

SERIES 50[®]

Service Manual

Detroit Diesel[®] Series 50 Diesel and Natural Gas-Fueled Engines

DETROIT DIESEL
CORPORATION



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Printed in U.S.A.

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SCOPE AND USE OF THIS MANUAL

This manual contains complete instructions on operation, adjustment (tune-up), preventive maintenance, and repair (including complete overhaul) for the basic Series 50 Inline Diesel Engines. This manual was written primarily for persons servicing and overhauling the engine. In addition, this manual contains all of the instructions essential to the operators and users. Basic maintenance and overhaul procedures are common to all Series 50 Engines, and apply to all engine models.

This manual is divided into numbered sections. The first section covers the engine (less major assemblies). The following sections cover a complete system such as the fuel system, lubrication system, or air system. Each section is divided into subsections which contain complete maintenance and operating instructions for a specific engine subassembly. Each section begins with a table of contents. Pages and illustrations are numbered consecutively within each section.

Information can be located by using the table of contents at the front of the manual or the table of contents at the beginning of each section. Information on specific sub-assemblies or accessories within the major section is listed immediately following the section title.

SERVICE PARTS AVAILABILITY

Service parts are available throughout the world. A complete list of all Detroit Diesel Corporation (DDC) distributors and dealers is available in the *Detroit Diesel Corporation World Wide Parts and Service Directory*, 6SE280. This publication can be ordered from any authorized DDC distributor. The dealer must have the engine identification and model number (located on the engine block directly beneath the intake manifold) to fill a parts order.

CLEARANCE OF NEW PARTS AND WEAR LIMITS

New parts clearances apply only when all new parts are used at the point where the various specifications apply. This also applies to references within the text of the manual. The column entitled Limits must be qualified by the judgement of personnel responsible for installing new parts. For additional information, refer to the section entitled "Inspection" within this section. Refer to Section ADDITIONAL INFORMATION, "Specifications, New Clearances, and Wear Limits" under "Specifications", for a listing of clearances of new parts and wear limits on used parts.

Four-inch, 3M Scotch-Brite Surface Conditioning Discs, used with an electric or air powered hand drill (with a speed of 15,000-18,000 r/min), have proven successful in removing the gasket eliminator without damaging the mating surfaces of engine parts. See Figure 10.

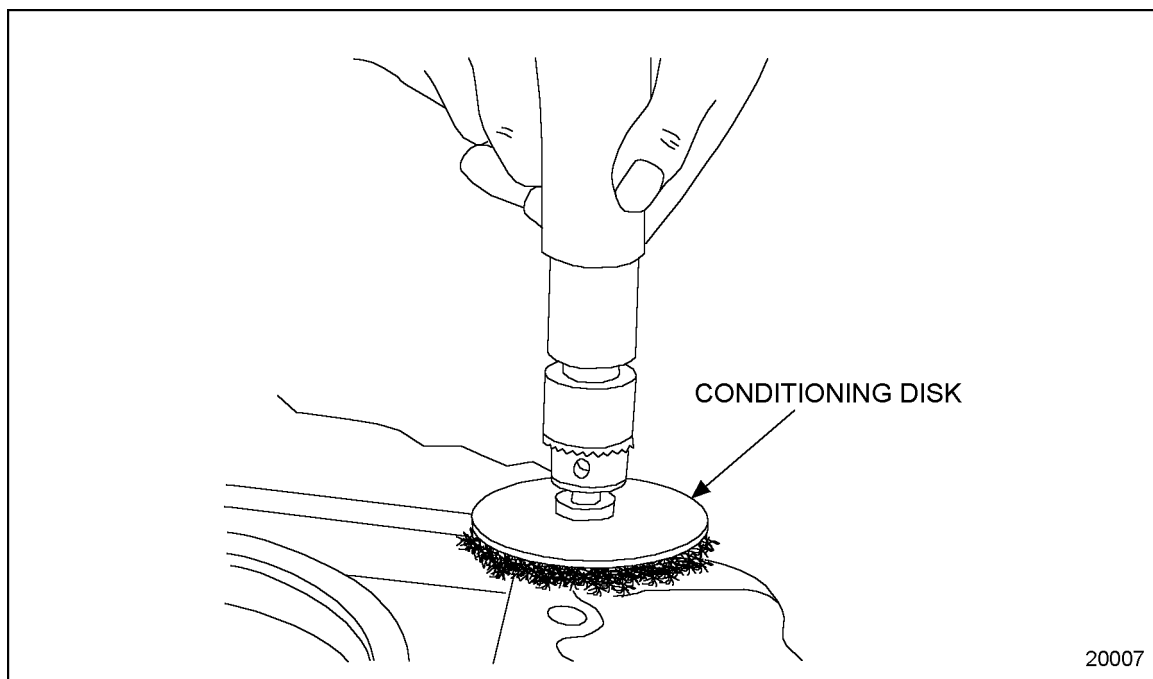


Figure 10 Gasket Eliminator Removal

A coarse pad, J 36571-3 part of tool set J 36571, (3M #07450, brown color), is suitable for steel surfaces. A medium pad, J 36571-2 part of tool set J 36571 (3M #07451, maroon color), is recommended for aluminum surfaces.

Description	By	Unit of Measurement
Multiply Fuel Performance	By	To get equivalent number of:
Miles/gal (mile/gal)	0.4251	Kilometers/liter (km/L)
Gallons/mile (gal/mile)	2.3527	Liter/kilometer (L/km)
Multiply Velocity	By	To get equivalent number of:
Miles/hour (mile/hr)	1.6093	Kilometers/hour (km/hr)

Table 5 English to Metric Conversion

4. If the water jackets are heavily scaled, proceed as follows:
 - [a] Agitate the block in a bath of inhibited phosphoric acid.
 - [b] Allow the block to remain in the acid bath until the bubbling action stops (approximately 30 minutes).
 - [c] Lift the block, drain it and re-immerses it in the same acid solution for 10 more minutes. Repeat until all scale is removed from the water jacket area.
 - [d] Rinse the block in clear, hot water to remove the acid solution.
 - [e] Neutralize the acid that may cling to the casting by immersing the block in an alkaline bath.
 - [f] Wash the block in clean water or steam clean it.

**CAUTION:**

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

5. Dry the cylinder block with compressed air. Blow out all of the bolt holes and passages with compressed air.

NOTE:

The above cleaning procedure may be used on all ordinary cast iron and steel parts for the engine. Aluminum parts, such as flywheel housing, air intake manifold, oil filter adaptor and the camshaft gear access cover should NOT be cleaned in this manner. Mention will be made of special procedures when necessary.

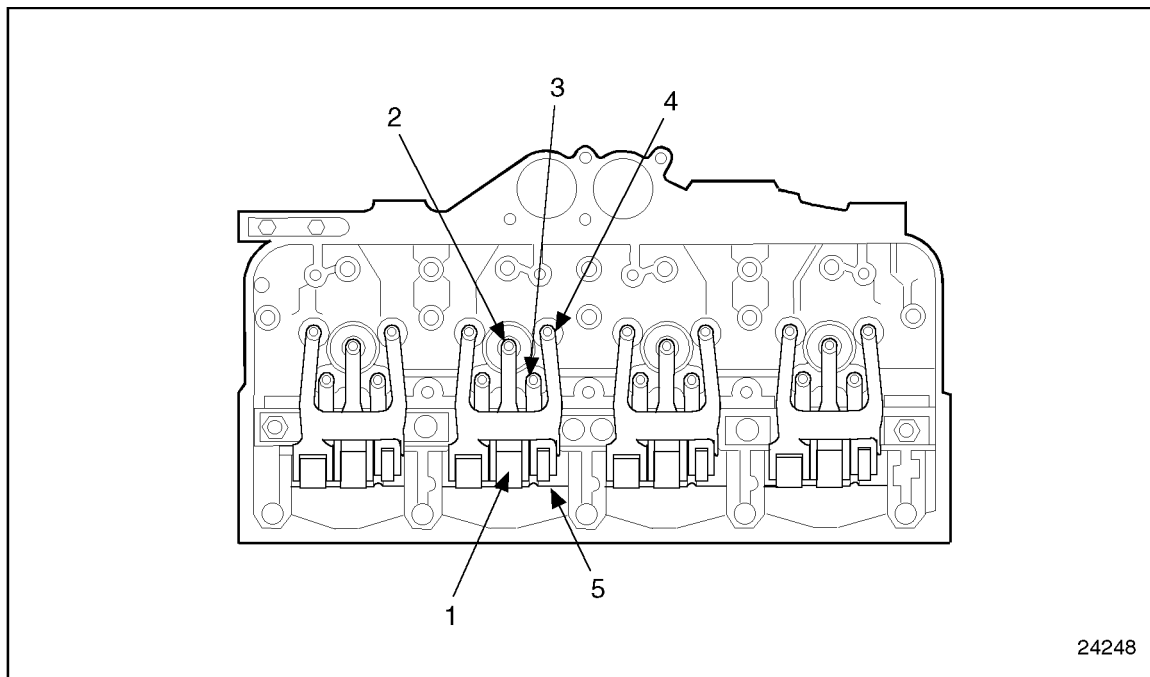
6. Be certain that all water passages and oil galleries have been thoroughly cleaned and dried. Install weep hole plugs and precoated pipe plugs. Install new cup plugs using a coating of good grade non-hardening sealant such as Loctite 620 or equivalent.
7. Pressure test the cylinder block. Two methods of cylinder block pressure testing may be used depending on the test facilities available:
 - [a] Immersion method; refer to Section 1.1.3.1.
 - [b] Leak-marker method; refer to Section 1.1.3.2.

1.1.3.1 Cylinder Block Immersion Method Pressure Testing

Use cylinder block pressure test kit, for immersion method pressure testing as follows:

1. Install cylinder liners with new seal rings and crevice seals. Refer to Section 1.20.3. Seat the liners firmly in the block counterbores with cylinder liner installation tool, J 35597-A.

The nested roller follower type rocker arms transmit cam motion directly to the valves and injectors. See Figure 1-20.



- | | |
|----------------------------|-----------------------------|
| 1. Roller Follower | 4. Exhaust Valve Rocker Arm |
| 2. Injectors | 5. Camshaft |
| 3. Intake Valve Rocker Arm | |

Figure 1-20 **Cylinder Head Assembly**

 **CAUTION:**

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

5. Clean the camshaft and camshaft bearings, valves, springs, valve rotators and rocker arm shafts in fuel oil and blow dry with compressed air.
6. Refer to Section 1.3.2 for cleaning of rocker arm and roller follower assemblies.

1.2.3 Inspection of Cylinder Head

The following steps must be performed before inspecting the cylinder head:

1. Replace the plugs removed for cleaning. If the old plugs are reused, coat the plugs with Loctite; pipe sealant, J 26558-92 part of PT-7276: with Teflon; or equivalent.

NOTE:

If both front fuel galley plugs have been removed, it will be necessary to replace both plugs.

2. If injector tubes have been removed, install new injector tubes. Refer to Section 2.4.5.
3. Install new cup plugs using a good grade non-hardening sealant such as Loctite 620 or equivalent.

Perform the following tests for cylinder head inspection.

- Pressure test, refer to Section 1.2.3.1
- Firedeck straightness test, refer to Section 1.2.3.2

1.2.3.1 Pressure Test

Perform the following steps to pressure test the cylinder head:

Each of the three rocker arm assemblies contain bushings where the rocker arms are supported on the rocker arm shafts. These bushings are not serviced separately. Each intake rocker arm assembly operates two intake valves in each cylinder. Each exhaust rocker arm assembly operates two exhaust valves in each cylinder. In each set of three rocker arm assemblies, the exhaust rocker assembly is the widest, straddling the intake and fuel injector rockers. The center rocker operates the injector follower. See Figure 1-46.

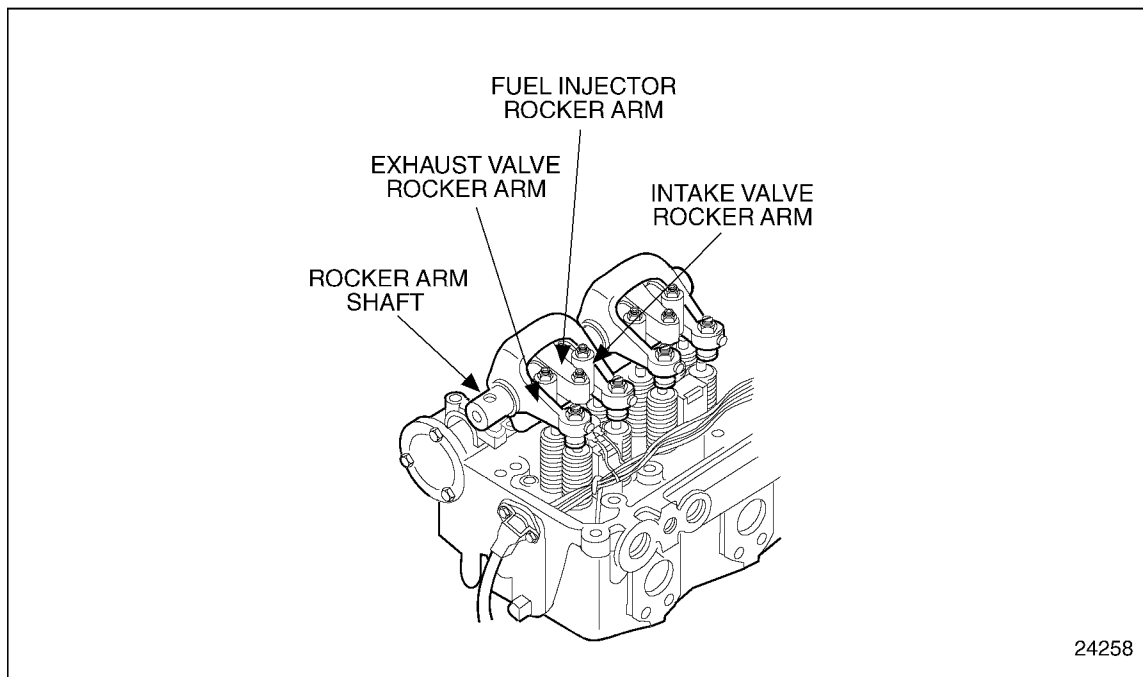
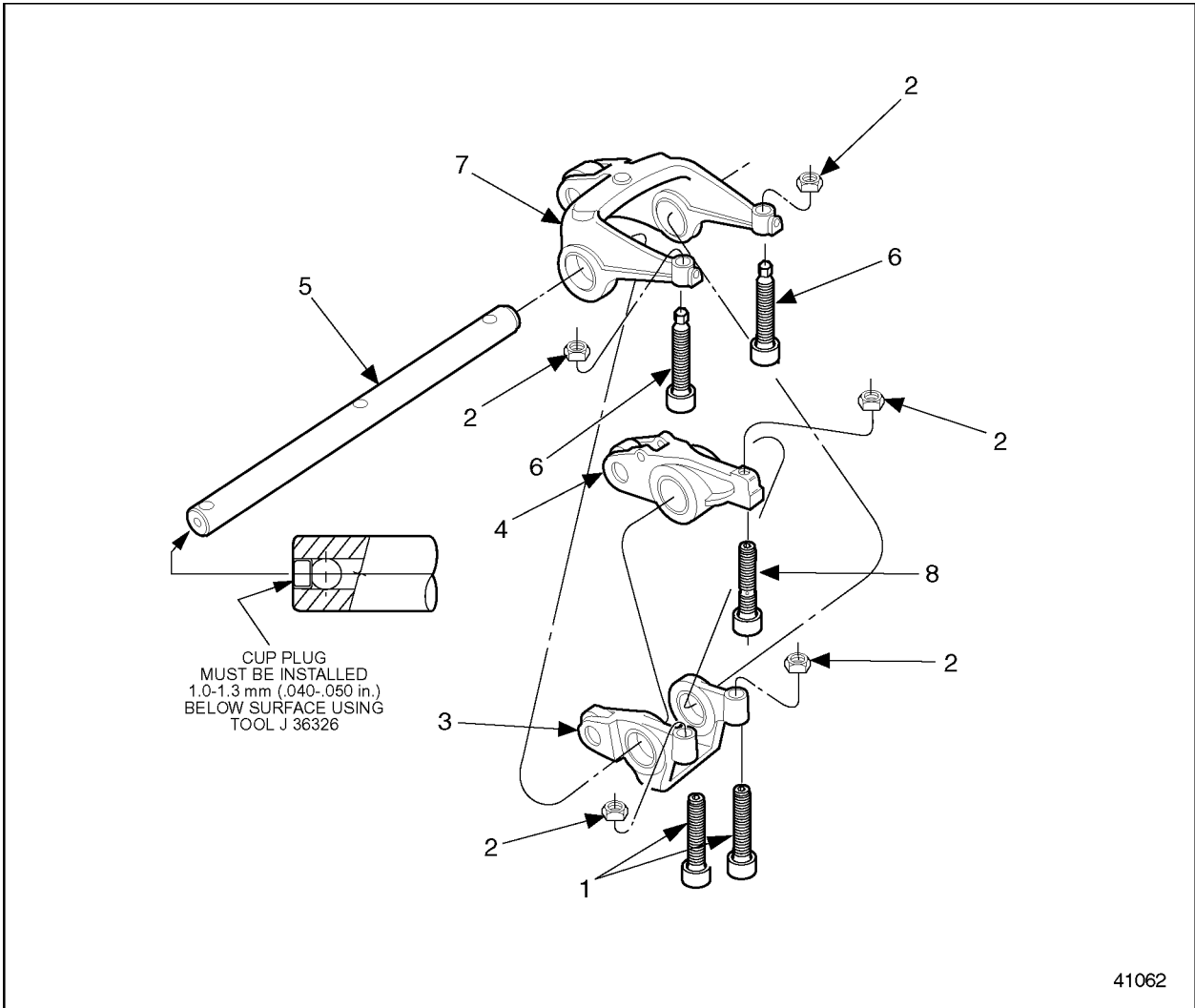


Figure 1-46 **Rocker Arm Identification**

1.3.4 Installation of Rocker Arm Shaft Assembly

Perform the following for rocker arm assembly installation:

1. Ensure the cup plugs are properly installed to each end of the rocker arm shafts before the shafts are installed to the engine. See Figure 1-58. Refer to Section 1.3.3.1, step 1.



- | | |
|---|---|
| 1. Unitized Valve Adjusting Screw Assembly; Intake position | 5. Rocker Arm Shaft |
| 2. Locknut | 6. Unitized Valve Adjusting Screw Assembly; Exhaust position |
| 3. Intake Rocker Arm Assembly | 7. Exhaust Rocker Arm Assembly |
| 4. Fuel Injector Rocker Arm Assembly | 8. Unitized Valve Adjusting Screw Assembly; Injector position |

Figure 1-58 Rocker Arm and Related Parts

 **CAUTION:**

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

1. Using proper eye protection, clean all of the disassembled parts with fuel oil and dry with compressed air.

1.4.3.2 Cleaning of Valve Stems

Perform the following for valve stem cleaning:

1. Clean the carbon from the valve stems and wash the valves with fuel oil.

1.4.3.3 Cleaning of Valve Guide Bore

Perform the following for valve guide bore cleaning:

1. Clean the valve guide bore with bore brush, J 5437 (or equivalent), to remove all gum and carbon deposits.

1.4.4 Valve Guide Removal

Perform the following steps for valve guide removal:

NOTE:

Valve guides are not replaceable on natural gas engines

NOTICE:

Be sure that all valve spring seats have been installed before the valve stem seal is installed.

5. The valve stem oil seal may be installed with or without oil. Push the seal over the protector. See Figure 1-90.

NOTE:

The valve stem oil seal on the natural gas engine has a larger inside diameter than the seal on the diesel engine.

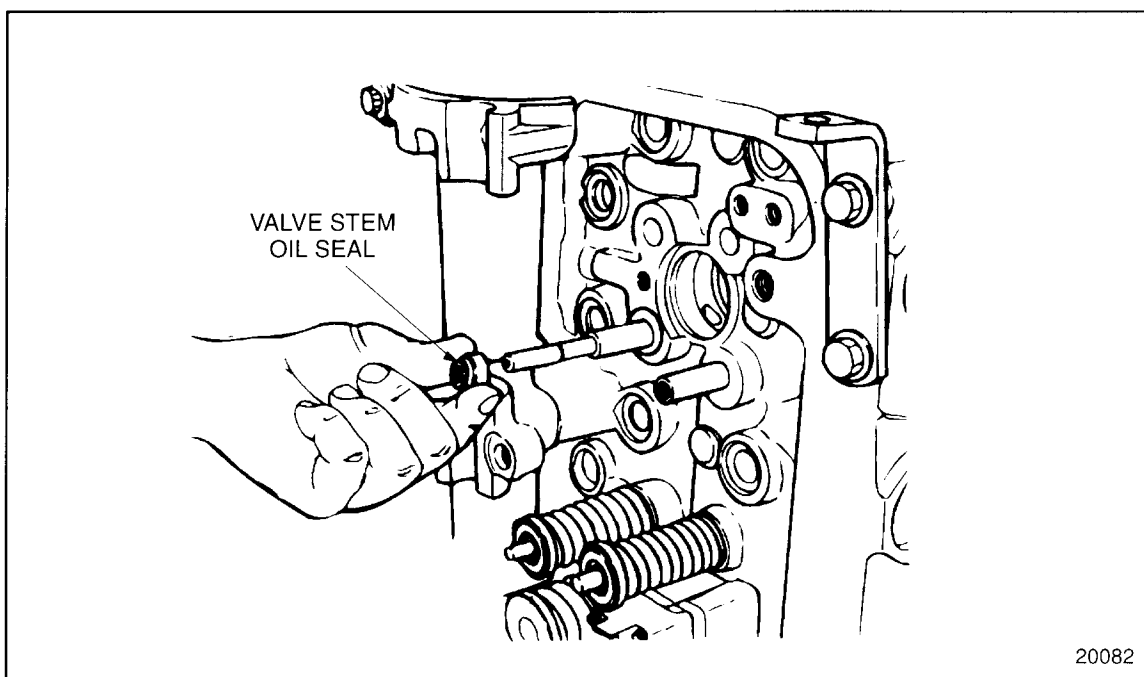


Figure 1-90 **Valve Stem Oil Seal Installation**

To remove the two-piece rocker cover:

1. Remove the ignition boots from the spark plug wells. Refer to Section 15.5.1.
2. Remove the eight bolts that attach the ignition boot retainer from the rocker cover cap. Lift off the retainers, covers, and O-rings.
3. Remove the six bolts that attach the rocker cover cap to the base.
4. Lift the cap off the base leaving the four extensions tubes in the cylinder head.

**CAUTION:**

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

5. Blow any excess oil from the outside of the extension tube so that the oil will not enter the spark plug well when the extensions tubes are removed.
6. Pull the four extension tubes from the cylinder head.
7. Loosen and remove the eight bolt/isolator assemblies that attach the base to the cylinder head.
8. Lift the base straight up off the cylinder head.

1.6.5 Removal and Precleaning of Two-Piece Rocker Cover-Gas Engines with Coil Over Plug Ignition System Only

Preclean the rocker cover, especially around its base on the cylinder head and in the attaching bolt recesses to keep dirt and debris out of the valve gear chamber.

To remove the two-piece rocker cover:

1. Remove the ignition boots from the spark plug wells. Refer to Section 15.5.1.
2. Lift the cap off the base leaving the four extensions tubes in the cylinder head.
3. Blow any excess oil from the outside of the extension tube so that the oil will not enter the spark plug well when the extensions tubes are removed.
4. Pull the four extension tubes from the cylinder head.
5. Loosen and remove the eight bolt/isolator assemblies that attach the base to the cylinder head.
6. Lift the base straight up off the cylinder head.

14. Remove and inspect the piston and connecting rod assemblies. Refer to Section 1.18.2 and refer to Section 1.18.3.1 for inspection.

NOTE:

The connecting rod caps must be reinstalled to their respective connecting rods. The main bearing caps should be kept in sequence, so that they may be installed to their original positions.

15. Loosen and remove the main bearing cap bolts. Remove the main bearing caps.
16. Remove and inspect the thrust washers from each side of the No. 4 main bearing cap.
17. Remove and inspect the crankshaft, including the crankshaft gear and timing wheel. Refer to Section 1.27.2.
18. Remove and inspect the timing gear and timing wheel.
19. Remove the Woodruff key from the slot in the front crankshaft hub.

1.7.2.1 Inspection of Crankshaft

Perform the following steps for crankshaft inspection:

 CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.
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1. Clean out the oil passages thoroughly with a stiff wire brush. Clean the crankshaft with fuel oil and dry it with compressed air.
2. Inspect the crankshaft timing gear keyway for evidence of cracks or wear. Replace the crankshaft if these conditions are evident.
3. If the crankshaft shows evidence of excessive overheating, replace the crankshaft since the heat treatment has probably been destroyed.
4. Check the crankshaft journal surfaces for score marks and other imperfections. If excessively scored, the journal surfaces must be reground. Refer to Section ADDITIONAL INFORMATION.
5. Carefully, inspect the front and rear end of the crankshaft in the area of the oil seal contact surface for evidence of a rough or grooved condition. Any imperfections of the oil seal contact surfaces will result in oil leakage at these points.
6. If the crankshaft oil seal contact surfaces are grooved, the seal surfaces must be sleeved and an oversized seal used. Refer to Section 1.8.
7. Check the crankshaft thrust surfaces for excessive wear or grooving. If excessively worn, the thrust surfaces must be reground. Refer to Section ADDITIONAL INFORMATION.

1. Install puller, J 41329 part of J 35993, over crankshaft and hold against seal.
See Figure 1-123.

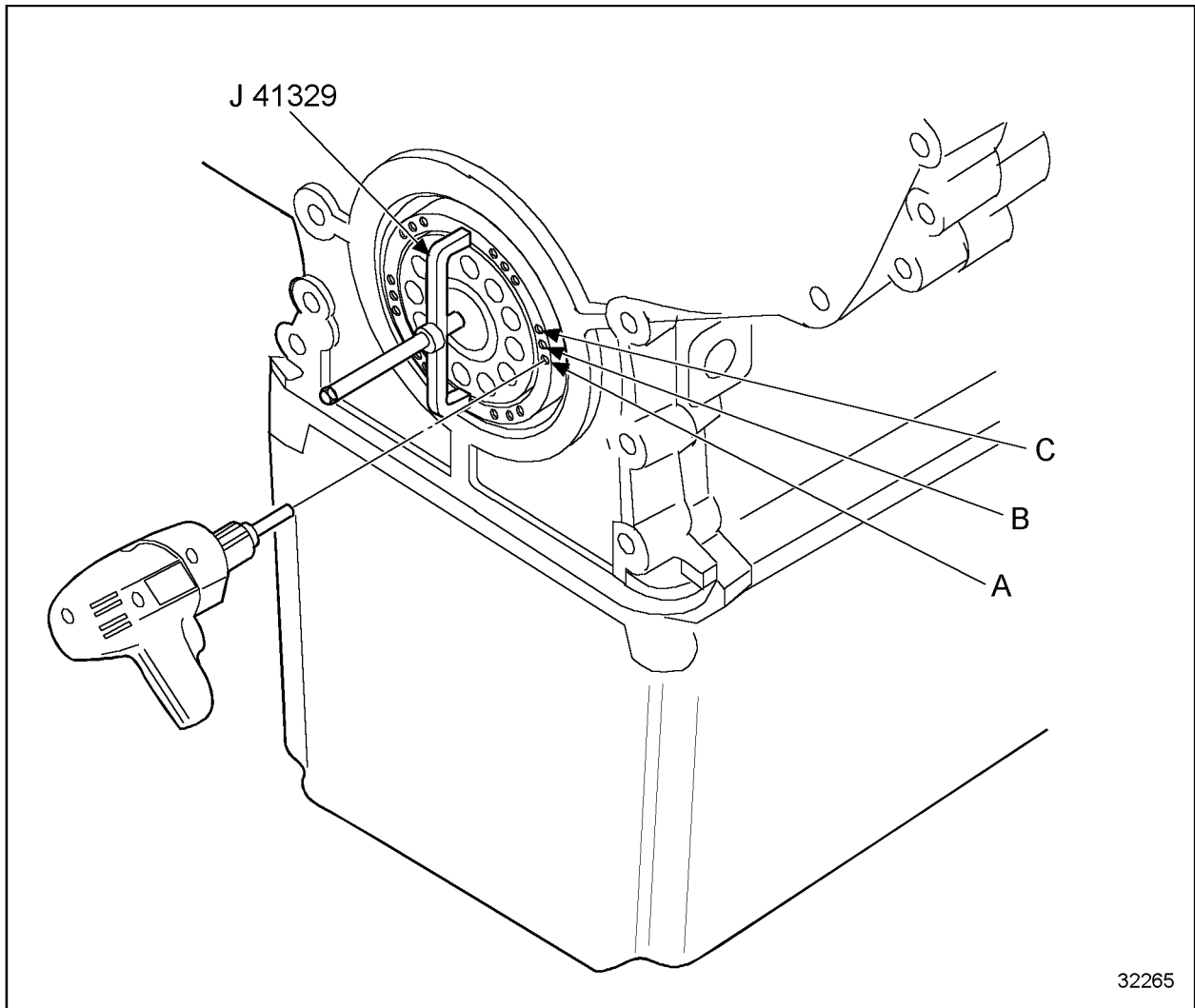


Figure 1-123 Removing Front Crankshaft Oil Seal from Gear Case Cover

2. Using variable speed drill motor and 5/32" bit, drill through outer and inner case of seal using smallest hole "A" as a guide.
3. Without moving J 41329 part of J 35993, drill two additional "A" holes equally spaced.

NOTE:

All six holes may be drilled if using three holes proves unsuccessful in pulling seal.

4. Rotate J 41329 part of J 35993 clockwise until the "B" holes align with drilled holes and install sheet metal screws.
5. Apply thread lubricant, J 23444-A part of J 35686-A, to forcing screw and remove seal.
6. Remove the sheet metal screws from the tool. Discard the oil seal.

