



200 ENGINE DISASSEMBLY

ENGINE DISASSEMBLY



200 ENGINE DISASSEMBLY

GENERAL

This section includes step-by-step procedures for complete disassembly of the MACK E7 engine upon removal from the vehicle. Major components are removed as assemblies and overhauled in the BENCH PROCEDURES section of this manual.

CAUTION

Failure to follow the sequence of operations listed below may result in damage to components or personal injury.

[219 EV] CENTRI-MAX™ AND SPIN-ON FILTER ELEMENTS

Refer to Figure 4-1.

1. Place a suitable container below the filter element area to catch any spilled fluids.

CAUTION

*Do not apply the filter wrench to any area other than that labeled **WRENCH HERE** on the Centri-Max™ filter housing, or damage to the Centri-Max™ housing will result.*

2. Using a suitable filter wrench, remove the fuel and oil filter elements. Do not reuse filter elements. Discard used elements in a responsible, environmentally safe manner.
3. Loosen drain hose assembly (4) from Centri-Max™ filter housing assembly by loosening hose clamp (3) at the Centri-Max™ housing.
4. Remove two nuts (6) and two washers (5) securing hose adapter (7) to studs (1) at the cylinder block. Discard O-ring (8).
5. Remove drain hose assembly (4).
6. Remove Centri-Max™ housing (9) and element (10). Discard seal ring (2).

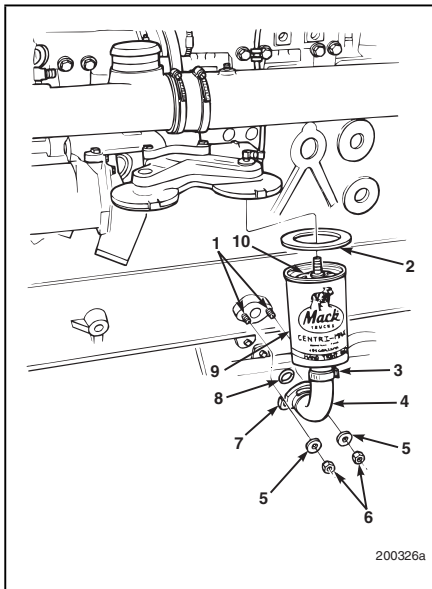


Figure 4-1 — Centri-Max™ Housing Removal Studs

1. Studs	6. Nuts
2. Seal ring	7. Adapter
3. Clamp	8. O-ring
4. Drain hose assembly	9. Centri-Max™ housing
5. Washers	10. Centri-Max™ element



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MOUNTING ENGINE IN STAND

WARNING

The engine is heavy (approximately 2,300 lbs. [1043 kg] wet). Stay out from under the engine when it is being lifted. Failure of the lifting device could result in serious injury or death. Make sure to use lifting equipment that is rated at a capacity greater than the weight of the engine.

NOTE

The fuel and oil filter elements, as well as the Centri-Max™ assembly, must be removed before mounting the adapter plate to the engine.

CAUTION

Engine stand, Kent-Moore tool number J 29109, and adapter plate J 38048, are recommended to safely support the engine during disassembly and assembly procedures.

CAUTION

When servicing an E7 engine with an isolating oil pan arrangement, avoid using an engine stand that supports the engine on the oil pan rail while the oil pan is still installed. Damage to the oil pan, pan gasket or the isolators may result. If this type of stand must be used and the oil pan is to remain installed, support the engine on the pads provided at each corner of the cylinder block as shown in Figure 6-56.

Special Tools Required

- Engine Stand J 29109
- Adapter Plate J 38048

Refer to Figure 4-2.

1. Using three mounting capscrews (2), secure adapter plate J 38048 (1) to the left side of the engine.
2. Secure adapter plate (1) to engine stand J 29109 (3) with six mounting capscrews (4).
3. Remove lifting device from the engine.



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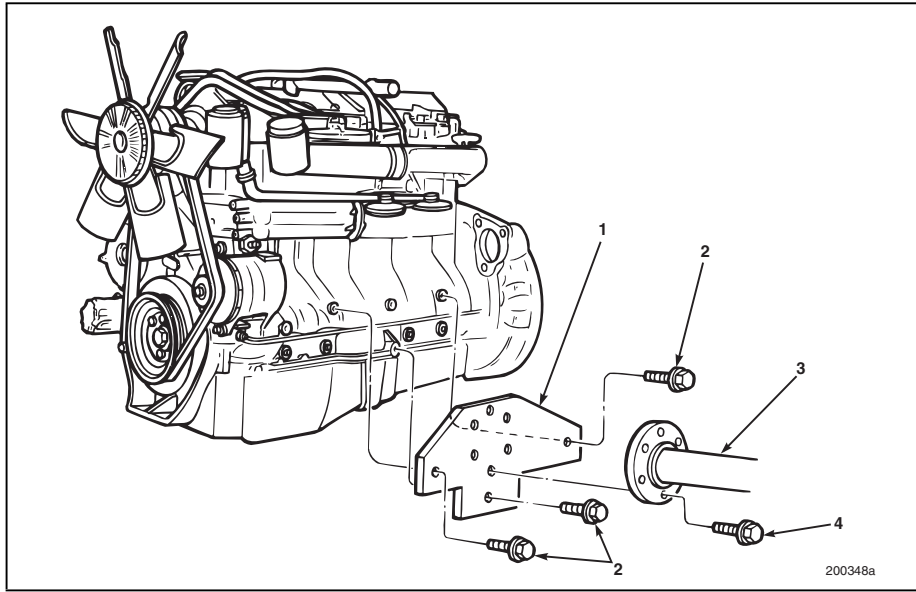


Figure 4-2 — Mount Engine in Stand

- | | |
|--------------------------|-------------------------|
| 1. Adapter plate J 38048 | 3. Engine stand J 29109 |
| 2. Capscrews | 4. CapscREW |



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[271 CB] ALTERNATOR

Refer to Figure 4-3.

1. Loosen adjusting capscrew (2) and mounting nuts (6).
2. Remove drive belts (1) and tag belts for reassembly.
3. Disconnect and tag electrical wires by removing mounting hardware.
4. Remove mounting nuts (6) and washers. Pull out capscrews (3) and remove alternator (7).
5. Remove alternator plate (5) by removing mounting hardware (4).

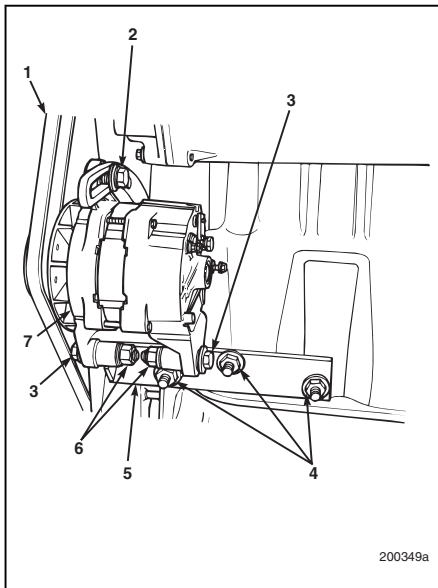


Figure 4-3 — Alternator Removal

- | | |
|-----------------------|---------------------|
| 1. Drive belt | 5. Alternator plate |
| 2. Adjusting capscrew | 6. Mounting nuts |
| 3. Capscrew | 7. Alternator |
| 4. Mounting hardware | |

[215 HB] FAN ASSEMBLY

Refer to Figure 4-4.

1. Loosen eight fan assembly mounting nuts (2) and capscrews (1).
2. While supporting fan assembly (3), remove nuts (2) from capscrews (1) and remove fan assembly.

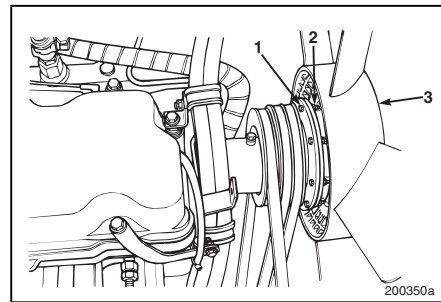


Figure 4-4 — Fan Assembly Removal

- | | |
|-------------|-----------------|
| 1. Capscrew | 3. Fan assembly |
| 2. Nut | |

Refer to Figure 4-5.

3. If the fan assembly is equipped with a viscous drive, be sure to store the assembly either horizontally, with the fan face down (hub flange up), or vertically, as shown in Figure 4-5. This will prevent fluid leaking from the assembly.

NOTE

Do not store the assembly horizontally with the fan face up (hub flange down). Fluid in the viscous drive reservoir can leak out.



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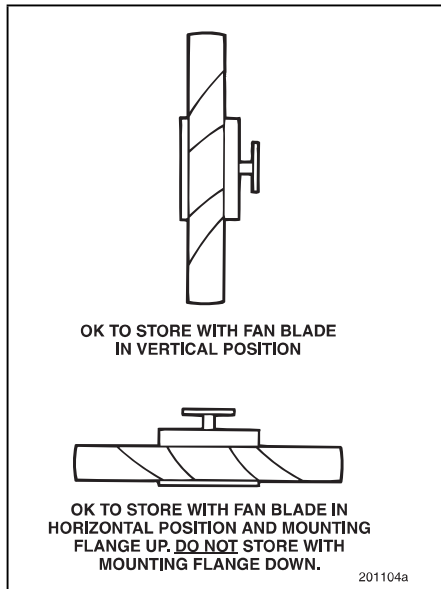


Figure 4-5 — Viscous Fan Drive Assembly Storage

[231 PB] FUEL FILTER ADAPTER ASSEMBLY

Refer to Figure 4-6

1. Disconnect three fuel lines from fittings (2, 3 and 5) on fuel filter adapter assembly (1). Tag and cap all lines.
2. Remove three capscrews (4) from the top of the fuel filter adapter assembly.
3. Remove fuel filter adapter assembly from the air inlet manifold (7).

