Yanmar
Gasoline Engines

John Deere Horicon Works
CTM12 (16MAY90)
LITHO IN U.S.A.
ENGLISH

This Component Technical Manual (CTM) contains necessary instructions to repair the engine and fuel and electrical systems. This manual also includes theory of operation, diagnostic, and testing procedures. For information on starting motors, alternators, power take-offs, and other miscellaneous accessories, order CTM-11 Engine Accessories.

Use this component technical manual in conjunction with the machine technical manual. An engine application listing in the Introduction (Group 00) identifies product-model/engine type-model relationship. See the machine technical manual for:

- Engine removal and installation.
- Gaining access to engine components.

This Safety-Alert symbol means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!

When you see this symbol on your machine or in your manual, be alert to the possibility of personal injury or death. Follow the instructions in the safety message.

CTM12,IFC -19-09NOV89

INTRODUCTION

This manual is part of a total service support program.

FOS MANUALS—REFERENCE

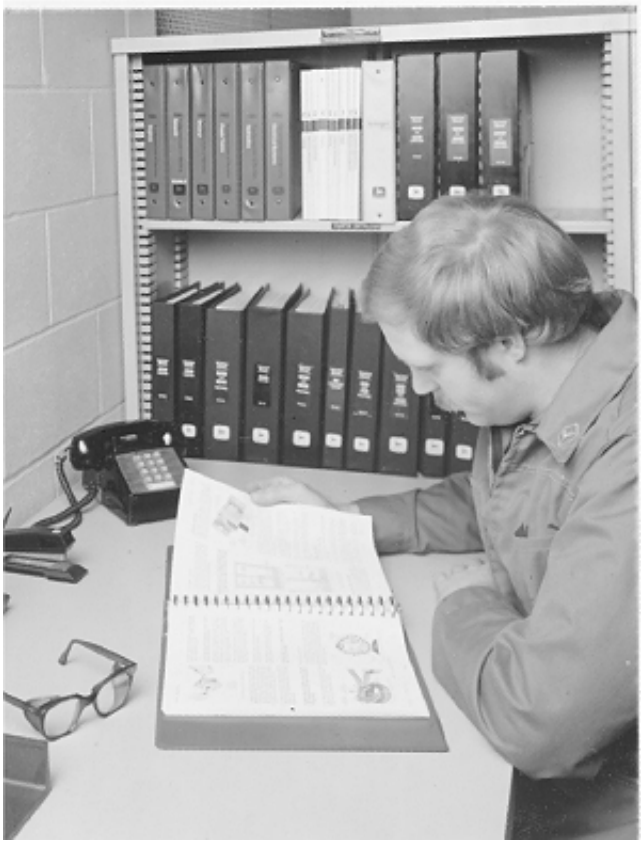
TECHNICAL MANUALS—MACHINE SERVICE

COMPONENT MANUALS—COMPONENT SERVICE

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

Technical Manuals are concise service guides for specific machines. Technical manuals are on-the-job guides containing only the vital information needed by an experienced service technician.

Component Technical Manuals are concise service guides for specific components. Component Technical Manuals are written as stand alone manuals covering multiple machine applications.



RW5559 -UN-23AUG88

O53,INTRO2 -19-03JUL85

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All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

CTM12-19-16MAY90

FEATURES OF THIS TECHNICAL MANUAL

05
2

John Deere ILLUSTRUCTION format emphasizing illustrations and concise instructions in easy-to-use modules.

Emphasis on diagnosis, analysis, and testing so you can understand the problem and correct it.

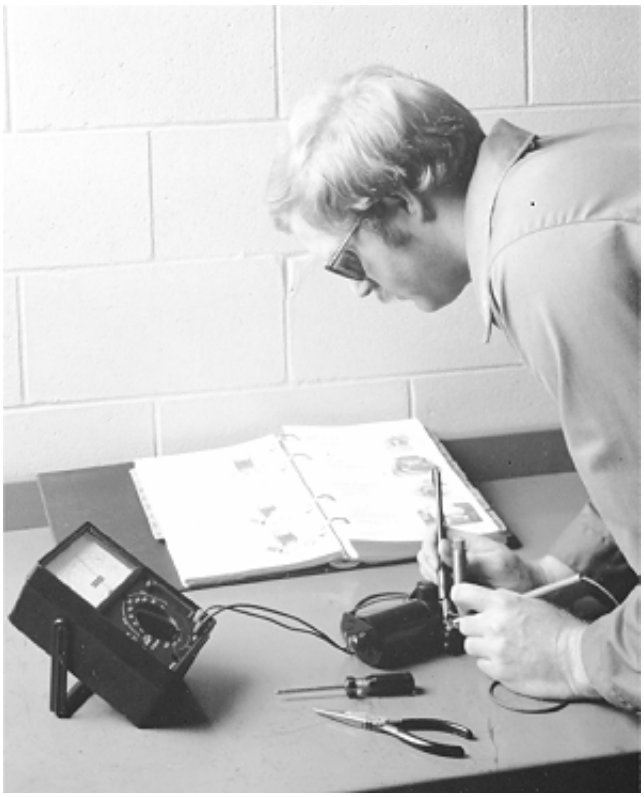
Diagnostic information presented with the most logical and easiest to isolate problems first to help you identify the majority of routine failures quickly.

Step-by-step instructions for teardown and assembly.

Summary listing at the beginning of each group of all applicable specifications, wear tolerances, torque values, essential tools, and materials needed to do the job.

An emphasis throughout on safety—so you do the job right without getting hurt.

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 when you need to know correct service procedures or specifications.



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O53,INTRO3 -19-07OCT85

ABOUT THIS MANUAL

This Component Technical Manual (CTM-12) covers the recommended repair procedures for Yanmar Gasoline Engines removed from the machine.

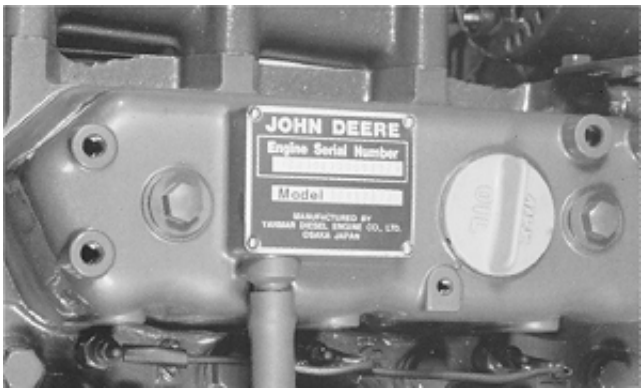
Some components may be serviced without removing the engine from the machine. You may want to determine the repair procedure before you remove the engine.

5M4,T1205,1 -19-25AUG87

ENGINE SERIAL NUMBER PLATE

The engine serial number plate is located on the rocker arm cover.

Refer to the engine model designation on your engine's serial number plate to identify repair information covered in the Component Technical Manual.



-UN-29AUG88
M37502

M21,TM305,2 -19-21APR86

ENGINE APPLICATION CHART

Refer to the engine application chart to identify product-model/engine type-model relationship.

Consumer Products

Machine No.	Lawn and Garden Tractors Engine Model
322	3TG66UJ

Machine No.	Front Mowers Engine Model
F912	3TG66UJ
F932	3TG72UJ

5M4,T1205,3 -19-12OCT87

ENGLISH TORQUE SPECIFICATIONS

NOTE: Wrench torque tolerance is ± 20%.

Bolt Diameter	Plain Head*		Three Radial Dashes*		Six Radial Dashes*	
	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m
1/4 in.	6	8	9	12	12	16
5/16 in.	10	14	18	24	25	34
3/8 in.	20	27	30	41	45	61
7/16 in.	30	41	50	68	70	95
1/2 in.	45	61	75	101	110	149
9/16 in.	70	95	110	150	155	210
5/8 in.	95	128	155	210	215	290
3/4 in.	165	225	270	365	385	520
7/8 in.	170	230	435	590	620	840
1 in.	255	345	660	895	930	1260

Torque figures indicated above and in the Specification Sections of this manual are valid for non-greased or non-oiled threads and heads unless otherwise specified. Therefore, do not grease or oil bolts or cap screws unless otherwise specified in this manual.

** Torque value for bolts and cap screws are identified by their head markings.*

S11,2000,DD -19-11JUL85

METRIC TORQUE SPECIFICATIONS

NOTE: Wrench torque tolerance is ± 20%.

Bolt Diameter	Property Class 8.8*		Property Class 10.9*	
	lb-ft	N·m	lb-ft	N·m
M5	5	6	7	9
M6	8	10	11	15
M8	18	25	26	35
M10	37	50	52	70
M12	66	90	92	125
M16	166	225	229	310
M20	321	435	450	610
M24	554	750	775	1050

Torque figure indicated above and in the Specification Sections of this manual are valid for non-greased or non-oiled threads and heads unless otherwise specified. Therefore, do not grease or oil bolts or cap screws unless otherwise specified in this manual.

** Torque value for bolts and cap screws are identified by their head markings.*

S11,2000,DE -19-11JUL85

ENGINE: 3TG72

GROUP 10—Valve Train and Camshaft

Item	Specification
Valve Clearance	0.2 mm (0.008 in.)
Rocker Arm	
Minimum Shaft O.D.	11.9 mm (0.469 in.)
Maximum Shaft Support I.D.	12.1 mm (0.476 in.)
Maximum Arm I.D.	12.1 mm (0.476 in.)
Maximum Shaft Clearance	0.12 mm (0.005 in.)
Rocker Arm Assembly Cap Screw and Nut Torque	25 N·m (225 lb-in.)
Rocker Arm Cover Nut Torque	26 N·m 226 lb-in.)
Push Rod	
Maximum T.I.R.	0.3 mm (0.012 in.)
Minimum Length	141 mm (5.55 in.)
Cam Follower	
Minimum O.D.	20.85 mm (0.821 in.)
Maximum Bore I.D.	21.10 mm (0.831 in.)
Maximum Clearance	0.15 mm (0.006 in.)
Camshaft	
Maximum End Play	0.5 mm (0.02 in.)
Maximum Gear Backlash	0.2 mm (0.008 in.)
Minimum End Journals O.D.	39.84 mm (1.568 in.)
Minimum Intermediate Journals O.D.	39.81 mm (1.567 in.)
Minimum Lobe Height	33.6 mm (1.323 in.)
Maximum Bushing I.D.	41.115 mm (1.619 in.)
Maximum Intermediate and Flywheel End Bores I.D.	40.075 mm (1.578 in.)
Maximum Journal Clearance	0.18 mm (0.007 in.)
Attaching Cap Screw Torque	11 N·m (96 lb-in.)
Gear Housing Cover Cap Screw Torque	9 N·m (78 lb-in.)
Crankshaft Pulley Cap Screw Torque	113 N·m (84 lb-ft)

GROUP 15—Cylinder Head, Valves, and Manifolds

Item	Specification
Manifold	
Exhaust Manifold Cap Screw Torque	26 N·m (226 lb-in.)
Intake Manifold Cap Screw Torque	11 N·m (96 lb-in.)
Cylinder Head	
Maximum Valve Recession	0.60 mm (0.024 in.)
Valve Spring Free Length (Approx.)	36.9 mm (1.453 in.)
Valve Spring Test Length	22.5 mm (0.866 in.)
@ Test Force	299 N (67 lb)

5M4,T1206,1 -19-12OCT87

ENGINE: 3TG72

Item	Specification
Cylinder Head (continued)	
Minimum Valve Stem O.D.	6.90 mm (0.272 in.)
Exhaust Valve Angle	45°
Intake Valve Angle	30°
Maximum Valve Guide I.D.	7.08 mm (0.279 in.)
Valve Guide-to-Valve Stem Clearance:	
(Replace)	0.15 mm (0.006 in.)
Valve Seat Width	
Intake	1.43 mm (0.056 in.)
Exhaust	1.73 mm (0.068 in.)
Valve Seat Angle	
Intake	30°
Exhaust	45°
Cylinder Head Flatness	0.10 mm (0.004 in.)
Mill Cylinder Head No More Than	0.2 mm (0.008 in.)
Valve Guide Height	9 mm (0.354 in.)
Cylinder Head Cap Screw Torque	
In sequence (Lubricated)	61 N·m (45 lb-ft)

GROUP 20—Flywheel

Item	Specification
Stub Shaft	
Maximum T.I.R.	0.2 mm (0.008 in.)
Flatness	0.05 mm (0.002 in.)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)
Flywheel	
Flatness	0.05 mm (0.002 in.)
Attaching Cap Screw Torque	83 N·m (61 lb-ft)
Flywheel Housing	
Mounting Plate or Housing	
Cap Screw Torque	49 N·m (36 lb-ft)
Starter-to-Mounting Plate	
Cap Screw Torque	49 N·m (36 lb-ft)
Flywheel Housing or Shield	
Cap Screw or Nut Torque	
M10	49 N·m (36 lb-ft)
M8	26 N·m (226 lb-in.)
M12 Nut	88 N·m (65 lb-ft)

5M4,T1206,2 -19-12OCT87

ENGINE:3TG72

GROUP 25—Connecting Rods and Pistons

Item	Specification
Connecting Rod	
Maximum Side Play	0.8 mm (0.031 in.)
End-Cap Screw Torque	23 N·m (200 lb-in.)
Maximum Bearing Clearance	0.12 mm (0.005 in.)
Minimum Journal O.D.	39.93 mm (1.572 in.)
Maximum Bearing I.D.	40.07 mm (1.577 in.)
Maximum Bearing Clearance	0.12 mm (0.005 in.)
Piston	
Maximum Ring Groove Clearance	
Top Ring	0.25 mm (0.010 in.)
Second Ring	0.25 mm (0.010 in.)
Oil Ring	0.25 mm (0.010 in.)
Maximum Ring End Gap	
Top Ring	1.25 mm (0.049 in.)
Second Ring	1.25 mm (0.049 in.)
Oil Ring	1.90 mm (0.075 in.)
Minimum Pin O.D.	20.9 mm (0.823 in.)
Maximum Pin Bushing I.D.	21.1 mm (0.831 in.)
Maximum Pin Bushing Clearance	0.15 mm (0.006 in.)
Maximum Pin Bore I.D.	21.08 mm (0.830 in.)
Maximum Pin Bore Clearance	0.10 mm (0.004 in.)
Minimum Piston O.D.	71.9 mm (2.831 in.)
Maximum Cylinder Bore I.D.	72.15 mm (2.841 in.)
Maximum Piston to Bore Clearance	0.15 mm (0.006 in.)

GROUP 30—Crankshaft and Main Bearings

Item	Specification
Crankshaft	
Maximum End Play	0.50 mm (0.020 in.)
Main Bearing Cap Screw Torque	79 N·m (58 lb-ft)
Maximum Main Bearing Clearance	0.12 mm (0.005 in.)
Oil Seal Case Cap Screw Torque	
Seal Case to Block	11 N·m (96 lb-in.)
Oil Pan to Seal Case	9 N·m (78 lb-in.)
Minimum Main Bearing Journal O.D.	43.93 (1.730 in.)
Maximum Main Bearing I.D.	40.07 mm (1.578 in.)

5M4,T1206,3 -19-12OCT87

ENGINE:3TG72

GROUP 35—Gear Housing

Item	Specification
Gear Housing Cap Screw Torque	9 N·m (78 lb-in.)
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-ft)
Timing Gear Backlash	
Governor	0.38 mm (0.015 in.)
Idler	0.2 mm (0.008 in.)
Camshaft	0.2 mm (0.008 in.)
Crankshaft	0.2 mm (0.008 in.)
Oil Pump	0.3 mm (0.012 in.)
Timing Gear Wear Specifications	
Idler Gear Bushing Diameter	20.08 mm (0.791 in.)
Idler Shaft Diameter	19.9 mm (0.783 in.)
Idler Shaft Oil Clearance	0.1 mm (0.004 in.)

GROUP 40—Lubrication System

Item	Specification
Oil Pump	
Gear Backlash, Maximum	0.30 mm (0.012 in.)
Rotor Recess, Maximum	0.25 mm (0.010 in.)
Outer rotor-to-Pump Body Maximum Clearance	0.25 mm (0.010 in.)
Inner Rotor-to-outer Rotor Maximum Clearance	0.25 mm (0.010 in.)
Oil Pump Attaching Cap Screw Torque	11 N·m (96 lb-in.)
Oil Pressure Regulating Valve	
Valve Spring Free Length	43.5—48.5 mm (1.7—1.9 in.)
Valve Spring Test Length	27.5 mm (1.08 in.)
@ Test Force	20.5 ± 3.1 N (9.6 ± 0.7 lb)
Oil Pressure Change Per 1 mm (0.039 in.) of Shim Thickness	10.9 kPa (2 psi)
Oil Pan	
Strainer Tube Attaching Cap Screw Torque	11 N·m (96 lb-in.)
Oil Pan-to-Block Cap Screw Torque	11 N·m (96 lb-in.)
Oil Pan-to-Gear Housing Cover Torque	9 N·m (78 lb-in.)

5M4,T1206,4 -19-12OCT87

ENGINE: 3TG72

GROUP 45—Cooling system

Item	Specification
Thermostat	
Begin Opening Temperature	71° (160°F)
Fully Open Temperature	85°C (184°F)
Housing Cover Cap Screw Torque	20 N·m (180 lb-in.)
Water Pump	
Plate Screws Torque	9 N·m (78 lb-in.)
Pulley Cap Screws Torque	11 N·m (96 lb-in.)
Attaching Cap Screws	26 N·m (226 lb-in.)
Alternator Belt Deflection	13 mm (0.5 in.) at 107N (24 lb force) applied midway between pulleys.

GROUP 50—Carburetor

GROUP 55—Governor

Item	Specification
Governor Gear Backlash (New)	0.11—0.30 mm (0.004—0.012 in.)
Governor Gear Backlash (Maximum)	0.38 mm (0.015 in.)
Fuel Control Linkage Bore Maximum I.D.	8.15 mm (0.321 in.)
Governor Shaft Minimum Diameter	7.90 (0.311 in.)
Governor Shaft Clearance (Maximum) (Bore I.D. Minus Shaft O.D.)	0.18 mm (0.0071 in.)

GROUP 60—Starter
See Starter Specifications in this Group

GROUP 65—Alternator
See Alternator Specifications in this Group

GROUP 70—Ignition System
See Ignition System Specifications in this Group

5M4,T1206,5 -19-12OCT87

ENGINE: 3TG66

GROUP 10—Valve Train and Camshaft

Item	Specification
Valve Clearance	0.2 mm (0.008 in.)
Rocker Arm	
Minimum Shaft O.D.	9.9 mm (0.390 in.)
Maximum Shaft Support I.D.	10.1 mm (0.398 in.)
Maximum Arm I.D.	10.1 mm (0.398 in.)
Maximum Shaft Clearance	0.10 mm (0.004 in.)
Rocker Arm Assembly Cap Screw and Nut Torque	25 N·m (225 lb-in.)
Rocker Arm Cover Nut Torque	26 N·m (226 lb-in.)
Push Rod	
Maximum T.I.R.	0.3 mm (0.012 in.)
Minimum Length	114 mm (4.49 in.)
Cam Follower	
Minimum O.D.	17.85 mm (0.703 in.)
Maximum Bore I.D.	18.1 mm (0.713 in.)
Maximum Clearance	0.1 mm (0.004 in.)
Camshaft	
Maximum End Play	0.5 mm (0.02 in.)
Maximum Gear Backlash	0.2 mm (0.008 in.)
Minimum End Journals O.D.	35.84 mm (1.411 in.)
Minimum Intermediate Journals O.D.	35.81 mm (1.410 in.)
Minimum Lobe height	29.7 mm (1.169 in.)
Maximum Bushing I.D.	36.115 mm (1.422 in.)
Maximum Intermediate and Flywheel End Bores I.D.	36.075 mm (1.421 in.)
Maximum Journal Clearance	0.18 mm (0.007 in.)
Attaching Cap Screw Torque	11 N·m (96 lb-in.)
Gear Housing Cover Cap Screw Torque	9 N·m (78 lb-in.)
Crankshaft Pulley Cap Screw Torque	113 N·m (84 lb-ft)

GROUP 15—Cylinder Head, Valves, and Manifolds

Item	Specification
Manifold	
Exhaust Manifold Cap Screw Torque	11 N·m (96 lb-in.)
Intake Manifold Cap Screw Torque	11 N·m (96 lb-in.)
Cylinder Head	
Maximum Valve Recession	0.50 mm (0.020 in.)
Valve Spring Free Length (Approx.)	27.5 mm (1.083 in.)
Valve Spring Test Length @ Test Force	17 mm (0.591 in.) 125 N (28 lb)

5M4,T1206,6 -19-12OCT87

ENGINE: 3TG66

Item	Specification
Cylinder Head (continued)	
Minimum Valve Stem O.D.	5.40 mm (0.213 in.)
Exhaust Valve Angle	45°
Intake Valve Angle	30°
Maximum Valve Guide I.D.	5.57 mm (0.219 in.)
Valve Guide-to-Valve Stem Clearance:	
(Replace)	0.14 mm (0.006 in.)
Valve Seat Width	
Intake	1.14 mm (0.042 in.)
Exhaust	1.37 mm (0.054 in.)
Valve Seat Angle	
Intake	30°
Exhaust	45°
Cylinder Head Flatness	0.10 mm (0.004 in.)
Mill Cylinder Head No More Than	0.2 mm (0.008 in.)
Valve Guide Height	7 mm (0.276 in.)
Cylinder Head Cap Screw Torque	
In Sequence (Lubricated)	34 N·m (25 lb-ft)

GROUP 20—Flywheel

Item	Specification
Stub Shaft	
Maximum T.I.R.	0.2 mm (0.008 in.)
Flatness	0.05 mm (0.002 in.)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)
Flywheel	
Flatness	0.05 mm (0.002 in.)
Attaching Cap Screw Torque	83 N·m (61 lb-ft)
Flywheel Housing	
Mounting Plate or Housing	
Cap Screw Torque	49 N·m (36 lb-ft)
Starter-to-Mounting Plate	
Cap Screw Torque	49 N·m (36 lb-ft)
Flywheel Housing or Shield	
Cap Screw or Nut Torque	
M10	49 N·m (36 lb-ft)
M8	26 N·m (226 lb-in.)
M12 Nut	88 N·m (65 lb-ft)

5M4,T1206,7 -19-12OCT87

ENGINE: 3TG66

GROUP 25—Connecting Rods and Pistons

Item	Specification
06 8	
Connecting Rod	
Maximum Side Play	0.8 mm (0.031 in.)
End-Cap Screw Torque	23 N·m (200 lb-in.)
Maximum Bearing Clearance	0.12 mm (0.0048 in.)
Minimum Journal O.D.	35.93 mm (1.415 in.)
Maximum Bearing I.D.	36.07 mm (1.420 in.)
Maximum Bearing Clearance	0.12 mm (0.005 in.)
Piston	
Maximum Ring Groove Clearance	
Top Ring	0.25 mm (0.010 in.)
Second Ring	0.25 mm (0.010 in.)
Oil Ring	0.25 mm (0.010 in.)
Maximum Ring End Cap	
Top Ring	1.30 mm (0.051 in.)
Second Ring	1.30 mm (0.051 in.)
Oil Ring	1.80 mm (0.071 in.)
Minimum Pin O.D.	19.9 mm (0.783 in.)
Maximum Pin Bushing I.D.	20.1 mm (0.791 in.)
Maximum Pin Bushing Clearance	0.15 mm (0.006 in.)
Maximum Pin Bore I.D.	20.08 mm (0.791 in.)
Maximum Pin Bore Clearance	0.10 mm (0.004 in.)
Minimum Piston O.D.	65.88 mm (2.593 in.)
Maximum Cylinder Bore I.D.	66.12 mm (2.603 in.)
Maximum Piston To Bore Clearance	0.15 mm (0.006 in.)

GROUP 30—Crankshaft and Main Bearings

Item	Specification
Crankshaft	
Maximum End Play	0.30 mm (0.012 in.)
Main Bearing Cap Screw Torque	54 N·m (40 lb-ft)
Maximum Main Bearing Clearance	0.12 mm (0.005 in.)
Oil Seal Case Cap Screw Torque	
Seal Case to Block	11 N·m (96 lb-in.)
Oil Pan to Seal Case	9 N·m (78 lb-in.)
Minimum Main Bearing Journal O.D.	40.93 (1.611 in.)
Maximum Main Bearing I.D.	40.07 mm (1.578 in.)

5M4,T1206,8 -19-11SEP87

ENGINE: 3TG66

GROUP 35—Gear Housing

Item	Specification
Gear Housing Cap Screw Torque	9 N·m (78 lb-in.)
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-ft)
Timing Gear Backlash	
Governor	0.38 mm (0.015 in.)
Idler	0.2 mm (0.008 in.)
Camshaft	0.2 mm (0.008 in.)
Crankshaft	0.2 mm (0.008 in.)
Oil Pump	0.3 mm (0.012 in.)
Timing Gear Wear Specifications	
Idler Gear Bushing Diameter	20.08 mm (0.791 in.)
Idler Shaft Diameter	19.9 mm (0.783 in.)
Idler Shaft Oil Clearance	0.1 mm (0.004 in.)

GROUP 40—Lubrication System

Item	Specification
Oil Pump	
Gear Backlash, Maximum	0.30 mm (0.012 in.)
Rotor Recess, Maximum	0.25 mm (0.010 in.)
Outer rotor-to-Pump Body Maximum Clearance	0.25 mm (0.010 in.)
Inner Rotor-to-Outer Rotor Maximum Clearance	0.25 mm (0.010 in.)
Oil Pump Attaching Cap Screw Torque	11 N·m (96 lb-in.)
Oil Pressure Regulating Valve	
Valve Spring Free Length	21.9—24.5 mm (0.86—0.96 in.)
Valve Spring Test Length	14.7 mm (0.58 in.)
@ Test Force	12 ± 1.8 N (2.7 ± 0.4 lb)
Oil Pressure Change Per 1 mm (0.039 in.) of Shim Thickness	13.8 kPa (2 psi)
Oil Pan	
Strainer Tube Attaching Cap Screw Torque	11 N·m (96 lb-in.)
Oil Pan-to-Block Cap Screw Torque	11 N·m (96 lb-in.)
Oil Pan-to-Gear Housing Cover Torque	9 N·m (78 lb-in.)

5M4,T1206,9 -19-12OCT87

ENGINE: 3TG66

GROUP 45—Cooling system

Item	Specification
Thermostat	
Begin Opening Temperature	71˚C (160˚F)
Fully Open Temperature	85˚C (184˚F)
Housing Cover Cap Screw Torque	9 N·m (78 lb-in.)
Water Pump	
Plate Screws Torque	9 N·m (78 lb-in.)
Pulley Cap Screws Torque	11 N·m (96 lb-in.)
Attaching Cap Screws	26 N·m (226 lb-in.)
Alternator Belt Deflection	13 mm (0.5 in.) at 107N (24 lb force) applied midway between pulleys.

GROUP 50—Carburetor

GROUP 55—Governor

Item	Specification
Governor Gear Backlash (New)	0.11—0.30 mm (0.004—0.012 in.)
Governor Gear Backlash (Maximum)	0.38 mm (0.015 in.)
Fuel Control Linkage Bore Maximum I.D.	8.15 mm (0.321 in.)
Governor Shaft Minimum Diameter	7.90 (0.311 in.)
Governor Shaft Clearance (Maximum) (Bore I.D. Minus Shaft O.D.)	0.18 mm (0.0071 in.)

GROUP 60—Starter
See Starter Specifications in this Group

GROUP 65—Alternator
See Alternator Specifications in this Group

GROUP 70—Ignition System
See Ignition System Specifications in this Group

5M4,T1206,10 -19-12OCT87

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Feeler Gauge	Measure valve clearance
Outside Micrometer	Measure engine components
Telescoping Gauge	Measure engine components
Valve Inspect Center	Measure pushrod TIR
Vernier Calipers	Measure pushrod length
Strap Wrench	Hold crankshaft pulley
13-Ton Puller Set	Remove crankshaft pulley
Magnetic Base with Adjustable Arm	To hold dial indicator
Dial Indicator	Measure gear and shaft end play
Magnetic Follower Holder Kit	To hold cam followers in place when removing camshaft
Bushing, Bearing, and Seal Driver Set	To service bushings, bearings, and oil seals
Press	To service camshaft gear

M21,TM310,1 -19-05FEB86

OTHER MATERIAL

Number	Name	Use
PT502	John Deere GASKET MAKER®	To seal camshaft plug
T43512	John Deere LOCTITE® Thread Lock and Sealer (Medium Strength)	Apply to threads of crankshaft pulley cap screw.
PT94	John Deere Form-In-Place Gasket (RTV rubber silicone sealant)	To seal gear case cover.

GASKET MAKER is a trademark of the Permatex Corp.

LOCTITE is a trademark of the Loctite Corp.

M21,TM310,2 -19-23JUL87

SERVICE PARTS KITS

The following kits are available through your parts catalog:

Cylinder Block Gasket Kit.

Cylinder Head Gasket Kit.

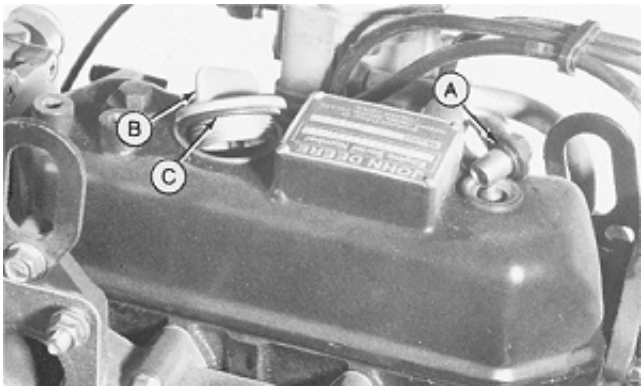
M21,TM310,3 -19-17MAR86

REMOVE AND DISASSEMBLE ROCKER ARM COVER

1. Remove rocker arm cover.

2. Remove O-ring (A) from special nuts.

3. Remove oil fill cap (B) and O-ring (C).



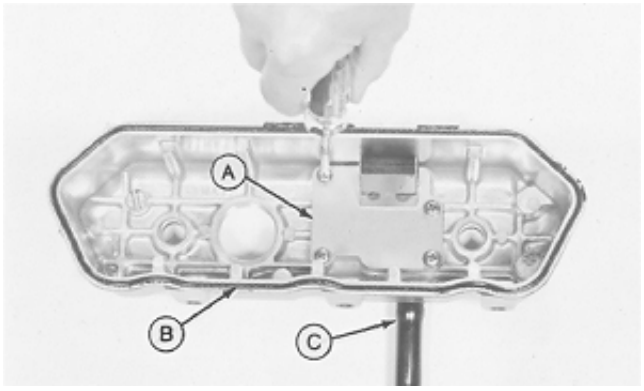
M46065 -UN-08JAN90

5M4,T1210,1 -19-11SEP87

4. Remove O-ring (B) and crankcase breather tube (C).

5. Remove four screws and lock washers to remove baffle (A).

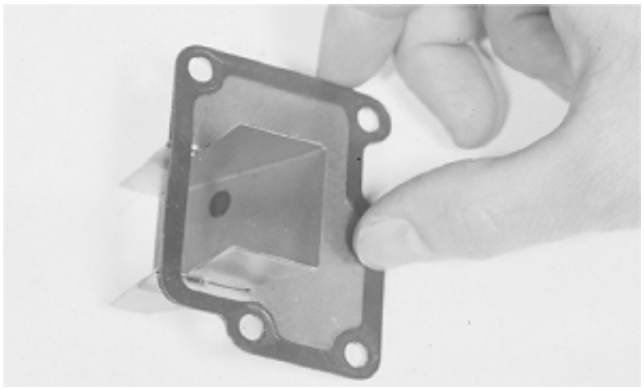
A—Baffle
B—O-Ring
C—Crankcase Breather Tube



M35328 -UN-29AUG88

5M4,T1210,2 -19-11SEP87

6. Remove gasket from baffle.

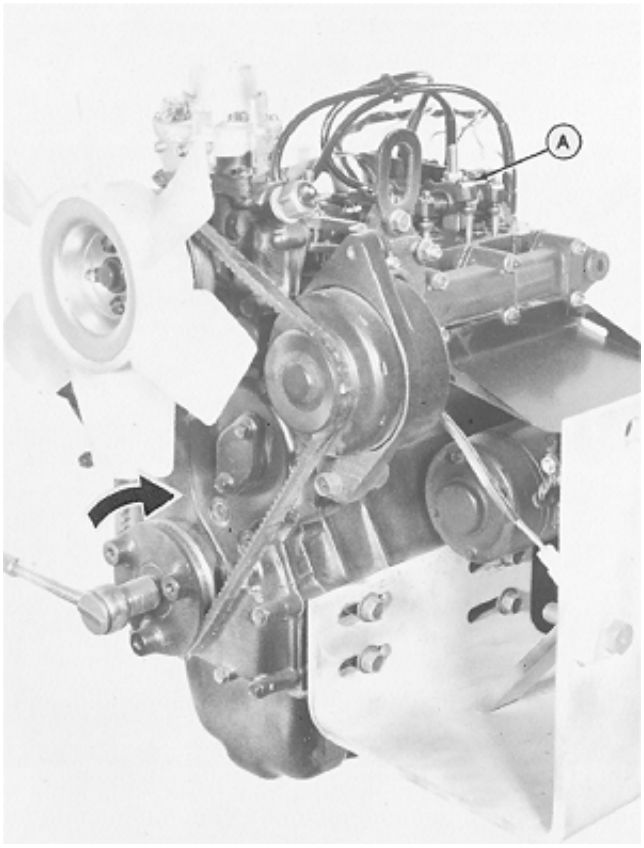


M35329 -UN-29AUG88

5M4,T1210,3 -19-12OCT87

MEASURE AND ADJUST VALVE CLEARANCE

1. Turn crankshaft clockwise until No. 1 cylinder intake valve (A) opens.



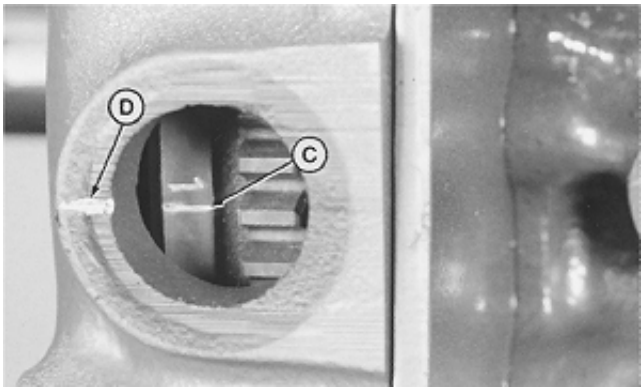
M46066 -UN-08JAN90

5M4,T1210,4 -19-12OCT87

NOTE: TDC—Top Dead Center (the piston at its highest point).

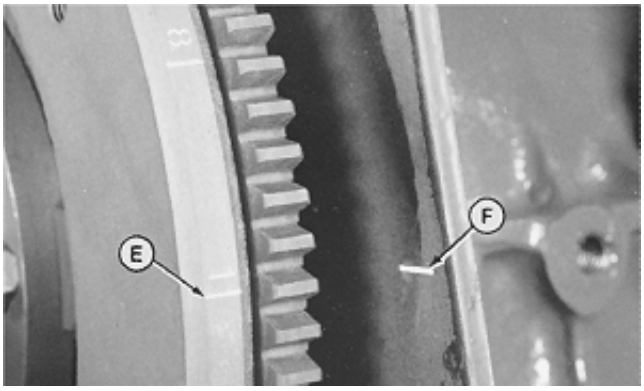
2. Remove flywheel housing plug. Continue turning crankshaft until No. 1 timing mark (C) on flywheel lines up with mark (D) on flywheel housing. (TDC on compression stroke.)

If equipped, remove flywheel shield. Continue turning crankshaft until No. 1 timing mark (E) on flywheel lines up with mark (F) on mounting plate. (TDC on compression stroke).



M37500 -UN-29AUG88

3TG66 (Lawn Tractor)



M37501 -UN-29AUG88

3TG66, 3TG72 (Front Mower)

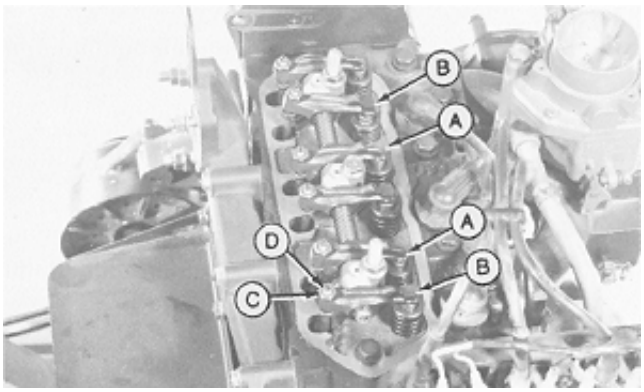
5M4,T1210,5 -19-12OCT87

3. Measure valve clearance.

VALVE CLEARANCE SPECIFICATIONS

Intake Valves (A) . . . . . 0.2 mm (0.008 in.)
Exhaust Valves (B) . . . . . 0.2 mm (0.008 in.)

4. To adjust valves (A and B), loosen nut (C) and turn adjusting screw (D) to proper clearance. Hold screw while tightening nut.



-UN-08JAN90
M46067

View From Flywheel End

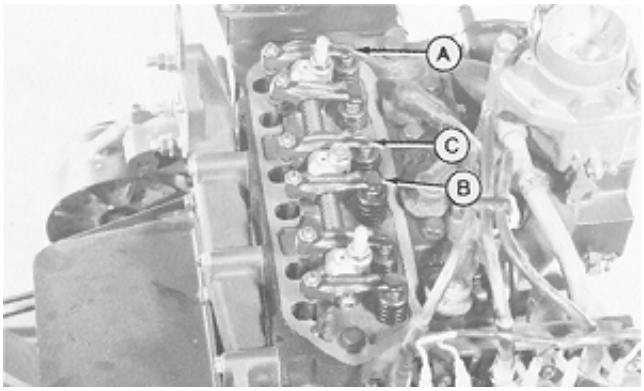
5M4,T1210,6 -19-12OCT87

5. To adjust remaining valves (A and B):

a. Turn crankshaft until No. 2 cylinder intake valve (C) opens.

Continue turning crankshaft to align the No. 2 timing mark on flywheel with mark on flywheel housing or mounting plate.

b. See Step 4 to adjust intake and exhaust valve. Adjust valves to 0.2 mm (0.008 in.).



