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.

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.

FOS

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 on-the-job guides containing only the vital information [illegible] 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 I - 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 each section.

SECTION AND GROUP CONTENTS OF THIS MANUAL

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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.

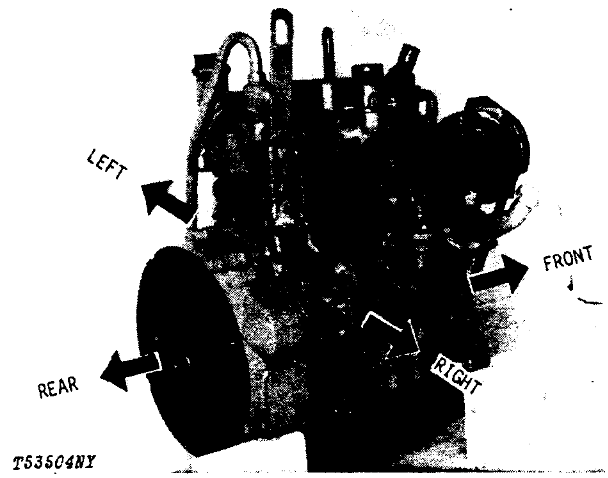

Fig. 1-Front, Rear, Left and Right of Engine

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.

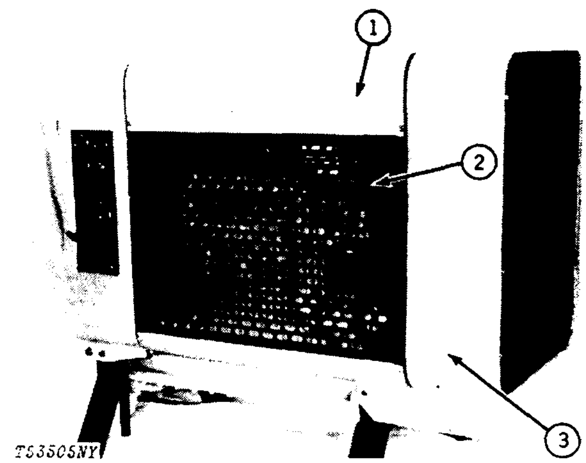

Fig. 2-Engine Enclosure

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).

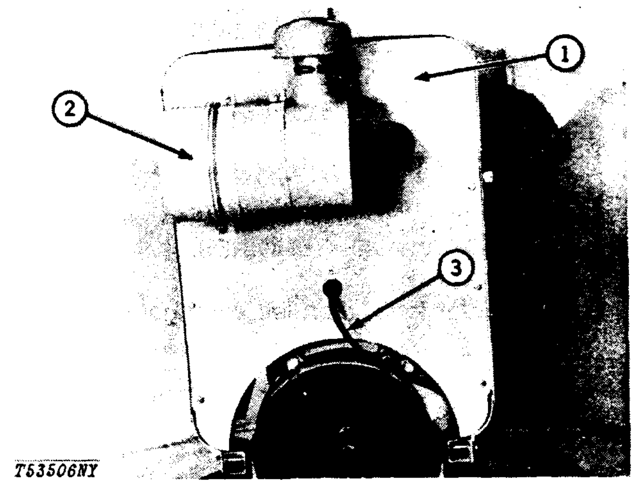

Fig. 3-Engine Enclosure Rear Panel

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).

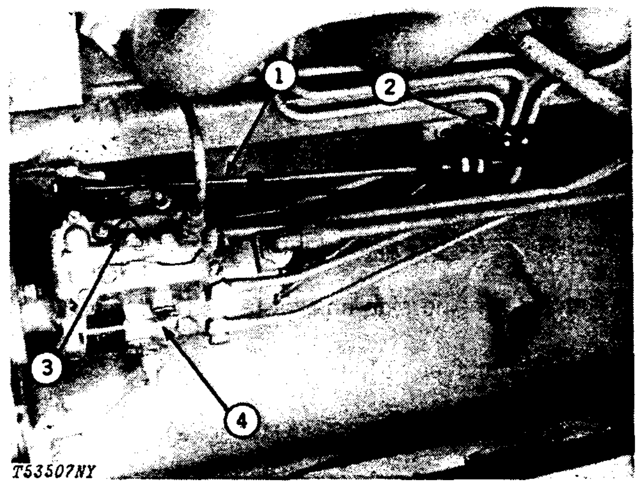

Fig. 4-Speed Control Cable and Fuel Shut-Off Wiring

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

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

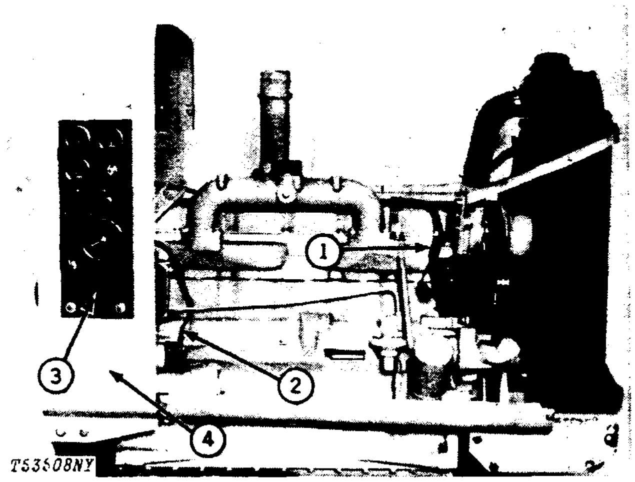

Fig. 5-Solenoid and Alternator Wiring

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.

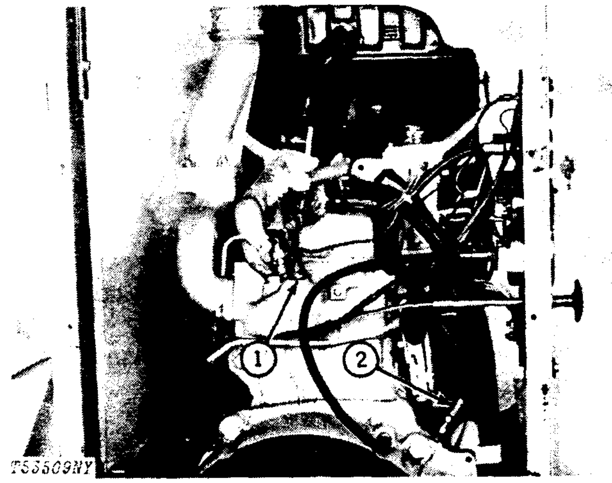

Fig. 6-Oil Pressure Hose and Temperature Sending Unit

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

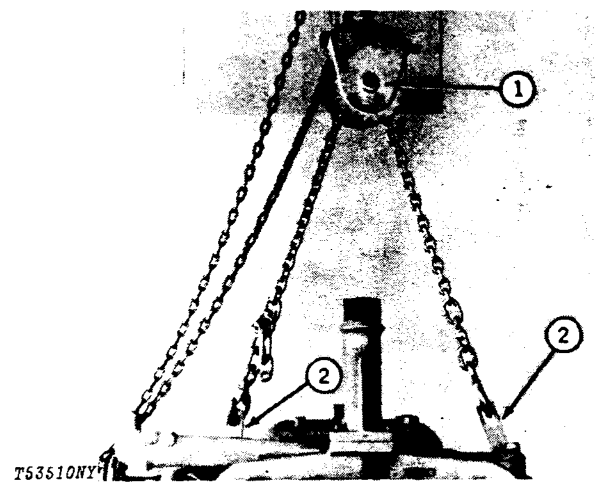

Fig. 7-D01043AA Load Positioning Sling Attached

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.

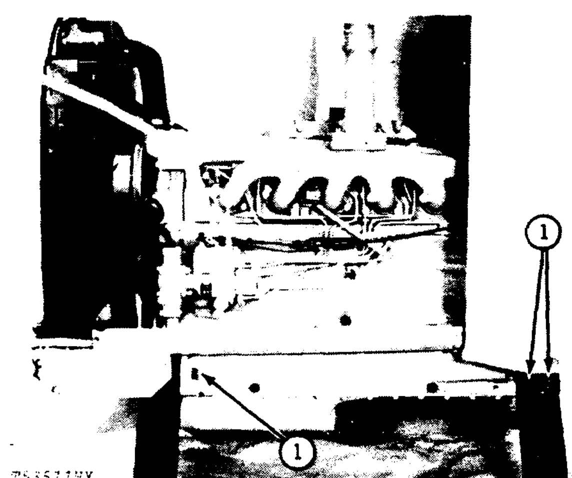

Fig. 8-Engine Mounting Hardware

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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.

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.

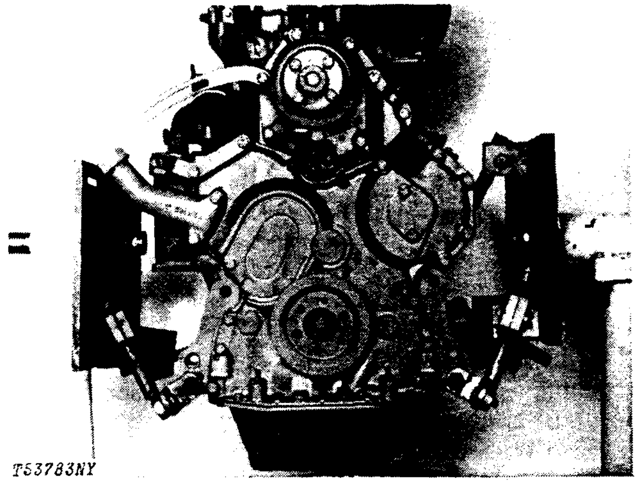

Fig. 9-Three or Four Cylinder Engine Mounted in D01003AA Engine Stand

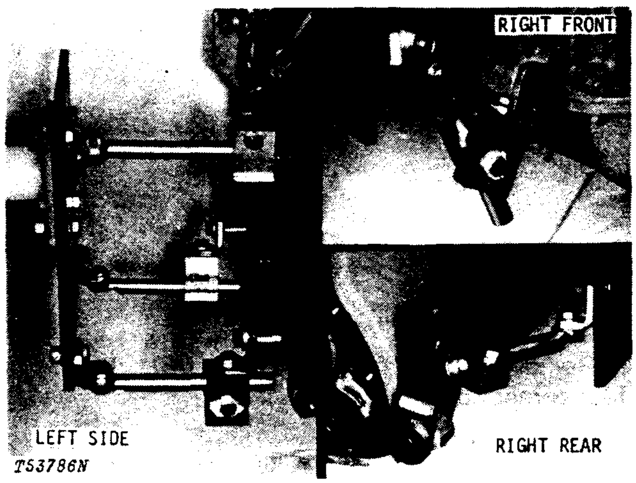

Fig. 10-Six Cylinder Engine Mounting Points

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).

4

Group 0401
CRANKSHAFT AND MAIN BEARINGS

4

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).

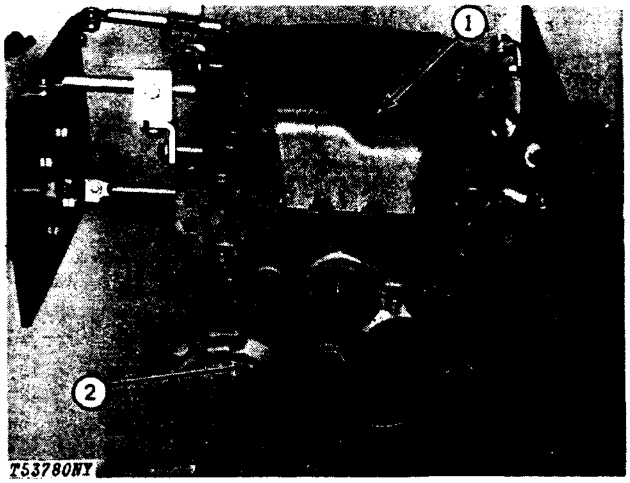

Fig. 1-Engine Inverted

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)

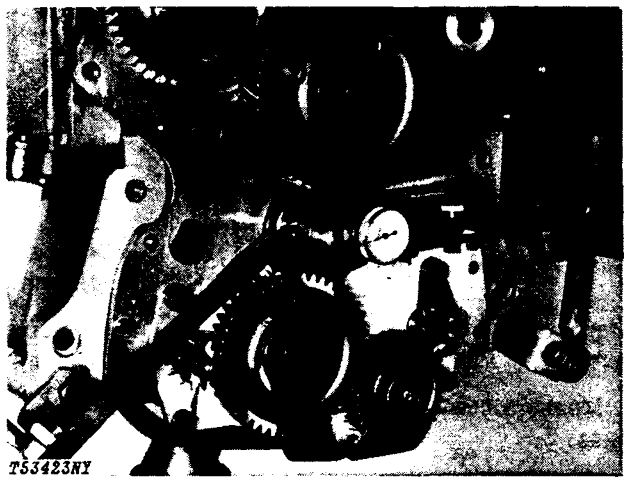

Fig. 2-Crankshaft End Play

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.

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

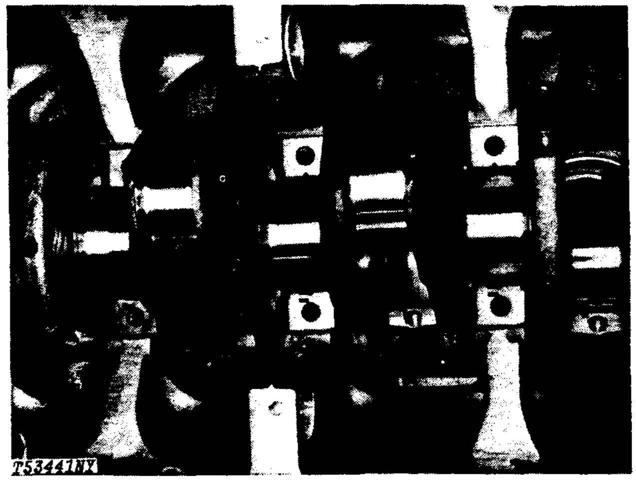

Fig. 3-Connecting Rod and Main Bearing Caps Removal

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)

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)

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.

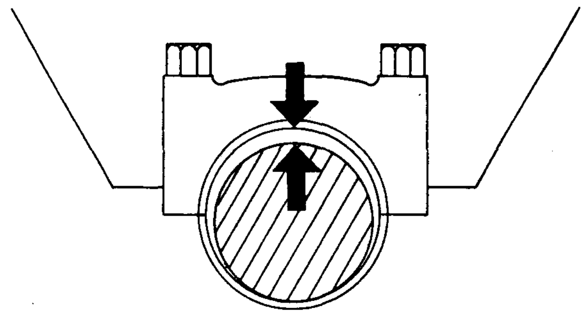
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Fig. 4-Main Bearing Clearance

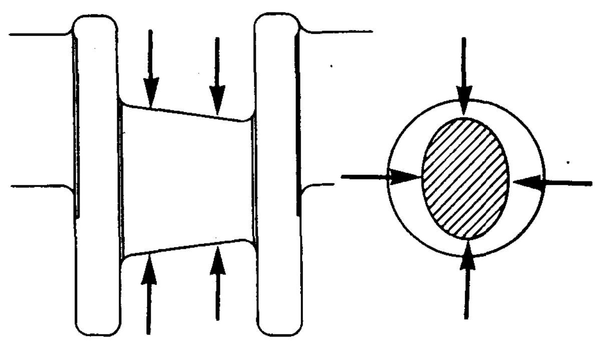
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Fig. 5-Main Bearing Measurement

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).

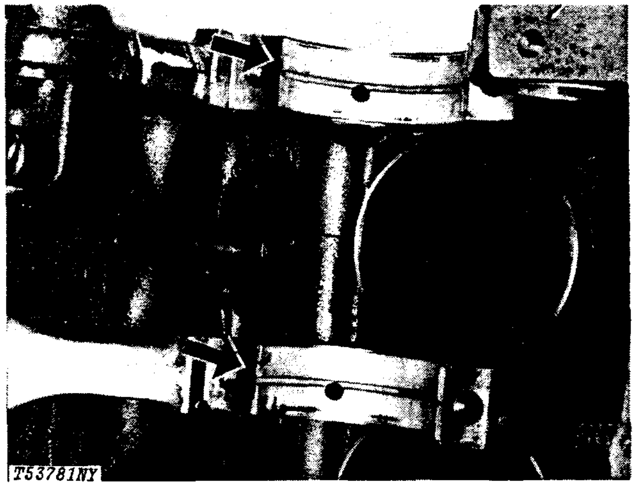

Fig. 6-Main Bearing Insert Installation

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.

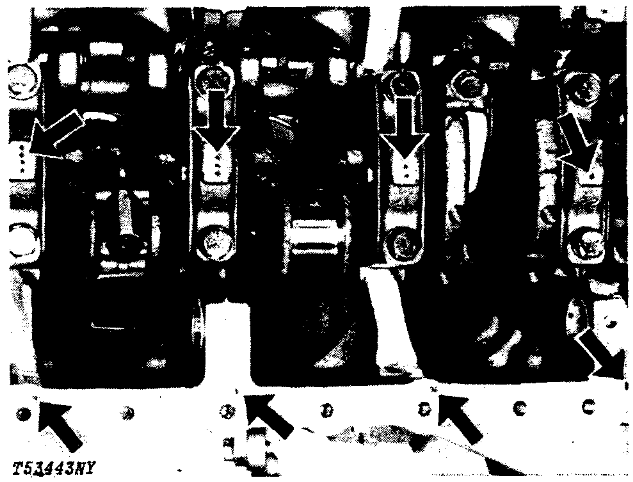

Fig. 7-Main Bearing Caps

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.

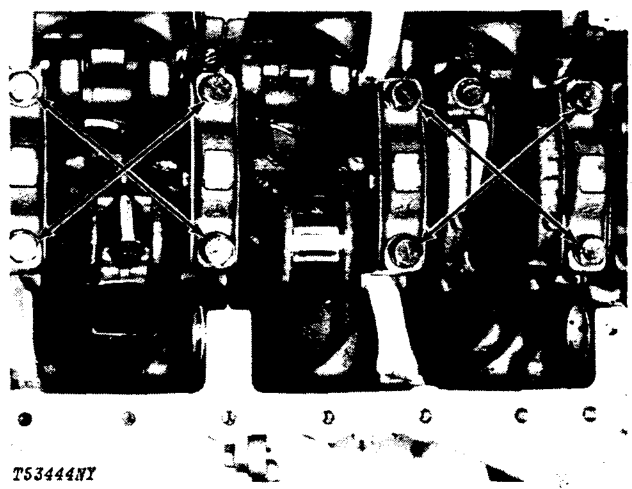

Fig. 8-Main Bearing Cap Screws

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)

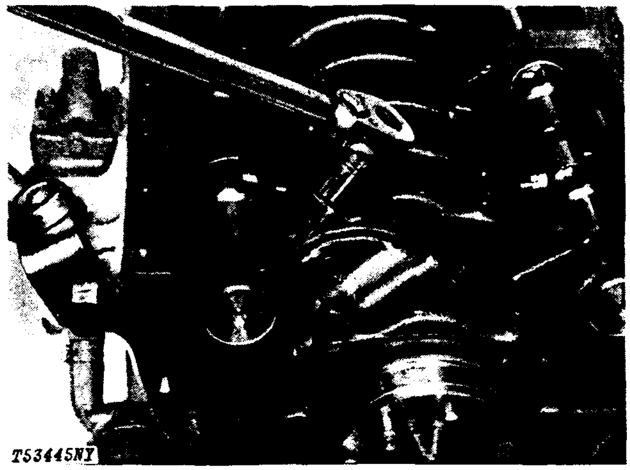

Fig. 9-Connecting Rod Cap Screw Torque

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.

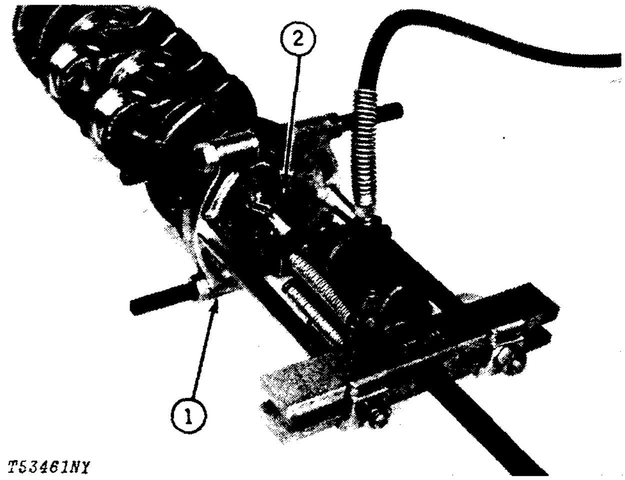

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Fig. 10-Crankshaft Gear Removal

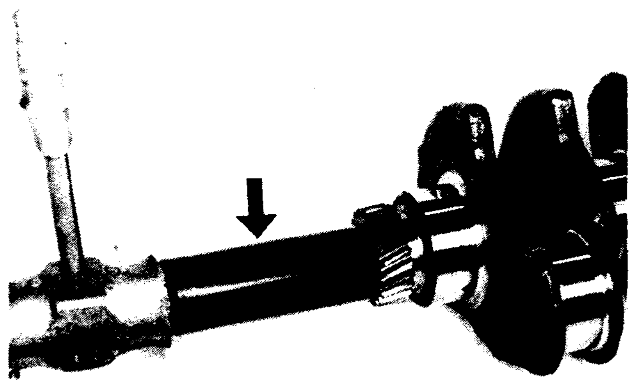
CAUTION: Plan safe handling procedure to avoid burns.

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).



T53462NY

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).

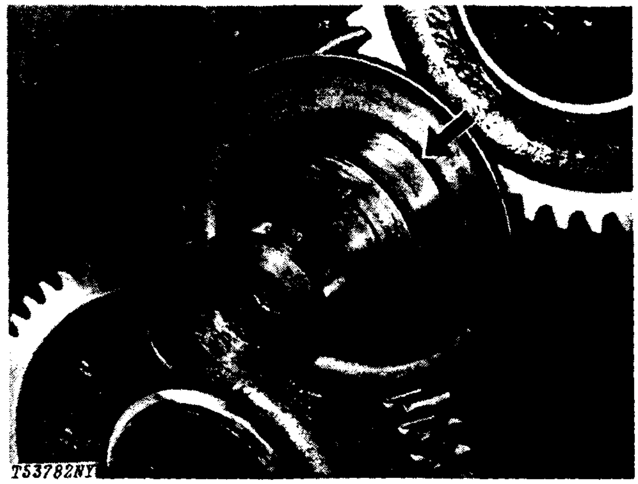
Slide wear ring off of crankshaft (Fig. 12).

Installation

Slide wear ring onto crankshaft.

Install timing gear cover (Group 0402).

Install vibration damper (Group 0401).



T53782NY

Fig. 12-Crankshaft Front Wear Ring

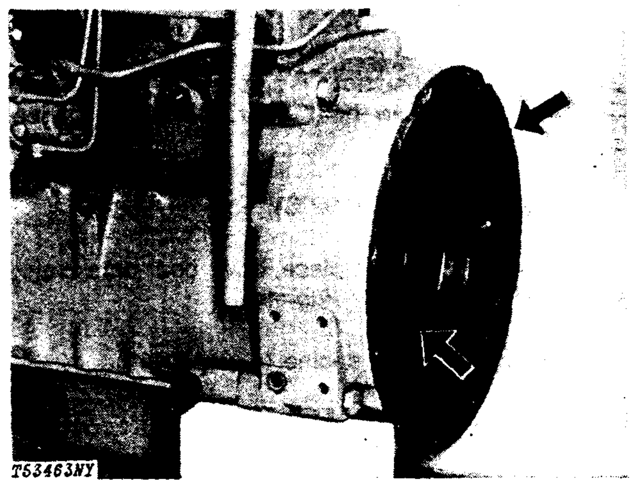
CRANKSHAFT FRONT OIL SEAL

See Group 0402 to service crankshaft front oil seal.

CRANKSHAFT REAR WEAR RING

Removal

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



T53463NY

Fig. 13-Remove Flywheel and Flywheel Housing

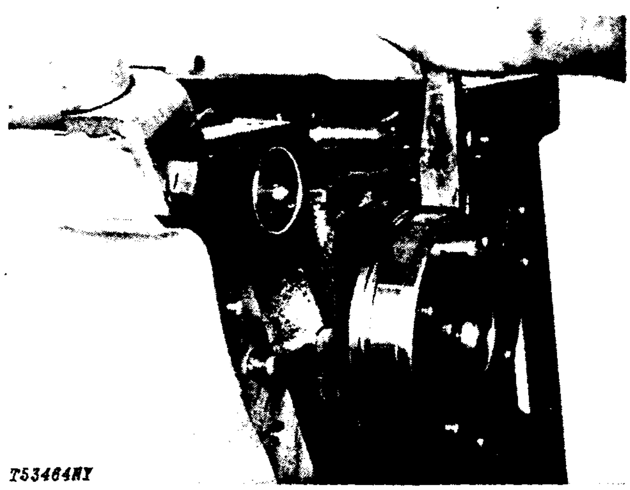
Using a dull chisel, score the wear ring in several places (Fig. 14).

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.



T53464NY

Fig. 14-Score Wear Ring

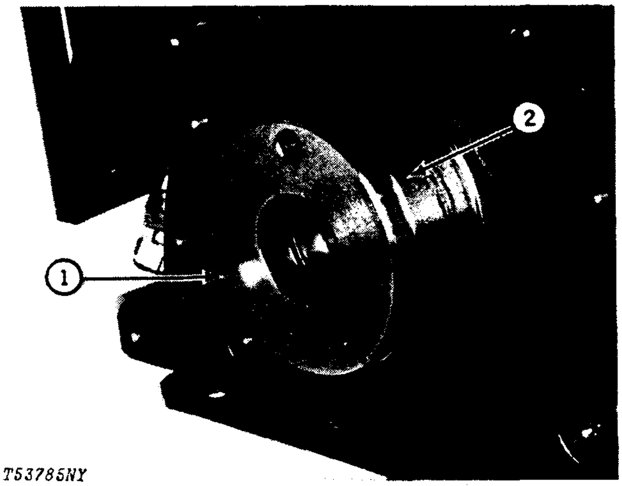
Installation

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.



T53785NY

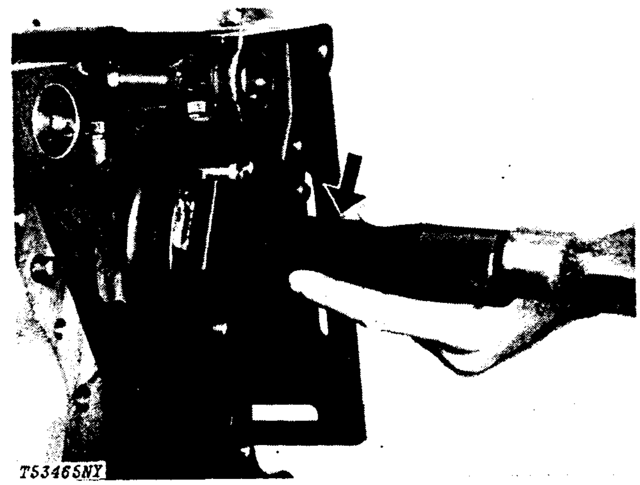
Fig. 15-JD-251-2 Pilot Plate

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.



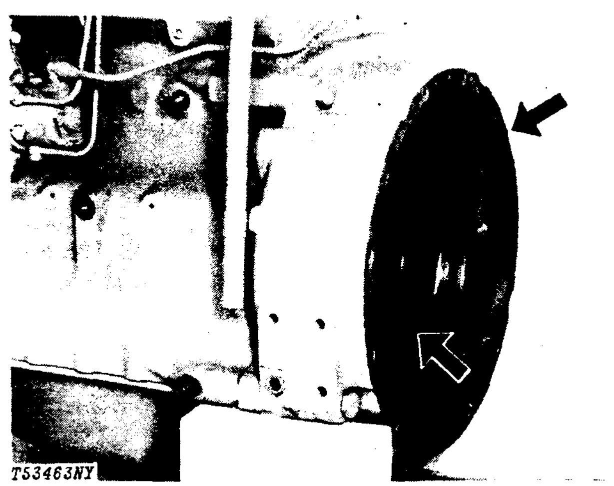
T53465NY

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.



T53463NY

Fig. 17-Install Flywheel Housing and Flywheel

4

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.

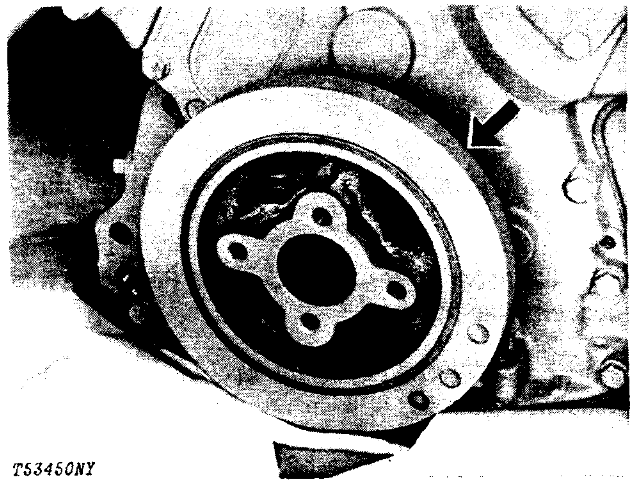


Fig. 18-Vibration Damper

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.

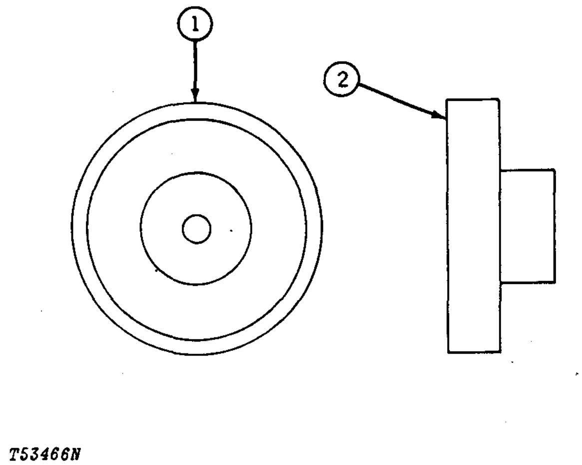


Fig. 19-Vibration Damper Measurement

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)

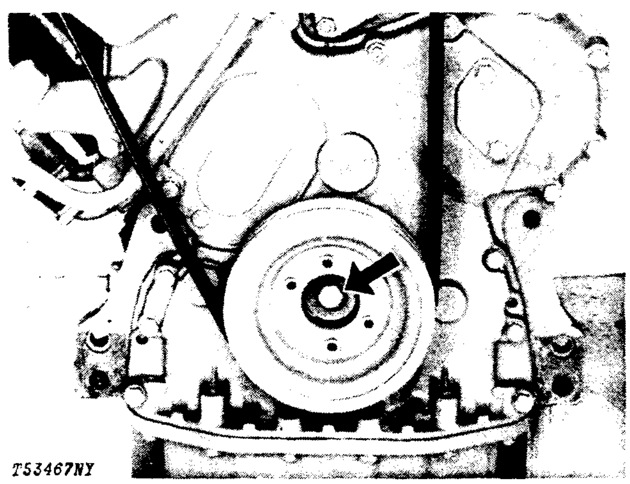


Fig. 20-Vibration Damper Cap Screw Torque

Group 0402
CAMSHAFT AND VALVE ACTUATING MEANS

VALVE LIFT CHECK

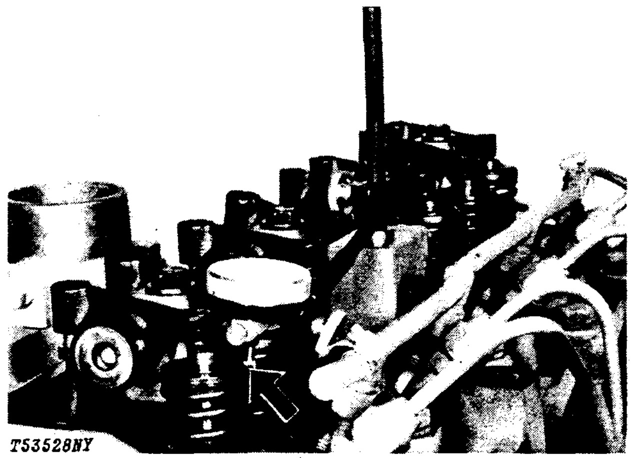
Measuring valve lift can give an indication of wear to cam lobes, cam followers, and push rods.

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.



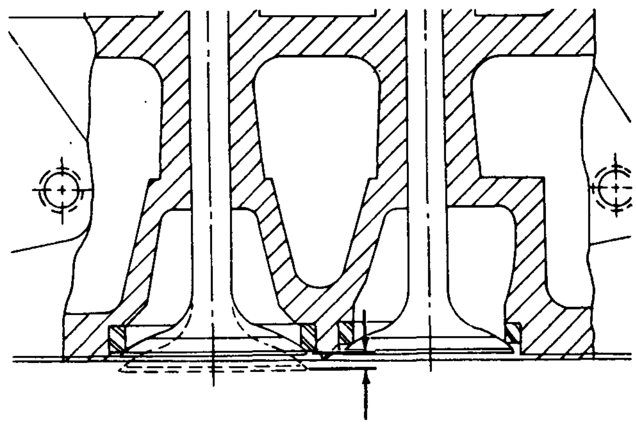
T53528NY

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)



T53529N

Fig. 2-Valve Lift

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).

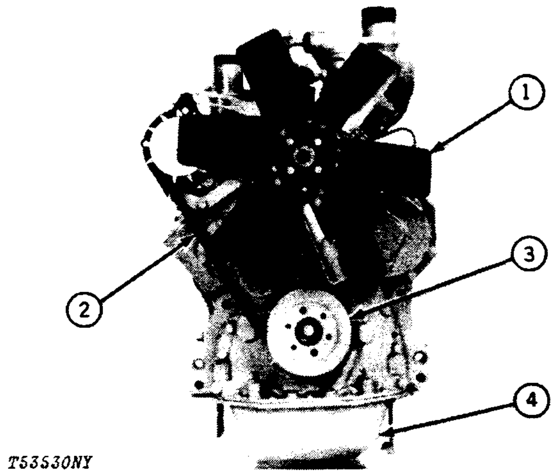


Fig. 3-Accessory Removal

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

NOTE: Count adjusting washers for reassembly.

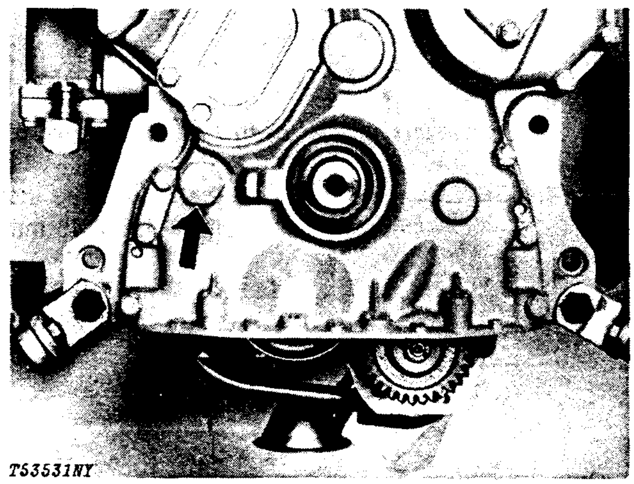


Fig. 4-Remove Oil Pressure Control Valve

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

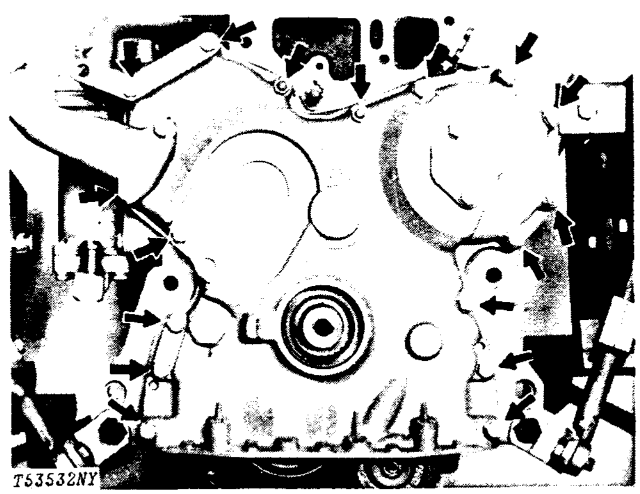


Fig. 5-Attaching Hardware

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).

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).

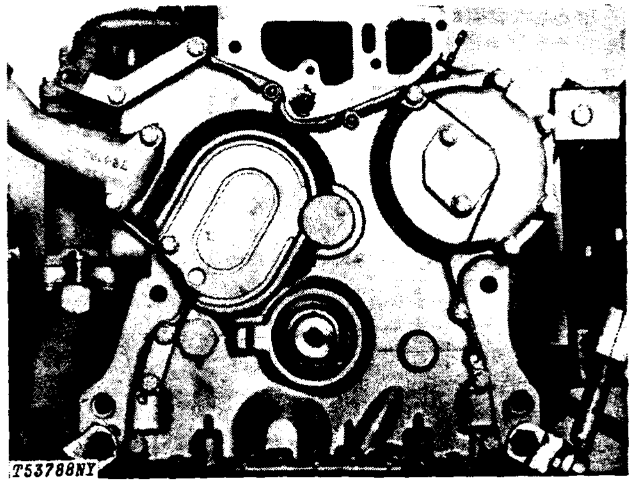


Fig. 6-Install Timing Gear Cover

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.

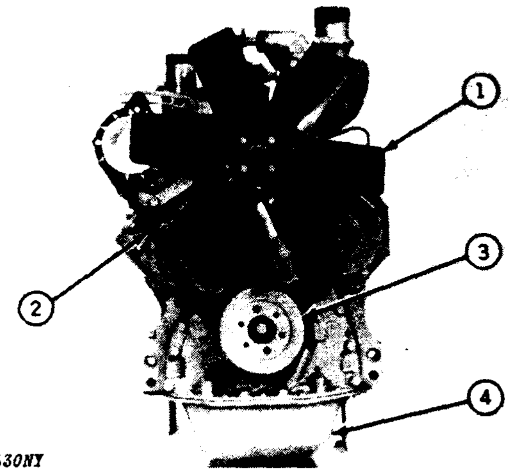


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Fig. 7-Accessory Installation

CAMSHAFT

Removal

Remove timing gear cover (Group 0402).

Remove flywheel and flywheel housing (Group 0433).

Remove fuel transfer pump (Group 0421).

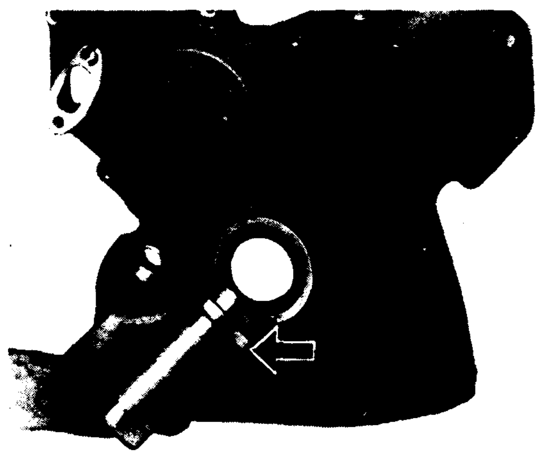

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Fig. 8-JD-250 Driver

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).

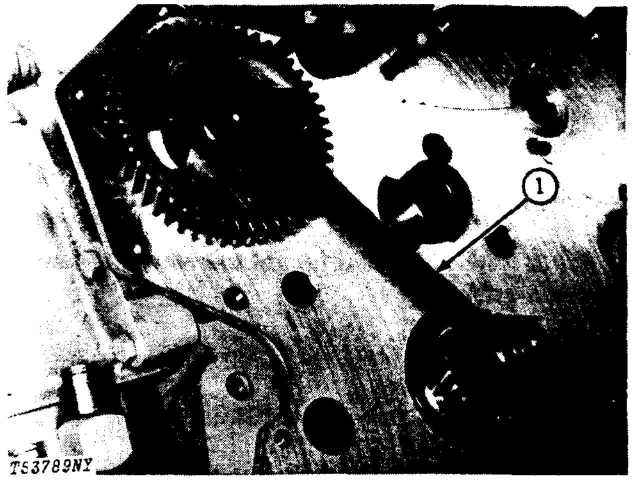

Fig. 9-JD-254 Timing Tool

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.

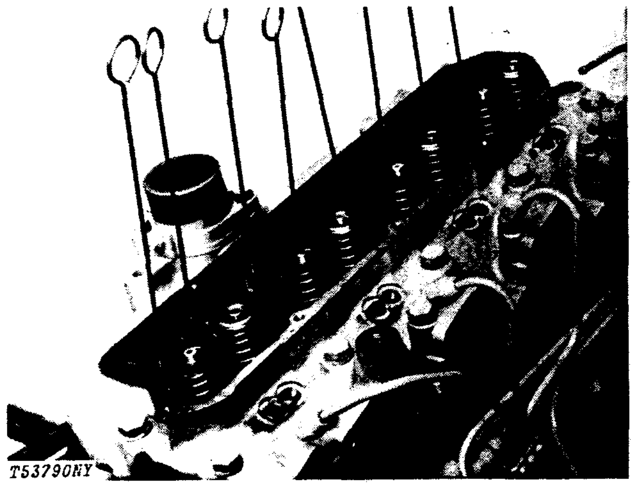

Fig. 10-D-15001-NU Magnetic Lifter Holder

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.

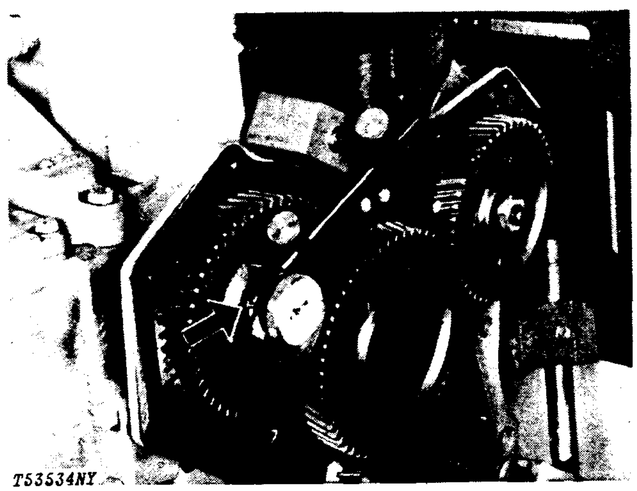

Fig. 11-Camshaft End Play

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)

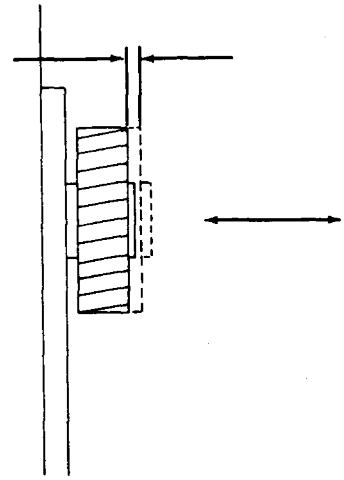
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Fig. 12-Camshaft End Play

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.

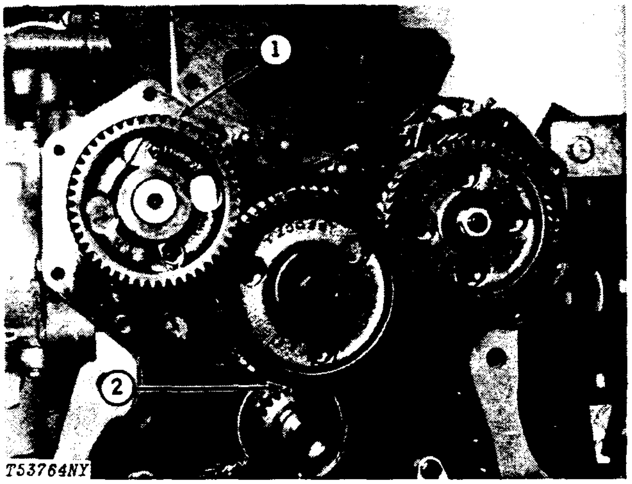

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Fig. 13-Camshaft Gear Backlash

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

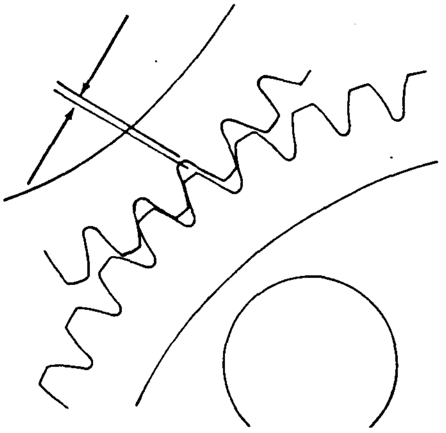
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Fig. 14-Camshaft Gear Backlash

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.

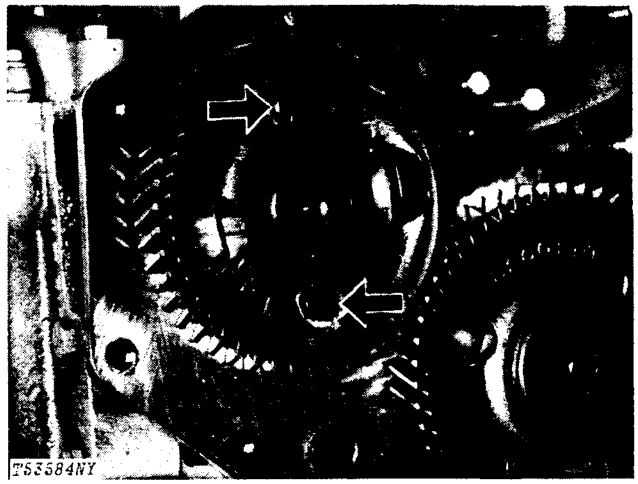

Fig. 15-Remove Camshaft Thrust Plate Cap Screws

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.

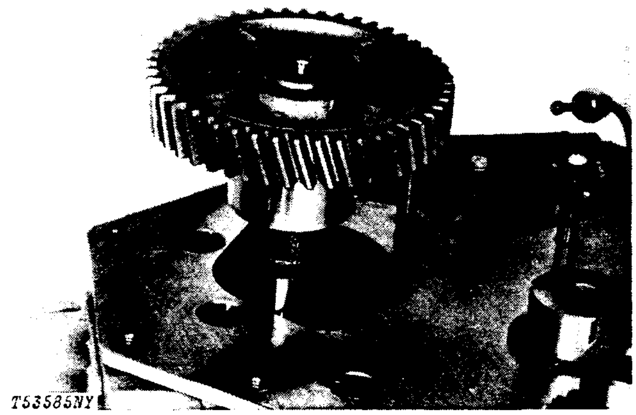

Fig. 16-Camshaft Removal

Press camshaft gear off camshaft if it is damaged.

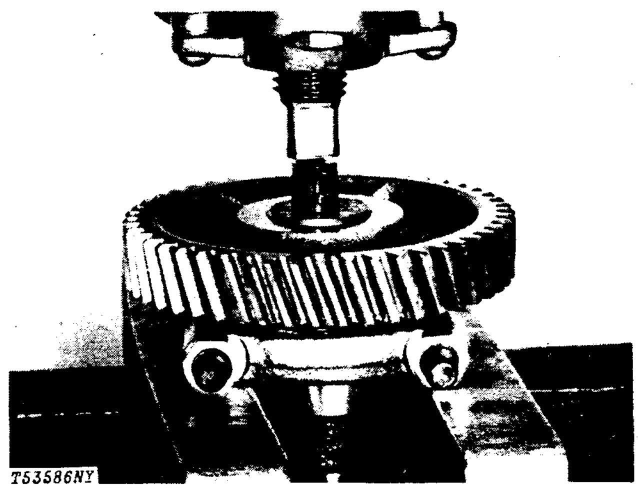

Fig. 17-Remove Cramshaft Gear

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.

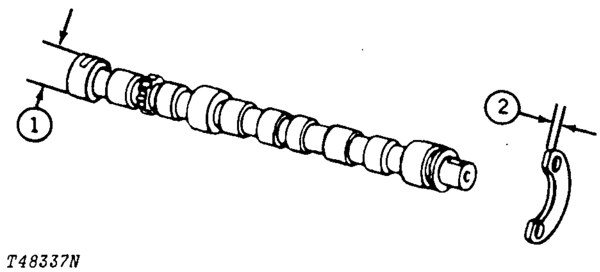

Fig. 18-Camshaft Measurement

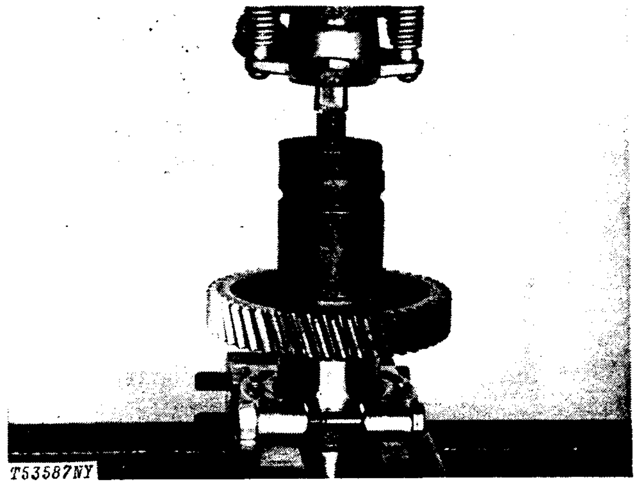

Fig. 19-Camshaft Gear Installation

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.

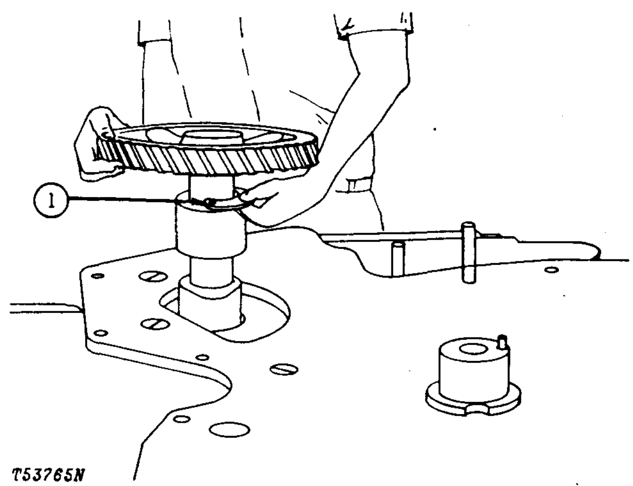

Fig. 20-Installing Camshaft

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.

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).

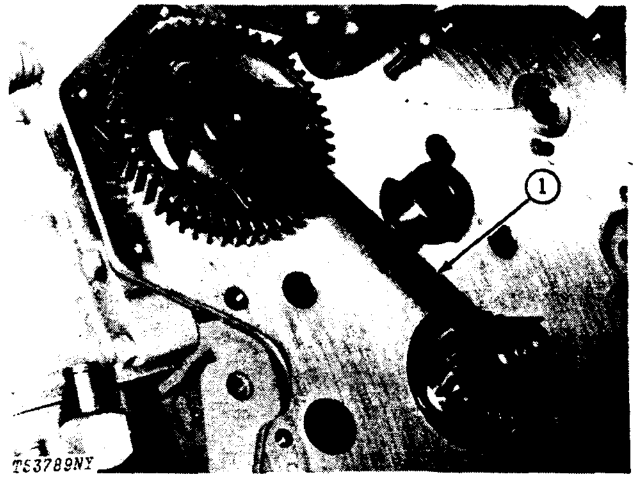

Fig. 21-JD-254 Timing Tool

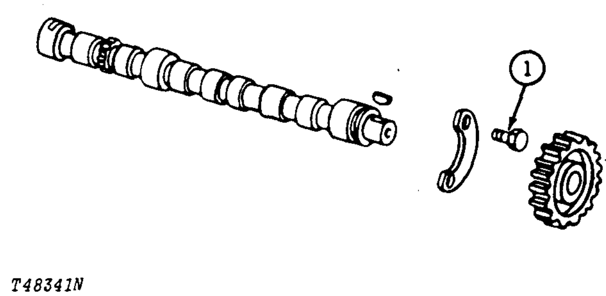

Fig. 22-Thrust Plate Cap Screw Torque

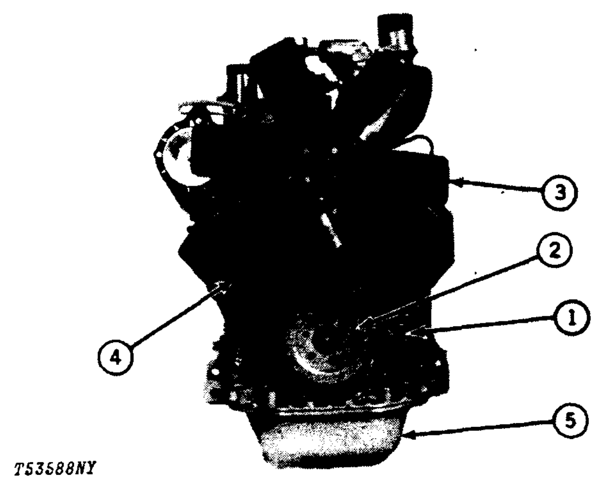

Fig. 23-Accessory Installation

4

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).

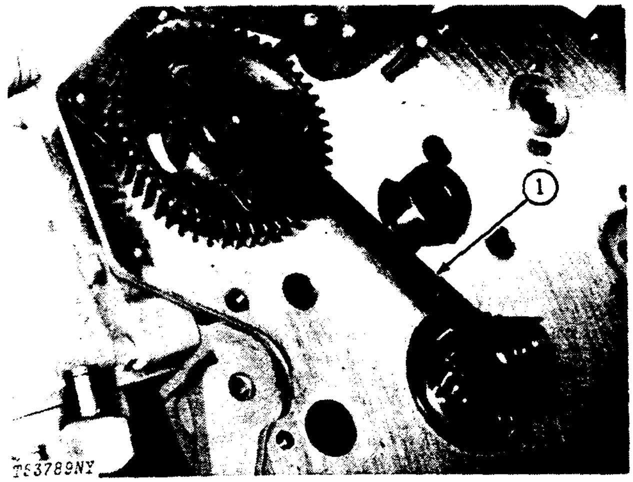

Fig. 24-JD-254 Timing Tool

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)

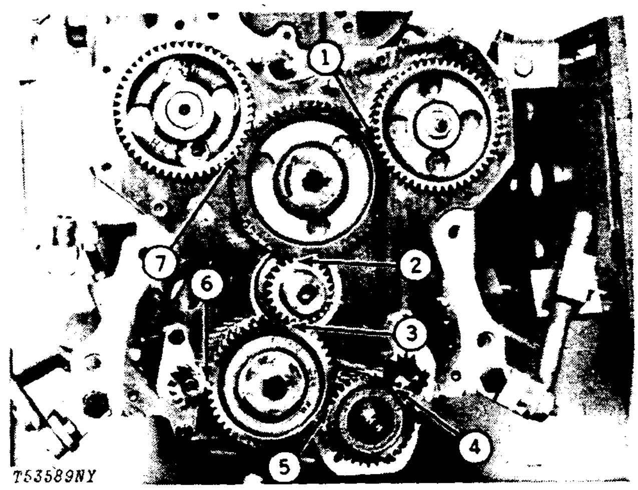

Fig. 25-Timing Gear Train Backlash

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)

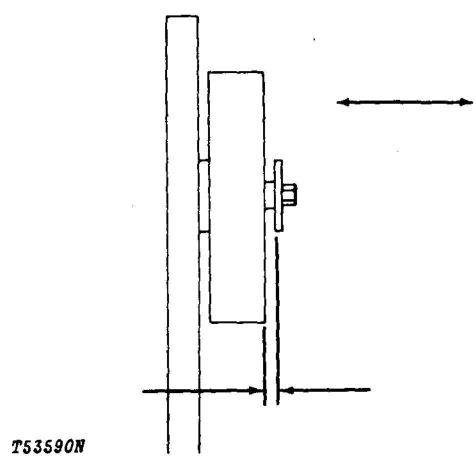

Fig. 26-Idler Gear End Play

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.

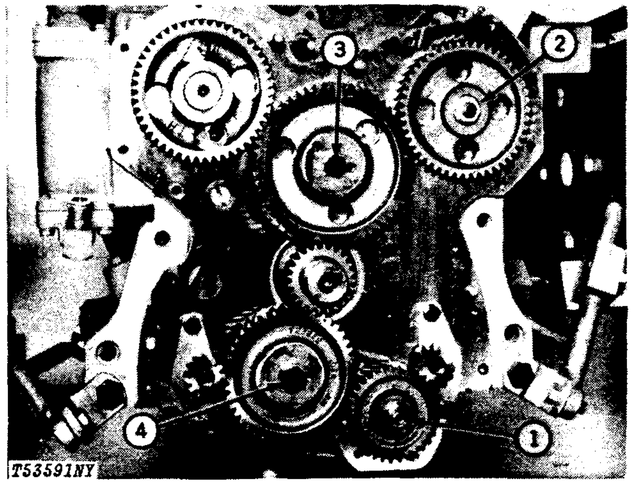

Fig. 27-Removing Idler Gears

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.

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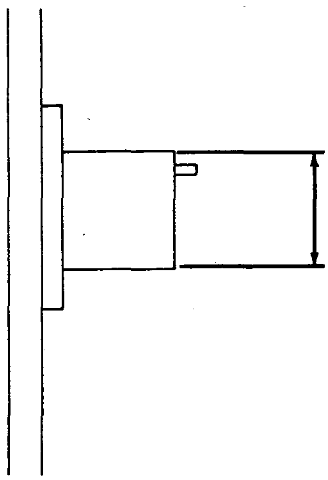


Fig. 28-Idler Gear Shaft Measurement

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).

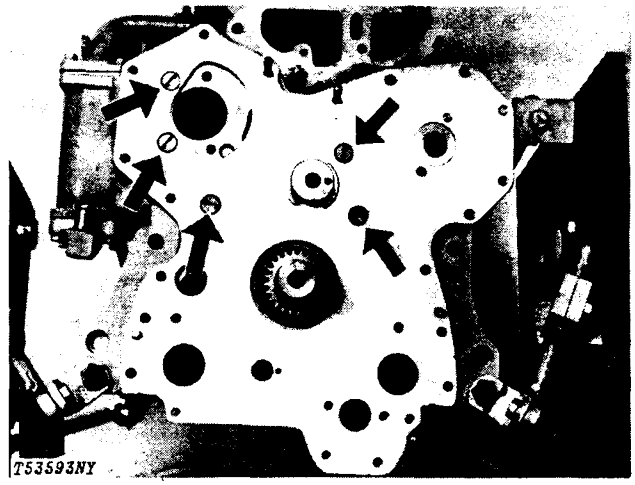


Fig. 29-Front Plate Attaching Hardware

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)

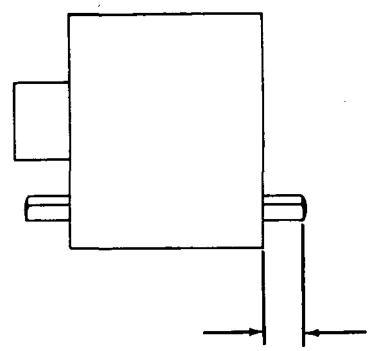


Fig. 30-Spring Pin Height

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)

4

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

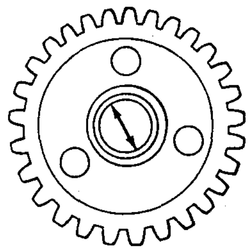

T53595N

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.

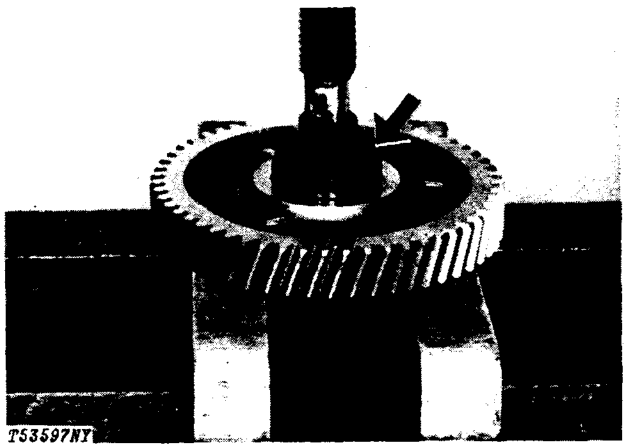

T53597NY

Fig. 32-JD-252 Bushing Driver

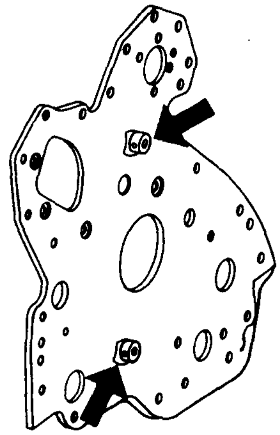
Installation

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).

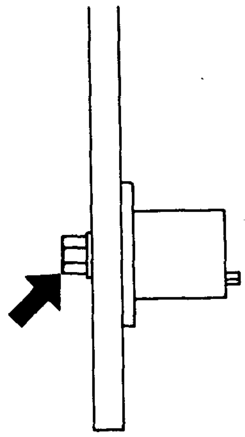


T53769N

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)

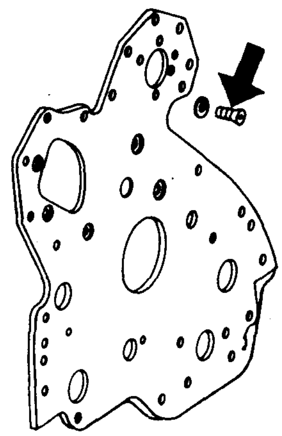


T53596N

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.

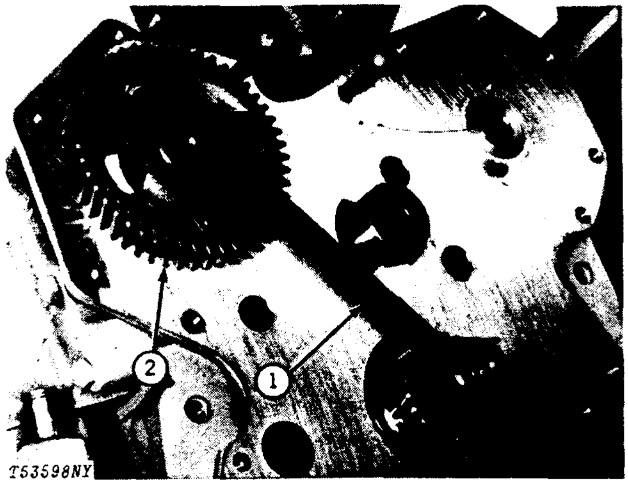


Fig. 36-JD-254 Timing Tool

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.

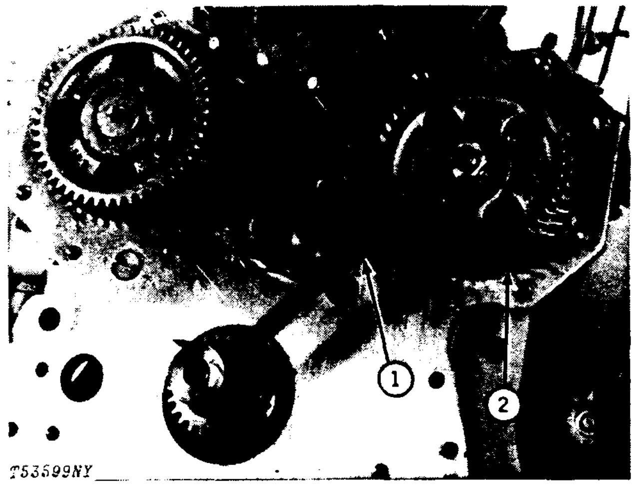


Fig. 37-JD-254 Timing Tool

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.

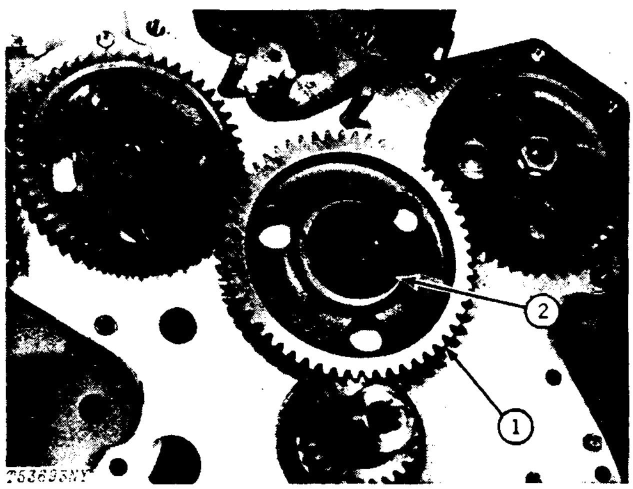


Fig. 38-Upper Idler Gear and Thrust Washer

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.

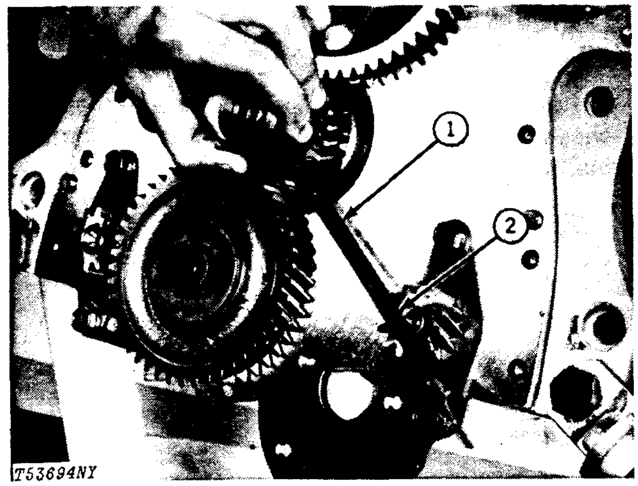


Fig. 39-JD254 Timing Tool

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.

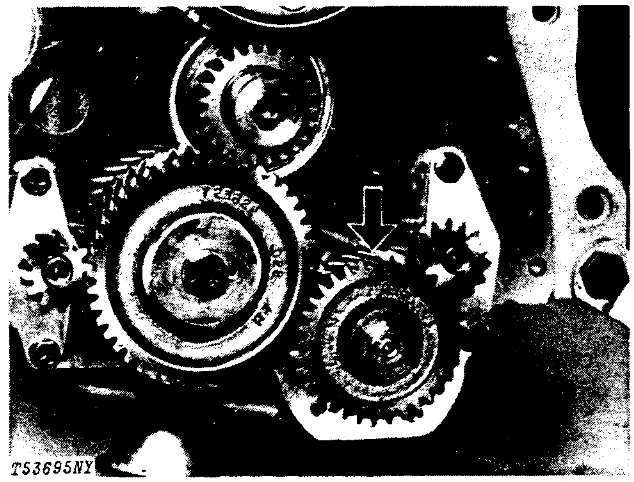


Fig. 40-Oil Pump Drive Gear

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.

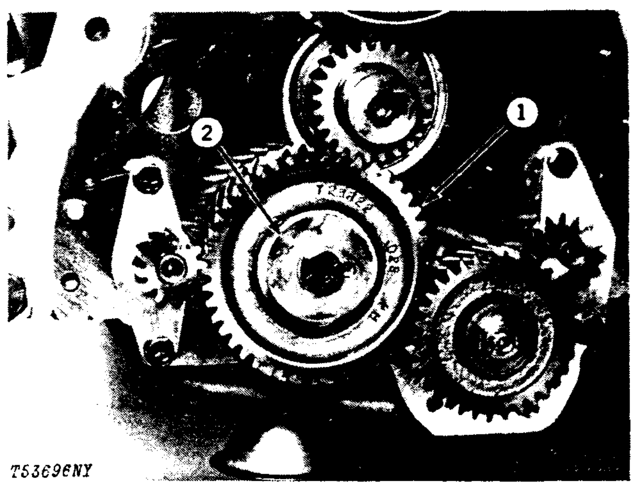


Fig. 41-Lower Idler Gear and Thrust Washer

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.

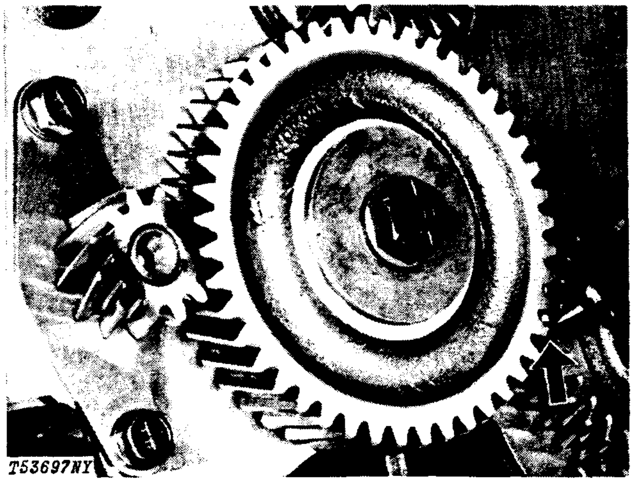


Fig. 42-Locking Timing Gear Train

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)

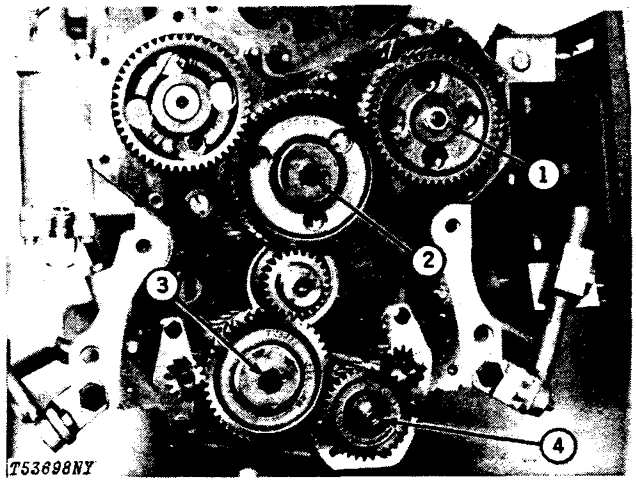


Fig. 43-Timing Gear Train Torque

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.

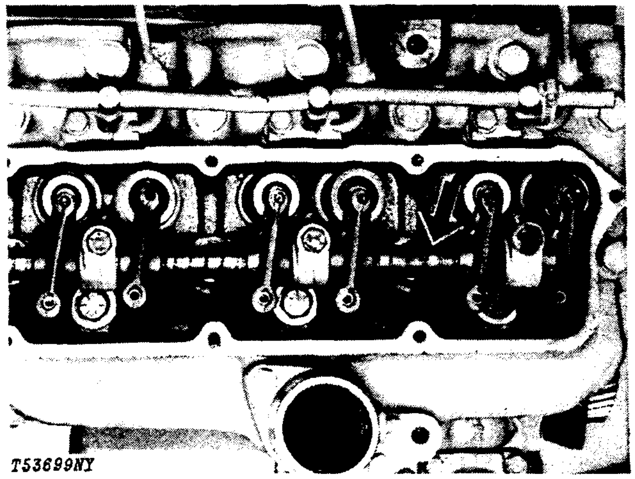


Fig. 44-Rocker Arm Assembly

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.

