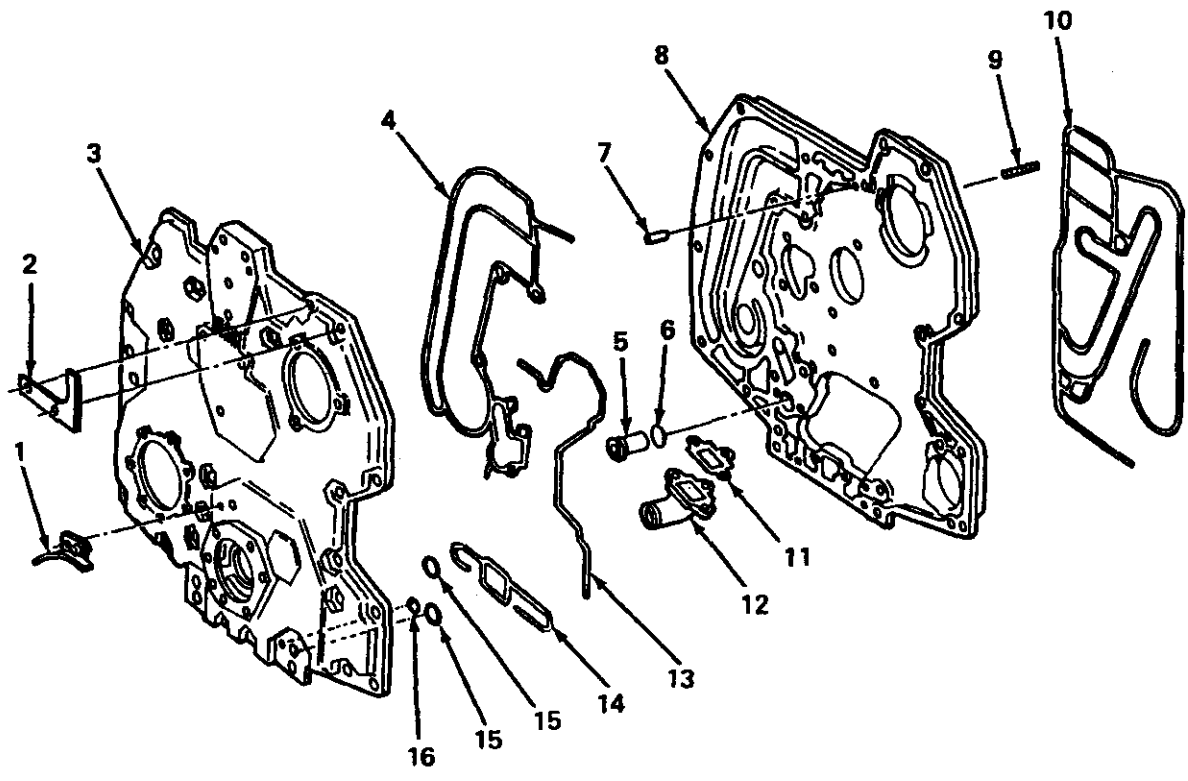
DETROIT DIESEL

SERIES 40

Service Manual Section 11 - Appendix F

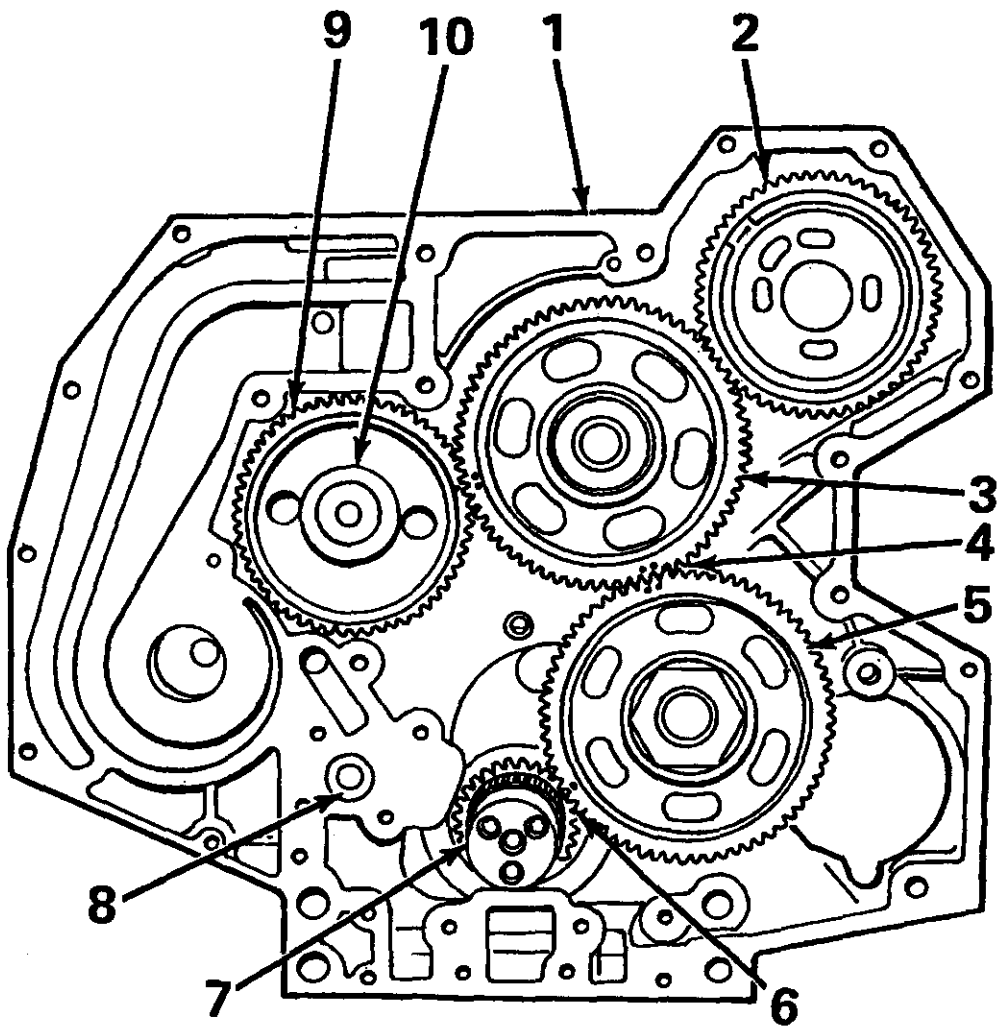
11 TIMING GEAR TRAIN AND FRONT COVER

11.1 CRANKCASE FRONT COVER AND RELATED PARTS EXPLODED VIEW



1. Timing Indicator
2. Bracket
3. Front Crankcase Cover (Front Half)
4. Front Cover Gasket
5. Relief Valve Assembly
6. Gasket
7. Dowel
8. Front Crankcase Cover (Rear Half)
9. Stud
10. Gasket (Front Cover to Crankcase)
11. Water Inlet Elbow Gasket
12. Water Inlet Elbow
13. Front Cover Gasket
14. Front Cover Gasket
15. O–ring
16. O–ring

FIGURE 11–1 Crankcase Front Cover and Related Parts.



1. Rear Half Front Cover
2. Fuel Injection Pump Timing Gear
3. Upper Idler Gear
4. Upper Idler/Lower Idler Gear Timing Marks
5. Lower Idler Gear
6. Lower Idler Gear/Crankshaft Timing Marks
7. Crankshaft
8. Pressure Regulator Valve 80 lb/in.^{2} (550 kPa)
9. Camshaft Gear
10. Camshaft

FIGURE 11–2 Gear Train

11.2 SPECIFICATIONS

DIMENSION	VALUES
Timing Gears:	
Crankshaft to Idler Backlash	TBD
Idler to Camshaft Backlash	TBD
Idler to Injection Pump Backlash	TBD
Idler to Idler Backlash	TBD

11.2.1 Special Torques

Crankcase Front Cover Bolts (Front & Rear Halves)	13 lb·ft or 156 lb·in. (18 N·m)
Idler Gear Retaining Bolt (Upper)	265 lb·ft (359 N·m)
Idler Gear Retaining Bolt (Lower)	470 lb·ft (637 N·m)
Camshaft Thrust Plate Bolt	19 lb·ft or 228 lb·in. (26 N·m)
Injection Pump Drive Gear Bolts	38 lb·ft (51 N·m)
Air Compressor Tail Bracket Mounting Bolts (Crankcase)	85 lb·ft (115 N·m)
Air Compressor Tail Bracket Mounting Bolt (Compressor)	49 lb·ft (66 N·m)
Air Compressor Drive Gear Nut	110 lb·ft (149 N·m)
Air Compressor Mounting Bolts	46 lb·ft (62 N·m)
Belt Tensioner (Front Cover)	37 lb·ft (50 N·m)
Belt Tensioner (Freon Compressor)	37 lb·ft (50 N·m)
Fuel Pump Gear Housing Cover	66 lb·in. (7 N·m)
Water Pump Pulley	66 lb·in. (7 N·m)
Fan Drive	13 lb·ft or 156 lb·in. (18 N·m)
Front Cover Bracket to Head (No Air Conditioner)	60 lb·ft (81 N·m)
Front Cover Bracket to Head (With Air Conditioner)	83 lb·ft (113 N·m)

11.2.2 Special Service Tools

Tool No.	Description
J39266	Vibration Damper Wear Sleeve Installing Tool
J41161	Timing Pin (To Set Timing)
J41162	Plunger Pin (To Check Timing)
J41167	Lower Idler Gear Socket (3/4 in./20 mm 12 point)

11.3 ENGINE GEAR TRAIN TIMING

Valve train failures from broken or bent push rods, valves, rocker arms and worn valve keepers and/or rotators in many instances could be caused by improper timing of the gear train. Depending on valve lash setting, if the camshaft gear is improperly timed by one (1) tooth early, the engine pistons will strike the intake valve heads or if the timing is set one (1) tooth late, the exhaust valve may contact pistons.

11.3.1 Checking Engine Gear Train Timing Without Removing Front Cover And/ Or Engine Tear Down.

NOTE:

No. 1 intake valve setting with No. 1 piston @ TDC (compression) is 0.029 in. (0.74 mm).

11.3.1.1 Method One — Using A Feeler Gauge

1. Adjust the No. 1 intake valve with the No. 1 piston set at TDC (Top Dead Center) compression stroke to 0.029 in. (0.74 mm).
2. Turn the engine forward to approximately BDC (Bottom Dead Center).
3. Place a 0.004 in. (0.10 mm) feeler gauge between the valve lever and valve stem of the No. 1 intake valve and slowly rotate the engine forward until the feeler gauge becomes tight. This is now the point at which the No. 1 intake valve starts to open before top dead center. The degree reading on the vibration damper should be 245° +/– 35°.

NOTE:

One (1) tooth "out of time" on gear train equals approximately 11 degrees movement of vibration damper.

NOTE:

If the timing on the No. 1 valve is within specifications, the other valves barring extreme camshaft lobe wear or poor adjustment will also be in time.

4. Readjust the No. 1 intake valve to its proper lash as described in Section 7.
5. If timing is found to be incorrect, removal of the engine's front cover is required to inspect punch mark and gear tooth position. **FIGURE 11–2** depicts a properly timed assembly and number of teeth between marks.

11.3.1.2 Method Two — Using A Dial Indicator

1. Adjust the No. 1 intake valve with the No. 1 piston set at TDC (Top Dead Center) compression stroke to 0.029 in. (0.74 mm).
2. Position the dial indicator fixture magnetic base on the valve cover fence rail with the indicator shaft on the No. 1 intake valve rotator.
3. Set dial indicator at zero.
4. Rotate the engine approximately one full revolution either direction to a position of 360° from starting point.
5. The dial indicator should read .155 to .220 in. (3.93 to 5.59 mm) for proper gear train timing.

ENGINE GEAR TRAIN TIMING

6. If dial indicator readings are outside the specified range, the engine's front cover must be removed and punch mark and gear tooth position adjusted as specified in **FIGURE 11–2.**

7. Readjust the No. 1 intake valve to its proper lash as described in Section 7.

NOTICE: **Engine gear train timing and valve lash adjustment must be performed. Following these procedures to assure proper valve and piston relationship and prevent pistons from striking valves.**

11.4 FRONT COVER

11.4.1 Removal

1. Prior to front cover removal, remove the following components:

NOTE:
Refer to the appropriate manual section for detailed removal procedures.

- ❑ Vibration damper
- ❑ Oil pump assembly
- ❑ Water inlet elbow
- ❑ Water pump and pulley
- ❑ Oil pan
- ❑ Oil cooler
- ❑ Coolant filter and header
- ❑ Fuel injection pump
- ❑ Fuel injection lines (high and low pressure)

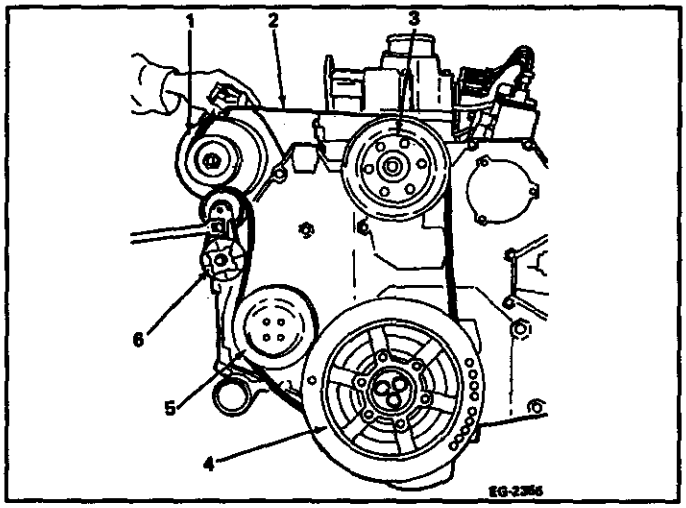
2. Remove the serpentine belt and tensioner as follows:

   a. Install breaker bar into belt tensioner and remove tension on belt. Refer to **FIGURE 11–3.**

   b. Remove serpentine belt.

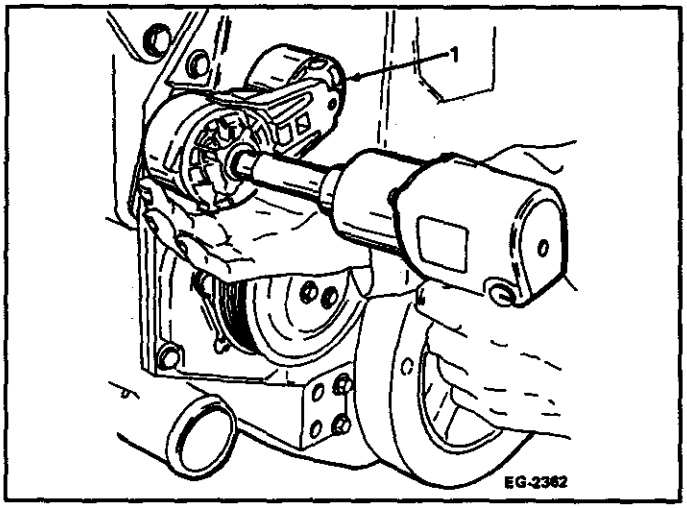
   c. Return tensioner back to original position and remove breaker bar.

   d. Loosen mounting bolt and remove tensioner. Refer to **FIGURE 11–4.**



1. **Alternator**
2. **Serpentine Belt**
3. **Fan Drive Pulley**
4. **Vibration Damper**
5. **Water Pump Pulley**
6. **Belt Tensioner**

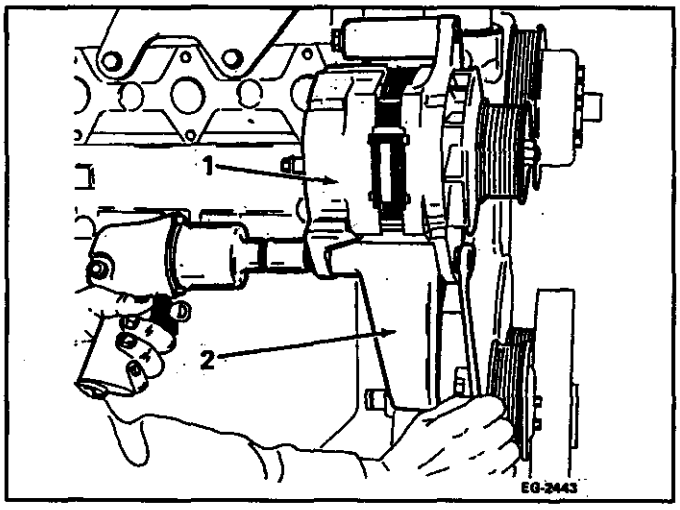
FIGURE 11–3



1. **Belt Tensioner**

FIGURE 11–4

FRONT COVER



1. **Alternator**
2. **Bracket**

FIGURE 11–5

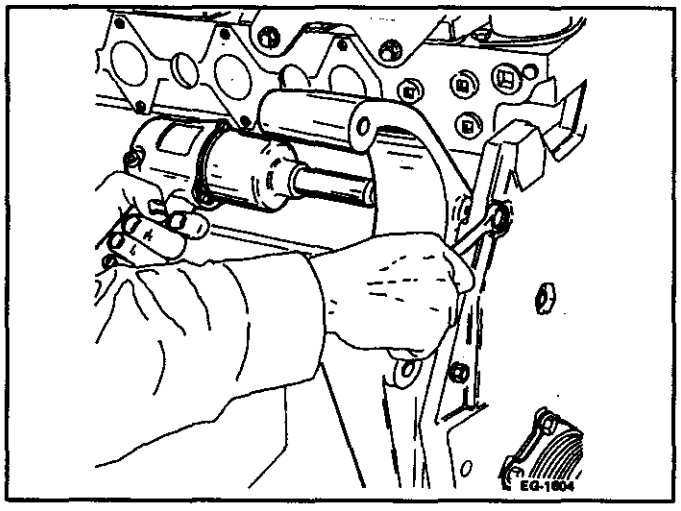
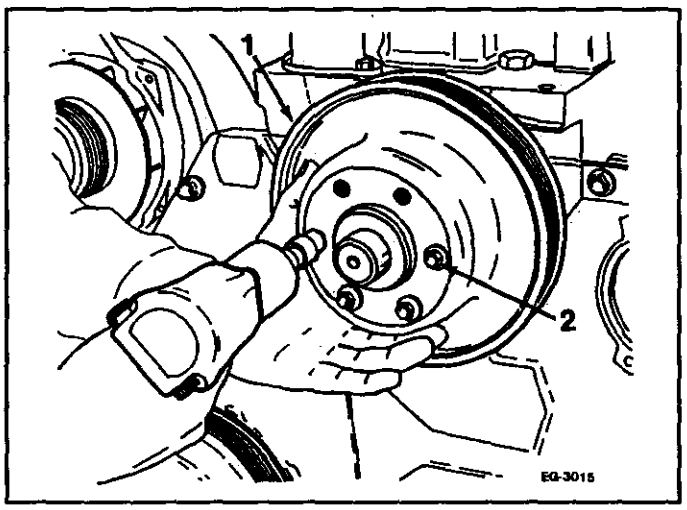


FIGURE 11–6

3. Remove the alternator as follows: Refer to **FIGURE 11–5.**
   a. Loosen and remove the lower alternator mounting bolt and the top rolling pin.
   b. Remove the alternator
   c. Loosen and remove the alternator mounting bracket bolts. Refer to **FIGURE 11–6.**
   d. Remove the bracket.

