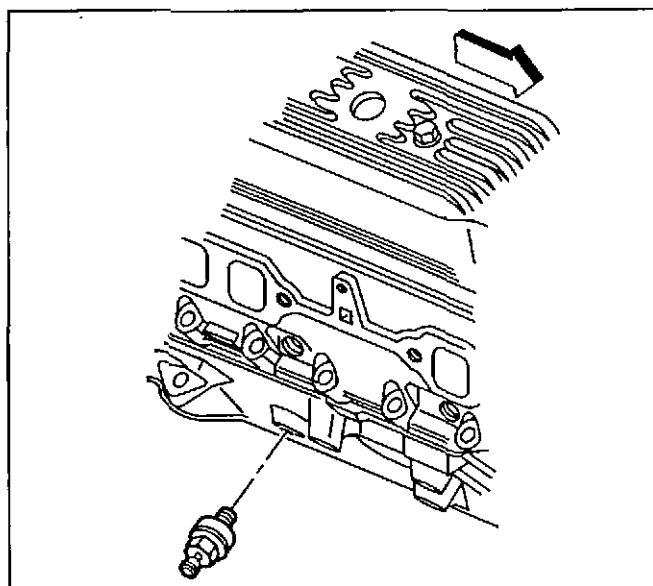
1. Remove the transmission locator pins (if required).



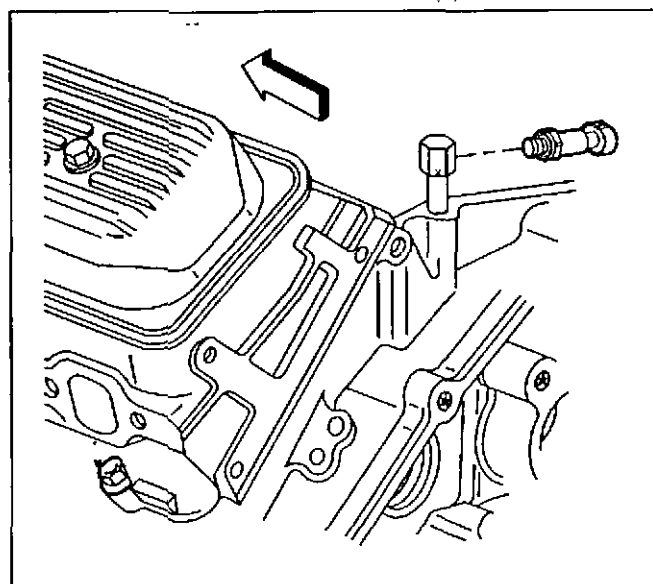
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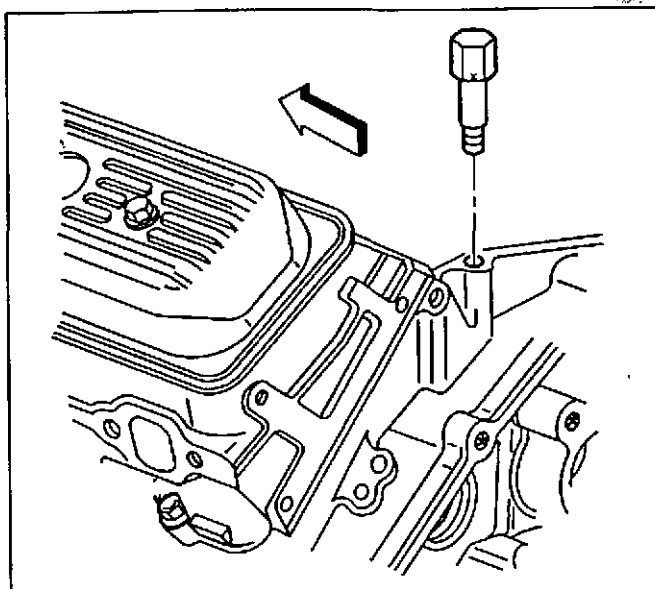
333649

2. Remove the expansion cup plug (camshaft rear bearing hole).

3. Remove the knock sensor.

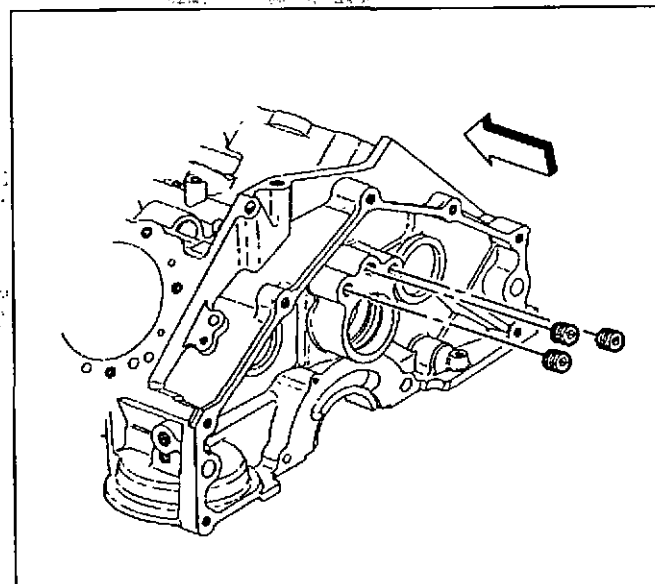
4. Remove the engine oil pressure gauge sensor using the J 41712.

5. Remove the engine oil pressure sensor gauge sensor fitting.



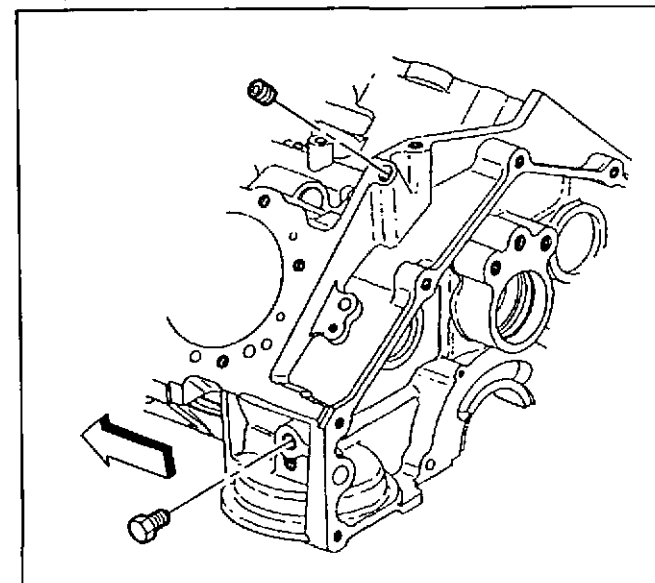
333652

6. Remove the square socket plugs (engine block oil gallery) from the rear of the engine block.

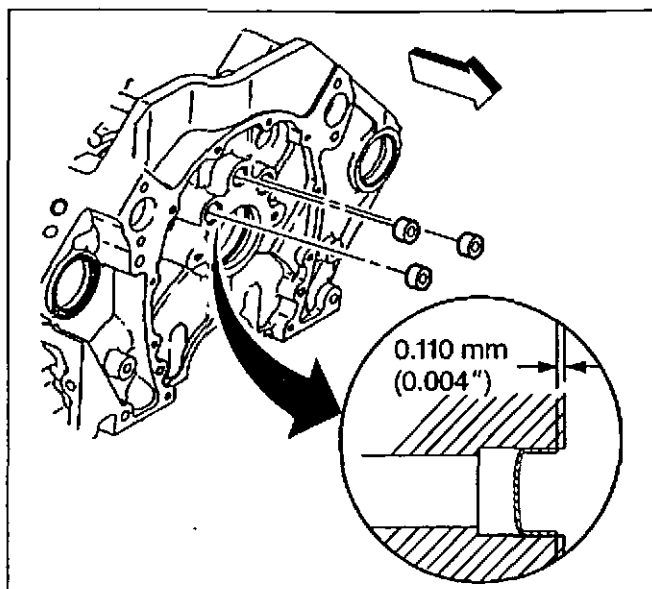


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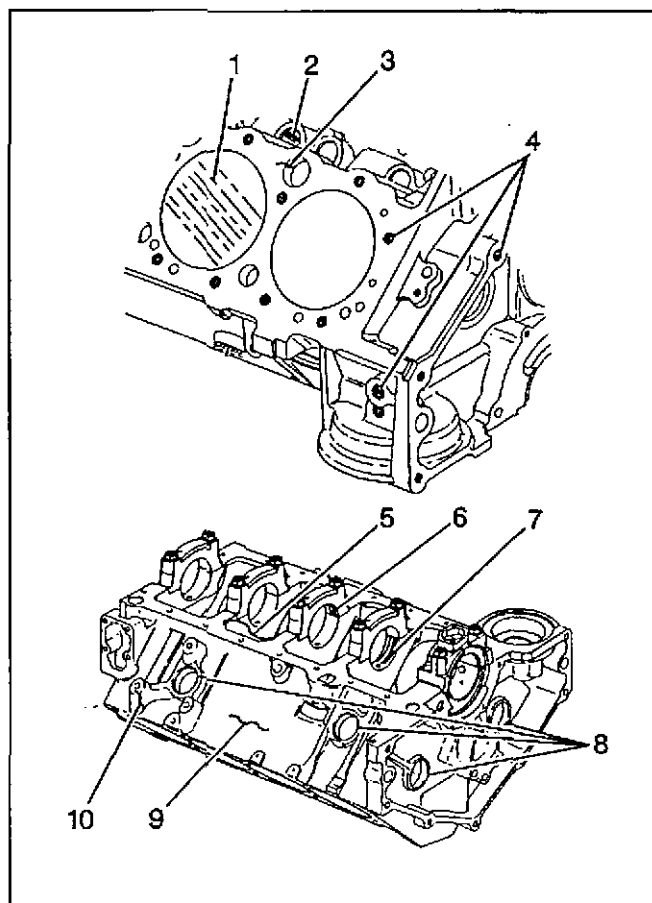
7. Remove the left side rear and left rear top engine block oil gallery plugs.



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8. Remove the engine block oil gallery plugs from the front of the engine block.
Insert a rod into the rear oil gallery holes in order to drive out the engine block oil gallery plugs.

SIE-ID - 66842

Engine Block Clean and Inspect

SIO-ID - 67829

Tools Required

J 8087 Cylinder Bore Gauge

1. Clean all the remaining sealing or gasket material from the sealing surfaces.
2. Boil the engine block in caustic solution.
3. Flush the engine block with clean water or steam.
4. Clean the cylinder bores.
5. Clean the oil galleries and the oil passages.
6. Clean the scale and the deposits from the coolant passages.
7. After cleaning the engine block, spray or wipe the cylinder bores and the machined surfaces with clean engine oil GM P/N 12345610 or equivalent.
8. Inspect the following areas:
 - Cylinder bores (1) for scratches or gouging
 - Valve lifter bores (2) for excessive scoring or wear
 - Coolant jackets (3) for cracks
 - Threaded holes (4) for damage
 - Crankshaft bearing webs (5) for cracks
 - Crankshaft bearing caps (6) and the crankshaft bearing bores (7) for damage
 - The crankshaft bearing bores should be round and uniform when measuring the inside diameter (ID).
 - The surface where the crankshaft bearings contact the crankshaft bearing bore should be smooth.
 - If a crankshaft bearing cap is damaged and requires replacement, replace the crankshaft bearing cap first. Then rebore the engine block crankshaft bearing bores

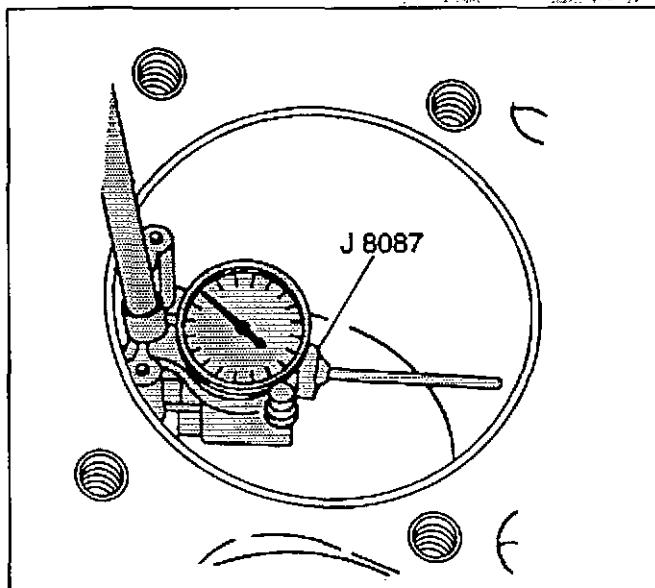
and check for the proper alignment.

Finally, check the crankshaft bearings for the proper clearances.

- Expansion cup plug bores (8) for damage
- Engine block (9) for cracks or damage
- Engine mount bosses (10) for damage

9. Measure the cylinder bores for taper and out-of-round.

- 9.1. Depress the plunger on the *J 8087* 7 mm (0.275 in) or until the *J 8087* enters the cylinder bore.
- 9.2. Center the *J 8087* in the cylinder bore and turn the indicator dial to zero.
- 9.3. Move the *J 8087* up and down the cylinder bore to determine the taper. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
- 9.4. Turn the *J 8087* to different points around the cylinder bore to determine the out-of-round condition. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.



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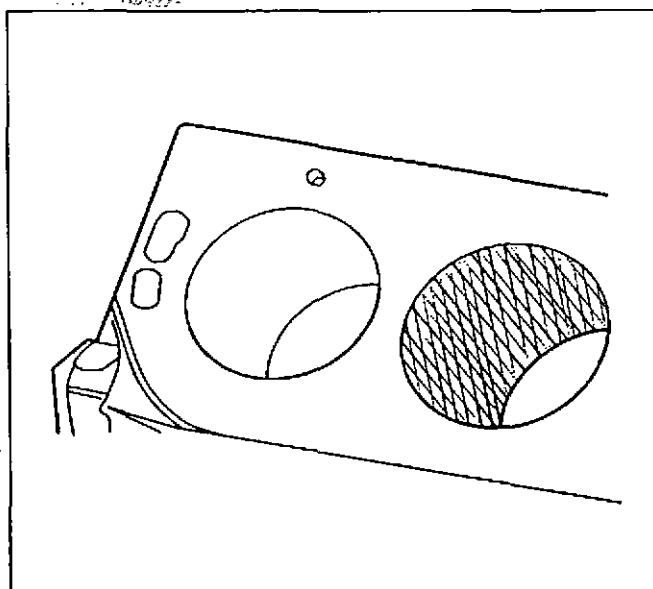
SIE-ID - 69045

Cylinder Boring and Honing

Cylinder Honing

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

- When honing the cylinder bores, 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 to be removed.
 - Dull, dirty stones cut unevenly and generate excessive heat.
 - DO NOT hone to a final grade with a coarse or medium-grade stone.
 - Leave sufficient metal so that all the stone marks will be removed with the fine grade stones.
 - Perform the final honing with a fine-grade stone and hone the cylinder bore in a cross hatch pattern at 45–65 degrees to obtain the proper clearance.
- During the honing operation, thoroughly check the cylinder bore.
 - Repeatedly check the cylinder bore fit with the selected piston.
 - All measurements of the piston or cylinder bore should be made with the components at normal room temperature.
- When honing to eliminate taper in the cylinder bore, use full strokes the complete length of the



186747

cylinder bore.

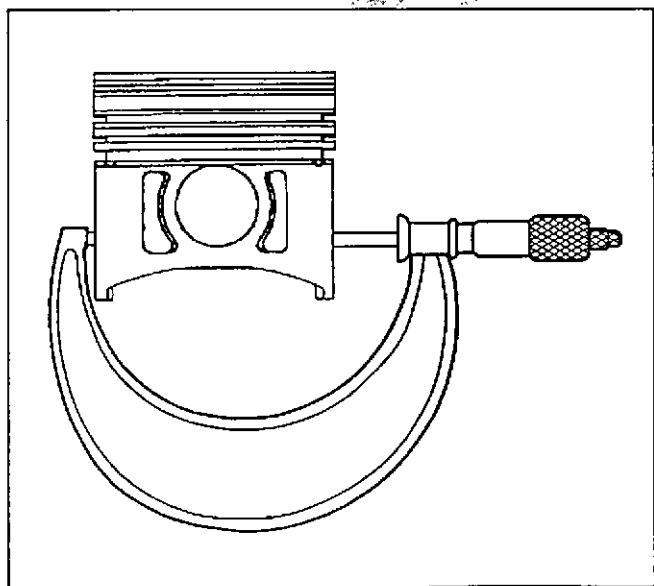
Repeatedly check the measurement at the top, the middle, and the bottom of the cylinder bore.

- The finish marks should be clean but not sharp.
 - The finish marks should be free from imbedded particles or torn or folded metal.
4. By measuring the selected piston at the sizing point and then by adding the average of the clearance specification, the final cylinder bore honing dimension required can be determined.
 5. When finished, the reconditioned cylinder bores should have less than or meet the specified out-of-round and taper requirements.
 6. After the final honing and before the piston is checked for fit, clean the cylinder bore with hot water and detergent.
 - 6.1. Scrub the cylinder bores with a stiff bristle brush.
 - 6.2. Rinse the cylinder bores thoroughly with clean hot water.
 - 6.3. Dry the cylinder bores with a clean rag.
 - 6.4. Do not allow any abrasive material to remain in the cylinder bores.
 - Abrasive material may cause premature wear of the new piston rings and the cylinder bores.
 - Abrasive material will contaminate the engine oil and may cause premature wear of the bearings.
 7. Perform final measurements of the piston and the cylinder bore.
 8. Permanently mark the top of the piston for the specified cylinder to which it has been fitted.
 9. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Boring Procedure

Caution: *S10-ID - 5011 Wear safety glasses in order to avoid eye damage.*

1. Before starting the honing or reboring operation, measure all the new pistons with the micrometer contacting at points exactly 90 degrees from the piston pin centerline.
2. File the top of the cylinder block in order to remove any dirt or burrs before using any type of boring bar.
3. Follow the instructions furnished by the manufacturer regarding use of the boring equipment.
4. When reboring the cylinders, make sure all the crankshaft bearing caps are installed in the original position and direction.
5. Tighten the crankshaft bearing caps to the proper torque specifications in order to avoid distortion of the cylinder bores in the final assembly.
6. When making the final cut with the boring bar,



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leave 0.03 mm (0.001 in) on the cylinder bore diameter for finish honing. This gives the required position to the cylinder clearance specifications. (Carefully perform the honing and boring operation in order to maintain the specified clearances between the pistons, the piston rings, and the cylinder bores).

SIE-ID - 69074

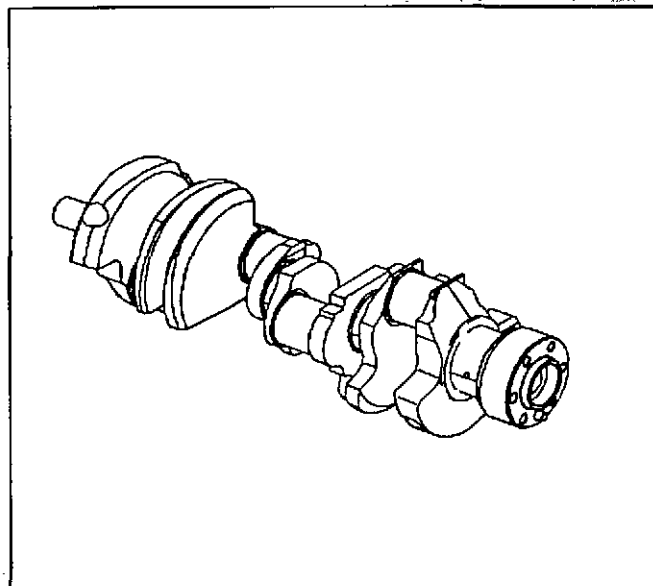
Crankshaft and Bearings Clean and Inspect

Tools Required

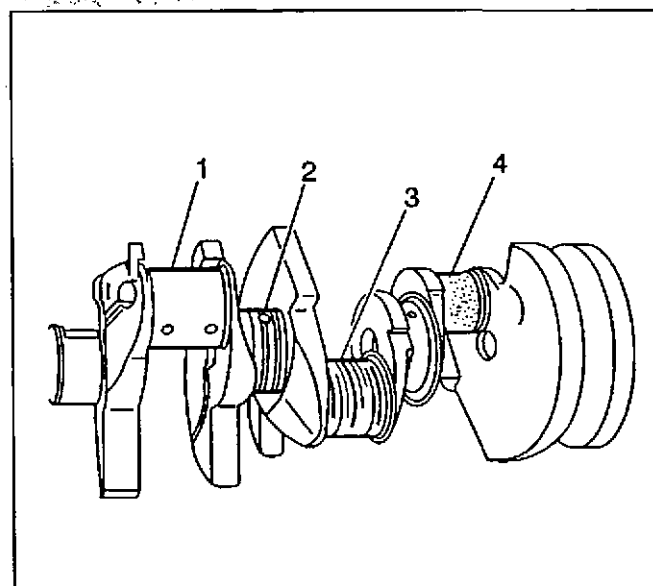
- J 7872 Magnetic Base Dial Indicator
- J 36660 Electronic Torque Angle Meter

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

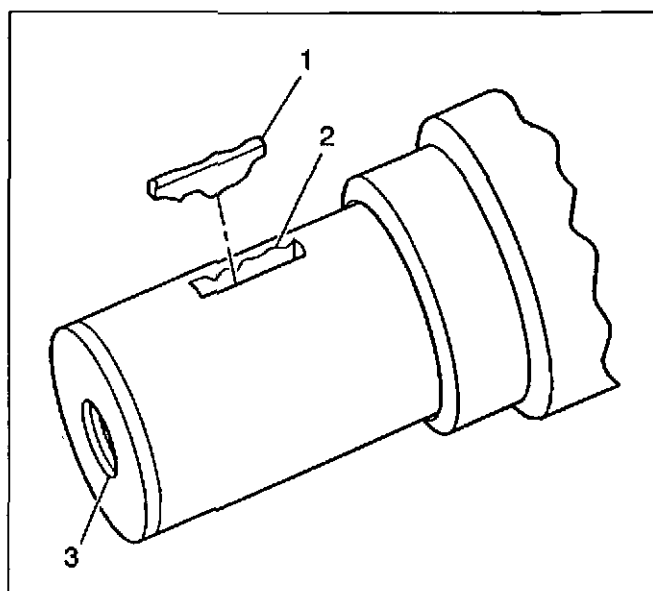
1. Clean the crankshaft in cleaning solvent. Remove all sludge or restrictions from the oil passages.
2. Clean the crankshaft bearings in cleaning solvent. Wipe the crankshaft bearings clean with a soft cloth, do not scratch the crankshaft bearing surfaces.
3. Dry the crankshaft and crankshaft bearings with compressed air.
4. Inspect the crankshaft for the following:
 - Crankshaft journals (1) should be smooth with no evidence of scoring or damage.
 - Deep grooves (2)
 - Scratches or uneven wear (3)
 - Pitted surfaces (4)
 - Wear of damage to the thrust journal surfaces
 - Scoring or damage to the front or rear seal surface
 - Restrictions to the oil passages
 - A loose or damaged rear oil gallery plug
 - Damage to the threaded bolt holes



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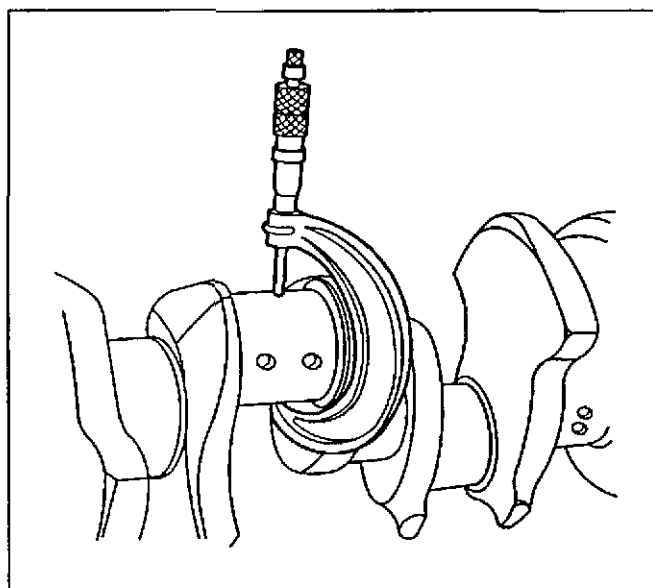


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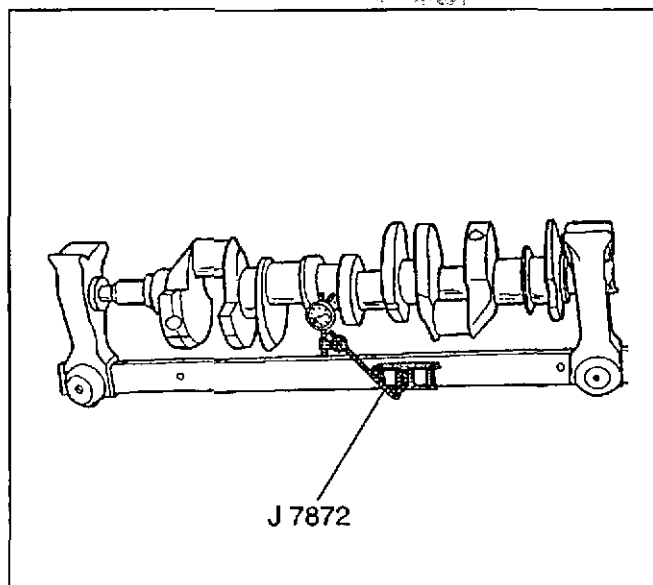
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5. Inspect the woodruff keys (crankshaft balancer) (1), the keyway (2), and the threaded hole (3) for damage.



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6. Measure the crankpins for out-of-round and taper.



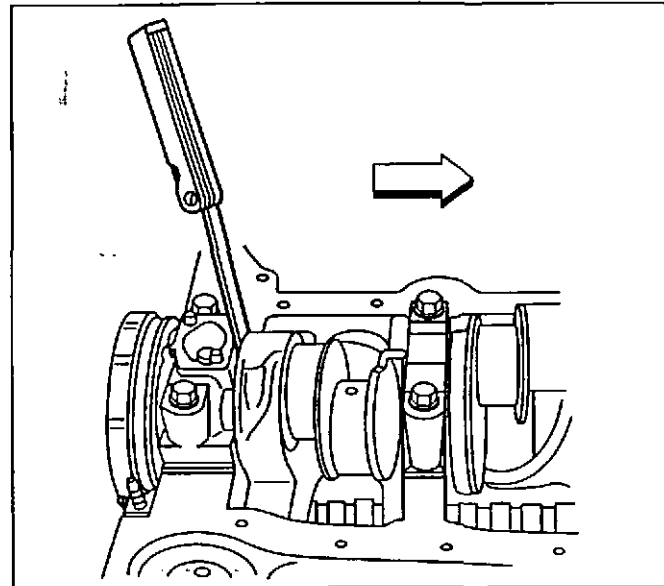
35210

7. Using wooden V-blocks, support the crankshaft on the front and rear journals.
8. Use the J 7872 in order to measure crankshaft journal runout.
- The crankshaft runout should not exceed 0.038 mm (0.0015 in).

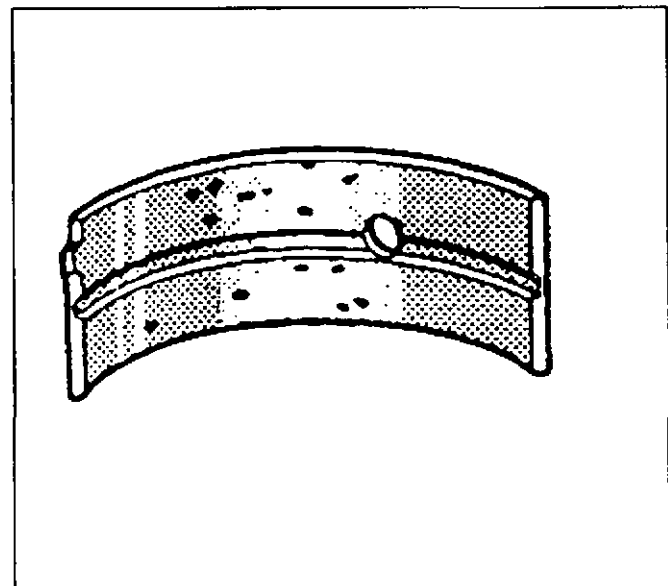
9. Measure the crankshaft end play.

Important: In order to properly measure the crankshaft end play, the crankshaft, the crankshaft bearings, the crankshaft bearing caps, and the fasteners must be installed into the engine block and the bolts and studs tightened to specifications.

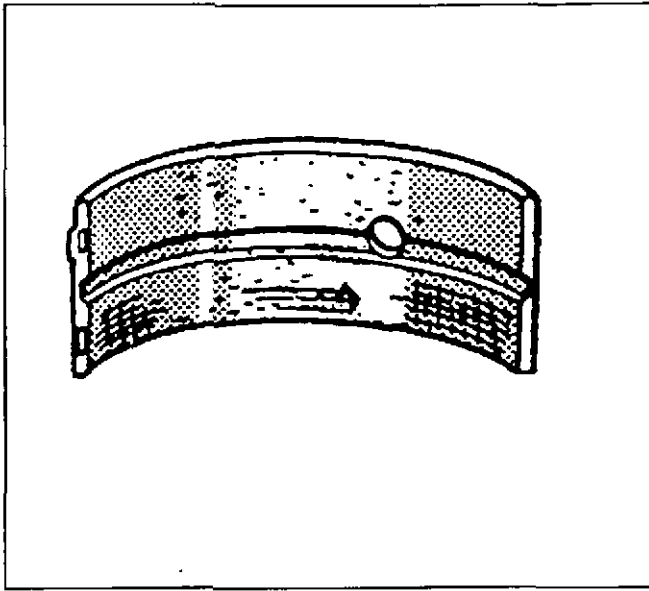
- 9.1. Firmly thrust the end of the crankshaft first rearward then forward. This will line up the rear crankshaft bearing and the crankshaft thrust surfaces.
 - 9.2. With the crankshaft pushed forward, insert a feeler gauge between the crankshaft and the crankshaft bearing surface and then measure the clearance. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
 - 9.3. If the correct end play cannot be obtained, verify that the correct size crankshaft bearing has been installed. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
 - 9.4. Inspect the crankshaft for binding. Turn the crankshaft to check for binding. If the crankshaft does not turn freely, loosen the crankshaft bearing bolts and studs, one crankshaft bearing cap at a time, until the tight crankshaft bearing is located.
 Burrs on the crankshaft bearing cap, foreign matter between the crankshaft bearing and the engine block or the crankshaft bearing cap, or a faulty crankshaft bearing could cause a lack of clearance at the crankshaft bearing.
10. Inspect the crankshaft bearings for craters or pockets. Flattened sections on the crankshaft bearing halves also indicate fatigue.



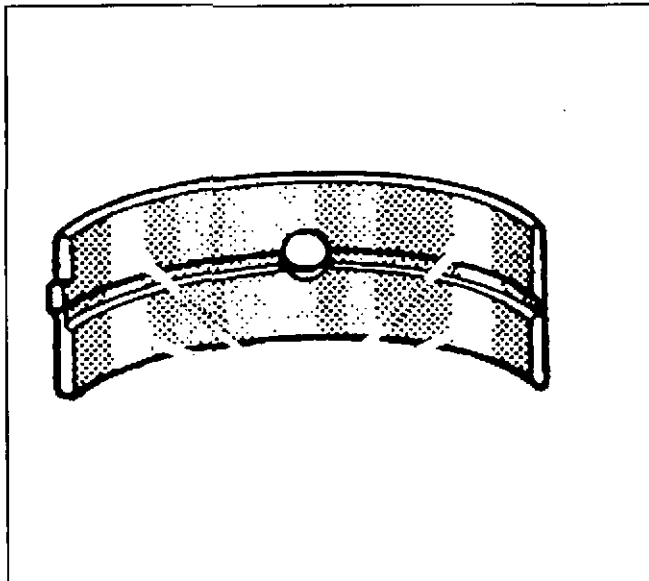
188467



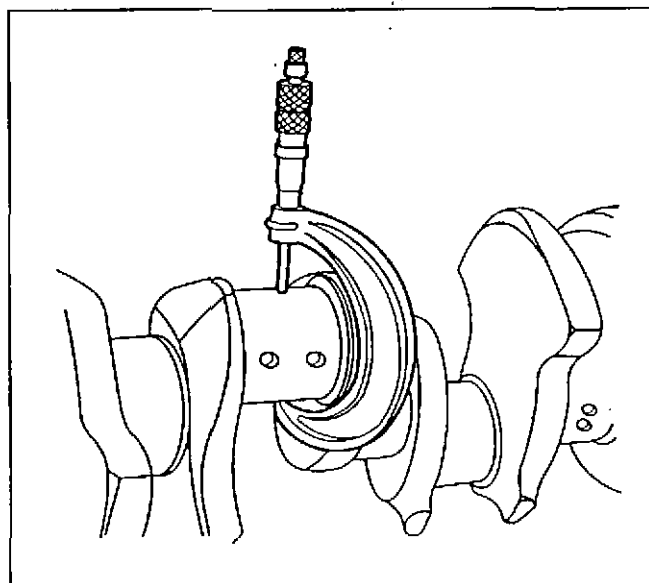
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11. Inspect the crankshaft bearings for excessive scoring or discoloration.
12. Inspect the crankshaft bearings for dirt or debris imbedded into the crankshaft bearing material.

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

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

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

Bearing Clearance Measuring Procedures

The crankshaft bearings are of the precision insert type and do not use shims for adjustment. If the clearances are excessive, then new upper and lower crankshaft bearings will be required. The service crankshaft bearings are available in the standard size and an undersize.

The selective fitting of the crankshaft bearings are necessary in production in order to obtain close tolerances. For this reason, in one journal bore you may use one-half of a standard crankshaft bearing with one-half of a undersize crankshaft bearing.

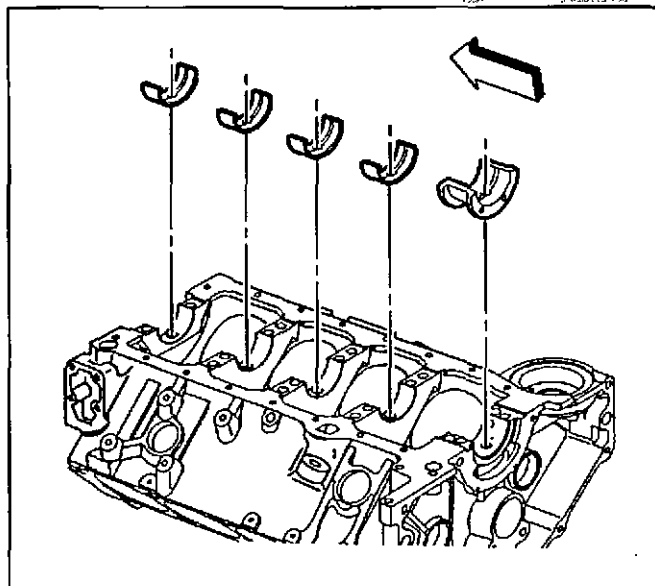
In order to determine the correct replacement crankshaft bearing size, the crankshaft bearing clearance must be measured accurately. Either the micrometer or plastic gauge method may be used; however, the micrometer method gives more reliable results and is preferred.

Micrometer Method for Crankshaft Bearings

1. Measure the crankshaft journal diameter with a

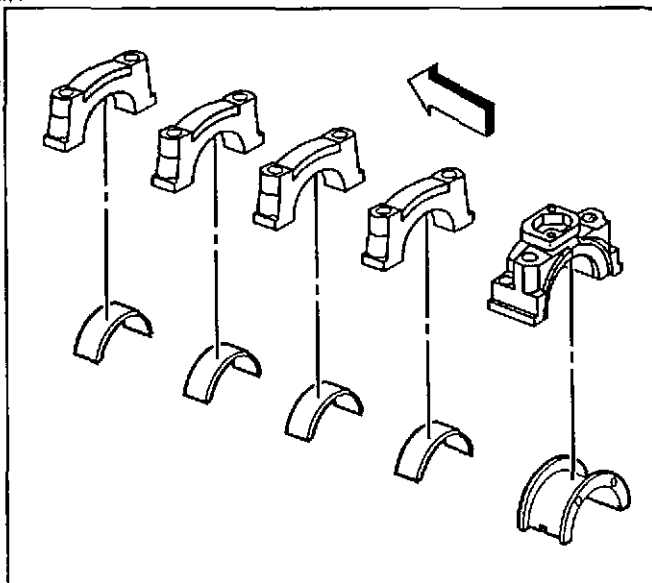
micrometer in several places, approximately 90 degrees apart, and then average the measurements.

2. Determine the taper and the out-of-round of the crankshaft journal. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
3. Install the crankshaft bearings into the engine block.

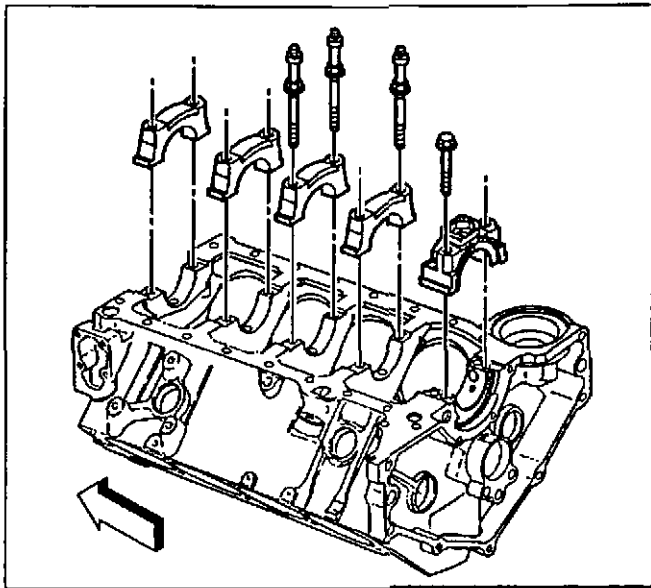


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4. Install the crankshaft bearings into the crankshaft bearing caps.



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Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the crankshaft bearing caps in the original positions and with the arrow on the crankshaft bearing caps in the direction of the front of the engine block.
6. Install the crankshaft bearing cap bolts and studs.

Tighten

- 6.1. Tighten the crankshaft bearing cap bolts and studs on the first pass to 20 N·m (15 lb ft).
- 6.2. Tighten the crankshaft bearing cap bolts and studs (two bolt caps) on the final pass to 73 degrees using the J 36660.
- 6.3. Tighten the outboard crankshaft bearing cap bolts and studs (four bolt cap) on the final pass to 43 degrees using the J 36660.
- 6.4. Tighten the inboard crankshaft bearing cap bolts and studs (four bolt caps) on the final pass to 73 degrees using the J 36660.
7. Measure the crankshaft bearing inside diameter (ID) at the top and bottom using an inside micrometer.
8. In order to determine the crankshaft bearing clearance, subtract the journal diameter from the crankshaft bearing ID.
9. Compare the crankshaft bearing clearance to the specifications. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
10. If the crankshaft bearing clearances exceeds specifications, install the new crankshaft bearings as follows:
 - 10.1. Measure the crankshaft bearing inside diameter (ID) using an inside micrometer.
 - 10.2. Compare the crankshaft bearing clearance to the specifications. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.

Replace or repair the crankshaft if the proper clearances cannot be obtained.

Micrometer Method for Connecting Rod Bearings

Notice: 510-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

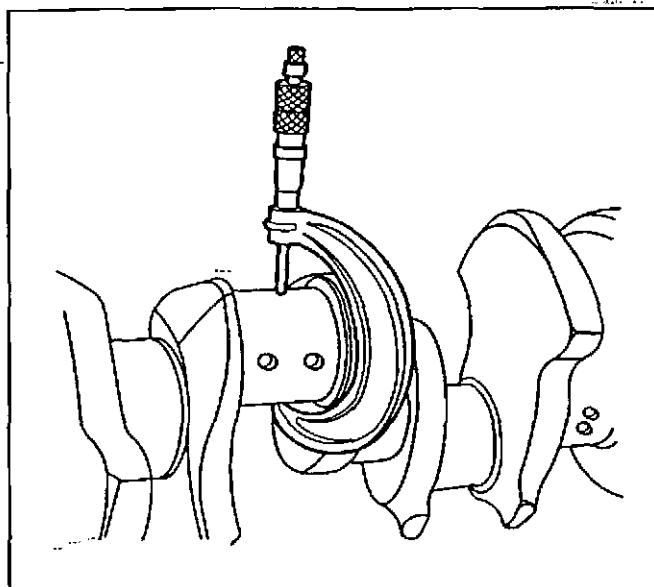
1. Measure the crankpin diameter with a micrometer in several places, approximately 90 degrees apart, and then average the measurements.
2. Determine the taper and the out-of-round. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
3. Install the connecting rod bearings into the connecting rod cap and the connecting rod.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

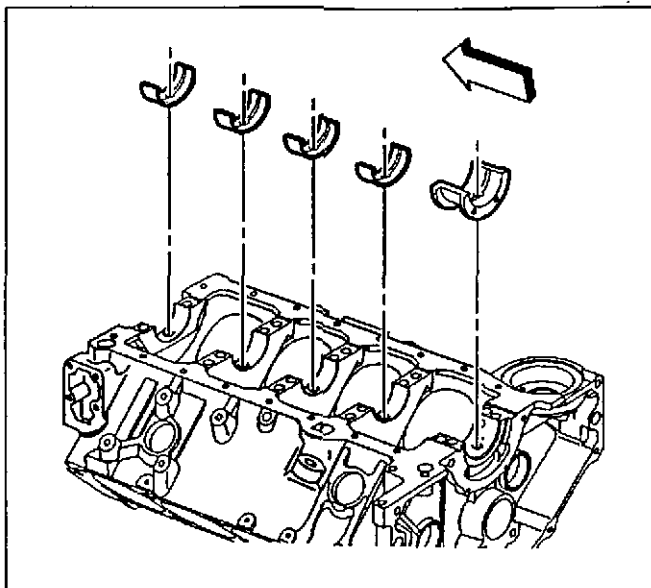
4. Install the connecting rod caps and the nuts.

Tighten

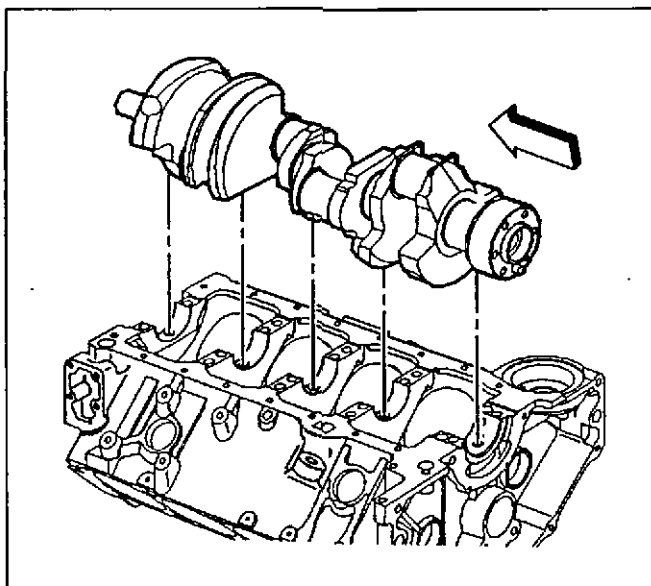
- 4.1. Tighten the connecting rod nuts in the first pass, evenly to 27 N.m (20 lb ft).
- 4.2. Tighten the connecting rod nuts in the final pass an additional 55 degrees using the J 36660 .
5. Measure the connecting rod bearing inside diameter (ID) at the top and bottom using an inside micrometer.
6. Compare the connecting rod bearing clearance specifications. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
7. If the connecting rod bearing clearance is within specifications, the connecting rod bearing is satisfactory.
 - If the clearance is not within specifications, replace the connecting rod bearings.
 - Always replace both the upper and the lower connecting rod bearings as an assembly.
8. A standard or undersize connecting rod bearing combination may result in the proper clearance. If the proper connecting rod bearing clearance cannot be achieved using the standard or the undersize connecting rod bearings, it will be necessary to replace or repair the crankshaft.



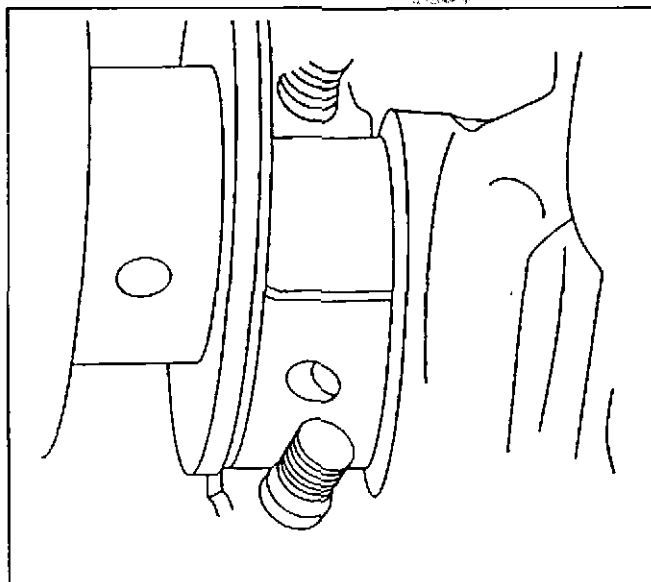
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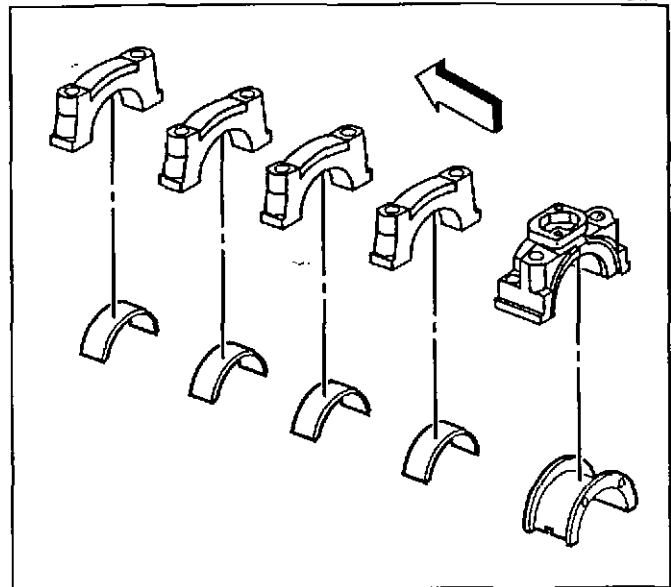
Plastic Gauge Method for Main or Connecting Rod Bearings

1. Install the crankshaft bearings into the engine block.

2. Install the crankshaft.

3. Install the gauging plastic the full width of the journal.

4. Install the crankshaft bearings into the crankshaft bearing caps



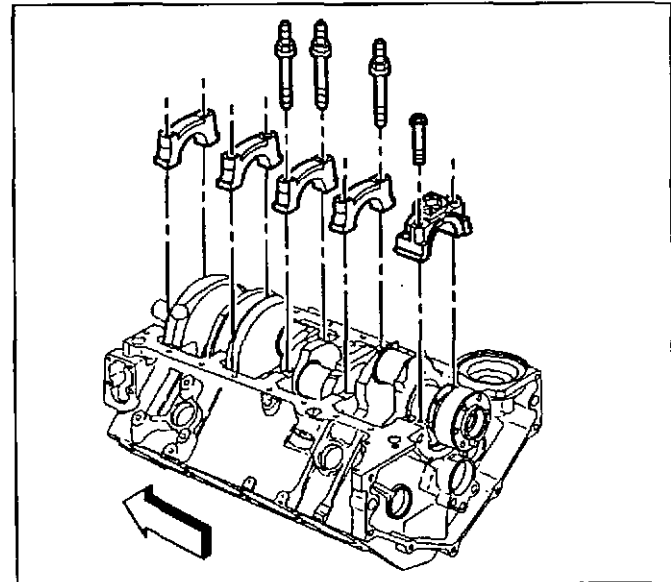
317295

Notice: Refer to *Fastener Notice* in *Cautions and Notices*.

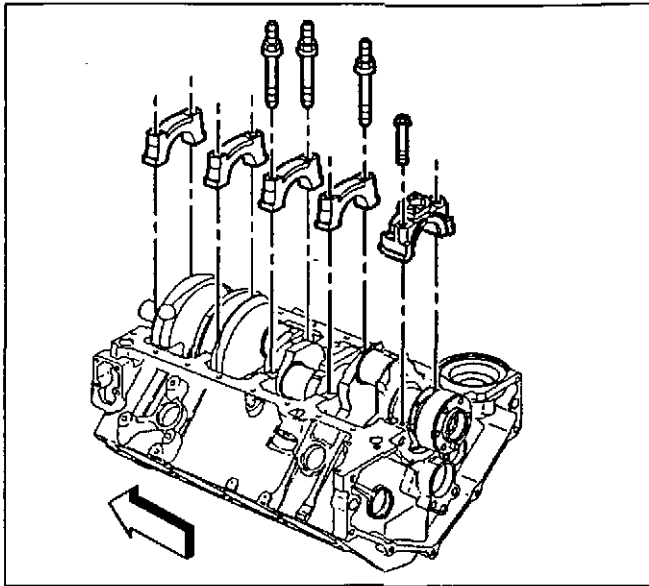
5. Install the crankshaft bearing caps in the original positions and the arrow on the crankshaft bearing caps in the direction of the front of the engine block.
6. Install the crankshaft bearing cap bolts and studs.

Tighten

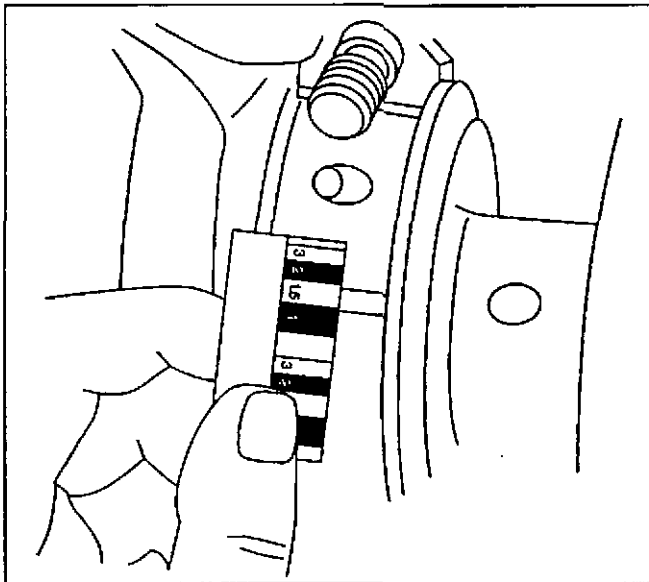
- 6.1. Tighten the crankshaft bearing cap bolts and studs on the first pass to 20 N·m (15 lb ft).
- 6.2. Tighten the crankshaft bearing cap bolts and studs (two bolt caps) on the final pass to 73 degrees using the J 36660.
- 6.3. Tighten the outboard bearing cap bolts and studs (four bolt cap) on the final pass to 43 degrees using the J 36660.
- 6.4. Tighten the inboard bearing cap bolts and studs (four bolt caps) on the final pass to 73 degrees using the J 36660.



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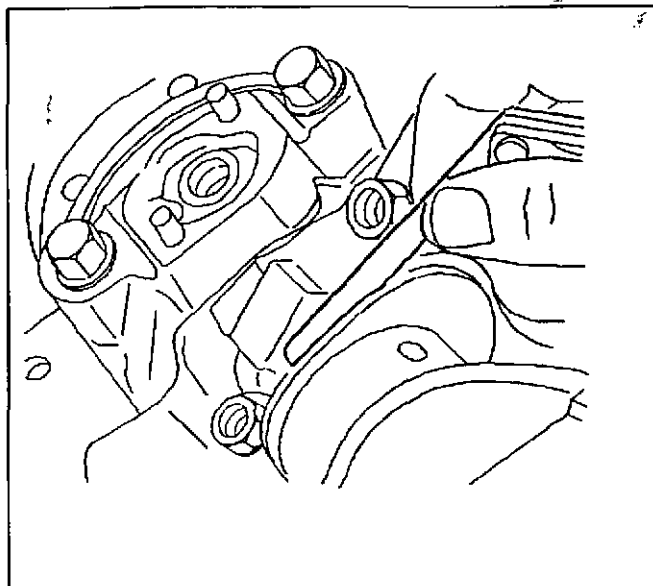
4981

7. Remove the crankshaft bearing cap bolts and studs.
8. Remove the crankshaft bearing caps. The gauging plastic may adhere to either the crankshaft bearing journal or the crankshaft bearing surface.
9. Without removing the gauging plastic, measure the compressed width at the widest point using the graduated scale on the edge of the gauging plastic envelope.
 - If the flattened gauging plastic tapers toward the middle or the ends, there may be a difference in clearance indicating taper, low spot or other irregularity of the crankshaft bearing or the crankshaft bearing journal.
 - Normally the crankshaft bearing journals wear evenly and are not out-of-round. However, if a crankshaft bearing is being fitted to an out-of-round 0.0254 mm (0.001 in) (maximum) crankshaft bearing journal, be sure to fit to the maximum diameter of the crankshaft bearing journal. If the crankshaft bearing is fitted to the minimum diameter and the crankshaft bearing journal is excessively out-of-round, the interference between the crankshaft bearing and the crankshaft bearing journal will result in rapid crankshaft bearing failure.
 - If the crankshaft bearing clearance is within specifications, the crankshaft bearing is satisfactory. If the clearance is not within specifications, replace the crankshaft bearing. Always replace both the upper and lower crankshaft bearings as a unit.
 - A standard or undersize crankshaft bearing combination may result in the proper clearance. If the proper crankshaft bearing clearance cannot be achieved using the standard or the undersize crankshaft bearings, it may be necessary to repair or replace the crankshaft.
- Notice:** S10-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.
10. Remove the flattened gauging plastic.
11. Measure the remaining crankshaft and

connecting rod bearing journals.

Connecting Rod Side Clearance Measuring Procedure

1. Insert a feeler gauge between the connecting rod caps and measure the connecting rod side clearance. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
2. The connecting rod side clearances may also be measured with a dial indicator set.



5163

SIE-ID - 194518

Crankshaft Balancer Clean and Inspect

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the crankshaft balancer in cleaning solvent.
2. Dry the crankshaft balancer with compressed air.
3. Inspect the crankshaft balancer for the following:
 - Worn or damaged bolt hole threads (1)
 - Worn, chunking, or deteriorated rubber (2) between the hub and pulley
 - Loose or improperly installed balance weights (3)

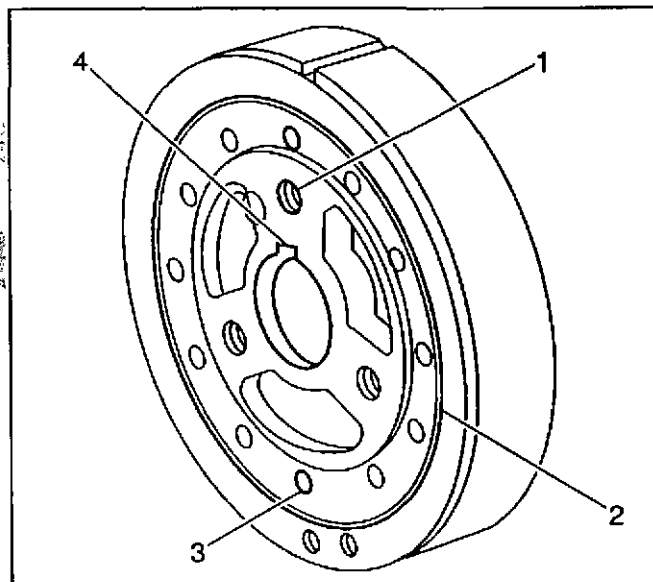
A properly installed balance weight should be installed until flush or below flush with the face of the crankshaft balancer.

- Worn or damaged keyway (4)

Important: A crankshaft front oil sealing surface with excessive scoring, grooves, rust, or other damage must be replaced.

- Worn, grooved, or damaged crankshaft front oil sealing surface

Minor imperfections on the crankshaft balancer crankshaft front oil seal surface may be removed with a polishing compound or fine grade emery cloth.



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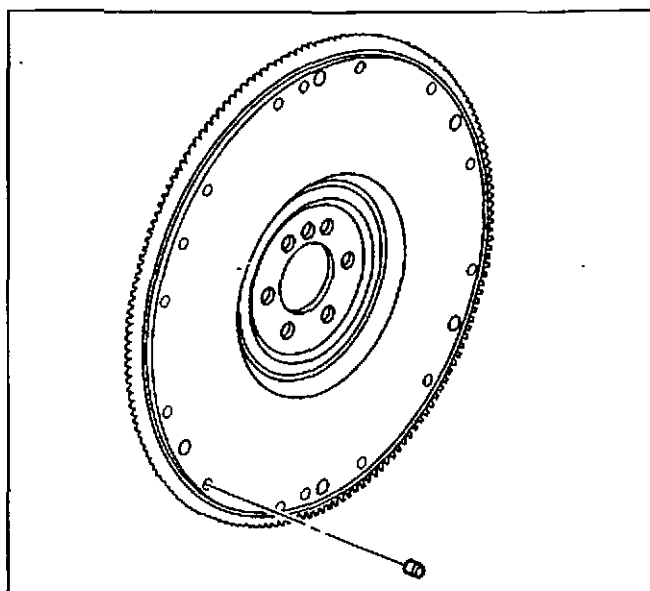
SIE-ID - 195065

Engine Flywheel Clean and Inspect

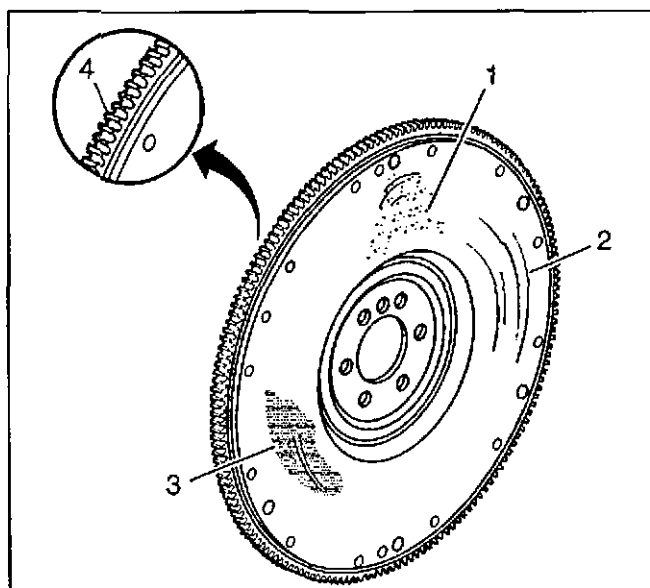
Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the engine flywheel in cleaning solvent.
2. Dry the engine flywheel with compressed air.
3. Inspect the engine flywheel (manual transmission) for loose or improperly installed flywheel weights (if applicable).

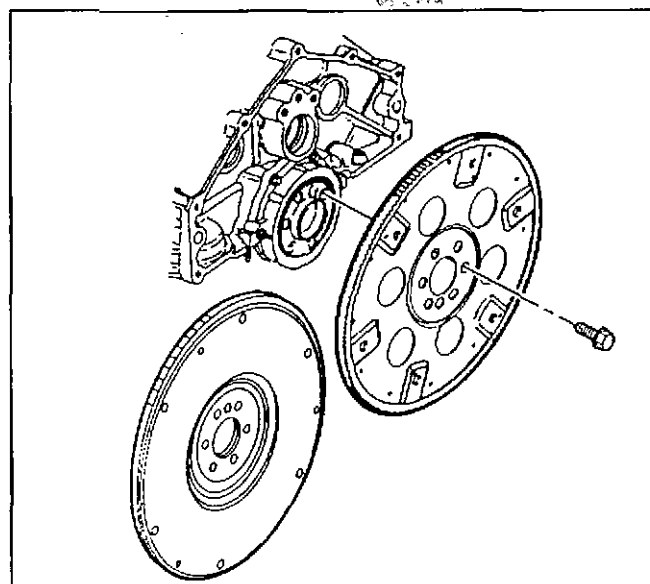
A properly installed flywheel weight should be installed until flush or below flush with the face of the engine flywheel.



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4. Inspect the engine flywheel (manual transmission) for the following:

- Pitted surface (1)
- Scoring or grooves (2)
- Rust or other surface damage
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

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

Important: Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel. Install a NEW engine flywheel if any cracks are found.

5. Inspect the engine flywheel (automatic transmission) for the following:
- Damaged ring gear teeth
 - Stress cracks around the flywheel-to-crankshaft bolt hole locations.
 - Welded areas that retain the ring gear onto the engine flywheel for cracking.

SIE-ID - 195087

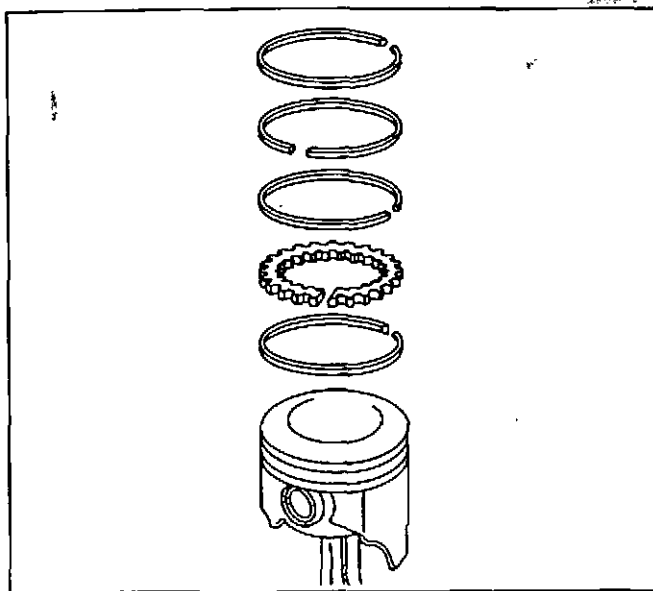
Piston and Connecting Rod Disassemble

Tools Required

J 24086-C Piston Pin Remover/Installer

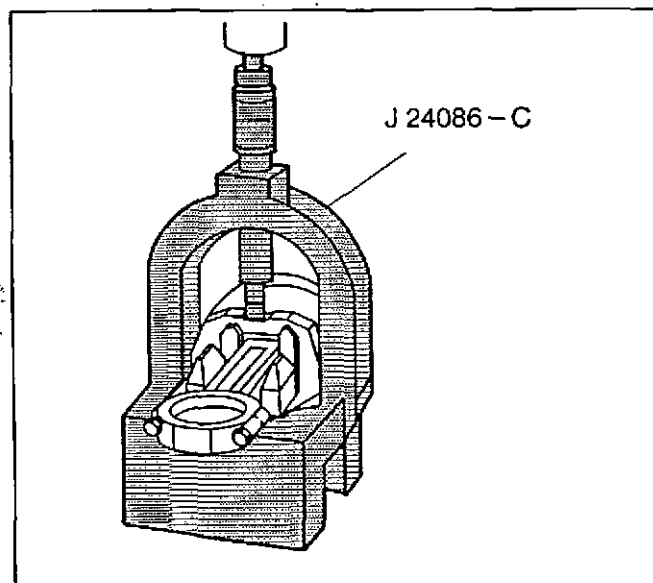
Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Remove the piston rings from the pistons.



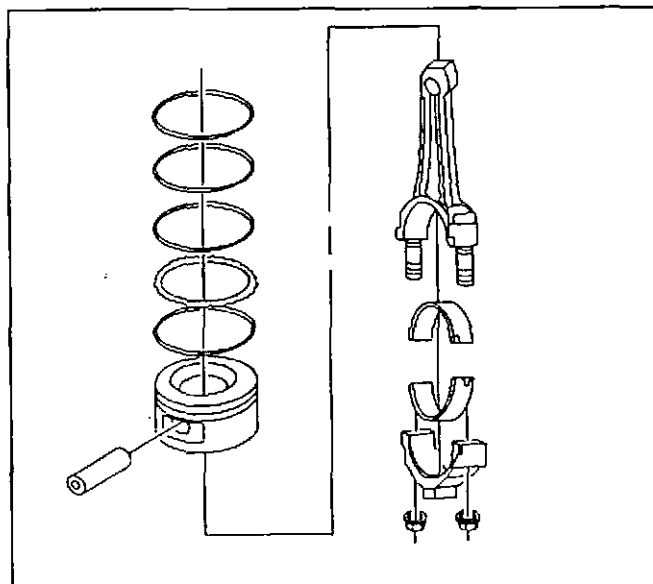
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2. Press the piston pin from the connecting rod using the J 24086-C.
The piston pin has an interference fit into the connecting rod, and is full floating in the piston.

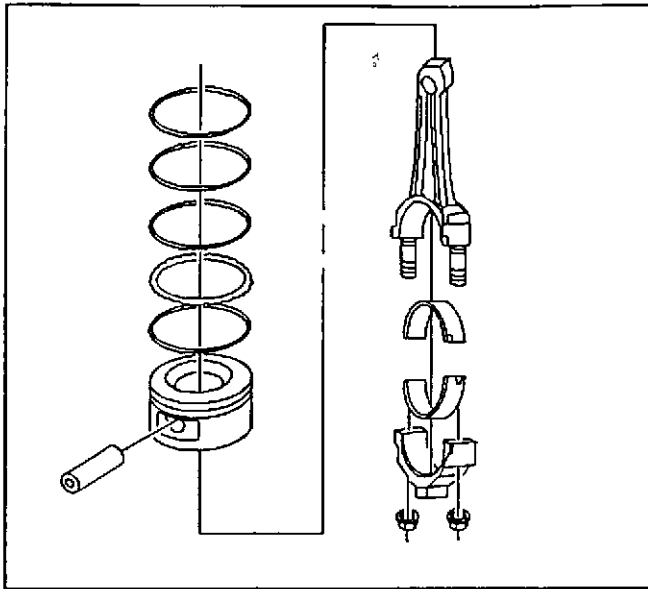


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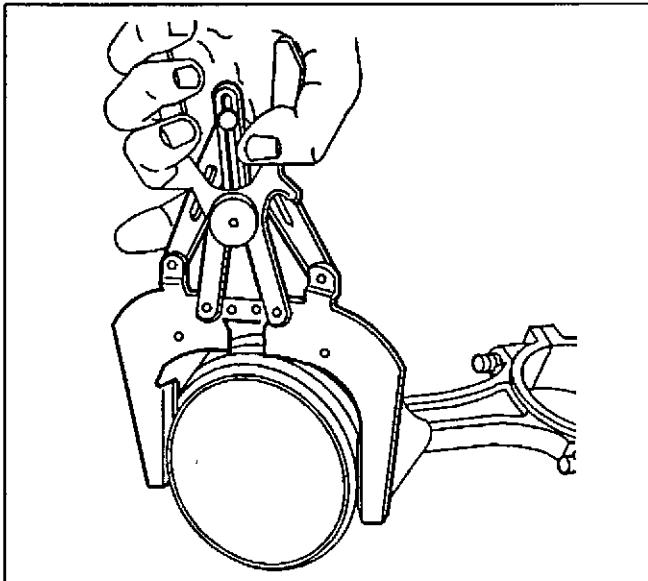
3. Mark, separate, and organize the parts for assembly.



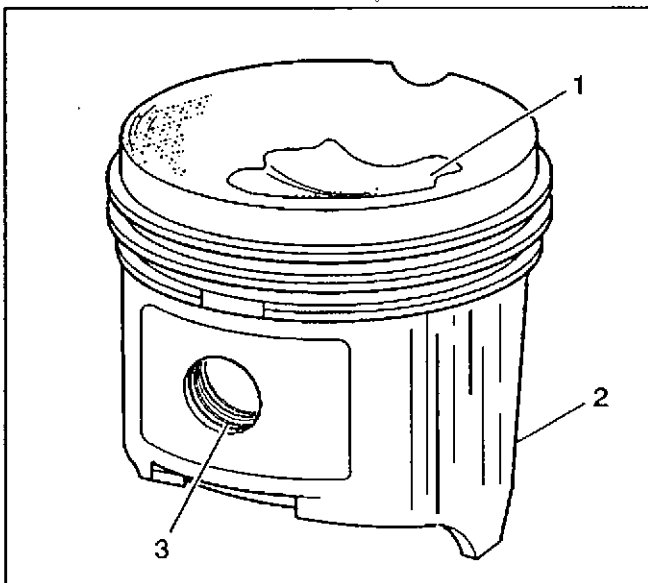
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SIE-ID = 39133

Piston, Connecting Rod and Bearings Clean/Inspect

Caution: SIO-ID = 5011 *Wear safety glasses in order to avoid eye damage.*

Important: Measurement of all components should be taken with the components at room temperature. Do not use a wire brush in order to clean any part of the piston.

1. Clean the piston and connecting rod in cleaning solvent.

Caution: SIO-ID = 5011 *Wear safety glasses in order to avoid eye damage.*

2. Dry the components with compressed air.

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.

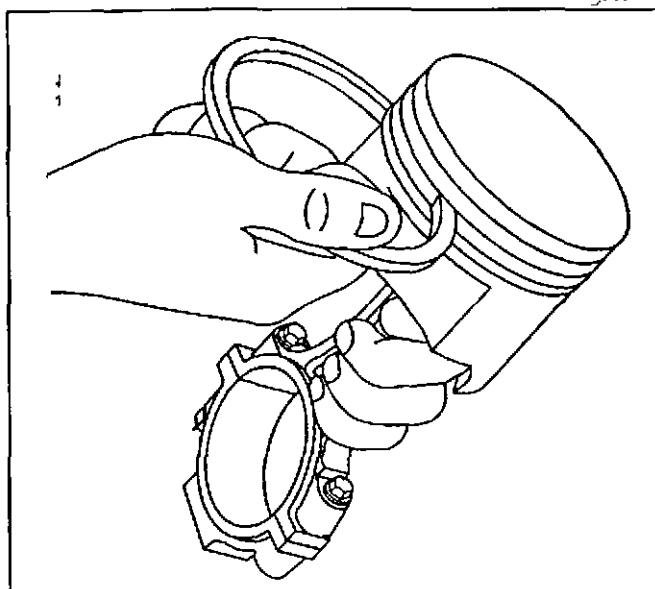
4. Clean the piston oil lubrication holes and slots.
5. Inspect the piston for the following:
 - Eroded areas (1) on the top of the piston
 - Scuffed or damaged skirt (2)
 - Damage to the piston pin bore (3)
 - Cracks in the piston ring lands, the piston skirt, or the piston pin bosses
 - Piston ring grooves for nicks, burrs, or other warpage which may cause the piston ring to bind.
6. Inspect the piston pin for scoring, wear or other damage.

7. Measure the piston ring-to-piston ring groove side clearance.

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

7.2. Roll the piston ring completely around the piston.

- If binding is caused by a distorted piston ring groove, MINOR imperfections may be removed with a fine file.
- If binding is caused by a distorted piston ring, then replace the piston ring.

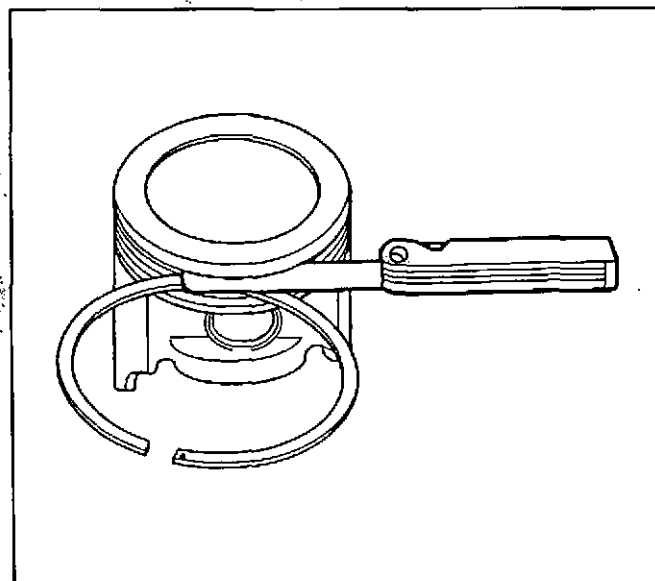


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8. Measure the piston ring side clearance with a feeler gauge.

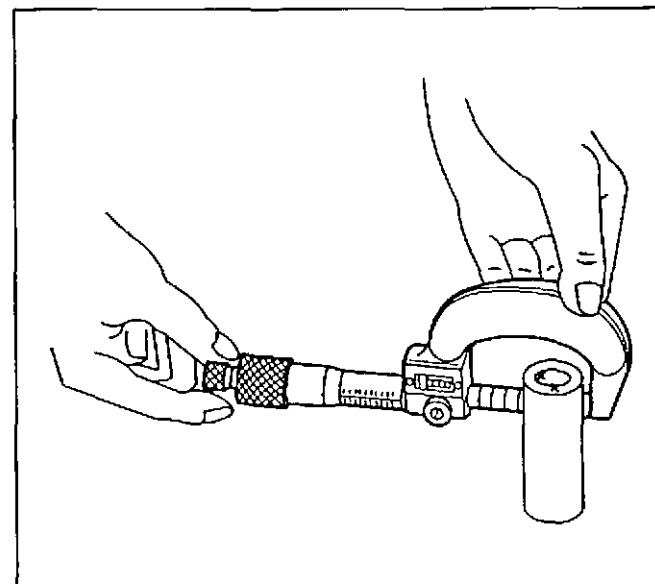
- If the piston ring side clearance is too small, try another piston ring set.
- If the proper piston ring-to-piston ring groove clearance cannot be achieved, replace the piston and pin assembly.

9. To determine the proper piston ring side clearance, refer to *Engine Mechanical Specifications (L31 (VIN R))*.

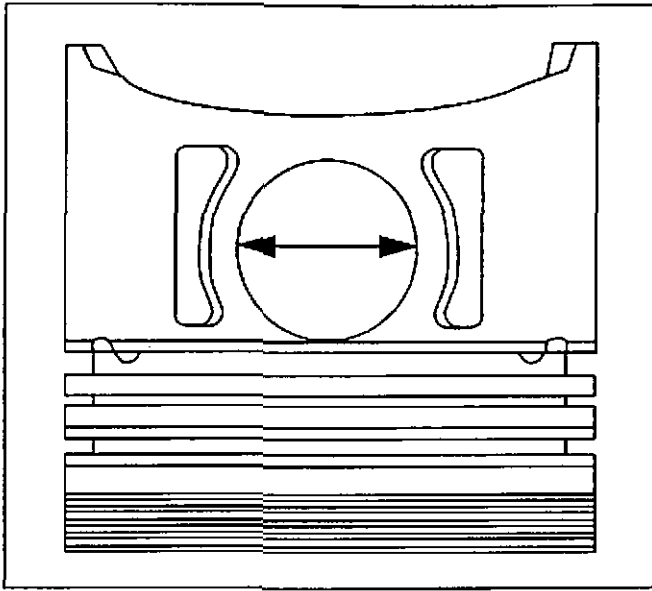


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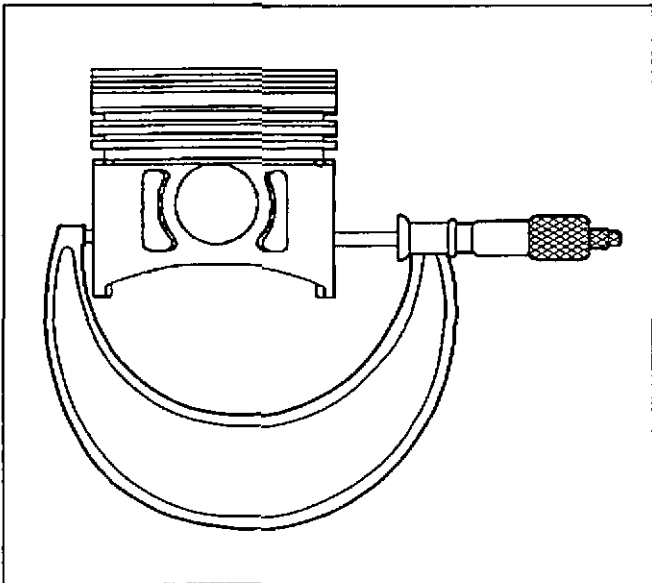
10. To determine piston pin-to-bore clearance use a micrometer and measure the piston pin.



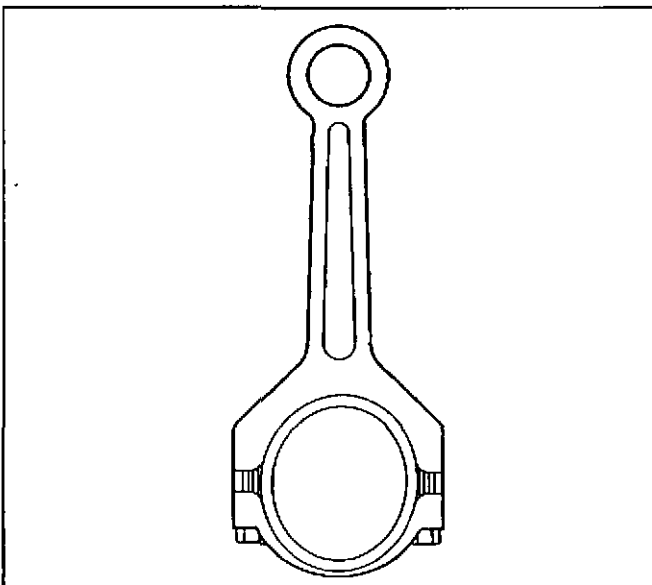
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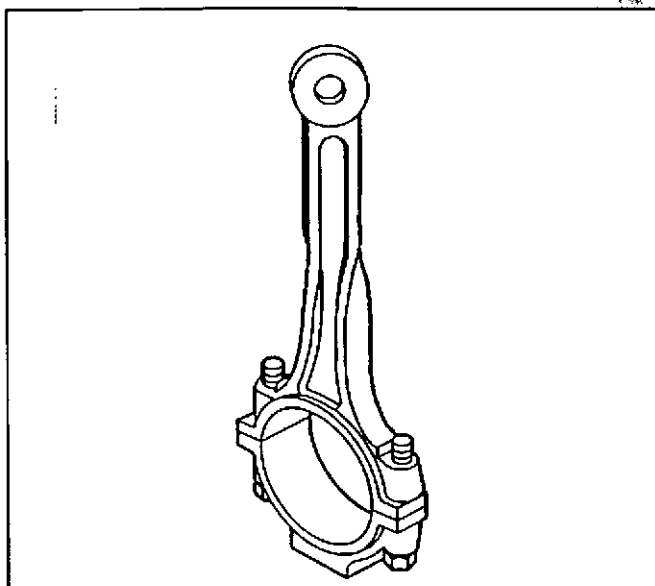
156167

11. To determine piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore.
12. To determine the piston pin-to-bore clearance, subtract the piston pin diameter from the piston pin bore diameter. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.

13. Measure the piston for out-of-round.
 - 13.1. With a micrometer at a right angle to the piston, measure the piston at 11 mm (0.433 in) from the bottom of the skirt.
 - 13.2. Measure the piston at three different points 120 degrees apart and compare the readings, refer to *Engine Mechanical Specifications (L31 (VIN R))*.
If the clearance is not within specifications, then replace the piston and piston pin as an assembly.

14. Inspect the connecting rod for an out-of-round bearing bore.

15. Inspect the connecting rod for twisting.
16. Inspect the connecting rod for damage to the connecting rod bolt threads.

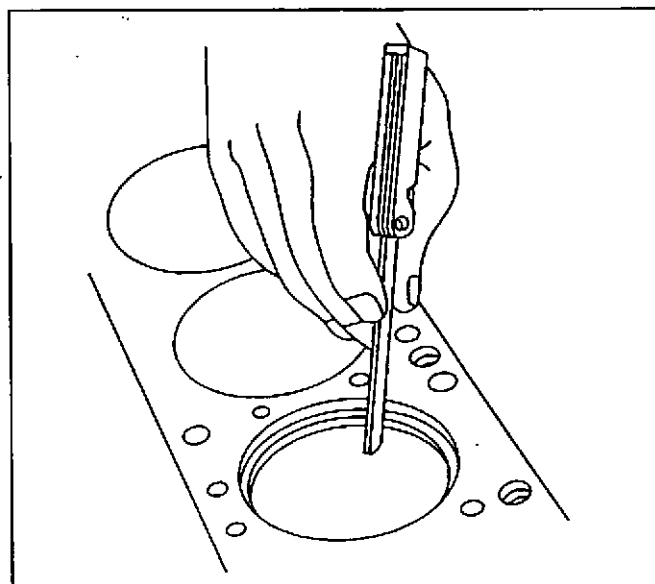


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17. Measure the piston compression ring end gap.

Important: Fit each piston compression ring to the cylinder in which it will be used.

- 17.1. Place the piston compression ring into the cylinder bore.
- 17.2. Push the piston compression ring into the cylinder bore to approximately 6.5 mm (0.25 in) above the piston ring travel. The piston ring must be square to the cylinder wall.
- 17.3. Use a feeler gage in order to measure the piston ring end gap. Select another size piston ring set if the piston ring end gap exceeds specifications.



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SIE-ID - 197522

Piston Selection

Tools Required

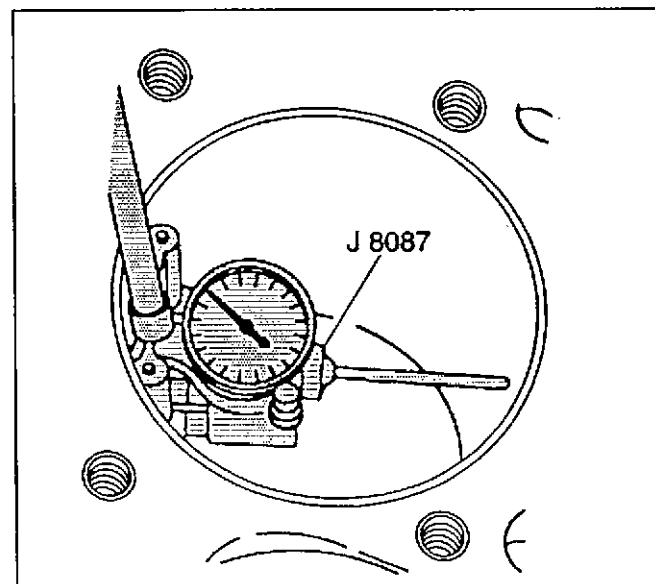
J 8087 Cylinder Bore Gauge

Important: Measurements of all components should be taken with the components at normal room temperature.

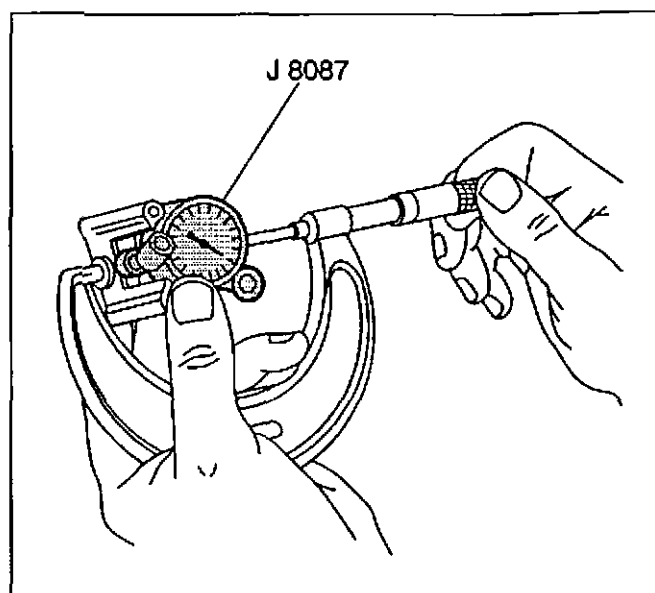
For proper piston fit, the engine block cylinder bores should not have excessive wear or taper.

A used piston and pin set may be reinstalled if, after cleaning and inspection, the piston and pin set are within specifications.

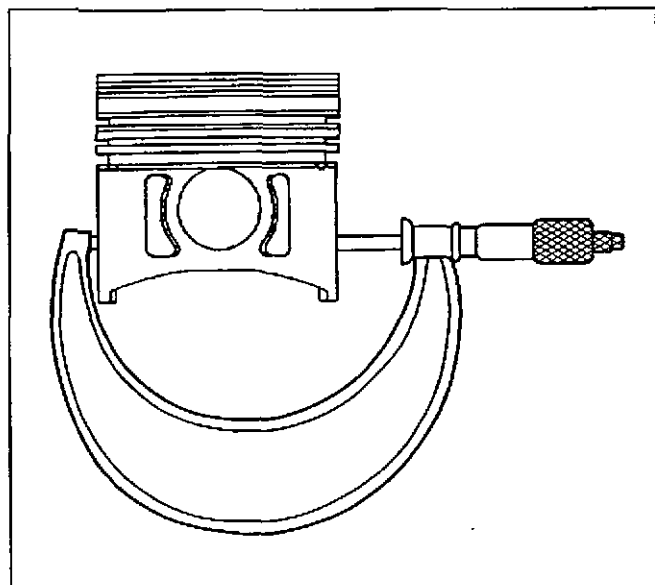
1. Inspect the engine block cylinder bore. Refer to *Engine Block Clean and Inspect*.
2. Inspect the piston and piston pin. Refer to *Piston, Connecting Rod and Bearings Clean/Inspect*.



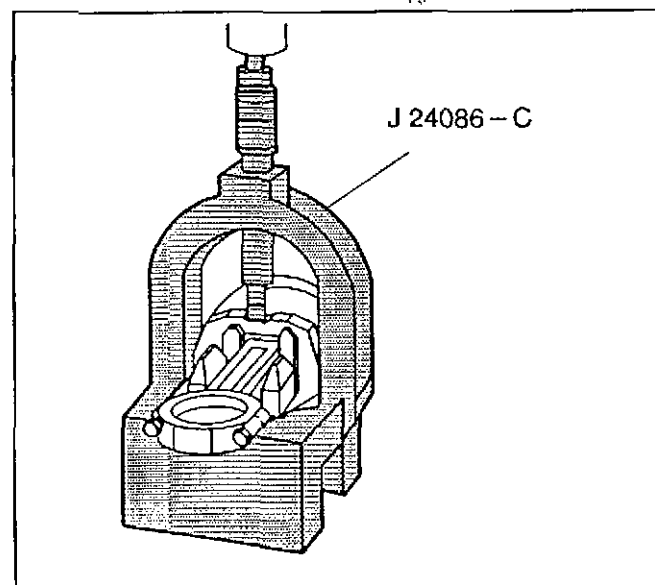
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3. Measure the J 8087 with a micrometer and record the reading.

4. With a micrometer or caliper at a right angle to the piston, measure the piston 11 mm (0.433 in) from the bottom of the skirt.

5. Subtract the piston diameter measurement from the cylinder bore diameter measurement in order to determine piston-to-bore clearance. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.

6. If the proper clearance cannot be obtained, select another piston and measure the clearances.

If the proper fit cannot be obtained, the cylinder bore may require honing or boring.

7. When the piston-to-cylinder bore clearance is within specifications, permanently mark the top of the piston for installation into the proper cylinder.

SIE-ID - 195097

Piston and Connecting Rod Assemble

Tools Required

J 24086-C Piston Pin Remover/Installer

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

Notice: SIO-ID - 38775 After the J 24086-C installer hub bottoms on the support assembly, DO NOT exceed 35 000 kPa (5,000 psi) or the tool may be damaged.

Important: When assembling the piston and connecting rod, the mark on the top of the piston must point to the front of the engine block. The left bank connecting rods should have the flange face toward the front of the engine block. The right bank connecting rods should have the flange face toward the rear of the engine block.

The piston pin has an interference fit into the connecting rod and is full floating in the piston.

1. Install the piston pin and connecting rod assembly.

- 1.1. Lubricate the piston and connecting rod pin bores with clean engine oil.
- 1.2. Press the piston pin into the piston and connecting rod assembly using the *J 24086-C*.
- 1.3. Inspect for the proper installation of the piston and piston pin.
The piston should move freely on the piston pin with no binding or interference.

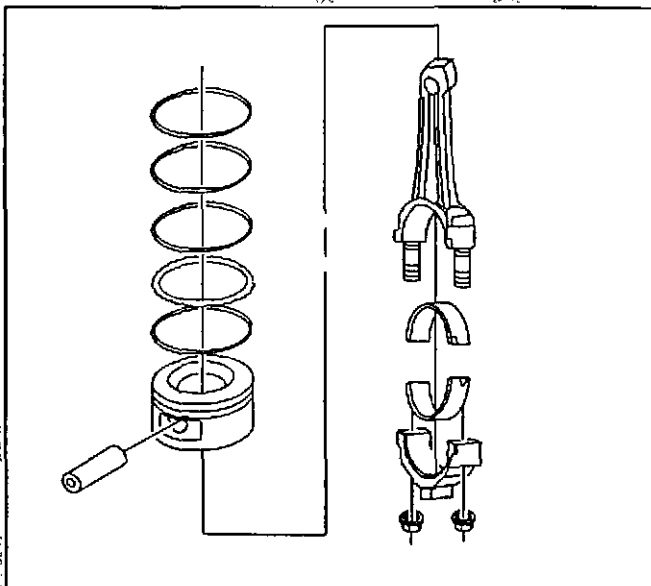
Notice: *S10-ID - 16608* Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

2. Install the piston rings onto the piston.

- 2.1. Install the oil control ring spacer.
- 2.2. Install the lower oil control ring.
- 2.3. Install the upper oil control ring.
- 2.4. Install the lower compression ring.
The mark on the side of the piston ring should face the top of the piston.
- 2.5. Install the upper compression ring.
The mark on the side of the piston ring should face the top of the piston.

3. Space the compression ring end gaps 120 degrees apart.

4. Space the oil control ring end gaps a minimum of 90 degrees apart.



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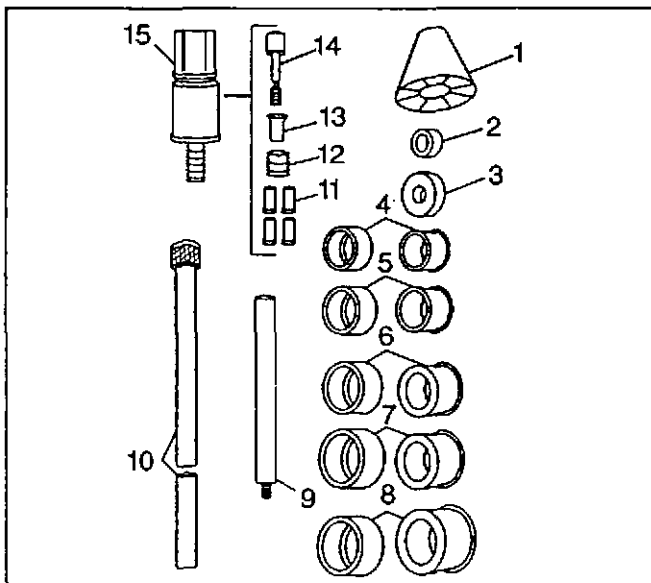
S1E-ID - 195130

Camshaft Bearing Removal

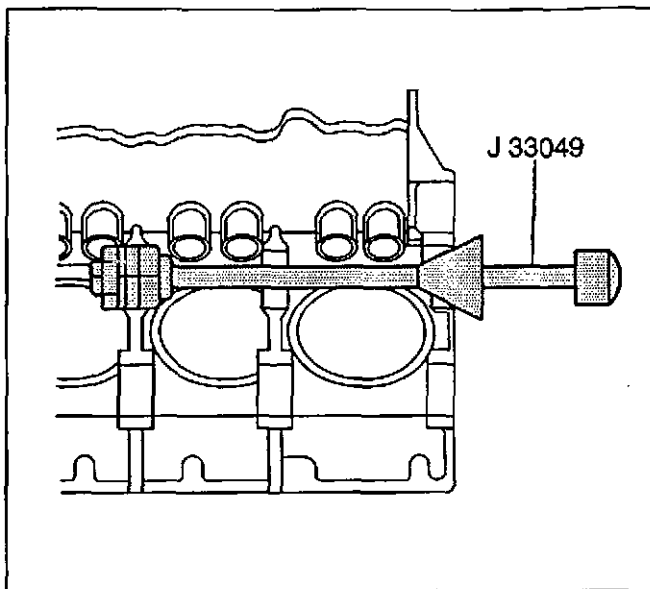
Tools Required

J 33049 Camshaft Bearing Service Set

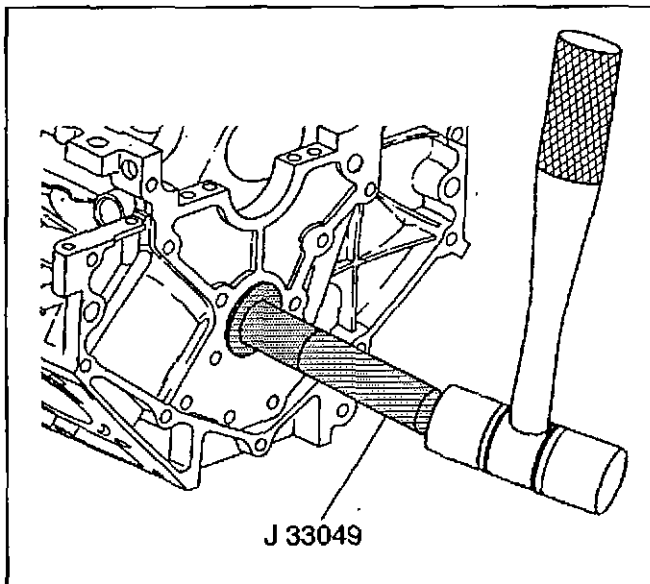
1. Select the cone (1), handle (10), expanding driver (4-8), and the washers (2 and 3) from the *J 33049*.
2. Assemble the *J 33049*.



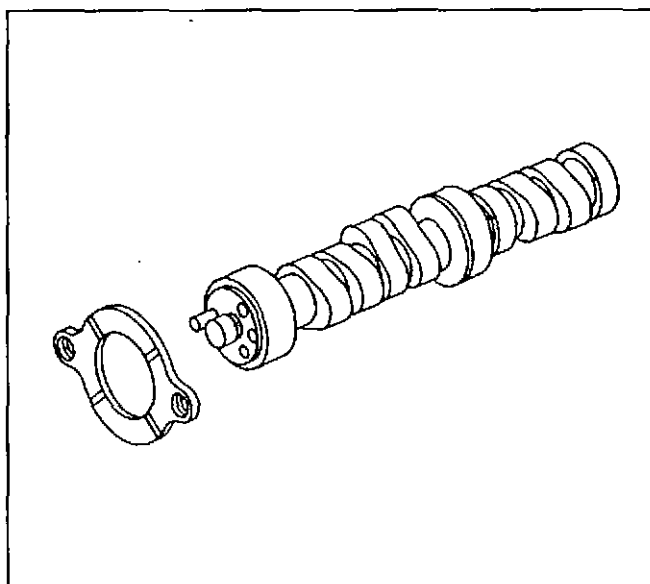
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Important: A loose camshaft bearing may be caused by an enlarged, out-of-round, or damaged engine block camshaft bearing bore.

3. Prior to camshaft bearing removal, inspect the camshaft bearings for loose fit in the engine block camshaft bearing bores.

Important: Remove the inner camshaft bearings #2, #3, and #4 first. The outer camshaft bearings #1 and #5 serve as a guide for the J 33049.

4. Insert the J 33049 through the front of the engine block and into the camshaft bearing.
5. Tighten the expander assembly nut until snug.
6. Push the guide cone into the front camshaft bearing to align the J 33049.
7. Drive the inner camshaft bearings from the camshaft bearing bores.
8. Assemble the J 33049 handle, the expanding driver, and the washer.
9. Insert the J 33049 into the engine block end camshaft bearings #1 or #5.
10. Remove the camshaft bearings from the camshaft bearing bores using the J 33049.

SIE-ID - 32312

Camshaft and Bearings Clean and Inspect

Tools Required

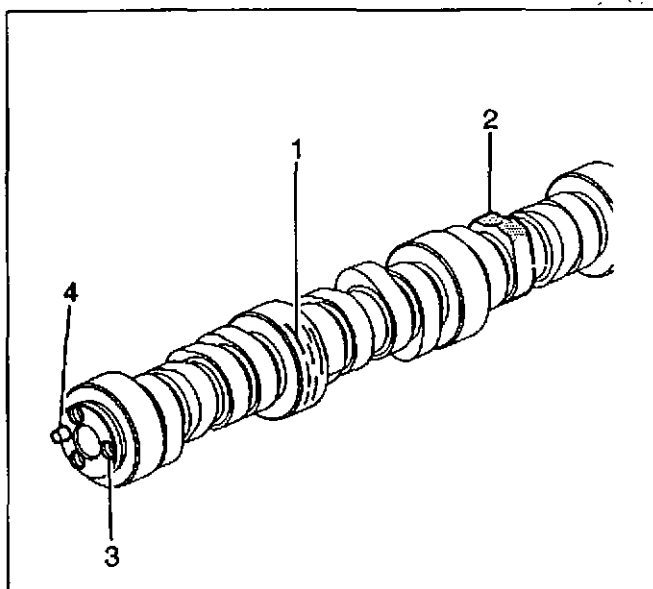
J 7872 Magnetic Base Dial Indicator

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the engine camshaft in cleaning solvent.
2. Dry the engine camshaft with compressed air.
3. Inspect the camshaft retainer plate for damage.

4. Inspect the engine camshaft for the following:

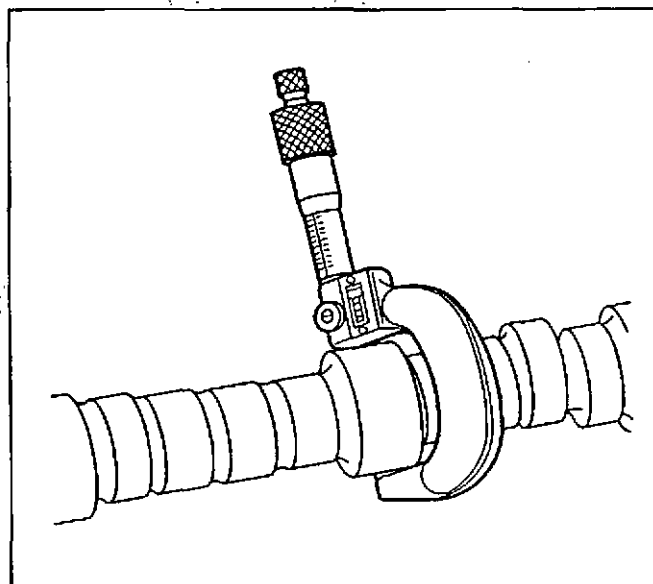
- Worn, scored, or damaged bearing journals (1)
- Worn engine camshaft lobes (2)
- Damaged bolt hole threads (3)
- Damaged camshaft sprocket locator pin (4)



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5. Measure the engine camshaft journals with a micrometer.

If the camshaft journals are more than 0.025 mm (0.0010 in) out-of-round, then replace the engine camshaft.



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6. Measure for a bent engine camshaft or excessive engine camshaft runout using the J 7872.

6.1. Mount the engine camshaft in a suitable stand between centers.

6.2. Use the J 7872 in order to check the intermediate engine camshaft journals.

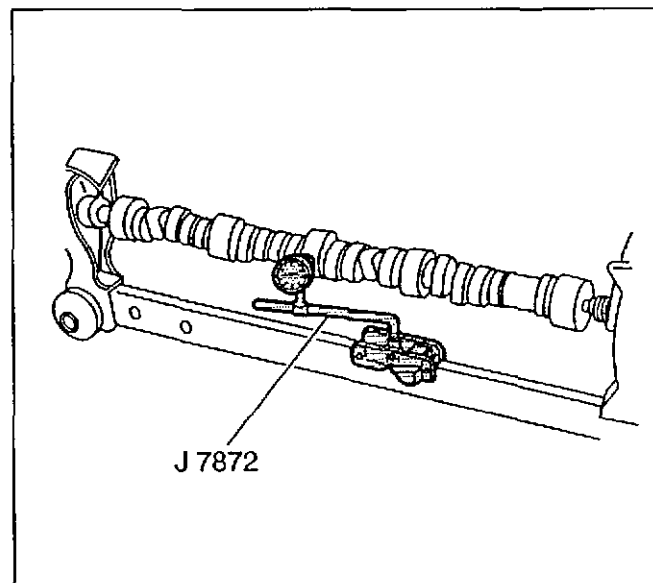
If the runout exceeds 0.065 mm (0.0026 in), the engine camshaft is bent and should be replaced.

7. Measure the engine camshaft lobe lift using the J 7872.

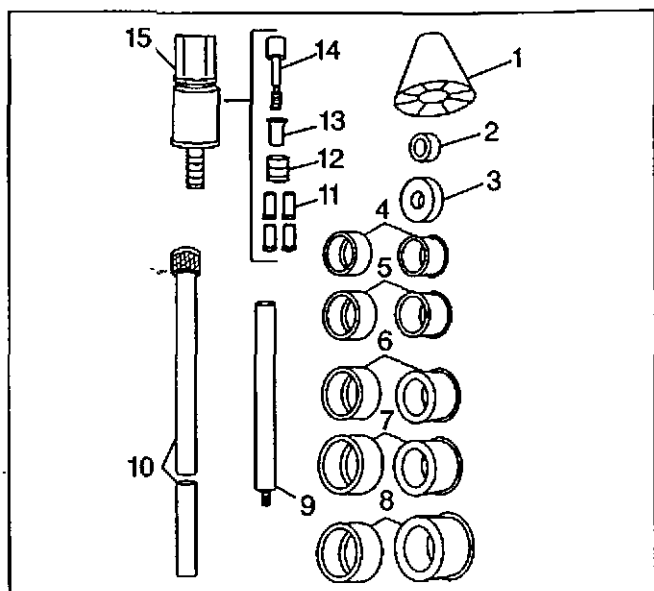
7.1. Place the engine camshaft on the V-blocks.

7.2. Use the J 7872 in order to measure the engine camshaft lobe lift.

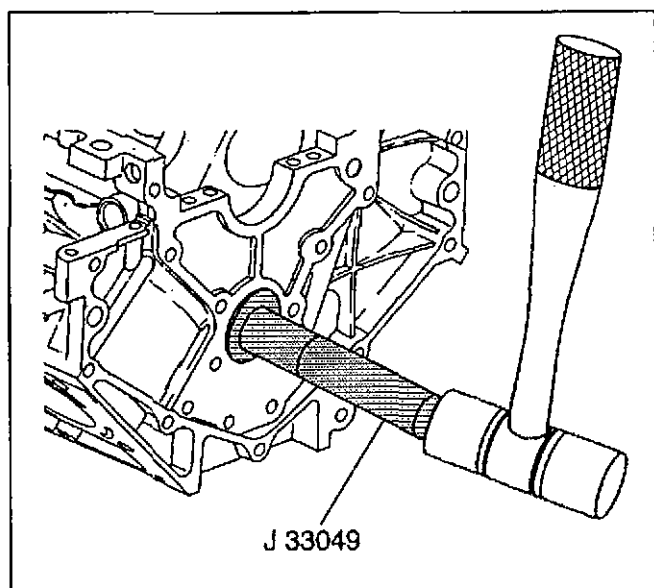
8. Replace the engine camshaft if the engine camshaft lobe lift is not within specifications.



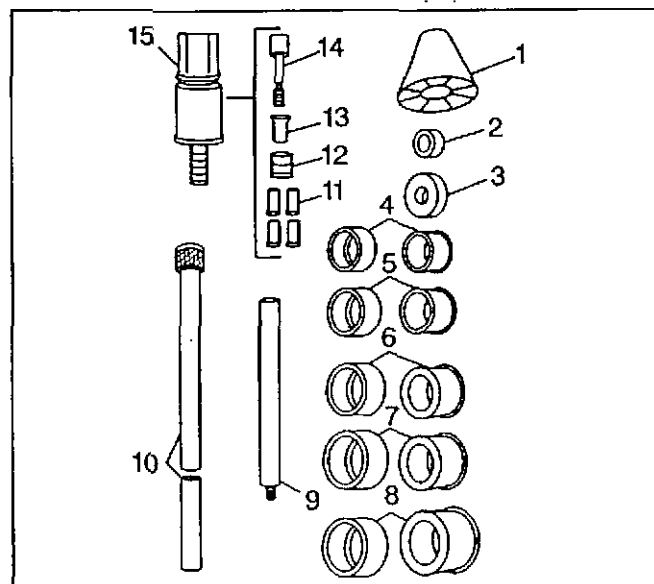
188012



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63219



66100

SIE-ID = 195136

Camshaft Bearing Installation

Tools Required

J 33049 Camshaft Bearing Service Set

1. Assemble the *J 33049* handle, the expanding driver, and the washer.

Important: The outer camshaft bearings #1 and #5 must be installed first. These camshaft bearings serve as guides for the *J 33049* and help center the inner camshaft bearings during the installation process.

Ensure the correct camshaft bearing fits into the proper bore. The camshaft bearing bores may vary in size.

Ensure that the camshaft bearing lubrication hole or holes align with the oil gallery hole or holes in the engine block. On some engines, the oil holes may be difficult to see. Verify that the holes are aligned.

An improperly aligned camshaft bearing oil gallery hole will restrict oil flow to the camshaft bearing and the engine camshaft journal.

2. Install the camshaft bearing #1 into the engine block camshaft bearing bore using the *J 33049*
3. Install the camshaft bearing #5 into the engine block camshaft bearing bore using the *J 33049*.
4. Select the expanding driver (4–8) and washer (2 and 3) using *J 33049*.
5. Assemble the *J 33049*.

6. Insert the *J 33049* through the front of the engine block and to the inner camshaft bearing bores #2, #3, and #4.
7. Install the camshaft bearing onto the expanding driver.
8. Tighten the expander assembly nut until the *J 33049* is snug in the camshaft bearing.

Important: The camshaft bearing oil holes must align with the oil galleries in the engine block.

After installation of the camshaft bearings, inspect the camshaft bearing oil holes for proper alignment with the oil galleries.

An improperly aligned camshaft bearing oil gallery hole will restrict oil flow to the camshaft bearing and the engine camshaft journal.

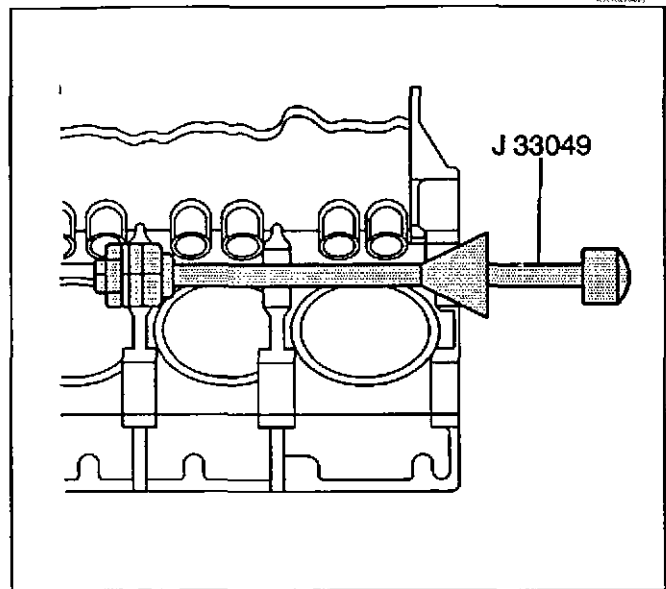
9. Align the oil lubrication hole in the camshaft bearing with the oil galleries in the engine block.
10. Push the guide cone into the front camshaft bearing bore to align the *J 33049*.
11. Drive the camshaft bearing into the engine block camshaft bearing bore.
12. Remove the *J 33049*.

SIE-ID - 195154

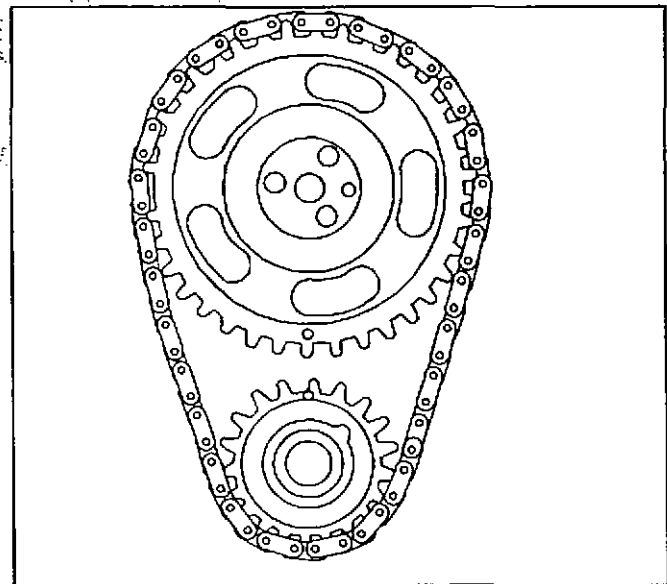
Timing Chain and Sprockets Clean and Inspect

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

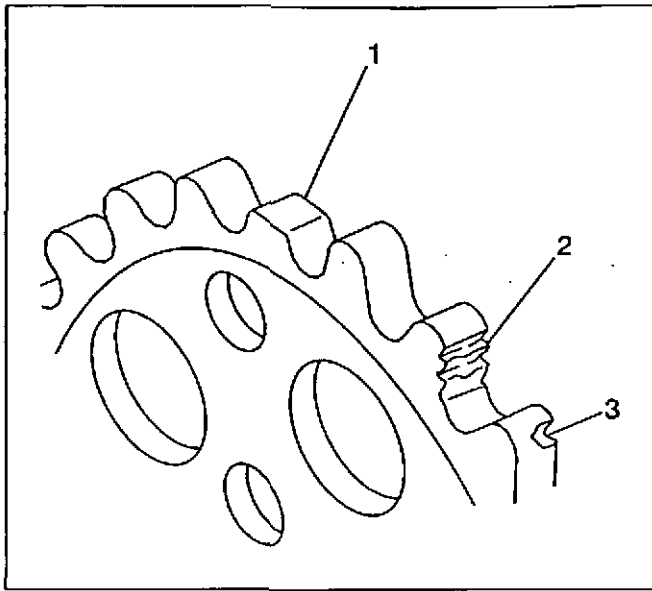
1. Clean the components in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the camshaft timing chain for binding or wear.



4985

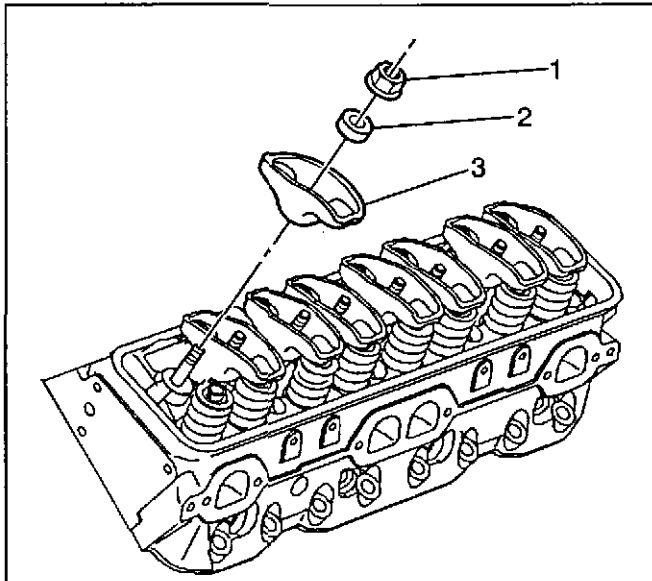


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188097

4. Inspect the camshaft and crankshaft sprockets for:
- Broken teeth (1)
 - Damaged teeth (2)
 - Chipped teeth (3)
 - Worn teeth
 - Uneven wear on one edge of the teeth
 - Worn valleys between the sprocket teeth
 - Crankshaft sprocket keyway for wear
 - Woodruff key (crankshaft sprocket) for wear or damage



182835

SIE-ID - 195201

Valve Rocker Arm and Push Rods Clean and Inspect

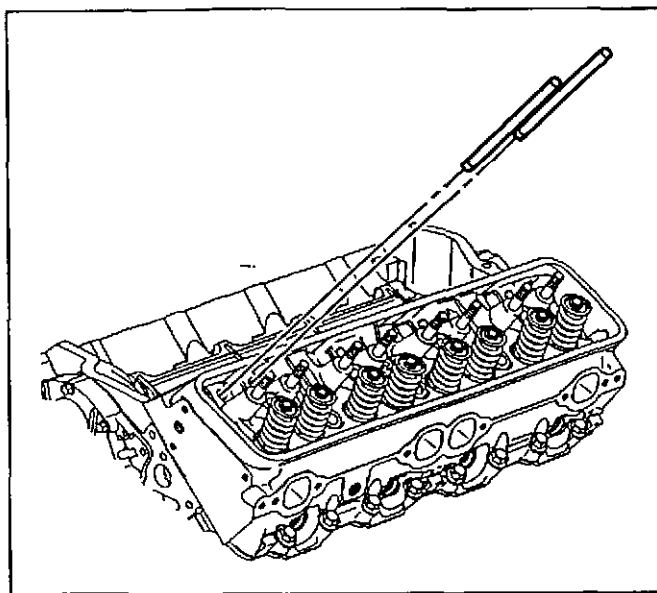
Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

Important: Parts that are to be reused must be marked, sorted and organized for assembly.

1. Mark, sort, and organize the components for assembly.
2. Clean the components with cleaning solvent.
3. Dry the components with compressed air.
4. Inspect the valve rocker arms (3) for wear or scoring in the ball area.
5. Inspect the valve rocker arm (3) pushrod sockets and valve stem mating surfaces for wear or scoring.
6. Inspect the valve rocker arm ball (2) for wear or scoring.

The surfaces should be smooth with no scoring or exceptional wear.

7. Inspect the valve pushrods for worn or scored ends.
The surfaces should be smooth with no scoring or exceptional wear.
8. Inspect the valve pushrods for bends. Roll the valve pushrod on a flat surface to determine if the valve pushrod is bent.
9. Inspect the valve pushrod oil passages for restrictions.



22766

SIE-ID - 195248

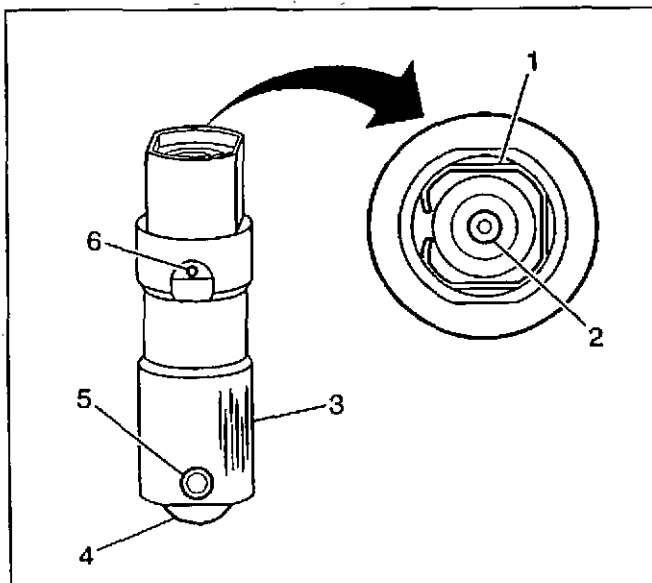
Valve Lifters and Guides Clean and Inspect

Caution: SIO-ID - 5011 Wear safety glasses in order to avoid eye damage.

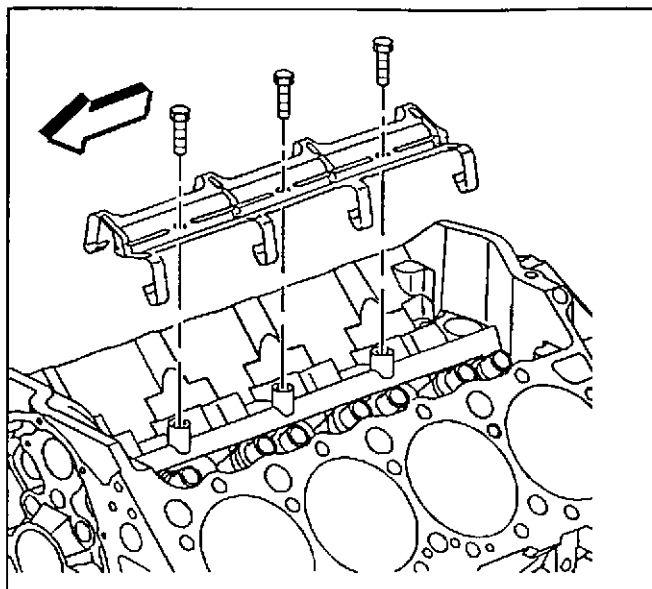
Important: Components that are to be reused must be marked, sorted, and organized for assembly.

1. Mark, sort, and organize the components for assembly.
2. Clean the components in cleaning solvent.
3. Dry the components with compressed air.
4. Inspect the valve lifter for the following:
 - Broken or damaged clip (1)
 - Worn valve pushrod socket (2)
 - Wear or scuffing (3)
 - Worn roller (4)
 - Loose or damaged pin (5)
 - Plugged oil hole (6)

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

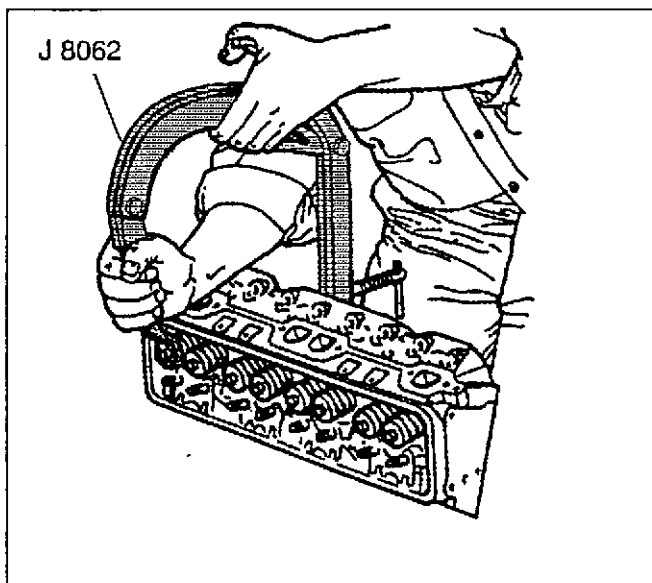


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5. Inspect the valve lifter guides for excessive wear.
6. Inspect the valve lifter guides for cracks or damage.
7. Inspect the valve lifter guide retainer for:
 - Wear, damage, or stress cracking in the leg areas
 - Wear or damage in the bolt holes



34468

SIE-ID = 195340

Cylinder Head Disassemble

Tools Required

J 8062 Valve Spring Compressor

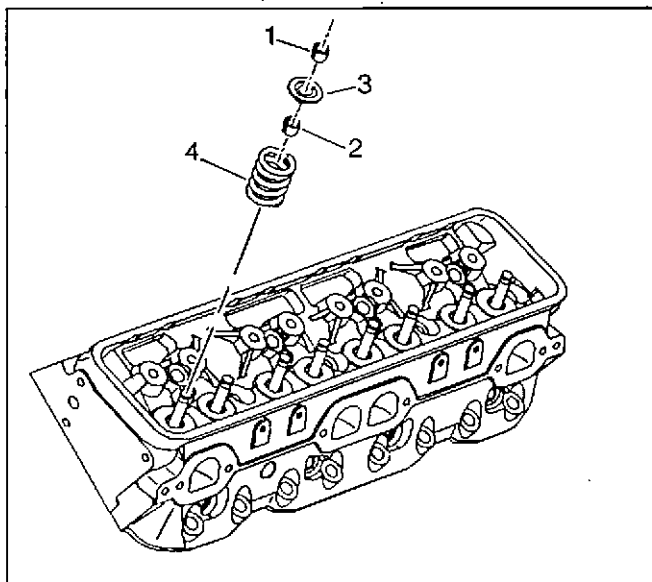
Caution: SIO-ID = 411464 Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

Caution: SIO-ID = 5011 Wear safety glasses in order to avoid eye damage.

1. Use the J 8062 in order to compress the valve springs.

Important: Place the valves in a rack, in the proper sequence, so that the valves can be installed in the same order as the valve were removed.

2. Remove the valve stem keys (1).
3. Remove the J 8062 from the cylinder head.
4. Remove the valve spring cap (3).
5. Remove the valve spring (4).
6. Remove the valve stem oil seal (2).
7. Discard the valve stem oil seal.
8. Remove the valve.



69538

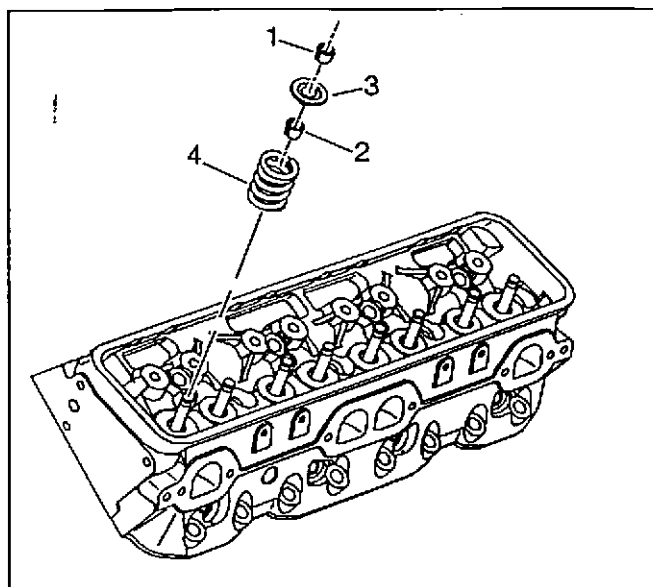
SIE-ID - 69089

Cylinder Head Clean and Inspect**Tools Required**

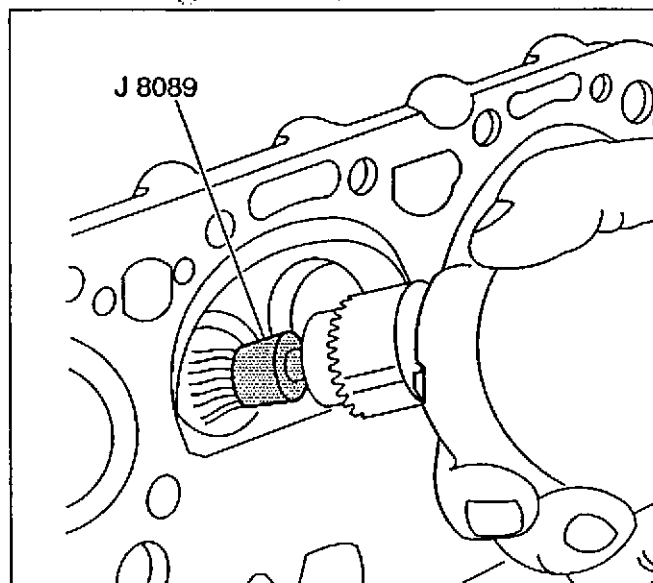
- J 8001 Dial Indicator Set
- J 8089 Carbon Removing Brush
- J 9666 Valve Spring Tester

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

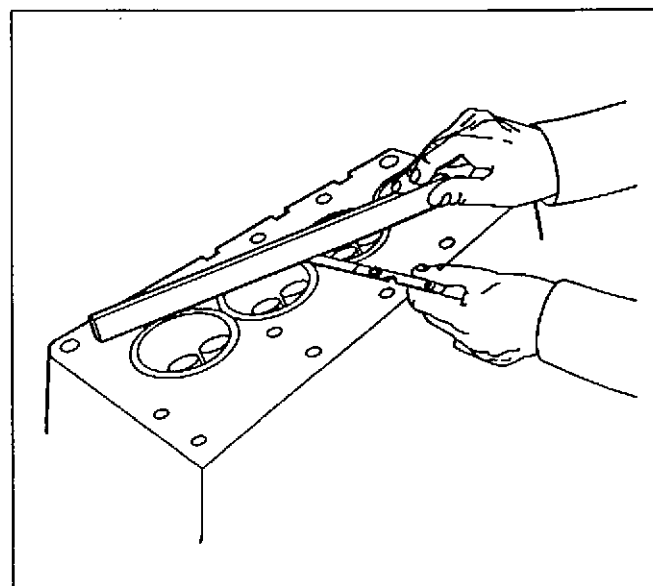
1. Clean the valve stems and cylinder heads on a buffing wheel.
2. Clean the following components in cleaning solvent:
 - Valve stem keys (1)
 - Valve spring cap (3)
 - Valve spring (4)
 - Cylinder head
3. Dry the components with compressed air.
4. Use the J 8089 to clean the carbon from the cylinder head combustion chambers. Be careful not to scuff the combustion chambers.
5. Inspect the cylinder head for the following:
 - Damage to the gasket surfaces
 - Damage to the threaded bolt holes
 - Burnt or eroded areas in the combustion chamber
 - Cracks in the exhaust ports and combustion chambers
 - External cracks in the water chamber
 - Restrictions in the intake or exhaust passages
 - Restrictions in the cooling system passages
 - Rusted, damaged, or leaking core plugs
6. Measure the cylinder head for warpage with a straight edge and feeler gauge.
 - A cylinder head block deck with warpage in excess of 0.10 mm (0.004 in) within a 152.4 mm (6.0 in) area must be repaired or replaced.
 - A cylinder head exhaust manifold deck with warpage in excess of 0.5 mm (0.002 in) must be repaired or replaced.
 - A cylinder head intake manifold deck with warpage in excess of 0.10 mm (0.004 in) must be repaired or replaced.



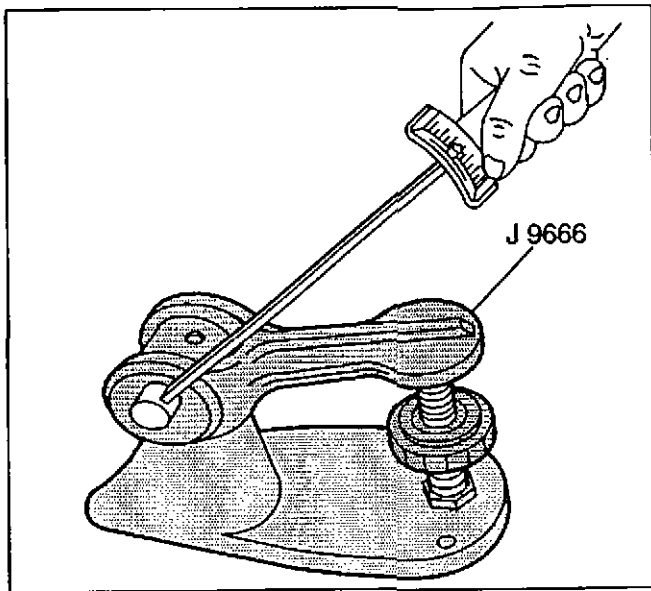
69538



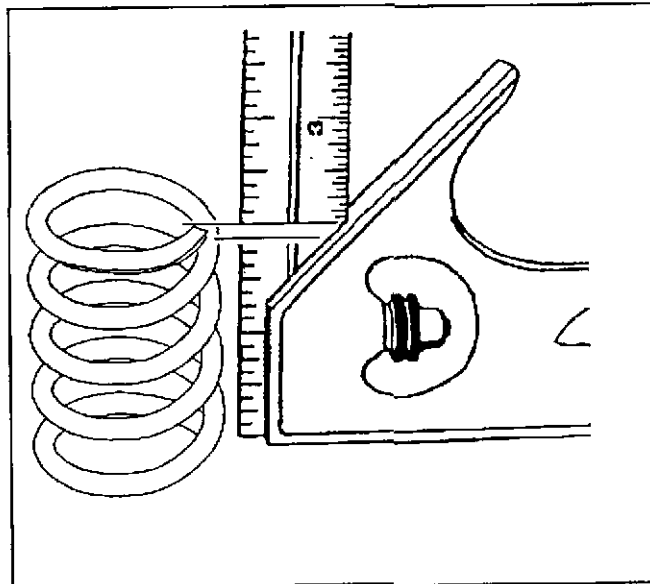
4957



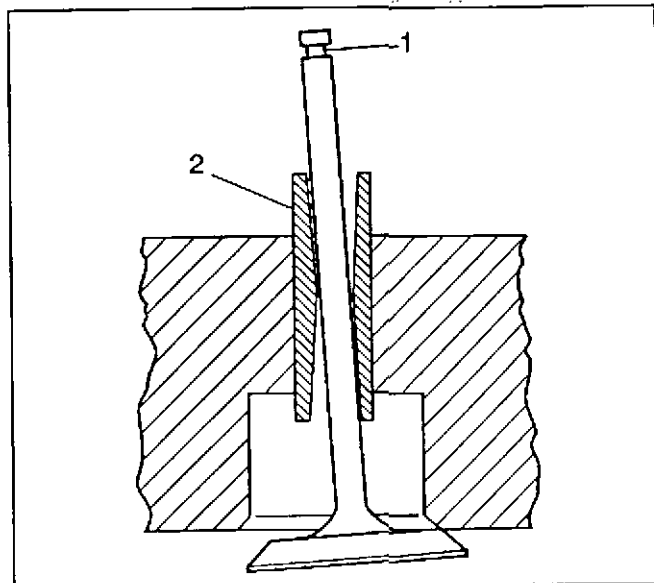
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7. Use the J 9666 in order to measure the valve spring.

Replace the valve spring if the valve spring tension is less than 338 N (76 lb) at 43.2 mm (1.70 in).

8. Inspect the valve springs for squareness.

9. Valve stems (1) with excessive guide (2) clearance must be repaired or replaced.

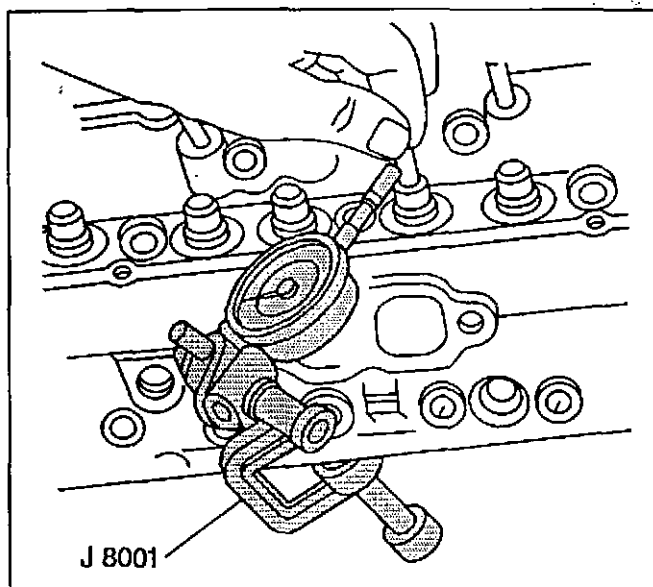
10. Measure the valve stem-to-guide clearance.

Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.

- 10.1. Clamp the *J 8001* on the exhaust port side of the cylinder head.
- 10.2. Locate the dial indicator so that the movement of the valve stem from side to side (crosswise to the cylinder head) will cause a direct movement of the dial indicator stem.

The dial indicator stem must contract the side of the valve stem just above the valve guide.

- 10.3. Drop the valve head about 1.6 mm (0.063 in) off the valve seat.
- 10.4. Use light pressure and then move the valve stem from side to side in order to obtain a clearance reading. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.



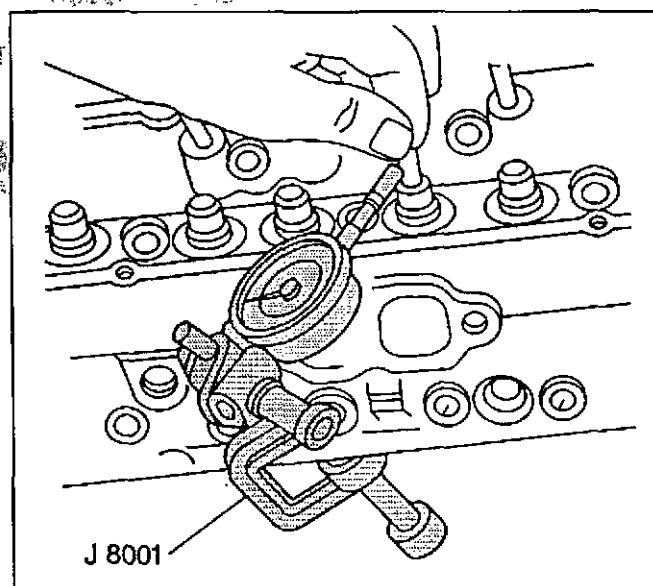
35214

SIE-ID - 69806

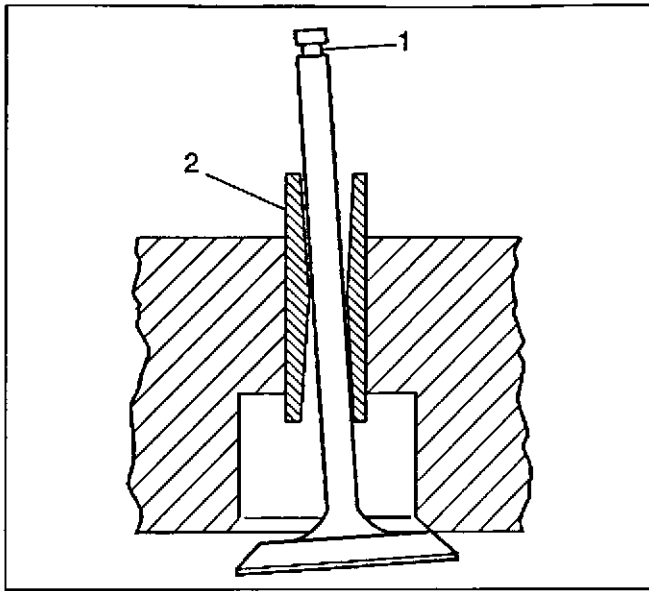
Valve Guide Reaming/Valve and Seat Grinding**Tools Required**

J 8001 Dial Indicator Set

1. Measure the valve stem-to-guide clearance.
Refer to *Cylinder Head Clean and Inspect*.

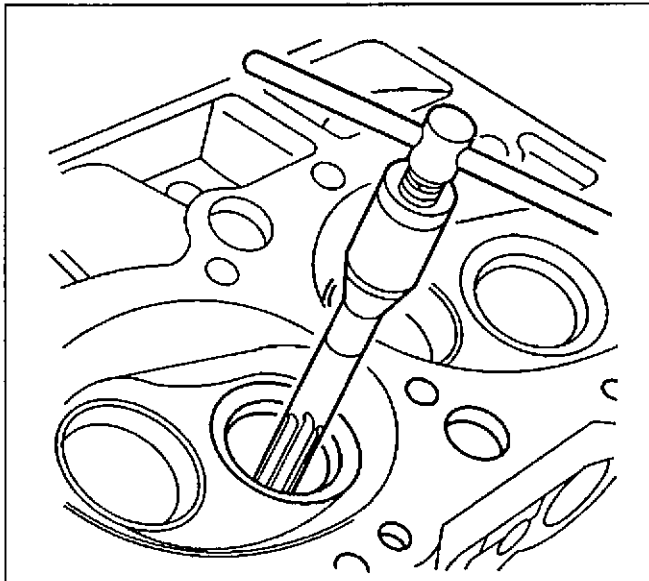


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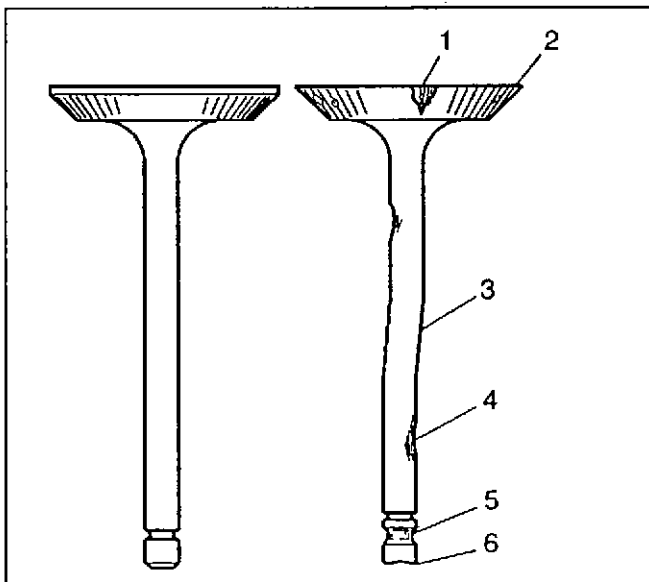
2. Improper valve stem (1) to valve guide (2) clearance may cause excessive oil consumption.



4956

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

3. Ream the valve guide as necessary to achieve proper valve stem-to-guide clearance.
 - 3.1. Ream the valve guide oversize to accept a valve guide sleeve.
 - 3.2. Insert the valve guide sleeve into the valve guide bore.
 - 3.3. Ream the sleeve to achieve proper valve stem-to-guide clearance.
4. Always recondition the valve and the valve seat after reaming the valve guide bores or installing new valves.



156174

5. Inspect the valves for the following:
 - Burnt or damaged areas (1)
 - Undersized margin (2)
 - Bent stem (3)
 - Scoring or other damage to the stem (4)
 - Worn key groove (5)
 - Worn stem tip (6)

6. Inspect the valve contact surface for the following:

- Undersized margin (1)
- Pitted surface (2)
- Burnt or eroded areas (3)
- Acceptable edge (margin) (4)

Valves with excessive damage must be replaced.

Minor imperfections of the valve or valve seat may be repaired.

7. Reconditioning of the valves and valve seats:

- The valves must seat perfectly for the engine to deliver optimum power and performance.
- Cooling the valve heads is another important factor. Good contact between each valve and valve seat in the cylinder head is necessary to insure that the heat in the valve head is properly carried away.
- Regardless of what type of equipment is used, it is essential that the valve guide bores are free from carbon or dirt to ensure the proper centering of the pilot in the valve guide.

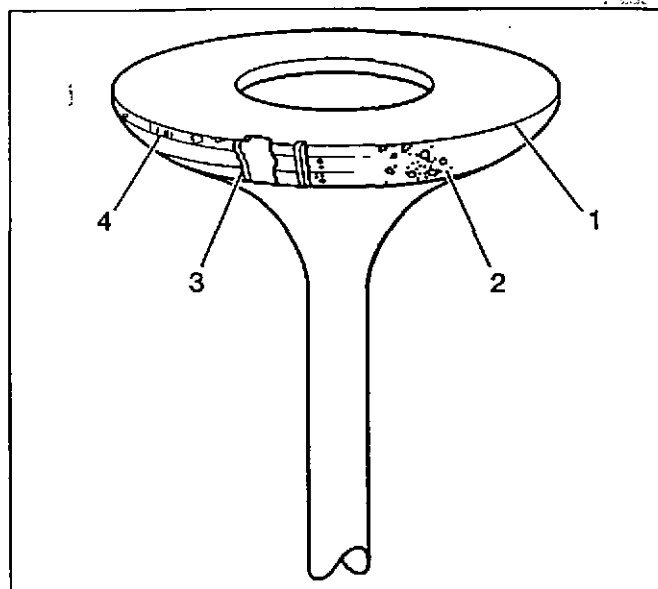
The valve seats should be concentric to within 0.05 mm (0.031 in) total indicator reading.

- Reface pitted valves on a valve refacing machine in order to insure the correct relationship between the valve head and the valve stem.

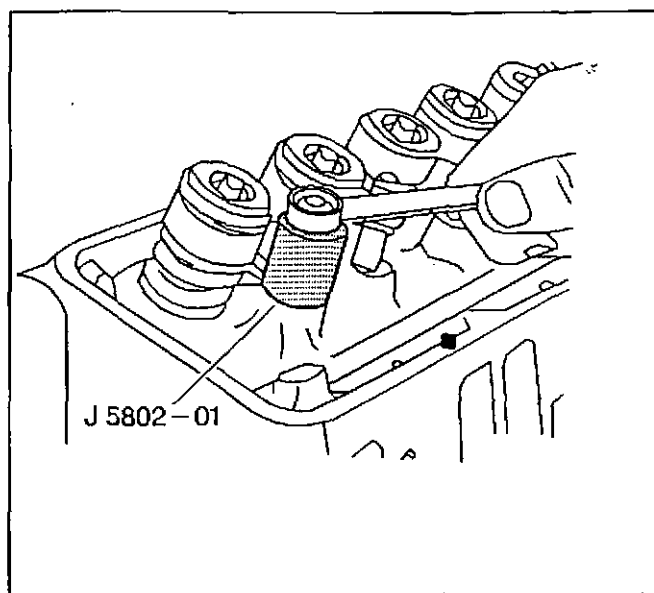
Replace the valve stems that show excessive wear or are warped.

Replace the valve if the edge of the valve head is less than 0.79 mm (0.031 in) thick after grinding.

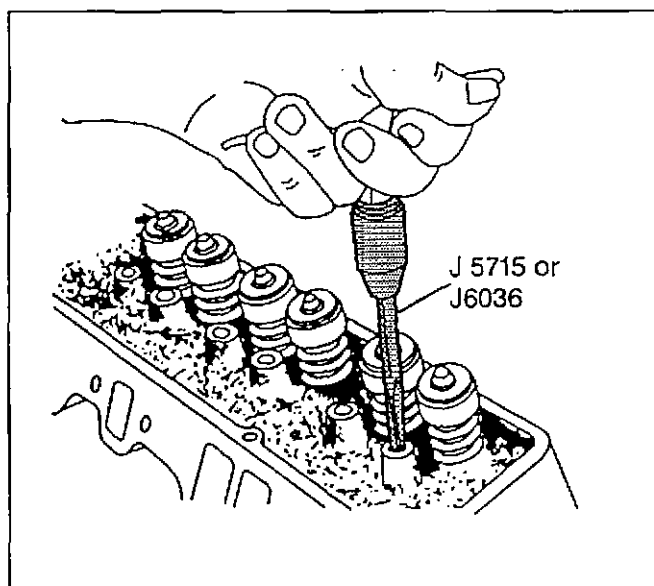
- Several different types of equipment are available for reconditioning valves and valve seats. Follow the manufacturer's recommendations for equipment use to attain the proper results.



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SIE-ID - 195352

Valve Rocker Arm Stud Removal

Tools Required

J 5802-01 Rocker Arm Stud Remover

Valve rocker arm ball studs that have damaged threads or are loose in cylinder heads should be replaced.

Valve rocker arm ball studs are pressed into the cylinder head.

New valve rocker arm ball studs are available in 0.0762 mm (0.003 in) and 0.3302 mm (0.013 in) oversize.

1. Place the J 5802-01 over the valve rocker arm ball stud to be removed.
2. Install a nut and a flat washer.
3. Rotate the nut clockwise to remove the valve rocker arm ball stud.

SIE-ID - 195354

Valve Rocker Arm Stud Installation

Tools Required

- J 5715 Reamer (0.0762 mm (0.003 in))
- J 6036 Reamer (0.03302 mm (0.013 in))
- J 5802-01 Rocker Arm Stud Installer

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

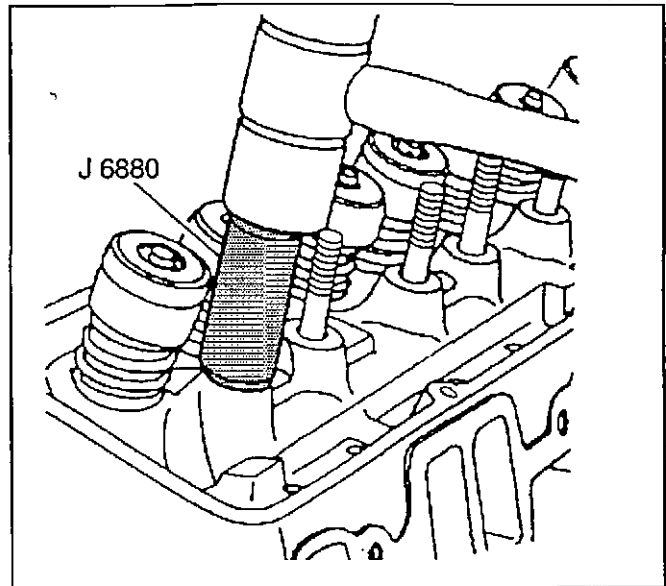
Important: Valve rocker arm ball studs that have damaged threads or are loose in cylinder heads should be replaced. New valve rocker arm ball studs are available in 0.0762 mm (0.003 in) and 0.3302 mm (0.013 in) oversize.

1. Ream the hole to the proper size for the replacement oversize valve rocker arm ball stud.

Use J 5715 for 0.0762 mm (0.003 in) oversize valve rocker arm ball studs, or J 6036 for 0.3302 mm (0.013 in) oversize valve rocker arm ball studs.

2. Apply lubricant GM P/N 1052271 or equivalent the lower end (press-fit end) of the valve rocker arm ball stud.

3. Use the *J 6880* and a hammer to install the valve rocker arm ball stud into place.
The valve rocker arm ball stud is installed to proper depth when the *J 6880* bottoms onto the cylinder head.



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SIE-ID - 195342

Cylinder Head Assemble

Tools Required

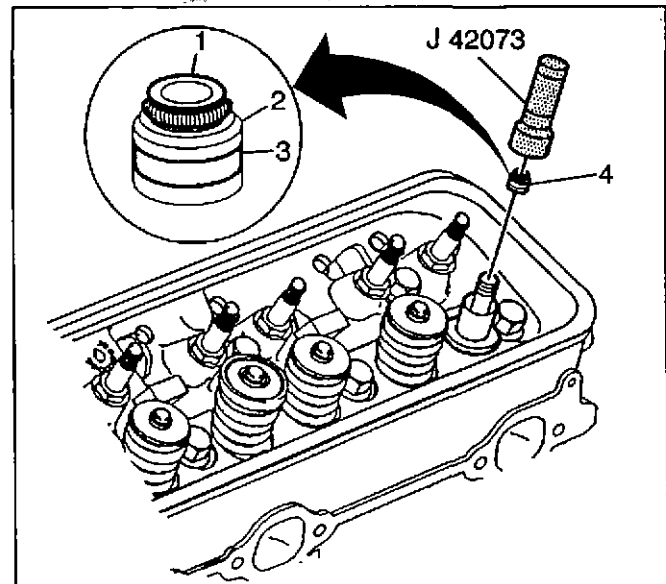
- *J 8062* Valve Spring Compressor
- *J 42073* Valve Stem Seal Installer

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

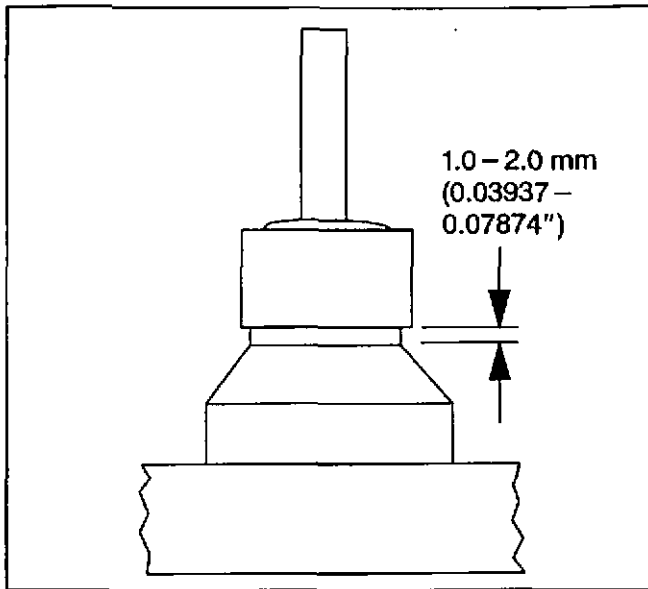
Important: The exhaust valve oil stem seal has the letters EX (1) molded into the top of the seal. The exhaust valve oil stem seal material is brown in color (2) with a white stripe (3) painted onto the outside diameter of the seal.

1. Assemble the valve into the proper valve guide.
2. Select the proper valve stem oil seal for the specific valve guide.
3. Lubricate the valve stem oil seal and guide with clean engine oil GM P/N 12345610 or equivalent.
4. Assemble the valve stem oil seal onto the valve stem.
5. Install the valve stem oil seal onto the valve guide using the *J 42073*.

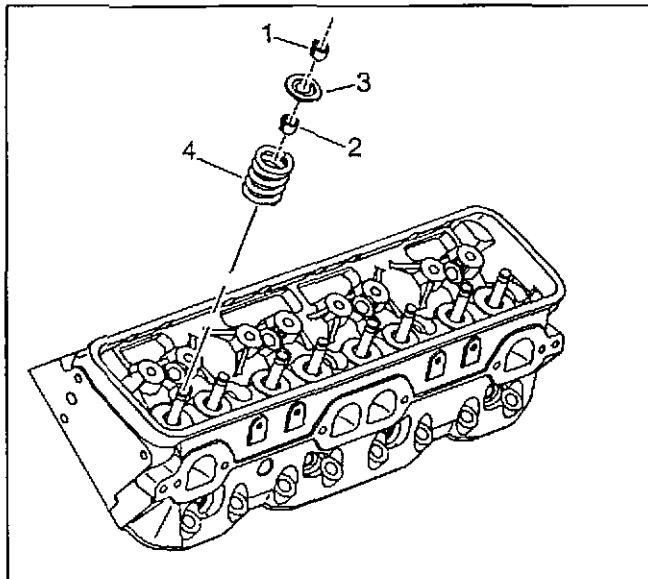
Install the valve stem oil seal onto the valve guide until the *J 42073* bottoms against the valve spring seat.



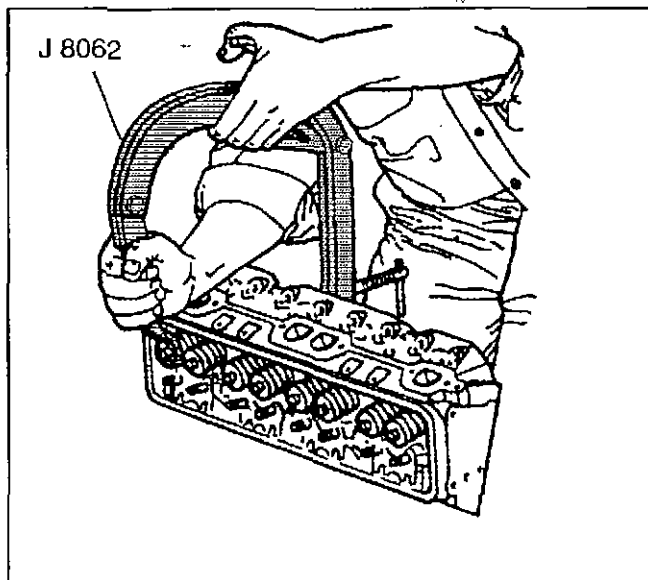
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6. Inspect the valve stem oil seal. The valve stem oil seal should not be bottomed against the valve guide.

There should be a 1-2 mm (0.03937-0.07874 in) gap between the bottom edge of the valve stem oil seal and the valve guide.

7. Install the valve spring (4).

8. Install the valve spring cap (3) onto the valve spring (4) and over the valve stem.

Caution: SIO-ID - 411464 *Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.*

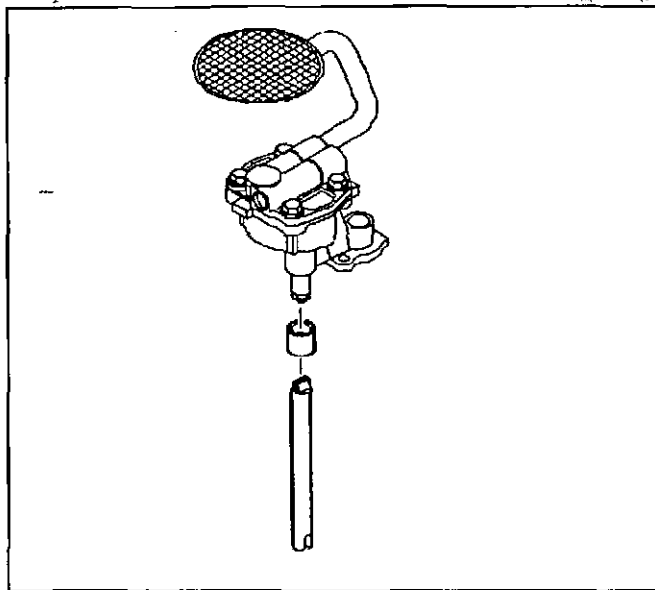
9. Use the J 8062 in order to compress the valve spring.
10. Install the valve stem keys.
 - 10.1. Use grease in order to hold the valve stem keys in place while disconnecting the J 8062.
 - 10.2. Ensure that the valve stem keys seat properly in the upper groove of the valve stem.
 - 10.3. Tap the end of the valve stem with a

plastic-faced hammer in order to seat the valve stem keys, if necessary.

