

# ENGINE OILING

## ENGINE LUBRICATION SYSTEM

**NOTE:** Engine contains a high pressure oiling system and a low pressure oiling system.

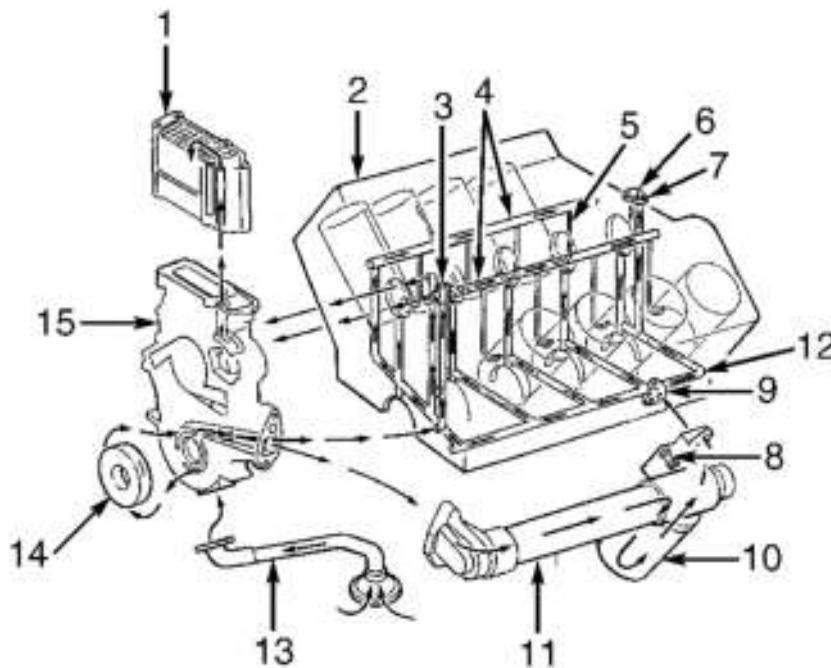
### High Pressure Oiling System

1. High-pressure oiling system supplies oil pressure for fuel injector operation. See **Fig. 72**. During initial start or cold start, gear-driven high pressure oil pump receives unfiltered engine oil from driver-side valve lifter oil galley through anti-drain check ball.
2. Once engine starts or during warm engine starts, anti-drain check ball closes and high pressure oil pump receives filtered engine oil from high pressure oil pump reservoir.
3. High-pressure oil pump delivers engine oil through oil rail in cylinder head at pressures of 600-3000 psi (42.19-210.93 kg/cm<sup>2</sup>) to fuel injectors.
4. During initial start or cold start, the high pressure oil pump receives unfiltered oil from the left side valve lifter oil gallery through the anti-drain back check ball valve.
5. Once the engine starts or during warm engine starts, the check ball closes and the high pressure oil pump receives filtered oil from the high pressure oil pump reservoir.
6. The high pressure oil pump pumps the oil under extremely high pressures 600-3,000 psi (42-211 Kg/Cm<sup>2</sup>) through the left and right side high pressure supply hoses to the high pressure oil rails (integral to the cylinder heads).
7. Once in the oil rail, the oil is fed to the fuel injector bores through 4 oil feed galleries drilled and machined in the cylinder head. The high pressure oil then actuates the fuel injectors.

### Low Pressure Oil System

1. Crankshaft-driven low pressure oil pump supplies pressurized lubrication for engine oiling system. See **Fig. 137**. Oil cooler is used for cooling of engine oil.
2. The lubrication system is comprised of a low pressure system and a high pressure system. The low pressure system provides primary engine lubrication while the high pressure system provides the hydraulic pressure required to actuate the fuel injectors.
3. The low pressure lubricating system draws oil from the engine oil pan through the oil pump screen cover and tube into the oil inlet passage in the front cover. The gerotor oil pump then pumps the oil back out through the outlet passage in the front cover. The oil separates into 2 paths.
4. One flow path sends oil into the high pressure pump reservoir initial fill gallery (integral to the cylinder block) and through the anti-drainback check ball. During cold start the oil feeds in 2 directions from the anti-drainback check ball. One feed leaves the check ball and enters the front cover. From there it enters the high pressure oil reservoir. The second feed exits the check ball and enters the left bank valve lifter oil gallery.
5. After leaving the front cover outlet passage, the second oil path sends the oil through the oil cooler and filter assembly. Once inside the filter housing, the oil filter bypass valve may open to vent excess pressure and oil back into the oil pan.
6. After the oil has been circulated through the oil filter, the oil feed then enters the main oil gallery (integral to the cylinder block). Once in the main oil gallery, the oil is routed to the 5 crankshaft main bearings through 5 drilled and machined feed galleries (integral to the cylinder block).

