200 GENERAL INFORMATION

INTRODUCTION

This manual is intended to assist the technician in properly overhauling MACK E7 engines. The manual is divided into nine major sections. Working on the E7 engine is not difficult, but like most present-day precision equipment, it requires proper tools and knowledge.

The overhaul procedures are separated into three sections: engine disassembly, bench procedures and engine assembly. Each section contains detailed procedures that must be followed in the order specified. If a step calls for a procedure that has already been described earlier in the manual, you will be referred to the section where the original procedure appeared. This manual covers the overhaul of an engine once it is removed from the vehicle, but also gives instructions for removing the engine from a nonspecified chassis.

The new E7 is the most fuel-efficient diesel engine MACK has ever produced. This engine provides higher horsepower ratings, better fuel economy, increased durability and improved serviceability. In addition, the E7 still easily meets all applicable emissions standards. All this, coupled with the latest manufacturing techniques and equipment, makes the new E7 the highest-quality MACK engine ever made.

Externally, all E7 engine models look the same. However, Mack Trucks, Inc. has made many major internal design changes to comply with current and future EPA emission standards. To properly identify the E7 engine model year, refer to the engine information plate and the following pages of this section for additional engine plate information.

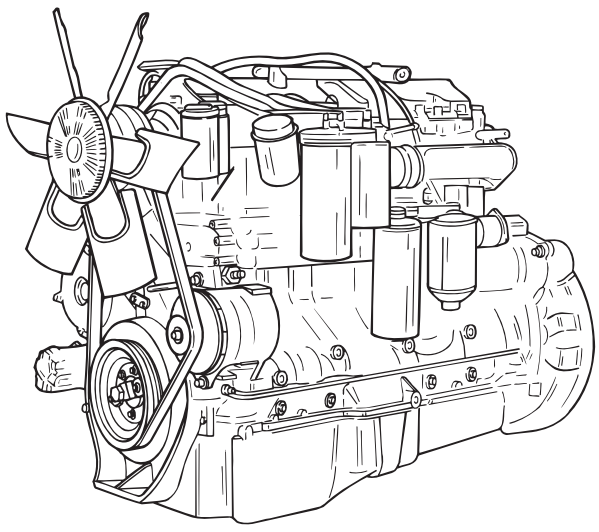

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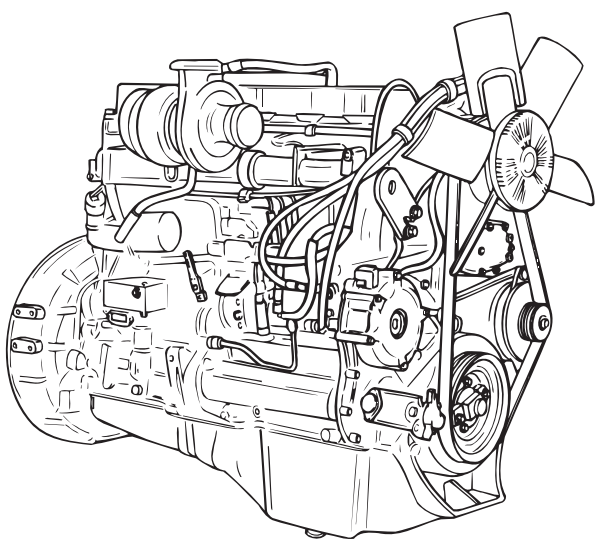
Figure 1 — 3/4 View E7, Front, Left



3/4 VIEW E7

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Figure 2 — 3/4 View E7, Front, Right

SPECIFICATIONS

Improved Design

Compared to earlier designs, the E7 engines include improvements required to accommodate higher horsepower ratings and future emission standards. These changes require increased displacement, higher peak cylinder pressures and a superior engine cooling system. This was all accomplished without a substantial change in engine weight.

Engine General Specifications

Characteristic	Description
Weight (wet*)	2300 lbs. (1043.3 kg)
Weight (dry)	2210 lbs. (1002.5 kg)
Displacement	728 cu. in. (12L)
Bore and stroke	4-7/8 x 6-1/2 in. (123.83 x 165.10 mm)
Engine oil capacity	33.5 qts. (32L)
Coolant capacity	13 qts. (12.3L)
Compression ratio	16.5:1 (up to 375 hp); 15.3:1 (375 hp and above)
Fasteners and threads	Metric and English

*Wet includes oil and coolant

Engine Features

Component	Description
Cylinder block	Alloyed gray cast iron
Main bearing caps	Ductile iron, intermediate supported with buttress screws to prevent bulkhead movement
Flywheel housing	Standard — Aluminum, standard SAE No. 1, precision doweled Optional — Ductile iron
Cylinder sleeves	Wet/dry, replaceable, centrifugally cast, alloyed cast iron
Cylinder sleeve seal	Teflon-coated AFLAS/EPDM, intolerant of oil (use glycol for installation lubricant)
Cylinder heads	Alloy gray cast iron; four valves per cylinder, two cylinder heads per engine
Cylinder head gaskets	
— Body	Nonasbestos material with a steel core (two per engine)
— Fire ring	Steel, six per engine
Piston assembly	Refer to Tune-Up Specifications manual.
Pistons (1989–1990)	Aluminum alloy, Ni-resist insert top two grooves, steel insert third groove, oval and roll burnished pin bores, continuous oil cooling
Pistons (1991 and later)	Two-piece, top crown material steel, aluminum alloy skirt, three-ring piston
Piston rings (1989–1990)	
— Compression	Chrome, three per cylinder
— Oil control	Chrome, one per cylinder
Piston rings (1991 and later)	
— Compression	Plasma, top ring; chrome, second ring
— Oil control	Chrome, one per cylinder
Piston pins	Full-floating, 2.25 inch (5.72 cm) diameter, full-pressure lubrication through rifle-drilled holes in connecting rods

Fits and Limits (Cont.)