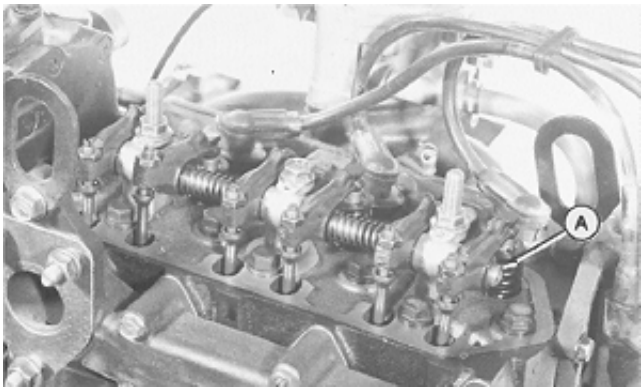
-UN-12JAN90
M46068

View From Flywheel End

5M4,T1210,7 -19-12OCT87

REMOVE AND DISASSEMBLE ROCKER ARM ASSEMBLY

1. Remove rocker arm assembly (A).

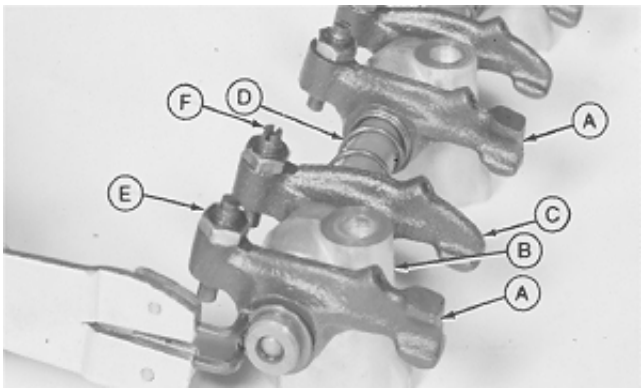


-UN-08JAN90
M46069

5M4,T1210,8 -19-11SEP87

2. Remove snap ring and parts (A—F).

A—Exhaust Rocker Arm (2 used)
B—Support
C—Intake Rocker Arm
D—Spring
E—Nut (3 used)
F—Adjusting Screw (3 used)

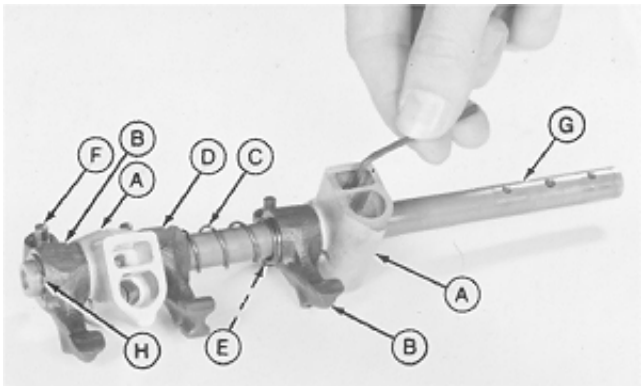


M35260 -UN-29AUG88

5M4,T1210,9 -19-12OCT87

3. Remove set screw and parts (A—H).

A—Support
B—Intake Rocker Arm
C—Spring
D—Exhaust Rocker Arm
E—Nut
F—Adjusting Screw
G—Rocker Arm Shaft
H—Snap Ring

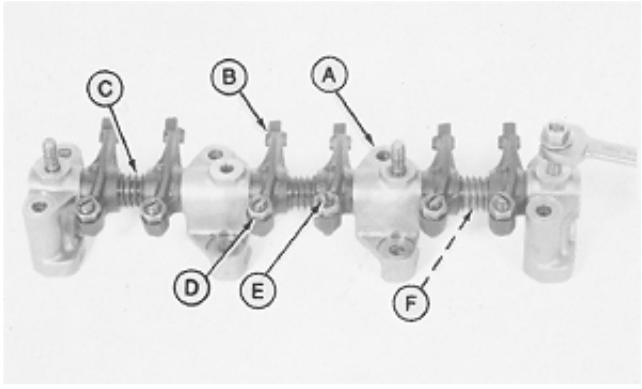


M35261 -UN-29AUG88

M21,TM310,16 -19-17FEB86

4. Remove three studs using two M8 nuts. Remove parts (A—F).

A—Support (4 used)
B—Rocker Arm (6 used)
C—Spring (3 used)
D—Nut (6 used)
E—Adjusting Screw (6 used)
F—Rocker Arm Shaft



M37504 -UN-29AUG88

5M4,T1210,10 -19-14SEP87

5. Measure rocker arm shaft outside diameter at each rocker arm location.

ROCKER ARM SHAFT O.D. SPECIFICATION

Engine	Wear Tolerance
3TG66	9.9 mm (0.390 in.)
3TG72	11.9 mm (0.469 in.)

If rocker arm shaft diameter is less than wear tolerance, replace shaft.

M35262 -UN-29AUG88

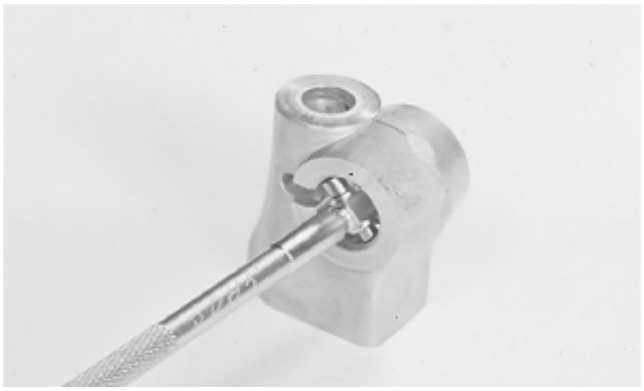
5M4,T1210,11 -19-05OCT87

6. Measure each rocker arm shaft support inside diameter.

ROCKER ARM SHAFT SUPPORT I.D. SPECIFICATION

Engine	Wear Tolerance
3TG66	10.1 mm (0.398 in.)
3TG72	12.1 mm (0.476 in.)

If rocker arm shaft support diameter exceeds wear tolerance, replace support.



M35263 -UN-29AUG88

5M4,T1210,12 -19-14SEP87

7. Measure each rocker arm inside diameter and determine rocker arm shaft clearance (rocker arm I.D. minus rocker arm shaft O.D.).

Inspect rocker arm to valve surface and adjusting screw for metal flakes or wear.

ROCKER ARM SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	Arm I.D.	10.1 mm (0.398 in.)
3TG66	Shaft Clearance	0.10 mm (0.004 in.)
3TG72	Arm I.D.	12.1 mm (0.476 in.)
3TG72	Shaft Clearance	0.12 mm (0.005 in.)

If rocker arm bore diameter exceeds wear tolerance, replace rocker arm.

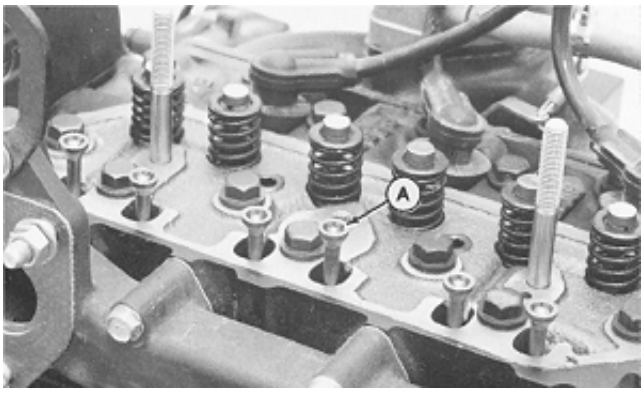
If shaft clearance exceeds wear tolerance, replace rocker arm shaft, rocker arm, or both.

M35264 -UN-29AUG88

5M4,T1210,13 -19-14SEP87

REMOVE AND INSPECT PUSHRODS AND CAM FOLLOWERS

1. Remove pushrods (A).



M46070 -UN-08JAN90

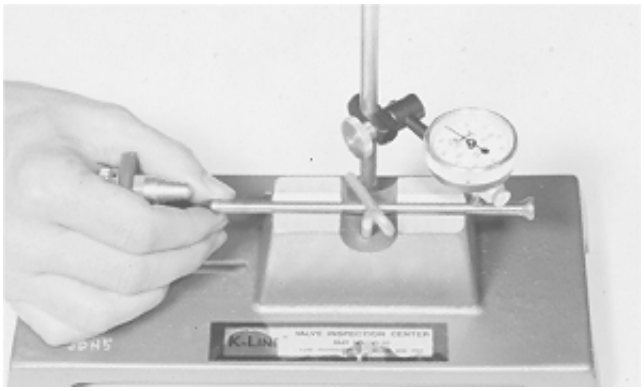
5M4,T1210,14 -19-12OCT87

2. Measure pushrod TIR (Total Indicator Runout) using Valve Inspection Center.

SPECIFICATION

Pushrod TIR (Max)	0.30 mm (0.012 in.)

If pushrod TIR exceeds 0.30 mm (0.012 in.), replace it.



M35400 -UN-06SEP88

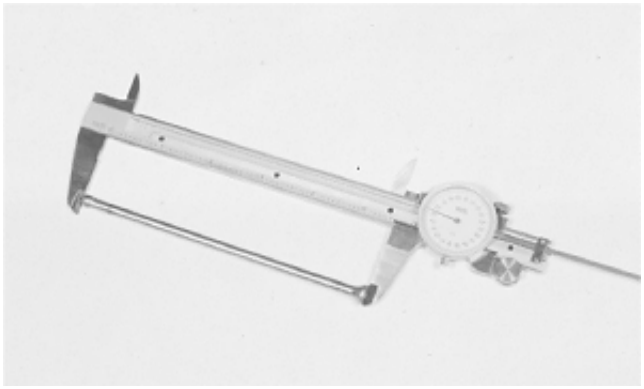
M21,TM310,22 -19-22APR86

3. Measure pushrod length.

PUSHROD LENGTH SPECIFICATION

Engine	Wear Tolerance
3TG66	114 mm (4.49 in.)
3TG72	141 mm (5.55 in.)

If pushrod length is less than wear tolerance, replace it.



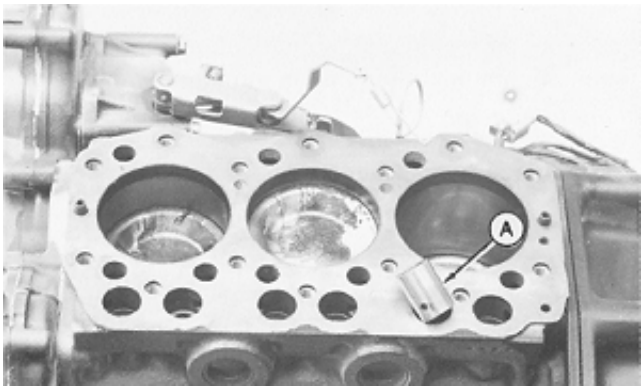
5M4,T1210,15 -19-14SEP87

4. Remove cylinder head. (See Group 15 in this manual).

IMPORTANT: Cam followers must be installed in the same bores they were removed from.

5. Put a mark on each cam follower and cylinder block bore to aid in assembly.

6. Remove cam followers (A).



5M4,T1210,16 -19-14SEP87

7. Measure cam followers outside diameter.

CAM FOLLOWER O.D. SPECIFICATIONS

Engine	Wear Tolerance
3TG66	17.85 mm (0.703 in.)
3TG72	20.85 mm (0.821 in.)

If cam follower diameter is less than wear tolerance, replace it.

8. Inspect cam follower-to-camshaft surface for uneven wear or damage; replace as necessary.

5M4,T1210,17 -19-12OCT87

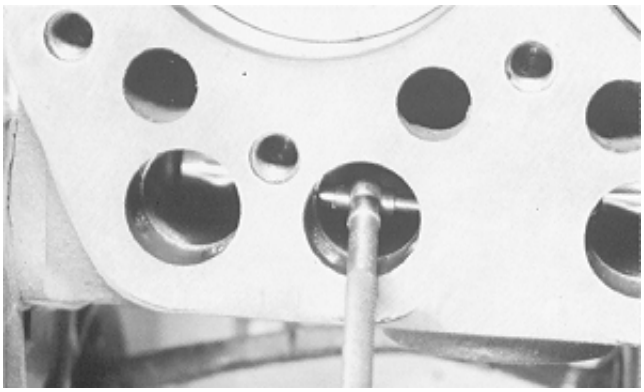
9. Measure cam follower bore inside diameter and determine cam follower clearance (cam follower bore I.D. minus cam follower O.D.).

CAM FOLLOWER BORE SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	Bore I.D.	18.1 mm (0.713 in.)
3TG66	Clearance	0.1 mm (0.004 in.)
3TG72	Bore I.D.	21.00 mm (.823 in.)
3TG72	Clearance	0.15 mm (0.006 in.)

If cam follower bore diameter exceeds wear tolerance, replace cylinder block.

If cam follower clearance exceeds wear tolerance; replace cam follower, cylinder block or both.



M46072 -UN-08JAN90

5M4,T1210,18 -19-14SEP87

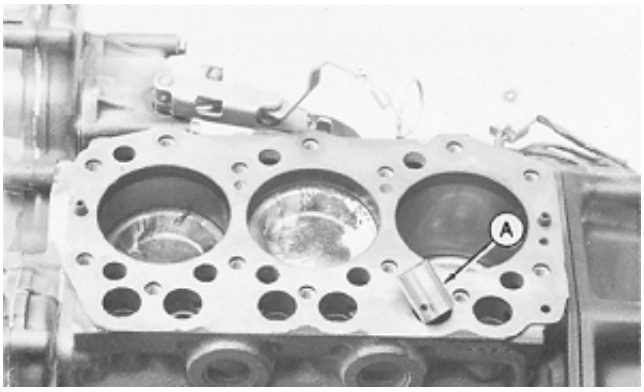
INSTALL PUSHRODS AND CAM FOLLOWERS

1. Put clean engine oil on cam followers.

IMPORTANT: Cam followers must be installed in the same bores they were removed from.

2. Install cam followers (A).

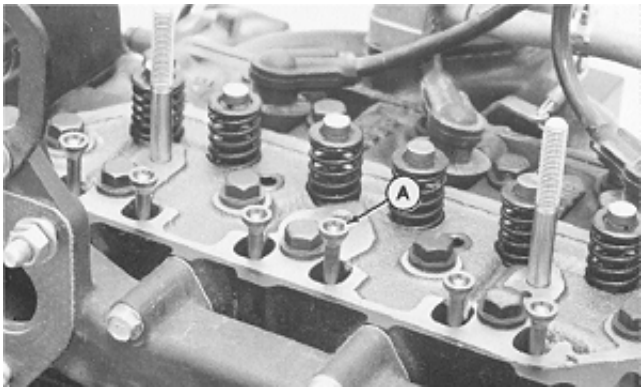
3. Install cylinder head. (See Group 15 in this manual.)



M46071 -UN-08JAN90

5M4,T1210,19 -19-14SEP87

4. Install the pushrods.



M46070 -UN-08JAN90

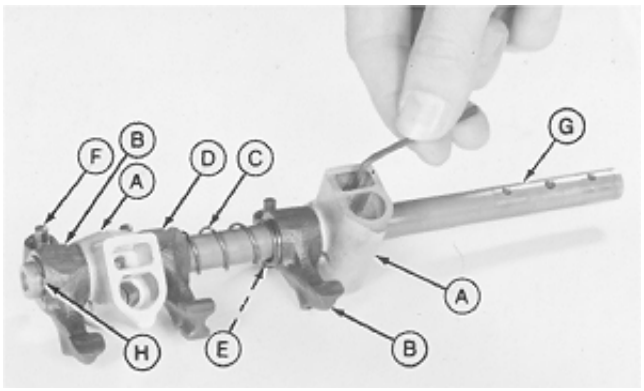
5M4,T1210,20 -19-14SEP87

ASSEMBLE AND INSTALL ROCKER ARM ASSEMBLY

1. Install parts (A—H) on rocker arm shaft.

2. Align set screw hole in support with center hole in rocker arm shaft. Install and tighten set screw.

A—Support (2 used)
B—Intake Rocker Arm (2 used)
C—Spring
D—Exhaust Rocker Arm
E—Nut (3 used)
F—Adjusting Screw (3 used)
G—Rocker Arm Shaft
H—Snap Ring



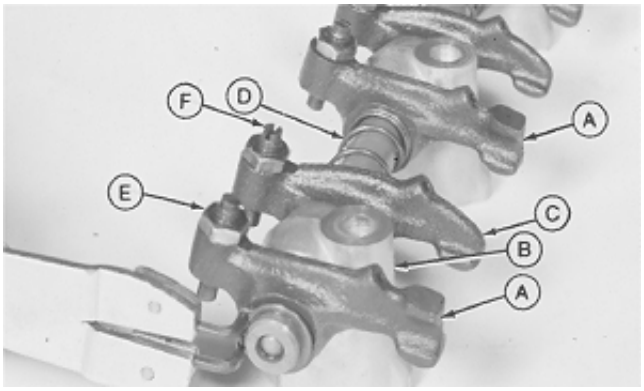
-UN-29AUG88
M35261

5M4,T1210,21 -19-14SEP87

3. Install parts (A—F) on rocker arm shaft.

4. Install snap ring.

A—Exhaust Rocker Arm
B—Support
C—Intake Rocker Arm
D—Spring
E—Nut
F—Adjusting Screw



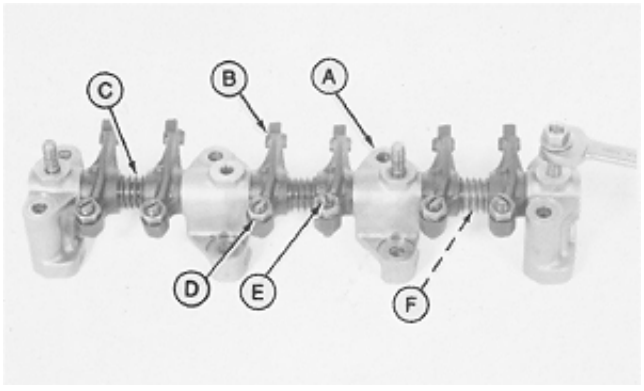
-UN-29AUG88
M35260

M21,TM310,30 -19-17FEB86

5. Install parts (A—F) on rocker arm shaft.

6. Align hole in each support with hole in rocker arm shaft. Install and tighten three studs using two M8 nuts.

A—Support (4 used)
B—Rocker Arm (6 used)
C—Spring (3 used)
D—Nut (6 used)
E—Adjusting Screw (6 used)
F—Rocker Arm Shaft

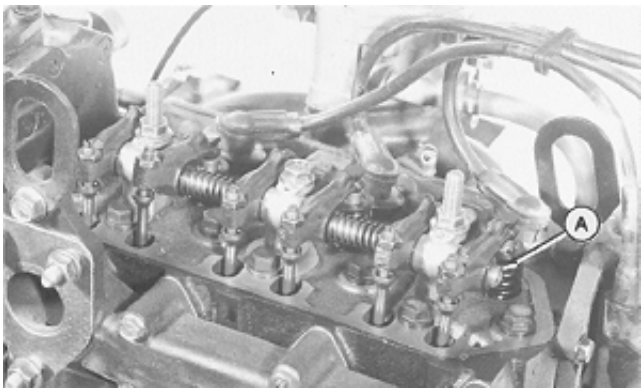


-UN-29AUG88
M37504

5M4,T1210,22 -19-14SEP87

7. Install rocker arm assembly. Be sure adjusting screws (A) are in pushrod sockets.

8. Install and tighten two nuts and cap screw to 25 N·m (225 lb-in.).



-UN-08JAN90
M46069

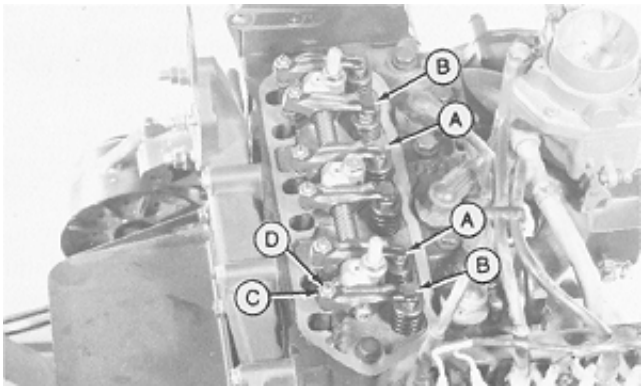
5M4,T1210,23 -19-14SEP87

9. Measure valve clearance. (See Measure and Adjust Valve Clearance in this section.)

VALVE CLEARANCE SPECIFICATIONS

Intake Valves (A)	0.2 mm (0.008 in.)
Exhaust Valves (B)	0.2 mm (0.008 in.)

A—Intake Valve (3 used)
B—Exhaust Valve (3 used)
C—Nut (6 used)
D—Adjusting Screw (6 used)

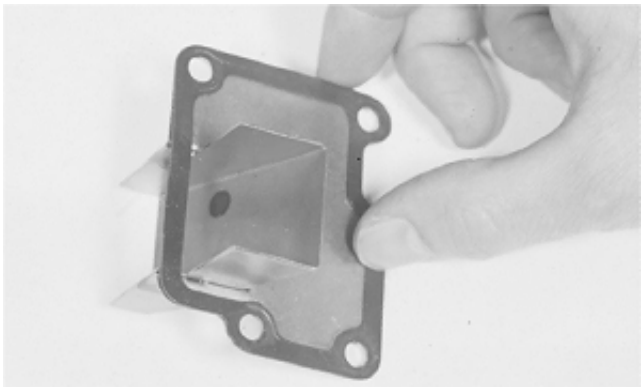


-UN-08JAN90
M46067

5M4,T1210,24 -19-12OCT87

ASSEMBLE AND INSTALL ROCKER ARM COVER

1. Install a new gasket on baffle.



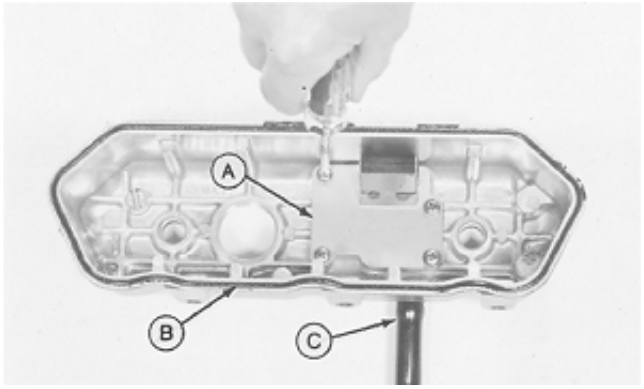
-UN-29AUG88
M35329

5M4,T1210,25 -19-14SEP87

2. Install crankcase breather tube (C) and O-ring (B).

3. Install baffle (A) and fasten with four lock washers and screws.

A—Baffle
B—O-Ring
C—Crankcase Breather Tube



-UN-29AUG88
M35328

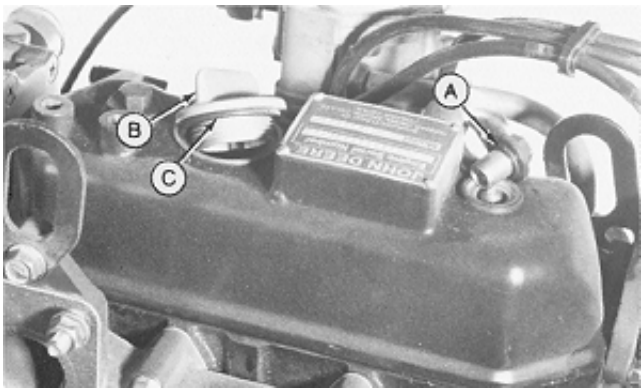
5M4,T1210,26 -19-05OCT87

4. Install rocker arm cover.

5. Install O-ring (C) on oil fill cap (B). Install oil fill cap.

6. Install an O-ring (A) on each special nut.

7. Install and tighten two special nuts to 26 N·m (226 lb-in.)



-UN-08JAN90
M46065

5M4,T1210,27 -19-05OCT87

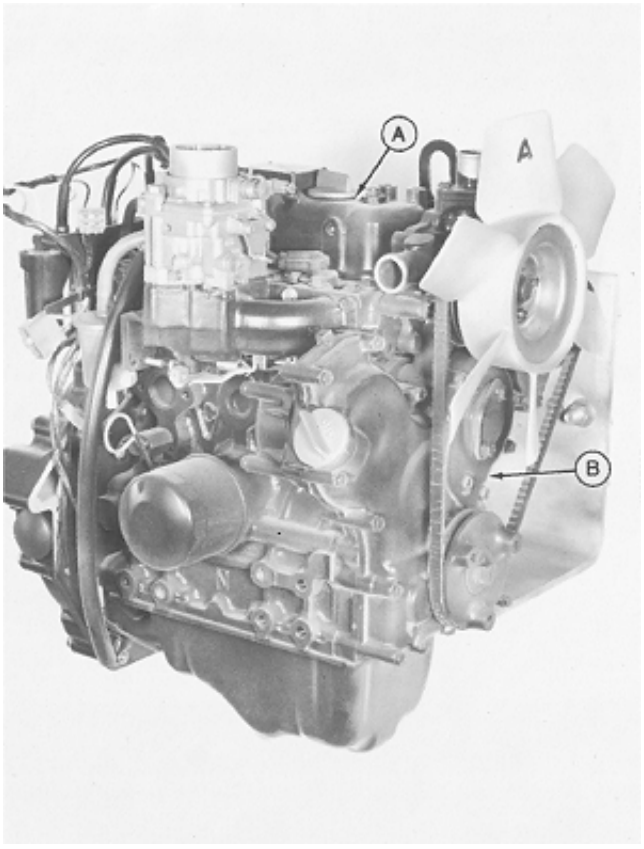
REMOVE CAMSHAFT

1. Remove engine. (See machine technical manual.)

2. Remove fan alternator belt, and alternator.

3. Remove rocker arm cover, rocker arm assembly, and pushrods (A). (See Group 10 in this manual.)

4. Remove timing gear cover (B). (See Group 35 in this manual.)

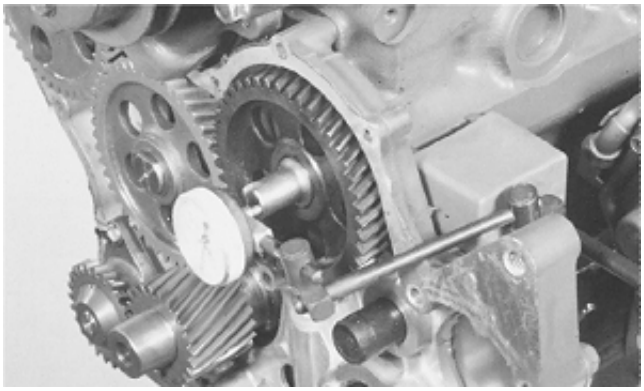


-UN-08JAN90
M46073

5M4,T1210,28 -19-14SEP87

5. Measure camshaft end play.

If end play exceeds 0.5 mm (0.02 in.), replace camshaft thrust plate.



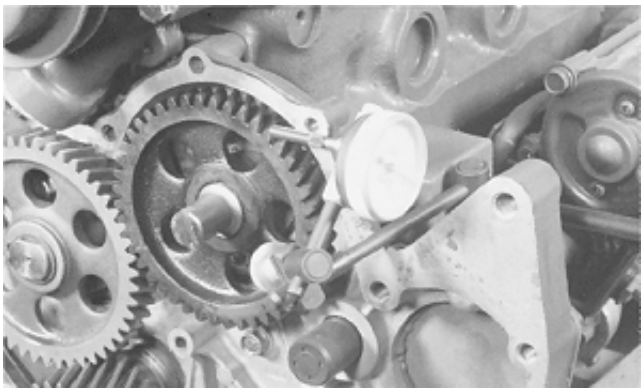
-UN-06SEP88
M37512

5M4,T1210,29 -19-14SEP87

6. If end play is correct, measure camshaft gear backlash.

Check backlash of other timing gears; replace these gears as necessary. (See Group 35 in this manual for backlash Specifications.)

If backlash exceeds 0.2 mm (0.008 in.), replace camshaft gear.

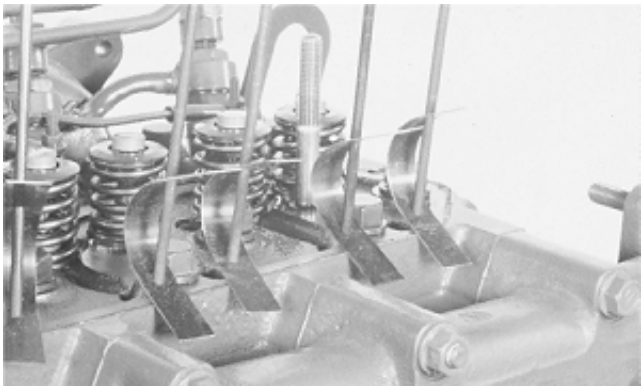


M37513 -UN-06SEP88

5M4,T1210,30 -19-14SEP87

NOTE: If a magnetic follower holder kit is not available, turn engine until oil pan is upward, to hold cam followers away from camshaft.

7. Hold cam followers away from camshaft using a magnetic follower holder kit such as JTO1783.



M37514 -UN-06SEP88

5M4,T1210,31 -19-14SEP87

8. Turn engine on engine stand with flywheel side down.

IMPORTANT: DO NOT allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

9. Remove two cap screws and carefully remove camshaft.

M35279 -UN-29AUG88

5M4,T1210,32 -19-14SEP87

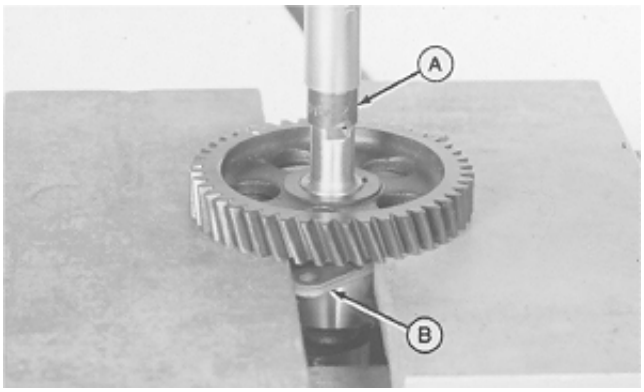
DISASSEMBLE AND INSPECT CAMSHAFT

1. Inspect gear for chipped or broken teeth, replace if necessary.

IMPORTANT: Be sure to hold camshaft while removing camshaft gear.

2. Remove gear using 11/16-in. driver disk (A) and a press.

3. Remove thrust plate (B).



-UN-29AUG88
M35280

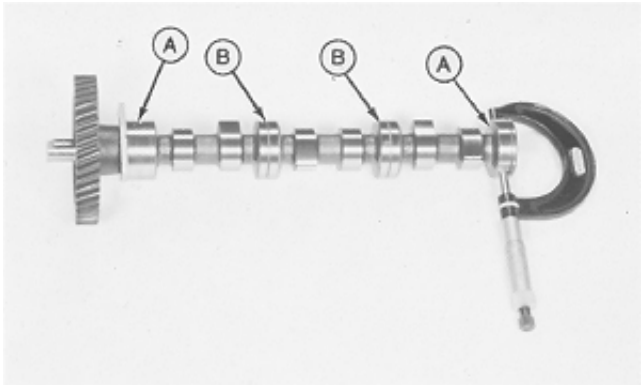
M21,TM310,47 -19-18FEB86

4. Measure camshaft end journal diameter (A), and intermediate journal diameter (B).

CAMSHAFT JOURNAL SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	End Journal O.D.	35.84 mm (1.411 in.)
3TG66	Intermediate Journal O.D.	35.81 mm (1.410 in.)
3TG72	End Journal O.D.	39.84 mm (1.568 in.)
3TG72	Intermediate Journal O.D.	39.81 mm (1.567 in.)

If end journal diameter or intermediate journal diameter is less than wear tolerance replace camshaft.



-UN-29AUG88
M35282

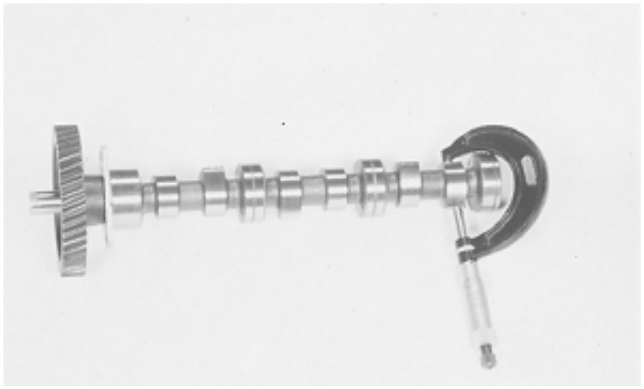
5M4,T1210,33 -19-12OCT87

5. Measure camshaft lobe height.

CAMSHAFT LOBE HEIGHT SPECIFICATION

Engine	Wear Tolerance
3TG66	29.7 mm (1.169 in.)
3TG72	33.6 mm (1.323 in.)

If height is less than wear tolerance, replace camshaft.



M35283 -UN-16NOV89

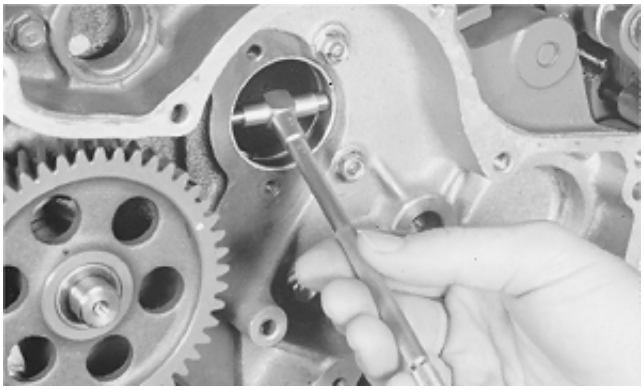
5M4,T1210,34 -19-12OCT87

6. Measure gear housing side camshaft bushing diameter.

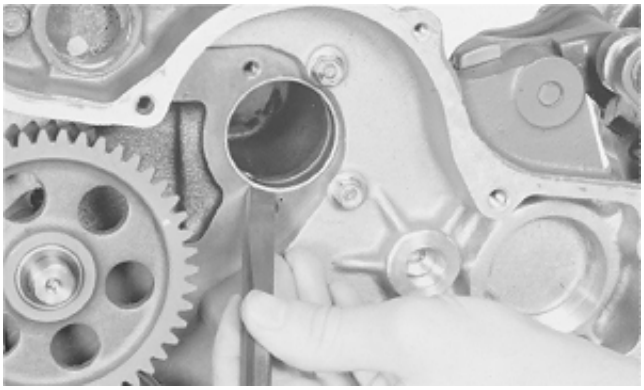
CAMSHAFT BUSHING I.D. SPECIFICATION

Engine	Wear Tolerance
3TG66UJ	36.115 mm (1.422 in.)
3TG72	41.115 mm (1.618 in.)

If diameter exceeds wear tolerance, replace bushing. Use a chisel to remove bushing. Be careful not to push bushing inside of engine.



M35284 -UN-29AUG88



M35285 -UN-29AUG88

5M4,T1210,35 -19-14SEP87

7. Measure camshaft intermediate bore diameter.

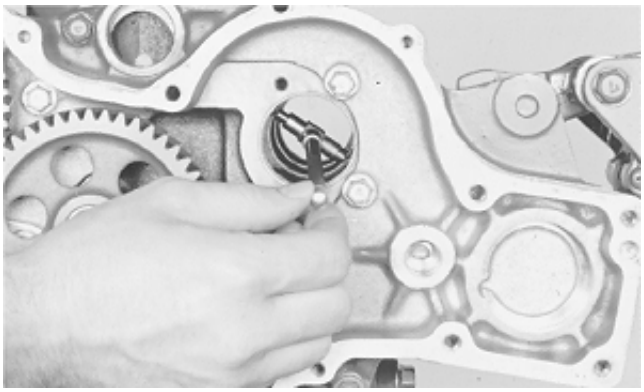
CAMSHAFT BORE I.D SPECIFICATION

Engine	Wear Tolerance
3TG66	36.075 mm (1.421 in.)
3TG72	40.075 mm (1.578 in.)

If diameter exceeds wear tolerance, replace cylinder block.

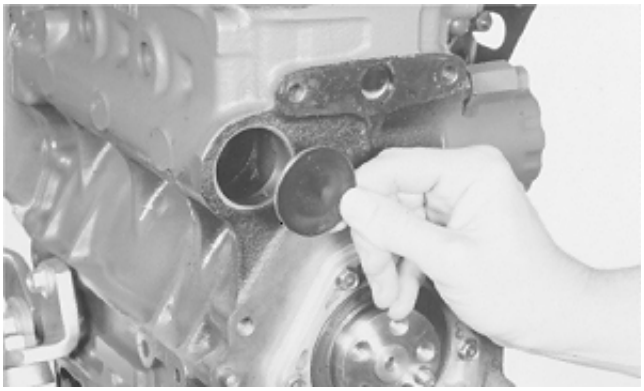
8. Measure the other intermediate and flywheel side camshaft bore diameters using the following procedure:

a. Remove flywheel assembly. (See Group 15 in this (manual.)



5M4,T1210,36 -19-12OCT87

b. Remove plug using a wooden dowel. Remove plug from gear housing side.



M21,TM310,51 -19-18FEB86

c. Measure intermediate and flywheel side camshaft bore diameters.

CAMSHAFT BORE I.D SPECIFICATIONS

Engine	Wear Tolerance
3TG66	36.075 mm (1.421 in.)
3TG72	40.075 mm (1.578 in.)

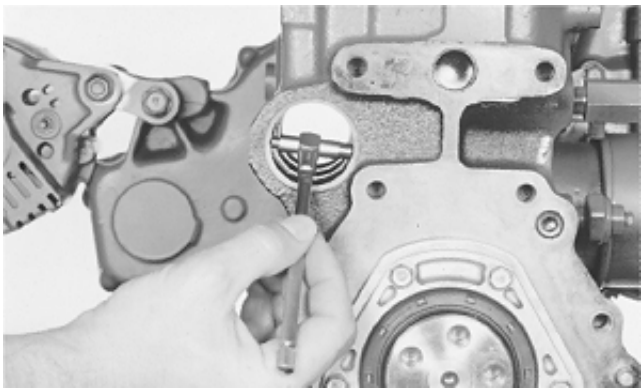
d. Determine camshaft journal clearance (bushing, or bore diameter minus journal diameter).

CAMSHAFT JOURNAL CLEARANCE SPECIFICATION

Engine	Wear Tolerance
3TG66, 3TG72	0.18 mm (0.007 in.)

If diameter exceeds wear tolerance, replace cylinder block.

If clearance exceeds 0.18 mm (0.007 in.), replace camshaft, cylinder block, or both.



M35288 -UN-29AUG88

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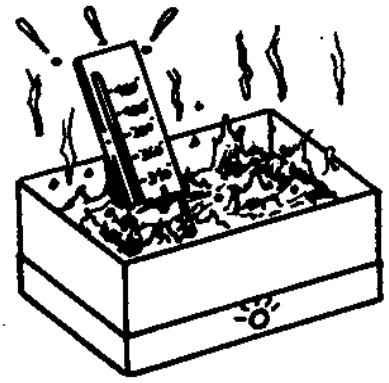
5M4,T1210,37 -19-12OCT87

ASSEMBLE CAMSHAFT


T81191 -UN-23FEB89

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

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18

1. Heat camshaft gear to approximately 150˚C (300˚F).

2. Install thrust plate (B) on camshaft.

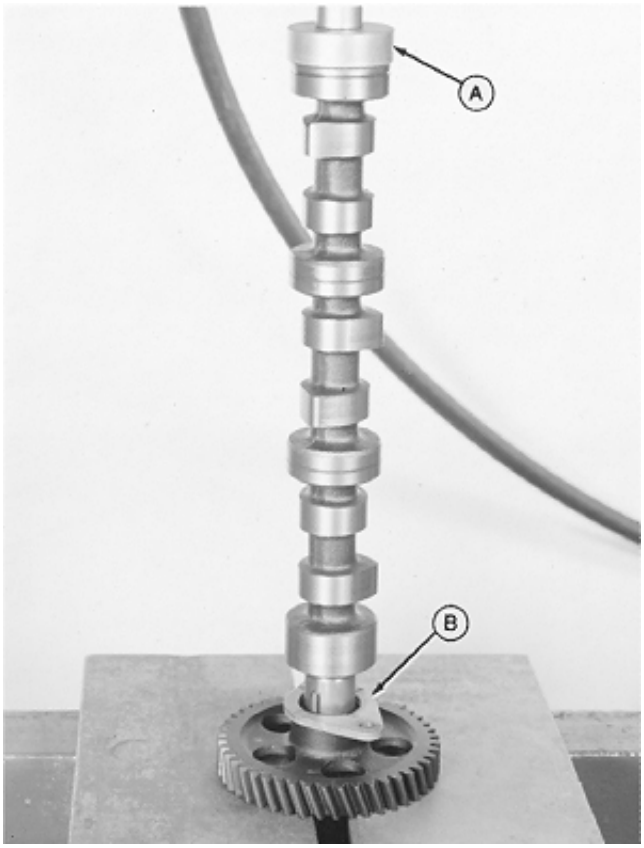
3. Put gear with timing mark side downward on press table.

4. Align slot in gear with key in shaft.

IMPORTANT: Be sure thrust plate is not between camshaft gear and camshaft shoulder while installing gear.