7. The 5 camshaft bearings receive the oil feed through 5 vertically drilled and machined feed galleries connected to the main bearing feed galleries. The front main bearing feed gallery also supplies oil to the right bank valve lifter oil gallery through a vertically drilled and machined oil feed gallery (integral to the cylinder block).
8. The rear main bearing oil feed gallery also supplies oil to the turbocharger assembly through a vertically drilled and machined oil feed gallery (integral to the cylinder block).
9. Pressurized oil entering the turbocharger assembly is utilized to lubricate the compressor/turbine shaft. The oil drains back through the turbocharger mounting pedestal and back into the oil pan.
10. The valve lifter oil gallery supplies pressurized oil to the valve tappets and to the piston cooling oil jets. Oil from the valve tappets is routed upward to the cylinder head valve train through hollow push rods. Once in the cylinder head, the oil drains back to the oil pan through return ports at each end of the cylinder head.



- |                                     |                                    |
|-------------------------------------|------------------------------------|
| 1. High-Pressure Oil Pump Reservoir | 8. Pressure Relief/Regulator Valve |
| 2. Cylinder Block                   | 9. Oil Filter By-Pass Drain        |
| 3. Anti-Drain Check Ball            | 10. Oil Filter                     |
| 4. Valve Lifter Oil Galley          | 11. Oil Cooler Assembly            |
| 5. Piston Cooling Oil Jet           | 12. Main Oil Galley                |
| 6. Turbocharger Oil Return Galley   | 13. Oil Pump Pick-Up Tube          |
| 7. Turbocharger Oil Supply Galley   | 14. Low-Pressure Oil Pump          |
|                                     | 15. Front Cover                    |

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**Fig. 137: Engine Low Pressure Engine Oiling System**  
 Courtesy of FORD MOTOR CO.

**Crankcase Capacity**

Crankcase capacity is 15 qts. (14.2L) with oil filter and 13 qts. (12.3L) without replacing oil filter.

## Oil Pressure

Engine oil pressure should be 40-70 psi (2.8-4.9 kg/cm<sup>2</sup>) at 3300 RPM, with engine at normal operating temperature.

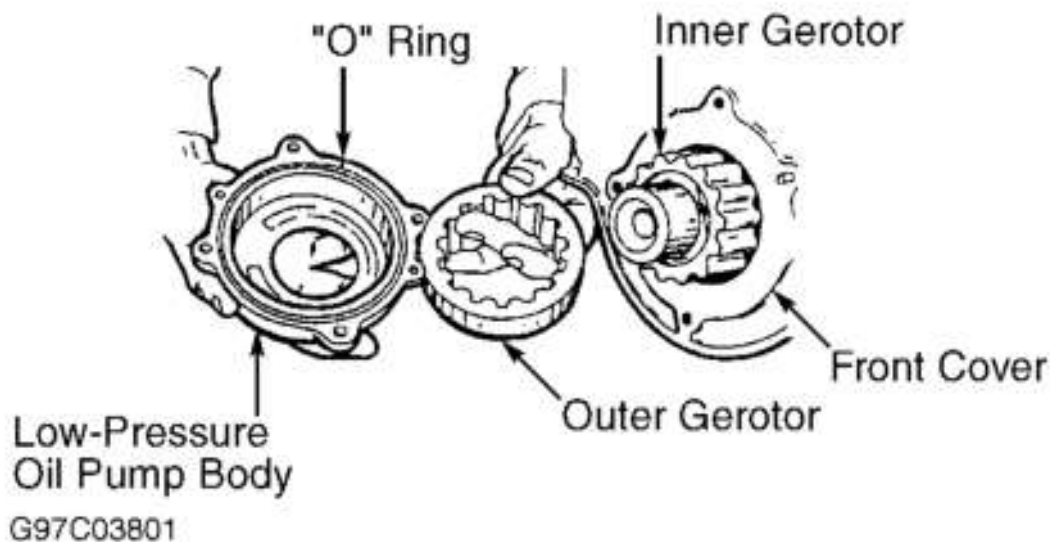
## HIGH-PRESSURE OIL PUMP

For servicing of high pressure oil pump, see **HIGH-PRESSURE OIL PUMP** under REMOVAL & INSTALLATION.