The upper and lower bearing shells are located in the respective block and bearing cap by a tang. The tang is located at the parting line at one end of each bearing shell. The tangs are offset from center to aid correct insertion. Bearing shell sets are supplied as a matched assembly and should not be mixed.

A hole in each upper bearing shell registers with a vertical oil passage in the cylinder block. Lubricating oil, under pressure, passes from the cylinder block oil gallery by way of the bearing shells to the drilled passage in the crankshaft, then to the connecting rods and connecting rod bearings. The upper bearing shell is also grooved.

The lower main bearing shells have no oil holes or grooves. Therefore, the upper and lower main bearing shells must not be interchanged.

The fan support bracket includes the access cover for the adjustable idler gear. See Figure 1-150.

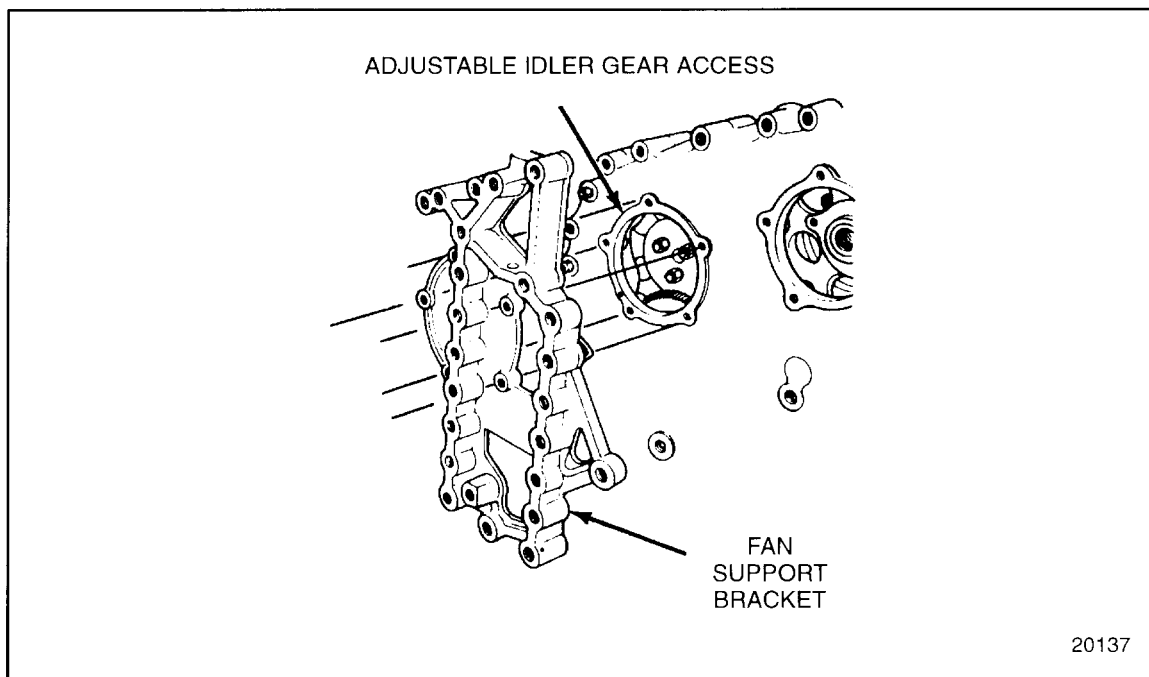


Figure 1-150 Fan Support Bracket for Truck Models

With the fan support bracket and the camshaft drive gear access cover removed, the gear lash between the adjustable idler gear and the camshaft drive gear can be measured and adjusted. Refer to Section 1.21.2.1.

12. Insert a new gasket between the camshaft drive gear access cover and the gear case cover. Install the camshaft drive gear access cover to the gear case cover. Torque the bolts to 30-38 N·m (22-28 lb·ft), using the tightening sequence. See Figure 1-165.

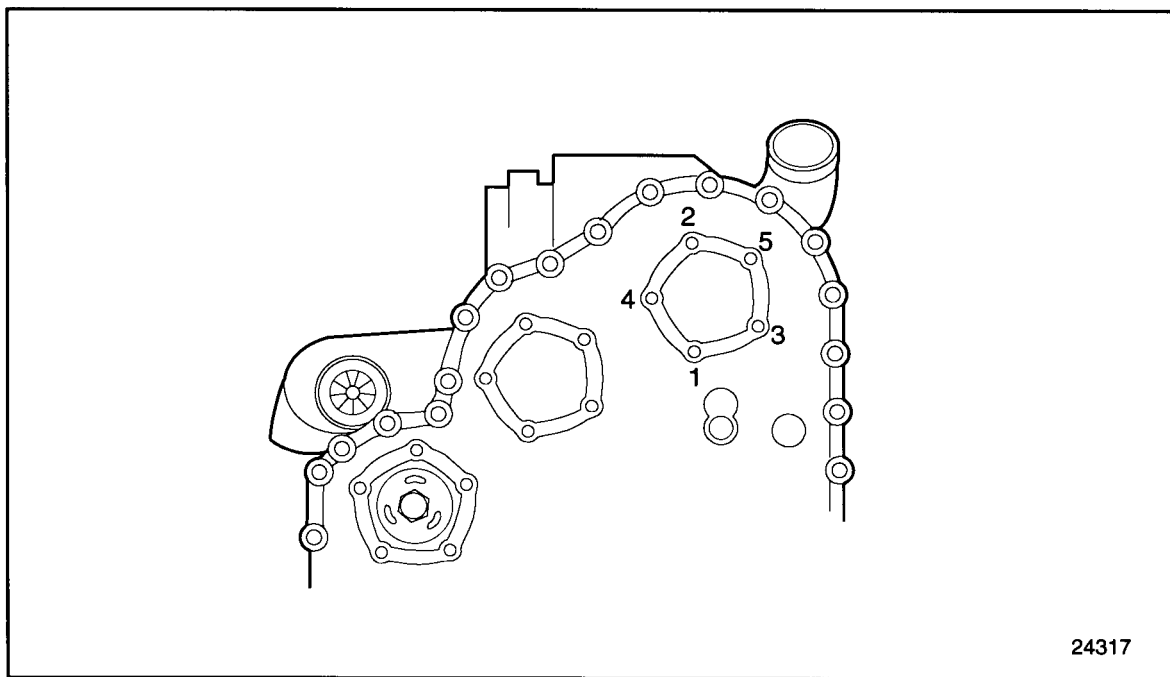


Figure 1-165 Access Cover Bolt Torque Sequences

13. Install the air conditioner compressor and brackets. Install the air conditioner compressor drive belt.
14. Install the alternator and brackets. Install the alternator drive belts.
15. Adjust the alternator and air conditioner compressor drive belts to the specifications. Refer to Section 13.5.7.
16. Install the engine oil pan and fill the crankcase. Refer to Section 13.5.1.

11. Install the crankshaft protector, J 35994, to the oil seal contact area of the crankshaft. This will help to protect the crankshaft seal surface when removing the bull gear and camshaft idler gear assembly. See Figure 1-180.

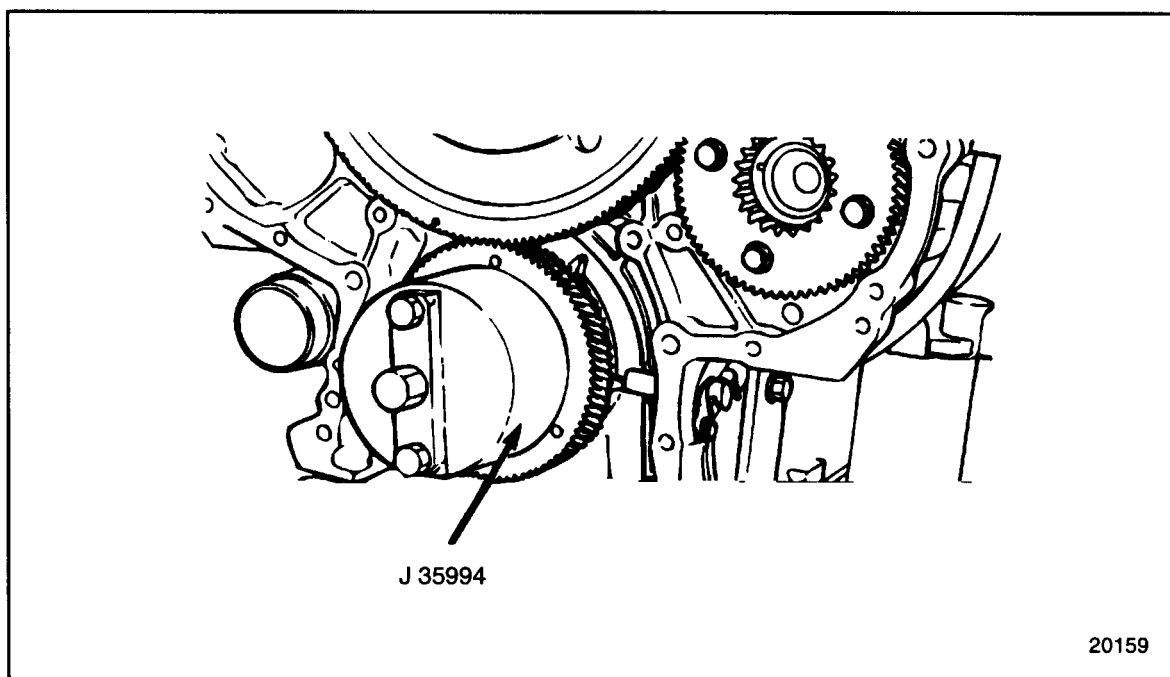


Figure 1-180 Crankshaft Protector Installation

12. Remove the bull gear and camshaft idler gear assembly from the engine. Refer to Section 1.26.2.
13. Remove the adjustable idler gear assembly from the gear case. Refer to Section 1.25.2.
14. Using a plastic hammer or fiber mallet, tap the rear face of the camshaft thrust plate to remove the thrust plate, camshaft drive gear hub and camshaft drive gear from the gear case.

6. Remove the isolated pulley from the spindle by removing the large center bolt (if equipped with this pulley style). Refer to section 1.13.2.
7. Remove two of the six crankshaft pulley or crankshaft pulley spindle-to-crankshaft special attaching bolts and hardened washers that are 180 ° apart. Discard the bolts. These bolts are not reusable.
8. Install two guide studs, J 36235, into the holes where the bolts were removed.

NOTICE:

Use care when removing the crankshaft pulley as the vibration damper may come off. If the damper is allowed to fall, internal damage to the damper will result.

9. Remove the remaining four special crankshaft pulley bolts and hardened washers. Discard the bolts. These bolts are not reusable.

NOTICE:

Do not pound with a hammer or pry with other tools to remove the viscous damper from the crankshaft, since the outer shell may be dented and cause the flywheel to turn at the same speed as the outer shell. This renders the damper ineffective. The damper CANNOT be repaired.
--

10. Remove the vibration damper by sliding it off the guide studs.
11. Remove the flywheel lock and guide studs.

1.12.2.1 Inspection of the Vibration Damper

Inspect the vibration damper as follows:

NOTICE:

Dents may render the damper ineffective.
--

1. Inspect the outer casing of the damper for damage.
 - [a] Check outer casing for dents, cracks, nicks, fluid leaks or bulges.
 - [b] If any dents or cracks are detected, replace with new damper.
 - [c] Bulges or splits indicate that the damper fluid has deteriorated. If any are detected, replace with new damper.
2. Inspect the damper inner contact surfaces and the crankshaft end for damage. See Figure 1-196
 - [a] Check for galling or burrs.
 - [b] Slight scratches or burrs may be removed with an emery cloth.

Install the spindle mounted pulley and hub assembly as follows:

1. If removed, install the flywheel lock, J 36375–A. See Figure 1-195.
2. Thread the center screw of the tool in until the top of the tool rests between two teeth of the flywheel ring gear.
3. Finger-tighten the knurled knob.

NOTE:

It may be necessary to bar the engine over (using the square hole in the middle of the crankshaft pulley) so that the tool center screw is exactly between two teeth.

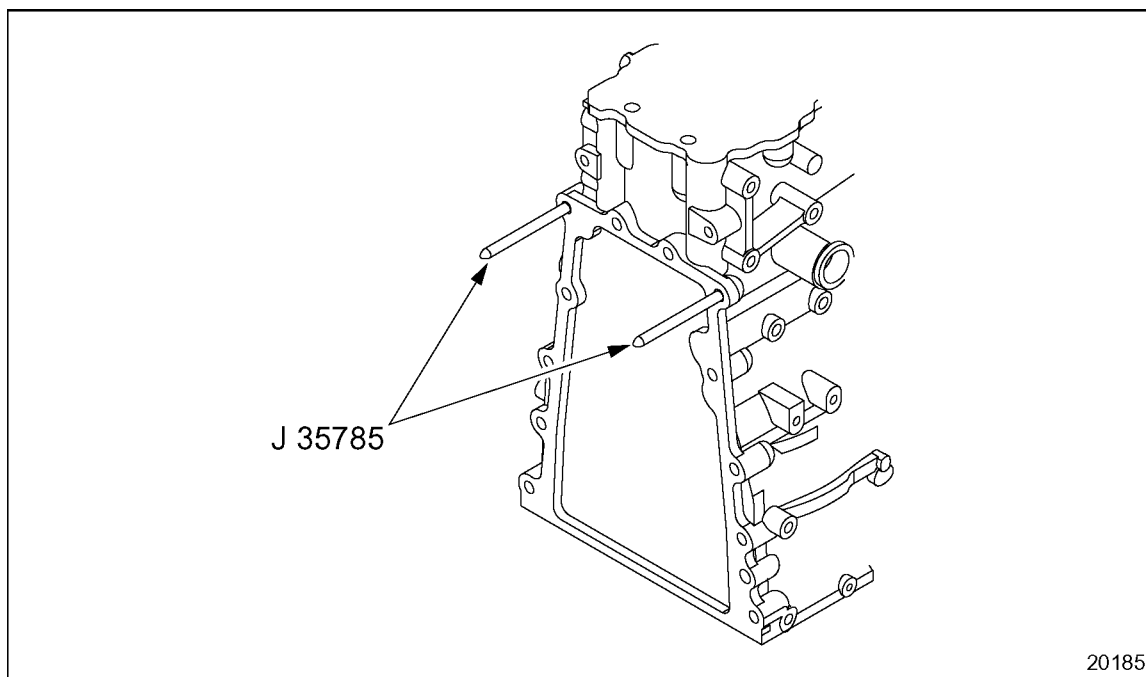
4. Install two guide studs to two of the holes in the crankshaft that are 180 degrees apart.
5. Install the vibration damper over the guide studs and onto the crankshaft.
Refer to section 1.12.3.

1.16.2 Cleaning and Removal of Flywheel Housing

Precleaning is not necessary.

Remove the flywheel housing as follows:

1. If the engine is removed from the vehicle, mount the engine on an overhaul stand. Refer to Section 1.1.2.
2. Drain engine oil and remove the oil pan. Refer to Section 3.9.2.
3. Remove the flywheel and scuff plate. Refer to Section 1.14.2.
4. Remove the four long outer bolts and the eight short inner bolts that secure the flywheel housing to the engine. See Figure 1-217.
5. To guide the flywheel housing until it clears the end of the crankshaft, thread two guide studs, J 43431 for 14 mm bolts or J 35785 for 12 mm bolts, into the cylinder block. See Figure 1-219.



NOTE: The illustration is shown with the flywheel housing already removed for clarity.

Figure 1-219 Pilot Stud Installation

6. Thread eye bolts into the tapped holes in the side pads of the flywheel housing.
7. Attach a suitable sling to the eye bolts.
8. Strike the front face of the housing alternately on each side with a soft hammer to loosen and work it off the dowel pins.
9. Remove and discard the crankshaft rear oil seal.

 **CAUTION:**

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

NOTICE:

After cleaning, do not leave glass beads in the piston dome. **Do not allow the glass beading to contact any area of the piston pin bushing or pin bore.** Glass beading will remove the tin plating.

4. The piston dome, including the compression ring grooves, is not tin plated and may be wire-brushed to remove any hard carbon. Glass beading can be used to clean a piston dome. Micro Bead Glass Shot MS-M (0.0029-0.0058 in.) is recommended. Allowable air pressure is 552-689 kPa (80-100 lb/in.²).

NOTE:

Do not wire-brush the piston skirt.

5. Clean the ring grooves with a suitable tool or a piece of an old compression ring that has been ground to a bevel edge.
6. Clean the inside surfaces of the piston dome and skirt and the oil relief channels in the oil ring grooves.

Inspect the piston and piston rings as follows:

1. Inspect the piston skirt and dome.
 - [a] Check the skirt and dome for score marks, cracks, damaged ring grooves or overheating indications.
 - [b] If any of these indications are present, the piston must be replaced.

NOTE:

Burn spots may indicate an obstruction in the connecting rod or piston pin oil passage.

2. Inspect the tapered fire ring groove (top) in the piston dome.
 - [a] Using the piston ring land step gage, J 35884-A or J 38609-A, check tapered fire ring groove. See Figure 1-233.
 - [b] Insert the center tang of the tool gage into the top piston ring groove ash. See Figure 1-233.
 - [c] Hold the tool at a 90° angle to the ring groove to prevent false readings.
 - [d] With the center tang into the ring groove as far as it will go, there should be no contact of the piston with the shoulder of the gage. If the gage makes contact at point A or point B, the fire ring groove is worn beyond usable limits. Check the groove

3. Coat the piston liberally with the engine oil, saturating the piston rings and lands.
See Figure 1-243.

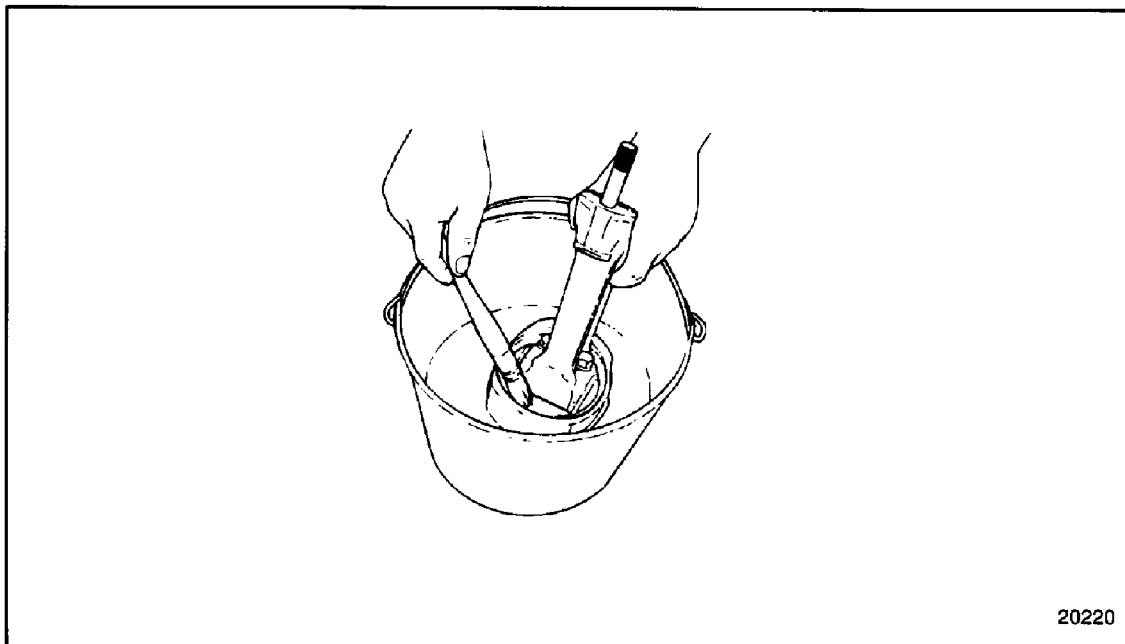
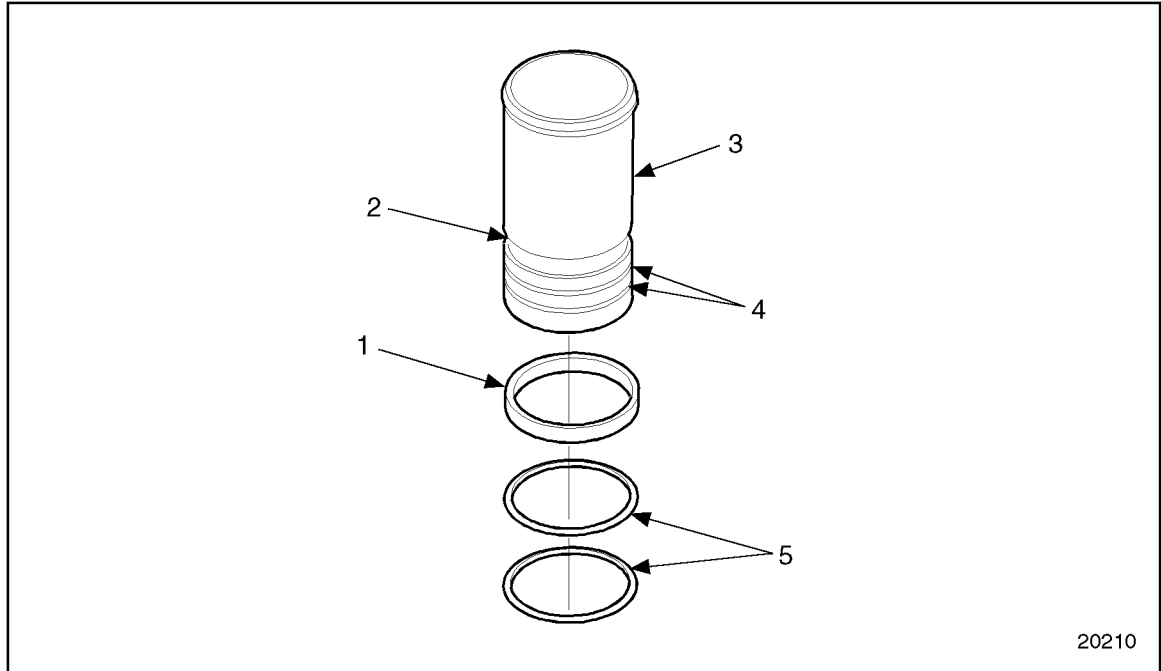


Figure 1-243 Piston and Connecting Rod Assembly Lubrication

1.20 CYLINDER LINER

The cylinder liner is of the replaceable wet type, made of hardened alloy cast iron, and is slip fit in the cylinder block. See Figure 1-256.



- | | |
|------------------------|-------------------|
| 1. Crevice Seal | 4. D-ring Grooves |
| 2. Crevice Seal Groove | 5. D-ring Seals |
| 3. Cylinder Liner | |

Figure 1-256 Cylinder Liner and Related Parts

Coolant in the cylinder block water jacket surrounds the liner and cools it directly. A cooling channel is also cut into the liner immediately below the flange. Coolant flow through this channel and around the rest of the liner controls critical ring and liner temperatures for long cylinder component life.

- | | |
|---------------------------------------|-----------------------------------|
| 11. Camshaft Thrust Plate | 24. Bull Gear/Idler Gear Carrier |
| 12. Camshaft Thrust Plate Seal O-ring | 25. Bull Gear/Idler Gear Bearings |
| 13. Camshaft Drive Gear Hub | |

Figure 1-269 Gear Train and Related Parts

The bull gear and camshaft idler gear are a press-fit to the bull gear and camshaft idler gear carrier. Both gears are keyed to the carrier by the same key. The carrier is supported by two tapered roller bearings, which ride on a hub bolted to the engine block by four bolts. The bull gear and camshaft idler gear assembly is retained to the hub by a **left-hand threaded nut**.

The camshaft idler gear drives the camshaft drive gear through an adjustable idler gear. The adjustable idler gear is supported by a bushing and is mounted on an adjustable hub secured by three studs pressed into the gear case from the rear.

The balance shaft idler gear drives the right balance shaft gear and oil pump gear. The oil pump gear drives the left hand balance shaft, causing the balance shafts to counter-rotate.

The camshaft must be in time with the crankshaft timing gear. Since there are three gears between them, timing marks have been stamped or etched on the face of the gears to facilitate correct gear train timing. See Figure 1-270.

- [t] Before installing the rocker arm shaft assemblies, check the torque on the end studs to ensure they were not loosened at time of removal. The torque specification is 101-116 N·m (75-86 lb·ft).
- [u] Install the front and rear rocker arm shaft assemblies to the cylinder head. Install the six rocker arm shaft thru-bolts and two nuts, finger tight.
- [v] Install the rocker arms and torque the rocker arm shaft's thru-bolts and nuts to 101-116 N·m (75-86 lb·ft) using the sequence. See Figure 1-282.

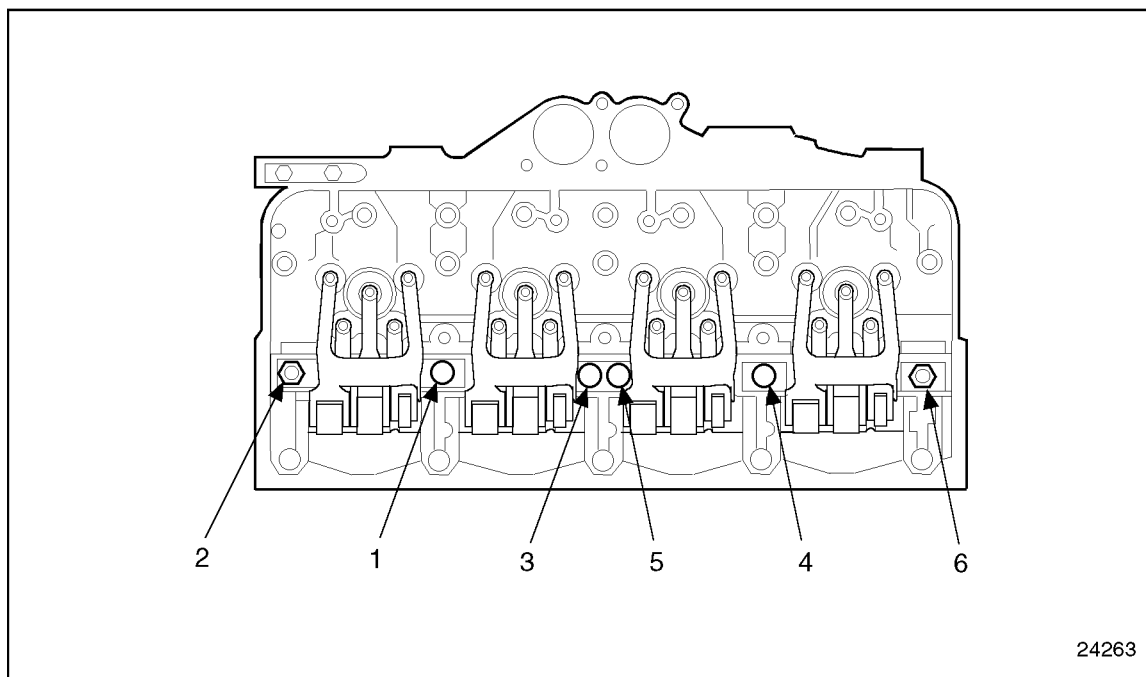


Figure 1-282 Rocker Arm Shaft Bolt and Nut Torque Sequence

- [w] Refer to Section 12.2 and adjust the intake and exhaust valve clearances, and fuel injector heights.
- [x] Install the rocker cover. Refer to Section 1.6.6.

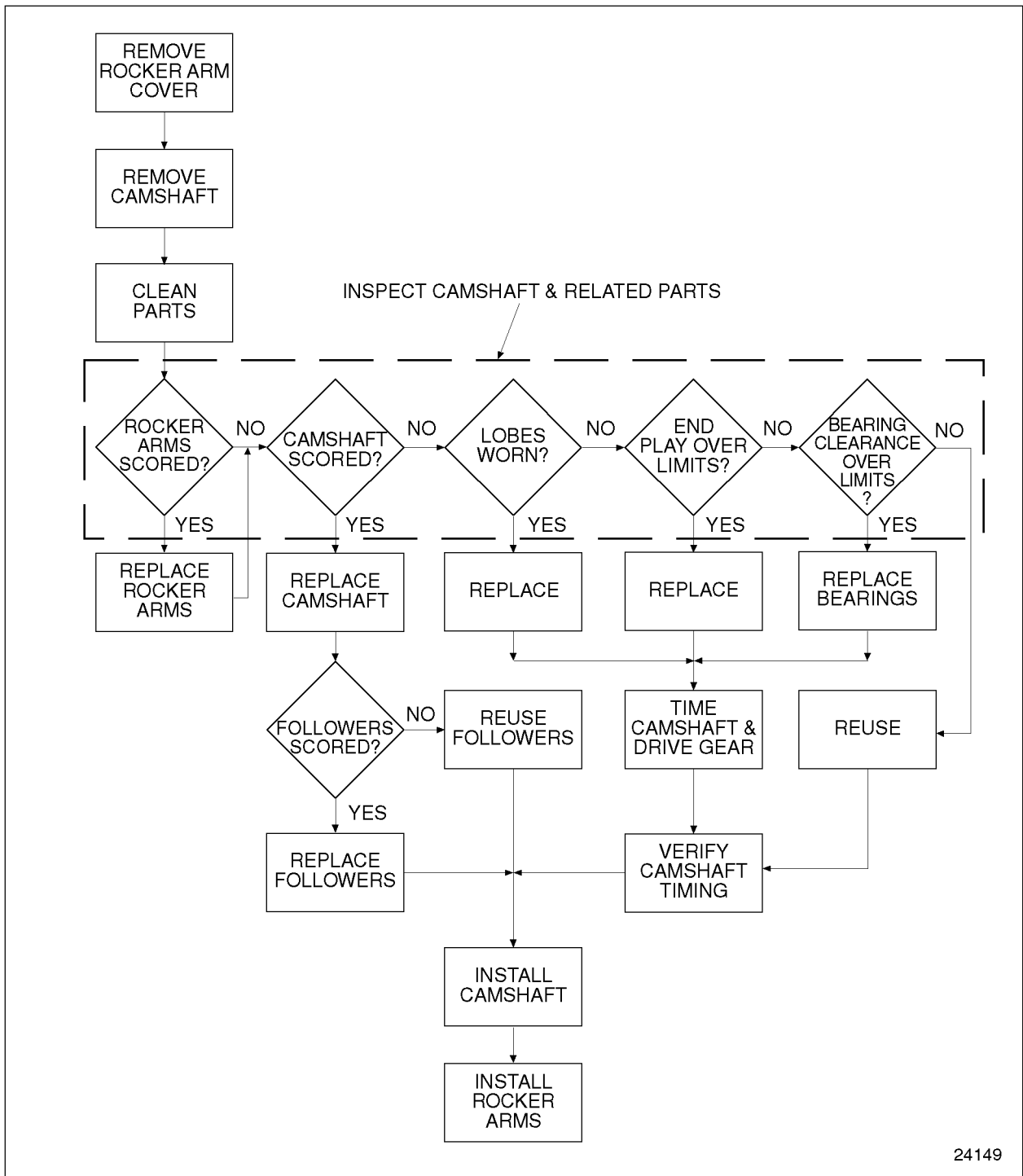


Figure 1-297 Flowchart for Repair or Replacement of Camshaft

1.22.2 Removal of Camshaft and Camshaft Bearing

Removal of camshaft and camshaft bearings as follows:

1. Remove the rocker cover. Refer to Section 1.6.2.

NOTICE:

Failure to tighten the camshaft hub retaining bolt to the required torque may result in bolt loosening during engine operation, which may lead to camshaft alignment pin damage, altered engine timing, and erratic engine operation.