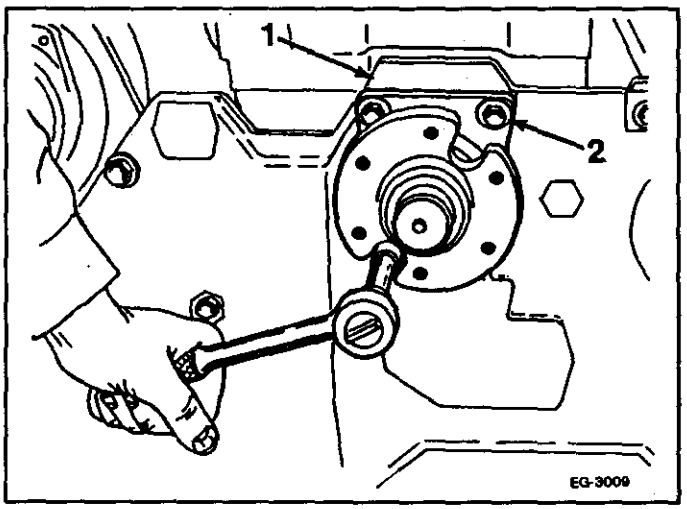
FRONT COVER

4. Remove the fan drive hub and pulley as follows: Refer to **FIGURE 11–7**.
   a. Remove the bolts and fan pulley.
   b. Remove fan hub drive capscrews and hub. Refer to **FIGURE 11–8.**



1. **Fan Hub Pulley**
2. **Fan Hub Mounting Bolts (6)**

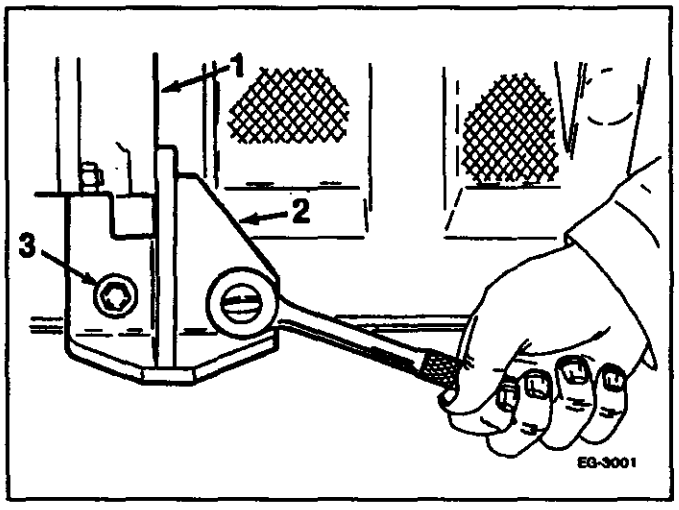
FIGURE 11–7



1. **Bracket**
2. **Fan Hub Mount**

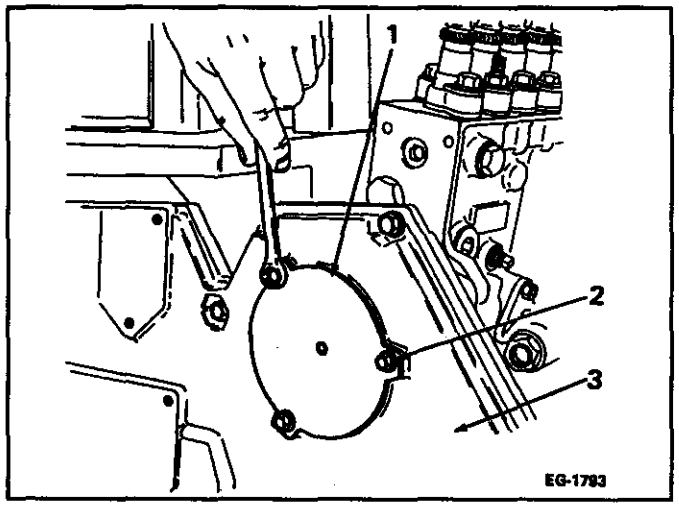
FIGURE 11–8

FRONT COVER



1. Air Compressor
2. Air Compressor Bracket
3. Mounting Bolts (2)

FIGURE 11–13



1. Access Cover
2. Mounting Bolt
3. Front Cover

FIGURE 11–14

e. Remove two (2) bolts securing bracket to crankcase. Remove bracket (**FIGURE 11–13**).

f. Remove two (2) bolts securing air compressor to front cover and remove air compressor.

6. Loosen and remove the three fasteners which secure the injection pump drive gear access cover and gasket to front cover. Remove cover and discard the O–ring. (Refer to **FIGURE 11–14**)

7. Remove the fuel injection pump. Refer to **Section 14,** "Fuel Injection Pump."

NOTE:
The fuel injection pump drive gear is free and is removed when the front cover is removed.

NOTICE: **Prior to removing the injection pump, follow the injection pump to engine timing procedure to facilitate reassembly, refer to Section 14.**

FRONT COVER

8. Remove the front cover as follows:

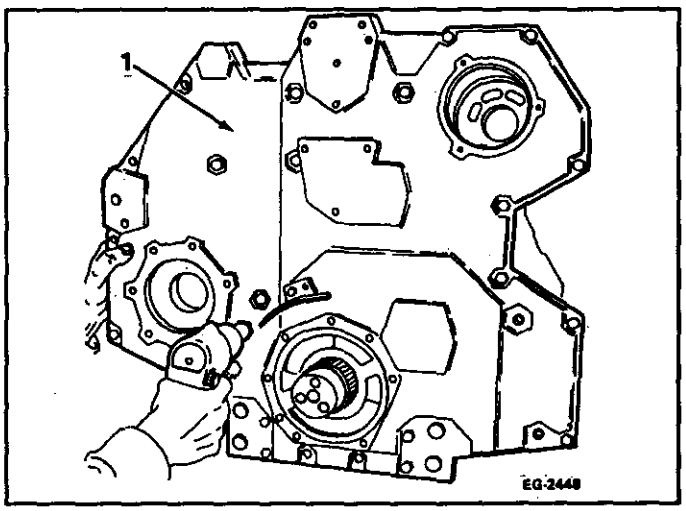
NOTE:

The engine may be rotated to the vertical position (front cover facing up) to allow retention of the hardware in the cover.

a. Loosen and remove all the front cover mounting bolts which secure the front cover(front half) to the rear half of the front cover and crankcase. Refer to **FIGURE 11–15.**

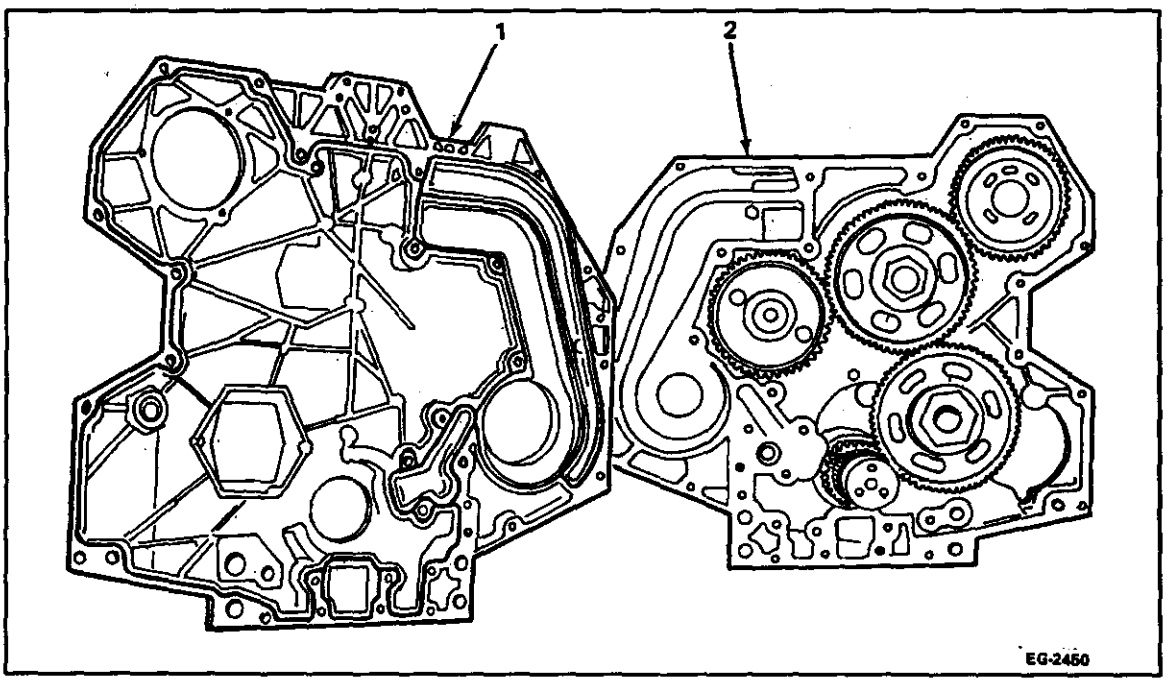
b. Lift the front cover (with hardware) from the crankcase and set aside.

c. Remove front cover gaskets and O–rings from front cover and discard. Refer to **FIGURE 11–16.**



1. Front Cover

FIGURE 11–15

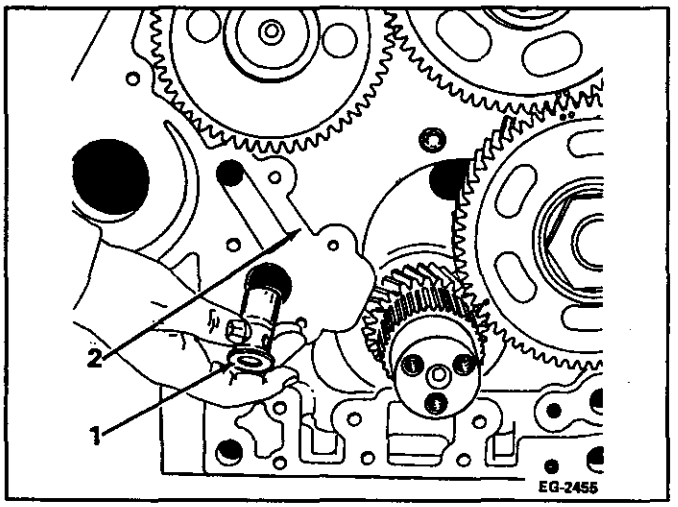


1. Front Half Front Cover

2. Rear Half Front Cover

FIGURE 11–16

FRONT COVER



1. Oil Pressure Relief Valve
2. Front Cover Rear Half

FIGURE 11–17

9. Remove oil pressure relief valve from front cover (rear half). Mark valve to identify its proper location when installing. (Refer to FIGURE 11–17)

NOTE:
Valve may be removed by depressing plunger and trapping a length of copper wire when released. Valve may then be removed by copper wire.

NOTICE: **The oil pressure relief valve should be tagged upon removal to ensure identification. DO NOT mix oil pressure relief valve with oil pressure regulator valve (found in side of crankcase).**

11.4.2 Cleaning

1. Remove all gasket material and RTV from front cover using a scraper or wire brush.
2. Clean all bolt threads prior to reassembly.

11.4.3 Inspection

1. Visually inspect the front cover for cracks or porosity.

NOTE:
This is especially important if oil and coolant contamination has been found and no other cause is discovered.

2. Replace any front cover which fails visual inspection.

11.5 TIMING GEAR TRAIN

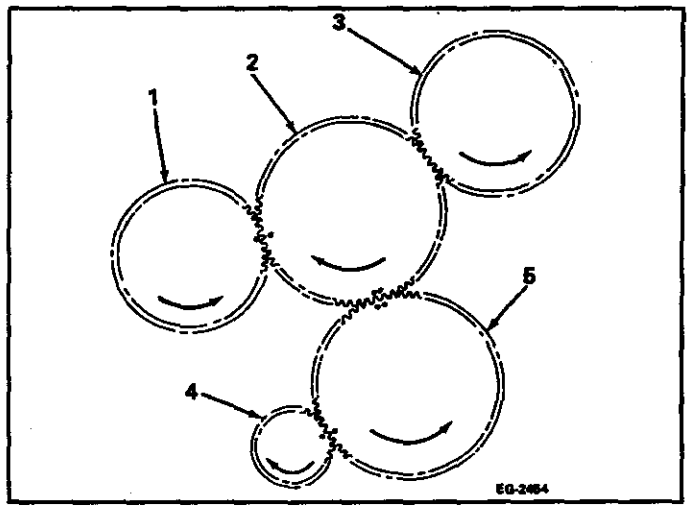
11.5.1 Inspection Prior To Removal

1. Rotate engine so timing marks on lower and upper idler gears, crankshaft and camshaft gear are aligned (Refer to **FIGURE 11–18**)

NOTE:
Once assembled at "marks aligned" position, engine will require 37 crankshaft revolutions for "marks aligned" position again.

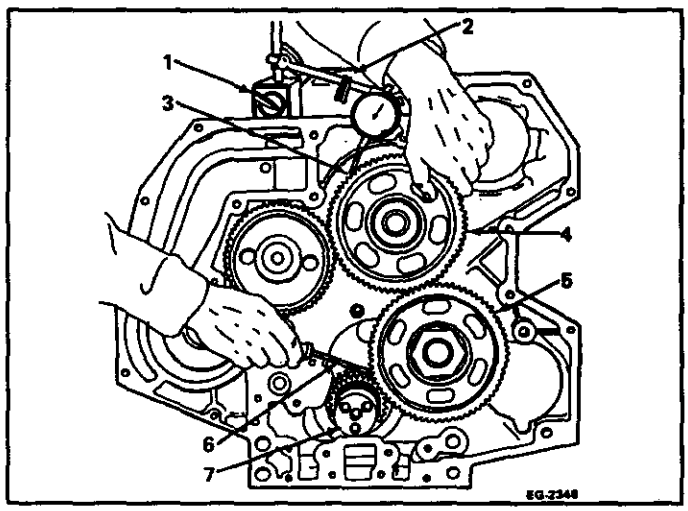
NOTICE: **Prior to removing any gear, mount a dial indicator onto the engine and check for gear backlash.**

2. Check upper idler gear lash as follows: (Refer to **FIGURE 11–19**)
   a. Mount magnetic base dial indicator on top of crankcase.
   b. Position dial indicator on gear tooth and "zero" indicator.



1. **Camshaft Gear**
2. **Upper Idler Gear**
3. **Fuel Pump Gear**
4. **Crankshaft Gear**
5. **Lower Idler Gear**

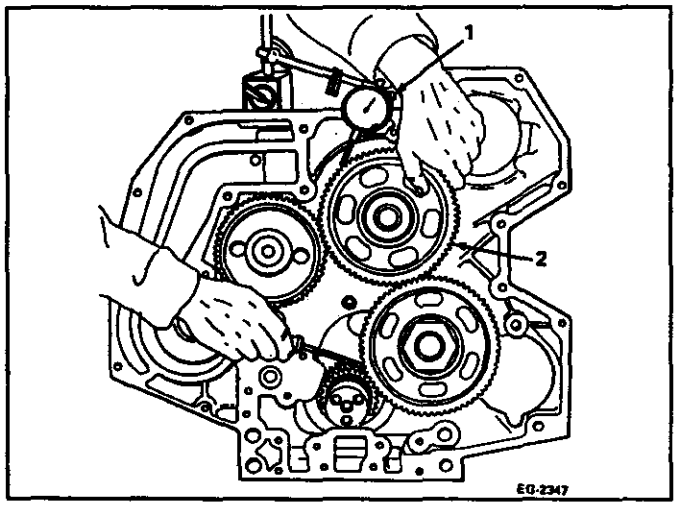
FIGURE 11–18



1. **Dial Indicator**
2. **Crankcase**
3. **Dial Indicator Position**
4. **Upper Idler Gear**
5. **Lower Idler Gear**
6. **Screwdriver**
7. **Crankshaft**

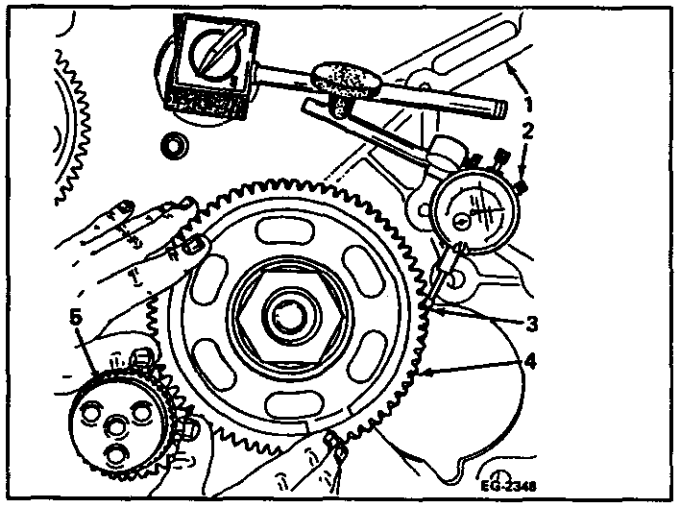
FIGURE 11–19

TIMING GEAR TRAIN



1. Dial Indicator
2. Upper Idler Gear

FIGURE 11–20



1. Front Cover
2. Dial Indicator
3. Dial Indicator Position
4. Lower Idler Gear
5. Crankshaft

FIGURE 11–21

c. Place a screwdriver between crankshaft and lower idler gear.

d. Move upper idler gear back and forth.

e. Record reading on dial indicator (**FIGURE 11–20**). If end play exceeds specified limits (See "Specifications"), replace upper idler gear.

3. Using dial indicator also check upper idler gear end play.

4. Check lower idler gear lash as follows: (Refer to **FIGURE 11–21**)

a. Mount a magnetic base dial indicator onto front cover.

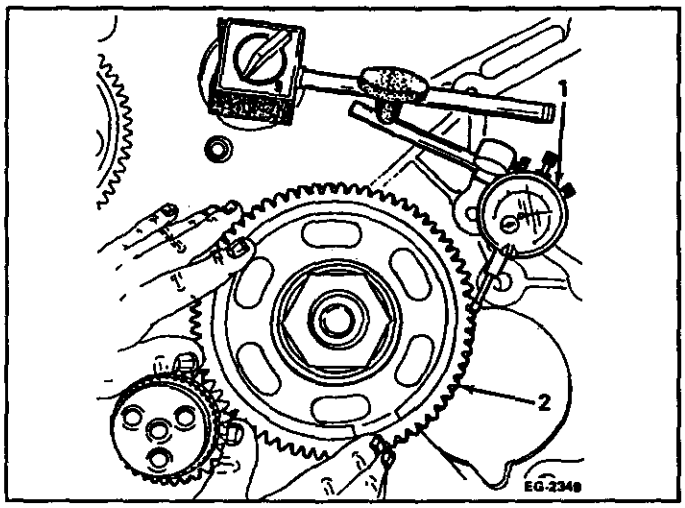
b. Position dial indicator on gear tooth and "zero" indicator.

TIMING GEAR TRAIN

c. Move lower idler gear back and forth

d. Record reading on dial indicator (**FIGURE 11–12**). If end play exceeds specified limits (See "Specifications"), replace lower idler gear.

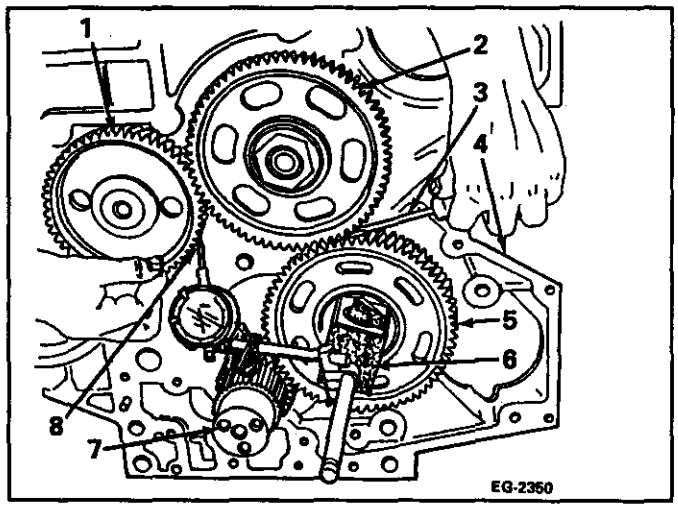
5. Using dial indicator also check lower idler gear end play.