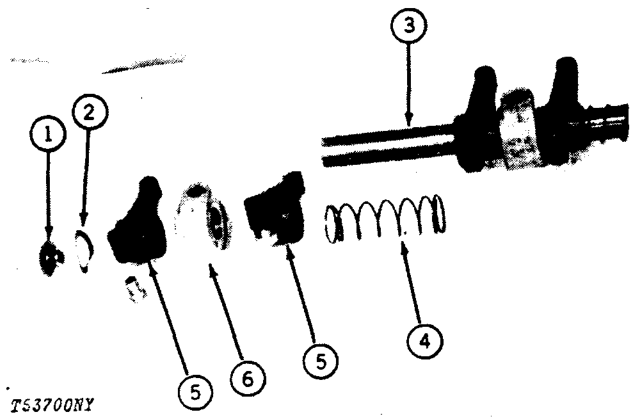


Fig. 45-Rocker Arm Assembly

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)

4

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.

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)

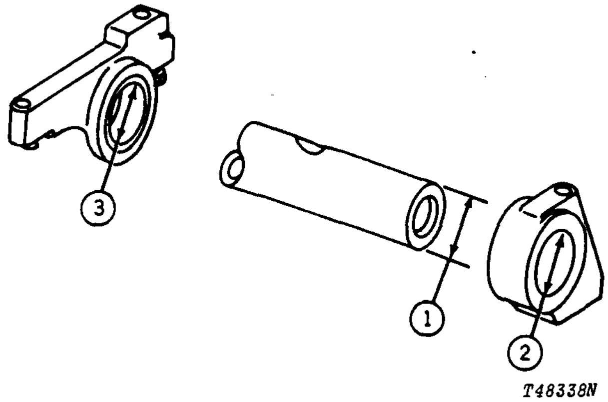


Fig. 46-Rocker Arm Measurement

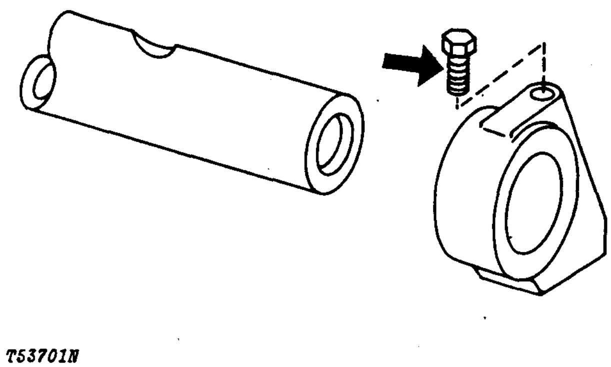


Fig. 47-Rocker Arm Support Cap Screw

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)

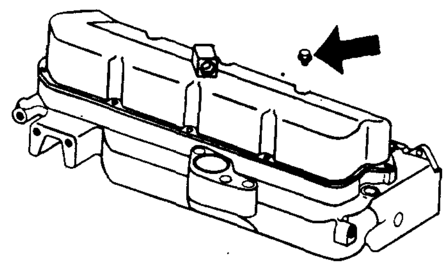


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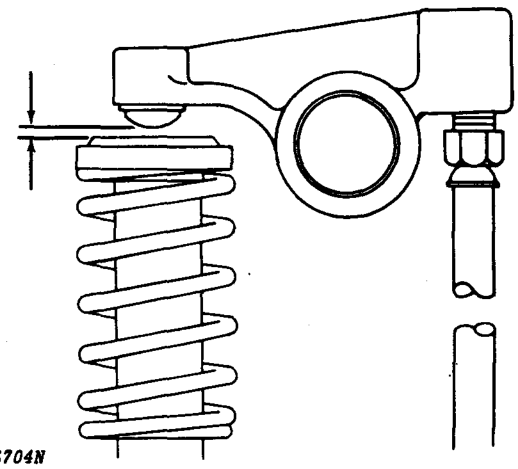
Fig. 48-Rocker Arm Cover Cap Screw

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)



T53704N

Fig. 49-Valve Clearance

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).

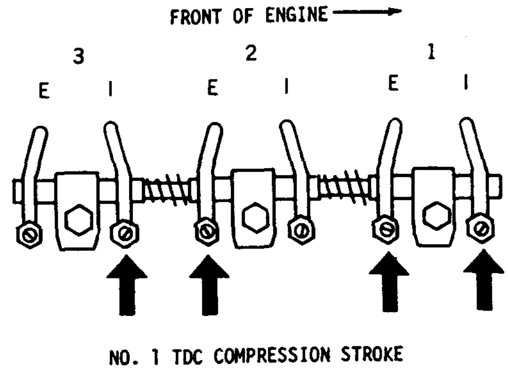


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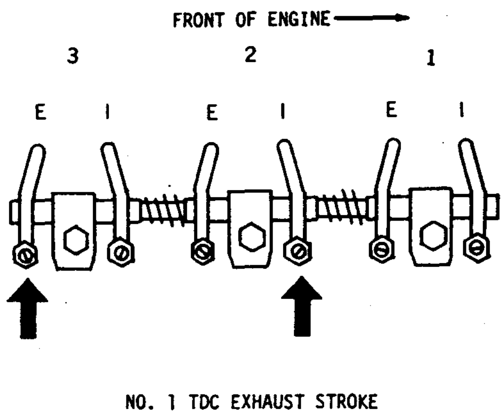
Fig. 50-Valve Clearance Adjustment

Rotate crankshaft 360°.

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



T53706N

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).

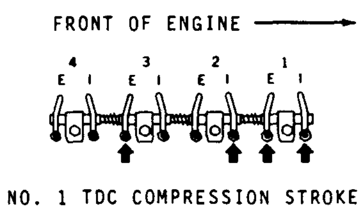


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Fig. 52-Valve Clearance Adjustment

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).

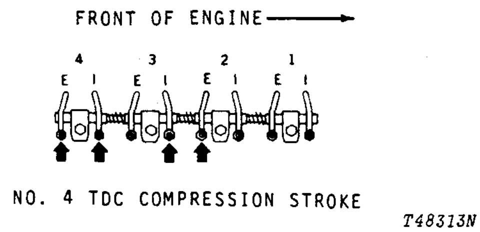


Fig. 53-Valve Clearance Adjustment

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).

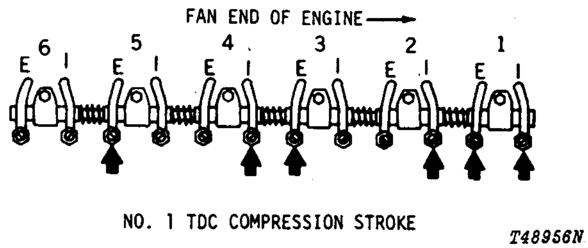


Fig. 54-Valve Clearance Adjustment

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).

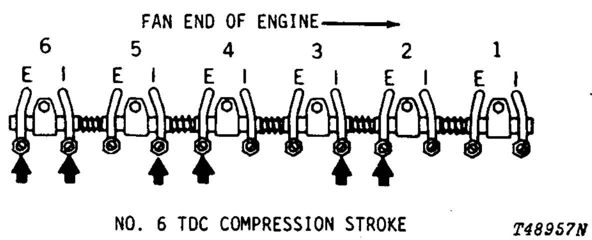


Fig. 55-Valve Clearance Adjustment

4

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.

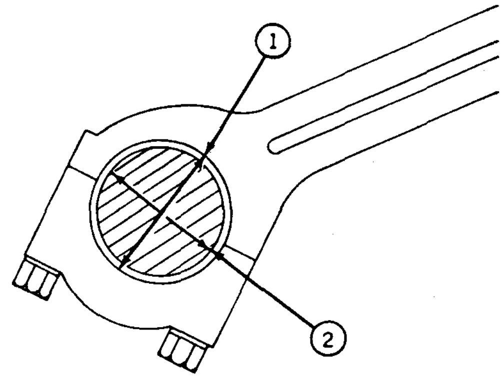
Remove oil pan (Group 0407).

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)



T53766N

Fig. 1-Connecting Rod Bearing Measurement

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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.

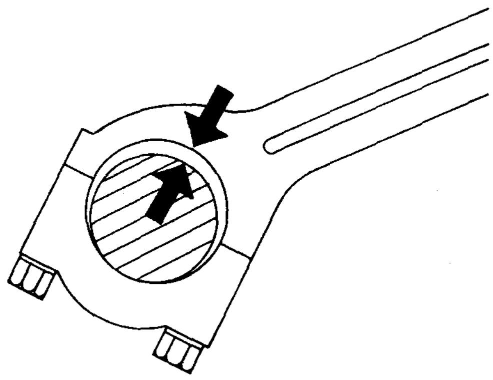

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Fig. 2-Oil Clearance

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.

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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.

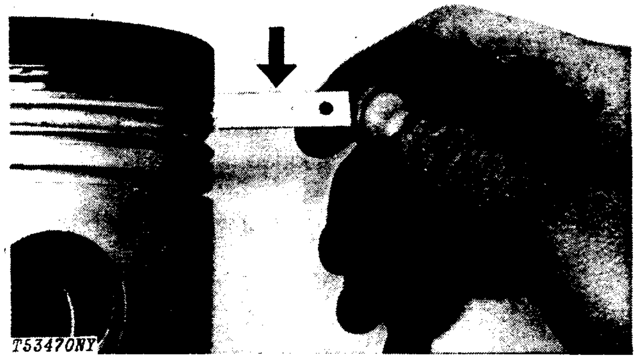

Fig. 3-JDE-62 Ring Groove Wear Gauge

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

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

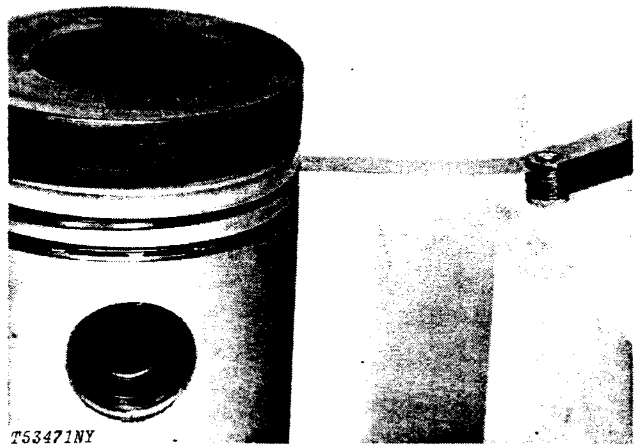

Fig. 4-Measure Ring Grooves

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).

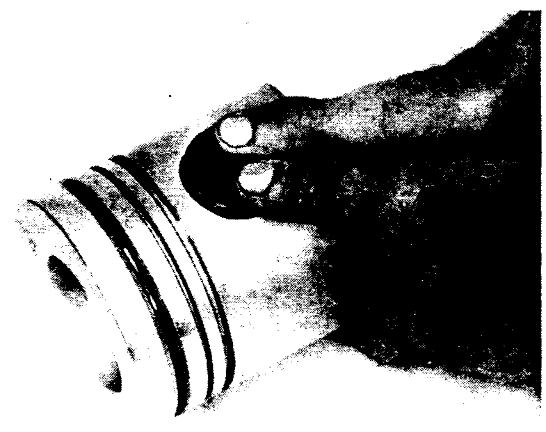

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Fig. 5-Piston Pin Assembly

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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.

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

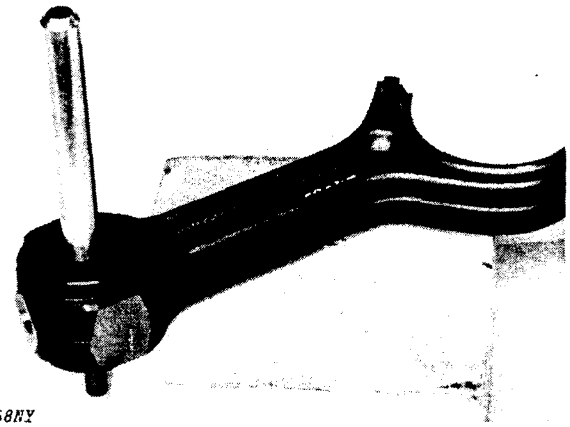

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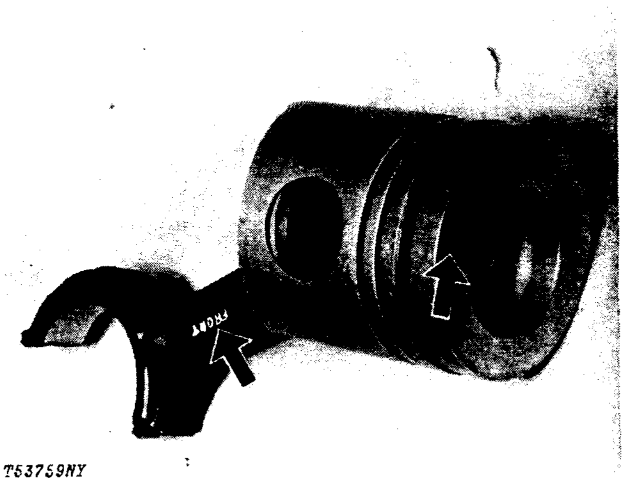
Fig. 6-JDE-88 - Pin Bushing Remover and Installer

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.

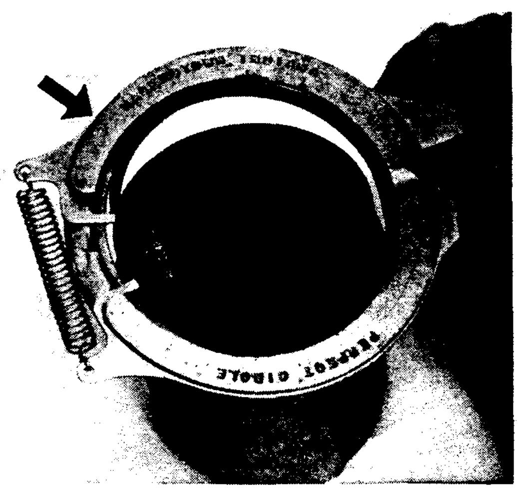


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Fig. 8-JDE-45 or JDE-85 Piston Ring Expander

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.

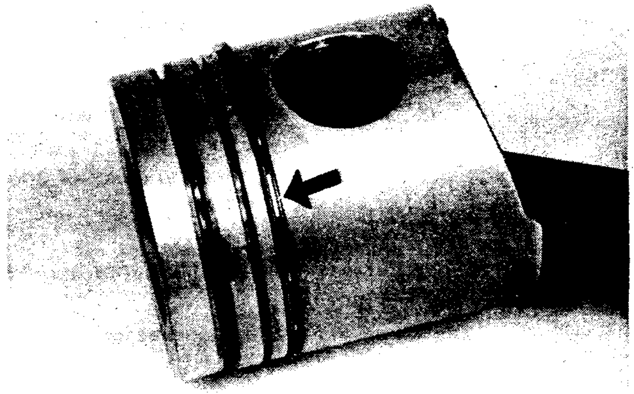

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Fig. 9-Oil Control Ring

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.

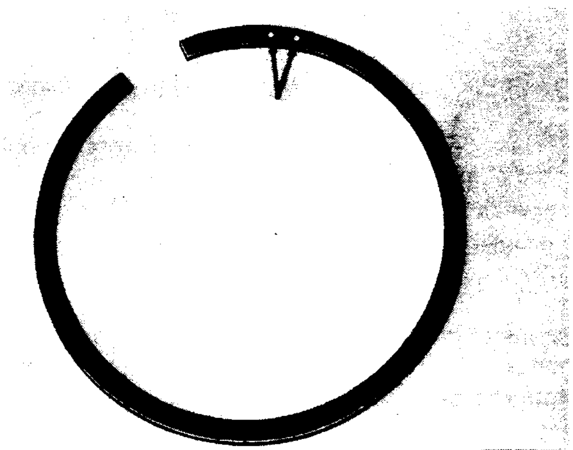

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Fig. 10-Piston Ring Pip Marks

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.

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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.

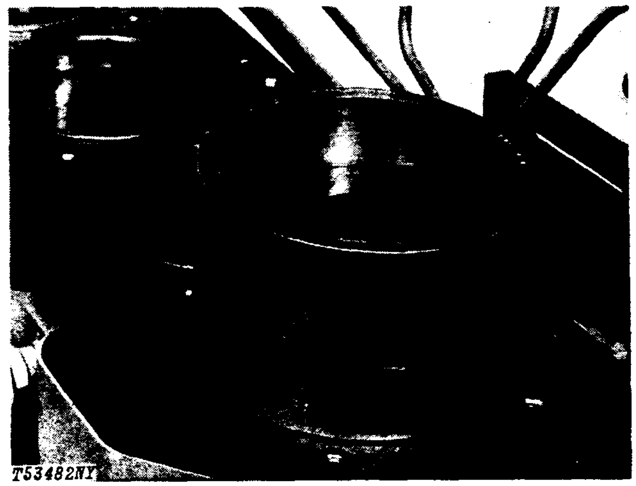

Fig. 12-JD-271 or JDE-84 Piston Ring Compressor

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.

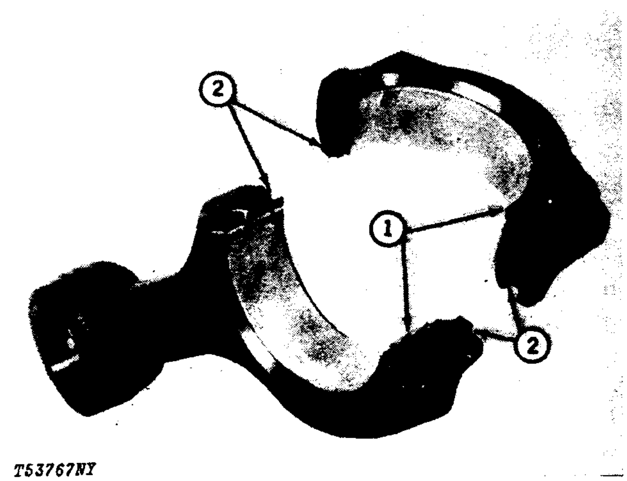

Fig. 13-Rod and Bearing Assembly

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)

Install oil pan (Group 0407).

Install cylinder head (Group 0409).

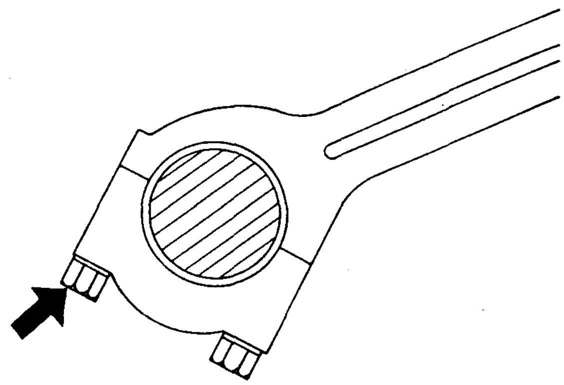

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Fig. 14-Connecting Rod Cap Screw

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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.

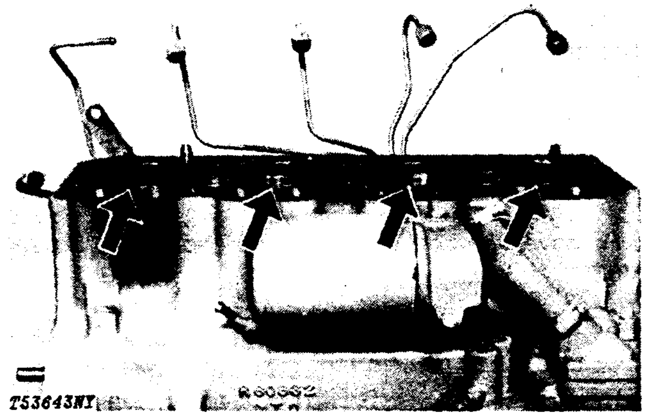

Fig. 1-Location of Liners in Cylinder Block

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).

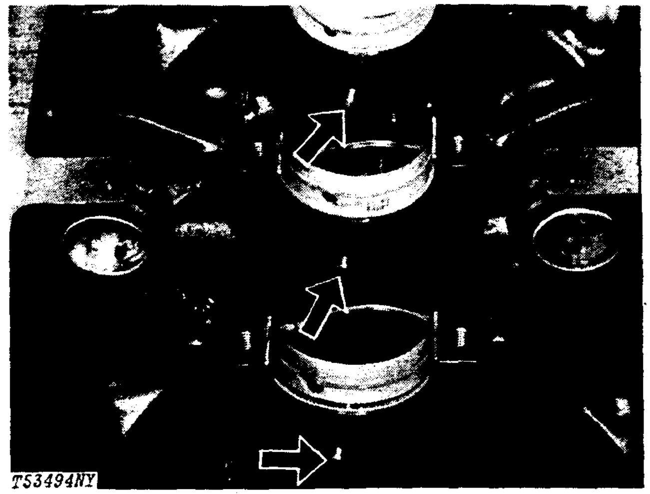

Fig. 2-Piston Cooling Orifices

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.

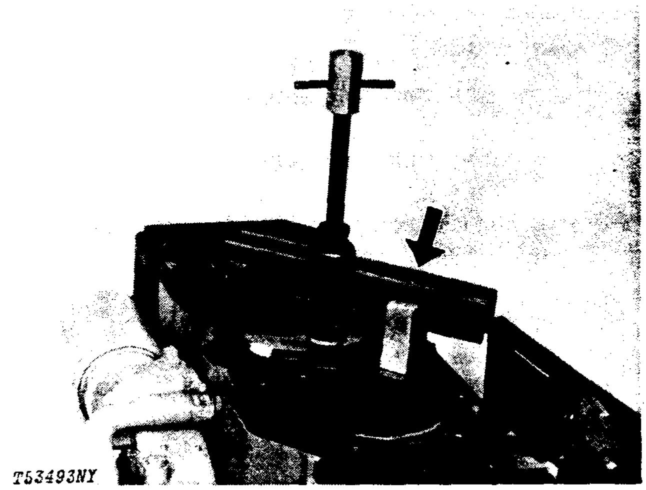

Fig. 3-Removing Cylinder Liner

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.

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)

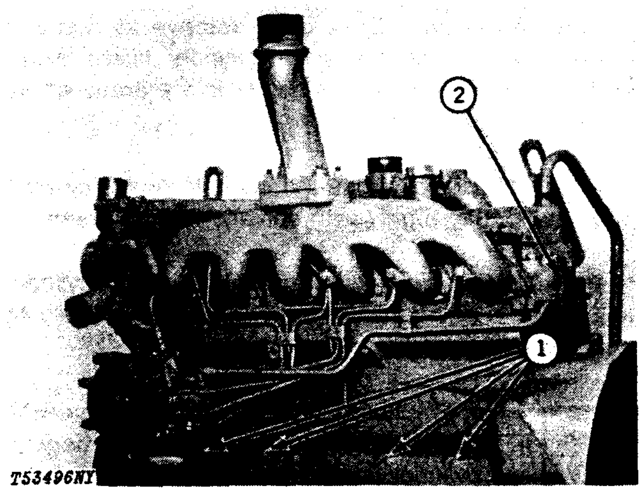

Fig. 4-Oil Gallery Plugs and Core Hole Plugs

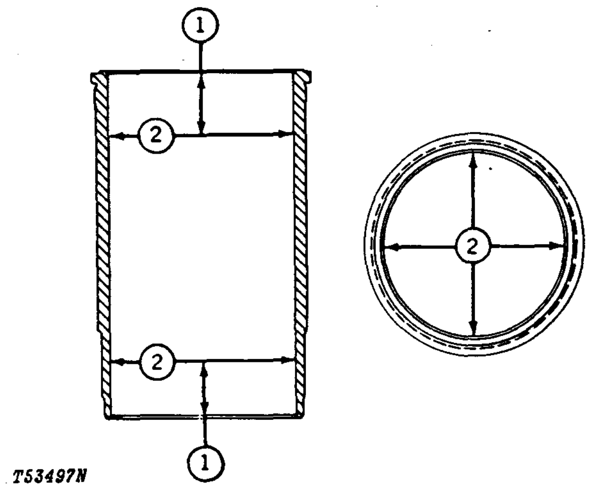

Fig. 5-Liner Measurements

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).

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.

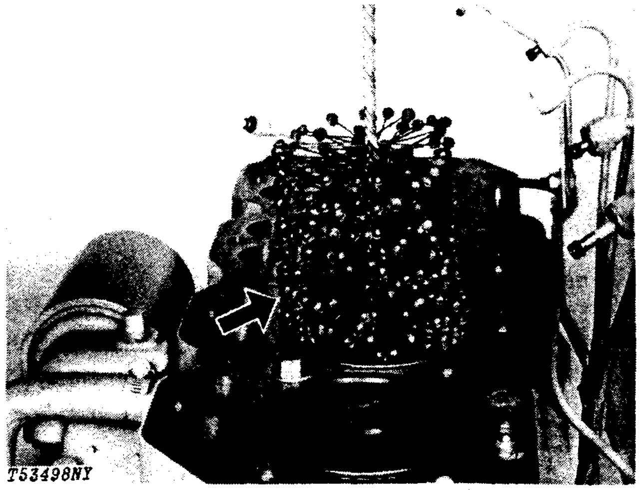

Fig. 6-Deglazing Cylinder Liners

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.

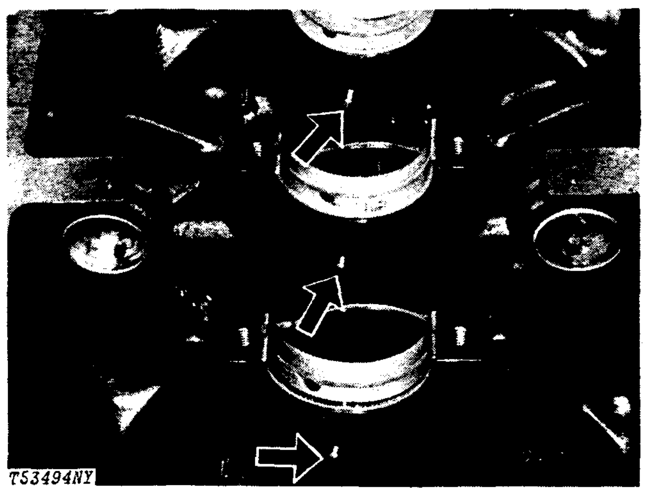

Fig. 7-Piston Cooling Orifices

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.

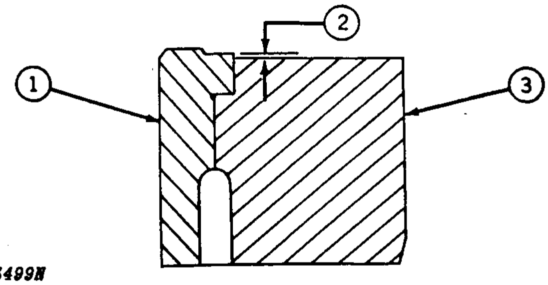

Fig. 8-Liner Flange Height

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.

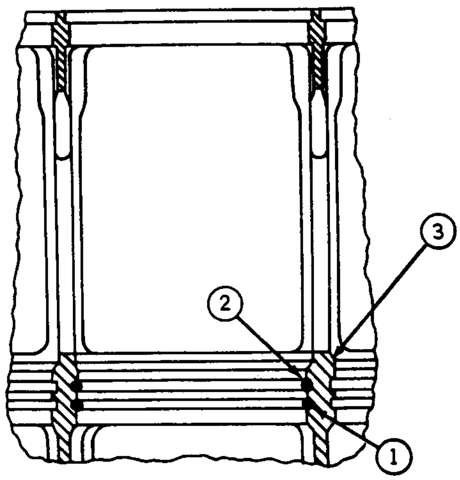

Fig. 9-Packing Installation

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.

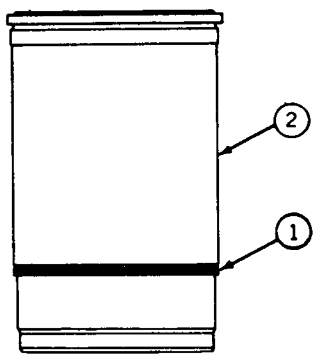

Fig. 10-Four Sided Packing Installation

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).

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.

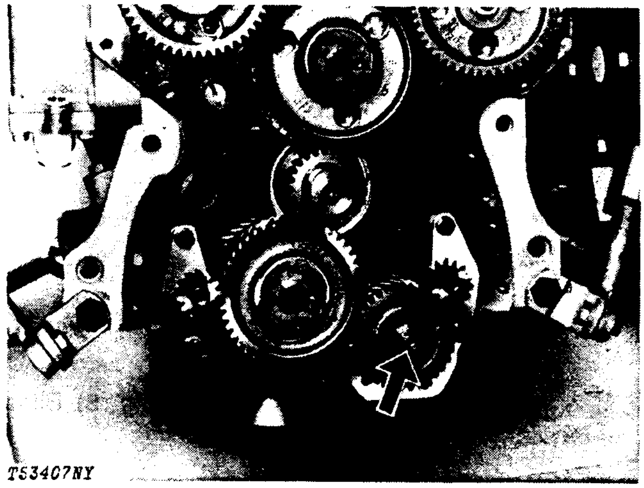

Fig. 1-Oil Pump Drive Gear

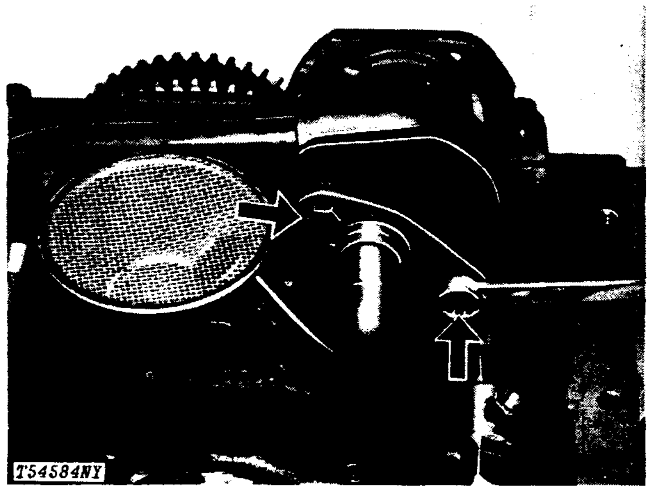

Fig. 2-Oil Filter

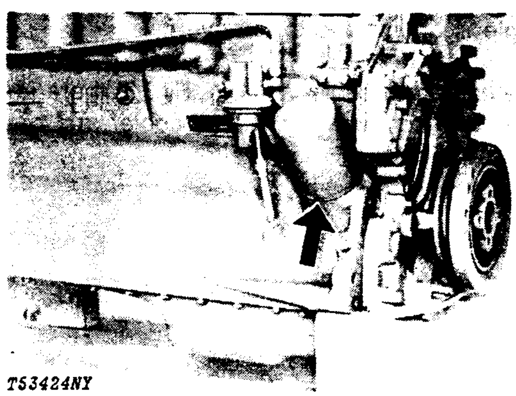

Fig. 3-Oil Pump Cap Screws

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.

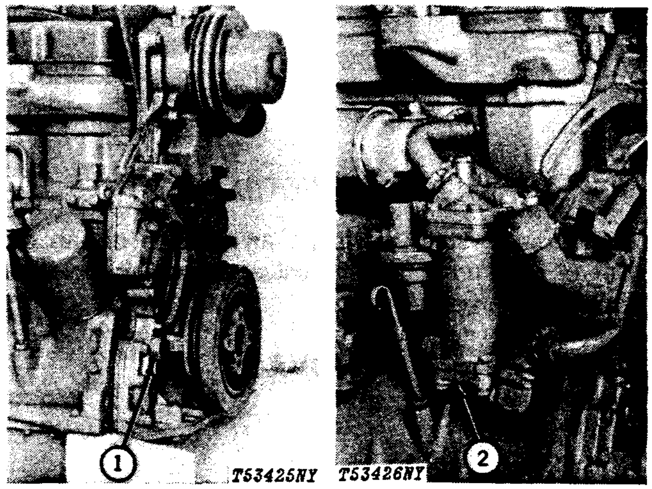

Fig. 4-Oil Pressure Control Valve Locations

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.

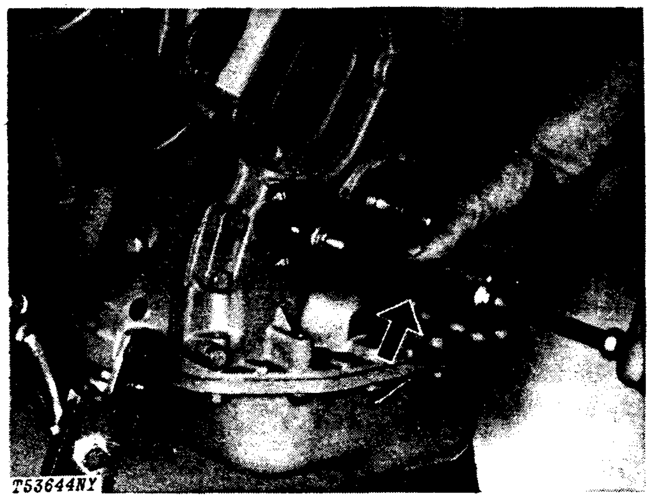

Fig. 5-Oil Pressure Control Valve Bushing

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.

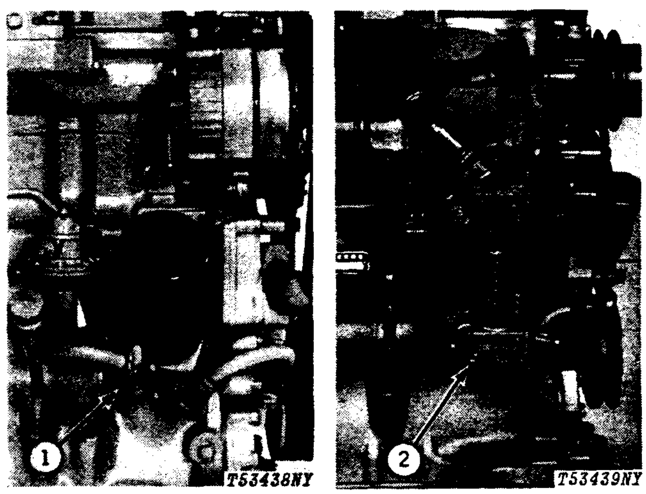

Fig. 6-Oil Filter Nipple Types

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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.

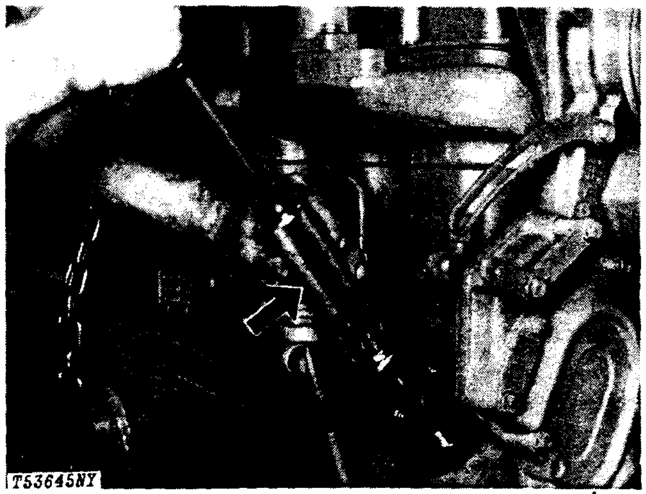

Fig. 7-Pulling Oil Filter Nipple

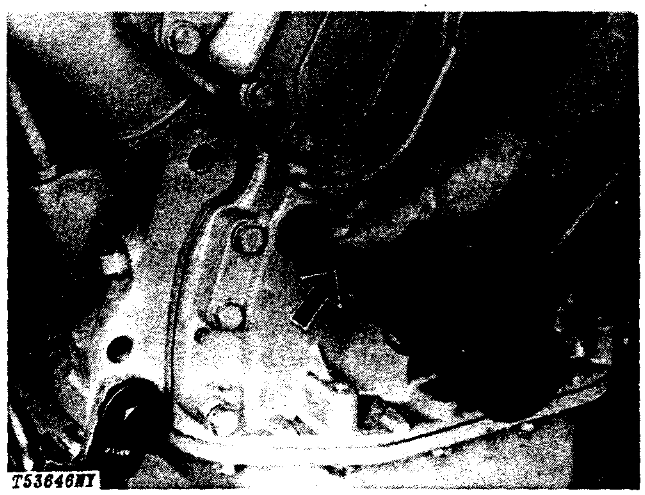

Fig. 8-Bushing Installation

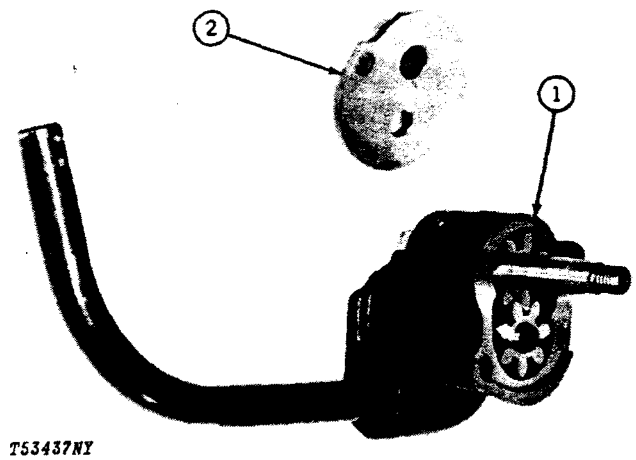

Fig. 9-Oil Pump

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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.

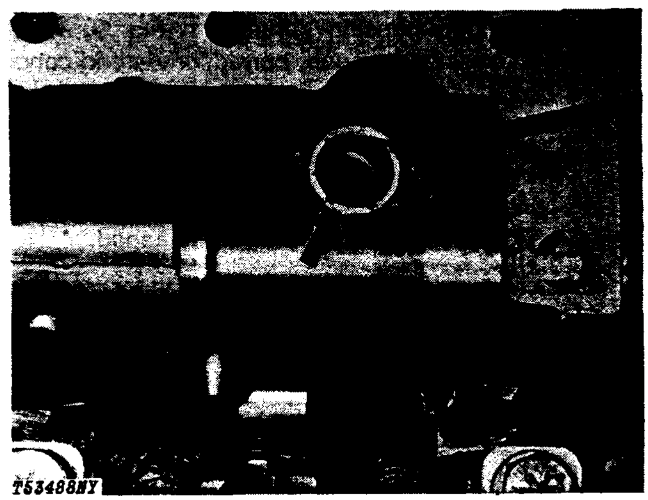

Fig. 10-Installing Oil Pump O-ring

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.

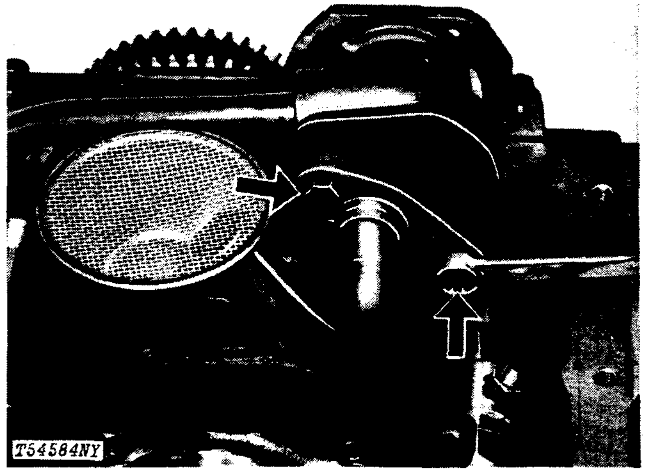

Fig. 11-Oil Pump Installation

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).

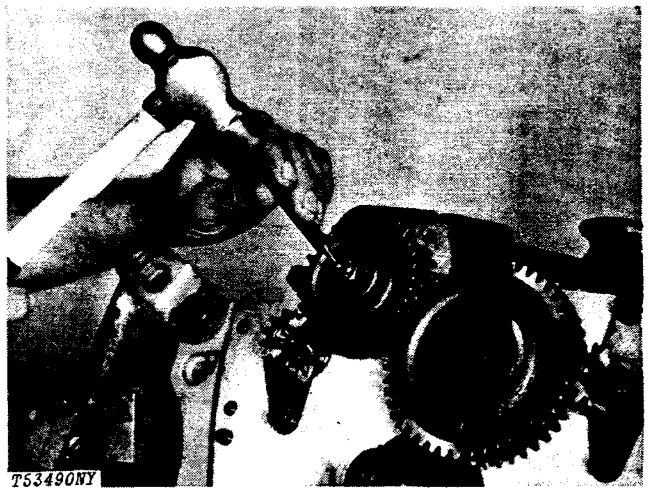

Fig. 12-Staking Oil Pump Gear

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.

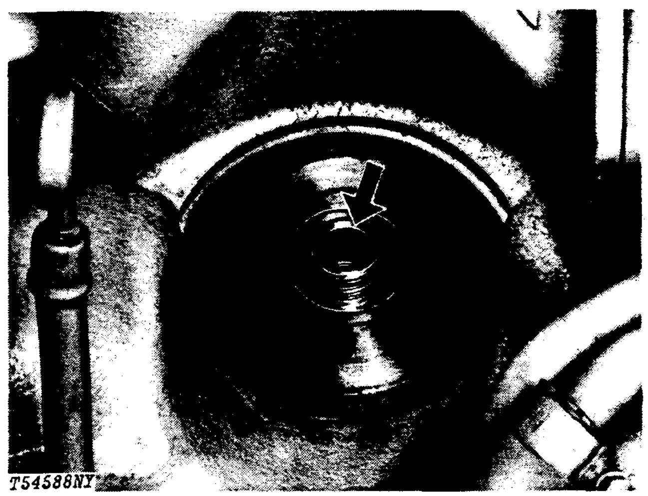

Fig. 13-Oil Filter Nipple Installation

4

Group 0408
VENTILATING SYSTEM

GENERAL INFORMATION

The engine ventilating system prevents pressure build up in the crankcase. This allows the engine to breathe freely which is necessary for proper lubrication. It consists of a tube leading from the valve cover down the side of the engine (Fig. 1).

Fig. 1-Engine Ventilating Tube

REMOVAL

Loosen side clamp.

Loosen upper clamp if engine is equipped with a flexible hose.

Remove ventilating hose or tube.

REPAIR

Inspect tube or hose for cracks.

Check tube for restrictions by pouring water through it.

Empty water from the tube.

Replace bent or crushed tubes. Replace broken or split hoses.

INSTALLATION

Replace O-ring in rocker arm cover.

Install tube on hose and secure with clamp.

4

Group 0409
CYLINDER HEAD AND VALVES

REMOVAL

Remove turbocharger (Group 0416) from turbocharged engines.

Remove air inlet piping from non-turbocharged engines (Group 0520).

Remove water manifolds or thermostat housing (Group 0418).

Remove fuel filter (Group 0420).

Remove exhaust manifold (Group 0410).

Remove injection nozzles and injection lines (Group 0413).

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

Remove cylinder head cap screws.

NOTE: Do not rotate crankshaft with cylinder head removed unless all cylinder liners are secured with short cap screws and large flat washers.

IMPORTANT: Do not use screwdrivers or pry bars between cylinder block and cylinder head to loosen cylinder head.

Lift cylinder head from cylinder block. If cylinder head sticks, use a soft hammer to tap the cylinder head.

Remove any gasket residue remaining on cylinder head.

Measure cylinder head deck to valve head distance with valve seated.

Cylinder head to intake valve
head distance (new) (1, Fig. 1) . 0.023 to 0.047 inch
(0.58 to 1.19 mm)

Cylinder head to exhaust
valve head distance (new) (2) . . 0.038 to 0.072 inch
(0.97 to 1.83 mm)

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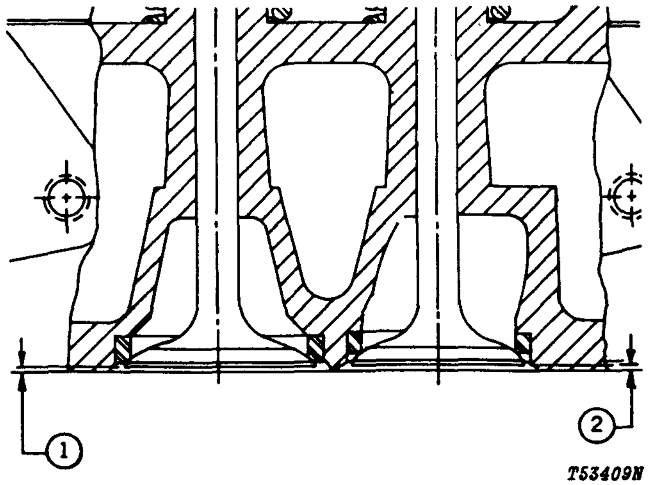

Fig. 1-Cylinder Head to Valve Head Distance

Using a valve spring compressor, compress valve springs far enough to remove retainer locks.

Release spring tension and remove valve spring cap (or rotator, if so equipped) and valve spring. Mark each part so that it can be reassembled in the same position it was removed from.

Remove valves, marking them for reassembly.

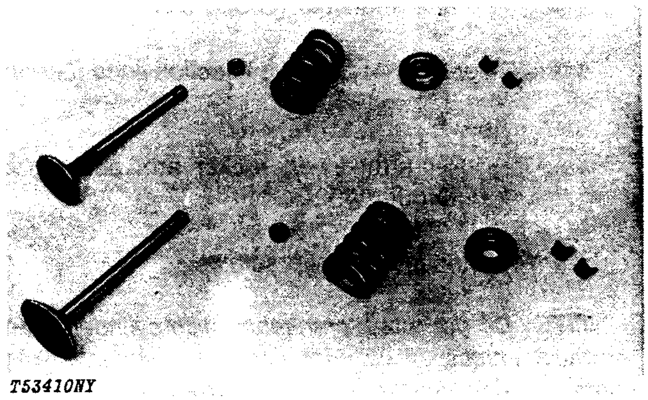

Fig. 2-Valve Removal

REPAIR

Measure cylinder head flatness (Fig. 3).

Cylinder head flatness
(maximum warp) (1) . . . . 0.002 inch
(0.05 mm)

Cylinder head may be resurfaced if necessary.

Maximum material removal
from cylinder head (2) . . . . 0.030 inch
(0.76 mm)

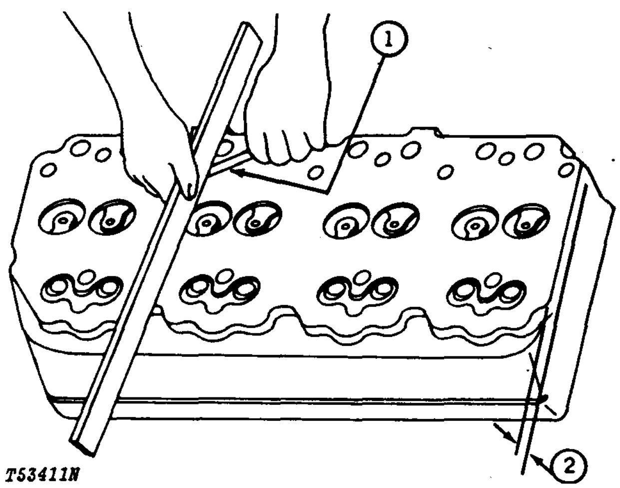

Fig. 3-Cylinder Head Flatness

If necessary to resurface valve face, grind valve face at following angle (Fig. 4):

Engine	Intake Valve	Exhaust Valve
3-164	45°	45°
4-219	45°	45°
4-276	30°	45°
6-329	45°	45°
6-414	30°	45°

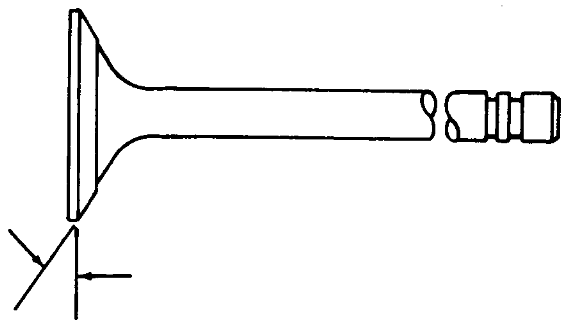
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Fig. 4-Valve Face Angle

If necessary to resurface valve seat, grind valve seat at following angle and width (Fig. 5):

Engine	Intake Valve Seat	Exhaust Valve Seat
3-164	45°	45°
4-219	45°	45°
4-276	30°	45°
6-329	45°	45°
6-414	30°	45°

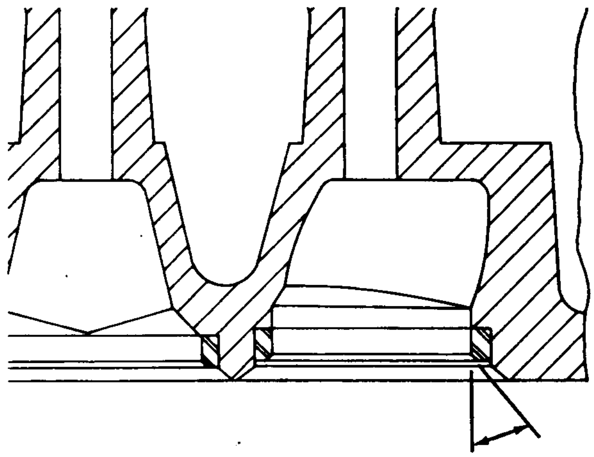
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Fig. 5-Valve Seat Angle

When resurfacing valve seats, the valve seat width must be maintained (Fig. 6).

Engine	Valve Seat Width
3-164	0.078 to 0.094 inch (1.98 to 2.39 mm)
4-219	0.063 to 0.078 inch (1.60 to 1.98 mm)
4-276	0.083 to 0.093 inch (2.11 to 2.36 mm)
6-329	0.047 to 0.078 inch (1.19 to 1.98 mm)

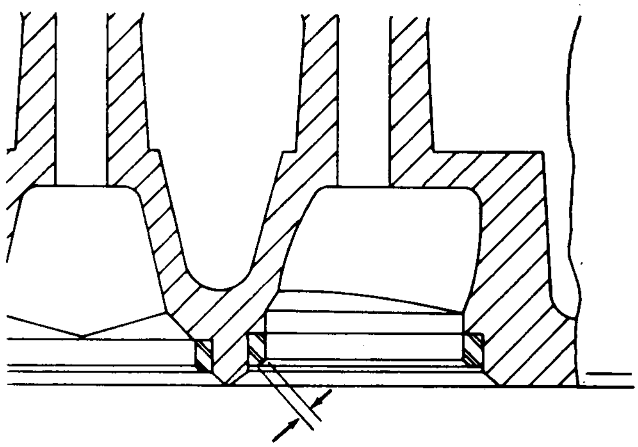
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Fig. 6-Valve Seat Width

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When resurfacing valve seats, the valve seat run-out must be maintained (Fig. 7).

Valve seat
run-out (maximum) .... 0.002 inch
(0.05 mm)

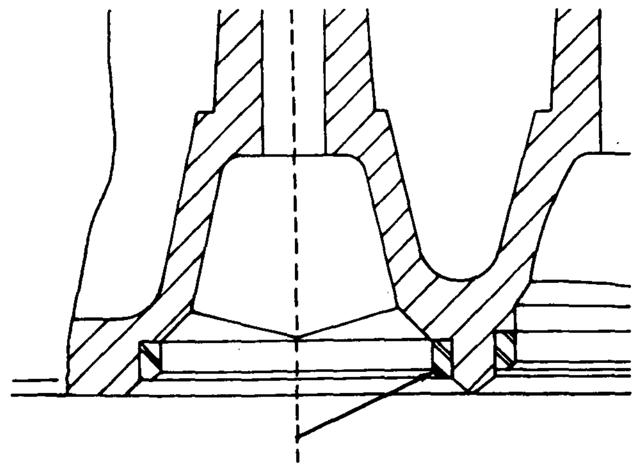

Fig. 7-Valve Seat Run-Out

Use JDE-77 Valve Seat Puller to remove intake valve seat inserts or JDE-87 Valve Seat Puller to remove exhaust valve seat inserts if they must be replaced on 4-276T, 6-414D or 6-414T engines (Fig. 8).

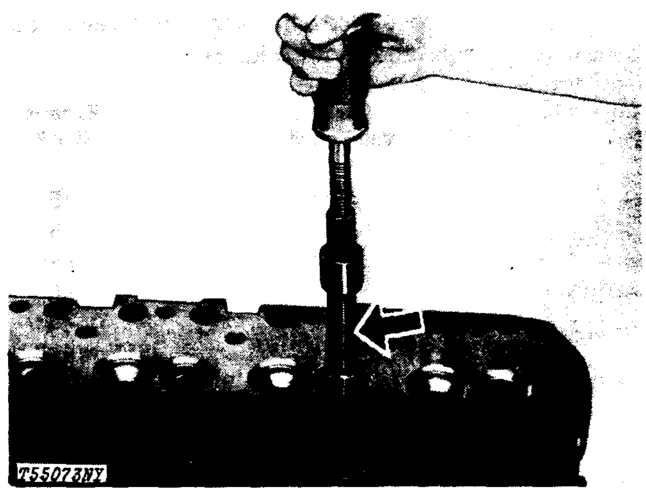

Fig. 8-JDE-77 or JDE-87 Valve Seat Puller

Use JDE-7 Driver (1, Fig. 9) with JDE-86 valve seat installer (2) (for exhaust) and JD-287 valve seat installer (2) (for intake) to install valve seat inserts. Chill the valve seat installer and valve seat insert to −20°F (−29°C) before driving into cylinder head.

Grind valve seats to obtain correct cylinder head deck to valve head distance.

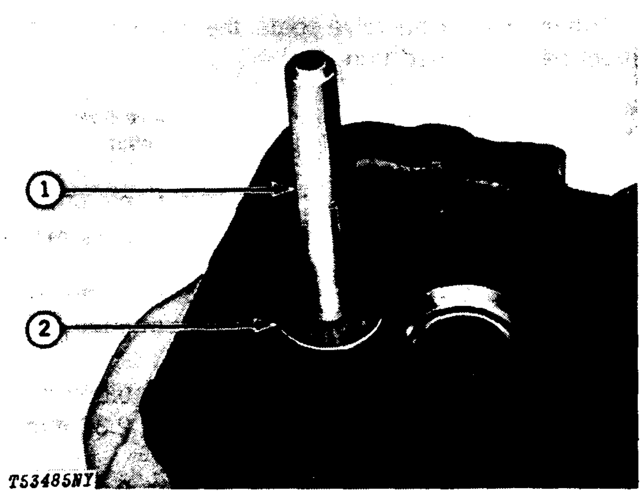

Fig. 9-JDE-7 Driver and JDE-86 or JD-287 Valve Seat Installer

Measure valve stem oil clearance (Fig. 10).

Valve stem
O.D. (new) (1) .... 0.372 to 0.373 inch
(9.45 to 9.47 mm)

Valve guide
I.D. (new) (2) .... 0.375 to 0.876 inch
(9.53 to 9.55 mm)

Valve stem oil
clearance (new) .... 0.002 to 0.004 inch
(0.05 to 0.10 mm)

Valve stem oil
clearance (maximum) .... 0.006 inch
(0.15 mm)

If valve guide oil clearance is more than maximum allowable but not more than 0.008 inch (0.20 mm) valve guides can be knurled.

Use D-20002-WI Valve Guide Knurler (Fig. 11) as directed by manufacturer to knurl valve guides.

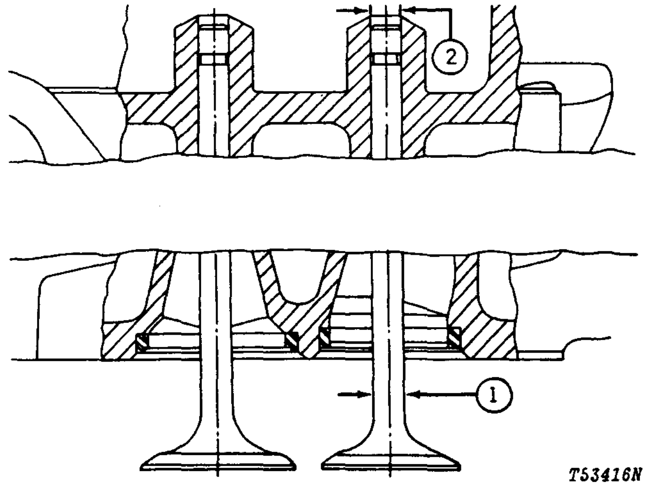

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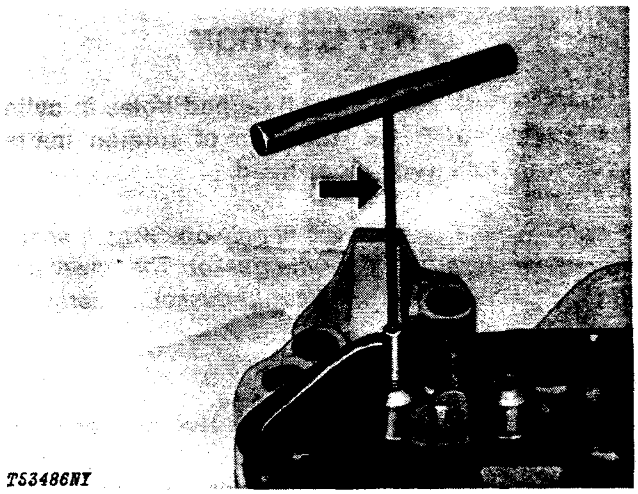
Fig. 10-Valve Stem Oil Clearance



T53486NY

Fig. 11-D-20002-WI Valve Guide Knurler

Inspect valve springs for rust, cracked coils, cocking, or any other damage.

Measure valve spring free length and compression.

Valve spring
free length (approx.) (1, Fig. 12) .... 2.12 in.
(53.8 mm)
Valve spring (2) .... 1.81 in.
(46.0 mm)
when compressed with 54 to 62 lb.
(240 to 276 N) (24 to 28 kg)
Valve spring (3) .... 1.36 in.
(34.5 mm)
when compressed with 133 to 153 lb.
(592 to 681 N) (60 to 69 kg)

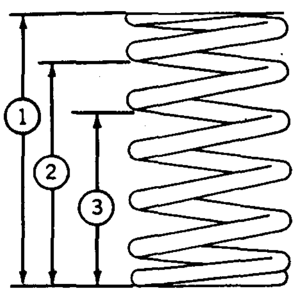


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Fig. 12-Valve Spring Length

ASSEMBLY

Apply AR44402, Valve Stem Lubricant, or its equivalent, to valve stems and guides. Install valves into guides from which they were removed. Valves must move freely and seat properly.

Position valve springs with end of spring correctly located in the machined counterbore (Fig. 13) of the cylinder head.

Install spring caps or rotators, if so equipped, and new retainer locks. "Pop" each valve three or four times by tapping the end of the valve stem with a soft mallet.

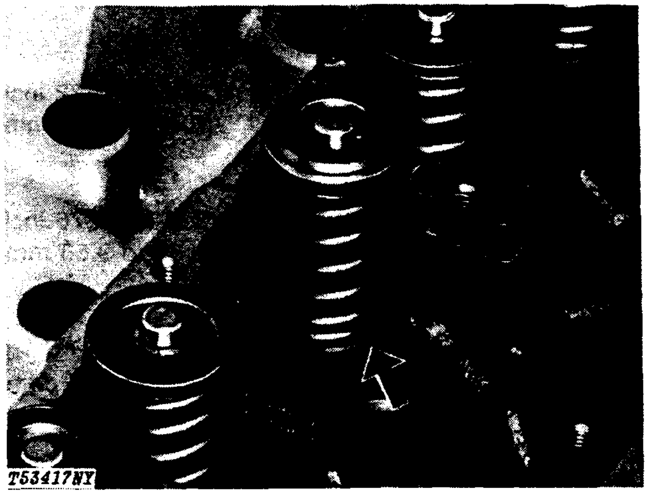

Fig. 13-Valve Spring Counterbore

INSTALLATION

IMPORTANT: Be sure all tapped holes in cylinder block are clean and free of foreign matter before installing cylinder head.

NOTE: Head gasket will fit only one way. It should not be necessary to force the gasket. The dowel pins on the cylinder head will line up gasket properly.

Install cylinder head gasket dry.

Set cylinder head in place on the cylinder block.

Inspect cap screws for thread or under head damage. Replace as necessary.

Use hardened flat washers under all cap screws. Dip cap screws in oil prior to installation. Start cylinder head to cylinder block cap screws by hand and tighten evenly, in several steps with 95 lb-ft (129 Nm) (13 kg-m) torque following applicable sequence illustrated in Fig. 14, 15 or 16.

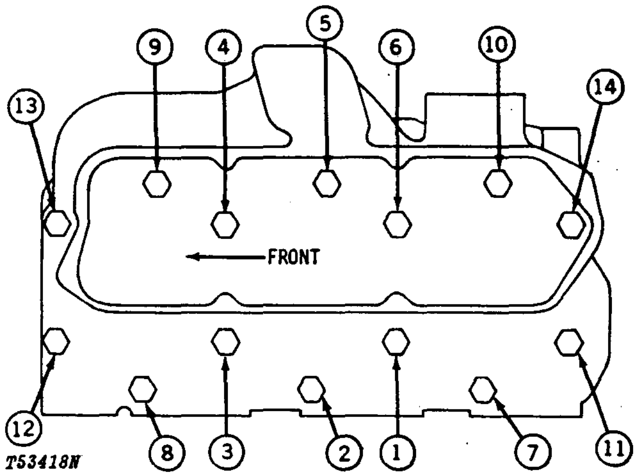

Fig. 15-Three Cylinder Cylinder Head Torque Sequence

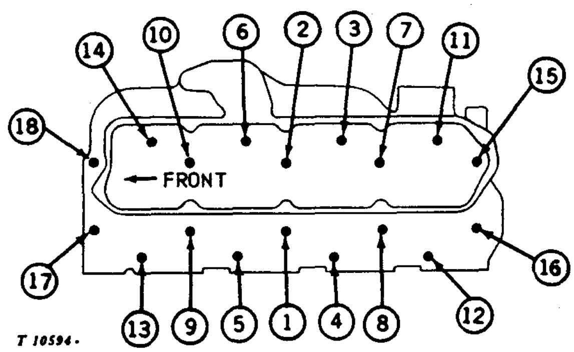

Fig. 15-Four Cylinder Cylinder Head Torque Sequence

Install valve stem wear caps making sure they turn freely.

Install pushrods, rocker arm assembly, adjust valve clearance, and install rocker arm cover (Group 0402).

Install injection nozzles and injection lines (Group 0413).

Install exhaust manifold (Group 0410).

Install fuel filter (Group 0420).

Install water manifold or thermostat housing (Group 0418).

Install air inlet piping on non-turbocharged engines (Group 0520) or turbocharger (Group 0416).

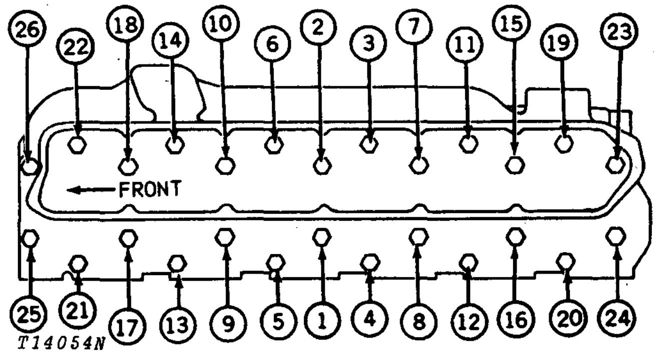

Fig. 16-6 Cylinder Cylinder Head Torque Sequence

Group 0410
EXHAUST MANIFOLD

GENERAL INFORMATION

The exhaust manifold is an external pipe located on the left side of the engine, as shown in Fig. 1.

REMOVAL

Stop engine.

Allow engine time to cool.

Disconnect battery negative (−) ground.

Remove turbocharger if equipped (See Group 0416).

Disconnect or remove exhaust pipe.

Remove cap screws that hold exhaust manifold to the engine.

Remove exhaust manifold.

REPAIR

Inspect exhaust manifold for cracks and holes. Replace or repair as necessary.

Clean manifold.

INSTALLATION

Replace all gaskets.

Reinstall exhaust manifold.

Replace turbocharger if equipped (Group 0416).

Connect exhaust pipe.

Connect battery negative (−) ground.

Start engine. Check for leaks in system.

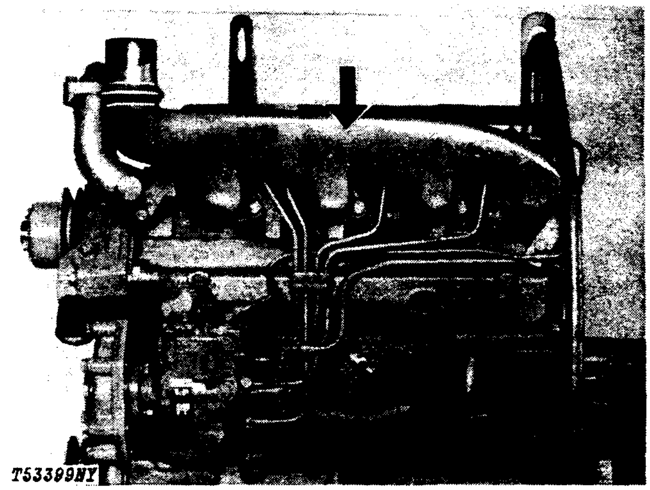

Fig. 1-Exhaust Manifold

Group 0413
FUEL INJECTION SYSTEM

FUEL INJECTION PUMP

REMOVAL

IMPORTANT: Never steam clean or pour cold water on an injection pump while the pump is running or while it is warm.

Clean the injection pump, lines, and area around the pump with cleaning solvent or a steam cleaner.

3-164D, 4-219D, 4-276D and 6-329D Engines

Fuel Injection Pump Only

Position crankshaft so that number one piston is at top dead center on compression stroke.

CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin causing serious personal injury.

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

To relieve high pressure in the fuel system, slightly crack fuel injection line connections at each injection nozzle with two wrenches (Fig. 1).

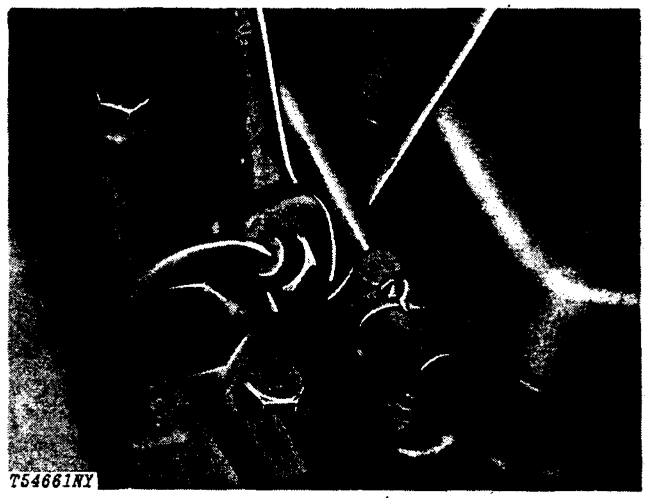

Fig. 1-Crack Injection Lines at Nozzles

Disconnect fuel supply line (1, Fig. 2), fuel return line (2), and fuel injection lines (3). Plug or cap all openings.

Disconnect throttle linkage (4) and wire throttle lever in high idle position.

Remove nuts (5) attaching injection pump to engine front plate.

4

Slide pump in a straight line away from the front plate.

Injection pump drive gear and shaft will remain on front plate.

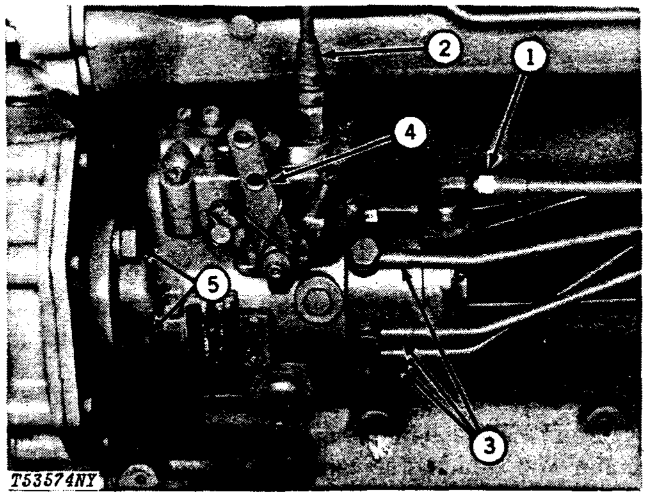

Fig. 2-Fuel Injection Pump Removal

Injection Pump Drive Shaft

Remove injection pump (Group 0413).

Remove injection pump gear cover.

Remove thrust pin (1, Fig. 3) and thrust spring.

Loosen nut (2) to the end of the drive shaft.

Using a brass drift, drive the drive shaft to the rear.

Remove nut and pull drive shaft out being careful not to drop the woodruff key.

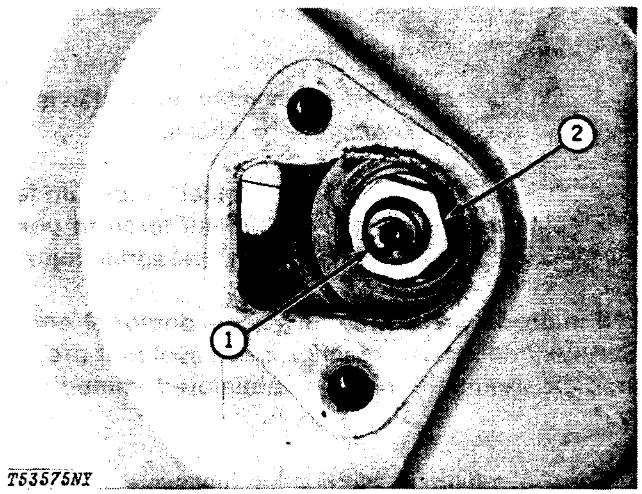

Fig. 3-Drive Shaft Removal

Injection Pump Drive Gear and Shaft

Remove timing gear cover (Group 0402).

Using JD-254 Timing Tool, check to see that drive gear timing marks align with timing tool (Fig. 4).

Slide drive gear and shaft forward to remove them.

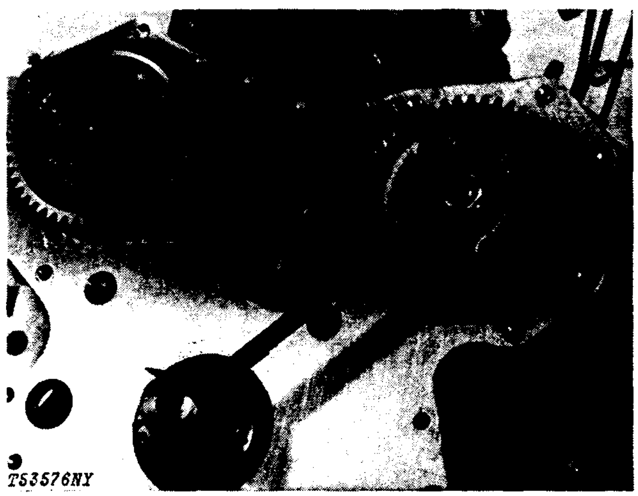

Fig. 4-JD-254 Timing Tool

4-276T, 6-414D, and 6-414T Engines

Remove timing hole cover and install 19918 Timing Window on injection pump.

Rotate crankshaft to position number one piston at top dead center on compression stroke. The timing marks on the governor weight retainer and cam ring should align.