23. Using a 27 mm impact socket and suitable torque wrench, torque the camshaft drive gear-to-camshaft bolt to 75 N·m (55 lb·ft). See Figure 1-310.

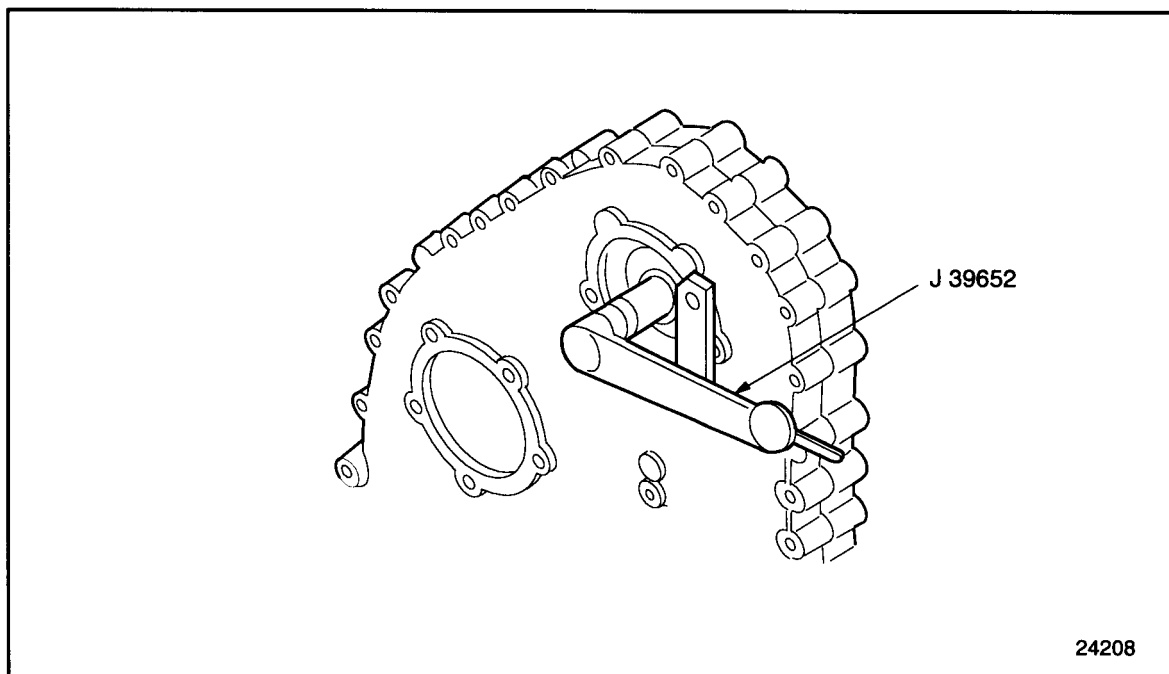


Figure 1-310 Camshaft Drive Gear-to-Camshaft Bolt Tightening

2. Wipe the groove clean after inspection.

1.23.3 Installation of Thrust Plate Perimeter Seal

Install the thrust plate perimeter seal as follows:

NOTICE:
Failure to install seals properly, failure to install new, dry (no lubrication) bolts where required, or failure to tighten bolts to the required torque using an accurately calibrated hand torque wrench may result in bolt loosening and loss of clamping load, which may cause severe engine damage.

NOTICE:
Do not use RTV or any other type of sealant on the thrust plate perimeter seal. Application of sealant will prevent proper seal crush (flow), which may result in seal leakage.

1. After passing a new perimeter seal between the thrust plate and cylinder head, carefully install it in the thrust plate groove with the ribbed edges against the sides of the groove and the beveled edge facing out.

9. Press the hub out of the camshaft drive gear until the hub separates from the camshaft thrust plate. See Figure 1-331.

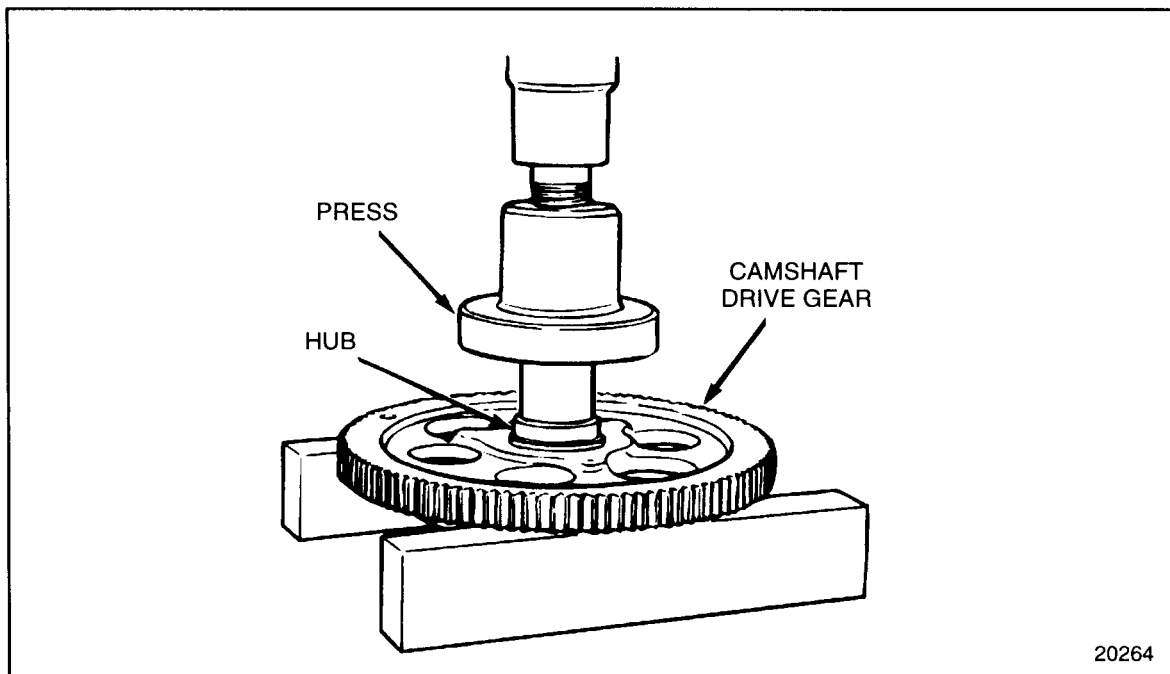


Figure 1-331 Camshaft Hub Removal

10. Remove the O-ring and seal from grooves in the camshaft thrust plate. Discard O-ring and seal.

1.24.2.1 Inspection of Camshaft Drive Gear

Inspect camshaft drive gear as follows:

1. Clean all parts with fuel oil.

⚠ CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

2. Dry them with compressed air.
3. Examine the camshaft drive gear teeth for scoring, pitting, excessive wear and cracking, peening of the Woodruff key slot.
4. If camshaft drive gear is damaged, replace drive gear.
5. Inspect the camshaft drive gear hub for scoring, pitting, galling or cracking, peening of the Woodruff key slot.

9. Looking through the inspection hole in the bull gear, align the timing marks on the camshaft idler gear (mounted to the rear of the bull gear) with the adjustable idler gear. Align the timing marks on the bull gear and crankshaft timing gear. Refer to Section 1.21. Install the bull gear hub assembly to the cylinder block. Refer to Section 1.26.3.
10. Install the gear case cover. Refer to Section 1.10.3.
11. Using the gear lash adjusting tool, J 35596, adjust the gear lash between the adjustable idler gear and camshaft drive gear. Refer to Section 1.25.3.
12. Install any other components that were removed for access to the gear case cover.

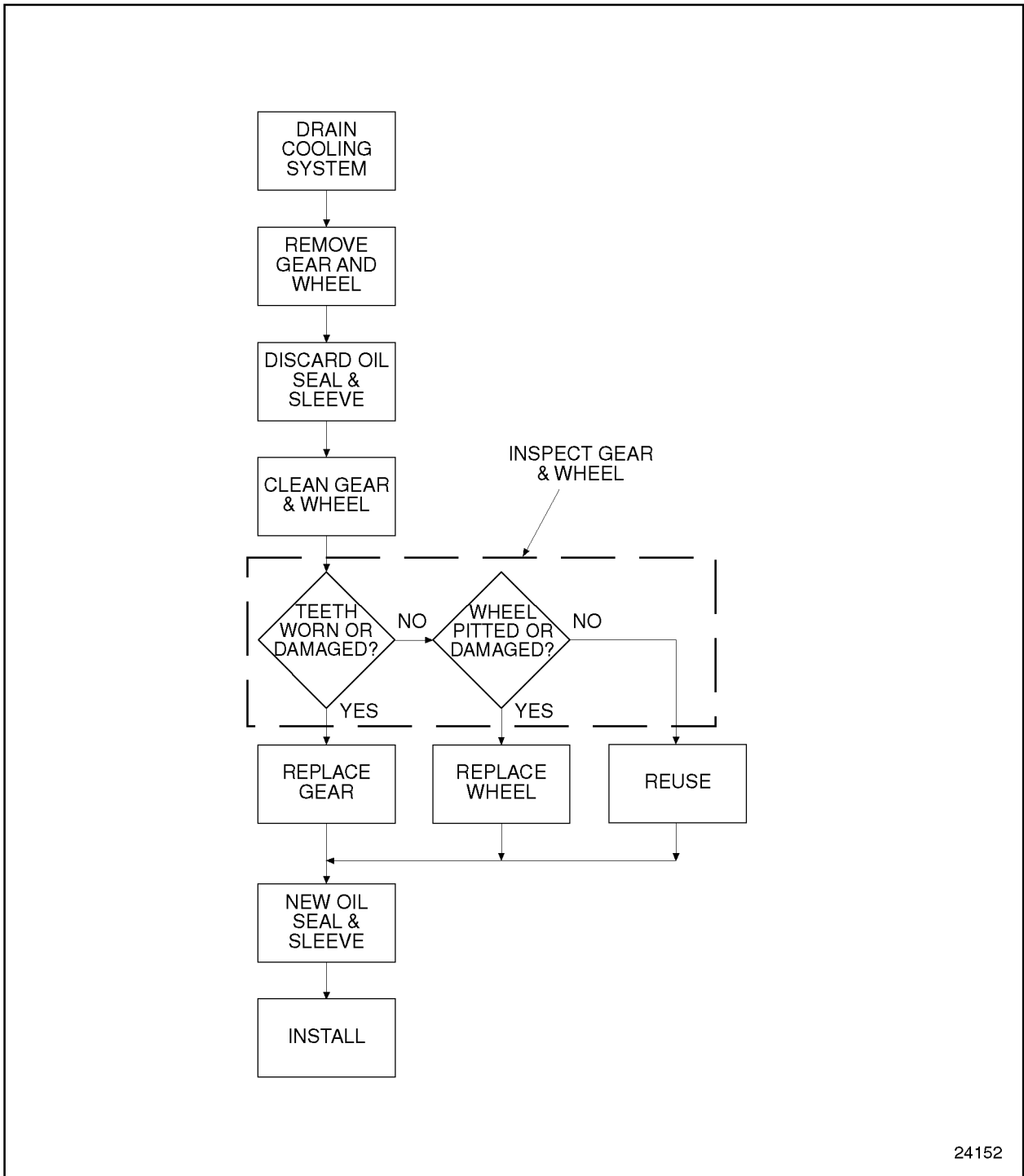


Figure 1-355 Flowchart for Repair or Replacement of Crankshaft Timing Gear and Timing Wheel

1.27.2 Removal of Crankshaft Timing Gear and Timing Wheel Removal

Remove the gear and the timing wheel as follows:

- [e] Remove the pressure plate, J 35642-4 part of J 35642, part of tool kit J 35642, from the three pulley legs.
 - [f] Remove the three legs of timing gear puller, J 35642-2 part of J 35642, part of tool kit J 35642, from the threaded holes in the crankshaft timing gear.
 - [g] Remove the base post, J 35642-1 part of J 35642, part of tool kit J 35642, and two crankshaft pulley retaining bolts from the end of the crankshaft.
13. Install the bull gear and camshaft idler gear assembly to the gear case.
Refer to Section 1.26.3.

NOTE:

Be sure to time the gears as instructed.

- 14. Install the balance assembly and outlet pipes. Refer to Section 1.28.3.
- 15. Measure the gear lash between the crankshaft timing gear and oil pump drive gear.
Refer to Section 1.21.2.1.
- 16. Measure the lash between the crankshaft timing gear and the bull gear.
Refer to Section 1.21.2.1.
- 17. Install the gear case cover. Refer to Section 1.10.3.
- 18. Install a new crankshaft seal and sleeve. Refer to Section 1.8.7.
- 19. Install the timing reference sensor (TRS). Refer to Section 2.21.3.
- 20. Install any components that were removed for access to the gear case cover.

- Spin the pump/idler gears until the "Y" letters line up. See Figure 1-382. This may require up to 20 turns.

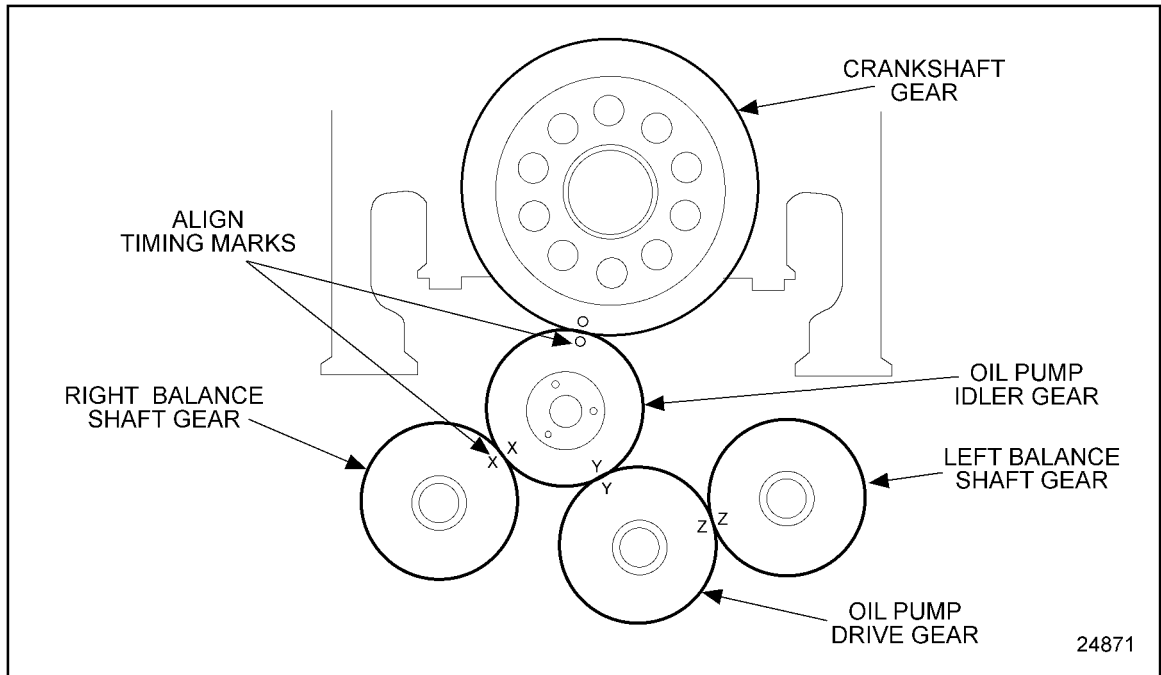


Figure 1-382 Balance Shaft Drive Gear Timing

- With the "Y's" lined up on the pump gear and idler gear, install the left and right balance shafts with the timing marks lined up as shown. See Figure 1-382.

16. Remove the snap ring from the accessory driveshaft. See Figure 1-396.

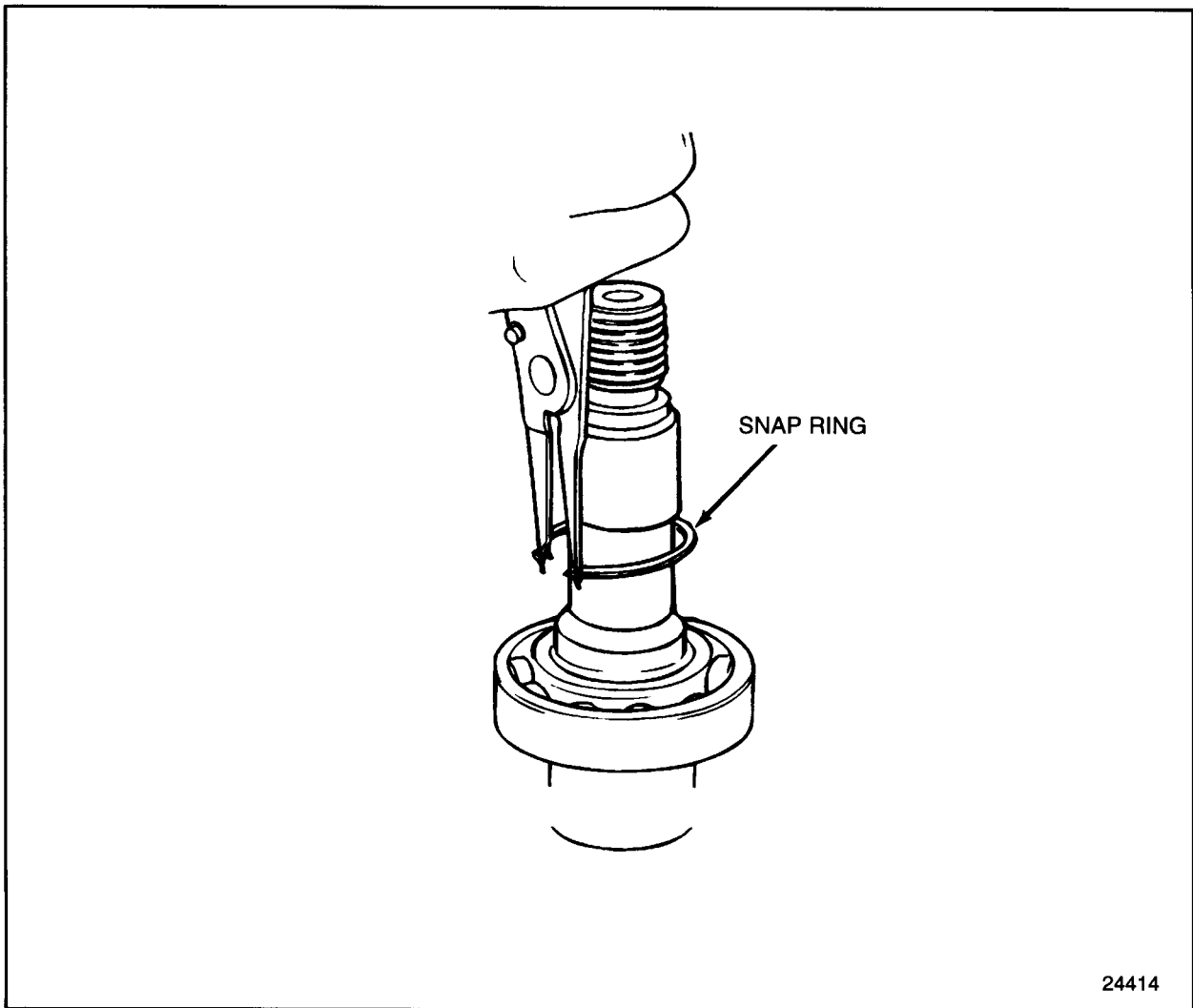


Figure 1-396 Snap Ring Removal

22. Support the accessory drive assembly. See Figure 1-411.

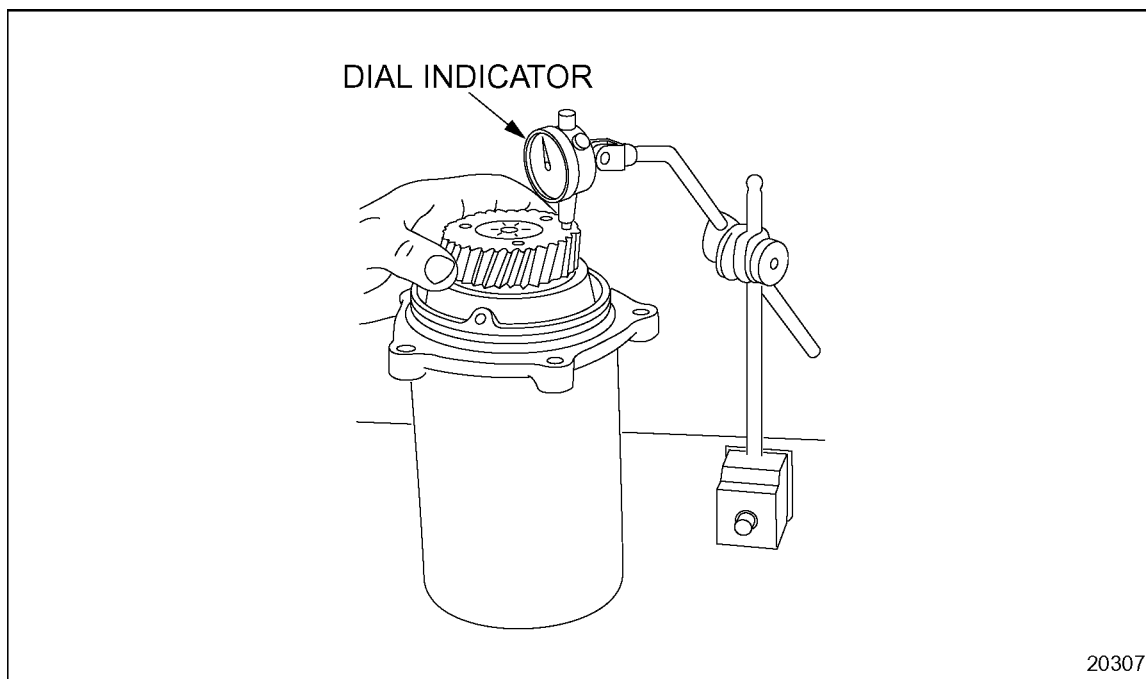


Figure 1-411 Accessory Drive Gear TIR Measurement

23. Assemble a dial indicator and magnetic base, so that the indicator stem rests on the face of the accessory drive gear just inboard of the drive gear teeth. See Figure 1-411.
24. Zero the dial indicator.
25. Rotate the drive gear two full rotations. See Figure 1-411. As the gear is rotated, the dial indicator needle may register both to the left and right of zero.
26. The total amount the dial indicator needle moves to the left and right of zero, added together, gives the total indicated run-out (TIR). Allowable TIR is 0.04 mm (0.0015 in.).

1.29.5 Installation of the Accessory Drive

Install the accessory drive as follows:

1. Install the O-ring seal in the groove on the drive housing.
2. Lubricate the O-ring with petroleum jelly.
3. Install the accessory drive housing to its original position in the gear case cover.

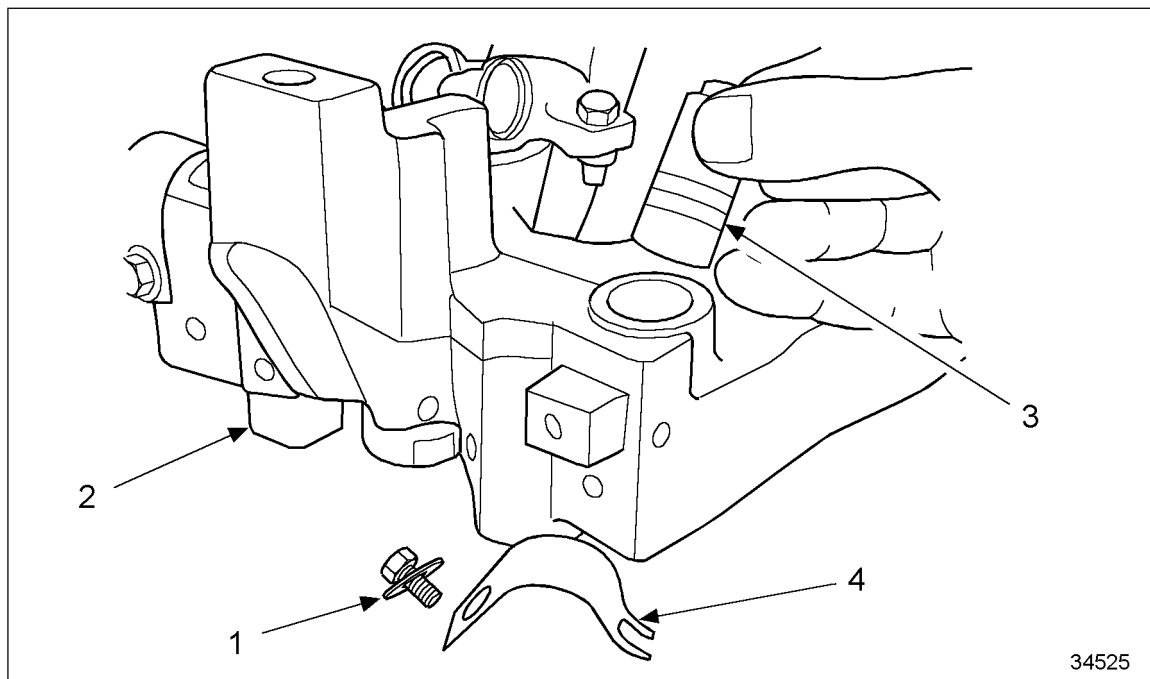
NOTE:

The word "UP" is cast into the drive housing.

2. Remove the master piston. See Figure 1-424.

NOTE:

Use needle-nose pliers, if necessary.



1. Washer and Screw Assembly

3. Master Piston

2. Jake Brake Assembly

4. Master Piston Spring

Figure 1-424 Removing the Master Piston

Remove the slave piston as follows:

1. Remove the screw and washer that retains the slave piston return spring.

1.30.5.1 Adjustment of Slave Piston

Make the following adjustment with the engine stopped and cold, and the oil temperature at 60°C (140°F) or below. The exhaust valves on the cylinder *must* be in the closed position (rocker arm roller on the base circle of the camshaft). When setting the engine brake lash, the exhaust valves must be in the closed position.

Adjust the slave piston on all models as follows:

NOTICE:

This application and adjustment information must be strictly followed. Failure to follow these instructions may result in serious engine or engine brake damage.
--

NOTE:

Model 750B Jacobs engine brake requires a special procedure for adjusting the slave piston. The procedure is clearly indicated in the following adjustment steps.

NOTICE:

Improper slave piston adjustment can result in engine or brake housing damage.
--

NOTICE:

Strictly follow the slave piston adjustment procedure. Failure to use the proper adjustment procedure will result in poor engine brake performance and/or serious engine damage.
--

1. Refer to Section 1.30 for proper slave piston clearance setting.

Grinding Main Bearing Journals

Perform the following steps for grinding main bearing journals:

1. Grind the main bearing O.D. surface to the specified undersize. The undersize conditions are 0.250, 0.500 or 0.750 mm (approximately 0.010, 0.020, or 0.030 in.) undersize.

NOTE:

Avoid localized heating, which often produces grinding cracks. Cool the crankshaft generously with coolant while grinding. Do not crowd the grinding wheel into the work.

2. ALL main bearing journals must be ground to the same undersize conditions.
3. Journal taper on a radial basis shall not exceed 0.012 (0.0005 in.) overall or exceed 0.006 mm (0.00024 in.) on half-length.

Other Machining Operations:

Perform the following steps for other machining operations:

1. Examine the thrust wall (No. 4 Main Bearing):
 - [a] If the thrust wall surface is scored, scratched or groove worn, the thrust wall must be "bump ground."
 - [b] The maximum run out of the thrust wall is 0.038 mm (0.0015 in.) TIR.
 - [c] If wear is 0.0508 mm (0.002 in.) or more, regrind to restore flatness to the thrust wall. See Figure 1-444.