## LOW PRESSURE OIL PUMP

### Removal & Disassembly

1. Low pressure oil pump is located on front cover. See **Fig. 137**.
2. Remove the crankshaft vibration damper. See **CRANKSHAFT FRONT SEAL** under REMOVAL & INSTALLATION.
3. Remove bolts, low pressure oil pump body plate, "O" ring seal, outer gerotor and inner gerotor. See **Fig. 138**.



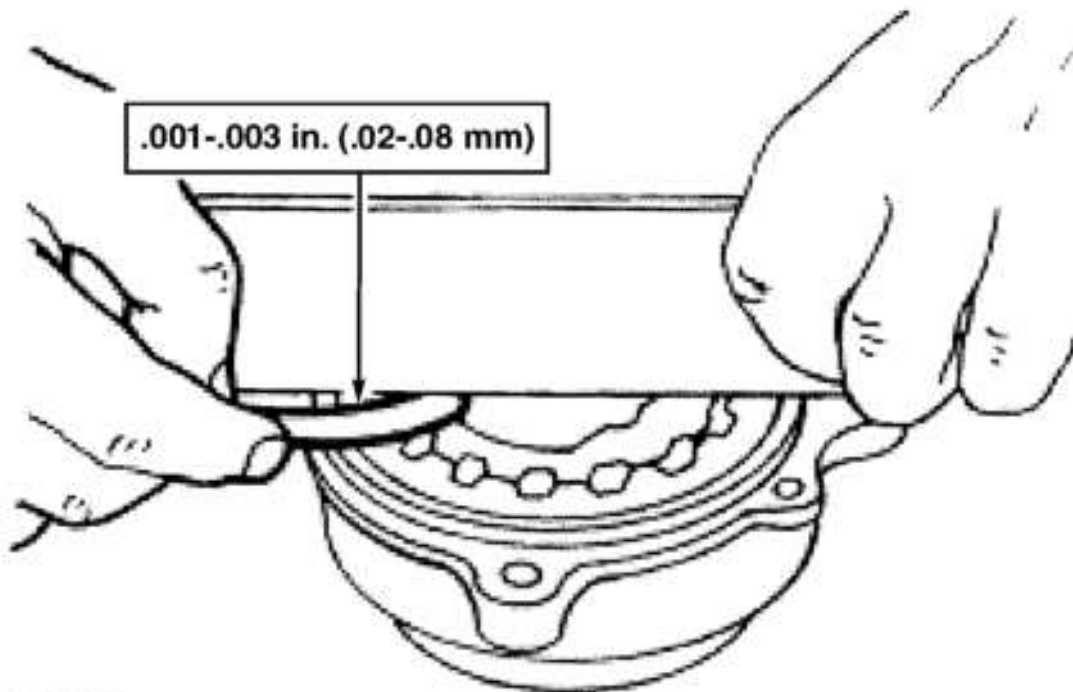
**Fig. 138: Locating Low Pressure Oil Pump Components**  
Courtesy of FORD MOTOR CO.

### Inspection

1. Inspect components for damage and wear. Install inner and outer rotors in low pressure oil pump body. Place straightedge across low pressure oil pump body so it is above both rotors.
2. Using feeler gauge, measure rotor end clearance between rotor and straightedge. See **Fig. 139**. Rotor

