300 Series OEM Engines

John Deere

300 SERIES OEM ENGINES

Technical Manual
TM-1190 (Sep-77)

SECTIONAL CONTENTS OF THIS MANUAL

The specifications and design information contained in this manual were correct at the time it was printed. It is John Deere's Policy to continually improve and update our machines. Therefore, the specifications and design information are subject to change without notice. Wherever applicable, specifications and design information are in accordance with SAE and ICED standards.

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INTRODUCTION

Use FOS Manuals for Reference

Use Technical Manuals for Actual Service

This technical manual is part of a twin concept of service:

The two kinds of manuals work as a team to give you both the general background and technical details of shop service.

•FOS Manuals—for reference

Fundamentals of Service (FOS) Manuals cover basic theory of operation, *fundamentals* of trouble shooting, *general* maintenance, and *basic* types of failures and their causes. FOS Manuals are for training new personnel and for reference by experienced service technicians.

When a service technician should refer to a FOS Manual for more information, a FOS symbol like the one at the left is used in the TM to identify the reference.

•Technical Manuals—for actual service

Technical Manuals are concise service guides for a specific machine. Technical manuals are service guides containing only the vital information needed by an experienced service technician.

This technical manual was planned and written for you—an experienced service technician. Keep it in a permanent binder in the shop where it is handy. Refer to it whenever in doubt about correct service procedures or specifications.

Some features of this manual:

- Inside front cover - "Table of Contents".
- Section 1 - Contents
- Sections 4 through 19 - Removal, repair, testing (components removed), installation, and adjustment.
- Section 90 - Detailed explanation of system operation, diagnosis, visual inspection, testing, and adjustments.
- Specifications grouped and illustrated at the end of pertinent sections.

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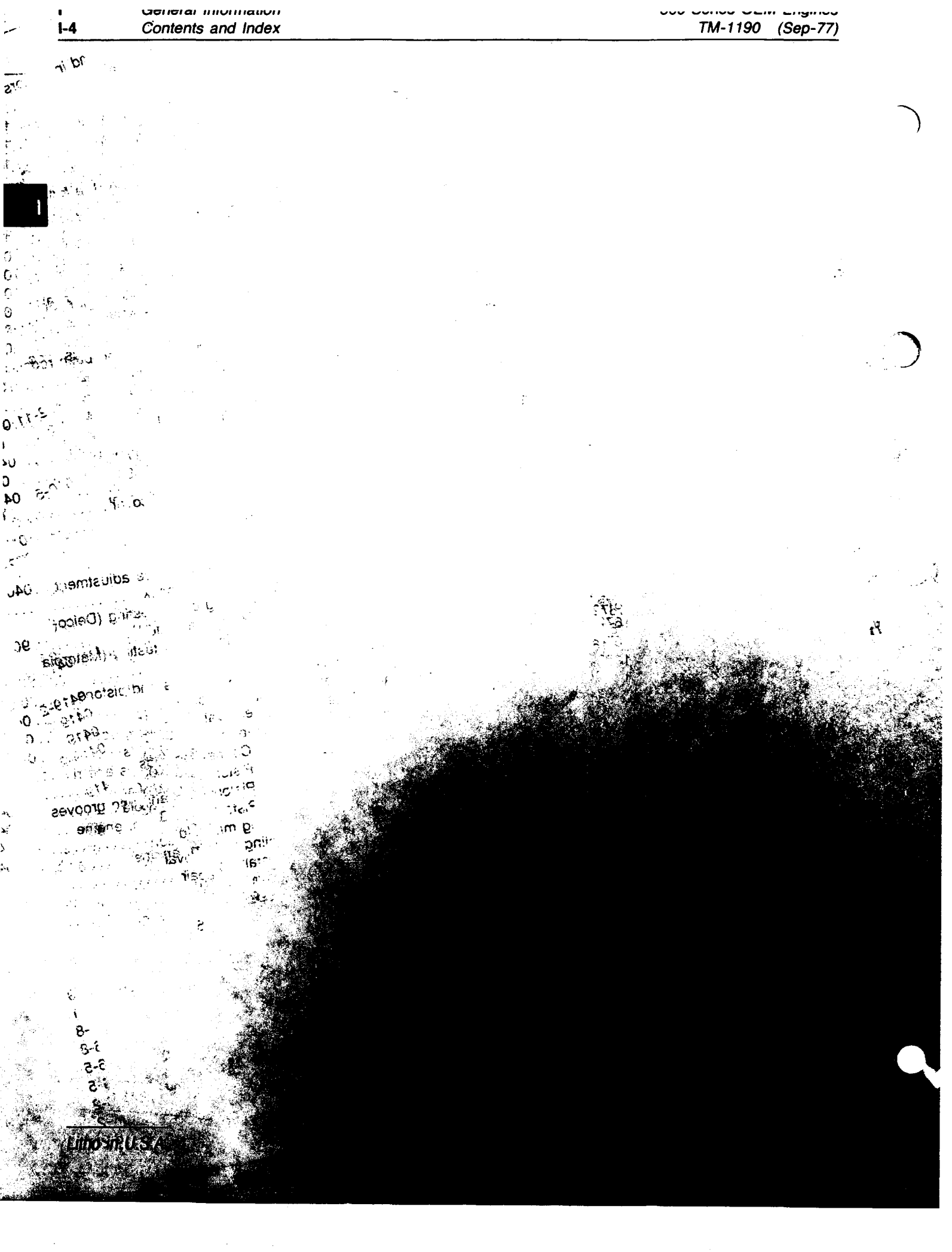
SECTION AND GROUP CONTENTS OF THIS MANUAL



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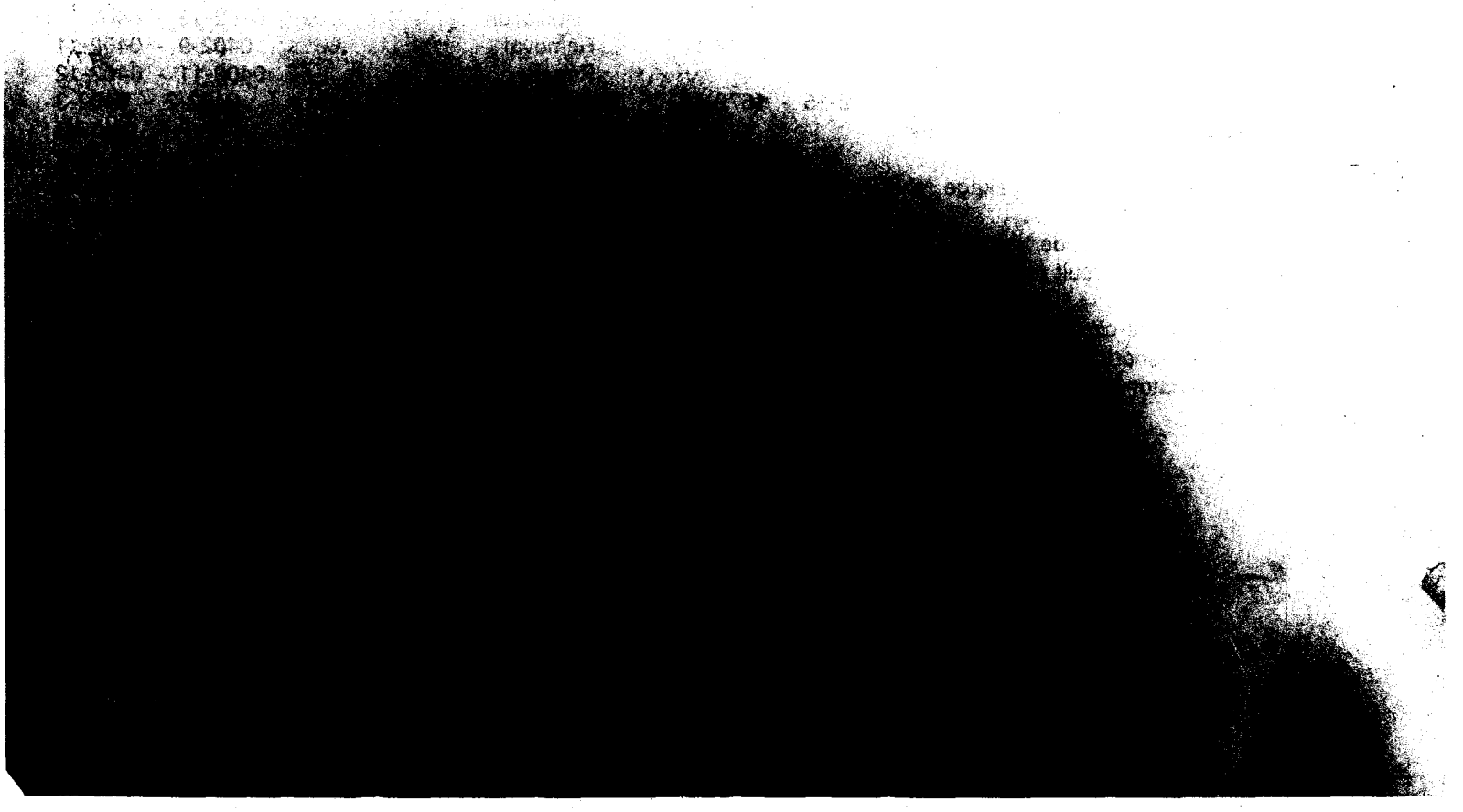

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Section 4
ENGINE

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Group 0400
REMOVAL AND INSTALLATION

GENERAL INFORMATION

For basic theory of engine operation, see "Basic Engine" in FOS Manual - ENGINES.

See Fig. 1 for front, rear, left and right of engine.

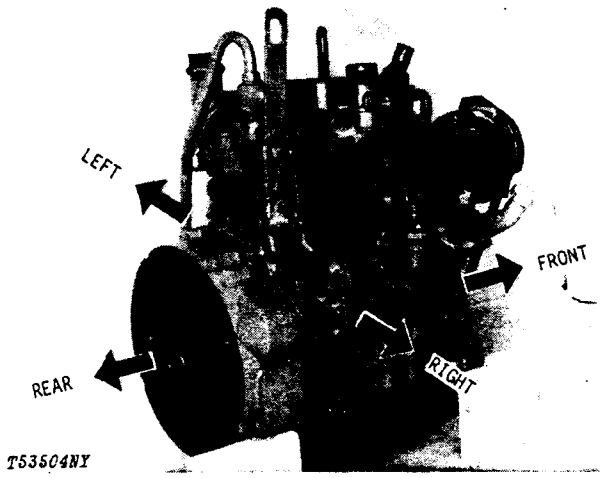

Fig. 1-Front, Rear, Left and Right of Engine

REMOVAL

Disconnect battery negative (−) cable. Disconnect battery positive (+) cable from starter.

Remove engine side shields (2, Fig. 2).

Remove muffler.

Remove hood Group 1910 (1, Fig. 2).

Drain engine cooling system.

Drain engine oil.

Disconnect fuel inlet line at fuel transfer pump.

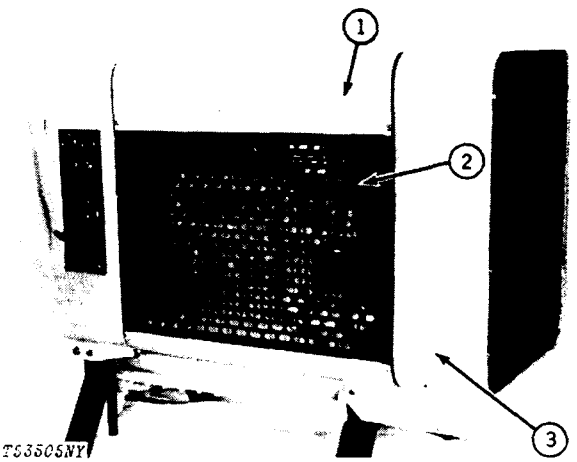

Fig. 2-Engine Enclosure

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Disconnect tachometer drive cable (3, Fig. 3) from flywheel housing.

Disconnect air cleaner hose on right side of engine.

Remove rear panel (1, Fig. 3) with air cleaner (2) attached.

Remove front shroud (3, Fig. 2).

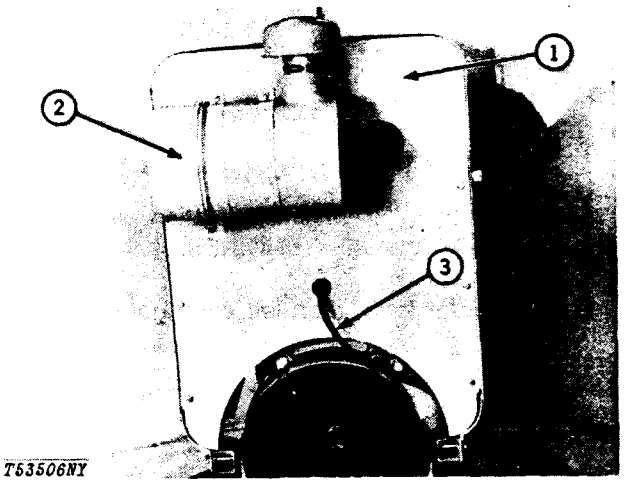

Fig. 3-Engine Enclosure Rear Panel

Disconnect speed control cable (1, Fig. 4) and bracket (2).

NOTE: Tag wires and terminals for reassembly.

Disconnect fuel shut-off wiring (3, Fig. 4) from fuel injection pump (4).

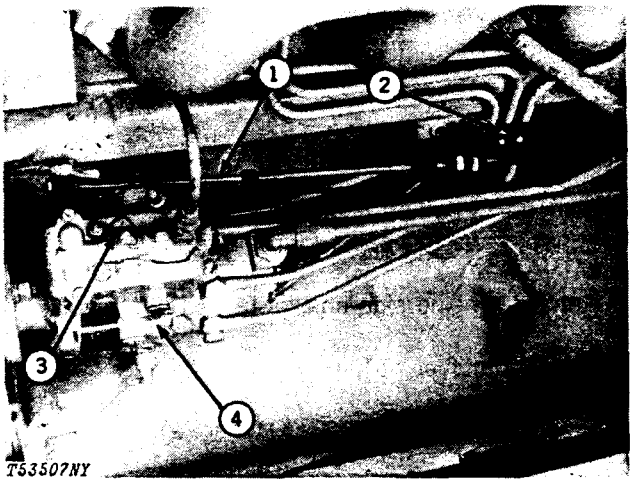

Fig. 4-Speed Control Cable and Fuel Shut-Off Wiring

Disconnect alternator wiring (1, Fig. 5) from alternator.

Disconnect solenoid wiring (2, Fig. 5) from solenoid.

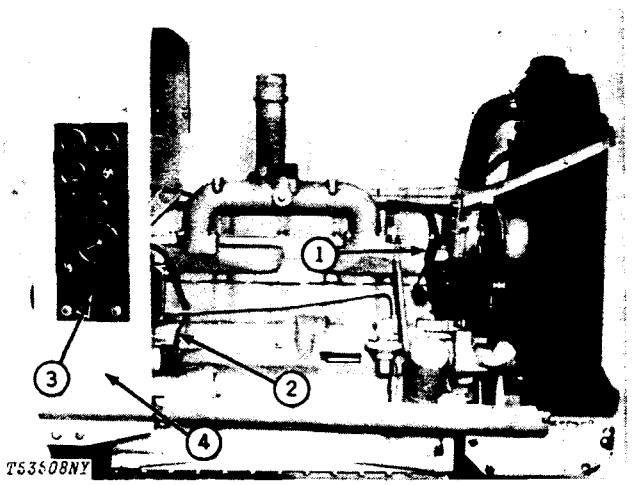

Fig. 5-Solenoid and Alternator Wiring

Disconnect temperature sending unit (1, Fig. 6) from rear of cylinder head.

Disconnect oil pressure hose (2, Fig. 6) from rear of cylinder block.

Remove rear shroud (4, Fig. 5) with instrument panel (3) attached.

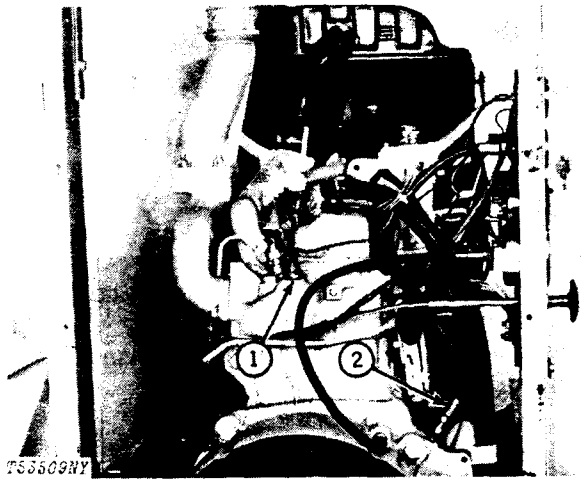

Fig. 6-Oil Pressure Hose and Temperature Sending Unit

Attach hoist with D01043AA load-positioning sling (1, Fig. 7) to engine lifting eyes (2).

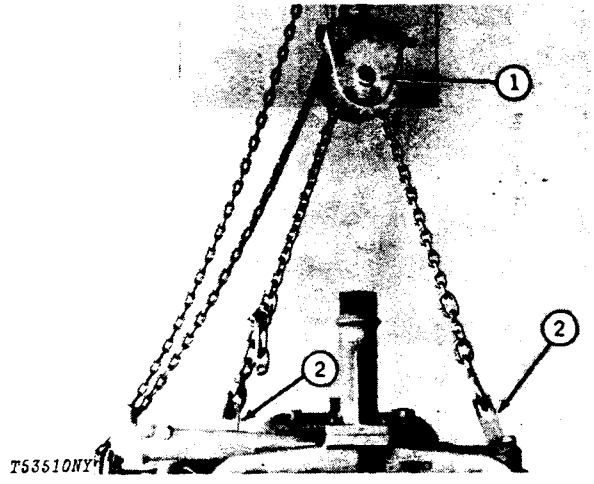

Fig. 7-D01043AA Load Positioning Sling Attached

Remove engine mounting hardware (1, Fig. 8) at four corners of engine.

Raise hoist to remove engine.

Cap or plug air inlet tube, fuel inlet fitting, and exhaust manifold tube. Steam-clean engine thoroughly.

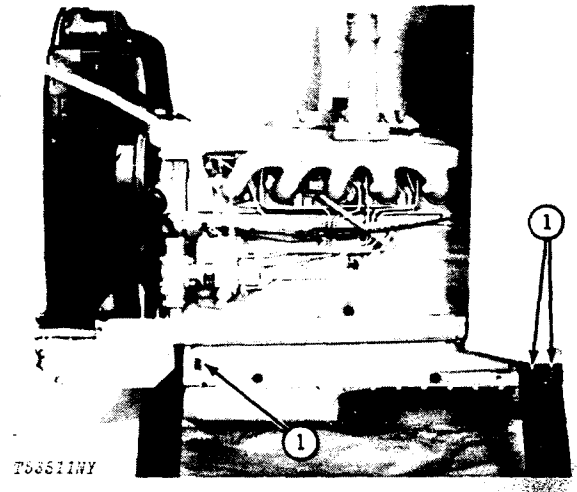

Fig. 8-Engine Mounting Hardware

INSTALLATION

Mounting Engine in D01003AA Stand

Attach hoist with D01043AA load-positioning sling (1, Fig. 7) to engine lifting eyes (2).

Lift engine into position on D01003AA engine stand. Refer to Fig. 9 to mount three or four cylinder engine. Refer to Fig. 10 to mount six cylinder engine.

4

Adjust engine stand rods and install cap screws holding rod brackets to engine.

⚠ CAUTION: Tighten all engine stand mounting hardware securely before removing hoist.

Check that all engine stand mounting hardware is tight.

Remove hoist and sling (1, Fig. 7) from engine.