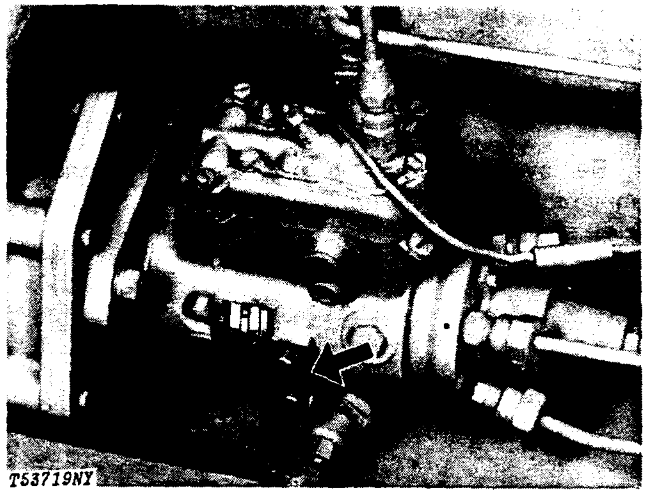

Fig. 5-19918 Timing Window

CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin causing serious personal injury.

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

To relieve high pressure in the fuel system, slightly crack fuel injection line connectors at each injection nozzle.

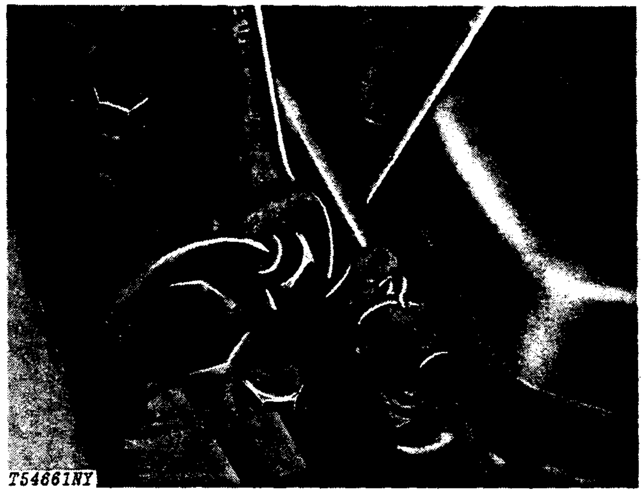

Fig. 6-Crack Injection Lines at Nozzles

Disconnect throttle linkage (1, Fig. 7).

Disconnect fuel supply line (2) and fuel return line (3).

IMPORTANT: When removing injection lines, do not turn pump outlet fittings. Turning these fittings may damage pump internally.

Using two wrenches, disconnect injection lines (4).

Plug or cap all openings.

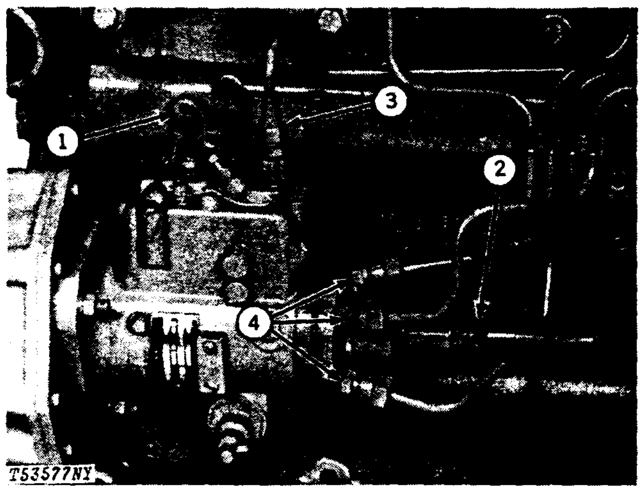

Fig. 7-Fuel Injection Pump Removal

Remove injection pump gear cover from timing gear cover.

Remove drive gear nut (1, Fig. 8).

Remove injection pump attaching nuts (2) and remove injection pump from front plate.

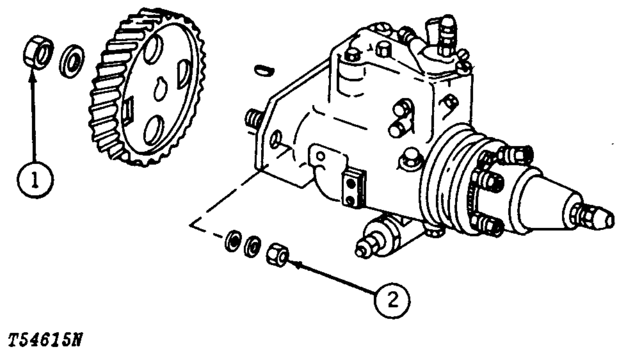

Fig. 8-Drive Gear Nut

4

REPAIR

3164D, 4219D, 4276D, and 6329D Engines

Roosa-Master Model JDB (Fig. 9)

For injection pump repair information, refer to SM-2045, "Testing and Servicing Fuel Injection Pumps and Nozzles".

For test stand specifications, see Group 0499.

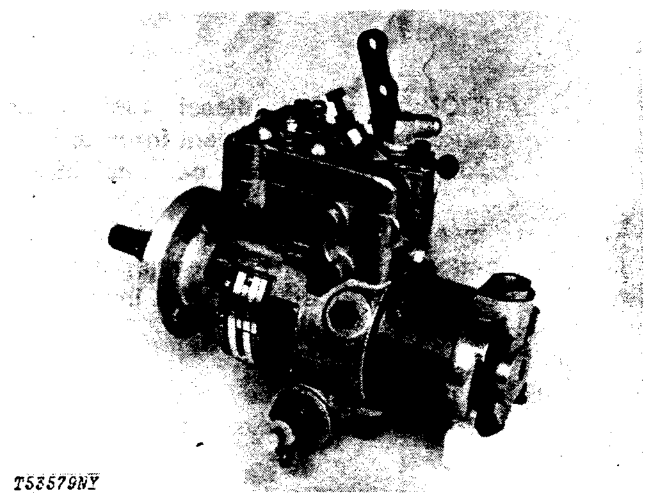

Fig. 9-Roosa-Master Model JDB

Drive Shaft and Gear

Remove thrust pin (1, Fig. 10) and thrust spring (2) from shaft.

Remove nut (3) from end of shaft.

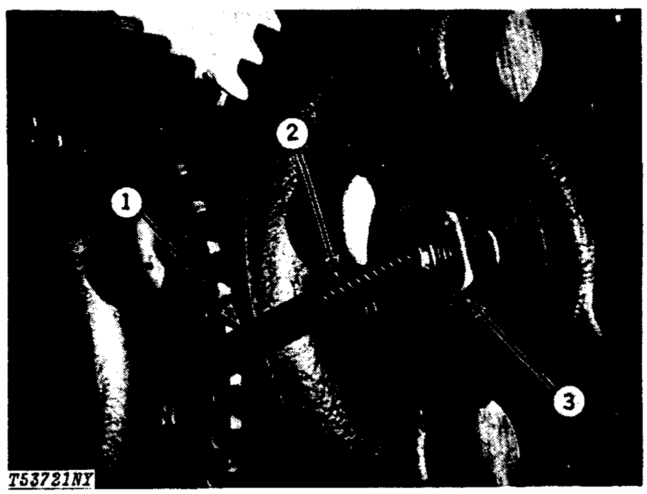

Fig. 10-Drive Shaft and Gear

Support gear and press shaft from gear (Fig. 11).

Inspect gear for cracked and broken teeth.

For drive shaft repair information, refer to SM-2045 "Testing and Servicing Fuel Injection Pumps and Nozzles".

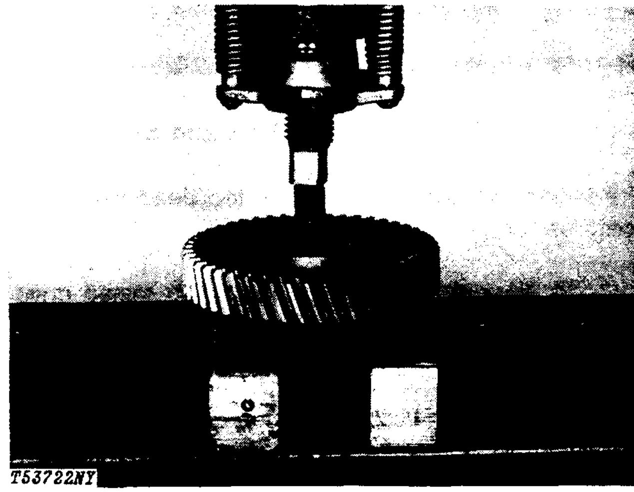

Fig. 11-Separate Gear and Shaft

When installing drive gear on drive shaft, tighten nut (Fig. 12) with 35 lb-ft (47 Nm) (5 kg-m) torque.

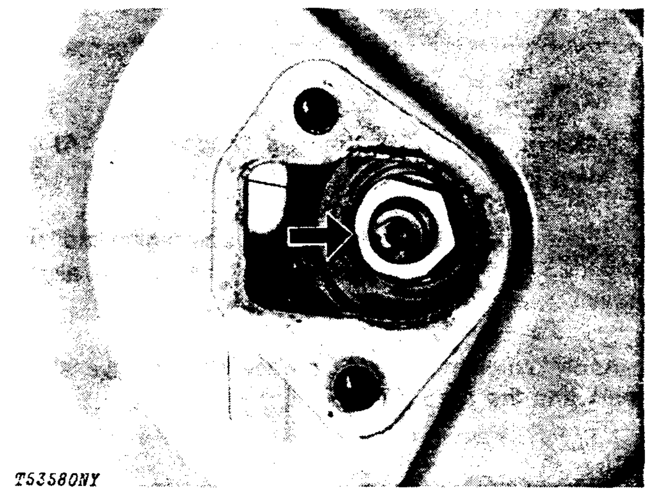

Fig. 12-Injection Pump Drive Gear Nut

4

4276T, 6416D, and 6414T Engines

Roosa-Master Model DM (Fig. 13)

For injection pump repair information, refer to TM-1109, "Fuel Injection Equipment - Roosa-Master (Industrial)".

For test stand specifications, see Group 0499.

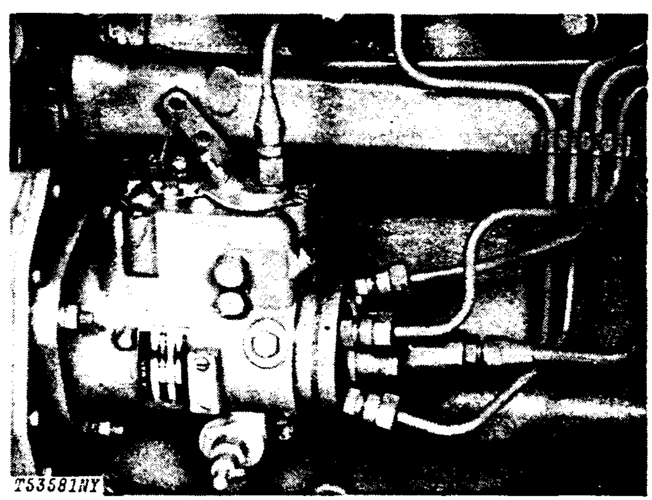

Fig. 13-Roosa-Master Model DM

INSTALLATION

3164D, 4219T, 4276D, and 6329D Engines

Injection Pump Drive Gear and Shaft

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

Using JD-254 Timing Tool (Fig. 14), install drive gear and shaft with timing marks on gear in alignment with the timing tool.

Install timing gear cover (Group 0402).

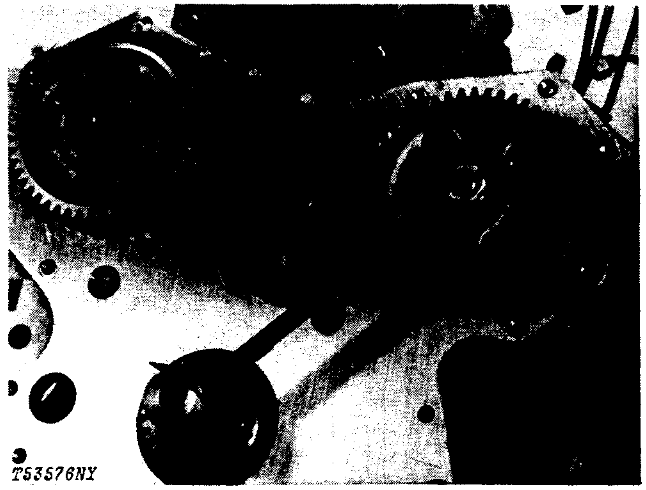

Fig. 14-JD-254 Timing Tool

Fuel Injection Pump

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

Install JD-259 (13366) Timing Window (Fig. 15) on injection pump timing hole.

Rotate injection pump drive shaft until timing lines on cam ring and governor weight retainer are in alignment.

Apply a coating of light grease to the drive shaft seals and the area around them.

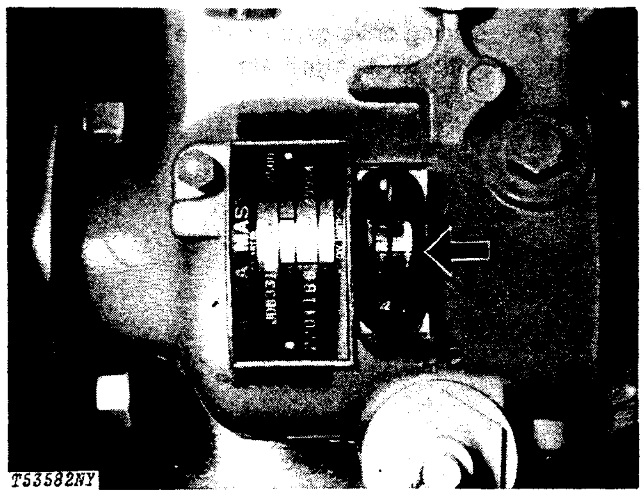

Fig. 15-JD-259 (13366) Timing Window

IMPORTANT: Do not invert drive shaft seal lips. If resistance is felt, stop and inspect position of seal. If seal has been forced back, replace seal.

Using JD-256 (13371) Drive Shaft Seal Compressing Tool (Fig. 16), compress seal on drive shaft and slide pump into place.

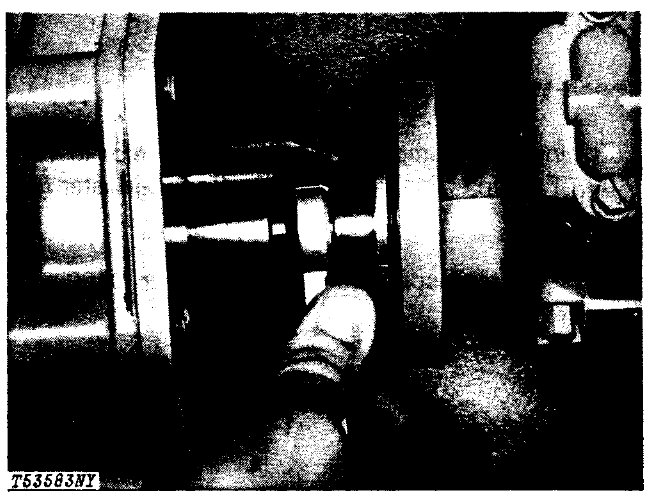

Fig. 16-JD-256 (13371) Drive Shaft Seal Compressing Tool

Install pump attaching nuts finger tight.

Rotate pump counterclockwise (viewed from flywheel end) then in opposite direction until timing lines (Fig. 17) on cam ring and governor weight retainer are aligned.

Tighten pump attaching nuts.

Rotate crankshaft counterclockwise (viewed from front end) approximately 180°. Reverse crankshaft rotation and reposition number one piston at top dead center on compression stroke.

Check timing lines on injection pump. If not aligned, retime pump.

IMPORTANT: Do not use washers other than those specified.

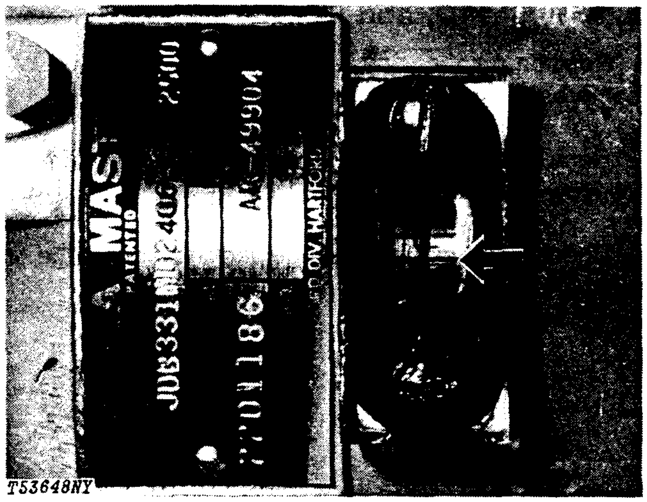

Fig. 17-Injection Pump Timing Lines

Connect injection lines to injection pump using NEW washers (Fig. 18).

Injection line to injection
pump screw torque .... 35 lb-ft
(47 Nm) (5 kg-m)

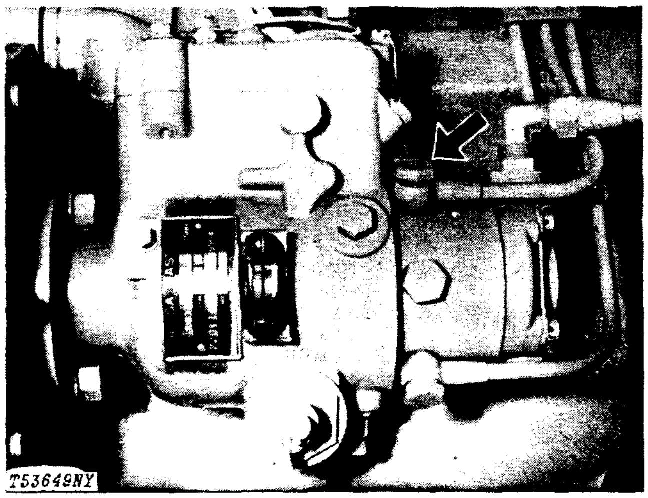

Fig. 18-Injection Line to Injection Pump Screw Torque

Connect fuel supply line (1, Fig. 19) and fuel return line (2).

Fuel supply line
connection torque (1) .... 20 lb-ft
(27 Nm) (3 kg-m)

Fuel return line
connection torque (2) .... 20 lb-ft
(27 Nm) (3 kg-m)

Connect throttle linkage, remove timing window, and install timing hole cover.

Bleed the fuel system (Group 0413).

See Group 9010 for adjustments.

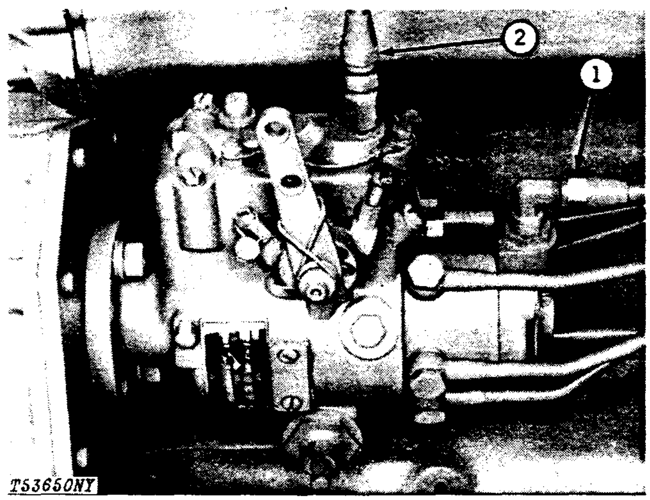

Fig. 19-Fuel Supply and Return Lines

4276T, 6414D, and 6414T Engines

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

Remove timing hole cover and install 19918 Timing Window (Fig. 20) on injection pump.

Check pump mounting flange packing for damage or wear. Replace if necessary.

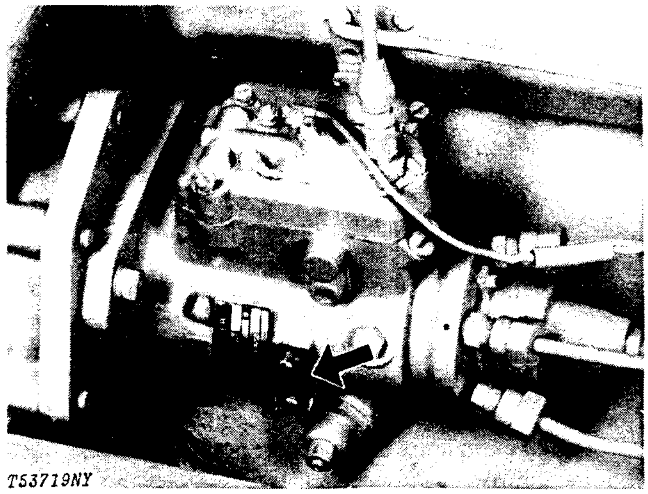

Fig. 20-19918 Timing Window

Rotate pump drive shaft and align timing lines (Fig. 21) on governor weight retainer and cam ring.

Position pump on engine front plate making sure Woodruff key enters drive gear.

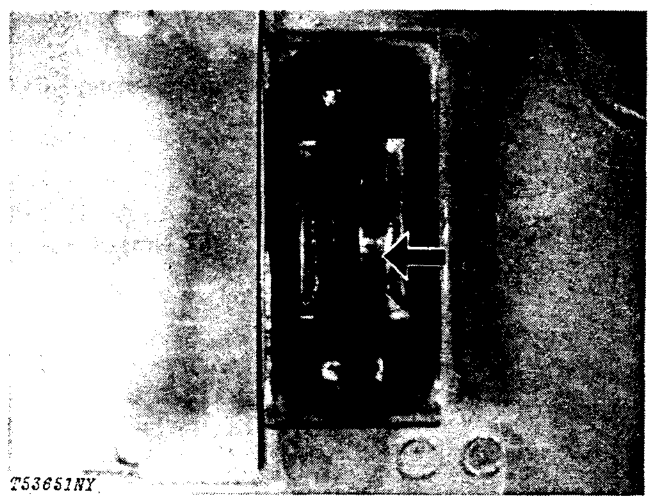

Fig. 21-Injection Pump Timing Lines

Install washer and nut on oiled pump drive shaft (Fig. 22).

Injection pump drive
gear nut torque (oiled) .... 150 lb-ft
(203 Nm) (21 kg-m)

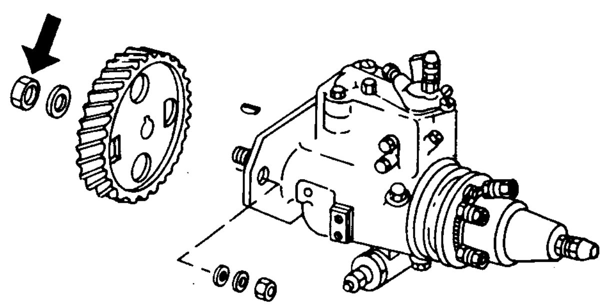

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Fig. 22-Injection Pump Drive Gear Nut

Install pump attaching nuts (Fig. 23) finger tight.

Rotate injection pump housing counterclockwise (viewed from flywheel end) as far as possible.

Rotate crankshaft counterclockwise (viewed from front end) approximately 180°. Reverse rotation and reposition number one piston at top dead center on compression stroke.

Rotate injection pump housing clockwise (viewed from flywheel end) until timing lines align.

Tighten injection pump attaching nuts (Fig. 23).

Injection pump attaching
nut torque .... 20 lb-ft
(27 Nm) (3 kg-m)

Rotate crankshaft counterclockwise (viewed from front end) approximately 180°. Reverse rotation and reposition number one piston at top dead center on compression stroke.

Injection pump timing lines should be aligned. If not, retime injection pump.

Connect fuel supply line (1, Fig. 24), fuel return line (2) and fuel injection lines (3).

Fuel line
connection torque (1) .... 20 lb-ft
(27 Nm) (3 kg-m)

Fuel return line.......................... 20 lb-ft
(27 Nm) (3 kg-m)

Fuel injection line
connector torque .... 35 lb-ft
(47 Nm) (5 kg-m)

Connect throttle linkage, remove timing window, and install timing hole cover.

Bleed the fuel system (Group 0413).

See Group 9010 for adjustments.

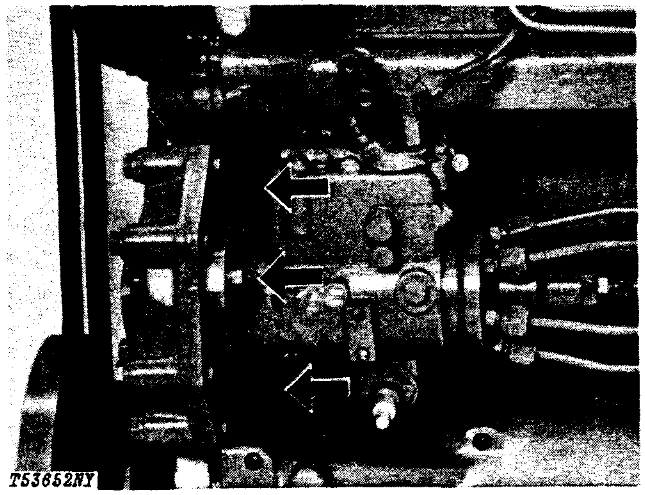

Fig. 23-Injection Pump Attaching Nuts

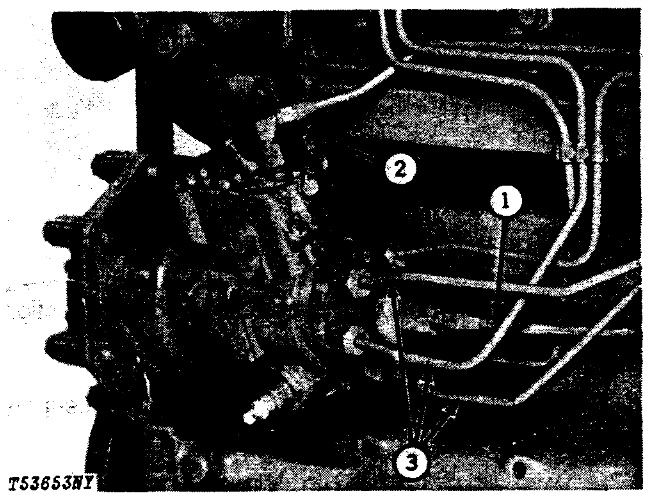

Fig. 24-Fuel Supply and Return Lines

4

BLEEDING

Loosen fuel filter bleed screw (Fig. 25).

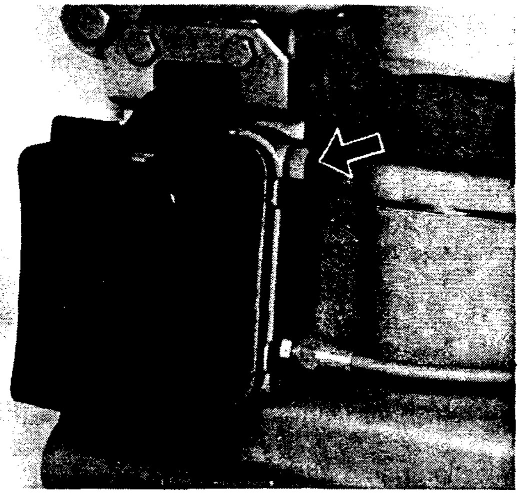

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Fig. 25-Fuel Filter Bleed Screw

Pump primer lever, located on fuel transfer pump, until no air flows from bleed screw.

Tighten the bleed screw.

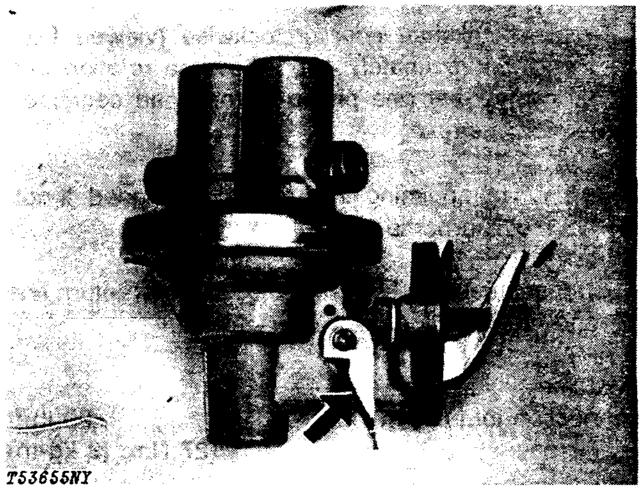

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Fig. 26-Fuel Transfer Pump Primer Lever

Slightly crack fuel supply line connection at injection pump (Fig. 27).

Pump primer lever until no air flows from fuel supply line connection.

Tighten line connection.

Fuel supply line
connection torque .... 20 lb-ft
(27 Nm) (3 kg-m)

Leave primer lever positioned toward the cylinder block.

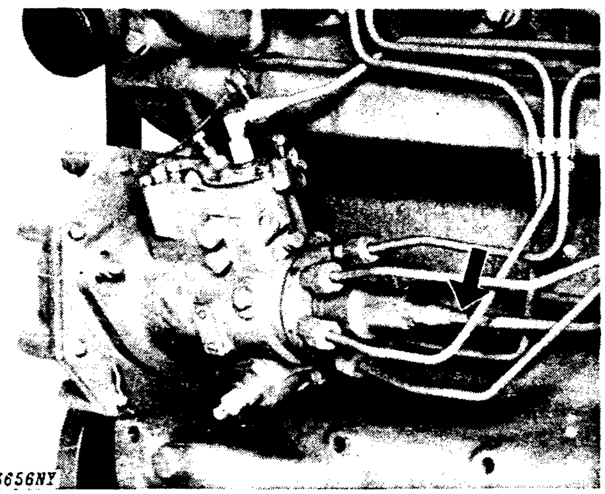

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Fig. 27-Fuel Supply Line Connection

FUEL INJECTION NOZZLES

REMOVAL

CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin causing serious personal injury.

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

To relieve high pressure in the fuel system, slightly crack fuel injection line connectors at each injection nozzle with two wrenches (Fig. 28).

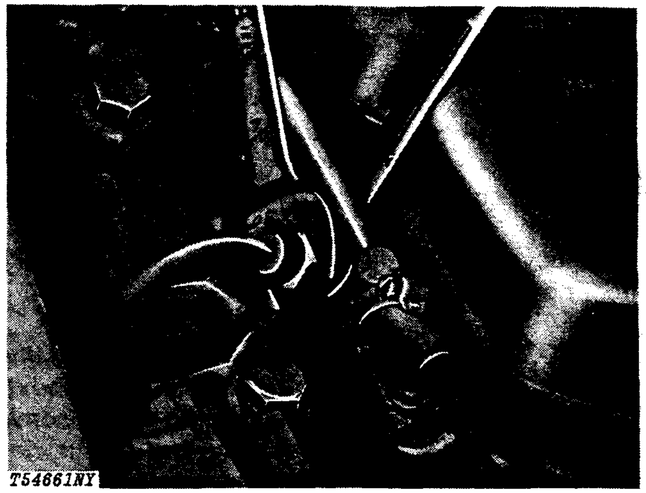

Fig. 28-Crack Injection Lines at Nozzles

Disconnect nozzle from fuel injection line at nozzle inlet connector (1, Fig. 29) and unscrew hex fitting (2) from leak off connector (3).

Remove nozzle hold down cap screw and washer (4), clamp (5), and spacer (6).

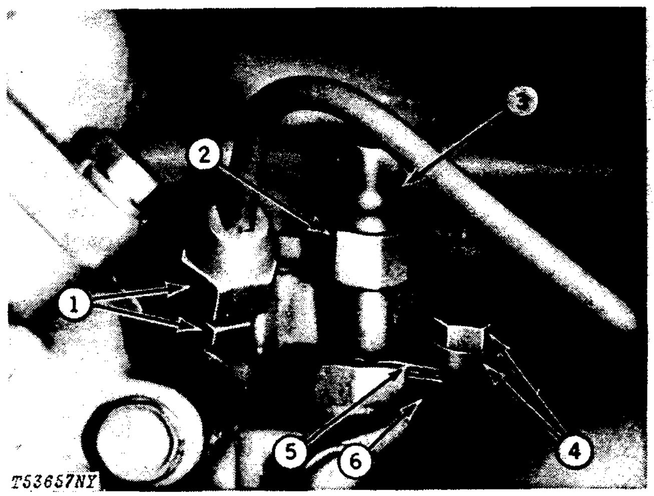

Fig. 29-Injection Nozzle Removal

IMPORTANT: Do not use screw driver or pry bars to remove injection nozzles from cylinder head.

Pull injection nozzle from cylinder head. If nozzle cannot be easily removed, use JDE-38 Nozzle Puller (Fig. 30) to remove it.

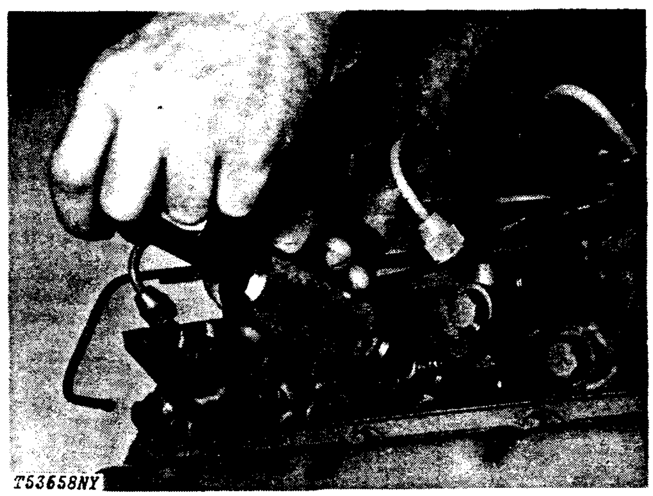

Fig. 30-JDE-38 Nozzle Puller

REPAIR

IMPORTANT: Do not attempt to test or disassemble nozzles unless the proper service tools are available. See TM-1109 "Fuel Injection Equipment-Roosa Master" (Industrial) for repair and testing procedures necessary to service injection nozzles.

For test stand specifications, see Group 0499.

Remove carbon seal (1, Fig. 31) and seal washer (2) from nozzle.

IMPORTANT: Do not scrape or otherwise damage the Teflon coating on the nozzle body above the carbon seal groove. This coating will become discolored during normal service, but this is not harmful. Do not use a motor-driven brush to clean the nozzle body.

Clean the exterior of nozzle by soaking in clean solvent or diesel fuel. Then clean the spray tip with a brass wire brush.

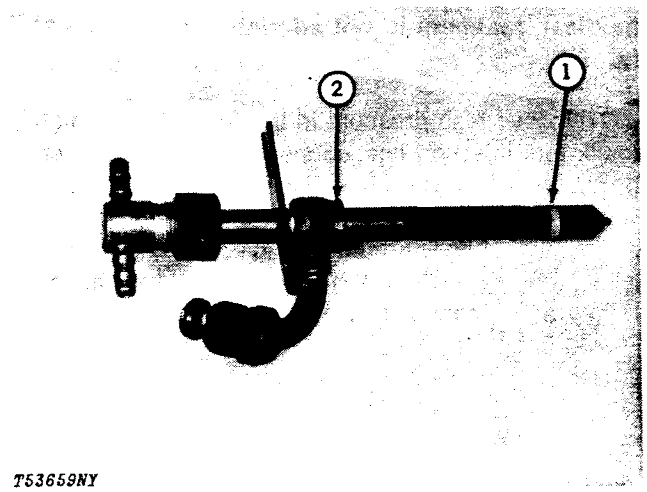

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Fig. 31-Seal Removal

Position JD-258 (16477) pilot (2, Fig. 32) over nozzle tip and place new carbon seal (3) over pilot.

Use a new seal washer (1) to help slide the carbon seal into place in its groove.

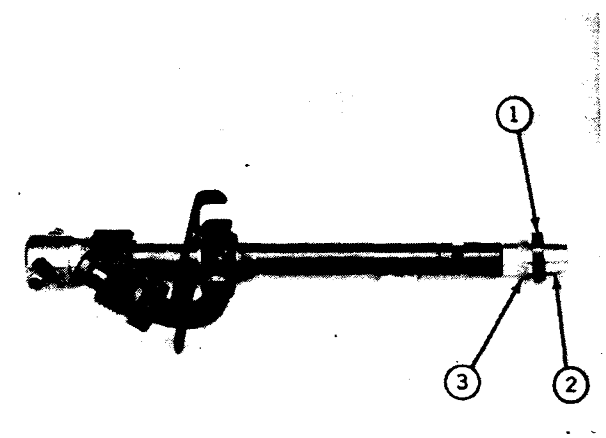

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Fig. 32-JD-258 (16477) Pilot

Using JDE-39 Nozzle Bore Cleaning Tool (Fig. 33), clean the cylinder head nozzle bore.

Use compressed air to remove debris from nozzle bore.

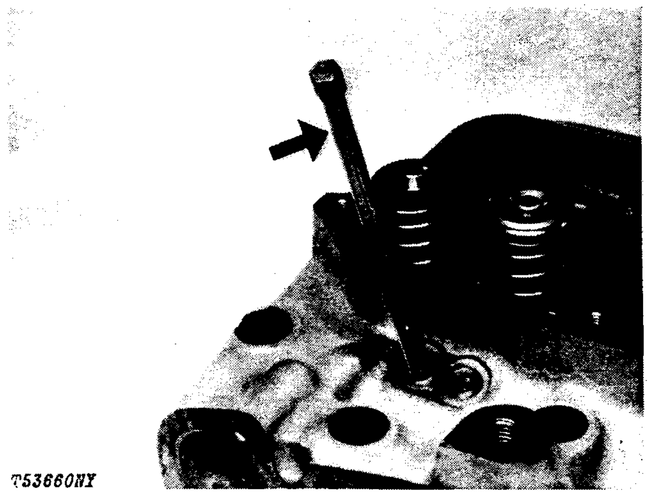

Fig. 33-JDE-39 Nozzle Bore Cleaning Tool

INSTALLATION

Install injection nozzle in cylinder head bore with a twisting motion.

Install spacer (6, Fig. 34), clamp (5), and cap screw and washer (4).

Connect injection line to nozzle inlet connector (1) and hand tighten.

Screw hex fitting (2) onto leak off connector (3).

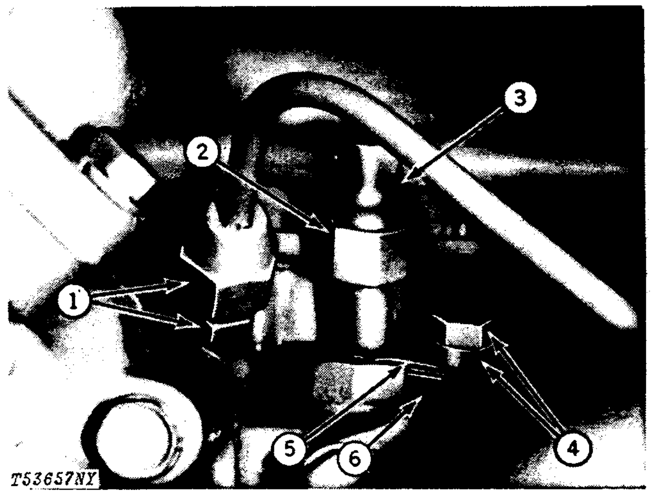

Fig. 34-Injection Nozzle Installation

Tighten nozzle hold down cap screw (1, Fig. 35) and inlet connector (2).

Nozzle hold down
cap screw torque (1) .... 20 lb-ft
(27 Nm) (3 kg-m)

Nozzle inlet
connector torque (2) .... 35 lb-ft
(47 Nm) (5 kg-m)

Bleed the fuel injection system (Group 0413).

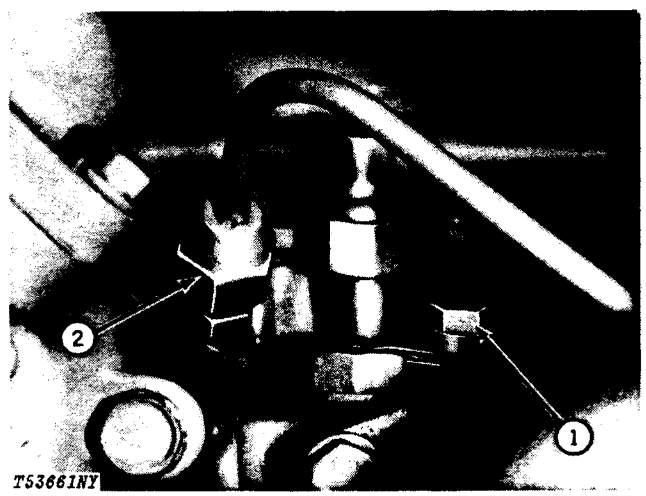

Fig. 35-Nozzle Hold Down and Inlet Connector Torque

Litho in U.S.A.

Group 0414
INTAKE MANIFOLD

GENERAL INFORMATION

The intake manifold will be located on the right side of the engine cylinder head. The manifold will either be cast into the head or it will consist of an external manifold (Fig. 1). It may be fed directly from the air cleaner or from a turbocharger.

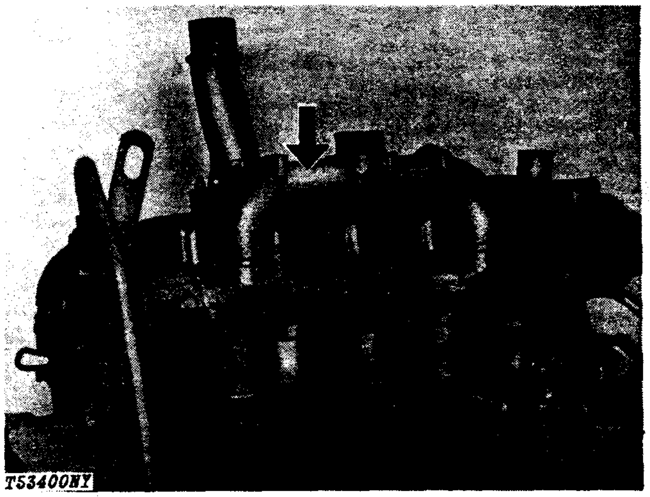

Fig. 1-Intake Manifold Location

REMOVAL

Stop engine.

Disconnect battery negative (–) cable.

Allow engine to cool.

Remove air cleaner hose.

Remove turbocharger if equipped (Group 0416).

Remove air cleaner supports if equipped.

Disconnect cold weather starting fluid tube if equipped.

REPAIR

Inspect manifold for cracks.

Clean and inspect all passages.

INSTALLATION

Using new gaskets install air intake manifold on cylinder head.

Install air cleaner support and air cleaner.

Install turbocharger (Group 0416) if equipped.

Connect battery negative (–) cable.

Make sure all connections are tight and sealed to prevent unfiltered air entry into engine.

4

4

Group 0415
ENGINE BALANCER

GENERAL INFORMATION

Two types of balancer shafts are used (Fig. 1). They are mounted in the lower half of the cylinder block and each rotates in three pressure-lubricated replaceable bushings.

The balancer shafts rotate in opposite directions to reduce engine vibration. Thrust of the balancer shafts is absorbed by thrust plates fastened to the front of the cylinder block.

REMOVAL

Remove fan belts, alternator, and fan.

Remove oil pan.

Disconnect oil cooler lines.

Use a pulley puller to remove the crankshaft pulley.

Remove the timing gear cover.

Remove weights from the balancer shafts (2, Fig. 1), if equipped.

Remove oil pump gear and lower idler gear.

Remove balancer shafts and identify as left and right.

Remove balancer shaft gears (4, Fig. 1) by pressing them off.

Remove balancer shaft thrust plates (3, Fig. 1).

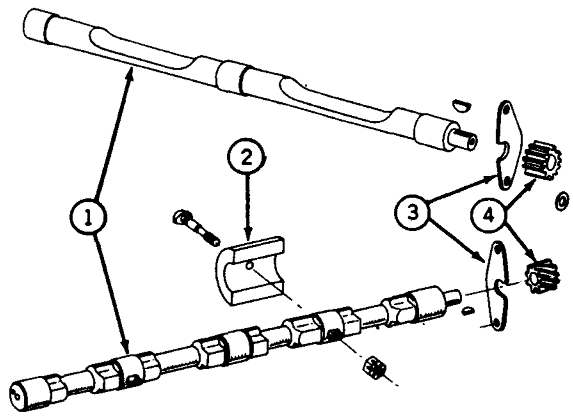

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Fig. 1-Engine Balancer Shafts

REPAIR

Determine if balancer shaft journals (2, Fig. 2) are within 1.500 to 1.501 in. (38.09 to 38.11 mm) and bushings (1, Fig. 2) are within 1.502 to 1.504 in. (38.15 to 38.20 mm). Check journal and bushings for scuffing or other damage. Replace shafts or bushings as required.

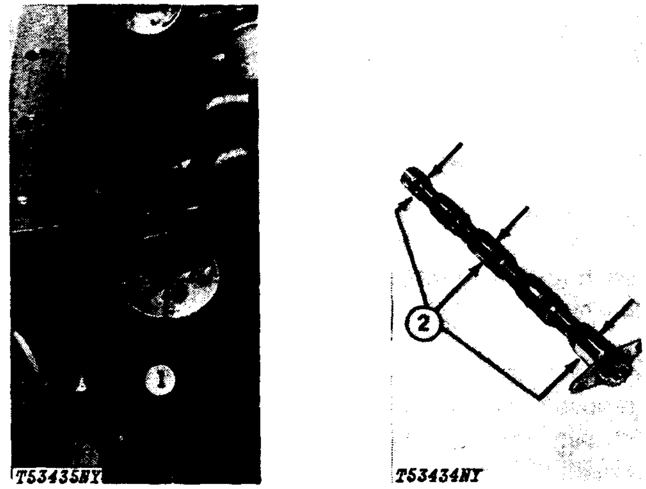


Fig. 2-Balancer Shaft Journals and Bushings Measurement

The first two bushings can be replaced using JD-249 Tool, Fig. 3.

To remove the third bushing the flywheel housing must be removed, see Group 0433.

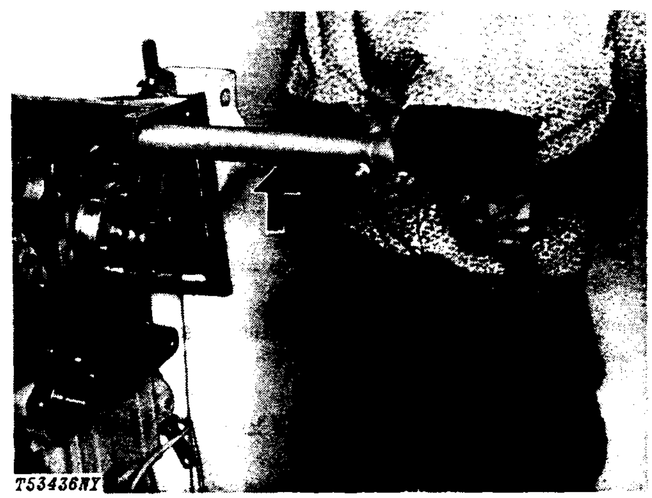


Fig. 3-Bushing Removal

IMPORTANT: Be sure that hole in each bushing lines up with upper oil lead hole in cylinder block.

Press all bushings in from the front of the engine until flush with bushing bore chamfer in block using JD249 Tool.

Inspect balancer shaft gears for worn, cracked or broken teeth.

Installing Drive Gear

It may be necessary to place thrust plate on the shaft before installing the gear on the shaft depending on the type of thrust plate used.

Position balancer shaft drive gear on front of balancer shaft so slot in gear lines up with special key, and timing mark on front of gear faces away from balancer shaft. Press on gear using JD-247 Holding Tool to support shaft as shown in Fig. 4. Press gear on shaft with thrust plate in position. Clearance between thrust plate and gear should be 0.002 to 0.010 in. (0.05 to 0.25 mm).

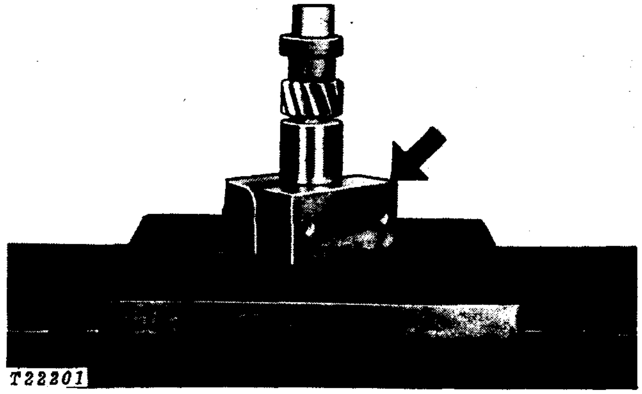


Fig. 4-Replacing Balancer Shaft Gear

INSTALLATION

Apply a light film of oil to balancer journals and bushings.

Secure thrust plates to front plate with hardware and tighten with 35 lb-ft (47 Nm) (5 kg-m).

Install balancer shafts in their respective bores. Time balancer shafts as shown in Fig. 5 using JD254 Timing Tool.

Fig. 5-Timing Balancer Shaft

With a dial indicator check balancer shaft for end play of no more than 0.010 in. (0.25 mm) or no less than 0.0020 in. (0.051 mm)

Install balancer shaft weights if used being sure weights are installed on the machine surfaces of the shaft. Run the balancer shaft bolts through the weights and then through the shafts as shown in Fig. 6. Tighten special nuts to 43 lb-ft (58 Nm) (6 kg-m).

Replace oil pump gear and lower idler gear if necessary.

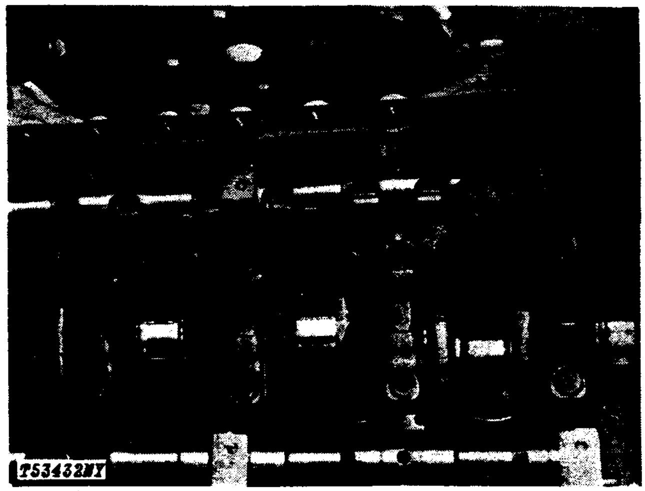


Fig. 6-Installing Balancer Shaft Weights

Install timing gear cover and crankshaft pulley (Fig. 7).

Install engine oil cooler coolant hose.

Install fan, alternator and fan belts.

Adjust fan belts as described in Group 0433.

Install engine oil pan. Use a new gasket.

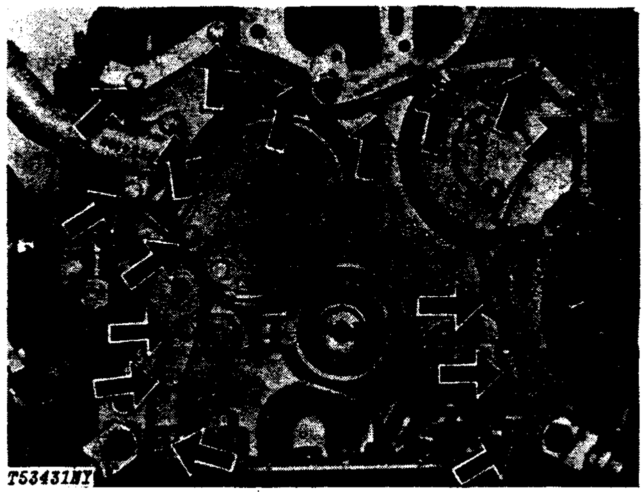


Fig. 7-Installing Timing Gear Cover

Group 0416
TURBOCHARGER

GENERAL INFORMATION

The turbocharger is located on the left side of the 4-276T and the 6-414T engines as shown in Fig. 1.

FOS

For theory of turbocharger operation, refer to FOS Manual—ENGINES.

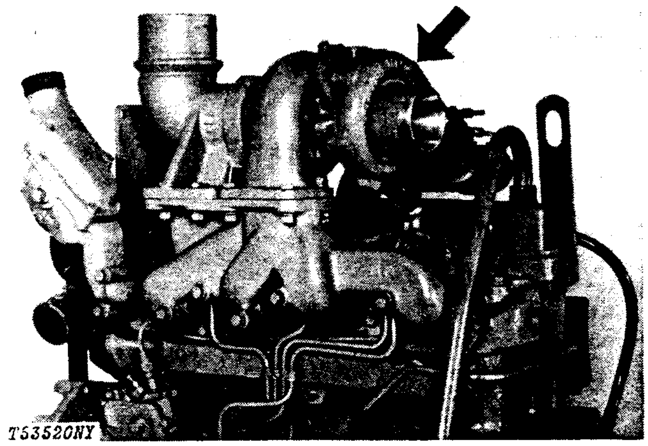


Fig. 1-Turbocharger

REMOVAL

Stop engine and allow exhaust system time to cool.

Remove engine enclosers until turbocharger is accessible.

Disconnect the air intake hose (1, Fig. 2) at turbocharger.

Remove exhaust elbow (2) and adapter (3).

Disconnect the inlet oil line (4) and return oil line (5) at turbocharger.

Remove the turbocharger mounting flange stud nuts (6). Loosen, but do not remove compressor housing cap screws (7).

Lift turbocharger off exhaust manifold, and disengage turbocharger and coupling (8) from intake manifold.

Cover all openings and clean exterior of turbocharger with a pressure spray of cleaning solvent. Dry turbocharger.

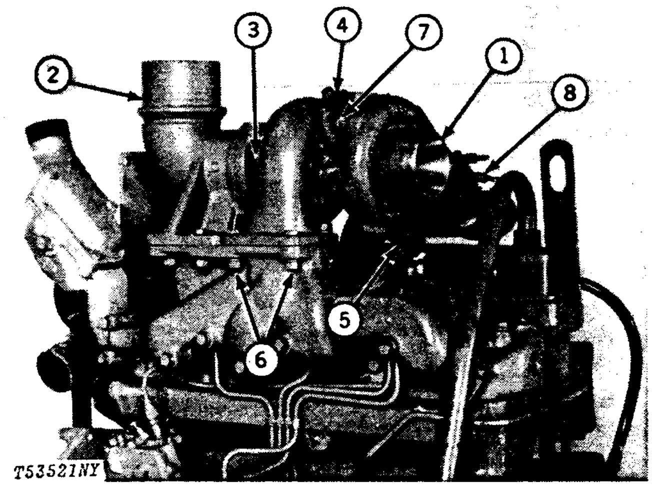


Fig. 2-Turbocharger Removal

4

TESTING

Radial Bearing Movement

Fasten a plunger dial indicator to the turbocharger housing mounting flange as shown in Fig. 3.

Apply side pressure on the turbine shaft back and forth, equal pressures should be applied simultaneously (Fig. 3).

The total movement should be 0.003 to 0.006 in. (.08 to 0.15 mm).

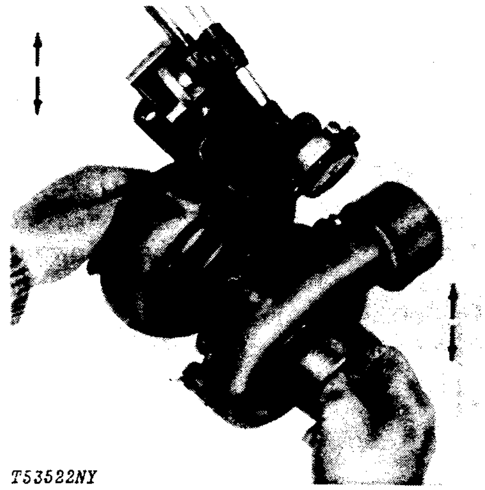


Fig. 3-Radial Bearing Movement Check

Axial Bearing Movement (Bearing End Play)

Remove compressor housing-to-center housing cap screws (7, Fig. 6), lock plates (6) and clamps (5).

Fasten dial indicator to turbine housing so that the indicator tip rests on the end of the shaft (Fig. 4).

Move the shaft back and forth axially by hand. The total axial movement of the shaft should be 0.001 to 0.004 in. (0.03 to 0.10 mm). If not repair or replace unit.

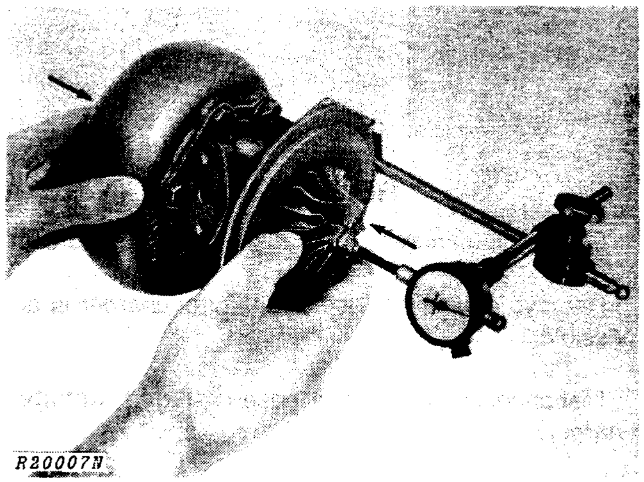


Fig. 4-Axial Bearing Movement Check

REPAIR

As each part is removed, place it in a clean protective container.

Refer to Fig. 6 for part identification and relationship.

Scribe a line on the mating surfaces of the turbine housing (1, Fig. 5) and center housing (2) to aid in alignment during reassembly.

Remove the turbine housing-to-center housing cap screws (5, Fig. 5), lock plates (3), and clamps (4). Carefully remove turbine housing.

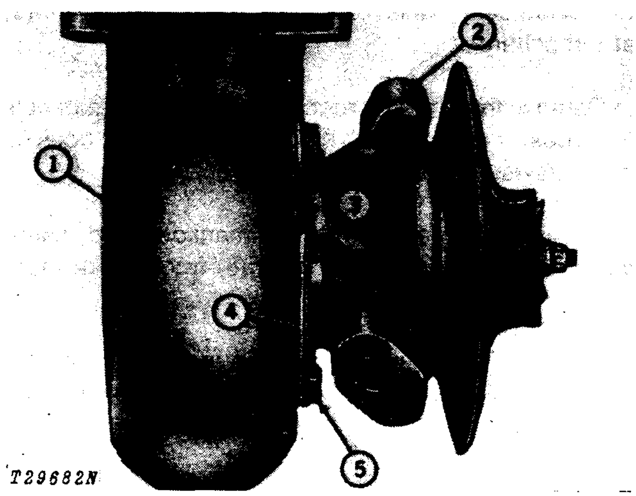
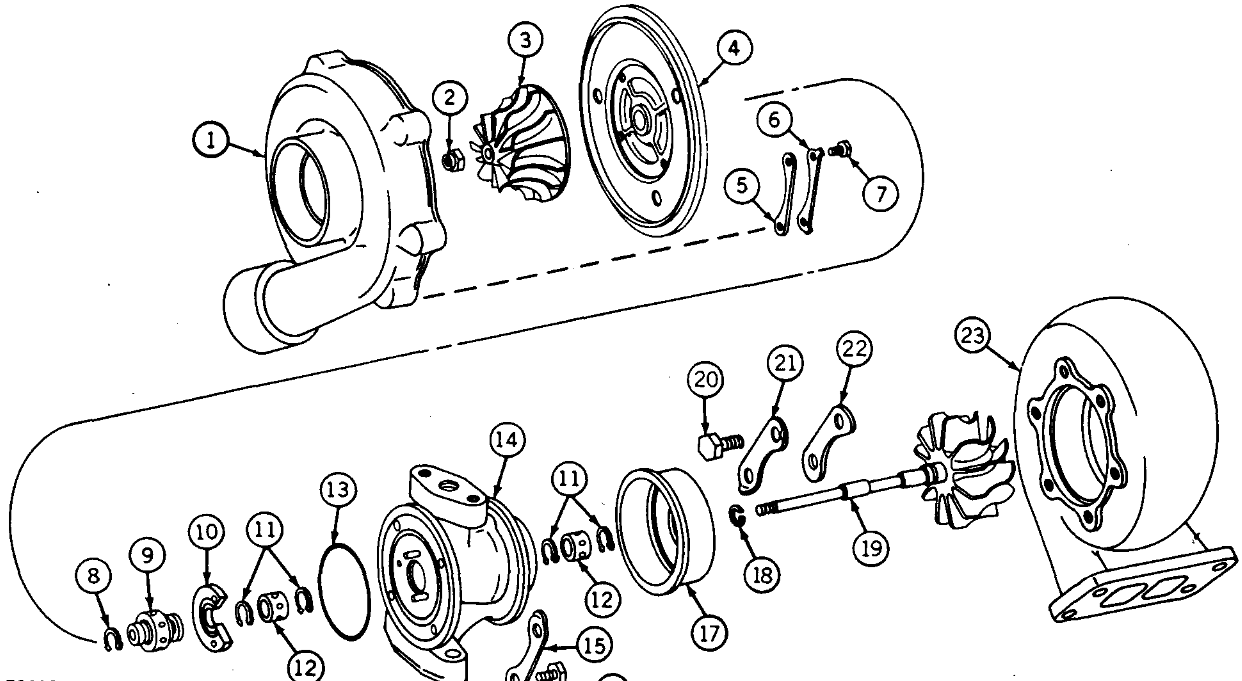


Fig. 5-Turbine Housing Removal



1—Compressor Housing
2—Lock Nut
3—Impeller
4—Backplate Assembly
5—Clamp (3 used)
6—Lock Plate (3 used)
7—Cap Screw (6 used)
8—Piston Ring
9—Thrust Collar
10—Bearing
11—Retaining Ring (4 used)
12—Bearing (2 used)
13—O-Ring
14—Center Assembly Housing
15—Lock Plate (2 used)
16—Cap Screw (4 used)
17—Wheel Shroud
18—Piston Ring
19—Turbine Wheel with Shaft
20—Special Bolt (6 used)
21—Lock Plate (3 used)
22—Clamp (3 used)
23—Turbine Housing

Fig. 6-Turbocharger Exploded View

Mount a suitable holding fixture (1, Fig. 7) (see Group 0499 Special Tools - Turbocharger) in a vise.

Insert the turbine wheel into the fixture.

Use a double universal socket to remove the compressor wheel retaining nut to avoid possible bending of the shaft.

Remove the impeller (2, Fig. 7) from the shaft.

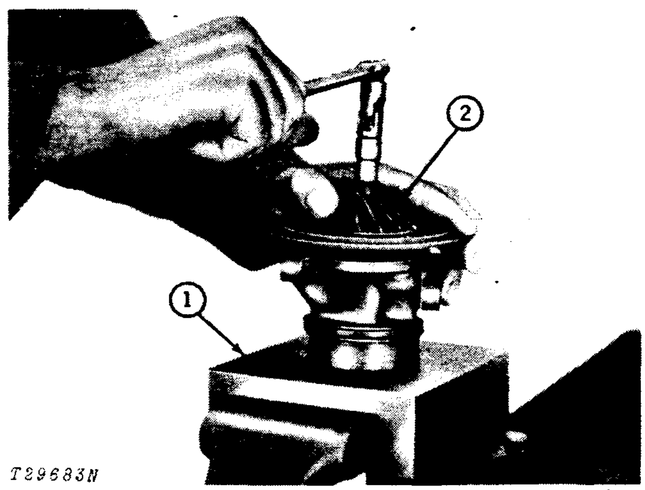


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Fig. 7-Removing Compressor (Impeller)

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Remove the turbine wheel and shaft assembly (3, Fig. 8) from the center housing keeping it centered until it is clear of the housing. Fig. 8 shows the turbine wheel assembly (1). The piston ring (2) can now be removed.

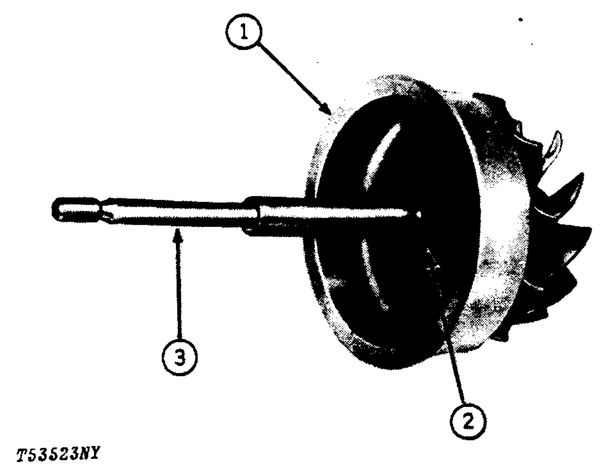

Fig. 8-Shaft and Wheel Assembly

Remove the back plate to center housing cap screw (16, Fig. 6) and lock plates (15).

Carefully remove back plate by tapping with a soft mallet.

IMPORTANT: Back plate (2, Fig. 9) and the spring (1) are sold only as an assembly. The installed depth of the spring is a controlled dimension. Therefore, do not remove or replace the spring by itself. Cleaning can be done without removing the spring from the back plate.

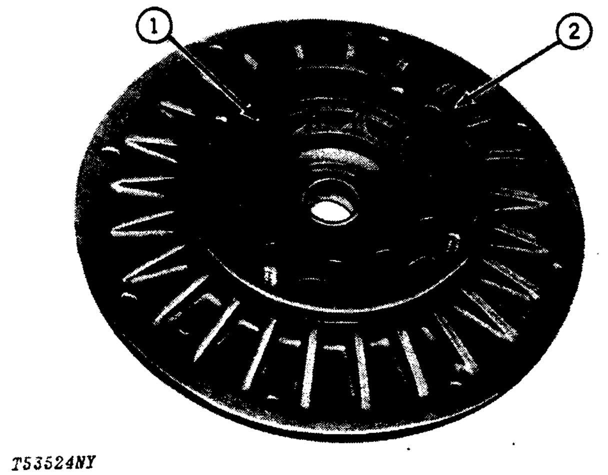

Fig. 9-Back Plate Assembly

Remove the thrust collar (2, Fig. 10) and thrust washer (3) as shown in Fig. 10. Remove the O-ring (1) from housing and piston ring (4) from thrust collar.

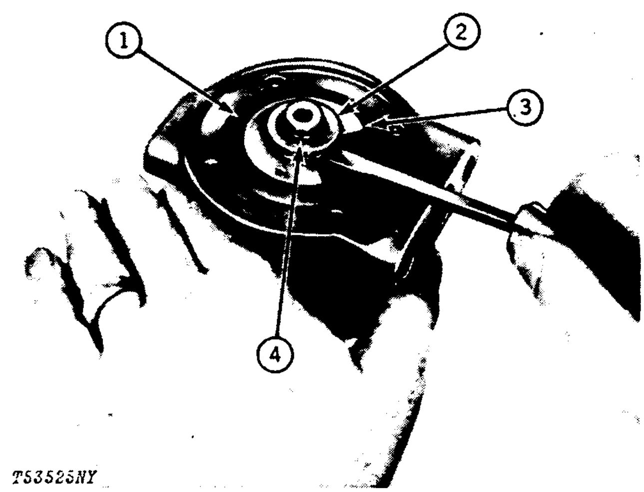

Fig. 10-Removing Thrust Collar and Thrust Washer

Remove retaining rings (2, Fig. 11) and bearings (1) from both sides of the center housing.

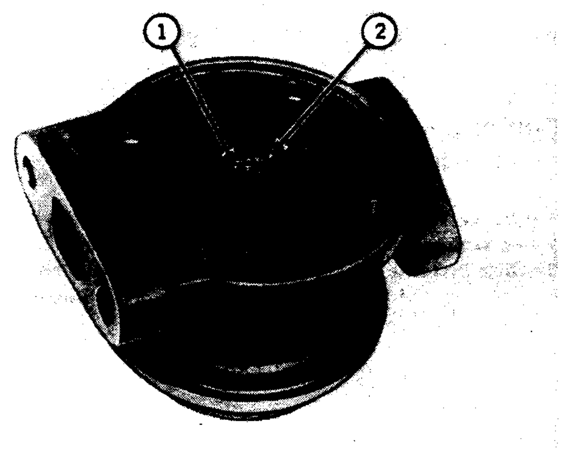

Fig. 11-Retaining Ring and Bearing Removal

Cleaning

Before cleaning, inspect parts for signs of burning, rubbing, or other damage which might not be evident after cleaning.

Soak all parts in clean carbon solvent for approximately 25 minutes. After soaking use a stiff bristle brush to remove all dirt particles. Dry parts thoroughly.

NOTE: Normally, a light accumulation of carbon deposits will not affect turbine wheel operation.

Inspection

Replace the following parts: O-ring (13, Fig. 6), lock plates (6, 15, and 21) piston rings (8 and 18), retaining rings (11), and all damaged nuts and bolts.

NOTE: If bearings and thrust washers show signs of nicks, scores, shellac deposits, or foreign material imbedment, replace them.

After cleaning, if any of the parts in the assembly show signs of rubbing, scoring, scratches, or seizure, replace them.

Assembly

Be sure each part is clean before assembling. As parts are assembled, cover openings to prevent entry of dirt or other foreign material.

NOTE: If any particle falls into the turbocharger during assembly, remove the particle immediately, even if extensive disassembly is required.

Check piston ring clearance (18, Fig. 6) in turbine wheel ring groove. Inspect for burrs or foreign matter.

Install bearing retaining rings (Fig. 12) using JD274 Retaining Ring Assembly Tool. Lubricate bearings with clean engine oil and insert in place.

1—Sleeve Tool
2—Retaining Ring
3—Ring Installer (JD274-3)
4—Inner Ring Sleeve (JD274-1)
5—Retaining Ring Installed
6—Bearing Installed
7—Outer Ring Sleeve (JD274-2)

Fig. 12 Legend

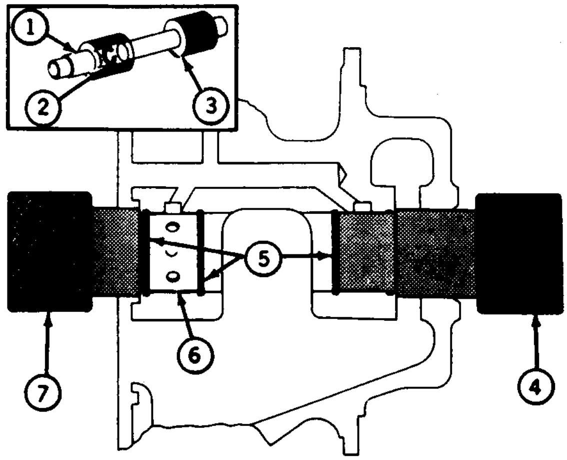

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Fig. 12-JD-274 Retaining Ring Assembly Tool

Install piston ring on turbine wheel shaft (Fig. 13). With turbine wheel shaft upright, guide through the wheel shroud and bearings. Do not use force to compress piston ring in place. A gentle rocking and pushing action will allow the piston ring to seat and the shaft to bottom. A thin tool, such as a dental pick or JDH-6 O-Ring Seal Hook may be used as an aid in compressing the ring if difficulty is encountered.

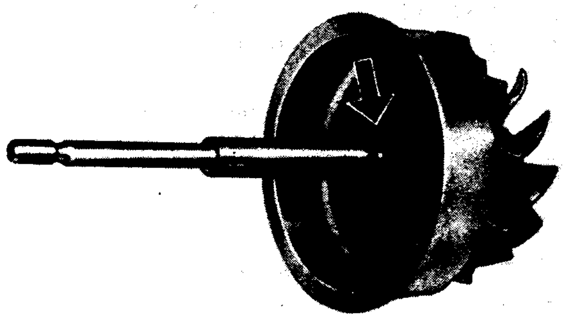

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Fig. 13-Piston Ring

Install piston ring (1, Fig. 14) on thrust collar (2). Place thrust collar, with channeled side toward center housing, over shaft (3), and flat against the center housing, (4), engaging the pins in the back side of the thrust washer.