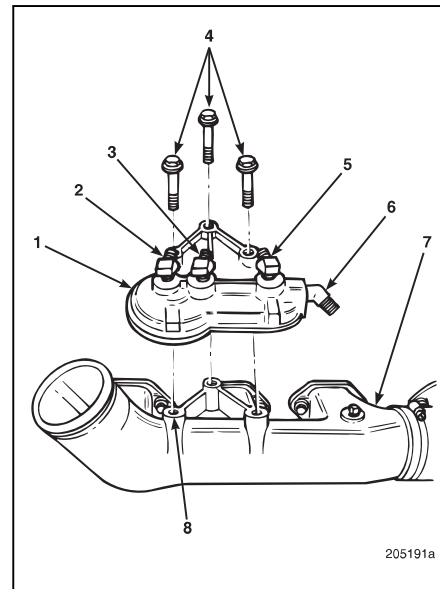


Figure 4-6 — Fuel Filter Adapter Assembly Removal

- | | |
|-----------------------------------|---------------------------------|
| 1. Fuel filter adapter assembly | 4. Capscrews |
| 2. Secondary filter fitting (out) | 5. Primary filter fitting (out) |
| 3. Secondary filter fitting (in) | 6. Primary filter fitting (in) |
| | 7. Air inlet manifold |
| | 8. Mounting flange |



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[215 LD] COOLANT CONDITIONER ELEMENT

Refer to Figure 4-7.

1. Cut the plastic tie wrap (1) securing coolant conditioner supply tube (2) to cylinder head manifold overflow line.
2. Disconnect fittings (3) from both ends of the coolant conditioner supply tube. Remove tube (2).

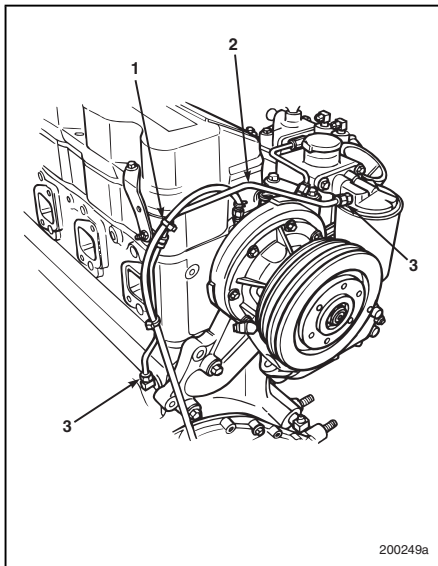


Figure 4-7 — Coolant Conditioner Supply Tube Removal

1. Plastic tie wrap
2. Coolant conditioner
supply tube

3. Fittings

Refer to Figure 4-8.

3. Place a suitable container below the coolant filter area to catch any spilled coolant.
4. Using a suitable filter wrench (J 29927 or equivalent), remove the coolant conditioner filter element (13). Discard element.
5. Remove coolant conditioner head assembly (2) from thermostat housing (5) and coolant manifold (9) by removing mounting capscrews (1).
6. Remove and discard O-ring (4).
7. Carefully remove and examine the check valve assembly (3). Examine check valve assembly by depressing the check ball. If it resists movement and does not return to its seat freely, the check valve assembly must be replaced.



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[215 NU] THERMOSTAT

Refer to Figure 4-8.

1. With the coolant conditioner element removed, remove two capscrews (13) that secure the thermostat housing (5) to coolant manifold (9).
2. Loosen two hose clamps (10) on the coupling (12) that connects the oil cooler supply tube (11) to the thermostat housing.
3. Taking care to prevent the thermostat (7) from falling, remove the thermostat housing (5) and thermostat. Discard gasket (8).

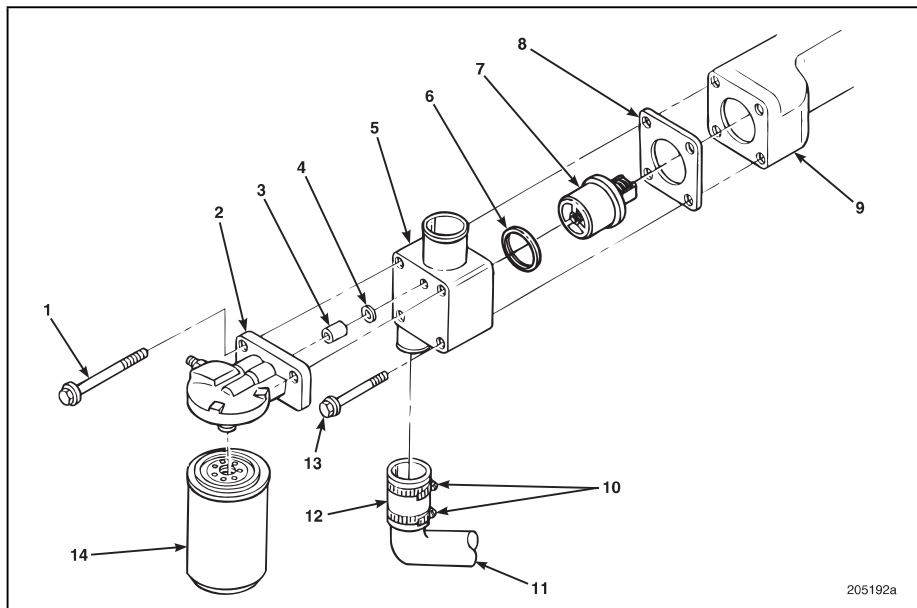


Figure 4-8 — Coolant Conditioner Removal

- | | |
|--------------------------------------|--|
| 1. Capscrew | 8. Gasket |
| 2. Coolant conditioner head assembly | 9. Coolant manifold |
| 3. Check valve assembly | 10. Clamps |
| 4. O-ring | 11. Oil cooler supply tube |
| 5. Thermostat housing | 12. Coupling |
| 6. Thermostat seal | 13. Capscrew |
| 7. Thermostat | 14. Coolant conditioner filter element |



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[214 HD] AIR INLET MANIFOLD

Refer to Figure 4-9.

1. Support the air inlet manifold sections and remove 12 capscrews (9) that secure the manifold sections (6 and 8) to the cylinder heads.
2. Remove air inlet manifold. It may be necessary to gently pry or tap the manifold lightly with a soft mallet to break the seal.
3. If the air inlet manifold is to be replaced, remove sensor (7) located on the inlet manifold (6), if installed.

[215 NK] COOLANT MANIFOLD

Refer to Figure 4-9.

1. Support the coolant manifold sections and remove 12 capscrews (5) retaining the manifold sections (1 and 4) to the cylinder heads.
2. Remove manifold assembly. It may be necessary to pry or tap lightly with a soft mallet on the housing sections to break the seal.
3. If necessary, separate the two coolant manifold sections (1 and 4) by loosening two clamps (3) and removing the coupling (2).

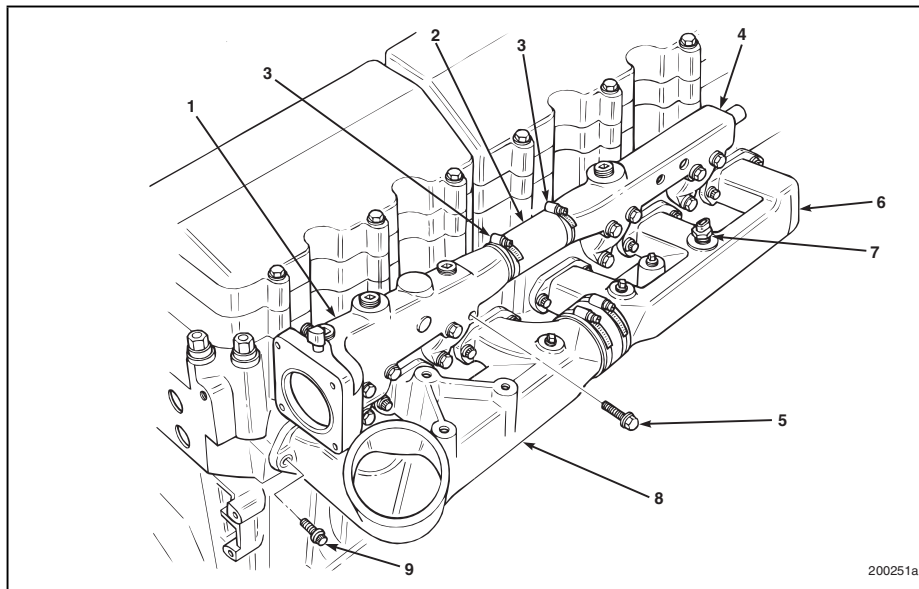


Figure 4-9 — Air Inlet Manifold Removal

- | | |
|------------------------------------|--------------------------------------|
| 1. Coolant manifold, front section | 6. Air inlet manifold, rear section |
| 2. Coupling | 7. Sensor |
| 3. Clamp | 8. Air inlet manifold, front section |
| 4. Coolant manifold, rear section | 9. Capscrew, 12-point |
| 5. Capscrew | |



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[215 DW & 219 EP] OIL COOLER AND OIL FILTER HOUSING ASSEMBLY

Refer to Figure 4-10.