SIE-ID - 195049

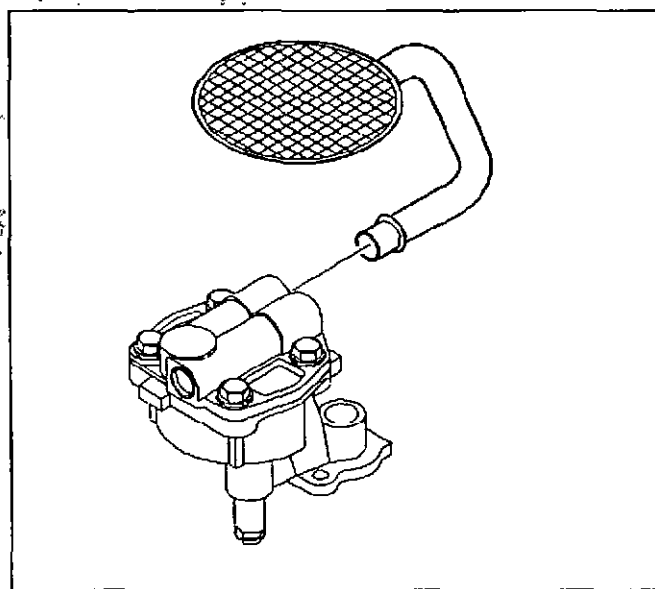
Oil Pump Disassemble

1. Remove the oil pump driveshaft and oil pump driveshaft retainer.

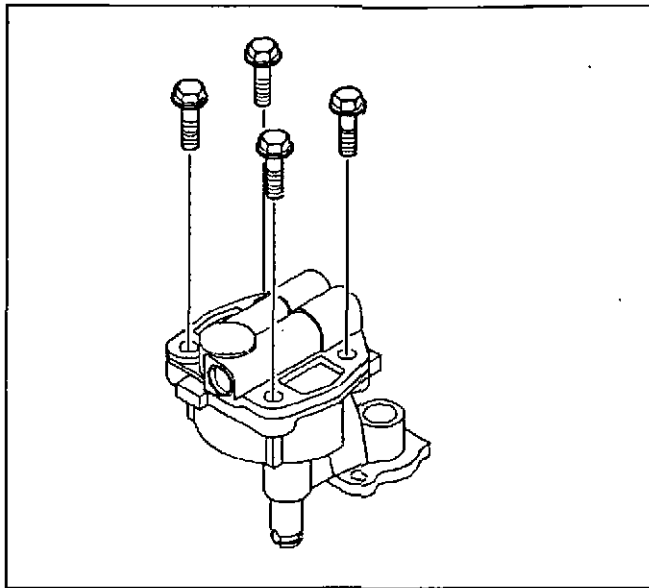


5274

2. Remove the oil pump screen (If necessary).
 - The oil pump screen has a press fit into the oil pump cover.
 - DO NOT remove the oil pump screen from the pipe. The pipe and oil pump screen are serviced as a complete assembly.

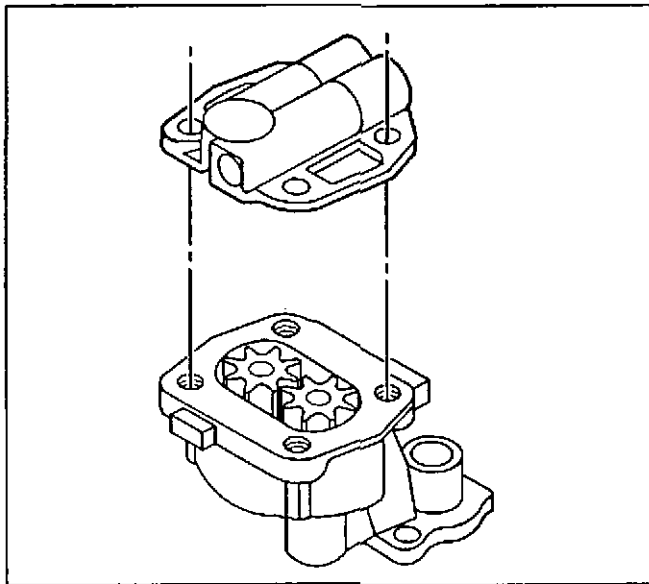


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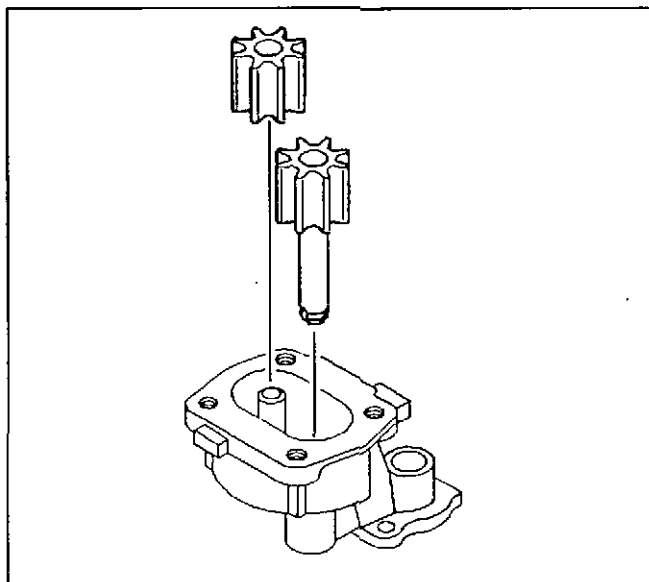
5276

3. Remove the oil pump cover bolts.



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4. Remove the oil pump cover.



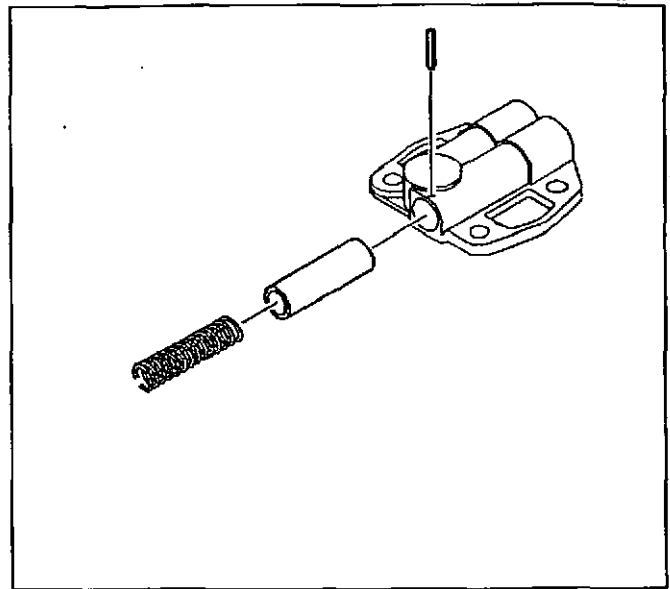
5278

5. Remove the oil pump drive gear and the oil pump driven gear.

6. Matchmark the gear teeth for assembly.

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

7. Remove the following items:
 - 7.1. The oil pump pressure relief valve spring straight pin
 - 7.2. The oil pump pressure relief spring
 - 7.3. The oil pump pressure relief valve



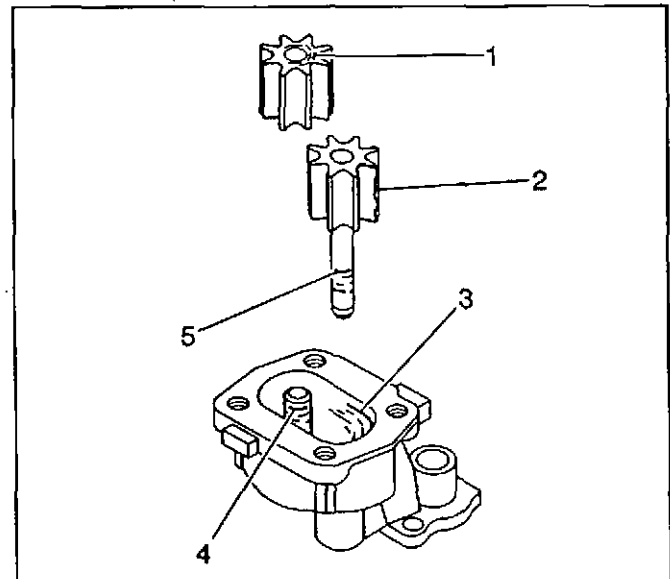
30401

SIE-ID - 35473

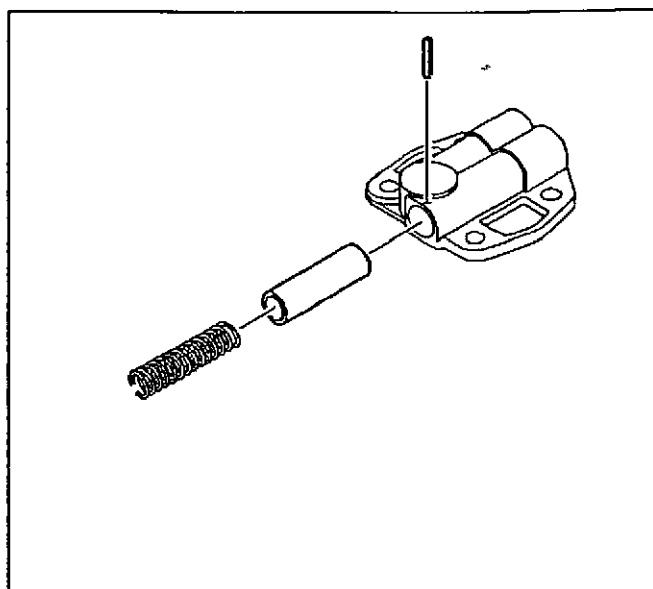
Oil Pump Clean and Inspect

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

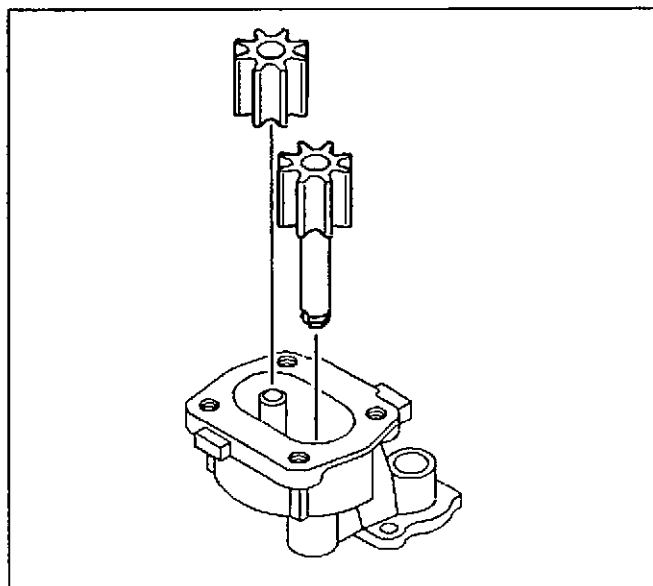
1. Clean the oil pump components in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the oil pump for the following conditions:
 - Scoring, damage or casting imperfections to the body (3)
 - Damaged gears (2) for
 - Chipping
 - Galling
 - Wear
 - Scoring on the top of the gears (1)
 - Damaged or scored gear shaft (5)
 - Damaged bolt hole threads
 - Worn oil pump driveshaft bore
 - Damaged or sticking oil pump pressure relief valve (minor imperfections may be removed with a fine oil stone).
 - Collapsed or broken oil pump pressure relief valve spring
4. If the oil pump is to be reused, install a NEW oil pump pressure relief valve spring.
5. During oil pump installation, install a NEW oil pump driveshaft retainer.



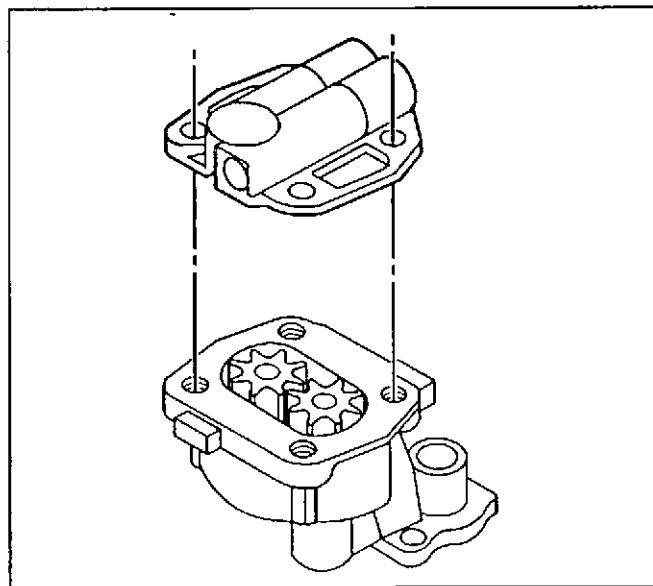
186750



30401



5278



5277

SIE-ID = 389671

Oil Pump Assemble

Tools Required

J 21882 Oil Suction Pipe Installer

1. Apply clean engine oil GM P/N 12345610 or equivalent to the oil pump pressure relief valve, oil pump pressure relief valve spring, and oil pump body.

Caution: SIO-ID = 5011 **Wear safety glasses in order to avoid eye damage.**

Important: Replace the oil pump pressure relief valve spring when you reuse the oil pump.

2. Install the following items:
 - 2.1. The oil pump pressure relief valve
 - 2.2. The oil pump pressure relief valve spring
 - 2.3. The oil pump pressure relief valve spring straight pin
3. Apply clean engine oil GM P/N 12345610 or equivalent to the oil pump drive gear, the oil pump driven gear, and the oil pump body internal surfaces.
4. Install the oil pump drive gear and the oil pump driven gear into the oil pump body.
 - 4.1. Align the matchmarks on the oil pump drive and driven gears.
 - 4.2. Install the smooth side of the oil pump drive and driven gears toward the oil pump cover.
5. Install the oil pump cover.

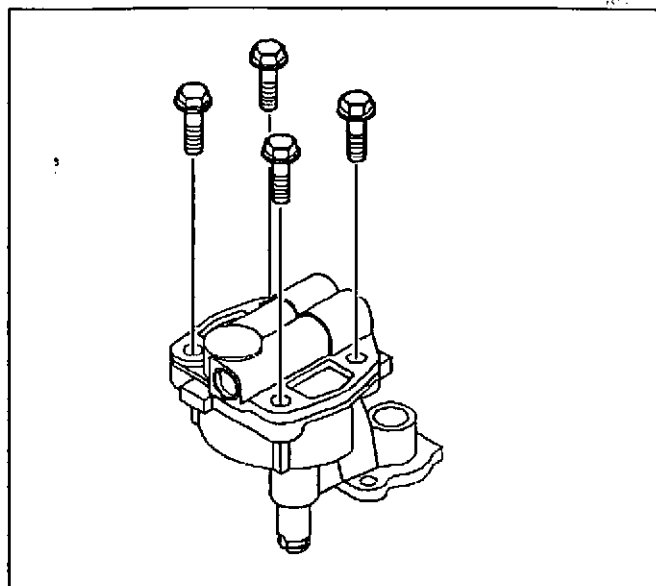
Notice: Refer to *Fastener Notice* in Caution and Notices.

6. Install the oil pump cover bolts.

Tighten

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

7. Inspect the oil pump for smoothness of operation by turning the oil pump driveshaft by hand.



5276

8. Install the oil pump screen.

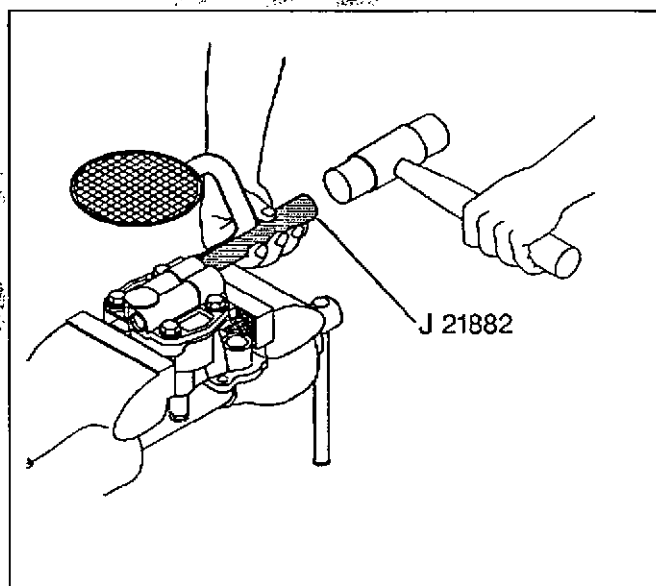
8.1. If removed, replace the oil pump screen. The oil pump screen must have a good press fit into the oil pump body.

8.2. Mount the oil pump in a soft jawed vise.

8.3. Apply sealant GM P/N 12346004 or equivalent to the end of the oil pump screen pipe.

8.4. Use the J 21882 and a soft-faced hammer in order to tap the oil pump screen into the pump body.

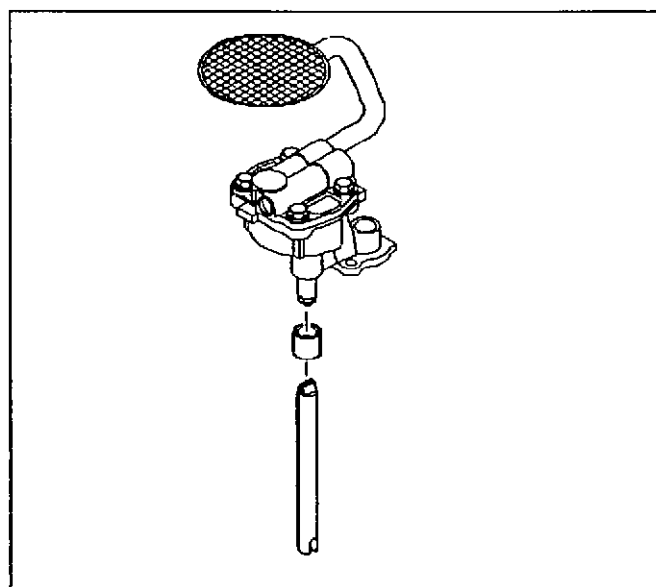
The oil pump screen must align parallel with the bottom of the oil pan when the oil pan is installed.



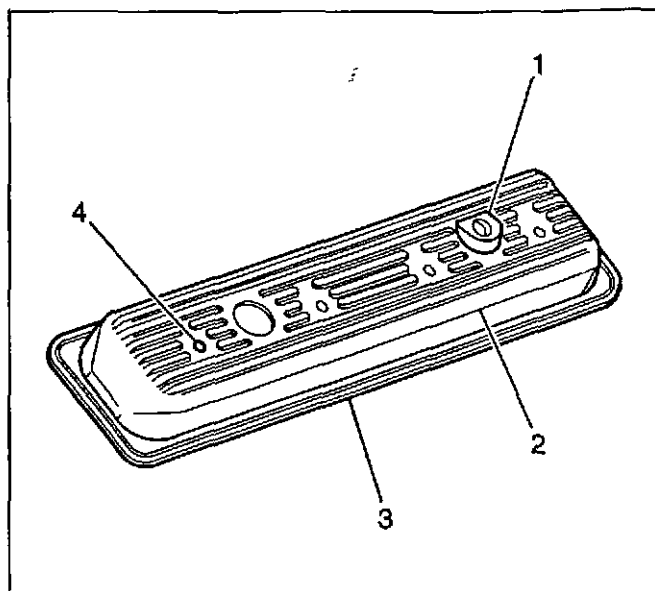
5280

Important: Install a NEW oil pump driveshaft retainer during assembly.

9. Install the oil pump driveshaft and the NEW oil pump driveshaft retainer.



5274



333657

SIE-ID - 195020

Valve Rocker Arm Cover Clean and Inspect

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the valve rocker arm cover in cleaning solvent.
2. Dry the valve rocker arm cover with compressed air.
3. Inspect the valve rocker arm cover for the following:
 - Damage to the PCV valve grommet (1)
 - Dents or damage to the exterior of the valve rocker arm cover (2)

A dented or damaged cover may interfere with the valve rocker arms.

 - Gouges or damage to the sealing surface (3)
 - Damage to the bolt holes (4)
 - Restrictions to the ventilation system passages

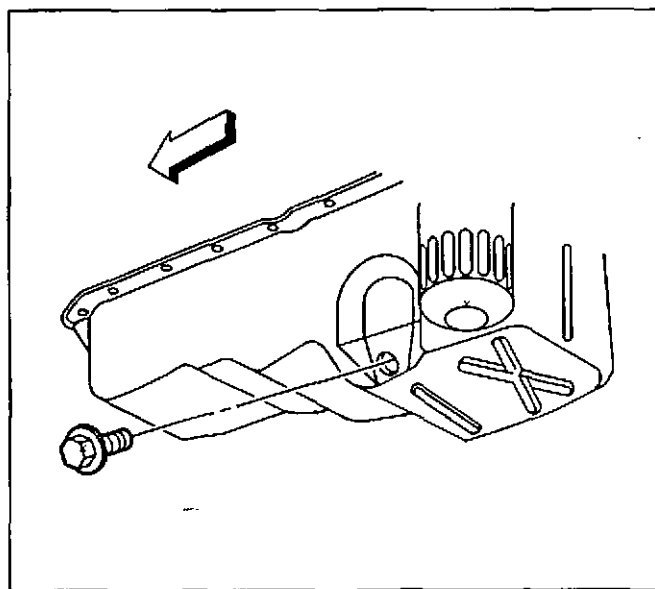
SIE-ID - 194998

Oil Pan Clean and Inspect

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the oil pan in cleaning solvent.
2. Dry the oil pan with compressed air.
3. Inspect the oil pan for the following:
 - The oil pan drain plug hole for damaged threads.
 - Gouges or damage to the oil pan sealing surfaces
 - Damage to the oil pan baffle
 - Dents or damage to the exterior of the oil pan

An oil pan that is dented may interfere with the position of the oil pump screen or not distribute oil properly in the oil pan sump area.

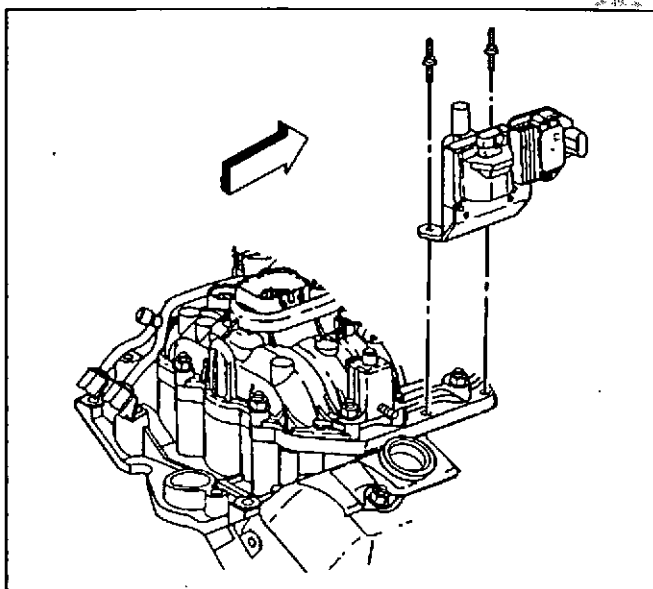


182850

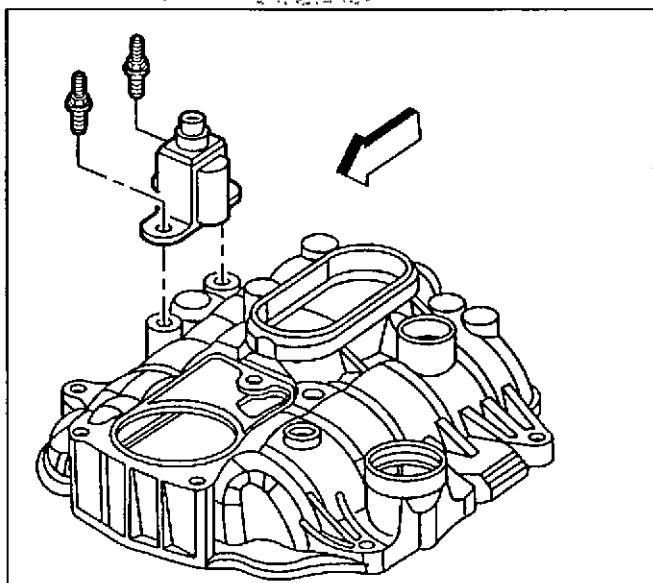
SIE-ID - 193478

Intake Manifold Disassemble

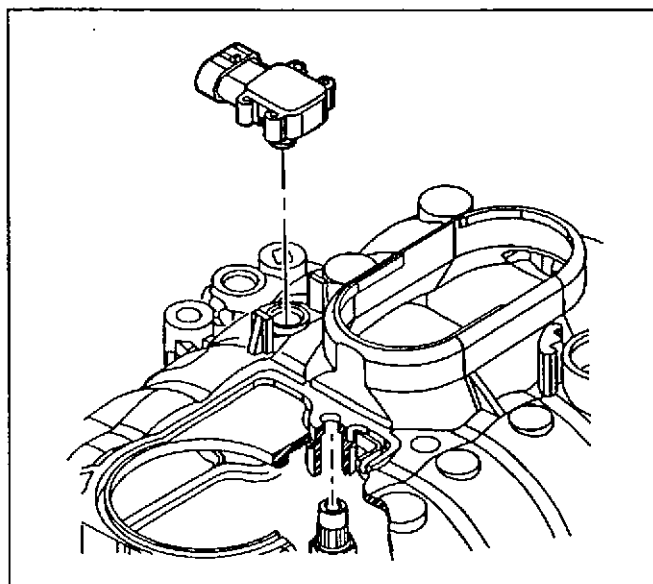
1. Remove the studs and the ignition coil.
2. Remove the studs and the evaporative emission (EVAP) canister purge solenoid valve.
3. Remove the manifold absolute pressure (MAP) sensor and the upper intake manifold.
4. Remove the seal (O-ring) from the MAP sensor and discard.



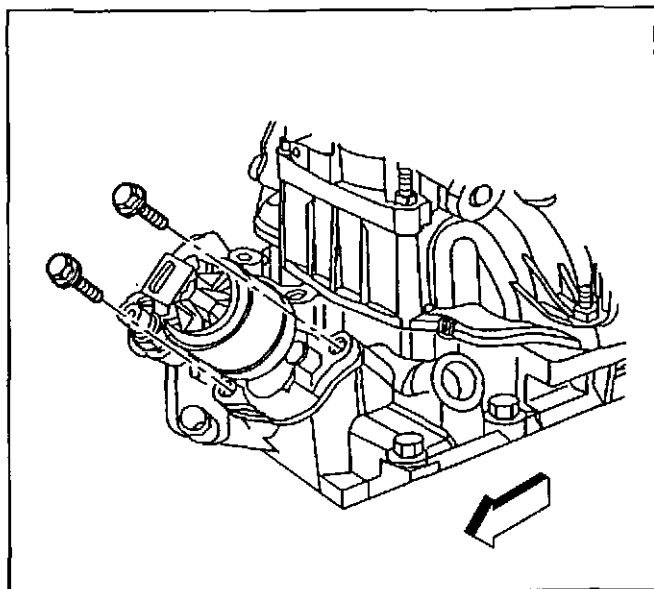
31466



334511



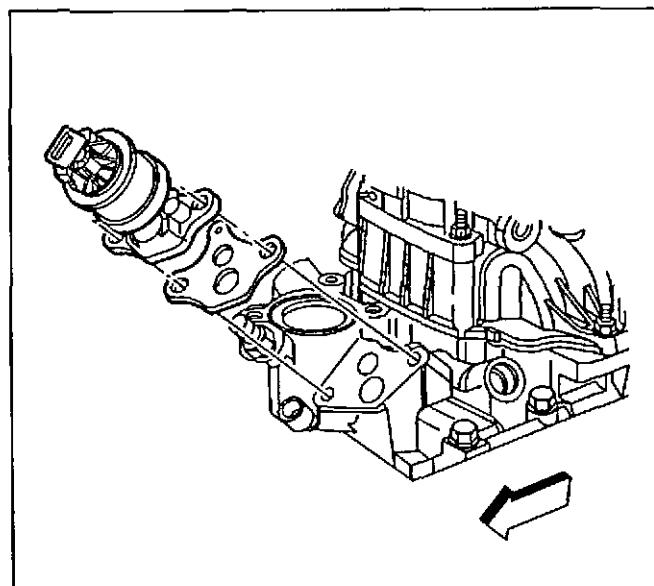
10933



22075

Important: Note the position and direction of the exhaust gas recirculation (EGR) valve before removal. It is possible to improperly install the EGR valve 180 degrees from the original position.

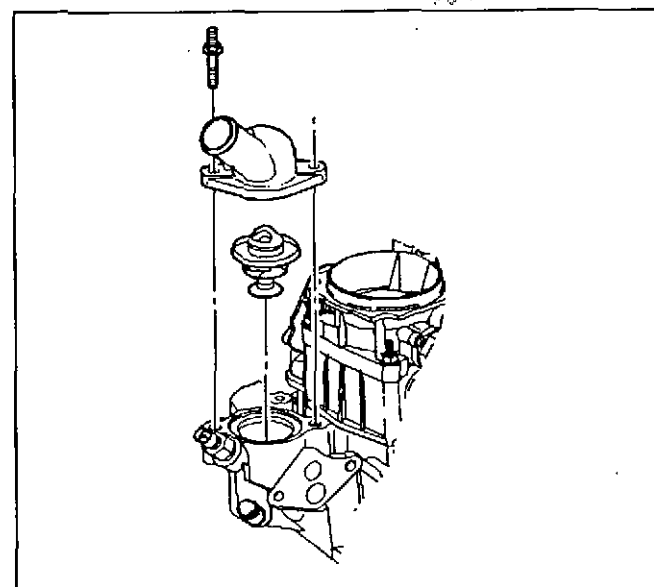
5. Remove the exhaust gas recirculation (EGR) valve bolts.



22076

Notice: S10-ID - 5005 The Linear EGR valve is an electrical component. DO NOT soak in any liquid cleaner or solvent because damage may result.

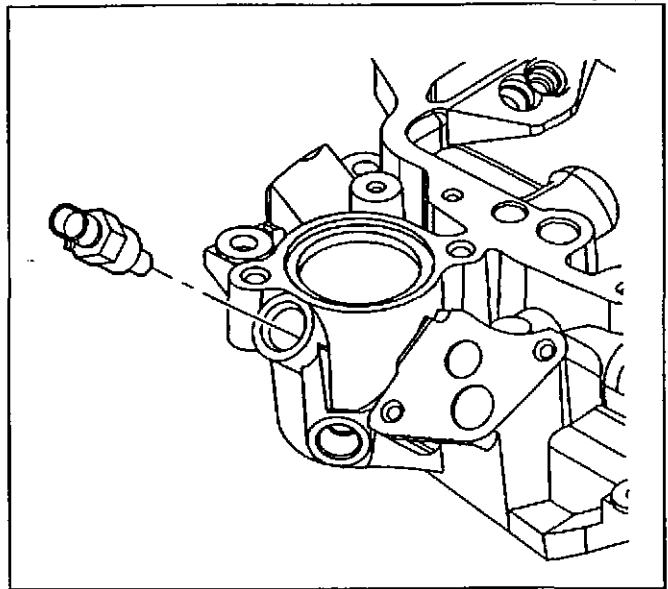
6. Remove the EGR valve and gasket from the lower intake manifold.
7. Discard the EGR valve gasket.



48323

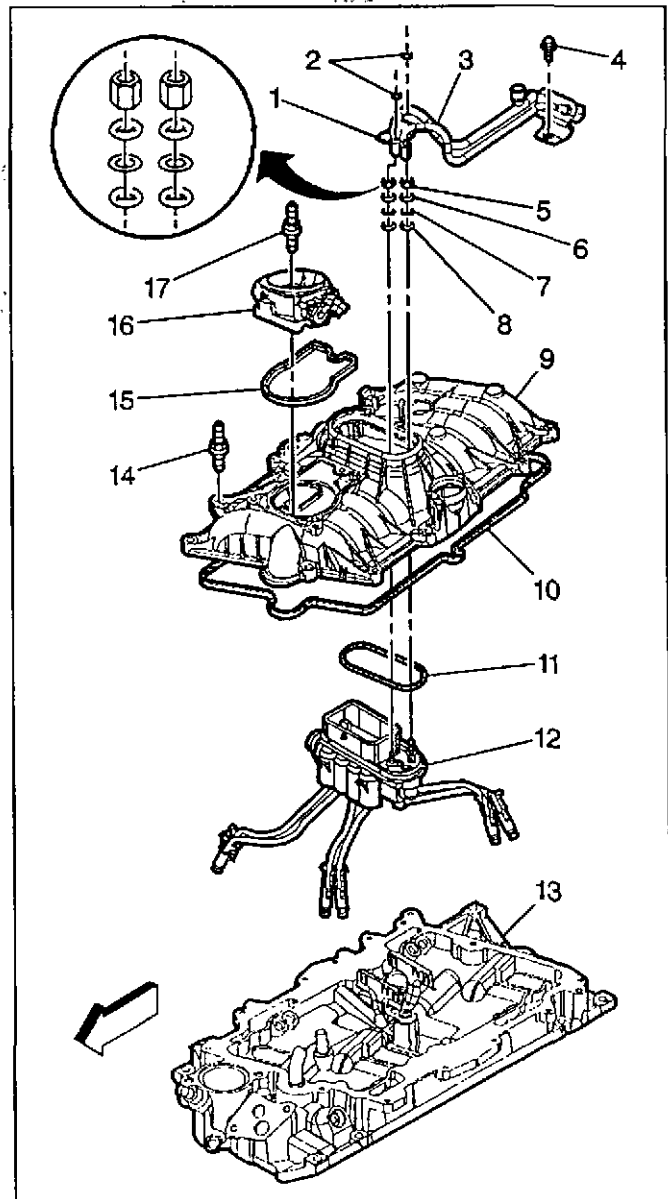
8. Remove the water outlet studs.
9. Remove the water outlet, the engine coolant thermostat, and the engine coolant thermostat seal (O-ring).
10. Discard the engine coolant thermostat seal (O-ring).

11. Remove the engine coolant temperature (ECT) sensor from the lower intake manifold.

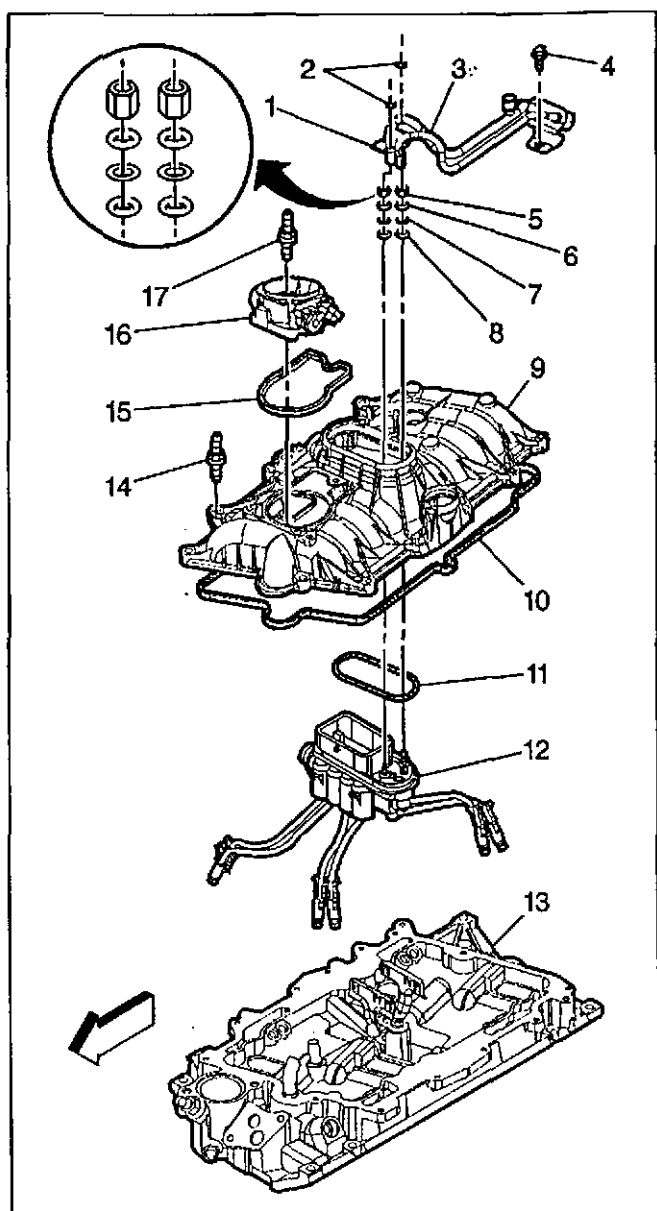


10932

12. Remove the throttle body attaching studs (17).
13. Remove the throttle body (16) and the throttle body gasket (15).
14. Discard the throttle body gasket (15).
15. Remove the fuel pipe bolt (4).
16. Remove the nuts (2) and the fuel pipe retainer (1).
17. Remove the fuel pipe (3).
18. Remove and discard the fuel seal retainers (5).
19. Remove and discard the fuel seals (6) (yellow O-rings).
20. Remove and discard the spacer rings (7) (flat washers).
21. Remove and discard the fuel seals (8) (black O-rings).
22. Remove the upper intake manifold studs (14).
23. Remove the upper intake manifold (9) and the upper intake manifold to lower intake manifold gasket (10).
24. Discard the upper intake manifold to lower intake manifold gasket (10).
25. Remove the TBI fuel meter (12) and fuel meter body seal (11).
26. Discard the fuel meter body seal (11).



66929



66929

SIE-ID - 66845

Intake Manifold Clean and Inspect

SIO-ID - 66893

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the upper intake manifold (9) and the lower intake manifold (13) in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the upper intake manifold (9) for the following:
 - Cracks or other damage to the exterior
 - Cracking or damage in the gasket grooves
 - Loose or damaged bolt hole thread inserts
 - Damage to the throttle body mounting surface
4. Inspect the lower intake manifold (13) for the following:
 - Cracks or damage
 - Damage to the gasket sealing surfaces
 - Damage to the threaded bolt holes
 - Restricted exhaust gas recirculation (EGR) system passages
 - Restricted cooling system passages

SIE-ID - 194513

Intake Manifold Assemble

1. Install the TBI fuel meter (12) into the lower intake manifold (13).
2. Install the NEW fuel meter body seal (11) into the groove on the TBI fuel meter (12).
3. Install the NEW upper intake manifold to lower intake manifold gasket (10) into the groove of the upper intake manifold (9).
4. Install the upper intake manifold (9) (with gasket) onto the lower intake manifold (13).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the upper intake manifold studs (14).

Tighten

- 5.1. Tighten the upper intake manifold studs on the first pass to 5 N.m (44 lb in).
- 5.2. Tighten the upper intake manifold studs on the second pass to 10 N.m (88 lb in).

6. Install the NEW fuel seals (8) (black O-rings) into the TBI fuel meter (12).
7. Install the NEW spacer rings (7) (flat washers) into the TBI fuel meter (12).
8. Install the NEW fuel seals (6) (yellow O-rings) into the TBI fuel meter (12).
9. Install the NEW fuel seal retainers (5) into the TBI fuel meter (12).
10. Install the fuel pipe (3) into the TBI fuel meter (12).
11. Install the fuel pipe retainer (1) and the nuts (2).
12. Install the fuel pipe bolt (4).

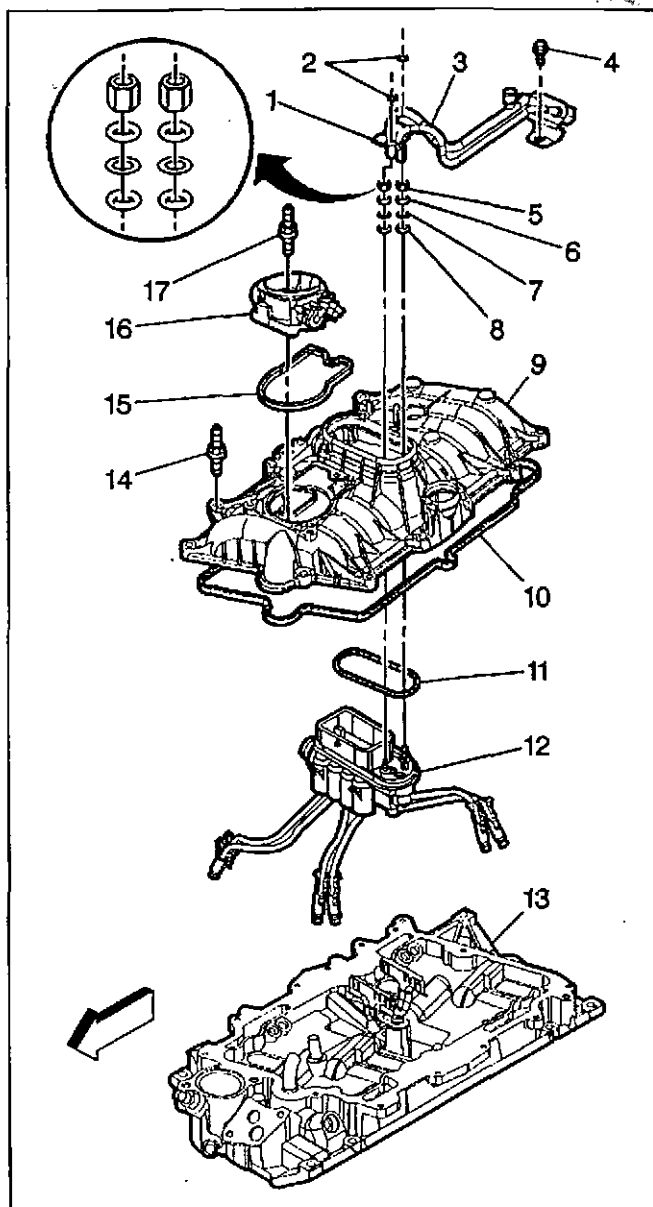
Tighten

- 12.1. Tighten the fuel pipe bolt to 6 N.m (53 lb in).
- 12.2. Tighten the fuel pipe retainer nuts to 3 N.m (27 lb in).

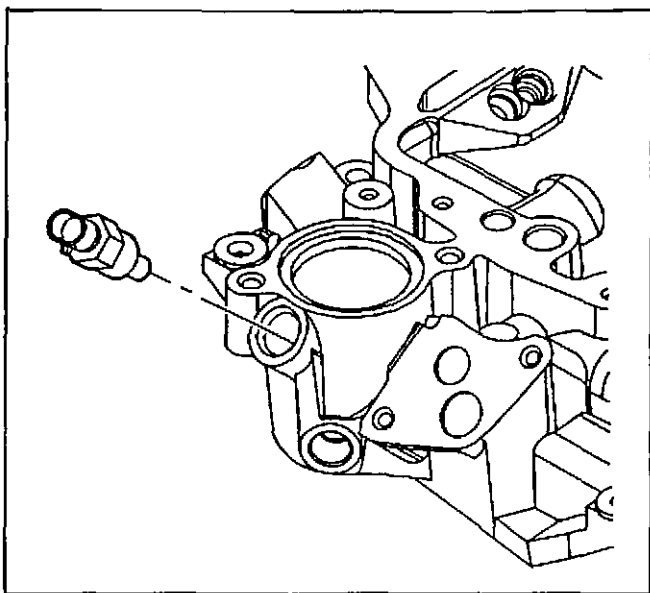
13. Install a NEW throttle body gasket (15) into the groove of the upper intake manifold (9).
14. Install the throttle body (16) and attaching studs (17).

Tighten

Tighten the throttle body attaching studs to 9 N.m (80 lb in).



66929

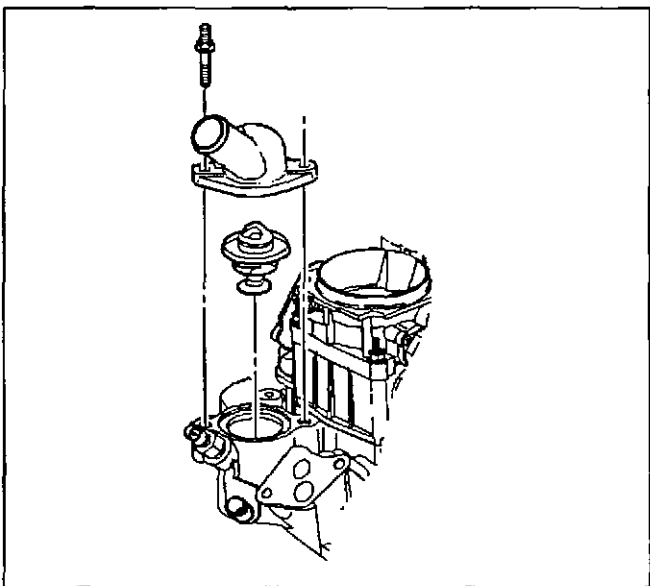


10932

15. Apply sealant GM P/N 12346004 or equivalent to the threads of the engine coolant temperature (ECT) sensor.
16. Install the ECT sensor into the lower intake manifold.

Tighten

Tighten the ECT sensor to 20 N·m (15 lb ft).

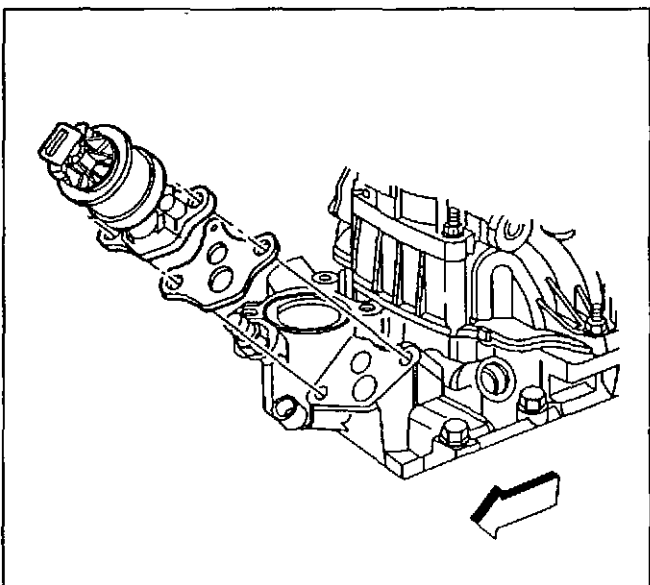


48323

17. Install the engine coolant thermostat and NEW engine coolant thermostat seal (O-ring) into the lower intake manifold.
18. Install the water outlet and studs.

Tighten

Tighten the water outlet studs to 25 N·m (18 lb ft).



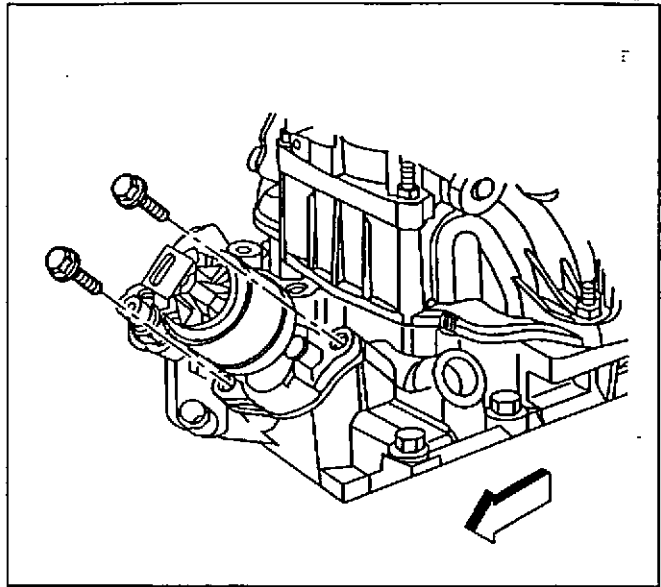
22078

19. Install the exhaust gas recirculation (EGR) valve and NEW EGR valve gasket to the lower intake manifold.

20. Install the EGR valve bolts.

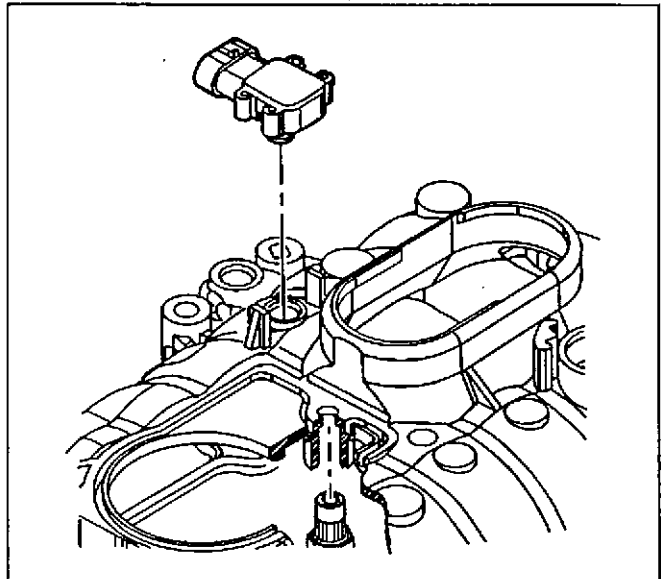
Tighten

- 20.1. Tighten the EGR valve bolts on the first pass to 10 N·m (88 lb in).
20.2. Tighten the EGR valve bolts on the final pass to 30 N·m (22 lb ft).



22075

21. Install a NEW manifold absolute pressure (MAP) sensor seal onto the MAP sensor.
22. Apply a small amount of clean engine oil GM P/N 12345610 or equivalent to the MAP sensor seal.
23. Install the MAP sensor into the upper intake manifold.

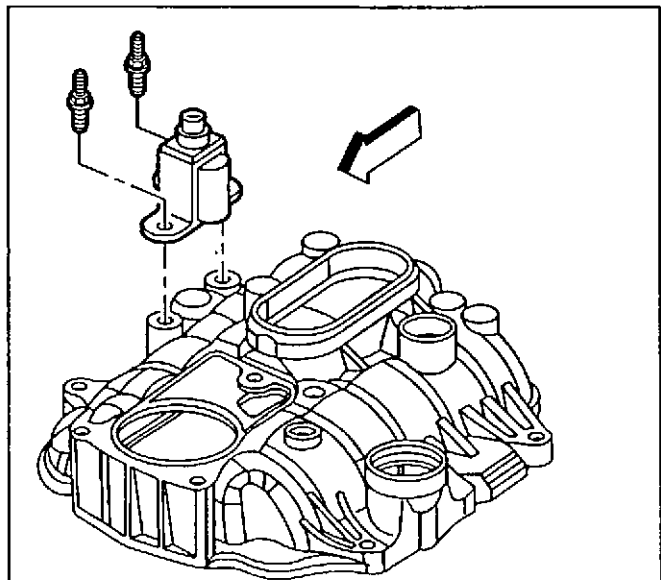


10933

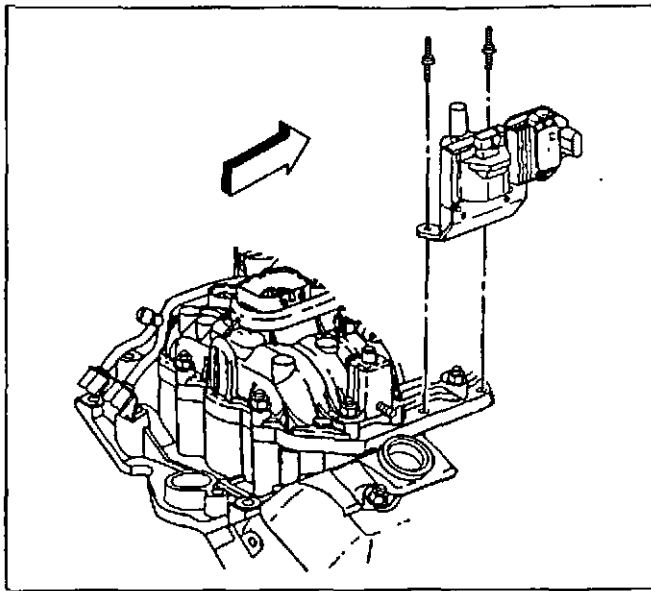
24. Install the evaporative emission (EVAP) canister purge solenoid valve and studs.

Tighten

Tighten the EVAP canister purge solenoid valve studs to 12 N·m (106 lb in).



334511

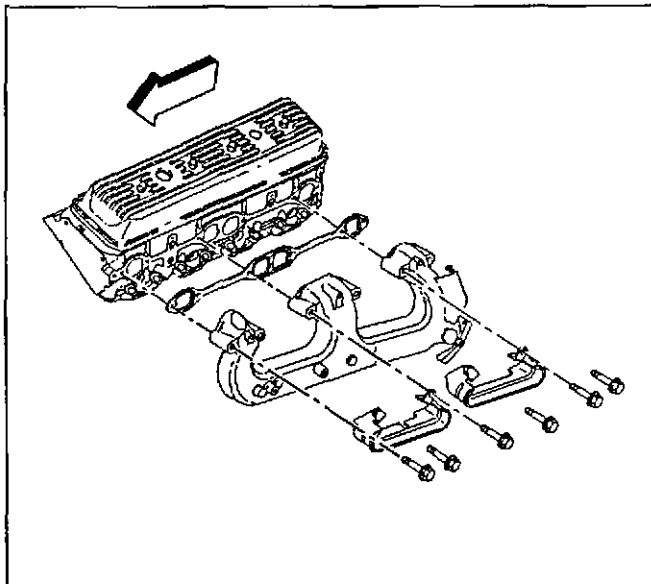


31466

25. Install the ignition coil and studs.

Tighten

Tighten the ignition coil studs to 12 N.m (106 lb in).



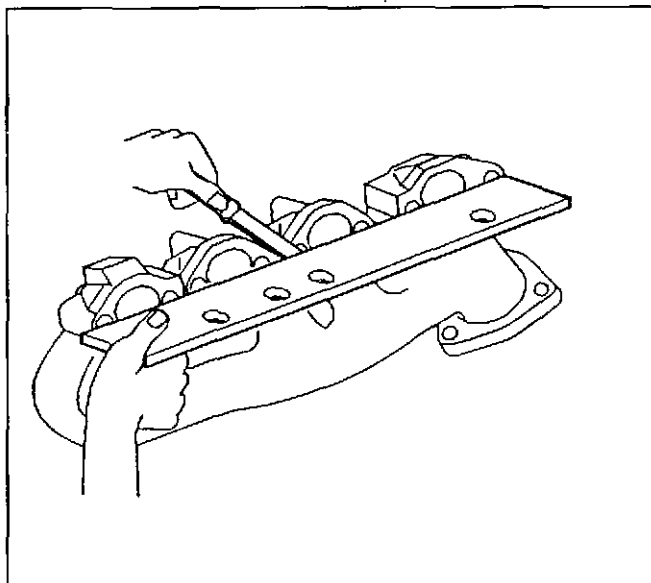
64925

SIE-ID = 69043

Exhaust Manifold Clean and Inspect

Caution: SIO-ID = 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the exhaust manifolds in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the exhaust manifolds for the following:
 - Damage to the gasket sealing surfaces
 - Damage to the exhaust gas recirculation (EGR) pipe fitting (left manifold)
 - Damage to the take down studs
 - Restrictions within exhaust passages
 - Broken or damaged exhaust manifold heat shields (if applicable)
 - Damaged or cracked exhaust manifold
4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. Refer to *Engine Mechanical Specifications (L31 (VIN R))*.
If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.



66607

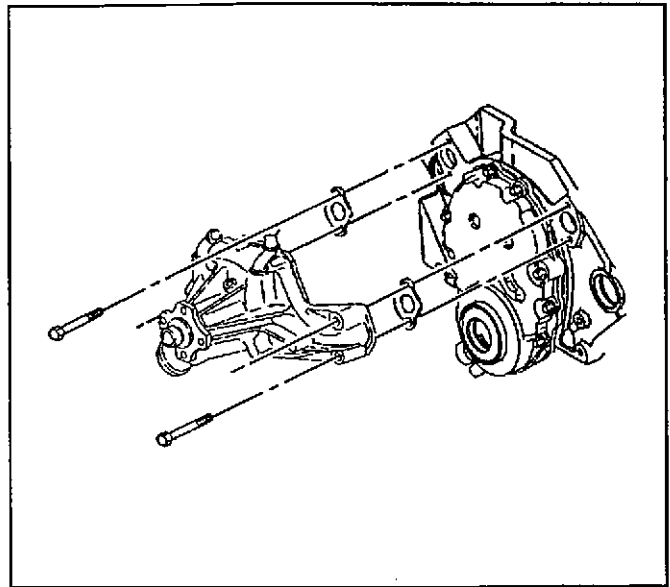
SIE-ID - 194965

Water Pump Clean and Inspect

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Remove the old gasket material from the water pump sealing surfaces.
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump for the following:
 - Gasket 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 inlet pipe or housing rear cover gasket
 - Leakage at the water pump vent hole

A stain around the vent hole is acceptable. If leakage occurred (dripping) with the engine operating and the cooling system pressurized, then replace the water pump.
 - Damaged bolt hole threads



69011

SIE-ID - 43122

Service Prior to Assembly

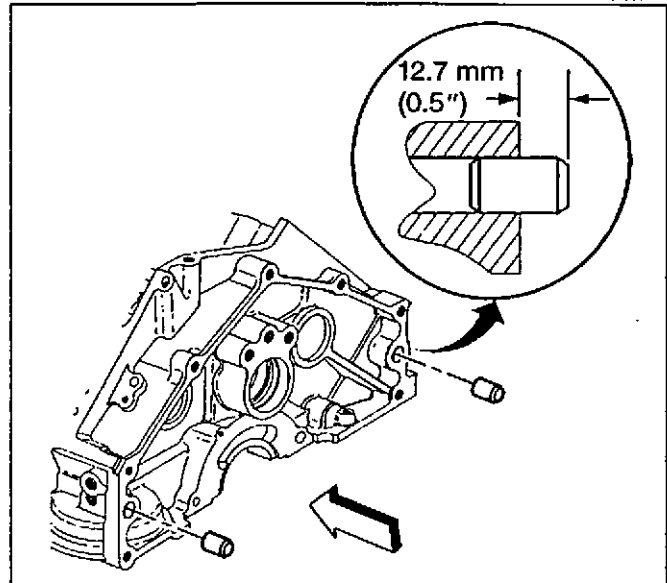
- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
- Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are re-installed into an engine, return the components to the original location, position, and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). The engine oil will provide the initial lubrication when the engine is first started.

SIE-ID - 348917

Engine Block Plug Installation**Tools Required****J 41712 Oil Pressure Switch Socket**

1. Install the transmission locator pins (if required).

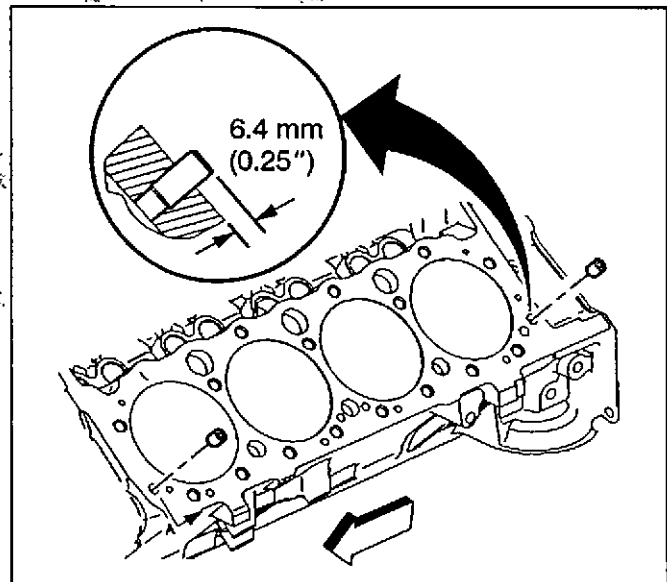
A properly installed transmission locator pin will protrude 12.7 mm (0.5 in) from the rear face of the engine block.



182855

2. Install the dowel pins (cylinder head locator) (if required).

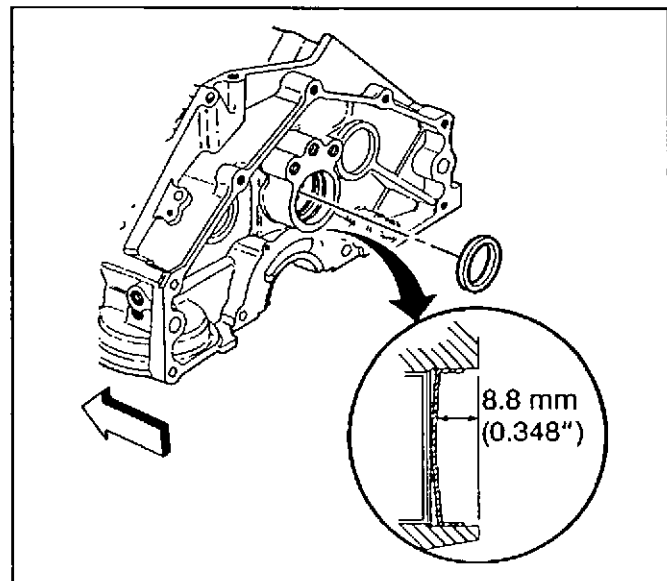
A properly installed dowel pin will protrude 6.4 mm (0.25 in) from the cylinder head deck surface of the engine block.



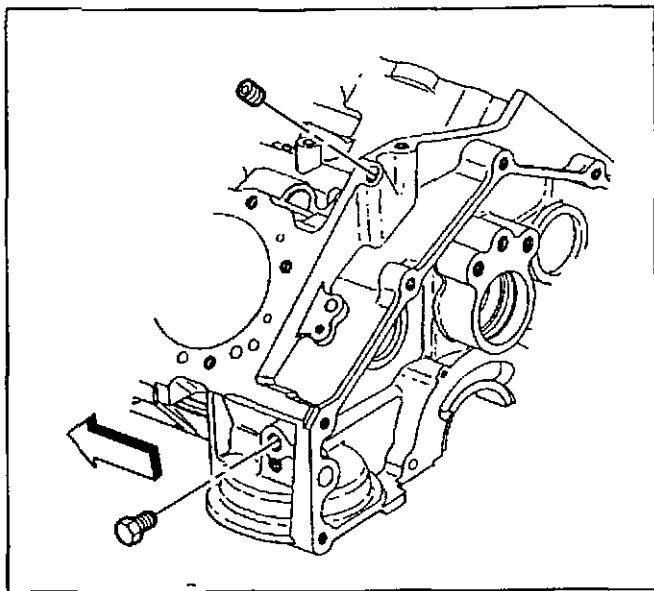
182846

3. Apply sealant GM P/N 12346004 or equivalent to the outside diameter of the NEW expansion cup plug (camshaft rear bearing hole).
4. Install the NEW expansion cup plug (camshaft rear bearing hole).

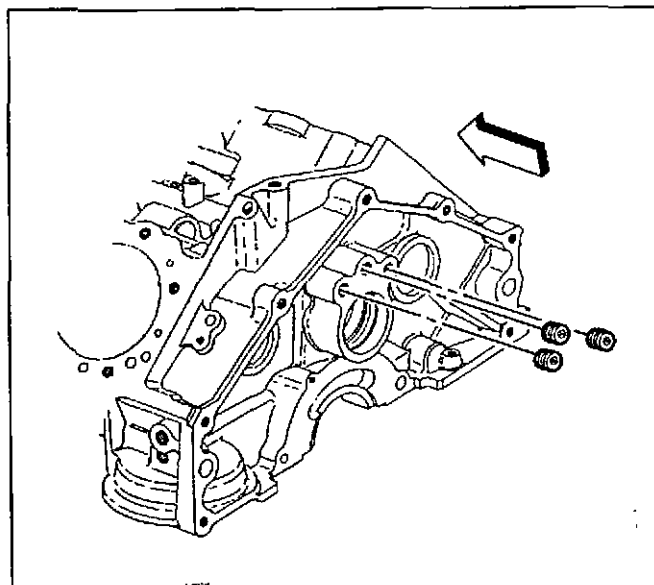
A properly installed expansion cup plug will be installed 8.8 mm (0.348 in) into the rear of the engine block.



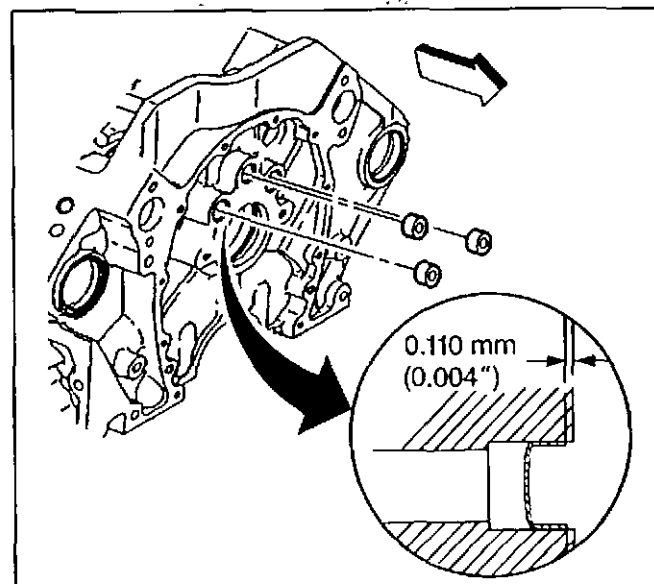
182854



182B41



69847



182B38

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Apply sealant GM P/N 12346004 or equivalent to the threads of the left side rear and left rear top engine oil gallery plugs.
6. Install the left side rear and left rear top oil engine gallery plugs.

Tighten

Tighten the left side rear and left rear top engine oil gallery plugs to 20 N·m (15 lb ft).

7. Apply sealant GM P/N 12346004 or equivalent to the threads of the square socket plugs (engine block oil gallery).
8. Install the rear oil gallery plugs.

Tighten

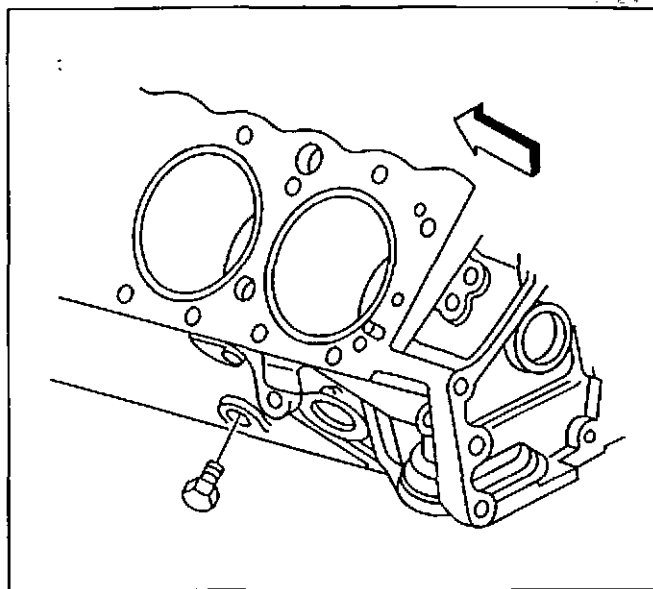
Tighten the square socket plugs to 20 N·m (15 lb ft).

9. Apply sealant GM P/N 12346004 or equivalent to the outside diameter of the NEW engine oil gallery plugs.
10. Install the NEW engine block oil gallery plugs.
A properly installed engine oil gallery plug must be installed below flush with the front face of the engine block.

11. Apply sealant GM P/N 12346004 or equivalent to the threads of the engine block coolant drain hole plug.

12. Install the engine block coolant drain hole plug.
Tighten

Tighten the engine block coolant drain hole plug to 20 N.m (15 lb ft).



69033

13. Apply sealant GM P/N 12346004 or equivalent to the threads of the engine oil pressure sensor fitting.

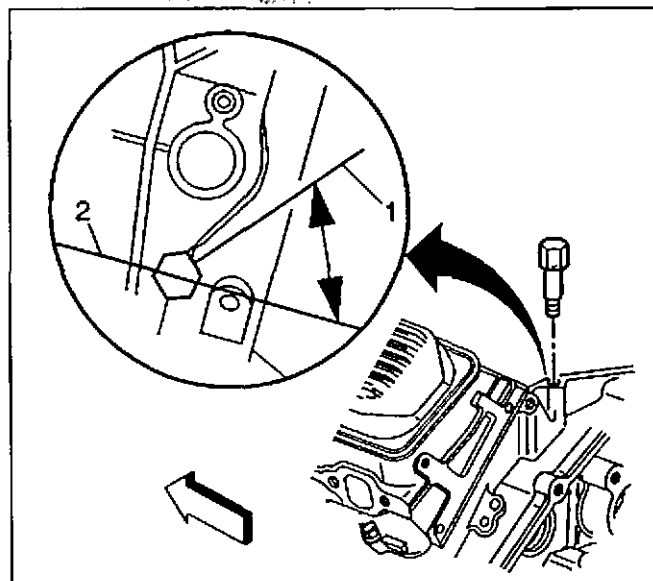
Important: Do not loosen the oil pressure sensor fitting after the initial torque has been obtained.

14. Install the engine oil pressure sensor fitting.
Tighten

Tighten the engine oil pressure sensor fitting to 15 N.m (11 lb ft).

Important: Do not rotate the engine oil pressure sensor fitting more than 359 degrees after the initial torque has been obtained.

15. Rotate the engine oil pressure sensor fitting clockwise to the proper position (1), 50 degrees from the centerline (2).



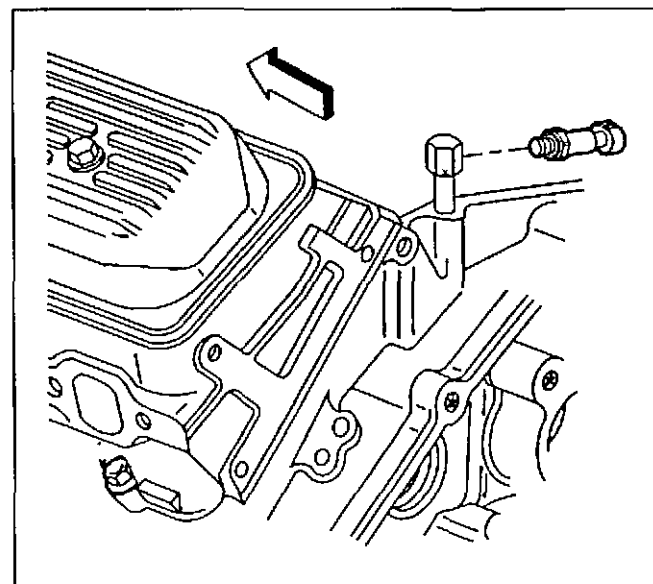
333659

16. Apply sealant GM P/N 12346004 or equivalent to the threads of the engine oil pressure gauge sensor.

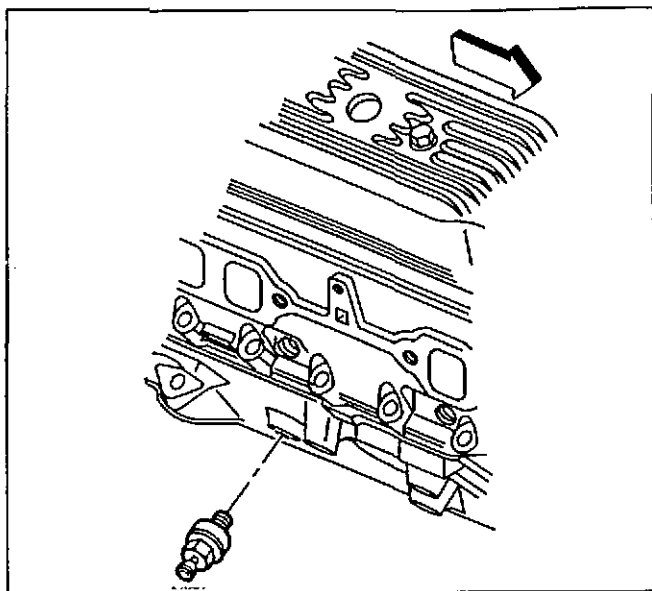
17. Install the engine oil pressure gauge sensor using the J 41712.

Tighten

Tighten the engine oil pressure gauge sensor to 30 N.m (22 lb ft).



333649



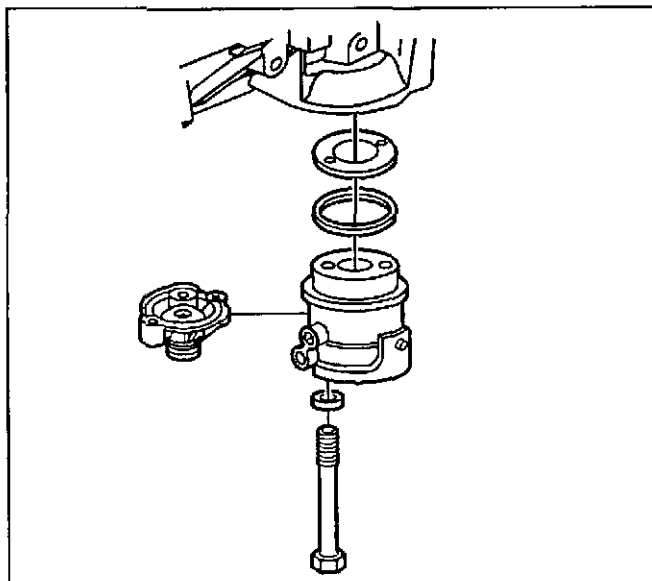
182837

18. Apply sealant GM P/N 12346004 or equivalent to the threads of the knock sensor.

19. Install the knock sensor.

Tighten

Tighten the knock sensor to 19 N.m (14 lb ft).



39122

SIE-ID - 69508

Oil Filter Adapter and Valve Assembly Installation

1. Apply clean engine oil GM P/N 12345610 or equivalent to the NEW oil filter adapter seal (O-ring) (if applicable).
2. Install the NEW oil filter adapter seal into the groove in the oil filter adapter (if applicable).
3. Install the NEW oil filter adapter gasket (if applicable) and the oil filter adapter.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the oil filter adapter flat washers (if applicable) and the oil filter adapter bolts.

Tighten

Tighten the oil filter adapter bolts to 25 N.m (18 lb ft).

SIE-ID - 66853

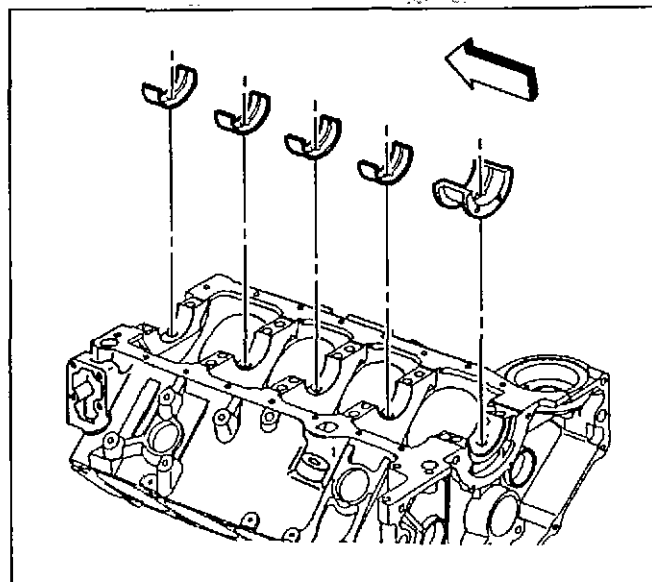
Crankshaft and Bearings Installation

SIO-ID - 66901

Tools Required

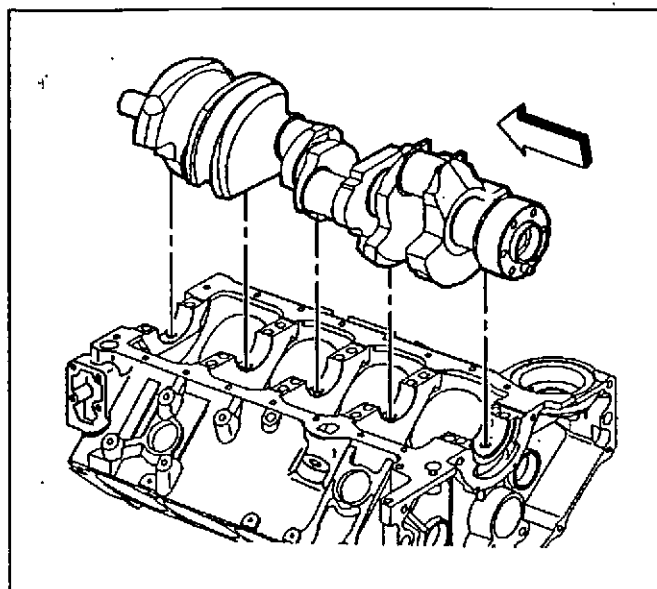
J 36660 Electronic Torque Angle Meter

1. Install the crankshaft bearings into the engine block.
2. Apply clean engine oil GM P/N 12345610 or equivalent to the crankshaft bearings.



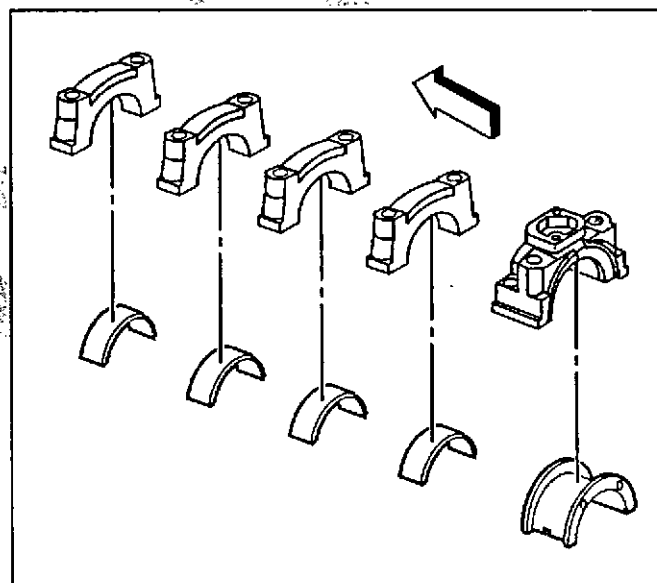
317292

3. Apply clean engine oil GM P/N 12345610 or equivalent to the crankshaft bearing journals.
4. Install the crankshaft.



317351

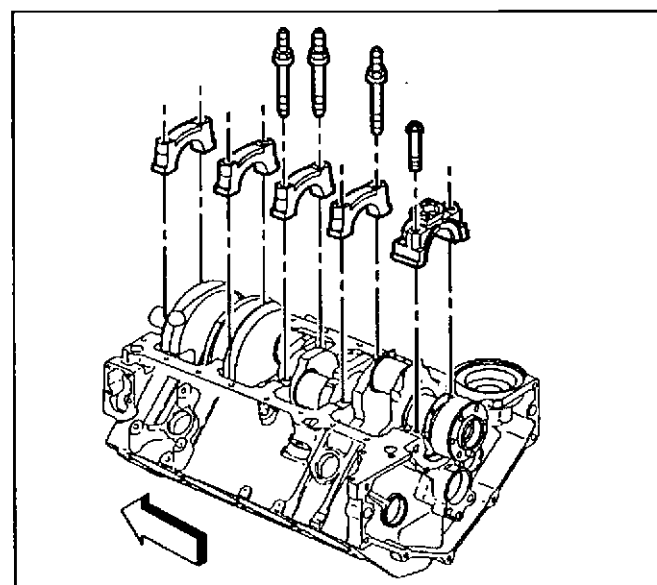
5. Install the crankshaft bearings into the crankshaft bearing caps.
6. Apply clean engine oil GM P/N 12345610 or equivalent to the crankshaft bearings.



317295

Important: Be sure that the crankshaft bearing cap directional arrow point toward the front of the engine block and the crankshaft bearing cap is in the original location and position.

7. Install the crankshaft bearing caps in the original positions and with the arrow on the crankshaft bearing caps in the direction of the front of the engine block.
- Notice:** Refer to *Fastener Notice* in Cautions and Notices.
8. Install the crankshaft bearing cap bolts and studs.
9. Thrust the crankshaft rearward in order to set and align the crankshaft thrust bearings and the crankshaft bearing caps.
10. Thrust the crankshaft forward in order to align the rear faces of the crankshaft thrust bearings.
11. Tighten the crankshaft bearing cap bolts and studs.



317268

Tighten

- 11.1. Tighten the crankshaft bearing cap bolts and studs on the first pass to 20 N·m (15 lb ft).
- 11.2. Tighten the crankshaft bearing cap bolts and studs (two bolt caps) on the final pass to 73 degrees using the *J 36660*.
- 11.3. Tighten the outboard bearing cap bolts (four bolt caps) on the final pass to 43 degrees using the *J 36660*.
- 11.4. Tighten the inboard bearing cap bolts and studs (four bolt caps) on the final pass to 73 degrees using the *J 36660*.

SIE-ID - 348923

Crankshaft Rear Oil Seal and Housing Installation**Tools Required***J 35621-B* Rear Main Seal Installer**Notice:** Refer to *Fastener Notice* in Cautions and Notices.

1. Install the crankshaft rear oil seal housing retainer stud.

Tighten

Tighten the crankshaft rear oil seal housing retainer stud to 6 N·m (53 lb in).

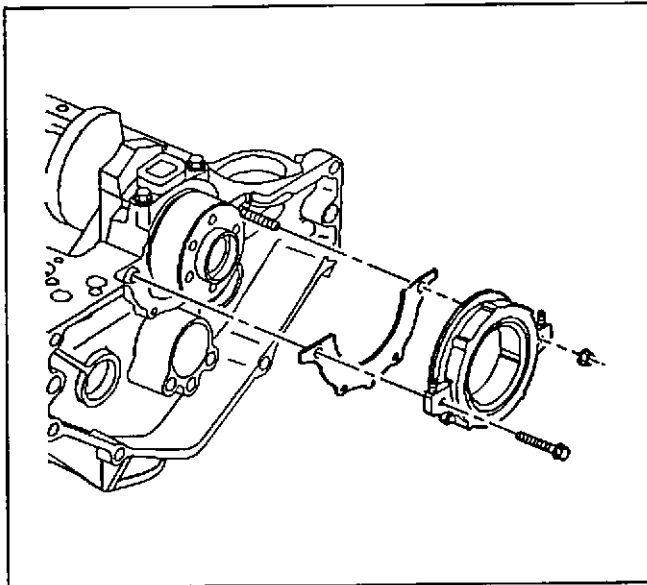
Important: Always use a NEW crankshaft rear oil seal housing gasket when installing the crankshaft rear oil seal housing.

2. Install the NEW crankshaft rear oil seal housing gasket and the crankshaft rear oil housing onto the crankshaft rear oil seal housing retainer stud.
3. Install the crankshaft rear oil seal housing nut and bolts.

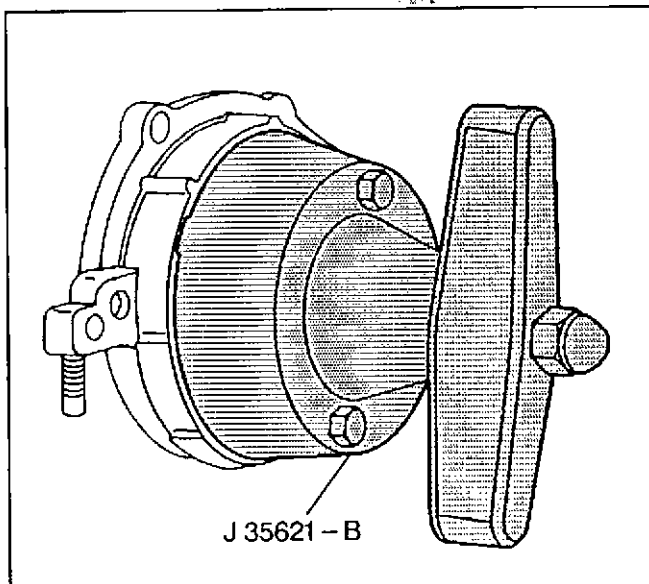
Tighten

Tighten the crankshaft rear oil seal housing nut and bolts to 12 N·m (106 lb in).

4. Apply a small amount (2 to 3 drops) of clean engine GM P/N 12345610 or equivalent oil to the bore of the crankshaft rear oil seal housing.
5. Inspect the outside diameter of the engine flywheel pilot flange for imperfections or rust. Minor imperfections and/or rust may be removed with a fine grade emery cloth.
6. Apply a small amount (2 to 3 drops) of clean engine GM P/N 12345610 or equivalent oil to the outside diameter of the engine flywheel pilot flange.
7. Apply a small amount (1 drop) of clean engine oil GM P/N 12345610 or equivalent to the outside diameter of the flywheel locator pin.
8. Apply a small amount of clean engine GM P/N 12345610 or equivalent oil to the crankshaft seal surface.
9. Inspect the *J 35621-B* flange for imperfections that may damage the crankshaft rear oil seal.



11479



J 35621-B

334550

Minor imperfections may be removed with a fine grade emery cloth.

Important: DO NOT allow oil or any other lubricants to contact the seal lip surface of the crankshaft rear oil seal.

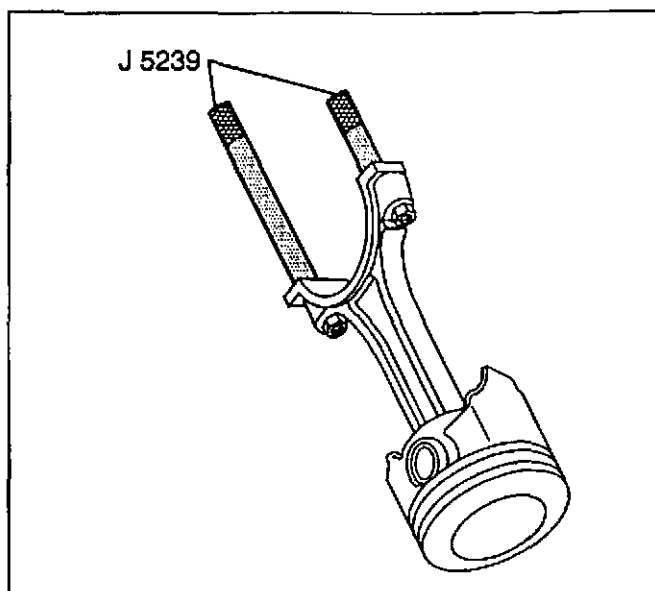
10. Remove the installation guide from the NEW crankshaft rear oil seal.
11. Apply a small amount (2 to 3 drops) of clean engine oil GM P/N 12345610 or equivalent to the outside diameter of the NEW crankshaft rear oil seal.
12. Install the NEW crankshaft rear oil seal onto the *J 35621-B*.
13. Install the *J 35621-B* onto the rear of the crankshaft and hand tighten the tool bolts until snug.

Notice: SIO-ID = 348112 Proper alignment of the crankshaft rear oil seal is critical. Install the crankshaft rear oil seal near to flush and square to the crankshaft rear oil seal housing. Failing to do so may cause the crankshaft rear oil seal or the crankshaft rear oil seal installation tool to fail.

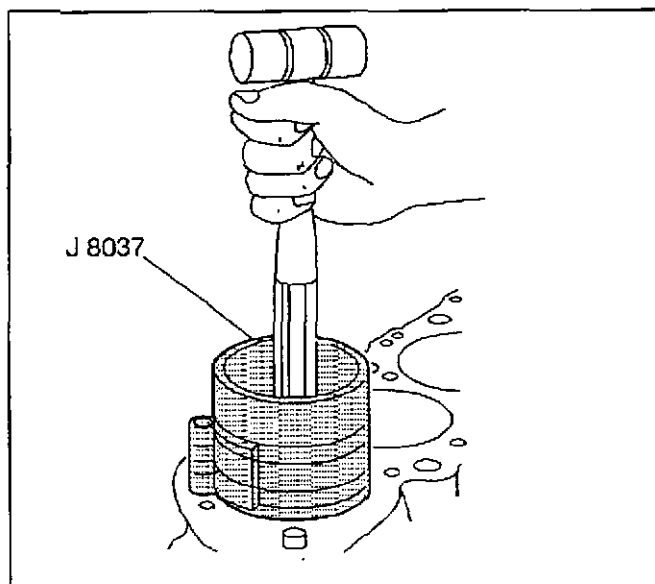
Important: A properly installed crankshaft rear oil seal will be near to flush and square to the crankshaft rear oil seal housing.

14. Install the crankshaft rear oil seal onto the crankshaft and into the crankshaft rear oil seal housing.
 - 14.1. Turn the *J 35621-B* wing nut clockwise until the crankshaft rear oil seal is installed near to flush and square to the crankshaft rear oil seal housing.

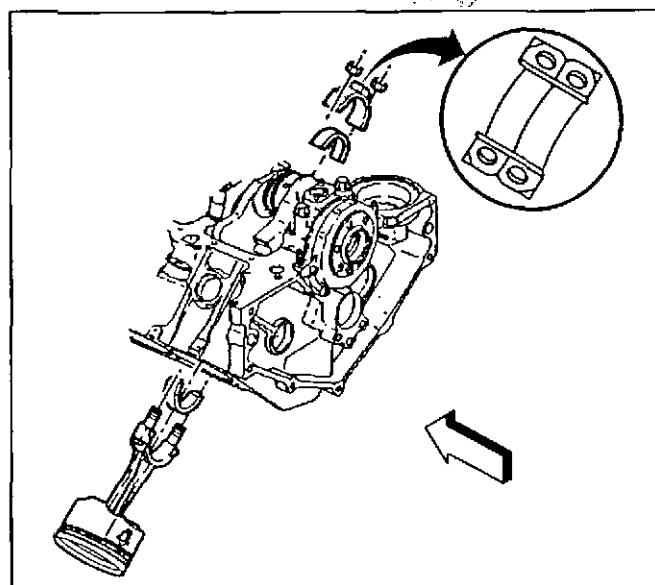
Increased resistance will be felt when the crankshaft rear oil seal has reached the bottom of the crankshaft rear oil seal housing bore.
 - 14.2. Turn the *J 35621-B* wing nut counter clockwise to release the *J 35621-B* from the crankshaft rear oil seal.
15. Remove the *J 35621-B* from the crankshaft.
16. Wipe off any excess engine oil with a clean rag.



387765



5159



39124

SIE-ID - 222610

Piston, Connecting Rod, and Bearing Installation

SIO-ID - 222562

Tools Required

- J 5239 Connecting Rod Bolt Guide Set
- J 8037 Ring Compressor
- J 36660 Electronic Torque Angle Meter

1. Apply clean engine oil to the following components:
 - The piston
 - The piston rings
 - The cylinder bore
 - The connecting rod bearing surfaces
2. Install the J 5239 onto the connecting rod bolts.

3. Install the J 8037 onto the piston and compress the piston rings.

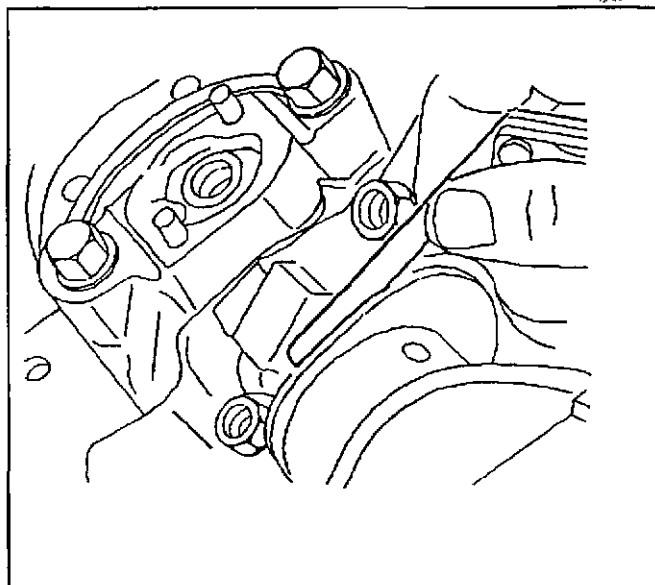
4. Install the piston and connecting rod assembly into the proper cylinder.
 - The mark on the top of the piston must face the front of the engine block.
 - When assembled, the flanges on the connecting rod and connecting rod cap should point to the front of the engine block on the left bank and point to the rear of the engine block on the right bank.
5. Use the J 8037 and the J 5239 and lightly tap the top of the piston with a wooden hammer handle.
 - Hold the J 8037 firmly against the engine block until all of the piston rings have entered the cylinder bore.
 - Use the J 5239 in order to guide the connecting rod onto the crankshaft journal.
6. Remove the J 5239 from the connecting rod bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the connecting rod cap and nuts.

Tighten

- 7.1. Tighten the nuts on the first pass evenly to 27 N·m (20 lb ft).
- 7.2. Tighten the nuts on the final pass to 55 degrees using the *J 36660*.
8. Once the piston and connecting rod assemblies have been installed, lightly tap each connecting rod assembly (parallel to the crankpin) in order to make sure that the connecting rods have the proper side clearance.
9. Use a feeler gauge or a dial indicator to measure the side clearance between the connecting rod caps. The connecting rod side clearance measurement should be 0.15–0.61 mm (0.006–0.024 in).



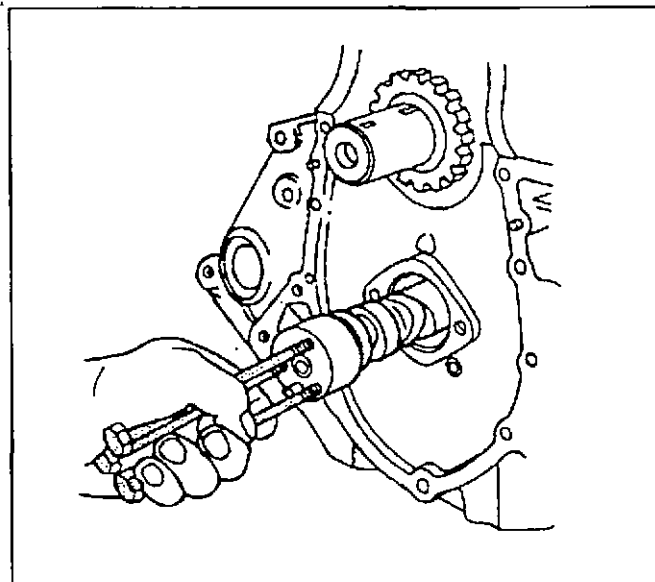
5163

SIE-ID = 66855

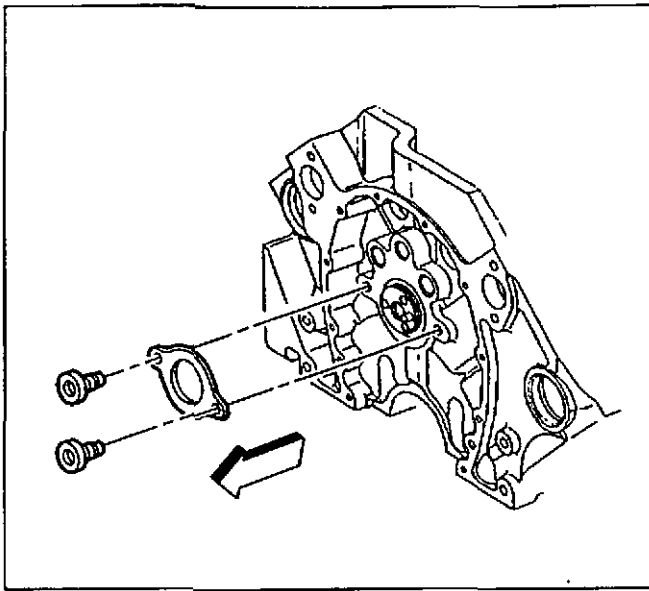
Camshaft Installation

Notice: SIO-ID = 13833 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.

1. Lubricate the following components with clean engine oil GM P/N 12345610 or equivalent or engine oil supplement GM P/N 1052367 or equivalent:
 - The engine camshaft lobes
 - The camshaft bearing journals
 - The camshaft bearings
2. Install the three 5/16–18 x 4.0 inch bolts in the engine camshaft bolt holes.
3. Install the engine camshaft using the bolts as a handle.
4. Remove the three bolts from the engine camshaft.



69013



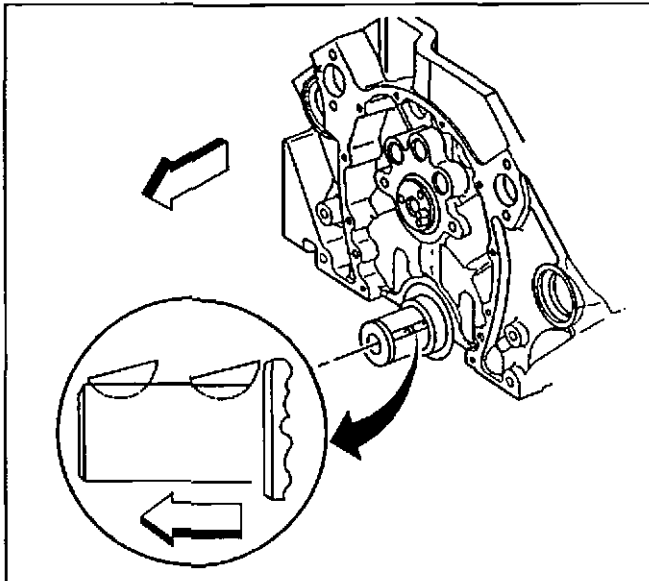
182836

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the camshaft retainer and bolts.

Tighten

Tighten the camshaft retainer bolts to 12 N.m (106 lb in).



182847

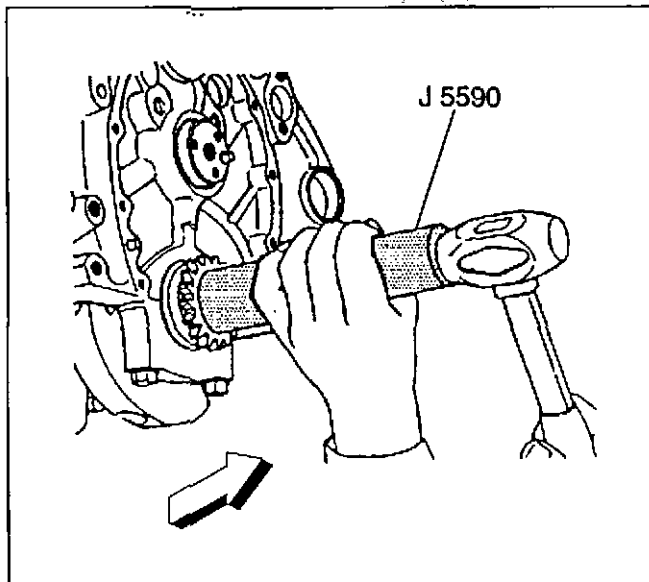
SIE-ID = 69464

Timing Chain and Sprockets Installation

Tools Required

J 5590 Installer

1. Install the woodruff key (crankshaft balancer) into the crankshaft keyway.



32066

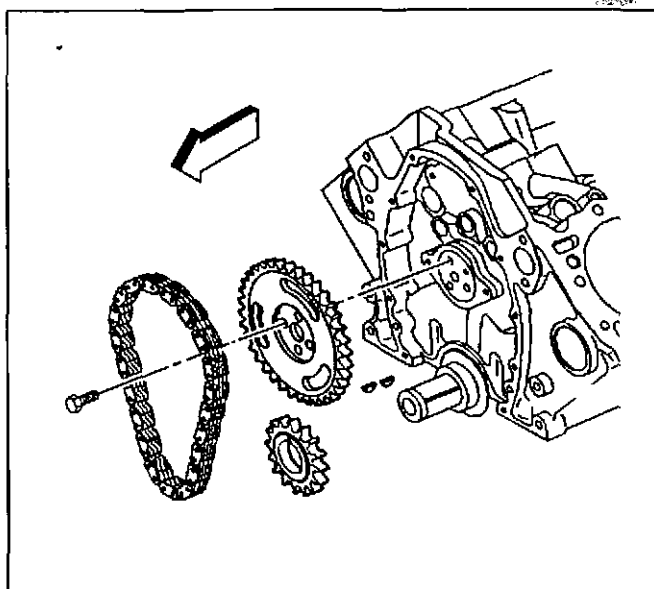
2. Align the keyway of the crankshaft sprocket with the woodruff key (crankshaft balancer).

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

3. Use the J 5590 in order to install the crankshaft sprocket.
4. Rotate the crankshaft until the crankshaft sprocket alignment mark is in the 12 o'clock position.

5. Install the camshaft sprocket and the camshaft timing chain.

Install the camshaft sprocket with the alignment mark in the 6 o'clock position.



65453

Important: Do not use a hammer to install the camshaft sprocket onto the camshaft. To do so may dislodge the expansion cup plug (camshaft rear bearing hole) and/or damage the camshaft.

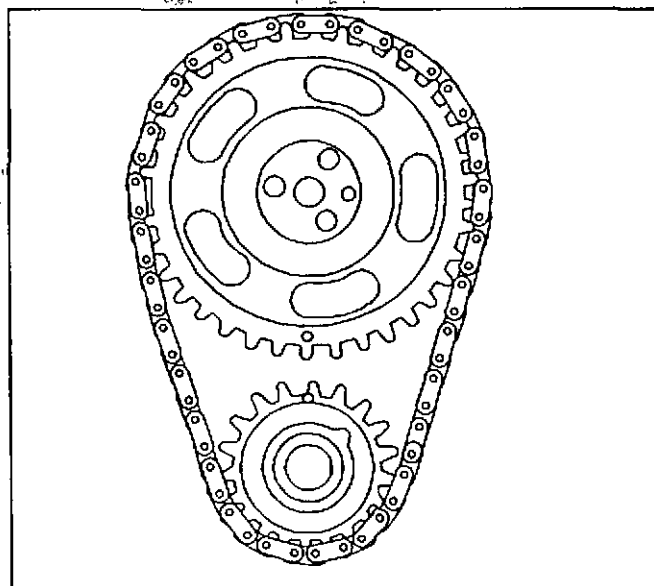
6. Rotate the camshaft until the camshaft and crankshaft sprocket alignment marks are in the proper position.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install camshaft sprocket bolts.

Tighten

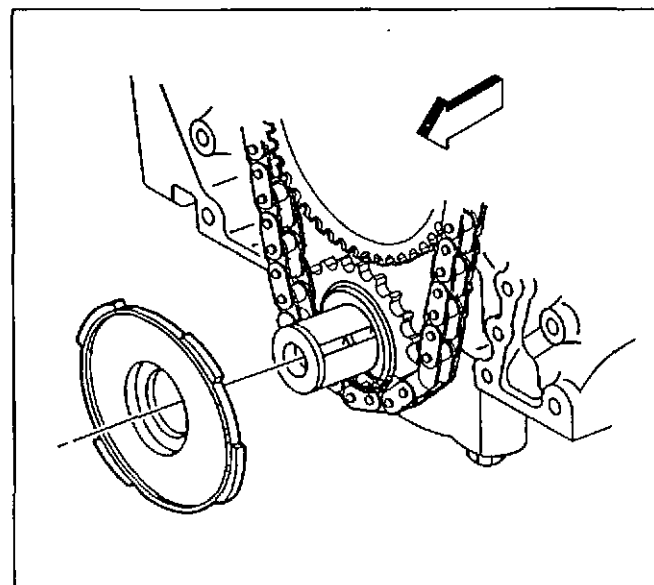
Tighten the camshaft sprocket bolts to 25 N·m (18 lb ft).



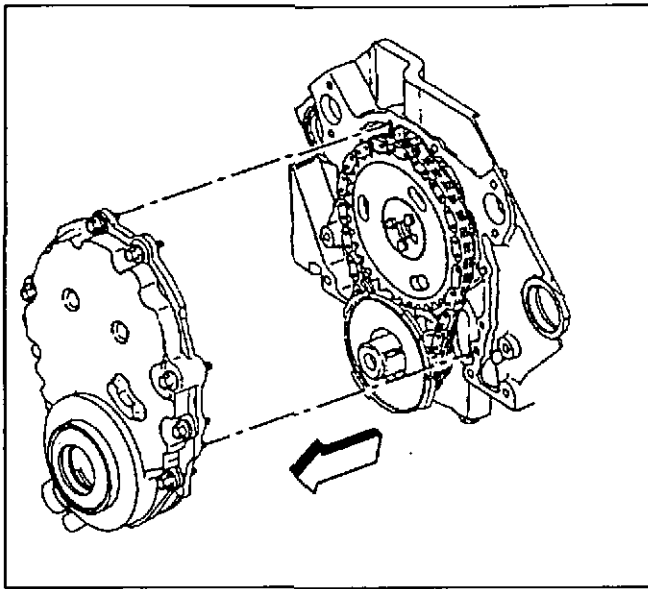
11503

Important: Align the keyway on the crankshaft position sensor reluctor ring with the woodruff key (crankshaft balancer) in the crankshaft, and install the crankshaft position sensor reluctor ring onto the crankshaft until completely seated against the crankshaft sprocket.

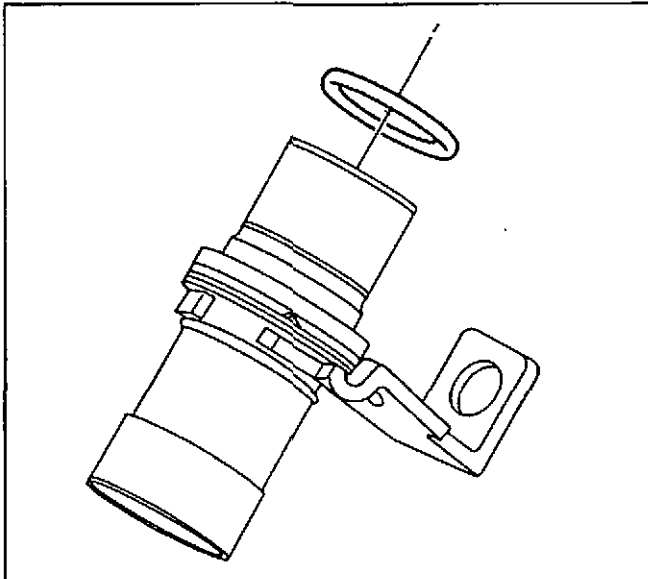
8. Install the crankshaft position sensor reluctor ring.
 - 8.1. Align the keyway on the crankshaft position sensor reluctor ring with the woodruff key (crankshaft balancer) in the crankshaft.
 - 8.2. Use the J 5590 in order to push the crankshaft position sensor reluctor ring onto the crankshaft until completely seated against the crankshaft sprocket.



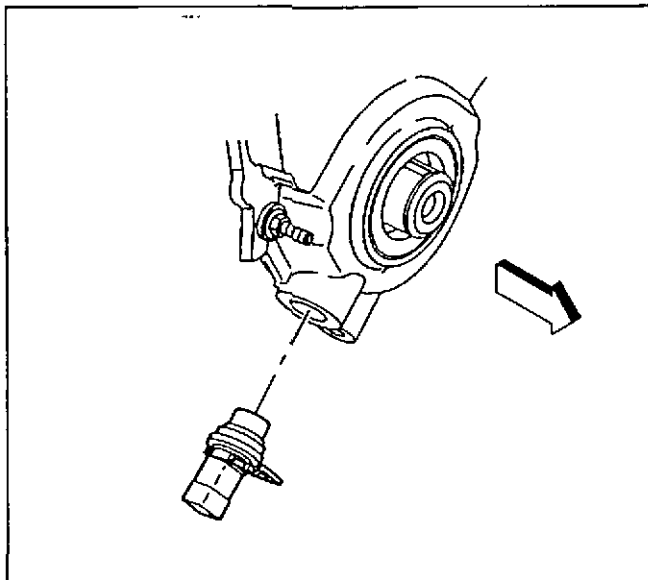
69450



69010



387759



10939

SIE-ID - 194773

Engine Front Cover Installation

Important: Do not reuse the composite type engine front cover and seal. Always install a NEW engine cover (includes a new seal).

1. Install the NEW engine front cover (includes a new seal).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the engine front cover bolts.

Tighten

Tighten the engine front cover bolts to 12 N·m (106 lb in).

Important: DO NOT reuse the original crankshaft position sensor seal (O-ring). When installing the crankshaft position sensor be sure the crankshaft position sensor is fully seated and held stationary in the engine front cover crankshaft position sensor bore. A crankshaft position sensor that is not completely seated will cock in the engine front cover and may result in erratic engine operation.

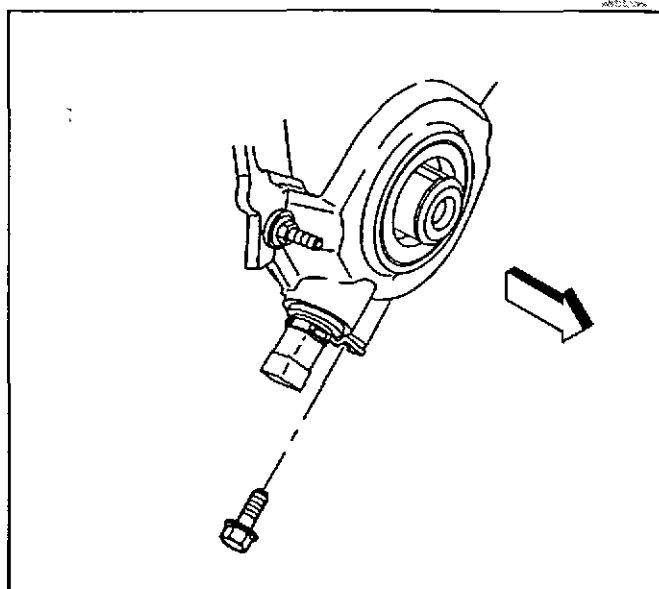
3. Lubricate the NEW crankshaft position sensor seal (O-ring) with clean engine oil.
4. Install the NEW crankshaft position sensor seal (O-ring) onto the crankshaft position sensor.

5. Install the crankshaft position sensor.

6. Install the crankshaft position sensor bolt.

Tighten

Tighten the crankshaft position sensor bolt to 9 N.m (80 lb in).



10938

SIE-ID = 32349

Oil Level Indicator and Tube Installation

1. Apply sealant GM P/N 12346004 or equivalent around the oil level indicator tube 13 mm (0.5 in) below the tube bead.
2. Install the oil level indicator tube into the engine block. Rotate the oil level indicator tube into position.

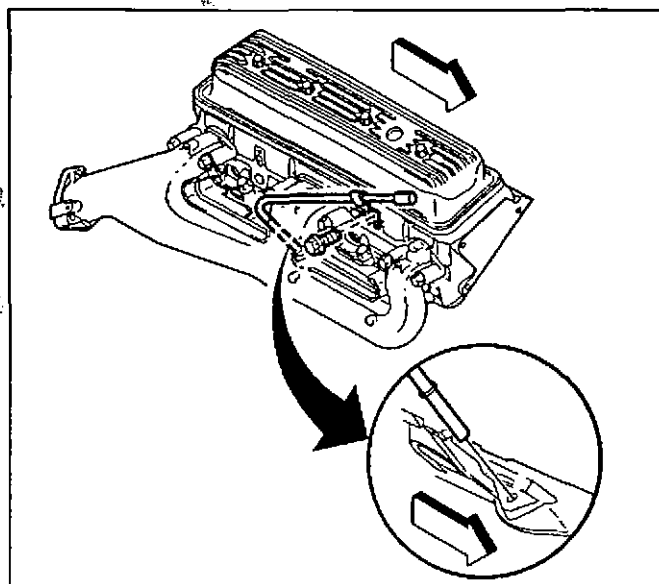
Notice: Refer to *Fastener Notice in Cautions and Notices*.

3. Install the oil level indicator tube bolt.

Tighten

Tighten the oil level indicator tube bolt to 12 N.m (106 lb in).

4. Install the oil level indicator into the oil level indicator tube.

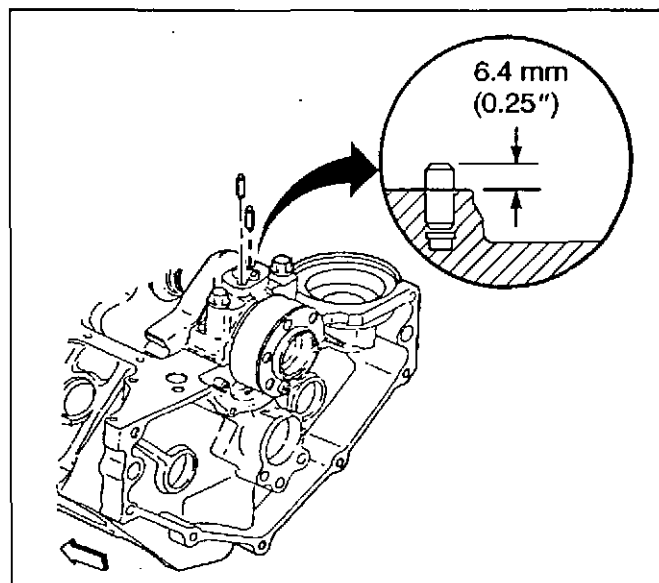


182831

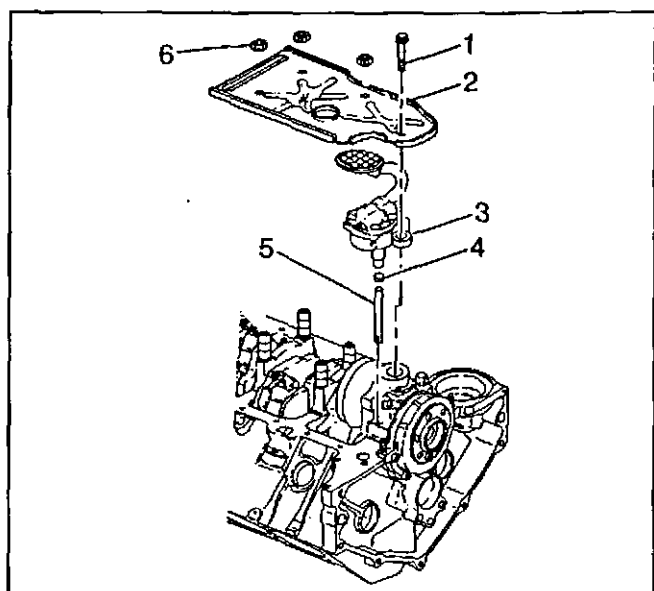
SIE-ID = 194869

Oil Pump, Pump Screen and Deflector Installation

1. Inspect for properly installed pins (oil pump locator).



182852



11438

Important: Do not reuse the oil pump driveshaft retainer (4).

During assembly, install a NEW oil pump driveshaft retainer.

2. Assemble the oil pump (3), oil pump driveshaft (5), and a NEW oil pump driveshaft retainer (4).

3. Install the oil pump (3).

Position the oil pump onto the pins.

4. Install the bolt (1) attaching the oil pump to the rear crankshaft bearing cap.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the crankshaft oil deflector (2) and nuts (6).

Tighten

- Tighten the oil pump bolt to 90 N·m (66 lb ft).
- Tighten the crankshaft oil deflector nuts to 40 N·m (29 lb ft).

SIE-ID # 66859

Oil Pan Installation

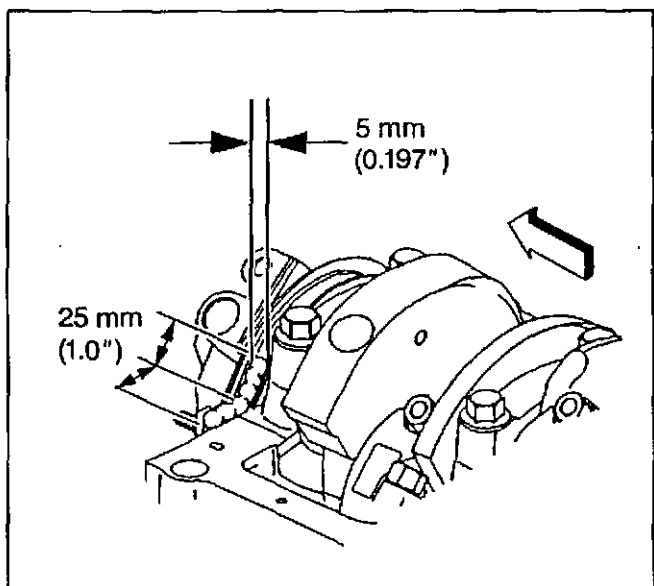
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the oil pan studs into the engine block.

Tighten

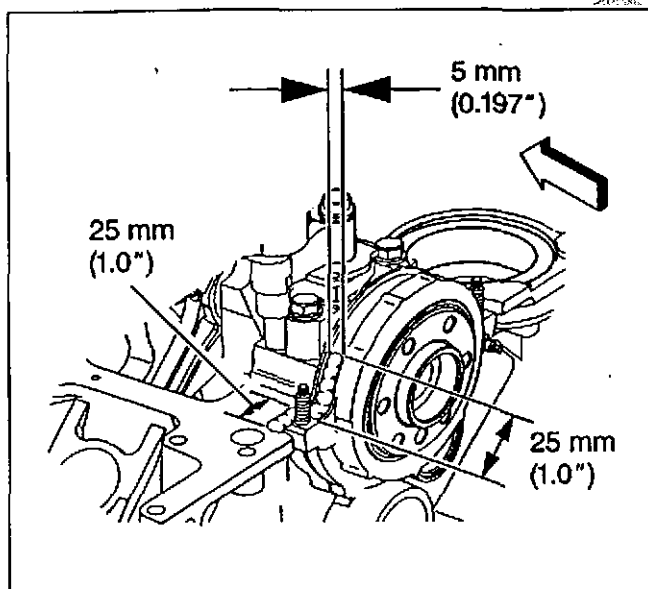
Tighten the oil pan studs to 6 N·m (53 lb in).

2. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive GM P/N 12346141 or equivalent, to the engine front cover to engine block junction at the oil pan sealing surfaces.



317310

3. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive GM P/N 12346141 or equivalent, to the crankshaft rear oil seal housing to engine block junction at the oil pan sealing surfaces.



317313

Important: Always install a NEW oil pan gasket.

The oil pan gasket and oil pan must be installed and the fasteners tightened while the adhesive is still wet to the touch.

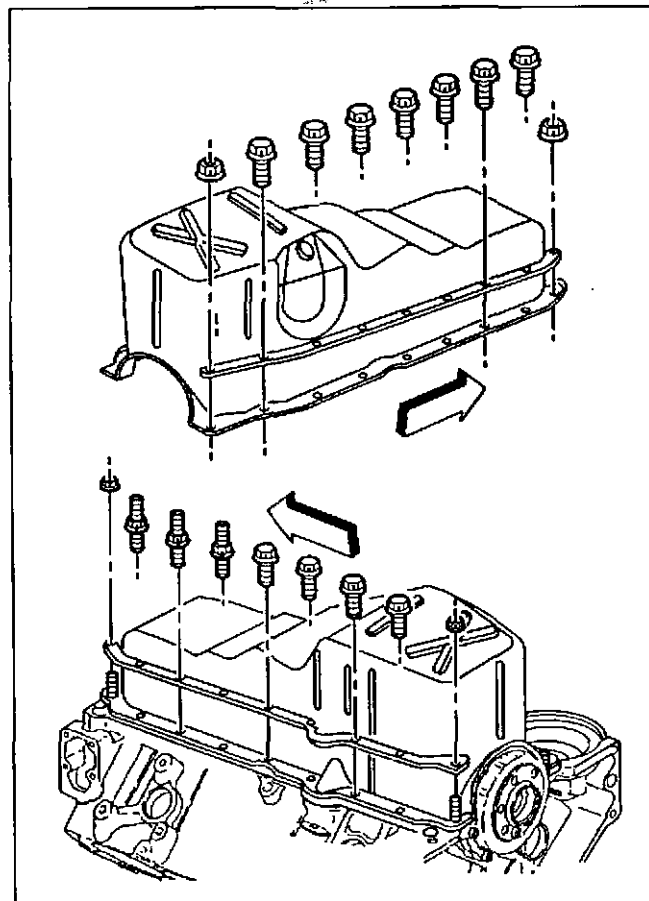
4. Install the NEW oil pan gasket.
5. Install the oil pan.

Press the oil pan gasket into the grooves of the engine front cover and crankshaft rear oil seal housing.

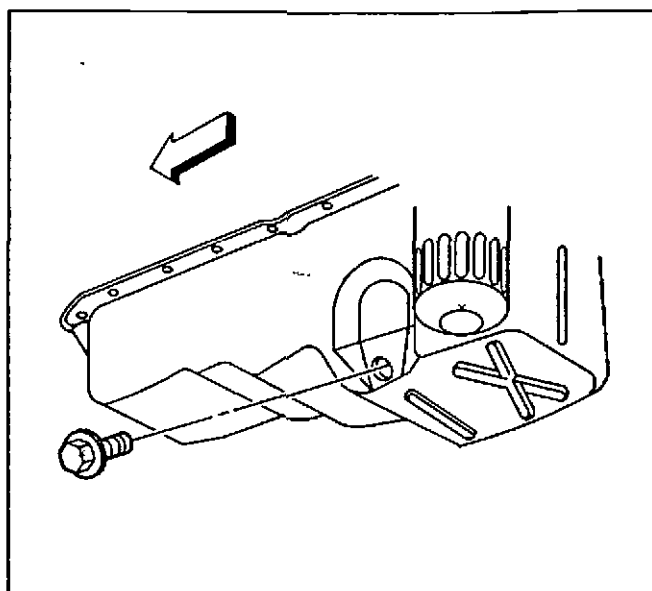
6. Install the oil pan reinforcements.
7. Install the nuts and the bolts.

Tighten

- 7.1. Tighten the oil pan bolts to 12 N·m (106 lb in).
- 7.2. Tighten the oil pan nuts to 25 N·m (18 lb ft).



182851



182850

8. Install a NEW oil pan drain plug seal (O-ring) onto the oil pan drain plug.

9. Install the oil pan drain plug into the oil pan.
Tighten

Tighten the oil pan drain plug to 25 N·m (18 lb ft).

SIE-ID = 66868

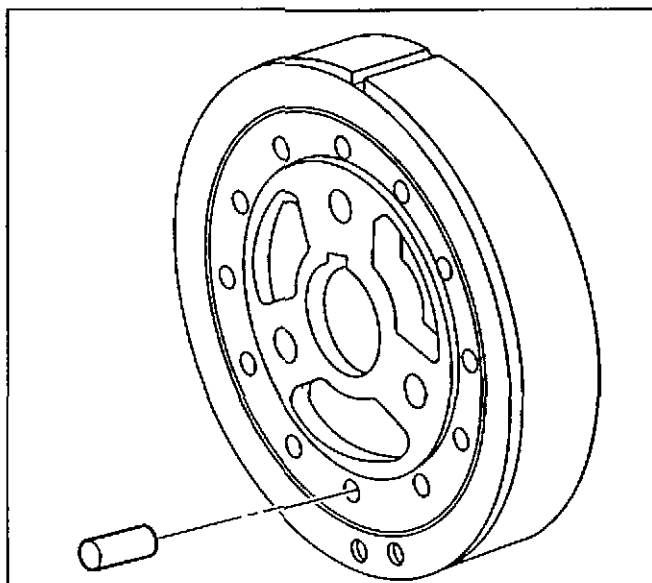
Crankshaft Balancer Installation

SIO-ID = 67079

Tools Required

J 23523-F Balancer Remover and Installer

1. Look to ensure that the front groove pin (crankshaft balancer) is installed in the proper location (if applicable).

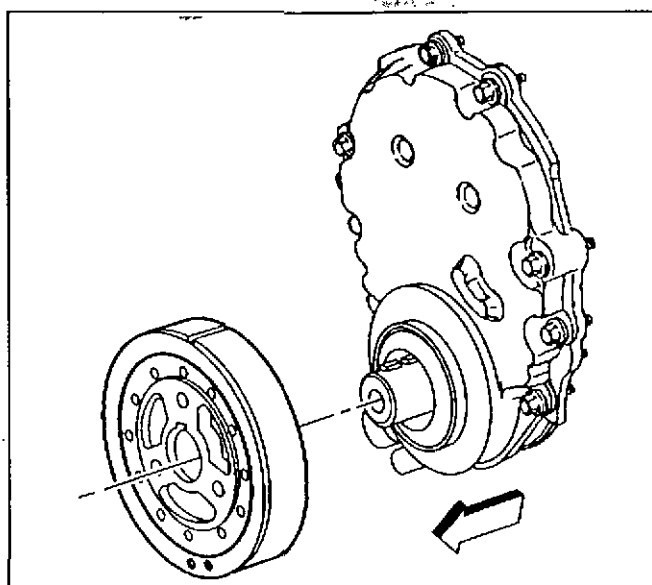


182849

Notice: SIO-ID = 16580 The inertial weight section of the crankshaft balancer is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the crankshaft balancer.

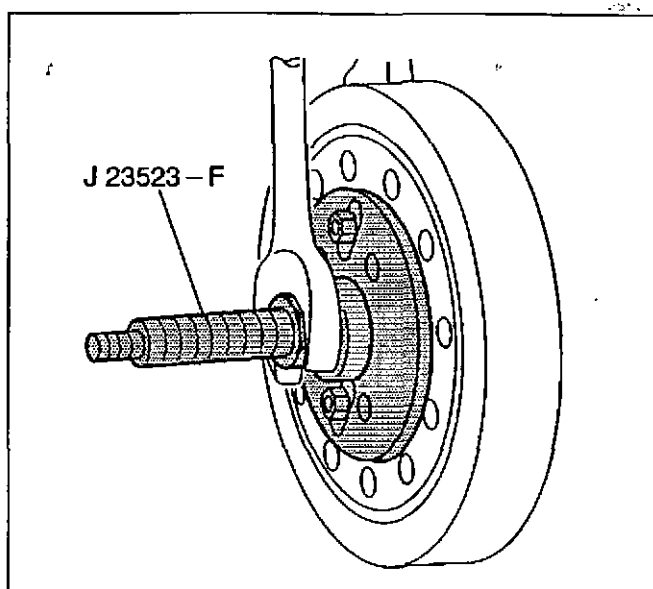
2. Apply a small amount of adhesive GM P/N 12346141 or equivalent onto the crankshaft balancer keyway in order to seal the crankshaft balancer keyway and crankshaft joint.
3. Install the crankshaft balancer onto the end of the crankshaft.

Align the keyway of the crankshaft balancer with the woodruff key (crankshaft balancer).



182832

4. Use the *J 23523-F* in order to press the crankshaft balancer onto the crankshaft.
 - 4.1. Install the *J 23523-F* into the front of the crankshaft.
 - 4.2. Rotate the *J 23523-F* nut until the nut, the washer, and the bearing are firmly against the crankshaft balancer.
 - 4.3. Use one wrench to hold the *J 23523-F* forcing screw.
 - 4.4. Use a second wrench and rotate the *J 23523-F* nut clockwise until the crankshaft balancer hub is completely seated against the crankshaft position sensor reluctor ring.
 - 4.5. Remove the *J 23523-F*.



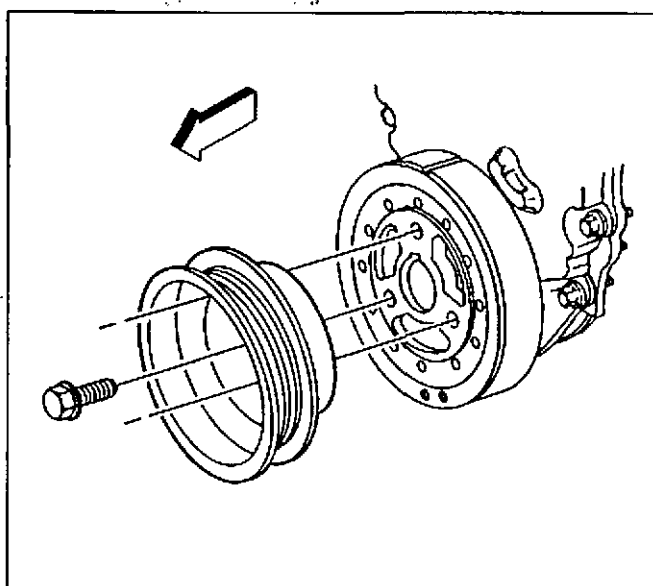
4065

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the crankshaft pulley and bolts.

Tighten

Tighten the crankshaft pulley bolts to 58 N·m (43 lb ft).

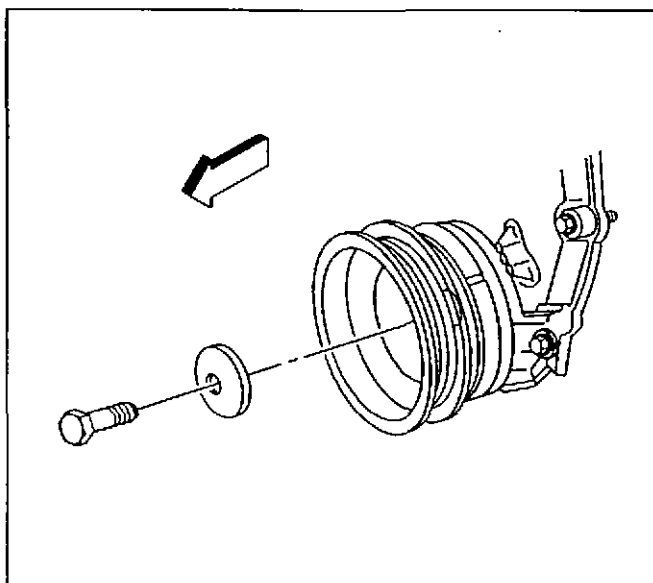


188055

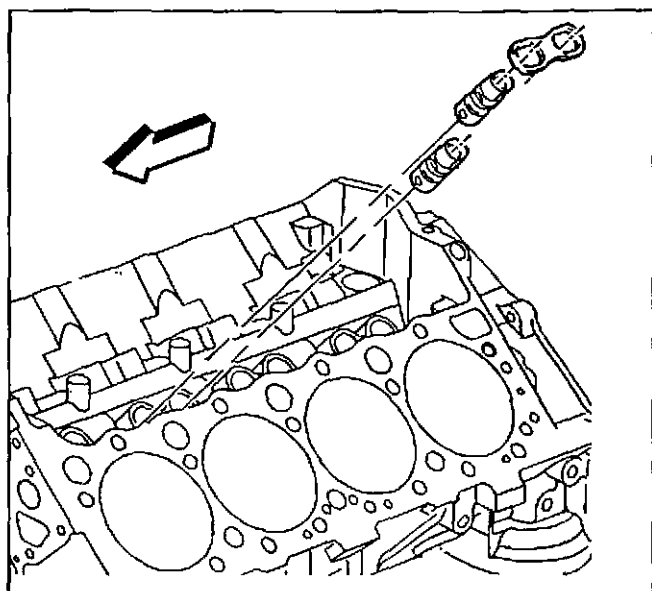
6. Install the crankshaft balancer washer and the bolt.

Tighten

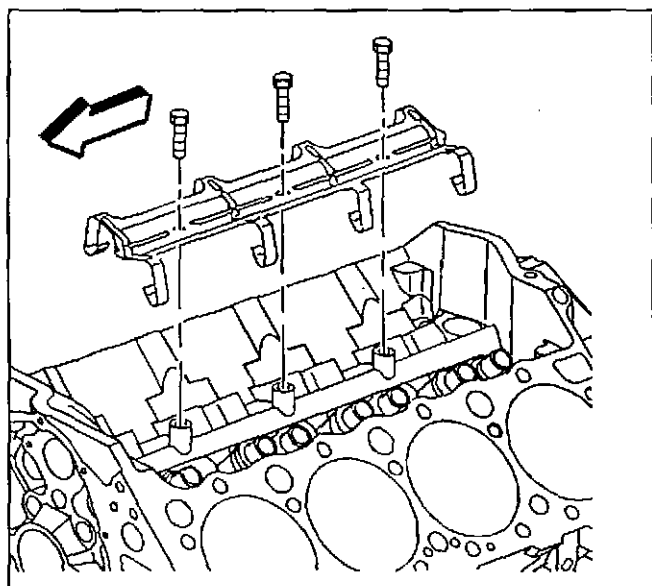
Tighten the crankshaft balancer bolt to 95 N·m (70 lb ft).



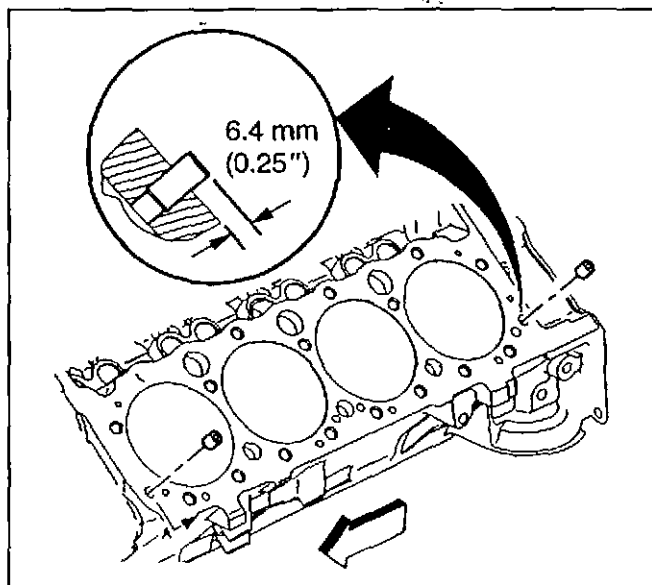
173172



11509



11508



182846

SIE-ID - 69825

Valve Lifter Installation

SIO-ID - 68951

1. Apply lubricant GM P/N 12345501 or equivalent to the valve lifter rollers.

Important: If reusing the valve lifters, install the valve lifters in the original positions.

2. Install the valve lifters.

3. Install the valve lifter guides.

4. Install the valve lifter guide retainer.

Notice: Refer to *Fastener Notice* in *Cautions and Notices*.

5. Install the valve lifter guide retainer bolts.

Tighten

Tighten the valve lifter guide retainer bolts to 25 N.m (18 lb ft).

SIE-ID - 66861

Cylinder Head Installation (Left)

SIO-ID - 66903

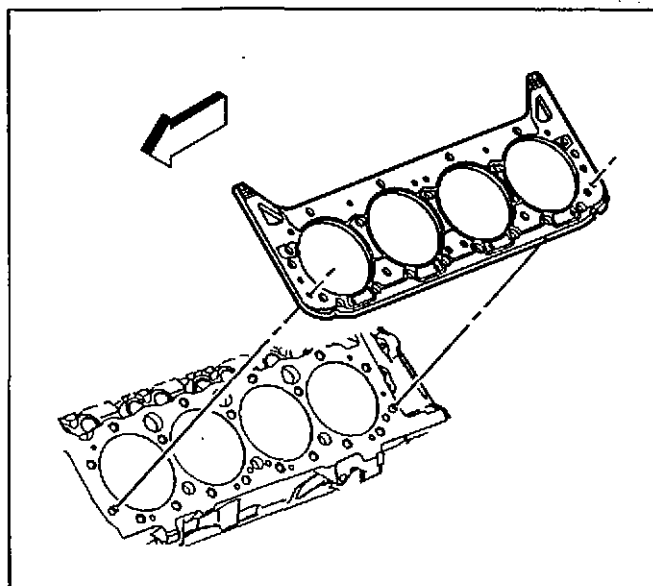
Tools Required

J 36660 Electronic Torque Angle Meter

1. Clean the cylinder gasket surfaces on the engine block.
2. Inspect the dowel pins (cylinder head locator) for proper installation.
3. Clean the cylinder head gasket surfaces on the cylinder head.

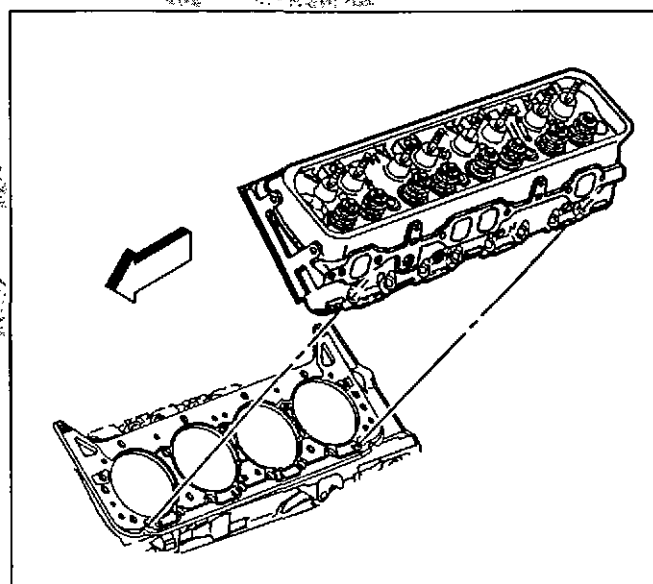
Important: Do not use any type sealer on the cylinder head gasket (unless specified).

4. Place the NEW cylinder head gasket in position over the dowel pins (cylinder head locator).



317233

5. Install the cylinder head to the engine block. Guide the cylinder head carefully into place over the dowel pins and the cylinder head gasket.

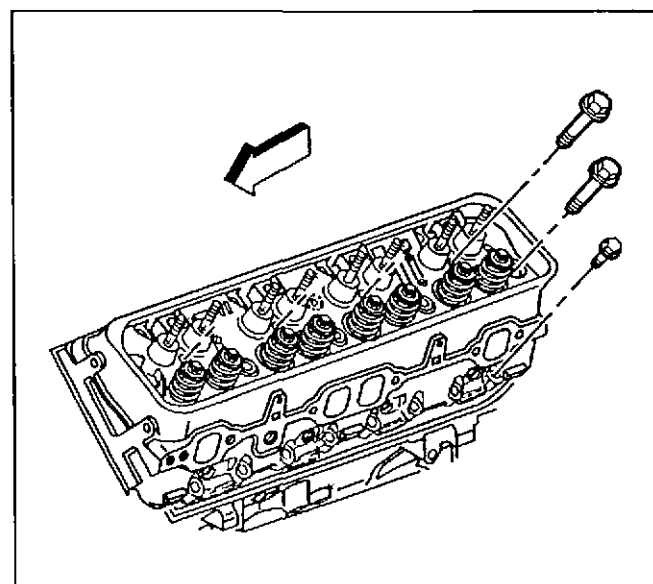


317227

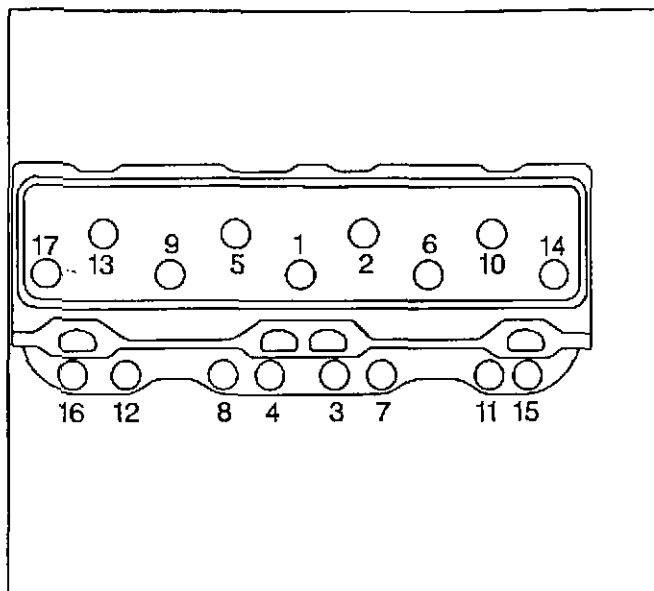
6. Apply sealant GM P/N 12346004 or equivalent to the threads of the cylinder head bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

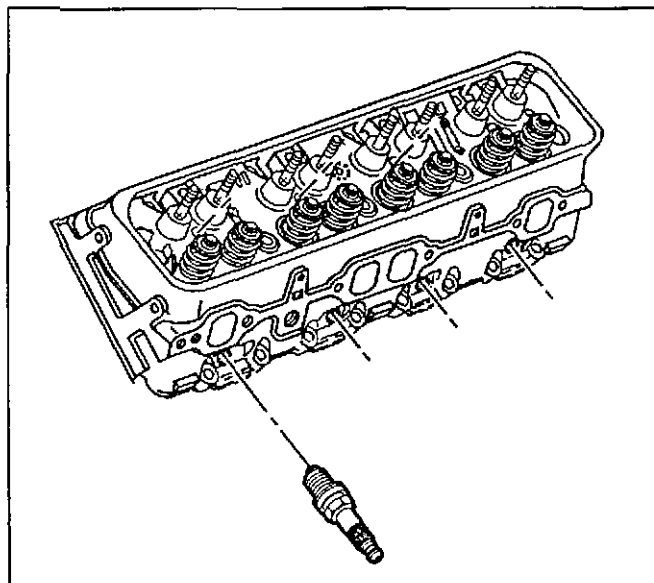
7. Install the cylinder head bolts.



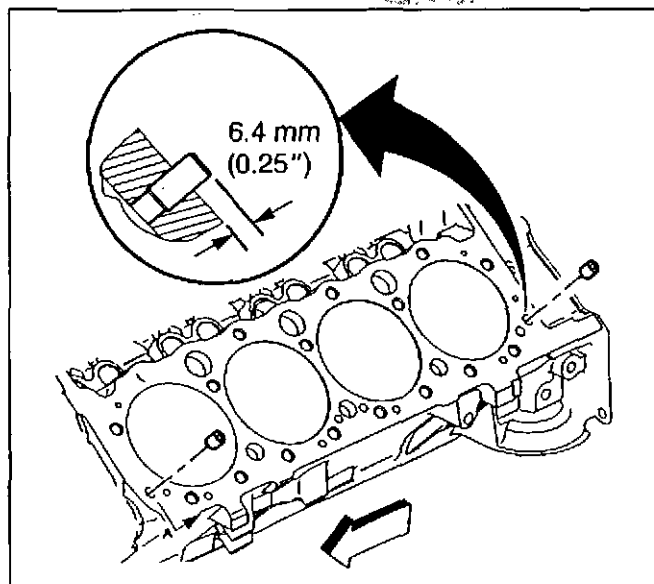
317217



11523



317307



182846

8. Tighten the cylinder head bolts in sequence on the first pass.

Tighten

Tighten the bolts in sequence on the first pass to 30 N.m (22 lb ft).

9. Use the *J 36660* in order to tighten the cylinder head bolts in sequence on the final pass.

Tighten

- Tighten the long bolts (1, 2, 5, 6, 9, 10, and 13) on the final pass in sequence to 75 degrees.
- Tighten the medium bolts (14 and 17) on the final pass in sequence to 65 degrees.
- Tighten the short bolts (3, 4, 7, 8, 11, 12, 15, and 16) on the final pass in sequence to 55 degrees.

10. Measure the NEW spark plugs for the proper gap.

Adjust the spark plug gap if necessary.

Specification

Spark plug gap to 1.52 mm (0.060 in).

11. Install the NEW spark plugs.

Tighten

- Tighten the spark plugs for a USED cylinder head to 15 N.m (11 lb ft).
- Tighten the spark plugs for the initial installation of a NEW cylinder head to 30 N.m (22 lb ft).

SIE-ID = 194890

Cylinder Head Installation (Right)

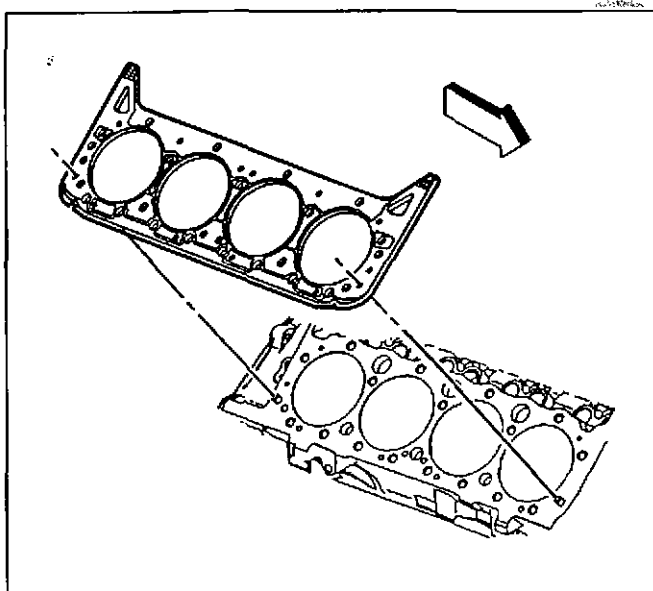
Tools Required

J 36660 Electronic Torque Angle Meter

1. Clean the cylinder gasket surfaces on the engine block.
2. Inspect the dowel pins (cylinder head locator) for proper installation.
3. Clean the cylinder head gasket surfaces on the cylinder head.

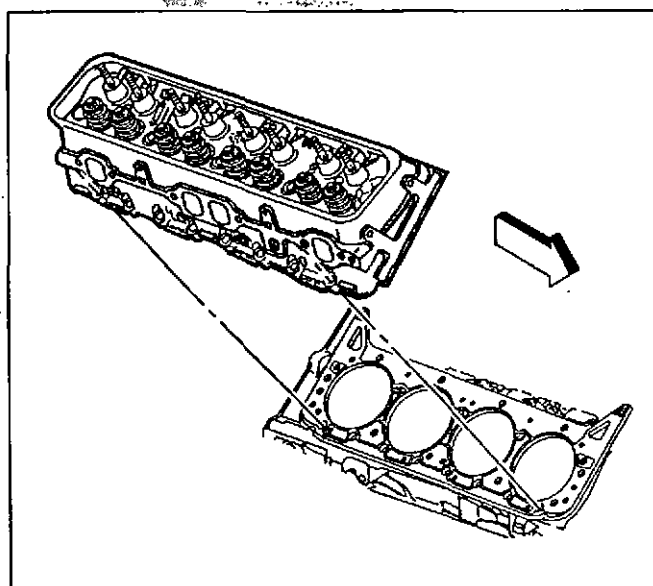
Important: Do not use any type sealer on the cylinder head gasket (unless specified).

4. Place the NEW cylinder head gasket in position over the dowel pins (cylinder head locator).



317255

5. Install the cylinder head to the engine block. Guide the cylinder head carefully into place over the dowel pins and the head gasket.

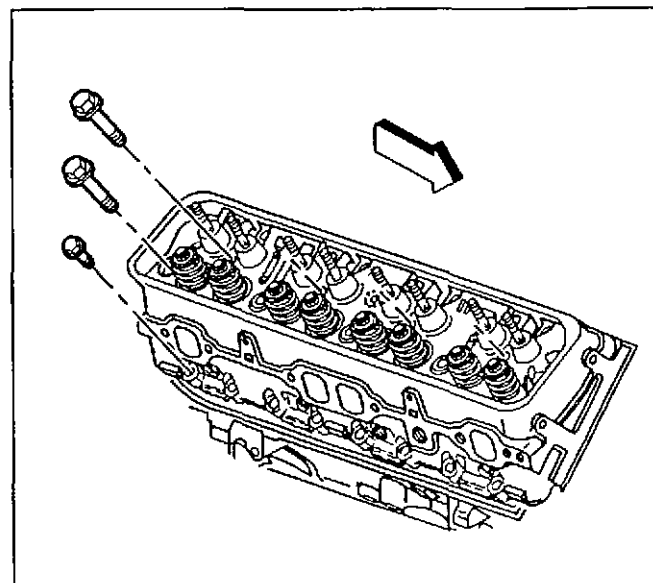


317246

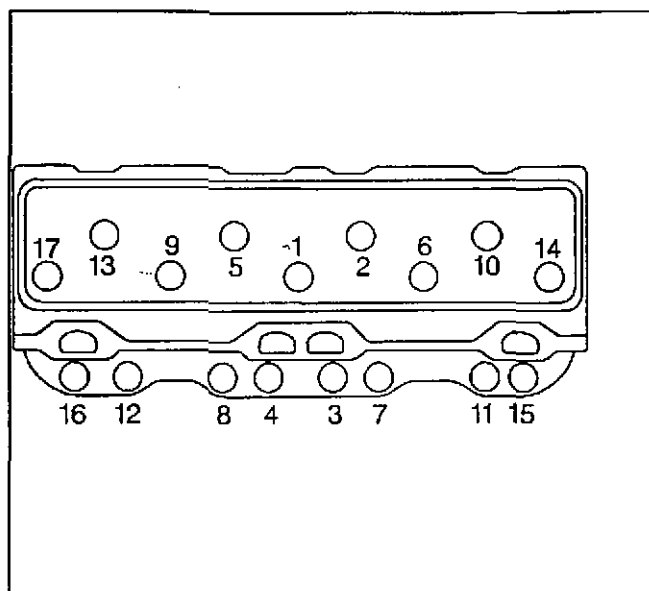
6. Apply sealant GM P/N 12346004 or equivalent to the threads of the cylinder head bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

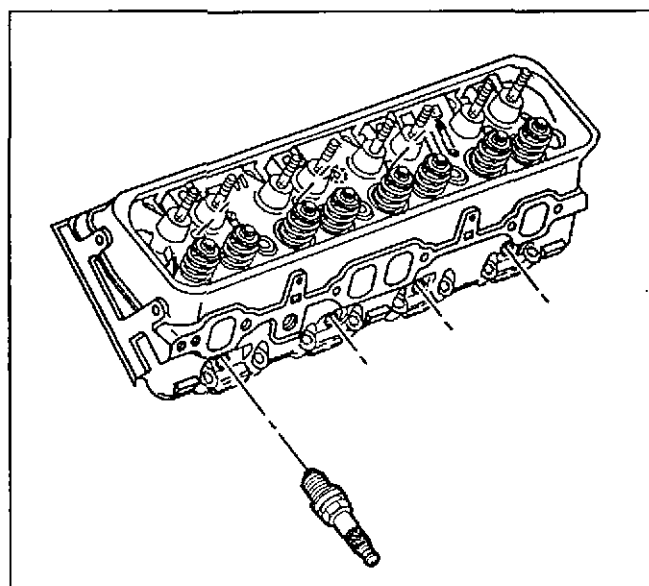
7. Install the cylinder head bolts.



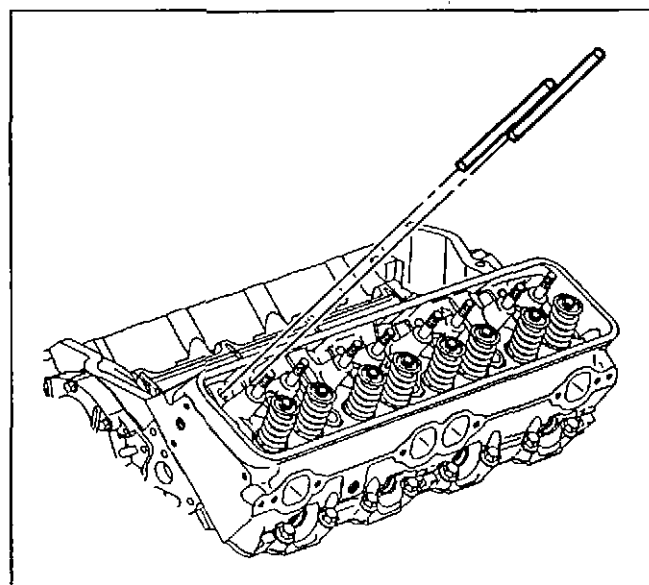
317239



11523



317307



22766

8. Tighten the cylinder head bolts in sequence on the first pass.

Tighten

Tighten the bolts in sequence on the first pass to 30 N.m (22 lb ft).

9. Use the J 36660 in order to tighten the cylinder head bolts in sequence on the second pass.

Tighten

- Tighten the long bolts (1, 2, 5, 6, 9, 10, and 13) on the second pass in sequence to 75 degrees.
- Tighten the medium bolts (14 and 17) on the second pass in sequence to 65 degrees.
- Tighten the short bolts (3, 4, 7, 8, 11, 12, 15, and 16) on the second pass in sequence to 55 degrees.

10. Measure the NEW spark plugs for the proper gap.

Adjust the spark plug gap if necessary.

Specifications

Spark plug gap to 1.52 mm (0.060 in).

11. Install the NEW spark plugs.

Tighten

- Tighten the spark plugs for a USED cylinder head to 15 N.m (11 lb ft).
- Tighten the spark plugs for the initial installation of a NEW cylinder head to 30 N.m (22 lb ft).