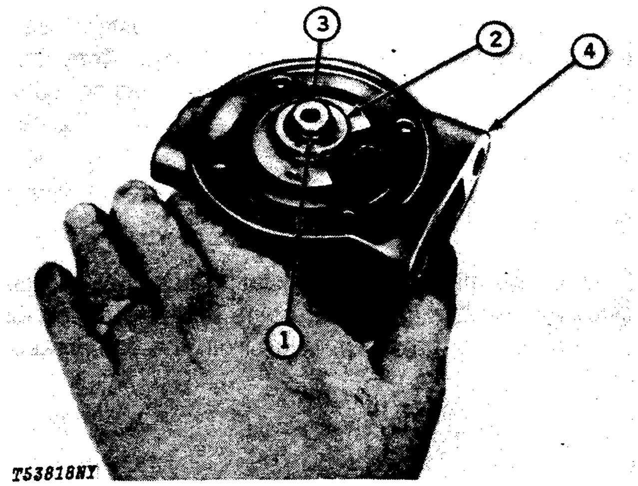

Fig. 14-Install Piston Ring On the Thrust Collar.

IMPORTANT: Back plate and spring are sold only as an assembly. The installed depth of the spring is a controlled dimension. Therefore, do not replace or remove the spring.

Be sure that the thrust spring is installed in back plate.

Align mounting holes of center housing and back plate and install back plate over shaft and thrust collar (Fig. 15). Use care not to break piston ring when engaging seal in back plate bore. Back plate is easily installed if open end of piston ring is engaged in back plate bore first.

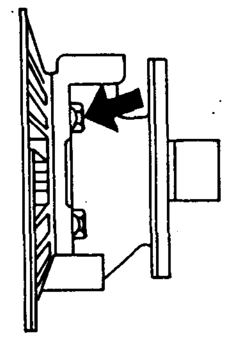

Fig. 15-Back Plate Cap Screws

Install back plate-to-center housing cap screws (Fig. 15) and lock plates. Tighten cap screws to 75 to 90 lb-in. (8.47 to 10.17 Nm) (0.86 to 1.04 kg/m), and bend corners of lock plates against head of cap screw.

Install compressor wheel and tighten lock nut (Fig. 16) to 18 to 20 lb-in. (2.03 to 2.26 Nm) (0.21 to 0.23 kg/m), then tighten through an angle of 90°.

Check axial bearing movement and radial bearing movement. If bearing end play is not within 0.001 to 0.004 in. (0.03 to 0.10 mm) or if bearing clearance is not within 0.003 to 0.006 in. (0.08 to 0.15 mm), reinspect parts and replace as necessary.

Make sure there is clearance between wheel shroud and turbine wheel.

Install compressor housing on center housing (Fig. 16), but do not tighten cap screws at this time. Leave the cap screws finger tight until turbocharger has been mounted.

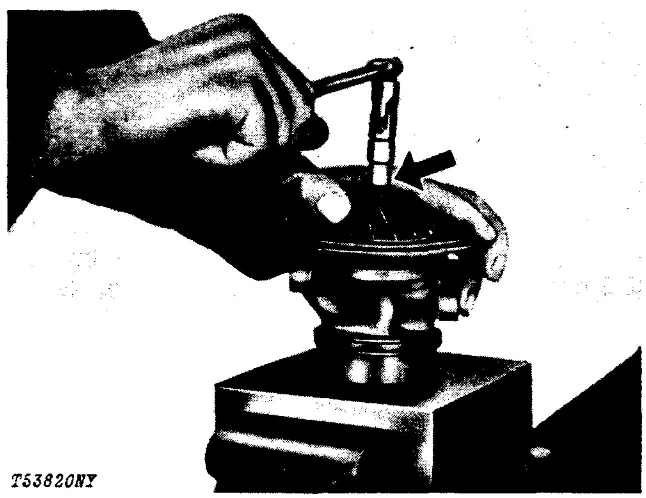

Fig. 16-Compressor Wheel Nut Torque

Orient turbine housing to center housing using scribe lines made during disassembly. Coat bolt threads with a high temperature, anti-seizing compound. Install lock plates, clamps and bolts. Tighten bolts (Fig. 17) to 140 to 170 lb-in. (15.8 to 19.2 Nm) (1.6 to 2.0 kg/m), and bend corners of lock plates against head of cap screw.

After assembly, push the rotating assembly as far away as possible from the turbine end and check for binging. Repeat check, pushing from the compressor end.

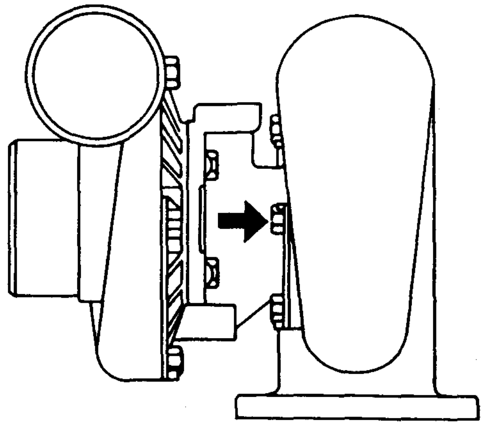

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Fig. 17-Turbine Housing Bolt

INSTALLATION

Fill the center housing with new engine oil through the oil drain hole.

Turn the rotating assembly by hand to lubricate the bearings and thrust washer.

Install new O-rings on turbocharger to intake coupling. Use a small amount of AR54749 Soap Lubricant or an equivalent on O-rings.

Using a new gasket, install turbocharger on engine.

Check alignment of compressor housing to intake manifold (Fig. 18). If necessary, rotate compressor housing so manifold coupling is radially centered in compressor housing and intake manifold.

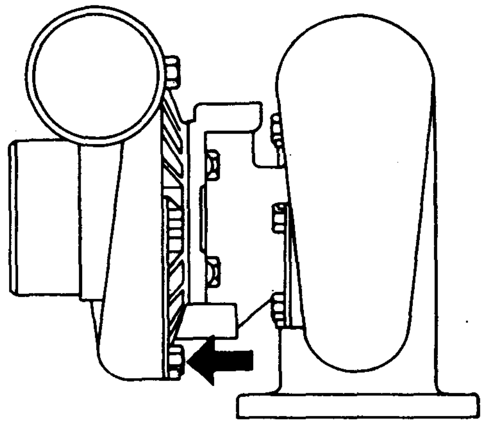

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Fig. 18-Compressor Housing Cap Screw

Tighten the mounting stud nuts, then tighten the back plate-to-compressor housing cap screws (Fig. 18) to 100 to 130 lb-in (11.3 to 14.7 Nm) (1.15 to 1.50 kg-m). Bend the corners of the lock plates against heads of cap screws.

When installing turbocharger exhaust adapter (3, Fig. 19) and exhaust elbow (4) be certain that the installation does not apply a force on the turbine housing (2). The exhaust adapter must have 0.03 inch (0.8 mm) minimum end play (1) and rotate freely.

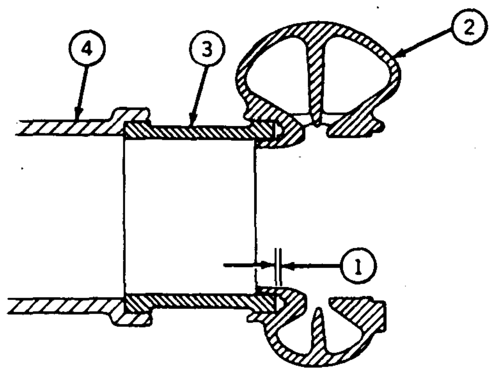

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Fig. 19-Exhaust Adapter Clearance

Install a 100 mesh or finer screen in the turbocharger oil inlet if engine internal parts have been replaced or repaired. Remove screen from oil inlet during 100 hour engine oil change.

Using new gaskets, connect oil inlet and outlet lines to the turbocharger (Fig. 20).

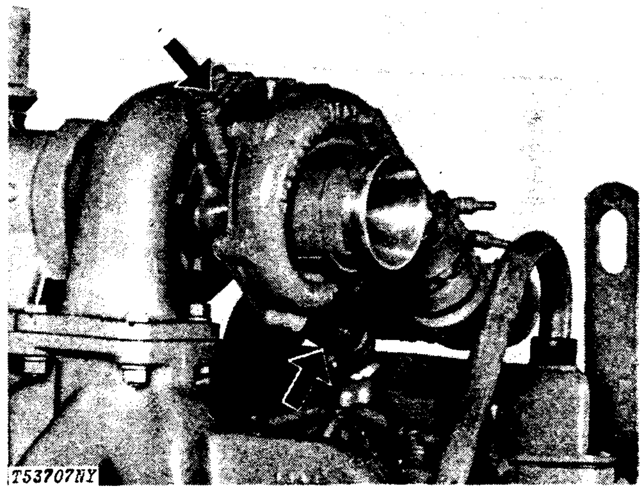

Fig. 20-Connecting Turbocharger Oil Lines.

IMPORTANT: Since the greatest amount of suction occurs between the air cleaner and turbocharger, it is essential that the hose connections are tight to prevent entry of dirt into the engine.

Inspect the air cleaner-to-turbocharger hoses to see that they are in good condition. If they are not, replace with new ones. Install air intake pipe, and tighten hose clamps securely.

Connect battery negative (−) cables to batteries.

IMPORTANT: When starting engine with a new or repaired turbocharger, hold the engine shut-off knob out and crank the engine with the starter until the engine oil pressure gauge registers sufficient pressure. Run engine at low idle, and check oil inlet connection for leaks.

Group 0417
WATER PUMP

GENERAL INFORMATION

The centrifugal-type water pump is attached at front of the engine.

REMOVAL

Disconnect battery negative (−) cable at the battery terminal.

Allow engine to cool.

Drain cooling system.

Remove alternator, fan belts, and fan.

Disconnect cooling system bypass hose at top of water pump (Fig. 1).

Disconnect lower radiator hose at water pump and engine oil cooler hose at lower rear of water pump (1, Fig. 2).

Remove water pump attaching hardware (2, Fig. 2) and remove water pump from engine.

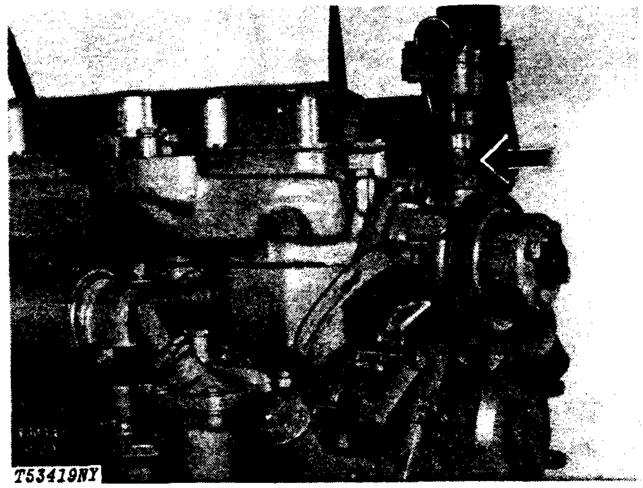

Fig. 1-Bypass Hose

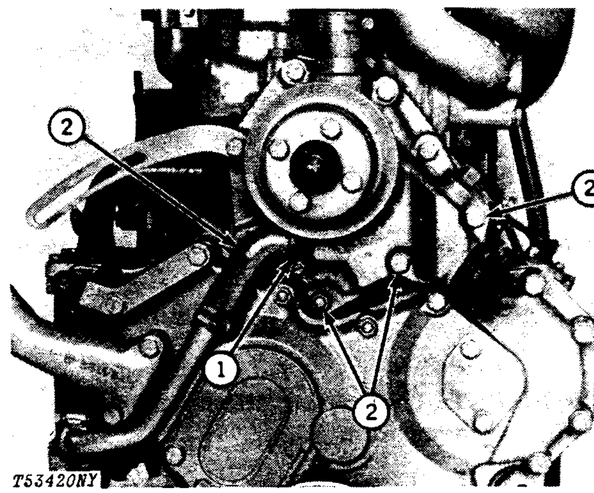

Fig. 2-Water Pump Removal

4

REPAIR

Remove cover plate (1, Fig. 3) and gasket (2) from pump housing.

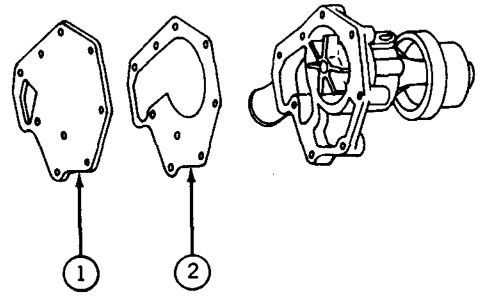

Fig. 3-Cover Plate Removal

Support the pump housing from the pulley side (Fig. 4). The lower flange on the fan pulley should be a minimum of 3.00 in. (76 mm) above the press rails. The pulley must be free to travel down a minimum of 3.00 in. (76 mm) during bearing removal.

IMPORTANT: Do not attempt to press shaft from pulley end. A flange in the bearing bore prevents bearing passage through housing.

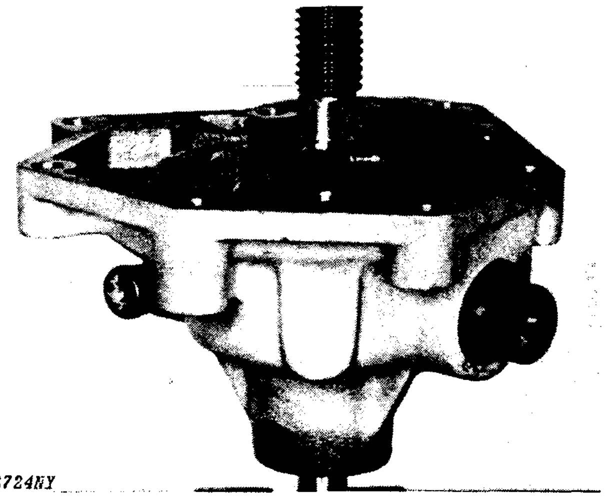

Fig. 4-Pump Placement and Bearing Removal

Select a drift which is slightly smaller than the bearing shaft at the impeller end. Press the bearing and pulley out of the housing as one piece from impeller end.

IMPORTANT: The bearing should always be replaced if removed from pump.

Remove the impeller, which is loose, and the seal (2, Fig. 5) from the housing.

Remove ceramic insert (1, Fig. 5) and cupped rubber insert found in counter bore in the impeller.

Inspect impeller, ceramic insert, and cupped rubber insert. Replace if necessary.

Inspect housing for damage behind impeller. Replace if metal has been scrapped away by impeller.

ASSEMBLY

IMPORTANT: Do not press against bearing shaft.

Using a JDE-74 Water Pump Bearing Driver or any tubular-type driver that contacts only the outer race of bearing; press shaft and bearing assembly into housing until outer race is flush with pump housing (Fig. 6).

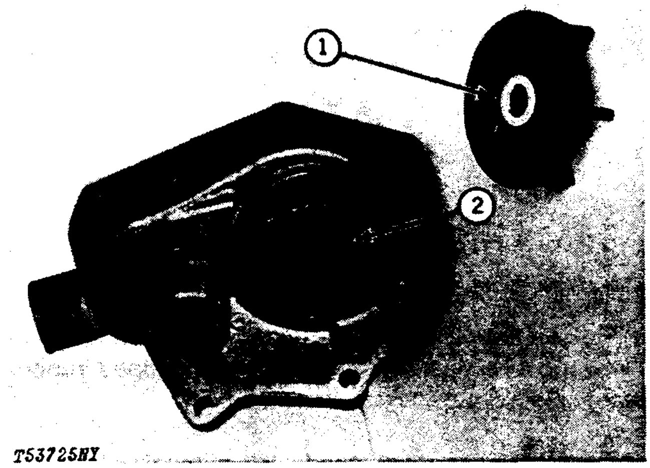

Fig. 5-Ceramic Insert Removal

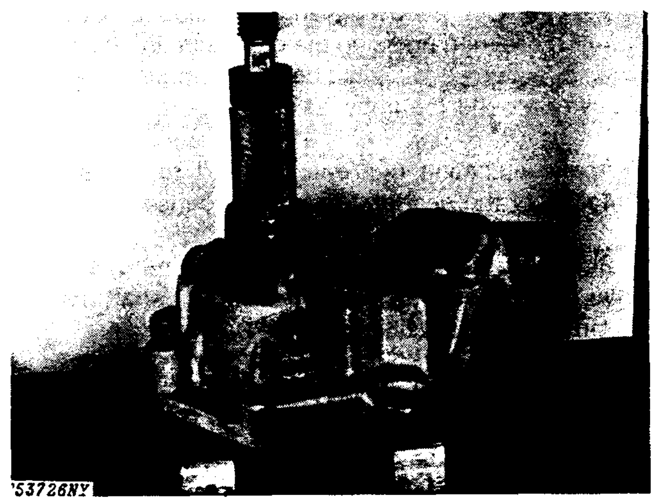

Fig. 6-Bearing Assembly

Sparingly coat the flange portion of the seal with joint sealing compound. Press seal into housing by hand until flange bottoms on housing (Fig. 7). Wipe away any excess joint sealing compound.

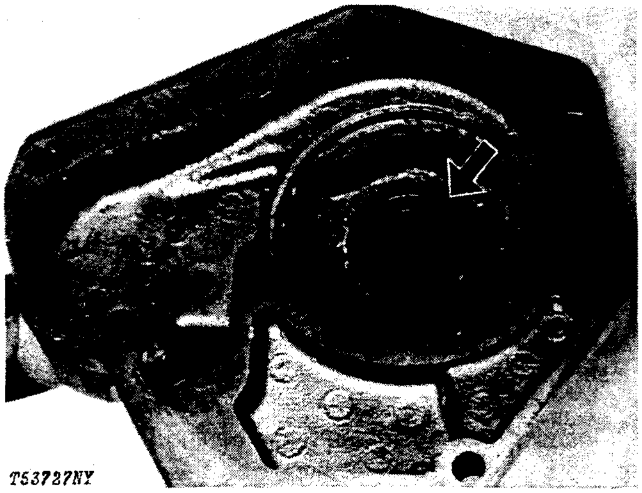

Fig. 7-Seal Replacement

Place ceramic insert in cupped rubber insert with "V" groove on ceramic insert toward cupped rubber insert. Be sure parts are dry and clean.

Dip inserts in light oil and install in impeller counterbore with cupped rubber insert against impeller. This is best accomplished by placing one side of insert in counterbore then pressing the other side in place. The sides of both inserts should be a uniform distance all of the way around the impeller counterbore.

Apply a coating of clean, light oil to the sealing surfaces of the seal and the ceramic insert.

Support pump assembly on pulley end of bearing shaft and press impeller on bearing shaft (vanes toward housing) until impeller is 0.25.

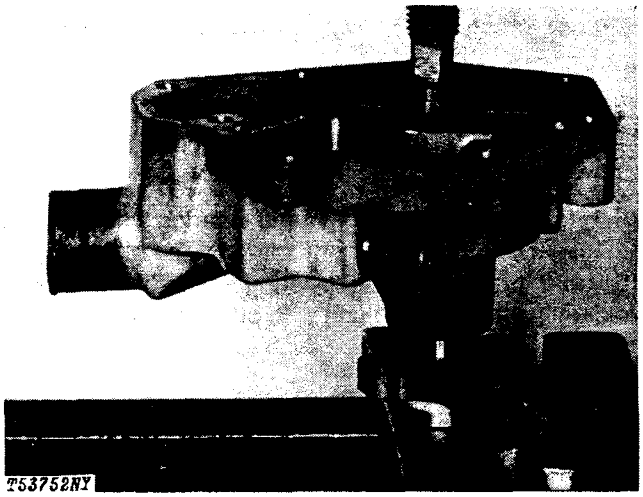

Fig. 8-Impeller Replacement

Using a support smaller than the impeller end of the bearing shaft, support impeller end of bearing shaft and press fan pulley onto opposite end of shaft to a distance from the fan surface on pulley to rear surface of housing (without cover plate or gasket) of inch (mm).

Spin the fan pulley to be sure no parts are binding or striking.

INSTALLATION

Using a new gasket, install cover plate on pump assembly. Tighten attaching cap screws to 35 lb-ft (47 Nm) (5 kg-m), Fig. 9.

Install water pump on cylinder block.

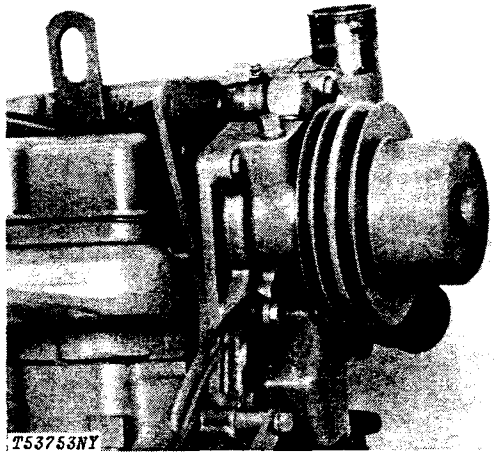

Fig. 9-Water Pump Assembly

Connect engine oil cooler hoses (if equipped with oil cooler).

Connect lower radiator hose (Fig. 10).

Connect cooling system by-pass hose to water pump.

Install alternator, fan and fan belts.

Adjust fan belts (Group 9010).

Fill cooling system.

Connect battery negative (−) cable to battery terminal.

Run engine and inspect hose connections and water pump for leaks.

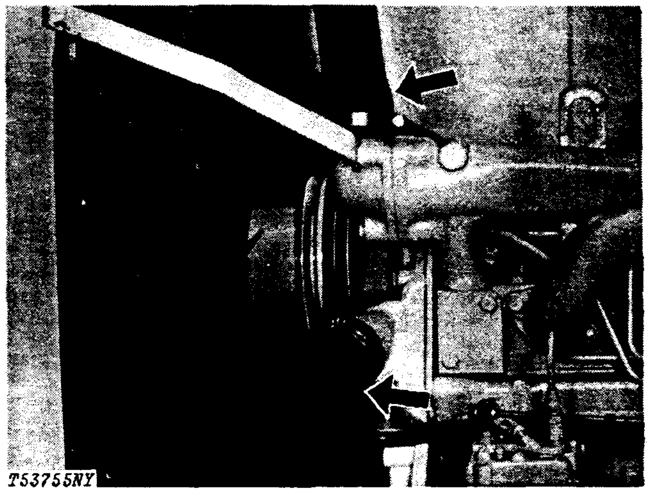

Fig. 10-Connecting Radiator Hoses

4

4

Group 0418
THERMOSTATS, HOUSINGS AND WATER PIPING

GENERAL INFORMATION

The cooling manifold is located on the left side of the engine near the valve gear cover (Fig. 1). On some engines it is cast into the block.

REMOVAL

Stop engine.

Disconnect negative (–) battery cable.

Allow engine to cool.

Drain engine coolant.

CAUTION: Do not drain engine coolant until the coolant temperature is below operating temperature. Then loosen drain cock slowly to relieve any excess pressure.

Remove upper radiator hose.

Remove thermostat housing cover.

Lift out thermostat (Fig. 2).

REPAIR

If engine is running too hot or too cold inspect thermostat for defects. Test in hot water for proper opening and closing.

Thermostat test temperature:

Engine	Code	Full Open Temperature	Opening Temperature
3-164 and 4-219	2201	183°F (84°C)	156 to 163°F (69 to 73°C)
	2202	212°F (100°C)	189 to 197°F (87 to 92°C)
	2203	213°F (101°C)	201 to 207°F (94 to 97°C)
	2204	203°F (95°C)	176 to 183°F (80 to 84°C)

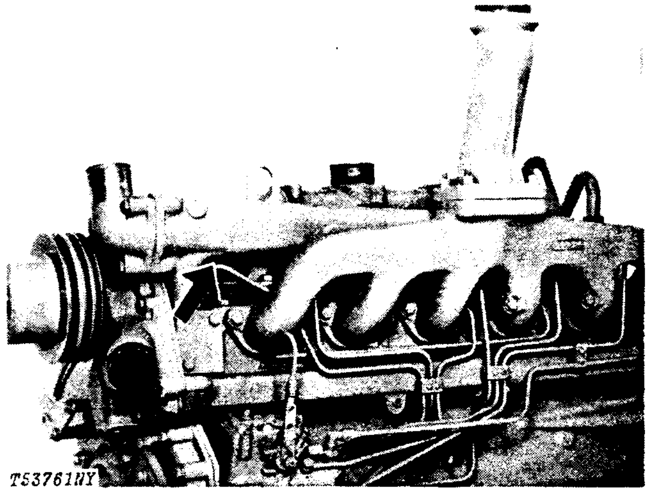

Fig. 1-Cooling Manifold Location

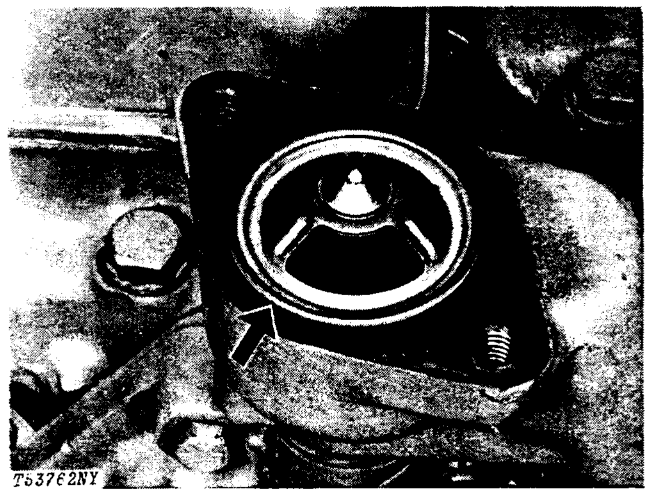

Fig. 2-Thermostat Removal

test temperature continued:

Code	Full Open Temperature	Opening Temperature
2204	203°F (95°C)	176 to 182°F (80 to 83°C)
	200°F (93°C)	180 to 195°F (82 to 91°C)
2204	203°F (95°C)	176 to 182°F (80 to 83°C)

:t hoses for cracks or leaks.

all passages.

ıce all gaskets and o-rings.

INSTALLATION

ɔw the removal procedure in reverse order.

Group 0419
OIL COOLER

3-164D, 4-219D, AND 6-329D ENGINES

Removal

Disconnect coolant lines (1, Fig. 1).

Remove oil filter (2).

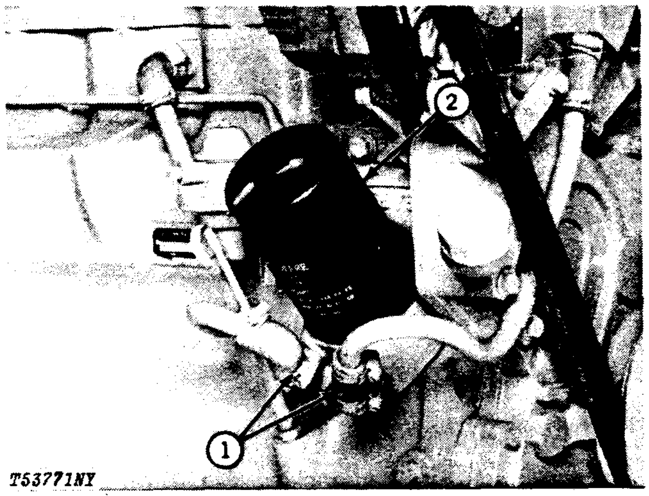

Fig. 1-Oil Cooler Lines

Unscrew oil cooler nipple (Fig. 2) and lift oil cooler off of cylinder block.

Remove four sided packing from bottom of oil cooler.

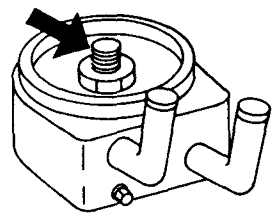

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Fig. 2-Oil Cooler Nipple

4

4

Repair

Pressure check the coolant side of the oil cooler using 15 psi (1 bar) (1 kg/m) maximum air pressure.

Remove oil cooler bypass valve by driving it out the bottom of the oil cooler from the top side.

Inspect bypass valve and spring (Fig. 3) for damage and replace as necessary.

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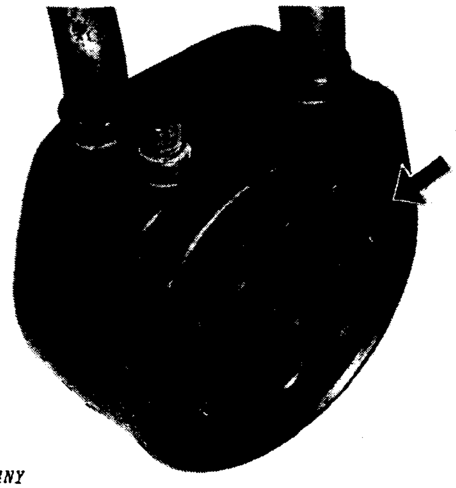
Fig. 3-Oil Cooler Bypass Valve and Spring

Installation

Install new four sided packing (Fig. 4) on bottom of oil cooler.

Position oil cooler on engine and install oil cooler nipple.

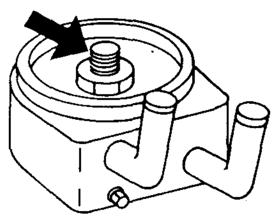


T53774NY

Fig. 4-Four Sided Packing

Oil cooler nipple torque (Fig. 5) . . . . 20 to 35 lb-ft (27 to 47 Nm) (30 to 50 kg-m)

Connect coolant hoses to oil cooler and install new oil filter (Group 0407).



T53809N

Fig. 5-Oil Cooler Nipple

4-276D, 4-276T, 6-414D, AND 6414T ENGINES

Removal

Disconnect coolant lines (1, Fig. 6) and remove oil filter (2).

Remove oil cooler assembly attaching cap screws (3).

Remove oil filter housing (4) from oil cooler.

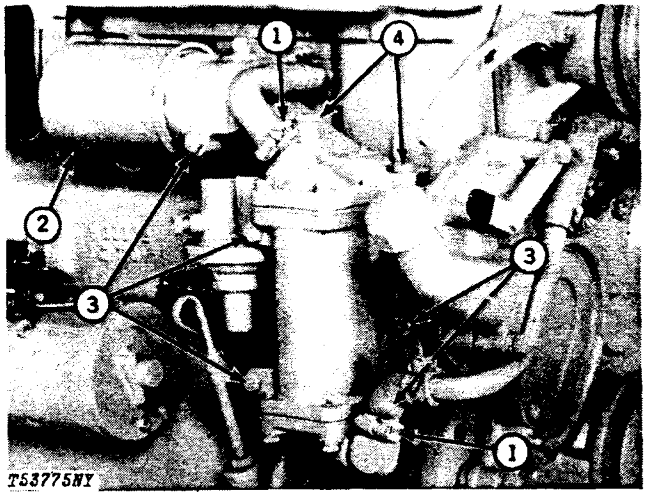


Fig. 6-Oil Cooler Assembly Removal

Repair

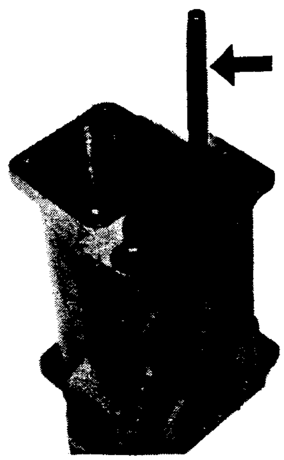
Remove top and bottom covers.

Using a suitable driver, drive oil cooler out of housing from bottom side (Fig. 7).


T53810NY

Fig. 7-Remove Oil Cooler

Drive oil cooler bypass valve out the bottom from the top using a pin punch against the top of the valve (Fig. 8).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Remove 8-Remove Oil Cooler Relief Valve

4

Inspect oil cooler for damage or build-up of foreign material and clean as needed.

The oil cooler can be pressure checked with a maximum of 50 psi (3 bar) (4 kg/cm²) air pressure.

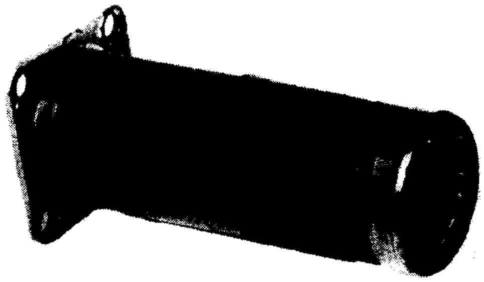

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Fig. 9-Oil Cooler

Check oil cooler bypass valve spring length:

Valve spring
free length (1, Fig. 10) .... 2.60 inch
(66.0 mm)

Valve spring
length (2) .... 1.91 inch
(48.5 mm)

when compressed with 29.5 to 37.5 lb
(131 to 167 N) (13 to 17 kg)

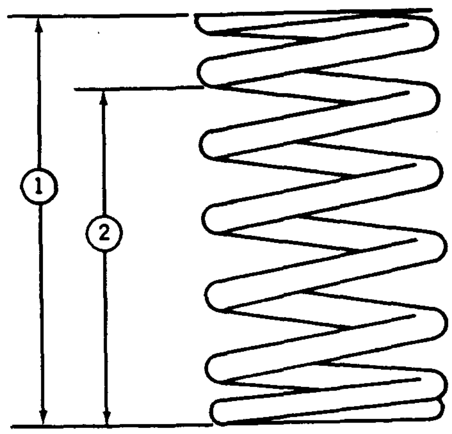

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Fig. 10-Oil Cooler Bypass Valve Spring Length

Remove O-rings from housing at bottom of oil cooler bore.

Remove all gasket residue from parts.

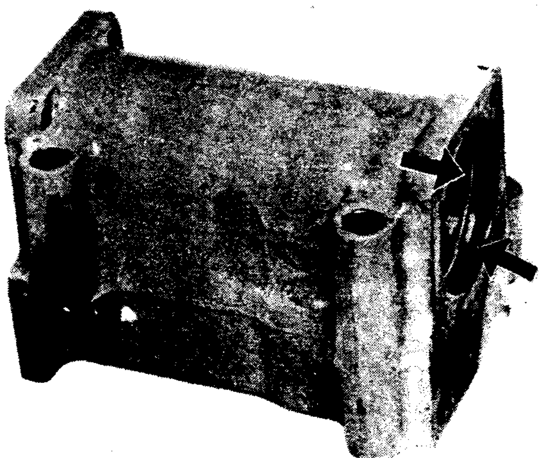

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Fig. 11-Remove O-rings

Place a piece of paper (1, Fig. 13) under the brush (2, Fig. 13). Hook a spring tension scale on the head of the brush attaching screw. Pull the scale on a line parallel to the brush and note the reading when the paper is released. Minimum brush spring tension is 80 ounces (2.3 kg). Bend springs, if it is necessary, to adjust the tension.

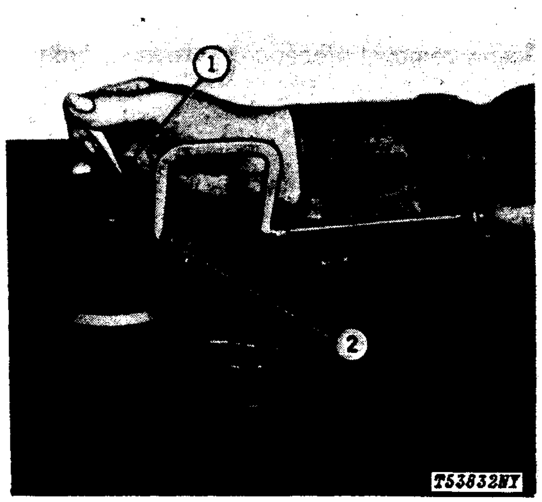

Fig. 13-Testing Brush Spring Tension

Pinion Clearance

The pinion clearance cannot be adjusted but should be checked after reassembly of the starting motor to insure proper clearance. Improper clearance is an indication of worn parts.

To check pinion clearance use the following steps:

1. Disconnect the motor field coil connector (12, Fig. 5) from the solenoid motor terminal and insulate it carefully.

2. Connect a battery (1, Fig. 14), of the same voltage as the solenoid (2) (12 volt), from the solenoid switch terminal(s) to the solenoid frame.

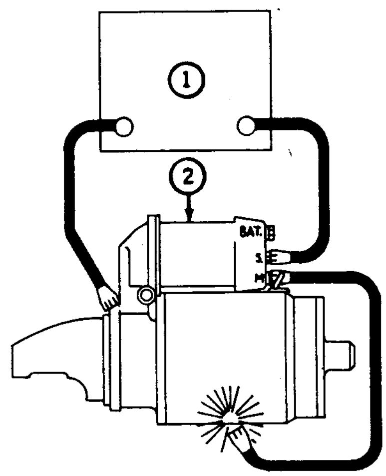

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Fig. 14-Circuit For Checking Pinion Clearance

Momentarily flash a jumper lead from the solenoid motor terminal to solenoid frame. This will shift the pinion into cranking position and it will remain so until the battery is disconnected.

Push the pinion (1) back toward the commutator end as indicated by the larger arrow in Fig. 15, to eliminate slack movement.

Measure the distance between pinion and pinion stop (2). The clearance should be 0.010 inch (0.25 mm) to 0.140 inch (3.56 mm) as measured with a feeler gauge (3).

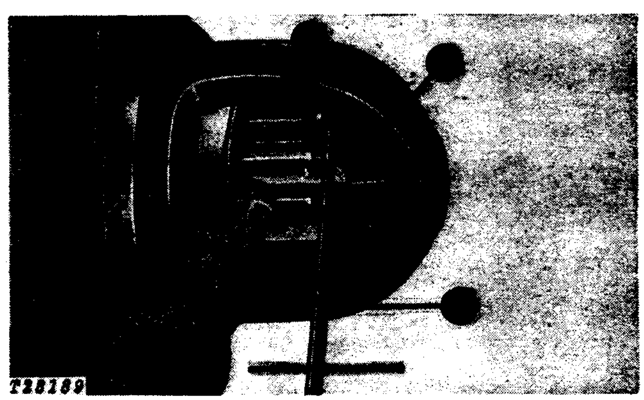

Fig. 15-Checking Pinion Clearance

INSTALLATION

Follow removal procedure in reverse order.

Connect battery positive cable and red and black wires to "BAT". Connect neutral wire to "S" terminal.

Bushing (Prelubricated)

Install prelubricated bushings using an arbor to prevent bearing collapse. After installation, check bushing size. Burnish bushing to size if necessary.

Wick-Lubricated Bushings

Remove pipe plugs, expansion plugs and oil wicks from housings. Press out old bushing. Press new bushing in to same depth as old bushing. Carefully drill bushing through oil wick hole using same size drill as oil wick hole.

After drilling, ream bushing to maintain proper oil clearance between shaft and bushing.

Soak new wicks in SAE 10 engine oil. Install wicks, expansion plugs and pipe plugs.

Bushing Specifications

Bushing, Overrunning Clutch ( )

I.D.	0.5620 - 0.5630 in. (14.274 - 14.300 mm)
Wear tolerance	0.5740 in. (14.579 mm)

Bushing, Drive Housing

I.D.	0.4990 - 0.5010 in. (12.674 - 12.725 mm)
Wear tolerance	0.5110 in. (12.979 mm)
Oil clearance	0.0020 - 0.0050 in. (0.050 - 0.127 mm)
Wear tolerance	0.0170 in. (0.431 mm)

Bushing, Commutator End Frame

I.D.	0.5625 - 0.5635 in. (14.288 - 14.312 mm)
Wear tolerance	0.5730 in. (14.554 mm)
Oil clearance	0.0020 - 0.0050 in. (0.050 - 0.127 mm)
Wear tolerance	0.0160 in. (0.406 mm)

Bushing, Center Bearing

I.D.	0.7570 - 0.7620 in. (19.227 - 19.354 mm)
Wear tolerance	0.7220 in. (18.338 mm)
Oil clearance	0.0070 - 0.0150 in. (0.178 - 0.381 mm)
Wear tolerance	0.0250 in. (0.635 mm)

Solenoid Switch

Remove nuts and sealing washers from solenoid motor and "S" terminals when removing switch cover.

The "R" terminal contact finger (2, Fig. 10) height (3) above the surface of the main contact (1, Fig. 10) should be 0.0625 to 0.0938 inch (1.588 mm to 2.383 mm). Bend the finger to adjust contact height.

4

Replacement "S" terminal clips and motor terminal studs are soldered to winding leads. Use new sealing washers when assembling the solenoid.

ASSEMBLY

To assemble starting motor, reverse the disassembly procedures.

Lubricate splines and drive end of armature shaft with SAE 10 engine oil. Heavier oil may cause failure to mesh at low temperature. Lubricate the bearing surfaces of the center bearing, drive end frame, and commutator end frame with Delco-Remy lubricant No. 1960954.

With overrunning clutch in place, install pinion stop with cupped side out and retaining ring.

Proceed as follows when assembling retaining ring and pinion stop on shaft.

With the pinion stop placed over the shaft (cupped surface facing the end of the shaft), force the retaining ring (1, Fig. 11) over the shaft with a light hammer blow and slide ring into the groove (2, Fig. 11).

To force the pinion stop (1, Fig. 12) over the ring, place a suitable washer (2) over the shaft and squeeze with pliers. Remove the washer.

Use Permatex No. 2 sealing compound between solenoid flange and starting motor field frame.

Carefully install field frame so that brush holders are not broken. Align brushes with commutator and tighten brushes.

If it is necessary to seat brushes, use No. 00 sandpaper. Clean all dust from starting motor.

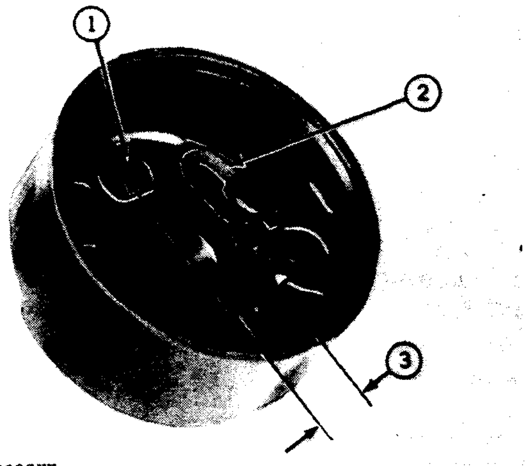

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Fig. 10-Solenoid Servicing

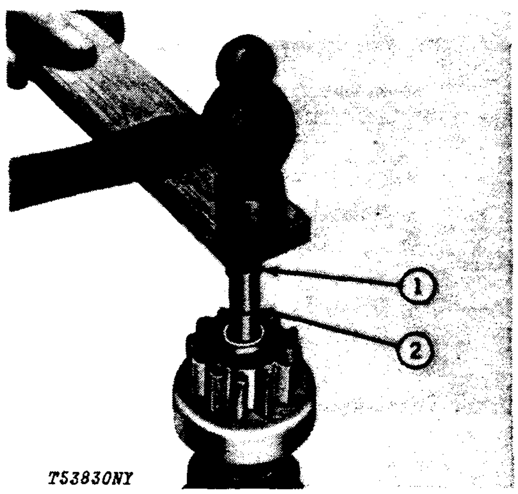

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Fig. 11-Installing Retaining Pins

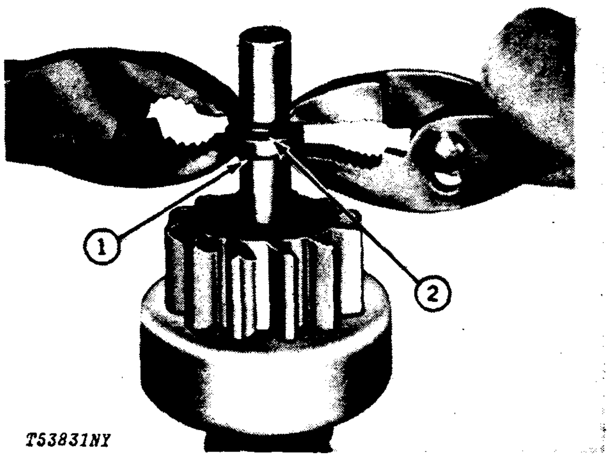

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Fig. 12-Installing Pinion Stop

Remove retaining ring. If it is badly distorted, use a new retaining ring when reassembling the clutch.

Remove armature and clutch from lever housing and separate solenoid from the housing.

Do not clean any parts in grease dissolving solvents. Wipe the drive with a clean cloth.

Checking Brushes

Inspect brushes. If they are oil soaked or are worn to approximately 5/16 inch (8 mm), replace them.

Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to insure that the brush springs are giving firm contact between the brushes and commutator. If the springs are distorted or discolored, they should be replaced.

To remove brush holders, slide pivot pins out. Tighten brushes after assembling starting motor.

Armature

If the commutator is excessively worn, dirty, out of round, or if it has high insulation, it should be turned down on a lathe. Do not under cut the insulation.

The commutator may be cleaned with No. 00 sand paper. Do not use emery cloth.

The armature should be checked for short circuits, opens and grounds.

1. Short circuits are located by rotating the armature in a growler with a steel strip such as a hacksaw blade held on the armature. The steel strip will vibrate on the area of the short circuit. Shorts between bars are sometimes produced by brush dust or copper between bars. Undercutting the insulation will eliminate these shorts.

Opens may be located by inspecting the points where the conductors are joined to the cummutator for loose connections. Poor connections cause arcing and burning of the commutator. If the bars are not badly burned, leads originally soldered to the riser bars can be resoldered.

Grounds in the armature can be detected by the use of a test lamp. If the lamp lights when one test probe is placed on the commutator and the other test probe on the armature core or shaft, the armature is grounded. If the commutator is worn, dirty, out of round, or has high insulation, the commutator should be turned down.

Field coils should be tested for grounds using a test lamp (1, Fig. 7).

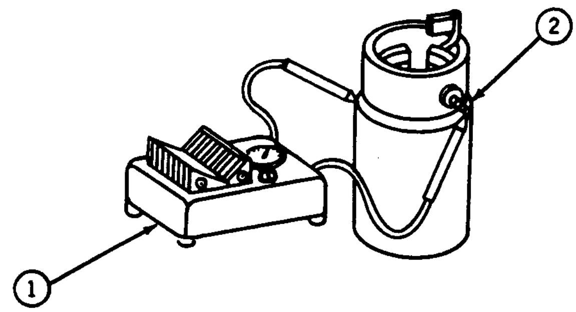


Fig. 7-Field Winding Test Grounds

Grounded Winding Test (Fig. 7)

Disconnect field coil ground connections. Connect one test probe to the field frame (1, Fig. 7) and the other to the field connector (2). If the lamp lights, the field coils are grounded and must be repaired or replaced.

Field Winding Opens Test (Fig. 8)

Connect test lamp (1, Fig. 8) to ends of field coils (2). If lamp does not light field coils are open (Fig. 8).

Before removing pole shoes scibe lines to be sure they are assembled in their original position.

Remove pole shoe screws.

When replacing field coils, care should be taken to prevent grounding or shorting them as they are tightened into place.

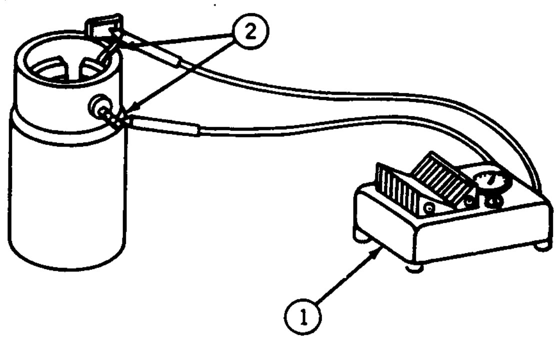


Fig. 8-Field Winding Opens Test

Overrunning Clutch Assembly

The pinion (2) should turn smoothly with a slight drag in the overrunning direction and lock up in the opposite direction. If not, the entire clutch and pinion assembly must be replaced as the assembly cannot be repaired except for the spring (1, Fig. 9) and collar.

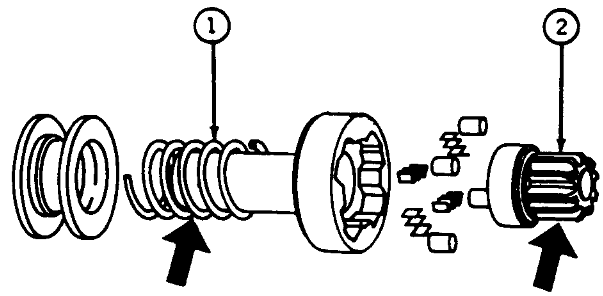


Fig. 9-Clutch Assembly

Interpret the test results as follows:

1. Rated current draw and no load speed indicates normal condition of the starting motor.

2. Low free speed and high current draw indicates:

   a. Too much friction - tight, dirty, or worn bearings, bent armature shaft or loose pole shoes, allowing armature to drag.

   b. Shorted armature. This can be further checked on a growler after disassembly.

   c. Grounded armature or fields. Check further after disassembly.

3. Failure to operate with high current draw indicates:

   a. A direct ground in the terminal or fields.

   b. Frozen bearings (this should have been determined by turning the armature by hand).

4. Failure to operate with no current draw indicates:

   a. Open field circuit. This can be checked after disassembly by inspecting internal conditions and tracing circuit with a test lamp.

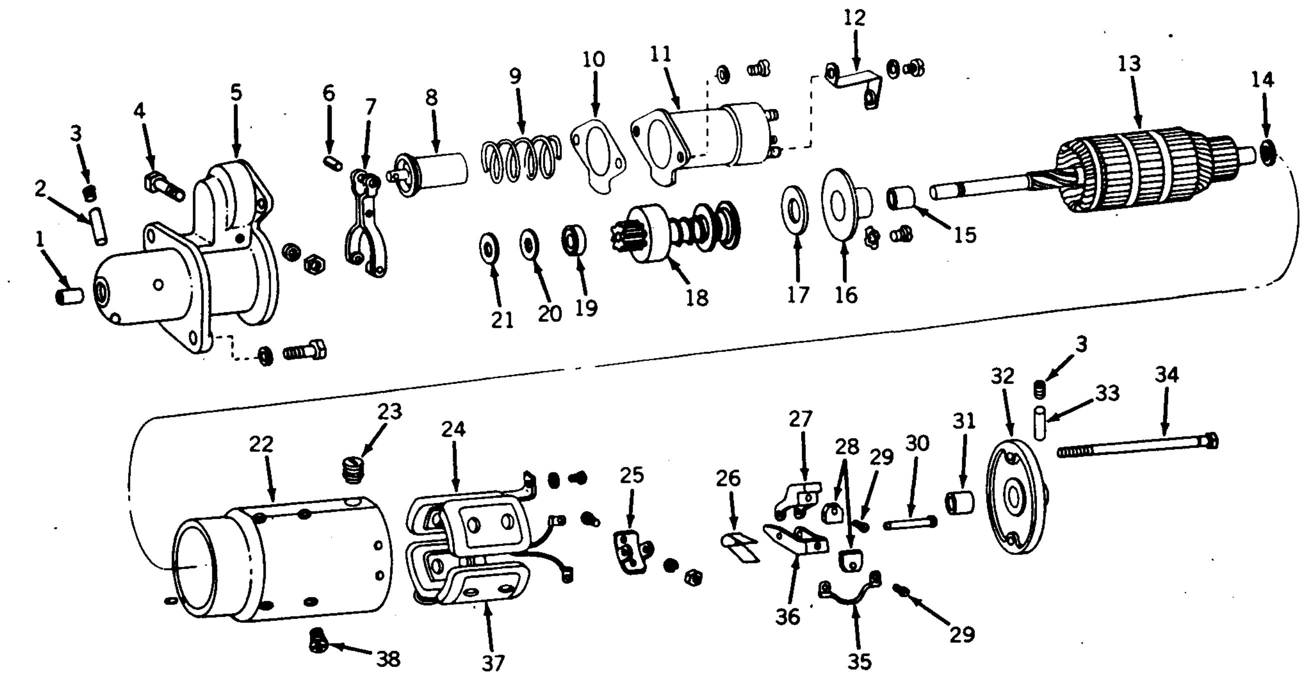
   b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

   c. Broken brush springs, worn brushes, high insulation between the commutator bars, or other causes which would prevent good contact between the brushes and commutator.

5. Low no-load speed and low current draw indicates:

   a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under no. 4.

6. High free speed and high current draw indicates shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.



1—Bushing
2—Lubricating Wick
3—Plug (2 used)
4—Shift Lever Pivot Screw
5—Drive End Housing
6—Spring Pin
7—Shift Lever
8—Solenoid Plunger
9—Solenoid Return Spring
10—Gasket
11—Solenoid Assembly
12—Field Coil Connector
13—Armature
14—Thrust Washer
15—Bushing
16—Center Bearing
17—Brake Washer
18—Overrunning Clutch
19—Pinion Stop
20—Retaining Ring
21—Thrust Collar
22—Field Frame
23—Insulating Bushing
24—Field Coil Assembly
25—Brush Support
26—Brush Spring
27—Insulated Brush Holder
28—Brushes
29—Brush Mounting Screws (2 used)
30—Brush Pivot Pin (2 used)
31—Bushing
32—Commutator End Frame
33—Lubricating Wick
34—Through Bolts (2 used)
35—Brush Ground Lead (2 used)
36—Grounded Brush Holder
37—Field Pole Shoe (4 used)
38—Pole Shoe Screw (8 used)

Fig. 5-Delco-Remy Starting Motor

REPAIR

Disassemble motor only as far as necessary to make repairs (Fig. 5).

Mark position of commutator end frame with regard to main frame to aid in alignment during reassembly.

Disconnect field coil connector (12, Fig. 5) from solenoid motor terminal and remove solenoid mounting screws.

Remove commutator end frame (32, Fig. 5). Remove field frame and solenoid from drive housing (5). Separate armature (13) and clutch assembly (18) from drive housing.

Slide a standard half-inch pipe coupling onto the shaft so it butts against the pinion stop. Tap coupling, driving stop (19, Fig. 5) toward the armature end, off the retaining ring (Fig. 6).

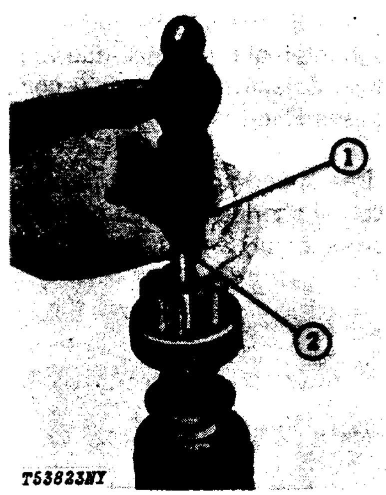


Fig. 6-Forcing Retaining Ring Over Shaft

Group 0422
STARTING MOTOR AND FASTENINGS

GENERAL INFORMATION

It is possible for the engine to be equipped with either of two types of starters: a John Deere Starter or a Delco-Remy starter. Both repair procedures are contained in this section.

DELCO-REMY STARTING MOTOR

REMOVAL

Starter is located on either right or left side of engine at the rear.

Disconnect battery negative (−) cable.

Disconnect wires from starting motor.

Remove cap screws that attach motor to flywheel housing.

NOTE: The JDE-80 starter wrench may be necessary to remove the rear attaching cap screw.

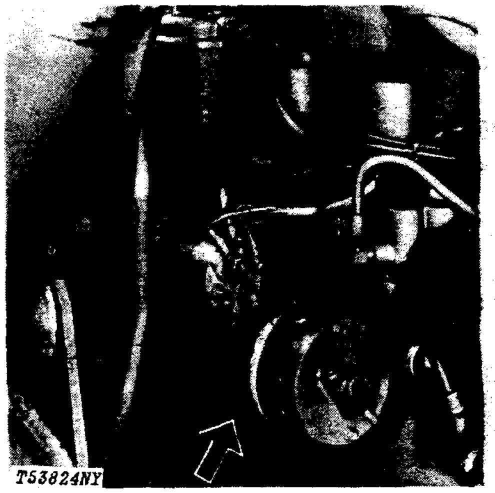


Fig. 1-Delco-Remy Starting Motor

TESTING AND DIAGNOSIS

Solenoid Tests (Starting Motor Removed)

Testing Pull-In Windings

Disconnect field connector from solenoid motor terminal. Connect ammeter in series with a carbon pile resistor to terminal "S" and to battery. Connect voltmeter (1) to terminal "S" and to solenoid motor terminal (Fig. 2). With carbon pile (2) in the off position, connect other battery post (3) to solenoid motor terminal. Quickly adjust the carbon pile (2) to obtain 5 volts. The ammeter (4) reading should be 13 to 15.5 amps.

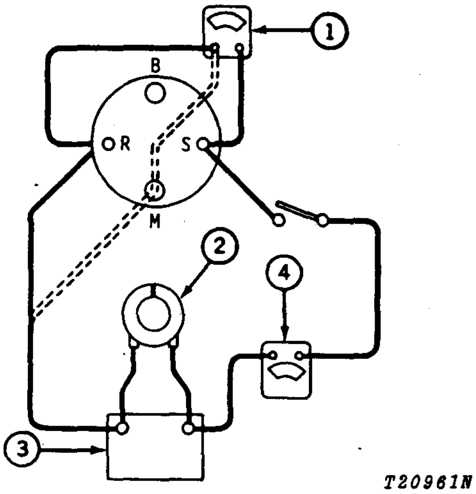


Fig. 2-Solenoid Pull-In Test

Testing Hold-In Windings

Disconnect solenoid. Connect ammeter in series with a switch to terminal "S" and to battery. Connect voltmeter to terminal "S" and to solenoid ground. Connect carbon pile resistor across the battery. Connect other battery post to solenoid ground. Close the switch and adjust carbon pile to obtain 10 volts. The ammeter reading should be 14.5 to 16.5 amps.

4

High Ammeter Reading

Windings are grounded or short circuited

Low Ammeter Reading

Excessive resistance is present (usually in a connection)

No Ammeter Reading

Windings are open circuited

To prevent overheating, do not energize the pull-in winding longer than 15 seconds. Current draw will decrease as the winding temperature increases.

If the fault cannot be repaired and the solenoid performance is questionable, replace the windings.

No Load Starting Motor Test (Fig. 3)

Place starter in a vise.

Connect the circuit in Fig. 3 starting with the battery positive terminal (2) with heavy wire to the ampmeter (3) then to the "BAT." contact of the solenoid. Connect a switch across the "BAT." and S of the solenoid.

Place a voltmeter from the M terminal to the starter motor casing. Connect the starter motor casing to the negative of the battery. Connect a carbon pile to the positive and negative of the battery to adjust the voltage. Connect a tachometer to the starter motor.

The meters should read as follows (Fig. 4).

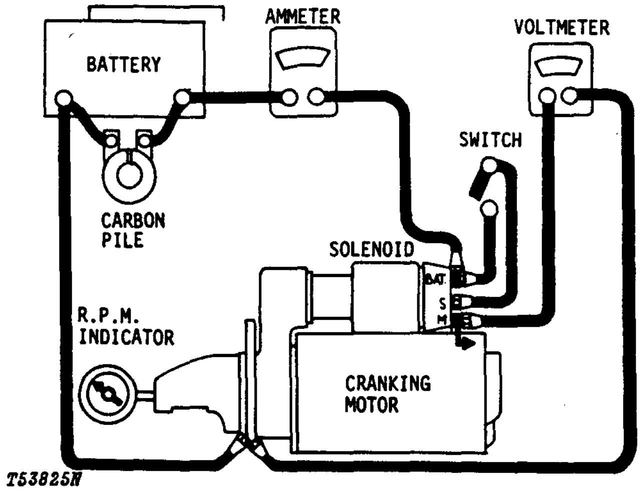


Fig. 3-No Load Starter Test Circuit

Motor No.	Test Volts	Min. Amps	Max. Amps	Min. rpm	Max. rpm
1109251	9	20*	120*	9000	14000
1107871	9	40*	140*	8000	13000
1114381	9	124*	185*	4700	7600

**Includes Solenoid*

Fig. 4-Test Data For A Delco-Remy Starter

Group 0421
FUEL TRANSFER PUMP

GENERAL INFORMATION

The fuel transfer pump is located on the right side of the engine as shown on (1, Fig. 1).

REMOVAL

Disconnect and plug fuel lines (2, Fig. 1) at pump.

Remove attaching hardware.

REPAIR

To remove or install primer lever, (1, Fig. 2) compress rocker arm lever (2). And pull primer lever out.

Further disassembly of the transfer pump is not possible.

INSTALLATION

Follow removal procedure in reverse order. Bleed fuel system.

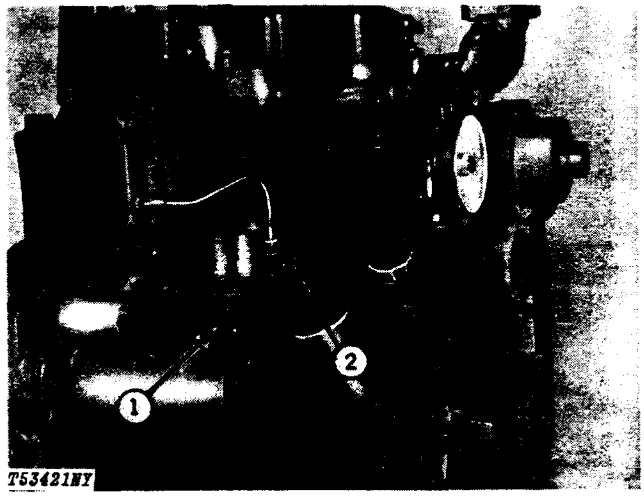


Fig. 1-Fuel Pump Location

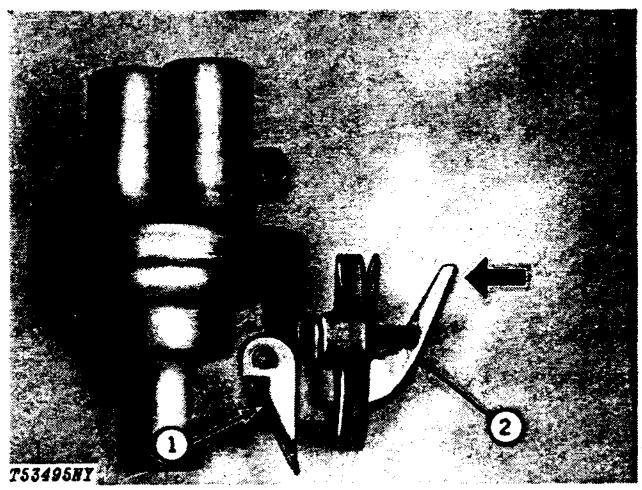


Fig. 2-Fuel Pump Removal

4

4

Litho in U.S.A.

Group 0420
FUEL FILTER

GENERAL INFORMATION

The fuel filter is located on the right side of the cylinder block, in the upper rear corner (Fig. 1).

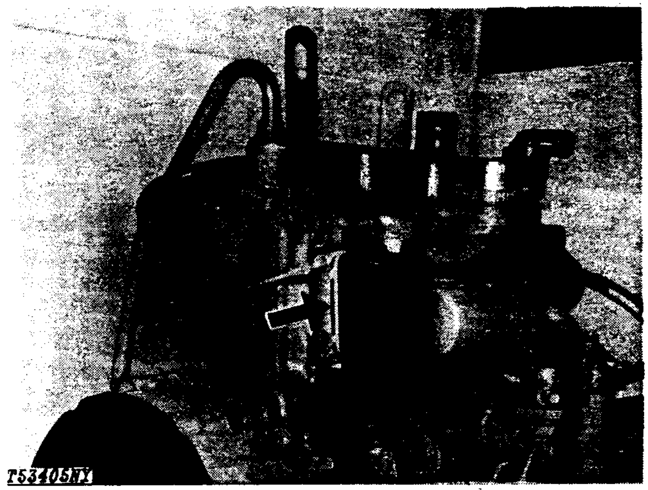
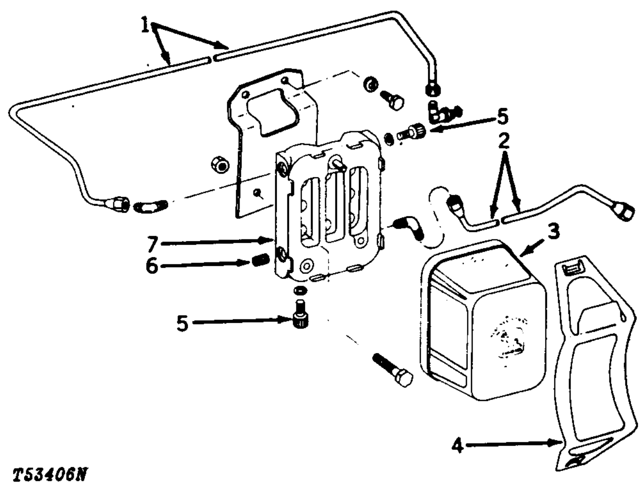


Fig. 1-Fuel Filter

REMOVAL

To remove filter element (3, Fig. 2), pull off retaining spring (4) and slip off filter element.

To remove filter body (7), disconnect and cap inlet line (2) and outlet hose (1). Remove cap screws securing body to mounting bracket.



T53406N

Fig. 2-Fuel Filter Assembly

INSTALLATION

Replace body on engine block.

Connect fuel inlet and outlet lines.

Mount and secure fuel filter on body.

Replace bleed screw (4, Fig. 2) and drain plug (5).

Bleed fuel system (Group 0413).

Litho in U.S.A.

Installation

Position oil cooler relief valve spring (1, Fig. 12), valve (2), and valve seat (3) in bore in bottom of housing (4).

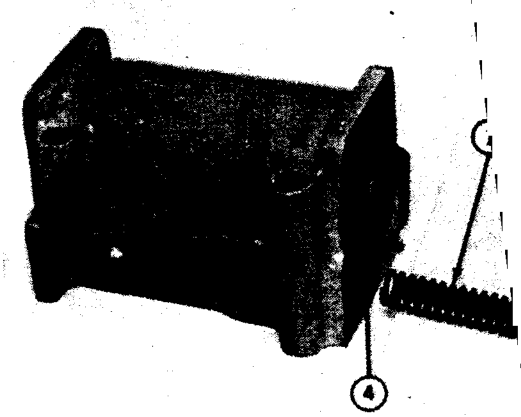


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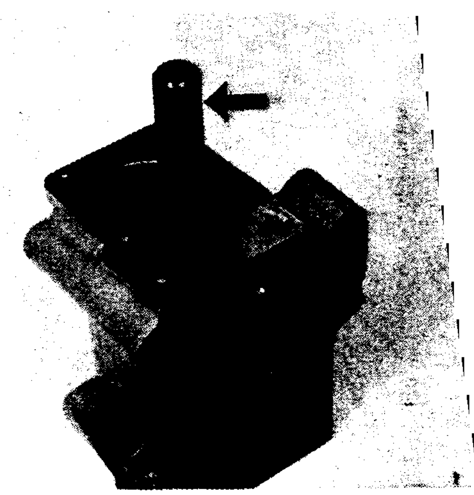
Fig. 12-Install Oil Cooler Relief Valve

Using a suitable driver (Fig. 13), drive the valve seat into the housing until the seat bottoms.



T53816NY

Fig. 13-Drive Oil Cooler Relief Valve Seat

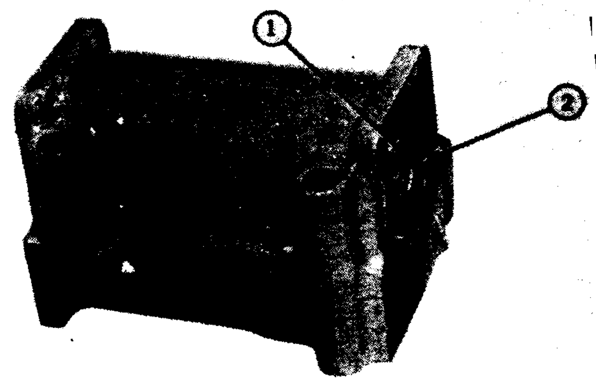
Install new O-rings in housing at bottom of oil cooler bore, red O-ring in upper groove (1, Fig. 14) and black O-ring in lower groove (2).

Using new gasket, install oil cooler in housing from op side, being careful not to shear O-rings.

Using new gaskets, install top and bottom covers nd oil filter housing.

Position oil cooler assembly on engine and install o screws.

Connect oil cooler coolant lines and install a new oil r.