5. Push camshaft gear tight against camshaft shoulder using 1 11/16 in. driver disk (A) and a press.

6. Thrust plate must spin freely on camshaft; if it does not, remove gear and repeat steps 1—5.



M35281 -UN-29AUG88

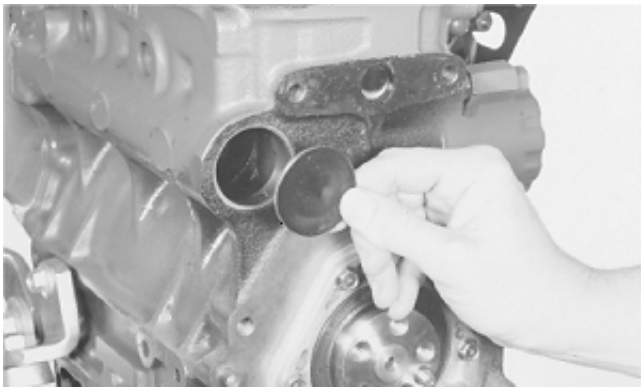
M21,TM310,53 -19-28AUG87

INSTALL CAMSHAFT

1. Thoroughly clean and dry all parts. Use a cylinder block and cylinder head gasket kit when assembling the engine.

2. Apply gasket maker or an equivalent on outer edge of plug.

3. Install plug flush with surface of cylinder block.


M35287 -UN-29AUG88

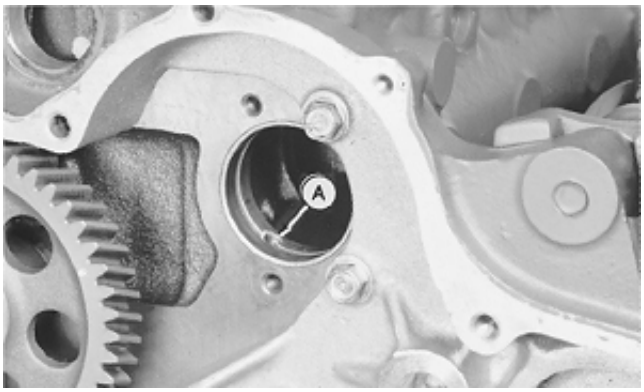
M21,TM310,54 -19-19FEB86

4. Install flywheel assembly. (See Group 15 in this manual.)

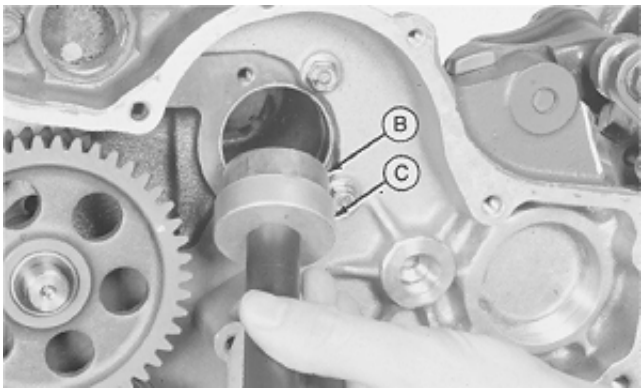
5. Align oil holes (A) in bushing and cylinder block. Install bushing flush with surface of cylinder block using the correct driver disks (B and C).

DISKS FOR BUSHING INSTALLATION

Engine	Size (in.)	
	(B)	**(C)**
3TG66UJ	1-7/16	1-1/2
3TG72	1-9/16	1-11/16



M35289 -UN-29AUG88



M35291 -UN-29AUG88

5M4,T1210,38 -19-14SEP87

6. Turn engine on engine stand with flywheel side down.

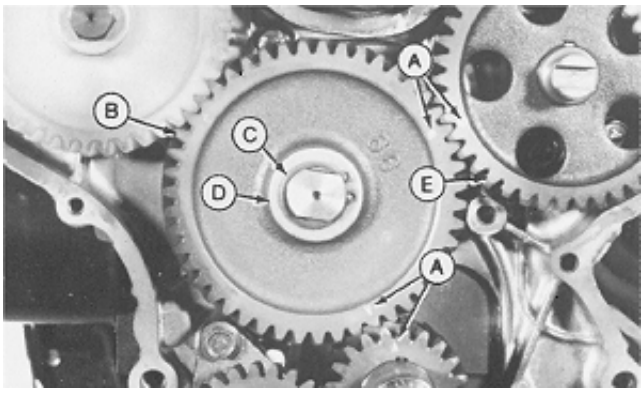
7. Put clean engine oil on camshaft bearing journals.

IMPORTANT: DO NOT allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

8. Remove snap ring (C) and washer (D) to remove idler gear (B).

9. Carefully install camshaft (E). Align timing marks (A) and install idler gear.

10. Install washer and snap ring.



M46096 -UN-08JAN90

A—Timing Marks
B—Idler Gear
C—Snap Ring
D—Washer
E—Camshaft

5M4,T1210,39 -19-14SEP87

11. Install and tighten two cap screws to specifications.

CAMSHAFT CAP SCREW SPECIFICATIONS

3TG66 . . . . . Torque . . . . . 11 ± 1 N·m

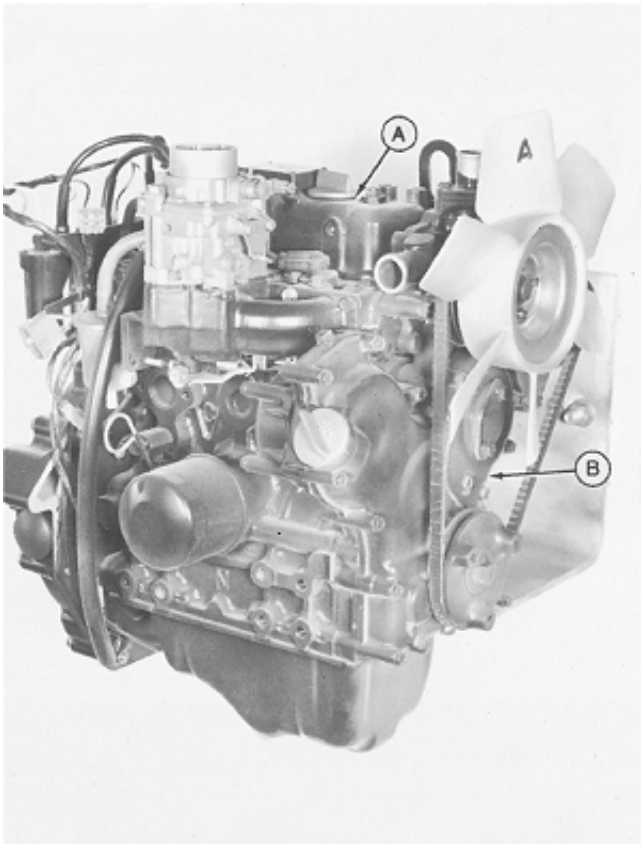
3TG72 . . . . . (96 ± 8 lb-in.)

M35292 -UN-29AUG88

5M4,T1210,40 -19-14SEP87

12. Install timing gear cover (B). (See Group 35 in this manual.)

13. Install pushrods, rocker arm assembly, and rocker arm cover (A). (See Group 10 in this manual.)



M46073 -UN-08JAN90

5M4,T1210,41 -19-10SEP87

ESSENTIAL TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Number	Name	Use
JDE-118	Valve Guide Driver	Remove and install valve guides on 3TG72 engine.
JDG-504	Valve Guide Driver	Remove and install valve guides on 3TG66 engine.

5M4,T1215,1 -19-12OCT87

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SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Depth Gauge	Measure valve recession
Valve Spring Compressor	Remove and install valves
Valve Inspection Center	Measure valve out-of-round
Outside Micrometer	Measure valves
Valve Guide Brush	Clean valve guide internal bores
Ball Gauge	Measure valve guide internal bores
Vernier Calipers	Measure Valve seat width
Valve Seat Grinder	Recondition valve seat
Feeler Gauge	Measure cylinder head flatness
Spring Compression Tester	Check valve springs

M21,TM315,2 -19-22APR86

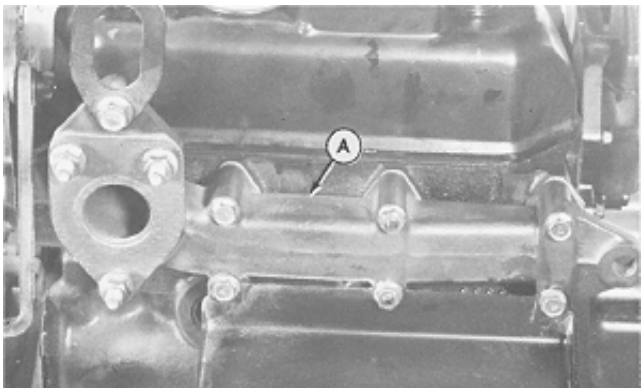
SERVICE PART KITS

The following kits are available through your parts catalog:

Cylinder Head Gasket Kit

M21,TM315,3 -19-19FEB86

REMOVE, REPAIR, AND INSTALL EXHAUST MANIFOLD



-UN-08JAN90
M46074

NOTE: Exhaust manifold can be removed with engine in the tractor.

1. Remove cap screws, nuts, and exhaust manifold (A).

2. Remove gasket material.

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

4. Install gasket, manifold, nuts, and cap screws. Tighten nuts and cap screws to specifications.

EXHAUST MANIFOLD CAP SCREW AND NUT TORQUE SPECIFICATION

Engine	Specification
3TG66	11 N·m (96 lb-in.)
3TG72	26 N·m (226 lb-in.)

5. Install muffler.

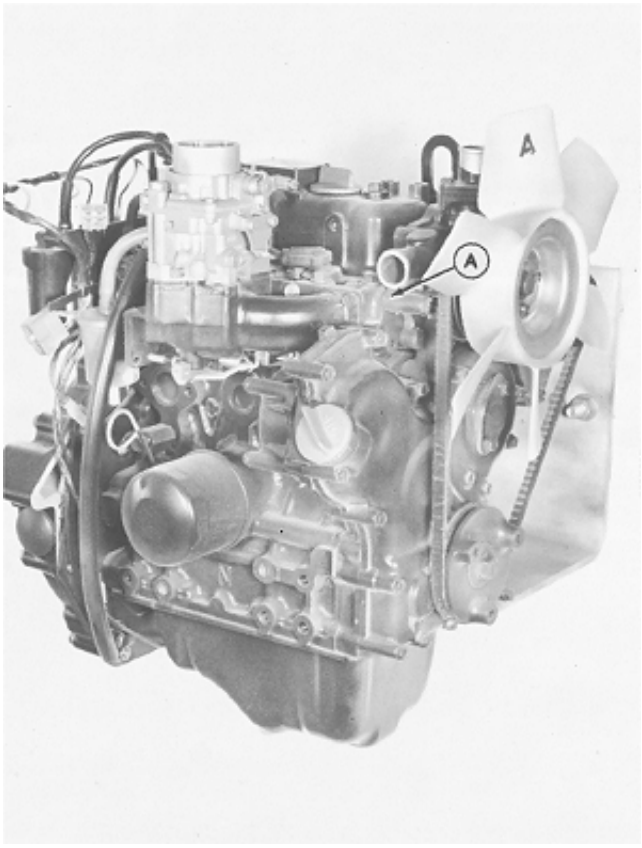
6. Start engine and check exhaust system for leaks. After engine is at normal operating temperature, retighten exhaust manifold cap screws and nuts to specifications.

5M4,T1215,2 -19-12OCT87

REMOVE, REPAIR, AND INSTALL INTAKE MANIFOLD

NOTE: Intake manifold can be removed with engine in the tractor.

1. Remove cylinder head (A). (See Group 15 in this manual.)



M46075 -UN-12JAN90

5M4,T1215,3 -19-12OCT87

2. Remove cap screws and intake manifold (A).

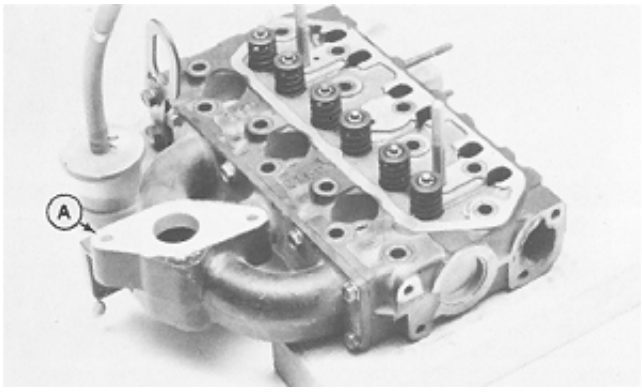
3. Remove gasket material.

4. Inspect manifold for cracks and holes. Repair or replace as necessary.

5. Install new gasket, manifold, and cap screws. Tighten cap screws to specifications.

INTAKE MANIFOLD CAP SCREW TORQUE SPECIFICATION

Engine	Specification
3TG66, 3TG72	11 N·m (96 lb-in.)



M46076 -UN-08JAN90

5M4,T1215,4 -19-15SEP87

REMOVE CYLINDER HEAD

NOTE: Cylinder head can be removed with engine in the tractor.

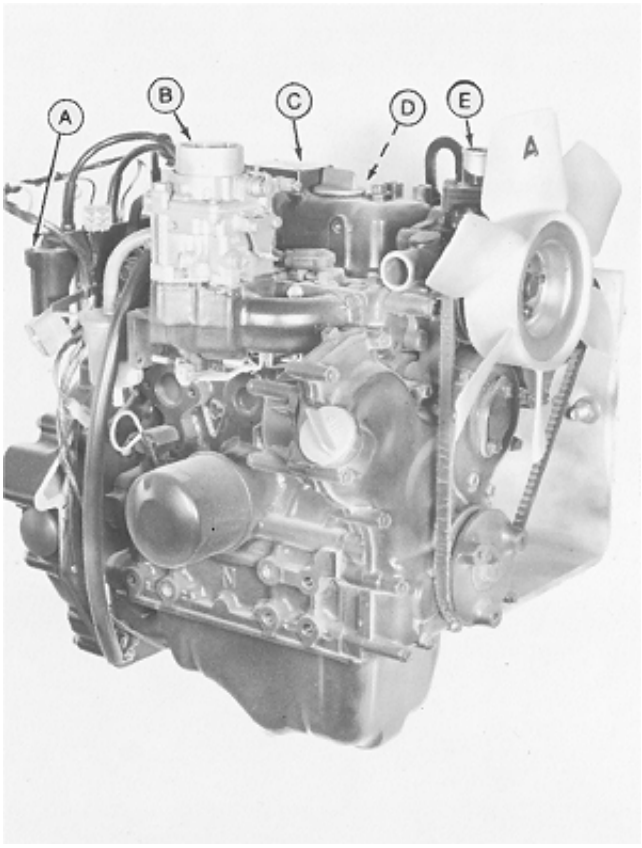
1. Remove exhaust manifold (D). (See Group 15 in this manual.)

2. Remove water pump (E). (See Group 45 in this manual.)

3. Remove carburetor and intake manifold (B).

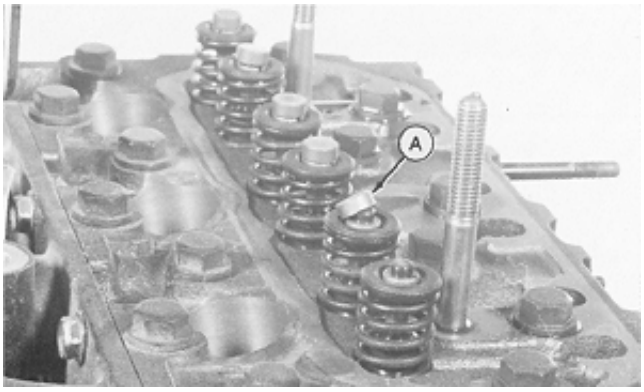
4. Remove ignition coils (A) and spark plugs.

5. Remove rocker arm cover (C), rocker arm assembly, and pushrods. (See Group 10 in this manual.)



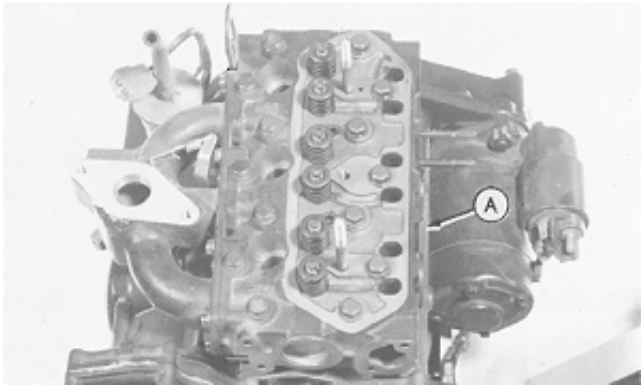
5M4,T1215,5 -19-15SEP87

6. Remove valve caps (A).



5M4,T1215,6 -19-15SEP87

7. Remove cap screws to remove cylinder head (A) and gasket.



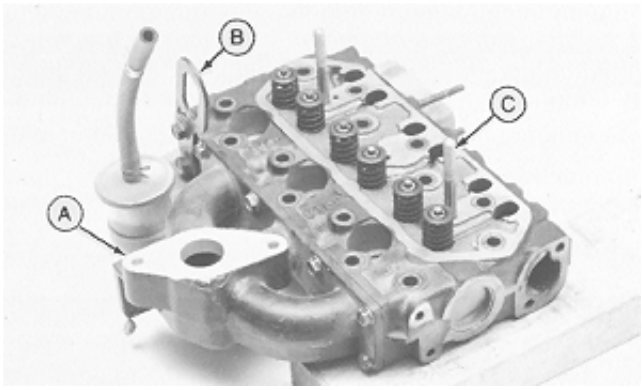
5M4,T1215,7 -19-15SEP87

DISASSEMBLE CYLINDER HEAD

1. Remove intake manifold (A).

2. Remove lifting bracket (B).

3. Remove four studs (C).

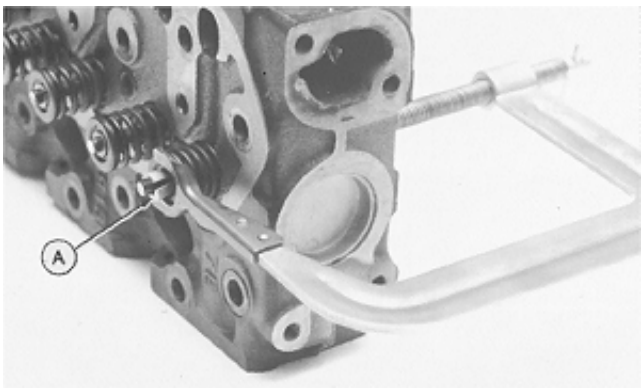


-UN-08JAN90
M46080

5M4,T1215,8 -19-15SEP87

4. Compress valve springs using a valve spring compressor. Remove retainers (A). Release spring pressure and remove compressor.

Inspect retainers for groove, wear, or damage on outside surface and wear or damage to inside tang. Replace retainers as necessary.



-UN-08JAN90
M46081

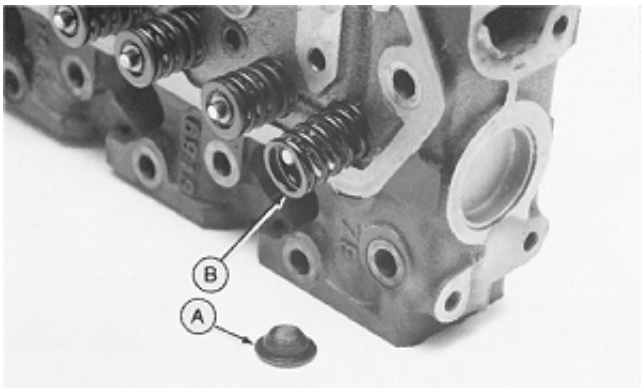
5M4,T1215,9 -19-17SEP87

5. Remove spring retainers (A) and springs (B).

6. Inspect springs for damaged or weak coils. Check spring using a spring compression tester. If spring strength is not correct, install new spring.

SPRING SPECIFICATIONS

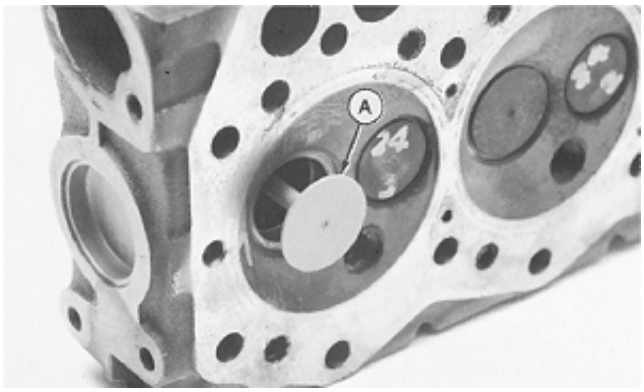
Engine	Measurement	Wear Tolerance
3TG66	Free length	27.5 mm
	(approx)	(1.083 in.)
	Test length at 125 N (28 lb force)	17 mm (0.591 in.)
3TG72	Free length	36.9 mm
	(approx)	(1.453 in.)
	Test length at 299 N (67 lb force)	22.5 mm (0.886 in.)



-UN-08JAN90
M46082

5M4,T1215,10 -19-12OCT87

7. Remove intake and exhaust valves (A).



-UN-08JAN90
M46083

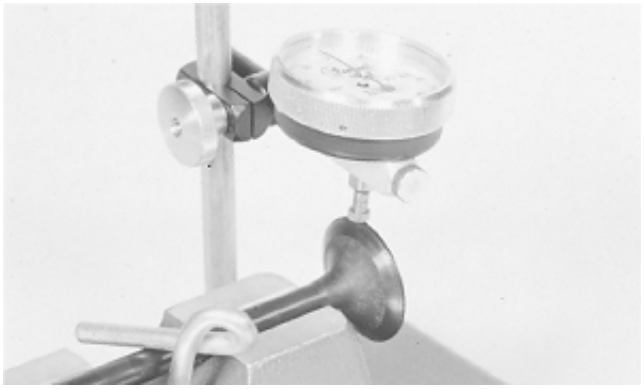
5M4,T1215,11 -19-17SEP87

8. Clean carbon from valve face, head, and stem using a soft wire wheel on a bench grinder.

9. Remove scratches from valve stems using steel wool or crocus cloth.

10. Inspect valve for damage, corrosion, pitting, or burned face.

11. Check valve for out-of-round, bent, or warped condition using a valve inspection center.



-UN-29AUG88
M35307

M21,TM315,21 -19-19FEB86

12. Measure valve stem diameter.

VALVE STEM O.D. SPECIFICATION

Engine	Wear Tolerance
3TG66UJ	5.40 mm (0.213 in.)
3TG72	6.90 mm (0.272 in.)

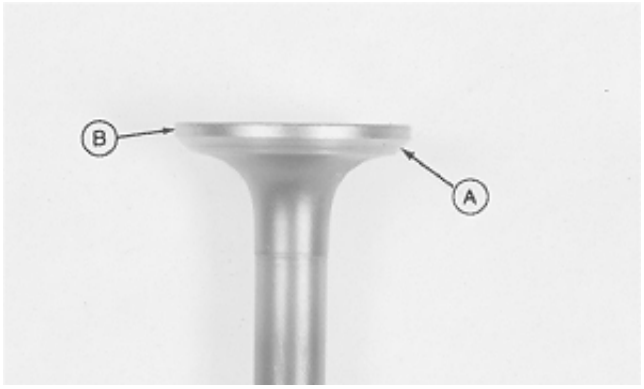
-UN-29AUG88
M35308

5M4,T1215,12 -19-17SEP87

13. If valve faces are worn, burned or pitted, grind valves to proper face angle (A) following manufacturers instructions. If valve face margin (B) is less than 0.51 mm (0.020 in.) after grinding, replace valve.

VALVE ANGLE

Exhaust Valve	45˚
Intake Valve	30˚

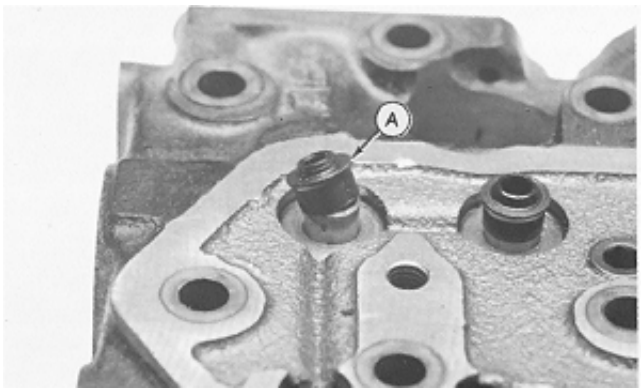


-UN-29AUG88
M36267

M21,TM315,23 -19-22APR86

IMPORTANT: Do not reuse valve stem seals if seals are removed.

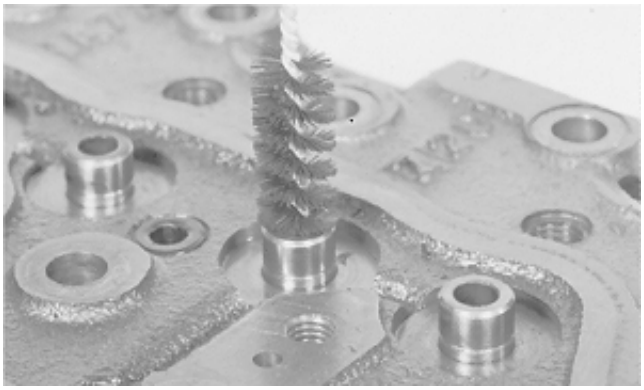
14. If necessary, remove valve stem seal (A) and discard.



-UN-08JAN90
M46084

5M4,T1215,13 -19-17SEP87

15. Clean valve guides using a valve guide brush.



-UN-29AUG88
M35310

M21,TM315,25 -19-19FEB86

16. Measure valve guide diameter.

17. If diameter is correct, determine guide-to-stem clearance (guide diameter minus stem diameter).

VALVE GUIDE SPECIFICATION

Engine	Measurement	Wear Tolerance
3TG66	Guide I.D.	5.57 mm (0.219 in.)
	Clearance	0.15 mm (0.006 in.)
3TG72	Guide I.D.	7.08 mm (0.279 in.)
	Clearance	0.15 mm (0.006 in.)

If valve guide diameter exceeds wear tolerance, knurl or replace valve guide.

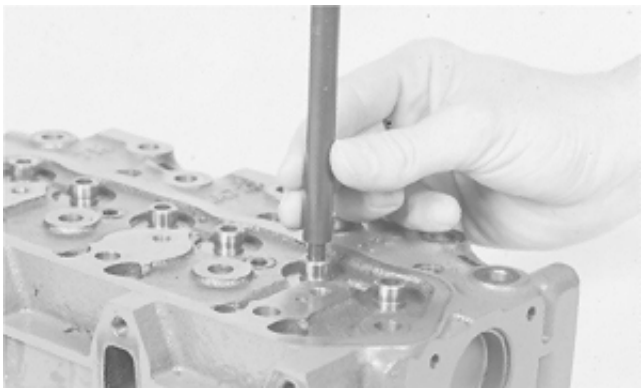
If clearance exceeds 0.15 mm (0.006 in.) but is less than 0.20 mm (0.008 in.), knurl valve guide.

If clearance exceeds 0.20 mm (0.008 in.), replace valve guide.

-UN-29AUG88
M35311

5M4,T1215,14 -19-17SEP87

18. If necessary, remove valve guides using JDE-118 (3TG72) or JDG-504 (3TG66) Valve Guide Driver.



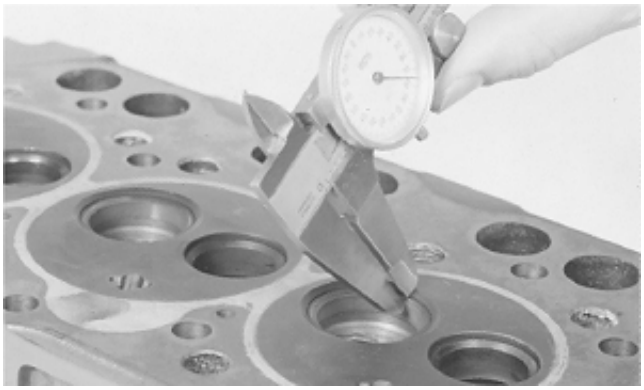
5M4,T1215,15 -19-17SEP87

19. Clean carbon from valve seats using a wire brush and an electric drill.

20. Inspect valve seats for cracks, pits, or excessive wear.

21. Measure valve seat width.

22. If necessary, grind valve seats to recondition or to meet specifications.



VALVE SEAT SPECIFICATIONS

Engine	Measurement	Specification
3TG66	Intake Seat Width	1.14 mm (0.045 in.)
	Exhaust Seat Width	1.37 mm (0.054 in.)
3TG72	Intake Seat Width	1.43 mm (0.056 in.)
	Exhaust Seat Width	1.73 mm (0.068 in.)

5M4,T1215,16 -19-17SEP87

IMPORTANT: Valve seats should never be cut. Cutting a valve seat can damage its sealing surface, which may result in leaks or valve/seat failure. Valve seats should be ground and lapped.

NOTE: LIGHTLY grind valve seats for a few seconds only to avoid excessive valve seat width.

23. Grind intake valve seat using a 30° seat grinder and exhaust valve seat using a 45° seat grinder. Follow tool manufactures instructions.

-UN-09DEC88
R26143N

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M21,TM315,30 -19-22APR86

24. Measure valve seat width after grinding.

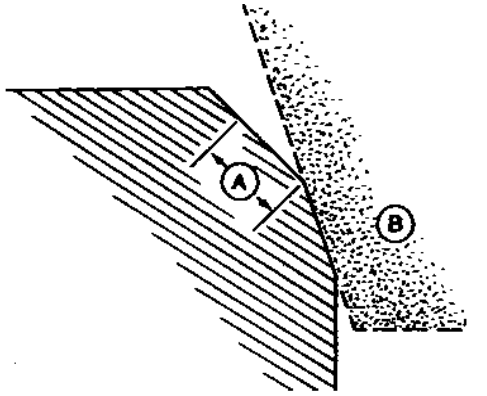
25. If seat is too wide after grinding, grind lower seat surface using a 70° seat grinder (B) until seat width (A) is close to specifications.

Grind upper seat surface using a 15° Seat grinder (B) until seat width (A) is narrowed to specifications.

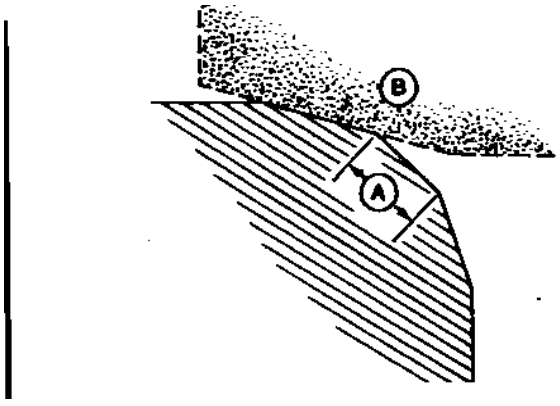
26. If valve seats are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.

If valve recession exceeds maximum specifications or seats cannot be reconditioned, replace valves, valve seats and/or cylinder head.

NOTE: Valve seat inserts are available for 3TNA72 and 3TN75 engines only.



-UN-30NOV88
RW538



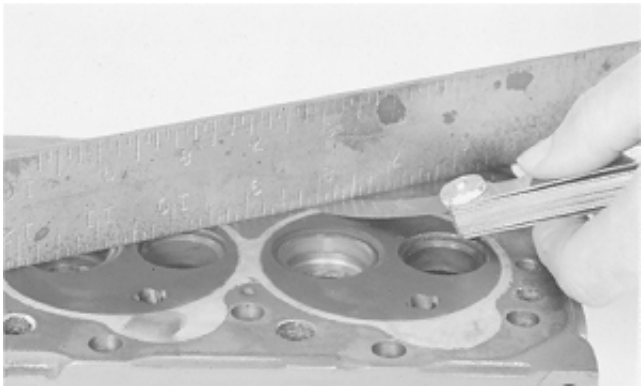
-UN-30NOV88
RW539

M21,TM315,31 -19-22APR86

27. Carefully clean carbon deposits from combustion chamber and gasket surface with a soft wire brush. Thoroughly clean cylinder head in solvent.

28. Inspect cylinder head for cracks or discoloration.

29. Measure cylinder head flatness in several directions.



CYLINDER HEAD FLATNESS SPECIFICATION

Engine	Wear Tolerance
3TG66	0.10 mm (0.004 in.)
3TG72	0.10 mm (0.004 in.)

15
10

If cylinder head distortion exceeds wear tolerance, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat; but do not remove more than 0.2 mm (0.008 in.).

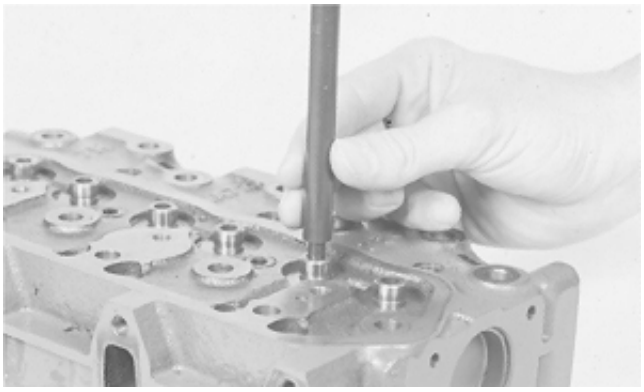
If cylinder head is milled down to head flatness specification, measure valve recession.

5M4,T1215,17 -19-12OCT87

ASSEMBLE CYLINDER HEAD

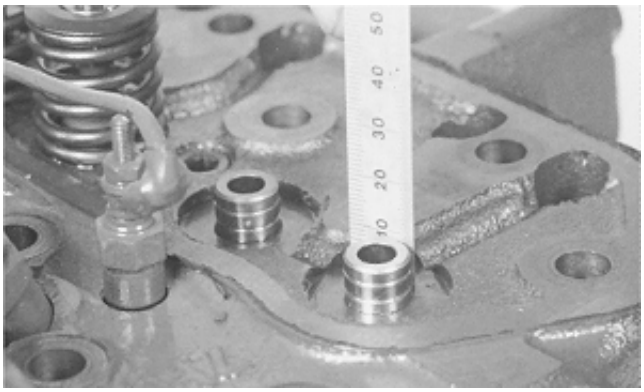
1. Thoroughly clean and dry all parts. Use a cylinder head gasket kit when assembling the engine.

2. Install valve guides with grooves upward, using JDG-504 (3TG66UJ Engine only) Valve Guide Driver. Push valve guide down until top of valve guide is specified distance above machined surface of cylinder head.



VALVE GUIDE DISTANCE SPECIFICATION

Engine	Specification
3TG66UJ	7 mm (0.276 in.)



5M4,T1215,18 -19-12OCT87

3. Measure new valve guide diameter.

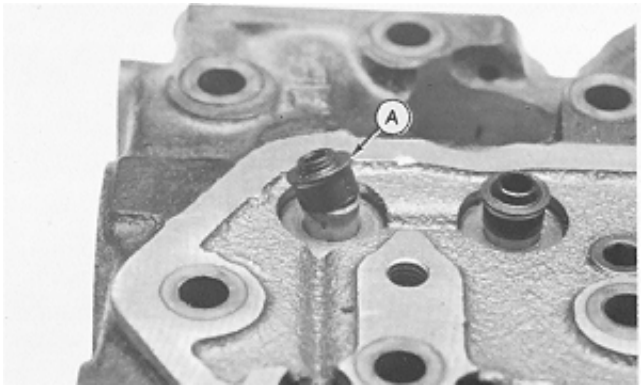
4. If necessary, ream inside diameter of valve guides to specifications using a valve guide reamer.

M21,TM315,34 -19-20FEB86

15
11

IMPORTANT: Do not reuse valve stem seals if seals were removed.

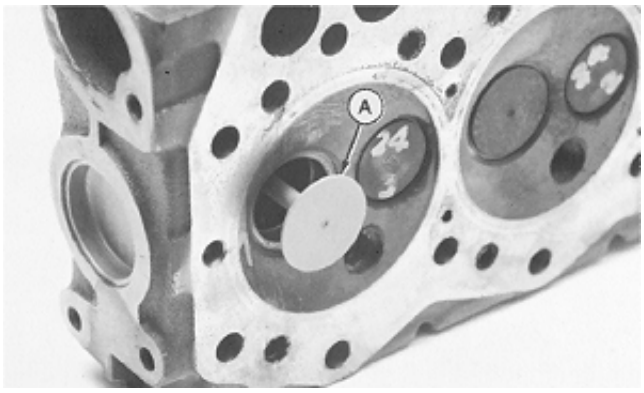
5. Install new valve stem seals (A).



5M4,T1215,19 -19-12OCT87

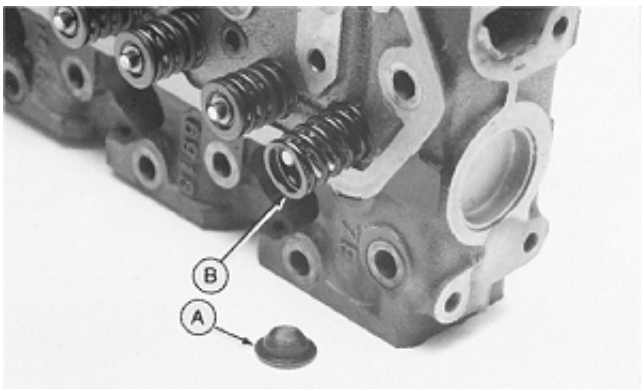
6. Put clean engine oil on valve stems.

7. Install intake and exhaust valves (A).



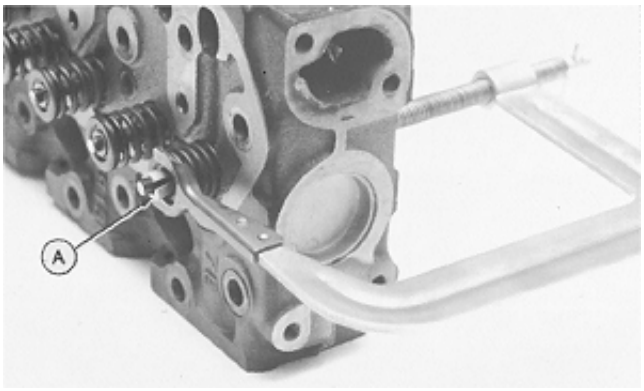
5M4,T1215,20 -19-17SEP87

8. Install springs (B), with smaller pitch end (paint mark) toward cylinder head, and spring retainers (A).



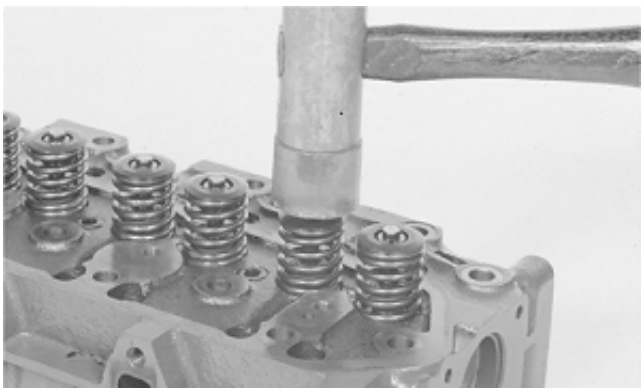
5M4,T1215,21 -19-17SEP87

9. Compress valve springs using a valve spring compressor. Install retainers. Release spring pressure and remove compressor.



5M4,T1215,22 -19-17SEP87

10. Hit valve stems lightly to seat the retainers.

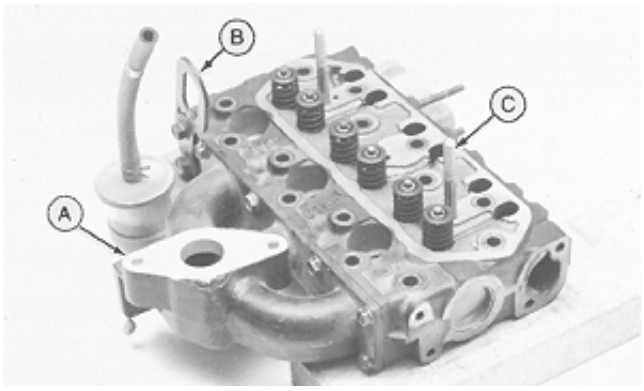


M21,TM315,39 -19-20FEB86

11. Install four studs (C).

12. Install lifting bracket (B).

13. Install intake manifold (A). (See Group 15 in this manual.)



5M4,T1215,23 -19-17SEP87

INSTALL CYLINDER HEAD

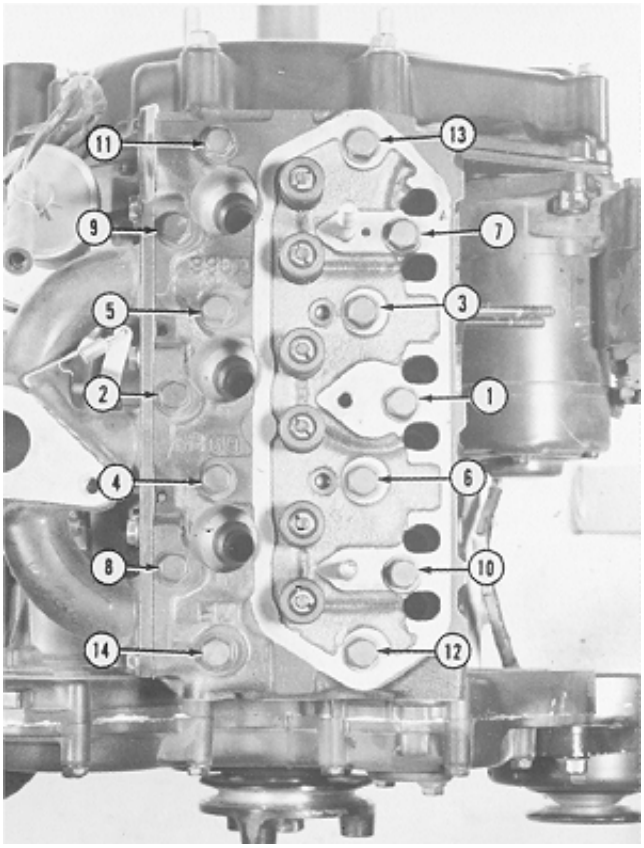
1. Install new gasket on cylinder block.