1. Disconnect turbocharger lubrication supply hose (6) from the oil filter/cooler assembly (5).
2. Disconnect feed line (2) from the centrifugal filter housing fitting. Tag and cap line and fitting.
3. Disconnect Centri-Max™ filter breather hose (1) by sliding hose from fitting. (For MR chassis Jake Brake applications, remove the Centri-Max™ breather filter. Clean with suitable solvent to make sure breather is clear.)
4. Remove four capscrews (3) securing oil filter feed assembly (4) to engine block.

NOTE

Unless it is necessary to repair any portion of the oil cooler or oil filter housing, remove the units as an assembly. The assembly can be disassembled later if necessary. Refer to Oil Cooler Disassembly in the BENCH PROCEDURES section.

NOTE

Effective with the introduction of the S300 and S400 model turbochargers (May 1996), a new style oil inlet line is used. The line is a stainless steel braided line which replaces the conventional hose type line and steel oil inlet tube. The new oil line is connected directly to the threaded oil inlet port at the turbocharger.

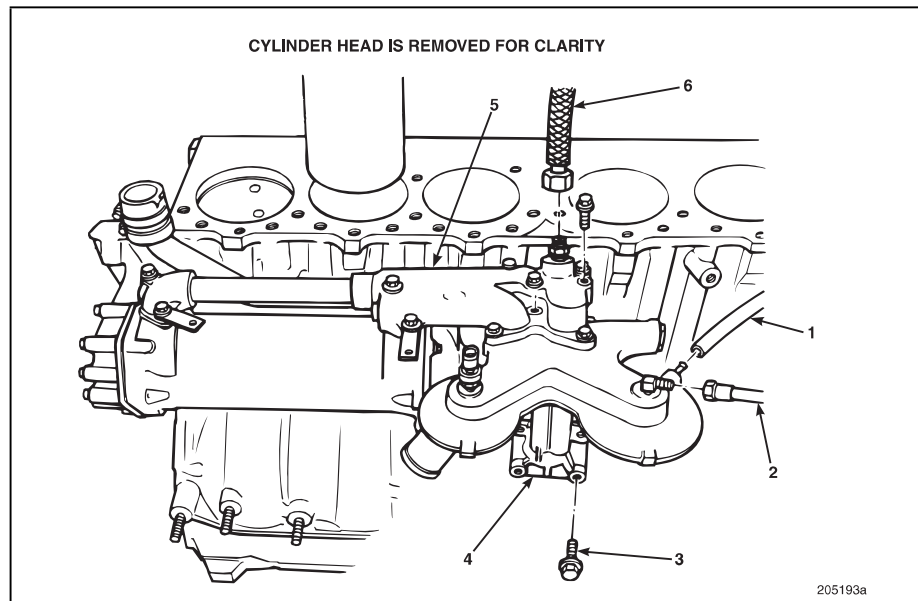


Figure 4-10 — Oil Cooler Removal

- | | |
|---|---------------------------------------|
| 1. Centri-Max™ filter breather hose (MR chassis with Jake Brake uses breather assembly) | 4. Oil filter feed assembly |
| 2. Feed line | 5. Oil filter/cooler assembly |
| 3. Capscrew | 6. Turbocharger lubrication feed hose |



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[215 SW] WATER PUMP

Refer to Figure 4-11.

1. Disconnect coolant return hose to air compressor (1) at fitting.
2. Remove three mounting capscrews (3) and remove water pump (2).

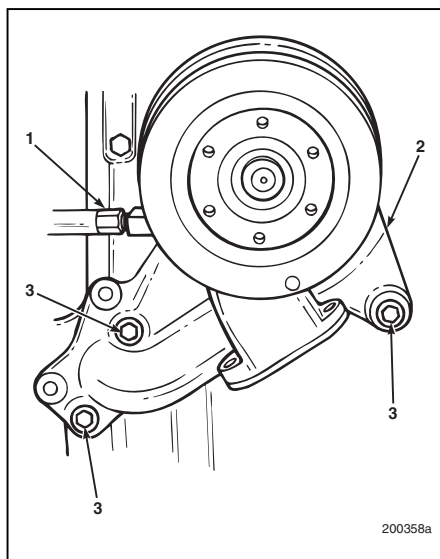


Figure 4-11 — Water Pump Removal

- | | |
|---------------------------------------|-------------|
| 1. Air compressor coolant return line | 3. Capscrew |
| 2. Water pump | |

[214 SD] TURBOCHARGER

Refer to Figure 4-12.

1. Remove two capscrews (3) securing turbocharger lubrication drain tube (4) to turbocharger (1).
2. Loosen hose clamp (5) securing drain tube to oil fill tube. Remove drain tube (4).
3. Remove turbocharger lubrication feed hose (2).

NOTE

Beginning with May 1996 production, Schwitzer turbocharger models S300 and S400 replace models S3B and S4B. Service old with old and new with new. Also note that with the S300 and S400 models, a stainless-steel braided oil feed line is used.

4. Loosen four turbocharger mounting nuts (6) and remove turbocharger (1).

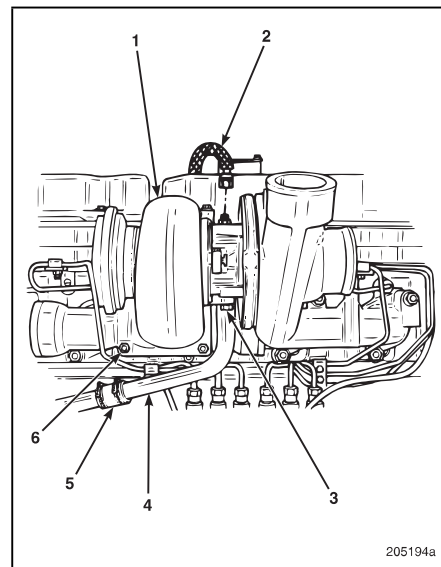


Figure 4-12 — Turbocharger Removal

- | | |
|--------------------------|---------------------------|
| 1. Turbocharger | 4. Lubrication drain tube |
| 2. Lubrication feed hose | 5. Clamp |
| 3. Capscrew | 6. Mounting nut |



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[222 KD] FUEL NOZZLE INLET TUBE ASSEMBLY

Refer to Figure 4-13.

1. Loosen six tube sleeve nuts (6) at the injection pump. Be careful to avoid twisting lines while loosening nuts.
2. Loosen brackets (3 and 5) by removing retaining hardware.
3. Loosen tube sleeve nuts (1) and tube clamping screws at the cylinder heads and remove front (4) and rear (2) tube assemblies. Cap all lines and fittings to prevent contaminants from entering the system.

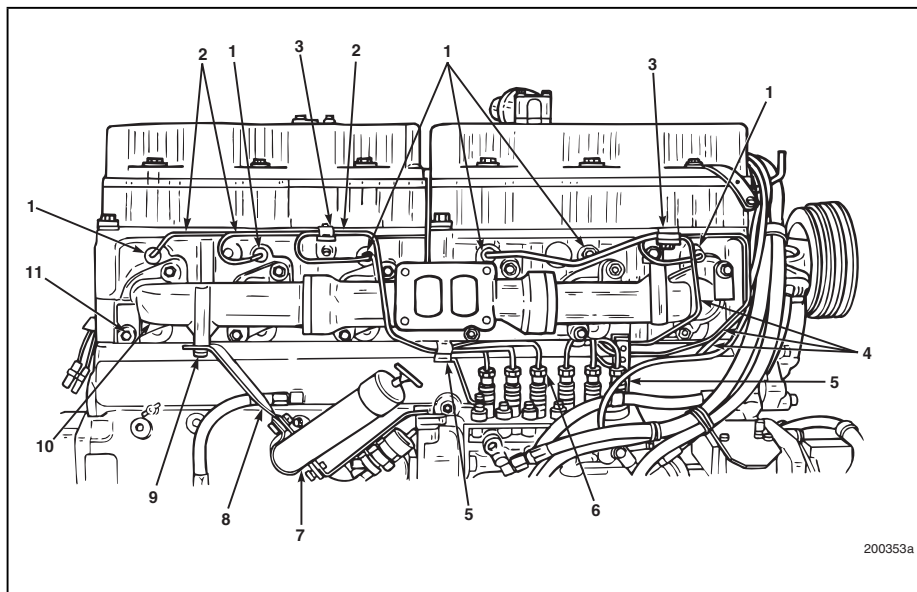


Figure 4-13 — Fuel Inlet Tube Assembly Removal

- | | |
|--|---------------------------------|
| 1. Nozzle fuel inlet tube and sleeve nut | 7. Oil filler feed tube |
| 2. Rear fuel inlet tube assembly | 8. Oil filler feed tube bracket |
| 3. Bracket/insulator (tube clamp) | 9. Capscrew |
| 4. Front fuel inlet tube assembly | 10. Exhaust manifold |
| 5. Bracket/insulator (tube clamp) | 11. Capscrew |
| 6. Sleeve nut | |



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Refer to Figure 4-14.