SIE-ID = 194762

Valve Rocker Arm and Push Rod Installation

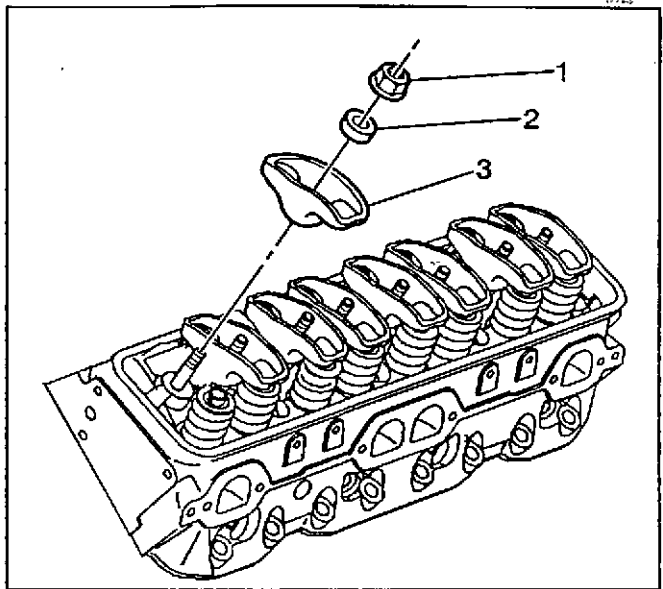
Important: Be sure to keep parts in order. Parts must be put back from where they were removed.

1. Apply prelube GM P/N 12345501 or equivalent to the valve rocker arm and the valve rocker arm ball bearing surfaces.

Important: Be sure that the valve pushrods seat in the valve lifter sockets.

2. Install the valve pushrods.

3. Install the following parts:
 - 3.1. The valve rocker arm nuts (1)
 - 3.2. The valve rocker arm balls (2)
 - 3.3. The valve rocker arms (3)

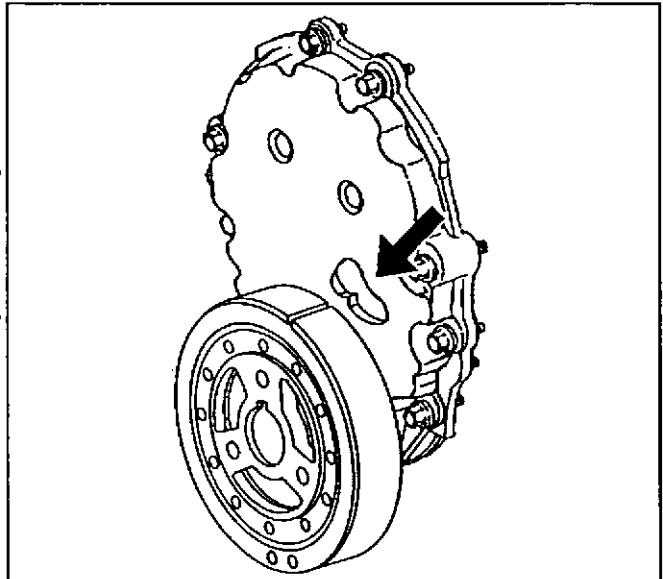


182835

SIE-ID - 194734

Valve Lash Adjustment

1. Turn the valve rocker arm nuts clockwise until all of the valve lash is removed.
2. Turn the crankshaft clockwise until the alignment mark on the crankshaft balancer is aligned with the notch in the engine front cover tab.
3. Look at the number 1 cylinder valves as the crankshaft balancer alignment mark approaches the notch in the engine front cover tab. If a valve moves as the alignment mark moves into position, the engine is in the number 6 firing position. If this happens, turn the crankshaft clockwise one revolution in order to reach the number 1 cylinder firing position.



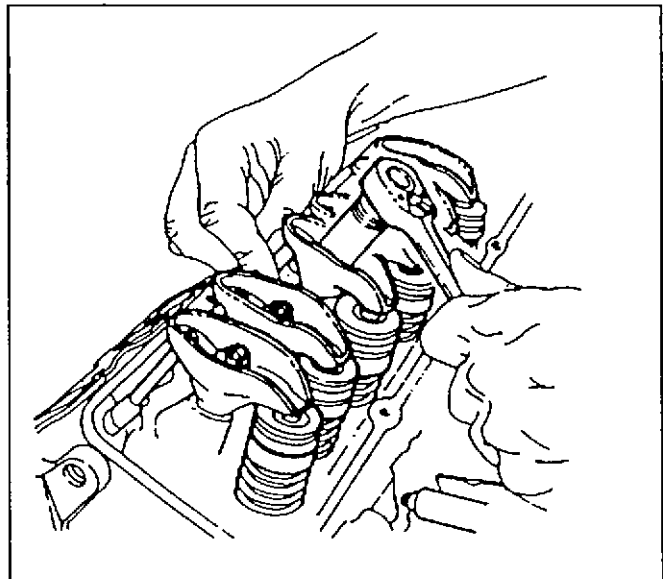
195336

4. With the engine in the number 1 firing position, adjust the exhaust valves for cylinders number 1, 3, 4, and 8 and the intake valves for cylinders number 1, 2, 5, and 7.

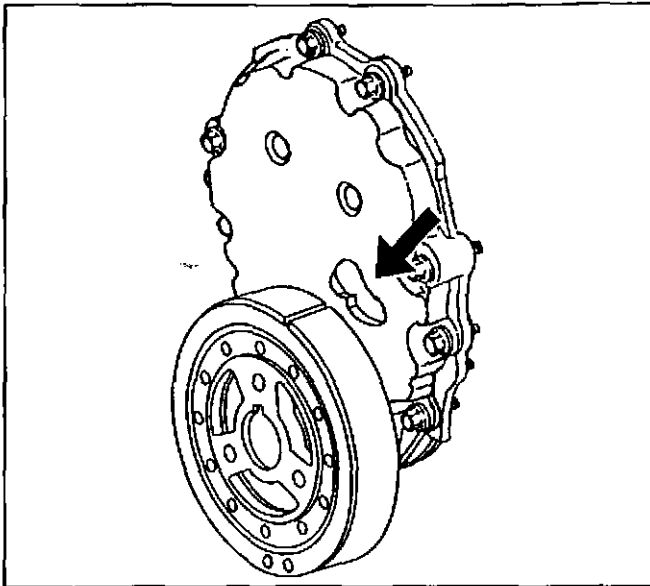
- 4.1. Turn the valve rocker arm nut counter clockwise until the valve lash is felt in the valve pushrod.
- 4.2. Turn the valve rocker arm nut clockwise until all the valve lash is removed (zero valve lash).

Zero valve lash can be felt by moving the valve pushrod up and down between your thumb and forefinger until there is no more up and down movement of the valve push rod.

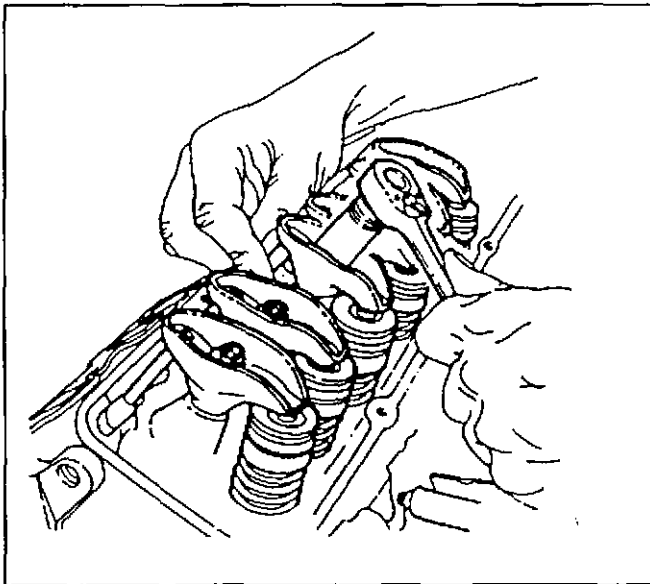
- 4.3. When all the valve lash is removed, then turn the valve rocker arm nut clockwise 1 additional turn (360 degrees).



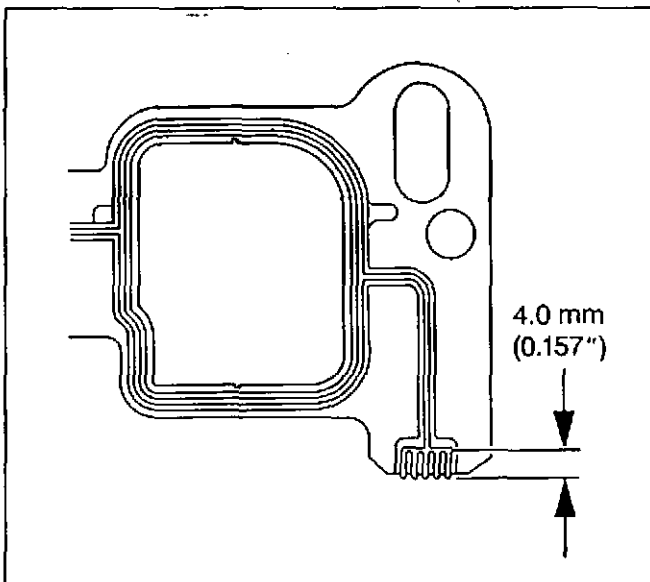
22759



195336



22759



38512

5. Turn the crankshaft clockwise 1 revolution until the alignment mark on the crankshaft balancer is aligned with the notch in the engine front cover tab.

6. With the engine in the number 6 firing position, adjust the exhaust valves for cylinders number 2, 5, 6, and 7 and the intake valves for cylinders number 3, 4, 6, and 8.

6.1. Turn the valve rocker arm nut counter clockwise until the valve lash is felt in the valve pushrod.

6.2. Turn the valve rocker arm nut clockwise until all the valve lash is removed (zero valve lash).

Zero valve lash can be felt by moving the valve pushrod up and down between your thumb and forefinger until there is no more up and down movement of the valve push rod.

6.3. When all the valve lash is removed, then turn the valve rocker arm nut clockwise 1 additional turn (360 degrees).

SIE-ID - 66866

Intake Manifold Installation

SIO-ID - 67832

Notice: SIO-ID - 16302 Applying excessive amounts of sealant may prohibit the intake gasket from sealing properly.

Important: The lower intake manifold must be installed and the fasteners tightened while the adhesive is still wet to the touch.

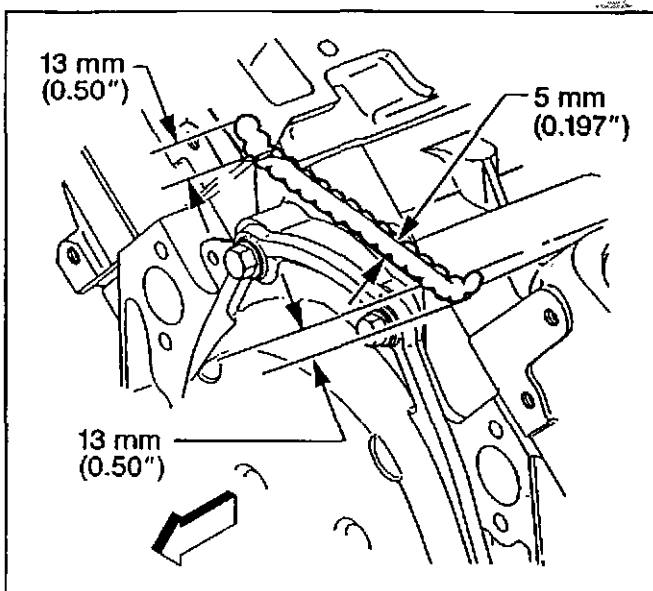
1. Apply a 4.0 mm (0.157 in) patch of adhesive GM P/N 12346141 or equivalent to the cylinder head side of the lower intake manifold gasket at each end.
2. Install the lower intake manifold gasket onto the cylinder head.

Use the gasket locator pins in order to properly seat the lower intake manifold gasket onto the cylinder head.

Notice: SIO-ID - 41431 Care must be used to apply the correct amount of sealant onto the gaskets. Applying excessive amounts of sealant may prohibit the intake gaskets from sealing properly.

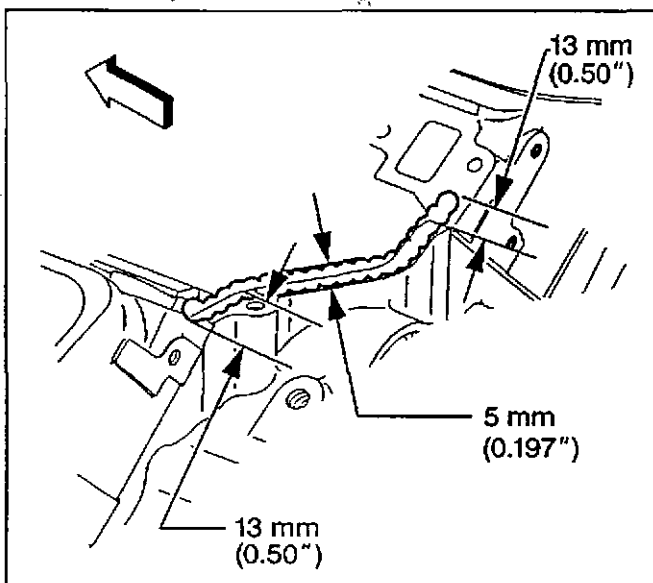
Important: All sealing surfaces must be clean, free of oil, dirt, or any other foreign material.

3. Apply a 5 mm (0.197 in) bead of adhesive GM P/N 12346141 or equivalent to the front top of the engine block.
4. Extend the adhesive bead 13 mm (0.50 in) onto the each lower intake manifold gasket.



26744

5. Apply a 5 mm (0.197 in) bead of adhesive GM P/N 12346141 or equivalent to the rear top of the engine block.
6. Extend the adhesive bead 13 mm (0.50 in) onto each lower intake manifold gasket.

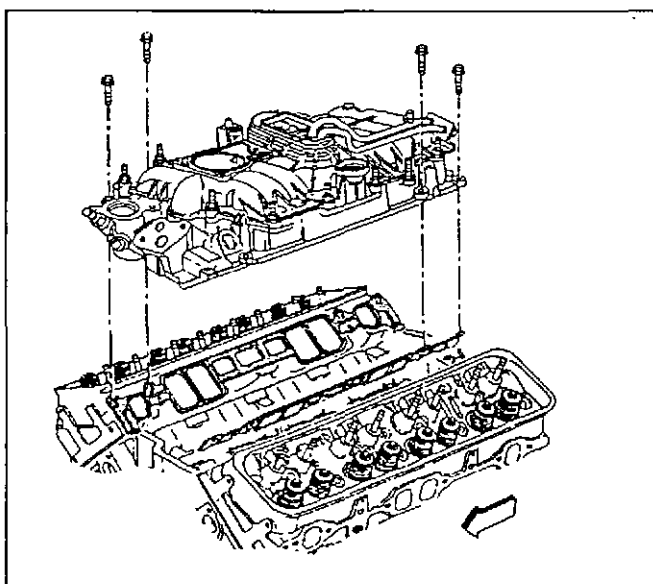


26743

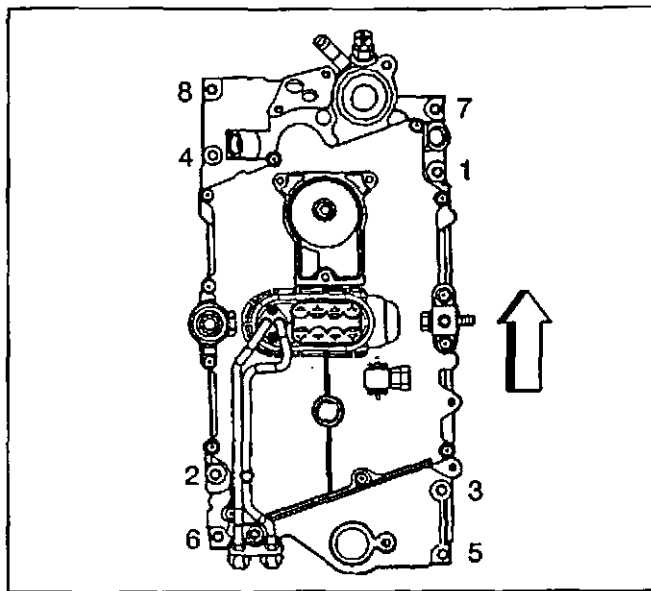
7. Install the lower intake manifold onto the engine block and the cylinder heads.

Notice: Refer to *Fastener Notice* in *Cautions and Notices*.

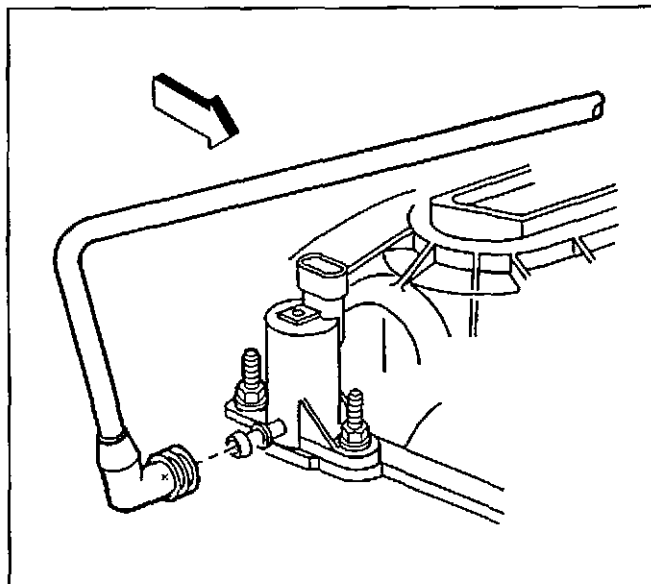
8. Apply threadlock GM P/N 12345382 or equivalent to the threads of the lower intake manifold bolts.



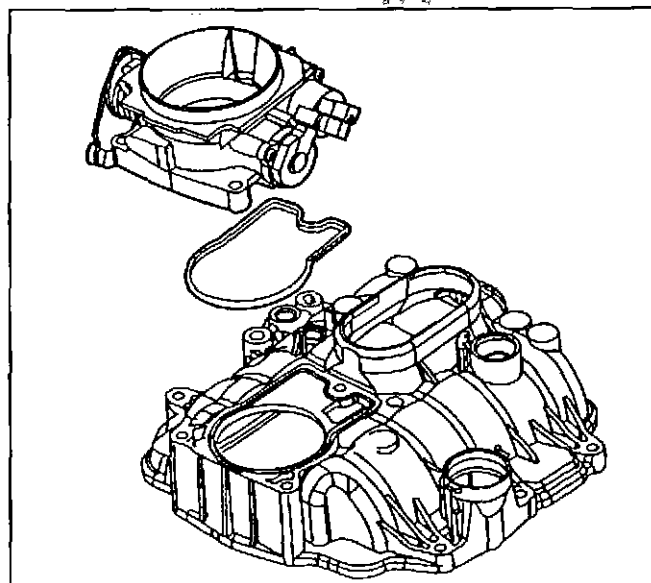
66456



31698



317211



12853

Notice: S10-10 - 382467 Proper lower intake manifold fastener tightening sequence and torque is critical. Always follow the tightening sequence, and torque the intake manifold bolts using the 3 step method. Failing to do so may distort the crankshaft bearing bore alignment and cause damage to the crankshaft bearings.

9. Install the lower intake manifold bolts.

Tighten

- 9.1. Tighten the bolts on the first pass in sequence (1-8) to 3 N.m (27 lb in).
- 9.2. Tighten the bolts on the second pass in sequence (1-8) to 12 N.m (106 lb in).
- 9.3. Tighten the bolts on the final pass in sequence (1-8) to 15 N.m (11 lb ft).

10. Connect the evaporative emission (EVAP) canister purge solenoid valve harness.

11. Install the vacuum hose.

S1E-1D - 194662

Throttle Body Installation

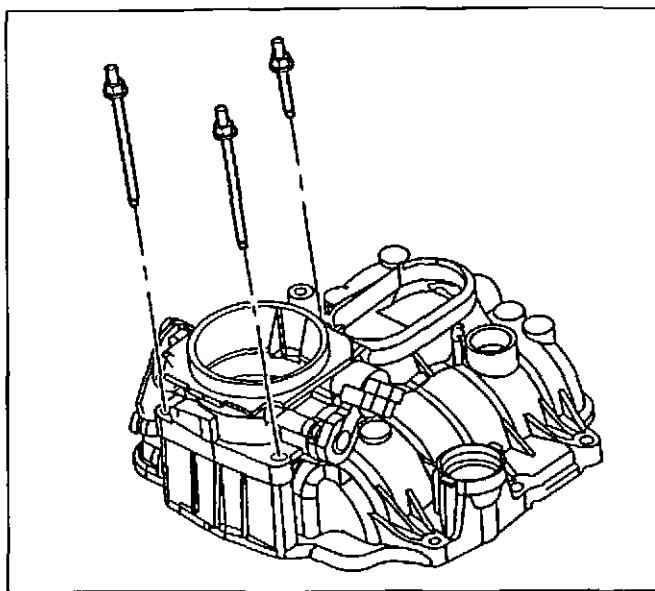
1. Install a NEW throttle body gasket into the groove of the upper intake manifold.
2. Install the throttle body onto the upper intake manifold.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the throttle body attaching studs.

Tighten

Tighten the throttle body attaching studs to 9 N.m (80 lb in).

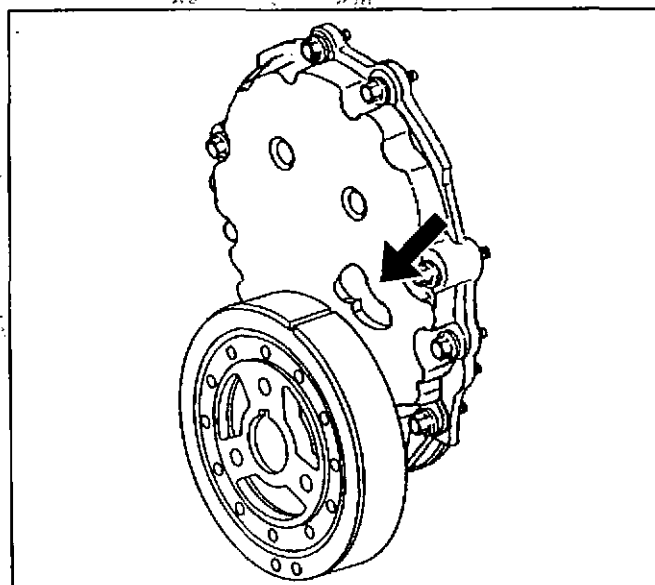


12852

SIE-ID ~ 69509

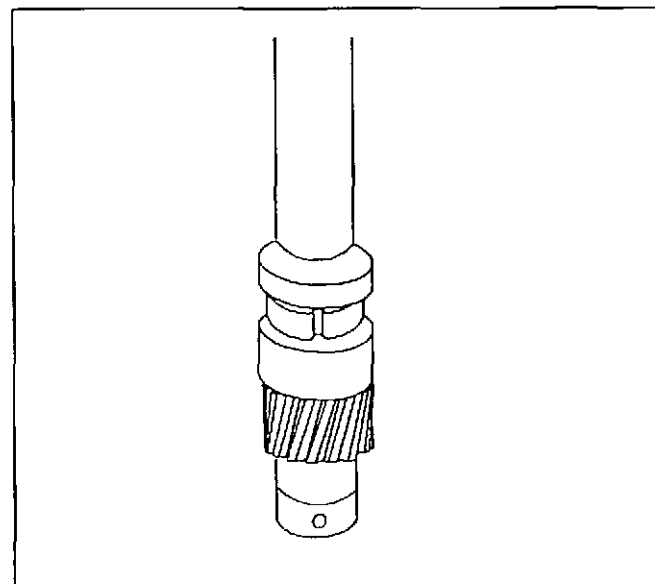
Distributor Installation

1. Bring cylinder number one piston to Top Dead Center (TDC) of compression stroke.
2. Remove the distributor cap bolts and discard.
3. Remove the distributor cap.

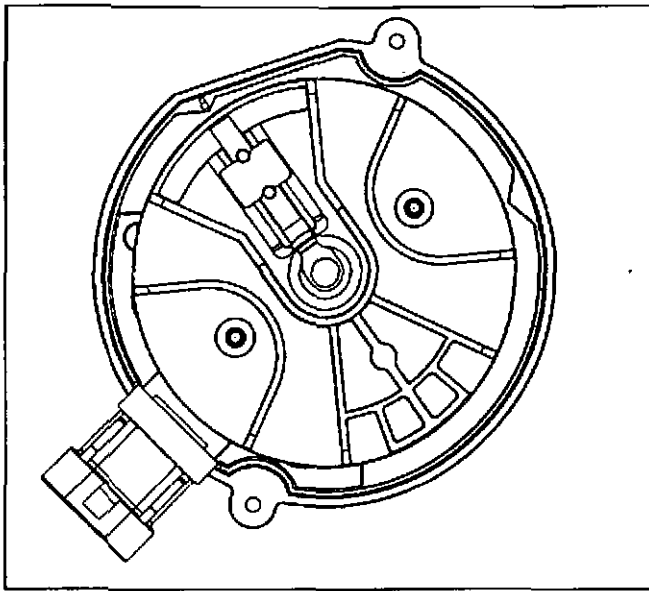


195336

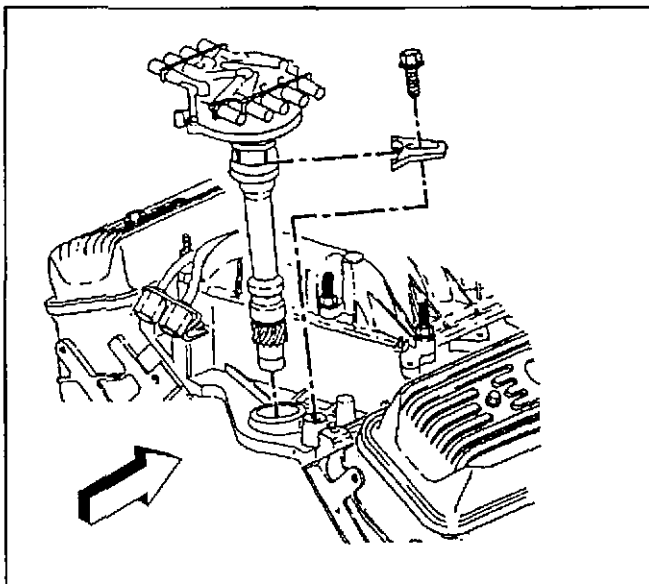
4. Align the indent hole on the driven gear with the paint mark on the distributor housing.



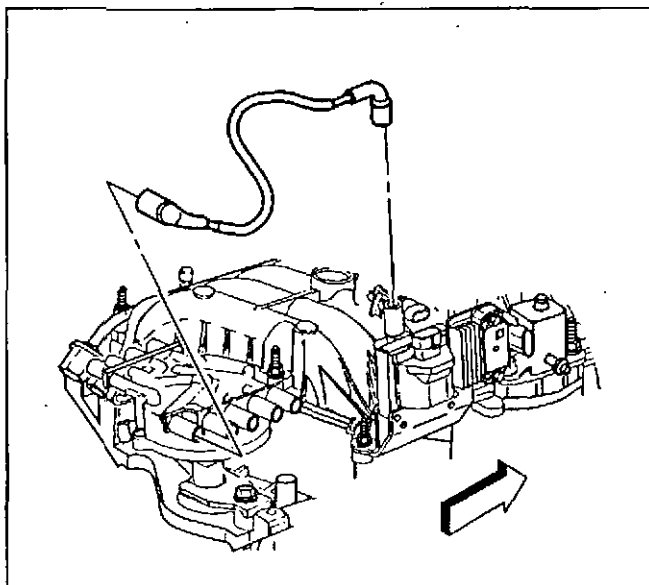
43756



68505



69303



341359

5. Ensure that the distributor rotor segment points to the cap hold area.
6. Align the slotted tang in the oil pump driveshaft with the distributor driveshaft. Rotate the oil pump driveshaft with a screwdriver if necessary.
7. Install the distributor and NEW distributor gasket. The flat in the distributor housing must point toward the front of the engine.
8. Once the distributor is fully seated, align the distributor rotor segment with the number 8 pointer that is cast into the distributor base.
9. If the distributor rotor segment does not come within a few degrees of the number 8 pointer, the gear mesh between the distributor and camshaft may be off a tooth or more. Repeat the procedure in order to achieve proper alignment.

10. Install the distributor cap.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

11. Install the NEW distributor cap mounting bolts. Do not overtighten the NEW bolts as the distributor housing boss may strip.

Tighten

Tighten the distributor cap bolts to 5 N·m (44 lb in).

12. Install the distributor clamp and bolt.

Tighten

Tighten the distributor clamp bolt to 25 N·m (18 lb ft).

13. Install the ignition coil wire harness.

SIE-ID - 66864

Valve Rocker Arm Cover Installation (Left)

SIO-ID - 66906

Important: Always install a NEW valve rocker arm cover gasket.

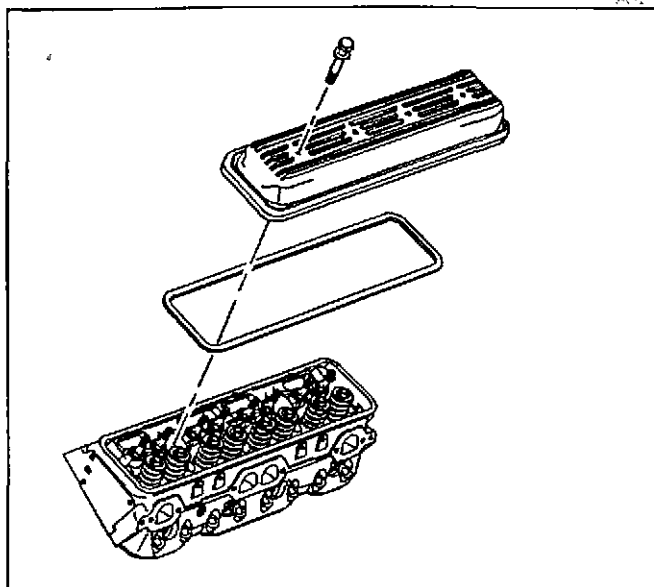
1. Install the NEW valve rocker arm cover gasket.
2. Install the valve rocker arm cover.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the valve rocker arm cover washers and bolts.

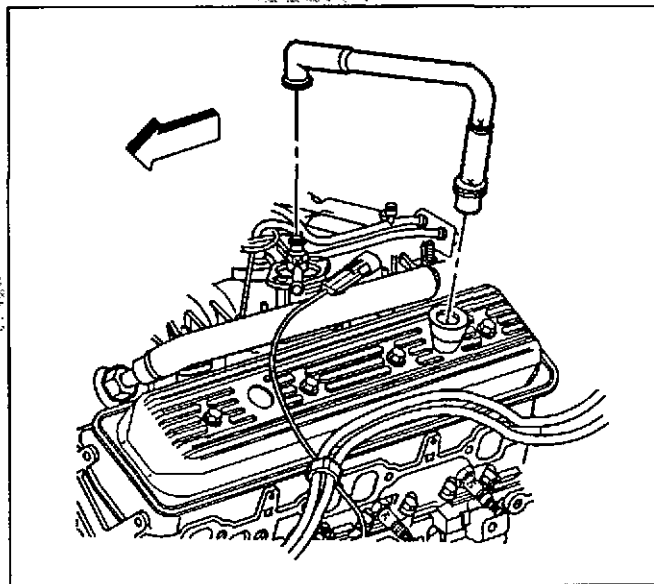
Tighten

Tighten the bolts to 12 N.m (106 lb in).



39119

4. Install the PCV valve hose assembly.



317197

SIE-ID - 194900

Valve Rocker Arm Cover Installation (Right)**Important:** Always install a NEW valve rocker arm cover gasket.

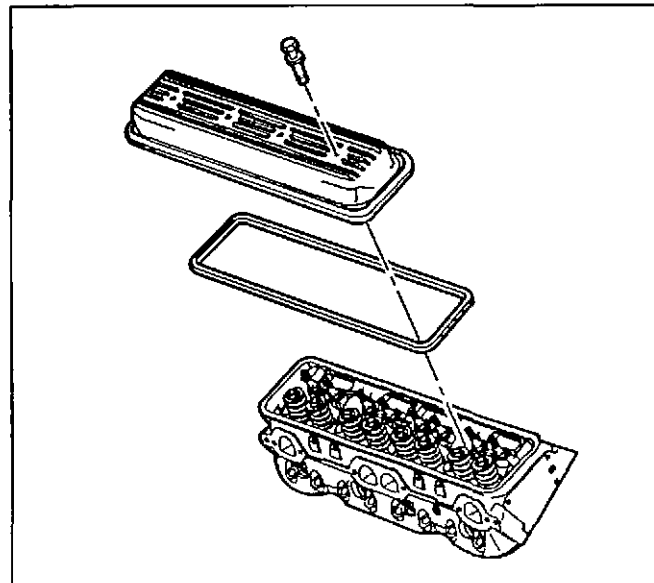
1. Install the NEW valve rocker arm cover gasket.
2. Install the valve rocker arm cover.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the valve rocker arm cover washers and bolts.

Tighten

Tighten the bolts to 12 N.m (106 lb in).



182833

SIE-ID - 69040

Water Pump Installation

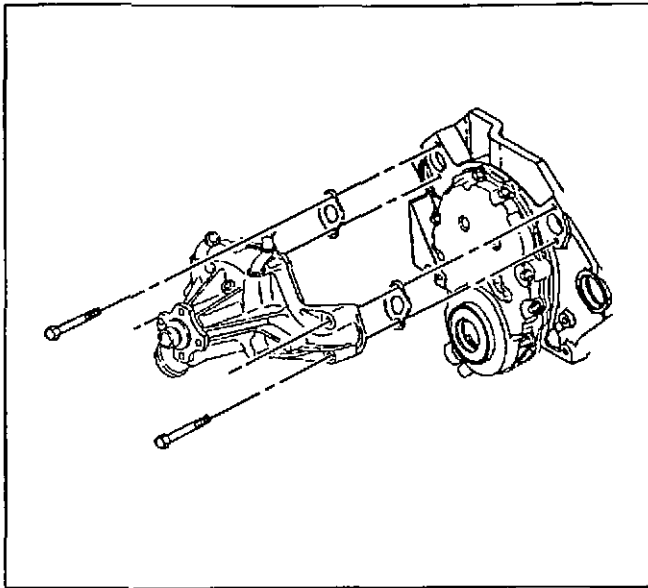
1. Apply sealant GM P/N 12346004 or equivalent to the threads of the water pump bolts.
2. Install NEW water pump gaskets.
3. Install the water pump.

Notice: Refer to *Fastener Notice* in *Cautions and Notices*.

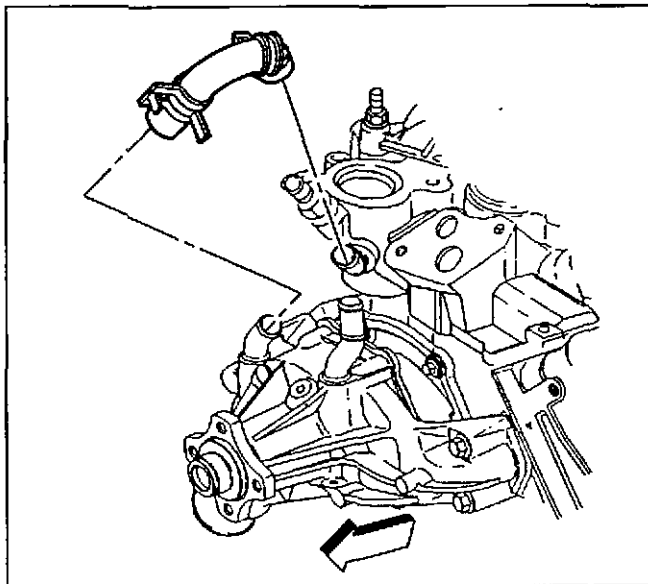
4. Install the water pump bolts.

Tighten

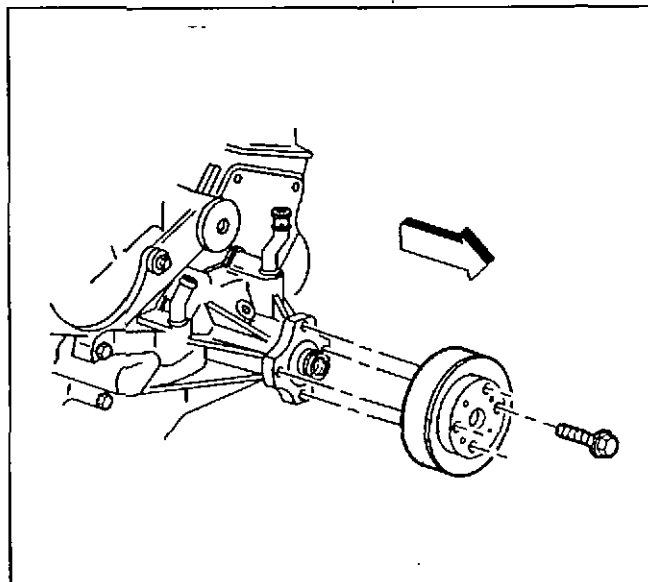
Tighten the water pump bolts to 45 N.m (33 lb ft).



69011



182853



317191

Important: After final assembly, the water pump inlet hose clamp tangs (water pump end) must point forward and the upper tang should be level with the outside diameter of the water pump inlet hose.

5. Install the water pump inlet hose and the water pump inlet hose clamps.

6. Install the fan and water pump pulley and bolts.

Tighten

Tighten the fan and water pump pulley bolts to 25 N.m (18 lb ft).

SIE-ID - 67320

Exhaust Manifold Installation (Left)

SIO-ID - 66909

1. Install the NEW exhaust manifold gasket.
2. Install the exhaust manifold.
3. Install the spark plug wire shields.
4. Apply threadlock GM P/N 12345493 or equivalent to the threads of the exhaust manifold bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the exhaust manifold bolts.

Tighten

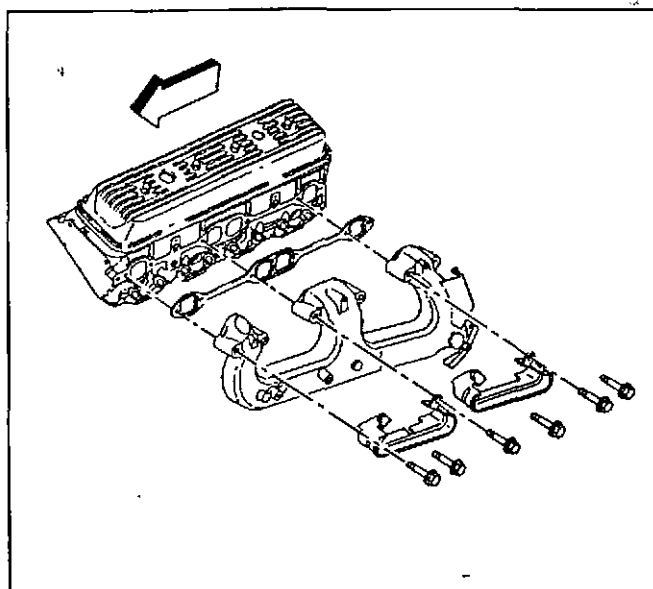
- 5.1. Tighten the exhaust manifold bolts on the first pass to 15 N.m (11 lb ft).
- 5.2. Tighten the exhaust manifold bolts on the final pass to 30 N.m (22 lb ft).

6. Install the spark plug wire supports and bolts.

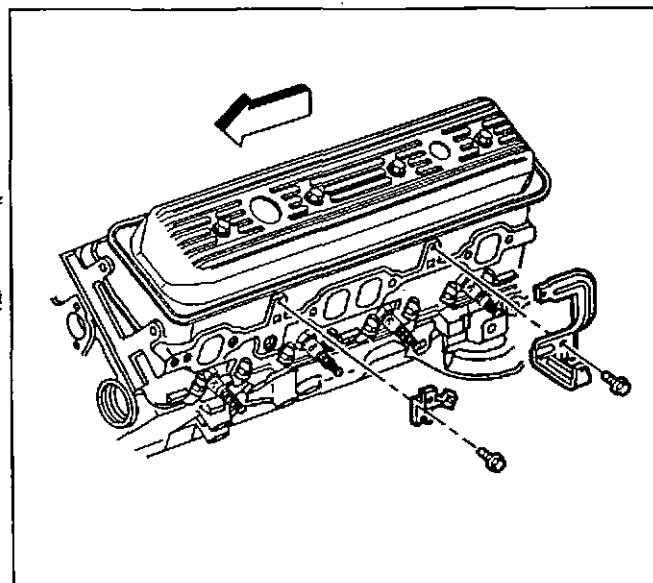
Tighten

Tighten the bolts to 12 N.m (106 lb in).

7. Install the spark plug wires onto the spark plugs.



64925



317185

SIE-ID - 66869

Exhaust Manifold Installation (Right)

SIO-ID - 66908

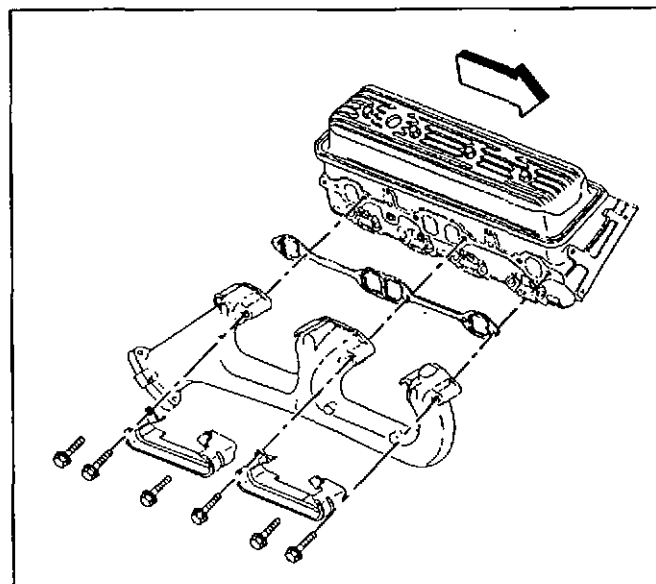
1. Install the NEW exhaust manifold gasket.
2. Install the exhaust manifold.
3. Install the spark plug heat shields.
4. Apply threadlock GM P/N 12345493 or equivalent to the threads of the exhaust manifold bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

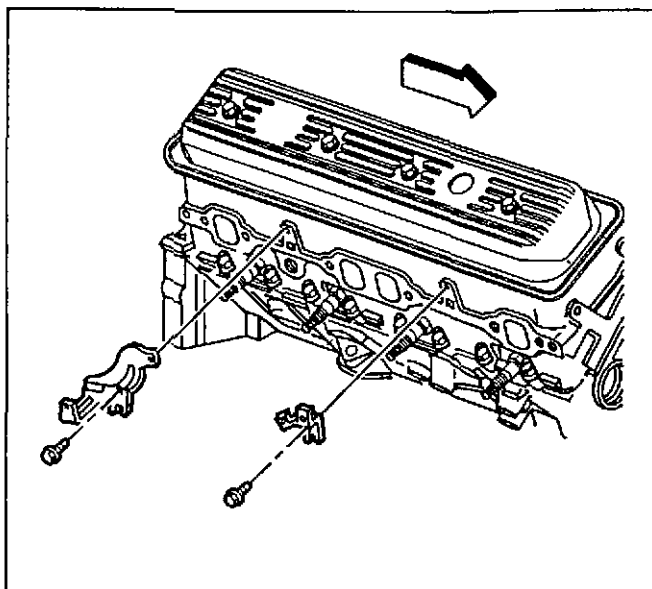
5. Install the exhaust manifold bolts.

Tighten

- 5.1. Tighten the exhaust manifold bolts on the first pass to 15 N.m (11 lb ft).
- 5.2. Tighten the exhaust manifold bolts on the final pass to 30 N.m (22 lb ft).



69032



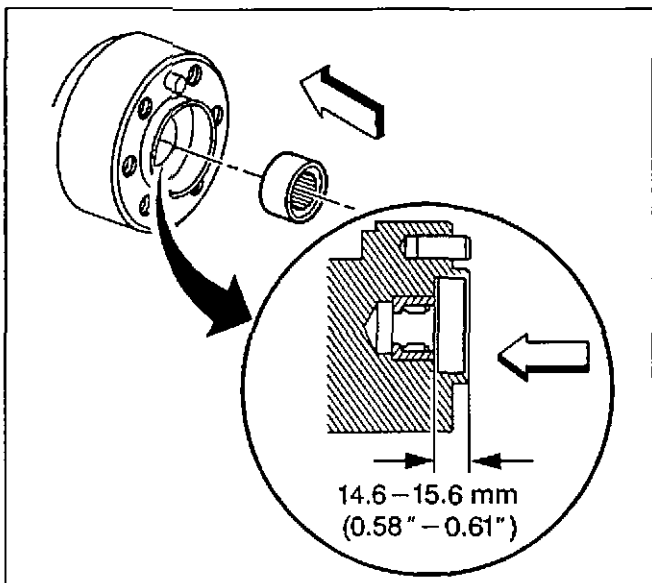
317179

6. Install the spark plug wire supports and bolts.

Tighten

Tighten the bolts to 12 N.m (106 lb in).

7. Install the spark plug wires onto the spark plugs.



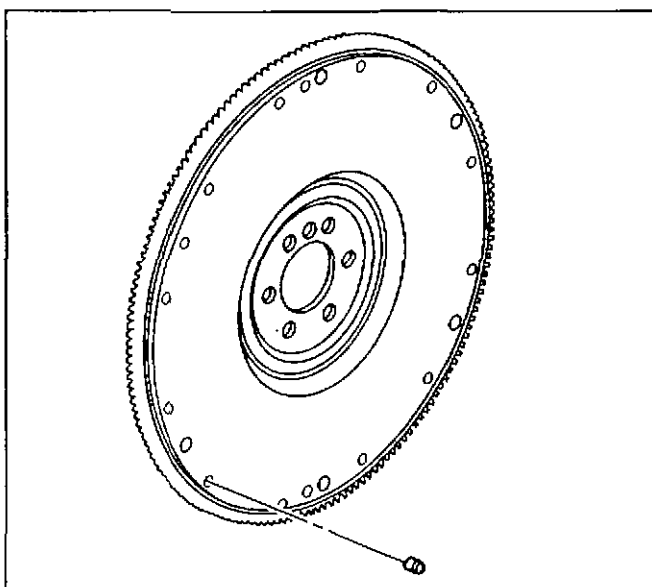
373138

SIE-ID = 375499

Clutch Pilot Bearing Installation

Caution: SIO-ID = 5011 *Wear safety glasses in order to avoid eye damage.*

1. Install the NEW clutch pilot bearing.
2. Measure to ensure the proper installation depth is obtained.



64126

SIE-ID = 66871

Engine Flywheel Installation

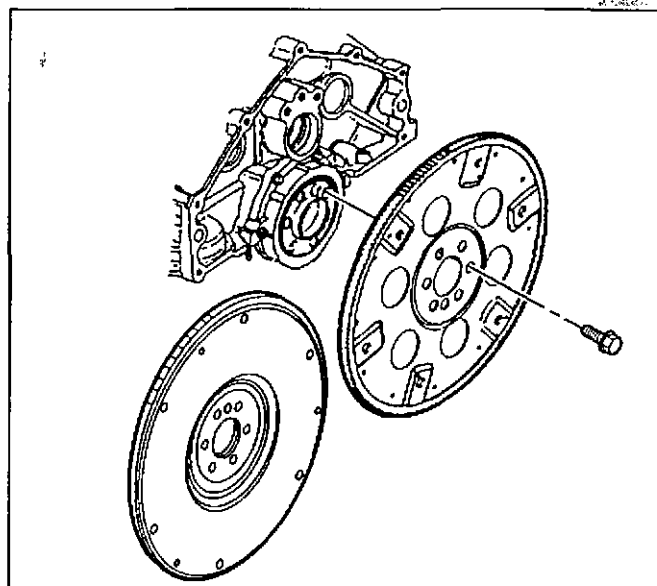
SIO-ID = 66957

Important: If replacing the engine flywheel (manual transmission), note the position of the original flywheel weights (if applicable). Flywheel weights must be installed into the new engine flywheel (manual transmission) in the same location.

1. Note the position of the flywheel weights (manual transmission applications), install the NEW flywheel weights as required.

A properly installed flywheel weight should be installed until flush or below flush with the face of the engine flywheel.

2. Install the engine flywheel.
- Align the engine flywheel locator hole to the flywheel locator pin.



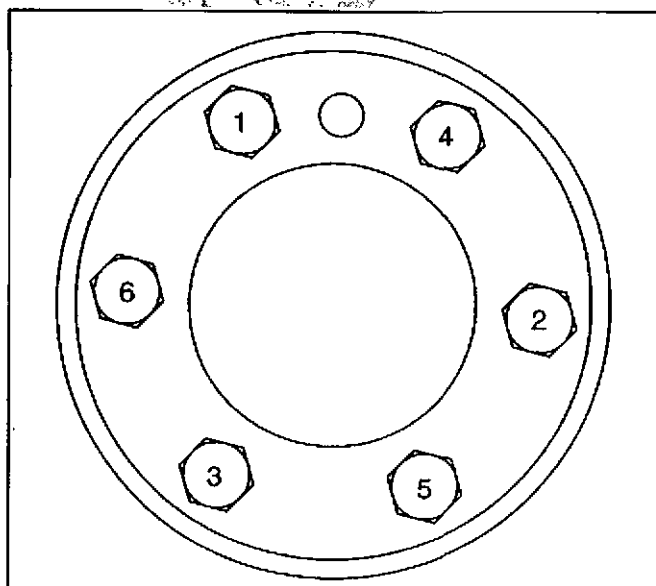
69012

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the engine flywheel bolts.

Tighten

Tighten the engine flywheel bolts in sequence (1-8) to 100 N·m (74 lb ft).



63174

SIE-ID - 69044

Engine Set-Up and Testing

After overhaul, the engine must be tested before it is installed in the vehicle. If a suitable test stand is not available, the following procedure can be used after the engine is installed in the vehicle.

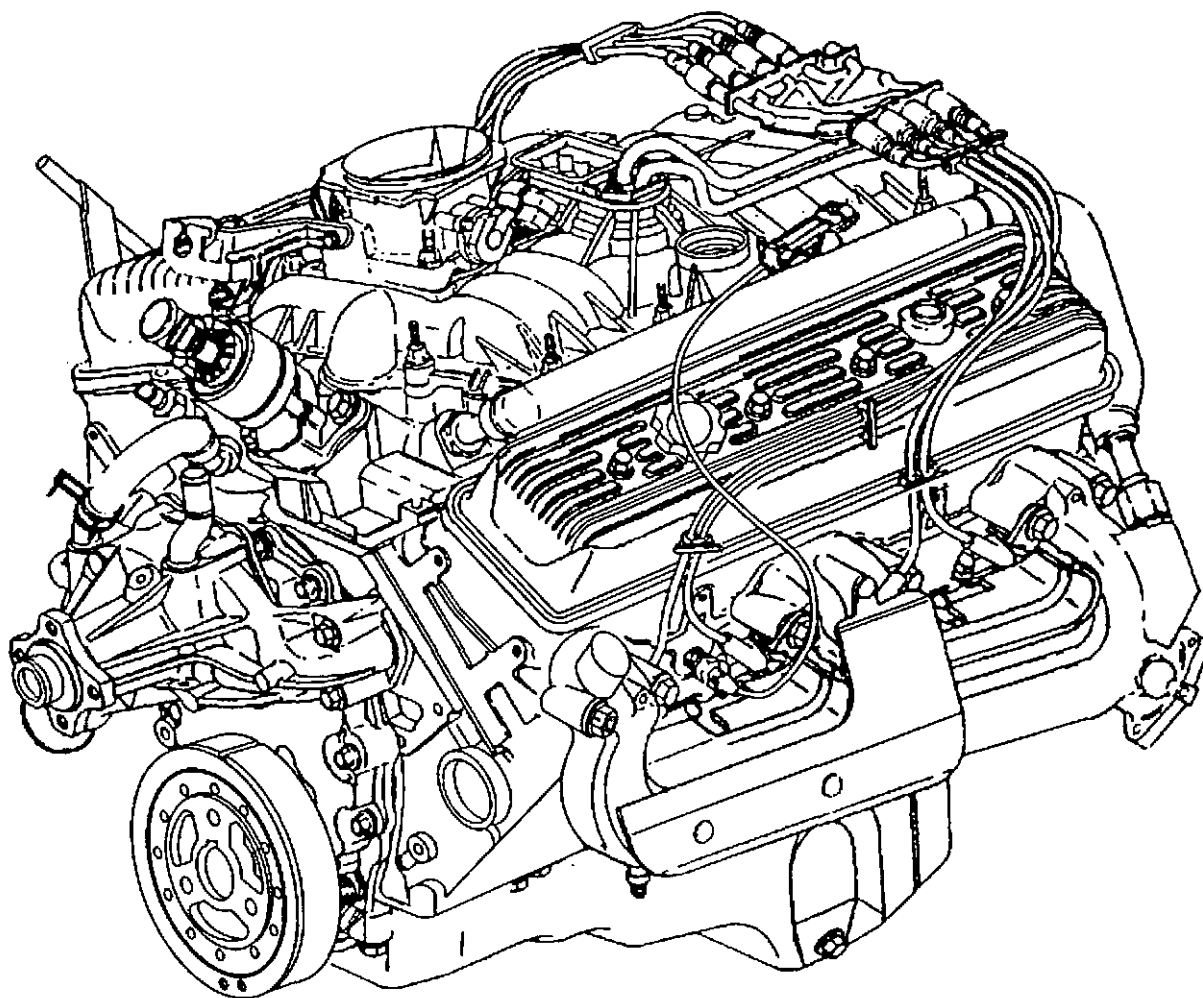
1. Fill the crankcase with the proper quantity and grade of oil.
2. Add engine oil supplement GM P/N 1052367 or equivalent to the engine oil.
3. Fill the cooling system with the proper quantity and grade of coolant.
 - Whenever the cooling system is serviced or drained for service procedures, two cooling system sealing pellets GM P/N 3634621 or equivalent, must be added to the cooling system.
 - Cooling system sealing pellets must be crushed prior to installation. The cooling system sealing pellets must be added to the radiator or the pressurized coolant reservoir.
 - Do not place the cooling system sealing pellets into a non-pressurized coolant recovery reservoir. On these systems, the pellets must be added to the radiator.
 - The sealant pellets may leave a film on the sides of the pressurized and non-pressurized coolant recovery reservoirs. This film is normal.
4. With the ignition OFF or disconnected, crank the engine several times. Listen for any unusual noises or evidence that any of the parts are binding.
5. Start the engine and listen for unusual noises.
6. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.

If necessary, install an oil pressure gauge and measure the engine oil pressure.
7. Operate the engine at about 1000 RPM until the engine has reached normal operating temperature.
8. Listen for improperly adjusted or sticking valves, sticking valve lifters, or other unusual noises.
9. Inspect for oil and/or coolant leaks while the engine is operating.
10. Verify that the distributor is properly positioned/adjusted (Camshaft Retard Offset procedure).
11. Perform a final inspection for the proper engine oil and coolant levels.

Description and Operation

SIE-ID - 69042

Engine Component Description



182830

Cylinder Block

The engine block is made of cast iron and has eight cylinders arranged in a V shape with four cylinders in each bank. The cylinder block is a one piece casting with the cylinders encircled by coolant jackets.

Cylinder Head

The cylinder heads are made of cast iron. The valve guides and valve seats are machined surfaces integral to the cylinder head. The 5.7L heavy duty applications have pressed in exhaust valve seats. The spark plugs are located between the intake and exhaust ports.

Camshaft

A steel engine camshaft is supported by five

camshaft bearings pressed into the engine block. The camshaft sprocket, mounted to the front of the engine camshaft, is driven by the crankshaft sprocket through a camshaft timing chain.

Motion from the engine camshaft is transmitted to the valves by hydraulic roller valve lifters, valve pushrods, and ball-pivot type valve rocker arms.

Crankshaft

The crankshaft is made of cast nodular iron. The crankshaft is supported by five crankshaft bearings. The crankshaft bearings are retained by the crankshaft bearing caps, which are machined with the engine block for proper alignment and clearances. Light duty 5.0L and 5.7L engines have two bolts per crankshaft bearing cap. The heavy duty 5.7L engines have four bolts per crankshaft bearing

cap, on bearing caps 2, 3, and 4. The number 5 crankshaft bearing cap at the rear of the engine is the end thrust bearing cap. The four connecting rod journals (two connecting rods per journal) are spaced 90 degrees apart. The crankshaft position sensor reluctor ring is pushed onto the front of the crankshaft. The crankshaft position sensor reluctor ring has four lugs used for crankshaft timing and it is constructed of powdered metal. The reluctor ring has an interference fit onto the crankshaft and an internal keyway for correct positioning.

Pistons and Connecting Rods

The pistons are made of cast aluminum that use two compression rings and one oil control ring assembly. The piston is a low-friction, lightweight design with a flat top and barrel-shaped skirt. The piston pins are chromium steel. The piston pins have a floating fit in the piston and are retained by a press fit in the connecting rod assembly. The connecting rods are made out of either forged powdered metal or forged steel. The connecting rods are machined with the connecting rod cap installed for proper clearances and alignment.

Valve Train

The valve train is a ball pivot type. Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular valve pushrods to the valve rocker arms. The valve rocker arm pivots on a ball in order to open the valve. The hydraulic roller valve lifters keep all parts of the valve train in constant contact. The valve rocker arm ball is retained on the valve rocker arm ball stud with a locking nut. The valve rocker arm ball studs are pressed into the cylinder head.

Intake Manifold

The intake manifold is a two piece design. The upper intake manifold portion is made from a composite material and the lower intake manifold portion is cast-aluminum. The throttle body mounts to the upper intake manifold. The lower intake manifold has an exhaust gas recirculation (EGR) port cast into the manifold for mixture of exhaust gases with the fuel and air mixture. The EGR valve mounts to the lower intake manifold.

The Central Sequential Multiport Fuel Injection, Central (SFI) system uses multiple injectors to meter and distribute fuel to each engine cylinder. The Central (SFI) unit is retained by a bracket bolted to the lower intake manifold. The TBI fuel meter also houses the pressure regulator. Metal inlet and outlet fuel lines and nylon delivery tubes independently distribute fuel to each cylinder through nozzles located at the port entrance of each manifold runner where the fuel is atomized.

SIE-ID = 348429

New Product Information

The purpose of New Product Information is to highlight or indicate important product changes from the previous model year.

Changes may include one or more of the following items:

- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required
- A component comparison from the previous year

Torque Values and/or Fastener Tightening Strategies

- Cylinder head bolts, crankshaft bearing cap bolts, and connecting rod bolts apply a torque angle strategy.
In an on-vehicle situation where a torque angle meter may not fit into the vehicle packaging, a three step tightening process may be used with a torque wrench.
- Certain fasteners should not be reused. Bolts, studs, or other fasteners that must be replaced will be called out in the specific service procedure.

Changed Engine Specifications

Engine specifications remain the same as the 1998 products.

Disassembly and Assembly Procedure Revisions and Additions

- A new design Teflon® crankshaft rear oil seal installation procedure
- Engine block plug information has been enhanced to include the engine oil pressure gauge sensor and the engine oil pressure gauge sensor fitting.
- Clutch pilot bearing removal and installation procedure has been added

Engine Mechanical Diagnostic Procedure Revisions

- Valve Train diagnostic information is now provided in table form. Potential or probable causes are supplied for each specific concern.
- Engine Noise diagnostic information is now provided in table form. Potential or probable causes are supplied for each specific concern.

New Special Tools Required

- Tool J 35621-B is a revision of J 35621-A and services ALL applications.
- Tool J 41712 has been added for the removal and installation of the oil pressure gauge sensor.
- Tool J 43276 has been added for the removal of the clutch pilot bearing.
Refer to *Special Tools*.

SIE-ID - 195404

Engine Identification

The Vehicle Identification Number (VIN) is located on the left side rear of the engine block (near the transmission bellhousing) and typically is a nine digit number stamped onto the engine at the vehicle assembly plant.

- The first-digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last six digits of the Vehicle Identification Number (VIN).

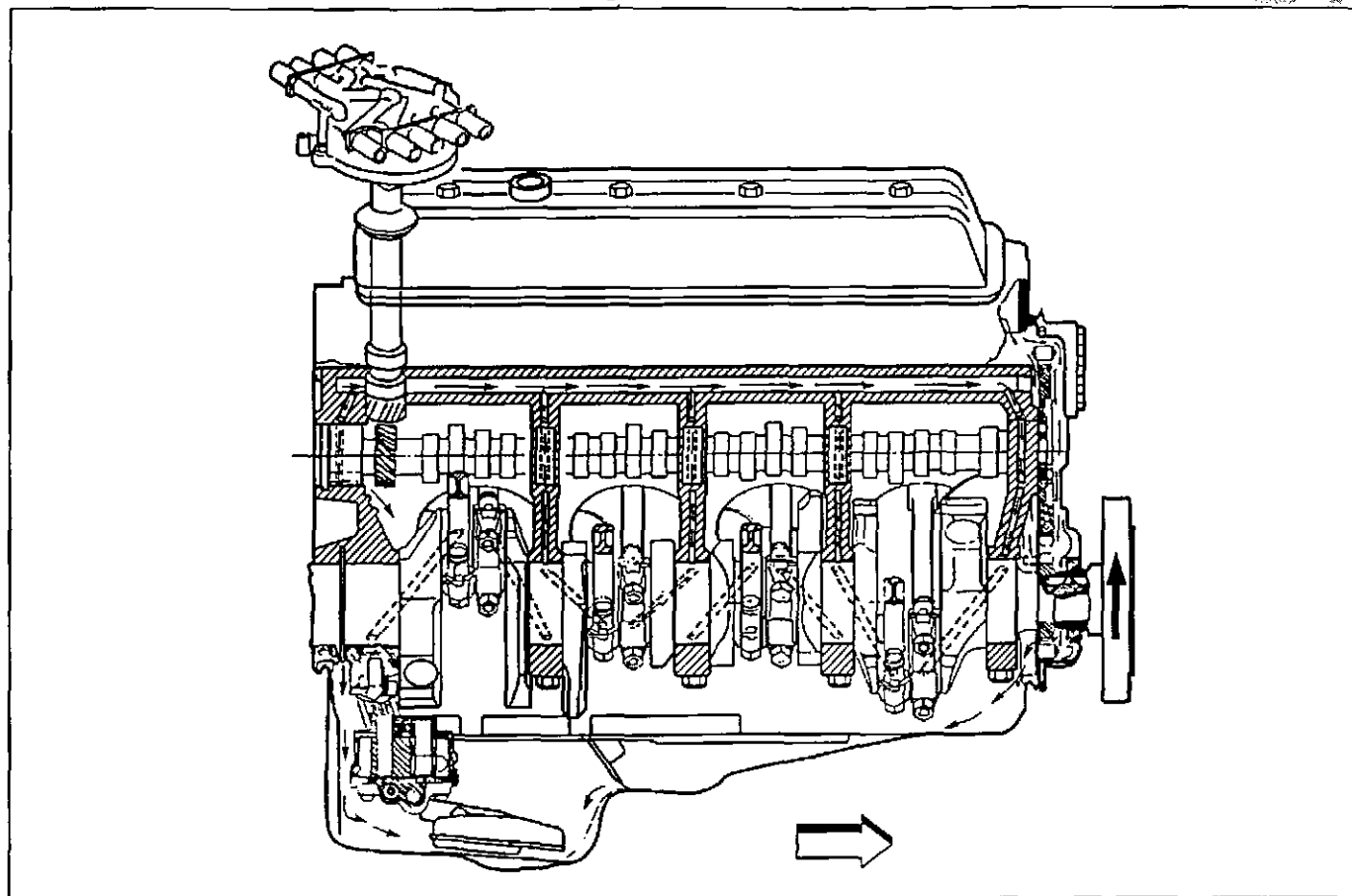
SIE-ID - 66834

Lubrication

The gear-type oil pump is driven through an extension driveshaft. The extension driveshaft is driven by the distributor which is gear driven by the camshaft. The oil is drawn from the oil pan through a pickup screen and tube. Pressurized oil is delivered through internal passages in order to lubricate the camshaft and the crankshaft bearings and to provide lash control in the hydraulic valve lifters. Oil is metered from the valve lifters through the valve pushrods in order to lubricate the valve rocker arms and valve rocker arm ball pivots. Oil returning to the oil pan from the cylinder heads and the camshaft front bearing, lubricates the camshaft timing chain and the crankshaft and the camshaft sprockets.

SIO-ID - 71039

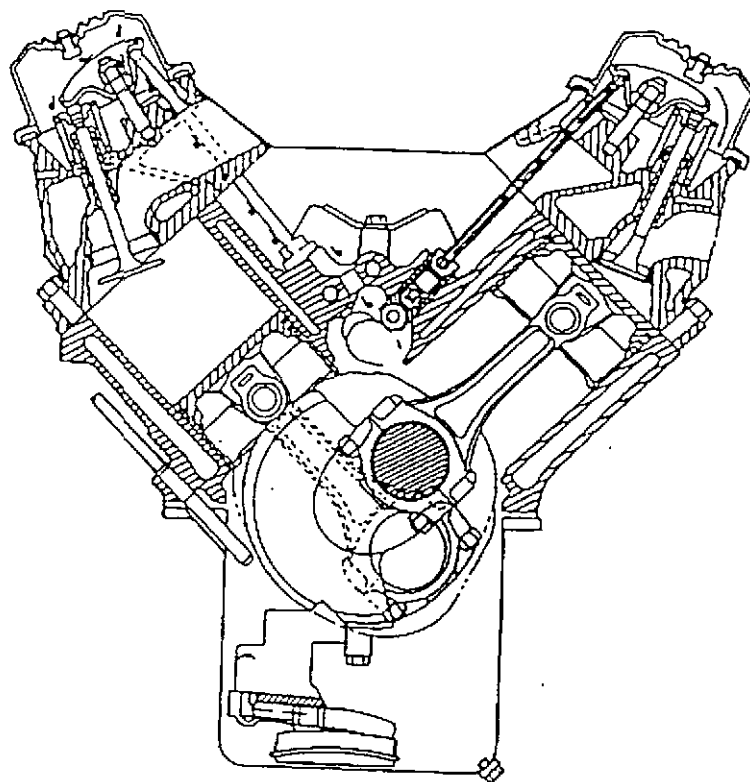
Right Side View



67757

SIO-ID - 71037

Front View



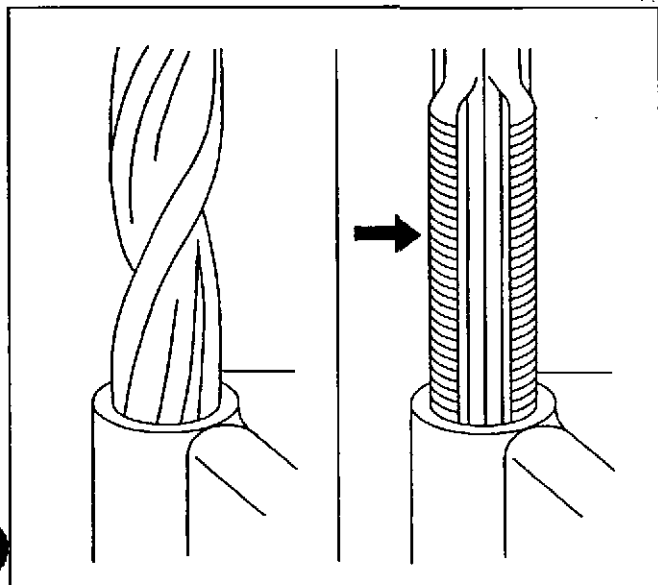
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SIE-ID - 43119

Thread Repair

Tools Required

General purpose thread repair kits. These kits are available commercially.



4962

instructions regarding the size of the drill and which tap to use.

Avoid any buildup of chips. Back out the tap every few turns and remove the chips.

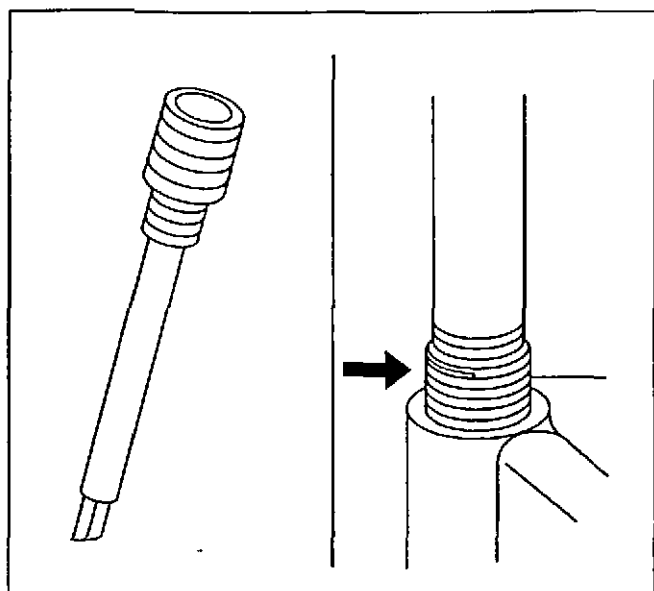
1. Determine the size, the pitch, and the depth of the damaged thread.

Adjust the stop collars on the cutting tool as needed. Tap the collars to the required depth.

2. Drill out the damaged thread. Clean out any chips.
3. Tap the hole. Lubricate the tap with light engine oil. Clean the thread.

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

Important: Refer to the kit manufacturer's



4963

4. Thread the insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

Important: The insert should be flush to 1 turn below the surface.

5. Lubricate the insert with light engine oil (except when installing in aluminum) and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break off the tang using a drift punch.

SIE-ID - 19007

Cleanliness and Care

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, the components should be marked, organized or retained in a specific order for re-assembly.
- At the time of installation, the components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. The surfaces should be protected to avoid component damage.
- Apply a liberal amount of clean engine oil to friction areas during assembly.
- Proper lubrication will protect and lubricate friction areas during initial operation.

SIE-ID - 66654

Replacing Engine Gaskets

Gasket Reuse and Applying Sealant

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless specified in the service procedure.

Separating Components

- Use a rubber mallet in order to separate the components.
- Bump the part sideways in order to loosen the components.
- Bumping of the component should be done at bends or reinforced areas of the component to prevent distortion of the components.

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.
Do not use any other method or technique to remove the sealant or the gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.

This fine grit is an abrasive and can cause internal engine damage.

Assembling Components

- Assemble components using only the sealant (or equivalent) that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- Do not allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener from clamping properly or cause component damage when tightened.
- Tighten fasteners to the proper specifications. DO NOT overtighten the fasteners.

SIE-ID - 411537

Use of RTV and Anaerobic Sealer

Sealant Types

Important: The correct sealant and amount of sealant must be used in the proper location to prevent oil leaks, coolant leaks, or the loosening of the fasteners. DO NOT interchange the sealants. Use only the sealant (or equivalent) as specified in the service procedure.

The following 2 major types of sealant are commonly used in engines:

- Aerobic sealant (Room Temperature Vulcanizing (RTV))
- Anaerobic sealant, which include the following:
 - Gasket eliminator
 - Pipe
 - Threadlock

Aerobic Type Room Temperature Vulcanizing (RTV) Sealant

Aerobic type Room Temperature Vulcanizing (RTV) sealant cures when exposed to air. This type of sealant is used where 2 components (such as the intake manifold and the engine block) are assembled together.

Use the following information when using RTV sealant:

- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket
 - Any other surfaces where a different type of sealant is specified in the service procedure
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

Important: Do not allow the RTV sealant to enter any blind threaded holes, as it may prevent the fasteners from clamping properly or cause damage when the fastener is tightened.

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.
- Apply the RTV sealant bead to the inside of any bolt holes areas.
- Assemble the components while the RTV sealant is still wet to the touch (within 3 minutes). Do not wait for the RTV sealant to skin over.
- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

Anaerobic Type Gasket Eliminator Sealant

Anaerobic type gasket eliminator sealant cures in the absence of air. This type of sealant is used where 2

rigid parts (such as castings) are assembled together. When 2 rigid parts are disassembled and no sealant or gasket is readily noticeable, then the 2 parts were probably assembled using an anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

- Always follow all the safety recommendations and directions that are on the gasket eliminator sealant container.
- Apply a continuous bead of gasket eliminator sealant to one flange.

The surfaces to be sealed must be clean and dry.

Important: Do not allow the gasket eliminator sealant to enter any blind threaded holes, as the gasket eliminator sealant may prevent the fasteners from clamping properly, seating properly, or cause damage when the fastener is tightened.

- Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.

Important: Gasket eliminator sealed joint fasteners that are partially torqued and the gasket eliminator sealant allowed to cure more than five minutes, may result in incorrect shimming and sealing of the joint.

- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.
- After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

Anaerobic type threadlock sealant cures in the absence of air. This type of sealant is used for threadlocking and sealing of bolts, fittings, nuts, and studs. This type of sealant cures only when confined between 2 close fitting metal surfaces.

Use the following information when using threadlock sealant:

- Always follow all safety recommendations and directions that are on the threadlock sealant container.
- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

Important: Fasteners that are partially torqued and then the threadlock sealant allowed to cure more than five minutes, may result in incorrect clamp load of assembled components.

- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

Anaerobic Type Pipe Sealant

Anaerobic type pipe sealant cures in the absence of air and remains pliable when cured. This type of sealant is used where 2 parts are assembled together and require a leak proof joint.

Use the following information when using pipe sealant:

- Do not use pipe sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket
 - Surfaces where a different sealant is specified
 - Always follow all the safety recommendations and the directions that are on the pipe sealant container.
 - The surfaces to be sealed must be clean and dry.
 - Use a pipe sealant bead of the size or quantity as specified in the service procedure.
- Important:** Do not allow the pipe sealant to enter any of the blind threaded holes, as the pipe sealant may prevent the fastener from clamping properly, or cause component damage when the fastener is tightened.
- Apply the pipe sealant bead to the inside of any bolt hole areas.
 - Apply a continuous bead of pipe sealant to 1 sealing surface.
 - Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

SIE-ID - 194497

Separating Parts

Important: Many internal engine components will develop specific wear patterns on their friction surfaces.

When disassembling the engine, internal components **MUST** be separated, marked and organized in a way to ensure reinstallation to original location and position.

Mark or identify the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the specific cylinder bore
- Connecting rod to the crankshaft journal
- Connecting rod to connecting rod cap
- Crankshaft bearings and connecting rod bearings
- Engine camshaft and valve lifters
- Valve lifters and valve rocker arms
- Valve to the valve guide
- Valve spring to cylinder head location
- Engine block bearing cap location and direction
- Oil pump drive and driven gears

SIE-ID - 73997

Tools and Equipment

SIO-ID - 70760

Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well-lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

Special Tools and Equipment

SIE-ID - 348394

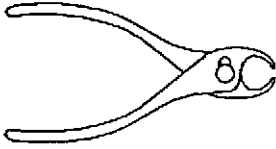
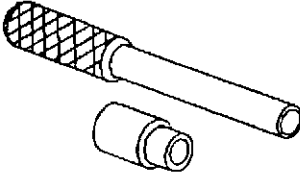
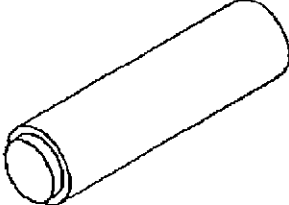
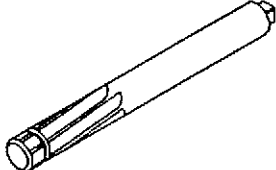
Illustration	Tool Number/ Description
 14487	J 3049-A Valve Lifter Remover
 3404	J 5239 Connecting Rod Bolt Guide Set
 3407	J 5590 Installer
 14492	J 5715 or J 6036 Reamer

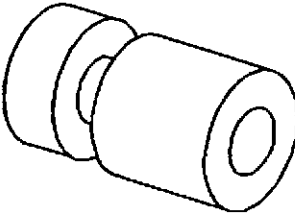
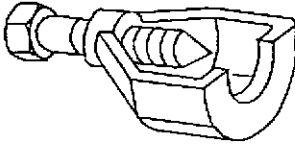
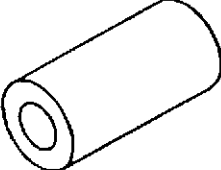
Illustration	Tool Number/ Description
 35460	J 5802-01 Rocker Arm Stud Remover
 3406	J 5825-A Crankshaft Gear Remover
 3399	J 5892-D Valve Spring Compressor
 35461	J 6880 Rocker Arm Stud Installer

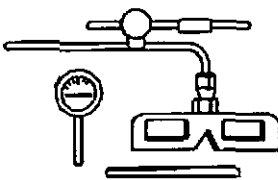
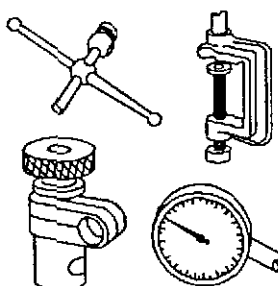
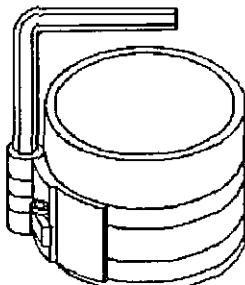
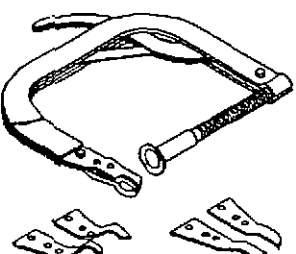
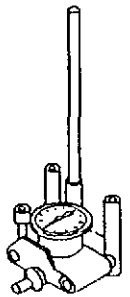
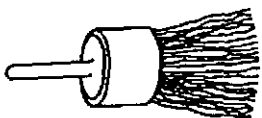
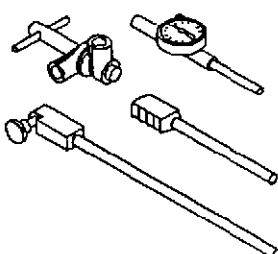
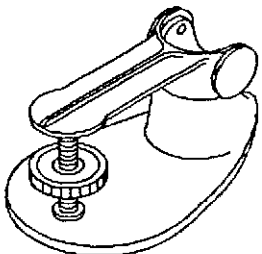
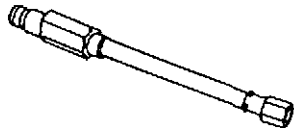
Illustration	Tool Number/ Description
 35463	J 7872 Magnetic Base Dial Indicator
 2014	J 8001 Dial Indicator Set
 3403	J 8037 Ring Compressor
 3414	J 8062 Valve Spring Compressor
 5110	J 8087 Cylinder Bore Gauge

Illustration	Tool Number/ Description
 35464	J 8089 Carbon Removing Brush
 3408	J 8520 Cam Lobe Lift Indicator
 5112	J 9666 Valve Spring Tester
 3416	J 21882 Oil Suction Pipe Installer
 26998	J 22794 Spark Plug Port Adapter

Engine

Engine Mechanical - 5.0L, 5.7L 6-255

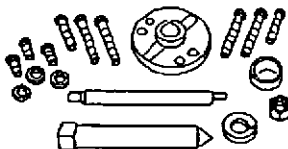
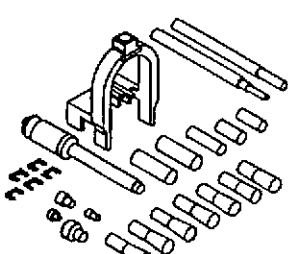
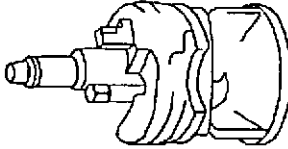
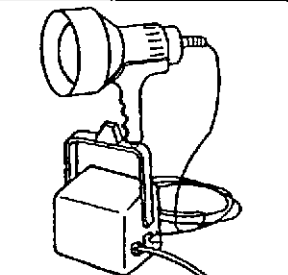
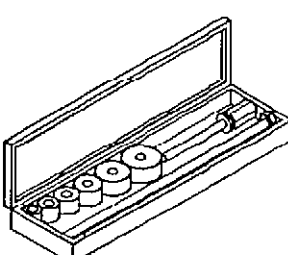
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	J 23523-F Balancer Remover and Installer
66168	
	J 24086-C Piston Pin Remover/Installer Set
14495	
	J 24270 Cylinder Bore/Ridge Reamer
3412	
	J 28428-E High Intensity Black Light Kit
62292	
	J 33049 Camshaft Bearing Service Set
5118	

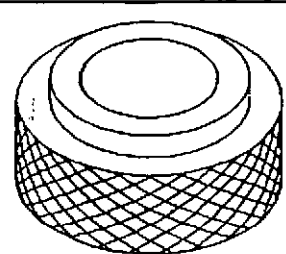
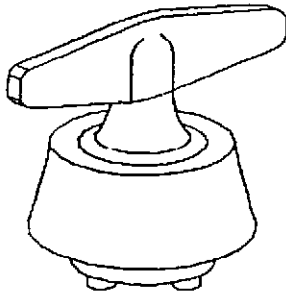
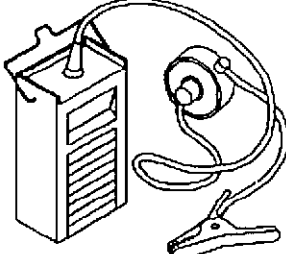
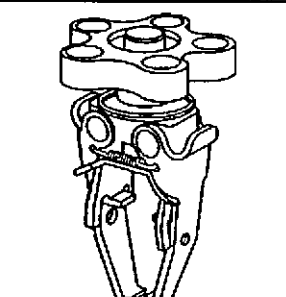
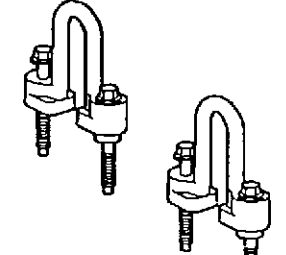
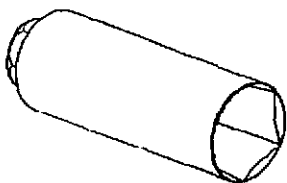
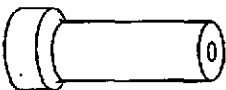
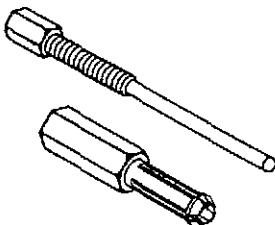
Illustration	Tool Number/ Description
	J 35468 Cover Aligner/Seal Installer
3401	
	J 35621-B Rear Main Seal Installer
350498	
	J 36660 Electronic Torque Angle Meter
3413	
	J 38606 Valve Spring Compressor
33658	
	J 41427 Engine Lift Brackets
66511	

Illustration	Tool Number/ Description
 67136	J 41712 Oil Pressure Switch Socket
 38509	J 42073 Valve Stem Seal Installer
 355040	J 43276 Clutch Pilot Bearing Remover

Engine Mechanical - 7.4L

Specifications

SIE-ID - 361824

Fastener Tightening Specifications

Application	Specification	
	Metric	English
A/C Compressor Bolt	50 N.m	37 lb ft
AIR Pump Mounting Bolt	50 N.m	37 lb ft
Camshaft Retainer Bolt	12 N.m	106 lb in
Camshaft Sprocket Bolt	30 N.m	22 lb ft
Connecting Rod Bolt Nut	64 N.m	47 lb ft
Coolant Outlet Housing Bolt	40 N.m	30 lb ft
Coolant Temperature Gauge Sensor	20 N.m	15 lb ft
Coolant Temperature Sensor	20 N.m	15 lb ft
Crankshaft Balancer Bolt	149 N.m	110 lb ft
Crankshaft Bearing Cap Bolt	138 N.m	102 lb ft
Crankshaft Position Sensor Bolt	12 N.m	106 lb in
Cylinder Head Bolt in Sequence		
First Pass	50 N.m	37 lb ft
Second Pass	+60 degrees	
Final Pass - Long Bolt	+90 degrees	
Final Pass - Short Bolt	+30 degrees	
Distributor Clamp Bolt	33 N.m	24 lb ft
EGR Valve Bolt	22 N.m	16 lb ft
Engine Block Coolant Drain Hole Plug	20 N.m	15 lb ft
Engine Block Oil Gallery Front Plug	30 N.m	22 lb ft
Engine Block Oil Gallery Left Side Plug	30 N.m	22 lb ft
Engine Block Oil Gallery Rear Plug	30 N.m	22 lb ft
Engine Block Oil Gallery Top Plug	20 N.m	15 lb ft
Engine Flywheel Bolt	88 N.m	65 lb ft
Engine Flywheel Housing Bolt	40 N.m	30 lb ft
Engine Front Cover Bolt	10 N.m	89 lb in
EVAP Purge Solenoid Bolt	12 N.m	106 lb in
Exhaust Manifold Center Bolt	54 N.m	40 lb ft
Exhaust Manifold Nut	30 N.m	22 lb ft
Exhaust Manifold Stud	30 N.m	22 lb ft
Fuel Rail Bolt	10 N.m	89 lb in
Fuel Rail Stud	25 N.m	18 lb ft
Generator Mounting Bolt	50 N.m	37 lb ft
Generator Mounting Bracket to Engine Long Bolt	66 N.m	49 lb ft
Generator Mounting Bracket to Engine Short Bolt	66 N.m	49 lb ft
Generator Mounting Bracket to Engine Nut	66 N.m	49 lb ft
Generator Mounting Bracket to Engine Stud	20 N.m	15 lb ft
Generator Mounting Rear Bracket Bolt	50 N.m	37 lb ft
Idler Pulley Bolt	50 N.m	37 lb ft

Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Idle Pulley Bracket Bolt (Long)	83 N.m	61 lb ft
Idle Pulley Bracket Bolt (Short)	50 N.m	37 lb ft
Ignition Coil Bolt	25 N.m	18 lb ft
Ignition Coil Stud	25 N.m	18 lb ft
Knock Sensor	19 N.m	14 lb ft
Knock Sensor Heat Shield	12 N.m	106 lb in
Lower Intake Manifold Bolt (in Sequence)	40 N.m	30 lb ft
MAP Sensor Nut	25 N.m	18 lb ft
Oil Filter	40 N.m	30 lb ft
Oil Filter Adapter Bolt	25 N.m	18 lb ft
Oil Filter Adapter Fitting	66 N.m	49 lb ft
Oil Pan Bolt	25 N.m	18 lb ft
Oil Pan Drain Plug	28 N.m	21 lb ft
Oil Pump Bolt	90 N.m	65 lb ft
Oil Pump Cover Bolt	12 N.m	106 lb in
Oil Pressure Gauge Sensor	30 N.m	22 lb ft
Power Steering Pump Mounting Bracket Long Bolt	66 N.m	49 lb ft
Power Steering Pump Mounting Bracket Nut	66 N.m	49 lb ft
Power Steering Pump Mounting Bracket Stud	20 N.m	15 lb ft
Power Steering Pump Rear Bracket Bolt	25 N.m	18 lb ft
Spark Plug (New Cylinder Head)	30 N.m	22 lb ft
Spark Plug (all Subsequent Installations)	20 N.m	15 lb ft
Spark Plug Heat Shield Nut	20 N.m	15 lb ft
Starter Motor Bolt	50 N.m	37 lb ft
Starter Motor Shield Bolt	3 N.m	27 lb in
Starter Motor Shield Nut	5 N.m	44 lb in
Throttle Body Nut	10 N.m	89 lb in
Throttle Body Stud	12 N.m	106 lb in
Upper Intake Manifold Bolt in Sequence		
First Pass	8 N.m	71 lb in
Final Pass	18 N.m	13 lb ft
Valve Lifter Guide Retainer Bolt	25 N.m	18 lb ft
Valve Rocker Arm Bolt	54 N.m	40 lb ft
Valve Rocker Arm Cover Bolt	12 N.m	106 lb in
Water Pump Bolt	40 N.m	30 lb ft
Water Pump Pulley Bolt	25 N.m	18 lb ft

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Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
Engine Type	V-8	

Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Displacement	7.4L	454 CID
RPO	L29	
VIN	J	
Bore	107.95 mm	4.25 in
Stroke	101.6 mm	4.00 in
Compression Ratio	9.0:1	
Firing Order	1-8-4-3-6-5-7-2	
Spark Plug Gap	0.8890 mm	0.060 in
Cylinder Head		
Surface Flatness	0.0762 mm	0.003 in
Maximum Cylinder Head Block Deck Resurfacing	0.3048 mm	0.012 in
Exhaust Manifold		
Surface Flatness	0.254 mm	0.010 in
Lubrication System		
Oil Capacity without Filter Change	5.7 liters	6.0 qt
Oil Pressure (Fully Warmed Oil not Hot)	68.65 kPa @ 600 RPM 172.37 kPa @ 2,000 RPM	10 psi @ 600 RPM 25 psi @ 2,000 RPM
Oil Filter System	Full Flow	
Oil Pump Type	Gear Driven	
Cylinder Bore		
Diameter	107.950–107.968 mm	4.2500–4.2507 in
Out-of-Round Production	0.0254 mm (Maximum)	0.001 in (Maximum)
Out-of-Round Service	0.051 mm (Maximum)	0.002 in (Maximum)
Taper Production Thrust Side	0.0127 mm (Maximum)	0.0005 in (Maximum)
Taper Production Relief Side	0.0254 mm (Maximum)	0.001 in (Maximum)
Taper Service	0.0254 mm (Maximum)	0.001 in (Maximum)
Piston		
Piston Diameter	1.07891–1.07904 mm	4.2477–4.2482 in
Clearance Production	0.0457–0.0762 mm	0.0018–0.0030 in
Clearance Service Limit	0.0457–0.219 mm	0.0018–0.0048 in
Piston Ring Compression		
Top Groove Production Clearance	0.031–0.074 mm	0.0012–0.0029 in
Second Groove Production Clearance	0.031–0.074 mm	0.0012–0.0029 in
Service Limit Groove Clearance	0.305–0.0991 mm	0.0012–0.0039 in
Top Ring Production Gap	0.254–0.457 mm	0.010–0.018 in
Top Ring Service Limit Gap	0.254–0.711 mm	0.010–0.028 in
Second Ring Production Gap	0.406–0.609 mm	0.016–0.024 in
Second Ring Service Limit Gap	0.406–0.863 mm	0.016–0.034 in

Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Piston Ring Oil Control		
Production Groove Clearance	0.127–0.165 mm	0.0050–0.0065 in
Service Limit Groove Clearance	0.127–0.191 mm	0.0050–0.0075 in
Production Gap	0.254–0.762 mm	0.010–0.030 in
Service Limit Gap	0.254–1.016 mm	0.010–0.040 in
Piston Pin		
Diameter	25.132–25.137 mm	0.98945–0.98965 in
Clearance in Piston Production	0.005–0.017 mm	0.0002–0.0007 in
Clearance in Piston Service Limit	0.005–0.025 mm	0.0002–0.0010 in
Fit in Rod	0.078–0.053 mm Interference	0.0021–0.0031 in Interference
Crankshaft		
Crankshaft Run Out	0.051 mm (Maximum)	0.002 in (Maximum)
Crankshaft Journal Diameter #1, #2, #3, #4, #5	69.804–69.822 mm	2.7482–2.7489 in
Crankshaft Journal Taper Production	0.010 mm (Maximum)	0.0004 in (Maximum)
Crankshaft Journal Taper Service Limit	0.025 mm (Maximum)	0.0010 in (Maximum)
Crankshaft Journal Out-of-Round Production	0.010 mm (Maximum)	0.0004 in (Maximum)
Crankshaft Journal Out-of-Round Service Limit	0.025 mm (Maximum)	0.0010 in (Maximum)
Crankshaft Bearing Clearance #1 Production	0.043–0.076 mm	0.0017–0.0030 in
Crankshaft Bearing Clearance #2, #3, #4 Production	0.028–0.061 mm	0.0011–0.0024 in
Crankshaft Bearing Clearance #5 Production	0.063–0.096 mm	0.0025–0.0038 in
Crankshaft Bearing Clearance #1, #2, #3, #4 Service Limit	0.025–0.076 mm	0.0010–0.0030 in
Crankshaft Bearing Clearance #5 Service Limit	0.063–0.101 mm	0.0025–0.0040 in
Crankshaft End Play	0.127–0.279 mm	0.005–0.011 in
Crankshaft Thrust Wall Width	46.1391–46.2153 mm	1.8165–1.8195 in
Crankshaft Thrust Wall Maximum Runout	0.025 mm	0.001 in
Crankpin Diameter	55.854–55.869 mm	2.1990–2.1996 in
Crankpin Taper Production	0.0127 mm	0.0005 in
Crankpin Taper Service Limit	0.025 mm	0.0010 in
Crankpin Out-of-Round Production	0.013 mm	0.0005 in
Crankpin Out-of-Round Service Limit	0.025 mm	0.0010 in
Rod Bearing Clearance Production	0.028–0.074 mm	0.0011–0.0029 in
Rod Bearing Clearance Service Limit	0.028–0.099 mm	0.0011–0.0039 in
Connecting Rod Side Clearance	0.033–0.584 mm	0.0013–0.0230 in
Camshaft		
Camshaft Run Out	0.051 mm (Maximum)	0.002 in (Maximum)
Lobe Lift Intake	7.115–7.216 mm	0.2801–0.2841 in
Lobe Lift Exhaust	7.170–7.272 mm	0.2823–0.2863 in

Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Journal Diameter	49.471–49.522 mm	1.9477–1.9497 in
Valve System		
Lifter	Hydraulic, Roller Followers	
Rocker Arm Ratio	1.70:1	
Valve Lash Intake	Net Lash	
Valve Lash Exhaust	Net Lash	
Face Angle (Intake & Exhaust)	45 degrees	
Seat Angle (Intake & Exhaust)	46 degrees	
Seat Runout (Intake & Exhaust)	0.051 mm (Maximum)	0.002 in (Maximum)
Seat Width Intake	0.762–1.524 mm	0.030–0.060 in
Seat Width Exhaust	1.524–2.413 mm	0.060–0.095 in
Stem Clearance Production Intake	0.025–0.0737 mm	0.0010–0.0029 in
Stem Clearance Production Exhaust	0.030–0.079 mm	0.0012–0.0031 in
Stem Clearance Service Intake	0.025–0.094 mm	0.0010–0.0037 in
Stem Clearance Service Exhaust	0.030–0.124 mm	0.0012–0.0049 in
Valve Spring Pressure Closed	316–351 N @ 46.685 mm	71–79 lb @ 1.838 in
Valve Spring Pressure Open	1059–1165 N @ 34.213 mm	238–262 lb @ 1.347 in
Valve Spring Installed Height	46.685–47.479 mm	1.838–1.869 in
Maximum Valve Spring Installed Height Shim	0.726 mm	0.030 in
Maximum Valve Spring Tension Shim	0.726 mm	0.030 in
Maximum Combined Valve Spring Installed Height and Valve Spring Tension Shim	1.524 mm	0.060 in

SIE-ID = 65721

GM SPO Group Numbers

Application	GM SPO Group Number
Camshaft	0.519
Camshaft Sprocket	0.736
Camshaft Timing Chain	0.724
Crankshaft	0.646
Crankshaft Bearing Kit	0.096
Crankshaft Sprocket	0.728
Connecting Rod	0.603
Cylinder Head	0.269
Cylinder Head Gasket Kit	0.289
Distributor Gasket Kit	2.363
EGR Valve	3.670
EGR Valve Gasket	3.680
Exhaust Manifold	3.601
Exhaust Manifold Gasket	3.270
Engine Front Cover Gasket	0.207

GM SPO Group Numbers (cont'd)

Application	GM SPO Group Number
Engine Front Cover	0.206
Intake Manifold (With Gasket)	3.265
Oil Filter	1.836
Oil Level Indicator	1.516
Oil Pan	1.426
Oil Pan Gasket	1.429
Oil Pump Cover	1.723
Oil Pump Cover Gasket	1.724
Oil Pump (With Gasket)	1.652
Piston Ring Kit	0.643
Spark Plug	2.270
Valve Lifter	0.459
Thermostat	1.246
Valve Pushrod	0.426
Valve Rocker Arm	0.333
Valve Rocker Arm Cover Gasket Kit	0.423
Water Pump Kit (With Gasket)	1.069

SIE-ID # 210918

Sealers, Adhesives, and Lubricants

Application	Type of Material	GM Part Number
Block Heater O-ring	Lubricant	9985253
Camshaft Rear Bearing Hole Plug	Sealant	12346004
Coolant Sealing Pellets	Sealant	3634621
Coolant Sensor (ETC) Threads	Sealant	12346004
Crankshaft Keyway	Sealant	12345739
Cylinder Head Bolt Threads	Sealant	12346004
Engine Block Coolant Drain Plugs	Sealant	12346004
Engine Block Oil Gallery Plugs	Sealant	12346004
Engine Front Cover	Sealant	12345739
Engine Oil Supplement	Lubricant	1051396
Knock Sensor Threads	Sealant	12346004
Upper Intake Manifold Bolt Threads	Threadlock	12345393
Lower Intake Manifold Bolt Threads	Threadlock	12345382
MAP Sensor Seal	Lubricant	9985770
Oil Pan	Adhesive	12345739
Oil Pressure Sensor Fitting Threads	Sealant	12346004
Oil Pressure Sensor Threads	Sealant	12346004
Valve Train Component Prelube	Lubricant	1052367
Water Pump Bolt Threads	Sealant	12346004

Diagnostic Information and Procedures

SIE-ID = 197512

SIO-ID = 197504

Base Engine Misfire Diagnosis

Checks	Action
Engine performance diagnosis procedures are covered in Engine Controls and should be consulted for diagnosis of any Driveability, Emissions, or Malfunctioning Indicator Lamp (MIL) concerns. The following diagnosis covers common concerns and possible causes. When the proper diagnosis is made, the concern should be corrected by adjustment, repair or replacement as required. Refer to the appropriate section of the service manual for each specific procedure. This diagnostic table will assist in engine misfire diagnosis due to a mechanical concern such as a faulty camshaft, worn or damaged bearings or bent pushrod. This table will not isolate a crossed injector wire, faulty injector or any other driveability component failure that may cause a misfire. The Powertrain On-Board Diagnostic System checks must be performed first. When using this table to make a Base Engine Misfire diagnosis, begin with the preliminary information below and then proceed to the specific category.	
Preliminary	1. Perform DTC P0300 engine performance diagnostic procedures found in the diagnostic table before proceeding with Base Engine Misfire Diagnosis information. - DTC P0300 will assist in determining which cylinder or cylinders are misfiring. 2. Perform a visual inspection of the following: • A loose or improperly installed engine flywheel or crankshaft balancer • Worn, damaged or misaligned accessory drive system components 3. Listen to the engine for any abnormal internal engine noises. 4. Inspect the engine for acceptable oil pressure. 5. Verify if the engine has excessive oil consumption. 6. Verify if the engine has excessive coolant consumption. 7. Perform a compression test on the engine.
Intake Manifold Leaks	An intake manifold that has a vacuum leak may cause a misfire. Inspect for the following: • Improperly installed or damaged vacuum hoses • Faulty or improperly installed intake manifold and/or gaskets • Cracked or damaged intake manifold Inspect the areas between the intake runners • Improperly installed MAP sensor The sealing grommet of the MAP sensor should not be torn or damaged • Improperly installed throttle body or damaged gasket • Warped intake manifold • Warped or damaged sealing surface on cylinder head
Coolant Consumption	Coolant consumption may or may not cause the engine to overheat. Inspect for the following: • External coolant leaks • Faulty cylinder head gasket • Warped cylinder head • Cracked cylinder head • Damaged engine block • Damaged Intake manifold and/or intake manifold gasket

Base Engine Misfire Diagnosis (cont'd)

Checks	Action
Oil Consumption	1. Remove the spark plugs and inspect for an oil fouled spark plug. Oil consumption may or may not cause the engine to misfire. 2. Perform a cylinder compression test. 3. If the compression test indicates worn valves or valve guides, inspect the following: • Worn, brittle, or improperly installed valve stem oil seals • Worn valve guides • Worn valve stems • Worn or burnt valves or valve seats 4. If the compression test indicates worn or damaged piston rings, inspect the following: • Broken or improperly seated piston rings • Excessive piston ring end gap • Excessive cylinder bore wear or taper • Cylinder damage • Piston damage
Abnormal Internal Engine Noises	Important: A slight COLD knock or piston slapping noise could be considered normal if not present after the engine has reached normal operating temperatures. 1. Connect a timing light to the engine and run engine to determine if the noise is timed to camshaft speed or crankshaft speed. Two knocks per flash indicates crankshaft speed and one knock per flash indicates camshaft speed. 2. If the noise is timed to camshaft speed, inspect the following: • Missing or loose valve train components • Worn or loose valve rocker arms • Worn or bent pushrods • Faulty valve springs • Worn or damaged valve rotators • Bent or burnt valves • Worn camshaft lobes • Worn or damaged timing chain and/or sprockets 3. If the knock is timed to crankshaft speed, inspect the following: • Worn crankshaft main or connecting rod bearings • Piston or cylinder damage • Worn piston or piston pin • Faulty connecting rod • Excessive carbon build-up on the top of the piston
No Abnormal Internal Engine Noise	1. Inspect for a worn or improperly installed timing chain and/or sprockets 2. Remove the valve rocker arm cover on the side of the engine with the cylinder that is misfiring. 3. Inspect for the following: • Loose valve rocker arm bolts • Bent push rods • Faulty valve springs • Faulty valve lifters (bleeding down) • Worn or improperly seated valves • Worn camshaft lobes. • Inspect for a chipped or cracked reluctor ring

Test Procedure

1. Disconnect the positive ignition coil:wire plug from ignition coil.
2. Disconnect the fuel injector electrical connector.
3. Remove all the spark plugs.
4. Block the throttle plate wide open.
5. Charge the battery if the battery is not fully charged.
6. Start with the compression gauge at zero. Then crank the engine through four compression strokes (four puffs).
7. Make the compression check the same for each cylinder. Record the reading.

The minimum compression in any one cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any one cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1035 \times 70\% = 725$) ($150 \times 70\% = 105$).

8. If some cylinders have low compression, inject approximately 15 ml (one tablespoon) of engine oil into the combustion chamber through the spark plug hole.
 - Normal — Compression builds up quickly and evenly to the specified compression for each cylinder.
 - Piston Rings Leaking — Compression is low on the first stroke. Then compression builds up with the following strokes but does not reach normal. Compression improves considerably when you add oil.
 - Valves Leaking — Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
 - If two adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the two cylinders.

SIE-ID = 192333

SIO-ID = 192310

Engine Noise Diagnosis

Symptom	Cause
When diagnosing engine noise complaints use the following steps to isolate the source of the engine noise: 1. Determine the type of the noise. This may include a light rattle, tapping or low rumble or knock. 2. Verify the exact operating condition when the noise occurs. This would include ambient engine temperature, engine warm-up time, engine operating temperature, and engine RPM. 3. Isolate the rate when the noise occurs. Generally speaking, engine noises are timed to either engine speed (crankshaft, flywheel, connecting rods, balancer, or pistons and related components) or one-half engine speed (valve train noise such as rocker arms, valve lifters, and timing chain). 4. Compare the engine sounds to a known good engine to prevent trying to fix a noise that is normal.	
Noise on Start-Up but Lasts a Few Seconds	The following condition(s) may produce engine knocks on initial start-up, but only last a few seconds: • Improper oil viscosity. • Install proper oil viscosity for expected temperatures. Refer to Maintenance and Lubrication
Knocks Cold and Continues for 1 to 2 Minutes	• Engine flywheel contacting the splash shield. Reposition the splash shield. • Loose or broken crankshaft balancer or drive pulleys. Tighten or replace as necessary. • Excessive piston to bore clearance. Replace the piston. • Cold engine knock usually disappears when the specific cylinder secondary ignition circuit is grounded out. Cold engine piston knock which disappears in 1.5 minutes should be considered acceptable. • Bent connecting rod.
Intermittent Noise on Idle, Disappearing When Engine Speed is Increased	• Dirt in the lifter. Replace the valve lifter if necessary. • A pitted or damaged valve lifter check ball. Replace the valve lifter if necessary.
Valve Train Noise (Rattle/Tapping)	The following conditions may cause valve train noise: • Low oil pressure. • Loose valve rocker arm attachments • Worn valve rocker arm and/or pushrod. • Broken valve spring. • Worn or damaged valve rotators. • Sticking valves. Inspect the valves. • Worn, dirty or faulty valve lifters. • Worn or faulty camshaft. Replace the camshaft. • Worn or faulty oil pump • Bent, broken, or damaged timing chain sprocket teeth • Worn valve guides. Repair as necessary. • Oil overfull causing foaming of oil.

Engine Noise Diagnosis (cont'd)

Symptom	Cause
Knocks at Idle Hot (Rumble/Knocking)	- Inspect the drive belt for wear. Check the tension and/or replace as necessary. - Inspect the A/C compressor or generator bearing. Replace or repair as necessary. - Inspect the valve train. Replace the parts as necessary. - Inspect for improper oil viscosity. Install proper viscosity oil for expected temperature. Refer to Maintenance and Lubrication for engine oil specifications. - Inspect for excessive piston pin clearance. Replace the piston and pin as necessary. - Inspect the connecting rod alignment. Check and replace the rods as necessary. - Inspect for insufficient piston-to bore clearance. - Bore, Hone, and fit the new piston. - Inspect the crankshaft balancer for looseness. Torque and/or replace the worn parts. - Ensure that the piston pin is not offset to the wrong side. Install the correct piston.
Light Knock Hot	- Detonation or spark knock. Check operation of EST or ESC. Refer to Engine Controls. - Loose torque converter bolts. - Exhaust leak at the manifold. Tighten the bolts and/or replace the gasket. - Excessive rod bearing clearance. Replace bearings as necessary.
Noise at Slow Idle or With Hot Oil; Quiet at Higher Engine Speeds or With Cold Oil	High valve lifter leak down rate may cause noise at slow idle or with hot oil. Replace the valve lifter.
Noise at High Vehicle Speeds, Quiet at Low Speeds	Noise at high vehicle speeds may be caused by the following conditions: - High oil level. Oil levels above the FULL mark allows the crankshaft counterweights to churn the oil into foam. When foam is pumped into the valve lifters, they will become noisy since a solid column of oil is required for proper operation. Drain the oil to the proper level. - A low oil level. Oil below the ADD mark allows the oil pump to pump air at high speeds, which results in noisy valve lifters. Add oil as necessary. - Oil pan bent up against the oil pump pickup screen. - Oil pump pickup screen bent or loose.
Noise Regardless of Engine Speed	- Incorrect valve adjustment leading to noise regardless of engine speed. Check valve lash. - Excessive valve lash may cause engine noise. Check for valve lash by turning the engine so that the piston in that cylinder is on TDC of the firing stroke. If the valve lash is present, the pushrod can be freely moved up and down a certain amount with the valve rocker arm held against the valve. - Excessive valve lash may be caused by the following conditions: - A worn pushrod upper end ball. Replace the pushrod and the valve rocker arm. - A bent pushrod. - Improper lubrication of the pushrod. Replace the pushrod and the valve rocker arm. - Check the lubrication system feed to the pushrod - A loose or damaged valve rocker arm. - If the pushrod and valve rocker are OK, trouble in the valve lifter is indicated. Replace the valve lifter.
Vibrating or Rattling from Exhaust System	Vibration or rattling from the exhaust system may be caused by loose and/or misaligned exhaust components. Align, then tighten the connections. Check for damaged hangers or mounting brackets and clamps.

Engine Noise Diagnosis (cont'd)

Symptom	Cause
Exhaust Leakage and/or Noise	Exhaust leakage and/or noise may be caused by the following conditions: • Leakage at the exhaust component joints and couplings. Tighten the clamps or couplings to the specified torque. • Improperly installed or misalignment of the exhaust system. Align, then tighten the exhaust clamps. • A cracked or broken exhaust manifold. Replace the exhaust manifold. • A leak between the exhaust manifold or the cylinder head. Tighten the exhaust manifold to the cylinder head nuts and bolts to specifications. • Damaged or worn exhaust seals. Replace as necessary. • A burned or rusted out exhaust pipe. Replace the exhaust pipe as necessary. • A burned or blown out muffler. Replace the muffler assembly. • A broken or loose exhaust clamp and/or bracket. Replace as necessary.
Heavy Knock with Torque Applied	• Broken balancer or pulley hub. Replace parts as necessary. • Loose torque converter bolts. • Accessory belts too tight or nicked. Replace and/or tension to specifications as necessary. • Flywheel cracked. • Excessive main bearing clearance. Replace as necessary. • Excessive rod bearing clearance. Replace as necessary.

SIE-ID = 362077

Valve Train Diagnosis

General Information

Symptom	Cause
• A light tapping noise at 1/2 engine speed, or any varying frequency, may indicate a valve train problem. • Tapping noises will typically increase with increased engine speed. • Before attempting to diagnose a valve train noise, check for the proper oil level and allow the engine to obtain normal operating temperature. Following this procedure will bring all engine components to a normal state of expansion. • Sit in the driver's seat, then operate the engine at various speeds and listen for any abnormal engine noise.	
A light tapping noise similar to valve train noise may be caused by the following components:	• Fuel Injectors • Evaporative emissions (EVAP) purge solenoid • Detonation • Loose heat shields

General Information (cont'd)

Symptom	Cause
Valve Train Noise	• Low engine oil pressure • A worn or faulty oil pump • A loose or plugged oil pump screen • Loose valve rocker arm attachments (causing excessive valve lash) • A worn or damaged valve rocker arm ball • A worn valve rocker arm and/or pushrod • A broken valve spring • Worn or damaged valve rotators • Sticking valves • Valve lifters worn, dirty, or faulty • a broken valve lifter guide • Camshaft valve lifter lobes worn • Worn valve guides or valve stems • Worn or damaged valve keys • Bent valve pushrods • Excessive play in the camshaft timing chain • Bent, broken, or damaged timing chain sprocket teeth

Diagnostic Table

Step	Action	Value(s)	Yes	No
DEFINITION: A light tapping noise at 1/2 engine speed, or any varying frequency.				
1	Is there valve train noise?	—	Go to Step 2	System OK
2	Check for a high engine oil level. An engine with the engine oil level above the FULL mark allows the crankshaft counterweights to churn the engine oil into foam. When foamy engine oil is pumped into the valve lifters, the valve lifters become noisy. A solid column of engine oil ensures proper valve lifter operation. Is the engine oil level too high?	—	Go to Step 3	Go to Step 4
3	Drain the engine oil to the proper level. Is the tapping noise gone?	—	System OK	Go to Step 6
4	Check for a low engine oil level. An engine with the engine oil level below the ADD mark may allow the oil pump to pump air at high engine RPM. Is the engine oil level too low?	—	Go to Step 5	Go to Step 6
5	Add engine oil as required. Is the tapping noise gone?	—	System OK	Go to Step 6
6	Check for the proper engine oil pressure. Refer to <i>Engine Mechanical Specifications and Oil Pressure Diagnosis and Testing</i> . Is the engine oil pressure within specifications?	68.65 kPa (10 psi)	Go to Step 11	Go to Step 7
7	Check the oil pump screen for damage or a loose fit to the oil pump. Is the oil pump screen loose or is the oil pump screen damaged?	—	Go to Step 8	Go to Step 9
8	Repair as required. Is the tapping noise gone?	—	System OK	Go to Step 9
9	Check for a damaged oil pump or loose mounting bolts Refer to <i>Oil Pump Clean and Inspect</i> Is the oil pump damaged or are the mounting bolts loose?	—	Go to Step 10	Go to Step 11
10	Repair as required. Is the tapping noise gone?	—	System OK	Go to Step 11

Diagnostic Table (cont'd)

Step	Action	Value(s)	Yes	No
11	Remove and inspect the valve lifters, valve rocker arms, and valve pushrods. Refer to <i>Valve Rocker Arm and Push Rods Clean and Inspect</i> and <i>Valve Lifters and Guides Clean and Inspect</i> . Are the components worn or damaged?	—	Go to Step 12	Go to Step 13
12	Replace the components as required. Is the tapping noise gone?	—	System OK	Go to Step 13
13	Perform a camshaft lobe lift test. Refer to <i>Camshaft and Bearings Clean and Inspect (ERROR - NOT IN CURRENT PSD)</i> . Is the test within <i>Engine Mechanical Specifications</i> ?	—	Go to Step 15	Go to Step 14
14	Replace the camshaft and valve lifters. Is the tapping noise gone?	—	System OK	Go to Step 15
15	Remove the engine front cover and inspect the camshaft timing chain and sprockets for excessive wear or damage. Refer to <i>Timing Chain and Sprockets Clean and Inspect</i> . Are the components worn or damaged?	—	Go to Step 17	Go to Step 16
16	Replace the components as required. Is the tapping noise gone?	—	System OK	Go to Step 17
17	Perform a complete disassembly of the engine and inspect all components. Are the components worn or damaged?	—	Go to Step 18	System OK
18	Replace the components as required. Did you complete the worn and damaged component replacement?	—	System OK	—

SIE-ID = 294973

Oil Consumption Diagnosis

Excessive oil consumption (not due to leaks) is the use of more than 0.95 liter (1 quart) of engine oil within 100 gallons of fuel used. However, during initial engine break-in periods 4 828–6 437 kilometers (3,000–4,000 miles) oil consumption may exceed 1.9 liters (2 quarts) or more per 100 gallons of fuel used. The causes of excessive oil consumption include the following conditions:

- External oil leaks. Tighten bolts and/or replace gaskets and oil seals as necessary.
- Incorrect oil level or improper reading of oil level indicator. With the vehicle on a level surface, allow adequate drain down time and check for the correct oil level.
- Improper oil viscosity. Use recommended SAE viscosity for the prevailing temperatures.
- Continuous high speed driving and/or severe usage.
- Crankcase ventilation system restrictions or malfunctioning components.
- Valve guides and/or valve stem oil seals worn, or the seal omitted. Ream guides and install oversize service valves and/or new valve stem oil seals.
- Piston rings broken, improperly installed, worn, or not seated properly. Allow adequate time for rings to seat. Replace broken or worn rings as

necessary.

- Piston improperly installed or miss-fitted.

SIE-ID = 42493

Oil Pressure Diagnosis and Testing

SIO-ID = 18963

1. With the vehicle on a level surface, allow adequate drain down time (2–3 minutes) and measure for a low engine oil level.
Add the recommended grade engine oil GM P/N 12345610 or equivalent, and fill the crankcase until the oil level measures FULL on the oil level indicator.
2. Operate the engine and verify low or no oil pressure on the vehicle oil pressure gauge or oil indicator light.
Listen for a noisy valve train or knocking noise.
3. Inspect for the following:
 - Engine oil diluted by moisture or unburned fuel mixtures
 - Improper engine oil viscosity for the expected temperature
 - Incorrect or faulty oil pressure gauge sensor
 - Incorrect or faulty oil pressure gauge
 - Plugged oil filter
 - Malfunctioning oil filter bypass valve
4. Remove the oil pressure gauge sensor or another engine block oil gallery plug.

5. Install an oil pressure gauge and measure the engine oil pressure.
6. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
 - Oil pump worn or dirty
 - Malfunctioning oil pump pressure relief valve
 - Oil pump screen loose, plugged, or damaged
 - Excessive bearing clearance
 - Cracked, porous or restricted oil galleries
 - Engine block oil gallery plugs missing or incorrectly installed
 - Broken valve lifters

SIE-ID - 204344

Oil Leak Diagnosis

Step	Action	Value(s)	Yes	No
DEFINITION: You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.				
1	1. Operate the vehicle until it reaches normal operating temperature. Refer to <i>Engine Mechanical Specifications</i> . 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait (15 minutes). 4. Check for drippings. 5. Are drippings present?	—	Go to Step 2	Go to Step 3
2	1. Identify the type of fluid and the approximate location of the leak. 2. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 3
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 4
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait (15 minutes). 5. Identify the type of fluid, and the approximate location of the leak. 6. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 5

Oil Leak Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
5	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 6
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder (baby powder, foot powder, etc.) to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. 5. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 7
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 8
8	1. Using the J 28428-E, Dye and Light Kit, identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. 2. Can you identify the type of fluid and the approximate location of the leak?	—	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components 3. Can you identify the source of the leak?	—	Go to Step 10	Go to Step 12

Oil Leak Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
10	1. Check for the following conditions: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Is there mechanical damage to the engine?	—	Go to Step 11	—
11	Repair or replace all damaged components.	—	Go to Step 1	—
12	System OK.	—	—	—

SIE-ID - 371683

Drive Belt Diagnosis

Definitions

The following are symptomatic noises of the drive belt system:

Chirping

The following items are indications of chirping:

- A high pitched noise that is usually heard once per revolution of a pulley or a belt.
- It is most common on cold, damp mornings.
- Verify this condition by squirting water onto the belt. The noise will momentarily stop.

Squeal

The following items are indications of squeal:

- A loud screeching noise that is caused by a slipping belt (this is unusual for a belt with multiple ribs).
- The noise occurs when a heavy load is applied to the belt, such as an air conditioning compressor engagement, snapping the throttle, or slipping on a seized pulley.

Whine

A high pitched continuous noise that may be caused by a failed bearing.

Faint Cycle Rumbling

A low frequency noise heard once per revolution of the drive belt.

Pilling

The following items are indications of pilling:

- The random accumulation of rubber dust in the bottom of the multi-ribbed belt grooves.
- A small amount of pilling is normal.
- Operation of the drive belt system will not be effected unless the buildup exceeds one third (1/3) of the belt groove depth.

Multiple-ribbed type drive belts wear evenly with their

pulleys. Unusual wear indicates a correction is needed. The following diagnostic tables will aid in diagnosing drive belt system conditions.

Drive Belt Diagnosis

Step	Action	Value(s)	Yes	No
1	Check for misalignment of the pulleys. Are any of the pulleys misaligned?	—	Go to Step 2	Go to Step 3
2	Replace any misaligned pulleys. Is the chirp still present?	—	Go to Step 3	System OK
3	Check for bent or cracked brackets. Are there any bent or cracked brackets?	—	Go to Step 4	Go to Step 5
4	Replace any bent or cracked brackets. Is the chirp still present?	—	Go to Step 5	System OK
5	Check for any loose or missing fasteners. Are there any loose or missing fasteners?	—	Go to Step 6	Go to Step 7
6	Tighten any loose fasteners and properly install any missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . Is the chirp still present?	—	Go to Step 7	System OK
7	Check for a bent pulley flange. Is the pulley flange bent?	—	Go to Step 8	Go to Step 9
8	Replace the pulley flange. Is the chirp still present?	—	Go to Step 9	System OK
9	Check for severe pilling, exceeding 1/3 of the belt groove depth. Is there severe pilling?	—	Go to Step 10	—
10	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> . Is the chirp still present?	—	—	System OK

Drive Belt Squeal

Step	Action	Value(s)	Yes	No
11	Check for a misaligned pulley. Is there a pulley misaligned?	—	Go to Step 13	Go to Step 12
12	Check for incorrect belt length. Refer to <i>Drive Belt Replacement</i> . Is the belt length correct?	—	Go to Step 14	Go to Step 15
13	Repair or install new parts as necessary. Is the repair complete?	—	System OK	—
14	Check for a malfunctioning drive belt tensioner. Refer to <i>Drive Belt Tensioner Diagnosis</i> . Is the tensioner malfunctioning?	—	Go to Step 13	Go to Step 15
15	Check for correct pulley size. Are the pulleys the correct size?	—	Go to Step 16	Go to Step 13
16	Check for siezed bearings. Is there a siezed bearing?	—	Go to Step 13	System OK

Drive Belt Whine

Step	Action	Value	Yes	No
17	Check for a worn accessory component bearing. Is a bearing making the noise?	—	Go to Step 18	System OK
18	Install new parts as necessary. Is the repair complete?	—	System OK	—

Drive Belt Rumbling

Step	Action	Value(s)	Yes	No
19	Check for severe pilling. Is there severe pilling of more than 1/3 of the rib depth?	—	Go to Step 19	System OK
20	Clean the drive belt pulleys. Are the drive belt pulleys clean?	—	Go to Step 20	Go to Step 21
21	Install a new drive belt. Refer to Drive Belt Replacement in Engine Mechanical <i>Drive Belt Replacement</i> Is the repair complete?	—	System OK	—

Drive Belt Vibration

Step	Action	Value(s)	Yes	No
22	Check for loose or missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . Are there loose or missing fasteners?	—	Go to Step 22	Go to Step 24
23	Re-tighten or replace as necessary. Is the repair complete?	—	System OK	—
24	Check for damaged fan blades. Are there damaged fan blades?	—	Go to Step 25	Go to Step 26
25	Replace as necessary. Refer to <i>Fan Clutch Replacement (ERROR - NOT IN CURRENT PSD)</i> in Engine Cooling. Is the replacement complete?	—	System OK	—
26	Check for a bent fan clutch or coolant pump shaft. Is the fan clutch or coolant pump shaft bent?	—	Go to Step 27	Go to Step 28
27	Replace as necessary. Refer to <i>Fan Clutch Replacement (ERROR - NOT IN CURRENT PSD)</i> in Engine Mechanical. Is the repair complete?	—	System OK	—
28	Check for bent or cracked brackets. Are there bent or cracked brackets?	—	Go to Step 29	System OK
29	Replace the brackets as necessary. Refer to <i>Accessory Brackets Replacement (AC)</i> Is the repair complete?	—	System OK	—

Drive Belt Falls Off

Step	Action	Value(s)	Yes	No
30	Check for a misaligned or a bent pulley. Are the pulleys misaligned?	—	Go to Step 31	Go to Step 32
31	Replace any misaligned or bent pulleys. Does the drive belt continue to fall off?	—	Go to Step 32	System OK
32	Check for a bent or a cracked bracket. Are any of the brackets bent or cracked?	—	Go to Step 33	Go to Step 34
33	Replace the damaged brackets. Does the drive belt continue to fall off?	—	Go to Step 34	System OK
34	Check for loose or missing fasteners. Are there any loose or missing fasteners?	—	Go to Step 35	Go to Step 36
35	Replace any missing fasteners and tighten to specifications. Refer to <i>Fastener Tightening Specifications</i> . Does the drive belt continue to fall off?	—	Go to Step 36	System OK

Drive Belt Falls Off (cont'd)

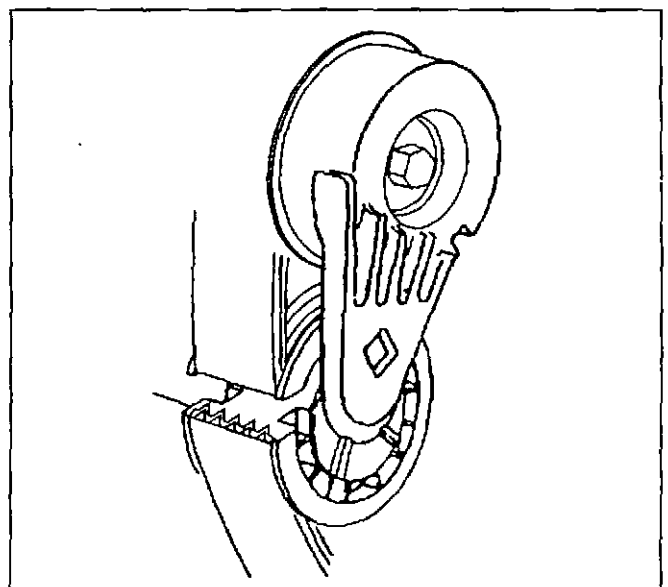
Step	Action	Value(s)	Yes	No
36	Check for a misaligned power steering pump pulley. Is the power steering pump pulley misaligned?	—	Go to Step 37	Go to Step 38
37	Realign or replace the power steering pump pulley. Refer to <i>Power Steering Pump Replacement (6.5L)</i> in <i>Power Steering</i> . Does the drive belt continue to fall off?	—	Go to Step 38	System OK
38	Check for a damaged drive belt. Is the drive belt damaged?	—	Go to Step 39	Go to Step 40
39	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> . Does the drive belt continue to fall off?	—	Go to Step 40	System OK
40	Check for a malfunctioning drive belt tensioner. Is the drive belt tensioner malfunctioning?	—	Go to Step 41	Go to Step 42
41	Replace the drive belt tensioner. Refer to <i>Drive Belt Tensioner Replacement</i> in <i>Engine Mechanical</i> . Does the drive belt continue to fall off?	—	Go to Step 42	System OK
42	Check for worn idler or tensioner pulley bearings. Are the idler or tensioner pulley bearings worn?	—	Go to Step 43	—
43	Replace the worn bearings. Does the drive belt continue to fall off?	—	—	System OK

Drive Belt Diagnosis

Step	Action	Value(s)	Yes	No
44	Check to see if the ribs in the drive belt do not match the grooves in the pulley. Do the ribs in the drive belt match the grooves in the pulley?	—	—	Go to Step 45
45	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> . Is there still excessive wear in either outside groove of the drive belt?	—	—	System OK

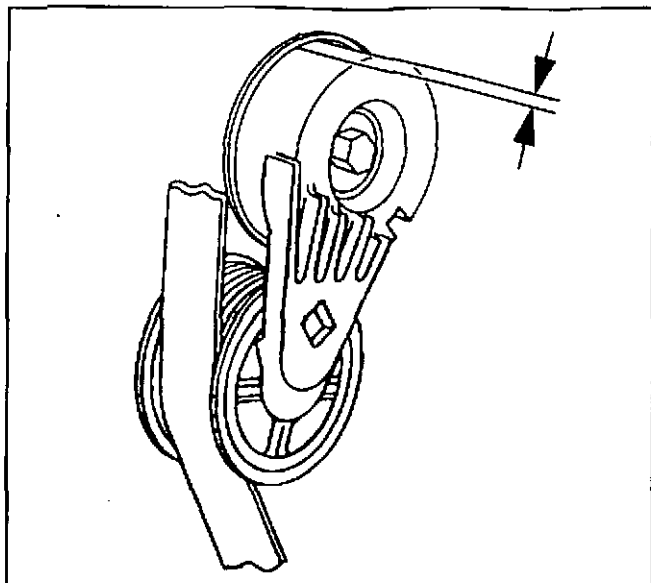
General Instructions

The following graphics illustrate the correct way to route the drive belt over the pulleys, and some examples of incorrect belt placement.



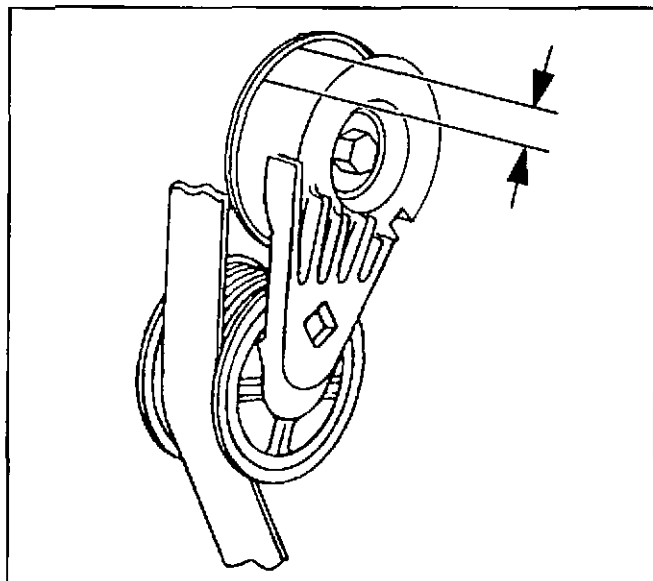
1. Observe the drive belt correctly installed on the pulley. Each groove on the drive belt rests

inside a matching groove in the pulley.



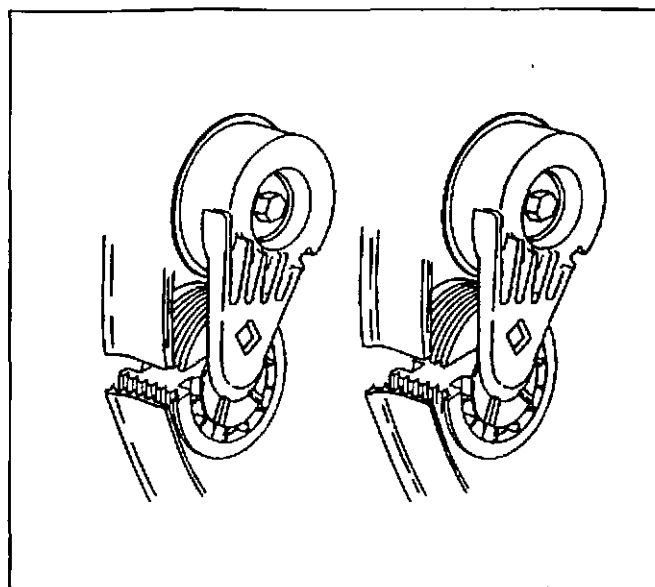
172989

2. When installing a new drive belt, observe the indicator on the tensioner. A new drive belt should fall inside this range.



172991

3. When installing a used drive belt, observe the indicator on the tensioner. A used drive belt should fall inside this range.



172993

4. Observe these incorrectly installed drive belts. Avoid mis-positioning the belt by one or more grooves.

SIE-ID - 332590

Drive Belt Tensioner Diagnosis

Inspection Procedure

Notice: SIO-ID - 3753 Allowing the drive belt tensioner to snap into the free position may result in damage to the tensioner.

1. Remove the drive belts. Refer to *Drive Belt Replacement* in Engine Mechanical.
2. Position a hex-head socket on the belt tensioner pulley bolt head.
3. Move the drive belt tensioner through it's full travel.
 - The movement should feel smooth.
 - There should be no binding.
 - The tensioner should return freely.
4. If any binding is observed, replace the tensioner. Refer to *Drive Belt Tensioner Replacement* in Engine Mechanical.
5. Install the drive belt. Refer to *Drive Belt Replacement* in Engine Mechanical.

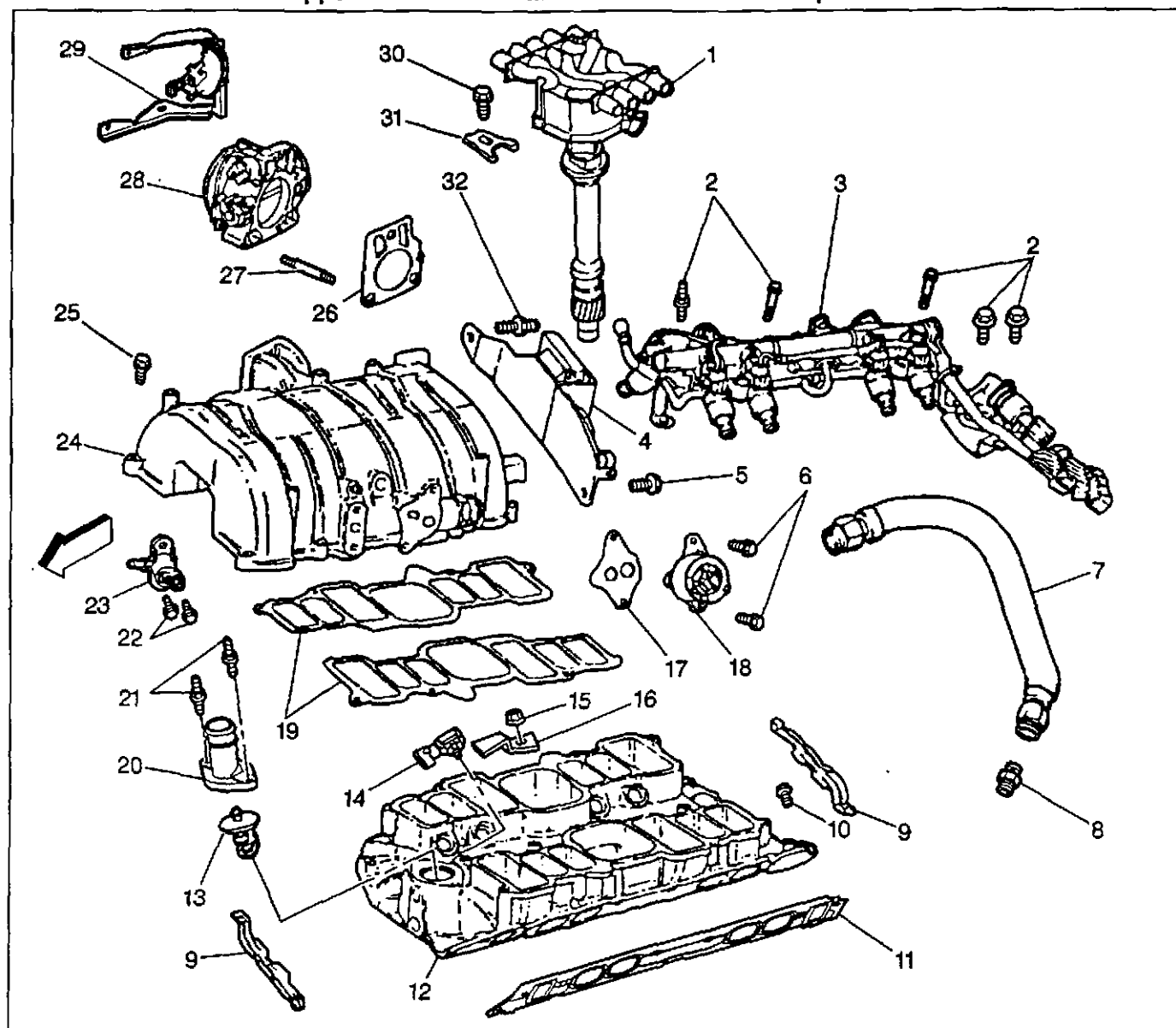
Visual Identification

SIE-ID - 201613

Disassembled Views

SIO-ID - 201487

Upper and Lower Intake Manifolds and Components



212464

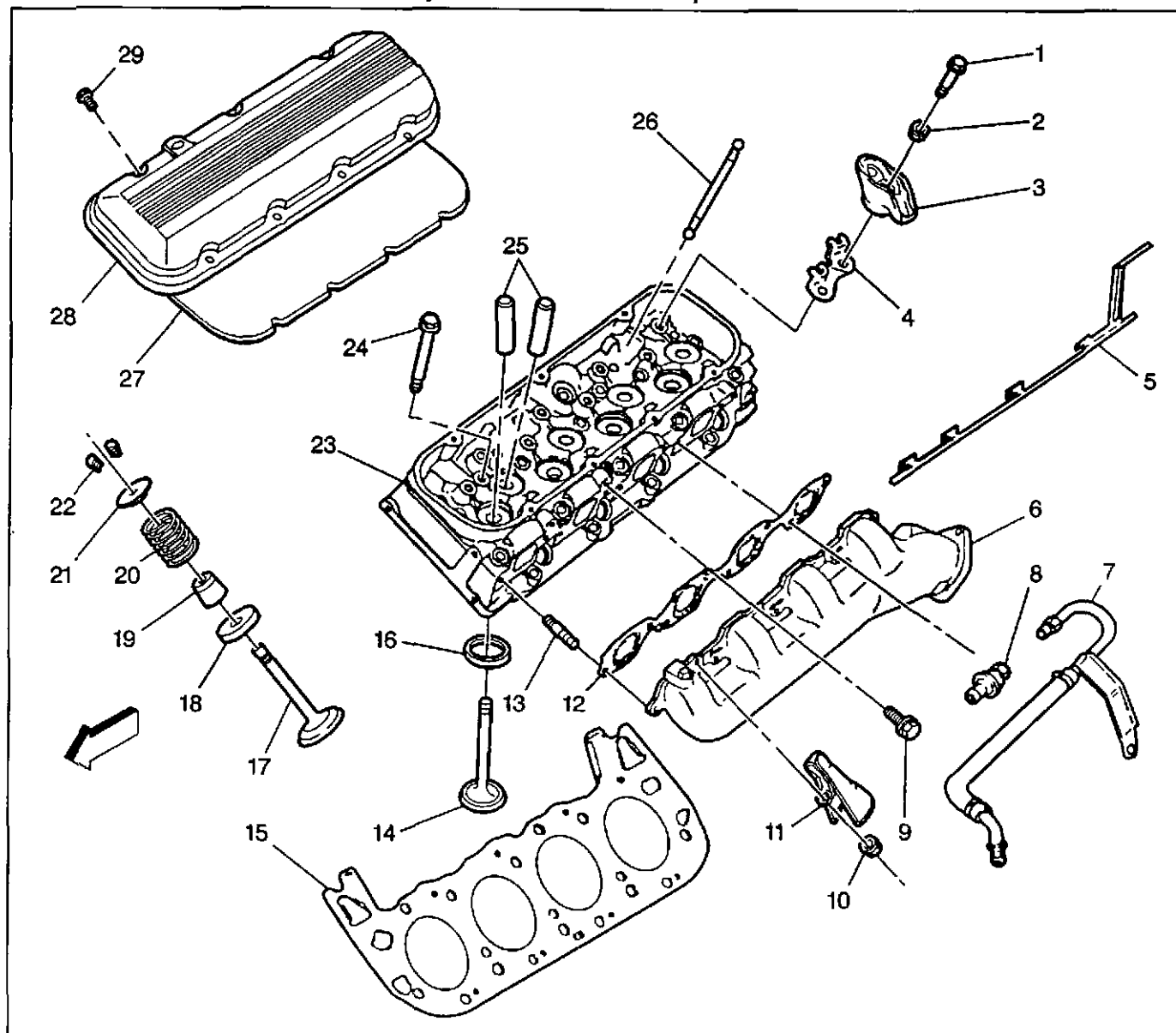
Legend

- | | |
|--|------------------------------------|
| (1) High Voltage Distributor | (12) Lower Intake Manifold |
| (2) Fuel Rail Bolt | (13) Thermostat |
| (3) Fuel Rail Assembly | (14) MAP Sensor |
| (4) Ignition Coil | (15) MAP Sensor Bracket |
| (5) Ignition Coil Bolt | (16) MAP Sensor Bracket Nut |
| (6) EGR Valve Bolt | (17) EGR Valve Gasket |
| (7) EGR Inlet Pipe | (18) EGR Valve |
| (8) EGR Inlet Pipe Fitting | (19) Upper Intake Manifold Gaskets |
| (9) Lower Intake Manifold End Gaskets | (20) Water Outlet Housing |
| (10) Lower Intake Manifold Bolt | (21) Water Outlet Housing Studs |
| (11) Lower Intake Manifold Side Gasket | (22) EVAP Purge Valve Bolts |

- (23) EVAP Purge Valve
- (24) Upper Intake Manifold
- (25) Upper Intake Manifold Bolt
- (26) Throttle Body Gasket
- (27) Throttle Body Stud
- (28) Throttle Body
- (29) Governor Bracket (RPO 9C2 only)
- (30) Distributor Clamp Bolt
- (31) Distributor Clamp
- (32) Ignition Coil Stud

SIO-ID - 201528

Cylinder Head and Components



180857

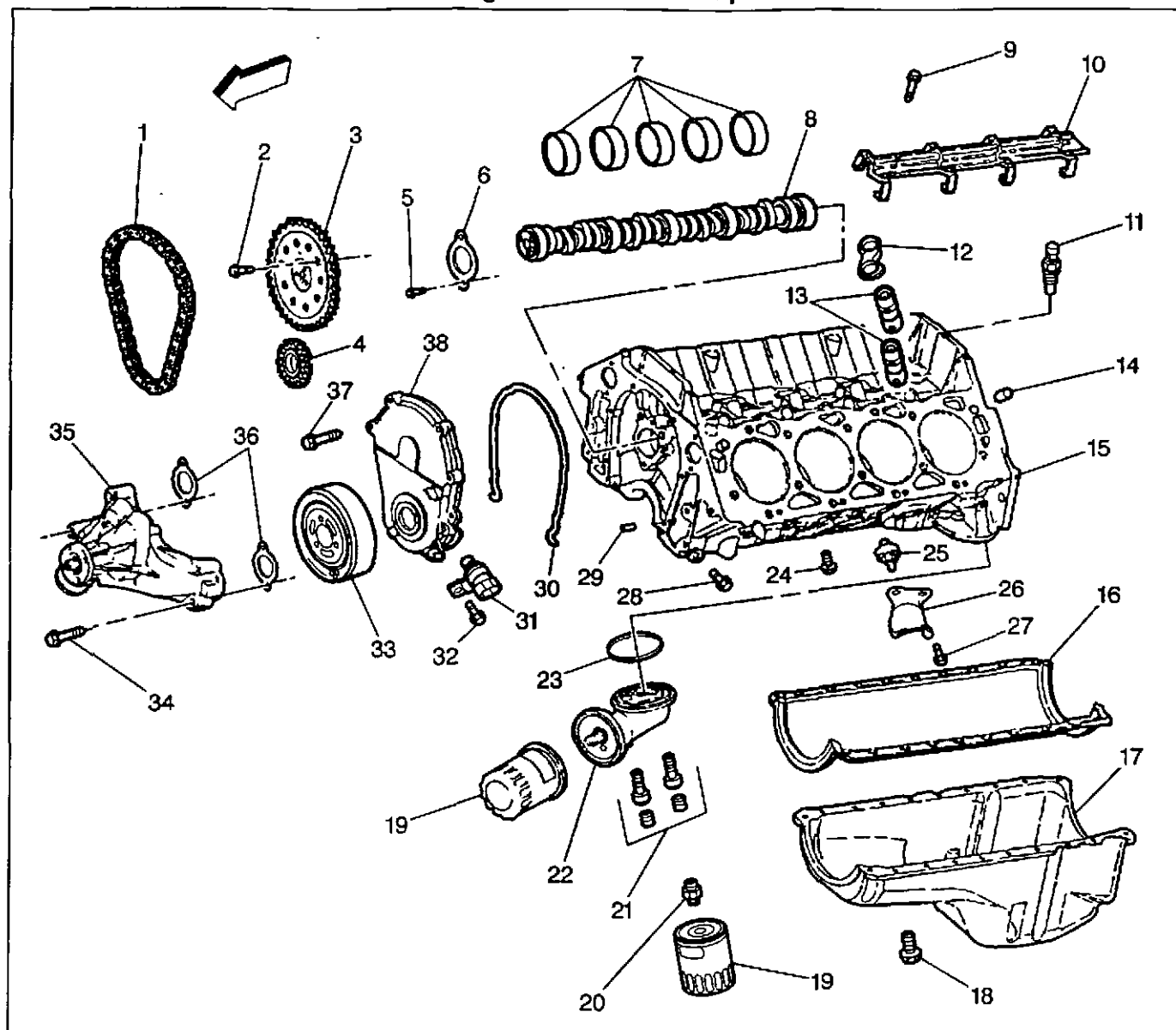
Legend

- (1) Valve Rocker Arm Bolt
- (2) Valve Rocker Arm Ball
- (3) Valve Rocker Arm
- (4) Pushrod Guide
- (5) Spark Plug Wire Bracket
- (6) Exhaust Manifold
- (7) AIR Tube (California Only)
- (8) AIR Tube Check Valve (California Only)

- (9) Exhaust Manifold Center Bolt
 - (10) Heat Shield Nut
 - (11) Heat Shield
 - (12) Exhaust Manifold Gasket
 - (13) Exhaust Manifold Stud
 - (14) Valve
 - (15) Cylinder Head Gasket
 - (16) Valve Seat
 - (17) Valve
 - (18) Valve Rotator
 - (19) Valve Stem Oil Seal
 - (20) Valve Spring
 - (21) Valve Cap
 - (22) Valve Keys
 - (23) Cylinder Head
 - (24) Cylinder Head Bolt
 - (25) Valve Guides
 - (26) Valve Pushrod
 - (27) Valve Rocker Arm Cover Gasket
 - (28) Valve Rocker Arm Cover
 - (29) Valve Rocker Arm Cover Bolt
-

SIO-ID - 201531

Lower Engine Block and Components



180859

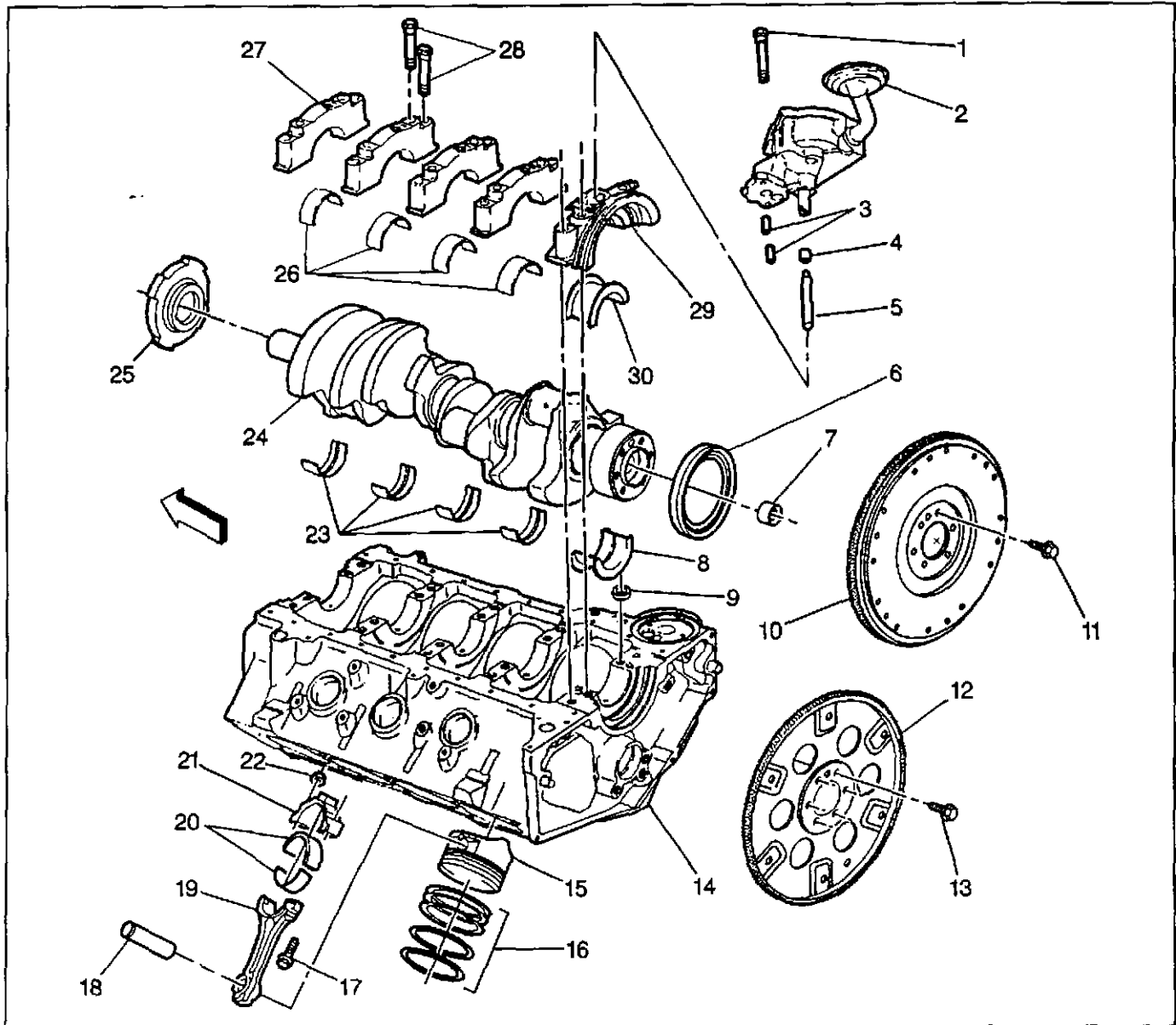
Legend

- | | |
|--------------------------------------|---|
| (1) Timing Chain | (17) Oil Pan |
| (2) Camshaft Sprocket Bolt | (18) Oil Pan Bolt |
| (3) Camshaft Sprocket | (19) Oil Filter |
| (4) Crankshaft Sprocket | (20) Oil Filter Fitting |
| (5) Camshaft Retainer Bolt | (21) Oil Filter Adapter Bolts and Plugs |
| (6) Camshaft Retainer | (22) Oil Filter Adapter Assembly |
| (7) Camshaft Bearings | (23) Oil Filter Adapter O-Ring |
| (8) Camshaft | (24) Engine Block Coolant Drain Hole Plug |
| (9) Valve Lifter Guide Retainer Bolt | (25) Knock Sensor |
| (10) Valve Lifter Guide Retainer | (26) Knock Sensor Heat Shield |
| (11) Oil Pressure Sensor | (27) Knock Sensor Heat Shield Bolt |
| (12) Valve Lifter Guide | (28) Engine Block Oil Gallery Plug |
| (13) Valve Lifter | (29) Engine Front Cover Locating Pin |
| (14) Cylinder Head Locating Pin | (30) Engine Front Cover Gasket |
| (15) Engine Block | (31) Crankshaft Position Sensor |
| (16) Oil Pan Gasket | (32) Crankshaft Position Sensor Bolt |

- (33) Crankshaft Balancer
- (34) Water Pump Bolt
- (35) Water Pump
- (36) Water Pump Gaskets
- (37) Engine Front Cover Bolt
- (38) Engine Front Cover

SIO-ID - 201534

Engine Crankshaft and Components

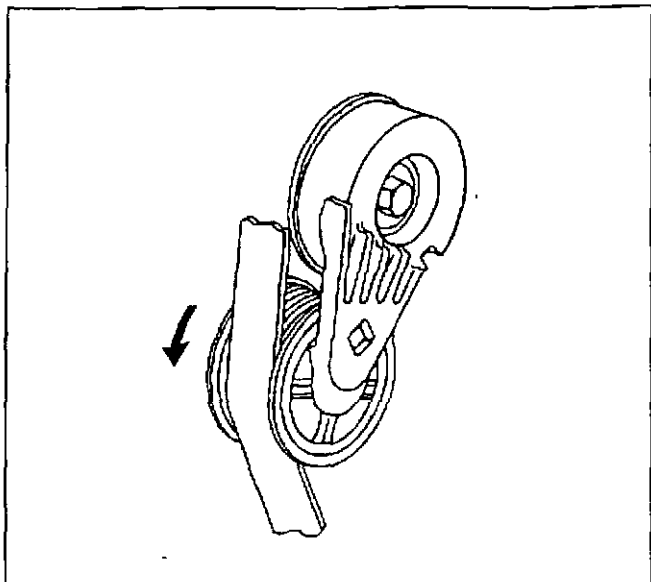


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Legend

- | | |
|-------------------------------------|---|
| (1) Oil Pump Bolt | (9) Crankshaft Bearing Cap Oil Seal |
| (2) Oil Pump | (10) Engine Flywheel (Manual Transmission) |
| (3) Oil Pump Locating Pins | (11) Engine Flywheel Bolt |
| (4) Oil Pump Driveshaft Retainer | (12) Engine Flywheel (Automatic Transmission) |
| (5) Oil Pump Driveshaft | (13) Engine Flywheel Bolt |
| (6) Crankshaft Rear Seal | (14) Engine Block |
| (7) Clutch Pilot Bearing | (15) Piston |
| (8) Crankshaft Upper Thrust Bearing | (16) Piston Ring Assembly |

- (17) Connecting Rod Bolt
 - (18) Piston Pin
 - (19) Connecting Rod
 - (20) Connecting Rod Bearings
 - (21) Connecting Rod Cap
 - (22) Connecting Rod Nut
 - (23) Crankshaft Upper Bearings
 - (24) Crankshaft
 - (25) Crankshaft Position Sensor Reluctor Ring
 - (26) Crankshaft Lower Bearings
 - (27) Crankshaft Bearing Cap
 - (28) Crankshaft Bearing Cap Bolts
 - (29) Crankshaft Bearing Thrust Cap
 - (30) Crankshaft Lower Thrust Bearing
-



177620

Repair Instructions

SIE-ID - 332653

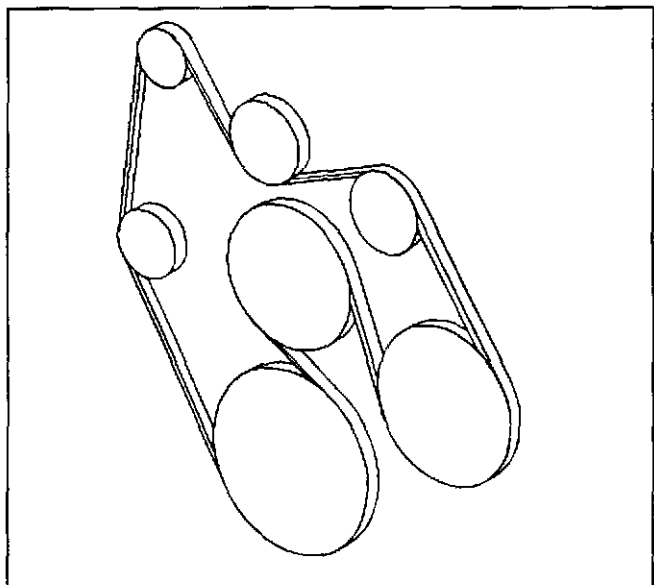
Drive Belt Replacement

Removal Procedure

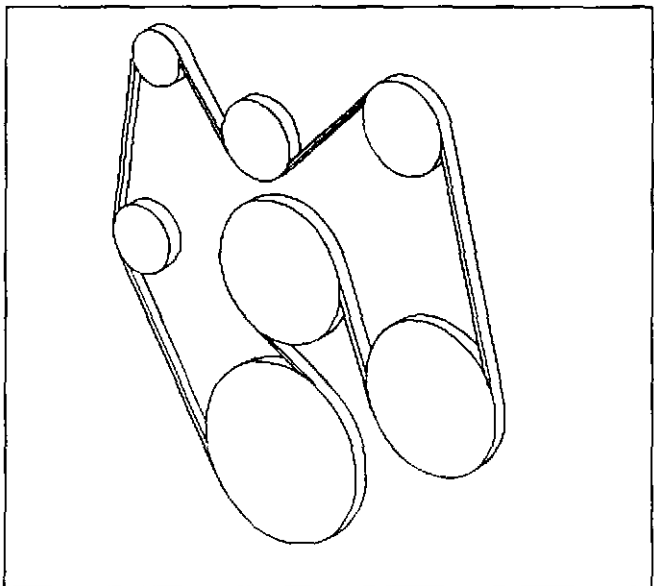
1. Install a 3/8 inch drive wrench on the tensioner arm and rotate the arm counterclockwise.
2. Remove the drive belt.
3. Slowly release the tension on the tensioner arm.