2. Install cylinder head.

3. Dip entire cylinder head cap screw in clean engine oil. Install cap screws. Tighten cap screws in the sequence illustrated in several steps. Tighten to specifications.

CYLINDER HEAD CAP SCREW TORQUE SPECIFICATION

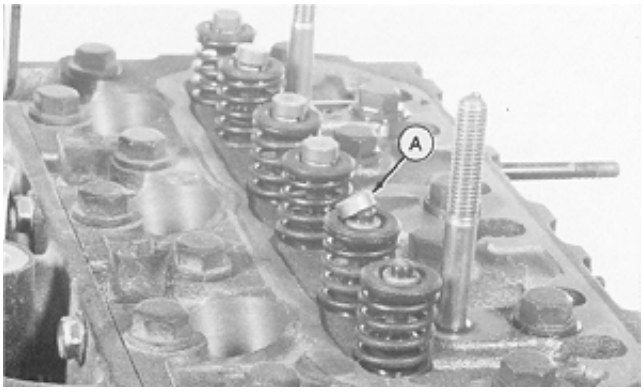
Engine	Specification
3TG66	34 N·m (25 lb-ft)
3TG72	61 N·m (45 lb-ft)



M46085 -UN-08JAN90

5M4,T1215,24 -19-12OCT87

4. Install valve caps (A).



M46078 -UN-08JAN90

5M4,T1215,25 -19-17SEP87

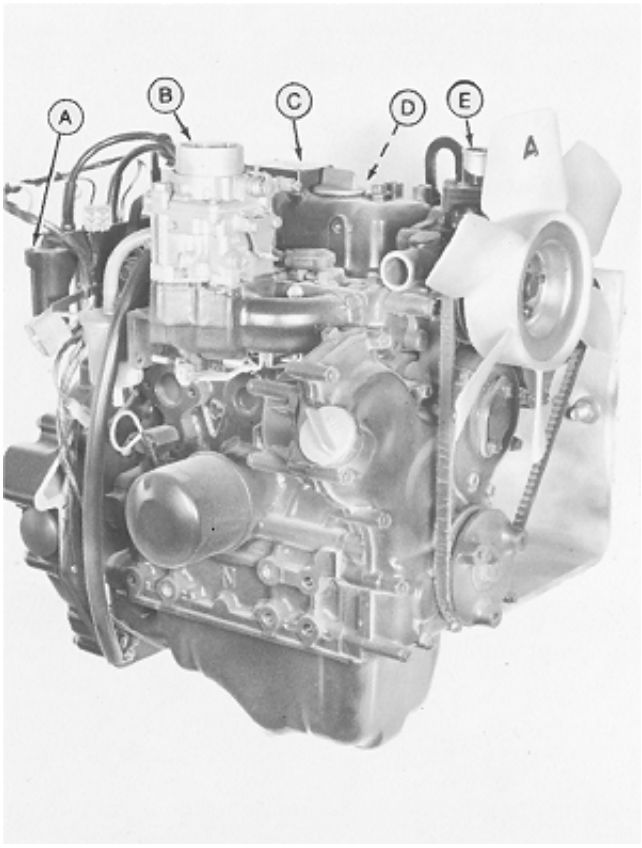
5. Install pushrods, rocker arm assembly, and rocker arm cover (C). (See Group 10 in this manual.)

6. Install ignition coils (A) and spark plugs.

7. Install carburetor and intake manifold (B).

8. Install water pump (E) (See Group 45 in this manual.)

9. Install exhaust manifold (D). (See Group 15 in this manual.)



M46077 -UN-08JAN90

5M4,T1215,26 -19-12OCT87

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Dial Indicator	Measure stub shaft TIR
Magnetic Base with Adjustable Arm	To hold dial indicator
Feeler Gauge	Measure flywheel flatness

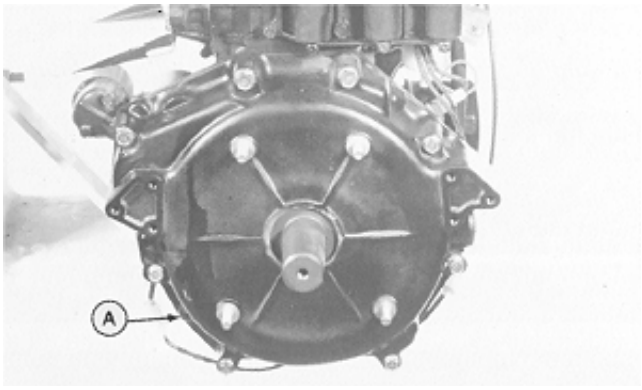
M21,TM320,1 -19-22APR86

REMOVE FLYWHEEL HOUSING AND FLYWHEEL

1. Remove engine (See machine technical manual.)

2. If equipped, remove electric clutch assembly. (See machine technical manual.)

3. Remove flywheel housing (A), if equipped.



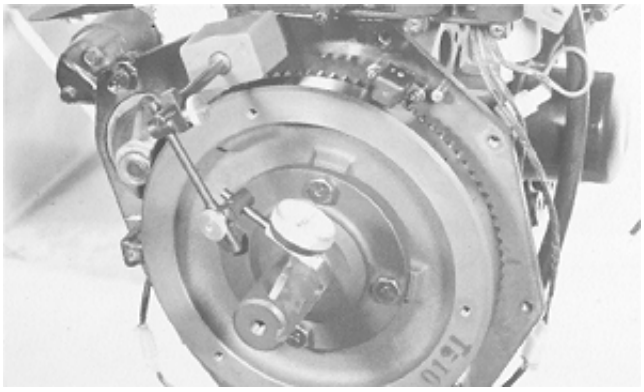
-UN-08JAN90
M46033

5M4,T1220,1 -19-17SEP87

4. While turning crankshaft, measure stub shaft TIR (total indicator runout) using a dial indicator. Maximum TIR is 0.2 mm (0.008 in.).

NOTE: Turn engine crankshaft using crankshaft pulley cap screw.

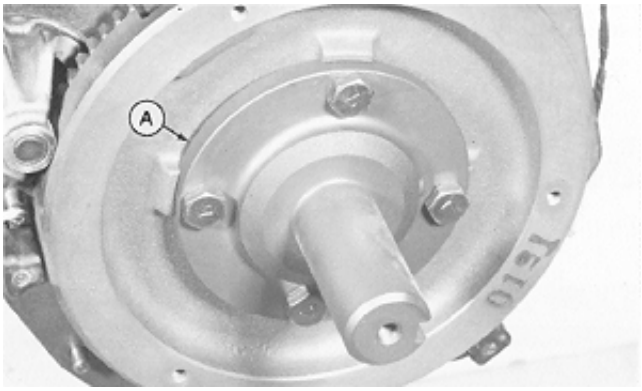
If stub shaft TIR exceeds 0.2 mm (0.008 in.), replace stub shaft.



-UN-08JAN90
M46034

5M4,T1220,2 -19-17SEP87

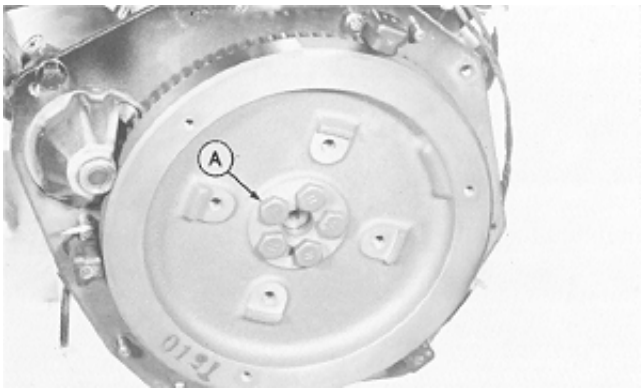
5. Remove four cap screws to remove stub shaft (A).



-UN-08JAN90
M46035

5M4,T1220,3 -19-17SEP87

6. Remove cap screws (A) to remove flywheel.

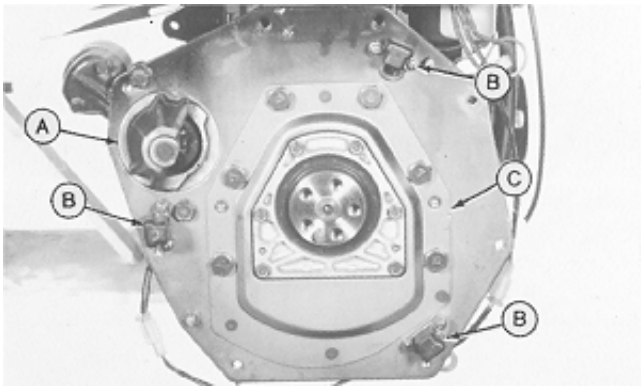


5M4,T1220,4 -19-17SEP87

7. Remove starter (A).

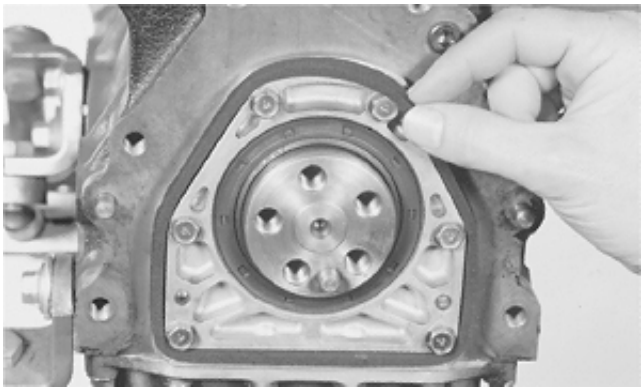
8. Remove three pulsars (B).

9. Remove six large-headed cap screws to remove mounting plate (C).



5M4,T1220,5 -19-17SEP87

10. Remove foam seal.



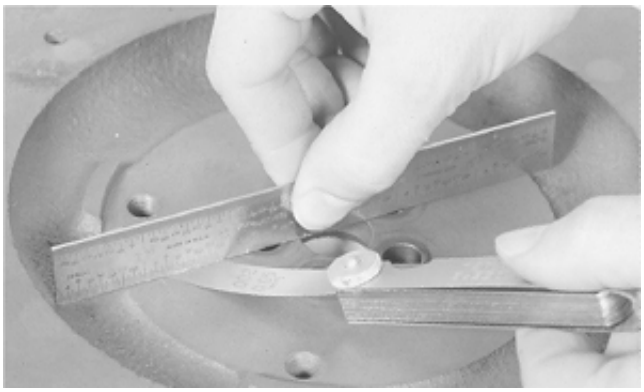
5M4,T1220,6 -19-17SEP87

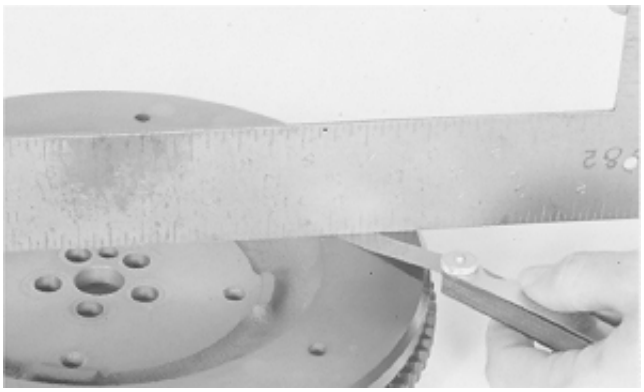
INSPECT FLYWHEEL AND STUB SHAFT

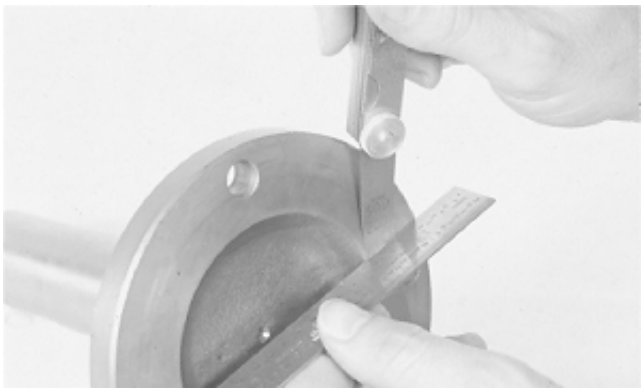
1. Check flywheel and stub shaft flatness using a straight edge and feeler gauge.

2. New part flatness specification is 0.05 mm (0.002 in.).

3. Inspect flywheel ring gear for chipped or broken teeth. Replace flywheel as necessary.


M35336 -UN-29AUG88

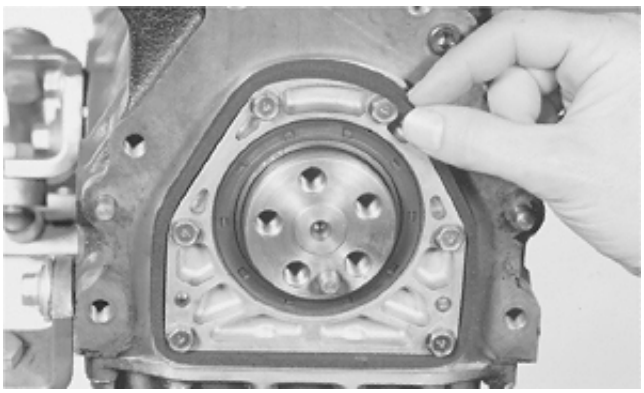

M35337 -UN-29AUG88


M35338 -UN-29AUG88

5M4,T1220,7 -19-17SEP87

INSTALL FLYWHEEL AND FLYWHEEL HOUSING

1. Install foam seal.

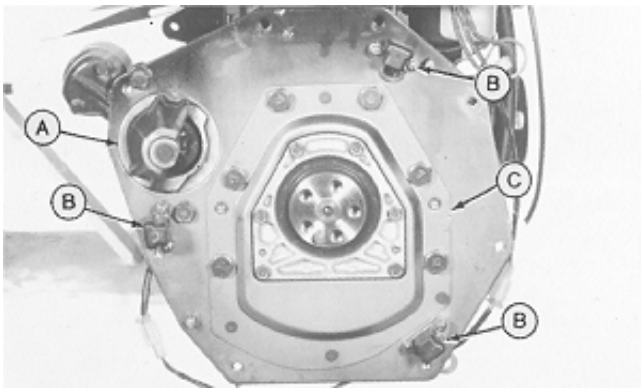

M35341 -UN-29AUG88

5M4,T1220,8 -19-17SEP87

2. Install mounting plate (C). Tighten cap screws to 49 N·m (36 lb-ft).

3. Install three pulsars (B).

4. Install starter (A). Tighten nuts to 49 N·m (36 lb-ft).

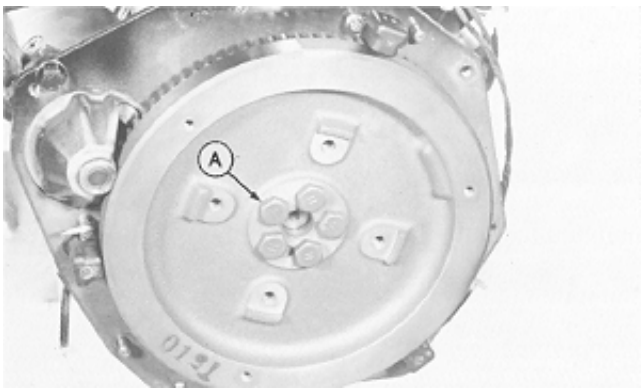


5M4,T1220,9 -19-17SEP87

5. Align hole in flywheel with pin in crankshaft.

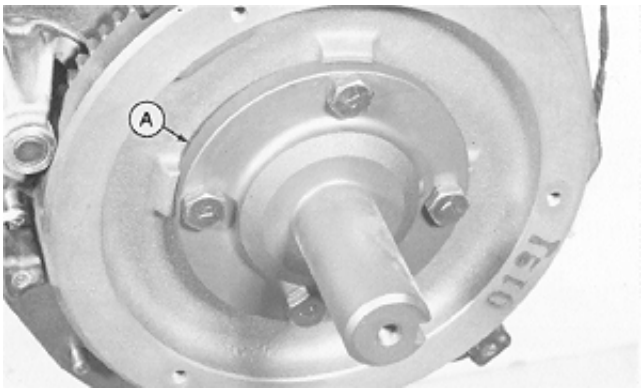
IMPORTANT: Install new cap screws each time flywheel is removed.

6. Install flywheel, and cap screws (A). Tighten cap screws to 83 N·m (61 lb-ft).



5M4,T1220,10 -19-17SEP87

7. Install stub shaft (A) and four cap screws. Tighten cap screws to 59 N·m (44 lb-ft).

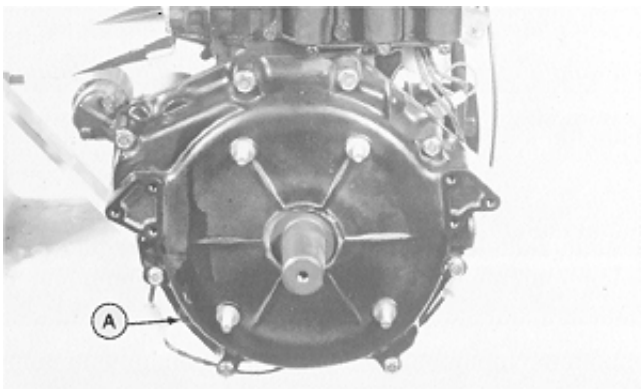


5M4,T1220,11 -19-17SEP87

8. If equipped, install flywheel housing (A) and cap screws.

FLYWHEEL HOUSING OR SHIELD TORQUE SPECIFICATIONS

Engine	Item	Specification
3TG66	Cap Screw (A) (2 used)	49 N·m (36 lb-ft)
3TG72	Cap Screw (B) (5 or 6 used)	26 N·m (226 lb-in.)



5M4,T1220,12 -19-17SEP87

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Feeler Gauge	Measure clearances
Outside Micrometer	Measure engine components
Cylinder Bore Ridge Reamer	To remove ridge from top of cylinder bore
Telescoping Gauge	Measure engine components
Piston Ring Expander	Remove and install piston rings
Bushing, Bearing, and Seal Driver Set	Remove and install connecting rod bushing
Vernier Calipers	Measure piston O.D.
Inside Micrometer	Measure piston bore I.D.
Flex Hone	To deglaze cylinder bores
Piston Ring Compressor	Install pistons in cylinder block

M21,TM325,1 -19-06AUG87

25
1

OTHER MATERIALS

Name	Use
PLASTIGAGE®	Measure connecting rod bearing clearance

PLASTIGAGE is a trademark of the TRW Corporation

M21,TM325,2 -19-22APR86

SERVICE PART KITS

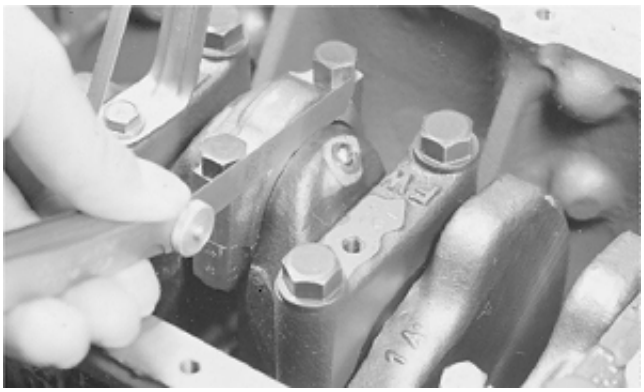
The following kits are available through your parts catalog:

Cylinder Block Gasket Kit.

Cylinder Head Gasket Kit.

M21,TM325,3 -19-03MAR86

MEASURE CONNECTING ROD SIDE PLAY



1. Remove engine. (See machine technical manual.)

2. If equipped, remove electric clutch assembly. (See machine technical manual.)

3. Remove flywheel assembly. (See Group 20 in this manual.)

4. Remove oil pan.

5. Measure connecting rod side play.

CONNECTING ROD SIDE PLAY SPECIFICATION

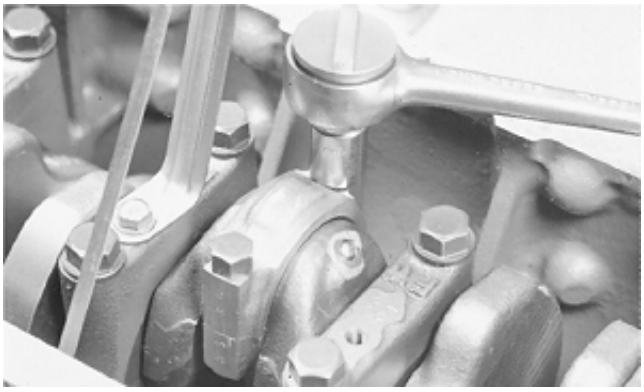
Engine	Wear Tolerance
3TG66 and 3TG72	0.8 mm (0.031 in.)

If side play exceeds wear tolerance, replace connecting rod and connecting rod cap.

25
2

5M4,T1225,1 -19-17SEP87

MEASURE CONNECTING ROD BEARING CLEARANCE



Measure each connecting rod bearing clearance, using the following PLASTIGAGE method or by measuring after the pistons have been removed:

PLASTIGAGE Method

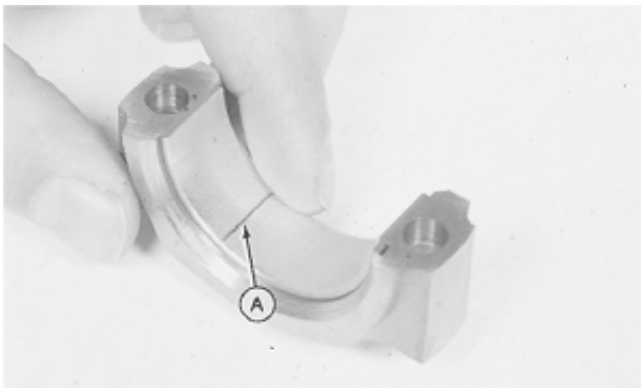
IMPORTANT: Connecting rod end caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove connecting rod cap.

2. Wipe oil from bearing insert and crankshaft journal.

M21,TM325,11 -19-22APR86

3. Put PLASTIGAGE (A) or an equivalent on the full length of the bearing insert about 6 mm (0.25 in.) off center.

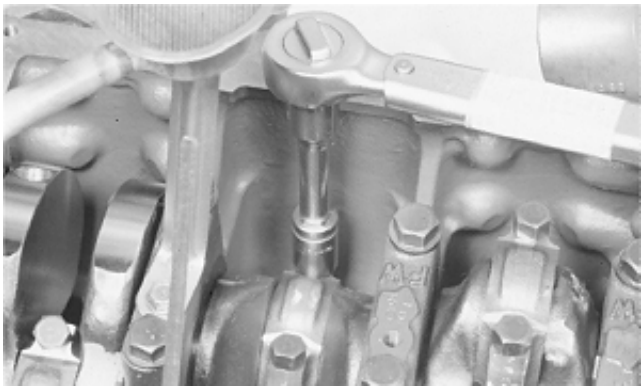


M21,TM325,12 -19-03MAR86

4. Turn crankshaft about 30˚ from BDC (bottom dead center). Install connecting rod cap and cap screws. Tighten cap screws to specifications.

CONNECTING ROD CAP SCREW TORQUE SPECIFICATION

Engine	Specification
3TG66 and 3TG72	23 N·m (200 lb-in.)



5M4,T1225,2 -19-17SEP87

5. Remove cap screws and connecting rod cap.

6. The flattened Plastigage will be found on either the bearing or crankshaft journal.

7. Use the graduation marks on the envelope to compare the width of the flattened Plastigage at its WIDEST point.

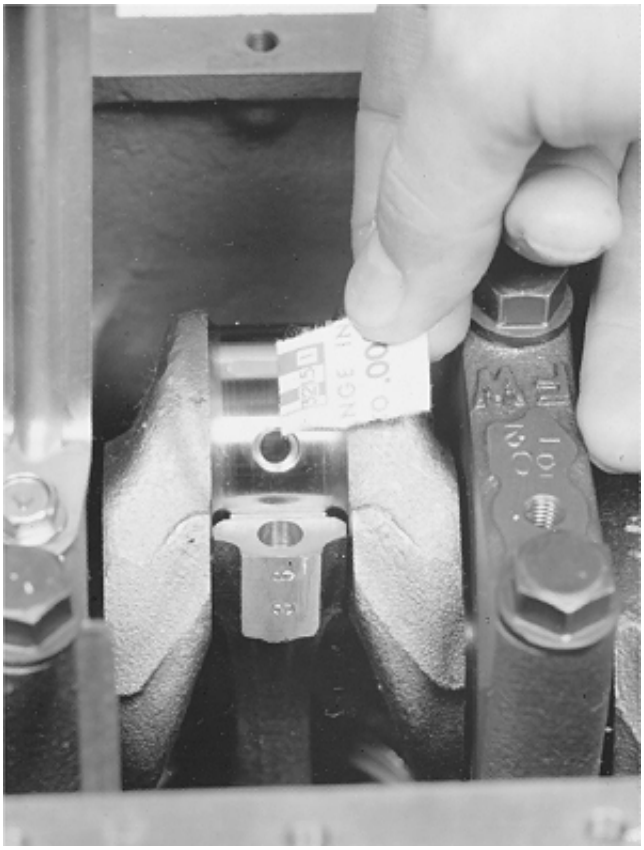
8. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in thousandths of an inch or in millimeters depending on which side of the envelope is used. Remove plastigage.

CONNECTING ROD BEARING CLEARANCE SPECIFICATION

Engine	Wear Tolerance
3TG66 and 3TG72	0.12 mm (0.0048 in.)

If clearance exceeds wear tolerance, replace bearings.

If clearance is correct, install connecting rod caps. Install and tighten cap screws to specifications.



5M4,T1225,3 -19-17SEP87

REMOVE PISTONS AND CONNECTING RODS

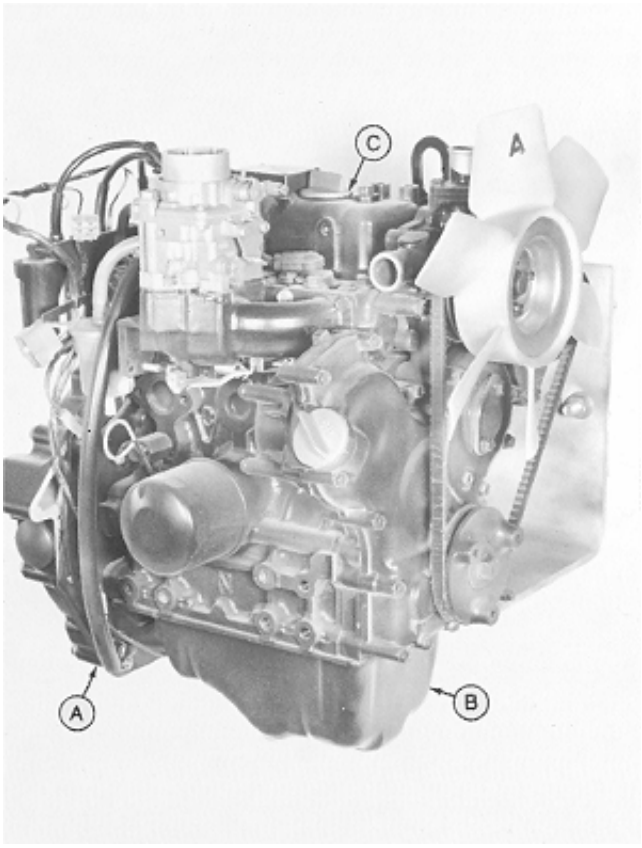
1. Remove engine. (See machine technical manual.)

2. If equipped, remove electric clutch assembly. (See machine technical manual.)

3. Remove flywheel assembly (A). (See Group 20 in this manual.)

4. Remove oil pan (B).

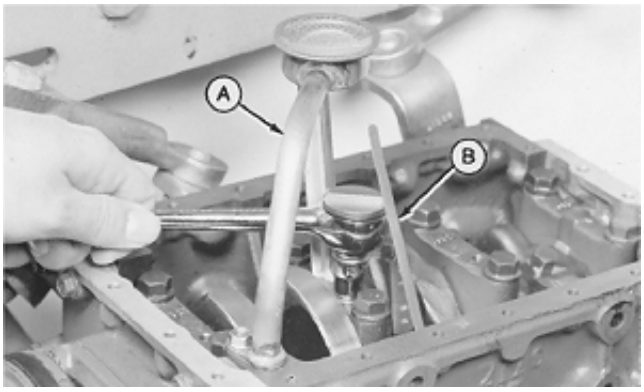
5. Remove cylinder head (C). (See Group 15 in this manual.)



-UN-08JAN90
M46088

5M4,T1225,4 -19-21SEP87

6. Remove two cap screws, oil suction strainer (A), and dipstick (B).

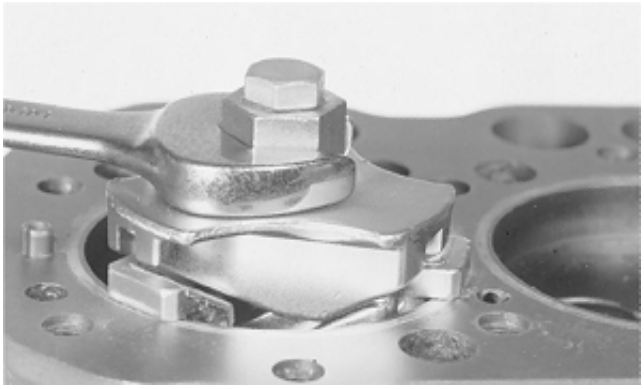


-UN-29AUG88
M35354

5M4,T1225,5 -19-21SEP87

7. Before piston removal, check cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed.

8. If necessary, remove ridge from top of cylinder bore using a ridge reamer.



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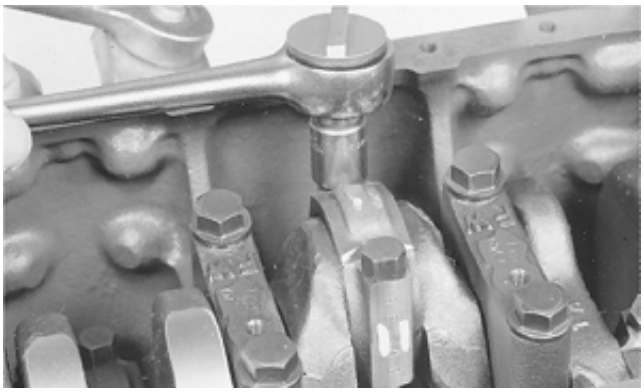
M35355

5M4,T1225,6 -19-21SEP87

IMPORTANT: Connecting rod caps must be installed on the same connecting rod they were removed from.

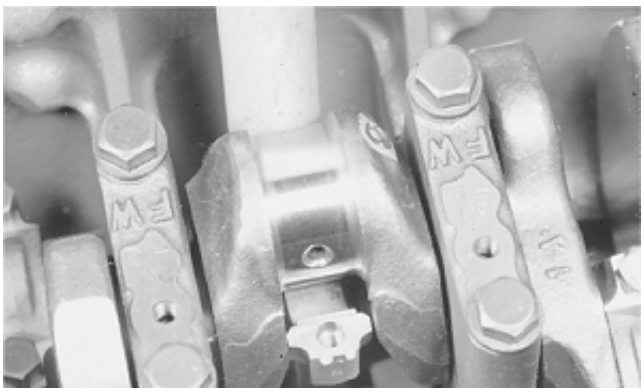
9. Remove two cap screws to remove connecting rod cap.



M35356 -UN-29AUG88

5M4,T1225,7 -19-12OCT87

10. Push piston and connecting rod out of cylinder bore using a wooden dowel.



M35357 -UN-29AUG88

5M4,T1225,8 -19-21SEP87

INSPECT PISTONS AND CONNECTING RODS

1. Measure crankshaft connecting rod journal diameter. Measure several places around each journal and each side of every journal.

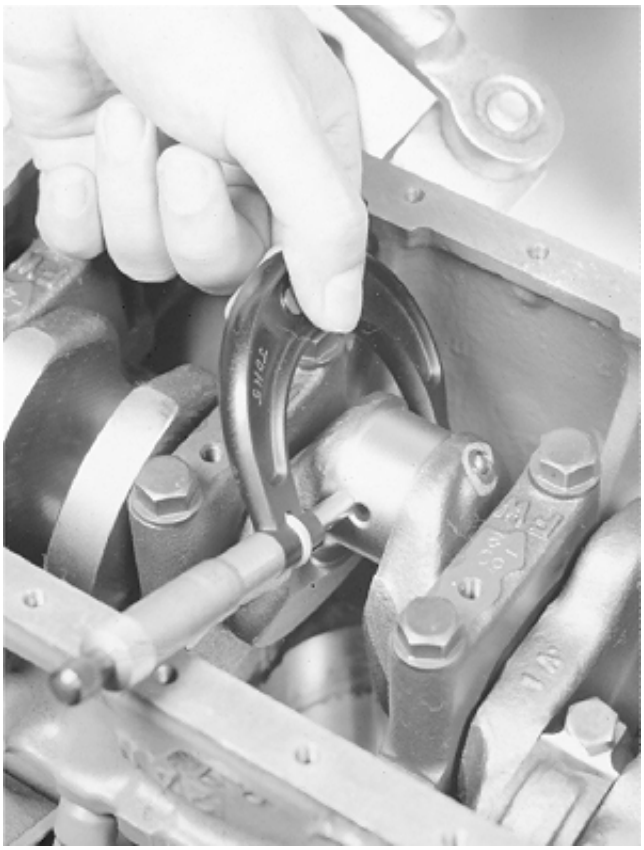
NOTE: If engine has had a previous major overhaul, connecting rod journals may have been ground and undersize bearing inserts installed.

CONNECTING ROD JOURNAL O.D. SPECIFICATION

Engine	Wear Tolerance
3TG66	35.93 mm (1.415 in.)
3TG72	39.93 mm (1.572 in.)

2. If journal diameter is less than wear tolerance, replace crankshaft or have journals ground undersize by a qualified machine shop.

If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.



M35358 -UN-29AUG88

5M4,T1225,9 -19-21SEP87

3. Install connecting rod cap and bearing insert on connecting rod. Tighten connecting rod cap screws to specifications.

4. Measure connecting rod bearing diameter and connecting rod bearing clearance (bearing I.D. minus journal O.D.).

CONNECTING ROD CAP SCREW TORQUE SPECIFICATION

Engine	Specification
3TG66	23 N·m (200 lb-in.)
3TG72	

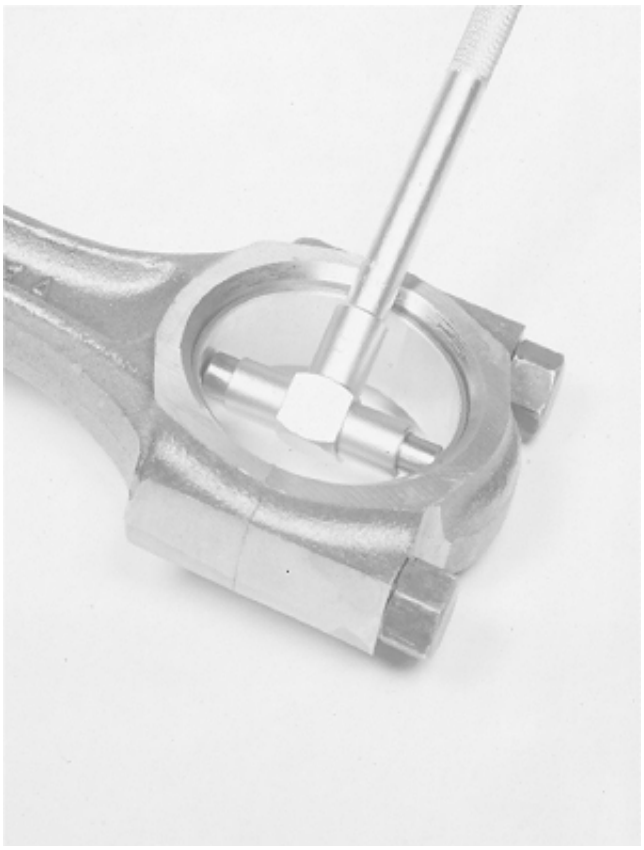
CONNECTING ROD BEARING SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	Bearing I.D.	36.07 mm (1.420 in.)
3TG66	Clearance	0.12 mm (0.005 in.)
3TG72	Bearing I.D.	40.07 mm (1.577 in.)
3TG72	Clearance	0.12 mm (0.005 in.)

If bearing diameter exceeds wear tolerance, replace bearing inserts.

If bearing clearance exceeds wear tolerance, grind crankshaft connecting rod journals and install undersize bearing inserts, or replace bearing inserts and crankshaft.

If bearing diameter and clearance are within specifications and bearings are not damaged, bearings can be reused.



M35359 -UN-29AUG88

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5M4,T1225,10 -19-12OCT87

5. Measure piston ring groove clearance. Measure several places around each piston.

PISTON RING GROOVE SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	Clearance	0.25 mm
3TG72	(all rings)	(0.010 in.)

If clearance exceeds wear tolerance, replace rings or piston.

M35360 -UN-29AUG88

5M4,T1225,11 -19-21SEP87

6. Remove piston rings using a piston ring expander.

7. If necessary, clean piston ring groove with a piston ring groove cleaner, or the end of a piston ring filed to a sharp point.

M35361 -UN-29AUG88

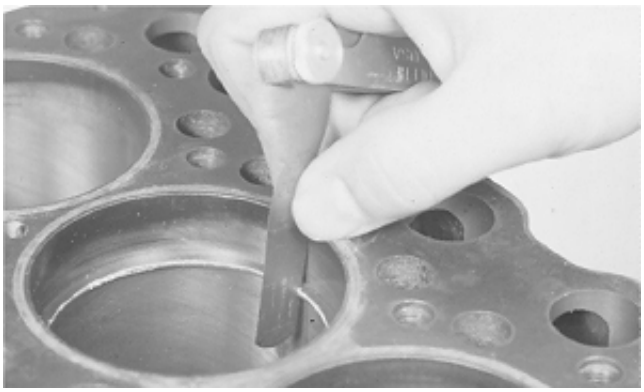
M21,TM325,23 -19-04FEB86

8. Measure piston ring end gap. Push ring into cylinder bore until ring is approximately 30 mm (1.181 in.) from bottom of cylinder bore.

PISTON RING GAP SPECIFICATIONS

Engine	Measurement (End Gap)	Wear Tolerance
3TG66	Top Ring	1.30 mm (0.051 in.)
	Second Ring	1.30 mm (0.051 in.)
	Oil Ring	1.80 mm (0.071 in.)
3TG72	Top Ring	1.25 mm (0.049 in.)
	Second Ring	1.25 mm (0.049 in.)
	Oil Ring	1.90 mm (0.075 in.)

If end gap exceeds wear tolerance, replace rings.



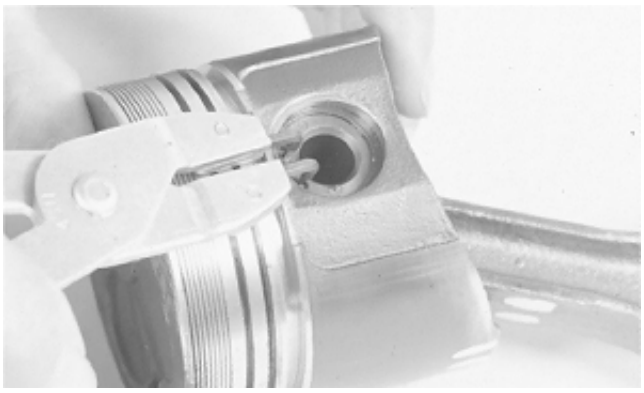
5M4,T1225,12 -19-12OCT87

IMPORTANT: Pistons must be installed in the same direction and on the same connecting rod they were removed from.

9. Put a mark on each piston and connecting rod for proper identification to aid in assembly.

10. Remove two snap rings.

11. Remove piston pin using a wooden dowel.



M21,TM325,25 -19-04MAR86

12. Measure diameter of piston pin at six places; two measurements 90° apart at each end and two measurements 90° at center.

PISTON PIN O.D. SPECIFICATION

Engine	Wear Tolerance
3TG66	19.9 mm (0.783 in.)
3TG72	20.9 mm (0.823 in.)