4. If necessary, separate fuel inlet tubes (4) from bracket assembly. Remove nuts (6) from capscrews (1) and remove clamp plate (2), insulators (3) and bracket (5).

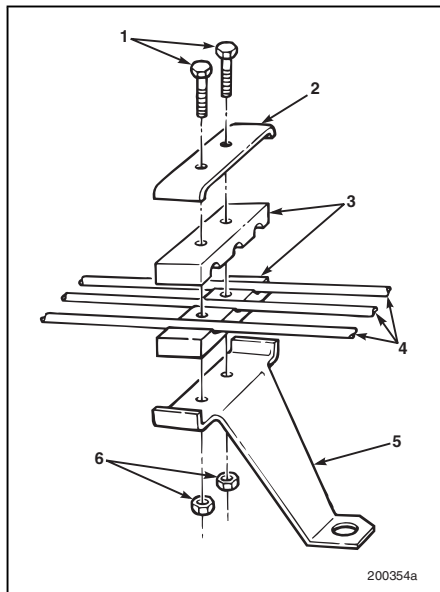


Figure 4-14 — Inlet Tube Clamp Disassembly

- | | |
|----------------|---------------------|
| 1. Capscrews | 4. Fuel inlet tubes |
| 2. Clamp plate | 5. Bracket |
| 3. Insulator | 6. Nuts |

[214 EG] EXHAUST MANIFOLD

Refer back to Figure 4-13.

1. Remove capscrew (9) securing oil filler tube bracket (8) to exhaust manifold (10).
2. If necessary, remove the retaining clamp for the injection pump wiring and connector from the holder.
3. Remove capscrews securing oil filler feed tube (7) to cylinder block. Remove tube.
4. Support the exhaust manifold and remove 12 mounting capscrews (11) securing the manifold (10) to cylinder heads.
5. Remove exhaust manifold.
6. Discard gaskets.

[213 JB] VALVE COVER AND RISER

NOTE

If engine is equipped with a Jake Brake®, a riser is installed under the valve cover. Longer capscrews are used to secure the valve cover and riser to the cylinder head.

Refer to Figure 4-16.

1. Remove valve covers (3) by removing six retaining capscrews (4 and 5) from each cover.
2. Discard seals.

Refer to Figure 4-15.

3. If a Jake Brake is installed, perform the following:
 - a. Remove control wire (3) from left side of each riser housing (4).

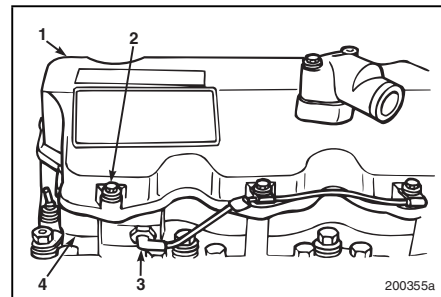


Figure 4-15 — Control Wire Removal

- | | |
|----------------|------------------|
| 1. Valve cover | 3. Control wire |
| 2. Capscrew | 4. Riser housing |

Refer to Figure 4-16.

- b. Disconnect wires (1) at the actuator solenoid connector (14).
- c. Remove risers (2). Discard seals.



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[213 LP, NV & LH] ROCKER ARM, VALVE YOKE AND PUSH ROD

Refer to Figure 4-16.

If equipped with a Jake Brake, perform the following:

1. Remove three capscrews (6) from each actuator assembly (15).
2. Remove actuator assemblies from cylinder heads (one actuator assembly per head).

NOTE

If a Jake Brake was not installed, there will be six capscrews per rocker arm assembly. If a Jake Brake was installed, there will be only three capscrews per rocker arm assembly remaining.

3. Remove remaining capscrews (13) and washers (12) from rocker arm shaft brackets (7). Remove rocker arm assembly (11) from each head.
4. Remove valve yokes (8) from each pair of valves by lifting straight up on each yoke. Tag yokes for reassembly.
5. Remove valve push rods (10) and tag rods for reassembly.

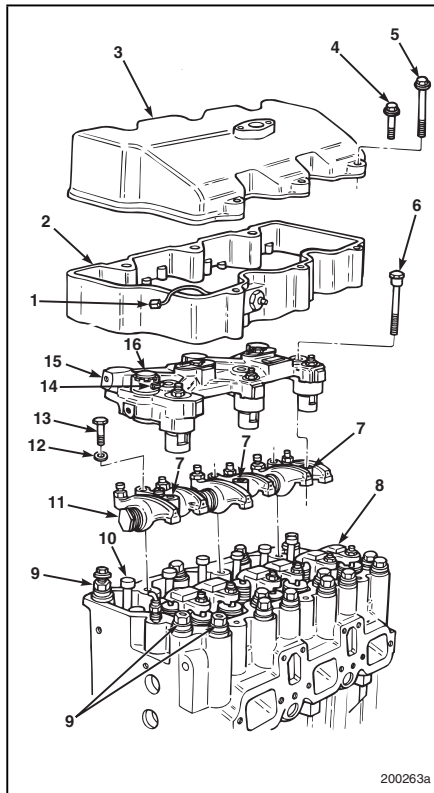


Figure 4-16 — Valve Cover and Rocker Arm Removal

1. Wire connector	9. Head bolt with threaded hole
2. Riser	10. Push rod
3. Valve cover	11. Rocker arm assembly
4. Short capscrew	12. Washer
5. Long capscrew	13. Capscrew
6. Actuator capscrew	14. Connector
7. Rocker arm shaft bracket	15. Actuator assembly
8. Valve yoke	16. Actuator solenoid



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[222 KG] NOZZLE HOLDER

Special Tool Required

- Injection Nozzle Puller J 37093

SERVICE HINT

After removing the nozzles, it is a good practice to label or tag them for reinstallation into the same cylinders. After removal, place nozzles on a clean surface.

Refer to Figure 4-17.

1. Remove nozzle holder retainer (2).
2. Assemble injection nozzle puller J 37093 as follows:
 - a. Attach nut (12), bearing (11), spacer (10) and rubber washer (9) to tool handle (1).
 - b. Screw handle (1) in threaded hole of nozzle holder (5) until rubber washer (9) is slightly compressed.
3. With tool in position, turn nut (12) clockwise to draw nozzle holder from cylinder head nozzle mounting hole (8).
4. Continue turning nut until nozzle holder is free of insert. Remove nozzle holder and puller tool as an assembly.
5. Remove nozzle holder gasket (7). The gasket is manufactured from a special iron material 0.060 inch (1.524 mm) thick.
6. Remove remaining nozzle holders in the same manner.

NOTE

Current production nozzle holders do not have the lower O-ring groove.

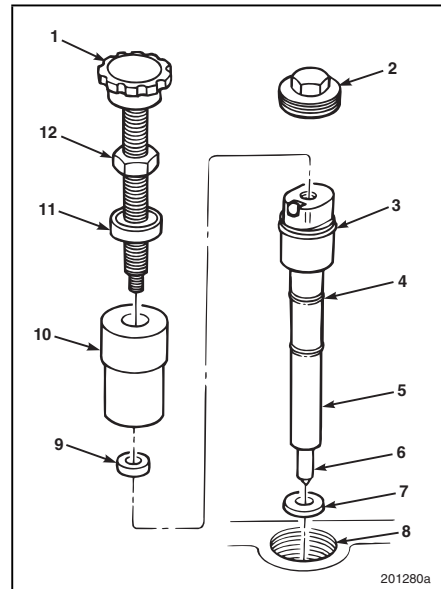


Figure 4-17 — Nozzle Holder Removal

1. Handle	7. Gasket
2. Nozzle holder retainer	8. Nozzle mounting hole
3. O-ring	9. Rubber washer
4. O-ring	10. Spacer
5. Nozzle holder	11. Bearing
6. Nozzle	12. Nut



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[213 EV] CYLINDER HEAD ASSEMBLY REMOVAL

Refer to Figure 4-18.

1. Remove fuel return tube (3) from between the cylinder head assemblies (4) by loosening the tube sleeve nuts from each end.
2. Remove fuel return line (1) at the front of the forward cylinder head.
3. Remove cylinder head bolts (2 and 5). Refer to cylinder head bolt torque sequence chart in Cylinder Head Installation for location of bolts, if necessary.

WARNING

Cylinder head assemblies are heavy. Lifting a cylinder head requires the help of an assistant or suitable lifting device. Attempting to lift a cylinder head without assistance may result in severe personal injury.

4. Using a suitable lifting device, remove heads from the engine block.
5. Remove gaskets and six fire rings. Discard gaskets and fire rings.