1. **Magnetic Dial Indicator**
2. **Lower Idler Gear**

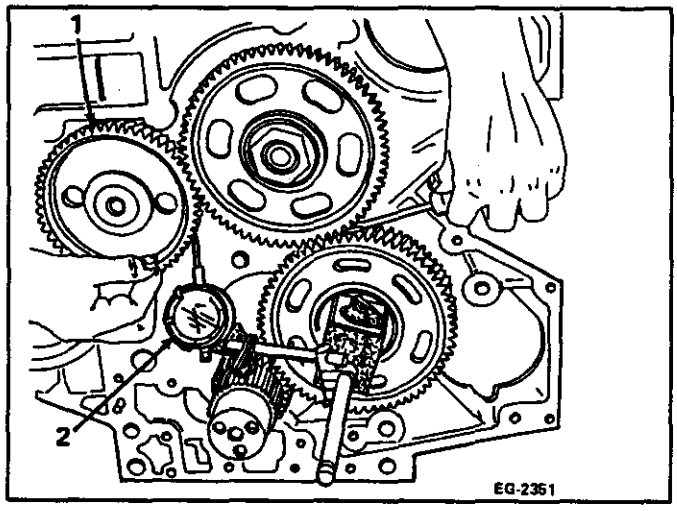
FIGURE 11–22

TIMING GEAR TRAIN



1. **Camshaft Gear**
2. **Upper Idler Gear**
3. **Screwdriver**
4. **Front Cover**
5. **Lower Idler Gear**
6. **Dial Indicator**
7. **Crankshaft**
8. **Dial Indicator Position**

FIGURE 11–23



1. **Magnetic Dial Indicator**
2. **Camshaft Gear**

FIGURE 11–24

6. Check camshaft gear lash as follows: (Refer to **FIGURE 11–23**)
   a. Mount a magnetic base dial indicator onto the front cover or lower idler gear.
   b. Position dial indicator onto camshaft tooth and "zero" dial indicator.
   c. Place a screwdriver between the lower and upper idler gears.
   d. Move the camshaft gear back and forth.
   e. Record reading on dial indicator (**FIGURE 11–24**). If end play exceeds specified limits (See "Specifications"), replace camshaft gear.
7. Using dial indicator also check camshaft gear end play.

TIMING GEAR TRAIN

Visually inspect all gears for nicks, chips or wear. Replace as necessary.

11.5.2 Removal of Idler Gear Assemblies

1. Remove the lower idler gear as follows: Refer to **FIGURE 11–25**.

   a. Loosen and remove the idler gear retaining bolt using lower idler **J41167**.

   b. Remove the idler gear assembly from the front cover.

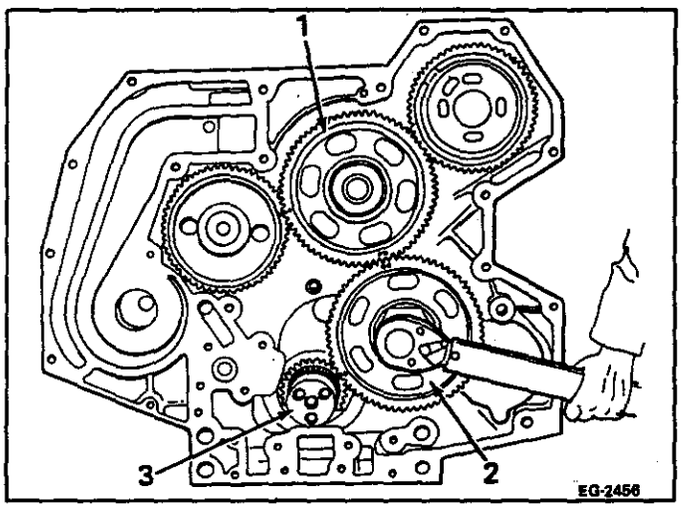
NOTE:
Each idler gear (upper and lower) are supported on tapered roller bearings and shafts.

2. Remove the upper idler gear as follows: Refer to **FIGURE 11–26**.

   a. Remove the idler gear retaining bolt and DISCARD.

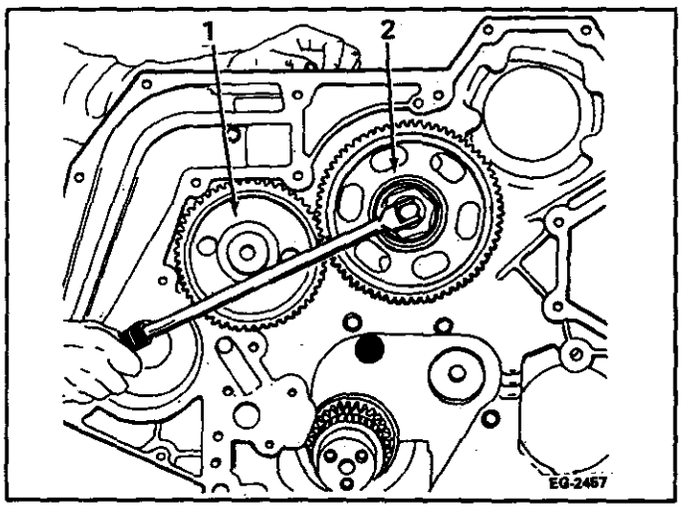
NOTICE: **A new upper idler gear bolt must be used at each installation of upper idler gear.**

   b. Remove the idler gear assembly from the front cover.



1. **Upper Idler Gear**
2. **Lower Idler Gear**
3. **Crankshaft**

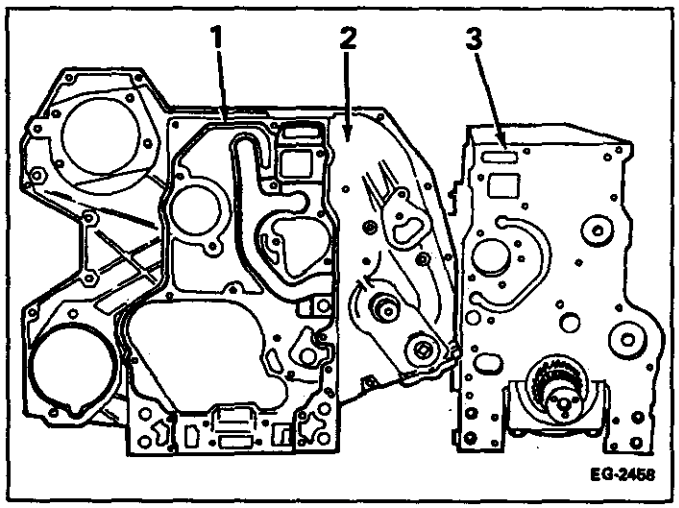
FIGURE 11–25



1. **Camshaft Gear**
2. **Upper Idler Gear**

FIGURE 11–26

TIMING GEAR TRAIN TIMING



1. Gasket
2. Front Cover
3. Crankcase

FIGURE 11–27

11.5.3 Removal of Camshaft Gear and Crankshaft Gear

1. Refer to Section 8 for the camshaft and/or gear removal procedure.

NOTE:

The camshaft gear must be pressed off the camshaft since it is a shrink fit. Remove only if damaged or worn.

2. Refer to Section 10 for the crankshaft and/or gear removal procedure.

11.5.4 Removal of the Front Cover (Rear Half)

With the gears removed, remove the front cover as follows:

1. Remove the nine retaining bolts which secure the front cover to the crankcase. Refer to **FIGURE 11–27.**
2. Lift the front cover (with dowels) off the crankcase.
3. Discard the O–ring and clean any sealing material from the front cover or crankcase.

11.5.5 Cleaning and Inspecting the Front Cover

1. Remove sealing material from front cover (rear half) using a scraper or wire brush.
2. Clean all bolt threads prior to reassembly.
3. Visually inspect the front cover for cracks or porosity.

NOTE:

This is especially important if oil or coolant contamination has been found and no other cause is discovered.

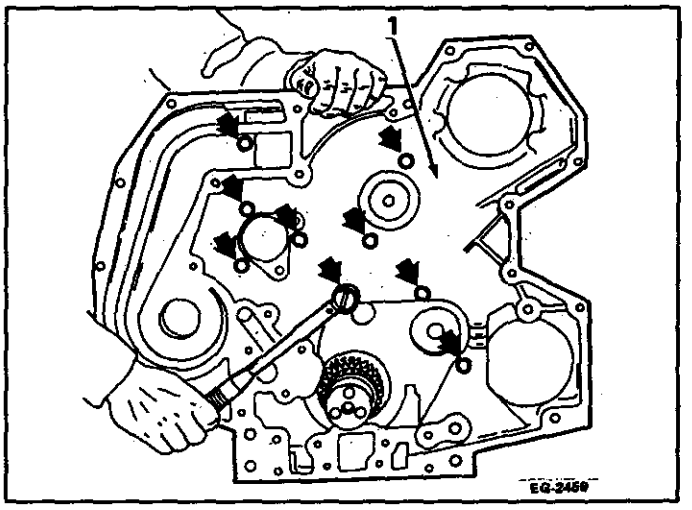
INSTALLATION

11.5.6 Cleaning and Inspecting the Idler Gear Assemblies

1. Clean all gears and related components, which are to be reinstalled, as follows:
   a. Clean all components in a suitable solvent.
   b. Dry with filtered compressed air.
2. Visually inspect the bearings and shaft for wear or damage. Replace gear and bearing assembly as required.
3. Visually inspect the gear teeth for chips or nicks. Replace assembly if required.

NOTE:
Bearing and Gear are serviced as an assembly.

NOTE:
Inspection of the camshaft, crankshaft and oil pump spline gears is performed prior to gear removal or disassembly. Refer the Injection Pump Drive Gear Inspection in this section.



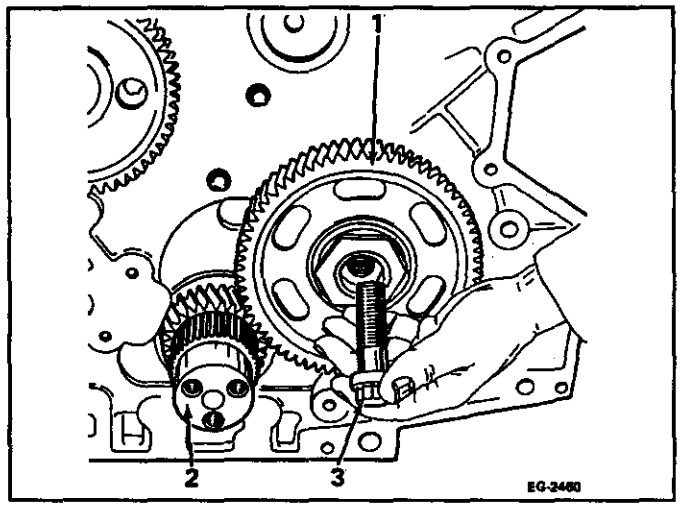
1. Front Cover

FIGURE 11–28

11.6 INSTALLATION

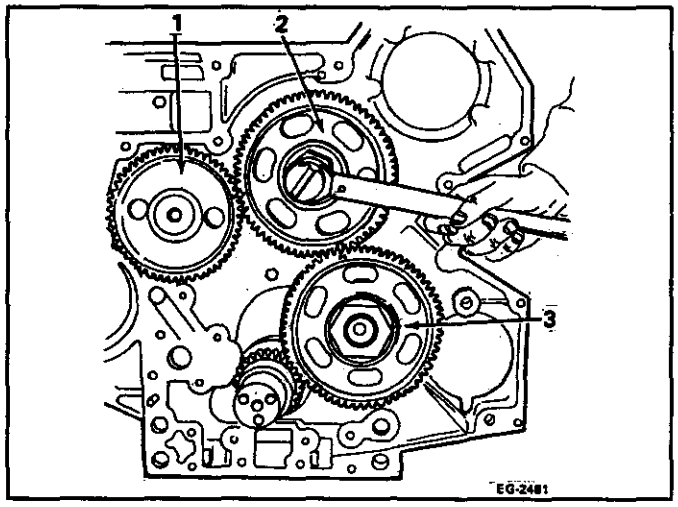
1. Install the crankcase front cover (rear half) as follows:
   a. Install a new front cover O–ring into the groove in the cover. Refer to **FIGURE 11–28.**
   b. Mount the front cover to the crankcase using nine bolts. Tighten the bolts to the specified "Special Torque." Refer to **FIGURE 11–26.**
2. Install a new crankshaft gear and oil spline gear, if required, as specified in Section 10.

INSTALLATION



1. **Lower Idler Gear**
2. **Crankshaft**
3. **Mounting Bolt**

FIGURE 11–29



1. **Camshaft Gear**
2. **Upper Idler Gear**
3. **Lower Idler Gear**

FIGURE 11–30

3. Reinstall the crankshaft. Refer to Section 10 for installation instructions.
4. If required, press on a new camshaft gear as explained in Section 8.
5. Install the camshaft and gear assembly as specified in Section 8.

NOTE:
Check camshaft end play and be sure the tappets move freely in their bores.

11.6.1 Installation of Lower and Upper Idler Gear

Install the lower idler gear as follows: (Refer to **FIGURE 11–29**).

1. Install the gear with the timing marks facing out.
2. Tighten the retaining bolt to the specified "Special Torque."

NOTICE: **Remeasure crankshaft to idler gear backlash, after installation to confirm proper reassembly.**

Install the upper idler gear as follows: (Refer to **FIGURE 11–30**).

NOTICE: **A new upper idler gear bolt must be used at each installation of upper idler gear.**

1. Install the gear with the timing marks facing out.
2. Tighten the retaining bolt to the specified "Special Torque."

INSTALLATION

3. When an engine has been disassembled and the camshaft, crankshaft or idler gear removed, the gears must be assembled with the timing marks properly aligned, as shown in **FIGURE 11–31.**

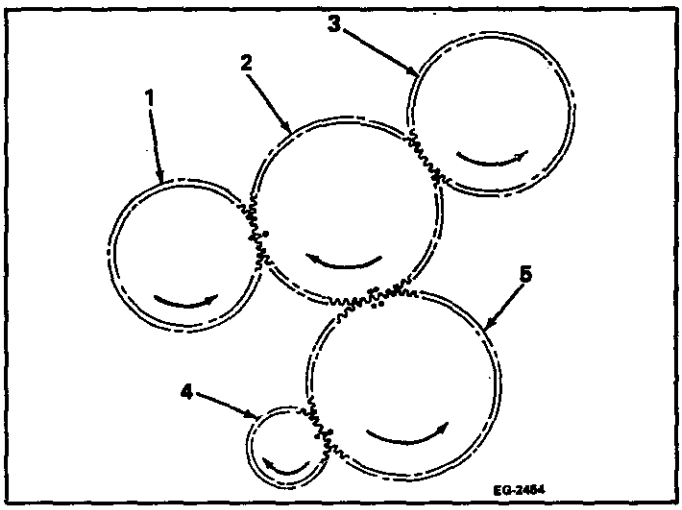
NOTE:
The single punch marks on the crankshaft and lower idler gear and camshaft and upper idler gear must align, while the two punch marks on both the idler gears must align.

NOTE:
Once assembled at "marks aligned" position, engine will require 37 crankshaft revolutions for "marks aligned" position again.

NOTICE: **Remeasure camshaft to idler gear after installation to confirm proper reassembly.**

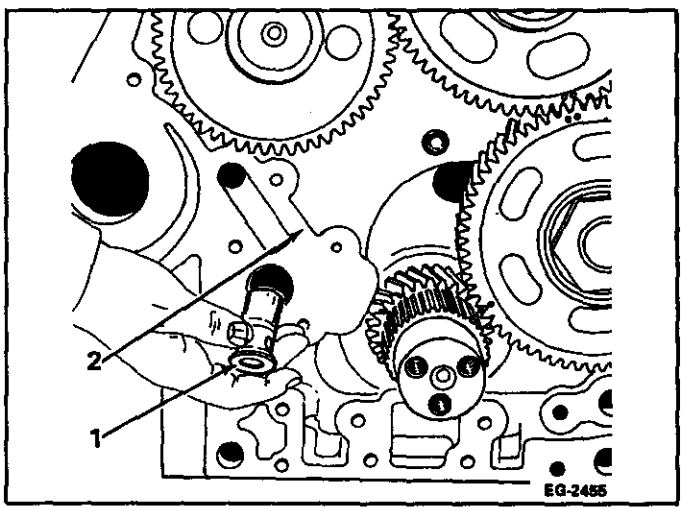
4. Install the fuel pump drive gear in position, with the machined side towards the outside (front) of engine. The gear has 5 kidney–shaped holes. Three holes are grouped together and the middle hole should be placed in the 10 o'clock position.

5. Install the oil pressure relief valve into the front cover (rear half). Refer to **FIGURE 11–32.**



1. Camshaft Gear
2. Upper Idler Gear
3. Fuel Pump Gear
4. Crankshaft Gear
5. Lower Idler Gear

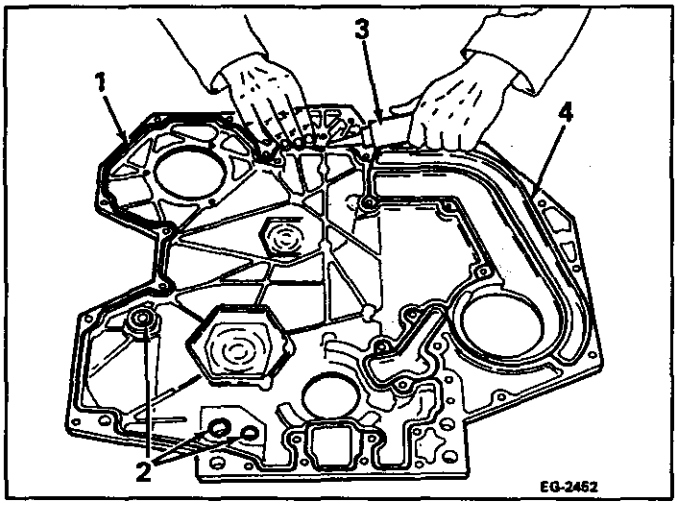
FIGURE 11–31



1. Oil Pressure Relief Valve
2. Front Cover Rear Half

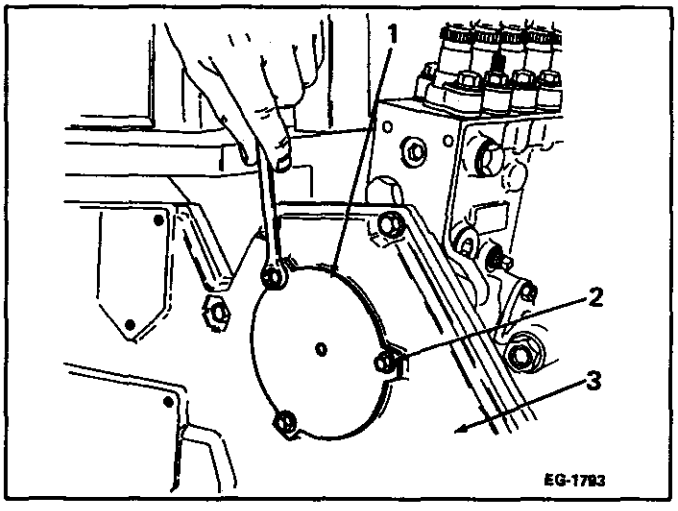
FIGURE 11–32

INSTALLATION



1. Gasket
2. O–ring
3. Liquid Gasket
4. Gasket

FIGURE 11–33



1. Access Cover
2. Mounting Bolt
3. Front Cover

FIGURE 11–34

11.6.2 Installation of Front Cover (Front Half)

Install the front cover as follows: Refer to **FIGURE 11–33.**

1. Apply assembly grease to the three O–rings and install into the front cover.
2. Install a new gasket (3 segments) into the front cover. Two of the gasket segments are molded pieces and the third is a bulk piece. Once the gasket segments are in place, apply RTV to the joints.
3. Install the front cover on the locating dowel pins and install the mounting hardware.
4. Tighten the front cover mounting bolts to the specified torque. See "Specifications."

11.6.3 Installation of Injection Pump Drive Gear Access Cover

Install the injection pump drive gear access cover using a new gasket as follows: Refer to **FIGURE 11–34.**

NOTE:

Install fuel injection pump prior to access cover installation. Refer to Section 14, "Fuel Injection Pump" for pump installation instructions.

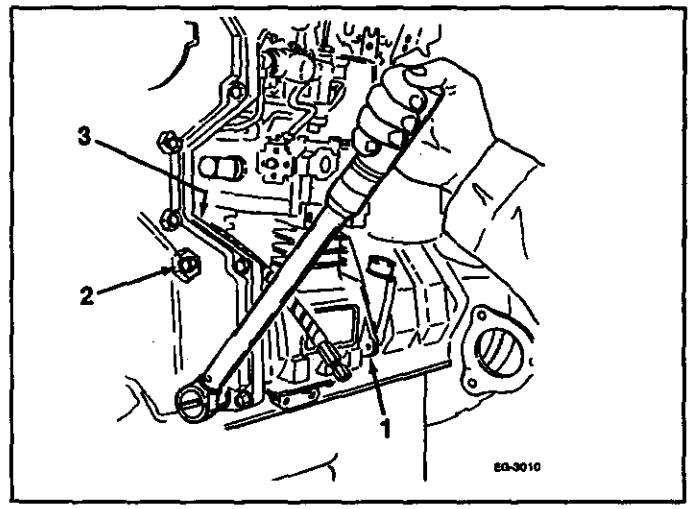
1. Secure the three bolts and washers which fasten into the front cover casting.
2. Tighten the fasteners to the standard torque. See "Specifications."