If pin diameter is less than wear tolerance, replace pin.

M35365 -UN-29AUG88

5M4,T1225,13 -19-21SEP87

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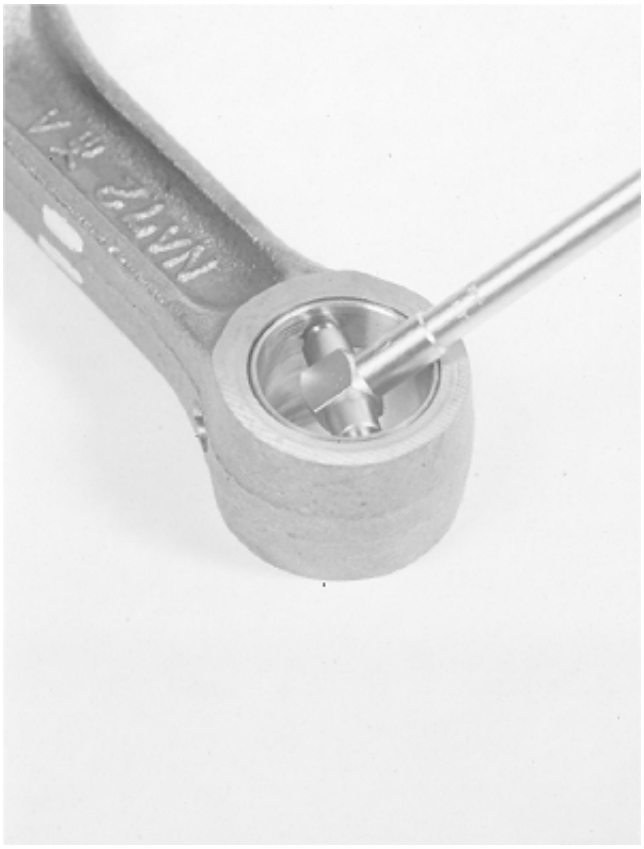
13. Measure piston pin bushing and piston pin bushing clearance (bushing I.D. minus pin O.D.).

PISTON PIN BUSHING SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	Bushing I.D.	20.1 mm (0.791 in.)
	Clearance	0.15 mm (0.006 in.)
3TG72	Bushing I.D.	21.1 mm (0.831 in.)
	Clearance	0.15 mm (0.006 in.)

If bushing diameter exceeds wear tolerance, replace bushing.

If bushing clearance exceeds wear tolerance, replace bushing, piston pin, or both.



M35366 -UN-29AUG88

5M4,T1225,14 -19-21SEP87

14. Measure piston pin bore in piston and piston pin clearance (bore I.D. minus pin O.D.).

PISTON PIN BORE SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	Bore I.D.	20.08 mm (0.791 in.)
3TG66	Clearance	0.10 mm (0.004 in.)
3TG72	Bore I.D.	21.08 mm (0.830 in.)
	Clearance	0.10 mm (0.004 in.)

If piston pin bore diameter exceeds wear tolerance, replace piston.

If piston pin clearance exceeds wear tolerance, replace piston, piston pin, or both.

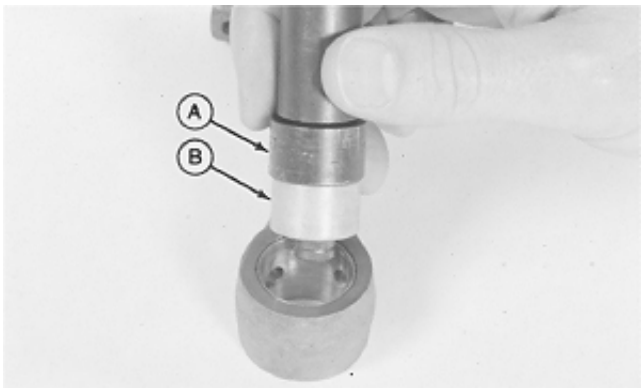
-UN-06SEP88
M37683

5M4,T1225,15 -19-21SEP87

15. Remove bushing using driver disks (A and B).

DISKS FOR BUSHING REMOVAL

Engine	Size (in.) (A)	and (B)
3TG66UJ	13/16	3/4
3TG72	15/16	13/16



-UN-29AUG88
M35368

5M4,T1225,16 -19-22SEP87

16. Measure piston O.D. perpendicular to piston pin bore at approximate specified distance from bottom of piston.

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

PISTON SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	O.D. at 4 mm (0.157 in.)	65.85 mm (2.593 in.)
3TG72	O.D. at 6 mm (0.236)	71.9 mm (2.831 in.)

If piston diameter is less than wear tolerance, install a new piston.

25 12 Inspect piston for cracks at ring lands, skirts, and pin bores.

Inspect piston for scuffing or scoring; replace as necessary.

M35369 -UN-29AUG88

5M4,T1225,17 -19-22SEP87

17. Measure piston bore I.D. at six places; two measurements 90° apart at top, middle, and bottom of ring travel.

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed.

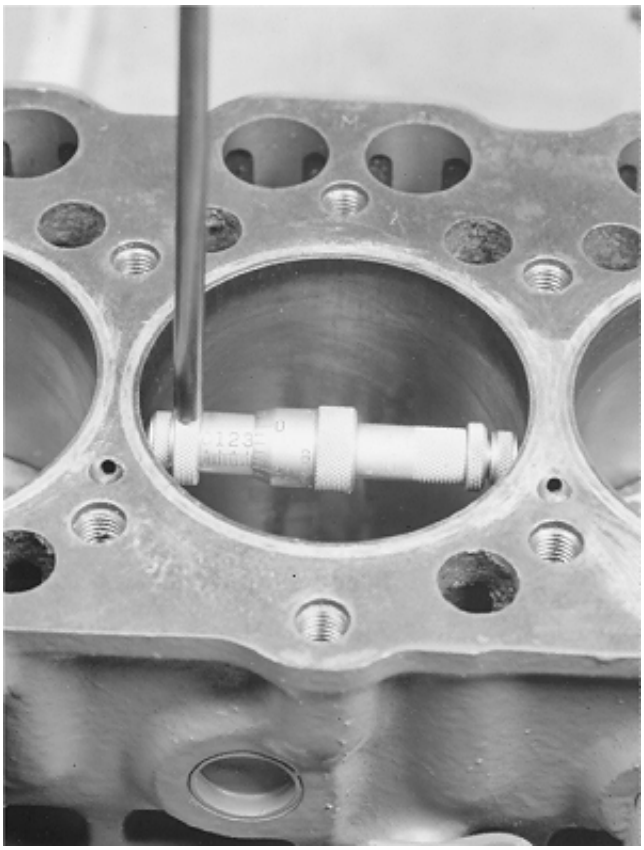
18. Measure piston clearance (piston bore I.D. minus piston O.D.).

CYLINDER BORE SPECIFICATIONS

Engine	Measurement	Wear Tolerance
3TG66	Bore I.D.	66.12 mm (2.603 in.)
3TG66	Piston clearance	0.15 mm (0.059 in.)
3TG72	Bore I.D.	72.15 mm (2.841 in.)
3TG72	Piston clearance	0.15 mm (0.059 in.)

If cylinder bore exceeds wear tolerance, replace cylinder block or have cylinder rebored by a qualified machine shop. If cylinder is rebored, oversize piston and rings must be installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

If piston clearance exceeds wear tolerance, replace cylinder block, piston or both; or rebore cylinder and install oversize piston and rings.



M35370 -UN-29AUG88

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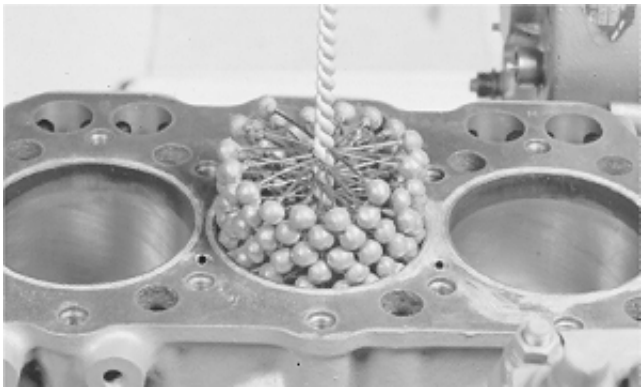
5M4,T1225,18 -19-22SEP87

DEGLAZE CYLINDER BORES

IMPORTANT: If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex-hone.



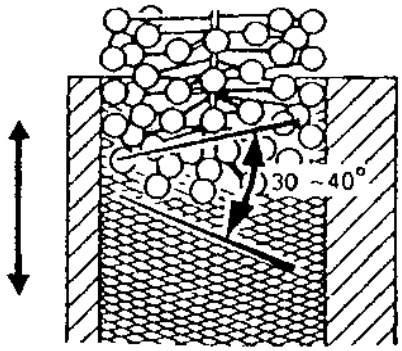
M35371 -UN-29AUG88

5M4,T1225,19 -19-05OCT87

2. Use flex-hone as instructed by manufacturer to obtain 30—40° crosshatch pattern as shown.

IMPORTANT: Do not use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Remove excess abrasive residue from cylinder walls using a clean dry rag. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.



M52958 -UN-05APR89

M21,TM325,33 -19-04MAR86

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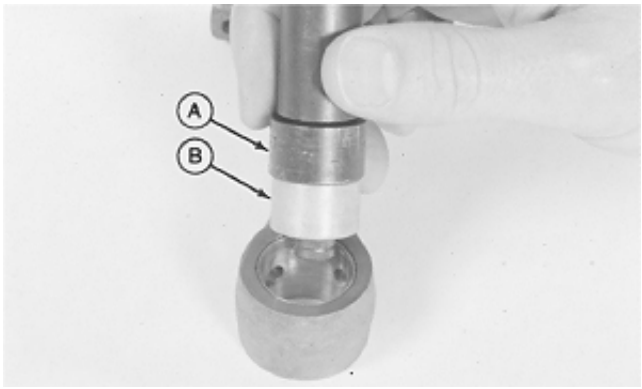
ASSEMBLE PISTONS AND CONNECTING RODS

1. Turn bushing so oil holes in bushing and connecting rod are aligned.

2. Install bushing using driver disks (A and B).

DISKS FOR BUSHING INSTALLATION

Engine	Size (in.) (A)	(B)
3TG66	1	3/4
3TG72	1	13/16



M35368 -UN-29AUG88

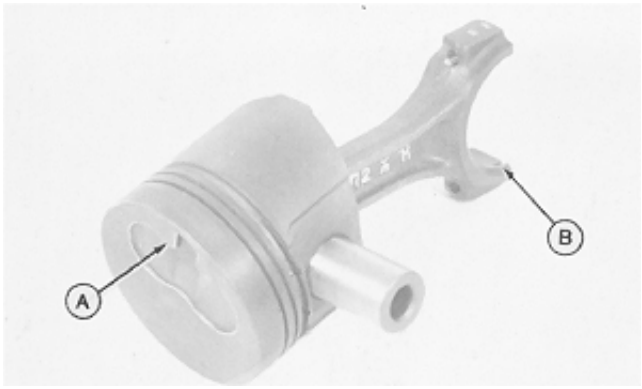
5M4,T1225,20 -19-12OCT87

IMPORTANT: Pistons must be installed on connecting rods from which they were removed.

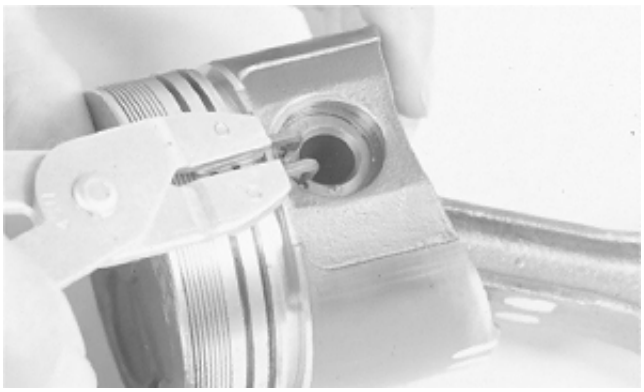
3. Identification marks on piston must be the same side as marks on connecting rod. If a new piston or connecting rod is used, assemble piston to connecting rod with piston recess (A) opposite bearing insert groove (B).

4. Put clean engine oil on piston pin. Install pin through piston and connecting rod.

5. Install snap rings. Be sure snap rings are fastened in groove all around.



M37685 -UN-06SEP88



M35364 -UN-29AUG88

M21,TM325,35 -19-04MAR86

6. Install oil ring expander in bottom piston ring groove. Turn expander so ends are above either end of piston pin

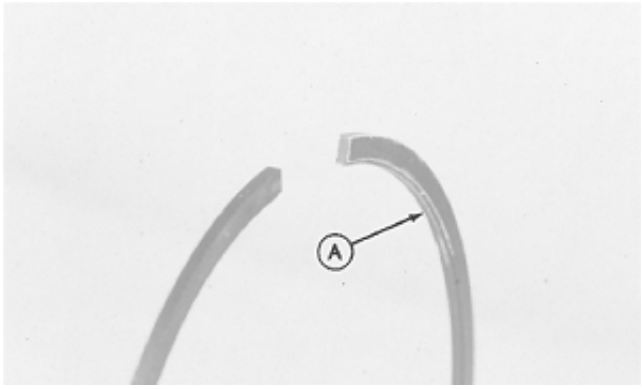
7. Install oil ring over expander with a piston ring expander. Turn oil ring so ends are on opposite side of piston from the expander ends.

M35361 -UN-29AUG88

M21,TM325,36 -19-04MAR86

8. Install second ring in middle groove, with chamfer (A) toward top of piston. Turn ring until gap is 120˚ away from oil ring gap.

Install rectangular ring, with identification mark (B) toward top of piston, in top groove. Turn ring until gap is 120˚ away from second ring gap.



M35372 -UN-08SEP88

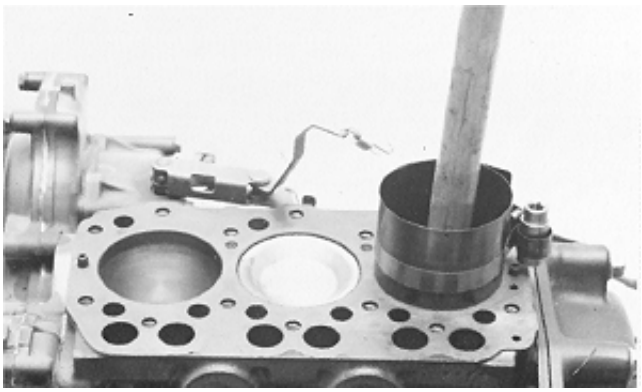
5M4,T1225,21 -19-22SEP87

INSTALL PISTONS AND CONNECTING RODS

IMPORTANT: Pistons must be installed in cylinders from which they were removed and in the same direction. Be careful not to damage crankshaft rod journal while installing piston.

1. Put clean engine oil on pistons, rings, and cylinder bore.

2. Install pistons using a piston ring compressor. Push pistons down until top ring is in cylinder.



5M4,T1225,22 -19-22SEP87

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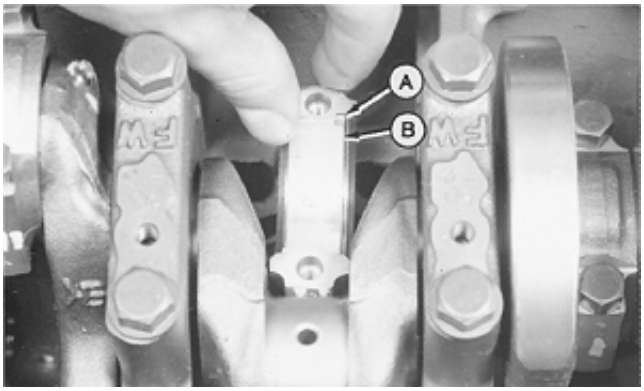
IMPORTANT: Do not touch the bearing insert surface. Oil and acid from your finger will corrode the bearing surface.

3. Install bearing insert in connecting rod with tang (B) in groove (A).

4. Put clean engine oil on insert and crankshaft journal.

5. Pull connecting rod to crankshaft.

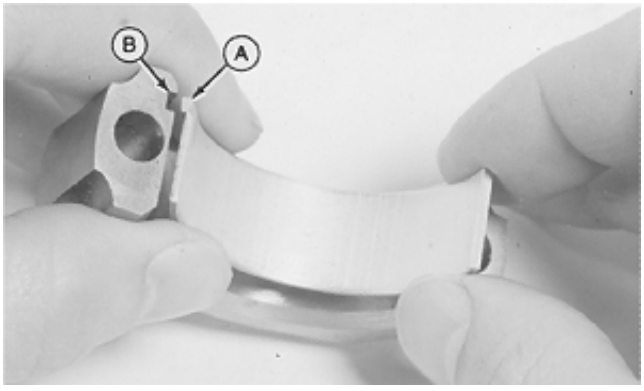


M21,TM325,39 -19-04MAR86

IMPORTANT: Do not touch the bearing insert surface. Oil and acid from your finger will corrode the bearing surface.

6. Install bearing insert in connecting rod cap with tang (A) in groove (B).

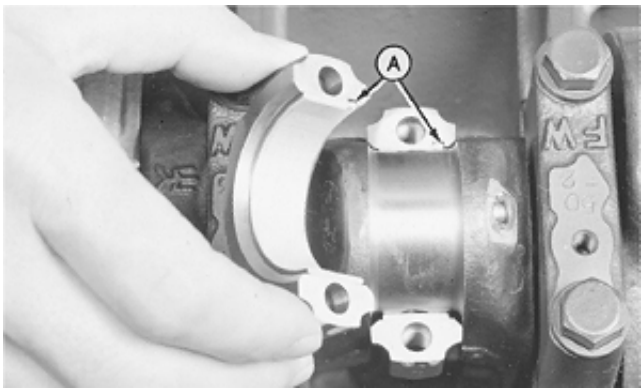
7. Put clean engine oil on insert.



M21,TM325,40 -19-04MAR86

IMPORTANT: Connecting rod caps must be installed on the same connecting rod they were removed from and in the same direction.

8. Install cap on connecting rod with tangs (A) to same side.



M35376 -UN-06SEP88

M21,TM325,41 -19-04MAR86

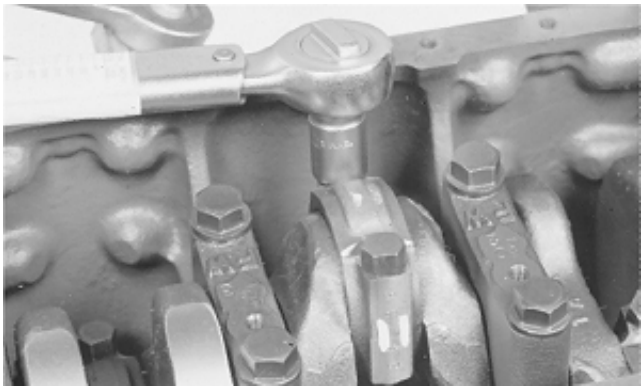
IMPORTANT: Never reuse connecting rod cap screws.

9. Dip entire connecting rod cap screw in clean engine oil. Install cap screws in connecting rods.

10. Tighten cap screws to specifications.

CONNECTING ROD CAP SCREW TORQUE SPECIFICATION

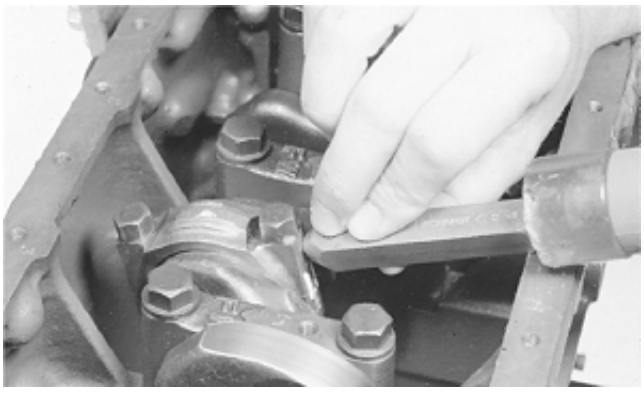
Engine	Specifications
3TG66, 3TG72	12 ± 2 N·m (200 ± 17 lb-in.)



M35377 -UN-06SEP88

5M4,T1225,23 -19-12OCT87

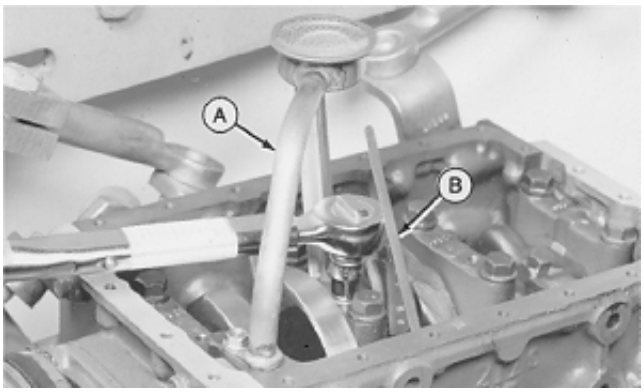
11. If a new piston and connecting rod have been installed, stamp a number corresponding to the cylinder number on the connecting rod cap and connecting rod.



M35378 -UN-06SEP88

M21,TM325,43 -19-04MAR86

12. Install dipstick (B), oil suction strainer (A), and two cap screws.
13. Install oil pan.
14. Install flywheel assembly. (See Group 20 in this manual.)
15. Install cylinder head (See Group 15 in this manual.)
16. If equipped, install electric clutch assembly. (See machine technical manual.)
17. Install engine. (See machine technical manual.)



5M4,T1225,24 -19-12OCT87

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SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Dial Indicator	Measure crankshaft end play
Magnetic Base with Adjustable Arm	To hold dial indicator
Bushing, Bearing, and Seal Driver Set	Remove and install seals
13-Ton Puller Set	Remove crankshaft gear
Press	To service crankshaft gear
Outside Micrometer	Measure crankshaft journals
Telescoping Gauge	Measure crankshaft bearing bore

M21,TM330,1 -19-05MAR86

SERVICE PART KITS

The following kits are available through your parts catalog:

Cylinder Block Gasket Kit

Cylinder head Gasket Kit

M21,TM330,2 -19-23APR86

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OTHER MATERIAL

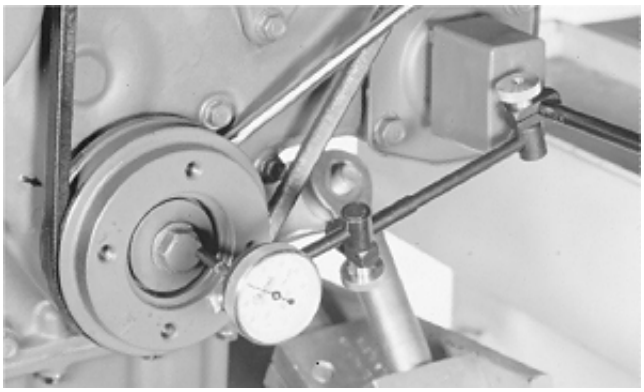
Number	Name	Use
	PLASTIGAGE®	Measure crankshaft bearing clearance
PT94	John Deere Form-In-Place Gasket (RTV rubber silicone sealant)	To seal oil seal case

PLASTIGAGE is a trademark of the TRW Corporation

LOCTITE is a trademark of the LOCTITE Corp.

M21,TM330,3 -19-06AUG87

MEASURE CRANKSHAFT END PLAY



1. Fasten dial indicator to engine.

IMPORTANT: Do not use excessive force when moving crankshaft to avoid damaging bearings.

2. Push crankshaft toward front then toward rear.

3. Measure crankshaft end play.

CRANKSHAFT END PLAY SPECIFICATION

Engine	Wear Tolerance
3TG66	0.30 mm (0.012)
3TG72	0.50 mm (0.020 in.)

If crankshaft end play exceeds wear tolerance, remove crankshaft and inspect thrust bearings for wear.

5M4,T1230,1 -19-12OCT87

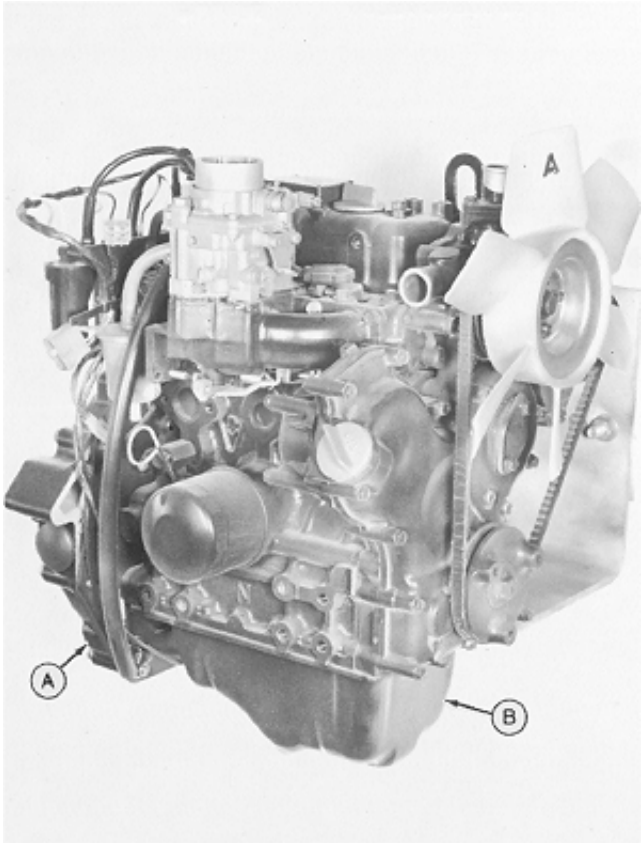
MEASURE CRANKSHAFT BEARING CLEARANCE

1. Remove engine. (See machine technical manual.)

2. If equipped, remove electric clutch assembly. (See machine technical manual.)

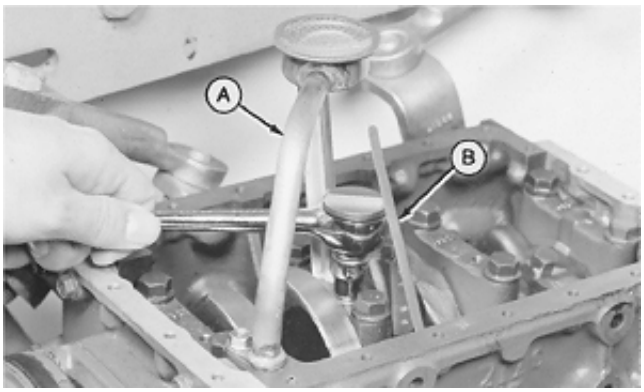
3. Remove flywheel assembly (A). (See Group 20 in this manual.)

4. Remove oil pan (B).



5M4,T1230,2 -19-22SEP87

5. Remove oil suction strainer (A), and dipstick (B).



M35354 -UN-29AUG88

M21,TM330,8 -19-06AUG87

6. Measure reach crankshaft bearing clearance using the following PLASTIGAGE method or by measuring after the crankshaft has been removed.

PLASTIGAGE method:

IMPORTANT: Main bearing caps must be installed on the same main bearing from which they were removed. Arrows on bearing caps point toward flywheel end of block.

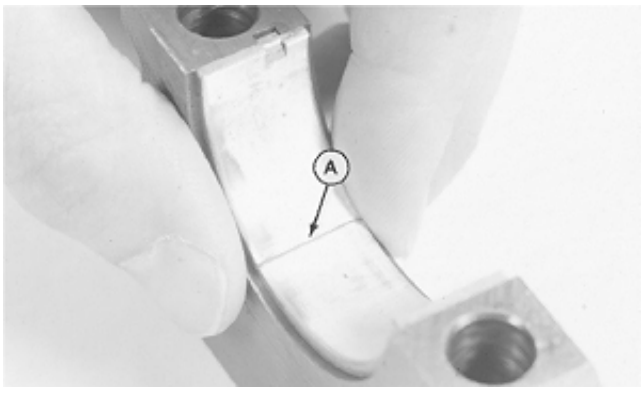
a. Remove main bearing cap.

b. Wipe oil from bearing insert and crankshaft journal.

M35381 -UN-06SEP88

M21,TM330,9 -19-05MAR86

c. Put a piece of PLASTIGAGE (A) or an equivalent on the full length of the bearing insert about 6 mm (1/4 in.) off center.



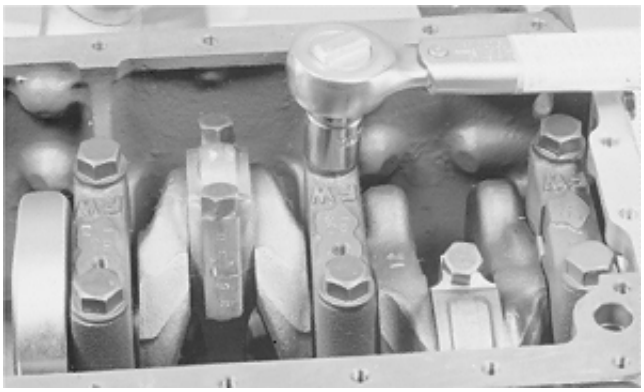
M35382 -UN-06SEP88

M21,TM330,10 -19-05MAR86

d. Install main bearing cap and cap screws. Tighten cap screws to specifications.

MAIN BEARING CAP SCREW TORQUE SPECIFICATION

Engine	Specification
3TG66	54 N·m (40 lb-ft)
3TG72	79 N·m (58 lb-ft)



5M4,T1230,3 -19-22SEP87

e. Remove cap screws and main bearing cap.

f. The flattened Plastigage will be found on either the bearing or crankshaft journal.

g. Use the graduation marks on the envelope to compare the width of the flattened Plastigage at its WIDEST point.

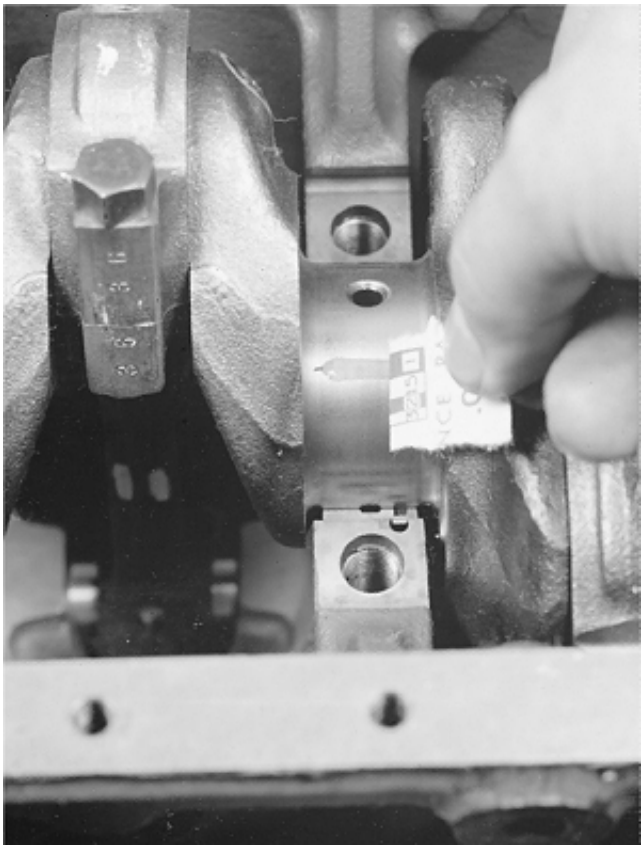
h. Determine main bearing clearance. The number within the graduation marks on the envelope indicates the bearing clearance in thousandths of an inch or in millimeters depending on which side of the envelope is used. Remove Plastigage.

MAIN BEARING CLEARANCE SPECIFICATION

Engine	Wear Tolerance
3TG66 3TG72	0.12 mm (0.005 in.)

If clearance exceeds wear tolerance, remove crankshaft.

If clearance is correct, install main bearing caps and tighten cap screws to specifications.



5M4,T1230,4 -19-22SEP87

REMOVE CRANKSHAFT OIL SEAL

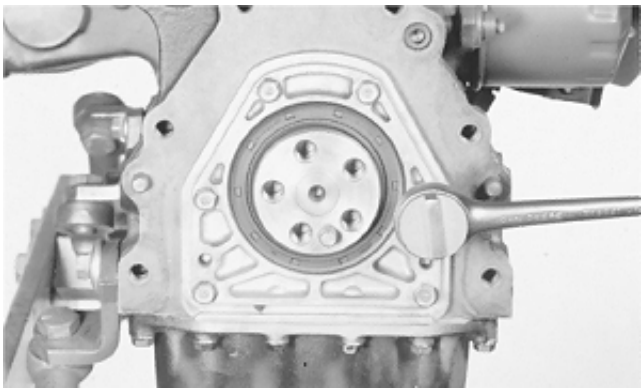
1. Remove engine. (See machine technical manual.)

2. If equipped, remove electric clutch. (See machine technical manual).

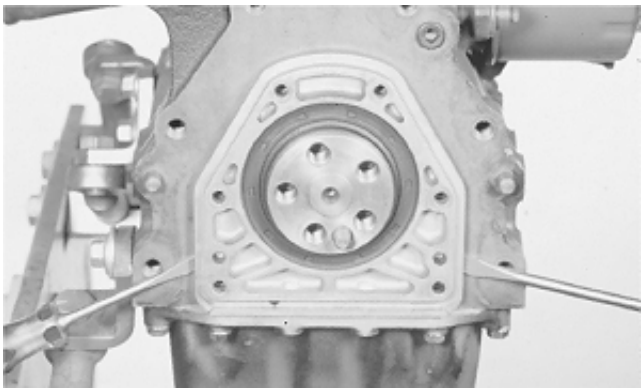
3. Remove flywheel assembly. (See Group 20 in this manual.)

4. Remove attaching cap screws.

5. Remove oil seal case.



M35404 -UN-06SEP88



M35405 -UN-06SEP88

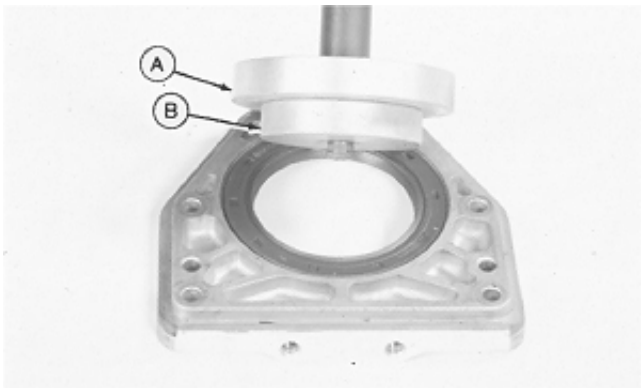
5M4,T1230,5 -19-22SEP87

6. Remove oil seal using driver disks (A and B).

7. Remove old gasket material from plate.

DISKS FOR SEAL REMOVAL

Engine	Size (in.) (A)	Size (in.) (B)
3TG66 3TG72	3-13/16	2-5/16



M35387 -UN-06SEP88

5M4,T1230,6 -19-12OCT87

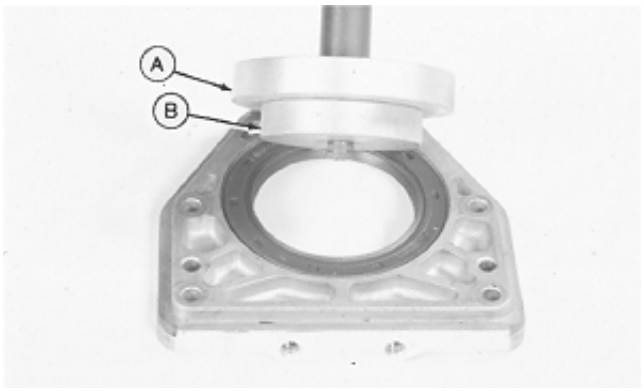
INSTALL CRANKSHAFT OIL SEAL

1. Install seal, with lip of seal, toward cylinder block. Use driver disks (A and B) to push seal even with surface of oil seal case.

If crankshaft is grooved at oil seal contact point, seal can be installed 3 mm (0.12 in.) farther into oil seal case.

DISKS FOR SEAL INSTALLATION

Engine	Size (in.) (A)	(B)
3TG66	3-13/16	2-5/16
3TG72		



-UN-06SEP88
M35387

5M4,T1230,7 -19-12OCT87

2. Apply plastic gasket or an equivalent on the oil seal case.

3. Align oil seal case with dowel pins on the cylinder block.

4. Install and tighten cap screws to specifications.

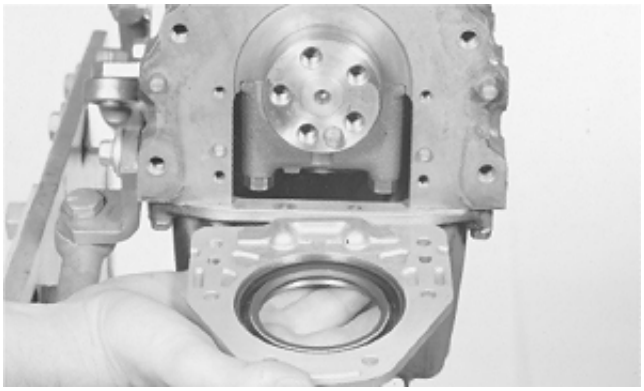
OIL SEAL CASE CAP SCREW SPECIFICATIONS

Engine	Item	Specification
3TG66, 3TG72	Seal case to block	11 N·m (96 lb-in.)
	Oil pan to seal Case	9 N·m (78 lb-in.)

5. Install flywheel assembly. (See Group 20 in this manual.)

6. If equipped install electric clutch. (See machine technical manual).

7. Install engine. (See machine technical manual.)



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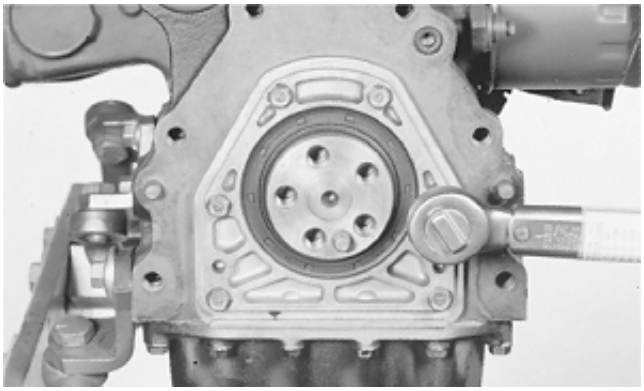
M35406



-UN-06SEP88
M35407

5M4,T1230,8 -19-12OCT87

REMOVE CRANKSHAFT

1. Remove engine. (See machine technical manual.)

2. Measure crankshaft end play. (See Group 30 in this manual.)

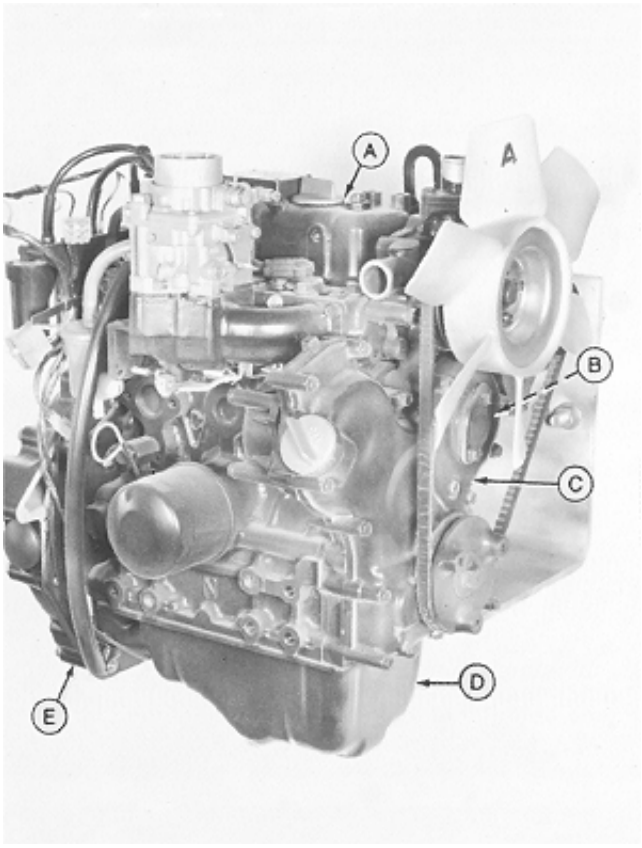
3. Remove cylinder head (A) and cam followers. (See Group 15 in this manual.)