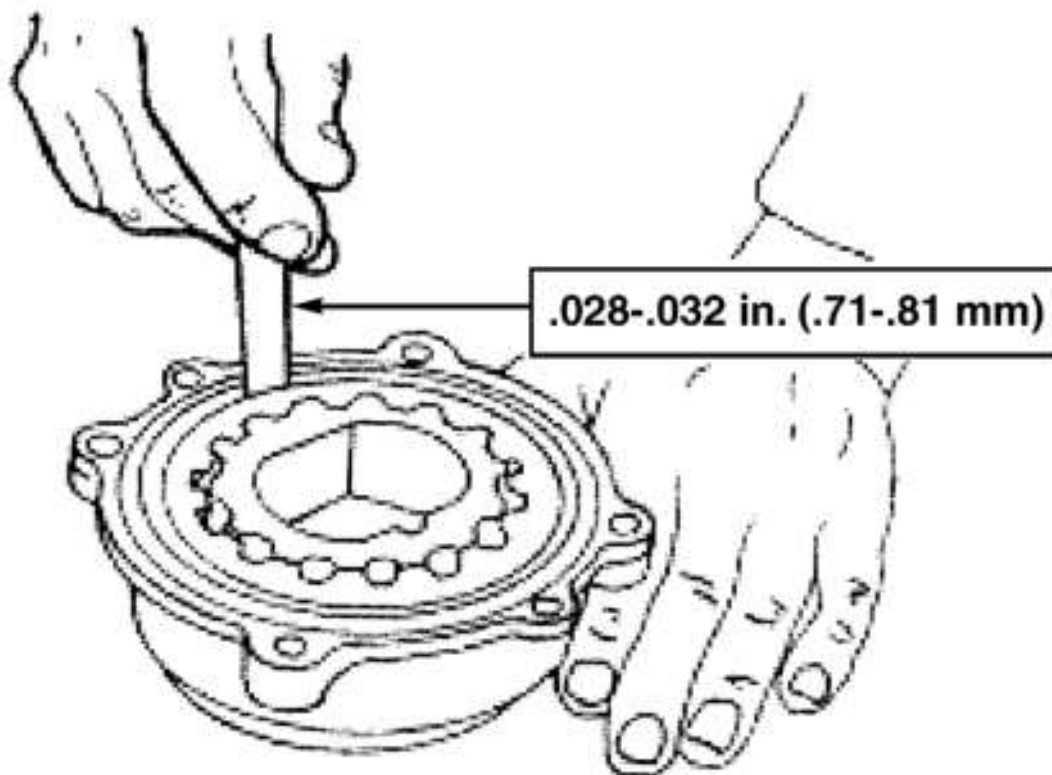
end clearance should be .00078-.00315" (.020-.080 mm).

3. With both rotors installed in low pressure oil pump body, use feeler gauge to measure clearance between outer edge of outer gerotor and oil pump body. See **Fig. 140**.
4. Outer gerotor-to-oil pump body clearance should be .02795-.03189" (.71-.81 mm). Replace low pressure oil pump if any measurement is not within specification.



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**Fig. 139: Measuring Oil Pump Rotor End Clearance**  
Courtesy of FORD MOTOR CO.



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**Fig. 140: Measuring Outer Gerotor-To-Oil Pump Body Clearance**  
 Courtesy of FORD MOTOR CO.

#### Reassembly & Installation

**CAUTION:** The inner and outer gerotor must be installed with the words "OUT" or "DAMPER" facing away from the engine.

**NOTE:** The inner gerotor must be installed onto the crankshaft nose before the oil pump is installed onto the engine front cover.

1. Install the inner gerotor. Lubricate the oil pump with clean engine oil. Position the outer gerotor in the oil pump body plate. Install a NEW "O" ring seal.
2. Position the oil pump body plate and outer gerotor on the crankshaft nose. Install the oil pump body plate bolts and tighten to specification. See TORQUE SPECIFICATIONS.

**NOTE:** Manufacturer recommends installing NEW crankshaft front seal any time vibration damper is removed.

3. Carefully remove and discard the crankshaft front seal. See CRANKSHAFT FRONT SEAL under REMOVAL & INSTALLATION. Install NEW crankshaft front seal. Install the crankshaft vibration damper.
4. Install a NEW engine oil filter. Fill the engine to proper level using appropriate engine oil. See