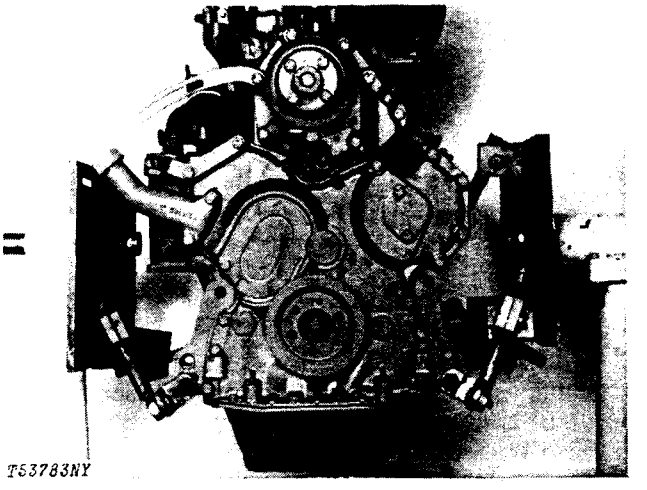

Fig. 9-Three or Four Cylinder Engine Mounted in D01003AA Engine Stand

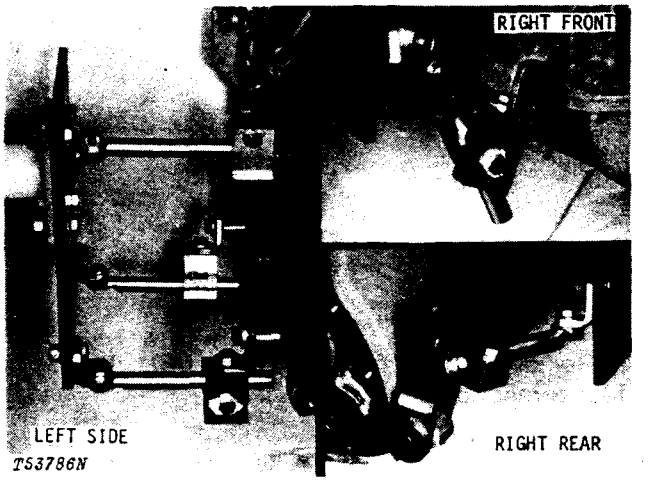

Fig. 10-Six Cylinder Engine Mounting Points

Mounting Engine in Enclosure

Attach hoist with D01043AA load-positioning sling (1, Fig. 7) to engine lifting eyes (2).

Lift engine into position on enclosure mounting skid. Install engine mounting hardware (1, Fig. 8) at lower four corners of engine.

Remove load-positioning sling and hoist from engine.

Install rear shroud (4, Fig. 5) with instrument panel (3) attached.

Connect oil pressure hose (2, Fig. 6) to rear of cylinder block.

Connect temperature sending unit (1, Fig. 6) to rear of cylinder head.

Connect solenoid wiring (2, Fig. 5).

Connect alternator wiring (1, Fig. 5).

Connect fuel shut-off wiring (3, Fig. 4) to fuel injection pump (4).

Connect speed control cable (1. Fig. 4) and install bracket (2).

Install front shroud (3, Fig. 2).

Install rear panel (1, Fig. 3) with air cleaner (2) attached.

Connect air cleaner hose to intake tube on right side of engine.

Connect tachometer drive cable (3, Fig. 3) to flywheel housing.

Connect fuel inlet line to fuel transfer pump.

Fill crankcase to correct level using proper oil.

Fill radiator to correct level using proper coolant.

Install hood (1, Fig. 2).

Install muffler.

Install engine side shields (2, Fig. 2).

Connect battery positive (+) cable to starter.

Connect battery negative (−) cable to battery.

Adjust speed control linkage if necessary (Group 0515).

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Group 0401
CRANKSHAFT AND MAIN BEARINGS

CRANKSHAFT

Removal

Invert engine.

Remove oil pan (1, Fig. 1) (Group 0407).

Remove engine timing gear cover (2) (Group 0404).

Remove flywheel and flywheel housing (Group 0433).

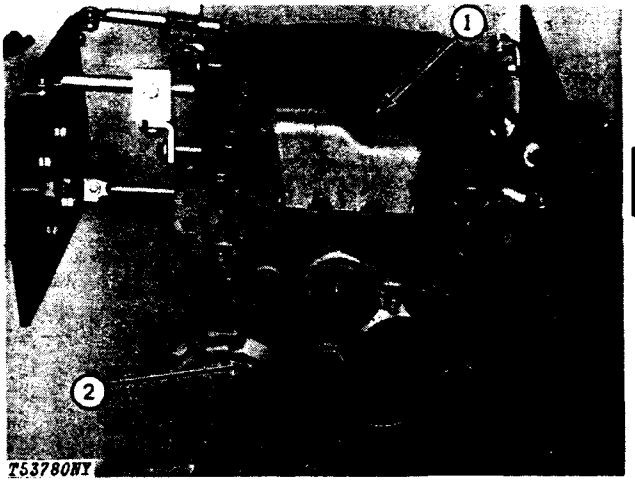

Fig. 1-Engine Inverted

Crankshaft End Play

Position a dial indicator against end of crankshaft (Fig. 2).

IMPORTANT: Do not apply too much pressure with pry bar as this could damage bearings.

Using pry bar, carefully move crankshaft rearward.

Zero the dial indicator.

Using pry bar, carefully move crankshaft forward.

Read dial indicator.

Specifications are as follows:

New crankshaft end play... 0.002 to 0.008 inch (0.05 to 0.20 mm)

Maximum crankshaft end play ..... 0.015 inch (0.38 mm)

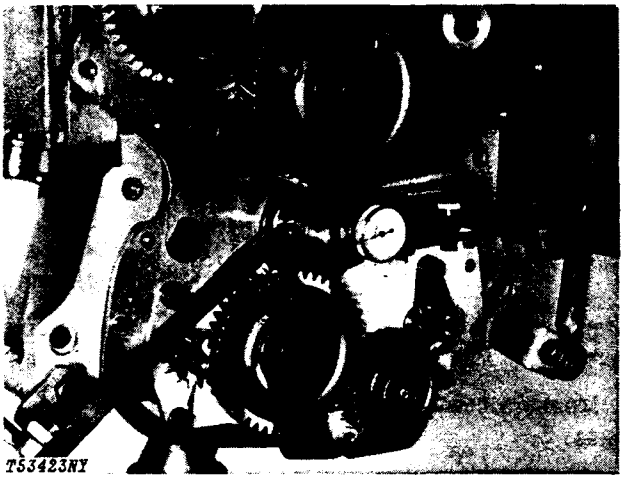

Fig. 2-Crankshaft End Play

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Remove connecting rod caps (Fig. 3). Slide pistons and connecting rods toward the cylinder head.

Use a center punch to mark main bearing caps to correspond to numbers stamped on pan rail (Fig. 7).

Remove main bearing caps.

Lift crankshaft from cylinder block.

4

Remove main bearing inserts from cylinder block and from main bearings caps.

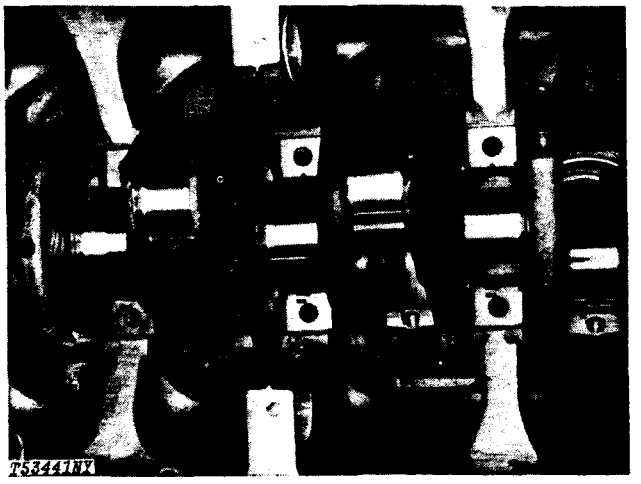

Fig. 3-Connecting Rod and Main Bearing Caps Removal

Repair

Measure crankshaft main journal to main bearing clearance.

Main bearing journal O.D.
(new) ..... 3.123 to 3.124 inch
(79.32 to 79.35 mm)

Assembled Main bearing I.D.
(new) ..... 3.126 to 3.128 inch
(79.39 to 79.45 mm)

Main bearing clearance
(new) ..... 0.0017 to 0.0047 inch
(0.043 to 0.119 mm)

Main bearing clearance (maximum)..... 0.006 inch
(0.15 mm)

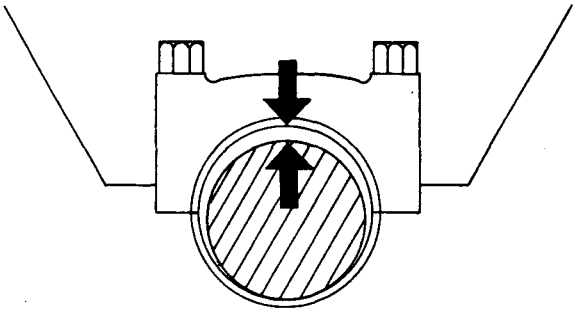

Fig. 4-Main Bearing Clearance

Measure crankshaft main journal taper and roundness.

Journal taper (maximum)
(1, Fig. 5)..... 0.001 inch per 1.00 inch
(0.03 mm per 25.4 mm)

Journal out-of-round (maximum)
(2, Fig. 5)..... 0.003 inch
(0.08 mm)

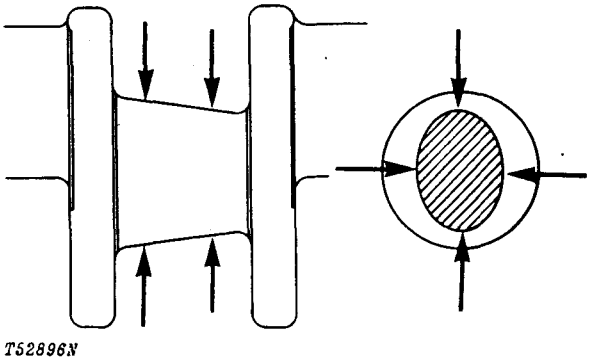

Fig. 5-Main Bearing Measurement

If wear is even, but out of specifications, dress crankshaft main journals and select proper undersize bearing inserts.

If journals are out-of-round or tapered, grind crankshaft and select proper undersize bearing inserts.

If crankshaft end play is excessive, replace worn thrust bearings or grind crankshaft thrust surfaces and select proper oversize thrust bearing.

Installation

Position bearing inserts in cylinder block and main bearing caps with the tang on the insert engaged in the slot in the cylinder block and main bearing caps (Fig. 6).

Apply a coat of clean engine oil to the bearing surface of the inserts.

Position crankshaft in cylinder block.

NOTE: Main bearing caps and cylinder block are numbered. During installation, the number stamped on the caps must match and be on same side of crankshaft as numbers on cylinder block (Fig. 7).

Position main bearing caps on cylinder block.

Dip main bearing cap screws in clean engine oil and position them in the main bearing caps.

IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws.

Before tightening cap screws on main bearing caps, align upper and lower thrust flanges on main thrust bearings. Using soft-face hammer, tap crankshaft to the rear and then to the front to line up thrust bearing flanges.

Rotate crankshaft by hand. Crankshaft should rotate with little effort.

Main bearing cap screw torque (Fig. 8) . . . 85 lb-ft (115 Nm) (12 kg-m)

Measure crankshaft end play. Adjust if necessary.

NOTE: Number stamped on connecting rod cap must match and be on same side of crankshaft as number on connecting rod.

Apply clean engine oil to connecting rod inserts.

Position connecting rod caps on connecting rods.

Dip connecting rod cap screws in clean engine oil and position them in the connecting rod caps.

IMPORTANT: Do not use pneumatic wrench to install connecting rod cap screws.

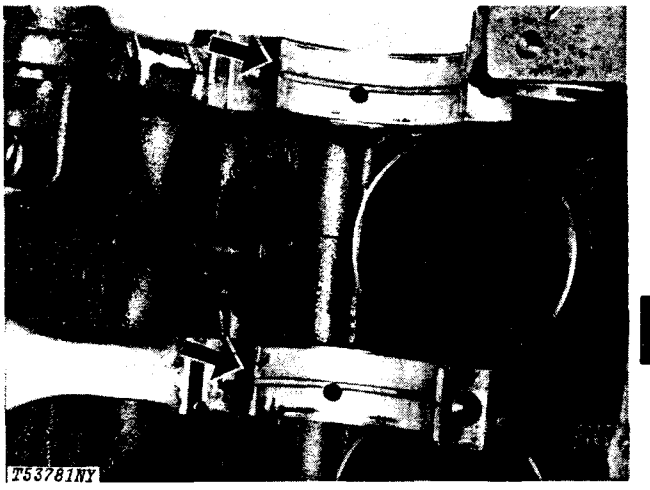

Fig. 6-Main Bearing Insert Installation

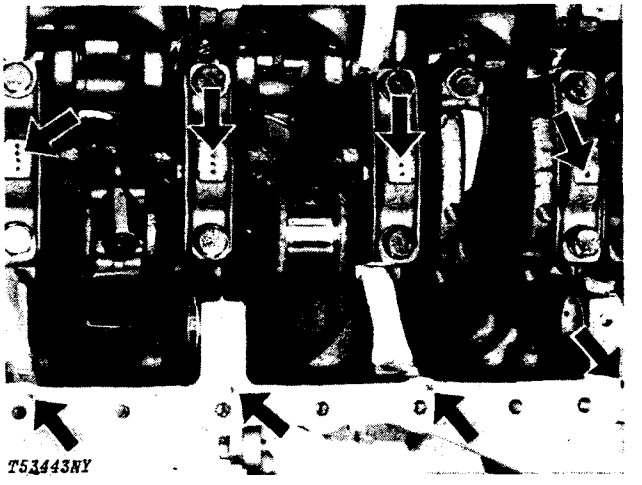

Fig. 7-Main Bearing Caps

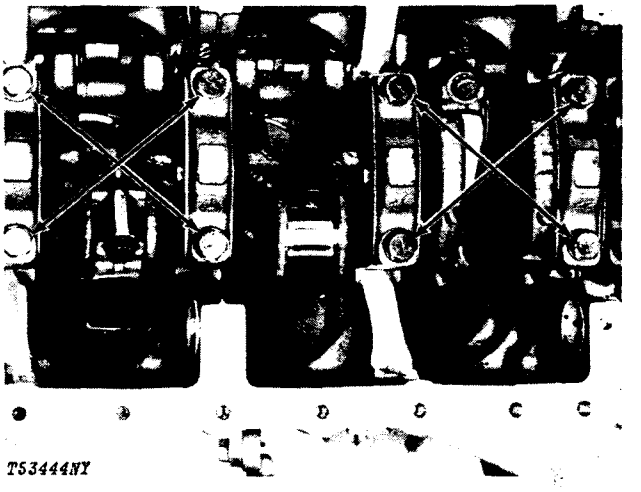

Fig. 8-Main Bearing Cap Screws

Engine	Connecting Rod Cap Screw Torque
3-164D	65 lb-ft (88 Nm) (9 kg-m)
4-219D	65 lb-ft (88 Nm) (9 kg-m)
4-276T	95 lb-ft (129 Nm) (13 kg-m)
6-329D	65 lb-ft (88 Nm) (9 kg-m)
6-414D	95 lb-ft (129 Nm) (13 kg-m)
6-414T	95 lb-ft (129 Nm) (13 kg-m)

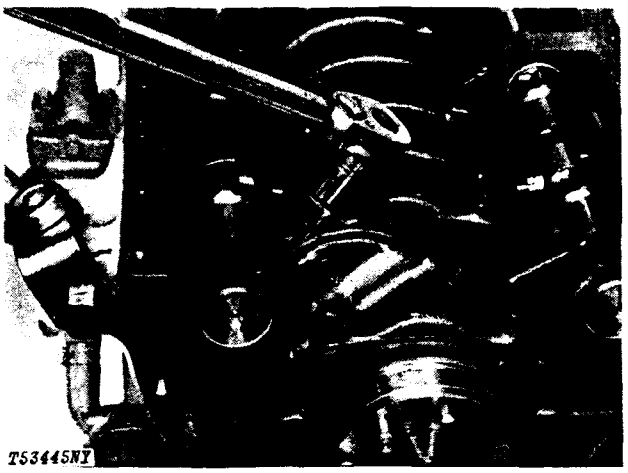

Fig. 9-Connecting Rod Cap Screw Torque

Install engine front plate (Group 0404).

Install camshaft (Group 0402).

Install timing gear train (Group 0402).

Install timing gear cover (Group 0402).

Install vibration damper (Group 0401).

Install fan belt and alternator belt (Group 0429).

Install flywheel housing (Group 0433).

Install flywheel (Group 0433).

Install oil pan (Group 0407).

Install pushrods and rocker arm assembly (Group 0402).

Install rocker arm cover (Group 0402).

Install fuel transfer pump (Group 0421).

CRANKSHAFT GEAR

Removal

Remove crankshaft from engine (Group 0401).

Use knife-edge puller (1, Fig. 10) to remove crankshaft gear (2) from crankshaft.

Repair

Inspect crankshaft gear for worn, cracked, or broken teeth. Replace damaged gear.

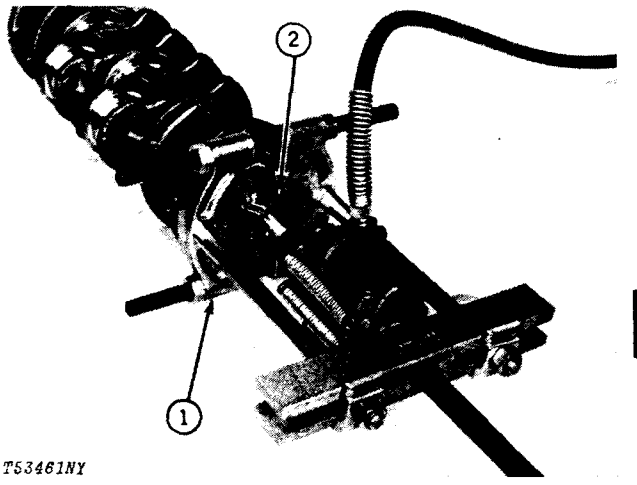

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Fig. 10-Crankshaft Gear Removal

CAUTION: Plan safe handling procedure to avoid burns.

IMPORTANT: Do not use torch or small concentrated flames to heat gear. Do not overheat gear.

Heat gear to 360°F (182°C).

With Woodruff key in place, drive gear onto crankshaft with JDH-7 Driver (Fig. 11).

Install crankshaft in engine (Group 0401).

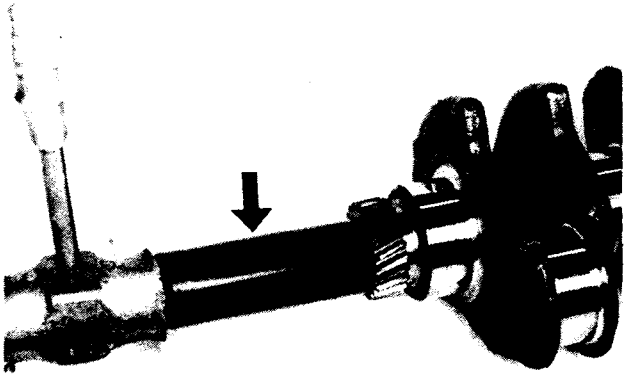

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Fig. 11-JDH-7 Driver

CRANKSHAFT FRONT WEAR RING (used on 6-329D, 6-414D, and 6-414T)

Removal

Remove timing gear cover (Group 0402).

Slide wear ring off of crankshaft (Fig. 12).

Installation

Slide wear ring onto crankshaft.

Install timing gear cover (Group 0402).

Install vibration damper (Group 0401).

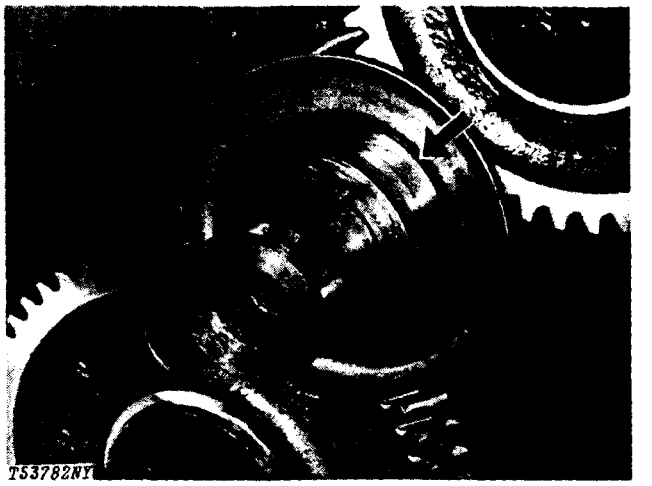


Fig. 12-Crankshaft Front Wear Ring

CRANKSHAFT FRONT OIL SEAL

See Group 0402 to service crankshaft front oil seal.

CRANKSHAFT REAR WEAR RING

Removal

Remove flywheel and flywheel housing (Group 0433) (Fig. 13).

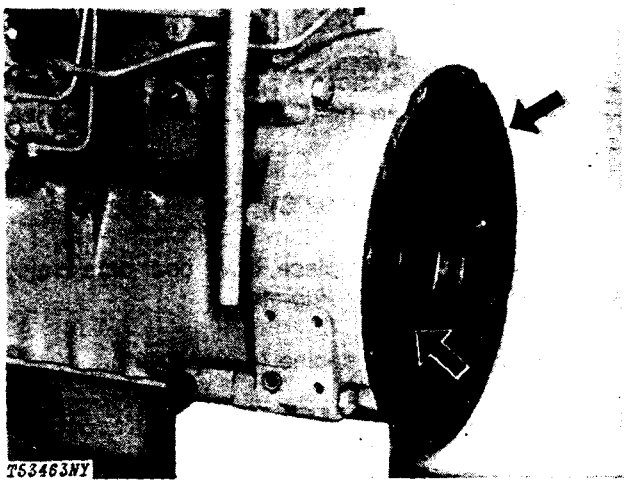


Fig. 13-Remove Flywheel and Flywheel Housing

Using a dull chisel, score the wear ring in several places (Fig. 14).