Component	Standard Size or Fit	
	English	Metric
CONNECTING ROD (CONT.)		
Side clearance	0.007–0.014 in.	0.1778–0.3556 mm
Twist within 12 inches (30.48 cm)	0.010 in.	0.254 mm
Bend within 12 inches (30.48 cm)	0.004 in.	0.1016 mm
CRANKSHAFT		
Crankpin journal OD	3.248–3.247 in.	82.4992–82.4738 mm
End play at No. 4 main	0.004–0.013 in.	0.1016–0.3302 mm
Main journal OD	4.4974–4.4964 in.	114.2340–114.2086 mm
Journal out-of-round or taper (maximum diameter)	0.00035 in.	0.00889 mm
Max. Runout at No. 4 journal (shaft supported on No. 1 and No. 7)	0.007 in.	0.178 mm
CYLINDER BLOCK		
Deck flatness	0.002 in.	0.0508 mm
Dowel pin holes (flywheel housing to block mounting)	0.6237–0.6247 in.	15.8420–15.8674 mm
Cylinder bore in block — upper	5.501–5.500 in.	139.725–139.970 mm
— lower	5.1266–5.1250 in.	130.2156–130.1750 mm
Cylinder bore out-of-round or taper on diameter For service block only — maximum on reboring block: 0.001 inch (0.0254 mm).	0.004 in. max.	0.1016 mm
Sleeve, flange channel depth above block deck (do not measure from top of bead)	0.022–0.027 in	0.5588–0.6858 mm
Sleeve OD at upper pilot diameter	5.5040–5.5030 in.	139.8016–139.7762 mm
Sleeve bead for fire ring — protrusion above sleeve channel	0.0067–0.010 in.	0.1702–0.2540 mm
Sleeve in bore — upper press fit	0.004–0.002 in.	0.1016–0.0508 mm
— lower loose fit	0.0029–0.0003 in.	0.0737–0.0076 mm
Sleeve ID installed STD — minimum	4.8755 in.	123.8377 mm
— maximum	4.877 in.	123.8758 mm
Main bearing bore in block	4.818–4.817 in.	122.3772–122.3518 mm
Main bearing-to-crankshaft journal clearance	0.0022–0.0056 in.	0.0559–0.1422 mm
Main bearing ID in place	4.502–4.4996 in.	104.3508–114.2898 mm
Valve lifter bore	0.6865–0.6875 in.	17.4371–17.4625 mm
Valve lifter shank diameter	0.6855–0.6860 in.	17.4117–17.4244 mm
Valve lifter OD	1.380–1.385 in.	35.052–35.179 mm
Valve lifter to bore clearance	0.0005–0.0020 in.	0.0127–0.0508 mm
NOTE: Extension of the cylinder sleeve above the cylinder block deck can vary under the same head, as long as all are within the 0.022–0.027 inch specification.		
CYLINDER HEAD		
Alignment across exhaust ports	0.005 in.	0.127 mm
Deck flatness over 18 in. (45.72 cm)	0.0015 in.	0.0381 mm
Overall height	6.391–6.397 in.	162.331–162.484 mm

200 ENGINE DISASSEMBLY

[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).