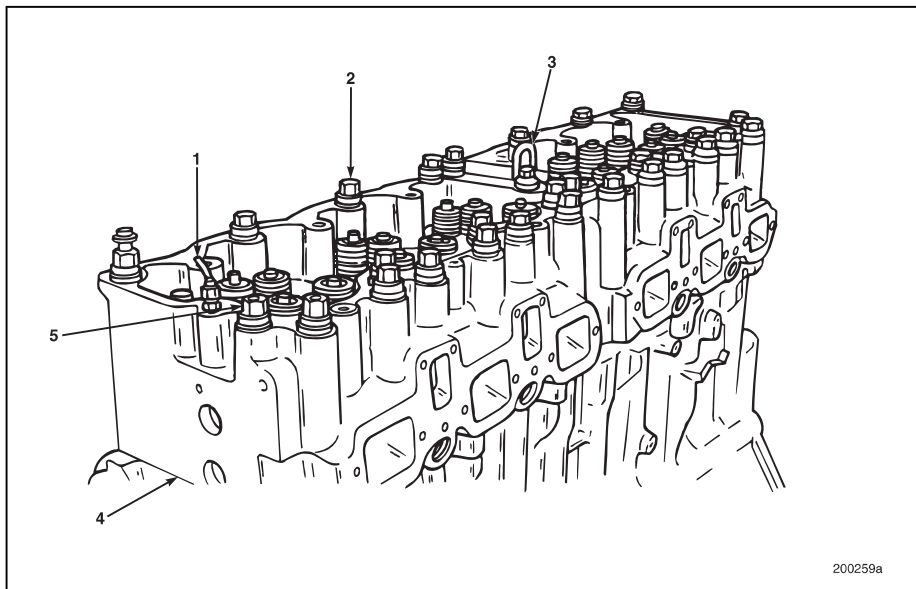


Figure 4-18 — Cylinder Heads

- | | |
|---------------------|---------------------------|
| 1. Fuel return line | 4. Cylinder head |
| 2. Bolt | 5. Bolt with hole in head |
| 3. Fuel return tube | |



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[212 RB & RH] VIBRATION DAMPER AND CRANKSHAFT HUB

Refer to Figure 4-19.

1. Remove six mounting capscrews (4) and turnover bracket, if equipped.
2. Remove vibration damper (3) and fan belt drive pulley (1) together.
3. Using a 1-7/16 inch wrench, remove crankshaft hub capscrew (2).
4. Using a suitable puller such as J 24420-C, remove the crankshaft hub.

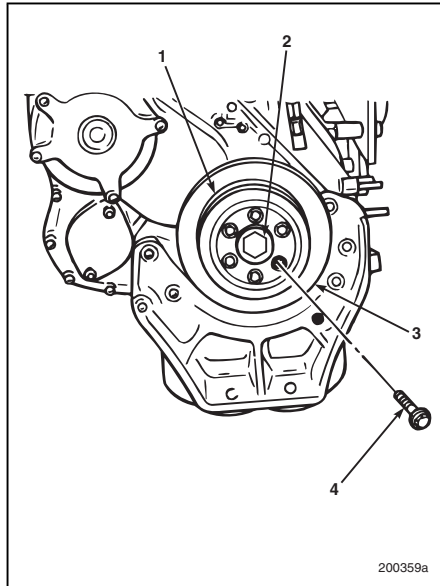


Figure 4-19 — Vibration Damper Removal

- | | |
|-------------|---------------------|
| 1. Pulley | 3. Vibration damper |
| 2. Capscrew | 4. Capscrew |

[261 CK] AIR COMPRESSOR

Refer to Figure 4-20.

Disconnect two coolant lines (1 and 4) from the air compressor head (2) at the fittings. Tag and cap lines.

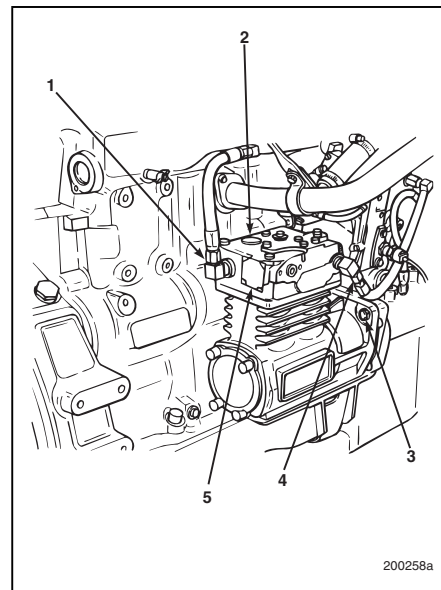


Figure 4-20 — Air Compressor Connections

- | | |
|------------------------|---------------------------------|
| 1. Coolant supply line | 4. Coolant return line |
| 2. Air compressor head | 5. Air governor mounting flange |
| 3. Capscrew | |

WARNING

The air compressor is heavy. Lifting the air compressor may require the help of an assistant or suitable lifting device. Attempting to lift the compressor without such assistance may result in severe personal injury.



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Refer to Figure 4-21.

1. Remove three mounting capscrews (5) securing air compressor (1) to auxiliary driveshaft housing (3).

2. Taking care not to damage or lose the lubrication oil supply tube (2), remove the air compressor by pulling it rearward out of the mounting flange. Discard gasket.

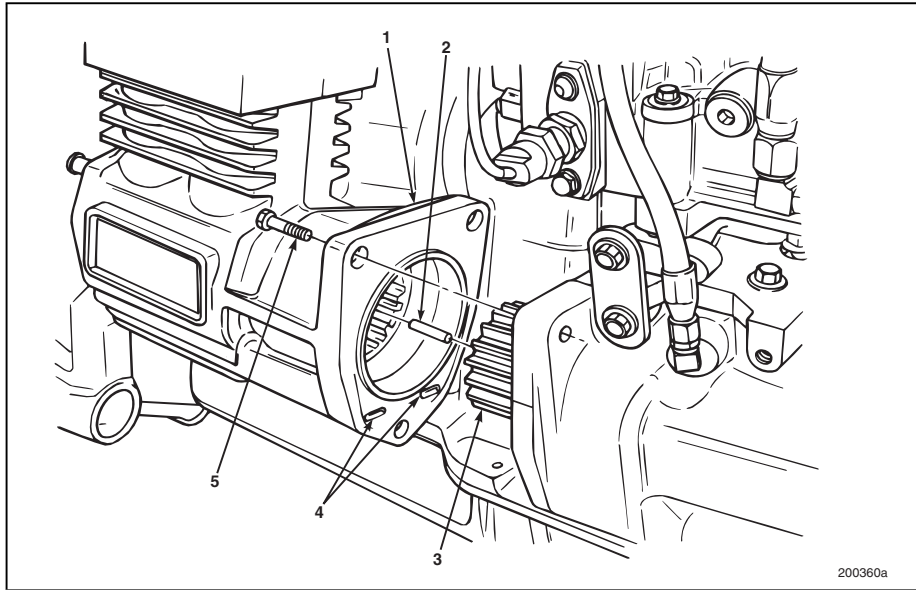


Figure 4-21 — Air Compressor Removal

1. Air compressor
2. Oil supply tube
3. Auxiliary driveshaft

4. Oil drain openings
5. Capscrew



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[221 GP] INJECTION PUMP

Refer to Figure 4-22.

1. Disconnect lubrication supply line (6) at both fittings. Tag and cap fittings.
2. Disconnect fuel lines (1, 3, 4, and 5) at the fittings. Tag and cap all lines. Remove lines from the engine by removing clamp retaining capscrew. Set fuel lines on a clean surface.

SERVICE HINT

If the fuel injection pump does not require servicing, set pump-to-engine timing before removal. This will allow ease of installation. Refer to the SETUP AND ADJUSTMENTS section for Fuel Injection Pump Fixed Timing Procedure.

3. Remove rear support link assembly by removing mounting hardware (7 and 8), V-MAC engines only.
4. Mechanically governed engines — Working from the front of the engine, remove four capscrews securing the injection pump drive gear and remove gear. For V-MAC engines, omit this step and go on to step 5.
5. Remove mounting capscrews securing pump to adapter.
6. Remove injection pump by moving it away from mounting flange.

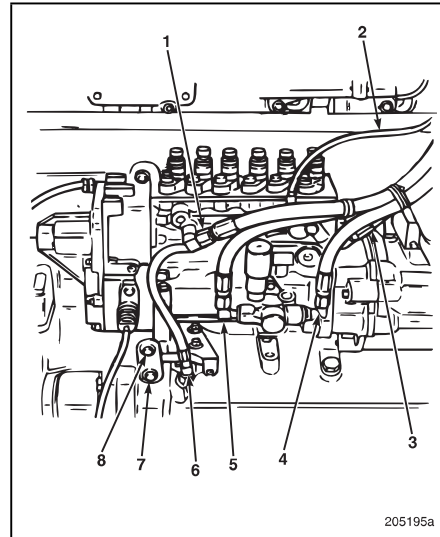


Figure 4-22 — Fuel Line Removal

1. Return from secondary filter	5. Return from primary filter
2. Cylinder head overflow line	6. Lubrication supply line
3. Return to tank line	7. Capscrew
4. Return to secondary filter	8. Capscrew



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[221 CD] ECONOVANCE

V-MAC Equipped Engines

Refer to Figure 4-23.

1. Working from front of engine, remove four capscrews securing the injection pump drive gear. Remove gear.

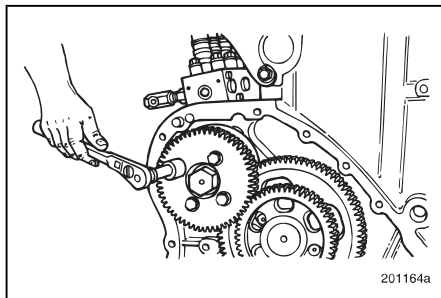


Figure 4-23 — Fuel Injection Pump Drive Gear Removal

Refer to Figure 4-24.