IMPORTANT: Do not score wear ring too deeply as it may damage the crankshaft surface.

When wear ring is loosened remove it from crankshaft.

Repair

Inspect crankshaft flange for nicks or burrs. If necessary clean flange area with a fine cut file and fine emery cloth.

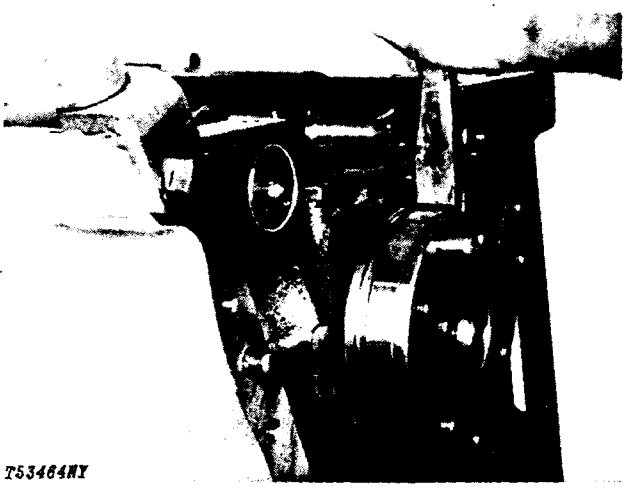


Fig. 14-Score Wear Ring

Installation

If abrasive was used to clean up crankshaft flange, apply a thin coat of non-hardening gasket sealer to crankshaft flange.

Position JD-251-2 Pilot Plate (1, Fig. 15) on crankshaft.

Position wear ring (2) over JD-251-2 Pilot Plate with rounded edge out.

Start wear ring on crankshaft by hand (avoid heavy pressure or cocking of wear ring.

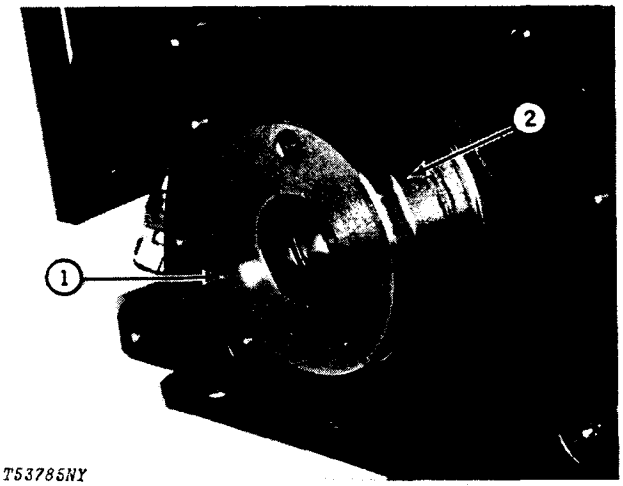


Fig. 15-JD-251-2 Pilot Plate

Using JD297-1 Driver with 27489 Handle, drive wear ring onto crankshaft until driver bottoms on pilot plate (Fig. 16).

Remove pilot plate and drive wear ring onto crankshaft until driver bottoms on crankshaft.

Remove any excess gasket sealer from area. Inspect crankshaft and wear ring surfaces for nicks and burrs. Remove nicks or burrs with emery cloth if not in seal contact area.

NOTE: Replace wear ring with nicks or burrs in seal contact area.

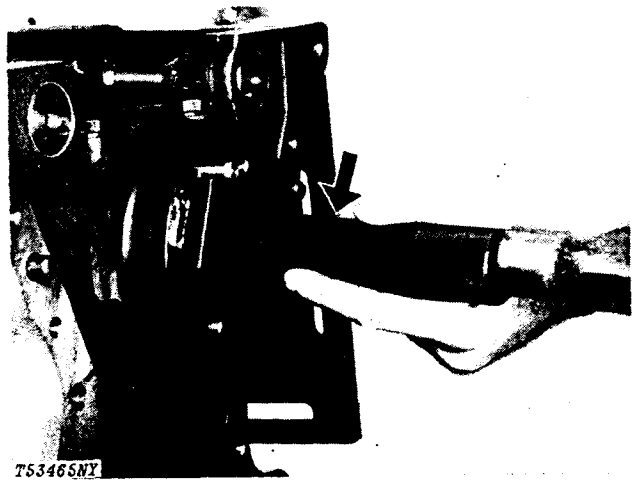


Fig. 16-JD297-1 Driver with 27489 Handle

Install flywheel housing and flywheel (Group 0433) (Fig. 17).

CRANKSHAFT REAR OIL SEAL

See Group 0433 to service crankshaft rear oil seal.

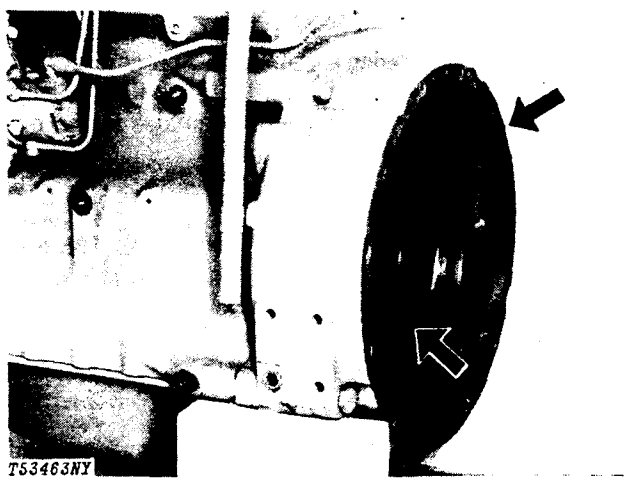
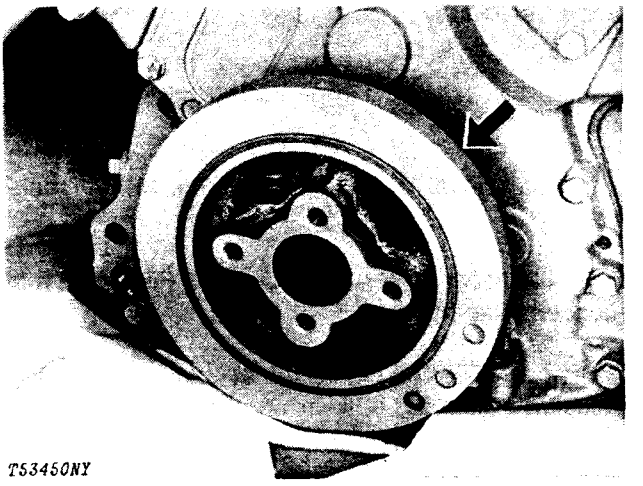


Fig. 17-Install Flywheel Housing and Flywheel

VIBRATION DAMPER

Service life of the vibration damper is affected by engine speed and load variations as well as extreme heat or cold (Fig. 18).

Replace vibration damper after 4500 hours or every five years, whichever occurs first.



T53450NY

Fig. 18-Vibration Damper

Measure total run-out (1, Fig. 19) and wobble (2) of vibration damper outer ring.

Total run-out (1)	0.060 inch (1.52 mm)
Wobble (2)	0.060 inch (1.52 mm)

Replace vibration damper if run-out or wobble is out of specifications or if outer ring has slipped relative to the rubber member or drive hub.

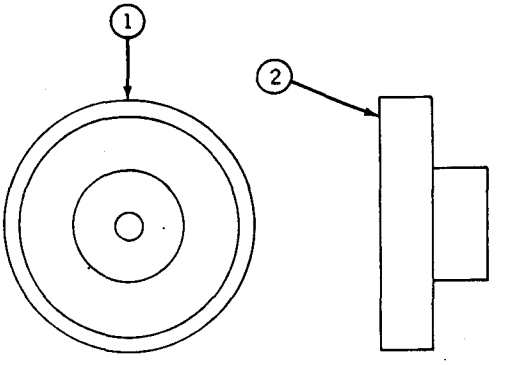


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Fig. 19-Vibration Damper Measurement

Installation

Handle dampers with care. They are sensitive to impacts such as being dropped or hammered on. Impact damage can impair the "tuning effect" of the damper, which prevents torsional damage to the engine.

Vibration damper cap screw torque (Fig. 20)	85 lb-ft (115 Nm) (12 kg-m)

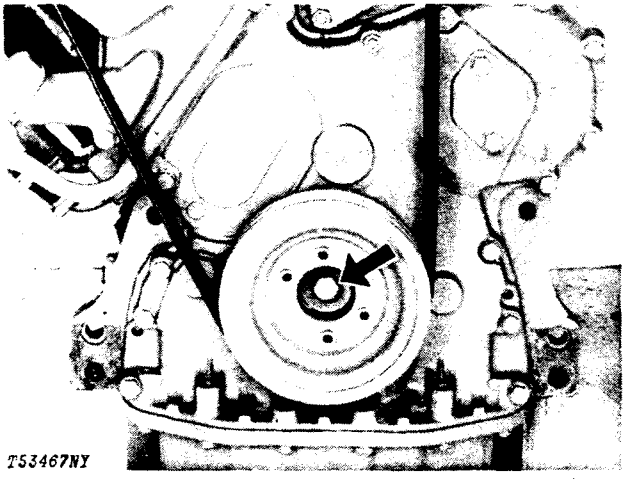

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Fig. 20-Vibration Damper Cap Screw Torque

Group 0402
CAMSHAFT AND VALVE ACTUATING MEANS

VALVE LIFT CHECK

Measuring valve lift can give an indication of wear to cam lobes, cam followers, and push rods.

Adjust valve clearance (Group 0402).

Position dial indicator on valve rotator or valve spring cap (Fig. 1). (Be sure valve is fully closed and rocker arm moves freely).

Zero dial indicator.

Manually rotate crankshaft clockwise, as viewed from front end.

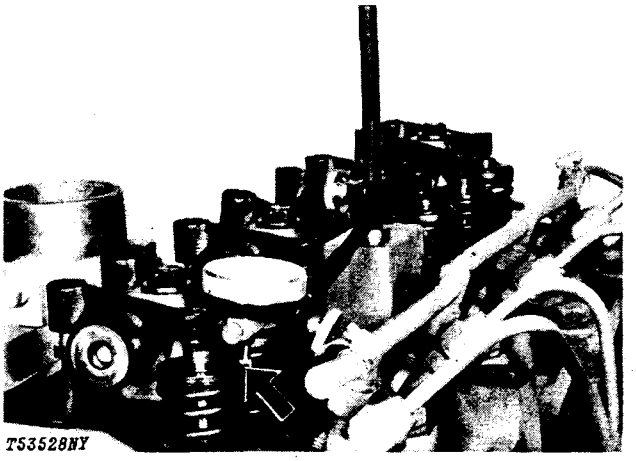
T53528NY

Fig. 1-Measuring Valve Lift

Repeat valve lift check on each valve. Lift should be:

Intake ..... 0.460 to 0.490 inch (11.68 to 12.45 mm)

Exhaust ..... 0.456 to 0.482 inch (11.58 to 12.24 mm)

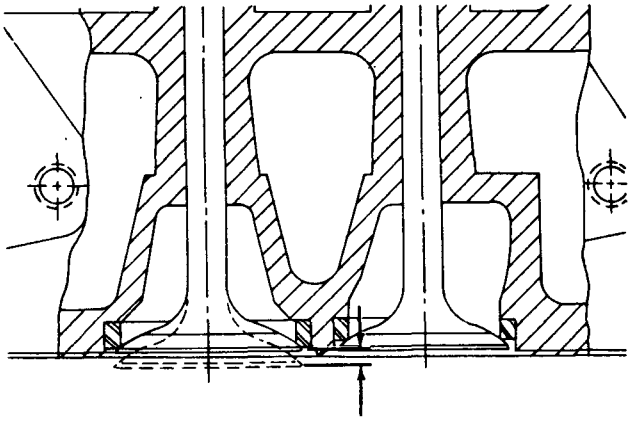
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Fig. 2-Valve Lift

Litho in U.S.A.

TIMING GEAR COVER

Removal

Remove fan (1, Fig. 3) and fan belt (2) or belts.

Remove vibration damper (3) (Group 0401).

Remove oil pan (4) (Group 0407).

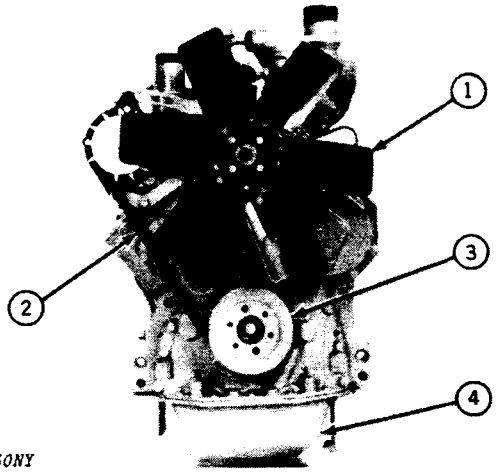

Fig. 3-Accessory Removal

Remove oil pressure control valve (Engines 3164D, 4219D, 6414D, and 6414T) (Group 0407) (Fig. 4).

NOTE: Count adjusting washers for reassembly.

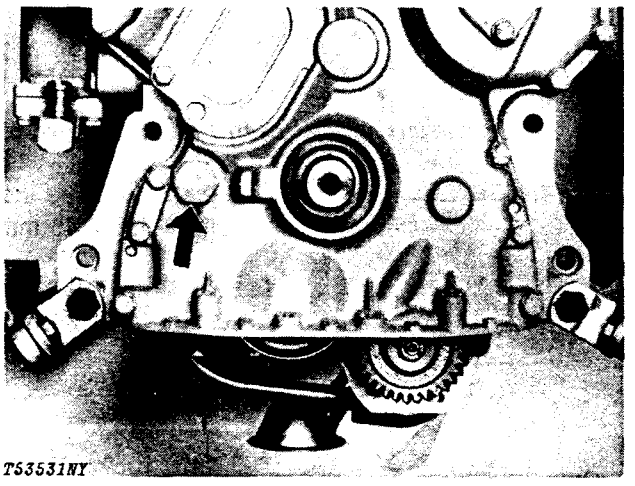

Fig. 4-Remove Oil Pressure Control Valve

Remove timing gear cover attaching nuts and cap screws (Fig. 5).

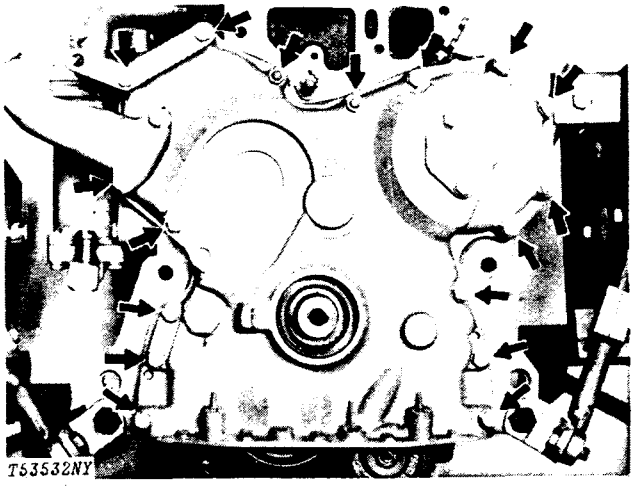

Fig. 5-Attaching Hardware

Repair

Remove gasket residue from cylinder block and timing gear cover.

Inspect timing gear cover for cracks and breaks.

Replace crankshaft front oil seal (Group 0402).

Litho in U.S.A.

Installation

Apply a light coat of high-temperature grease to the lip of the crankshaft front oil seal.

Using a new gasket, install timing gear cover on cylinder block with a slight twisting motion.

IMPORTANT: Be careful not to invert crankshaft front oil seal lip.

Install oil pan (6, Fig. 7) (Group 0407).

Install vibration damger (4) (Group 0401).

Install alternator belt (3), fan belt (2), and fan (1).

Adjust belt tension (Group 9010).

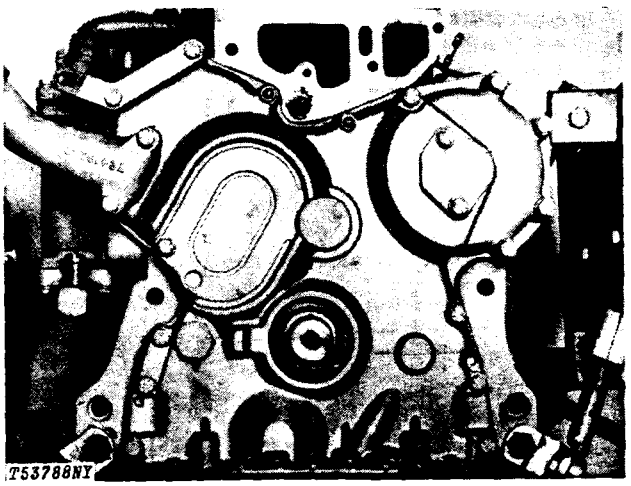

Fig. 6-Install Timing Gear Cover

CRANKSHAFT FRONT OIL SEAL

Removal

Remove timing gear cover (Group 0402).

Drive crankshaft front oil seal out of timing gear cover.

Installation

Coat outer surface of seal with non-hardening gasket cement and inner surface with high temperature grease.

Support the oil seal bore area of the timing gear cover.

Using JD-250 Driver (Fig. 8), press oil seal to bottom of bore with spring-loaded lip facing inward.

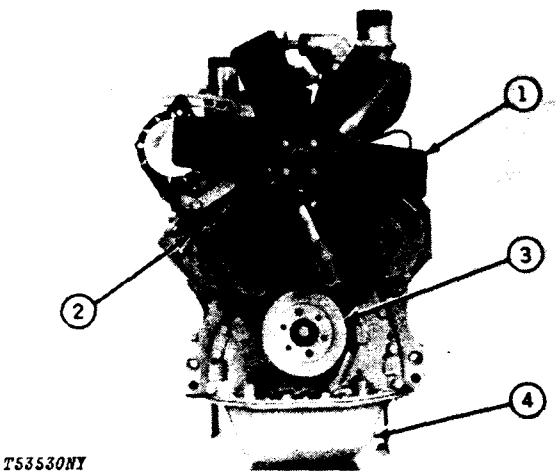

Fig. 7-Accessory Installation

CAMSHAFT

Removal

Remove timing gear cover (Group 0402).

Remove flywheel and flywheel housing (Group 0433).

Remove fuel transfer pump (Group 0421).

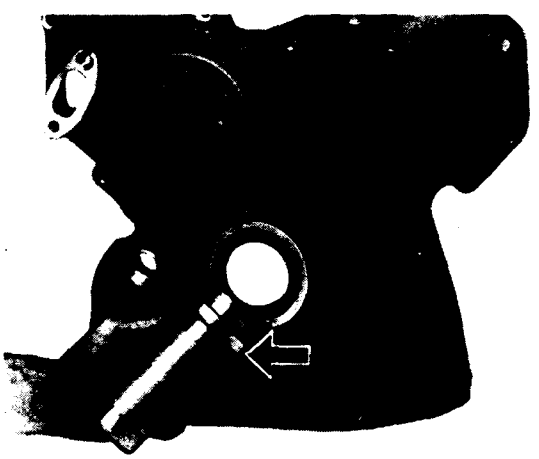

Fig. 8-JD-250 Driver

Rotate crankshaft clockwise, as viewed from the front end, until number one piston is at top dead center on its compression stroke (both rocker arms for number one cylinder will be loose).

Using JD-254 Timing Tool (1, Fig. 9), align timing mark on camshaft gear with the timing tool.

Remove rocker arm assembly and push rods (Group 0402).

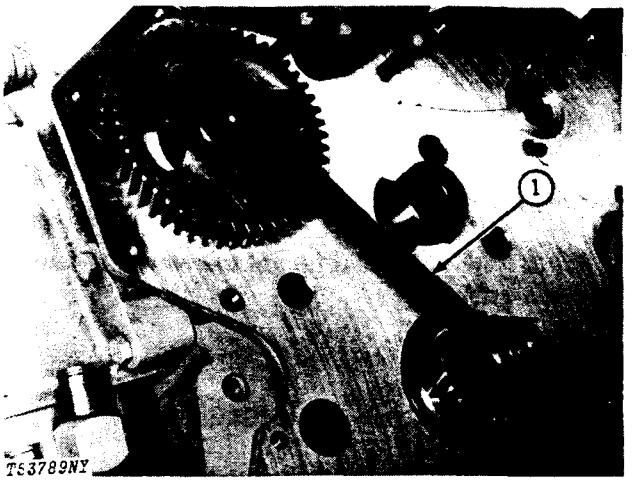

Fig. 9-JD-254 Timing Tool

Using D-15001-NU Magnetic Lifter Holder (Fig. 10), raise cam followers off camshaft lobes. Secure holders so that cam followers will not drag on cam lobes.