4. Remove camshaft (B). (See Group 15 in this manual.)

5. Remove gear housing (C). (See Group 35 in this manual.)

6. Remove flywheel assembly (E). (See Group 20 in this manual.)

7. Remove oil pan (D).

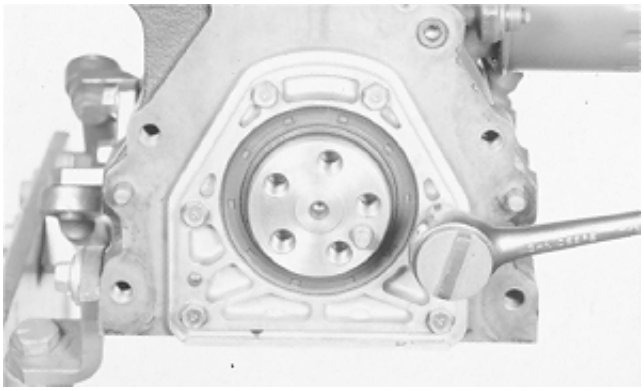


M46087 -UN-08JAN90

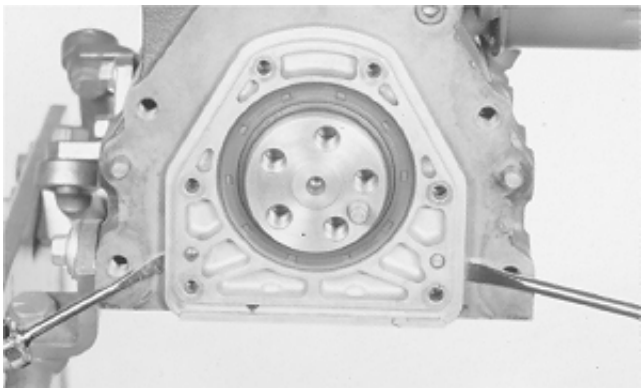
5M4,T1230,9 -19-22SEP87

8. Remove attaching cap screws.

9. Remove oil seal case.



M35385 -UN-06SEP88



M35386 -UN-06SEP88

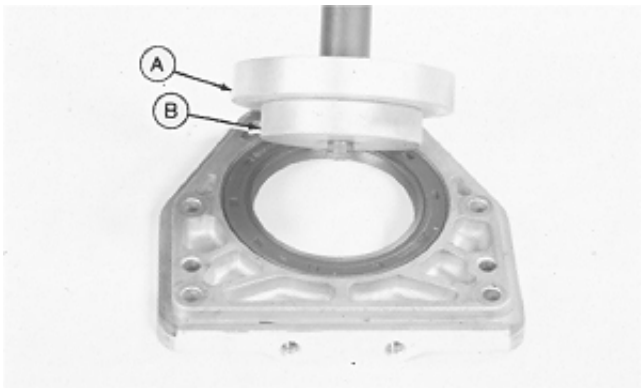
M21,TM330,19 -19-05MAR86

10. Remove oil seal using driver disks (A and B).

11. Remove old gaskets material from plate.

DISKS FOR SEAL REMOVAL

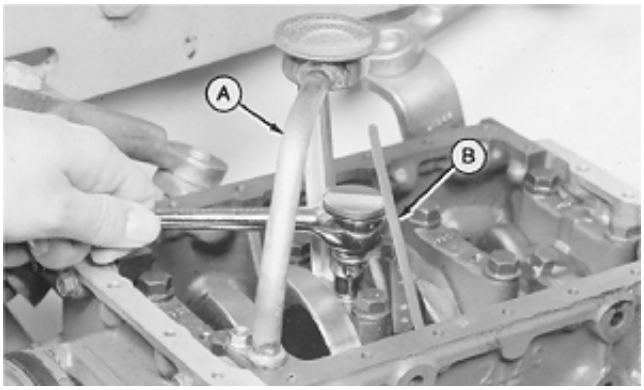
Engine	Size (in.) (A)	(B)
3TG66 3TG72	3-13/16	2-5/16



-UN-06SEP88
M35387

5M4,T1230,10 -19-12OCT87

12. Remove oil suction strainer (A), and dipstick (B).



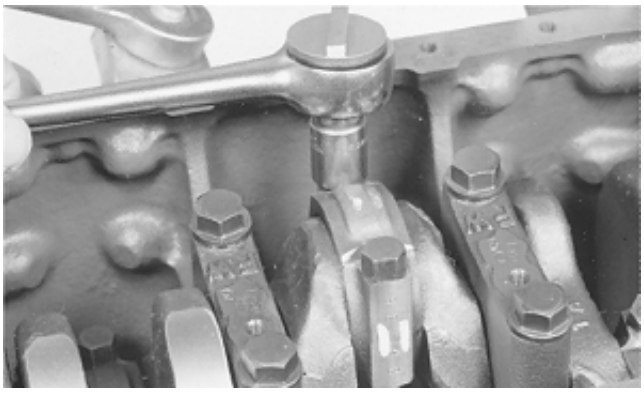
-UN-29AUG88
M35354

M21,TM330,21 -19-07AUG87

IMPORTANT: Connecting rod end caps must be installed on the same connecting rod from which they were removed.

13. Remove cap screws and connecting rod caps.

14. Push pistons and connecting rod away from crankshaft but not out of the block.



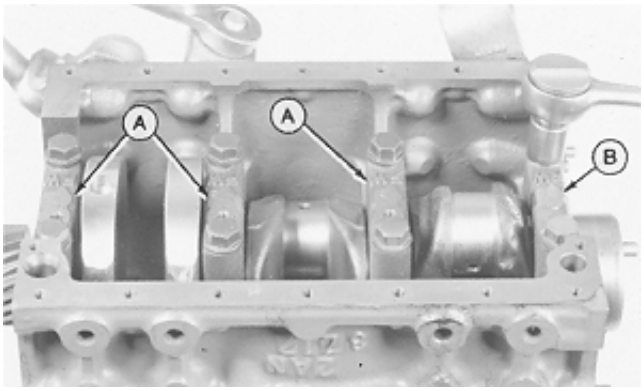
-UN-29AUG88
M35356

M21,TM330,22 -19-05MAR86

IMPORTANT: Main bearing caps must be installed on the same main bearings from which they were removed.

15. Remove cap screws and main bearing caps (A).

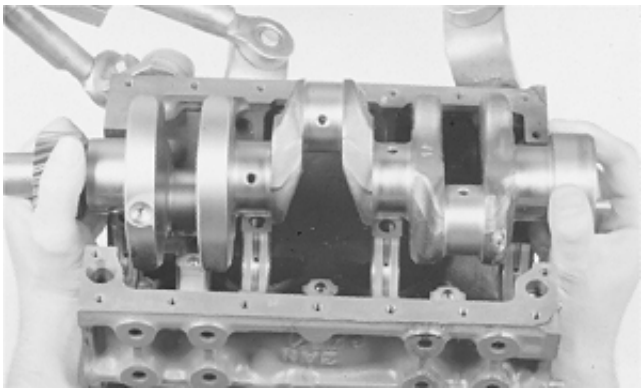
16. Remove two cap screws, main bearing cap (B), and thrust bearing set.



-UN-06SEP88
M35388

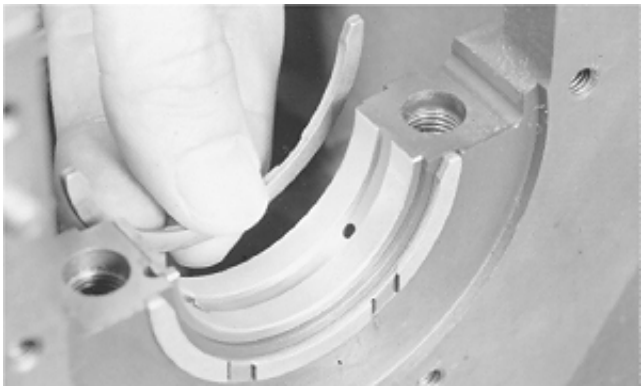
M21,TM330,23 -19-07AUG87

17. Remove crankshaft.



M21,TM330,24 -19-05MAR86

18. Remove thrust bearings.



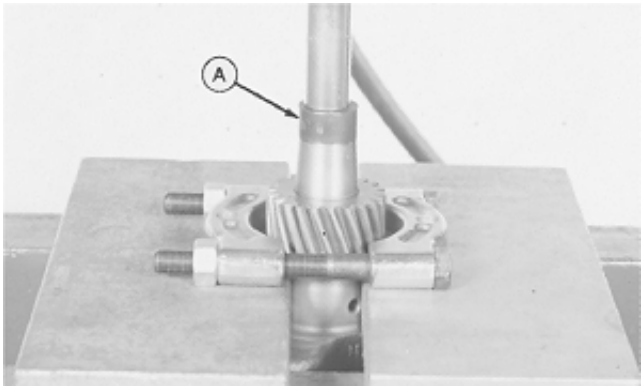
M21,TM330,25 -19-05MAR86

DISASSEMBLE AND INSPECT CRANKSHAFT

1. Inspect gear for chipped or broken teeth; replace if necessary.

IMPORTANT: Be sure to hold crankshaft while removing crankshaft gear.

2. Remove gear using a 1-in. driver disk (A), bearing puller attachment, and a press.

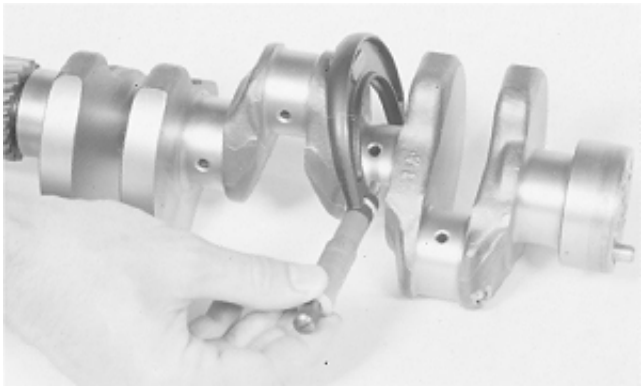


M21,TM330,26 -19-05MAR86

3. Measure crankshaft main bearing journal diameter.

NOTE: If engine has had a previous major overhaul, crankshaft journals may have been ground and undersize bearing inserts installed.

4. Measure several places around each journal and each side of every journal. For connecting rod journal specifications, see Pistons and Connecting Rods in Group 25.



M35392 -UN-06SEP88

MAIN BEARING JOURNAL O.D. SPECIFICATION

Engine	Wear Tolerance
3TG66, 3TG72	39.93 mm (1.572 in.)

If journal diameter is less than wear tolerance, replace crankshaft or have journals ground undersize by a qualified machine shop.

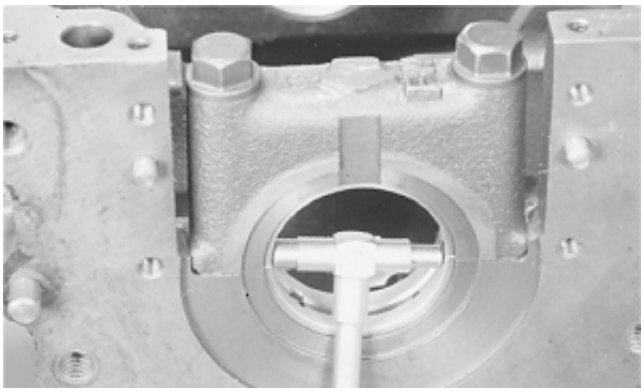
If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

30
10

5M4,T1230,11 -19-12OCT87

5. Install main bearing cap and bearing insert on main bearing. Tighten main bearing cap screws to specifications.

6. Measure main bearing diameter and main bearing clearance (bearing I.D. minus journal O.D.).



MAIN BEARING CAP SCREW TORQUE SPECIFICATION

Engine	Specifications
3TG66	54 N·m (40 lb-ft)
3TG72	79 N·m (58 lb-ft)

MAIN BEARING SPECIFICATIONS

Engine	Measurement	Specifications
3TG66	Bearing I.D.	40.93 mm (1.572 in.)
	Clearance	0.12 mm (0.005 in.)
3TG72	Bearing I.D.	43.93 mm (1.729)
	Clearance	0.12 mm (0.005 in.)

If bearing diameter exceeds wear tolerance, replace bearing inserts.

If bearing diameter exceeds wear tolerance; replace bearing inserts and crankshaft, or have crankshaft main bearing journals ground undersize by a qualified machine shop.

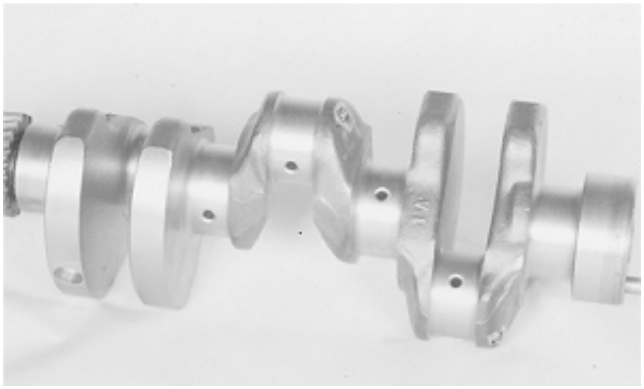
If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

If bearing diameter and clearance are within specifications and bearings are not damaged, bearings can be reused.

5M4,T1230,12 -19-22SEP87

7. Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block. Use a piece of wire to clean oil passages if necessary.

8. Inspect crankshaft for cracks or other damage; replace crankshaft as necessary.

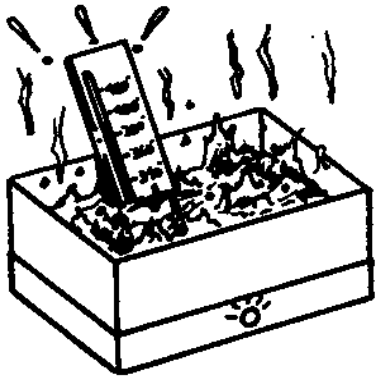


M35394 -UN-06SEP88

M21,TM330,29 -19-05MAR86

ASSEMBLE CRANKSHAFT

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



T81191 -UN-23FEB89

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12

1. Heat crankshaft gear to approximately 150˚C (300˚F).

2. Install gear (B) with timing mark “A” or dot on press table.

3. Align slot in gear with key in shaft.

4. Push crankshaft into gear until gear is tight against crankshaft shoulder. Use a 1-11/16 in. driver disk (A) and a press.

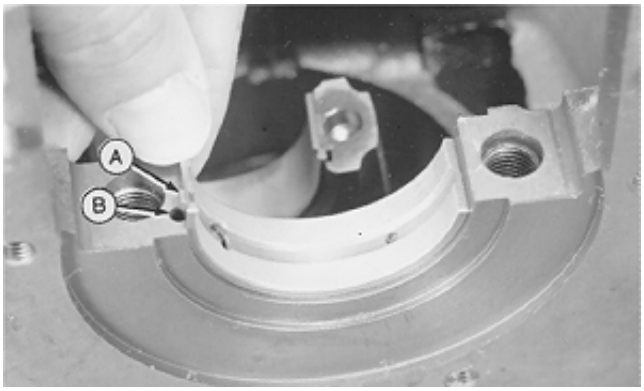
M21,TM330,30 -19-28AUG87

INSTALL CRANKSHAFT

IMPORTANT: Do not touch the bearing insert surface. Oil and acid from your finger will corrode the bearing surface.

1. Install bearing inserts in crankshaft bearing bores with tang (A) in groove (B).

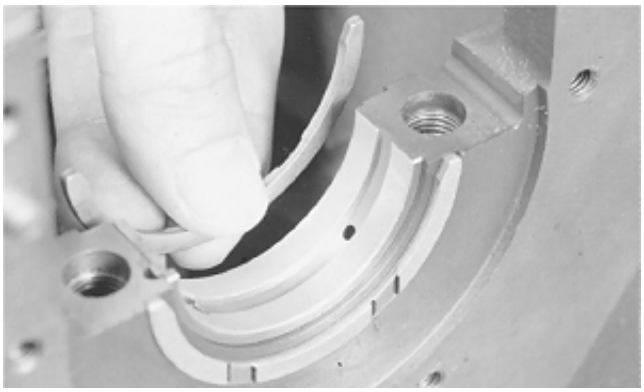
2. Put clean engine oil on inserts.



M35396 -UN-06SEP88

M21,TM330,31 -19-05MAR86

3. Install thrust bearings, with oil grooves to the outside, in the number “1” main bearing bore.

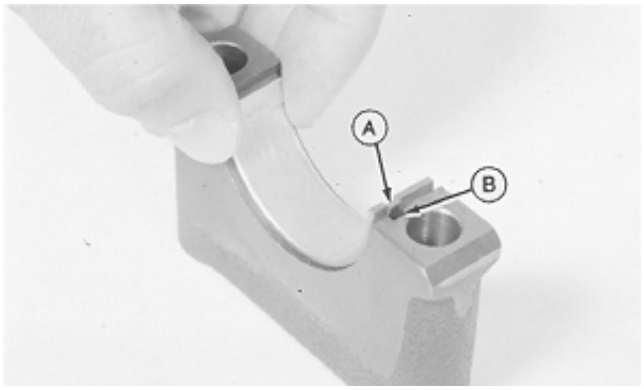


M21,TM330,32 -19-05MAR86

IMPORTANT: Do not touch the bearing insert surface. Oil and acid from your finger will corrode the bearing surface.

4. Install bearing inserts in main bearing caps with tang (A) in groove (B).

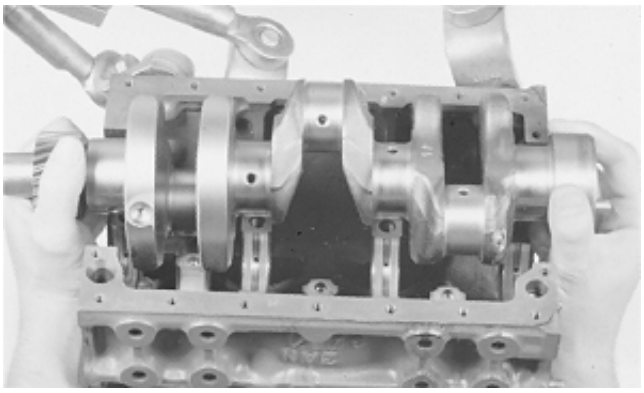
5. Put clean engine oil on insert.



M21,TM330,33 -19-05MAR86

6. Put clean engine oil on crankshaft main bearing journals.

7. Install crankshaft in cylinder block.



M21,TM330,34 -19-05MAR86

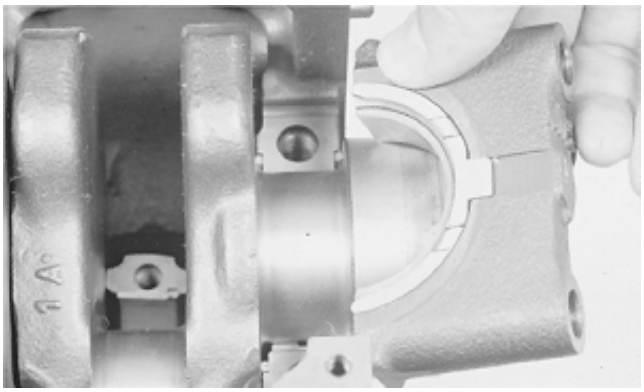
IMPORTANT: Main bearing caps must be installed on the same main bearing from which they were removed. Main bearing caps and cylinder block are numbered.

8. Install main thrust bearing, with oil grooves to the outside, in the number “1” main bearing bore.

9. Install main bearing caps in cylinder block. Caps and cylinder block are numbered, so caps can be installed in their original locations. Arrows (A) must point toward flywheel side of engine.

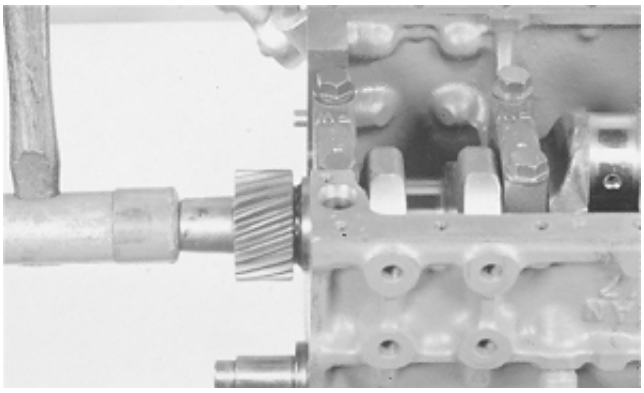
10. Dip entire main bearing cap screws in clean engine oil.

11. Install cap screws in main bearing cap. Tighten cap screws tight.



M21,TM330,35 -19-05MAR86

12. Lightly hit the front end of the crankshaft with a soft-faced hammer; then the rear end of the crankshaft to align the main thrust bearing halves.



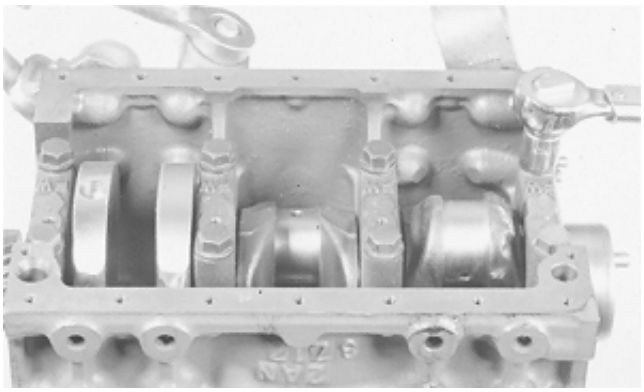
M21,TM330,36 -19-05MAR86

IMPORTANT: DO NOT use high speed power tools or air wrenches to tighten main bearing cap screws.

13. Tighten main bearing cap screws to specifications. Turn crankshaft by hand. If it does not turn easily, disassemble parts and find the cause.

MAIN BEARING CAP SCREW TORQUE SPECIFICATION

Engine	Specifications
3TG66	54 N·m (40 lb-ft)
3TG72	79 N·m (58 lb-ft)

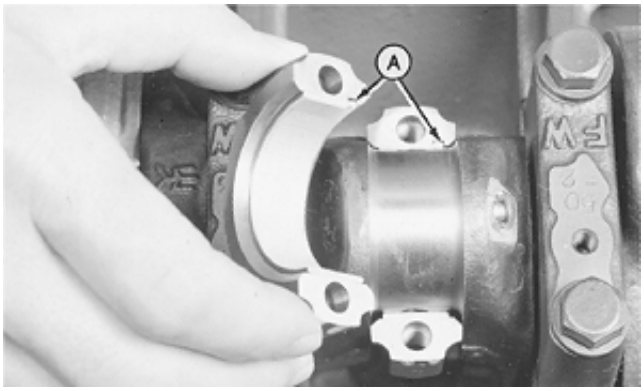


M35410 -UN-06SEP88

5M4,T1230,13 -19-12OCT87

IMPORTANT: Connecting rod caps must be installed on the same connecting rod they were removed from and in the same direction.

14. Install cap on connecting rod with tang (A) to same side.



M35376 -UN-06SEP88

M21,TM330,38 -19-05MAR86

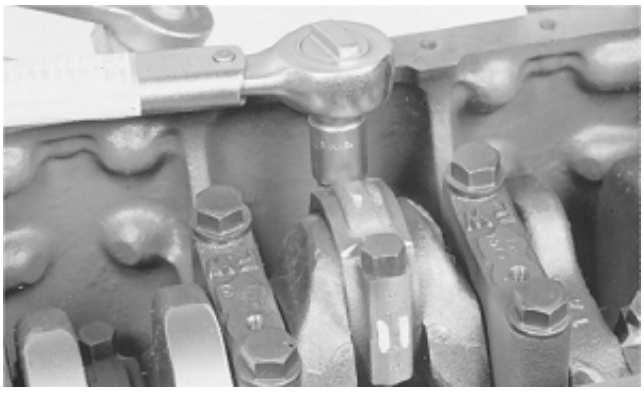
IMPORTANT: Never reuse connecting rod cap screws.

15. Dip entire connecting rod cap screw in clean engine oil. Install cap screws in connecting rods.

16. Tighten cap screws to specifications.

CONNECTING ROD CAP SCREW TORQUE SPECIFICATION

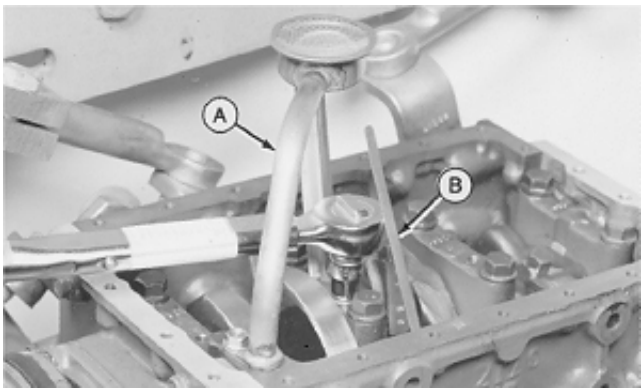
Engine	Specification
3TG66 and 3TG72	23 N·m (200 lb-in.)



M35377 -UN-06SEP88

5M4,T1230,14 -19-12OCT87

17. Install dipstick (B), and oil suction strainer (A).



-UN-06SEP88
M35379

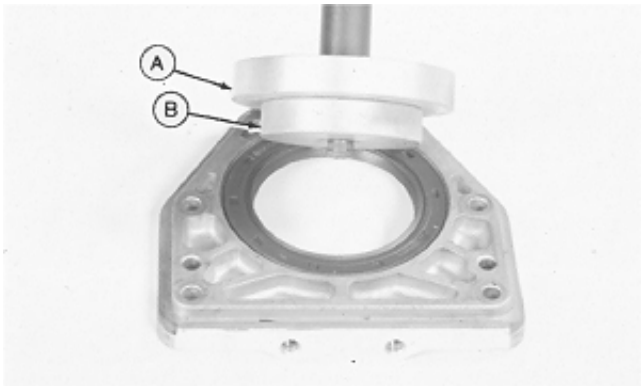
M21,TM330,40 -19-07AUG87

18. Install seal with lip of seal toward cylinder block. Use driver disks (A and B) to push seal even with surface of oil seal case.

If crankshaft is grooved at oil seal contact point, seal can be installed 3 mm (0.12 in.) farther into oil seal case.

DISKS FOR SEAL INSTALLATION

Engine	Size (in.) (A)	(B)
3TG66 and 3TG72	3-13/16	2-5/16



-UN-06SEP88
M35387

5M4,T1230,15 -19-12OCT87

19. Apply plastic gasket or an equivalent on the oil seal case.

20. Align oil seal case with dowel pins on the cylinder block.

21. Install and tighten cap screws to specifications.

OIL SEAL CASE CAP SCREW SPECIFICATIONS

Engine	Item	Specification
3TG66, 3TG72	Seal case to block	11 N·m (96 lb-in.)
3TG72	Oil pan to seal case	9 N·m (78 lb-in.)

22. Install oil pan. (See Group 40 in this manual.)

23. Install flywheel assembly. (See Group 20 in this manual.)

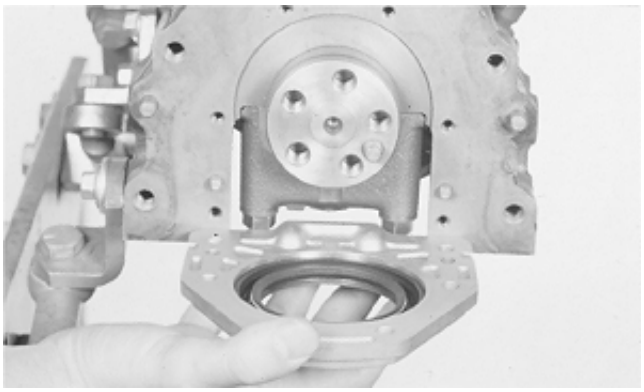
24. If equipped, install electric clutch assembly. (See machine technical manual.)

25. Install gear housing. (See Group 35 in this manual.)

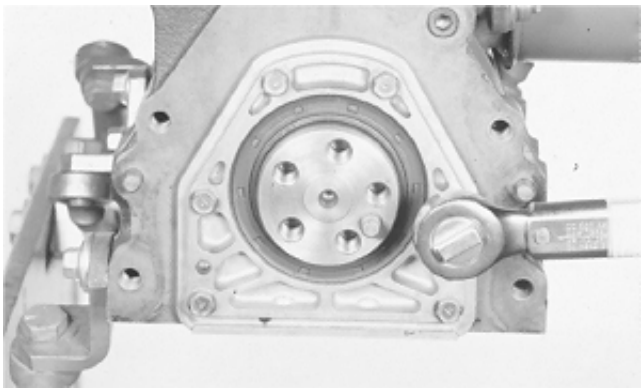
26. Install camshaft. (See Group 15 in this manual.)

27. Install cam followers and cylinder head. (See Group 15 in this manual.)

28. Install engine. (See machine technical manual.)



M35411 -UN-06SEP88



M35412 -UN-16NOV89

5M4,T1230,16 -19-12OCT87

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Strap Wrench	Remove crankshaft pulley
13-Ton Puller Set	Remove crankshaft pulley and gears
Bushing, Bearing, and Seal Driver Set	Remove and install seals
Dial Indicator	Measure timing gear backlash
Telescoping Gauge	Measure idler gear bushing diameter
Outside Micrometer	Measure idler shaft diameter
Belt Tension Gauge	Check belt tension
O-Ring Seal Tool Set	Remove and install O-rings

M21,TM335,1 -19-23MAY86

35
1

OTHER MATERIAL

Number	Name	Use
PT94	John Deere Form-In-Place Gasket (RTV rubber silicone sealant)	To seal gear housing cover and gear housing.
AT52853	John Deere LOCTITE Thread Lock and Sealer (Low Strength)	Apply to threads of gear housing studs.
T43512	John Deere LOCTITE Thread Lock and Sealer (Medium Strength)	Apply to threads of crankshaft pulley cap screw.

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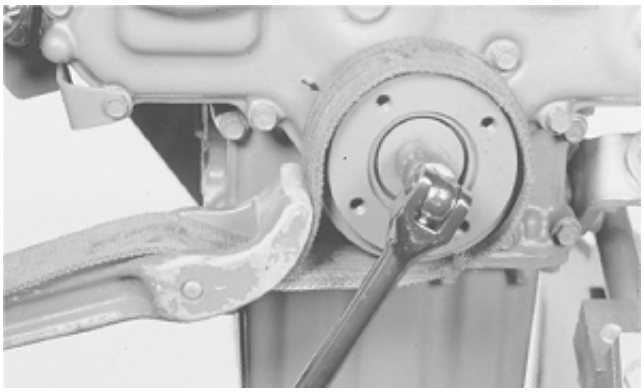
M21,TM335,2 -19-07AUG87

REMOVE TIMING GEAR COVER

1. Remove engine. (See Machine Technical manual.)

2. Remove fan, alternator belt, and alternator.

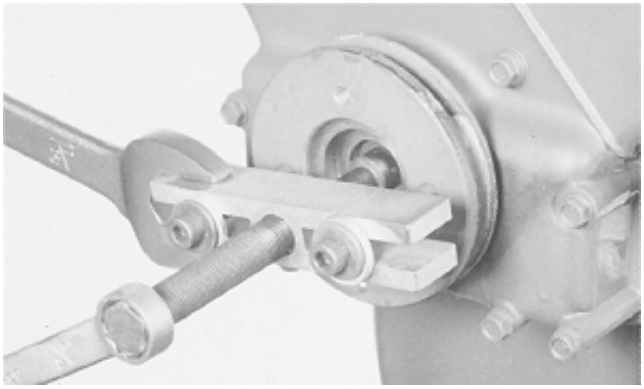
3. Hold crankshaft pulley using a strap wrench. Remove cap screw and washer.



M35270 -UN-29AUG88

5M4,T1235,1 -19-23SEP87

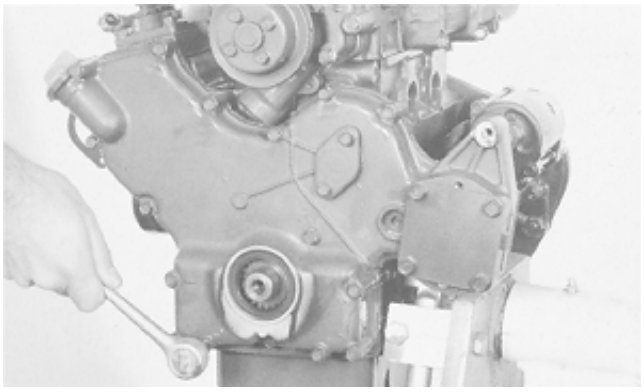
4. Remove crankshaft pulley using puller, shaft protector, and two 8 mm cap screws.



M37508 -UN-29AUG88

5M4,T1235,1A -19-23SEP87

5. Remove cap screws to remove gear housing cover. Remove gasket material from cover and gear housing.



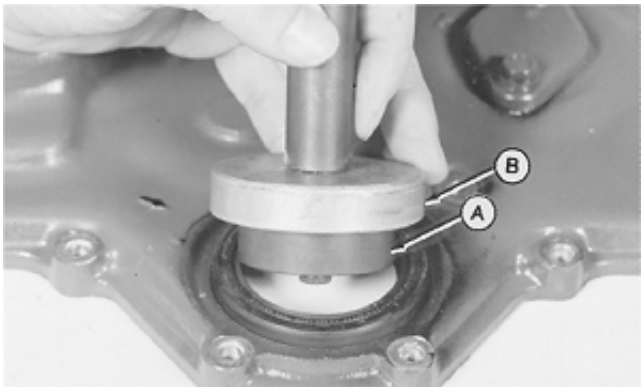
M37511 -UN-06SEP88

5M4,T1235,2 -19-12OCT87

6. Remove seal using the correct driver disks (A and B).

DISKS FOR SEAL REMOVAL

Engine	Size (in.) (A)	(B)
3TG66UJ	1-11/16	2-3/8
3TG72	1-3/4	2-7/16



M35275 -UN-29AUG88

5M4,T1235,3 -19-23SEP87

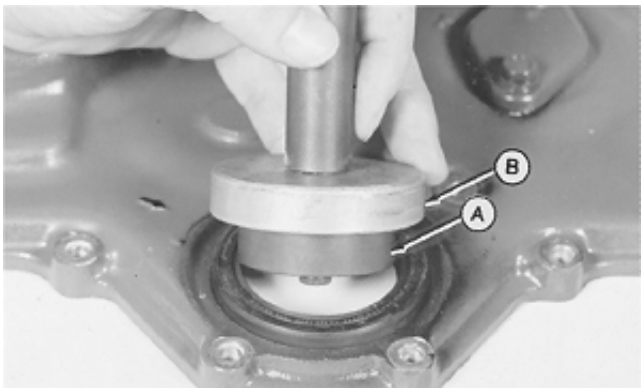
INSTALL TIMING GEAR COVER

1. Thoroughly clean and dry all parts. Use new gaskets, O-rings, and oil seals when assembling the engine.

2. Install seal with lip of seal toward inside of gear housing cover. Use the correct driver disks (A and B) to install seal flush with surface of gear housing cover.

DISKS FOR SEAL INSTALLATION

Engine	Size (in.) (A)	(B)
3TG66	1-11/16	2-1/2
3TG72	1-3/4	2-9/16



-UN-29AUG88
M35275

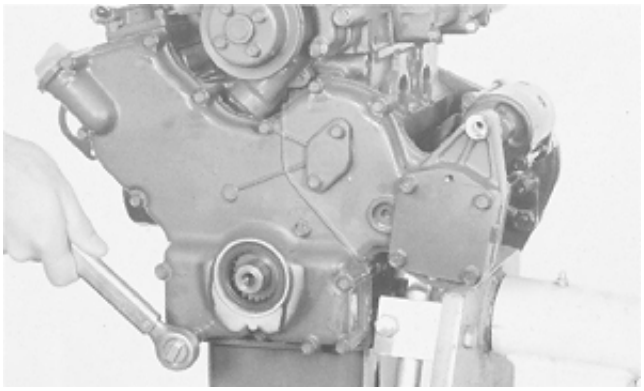
5M4,T1235,4 -19-12OCT87

3. Apply a bead of plastic gasket or equivalent on sealing surface of gear housing cover.

4. Install gear housing cover and fasten with cap screws. Tighten cap screws to specifications.

GEAR HOUSING COVER CAP SCREW TORQUE SPECIFICATION

Engine	Specification
3TG66 and 3TG72	9 N·m (78 lb-in.)



-UN-06SEP88
M37519

35
3

5M4,T1235,5 -19-23SEP87

5. Install pulley.

6. Apply thread lock and sealer (medium strength) on threads of cap screw. Install washer and cap screw. Tighten cap screw to 115 N·m (85 lb-ft).

7. Install alternator, alternator belt, and fan.

8. Install engine. (See Machine Technical Manual.)

-UN-29AUG88
M35296

5M4,T1235,6 -19-23SEP87

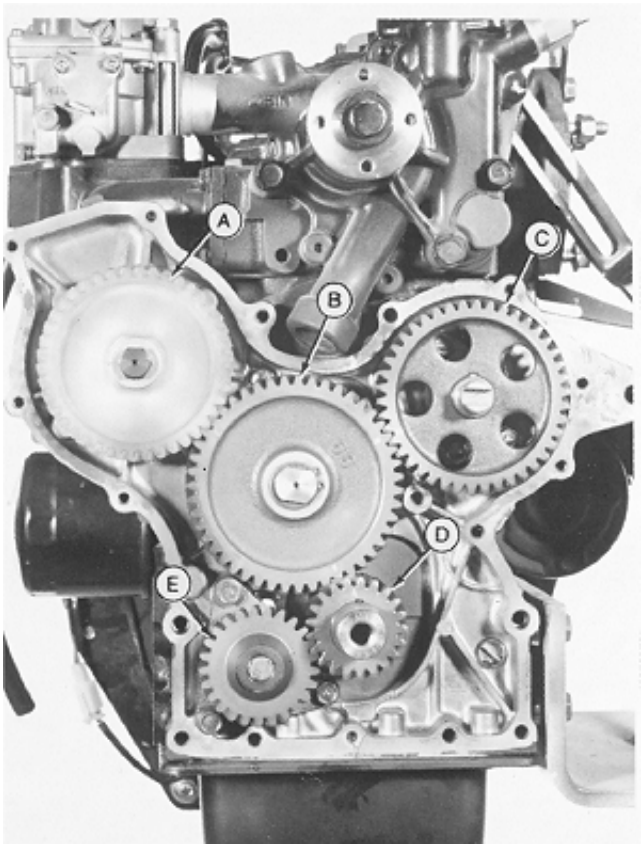
REMOVE AND INSPECT TIMING GEARS

1. Measure backlash between gear.

TIMING GEAR BACKLASH

Engine	Gear	Specification
3TG66	Governor (A)	0.38 mm (0.015 in.)
	Idler (B)	0.2 mm (0.008 in.)
	Camshaft (C)	0.2 mm (0.008 in.)
	Crankshaft (D)	0.2 mm (0.008 in.)
	Oil Pump (E)	0.3 mm (0.012 in.)
3TG72	Governor (A)	0.38 mm (0.015 in.)
	Idler (B)	0.2 mm (0.008 in.)
	Camshaft (G)	0.2 mm (0.008 in.)
	Crankshaft (D)	0.2 mm (0.008 in.)
	Oil Pump (E)	0.3 mm (0.012 in.)

If backlash exceeds specification replace gears as required.



M46091 -UN-08JAN90

5M4,T1235,7 -19-12DEC87

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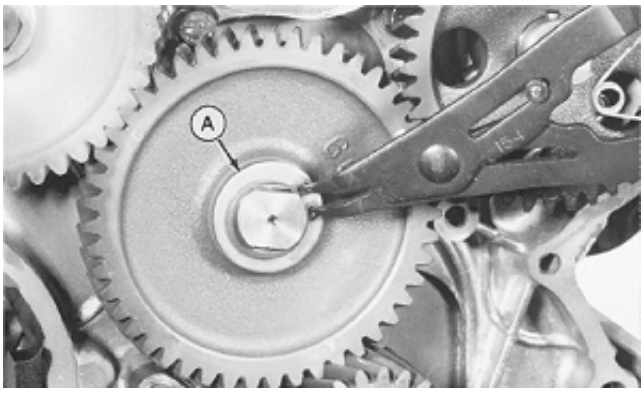
4

2. Remove snap ring and washer (A) to remove idler gear. Inspect gear for chipped or broken teeth; replace if necessary.



M46092 -UN-08JAN90

5M4,T1235,8 -19-28SEP87

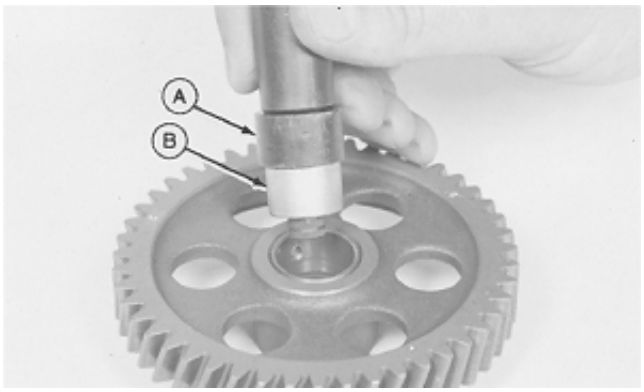
3. Measure bushing inside diameter.