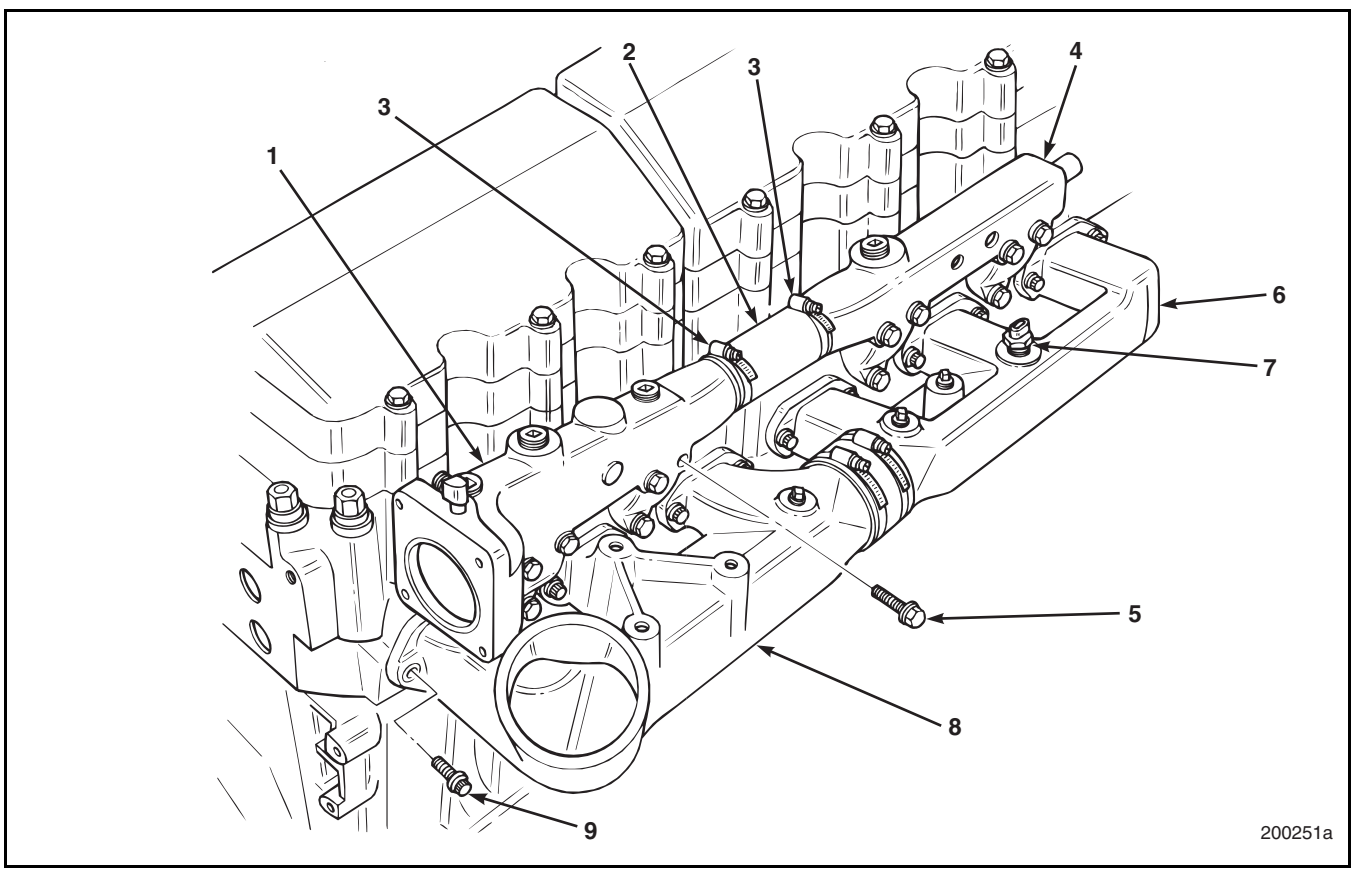

Figure 4-9 — Air Inlet Manifold Removal

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

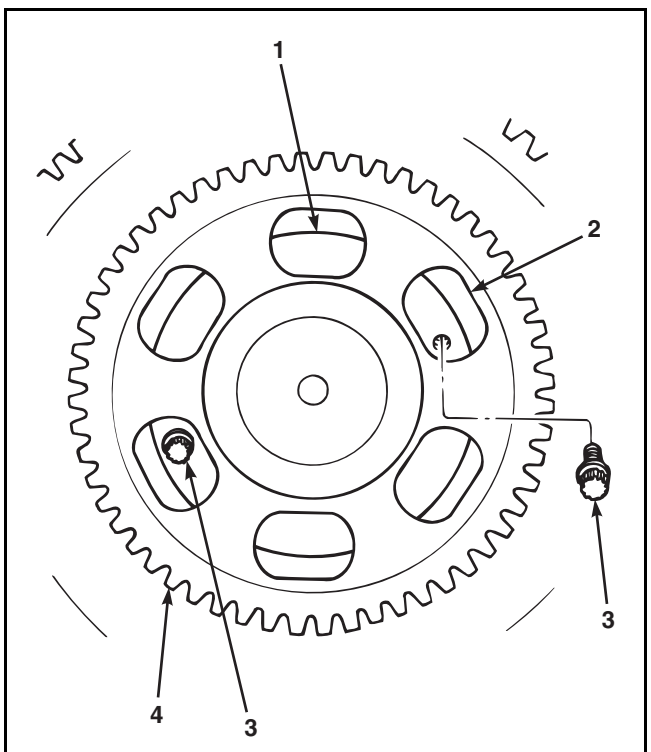

Figure 4-30 — Camshaft Thrust Washer Capscrews

1. Thrust washer 2. Openings	3. Capscrew, 12-point 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.

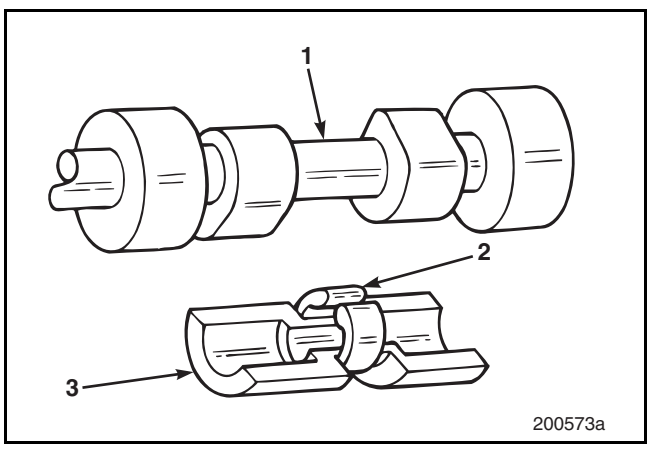

Figure 4-31 — Camshaft Removal/Installation Tool

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

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.

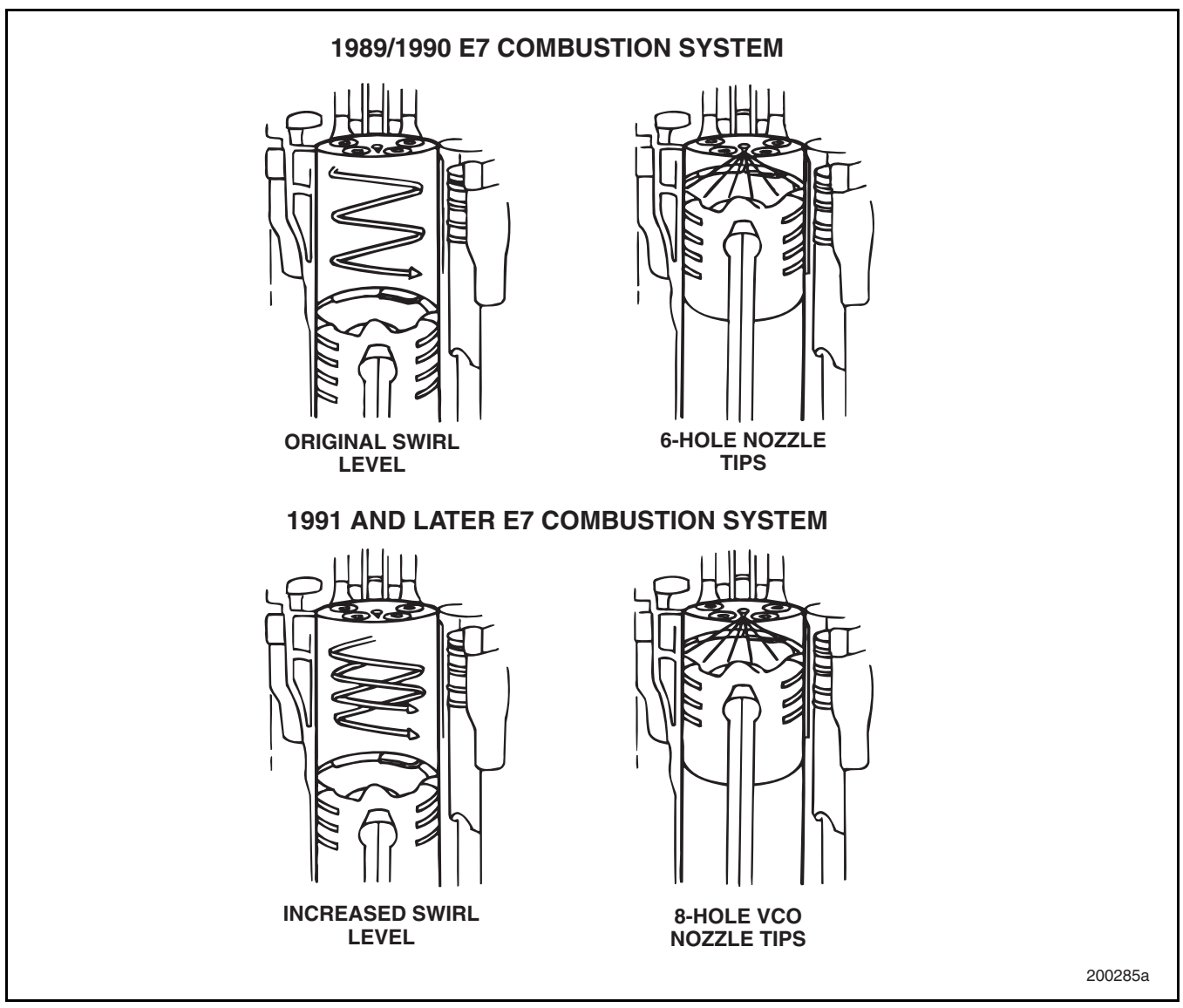

Figure 5-23 — Combustion Chamber Design

Refer to Figure 5-24.

The cast iron cylinder head is constructed using a special iron alloy. The head contains cored inlet, exhaust and coolant passages, drilled oil passages, replaceable inlet and exhaust guides and seats, various drilled passages and tapped holes. Each cylinder head covers three cylinders and has two inlet and two exhaust valves per cylinder. Circular grooves correspond with the fire ring bead on cylinder sleeves. This design sets the fire ring over the liner, the lip and into groove of the cylinder head while providing a positive combustion pressure seal. Use a rotary brass-wire brush to clean the circular groove.

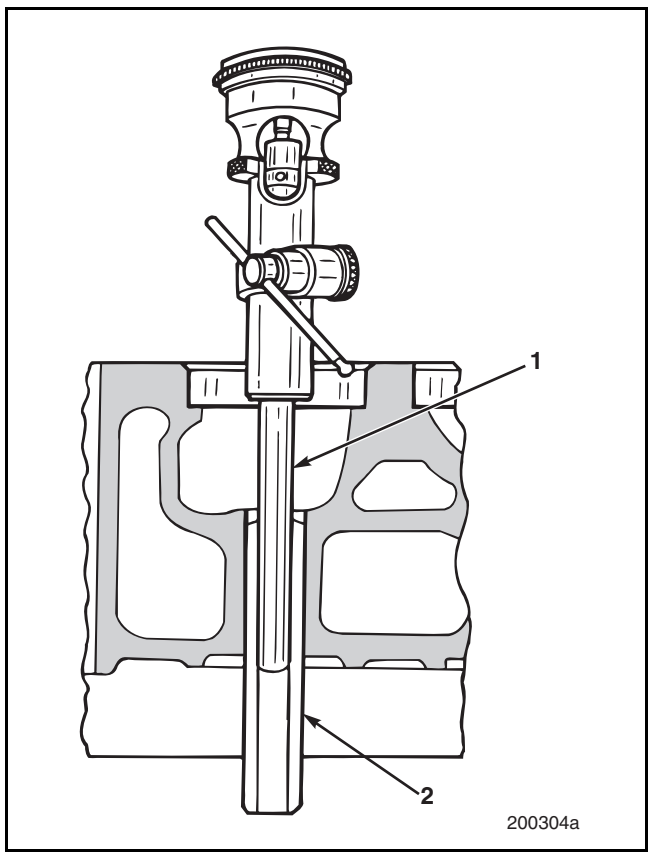

Figure 5-48 — Checking Valve Seat Runout

1. Arbor	2. Valve guides

[213 MB] Valve Springs

1. Visually inspect inside surfaces of coils. Also, feel inside surfaces of spring for any indication of roughness or grooving. If any of these conditions exist, replace spring.