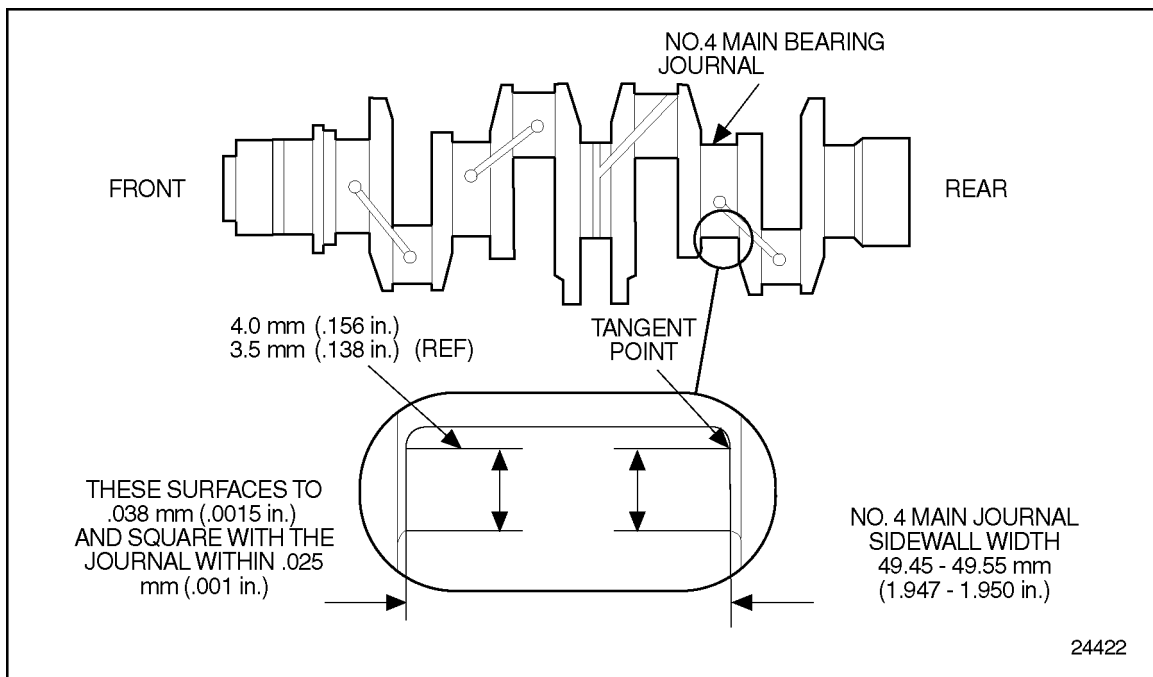


Figure 1-444 No. 4 Main Journal Thrust Wall Dimensions

Engine Part (Standard Size, New)	Minimum	Maximum	Limits
Bearing-to-Journal Clearance	0.040 mm (0.0016 in.)	0.126 mm (0.005 in.)	0.151 mm (0.006 in.)
Bearing Thickness 90° from Parting Line	3.962 mm (0.1559 in.)	3.980 mm (0.1566 in.)	3.937 mm (0.1550 in.)

Table 1-18 Main Bearing

Engine Part (Standard Size, New)	Minimum	Maximum	Limits
Diameter (bearing journals)	64.974 mm (2.558 in.)	65.000 mm (2.5559 in.)	-
Run-out at Center Bearing (when mounted on end bearings should not exceed)	-	-	0.050 mm (0.002 in.)
End Thrust	0.076 mm (0.003 in.)	0.381 mm (0.015 in.)	-

Table 1-19 Camshaft

Engine Part (Standard Size, New)	Minimum	Maximum	Limits
Bearing-to-Journal Clearance	0.090 mm (0.0035 in.)	0.166 mm (0.0065 in.)	0.191 mm (0.0075 in.)
Bearing Thickness (90° from Parting Line)	1.942 mm (0.0764 in.)	1.955 mm (0.0769 in.)	-

Table 1-20 Camshaft Bearing

Engine Part (Standard Size, New)	Minimum	Maximum	Limits
Inside Diameter:	-	-	-
Camshaft Drive Gear	52.00 mm (2.0472 in.)	52.0 mm (2.0484 in.)	-
Outside Diameter:	-	-	-
Camshaft Hub	52.10 mm (2.0511 in.)	52.03 mm (2.0523 in.)	-
* Interference (gear-to-hub)	0.07 mm (0.0027 in.)	0.13 mm (0.0051 in.)	-
Backlash (cam gear-to-adjustable idler)	0.051 mm (0.002 in.)	0.229 mm (0.009 in.)	0.305 mm (0.012 in.)

* A minimum force of 20.0 kN (4500 lb) must be obtained when pressing the camshaft drive gear to the drive gear hub.

Table 1-21 Camshaft Drive Gear

2.3 ELECTRONIC UNIT INJECTOR

The Electronic Unit Injector (EUI) is a lightweight, compact unit that injects diesel fuel directly into the combustion chamber. See Figure 2-2. The amount of fuel injected and the beginning of injection timing is determined by the ECM. The ECM sends a command pulse which activates the injector solenoid. The EUI performs four functions:

- Creates the high-fuel pressure required for efficient injection.
- Meters and injects the exact amount of fuel required to handle the load.
- Atomizes the fuel for mixing with the air in the combustion chamber.
- Permits continuous fuel flow for component cooling.

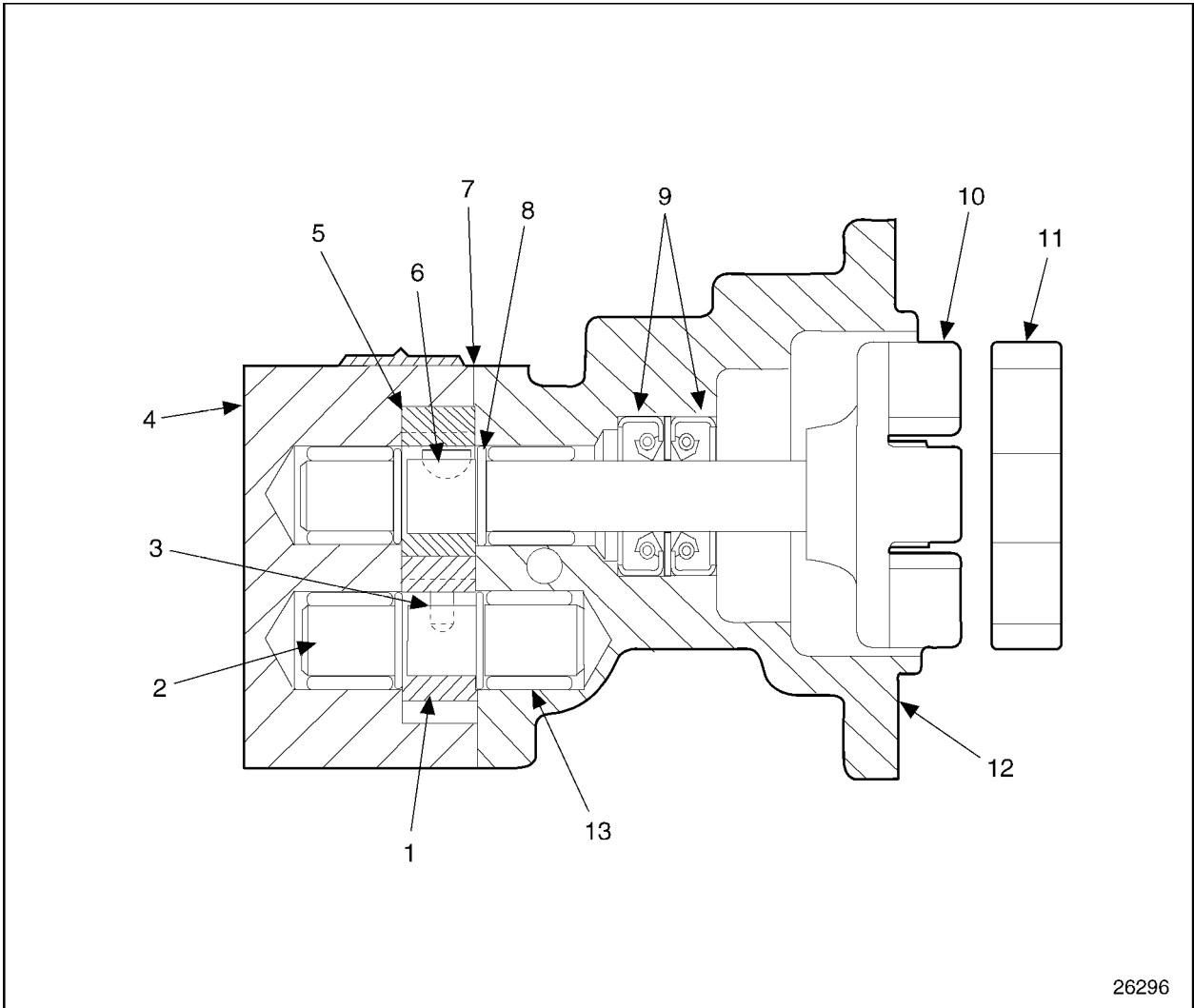
Engine combustion is obtained by injecting, under pressure, a small quantity of accurately metered and finely atomized fuel oil into the cylinder. Metering and timing of the fuel is accomplished by the ECM which actuates the solenoid poppet valve to stop the free flow of fuel through the injector. When the solenoid poppet valve closes, fuel is trapped in the injector body and under the plunger. The continuous fuel flow through the injector prevents air pockets in the fuel system and cools those injector parts subjected to high combustion temperatures.

NOTE:

Do not test new or reliable[®] remanufactured electronic unit injectors prior to installation in the engine. The Kent-Moore[®] POP stand should be only be used as a diagnostic tool on fuel injectors that have been *removed* from an engine.

6. Install the valve rocker cover. Refer to Section 1.6.6.
7. Turn the ignition on. Plug in DDR to DDL connector, and select injector calibration. View injector calibration to ensure injector calibration is correct for each cylinder. If not correct, select update injector calibration and set correctly.

The positive displacement gear-type fuel pump is seen in the next illustration. See Figure 2-28, for improved fuel pump or See Figure 2-29, for former fuel pump.



- | | |
|-----------------|----------------------------------|
| 1. Driven Gear | 8. C-clip |
| 2. Driven Shaft | 9. Oil Seals |
| 3. Pin, Drive | 10. Drive Shaft and Hub Assembly |
| 4. Cover | 11. Coupling |
| 5. Drive Gear | 12. Pump Body |
| 6. Key | 13. Needle Bearing |
| 7. Gasket | |

Figure 2-28 **Current Compressor-Mounted Fuel Pump Assembly with One-piece Drive Shaft and Hub Assembly**

seals until it contacts the bench. See Figure 2-40. Approximately 3 mm (1/8 in.) of the open end of the protector should remain above the inner seal.

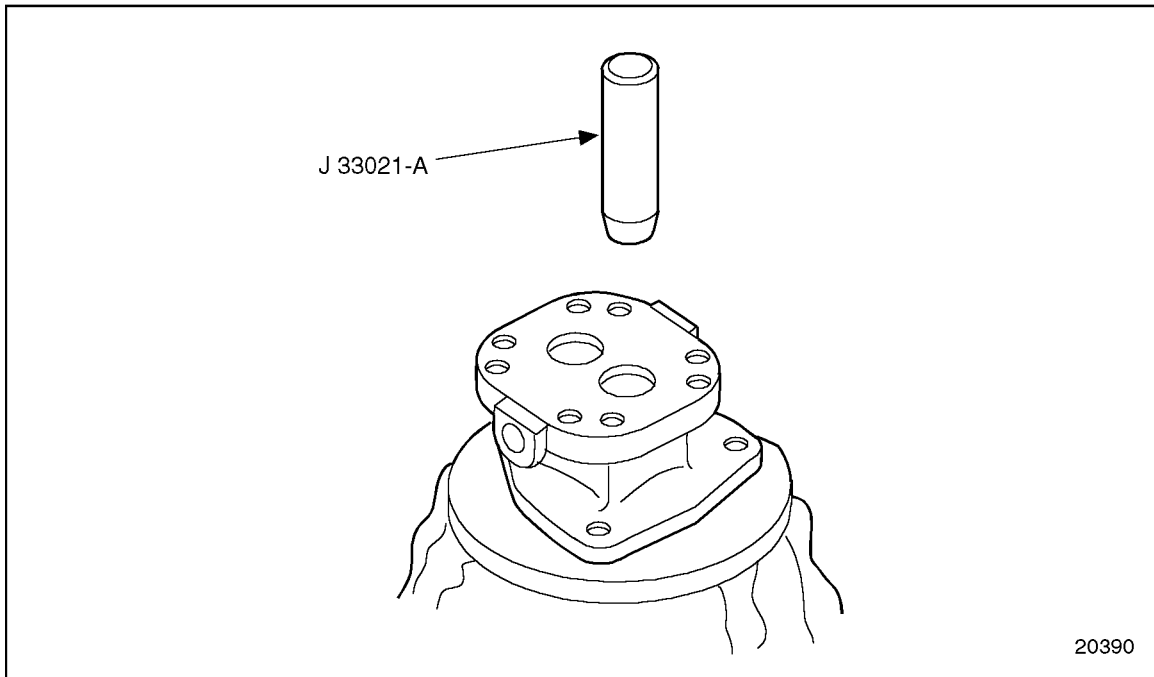


Figure 2-40 Seal Protector Installation

17. Install a new needle bearing assembly in the drive shaft bore. See Figure 2-41.

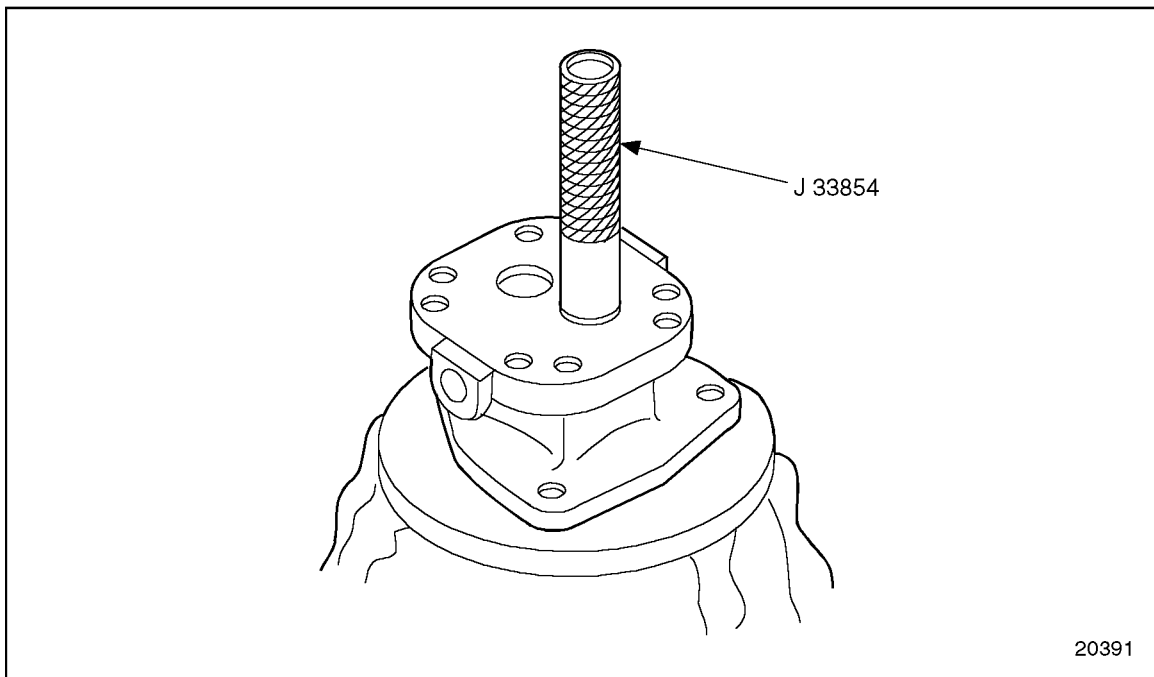


Figure 2-41 Drive Shaft Bearing Installation

2.8.3 Removal of PRO-CHEK[®] Fuel System Check Valve

Remove the valve as follows:

NOTICE:
The PRO-CHEK [®] fuel system check valve is installed after the secondary filter. Any dirt or debris entering the fuel system at this point may cause severe injector damage.

1. Clean the area around the PRO-CHEK[®] valve thoroughly to remove loose dirt or debris.
2. Disconnect the fuel supply and return lines from the bottom of the valve and cap the hoses immediately to prevent the entrance of dirt.
3. Disconnect the air purge line from the top elbow on the valve and cap the line to prevent the entrance of dirt.
4. Remove the valve and bracket assembly from the engine as follows:
 - [a] If rear mounted, remove the two 12 mm bolts securing the valve to the rear lifter bracket.
 - [b] If side mounted, remove the two 10 mm bolts and spacers holding the valve to the cylinder head.

2.8.3.1 Inspection of the PRO-CHEK[®] Fuel System Check Valve

Inspect the PRO-CHEK[®] fuel system check valve as follows:

1. Visually inspect exterior casing of the PRO-CHEK[®] valve for cracks, leaks, or other signs of damage.
 - [a] If the PRO-CHEK[®] valve has no cracks, leaks, or other signs of damage, reuse the valve.
 - [b] If the PRO-CHEK[®] valve has cracks, leaks, or other signs of damage, replace the valve.

2.8.4 Installation of PRO-CHEK[®] Fuel System Check Valve

Install the PRO-CHEK[®] valve as follows:

1. Mount the PRO-CHEK[®] valve on the side or rear of the Series 50 engine.

2.11.2 Removal of the DDEC III ECM

Perform the following steps for ECM removal:

1. Carefully disengage the lock tab on the power harness and injector harness connectors.
2. Remove the two wire and three wire harness connections at the ECM.
3. Remove the thru-bolts holding the ECM to the engine.
4. Remove the ECM and cold plate from the engine, if so equipped.
5. Remove the screws securing the cold plate to the ECM. Remove the cold plate from the ECM, if so equipped.

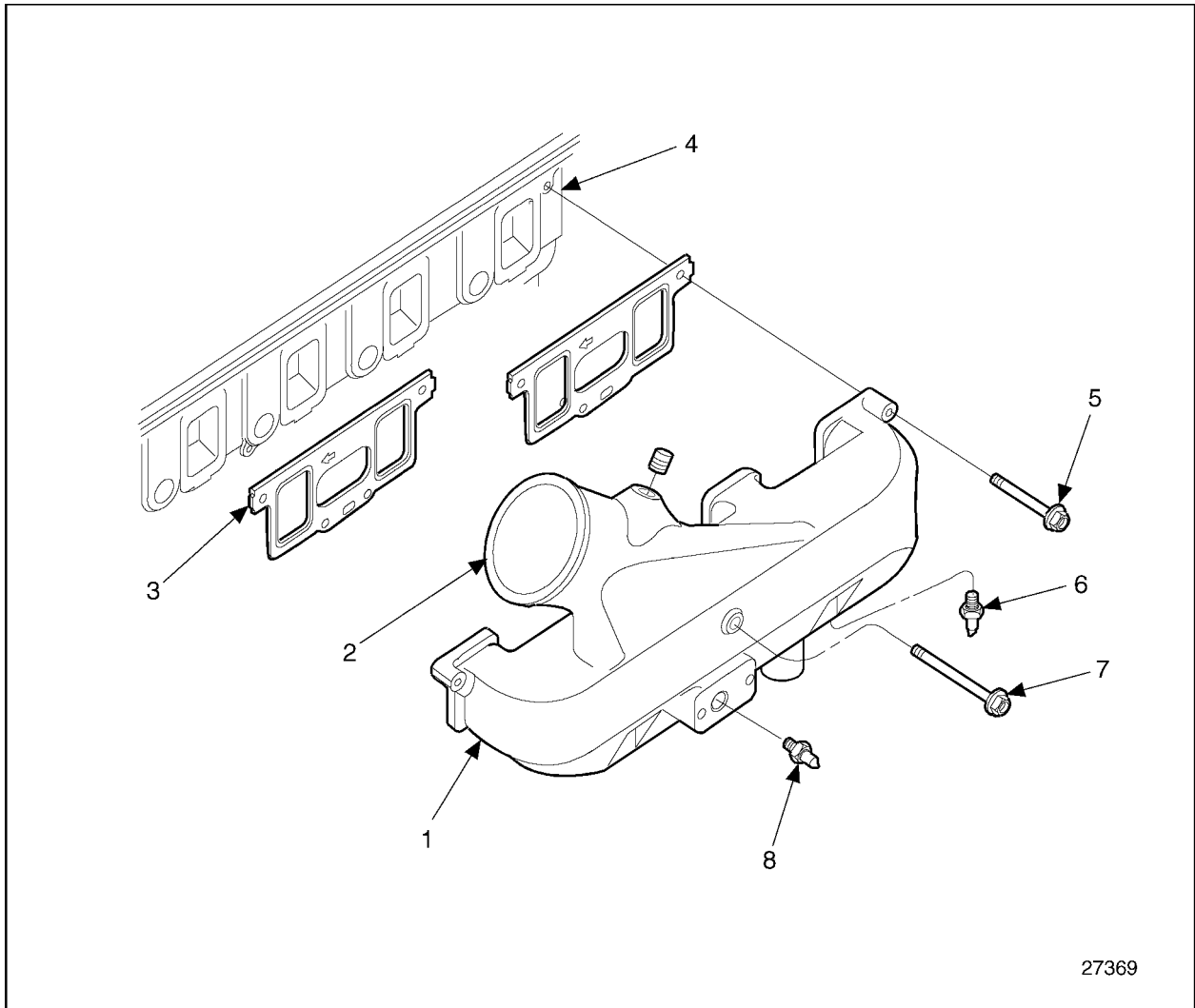
2.11.3 Installation of the DDEC III ECM

Perform the following steps for ECM installation:

1. Install the cold plate on the ECM, if so equipped. Tighten the screws securing the cold plate to the ECM. Use Loctite 262, or equivalent, on the cold plate-to-ECM screws. Torque to 9.5-12 N·m (84-106 lb· in.).
2. Inspect the ECM isolators for damage and replace if required.
3. Mount the ECM and cold plate to the engine.
4. Secure the ECM to the engine with thru-bolts. Torque the ECM-to-engine bolts to 23-27 N·m (17-20 lb·ft). Torque the ECM connector hold-down screws to 2.4-3.0 N·m (22-28 lb· in.).
5. Install the connectors in the ECM and torque the jack screws to 2.49-3.16 N·m (22-28 lb·in.).
6. Engage the lock tab on the power harness and injector harness connectors.
7. Turn the ignition to the "ON" position. Observe or read any diagnostic codes. If any code except code 25 is obtained, refer to the Detroit Diesel *DDEC III/IV Single ECM Troubleshooting Manual*, 6SE497.

2.15 TURBO BOOST PRESSURE SENSOR FOR THE SERIES 50G ENGINES

The Turbo Boost Sensor (TBS) is threaded into the intake manifold. See Figure 2-66. The Series 50G natural gas engines use a wide range sensor that allows pressure measurement under conditions of either manifold vacuum or boost.



- | | |
|---------------------------|---------------------------|
| 1. Intake Manifold | 5. Bolt |
| 2. Intake Manifold Inlet | 6. Air Temperature Sensor |
| 3. Intake Manifold Gasket | 7. Bolt |
| 4. Cylinder Head | 8. Turbo Boost Sensor |

Figure 2-66 Turbo Boost Pressure Sensor Series 50G

This device is a pressure sensor that sends an electrical signal to the ECM. The ECM uses this information to compute the amount of air entering the engine. Fuel supply is regulated by the TBS information to control engine air fuel ratio. The TBS information is also used to control ignition timing.

1. Open the drain cock at the bottom of the radiator and drain the coolant into an appropriate container. Remove only as much coolant as is necessary to clear the CLS probe.
2. Remove ground wire screw and ground wire from side of probe. Loosen and remove nut from sensor lead of probe. Remove sensor lead, or unplug the two-pin connector.
3. Use the appropriate wrench on the hex portion of the sensor and unscrew it from the radiator.

2.22.3 Installation of Cooling Reference Sensor

Install the CLS probe as follows:

1. Use the appropriate wrench on the hex portion of the sensor and screw it into the radiator.
2. Install ground wire screw and ground wire from side of probe. Install and tighten nut from sensor lead of probe. Install sensor lead, or unplug the two-pin connector.
3. Close the drain cock at the bottom of the radiator.
4. Refer to Section 4 and fill the cooling system.
5. Turn the ignition to the "ON" position. Observe or read any diagnostic codes. If any code other than 25 appears, refer to the *DDEC II Troubleshooting Guide*, 6SE489, or *DDEC III/IV Single ECM Troubleshooting Guide*, 6SE497.



CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- Always start and operate an engine in a well ventilated area.**
- If operating an engine in an enclosed area, vent the exhaust to the outside.**
- Do not modify or tamper with the exhaust system or emission control system.**

6. Start the engine and check for leaks.

2.22.4 Removal of Cooling Reference Sensor Module

Remove the CLS module as follows:

1. Disengage the locking tang on the CLS module connector. Grasp the connector bodies and gently pull them apart.
2. Remove module from vehicle.

2.28 OVERVIEW OF THE HIGH PRESSURE FUEL SYSTEM FOR THE SERIES 50G AUTOMOTIVE ENGINE (PRE 1998)

The purpose of the fuel system is to store the fuel, keep it clean and free from air, water, or other impurities and to deliver it to the combustion chamber at the correct pressure, temperature, air and fuel mixture. The Series 50G engine requires an adequate fuel supply for proper performance and to develop full rated power. This section describes the function requirements for the Detroit Diesel Series 50G high pressure natural gas fuel system.

The following are DDC supplied parts:

- Gas Mixer
- Compuvalve
- GFI pressure regulator
- Hose from compuvalve to Gas Mixer

The following are OEM supplied parts and are not serviced by Detroit Diesel:

- Tescom regulator
- Fuel tank
- Line from tank to regulator
- GFI pressure regulator bracket
- Fuel filters and brackets
- Hose from regulator to coalescing fuel filter
- Manual gas shutoff valve
- DDEC controlled shutoff valve
- Pressure gages
- Vehicle vent system
- Hose from coalescing fuel filter to compuvalve. See Figure 2-84 and see Figure 2-85.

The Series 50G spark ignited natural gas engine utilizes both Detroit Diesel Electronic Controls (DDEC) and the Gaseous Fuel Ignition (GFI) system to provide engine control. DDEC provides ignition timing, throttle position, and engine protection. The GFI system provides control and metering of the natural gas, based on input from sensors mounted directly on the engine.

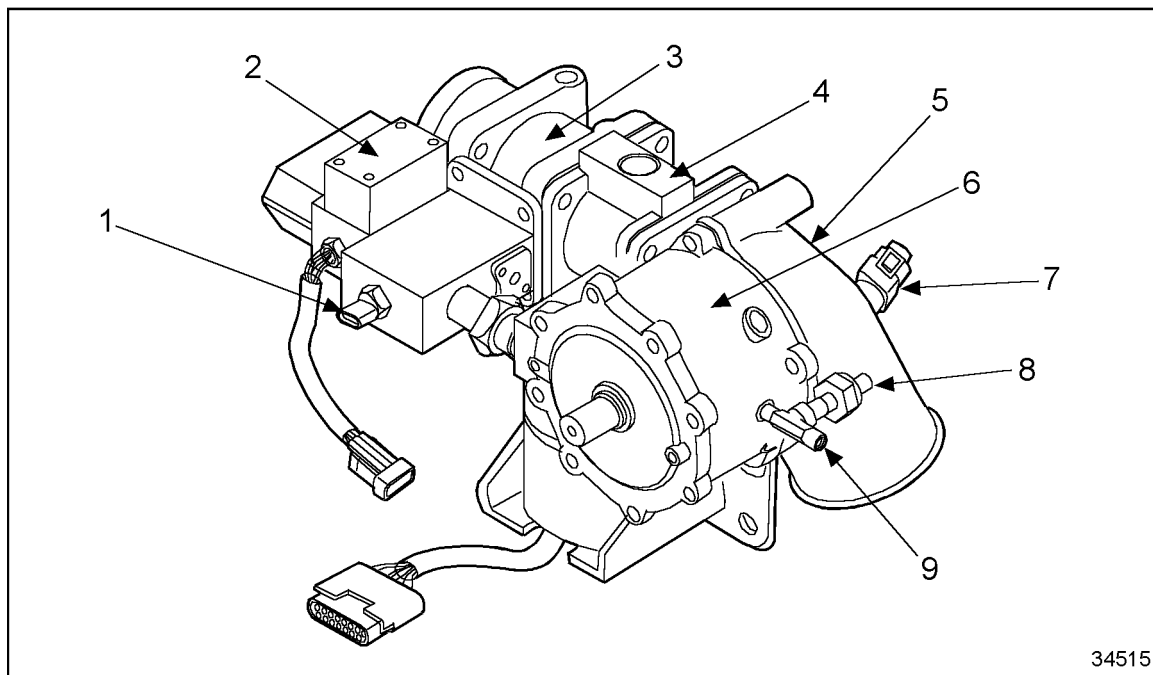
The fuel system uses computer calculations for both fuel flow and air flow, and maintains a lean air - fuel mixture for low emissions and good fuel economy. Calculations are based on knowing the temperature and pressure of the air and fuel. The manifold absolute pressure (MAP), barometric absolute pressure (BAP), fuel absolute pressure (FAP), and fuel regulated temperature (FRT) are sensors internally located in the metering valve. The intake air temperature (IAT) sensor is mounted in the intake tube between the throttle and the air intake manifold. The additional oil temperature sensor (OTS) (displayed as MST on GFI fuel monitor) that is used by the fuel system is located in the left rear of block a few inches above the current DDEC oil temperature sensor.

2.28.1 Compressed Natural Gas Fuel System

The Series 50G engine has been designed for operation with two types of high pressure fuel systems, either compressed natural gas (CNG) or liquefied natural gas (LNG).

2.33 FUEL MIXER FOR THE SERIES 50G HIGH PRESSURE SYSTEM 1998 AND LATER

The venturi fuel mixer assembly consists of a die cast aluminum body with a spun aluminum venturi permanently inserted into it. The unit has no moving parts. The mixer assembly is attached to the throttle located at the left front of the engine. See Figure 2-91.