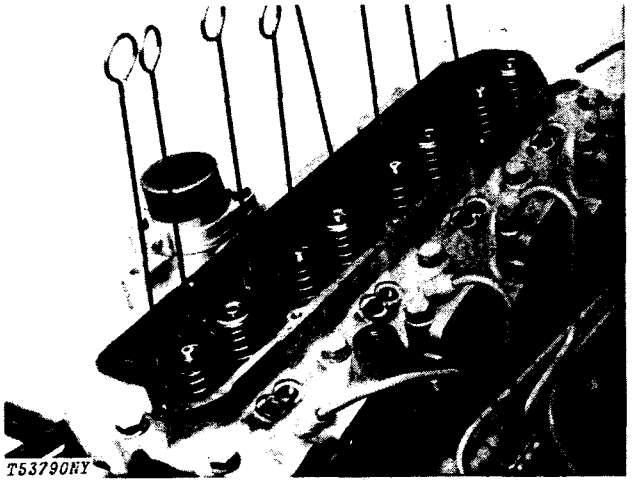

Fig. 10-D-15001-NU Magnetic Lifter Holder

Position a dial indicator on the camshaft gear (Fig. 11).

Push camshaft to the rear of the engine as far as possible.

Zero dial indicator.

Using two screwdrivers or pry bars, move camshaft to the front of the engine as far as possible.

Read dial indicator.

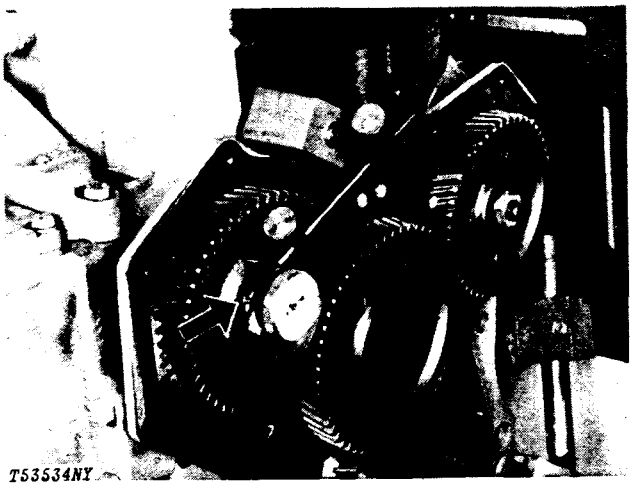

Fig. 11-Camshaft End Play

Camshaft end play (new) .... 0.003 to 0.009 inch (0.08 to 0.23 mm)

Camshaft end play (max.) ..... 0.015 inch (0.38 mm)

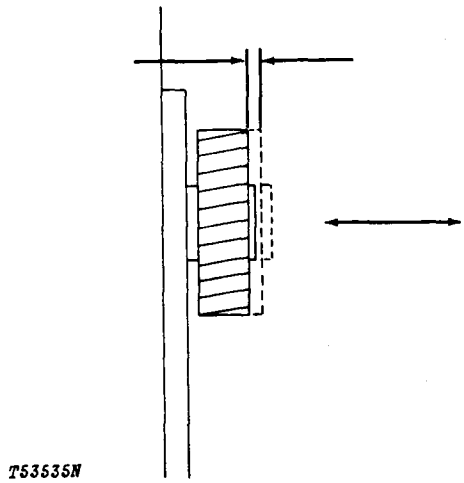
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Fig. 12-Camshaft End Play

Position a dial indicator against a tooth on the camshaft gear (1, Fig. 13).

Hold upper idler gear (2) securely.

Rotate camshaft gear back-and-forth.

Note variation on dial indicator.

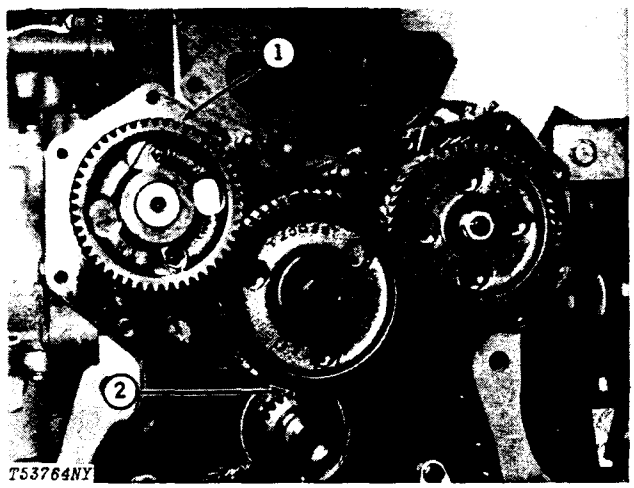

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Fig. 13-Camshaft Gear Backlash

Camshaft gear backlash ..... 0.003 to 0.014 inch (0.08 to 0.36 mm)

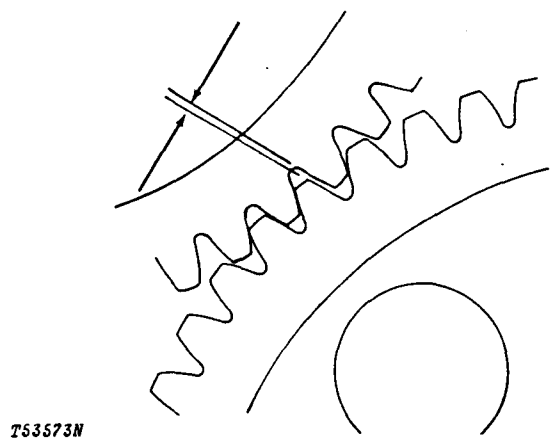
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Fig. 14-Camshaft Gear Backlash

Rotate crankshaft until hole in camshaft gear aligns with one thrust plate cap screw and remove cap screw.

Rotate crankshaft until hole in camshaft gear aligns with second thrust plate cap screw and remove cap screw.

Using JD-254 Timing Tool, rotate crankshaft until timing mark on camshaft gear is under the timing tool.

4

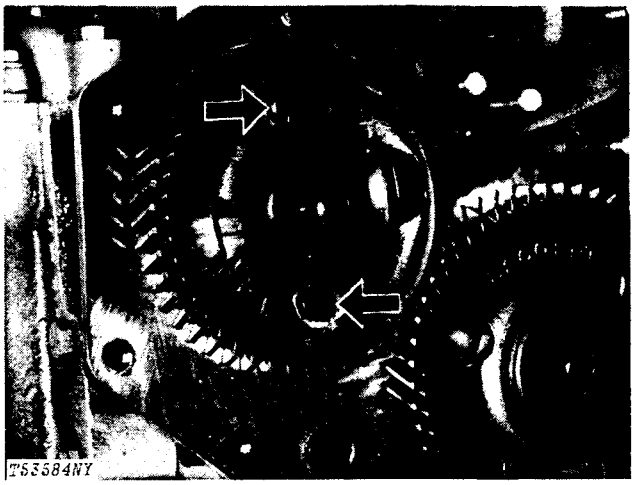

Fig. 15-Remove Camshaft Thrust Plate Cap Screws

Rotate engine to a front up position.

IMPORTANT: Do not allow cam lobes to drag on bearing surfaces while removing camshaft.

Remove camshaft from cylinder block.

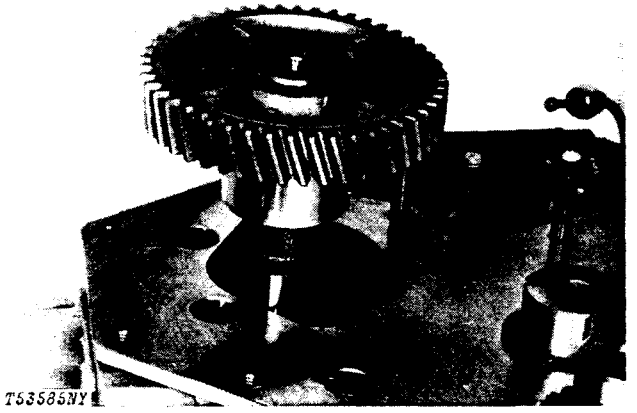

Fig. 16-Camshaft Removal

Press camshaft gear off camshaft if it is damaged.

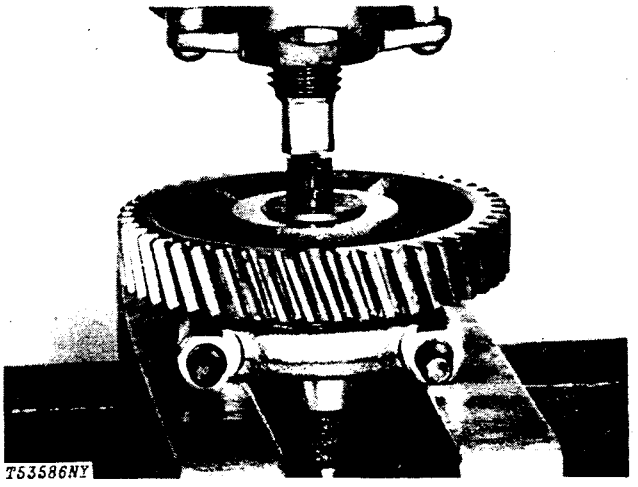

Fig. 17-Remove Cramshaft Gear

Repair

Camshaft bearing journal
O.D. (new) (1, Fig. 18) ..... 2.1997 to 2.2007 inch (55.872 to 55.898 mm)

Camshaft bearing journal
O.D. (min.) ..... 2.1987 inch (55.847 mm)

Thrust plate thickness
(New) (2) ..... 0.156 to 0.158 inch (3.96 to 4.01 mm)

Thrust plate thickness (min.) ..... 0.151 inch (3.84 mm)

Examine camshaft gear for worn or broken teeth.

Inspect camshaft lobes for wear or damage.

If camshaft is replaced, also replace cam followers.

Examine tachometer drive gear or shaft for wear and damage.

Support the camshaft under the first journal (Fig. 19).

Install Woodruff key and place gear on camshaft with timing mark side away from the camshaft.

Using a tubular driver press gear on until tight against camshaft shoulder.

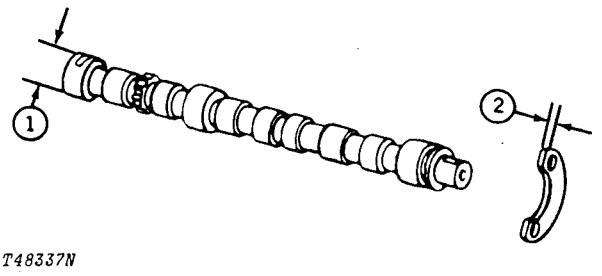

Fig. 18-Camshaft Measurement

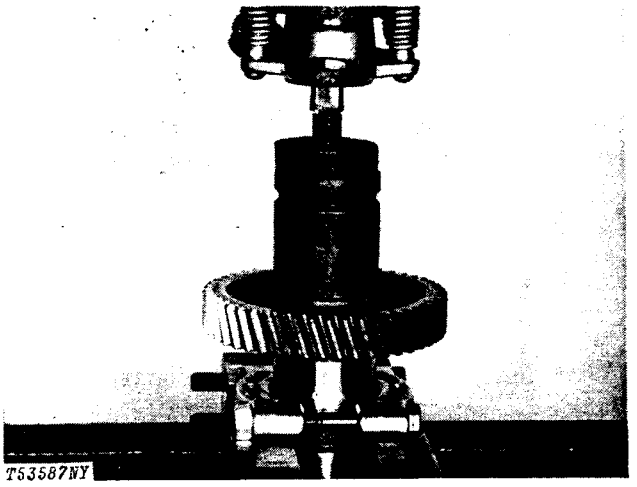

Fig. 19-Camshaft Gear Installation

Installation

Make sure cam followers are clear of the camshaft bore area.

Coat camshaft journals and lobes with high temperature grease.

Make sure crankshaft is at toop dead center on compression stroke.

Position the thrust plate (1, Fig. 20) in its groove in the camshaft.

IMPORTANT: Do not allow cam lobes to drag on bearing surfaces while installing camshaft.

While holding the thrust plate in position, lower the camshaft into the cylinder block.

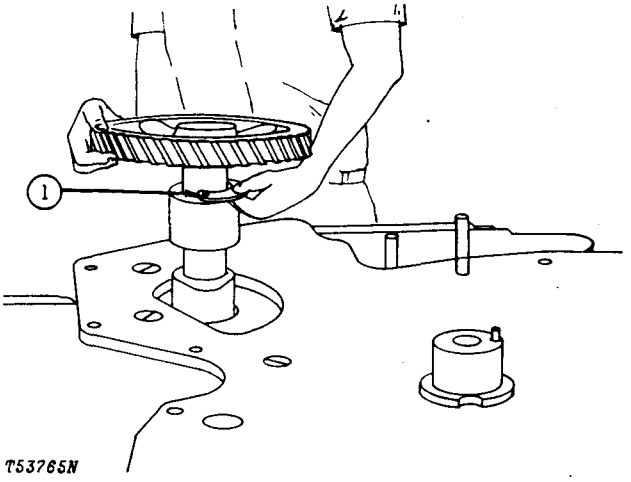

Fig. 20-Installing Camshaft

Using JD-254 Timing Tool (1, Fig. 21), check the location of the camshaft gear timing mark.

Raise the camshaft to disengage the gear teeth and rotate it until timing mark is correctly located under the timing tool.

Rotate crankshaft until a hole in camshaft gear aligns with thrust plate cap screw hole.

4

Install thrust plate cap screw.

Thrust plate cap screw torque
(1, Fig. 22) ..... 35 lb-ft
(47 Nm) (5 kg-m)

Rotate crankshaft until a hole in camshaft gear aligns with second thrust plate cap screw hole.

Install thrust plate cap screw (1, Fig. 22).

Check camshaft end play as described in "Camshaft Removal".

Install push rods and rocker arm assembly (Group 0402).

Install rocker arm cover (Group 0403).

Install timing gear cover (1, Fig. 23) (Group 0402), vibration damper (2) (Group 0401), fan and fan belt or belts (4) (Group 0429), and oil pan (5) (Group 0407).

Install fuel transfer pump (Group 0421).

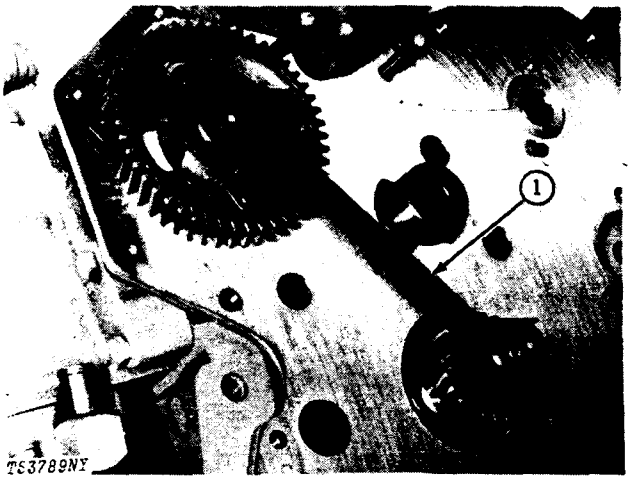

Fig. 21-JD-254 Timing Tool

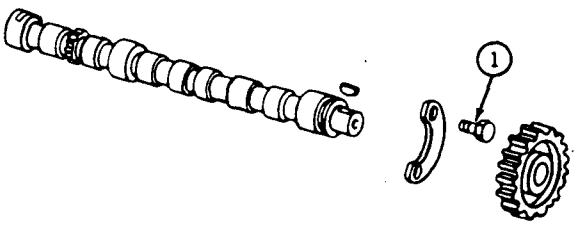

Fig. 22-Thrust Plate Cap Screw Torque

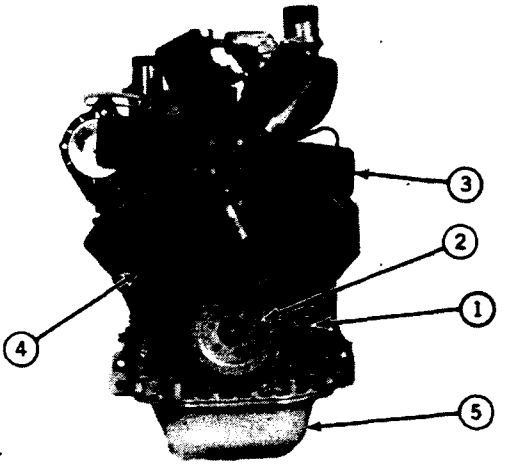

Fig. 23-Accessory Installation

TIMING GEAR

Removal

Remove timing gear cover (Group 0402).

Using JD-254 timing tool, rotate crankshaft until timing mark on camshaft gear is positioned under timing tool and number one piston is at top dead center (Fig. 24).

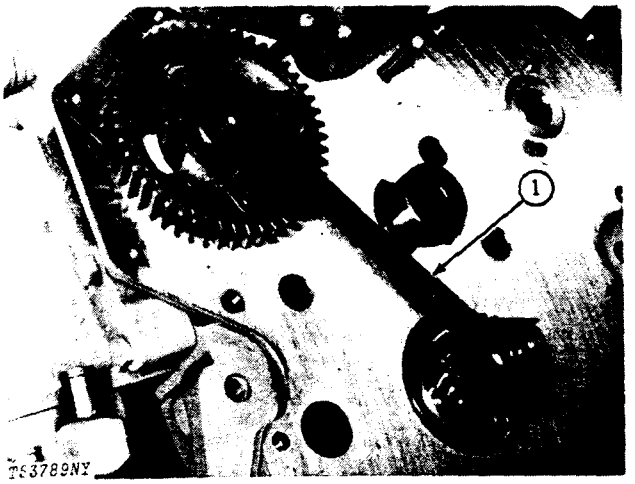

Fig. 24-JD-254 Timing Tool

Using a dial indicator, check timing gear train backlash.

Gear (new)	Backlash
Injection pump to upper idler (1, Fig. 25)	0.003 to 0.014 inch (0.08 to 0.36 mm)
Crankshaft to upper idler (2)	0.003 to 0.017 inch (0.08 to 0.43 mm)
Crankshaft to lower idler (3)	0.003 to 0.014 inch (0.08 to 0.36 mm)
Oil pump to left balancer (4)	0.002 to 0.014 inch (0.05 to 0.36 mm)
Oil pump to lower idler (5)	0.003 to 0.014 inch (0.08 to 0.36 mm)
Lower idler to right balancer (6)	0.002 to 0.016 inch (0.05 to 0.41 mm)
Upper idler to camshaft (7)	0.003 to 0.014 inch (0.08 to 0.36 mm)

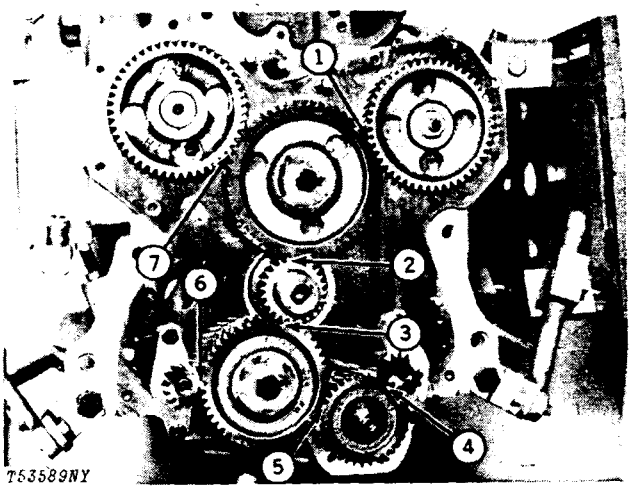

Fig. 25-Timing Gear Train Backlash

Measure idler gear end play (Fig. 26).

Idler gear end play (new)	0.001 to 0.007 inch (0.03 to 0.18 mm)
Idler gear end play (max.)	0.015 inch (0.38 mm)

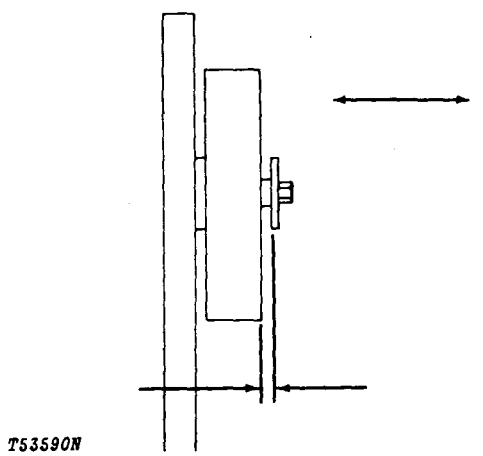

Fig. 26-Idler Gear End Play

Litho in U.S.A.