Refer to Figure 5-49.

2. Check spring tension on universal spring tester J 22738-02.

   Part No. 575GC213 (E7)
   142.5–157.5 lb. at 1.435 inches
   (64.6–71.4 kg at 36.4 mm)

   Part No. 575GC35 (E7 with Extarder)
   190–210 lb. at 1.5 inches
   (86.2–95.3 kg at 38.1 mm)

NOTE

If spring force does not meet specification, discard and install new spring.

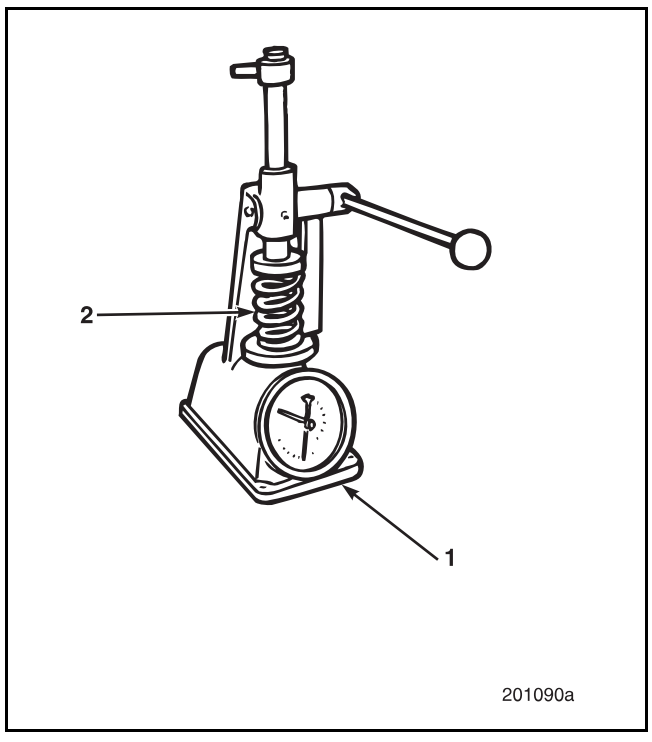

Figure 5-49 — Checking Valve Spring Tension

1. Spring tester J 22738-02	2. Valve spring

[213 GB] Injection Nozzle Holder Insert

The injection nozzle holder insert is machined to provide a press fit in cylinder head.

INJECTION NOZZLE HOLDER INSERT REMOVAL

1. To remove injection nozzle holder insert, tap ID with 3/4-10 tap.

Refer to Figure 5-50.

2. Install nozzle sleeve puller J 29880 (2) to slide hammer J 2619-01 (1) or equivalent.
3. Thread sleeve puller into end of injection nozzle holder insert. Use slide hammer to remove insert.

18. Connect jumper wire to Dynatard engine brake harness connection.
19. Attach wire tie around jumper wire and Dynatard switch bracket.
20. Test engine brake and check for leaks.

INSTALLATION (V-MAC APPLICATIONS)

1. Connect engine brake wiring harness to connection located on right-hand side engine harness.
2. Secure connection to air compressor coolant line with wire tie.
3. Secure engine brake wiring to a clamp located on cylinder block near rear of injection pump.
4. Test engine brake and check for leaks.

[266] JACOBS® ENGINE BRAKE

E7 engines built from mid-year 1993 through December 1993 were equipped with either a Dynatard engine brake or a Jake Brake. Since January 1, 1994, the Jake Brake has been used exclusively.

The Model 680B Jake Brake engine retarder is a vehicle-slowing device designed and approved for use on MACK E7 engines. Energizing the Jake Brake effectively converts a power-producing diesel engine into a power-absorbing air compressor. This is accomplished by opening the cylinder exhaust valves near the top of the compression stroke, releasing the compressed air to exhaust.

Releasing compressed air to exhaust prevents the return of energy to the engine piston on the power stroke. The result is a net energy loss used to slow the vehicle. For more detailed information, specifications and repair procedures, refer to the appropriate Jacobs service manual.

[266] ENGINE BRAKE SWITCH AND BRACKET ASSEMBLY

Description

Beginning in 1991, a cylinder block-mounted engine brake switch and mounting bracket assembly was released for E7 mechanically governed (non V-MAC) engines equipped with either a Jake Brake or Dynatard system (pre-1994). The bracket design improves the service life of the switch by significantly reducing the engine vibration levels that the switch is subjected to. This reduction in vibration levels is accomplished by relocating the mounting of the bracket from the rear of the injection pump to the auxiliary housing area of the cylinder block. Refer to Figure 5-65.

In mid 1992, an improved switch (part No. 1MR3529) was incorporated into the assembly. This new switch, along with relocation of the bracket, adds significantly to the service life of the assembly.

⚠ CAUTION

Proper adjustment is essential. Over-adjustment of this switch arrangement will cause accelerated switch wear or switch failure.

Adjustment (E7 Mechanically Governed Engine with Engine Brake)

1. Loosen the two screws holding the throttle switch to the switch bracket.
2. Check the continuity by connecting a volt-ohmmeter across the switch terminals.
3. Insert an 0.008-inch (0.203 mm) thickness gauge between the low idle screw and the idle lever.
4. Secure the throttle lever in the low idle position.
5. Slide the switch toward the throttle lever to the point where continuity is obtained.
6. Torque the two screws that hold the throttle switch to the switch bracket to 10 lb-in using torque wrench J 24405 or equivalent.