INSTALLATION

11.6.4 Installation of Air Compressor/ Power Steering Pump (If Applicable)

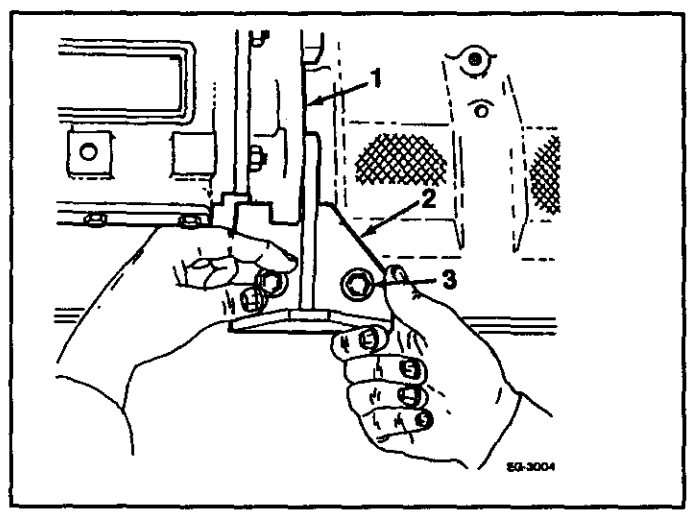
Install the air compressor/power steering pump as follows:

1. Apply a small amount of assembly grease to the O–ring and install into groove on front cover.
2. Mount air compressor to front cover and attach with capscrews. Refer to **FIGURE 11–35.**
3. Place air compressor bracket against crankcase, then slide forward to air compressor mounting face. Install two (2) bolts and finger–tighten to secure bracket to crankcase. Refer to **FIGURE 11–36**.



1. **Air Compressor**
2. **Front Cover**
3. **Mounting Bolts (2)**

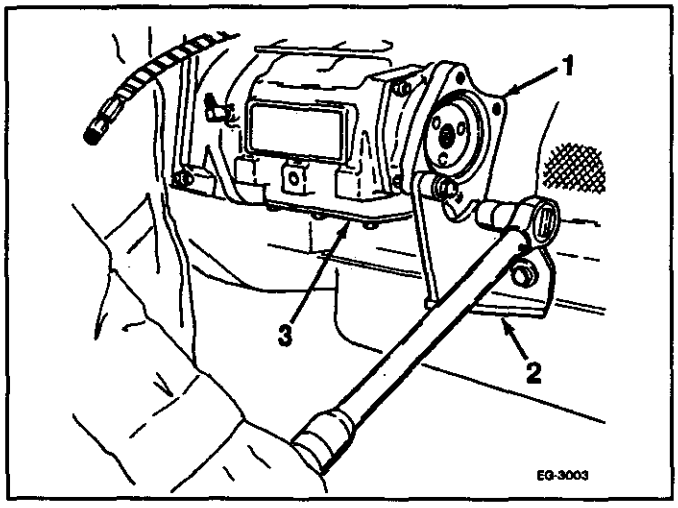
FIGURE 11–35



1. **Air Compressor**
2. **Tail Bracket**
3. **Power Steering Pump Bracket**

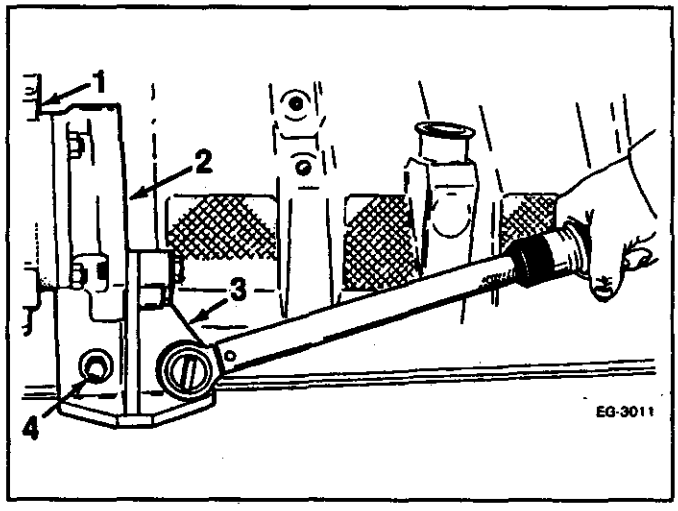
FIGURE 11–36

INSTALLATION



1. **Bracket**
2. **Tail Bracket**
3. **Air Compressor**

FIGURE 11–37



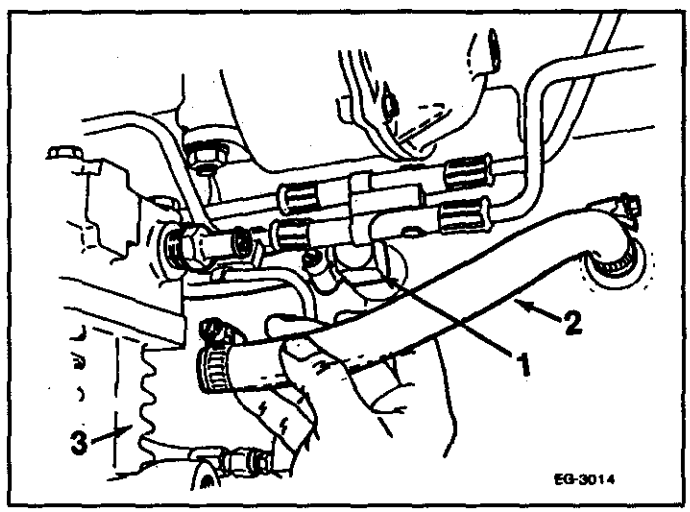
1. **Air Compressor**
2. **Tail Bracket**
3. **Power Steering Pump Bracket**

FIGURE 11–38

4. Secure air compressor bracket to air compressor using two (2) bolts and two (2) washers. Tighten to standard torque. Refer to **FIGURE 11–37.**
5. Torque two (2) bolts securing bracket to crankcase to special torque value (**FIGURE 11–38**).

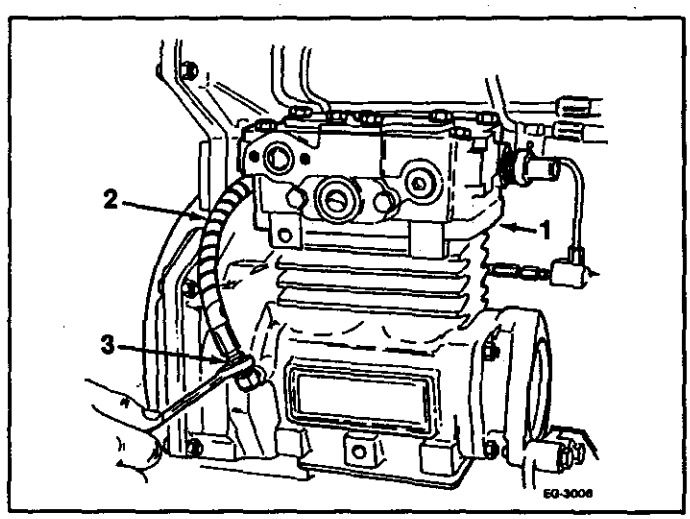
INSTALLATION

6. Install two (2) coolant hoses to air compressor and to crankcase (**FIGURE 11–39**).
7. Install lubrication line to air compressor and tighten nuts in two (2) places (**FIGURE 11–40**).



1. Coolant Fitting
2. Coolant Hose
3. Air Compressor

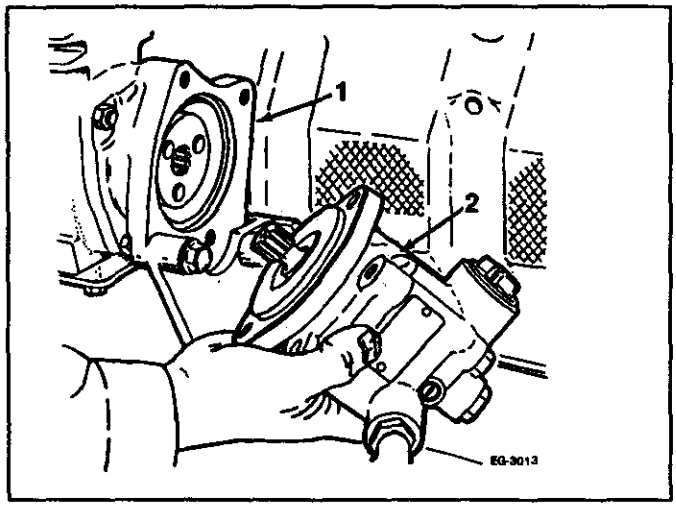
FIGURE 11–39



1. Air Compressor
2. Lub Oil Line
3. Nuts (2)

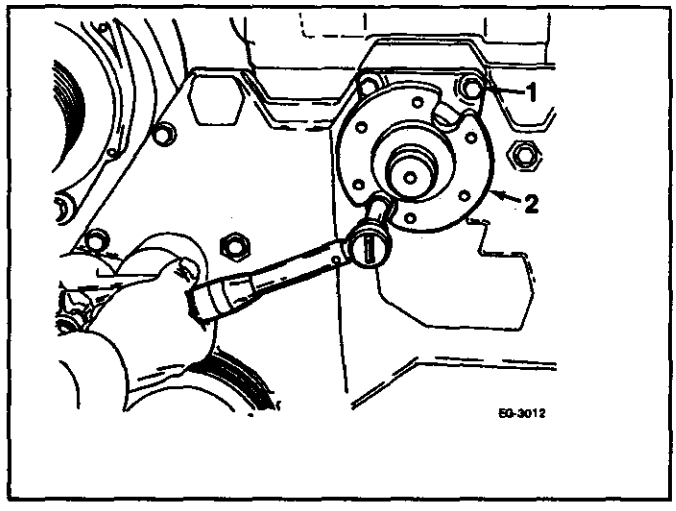
FIGURE 11–40

INSTALLATION



1. Air Compressor
2. Power Steering Pump

FIGURE 11–41



1. Mounting Bolts (4)
2. Fan Hub

FIGURE 11–42

8. Using two (2) bolts, mount steering pump to air compressor (**FIGURE 11–41**). Tighten bolts to standard torque.

11.6.5 Installation of Fan Hub and Pulley

Install the fan drive hub and pulley as follows: Refer to **FIGURE 11–42**.

1. Mount the lower bolt to the hub and tighten until snug.
2. Mount the fan drive pulley to the fan hub and tighten to the specified "Special Torque."

FAN HUB AND PULLEY

3. Install alternator support bracket to front cover and secure with capscrews coated with Loctite® 262.
4. Install the alternator and secure to support bracket with lower mounting bolt and top rolling pin.

INSTALLATION

11.6.6 Installation of Serpentine Belt

Install auto tensioner to front cover as follows:

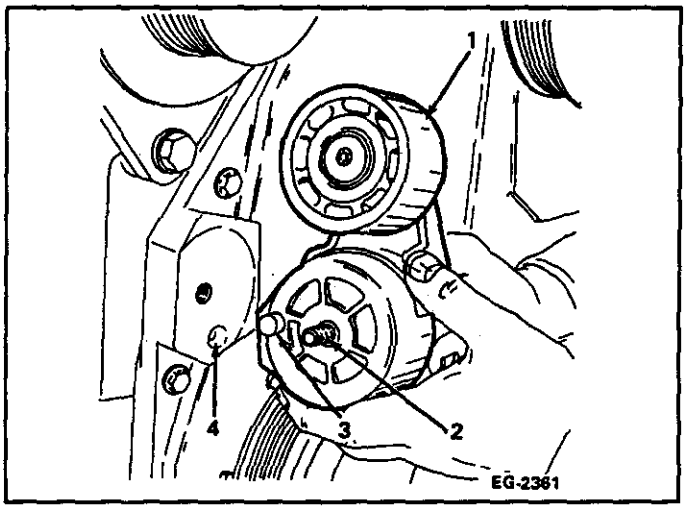
1. Locate recess on front cover and mount tensioner with locating pin at recess (**FIGURE 11–43**).

NOTICE: **Tighten 80 mm length mounting bolt to the specified "Special Torque."**

2. Apply leverage to auto tensioner and feed serpentine belt over all pulleys. Refer to **FIGURE 11–44.**

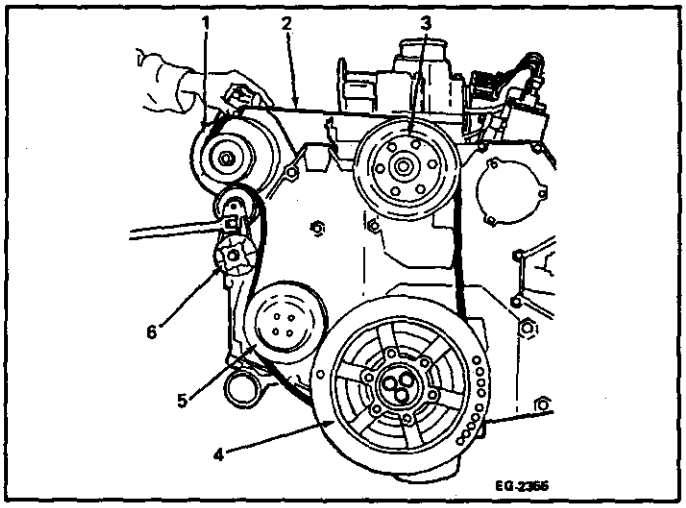
11.6.7 Component Installation

1. Reinstall the following components: Refer to appropriate section for installation procedures.
   - ❑ Vibration damper
   - ❑ Oil pump assembly
   - ❑ Water inlet elbow
   - ❑ Water pump and pulley
   - ❑ Oil pan
   - ❑ Oil cooler
   - ❑ Coolant filter and header
   - ❑ Fuel injection pump
   - ❑ Fuel injection lines (high and low pressure)
2. Prime the lubricating system as specified in Section 9 prior to returning engine to service.



1. **Tensioner**
2. **Bolt**
3. **Locating Pin**
4. **Recess**

FIGURE 11–43



1. **Alternator**
2. **Serpentine Belt**
3. **Fan Hub Pulley**
4. **Vibration Damper**
5. **Water Pump Pulley**
6. **Belt Tensioner**

FIGURE 11–44

12 LUBRICATING OIL PUMP, OIL FILTERS & COOLER

12.1 LUBRICATION SYSTEM EXPLODED VIEWS

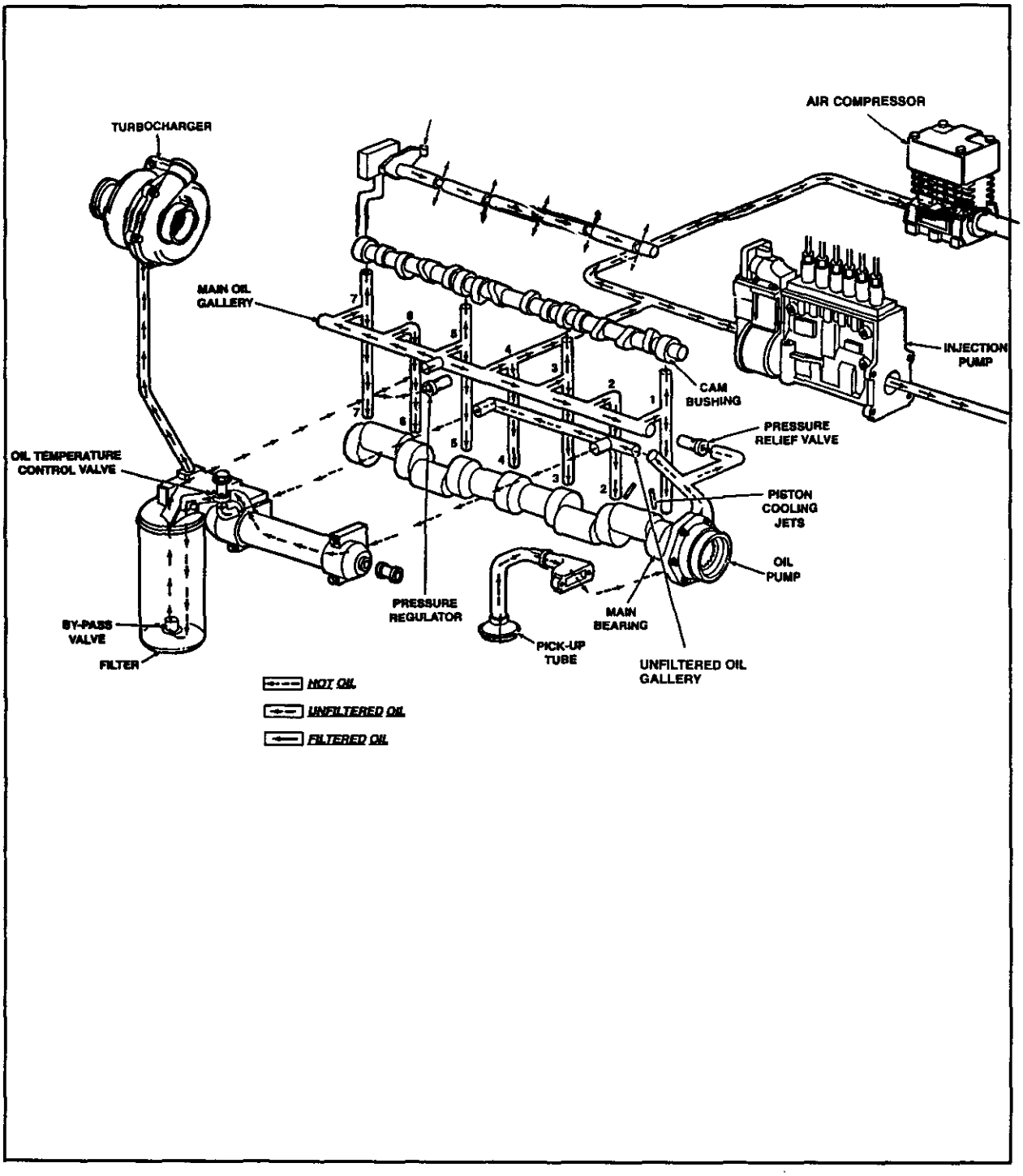
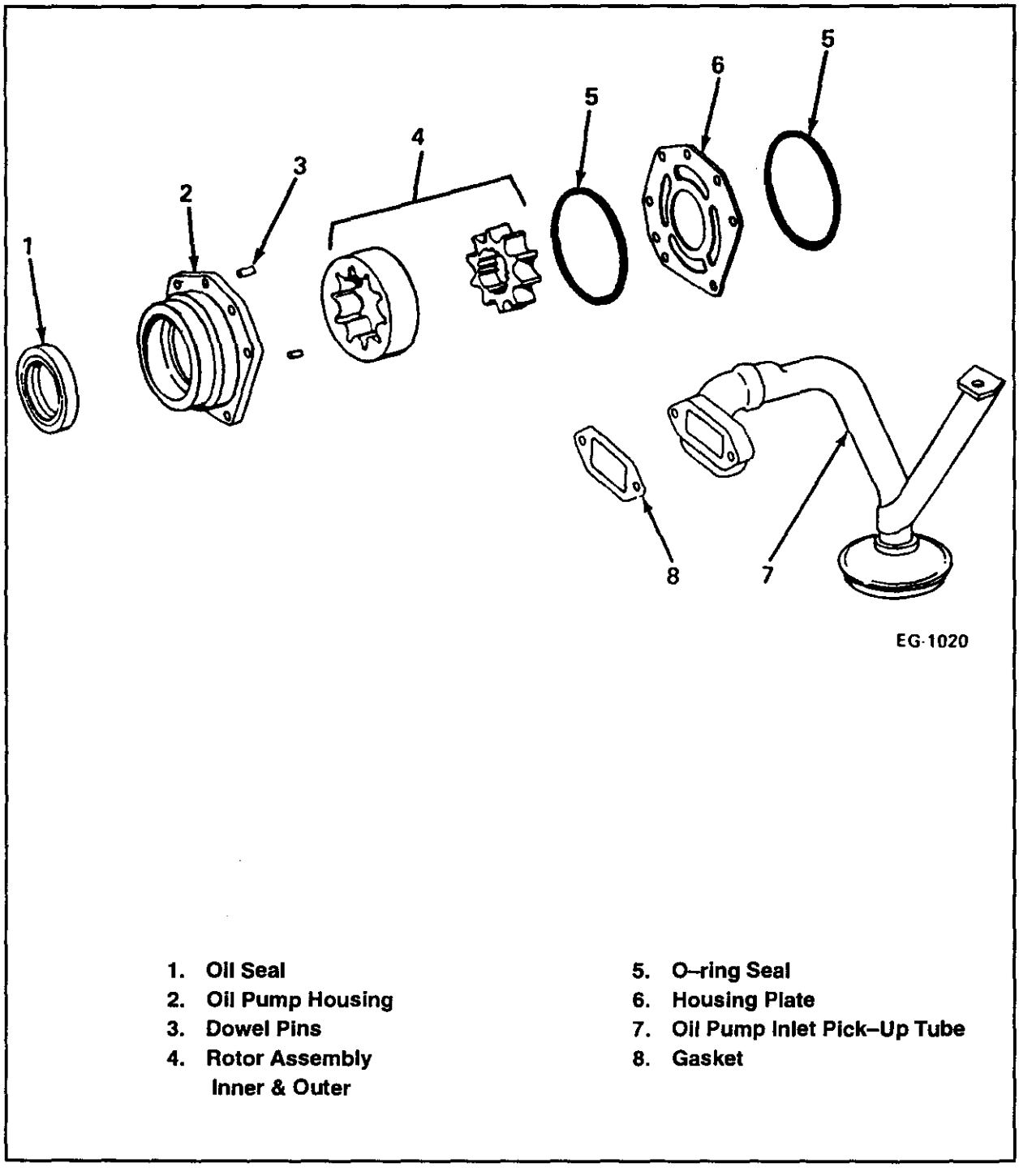
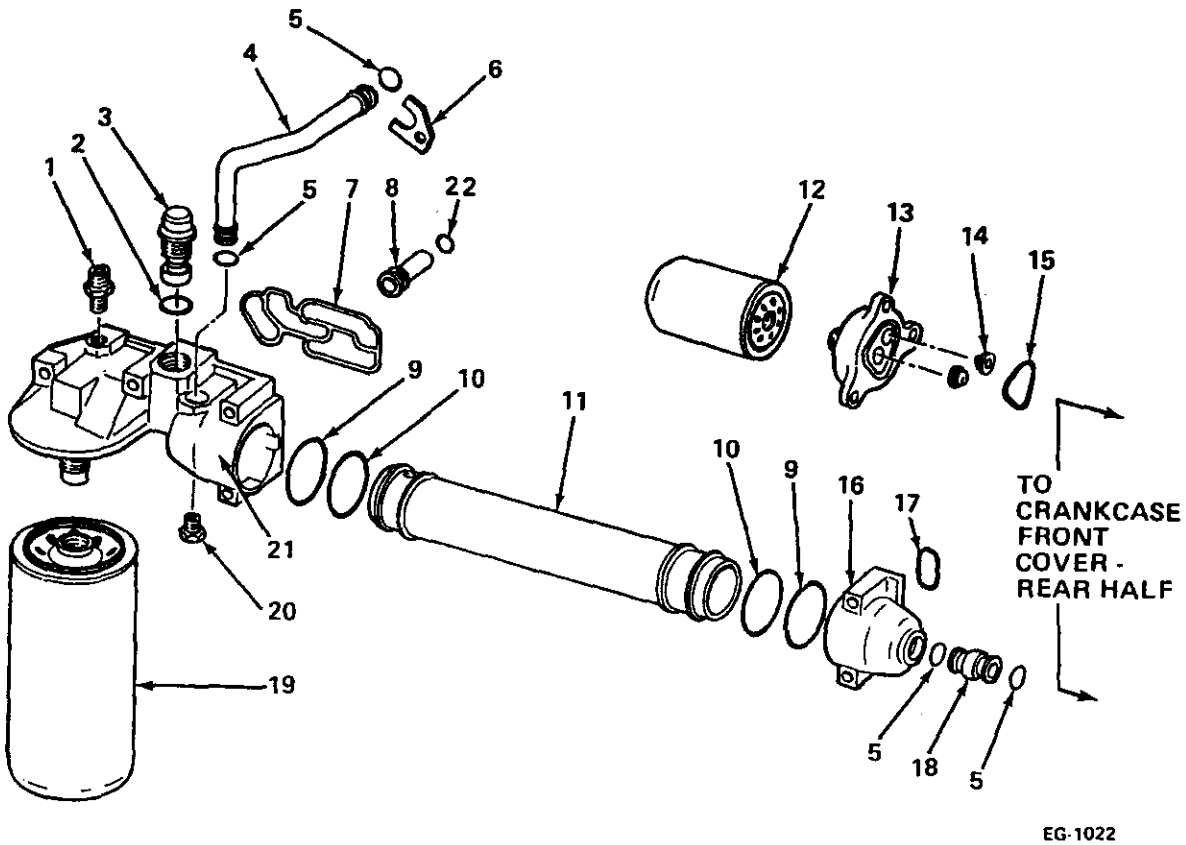