Remove oil pump drive gear nut (1, Fig. 27), injection pump drive gear nut (2), upper idler gear cap screw (3), and lower idler gear cap screw (4).

Remove upper and lower idler gears.

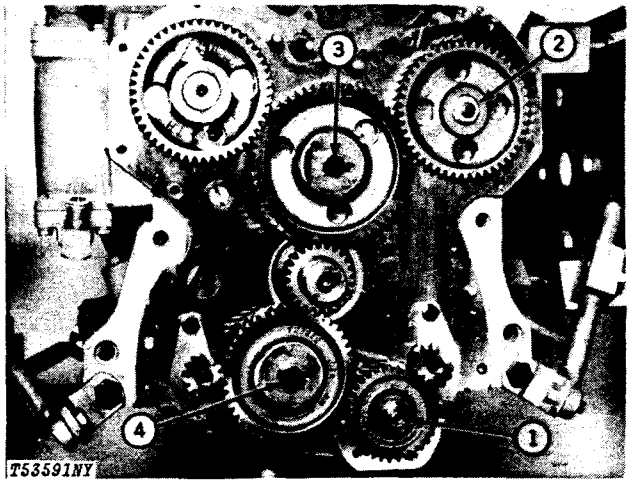

Fig. 27-Removing Idler Gears

Measure idler gear shaft O.D. (Fig. 31)

Idler gear shaft O.D. . . . . 1.750 to 1.751 inch (44.45 to 44.48 mm)

If either idler gear shaft must be replaced, remove the engine front plate.

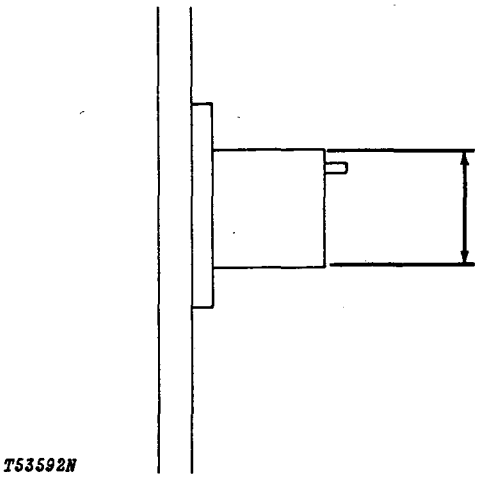

Fig. 28-Idler Gear Shaft Measurement

IMPORTANT: Never pry gears from shafts.

Remove oil pump drive gear (Group 0407) and injection pump drive gear (Group 0413) with a puller.

Remove oil pump (Group 0407) and fuel injection pump (Group 0413).

Remove balancer shafts from cylinder block (Group 0415).

Remove camshaft (Group 0402).

Remove front plate attaching cap screws and screws (Fig. 29).

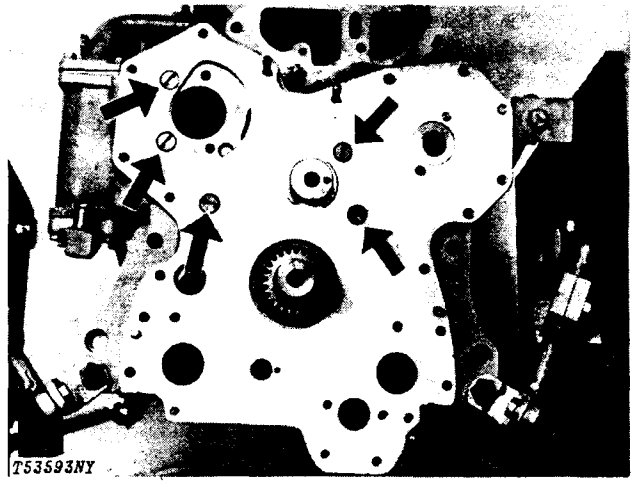

Fig. 29-Front Plate Attaching Hardware

Remove lower idler gear shaft attaching cap screw.

Drive idler gear shafts out of engine front plate.

Repair

If new idler gear shafts are to be installed, press new spring pins into shaft.

Idler gear shaft spring pin height (Fig. 30) ..... 0.20 to 0.28 inch (5.1 to 7.1 mm)

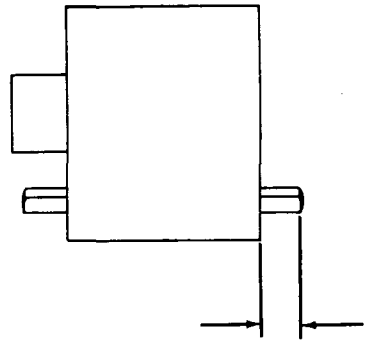

Fig. 30-Spring Pin Height

Measure idler gear bushing I.D.

Idler gear bushing Fig. 31
I.D. (new) ..... 1.752 to 1.753 inch
(44.50 to 44.53 mm)

Idler gear bushing
oil clearance (new) ..... 0.002 to 0.004 inch
(0.05 to 0.10 mm)

Idler gear bushing
oil clearance (max.) ..... 0.006 inch
(0.15 mm)

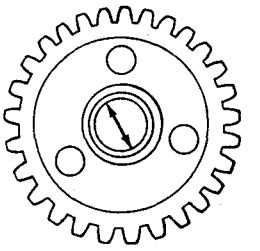

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Fig. 31-Idler Gear Bushing I.D.

Press worn idler gear bushings out of gears.

Use JD-252 Bushing Driver (Fig. 32) to press new idler gear bushings into gears flush with either side of gear.

If idler gear end play is excessive, replace thrust washers.

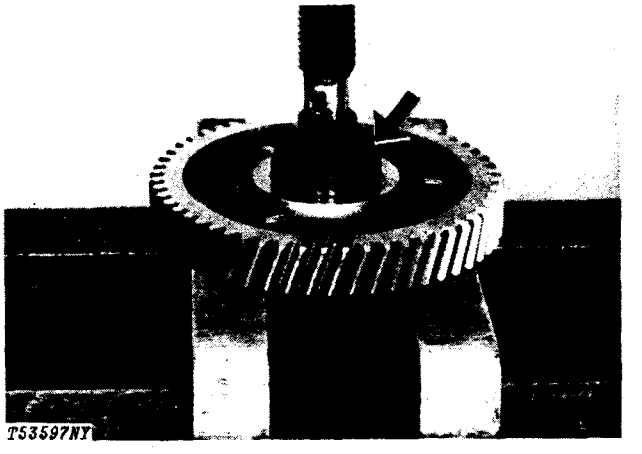

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Fig. 32-JD-252 Bushing Driver

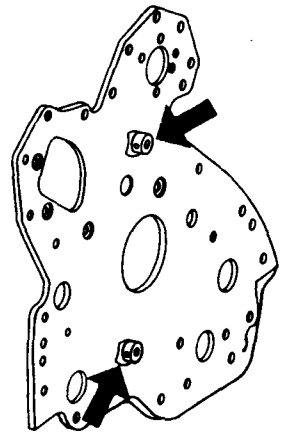
Installation

Make certain number one piston is at top dead center. The crankshaft gear keyway (not pulley keyway) should be pointing straight up at the top of the engine.

Do not rotate crankshaft after top dead center has been set.

NOTE: Lower idler gear shaft has a threaded inside diameter and the upper idler gear shaft inside diameter is not threaded.

Position thrust washers behind shafts and press the shafts into the front plate, (Fig. 33).

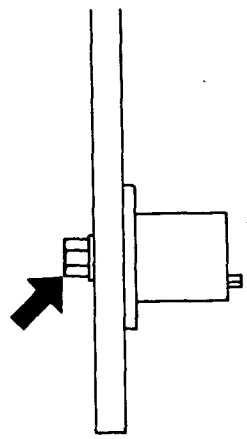


T53769N

Fig. 33-Install Idler Gear Shaft

Install cap screw and washer in lower idler gear shaft from engine front plate side.

Lower idler gear
shaft torque (Fig. 34) ..... 95 lb-ft
(129 Nm) (13 kg-m)

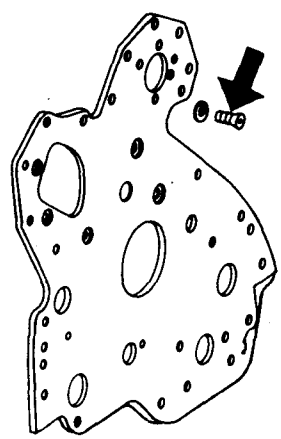


T53596N

Fig. 34-Lower Gear Shaft Torque

Position engine front plate on front of cylinder block and install attaching hardware.

Engine front plate
screw torque (Fig. 35) ..... 20 to 25 lb-ft
(27 to 34 Nm) (2.8 to 3.5 kg-m)



T53770N

Fig. 35-Front Plate Screw Torque

Install camshaft (Group 0402).

Using JD-254 Timing Tool (1, Fig. 36), align timing mark on camshaft gear (2) with the timing tool.

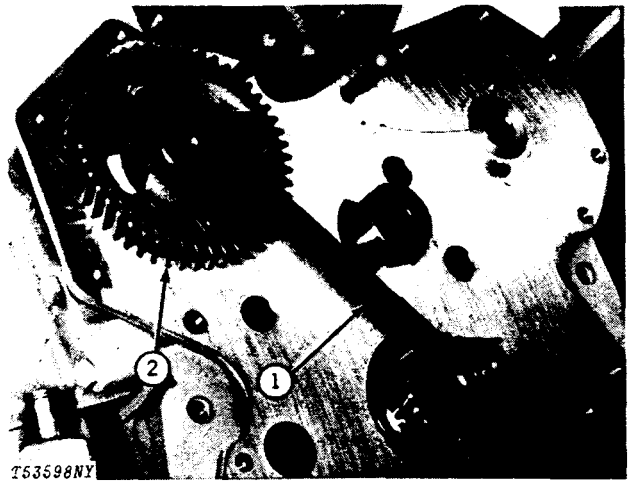


Fig. 36-JD-254 Timing Tool

Install fuel injection pump (Group 0413).

Install but do not tighten fuel injection pump drive gear nut.

Using JD-254 Timing Tool (1, Fig. 37), align timing mark on fuel injection pump gear (2) with the timing tool.

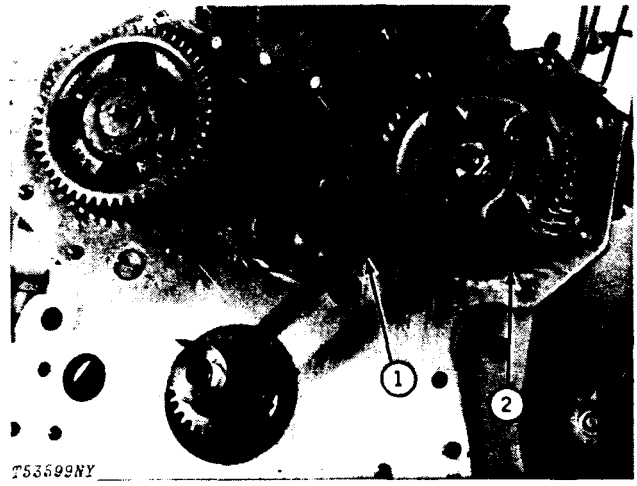


Fig. 37-JD-254 Timing Tool

Position upper idler (1, Fig. 38) and thrust washers (2), without moving the camshaft gear or fuel injection pump gear, on the upper idler gear shaft. Make sure the roll pin in the idler shaft aligns with hole in thrust washer.

Install, but do not tighten, upper idler gear cap screw.

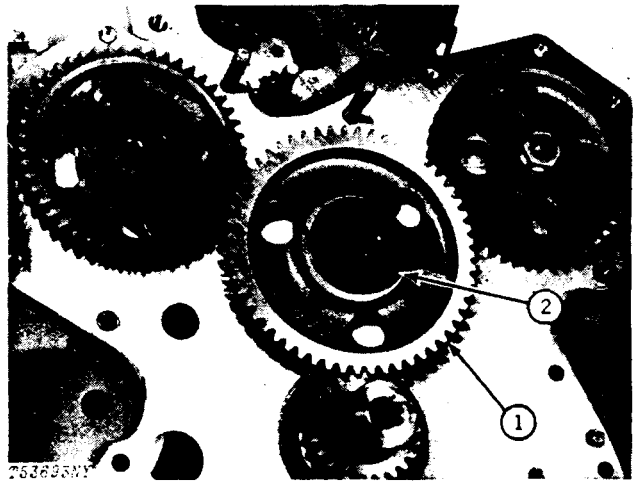


Fig. 38-Upper Idler Gear and Thrust Washer

On four cylinder engines, install balancer shafts (Group 0415).

Using JD-254 Timing Tool (1, Fig. 39), align timing mark (2) on each balancer shaft gear with the timing tool.

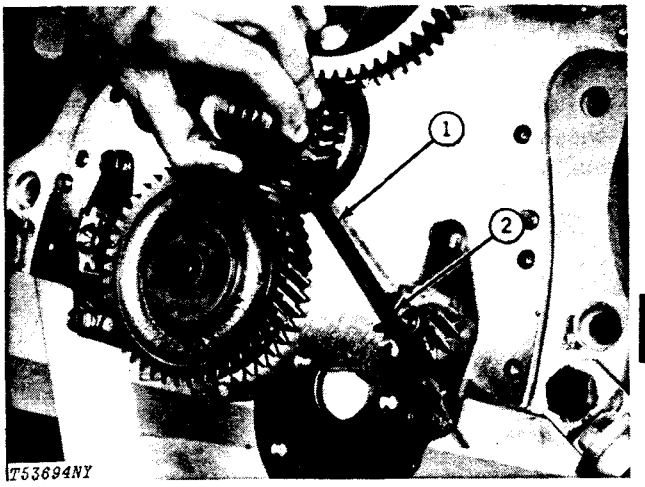


Fig. 39-JD254 Timing Tool

Install oil pump on front plate.

Position oil pump drive gear on oil pump drive shaft without moving the left balancer shaft (Fig. 40).

Install oil pump gear nut but do not tighten it.

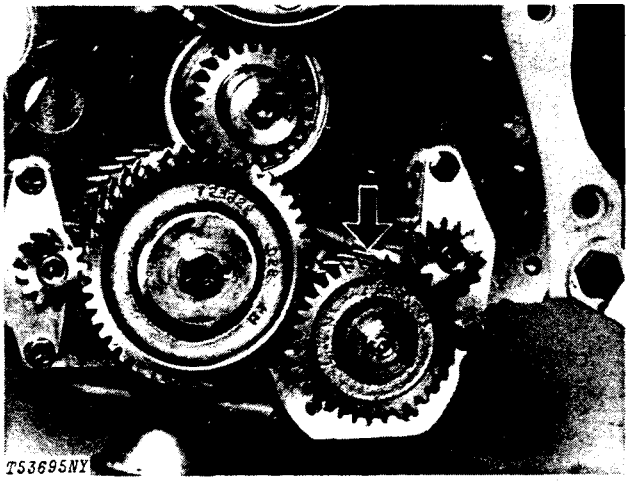


Fig. 40-Oil Pump Drive Gear

Position lower idler gear (1, Fig. 41) and thrust washers (2) on lower idler gear shaft without moving any of the other gears.

Install, but do not tighten, lower idler gear cap screw.

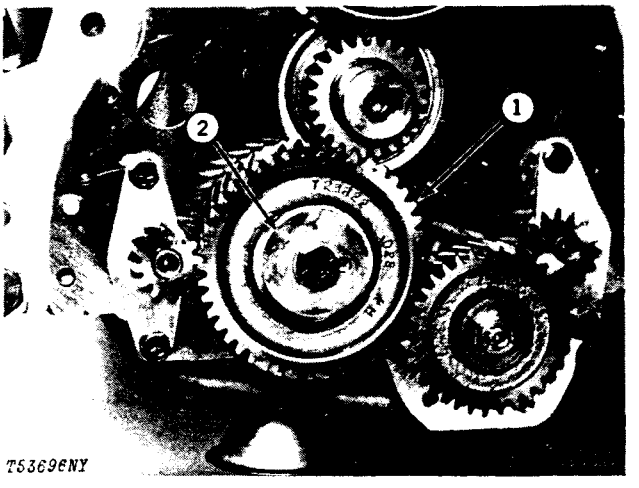


Fig. 41-Lower Idler Gear and Thrust Washer

Litho in U.S.A.

Using JD-254 Timing Tool check all of the timing marks to make sure they are properly aligned.

Position a screwdriver blade in the gear teeth between two gears (Fig. 42) to prevent them from rotating.

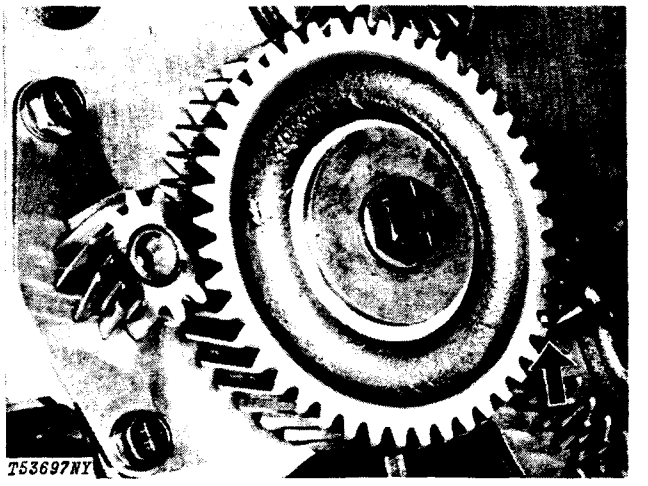


Fig. 42-Locking Timing Gear Train

Tighten the timing gear train attaching hardware using the following specifications:

Fuel injection pump
gear torque (1, Fig. 43) ..... 20 lb-ft
(27 Nm) (3 kg-m)

Upper idler gear
torque (2) ..... 65 lb-ft
(88 Nm) (9 kg-m)

Lower idler gear
torque (3) ..... 95 lb-ft
(129 Nm) (13 kg-m)

Oil pump gear
torque (4) ..... 35 to 45 lb-ft
(47 to 61 Nm) (5 to 6 kg-m)

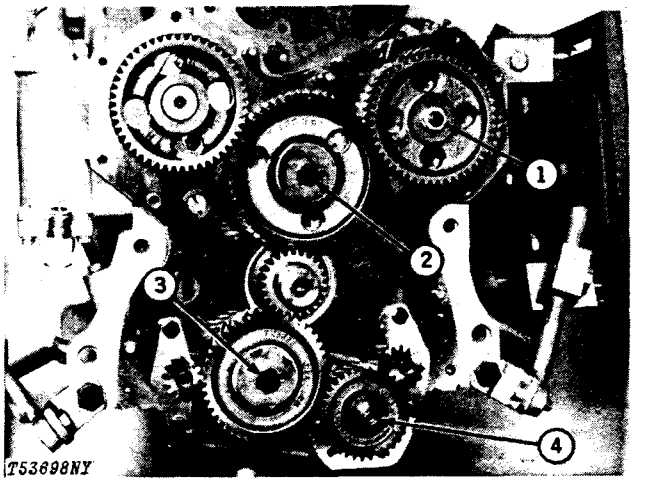


Fig. 43-Timing Gear Train Torque

Install push rods and rocker arm assembly (Group 0402).

Adjust valve clearance (Group 0402).

Install rocker arm cover (Group 0402).

Install timing gear cover (Group 0402).

Install oil pan (Group 0407).

Install oil pressure control valve (Group 0407).

Install vibration damper (Group 0401).

Install fan and fan belts (Group 0429).

Install fuel transfer pump (Group 0421).

ROCKER ARMS AND PUSH RODS

Removal

Remove rocker arm cover.

Remove cap screws attaching rocker arm supports to cylinder head.

Lift push rods from their bores keeping them separated so that each can be placed in the bore from which it was removed during assembly.

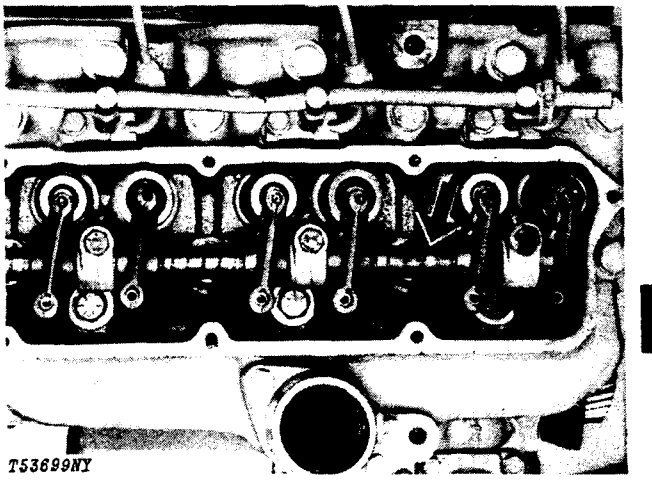


Fig. 44-Rocker Arm Assembly

Repair

Do not straighten bent push rods, replace them.