If diameter exceeds 20.08 mm (0.791 in.), replacing bushing.

M35492 -UN-26AUG88

M21,TM335,14 -19-07FEB86

4. If necessary, remove bushing using a 7/8 in. driver disk (A) and 3/4 in. driver disk (B).



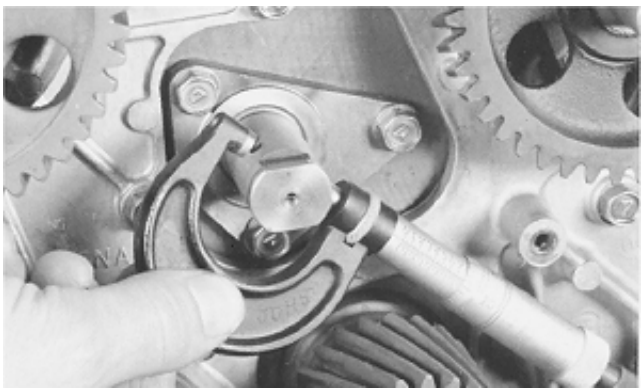
M21,TM335,15 -19-07FEB86

5. Measure idler shaft diameter.

If diameter is less than 19.93 mm (0.785 in.), replace idler shaft.

6. Determine idler shaft oil clearance (bushing diameter minus shaft diameter).

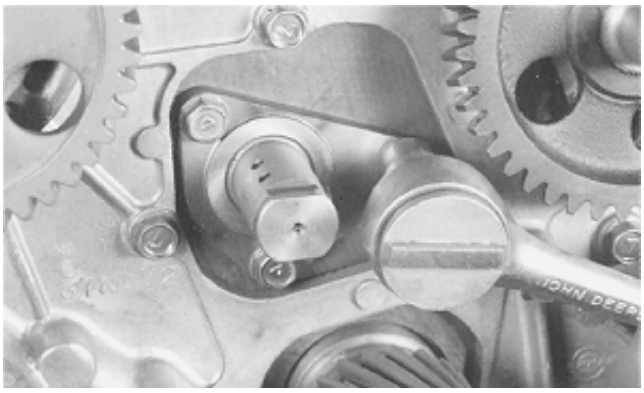
If clearance exceeds 0.15 mm (0.006 in.), replace idler shaft, idler bushing, or both.



M21,TM335,25 -19-23APR86

35
5

7. Remove three cap screws to remove idler shaft.

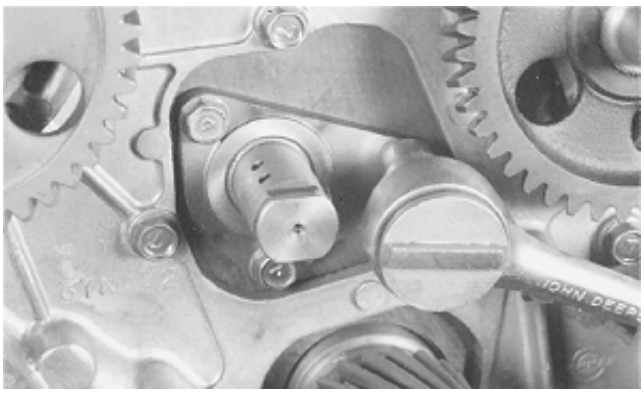


M21,TM335,26 -19-07FEB86

INSTALL TIMING GEARS

1. Thoroughly clean and dry all parts.

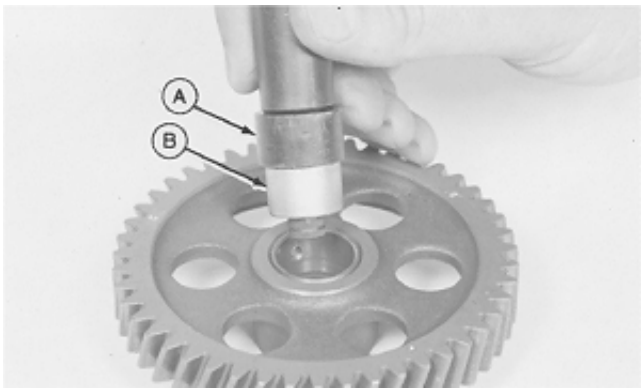
2. Install idler shaft and three cap screws. Tighten cap screws.



5M4,T1235,9 -19-28SEP87

3. Align oil holes in bushing and idler gear.

4. Install bushing even with surface of idler gear using a 1 in. driver disk (A) and 3/4 in. driver disk (B).



M35493 -UN-26AUG88

M21,TM335,28 -19-07FEB86

5. Install gears, if removed.

6. Align timing marks (A and B) between crankshaft, idler, and camshaft gears.

7. Install idler gear, washer, and snap ring.

M46093 -UN-08JAN90

5M4,T1235,10 -19-28SEP87

35
6

REMOVE GEAR HOUSING

1. Remove timing gear cover. (See Group 35 in this manual).

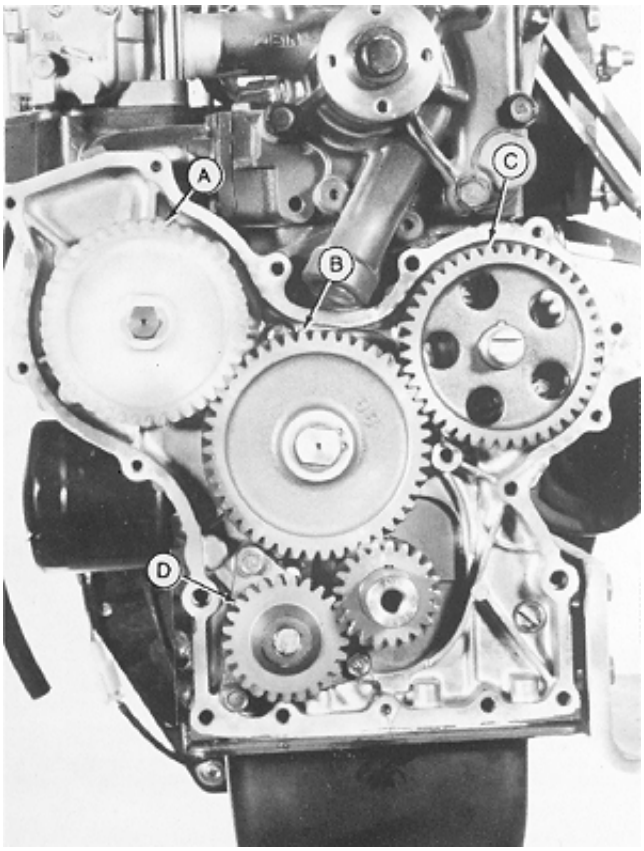
2. Remove governor assembly (A). (See Group 50 in this manual).

3. Remove idler gear (B). (See Group 35 in this manual).

4. Remove engine camshaft and gear (C). (See Group 10 in this manual).

5. Remove oil pump assembly (D). (See Group 40 in this manual.)

A—Governor
B—Idler Gear
C—Camshaft
D—Oil Pump

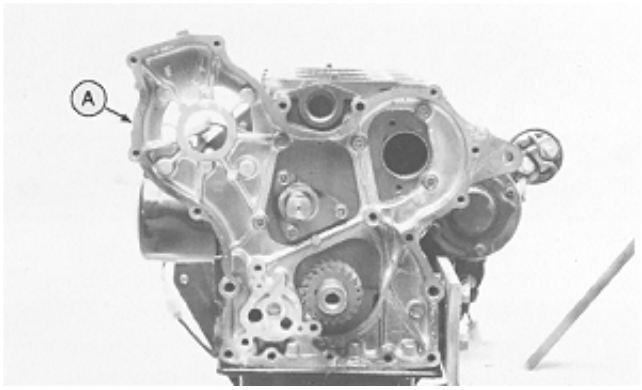


M46094 -UN-08JAN90

5M4,T1235,11 -19-28SEP87

6. Remove cap screws to remove gear housing (A).

7. Remove old gasket material from gear housing and cylinder block.



M46095 -UN-08JAN90

5M4,T1235,12 -19-28SEP87

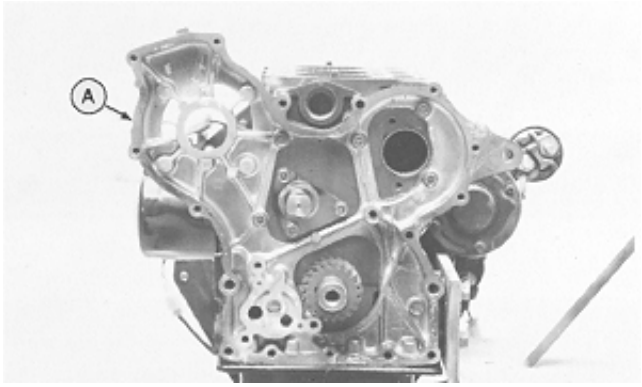
INSTALL GEAR HOUSING

1. Thoroughly clean and dry all parts. Use new gaskets, O-rings, and oil seals when assembling the engine.

2. Apply plastic gasket or an equivalent on the gear housing.

3. Align gear housing holes with dowel pins on the cylinder block. Install gear housing.

4. Install and tighten cap screws.



M46095 -UN-08JAN90

3TG66 AND 3TG72 CAP SCREW TORQUES

Material	Torque
Cast Iron	11 N·m (96 lb-in.)
Aluminum	9 N·m (78 lb-in.)

5M4,T1235,13 -19-28SEP87

35
7

5. Install oil pump (D). (See Group 40 in this manual.)

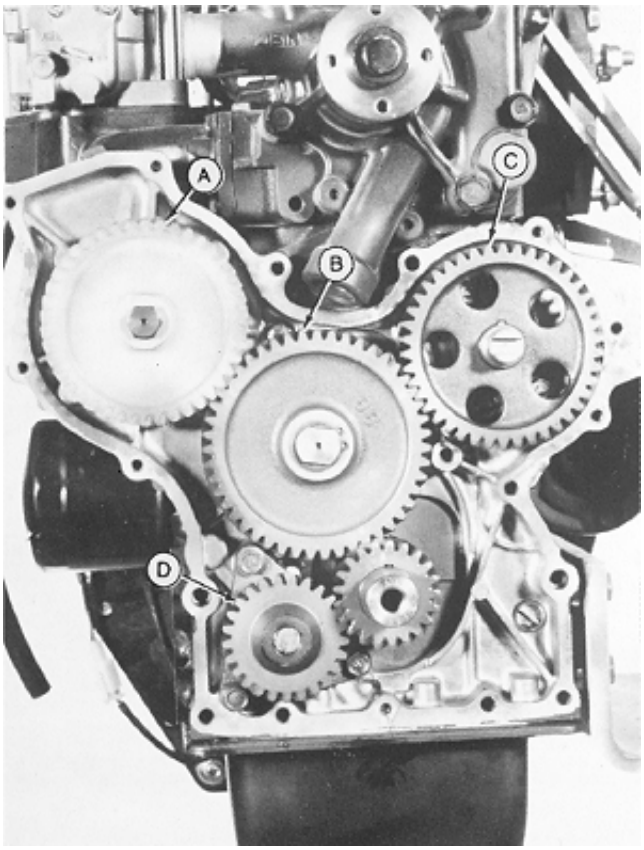
IMPORTANT: Make sure to align timing marks between crankshaft, idler, injection pump, and camshaft gears.

6. Governor (A). (See Group 50 in this manual.)

7. Install camshaft (C). (See Group 10 in this manual.)

8. Install idler gear (B). (See Group 35 in this manual.)

9. Install timing gear cover (See Group 35 in this manual.)



M46094 -UN-08JAN90

5M4,T1235,14 -19-28SEP87

35
8

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Strap Wrench	Remove crankshaft pulley
13-Ton Puller Set	Remove crankshaft pulley and gears
Bushing, Bearing, and Seal Driver Set	Remove and install seals
Dial Indicator	Measure oil pump gear backlash
Depth Micrometer	Measure oil pump body depth
Outside Micrometer	Measure oil pump components
Telescoping Gauge	Measure oil pump components
Vernier Calipers	Measure rotor ring diameter
Belt Tension Gauge	Check belt tension
Spring Compression Tester	Check oil pressure regulating valve spring
O-Ring Seal Tool Set	Remove and install O-rings

40
1

M21,TM340,1 -19-28AUG87

OTHER MATERIAL

Number	Name	Use
T43512	John Deere LOCTITE® Thread Lock and Sealer (Medium Strength)	Apply to threads of crankshaft pulley cap screw.
PT94	John Deere Form-In-Place Gasket (RTV rubber silicone sealant)	To seal gear housing cover, oil pan spacer, crankshaft seal case, and oil pan.

LOCTITE is a trademark of the Loctite Corp.

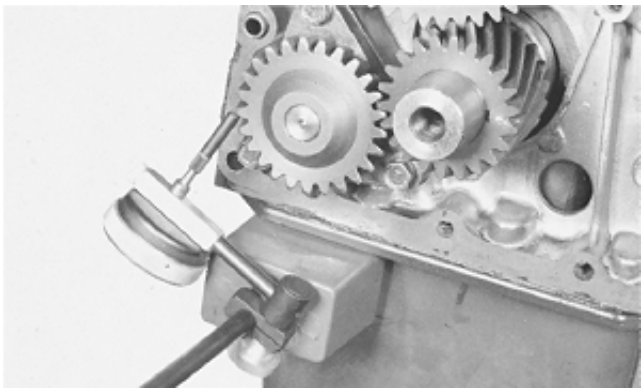
M21,TM340,2 -19-28AUG87

REMOVE AND INSPECT OIL PUMP

1. Remove gear housing cover as instructed in Remove Timing Gears, Group 35.

2. Check oil pump gear backlash. Replace gear if backlash is more than listed below.

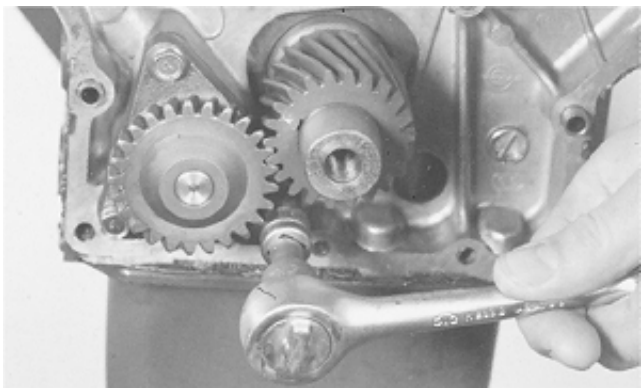
Engine	Maximum Backlash
3TG72 and 3TG66	0.30 mm (0.012 in.)



-UN-29AUG88
M37772

TM4,T1240,1 -19-28SEP87

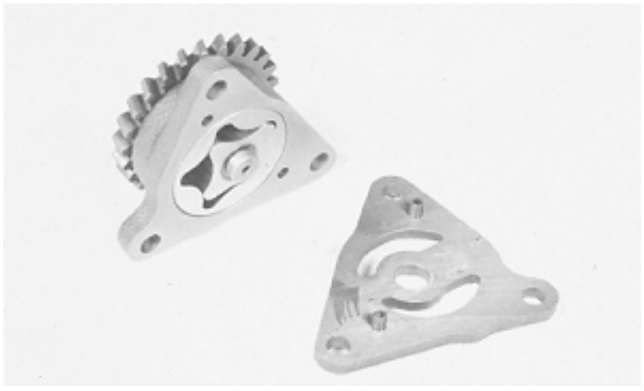
3. Remove oil pump attaching hardware and remove oil pump.



-UN-29AUG88
M37773

M21,TM340,67 -19-06MAR86

4. Carefully remove backing plate from pump.

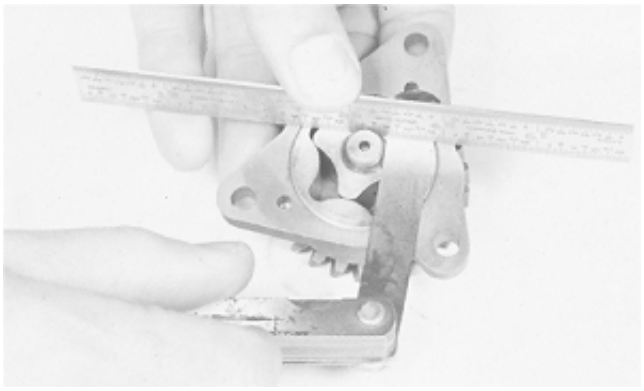


-UN-29AUG88
M37774

M21,TM340,68 -19-06MAR86

5. Check rotor recess. If rotors are recessed below face of pump housing more than listed below, replace rotor assembly.

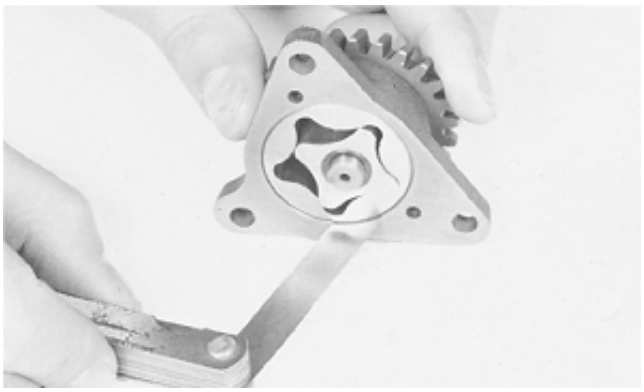
Engine	Maximum Recess
3TG66 and 3TG72	0.25 mm (0.010 in.)



-UN-29AUG88
M37775

5M4,T1240,2 -19-28SEP87

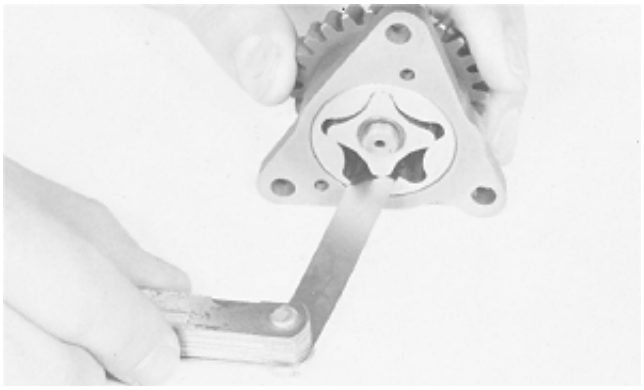
6. Check outer rotor-to-pump body clearance. If clearance is more than 0.25 mm (0.010 in.), replace oil pump.



M21,TM340,70 -19-06MAR86

7. Check inner-to-outer rotor clearance. If clearance is more than listed below, replace rotor assembly.

Engine	Maximum Recess
3TNA72-UJ/3TN78-RJB/ 3TN82-RJB/4TN78T-RJB	0.15 mm (0.006 in.)
All other engines	0.25 mm (0.010 in.)

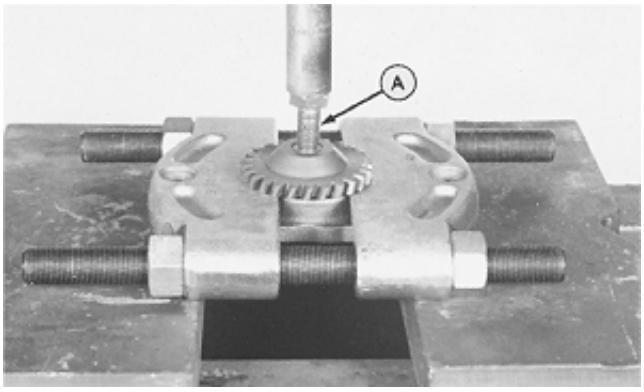


M21,TM340,71 -19-28AUG87

8. Remove outer rotor from pump body.

IMPORTANT: Hold oil pump shaft while pressing from gear.

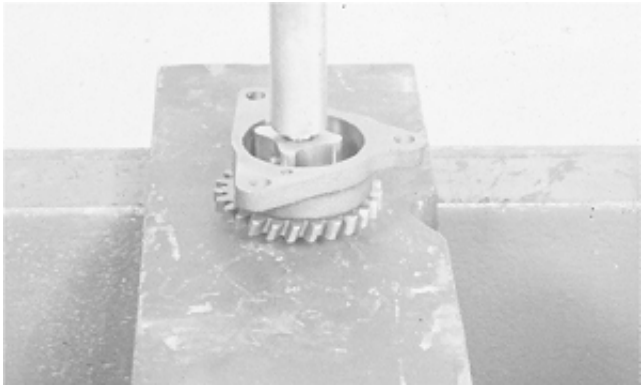
9. Support oil pump gear on a knife edge puller. Use a cap screw (A) to press shaft from gear.



M21,TM340,72 -19-23APR86

ASSEMBLE AND INSTALL OIL PUMP

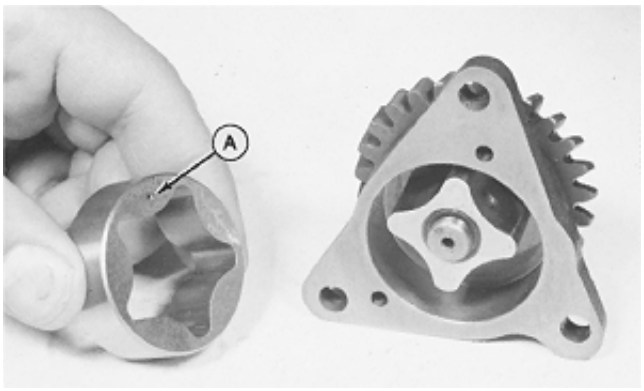
1. Press inside rotor into housing.



5M4,T1240,3 -19-28SEP87

2. Coat all parts with clean engine oil. Install outer rotor with identification mark (A) facing inside of housing.

3. Install backing plate onto pump body.



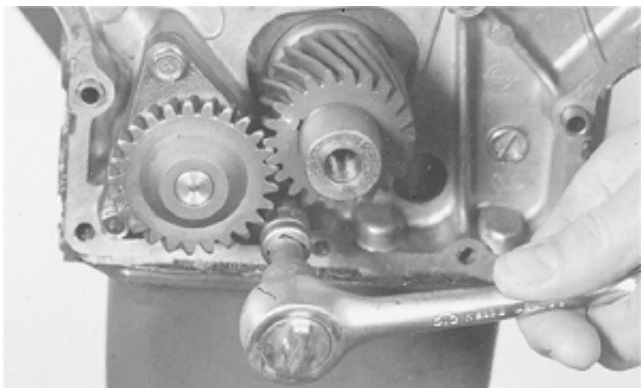
M21,TM340,74 -19-06MAR86

4. Install oil pump on engine using new gasket. Tighten hardware to 11 N·m (96 lb-in.).

5. Install gear housing cover.

6. If a new oil pump is installed or if reinstalling used oil pump, check oil pressure (See Sec. 220).

If oil pressure is above specification, check oil pressure regulating valve for excess shims.



5M4,T1240,4 -19-12OCT87

REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE

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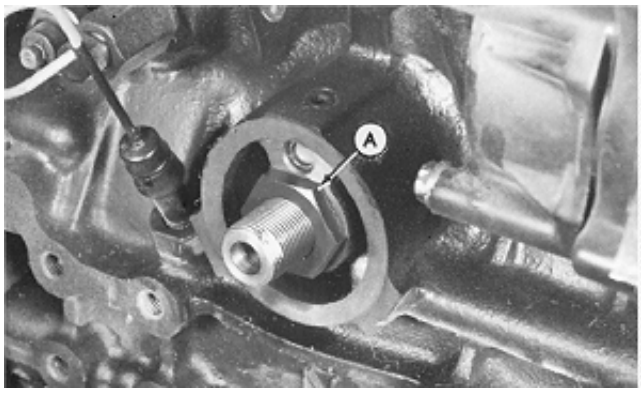
4

1. Remove oil filter.

2. Loosen lock nut (A) to remove valve assembly.

3. Install valve assembly and tighten. Tighten lock nut (A).

4. Install oil filter.



5M4,T1240,5 -19-28SEP87

ADJUST OIL PRESSURE REGULATING VALVE

Use a shim kit when adjusting the oil pressure regulating valve.

1. Remove valve plug (A), shims (B), spring (C), and valve (D).

2. Inspect internal components. If any part is worn, broken, or missing (except shims), the entire oil pressure regulating valve must be replaced.

3. Check spring for free and compressed lengths.

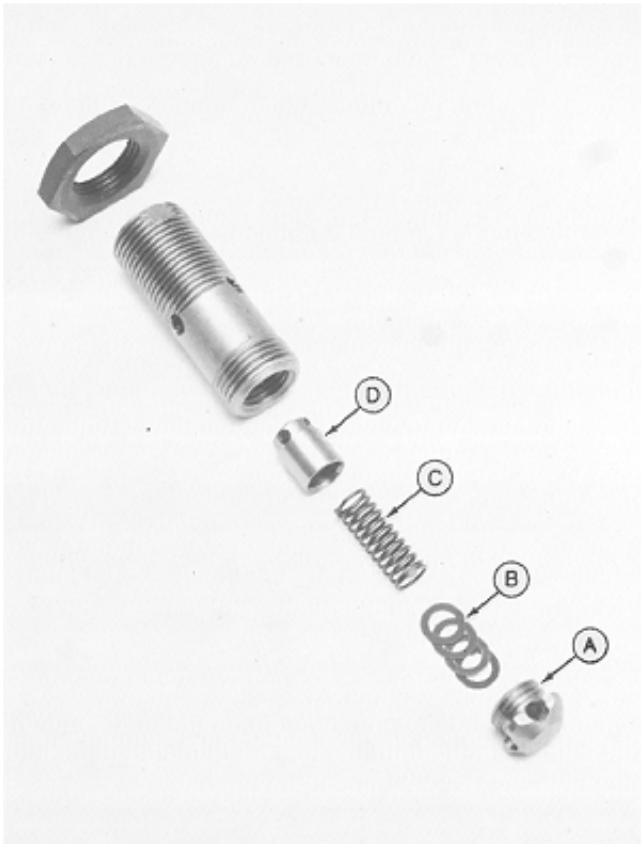
FREE LENGTH SPECIFICATIONS

Engine	Specification
3TG66	21.9—24.5 mm (0.86—0.96 in.)
3TG72	43.5—48.5 mm (1.7—1.9 in.)

COMPRESSED LENGTH SPECIFICATIONS

Engine	Specification
3TG66	14.7 mm (0.58 in.) at 12 N (2.7 lb)
3TG72	27.5 mm (1.08 in.) at 20.5 N (9.6 lb)

4. Assemble oil pressure regulating valve, add or subtract shims (B) as required, and tighten valve plug.



M46064 -UN-08JAN90

A—Valve Plug
B—Shims (as required)
C—Spring
D—Valve

5M4,T1240,6 -19-28SEP87

ESSENTIAL TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Number	Name	Use
JDG-506	Bearing Driver	Remove and install water pump bearing shaft on 3TG66 and 3TG72 engines.

5M4,T1245,1 -19-12OCT87

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Thermostat Tester	Check thermostat opening temperature
Strap Wrench	Hold water pump pulley
13-Ton Puller Set	Remove water pump pulley flange
Press	Remove and install water pump components
O-ring Seal Tool Set	Remove and install water pump seals and O-rings
Bushing, Bearing, and Seal Driver Set	Install water pump components
Belt Tension Gauge	Check Belt Tension

45
1

M21,TM345,2 -19-23APR86

SERVICE THERMOSTAT

CAUTION: DO NOT remove thermostat until engine is cool to the touch.

1. Open radiator and engine drain valves to drain coolant.

2. Disconnect water pump outlet hose.

3. Remove two cap screws to remove thermostat cover (A).

4. Remove O-ring gasket (B).

5. Remove thermostat (C).

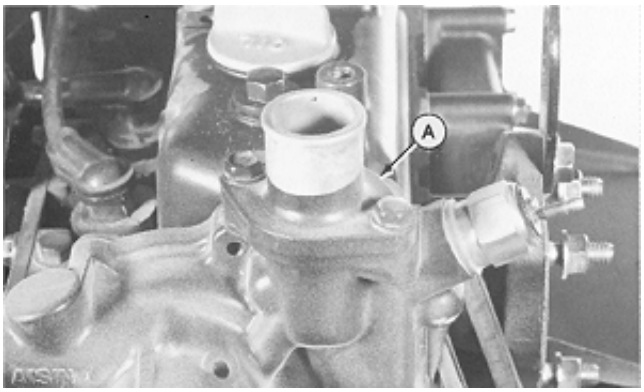
6. Check thermostat using a thermostat tester. Heat thermostat in water to check opening temperature.

THERMOSTAT SPECIFICATIONS

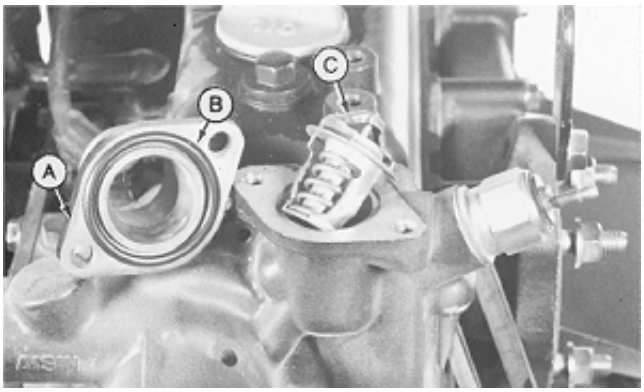
Begin Opening	71˚C (160˚F)
Fully Open	85˚C (184˚F)

If thermostat is not fully open at 85˚C (184˚F), replace thermostat.

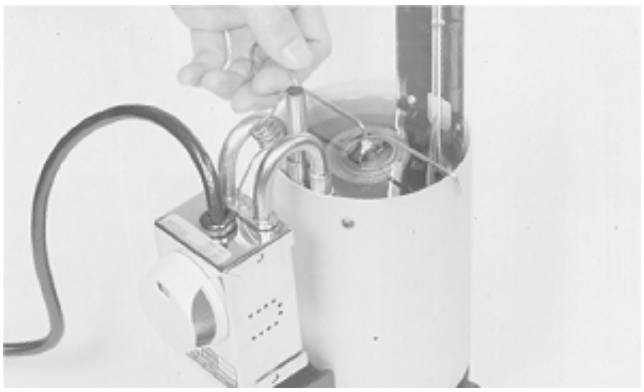
7. Install thermostat, O-ring gasket, housing, and two cap screws. Tighten cap screws to 9 N·m (78 lb-in.).



M46038 -UN-08JAN90



M46039 -UN-08JAN90


M35635 -UN-26AUG88

5M4,T1245,2 -19-28SEP87

REMOVE WATER PUMP

CAUTION: DO NOT remove water pump until engine is cool to the touch.

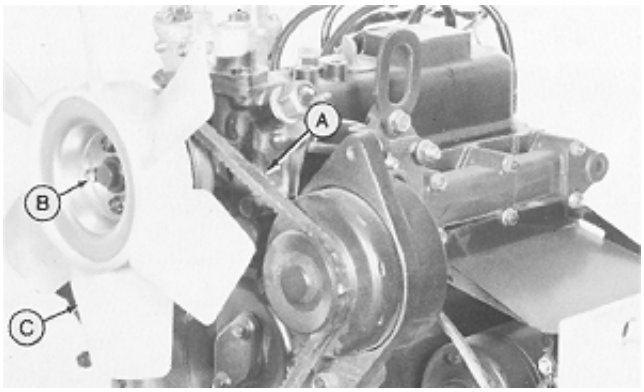
1. Open the radiator and engine drain valve to drain coolant.

2. Disconnect inlet and outlet coolant lines from water pump.

3. Disconnect coolant temperature sender wire.

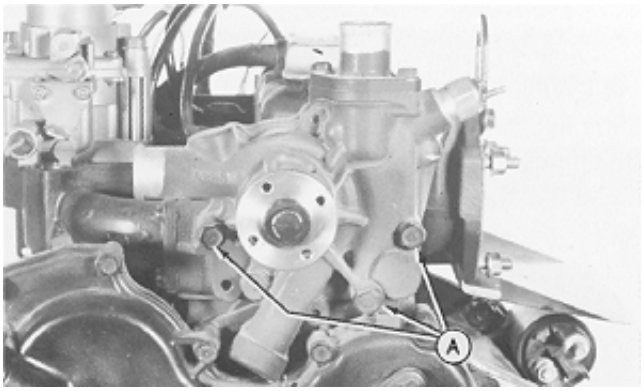
4. Loosen cap screw and remove alternator belt (A). Move alternator away from water pump area.

5. Remove four cap screws (B) to remove fan (C).



5M4,T1245,3 -19-12OCT87

6. Remove three cap screws (A) to remove water pump and gasket.



5M4,T1245,4 -19-28SEP87

45
3

DISASSEMBLE WATER PUMP

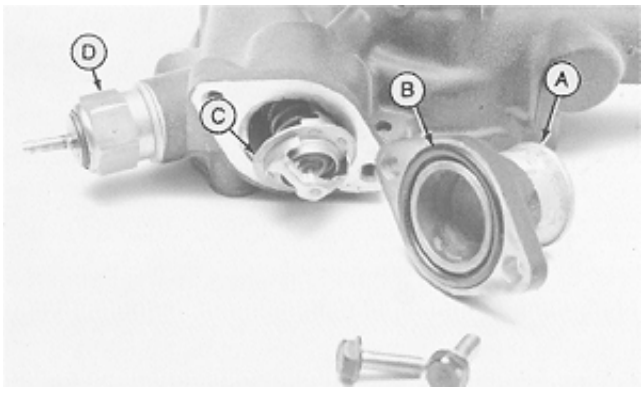
1. Remove two cap screws to remove thermostat cover (A).

2. Remove O-ring gasket (B).

3. Remove thermostat (C).

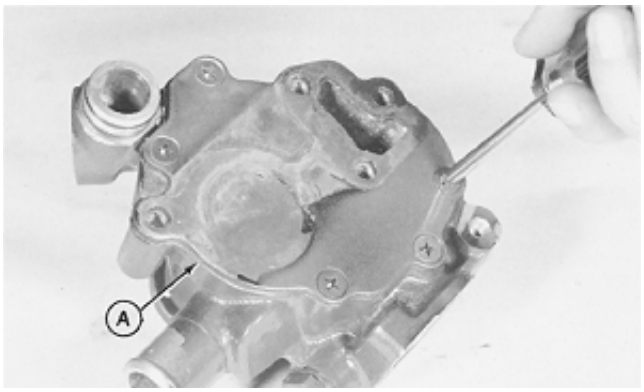
4. Remove temperature sender (D) and washer.

A—Thermostat Cover
B—O-Ring Gasket
C—Thermostat
D—Temperature Sender



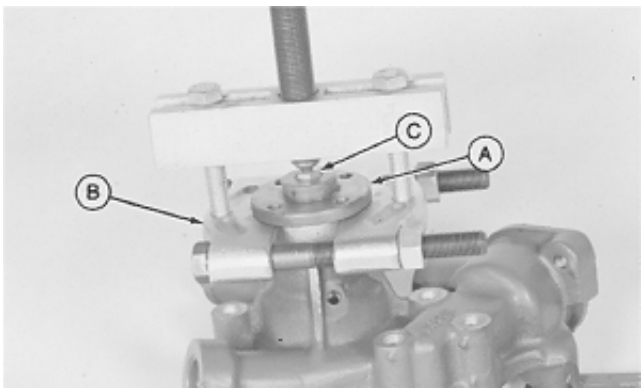
5M4,T1245,5 -19-28SEP87

5. Remove five screws to remove plate and gasket (A).



5M4,T1245,6 -19-28SEP87

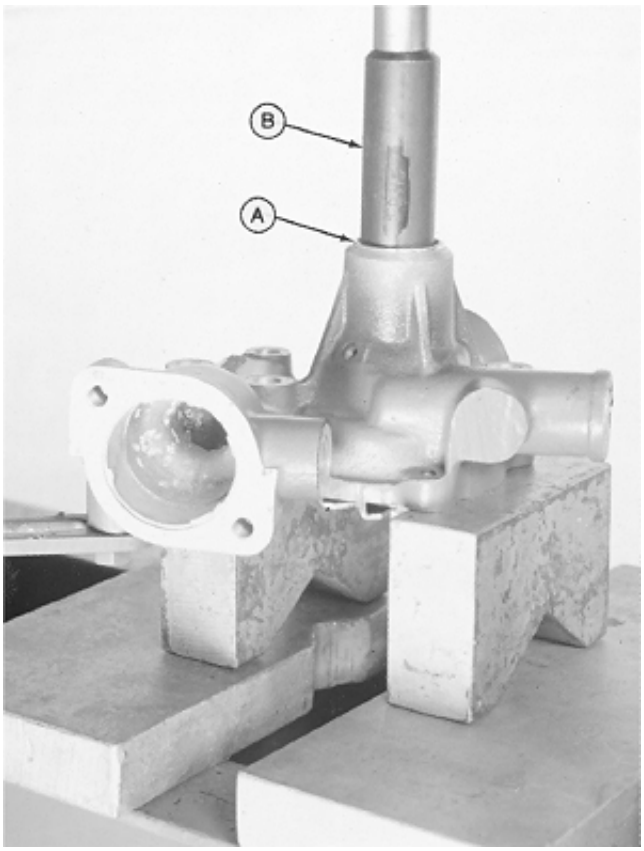
6. Remove pulley flange (A) using a puller (B) and small nuts (C).



M21,TM345,22 -19-10MAR86

NOTE: Be sure press blocks do not hit impeller.

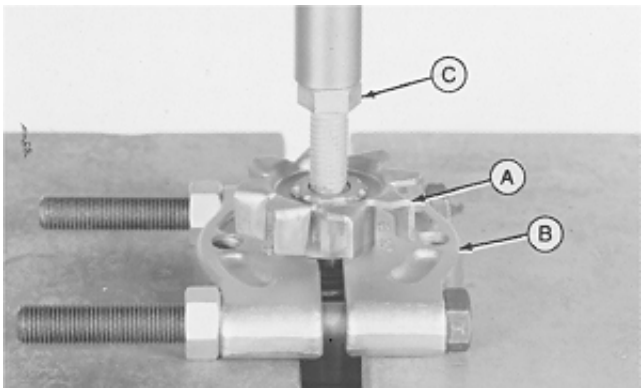
7. Remove bearing shaft (A) using JDG-506 Bearing Driver.



5M4,T1245,7 -19-28SEP87

IMPORTANT: Impeller bore is tapered. Allow enough clearance between cap screw and impeller bore to prevent cap screw from binding.