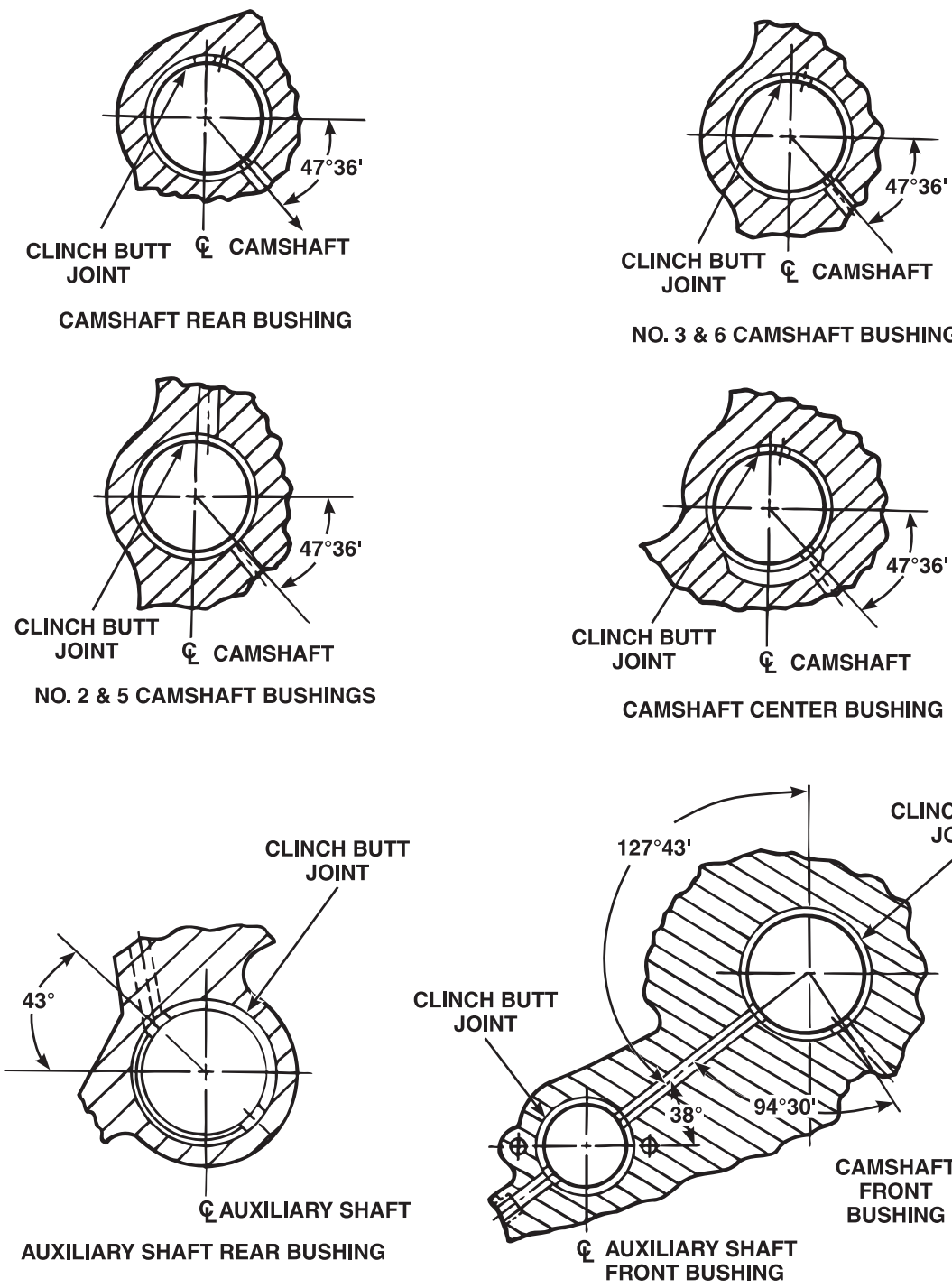

Figure 6-7 — Camshaft and Auxiliary Shaft Bushing Alignment

Refer to Figure 6-25.

9. Check rod side clearance by installing a thickness gauge between rod and side of journal at the entire parting line area.

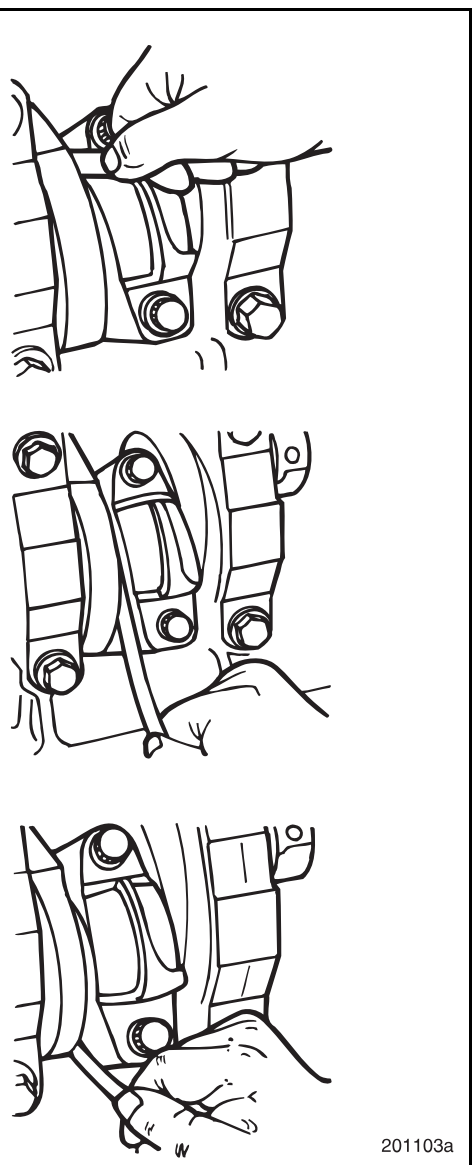

Figure 6-25 — Connecting Rod Side Clearance Check

10. The clearance must be within specification shown in the Fits and Limits chart. If not, recheck for proper cap and rod alignment.

[211 HD] FLYWHEEL HOUSING

Description

Beginning in 1991, flywheel and flywheel housings for E7 engines equipped with standard transmissions incorporate engine timing and engine turnover features. In addition, new procedures and tools were introduced and must be used to ensure optimum performance, engine durability and emission compliance.

Inspection

Inspect the flywheel housing machined surfaces, capscrews, holes and dowel locations for cracks or wear. Replace if cracks are evident.

⚠ CAUTION

Before installing flywheel housing, examine crankshaft flange for any cracks, surface damage or presence of foreign particles. This type of damage could ruin the sealing capabilities of the new seal and lead to oil leakage.

Dowel Pins

The diamond locating dowel pins, used to install the front timing gear cover, flywheel, and flywheel housing, have been replaced in production by blade-style locating dowel pins. The diamond pins were dual-diameter type pins with a smaller diameter at the round end that goes into the cylinder block. The blade-style pins are the same diameter at the round end and the blade end. There are no changes in the size of the hole in the flywheel housing. However, the cylinder block has a larger hole to accept the blade-style dowel pins. The old cylinder block flywheel housing pin number is 183GC219 and the new number, starting with serial No. 2T (August 1992), is 183GC237.

Use a dowel size and type that is appropriate for the block being used. (Service old with old and new with new.) Install the blade-style dowel with the blade in a vertical direction (pointing up and down).

[211 SB] TIMING GEAR COVER SEAL

Special Tool Required

- Crankshaft Front Seal Installer J 37715-A

Installation

Refer to Figure 6-52.

1. To install the lip-type seal, use crankshaft front seal installer J 37715-A. Position the seal on the tool, with the solid portion of the seal outward (toward the tool).
2. Position the tool over hub and into the seal opening.