Remove plugs (1, Fig. 45) and bowed washers (2) from rocker arm shaft (3).

Slide springs (4), rocker arms (5), and rocker arm supports (6) off rocker arm shaft identifying their parts for reassembly in the same relationship they were in before disassembly.

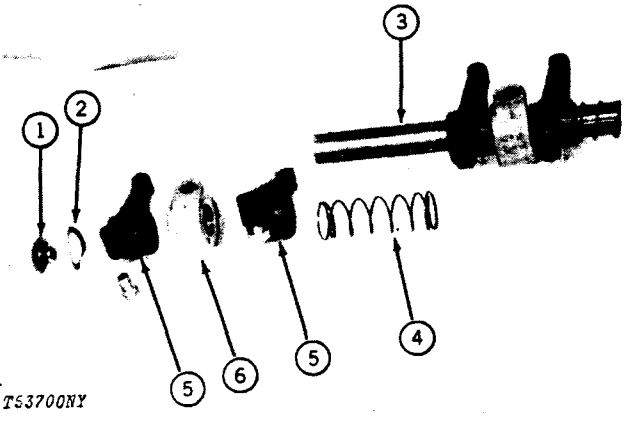


Fig. 45-Rocker Arm Assembly

Litho in U.S.A.

Clean lubrication holes in rocker arms, rocker arm shaft, and rocker arm supports.

Measure rocker arm shaft and rocker arms.

Rocker arm shaft
O.D. (new) (1, Fig. 46) ..... 0.787 to 0.788 inch (19.99 to 20.01 mm)

Rocker arm shaft
O.D. (minimum) (1) ..... 0.785 inch (19.94 mm)

Rocker arm shaft
support I.D. (maximum) (2) ..... 0.794 inch (20.17 mm)

Rocker arm
I.D. (new) (3) ..... 0.790 to 0.792 inch (20.07 to 20.12 mm)

Rocker arm
I.D. (maximum) (3) ..... 0.794 inch (20.17 mm)

Reassemble rocker arm assembly.

Inspect valve stem caps for wear and cracks. Replace as necessary.

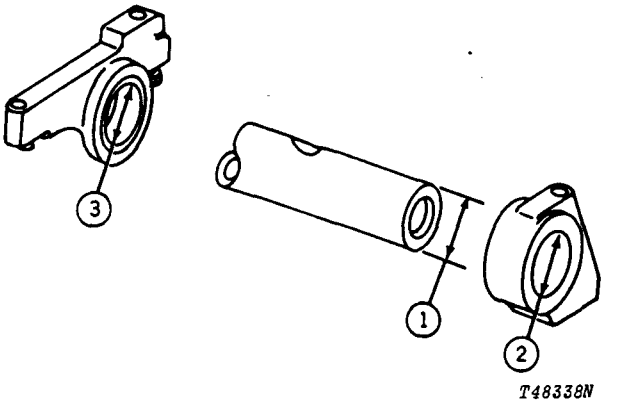


Fig. 46-Rocker Arm Measurement

Installation

Install valve stem wear caps on valve stems. Make certain caps rotate freely.

Install rocker arm assembly making certain adjusting screws seat on push rods.

Tighten rocker arm support cap screws.

Rocker arm support
cap screw torque (Fig. 47) ..... 35 lb-ft (47 Nm) (5 kg-m)

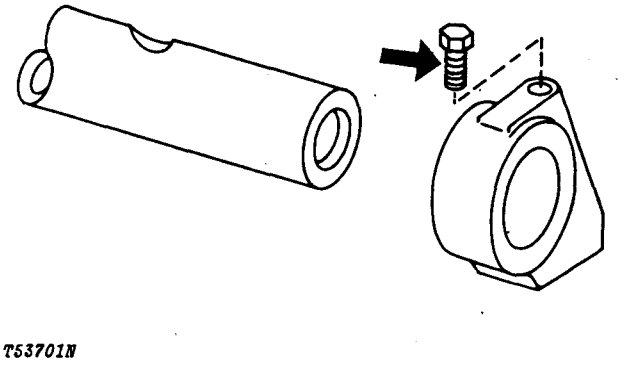


Fig. 47-Rocker Arm Support Cap Screw

Adjust valve clearance (Group 0402).

Cement a new rocker arm cover gasket to the rocker arm cover.

Position rocker arm cover on cylinder head.

Install rocker arm cover special cap screws.

Rocker arm cover
cap screw torque (Fig. 48) ..... 20 to 25 lb-in.
(2.3 to 2.8 Nm) (0.23 to 0.29 kg-m)

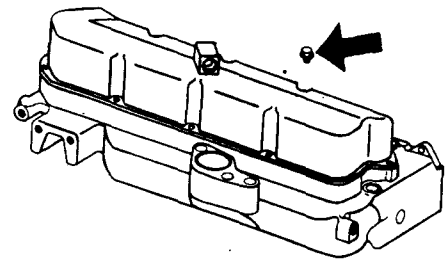


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Fig. 48-Rocker Arm Cover Cap Screw

VALVE CLEARANCE ADJUSTMENT

Valve clearance can be adjusted with engine either hot or cold (Fig. 49).

Intake valve clearance ..... 0.014 inch
(0.36 mm)

Exhaust valve clearance ..... 0.018 inch
(0.46 mm)

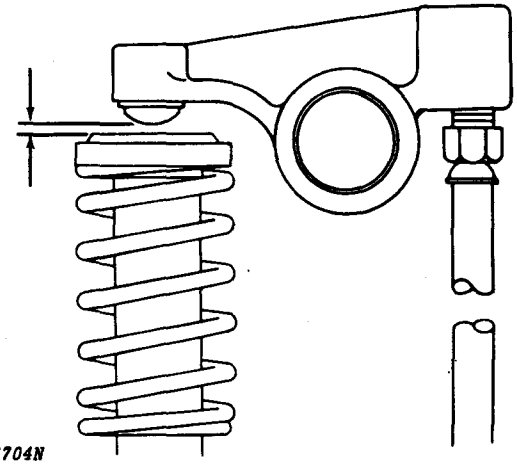

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Fig. 49-Valve Clearance

Litho in U.S.A.

THREE CYLINDER ENGINE

Position number one piston at top dead center on compression stroke.

Adjust valve clearance on number one and two cylinders exhaust valves and on number one and three cylinders intake valves (Fig. 50).

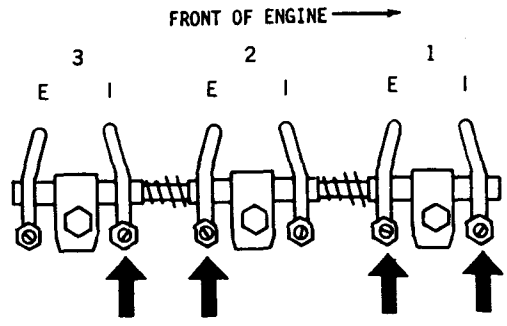

Fig. 50-Valve Clearance Adjustment

Rotate crankshaft 360°.

Adjust valve clearance on number three cylinder exhaust valve and on number two cylinder intake valve (Fig. 51).

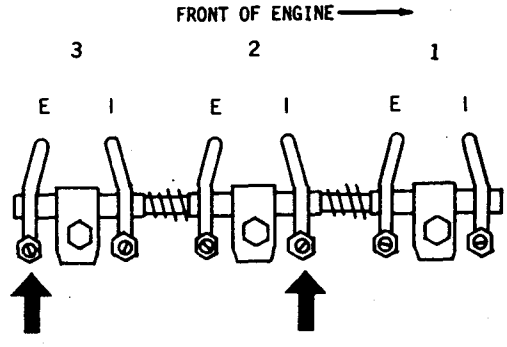

Fig. 51-Valve Clearance Adjustment

FOUR CYLINDER ENGINES

Position number one piston at top dead center on compression stroke.

Adjust valve clearance on number one and three cylinders exhaust valves and on number one and two cylinders intake valves (Fig. 52).

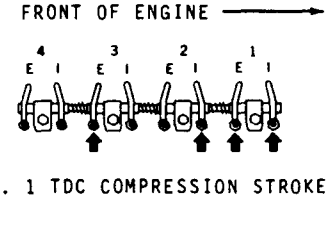

Fig. 52-Valve Clearance Adjustment

Rotate crankshaft 360°.

Adjust valve clearance on number two and four cylinders exhaust valves and on number three and four cylinders intake valves (Fig. 53).

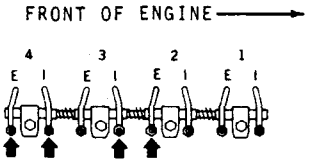

Fig. 53-Valve Clearance Adjustment

4

Six Cylinder Engines

Position number one piston at top dead center on compression stroke.

Adjust valve clearance on number one, three, and five cylinders exhaust valves and on number one, two, and four cylinders intake valves (Fig. 54).

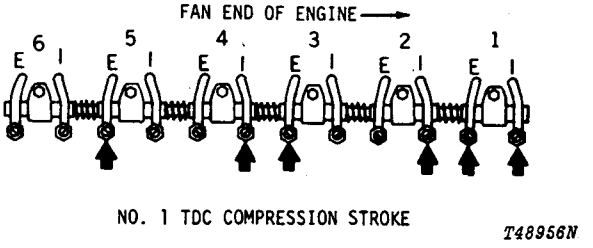

Fig. 54-Valve Clearance Adjustment

Rotate crankshaft 360°.

Adjust valve clearance on number two, four, and six cylinders exhaust valves and on number three, five, and six cylinders intake valves (Fig. 55).

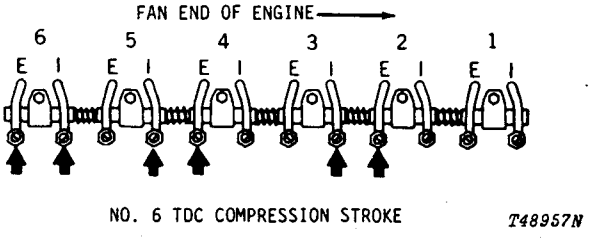

Fig. 55-Valve Clearance Adjustment

Litho in U.S.A.

4

Litho in U.S.A.

Group 0403
CONNECTING RODS AND PISTONS

REMOVAL

Remove cylinder head (Group 0409).

Install short cap screws with large flat washers to hold cylinder liners down.

Remove ridge or carbon from cylinder liners using a ridge reamer.

Remove oil pan (Group 0407).

NOTE: Do not use pneumatic wrench to remove connecting rod cap screws.

Remove connecting rod cap screws.

Measure connecting rod bearing-to-crankshaft rod journal clearance.

Engine	Connecting Rod Bearing Assembled I.D. (new) (1, Fig. 1).	Crankshaft Rod Journal O.D. (new) (2, Fig. 1).
3-164	2.750 to 2.752 inch (69.85 to 69.90 mm)	2.748 to 2.749 inch (69.80 to 69.82 mm)
4-219	2.750 to 2.752 inch (69.85 to 69.90 mm)	2.748 to 2.749 inch (69.80 to 69.82 mm)
4-276	3.255 to 3.256 inch (82.68 to 82.70 mm)	3.063 to 3.064 inch (77.80 to 77.83 mm)
6-329	2.750 to 2.752 inch (69.85 to 69.90 mm)	2.748 to 2.749 inch (69.80 to 69.82 mm)
6-414	3.066 to 3.068 inch (77.88 to 77.93 mm)	3.063 to 3.064 inch (77.80 to 77.83 mm)

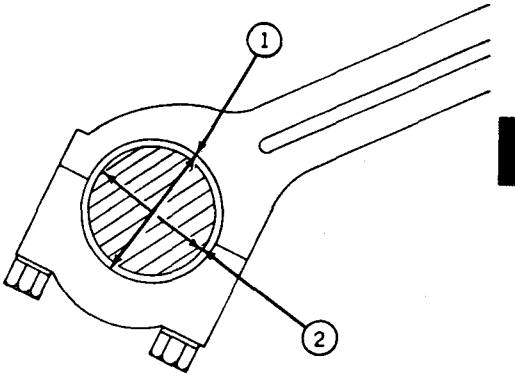

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Fig. 1-Connecting Rod Bearing Measurement

Connecting rod bearing to crankshaft oil clearance (new) Fig. 2 ..... 0.001 to 0.005 inch (0.025 to 0.127 mm)

Connecting rod bearing to crankshaft oil clearance (maximum) (Fig. 2) ..... 0.006 inch (0.152 mm)

Mark pistons for re-installation in same bore from which they are removed.

Push pistons out top of the cylinder liners.

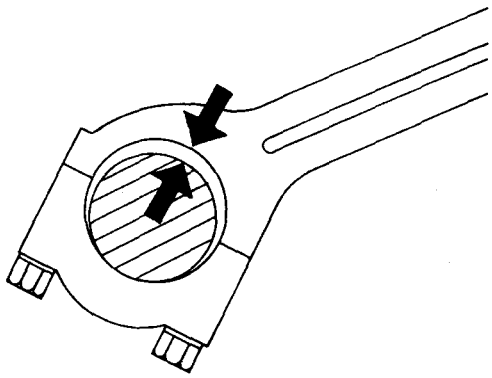

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Fig. 2-Oil Clearance

REPAIR

Pistons

Pistons and cylinder liners are serviced as sets. See Group 0404 for piston-to-cylinder liner measurements.

Remove piston rings.

IMPORTANT: Do not soak pistons more than 60 minutes.

CAUTION: Avoid contact of solution with skin or eyes.

Soak pistons in 50 percent solution of "Mr. Clean" (or equivalent) and water for 30 to 60 minutes.

IMPORTANT: Never clean pistons with wire brush or abrasives.

Scrub piston with stiff bristle brush.

Rinse pistons in clean water and dry with clean towels.

Litho in U.S.A.

Piston Rings and Ring Grooves

NOTE: Do not re-use piston rings.

Using JDE-62 Ring Groove Wear Gauge (Fig. 3), measure top ring groove. If gauge shoulders contact the ring land, groove is excessively worn.

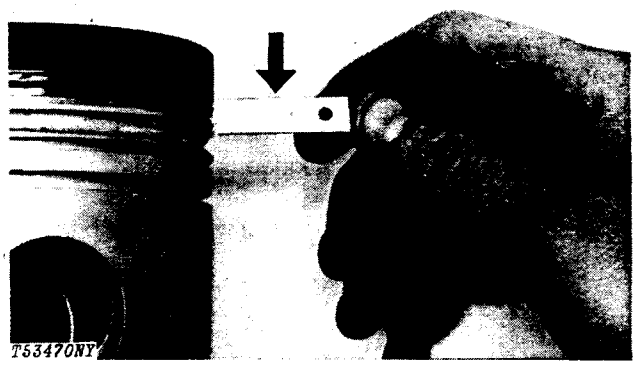

Fig. 3-JDE-62 Ring Groove Wear Gauge

Measure rectangular ring grooves with proper new ring and a feeler gauge.

Ring groove
clearance (maximum) (Fig. 4)..... 0.008 inch (0.20 mm)

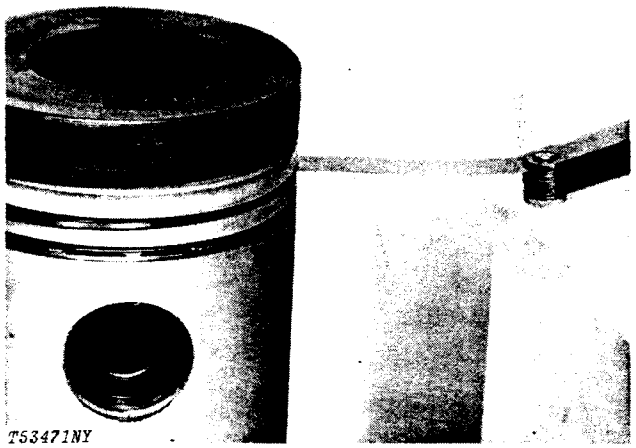

Fig. 4-Measure Ring Grooves

Piston Pins

Piston pins must fit piston pin bore with a thumb press fit.

Replace piston pin bushing if worn. Hone new bushing until pin fits with a thumb press fit (Fig. 5).

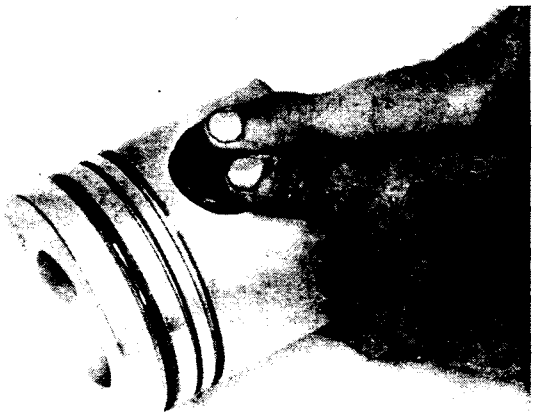

Fig. 5-Piston Pin Assembly

Litho in U.S.A.

Connecting Rods

Check connecting rods for straightness.

If piston pins do not fit bushings with a thumb press fit, remove bushings with JDE-88 Pin Bushing Remover and Installer (Fig. 6).

Press new bushings in flush with one side of connecting rod with oil holes aligned.

4

Hone new bushings until pins fit with a thumb press fit.

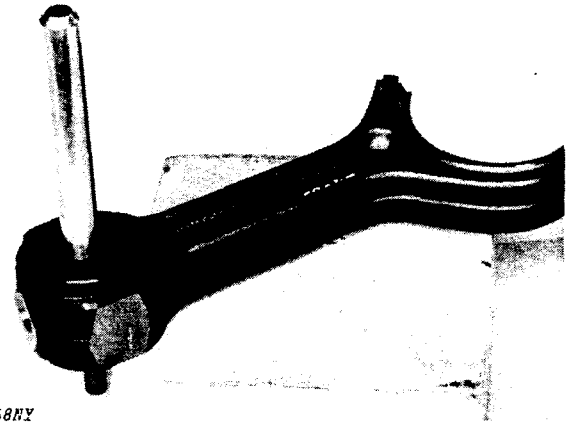

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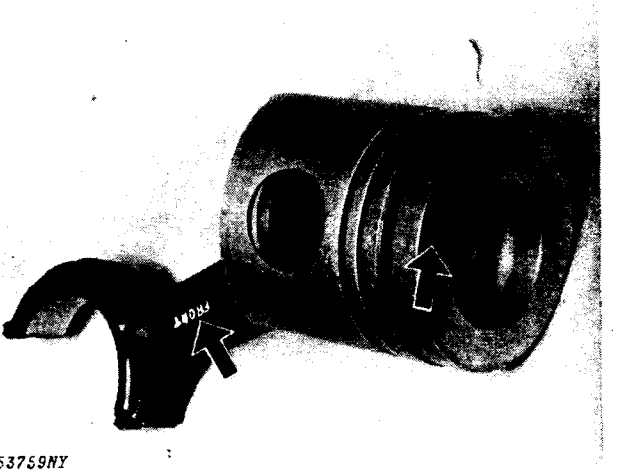
Fig. 6-JDE-88 - Pin Bushing Remover and Installer

INSTALLATION

Assemble pistons and connecting rods, making sure the word "FRONT" on top of the piston and side of connecting rod are on same side (Fig. 7).

Coat piston pin with a film of engine oil and insert into piston pin bore. Install new piston pin snap rings. Check to be sure snap rings are seated in grooves of piston pin bore.



T53759NY

Fig. 7-Piston and Rod "Front"

IMPORTANT: Incorrect size ring expander will damage rings.

Use correct piston ring expander for your engine (Fig. 8).

Engine	Piston Ring Expander
3-164	JDE-45
4-219	JDE-45
4-276	JDE-85
6-329	JDE-45
6-414	JDE-85

NOTE: New rings are furnished with correct end gap; therefore, fitting ring to the liner is not necessary.

T53480NY

Fig. 8-JDE-45 or JDE-85 Piston Ring Expander

Install oil ring expander in bottom ring groove. Position end gap over either end of piston pin.

Install oil control ring in bottom ring groove over ring expander. Install with end gap on opposite side of piston from ring expander gap.

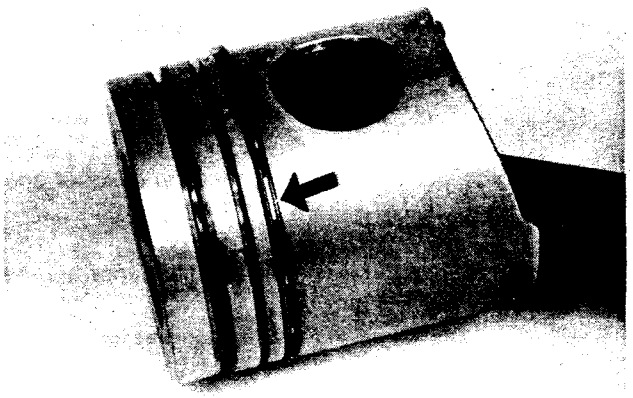


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Fig. 9-Oil Control Ring

Rectangular compression ring has two pip marks (Fig. 10). Install rectangular compression ring in center ring groove with pip mark toward top of piston.