T53817NY

Fig. 14-O-Ring Installation

4

OILING SYSTEM (0407)

SPECIFICATIONS AND TORQUE VALUES—Continued

Oil pan cap screw torque .... 35 lb-ft
(47 Nm) (5 kg-m)

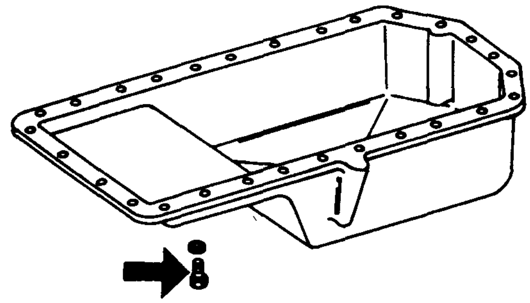


Fig. 34-Oil Pan Cap Screw Torque

CYLINDER HEAD AND VALVES (0409)

SPECIFICATIONS AND TORQUE VALUES

Cylinder head-to-intake valve
head distance (new) (1, Fig. 35) 0.023 to 0.047 inch
(0.58 to 1.19 mm)

Cylinder head-to-exhaust valve
head distance (new) (2) .... 0.038 to 0.072 inch
(0.97 to 1.83 mm)

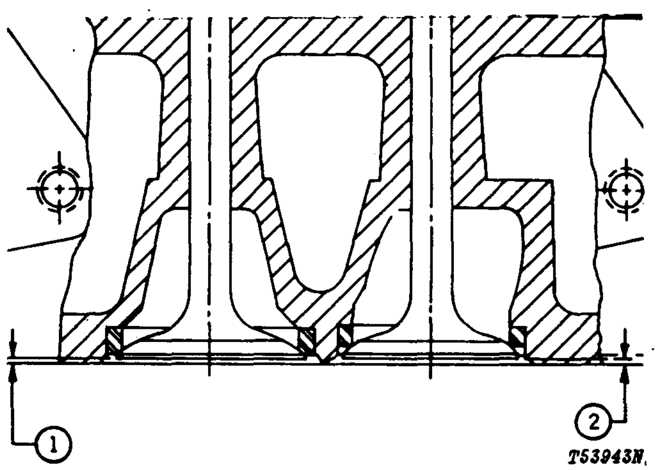


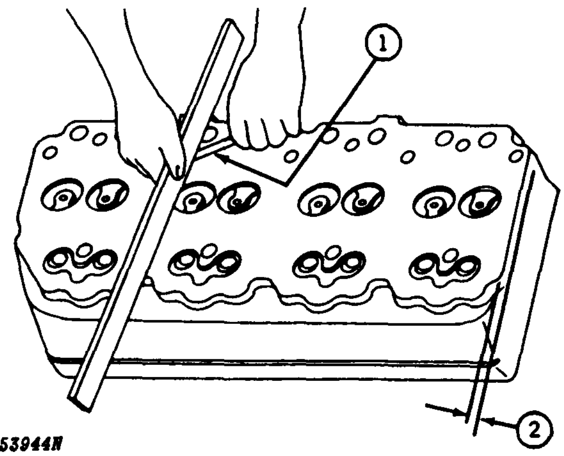
Fig. 35-Cylinder Head to Valve Head Distance

CYLINDER HEAD AND VALVES (0409)

SPECIFICATIONS AND TORQUE VALUES—Continued

Cylinder head flatness
(maximum warp) (1, Fig. 36)............ 0.002 inch
(0.05 mm)

Maximum material removal
from cylinder head (2) .... 0.030 inch
(0.76 mm)

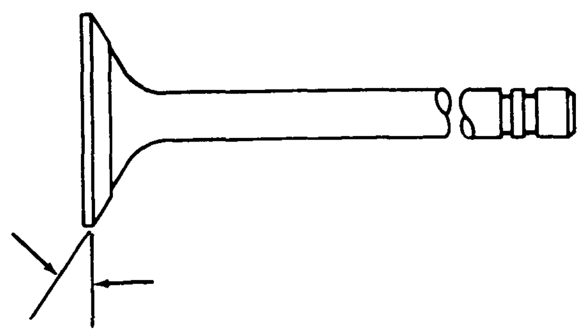


T53944N

Fig. 36-Cylinder Head Flatness

Valve face angle:

Engine	Intake Valve	Exhaust Valve
3-164	45°	45°
4-219	45°	45°
4-276	30°	45°
6-329	45°	45°
6-414	30°	45°

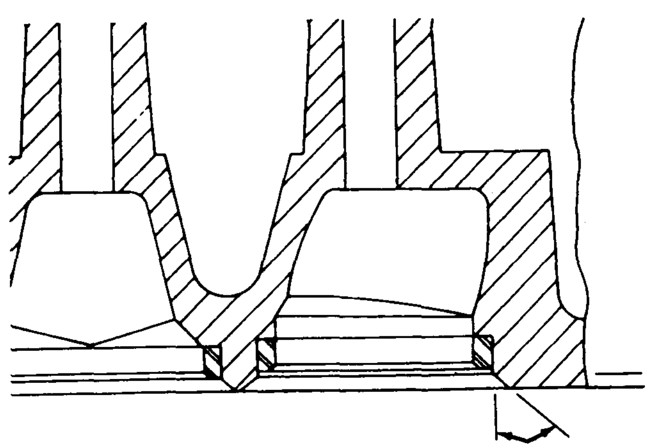


T53945N

Fig. 37-Valve Face Angle

Valve seat angle:

Engine	Intake Valve Seat	Exhaust Valve Seat
3-164	45°	45°
4-219	45°	45°
4-276	30°	45°
6-329	45°	45°
6-414	30°	45°



T53946N

Fig. 38-Valve Seat Angle

CYLINDER BLOCK (0404)

SPECIFICATIONS AND TORQUE VALUES

Cylinder liner protrusion .... 0.001 to 0.004 inch
(0.03 to 0.10 mm)

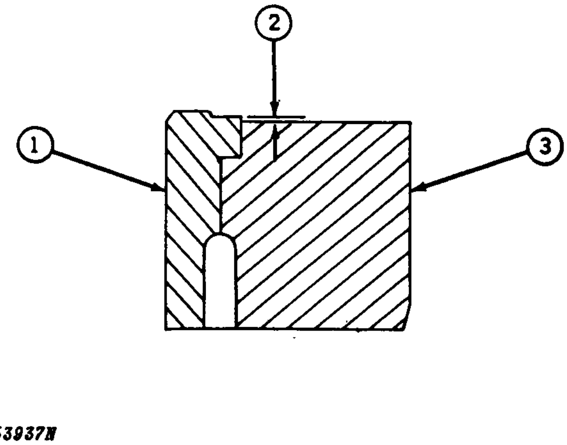


Fig. 28-Cylinder Liner Protrusion

Cylinder liner taper (maximum).......... 0.002 inch
(0.05 mm)

Cylinder liner out-of-round
(maximum)............................ 0.002 inch
(0.05 mm)

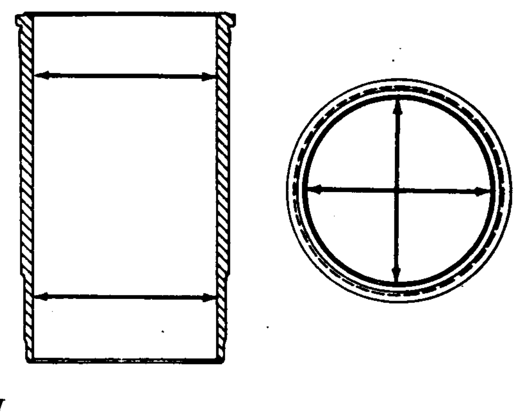


Fig. 29-Cylinder Liner Measurement

Piston cooling orifice torque .... 85 to 110 lb-in
(9.6 to 12.4 Nm) (0.98 to 1.27 kg-m)

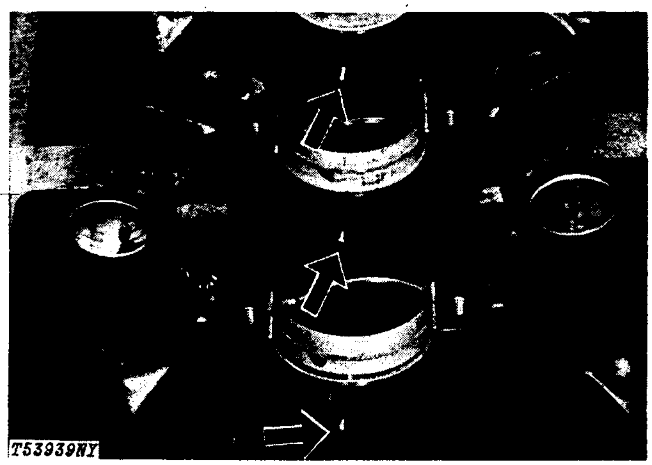


Fig. 30-Piston Cooling Orifice Torque

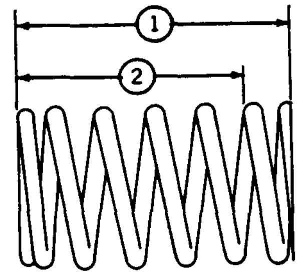
OILING SYSTEM (0407)

SPECIFICATIONS AND TORQUE VALUES—Continued

Oil pressure control spring free length .... 4.68 inch (118.9 mm)

Oil pressure control spring length .... 1.68 inch (42.7 mm)

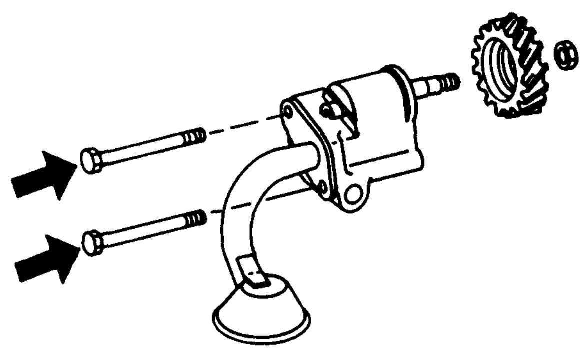
when compressed with 13.5 to 16.5 lb (60 to 73 Nm) (6 to 7 kg)



T50940N.

Fig. 31-Oil Pressure Control Spring Length

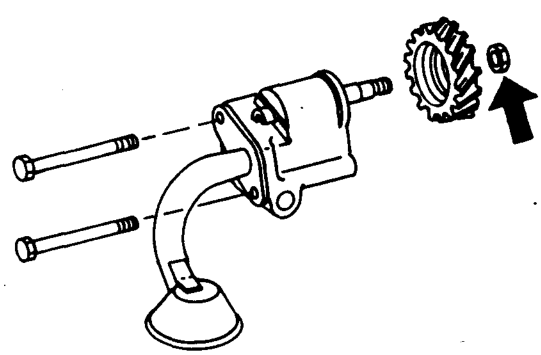
Oil pump attaching cap screw torque .... 35 lb-ft (47 Nm) (5 kg-m)



T53940N

Fig. 32-Oil Pump Attaching Cap Screw Torque

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



T53941N

Fig. 33-Oil Pump Drive Gear Nut Torque

CONNECTING RODS AND PISTONS (0403)

SPECIFICATIONS AND TORQUE VALUES

Connecting Rod Journal and Bearing Diameter

Engine	Connecting Rod bearing assembled I.D. (new) (1, Fig. 24)	Crankshaft rod journal O.D. (new) (2)
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)

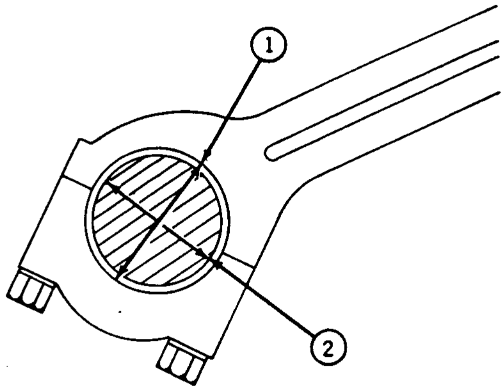


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Fig. 24-Connecting Rod Bearing Measurement

Connecting rod bearing to crankshaft oil clearance (new) . . 0.001 to 0.005 inch (0.03 to 0.13 mm)

Connecting rod bearing to crankshaft oil clearance (maximum). . . . . 0.006 inch (0.17 mm)

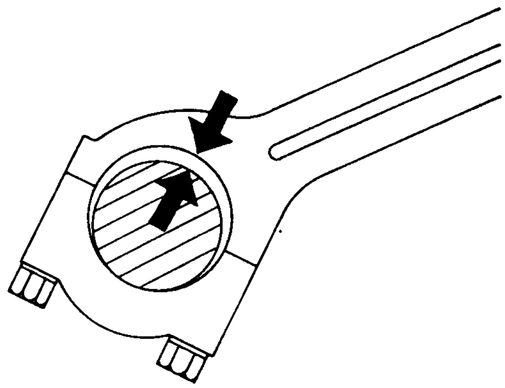

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Fig. 25-Connecting Rod Oil Clearance

CONNECTING RODS AND PISTONS (0403)

SPECIFICATIONS AND TORQUE VALUES—Continued

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

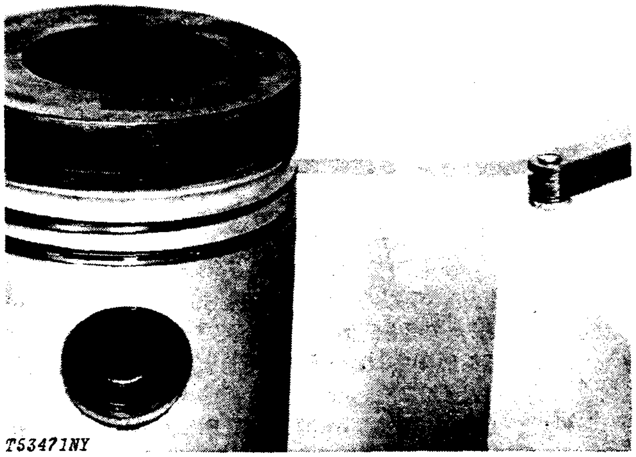


Fig. 26-Rectangular Ring Groove Clearance

Connecting Rod Cap Screw Torque

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)

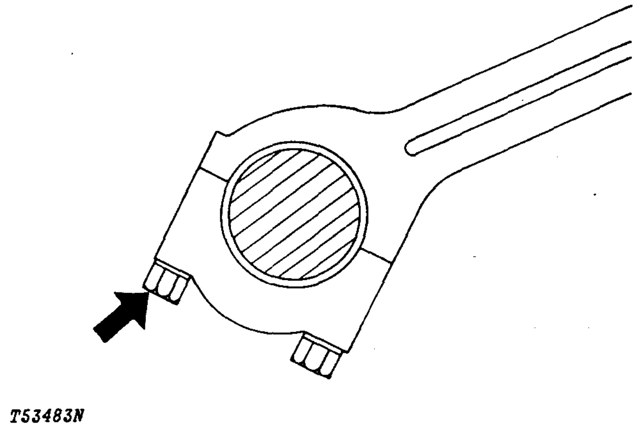


Fig. 27-Connecting Rod Cap Screw Torque

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIFICATIONS AND TORQUE VALUES—Continued

Rocker arm shaft
O.D. (new) (1, Fig. 20) .... 0.787 to 0.788 inch
(19.99 to 20.02 mm)

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

Rocker arm shaft
support I.D. (new) (2) .... 0.790 to 0.792 inch
(20.07 to 20.12 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)

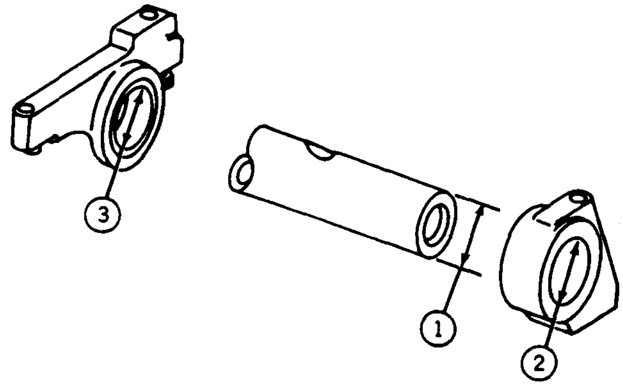


Fig. 20-Rocker Arm Measurement

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

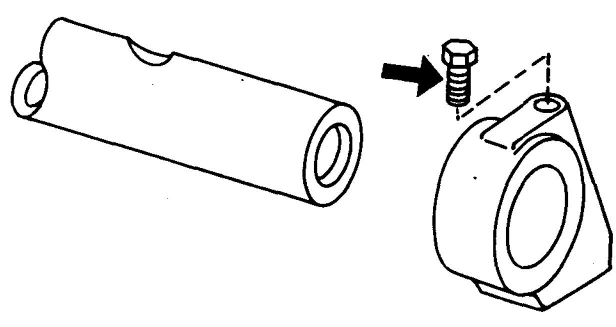
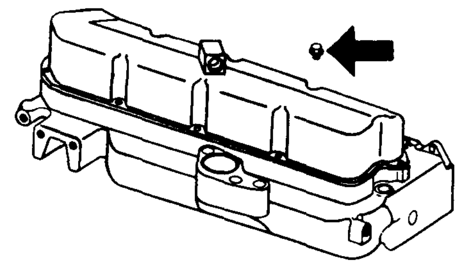


Fig. 21-Rocker Arm Support Cap Screw Torque

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIFICATIONS AND TORQUE VALUES—Continued

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

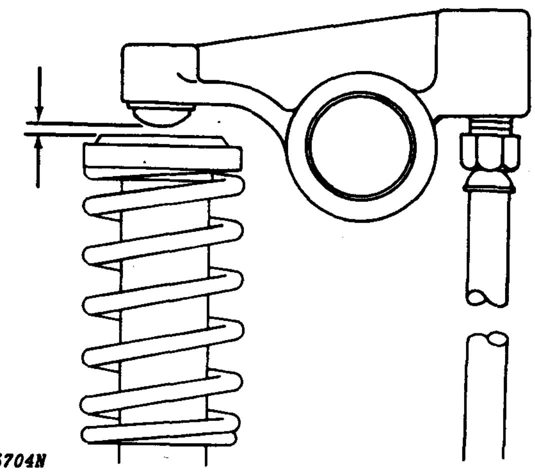


T53935N

Fig. 22-Rocker Arm Cover Cap Screw Torque

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

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



T53704N

Fig. 23-Valve Clearance

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIFICATIONS AND TORQUE VALUES—Continued

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

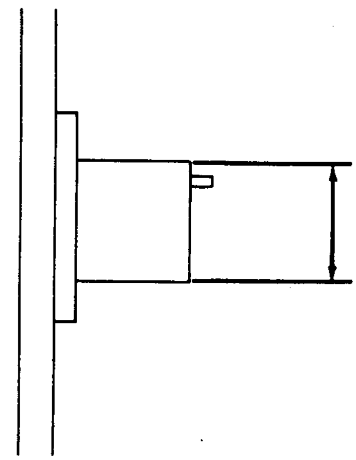


Fig. 14-Idler Gear Shaft Measurement

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

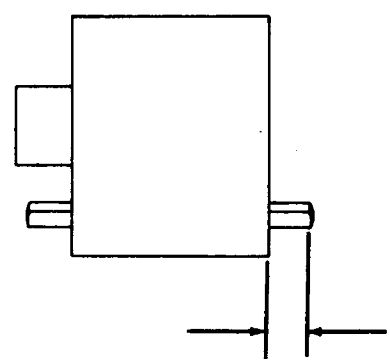


Fig. 15-Spring Pin Height

Idler gear bushing 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)

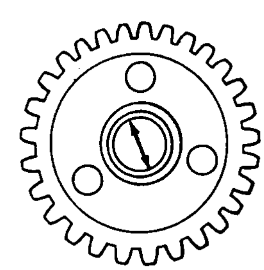


Fig. 16-Idler Gear Oil Clearance

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIFICATIONS AND TORQUE VALUES—Continued

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

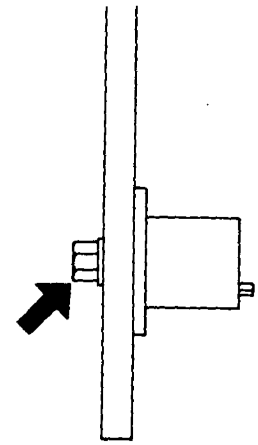


Fig. 17-Lower Idler Gear Shaft Torque

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

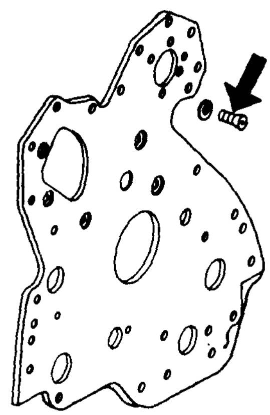


Fig. 18-Front Plate Screw Torque

uel injection pump gear
ırque (1, Fig. 19) .... 20 lb-ft
(27 Nm) (3 kg-m)

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

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

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

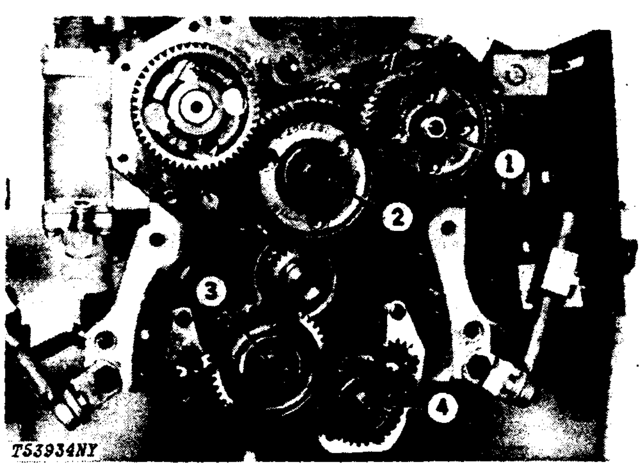


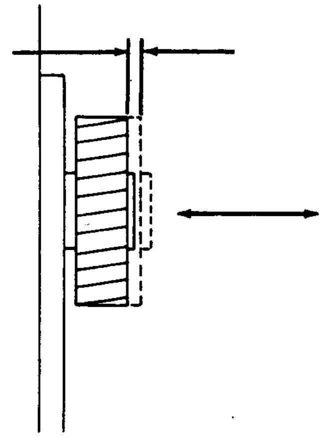
Fig. 19-Timing Gear Train Torque

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIFICATIONS AND TORQUE VALUES—Continued

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

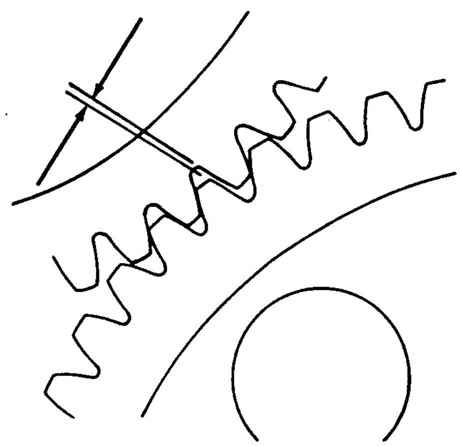
Camshaft end play (max.) .... 0.015 inch (0.38 mm)



T53927N

Fig. 9-Camshaft End Play

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



T53928N

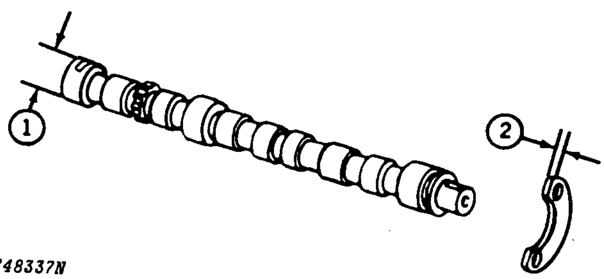
Fig. 10-Camshaft Gear Backlash

Camshaft bearing journal O.D. (new) (1, Fig. 11) .... 2.200 to 2.201 inch (55.87 to 55.90 mm)

Camshaft bearing journal O.D. (min.) .... 2.199 inch (55.85 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)



T48337N

Fig. 11-Camshaft Measurement

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIFICATIONS AND TORQUE VALUES—Continued

Timing Gear Train Backlash

Gear (New)	Backlash
Injection pump to upper idler	0.003 to 0.014 inch (0.08 to 0.36 mm)
Crankshaft to upper idler	0.003 to 0.017 inch (0.08 to 0.43 mm)
Crankshaft to lower idler	0.003 to 0.014 inch (0.08 to 0.36 mm)
Oil pump to left balancer	0.002 to 0.014 inch (0.05 to 0.36 mm)
Oil pump to lower idler	0.003 to 0.014 inch (0.08 to 0.36 mm)
Lower idler to right balancer	0.002 to 0.016 inch (0.05 to 0.41 mm)
Upper idler to camshaft	0.003 to 0.014 inch (0.08 to 0.36 mm)
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)

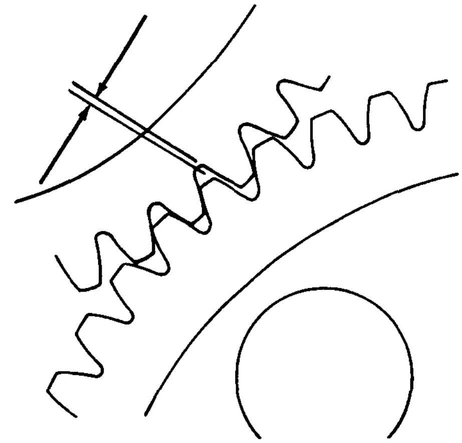


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Fig. 12-Timing Gear Train Backlash

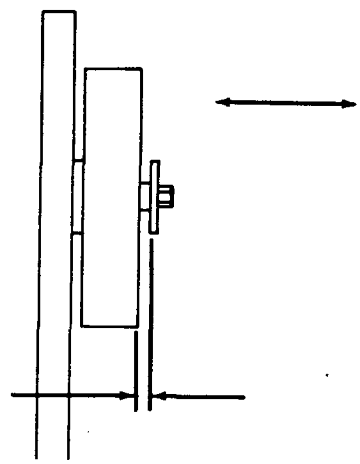

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Fig. 13-Idler Gear End Play

CRANKSHAFT AND MAIN BEARINGS (0401)
SPECIFICATIONS AND TORQUE VALUES—Continued

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

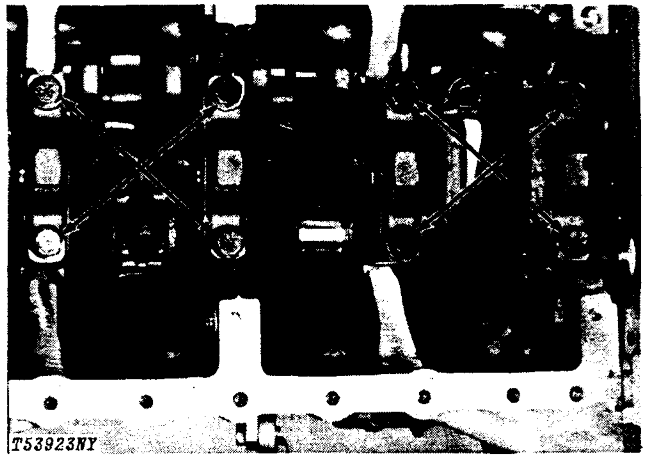


Fig. 4-Main Bearing Cap Screw Torque

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)

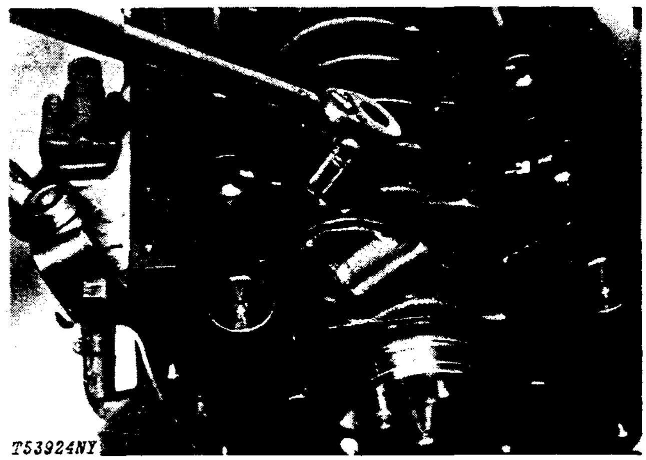


Fig. 5-Connecting Rod Cap Screw Torque

Vibration damper total run-out (1, Fig. 6) .... 0.060 inch (1.52 mm)

Vibration damper total wobble (2, Fig. 6) .... 0.060 inch (1.52 mm)

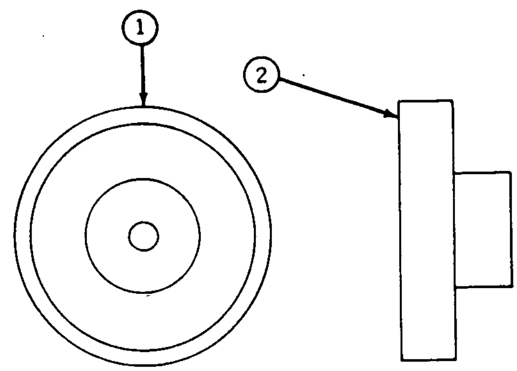


Fig. 6-Vibration Damper Measurement

CRANKSHAFT AND MAIN BEARINGS (0401)

SPECIFICATIONS AND TORQUE VALUES—Continued

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

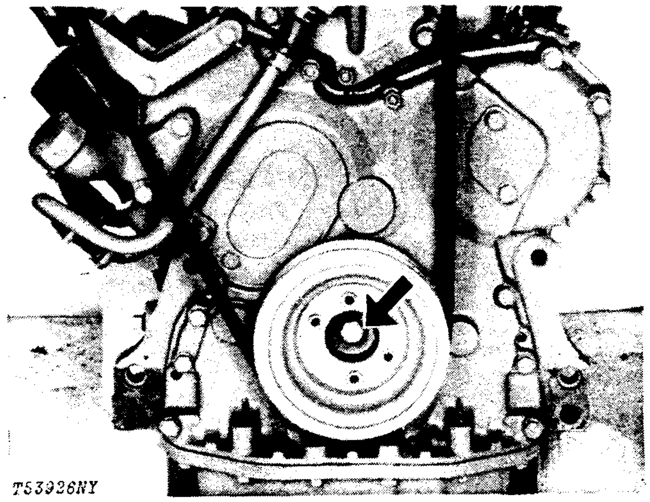


Fig. 7-Vibration Damper Cap Screw Torque

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIFICATIONS AND SPECIAL TOOLS

Valve Lift

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)

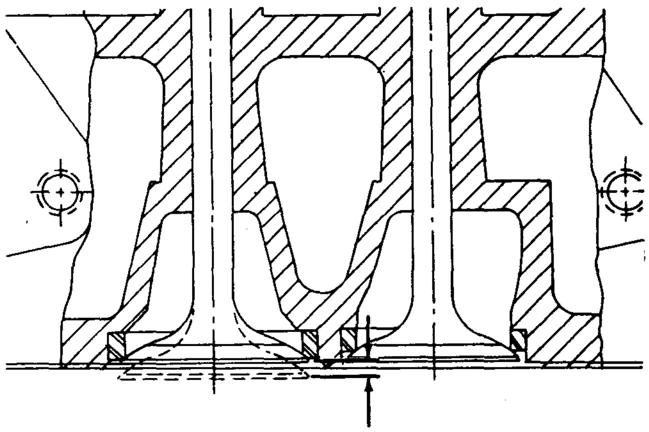


Fig. 8-Valve Lift

Group 0499
SPECIFICATIONS AND SPECIAL TOOLS
ENGINE BREAK-IN
SPECIFICATIONS AND TORQUE VALUES

NOTE: Whenever possible, use a dynamometer to provide a more accurate break-in, assuring proper initial seating of new piston rings.

Time	Load*	Engine Speed	Remarks
5 MINUTES	NO LOAD	800 RPM (SLOW IDLE)	CHECK OIL
5 MINUTES	NO LOAD	1500 TO 2000 RPM (1/2 THROTTLE)	PRESSURE,
5 MINUTES	1/4 LOAD	1900 TO 2200 RPM	COOLANT
10 MINUTES	1/2 LOAD	(3/4 THROTTLE)	TEMPERATURE,
10 MINUTES	1/2 TO 3/4 LOAD		AND LEAKAGE
10 MINUTES**	3/4 TO FULL LOAD		
100 HOURS+	ALL LOADS		FIELD ONLY

T49644N

*Loads can be simulated in the field by controlled operation.

**After this run, loosen cylinder head bolts 45 degrees; then retighten bolts one at a time, in sequence (Group 0409), with 95 lb-ft (129 Nm) (13 kg-m) torque. Loosen rocker arm support cap screws; then retighten with 35 lb-ft (47 Nm) (5 kg-m) torque. Check and reset valve clearance.

+After break-in, drain crankcase oil, and remove filter. Install new filter and fill crankcase with oil of proper viscosity and service classifications.

CRANKSHAFT AND MAIN BEARINGS (0401)

SPECIFICATIONS AND TORQUE VALUES

Crankshaft end play (new) ...... 0.002 to 0.008 inch (0.05 to 0.20 mm)

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

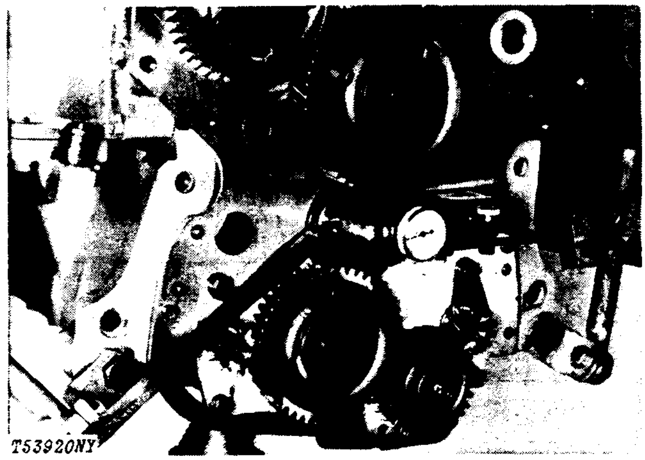


Fig. 1-Crankshaft End Play

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 (79.40 to 79.45 mm)

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

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

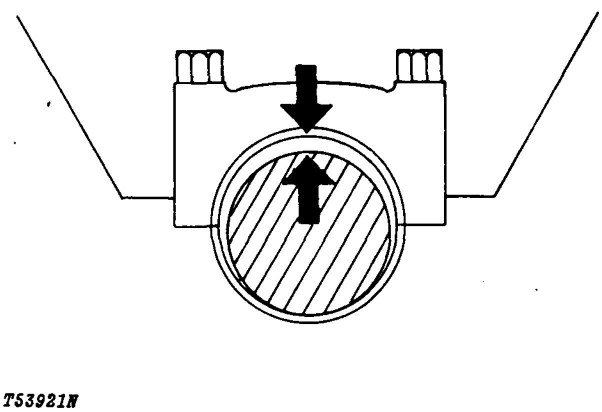


Fig. 2-Main Bearing Clearance

Journal taper (max.) (1, Fig. 3) .... 0.001 inch per 1.00 inch (0.03 mm per 25.4 mm)

Journal out-of-round (max.) (2, Fig. 3) ... 0.003 inch (0.08 mm)

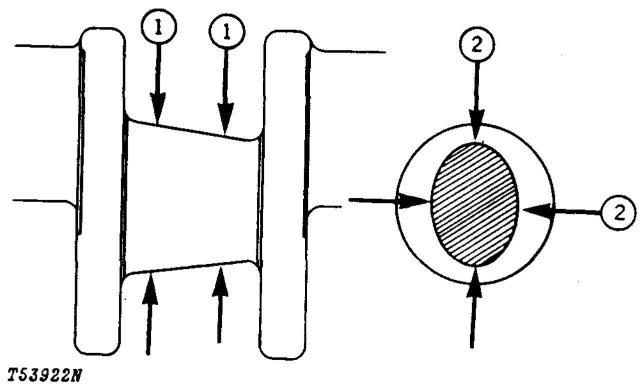


Fig. 3-Main Bearing Journal Measurement

Group 0433
FLYWHEEL, HOUSING AND FASTENINGS

GENERAL INFORMATION

The ring gear for the starting motor is shrunk in place on the front of the outer rim of the flywheel. On the front of the outer rim of the flywheel is a "TDC" (top dead center) mark which is used when timing the injection pump, and adjusting cam followers.

REMOVAL

Remove flywheel housing cover (2, Fig. 1).

Remove tachometer drive adapter and pinion if equipped.

CAUTION: Flywheel weighs approximately 85 lb. (39 kg). Plan proper handling procedures to avoid injuries.

Remove two flywheel attaching cap screws and install two pilot studs in their place.

Remove remaining flywheel attaching cap screws.

Remove flywheel.

Examine ring gear (Fig. 2) for worn or broken teeth.

Remove and replace ring gear if damaged.

CAUTION: Oil fumes or oil can ignite above 380°F (193°C). Use a thermometer and do not exceed 360°F (182°C). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

Heat new ring gear evenly in oil (to 360°F [182°C] maximum) or in oven (to 450°F [232°C] maximum) and install hot, with ring gear tooth chamfer toward engine side of flywheel. Drive ring gear onto flywheel until it bottoms all the way around on flywheel shoulder.

Remove flywheel housing from cylinder block (1, Fig. 1).

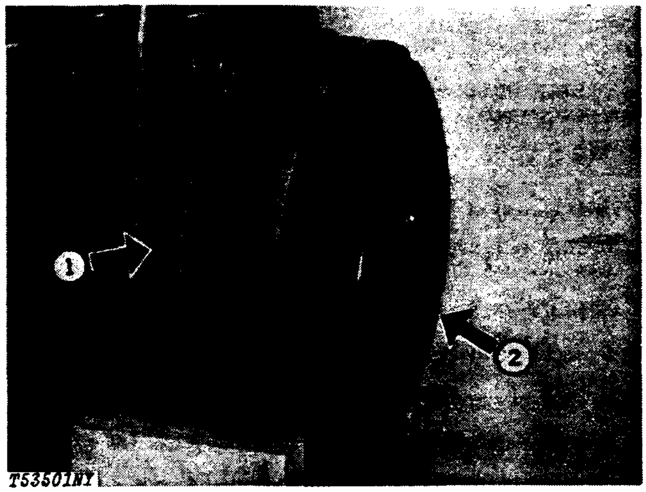


Fig. 1-Flywheel and Housing

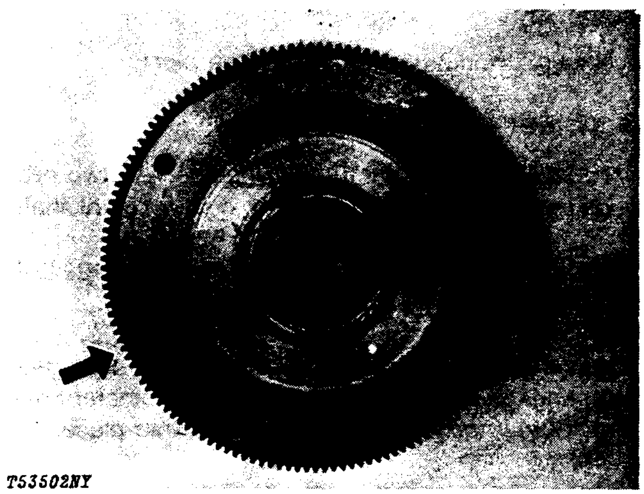


Fig. 2-Flywheel

4

Remove rear oil seal from flywheel housing.

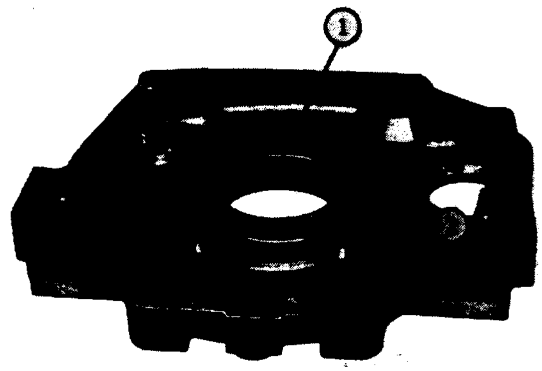
Place flywheel housing on a flat even surface. Install new rear oil seal.

Place JD297-2 Pilot (1, Fig. 3) and oil seal (2) in housing as shown.

It is not necessary to use 27409 Handle (1, Fig. 4) with the JD297-1 (2, Fig. 4) Driver to install the oil seal (3) but it does help.

Use a mallet to drive in the oil seal until the driver bottoms on the pilot.

Replace crankshaft wear ring (Group 0401).



T46608N

Fig. 3-Pilot and Oil Seal in Place

INSTALLATION

Replace flywheel housing gasket.

Position JD250-4 seal protector over rear of crankshaft and coat protector and wear ring with engine oil.

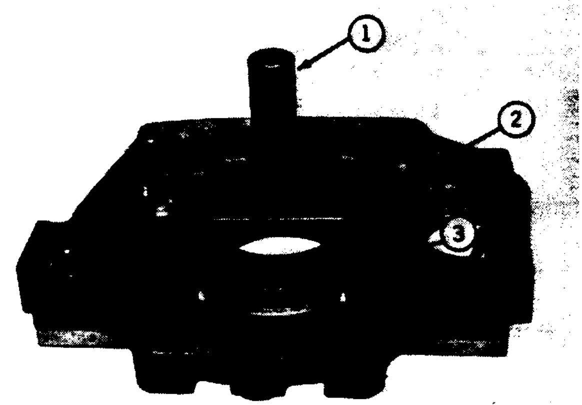
Install flywheel housing on engine block.

Flywheel

To facilitate installation of flywheel, screw two pilot studs into flywheel mounting screw holes in crankshaft.

Install and tighten attaching cap screws to 120 lb-ft (163 Nm) (17 kg-m) torque.

Install tachometer drive pinions making sure gear teeth engage with teeth on camshaft tachometer drive gear. Screw tachometer drive adapter into place.



T46609N

Fig. 4-Installing Crankshaft Rear Oil Seal

Group 0429
FAN DRIVE

GENERAL INFORMATION

The engine will be equipped with either a blower fan-blade or a suction fan-blade.

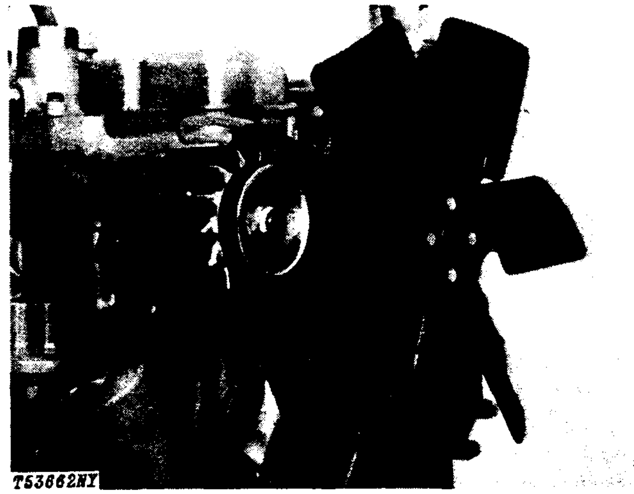


Fig. 1-Fan Removal

REMOVAL

Remove fan attaching cap screws (Fig. 1).

Remove fan.

Loosen alternator belts (1, Fig. 2).

Remove fan belt.

Remove fan pulley, see Group 0417.

Remove bolt on lower pulley (2, Fig. 2).

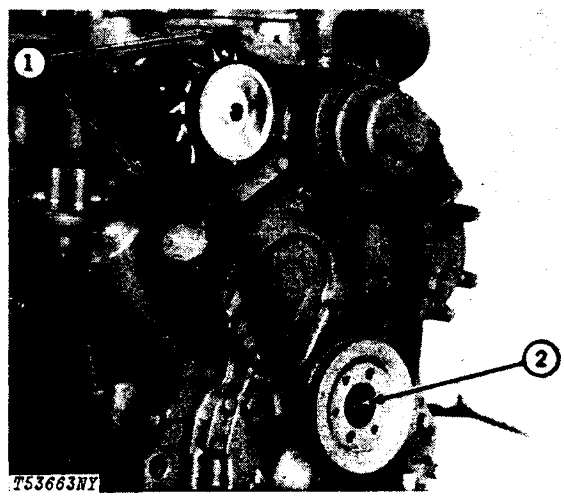


Fig. 2-Fan Drive Removal

Carefully remove lower pulley with a puller (Fig. 3).

IMPORTANT: The lower pulley on six cylinder engines is a vibration damper that prevents torsional damage to the crankshaft. Handle dampers with care. They are sensitive to impact and should not be dropped or hammered on.

Inspect fan for bent blades or missing blade rivets.

Inspect pulleys for damage.

Check belt for cracking and wear, replace if necessary.

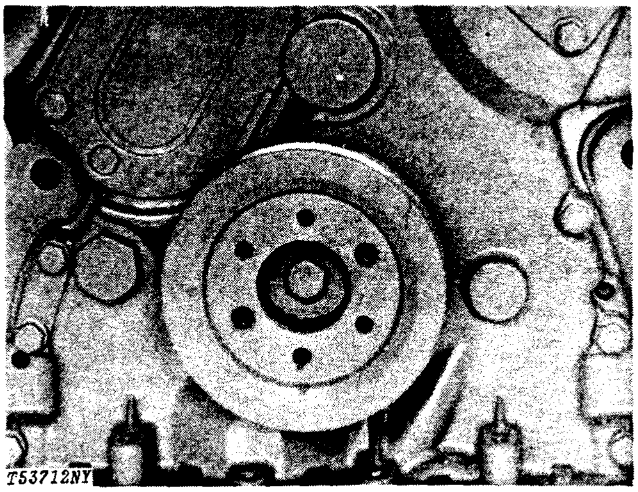


Fig. 3-Puller

INSTALLATION

To replace upper pulley refer to Group 0417.

Carefully fit the lower pulley on the crankshaft (Fig. 3).

Replace bolt on crankshaft pulley (Fig. 3).

Replace and bolt fan.

Replace fan belt.

Adjust fan belt.

Fan belt tension:

With gauge, initial: 100 to 110 lb. (445 to 490 N) (45 to 50 kg).

After 3 minutes of operation: 80 lb. minimum (356 N) (36 kg).

Without gauge: 3/4 inch (19 mm) flex with 20 lb. (89 N) (9 kg) force.

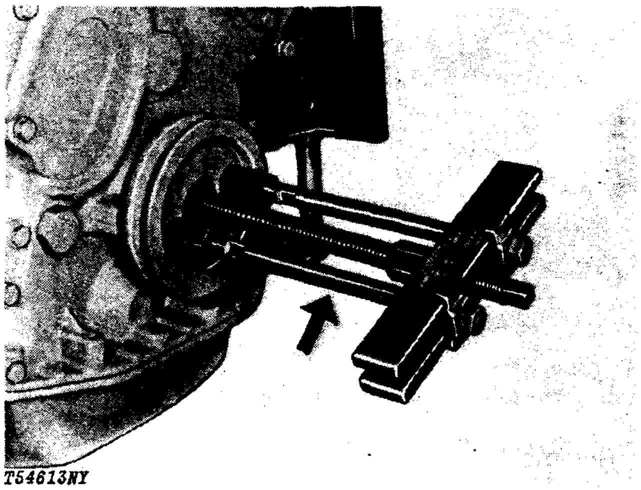


Fig. 4-Fan Drive Replacement (Lower Pulley)

Group 0423
ALTERNATOR AND GENERATOR MOUNTING

GENERAL INFORMATION

The alternator is located on the upper right side of the engine (Fig. 1).

REMOVAL

Loosen bolts (Fig. 1) that hold alternator to engine.

Remove belt from alternator pulley.

Remove bolts and lift off alternator.

INSTALLATION

Replace alternator and bolt in bracket. Set belt tension (Fig. 2).

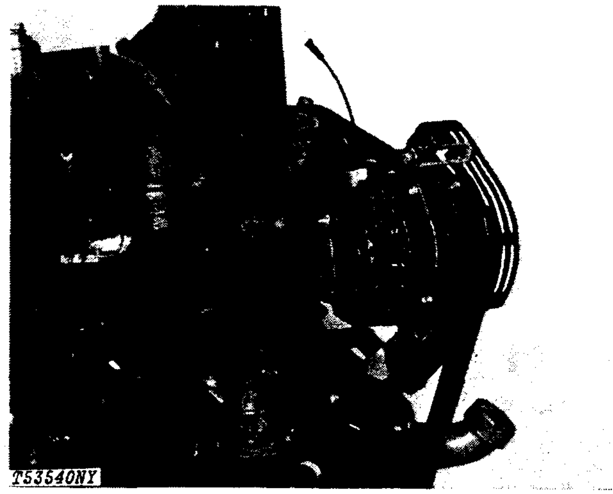


Fig. 1-Alternator Location

Belt Tension

With gauge: initial 100 to 110 lb. (445 to 490 N) (45 to 50 kg).

After 3 min. of operation: 80 lb. minimum (356 N) (36 kg).

Without gauge: 3/4 inch (19 mm) flex with 20 lb. (89 N) (9 kg) force.

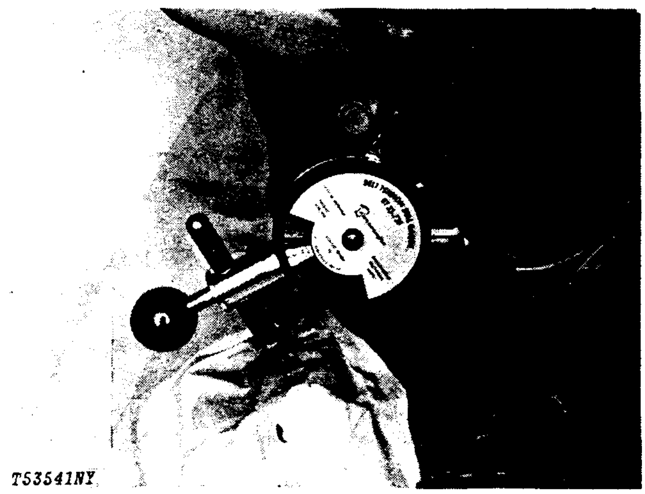
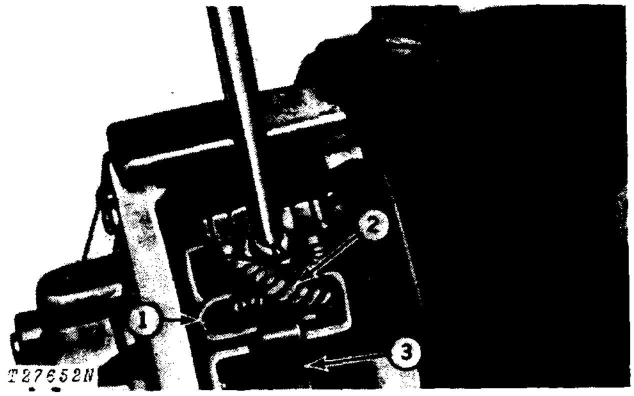


Fig. 2-Fan Belt Tension

4

When installing the brushes, twist brush leads 180 degrees (Fig. 30). Press the leads of the insulated brush down against the brush.

Give the assembled starting motor a no load test. Solenoid action during the test should be satisfactory.



T27652N

Fig. 30-Brush Installation

No Load Test

Connect a fully charged 12-volt battery (1) with a reservice capacity rating of 290 min., rheostat (2), ammeter (3), control switch (4), voltmeter (5), and tachometer (7) to the starting motor as shown in (Fig. 31).

Throw switch.

Starting motor should rotate smoothly at a constant speed of at least 3100 rpm at 11.7 volts with a current draw at less than 110 amps.

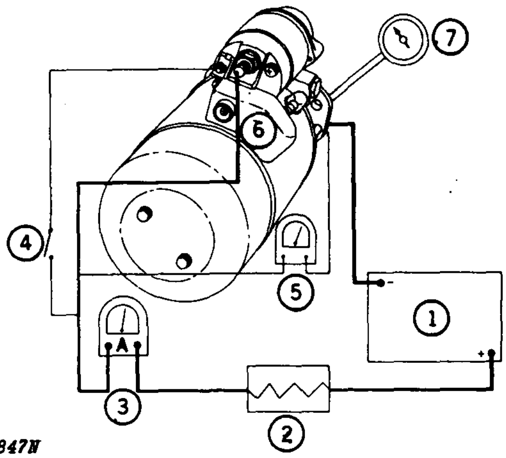


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Fig. 31-No Load Test Circuit (After Assembly)

Install starting motor and secure to flywheel housing with cap screws.

Connect to solenoid (5, Fig. 31) terminal (1) the positive battery cable (1), the solenoid to starting circuit relay (6) and the solenoid to alternator output terminal (2). Connect the solenoid to starting circuit relay (3) to the 5 terminal.

Connect battery.

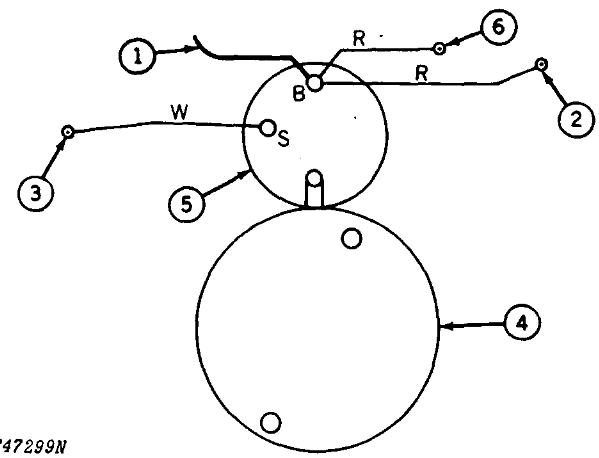

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Fig. 32-Solenoid Wire Connections

Overrunning Clutch and Pinion

Do not immerse the overrunning clutch and pinion 4, Fig. 21 in a cleaning solvent. The unit has been prelubricated and solvent will wash lubricant away. It may be cleaned with a cloth moistened with a cleaning solvent and wiped dry.

Rotate the pinion. Pinion gear should rotate smoothly (but not necessarily easily) in one direction, and should not rotate in the opposite direction.

If the pinion gear does not rotate smoothly, or if it is worn, chipped, or burred, it should be replaced.

Field Windings and Shunt Windings

Grounded Circuit Test (Fig. 24)

Remove the screw and hang the eyelet terminal in the air. Using an ohmmeter set to read on its highest scale, place one test lead on the copper terminal bolt and the other lead on a clean spot of the field frame (Fig. 24). If the ohmmeter dial indicator swings toward zero, a grounded circuit is indicated. Replace the field windings.

Shunt Winding Open Circuit Test (Fig. 25)

To check the shunt windings, set the ohmmeter to read on its lowest scale. Place one test lead on the terminal bolt and the other lead on the eyelet terminal (Fig. 25). If the ohmmeter does not swing to zero, it is open circuited and the field winding assembly will have to be replaced.

Field Winding Open Circuit Test (Fig. 26)

To check the field windings for an open circuit set the ohmmeter to read on its lowest scale and place one test lead on the copper terminal bolt and the other lead on the bare field end (Fig. 26). If the ohmmeter dial indicator does not swing to zero, the field windings are open-circuited. Replace the field windings.

Field Winding Installation

Before removing pole shoes, scribe marks on the pole shoe and the field frame to be sure they will be assembled in their original position.

Remove pole shoe screws from field frame.

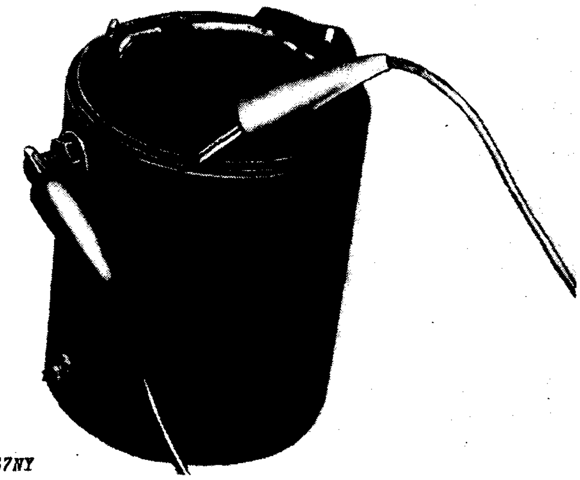

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Fig. 24-Grounded Circuit Test

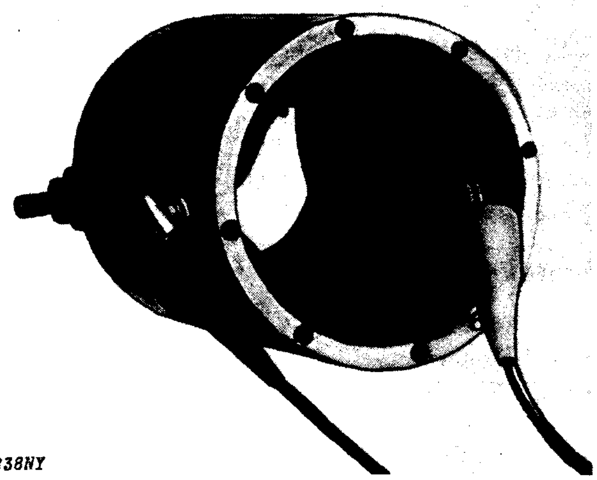

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Fig. 25-Shunt Winding Open Circuit Test

T53839NY

Fig. 26-Field Winding Open Circuit Test

4

Remove pole shoe and windings.

Install new windings and replace proper pole shoes. Torque pole shoe screws to 30 lb-ft (41 Nm) (4 kg-m)

Brushes

Replace brushes if they are oil soaked or if they are worn shorter than 5/8 in. (15.9 mm). Check brush insulated holders for grounds.

Brush Holder Insulation Test (Fig. 27)

With the ohmmeter set to its highest reading scale, connect one test lead onto the commutator end frame and the other lead to the brush holder Fig. 27. If the dial indicator swings towards zero, the positive brush holder is grounded and should be replaced.

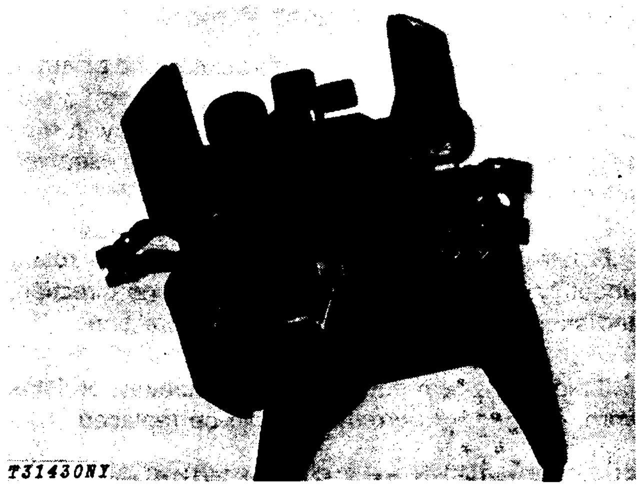

Fig. 27-Brush Holder Insulation Test

Brush Spring Tension (Fig. 28)

Measure the brush spring tension with a spring scale. The brush spring tension should be a minimum of 40 ounces (1 134 g) as the spring just leaves the brush holder. When taking the reading, the scale should be on a line parallel with the edge of the brush holder.

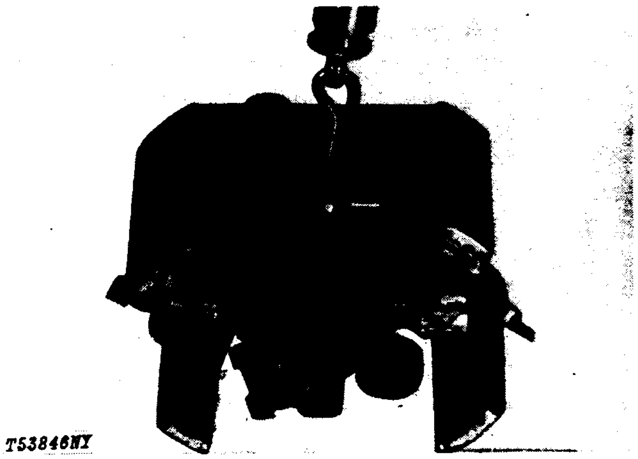

Fig. 28-Measuring Brush Spring Tension

Solenoid

Remove nuts from solenoid "S" terminal (2, Fig. 29) and from pull-in terminal (3). Then remove switch cover (1).

When installing switch cover (1, Fig. 29), place gaskets (4) on winding terminal, align main contact vertically, and place packing (5) on switch cover.

IMPORTANT: Solenoid contacts and plunger will be damaged if voltage is applied to solenoid when it is removed from starting motor.

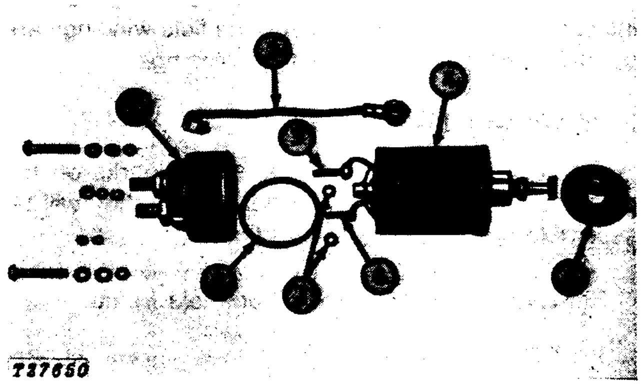

Fig. 29-Solenoid

ASSEMBLY

To assembly starting motor, reverse the disassembly procedures. Use new seals and packings.

Lubricate the shift lever, overrunning clutch, thrust washers, bushings, and armature bearing surfaces with John Deere Multi-Purpose Lubricant.

If the shift lever was removed, tighten the shift lever pivot screw with 30 lb-ft (41 Nm) (4 kg/m). Bend washered edge of screw down to prevent loosening.

Tighten center bearing housing to field frame bolts with 6 lb-ft (8 Nm) (0.8 kg/m). Tighten drive end and commutator end frame bolts with 10 lb-ft (14 Nm) (1 kg-m).

Commutator and Drive End Bushing Tools

Component	Bushing Removal	Bushing Installation
Handle	27487	27487
Disk (spacers)	27491	
	27492	
Disk	27494	27495
Disk (pilot)	27493	27493

Center Bushing

Component	Bushing	Oil Seal
Handle	27487	27487
Disk	27505	27512
Disk (pilot)	27501	27501

Check new bushings using the table below.

Commutator and Drive End Bushing Specifications*

I.D. of bushing	0.6693 to 0.6704 in. (17.00 to 17.03 mm)
Oil clearance**	0.0036 to 0.0070 in. (0.091 to 0.178 mm)
Maximum clearance**	0.016 in. (0.41 mm)
Bushing depth	0.008 to 0.022 in. (0.20 to 0.56 mm)

**Reaming may be necessary after installation.*

Center Bushing Specifications

I.D. of bushing	1.182 to 1.184 in. (30.02 to 30.07 mm)
Maximum clearance**	0.0236 in. (0.599 mm)
Bushing depth	0.017 to 0.032 in. (0.43 to 0.81 mm)

***The clearance is the difference between the shaft and the I.D. of the bushing.*

Armature

Check armature for straightness. Runout should not exceed 0.006 inch (0.15 mm). Maximum commutator runout is 0.016 inch (0.41 mm). If necessary, turn commutator and undercut insulation to 1/32-inch (0.794 mm). Undercut should never be less than 0.008 inch (0.20 mm) Commutator O.D. must be 1.77 inches (45.0 mm) or more. Clean copper dust from between the segments.

Check armature for opens, shorts and grounds. Burned edge of commutator indicates an open circuit.

Short Circuit Test

Place the armature in a growler and hold a hacksaw blade above each slot while slowly rotating the armature. If a coil is shorted, the blade will be attracted to and repelled from the slot.

A short circuit most often occurs because of copper dust or filings between two commutator segments. A short of this nature can be corrected by removal of such material.

With the ohmmeter set to read on its highest scale, place one test lead on the commutator and the other lead on the armature core or shaft (Fig. 22). If the test meter indicator swings towards zero, the armature is grounded. Replace armature.

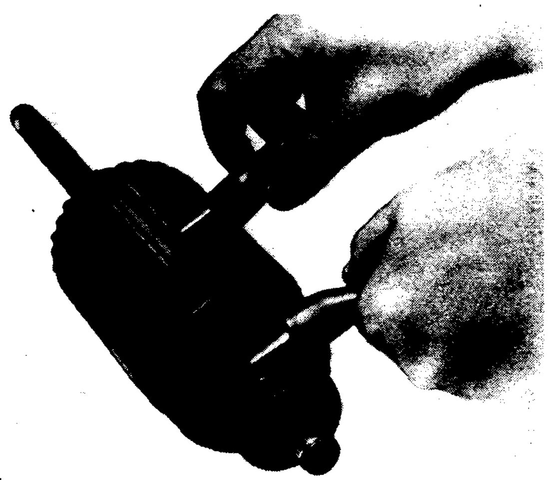

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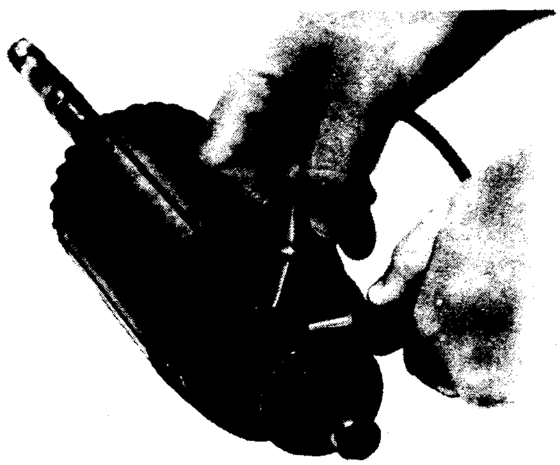
Fig. 22-Armature Ground Test

With the ohmmeter set to read on its lowest scale, place one test lead on the commutator segment and the other test lead on an adjacent segment (Fig. 23). Repeat this operation for all segments by moving one lead at a time. If the test meter indicator does not swing to zero and remains stationary, the armature coil between these two segements is open. Replace armature.

Burned commutator segments are usually an indication of an open circuited coil.



T53836NY

Fig. 23-Open Circuit Test

REPAIR

Refer to Fig. 21 for relative position of parts. Page 0422-17.

NOTE: Starting motor has metric bolts and nuts except for those on the solenoid switch cover.

Disconnect shunt winding lead (11, Fig. 21). Remove terminal cover (28), field coil connector (27), and solenoid assembly.

Remove end frame cover (30, Fig. 21) and gasket.

Remove brushes (33, Fig. 21), commutator end frame assembly (35) and brush ground strap (29).

Remove field frame (36).

Remove drive end housing (2, Fig. 21).

Drive pinion stop (18) toward pinion and remove snap ring (19) and pinion stop (18).

Remove armature (12) from center bearing housing (8).

Remove overrunning clutch assembly (4, Fig. 21) brake washer (17), and shift lever wear pads.

Remove shift lever pivot and shift lever (7, Fig. 21).

Cleaning

When cleaning component parts, do not immerse the solenoid, field windings or armature in cleaning solvent. Immersing any of these in solvent may damage their insulation. These may be cleaned by wiping the parts with a cloth that has been slightly moistened with cleaning solvent and then wiped dry with a clean dry cloth.

Do not immerse the drive end housing, overrunning clutch, center bearing housing, or commutator end frame in cleaning solvent. All of these parts have been prelubricated and solvent will wash this lubricant away. These components should be cleaned in the same method just mentioned, using a cloth slightly moistened with cleaning solvent and then wiped dry with a clean dry cloth.

All other parts which are not made of rubber or mentioned above can be dipped in clean solvent to remove all oil and dirt.

If replacing center bushing (15, Fig. 21), install a new oil seal (14, Fig. 21) and a new oil felt (16) saturated with engine oil.

When replacing bushings, press the new bushings in from the chamfered end. Make a bushing drive as shown in Group 0499 or use the following handle and disks from the D01046AA Universal Driver Set. Align hole in commutator and lubrication wick.

No Load Test

Make the connections shown in Fig. 20 starting with the battery (1) positive (+) terminal. Run a heavy wire to the positive terminal of the amp meter (3). From the negative (−) terminal of the amp meter run a heavy wire to the "Bat" terminal of the solenoid. Connect a switch (5) between the "Bat" and the "S" terminal. Reconnect the field coil connector. Connect the starter case to the negative of the battery. Connect a carbon pile resistor (2) across the positive (+) and negative (−) of the battery (1). Connect a voltmeter across the "Bat" and the starter case. Connect a tachometer to the starter drive.

Throw the switch.

The starting motor should draw 70 to 110 amps at 9.0 volts.

The armature speed should be 2500 to 4500 rpm.

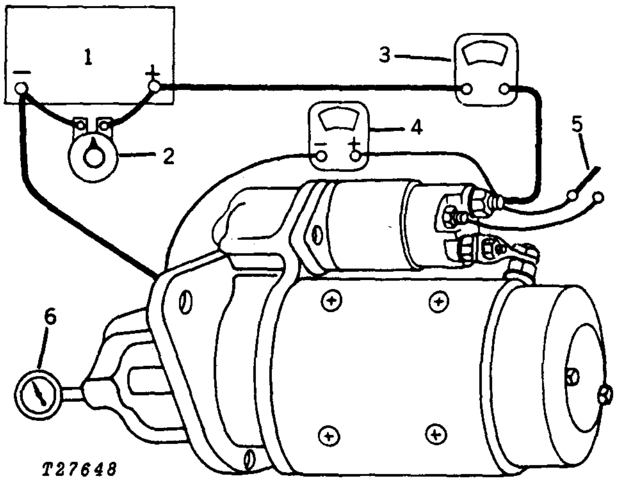


Fig. 20-No Load Test

Low Speed, Hign Current Draw

Excessive friction.
Shorted armature.
Grounded armature or fields.

High Speed, Low Current Draw

Open shunt field circuit.

High Speed, High Current Draw

Shorted series field coils.

No Load Test Diagnosis

Fails to Operate, Low Current Draw (Approx. 25 amps)

Open series field circuit.
Open armature coils.
Defective brush contact with commutator.

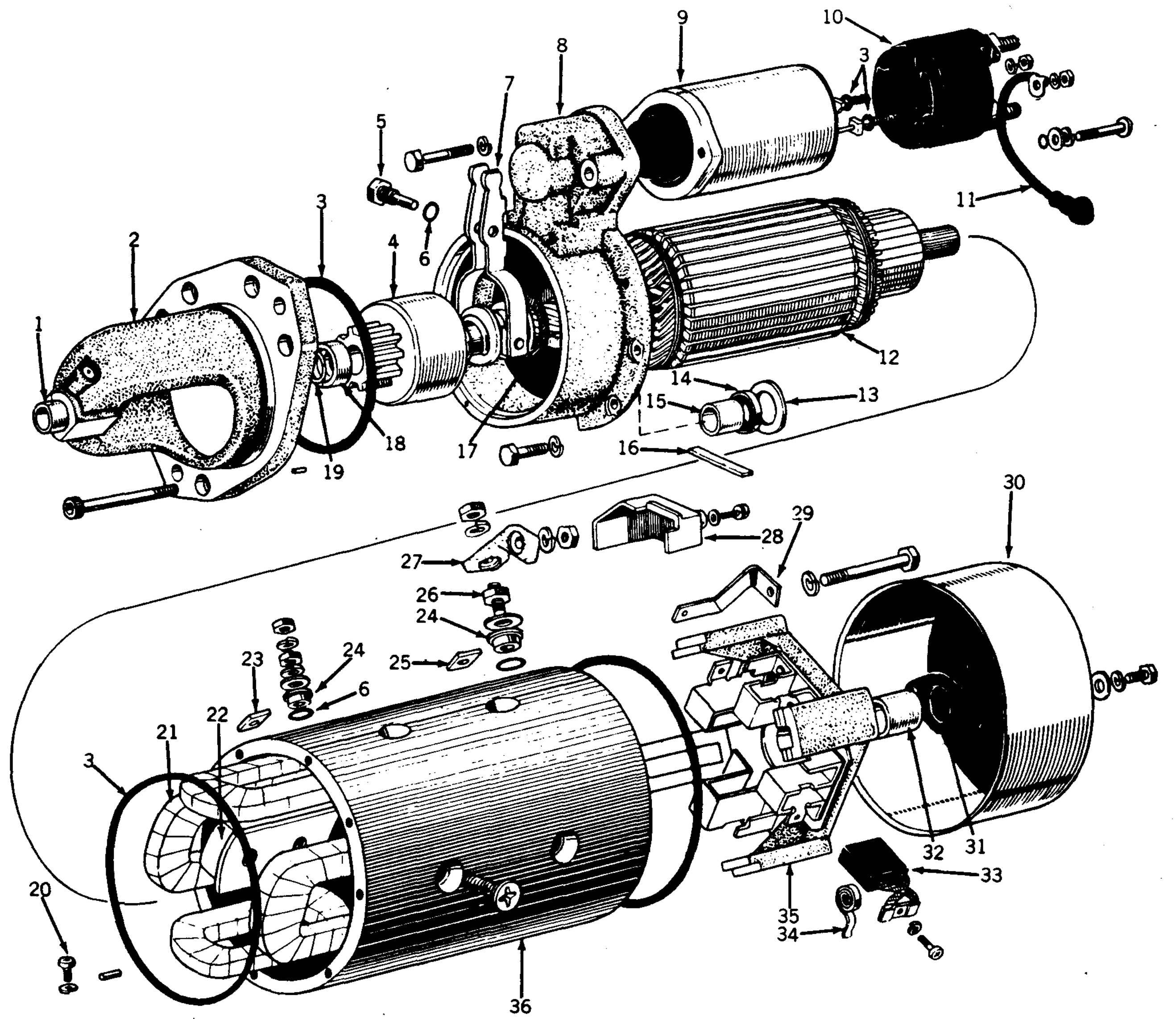
Fails to Operate, High Current Draw

Grounded terminal or fields.
Seized bearings.

Low Speed, Low Current Draw

High internal resistance.
Defective brush contact with commutator.