2. Remove mounting capscrews (1) securing injection pump adapter (2) to Econovance housing. Remove adapter.
3. Remove the drive coupling (3) by slipping it off of the splines (6).

NOTE

A metal two-piece style drive coupling was introduced into production on certified E7 V-MAC engines built after July 1, 1992 — beginning with serial No. 2P and above. When the Celeron drive coupling requires replacement, replace the drive coupling with the updated two-piece style. Older style shown.

4. Remove the Econovance (5) by removing four mounting capscrews (4). Rotate shaft to clear the camshaft gear.

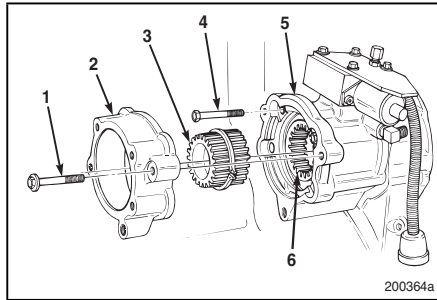


Figure 4-24 — Econovance Housing Removal (Pre-1992 Style Shown)

- | | |
|---------------------------|---------------|
| 1. Mounting capscrew | 4. Capscrew |
| 2. Injection pump adapter | 5. Econovance |
| 3. Drive coupling | 6. Splines |

[211 NB] OIL PAN

Refer to Figure 4-25.

1. Remove the nuts from the two studs securing the oil pan to the timing gear cover.
2. Remove the two nuts from the two studs securing the oil pan to the flywheel housing.
3. Remove the remaining shouldered bolts securing the oil pan to the pan rails and remove the oil pan.

NOTE

Oil pans with isolating gaskets are secured with nuts and shouldered studs at the timing gear cover and flywheel housing. Refer to Figure 4-25.



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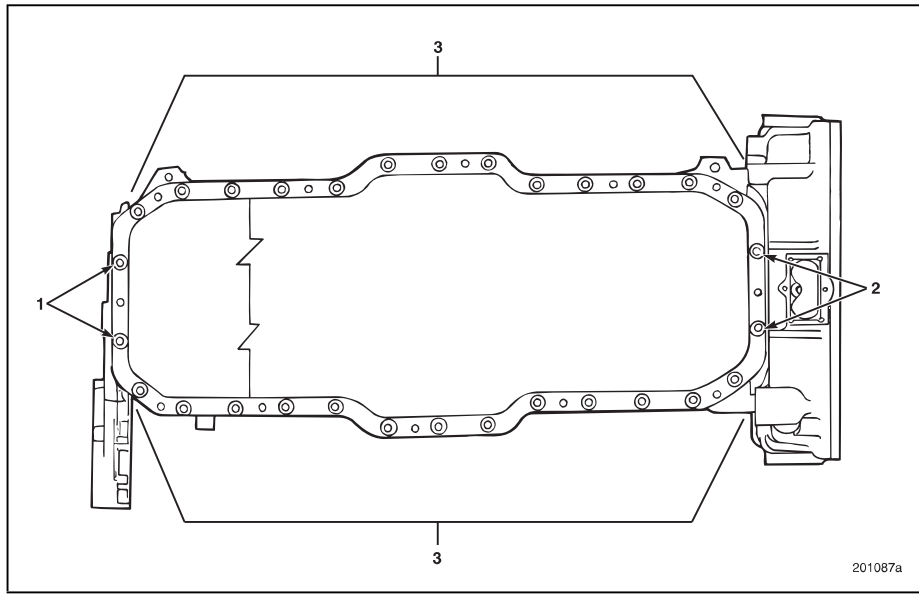


Figure 4-25 — Oil Pan Bolt Locations

- | | |
|---|-------------------------------------|
| 1. Studs and nuts at timing gear cover
2. Studs and nuts at flywheel housing | 3. Shouldered bolts along pan rails |
|---|-------------------------------------|



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[219 MU] OIL PUMP

Refer to Figure 4-26.

SERVICE HINT

If the oil pump must be disassembled for any reason, it will be easier to loosen the housing cover retaining capscrews (2), the screen capscrews (5), the sump capscrews (3), the cover plate capscrews (9), and the relief valve cap (8) while the pump is still secured in position. Do so before loosening the three retaining capscrews (1).

Remove the oil pump as a unit by removing three retaining capscrews (1).

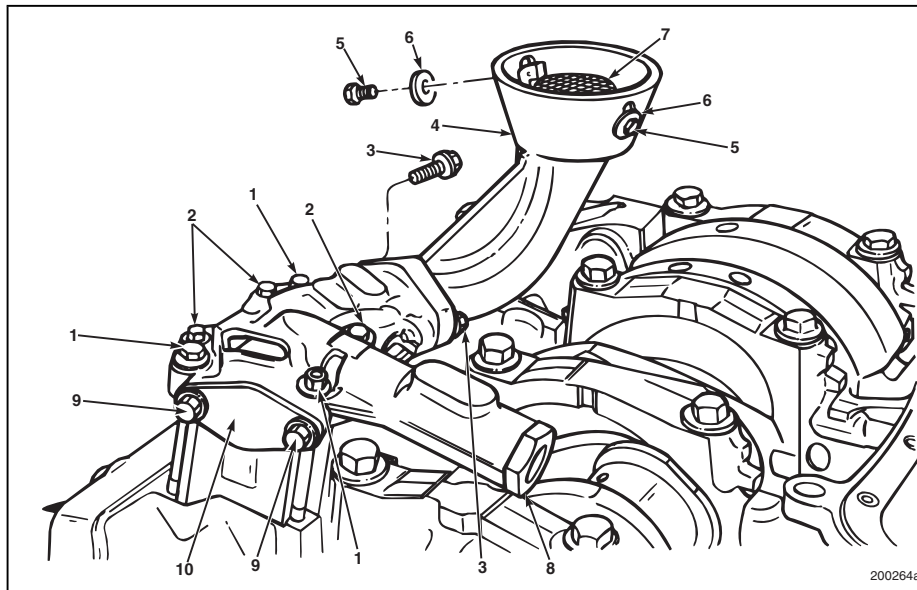


Figure 4-26 — Lubrication Oil Pump

- | | |
|------------------------|---------------------|
| 1. Capscrews | 6. Washer |
| 2. Capscrews | 7. Screen |
| 3. Capscrews, 12-point | 8. Relief valve cap |
| 4. Sump | 9. Capscrews |
| 5. Capscrews | 10. Plate |



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[211 RP] TIMING GEAR COVER

CAUTION

Do not attempt to remove timing gear cover without removing oil pan. Doing so may result in damage to the isolating oil pan gasket.

Refer to Figure 4-27.

1. Remove front engine mount pedestal (4) by removing six retaining capscrews (7 and 9).
2. Remove auxiliary pump and connecting hardware, if equipped. Discard O-ring seal.
3. If not equipped with an auxiliary pump, remove cover (12) and gasket (8) by removing mounting nuts (10) and washers (11).
4. Remove the injection pump timing cover (14) by removing the mounting capscrews (1 and 13). Discard O-ring (2).
5. Remove remaining mounting capscrews (13) from timing gear cover (3).

CAUTION

Do not damage the timing indicator (5), if equipped, when removing timing gear cover.

6. Remove timing gear cover. It will be necessary to pry the cover from the engine block. Be careful not to damage cover or block while using sharp tools around machined surfaces.

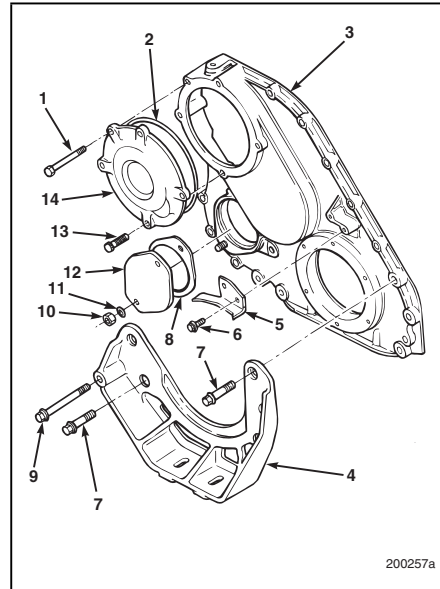


Figure 4-27 — Timing Gear Cover Removal

1. Capscrew	8. Gasket
2. O-ring	9. Capscrew
3. Timing gear cover	10. Nut
4. Front engine mount pedestal	11. Washer
5. Timing indicator	12. Cover
6. Capscrew	13. Capscrew
7. Capscrew	14. Injection pump timing cover



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[212 CV] AUXILIARY DRIVESHAFT

Refer to Figure 4-28.

1. Remove auxiliary driveshaft gear retaining nut (1).
2. Using a hub puller such as J 21834-4A, remove auxiliary driveshaft gear (2) from the splines (5) on the end of shaft.
3. Remove two retaining capscrews (3) from auxiliary driveshaft captured thrust washer (4). Remove washer.