Position gap in rectangular compression ring on opposite side of piston from oil control ring gap.

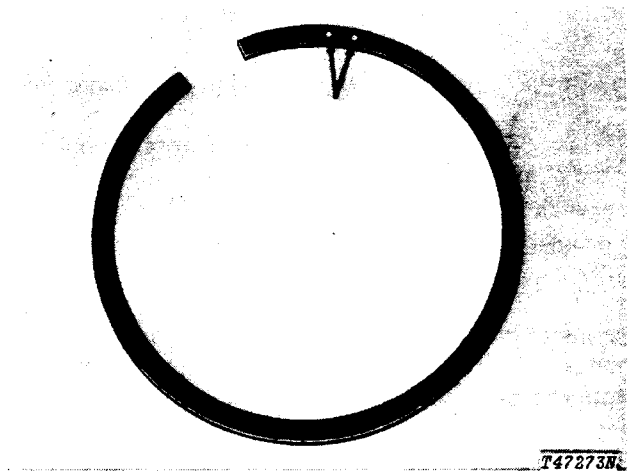

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Fig. 10-Piston Ring Pip Marks

Keystone compression ring (Fig. 11) has one pip mark. Install keystone compression ring in top ring groove with pip mark toward top of piston.

Position gap in Keystone compression ring on opposite side of piston from rectangular compression ring gap.

T53481NY

Fig. 11-Keystone Compression Ring

IMPORTANT: Do not install piston assemblies in cylinder liners until the liners have been properly prepared. See Group 0404 for preparation information.

Make sure cylinder liners are fastened down.

Put engine oil on piston rings and on cylinder liner walls.

4

Use correct piston ring compressor for your engine:

Engine	Piston Ring Compressor
3-164	JD-271
4-219	JD-271
4-276	JDE-84
6-329	JD-271
6-414	JDE-84

Position ring compressor on top of cylinder liner.

Insert piston, with "FRONT" to the front of engine, in ring compressor.

Push pistons into cylinder liners.

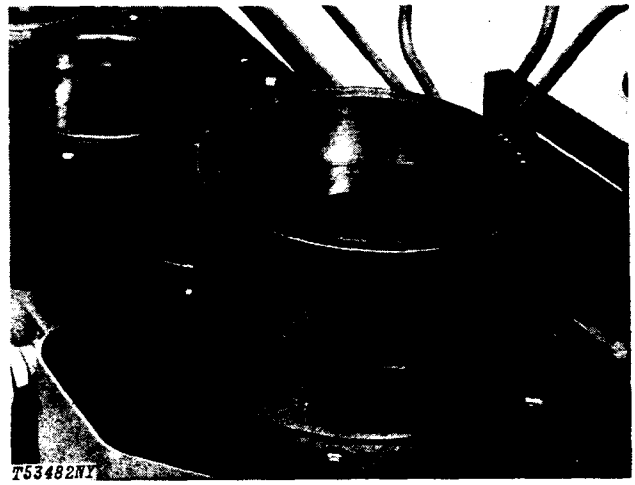

Fig. 12-JD-271 or JDE-84 Piston Ring Compressor

Install bearing inserts in connecting rod and cap with small tangs (1, Fig. 13) fitting in recesses in connecting rod and cap. Apply engine oil to inserts.

NOTE: Rod caps must be installed on same connecting rod from which they were removed.

Install rod caps so that large slot in cap fits large tang (2).

NOTE: Dip connecting rod cap screws in oil before installing.

IMPORTANT: Do not use pneumatic wrenches to install connecting rod cap screws.

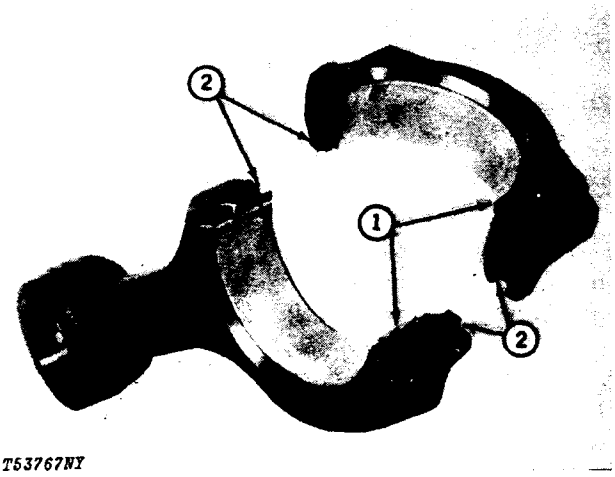

Fig. 13-Rod and Bearing Assembly

Tighten connecting rod cap screws using correct torque for your engine.

Engine	Connecting Rod Cap Screw Torque
3-164	65 ± 5 lb-ft (88 ± 7 Nm) (9 ± 0.7 kg-m)
4-219	65 ± 5 lb-ft (88 ± 7 Nm) (9 ± 0.7 kg-m)
4-276	95 ± 5 lb-ft (129 ± 7 Nm) (13 ± 0.7 kg-m)
6-329	65 ± 5 lb-ft (88 ± 7 Nm) (9 ± 0.7 kg-m)
6-414	95 ± 5 lb-ft (129 ± 7 Nm) (13 ± 0.7 kg-m)

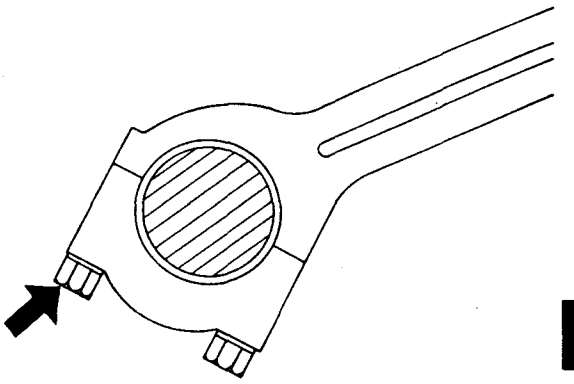
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Fig. 14-Connecting Rod Cap Screw

Install oil pan (Group 0407).

Install cylinder head (Group 0409).

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Group 0404
CYLINDER BLOCK

GENERAL INFORMATION

The cylinder liners are wet-sleeve replaceable types. Each liner has a square rubber packing that seals at a shoulder on the liner. Two O-ring packings fit in grooves in the cylinder bore. The square and O-ring packings seal the liner at the bottom of the cylinder bore. The top of the liner is sealed by cylinder head gasket compression.

Cylinder liners and pistons can be purchased only in matched sets.

REMOVAL

Cylinder Block

Remove intake manifold (Group 0414).

Remove exhaust manifold (Group 0410).

Remove fuel injection pump and fuel injection nozzles (Group 0413).

Remove starting motor (Group 0422).

Remove alternator (Group 1672) and fan belts.

Remove fuel filter assembly (Group 0402).

Remove rocker arm cover, rocker arm assembly and push rods (Group 0402).

Remove cylinder head and water manifold as one piece (Group 0409).

Do not rotate crankshaft with cylinder head removed unless cylinder liners are bolted down (Fig. 1). Use short cap screws and large flat washers to hold cylinder liners in place.

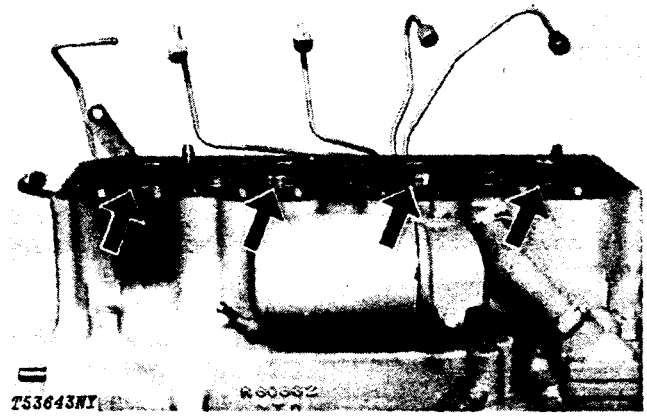

Fig. 1-Location of Liners in Cylinder Block

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Remove tappets from their bores (Group 0402).

Remove oil filter, oil filter housing, and dipstick (Group 0407) and engine oil cooler (Group 0419).

Remove engine oil pan and oil pump (Group 0407).

Remove crankshaft pulley and timing gear cover (Group 0402).

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Remove camshaft (Group 0402).

Remove the water pump (Group 0417).

Remove flywheel and flywheel housing (Group 0433).

Remove pistons and connecting rods (Group 0403).

Remove crankshaft (Group 0401) and piston cooling orifices (Fig. 2).

Cylinder Liner

Remove the cylinder head (Group 0409) and connecting rods and pistons (Group 0403).

Use D01062AA or D0106063AA Puller (Fig. 3) to remove cylinder liners, if necessary. (See page 0405-5 for liner flange height measurement.)

Remove cylinder packings from cylinder liner bore.

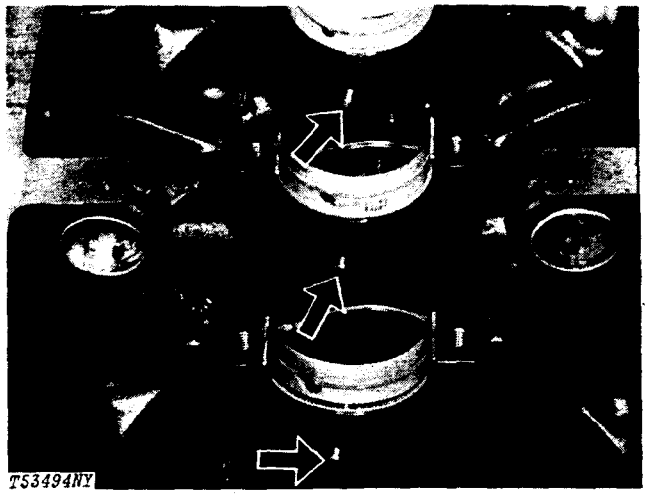

Fig. 2-Piston Cooling Orifices

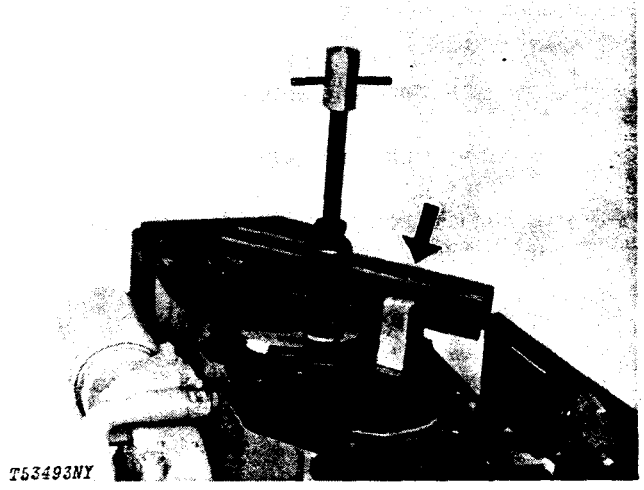

Fig. 3-Removing Cylinder Liner

REPAIR

Cylinder Block

Inspect the cylinder block for damage. If block is useable, scrape all gasket material from the cylinder block. Remove oil gallery plugs (1, Fig. 4) and core hole plugs (2).

Thoroughly clean the cylinder block.

Refer to "Basic Engine" in FOS Manual-ENGINES for additional information on cleaning cylinder blocks.

Make sure all passages and crevices are cleaned of sludge, rust, and grease. Be sure all coolant passages are cleaned of lime deposits and scale. Use a wire brush or emery cloth to carefully remove rust and scale from cylinder liner bores. Make certain there are no nicks or burrs in areas where cylinder liner packings will seat.

The cylinder block may be tested for cracks or leaks.

Refer to "Basic Engine" in FOS Manual-ENGINES for additional information on testing cylinder blocks.

Replace dowel pins, plugs, and studs, as necessary. Use "Lock Tite" on dowel pins.

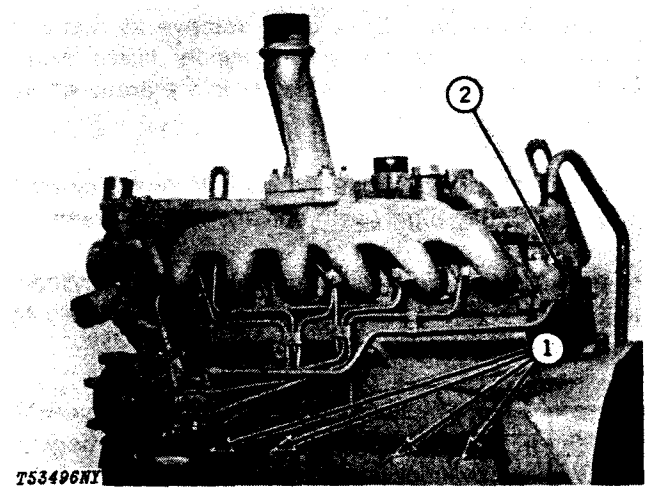

Fig. 4-Oil Gallery Plugs and Core Hole Plugs

Cylinder Liner Out Of Round and Taper

Check cylinder liner out of round and taper as shown in Fig. 5. Dimension 1, Fig. 5 is 1 inch (2.54 cm). Dimension 2, Fig. 5 is cylinder liner taper and out of round. The wear limits are shown below:

Liner Taper (max.)	0.002 in. (0.051 mm)
Liner Out-of-Round (max.)	0.002 in. (0.501 mm)

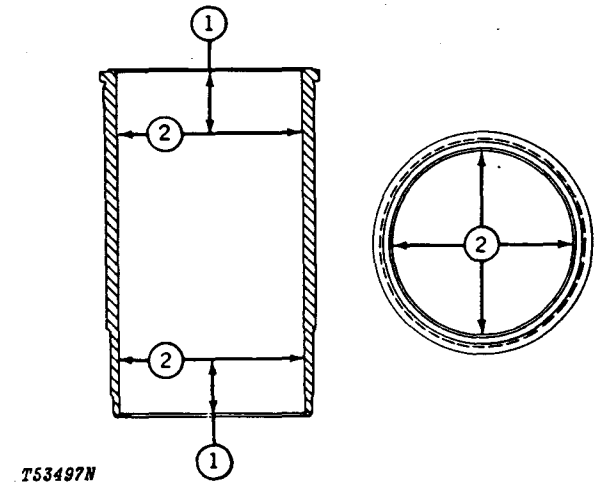

Fig. 5-Liner Measurements

Use a wire brush to carefully remove all rust and scale from the outside of the cylinder liners. Make certain there are no nicks or burrs in the areas where the packings will seat.

After removing the rust and scale from the cylinder liners wash thoroughly with solvent and dry them.

Use D17004BR Brush to deglaze each cylinder liner. Cross hatch pattern should be approximately 45 degrees. (Fig. 6).

FOS Refer to "Basic Engine" in FOS Manual-ENGINES for additional information on deglazing cylinder liners.

Immediately after deglazing, clean cylinder liner bore with waterless hand cleaner or soap. Rinse cylinder liner bores with clean water until rinse water is clear. Dry liners with clean towels. Wipe bore with clean engine oil.

IMPORTANT: Solvents will not remove honing residue.

Recheck liner-to-piston skirt clearance.

See Group 0403 for piston repair.

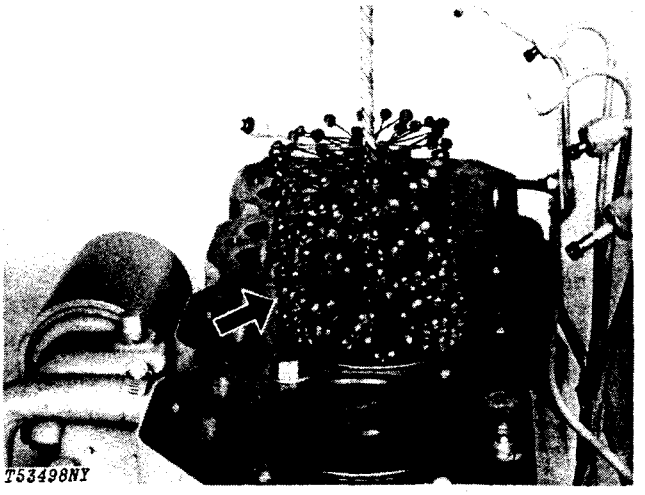

Fig. 6-Deglazing Cylinder Liners

Piston Cooling Orifices

Inspect for damage or clogging. Clean or replace orifices as required.

INSTALLATION

Install piston cooling orifices (Fig. 7) and tighten to 85 to 110 lb-in. (96 to 124 Nm) (0.98 to 1.27 kg-m) torque.

Install the crankshaft (Group 0401), flywheel, and flywheel housing (Group 0433).

When installing a new cylinder liner in block, first place liner in liner bore without cylinder liner packings. Use short cap screws and large flat washers to hold liners in place.

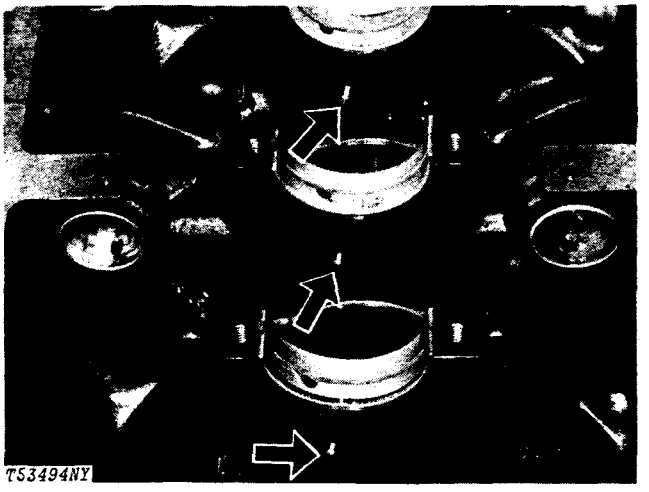

Fig. 7-Piston Cooling Orifices

Use a depth gauge to check the height of the liner flange (1, Fig. 8) above the top of the cylinder block (3). The height should be 0.001 to 0.004 in. (0.03 to 0.10 mm) (2, Fig. 8). Check this height several places around the liner to make sure the liner is seated squarely in the bore of the cylinder block. Remove the liner from its bore.

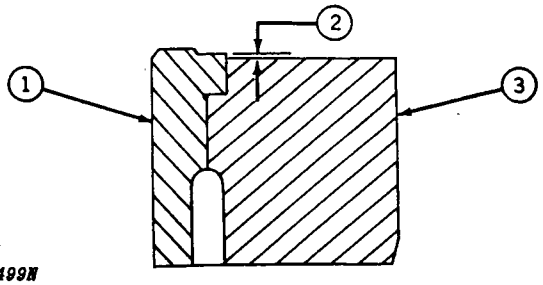

Fig. 8-Liner Flange Height

To install cylinder liners, pour AR54749 Soap Lubricant, or its equivalent, into a suitable container. Dip each of the new cylinder liner packings in the soap before they are installed. Do not leave the packings in the soap to soak.

IMPORTANT: Do not use oil on packings.

Install the red O-ring (2, Fig. 9) in the upper O-ring groove in the cylinder block.

Install the black O-ring (1) in the lower O-ring groove in the cylinder block.

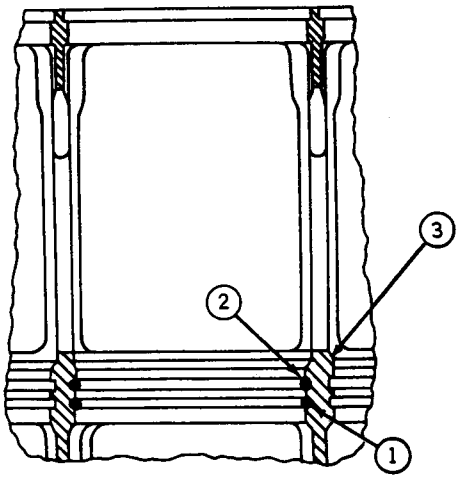

Fig. 9-Packing Installation

Turn the cylinder liner (2, Fig. 10) upside-down and install the four-sided packing (1) over the outside of the cylinder liner. Slide the packing down firmly against the second shoulder on the cylinder liner. Make sure that the packing is not twisted.

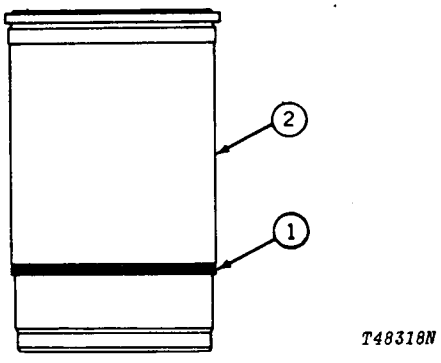

Fig. 10-Four Sided Packing Installation

Coat the liner packing, seating area of the liner, and cylinder block O-rings with AR54749 soap lubricant.