4



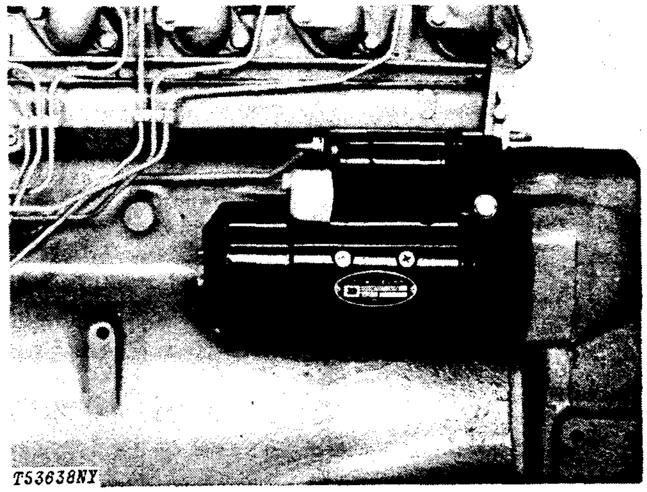
T31424N

1—Drive End Bushing
2—Drive End Housing
3—Packing
4—Overrunning Clutch
5—Shift Lever Pivot
6—O-Ring
7—Shift Lever
8—Center Bearing Housing
9—Solenoid Winding
10—Solenoid Switch Cover
11—Shunt Winding Lead
12—Armature
13—Bakelite Washer
14—Oil Seal
15—Center Bearing Bushing
16—Oil Felt
17—Brake Washer
18—Pinion Stop
19—Snap Ring
20—Shunt Winding Ground Screw
21—Field Winding
22—Pole Shoe (4 used)
23—Square Washer
24—Insulating Bushing
25—Square Insulator
26—Special Bolt
27—Field Coil Connector
28—Terminal Cover
29—Brush Ground Strap
30—End Frame Cover
31—Gasket
32—Commutator End Frame Bushing
33—Brush (4 used)
34—Brush Spring (4 used)
35—Commutator End Frame
36—Field Frame

Fig. 21-Starting Motor

JOHN DEERE STARTING MOTOR

The John Deere starting motor is located at the rear of the engine on the right or left side. A left side mount is shown in (Fig. 16).



T53638NY

Fig. 16-Starter Location

REMOVAL

Disconnect battery ground straps.

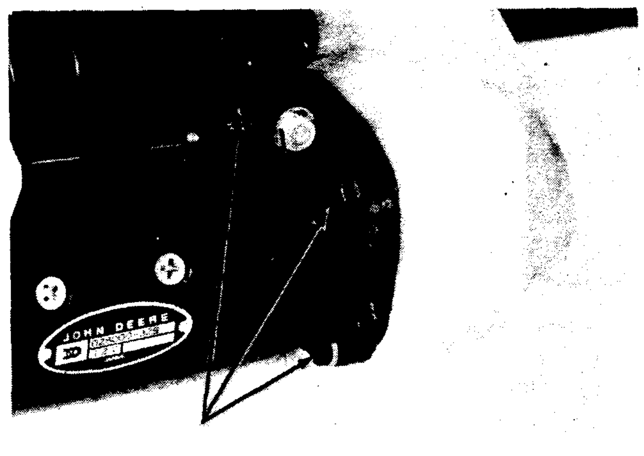
Disconnect wires from starting motor.

Remove three cap screws attaching starting motor to flywheel housing (Fig. 17).

Remove starting motor.

NOTE: The JDE-80 Starter Wrench might be necessary to remove the rear attaching cap screws.

Refer to Fig. 21 page 0422-17 for relative position of parts.



T53808NY

Fig. 17-Starter Motor Removal

To prevent damage, solenoid must be on starting motor when testing windings.

Remove terminal cover and field coil connector (27, Fig. 21).

Refer to Fig. 21 for the location of various parts called out.

TESTS

4

Solenoid Tests (Starting Motor Removed)

Disconnect the shunt field winding lead (11, Fig. 21).

Replace the solenoid if it fails one of the following tests.

Solenoid Pull-In Test

Connect the circuit shown in Fig. 18. Run a heavy wire from the positive terminal of the battery (1) to one side of the carbon pile resistor (3). From the other side of the resistor run a heavy wire to the "Bat" terminal of the solenoid. Then run a heavy wire from the "M" terminal of the solenoid to the negative (−) terminal of the battery. Connect a voltmeter (2) across the negative terminal of the battery and the "S" terminal of the solenoid.

Adjust the carbon pile to apply 8 volts to the solenoid. The solenoid should push the pinion out to the pinion stop when the jumper wire is connected. The drive should remain out at the pinion stop. Current through the jumper wire will be approximately 90 amps, so heavy jumper wire will be necessary.

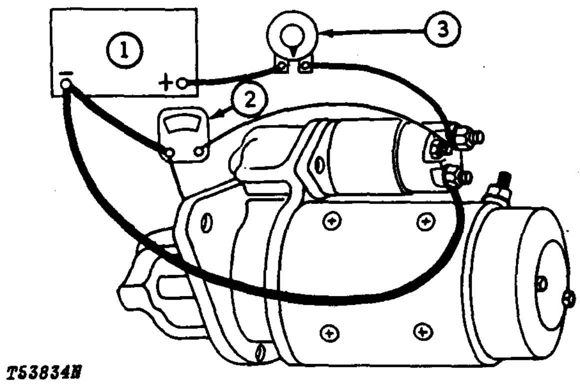


Fig. 18-Solenoid Pull-In Test

Solenoid Return Test

Make the connections shown in Fig. 19. Starting with the positive terminal of the battery (1, Fig. 19), run a heavy wire to a switch (2) then run a heavy wire to the "M" terminal of the solenoid and connect it. Run a wire from the case of the starter to the negative terminal of the battery.

When the switch is thrown, the drive should return without hesitation.

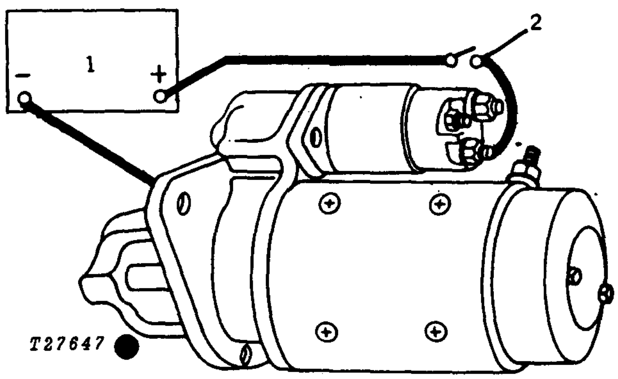


Fig. 19-Solenoid Return Test

CYLINDER HEAD AND VALVES (0409)

SPECIFICATIONS AND TORQUE VALUES—Continued

Valve seat width:

Engine	Valve Seat Width
3-164	0.078 to 0.094 inch (1.98 to 2.39 mm)
4-219	0.063 to 0.078 inch (1.60 to 1.98 mm)
4-276	0.083 to 0.093 inch (2.11 to 2.36 mm)
6-329	0.047 to 0.078 inch (1.19 to 1.98 mm)

Valve seat run-out (maximum)	0.002 inch (0.05 mm)

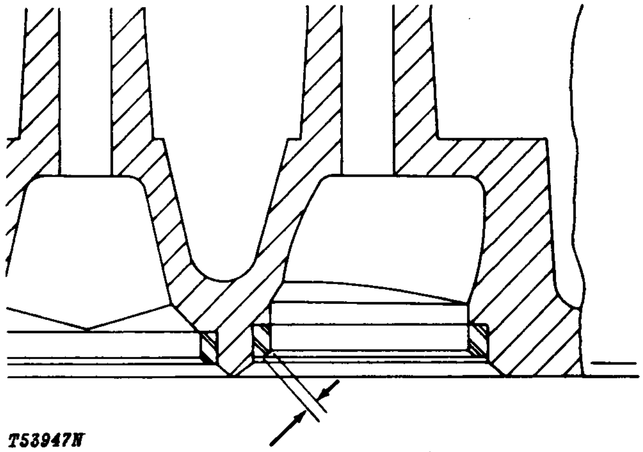


Fig. 39-Valve Seat Width

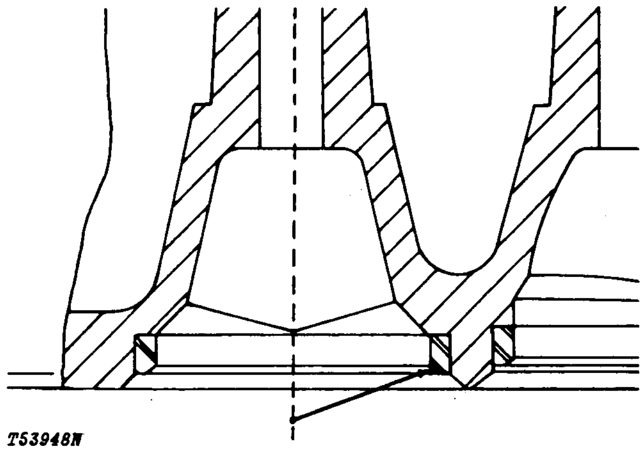


Fig. 40-Valve Seat Run-out

Valve stem O.D. (new) (1, Fig. 41)	0.372 to 0.373 inch (9.45 to 9.47 mm)
Valve guide I.D. (new) (2)	0.375 to 0.376 inch (9.53 to 9.55 mm)
Valve stem oil clearance (new)	0.002 to 0.004 inch (0.05 to 0.10 mm)
Valve stem oil clearance (maximum)	0.006 inch (0.15 mm)

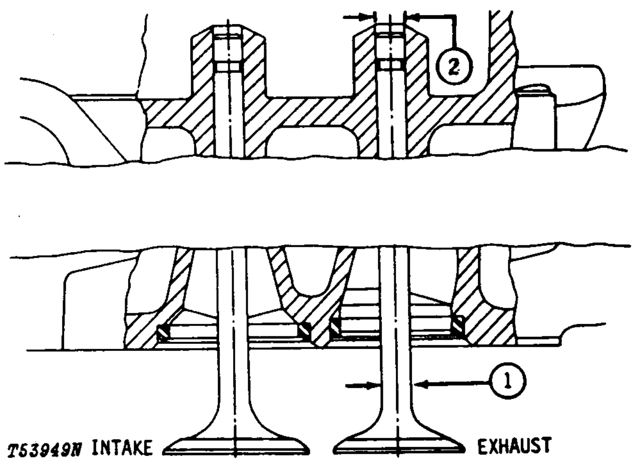


Fig. 41-Valve Stem Oil Clearance

CYLINDER HEAD AND VALVES (0409)
SPECIFICATIONS AND SPECIAL TOOLS—Continued

4

Valve spring
free length (approx.) (1, Fig. 42) .... 2.12 in.
(53.8 mm)
Valve spring (2) .... 1.81 in.
(46.0 mm)
when compressed with 54 to 62 lb.
(240 to 276 N) (24 to 28 kg)
Valve spring (3) .... 1.36 in.
(34.5 mm)
when compressed with 133 to 153 lb.
(592 to 681 N) (60 to 69 kg)

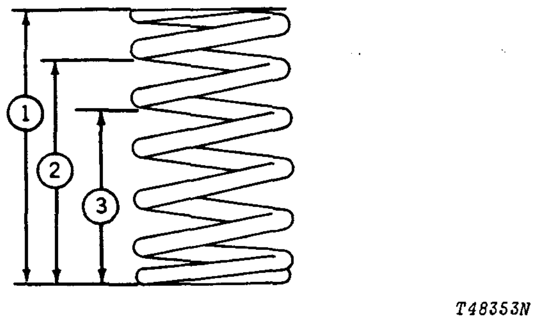


Fig. 42-Valve Spring Length

Cylinder head cap screw torque............. 95 lb-ft
(129 Nm) (13 kg-m)

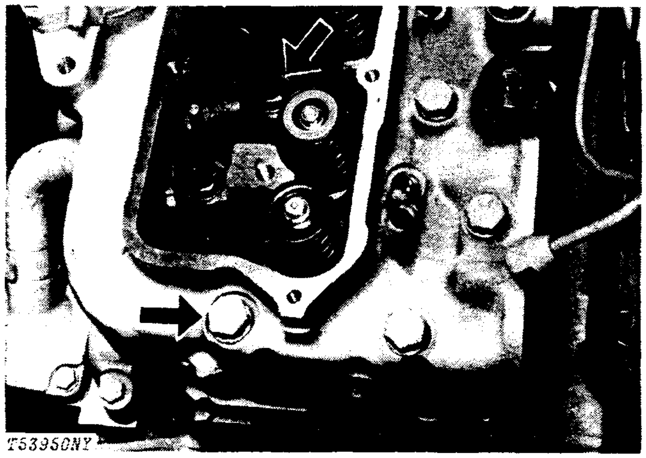


Fig. 43-Cylinder Head Cap Screw Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES (JDB331MD2406-AR49904)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

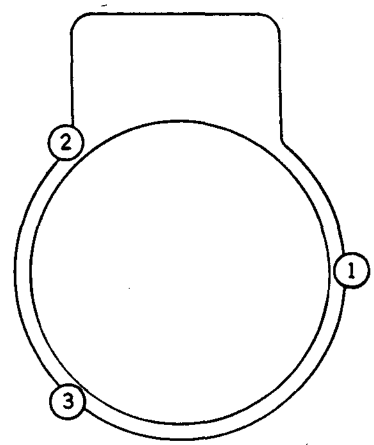
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) ....18 in. Hg. (609.5 mbar)

Transfer pump pressure (1250 rpm) ....85 to 95 psi (5.9 to 6.5 bar) (6.0 to 6.7 kg/cm²)



T53890N

Fig. 44-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB331MD2406-AR49904)

Automatic Speed Advance

rpm

325 to 525 .... 1°
750 to 850 .... 5°
by 1125 .... 7-1/2° minimum

4

Minimum cranking speed delivery (75 rpm)
Volume .... 42 cm^3/1000 strokes
Transfer pump pressure (minimum) .... 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (1250 rpm)
Volume .... 63 to 66 cm^3/1000 strokes
Maximum variation between cylinders .... 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume .... 64 to 68 cm^3/1000 strokes
Maximum variation between cylinders .... 5 cm^3/1000 strokes

High idle (WOT) (1340 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders .... 4 cm^3/1000 strokes

Governor cut-off (1365 rpm)
Volume .... 5 cm^3 max/1000 strokes

Low idle (400 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders .... 4 cm^3/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB331MD2406-AR49904)

1 - Fuel injection pump-to-engine nut torque .... 20 lb-ft
(27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 45 lb-ft
(61 Nm) (6 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft
(47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in
(1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft
(27 Nm) (3 kg-m)

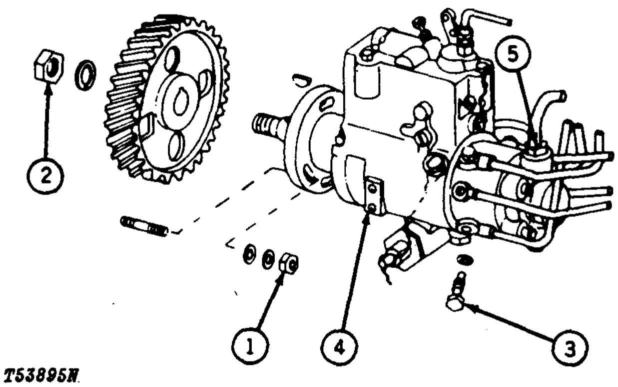


Fig. 45-Roosa-Master Model JDB Torque

4

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB635AL2446-AR51568)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (–) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) ....18 in. Hg. (609.5 mbar)

Transfer pump pressure (1250 rpm) ....85 to 90 psi (5.9 to 6.2 bar) (6.0 to 6.3 kg/cm²)

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

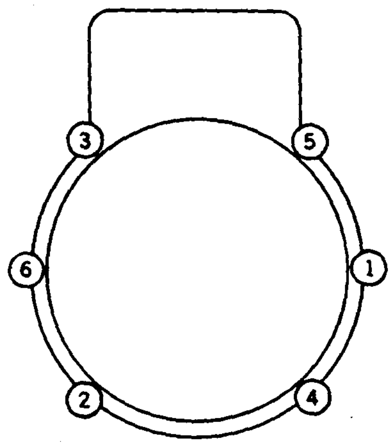


Fig. 46-Injection Line Connection

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB635AL2446-AR51568)

Automatic Speed Advance

rpm

350 to 550 .... 1°
900 to 1000 .... 5°
by 1100 .... 5-1/2° minimum

Minimum cranking speed delivery (75 rpm)
- Volume .... 33 cm^3/1000 strokes
- Transfer pump pressure (minimum) .... 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (1250 rpm)
- Volume .... 59 to 62 cm^3/1000 strokes
- Maximum variation between cylinders .... 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
- Volume .... 63 to 67 cm^3/1000 strokes
- Maximum variation between cylinders .... 4 cm^3/1000 strokes

High idle (WOT) (1325 rpm)
- Volume .... 10 to 12 cm^3/1000 strokes
- Maximum variation between cylinders .... 4 cm^3/1000 strokes

Governor cut-off (1350 rpm)
- Volume .... 5 cm^3 max/1000 strokes

Low idle (400 rpm)
- Volume .... 10 to 12 cm^3/1000 strokes
- Maximum variation between cylinders .... 4 cm^3/1000 strokes

Check shut-off at (200 rpm)
- Volume .... 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB635AL2446-AR51568)

1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 45 lb-ft (61 Nm) (6 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)

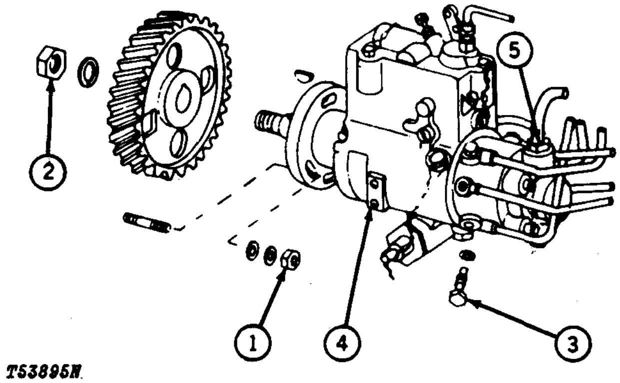


Fig. 47-Roosa-Master Model JDB Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435AL2442-AR51747)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required to pump inlet.

Transfer pump vacuum (200 rpm) (minimum) . . . . .18 in. Hg. (609.5 mbar)

Transfer pump pressure (1250 rpm) . . . .85 to 90 psi (5.9 to 6.2 bar) (6.0 to 6.3 kg/cm²)

**Available from: Viscosity Oil Company*
3200 So. Western Avenue
Chicago, Illinois 60608

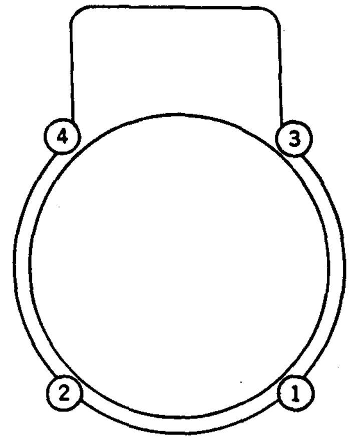


Fig. 48-Injection Line Connection

4

FUEL INJECTION SYSTEMS (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435AL2442-AR51747)

Automatic Speed Advance

rpm

325 to 525 .... 1°
800 to 900 .... 5°
by 1200 .... 6-1/2°

4

Minimum cranking speed delivery (75 rpm)
Volume .... 37 cm^3/1000 strokes
Transfer pump pressure (minimum) .... 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (1250 rpm)
Volume .... 60 to 63 cm^3/1000 strokes
Maximum variation between cylinders .... 5 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume .... 64 to 68 cm^3/1000 strokes
Maximum variation between cylinders .... 5 cm^3/1000 strokes

High idle (WOT) (1325 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders .... 5 cm^3/1000 strokes

Governor cut-off (1350 rpm)
Volume .... 6 cm^3 max/1000 strokes

Low idle (400 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders .... 5 cm^3/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435AL2442-AR51747)

1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 45 lb-ft (61 Nm) (6 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)

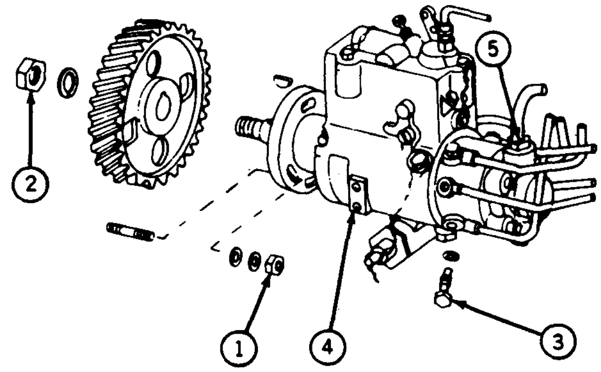


Fig. 49-Roosa-Master Model JDB Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB331CM2667-AR66282)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

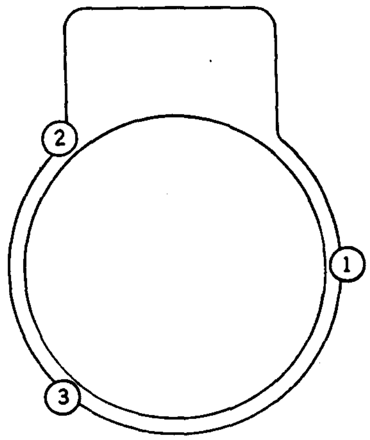
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) ....18 in. Hg. (609.5 mbar)

Transfer pump pressure (900 rpm) .....73 to 83 psi (5.0 to 5.7 bar) (5.1 to 5.8 kg/cm²)



T53890N

Fig. 50-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB331CM2667-AR66282)

Automatic Speed Advance

rpm
250 to 450 .... 1°
by 700 .... 5-1/2°

Minimum cranking speed
delivery (75 rpm)
Volume .... 42 cm^3/1000 strokes
Transfer pump pressure (minimum) .... 12 psi
(1 bar) (1 kg/cm^2)

Fuel delivery (900 rpm)
Volume .... 63 to 66 cm^3/1000 strokes
Maximum variation
between cylinders .... 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume .... 64 to 68 cm^3/1000 strokes
Maximum variation
between cylinders .... 5 cm^3/1000 strokes

High idle (WOT) (927 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation
between cylinders .... 4 cm^3/1000 strokes

Governor cut-off (955 rpm)
Volume .... 5 cm^3 max/1000 strokes

Low idle (200 rpm)
Volume .... to cm^3/1000 strokes
Maximum variation
between cylinders .... 4 cm^3/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm^3 max/1000 strokes

4

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB331CM2667-AR66282)

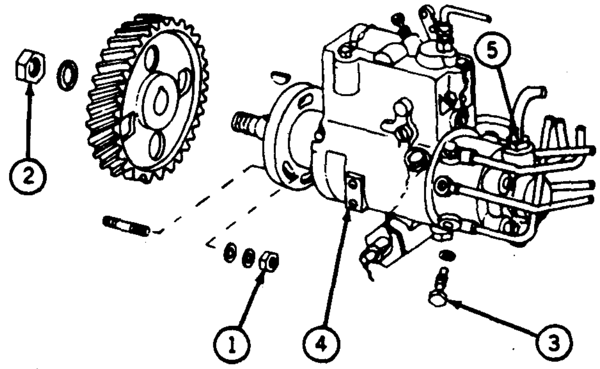
1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 45 lb-ft (61 Nm) (6 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)



T53895N

Fig. 51-Roosa-Master Model JDB Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627MD2684-AR66395)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

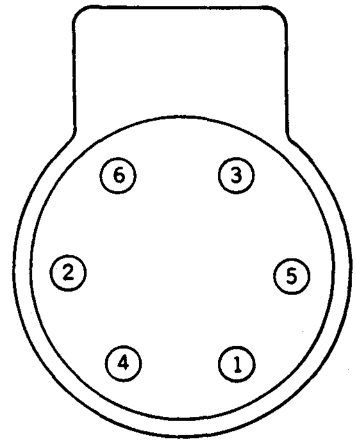
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) .... 18 in. Hg. (609.5 mbar)

Transfer pump pressure (1100 rpm) .... 80 to 90 psi (5.5 to 6.2 bar) (5.6 to 6.3 kg/cm²)



T53889N

Fig. 52-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627MD2684-AR66395)

Automatic Speed Advance

rpm	
300 to 500	1°
700 to 800	5°
by 925	6°

4

Minimum cranking speed delivery (75 rpm)
- Volume . . . . . 40 cm³/1000 strokes
- Transfer pump pressure (minimum) . . . . . 10 psi (1 bar) (1 kg/cm²)

Fuel delivery (1100 rpm)
- Volume . . . . . 70 to 73 cm³/1000 strokes
- Maximum variation between cylinders . . . . . 3 cm³/1000 strokes

Fuel delivery (750 rpm)
- Volume . . . . . 73 to 78 cm³/1000 strokes
- Maximum variation between cylinders . . . . . 5 cm³/1000 strokes

High idle (WOT) (1200 rpm)
- Volume . . . . . 10 to 12 cm³/1000 strokes
- Maximum variation between cylinders . . . . . 4 cm³/1000 strokes

Governor cut-off (1225 rpm)
- Volume . . . . . 5 cm³ max/1000 strokes

Low idle (200 rpm)
- Volume . . . . . 10to12 cm³/1000 strokes
- Maximum variation between cylinders . . . . . 4 cm³/1000 strokes

Check shut-off at (200 rpm)
- Volume . . . . . 2 cm³ max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627MD2684-AR66395)

1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 140 to 150 lb-ft (190 to 203 Nm) (19 to 21 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)

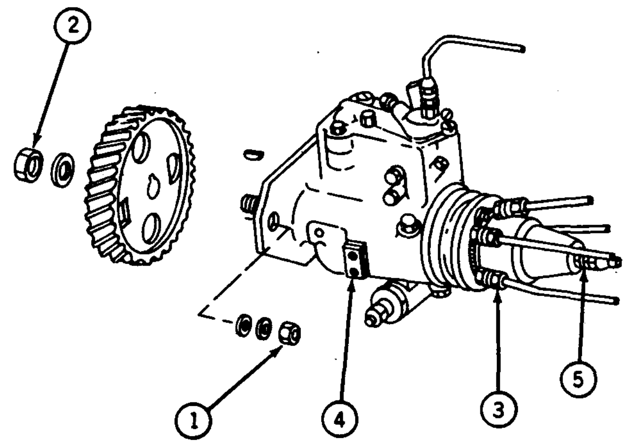


Fig. 53-Roosa-Master Model DM Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB431CM2701-AR66995)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

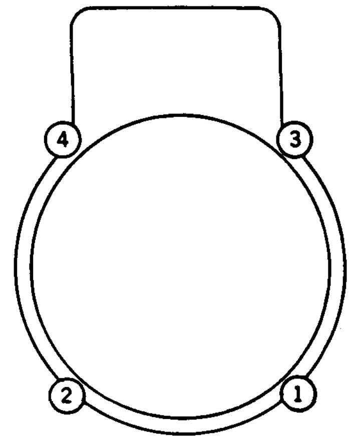
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) .... 18. in. Hg. (609.5 mbar)

Transfer pump pressure (900 rpm) .....75 to 80 psi (5.2 to 5.5 bar) (5.3 to 5.6 kg/cm²)



T53891N

Fig. 54-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB431CM2701-AR66995)

Automatic Speed Advance

rpm
250 to 450 . . . . 1°
by 1350 . . . . 5°

Minimum cranking speed delivery (75 rpm)
Volume . . . . 35 cm^3/1000 strokes
Transfer pump pressure (minimum) . . . . 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (900 rpm)
Volume . . . . 61 to 64 cm^3/1000 strokes
Maximum variation between cylinders . . . . 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume . . . . 60 to 64 cm^3/1000 strokes
Maximum variation between cylinders . . . . 5 cm^3/1000 strokes

High idle (WOT) (927 rpm)
Volume . . . . 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders . . . . 4 cm^3/1000 strokes

Governor cut-off (955 rpm)
Volume . . . . 5 cm^3 max/1000 strokes

Low idle (200 rpm)
Volume . . . . to cm^3/1000 strokes
Maximum variation between cylinders . . . . cm^3/1000 strokes

Check shut-off at (200 rpm)
Volume . . . . 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB431CM2701-AR66995)

4

1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 45 lb-ft (61 Nm) (6 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque.......................... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)

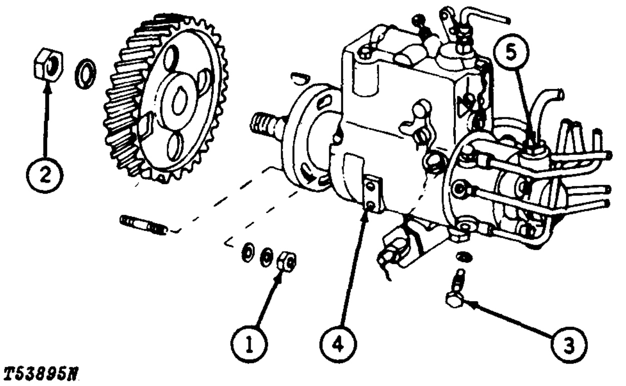


Fig. 55-Roosa-Master Model JDB Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB635CM2757-AR66996)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

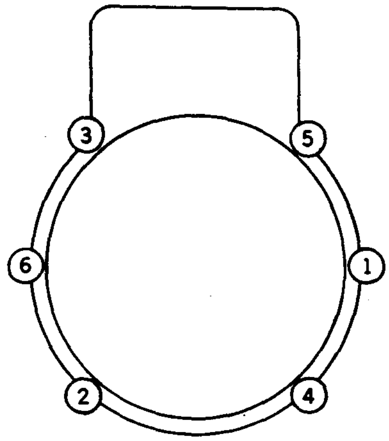
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) ....18 in. Hg. (609.5 mbar)

Transfer pump pressure (900 rpm) .....58 to 63 psi (4.0 to 4.3 bar) (4.1 to 4.4 kg/cm²)



T53892N

Fig. 56-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB635CM2757-AR66996)

Automatic Speed Advance

rpm

250 to 450 .... 1°
by 700 .... 4-1/2° minimum

Minimum cranking speed delivery (75 rpm)
Volume .... 33 cm³/1000 strokes
Transfer pump pressure (minimum) .... 12 psi (1 bar) (1 kg/cm²)

Fuel delivery (900 rpm)
Volume .... 59 to 62 cm³/1000 strokes
Maximum variation between cylinders .... 3 cm³/1000 strokes

Fuel delivery (750 rpm)
Volume .... 63 to 67 cm³/1000 strokes
Maximum variation between cylinders .... 4 cm³/1000 strokes

High idle (WOT) (927 rpm)
Volume .... 10 to 12 cm³/1000 strokes
Maximum variation between cylinders .... 4 cm³/1000 strokes

Governor cut-off (955 rpm)
Volume .... 5 cm³ max/1000 strokes

Low idle (rpm)
Volume ....   to   cm³/1000 strokes
Maximum variation between cylinders ....   cm³/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm³ max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB635CM2757-AR66996)

1 - Fuel injection pump
to engine nut torque .... 20 lb-ft
(27 Nm) (3 kg-m)

2 - Fuel injection pump
drive gear nut torque .... 45 lb-ft
(61 Nm) (6 kg-m)

3 - Injection line to
pump connector torque .... 35 lb-ft
(47 Nm) (5 kg-m)

4 - Timing cover screw
torque .... 15 to 20 lb-in
(1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump
fuel inlet connector
torque .... 20 lb-ft
(27 Nm) (3 kg-m)

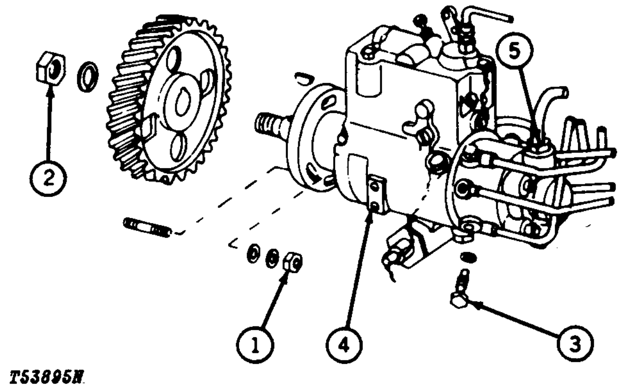


Fig. 57-Roosa-Master Model JDB Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435MD2793-AR70530)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

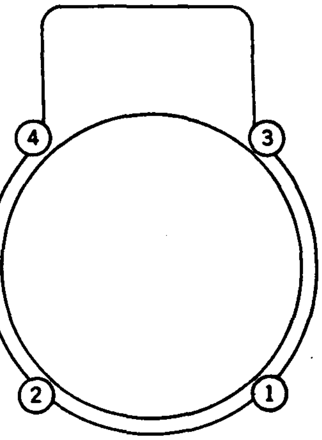
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07. 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm)
(minimum) ....18 in. Hg.
(609.5 mbar)

Transfer pump pressure (1250 rpm) ....85 to 95 psi
(5.9 to 6.5 bar) (6.0 to 6.7 kg/cm²)



T53891N

Fig. 58-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435MD2793-AR70530)

Automatic Speed Advance

rpm
300 to 500 . . . . 1°
750 to 850 . . . . 5°
by 1150 . . . . 7-1/2°

Minimum cranking speed delivery (75 rpm)
Volume . . . . 44 cm^3/1000 strokes
Transfer pump pressure (minimum) . . . . 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (1250 rpm)
Volume . . . . 70 to 73 cm^3/1000 strokes
Maximum variation between cylinders . . . . 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume . . . . 73 to 77 cm^3/1000 strokes
Maximum variation between cylinders . . . . 5 cm^3/1000 strokes

High idle (WOT) (1325 rpm)
Volume . . . . 15 to 17 cm^3/1000 strokes
Maximum variation between cylinders . . . . 4 cm^3/1000 strokes

Governor cut-off (1350 rpm)
Volume . . . . 8 cm^3 max/1000 strokes

Low idle (400 rpm)
Volume . . . . 15 to 17 cm^3/1000 strokes
Maximum variation between cylinders . . . . 4 cm^3/1000 strokes

Check shut-off at (200 rpm)
Volume . . . . 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435MD2793-AR70530)

1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (2 kg-m)

2 - Fuel injection pump drive gear nut torque .... 45 lb-ft (61 Nm) (6 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)

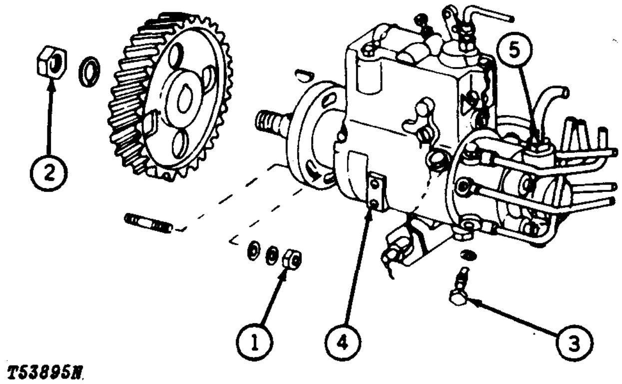


Fig. 59-Roosa-Master Model JDB Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435CM2819-AR70531)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

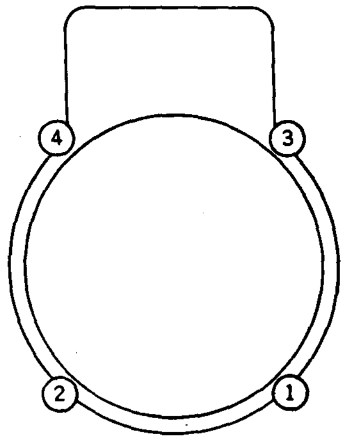
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21. bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm)
(minimum) ....18 in. Hg.
(609.5 mbar)

Transfer pump pressure (900 rpm) .....75 to 80 psi
(5.2 to 5.5 bar) (5.3 to 5.6 kg/cm²)



T53891N

Fig. 60-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435CM2819-AR70531)

Automatic Speed Advance

rpm
250 to 450 .... 1°
by 675 .... 5°

4

Minimum cranking speed delivery (75 rpm)
Volume .... 35 cm^3/1000 strokes
Transfer pump pressure (minimum) .... 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (900 rpm)
Volume .... 74 to 78 cm^3/1000 strokes
Maximum variation between cylinders .... 3 cm^3/1000 strokes

High idle (WOT) (927 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders .... 4 cm^3/1000 strokes

Governor cut-off (955 rpm)
Volume .... 5 cm^3 max/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (JDB435CM2819-AR70531)

1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 45 lb-ft (61 Nm) (6 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)

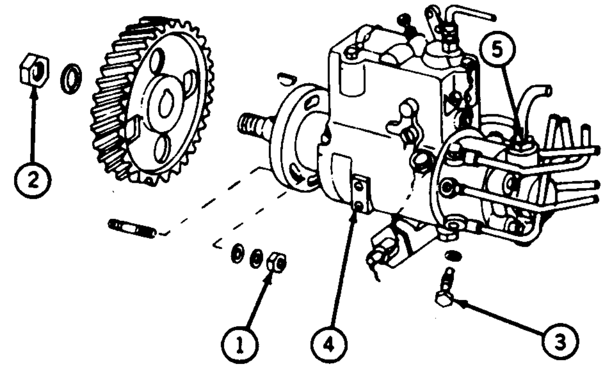


Fig. 61-Roosa-Master Model JDB Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427HB2915-AR70538)

4

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

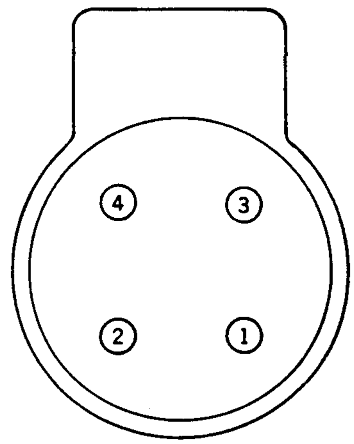
Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) ....18 in. Hg. (609.5 mbar)

Transfer pump pressure (900 rpm) .....73 to 83 psi (5.0 to 5.7 bar) (5.1 to 5.8 kg/cm²)

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*



T53888N

Fig. 62-Injection Line Connection

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427HB2915-AR70538)

Automatic Speed Advance

rpm

250 to 450 .... 1°
by 650 .... 3°

Minimum cranking speed delivery (75 rpm)
Volume .... 54 cm^3/1000 strokes
Transfer pump pressure (minimum) .... 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (900 rpm)
Volume .... 91 to 95 cm^3/1000 strokes
Maximum variation between cylinders .... 5 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume .... 92 to 96 cm^3/1000 strokes
Maximum variation between cylinders .... 7 cm^3/1000 strokes

High idle (WOT) (927 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders .... 4 cm^3/1000 strokes

Governor cut-off (950 rpm)
Volume .... 5 cm^3 max/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued
(DM4427HB2915-AR70538)

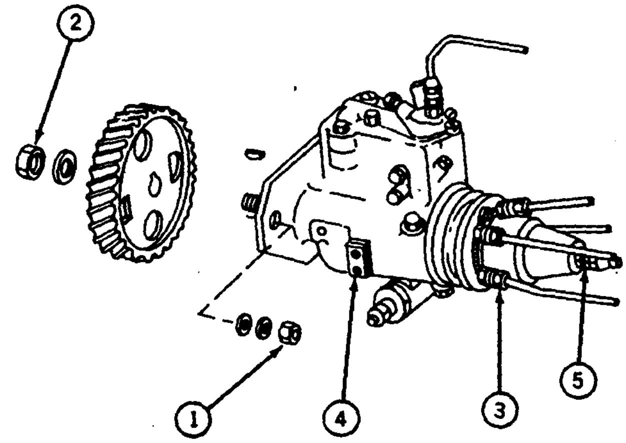
- Fuel injection pump
to engine nut torque .... 20 lb-ft
(27 Nm) (3 kg-m)

- Fuel injection pump
drive gear nut torque .... 140 to 150 lb-ft
(190 to 203 Nm) (19 to 21 kg-m)

- Injection line to
pump connector torque .... 35 lb-ft
(47 Nm) (5 kg-m)

- Timing cover screw
torque .... 15 to 20 lb-in
(1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump
fuel inlet connector
torque .... 20 lb-ft
(27 Nm) (3 kg-m)



T53898N

Fig. 63-Roosa-Master Model DM Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627HB2825-AR70551)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46° C).

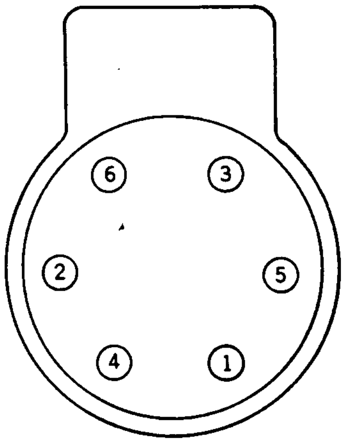
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) .... 18 in. Hg. (609.5 mbar)

Transfer pump pressure (900 rpm) ..... 75 to 80 psi (5.2 to 5.5 bar) (5.3 to 5.6 kg/cm²)



T53889N

Fig. 64-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627HB2825-AR70551)

Automatic Speed Advance

rpm
250 to 450 .... 1°
by 650 .... 3°

Minimum cranking speed delivery (75 rpm)
Volume .... 40 cm^3/1000 strokes
Transfer pump pressure (minimum) .... 10 psi (1 bar) (1 kg/cm^2)

Fuel delivery (900 rpm)
Volume .... 71 to 74 cm^3/1000 strokes
Maximum variation between cylinders .... 3 cm^3/1000 strokes

High idle (WOT) (925 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders .... 4 cm^3/1000 strokes

Governor cut-off (955 rpm)
Volume .... 5 cm^3 max/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627HB2825-AR70551)

1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 140 to 150 lb-ft (190 to 203 Nm) (19 to 21 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (2 kg-m)

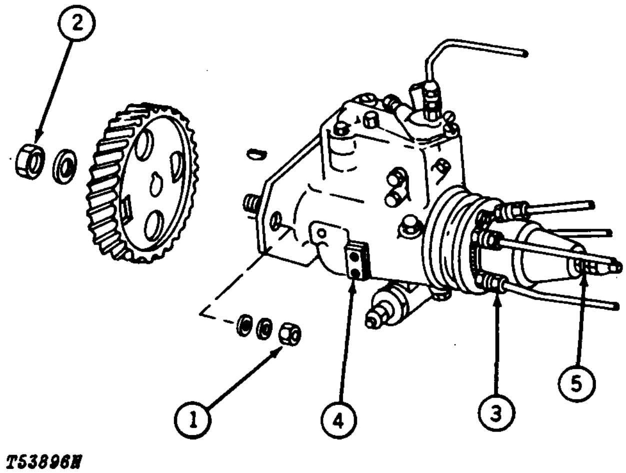


Fig. 65-Roosa-Master Model DM Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued
(DM4627AL2824-AR70778)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46° C).

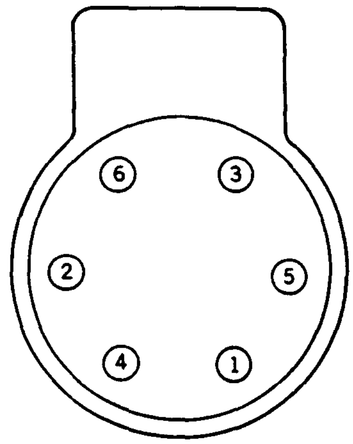
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm)
(minimum) ....18 in. Hg.
(609.5 mbar)

Transfer pump pressure (1100 rpm) ....80 to 90 psi
(5.5 to 6.2 bar) (5.6 to 6.3 kg/cm²)



T53889N

Fig. 66-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

Litho in U.S.A.

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627AL2824-AR70778)

Automatic Speed Advance

rpm
300 to 500 .... 1°
700 to 800 .... 5°
by 925 .... 6°

Minimum cranking speed
delivery (75 rpm)
Volume .... 50 cm^3/1000 strokes
Transfer pump pressure
(minimum) .... 10 psi
(1 bar) (1 kg/cm^2)

Fuel delivery (1100 rpm)
Volume .... 88 to 91 cm^3/1000 strokes
Maximum variation
between cylinders .... 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume .... 91 to 95 cm^3/1000 strokes
Maximum variation
between cylinders .... 5 cm^3/1000 strokes

High idle (WOT) (1200 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation
between cylinders .... 4 cm^3/1000 strokes

Governor cut-off (1225 rpm)
Volume .... 5 cm^3 max/1000 strokes

Low idle (400 rpm)
Volume .... 10 to 12 cm^3/1000 strokes
Maximum variation
between cylinders .... 4 cm^3/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm^3 max/1000 strokes

Litho in U.S.A.

4

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627AL2824-AR70778)

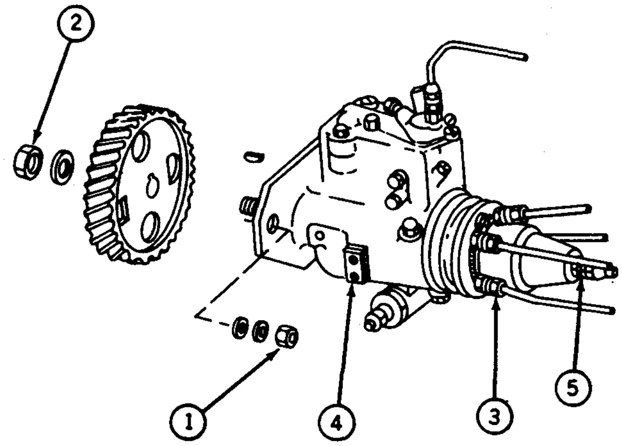
1 - Fuel injection pump
to engine nut torque .... 20 lb-ft
(27 Nm) (3 kg-m)

2 - Fuel injection pump
drive gear nut torque .... 140 to 150 lb-ft
(190 to 203 Nm) (19 to 21 kg-m)

3 - Injection line to
pump connector torque .... 35 lb-ft
(47 Nm) (5 kg-m)

4 - Timing cover screw
torque .... 15 to 20 lb-in
(1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump
fuel inlet connector
torque .... 20 lb-ft
(27 Nm) (3 kg-m)



T53896N

Fig. 67-Roosa-Master Model DM Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627HB2826-AR70780)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

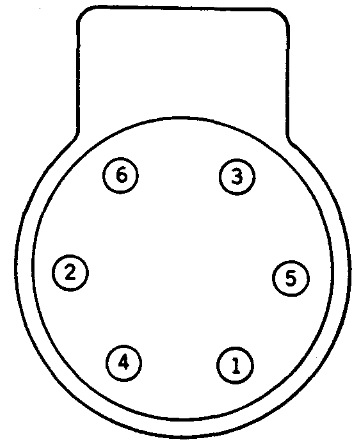
Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (–) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm)
(minimum) .... 18 in. Hg.
(609.5 mbar)

Transfer pump pressure
(900 rpm) .... 75 to 80 psi
(5.2 to 5.5 bar) (5.3 to 5.6 kg/cm²)



T53889N

Fig. 68-Injection Line Connection

**Available from: Viscosity Oil Company
3200 So. Western Avenue
Chicago, Illinois 60608*

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627HB2826-AR70780)

Automatic Speed Advance

rpm	
250 to 450	1°
by 650	3°

Minimum cranking speed delivery (75 rpm)
- Volume .... 50 cm^3/1000 strokes
- Transfer pump pressure (minimum) .... 10 psi (1 bar) (1 kg/cm^2)

Fuel delivery (900 rpm)
- Volume .... 95 to 99 cm^3/1000 strokes
- Maximum variation between cylinders .... 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
- Volume .... 98 to 102 cm^3/1000 strokes
- Maximum variation between cylinders .... 5 cm^3/1000 strokes

High idle (WOT) (925 rpm)
- Volume .... 15 to 17 cm^3/1000 strokes
- Maximum variation between cylinders .... 5 cm^3/1000 strokes

Governor cut-off (955 rpm)
- Volume .... 8 cm^3 max/1000 strokes

Check shut-off at (200 rpm)
- Volume .... 2 cm^3 max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4627HB2826-AR70780)

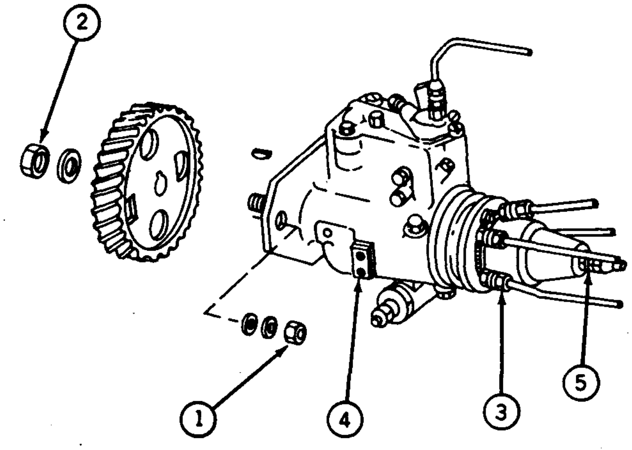
1 - Fuel injection pump
to engine nut torque .... 20 lb-ft
(27 Nm) (3 kg-m)

2 - Fuel injection pump
drive gear nut torque .... 140 to 150 lb-ft
(190 to 203 Nm) (19 to 21 kg-m)

3 - Injection line to
pump connector torque .... 35 lb-ft
(47 Nm) (5 kg-m)

4 - Timing cover screw
torque........................ 15 to 20 lb-in
(1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump
fuel inlet connector
toque .... 20 lb-ft
(27 Nm) (3 kg-m)



T53896N

Fig. 69-Roosa-Master Model DM Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427MD2876-AR71421)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm) (minimum) .... 18 in. Hg. (609.5 mbar)

Transfer pump pressure (1100 rpm) .... 80 to 90 psi (5.5 to 6.2 bar) (5.6 to 6.3 kg/cm²)

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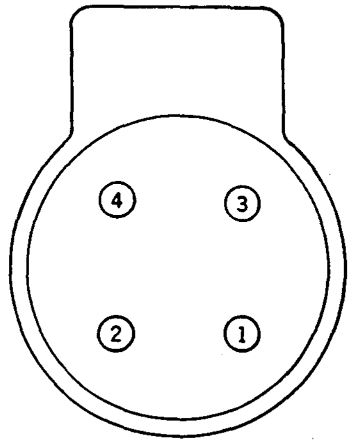
3200 So. Western Avenue
Chicago, Illinois 60608*



T53888N

Fig. 70-Injection Line Connection

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427MD2876-AR71421)

Automatic Speed Advance

rpm	
300 to 500	1°
600 to 700	5°
by 1100	7-1/2°

Minimum cranking speed delivery (75 rpm)
Volume . . . . . 54 cm^3/1000 strokes
Transfer pump pressure (minimum) . . . . . 12 psi (1 bar) (1 kg/cm^2)

Fuel delivery (1100 rpm)
Volume . . . . . 91 to 95 cm^3/1000 strokes
Maximum variation between cylinders . . . . . 3 cm^3/1000 strokes

Fuel delivery (750 rpm)
Volume . . . . . 94 to 98 cm^3/1000 strokes
Maximum variation between cylinders . . . . . 4 cm^3/1000 strokes

High idle (WOT) (1190 rpm)
Volume . . . . . 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders . . . . . 4 cm^3/1000 strokes

Governor cut-off (1215 rpm)
Volume . . . . . 5 cm^3 max/1000 strokes

Low idle (400 rpm)
Volume . . . . . 10 to 12 cm^3/1000 strokes
Maximum variation between cylinders . . . . . 4 cm^3/1000 strokes

Check shut-off at (200 rpm)
Volume . . . . . 2 cm^3 max/1000 strokes

4

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427MD2876-AR71421)

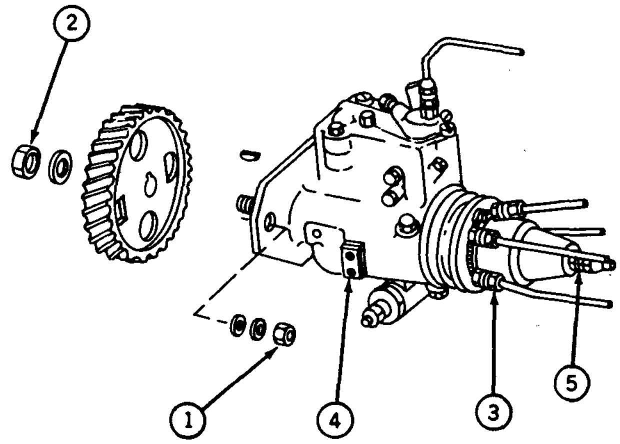
1 - Fuel injection pump to engine nut torque .... 20 lb-ft (27 Nm) (3 kg-m)

2 - Fuel injection pump drive gear nut torque .... 140 to 150 lb-ft (190 to 203 Nm) (19 to 21 kg-m)

3 - Injection line to pump connector torque .... 35 lb-ft (47 Nm) (5 kg-m)

4 - Timing cover screw torque .... 15 to 20 lb-in (1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump fuel inlet connector torque .... 20 lb-ft (27 Nm) (3 kg-m)



T53896N

Fig. 71-Roosa-Master Model DM Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427NH2957-AR76503)

IMPORTANT: In order to obtain proper test results, do the following:

Use 0.25 in. (6.4 mm) O.D. by 0.093 in. (2.36 mm) I.D. by 20 in. (508 mm) long test lines.

Use 12SD12 Robert Bosch Calibrating Nozzles, 2500 psi (172 bar) (176 kg/cm²) opening pressure. Use Viscor Number L1485*, or a test oil equivalent to SAE J967A with a 34 to 36 SUS rating with oil at 100°F (38°C).

Test oil should be 110° to 115°F (43° to 46°C).

Operate pump clockwise (viewed from drive end) at 500 rpm wide open throttle (WOT) for 10 minutes prior to test.

Electric shut-off connected to 12-volt D.C. negative (−) ground power source.

NOTE: 1 to 3 psi (0.07 to 0.21 bar) (0.07 to 0.21 kg/cm²) supply pressure required at pump inlet.

Transfer pump vacuum (200 rpm)
(minimum) ....18 in. Hg.
(609.5 mbar)

Transfer pump pressure
(1100 rpm)..........................75 to 85 psi
(5.2 to 5.9 bar) (5.3 to 6.0 kg/cm²)

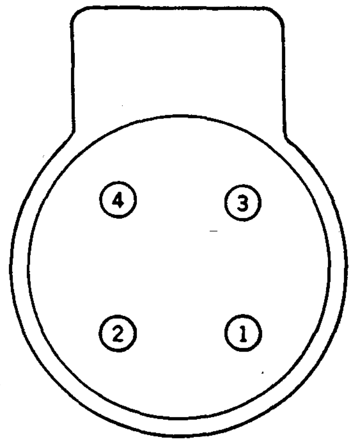


Fig. 72-Injection Line Connection

4

**Available from: Viscosity Oil Company*
3200 So. Western Avenue
Chicago, Illinois 60608

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427NH2957-AR76503)

Automatic Speed Advance

rpm

550 to 650 .... 1°
by 800 .... 3°

4

Light load advance

rpm	cm³/1000 strokes	
1100	40 to 50	3° maximum
1100	0 to 15	7-1/2° minimum
400	0 to 15	4° minimum

Minimum cranking speed delivery (75 rpm)
Volume .... 54 cm³/1000 strokes
Transfer pump pressure (minimum) .... 12 psi (1 bar) (1 kg-cm²)

Fuel delivery (1100 rpm)
Volume .... 91 to 95 cm³/1000 strokes
Maximum variation between cylinders .... 3 cm³/1000 strokes

Fuel delivery (750 rpm)
Volume .... 94 to 98 cm³/1000 strokes
Maximum variation between cylinders .... 4 cm³/1000 strokes

High idle (WOT) (1190 rpm)
Volume .... 10 to 12 cm³/1000 strokes
Maximum variation between cylinders .... 4 cm³/1000 strokes

Governor cut-off (1215 rpm)
Volume .... 5 cm³ max/1000 strokes

Low idle (400 rpm)
Volume .... 10 to 12 cm³/1000 strokes
Maximum variation between cylinders .... 4 cm³/1000 strokes

Check shut-off at (200 rpm)
Volume .... 2 cm³ max/1000 strokes

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued (DM4427NH2957 - AR76503)

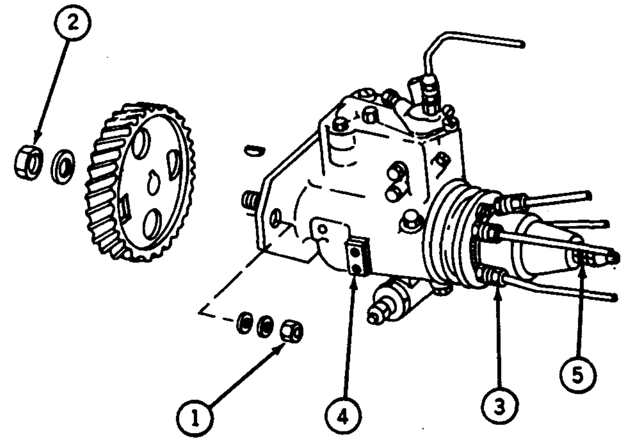
1 - Fuel injection pump
to engine nut torque .... 20 lb-ft
(27 Nm) (3 kg-m)

2 - Fuel injection pump
drive gear nut torque .... 140 to 150 lb-ft
(190 to 203 Nm) (19 to 21 kg-m)

3 - Injection line to
pump connector torque .... 35 lb-ft
(47 Nm) (5 kg-m)

4 - Timing cover screw
torque .... 15 to 20 lb-in
(1.7 to 2.3 Nm) (0.17 to 0.23 kg-m)

5 - Fuel injection pump
fuel inlet connector
torque .... 20 lb-ft
(27 Nm) (3 kg-m)



T53896N

Fig. 73-Roosa-Master Model DM Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued

Stanadyne (Roosa-Master) 9.5 millimeter Injection Nozzle Specifications (19763-AR56290)

GENERAL INFORMATION

4

Number of orifices 4

Orifice size .... 0.011 in. (0.28 mm)

NOZZLE SETTINGS

Nozzle opening pressure (new) .... 3150 to 3250 psi (217 to 224 bar) (221 to 228 kg/cm²)

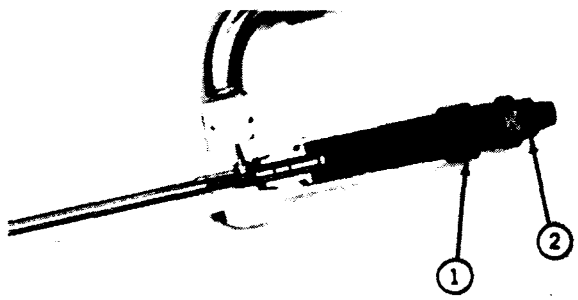
Nozzle opening pressure (used) .... 2950 to 3050 psi (203 to 210 bar) (207 to 214 kg/cm²)

Return oil leakage .... 3 to 10 drops per 30 seconds at 1500 psi (103 bar) (105 kg/cm²) from first drop (service only)

Nozzle valve lift .... 1/2 ± 1/8 turn from bottom (0.009 in. [0.23 mm] nominal)

1 - Pressure adjusting screw-to-nozzle body lock nut torque .... 70 to 80 lb-in (7.9 to 9.0 Nm) (0.81 to 0.92 kg-m)

2 - Lift adjusting screw lock nut torque .... 35 to 45 lb-in (4.0 to 5.1 Nm) (0.40 to 0.52 kg-m)



T53899NY

Fig. 74-Injection Nozzle Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued

Stanadyne (Roosa-Master) 9.5 millimeter Injection Nozzle Specifications (20501-AR56290)

GENERAL INFORMATION

Number of orifices 4

Orifice size .... 0.011 in. (0.28 mm)

NOZZLE SETTINGS

Nozzle opening pressure (new) .... 3150 to 3250 psi (217 to 224 bar) (221 to 228 kg/cm²)

Nozzle opening pressure (used) .... 2950 to 3050 psi (203 to 210 bar) (207 to 214 kg/cm²)

Return oil leakage .... 3 to 10 drops per 30 seconds at 1500 psi (103 bar) (105 kg/cm²) from first drop (service only)

Nozzle valve lift .... 1/2 ± 1/8 turn from bottom (0.009 in. [0.23 mm] nominal)

1 - Pressure adjusting screw-to-nozzle body lock nut torque .... 70 to 80 lb-in (7.9 to 9.0 Nm) (0.81 to 0.92 kg-m)

2 - Lift adjusting screw lock nut torque .... 35 to 45 lb-in (4.0 to 5.1 Nm) (0.40 to 0.52 kg-m)

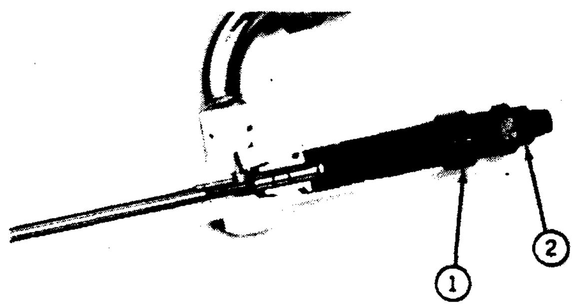


Fig. 75-Injection Nozzle Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued

Stanadyne (Roosa-Master) 9.5 millimeter Injection Nozzle Specifications (20272-AR68364)

GENERAL INFORMATION

4

Number of orifices 4

Orifice size ....0.012 in. (0.30 mm)

NOZZLE SETTINGS

Nozzle opening pressure (new) .... 3150 to 3250 psi (217 to 224 bar) (221 to 228 kg/cm²)

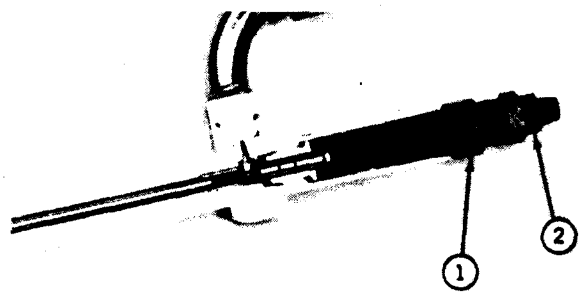
Nozzle opening pressure (used) .... 2950 to 3050 psi (203 to 210 bar) (207 to 214 kg/cm²)

Return oil leakage ....3 to 10 drops per 30 seconds at 1500 psi (103 bar) (105 kg/cm²) from first drop (service only)

Nozzle valve lift ....1/2 ± 1/8 turn from bottom (0.009 in. [0.23 mm] nominal)

1 - Pressure adjusting screw-to-nozzle body lock nut torque .... 70 to 80 lb-in (7.9 to 9.0 Nm) (0.81 to 0.92 kg-m)

2 - Lift adjusting screw lock nut torque .... 35 to 45 lb-in (4.0 to 5.1 Nm) (0.40 to 0.52 kg-m)



T53899NY

Fig. 76-Injection Nozzle Torque

FUEL INJECTION SYSTEM (0413)

SPECIFICATIONS AND TORQUE VALUES—Continued

Stanadyne (Roosa-Master) 9.5 millimeter Injection Nozzle Specifications (20505-AR68364)

GENERAL INFORMATION

Number of orifices 4

Orifice size ....0.012 in. (0.30 mm)

NOZZLE SETTINGS

Nozzle opening pressure (new) .... 3150 to 3250 psi (217 to 224 bar) (221 to 228 kg/cm²)

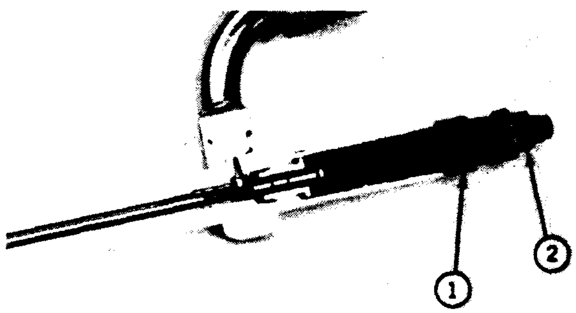
Nozzle opening pressure (used) .... 2950 to 3050 psi (203 to 210 bar) (207 to 214 kg/cm²)

Return oil leakage ....3 to 10 drops per 30 seconds at 1500 psi (103 bar) (105 kg/cm²) from first drop (service only)

Nozzle valve lift ....1/2 ± 1/8 turn from bottom (0.009 in. [0.23 mm] nominal)

1 - Pressure adjusting screw-to-nozzle body lock nut torque .... 70 to 80 lb-in (7.9 to 9.0 Nm) (0.81 to 0.92 kg-m)

2 - Lift adjusting screw lock nut torque .... 35 to 45 lb-in (4.0 to 5.1 Nm) (0.40 to 0.52 kg-m)



T53899NY

Fig. 77-Injection Nozzle Torque

4

ENGINE BALANCER (0415)

SPECIFICATIONS AND TORQUE VALUES

1 - Bushing inside diameter (new) .... 1.502 to 1.504 inch (38.15 to 38.20 mm)

2 - Shaft journals outside diameter (new)..... 1.500 to 1.501 inch (38.10 to 38.13 mm)

3 - Clearance between thrust plate and gear (new)................ 0.002 to 0.010 inch (0.05 to 0.25 mm)

4 - Thrust plate to engine front plate cap screw torque .... 35 lb-ft (47 Nm) (5 kg-m)

5 - Thrust plate thickness (new) 0.117 to 0.119 inch (2.97 to 3.02 mm)

6 - Weight lock nut torque .... 43 lb-ft (58 Nm) (6 kg-m)

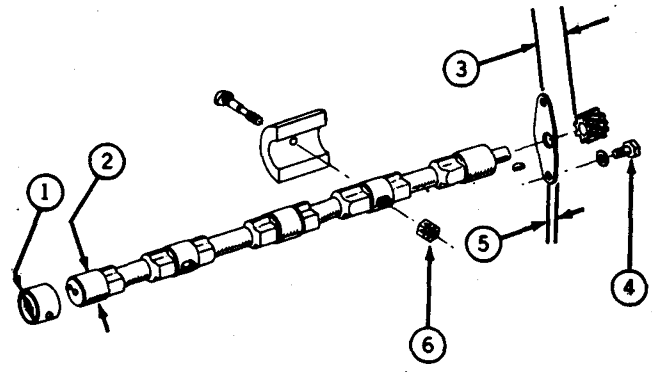


Fig. 78-Engine Balancer Specifications

TURBOCHARGER (0416)

SPECIFICATIONS AND TORQUE VALUES

1 - Radial bearing movement .... 0.003 to 0.006 in (0.08 to 0.15 mm)

2 - Rotating assembly axial movement .... 0.001 to 0.004 in. (0.03 to 0.10 mm)

3 - Impeller nut torque .... 18 to 20 lb-in (2.0 to 2.3 Nm) (0.21 to 0.23 kg/m)

4 - Lock plate bolts torque.......... 40 to 60 lb-in (4.5 to 6.8 Nm) (0.46 to 0.69 kg/m)

5 - Turbine housing to center housing nut torque .... 100 to 130 lb-in (11.3 to 14.7 Nm) (1.15 to 1.50 kg/m)

Exhaust adapter end play............................... 0.03 inch (0.8 mm)

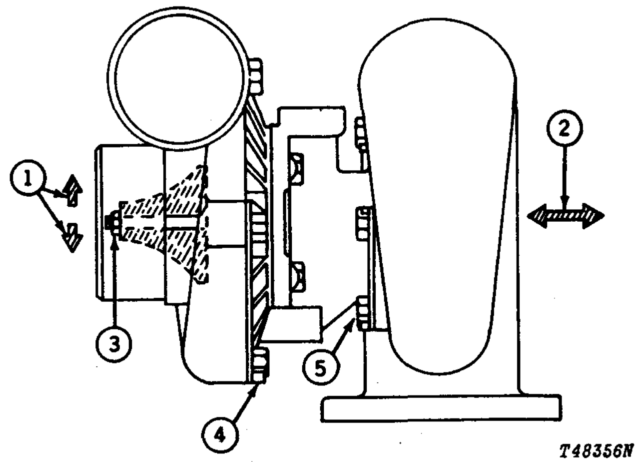


Fig. 80-Turbocharger Specifications

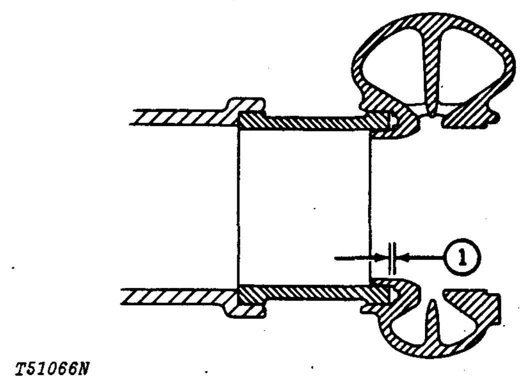


Fig. 81-Exhaust Adapter End Play

WATER PUMP (0417)

SPECIFICATIONS AND TORQUE VALUES

Rear Cover Cap Screw Torque (1, Fig. 82) — 35 lb-ft (47 Nm) (5 kg-m)

Impeller position:

Engine	Pump Code	Distance
3-164D and 4-219D	2001 (3) (Fig. 82)	0.000 to 0.010 inch (0.00 to 0.25 mm)
	2002 (3)	0.000 to 0.010 inch (0.00 to 0.25 mm)
	2004 (3)	0.000 to 0.010 inch (0.00 to 0.25 mm)
	2005 (3)	0.000 to 0.010 inch (0.00 to 0.25 mm)
4-276D	2001 (3)	0.000 to 0.010 inch (0.00 to 0.25 mm)
4-276T	2001 (2)	0.015 to 0.035 inch (0.38 to 0.89 mm)
6-329D	2001 (3)	0.000 to 0.010 inch (0.00 to 0.25 mm)
	2004	
6-414D and 6-414T	2001 (2)	0.015 to 0.035 inch (0.38 to 0.89)

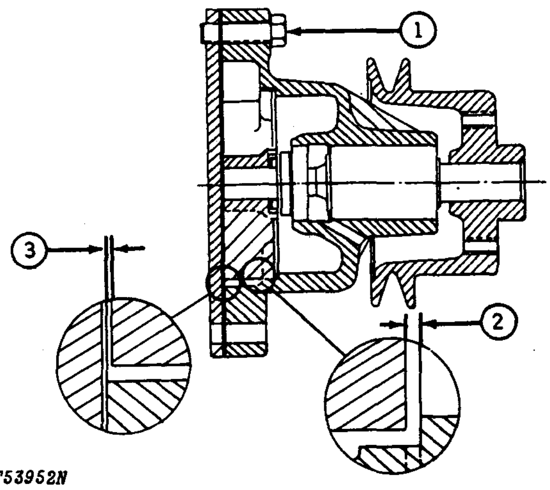


Fig. 82-Water Pump Specifications

WATER PUMP (0417)

SPECIFICATIONS AND TORQUE VALUES—Continued

Water Pump Pulley Position:

Engine	Pump Code	Distance
3-164D and 4-219D	2001 (2)	
	2002	
	2004 (1)	5.47 inch (138.9 mm)
	2005	
4-276D	2001	
4-276T	2001 (1)	6.38 inch (162.1 mm)
6-329D	2001	
	2004	
6-414D and 6-414T	2001 (1)	6.38 inch (162.1 mm)

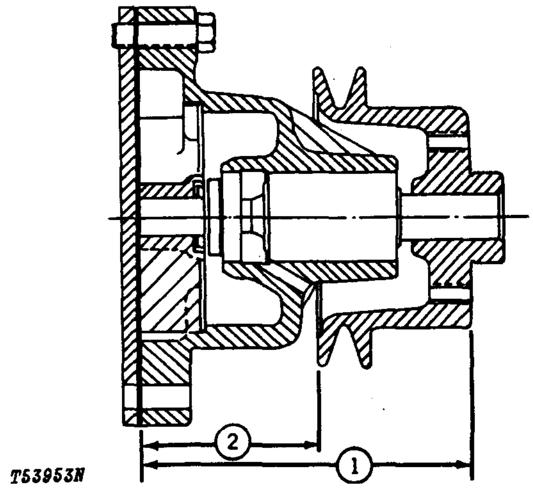


Fig. 83-Water Pump Specifications

THERMOSTATS, HOUSINGS AND WATER PIPING (0418)

SPECIFICATIONS AND TORQUE VALUES

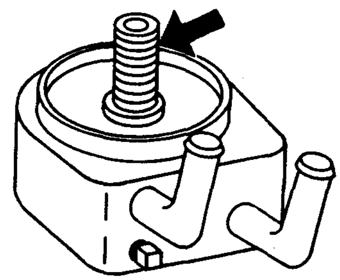
Thermostat test temperature:

Engine	Code	Full Open Temperature	Opening Temperature
3-164 and 4-219	2201	183°F (84°C)	156 to 163°F (69 to 73°C)
	2202	212°F (100°C)	189 to 197°F (87 to 92°C)
	2203	213°F (101°C)	201 to 207°F (94 to 97°C)
	2204	203°F (95°C)	176 to 183°F (80 to 84°C)
4-276	2204	203°F (95°C)	176 to 182°F (80 to 83°C)
6-329		200°F (93°C)	180 to 195°F (82 to 91°C)
6-414	2204	203°F (95°C)	176 to 182°F (80 to 83°C)

OIL COOLER (0419)

SPECIFICATIONS AND TORQUE VALUES

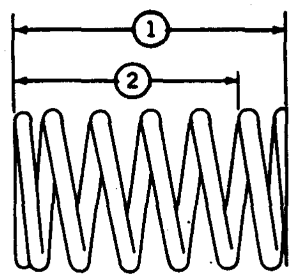
Oil cooler nipple
torque .... 20 to 25 lb-ft
(27 to 34 Nm) (3 to 3.5 kg-m)



T53954N

Fig. 84-Oil Cooler Nipple Torque

Oil cooler-bypass
valve spring
Free length (approx.) .... 2.60 in.
(66.04 mm)
Test length .... 1.91 in.
(48.5 mm)
when compressed with 29.5 to 36.5 lb.
(131 to 162 N) (13 to 17 kg)



T50940N.