Installation Procedure

1. Route the belt over all the pulleys except the tensioner arm.
2. Observe belt routing for vehicles without air conditioning.
3. Observe belt routing for vehicles with air conditioning.

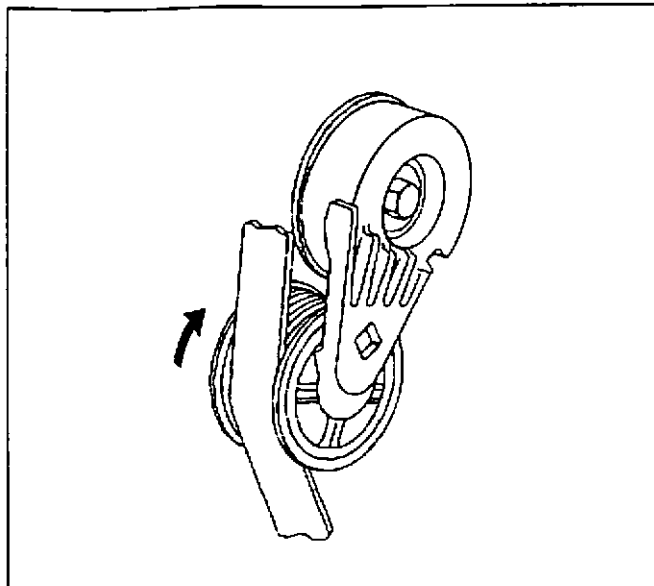


43858



43859

4. Install a 3/8 inch drive wrench on the tensioner arm and rotate the arm counterclockwise.
5. Install the belt over the tensioner arm pulley.
6. Slowly release the tension on the tensioner arm.
7. Confirm that the belt is properly routed.



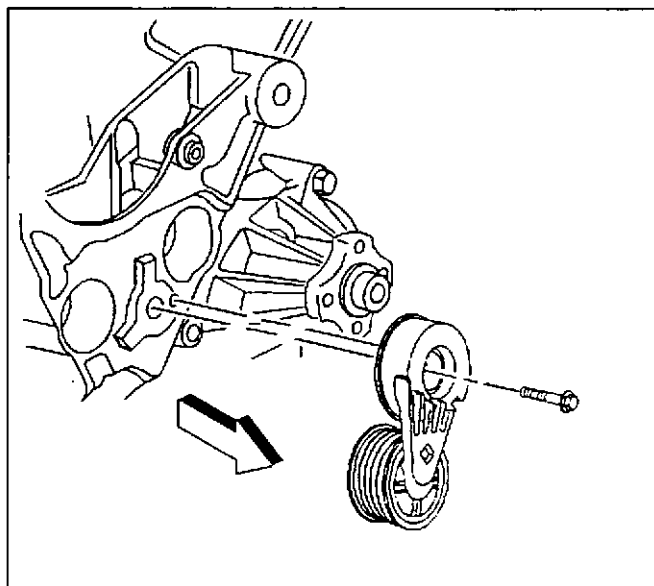
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SIE-ID - 332659

Drive Belt Tensioner Replacement

Removal Procedure

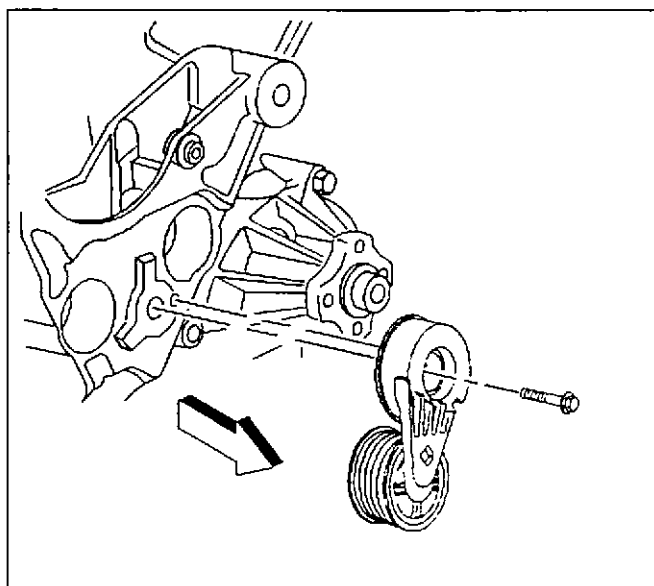
1. Remove the drive belt.
Refer to *Drive Belt Replacement*.
2. Remove the bolt.
3. Remove the tensioner.



43854

Installation Procedure

1. Install the drive belt tensioner assembly.
Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the attaching bolt.
Tighten
Tighten the tensioner assembly bolt to 50 N.m (37 lb ft).
3. Install the drive belt.
Refer to *Drive Belt Replacement*.



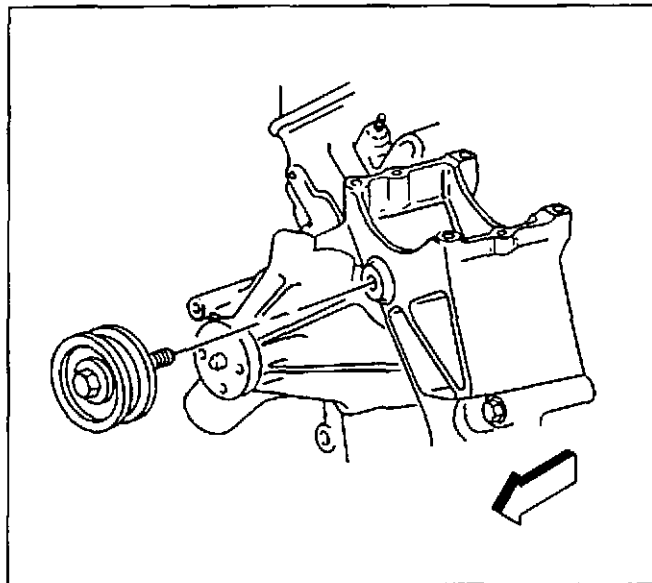
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SIE-ID - 332664

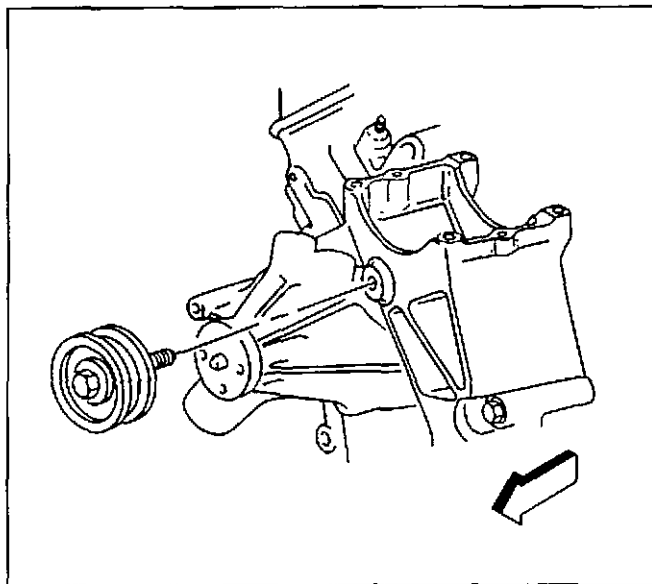
Drive Belt Idler Pulley Replacement

Removal Procedure

1. Remove the upper fan shroud from the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in engine cooling.
2. Remove the drive belt from the vehicle. Refer to *Drive Belt Replacement*.
3. Remove the drive belt idler pulley from the engine.



188927



188927

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the drive belt idler pulley to the engine assembly..

Tighten

Tighten the bolt to 50 N.m (37 lb ft).

2. Install the drive belt to the vehicle. Refer to *Drive Belt Replacement*.
3. Install the upper fan shroud to the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in engine cooling.

SIE-ID - 332672

Engine Mount Inspection

SIO-ID - 43176

Notice: SIO-ID - 5167 Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

Notice: SIO-ID - 5168 When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

1. Raise the engine in order to complete the following tasks:
 - Remove weight from the mount.
 - Place a slight tension on the rubber cushion.
 - Observe the mount while raising the engine.
2. Replace the mount if the following conditions exist:
 - Heat check cracks cover the hard rubber surface.
 - The rubber cushion is separated from the metal plate of the mount.
 - There is a split through the rubber cushion.
3. If the mount is loose, lower the engine and tighten the bolts or the nuts to the engine frame or the bracket.

SIO-ID - 43175

Notice: SIO-ID - 5167 Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

1. Push up and pull down on the transmission extension housing. Observe the transmission mount.
2. Replace the mounting if the following conditions exist:
 - The rubber cushion is separated from the metal plate of the mounting.
 - The mounting has bottomed out.
 - The extension housing moves up but not down.
3. If a mount is loose, tighten the bolts or nuts that attach the mount to the transmission or to the crossmember.

Tighten

- For the transmission mounts to transmission bolts, tighten the bolts to 47 N.m (35 lb ft).
- For the transmission mount to support nuts, tighten the nuts to 47 N.m (35 lb ft).

Notice: Refer to *Fastener Notice* in General Information.

SIE-ID - 332676

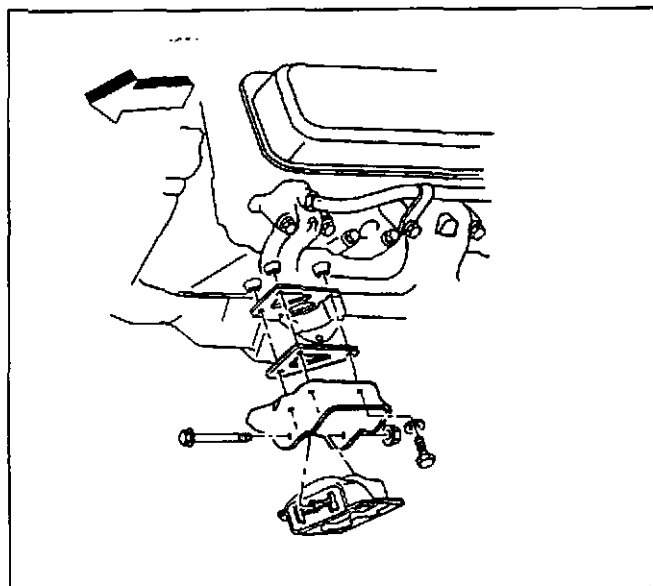
Engine Mount Replacement

Removal Procedure

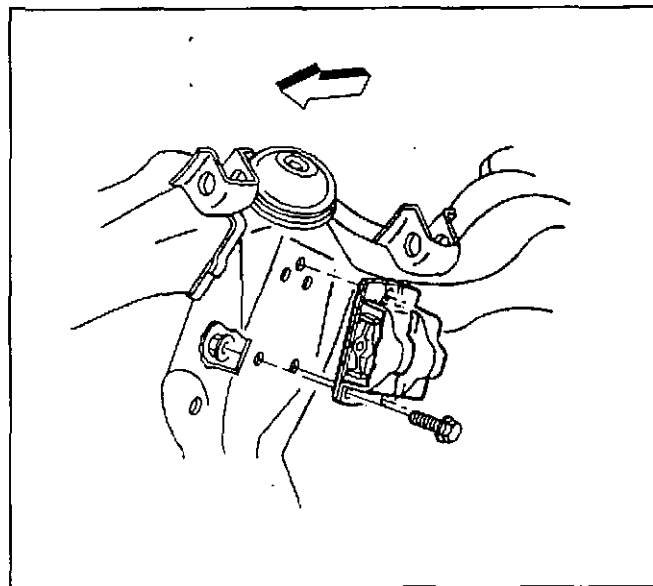
1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.

Notice: SIO-ID - 5168 When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

2. Support the engine with a suitable jack. Do not load the engine mounts.
3. Remove the engine mount through bolt and the nut.
4. Raise the engine only enough to permit removal of the engine mount.



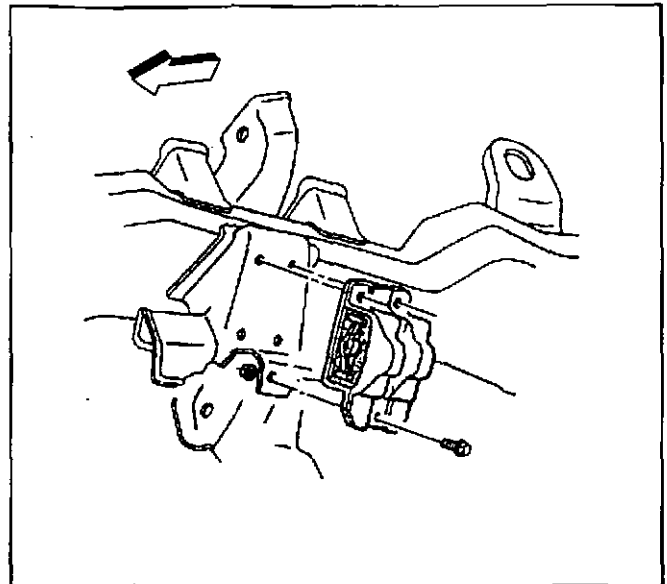
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5. If servicing a 2 wheel drive model truck, remove the engine mount assembly bolts, nuts, and washers.
6. Remove the engine mount assembly.

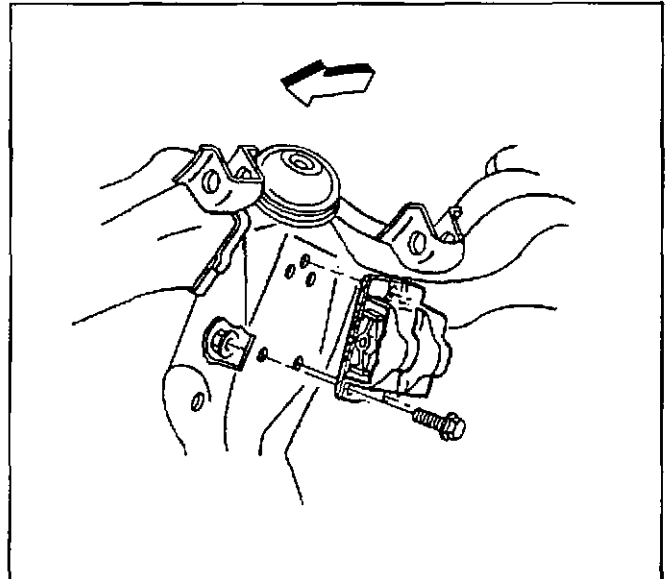
7. If servicing a 4 wheel drive model truck, remove the engine mount assembly bolts, nuts, and washers.
8. Remove the engine mount assembly.



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Installation Procedure

1. If servicing a 2 wheel drive model truck, install the engine mount assembly.



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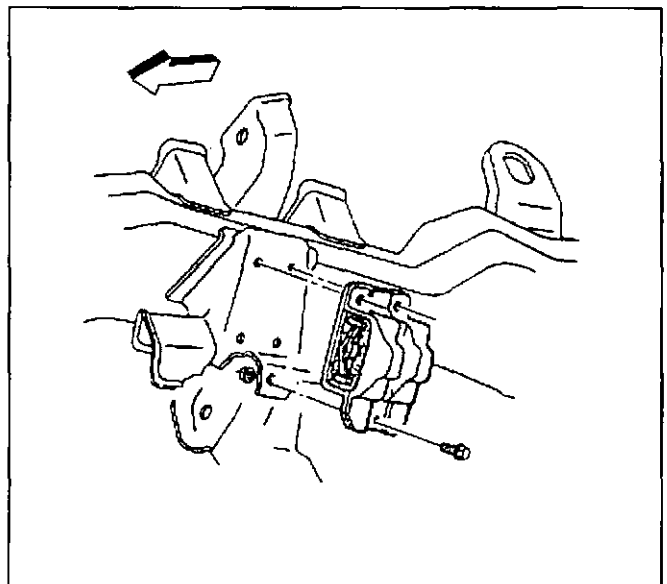
2. If servicing a 4 wheel drive model truck, install the engine mount assembly.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

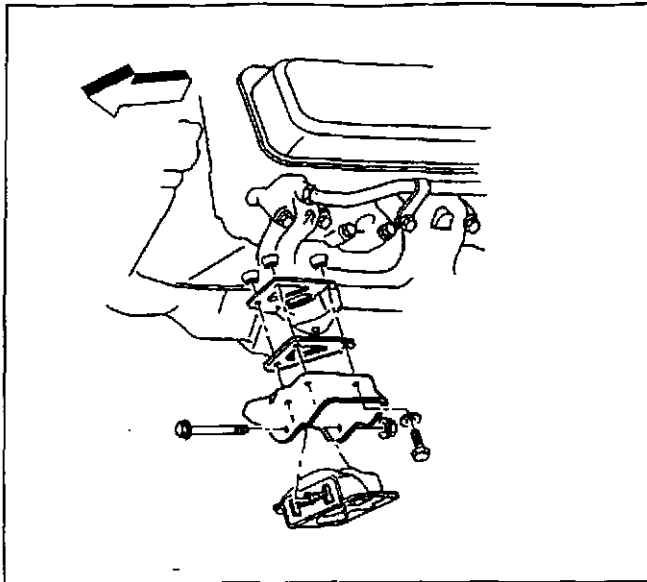
3. Install the engine mount assembly bolts, nuts, and washers.

Tighten

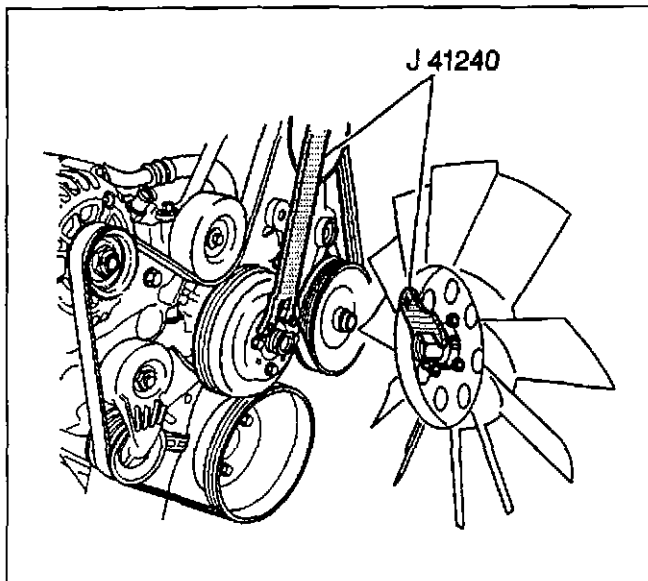
- Tighten the bolts to 59 N.m (44 lb ft).
- Tighten the nuts to 45 N.m (33 lb ft).



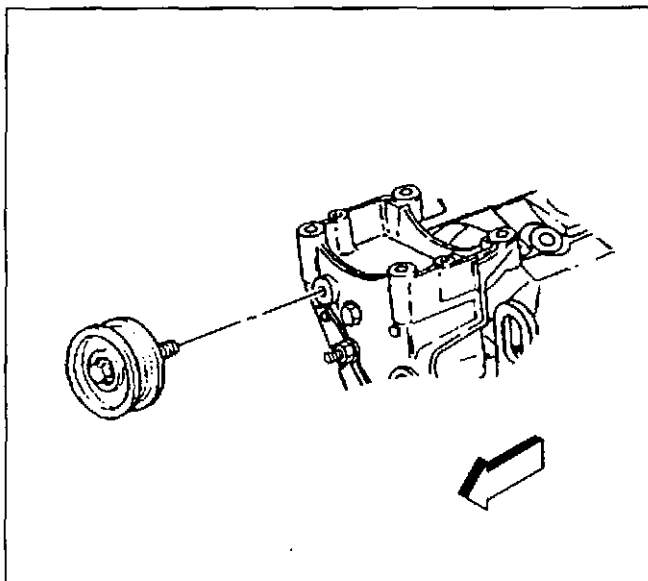
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4. Lower the engine until the engine mount through bolt can be inserted.
5. Install the engine mount through bolt and the nut.

Tighten

Tighten the through bolt nut to 68 N.m (50 lb ft).

6. Connect the battery negative cable. Refer to *Battery Cable (0)* in engine electrical.

SIE-ID = 358198

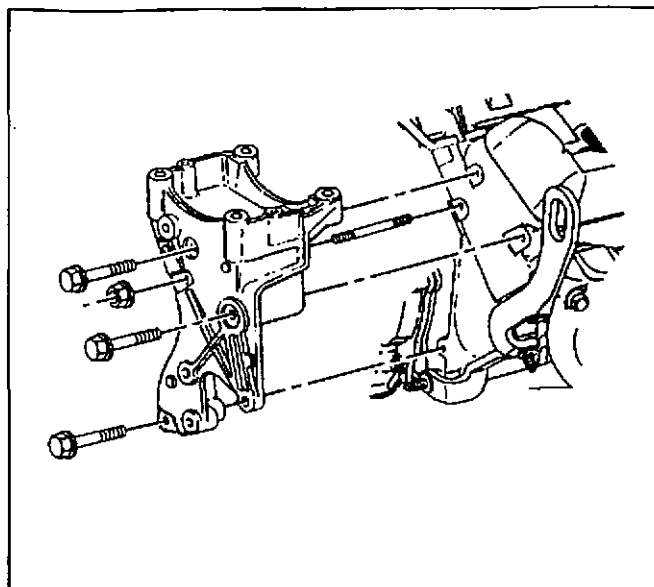
Accessory Brackets Replacement (AC)**Removal Procedure**

1. Remove the engine cooling fan. Refer to *Fan Clutch Replacement (ERROR - NOT IN CURRENT PSD)* in engine cooling.
2. Remove the drive belt. Refer to *Drive Belt Replacement* in Engine Mechanical.

Important: Do not evacuate the air conditioning system.

3. Remove the mounting bolts for the air conditioning compressor, if equipped. Refer to *Compressor Replacement (7.4L)* in HVAC.
4. Move the compressor aside and support.
5. Remove the drive belt idler pulley if not equipped with A/C. Refer to *Drive Belt Idler Pulley Replacement* in Engine Mechanical.
6. Remove the power steering pump pulley. Refer to *Power Steering Pump Replacement (7.4L)* in Power Steering Systems.

7. Remove the three bolts and nut holding the accessory mounting bracket to the engine.
8. Slide the bracket off the stud and power steering pump.

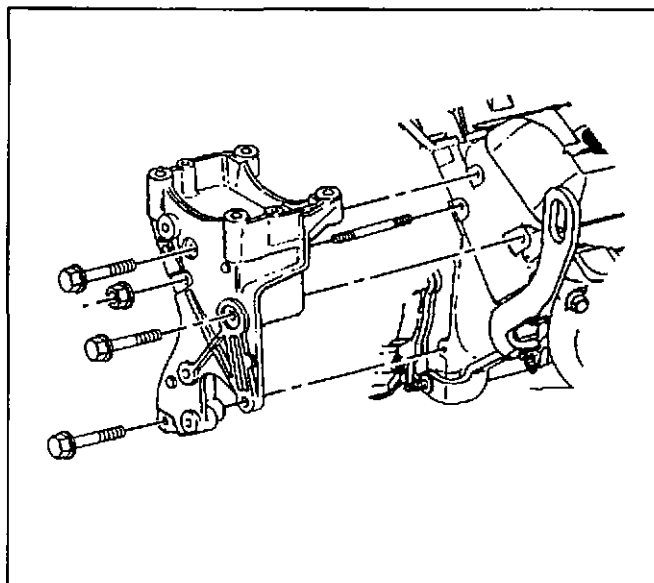


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Installation Procedure

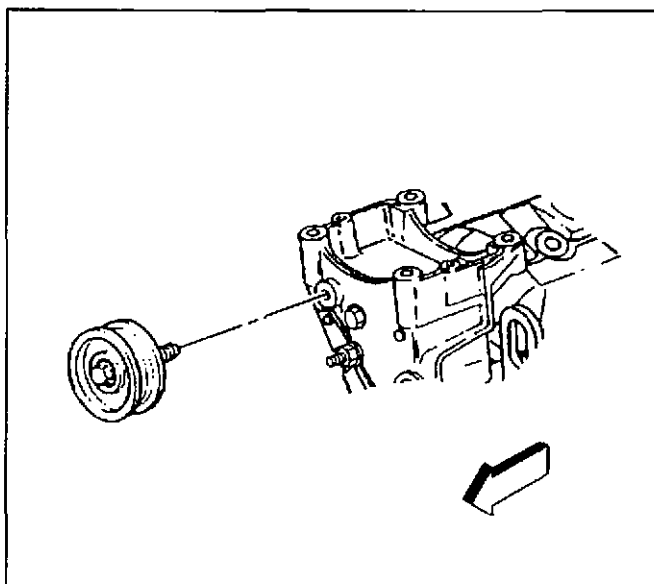
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Slide the bracket on the stud and the power steering pump.
 2. Install the three bolts and the nut.
- Tighten**
- Tighten the bolts and nut to 44 N.m (32 lb ft).
3. Install the power steering pump. Refer to *Power Steering Pump Replacement (7.4L)* in Power Steering Systems.
 4. Install the air conditioning compressor, if equipped. Refer to *Compressor Replacement (7.4L)* in HVAC systems with A/C-Manual.

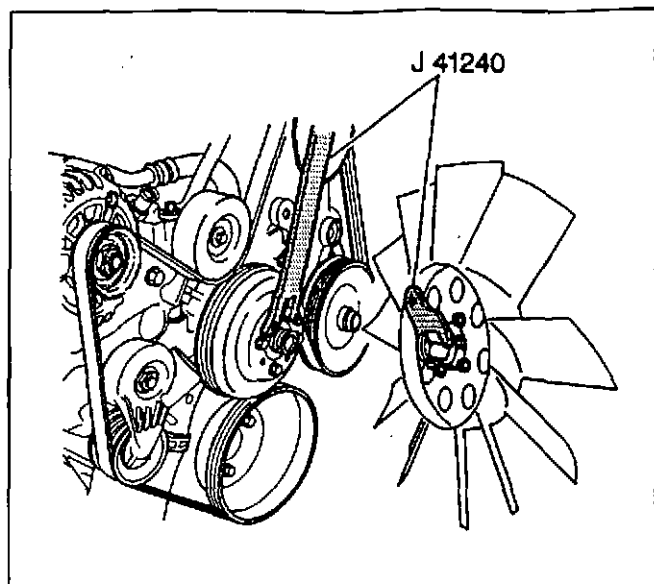


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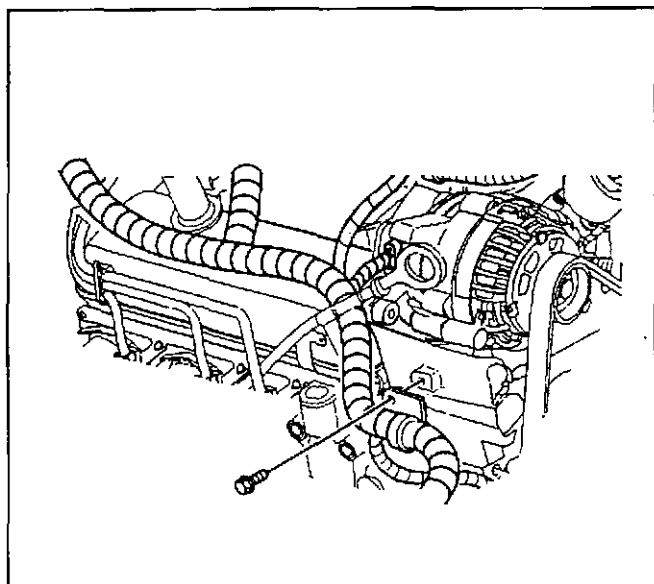
5. Install the drive belt idler pulley if not equipped with A/C. Refer to *Drive Belt Idler Pulley Replacement* in Engine Mechanical.
6. Install the drive belt. Refer to *Drive Belt Replacement* in Engine Mechanical.
7. Install the engine cooling fan. Refer to *Fan Clutch Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.



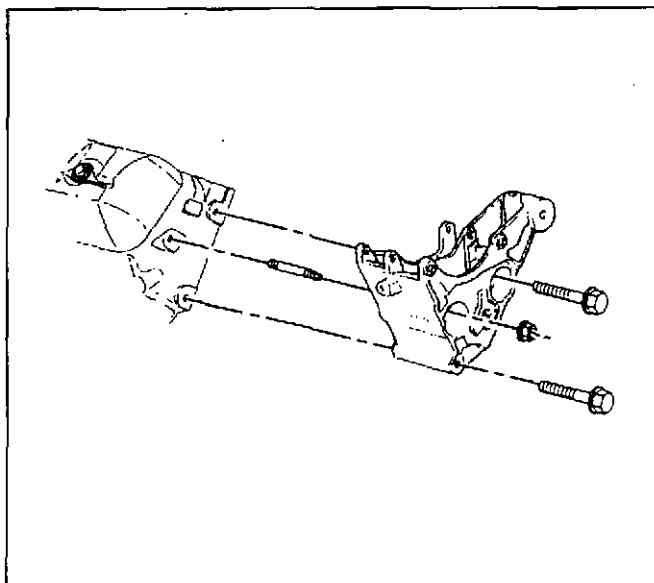
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SIE-ID = 358201

Accessory Brackets Replacement (Generator)

Removal Procedure

1. Remove the engine cooling fan. Refer to *Fan Clutch Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
2. Disconnect the battery negative cable. Refer to *Battery Cable (0)* in engine electrical.
3. Remove the drive belt. Refer to *Drive Belt Replacement*.
4. Remove the generator. Refer to *Generator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
5. Remove the wire harness bracket from the generator mounting bracket.
6. Remove the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement*.
7. Remove the drive belt idler pulley. Refer to *Drive Belt Idler Pulley Replacement*.
8. Remove the three bolts and nut holding the generator bracket to the engine.
9. Slide the bracket off of the stud.

Installation Procedure

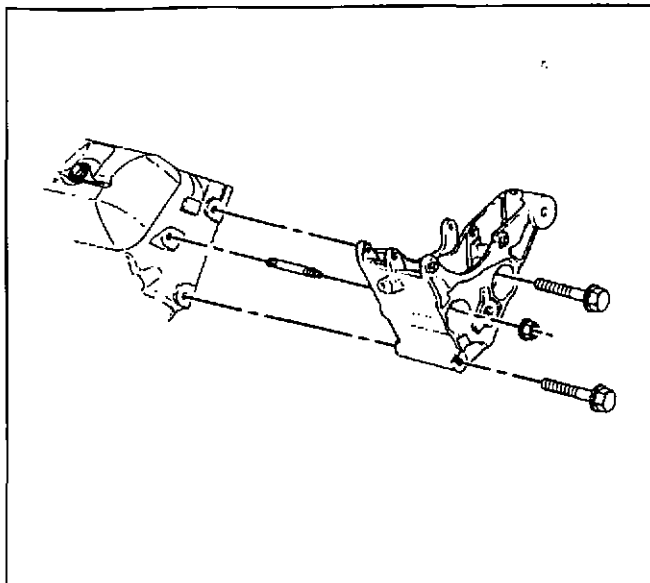
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Slide the bracket on the stud.
2. Install the three bolts and the nut.

Tighten

Tighten the bolts and nut to 41 N.m (30 lb ft).

3. Install the drive belt idler pulley. Refer to *Drive Belt Idler Pulley Replacement*.
4. Install the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement*.



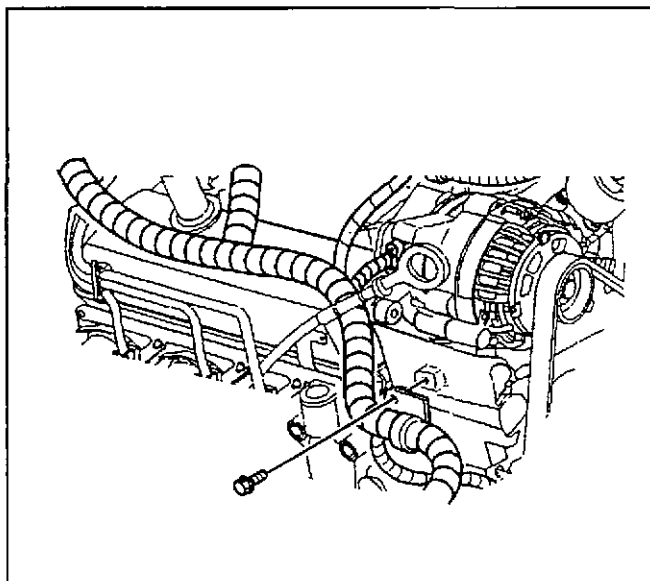
196643

5. Install the wire harness bracket to the generator mounting bracket..

Tighten

Tighten the bolt to 24 N.m (18 lb ft).

6. Install the generator. Refer to *Generator Replacement (ERROR - NOT IN CURRENT PSD)* in engine electrical.
7. Install the drive belt. Refer to *Drive Belt Replacement*.
8. Connect the battery negative cable. Refer to *Battery Cable (0)* in engine electrical.
9. Install the engine cooling fan. Refer to *Fan Clutch Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.



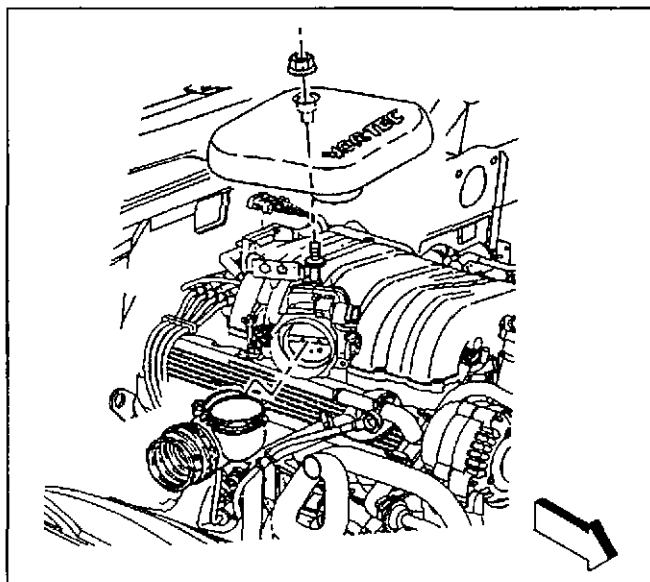
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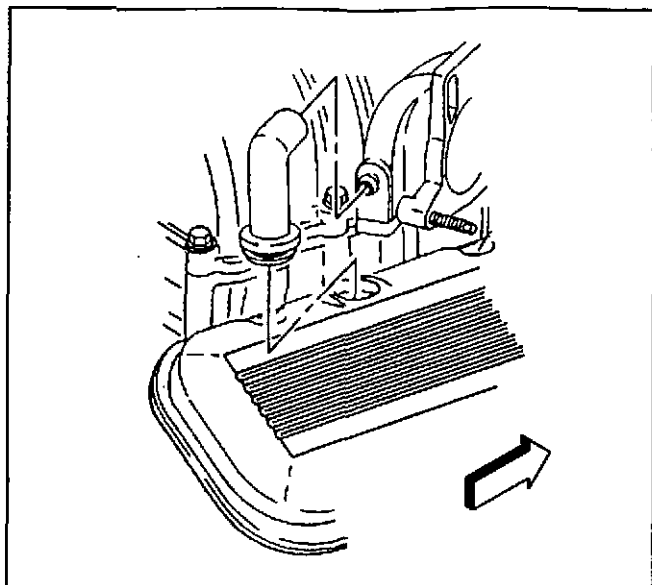
Intake Manifold Replacement (Upper)

Removal Procedure

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the intake air resonator from the throttle body. Refer to *Intake Air Resonator Replacement* in Engine Controls-7.4L.
3. Remove the air cleaner intake duct from the throttle body. Refer to *Air Air Cleaner Intake Duct Replacement* in Engine Controls-7.4L.

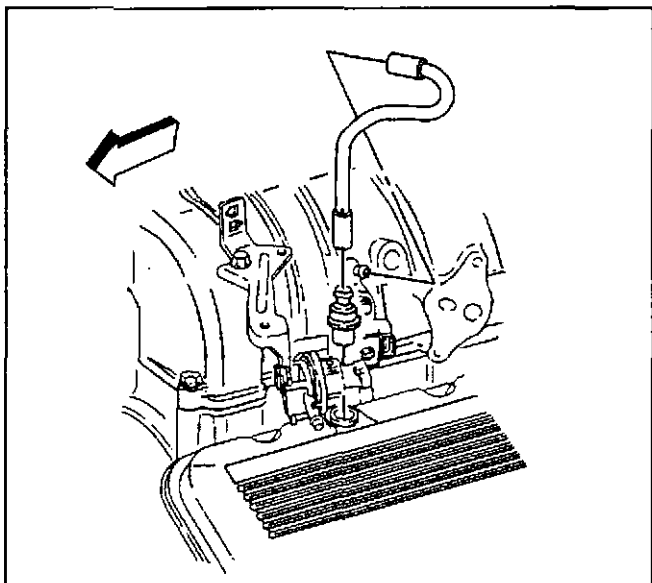


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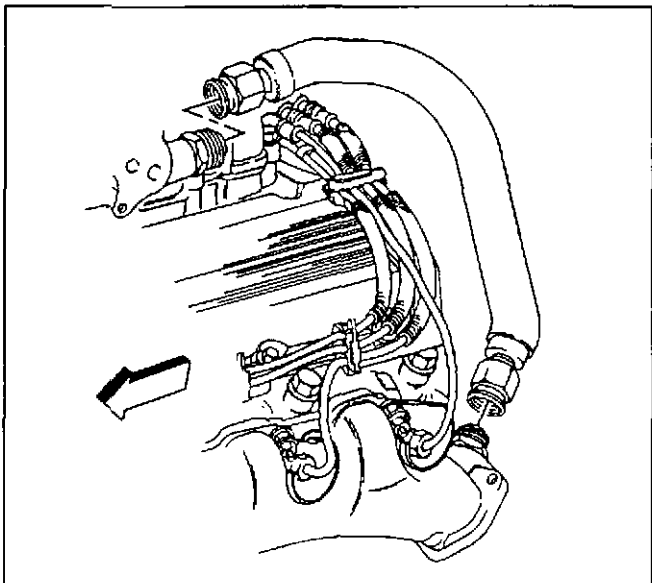
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4. Remove the crankcase vent tube from the throttle body.



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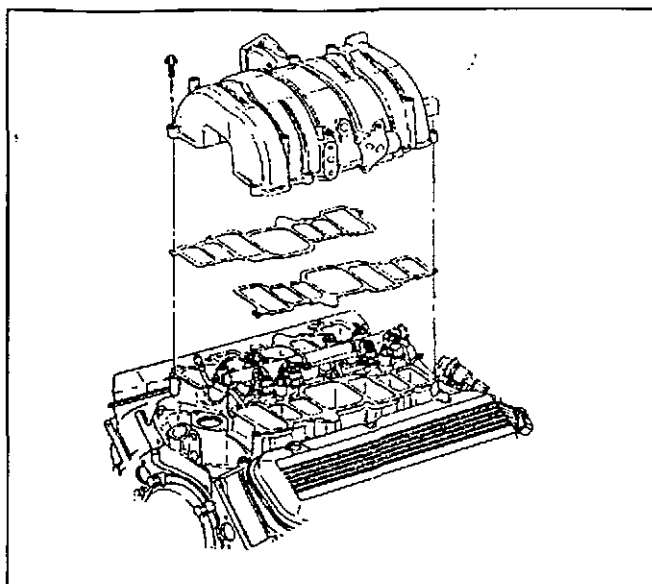
5. Remove the PCV valve from the valve rocker arm cover.



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6. Remove the EGR pipe from the upper intake manifold. Refer to *EGR Valve Replacement (ERROR - NOT IN CURRENT PSD)* in engine controls.
7. Remove Left and Right Side Secondary AIR Injection Pipe. If so Equipped. Refer to *Sec Air Injection Check Valve/Pipe Replacement* in engine controls.
8. Remove the ignition coil from the intake manifold. Refer to *Ignition Coil and ICM Replacement (7.4L)* in Engine Electrical.
9. Remove the throttle body from the upper intake manifold. Refer to *Throttle Body Removal*.
10. Remove the EVAP canister solenoid valve. Refer to *EVAP Canister Purge Solenoid Valve Replacement* in Engine Controls-7.4L.
11. Remove the number 8 spark plug wire from the distributor.

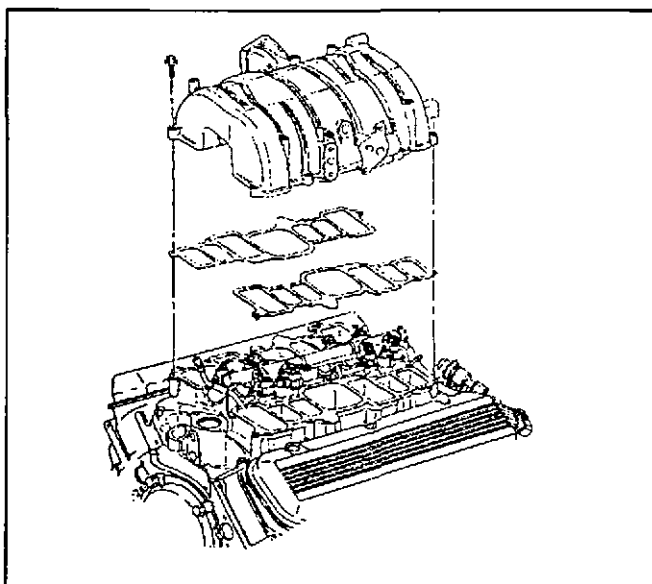
12. Remove the upper intake manifold bolts.
13. Remove the upper intake manifold and gaskets.
14. Clean the excessive carbon deposit from the exhaust and the EGR valve passages. Refer to *Intake Manifold Clean and Inspect (ERROR - NOT IN CURRENT PSD)*.



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Installation Procedure

1. Install the upper intake manifold gaskets.
 2. Install the upper intake manifold.
- Important:** Failure to follow the procedure listed, could cause a driveability problem.
3. Coat a minimum of eight threads of the bolts with thread locking sealant.



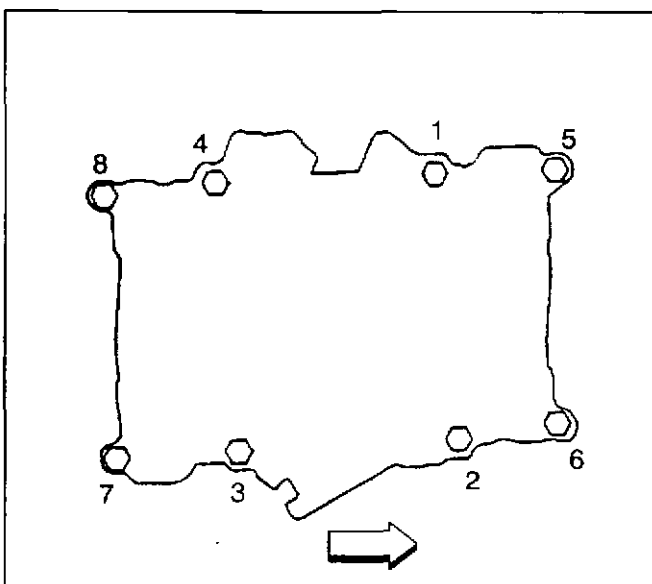
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Notice: Refer to *Fastener Notice* in Cautions and Notices.

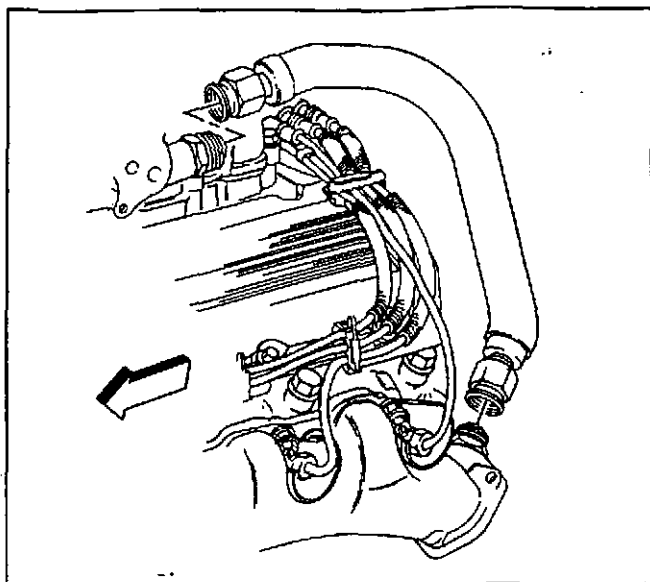
4. Install the upper intake manifold bolts.

Tighten

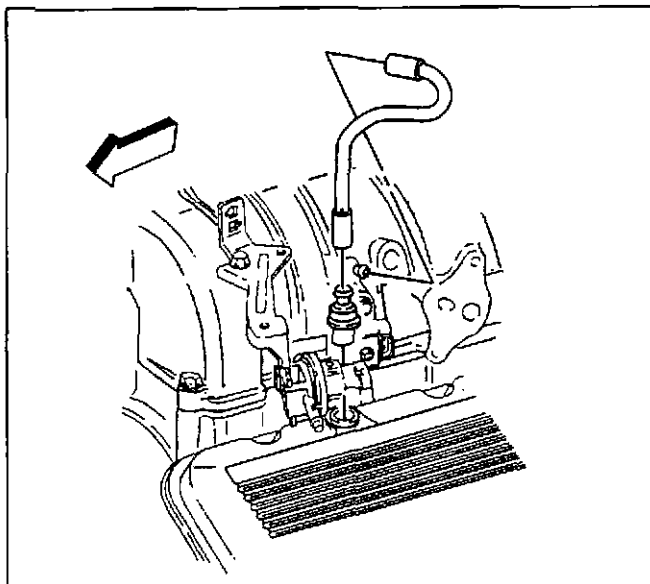
- 4.1. Tighten the bolts in the following manner:
 - 4.2. Tighten the bolts in sequence to 8 N.m (72 lb in).
 - 4.3. Re tighten the bolts in sequence to 18 N.m (13 lb ft).
5. Install the number 8 spark plug wire.
 6. Install the ignition coil to the upper intake manifold. Refer to *Ignition Coil and ICM Replacement (7.4L)* in Engine Electrical.
 7. Install the EGR valve if necessary. Refer to *EGR Valve Replacement* in engine controls.



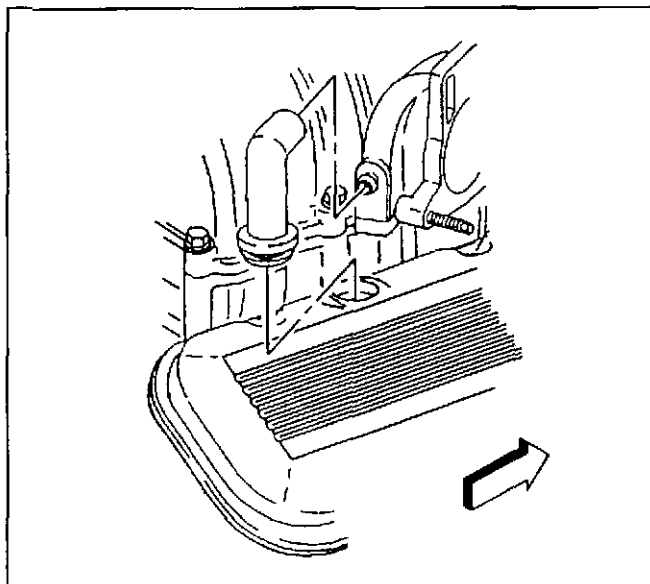
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8. Install the EGR pipe to the upper intake manifold.

Tighten

Tighten EGR valve fittings to 60 N.m (46 lb ft).

9. Install Left and Right Side Secondary AIR Injection Pipes. If so equipped. Refer to *Sec Air Injection Check Valve/Pipe Replacement* in engine controls.
10. Install the EVAP canister solenoid valve to the intake manifold. Refer to *EVAP Canister Purge Solenoid Valve Replacement* in Engine Controls
11. Install the throttle body to the upper intake manifold. Refer to *Throttle Body Assembly Replacement (ERROR - NOT IN CURRENT PSD)*.
12. Install the PCV valve to the valve rocker arm cover to the cylinder head.

13. Install the crankcase vent tube to the valve rocker arm cover.
14. Install the air cleaner intake duct to the throttle body. Refer to *Air Cleaner Intake Duct Replacement* in Engine Controls.
15. Install the intake air resonator to the throttle body. Refer to *Intake Air Resonator Replacement* in Engine Controls.
16. Connect the battery negative cables to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

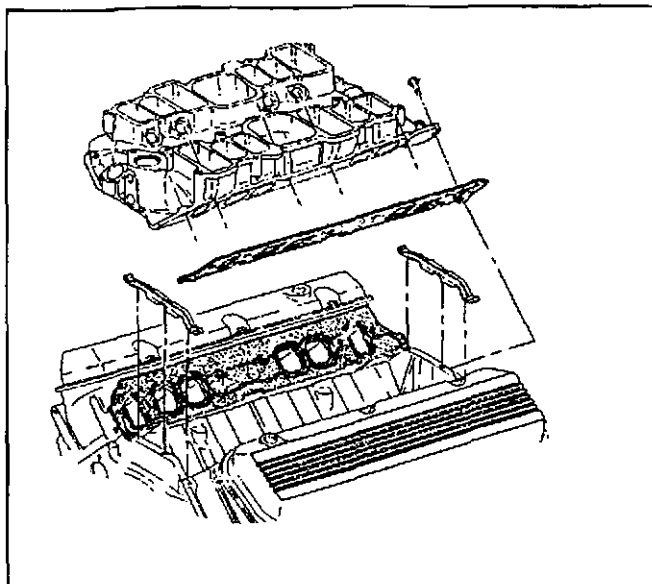
SIE-ID - 390892

Intake Manifold Replacement (Lower)

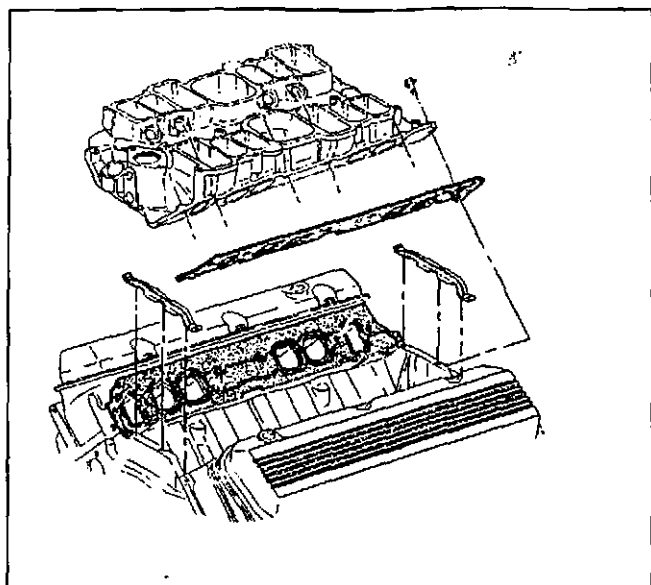
Removal Procedure

Important: The lower intake manifold gaskets and seals are reusable. Replace only the gaskets and seals if they are damaged.

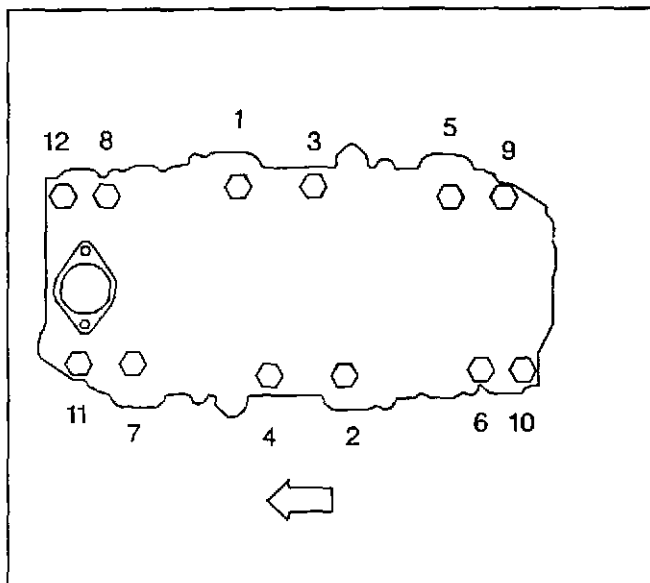
1. Drain the cooling system. Refer to *Draining and Filling Cooling System* in Engine Cooling.
2. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
3. Remove the upper intake manifold from the lower intake manifold. Refer to *Intake Manifold Replacement (Upper)*.
4. Remove the suction line from Air Conditioning from the A/C compressor. Refer to *Compressor Hose Assembly Replacement (Gasoline Engines)* in HVAC.
5. Remove the distributor from the lower intake manifold. Refer to *Distributor Replacement (7.4L)* in engine electrical.
6. Remove the MAP sensor from the lower intake manifold. Refer to *MAP Sensor Replacement* in Engine Controls.
7. Remove the radiator hose from the thermostat. Refer to *Radiator Hose Replacement (7.4L)* in Engine Cooling.
8. Remove the thermostat housing from the lower intake manifold from the engine block. Refer to *Thermostat Replacement (Gasoline)* in Engine Cooling.
9. Remove the heater hoses from the heater core. Refer to *Heater Core Replacement* in Engine Cooling.
10. Remove the coolant bypass hose from the lower intake manifold and the water pump.
11. Remove the retaining bolts for the fuel rail. Refer to *Fuel Rail Assembly Replacement* in Engine Controls.
12. Remove the fuel rail from the lower intake manifold. Refer to *Fuel Rail Assembly Replacement* in Engine Controls.
13. Remove the lower intake manifold bolts from the engine head.
14. Remove the lower intake manifold from the cylinder head.
15. Remove the lower intake manifold gaskets and seals from the cylinder head.
16. Clean all sealing surfaces of oil and grease. Refer to *Intake Manifold Clean and Inspect (Lower)*.



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Installation Procedure

1. Install the lower intake manifold gaskets to the cylinder head with **THIS SIDE UP** stamped facing up.
2. Install the lower intake manifold to the engine block.
3. Apply bolt thread locking material to the lower intake manifold bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the lower intake manifold bolts to the engine head.

Tighten

Tighten the bolts in sequence to 40 N·m (30 lb ft).

5. Install the fuel rail to the lower intake manifold. Refer to *Fuel Rail Assembly Replacement* in Engine Controls.
6. Install the fuel rail retaining bolts. Refer to *Fuel Rail Assembly Replacement* in Engine Controls.
7. Install the coolant bypass hose to the water pump.
8. Install the heater hoses to the lower intake manifold. Refer to *Heater Hoses Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
9. Install the thermostat housing to the lower intake manifold from the engine block. Refer to *Thermostat Replacement (Gasoline)* in Engine Cooling.

10. Install the MAP sensor to the lower intake manifold. Refer to *MAP Sensor Replacement* in Engine Controls.
11. Install the radiator hose to the thermostat housing. Refer to *Radiator Hose Replacement (7.4L)* in Engine Cooling.
12. Install the distributor to the engine block. Refer to *Distributor Replacement (7.4L)*.
13. Install the suction hose to the A/C compressor. Refer to *Compressor Hose Assembly Replacement (ERROR - NOT IN CURRENT PSD)* in HVAC.
14. Install the upper intake manifold to the lower intake manifold. Refer to *Intake Manifold Assemble (Upper)*.
15. Install the discharge line to the A/C compressor. Refer to *Compressor Hose Assembly Replacement (Gasoline Engines)* in HVAC.
16. Refill the cooling system. Refer to *Draining and Filling Cooling System* in Engine Cooling.
17. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

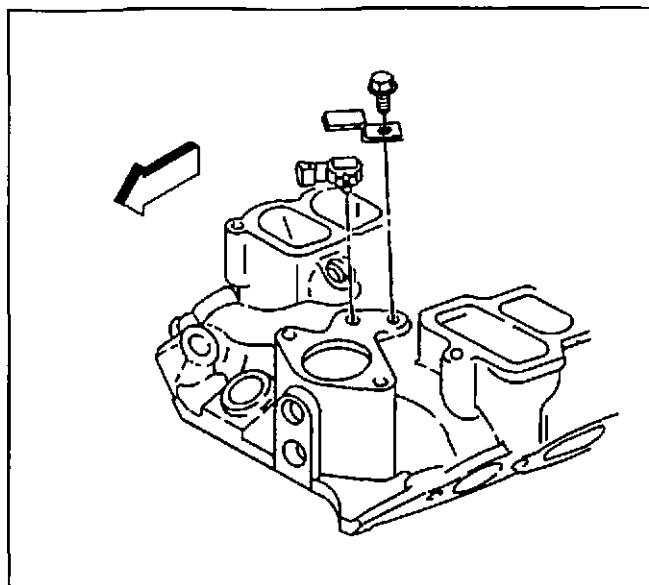
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Valve Rocker Arm Cover Replacement

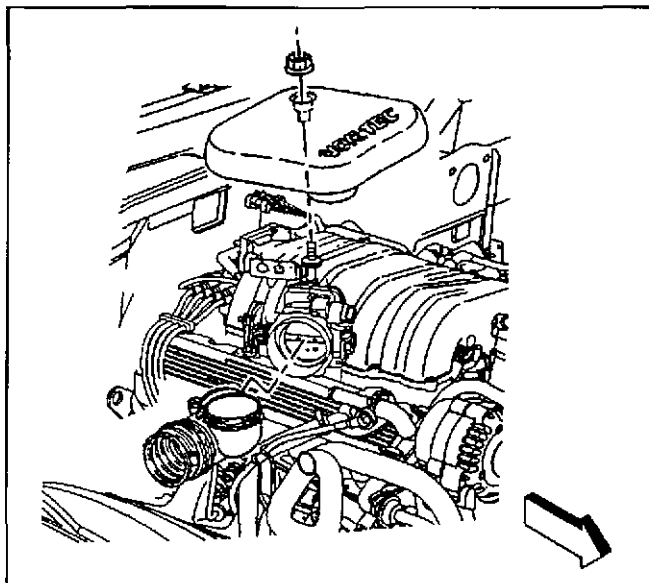
Removal Procedure

Important: Valve rocker arm cover gaskets are reusable. Replace the valve rocker arm cover gasket only if damaged.

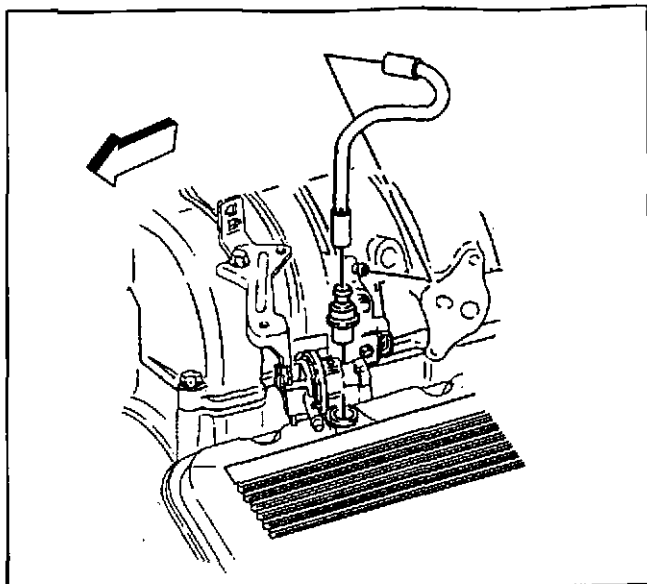
1. Remove the intake air resonator. Refer to *Intake Air Resonator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls 7.4L.
2. Remove the air cleaner intake duct from the throttle body. Refer to *Air Cleaner Intake Duct Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls 7.4L.
3. Remove the spark plug wires from the spark plugs. Refer to *Spark Plug Wire Harness Replacement (7.4L)* in Engine Electrical.



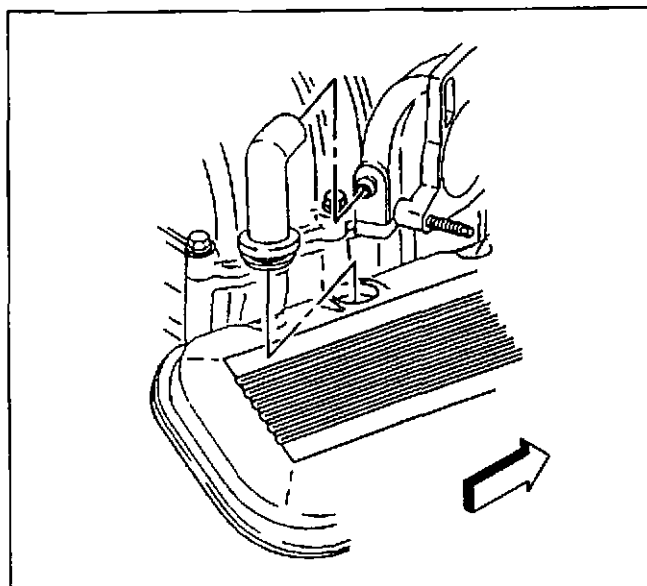
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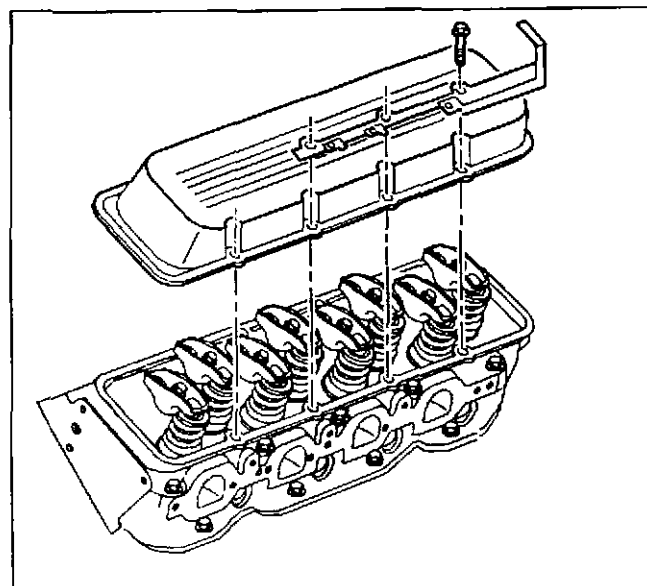
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4. Remove the PVC valve from then valve rocker arm cover if necessary.

5. Remove the engine vent tube from the throttle body if necessary.

6. Remove the throttle body from the intake manifold if necessary. Refer to *Throttle Body Removal*.

7. Remove the valve rocker arm cover bolts.

8. Remove the valve rocker arm cover from the cylinder head.

Installation Procedure

1. Install the valve rocker cover gasket to the cylinder head.
2. Install the valve rocker arm cover to the cylinder head. Refer to *Valve Rocker Arm Cover Removal (Left)*.

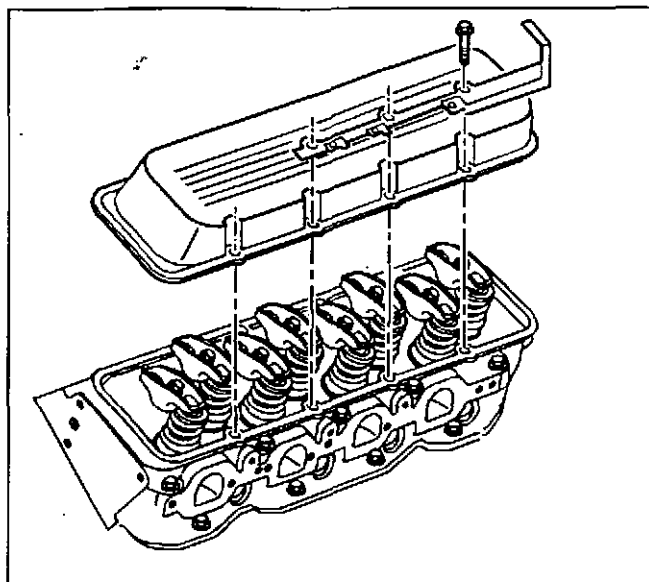
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the valve rocker arm cover bolts.

Tighten

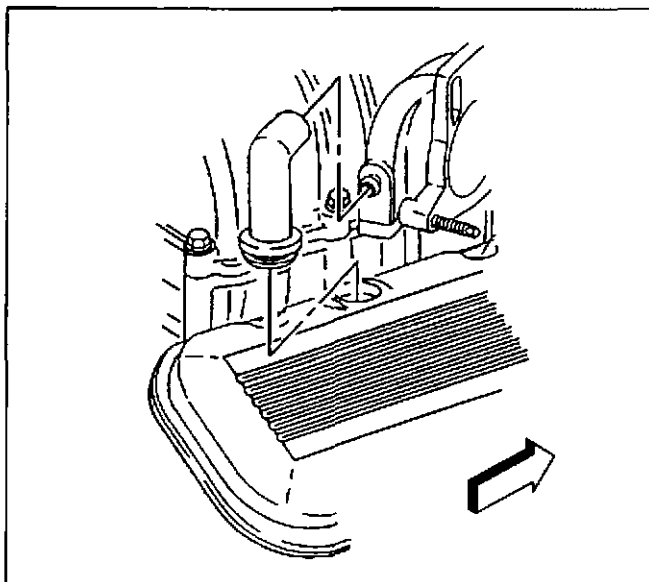
Tighten the bolts to 8 N·m (71 lb in).

4. Install the throttle body to the upper intake manifold. Refer to *Throttle Body Removal*.



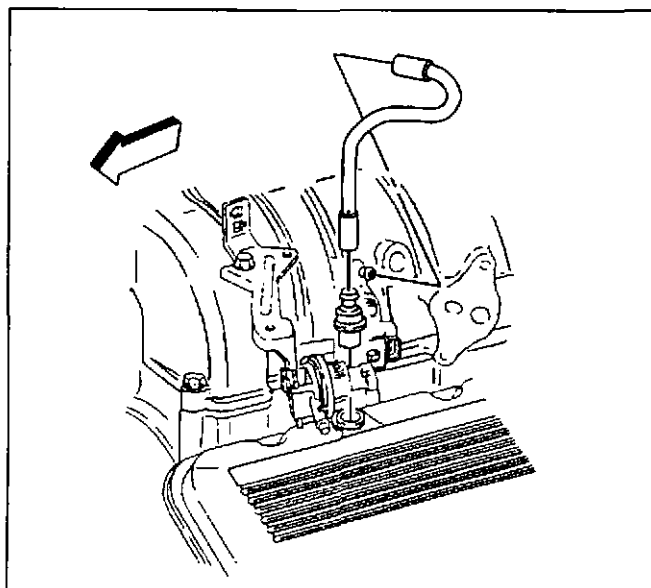
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5. Install the engine vent tube to the throttle body if necessary.



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6. Install the PVC valve to the valve rocker arm cover if necessary.
7. Install the spark plug wires to the spark plugs. Refer to *Spark Plug Wire Harness Replacement (7.4L)* in Engine Electrical.
8. Install the intake air resonator to the throttle body. Refer to *Intake Air Resonator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls.
9. Install the air cleaner intake duct. Refer to *Air Cleaner Intake Duct Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls.



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Valve Rocker Arm and Push Rod Replacement

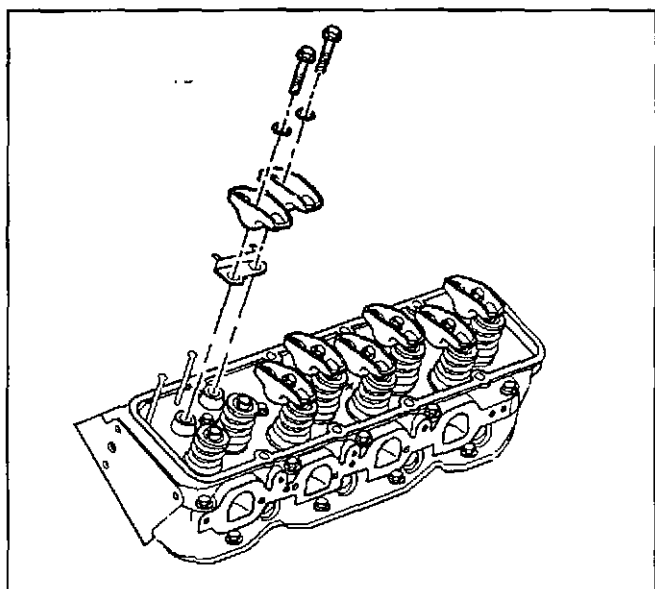
Removal Procedure

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the valve rocker arm covers from the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.

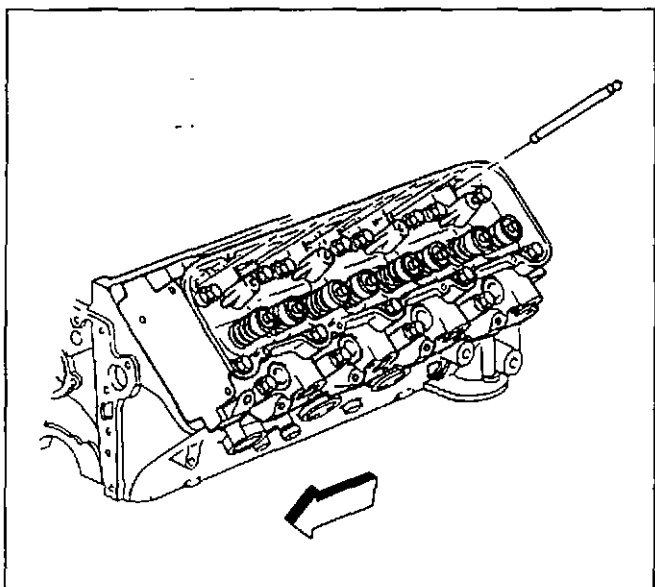
Important: If the push rod is the only item to be replaced, loosen the valve rocker arm bolt until the valve rocker arm can be rotated so the push rod can be removed.

3. Remove the valve rocker arm bolt from the cylinder head.
4. Remove the valve rocker arm and guide from the cylinder head.

Important: Store the valve train components in order so that the components can be reassembled in the same location.



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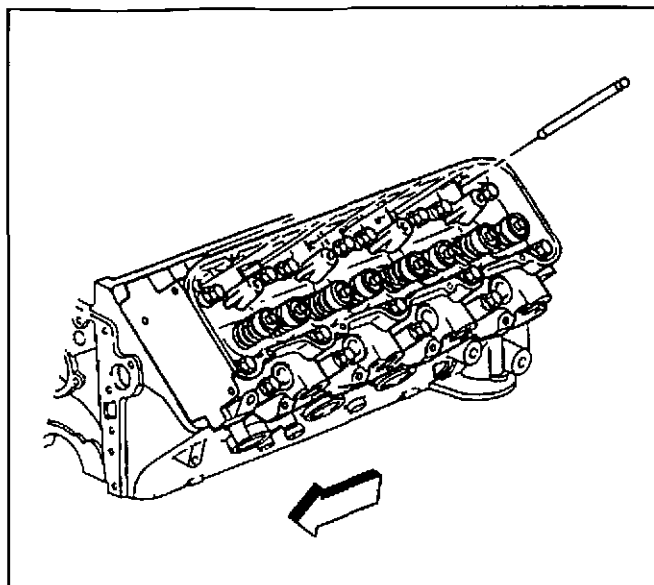
5. Remove the pushrod from the engine block.

Installation Procedure

Important: Make sure that the pushrod is properly seated in the valve lifter.

1. Install the pushrod into the engine block.

Important: When a new valve rocker arm and balls are installed, coat the bearing surfaces with clean engine oil.



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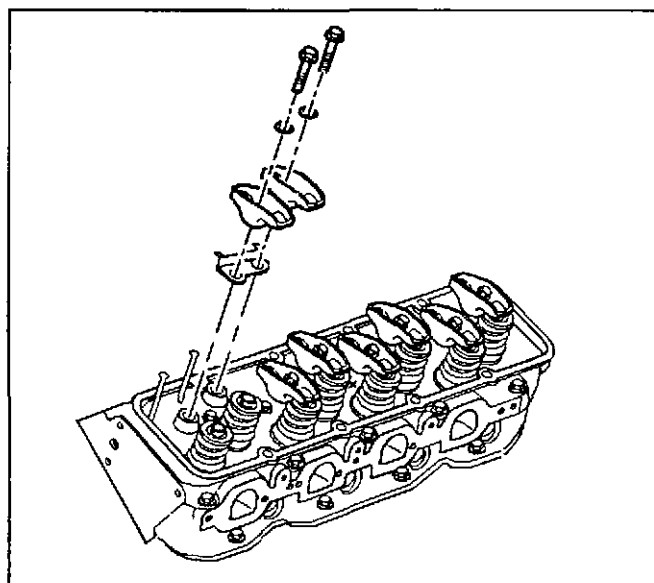
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the valve rocker arm bolt to the cylinder head.

Tighten

Tighten The bolts to 54 N.m (40 N.mlb ft).

3. Install the valve rocker arm cover to the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
4. Connect the battery negative to the battery. Refer to *Battery Cable (0)* in Engine Electrical.



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Valve Stem Oil Seal and Valve Spring Replacement

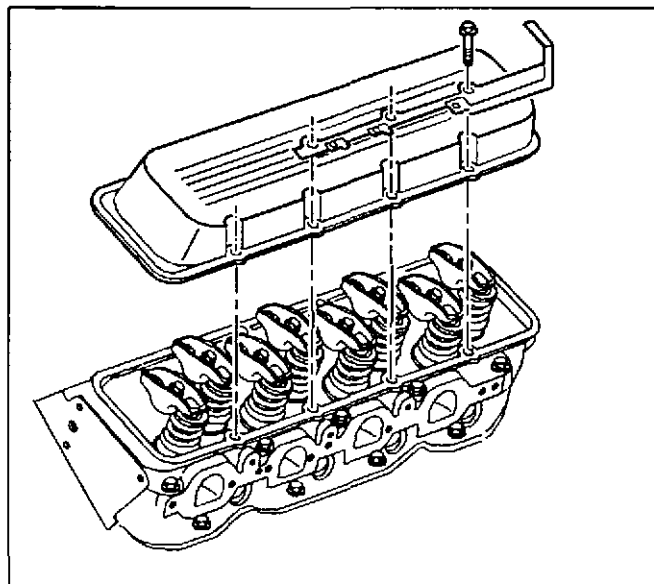
Removal Procedure

Tools Required

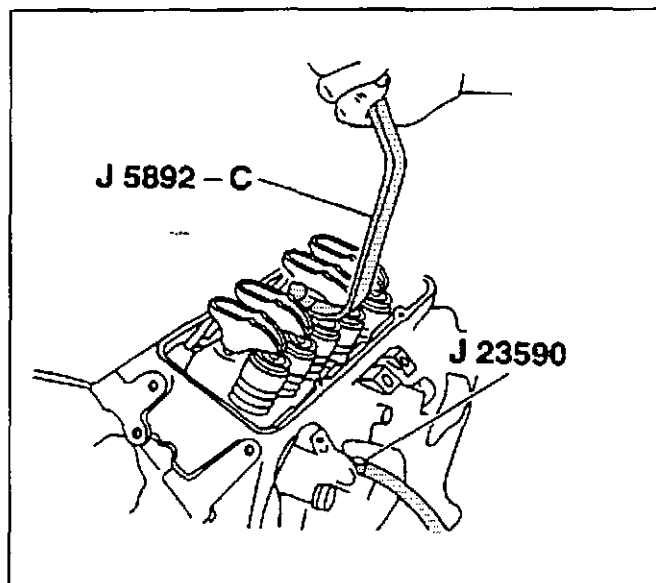
- J 5892-C Valve Spring Compressor
- J 23590 Spark Plug Port Adapter

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the valve rocker arm cover from the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
3. Rotate the crankshaft until both valves are closed before installing the compressed air into the cylinder being serviced.

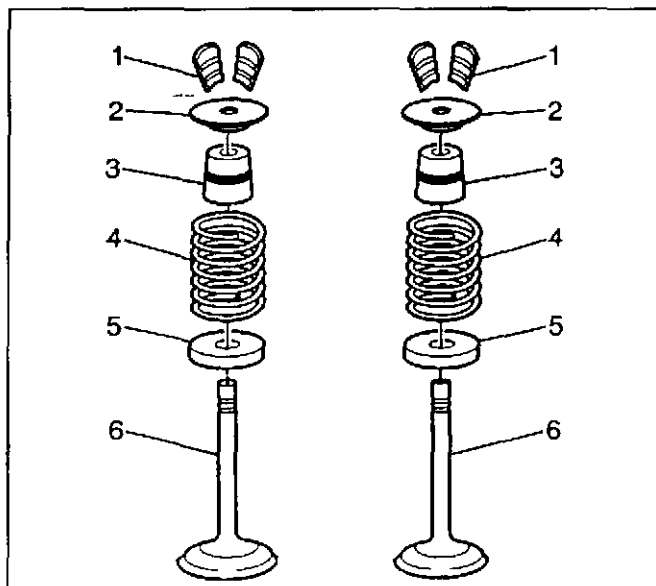
Important: Rotate the cylinder being serviced to the bottom of the stroke, to ensure that the



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- engine does not rotate when the compressed air is applied to the cylinder being serviced.
4. Remove the valve rocker arm from the cylinder head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
 5. Remove the valve push rod from the cylinder head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
 6. Remove the spark plugs from the cylinder head. Refer to *Spark Plug Wire Harness Replacement (7.4L)* in Engine Electrical.
 7. Remove the valve keepers as followed:
 - 7.1. Install the J 23590 into the spark plug hole.
 - 7.2. Apply compressed air into the cylinders in order to hold the valves closed.
 - 7.3. Lightly tap the valve spring retainer to loosen the valve keepers.
 - 7.4. Install the J 5892-C to the cylinder head.
 - 7.5. Install the valve rocker arm bolt.

Important: Tighten the valve rocker arm bolt enough to hold J 5892-C in place while compressing the valve and valve spring assembly.

 - 7.6. Use the J 5892-C to compress the valve spring assembly.
 - 7.7. Remove the valve keepers.

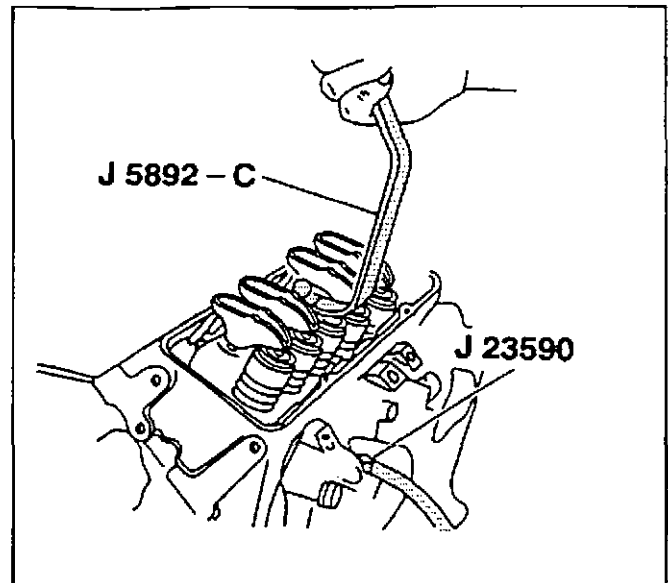
Important: Do not release the compressed air from the cylinder being worked on. The valve will fall into the cylinder bore.

 - 7.8. Carefully release the spring tension and remove the J 5892-C.
 - 7.9. Remove the J 5892-C from the cylinder head.
 8. Remove the valve spring retainer (2) and the valve spring (4) from the cylinder head.
 9. Remove the valve stem oil seal from the valve guide.

Installation Procedure

Tools Required

- J 5892-C Valve Spring Compressor
 - J 23590 Spark Plug Port Adapter
1. Install the valve stem oil seal to the valve guide.
 2. Install the valve spring retainer and the spring.
 3. Use the J 5892-C to install the valve springs and keepers to the cylinder head.
 4. Install the valve keepers to the valve as follows:
 - 4.1. With the compressed air still applied, use the J 5892-C to compress the valve spring assembly.
 - 4.2. Install the valve keepers to the valve being worked on. Apply a small amount of clean grease to hold the valve keepers in place.
 - 4.3. Carefully release the tension on the valve spring assembly. Make sure the valve keepers do not move while releasing the tension.
 - 4.4. Remove the J 5892-C from the valve assembly.
 - 4.5. Carefully release the compressed air from the cylinder being worked on.
 5. Install the spark plugs to the cylinder head into the cylinder being serviced. Refer to *Spark Plug Wire Harness Replacement (7.4L)* in Engine Electrical.
 6. Install the valve rocker arms to the cylinder head to the cylinder being serviced. Refer to *Valve Rocker Arm and Push Rod Removal*.
 7. Install the valve rocker arm covers to the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
 8. Connect the battery negative cables to the battery. Refer to *Battery Cable (0)* in Engine Electrical.



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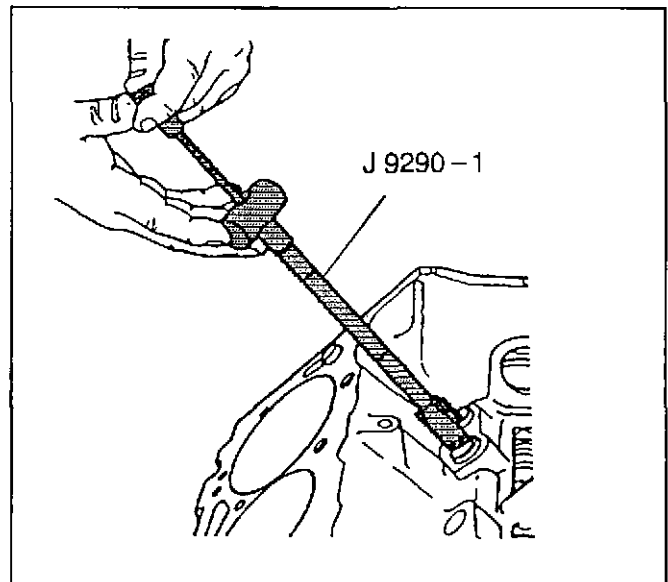
Valve Lifter Replacement

Removal Procedure

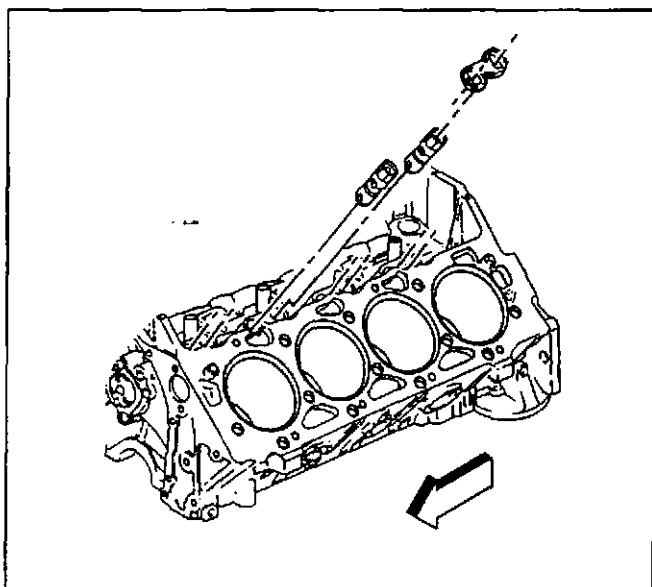
Tools Required

J 9290-01 Valve Lifter Remover (Slide Hammer Type)

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the upper intake manifold from the lower intake manifold. Refer to *Intake Manifold Replacement (Upper)*.
3. Remove the lower intake manifold from the cylinder heads. Refer to *Intake Manifold Replacement (Lower)*.
4. Remove the valve rocker arm cover from the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
5. Remove the valve rocker arm from the cylinder



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- head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
6. Remove the push rod from the engine block. Refer to *Valve Rocker Arm and Push Rod Replacement*.
 7. Remove the valve lifters one at a time. Place the valve lifters in an organizer rack in order to ensure that the valve lifters are later returned to the original bore during installation.
A stuck valve lifter can be removed using J 9290-01.

Installation Procedure

Important: Replace the engine oil and oil filter if new valve lifters or a new camshaft is installed.

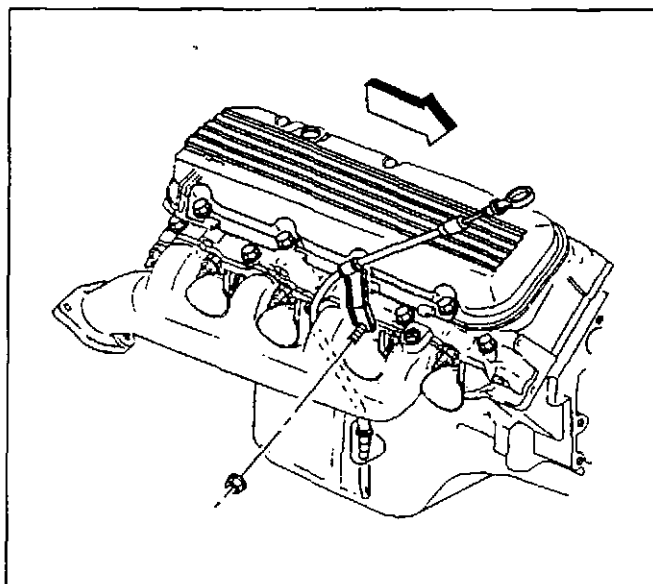
1. Install the valve lifters and guide into the engine block. Lubricate the valve lifter and the body with clean engine oil.
2. Install the push rods into the engine block. Refer to *Valve Rocker Arm and Push Rod Replacement*.
3. Install the valve rocker arms to the cylinder head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
4. Install the valve rocker arm cover to the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
5. Install the lower intake manifold to the lower intake manifold. Refer to *Intake Manifold Replacement (Lower)*.
6. Install the upper intake manifold to the lower intake manifold. Refer to *Intake Manifold Replacement (Upper)*.
7. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in engine electrical.

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Oil Level Indicator and Tube Replacement

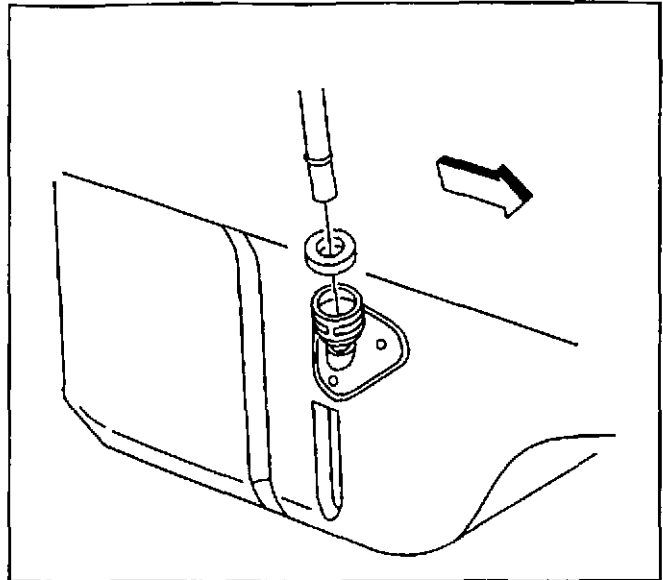
Removal Procedure

1. Remove the retaining nut for the oil level indicator tube.
2. Remove the oil level indicator and tube from the engine block.



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3. Remove the O-ring from the oil level indicator tube.

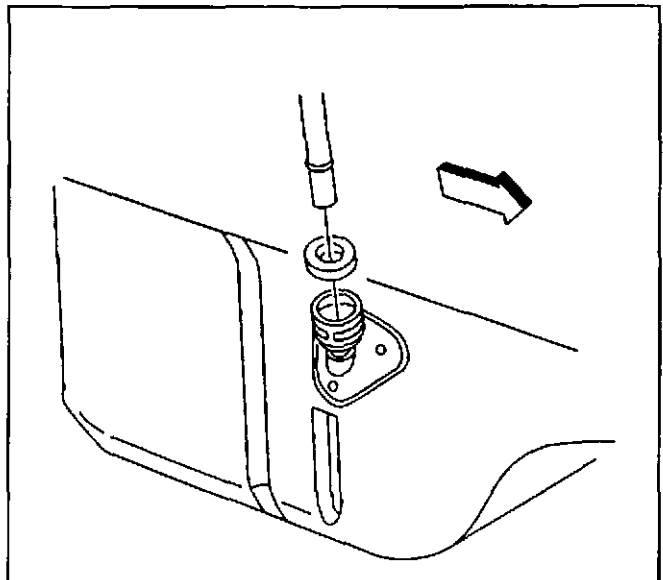


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Installation Procedure

Important: When installing the oil level indicator tube to the engine, always use a new O-ring.

1. Install the new O-ring on the oil level indicator tube.
2. Apply clean engine oil to the oil level indicator tube O-ring.



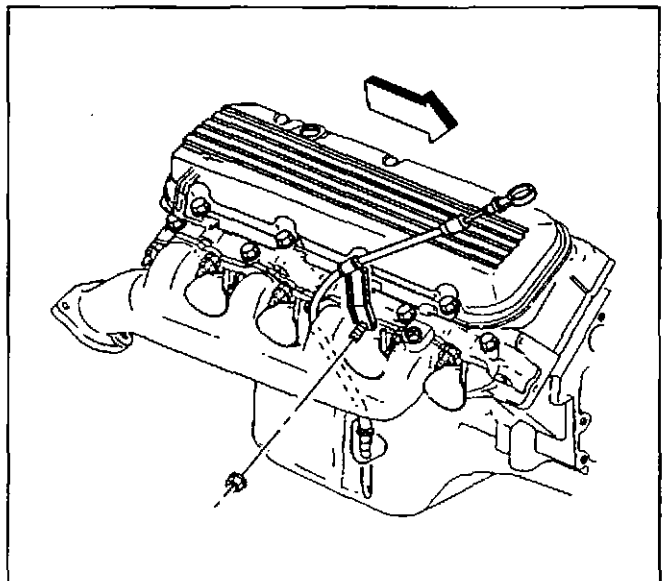
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Notice: Refer to *Fastener Notice* in *Cautions and Notices*.

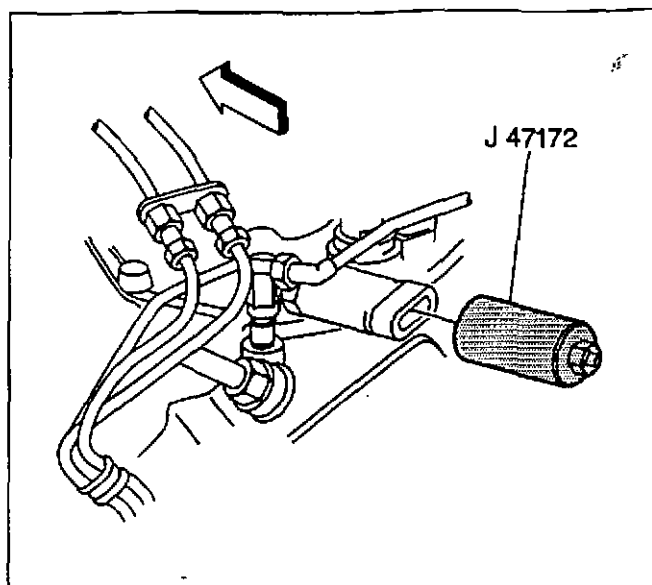
3. Install the oil level indicator tube and retaining nut to the engine.

Tighten

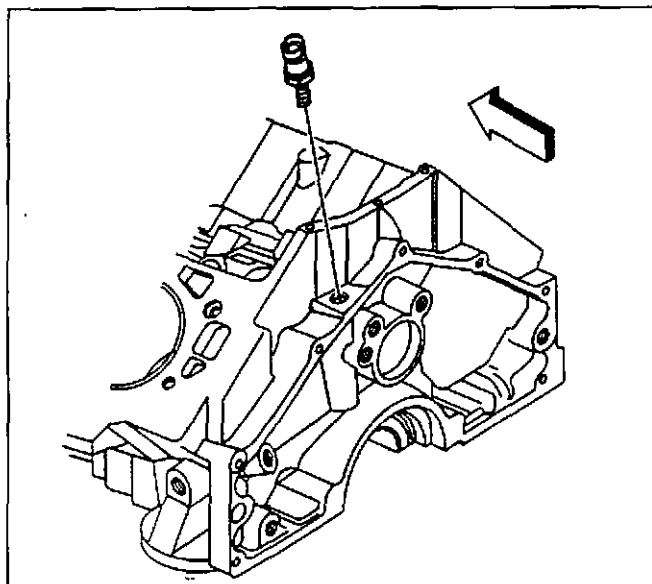
Tighten the oil level indicator tube nut to 54 N.m (40 lb ft).



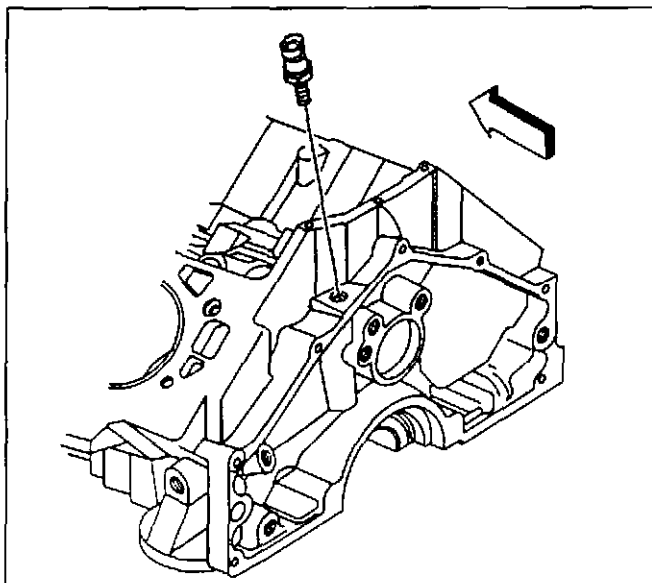
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Engine Oil Pressure Sensor/Switch Replacement

Removal Procedure

Tools Required

J 25254-10 A Oil Pressure Sensor Socket.

1. Disconnect the electrical connector from the engine pressure sensor / switch..
2. Hold the oil pressure sensor fitting with a wrench.
3. Remove the oil pressure sensor using J 25254-10 A.

Important: Note the alignment of the oil pressure sensor fitting prior to removal.

4. Remove the oil pressure sensor fitting, if necessary.

Installation Procedure

Tools Required

J 25254-10 A Oil Pressure Sensor Socket.

Notice: Fastener Notice.

Important: Do not tighten more than one turn.

1. Install the oil pressure sensor fitting, if removed.

Tighten

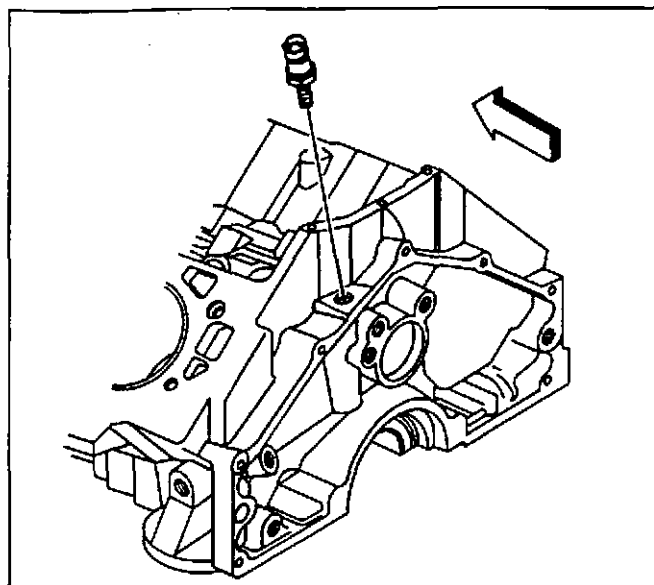
- 1.1. Tighten the oil pressure sensor fitting to 15N.m (11 lb ft).
- 1.2. Tighten the fitting until properly align.

2. Install the oil pressure sensor.
3. Hold the oil pressure sensor fitting with a wrench to prevent from turning.

Tighten

Using *J 25254-10 A* tighten the oil pressure sensor to 30N·m (22 lb ft).

4. Install the electrical connector.

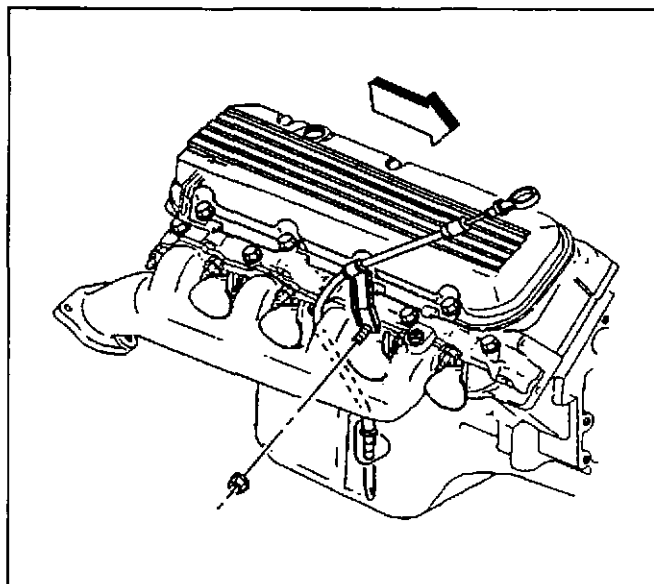


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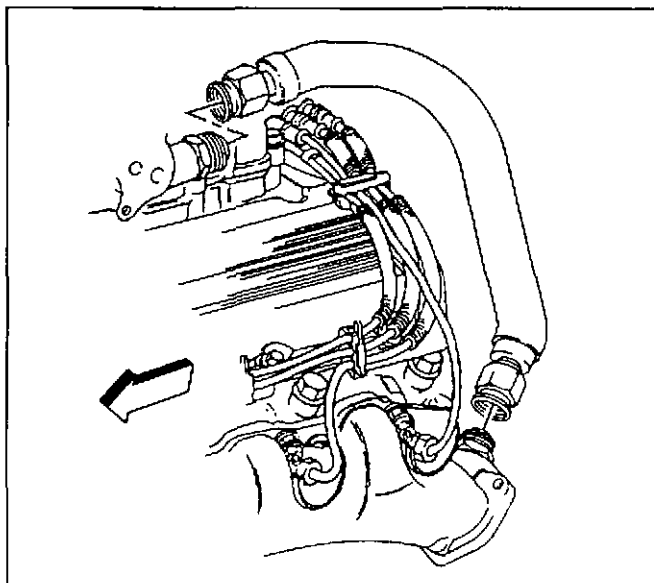
Exhaust Manifold Replacement**Removal Procedure**

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the oil level indicator and tube from the engine block. Refer to *Oil Level Indicator and Tube Replacement* in Engine Mechanical.

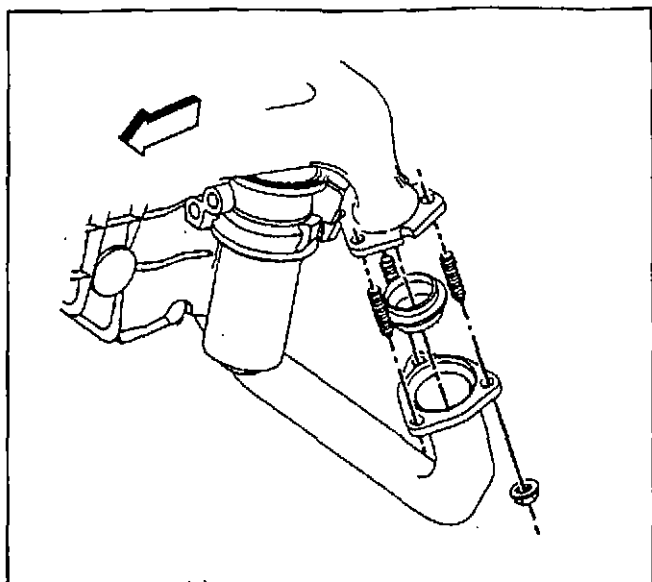


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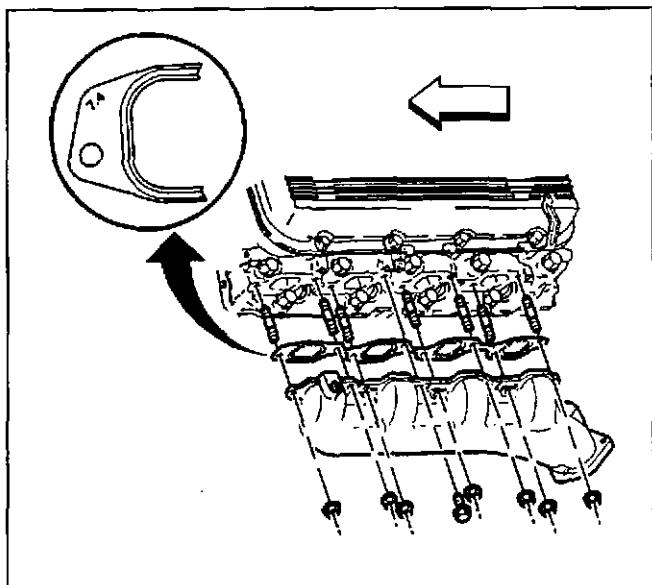
3. Remove the EGR valve pipe from the left exhaust manifold.
4. Remove the spark plugs cylinder head. Refer to *Oil Level Indicator and Tube Replacement* in Engine Electrical.
5. Raise the vehicle and support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.



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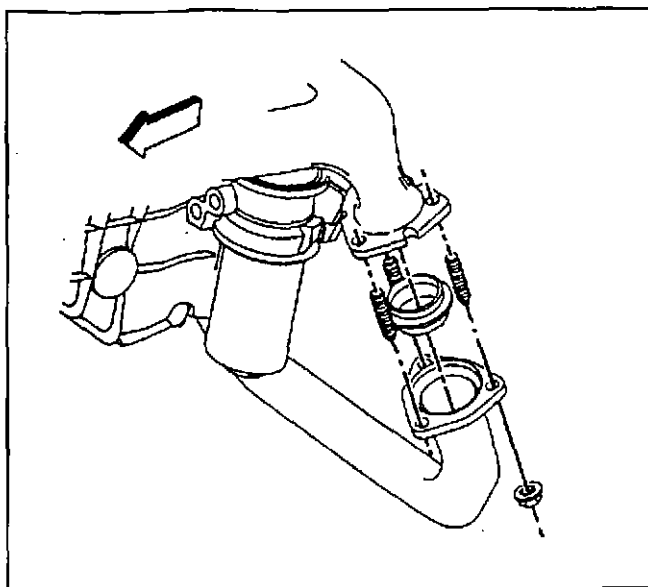
6. Remove the exhaust pipe from the exhaust manifold. Refer to *Exhaust Manifold Pipe Replacement (Diesel)* in engine controls.
 - For vehicles under 8600 lb GVWR, refer to *Catalytic Converter Replacement (Gas, below 8600 lb (GVWR))* in Engine Controls.
 - For vehicles above 8600 lb GVWR, refer to *Catalytic Converter Replacement (Gas, 8600 lb and above (GVWR))* in Engine Controls.
7. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.
8. Remove the left side exhaust manifold. Refer to *Exhaust Manifold Removal (ERROR - NOT IN CURRENT PSD)*.
9. Remove the right side exhaust manifold. Refer to *Exhaust Manifold Removal (ERROR - NOT IN CURRENT PSD)*.
10. Remove the exhaust manifold gasket from the cylinder head.
11. Clean and check the gasket mating surface and the cylinder head. Refer to *Exhaust Manifold Clean and Inspect (without RPO K19)*.

Installation Procedure

Important: Install the exhaust manifold gasket with the stamped 7.4 facing away from the cylinder head.

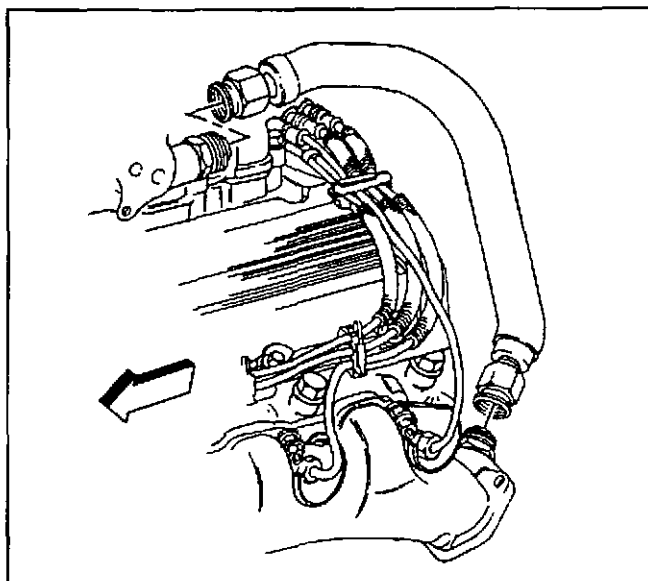
1. Install the exhaust manifold gaskets to the cylinder heads.
2. Install the left side exhaust manifold to the cylinder head. Refer to *Exhaust Manifold Installation (ERROR - NOT IN CURRENT PSD)*.
3. Install the right side exhaust manifold to the cylinder head. Refer to *Exhaust Manifold Installation (ERROR - NOT IN CURRENT PSD)*.
4. Install the left side spark plug heat shields.
5. Install the right side spark plug heat shields.
6. Install the oil level indicator tube to the exhaust manifold. Refer to *Oil Level Indicator and Tube Replacement*.
7. Install the spark plugs to the cylinder head. Refer to *Spark Plug Replacement* in Engine Electrical.
8. Raise the vehicle and support with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.

9. Install the exhaust pipes to the exhaust manifolds. Refer to *Exhaust Manifold Pipe Replacement (Diesel)* in engine exhaust.
 - For vehicle under 8600 GVWR, refer to *Catalytic Converter Replacement (Gas, below 8600 lb (GVWR))* in Engine Controls.
 - For vehicles above 8600 GVWR, refer to *Catalytic Converter Replacement (Gas, 8600 lb and above (GVWR))* in Engine Controls.
10. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.



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11. Install the EGR pipe to the intake manifold and the exhaust manifold.
12. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.



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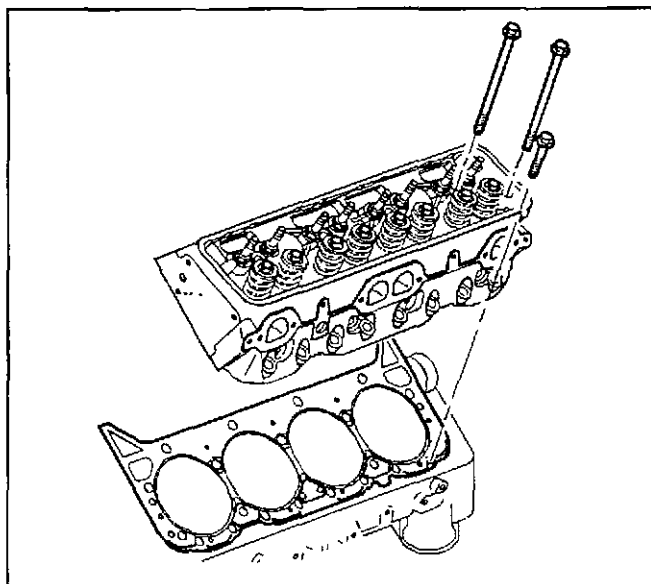
Cylinder Head Replacement

Removal Procedure

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Drain the cooling system. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
3. Remove the engine electrical wiring harness and lay to the side.
4. Disconnect the engine ground straps. Refer to *Ground Strap Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
5. Remove the air conditioning compressor from the accessory mounting bracket. Refer to *Compressor Replacement (7.4L) Air Conditioning Replacement* in HVAC.
6. Remove the air conditioning accessory

mounting bracket from the engine block head. Refer to *Accessory Brackets Replacement (AC)* in Engine Mechanical.

7. Remove the generator from the accessory mounting bracket. Refer to *Generator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
8. Remove the accessory mounting bracket from the engine block. Refer to *Accessory Brackets Replacement (Generator)*.
9. Remove the upper intake manifold from the lower intake manifold. Refer to *Intake Manifold Replacement (Upper)*.
10. Remove the lower intake manifold from the engine block. Refer to *Intake Manifold Replacement (Lower)*.
11. Remove the valve rocker arm covers from the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
12. Remove the valve rocker arm from the cylinder head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
13. Remove the pushrod from the engine block. Refer to *Valve Rocker Arm and Push Rod Replacement*.
14. Remove the spark plugs from the cylinder heads. Refer to *Spark Plug Replacement* in Engine Electrical.
15. Remove the exhaust manifolds from the cylinder head. Refer to *Exhaust Manifold Replacement*.
16. Remove cylinder head bolts from the engine block. Refer to *Cylinder Head Disassemble*.
17. Remove the cylinder heads and gaskets from the engine block.
18. Clean and inspect the sealing surfaces on the cylinder heads. Refer to *Cylinder Head Clean and Inspect*.
19. Clean and inspect the cylinder head bolts.



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Installation Procedure

Important: Do not use sealer on the composition gaskets, and make sure that the punch code (7.4L) on the cylinder head gasket is facing up. Refer to *Replacing Engine Gaskets (ERROR - NOT IN CURRENT PSD)*.

Important: When servicing the right cylinder head, use a rubber band to secure the cylinder head bolts to the valve spring to hold cylinder bolt for ease of cylinder head removal.

1. Assemble the cylinder head. Refer to *Cylinder Head Assemble*.
2. Install the cylinder head gaskets to the engine block.
3. Install the cylinder heads to the engine block.

Important: Make sure that the threads on the cylinder head bolts are clean as well as the threaded holes in the engine block.

4. Coat the threads of the cylinder head bolts with sealing compound.

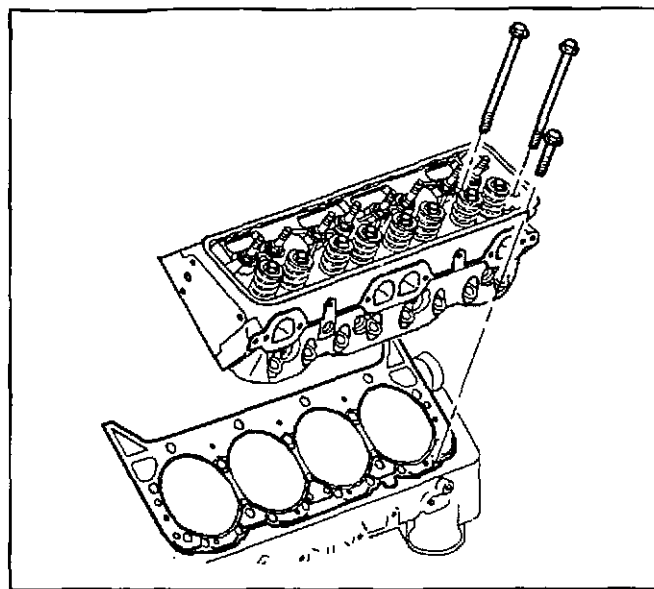
Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the cylinder head bolts to the cylinder head and tighten finger tight.

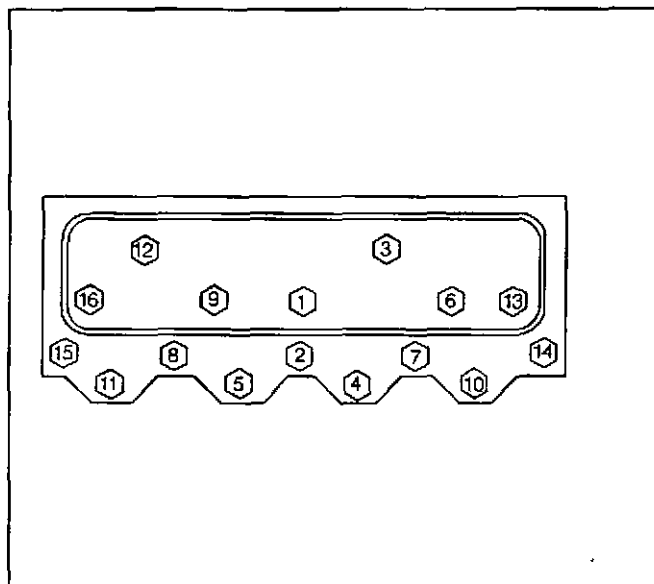
Tighten

- Tighten the first sequence to 40 N.m (30 lb ft).
- Tighten the second sequence to 80 N.m (59 lb ft).
- Tighten the final sequence to 125 N.m (92 lb ft).

6. Install the push rod into the engine block. Refer to *Valve Rocker Arm and Push Rod Replacement*.
7. Install the valve rocker arm to the cylinder head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
8. Install the valve rocker arm covers to the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
9. Install the exhaust manifolds to the cylinder heads. Refer to *Exhaust Manifold Replacement*.
10. Install the spark plugs to the cylinder head. Refer to *Spark Plug Replacement* in Engine Electrical.
11. Install the lower intake manifold to the cylinder head. Refer to *Intake Manifold Replacement (Lower)*.
12. Install the upper intake manifold to the lower intake manifold. Refer to *Intake Manifold Replacement (Upper)*.
13. Install the engine ground straps to the engine block. Refer to *Ground Strap Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
14. Install the generator mounting bracket to the



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engine block. Refer to *Accessory Brackets Replacement (Generator)*.

15. Install the generator to the mounting bracket. Refer to *Generator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
16. Install the air conditioning mounting bracket to the cylinder head. Refer to *Accessory Brackets Replacement (AC)*.
17. Install the air conditioning compressor to the mounting bracket. Refer to *Compressor Replacement (7.4L)* in Air Conditioning Compressor Replacement in HVAC.
18. Connect the engine electrical wiring harness.
19. Fill the cooling system. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
20. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

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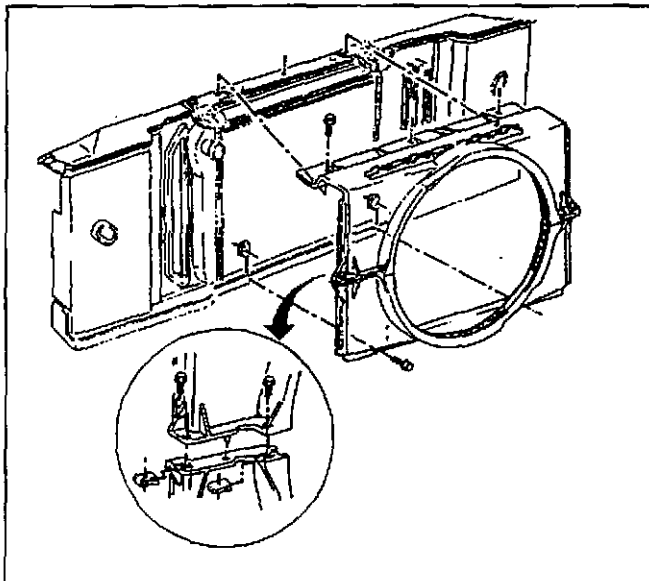
Crankshaft Balancer Replacement

Removal Procedure

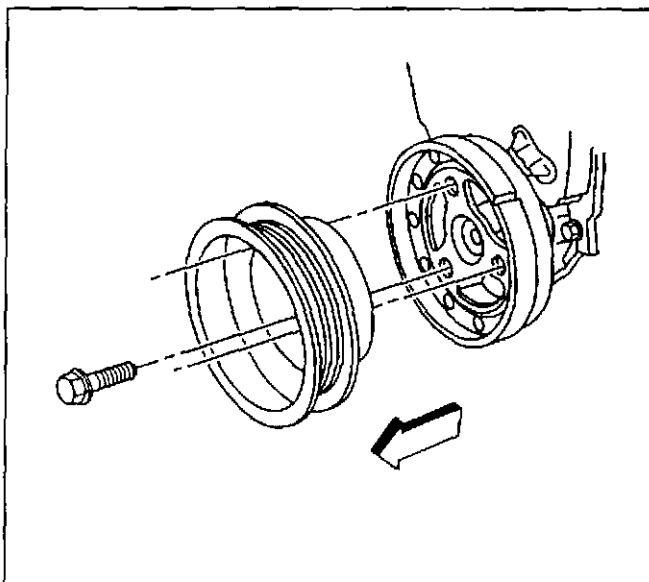
Tools Required

J 23523-F Crankshaft Balancer Puller and Installer

1. Remove the upper fan shroud from the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
2. Remove the drive belt from the vehicle. Refer to *Drive Belt Replacement*.
3. Raise the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
4. Remove the lower fan shroud from the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)*.
5. Remove the crankshaft pulley from the crankshaft balancer.

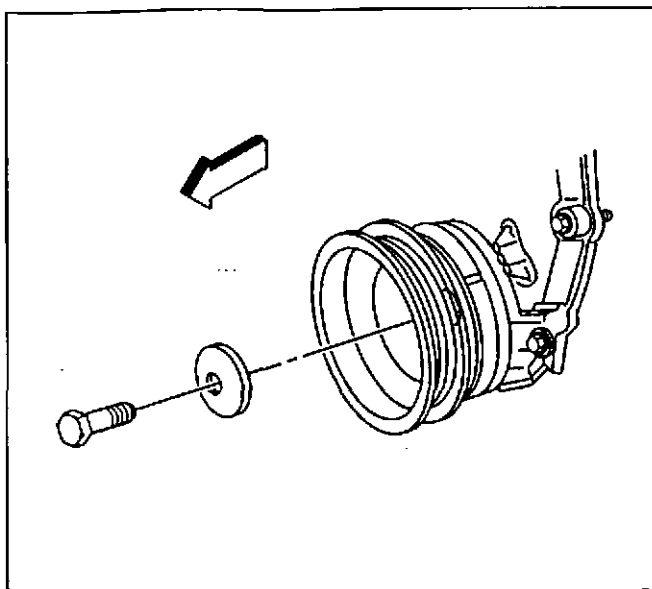


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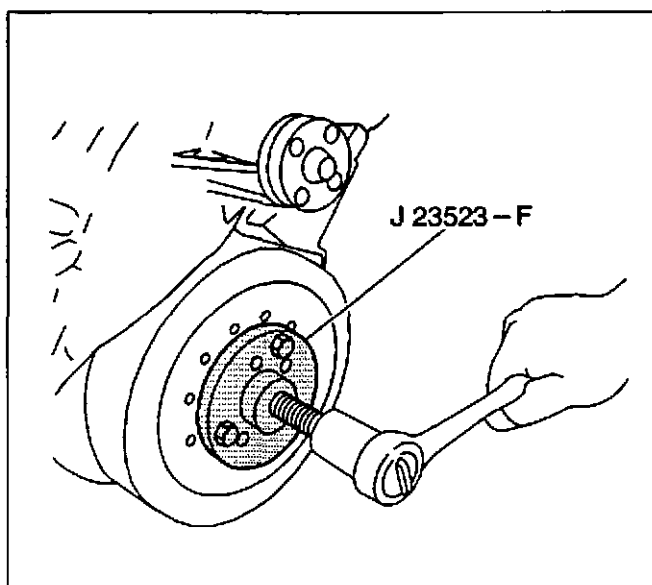
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6. Remove the crankshaft bolt and washer from the crankshaft.



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7. Use the *J 23523-F* to remove the crankshaft balancer
8. Remove the *J 23523-F* from the crankshaft balancer.



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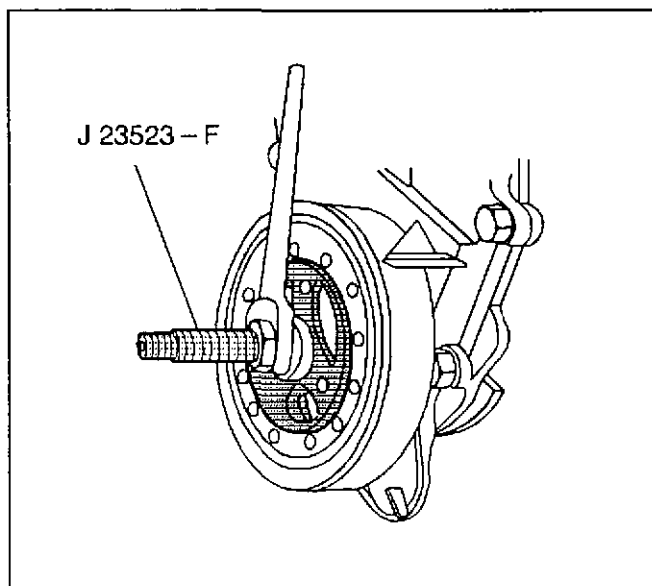
Installation Procedure

Tools Required

- *J 23523-F* Crankshaft Balancer Puller and Installer
- *J 22102* Oil Seal Installer

Important: The inertial weight section of the crankshaft balancer is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tools) must be followed or movement of the inertial weight section of the crankshaft balancer will destroy the balance and will have to be replaced.

1. Install the crankshaft balancer end of the crankshaft.
2. Install *J 23523-F* to the crankshaft balancer.
3. Use the *J 23523-F* and install the crankshaft balancer to the crankshaft.
4. Remove the tool from the crankshaft balancer.



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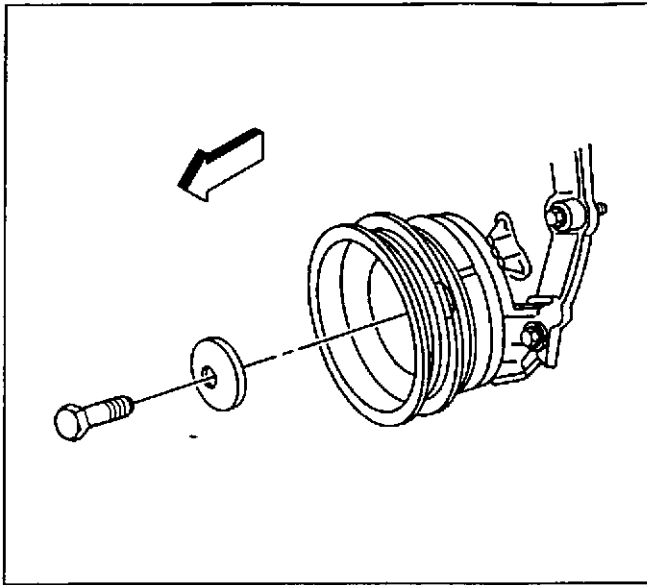
Important: Make sure that when installing the crankshaft bolt and washer, the curve part of the washer is facing away from the engine block.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

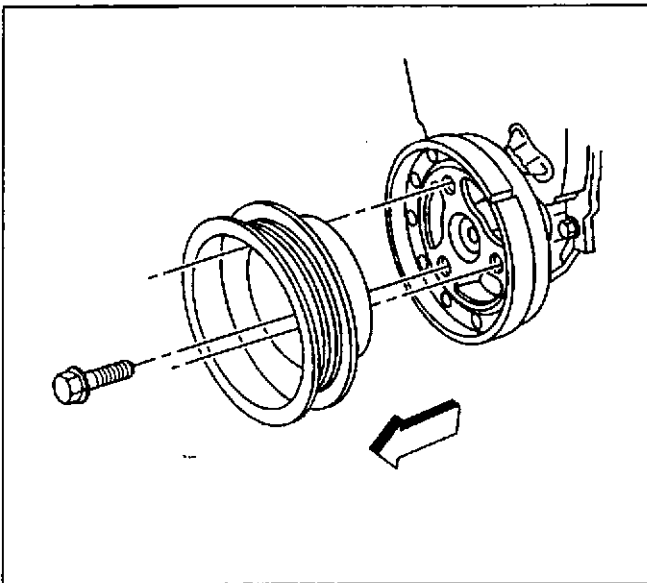
5. Install the crankshaft bolt and washer to the crankshaft.

Tighten

Tighten the crankshaft bolt to 149 N.m (110 lbN.mft).



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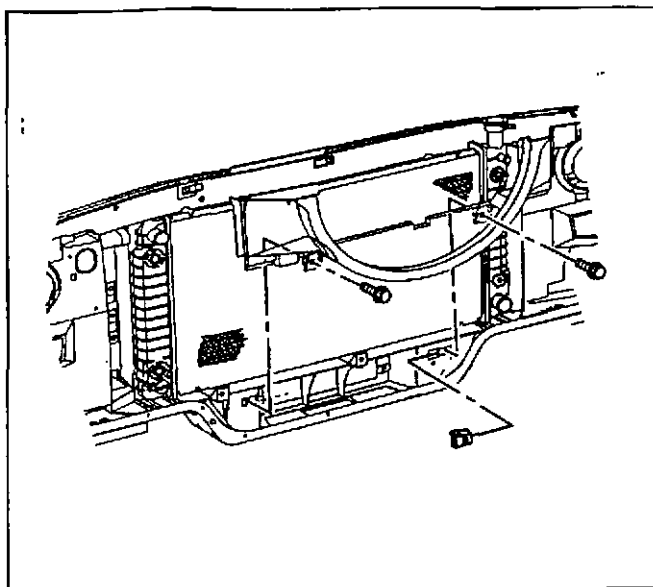
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6. Install the crankshaft pulley to the crankshaft.
7. Install the crankshaft pulley bolts.

Tighten

Tighten the bolts to 40 N.m (30 lb ft).

8. Install the lower fan shroud to the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
9. Lower the vehicle.
10. Install the drive belt on the pulley. Refer to *Drive Belt Replacement*.
11. Install the upper fan shroud to the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.



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Crankshaft Front Cover Oil Seal Replacement

Removal Procedure

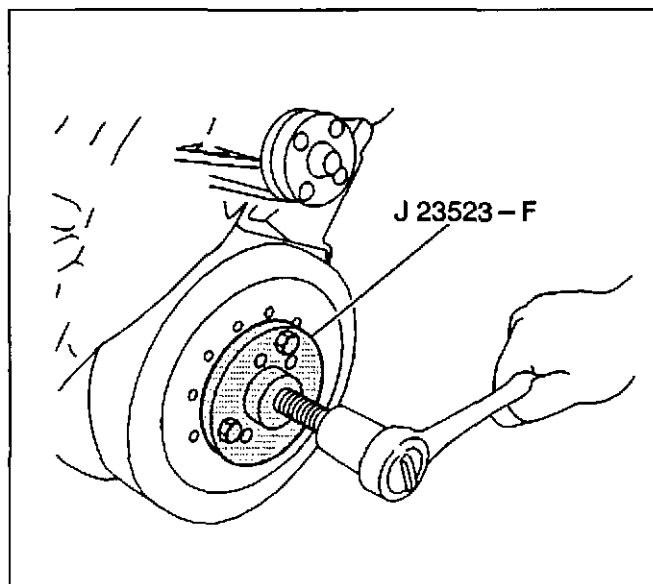
Tools Required

J 22102 Seal Installer

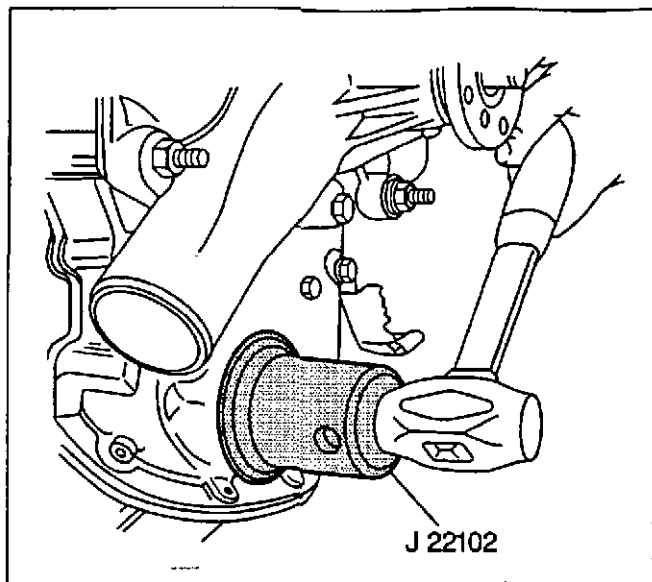
1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in general information.
2. Raise the vehicle. Refer to *Lifting and Jacking the Vehicle (ERROR - NOT IN CURRENT PSD)* in General Information.
3. Remove the drive belt from the vehicle's drive pulleys. Refer to *Drive Belt Replacement*.
4. Remove the lower fan shroud from the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
5. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Removal*.

Important: Use care as not to damage the engine front cover or the crankshaft sealing area when removing the crankshaft front cover oil seal.

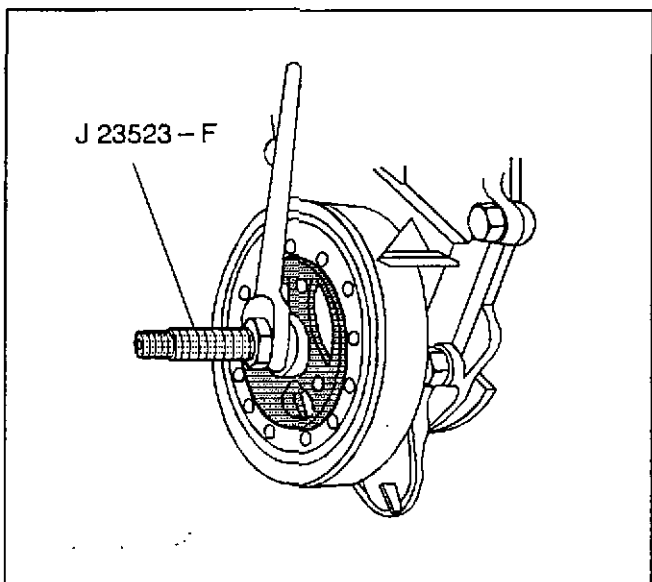
6. Remove the crankshaft front cover oil seal from the engine front cover.



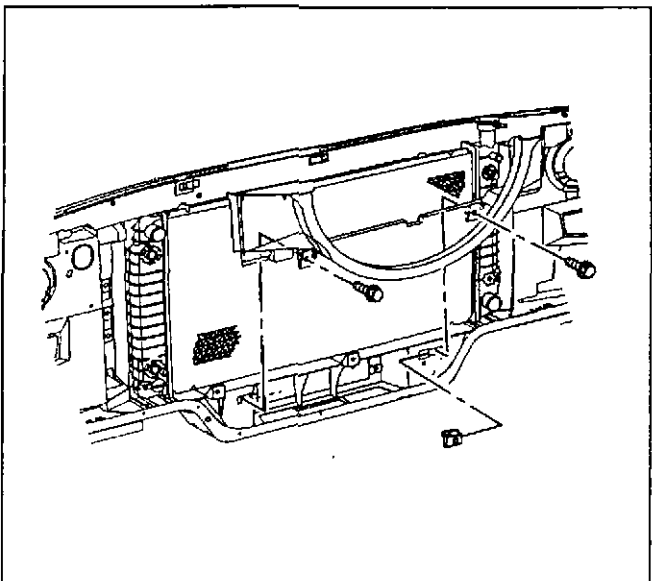
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Installation Procedure

Tools Required

J 22102 Seal Installer

1. Coat the crankshaft front cover oil seal with clean engine oil.
2. Use the J 22102 to install the crankshaft front cover oil seal.
3. Remove the J 22102 from the crankshaft front cover oil seal.
4. Install the crankshaft balancer to the crankshaft. Refer to *Crankshaft Balancer Removal*.
5. Install the drive belt on the vehicle drive pulleys. Refer to *Drive Belt Replacement*.
6. Install the lower fan shroud to the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
7. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.
8. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

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Engine Front Cover Replacement**Removal Procedure**

Important: The engine front cover gasket is reusable. Replace only if gasket is damaged.

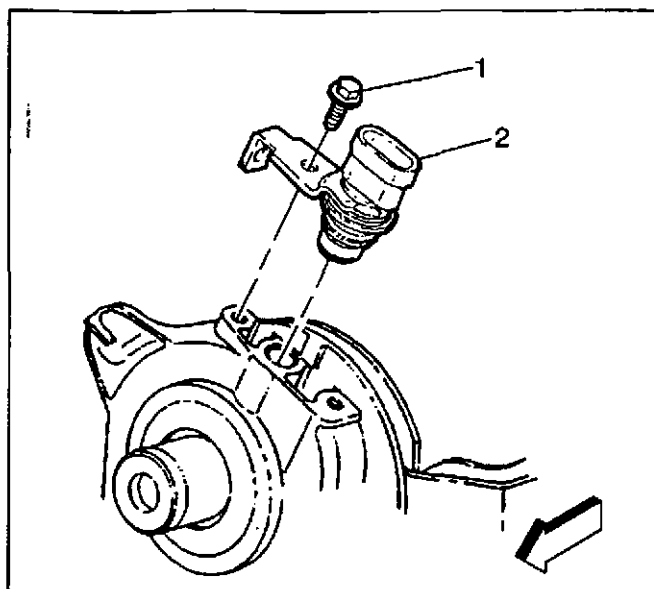
1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the drive belt from the drive pulleys. Refer to *Drive Belt Replacement*.
3. Remove the crankshaft position sensor from the engine front cover. Refer to *Crankshaft Position Sensor Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls.
4. Remove the crankshaft balancer from the crankshaft. Refer to *Crankshaft Balancer Replacement*.
5. Remove the water pump from the engine block. Refer to *Water Pump Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.

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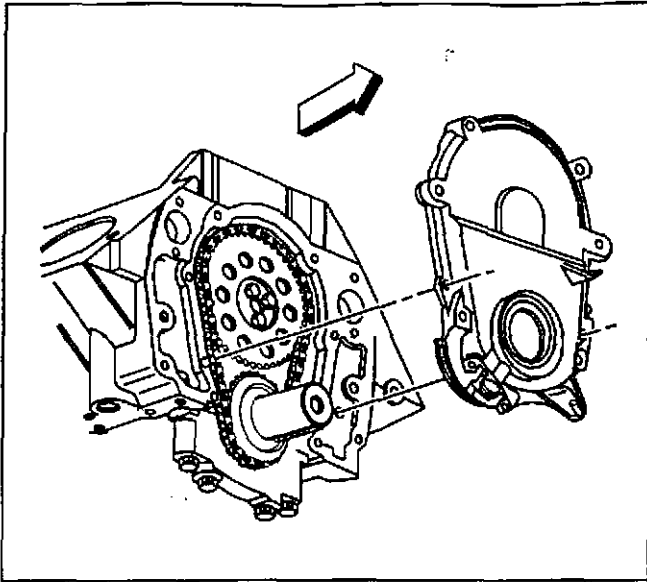
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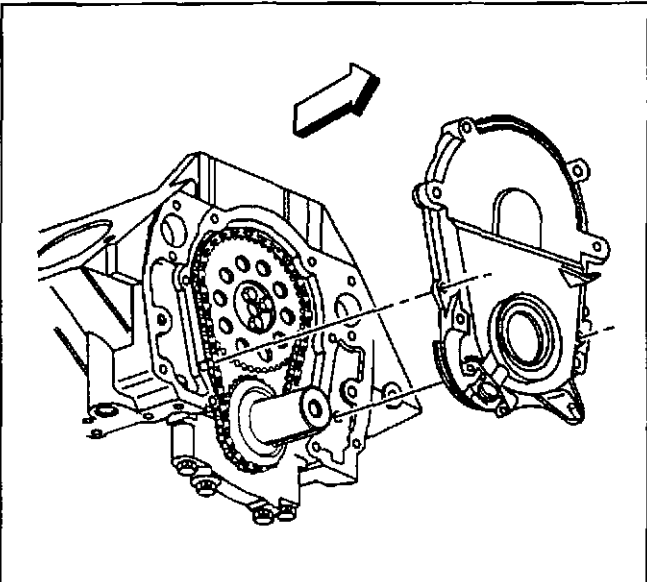
6. Remove the bolts from the oil pan to the engine block. Refer to *Oil Pan Replacement*.



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7. Remove the engine front cover mounting bolts.
8. Remove the engine front cover from the engine block. Refer to *Engine Front Cover Removal*.

Installation Procedure

Important: The engine front cover gasket is reusable. Replace only if gasket is damaged.

1. Install the engine front cover to the engine block. Refer to *Engine Front Cover Removal*.

Notice: Refer to *Fastener Notice* in cautions and Notices.

2. Install the engine front cover bolts
Tighten

Tighten the bolts to 10 N.m (89 lb in).

3. Install the oil pan to the engine block. Refer to *Oil Pan Installation*.
4. Install the crankshaft position sensor to the engine front cover. Refer to *Crankshaft Position Sensor Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls.
5. Install the crankshaft balancer to the crankshaft. Refer to *Crankshaft Balancer Replacement*.
6. Connect the battery cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

SIE-ID - 333924

Crankshaft Position Reluctor Ring Replacement

Removal Procedure

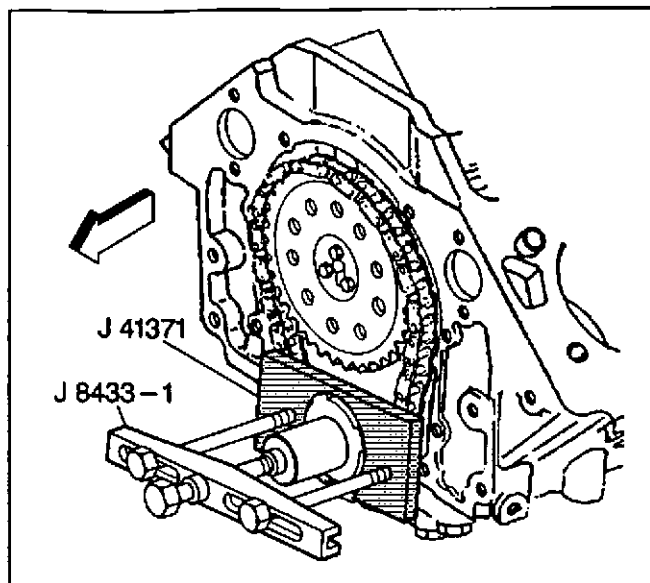
Tools Required

J 41371 Reluctor Wheel Remover

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the crankshaft balancer from the crankshaft. Refer to *Crankshaft Balancer Replacement*.
3. Remove the water pump from the engine block. Refer to *Water Pump Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
4. Remove the engine front cover from the engine

block. Refer to *Engine Front Cover Removal*.

5. Use the J 41371 to remove the reluctor ring from the crankshaft.

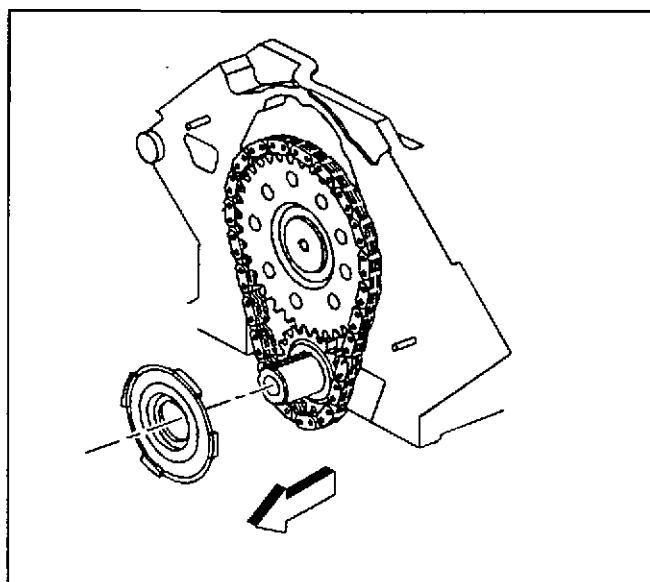


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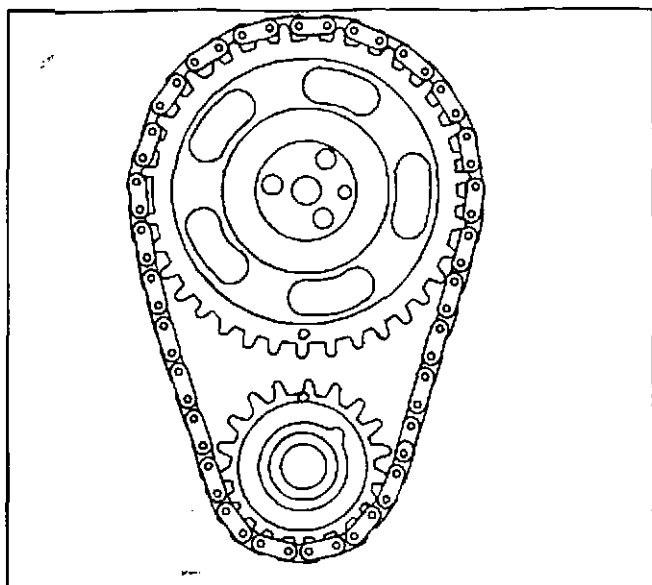
Installation Procedure

Important: Replace the crankshaft position sensor whenever the crankshaft position reluctor ring is replacement.

1. Install the crankshaft position reluctor ring on to the crankshaft.
2. Install the engine front cover to the engine block. Refer to *Engine Front Cover Removal*.
3. Install the water pump to the engine block. Refer to *Water Pump Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
4. Install the crankshaft balancer to the crankshaft. Refer to *Crankshaft Balancer Replacement*.
5. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.



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SIE-ID - 333939

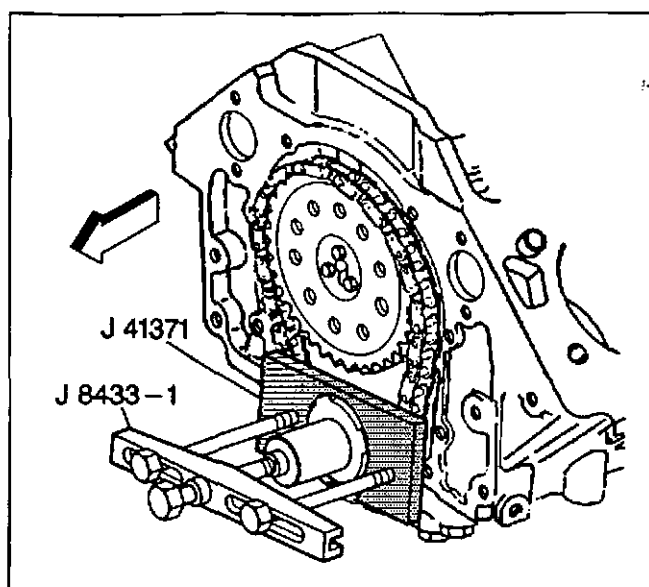
Timing Chain and Sprockets Replacement

Removal Procedure

Tools Required

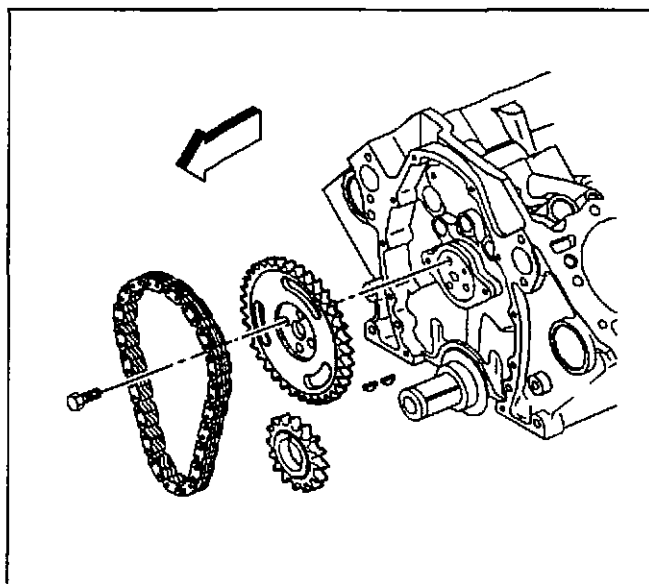
- J 28509-A Crankshaft Sprocket Remover
 - J 41371 Reluctor Wheel Remover.
1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
 2. Remove upper fan shroud from the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
 3. Rotate the engine until the timing marks on the crankshaft balancer and the engine front cover are on TDC.
 4. Remove the drive belt from the vehicles drive pulleys. Refer to *Drive Belt Replacement* in Engine Mechanical.
 5. Raise the vehicle and support with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
 6. Remove the lower fan shroud from the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
 7. Remove the crankshaft balancer from the crankshaft. Refer to *Crankshaft Balancer Replacement*.
 8. Remove the water pump from the engine block. Refer to *Water Pump Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
 9. Remove the engine front cover from the engine block. Refer to *Engine Front Cover Replacement* in Engine Mechanical.
- Important:** If the crankshaft position reluctor ring is removed, a new crankshaft position reluctor ring sensor must be installed.
10. Aligned the timing marks on the camshaft and crankshaft gears.

11. Use the *J 41371* to remove the crankshaft reluctor ring from the crankshaft. Refer to *Crankshaft Position Reluctor Ring Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Mechanical.



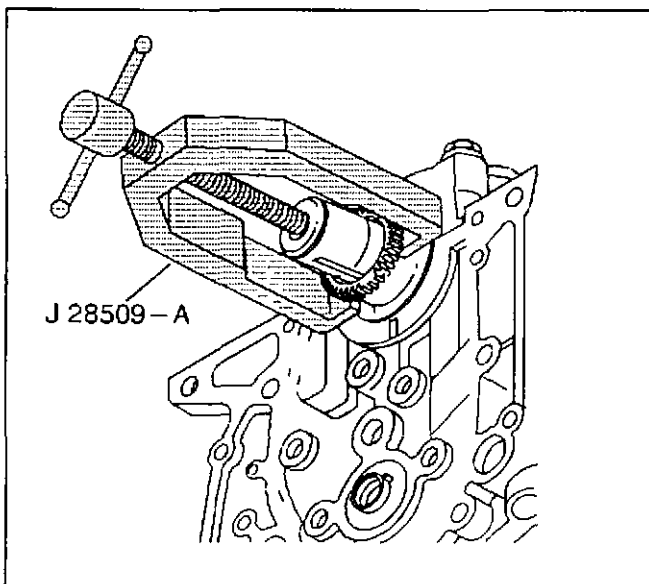
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12. Remove the camshaft sprocket retaining bolts.
13. Remove the timing chain and camshaft sprocket.

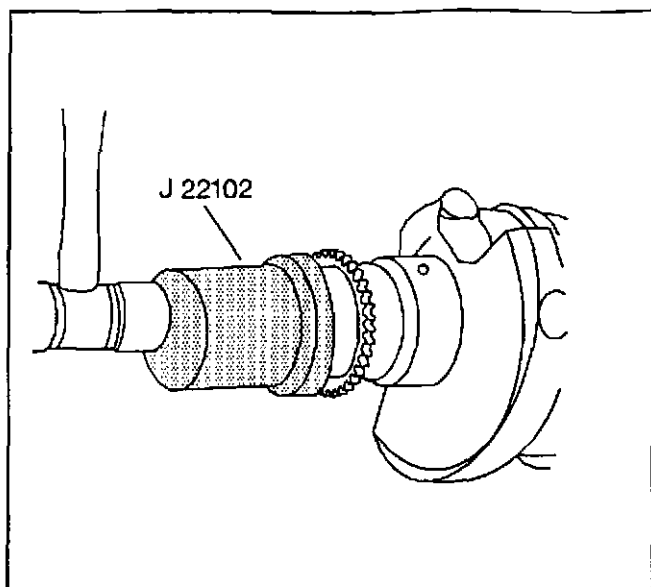


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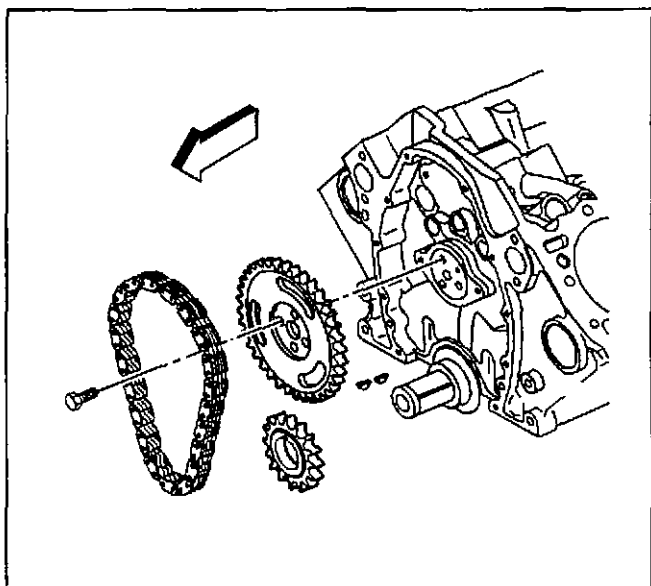
14. Use the *J 28509-A* to remove the crankshaft sprocket.



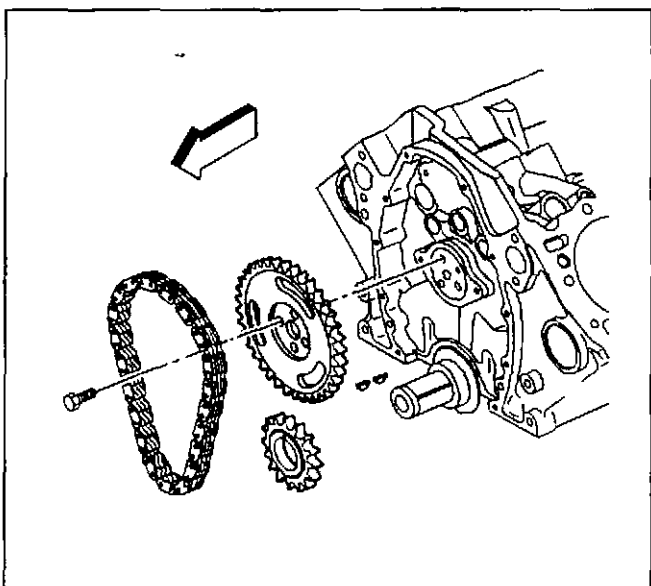
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Installation Procedure

Tools Required

J 22102 Crankshaft Sprocket Installer

Important: Ensure the following conditions exist:

- The camshaft and the crankshaft timing marks are aligned
- The camshaft dowel pin and the camshaft sprocket holes are properly aligned.
- The gears and the chain mesh properly

1. Use the J 22102 to install the crankshaft sprocket.

Notice: Refer to *Camshaft Sprocket/Camshaft Notice* in Cautions and Notices.

2. Install the timing chain and sprocket to the camshaft.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the camshaft retaining bolts to the camshaft.