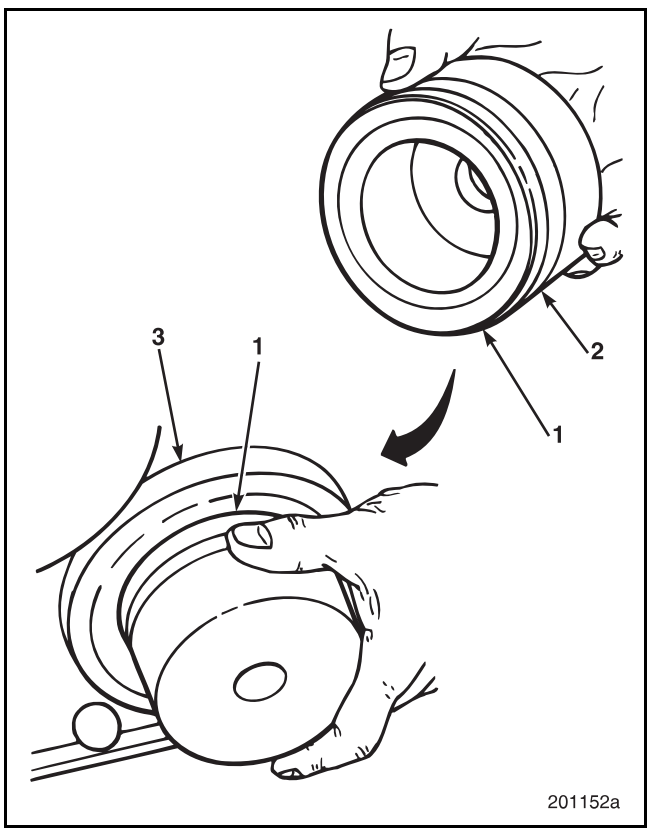

Figure 6-52 — Timing Gear Cover Seal Installation

1. Timing gear cover seal 2. Seal installer J 37715-A	3. Timing gear cover

3. Insert the hub capscrew into the hole in the seal installation tool and draw the seal in until the tool bottoms out on the face of the crankshaft.
4. Remove the tool and check the seal to make sure it has been evenly installed.

[221 GP] FUEL INJECTION PUMP INSTALLATION

Refer to SETUP AND ADJUSTMENTS section under Fuel Injection Fixed-Timing Procedures for pump installation procedure.

[212 RH] CRANKSHAFT HUB

Inspection

Inspect the crankshaft hub for scoring and condition of flange, threaded holes and keyway.

⚠ CAUTION

Replace the hub if the seal shows signs of wear. Mack Trucks, Inc. does not recommend the use of a service sleeve to repair the crankshaft hub when there is hub damage. When there is damage to the hub, replace it.

Installation

Refer to Figure 6-53.

1. Insert hub key in keyway of the crankshaft.
2. Using a suitable grease-type lubricant, coat the working surface of the seal in preparation for crankshaft hub installation.

NOTE

Teflon-type seals do not require greasing the seal working surface of the crankshaft hub.

3. Heat hub to approximately 250°F (121°C) prior to installation.
4. Using heat-resistant gloves, align keyway in the hub with key in the shaft.

NOTE

When engine has flywheel timing, the crankshaft hub will not have a keyway slot.

5. In a quick, even motion, push the hub onto to the crankshaft.
6. Install hub washer and capscrew. Tighten capscrew to 330 lb-ft (447 N•m) using torque wrench J 23775-01 or equivalent.

4. Insert nozzle holder in the nozzle holder hole. Be sure to align the locator ball in the nozzle holder with the socket in the cylinder head to ensure inlet tube alignment. Refer to Figure 6-63.

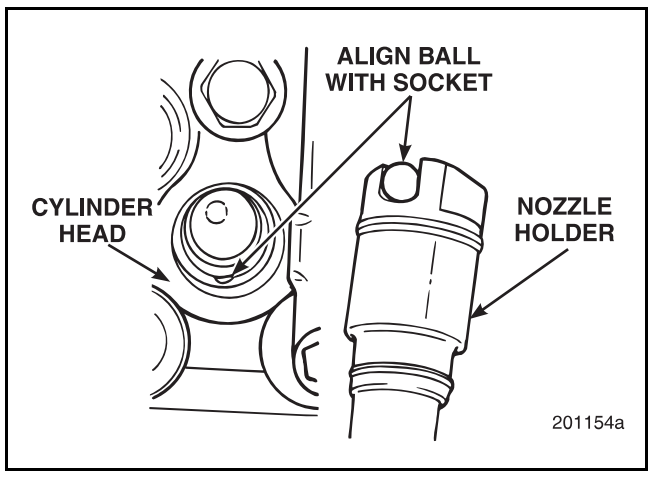

Figure 6-63 — Nozzle Holder Alignment

5. After making sure that the nozzle holder ball is properly aligned with the alignment socket in the cylinder head, push downward on the handle of the installation tool driving the nozzle holder into position. Refer to Figure 6-64.

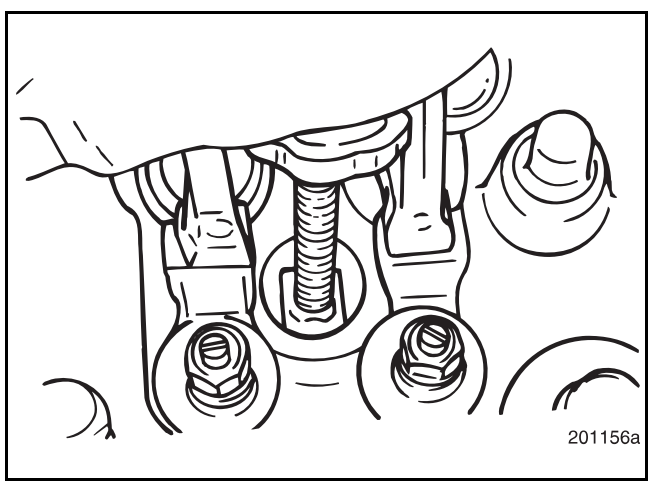

Figure 6-64 — Nozzle Holder Installation

6. Remove the tool from the nozzle holder and insert the gauge block on the end of the tool handle.
7. Insert the gauge block into the nozzle holder hole. The gauge block should be flush with the top of the cylinder head surface. Refer to Figure 6-65.
   - If the gauge block is too high, it may indicate that there are two gaskets installed under the nozzle holder, or the nozzle holder has not been fully inserted.
   - If a gauge block is not available, measure the distance from the top of the cylinder head to the top of the nozzle holder. The nominal measurement should be 0.564 inch (14.326 mm).

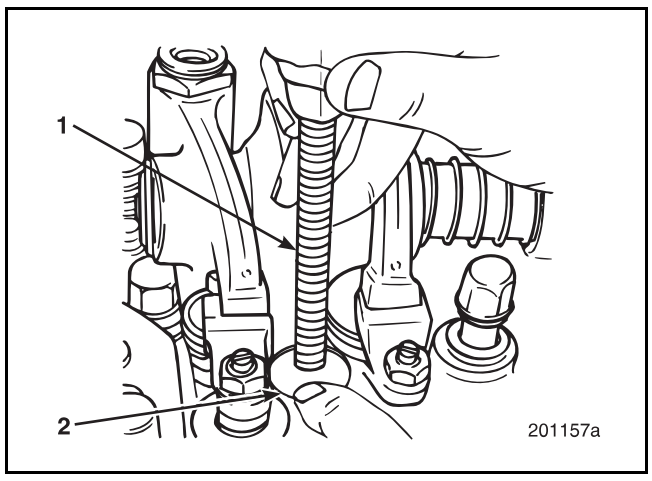

Figure 6-65 — Nozzle Holder Installation Check

1. Nozzle holder puller J 37093	2. Gauge block

8. Lubricate the threads of the retaining plug and install in position. Torque to 45 lb-ft (61 N•m) using torque wrench J 24407 or equivalent. Refer to Figure 6-66.