FIGURE 12–1 Engine Lubrication System



1. Oil Seal
2. Oil Pump Housing
3. Dowel Pins
4. Rotor Assembly Inner & Outer
5. O–ring Seal
6. Housing Plate
7. Oil Pump Inlet Pick–Up Tube
8. Gasket

FIGURE 12–2 Lubricating Oil Pump and Pick–Up Tube.



1. Connector
2. O–ring
3. Temp/Pressure Valve
4. Oil Cooler Water Inlet Tube
5. O–ring (4)
6. Water Inlet Tube Bracket
7. Gasket
8. Pressure Regulator Valve
9. O–ring
10. O–ring
11. Oil Cooler Assembly
12. Coolant Filter
13. Coolant Filter Header
14. Check Valve
15. O–ring
16. Front Oil Cooler Header
17. Seal
18. Tube
19. Oil Filter
20. Drain Plug (Coolant)
21. Oil Cooler/Filter Header
22. O–ring

FIGURE 12–3 Oil Filter Header, Filter, Oil Cooler and Coolant Filter

12.2 SPECIFICATIONS

DIMENSION	VALUES
OIL PUMP:	
Type	"GEROTOR"
Drive	Crankshaft
End Clearance Inner and Outer	
Radial Clearance between Outer Rotor Housing	TBD
Engine Oil Pressure* (Run engine until normal operating temperatures are reached)	
At Low Idle Speed (650 r/min) (minimum)	10 lb/in.^{2} (69 kPa)
Minimum At High Idle Speed	40 to 70 lb/in.^{2} (276 to 488 kPa)
ENGINE OIL FILTER:	
Type	"SPIN–ON"
Number	1
Filter Bypass Location	TBD
COOLANT FILTER:	
Type	"SPIN–ON"
Number	1
BYPASS VALVE SPRING:	
Location	In Filter
PRESSURE REGULATOR VALVE SPRING:	
Free Length	2.589 in. (65.76 mm)
Test Length	1.545 in. (39.24 mm)
Test Load	24.1 lbs ± 5% (107 N)
Outside Diameter	.600 in. (15.24 mm)
Location	In Crankcase, Behind Filter Header
Setting	48–52 lb/in.^{2} (331–359 kPa)
Valve Assembly Diameter	1.059 in. (26.89 mm)/ 1.068 in. (27.13 mm)

SPECIFICATIONS

DIMENSION	VALUES
Valve Clearance in Bore	0.0015 in. (0.381 mm)/ 0.0035 in. (0.089 mm)
Crankcase Bore I.D.	1.063 in. (27.00 mm)/ 1.065 in. (27.05 mm)

TBD = To Be Determined.

*Oil Pressure measurement should be made utilizing an oil gallery tap.

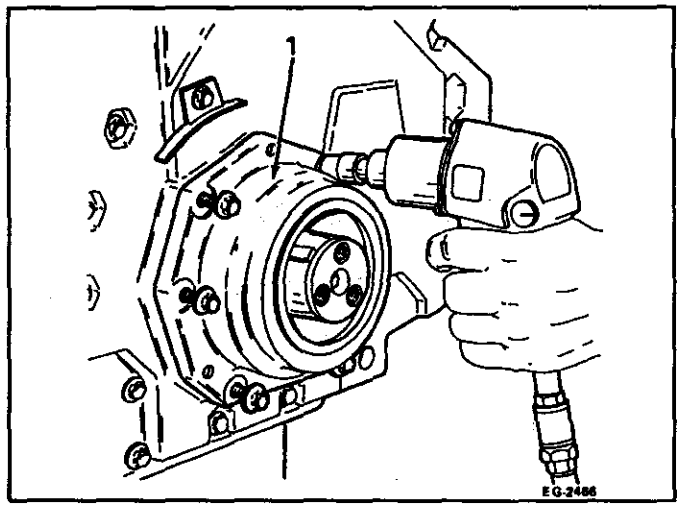
12.2.1 Special Torques

Oil Pan Drain Plug ..... 50 lb·ft (68 N·m)
Oil Pan Bolts ..... 13 lb·ft or 156 lb·in. (17 N·m)
Oil Pickup Tube Mounting Bolts ..... 13 lb·ft or 169 lb·in. (18 N·m)
Oil Level Gauge Tube Clamp ..... 30 lb·ft (41 N·m)
Oil Temperature Pressure Valve ..... 10 lb·ft or 120 lb·ft (13.5 N·m)

12.2.2 Special Service Tools

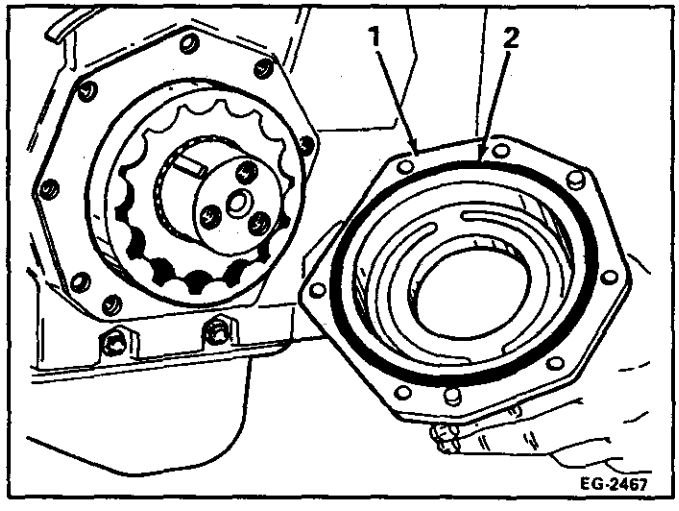
Tool No.	Description
J22738–02	Spring Load Tester

12.3 LUBRICATING OIL PUMP



1. Oil Pump Housing

FIGURE 12–4



1. Oil Pump Housing
2. O–ring

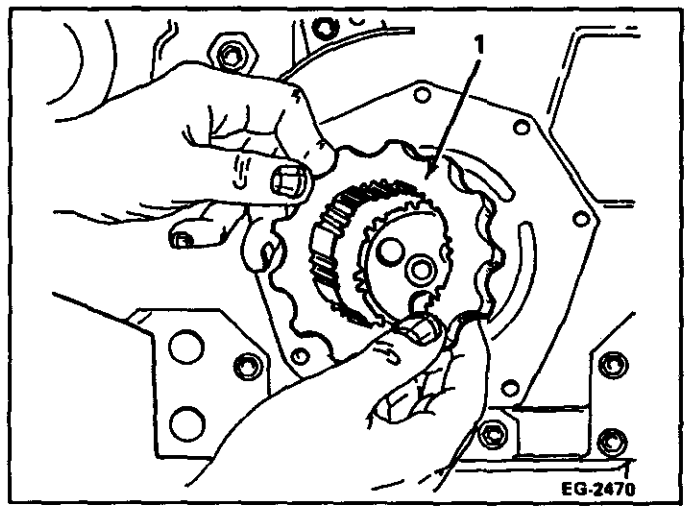
FIGURE 12–5

12.3.1 Removal

1. Remove the vibration damper as described in Section 10.
2. Remove front oil seal as follows:
   a. Mount front oil seal removal tool into crankshaft nose and over oil seal.
   b. Turn forcing screw to remove seal.
3. Remove the oil pump housing as follows:
   a. Loosen and remove the six capscrews (two short capscrews are located at the two and three o'clock positions). Refer to **FIGURE 12–4.**
   b. Remove the oil pump housing with O–ring seal from the front cover. Refer to **FIGURE 12–5**. Discard the O–ring seal.

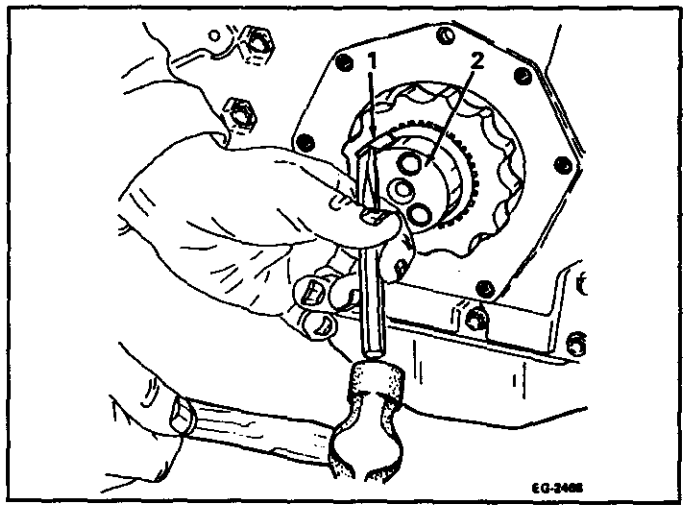
LUBRICATING OIL PUMP

4. Remove the outer rotor from the oil pump drive spline. Refer to **FIGURE 12–6.**
5. Using a hammer and chisel, remove the woodruff key from the crankshaft as shown in **FIGURE 12–7.**
6. Remove the inner rotor and oil slinger from the oil pump drive spline.



1. **Outer Rotor**

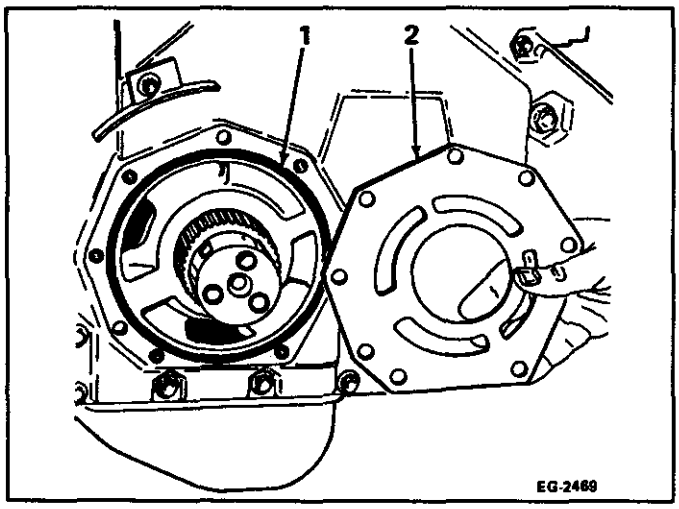
FIGURE 12–6



1. **Woodruff Key**
2. **Crankshaft**

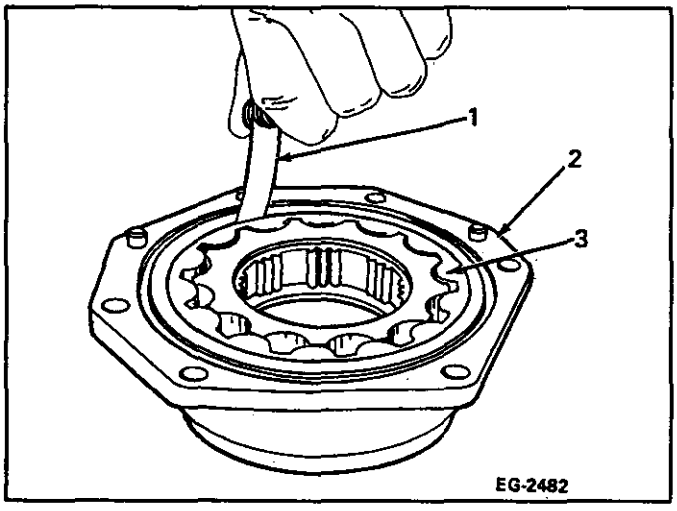
FIGURE 12–7

LUBRICATING OIL PUMP



1. O–ring
2. Oil Pump Plate

FIGURE 12–8



1. Feeler Gauge
2. Oil Pump Housing
3. Outer Rotor

FIGURE 12–9

7. Remove the oil pump housing plate. With the plate removed, remove the sealing O–ring from the front cover. Refer to **FIGURE 12–8**. Discard the O–ring seal.

12.3.2 Cleaning

1. Wash all parts thoroughly in an approved solvent.

2. Dry with filtered compressed air.

12.3.3 Inspection and Repair

1. Visually inspect the rotors, housing and plate for nicks, burrs or scoring.

2. Replace any damaged components.

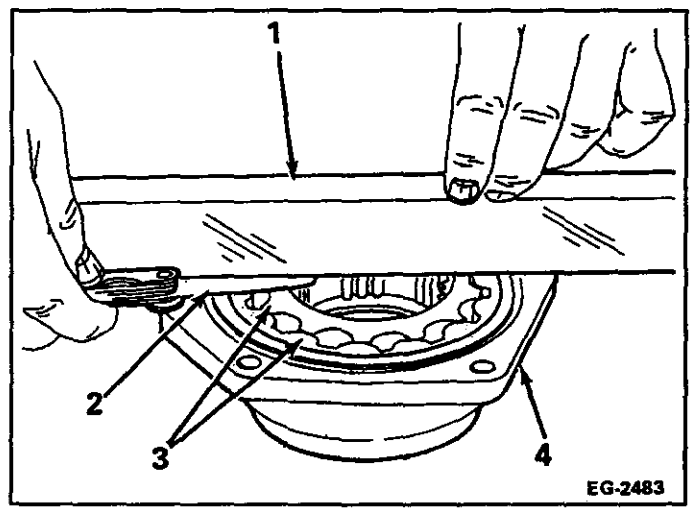
NOTE:
The inner and outer rotors are a matched set and cannot be replaced separately.

Inspect for wear as follows:

3. Check the radial clearance between the outer rotor and the pump housing using a feeler gauge as shown in **FIGURE 12–9**. Refer to "Specifications". If radial clearance exceeds the specifications, check housing to rotor clearance (see step 4).

LUBRICATING OIL PUMP

4. Check housing to rotor clearance as follows: Refer to **FIGURE 12–10.**
   a. With the O–ring removed from the oil pump housing, place a straightedge across the housing.
   b. Insert an appropriate feeler gauge under the straightedge at the housing and outer rotor. (See "Specifications.")
   c. If not within specifications, check the housing and inner rotor for wear. Replace worn components, as required.