Tighten

Tighten the retaining bolts to 30 N·m (22 lb ft)

4. Install the timing chain and sprocket to the camshaft.

5. Install the engine front cover to the engine block. Refer to *Engine Front Cover Replacement*.

6. Install a new crankshaft position reluctor ring to the crankshaft. Refer to *Crankshaft Position Reluctor Ring Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Mechanical.
7. Install the crankshaft balancer to the crankshaft. Refer to *Crankshaft Balancer Replacement*.
8. Install the water pump to the engine block. Refer to *Water Pump Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
9. Install the lower fan shroud to the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
10. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.
11. Install the drive belt on the vehicle drive pulleys. Refer to *Drive Belt Replacement*.
12. Install the upper fan shroud to the radiator. Refer to *Fan Shroud Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
13. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

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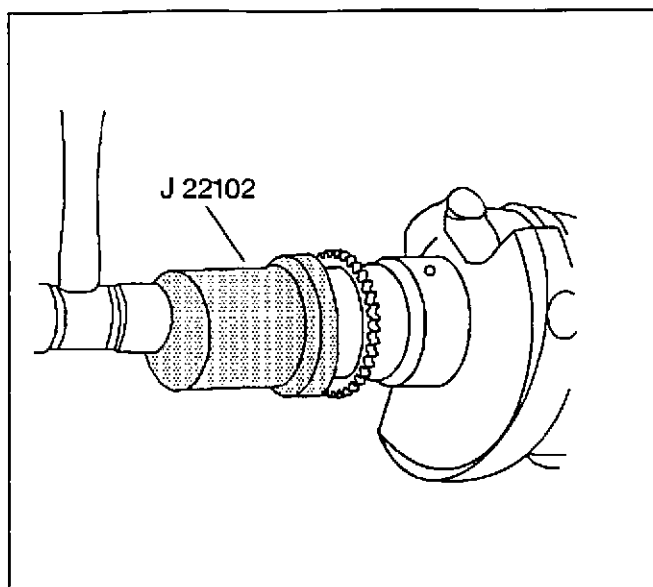
Camshaft Replacement

Removal Procedure

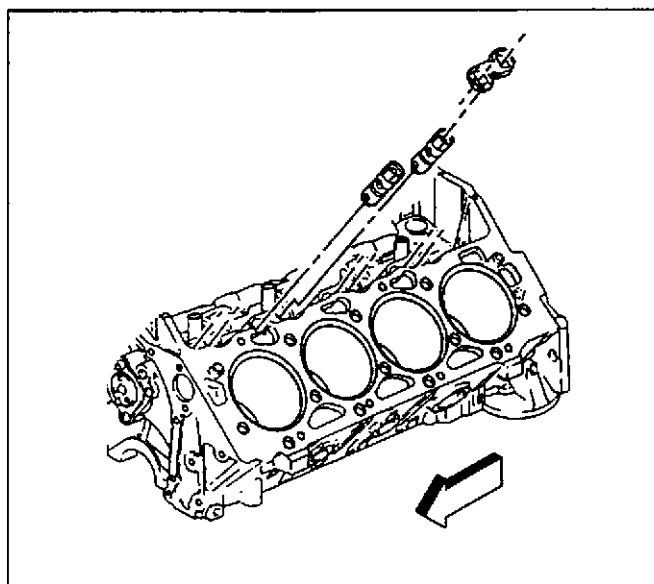
Tools Required

J 28509-A Sprocket Remover

1. Disconnect the battery negative cable from the battery. Refer to *Lifting and Jacking the Vehicle* in engine electrical.
2. Remove the air intake duct from the throttle body.
3. Remove the grille from the vehicle. Refer to *Grille Replacement (Luxury)* in Exterior Trim.
4. Remove the radiator assembly from the vehicle. Refer to *Radiator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
5. Remove the air conditioning condenser. Refer to *Condenser Replacement* in HVAC.
6. Remove the upper intake manifold from the engine block. Refer to *Intake Manifold Replacement (Upper)*.
7. Remove the lower intake manifold from the engine block. Refer to *Intake Manifold Replacement (Lower)*.
8. Remove the valve rocker arm covers from the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
9. Remove the valve rocker arms from the cylinder head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
10. Remove the valve push rods from the engine block. Refer to *Valve Rocker Arm and Push Rod Replacement*.
11. Remove the valve lifters from the engine block.
12. Remove the crankshaft balancer from the crankshaft. Refer to *Crankshaft Balancer*



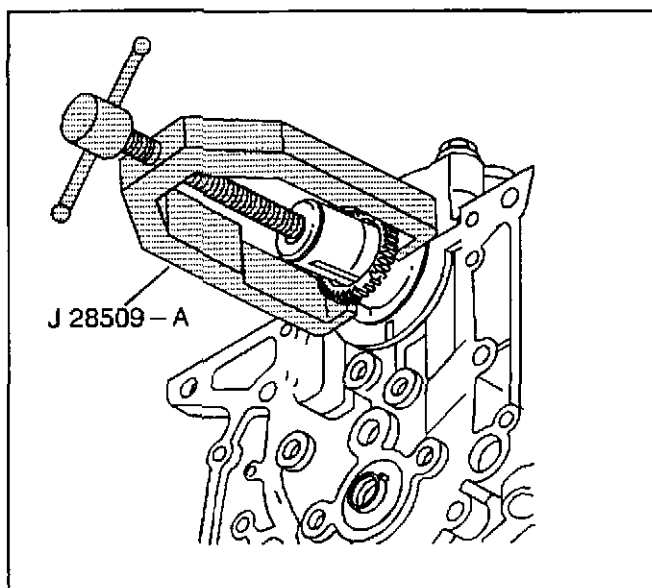
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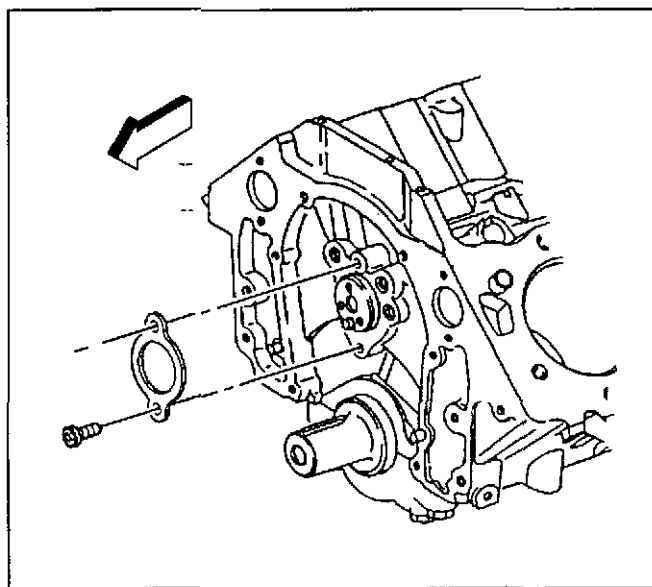
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Replacement.

13. Remove the water pump from the engine block. Refer to *Water Pump Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
14. Remove the engine front cover from the engine block. Refer to *Engine Front Cover Replacement*.
15. Remove the crankshaft position reluctor ring from the crankshaft. Refer to *Crankshaft Position Reluctor Ring Replacement*.
16. Remove the timing chain and sprockets from the engine block. Refer to *Timing Chain and Sprockets Replacement*.
17. Use the J 28509-A to remove the camshaft sprocket.



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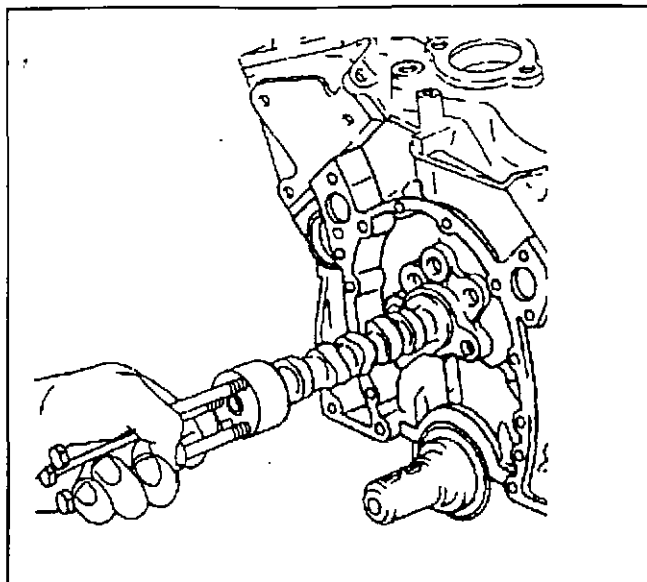


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18. Remove the camshaft retainer bolt and retainer from the engine block.
19. Install three 5/16 18 bolts 4 to 5 inches long into the camshaft threaded bolt holes. Use these bolts as a handle for the camshaft removal.
20. Pull the camshaft from the engine block. Use care as not to damage the camshaft bearing. Refer to *Camshaft Removal*.
21. Remove the three 5/16 18 bolts from the camshaft.

Installation Procedure**Tools Required***J 22101* Seal Installer

1. Install the three 5/16 18 bolts 4 to 5 inches long into the camshaft threaded bolt holes. Use these bolts as a handle to install the camshaft in the engine block.
2. Coat the camshaft lobes and journals with engine oil supplement GM P/N 1052367 before installing the camshaft into the cylinder block.
3. Install the camshaft into the engine block. Refer to *Camshaft Installation* in Engine Mechanical.
4. Remove the three 5/16 18 bolts from the camshaft.



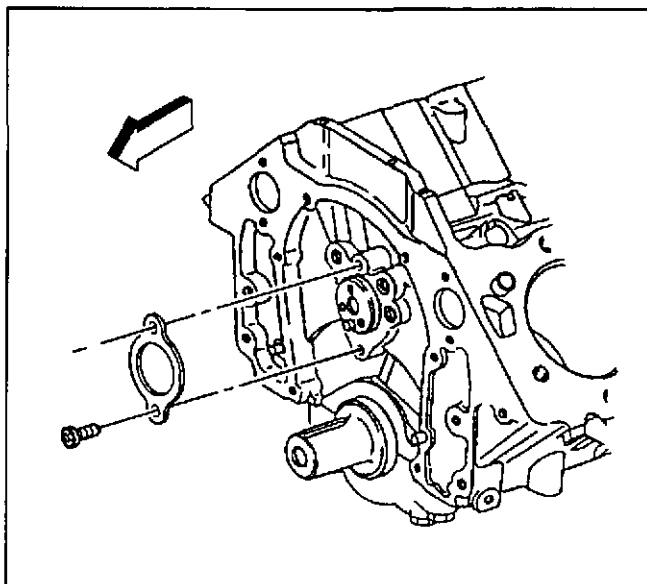
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Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the camshaft retainer and bolts in the engine block.

Tighten

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



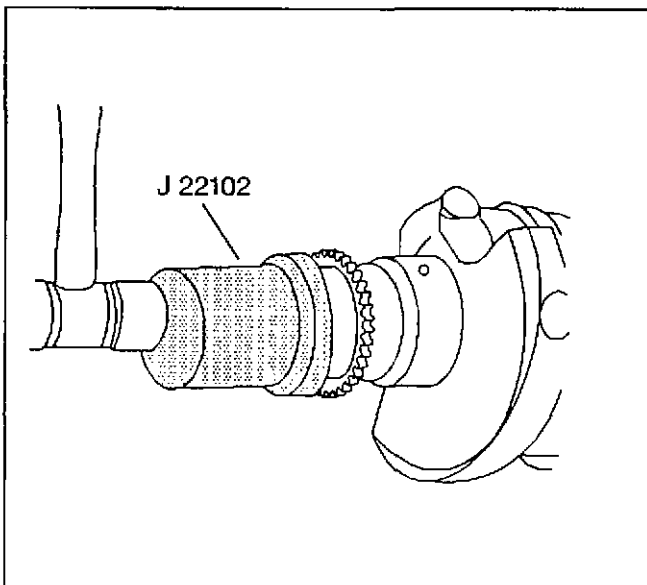
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6. Use the *J 22101* to install the crankshaft sprocket.
7. Install the timing chain and camshaft sprocket to the camshaft. Refer to *Timing Chain and Sprockets Installation*.
8. Install the camshaft sprocket bolts to the camshaft.

Tighten

Tighten the bolts to 30 N·m (22 lb ft).

9. Install the crankshaft position reluctor ring on the crankshaft. Refer to *Crankshaft Position Reluctor Ring Replacement*.
10. Install the engine front cover to the engine block. Refer to *Engine Front Cover Replacement*.
11. Install the water pump to the engine block. Refer to *Water Pump Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
12. Install the crankshaft balancer to the crankshaft.



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- Refer to *Crankshaft Balancer Replacement*.
13. Install the valve lifters to the engine block. Refer to *Valve Lifter Replacement*.
 14. Install the push rods into the engine block. Refer to *Valve Rocker Arm and Push Rod Replacement*.
 15. Install the valve rocker arms to the cylinder head. Refer to *Valve Rocker Arm and Push Rod Replacement*.
 16. Install the lower intake manifold to the engine block. Refer to *Intake Manifold Replacement (Lower)*.
 17. Install the upper intake manifold to the lower intake manifold. Refer to *Intake Manifold Replacement (Upper)*.
 18. Install the valve rocker arm covers to the cylinder head. Refer to *Valve Rocker Arm Cover Replacement*.
 19. Install the air cleaner duct to the throttle body.
 20. Install the radiator in the vehicle. Refer to *Radiator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
 21. Install the air conditioning condenser to the vehicle. Refer to *Condenser Replacement* in HVAC.
 22. Install the grille on the vehicle. Refer to *Grille Replacement (Luxury)* in Exterior Trim.
 23. Install the drive belt on the drive pulleys. Refer to *Drive Belt Replacement*.
 24. Connect the battery negative cables to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

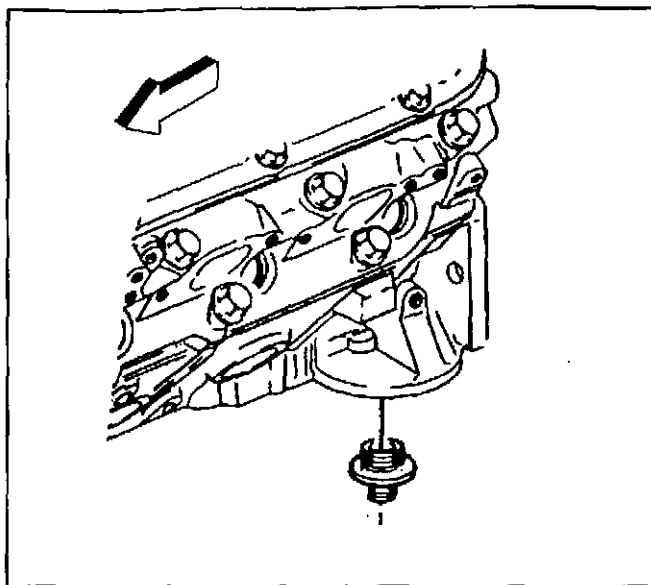
SIE-10 - 333954

Oil Filter Adapter and Valve Assembly Replacement

Removal Procedure

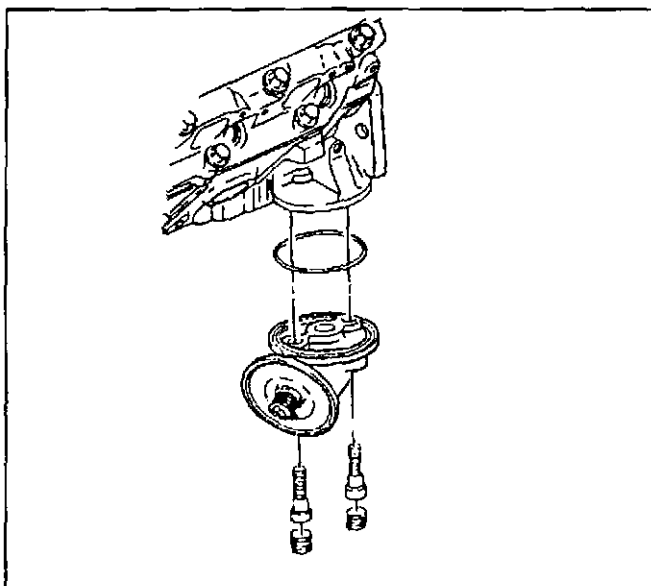
1. Raise the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
2. Remove the oil filter from the adapter from the engine block. Refer to *Engine Oil and Oil Filter Replacement* in Engine Mechanical.

3. Remove the oil filter adapter fittings(2 wheel drive) from the engine block. Refer to *Oil Filter Adapter and Valve Assembly Removal (2WD)*.



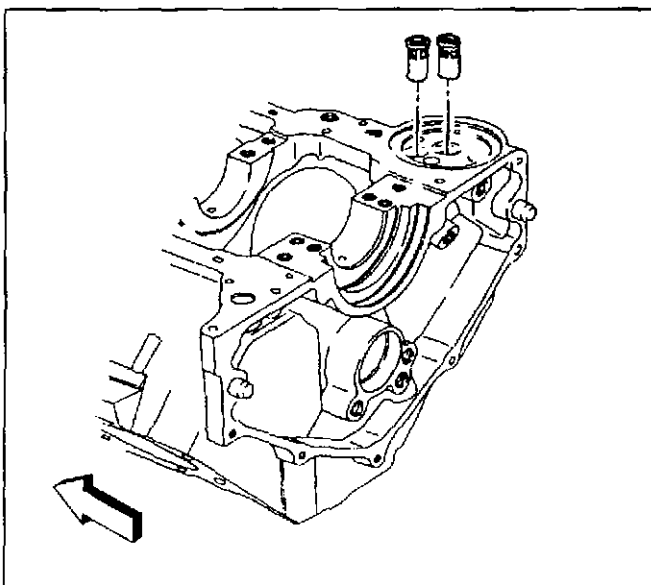
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4. Remove the oil filter adapter (4 wheel drive) from the engine block. Refer to *Oil Filter Adapter and Valve Assembly Removal (4WD)*.

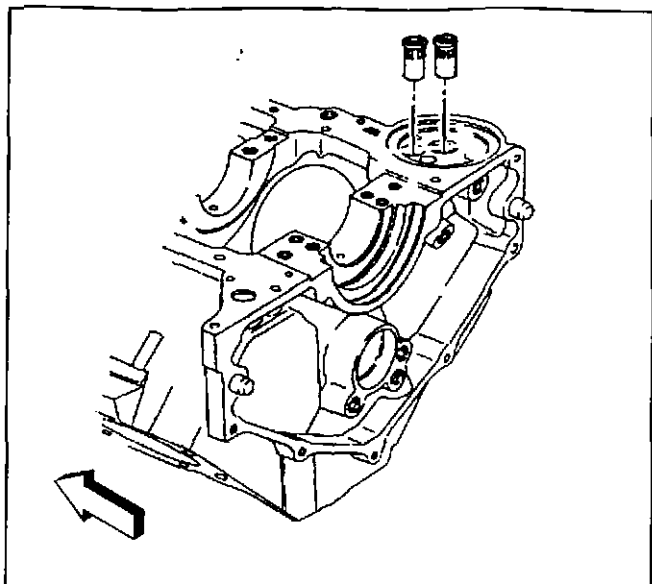


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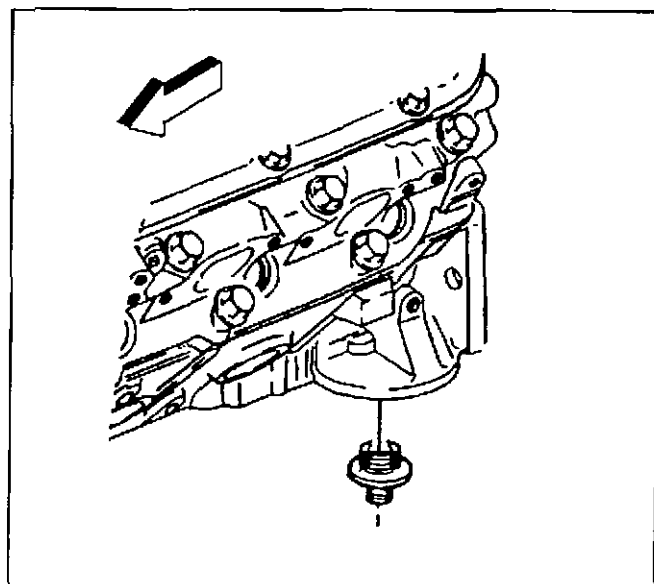
5. Remove the oil filter bypass valve from the engine block. Refer to *Oil Filter Adapter and Valve Assembly Removal (4WD)*.



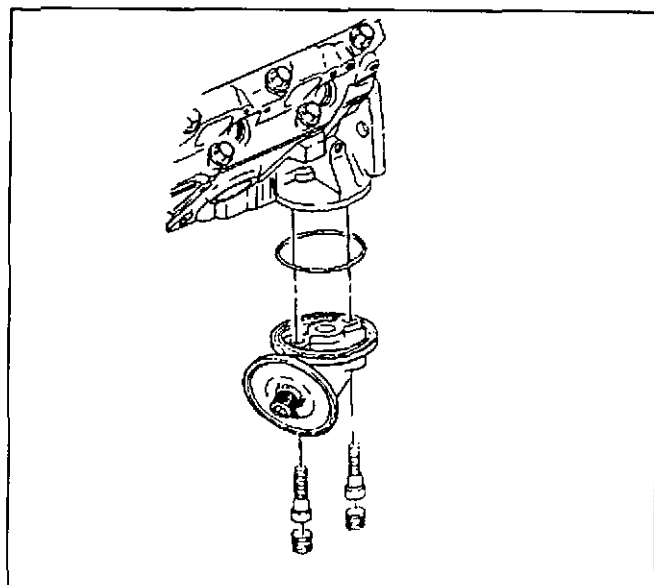
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Installation Procedure

1. Install the bypass valve in the engine block. Refer to *Oil Filter Adapter and Valve Assembly Installation (2WD)*.
2. Install the oil filter adapter (2 wheel drive) to the engine block.
3. Install the oil filter adapter (4WD) to the engine block. Refer to *Oil Filter Adapter and Valve Assembly Installation (4WD)* in Engine Mechanical.
4. Install the oil filter to the adapter. Refer to *Engine Oil and Oil Filter Replacement*.
5. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.

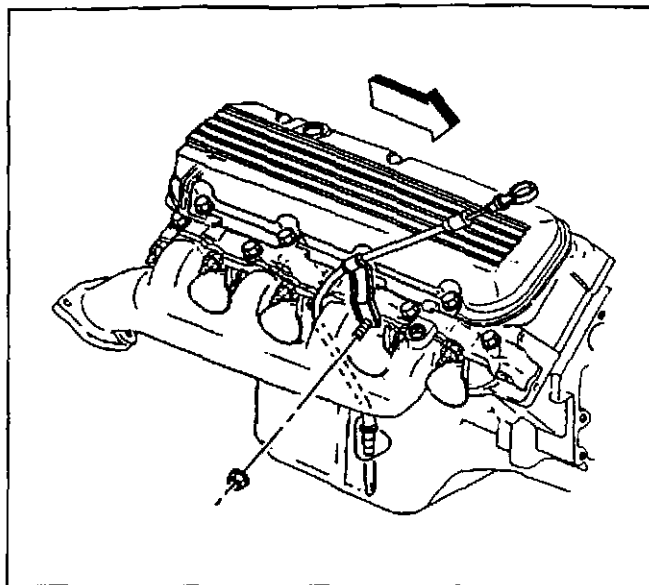
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Oil Pan Replacement

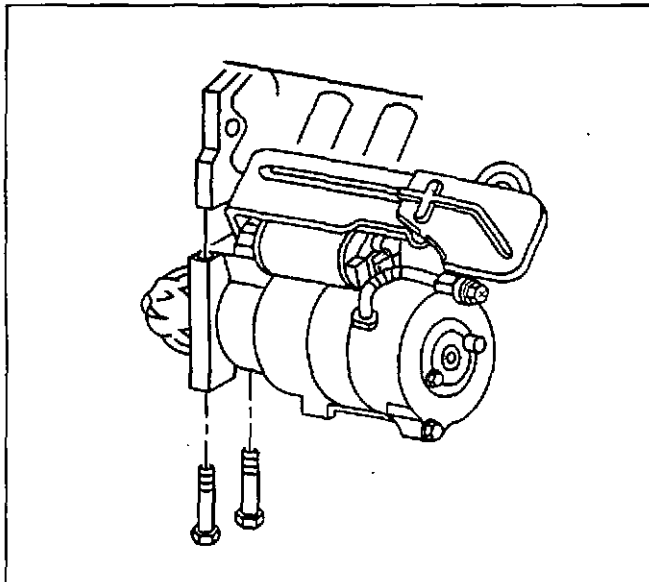
Removal Procedure

Important: Do not raise the engine by the crankshaft balancer to perform this service procedure. Damage to the crankshaft balancer or the crankshaft may occur.

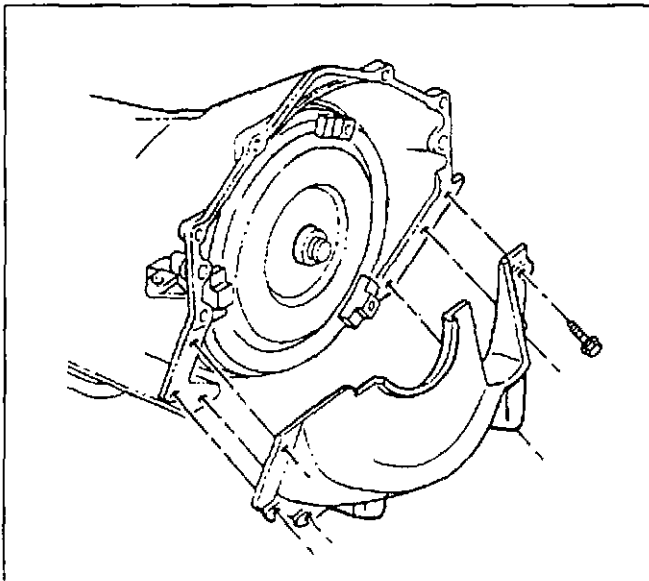
1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Remove the oil level indicator and tube from the engine. Refer to *Oil Level Indicator and Tube Replacement* in Engine Mechanical.
3. Raise the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
4. Drain the crankcase. Refer to *Engine Oil and Oil Filter Replacement* in Engine Mechanical-7.4L.
5. Remove the starter from the engine block. Refer to *Starter Motor Replacement (Gas, 7.4L)* in Engine Electrical.
6. Roll the front drive axle if servicing a 4 wheel drive truck. Refer to *Halfshaft Assembly Replacement (ERROR - NOT IN CURRENT PSD)* in Halfshaft Assmebly Replacement.
7. Remove the flywheel inspection cover if equipped.



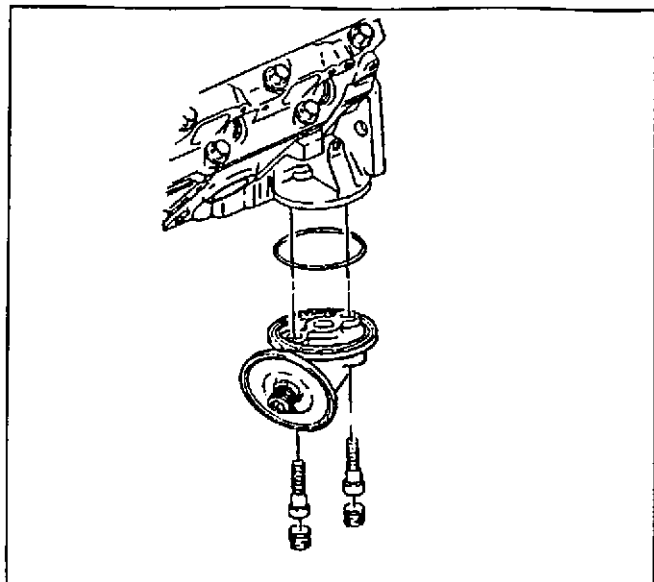
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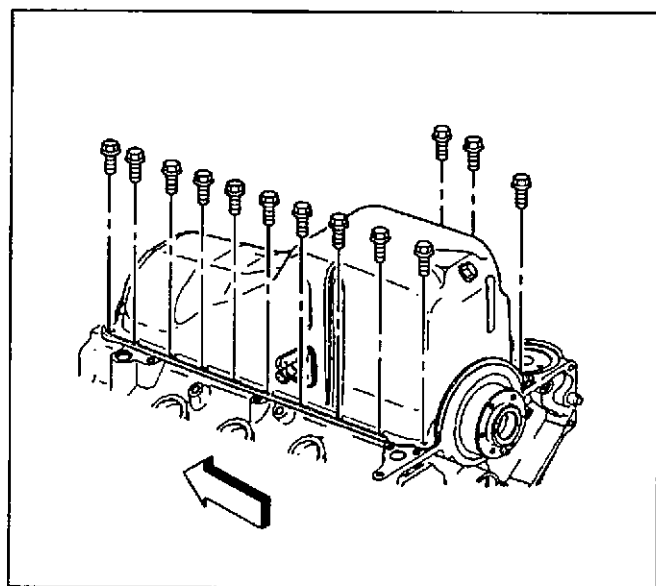
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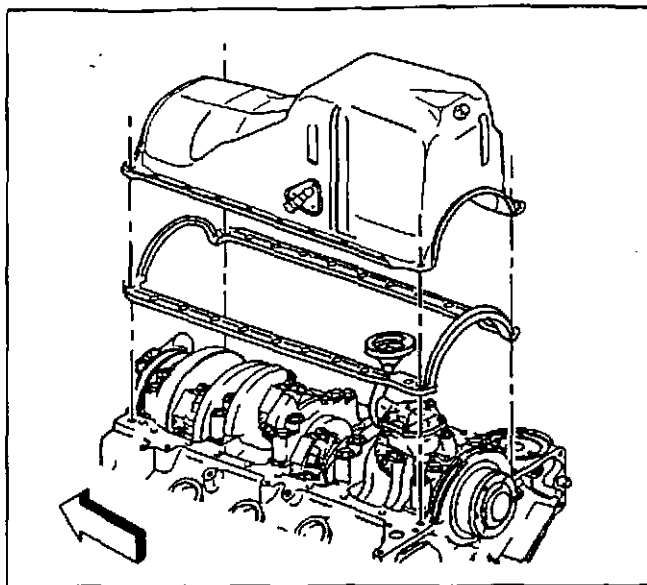
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8. Remove the oil filter and adapter (4 wheel drive) if equipped. Refer to *Oil Filter Adapter and Valve Assembly Replacement*.
9. Remove the oil cooler line retainer from the retaining bracket. Refer to *Engine Oil Cooler Line Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.

Important: DO NOT lift the engine by the crankshaft balancer to aide in removing the oil pan from the engine block. Damage to crankshaft balancer or crankshaft could occur.

10. Remove the transmission from the vehicle.
 - For the manual transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.
 - For the automatic transmission. Refer to *Transmission Replacement* or *Transmission Replacement* in Transmission/Transaxle.
 - Remove the clutch from the flywheel (if equipped). Refer to *Clutch Assembly Replacement* in Clutch.
 - Remove the flywheel from the crankshaft. Refer to *Engine Flywheel Replacement* in Engine Mechanical.
11. Remove the oil pan bolts from the engine block. Refer to *Oil Pan Clean and Inspect*.

12. Remove the oil pan from the vehicle.
13. Remove the oil pan gasket from the engine block.
14. Remove the oil from the sealing surfaces. Refer to *Oil Pan Clean and Inspect*.

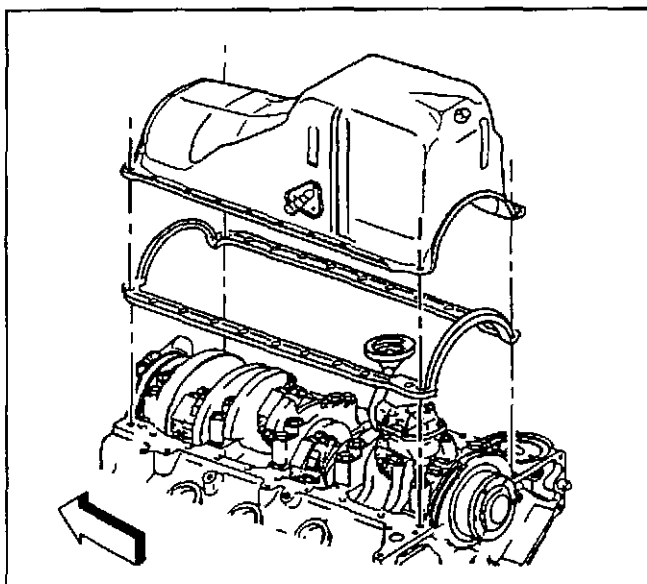


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Installation Procedure

Important: The oil pan gasket is reusable. Replace only if the gasket is damaged.

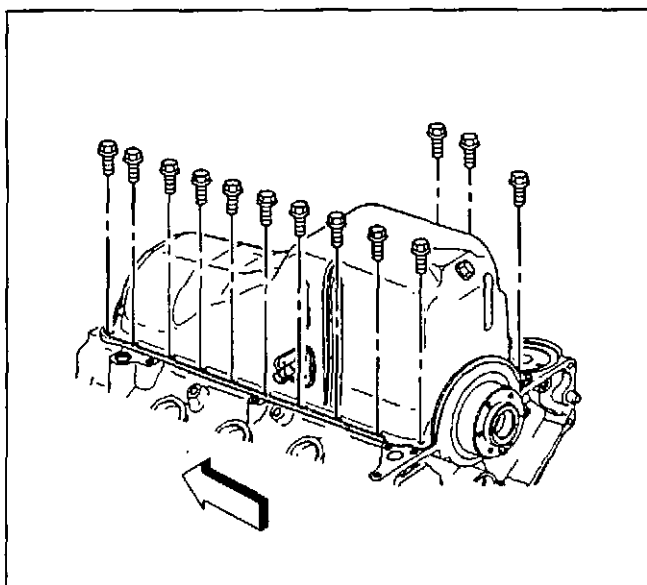
1. Install the oil pan gasket on the oil pan.
2. Install the oil pan gasket and oil pan to the engine block.



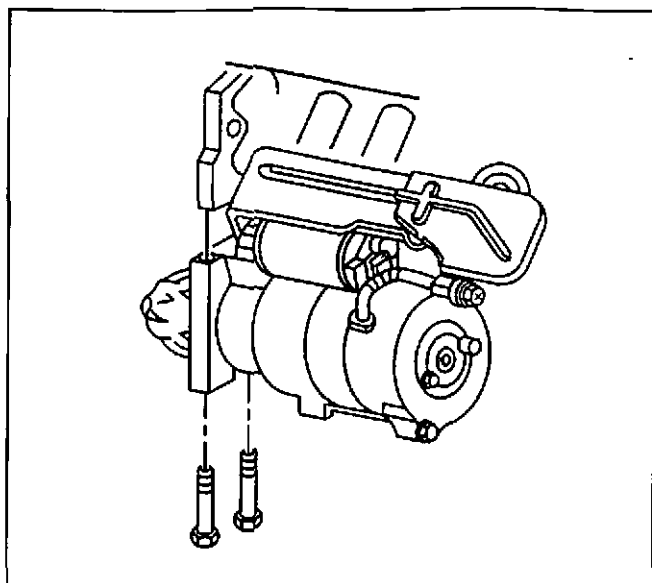
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Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the oil pan bolts to the engine block.
Tighten
Tighten the bolts to 25 N·m (18 lb ft).
4. Install the clutch assembly to the flywheel. Refer to *Clutch Assembly Replacement* in Clutch.
5. Install the flywheel to the crankshaft. Refer to *Engine Flywheel Replacement*.
6. Install flywheel inspection cover to the transmission.
7. Install the transmission in the vehicle.
8. For the automatic transmission. Refer to *Transmission Replacement* or *Transmission Replacement* in Transmission/Transaxle.
9. For the manual transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.



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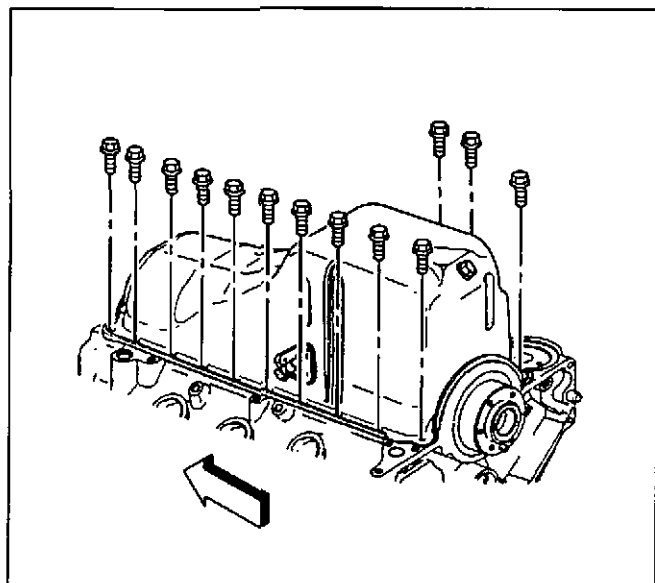
10. Install the starter to the engine block. Refer to *Starter Motor Replacement (Gas, 7.4L)* in Engine Electrical.
11. Install oil cooler line to the retainers. Refer to *Engine Oil Cooler Line Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
12. Install the oil filter adapter (4 wheel drive) to the cylinder block if equipped. Refer to *Oil Filter Adapter and Valve Assembly Installation (4WD)* in Engine Mechanical.
13. Install the front drive axle if servicing a 4 wheel drive truck. Refer to *Halfshaft Assembly Replacement (ERROR - NOT IN CURRENT PSD)* in Halfshaft Assembly Replacement.
14. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.
15. Install the oil level indicator and tube. Refer to *Oil Level Indicator and Tube Replacement*.
16. Fill the crankcase with new engine oil. Refer to *Engine Oil and Oil Filter Replacement*.
17. Connect the battery negative cables to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

SIE-ID - 333965

Oil Pump Replacement

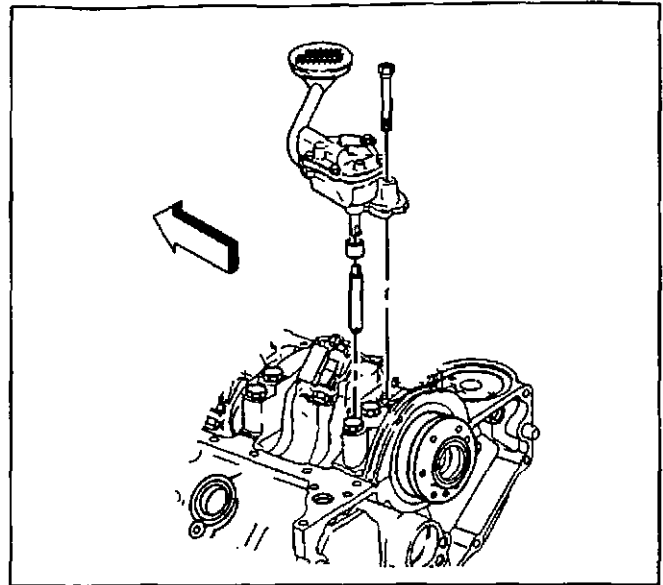
Removal Procedure

1. Disconnect the negative battery cable from the battery.
2. Drain the crankcase. Refer to *Engine Oil and Oil Filter Replacement*.
3. Remove the oil pan from the engine block. Refer to *Oil Pan Replacement*.



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4. Remove the oil pump retaining bolts from the oil pump. Refer to *Oil Pump Disassemble*.
5. Remove the oil pump assembly from the engine block.



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Installation Procedure

Important: When installing the oil pump, always replace the retainer between the oil pump and the shaft.

1. Install the oil pump to the engine block. Refer to *Oil Pump Assemble*.

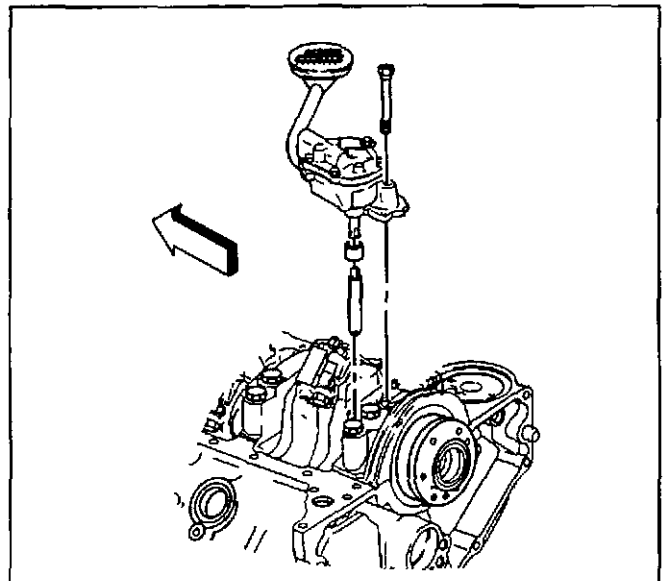
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the oil pump mounting bolts.

Tighten

Tighten the bolts to 90 N·m (65 lb ft).

3. Install the oil pan to the engine block. Refer to *Oil Pan Replacement*.
4. Connect the battery negative cables to the battery. Refer to *Battery Cable (0)* in Engine Electrical.



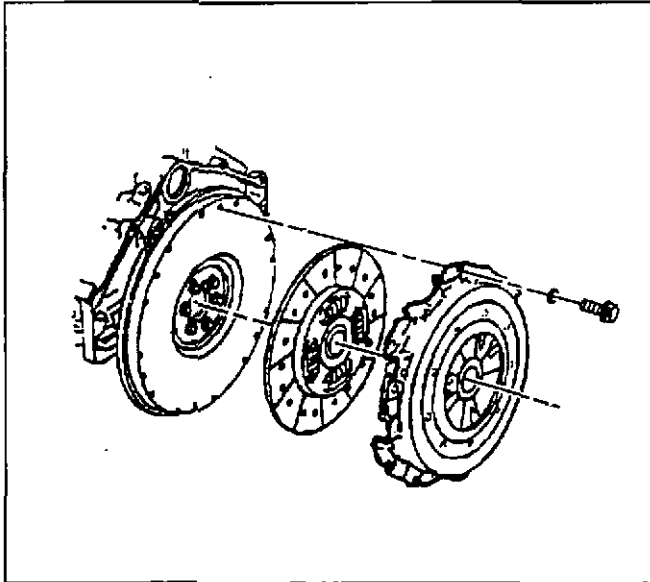
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Crankshaft Rear Oil Seal Replacement

Removal Procedure

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Raise the vehicle and support with safety stands. Refer to *Lifting and Jacking the Vehicle (ERROR - NOT IN CURRENT PSD)* in General Information.
3. Remove the transmission from the vehicle.
 - For the automatic transmission. Refer to *Transmission Replacement* or *Transmission Replacement* in Transmission/Transaxle.
 - For the manual transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.
4. Remove the clutch from the crankshaft if equipped. Refer to *Clutch Assembly*



34060

Replacement in Clutch.

5. Remove the flywheel from the crankshaft. Refer to *Engine Flywheel Replacement*.

Important: When removing the crankshaft rear oil seal from the cylinder block be careful not to nick the crankshaft sealing surface.

6. Remove the crankshaft rear oil seal from the engine block. Refer to *Crankshaft Rear Oil Seal Removal*.

Installation Procedure**Tools Required****J 38841 Rear Oil Seal Installer**

1. Install the crankshaft rear oil seal as follows:
 - 1.1. Lubricate the inner and outer diameter of the crankshaft rear oil seal with clean engine oil.
 - 1.2. Install the crankshaft rear oil seal the J 38841.
 - 1.3. Use the J 38841 to install the crankshaft rear oil seal on the crankshaft.
 - 1.4. Remove the J 38841 from the crankshaft.
2. Install the flywheel to the crankshaft. Refer to *Engine Flywheel Replacement*
3. Install the clutch to the crankshaft if equipped. Refer to *Clutch Assembly Replacement in Clutch*.
4. Install the transmission to the engine block.
 - 4.1. For the automatic transmission. Refer to *Transmission Replacement* or *Transmission Replacement in Transmission/Transaxle*.
 - 4.2. For the manual transmission. Refer to *Transmission Replacement in Transmission/Transaxle*.
5. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
6. Connect the battery negative cables to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

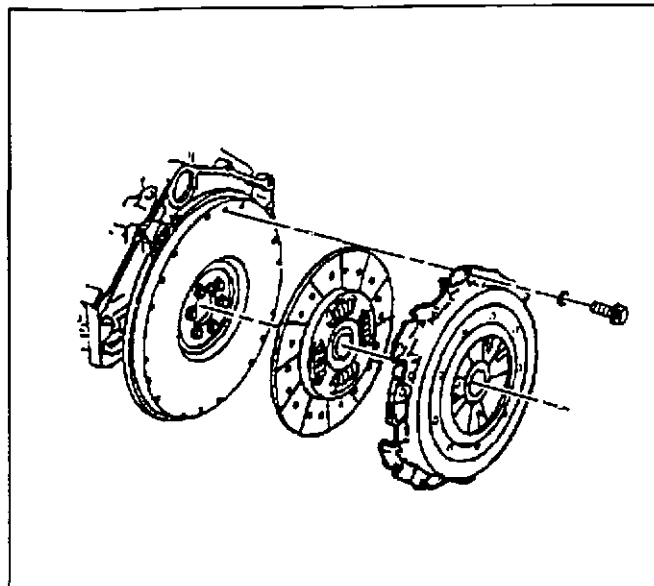
SIE-ID = 334010

Engine Flywheel Replacement**Removal Procedure**

1. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
2. Raise the vehicle and support with safety stands. Refer to *Lifting and Jacking the Vehicle (ERROR - NOT IN CURRENT PSD)* in General Information.
3. Remove the transmission from the vehicle.
 - 3.1. For the automatic transmission,. Refer to *Transmission Replacement* or *Transmission Replacement in Transmission/Transaxle*.
 - 3.2. For the manual transmission. Refer to *Transmission Replacement in*

Transmission/Transaxle.

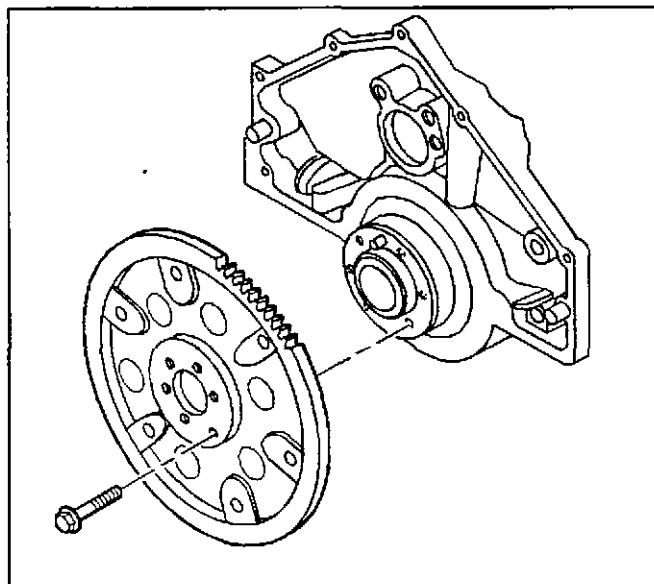
4. Remove the clutch assembly from the crankshaft if equipped. Refer to *Clutch Assembly Replacement* in Transmission/Transaxle.
5. Remove the flywheel from the crankshaft. Refer to *Engine Flywheel Removal (MW3 Manual Transmission)*.
6. Remove any burrs from the end of the crankshaft.



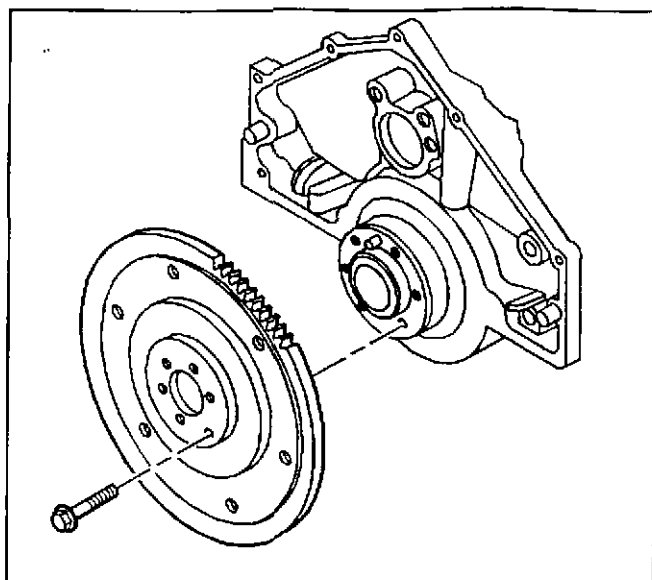
34060

Installation Procedure

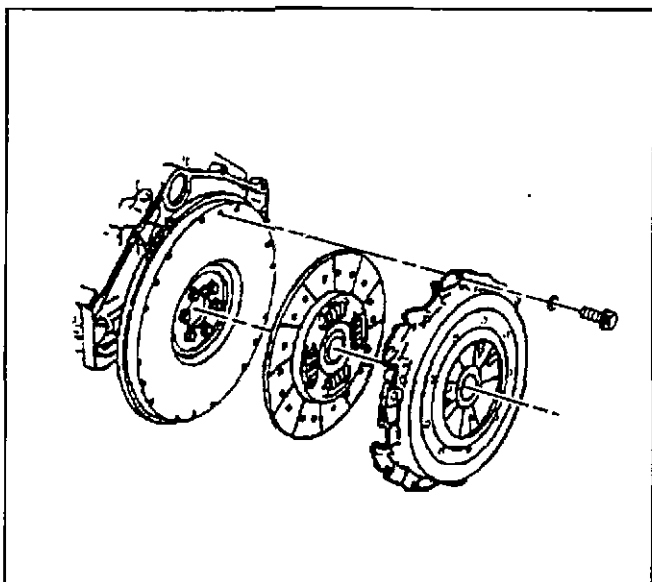
1. Install the flywheel to the crankshaft.
Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the flywheel mounting bolts.
Tighten
Tighten the bolts to 90 N·m (65 lb ft).



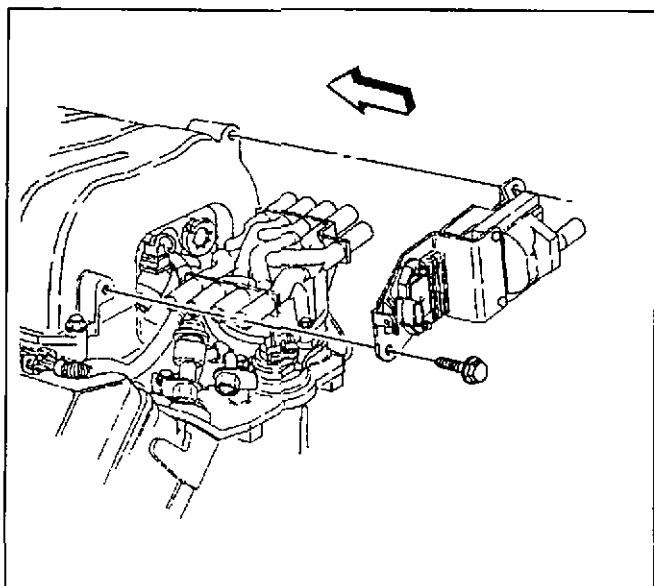
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66506

3. Install the flywheel (manual) to the crankshaft.
Tighten
Tighten the bolts to 90 N.m (65 lb ft).

4. Install the Clutch to the flywheel. Refer to *Clutch Assembly Replacement* in Clutch.
5. Install the transmission to the vehicle.
 - 5.1. For the automatic transmission. Refer to *Transmission Replacement* or *Transmission Replacement* in Transmission/Transaxle.
 - 5.2. For the manual transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.
6. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.

SIE-ID - 334014

Engine Replacement

Removal Procedure

Tools Required

J 36857 Engine Lift Brackets

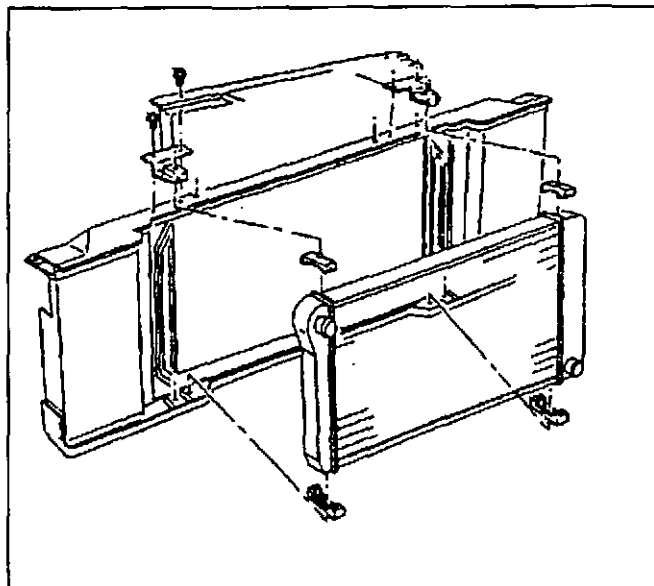
1. Remove the hood.
2. Disconnect the battery negative cable from the battery. Refer to *Battery Cable (0)* in engine electrical.
3. Remove the air cleaner duct and resonator from the throttle body.
4. Remove the ignition coil from the intake manifold. Refer to *Ignition Coil and ICM Replacement (7.4L)* in Engine Electrical.
5. Remove the electrical connector at the distributor. Refer to *Distributor Replacement (7.4L)* in Engine Electrical.
6. Remove the fuel supply lines from the fuel rail.

Refer to *Fuel Rail Assembly Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls.

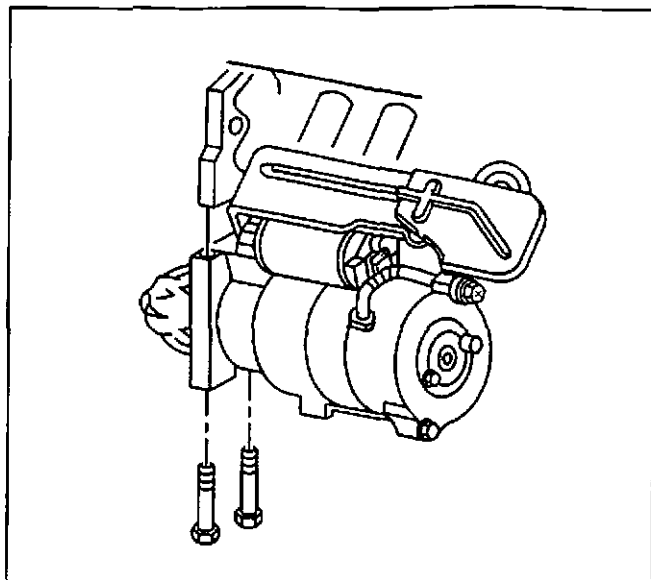
7. Drain the cooling system. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
8. Remove the air conditioning compressor from the engine block. Refer to *Compressor Replacement (7.4L)* in HVAC.
9. Remove the radiator from the vehicle. Refer to *Radiator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
10. Disconnect the electrical connectors on the throttle body. Refer to *Throttle Body Removal*.

Caution: *S10-10 - 352518 To help avoid potential personal injury or potential damage to the vehicle due to possible cable damage during service, replace the existing accelerator control cable with a NEW cable when removing or replacing the engine. Position the cruise control cable out of the way to ensure it is not damaged while removing or installing the engine. Do not bend the cruise control cable and cause a kink at the bend. Do not position the cruise control cable where the technician may lean or pry against the cable and cause damage to the cable.*

11. Remove the accelerator control cable from the throttle body. Refer to *Throttle Body Removal*.
12. Remove the cruise control cables from the throttle body if equipped. Refer to *Throttle Body Removal*.
13. Remove the vacuum lines from the engine.
14. Remove the electrical connector from the EGR valve. Refer to *EGR Valve Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls.
15. Remove the generator from the generator mounting bracket. Refer to *Generator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
16. Remove the engine electrical harness and tie out of the way.
17. Raise the vehicle and support with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
18. Remove the hoses from the power steering pump. Refer to *Power Steering Hoses Replacement* in Power Steering.
19. Remove the front propeller shaft if equipped. Refer to *Propeller Shaft Replacement (Front Axle- NP8)* or *Propeller Shaft Replacement (Front Axle- Exc NP8)* in Driveline and Axle.
20. Remove the ground wires from the engine block. Refer to *Ground Strap Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.

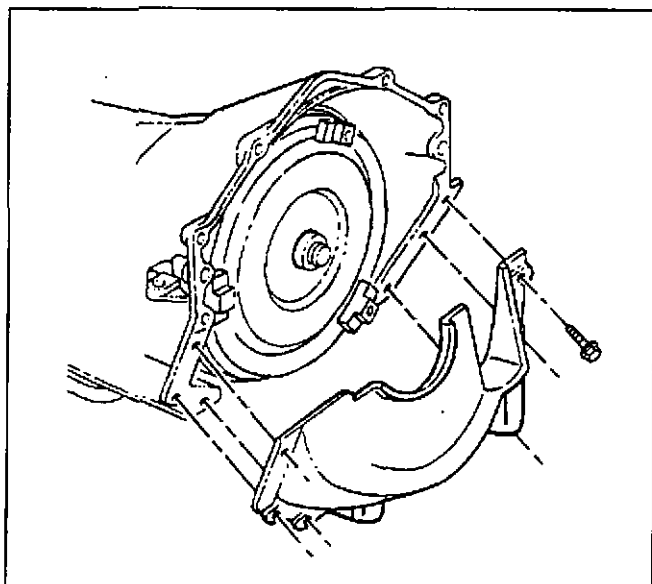


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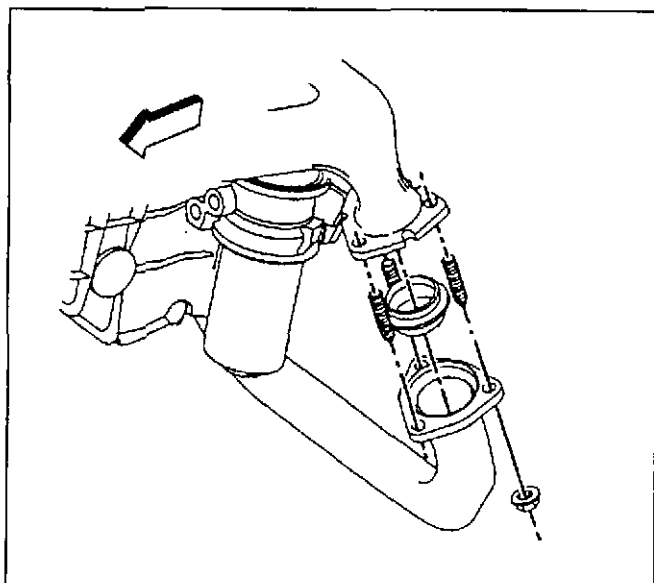
84599

21. Remove the starter motor from the engine block. Refer to *Starter Motor Replacement* (Gas, 7.4L) in Engine Electrical.



32688

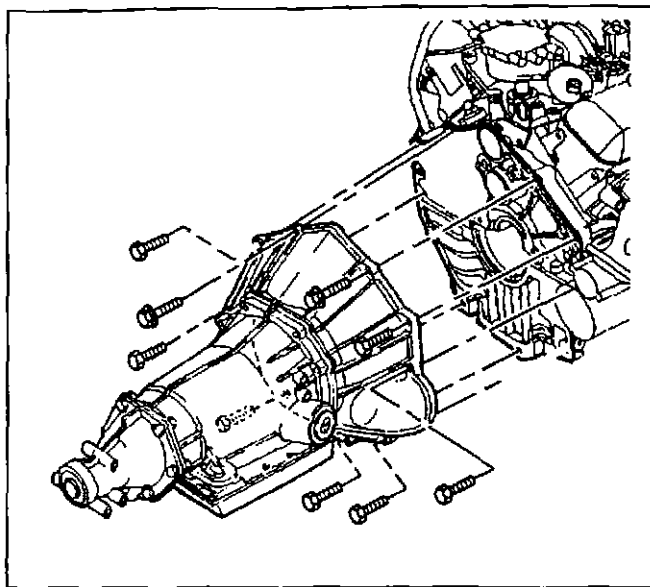
22. Remove the flywheel inspection cover from the transmission if equipped. Refer to *Transmission Replacement* or *Transmission Replacement* in Transmission/Transaxle.
23. Remove the bolts from the torque converter to the flywheel if equipped. Refer to *Transmission Replacement* or *Transmission Replacement* in Transmission/Transaxle.



78428

24. Remove the exhaust pipes from the exhaust manifolds.
- For vehicles under 8600 lb GVWR, refer to *Catalytic Converter Replacement* (Gas, below 8600 lb (GVWR)) in Engine Controls.
 - For vehicles over 8600 lb GVWR, refer to *Catalytic Converter Replacement* (Gas, 8600 lb and above (GVWR)) in Engine Controls.

25. Remove the bolts from the transmission to the engine block.
 - For the automatic transmission. Refer to *Transmission Replacement* in *Transmission/Transaxle*.
 - For the manual transmission Refer to *Transmission Replacement* in *Transmission/Transaxle*.
26. Remove the engine auxiliary oil cooler lines from the engine block. Refer to *Oil Cooler Line Replacement*.
27. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.
28. Support the transmission with a suitable jack.



29. Attach J 36857 to the rear of the right cylinder head.

Notice: Refer to *Damage May Result From The Use Of An Improper Bolt When...* in Cautions and Notices.

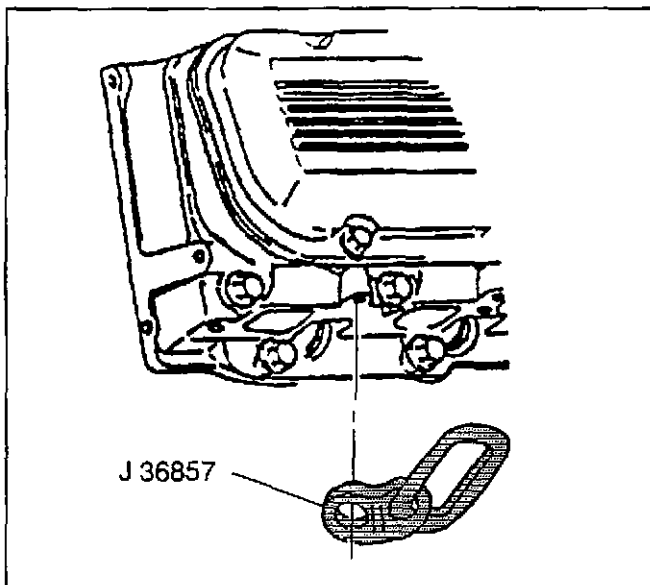
Notice: Refer to *Fastener Notice* in Cautions and Notices.

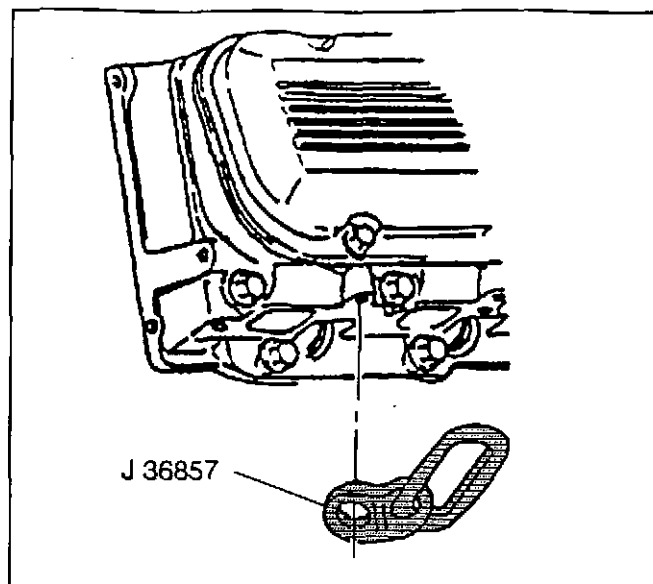
Install the attaching bolt and washer. Use GM P/N 9428217 with GM P/N 15650963.

Tighten

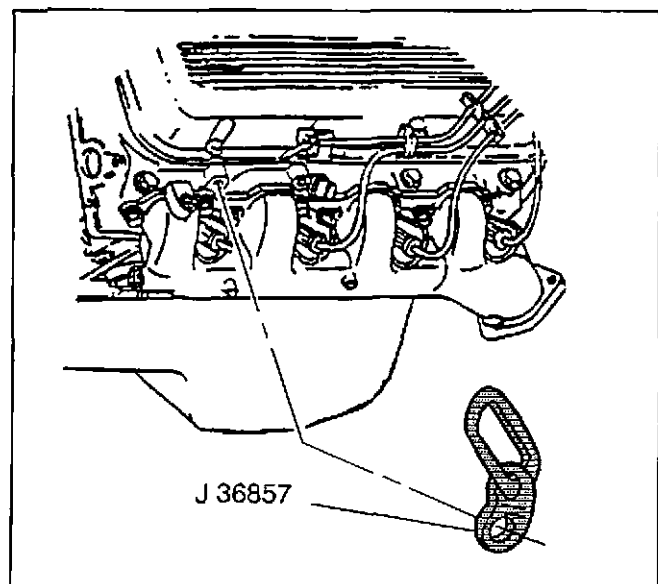
Tighten the lift bracket bolts to 40 N·m (30 lb ft).

30. Remove the front engine mount through bolts.
31. Remove the engine with a suitable lifting device.
32. Remove the generator mounting bracket from the engine block. Refer to *Accessory Brackets Replacement (Generator)*.
33. Remove the air conditioning compressor/power steering mounting bracket from the cylinder head. Refer to *Accessory Brackets Replacement (AC)*.
34. Remove the lift brackets from the cylinder head.





66457



66458

Installation Procedure

Notice: Refer to *Damage May Result From The Use Of An Improper Bolt When...* in Cautions and Notices.

1. Attach J 36857 to the rear of the right cylinder head.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

Install the attaching bolt and washer. Use GM P/N 9428217 with GM P/N 15650963.

Tighten

Tighten the lift bracket bolts to 40 N·m (30 lb ft).

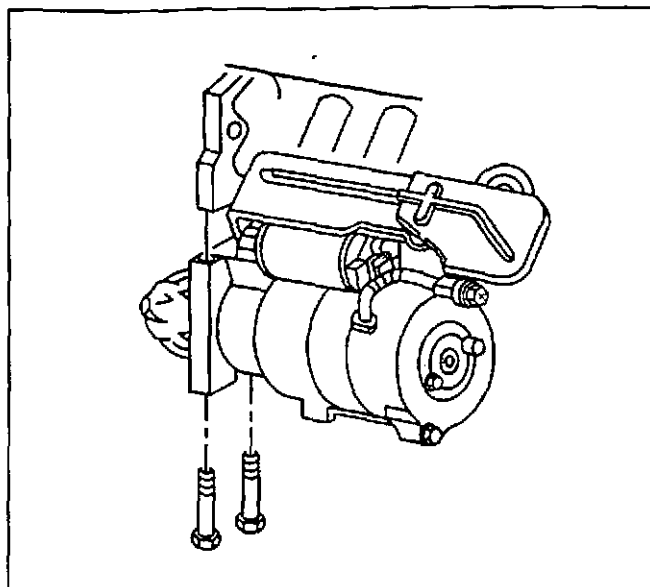
2. Attach J 36857 to the left front cylinder head. Install the attaching bolt and washer. Use GM P/N 9428217 with GM P/N 15650963.

Tighten

Tighten the lift bracket bolts to 40 N·m (30 lb ft).

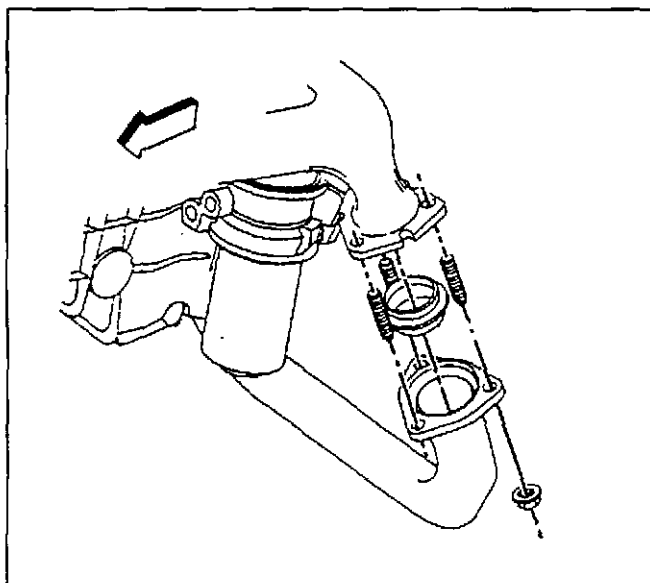
3. Install the engine into the vehicle.
4. Install the engine mounting through bolts.
5. Remove the engine lift hooks from the cylinder head.
6. Install the air compressor/power steering mounting bracket to the engine block. Refer to *Accessory Brackets Replacement (AC)*.
7. Install the generator mounting bracket. Refer to *Accessory Brackets Replacement (Generator)* in Engine Electrical.
8. Raise the vehicle and support with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
9. Install the bolts from the transmission to the engine block.
 - For the automatic transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.
 - For the manual transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.
10. Install the ground straps to the engine block. Refer to *Ground Strap Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
11. Install the hoses to the power steering pump. Refer to *Power Steering Hoses Replacement* in Power Steering.
12. Install the torque converter bolts. Refer to *Transmission Replacement* in Transmission/Transaxle.
13. Install the converter pan cover to the transmission. Refer to *Transmission Replacement* in Transmission/Transaxle.

14. Install the starter to the engine block. Refer to *Starter Motor Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Electrical.
15. Install the oil cooler lines to the engine block if equipped. Refer to *Engine Oil Cooler Line Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.



84599

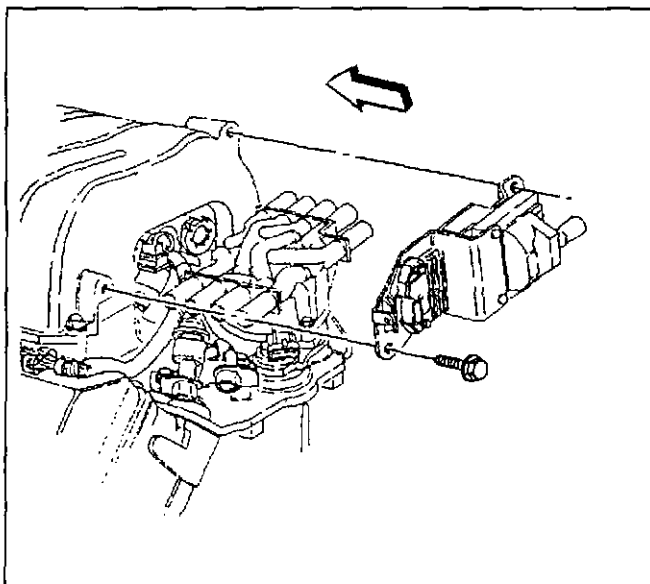
16. Install the exhaust pipes to the exhaust manifold.
 - For vehicles under 8600 lb GVWR, refer to *Catalytic Converter Replacement (Gas, below 8600 lb (GVWR))*
 - For vehicles over 8600 lb GVWR, refer to *Catalytic Converter Replacement (Gas, 8600 lb and above (GVWR))*.
17. Install the front propeller shaft (4WD). Refer to *Propeller Shaft Replacement (Front Axle- NP8)* or *Propeller Shaft Replacement (Front Axle- Exc NP8)* in Driveline and Axle.
18. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.
19. Install the fuel lines to the fuel rail. Refer to *Fuel Rail Assembly Replacement (ERROR - NOT IN CURRENT PSD)*.



78428

20. Install the ignition coil to the upper intake manifold. Refer to *Ignition Coil and ICM Replacement (7.4L)* in Engine Electrical.
21. Install the electrical connector to the distributor. Refer to *Distributor Replacement (7.4L)* in Engine Electrical.
22. Install the electrical connector to the EGR valve. Refer to *EGR Valve Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Controls.
23. Install the electrical connectors to the throttle body. Refer to *Throttle Body Installation*.

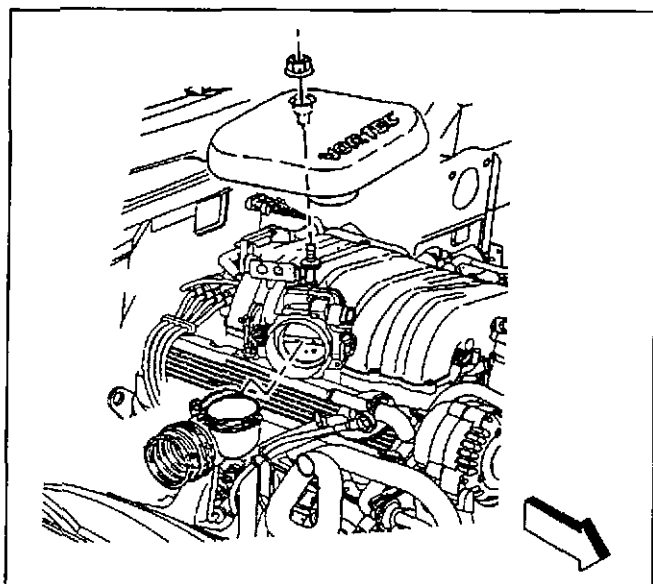
Caution: SIO-ID - 352518 To help avoid potential personal injury or potential damage to the vehicle due to possible cable damage during service, replace the existing accelerator control cable with a NEW cable when removing or replacing the engine. Position the cruise control cable-out of the way to ensure it is not damaged while removing or



68506

installing the engine. Do not bend the cruise control cable and cause a kink at the bend. Do not position the cruise control cable where the technician may lean or pry against the cable and cause damage to the cable.

24. Install the NEW accelerator control cable to the Throttle Body. Refer to *Throttle Body Installation*.
25. Install the vacuum lines to the engine.
26. Install the generator to the generator mounting bracket. Refer to *Accessory Brackets Replacement (Generator)* in Engine Electrical.
27. Install the air conditioning compressor to the air conditioning/power steering mounting bracket. Refer to *Accessory Brackets Replacement (AC)* in HVAC.
28. Install the engine electrical wiring harness to the engine.
29. Install the radiator to the vehicle. Refer to *Radiator Replacement (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
30. Install the Air Cleaner Duct and Resonator to the throttle body.
31. Fill the radiator with coolant. Refer to *Draining and Filling Cooling System (ERROR - NOT IN CURRENT PSD)* in Engine Cooling.
32. Recharge the air conditioning system. Refer to *Compressor Replacement (Diesel)* in HVAC.
33. Connect the battery negative cable to the battery. Refer to *Battery Cable (0)* in Engine Electrical.
34. Install the hood.



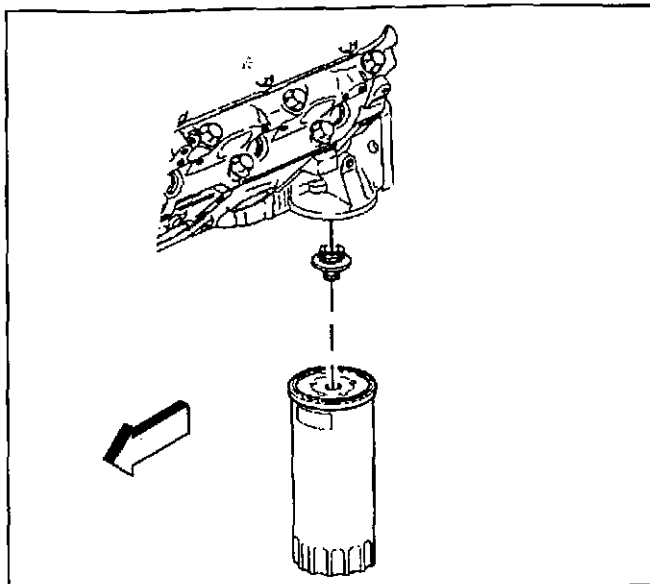
175670

SIE-ID - 334022

Engine Oil and Oil Filter Replacement

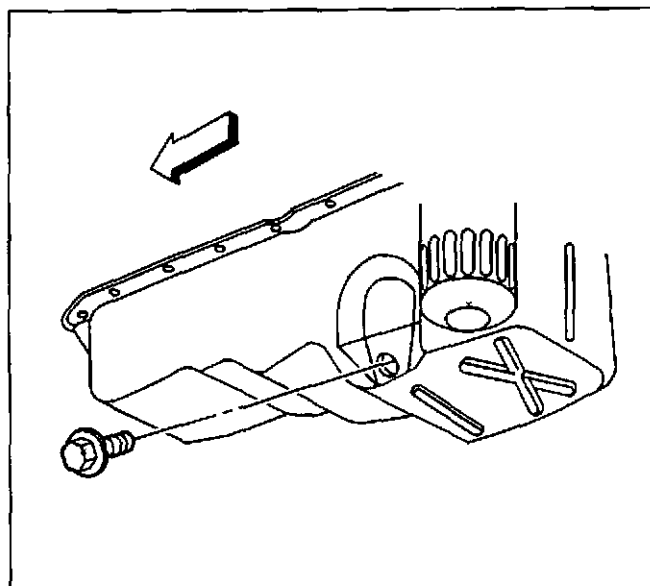
Removal Procedure

1. Raise the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
2. Remove the oil filter from the engine block.



181988

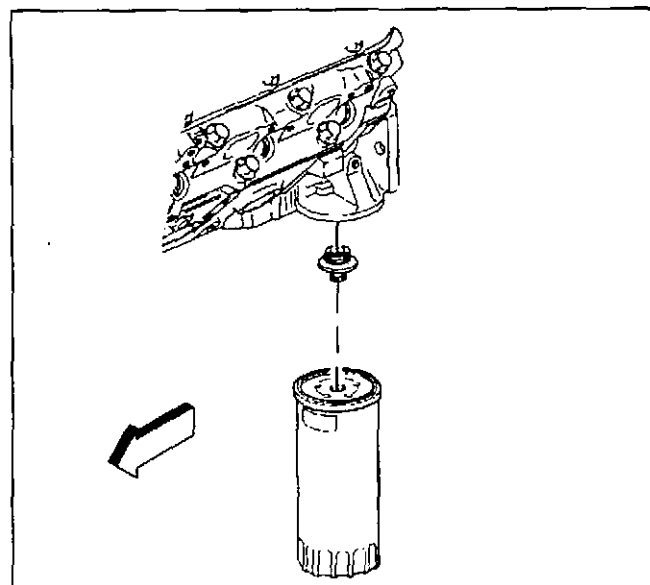
3. Remove the oil pan drain plug and drain the engine oil.



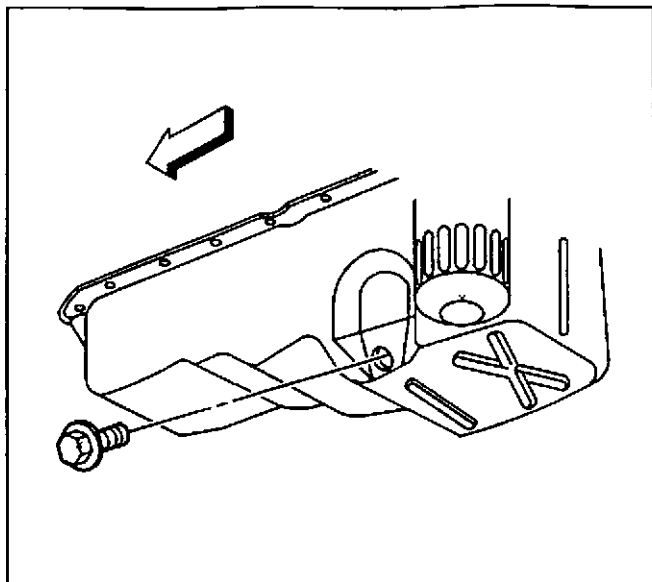
182850

Installation Procedure

1. Install the oil filter to the engine block.

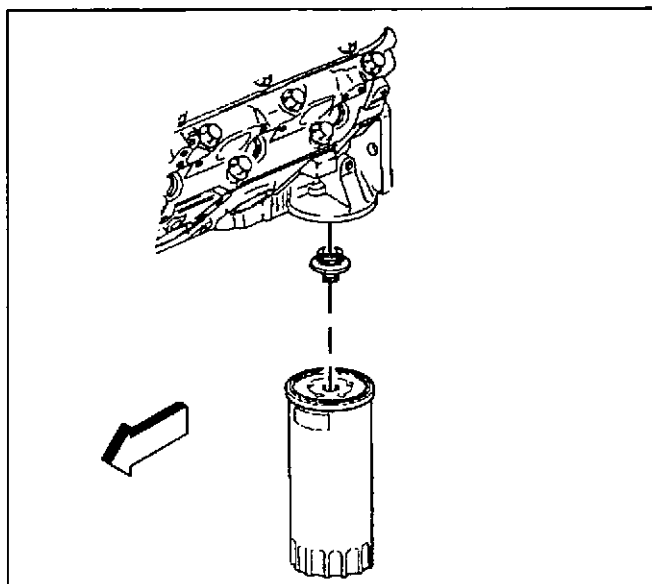


181988



182850

2. Install the drain plug to the oil pan.
3. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle* in general information.
4. Fill the crankcase with oil. Refer to *Maintenance and Lubrication in General Information*.



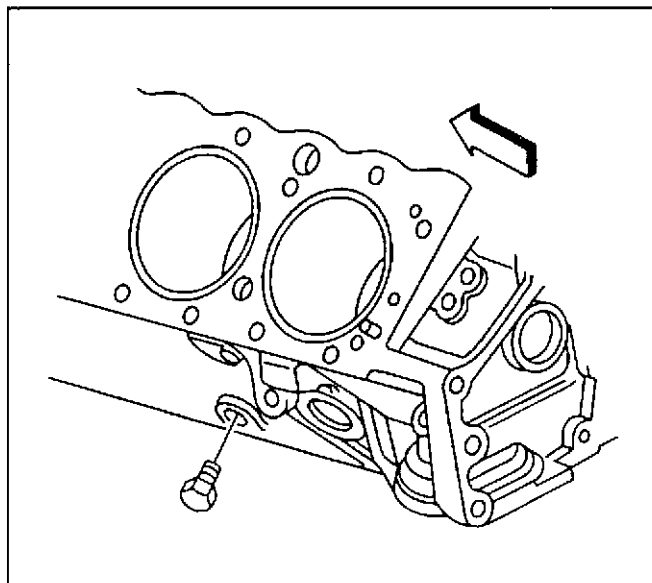
181988

SIE-ID = 197962

Draining Fluids and Oil Filter Removal

SIO-ID = 197937

1. Remove the oil pan drain plug.
2. Drain the engine oil.
3. Remove the oil filter.



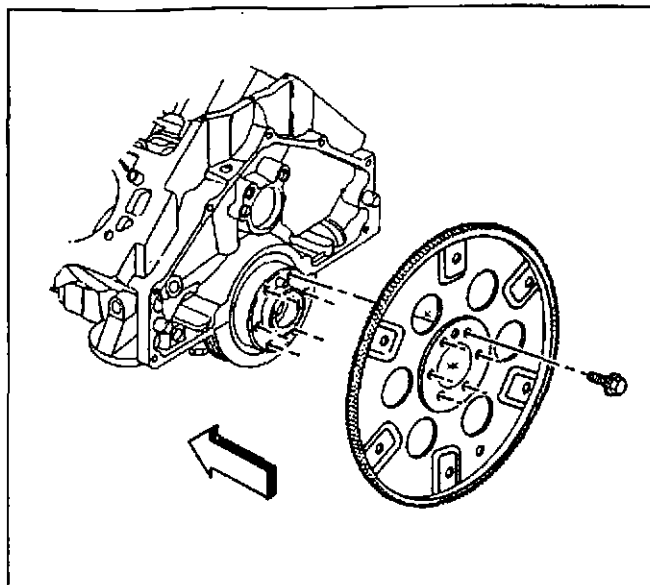
69033

4. Remove the coolant drain hole plugs.
5. Drain the coolant.

SIE-ID - 363421

Engine Flywheel Removal (MT1 Automatic Transmission)

1. Remove the engine flywheel bolts.
2. Remove the engine flywheel.

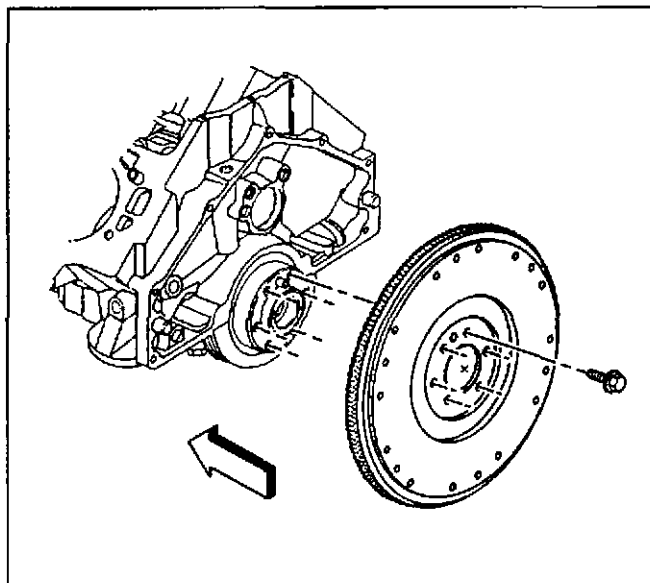


363414

SIE-ID - 363426

Engine Flywheel Removal (MW3 Manual Transmission)

1. Remove the engine flywheel bolts.
2. Remove the engine flywheel.



363409

SIE-ID - 378499

Clutch Pilot Bearing Removal

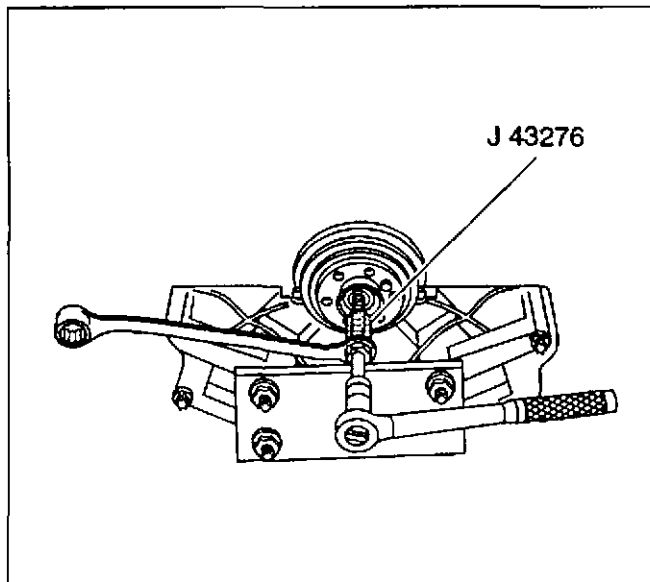
Tools Required

J 43276 Clutch Pilot Bearing Remover

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

Notice: SIO-ID - 352829 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 Clutch Pilot Bearing Remover tool body to rotate. Failing to do so will cause damage to the J 43276-1 Clutch Pilot Bearing Remover tool body.

1. Remove the clutch pilot bearing using the J 43276 .
 - 1.1. Install the J 43276-1 tool body into the clutch pilot bearing.
 - 1.2. Using a wrench secure the J 43276-1 tool body.



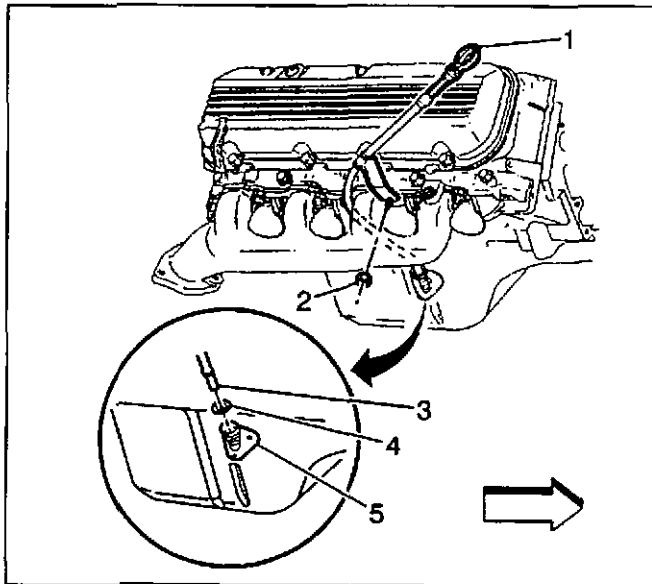
373133

- 1.3. Insert the J 43276-2 forcing screw into the J 43276-1 tool body.
- 1.4. Rotate the J 43276-2 forcing screw clockwise into the J 43276-1 tool body until the clutch pilot bearing is completely removed from the crankshaft.
- 1.5. Rotate the J 43276-2 forcing screw counterclockwise to remove the J 43276-2 forcing screw from the J 43276-1 tool body.
- 1.6. Remove the J 43276-1 tool body from the clutch pilot bearing.
2. Discard the clutch pilot bearing.

SIE-ID - 196174

Oil Level Indicator and Tube Removal

1. Remove the oil level indicator (1) from the oil level indicator tube (3).
2. Remove the oil level indicator tube bracket nut (2) from the right exhaust manifold stud.
3. Remove the oil level indicator tube (3) from the oil pan (5).
4. Remove the oil level indicator O-ring seal (4) (if required).

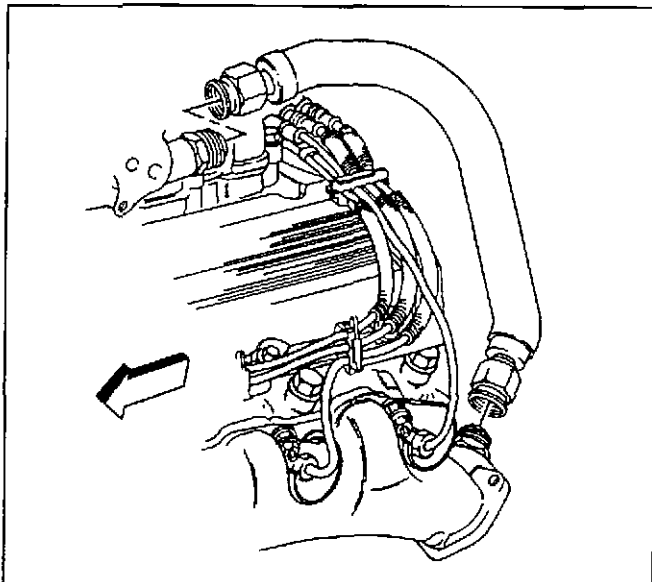


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SIE-ID - 364040

Exhaust Manifold Removal (Left)

1. Remove the exhaust gas recirculation (EGR) valve inlet pipe from the intake manifold.
2. Remove the EGR valve inlet pipe from the left exhaust manifold.

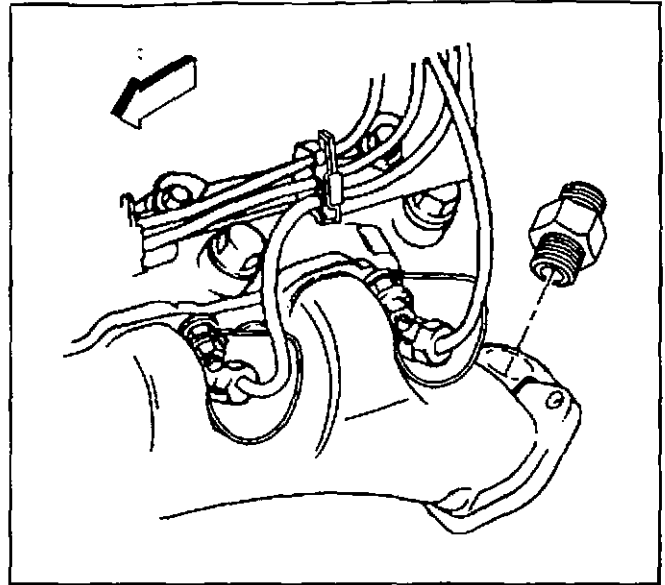


173284

3. Remove the exhaust manifold adapter, if required.

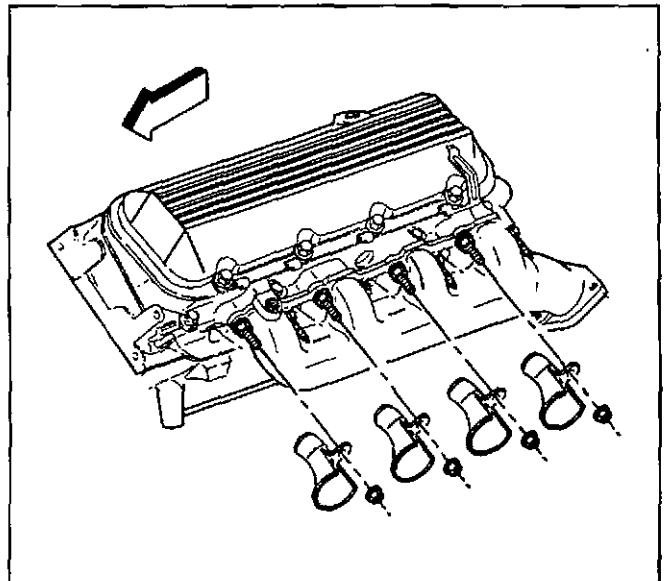
Important: Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

4. Remove the spark plug wire boots from spark plugs.



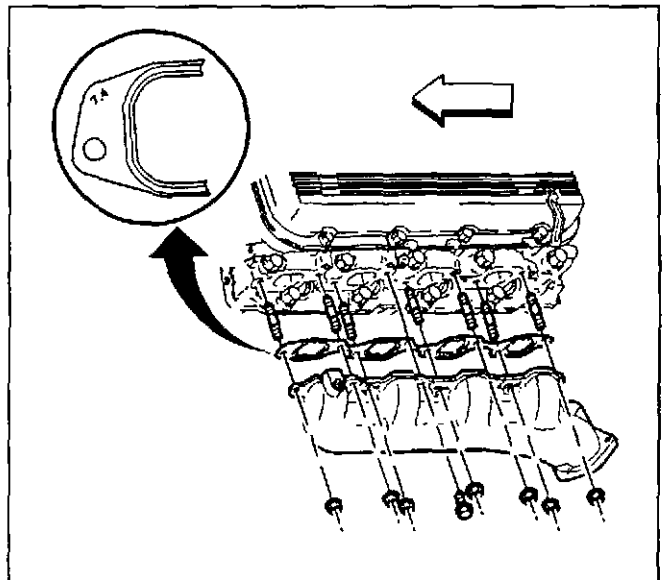
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5. Remove the spark plug heat shield nuts.
6. Remove the spark plug heat shields.



354056

7. Remove the exhaust manifold nuts and center bolt.
8. Remove the exhaust manifold.
9. Remove the exhaust manifold gasket. Discard the exhaust manifold gasket.
10. Remove the exhaust manifold studs, if required.

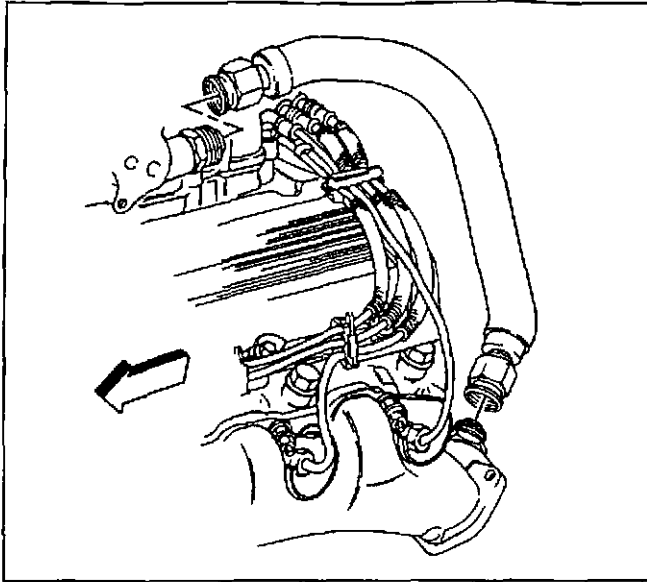


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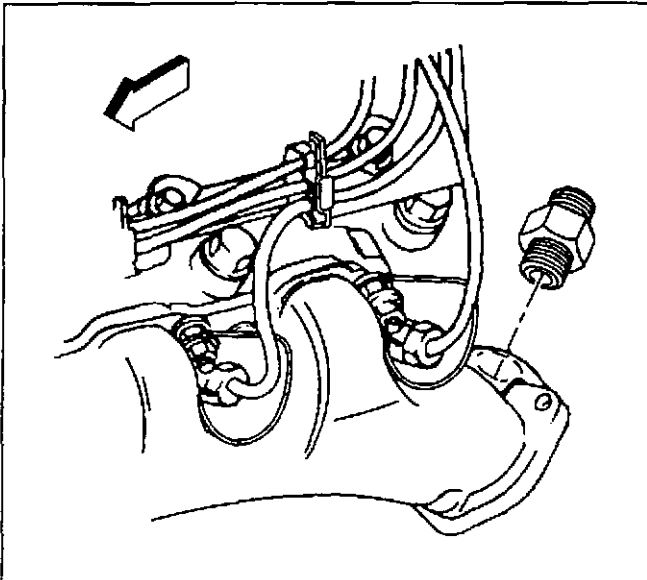
SIE-ID - 204023

Exhaust Manifold Removal (Left with RPO K19)

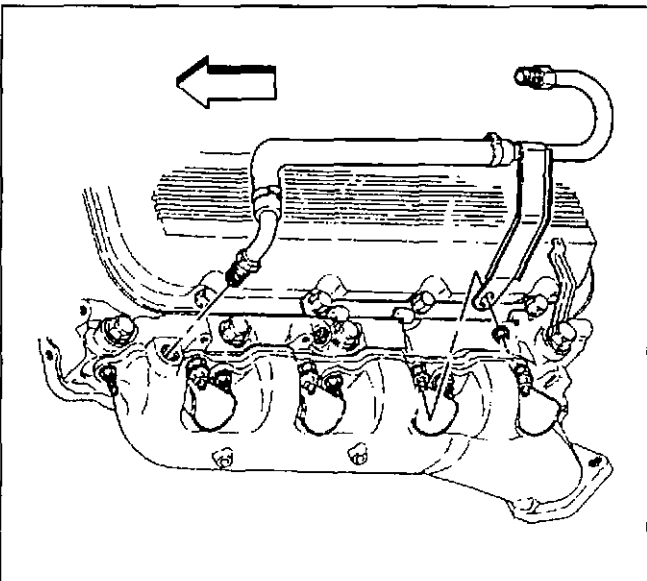
1. Remove the exhaust gas recirculation (EGR) valve inlet pipe from the intake manifold.
2. Remove the EGR valve inlet pipe from the left exhaust manifold.



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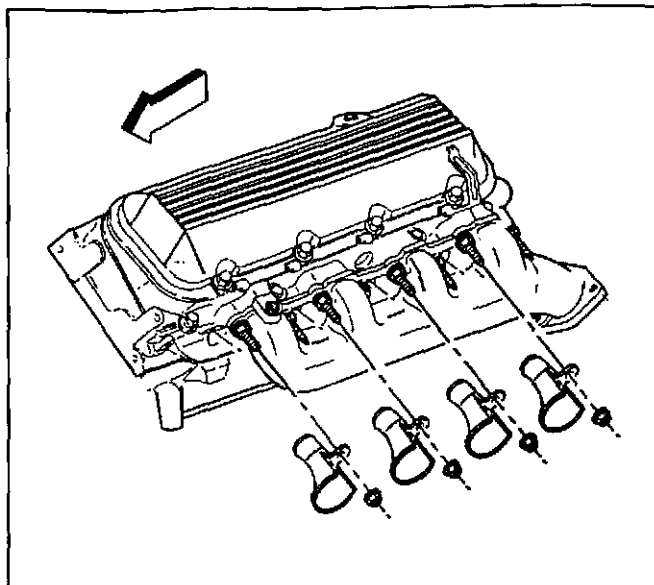
3. Remove the exhaust adapter, if required.

4. Remove the AIR tube assembly pipe fitting from the exhaust manifold, if required.
5. Remove the AIR tube assembly pipe bracket nut from the exhaust manifold stud.

Important: Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

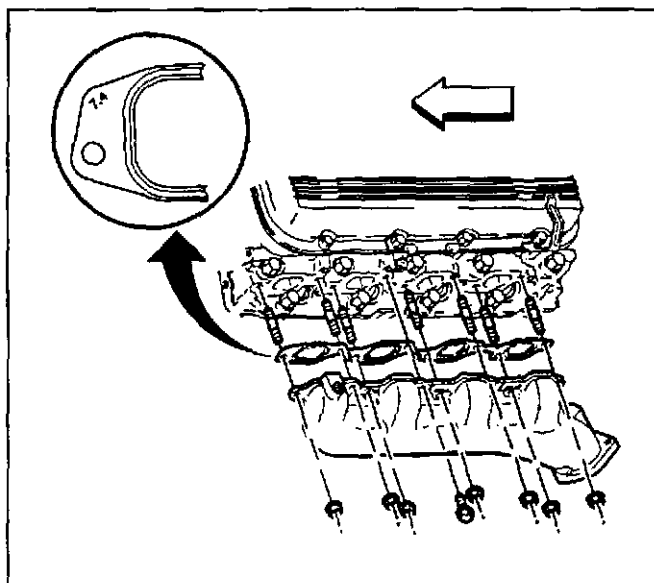
6. Remove the spark plug wire boots from spark plugs.

7. Remove the spark plug heat shield nuts.
8. Remove the spark plug heat shields.



354056

9. Remove the exhaust manifold nuts and center bolt.
10. Remove the exhaust manifold.
11. Remove the exhaust manifold gasket. Discard the exhaust manifold gasket.
12. Remove the exhaust manifold studs, if required.



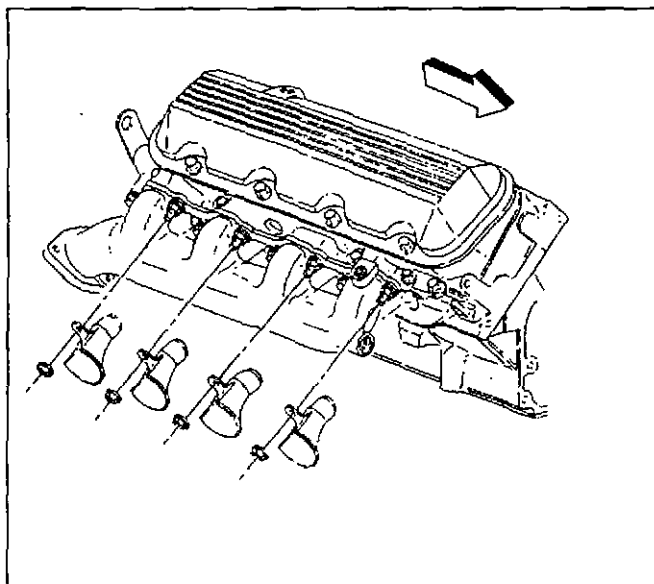
180882

SIE-ID - 364043

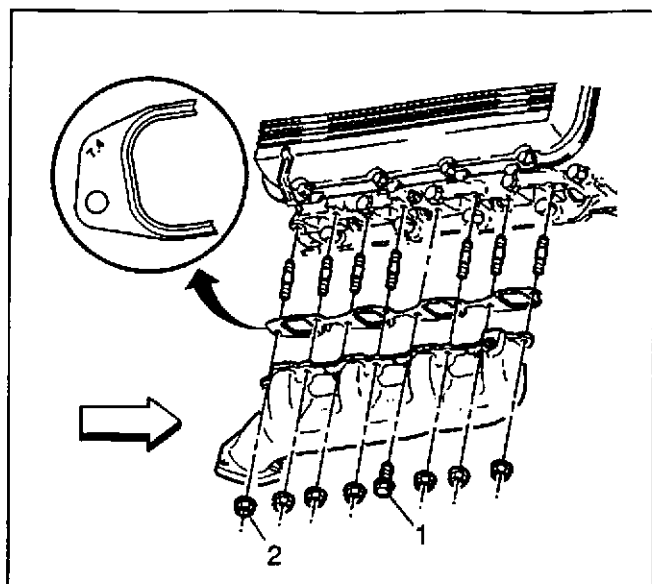
Exhaust Manifold Removal (Right)

Notice: SIO-ID - 2878 Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

1. Remove the spark plug wire boots from the spark plugs
2. Remove the spark plug heat shields nuts.
3. Remove the spark plug heat shields.

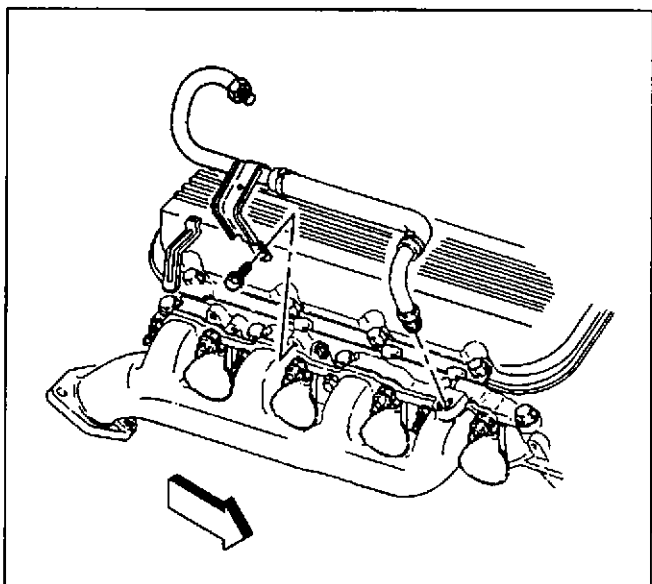


65852



180881

4. Remove the exhaust manifold nuts and center bolt.
5. Remove the exhaust manifold.
6. Remove the exhaust manifold gasket. Discard the exhaust manifold gasket.
7. Remove the exhaust manifold studs, if required.



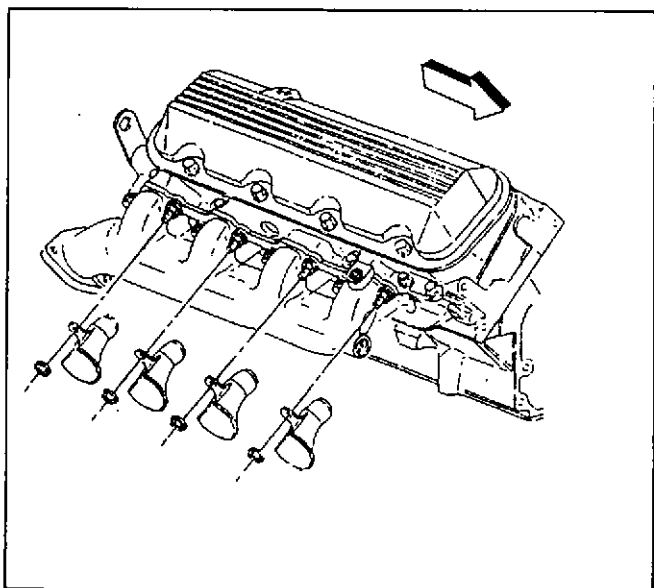
354054

SIE-ID - 192874

Exhaust Manifold Removal (Right with RPO K19)

Notice: SIO-ID - 2878 Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

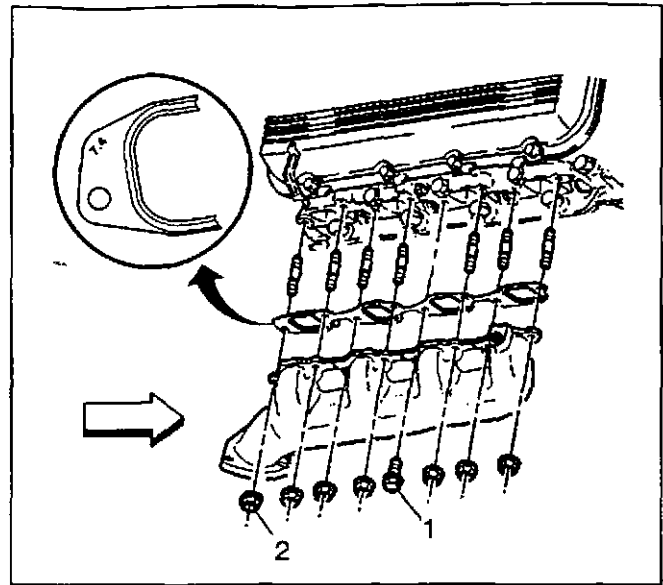
1. Remove the spark plug wire boots from the spark plugs
2. Remove the AIR tube assembly pipe fitting from the exhaust manifold, if required.
3. Remove the AIR tube assembly pipe bracket bolt from the cylinder head.



65852

4. Remove the spark plug heat shields nuts.
5. Remove the spark plug heat shields.

6. Remove the exhaust manifold nuts and center bolt.
7. Remove the exhaust manifold.
8. Remove the exhaust manifold gasket. Discard the exhaust manifold gasket.
9. Remove the exhaust manifold studs, if required.

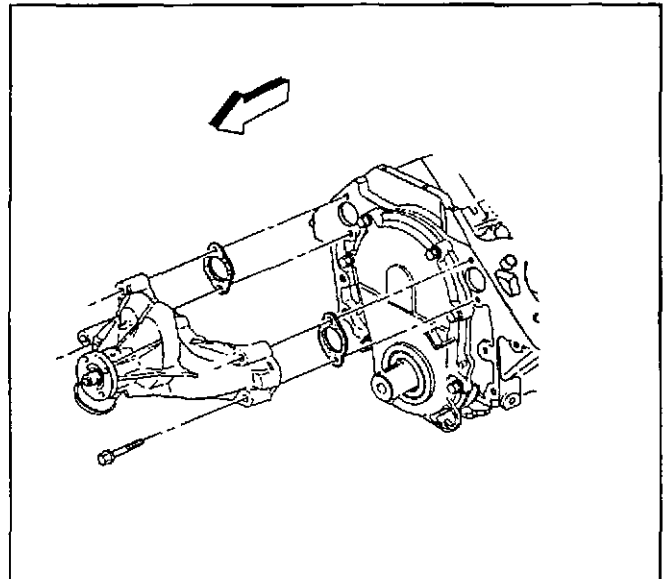


180881

SIE-ID = 66377

Water Pump Removal

1. Loosen the water pump bypass hose clamps.
2. Remove the water pump bolts.
3. Remove the water pump.
4. Remove the water pump gaskets.
5. Remove the water pump bypass hose and clamps.



66263

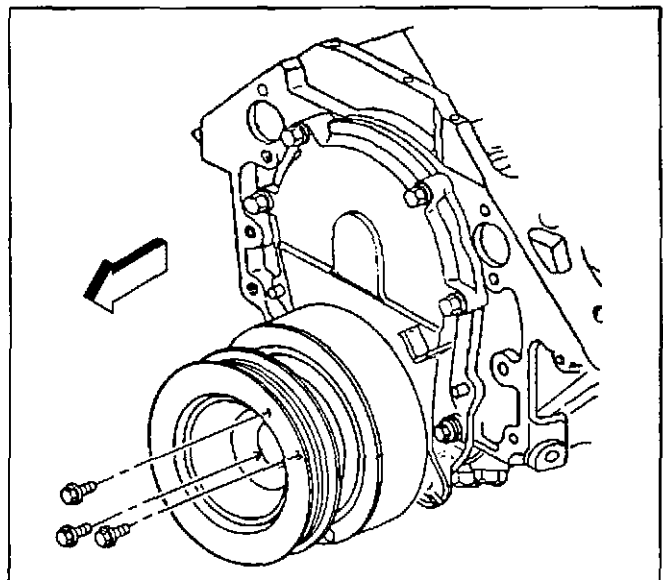
SIE-ID = 311315

Crankshaft Balancer Removal

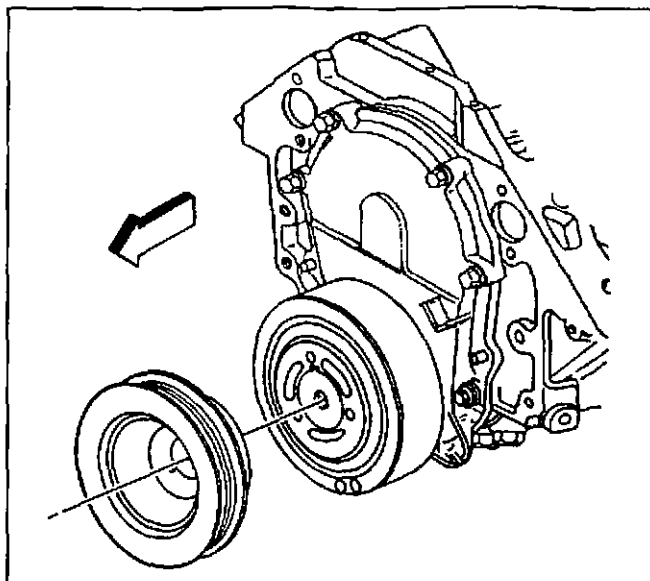
Tools Required

J 23523-F Crankshaft Balancer Remover and Installer

1. Remove the crankshaft pulley bolts.

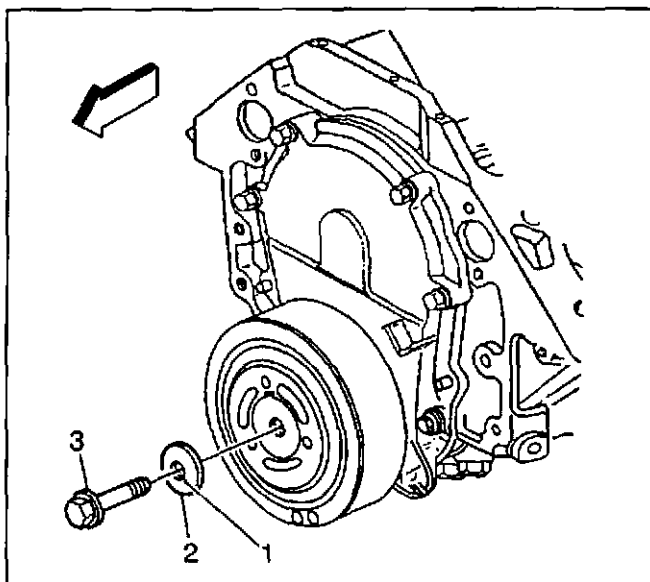


354014



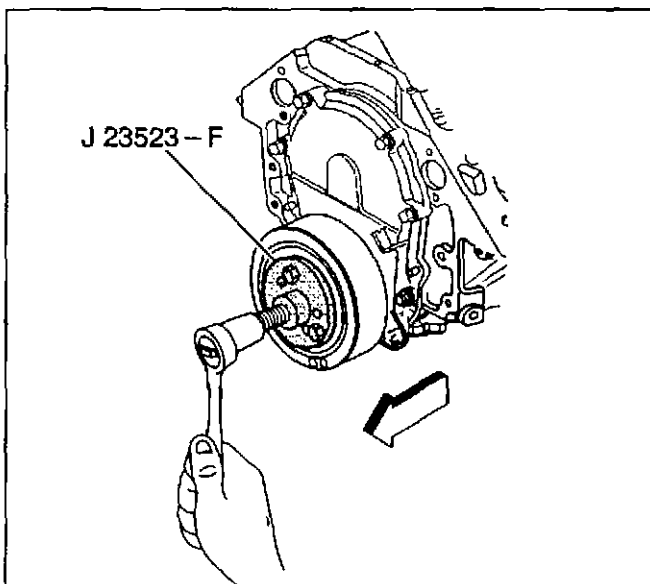
354015

2. Remove the crankshaft pulley.



354016

3. Remove the crankshaft balancer bolt and washer.



354023

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Use the *J 23523-F* in order to remove the crankshaft balancer.

4.1. Install the *J 23523-F* plate and bolts.

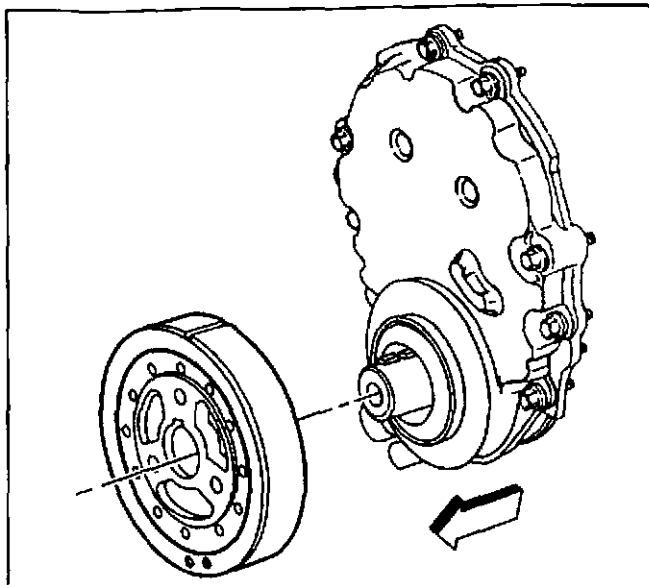
Tighten

Tighten the *J 23523-F* bolts to 25 N.m (18 lb ft).

4.2. Install the *J 23523-F* forcing screw.

4.3. Rotate the *J 23523-F* forcing screw clockwise in order to remove the crankshaft balancer.

5. Remove the crankshaft balancer.
6. Remove the *J 23523-F* from the crankshaft balancer.

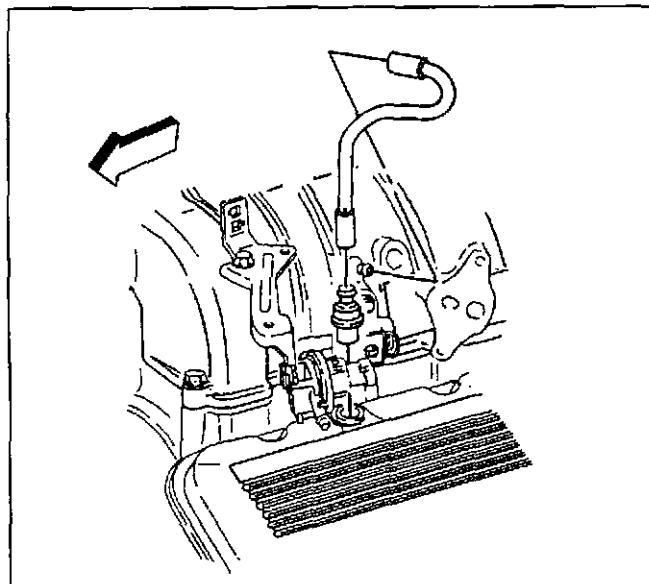


182832

SIE-ID = 204204

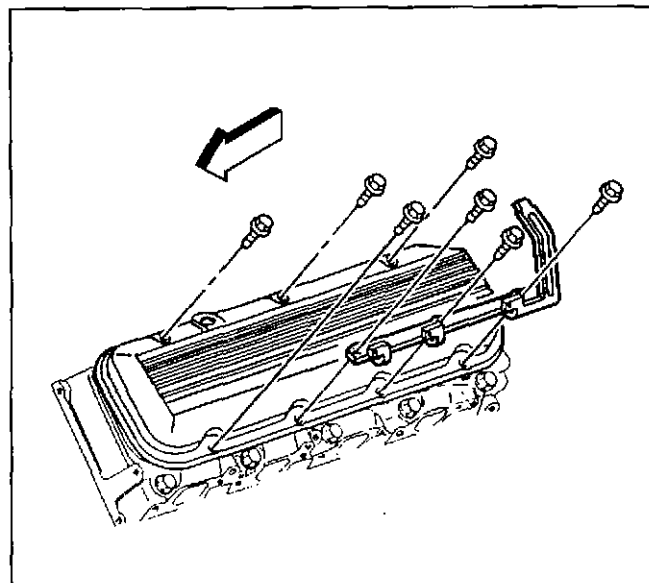
Valve Rocker Arm Cover Removal (Left)

1. Remove the Positive Crankcase Ventilation Valve (PCV) and crankcase ventilation tube.

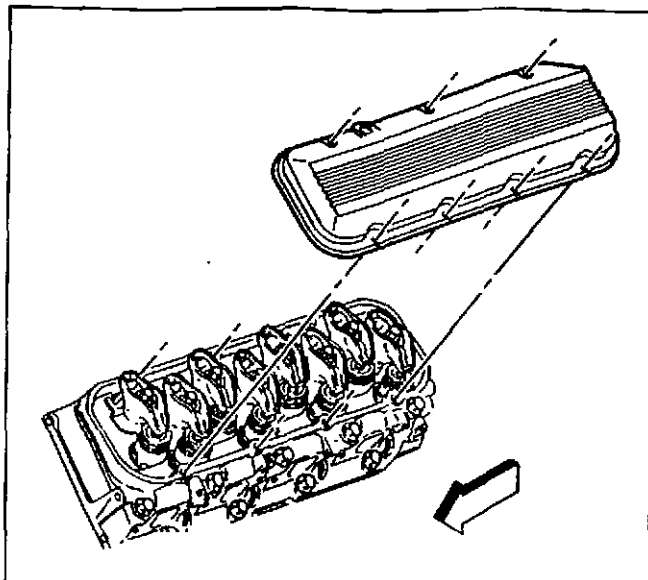


173187

2. Remove the valve rocker arm cover bolts.
3. Remove the spark plug wiring harness bracket(s).



354009



354006

4. Remove the valve rocker arm cover.

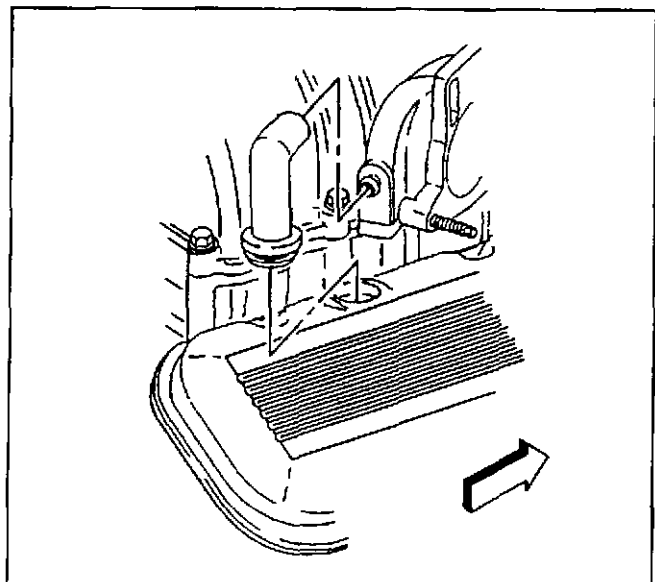
Important: The valve rocker arm cover gasket may be reused if not removed from valve rocker arm cover.

5. Remove the valve rocker arm cover gasket if it is cut or damaged.

S/E-ID = 204206

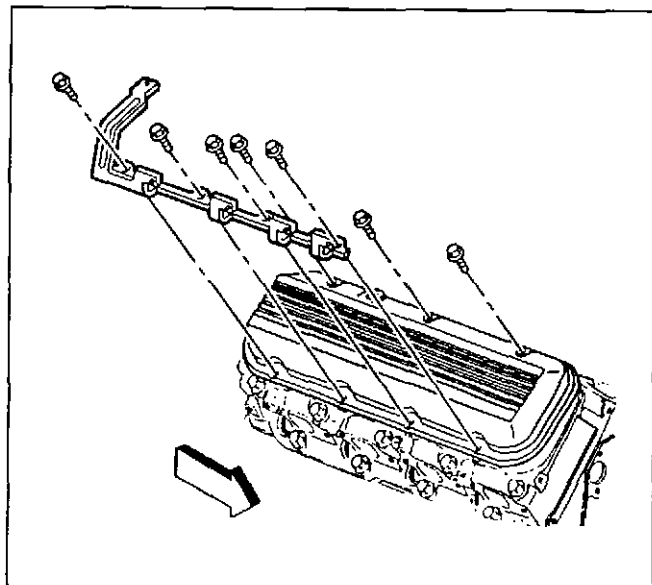
Valve Rocker Arm Cover Removal (Right)

1. Remove the crankcase ventilation tube.



173189

2. Remove the valve rocker arm cover bolts.
3. Remove the spark plug wiring harness bracket(s).

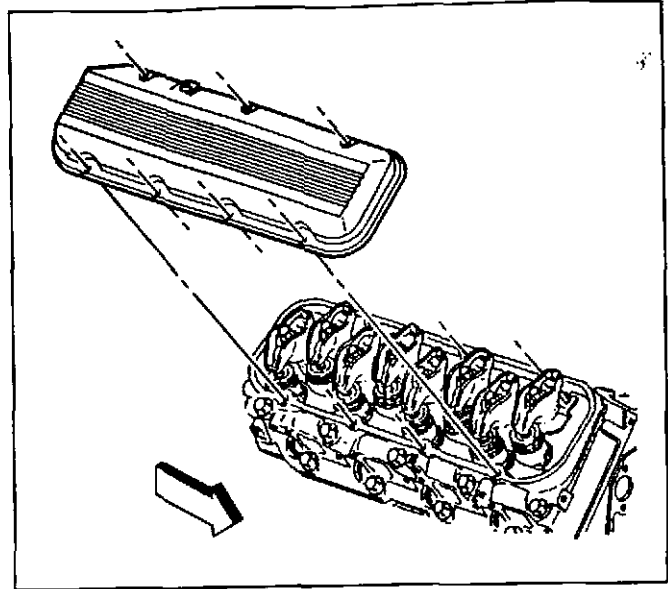


354012

4. Remove the valve rocker arm cover.

Important: The valve rocker arm cover gasket may be reused if not removed from valve rocker arm cover.

5. Remove the valve rocker arm cover gasket if it is cut or damaged.



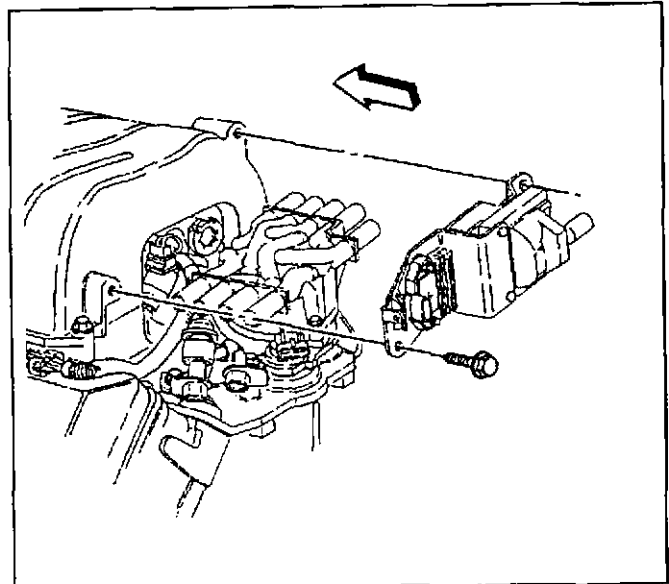
354010

S/E-ID = 192958

Distributor Removal

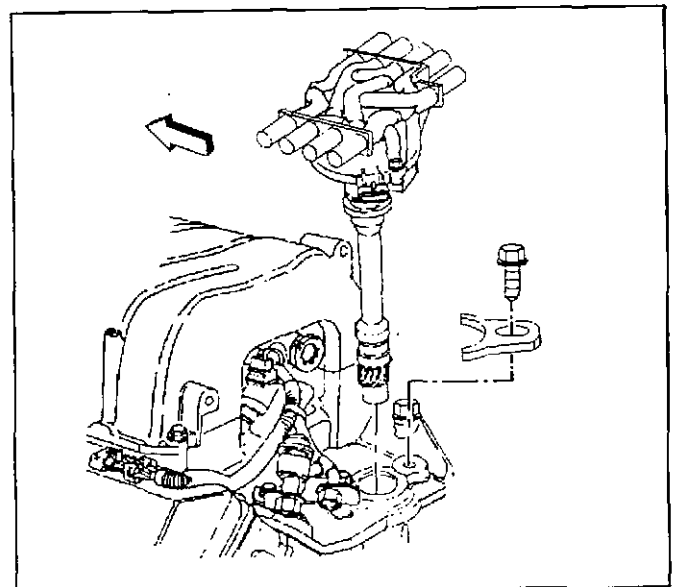
S/O-ID = 192952

1. Remove the spark plug wire clips from the spark plug wire brackets.
2. Remove the ignition coil wire from the ignition coil.
3. Remove the ignition coil bracket bolt and stud from the upper intake manifold.
4. Remove the ignition coil from the upper intake manifold.



68506

5. Remove the distributor hold down clamp bolt from the lower intake manifold.
6. Remove the distributor.

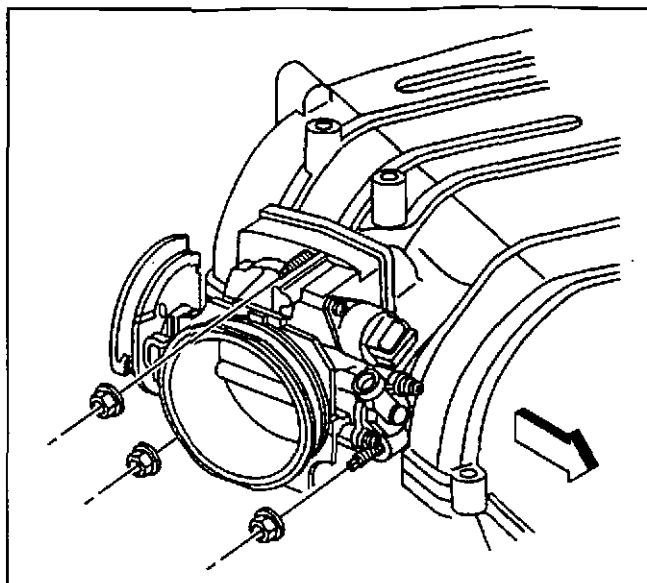


68504

SIE-ID - 195166

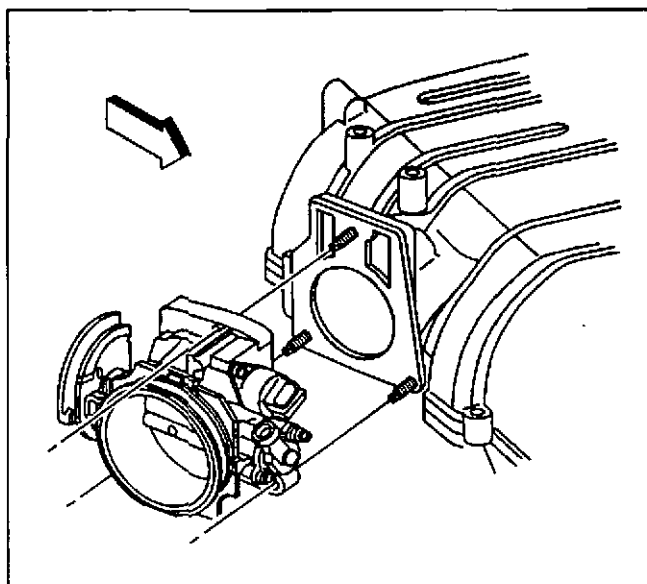
Throttle Body Removal

1. Remove the throttle body nuts.



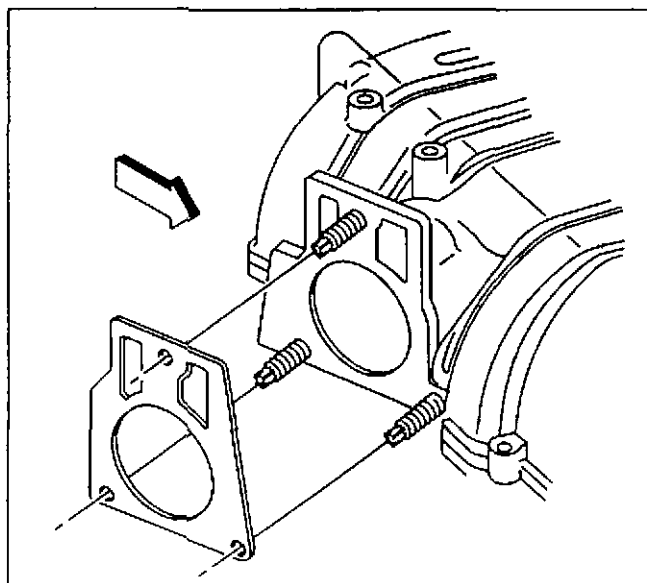
18299

2. Remove the throttle body.



18302

3. Remove the throttle body gasket.
4. Remove the throttle body studs, if required.



18303

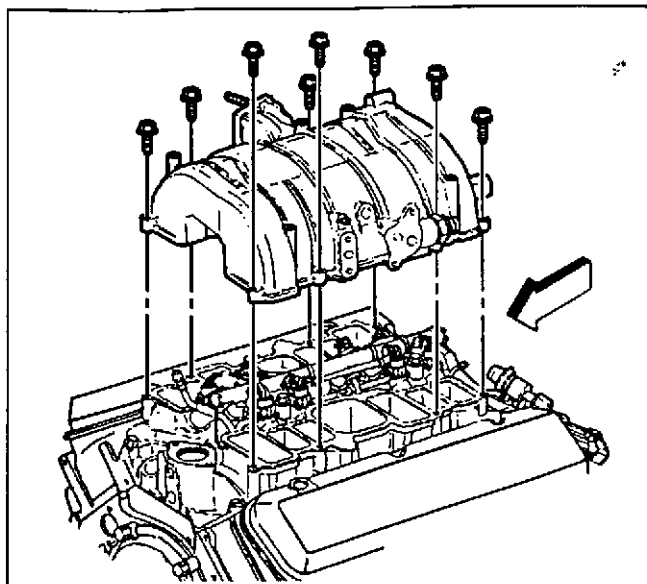
SIE-ID - 195230

Intake Manifold Removal

1. Remove the upper intake manifold bolts.

Important: Do not attempt to loosen the manifold by prying under the gasket surface with any tool.

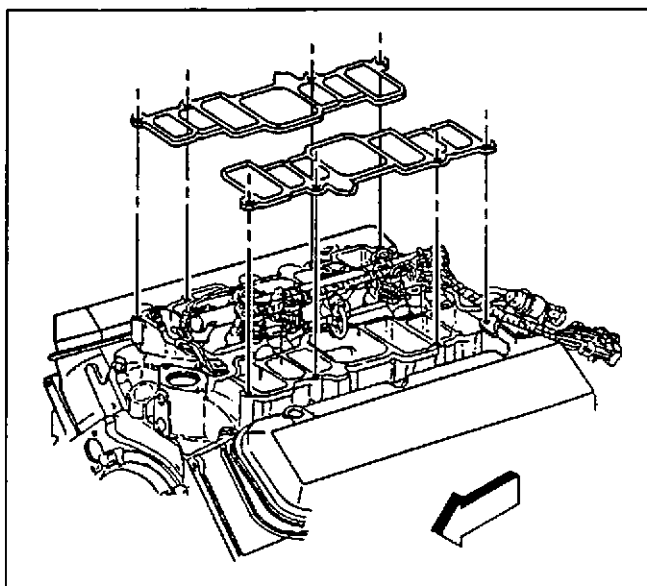
2. Remove the upper intake manifold.



351769

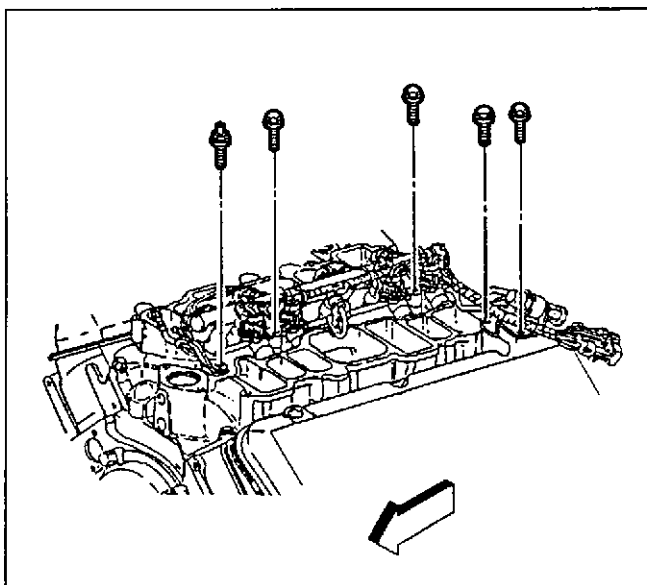
Important: The upper intake manifold gaskets are not reusable.

3. Remove and discard the upper intake manifold gaskets.

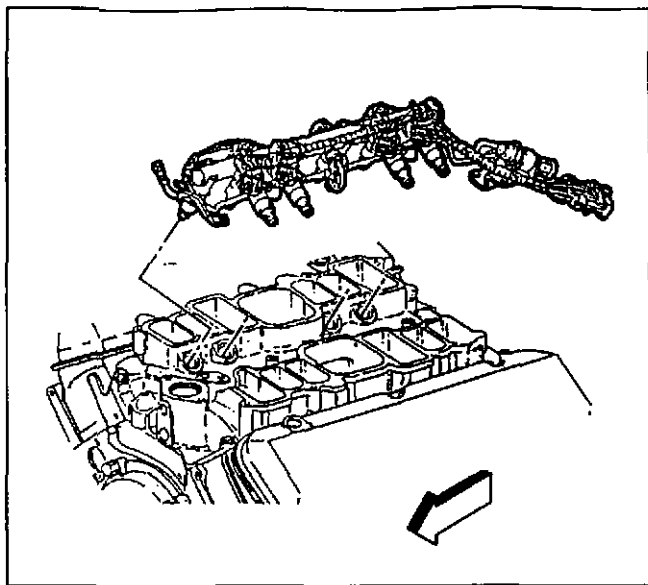


351764

4. Remove the fuel rail bolts.



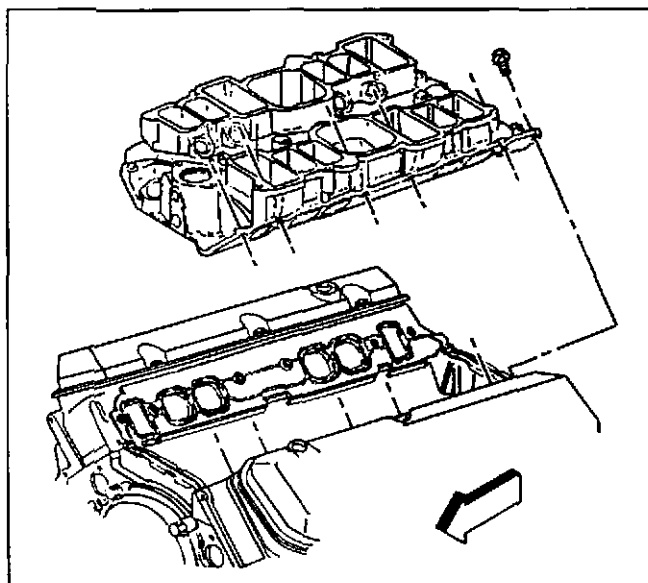
276370



276369

5. Remove the fuel rail assembly.

Lift evenly on both sides of the assembly until all the injectors have left their bores.



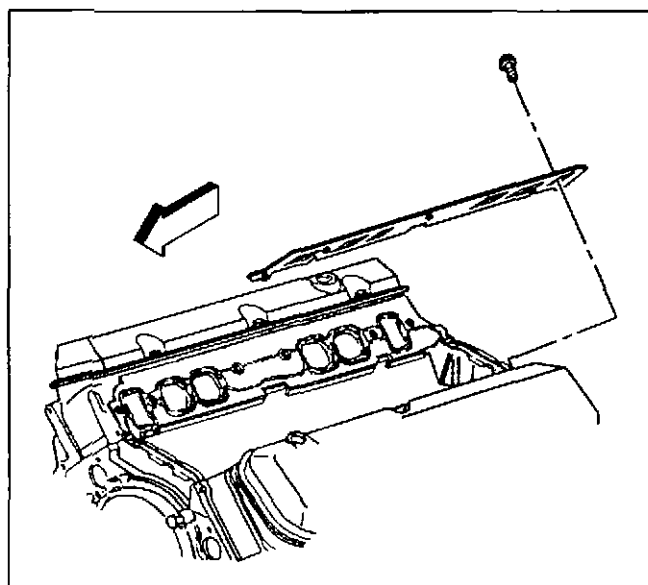
351763

6. Remove the lower intake manifold bolts.

Important: Do not attempt to loosen the manifold by prying under the gasket surface with any tool.

7. Remove the lower intake manifold.

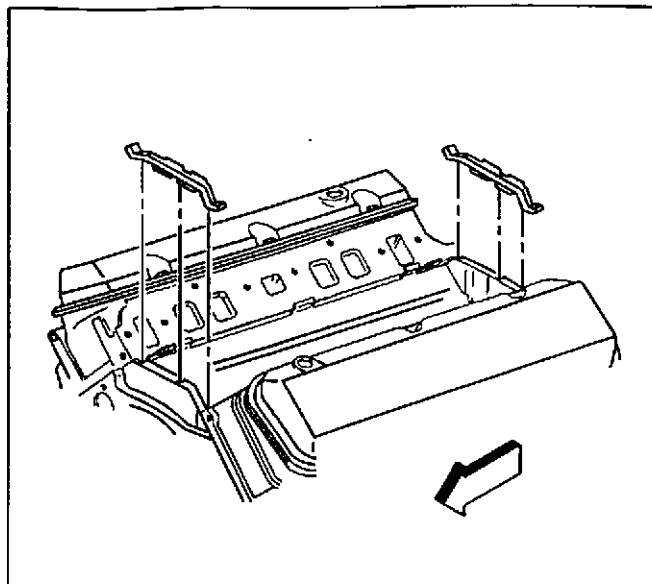
Lift the lower intake manifold up evenly until removed from the engine.



351760

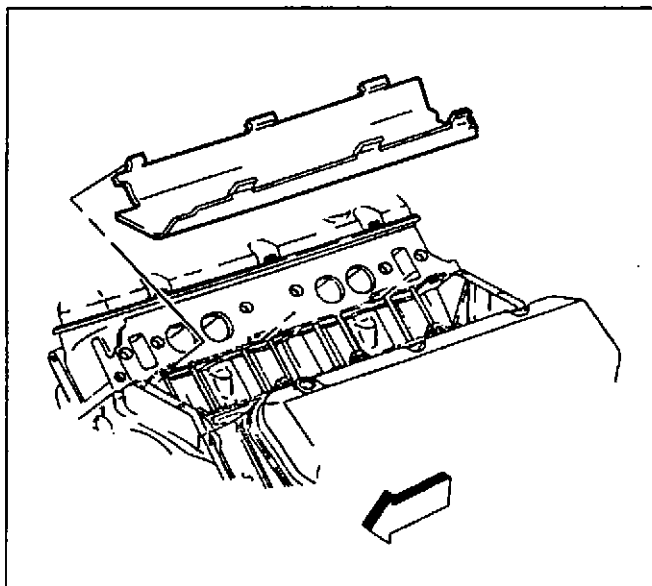
8. Remove and discard the lower intake manifold gaskets.

9. Remove and discard the lower intake manifold seals.



351757

10. Remove the splash shield.



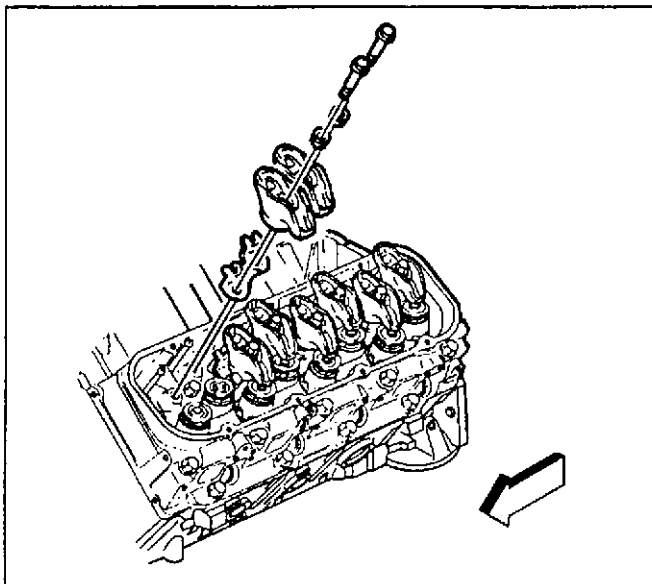
276364

SIE-ID - 195760 -

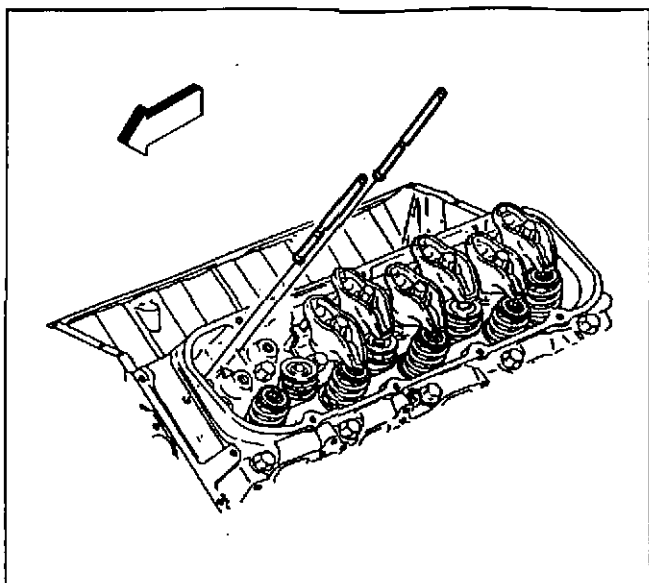
Valve Rocker Arm and Push Rod Removal

Important: Mark, organize and, sort the cylinder head components. Return the components to their original location during reassembly. Make an organizer rack from a piece of wood.

1. Remove the following parts:
 - 1.1. The valve rocker arm bolts
 - 1.2. The valve rocker balls
 - 1.3. The valve rocker arms
 - 1.4. The valve pushrod guides



354070



202196

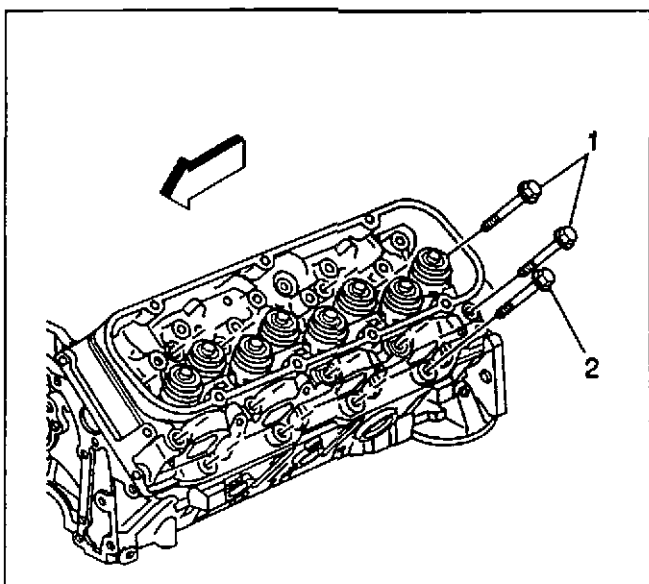
Important: The exhaust valve pushrods are longer than the intake valve pushrods.

2. Remove the valve pushrods.

SIE-ID = 195900

Cylinder Head Removal (Left)

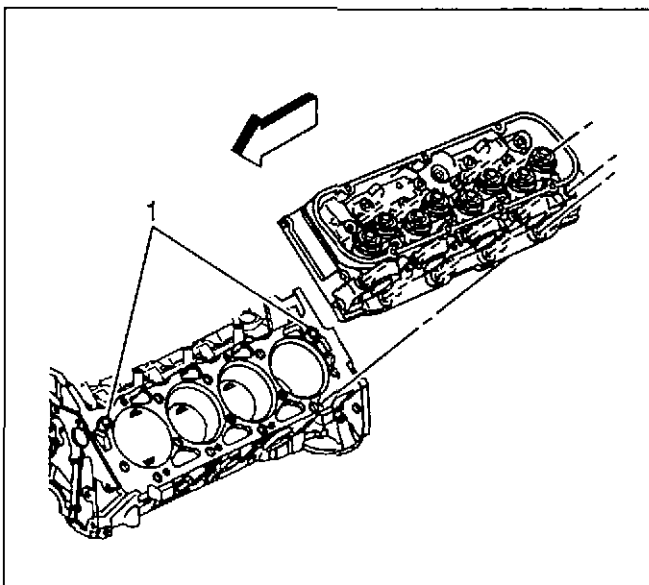
1. Remove the spark plugs from the cylinder head.
2. Remove and discard the cylinder head bolts.



354041

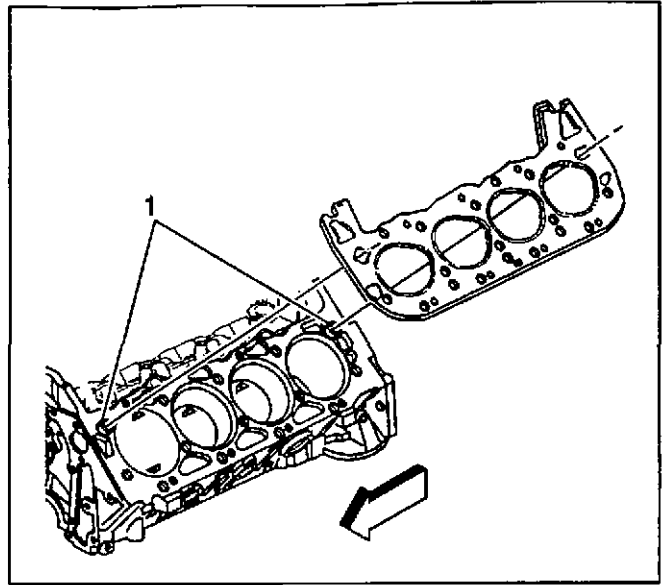
Important: Place cylinder head on two wood blocks to prevent damage to the sealing surfaces.

3. Remove the cylinder head.



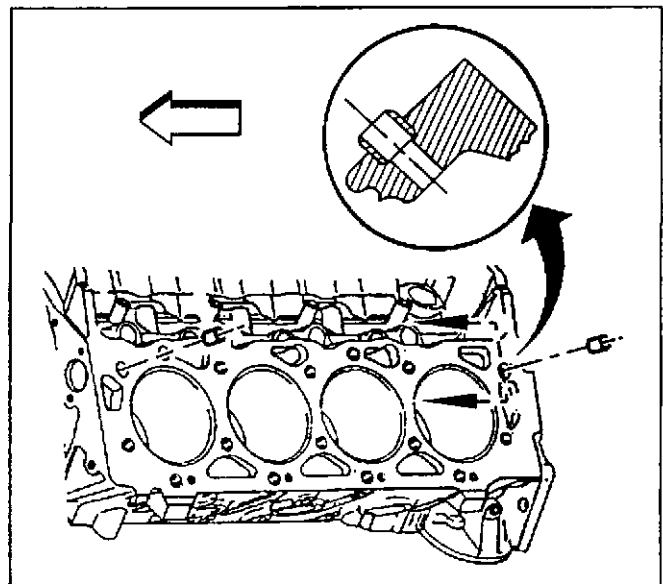
354040

4. Remove the cylinder head gasket.
5. Discard the cylinder head gasket.



354038

6. Remove the cylinder head locating pins, if required.

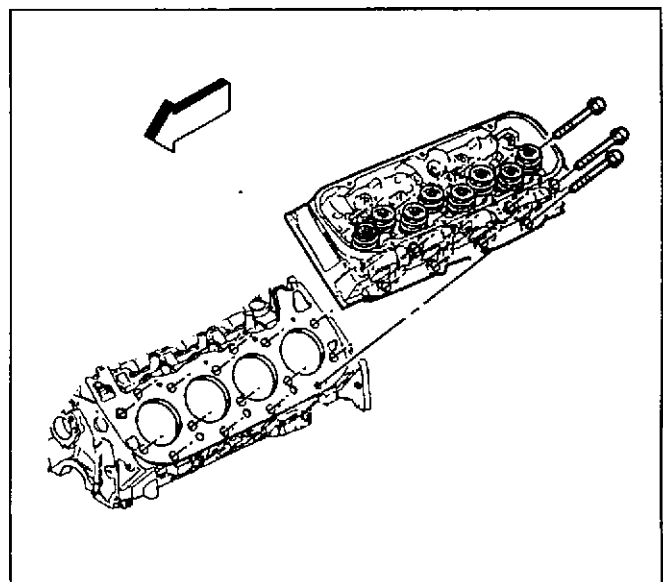


180904

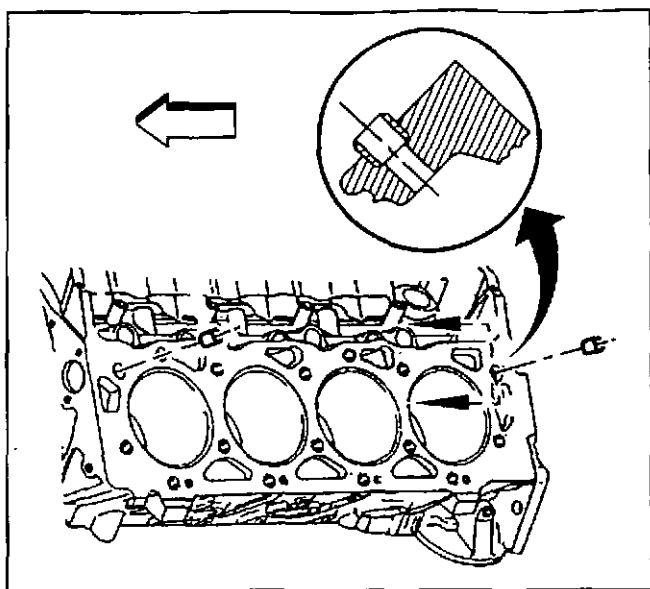
SIE-ID - 195903

Cylinder Head Removal (Right)

1. Remove the spark plugs from the cylinder head.
 2. Remove and discard the cylinder head bolts.
- Important:** Place cylinder head on two wood blocks to prevent damage to the sealing surfaces.
3. Remove the cylinder head.
 4. Remove the cylinder head gasket.
 5. Discard the cylinder head gasket.