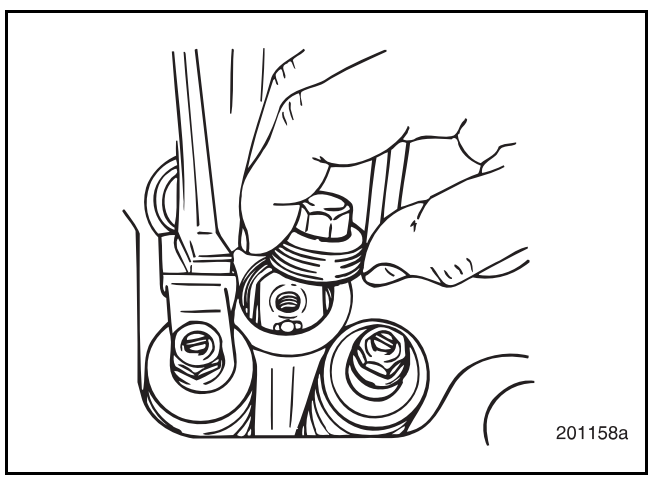

Figure 6-66 — Retaining Plug Installation

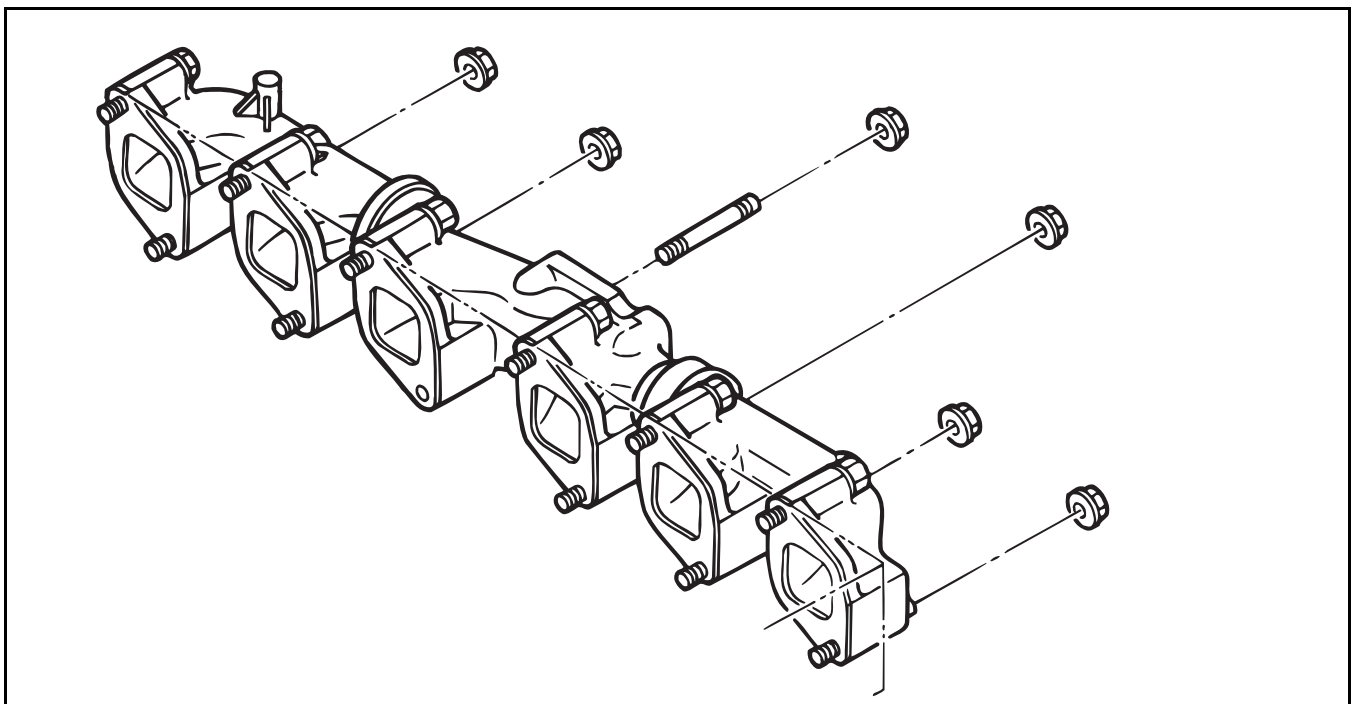

Figure 6-73 — Typical Exhaust Manifold Installation

[271 CB] ALTERNATOR

Installation

Refer to Figure 6-95.

1. Install the alternator plate (5) and mounting hardware (4).
2. Position the alternator (7) on the plate and install capscrews (3), washers and mounting nuts (6).
3. Connect the electrical wires as tagged during disassembly.
4. Install drive belt(s) (1).
5. Adjust drive belt tension to specification as described in the following Fan Belt(s) Adjustment procedure.

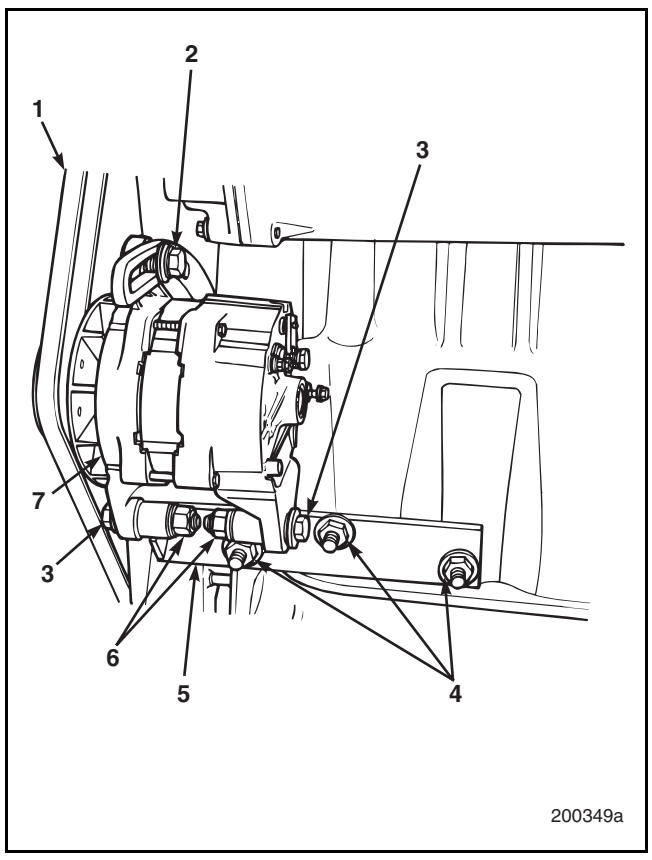

Figure 6-95 — Alternator Installation

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

Fan Belt(s)

ADJUSTMENT

1. For consistent measurements, use belt tension gauge tool BT3373-F to check the belt tension.
2. Check tension at the center of the longest span, and chalk-mark the point checked.
3. When installing new belt(s), initially adjust the tension to give a gauge reading of 130–150 lbs. (578–667 N). Chalk-mark the point checked. Run the engine for approximately 5–10 minutes. Allow the belt(s) to cool and recheck at the chalk mark. If the tension is less than 100 lbs. (445 N), readjust the tension to approximately 110–120 lbs. (489–534 N).
4. After adjusting belt tension, tighten alternator mounting bolts as follows:
   a. Tighten upper alternator adjusting capscrew (2) to 60–70 lb-ft (81–95 N•m) using torque wrench J 24407 or equivalent.
   b. Tighten lower alternator mounting fasteners (3 and 6) to 60–70 lb-ft (81–95 N•m) using torque wrench J 24407 or equivalent.