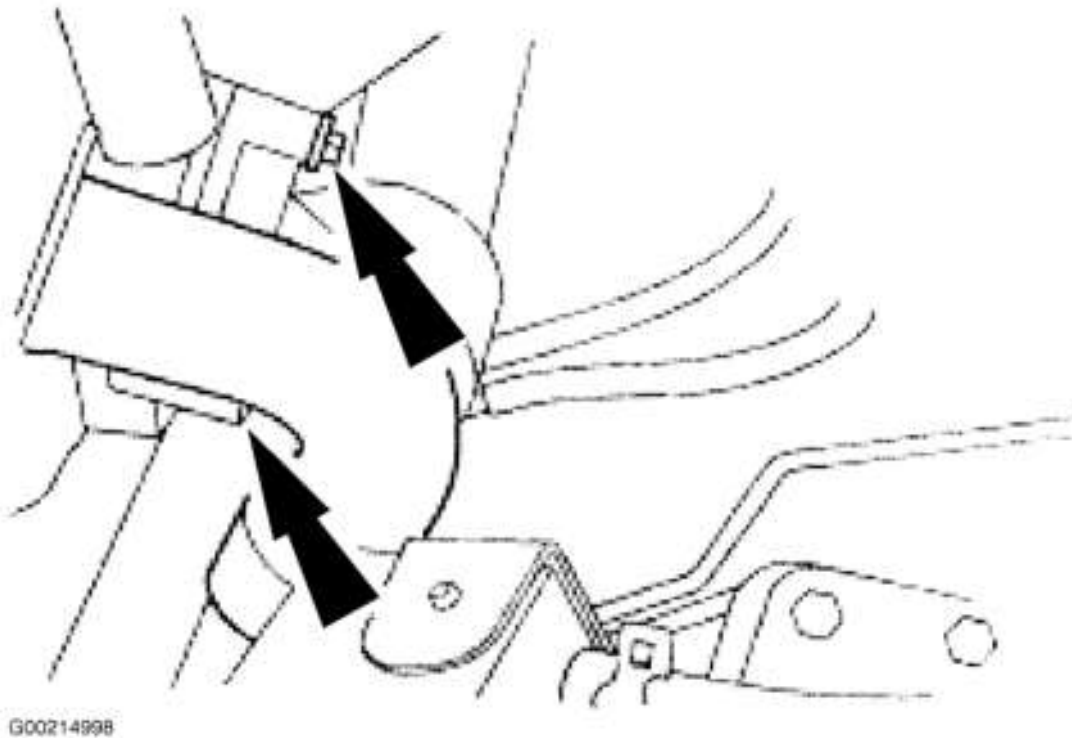
**ENGINE LUBRICATION SYSTEM.** Start the vehicle and check for leaks. Repair as necessary.

## OIL COOLER ASSEMBLY

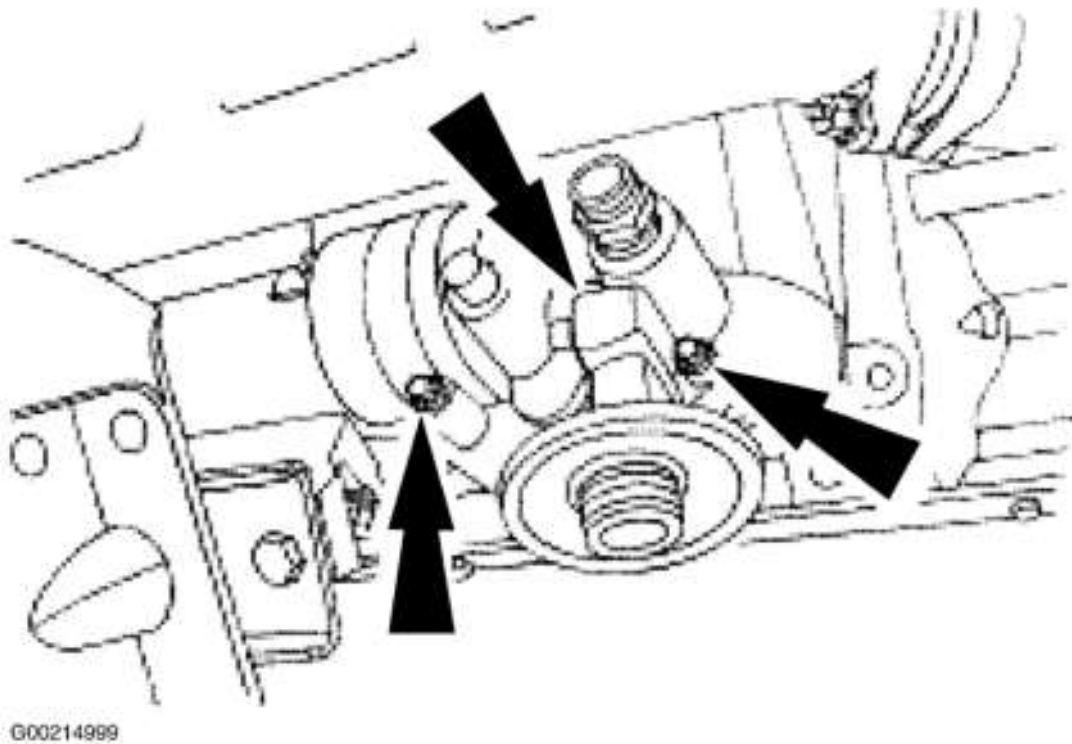
**CAUTION:** If main bearing or rod bearing failure exists, oil cooler must be replaced.