Fig. 85-Oil Cooler By-pass Valve Spring Length

4

STARTING MOTOR AND FASTENINGS (0422)

SPECIFICATIONS AND TORQUE VALUES

John Deere Starting Motor

No Load Test (Before Disassembly)

Current draw .... 70 to 110 amp at 9.0 volts
Armature speed .... 2500 to 4500 rpm

Solenoid Pull-In Test .... 8 volts or less
Solenoid Return Test .... 12 volts

No Load Test (After Assembly)

Battery .... 12-volt-reserve capacity 290 minutes
Speed .... 3100 rpm min.
Voltage .... 11.7 volts
Current Draw .... 110 amps max.

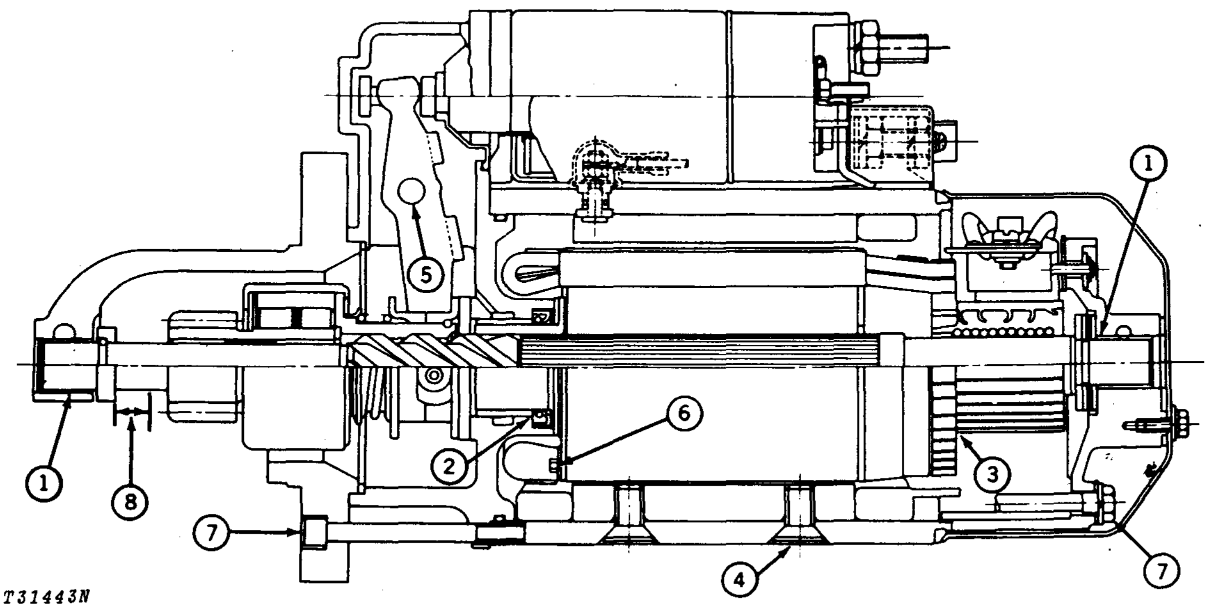


Fig. 86-Starting Motor

Starting Motor

1 - Commutator and drive
housing bushing I.D. .... 0.6693 to 0.6704 in. (17.000 to 17.028 mm)
Wear tolerance (maximum) .... 0.6740 in. (17.120 mm)
Oil clearance .... 0.0036 to 0.0070 in. (0.091 to 0.178 mm)
Wear tolerance (additional) .... 0.016 in. (0.41 mm)
Depth .... 0.008 to 0.022 in. (0.20 to 0.56 mm)

STARTING MOTOR AND FASTENINGS (0422)

SPECIFICATIONS AND TORQUE VALUES—Continued

2 - Center housing bushing
(Fig. 86) I.D. .... 1.182 to 1.184 in.
(30.02 to 30.07 mm)
Wear tolerance (maximum) .... 1.189 in.
(30.20 mm)
Oil clearance wear
tolerance .... 0.0236 in.
(0.600 mm)
Depth .... 0.017 to 0.037 in.
(0.43 to 0.94 mm)

3 - Armature (Fig. 86)
Armature runout .... 0.006 in.
(0.15 mm)
Commutator runout .... 0.016 in.
(0.41 mm)
Commutator minimum undercut .... 0.008 in.
(0.20 mm)
Commutator O.D. .... 1.77 in.
(44.9 mm)

4 - Torque—pole shoe screws
(Fig. 86) .... 30 lb-ft
(41 Nm) (4 kg-m)

5 - Torque—shift lever pivot
screw (Fig. 86) .... 30 lb-ft
(41 Nm) (4 kg-m)

6 - Torque—center bearing
housing to field frame
(Fig. 86) .... 6 lb-ft
(8 Nm) (0.8 kg-m)

7 - Torque—commutator frame and
drive housing (Fig. 86) .... 10 lb-ft
(14 Nm) (1 kg-m)

8 - Clearance between pinion
and pinion stop (Fig. 86) .... 0.012 to 0.185 in.
(0.30 to 4.70 mm)

Litho in U.S.A.

4

STARTING MOTOR AND FASTENINGS (0422)

SPECIFICATIONS AND SPECIAL TOOLS—Continued

1 - Brush minimum length ....5/8 in.
(15.88 mm)

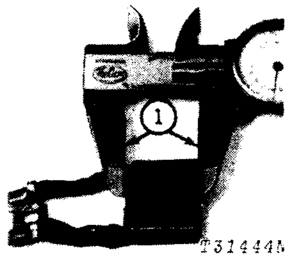


Fig. 87-Brush Length

Brush spring minimum
tension .... 40 oz.
(11 N) (1.1 kg)

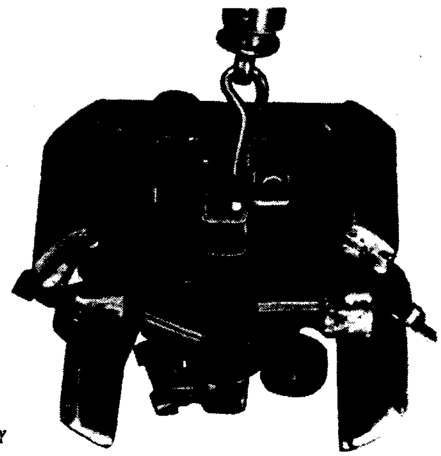


Fig. 88-Brush Spring Tension

Delco Remy Starting Motor No Load Test

Motor No.	Test Volts	Min. Amps	Max. Amps	Min. rpm	Max. rpm
1109251	9	20*	120*	9000	14000
1107871	9	40*	140*	8000	13000
1114381	9	124*	185*	4700	7600

**Includes Solenoid*

STARTING MOTOR AND FASTENINGS (0422)

SPECIFICATIONS AND TORQUE VALUES—Continued

1 - Brush spring minimum tension .... 35 oz. (10 N) (1.0 kg)

Fig. 89-Brush Spring Tension

1 - Brush minimum length beyond holder . 5/16 in. (7.938 mm)

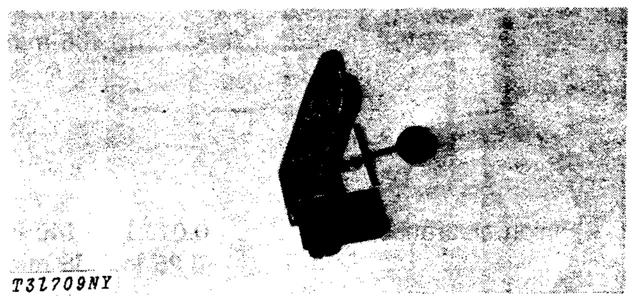


Fig. 90-Brush Length

1 - Drive housing bushing
- I.D. .... 0.4990 to 0.5010 in. (12.675 to 12.725 mm)
- Wear tolerance .... 0.511 in. (12.98 mm)
- Oil clearance .... 0.0020 to 0.0050 in. (0.051 to 0.127 mm)
- Wear tolerance .... 0.0170 in. (0.432 mm)

2 - Overrunning clutch housing
- I.D. .... 0.5620 to 0.5630 in. (14.275 to 14.300 mm)
- Wear tolerance .... 0.5740 in. (14.580 mm)

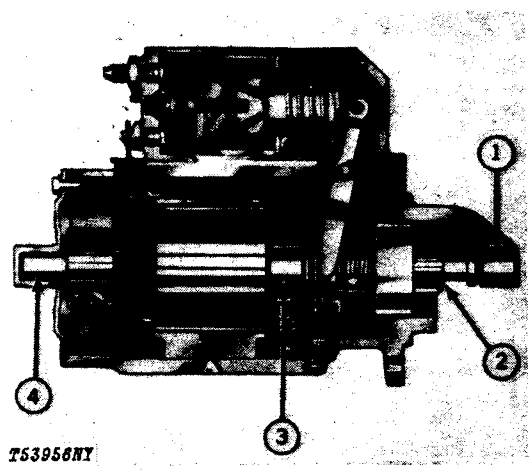


Fig. 91-Starting Motor

4

STARTING MOTOR AND FASTENINGS (0422)

SPECIFICATIONS AND TORQUE VALUES—Continued

3 - Center bearing bushing
I.D. .... 0.7600 to 0.7620 in. (19.304 to 19.355 mm)
Wear tolerance .... 0.7720 in. (19.609 mm)
Oil clearance .... 0.0100 to 0.0150 in. (0.254 to 0.381 mm)
Wear tolerance .... 0.0250 in. (0.635 mm)

4 - Commutator end frame bushing
I.D. .... 0.5625 to 0.5635 in. (14.288 to 14.313 mm)
Wear tolerance .... 0.5730 in. (14.554 mm)
Oil clearance .... 0.0020 to 0.0050 in. (0.051 to 0.127 mm)
Wear tolerance .... 0.0160 in. (0.406 mm)

1 - Pinion clearance .... 0.010 to 0.140 in. (0.25 to 3.56 mm)

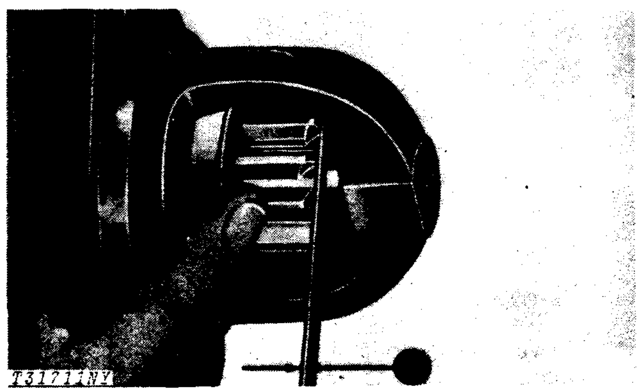


Fig. 92-Pinion Clearance

FAN DRIVE (0429)

SPECIFICATIONS AND TORQUE VALUES

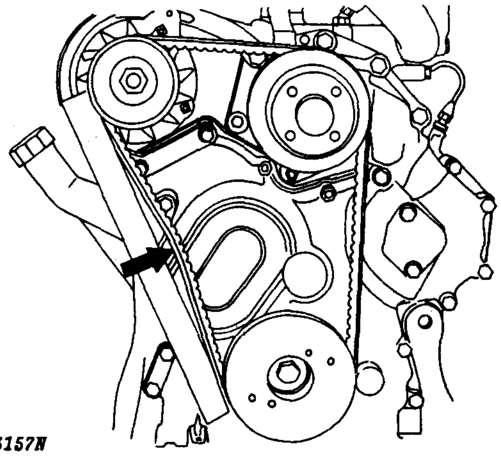
Fan drive belt tension:

With gauge (initial) .... 100 to 110 lb.
(445 to 490 N) (45 to 50 kg)

With gauge
(after 3 minutes operation) .... 80 lb.
(356 N) (36 kg)

without gauge .... 20 lb.
(89 N) (9 kg)

with belt flexed 0.75 inch
(19 mm)



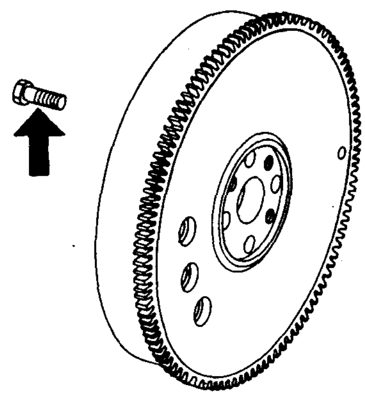
T53157N

Fig. 93-Fan Drive Belt Tension

FLYWHEEL, HOUSING AND FASTENINGS (0433)

SPECIFICATIONS AND TORQUE VALUES

Flywheel attaching
cap screw torque .... 120 lb-ft
(163 Nm) (17 kg-m)



T53958N

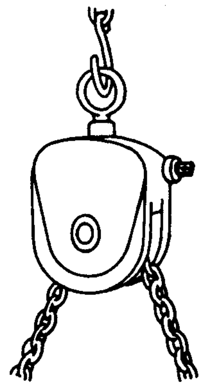
Fig. 94-Flywheel Attaching Cap Screws

ENGINE REMOVAL AND INSTALLATION (0400)

SPECIAL TOOLS

Convenience Tools

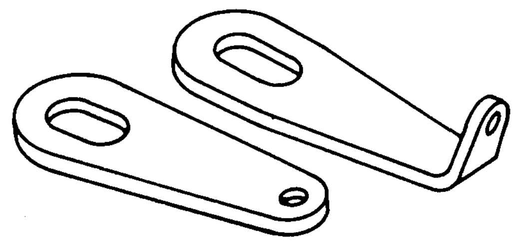
Tool Number	Use
D01043AA	Load Positioning Sling—To remove and install engine in unit. Comes with one set of JDG-19 Lifting Bracket.



T47209N

Fig. 95-Load Positioning Sling

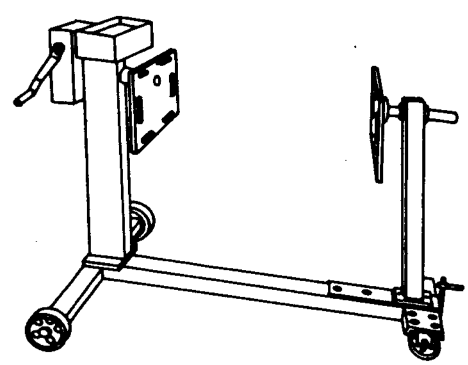
Tool Number	Use
JDG-19	Lifting Bracket—Used with D01043AA load positioning sling for engine removal and installation (1, Fig. 96).
JD-244	Lifting Eyes—Used with D01043AA load positioning sling for engine removal (engine may be equipped with these (Fig. 96).



T31364N

Fig. 96-Lifting Brackets and Lifting Eyes

Tool Number	Use
D01003AA	Engine Stand and Adapter Plates—Used to hold engine after removal from unit.



T47199N

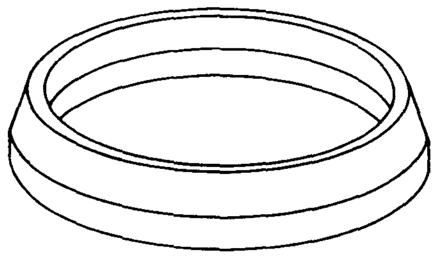
Fig. 97-Engine Stand

CRANKSHAFT AND MAIN BEARINGS (0401)

SPECIAL TOOLS

Convenience Tools

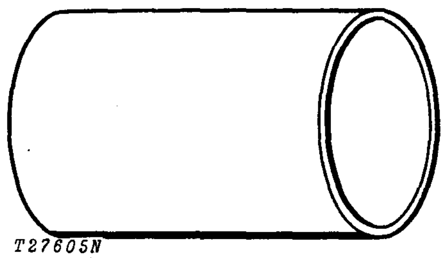
Tool Number	Use
JD-251-4	Seal Protector—Used to install flywheel housing.



T48357N

Fig. 98-Seal Protector

JDH-7	Rockshaft Seal Driver—Used to install oil seals and crankshaft gears.



T27605N

Fig. 99-Seal Driver

JD-297-1	Seal and Wear Sleeve Installer—Used on all 300 Series Engines.

T46643N

Fig. 100-Seal and Wear Sleeve Installer

CRANKSHAFT AND MAIN BEARINGS (0401)

SPECIAL TOOLS—Continued

Essential Tools

Tool Number	Use
JD-250	Front Crankshaft Oil Seal Driver—To install front crankshaft oil seal in timing gear cover.

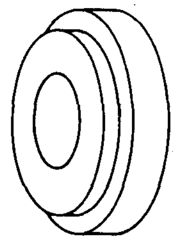

T31581N

Fig. 101-Oil Seal Driver

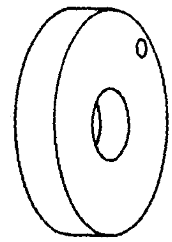
Litho in U.S.A.

CRANKSHAFT AND MAIN BEARINGS (0401)

SPECIAL TOOLS—Continued

Convenience Tools

Tool Number	Use
JD-251-2	Pilot Plate - To install crankshaft wear ring.



T48358N

Fig. 102-Pilot Plate

Tool Number	Use
10012	Socket Head Cap Screw.
27489	Handle - Attach to JD-297-1 Driver to install crankshaft wear ring.

T46(

Fig. 103-Handle and Screw

CAMSHAFT AND VALVE ACTUATING MEANS (0402)

SPECIAL TOOLS—Continued

Essential Tools

Tool Number	Use
JD-254	Gear Timing Tool—Use to time camshafts.

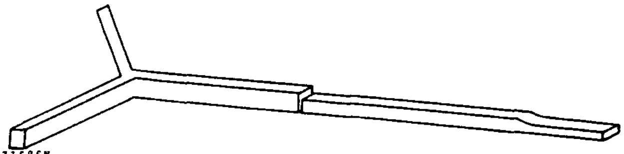

T31585N

Fig. 104-Gear Timing Tool

Tool Number	Use
JD-252	Idler Gear Bushing Driver—Used to install idler bushings.

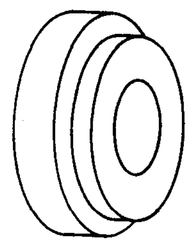

T31584N

Fig. 105-Idler Gear Bushing Driver

Convenience Tools

Tool Number	Use
JDE-81-1	Flywheel Turning Tool—Used to rotate flywheel when timing engine.

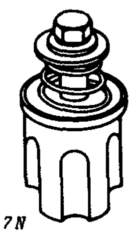

T34737N

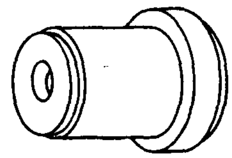
Fig. 106-Flywheel Turning Tool

CONNECTING RODS AND PISTONS (0403)

SPECIAL TOOLS

Essential Tools

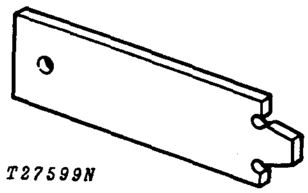
Tool Number	Use
JDE-88	Bushing Installation and Removal Tool—Used for removing and installing the piston pin bushings in the connecting rods.



T32805NY

Fig. 107-Bushing Installation and Removal Tool

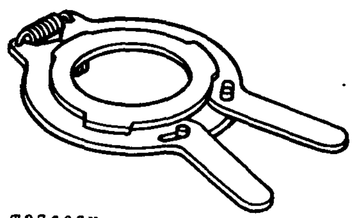
JDE-62	Ring Groove Wear Gauge—To measure keystone ring groove wear.



T27599N

Fig. 108-Ring Groove Wear Gauge

JD-45	Piston Ring Expander—Used on 3-164, 4-2A and 6-329 engines to remove and install piston rings.
JD-285	Piston Ring Expander—Used to remove and install piston rings on 4-276 and 6-414 engines.



T27603N

Fig. 109-Piston Ring Expander

CONNECTING RODS AND PISTONS (0403)

SPECIAL TOOLS—Continued

Essential Tools

Tool Number	Use
JD-84	Piston Ring Compressor—Used to install pistons in 4-276 and 6-414 engines.
JD-271	Piston Ring Compressor—Used to install pistons in 3-164, 4219, and 6-329 engines.

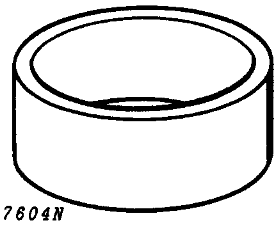

T27604N

Fig. 110-Piston Ring Compressor

CYLINDER BLOCK (0404)
SPECIAL TOOLS

Essential Tools

Tool Number	Use
D17004BR	Cylinder Brush—To deglaze cylinder liners.

Fig. 111-Cylinder Brush

4

Convenience Tools

Tool Number	Use
D01062AA or D01063AA	Cylinder Liner Puller—To remove cylinder liners.

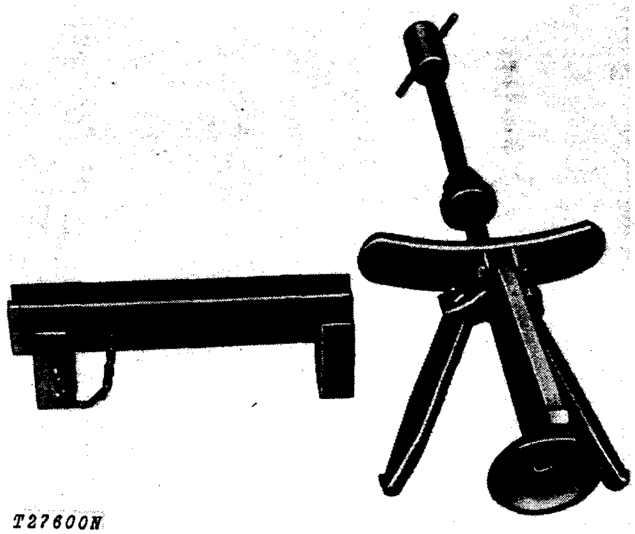


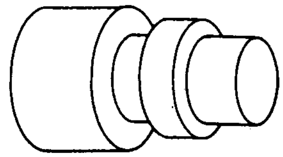
Fig. 112-Cylinder Liner Puller

OILING SYSTEM (0407)

SPECIAL TOOLS

Essential Tools

Tool Number	Use
JD-248	Driver - To install oil pressure control valve bushing.



T31580N

Fig. 113-Driver

CYLINDER HEAD AND VALVES (0409)

SPECIAL TOOLS

Essential Tools

Tool Number	Use
D2000Z WI	Knurling Tool - To knurl engine valve guides.

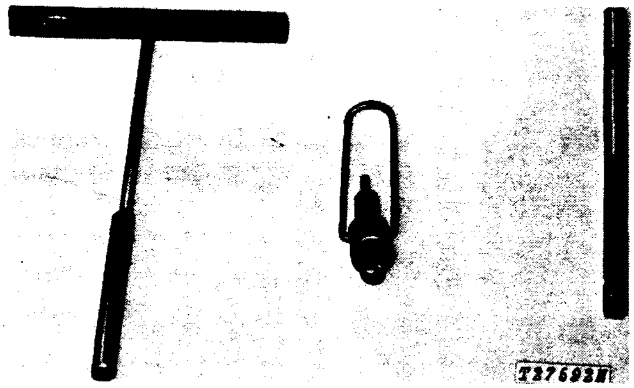
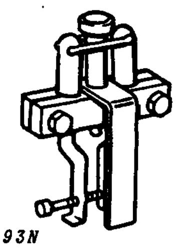


Fig. 114-Knurling Tool

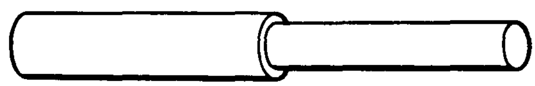
JDE-41296	Valve Seat Puller - Removes intake and exhaust valve seat of engines having replaceable seats.



T27593N

Fig. 115-Valve Seat Puller

JDE-7	Valve Guide Pilot Driver - Used for removing and installing valve guides with JDE-9.



T27596N

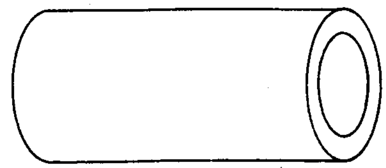
Fig. 116-Torque Wrench Adapter

CYLINDER HEAD AND VALVES (0409)

SPECIAL TOOLS—Continued

Essential Tools

Tool Number	Use
JDE-9	Valve Guide Driver—To correctly position valve guides when installing them.

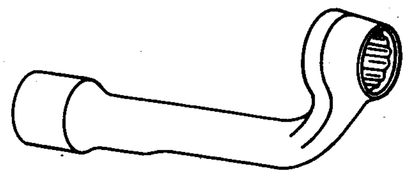


T31591N

Fig. 117-Valve Guide Driver

Convenience Tools

Tool Number	Use
JD-307	Torque Wrench Adapter—Allows mechanic to torque head bolts without removing rocker arm assembly.



T51077N

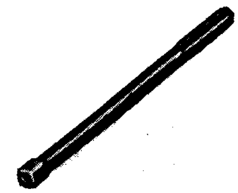
Fig. 118-Torque Wrench Adapter

FUEL INJECTION SYSTEM (0413)

SPECIAL TOOLS

Essential Tools

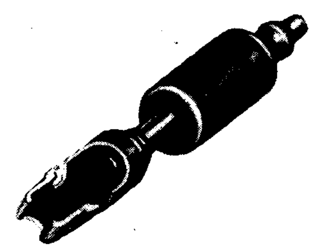
Tool Number	Use
JDE-39	Nozzle Bore Cleaning Tool - Used to clean carbon and other foreign matter from the nozzle bore.



T32810N

Fig. 119-Nozzle Bore Cleaner

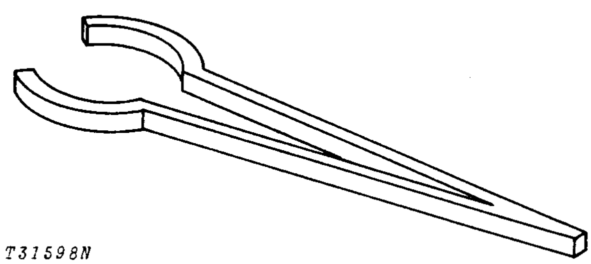
Tool Number	Use
JDE-3	Injection Nozzle Puller - Permits fast removal of fuel injection nozzles from cylinder head.



T32808N

Fig. 120-Injection Nozzle Puller

Tool Number	Use
JD-256	Injection Pump Drive Shaft Seal Installing Tool - For servicing Roosa Master Injection pumps.



T31598N

Fig. 121-Injection Pump Drive Shaft Seal Installing Tool

4

FUEL INJECTION SYSTEM (0413)

SPECIAL TOOLS—Continued

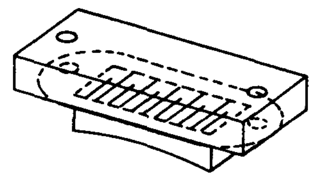
Essential Tool

Tool Number	Use
JD-258	Carbon Stop Seal Installing Tool - Used to properly install the carbon stop seal or "pencil type" fuel injection nozzles used in John Deere engines.

T32809N

Fig. 122-Carbon Stop Seal Installing Tool

Tool Number	Use
JD-259	Timing Window - For servicing "Roosa Master" injection pumps.



T31920N

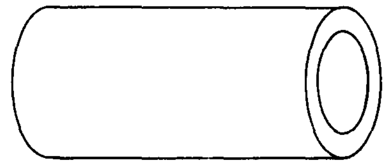
Fig. 123-Timing Window

WATER PUMP (0417)

SPECIAL TOOLS

Essential Tools

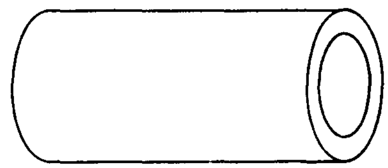
Tool Number	Use
JD-262-A	Water Pump Bearing Installing Tool—Used to install water pump bearing on 300 Series engine.



T31591N

Fig. 124-Water Pump Bearing Installing Tool

JDE-74	Water Pump Shaft and Bearing Driver—For servicing the new and larger water pump bearings found in turbocharged engines.



T31591N

Fig. 125-Water Pump Shaft and Bearing Tool

STARTING MOTOR AND FASTENINGS (0422)

SPECIAL TOOLS

Essential Tools (For JOHN DEERE STARTER)

Tool Number	Use
Commutator and Drive End Bushing Tools	
1 - 27487	Handle - For removing and installing commutator and drive end bushings.
2 - 27494	Disk - For removing commutator and drive end bushing.
27495	Disk - For installing commutator and drive end bushing.
3 - 27491 and 27492	Disk Spacer - For removing and installing commutator and drive end bushing.
4 - 27493	Disk Pilot - For removing and installing commutator and drive end bushing.

Tool Number	Use
Center Bushing and Oil Seal Tools	
1 - 27487	Handle - For installing center bushing and oil seal.
2 - 27505	Disk - For installing center bushing.
3 - 27512	Disk - For installing center oil seal.
4 - 27501	Disk Pilot - For installing center bushing and oil seal.

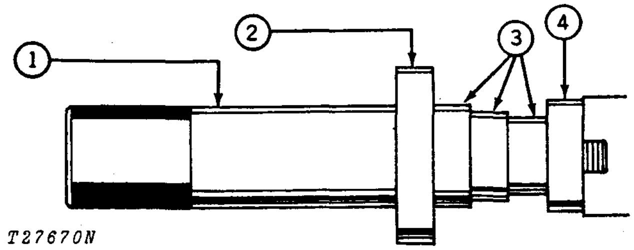


Fig. 126-End Drive Bushing Removal and Installation Tool

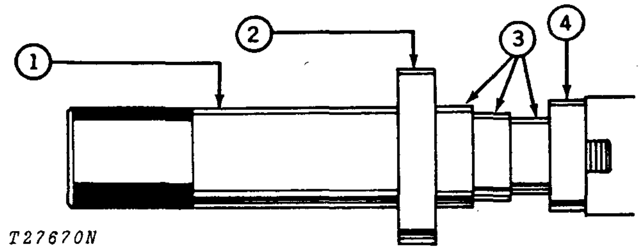


Fig. 127-Center Bushing and Oil Seal Tools

STARTING MOTOR AND FASTENINGS (0422)

SPECIAL TOOLS—Continued

Essential Tools

Tool

Commutator and Drive End Bushing Tool

Dimension	Removal	Installation
A	1 in.	1 in.
	(25 mm)	(25 mm)
B	0.732 to 0.736 in.	0.732 to 0.736 in.
	(18.59 to 18.69 mm)	(18.59 to 18.69 mm)
C	0.661 to 0.665 in.	0.661 to 0.665 in.
	(16.79 to 16.89 mm)	(16.79 to 16.89 mm)
D	2 in.	3.94 in.
	(51 mm)	(100.08 mm)
E	0.901 to 0.909 in.	0.018 to 0.022 in.
	(22.89 to 23.09 mm)	(0.46 to 0.56 mm)
F	0.783 to 0.791 in.	0.783 to 0.791 in.
	(19.89 to 20.09 mm)	(19.89 to 20.09 mm)

Center Bearing Bushing Tool

Dimension	Removal	Installation
A	1.57 in.	1.57 in.
	(39.9 mm)	(39.9 mm)
B	1.36 to 1.37 in.	1.36 to 1.37 in.
	(34.5 to 34.8 mm)	(34.5 to 34.8 mm)
C	1.17 to 1.18 in.	1.17 to 1.18 in.
	(29.7 to 30.0 mm)	(29.7 to 30.0 mm)
D	2 in.	2 in.
	(50.8 mm)	(50.8 mm)
E	0.95 to 1.02 in.	0.018 to 0.02 in.
	(24.1 to 25.9 mm)	(0.46 to 0.51 mm)
F	0.866 to 0.945 in.	0.966 to 1.000 in.
	(22.0 to 24.0 mm)	(25.54 to 25.40 mm)

JDE-80 Starter Wrench - To remove and install rear mounting nut on starting motor.

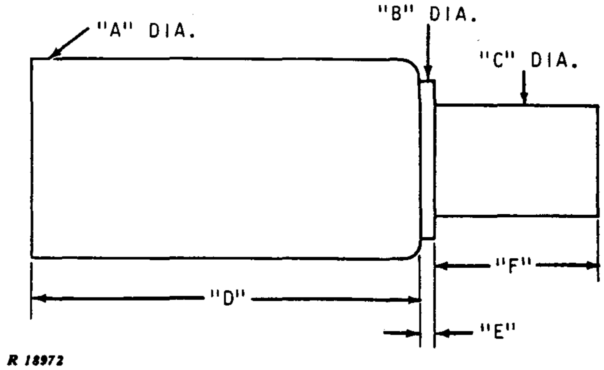


Fig. 128-Dimension for Shop-made Bushing Driver

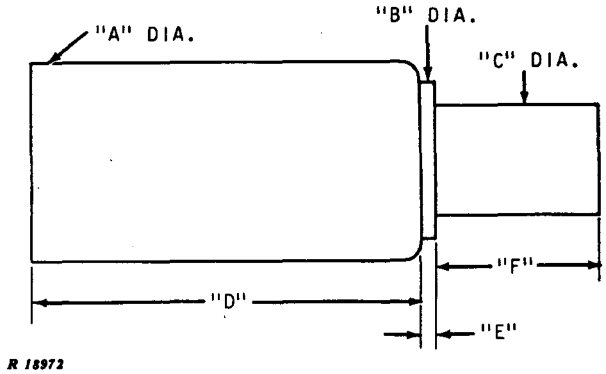


Fig. 129-Center Bearing Bushing Tool

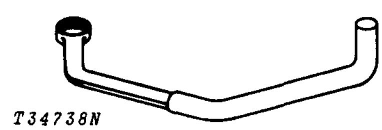


Fig. 130-Starter Wrench

STARTING MOTOR AND FASTENINGS (0422)

SPECIAL TOOLS—Continued

Convenience Tools (For a Delco-Remy Starter)

...... Armature Commutator Turning and Undercut Tool—Used to undercut armature and computator.

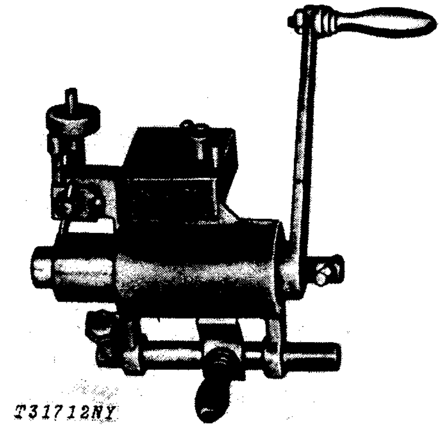


Fig. 131-Armature Commutator Turning and Undercut Tool

...... Pre-Lubricated Bushing Arbor—To install prelubricated bushings.

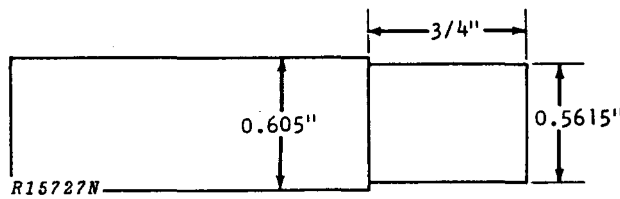


Fig. 132-Pre-Lubricated Bushing Arbor

...... Spring Tension Gauge—To check brush spring tension.

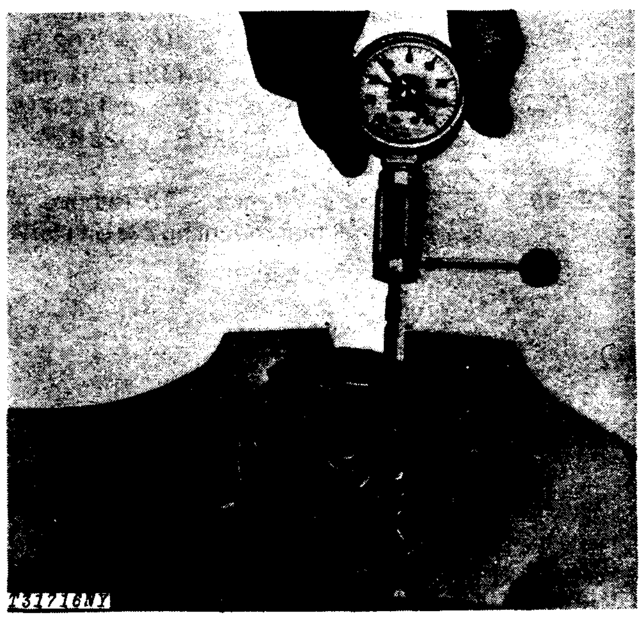


Fig. 133-Spring Tension Gauge

Section 5
ENGINE AUXILIARY SYSTEMS

CONTENTS OF THIS SECTION

5

Group 0510
ENGINE COOLING SYSTEM

GENERAL INFORMATION

The power unit cooling system consists of a radiator, fan and fan shroud.

The radiator (Fig. 2) and the fan are located at the front of the power unit.

REMOVAL

Disconnect battery negative cable.

Remove side shields by lifting and pulling out.

Remove top hood.

Remove screws that attach the front shroud.

Remove front shroud.

Drain cooling system.

Disconnect radiator braces (1, Fig. 1).

Remove radiator mounting screws (2, Fig. 1).

Remove radiator.

To remove the fan shroud, remove screws on the sides of the radiator.

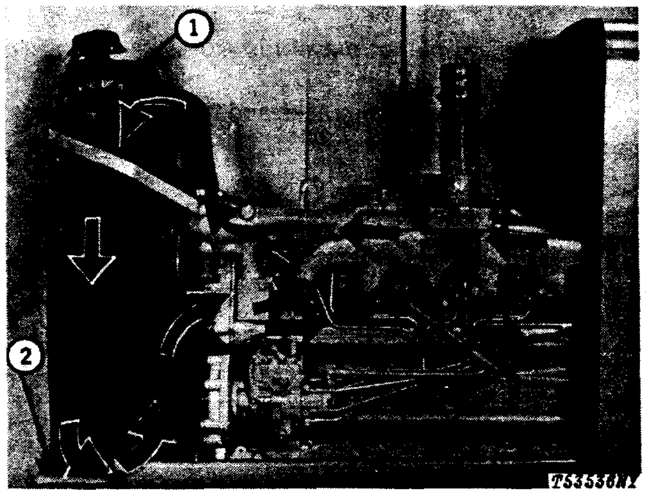


Fig. 1-Cooling System

To remove fan remove fan cap screws.

REPAIR

Inspect radiator for cracks and leaks. Repair or replace as necessary.

Clean foreign matter out of radiator.

Inspect fan shroud for cracks and holes. Replace as necessary.

Inspect fan for bent or broken blades. The fan is not a repairable part. Replace if defective.

Fig. 2-Connecting Radiator Hoses

INSTALLATION

Install fan and cap screws. Tighten cap screws to 35 lb-ft (47 Nm) (5 kg-m).

Replace fan shroud on radiator.

Install radiator.

Install radiator screws.

Connect radiator hoses (Fig. 2).

Connect radiator braces (Fig. 3).

Replace front shroud (Fig. 4).

Replace top panel.

Replace side shields.

Connect battery negative cable.

Fill cooling system with the proper coolant to the proper level.

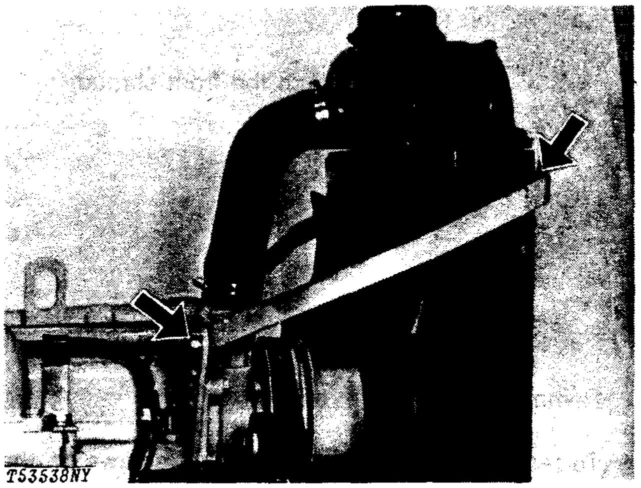


Fig. 3-Connecting Radiator Braces

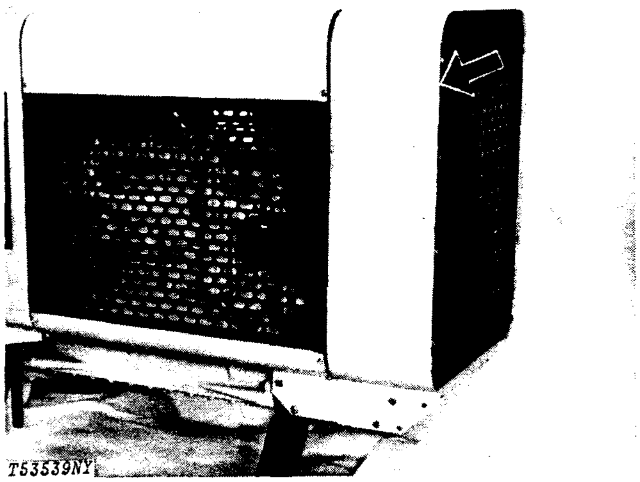


Fig. 4-Replacing Front Shroud

Group 0515
SPEED CONTROLS

GENERAL INFORMATION

The speed control consists of a cable control (Fig. 1) that runs from the injection pump to the handle on the panel of the power unit.

REMOVAL

Shut off engine.

Disconnect battery negative (−) cable.

Disconnect shut-off wire from injection pump.

Disconnect cable from the injection pump.

Disconnect cable from the cylinder block connect point (Fig. 1).

Remove handle mounting nuts.

Slowly pull cable out from power unit.

REPAIR

Inspect cable (Fig. 2) for any defects. Replace as necessary.

INSTALLATION

Slide cable through hole at the control panel.

Route cable to the injection pump.

Connect the cable to the injection pump.

Connect the cable to the connect point on the cylinder block.

For cable adjustment, refer to Group 9010.

Connect battery negative (−) cable.

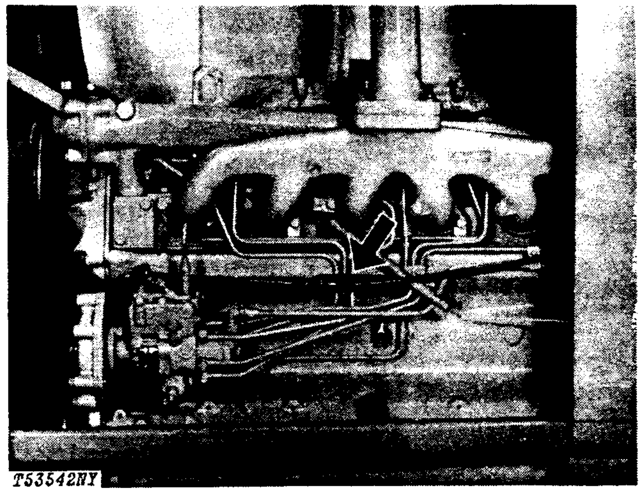


Fig. 1-Left Side

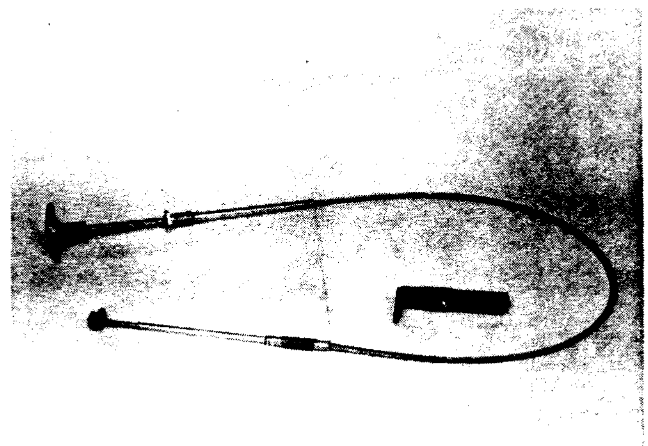


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Fig. 2-Cable Assembly

Litho in U.S.A.

Group 0520
INTAKE SYSTEM

GENERAL INFORMATION

If the power unit is equipped with an air cleaner system it is located at the rear of the engine (Fig. 1).

REMOVAL

Remove precleaner (1, Fig. 1).

Remove intake hose (2).

Remove bolts that hold air cleaner unit to the power unit housing (3).

Remove air cleaner cover.

Remove the wing nuts (5, Fig. 2) that hold the air cleaner elements (2, Fig. 2).

Remove elements.

REPAIR

Check filter elements for holes, tears and cracks. Replace if necessary.

Check the housing for holes. Replace if necessary.

Refer to the owner's manual for service of the filter elements.

INSTALLATION

Install both filter elements securely attach both wing nuts.

Empty dust bowl (1, Fig. 2).

Replace rubber skirt baffle (6).

Replace dust bowl.

Secure band (3, Fig. 1).

Replace air cleaner assembly on the power unit.

Replace the precleaner (3, Fig. 2).

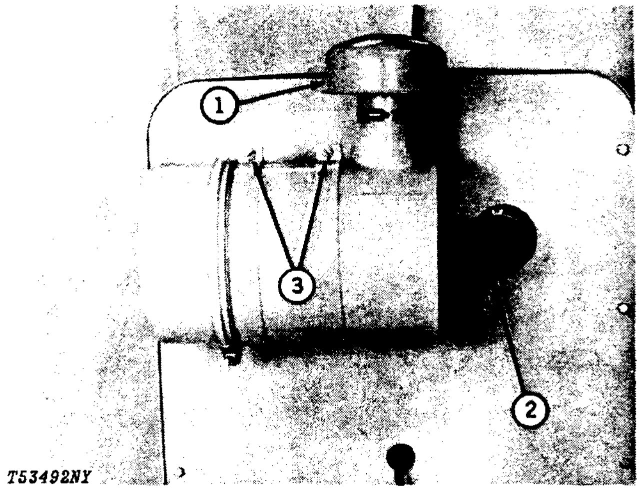

Fig. 1-Air Cleaner

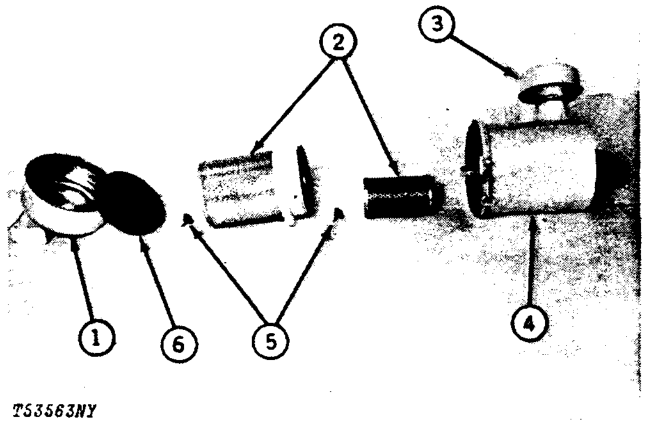

Fig. 2-Air Cleaner Assembly

Group 0599
SPECIFICATIONS AND SPECIAL TOOLS

COOLING SYSTEM

SPECIFICATIONS AND TORQUE VALUES

Fan cap screw
torque . . . . 35 lb-ft
(47 Nm) (5 kg-m)

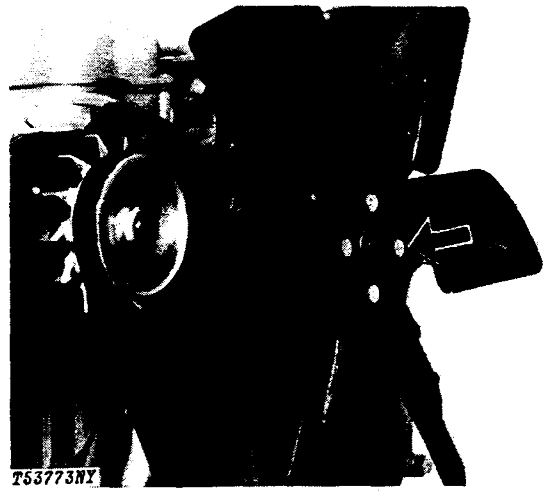

Fig. 1-Fan Cap Screw Torque

Section 16
ELECTRICAL SYSTEMS

CONTENTS OF THIS SECTION

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16

Group 1672
ALTERNATOR, REGULATOR AND CHARGING SYSTEM WIRING

REMOVAL

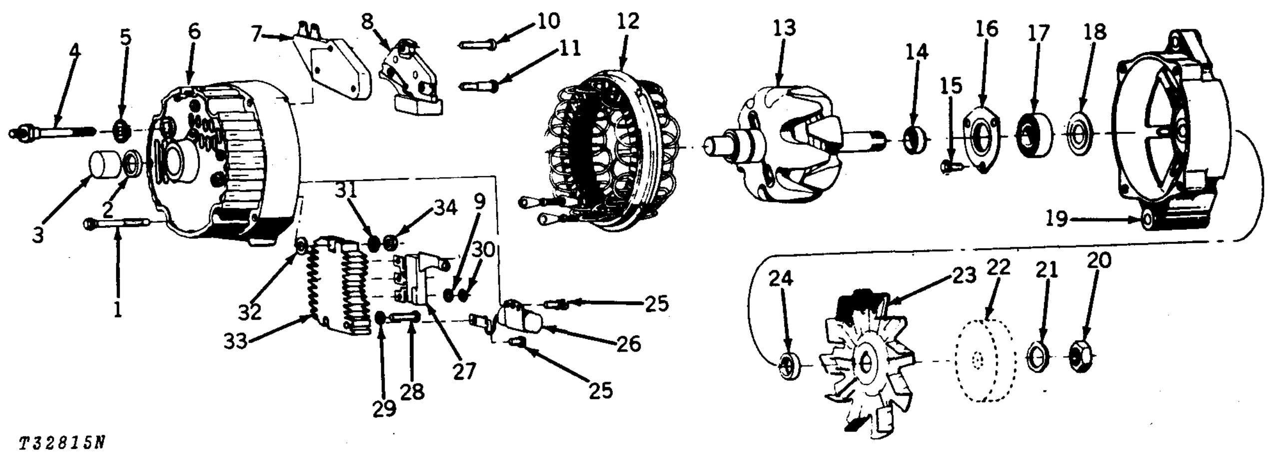
IMPORTANT: Disconnect battery negative (−) cable at the battery.

Disconnect battery wires from terminals and field wire connector.

Loosen bolts attaching alternator to mounting brackets and remove drive belt.

Remove attaching bolts and alternator.

DELCO-REMY



1—Through Bolt (4 used)
2—Oil Seal
3—Slip Ring End Bearing
4—Output Terminal
5—Insulating Washer
6—Slip Ring End Frame
7—Regulator
8—Brush Assembly
9—Lock Washer (3 used)
10—Regulator Ground Screw
11—Insulated Screw (2 used)
12—Stator
13—Rotor
14—Inner Collar
15—Screw (3 used)
16—Bearing Retainer
17—Drive End Bearing
18—Slinger Washer
19—Drive End Frame
20—Pulley Nut
21—Lock Washer
22—Pulley
23—Fan
24—Outer Collar
25—Screw (2 used)
26—Capacitor
27—Diode Trio
28—Rectifier Ground Screw
29—Lock Washer
30—Nut (4 used)
31—Washer
32—Insulating Washer
33—Rectifier Bridge
34—Nut

Fig. 1-Delco-Remy Alternator

Litho in U.S.A.

REPAIR

Remove through bolts. Pry stator and slip ring end frame assembly from the rotor and drive end frame assembly. After disassembly, place a piece of pressure-sensitive tape over the slip ring end bearing to prevent entry of dirt or foreign material.

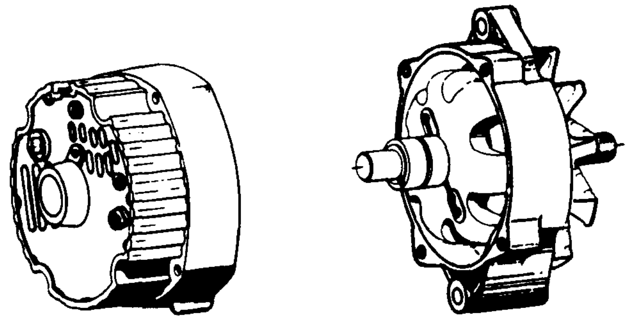


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Fig. 2-Separate Frames

Drive End Frame Bearing

Remove pulley, fan, and collar. Then separate the drive end frame from the rotor shaft. Remove the retainer plate and press bearing from the end frame (Fig. 3). The bearing may be reused if it is in satisfactory condition. Clean the bearing and fill it 1/4 full with Delco-Remy Lubricant No. 1948791 before assembly. Overfilling bearing may cause bearing to overheat.

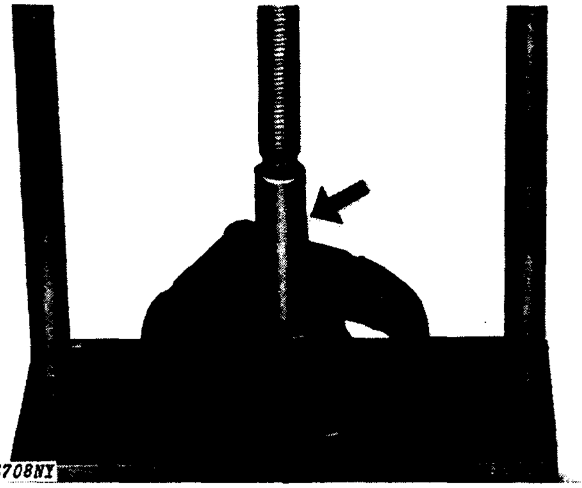

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Fig. 3-A-209 Tool

Install bearing (Fig. 4). Install new retainer plate if felt seal is hard or excessively worn. Fill cavity between retainer plate and the bearing with 1948791 Lubricant. Install rotor, collars, fan and pulley. Tighten nut to 40 to 60 lb-ft (54 to 81 Nm) (6 to 8 kg-m) torque.

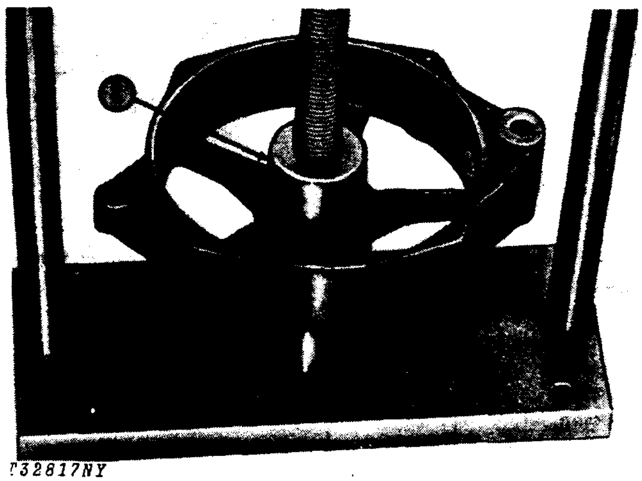

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Fig. 4-A-203 and A-207 Tool

Slip Ring End Bearing

Replace the slip ring end bearing if its grease supply is exhausted or if the bearing is defective. Do not attempt to relubricate bearing. Press bearing from outside to inside of frame (Fig. 5).

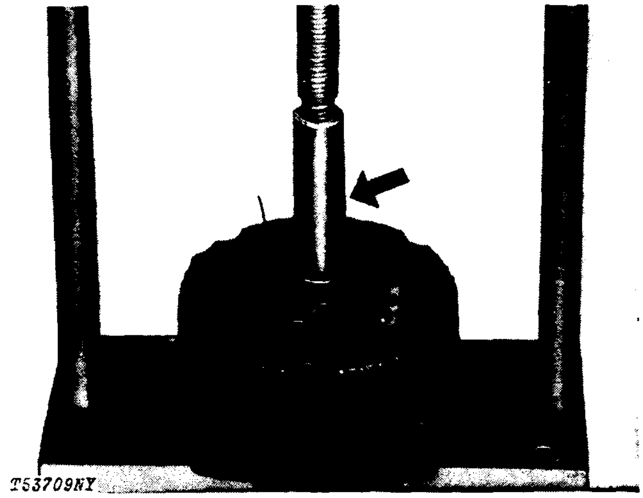

Fig. 5-A-209 Tool

To install a new bearing, place a flat plate over the bearing and press it in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame (Fig. 6). Support the inside of the frame with a cylinder to prevent breakage of the end frame.

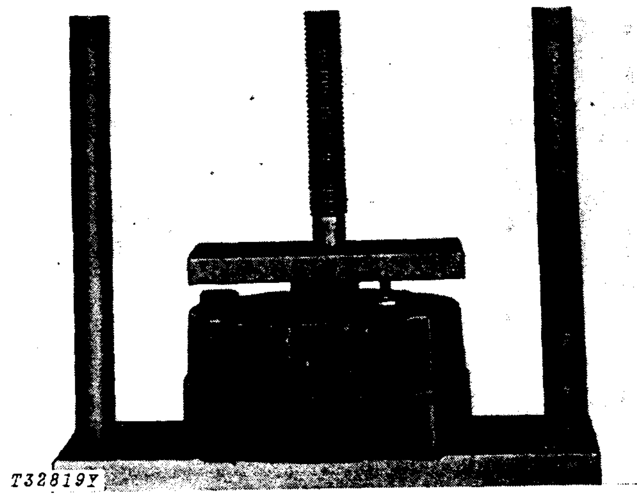

Fig. 6-Install Slip Ring End Bearing

Stator and Slip Ring End Frame

Before removing brushes or diode trio, check for grounds between points A to C and B to C (Fig. 7) with an ohmmeter, using the lowest range scale. Then reverse the lead connections.

If both A to C readings or both B to C readings are the same, the brushes may be grounded because of a defective insulating washer and sleeve at the two screws. If the screw assembly is not damaged, the regulator or diode trio is defective.

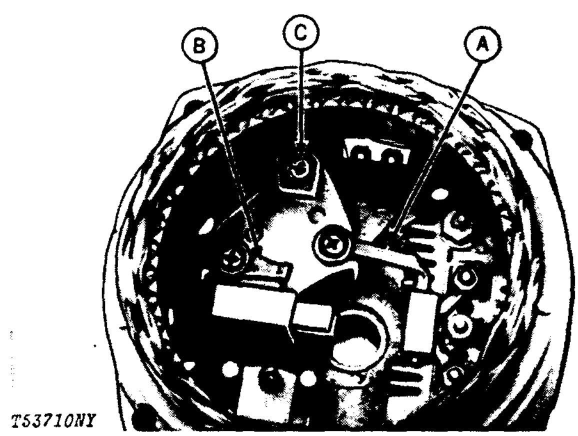

Fig. 7-Stator Ground Check

Diode Trio

To check the diode trio, first remove the stator. Then remove the diode trio, noting the insulator positions. With an ohmmeter, check between points A (Fig. 8) and D and then reverse the ohmmeter lead connections. A good diode trio will give one high and one low reading. If both readings are the same, the diode trio is defective. Repeat this test at points B and D and at points C and D.

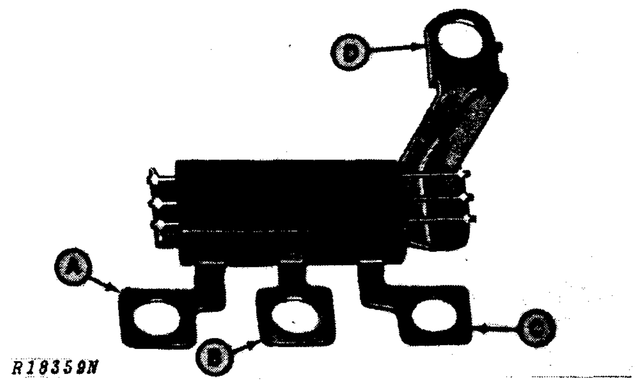

Fig. 8-Diode Trio

Rectifier Bridge

The rectifier bridge has a grounded heat sink (1, Fig. 9) and an insulated heat sink (2) that is connected to the output terminal. Connect ohmmeter to the grounded heat sink (A) and to the flat metal strip (B, Fig. 9). Then reverse the ohmmeter lead connections. If both readings are the same, the rectifier bridge is defective. Repeat this test between points A to C, A to D, B to E, C to E and D to E.

The ohmmeter check of the rectifier bridge, and of the diode trio as previously covered, is a valid and accurate test. Do not replace either unit unless at least one pair of readings is the same.

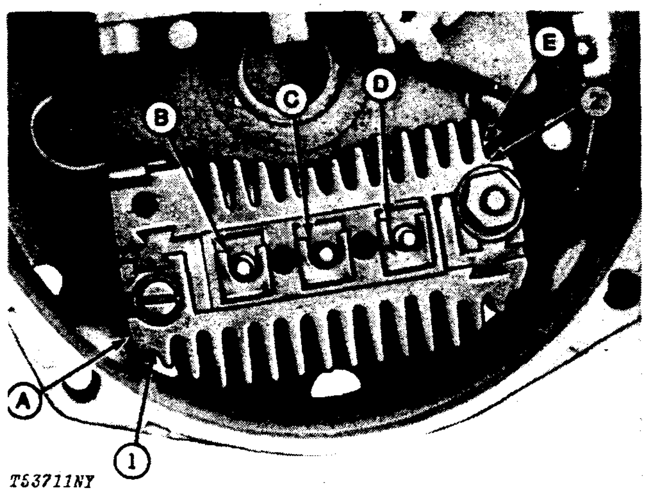

Fig. 9-Rectifier Bridge

Brush Assembly and Regulator

Check brushes for continuity between points A to B and C to D (Fig. 10). Wiggle the brush to locate poor connections.

After removing stator and diode trio, the brush assembly and the regulator may be removed. The screws at points B and C must have insulating washers and sleeves. A ground at these points will cause no output or uncontrolled output.

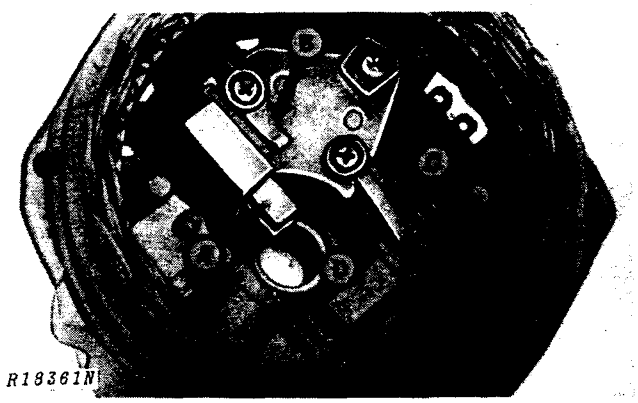

Fig. 10-Rectifier Bridge

Rotor

Test A—Short Circuit or High Resistance

Connect voltmeter (1, Fig. 11), ammeter (3), and battery (4) to rotor (2).

This test checks for short circuits or excessive resistance. The rotor winding current draws should be 4 to 4.5 amps at 12 volts.

An ammeter reading above this specified value indicates shorted windings, a reading below the specified value indicates excessive resistance.

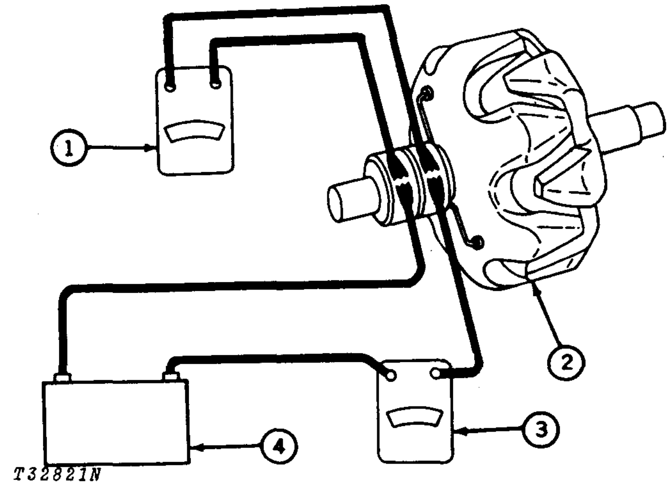

Fig. 11-Rotor Current Draw Test

Test B: Checking Field Coil for Opens

To check for opens connect the test lamp or ohmmeter to each slip ring (B, Fig. 12). If the test lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open.

Test C: Checking Field Coil for Grounds

Connect ohmmeter to either slip ring and to the shaft (C, Fig. 12). Test lamp should not light or ohmmeter reading should show a high resistance. If test lamp lights or ohmmeter resistance is low, the field windings are grounded.

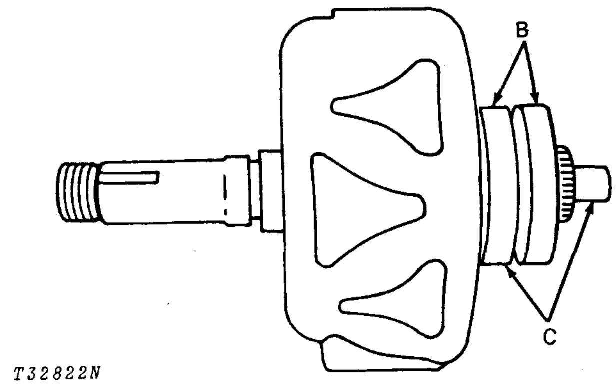

Fig. 12-Test B and C Test Points

Polish slip rings with 400-grit silicon carbide paper.

Examine stator for insulation failure or defects. The alternator is "Y" connected (1, Fig. 13).

Check for ground between any terminal and the stator frame. If the meter reading is low the windings are grounded. Check for an open circuit by connecting an ohmmeter from point A to B and from B to C (Fig. 13). If the meter readings are high the windings are open.

Shorted stator leads are usually discolored and have a burned odor.

Replace stator only after other electrical components have been checked and are satisfactory.

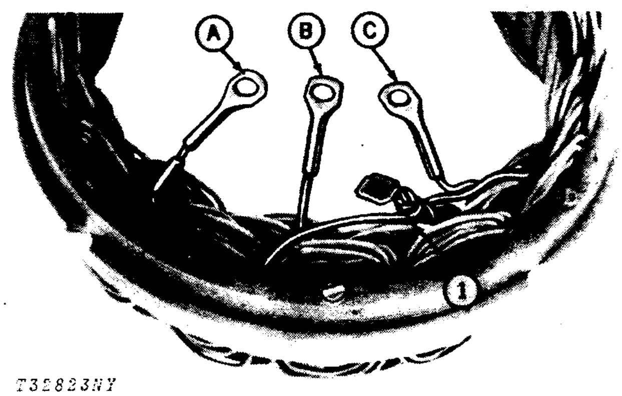

Fig. 13-Stator

ASSEMBLY

Alternator assembly is the reverse of the disassembly procedures. Be sure insulated screws for the regulator and brush holder and the insulating washer for the rectifier bridge are assembled correctly (Figs. 1 and 7).

To connect the slip ring end frame assembly to the rotor and drive end frame assembly, insert a pin through the hole (Fig. 14) to hold the brushes up. Remove the tape over the slip ring end bearing and make sure the shaft is perfectly clean. Carefully install the shaft in the slip ring end frame assembly to avoid seal damage. After tightening through bolts, remove the brush retaining pin.

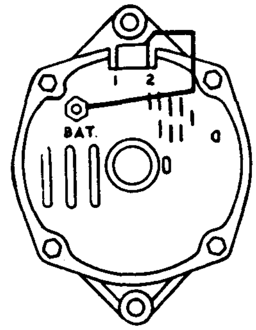

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Fig. 14-Brush Pin Hole

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Mount alternator on electrical servicer. Make connections shown in Fig. 15 using an AR55283 Delcotron harness. Connect jumper wire to terminal with resistor, not to terminal with orange wire.

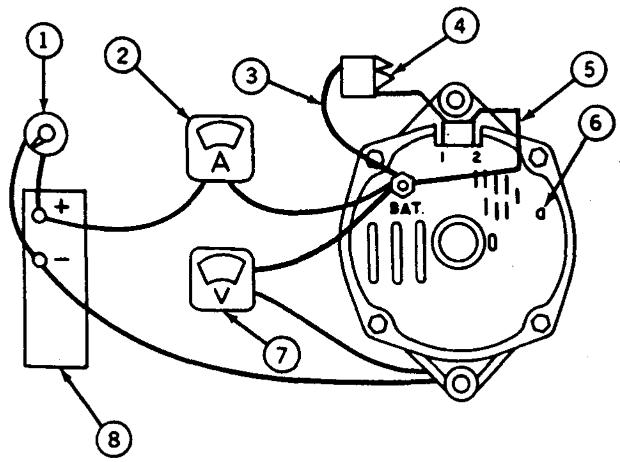

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Fig. 15-Alternator Test Connections

1—Carbon Pile Resistor
2—Ammeter
3—Jumper Wire
4—Resistor
5—AR55283 Delcotron Harness
6—Test Hole
7—Voltmeter
8—12-Volt Battery

Fig. 15-Legend

Run alternator at approximately 5000 rpm.

Use the following temperature/voltage chart to check the alternator:

Regulator Case Temperature	Voltage
85°F (29°C)	14.5—15.0 volts
105°F (41°C)	14.3—14.8 volts
125°F (52°C)	14.1—14.7 volts
145°F (63°C)	13.9—14.5 volts

If voltage rises above the specified voltage, check for a grounded brush lead clip.

If voltage falls below the specified voltage, adjust the carbon pile to obtain maximum amperage output.