Carefully place the liner, with packing installed, into the cylinder block bore. Do not scuff the packing across the upper bore.

As the liner is aligned with the pilot bore and lowers into position, a resistance will be felt as the liner enters the O-rings. Using only the pressure of both thumbs, the liner should drop to a point nearly flush at the upper flange of the liner and the cylinder block. Finish seating liners by placing a wood block over top end of liner and tap gently with hammer (Fig. 11).

Fig. 11-Liner Installation

Cylinder liner will protrude over the top of the cylinder block more than normal due to uncompressed packing and O-rings.

NOTE: If you suspect that a packing may have sheared or displaced during lowering into position, remove and examine the liner and packing assembly. If no damage is found, check the packings for proper position, resoap the packings and reinstall liner assembly.

When all liners have been installed in the block, hold the liners in place with short cap screws and large flat washers.

Clean cylinder liner bores with waterless hand cleaner after installation in block. Wipe dry with clean towels.

Install piston and connecting rod assemblies (Group 0403).

Install crankshaft (Group 0401).

Install front plate (Group 0402).

Install oil pump (Group 0407).

Install camshaft, timing gear train, and timing gear cover (Group 0402).

Install oil pan (Group 0407) and front crankshaft pulley (Group 0401).

Install cam followers (Group 0402) and remove short cap screws and large flat washers holding cylinder liner down in the cylinder block.

Install the cylinder head (Group 0409), the push rods, and rocker arm assembly. Adjust valve clearance, and install rocker arm cover (Group 0402).

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Install the water pump (Group 0417).

Install fuel injection nozzles (Group 0413) and the fuel injection pump-to-nozzle lines (Group 0560).

Install the exhaust manifold (Group 0410).

Install the starting motor (Group 0422).

Install the engine oil cooler (Group 0419), the oil filter, and dipstick (Group 0407).

Install the alternator (Group 1672) and fan belts and adjust fan belts as described in Group 9010.

Install the fuel transfer pump (Group 0421) and the fuel filter (Group 0420).

Install air cleaner assembly.

Connect exhaust system.

Fill cooling system.

Fill engine lubrication system with proper oil to proper level.

Bleed fuel system (Group 0413).

Connect battery negative (−) cable.

⚠ CAUTION: Escaping fluid under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Before disconnecting lines, be sure to relieve all pressure. Before applying pressure to system, be sure all connections are tight and that lines, pipes and hoses are not damaged. Fluid escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If injured by escaping fluid, see a doctor at once. Serious infection on reaction can develop if proper medical treatment is not administered immediately.

Start engine and check fuel line and radiator hoses for leaks.

Perform engine break-in (page 0499-1).

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Group 0407
OILING SYSTEM

GENERAL INFORMATION

The oiling system consists of an oil pump, oil pan, oil filter, oil pressure regulating valve, and an oil cooler (if equipped) (Group 0419).

REMOVAL

Oil Pump

NOTE: Before removing oil pump check engine oil pressure (Group 9010).

Drain oil from crankcase.

Remove oil pan cap screws.

Remove oil pan.

Remove timing gear cover.

Remove nut securing oil pump drive gear to oil pump shaft (Fig. 1).

Remove cap screws (Fig. 2) securing pump assembly to cylinder block and remove pump.

Oil Filter

Rotate oil filter (Fig. 3) counterclockwise to remove it.

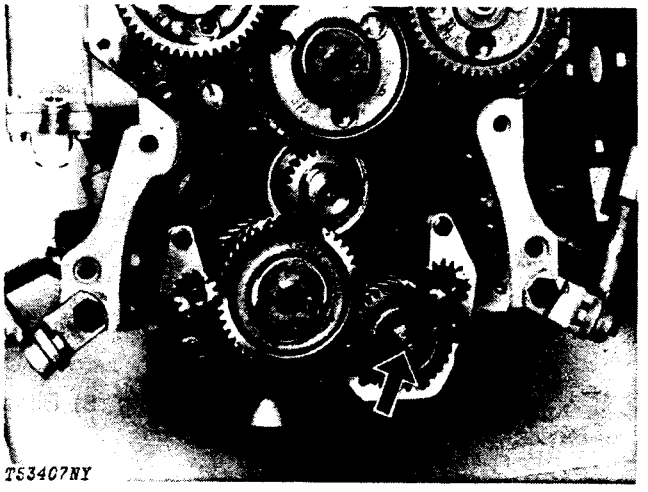

Fig. 1-Oil Pump Drive Gear

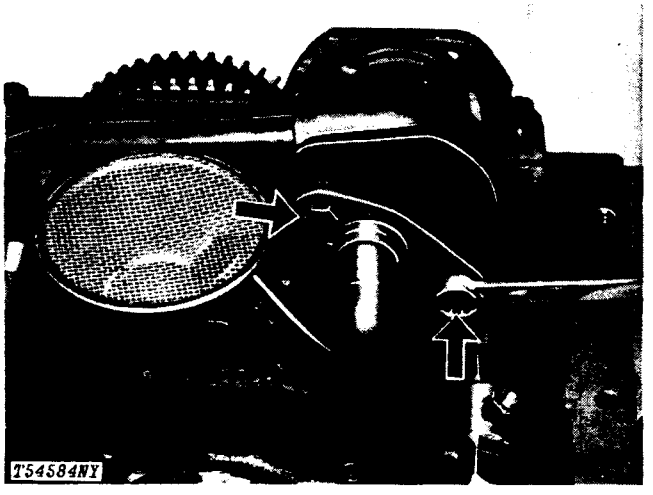

Fig. 2-Oil Filter

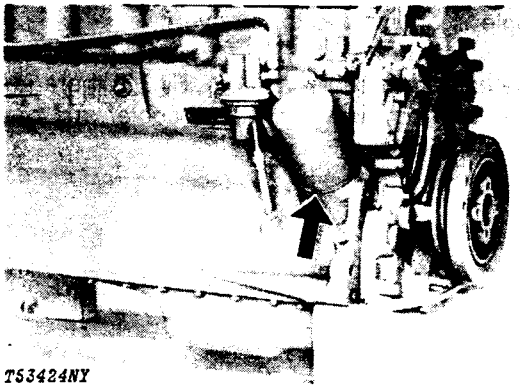

Fig. 3-Oil Pump Cap Screws

Oil Pressure Control Valve

The oil pressure control valve is located either in front of the timing gear cover (1, Fig. 4) or behind the oil cooler on 4-276 engines and 6-414 engine (2, Fig. 4).

If engine has a front mount oil pressure control valve (1, Fig. 3) it can be removed by removing the plug. Save shims for reassembly.

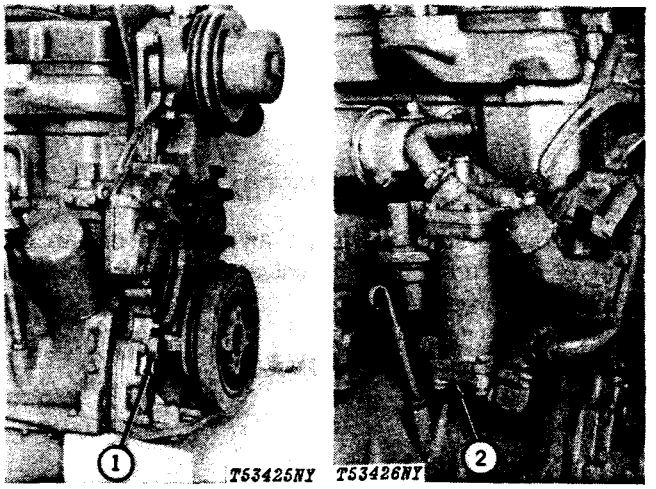

Fig. 4-Oil Pressure Control Valve Locations

Use 33859 Collet from D-01061AA (Fig. 5) Blind Hole Puller Set to remove valve seat.

For 4-276 and 6-414 refer to Group 0419 for oil pressure relief valve removal.

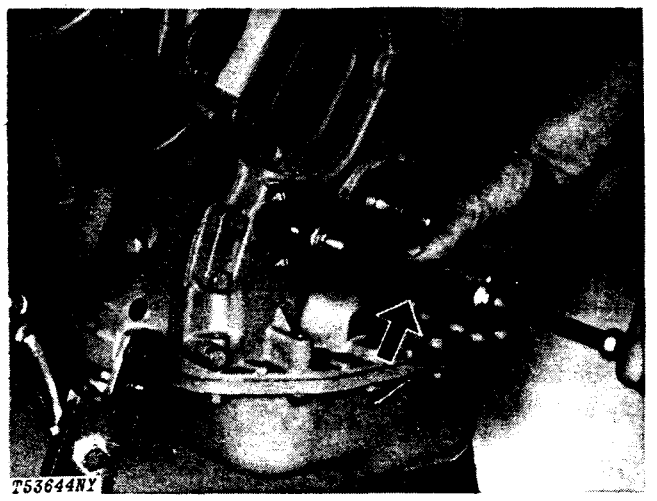

Fig. 5-Oil Pressure Control Valve Bushing

Oil Filter Nipple

The oil filter nipple will be located under the oil filter. Two types are possible (Fig. 6) depending on engine.

If engine is equipped with an oil cooler as in (2, Fig. 6) the nipple is unscrewed to remove it.

If engine has an oil cooler as in (1, Fig. 6) there are two nipples, one screwed into the oil cooler and one pressed into the block.

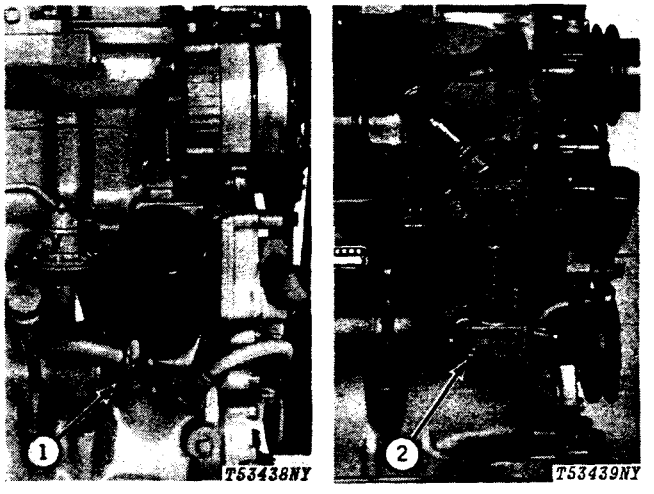

Fig. 6-Oil Filter Nipple Types

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To remove pressed in type oil filter nipple use an inside puller and slide hammer (Fig. 7).

Oil Pressure Control Valve

Inspect control valve seat in front of cylinder block for damage (especially at raised rim of bushing).

Press new valve seat into block using JD-248 Tool (Fig. 8). Press in seat until outer recessed edge of bushing is flush with bottom of counterbore in block. Do not press on raised inner rim of bushing. This rim is the oil pressure control valve seat.

Check oil pressure control spring. Free length is 4.68 in. (118.9 mm) and compressed length is 1.68 in. (42.7 mm) at 13.5 to 16.5 lb. (60 to 73 Nm) (6 to 7 kg) pressure.

Check pressure control valve plug threads for damage.

Oil Pump

Inspect pump housing surface (1, Fig. 9) which contacts cover (2) for rough, burred, or warped conditions. The seal between pump cover and housing is dependent upon these two surfaces being perfectly flat and smooth.

Examine screen on pump inlet tube to be sure it is clean and wire mesh screen is not damaged.

Inspect pump inlet tube and outlet tube for clogging.

Inspect gears for chipped or broken teeth. Replace if necessary.

Carefully inspect pump drive shaft assembly for wear, especially at points of contact.

NOTE: If pump drive shaft must be replaced, it must be replaced as an assembly with gear and groove pin. If pump idler gear shaft must be replaced, the pump housing must also be replaced with the shaft.

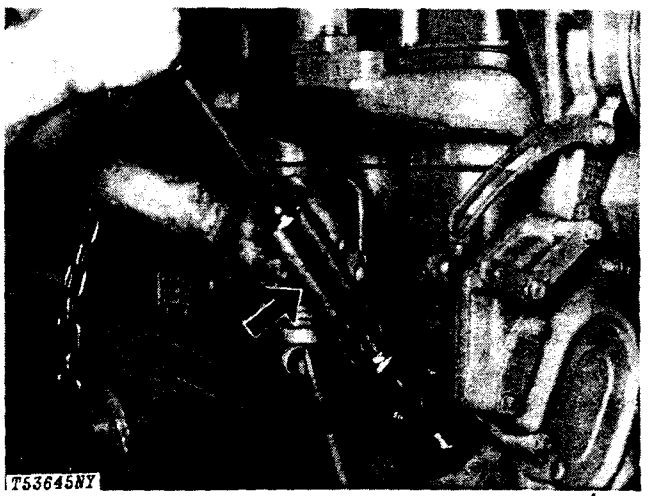

Fig. 7-Pulling Oil Filter Nipple

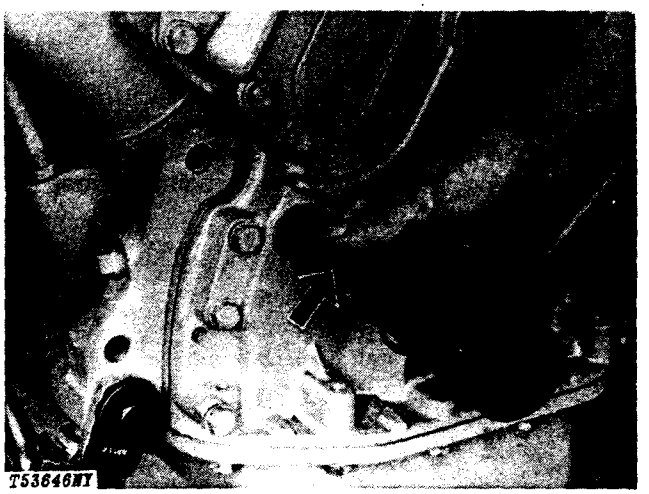

Fig. 8-Bushing Installation

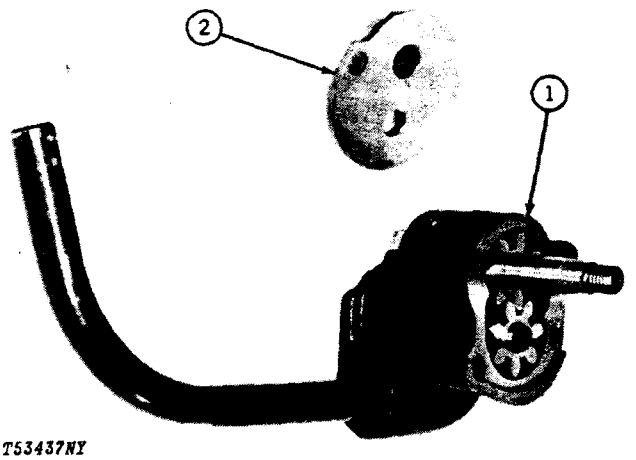

Fig. 9-Oil Pump

Oil Filter

Replace oil filter after first 100 hours of operation and then after every 200 hours of operation or sooner if necessary.

INSTALLATION

Oil Pump

Press idler shaft into pump housing until flush with outer surface of housing.

Assemble oil pump gears in pump housing. Both gears must rotate freely.

Install new O-ring on pump intake tube (Fig. 10). Install intake tube, pump cover, and discharge tube on pump housing. Be sure that gears still turn freely.

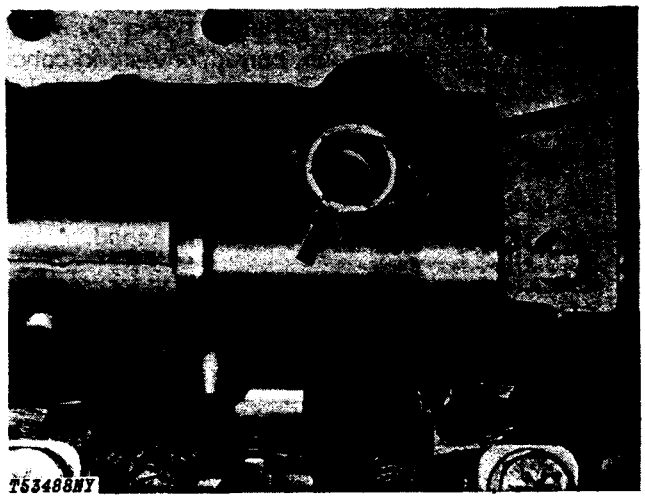

Fig. 10-Installing Oil Pump O-ring

Mount engine oil pump on cylinder block front plate and tighten cap screws (Fig. 11) to 35 lb-ft (47 Nm) (5 kg-m). Check shaft to be sure gear turns freely.

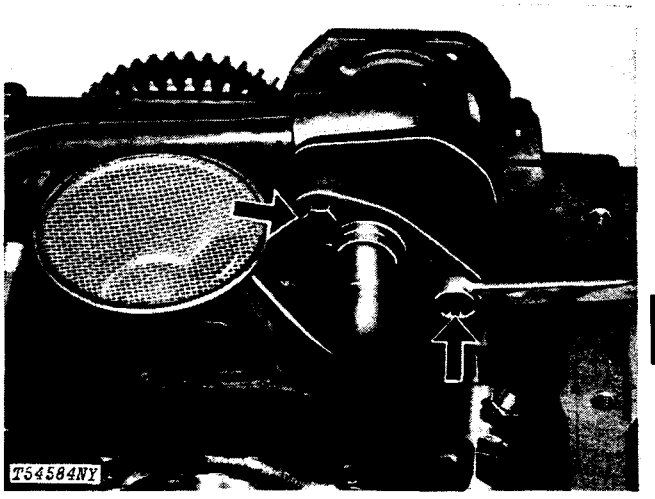

Fig. 11-Oil Pump Installation

Install oil pump drive gear, tighten gear nut to 35 to 45 lb-ft (47-61 Nm) (5 to 6 kg-m), and stake nut to shaft. (Fig. 12)

Install timing gear cover (Group 0402).

Install oil pan using an new gasket. Tighten oil pan cap screws with 35 lb-ft (47 Nm) (5 kg-m).

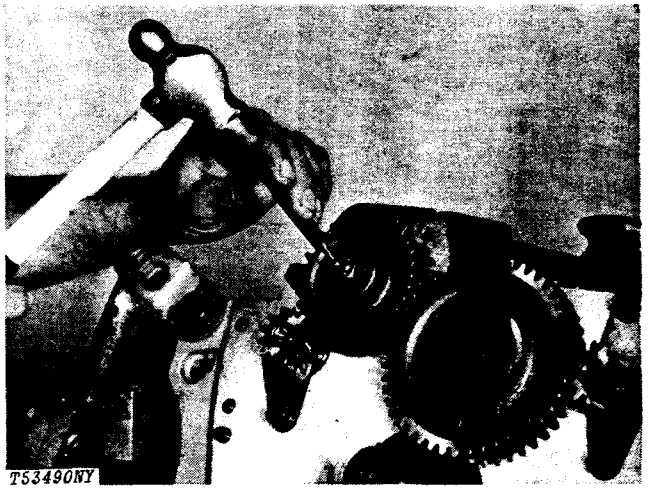

Fig. 12-Staking Oil Pump Gear

Install oil filter nipple in the position shown in Fig. 13.

Press nipple flush with counterbore in cylinder block.

Install oil cooler (Group 0419).

Install oil filter(s).

Fill engine crankcase to proper level with proper oil.

Run engine, check for leaks.

Stop engine check oil level.

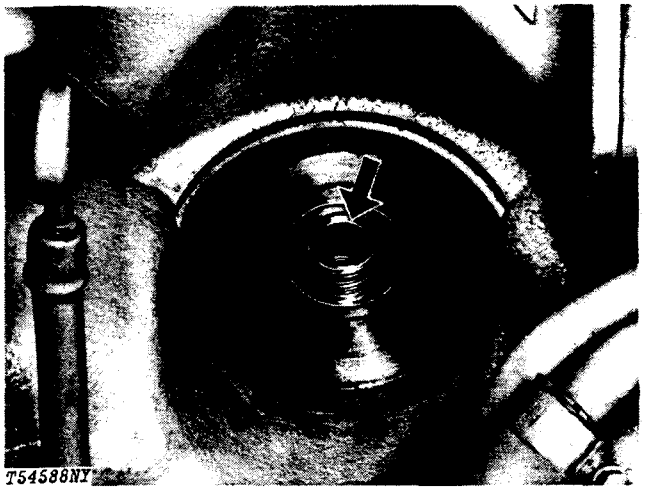

Fig. 13-Oil Filter Nipple Installation

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