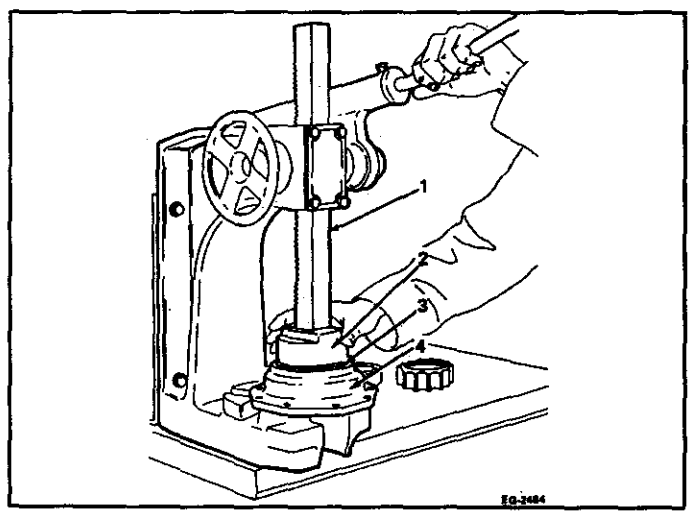


1. Straightedge
2. Feeler Gauge
3. Rotors
4. Oil Pump Housing

FIGURE 12–10

12.3.4 Reassembly

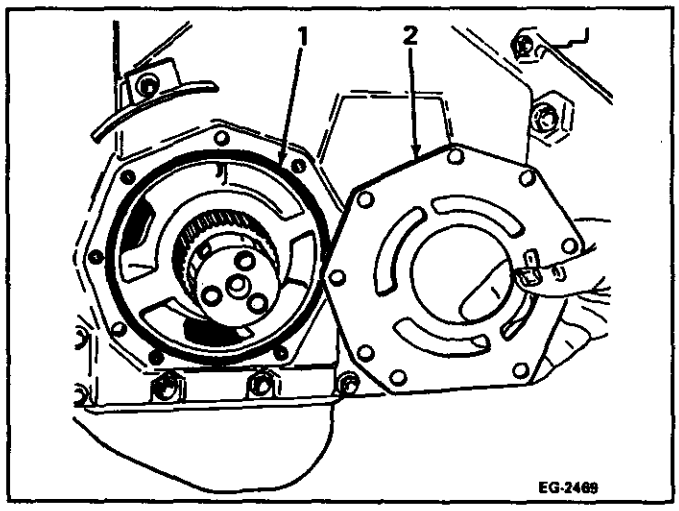
1. Install a new crankshaft front oil seal into the lubricating oil pump housing as follows:
   a. Apply gasket eliminator #515 to the O.D. of the oil seal.
   b. Slip oil seal into installing tool.
   c. Press the seal into the oil pump housing so the front of the seal is flush with the front of the oil pump housing. Refer to **FIGURE 12–11**



1. Press
2. Installation Tool
3. Oil Seal
4. Oil Pump Housing

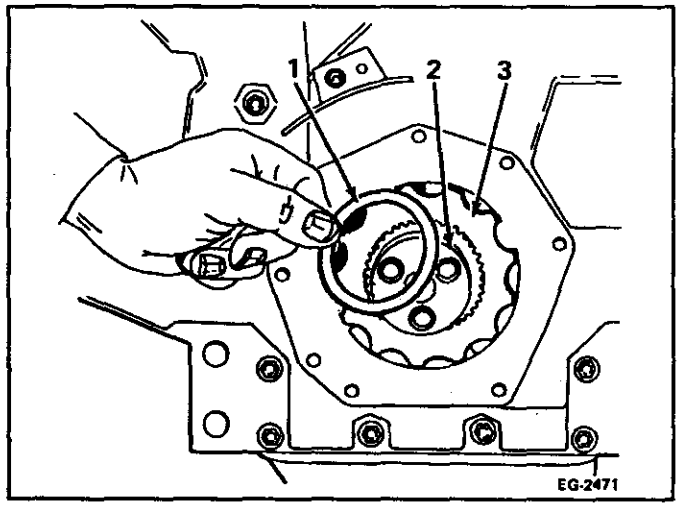
FIGURE 12–11

LUBRICATING OIL PUMP



1. O–ring
2. Oil Pump Plate

FIGURE 12–12



1. Slinger
2. Crankshaft
3. Inner Rotor

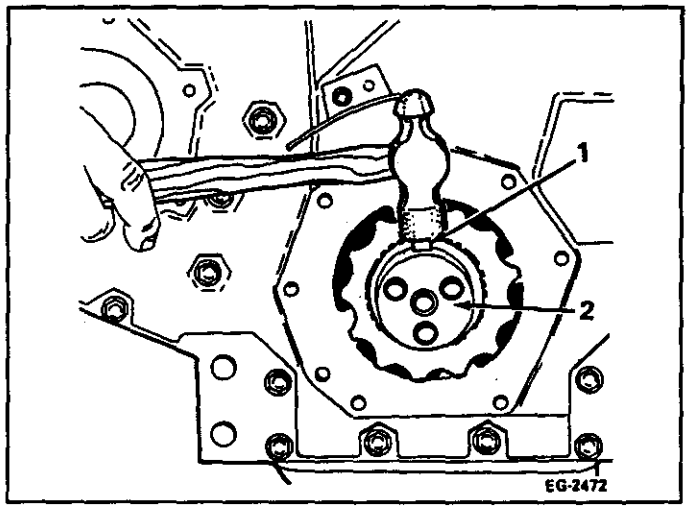
FIGURE 12–13

2. Install a new O–ring on the front cover, then install the housing plate. Refer to **FIGURE 12–12.**
3. Install the inner rotor and slinger onto the gear spline. Refer to **FIGURE 12–13.**

LUBRICATING OIL PUMP

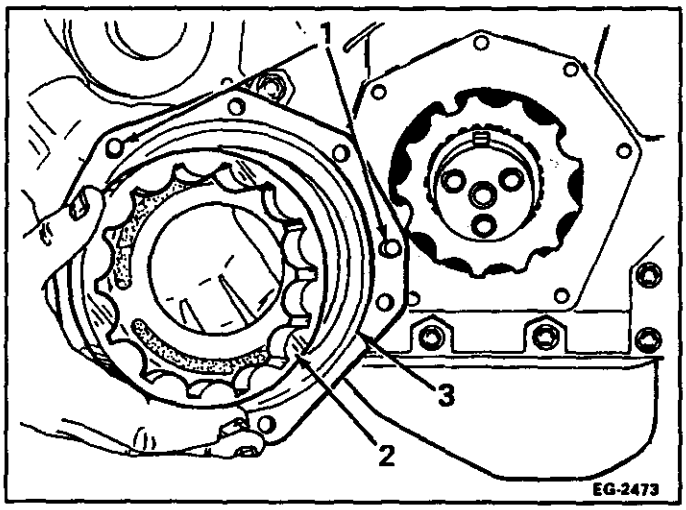
4. With the inner rotor installed, tap in the crankshaft key with a plastic hammer. Refer to **FIGURE 12–14.**
5. Install the outer rotor into the housing. Lubricate the rotator with clean engine oil. Refer to **FIGURE 12–15.**

NOTE:
Slinger fits with the convex shape facing out.



1. **Crankshaft Key**
2. **Crankshaft**

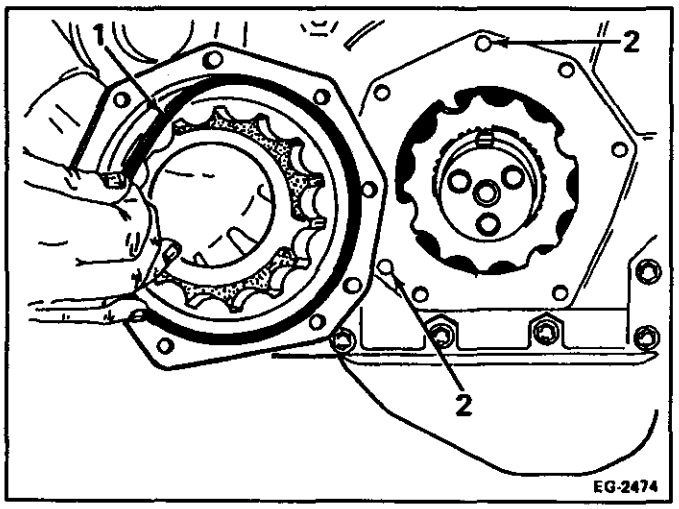
FIGURE 12–14



1. **Mounting Dowels**
2. **Outer Rotor**
3. **O–ring Groove**

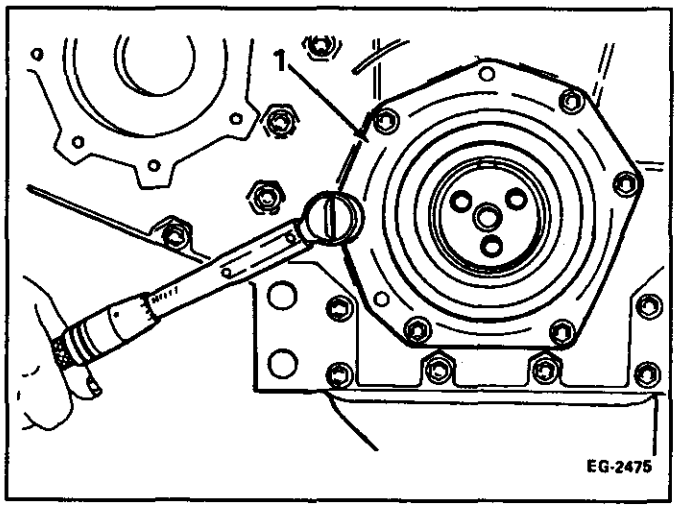
FIGURE 12–15

LUBRICATING OIL PUMP



1. O–ring
2. Dowel Mounting Position

FIGURE 12–16



1. Oil Pump Housing

FIGURE 12–17

6. Install a new O–ring into the housing groove and align housing dowel pins with mounting locations. Refer to **FIGURE 12–16.**
7. Install the six capscrews (two short capscrews are located at the two and three o'clock positions). Tighten the capscrews to the special torque. (See **Appendix**). Refer to **FIGURE 12–17.**
8. Install the vibration damper as specified in Section 10.

12.4 OIL FILTER AND HEADER

12.4.1 Removal

1. With oil and coolant drained from the engine, remove the oil filter using an appropriate filter wrench. Refer to **FIGURE 12–18**. Discard the filter.
2. Using a open end wrench, loosen and remove oil feed supply tube nut located on top of oil filter header. Remove and discard tube nut O–ring. Cap fitting on header. Refer to **FIGURE 12–19**.

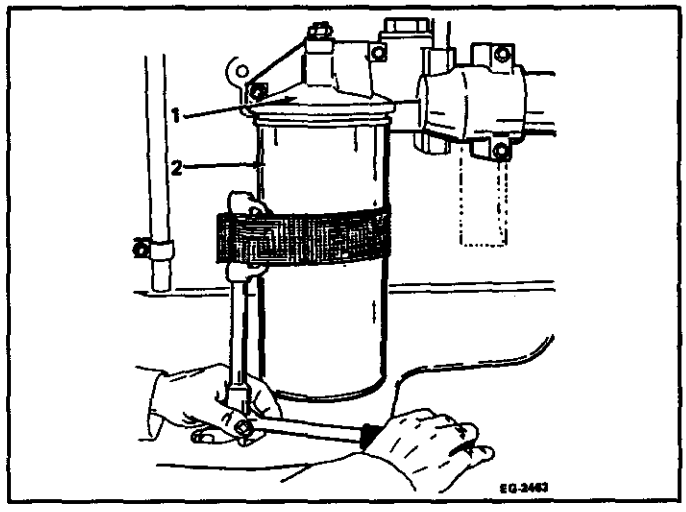
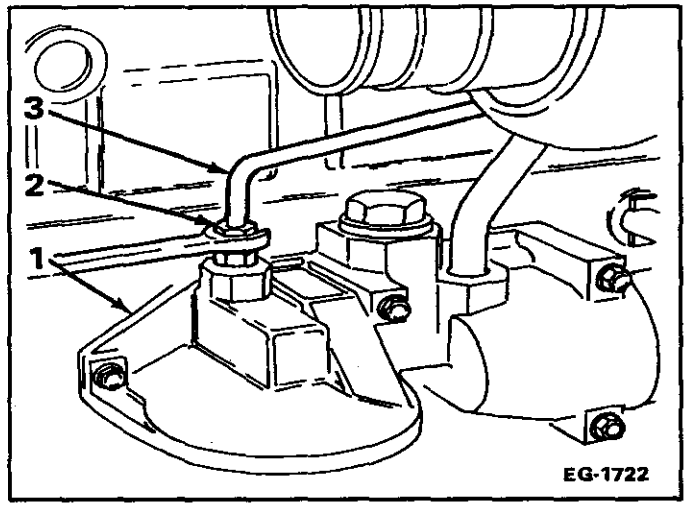


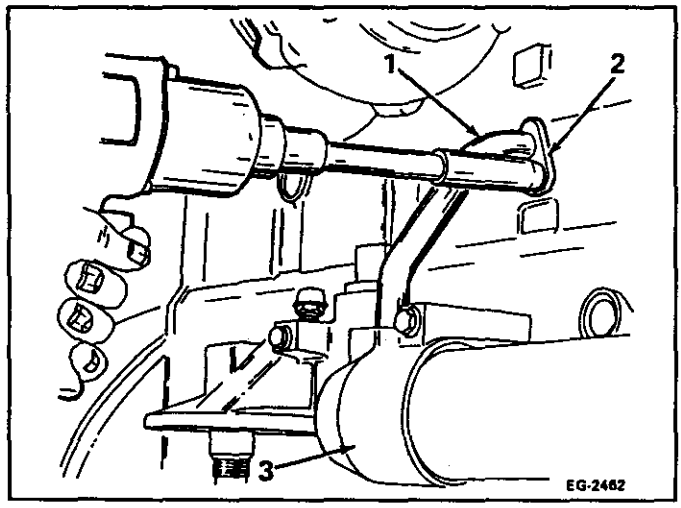
FIGURE 12–18



1. 1Oil Filter Header
2. Oil Feed Supply Tube Nut
3. Oil Feed Supply Tube

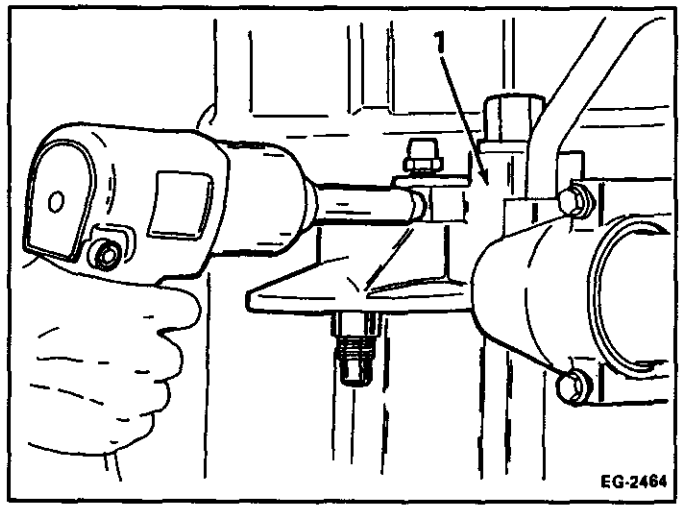
FIGURE 12–19

OIL FILTER AND HEADER



1. **Water Inlet Tube**
2. **Bracket**
3. **Lube filter/Oil Cooler Header**

FIGURE 12–20

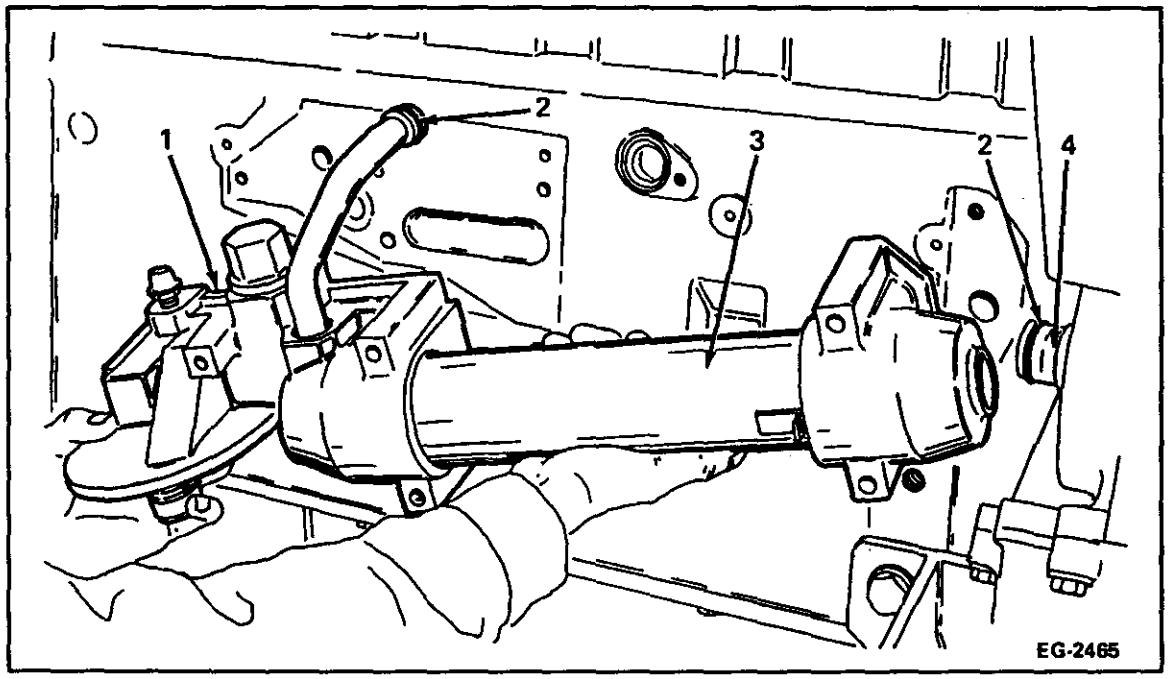


1. **Lube Filter/Oil Cooler Header**

FIGURE 12–21

3. Disconnect the oil cooler water inlet tube and bracket at the crankcase. Refer to **FIGURE 12–20**.
4. Remove the four retaining bolts which secure the header to the crankcase. Refer to **FIGURE 12–21**.
5. Remove the bolts that secure the front oil cooler header to the crankcase.

OIL FILTER AND HEADER



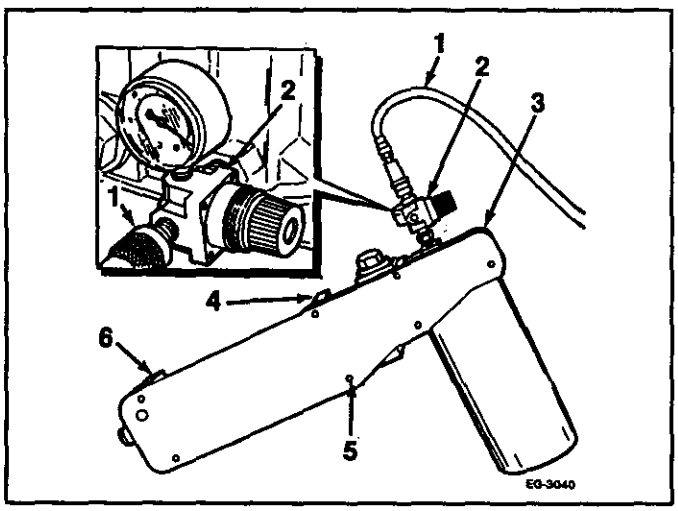
1. **Lube Filter/Oil Cooler Header**
2. **Water Inlet and Outlet O–rings**
3. **Oil Cooler**
4. **Water Outlet Tube**

FIGURE 12–22

6. Remove oil cooler/filter header as an assembly. Discard O–rings, gaskets and seals. Refer to **FIGURE 12–22.**

NOTICE: **Prior to disassembly, perform "oil cooler leakage test."**

OIL FILTER AND HEADER



1. **Air Hose**
2. **Air Pressure Gauge**
3. **Pressure Test Plate**
4. **Oil Cooler Filter Header**
5. **Pressure Test Plate Mounting Bolts (7)**
6. **Oil Cooler Front Header**

FIGURE 12–23

12.4.1.1 Leakage Test

See **FIGURE 12–23.**

Inspect oil cooler assembly for leaks using an "Air Pressure" test as follows:

1. Fasten oil cooler leakage test plate to oil cooler headers using new oil cooler gaskets.
2. Install oil filter.
3. Install air pressure gauge to oil cooler filter header at turbocharger supply fitting location.
4. Immerse assembly in a container of clean "tap" water.
5. Apply 100 lb/in.^{2} (690 kPa) air pressure while immersed.
6. Inspect header castings, O–ring seals and ¼ NPTF water side opening for moving or growing bubbles. Replace components as required.

OIL FILTER AND HEADER

12.4.2 Disassembly

1. With non–metallic hammer, gently rap front of oil filter header to loosen O–rings. Twist headers and separate from cooler bundle.
2. Remove, inspect and install oil temperature control thermostat located in filter/oil cooler header. Install with new O–ring.

NOTE:

Valve may be removed by depressing plunger and trapping a length of copper wire when released. Valve may then be removed by copper wire.

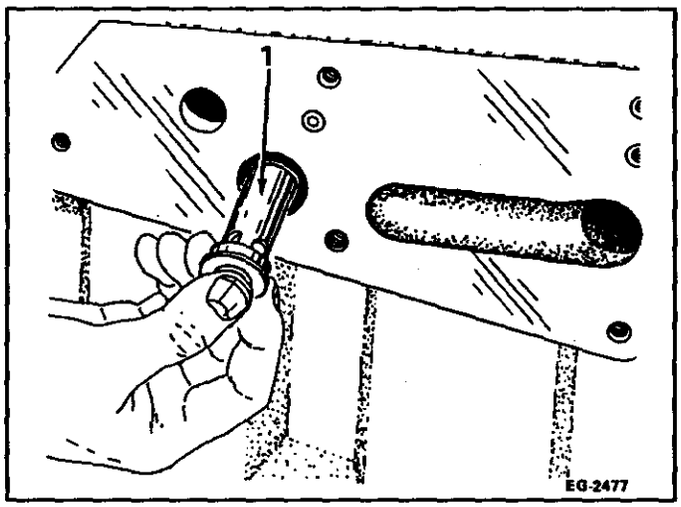
3. Remove, inspect and install pressure regulator valve located in crankcase. Refer to **FIGURE 12–24.**

NOTE:

In the event of bearing failure, oil cooler bundle must be replaced because failed bearing debris cannot be removed from cooler bundle.