- | | |
|----------------------------|---------------------------|
| 1. Fuel Temperature Sensor | 5. Air Inlet Elbow |
| 2. PSV | 6. Low Pressure Regulator |
| 3. Fuel Mixer | 7. Air Temperature Sensor |
| 4. Throttle | 8. Fuel Pressure Sensor |
| | 9. Fuel Inlet Tee Fitting |

Figure 2-91 Fuel Mixer for the Series 50G

2.33.1 Replacement of Fuel Mixer for the Series 50G Engine

The fuel mixer is non-serviceable and should be replaced as a unit. No adjustment is required.

2.33.2 Removal of Fuel Mixer for the Series 50G Engine

Remove the fuel mixer as follows:

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2.38.1 Replacement of Pulse Width Modulated Stepper Motor Valve for the Series 50G Engine

The PSV is non-serviceable and should be replaced as a unit. No adjustment is required.

2.38.2 Removal of Pulse Width Modulated Stepper Motor Valve for the Series 50G Engine

Remove the PSV as follows:

 **CAUTION:**

To avoid injury from the explosion of natural gas, the engine must be kept in a well-ventilated area away from open flames, sparks, and electrical resistance (heating) coils.

1. Vent fuel system, refer to Section 2.43.
2. Disconnect the seven wire connector from the engine sensor wiring harness.
3. Remove the four bolts connecting the PSV to the fuel mixer.
4. Slide the PSV forward to separate from the connecting tube.

2.38.3 Installation of Pulse Width Modulated Stepper Motor Valve for the Series 50G Engine

Install the PSV as follows:

1. Lubricate connector O-rings and PSV O-ring.
2. Loosen bolts attaching fuel mixer to throttle.

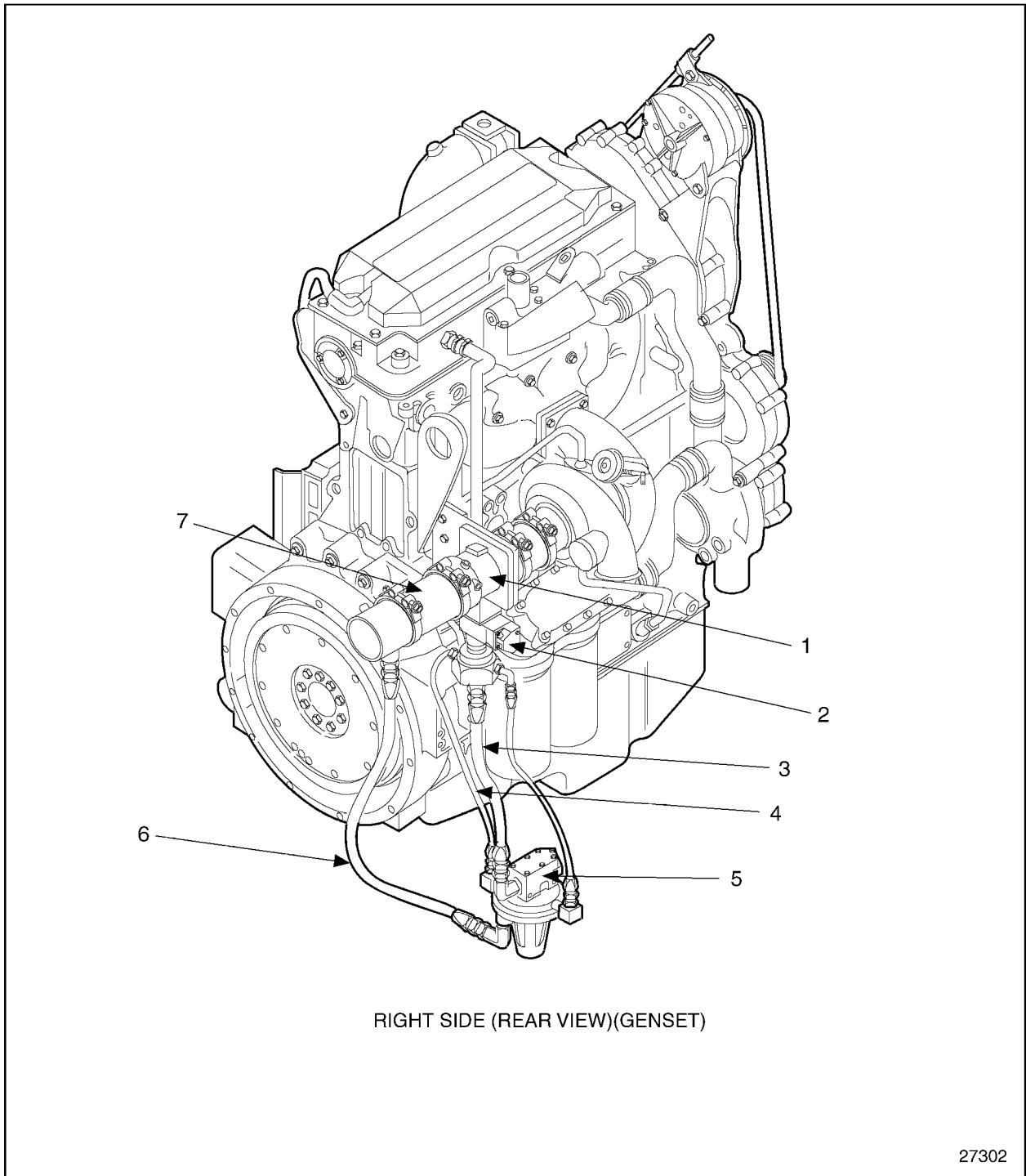
NOTE:

The bolt holes in the throttle are slotted to allow adjustment to align the PSV with the connector tube in the low pressure regulator.

3. Position PSV against mixer with O-ring in place and align gas inlet port with connector. Slide rearward to engage connector until bolts holes are aligned.
4. Secure PSV to the fuel mixer with four bolts and torque to 20 N·m (15 lb·ft).
5. Tighten fuel mixer to throttle attaching bolts.

2.42 FUEL MIXER FOR THE SERIES 50G LOW PRESSURE SYSTEM

The venturi fuel mixer assembly consists of a die cast aluminum body with a spun aluminum venturi permanently inserted into it. The unit has no moving parts. The mixer assembly is attached to support brackets and located at the right rear of the engine. See Figure 2-99.



4. Route hoses at least 6 in. away from high energy spark ignition wires to avoid electrical noise following hoses into wire harnesses or computer.
5. Route hoses at least 3 in. away from moving vehicle parts (e.g. fan belts).
6. Do not route hose against sharp edges or in an area where hose may rub or vibrate against vehicle parts.
7. Route hoses such that there is a minimum 2 in. clearance when the cab or rear engine compartment door is closed.
8. Secure all hoses with clips.

Install the fuel hoses as follows:

NOTICE:

Do not cut hoses so that installation and/or vehicle operation creates hose strain that may cause hoses to pull from fittings or otherwise rupture.

1. Determine the proper routing as described previously.
2. Remove protective caps and covers from fittings and ports.
3. Thoroughly clean any dirt and debris from threads of fittings and sealing surfaces.

NOTICE:

Do not scratch or mar sealing surfaces. Scratches can cause poor seals and subsequent gas leaks.
--

4. Connect the fitting nut into port threads and position hose as desired. Hand tighten nut.

NOTE:

When tightening the nut, fitting and hose may "travel" clockwise. Position hose and fitting a few degrees counter clockwise from desired position.

5. Torque nut. Do not over tighten. Torque specifications are listed in Table 2-9.

3 LUBRICATION SYSTEM

Section	Page
3.1 OVERVIEW OF LUBRICATING SYSTEM	3-3
3.2 OIL PUMP	3-8
3.3 OIL PRESSURE REGULATOR VALVE	3-20
3.4 OIL PRESSURE RELIEF VALVE	3-27
3.5 OIL FILTER	3-31
3.6 OIL FILTER ADAPTOR	3-33
3.7 OIL COOLER	3-38
3.8 OIL LEVEL DIPSTICK ASSEMBLY	3-46
3.9 OIL PAN	3-50
3.10 VENTILATING SYSTEM	3-55

1. Press cups in idler gear to snap ring.

NOTE:

Tool J 39769 is a holding tool only. Do not torque.

2. Install the idler gear, shaft, and tapered roller bearings cone and spacer in the pump housing.
3. Align the teeth of the idler gear, so that the "Y" on the gear and the "Y" on the drive gear are aligned.
4. Using tool J 39769, hold the shaft in place, and torque the left-hand threaded bolt to 199-231 N·m (147-170 lb·ft).
5. Check the gear lash between gears. Lash should read 0.051-0.203 mm (0.002-0.008 in.). See Figure 3-10.

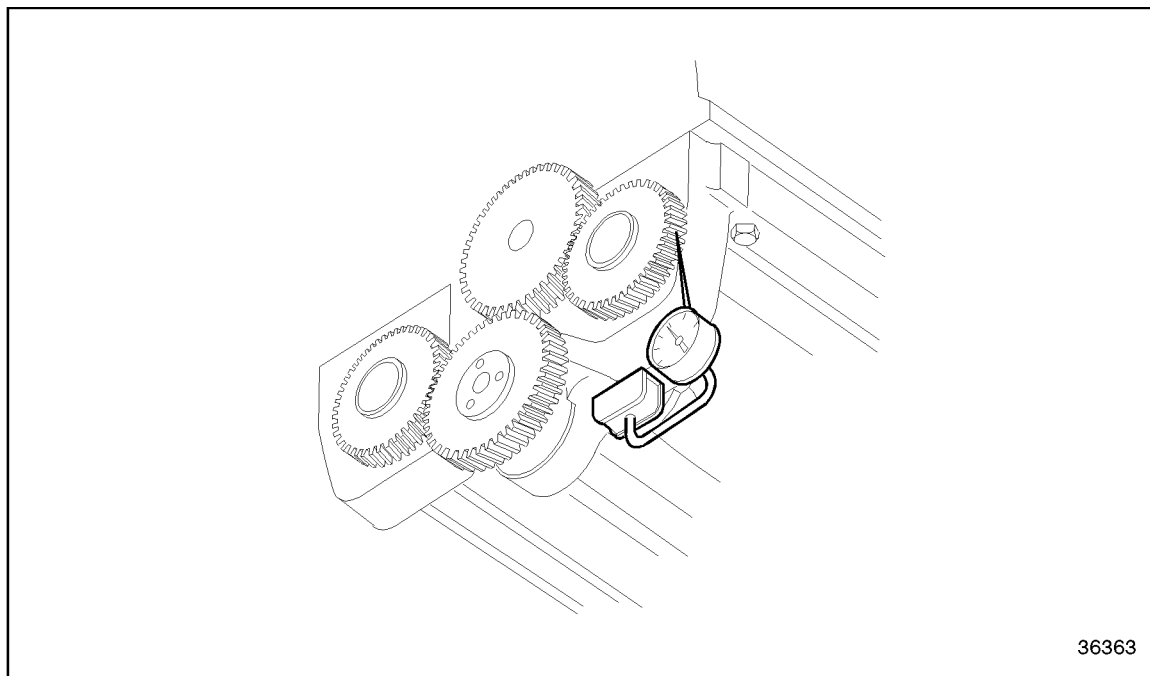


Figure 3-10 **Checking Gear Lash**

3.2.5 **Installation of Oil Pump**

Perform the following steps to install the oil pump:

3.6 OIL FILTER ADAPTOR

The oil filter adaptor is located on the right side of the engine and is joined to the oil cooler.

A bypass valve in the filter adaptor opens at approximately 124-145 kPa (18-21 lb/in.²) pressure differential, and will bypass the oil filters should the full flow filters become plugged.

3.6.1 Repair or Replacement of Oil Filter Adaptor

To determine if repair is possible or replacement is necessary, perform the following procedure. See Figure 3-20.

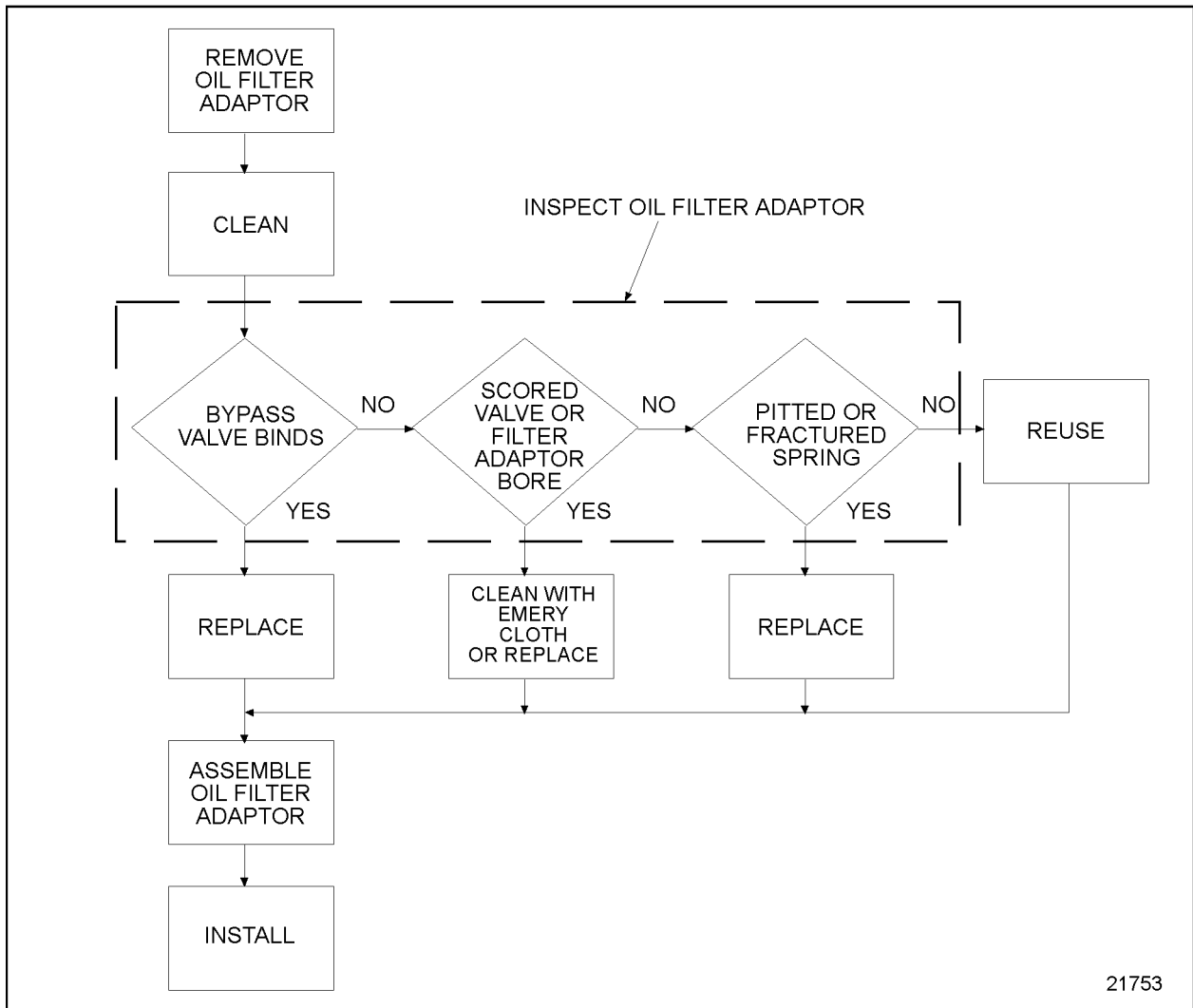


Figure 3-20 Flowchart for Repair or Replacement of Oil Filter Adaptor

3.6.2 Cleaning and Removal of Oil Filter Adaptor

Precleaning is not necessary.

3.8.2.1 Inspection of Oil Dipstick Assembly

Inspect oil dipstick assembly as follows:

1. Inspect dipstick assembly for any damaged parts.
 - [a] Check components for any broken or pinched parts.
 - [b] If any components are damaged, replace with new parts.

3.8.3 Installation of Oil Dipstick Assembly

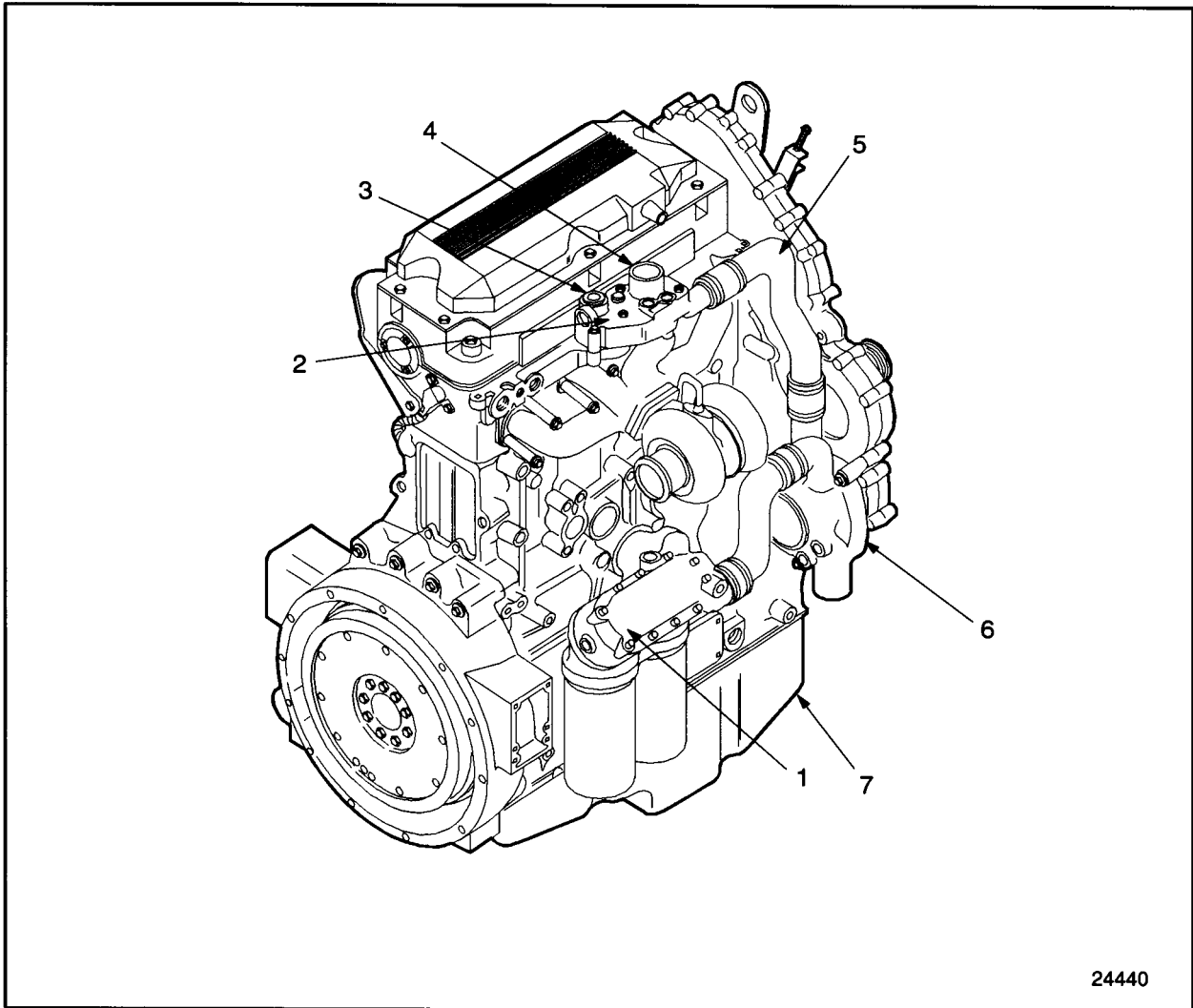
Assemble oil dipstick assembly as follows:

1. Install dipstick adaptor onto cylinder block. Torque to 22 N·m (16 lb·ft).
2. Insert the new copper seal and thread the oil gage tube assembly nut into the adaptor.
3. While holding the adaptor with a wrench, properly align the oil gage tube assembly.
4. Tighten the nut on the tube securely.
5. Install dipstick into tube assembly.

4.1 COOLING SYSTEM OVERVIEW

The cooling system consists of the following components (see Figure 4-1):

- Water pump
- Pressure control cap
- Thermostat
- Engine coolant fan
- Coolant filter and conditioner
- Radiator



- | | |
|-------------------------------|----------------------|
| 1. Oil Cooler Housing | 5. Water Bypass Tube |
| 2. Thermostat Housing | 6. Water Pump |
| 3. Vent Line Outlet | 7. Oil Pan |
| 4. Water Outlet (To Radiator) | |

Figure 4-1 Cooling System Operation

4. Install the extension tool, J 35988-3A part of tool set J 35988-B , on the end of the water pump shaft. Install the assembled bearing packs to the drive shaft. See Figure 4-13.

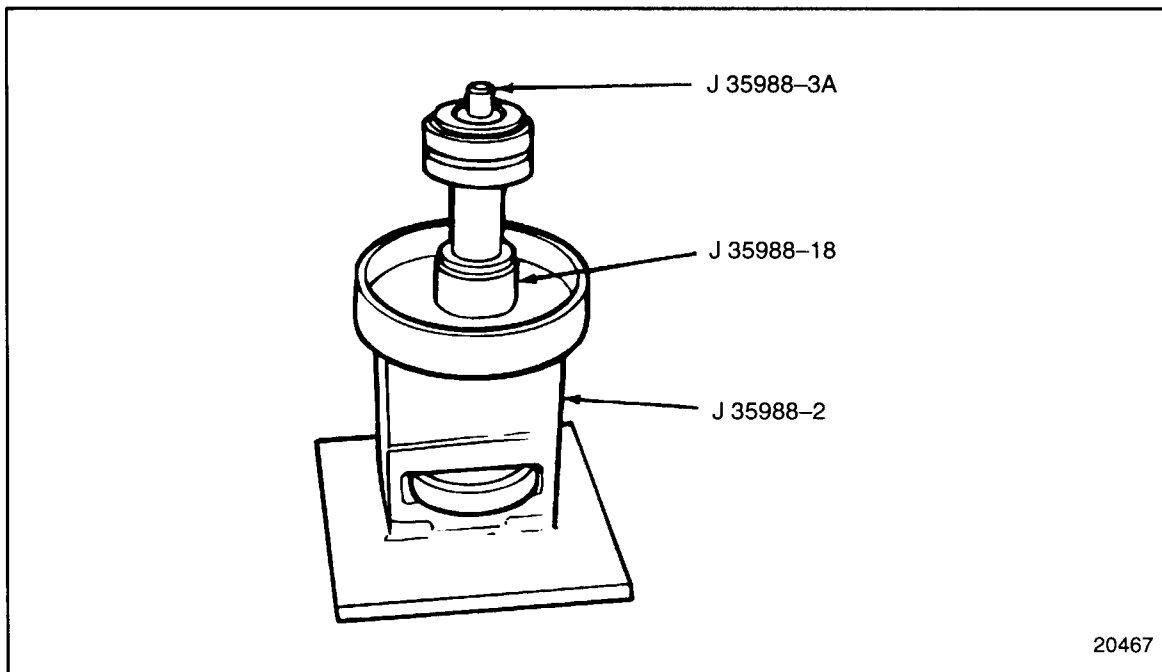


Figure 4-13 **Bearing Placement**

NOTICE:

If the gear has a press fit, turn the adjustor wheel to raise the extension J 35988-3A, part of tool set J 35988-B, until it contacts and supports the shaft. This is necessary to prevent damage to the bearings when pressing the gear onto the shaft.

23. Using the small end of tool J 35988-1 part of J 35998-B, part of tool set J 35988-B, press the drive gear down onto the drive shaft until it touches the bearings. See Figure 4-29.

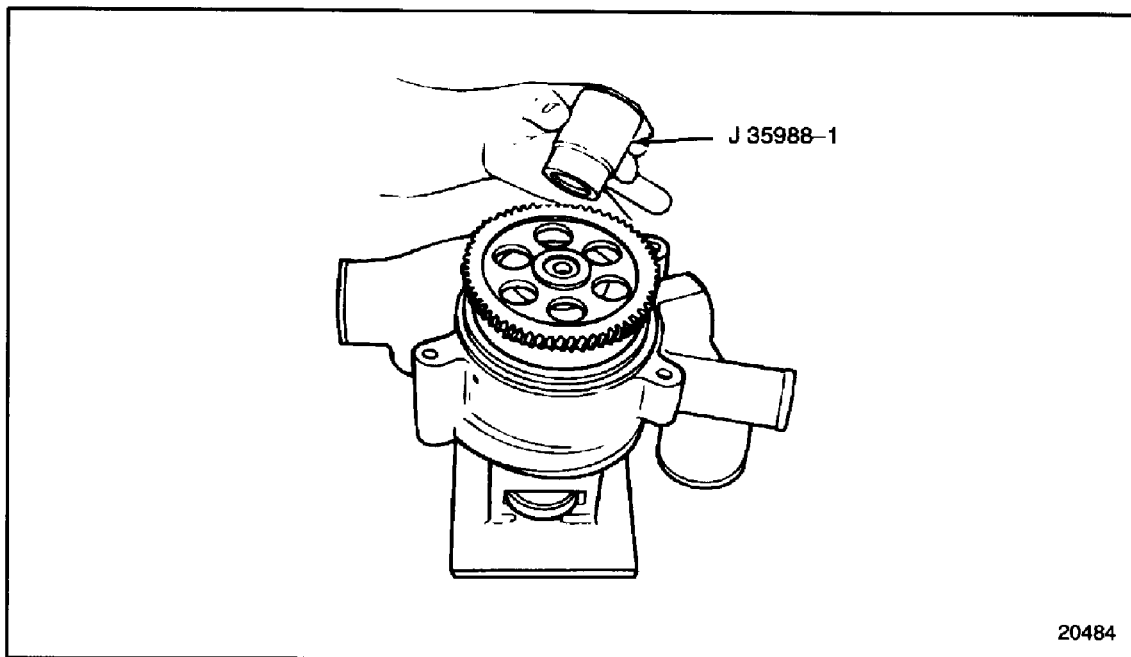


Figure 4-29 Water Pump Drive Gear Installation

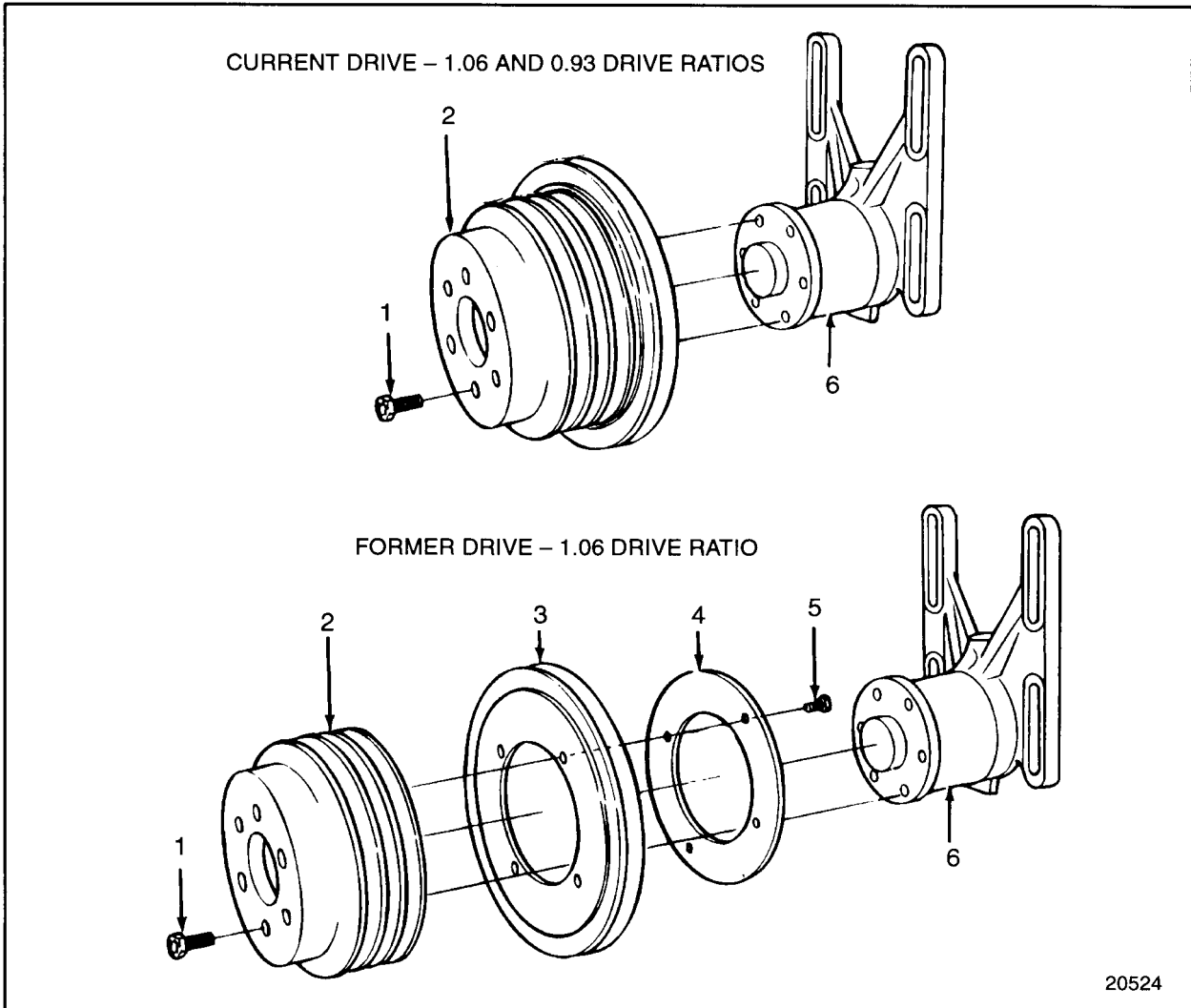
24. Install the retaining bolt and washer. Hold the square end of the drive shaft and torque the retaining bolt to 102-126 N·m (75-93 lb·ft).