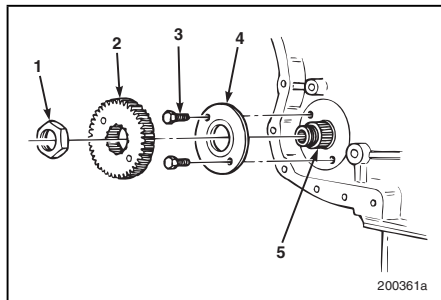


Figure 4-28 — Auxiliary Driveshaft Gear Removal

- | | |
|------------------------------|---------------------------|
| 1. Nut | 4. Captured thrust washer |
| 2. Auxiliary driveshaft gear | 5. Shaft splines |
| 3. Capscrew | |

Refer to Figure 4-29.

CAUTION

Be very careful to avoid damaging the auxiliary driveshaft bushings or journals while removing the shaft.

Remove the auxiliary driveshaft (3) by pulling it rearward out of the air compressor mounting flange opening. With engine oil pump in position, a rotating motion may be necessary to clear the engine oil pump drive gear (5).

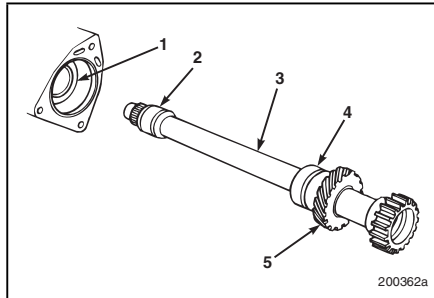


Figure 4-29 — Auxiliary Driveshaft Removal

- | | |
|-------------------------|------------------------|
| 1. Rear bushing | 4. Rear journal |
| 2. Front journal | 5. Oil pump drive gear |
| 3. Auxiliary driveshaft | |

[213 CH] CAMSHAFT

WARNING

Make sure all loose components are secured to, or removed from, the engine before rotating engine on the stand. Failure to do so may result in damage to components or severe personal injury.

1. Rotate engine so that the deck surface is downward and the oil pan rail is upward (engine inverted).

NOTE

When engine is rotated, the valve lifters will fall downward into the push rod holes but will be captured by their heads. They will be out of the way for camshaft removal.

Refer to Figure 4-30.

2. Remove the two 12-point capscrews (3) that retain camshaft thrust washer (1). Camshaft may have to be rotated slightly to make the capscrews accessible through openings (2) in the camshaft drive gear (4).



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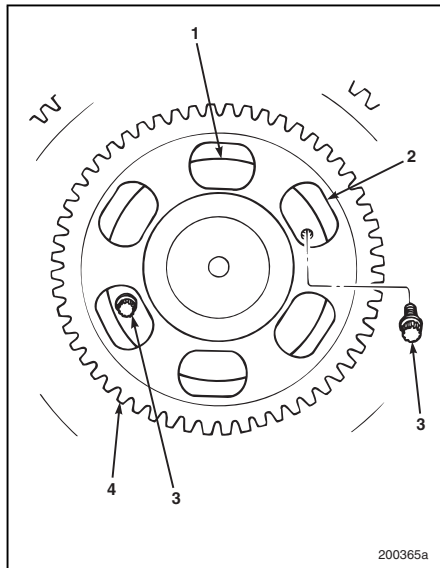


Figure 4-30 — Camshaft Thrust Washer Capscrews

- | | |
|------------------|------------------------|
| 1. Thrust washer | 3. Capscrew, 12-point |
| 2. Openings | 4. Camshaft drive gear |

Refer to Figure 4-31.

3. Install the camshaft removal/installation tool J 41461 (3) in position on the rear segment of the camshaft (1), securing it with the clip (2) to the shaft.

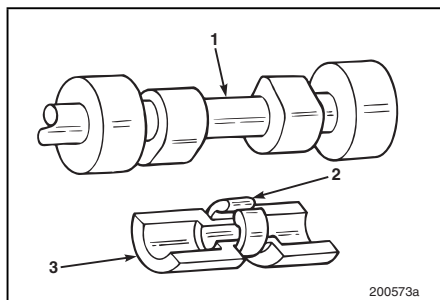


Figure 4-31 — Camshaft Removal/Installation Tool

- | | |
|-----------------------------|---------------------------------------|
| 1. Rear segment of camshaft | 3. Camshaft removal/installation tool |
| 2. Tool retaining clip | |

4. Taking care not to damage camshaft or bushings, pull camshaft out of the front of the engine. Carefully guide rear of shaft through the journals. If shaft does not come out freely, ensure all valve lifters are clear of camshaft cams and journals.

5. Remove valve lifters.

SERVICE HINT

Valve lifters have established wear patterns and should be reinstalled in same locations. Label each valve lifter upon removal and place on a clean work surface.

[212 NP & LQ] PISTON AND CONNECTING ROD ASSEMBLY

WARNING

The crankshaft and related components are heavy, have sharp edges and many possible pinch points. Always be careful while working in this area to avoid serious personal injury.

NOTE

Before removing pistons, connecting rods and rod caps, ensure they are marked so they can be reinstalled in the same cylinders from which they were removed.

NOTE

Remove connecting rod and piston assemblies in companion cylinder sets: 1 and 6, 2 and 5, and 3 and 4.

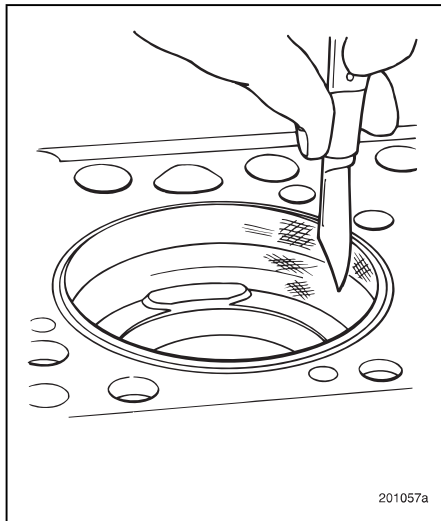
1. Rotate engine stand 90 degrees so that pistons lie horizontally in the block with top of pistons and connecting rods accessible.
2. Rotate crankshaft so that pistons 1 and 6 are lowered in the cylinder at least two inches (51 mm) to allow adequate room to remove carbon from upper edge of sleeves.



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Refer to Figure 4-32.

3. Using a sharp knife, carefully remove any carbon at the top of the sleeves. Remove any remaining carbon using crocus cloth or fine sandpaper, then wipe inside of sleeves with a clean cloth.

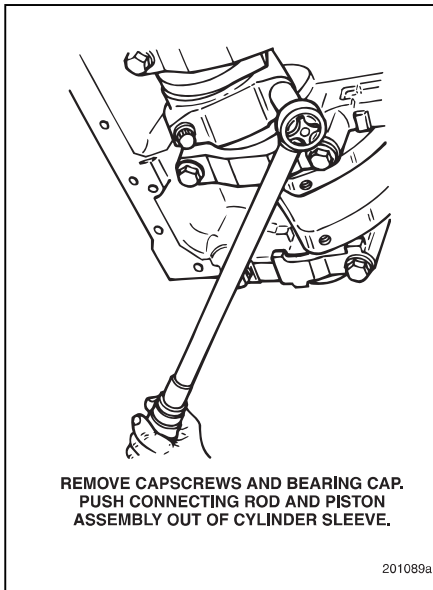


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Figure 4-32 — Carbon Removal from Cylinder Sleeves

Refer to Figure 4-33.

4. Rotate crankshaft so that pistons 1 and 6 are at bottom dead center. Remove connecting rod capscrews and rod bearing caps.



REMOVE CAPSCREWS AND BEARING CAP.
PUSH CONNECTING ROD AND PISTON
ASSEMBLY OUT OF CYLINDER SLEEVE.

201089a

Figure 4-33 — Piston and Connecting Rod Assembly Removal

5. Using a hammer handle, push piston 1 from the cylinder bore. Remove piston 6 in the same manner.
6. After removing pistons 1 and 6, rotate crankshaft so that next set of pistons (2 and 5) is at bottom dead center.
7. Repeat steps 2 through 6 for removing piston sets 2 and 5, and 3 and 4.



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[212 UC] FLYWHEEL

Refer to Figure 4-34.

1. With engine stand rotated so that engine is inverted (crankshaft horizontal), loosen all six flywheel retaining capscrews.
2. Remove two of the flywheel retaining capscrews that are opposite each other. Install two longer capscrews or studs to allow flywheel to be safely removed from the crankshaft.
3. Remove remaining capscrews.
4. Carefully tap flywheel by alternating from side to side to work it off the aligning dowel pins.

WARNING

The flywheel is heavy. Lifting the flywheel will require the help of an assistant or the use of a suitable lifting device (J 25026-A or equivalent). Attempting to lift a flywheel without such assistance may result in severe personal injury.

NOTE

Remove flywheel timing pointer, if present, to avoid damaging the pointer during flywheel removal.

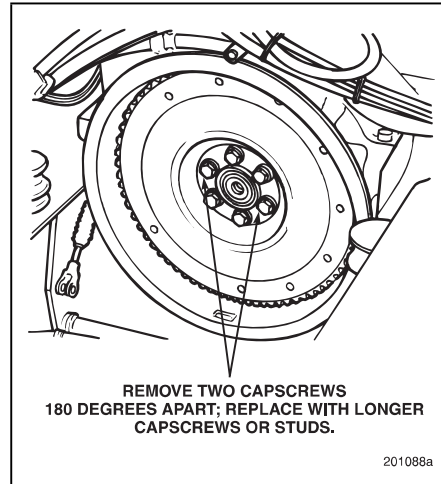


Figure 4-34 — Flywheel Removal

5. Support the flywheel and remove two guide capscrews.
6. Using a suitable lifting device such as J 25026-A, or adequate assistance, remove flywheel.