12.4.3 Cleaning

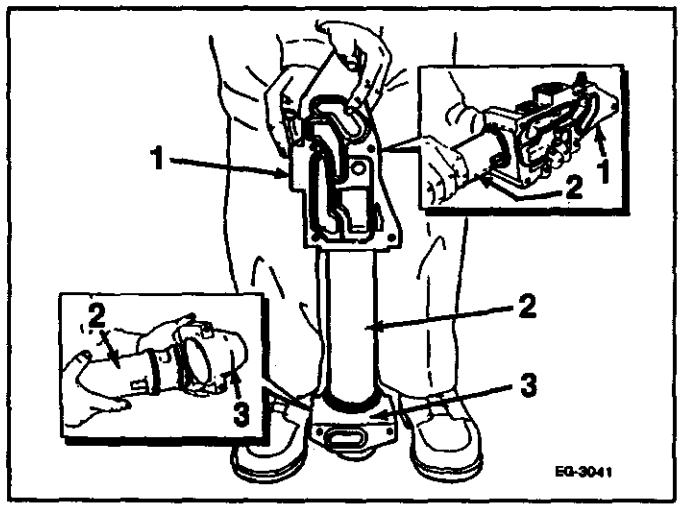
1. Immerse oil cooler, front and filter header in a suitable solvent. Flush and drain cooler to remove residue.
2. Dry all components thoroughly with filtered compressed air.



1. Pressure Regulator Valve

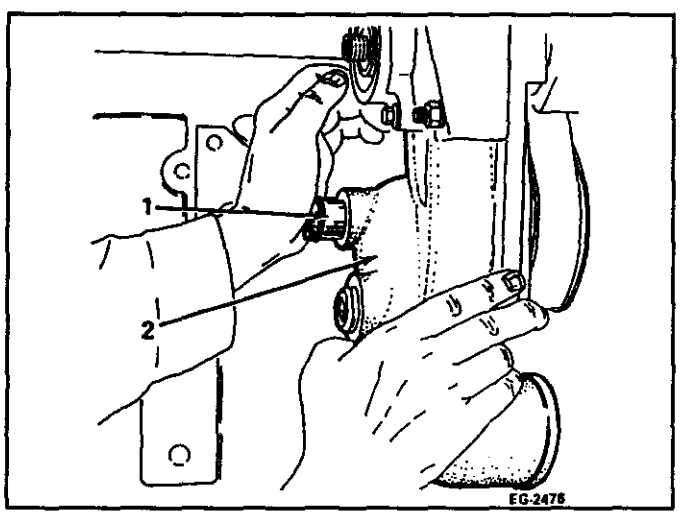
FIGURE 12–24

OIL FILTER AND HEADER



1. Oil Cooler Filter Header
2. Oil Cooler Bundle
3. Oil Cooler Front Header

FIGURE 12–25



1. Water Outlet Tube
2. Front Cover

FIGURE 12–26

12.4.4 Inspection and Repair

1. Visually inspect oil cooler for blocked tubes and corrosion where tubes are assembled to the bundle. Replace oil cooler tube bundle if required.
2. Visually inspect header for blocked orifices or damaged threads at oil filter threaded insert.
3. Remove any debris which may be blocking oil flow passages.

NOTICE: **Use new O–rings when reassembling oil cooler.**

12.4.5 Reassembly

Refer to **FIGURE 12–25.**

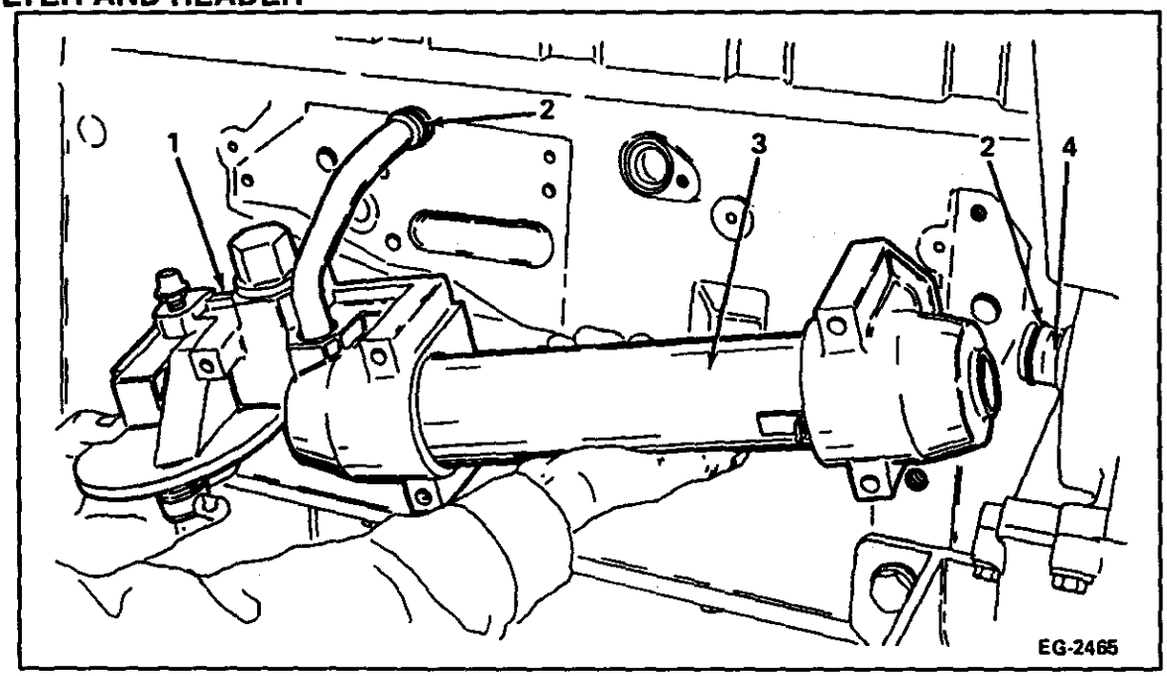
1. Using Lubriplate, lubricate oil cooler bundle, headers and O–rings on cooler bundle.
2. Carefully press assembly together assuring that locating clip of oil cooler headers (front and rear) align in slots of oil cooler bundle and header is not cocked. This procedure can be accomplished by using body weight to press assembly together.

12.4.6 Installation

1. Install water outlet tube in front cover. Refer to **FIGURE 12–26.**

NOTICE: **Install oil cooler assembly using a new square cut O–ring at front header and gasket at rear filter cooler header.**

OIL FILTER AND HEADER

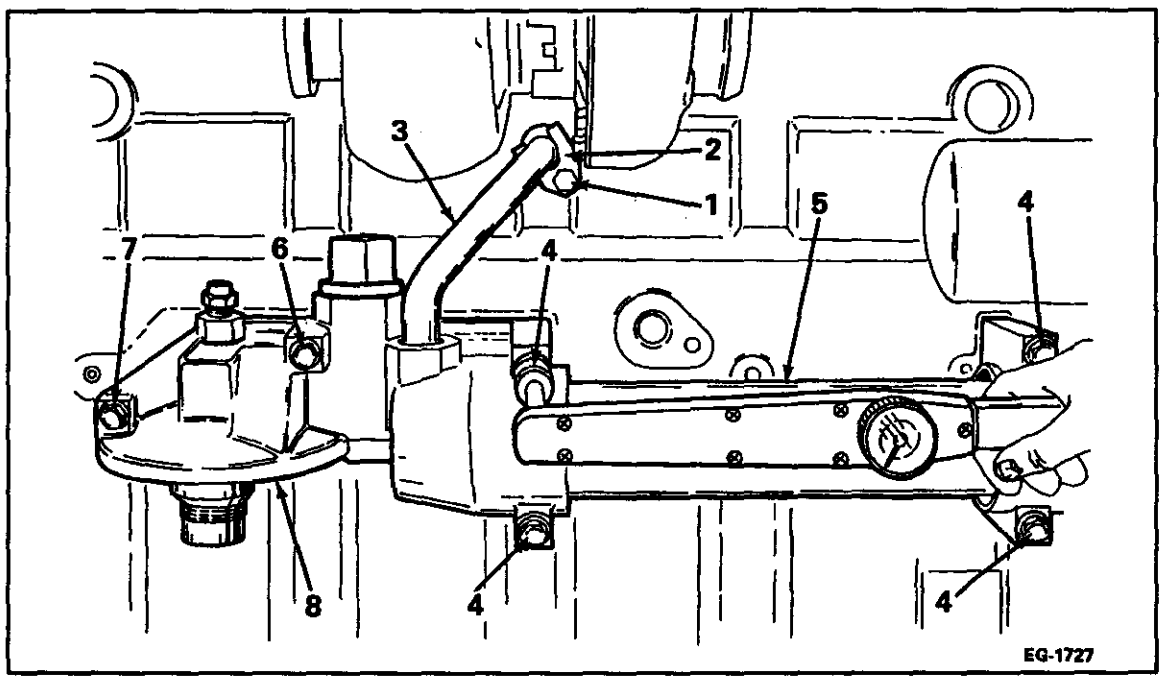


1. **Lube Filter/Oil Cooler Header**
2. **Water Inlet and Outlet O–rings**
3. **Oil Cooler**
4. **Water Outlet Tube**

FIGURE 12–27

2. Using a new O–ring, install the filter header/ oil cooler assembly to the crankcase. Refer to **FIGURE 12–27** and **FIGURE 12–28**. Tighten to the special torque.
3. Install bracket to retain water inlet tube to crankcase.
4. Reconnect the turbocharger oil inlet tube to the oil filter header elbow. Use a new sealing ring at the oil inlet tube nut.

OIL FILTER AND HEADER



1. **Mounting Bolt**
2. **Water Inlet Tube Bracket/Plate**
3. **Water Inlet Tube**
4. **Oil Cooler Mounting Bolts**
5. **Oil Cooler**
6. **Oil Filter Header Mounting Bolts**
7. **Oil Filter Header Mounting Bolt**
8. **Lube Filter/Oil Cooler Header**

FIGURE 12–28

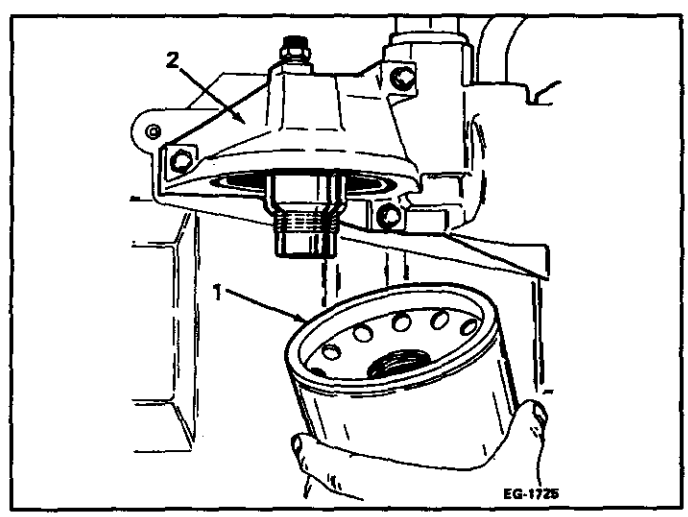
5. Install new oil filter as follows: Refer to **FIGURE 12–29.**

   a. Lubricate new filter gasket with clean engine oil.

   b. Hand tighten filter 1–1/4 to 1–3/4 turns after gasket first contacts filter header.

NOTICE: **DO NOT OVERTIGHTEN FILTER. Damaged filter may fracture or leak.**

6. Prime lubricating system as described in Section 10, "Vibration Damper, Crankshaft, Main Bearings, Flywheel and Crankcase."

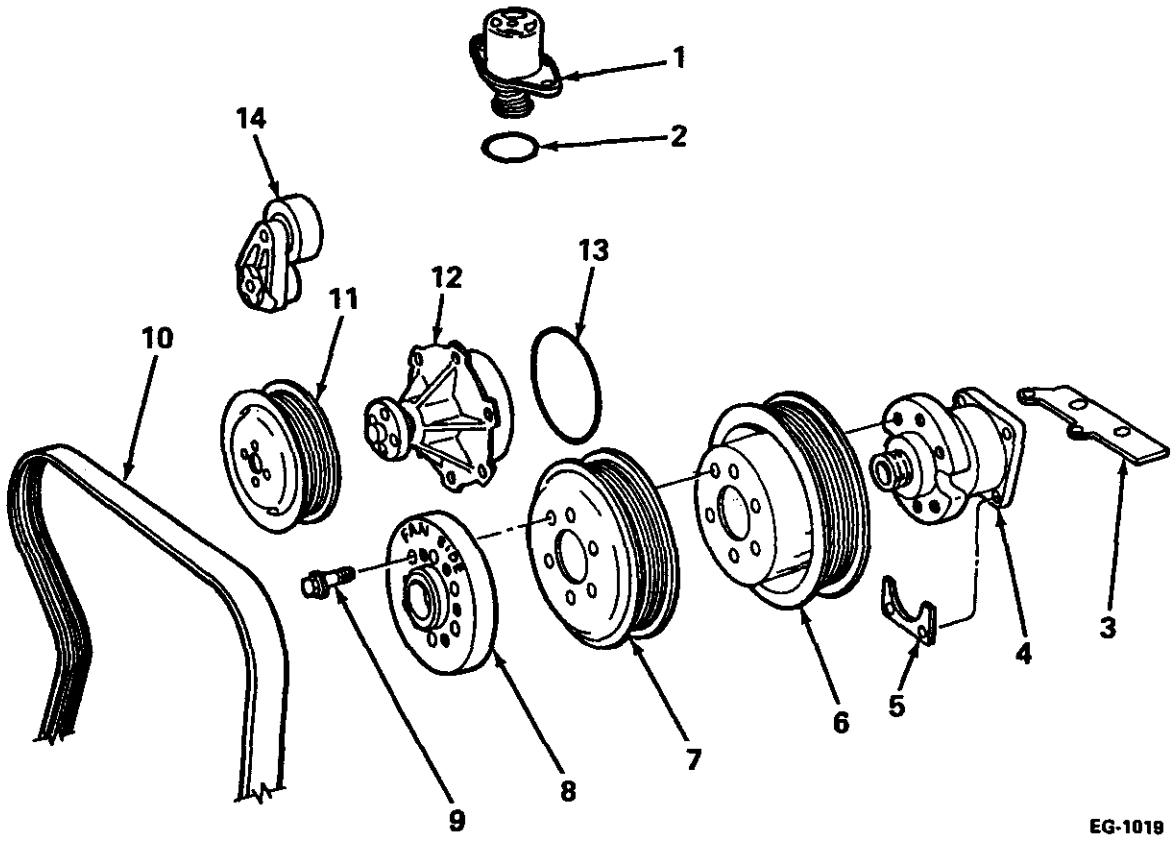


1. **Oil Filter**
2. **Oil Filter Header**

FIGURE 12–29

13 WATER PUMP AND THERMOSTAT

13.1 FAN DRIVE, THERMOSTAT AND WATER PUMP EXPLODED VIEW



1. Thermostat Assembly
2. O–ring
3. Fan Mounting Support Bracket
4. Fan Mounting Bracket With Hub
5. Bearing Retainer Used For Reverse Rotation Fuel Injection Pump.)
6. Fan Pulley
7. Freon Drive Pulley
8. Fan Spacer
9. Fan Pulley Mounting Bolt (6)
10. Fan Belt
11. Water Pump Pulley
12. Water Pump Assembly
13. Water Pump Seal
14. Belt Tensioner

FIGURE 13–1 Fan Drive, Thermostat And Water Pump.

13.2 SPECIFICATIONS

DIMENSION	VALUES
THERMOSTAT:	
Type	Poppet Valve, Pellet Operated
Operating Temperature Range	
Start to Open Temperature	1805 – 1855°F (825 – 855°C)
Full Open Temperature	2025°F (945°C)

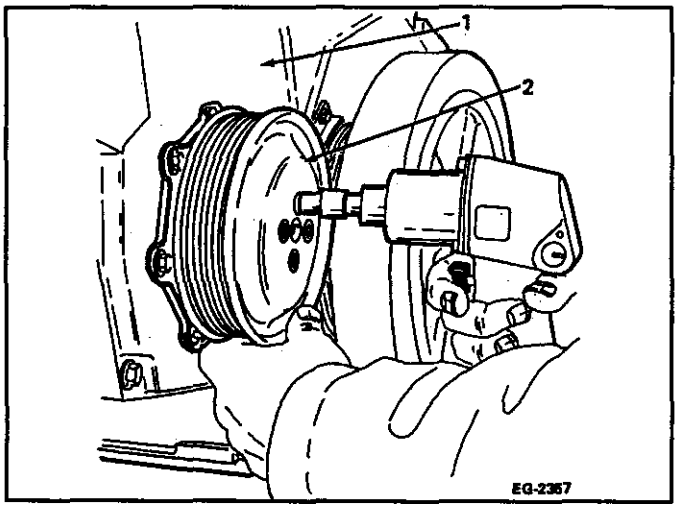
13.2.1 Special Torque Values

Water Pump Pulley (6 mm)	66 lb·in. (7 N·m)
Water Pump Mounting (6 mm)	66 lb·in. (7 N·m)
Belt Tensioner (Front Cover)	37 lb·ft (50 N·m)
Belt Tensioner (Freon Compressor)	37 lb·ft (50 N·m)
Fan Drive	13 lb·ft or 156 lb·in. (18 N·m)

13.2.2 Special Service Tools

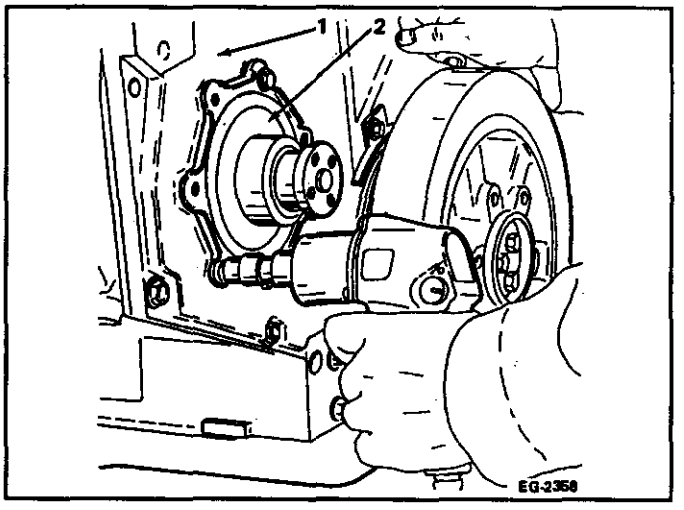
None required for this section

13.3 WATER PUMP



1. Front Cover
2. Water Pump Pulley

FIGURE 13–2



1. Front Cover
2. Water Pump

FIGURE 13–3

13.3.1 Removal

1. Remove the four (4) water pump pulley bolts. Refer to **FIGURE 13–2.**

NOTE:

Use a pry bar to keep the pulley from turning when loosening the pulley bolts.

2. Remove the pulley from the water pump hub.
3. Remove the bolts which secure the water pump to the front cover. Refer to **FIGURE 13–3.**

NOTE:

The bolt at the twelve O'clock position goes through front cover and is held with a nut.

4. Remove the water pump from the front cover. Discard the O–ring.

WATER PUMP

13.3.2 Inspection

The water pump should be visually inspected for damaged impeller, cracks and other faulty conditions. If any defects are noted, replace the water pump as an assembly.