202951



180904

6. Remove the cylinder head locating pins, if required.

SIE-ID - 196058

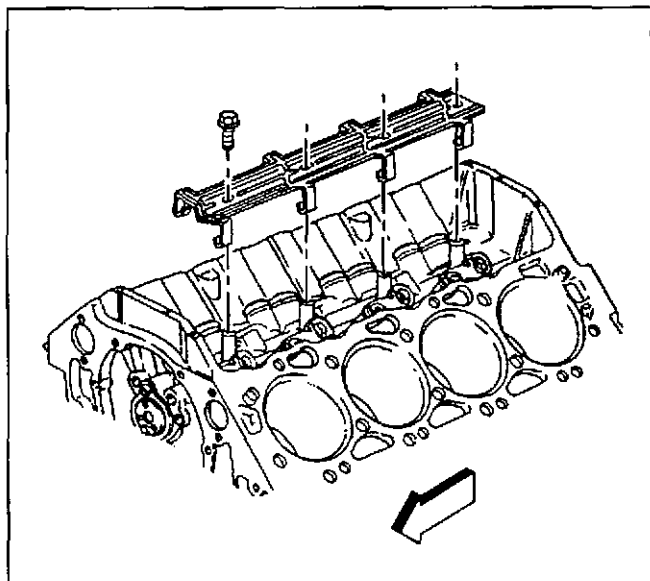
Valve Lifter Removal

Tools Required

J 3049-A Valve Lifter Remover

Important: Mark, sort, or organize the cylinder head components for return to their original location during assembly.

1. Remove the valve lifter guide retainer bolts and retainer.



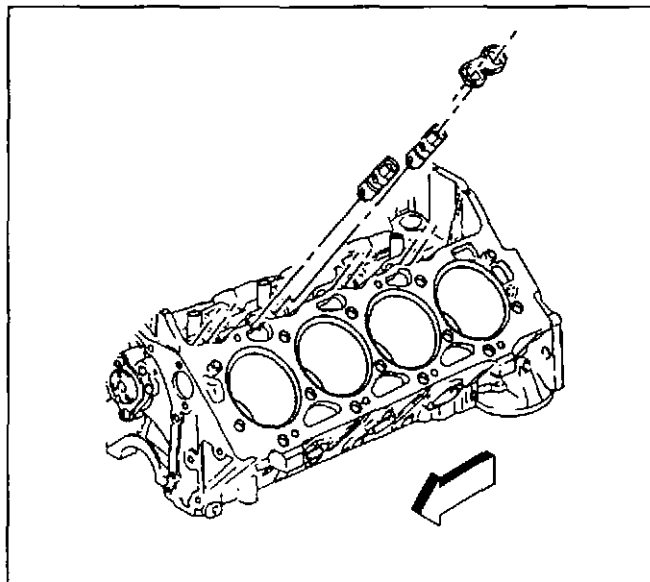
173193

2. Remove the valve lifter guides.

Important: Place the valve lifters in the organizer rack or tag them in a way to ensure they can be returned to the valve lifter bore from which they were removed.

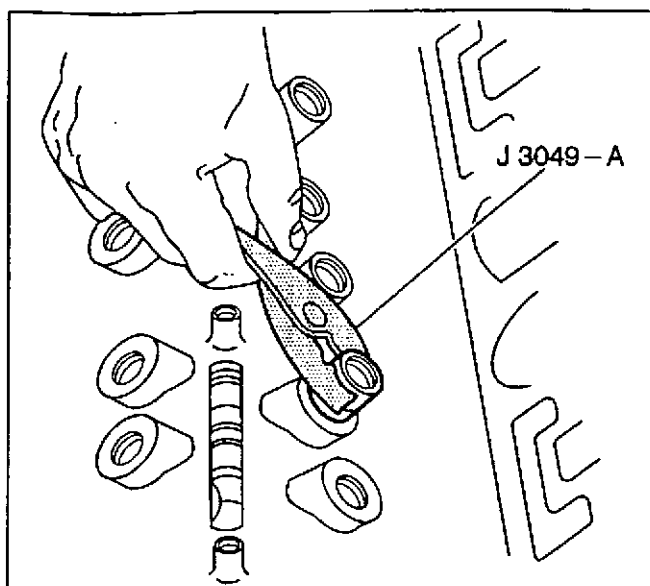
3. Remove the valve lifters.

Use a magnet in order to remove the valve lifters one at a time.



173176

4. Some valve lifters may be stuck in their bore due to gum or varnish deposits. These valve lifters can be removed using J 3049-A.

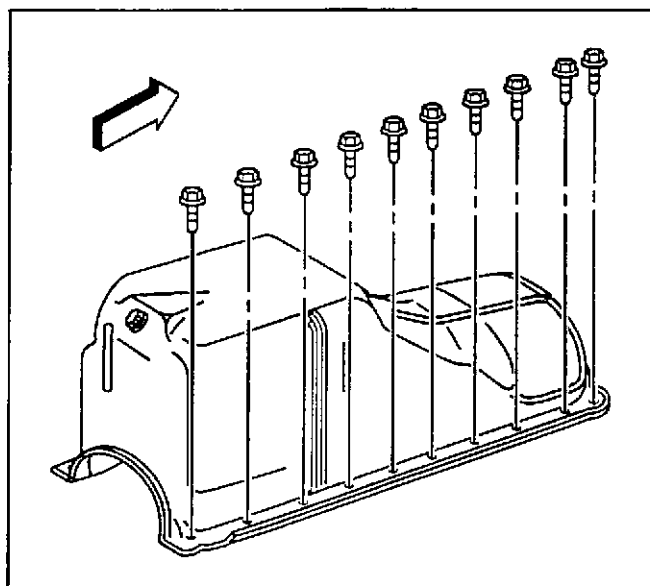


31350

SIE-ID - 196108

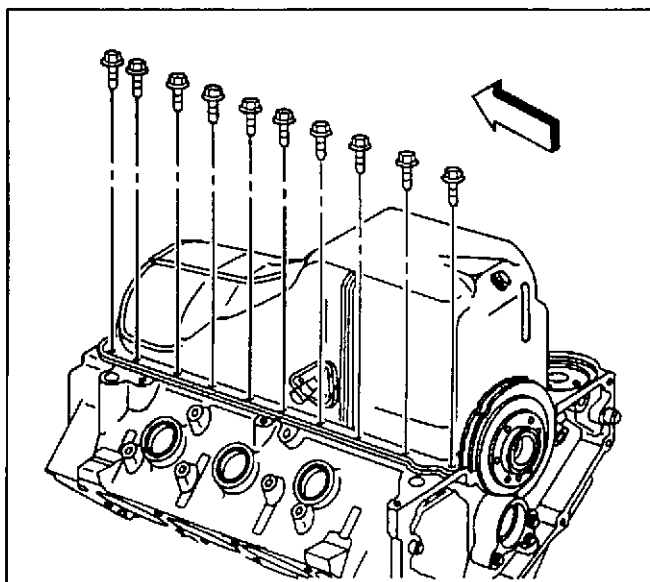
Oil Pan Removal

1. Remove the left side oil pan bolts.

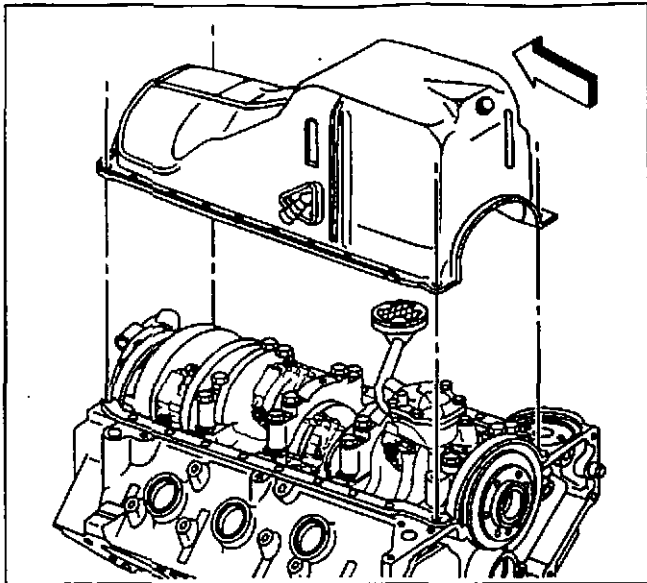


351809

2. Remove the right side oil pan bolts.

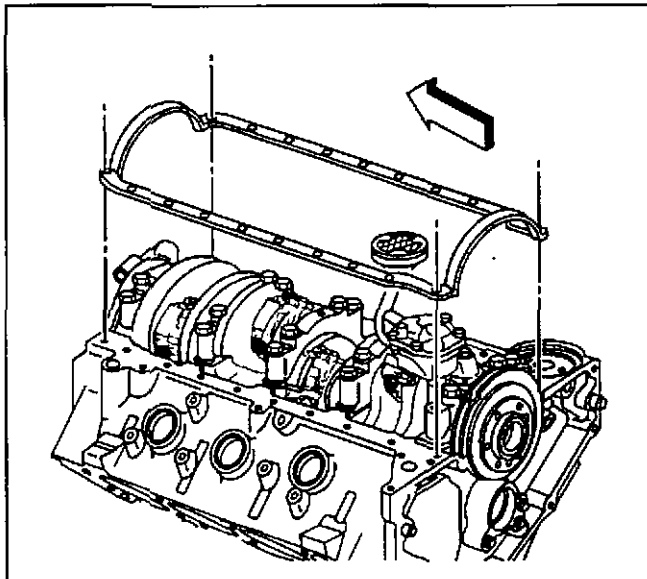


351806



351803

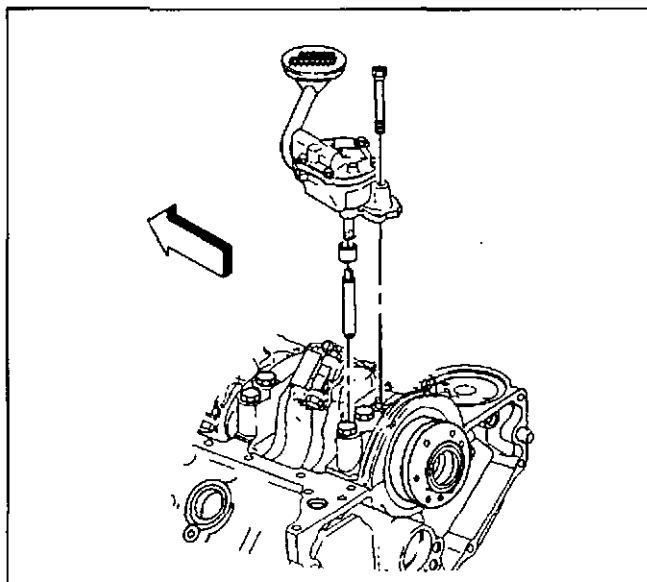
3. Remove the oil pan.



351800

Important: The oil pan gasket is reusable if not cut or damaged.

4. Remove the oil pan gasket.



173183

S/E-ID - 196166

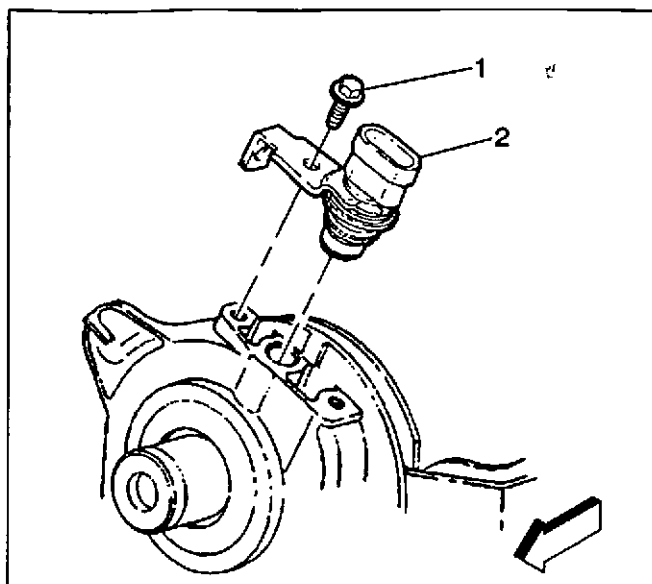
Oil Pump, Pump Screen and Deflector Removal

1. Remove the bolt that attaches the oil pump to the rear crankshaft bearing cap.
2. Remove the oil pump, driveshaft, and retainer from the rear crankshaft bearing cap.
3. Separate the oil pump, driveshaft, and retainer.
4. Discard the driveshaft retainer.

SIE-ID - 196184

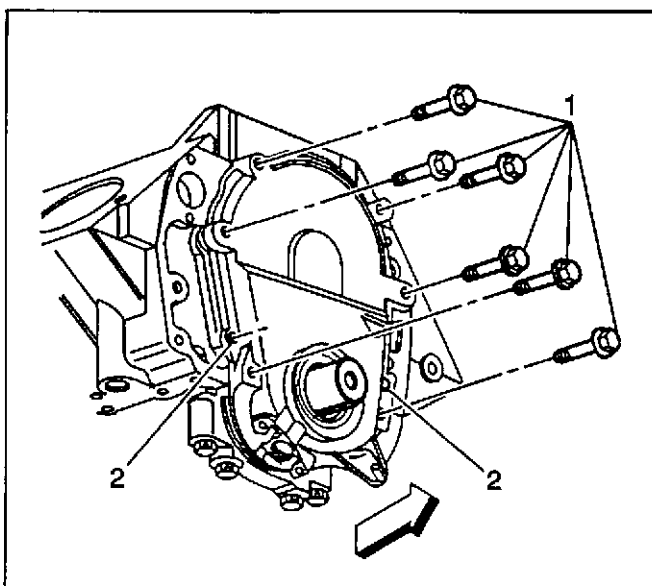
Engine Front Cover Removal

1. Remove the crankshaft position sensor bolt (1).
2. Remove the crankshaft position sensor (2).
3. Remove the O-ring seal from the crankshaft position sensor.
4. Discard the O-ring seal.



180901

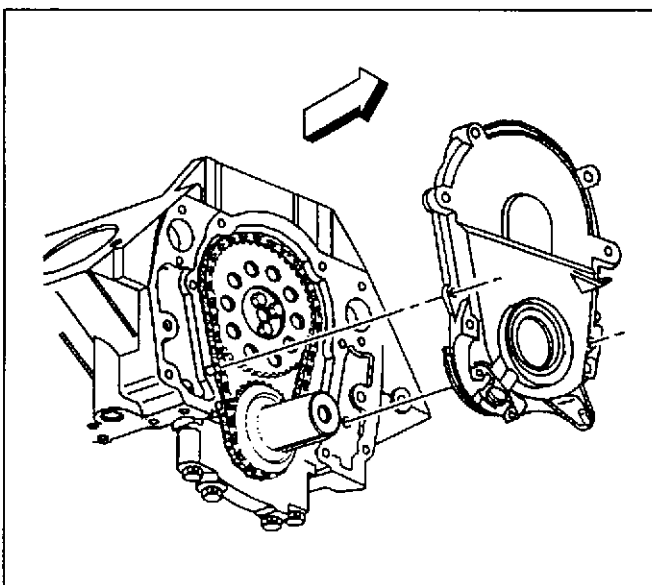
5. Remove the engine front cover bolts (1).



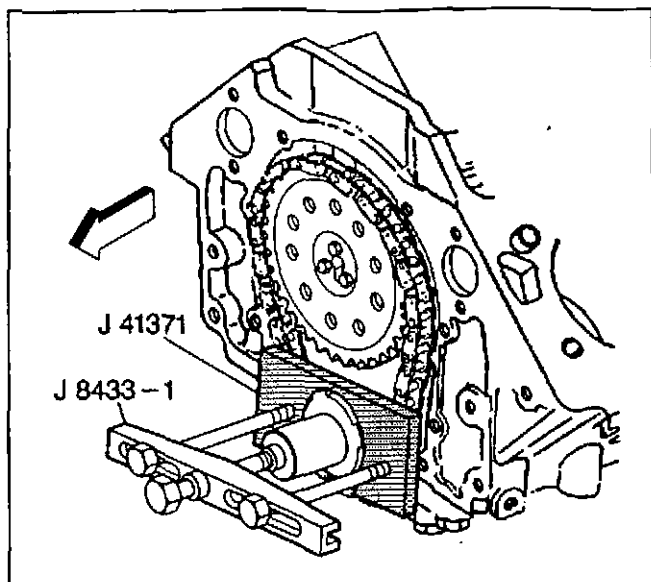
342207

Important: The engine front cover gasket is reusable.

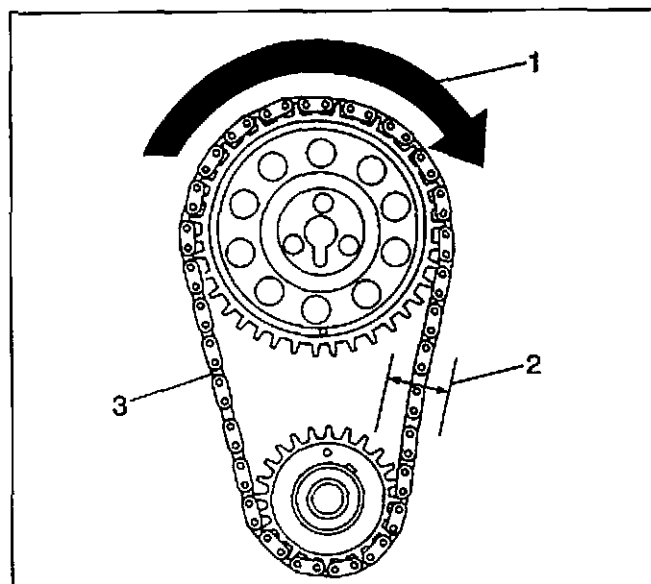
6. Remove the engine front cover and the gasket.



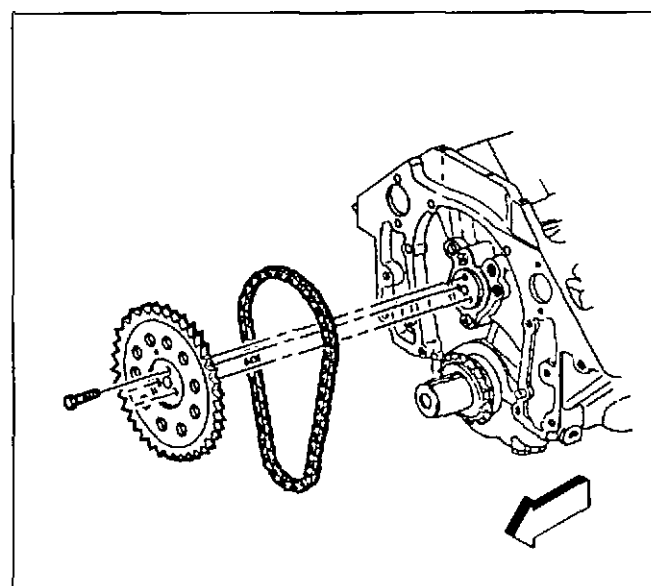
64547



181777



354026



196671

SIE-ID - 196185

Timing Chain and Sprockets Removal

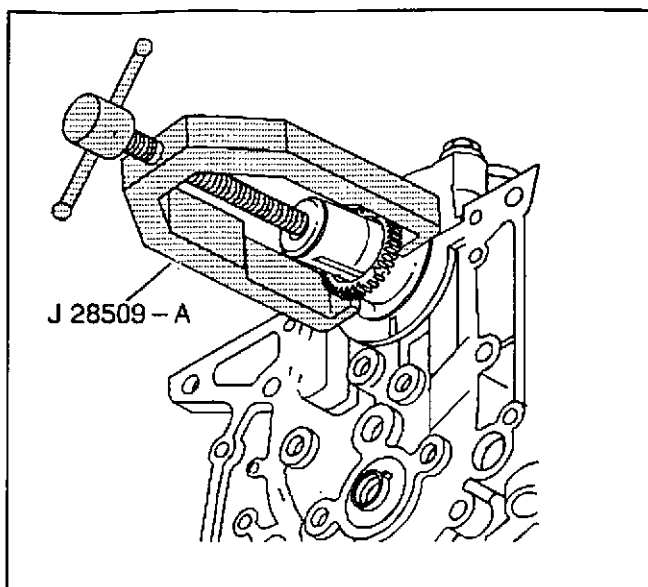
Tools Required

- J 28509-A Crankshaft Sprocket Remover
- J 41371 Reluctor Wheel Remover
- J 8433 Pulley Puller

Important: If the crankshaft sensor reluctor ring is removed, a new crankshaft sensor reluctor ring must be installed.

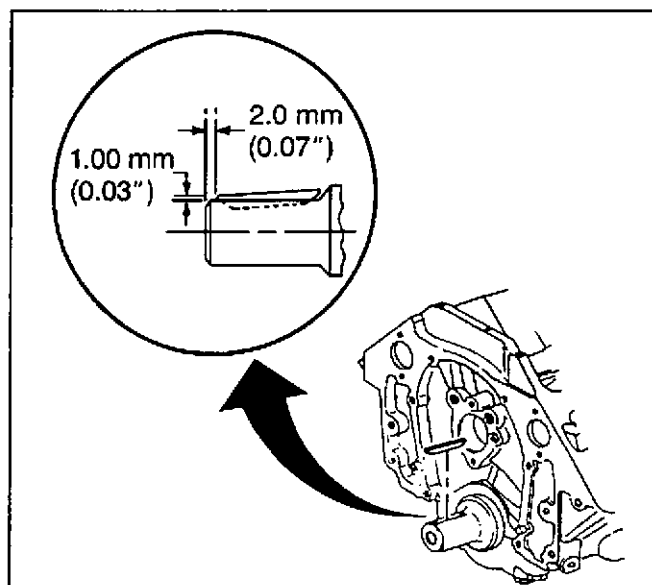
1. Remove the reluctor ring from the crankshaft using J 41371 and the J 8433 .
2. Measure the camshaft timing chain free play (2)
 - 2.1. Align the camshaft timing chain marks.
 - 2.2. Rotate the camshaft sprocket clockwise (1) in order to eliminate any slack (3).
 - 2.3. Measure the camshaft timing chain free play (2). If the chain can be moved back and forth in excess of 16 mm (0.625 in) the camshaft timing chain and the sprockets must be replaced during assembly.
3. Remove the camshaft sprocket bolts.
4. Remove the camshaft sprocket and the camshaft timing chain.

5. Remove the crankshaft sprocket using J 28509-A.



65848

6. Remove the crankshaft key from the crankshaft keyway, if required.

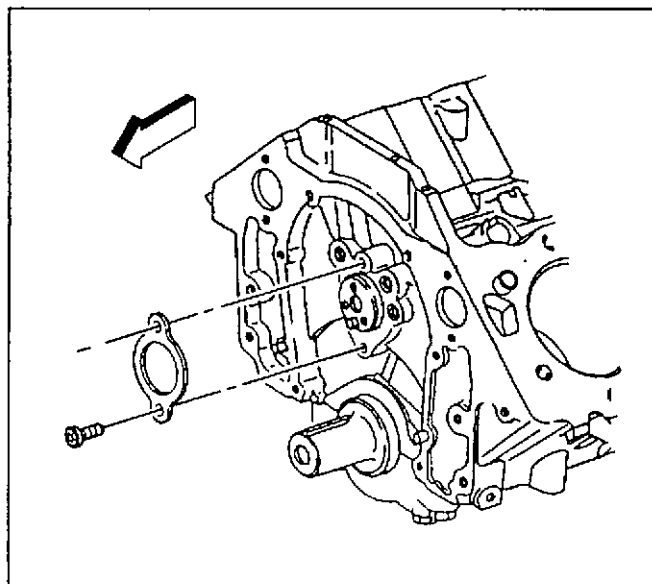


180902

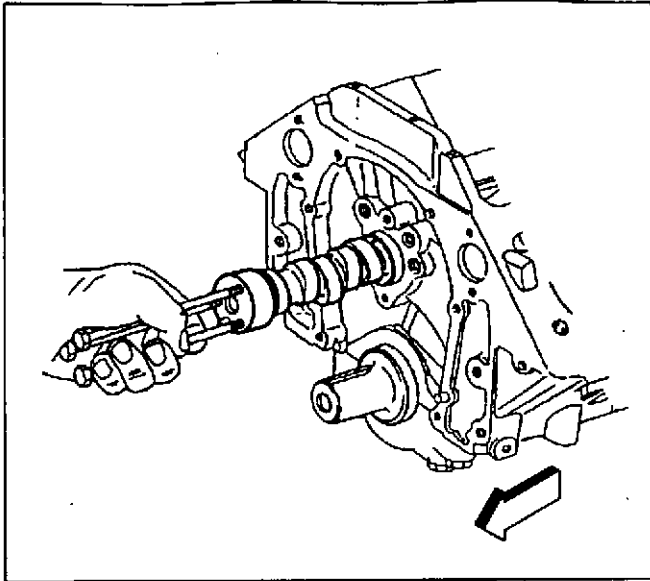
SIE-10 - 197514

Camshaft Removal

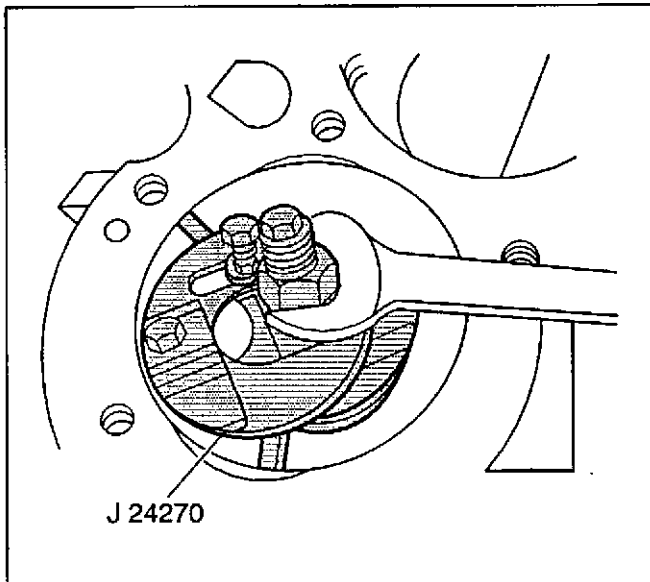
1. Remove the camshaft retainer bolts.
2. Remove the camshaft retainer.



193223



196588



11497

3. Install three 5/16-18 x 4.0 inch bolts in the camshaft front bolt holes.

Notice: SIO-ID - 13833 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.

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

SIE-ID - 65407

Piston, Connecting Rod, and Bearing Removal

Tools Required

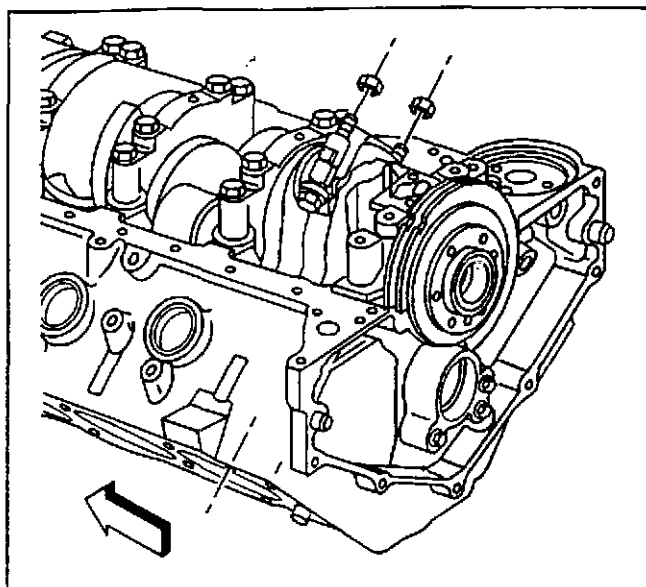
- J 24270 Ridge Reamer
- J 5239 Connecting Rod Guide Tool

Important: Do not remove the excessive material from the cylinder bore. Excessive removal of material may require cylinder boring to the next oversize.

1. Remove the cylinder bore ridge as necessary.
 - 1.1. Rotate the crankshaft until the piston is at the bottom of the stroke (BDC).
 - 1.2. Place a cloth on top of the piston.
 - 1.3. Perform the cutting operation with a J 24270 . Refer to the manufacturer's instructions before using the J 24270 .
 - 1.4. Remove the J 24270 .
 - 1.5. Rotate the crankshaft until the piston is at top dead center (TDC).
 - 1.6. Remove the cloth and the cuttings.
 - 1.7. Repeat the procedure for each piston.

Important: Place the matching marks or numbers on the connecting rods and the connecting rod caps. The connecting rod caps must be assembled to their original connecting rods.

2. Remove the connecting rod nuts.

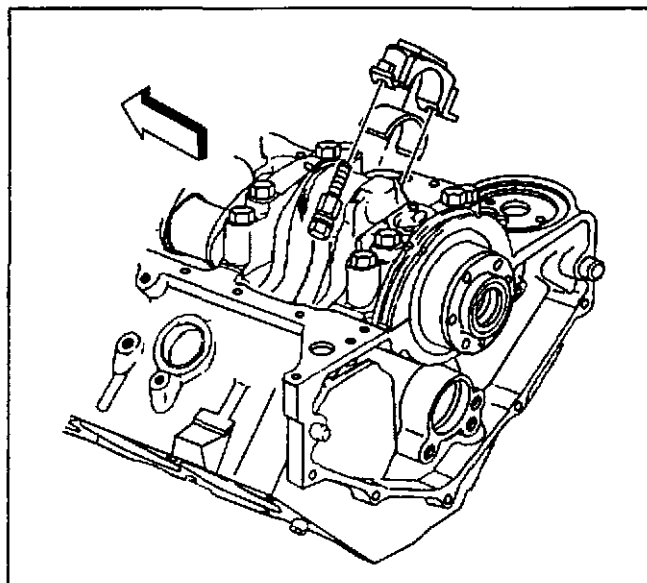


354031

Notice: SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

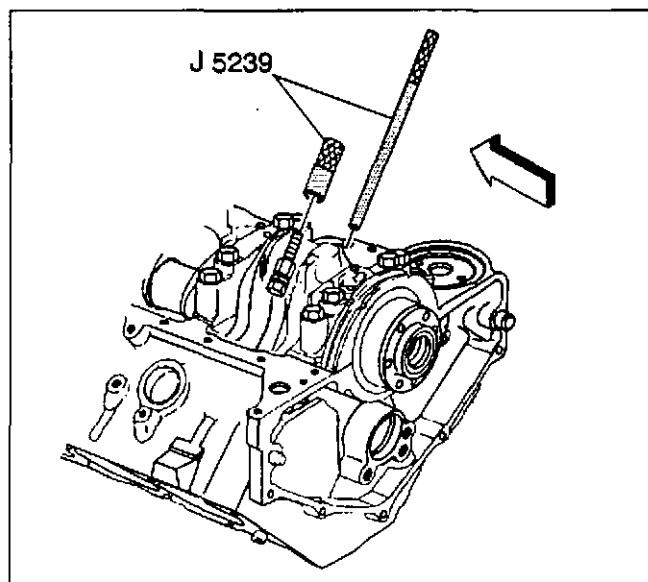
Important: If reusing bearings, keep the bearings with their original connecting rod and connecting rod cap.

3. Remove the connecting rod cap and the lower connecting rod bearing.

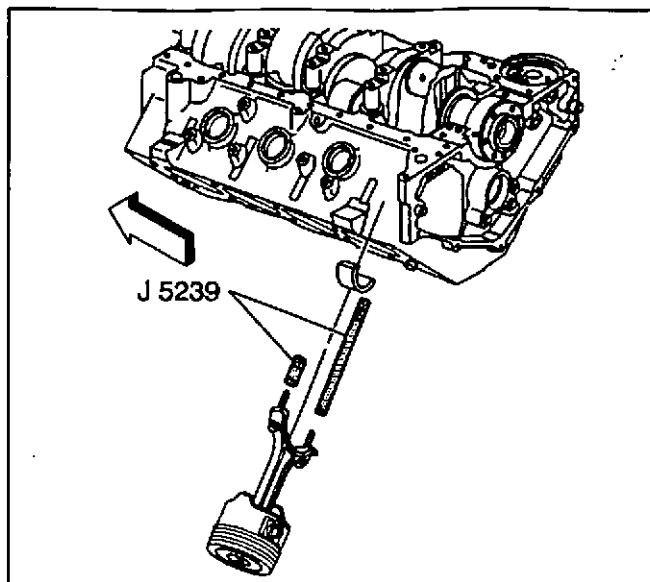


354030

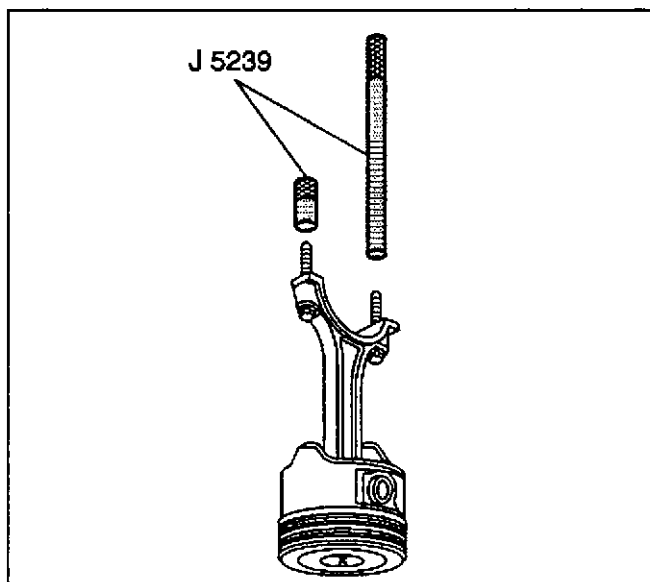
4. Install the J 5239 on the connecting rod bolts.



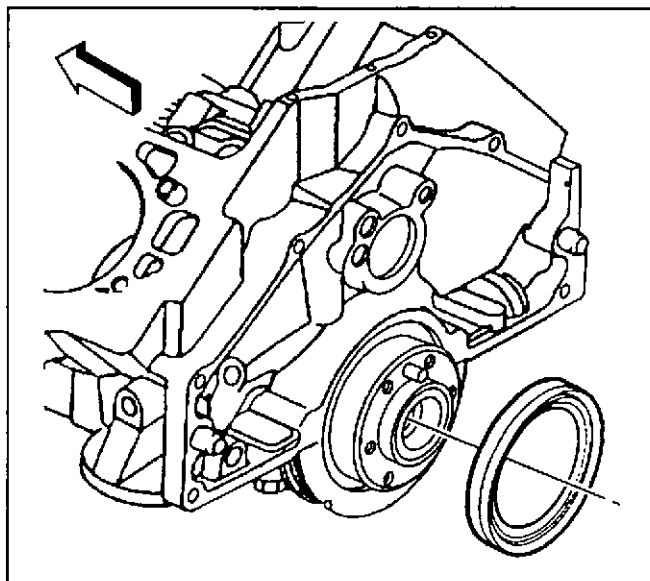
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5. Remove the piston, connecting rod and upper connecting rod bearing out of the top of the engine block using the *J 5239*.

6. Remove the *J 5239* from the connecting rod bolts.
7. Remove the remaining piston and the connecting rod assemblies.
8. Wipe the oil from the bearings and the crankpins.

SIE-ID - 314525

Crankshaft Rear Oil Seal Removal

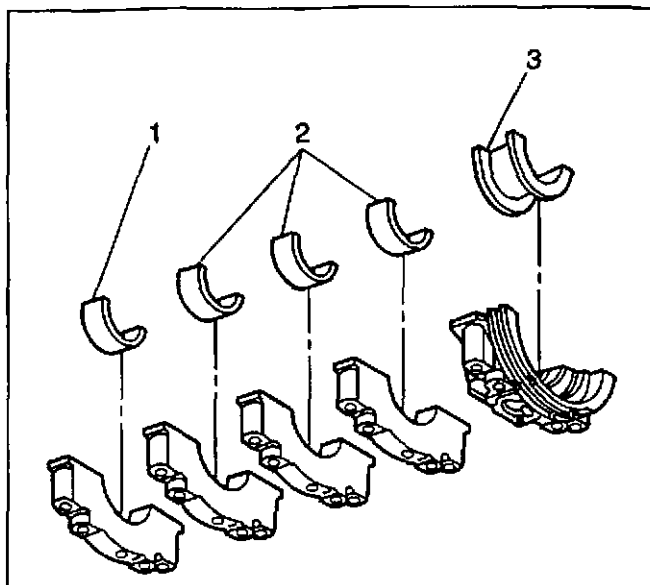
1. Loosen the crankshaft bearing cap bolts.
Important: Use caution and care to avoid scratching or damaging the crankshaft seal surface.
2. Pry the crankshaft rear oil seal from the bore.

SIE-10 - 197028

Crankshaft and Bearings Removal

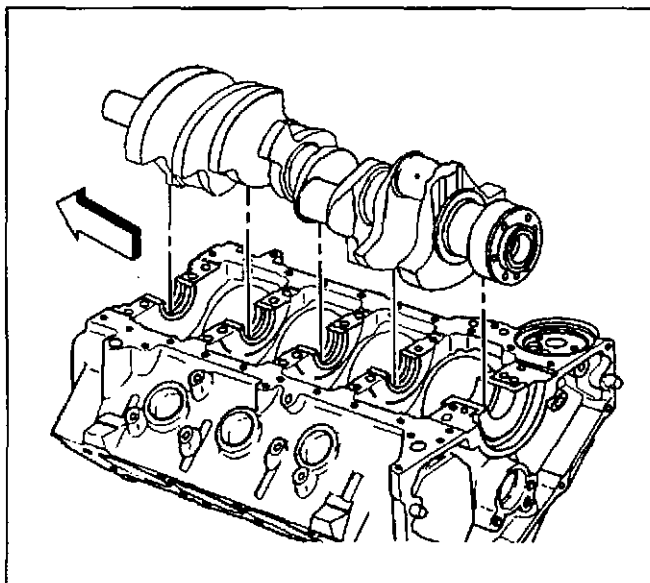
Important: Crankshaft bearing caps are machined with the engine block for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. Crankshaft bearing caps must be installed in their original locations.

1. Remove the crankshaft bearing cap bolts.
2. Remove the crankshaft bearing caps.
3. Remove the crankshaft lower bearings (1-3) from the crankshaft bearing caps.



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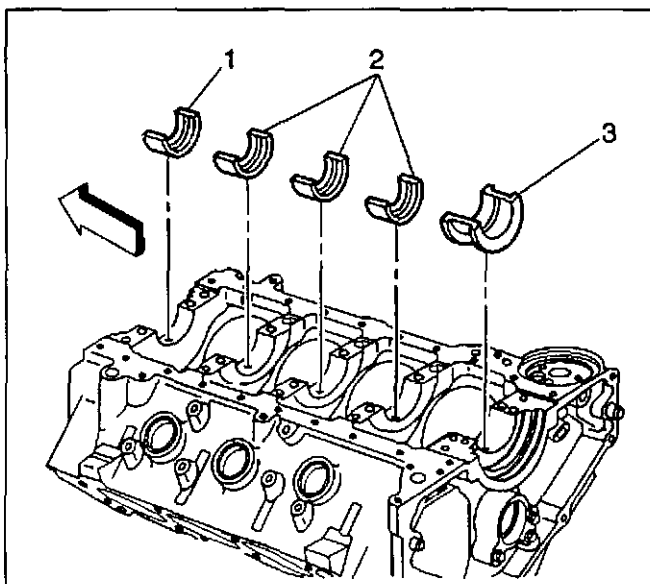
4. Remove the crankshaft.



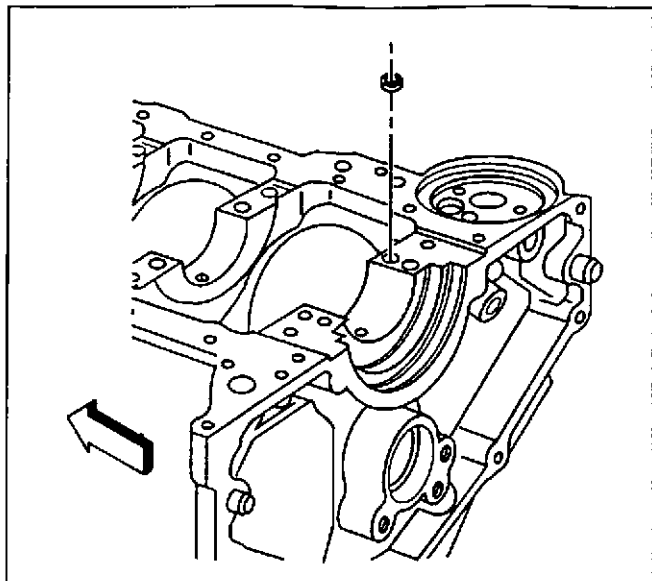
351779

Notice: SIO-10 - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

5. Remove the crankshaft upper bearings (1-3) from the engine block.

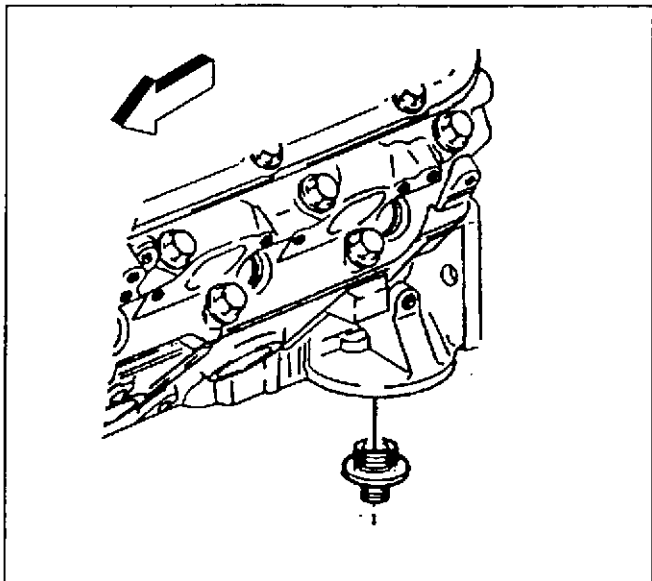


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6. Remove the crankshaft bearing cap oil seal.

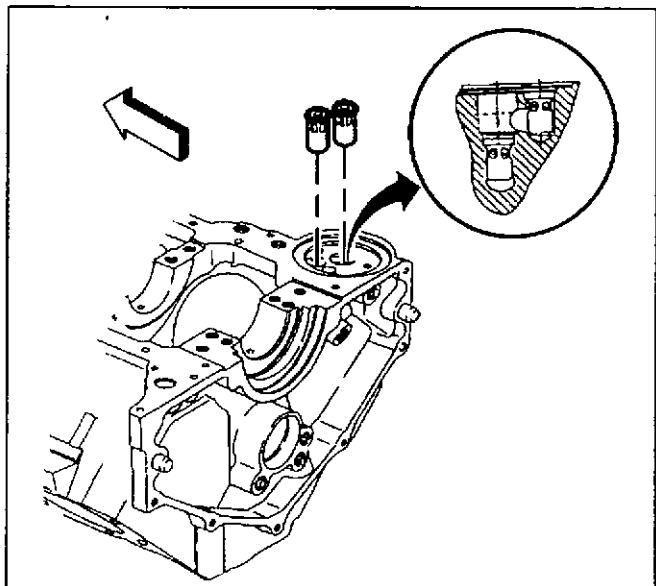


70416

SIE-ID - 280359

Oil Filter Adapter and Valve Assembly Removal (2WD)

1. Remove the oil filter fitting.
2. Remove the oil bypass valves (if required). Unstake the tangs on oil bypass valves and remove with long nose pliers.
3. Discard the valves.

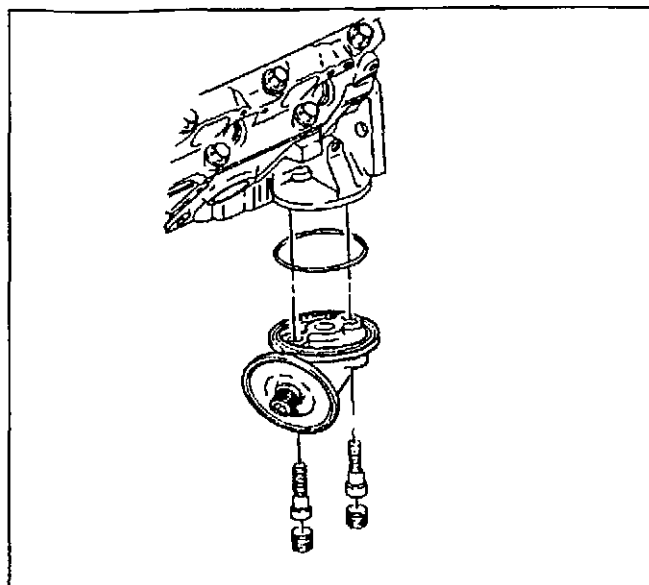


180862

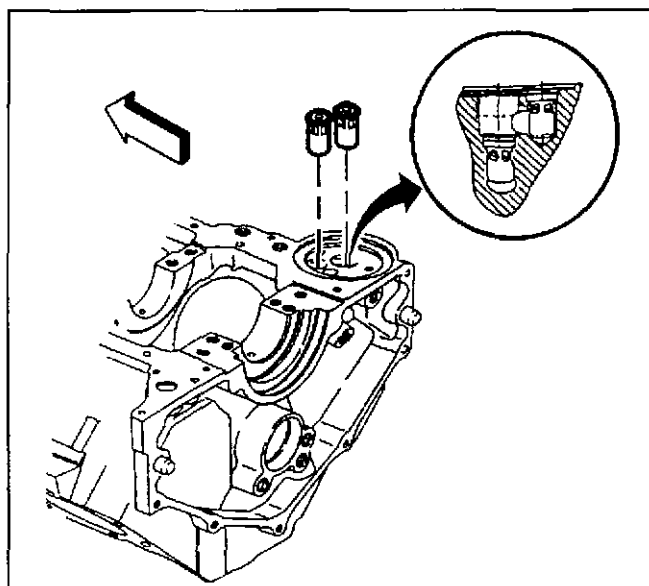
SIE-ID - 197519

Oil Filter Adapter and Valve Assembly Removal (4WD)

1. Remove the oil filter adapter using the following procedure:
 - 1.1. Remove the plugs from the oil filter adapter.
 - 1.2. Remove the bolts from the oil filter adapter.
 - 1.3. Remove the oil filter adapter and the O-ring seal.
2. Remove the oil bypass valves (if required). Unstake the tangs on oil bypass valves and remove with long nose pliers.
3. Discard the valves.



70415



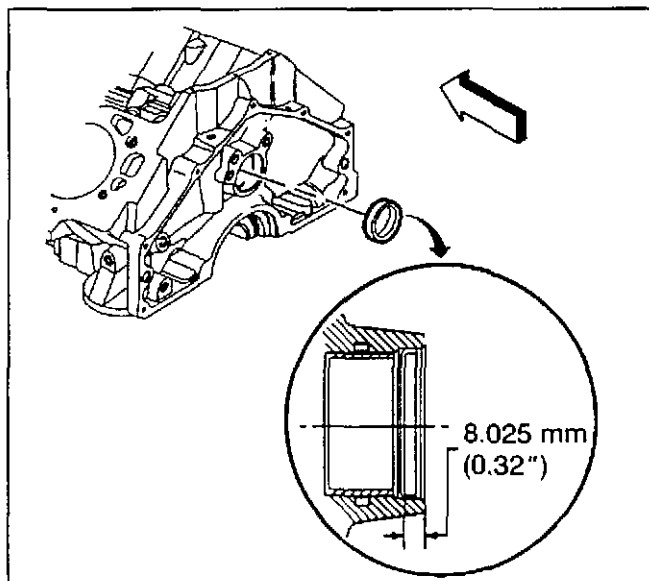
180862

SIE-ID - 197532

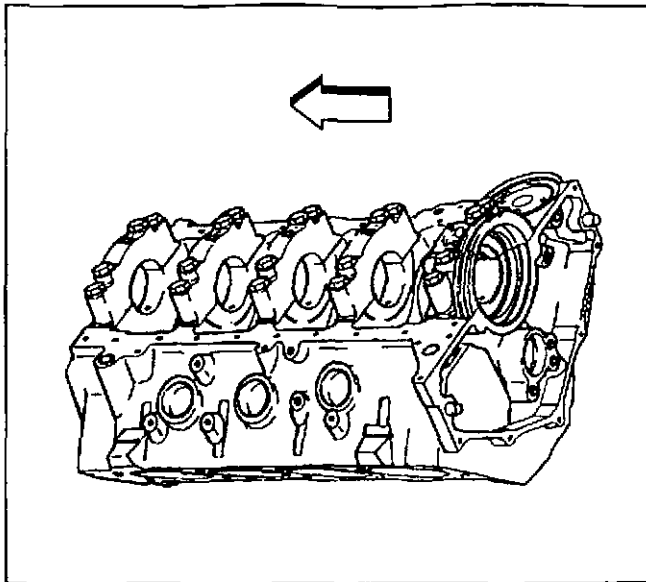
Engine Block Plug Removal

1. Remove the camshaft rear bearing hole plug:
 - 1.1. Obtain a suitable self-threading screw.
 - 1.2. Drill a hole into the plug.
 - 1.3. Install the self-threading screw.
 - 1.4. Pull on the plug until it has left the bore.

Important: Use care not to damage the camshaft bearings.
- 1.5. An alternate method to remove the plug would be to insert a long shaft or bar through the front of the engine and drive the plug from the bore.



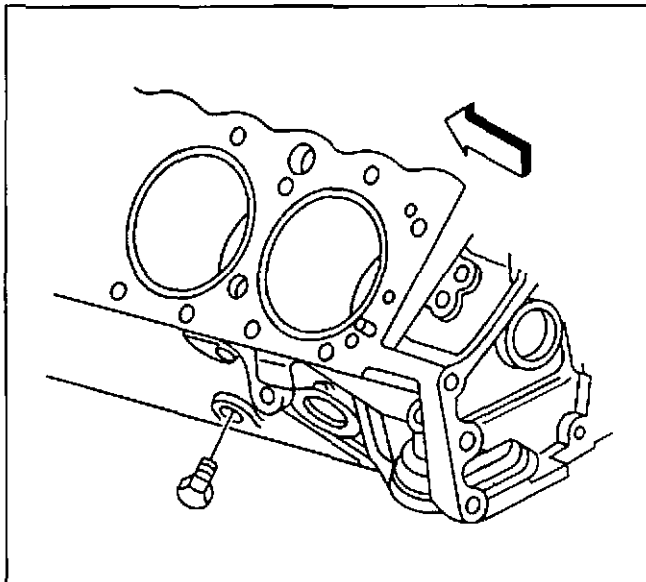
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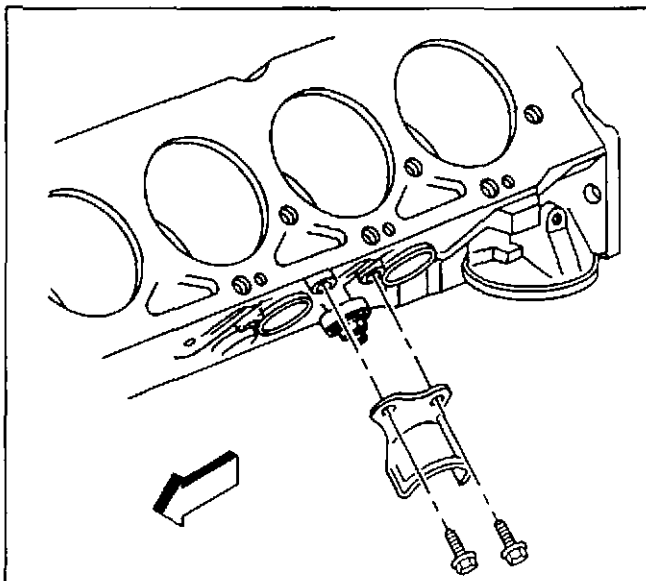
2. Remove the engine block expansion plugs from both sides of block.

- 2.1. Obtain a suitable self-threading screw.
- 2.2. Drill a hole into the plug.
- 2.3. Install the self-threading screw.
- 2.4. Pull on the plug until it has left the bore.



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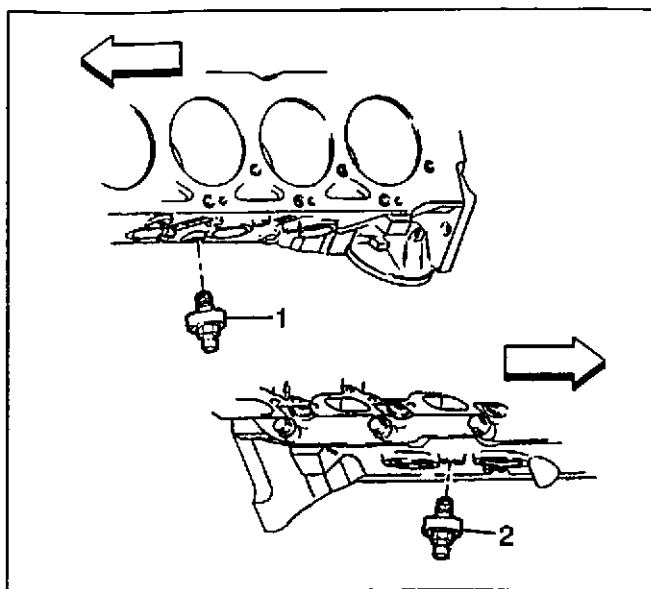
3. Remove the engine block coolant drain hole plugs.



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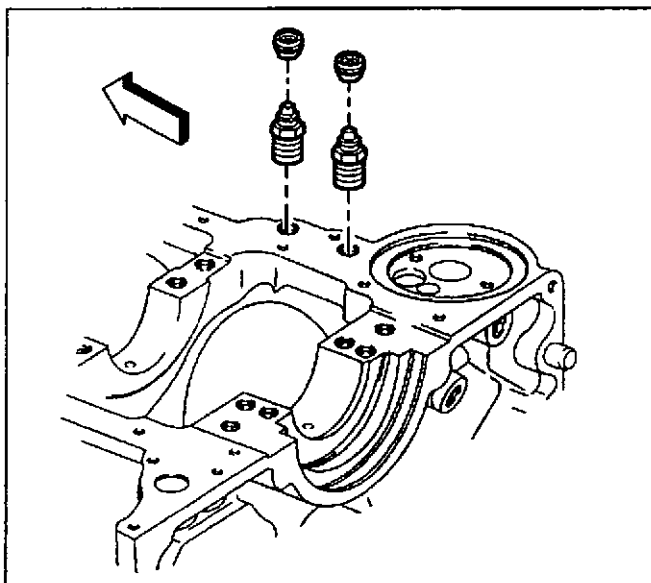
4. Remove the left side knock sensor shield bolts.
5. Remove the left side knock sensor shield.

6. Remove the left side knock sensor (1).
7. Remove the right side knock sensor (2).



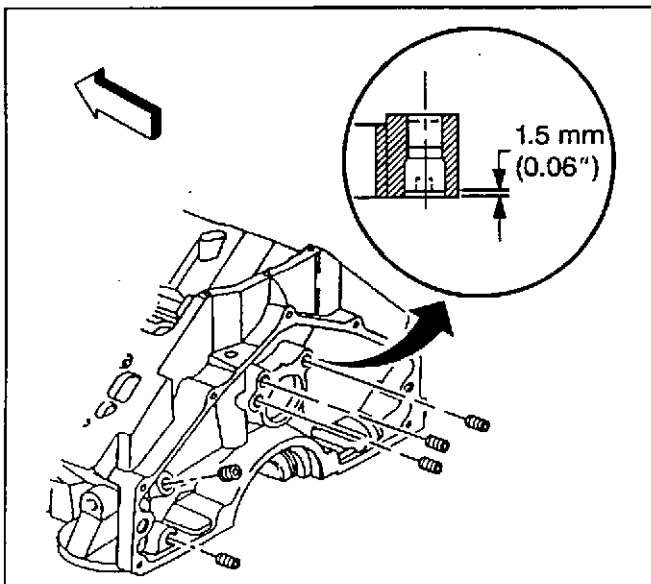
181034

8. Remove the engine block oil cooler hose plugs and grommets.
Discard the oil cooler plugs and grommets.

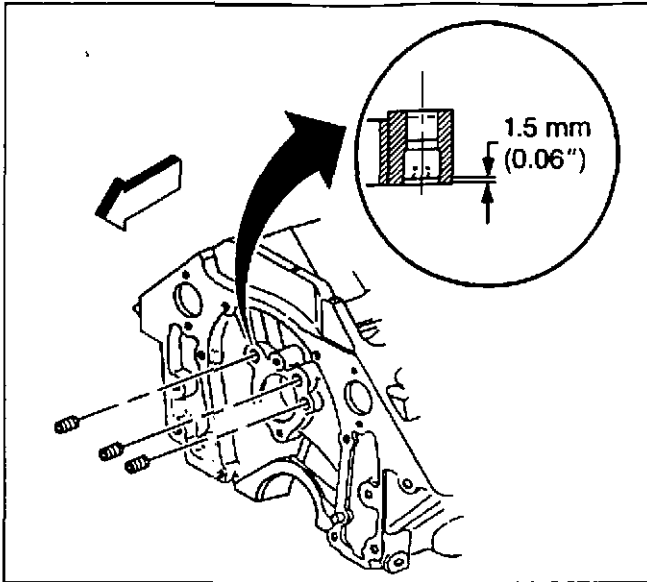


180864

9. Remove the rear oil gallery plugs.

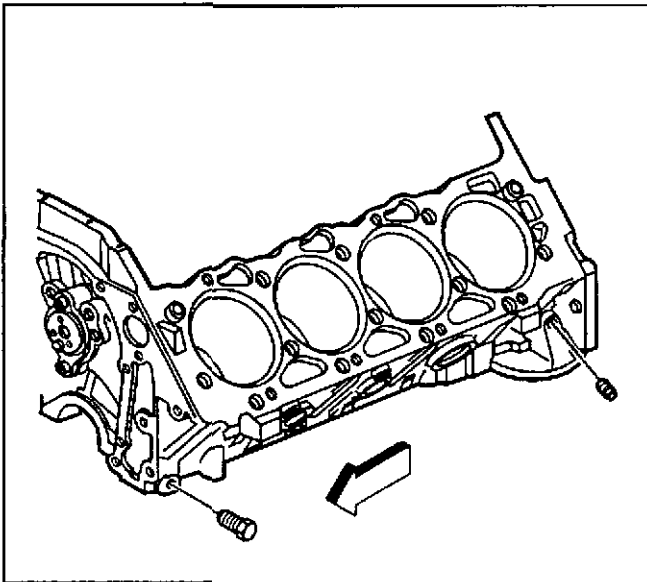


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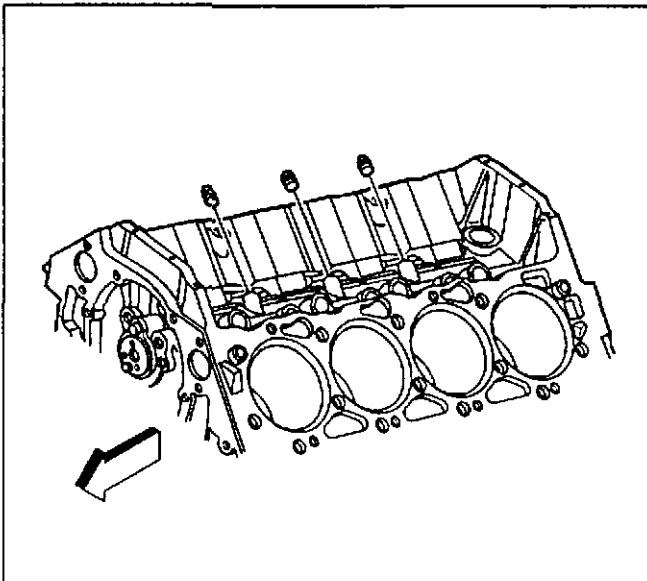
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10. Remove the front oil gallery plugs.



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11. Remove the left side oil gallery plugs.



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12. Remove the top oil gallery plugs.

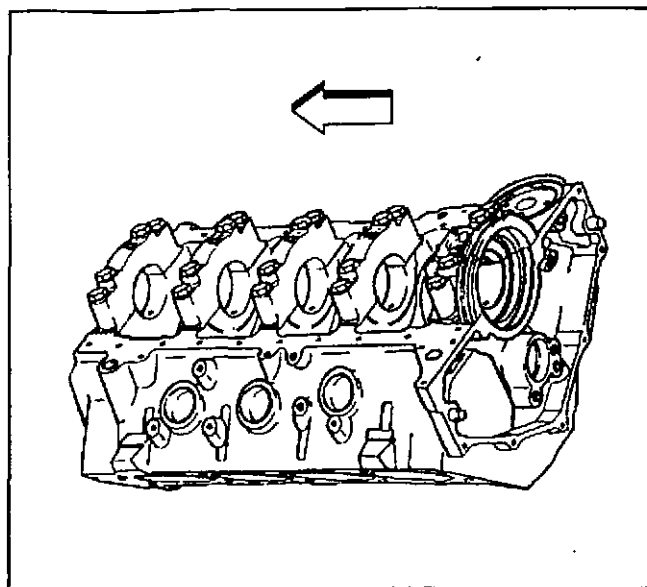
SIE-ID = 197121

Engine Block Clean and Inspect

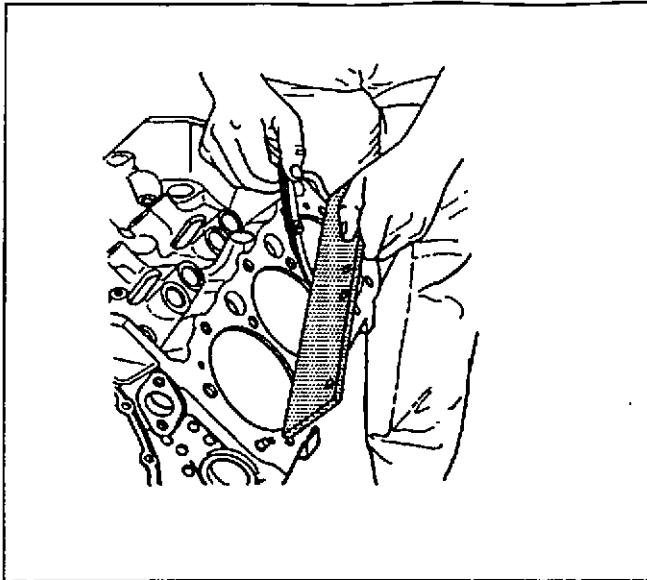
1. Boil the cylinder block in caustic solution.
2. Flush the cylinder block with clean water or steam.
3. Clean the following areas:
 - All gasket surfaces; Refer to *Replacing Engine Gaskets* (ERROR - NOT IN CURRENT PSD)
 - Cylinder bores, remove excessive cylinder ring ridge as required
 - Main bearing caps
 - Oil galleries, remove all sludge or restrictions
 - Scale deposits from the coolant passages
 - All dirt or debris from threaded bolt holes

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

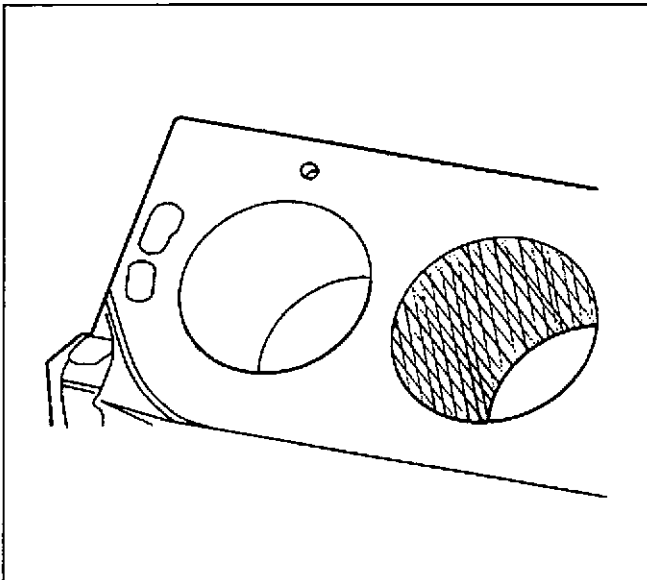
4. Dry the block with compressed air.
5. Lubricate the cylinder bores with clean engine oil to prevent rusting.
6. Inspect the engine block for the following conditions:
 - Gasket surfaces for deep gouges or other damage
 - Crankshaft bearing bores for wear
 - The surfaces where the crankshaft bearings contact the crankshaft bearing bore must be smooth.
 - All crankshaft bearing bores must be round and uniform in inside diameter (ID) at all the bearing supports.
 - If a crankshaft bearing cap is damaged and requires replacement, refer to *Crankshaft and Bearings Clean and Inspect*
 - Camshaft bearing bores for wear or damage
 - Valve lifter bores for scuffing or wear
 - Engine block for cracks or other damage
 - Cylinder walls for scoring or gouges
 - Coolant jackets for cracks
 - Crankshaft bearing webs for cracks
 - Engine mount bosses for damage
 - The oil passages for restrictions



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7. Inspect the engine block cylinder head deck for flatness using a straight edge and a feeler gauge.

The surface must be flat within 0.10 mm (0.004 in).

SIE-ID = 197787

Cylinder Boring and Honing

Cylinder Honing Procedure

Notice: SIO-ID = 311282 Always remove all bearings and components from engine block before cleaning, boring or honing the engine block.

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 a final grade 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 and hone the cylinder in a cross hatch pattern at 45 to 65 degrees to obtain 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 to eliminate taper in the cylinder, make full strokes of the hone in the cylinder. Repeatedly check the measurement at the top, the middle, and the bottom of the bore.
 - The finish marks should be clean but not sharp.
 - The finish marks should be free from imbedded particles and torn or folded metal.
4. By measuring the selected piston at the sizing

point and by adding the average of the clearance specification, you can determine the cylinder honing dimension required. Refer to *Engine Mechanical Specifications*

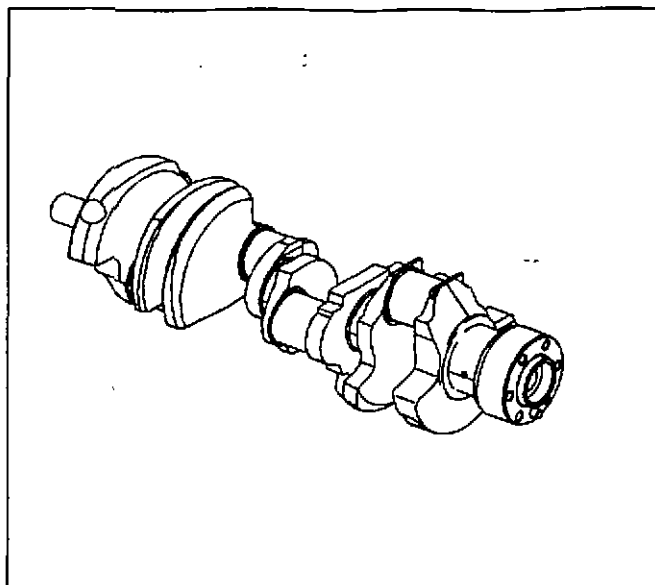
5. When finished, the reconditioned cylinder bores should have less than or meet the specified out-of-round or taper requirements.
6. After final honing and before the piston is checked for fit, clean the bores with hot water and detergent.
 - 6.1. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores.
 - Abrasive material may cause premature wear of new piston rings and cylinder bores.
 - Abrasive material will contaminate the engine oil and may cause premature wear of the bearings.
 - 6.2. After washing the cylinder bore, dry the bore with a clean shop towel.
7. Perform final measurements of the piston and cylinder bore.
8. Permanently mark the piston for the specific cylinder to which it has been fitted.
9. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Cylinder Boring Procedure

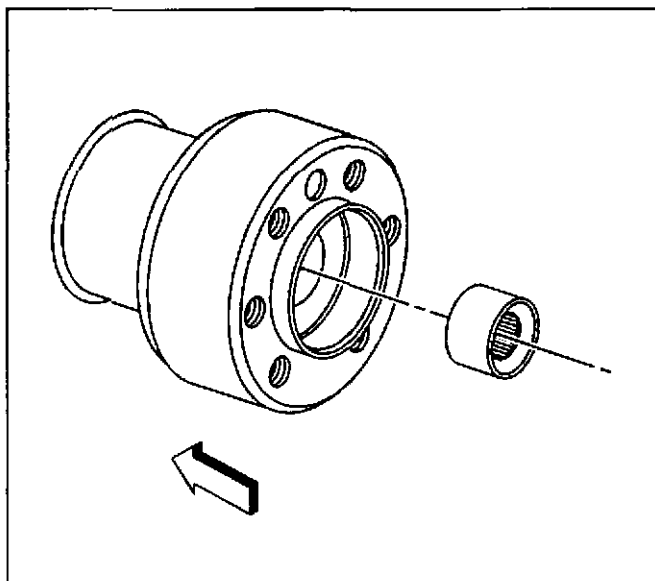
1. Before you start the honing or boring operation, measure all new pistons with the micrometer contacting at points exactly 90 degrees from the piston pin centerline.

Important: If you do not check the cylinder block, the boring bar may be tilted, this may result in incorrect rebored cylinder wall to crankshaft angle.

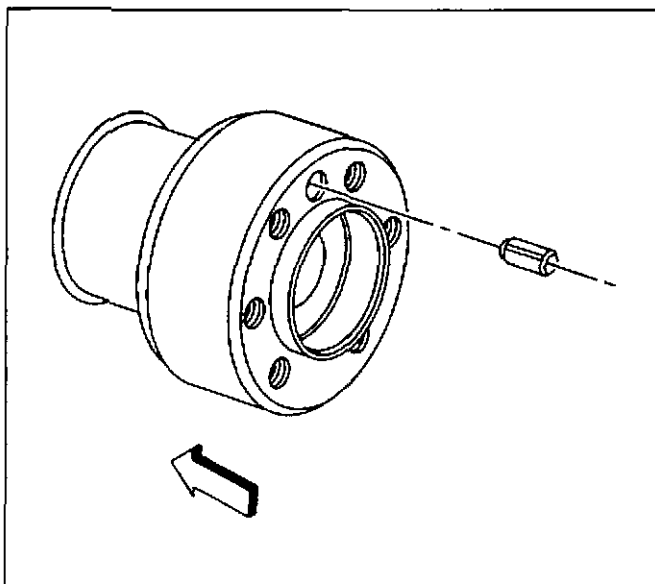
2. Before you use any type of boring bar, file the top of the cylinder block in order to remove any dirt or burrs.
3. Carefully follow the instructions furnished by the manufacturer regarding use of equipment.
4. When you rebore cylinders, make sure all crankshaft bearing caps are in place.
 - Tighten the bearing caps to the proper torque in order to avoid distortion of the bores in the final assembly.
 - The crankshaft must be clear of the boring cutter when you bore each cylinder.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the diameter for finish honing. This gives the required position to the cylinder clearance specifications. (Carefully perform the honing and boring operation in order to maintain the specified clearances between pistons, rings, and cylinder bores).



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SIE-ID - 199078

Crankshaft and Bearings Clean and Inspect

Crankshaft Inspection

Tools Required

J 7872 Magnetic Base Dial Indicator

Important: Use care when handling the crankshaft. Avoid damage to the bearing surfaces.

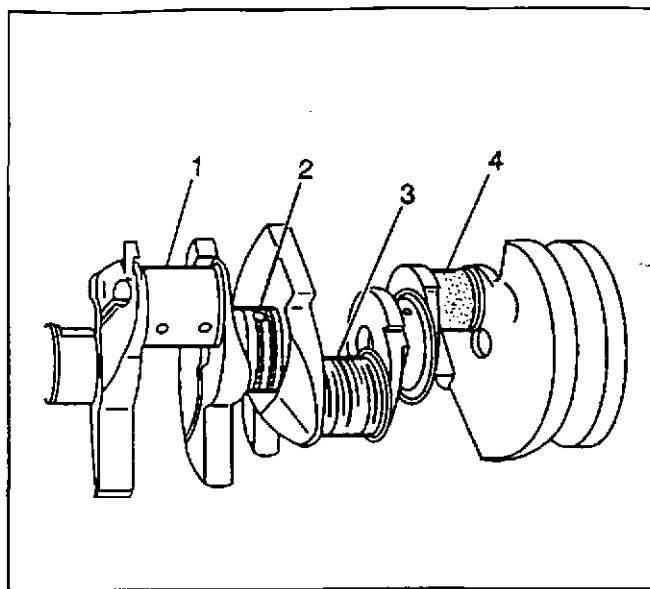
A loose or damaged crankshaft rear oil gallery plug must be replaced.

1. Clean the crankshaft in solvent. Remove all sludge or restrictions from the oil passages.
2. Replace the clutch pilot bearing anytime a manual transmission or clutch is removed. A worn clutch pilot bearing will not properly support or align the manual transmission input shaft.
3. Remove the engine flywheel locator pin, if damaged.

Notice: SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.
4. Clean the crankshaft bearings in solvent. Wipe the bearings clean with a soft cloth, do not scratch the bearing surfaces.

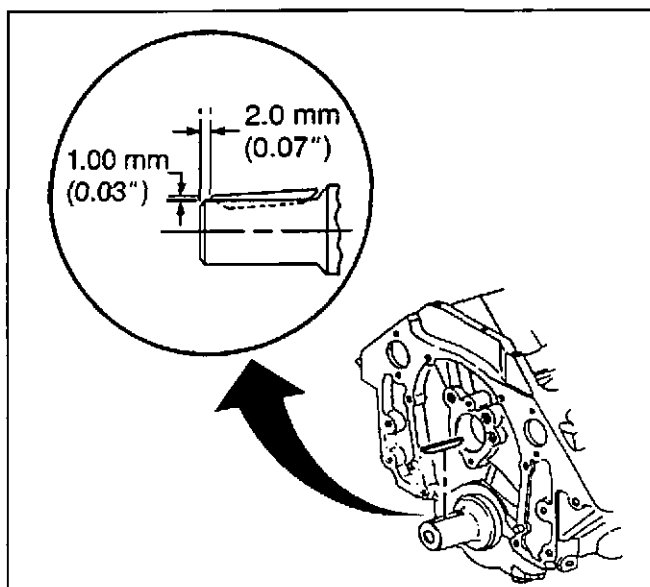
Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**
5. Dry the crankshaft and bearings with compressed air.

6. Inspect the crankshaft for the following conditions:
 - Crankshaft journals (1) should be smooth with no evidence of scoring or damage
 - Deep grooves (2)
 - Scratches or uneven wear (3)
 - Pitted surfaces (4)
 - Wear or damage to the thrust journal surfaces
 - Scoring or damage to the rear seal surface
 - Restrictions to oil passages
 - A loose or damaged rear oil gallery plug
 - Damage to threaded bolt holes



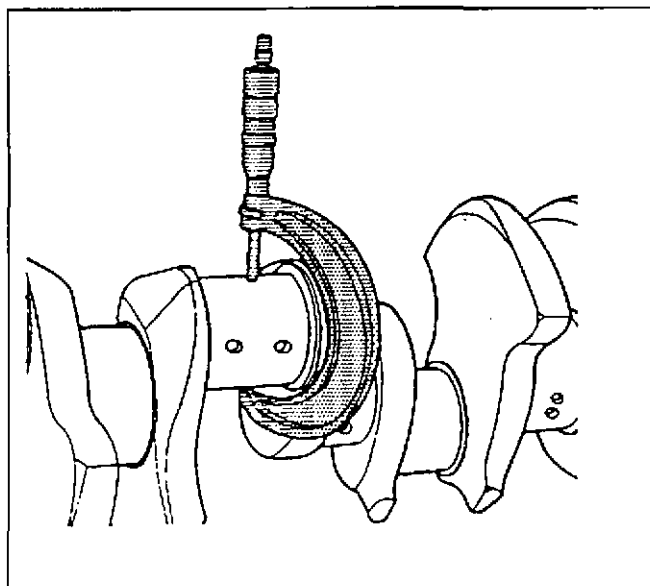
156170

7. Inspect the crankshaft key and keyway for damage.

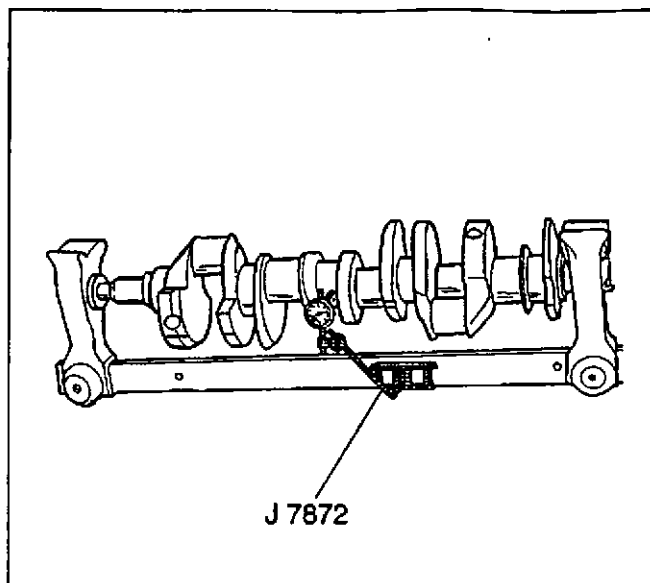


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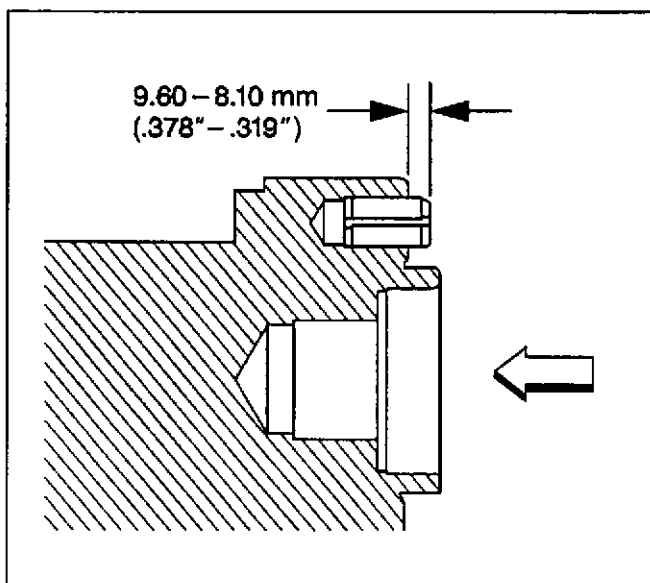
8. Measure the crankshaft main journals and crankpins for out-of-round and taper.



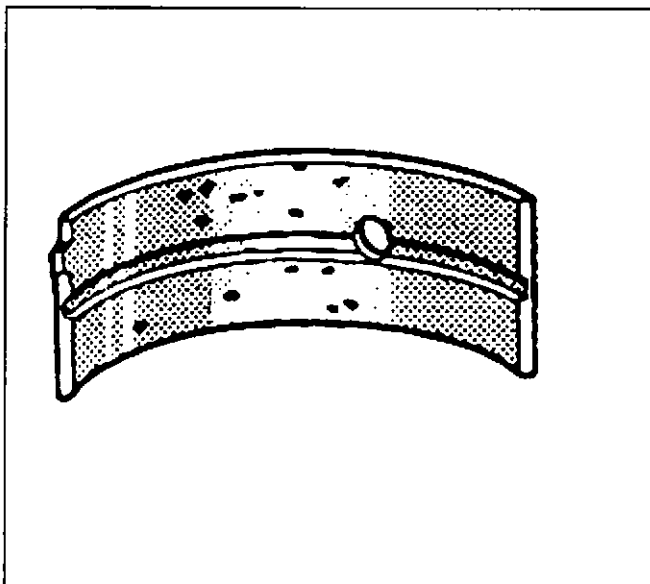
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9. Using a suitable fixture, support the crankshaft.

9.1. Measure the crankshaft runout using J 7872.

9.2. Crankshaft runout should not exceed 0.051 mm (0.002 in).

10. Inspect the crankshaft thrust wall surface for wear and/or excessive runout. Refer to *Engine Mechanical Specifications*.

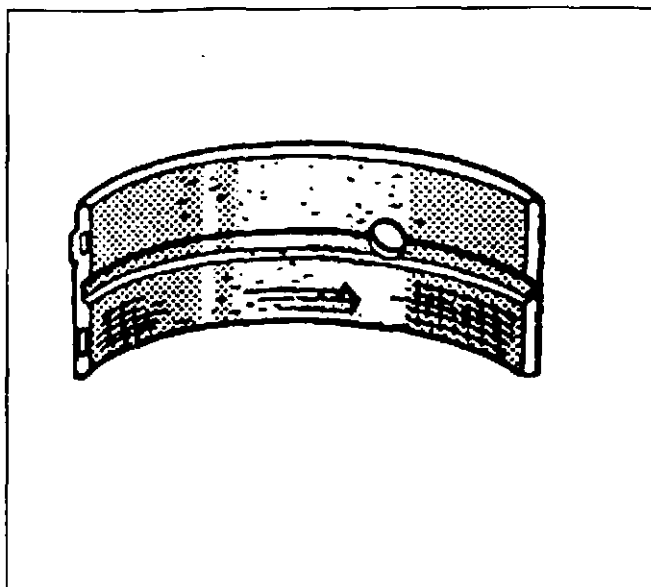
11. Install the engine flywheel locator pin, if removed.

Crankshaft and Connecting Rod Bearing Inspection

Notice: *S10-10 - 5016* Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

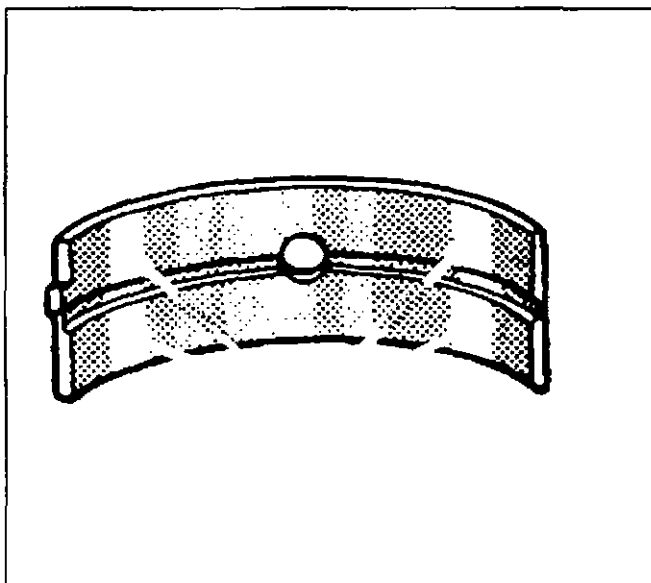
1. Inspect the bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

2. Inspect the bearings for excessive scoring or discoloration.
3. Inspect the bearings for dirt or debris imbedded into the bearing material.



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4. Inspect the bearings for improper seating indicated by bright, polished sections of the bearings.
 - If the lower half of the bearing is worn or damaged, both the 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.



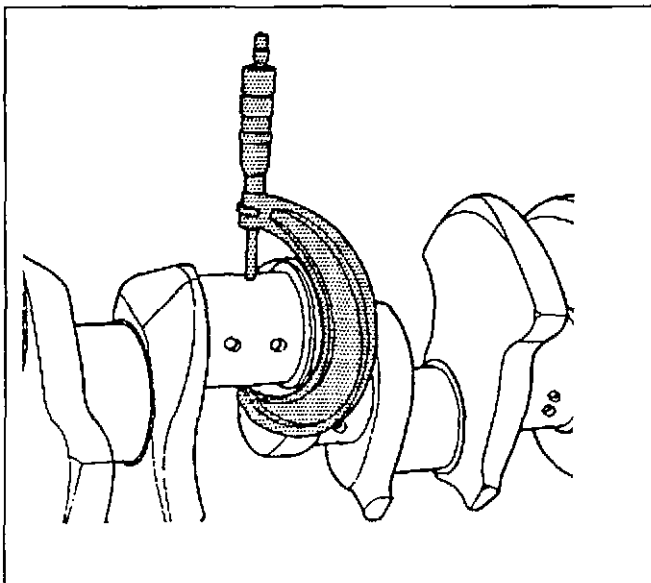
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Crankshaft and Connecting Rod Bearing Clearance Measurement

The crankshaft and connecting rod bearings are of the precision insert type and do not use shims for adjustment. If the clearances are excessive, the new upper and the lower bearings will be required. The service bearings are available in the standard size and an undersize.

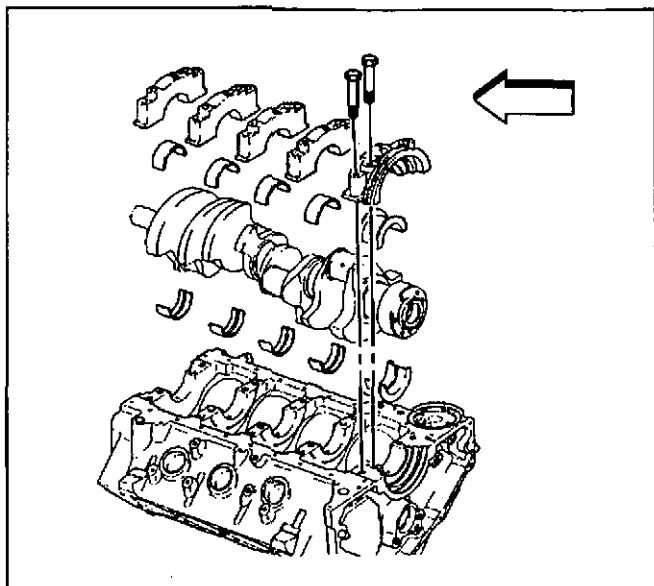
The selective fitting of the bearings are necessary in production in order to obtain close tolerances. For this reason, in one journal bore you may use one-half of a standard bearing with one-half of a undersize bearing.

In order to determine the correct replacement bearing size, the bearing clearance must be measured accurately. Either the micrometer or plastic gauge method may be used, however, the micrometer method gives more reliable results and is preferred.



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Micrometer Method for Crankshaft Bearings



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1. Measure the crankshaft main journal diameter with a micrometer in several places along the length approximately 90 degrees apart, (minimum of 4 places), and average the measurements.
2. Determine the taper and the out of round. Refer to *Engine Mechanical Specifications*.

Notice: *S10-ID - 5016* Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

3. Install the crankshaft bearings into the crankshaft bearing caps and the engine block.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important: Tighten the inner crankshaft bearing cap bolts before to tightening the outer crankshaft bearing cap bolts.

4. Install the crankshaft bearing caps and the crankshaft bearing cap bolts.

Tighten

- 4.1. Tighten the crankshaft bearing cap inner bolts to 138 N·m (102 lb ft).
- 4.2. Tighten the crankshaft bearing cap outer bolts to 138 N·m (102 lb ft).

5. Measure the crankshaft bearing inside diameter (ID) using an inside micrometer. Measure at a minimum of 4 places and average the measurements.
6. In order to determine the crankshaft bearing clearance, subtract the crankshaft journal diameter from the crankshaft bearing ID.
7. Compare the crankshaft bearing clearance to the specifications. Refer to *Engine Mechanical Specifications*.
8. If the crankshaft bearing clearances exceeds specifications, install the new crankshaft bearings.
9. Measure the new crankshaft bearing inside diameter (ID) using an inside micrometer.
10. Replace or repair the crankshaft if the proper clearances cannot be obtained.

Micrometer Method for Connecting Rod Bearings

Notice: SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

1. Measure the crankpin diameter with a micrometer in several places along the length, approximately 90 degrees apart (minimum of 4 places), and average the measurements.
2. Determine the taper and the out-of-round. Refer to *Engine Mechanical Specifications*.
3. Install the connecting rod bearings into the connecting rod cap and the connecting rod.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the connecting rod caps and the nuts.

Tighten

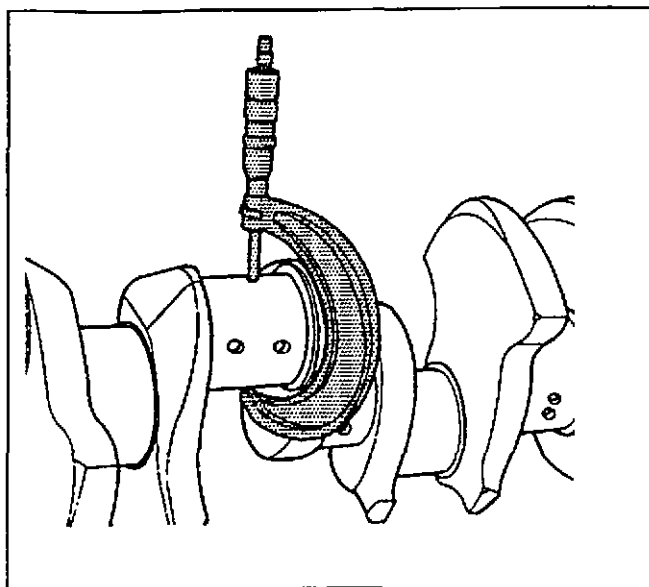
Tighten the connecting rod nuts to 64 N·m (47 lb ft).

5. Measure the connecting rod bearing inside diameter (ID) using an inside micrometer.
6. Compare the connecting rod bearing clearance specifications. Refer to *Engine Mechanical Specifications*.
7. If the connecting rod bearing clearance is within specifications, the connecting rod bearing is satisfactory.
 - If the clearance is not within specifications, replace the connecting rod bearing.
 - Always replace both the upper and the lower connecting rod bearings as an assembly.
8. A standard or undersize connecting rod bearing combination may result in the proper clearance. If the proper connecting rod bearing clearance cannot be achieved using the standard or the undersize connecting rod bearings, it will be necessary to replace or repair the crankshaft.

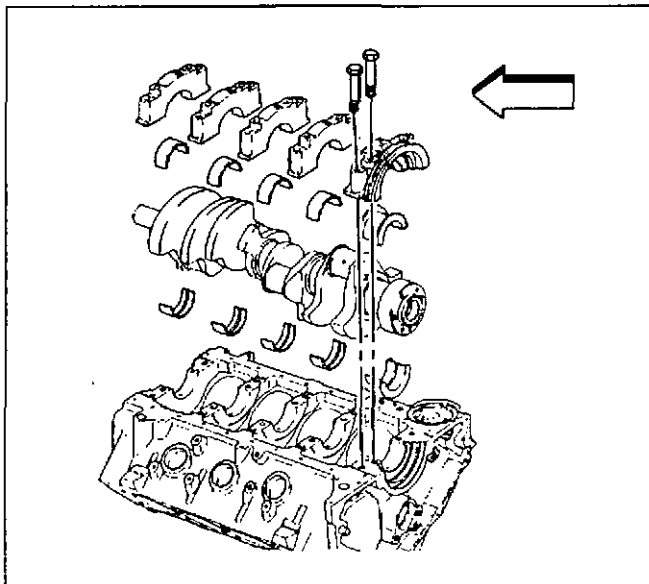
Plastic Gauge Method for Main Bearings

Notice: SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

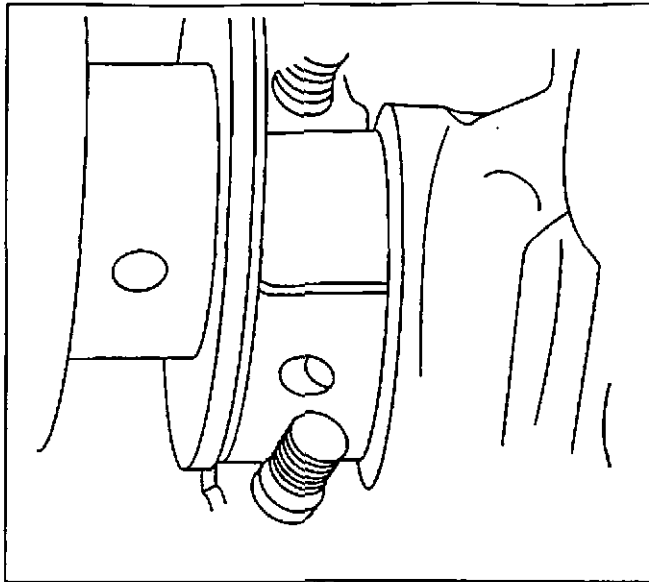
1. Install the crankshaft and crankshaft bearings into the block.



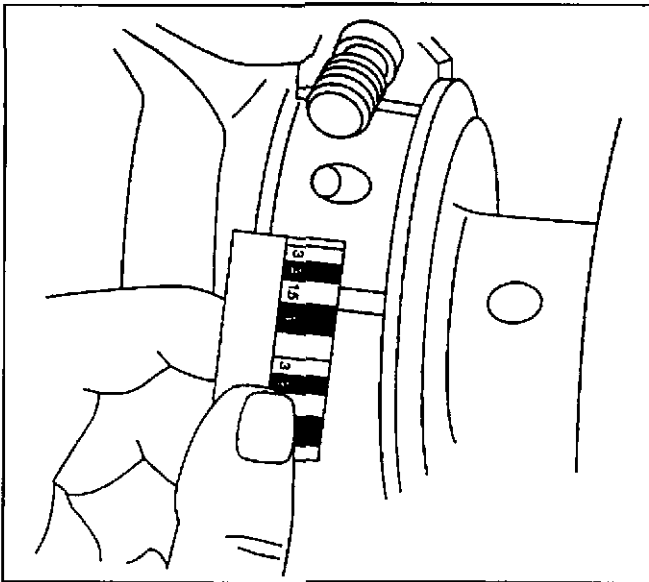
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2. Install the gauging plastic the full width of the crankshaft journal.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important: Tighten the inner crankshaft bearing cap bolts before to tightening the outer crankshaft bearing cap bolts.

3. Install the crankshaft bearing caps and the crankshaft bearing cap bolts.

Tighten

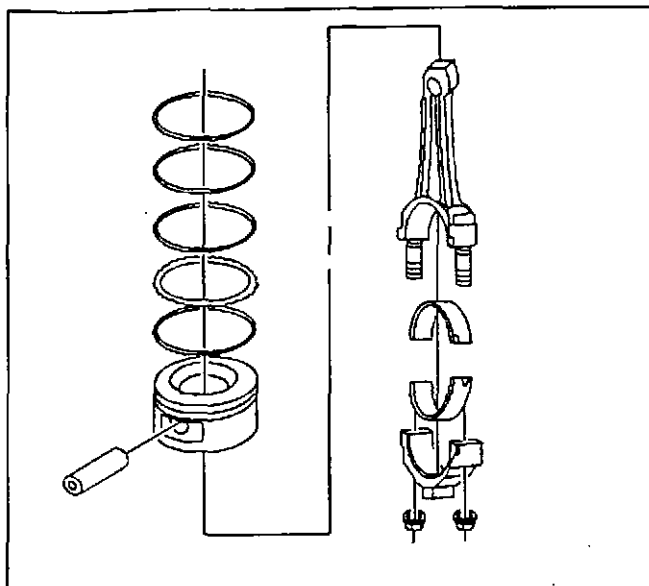
- 3.1. Tighten the crankshaft bearing cap inner bolts to 138 N·m (102 lb ft).
- 3.2. Tighten the crankshaft bearing cap outer bolts to 138 N·m (102 lb ft).
4. Remove the crankshaft bearing cap bolts and crankshaft bearing caps. The gauging plastic may adhere to either the crankshaft journal or the crankshaft bearing surface.
5. On the edge of the gauging plastic envelope there is a graduated scale. Without removing the gauging plastic, measure the compressed width at the widest point.
6. If the flattened gauging plastic tapers toward the middle or the ends, there may be a difference in clearance indicating taper, low spot or other irregularity of the crankshaft bearing or the crankshaft journal.
 - Normally the crankshaft journals wear evenly and are not out of round. However, if a crankshaft bearing is being fitted to an out of round 0.0254 mm (0.001 in maximum) crankshaft journal, be sure to fit to the maximum diameter of the crankshaft journal.
 - If the crankshaft bearing is fitted to the minimum diameter and the crankshaft journal is excessively out of round, the interference between the crankshaft bearing and the crankshaft journal will result in rapid crankshaft bearing failure.
- Notice:** SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.
7. If the crankshaft bearing clearance is within specifications, the crankshaft bearing is satisfactory.
 - If the clearance is not within specifications, replace the crankshaft bearing.
 - Always replace both the upper and lower crankshaft bearings as a unit.
 - A standard or undersize crankshaft bearing combination may result in the proper clearance. If the proper crankshaft bearing clearance cannot be achieved using the standard or the undersize crankshaft bearings, it may be necessary to repair or replace the crankshaft.
8. Remove the flattened gauging plastic.

9. Measure the remaining crankshaft journals.

Plastic Gauge Method for Connecting Rod Bearings

Notice: S10-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

1. Install the connecting rod bearings into the connecting rod and connecting rod cap.
2. Install the piston and connecting rod assembly onto the crankpin journal.



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3. Install the gauging plastic the full width of the crankpin journal.

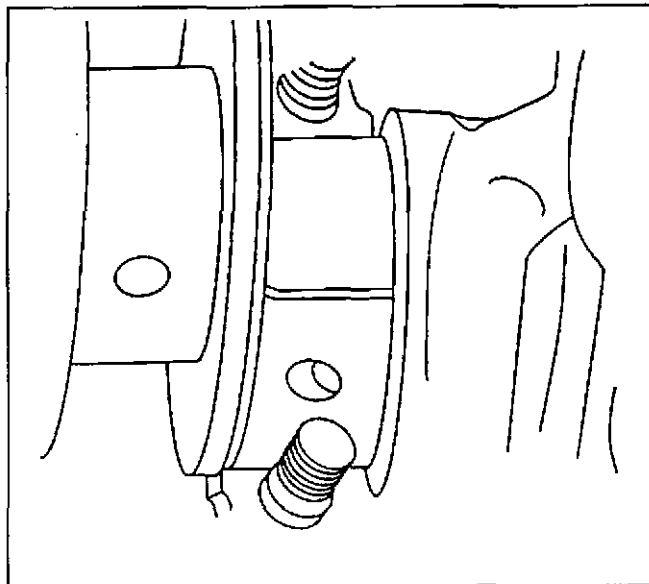
Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the connecting rod caps and nuts.

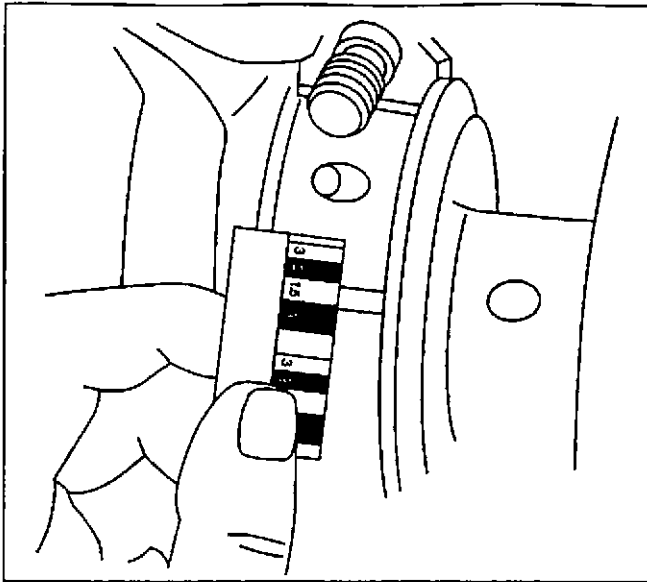
Tighten

Tighten the connecting rod cap nuts to 64 N.m (47 lb ft).

5. Remove the connecting rod cap and nuts. The gauging plastic may adhere to either the crankpin journal or the connecting rod bearing surface.



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6. On the edge of the gauging plastic envelope there is a graduated scale. Without removing the gauging plastic, measure the compressed width at the widest point.
If the flattened gauging plastic tapers toward the middle or the ends, there may be a difference in clearance indicating taper, low spot or other irregularity of the connecting rod bearing or the crankpin journal.

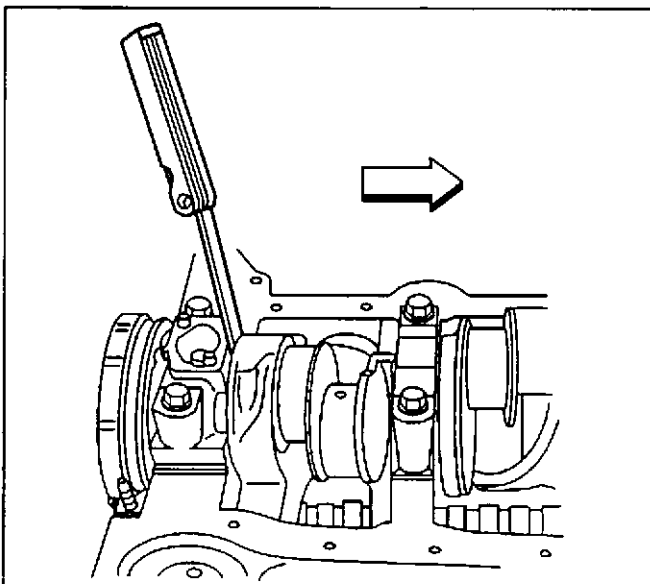
Notice: S10-10 - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

7. Normally the crankpin journals wear evenly and are not out of round. However, if a connecting rod bearing is being fitted to an out-of-round 0.0254 mm (0.001 in. maximum) crankpin journal, be sure to fit to the maximum diameter of the crankpin journal. If the connecting rod bearing is fitted to the minimum diameter and the crankpin journal is excessively out-of-round, the interference between the connecting rod bearing and the crankpin journal will result in rapid connecting rod bearing failure.
8. If the connecting rod bearing clearance is within specifications, the connecting rod bearing is satisfactory.
 - If the clearance is not within specifications, replace the connecting rod bearing.
 - Always replace both the upper and lower connecting rod bearings as a unit.
 - A standard or undersize connecting rod bearing combination may result in the proper clearance. If the proper connecting rod bearing clearance cannot be achieved using the standard or the undersize connecting rod bearings, it may be necessary to repair or replace the crankshaft or connecting rod.
9. Remove the flattened gauging plastic.
10. Measure the remaining crankpin journals.

Measuring Crankshaft End Play

Important: In order to properly measure the crankshaft end play, the crankshaft, bearings, bearing caps, and fasteners must be installed into the engine block and the bolts tightened to specifications.

1. Measure the crankshaft end play.
 - 1.1. Firmly thrust the end of the crankshaft first rearward then forward. This will line up the rear crankshaft bearing and the crankshaft thrust surfaces.
 - 1.2. With the crankshaft pushed forward, insert a feeler gauge between the crankshaft and the bearing surface and measure the clearance. Refer to *Engine Mechanical Specifications*.
 - 1.3. If the correct end play cannot be obtained, inspect for the following conditions:
 - Verify that the correct size crankshaft



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bearing has been installed, refer to *Engine Mechanical Specifications*

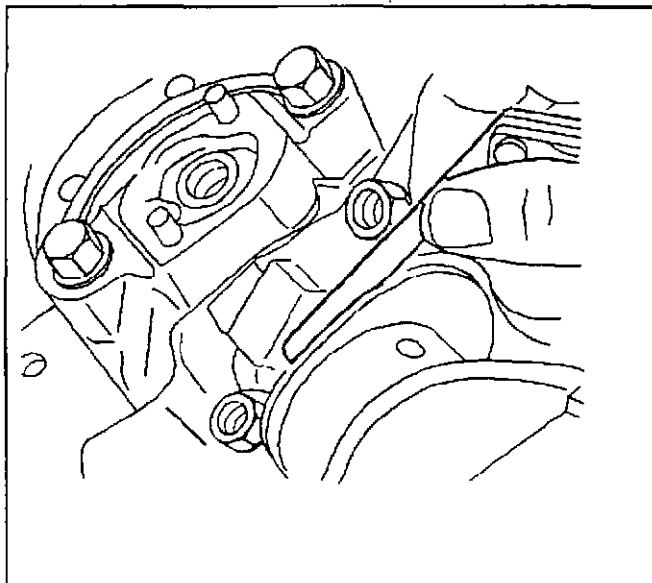
- Inspect the crankshaft thrust wall surface(s) for wear and/or excessive runout, refer to *Engine Mechanical Specifications*

2. Inspect the crankshaft for binding. Turn the crankshaft to check for binding. If the crankshaft does not turn freely, loosen the crankshaft bearing bolts, one cap at a time, until the tight bearing is located. The following condition(s) could cause a lack of clearance at the bearing:

- Burrs on the crankshaft bearing cap
- Foreign matter between the crankshaft bearing and the block or the crankshaft bearing cap
- A faulty crankshaft bearing

Measuring Connecting Rod Side Clearance

1. Insert a feeler gauge between the connecting rod caps and measure the connecting rod side clearance. Refer to *Engine Mechanical Specifications*.
2. Connecting rod clearances may also be measured with a dial indicator set.



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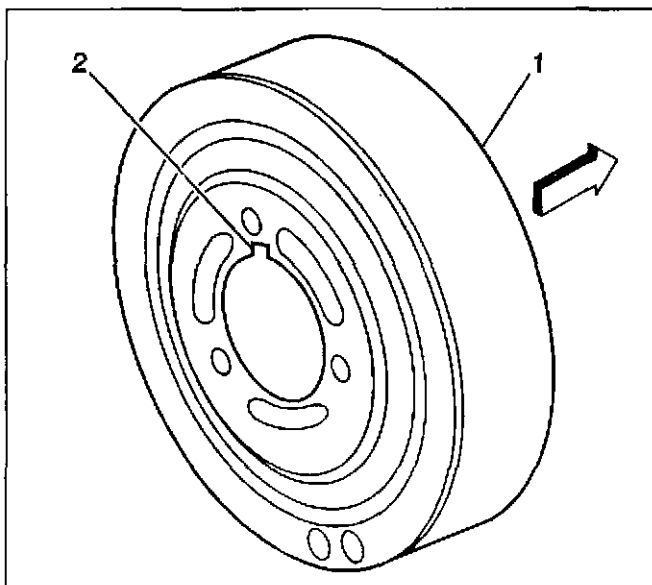
SIE-ID = 311319

Crankshaft Balancer Clean and Inspect

1. Clean the crankshaft balancer (1) in solvent.

Caution: SIO-ID = 5011 **Wear safety glasses in order to avoid eye damage.**

2. Dry the crankshaft balancer with compressed air.
3. Inspect the crankshaft balancer for the following:
 - 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 a polishing compound or fine grade emery cloth.
 - Worn, chunking, or deteriorated rubber between the hub and pulley
 - Worn or damaged keyway (2)



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SIE-ID - 198447

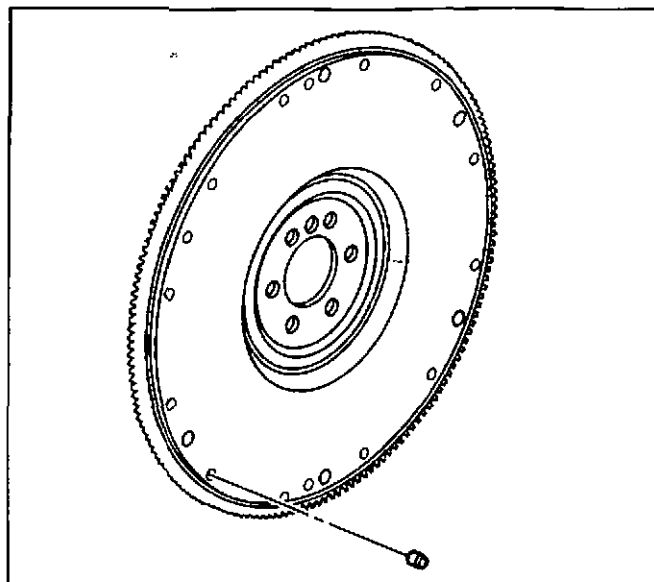
Engine Flywheel Clean and Inspect

1. Clean the engine flywheel in solvent.

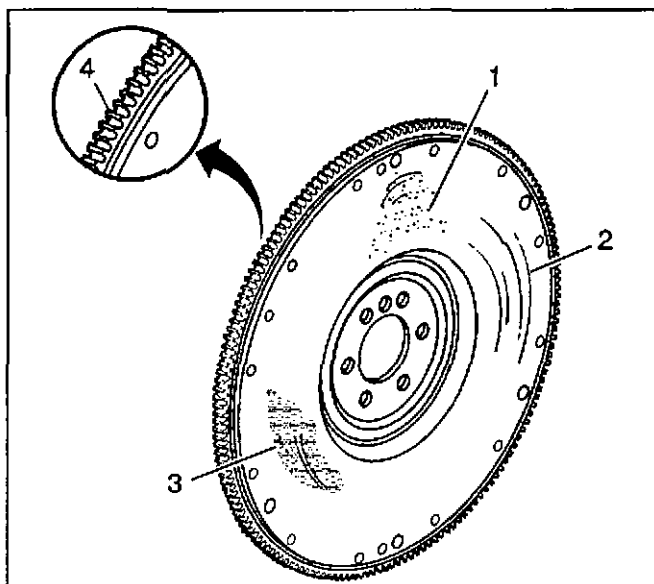
Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

2. Dry the engine flywheel with compressed air.
3. Inspect the manual transmission engine flywheel for loose or improperly installed balance weights.

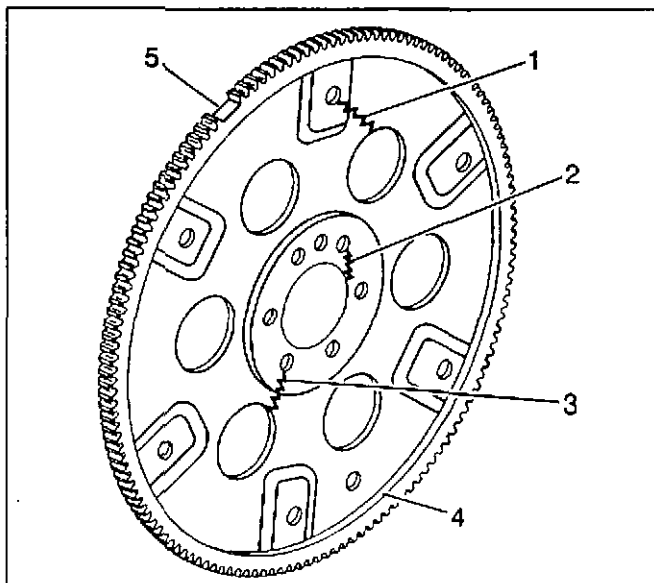
A properly installed balance weight should be installed until flush or below flush with the face of the engine flywheel.



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4. Inspect the manual transmission engine flywheel for the following conditions:

- Pitted surface (1)
- Scoring or grooves (2)
- Rust or other surface damage (3)
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

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

5. Inspect the automatic transmission engine flywheel for the following conditions:

- Stress cracks around the engine flywheel-to-torque converter mounting bolt hole locations (1) and/or engine flywheel-to-crankshaft (2, 3)

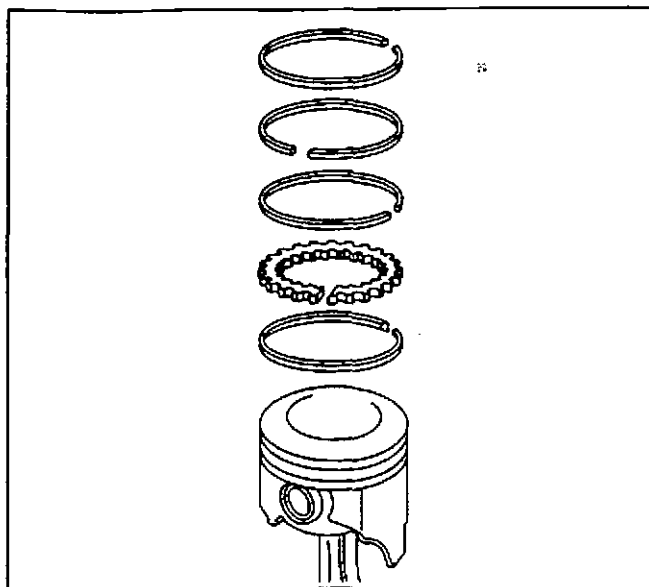
Important: Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel plate. Install a new engine flywheel.

- Cracks at welded areas that retain the ring gear onto the engine flywheel (4)
- Damaged or missing ring gear teeth (5)

SIE-ID = 198478

Piston and Connecting Rod Disassemble**Tools Required***J 24086-C* Piston Pin Remover and Installer

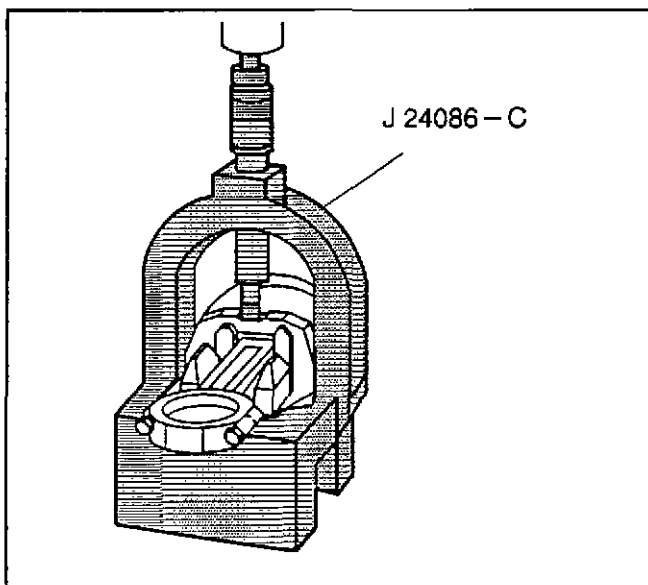
1. Remove the piston rings from the pistons.



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2. Press the pin from the connecting rod by using *J 24086-C*.

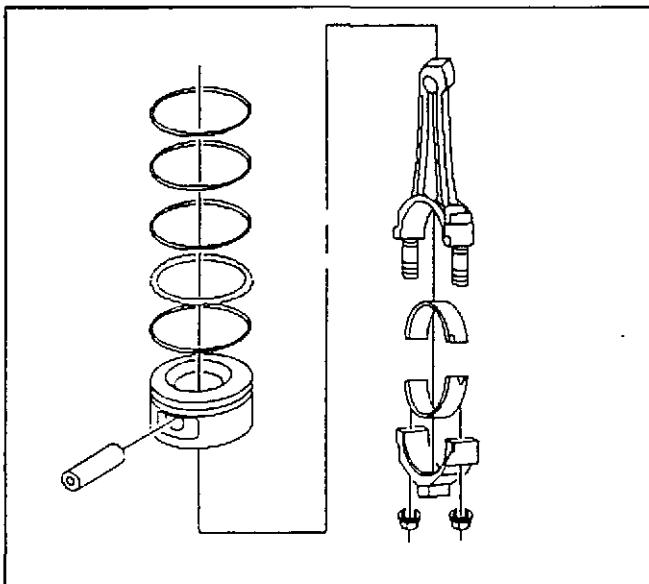
The piston pin has an interference fit into the connecting rod and is full floating in the piston.



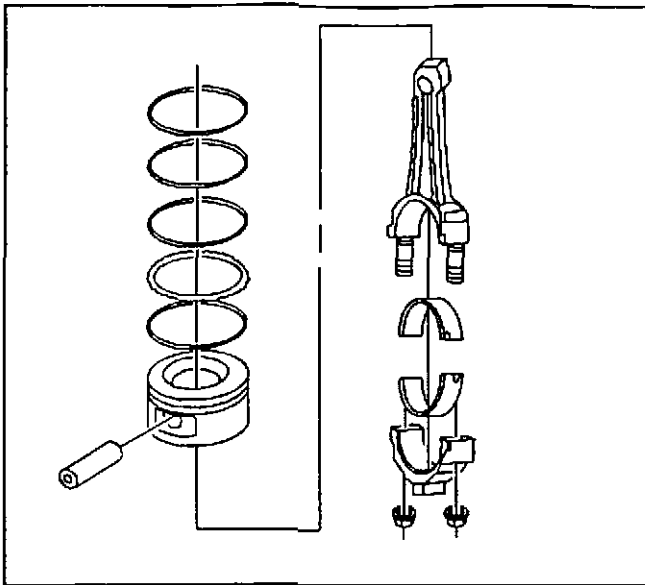
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Notice: SIO-ID = 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

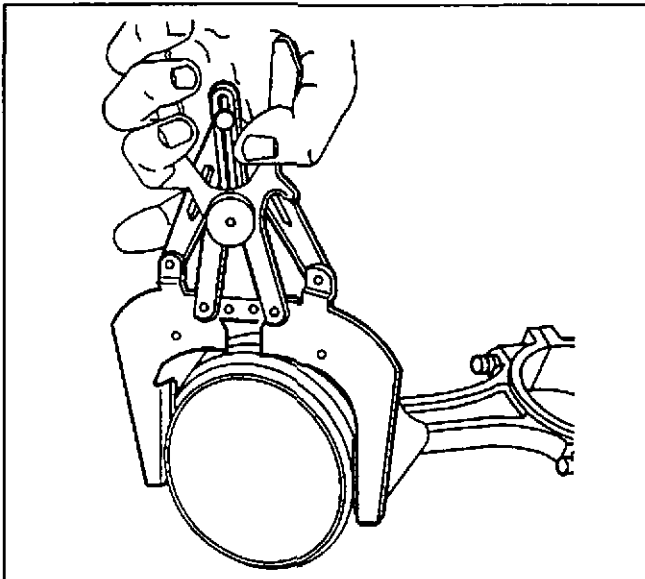
3. If the bearings will be reused, place the bearings in a rack in order to ensure reinstallation with the original connecting rod and the cap.



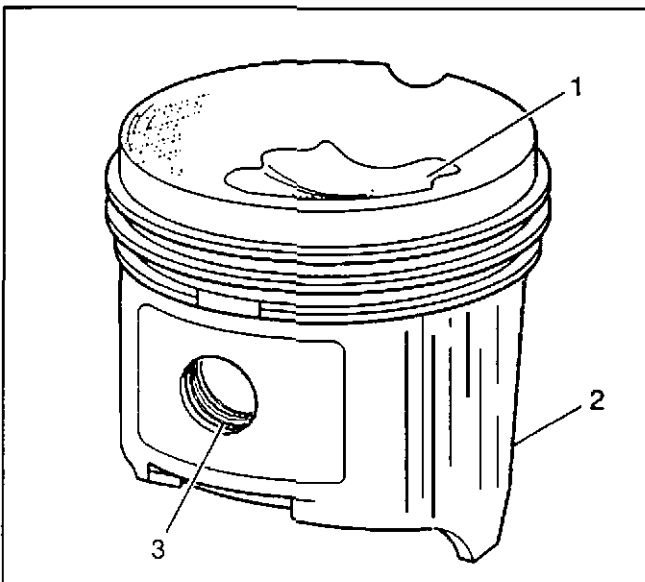
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S/E-ID - 198525

Piston, Connecting Rod and Bearings Clean/Inspect

Important: Measurement of all components should be taken with the components at room temperature. Do not use a wire brush in order to clean any part of the piston.

1. Clean the piston and connecting rod in solvent.

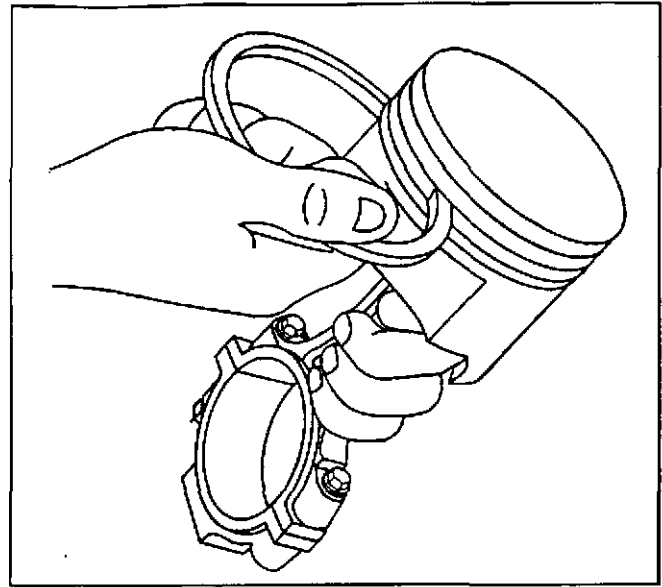
Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

2. Dry the components with compressed air.

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.

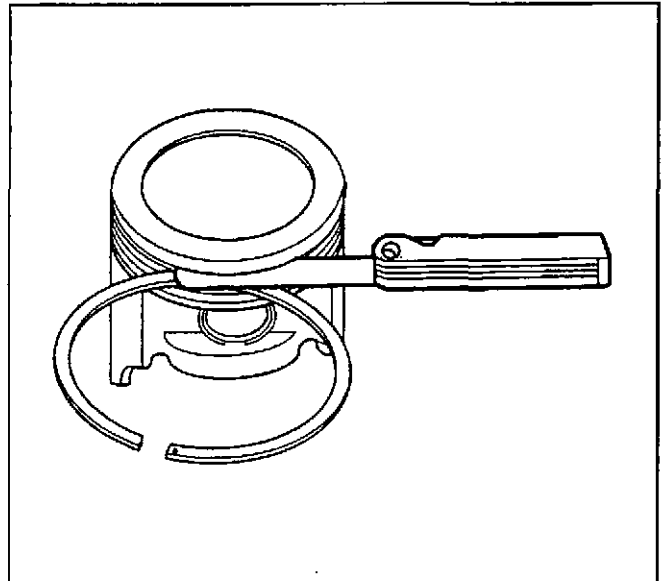
4. Clean the piston oil lubrication holes and slots.
5. Inspect the piston for the following conditions:
 - Eroded areas (1) on the top of the piston
 - Scuffed or damaged skirt (2)
 - Damage to the pin bore (3)
 - Cracks in the piston ring lands, the piston skirt, or the pin bosses
 - Piston ring grooves for nicks, burrs, or other warpage which may cause the piston ring to bind.
6. Inspect the piston pin for scoring, wear or other damage.

7. Measure the piston ring-to-piston ring groove side clearance. Refer to *Engine Mechanical Specifications*.
 - 7.1. Insert the edge of the piston ring into the piston ring groove.
Roll the piston ring completely around the piston.
 - 7.2. If binding is caused by a distorted piston ring groove, MINOR imperfections may be removed with a fine file.
 - 7.3. If binding is caused by a distorted piston ring, replace the piston ring.



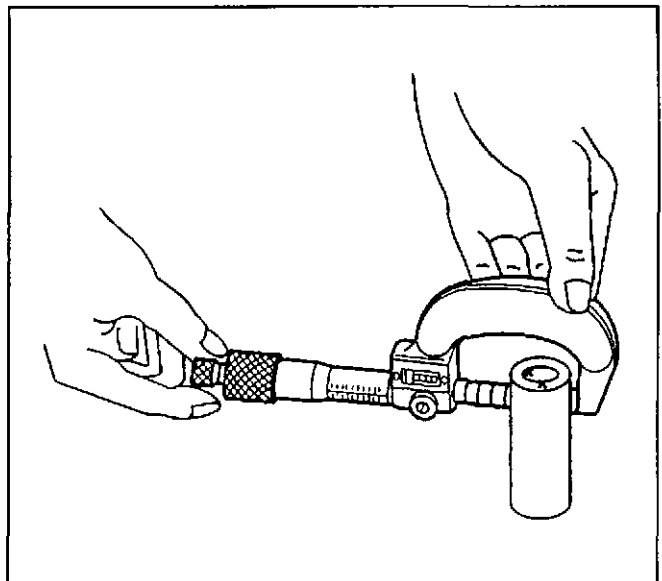
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8. Measure the piston ring side clearance with a feeler gauge.
9. If the side clearance is too small, try another piston ring set. Refer to *Engine Mechanical Specifications*.
10. If the proper piston ring-to-piston ring groove clearance cannot be achieved, replace the piston and pin assembly.

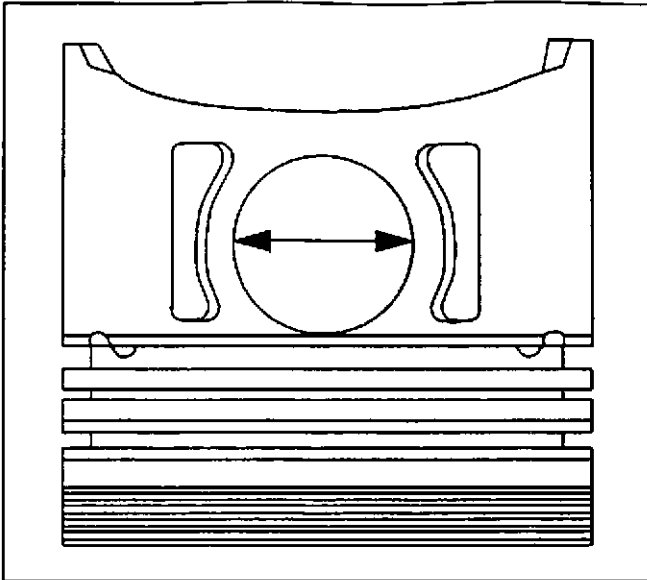


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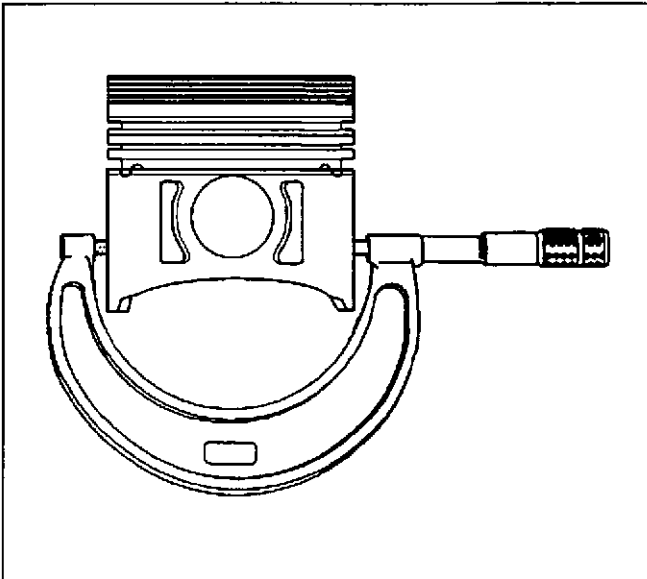
11. To determine piston pin-to-bore clearance use a micrometer and measure the piston pin.



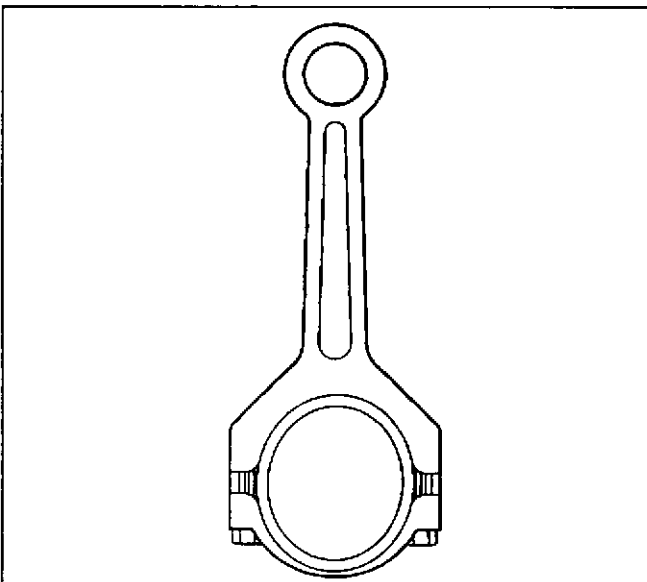
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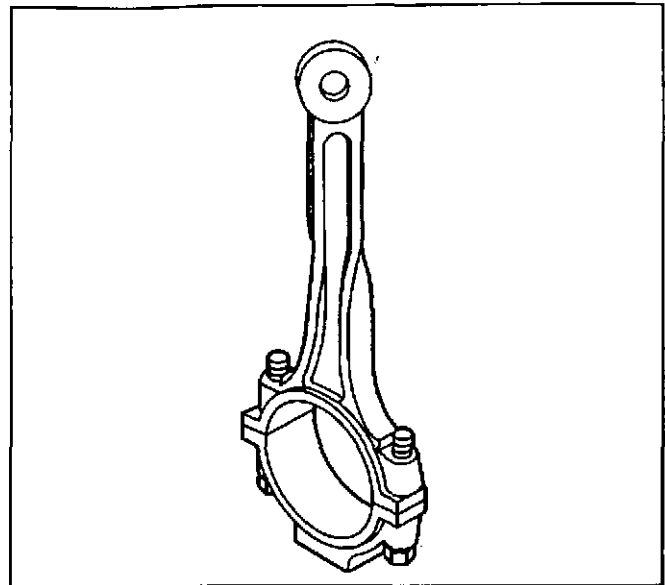
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12. To determine piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore.
13. To determine the piston pin-to-bore clearance, subtract the piston pin diameter from the piston pin bore diameter.

14. Measure the piston for out-of-round.
 - 14.1. With a micrometer at a right angle to the piston, measure the piston at 11 mm (0.433 in) from the bottom of the skirt.
 - 14.2. Measure the piston at three different points 120 degrees apart and compare the readings. Refer to *Engine Mechanical Specifications*.
 - 14.3. If the clearance is not within specifications, replace the piston and pin as an assembly.

15. Inspect the connecting rod for an out-of-round bearing bore.

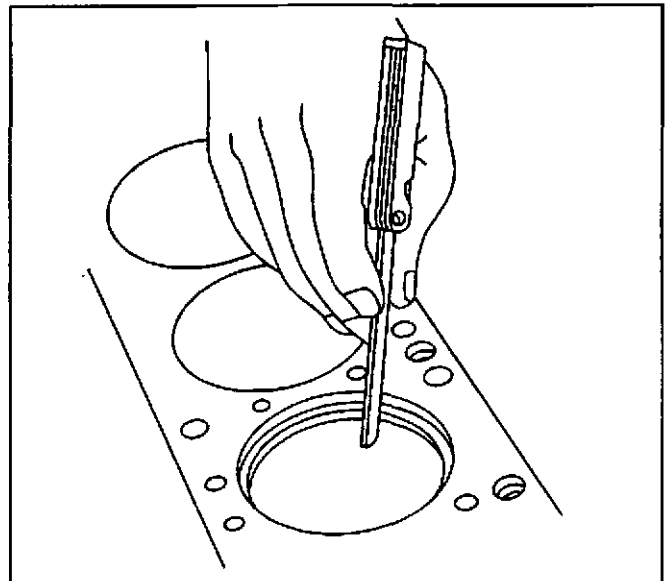
16. Inspect the connecting rod for twisting.
17. Inspect the connecting rod for damage the to the bearing cap stud threads.



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Important: Fit each compression ring to the cylinder in which it will be used.

18. Measure the piston compression ring end gap.
 - 18.1. Place the compression ring into the cylinder bore.
 - 18.2. Push the compression ring into the cylinder bore to approximately 6.5 mm (0.25 in) above the ring travel. The ring must be square to the cylinder wall.
 - 18.3. Use a feeler gage in order to measure the end gap.
 - 18.4. Select another size ring set if the end gap exceeds specifications.



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SIE-ID - 198614

Piston Selection

Tools Required

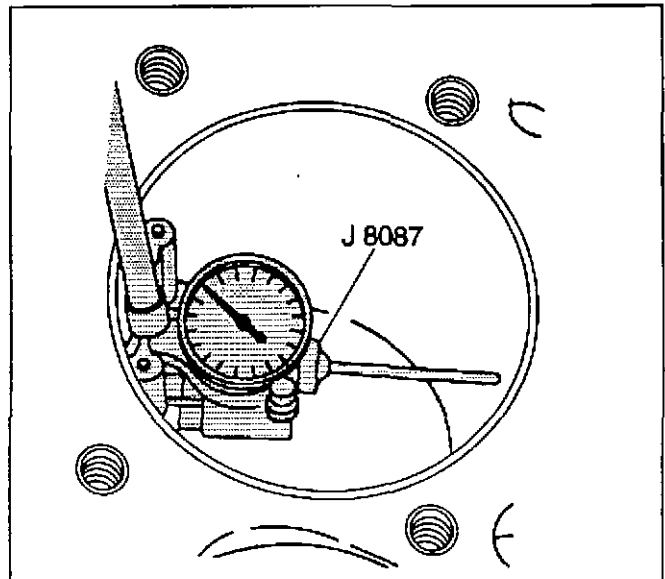
J 8087 Cylinder Bore Checking Gauge

Important: Measurements of all components should be taken with the components at normal room temperature.

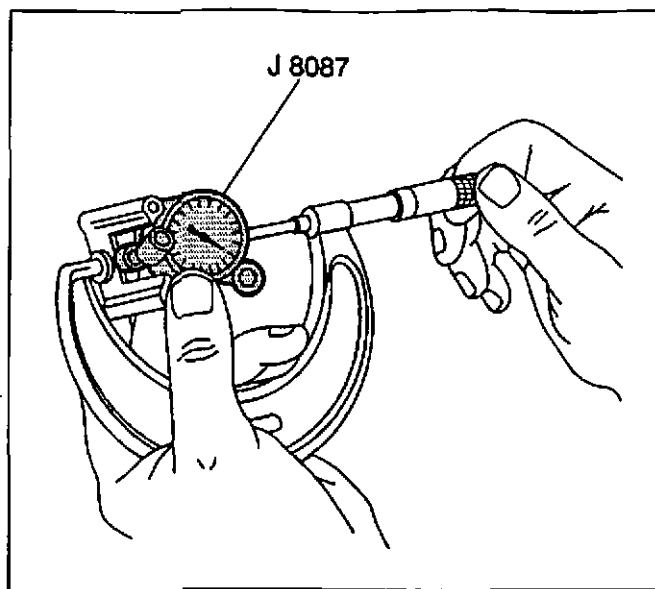
For proper piston fit, the engine block cylinder bores should not have excessive wear or taper.

A used piston and pin set may be reinstalled if, after cleaning and inspection, they are within specifications.

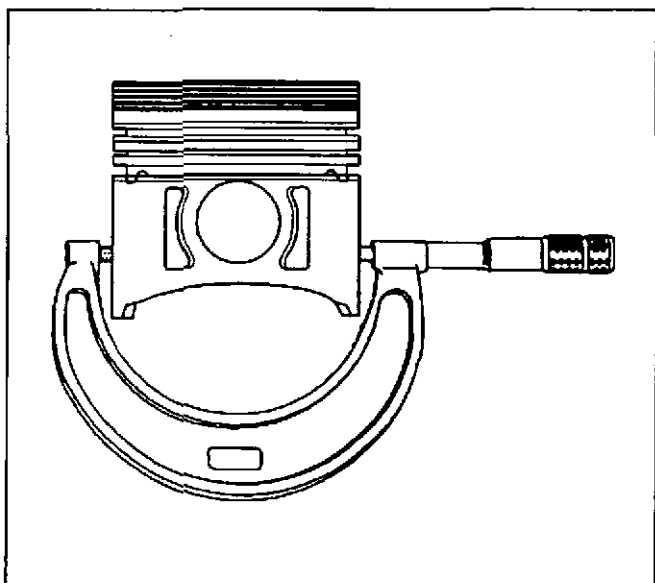
1. Inspect the engine block cylinder bore. Refer to *Cylinder Boring and Honing*.
2. Inspect the piston and pin. Refer to *Piston, Connecting Rod and Bearings Clean/Inspect*.
3. Use the J 8087 and measure the cylinder bore diameter. Measure at a point 64 mm (2.5 in) from the top of the cylinder bore.



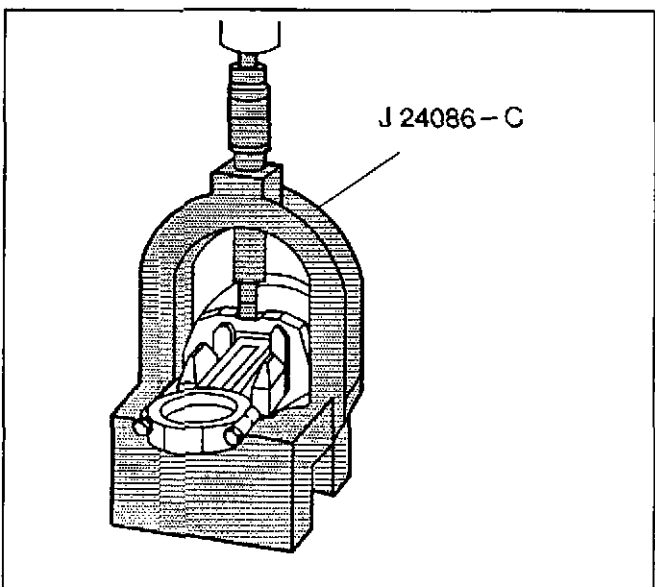
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4. Measure the bore gauge with a micrometer and record the reading.

5. With a micrometer or caliper at a right angle to the piston, measure the piston 11 mm (0.433 in) from the bottom of the skirt.
6. Subtract the piston diameter from the cylinder bore diameter in order to determine piston-to-bore clearance. Refer to *Engine Mechanical Specifications*.
7. If the proper clearance cannot be obtained, select another piston and measure the clearances.
If the proper fit cannot be obtained, the cylinder bore may require honing or boring.
8. When the piston-to-cylinder bore clearance is within specifications, permanently mark the top of the piston for installation into the proper cylinder.

SIE-ID - 195097

Piston and Connecting Rod Assemble

Tools Required

J 24086-C Piston Pin Remover/Installer

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

Notice: SIO-ID - 38775 After the J 24086-C installer hub bottoms on the support assembly, DO NOT exceed 35 000 kPa (5,000 psi) or the tool may be damaged.

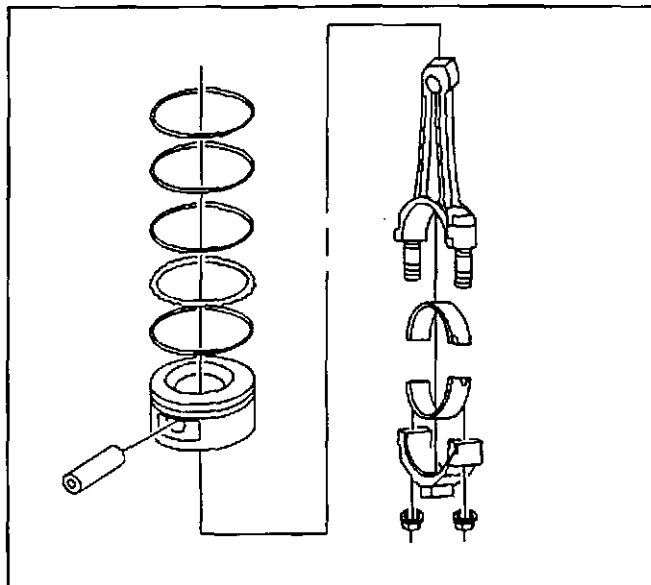
Important: When assembling the piston and connecting rod, the mark on the top of the piston must point to the front of the engine block. The left bank connecting rods should have the flange face toward the front of the engine block. The right bank connecting rods should have the flange face toward the rear of the engine block.

The piston pin has an interference fit into the connecting rod and is full floating in the piston.

1. Install the piston pin and connecting rod assembly.
 - 1.1. Lubricate the piston and connecting rod pin bores with clean engine oil.
 - 1.2. Press the piston pin into the piston and connecting rod assembly using the *J 24086-C*.
 - 1.3. Inspect for the proper installation of the piston and piston pin.
The piston should move freely on the piston pin with no binding or interference.

Notice: *SIO-ID - 16608* Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

2. Install the piston rings onto the piston.
 - 2.1. Install the oil control ring spacer.
 - 2.2. Install the lower oil control ring.
 - 2.3. Install the upper oil control ring.
 - 2.4. Install the lower compression ring.
The mark on the side of the piston ring should face the top of the piston.
 - 2.5. Install the upper compression ring.
The mark on the side of the piston ring should face the top of the piston.
3. Space the compression ring end gaps 120 degrees apart.
4. Space the oil control ring end gaps a minimum of 90 degrees apart.



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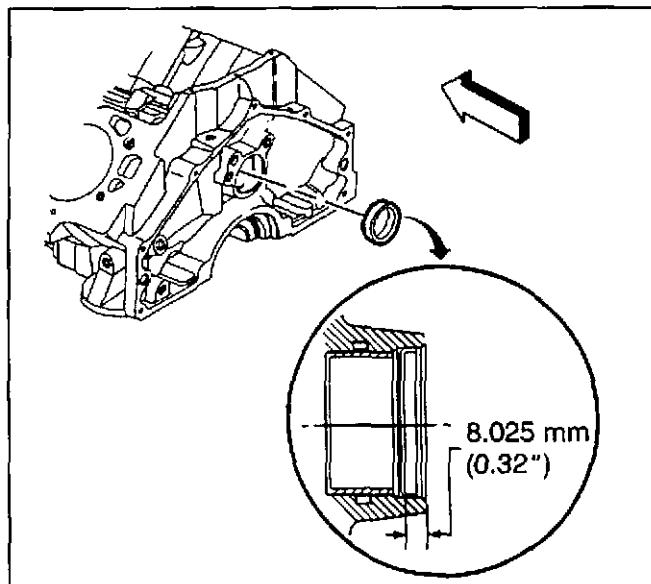
SIE-ID - 198752

Camshaft Bearing Removal

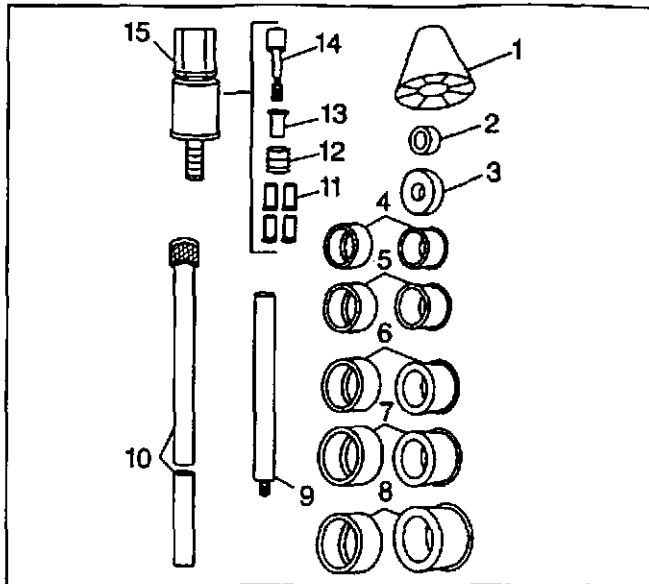
Tools Required

J 33049 Camshaft Bearing Remover/Installer

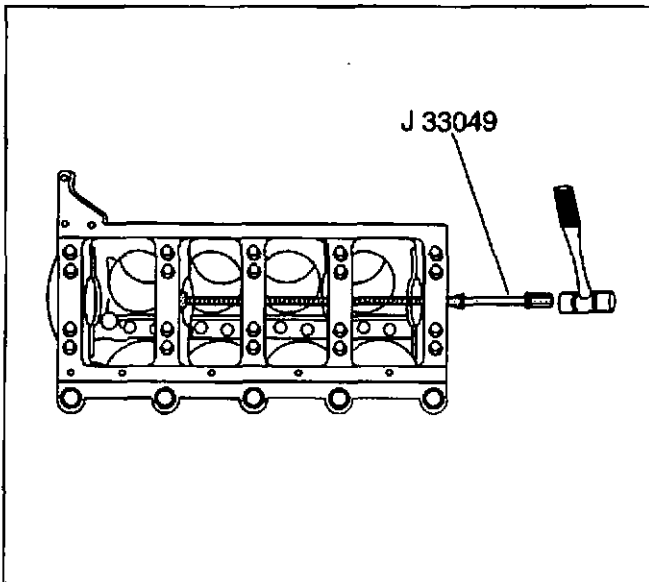
1. Remove the rear camshaft plug.
Insert a long bar through the front of the engine and drive the plug out of the rear bore.
- Important:** A loose camshaft bearing may be caused by an enlarged, out-of-round, or damaged engine block bearing bore.
2. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores.



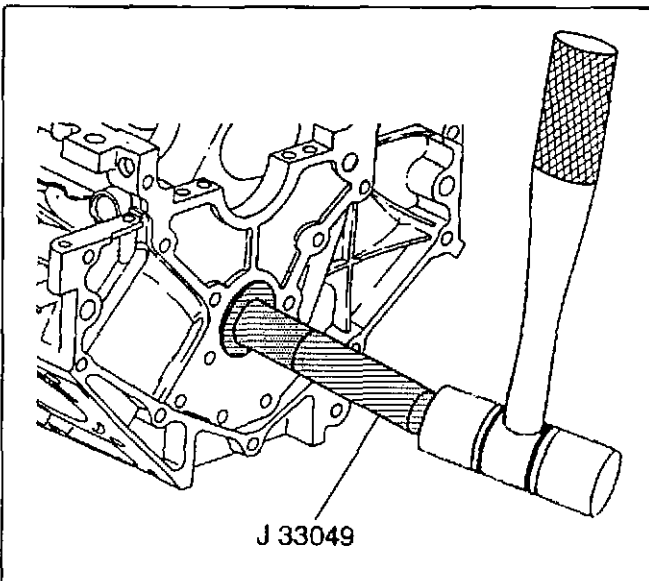
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3. Select the expanding driver (4-8) and washer (2 or 3) from the J 33049.
4. Assemble the J 33049.

Important: Remove the inner bearings (positions 2, 3, and 4) first. The outer bearings (positions 1 and 5) serve as a guide for the J 33049.

5. Insert the J 33049 through the front of the engine block and into the bearing.
6. Tighten the expander assembly nut (15) until snug.
7. Push the guide cone (1) into the front camshaft bearing (position 1) to align the J 33049.
8. Drive the inner bearings (positions 2, 3, and 4) from their block bores.
9. Assemble the J 33049 handle (10), expanding driver (4-8), and washer (2 or 3).
10. Insert the J 33049 into the outer camshaft bearings (positions 1 or 5).
11. Drive the outer bearings (positions 1 or 5) from the bore.

SIE-ID - 198875

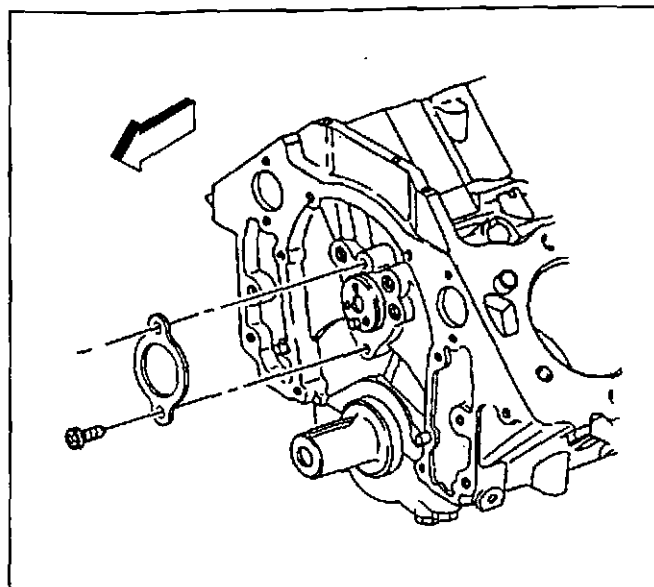
Camshaft and Bearings Clean and Inspect**Tools Required**

J 7872 Magnetic Base Dial Indicator Set

1. Clean the camshaft in solvent.

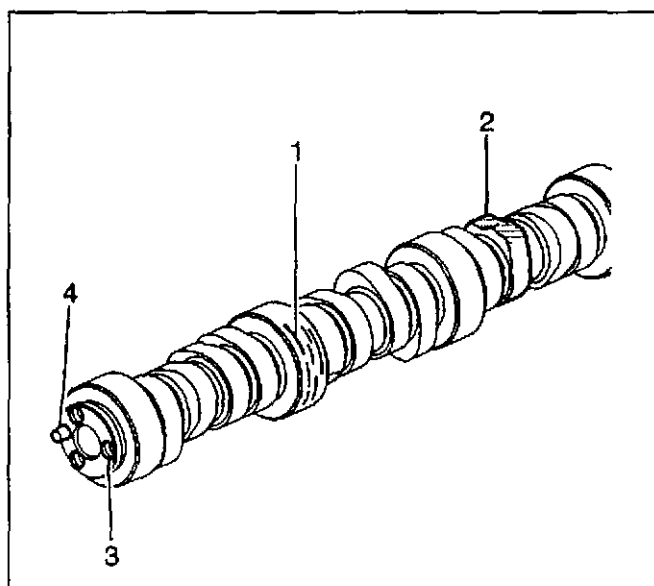
Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

2. Dry the camshaft with compressed air.
3. Inspect the camshaft retainer plate for damage.



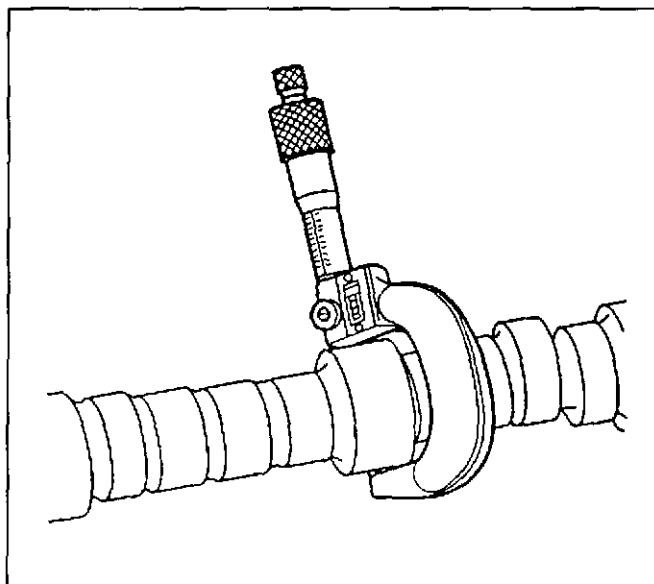
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4. Inspect the camshaft for the following conditions:
 - camshaft bearing journals (1) that are:
 - Worn
 - Scored
 - Damaged
 - Worn camshaft lobes (2)
 - Damaged sprocket bolt threads (3)
 - Damaged sprocket pin (4)



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5. Measure the camshaft journals with a micrometer. Refer to *Engine Mechanical Specifications*.
6. Measure for a bent camshaft or excessive camshaft runout using J 7872.
 - 6.1. Mount the camshaft in a suitable fixture.
 - 6.2. Use the J 7872 in order to measure for a bent camshaft. Refer to *Engine Mechanical Specifications*.
7. Replace the camshaft if runout exceeds specifications.



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SIE-ID - 198970

Camshaft Bearing Installation**Tools Required**

J 33049 Camshaft Bearing Remover/Installer

Important: The outer camshaft bearings (positions 1 and 5) must be installed first. These bearings serve as guides for the tool and help center the inner bearings during the installation process.

Ensure the correct camshaft bearing fits into the proper bore. The cam bearing bores may vary in size.

Ensure that the camshaft bearing lubrication hole or holes align with the oil gallery hole or holes in the block. On some engines, the oil holes may be difficult to see. Verify that the holes are aligned.

1. Assemble the tool handle (10), expanding driver (4-8), and washer (2 or 3).

2. Insert the J 33049 tool into the engine block end camshaft bearings (positions 1 or 5).

Notice: SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

Important: The camshaft bearing oil holes must align with the oil galleries in the engine block.

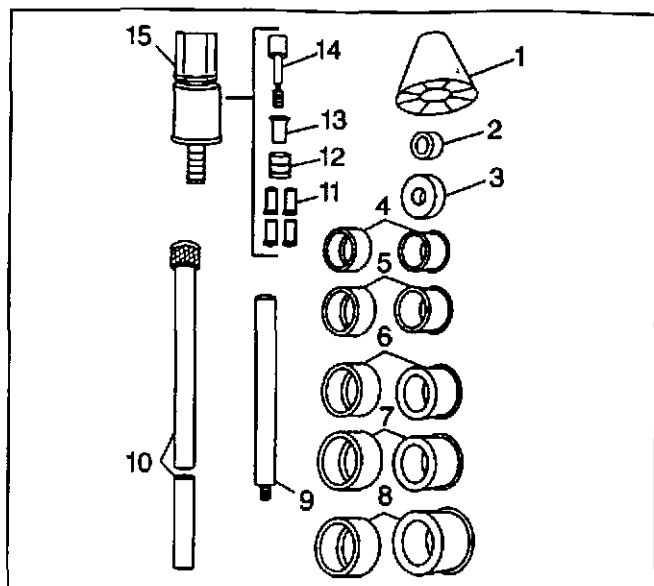
After installation of the camshaft bearings, inspect the camshaft bearing oil holes for proper alignment with the oil galleries.