### Removal

1. Disconnect negative cables. Drain cooling system. See **COOLING SYSTEM BLEEDING** under REMOVAL & INSTALLATION. Raise and support vehicle.
2. Disconnect exhaust pipe at turbocharger for access to oil cooler if necessary. Remove oil cooler front header-to-cylinder block bolts. See **Fig. 141**. Drain engine oil into a suitable drain pan and remove oil filter.
3. Disconnect retainer and cable from cylinder block heater. See **Fig. 33**. Cylinder block heater is located on driver-side rear corner of cylinder block, just below exhaust manifold, near oil filter.
4. Remove oil cooler rear header-to-cylinder block bolts. See **Fig. 142**. Remove oil cooler assembly and gaskets.



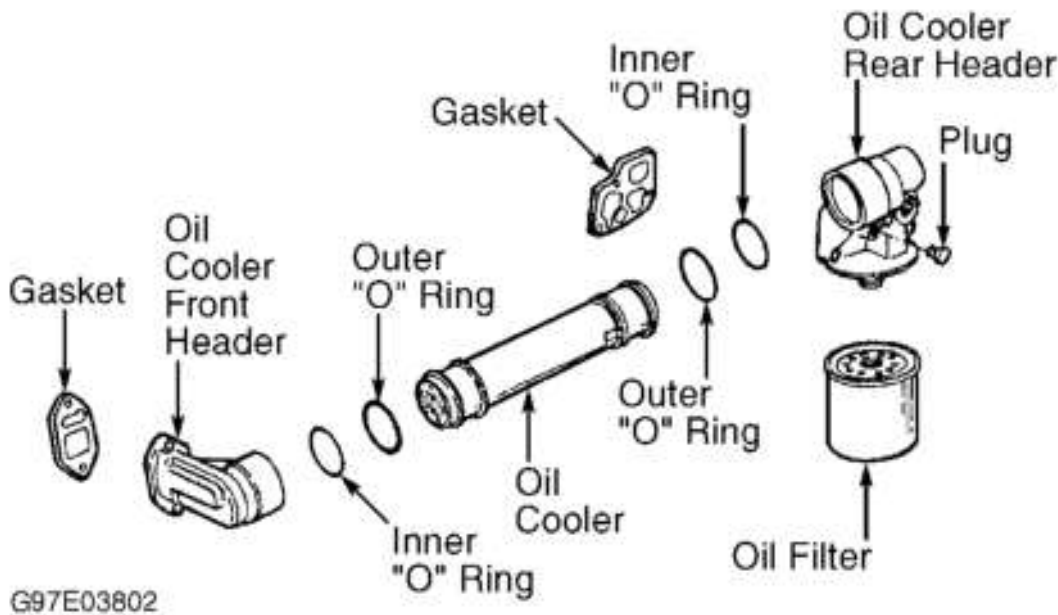
**Fig. 141: Locating Oil Cooler Front Header-To-Cylinder Block Header Bolts**  
Courtesy of FORD MOTOR CO.



**Fig. 142: Locating Oil Cooler Rear Header-To-Cylinder Block Header Bolts**  
Courtesy of FORD MOTOR CO.

### **Disassembly & Cleaning**

1. Using soft-faced hammer, tap on oil cooler front and rear headers to loosen "O" rings. Remove oil cooler front and rear headers from oil cooler by using twisting motion. See **Fig. 143**.
2. Thoroughly clean all components with solvent. Ensure oil cooler is thoroughly flushed to ensure all residue is cleaned from oil cooler. Dry components with compressed air.



**Fig. 143: Exploded View Of Oil Cooler Assembly**  
 Courtesy of FORD MOTOR CO.

### Reassembly

1. Apply engine oil to NEW "O" rings and "O" ring mating surfaces. Install large "O" rings and then small "O" rings on oil cooler.
2. Install oil cooler front and rear headers on oil cooler. Ensure locating clips are aligned in slots and headers are installed evenly on oil cooler.

### Installation

1. Using NEW gaskets, install oil cooler assembly onto cylinder block. Install and tighten oil cooler rear header-to-cylinder block bolts until bolts are snug. See **Fig. 142**. Install and tighten oil cooler front header-to-cylinder block bolts to specification. See **Fig. 141**. See **TORQUE SPECIFICATIONS**.
2. Lower engine. Install driver-side engine mount. Tighten oil cooler rear header-to-cylinder block bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Adjust engine oil level. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING** under REMOVAL & INSTALLATION.
3. If engine oil leaked into cooling system due to defective oil cooler, drain and flush cooling system as necessary. See **COOLING SYSTEM BLEEDING** under REMOVAL & INSTALLATION. If coolant leaked into crankcase due to defective oil cooler, change engine oil and oil filter.