4.2.5.1 Assembly Integrity Test

Verify the assembly integrity as follows:

1. Turn the pump over and install the water pump impeller slip and lash tester, J 35687, into the tapped holes provided in the impeller.

The three-groove pulley hub uses a matched set of three drive belts. On some units equipped with an air conditioning compressor, an additional pulley and retaining plate are attached to the three-groove pulley. See Figure 4-42.



- | | |
|--|-------------------------------------|
| 1. Bolt, Fan Retaining (6) | 4. Retaining Plate |
| 2. Fan Pulley | 5. Bolt, Air Conditioning Retaining |
| 3. Drive Pulley, Air Conditioning Compressor | 6. Fan Hub Assembly |

Figure 4-42 Air Conditioning Compressor Drive Pulley and Related Parts

Whenever it is necessary to replace one of the crankshaft pulley-to-fan hub drive belts, all three belts must be replaced as a matched set. Refer to Section 13.5.7 for belt adjustment or replacement information.

5.1 FUEL

The quality of fuel used is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels. The Series 50 engine was designed to operate on most diesel fuels marketed today. In general, fuels meeting the properties of ASTM Designation D 975 (Grades 1D and 2D) have provided satisfactory performance. The ASTM D 975 specification, however, does not in itself adequately define the fuel characteristics necessary to assure fuel quality. The properties listed in Table 5-1, Diesel Fuel Specification table, provide optimum engine performance.

General Fuel Classification	ASTM Test	No. 1-D	No. 2-D#
API Gravity, @ 60° F*	D 287	40 - 44	34 - 38
Specific Gravity, @ 60°F*	D 1298	0.806 - 0.825	0.835 - 0.855
Flash Point, °C, Minimum	D 93	38	52
Viscosity, Kinematic - cSt @ 40°C	D 445	1.3 - 2.4	1.9 - 4.1
Sulfur wt% Maximum for On-Road Use ‡	D 2622	0.05	0.05
Cloud Point °F (°C) †	D 2500	See Note	See Note
Cetane No., Minimum †	D 613	45	45
Cetane Index, Minimum †	D 4737	40	40
Distillation % Vol. Recovery, °C (°F)	D86	-	-
- IBP, Typical*	-	350 (177)	375 (191)
- 10% Typical*	-	385 (196)	430 (221)
- 50% Typical*	-	425 (218)	510 (256)
- 90% Maximum	-	500 (260)	625 (329)
- 95% Maximum*	-	550 (288)	671 (355)
- Recovery Volume, % Minimum*	-	98	98
Water & Sediment, % Maximum	D 2709	0.05	0.05
Ash, % Maximum	D 482	0.01	0.01
Carbon Residue on 10%, wt%, Maximum	D 524	0.15	0.35
Copper Corrosion, Maximum 3h	D 130	No. 3	No. 3
Accelerated Storage Stability, Maximum*	D 2274	15 mg/L	15 mg/L

Distilled or deionized water is preferred to minimize the adverse effects of minerals in water. The maximum allowable limits for minerals in water are listed in Table 5-12. The procedure for evaluating the quality of water is shown in the next illustration. see Figure 5-2.

Mineral	Limit-ppm	Limit -grains per gallon
Chlorides	40	2.5
Sulfates	100	5.8
Total dissolved solids	340	20
Total Hardness: Magnesium & Calcium	170	10

Table 5-12 Maximum Allowable Limits for Minerals in Water

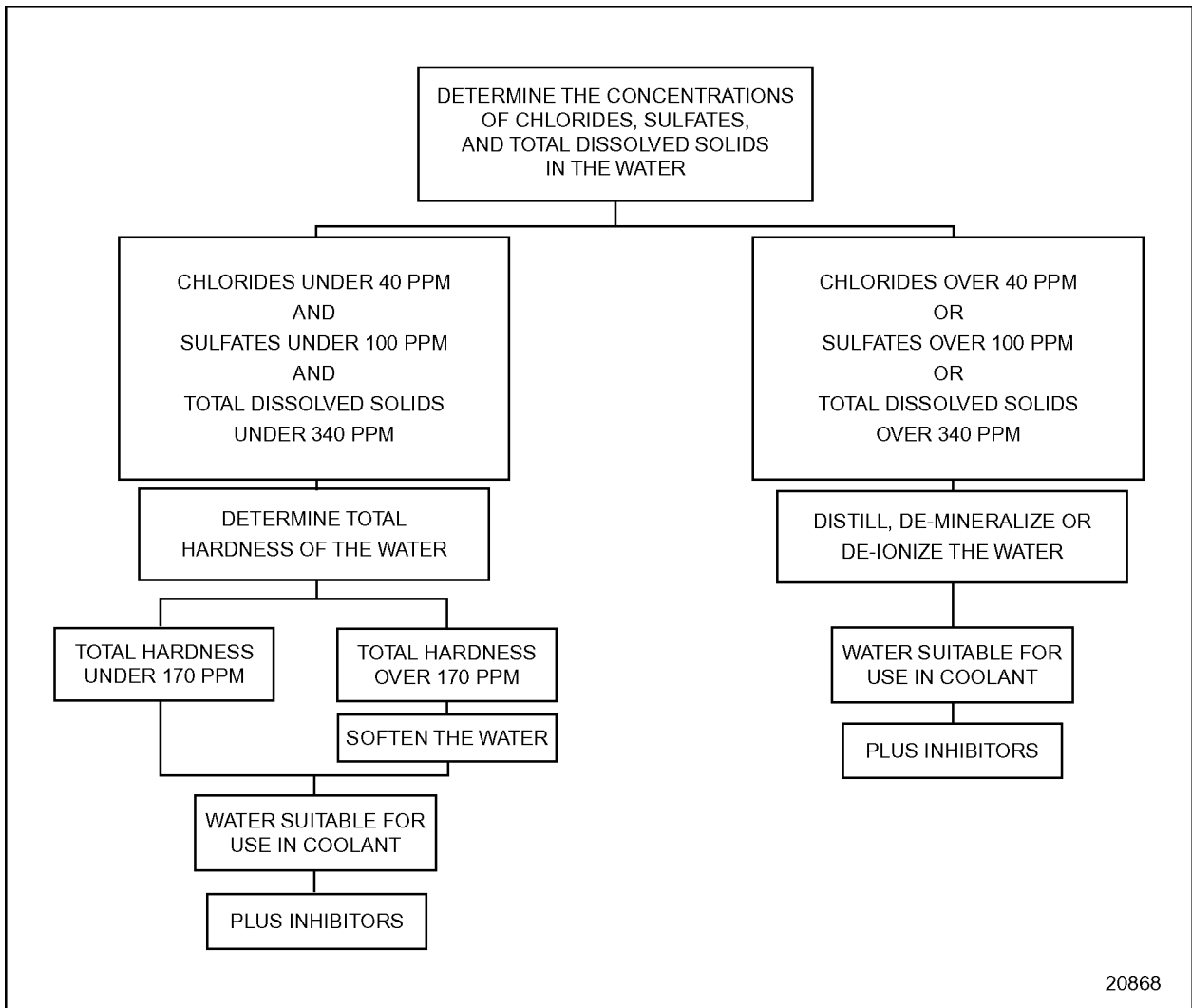


Figure 5-2 Water Evaluation Procedure

Repair and replacement procedures for the individual components of the air intake system are contained in this section.

6.1.2 Air System for Series 50G (High Pressure)

The air system components on the Series 50G engine with high pressure fuel system are similar to the diesel engine air system except for the addition of a gas mixer and throttle, see Figure 6-2. The turbocharger for this engine is also different and features a turbine bypass (wastegate) and compressor recirculation valve. These features are described in more detail in the turbocharger section ; refer to Section 6.5.

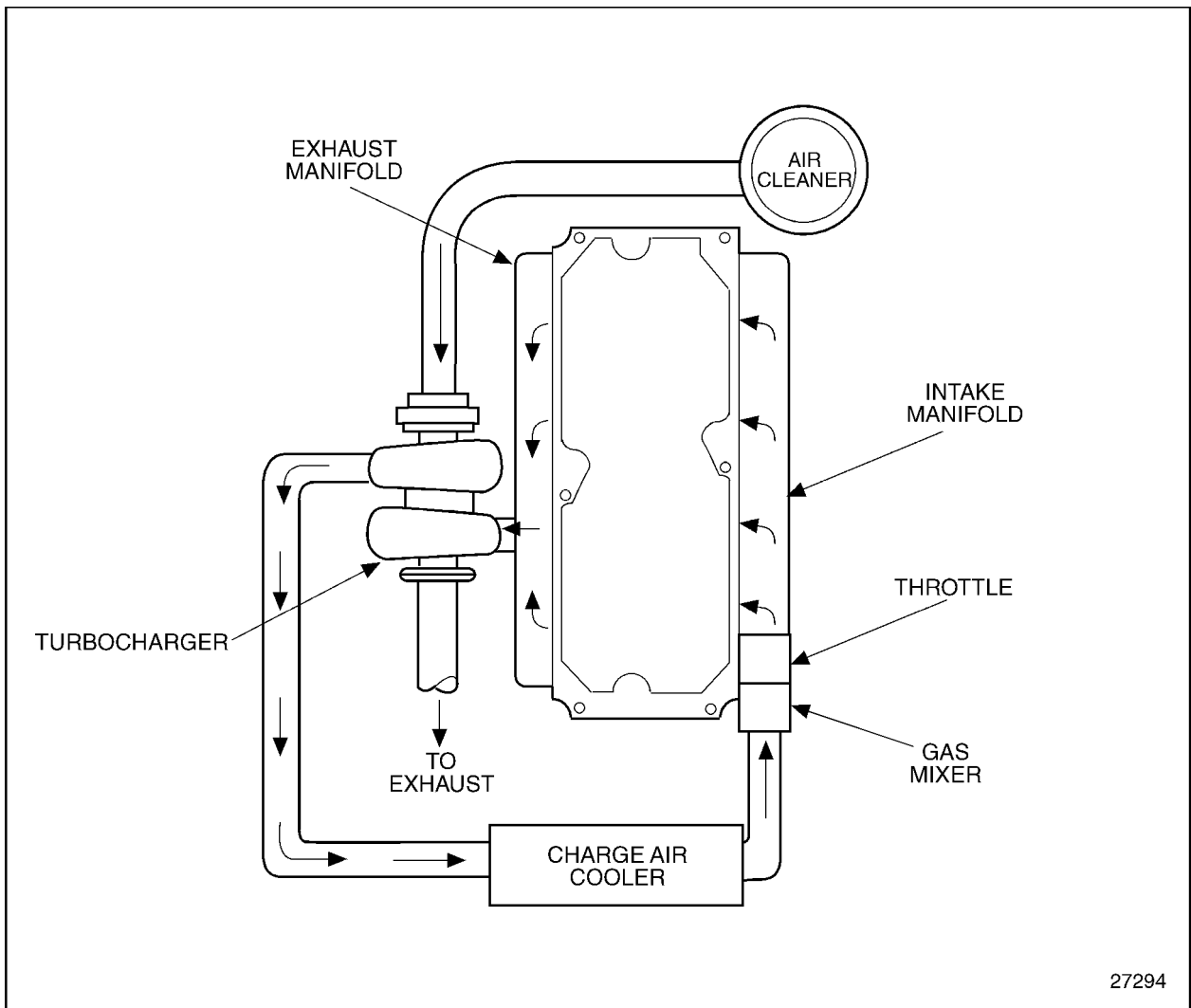


Figure 6-2 Air Intake System Schematic Series 50G (High Pressure)

6.4.3 Installation of the Closed Crankcase Breather

Install the closed crankcase breather as follows:

1. Insert new filter into the top of the assembly, ensuring the new filter contains the top O-ring. See Figure 6-11.

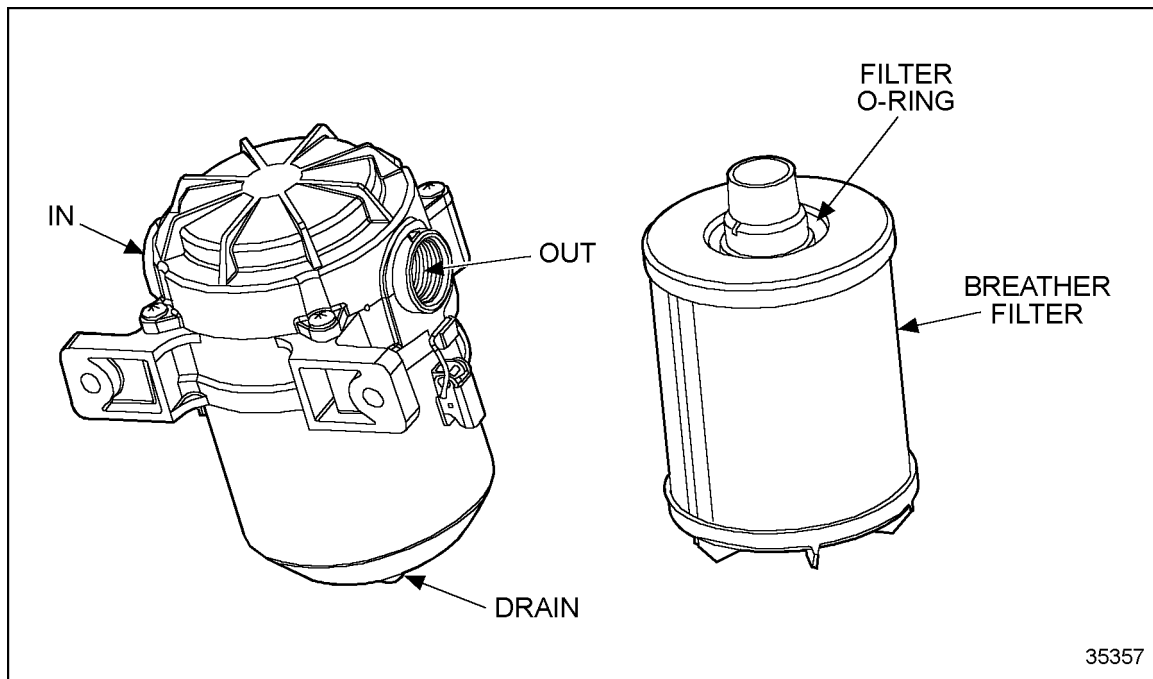


Figure 6-11 Location of O-ring and Breather Filters

2. Replace the lower canister ensuring the larger O-ring is secure in the top half of the assembly.
3. Secure the latches on the side of the can.
4. There are two O-rings in the system. One on the filter element itself and one that seals between the lower canister and the upper body. Ensure both O-rings are secure before reassembling the crankvent.

6.5.4 Removal of Wastegate Actuator

Remove the wastegate actuator as follows:

1. Remove actuator hose from top side of actuator can. See Figure 6-22. With the pressure gage setup, apply enough pressure to the actuator can until the rod begins to move. Refer to section 6.5.5.1.
2. Remove the retaining clip that holds the actuator rod end on the worm pin. Lift rod off the wastegate lever pin.

NOTICE:

Never remove the rod end from the wastegate lever pin without applying pressure to the top side actuator port, or damage to the actuator diaphragm may result.
--

3. Remove the locknuts that secure the actuator can to the base of the actuator bracket and remove the can from the turbocharger assembly.

6.5.5 Installation of Wastegate Actuator

Further adjustment of the actuator will be necessary to achieve the correct pressure setting, listed in Table 6-1.

Install the wastegate actuator as follows:

1. Install actuator can on bracket; tighten locknuts.
2. Using pressure gage setup, apply enough pressure to the new service actuator can until the rod begins to move.
3. Adjust actuator rod end by turning either clockwise or counterclockwise on rod so that the rod end hole lines up with the wastegate lever arm. While wastegate is held shut, slip rod over pin.
4. Before installing retaining clip, the rod end will need to be adjusted to the correct setting. Refer to section 6.5.5.1.

6.5.5.1 Setting the Wastegate

Before performing this procedure, check the actuator set pressure to see if adjustment is needed. Refer to section 6.5.3.2.

Set pressure adjustment as follows:

6.5.13 Installation of PWM Valve Assembly

Install the PWM assembly as follows: (See Figure 6-30.)

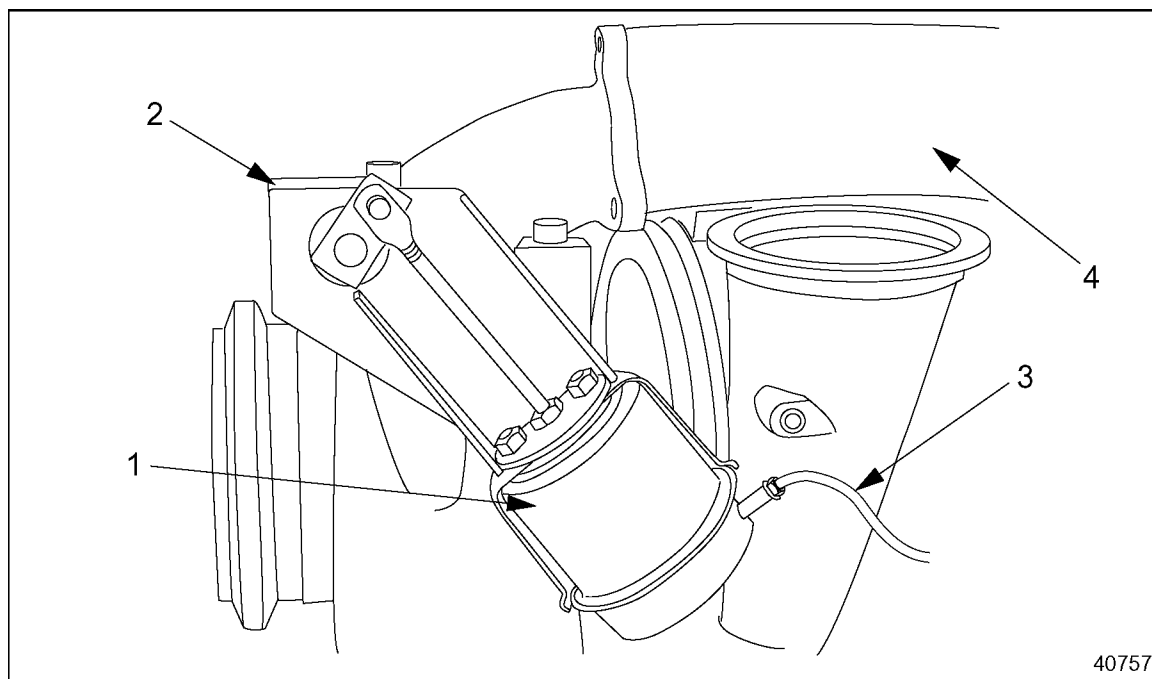
1. Install the two bolts that hold the bracket to the cylinder block.
2. Connect both electrical connectors.
3. Connect the air supply air line.
4. Connect the EGR solenoid air line to the EGR actuator.
5. Connect the PWM valve air line to the VNT actuator.

6.5.14 Removal of EGR Valve Assembly

The EGR valve assembly includes the EGR valve and actuator. It is only serviced as a complete assembly. The EGR valve actuator rod is preset at the factory and should not be altered in the field.

For engines equipped with the EGR Valve Assembly, remove as follows:

1. Disconnect the air supply line to actuator. See Figure 6-15.



1. EGR Actuator

3. Pressure Line

2. Bracket

4. Hot Pipe

Figure 6-31 EGR Valve Assembly

2. Remove the coupling from EGR housing to “hot” pipe leading to the EGR cooler. See Figure 6-32.

NOTICE:

Be sure to drain coolant before removing water lines from bearing housing.

6. Remove water lines from bearing housing.
7. Remove recirc valve line (Coach only).
8. Remove actuator return line on bottom port of actuator.
9. Attach a chain hoist and a suitable lifting sling to the turbocharger assembly.
10. Remove the nuts securing the turbocharger assembly to the exhaust manifold. Then, lift the turbocharger assembly away from the engine and place it on a bench.
11. Cover the end of the oil drain line, the oil outlet line, water supply, water return, the air inlet and the exhaust outlet openings on the engine and turbocharger to prevent the entry of foreign material.

**CAUTION:**

To avoid injury from improper use of chemicals, follow the chemical manufacturer's usage, handling, and disposal instructions. Observe all manufacturer's cautions.

12. Clean the exterior of the turbocharger with a non-caustic cleaning solvent before disassembly.

6.6.3 Disassembly of Turbochargers (50G)

Disassemble the turbocharger as follows:

1. Mark the related positions of the compressor housing, center housing and turbine house with a punch or scribe to assure reassembly in the same relative position.

NOTICE:

Exercise care when removing the compressor housing and turbine housing to prevent damage to the compressor and turbine wheels.

2. Loosen and remove the bolts and retaining clamps securing the compressor housing to the backplate assembly and remove the compressor housing.

6.7.2.1 Inspection of Charged Air Cooler

After a turbocharger failure, inspect charged air cooler as follows:

 **CAUTION:**

To avoid injury when working near or on an operating engine, remove loose items of clothing, jewelry, tie back or contain long hair that could be caught in any moving part causing injury.

NOTICE:

To avoid charged air cooler damage while cleaning or inspecting, observe all NOTICES, CAUTIONS, WARNINGS, etc. provided by the OEM cooler manufacturer.

1. Remove all the piping to and from the charged air cooler and the air intake manifold.

NOTICE:

If the charged air cooler is contaminated with metal particles resulting from a damaged turbocharger, it *must* be replaced with a new charged air cooler. Any debris left in the charged air cooler, especially metal particles, can cause severe engine damage.

2. Inspect all parts carefully for metal and oil contamination. If the charged air cooler is contaminated with engine oil, contact the vehicle OEM and obtain the charged air cooler manufacturer's recommendations on cleaning and inspection.
3. Remove and inspect the air intake manifold for any accumulation of oil. Remove the oil from the manifold and from the area above the valves before replacing the charged air cooler system.

NOTICE:

Failure to remove residual lubricating oil from charge air cooler may allow the oil to act as an external fuel source at engine startup. This can cause a sudden engine overspeed condition, which may result in severe engine damage.

6.7.3 Installation of Charge Air Cooler

Refer to the OEM guidelines for CAC installation procedures.

 **CAUTION:**

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

 **CAUTION:**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- Always start and operate an engine in a well ventilated area.
- If operating an engine in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system or emission control system.

10. Run the engine until normal operating temperature is reached.
11. Torque the bolts to 73 N·m (54 lb·ft) again. See Figure 7-5.
12. Refer to Section 11.3.6 for verification of proper exhaust manifold installation.

2. If a 50 DN alternator is used, install the pulley and lock nut, if removed, to the alternator. If an air cooled alternator is used, install the fan, drive pulley and locknut, if removed, to the alternator. Torque the pulley retaining nut to 315 N·m (225 lb·ft).
3. If the pulley was not removed, check the retaining nut for proper torque. Torque the retaining nut to 315 N·m (225 lb·ft), as necessary.
4. If the pulley was removed during disassembly, install two woodruff keys in mounting brackets.
5. Position the alternator on the mounting bracket, and align the holes in the alternator mounting flanges with those in the bracket support.

NOTE:

There are two holes in the front alternator end frame mounting flanges. One is threaded and one is not threaded. The threaded hole is positioned up and is used to secure the alternator to the adjusting rod.

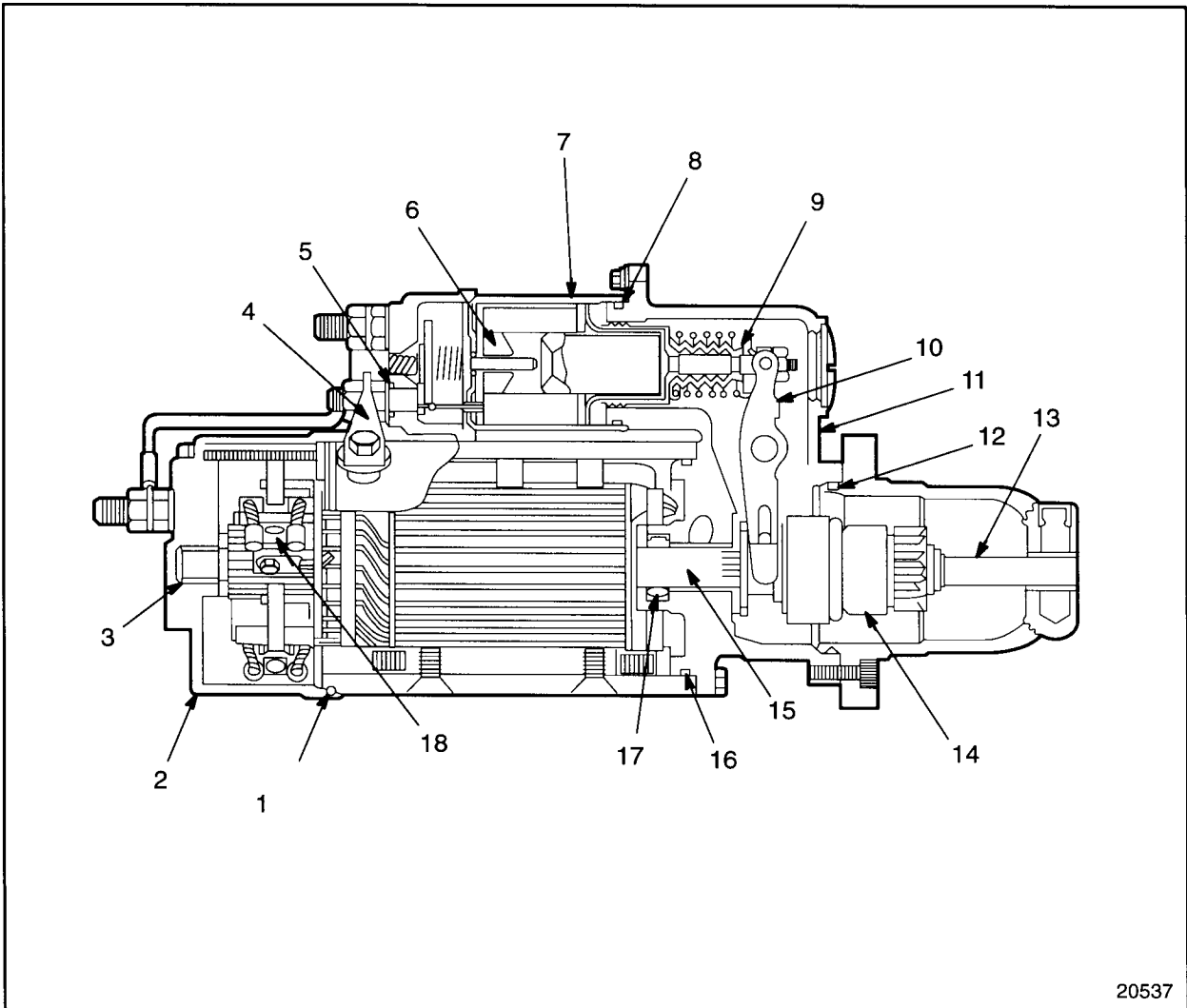
6. Install the alternator-to-bracket bolt and locknut. Insert the adjusting rod bolt, with washer installed, through the adjusting rod bracket and into the threaded hole in the alternator end frame. Tighten both bolts finger-tight. See Figure 8-1.

NOTICE:

Failure to properly orient the drive belt when installing it over the pulleys may result in belt damage at engine startup.

7. If alternator is oil cooled, connect the oil supply, return, and vent lines.
8. Install the belt carefully over the crankshaft or accessory drive pulley, the idler pulleys (if installed), and alternator drive pulley on the engine. If an auto belt tensioner is installed, use a breaker bar with a 3/4 inch drive to rotate the tensioner pulley upward for belt

The cranking motor armature is supported by three sintered bronze bearings located, one each, in the nose and intermediate housings, with one in the commutator end cap. See Figure 8-13.



- | | |
|--------------------------------------|---|
| 1. O-ring | 10. Shift Mechanism (Totally Enclosed) |
| 2. End Cap (Removal for Inspection) | 11. Two-piece Housing |
| 3. Bronze Bearing | 12. O-ring |
| 4. Connector Strap | 13. Bronze Bearing |
| 5. Gasket | 14. Heavy-duty Drive Overrunning Clutch |
| 6. Low Friction Bushing | 15. Bronze Bearing |
| 7. Seamless, One-piece Solenoid Case | 16. O-ring |
| 8. O-ring | 17. Shaft Seal |
| 9. Sealing Boot | 18. One-piece Brush |

Figure 8-13 Typical Cranking Motor Cross-Section

6. Insert the cable into the terminal until the stripped portion is positioned in the wire core wings, and the insulation portion ends just forward of the insulation wings. See Figure 8-22.