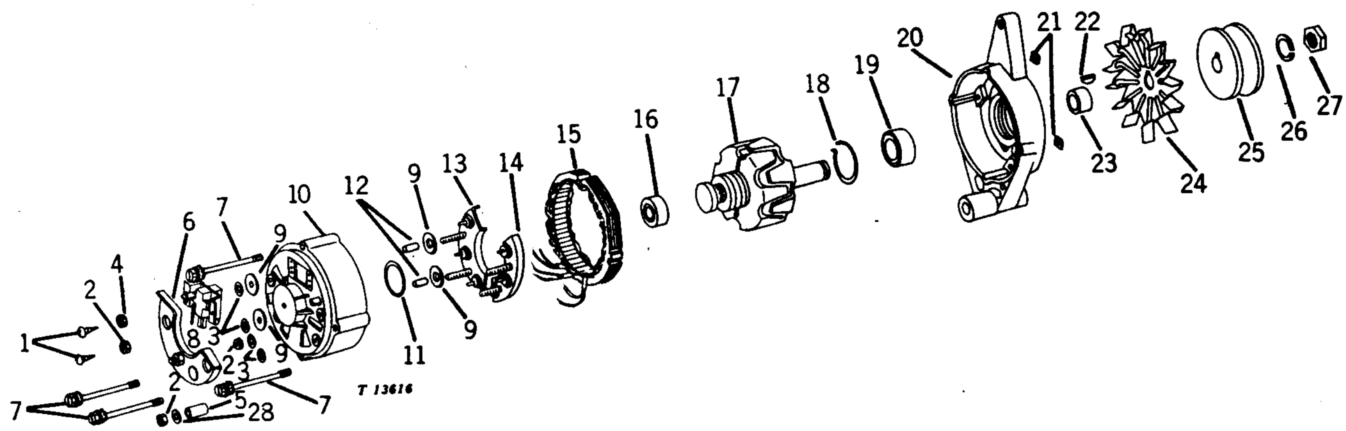
If amperage output is 60% or more of the rated amperage, the alternator is good.

If amperage output is low, ground field windings at tab in test hole (6, Fig. 15). If output is now correct, replace regulator and check field winding. If output is not correct, check diode trio, rectifier bridge, and stator.

Open carbon pile resistor and after voltage stabilizes, regulated voltage should be as listed in the following chart. If battery is partially discharged, it may be necessary to connect a 1/4-ohm resistor in series with the ammeter.

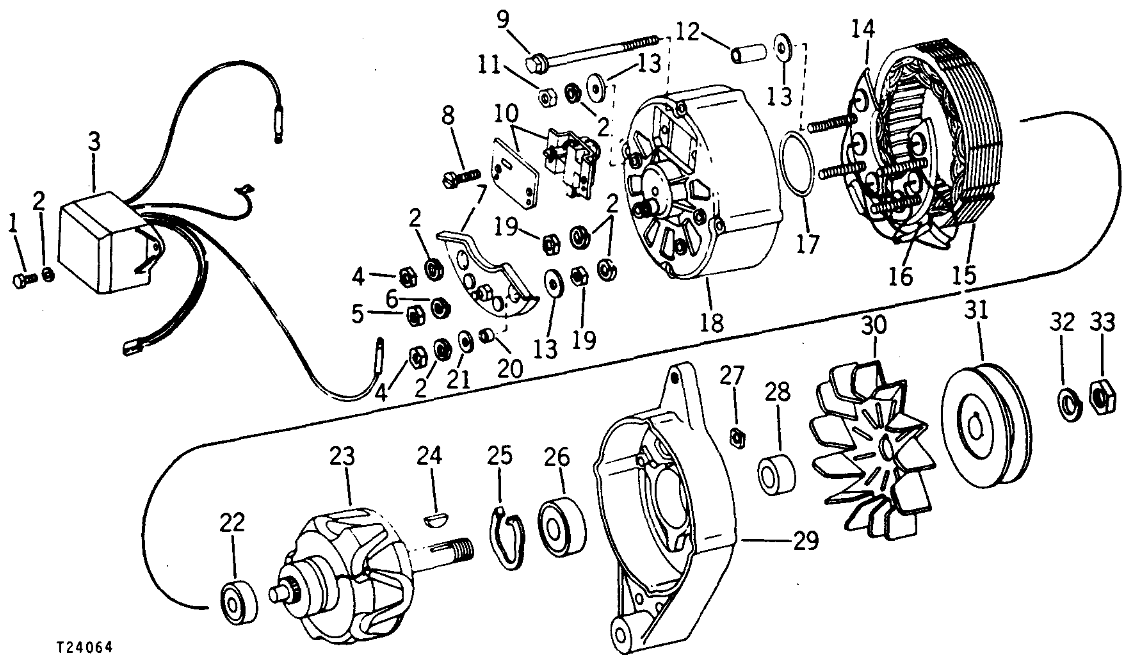
Regulator Case Temperature	Voltage
85°F (29°C)	14.5—15.0 volts
105°F (41°C)	14.3—14.8 volts
125°F (52°C)	14.1—14.7 volts
145°F (63°C)	13.9—14.5 volts

MOTOROLA



1—Drive Screw (2 used)
2—Nut (6 used)
3—Lock Washer (6 used)
4—Nut
5—Insulator Sleeve
6—Isolation Diode Assembly
7—Through Bolt (4 used)
8—Brush and Cover
9—Insulator Washer (5 used)
10—Rear Housing
11—Rear Bearing Retainer
12—Insulator Sleeve (2 used)
13—Positive Rectifier Diode Assembly
14—Negative Rectifier Diode Assembly
15—Stator
16—Rear Bearing
17—Rotor
18—Front Bearing Retainer
19—Front Bearing
20—Front Housing
21—Nut (4 used)
22—Woodruff Key
23—Spacer
24—Fan
25—Alternator Pulley
26—Lock Washer
27—Jam Nut
28—Insulator Washer (2 used)

Fig. 16-35 Amp Alternator Assembly



1—Self Tapping Screw (3 used)	12—Insulator Sleeve (2 used)	23—Rotor
2—Lock Washer (9 used)	13—Insulator Washer (5 used)	24—Woodruff Key
3—Regulator	14—Positive Rectifying Diode	25—Front Bearing Retainer
4—Nut (2 used)	15—Stator	26—Front Ball Bearing
5—Nut	16—Negative Rectifying Diode	27—Square Nut (4 used)
6—Lock Washer	17—Rear Bearing Retainer	28—Fan and Pulley Spacer
7—Dual Diode Insulator	18—Rear Housing	29—Front Housing
8—Drive Screw (2 used)	19—Nut (2 used)	30—Fan
9—Through Bolt (4 used)	20—Insulator Sleeve	31—Pulley
10—Brush and Cover	21—Insulator Washer	32—Lock Washer
11—Nut (2 used)	22—Rear Bearing	33—Jam Nut

Fig. 17-55 Amp Alternator Assembly

REPAIR

The pulley is a slip fit on the shaft with a Woodruff key. To remove the nut and lock washer, clamp pulley in vise as shown in Fig. 18. Belt protects pulley from damage. While supporting alternator, strike end of shaft with a wooden mallet or plastic hammer.

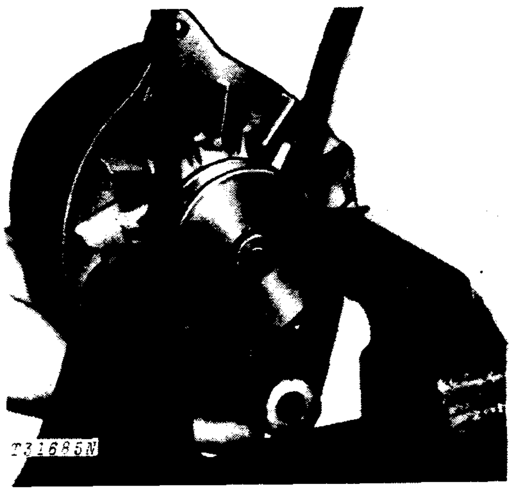


Fig. 18-Pulley Removal

Removing Rear Housing

IMPORTANT: Do not insert screwdriver blade deeper than 1/16 inch (1.6 mm).

Remove brush assembly, then remove isolation diode assembly (see Fig. 16 and 17). Remove the four through bolts and nuts. Insert a small-bladed screwdriver in the stator slots between stator and front housing (Fig. 19).

Apply prying pressure at several points around the stator to extract rotor and front housing as an assembly. Do not burr the stator core.

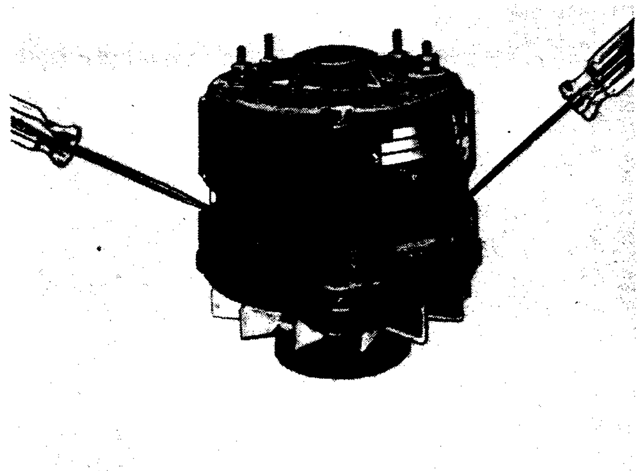


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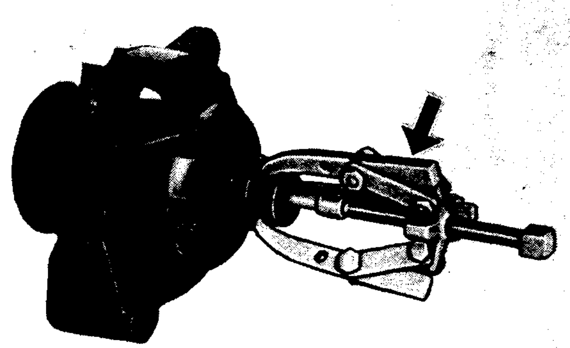
Fig. 19-Remove Rear Housing

16

Rear Bearing

Using A-216 Puller (Fig. 20), remove rear bearing.

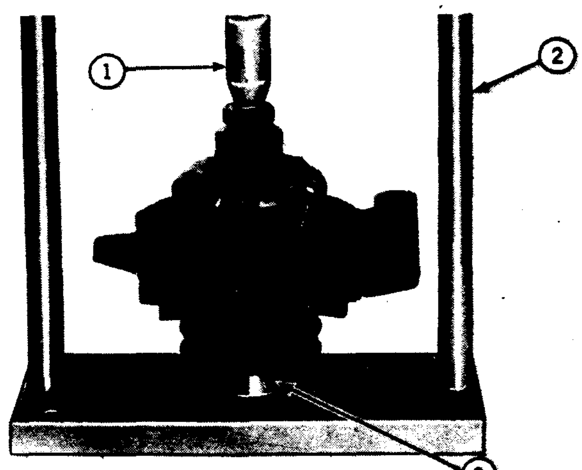
Replace rear bearing retainer (17, Fig. 17 or 11, Fig. 16).



T53733NY

Fig. 20-A-216-Puller

Using A-206 (1, Fig. 21), A-201 (2), and A-208 Tools, install rear bearing.



T53734NY

Fig. 21-Installing Rear Bearing

Front Bearing

Remove Woodruff Key (1, Fig. 22) from rotor shaft.

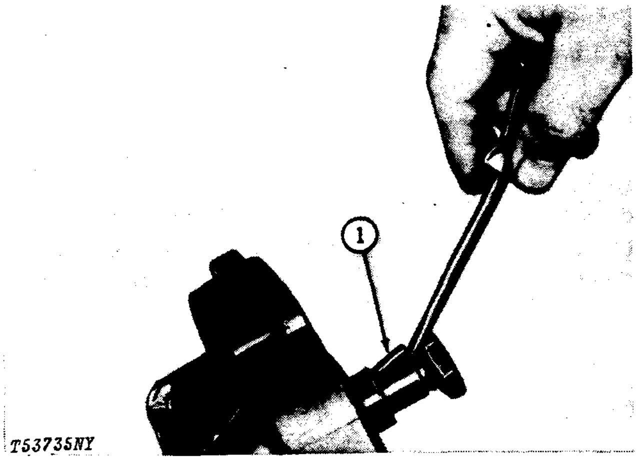


Fig. 22-Remove Woodruff Key

16

Compress bearing retainer (Fig.23) and remove rotor and bearing from front housing.

Press bearing from rotor shaft or use A-216 Puller to pull bearing from shaft.

Fig. 23-Compress Bearing Retainer

Using A-203 (1, Fig. 24) and A-207 (2) Tools, press bearing into housing.

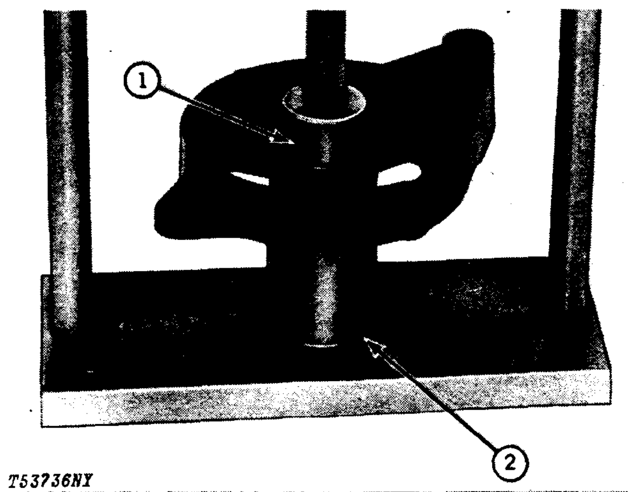
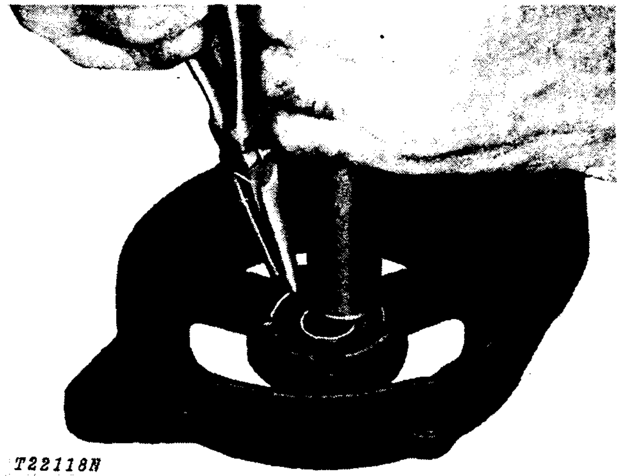


Fig. 24-Install Front Bearing

Install bearing retainer in front housing. Compress the waves of the bearing retainer to seat it in its groove (Fig. 25). Do not use a screwdriver or other small object that might slip off and damage the bearing seal.

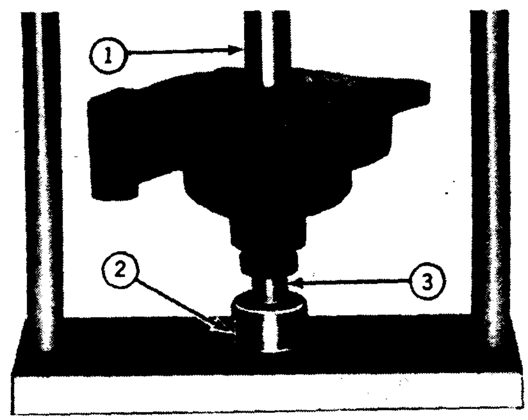


T22118N

Fig. 25-Install Bearing Retainer

Using A-209 (1, Fig. 26), A-208 (2), and A-203 (3) Tools, press housing and bearing onto shaft.

A-209 Tool presses against inner bearing race.



T53737NY

Fig. 26-Install Front Housing

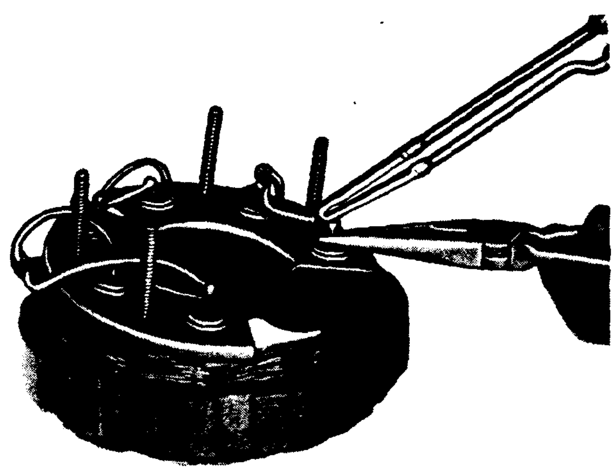
Removing Stator and Diodes

Remove stator and diode assembly from the rear housing. Carefully note locations of insulators and washers for proper reassembly. Do not unsolder stator-to-diode wire junctions. Avoid bending stator wires at junction.

When soldering and unsoldering leads from diodes, grasp the diode lead with pliers between the diode and the stator lead to be removed (Fig. 2). This gives better heat dissipation and protects the diode. Do not exert excessive stress on diode lead.

Note diode assembly to stator connections. Be sure replacement diode assembly connections are the same. The positive diode assembly has red printing and the negative has black printing—DO NOT INTERCHANGE.

IMPORTANT: Do not use an acid-core solder when soldering diode leads. Use rosin-core solder.



T53738NY

Fig. 27-Unsoldering Diode Leads

1

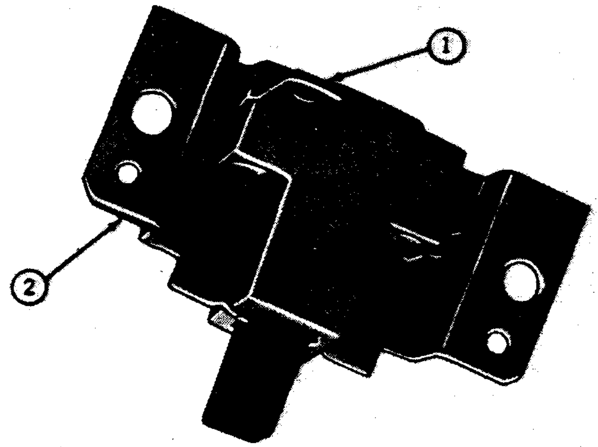
ALTERNATOR COMPONENT TESTS

Brush Assembly Insulation and Continuity Tests

Insulation Test

Connect ohmmeter or test lamp (12 to 120 volt) to field terminal (1, Fig. 28) and bracket (2).

Resistance should be high (infinite) or test lamp should not light. If resistance is low or test lamp lights, brush assembly is shorted and must be replaced.



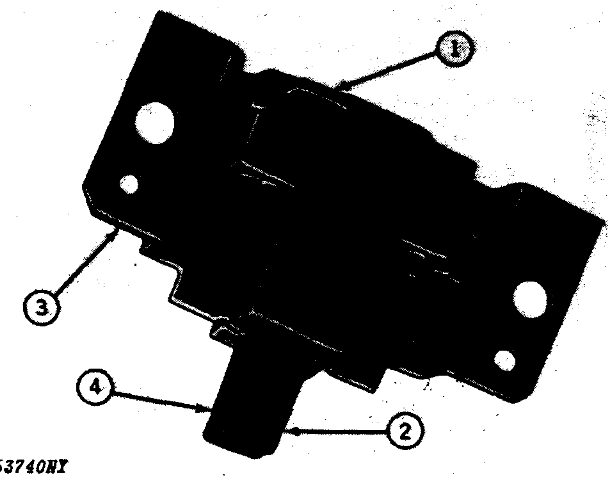
T53739NY

Fig. 28-Brush Insulation Test Points

Continuity Test

Connect an ohmmeter to field terminal (1, Fig. 29) and brush (2). Use an alligator clip to assure good contact to brush. Resistance reading should be zero. Move brush and brush lead wire to make certain that the brush lead wire connections are not intermittent. Resistance reading should not vary when brush and lead wire is being moved around.

Connect ohmmeter to bracket (3) and grounded brush (4). Resistance reading should be zero. Repeat same test on brush lead wire as described in above paragraph.

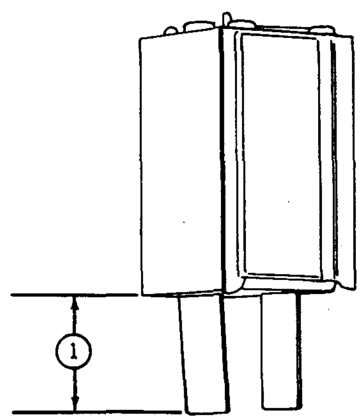


T53740NY

Fig. 29-Brush Continuity Test Points

Measure brush exposed length.

Brush exposed length (minimum)......... 0.25 inch (6.5 mm)



T53714N

Fig. 30-Brush Exposed Length

Isolation Diode Test

If a commercial diode tester is used, follow tester manufacturer's testing instructions. If a commercial tester is not available, use a DC test lamp.

IMPORTANT: Do not use a 120-volt test lamp, use a 12-volt DC test lamp only, otherwise diodes will be damaged.

Connect the test lamp to output terminal and regulator terminal (2). Then reverse test probes. The test lamp should light in one direction, but should not light in the other direction.

Repeat test after isolation diode has been removed to ascertain findings.

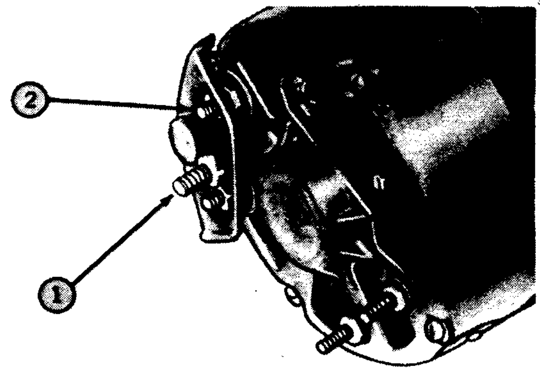


Fig. 31-Isolation Diode Test Points

In-Circuit Rectifier Diode Test With Diode Tester

Any commercial in-circuit diode tester will be adequate to make this check. Follow tester manufacturer's recommended testing procedure.

If the in-circuit tester indicates that diodes are faulty, recheck diodes individually after the diode assemblies have been disconnected from stator assembly.

Shorted stator coil or shorted insulating washers or sleeves on positive diode assembly would make diodes appear to be shorted.

To check negative diode assembly, connect tester to diode plate stud (1, Fig. 32) and to diode lead (2). Check remaining diodes (3 and 4) by the same method.

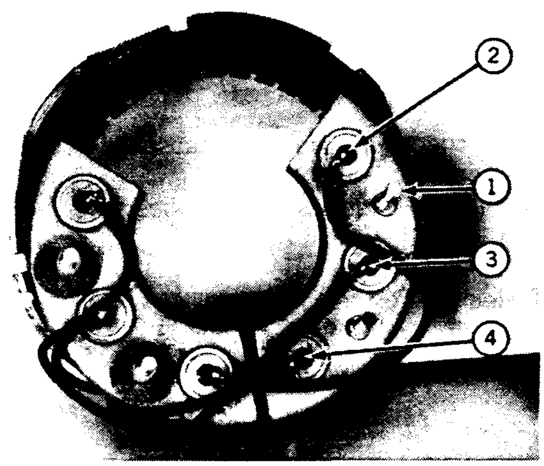


Fig. 32-In-Circuit Negative Rectifier Diode Test Points

To check positive diode assembly, connect tester to output terminal (1, Fig. 33) and to diode lead (2). Check remaining diodes (3 and 4) by the same method.

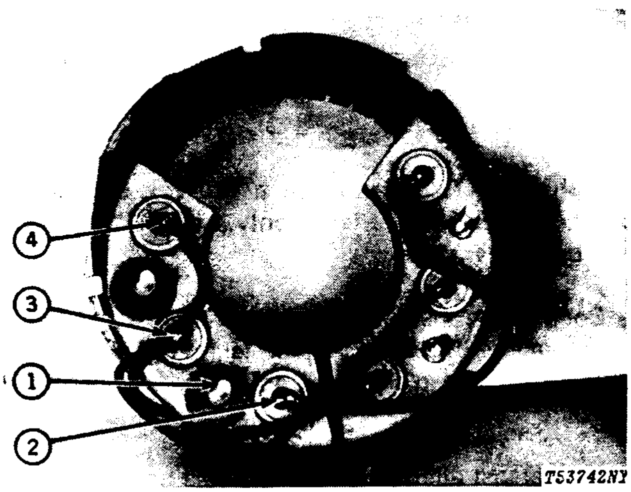


Fig. 33-In-Circuit Positive Rectifier Diode Test Points

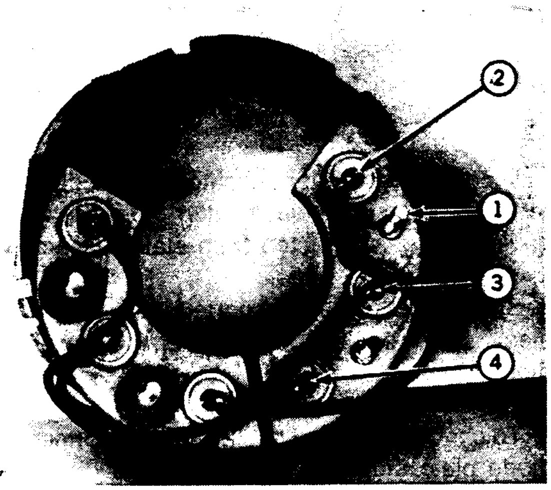
16

In-Circuit Rectifier Diode Test With Test Light

IMPORTANT: Do not use a 120-volt test lamp. Use a 12-volt DC test lamp only; otherwise diodes will be damaged.

To check negative diode assembly, connect test lamp probes to diode plate stud (1, Fig. 34) and to diode lead (2). Reverse test lamp probes. Test lamp should light in one direction only.

Recheck diodes individually after disassembly to determine which diode is shorted if test lamp lights in both directions.



T53741NY

Fig. 34-In-Circuit Negative Rectifier Diode Test Points

To check positive diode assembly, connect test lamp probes to output terminal (1, Fig. 35) and to diode lead (2). Reverse test lamp probes. Test lamp should light in one direction only.

Recheck diodes individually after disassembly to determine which diode is shorted if test lamp lights in both directions.

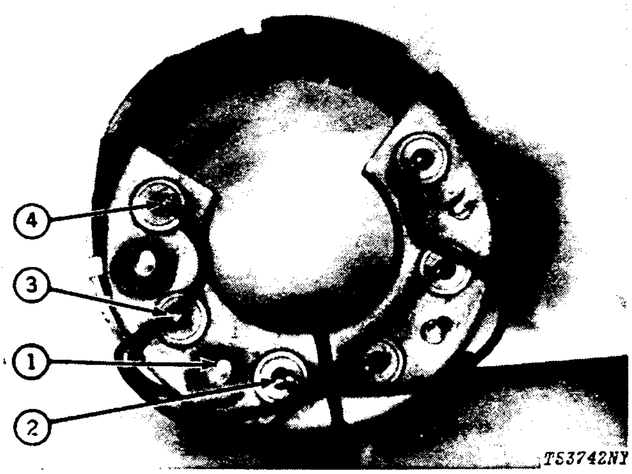


Fig. 35-In-Circuit Positive Rectified Diode Test Points

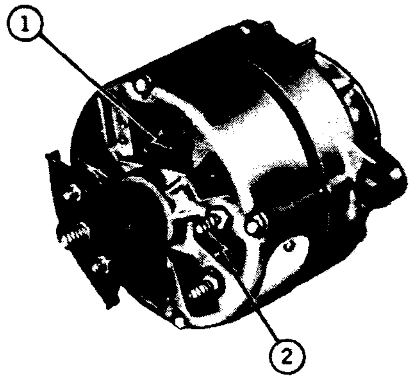
Field Leakage (Short) Test

Remove the regulator and brush assembly.

Connect ohmmeter or test lamp (12 volt or 120 volt may be used) test probes to one of the slip rings (1, Fig. 36) and to the ground terminal (2).

Ohmmeter resistance should be infinite (test lamp should not light).

Repeat test after rotor has been removed to ascertain leakage or short. Connect test probes to one of the slip rings and to rotor shaft.



T53743NY

Fig. 36-Field Leakage Test Points

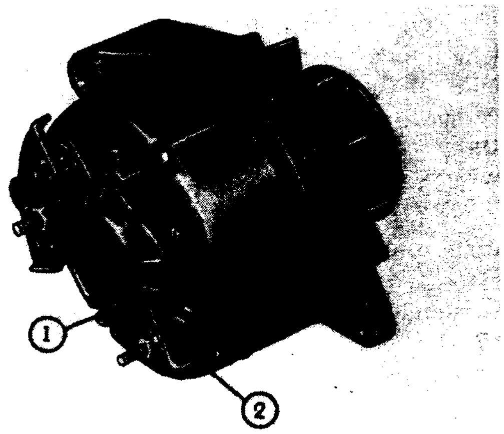
16

In-Circuit Stator Leakage (Short) Test

IMPORTANT: Do not use a 120-volt test lamp. Use a 12-volt DC test lamp only, otherwise diodes will be damaged.

To check stator leakage, connect test lamp probes to diode plate (1, Fig. 37) and to diode lead 2. Reverse test lamp probes. Test lamp should light in one direction only.

Repeat test after stator has been removed if test light lights in both directions.



T16231N

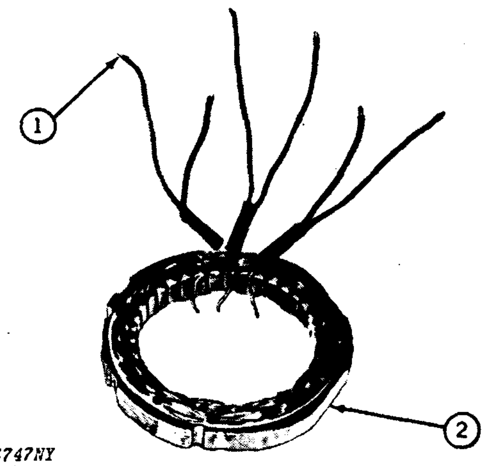
Fig. 37-In-Circuit Stator Leakage Test Points

Out-of-Circuit Stator Leakage (Short) Test

Remove rectifier diode plates and stator as an assembly.

Connect ohmmeter or test lamp (12 volt only) probes to a diode lead (1, Fig. 38) and to the stator (2).

Resistance reading should be infinite (test lamp should not light).



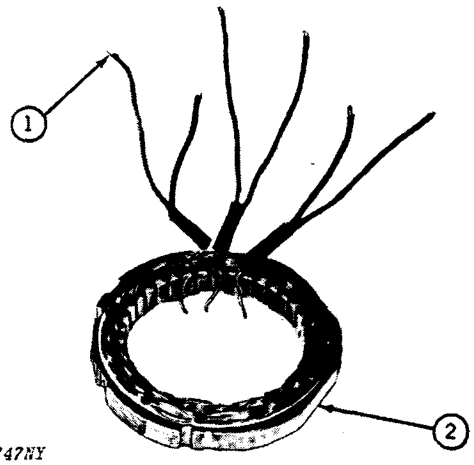
T53747NY

Fig. 38-Out-of-Circuit Stator Leakage Test Points

Stator

Disconnect the stator leads from the diode leads.

Check for a grounded winding by connecting ohmmeter probes to one stator lead (1, Fig. 39) and to the stator frame (2). The ohmmeter reading should be infinite.



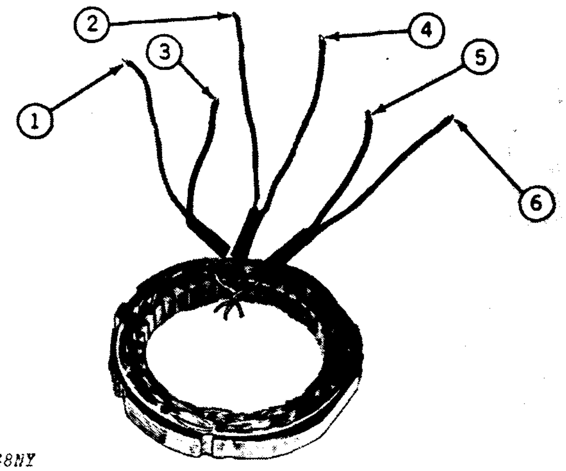
T53747NY

Fig. 39-Grounded Stator Winding Test Points

Using a sensitive ohmmeter which has been carefully zeroed, connect probes to lead (1, Fig. 40) and to lead (2). Resistance should be 0.4 ohm. If the reading is infinite replace stator.

With the ohmmeter probes on (1) and (2) touch leads (3) and (4) together. Resistance should be 0 ohm. If resistance is not 0 ohm, replace stator.

Repeat test on leads (1) and (5) and leads (2) and (5).



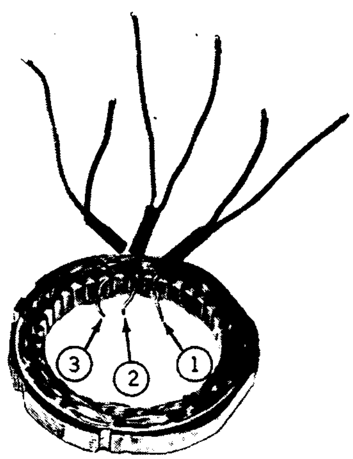
T53748NY

Fig. 40-Shorted Stator Winding Test Points

If a sensitive ohmmeter is not available, disconnect stator leads (1, 2, and 3, Fig. 41).

IMPORTANT: Stator leads may be brittle if they have been overheated or if they are old.

FOS — Refer to FOS Manual 20 - Electrical Systems to test stator.



T53749NY

Fig. 41-Stator Leads

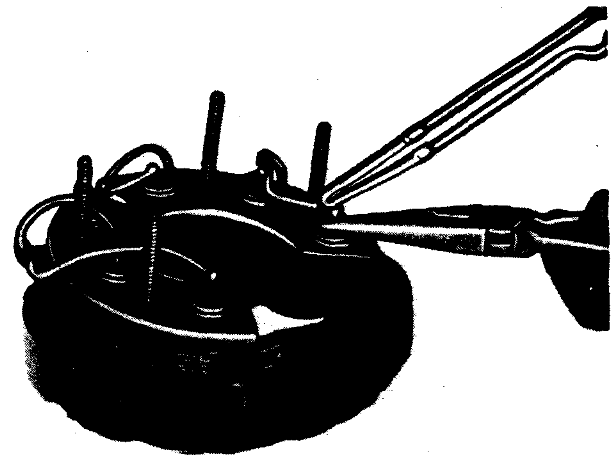
Out-of-Circuit Rectifier Diode Test

If a commercial "Alternator Rectifier Diode Tester" is used, follow the tester manufacturer's recommended testing procedure.

IMPORTANT: Do not use a 120-volt test lamp. Use a 12-volt DC test lamp only, otherwise diodes will be damaged.

If a commercial tester or ohmmeter is not readily available, check diodes with a test lamp.

When unsoldering the stator wires from the rectifier diode assembly, provide a heat sink to the diode terminal with long-nosed pliers (Fig. 41).



T53738NY

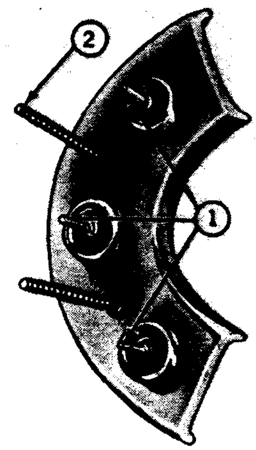
Fig. 42-Unsoldering Diodes

Connect the test lamp probes to diode terminal (1, Fig. 43) and diode plate stud (2) then reverse test lamp probes. The test lamp should light in one direction but not in the other.

Repeat test on remaining diodes. If test lamp fails to light or lights in both directions on any diode, replace rectifier diode assembly.

When testing with an ohmmeter, if a needle deflection is observed with the positive lead to the diode stem and negative lead to the case, the diode is positive. The reverse is true for a negative diode.

Positive diodes have red printing and negative diodes have black printing. DO NOT INTERCHANGE THEM.



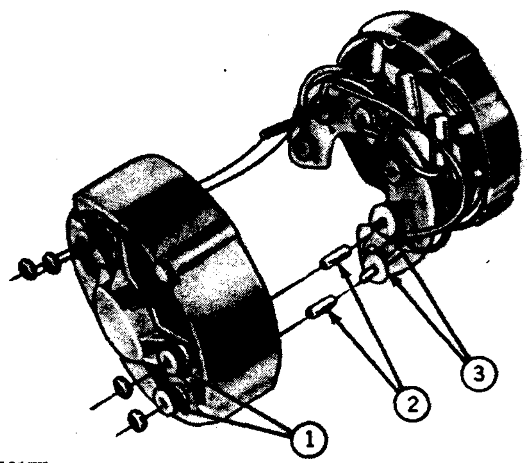
T53750NY

Fig. 43-Rectifier Diode Test Points

ASSEMBLY

Rear Housing to Front Housing

Assemble stator to rear housing making sure insulating washers (1, Fig. 44) and sleeves (2) are positioned as shown in Fig. 43.

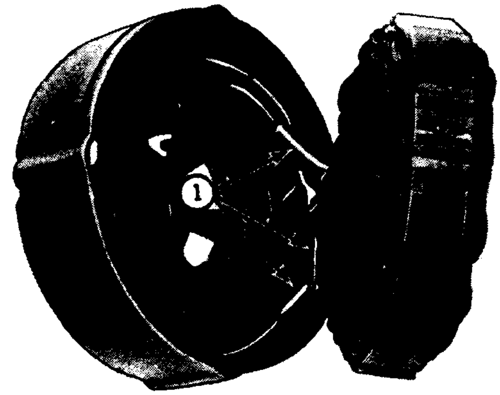


T53751NY

Fig. 44-Stator and Rear Housing Assembly

Position stator leads (1, Fig. 45) to prevent interference with rotor. Assemble stator and rear housing to the rotor and front housing. Tighten through bolts to 50 to 60 lb-in. (5.6 to 6.8 Nm) (0.58 to 0.69 kg-m). Install brush assembly and tighten screws to 20 to 30 lb-in. (2.3 to 3.4 Nm) (0.23 to 0.35 kg-m).

Seal small hole at center of bearing boss in rear housing.

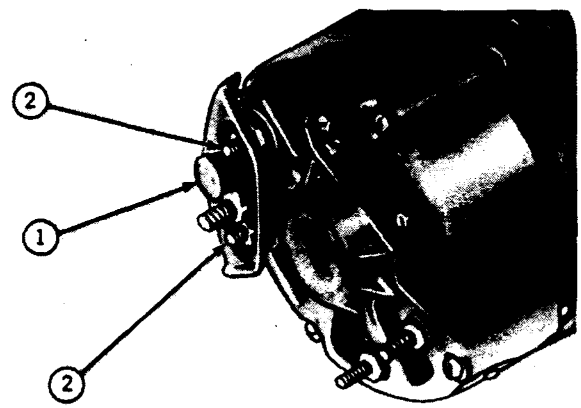


T53754NY

Fig. 45-Stator and Slip Ring End Frame

Before mounting isolation diode, make certain that the positive rectifier diode plate has been properly insulated from housing (Fig. 44).

The isolation diode (1, Fig. 46) is mounted to the positive (+) rectifier diode studs (2).



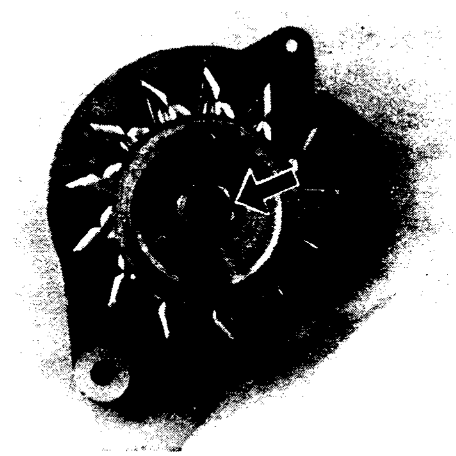
T53756NY

Fig. 46-Isolation Diode Assembly

Pulley

To facilitate tightening pulley retainer lock washer and nut, position Woodruff key, fan and pulley on shaft and grasp in vise with a belt protecting the pulley as shown in Fig. 47 40 to 50 lb-ft (54 to 68 Nm) (6 to 7 kg-m).

Alternator pulley nut torque.........40 to 50 lb-ft (54 to 68 Nm) (6 to 7 kg-m)



T53778NY

Fig. 47-Alternator Pulley Nut Torque

TESTING

See Group 9015 for charging system testing.

INSTALLATION

Position alternator in mounting brackets and install bolts.

Position alternator drive belt on pulley and tighten drive belt (Group 9010).

Delco-Remy

IMPORTANT: DO NOT ATTEMPT TO POLARIZE THE ALTERNATOR after connecting the battery. No polarization is needed.

Connect red wire to alternator output terminal (1, Fig. 48).

Join plastic connector (2).

Connect battery negative (−) cable to battery negative (−) terminal.

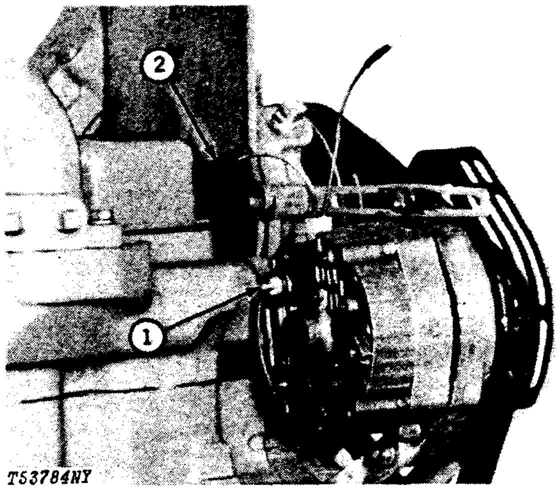


Fig. 48-Delco-Remy Wire Connection

Motorola

IMPORTANT: DO NOT ATTEMPT TO POLARIZE THE ALTERNATOR after connecting the battery. No polarization is needed.

Connect red wire to alternator output terminal (1, Fig. 49).

Join purple wires at plastic connector (2).

Connect battery negative (−) cable to battery negative (−) terminal

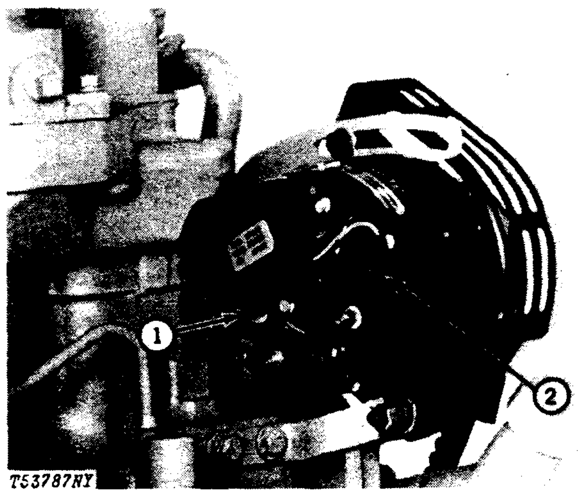


Fig. 49-Motorola Wire Connection

16

Group 1674
WIRING HARNESS AND SWITCHES

GENERAL INFORMATION

The wiring harness for the power units is shown in Figures 1 and 2. The wiring diagram is on the following page.

REMOVAL

Disconnect the battery negative (–) cable.

Disconnect and mark wires at the alternator (Fig. 1).

Disconnect and mark wires at the wires at the starter (Fig. 1).

Disconnect and mark all wires at the rear panel (Fig. 2).

Disconnect and mark wire at the injection pump.

REPAIR

Test wires with an ohmmeter as necessary.

All wires should have no resistance to current.

Replace all cracked or burned wires.

IMPORTANT: When replacing wires use the correct wire gauge and proper connectors.

INSTALLATION

Route wiring harness through the engine connect wires as needed, use wiring diagram (Fig. 3).

Connect battery negative (–) cable.

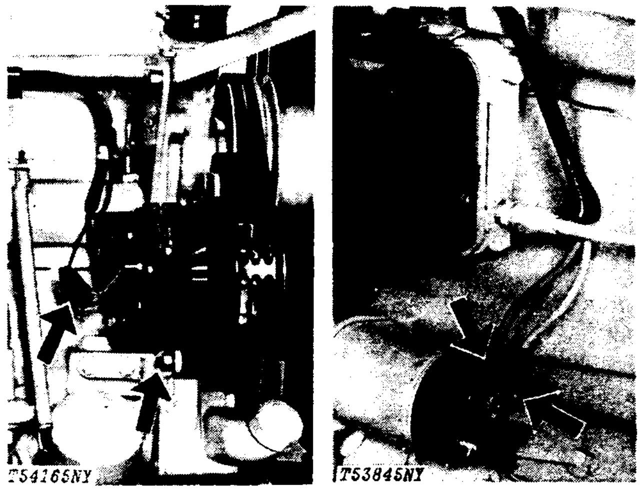


Fig. 1-Alternator and Generator Wiring

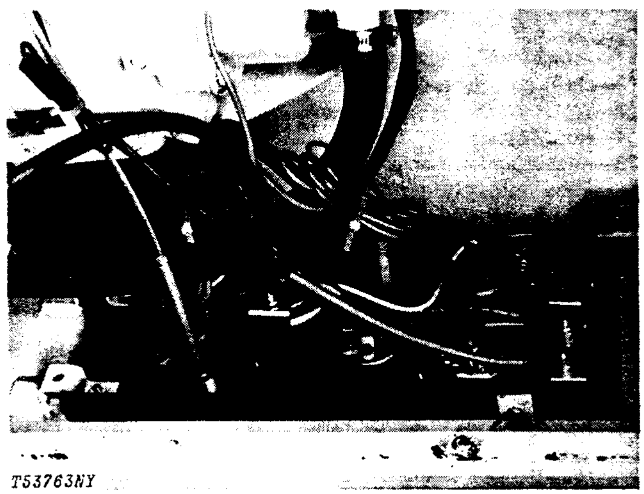
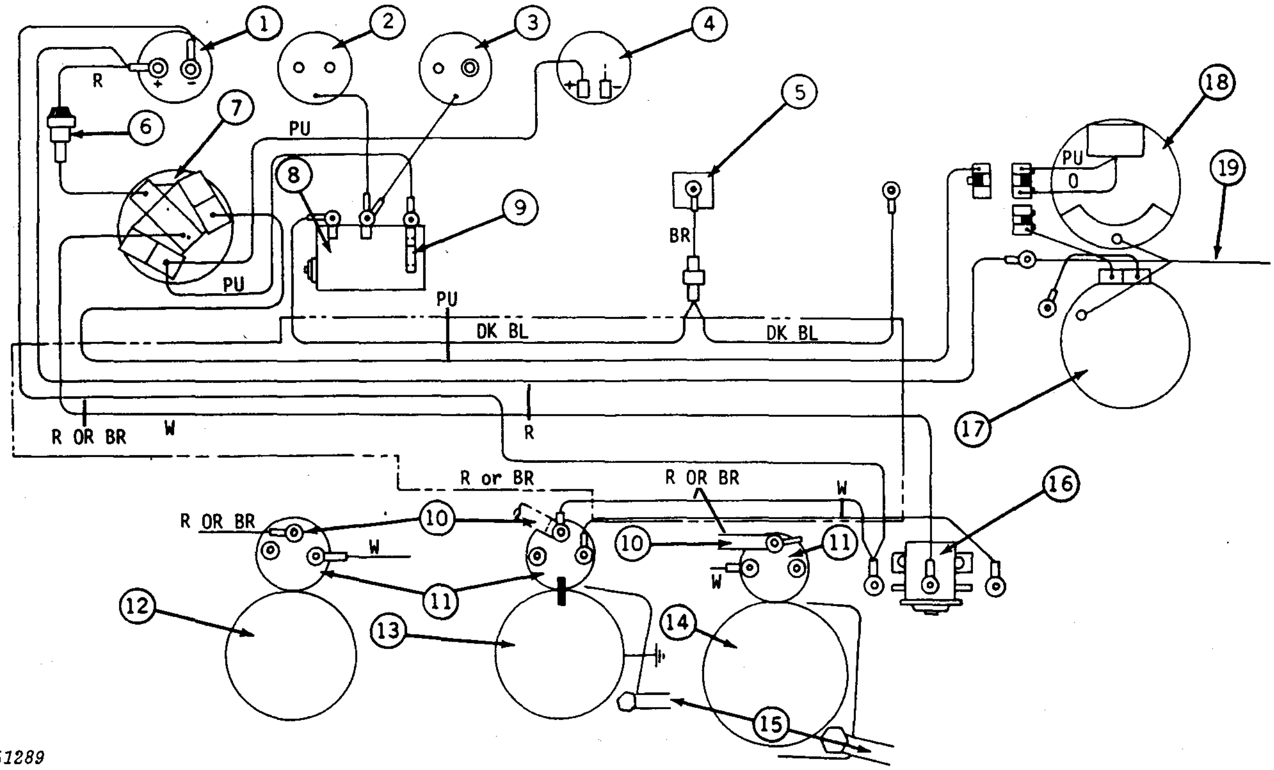


Fig. 2-Instrument Panel

16



1—Ammeter
2—Oil Pressure Gauge
3—Water Temperature Gauge
4—Hour Meter
5—Fuel Injection Pump
6—Fuse Holder (25 amp fuse)
7—Key Switch
8—Safety Switch
9—Fuse, 14 amp
10—Positive Battery Cable
11—Solenoid
12—Starting Motor (Delco Remy, R.H. side)
13—Starting Motor (Delco Remy, L.H. side)
14—Starting Motor (John Deere)
15—Negative Battery Cable
16—Starting Circuit Relay
17—Alternator (Delco Remy)
18—Motorola
19—Output to Battery

R—Red
O—Orange
BL—Blue
BR—Brown
W—White
PU—Purple
DK—Dark

Fig. 3-Wiring Diagram

16

Group 1676
INSTRUMENTS AND INDICATORS

GENERAL INFORMATION

The power unit is equipped with both mechanical and electrical instruments and indicators as shown in Fig. 1.

TACHOMETER (FIG. 1)

The tachometer is mechanically driven by a cable that is routed to the flywheel housing (Fig. 2).

Removal

Remove engine side shields.

Disconnect battery negative (−) cable.

Disconnect tachometer cable from the flywheel housing (Fig. 2).

Disconnect tachometer cable from the tachometer gauge (Fig. 2).

Remove tachometer gauge mounting screws.

Remove tachometer.

Repair

Inspect cable for defects; replace as necessary.

If tachometer is defective, replace it.

Installation

Install the tachometer and replace the mounting fasteners with lock washers.

Run cable through hole in back panel and fasten to tachometer drive.

Fasten cable to the tachometer.

Replace engine side.

Connect battery negative (−) cable.

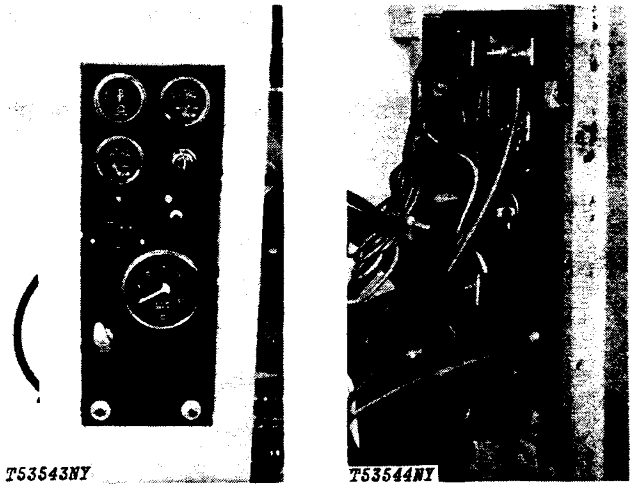


Fig. 1-Instrument Panel Front and Rear

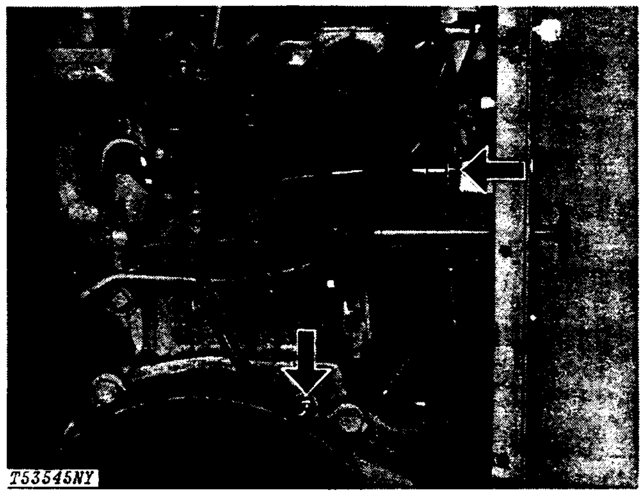


Fig. 2-Tachometer Drive

AMMETER

Removal

Disconnect battery negative (–) cable.

Remove fasteners that attach ammeter wires to the charging system.

Remove fasteners that attach ammeter to mounting bracket.

Remove ammeter.

Repair

Clean contacts if necessary.

If ammeter is defective replace it.

Installation

Install ammeter.

Install ammeter fasteners.

Install ammeter wires and fasteners.

Connect battery negative (–) cable.

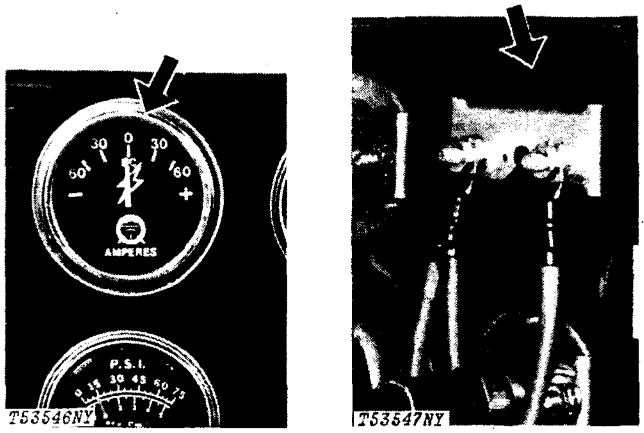


Fig. 3-Front and Rear of Ammeter

ENGINE HOUR METER

The hour meter is electric and records time as the ignition switch is turned on.

Removal

Disconnect battery negative (–) cable.

Disconnect wires behind the hour meter and mark their position with tape (Fig. 4).

Remove front screws of the hour meter (Fig. 4).

Remove the hour meter.

Repair

Clean contact behind hour meter.

Replace hour meter if necessary.

Installation

Place and fasten hour meter on the panel.

Connect wires, remove the tape and connect battery negative (–) ground cable.

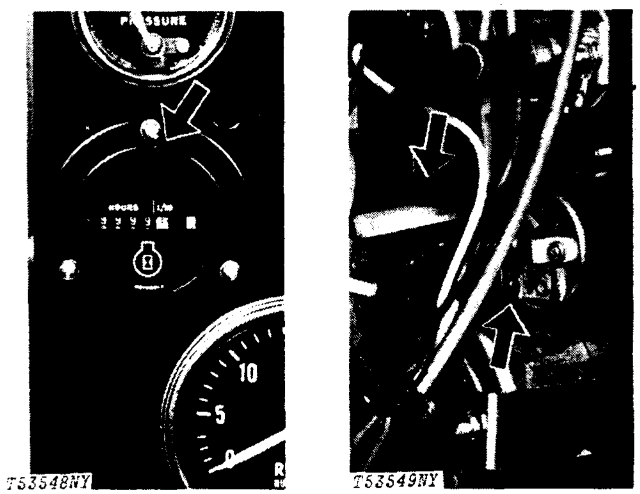


Fig. 4-Front and Rear of Hour Meter

6. If reading at No. 1 terminal is under 2 volts, there is an open energizing circuit. Check alternator fuse. Check between batteries to key switch "BAT" terminal, between key switch "BAT" and "IGN" terminals and between key switch "IGN" terminal and alternator No. 1 terminal.

7. If reading at No. 1 terminal is 2 to 9 volts, connect ammeter between alternator "BAT" terminal and the starter solenoid "BAT" terminal. Connect carbon pile across battery. Operate engine at 1800 rpm. Adjust carbon pile to obtain maximum output.

IMPORTANT: Disconnect battery ground straps when making connections if not using tong-type ammeter.

If output reading is 45 amps, alternator is not defective, recheck steps 1 through 5.

If output is below 45 amps, ground field by inserting screwdriver into test hole (9, Fig. 9).

IMPORTANT: Tab is within 3/4 inch (19.05 mm) of casting surface. Never force screwdriver deeper.

Operate engine at same speed as before. Adjust carbon pile to obtain maximum output.

Now if the output goes above 45 amps, replace regulator and check field winding.

If output is still low, check field windings, brushes, diode trio, rectifier bridge and stator. See Group 1672.

8. If reading at alternator No. 1 terminal (Fig. 8) is above 9 volts, insert screwdriver into test hole (Fig. 9) to ground field winding.

Now if reading goes below 9 volts, replace regulator and check field windings.

If reading stays above 9 volts, check brushes, slip rings, and field windings for open circuit. See Group 1672.

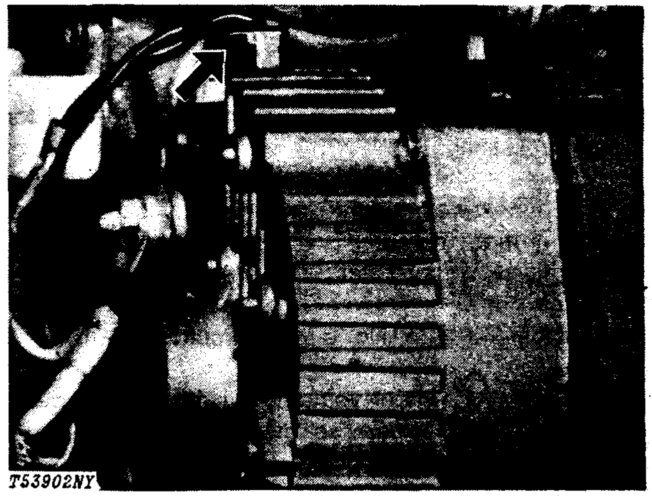


Fig. 8-Alternator Test

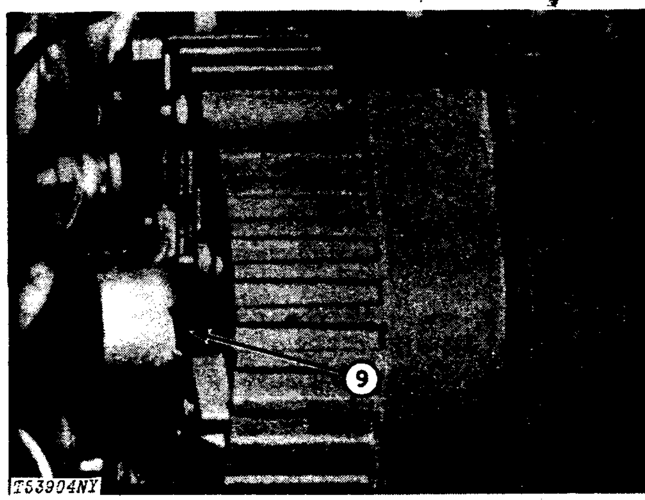


Fig. 9-Alternator Test

The following is a test and check procedure for an overcharged battery condition.

1. First check battery condition. See Group 1671 for "Battery Testing."

2. Connect voltmeter to alternator No. 2 terminal and to ground. Turn key switch on. Voltmeter should read 9 to 12 volts (battery voltage) (Fig. 14).

If reading is zero, No. 2 lead circuit is open.

If reading is battery voltage, but an obvious overcharge condition exists as evidenced by excessive battery water usage, proceed as follows:

a. Separate end frame as covered in Group 1672. Check field winding for shorts (see Group 1671). If shorted, replace rotor and regulator.

b. Connect ohmmeter using lowest range scale from brush lead clip to end frame (Fig. 11), then reverse lead connections.

If both readings are zero, either the brush lead clip is grounded or regulator is defective.

A grounded brush lead clip can result from omission of insulating washers (1, Fig. 11) or sleeve at screw. Remove screw to inspect sleeve. If satisfactory, replace regulator.

Testing Alternator Output on Unit

Disconnect wire from alternator output (BAT) terminal and connect ammeter between disconnected wire and output terminal (Fig. 13). Connect a carbon pile resistor (turned off) to the battery. Run engine at 1800 rpm and adjust carbon pile to obtain maximum output of 50 amps or more.

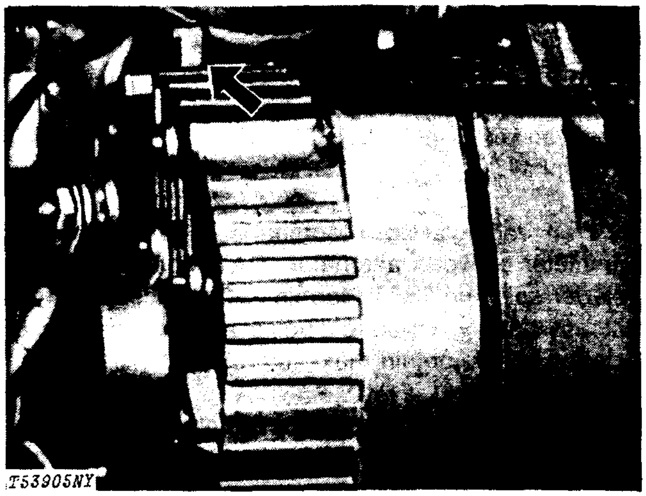


Fig. 10-Alternator Test

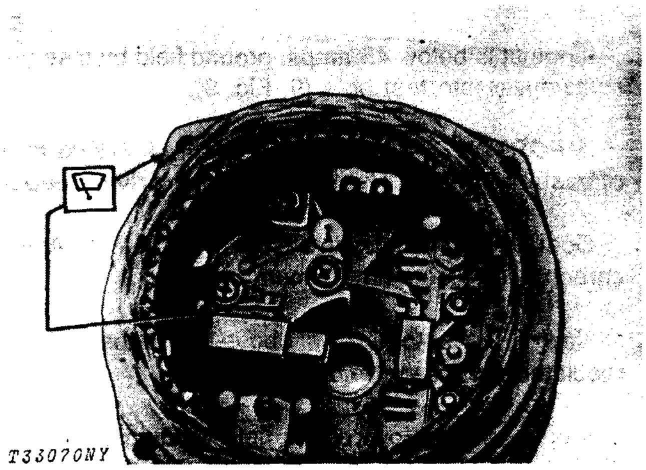


Fig. 11-Ohmmeter Connected to Brush Lead Clip and to End Frame

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Testing Regulator

The regulator must be checked with an alternator that is in good condition. Connect voltmeter (with ± 0.1 volt accuracy) to the alternator output terminal (BAT) and a good ground (Fig. 11). With charged batteries and the regulator brought to operating temperatures, the voltage should be as shown for the temperatures in the chart.

Measure the temperature about 1 inch (25 mm) from the slip ring end frame of the alternator.

Temperature	Voltage
85°F (29°C)	14.5-15.0 volts
105°F (41°C)	14.3-14.8 volts
125°F (52°C)	14.1-14.7 volts
145°F (63°C)	13.9-14.5 volts

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Litho in U.S.A.

Group 9035
SPECIFICATIONS AND SPECIAL TOOLS
ENGINE
SPECIFICATIONS AND TORQUE VALUES

Basic Engine

Combustion chamber
compression pressure
at 200 rpm engine
warm (minimum) .... 350 psi
(24 bar) (25 kg/cm²)

Combustion chamber
compression pressure
difference (maximum) .... 50 psi
(3 bar) (4 kg/cm²)

Engine Lubrication System

Oil pressure at 2500 rpm with engine oil at
normal operating temperature .... 45 to 65 psi
(3 to 4 bar) (3 to 4 kg/cm²)

Engine Cooling System

Radiator leakage test
pressure (maximum) .... 9 psi
(0.6 bar) (0.6 kg/cm²)

Radiator pressure cap
valve opening pressure .... 6.25 to 7.50 psi
(0.4 to 0.5 bar) (0.4 to 0.5 kg/cm²)

Fan belt deflection
(no gauge) .... 0.75 in. at 25 lb.
(19 mm at 111 N) (19 mm at 11 kg)

Fan belt deflection
(with gauge) (new
belt) .... 100 to 110 lb.
(445 to 490 N) (45 to 50 kg)

Fan belt deflection
(with gauge) (old
belt) .... 80 to 110 lb.
(356 to 490 N) (36 to 50 kg)

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ENGINE

SPECIFICATIONS AND TORQUE VALUES—Continued

Fuel System

Fuel supply pump
pressure .... 2 to 2.5 psi
(0.1 to 0.2 bar) (0.1 to 0.2 kg/cm^2)

Injection pump cam advance:

Pump Numbers
JDB435MD2793 (AR70530)

1. At 1900 rpm (full load) set at 6° (check 6° ± 1).
2. Advance must finish 7-1/2° minimum movement by 2500 rpm full load.
3. No load advance 4° movement at 1100 rpm.

JDB331MD2406 (AR49904)

1. At 1900 rpm (full load) set 6° (check 6° ± 1°).
2. Advance must finish 7-1/2° minimum movement by 2200 rpm full load.
3. No load advance is 4° movement at 1300 rpm.

JDB635AL2446 (AR51568)

1. At 1500 rpm (full load) set 4° (check 4° ± 1°).
2. Advance must finish 5-1/2° minimum movement by 2300 rpm full load.
3. No load advance is 4° movement 1200 rpm.

JDB435AL2442 (AR51747)

1. At 1900 rpm (full load) set 5° (check 5° ± 1°).
2. Advance must finish 6-1/2° minimum movement by 2500 rpm full load.
3. No load advance is 4° movement at 1100 rpm.

ENGINE

SPECIFICATIONS AND TORQUE VALUES—Continued

Speed Control Linkage

Speed control rod
excess travel
(fast idle) .... 1/8 to 1/4 in.
(3 to 6 mm)

Speed control rod
excess travel
(slow idle) .... 1/8 to 1/4 in.
(3 to 6 mm)

ENGINE

SPECIAL TOOLS

Essential Tools

Tool Number	Use
D14550-BA	Compression Gauge Adapter - to check engine compression.
D14547-BA	Compression Gauge - to check diesel engine compression.
------	Pressure Gauge - to check oil and fuel pressures.

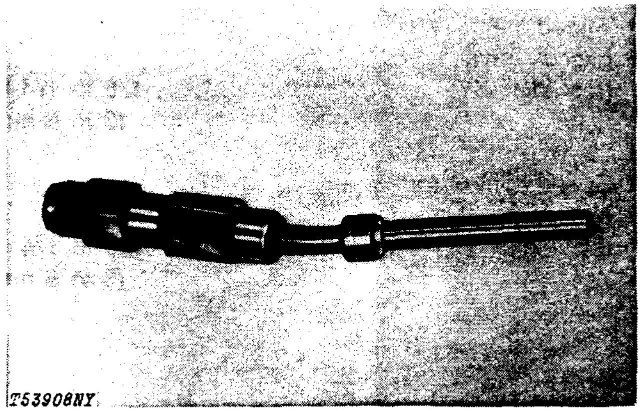


Fig. 1-Compression Gauge Adapter

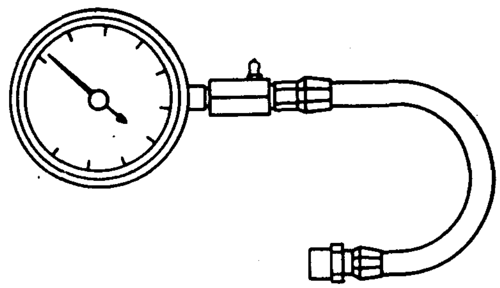


Fig. 2-Compression Gauge

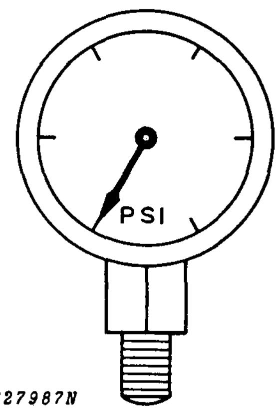


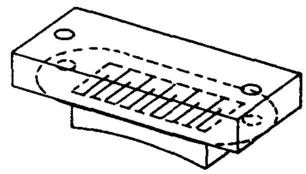
Fig. 3-Pressure Gauge

ENGINE

SPECIAL TOOLS

Essential Tools—Continued

Tool Number	Use
19918	Used for timing engines with Roosa Master DM fuel injection pumps.
13366	Used for timing engines with Roosa-Master JDB fuel injection pumps.



T31920N

Fig. 4-Timing Window

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ELECTRICAL SYSTEM

SPECIFICATIONS AND TORQUE VALUES

Starting Circuit Test Values

Test No. 1	9-12 Volts
Test No. 2	9-12 Volts
Test No. 3	9-12 Volts
Test No. 4	Zero Volts

Charging Circuit Test Values

Motorola Alternator

Test No. 1 - Isolation Diode Check
(Key Switch Off) .... 0 volts

Test No. 2 - Field Circuit Check
(Key Switch On, Engine
Not Running) .... 1.5 - 2.5 volts

Test No. 3 - Isolation Diode Check
(Key Switch On, Engine Running)
Regulator terminal .... 15.4 volts
Output terminal .... 14.4 volts

Test No. 4 - Field Draw Test (Key
Switch Off) .... 2 to 2.5 amps

Test No. 5 - Checking Alternator and Regulator
With Regulator Disconnected (Key
Switch On, Engine
Running) .... 15 to 16 volts

Test No 6 - 35 Amp Alternator Output
25 Amps .... 13 to 15 volts

55 Amp Alternator Output
43 Amps .... 13 to 15 volts

Test No. 7 - Testing Regulator (after
fifteen minutes of operation
at 1500 rpm) .... See Chart

Temperature*	Voltage
40° F (4° C)	14.4 - 14.9 volts
60° F (16° C)	14.3 - 14.7 volts
80° F (27° C)	14.2 - 14.6 volts
100° F (38° C)	14.0 - 14.4 volts
120° F (49° C)	13.8 - 14.3 volts
140° F (60° C)	13.6 - 14.1 volts

**Measured one inch (25 mm) from regulator.*

ELECTRICAL SYSTEM

SPECIFICATIONS AND TORQUE VALUES—Continued

Charging Circuit Test Values

Delco Remy Alternator

Test No. 5	Key switch on, engine stopped 9-12 volts.
Test No. 6	Key switch on, engine stopped 2 volts.
Test No. 7	Engine running at 180 rpm—at least 70 percent of rated output amperage.
Test No. 8	Engine running 9 volts.

Over Charged Battery Condition

Test No. 2	Key switch on 9-12 volts.
Alternator Output	Engine running: 70% of rated output amperage.

Regulator tests.

Temperature	Voltage
0°F (−18°C)	14.9 ± 2.5 volts
80°F (27°C)	14.2 ± 2.5 volts
160°F (71°C)	13.4 ± 2.5 volts

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ELECTRICAL SYSTEM

SPECIAL TOOLS

Essential Tools

Tool Number	Use
-------	Voltmeter - Check starting circuit, charging circuit, light circuit, accessory circuit and control circuits. Fig. 1.
-------	Ammeter - Check charging circuit, injection pump solenoid winding and horn. Fig. 1.
-------	Ohmmeter - Check injection pump solenoid, fuel gauge sender and control circuits. Fig. 1.

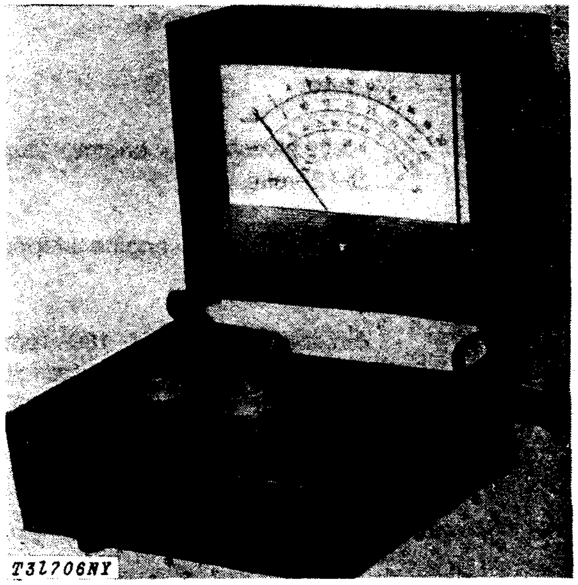

Fig. 1-Voltmeter, Ammeter and Ohmmeter