An improperly aligned camshaft bearing oil gallery hole will restrict oil flow to the bearing and the camshaft journal.

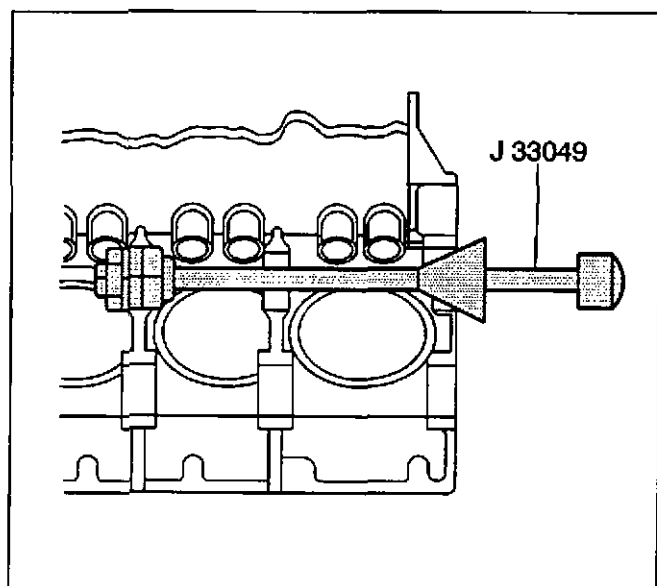
3. Drive the end bearings (positions 1 and 5) into the bore.

4. Select the expanding driver (4-8) and washer (2 or 3) from the J 33049.

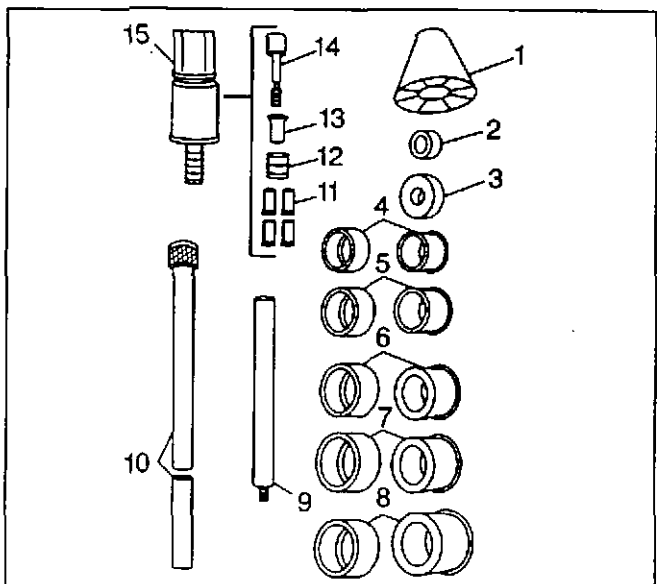
5. Assemble the tool.



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6. Insert the J 33049 tool through the front of the engine block and to the inner bearing bores (positions 2, 3, and 4).
7. Install the bearing onto the expanding driver (4-8).
8. Tighten the expander assembly nut (15) until the tool is snug in the bearing.

Important: The camshaft bearing oil holes must align with the oil galleries in the engine block.

After installation of the camshaft bearings, inspect the camshaft bearing oil holes for proper alignment with the oil galleries.

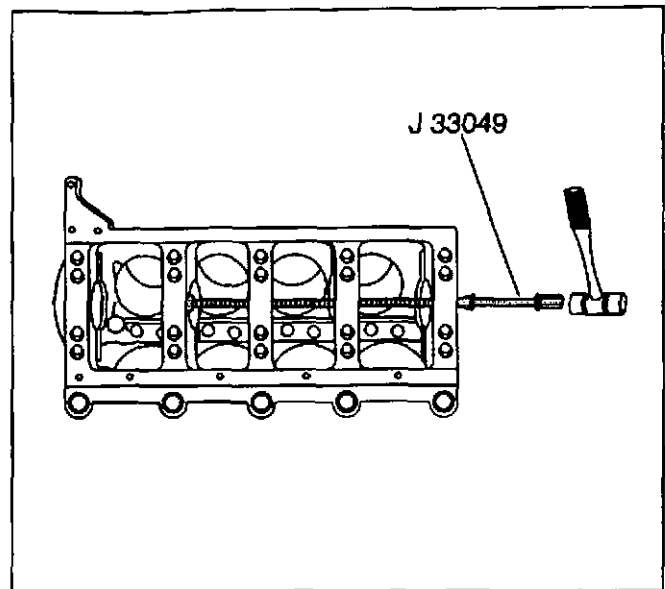
An improperly aligned camshaft bearing oil gallery hole will restrict oil flow to the bearing and the camshaft journal.

9. Align the oil lubrication hole in the bearing with the oil galleries in the engine block.
10. Push the guide cone (1) into the front camshaft bearing bore to align the tool.
11. Drive the bearing into the bore.

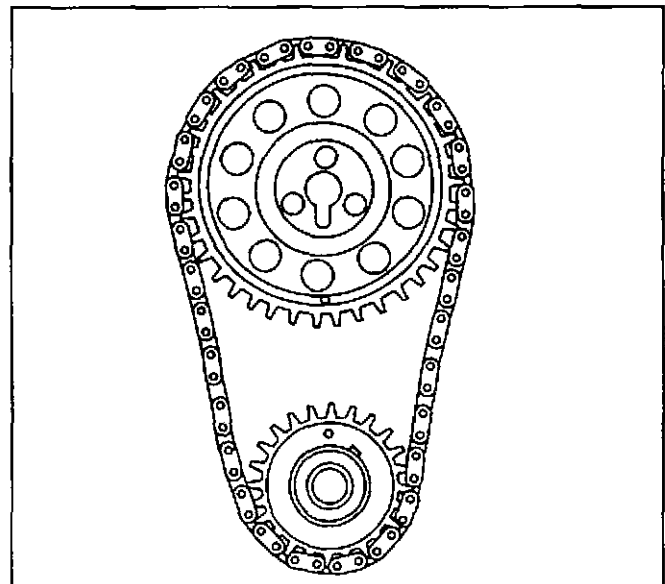
SIE-ID - 199175

Timing Chain and Sprockets Clean and Inspect

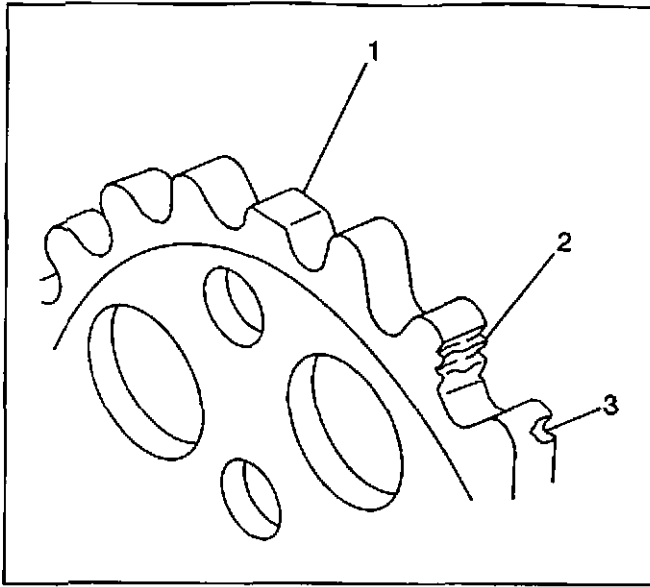
1. Clean the camshaft timing components in solvent.
- Caution:** SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*
2. Dry the components with compressed air.
 3. Inspect the camshaft timing chain for binding or wear.



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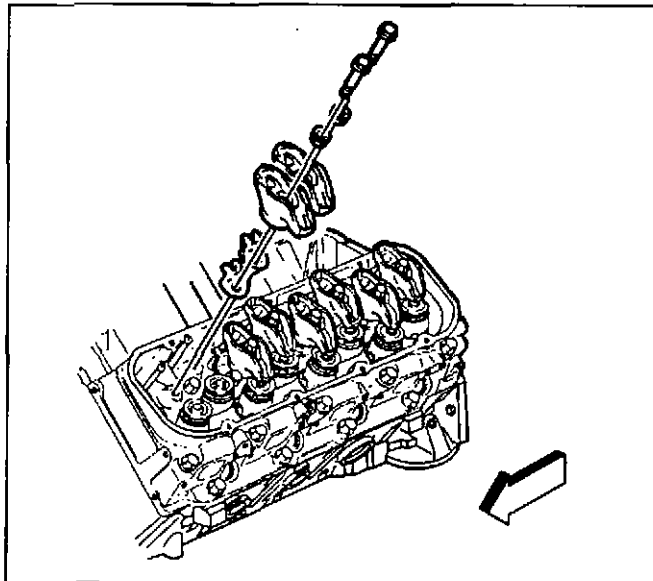
188097

4. Inspect the camshaft and crankshaft sprockets for the following conditions:
 - Worn teeth (1)
 - Damaged teeth (2)
 - Chipped teeth (3)
 - Uneven wear on one edge of the teeth
 - Worn valleys between the sprocket teeth
 - Crankshaft sprocket keyway for wear
 - Crankshaft sprocket key for wear or damage

SIE-ID - 199277

Valve Rocker Arm and Push Rods Clean and Inspect

Important: Parts that are to be reused must remain sorted or organized in order to return them to their original location.



354070

1. Clean the components with cleaning solvent.

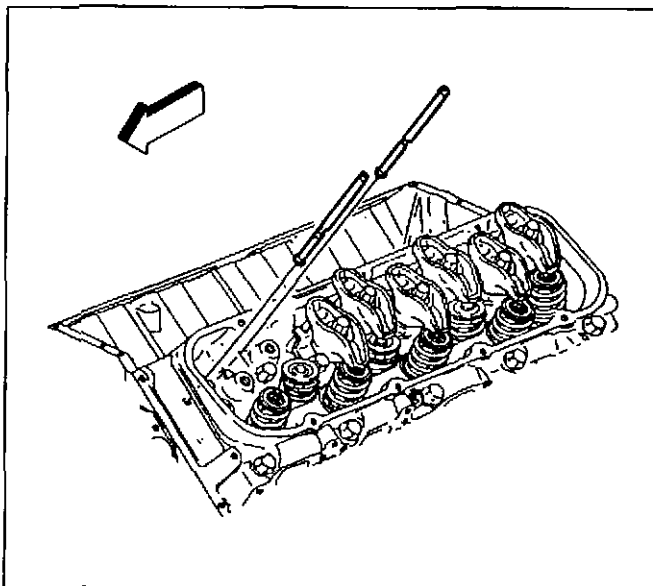
Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**
2. Dry the components with compressed air.
3. Inspect the valve rocker arms for wear or scoring in the ball area.
4. Inspect the valve rocker arm pushrod sockets and valve stem tip mating surfaces.
5. Inspect the valve rocker arm ball for wear or scoring.

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.

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

8. Inspect the pushrod oil passages for restrictions.
 - Clean out the pushrod tube with compressed air.
 - Visually look through the pushrod tube for obstructions, a clear pushrod will allow light through.
 - Replace pushrod(s) that cannot be cleaned out.



202196

SIE-ID - 199299

Valve Lifters and Guides Clean and Inspect

Important: Parts that are to be reused must remain sorted or organized in order to return them to their original location.

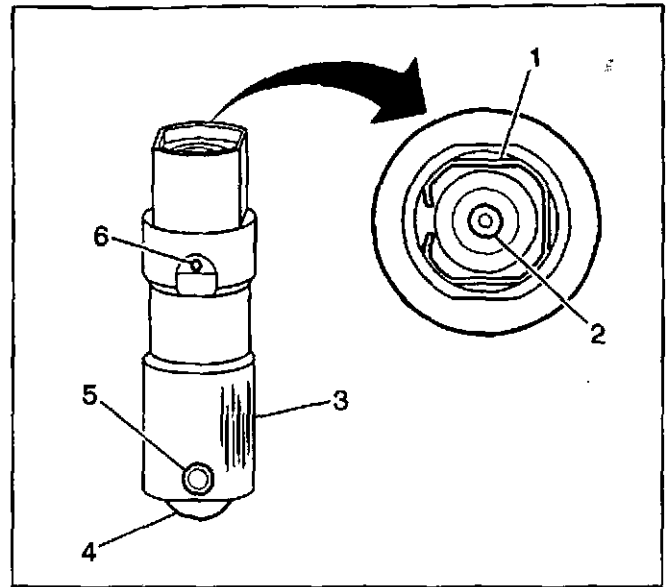
1. Clean the components in cleaning solvent.

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

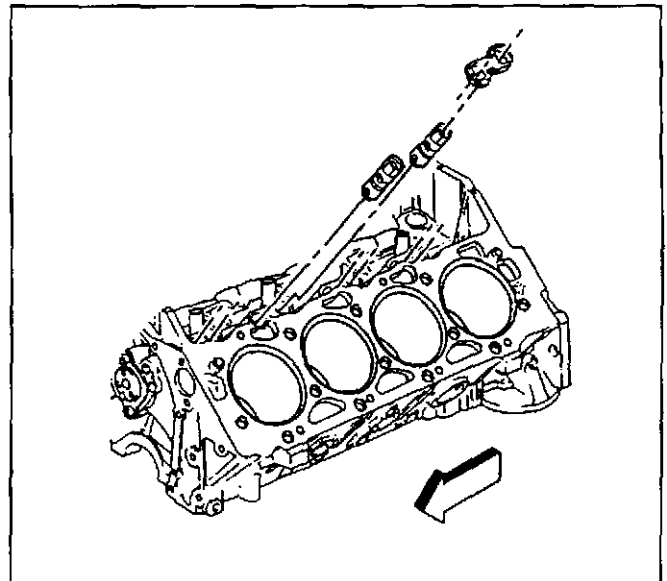
2. Dry the components with compressed air.
3. Inspect the valve lifters for the following:
 - A damaged or broken clip (1)
 - A scored or worn pushrod socket (2)
 - A severely scuffed or worn lifter body (3)

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

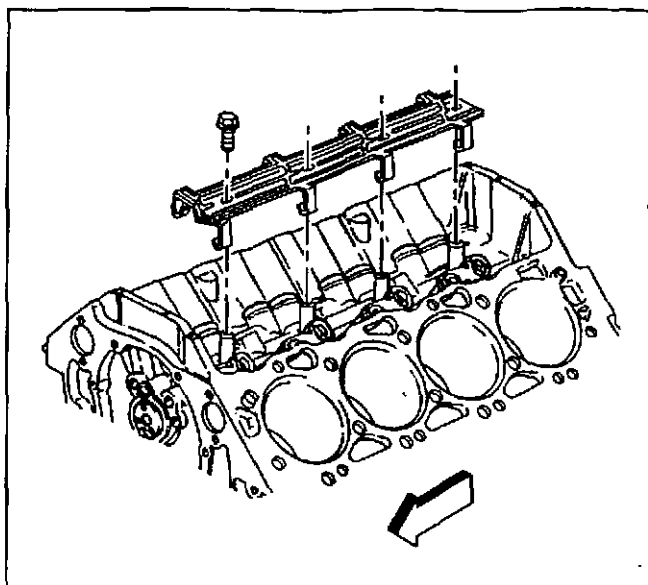
 - Flat spots on the roller (4)
 - A loose pin (5)
 - A plugged oil hole (6)
4. Inspect the valve lifter guides for excessive wear.
5. Inspect the valve lifter guides for cracks or damage.



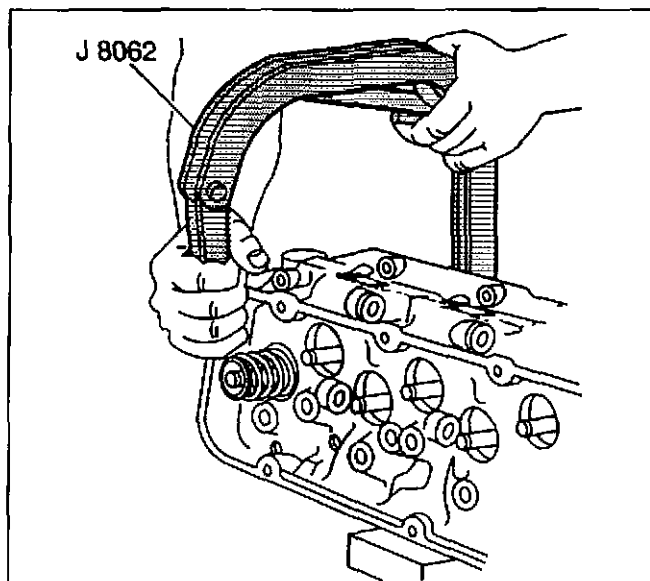
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173193



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6. Inspect the valve lifter guide retainer for:

- Wear, damage, or stress cracking in the leg areas
- Wear or damage around the retainer bolt holes

SIE-ID - 199439

Cylinder Head Disassemble

Tools Required

J 8062 Valve Spring Compressor

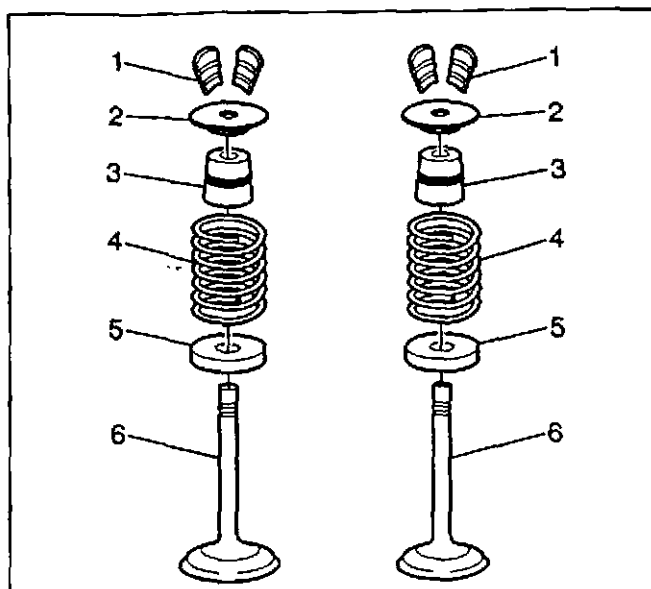
Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

Caution: SIO-ID - 411464 *Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.*

Important: Mark, sort, or organize components for return to their original locations.

1. Use J 8062 in order to compress the valve springs.

2. Remove the valve stem keys (1).
3. Release and remove J 8062.
4. Remove the cap (2).
5. Remove the valve spring (4).
6. Remove the valve stem oil seal (3).
7. Remove the valve rotator (5).
8. Remove the valve (6).



35216

SIE-ID = 199475

Cylinder Head Clean and Inspect

Cylinder Head Cleaning Procedure

Tools Required

J 8089 Carbon Removing Brush

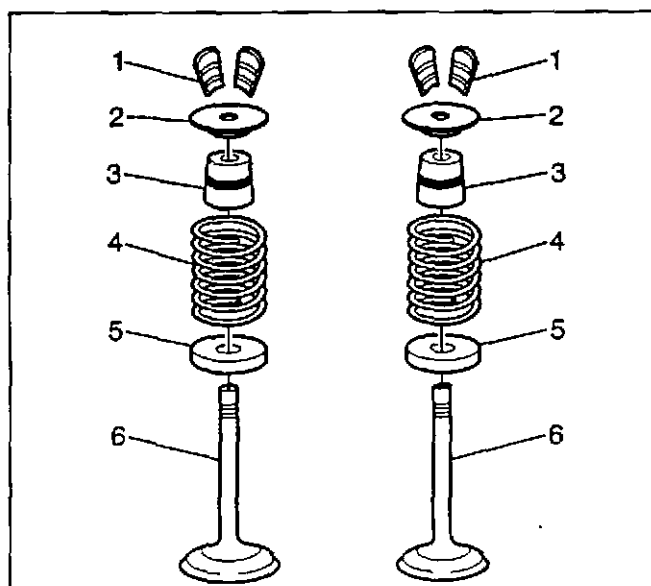
Caution: SIO-ID = 5011 **Wear safety glasses in order to avoid eye damage.**

Important: Mark, sort, or organize components for return to their original locations.

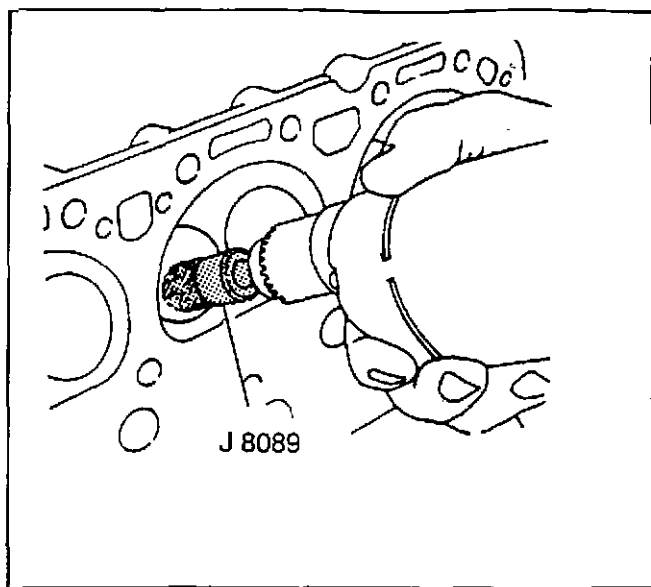
1. Clean the valve heads on a buffing wheel.
2. Clean the following components in solvent
 - Valve stem keys (1)
 - Valve spring cap (2)
 - Valve spring (4)
 - Valve rotators (5)
 - Valve (6)
 - Cylinder head

Caution: SIO-ID = 5011 **Wear safety glasses in order to avoid eye damage.**

3. Dry the components with compressed air.



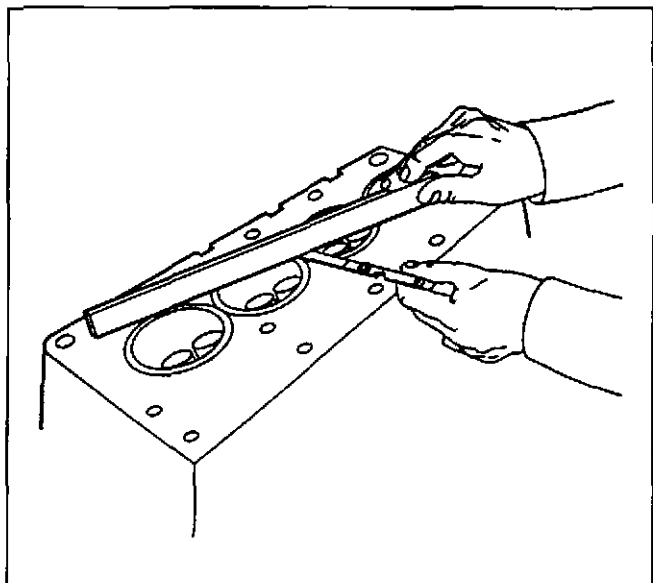
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35201

Important: Be careful not to scuff the chamber or damage the valve seat.

4. Use the *J 8089* in order to clean the carbon from the combustion chambers.



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Cylinder Head Visual Inspection Procedure

Inspect the cylinder head for the following conditions:

- Damaged gasket surfaces
- Damage to threaded bolt holes
- Burnt or eroded areas in the combustion chamber
- Cracks in the exhaust ports and combustion chambers
- External cracks in the water chamber
- Restrictions in the intake or exhaust passages
- Restrictions in the cooling system passages

Cylinder Head Flatness Measurement Procedure

1. Measure the cylinder head for warpage with a straight edge and feeler gauge.
 - A cylinder head block deck with warpage in excess of 0.076 mm (0.003 in) within a 152.4 mm (6.0 in) area must be repaired or replaced.
 - A cylinder head exhaust manifold deck with an overall warpage in excess of 0.152 mm (0.006 in) must be repaired or replaced.
 - A cylinder head intake manifold deck with warpage in excess of 0.10 mm (0.004 in) must be repaired or replaced.
2. A cylinder head block deck can be resurfaced up to 0.305 mm (0.012 in) maximum removal.

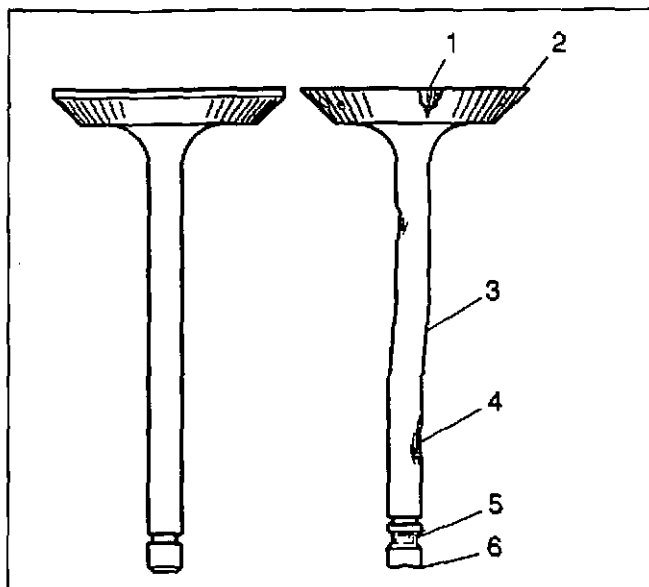
Important: Excessive cylinder head resurfacing will affect compression ratio and emission control.

3. A cylinder head that requires excessive resurfacing must be replaced.

Valve Inspection Procedure

1. Inspect the valves for the following conditions:

- Burnt or damaged areas (1)
- Undersized valve margin (2)
- Bent stem (3)
- Wear, scoring or other damage to the stem (4)
- Worn key groove (5)
- Worn stem tip (6)



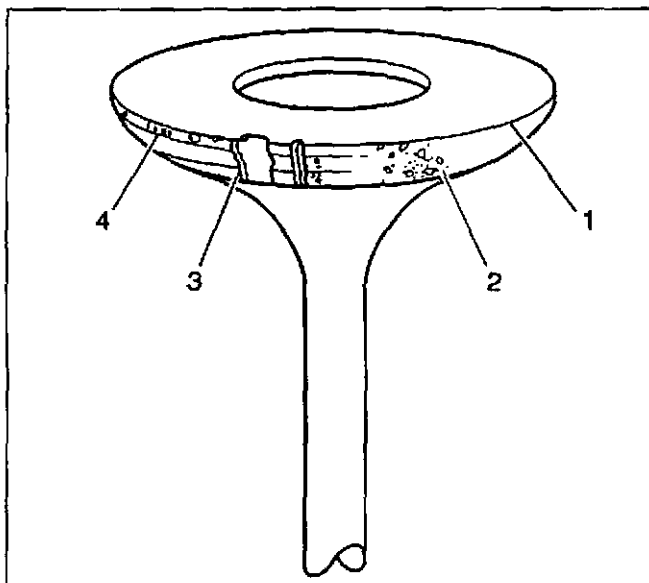
156174

2. Inspect the valve contact surface for the following conditions:

- Undersized margin (1)
- Pitted surface (2)
- Burnt or eroded areas (3)
- Acceptable edge (margin) (4)

Important: Minor imperfections of the valve may be corrected during reconditioning.

3. Valves with excessive damage must be replaced.



156173

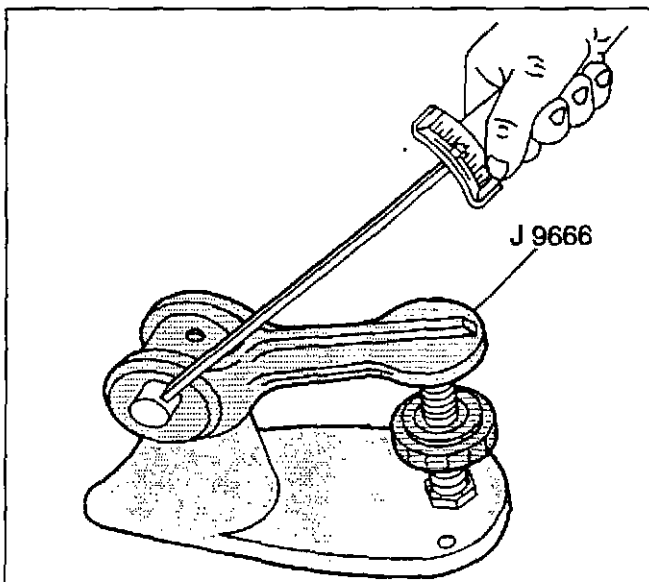
Valve Spring Inspection and Measurement**Tools Required**

J 9666 Valve Spring Tester

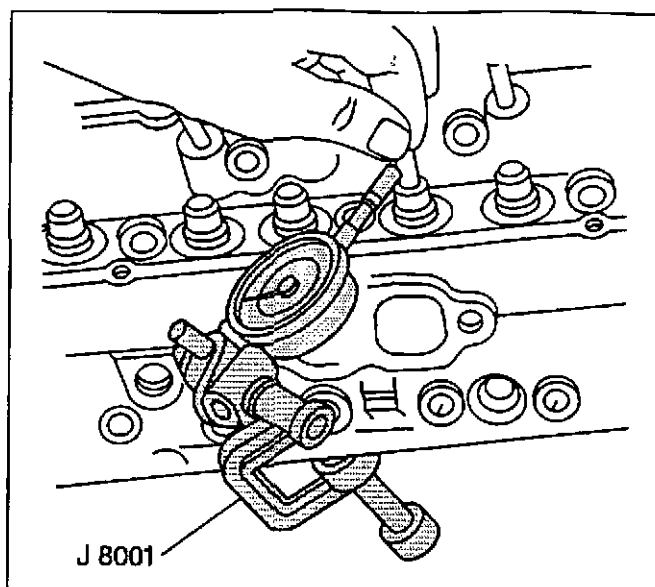
1. Inspect the valve springs for broken coils or coil ends.
2. Use the J 9666 in order to measure the valve spring tension. Refer to *Engine Mechanical Specifications*.

Important: Add a maximum of one shim up to 0.726 mm (0.030 in) thick to increase tension.

3. If low valve spring tension is found, use a shim to increase tension.
4. Recheck the valve spring tension, a valve spring that does not meet specification must be replaced.



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Valve Guide Measurement Procedure

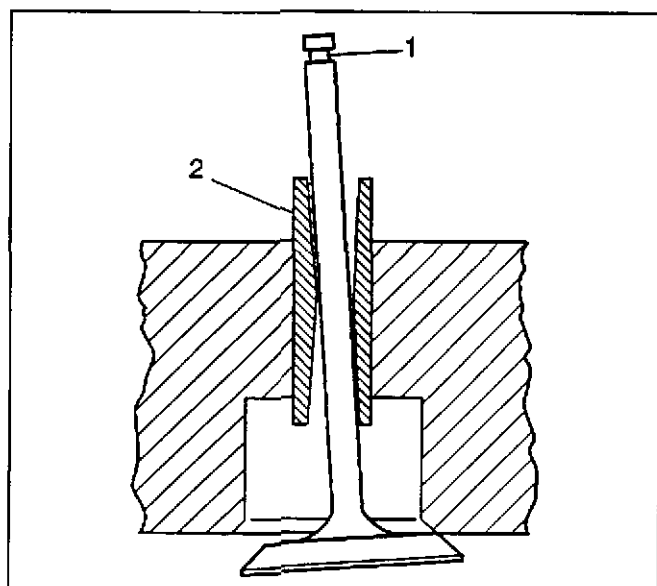
Tools Required

J 8001 Dial Indicator Set

Important: Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.

Important: The indicator stem must contact the side of the valve stem just above the valve guide.

1. Measure the valve stem-to-guide clearance.
 - Clamp the J 8001 on the exhaust port side of the cylinder head.
 - Locate the indicator so that the movement of the valve stem from side to side (crosswise to the cylinder head) will cause a direct movement of the indicator stem.
 - Drop the valve head about 1.6 mm (0.064 in) off the valve seat.
 - Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading. Refer to *Engine Mechanical Specifications*.
2. A valve guide (2) with excessive clearance must be repaired. Refer to *Valve Guide Reaming/Valve and Seat Grinding*.
3. Replace the cylinder head if the valve guide cannot be repaired.



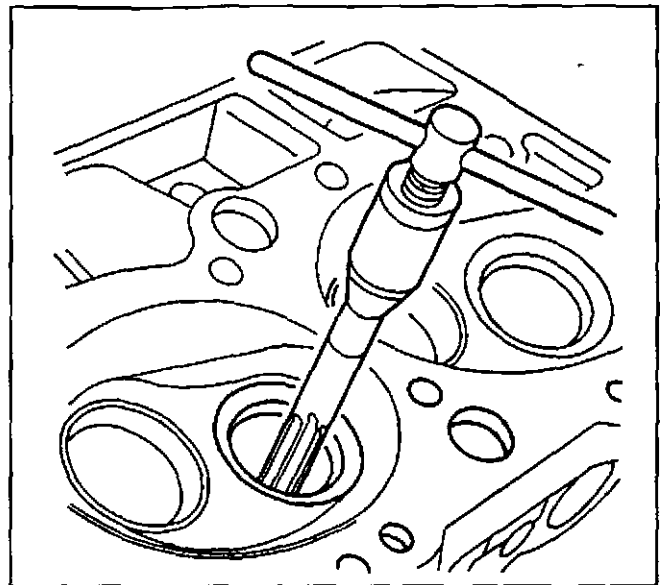
156172

SIE-ID - 199579

Valve Guide Reaming/Valve and Seat Grinding

Valve Guide Reaming Procedure

1. Ream the valve guide as necessary to achieve proper valve stem-to-guide clearance.
 - 1.1. Ream the valve guide oversize to accept a valve guide sleeve.
 - 1.2. Insert the valve guide sleeve into the guide bore.
 - 1.3. Ream the sleeve to achieve proper valve stem-to-guide clearance.
2. Always recondition the valve seat after reaming the valve guide bores or installing new valves.
3. Replace the cylinder head if the valve guide cannot be repaired.

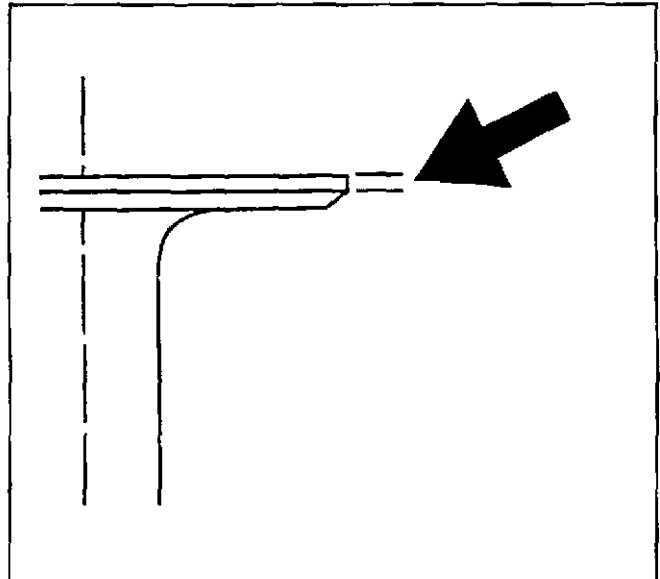


4956

Valve Reconditioning Procedure

1. Replace the valve if the valve stem shows excessive wear or is warped.

Important: Several different types of equipment are available for reconditioning valves. Use the manufacturers recommendations of equipment to attain the proper results.
2. Reface pitted valves on a valve refacing machine in order to insure the correct relationship between the head and the stem.
3. Replace the valve if the edge of the head is less than 0.79 mm (0.031 in) thick after grinding.



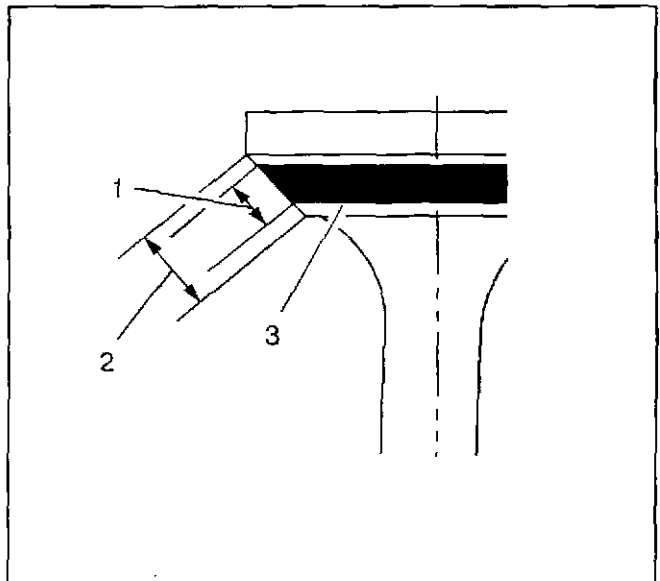
57502

Valve Seat Reconditioning Procedure

Important: Several different types of equipment are available for reconditioning valves. Use the manufacturers recommendations of equipment to attain the proper results.

Important: Always recondition the valve seat after reaming the valve guide bores or installing new valves.

1. Reconditioning of the valve seats:
2. The valves must seat perfectly for the engine to deliver optimum power, performance and emission control.
3. Ensure that the valve seat and valve are not shrouded (1) after valve seat reconditioning. Adequate flow past the valve seat and valve is essential for cooling the valve head and valve seat area.
4. Correct contact (1) between each valve and its seat in the cylinder head is also essential to



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ensure that the heat in the valve head is properly carried away.

Important: Regardless of what type of equipment is used, it is essential that the valve guide bores are free from carbon or dirt to ensure the proper centering of the pilot in the guide.

5. The valve seats should be concentric to within 0.05 mm (0.002 in) total indicator runout.

SIE-ID - 199829

Cylinder Head Assemble

Valve Installation

Tools Required

J 8062 Valve Spring Compressor

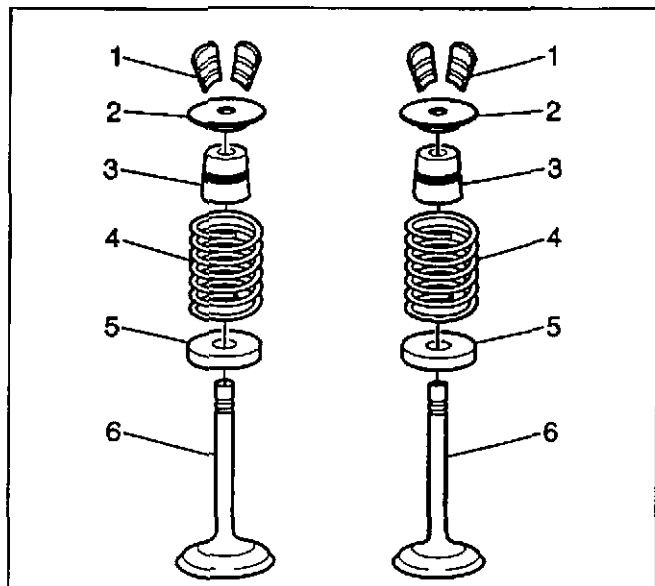
1. Lubricate the valve stems with clean engine oil.
2. Insert the valves into their proper locations.
3. Lubricate rotators with clean engine oil (5).
4. Install the rotators over the guide and onto the cylinder head.

Important: When installing valve stem oil seals onto the valve guides be careful not to tear the seal lip during installation.

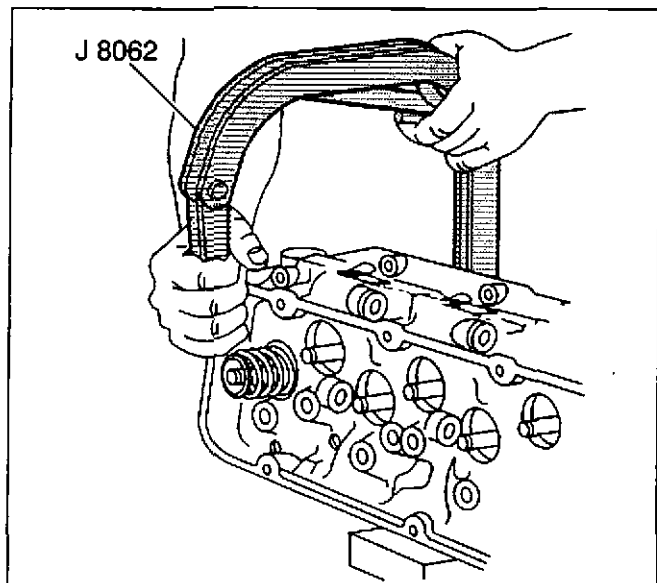
5. Install the valve stem oil seal (3) onto the valve guide.
6. Install the valve spring (4).
7. Install the valve spring cap (2).

Caution: SIO-ID - 411454 *Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.*

8. Compress the valve spring, using the J 8062, in order to clearly see the valve stem key grooves.
9. Install the valve stem keys (1).
 - 9.1. Use grease in order to hold the keys in place.
 - 9.2. Ensure that the valve stem keys seat properly in the upper groove of the valve stem.
 - 9.3. Release the J 8062.
 - 9.4. Remove the J 8062.
 - 9.5. Tap the end of the valve stem with a plastic-faced hammer in order to seat the valve stem keys.



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Checking Valve Spring Installed Height

1. Measure the valve spring for the properly installed height.

Use a thin scale and measure from the cylinder head spring seat to the top of the valve spring cap. Refer to *Engine Mechanical Specifications* for proper valve spring installed height specifications.

Important: Never shim the valve spring to obtain an valve spring installed height under the specified amount.

Important: Install the valve spring seat shims under the rotator (between the rotator and the cylinder head spring seat).

Important: Add a maximum of one shim, up to 0.726 mm (0.030 in) thick, to achieve the valve spring installed height specification.

Important: The combination of shims to correct valve spring installed height and valve spring tension should not exceed 1.524 mm (0.060 in) thick.

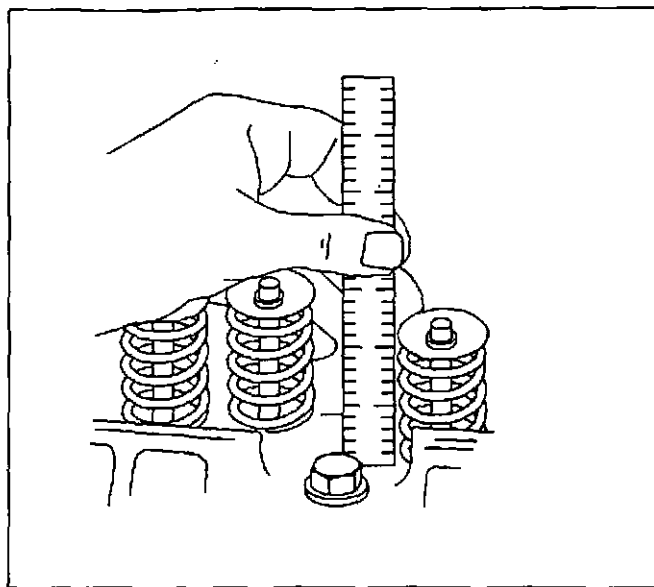
2. Install a valve spring seat shim if the valve spring installed height measurement is above the specification.
3. Recheck the valve spring installed height, replace the cylinder head if the valve spring installed height cannot be obtained.

SIE-ID = 200009

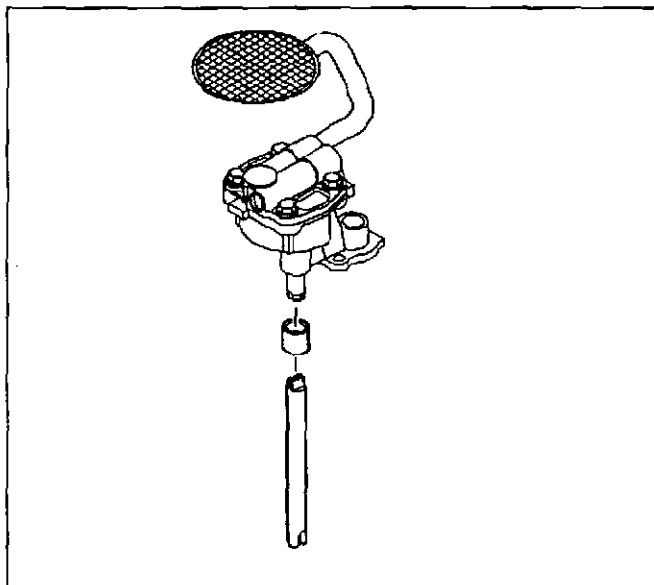
Oil Pump Disassemble

SIO-ID = 199974

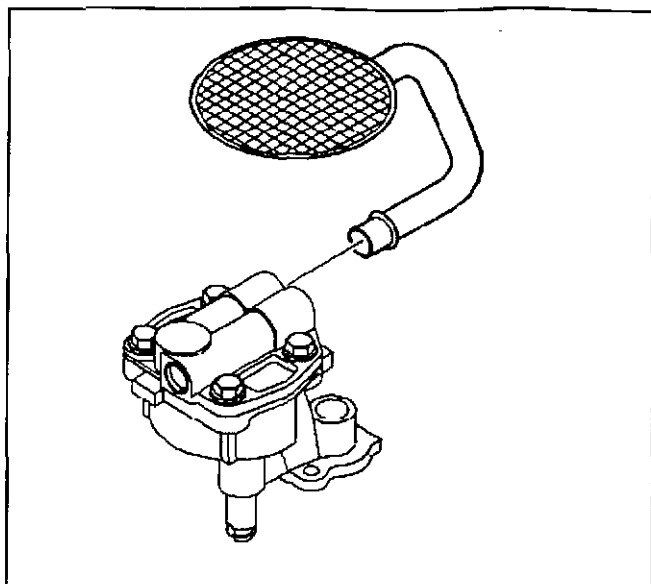
1. Remove the oil pump driveshaft and retainer.



35203



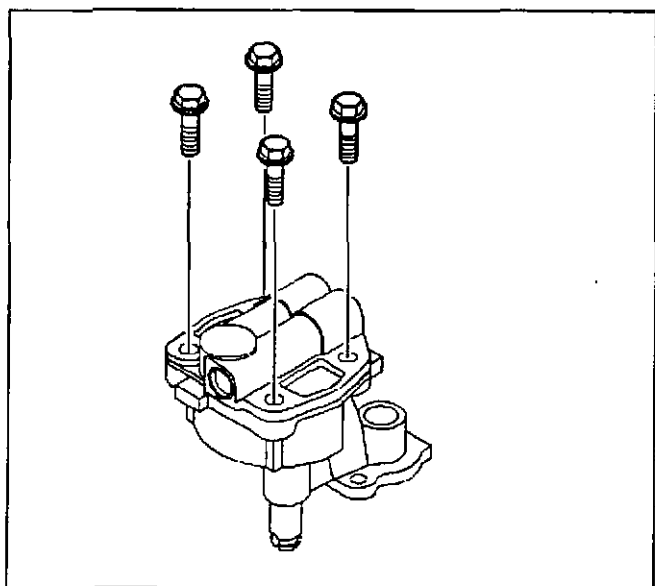
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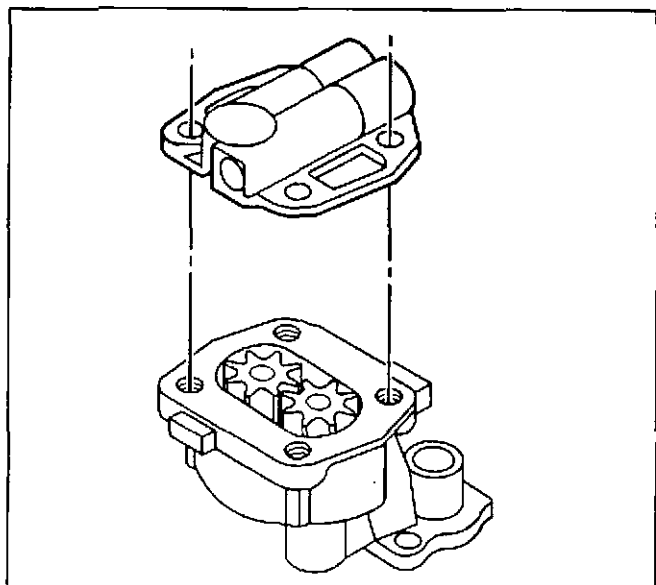
Important: The oil pump screen has a press fit in to the oil pump cover. DO NOT remove the screen from the pipe. The pipe and screen are serviced as a complete assembly.

2. Remove the oil pump screen.



5276

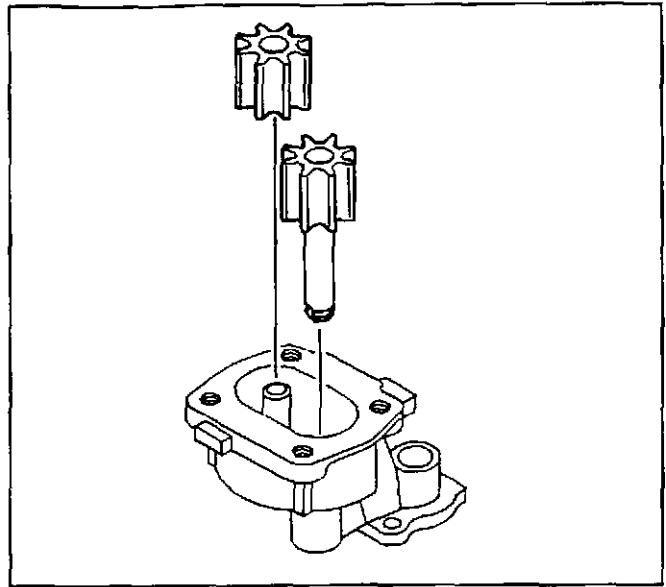
3. Remove the oil pump cover bolts.



5277

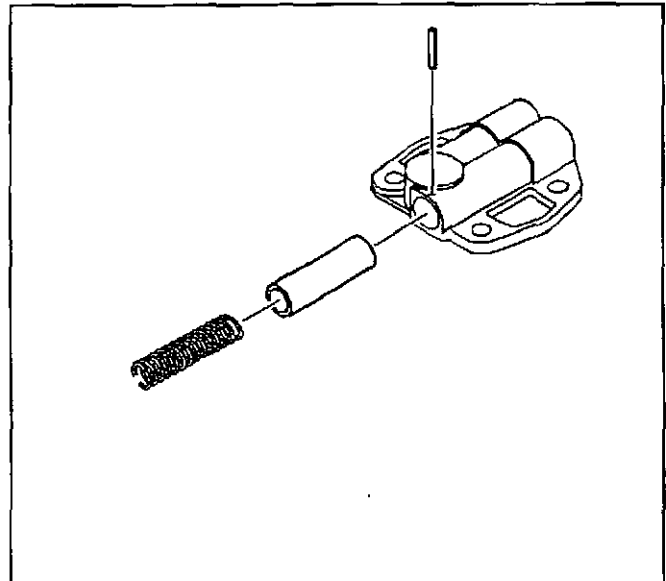
4. Remove the pump cover.

5. Remove the drive gear and the driven gear. Matchmark the gear teeth for assembly.



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6. Remove the following items:
 - 6.1. The retaining pin
 - 6.2. The pressure relief spring
 - 6.3. The pressure relief valve



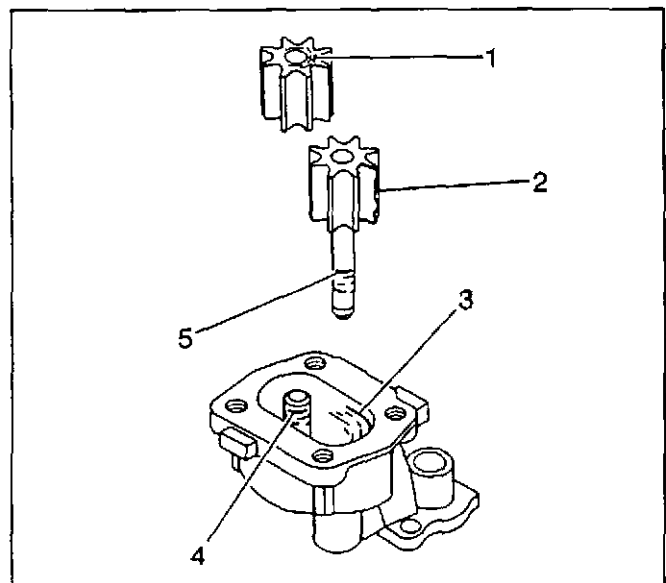
30401

SIE-ID - 35473

Oil Pump Clean and Inspect

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Clean the oil pump components in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the oil pump for the following conditions:
 - Scoring, damage or casting imperfections to the body (3)
 - Damaged gears (2) for
 - Chipping
 - Galling
 - Wear
 - Scoring on the top of the gears (1)
 - Damaged or scored gear shaft (5)



186750

- Damaged bolt hole threads
 - Worn oil pump driveshaft bore
 - Damaged or sticking oil pump pressure relief valve (minor imperfections may be removed with a fine oil stone).
 - Collapsed or broken oil pump pressure relief valve spring
4. If the oil pump is to be reused, install a NEW oil pump pressure relief valve spring.
 5. During oil pump installation, install a NEW oil pump driveshaft retainer.

SIE-ID - 200236

Oil Pump Assemble

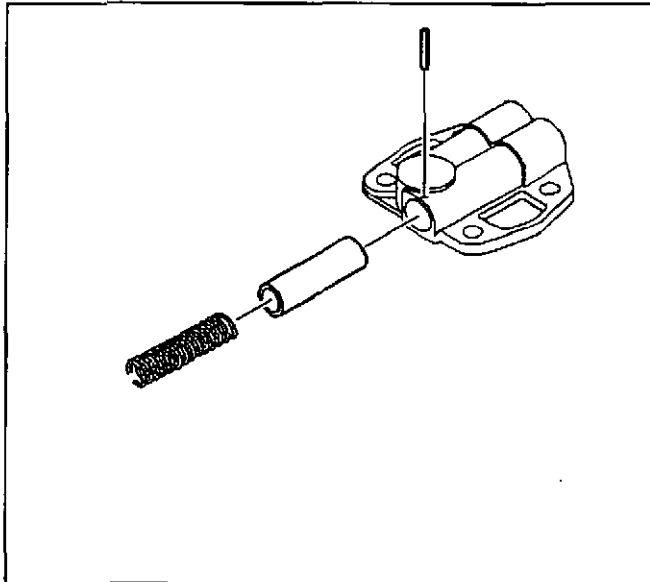
SID-ID - 200207

Tools Required

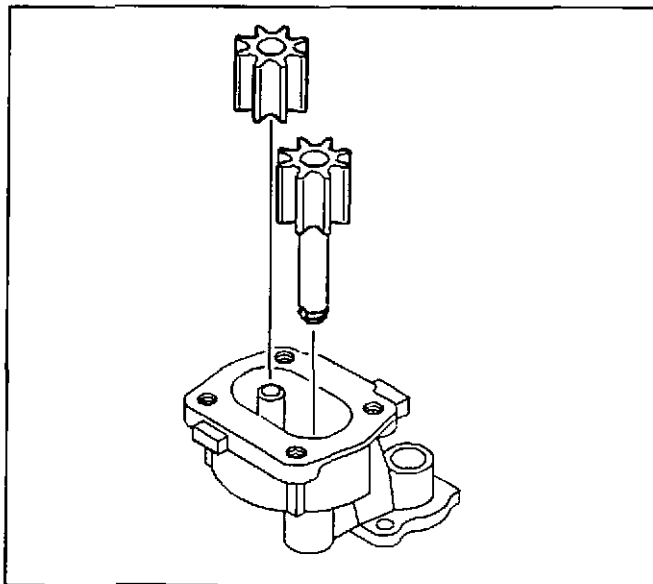
J 21882 Oil Suction Pipe Installer

Important: Replace the pressure relief valve spring when reusing the oil pump.

1. Install the following items:
 - 1.1. The pressure relief valve
 - 1.2. The pressure relief spring
 - 1.3. The retaining pin



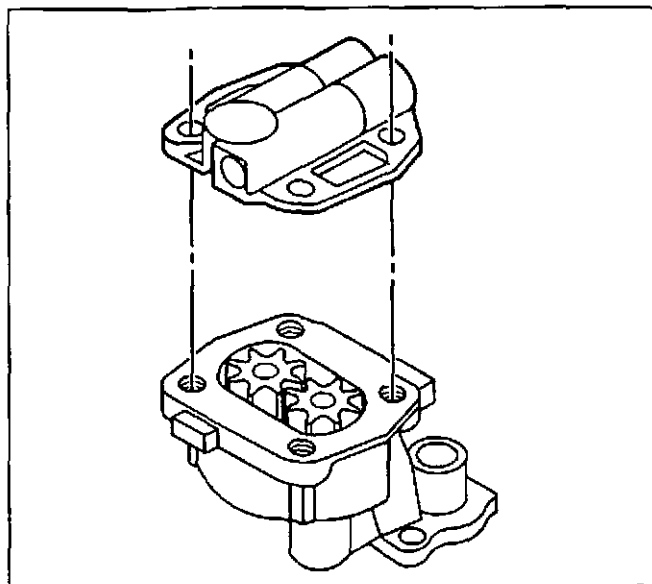
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2. Coat the drive gear, the driven gear and the housing gear surfaces with clean engine oil.
3. Install the drive gear and the driven gear into the pump body. Align the matching marks on the gears. Install the smooth side of the gear toward the pump cover.

4. Install the oil pump cover.



5277

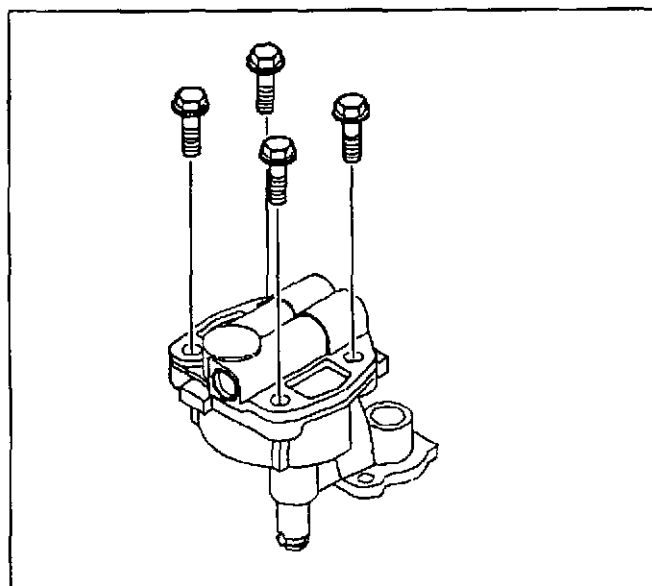
Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the oil pump cover bolts.

Tighten

Tighten the oil pump cover bolts to 12 N·m (106 lb in).

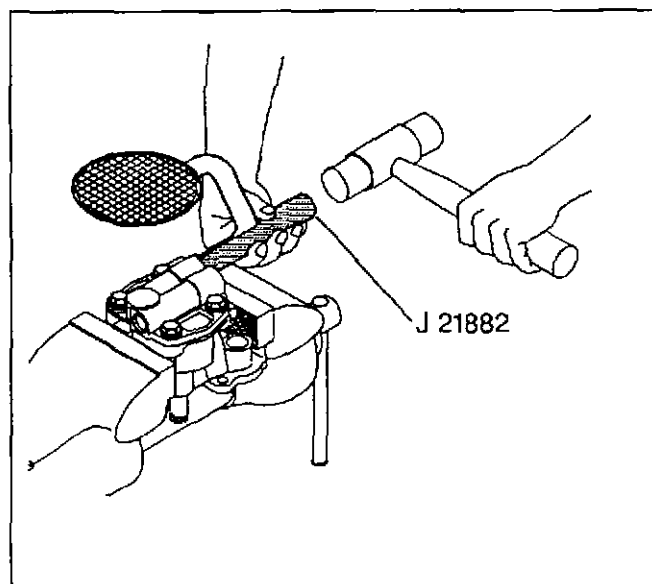
6. Inspect the oil pump for smoothness of operation by turning the oil pump driveshaft by hand.



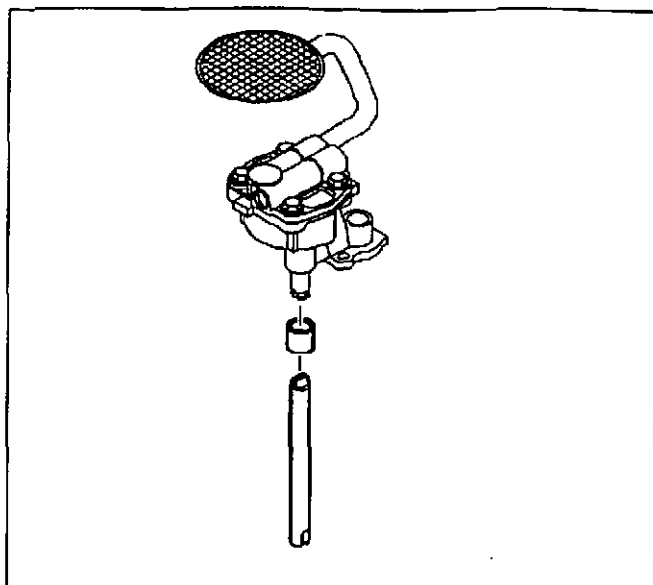
5276

7. Install the oil pump screen:

- 7.1. If removed, replace the oil pump screen. The oil pump screen must have a good press fit into the oil pump body.
- 7.2. Mount the oil pump in a soft-jawed vise.
- 7.3. Apply sealer to the end of the pipe.
- 7.4. Use the J 21882 and a soft-faced hammer in order to tap the oil pump screen into the pump body. The screen must align parallel with the bottom of the oil pan when it is installed.



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8. Install the oil pump driveshaft and the new retainer.

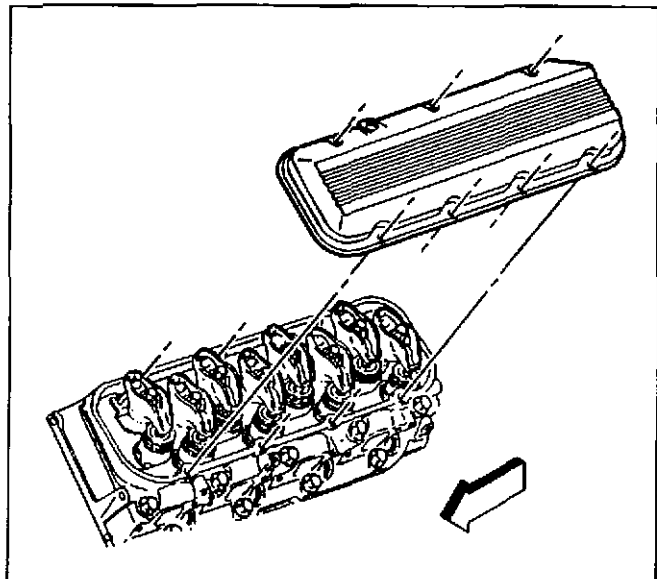
SIE-ID - 200301

Valve Rocker Arm Cover Clean and Inspect

1. Clean the valve rocker arm cover in solvent.

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

2. Dry the covers with compressed air.
3. Inspect the covers for the following components:
 - Gouges or damage to the sealing surfaces
 - Dent or damage to the exterior of the cover
A dented or damaged cover may interfere with the valve rocker arms.
 - Restrictions to the ventilation system passages
 - The PCV valve grommet for cracking or damage



354006

SIE-ID - 200373

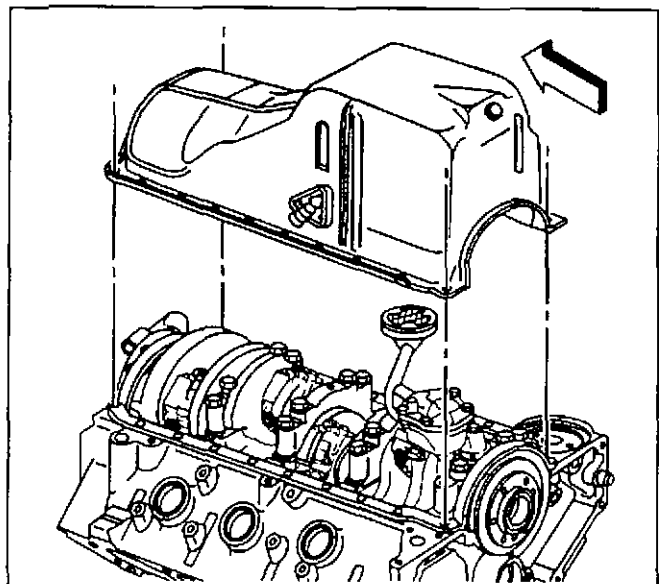
Oil Pan Clean and Inspect

1. Clean the oil pan in solvent.
2. Dry with compressed air.
3. Inspect the oil pan for the following conditions:

- The drain plug hole for damaged threads.
- Gouges or damage to the oil pan sealing surfaces
- Damage to the oil pan baffle
- Dents or damage to the exterior of the oil pan

An oil pan that is dented may interfere with the position of the oil pump screen or not distribute oil properly in the pan sump area.

- Damage to the oil level indicator tube area
- Damage to the oil pan gasket.

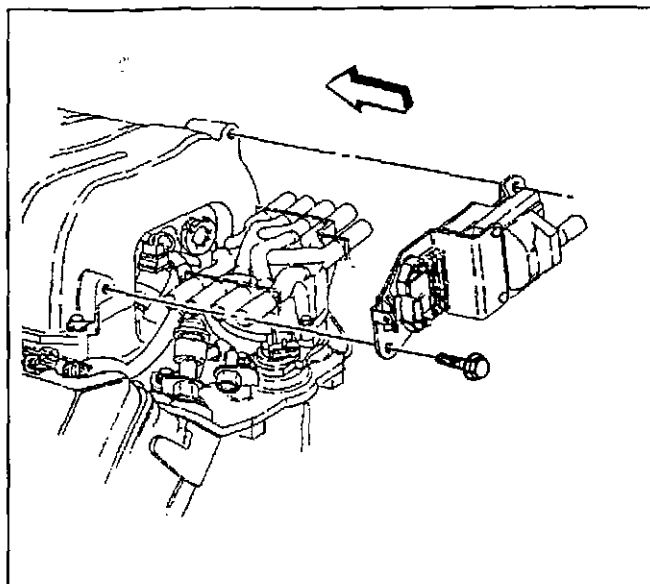


351803

SIE-ID - 377021

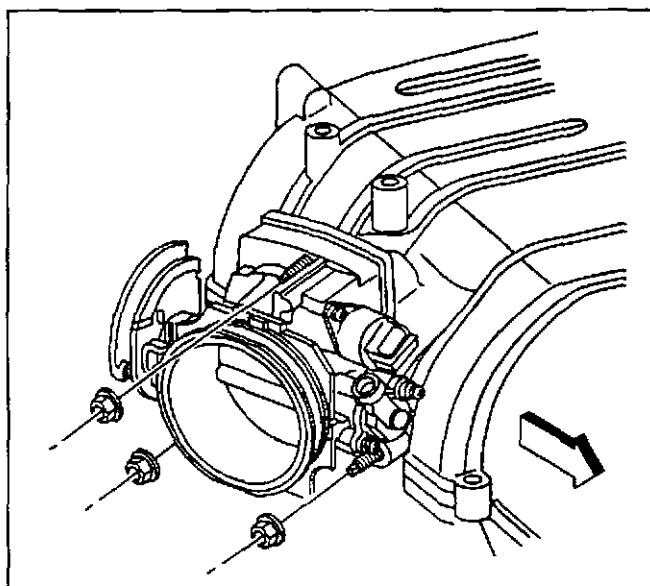
Intake Manifold Disassemble (Upper)

1. Remove the ignition coil bolt and stud.
2. Remove the ignition coil.



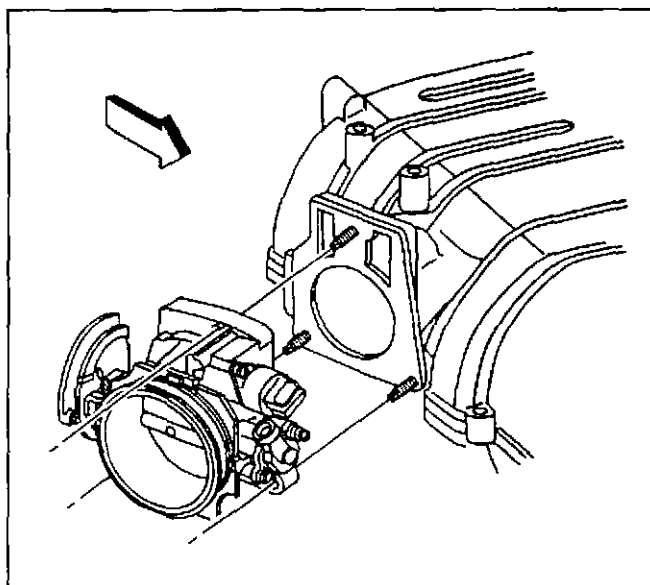
68506

3. Remove the throttle body nuts.

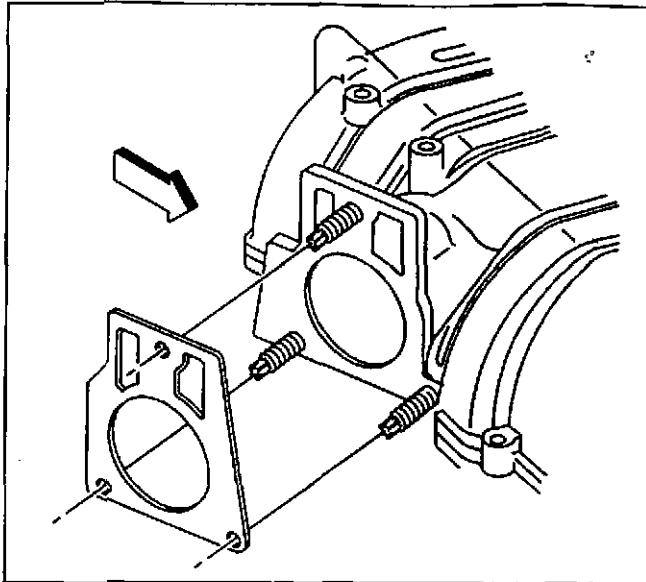


18299

4. Remove the throttle body.

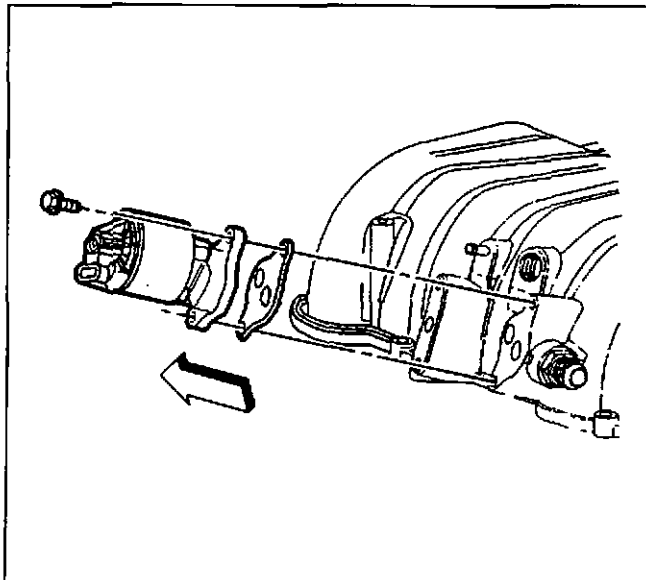


18302



18303

5. Remove the throttle body gasket.
6. Remove the throttle body studs, if required.



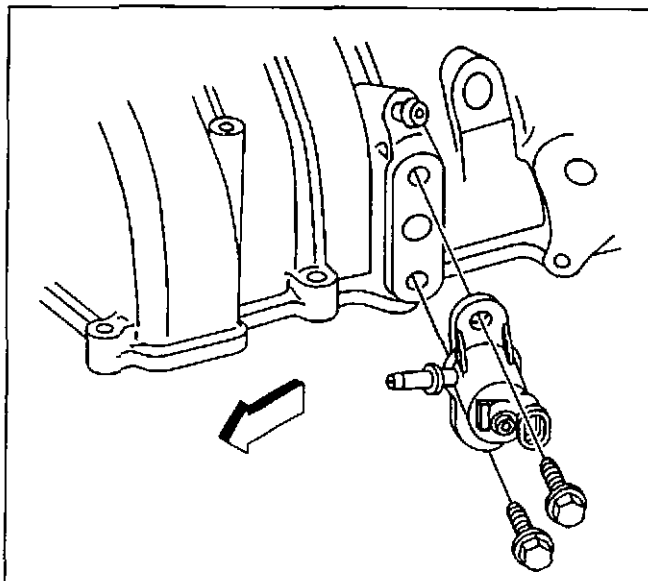
276413

Important: Note the position of the EGR valve before removal. It is possible to improperly install the EGR valve 180 degrees from the original position.

7. Remove the EGR valve bolts.

Notice: *S10-ID - 5005* The Linear EGR valve is an electrical component. DO NOT soak in any liquid cleaner or solvent because damage may result.

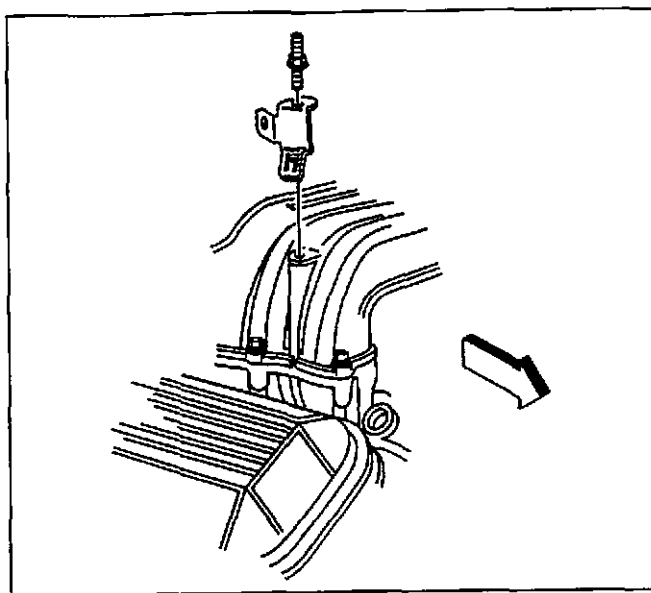
8. Remove the EGR valve.
9. Remove the EGR gasket.



351775

10. Remove the EVAP purge valve bolts.
11. Remove the EVAP purge valve.

12. Remove the secondary air injection check valve bracket bolt and bracket, if required (RPO K19 only).

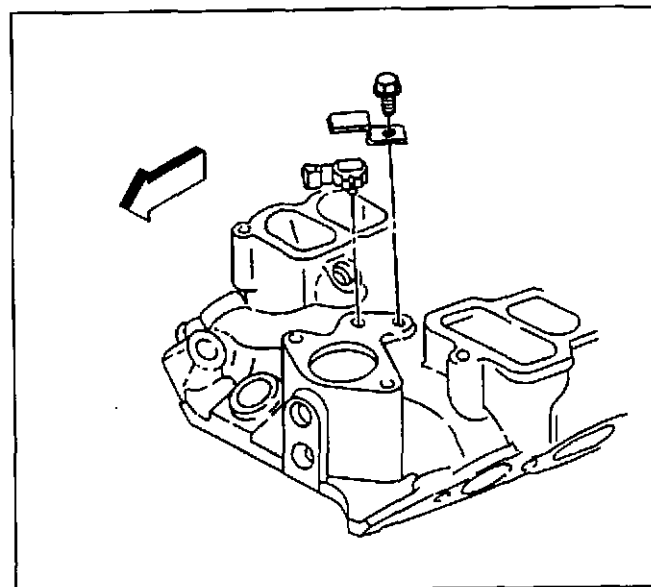


354044

SIE-ID = 377026

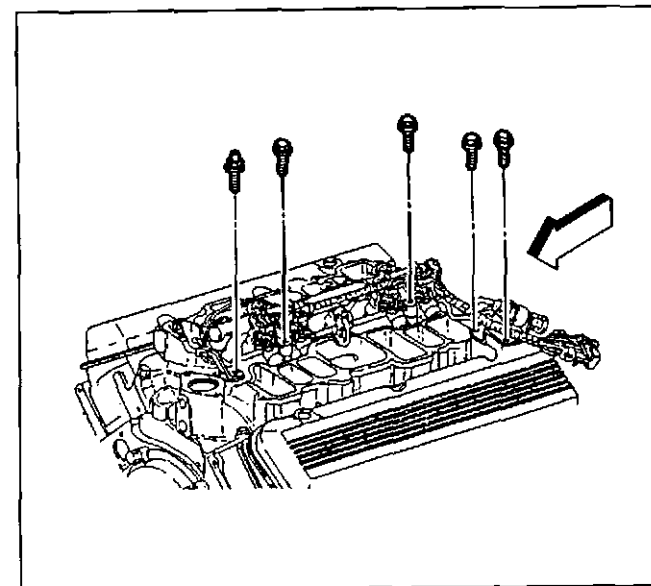
Intake Manifold Disassemble (Lower)

1. Remove the MAP sensor nut, retainer and the MAP sensor.

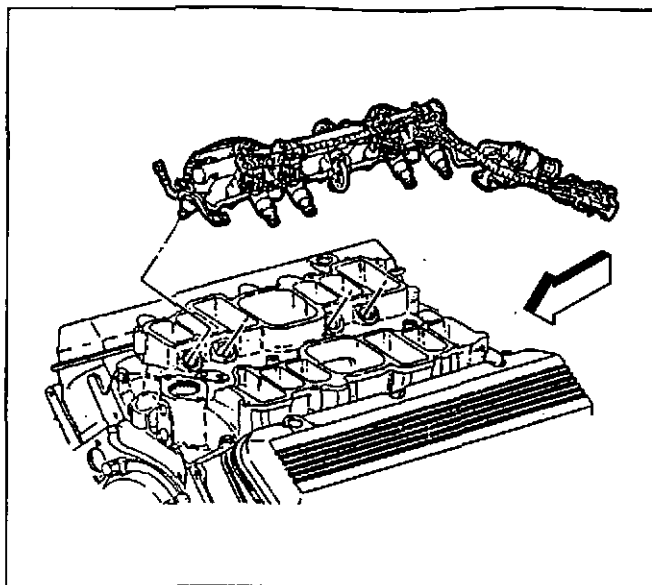


19673

2. Remove the fuel rail bolts and stud.

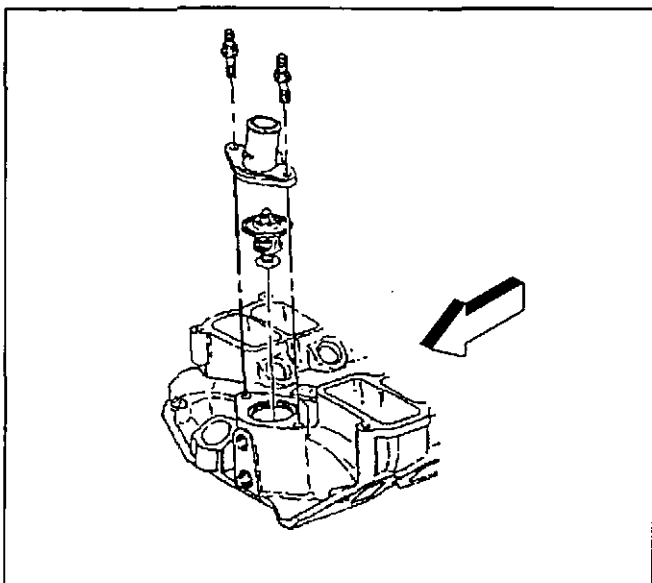


19162



19164

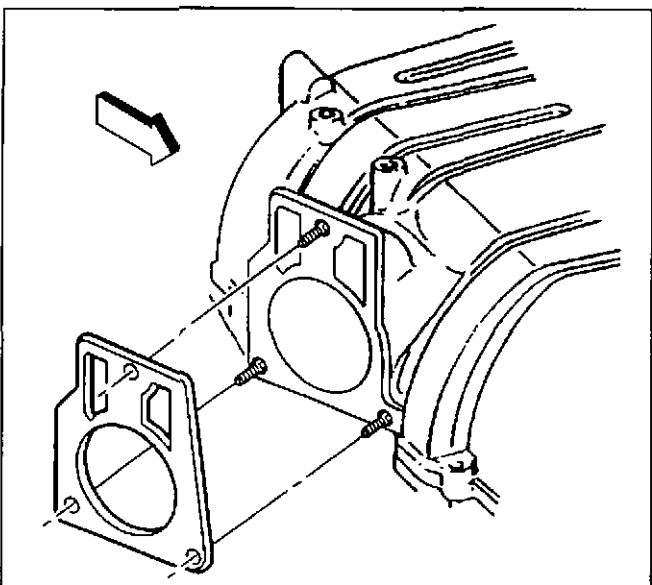
3. Remove the fuel rail.



65322

4. Remove the water inlet housing bolts, housing, and thermostat.

5. Remove the coolant temperature sensor from the lower intake manifold.



276417

SIE-ID - 377032

Intake Manifold Clean and Inspect (Upper)

Important: Do not reuse the upper intake manifold-to-lower intake manifold sealing gaskets.

1. Remove and discard the upper intake manifold-to-lower intake manifold gaskets.
2. Remove and discard the throttle body gasket.
3. Clean the upper intake manifold in an approved solvent.
 - Clean the upper intake manifold gasket sealing surfaces.
 - Clean all engine coolant passages of scale build up.
 - Clean all carbon from the EGR passages.
 - Clean all upper intake manifold ports.
 - Inspect upper intake manifold sealing surfaces for nicks and cracks.

Caution: SIO-ID - 5011 *Wear safety glasses in*

order to avoid eye damage.

- Dry the upper intake manifold with compressed air.

SIE-ID - 377034

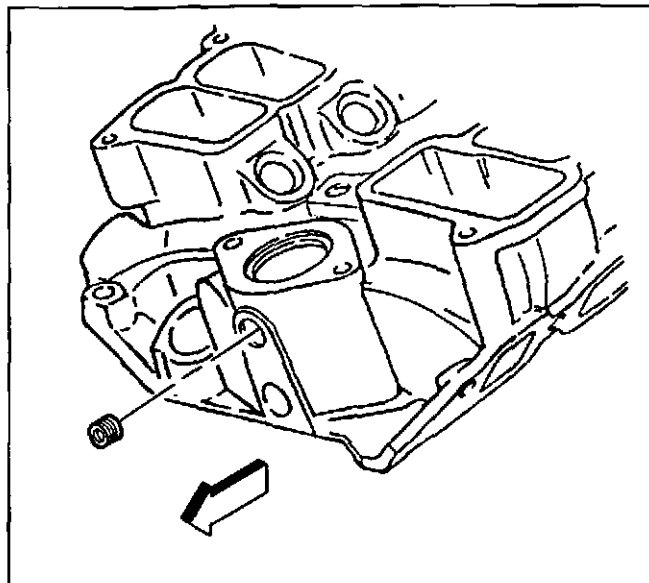
Intake Manifold Clean and Inspect (Lower)

Important: Do not reuse the lower intake manifold-to-cylinder head sealing gaskets.

1. Inspect the sealing grommet on the MAP sensor. The grommet should not be torn or damaged.
2. Remove and discard the lower intake manifold-to-cylinder head gaskets.
3. Clean the lower intake manifold in an approved solvent.
 - Clean the lower intake manifold gasket sealing surfaces.
 - Clean all engine coolant passages of scale build up.
 - Clean all carbon from the EGR passages.
 - Clean all lower intake manifold ports.
 - Inspect lower intake manifold sealing surfaces for nicks and cracks.

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

- Dry the lower intake manifold with compressed air.



181035

SIE-ID - 377036

Intake Manifold Assemble (Lower)

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the coolant outlet housing, thermostat, and bolts.

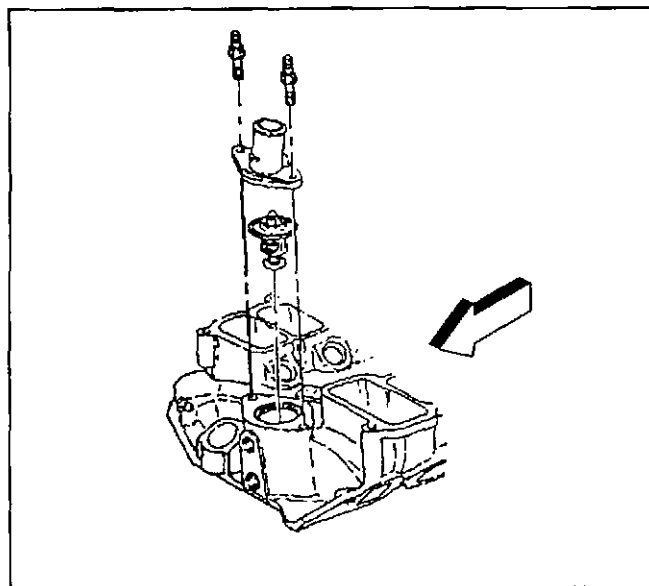
Tighten

Tighten the coolant outlet housing bolts to 40 N.m (30 lb ft).

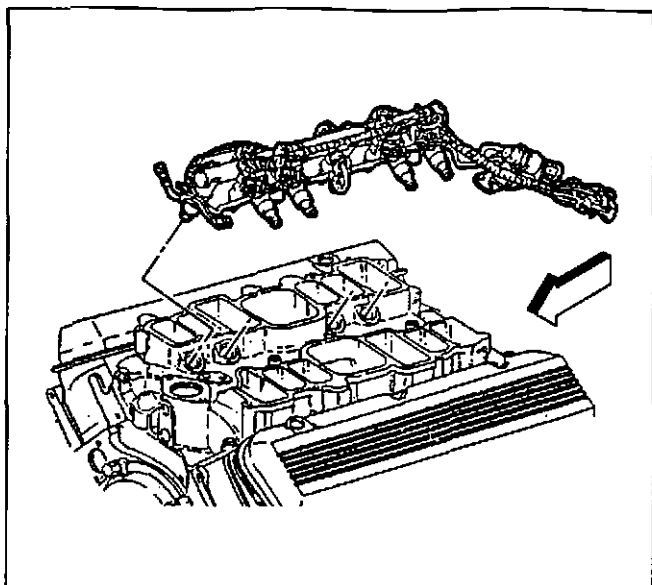
2. Install the coolant temperature sensor.

Tighten

Tighten the coolant temperature sensor to 20 N.m (15 lb ft).



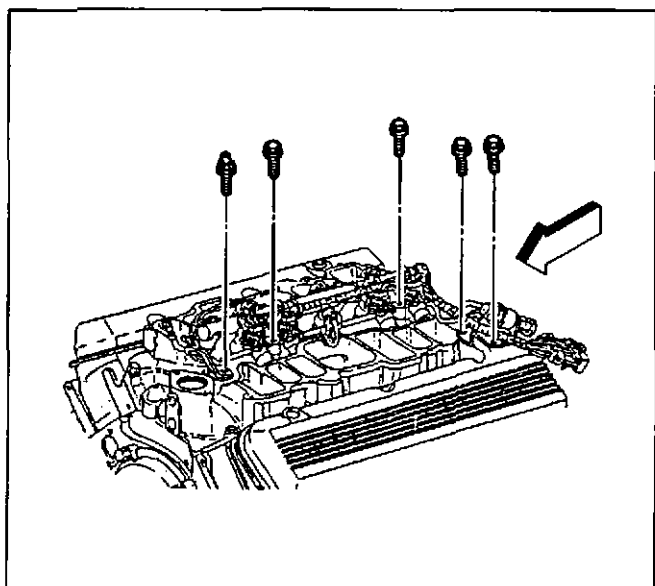
65322



19164

Important: Lubricate the injector O-ring seals with clean engine oil and install onto the spray tip end of each injector.

3. Install the fuel rail assembly in intake manifold. Tilt the rail assembly to install the injectors.

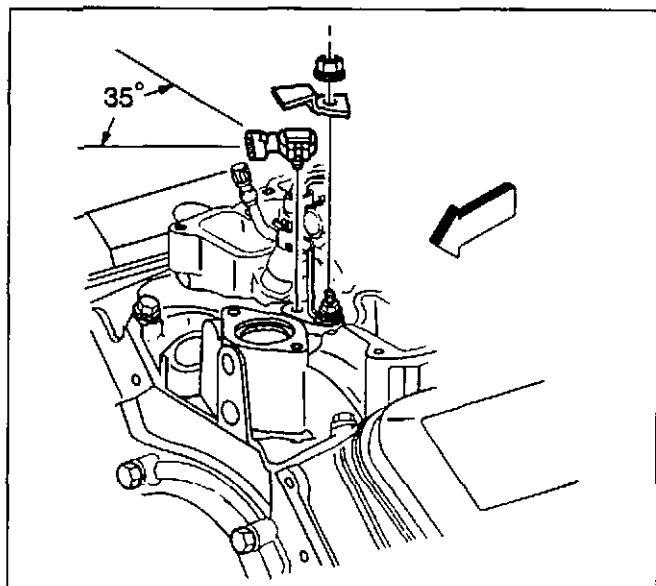


19162

4. Install the fuel rail bolts and stud.

Tighten

- Tighten the fuel rail bolts to 10 N·m (89 lb in).
- Tighten the fuel rail stud to 25 N·m (18 lb ft).



351773

5. Apply lubricant GM P/N 9985770 or equivalent to the MAP sensor seal.
6. Install the MAP sensor, retainer, and nut to the lower intake manifold.

Tighten

Tighten the MAP sensor retainer nut to 25 N·m (18 lb ft).

SIE-ID - 377046

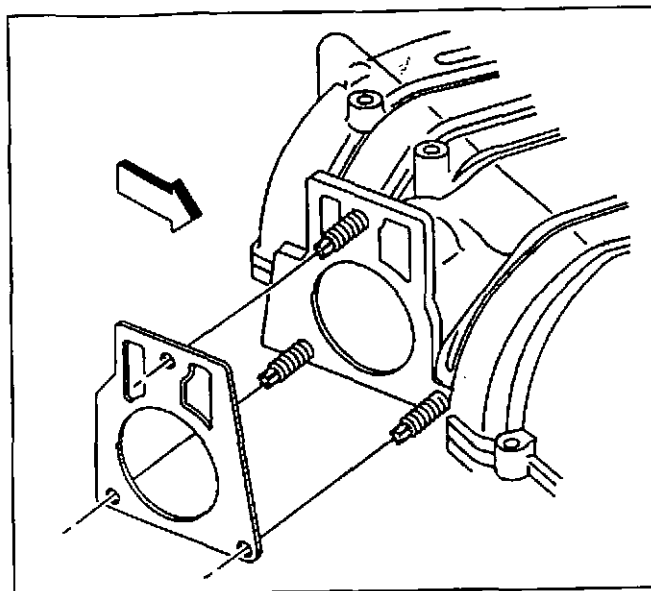
Intake Manifold Assemble (Upper)

1. Install the throttle body studs, if removed.

Tighten

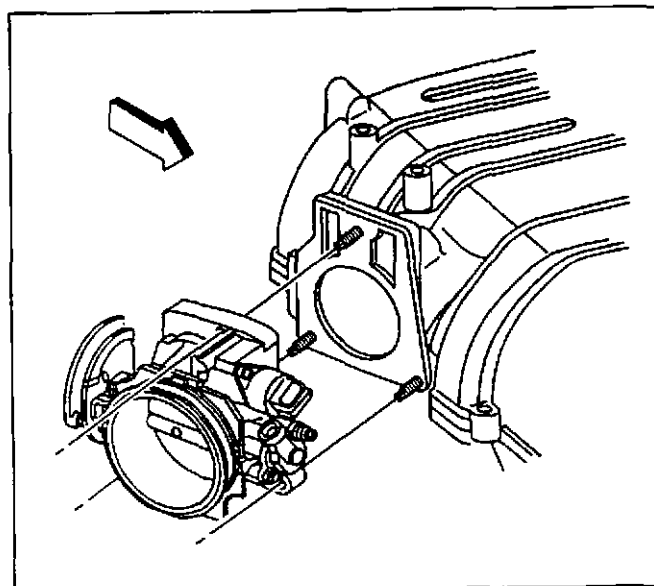
Tighten the throttle body studs to 12 N.m (106 lb in).

2. Install the throttle body gasket.



18303

3. Install the throttle body.

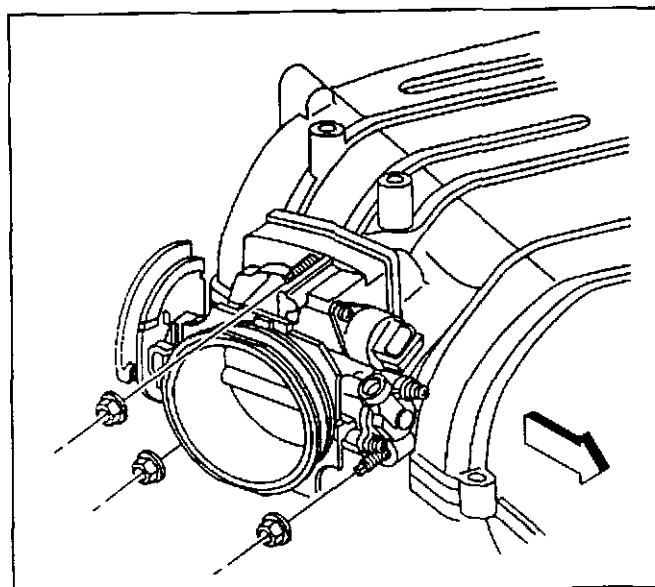


18302

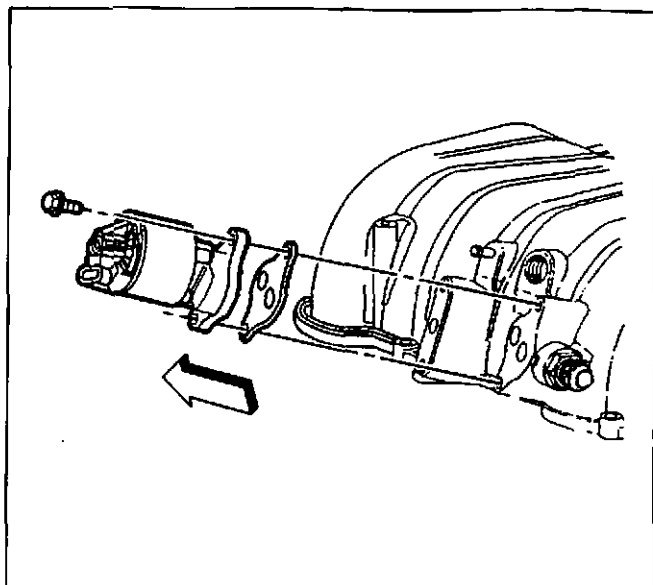
4. Install the throttle body nuts.

Tighten

Tighten the throttle body nuts to 10 N.m (89 lb in).



18299

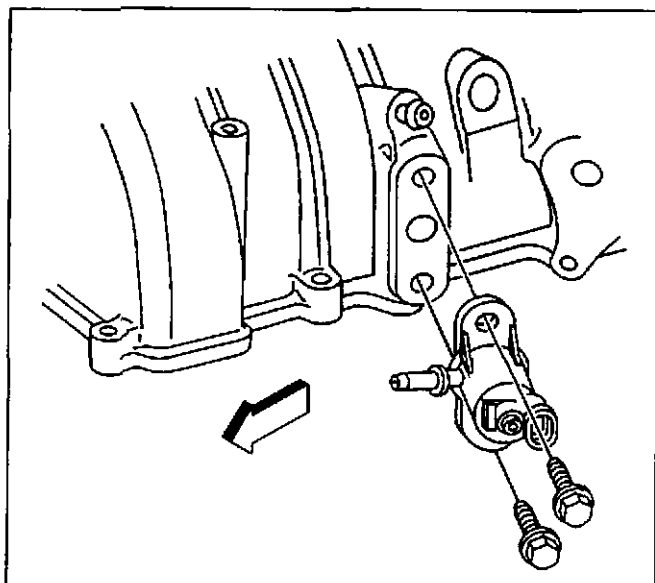


276413

5. Install the EGR gasket
6. Install the EGR valve.
7. Install the EGR valve bolts.

Tighten

- 7.1. Tighten the EGR valve bolts a first pass to 10 N.m (89 lb in).
- 7.2. Tighten the EGR valve bolts a final pass to 22 N.m (16 lb ft).

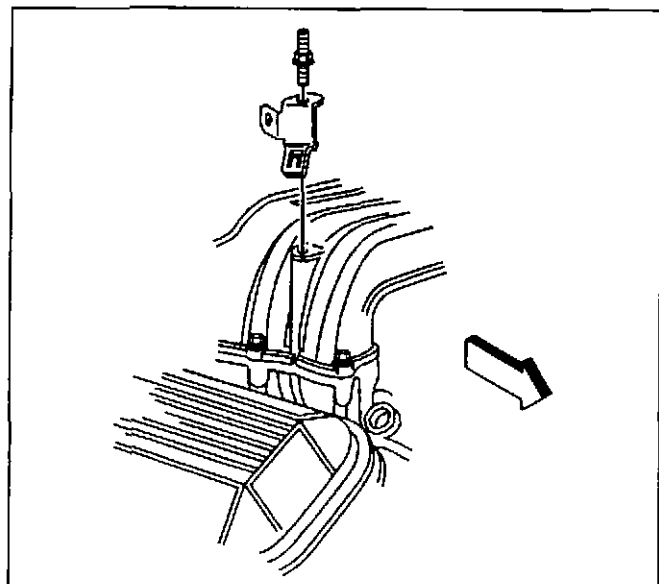


351775

8. Install the EVAP purge solenoid valve.
9. Install the EVAP purge solenoid valve bolts.

Tighten

Tighten the EVAP purge solenoid valve bolts to 12 N.m (106 lb in).



354044

10. Install the secondary air injection check valve bracket, if removed (RPO K19 only).
11. Install the secondary air injection check valve bracket bolt.

Tighten

Tighten the secondary air injection check valve bracket bolt to 25 N.m (18 lb ft).

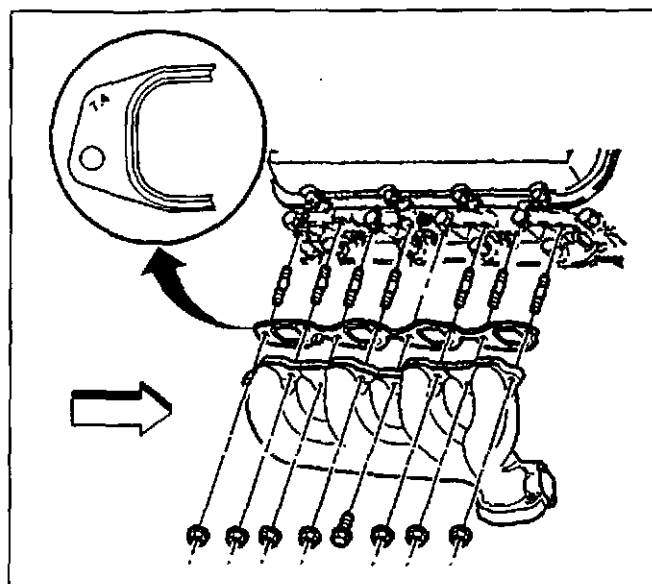
SIE-ID - 280773

Exhaust Manifold Clean and Inspect (without RPO K19)

1. Clean the exhaust manifolds in solvent.

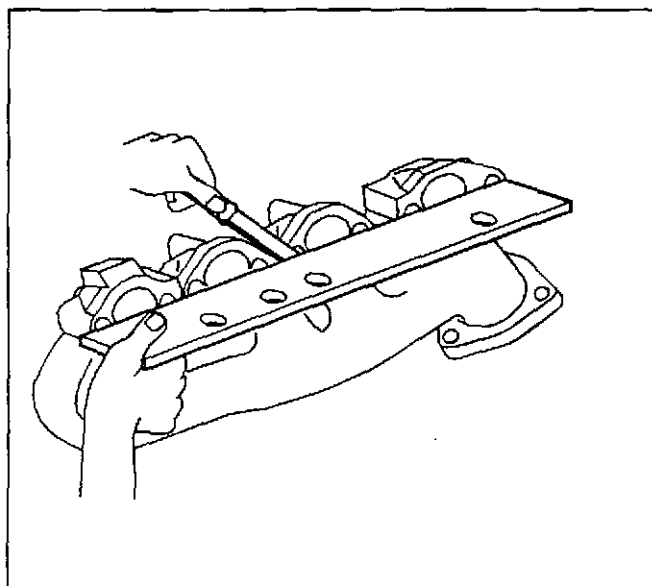
Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

2. Dry the components with compressed air.
3. Inspect the exhaust manifolds for the following:
 - Damage to the gasket sealing surfaces
 - Loose or damaged exhaust gas recirculation (EGR) pipe fitting (if applicable)
 - Damage to the take down studs
 - Restrictions within the exhaust passages
 - Broken or damaged heat shields (if applicable)



180921

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. Exhaust manifold surface flatness must not exceed 0.254 mm (0.01 in).
5. If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.



66607

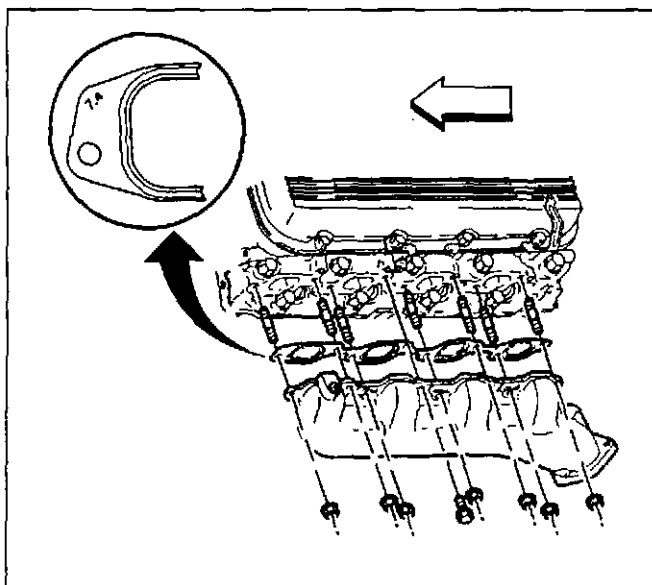
SIE-ID - 200426

Exhaust Manifold Clean and Inspect (with RPO K19)

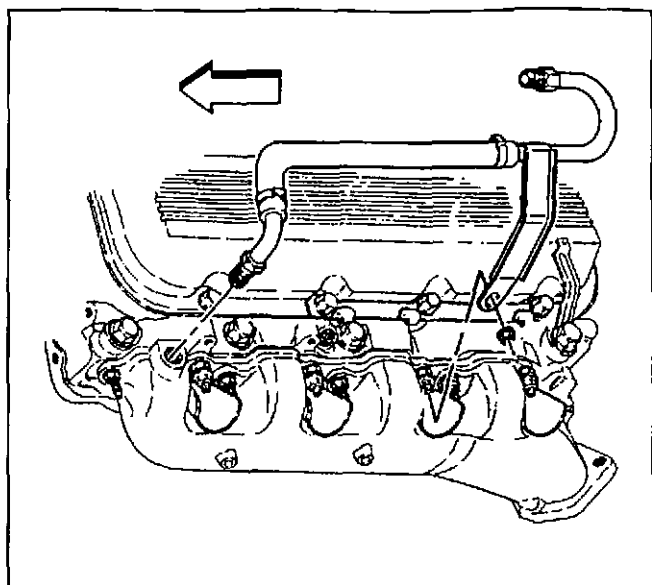
1. Clean the exhaust manifolds in solvent.

Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

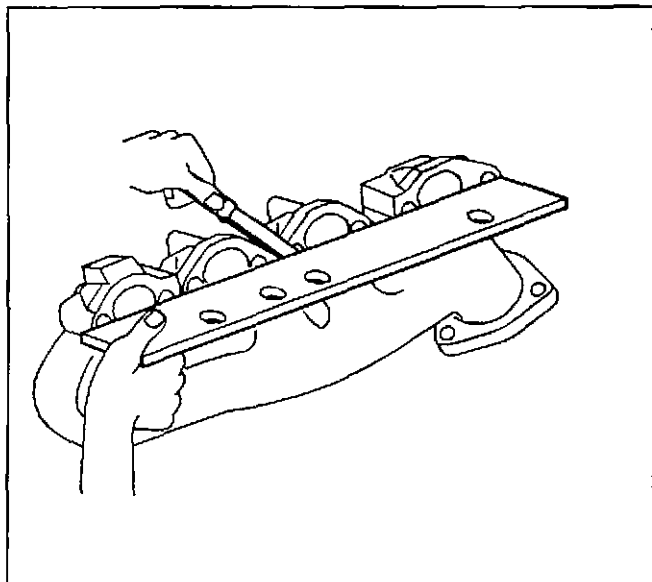
2. Dry the components with compressed air.
3. Inspect the exhaust manifolds for the following:
 - Damage to the gasket sealing surfaces
 - Loose or damaged EGR pipe fitting (if applicable)
 - Damage to the take down studs
 - Restrictions within the exhaust passages
 - Broken or damaged heat shields (if applicable)



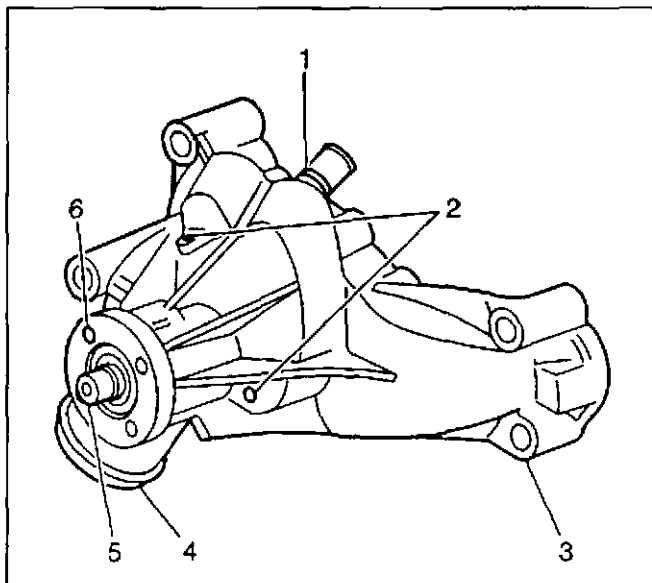
180888



180942



66607



381961

4. Inspect for restrictions within the AIR system passages (California only).
5. Inspect for damaged to threads of AIR inlet pipe opening (California only).

6. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. Exhaust manifold surface flatness must not exceed 0.254 mm (0.01 in).
7. If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.

SIE-10 - 200432

Water Pump Clean and Inspect

Important: Do not immerse the water pump in solvent. The solvent may enter the water pump's permanently lubricated bearings and cause premature bearing failure.

1. Remove the old gasket material from the water pump sealing surfaces. Refer to *Replacing Engine Gaskets (ERROR - NOT IN CURRENT PSD)*.
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump for the following:
 - Leakage at the hose fitting (1)
 - Leakage at the water pump weep hole (2)

A stain around the weep hole is acceptable. If leakage occurs (dripping) with the engine running and the cooling system pressurized, replace the water pump.

- Gasket sealing surfaces for excessive scratches or gouging (3)
- Restrictions within the internal coolant passages (4)
- Excessive side-to-side play in the pulley shaft (5)
 - If the shaft end play exceeds 0.381 mm (0.015 in), replace the water pump.
- Rotate the pump shaft by hand and inspect for roughness of operation (5)
 - If the hub wobbles, is noisy, or feels rough when rotated, replace the water pump.
 - The shaft and fan hub must turn straight and smoothly.
- Damage to threaded bolt holes (6)

SIE-ID = 195835

Service Prior to Assembly

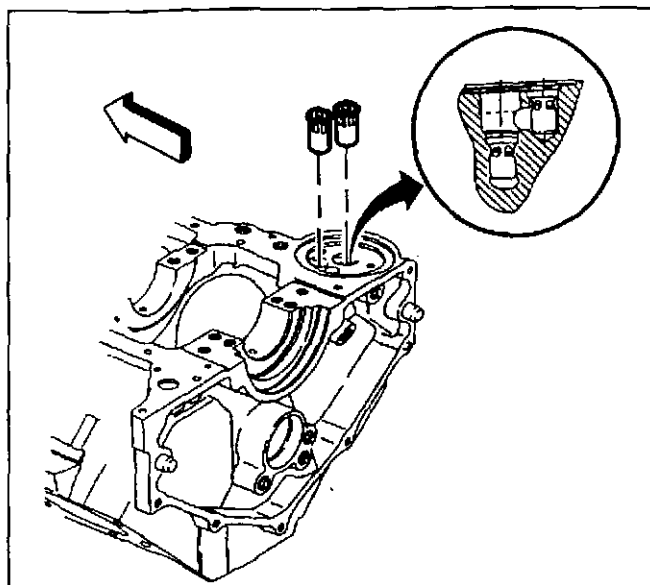
SIO-ID = 40497

- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
- Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position, and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). This will provide initial lubrication when the engine is first started.

SIE-ID - 200442

Engine Block Plug Installation

1. Install NEW oil filter bypass valves to the proper depth, if removed.
Stake the area around the bypass valve.



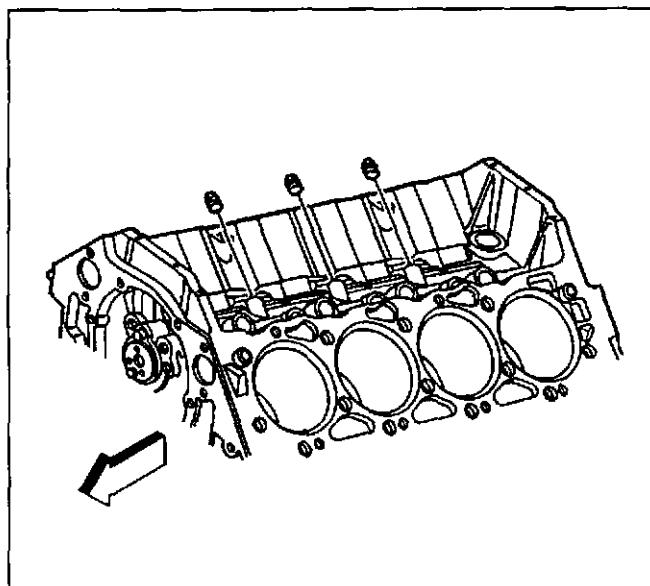
180862

2. Apply sealant GM P/N 12346004 or equivalent to the threads of the oil gallery plugs.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the engine block top oil gallery plugs.
Tighten

Tighten the top oil gallery plugs to 20 N.m (15 lb ft).

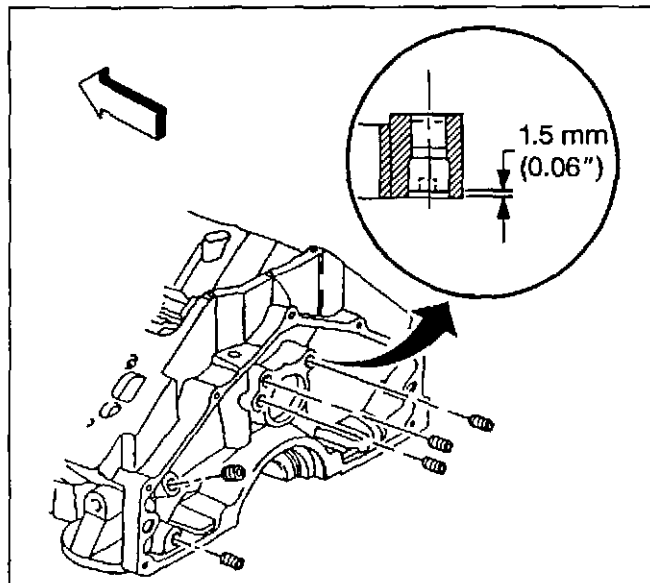


180870

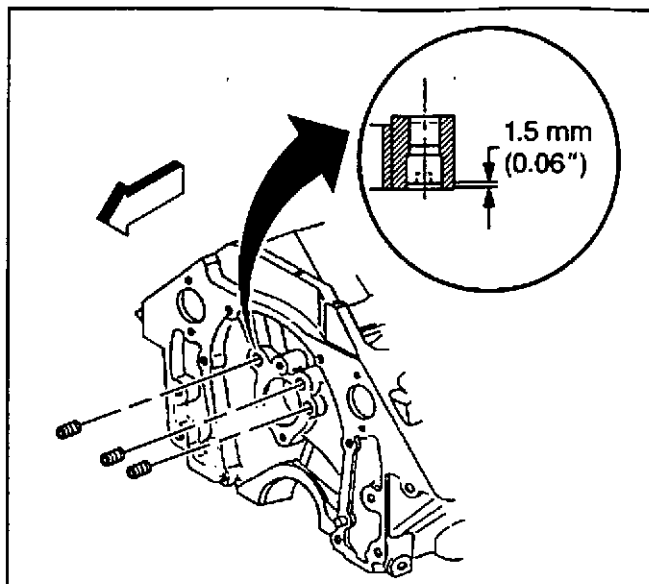
4. Apply sealant GM P/N 12346004 or equivalent to the threads of the oil gallery plugs.

5. Install the engine block rear oil gallery plugs.
Tighten

Tighten the rear oil gallery plugs to 30 N.m (22 lb ft).



180866

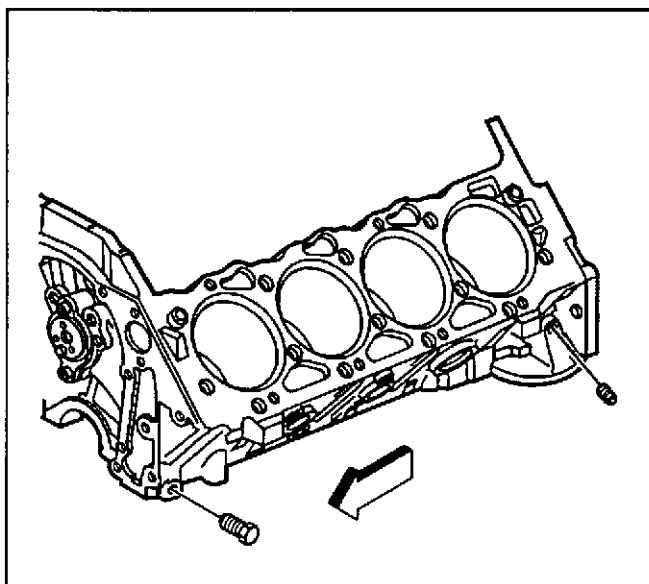


180871

6. Apply sealant GM P/N 12346004 or equivalent to the threads of the oil gallery plugs.
7. Install the engine block front oil gallery plugs.

Tighten

Tighten the front oil gallery plugs to 30 N.m (22 lb ft).

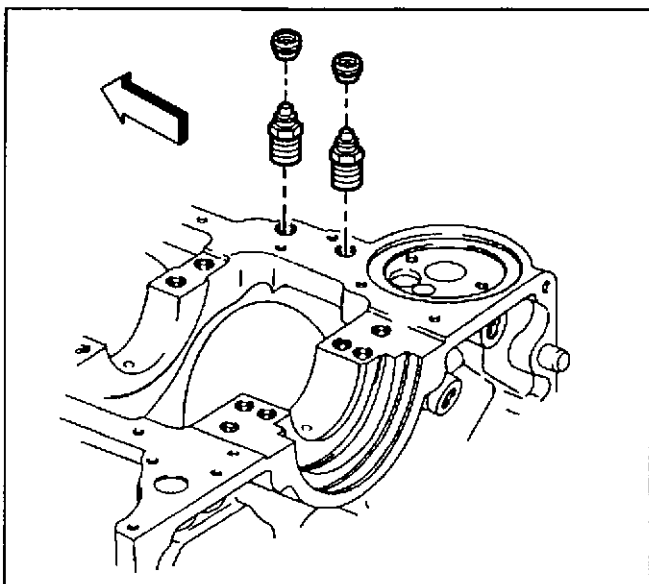


180869

8. Apply sealant GM P/N 12346004 or equivalent to the threads of the oil gallery plugs.
9. Install the engine block left side oil gallery plugs.

Tighten

Tighten the side oil gallery plugs to 30 N.m (22 lb ft).



180864

10. Apply sealant GM P/N 12346004 or equivalent to the threads of the oil cooler fittings.
11. Install the engine block oil cooler fittings.

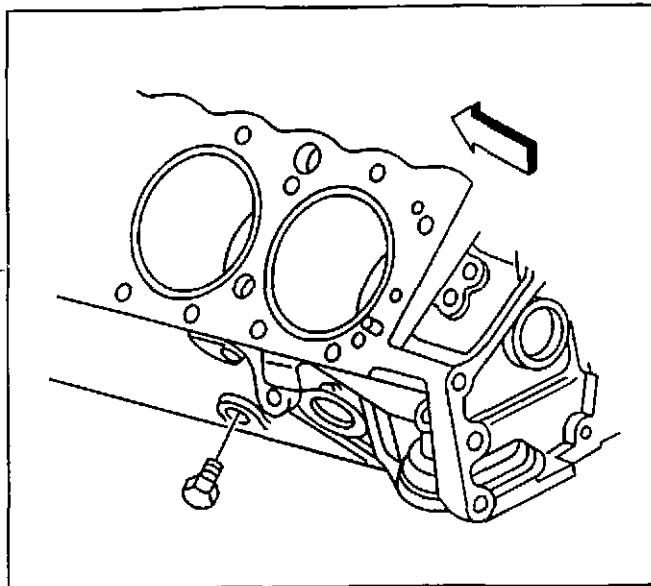
Tighten

Tighten the oil cooler fittings to 12 N.m (106 lb in).

12. Apply sealant GM P/N 12346004 or equivalent to the threads of the engine block coolant drain hole plug.

13. Install the engine block coolant drain hole plug.
Tighten

Tighten the coolant drain hole plug to 20 N.m (15 lb ft).



69033

14. Apply sealant GM P/N 12346004 or equivalent to the threads of the knock sensors.
15. Install the left knock sensor (1) to the engine block.

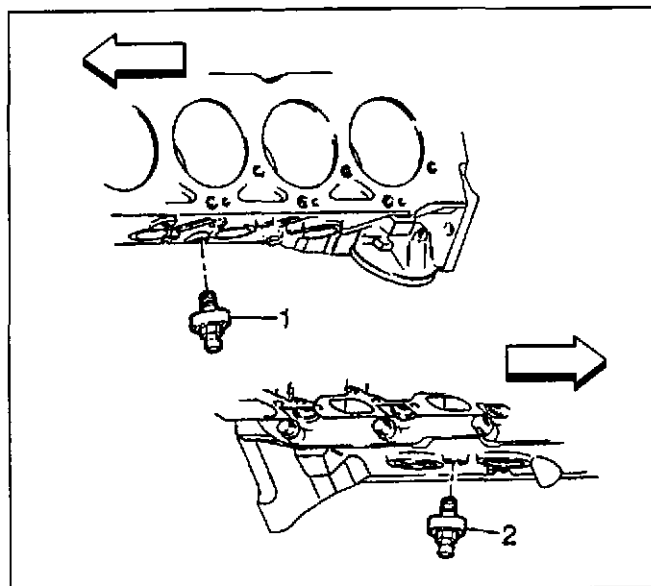
Tighten

Tighten the knock sensor to 19 N.m (14 lb ft).

16. Install the right knock sensor (2) to the engine block.

Tighten

Tighten the knock sensor to 19 N.m (14 lb ft).

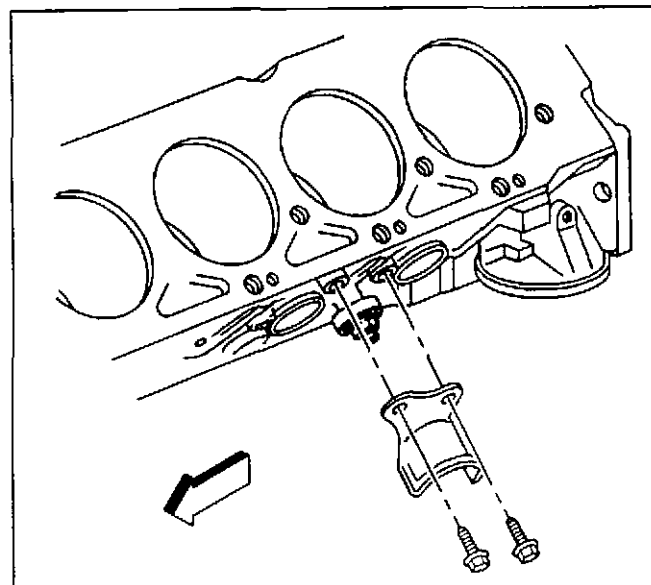


181034

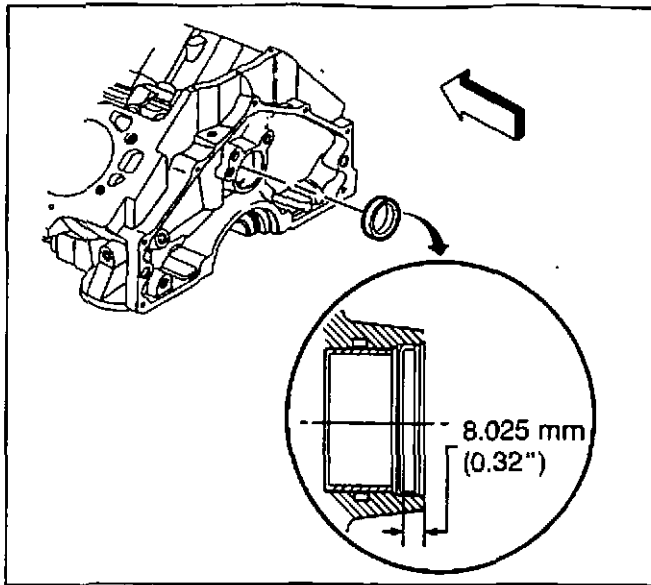
17. Install the left side knock sensor shield.
18. Install the left side knock sensor shield bolts.

Tighten

Tighten the left side knock sensor shield bolts to 12 N.m (106 lb in).

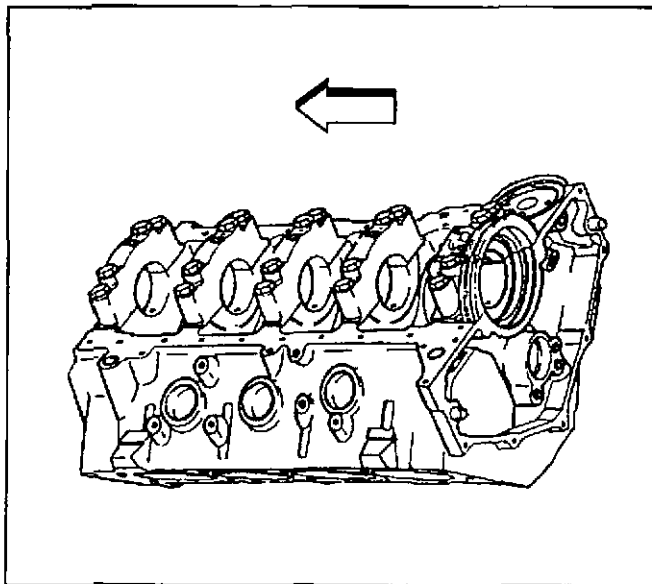


354072



180956

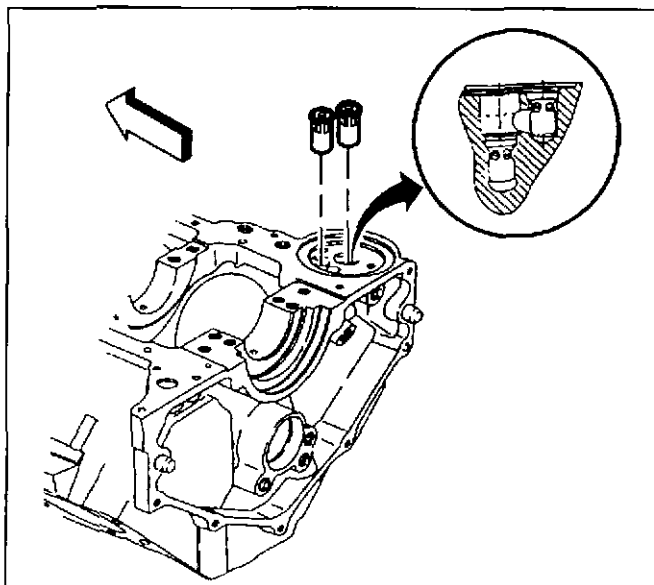
19. Apply sealer GM P/N 12345493 to the engine block camshaft rear bearing hole.
20. Install a NEW camshaft rear bearing hole plug to the proper depth.



183593

21. Apply sealer GM P/N 12345493 to the engine block expansion plug holes.
22. Install NEW engine block expansion plugs to the proper depth.

A properly installed expansion plug will be installed until flush or slightly below flush with the face of the block.



180862

SIE-ID - 281111

Oil Filter Adapter and Valve Assembly Installation (2WD)

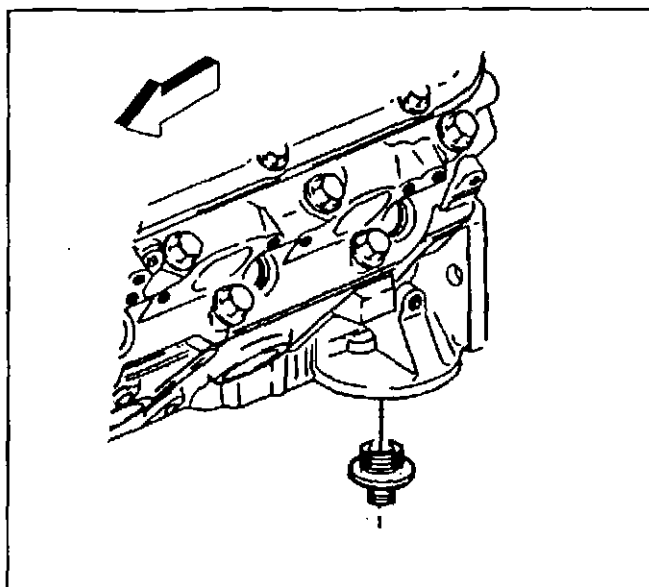
1. If removed, install the new oil bypass valves. Stake the tangs on the oil bypass valves.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the oil filter fitting.

Tighten

Tighten the oil filter fitting to 66 N·m (49 lb ft).

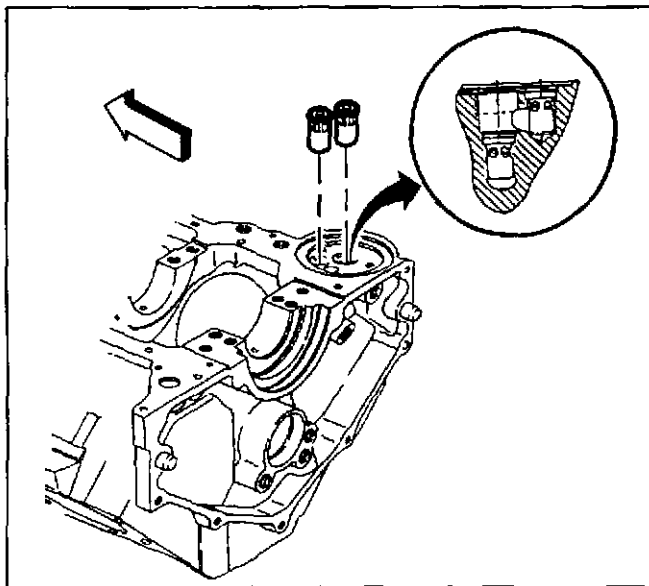


70416

SIE-ID = 200484

Oil Filter Adapter and Valve Assembly Installation (4WD)

1. If removed, install the new oil bypass valves. Stake the tangs on the oil bypass valves.



180862

2. Lubricate the NEW oil filter adapter O-ring seal with clean engine oil.
3. Install the oil filter adapter, with NEW adapter O-ring seal.

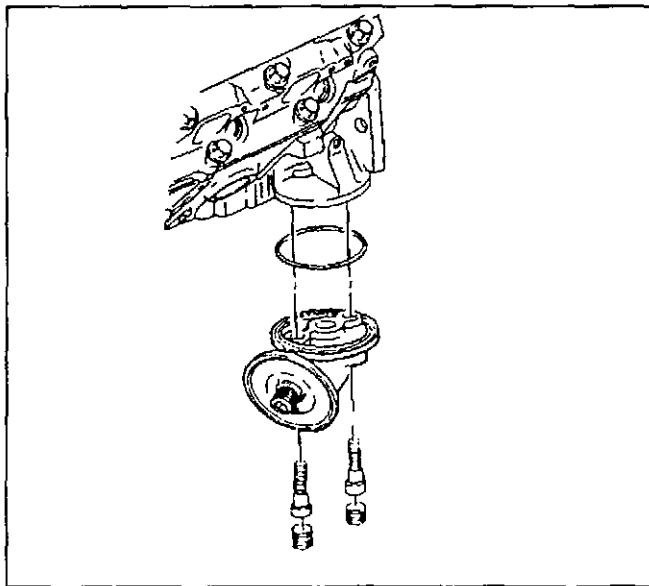
Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the oil filter adapter bolts.

Tighten

Tighten the oil filter adapter bolts to 25 N·m (18 lb ft).

5. Install the plugs into the oil filter adapter.



70415

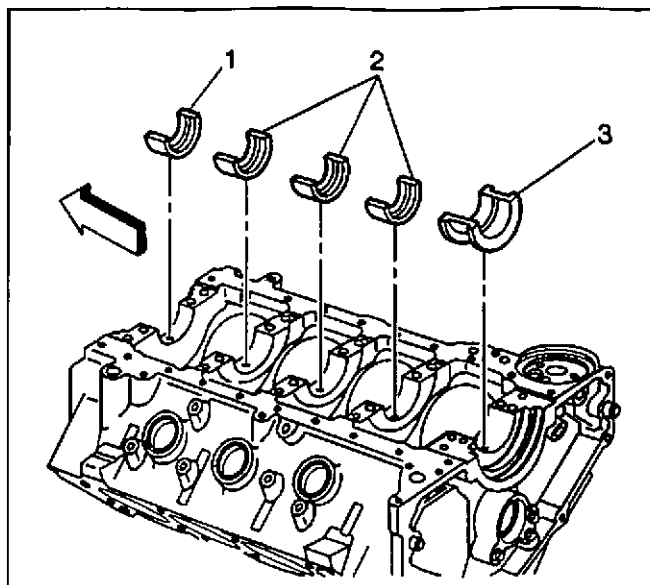
SIE-ID - 200566

Crankshaft and Bearings Installation

Notice: SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

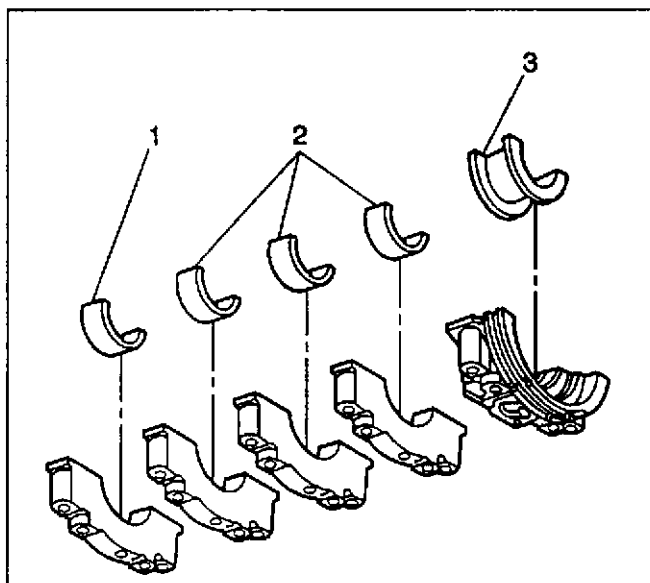
Important: If undersized bearings are used, ensure that the bearings are fitted to the proper journals. Lubricate the crankshaft bearings and crankshaft with clean engine oil.

1. Install the upper crankshaft bearings (1-3) into the block.



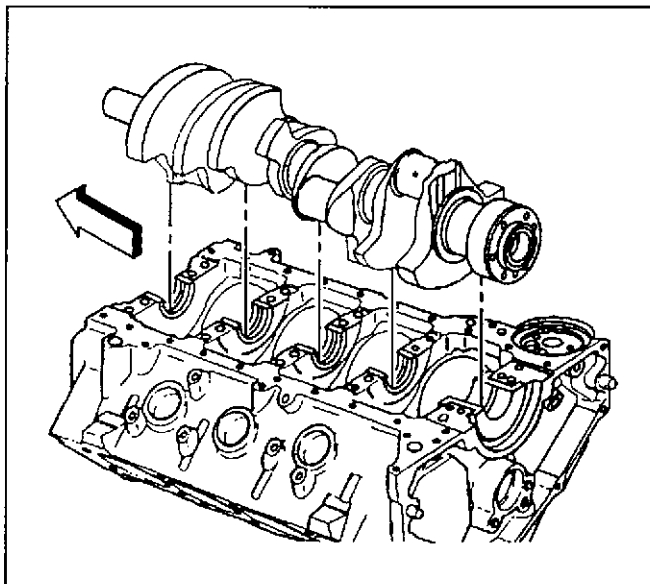
351777

2. Install the lower crankshaft bearings (1-3) into the crankshaft bearing caps.



351781

3. Install the crankshaft.

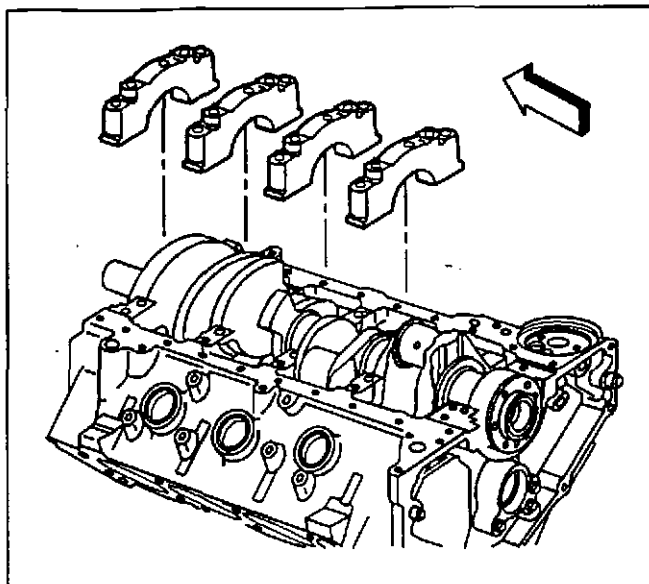


351779

Notice: *SIO-ID - 16506* In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead, or a leather mallet before the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.

Important: Ensure that the triangle symbol on the crankshaft bearings caps are facing the front of the engine. **DO NOT** install the rear crankshaft bearing cap at this time.

4. Install the crankshaft bearing caps.



351786

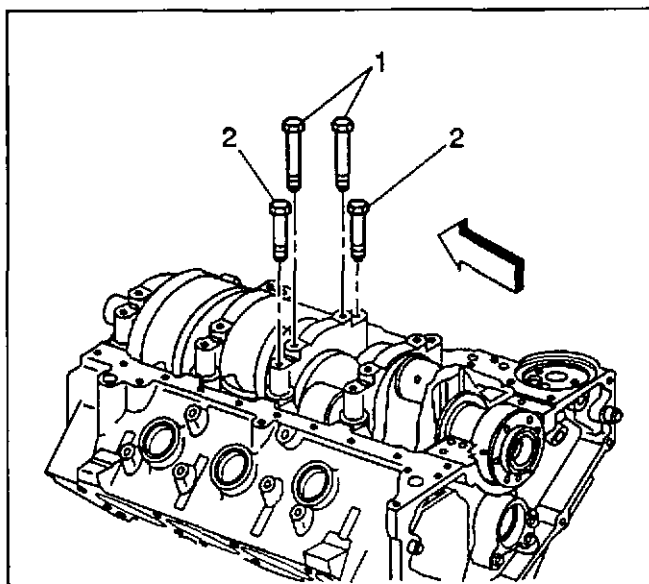
Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important: Tighten the inner crankshaft bearing cap bolts (1) before tightening the outer crankshaft bearing cap bolts (2).

5. Install the crankshaft bearing cap bolts (1, 2).

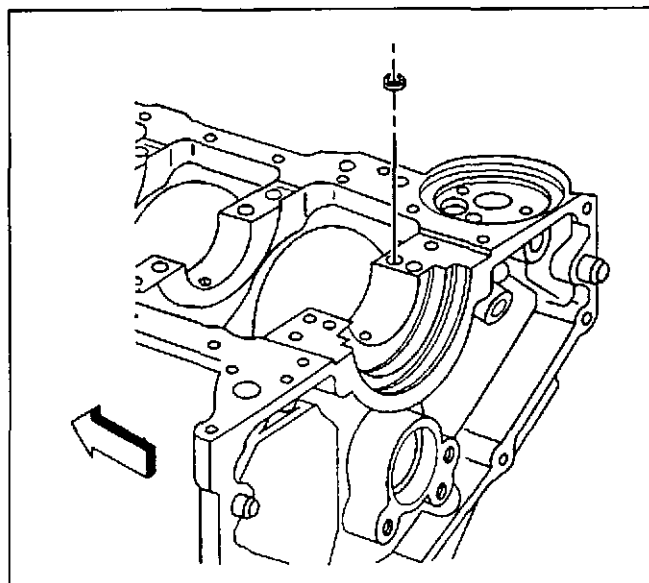
Tighten

- 5.1. Tighten the crankshaft bearing cap inner bolts (1) to 138 N.m (102 lb ft).
- 5.2. Tighten the crankshaft bearing cap outer bolts (2) to 138 N.m (102 lb ft).

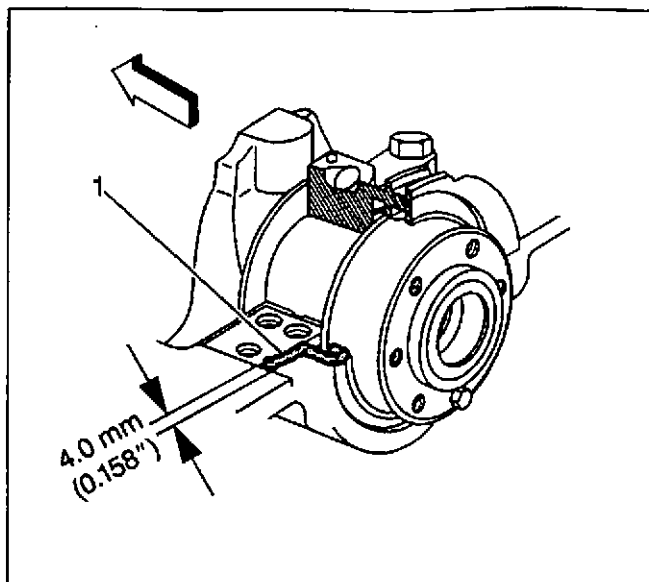


351789

6. Install the crankshaft bearing cap oil seal.

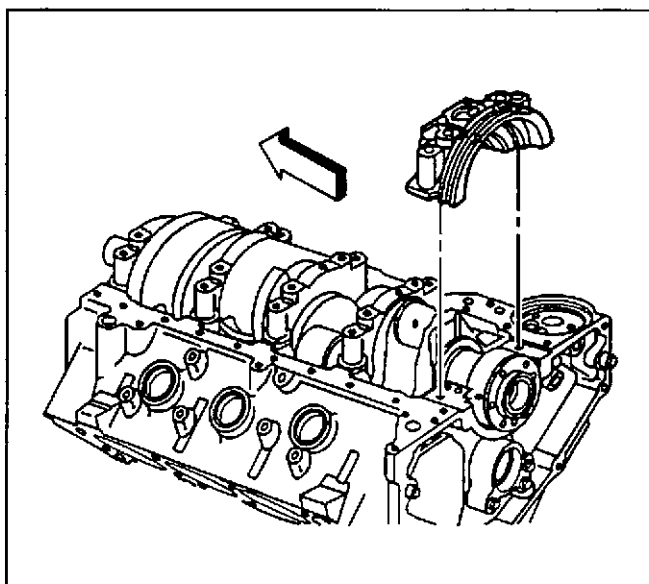


351825



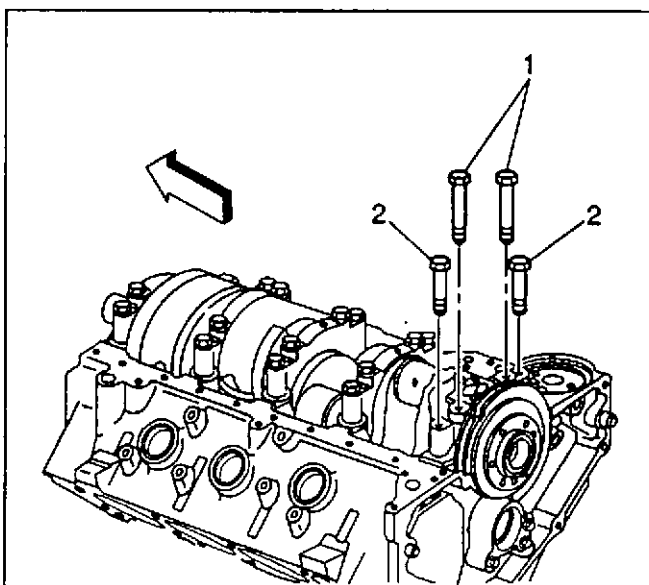
180890

7. Apply a 4 mm (0.158 in) bead of GM P/N 12345739 or equivalent to the rear bearing cap sealing face or to the rear bearing cap channel of the engine block (1).
Apply the sealant from the corner of the rear thrust bearing pocket to the edge of the channel.



351792

8. Install the rear crankshaft bearing cap.



351795

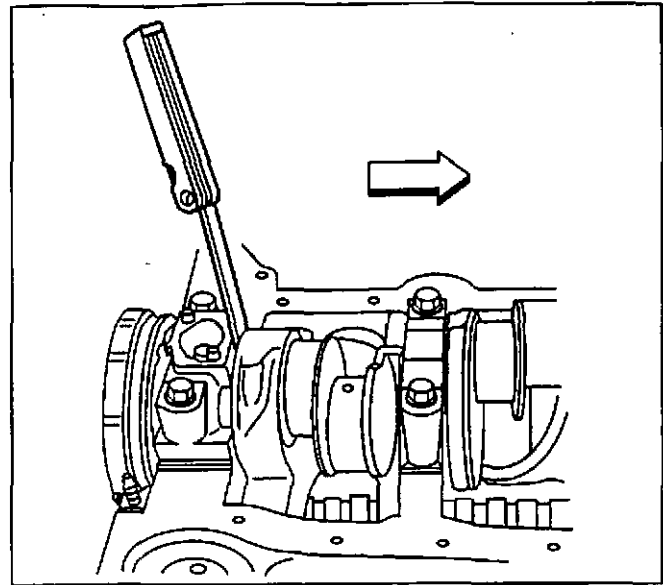
Important: Tighten the inner crankshaft bearing cap bolts (1) before tightening the outer crankshaft bearing cap bolts (2).

9. Install the rear crankshaft bearing cap bolts (1, 2) to the block.

Tighten

Tighten the rear crankshaft bearing cap bolts (1, 2) to 4 N·m (35 lb in).

10. Measure the crankshaft end play as follows:
- 10.1. Firmly thrust the crankshaft first rearward then forward. This will line up the rear crankshaft bearing and the crankshaft thrust surfaces.
- Important:** Tighten the inner crankshaft bearing cap bolts (1) before tightening the outer crankshaft bearing cap bolts (2).
- Tighten the rear crankshaft bearing cap bolts (1, 2).
- Tighten**
- 10.1. Tighten the rear crankshaft bearing
 1. cap inner bolts (1) to 138 N.m (102 lb ft).
 - 10.1. Tighten the rear crankshaft bearing
 2. cap outer bolts (2) to 138 N.m (102 lb ft).
- 10.2. With the crankshaft wedged forward, insert a feeler gauge between the thrust bearing and crankshaft thrust surface.
- The proper clearance is 0.127–0.279 mm (0.005–0.011 in)



35199

11. Rotate the crankshaft and check for binding.
- If the crankshaft does not turn freely, loosen the crankshaft bearing cap bolts on one cap at a time until the tight bearing is located.
- A bent crankshaft or lack of bearing clearance may cause binding.
12. A lack of bearing clearance may be caused by the following conditions:
- Burrs on the bearing cap
 - Foreign material between the bearing and the block
 - Foreign material between the bearing and the bearing cap
 - Damaged bearing
 - Improper size bearing

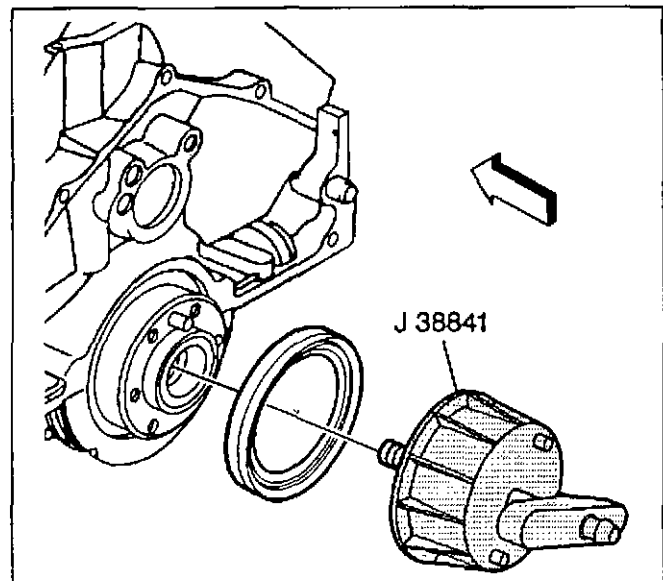
SIE-ID - 67682

Crankshaft Rear Oil Seal Installation

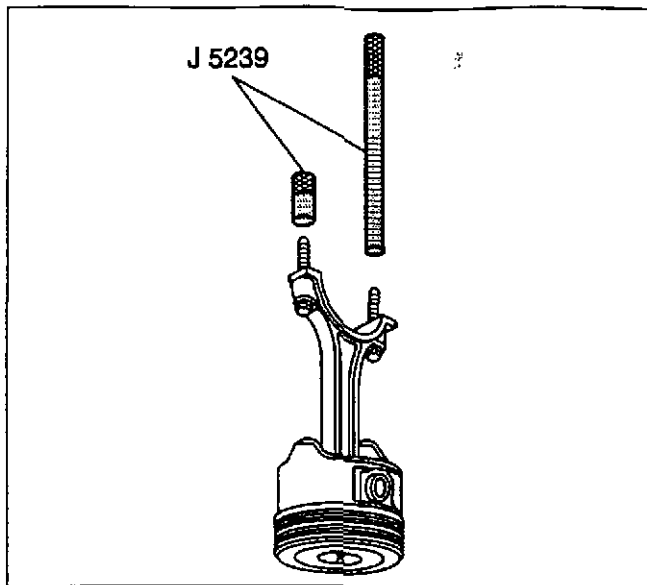
Tools Required

J 38841 Crankshaft Rear Oil Seal Installation

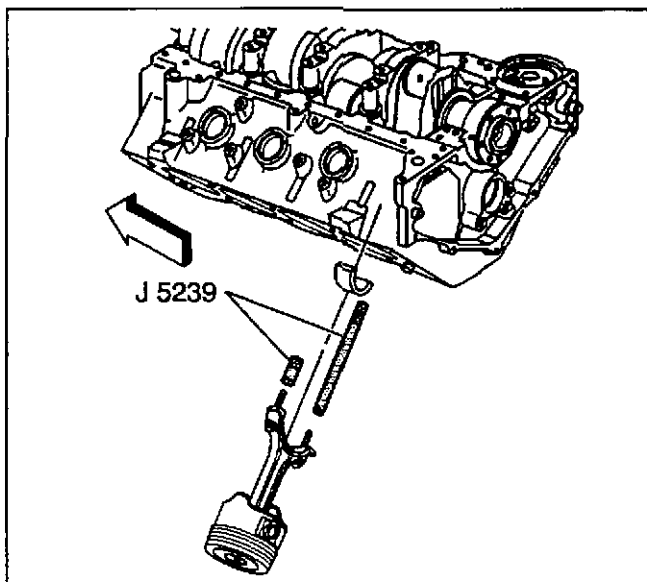
1. Make sure the crankshaft rear chamfer is free of grit, loose rust, and burrs. Correct as needed.
2. Lubricate the inner and the outer diameter of the seal with engine oil.
3. Install the seal on J 38841.
4. Position J 38841 against the crankshaft. Thread the attaching screws into the tapped holes in the crankshaft.
5. Tighten the screws securely with a screwdriver in order to ensure that the seal is installed squarely over the crankshaft.
6. Turn the handle until it bottoms.
7. Remove J 38841.



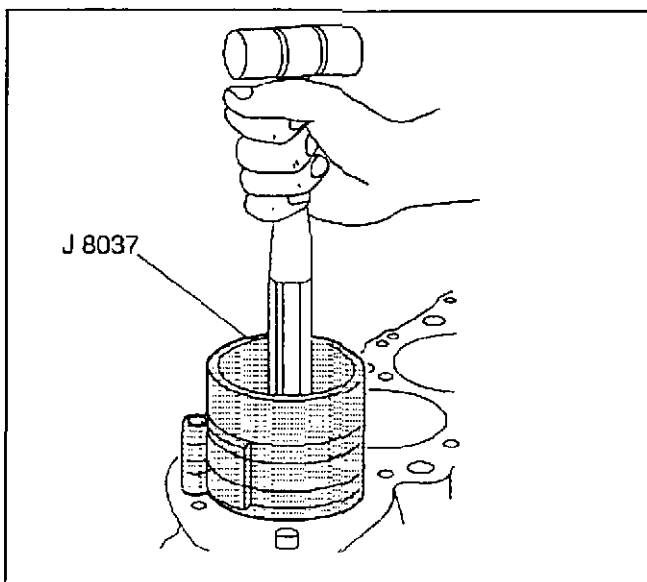
290961



354027



354028



5159

SIE-ID - 200725

Piston, Connecting Rod, and Bearing Installation

Tools Required

- J 5239 Guide Set
- J 8037 Piston Ring Compressor

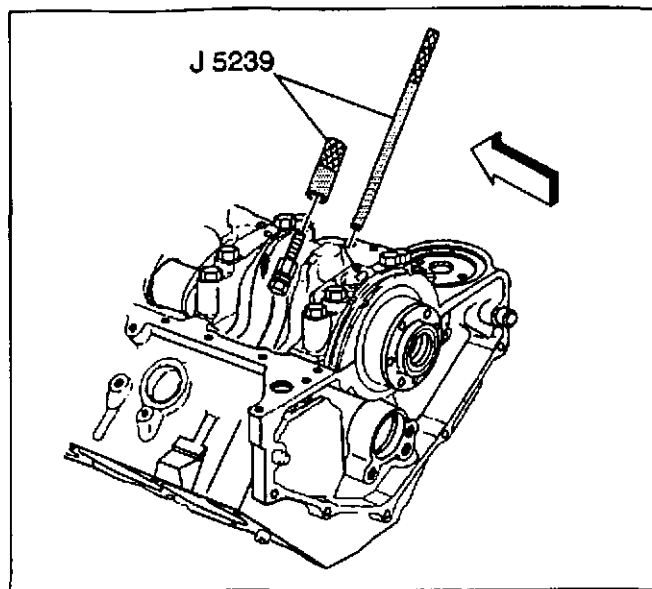
1. Coat the following components with clean engine oil:
 - The piston
 - The piston rings
 - The cylinder bore
 - The bearing surfaces
2. Install the J 5239 onto the connecting rod.

Notice: SIO-ID - 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

Important: The mark on the top of the piston must face the front of the engine block. When assembled, the flanges on the connecting rod and cap should face to the front of block on the left bank and to the rear of block on the right bank.

3. Install the piston, connecting rod and upper connecting rod bearing through the top of the engine block using the J 5239 .
4. Install the J 8037 onto the piston and compress the piston rings.
5. Use the J 8037 and the J 5239 and lightly tap the top of the piston with a wooden hammer handle.
6. Hold the J 8037 firmly against the engine block until all of the piston rings have entered the cylinder bore.