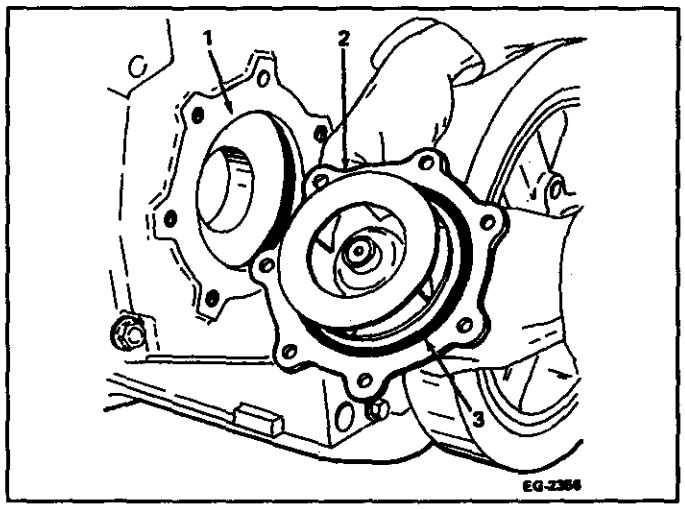
13.3.3 Installation

1. Apply a small amount of assembly grease to water pump and install a new O–ring onto water pump assembly. Refer to **FIGURE 13–4.**
2. Install water pump to front cover. Mount one bolt and nut at the twelve o'clock position and the remaining bolts in the mounting holes. Tighten mounting bolts to special torque. Refer to **FIGURE 13–5.**

NOTE:

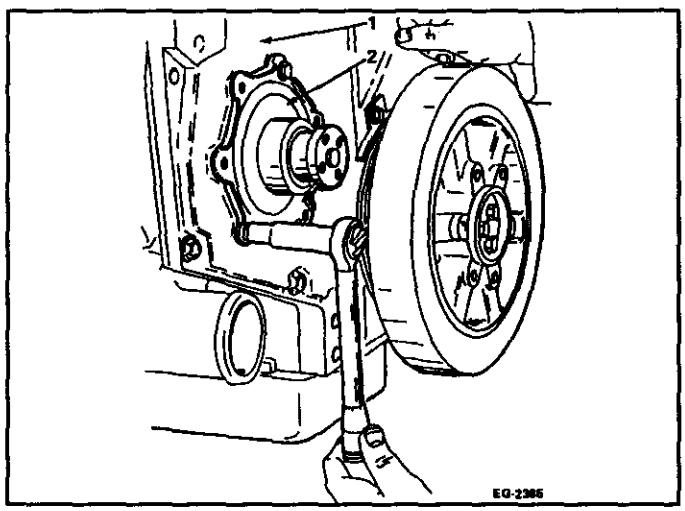
Be sure water pump rotates freely after installation.

3. Slide water pump pulley over water pump hub. Fasten pulley to hub using four (4) mounting bolts. Tighten mounting bolts to special torque value.



1. **Front Cover**
2. **Water Pump**
3. **O–ring**

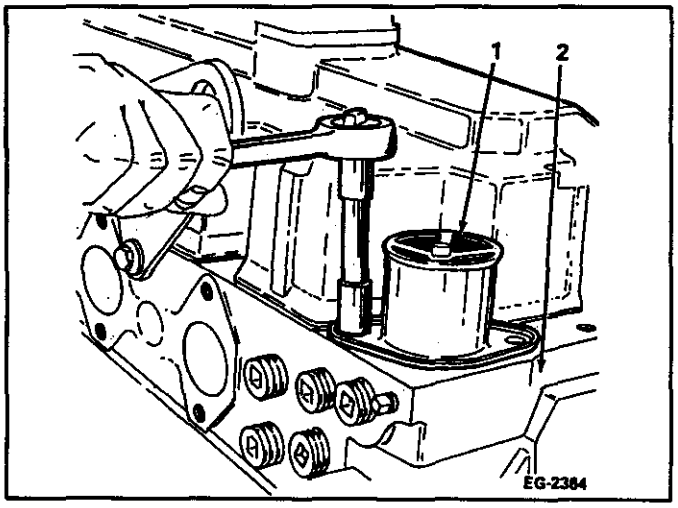
FIGURE 13–4



1. **Front Cover**
2. **Water Pump**

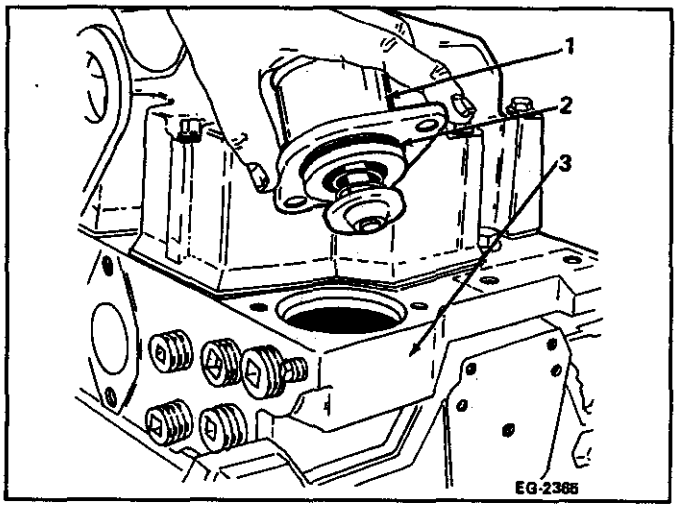
FIGURE 13–5

13.4 THERMOSTAT



1. Thermostat
2. Cylinder Head

FIGURE 13–6



1. Thermostat
2. O–ring
3. Cylinder Head

FIGURE 13–7

13.4.1 Removal

1. Loosen the worm clamp at the water outlet hose and remove from the thermostat.

2. Remove the two flanged head bolts which secure thermostat to cylinder head. Refer to **FIGURE 13–6.**

3. Remove the thermostat from cylinder head. Remove and discard O–ring. Refer to **FIGURE 13–7.**

13.4.2 Inspection

1. Inspect thermostat for cracks and pitting.

NOTE:
When servicing thermostat, it is essential that thermostat opens fully at specified temperature to avoid an overheating condition which may cause engine damage.

NOTE:
Only genuine Detroit Diesel thermostats assure proper coolant flow and positive sealing characteristics required to provide proper engine cooling.

THERMOSTAT

2. Check thermostat operation as follows: (Refer to **FIGURE 13–8**):

CAUTION

Exercise caution and good judgment to avoid injury when dealing with hot water and objects during thermostat operation check. Use heat resistant gloves and wear appropriate eye protection.

a. Manually open thermostat enough to insert a nylon ribbon under valve seat. Suspend thermostat in container so thermostat does not touch bottom of container.

b. Heat container filled with water to **"start–to–open"** temperature of thermostat 180° 0/+5° F (82.2° 0/ 2.8°C). Observe thermometer and record temperature as soon as thermostat drops from nylon ribbon. **This is the "start–to–open" temperature.**

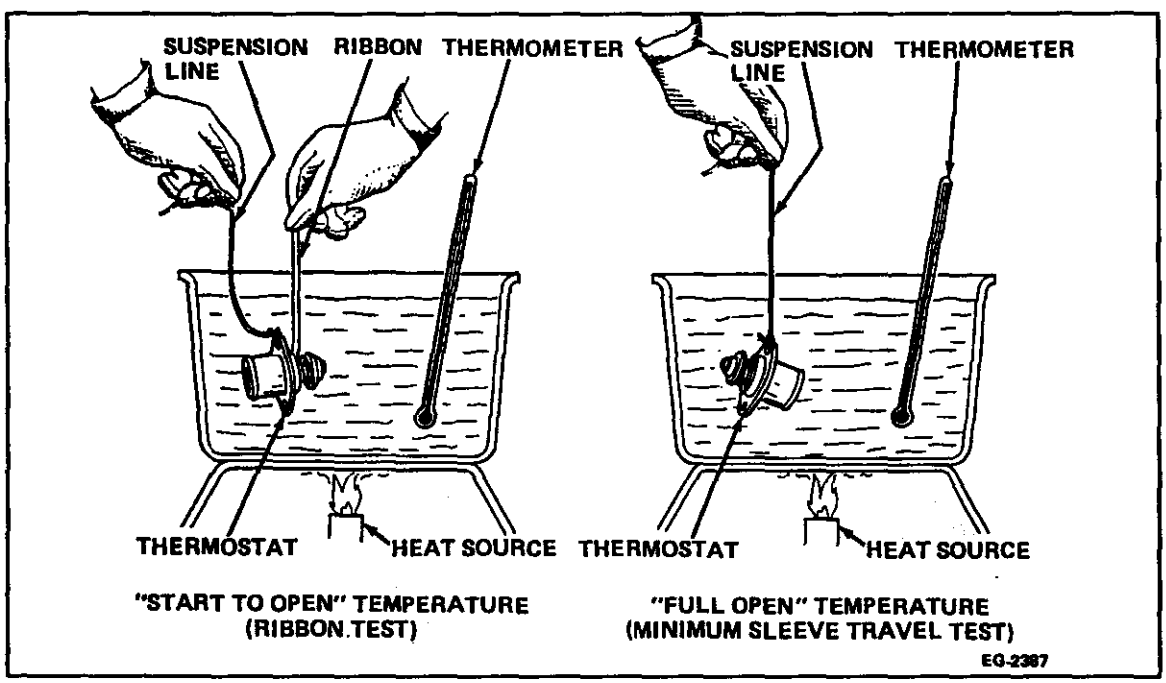


FIGURE 13–8

THERMOSTAT

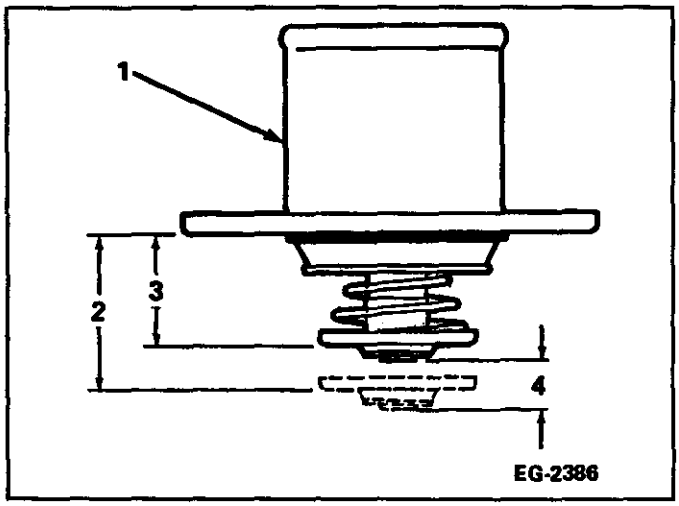


FIGURE 13–9

1. **Thermostat**
2. **Maximum Travel .757 in. (19.2 3mm)**
3. **Closed Dimension 1.167 in. (29.64 mm)**
4. **Maximum Travel 410 in. (10.41 mm)**

c. Continue to heat water to **"full–open"** temperature of thermostat 202°F (94.4°C). Observe thermometer and movement of thermostat. Observe thermostat movement when **"full–open"** temperature is achieved. Minimum travel at **"full– open"** temperature is .410 inches (9.0 mm). Refer to **FIGURE 13–9.**

CAUTION

Be sure to wear protective clothing when retrieving thermostat from boiling hot water container.

d. Remove thermostat from water, inspect seat area for pitting and foreign deposits.

e. Replace thermostat if it does not operate as described or meet visual inspection criteria.

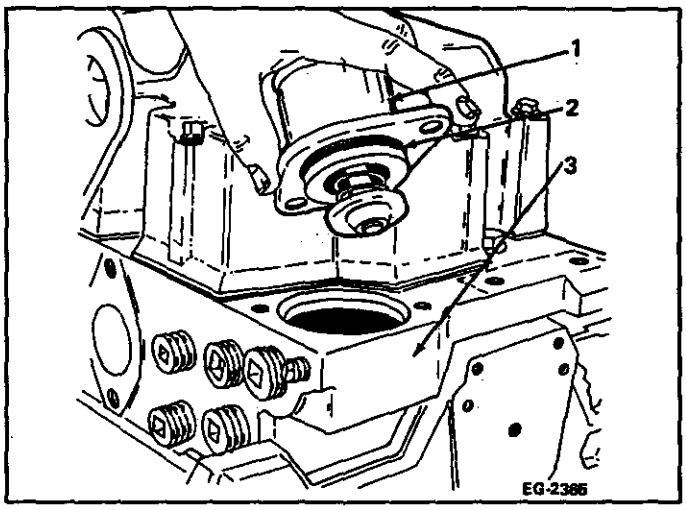
3. Visually inspect thermostat for the following conditions, which may cause improper closure:
   - ☐ Debris or loose fit at seat
   - ☐ Rough or uneven wear at seal seat location
   - ☐ Uneven seat
4. Replace as required (Refer to **FIGURE 13–9**).

THERMOSTAT

13.4.3 Installation

1. Install a new O–ring onto the thermostat assembly. Refer to **FIGURE 13–10.**

2. Install thermostat assembly into opening on top of cylinder head and secure with flanged head bolts. Tighten bolts to standard torque.



1. **Thermostat**
2. **O–ring**
3. **Cylinder Head**

FIGURE 13–10

13.5 COOLANT FILTER

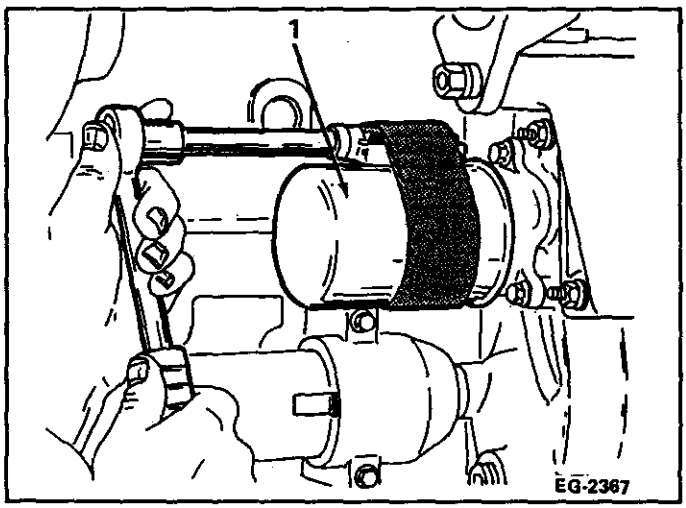
13.5.1 Removal

CAUTION

Relieve cooling system pressure by removing radiator cap prior to removing coolant filter.

1. Loosen and remove coolant filter using filter wrench/strap. The filter is located on the right hand side rear of the front cover. Refer to **FIGURE 13–11.**

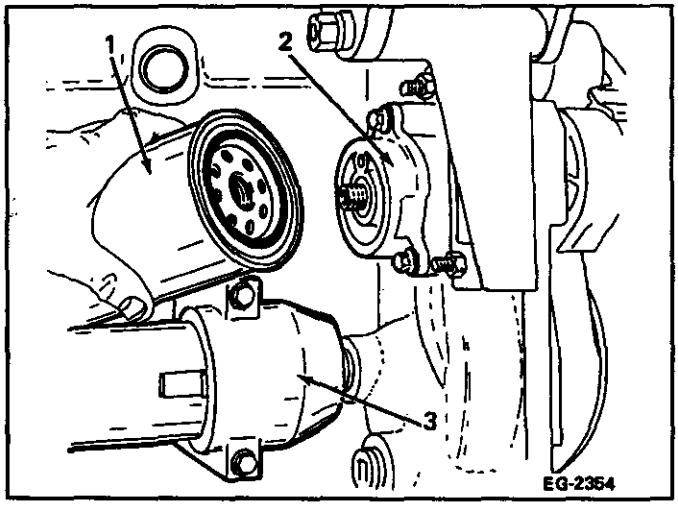
NOTE:
Coolant filter header is equipped with two check valves to stop flow of coolant when filter is removed.



1. **Coolant Filter**

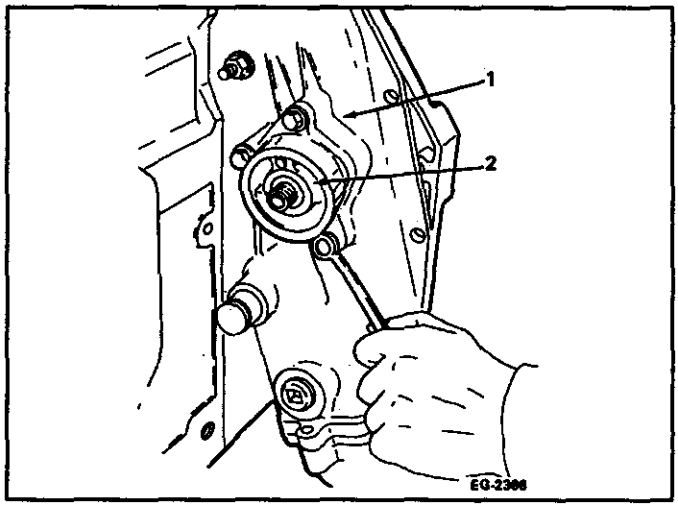
FIGURE 13–11

COOLANT FILTER



1. **Coolant Filter**
2. **Coolant Filter Header**
3. **Oil Cooler**

FIGURE 13–12



1. **Front Cover**
2. **Coolant Filter Header**

FIGURE 13–13

2. Loosen and remove three (3) coolant filter header mounting bolts.
3. Remove coolant filter header, check valves and O–ring. Discard O–ring. Refer to **FIGURE 13–12.**

13.5.2 Installation

1. Install a new O–ring into the rear of coolant filter header.
2. Install coolant filter header onto mounting pad of front cover and secure with mounting bolts. Tighten to special torque. Refer to **FIGURE 13–13.**
3. Install a new coolant filter.

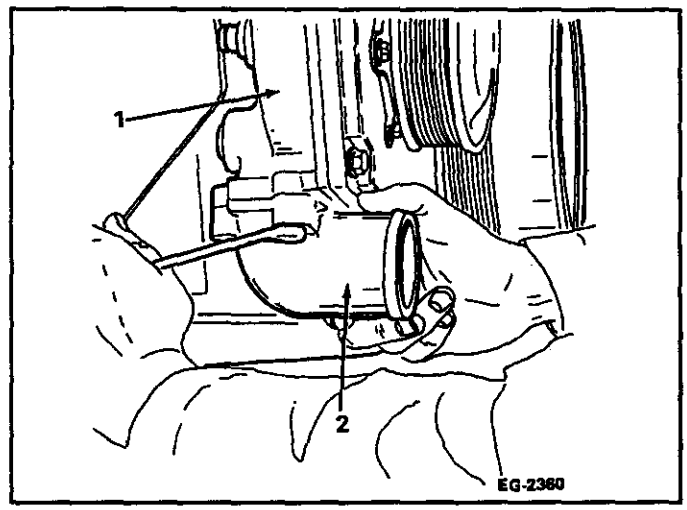
13.6 WATER INLET ELBOW

13.6.1 Removal

1. Remove three (3) mounting bolts that attach water inlet elbow to crankcase cover. Refer to **FIGURE 13–14**.
2. Remove water inlet elbow and gasket. Discard gasket.

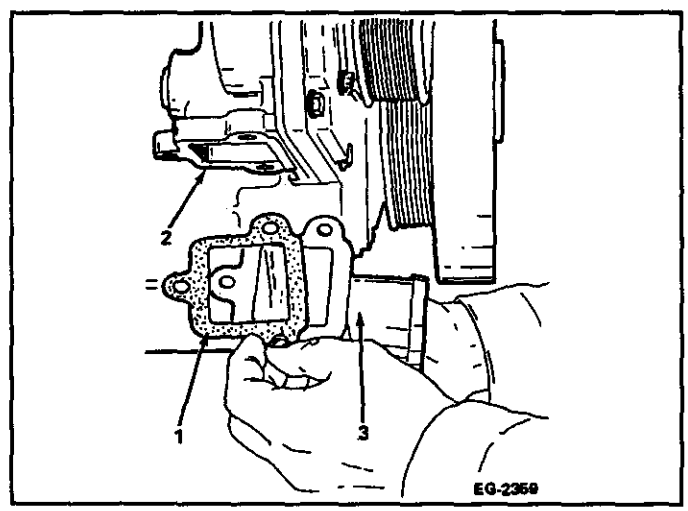
13.6.2 Installation

1. Install water inlet elbow with new gasket to crankcase.
2. Secure water inlet elbow using three (3) flanged bolts and tighten to special torque. Refer to **FIGURE 13–15**.



1. **Front Cover**
2. **Water Inlet Elbow**

FIGURE 13–14



1. **Gasket**
2. **Crankcase Front Cover**
3. **Water Inlet Elbow**

FIGURE 13–15