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[211 HD] FLYWHEEL HOUSING

Refer to Figure 4-35.

1. Remove eight mounting capscrews (3) from flywheel housing (2).
2. Remove flywheel housing. It may be necessary to tap lightly on the housing with a soft mallet to separate housing from engine block.

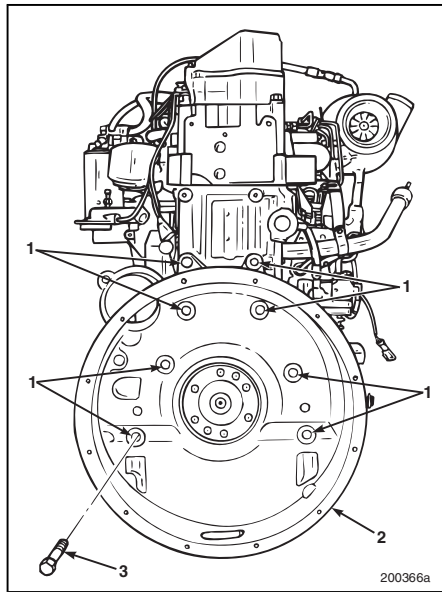


Figure 4-35 — Flywheel Housing Removal

- | | |
|-----------------------|-------------|
| 1. Capscrew locations | 3. Capscrew |
| 2. Flywheel housing | |

[211 JA] MAIN BEARING CAP

NOTE

Before removing main bearing caps, ensure they are marked so they can be reinstalled on the same journals. Keep the bearings with the same cap and tag them to identify the cam side of the bearings.

Refer to Figure 4-36.

1. Remove eight buttress capscrews (2 and 3).
2. Remove main bearing capscrews (1) from each of the seven bearing caps (4 and 5). The center main bearing cap (5) houses the thrust washers.
3. Position a lady-foot pry bar under the tabs provided on bearing caps and pry bearing caps upward. To work them loose, it may be necessary to tap the bearing caps alternately from side to side with a soft mallet.



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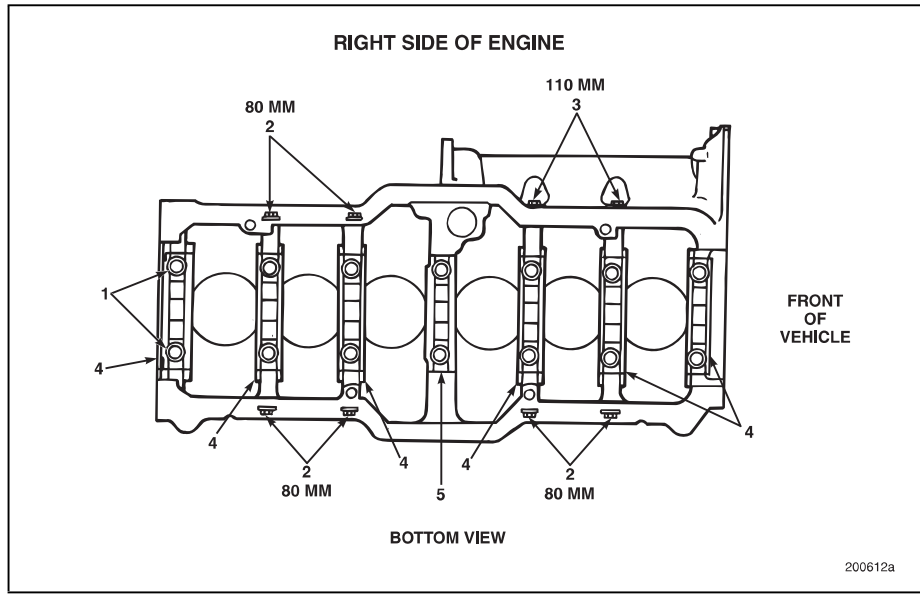


Figure 4-36 — Buttress Capscrew Installation

1. Main bearing cap capscrews
2. Buttress capscrews, 80 mm
3. Buttress capscrews, 110 mm

4. Main bearing caps
5. Center main bearing cap



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[212 HP] CRANKSHAFT

Refer to Figure 4-37.

1. Using a suitable lifting device, secure a sling or crankshaft support tool around the crankshaft and lifting device hook. Ensure crankshaft is evenly balanced when lifted from the engine block.
2. Lift crankshaft from engine block and store in a secured stand, or horizontally on V-blocks.

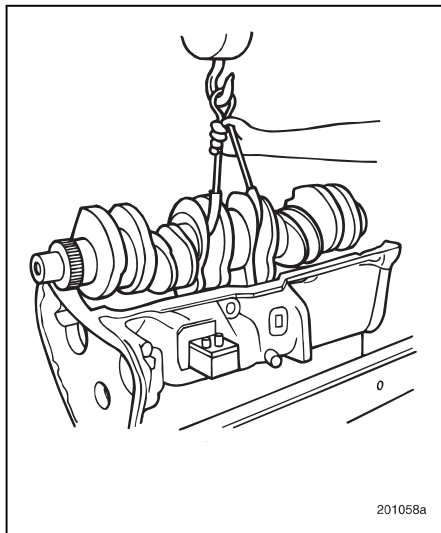


Figure 4-37 — Crankshaft Removal

[219 RV] PISTON COOLING SPRAY NOZZLE

CAUTION

To avoid damaging spray nozzles, remove them before removing sleeves.

SERVICE HINT

It is best to use a 10-mm, 6-point socket on a 12-inch extension to remove the nozzle retaining capscrews.

Refer to Figure 4-38.

1. Remove piston cooling spray nozzle (2) by removing retaining capscrew (3).
2. Carefully pull outward on the spray nozzle to remove it from the block.
3. Remove and discard elastomer seal (1).
4. Repeat steps 1 through 3 to remove remaining spray nozzles.

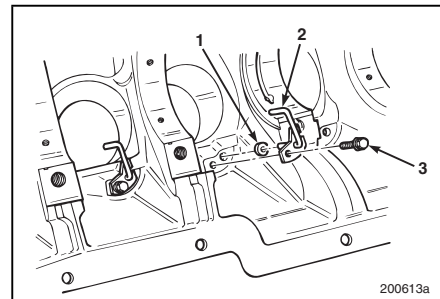


Figure 4-38 — Spray Nozzle Removal

- | | |
|-------------------|-------------|
| 1. Elastomer seal | 3. Capscrew |
| 2. Spray nozzle | |



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[212 NC] CYLINDER SLEEVE

Special Tool Required

- Cylinder Liner/Sleeve Puller PT6435

Refer to Figures 39 and 40.

1. Rotate engine in stand so that it is upright (deck surface upward).
2. Use puller PT6435, or equivalent, to remove cylinder sleeve (2) from cylinder block (4).
3. Position puller above the sleeve and guide the puller shaft through the sleeve.

CAUTION

Extreme care must be taken to make sure the puller shoe is properly aligned in the bottom of the sleeve to prevent damage to the block.

4. Position puller shoe so that it catches the lower lip of the sleeve. Ensure that it does not extend beyond outside edges of the sleeve so it will not come into contact with the cylinder block as the sleeve is removed.
5. Tighten screw on the puller until sleeve comes free from cylinder block bore. Remove shims (3), if installed.

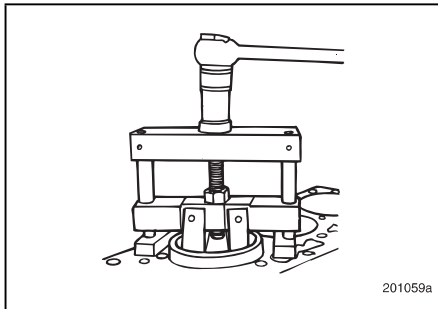


Figure 4-39 — Cylinder Liner/Sleeve Puller PT6435

6. Remove puller from sleeve.
7. Remove crevice seal (1) from sleeve.
8. Repeat steps 2 through 7 to remove remaining cylinder sleeves.

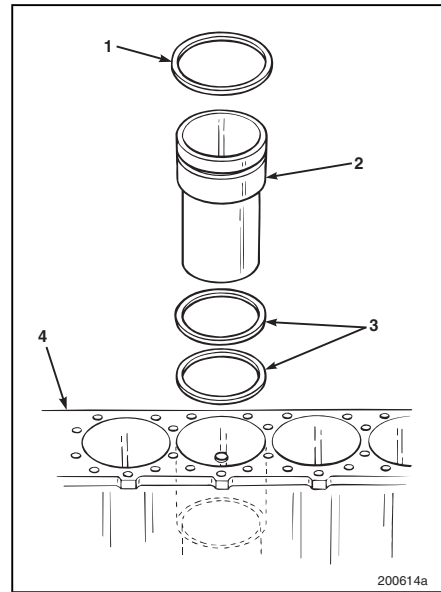


Figure 4-40 — Sleeve Removal

- | | |
|--------------------|-------------------|
| 1. Crevice seal | 3. Shims |
| 2. Cylinder sleeve | 4. Cylinder block |



NOTES