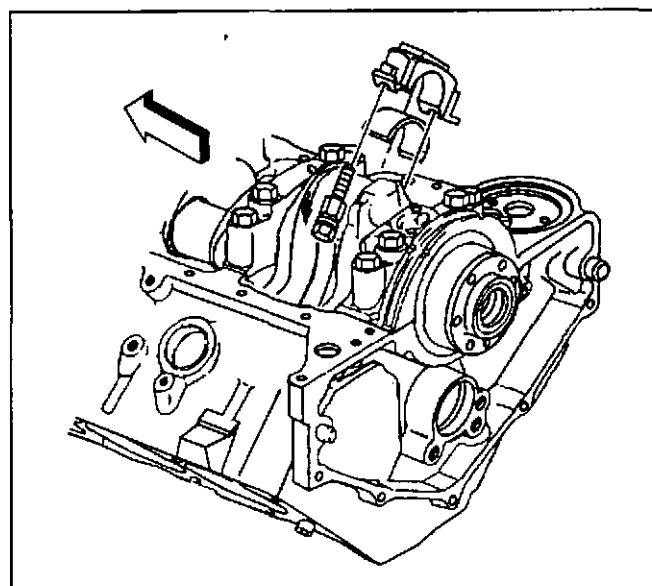
7. Use the *J 5239* in order to guide the connecting rod onto the crankshaft journal.
8. Remove the *J 5239*.



354029

Notice: *S10-ID - 5016* Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

9. Install the connecting rod cap and lower connecting rod bearing.



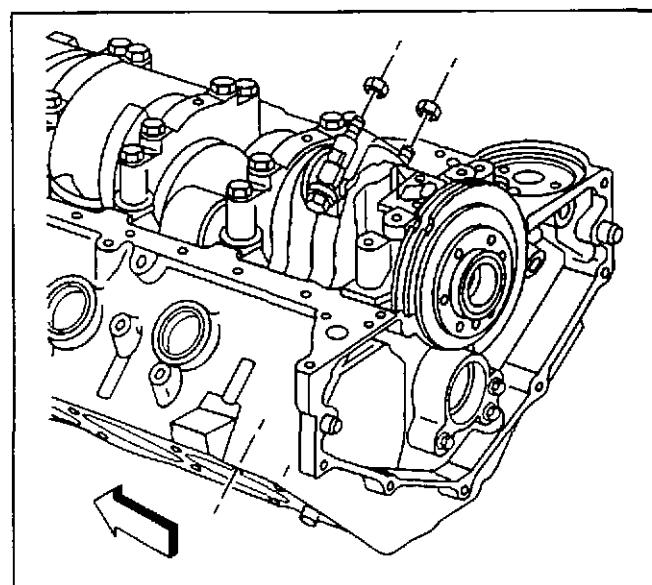
354030

Notice: Refer to *Fastener Notice* in Caution and Notices.

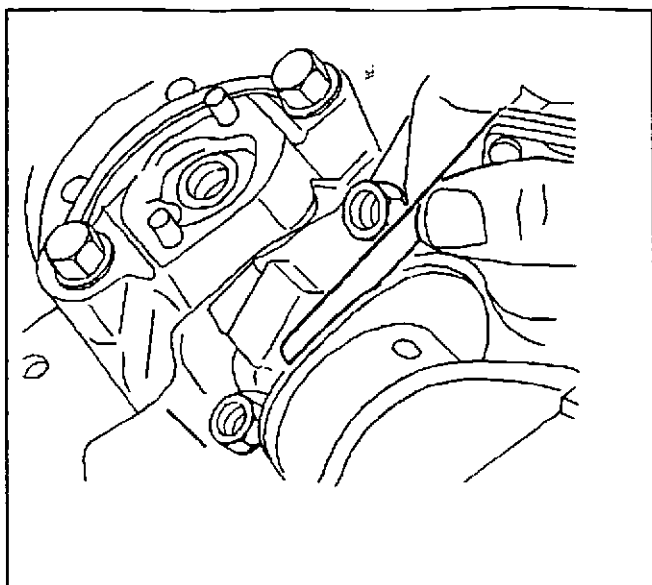
10. Install the connecting rod nuts.

Tighten

Tighten the connecting rod nuts to 64 N.m (47 lb ft).

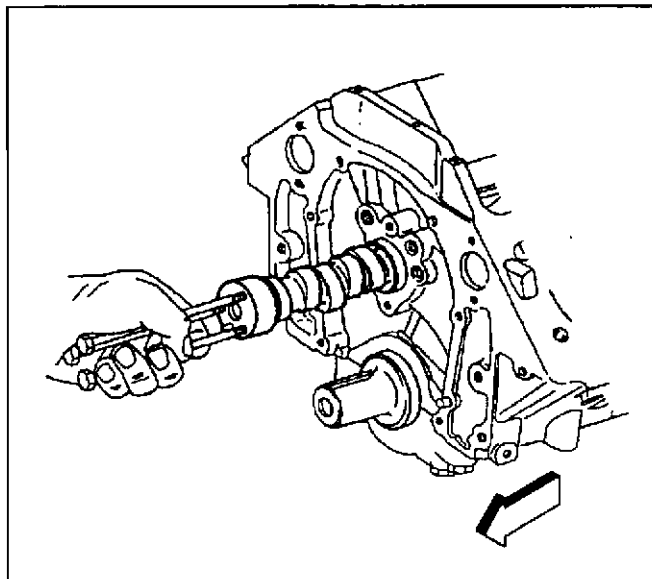


354031



5163

11. Once the piston and connecting rod assemblies have been installed, lightly tap each connecting rod assembly (parallel to the crankpin) in order to make sure that they have side clearance.
12. Use a feeler gauge or a dial indicator to measure the side clearance between the connecting rod caps. The rod side clearance should be 0.033–0.584 mm (0.0013–0.0230 in).



196588

SIE-ID - 200771

Camshaft Installation

1. Lubricate the following components with clean engine oil, engine oil supplement GM P/N 1052367, or equivalent:
 - The camshaft lobes
 - The camshaft bearing journals
 - The camshaft bearings

Notice: SIO-ID - 13833 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.

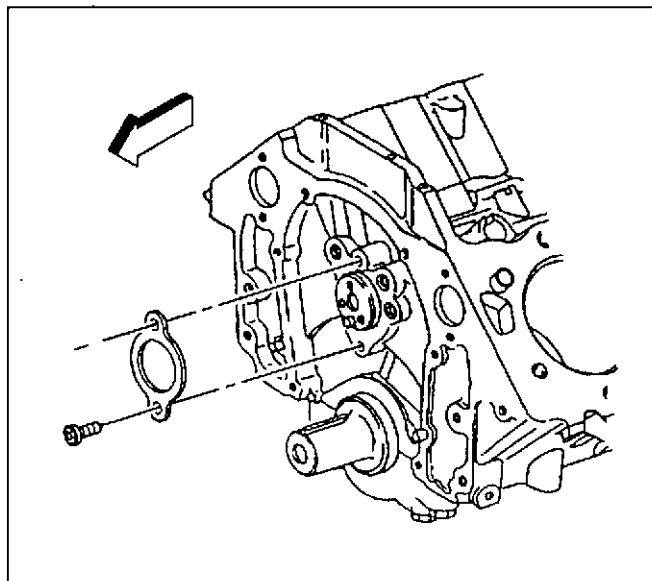
2. Install the three 5/16–18 x 4.0 inch bolts in the camshaft front bolt holes.
3. Using the bolts as a handle, install the camshaft.
4. Remove the three bolts from the front of the camshaft.
5. Install the camshaft retainer.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Install the camshaft retainer bolts.

Tighten

Tighten the camshaft retainer bolts to 12 N.m (106 lb in).

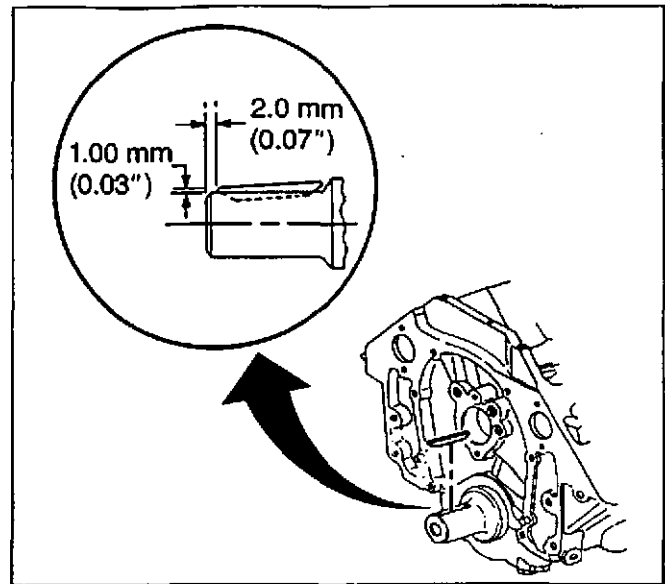


193223

SIE-ID • 201100

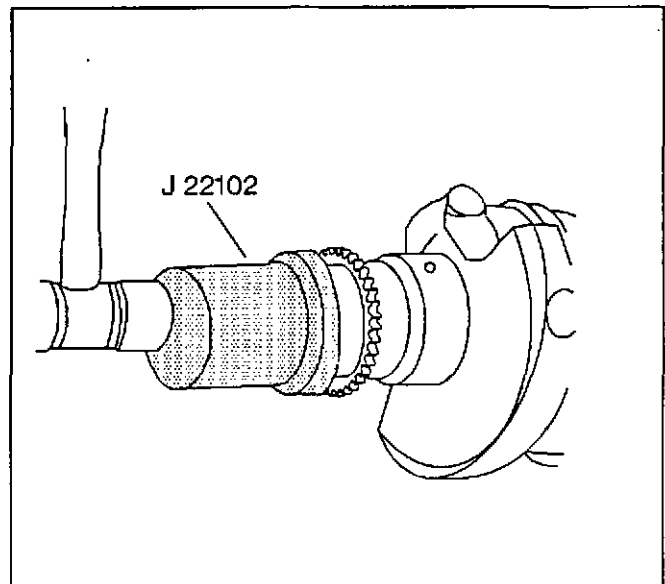
Timing Chain and Sprockets Installation**Tools Required****J 22102 Crankshaft Sprocket Installer**

1. Properly install the crankshaft key into the crankshaft keyway, if removed.



180902

2. Use the J 22102 in order to install the crankshaft sprocket.
Align the keyway of the crankshaft sprocket with the crankshaft key.
3. Rotate the crankshaft until the crankshaft sprocket alignment mark is at the 12 o'clock position.



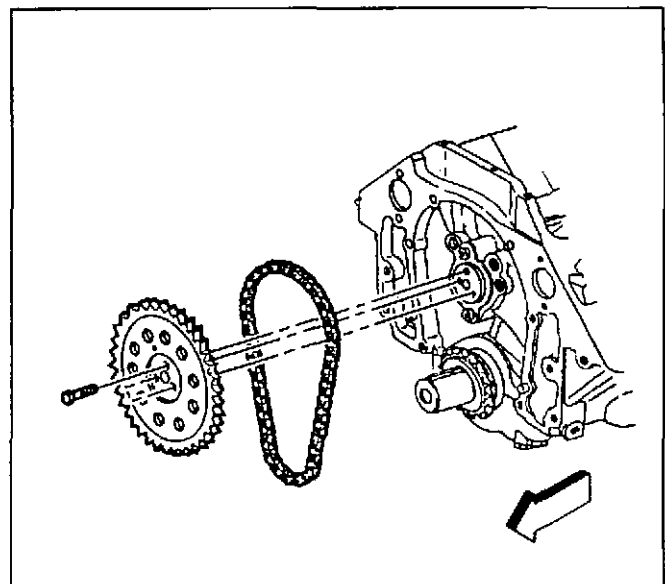
65850

Important: Install the camshaft sprocket with the alignment mark in the 6 o'clock position.

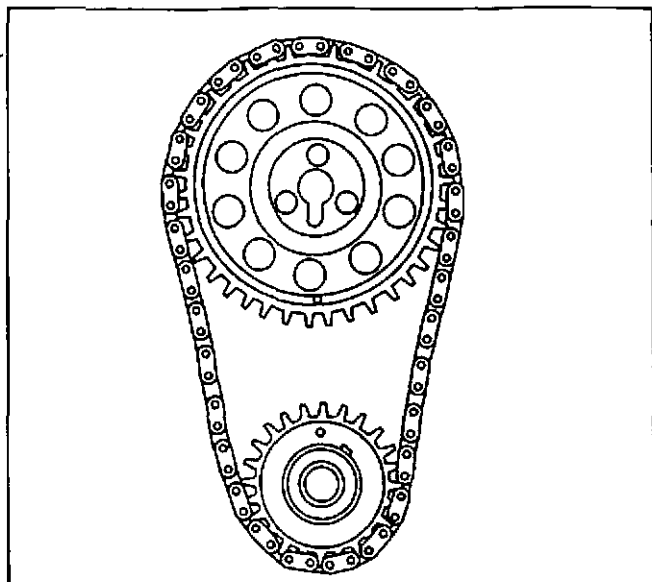
Important: The sprocket teeth must mesh with the timing chain in order to prevent damage to the camshaft retainer.

Important: Do not use a hammer to install the camshaft sprocket onto the camshaft. To do so may dislodge the rear camshaft plug and/or damage the camshaft.

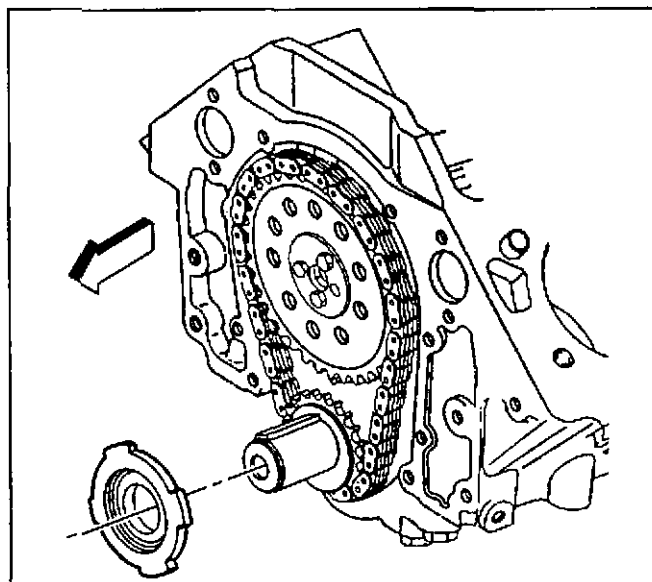
4. Install the camshaft sprocket and timing chain.



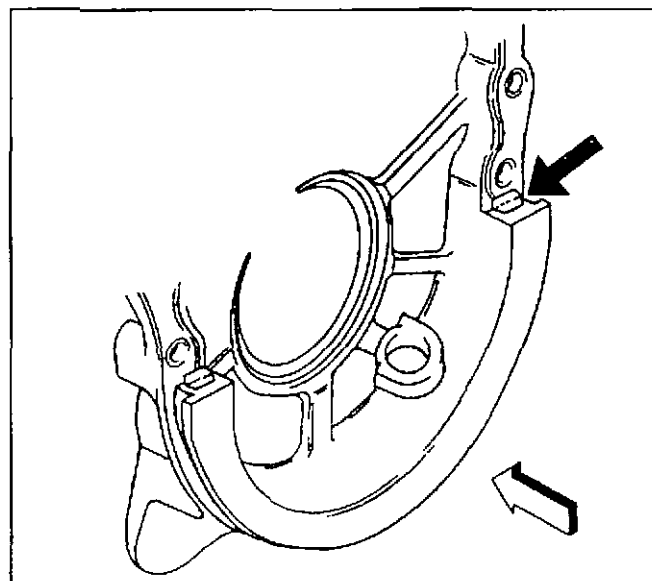
196671



196651



196642



173190

5. Look to ensure that the crankshaft sprocket is aligned at the 12 o'clock position and the camshaft sprocket is aligned at the 6 o'clock position.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Install camshaft sprocket bolts.

Tighten

Tighten the camshaft sprocket bolts to 30 N·m (22 lb ft).

Important: Align the keyway on the reluctor ring with the crankshaft key.

7. Install the crankshaft position reluctor ring onto the crankshaft.

Install the crankshaft position reluctor ring onto the crankshaft until the ring is completely seated against the crankshaft sprocket.

SIE-ID - 201101

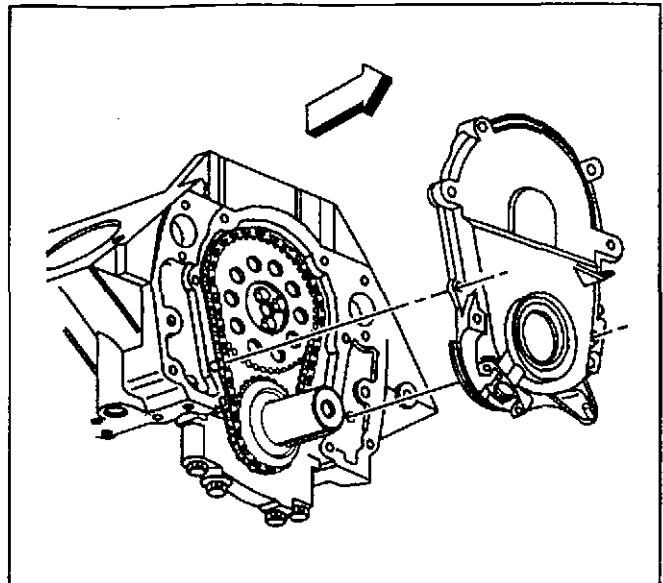
Engine Front Cover Installation

1. Lubricate the sealing surface of the crankshaft front oil seal with clean engine oil.

Important: The front cover must be installed and the fasteners tightened while the sealant is still wet to the touch.

2. Apply the sealant GM P/N 12345739 or equivalent in two sealant points on the front cover where the front cover meets the oil pan.

3. Install the engine front cover.



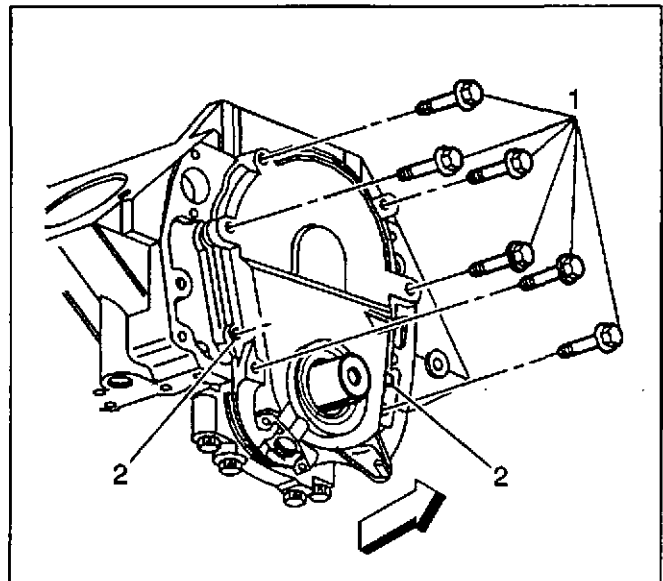
64547

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the engine front cover bolts (1).

Tighten

Tighten the engine front cover bolts (1) to 12 N·m (106 lb in).

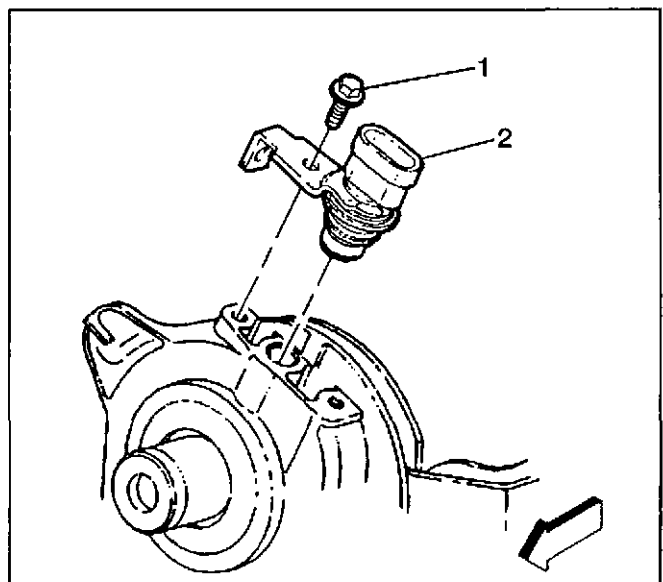


342207

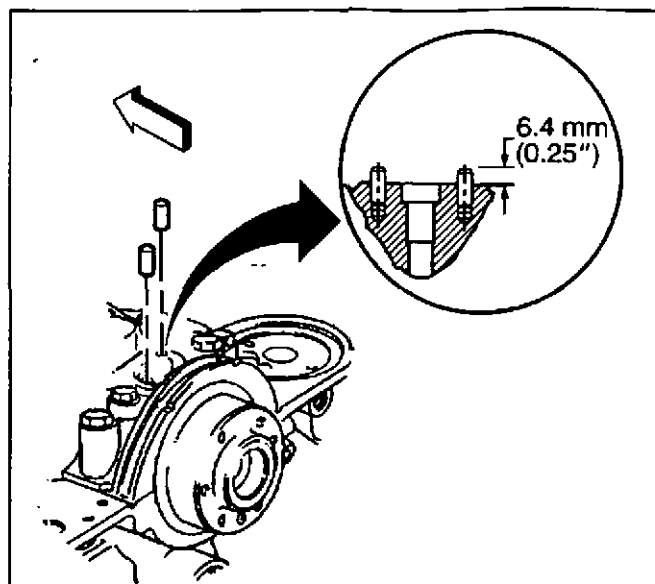
5. Install the new O-ring seal onto the crankshaft position sensor.
6. Install the crankshaft position sensor (2).
7. Install the crankshaft position sensor bolt (1).

Tighten

Tighten the crankshaft position sensor bolts (1) to 12 N·m (106 lb in).



180901

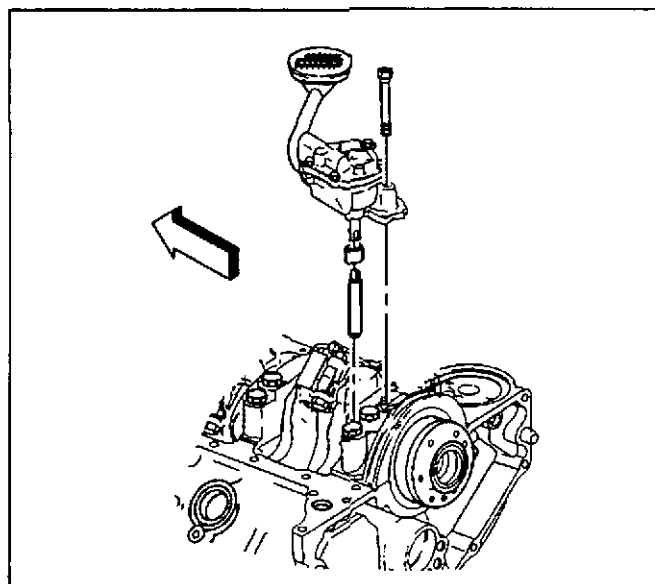


180863

SIE-ID = 201109

Oil Pump, Pump Screen and Deflector Installation

1. Inspect for properly installed oil pump locating pins.



173183

Important: During assembly, install a NEW oil pump driveshaft retainer. Slightly heat retainer above room temperature for ease of installation onto the oil pump driveshaft.

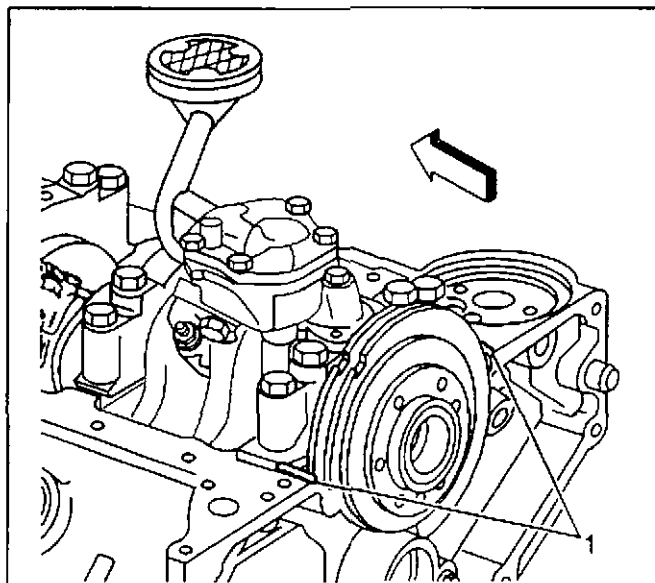
2. Assemble the oil pump, driveshaft, and a NEW retainer.
3. Install the oil pump assembly.
Position the oil pump onto the locating pins.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the bolt attaching the oil pump to the rear crankshaft bearing cap.

Tighten

Tighten the oil pump bolt to 88 N.m (65 lb ft).



351798

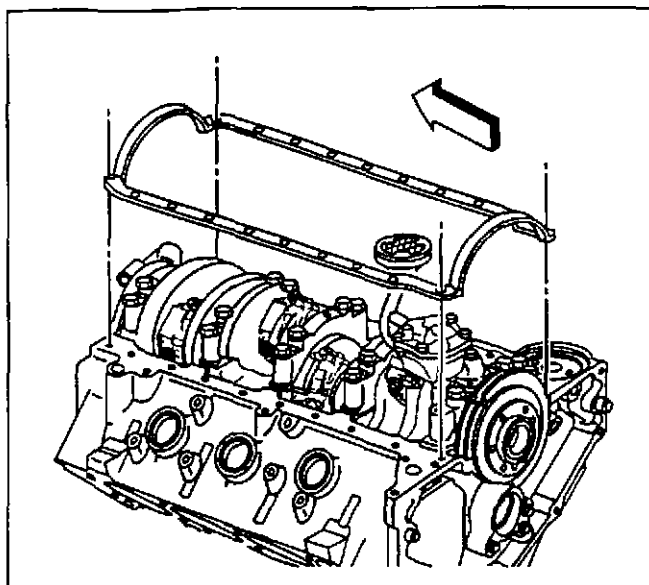
SIE-ID = 201119

Oil Pan Installation

Important: The oil pan must be installed and the fasteners tightened while the sealant is still wet to the touch.

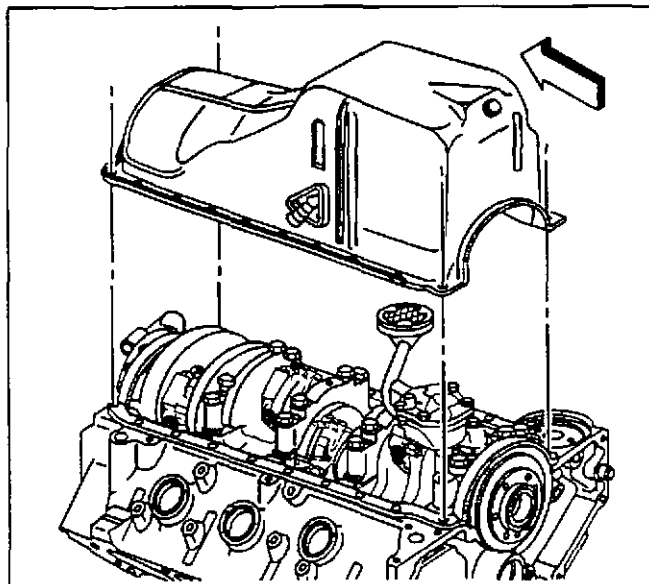
1. Apply sealant GM P/N 12345739 or the equivalent in two sealant points where rear crankshaft bearing cap meets the engine block.
2. Apply sealant GM P/N 12345739 or the equivalent in two sealant points where engine front cover meets the block.

3. Install the oil pan gasket onto the engine block.



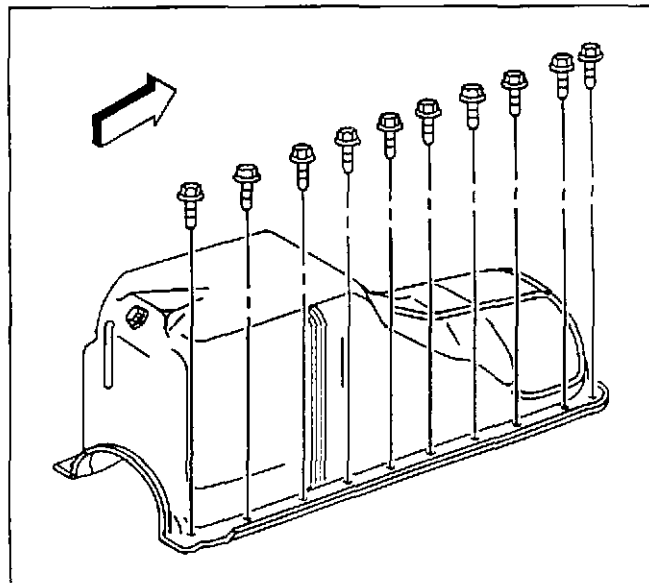
351800

4. Install the oil pan.

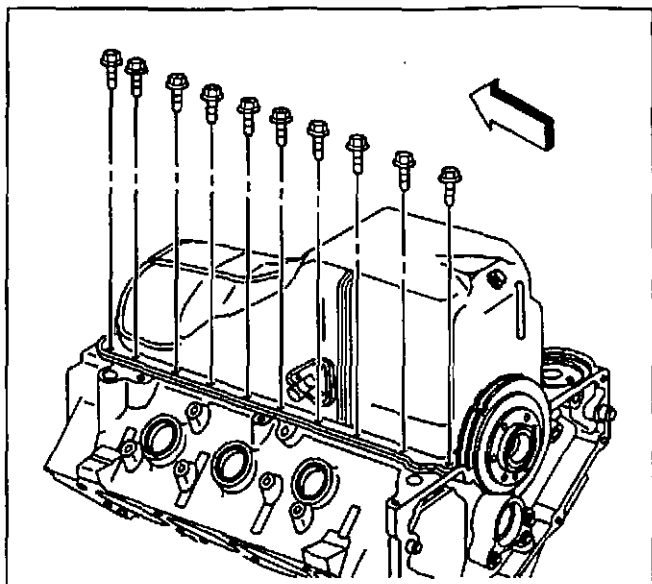


351803

5. Loosely install the left side oil pan bolts.



351809



351806

6. Loosely install the right side oil pan bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the oil pan bolts.

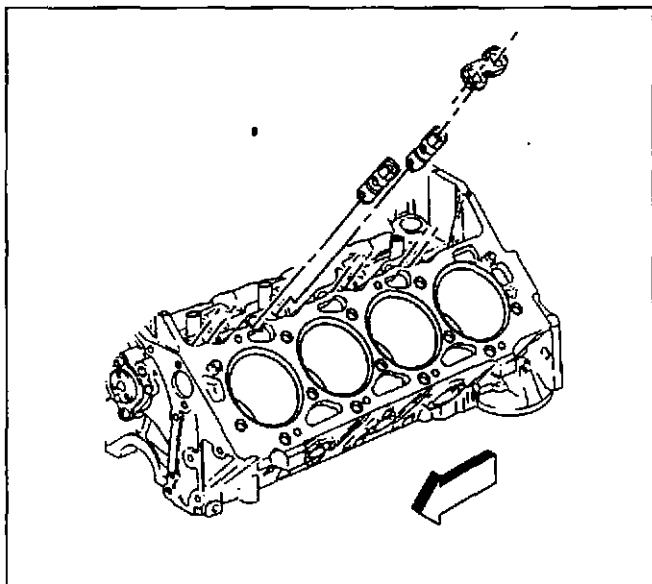
Tighten

Tighten the oil pan bolts to 25 N.m (18 lb ft).

8. Install the oil pan drain plug.

Tighten

Tighten the oil pan drain plug to 28 N.m (21 lb ft).



173176

SIE-ID = 201124

Valve Lifter Installation

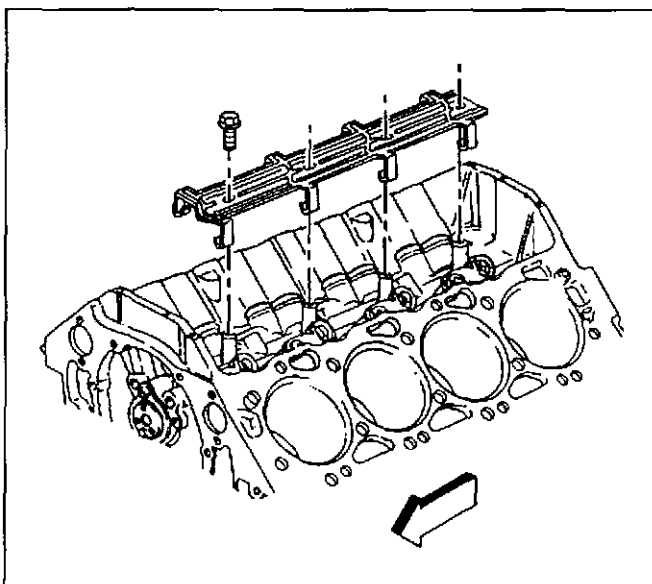
SIO-ID = 201123

Important: If a new camshaft is installed, replace all the valve lifters.

1. Coat the valve lifter rollers with prelube, GM P/N 1052367 or equivalent.

Important: If reusing the valve lifters, install in their original location. The valve lifter guide retainer must contact all of the valve lifter guides. If the valve lifter guide retainer is bent, the valve lifter guide retainer must be replaced.

2. Install the valve lifters.
3. Install the valve lifter guides.



173193

4. Install the valve lifter guide retainer.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the valve lifter guide retainer bolts.

Tighten

Tighten the valve lifter guide retainer bolts to 25 N.m (18 lb ft).

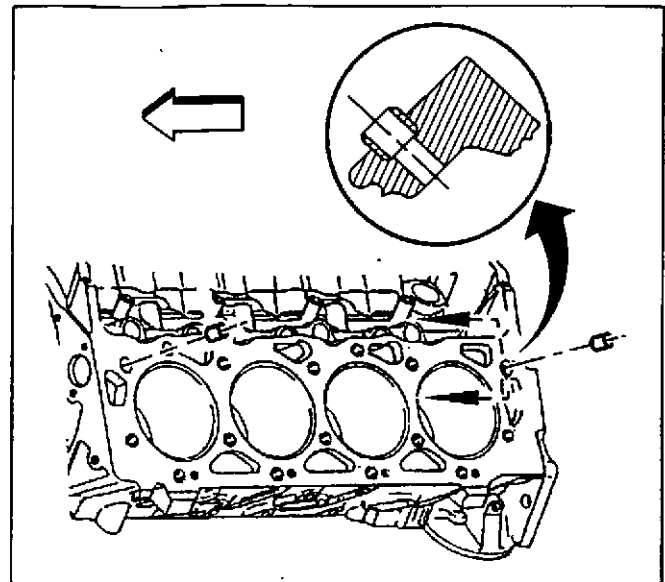
SIE-ID - 281855

Cylinder Head Installation (Left)

Tools Required

J 36660 Torque Angle Meter

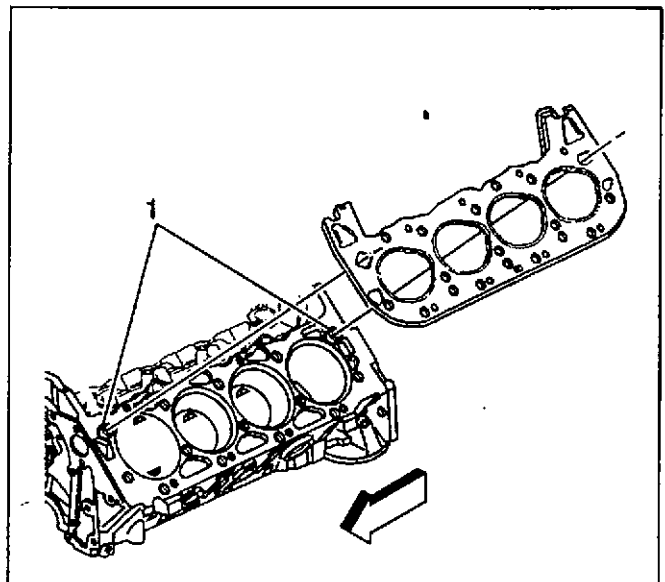
1. Clean the cylinder head gasket surfaces. Refer to *Replacing Engine Gaskets (ERROR - NOT IN CURRENT PSD)*.
2. Install the cylinder head locating pins, if removed.



180904

Important: Make sure the threaded holes in the engine block are clean and not damaged. Do not use sealer on any engines that use a composition type gasket. Align the cylinder head gasket locating mark to face up.

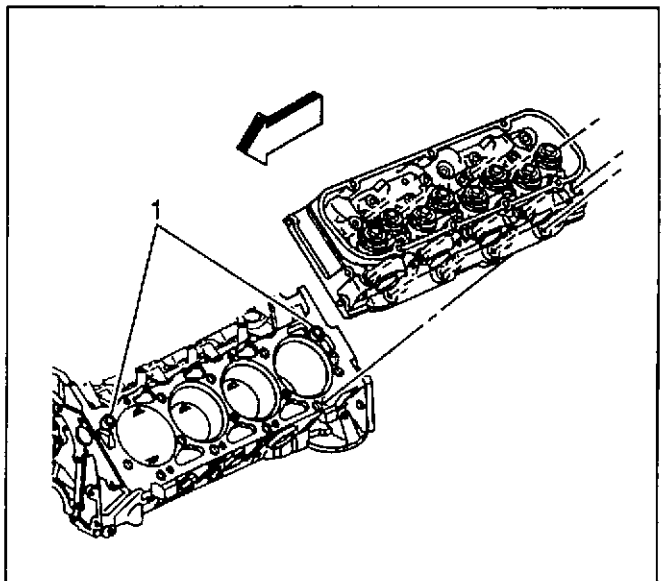
3. Place the cylinder head gasket in position over the cylinder head locating pins (1).



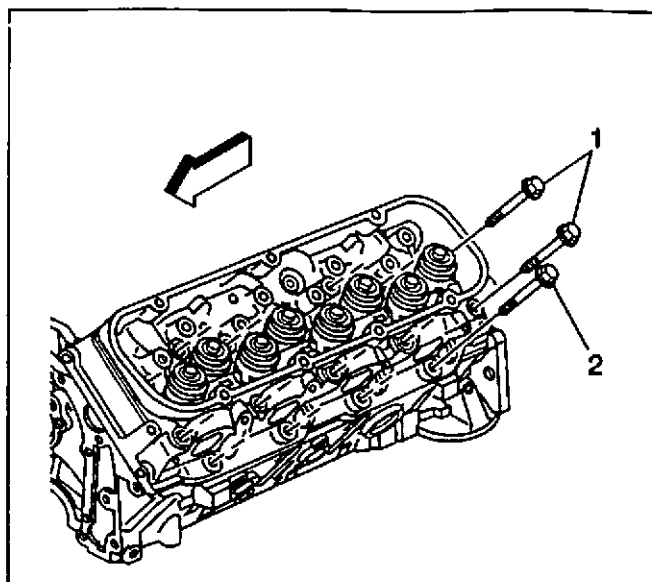
354038

Important: Guide the cylinder head carefully into place over the locating pins (1) and the cylinder head gasket.

4. Install the cylinder head to the block.



354040



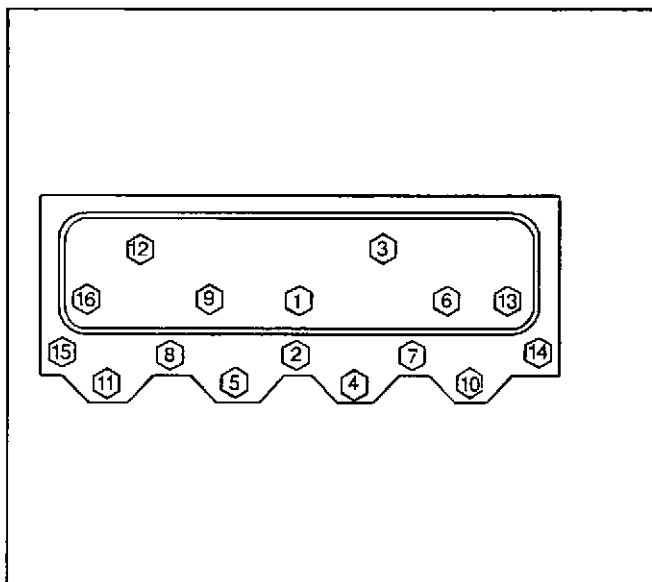
354041

5. Apply sealer GM P/N 12346004 or equivalent to a minimum of eight threads on the cylinder head bolts (1 and 2) and loosely install.

Notice: SIO-ID - 311287 Always use NEW cylinder head bolts when servicing the cylinder head.

Do not reuse the cylinder head bolts, because the bolts may stretch or break causing engine damage.

Notice: Refer to *Fastener Notice* in Cautions and Notices.



64549

6. Install the cylinder head bolts.

Tighten

- 6.1. Tighten the bolts a first pass in sequence to 50 N.m (37 lb ft).
- 6.2. Tighten the bolts a second pass in sequence an additional 60 degrees using the J 36660 .
- 6.3. Tighten the bolts (1, 2, 3, 6, 7, 8, 9, 12, 13, 14, 15, 16) an additional 90 degrees and bolts (4, 5, 10, 11) an additional 30 degrees a final pass in sequence using the J 36660 .

7. Install the spark plugs.

Tighten

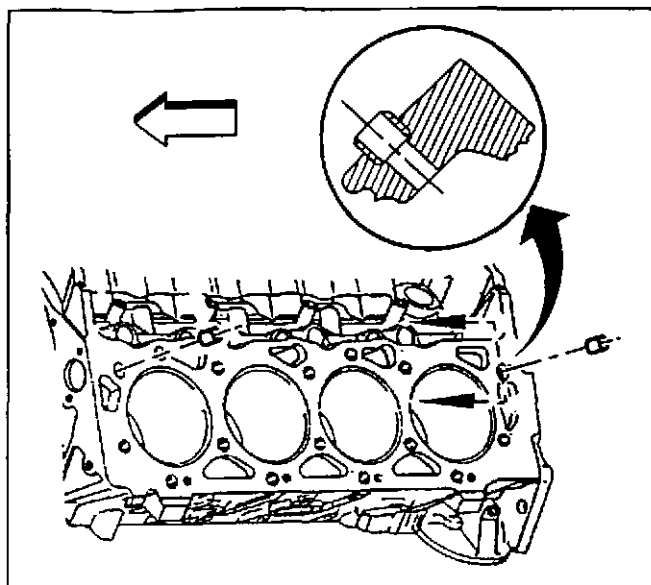
Tighten the spark plugs to 30 N.m (22 lb ft).

SIE-ID - 281857

Cylinder Head Installation (Right)**Tools Required**

J 36660 Torque Angle Meter

1. Clean the cylinder head gasket surfaces. Refer to *Replacing Engine Gaskets (ERROR - NOT IN CURRENT PSD)*.
2. Install the cylinder head locating pins, if removed.



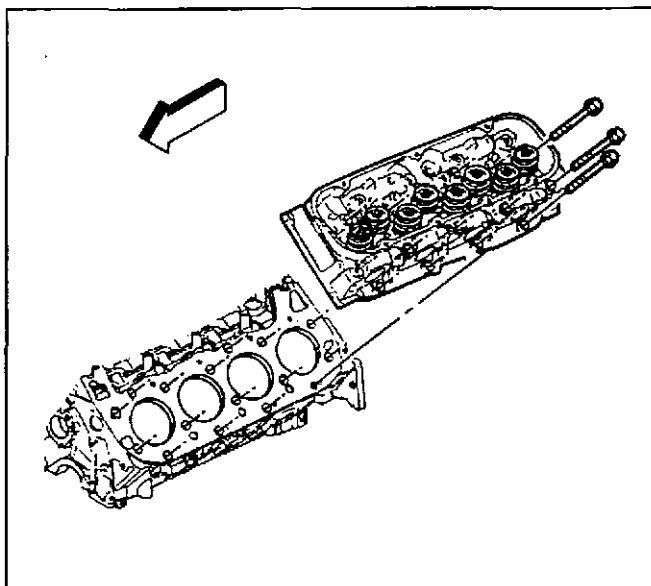
180904

Important: Make sure the threaded holes in the engine block are clean and not damaged. Do not use sealer on any engines that use a composition type gasket. Align the cylinder head gasket locating mark to face up.

3. Place the cylinder head gasket in position over the cylinder head locating pins.

Important: Guide the cylinder head carefully into place over the locating pins and the cylinder head gasket.

4. Install the cylinder head to the block.
5. Apply sealer GM P/N 12346004 or equivalent to a minimum of eight threads on the cylinder head bolts.



20295

Notice: SIO-ID - 311287 Always use NEW cylinder head bolts when servicing the cylinder head.

Do not reuse the cylinder head bolts, because the bolts may stretch or break causing engine damage.

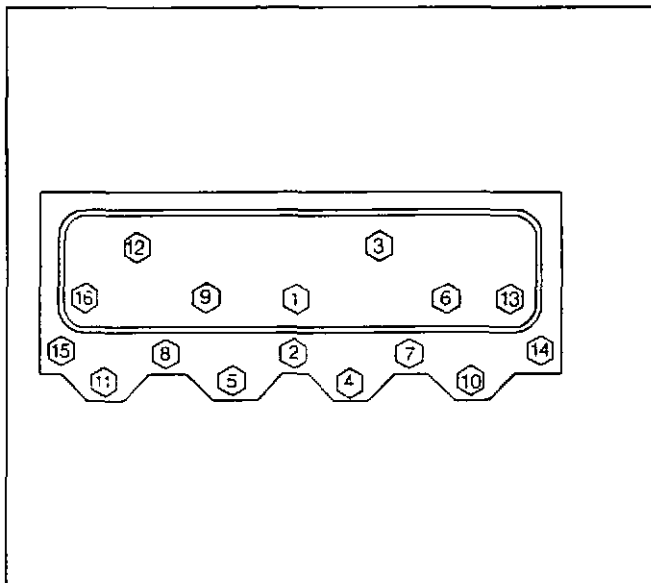
Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Install the cylinder head bolts.

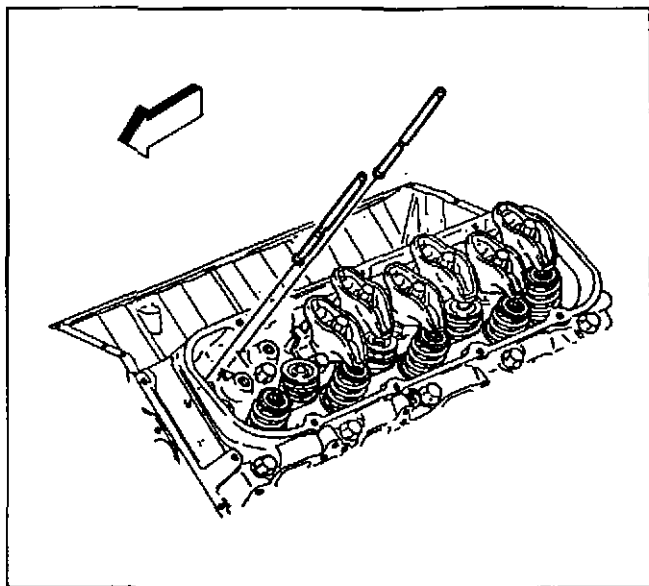
Tighten

- 6.1. Tighten the bolts a first pass in sequence to 50 N·m (37 lb ft).
- 6.2. Tighten the bolts a second pass in sequence an additional 60 degrees using the J 36660.
- 6.3. Tighten the bolts (1, 2, 3, 6, 7, 8, 9, 12, 13, 14, 15, 16) an additional 90 degrees and bolts (4, 5, 10, 11) an additional 30 degrees a final pass in sequence using the J 36660.

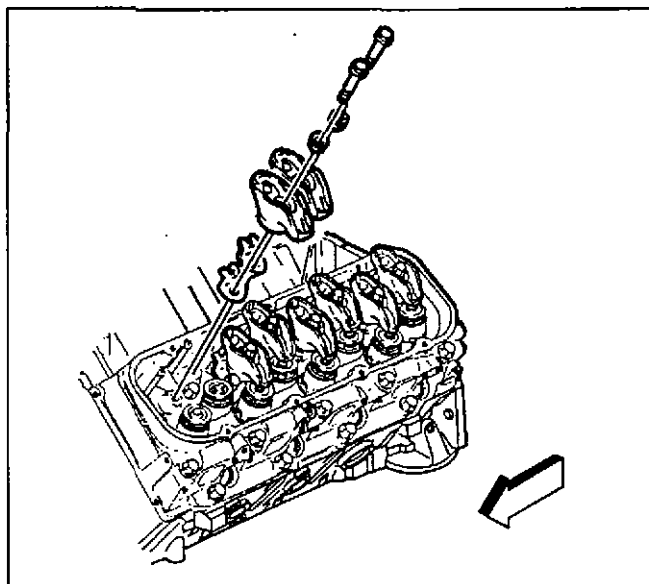
7. Install the spark plugs.



64547



202196



354070

Tighten

Tighten the spark plugs to 30 N·m (22 lb ft).

SIE-ID = 201161

Valve Rocker Arm and Push Rod Installation

Important: Be sure to keep parts in order. Parts must be put back from where they were removed.

1. Coat the valve rocker arm and valve rocker arm ball bearing surfaces with prelube GM P/N 1052367 or equivalent.

Important: Be sure that the valve pushrods seat in the valve lifter sockets.

Important: The 7.4L engine uses different length intake and exhaust valve pushrods.

The exhaust valve pushrods are longer than the intake valve pushrods.

2. Install the valve pushrods.

Notice: Refer to *Fastener Notice* in Caution and Notices.

3. Install the following parts:
 - 3.1. The valve pushrod guide
 - 3.2. The valve rocker arms
 - 3.3. The valve rocker arm balls
 - 3.4. The valve rocker arm bolts

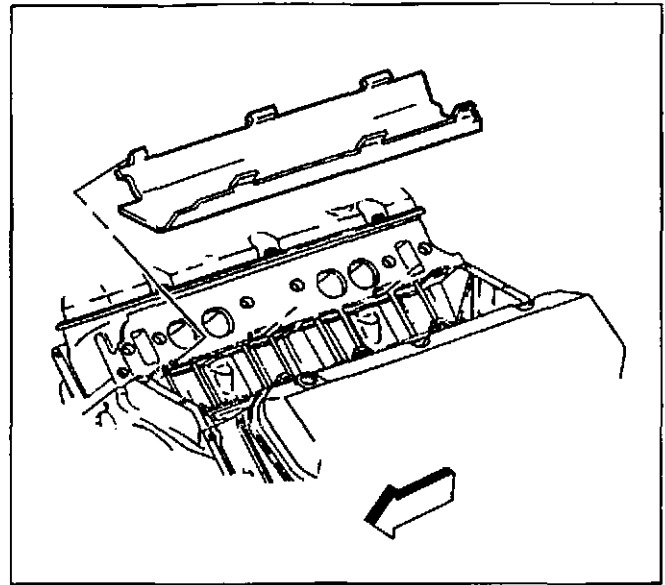
Tighten

Tighten the valve rocker arm bolts to 54 N·m (40 lb ft).

SIE-ID - 201174

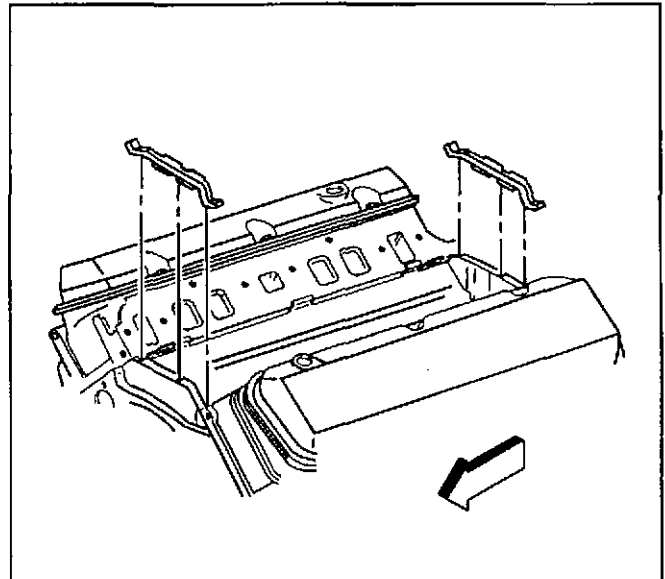
Intake Manifold Installation

1. Install the splash shield.
2. Ensure the splash shield snap fits between the cylinder heads.



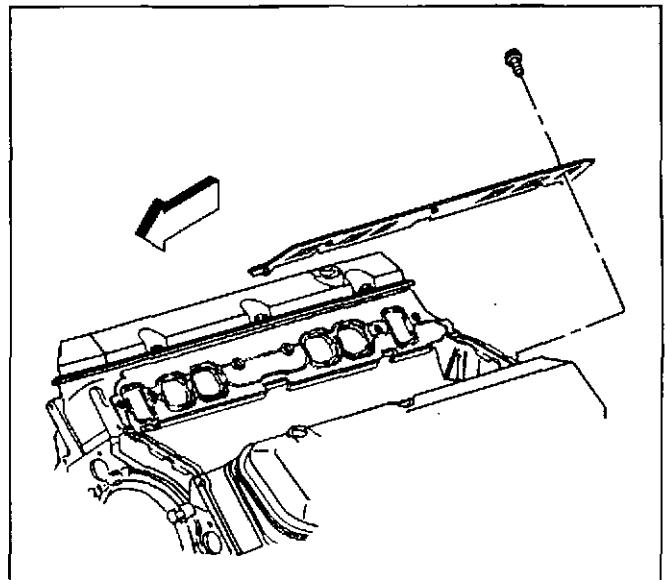
276364

3. Install the new lower intake manifold seals.

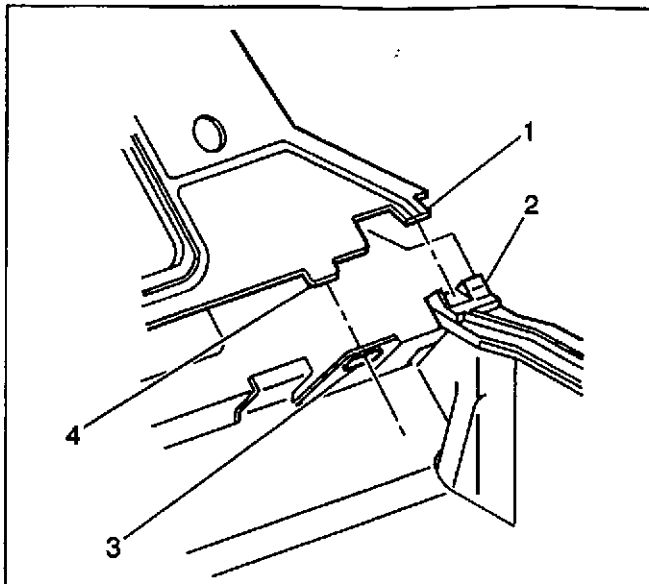


351757

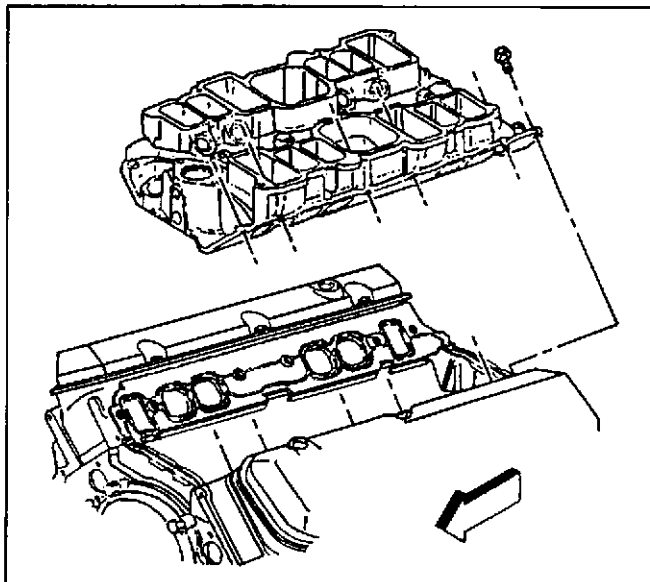
4. Install the new lower intake manifold gaskets onto the cylinder heads.



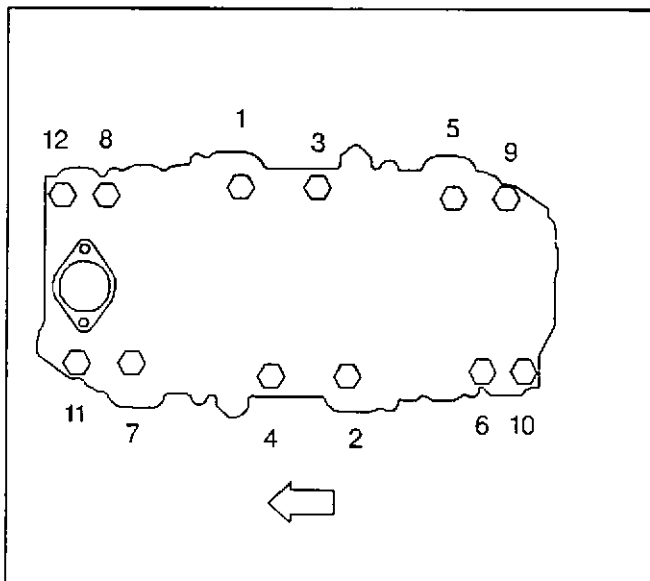
351760



351762



351763



67780

5. Ensure the lower intake manifold gasket tabs (4) align with the hole in the head gasket (3).
6. Ensure the lower intake manifold gasket tabs (1) align with the slot in the lower intake manifold seals (2).

7. Install the lower intake manifold onto the engine block.
8. Apply sealer GM P/N 12345382 or equivalent to a minimum of eight threads of the lower intake manifold bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

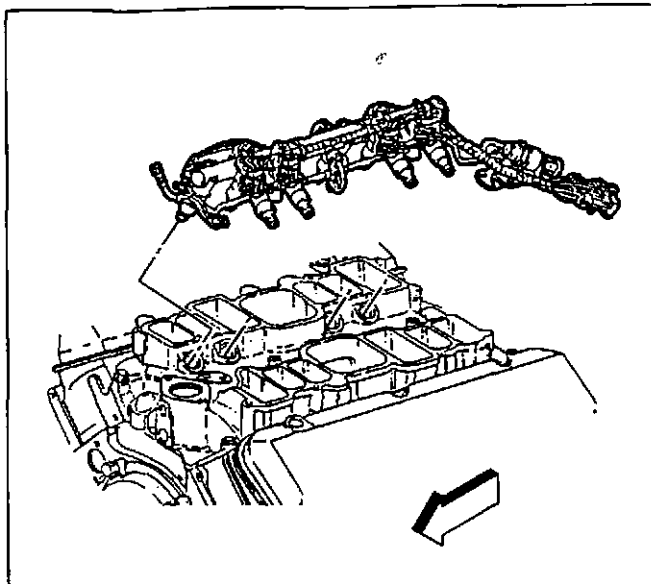
9. Install the lower intake manifold bolts.

Tighten

Tighten the lower intake manifold bolts (1–8) in sequence to 40 N·m (30 lb ft).

Important: Lubricate the injector O-ring seals with clean engine oil and install onto the spray tip end of each injector.

10. Install the fuel rail assembly into the intake manifold. Tilt the rail assembly to install the injectors.

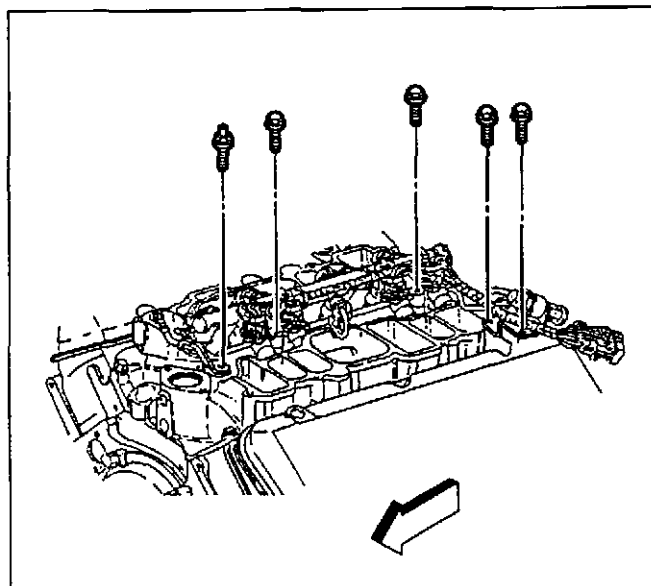


276369

11. Install the fuel rail bolts and stud.

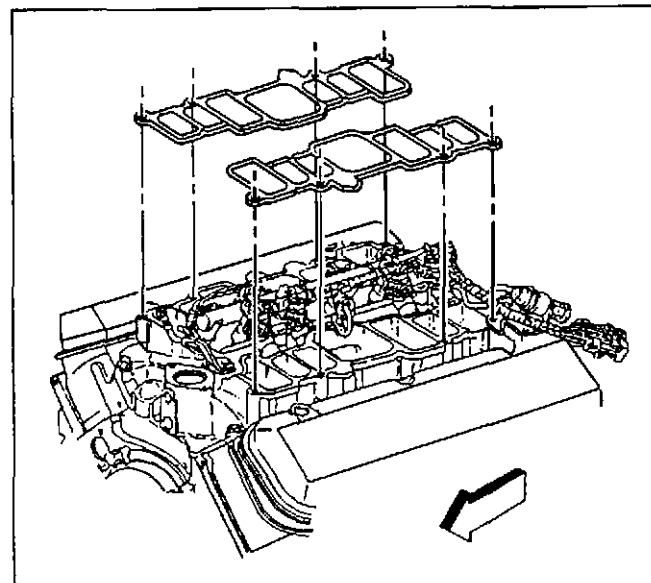
Tighten

- Tighten the fuel rail bolts to 10 N.m (89 lb in).
- Tighten the fuel rail stud to 25 N.m (18 lb ft).

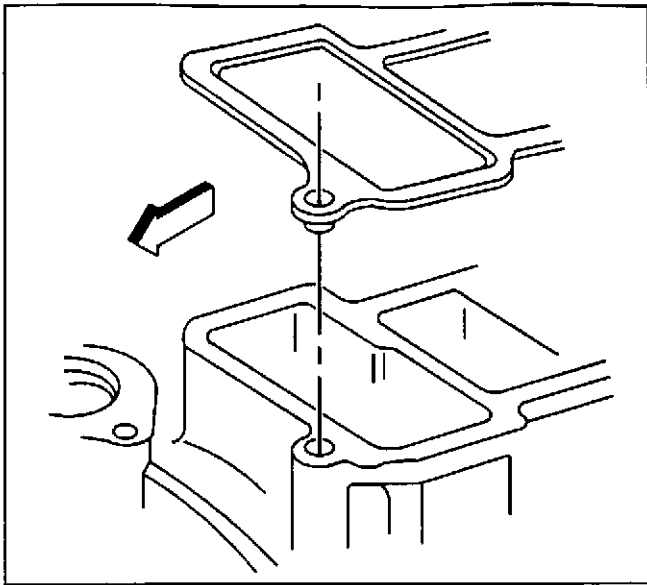


276370

12. Install the new upper intake manifold gaskets.

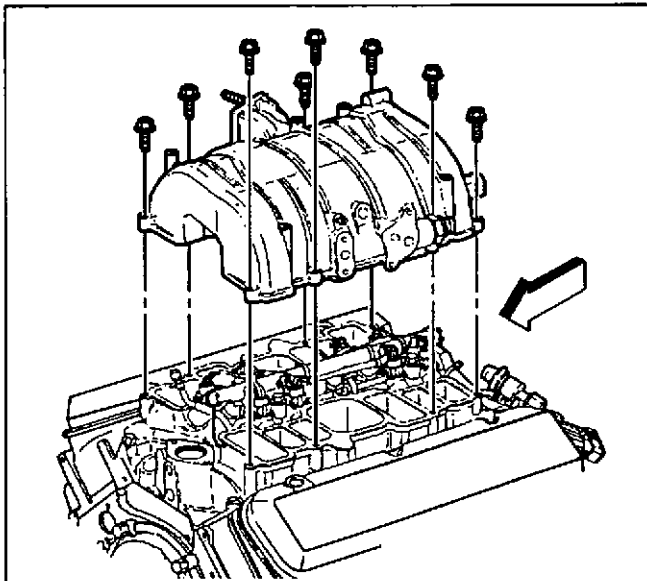


351764



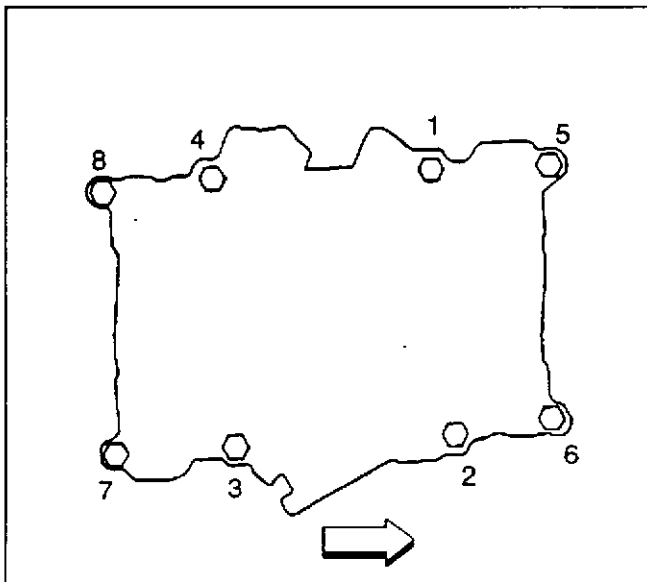
351766

13. Ensure the locating tabs on the gasket fit into the lower intake manifold counterbores.



351769

14. Install the upper intake manifold.
15. Apply sealer GM P/N 12345493 or equivalent to a minimum of eight threads of the upper intake manifold bolts.



67778

16. Install the upper intake manifold bolts.

Tighten

- 16.1. Tighten the upper intake manifold bolts (1-8) a first pass in sequence to 8 N.m (71 lb in).
16.2. Tighten the upper intake manifold bolts (1-8) a final pass in sequence to 18 N.m (13 lb ft).

SIE-ID - 201210

Throttle Body Installation

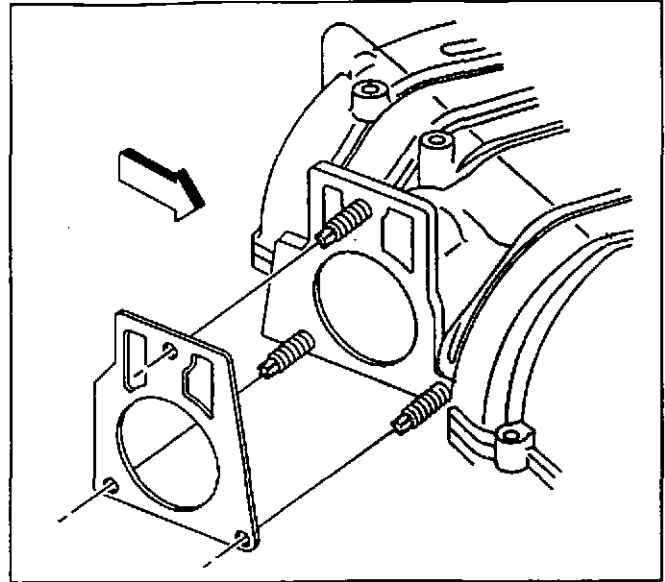
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the throttle body studs, if removed.

Tighten

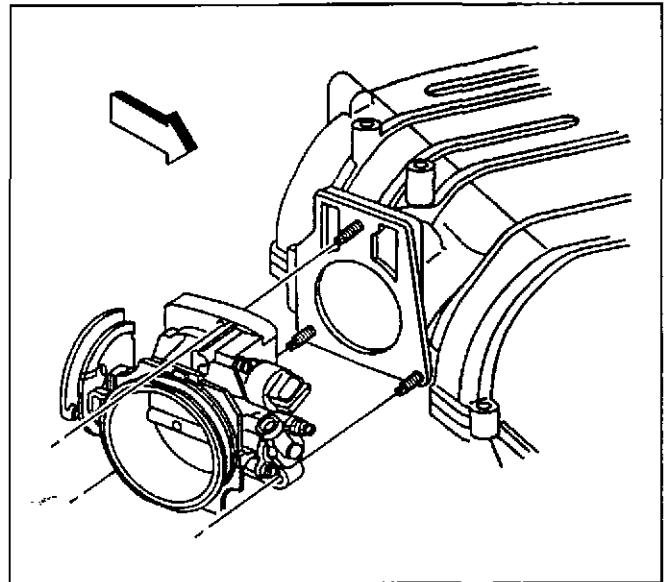
Tighten the studs to 12 N.m (18 lb ft).

2. Install the throttle body gasket.



18303

3. Install the throttle body onto the manifold.

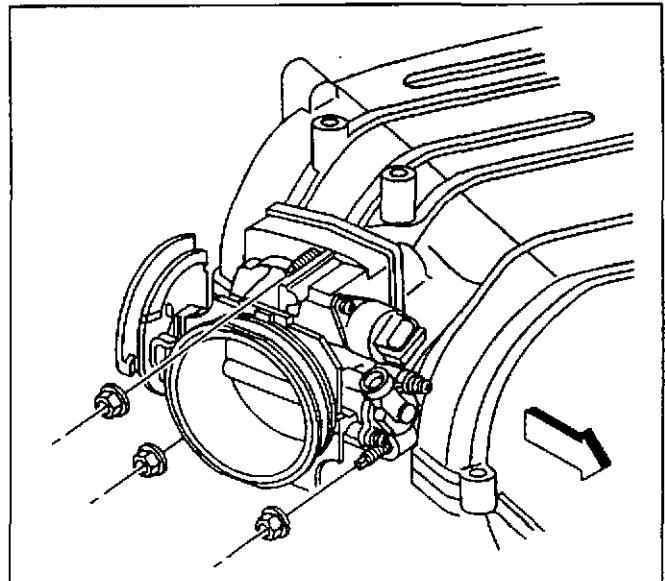


18302

4. Install the throttle body nuts.

Tighten

Tighten the nuts to 10 N.m (89 lb in).

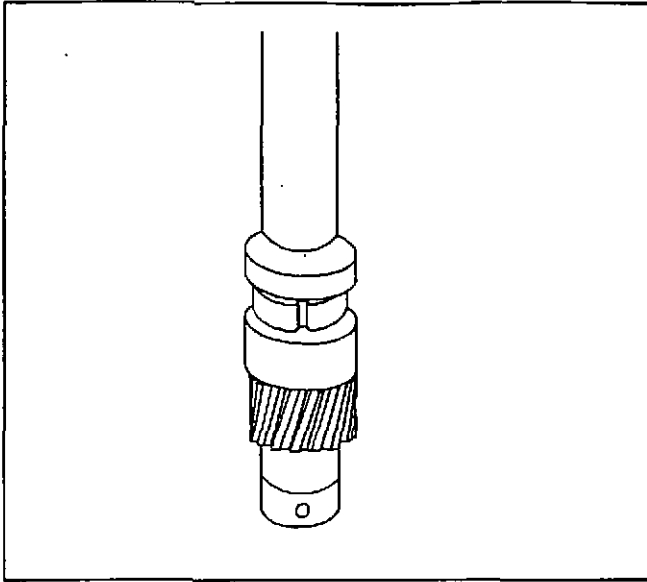


18299

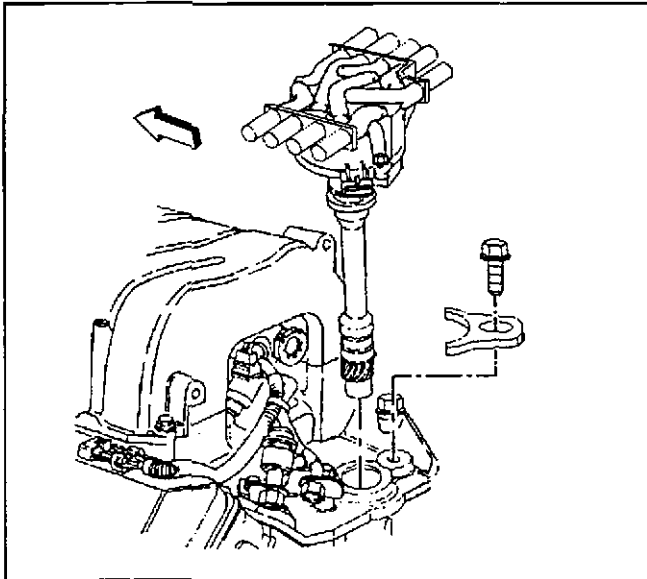
SIE-ID - 201189

Distributor Installation

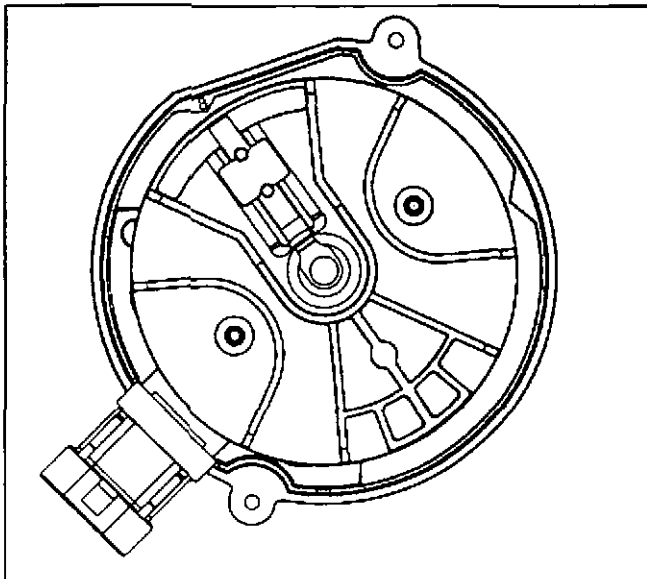
1. Bring cylinder number one piston to TDC (Top Dead Center) of the compression stroke.
Important: Distributor cap screws are not captured in the distributor cap.
2. Remove the distributor cap screws to expose the rotor.
3. Align the pre-drilled indent hole in the distributor driven gear with the white painted alignment line on the lower portion of the shaft housing.
4. Using a long screw driver,, align the oil pump drive shaft in the engine with the mating drive tab at the end of the distributor shaft.



43756



68504



68505

5. Guide the distributor into place.
6. Make sure the distributor is fully seated in the engine.
 - 6.1. If the distributor is not fully seated, the oil pump drive shaft may not be aligned with the mating drive tab at the end of the distributor shaft.
 - 6.2. Remove the distributor and align the oil pump drive shaft as stated above.
7. Once the distributor is fully seated, the rotor segment should be aligned with the pointer cast into the distributor base.
 - The pointer has a (8) cast into it, indicating the distributor is for an eight cylinder engine.
 - If the rotor segment does not come out within a few degrees of the pointer (8), the gear mesh between the distributor and the camshaft may be OFF by a tooth or more.
 - If this is the case repeat this procedure to achieve the proper alignment.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

8. Install the distributor hold down clamp bolt to the lower intake manifold.

Tighten

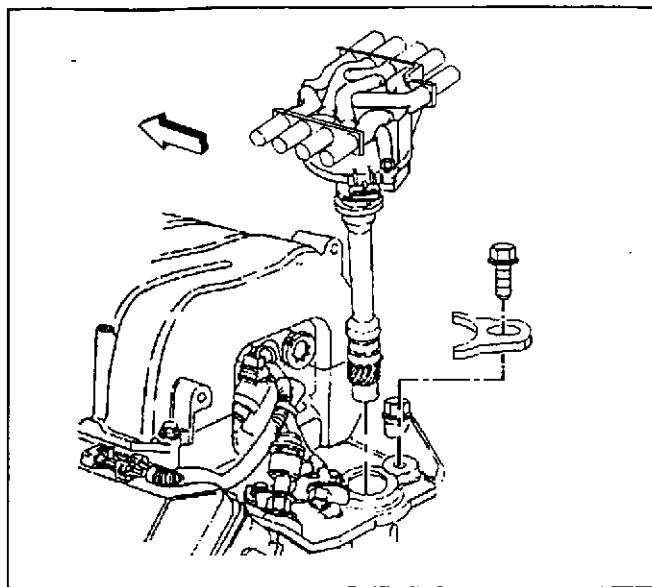
Tighten the distributor clamp bolt to 33 N.m (24 lb ft).

9. Install the distributor cap.

10. Install the distributor cap screws. Do not overtighten.

Tighten

Tighten the cap holding screws to 5 N.m (40 lb in).



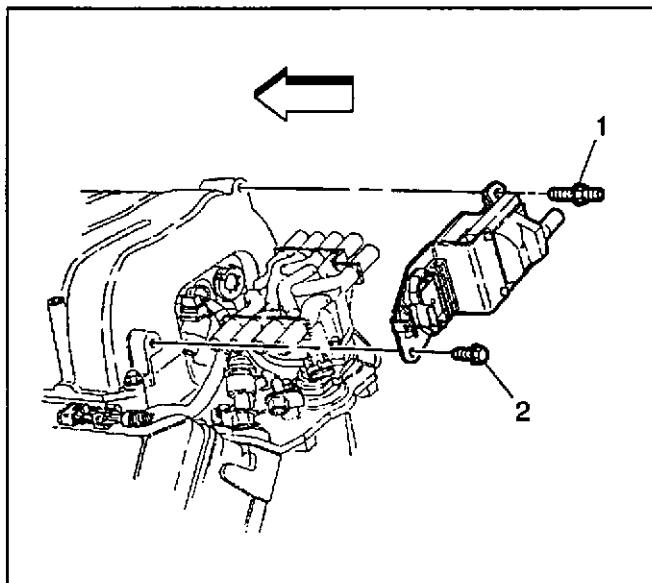
68504

11. Install the ignition coil to the upper intake manifold.
12. Install the ignition coil bracket bolt and stud to the upper intake manifold.

Tighten

Tighten ignition coil bracket bolt and stud to 25 N.m (18 lb ft).

13. Install the ignition coil wire from the ignition coil.
14. Install the spark plug wire clips to the spark plug wire brackets.

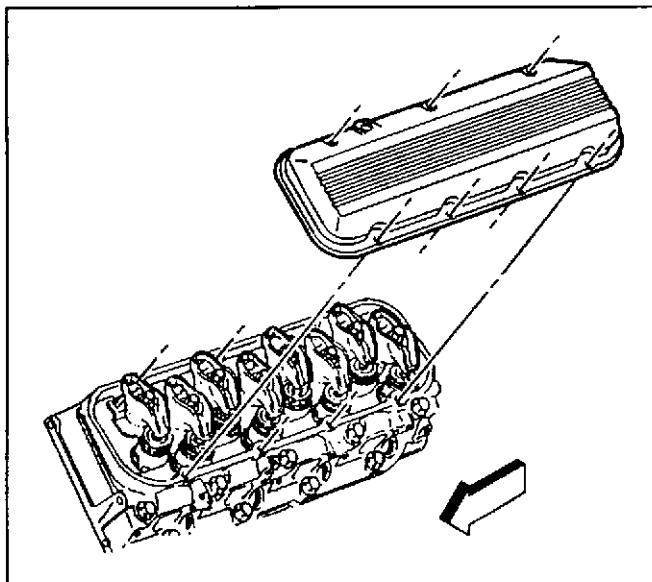


180900

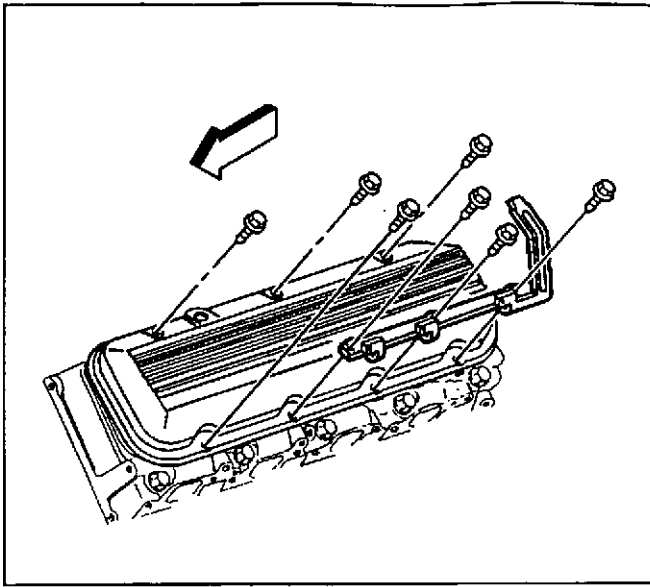
SIE-ID - 201220

Valve Rocker Arm Cover Installation (Left)

1. If valve rocker arm cover gasket was removed from the valve rocker arm cover, install a NEW valve rocker arm cover gasket.
2. Install the valve rocker arm cover with gasket.



354006



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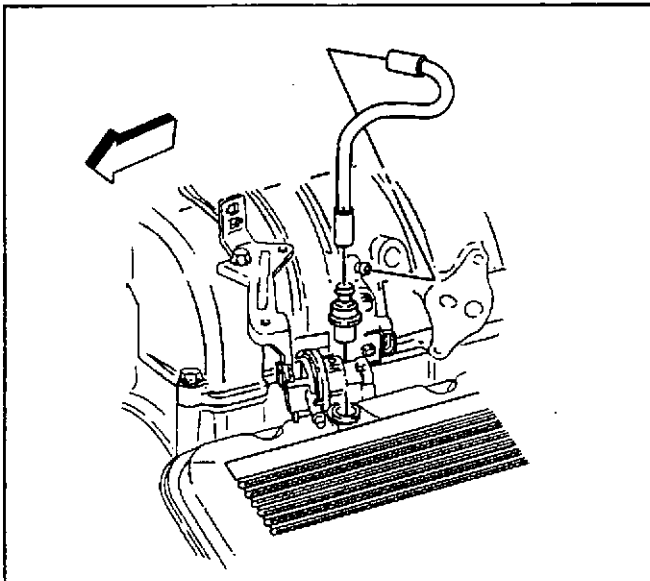
3. Install the spark plug wiring harness bracket(s) onto the valve rocker arm cover.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the valve rocker arm cover bolts.

Tighten

Tighten the valve rocker arm cover bolts to 12 N·m (106 lb in).



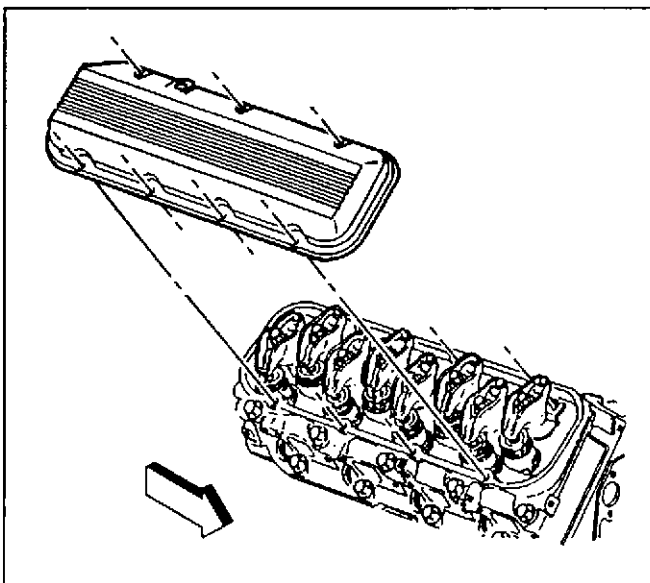
173187

5. Remove the Positive Crankcase Ventilation Valve (PCV) and crankcase ventilation tube.

SIE-ID = 201223

Valve Rocker Arm Cover Installation (Right)

1. If valve rocker arm cover gasket was removed from the valve rocker arm cover, install a NEW valve rocker arm cover gasket.
2. Install the valve rocker arm cover with gasket.



354010

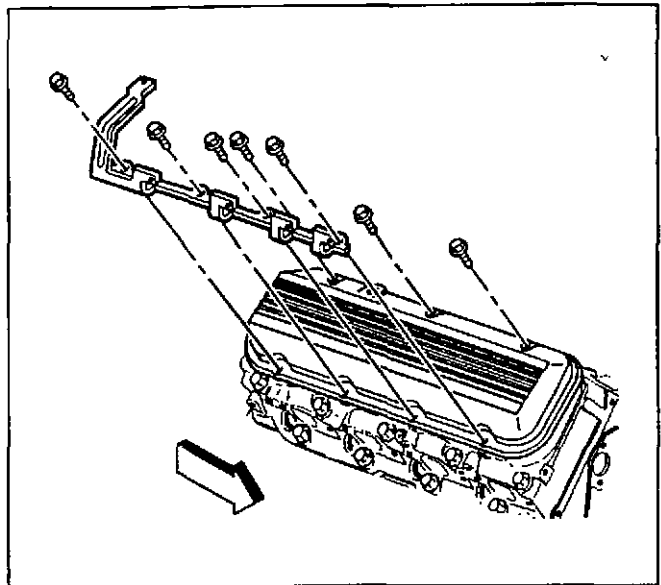
- Place spark plug wiring harness bracket(s) onto valve rocker arm cover.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

- Install the valve rocker arm cover bolts.

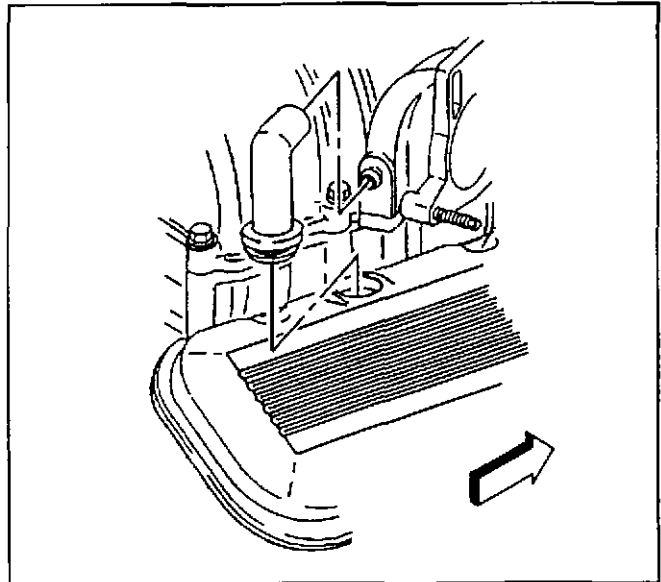
Tighten

Tighten the valve rocker arm cover bolts to 12 N·m (106 lb in).



354012

- Install the crankcase ventilation tube.



173189

SIE-ID = 201268

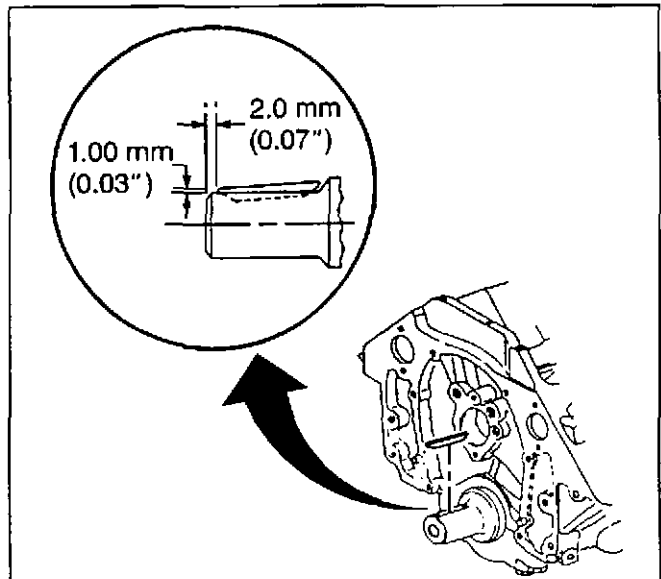
Crankshaft Balancer Installation

Tools Required

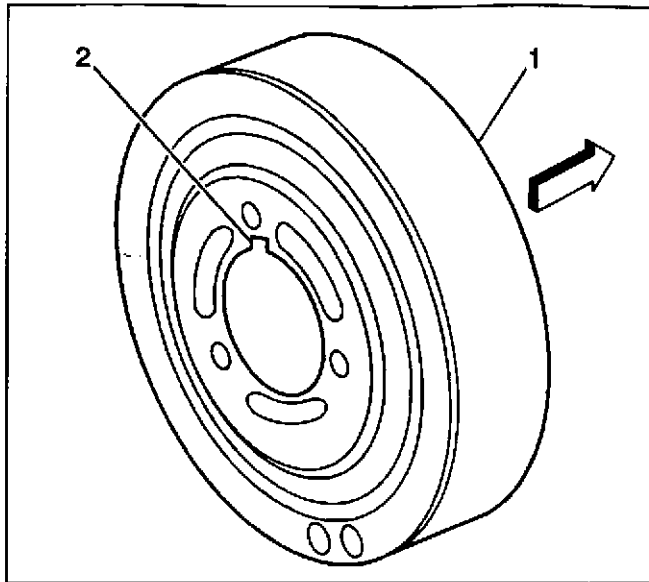
J 23523-F Crankshaft Balancer Remover and Installer

Notice: SJO-ID = 16580 The inertial weight section of the crankshaft balancer is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the crankshaft balancer.

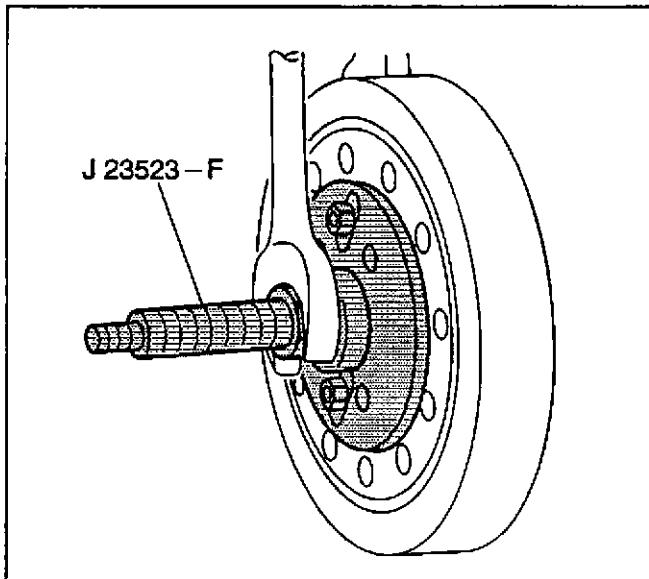
- Apply a small amount of GM P/N 12346141 or equivalent onto the crankshaft key and keyway in order to seal the crankshaft balancer keyway and crankshaft joint.
- Install the key into the crankshaft keyway.



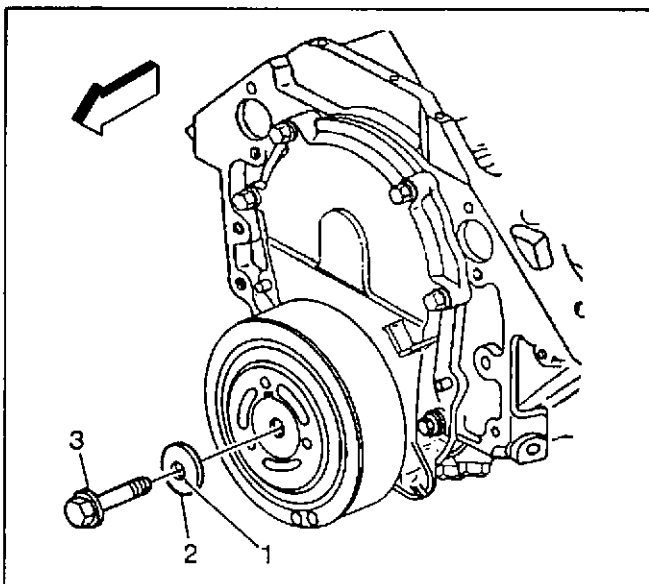
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3. Apply a small amount of GM P/N 12346141 or equivalent onto the crankshaft balancer keyway (2) in order to seal the crankshaft balancer keyway and crankshaft joint.
4. Install the crankshaft balancer onto the end of the crankshaft.
5. Align the keyway of the crankshaft balancer with the crankshaft key.

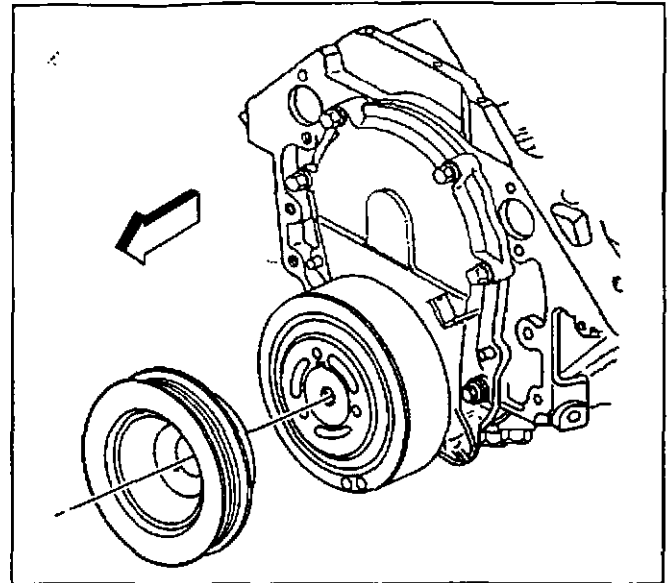
6. Use the *J 23523-F* in order to press the crankshaft balancer onto the crankshaft.
 - 6.1. Install the *J 23523-F* into the front of the crankshaft.
 - 6.2. Rotate the *J 23523-F* nut until the nut, washer, and bearing are firmly against the crankshaft balancer.
 - 6.3. Use one wrench to hold the *J 23523-F* forcing screw.
 - 6.4. Use a second wrench and rotate the *J 23523-F* nut clockwise until the hub is completely seated against the crankshaft position sensor reluctor ring.
 - 6.5. Remove the *J 23523-F* from the crankshaft.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the crankshaft balancer washer and bolt. **Tighten**

Tighten the crankshaft balancer bolt to 149 N·m (110 lb ft).

8. Install the crankshaft pulley.

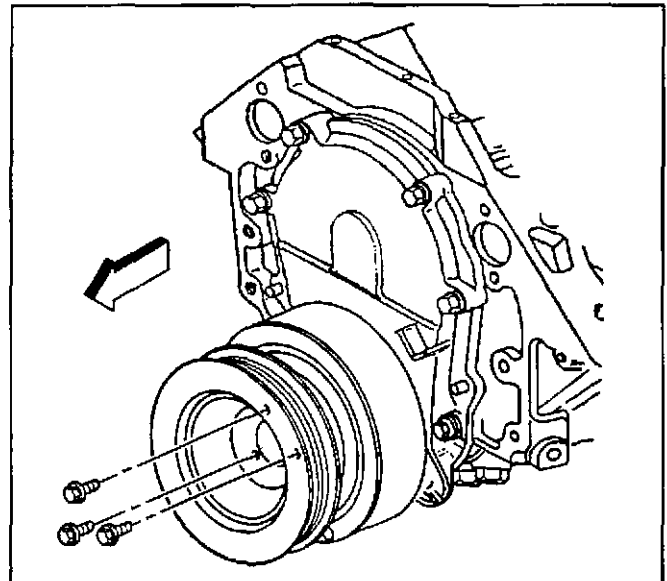


354015

9. Install the crankshaft pulley bolts.

Tighten

Tighten the crankshaft pulley bolts to 58 N·m (43 lb ft).



354014

SIE-ID - 66628

Water Pump Installation

1. Install the water pump gaskets.
2. Install the water pump bypass hose to the pump.
3. Loosely install the water pump bypass hose clamps.
4. Install the water pump.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the water pump bolts.

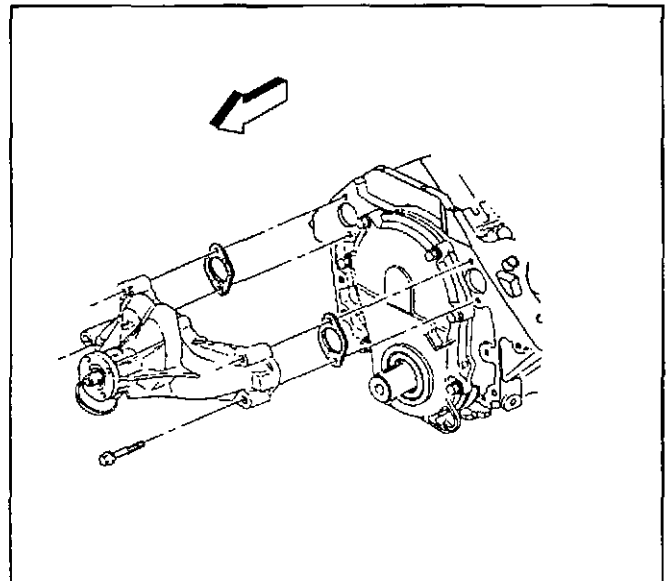
Tighten

Tighten the water pump bolts to 40 N·m (30 lb ft).

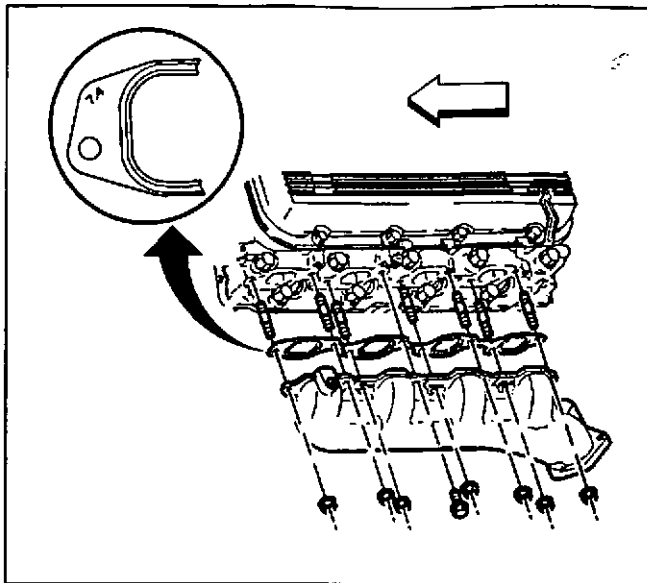
6. Tighten the water pump bypass hose clamps.

Tighten

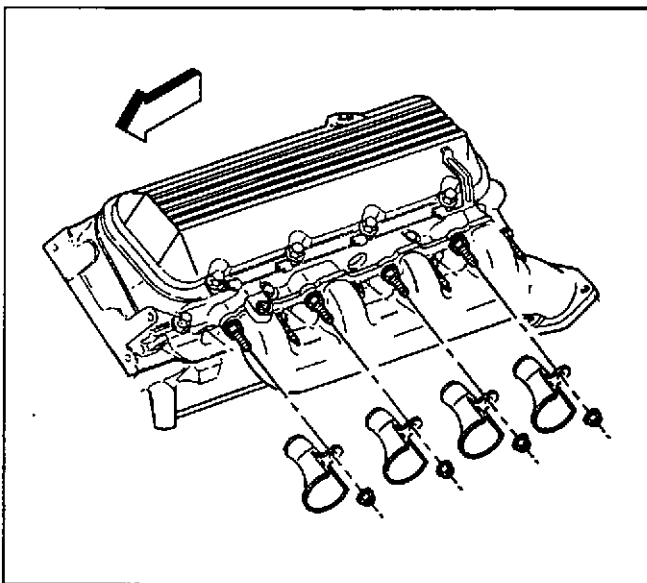
Tighten the water pump bypass clamps to 4 N·m (35 lb in).



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SIE-ID = 367923

Exhaust Manifold Installation (Left)

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the exhaust manifold studs, if removed.

Tighten

Tighten the exhaust manifold studs to 30 N.m (22 lb ft).

Important: Make sure the 7.4 marking on the gasket is facing away from the cylinder head.

2. Install the new exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold nuts and center bolt.

Tighten

- 4.1. Tighten the exhaust manifold nuts to 30 N.m (22 lb ft).

- 4.2. Tighten the exhaust manifold center bolt to 54 N.m (40 lb ft).

5. Install the spark plug heat shields.
6. Install the spark plug heat shield nuts.

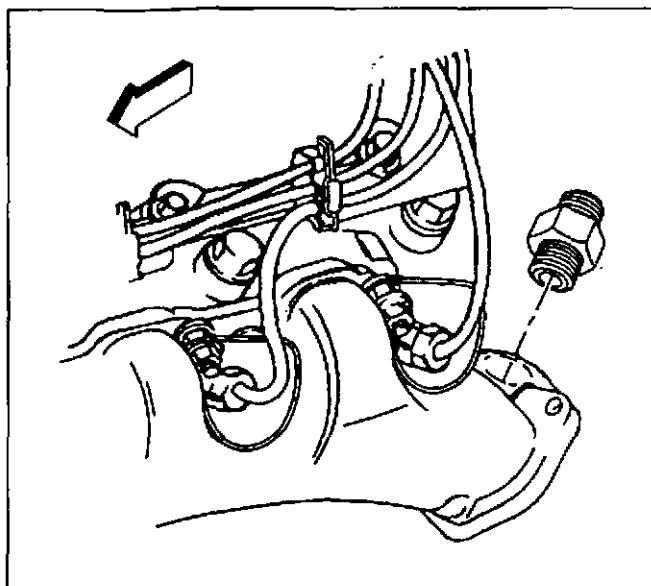
Tighten

Tighten the spark plug heat shield nuts to 20 N.m (15 lb ft).

7. Install the exhaust adapter, if removed.

Tighten

Tighten the exhaust adapter to 160 N.m (117 lb ft).



354034

8. Install the exhaust gas recirculation (EGR) inlet pipe to the exhaust manifold.

Tighten

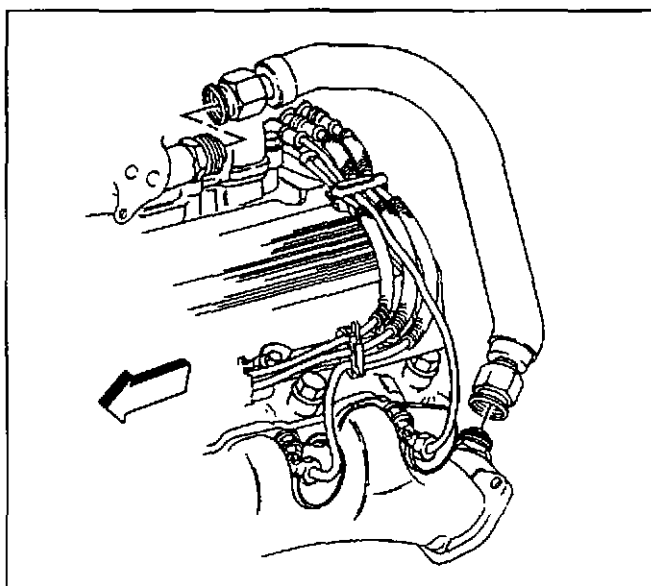
Tighten the EGR inlet pipe at the exhaust manifold to 60 N.m (44 lb ft).

9. Install the EGR inlet pipe to the intake manifolds.

Tighten

Tighten the EGR inlet pipe at the intake manifold to 60 N.m (44 lb ft).

10. Install the spark plug wires onto the spark plugs.



173284

SIE-ID - 201744

Exhaust Manifold Installation (Left with RPO K19)

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the exhaust manifold studs, if removed.

Tighten

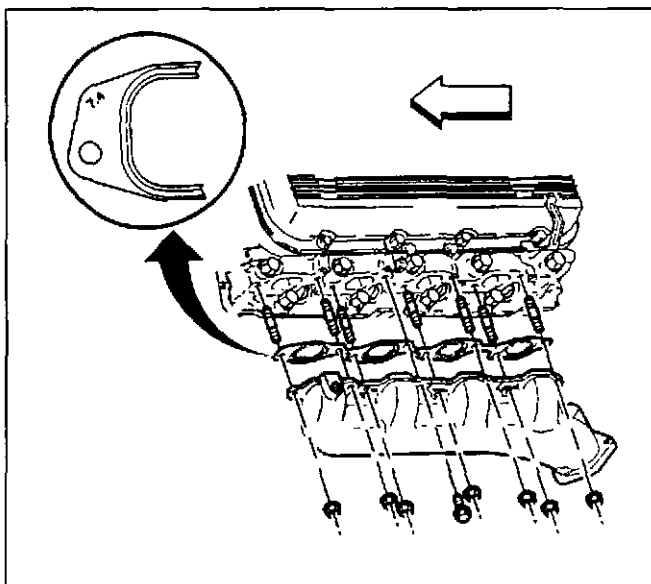
Tighten the exhaust manifold studs to 30 N.m (22 lb ft).

Important: Make sure the 7.4 marking on the gasket is facing away from the cylinder head.

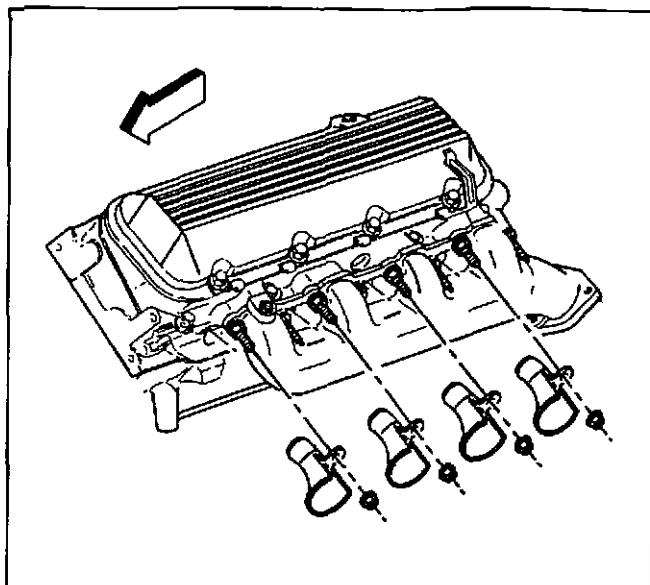
2. Install the new exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold nuts and center bolt.

Tighten

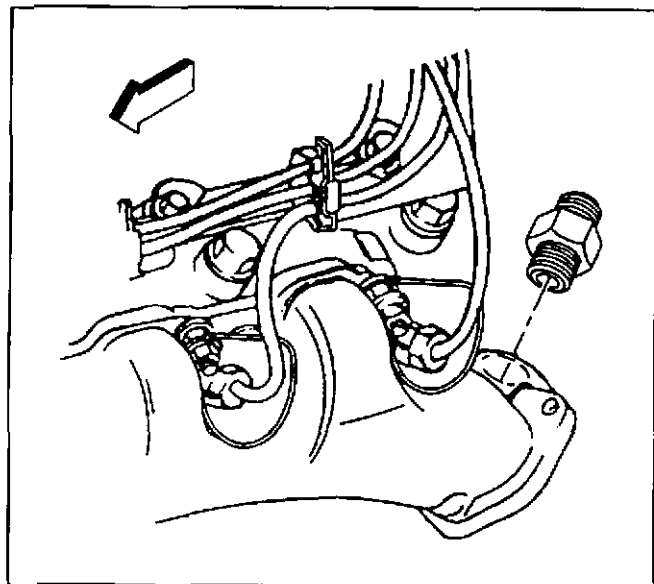
- 4.1. Tighten the exhaust manifold nuts to



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30 N.m (22 lb ft).

4.2. Tighten the exhaust manifold center bolt to 54 N.m (40 lb ft).

5. Install the spark plug heat shields.

6. Install the spark plug heat shield nuts.

Tighten

Tighten the spark plug heat shield nuts to 20 N.m (15 lb ft).

7. Install the exhaust manifold adapter to the exhaust manifold, if removed.

Tighten

Tighten the exhaust manifold adapter to 160 N.m (118 lb ft).

8. Install the exhaust gas recirculation (EGR) inlet pipe to the exhaust manifold.

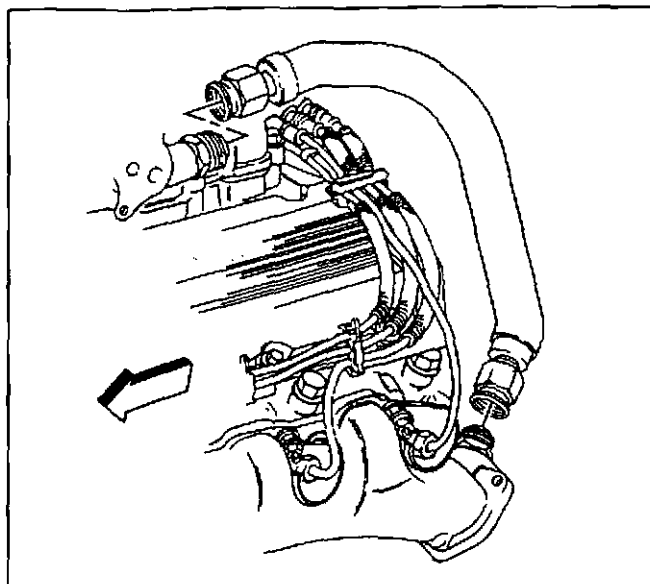
Tighten

Tighten the EGR inlet pipe nut at the exhaust manifold to 60 N·m (44 lb ft).

9. Install the EGR inlet pipe to the intake manifold.

Tighten

Tighten the EGR inlet pipe nut at the intake manifold to 60 N·m (44 lb ft).



173284

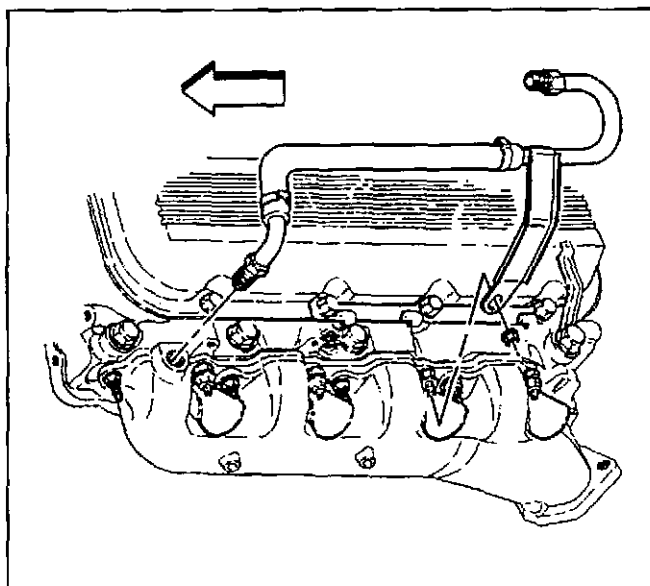
10. Install the AIR tube assembly pipe to the exhaust manifold, if removed.

Install the AIR tube assembly pipe bracket nut onto the exhaust manifold stud.

Tighten

- Tighten the AIR tube assembly pipe nut to 60 N·m (44 lb ft).
- Tighten the AIR tube assembly pipe bracket nut to 30 N·m (22 lb ft).

11. Install the spark plug wires onto the spark plugs.



180942

SIE-ID = 367927

Exhaust Manifold Installation (Right)

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the exhaust manifold studs, if removed.

Tighten

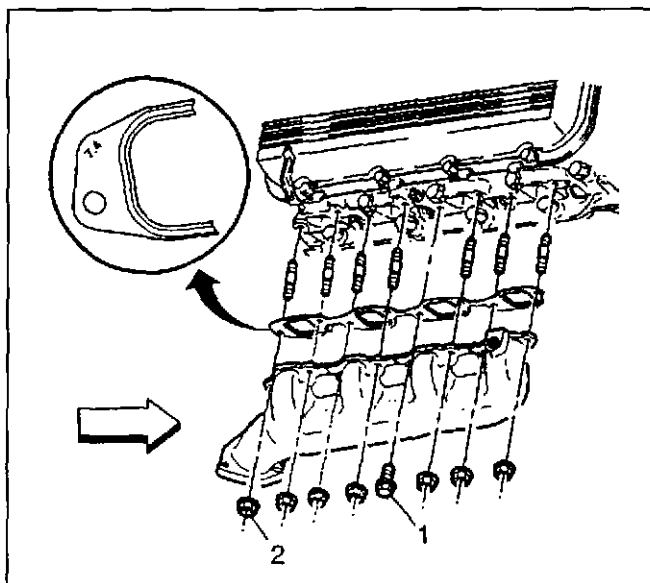
Tighten the exhaust manifold studs to 30 N·m (22 lb ft).

Important: Make sure the 7.4 marking on gasket is facing away from the cylinder head.

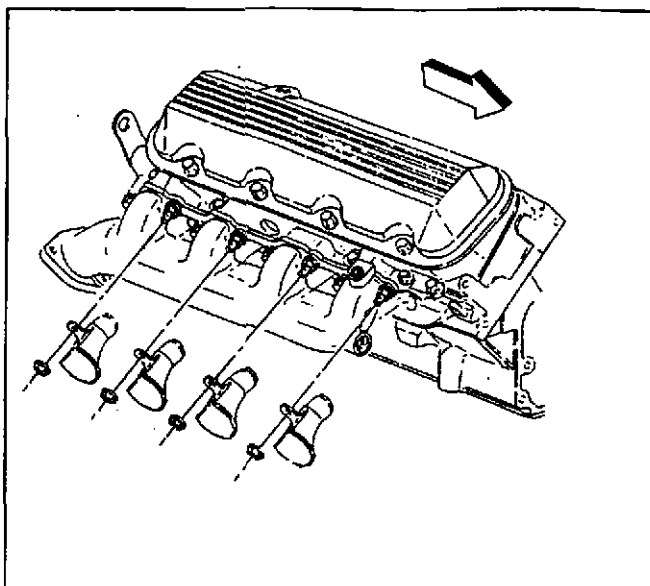
2. Install the new exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold nuts and center bolt.

Tighten

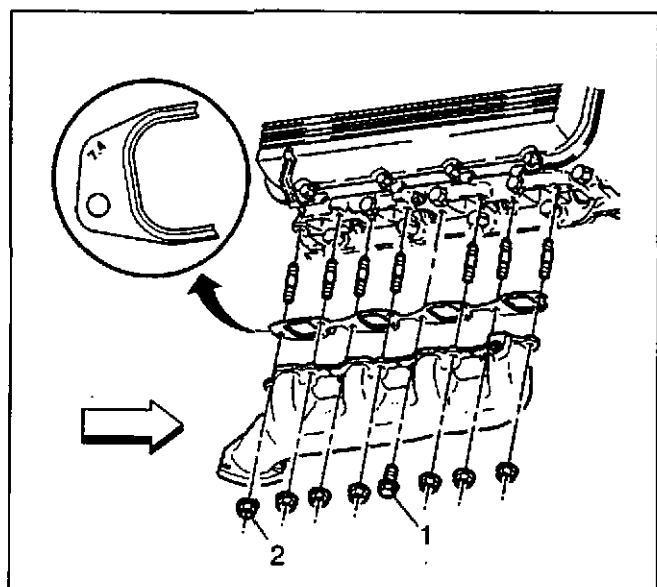
- 4.1. Tighten the exhaust manifold nuts to 30 N·m (22 lb ft).



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- 4.2. Tighten the exhaust manifold center bolt to 54 N·m (40 lb ft).

5. Install the spark plug heat shields.
6. Install the spark plug heat shield nuts.

Tighten

Tighten the spark plug heat shield nuts to 20 N·m (15 lb ft).

SIE-ID - 201792

Exhaust Manifold Installation (Right with RPO K19)

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the exhaust manifold studs, if removed.

Tighten

Tighten the exhaust manifold studs to 30 N·m (22 lb ft).

Important: Make sure the 7.4 marking on gasket is facing away from the cylinder head.

2. Install the new exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold nuts and center bolt.

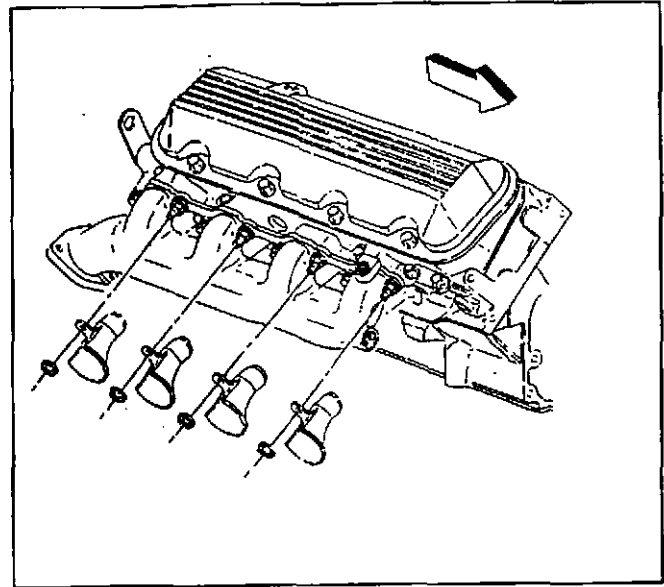
Tighten

- 4.1. Tighten the nuts to 30 N·m (22 lb ft).
- 4.2. Tighten the center bolt to 54 N·m (40 lb ft).

5. Install the spark plug heat shields.
6. Install the spark plug heat shield nuts.

Tighten

Tighten the spark plug heat shield nuts to 20 N·m (15 lb ft).

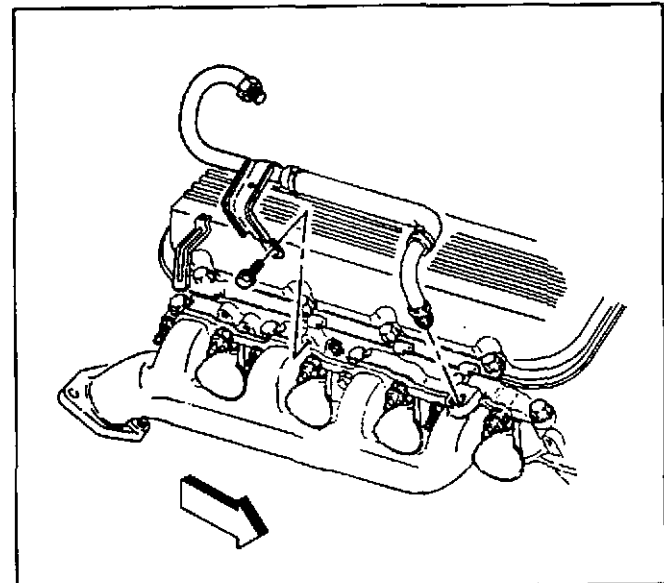


65852

7. Install AIR tube assembly pipe into the exhaust manifold, if removed.
8. Install the AIR tube assembly pipe bracket bolt to the cylinder head.

Tighten

- Tighten the AIR tube assembly pipe nut to 60 N·m (44 lb ft).
- Tighten the AIR tube assembly pipe bracket bolt to 40 N·m (30 lb ft).



354054

SIE-ID - 201108

Oil Level Indicator and Tube Installation

1. Install the oil level indicator tube (3) and NEW O-ring (4) into the oil pan (5).

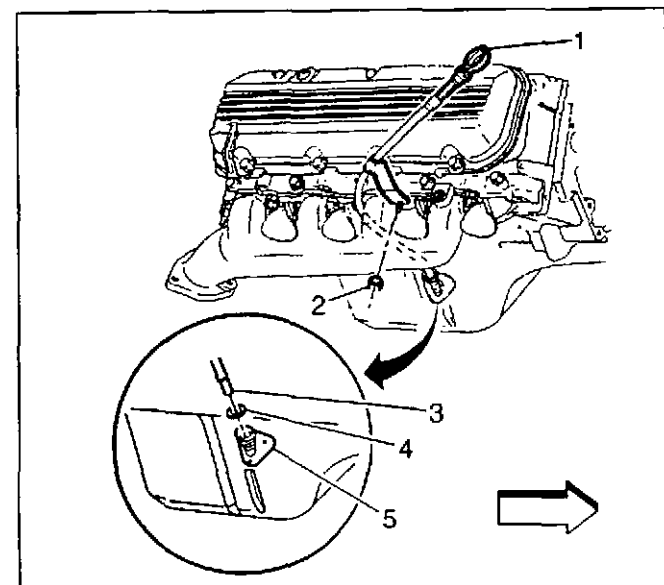
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Properly position the oil level indicator tube (1) and install the oil level indicator tube bracket nut (2) to the right exhaust manifold stud.

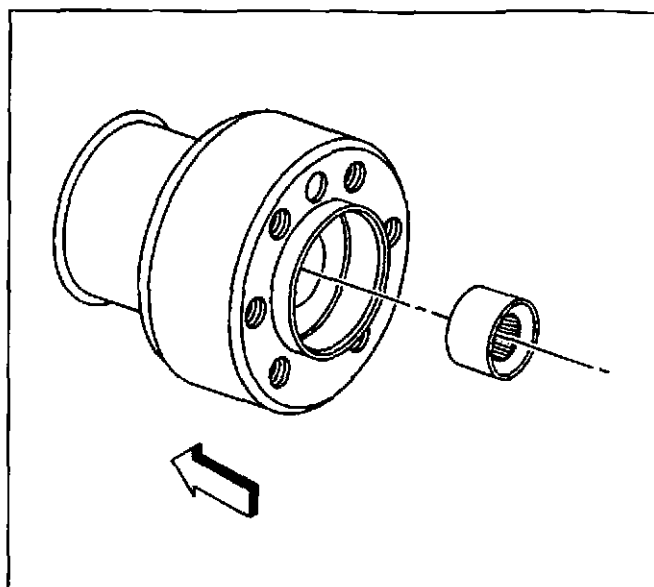
Tighten

Tighten the oil level indicator tube bracket nut to 54 N·m (40 lb ft).

3. Install the oil level indicator into the oil level indicator tube.



180884



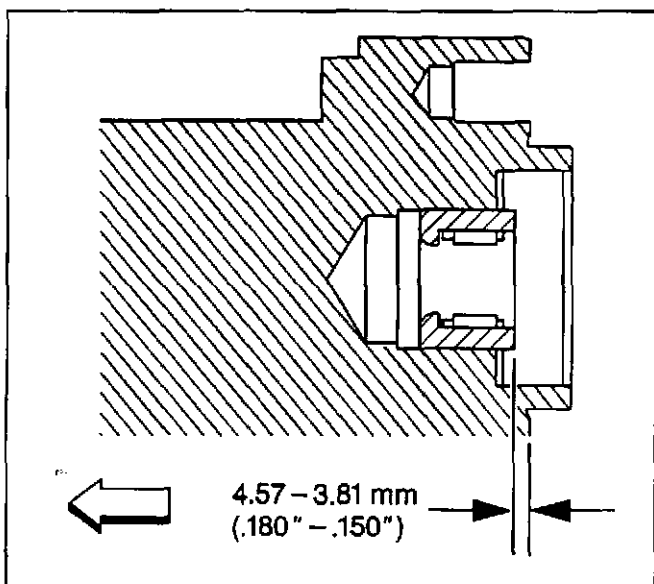
354086

SIE-ID - 378501

Clutch Pilot Bearing Installation

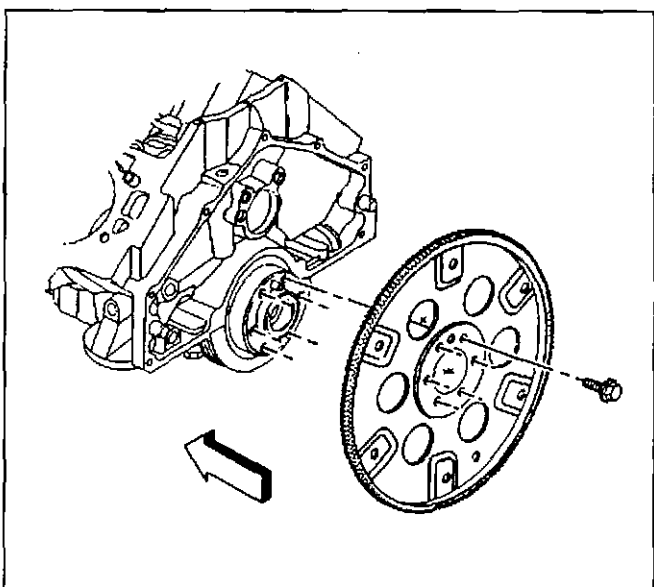
Caution: SIO-ID - 5011 *Wear safety glasses in order to avoid eye damage.*

1. Install the NEW clutch pilot bearing.



354088

2. Measure to ensure the proper installation depth is obtained.



363414

SIE-ID - 367909

Engine Flywheel Installation (MT1 Automatic Transmission)

1. Install the engine flywheel.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the engine flywheel bolts.

Tighten

Tighten the engine flywheel bolts to 90 N.m (66 lb ft).

SIE-ID - 367912

Engine Flywheel Installation (MW3 Manual Transmission)

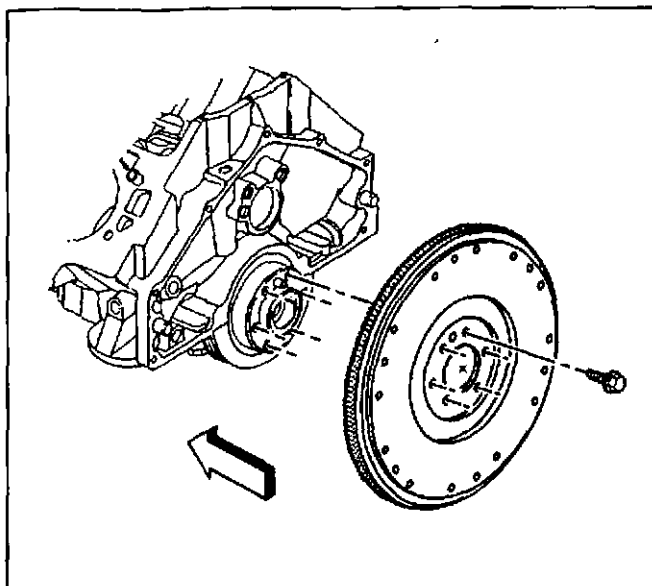
1. Install the engine flywheel.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the engine flywheel bolts.

Tighten

Tighten the engine flywheel bolts to 90 N·m (66 lb ft).



363409

SIE-ID - 298634

Engine Set-Up and Testing

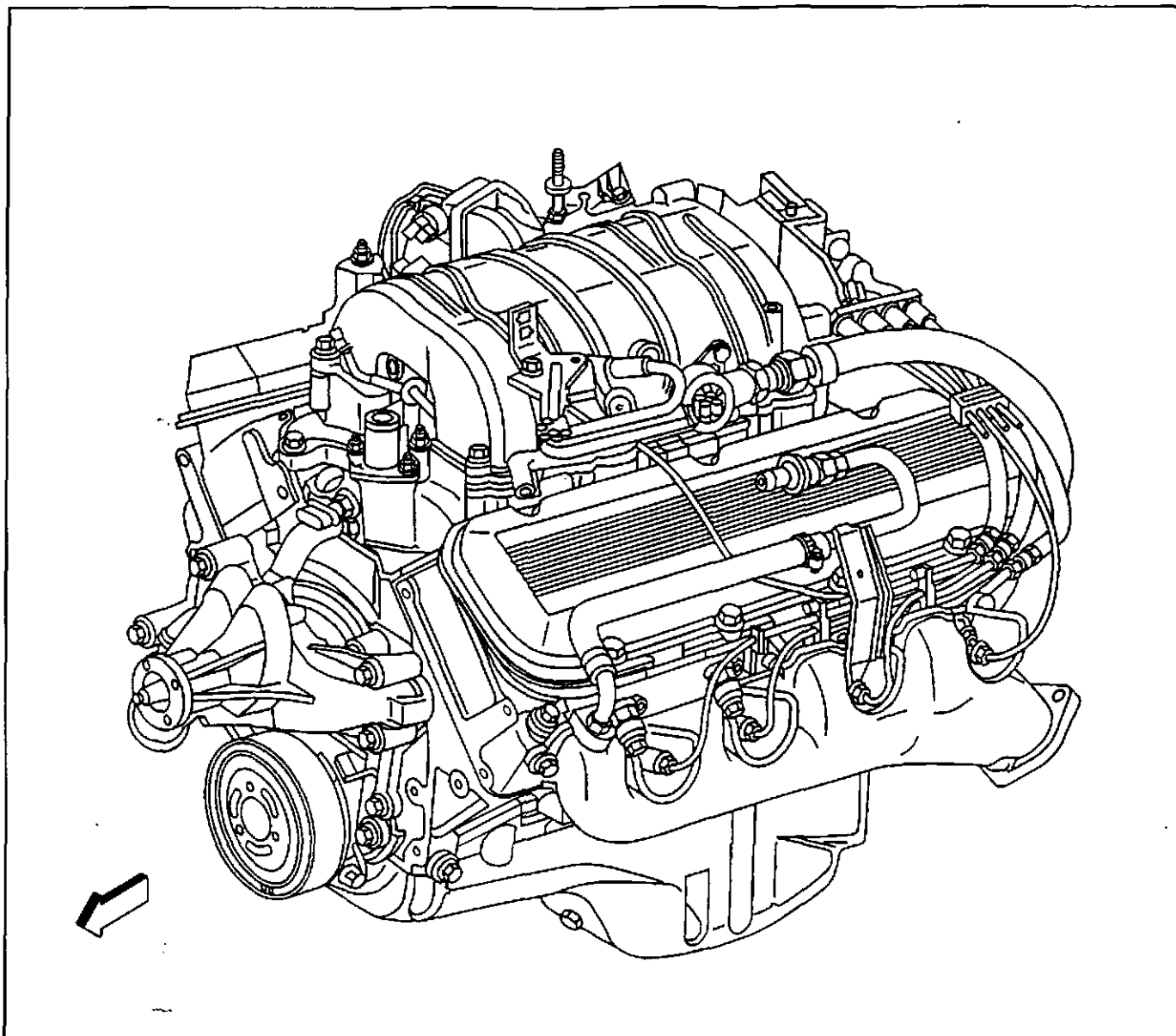
After overhaul, test the engine before it is installed in the vehicle. If a suitable test stand is not available, the following procedure can be used after the engine is installed in the vehicle.

1. Fill the crankcase with the proper quantity and grade of oil.
2. Add engine oil supplement GM P/N 1052367 or equivalent to the engine oil.
3. Fill the cooling system with engine coolant GM Goodwrench DEX-COOL (GM Specification 6277M).
4. With the ignition OFF or disconnected, crank the engine several times. Listen for any unusual noises or evidence that any of the parts are binding.
5. Start the engine and listen for unusual noises.
6. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
If necessary, install an oil pressure gauge and measure the engine oil pressure.
7. Run the engine at about 1000 RPM until the engine has reached normal operating temperature.
8. Listen for improperly adjusted or sticking valves, sticking lifters, or other unusual noises.
9. Inspect for oil and/or coolant leaks while the engine is running.
10. Verify that the distributor is properly positioned/adjusted.
11. Perform a final inspection for the proper engine oil and coolant levels.

Description and Operation

SIE-ID - 66632

Engine Component Description



180831

Cylinder Block

The engine block is made of cast iron and it has eight cylinders arranged in a V shape with four cylinders in each bank. The cylinder block is a one piece casting with the cylinders encircled by coolant jackets.

Cylinder Head

The cylinder heads are cast iron and have parent metal inlet valve guides and inlet valve seats. Cast iron exhaust valve guides and powdered metal valve seats are pressed into the exhaust ports. A spark plug is located between the valves in the side of the cylinder head.

Camshaft

A steel camshaft is supported by five bearings

pressed into the engine block. The camshaft sprocket, mounted to the front of the camshaft, is driven by the crankshaft sprocket through a camshaft timing chain.

Motion from the camshaft is transmitted to the valves by hydraulic roller valve lifters, valve pushrods, and ball-pivot type rocker arms. A spiral gear machined into the camshaft near the rear journal drives a shaft assembly which operates the oil pump driveshaft assembly.

Crankshaft

The crankshaft is made of cast nodular iron. The crankshaft is supported by five crankshaft bearings. The crankshaft bearings are retained by the crankshaft bearing caps, which are machined with the block for proper alignment and clearance. The

engine crankshaft bearing caps are retained by four bolts each. The number five crankshaft bearing at the rear of the engine is the end thrust bearing. The four connecting rod journals (two rods per journal) are spaced 90 degrees apart. The crankshaft position sensor reluctor ring is pushed onto the front of the crankshaft. The crankshaft position sensor reluctor ring has four lugs used for crankshaft timing and it is constructed of powdered metal. The reluctor ring has an interference fit onto the crankshaft and an internal keyway for correct positioning.

Pistons and Connecting Rods

The pistons are cast aluminum alloy that use two compression rings and one oil control ring assembly. The piston pins are a floating fit in the pistons and they are retained by a press fit in the connecting rod assembly. Connecting rods are forged steel, with precision insert type crankpin bearings.

Valve Train

The valve train is a ball pivot type. Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular valve pushrods to the valve rocker arms. The valve rocker arm pivots on a ball in order to open the valve. The hydraulic roller valve lifters keep all parts of the valve train in constant contact. Each lifter act as an automatic adjuster and maintains zero lash in the valve train. This eliminates the need for periodic valve adjustment. The valve rocker arm bolt retains the valve rocker arm and ball seat. The valve rocker arm bolt is threaded into the cylinder head.

Intake Manifold

The intake manifold is a two-piece design. Both upper and lower portions are made of cast aluminum. The throttle body is attached to the upper manifold. A linear EGR port is cast into the upper intake manifold for exhaust gas recirculation mixture. The (EGR) valve bolts into the upper intake manifold. The fuel rail assembly with eight separate fuel injectors is retained to the intake manifold by six bolts. The injectors are seated in their individual manifold bores with O-ring seals to provide sealing. A Manifold Absolute Pressure (MAP) sensor is mounted at the front of the upper intake manifold and sealed by an O-ring seal. The MAP sensor is retained by a retainer.

Exhaust Manifold

The two exhaust manifolds are constructed of cast iron. The manifolds direct exhaust gases from the combustion chambers to the exhaust system. The manifolds have a threaded port for EGR inlet system pipe fittings. Some manifolds have a threaded port for AIR pipe connections.

SI/E-ID - 2012B7

New Product Information

The purpose of New Product Information is to highlight important technical changes from the previous model year.

Changes may include one or more of the following

items:

- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required
- A component comparison from the previous year

Torque Values and/or Fastener Tightening Strategies

- Cylinder head bolts are tightened in four passes.
- Upper intake manifold bolts are tightened in two passes.
- Refer to *Fastener Tightening Specifications*

Changed Engine Specifications

- Crankshaft connecting rod diameter has changed slightly.
- Piston pin diameter specification was changed slightly.
- Refer to *Engine Mechanical Specifications*

Disassembly and Assembly Procedure Revisions

- Engine front cover removal procedure has been revised.
- Reluctor ring removal procedure has been revised.
Refer to *Timing Chain and Sprockets Removal*
- Install a NEW oil pump driveshaft retainer whenever removing or installing an oil pump assembly.
- Oil bypass valve removal and installation procedure has been revised.
- Upper intake manifold bolt tightening sequence revised.

Engine Mechanical Diagnostic Procedure Revisions

A new engine mechanical Base Engine Misfire chart has been added. Refer to *Base Engine Misfire Diagnosis*

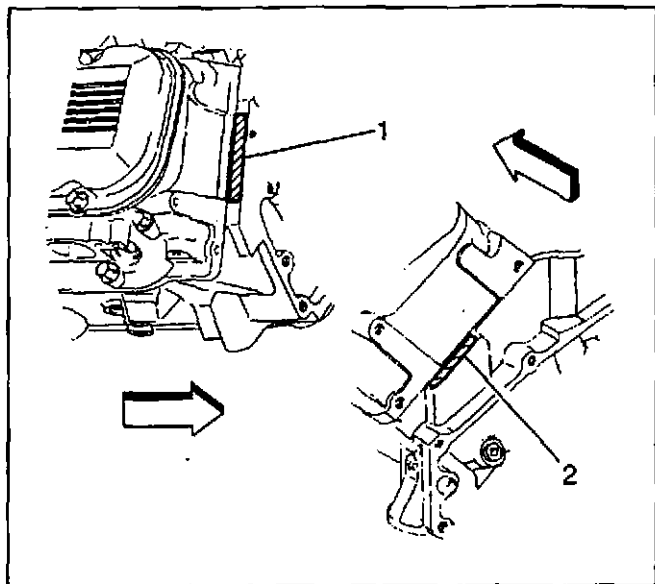
New Special Tools Required

- The valve lifter remover pliers J 3049-A replaces J 9290-1.
- Spark plug port adapter J 23590 has been replaced by J 22794.
- The crankshaft balancer remover/installer J 39046 has been replaced by J 23523-F
- Refer to *Special Tools (ERROR - NOT IN CURRENT PSD)*

Visual Identification

SIE-10 - 201290

Engine Identification



180875

The engine identification number is located on the right front side of the engine block (1). The engine identification number gives specific information about the assembly of the engine. If reading the identification number from the left the following information can be obtained:

- The first digit identifies the plant code.
- The second and third digits give the month of the engine build.
- The fourth and fifth digits describe the date of engine build.
- The sixth, seventh, eighth digits give the engine broadcast code.

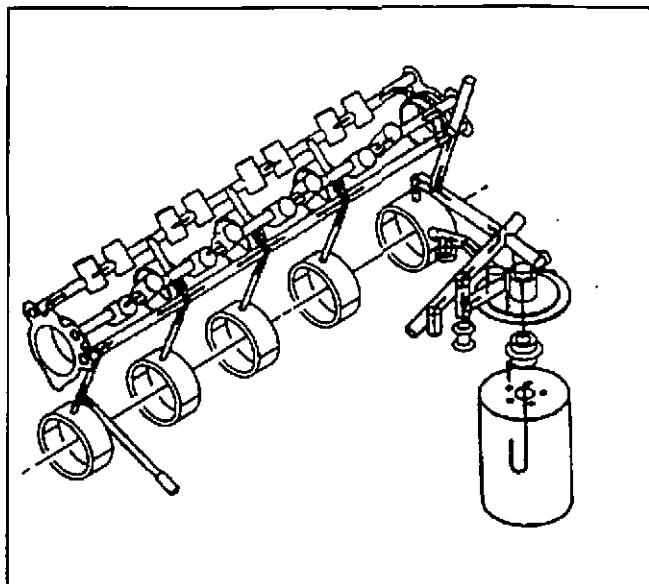
The Vehicle Identification Number (VIN) Derivative is located on the left rear side of the engine block (2) and is a nine digit number stamped or laser etched onto the engine at the vehicle assembly plant. If reading the identification number from the left the following information can be obtained:

- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last six digits of the Vehicle Identification Number (VIN).

Description and Operation

SIE-ID - 66633

Lubrication



66606

The gear-type oil pump is driven through an extension driveshaft. The extension driveshaft is driven by the distributor which is gear driven by the camshaft. The oil is drawn from the oil pan through a pickup screen and tube. Pressurized oil is delivered through internal passages in order to lubricate camshaft and crankshaft bearings and to provide lash control in the hydraulic valve lifters. Oil is metered from the valve lifters through the valve pushrods in order to lubricate the valve rocker arms and ball pivots. Oil returning to the oil pan from the cylinder heads and the front camshaft bearing, lubricates the camshaft timing chain and the crankshaft and the camshaft sprockets.

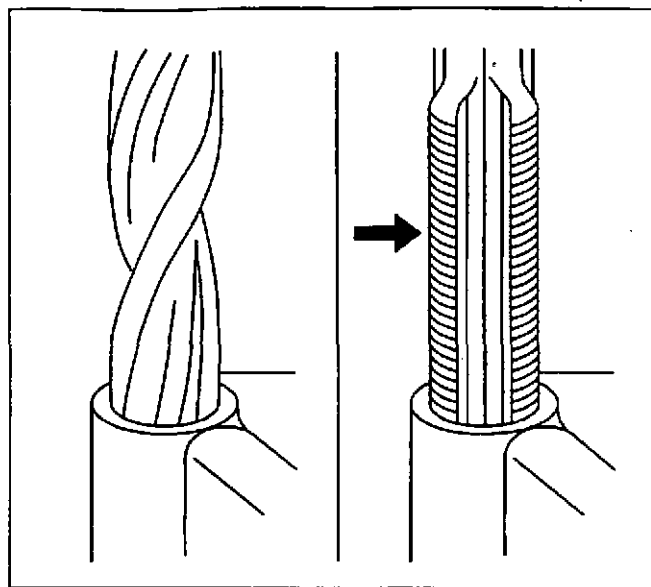
SIE-ID - 53544

Thread Repair

SIO-ID - 40879

Tools Required

General purpose thread repair kits. These kits are available commercially.



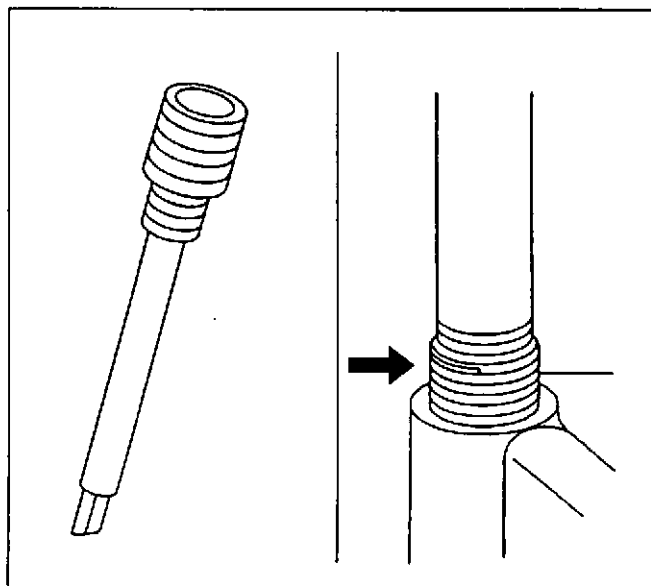
4962

Caution: SIO-ID - 5011 **Wear safety glasses in order to avoid eye damage.**

Important: Refer to the kit manufacturer's instructions regarding the size of the drill and tap to use.

Avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch, and the depth of the damaged thread. If necessary, adjust the stop collars on the cutting tool and tap to the required depth.
2. Drill out the damaged thread. Clean out any chips.
3. Tap the hole. Lubricate the tap with light engine oil. Clean the thread.



4963

4. Thread the insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

Important: The insert should be flush to one

turn below the surface.

5. Lubricate the insert with light engine oil (except when installing in aluminum) and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift punch.

SIE-ID - 189826

Cleanliness and Care

SIO-ID - 189770

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for reassembly.
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

SIE-ID - 66654

Replacing Engine Gaskets (new)

Gasket Reuse and Applying Sealant

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless specified in the service procedure.

Separating Components

- Use a rubber mallet in order to separate the components.
- Bump the part sideways in order to loosen the components.
- Bumping of the component should be done at bends or reinforced areas of the component to prevent distortion of the components.

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.

Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.

This fine grit is an abrasive and can cause internal engine damage.

Assembling Components

- Assemble components using only the sealant (or equivalent) that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- Do not allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener from clamping properly or cause component damage when tightened.
- Tighten fasteners to the proper specifications. DO NOT overtighten the fasteners.

SIE-ID - 411537

Use of RTV and Anaerobic Sealer

Sealant Types

Important: The correct sealant and amount of sealant must be used in the proper location to prevent oil leaks, coolant leaks, or the loosening of the fasteners. DO NOT interchange the sealants. Use only the sealant (or equivalent) as specified in the service procedure.

The following 2 major types of sealant are commonly used in engines:

- Aerobic sealant (Room Temperature Vulcanizing (RTV))
- Anaerobic sealant, which include the following:
 - Gasket eliminator
 - Pipe
 - Threadlock

Aerobic Type Room Temperature Vulcanizing (RTV) Sealant

Aerobic type Room Temperature Vulcanizing (RTV) sealant cures when exposed to air. This type of sealant is used where 2 components (such as the intake manifold and the engine block) are assembled together.

Use the following information when using RTV sealant:

- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket
 - Any other surfaces where a different type of sealant is specified in the service procedure
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

Important: Do not allow the RTV sealant to enter any blind threaded holes, as it may prevent the fasteners from clamping properly or cause damage when the fastener is tightened.

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.
- Apply the RTV sealant bead to the inside of any bolt holes areas.
- Assemble the components while the RTV sealant is still wet to the touch (within 3 minutes). Do not wait for the RTV sealant to skin over.
- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

Anaerobic Type Gasket Eliminator Sealant

Anaerobic type gasket eliminator sealant cures in the absence of air. This type of sealant is used where 2 rigid parts (such as castings) are assembled together. When 2 rigid parts are disassembled and no sealant or gasket is readily noticeable, then the 2 parts were probably assembled using an anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

- Always follow all the safety recommendations and directions that are on the gasket eliminator sealant container.
- Apply a continuous bead of gasket eliminator sealant to one flange.
The surfaces to be sealed must be clean and dry.

Important: Do not allow the gasket eliminator sealant to enter any blind threaded holes, as the gasket eliminator sealant may prevent the fasteners from clamping properly, seating properly, or cause damage when the fastener is tightened.

- Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.

Important: Gasket eliminator sealed joint fasteners that are partially torqued and the gasket eliminator sealant allowed to cure more than five minutes, may result in incorrect shimming and sealing of the joint.

- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.
- After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

Anaerobic type threadlock sealant cures in the absence of air. This type of sealant is used for threadlocking and sealing of bolts, fittings, nuts, and studs. This type of sealant cures only when confined between 2 close fitting metal surfaces.

Use the following information when using threadlock sealant:

- Always follow all safety recommendations and directions that are on the threadlock sealant container.
- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

Important: Fasteners that are partially torqued and then the threadlock sealant allowed to cure more than five minutes, may result in incorrect clamp load of assembled components.

- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

Anaerobic Type Pipe Sealant

Anaerobic type pipe sealant cures in the absence of air and remains pliable when cured. This type of sealant is used where 2 parts are assembled together and require a leak proof joint.

Use the following information when using pipe sealant:

- Do not use pipe sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket
 - Surfaces where a different sealant is specified
- Always follow all the safety recommendations and the directions that are on the pipe sealant container.
- The surfaces to be sealed must be clean and dry.
- Use a pipe sealant bead of the size or quantity as specified in the service procedure.

Important: Do not allow the pipe sealant to enter any of the blind threaded holes, as the pipe sealant may prevent the fastener from

- clamping properly, or cause component damage when the fastener is tightened.
- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to 1 sealing surface.
- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

SIE-ID = 189993

Separating Parts

SIO-ID = 189980

Important: Many internal engine components will develop specific wear patterns on their friction surfaces.

When disassembling the engine, internal components MUST be separated, marked or organized in a way to ensure reinstallation to original location and position.

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod to the crankshaft journal
- Connecting rod to the bearing cap
- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, guides, pushrods, pivot supports and rocker arms
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

SIE-ID = 190154

Tools and Equipment

SIO-ID = 190145

- Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.
- To properly service the engine assembly, the following items should be readily available:
 - Approved eye protection and safety gloves
 - A clean, well-lit, work area
 - A suitable parts cleaning tank

- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

Special Tools and Equipment

SIE-ID = 311462

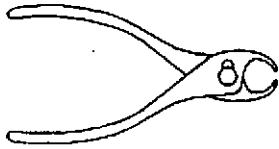
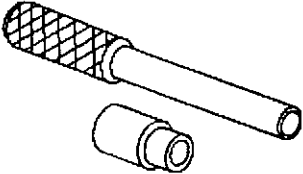
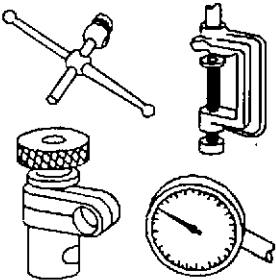
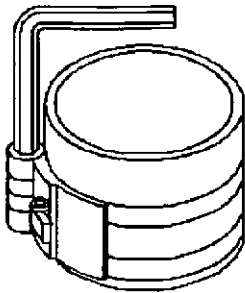
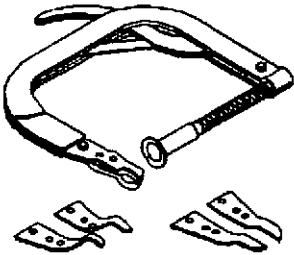
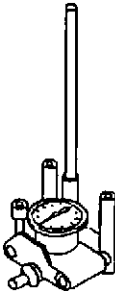
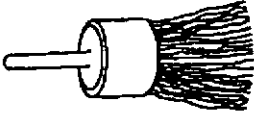
Illustration	Tool Number/ Description
 14487	J 3049-A Hydraulic Lifter Remover
 3404	J 5239 Connecting Rod Bolt Guide Tool
 3399	J 5892-C Valve Spring Compressor
 2014	J 8001 Dial Indicator Set

Illustration	Tool Number/ Description
 3403	J 8037 Piston Ring Compressor
 3414	J 8062 Valve Spring Compressor (Cylinder Head Off)
 5110	J 8087 Cylinder Bore Checking Gauge
 35464	J 8358 Carbon Removal Brush

Engine

Engine Mechanical - 7.4L 6-225

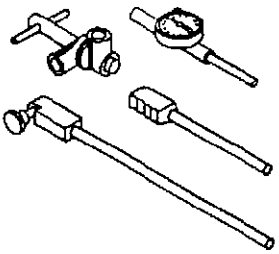
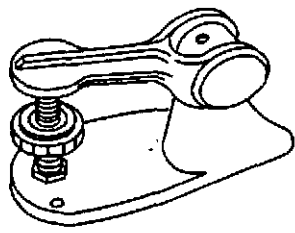
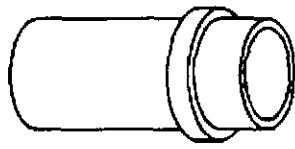
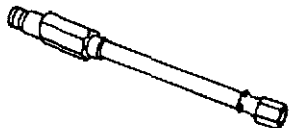
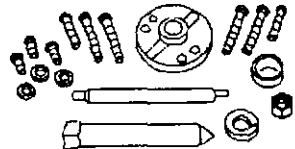
Illustration	Tool Number/ Description
 3408	J 8520 Camshaft Lobe Lift Indicator
 4997	J 9666 Valve Spring Tester
 65325	J 22102 Crankshaft Oil Seal and Sprocket Installer
 26998	J 22794 Spark Plug Port Adapter
 3398	J 23523-F Crankshaft Balancer Remover and Installer

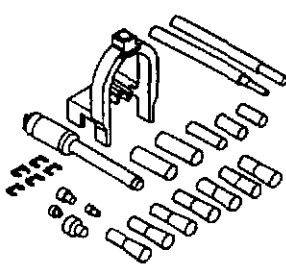
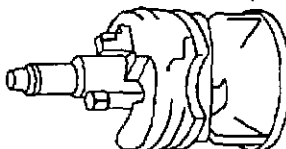
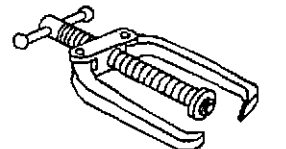
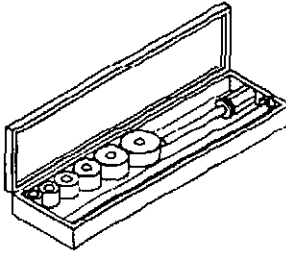
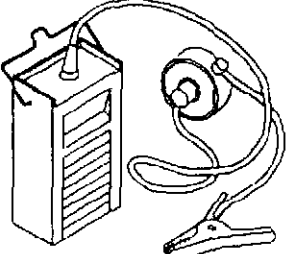
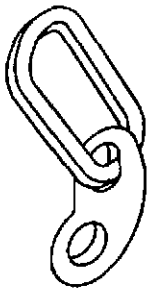
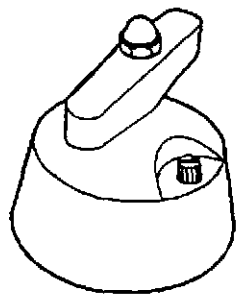
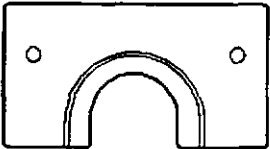
Illustration	Tool Number/ Description
 14495	J 24086-C Piston Pin Remove and Install
 3412	J 24270 Cylinder Bore Ridge Reamer
 66580	J 28509-A Counter Gear Bearing Remover
 5118	J 33049 Camshaft Bearing Service Set
 3413	J 36660 Torque Angle Meter

Illustration	Tool Number/ Description
 68653	J 36857 Engine Lift Bracket
 65999	J 38841 Crankshaft Rear Main Seal Installer
 68391	J 41371 Reluctor Wheel Remover