NOTE

With other belt types and configurations, refer to the current Maintenance and Lubrication Manual, TS494, for belt tensioning specifications.

3. Clean the J 37077 tool sensor probe points with compressed air before using. This helps prevent metallic contamination between the sensor probe points.

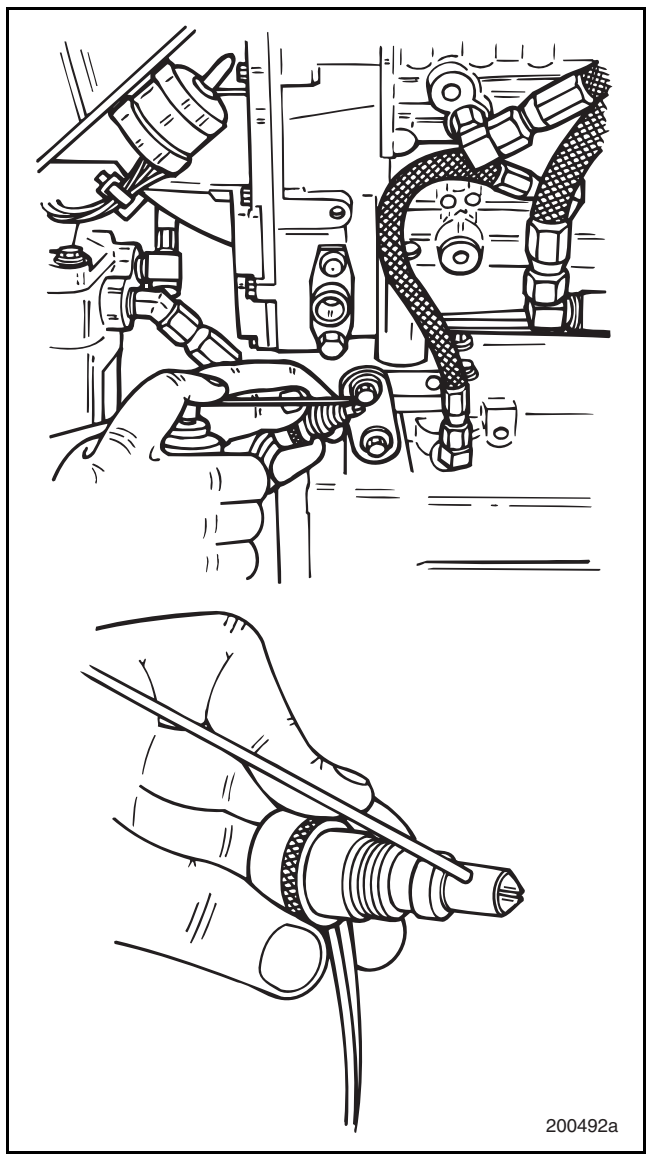

Figure 7-16 — Cleaning Sensor Probe Points

4. Install fixed timing position sensor tool J 37077. Make sure that tool is correctly aligned with the locating groove in the fixed timing port.

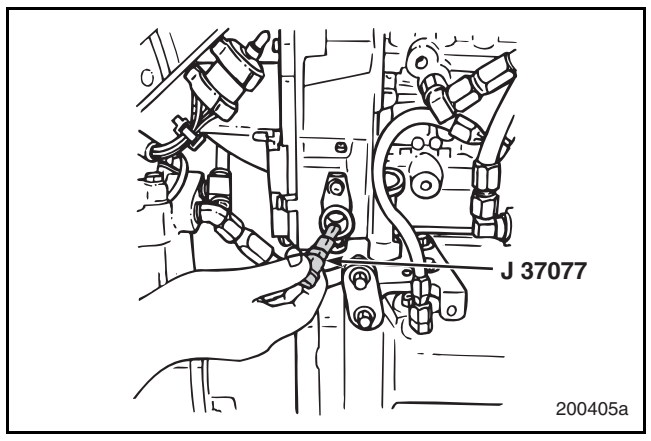

Figure 7-17 — Installing J 37077 Tool

5. Slowly turn the knurled surface clockwise to lock the tool into place. Check to make sure tool is seated by applying pressure to the end of the tool and checking for any movement. If movement is detected, remove and reinstall the tool.

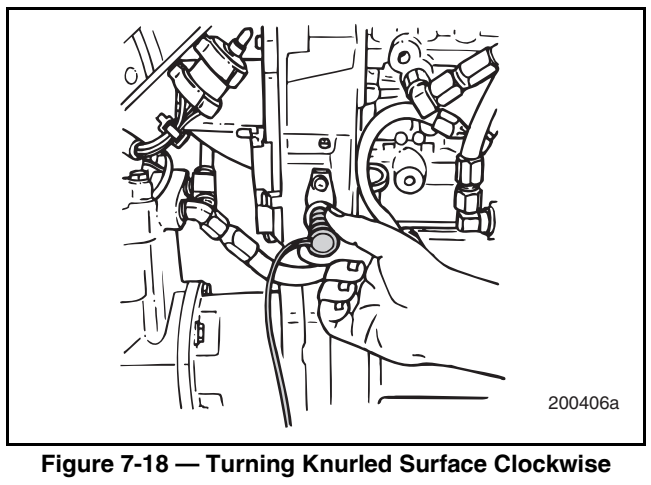

Figure 7-18 — Turning Knurled Surface Clockwise

6. Connect the fixed timing tool ground to the engine and press power switch on.

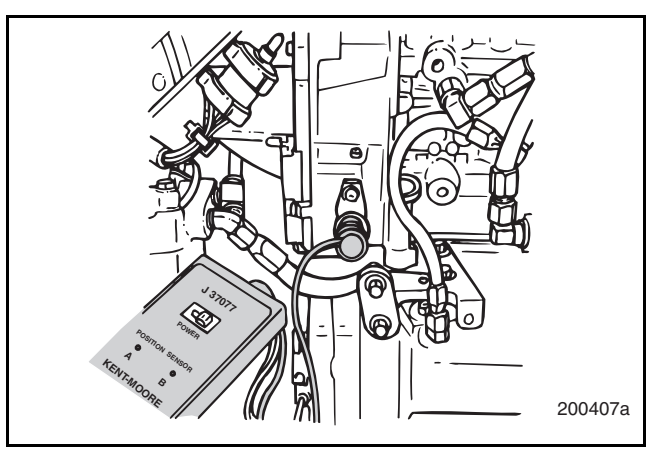

Figure 7-19 — Grounding and Turning Tool On