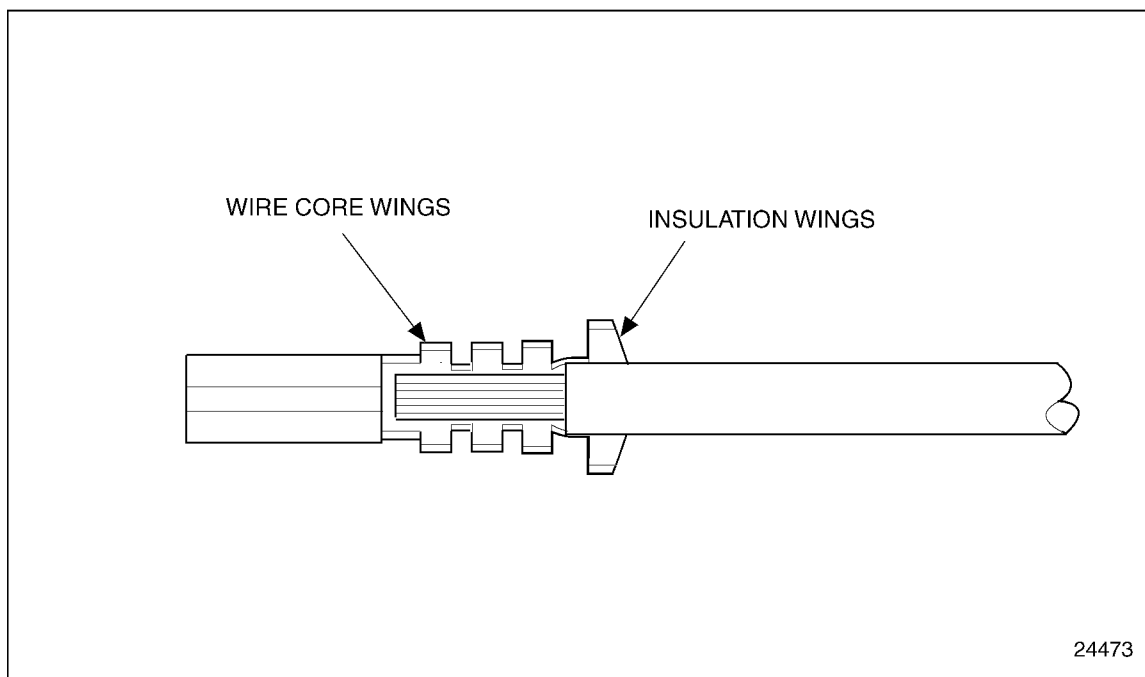


Figure 8-22 Cable to Terminal Alignment

8.A ADDITIONAL INFORMATION

Description	Page
SPECIFICATIONS	8-63
Torque Specification Exceptions - Fasteners	8-63
EXCEPTIONS TO STANDARD FASTENER TORQUE SPECIFICATIONS	8-63

SPECIFICATIONS

This section contains the exceptions to the fastener torque specifications.

Torque Specification Exceptions - Fasteners

The proper bolt and nut torque is dependent on its size. The proper torque for metric nuts and bolts are listed in Table 8 in the "General Information" section at the beginning of this manual. The exceptions to this rule are listed in Table 8-6. Standard (nonmetric) nut and bolt torque specifications are listed in Table 7 in the "General Information" section at the beginning of this manual.

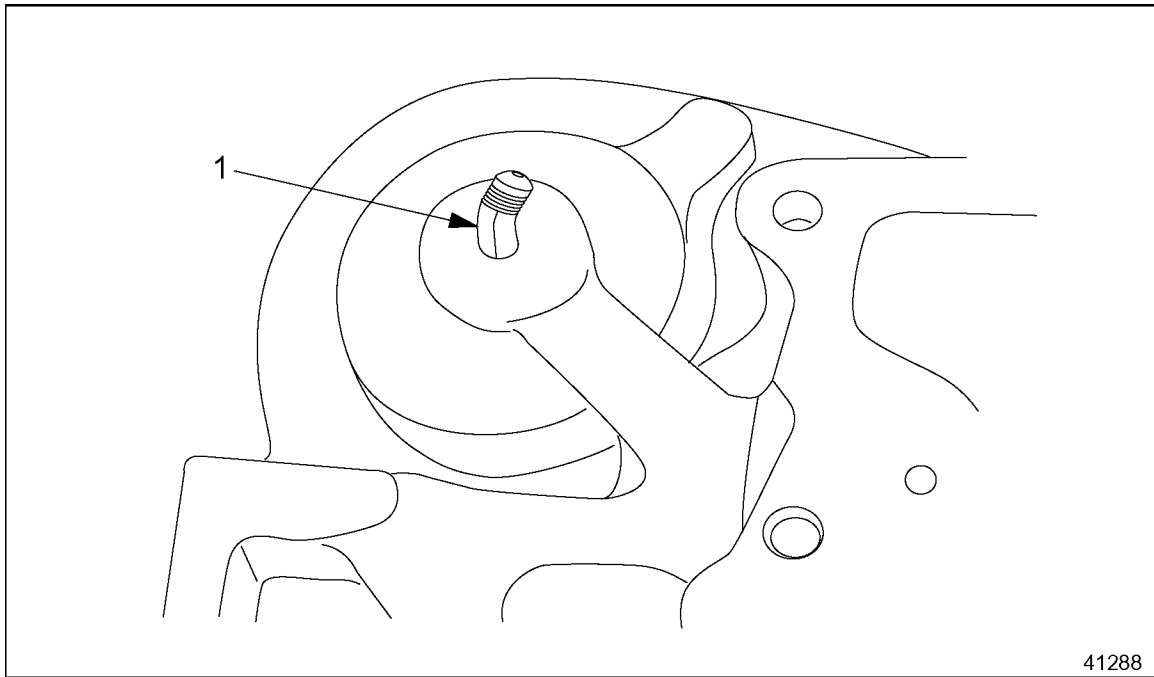
EXCEPTIONS TO STANDARD FASTENER TORQUE SPECIFICATIONS

Exceptions to standard fastener torque specifications are listed in Table 8-6.

Fastener	Torque, N-m	Torque, lb-ft
Bolt, Alternator Mounting Bracket	58-73	43-54
Nut, Drive Pulley	95-108	70-80
Bolt, Alternator-to-Mounting Bracket	81-95	60-70

Table 8-6 Exceptions - Metric Fastener Torque Specifications

4. Install oil fitting on back of flywheel housing. See Figure 9-11.



1. Oil Fitting

Figure 9-11 Installation of Oil Fitting

5. Insert two flywheel guide studs, J 36235 into the crankshaft. See Figure 9-12.

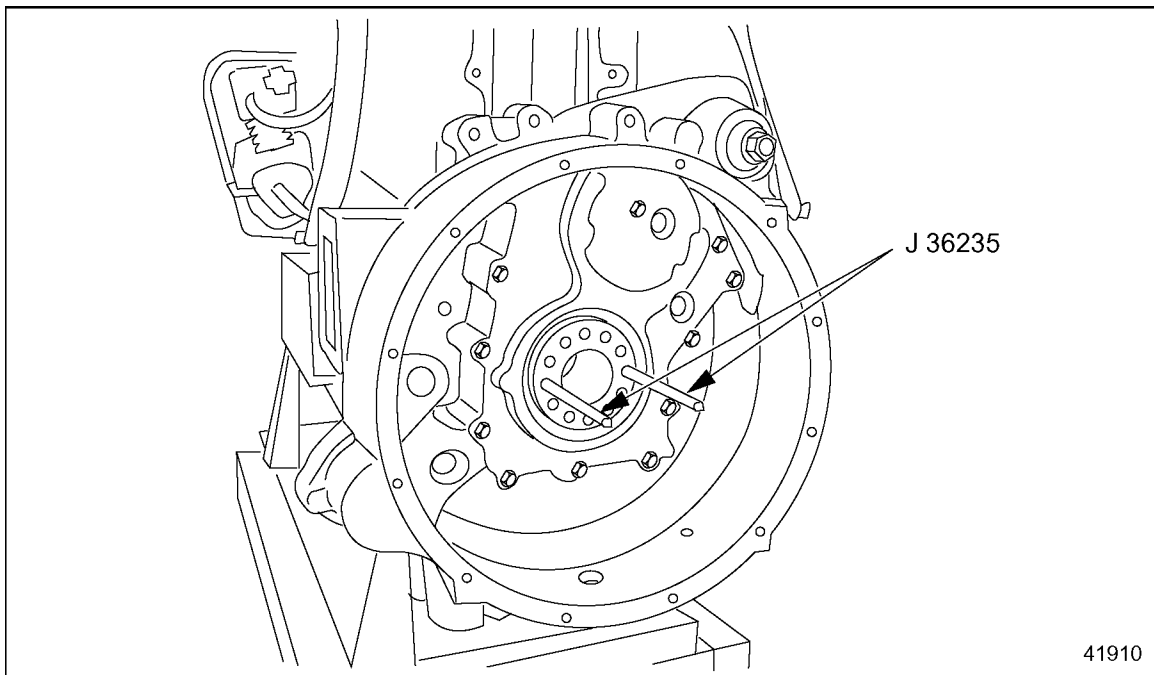


Figure 9-12 Flywheel Guide Studs

10.1 AIR COMPRESSOR

The Series 50 air compressor is flange mounted to the air compressor drive assembly, located on the left side of the engine at the rear of the gear case. See Figure 10-1.

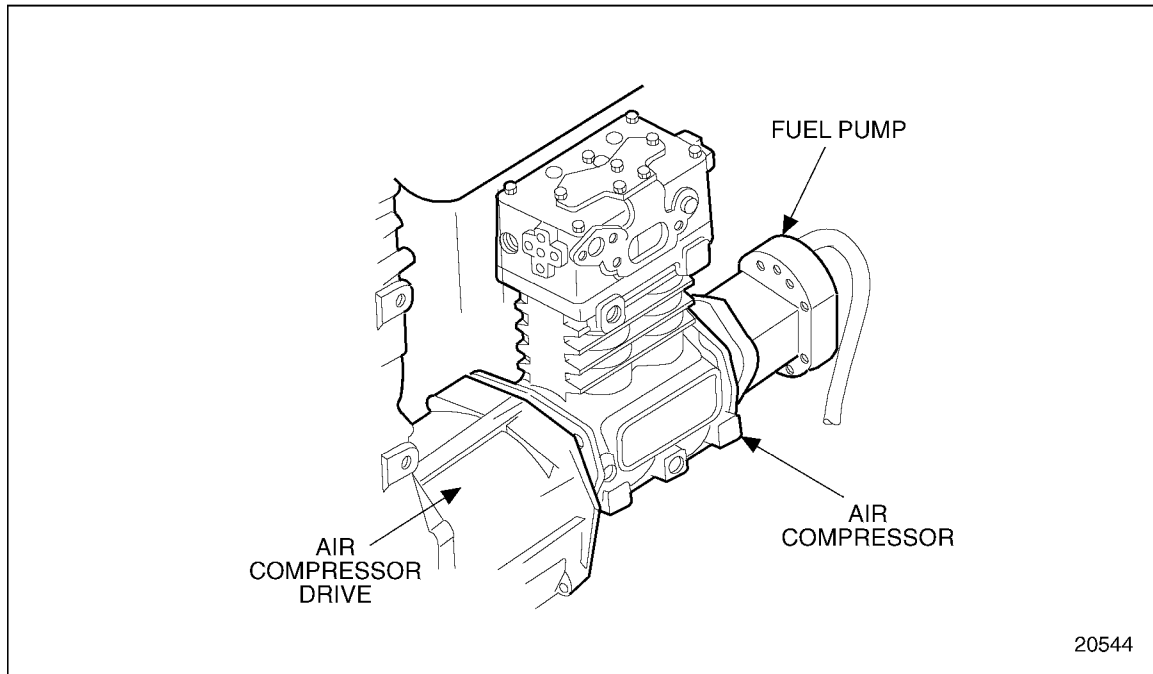


Figure 10-1 Air Compressor Mounting

Detroit Diesel has improved the mounting of the air compressor coolant inlet hose which runs from the cylinder block to the air compressor. The improved mounting eliminates the potential for air compressor coolant hose abrasion caused by rubbing against the cylinder block.

To eliminate abrasion caused by rubbing of the coolant inlet hose against the cylinder block, a new mounting clip (23506443) and bolt (11503454) are now used on all engines with Bendix air compressors.

Original air compressors were flange-mounted to the air compressor drive assembly. See Figure 10-2. Effective with unit serial number 4R6959 built November 22, 1994, adaptorless air compressors replaced the original compressors on the majority of Series 50 engines. Adaptorless compressors are flange-mounted directly to the gear case. See Figure 10-3. Improved cylinder blocks were released concurrent with this change. The adaptorless air compressors can only be used with the improved cylinder blocks. Refer to Section 1.1 for information on the improved cylinder blocks.

11. Remove the large snap ring retaining the ball bearing in the air compressor drive hub housing using snap ring pliers. See Figure 10-15.

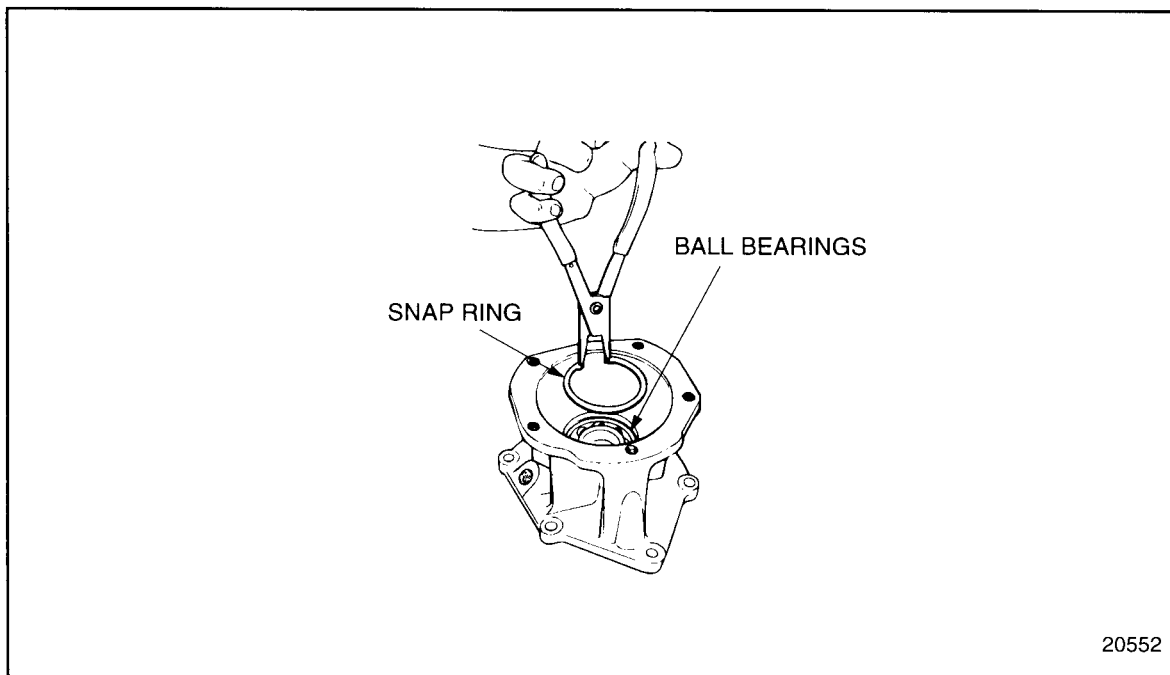


Figure 10-15 **Roller Bearing Snap Ring Removal**

12. On current design air compressor drive only, turn the air compressor drive housing over and support it on the press bed.
13. Using the narrow end of bearing installer, J 36310-6, part of tool set J 36310-A, against the bearing, press the bearing from the housing.
14. Discard the bearing.

NOTE:

The following steps apply only to the former design air compressor drive.

11.1 PREPARATION FOR A FIRST TIME START

Before starting an engine for the first time, carefully read and follow the instructions in this section. Also, refer to Section 13 .

NOTICE:

Attempting to run the engine before studying these instructions may result in serious damage to the engine.

NOTICE:

When preparing to start a new or overhauled engine or an engine that has been in storage, perform all of the operations listed below. Before a routine start (at each shift), see Daily Operations in the Preventive Maintenance Chart. Refer to Section 13.2. Failure to perform required prestart operations may result in engine damage.

11.1.1 Cooling System

Install all of the drain cocks and plugs in the cooling system as instructed below:

1. Open the cooling system vents.
2. Remove the filler cap and fill the cooling system with a coolant specified. Refer to Section 5.4. The coolant level should be within two inches (50 mm) of the filler neck to allow for fluid expansion.
3. Close the vents, if used, after filling the cooling system.

11.1.2 Lubrication System

The lubricating oil film on the rotating parts and bearings of a new or overhauled engine, or one which has been in storage, may be insufficient for proper lubrication when the engine is started for the first time.

It is recommended that the engine lubricating system be charged with a pressure prelubricator, set to supply a minimum of 172 kPa (25 lb/in.²) oil pressure, to ensure an immediate flow of oil to all bearings at the initial engine start-up. The oil supply line should be attached to the engine so that oil under pressure is supplied to the main oil gallery.

With the oil pan dry, use the prelubricator to prime the engine with sufficient oil to reach all bearing surfaces. Use lubricating oil as specified. Refer to Section 5.2. Then, remove the dipstick, wipe it with a clean cloth, insert and remove it again to check the oil level in the oil pan. Add sufficient oil, if necessary, to bring it to the *full* mark on the dipstick. Do not overfill.

If a pressure prelubricator is not available, fill the crankcase to the proper level with lubricating oil. Refer to Section 13.5.1. Then, prelubricate the upper engine parts by removing the valve rocker cover and pouring lubricating oil, of the same grade and viscosity as used in the crankcase, over the rocker arms, rocker arm shafts, camshaft lobes and camshaft follower rollers.

The GFI monitor screen for the Series 50G engine is graphically illustrated; see Figure 11-1.

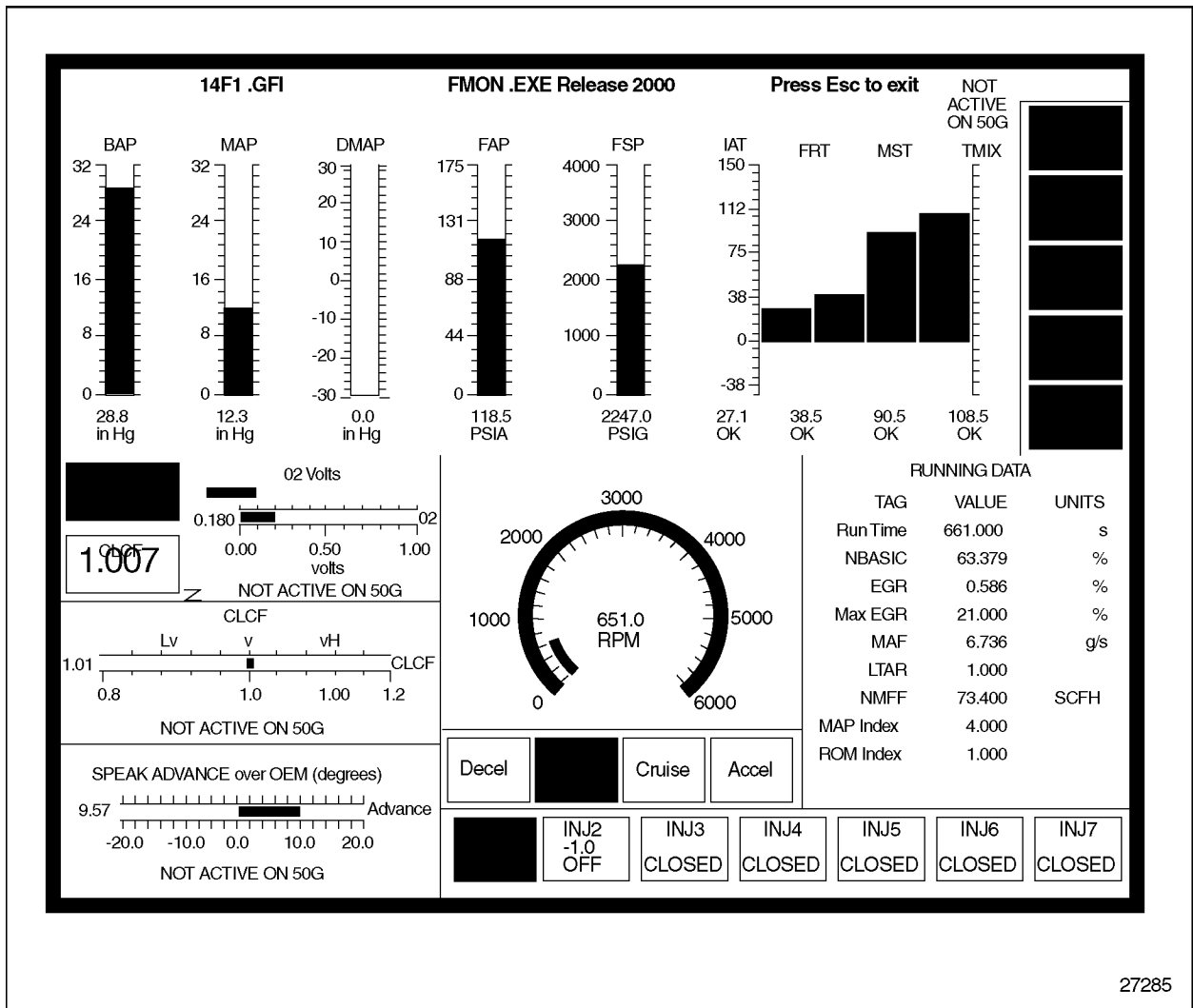


Figure 11-1 GFI Monitor Screen for Series 50G Engine

NOTICE:

Ensure the height gage seats on the machined surface with the tip in the pilot hole. Foreign material in the pilot hole or on the machined surface may prevent accurate setting of the injector height.

The fuel injector height is adjusted using the injector height gage, as listed in Table 12-1. On engines equipped with a Jake Brake[®], move the handle on the injector height gage to the alternate position, 90° to the shank. A height gage pilot hole is provided in the injector body on the machined surface contacted by the injector clamp near the solenoid. See Figure 12-3.

Component	Setting Dimensions	Tolerance
Fuel Injector Height: DDEC II Models 6047 GUXX	78.2 mm (3.078 in.) Use tool J 35637-A	77.95-78.45 mm (3.068-3.088 in.)
Fuel Injector Height: DDEC III Models 6047 GKXX	78.8 mm (3.103 in.) Use tool J 39697	77.55-79.05 mm (3.053-3.112 in.)
Fuel Injector Height: DDEC IV Model: 6047TKXX	80.3 mm (3.161 in.) Use tool J 42665	80.05-80.55 mm (3.151-3.171 in.)
Fuel Injector Height: DDEC IV Model: 6047MKXX	81.0 mm (3.190 in.)	
Intake Valve Clearance	0.203 mm (0.008 in.)	0.127-0.280 mm (0.005-0.011 in.)
Intake Valve Clearance Natural Gas Models 604XGKGX	0.279 mm (0.011 in.)	0.203-0.356 mm (0.008-0.014 in.)
Intake Valve Clearance Model 604XMKGX	0.267 mm (0.010 in.)	0.253 -0.281 mm (0.009-.0.011 in.)
Exhaust Valve Clearance*-"U" Valves Models 604XGUXX	0.508 mm (0.020 in.)	0.432-0.584 mm (0.017-0.023 in.)
Exhaust Valve Clearance*-"H" Valves Models 604XGKXX	0.660 mm (0.026)	0.584-0.736 mm (0.023-0.029 in.)
Exhaust Valve Clearance*-"J" All Natural Gas Models 604XXXGX	0.914 mm (0.036 in.)	-
Exhaust Valve Clearance **_Nickel-Alloy Valves Models 604XMKXX, 604XTKXX	0.508 mm (0.020 in.)	0.432-0.584 mm (0.017-0.023 in.)

XX Any characters in these positions set to the adjacent column.

* "U", "H", and "J" valves have the letter designation stamped in the recess of the valve head. "H" and "J" valves also have a machined identification ring above the valve lock groove. "U" valves do not.

** After engine serial number 4R37769 the valve is identified by the raised bump in the center of the recess on the combustion face, the deletion of the machined identification ring above the keeper groove and the part number.

Table 12-1 Valve Clearance and Injector Height Settings

13.3 MAINTENANCE OF VEHICLE ENGINES

Vehicle engine components must be maintained at various intervals.

13.3.1 6,000 Miles (10,000 km) Interval Maintenance (City Coach Only)

The oil must be changed on a City Coach Engine.

Every 6,000 miles (10,000 km), the following components must be lubricated;

- Fan hub bearings, refer to Section 13.5.23
- Idler pulley bearings, refer to Section 13.5.23

NOTE:

If grease fittings are installed on the fan hub and the idler pulley support, the fan hub bearings and fan belt idler pulley bearings **must** be lubricated.

13.3.2 7,500 Miles (12,000 km) Interval Maintenance

Every 7,500 miles (12,000 km), the following components must be inspected, serviced, corrected or replaced as necessary.

- Battery, refer to Section 13.5.6
- Drive belts, refer to Section 13.5.7
- Air compressor, refer to Section 13.5.8

13.3.3 12,000 Miles (19,000 km) Interval Maintenance (City Coach Only)

The oil must be changed on a City Coach Engine.

Every 12,000 miles (19,000 km), the following components must be lubricated;

- Fan hub bearings, refer to Section 13.5.23
- Idler pulley bearings, refer to Section 13.5.23

NOTE:

If grease fittings are installed on the fan hub and the idler pulley support, the fan hub bearings and fan belt idler pulley bearings **must** be lubricated.

13.3.4 15,000 Miles (24,000 km) or 6 Month Interval Maintenance

The following components must be replaced every 15,000 miles (24,000 km) or 6 months.

- Air cleaner, refer to Section 13.5.9
- Lubricating oil, refer to Section 13.5.1
- Lubricating oil filter, refer to Section 13.5.10
- Fuel filter, refer to Section 13.5.11
- Coolant filter and inhibitor, refer to Section 13.5.12
- Fan hub bearings, refer to Section 13.5.23

13.4.9 1,200 Hours (36,000 miles-58,000 km) Maintenance

Every 1,200 hours (36,000 miles-58,000 km), the following components must be inspected, serviced, corrected or replaced as necessary.

- Fuel tank, refer to Section 13.5.2
- Air compressor, refer to Section 13.5.8
- Air system, refer to Section 13.5.15
- Exhaust system, refer to Section 13.5.16
- Engine (steam clean), refer to Section 13.5.17
- Radiator and air-to-air charge cooler, refer to Section 13.5.18
- Oil pressure, refer to Section 13.5.19
- Battery charging alternator, refer to Section 13.5.20
- Engine and transmission mounts, refer to Section 13.5.21
- Crankcase pressure, refer to Section 13.5.22
- Thermostats and seals, refer to Section 13.5.24
- Crankcase breather, refer to Section 13.5.25

Likewise, the following components must be replaced every 1,200 hours (36,000 miles-58,000 km).

- Lubricating oil, refer to Section 13.5.1
- Lubricating oil filter, refer to Section 13.5.10
- Fuel filter, refer to Section 13.5.11
- Coolant filter and inhibitor, refer to Section 13.5.12

13.4.10 1,350 Hours (40,500 miles-65,000 km) Maintenance

Every 1,350 hours (40,500 miles-65,000 km), the following components must be inspected, serviced, corrected or replaced as necessary.

- Air compressor, refer to Section 13.5.8
- Air system, refer to Section 13.5.15
- Exhaust system, refer to Section 13.5.16

Likewise, the following components must be replaced every 1,350 hours (40,500 miles-65,000 km).

- Lubricating oil, refer to Section 13.5.1
- Lubricating oil filter, refer to Section 13.5.10
- Fuel filter, refer to Section 13.5.11
- Coolant filter and inhibitor, refer to Section 13.5.12

13.4.11 1,500 Hours (45,000 miles-72,000 km) Maintenance

Every 1,500 hours (45,000 miles-72,000 km), the following components must be inspected, serviced, corrected or replaced as necessary.

- Fuel tank, refer to Section 13.5.2
- Cooling system, refer to Section 13.5.4

13.5.8 Air Compressor

Remove and clean all air compressor air intake parts every 150 hours or 15,000 miles (24,000 km). Refer to Section 10.1.2. To clean either the hair-type or polyurethane-type compressor air strainer element, saturate and squeeze it in fuel oil, or any other cleaning agent that would not be detrimental to the element, until it is dirt-free. Then, dip the element in lubricating oil and squeeze it dry before placing it back in the air strainer.

For replacement of the air strainer element, contact the nearest servicing dealer; replace with the polyurethane element, if available.

Every 12 months or 30,000 miles (48,000 km) [300 hours for industrial applications] tighten the air compressor mounting bolts.

13.5.9 Air Cleaner

Inspect the air cleaner element every 15,000 miles (24,000 km) for vehicle engines, 150 hours for non-vehicle engines, or more often if the engine is operated under severe dust conditions. Replace the element if necessary. Check the gaskets for deterioration and replace, if necessary. If the dry type air cleaner is equipped with an aspirator, check for aspirator damage or clogging. Clean and repair as necessary.

Under no engine operating conditions should the air inlet restriction exceed 20 inches of water (5.0 kPa). A clogged air cleaner element will cause excessive intake restriction and a reduced air supply to the engine.

Dry-type air cleaner elements used in on-highway applications should be discarded and replaced with new elements when the maximum allowable air inlet restriction has been reached. No attempt should be made to clean or reuse on-highway elements after these intervals.

Dry-type elements used in industrial applications should be discarded and replaced with new elements after one year of service or when the maximum allowable air intake restriction has been reached, whichever comes first. In cases where the air cleaner manufacturer recommends cleaning or washing elements, the maximum service life is still one year or maximum restriction. Cleaning, washing and inspection must be done per the manufacturer's recommendations, if any. Inspection and replacement of the cover gaskets must also be done per the manufacturer's recommendations.

13.5.10 Lubricating Oil Filter

Install new full flow spin-on oil filters at a **maximum** of 15,000 miles (24,000 km) (truck engines) 6,000 miles (10,000 km) (coach engines) or 150 hours (non-vehicle engines) or each time the engine oil is changed, whichever comes first. Install the new filters, turning them until they contact the gasket fully with no side movement, then turn an additional 2/3 turn by hand.

Make a visual inspection of all lubricating oil lines for wear and/or chafing. If any indication of wear is evident, replace the oil lines and correct the cause.

If the engine has not been operated for a prolonged period or the turbocharger has been removed or replaced, prelubricate the turbocharger as outlined under " Assembly of Turbocharger."

Refer to Section 6.5.6.

13.6 PREVENTIVE MAINTENANCE FOR THE SERIES 50G ENGINE (CITY TRANSIT COACH)

The following is a list of items that are unique to the Series 50G engine for preventive maintenance (city transit coach):

13.6.1 Coalescing Fuel Filters

Drain coalescing fuel filters daily. Inspect natural gas fuel filter every 6,000 miles (9,600 km). Replace fuel filter if dirt, debris or foreign objects are present "inside" of the fuel filter. Also, replace if fuel filter seal is damaged.

NOTE:

Oil saturation on the outside of the fuel filter is a NORMAL condition of the oil coalescing process.

13.6.2 Valve Lash

Check valve lash. Valve lash should be inspected and adjusted every 60,000 miles as specified.

13.6.3 Closed Crankcase Breather System

The closed crankcase breather filter must be replaced every 6000 miles. The filter is located in the remote mounted crankvent assembly.

13.6.4 Dry Type Air Cleaner

Under no operating condition should the intake restriction exceed 20 inches of water at full load and rated speed. A clogged air cleaner element will cause excessive intake restriction and a reduced air supply to the engine. For equivalent restriction limits for lower speed, refer to Detroit Diesel Corporation Engineering Bulletin No. 39, "Air Cleaner Systems for Detroit Diesel Engines".

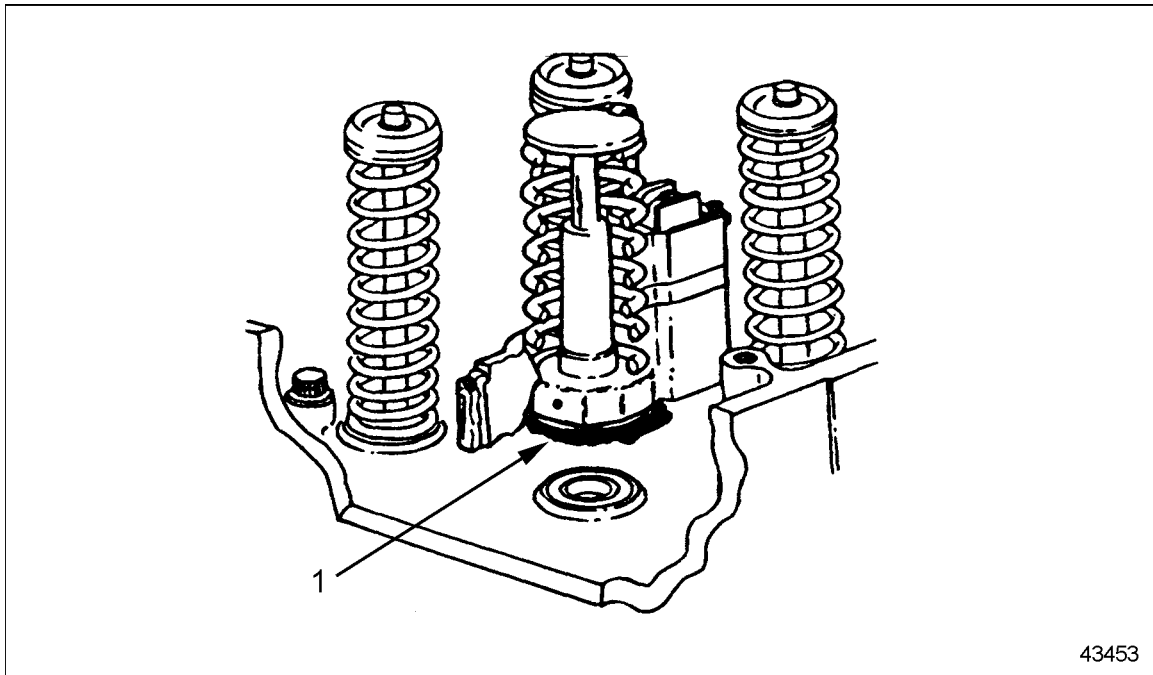
Inspect the air cleaner element every 12,000 miles (coaches). Inspect the air cleaner more often if the engine is operated under severe dust conditions. Replace the element if necessary. Check the gaskets for deterioration and replace, if necessary. If the dry type air cleaner is equipped with an aspirator, check for aspirator damage or clogging. Clean and repair as necessary.

13.6.5 Engine Lubricating Oil

Change the lubricating oil every 6,000 miles for city transit coaches. (Refer to Engine Requirements - Lubricating Oil, Fuel and Filters - 7SE272).

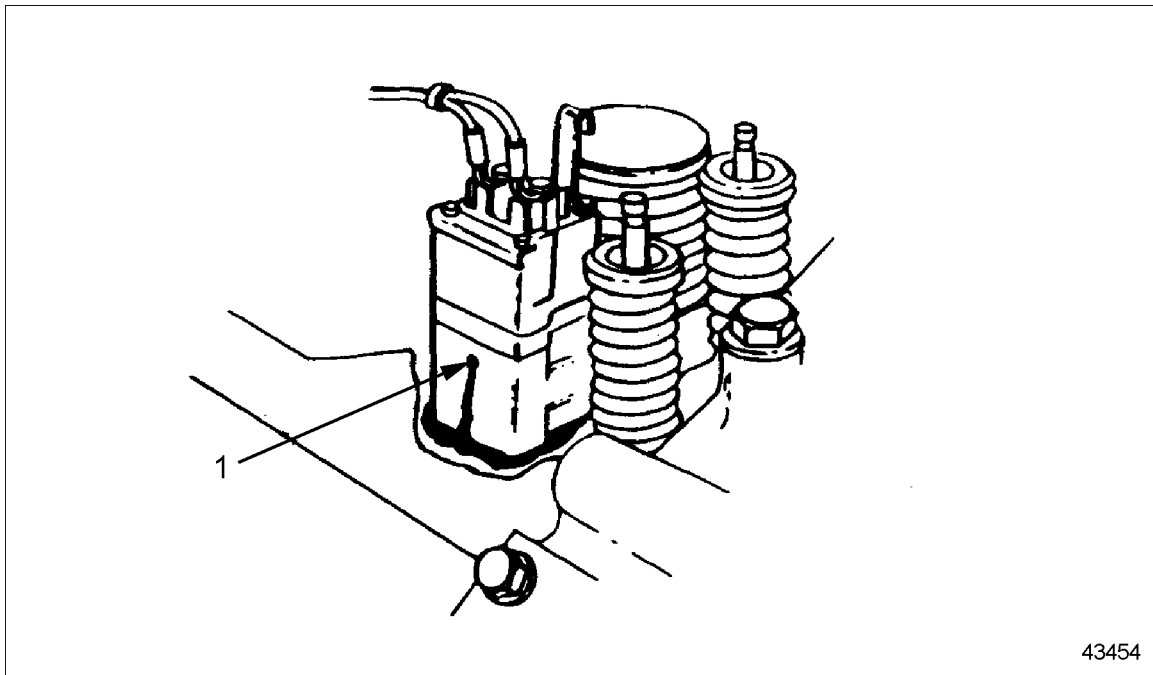
13.6.6 Engine Lubricating Oil Filters

Change the lubricating oil filters at each oil change 6,000 miles for city transit coaches).



1. Fuel Leakage at Injector Nut-to-Tube 'O' Ring Seal

Figure 13-13 Unacceptable-Fuel Leakage at Injector Nut-to-Tube 'O' Ring Seal



1. Fuel Leakage at High Pressure Body Plug and or Body Crack

Figure 13-14 Unacceptable-Fuel Leakage at High Pressure Body Plug and or Body Crack

NOTICE:

Do NOT use plastic sheeting for outdoor storage. Plastic is fine for indoor storage. When used outdoors, however, enough moisture can condense on the inside of the plastic to rust ferrous metal surfaces and pit aluminum surfaces. If a unit is stored outside for any extended period of time, severe corrosion damage can result.

Protect units with quality, weather-resistant tarpaulins (or other suitable covers) arranged to provide for air circulation.

The stored engine should be inspected periodically. If there are any indications of rust or corrosion, corrective steps must be taken to prevent damage to the engine parts.

14.1.5 Outdoor Storage (More Than 30 Days)

In some cases outdoor storage may be unavoidable.

NOTE:

Outdoor storage of engines is not recommended.

If units must be kept out-of-doors. Refer to Section 14.1.3.

NOTICE:

Do NOT use plastic sheeting for outdoor storage. Plastic is fine for indoor storage. When used outdoors, however, enough moisture can condense on the inside of the plastic to rust ferrous metal surfaces and pit aluminum surfaces. If a unit is stored outside for any extended period of time, severe corrosion damage can result.

Protect units with quality, weather-resistant tarpaulins (or other suitable covers) arranged to provide for air circulation.

The stored engine should be inspected periodically. If there are any indications of rust or corrosion, corrective steps must be taken to prevent damage to the engine parts. Perform a complete inspection at the end of one year and apply additional treatment as required.

15.4 WASTE WIRE HARNESS

The waste wire harness completes the high voltage electrical circuit for each ignition coil by grounding the towers that would otherwise be the waste spark side of an automotive DIS ignition system. The harness is subject to the same damage from contamination, abrasions on the insulation, and mishandling as the ignition wires.

NOTICE:

Do not allow the spark plug wires to contact any engine or vehicle component which would cause rubbing on the insulation during engine operation. Contact with engine or vehicle can cause damage to the spark plug wires.
--

NOTICE:

Do not allow spark wires to kink during handling. Kinking of spark plug wires can cause damage.

NOTICE:

Do not allow spark plug boot or spark plug wire to come in contact with engine oil. Exposure to engine oil can cause damage.
--

15.4.1 Removal of Waste Wire Harness

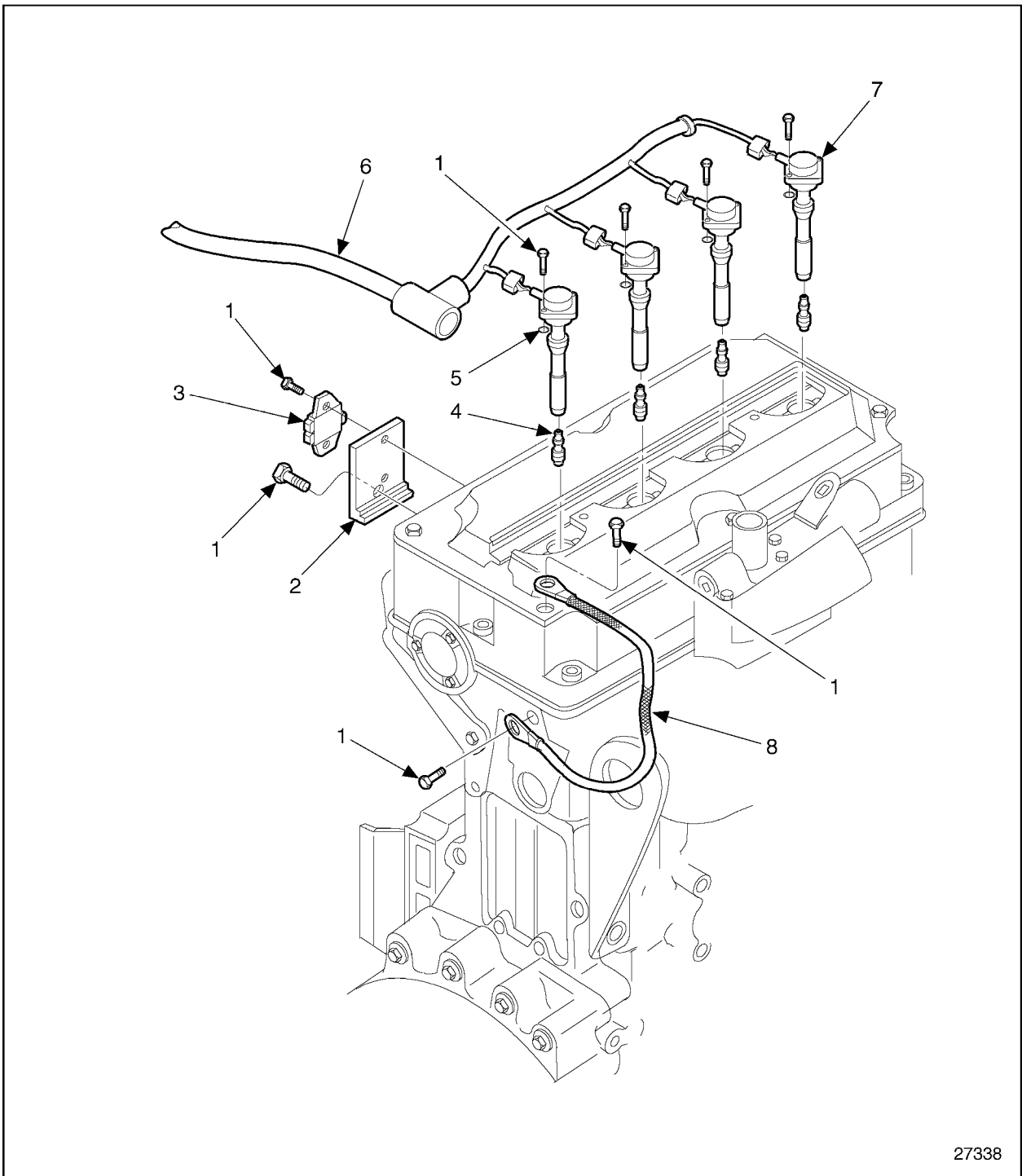
Remove the waste wire harness as follows:

1. Pull the waste wire harness connectors from the ignition coil at the coil towers.
2. Remove the M8 x 1.25 x 14 bolt holding the harness terminal to the cylinder head.
3. Inspect the waste wire harness. Refer to Section 15.4.1.1.

15.4.1.1 Inspection of Waste Wire Harness

Inspect the waste wire harness as follows:

1. Visually check the waste wire harness for cracks in the insulation or areas where the insulation has been damaged.
 - [a] If damage is found, replace as necessary.
 - [b] If no damage is found, reuse the waste wire harness.
2. Visually check the waste wire harness for dirt, debris, and engine oil.
 - [a] If contamination is found, clean as necessary and apply a light coat of dielectric grease to the inside of the ignition wire connector. Refer to Section 15.4.2.
 - [b] If no contamination is found, reuse the waste wire harness and apply a light coat of dielectric grease to the inside of each waste wire connector. Refer to Section 15.4.2.



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- | | |
|---------------------------|-----------------------------------|
| 1. Bolt | 5. Seal |
| 2. Igniter Module Bracket | 6. Igniter Coil Harness |
| 3. Igniter Module | 7. Coil and Igniter Boot Assembly |
| 4. Spark Plug | 8. Ground Strap |

Figure 15-13 **Coil Over Plug Ignition System**

 **CAUTION:**

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

 **CAUTION:**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- Always start and operate an engine in a well ventilated area.**
- If operating an engine in an enclosed area, vent the exhaust to the outside.**
- Do not modify or tamper with the exhaust system or emission control system.**

1. Start engine.
2. Run engine speed up to the occurrence of the misfiring.
3. Listen for misfiring cylinder.
 - [a] If the engine is not misfiring, no further troubleshooting is required. Shut down the engine.
 - [b] If the engine is misfiring, check for aerated fuel. Shut down the engine; refer to Section 16.2.

 **CAUTION:**

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

 **CAUTION:**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- Always start and operate an engine in a well ventilated area.**
- If operating an engine in an enclosed area, vent the exhaust to the outside.**
- Do not modify or tamper with the exhaust system or emission control system.**

1. Start the engine.
2. Run the engine at 1000 r/min.
3. Listen for misfiring cylinder.
 - [a] If the engine is not misfiring, shut down the engine. No further troubleshooting is required.
 - [b] If the engine is misfiring, shut down the engine and check for faulty fuel injector; refer to Section 16.5.

17.4 CORRODED OR DAMAGED BATTERY TERMINALS

To determine if corroded or damaged terminals is causing starting difficulty:

1. Visually inspect terminals for corrosion or damage.
 - [a] If corrosion or damage is not found, check the magnetic switch; refer to Section 17.5.
 - [b] If corrosion or damage is found, repair is necessary; refer to Section 17.4.1.


17.4.1 Corroded or Damaged Battery Terminal Repair


Perform the following to repair corroded or damaged battery terminals:

1. Repair or replace any corroded or damaged terminals; refer to OEM guidelines.
2. Verify repair of corroded or damaged terminals; refer to Section 17.4.1.1.

17.4.1.1 Test with Repaired Battery Terminals

Perform the following to determine if the repair resolved starting difficulty:

 CAUTION:
To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

 CAUTION:
Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.
<input type="checkbox"/> Always start and operate an engine in a well ventilated area. <input type="checkbox"/> If operating an engine in an enclosed area, vent the exhaust to the outside. <input type="checkbox"/> Do not modify or tamper with the exhaust system or emission control system.

1. Attempt to start and run the engine.
 - [a] If the engine starts and runs, no further troubleshooting is required. Shut the engine down.
 - [b] If the engine fails to start and run, check the magnetic switch; refer to Section 17.5.

 **CAUTION:**

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

 **CAUTION:**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- Always start and operate an engine in a well ventilated area.
- If operating an engine in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system or emission control system.

1. Attempt to start and run the engine.
 - [a] If the engine starts and runs, no further troubleshooting is required. Shut the engine down.
 - [b] If the engine fails to start and run, check compression; refer to Section 17.13.

19 EXCESSIVE OIL CONSUMPTION

Section	Page
19.1 MISCALIBRATED DIPSTICK	19-3
19.2 EXTERNAL OIL LEAKS	19-4
19.3 LEAKING OIL COOLER CORE	19-6
19.4 DEFECTIVE AIR COMPRESSOR	19-8
19.5 DEFECTIVE TURBOCHARGER	19-10
19.6 WORN OR DAMAGED VALVE OR CYLINDER KIT	19-11

20.2 DEFECTIVE AIR COMPRESSOR

To determine if a defective air compressor is causing excessive crankcase pressure, perform the following:

1. Perform a crankcase pressure test and record the test results; refer to Section 29.3.
2. Disconnect the air outlet line from the air compressor; see Figure 20-1; refer to Section 10.1.2.

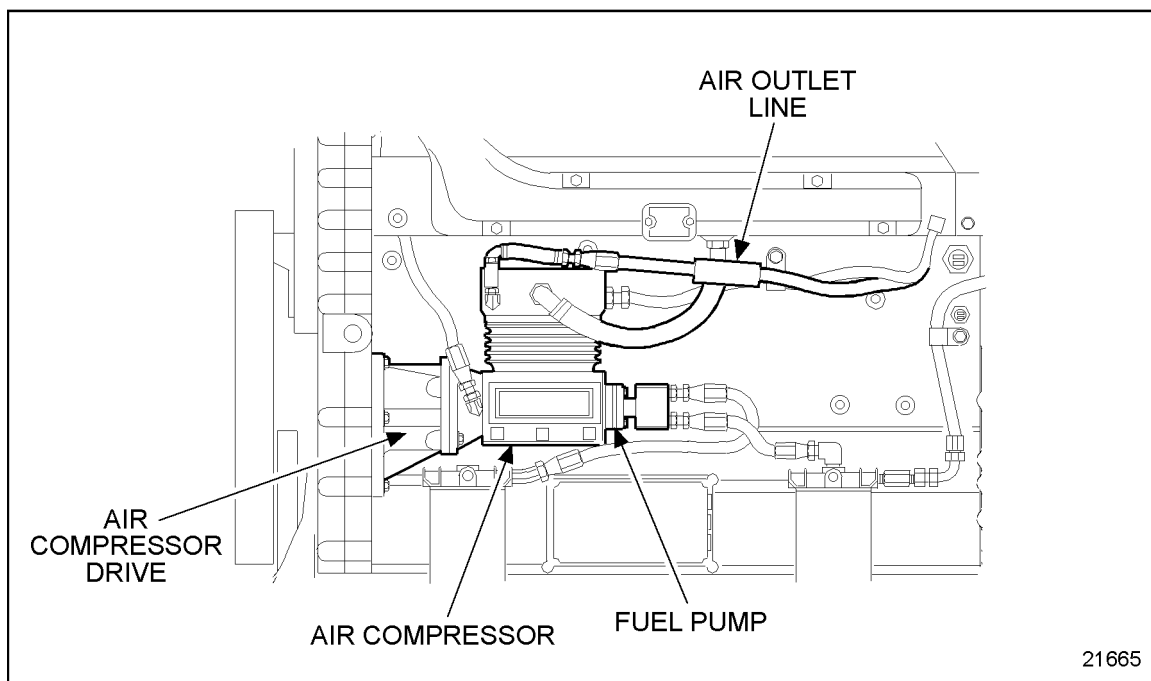


Figure 20-1 Air Compressor Air Outlet Line

3. Repeat step 1 and record the test results.
4. Compare the results of test one with test two.
 - [a] If the engine crankcase pressure remained the same, check the turbocharger; refer to Section 20.3.
 - [b] If the engine crankcase pressure decreased, repair the air compressor; refer to Section 20.2.1.

20.2.1 Air Compressor Repair

Perform the following steps to repair the defective air compressor:

1. Remove the air compressor from the engine; refer to Section 10.1.2.
2. Disassemble and repair the air compressor; refer to Section 10.1.3.
3. Install the repaired air compressor to the engine; refer to Section 10.1.4.

21.4.1 Engine Exhaust System Resolution

Perform the following steps to resolve the engine exhaust system:

1. Visually inspect the engine exhaust system; refer to OEM guidelines.
2. Repair and replace defective exhaust system components; refer to OEM guidelines.
3. Verify exhaust system resolution; refer to Section 21.4.1.1.

21.4.1.1 Test the Engine with Replaced Exhaust System

Perform the following steps to determine if replaced engine exhaust system components resolved excessive exhaust smoke condition:

 **CAUTION:**

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

 **CAUTION:**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- Always start and operate an engine in a well ventilated area.**
- If operating an engine in an enclosed area, vent the exhaust to the outside.**
- Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine at idle with a no-load for approximately 5 minutes, allowing the engine coolant to reach normal operating range.
3. Visually inspect exhaust for excessive smoke.
 - [a] If the engine exhaust emission appears normal, no further troubleshooting is required. Shut the engine down.
 - [b] If the engine exhaust emission is excessively black or gray, shut the engine down. Check the fuel injectors; refer to Section 21.5.

23.1 IMPROPER GRADE OF FUEL

To determine if an improper grade of fuel oil is causing excessive white smoke, perform the following:

1. Acquire a fuel oil sample from the vehicle fuel tank(s).
2. Submit fuel oil sample for an ASTM test analysis.
 - [a] If the fuel oil meets specifications, (listed in Table 29-4, refer to Section 29.6) check the fuel pump; refer to Section 23.2.
 - [b] If the fuel oil did not meet specifications, (listed in Table 29-4, refer to Section 29.6) resolve improper grade of fuel; refer to Section 23.1.1.

23.1.1 Improper Grade of Fuel Resolution

Perform the following steps to resolve the improper grade of fuel oil:

1. Drain the fuel oil tank(s), refer to OEM guidelines, and dispose of properly.
2. Refill the fuel oil tanks with new fuel oil having a cetane number greater than 40.
3. Verify fuel oil resolution; refer to Section 23.1.1.1.

23.1.1.1 Test the Engine with New Fuel Oil

Perform the following steps to determine if the new fuel oil refill resolved the excessive white smoke condition:

24 ROUGH RUNNING OR STALLING

Section	Page
24.1 LOW BATTERY VOLTAGE	24-3
24.2 AERATED FUEL OIL	24-5
24.3 INSUFFICIENT FUEL OIL FLOW	24-6
24.4 HIGH FUEL OIL TEMPERATURE RETURN	24-8
24.5 IMPROPER INJECTOR CALIBRATION SETTING (DDEC III ENGINES ONLY)	24-11
24.6 LOW COMPRESSION PRESSURE	24-13

25.1 AERATED FUEL

To determine if aerated fuel is causing lack of power, perform the following steps:

1. Test for aerated fuel; refer to Section 23.3.
2. Visually check to see if air bubbles are rising to the surface of the fuel within the container.
 - [a] If air bubbles are not present, shut down engine, check for high fuel pressure; refer to Section 25.2.
 - [b] If air bubbles are present, shut down engine; refer to Section 25.1.1.

25.1.1 Aerated Fuel Resolution

Perform the following to resolve aerated fuel:

1. Perform aerated fuel repair; refer to Section 23.3.1.
2. Verify aerated fuel resolution; refer to Section 25.1.1.1.

25.1.1.1 Test the Engine with Aerated Fuel Resolution

Perform the following to determine if aerated fuel resolution resolved lack of power condition:

25.8 HIGH ALTITUDE OPERATION

To determine if high altitude operation is causing lack of power, see Figure 25-3:

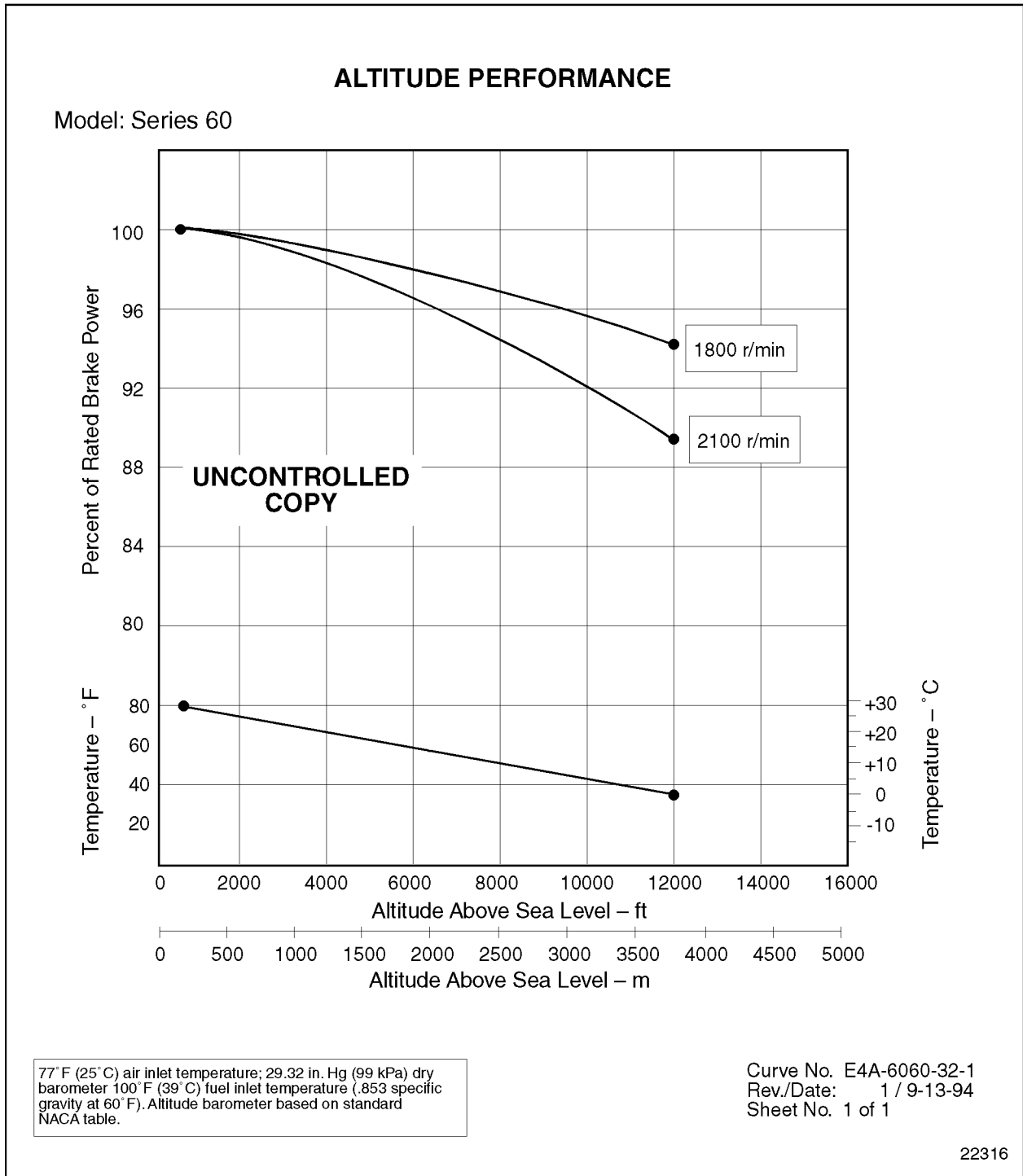


Figure 25-3 Altitude Performance Curves

26.6 ROCKER ARM SHAFT PLUGS MISSING (NEW OR REBUILT ENGINES ONLY)

If engine is not new or has not been rebuilt, refer to Section 26.7.

To determine if a missing rocker arm shaft plugs are causing low oil pressure, perform the following:

1. Remove the rocker arm cover; refer to Section 1.6.2.
2. Visually inspect the rocker arm shaft for missing or leaking shaft plugs.
 - [a] If the shaft plugs are present and are not leaking, check the oil cooler for restriction; refer to Section 26.7.
 - [b] If the shaft plugs are missing; refer to Section 26.6.2.
 - [c] If the shaft plugs are leaking, refer to Section 26.6.1.

26.6.1 Leaking Rocker Arm Shaft Plug Repair

Perform the following steps to repair leaking rocker arm shaft plugs:

1. Remove damaged shaft plugs; refer to Section 1.3.
2. Inspect rocker arm shaft for damage; refer to Section 1.3.3.1. If damage is found, replace the rocker arm shaft; refer to Section 1.3.2.
3. Install new shaft plugs; refer to Section 1.3.4.

NOTE:

Shaft plug **must** be installed 1.0-1.3 mm (0.040-0.050 in.) below surface using J 36236.

4. Install rocker arm cover; refer to Section 1.6.7.
5. Verify repair made to the rocker shaft plugs; refer to Section 26.6.2.1.

26.6.2 Missing Rocker Arm Shaft Plug Repair

Perform the following steps to repair missing rocker arm shaft plugs:

1. Inspect rocker arm shaft for damage; refer to Section 1.3.3.1. If damage is found, replace the rocker arm shaft; refer to Section 1.3.2.
2. Install new shaft plugs; refer to Section 1.3.4.

NOTE:

Shaft plug **must** be installed 1.0-1.3 mm (0.040-0.050 in.) below surface using J 36236.

3. Install rocker arm cover; refer to Section 1.6.7.
4. Verify repair made to the rocker shaft plugs; refer to Section 26.6.2.1.

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