8. Remove impeller (A) using a bearing puller (B), 3/8 in. cap screw (C), and a press.



-UN-26AUG88
M35647

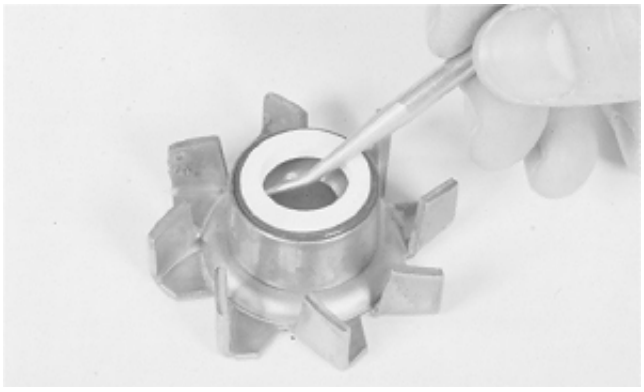
M21,TM345,24 -19-10MAR86

9. Remove shaft seal.

-UN-26AUG88
M35648

M21,TM345,25 -19-10MAR86

10. Remove ceramic seal.

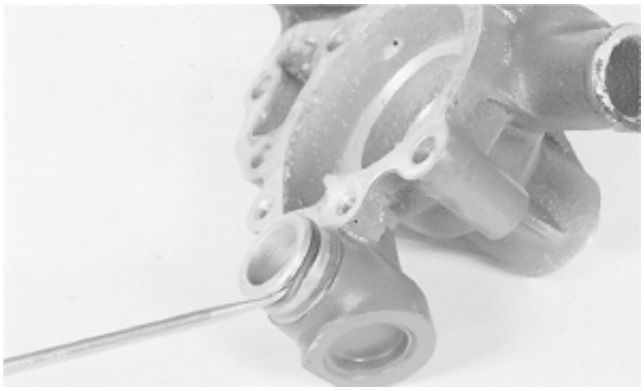


-UN-26AUG88
M35649

M21,TM345,26 -19-10MAR86

11. Remove O-ring, if equipped.

12. Thoroughly clean and inspect all parts. Replace parts as necessary.

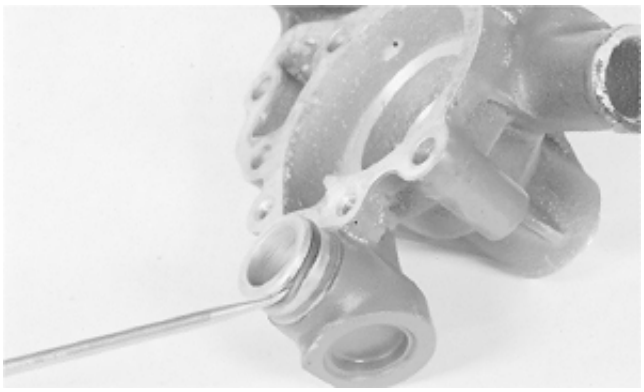


-UN-26AUG88
M35650

M21,TM345,27 -19-10MAR86

ASSEMBLE WATER PUMP

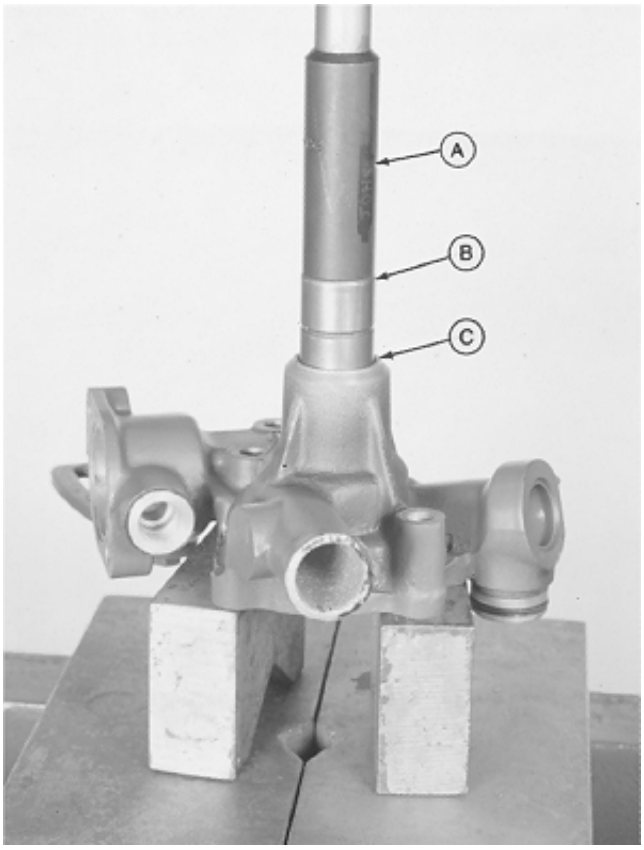
1. Install new O-ring, if equipped.



M21,TM345,28 -19-10MAR86

2. Install bearing shaft, long end down, using JDG-506 Bearing Driver and a press.

3. Press shaft into pump body until bearing surface (B) is flush with housing surface (C).

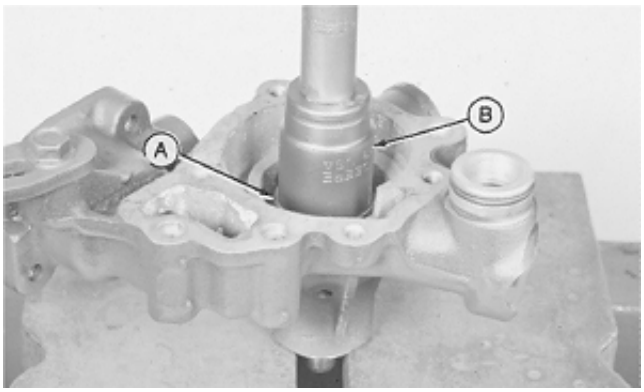


5M4,T1245,8 -19-12OCT87

4. Install new shaft seal over impeller side of shaft.

M21,TM345,30 -19-10MAR86

5. Push shaft seal (A) to the bottom of its bore. Use a 25 mm or 1 in. socket (B) and a press.

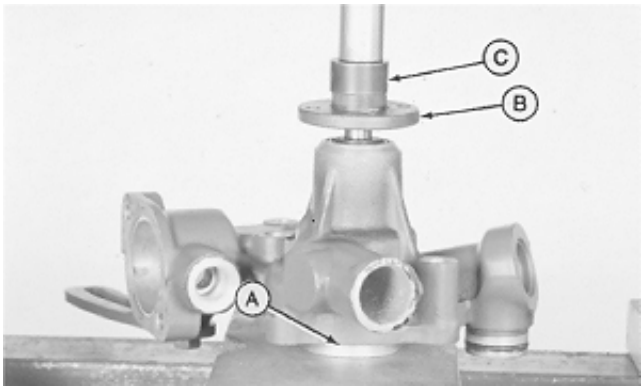


M21,TM345,31 -19-10MAR86

IMPORTANT: Support pump on bearing shaft only. DO NOT support on housing or you could damage the housing.

6. Support pump on bearing shaft using a driver disk (A).

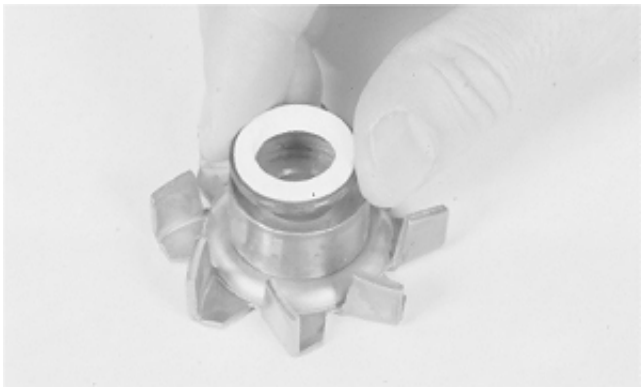
7. Push pulley flange (B) on bearing shaft until flange is flush with end of shaft. Use 1 in. driver disk (C) and a press.



5M4,T1245,9 -19-28SEP87

IMPORTANT: DO NOT touch lapped sealing surface of ceramic insert with bare hands: it must be clean and dry.

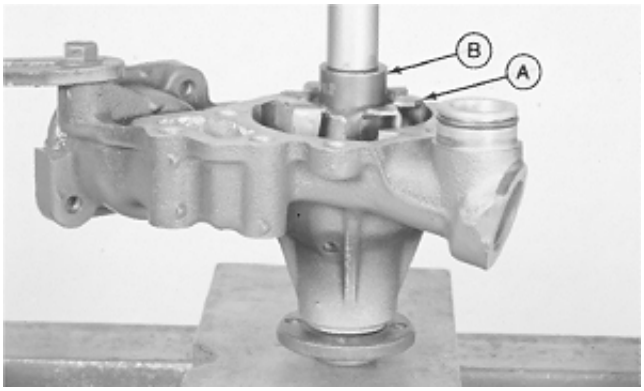
8. Install new ceramic seal (shaft seal assembly) in impeller.



M21,TM345,33 -19-10MAR86

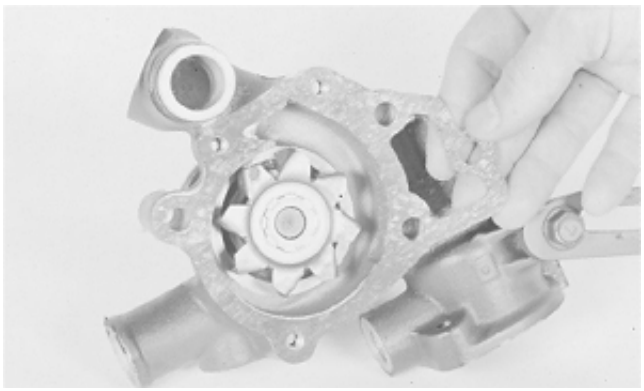
9. Install impeller (A) with ceramic seal toward the shaft seal.

10. Push impeller on bearing shaft until top of impeller is even with end of shaft. Use a 1 in. driver disk (B) and a press.



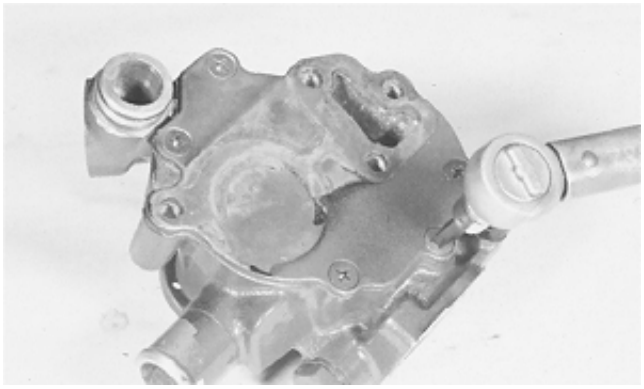
5M4,T1245,10 -19-28SEP87

11. Install new gasket on water pump housing.



5M4,T1245,11 -19-28SEP87

12. Install plate and five screws. Tighten screws to 9 N·m (78 lb-in.).



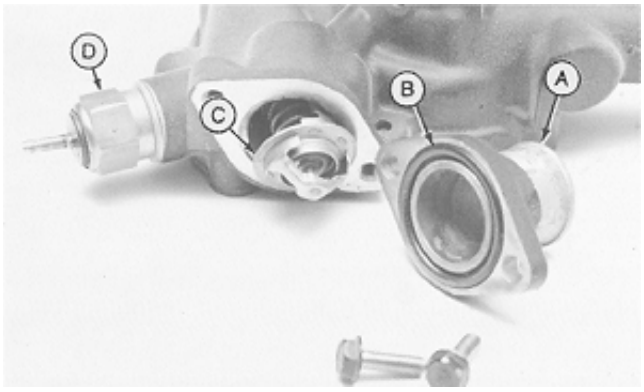
5M4,T1245,12 -19-29SEP87

13. Install plate and five screws. Tighten screws to 9 N·m (78 lb-in.).

14. Install thermostat (C).

15. Install O-ring gasket (B), thermostat cover (A) and two cap screws. Tighten cap screws to 9 N·m (78 lb-in.).

A—Thermostat Cover
B—O-Ring Gasket
C—Thermostat
D—Temperature Sender



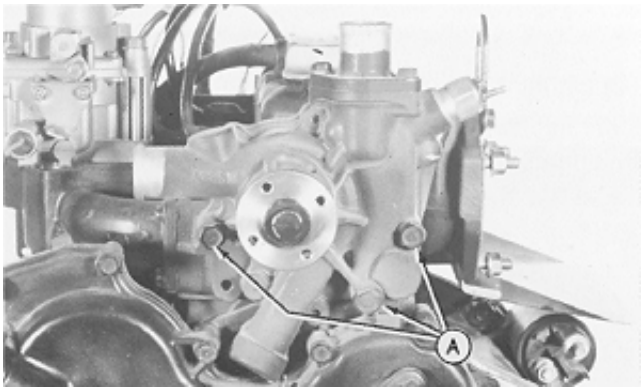
5M4,T1245,13 -19-12OCT87

INSTALL WATER PUMP

1. Thoroughly clean and dry all parts.

2. Install new gasket.

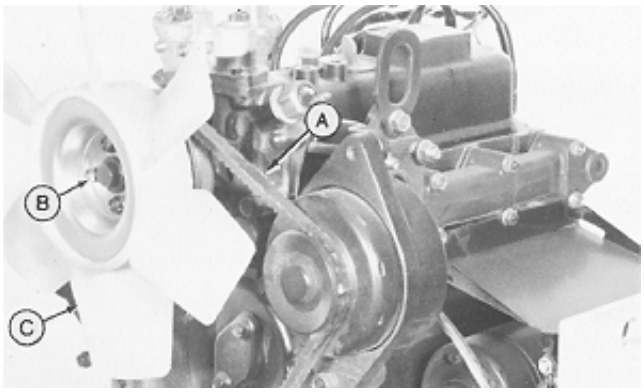
3. Install water pump and three screws. Tighten cap screws to 26 N·m (226 lb-in.).



5M4,T1245,14 -19-28SEP87

4. Install fan (C) and four cap screws (B). Tighten cap screws to 11 N·m (96 lb-in.).

5. Install alternator belt (A). Pull alternator to tighten belt and tighten cap screw.



-UN-08JAN90
M46040

5M4,T1245,15 -19-29SEP87

IMPORTANT: When adjusting belt tension, apply force ONLY to rear alternator housing (near the belt) to prevent alternator damage.

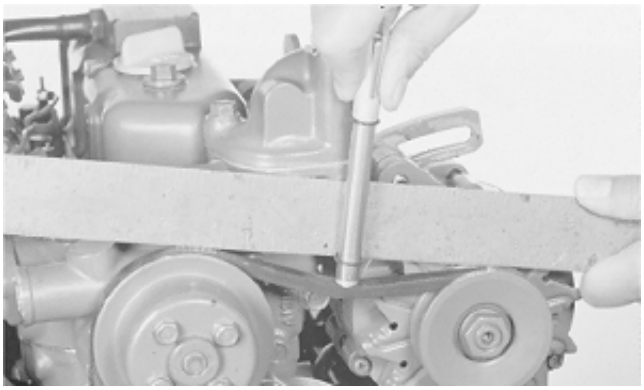
6. Check belt tension using a belt tension gauge. Alternator belt must deflect 13 mm (0.5 in.) at 107 N (24 lb) Force applied halfway between pulleys. If necessary, loosen cap screw and adjust belt tension.

7. Connect coolant temperature sender wire.

8. Connect inlet and outlet coolant lines and fasten with hose clamps.

9. Close the radiator and engine drain valves.

10. Fill cooling system with proper coolant to proper level.



-UN-26AUG88
M35667

M21,TM345,43 -19-10MAR86

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9

REMOVE AND INSTALL CARBURETOR

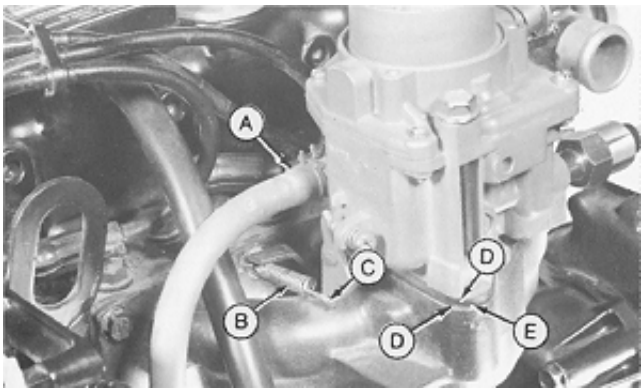
1. Disconnect spring (B) and link (C).

2. Disconnect fuel line (A).

3. Remove two cap screws to remove carburetor.

4. Remove gaskets (D) and spacer (E).

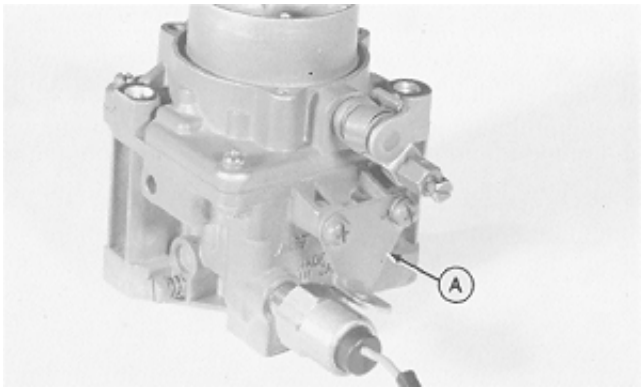
5. Install gaskets, spacer and carburetor. Tighten two cap screws. Connect fuel line and install link and spring.



-UN-08JAN90
M46018

5M4,T1250,1 -19-29SEP87

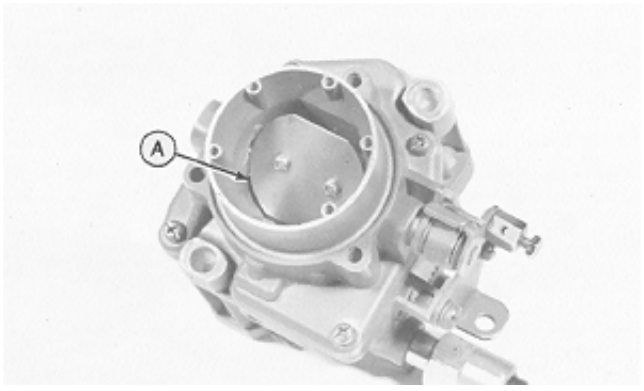
6. Remove two screws to remove choke control bracket (A).



-UN-08JAN90
M46019

5M4,T1250,2 -19-29SEP87

7. Remove two screws to remove choke plate (A).



-UN-08JAN90
M46020

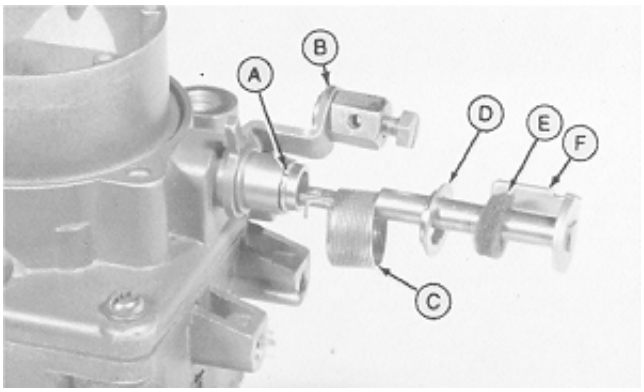
5M4,T1250,3 -19-29SEP87

8. Remove choke shaft (F), foam seal (E), collar (D) and spring (C).

9. Remove locking ring (A) to remove lever assembly (B).

Inspect choke shaft. Replace shaft if it shows excessive wear or is bent.

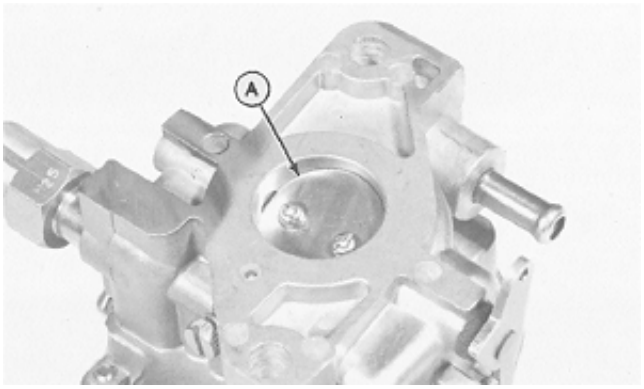
A—Locking Ring
B—Lever Assembly
C—Spring
D—Collar
E—Foam Seal
F—Choke Shaft



-UN-08JAN90
M46021

5M4,T1250,4 -19-29SEP87

10. Remove two screws to remove throttle plate (A).

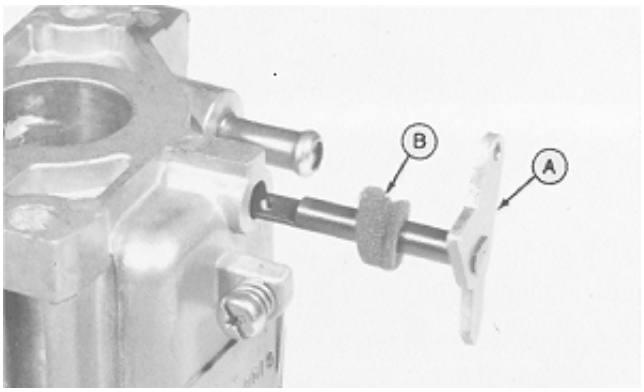


-UN-08JAN90
M46022

5M4,T1250,5 -19-29SEP87

11. Remove throttle shaft (A) and foam seal (B).

Inspect throttle shaft. Replace shaft if it shows excessive wear or is bent.

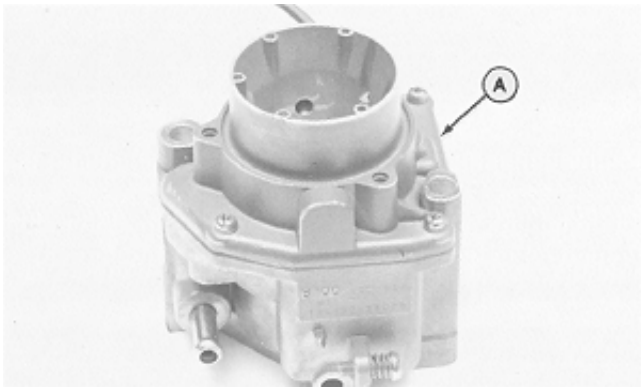


-UN-08JAN90
M46023

5M4,T1250,6 -19-29SEP87

12. Remove four screws to remove air intake (A).

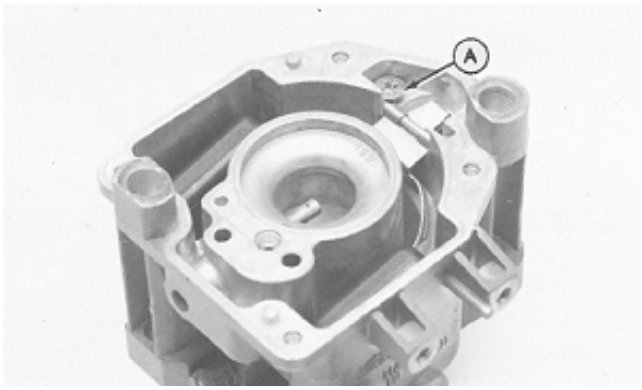
13. Remove and discard gasket.



-UN-08JAN90
M46024

5M4,T1250,7 -19-29SEP87

14. Remove float retaining screw (A).



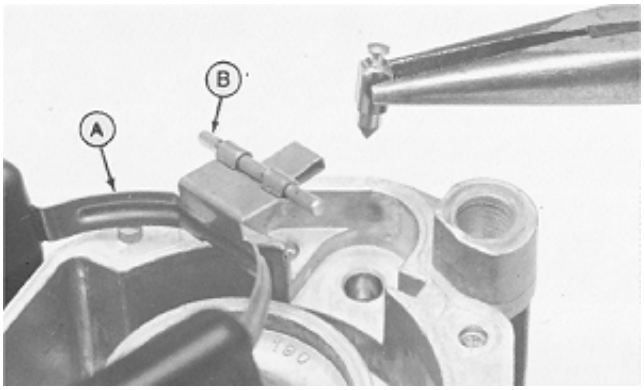
-UN-08JAN90
M46028

5M4,T1250,8 -19-29SEP87

15. Remove float (A), pivot pin (B), and needle valve.

Inspect needle valve. Replace valve if it is grooved or pitted.

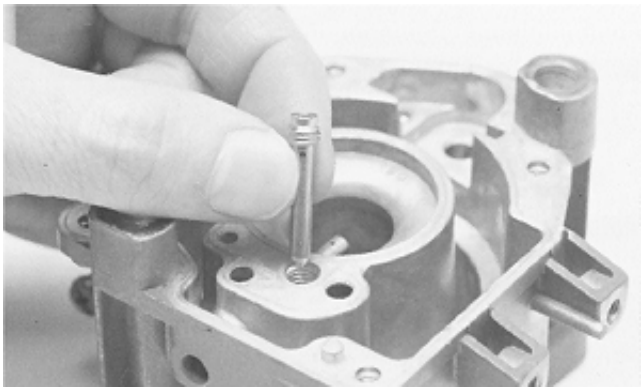
Check float for dents or leaks. Replace if defective or loaded with fuel.



-UN-08JAN90
M46029

5M4,T1250,9 -19-29SEP87

16. Remove slow idle jet.



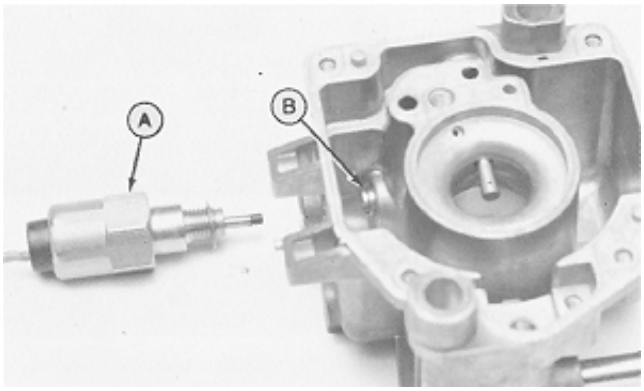
-UN-08JAN90
M46030

5M4,T1250,10 -19-29SEP87

17. Remove fuel shut-off solenoid (A) and bronze washer.

18. Remove main jet (B).

Inspect fuel shut-off solenoid. Replace solenoid if rubber tip is missing or shaft is bent.



-UN-08JAN90
M46031

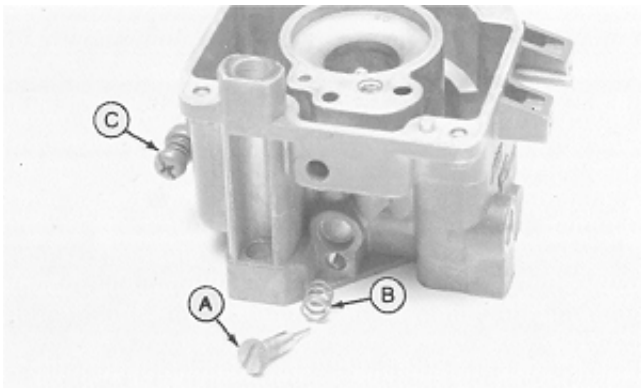
5M4,T1250,11 -19-29SEP87

19. Remove idle mixture screw (A) and spring (B).

Inspect seating surface of mixture screw. Replace if worn or damaged.

20. Remove idle speed screw (C) and spring.

Replace springs if weak or broken.



5M4,T1250,12 -19-29SEP87

CLEAN CARBURETOR

IMPORTANT: Never clean holes or passages with small drill bits or wire because a slight enlargement or burring of these holes will change the performance of the carburetor. No other method of cleaning other than solvent should be used.

1. Soak all metal components not replaced in carburetor cleaner. Do not soak non-metal floats or other non-metal parts.

2. Clean all carbon from carburetor bore. Be careful not to plug the idle or main fuel ports.

3. Dry out all passages with low pressure air 240 kPa (2.4 bar) (35 psi). Make sure all holes and passages are open. Do not use rags or paper to dry parts.

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M98,2050K,25 -19-21OCT85

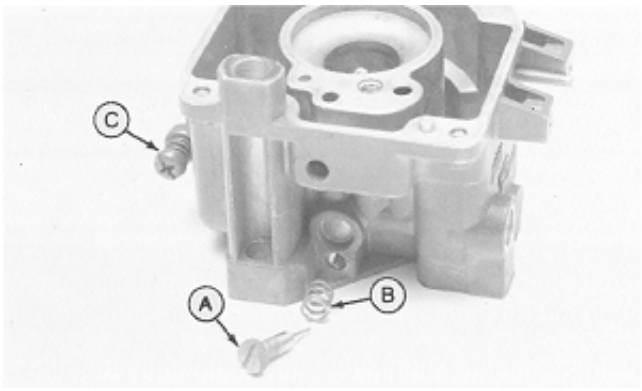
ASSEMBLE CARBURETOR

NOTE: Carburetor assembly includes procedures for all carburetors. The differences are noted.

Use new seals, gaskets, and O-ring when assembling carburetor.

1. Install idle speed screw (C) and spring.

2. Install idle mixture screw (A) and spring (B). Turn idle mixture screw in until lightly seated, then back it out 1-1/4 turns.



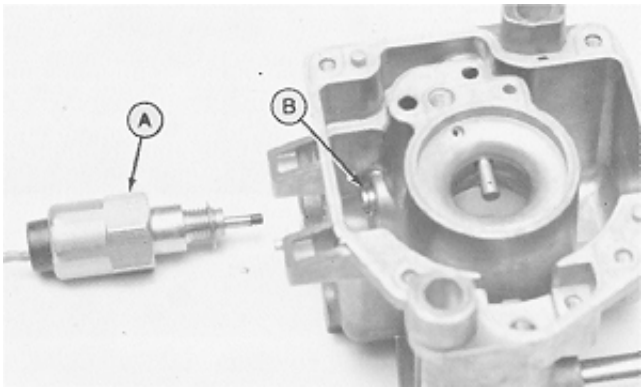
-UN-08JAN90
M46032

5M4,T1250,13 -19-12OCT87

NOTE: Main jet size may vary depending upon engine application and altitude. Check machine model number and parts catalog.

3. Install main jet (B).

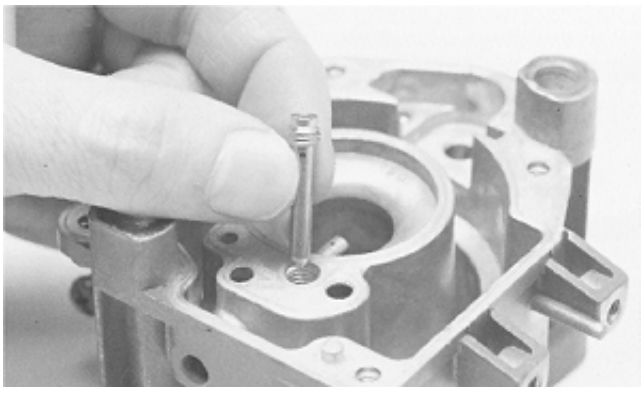
4. Install fuel shut-off solenoid (A) and bronze washer (gasket).



-UN-08JAN90
M46031

5M4,T1250,14 -19-29SEP87

5. Install slow idle jet.



-UN-08JAN90
M46030

5M4,T1250,15 -19-29SEP87

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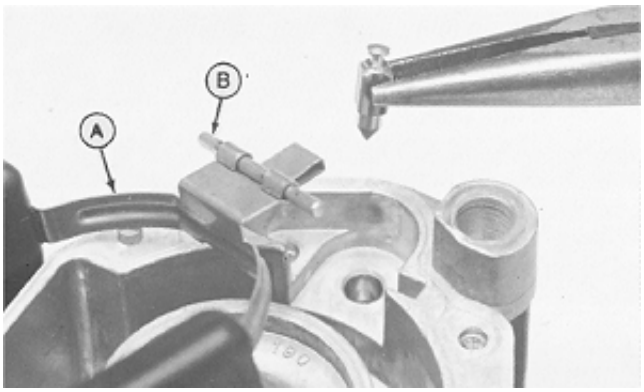
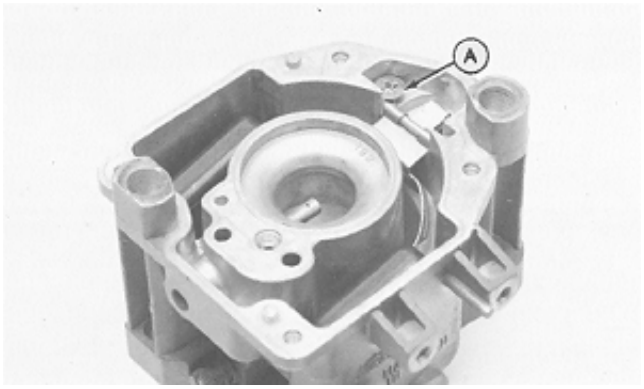
6. Install float (A), pivot pin (B), and valve. Be sure valve is hooked over tab on float.



-UN-08JAN90
M46029

5M4,T1250,16 -19-29SEP87

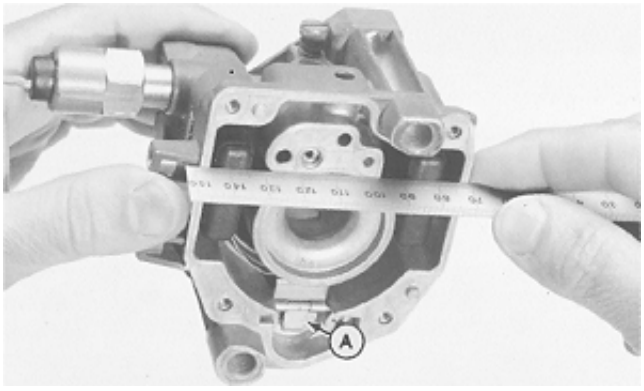
7. Fasten float assembly with retaining screw (A). Make sure pivot pin is in the groove and that the float moves freely without binding.



-UN-08JAN90
M46028

5M4,T1250,17 -19-29SEP87

8. Turn carburetor over and check float setting using a straightedge. Adjust floats so they are even with edge of bowl or no more than 1 mm (0.04 in.) beyond edge. Bend float tab (A) to adjust.



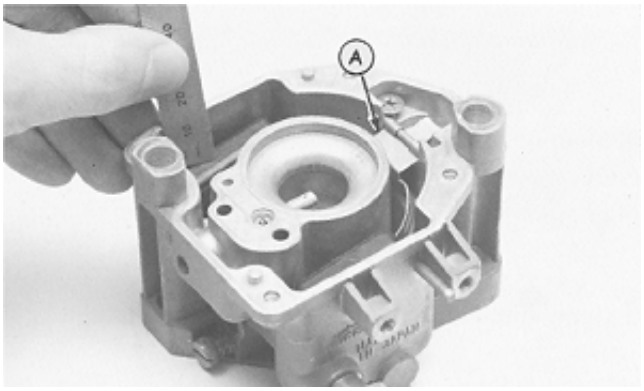
-UN-08JAN90
M46027

5M4,T1250,18 -19-29SEP87

9. Turn carburetor right side up and measure float drop. The distance from top of carburetor body to top of float (measured at highest point) must be at least 5 mm (0.20 in.).

Bend float arm (A) to adjust.

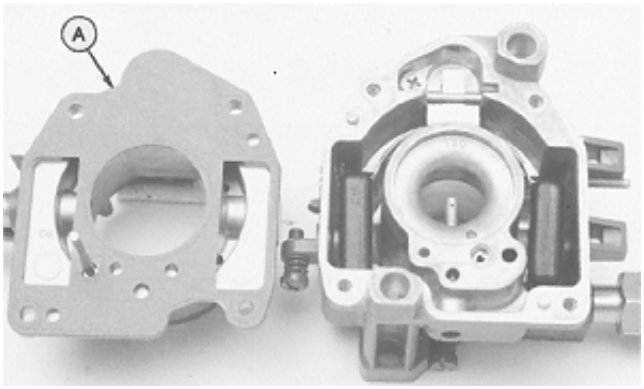
If float drop is adjust, check float level again.



-UN-08JAN90
M46026

5M4,T1250,19 -19-29SEP87

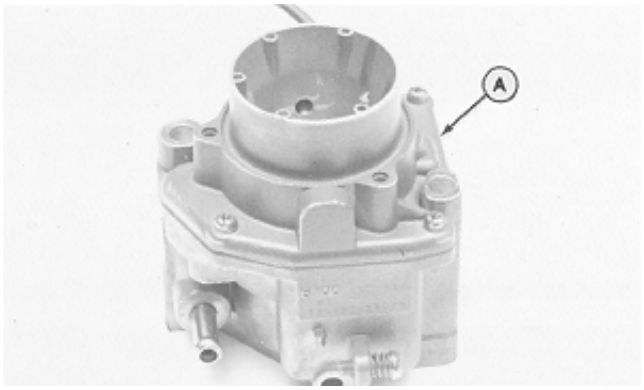
10. Install gasket (A).



-UN-08JAN90
M46025

5M4,T1250,20 -19-29SEP87

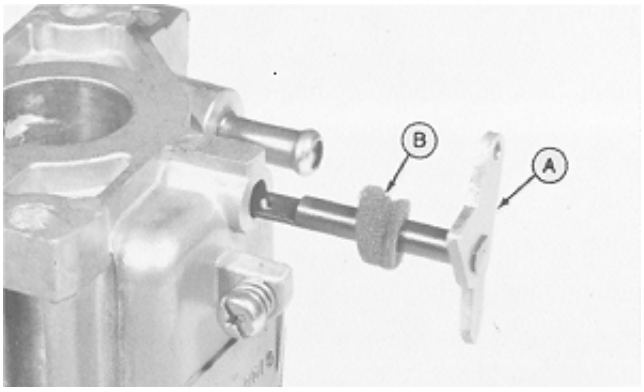
11. Install air intake. Fasten with four screws.



-UN-08JAN90
M46024

5M4,T1250,21 -19-29SEP87

12. Apply a small amount of oil to foam seal (B). Install seal and throttle shaft (A).

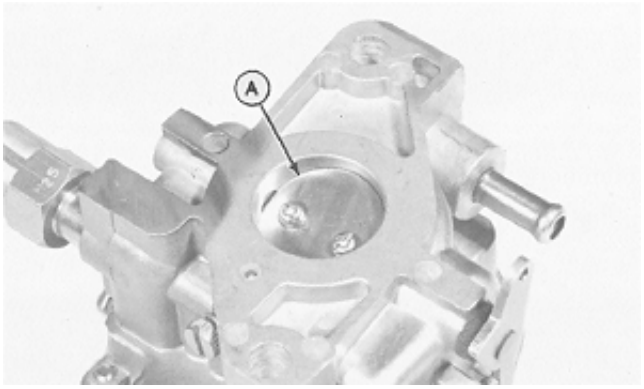


-UN-08JAN90
M46023

5M4,T1250,22 -19-29SEP87

13. Install throttle plate (A).

Adjust plate so that it is centered in the bore before tightening the two screws. To center the plate, back off the throttle stop screw and completely close the throttle lever. Seat the plate by tapping with a small screwdriver, then tighten screws.



-UN-08JAN90
M46022

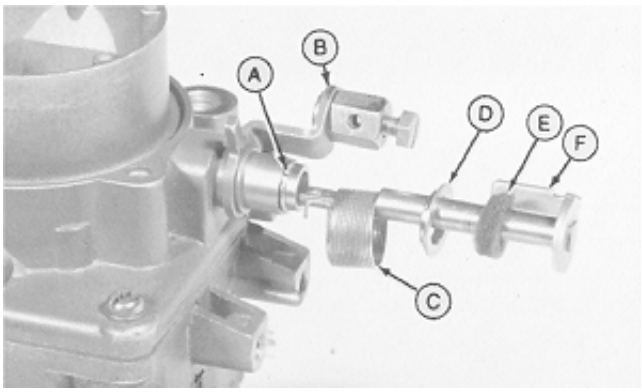
5M4,T1250,23 -19-29SEP87

14. Install lever assembly (B) and locking ring (A).

15. Apply a small amount of oil to foam seal (E).

16. Install spring (C), collar (D), foam seal (E), and choke shaft (F).

A—Locking Ring
B—Lever Assembly
C—Spring
D—Collar
E—Foam Seal
F—Choke Shaft

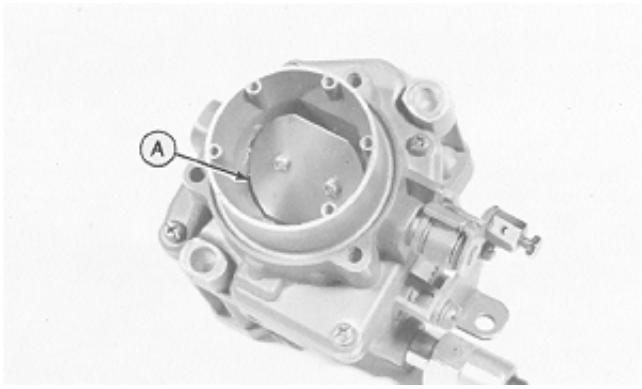


-UN-08JAN90
M46021

5M4,T1250,24 -19-12OCT87

17. Install choke plate (A).

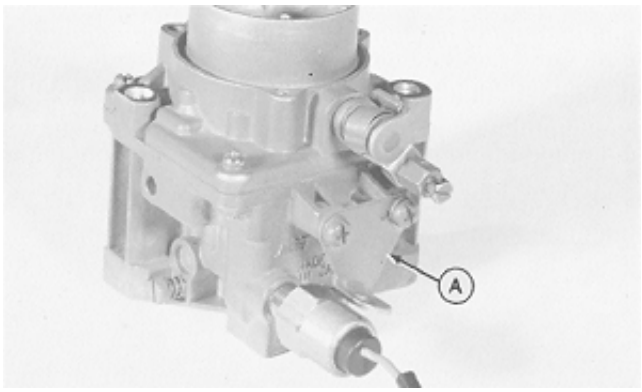
Adjust plate so that it is centered in the bore before tightening screws.



-UN-08JAN90
M46020

5M4,T1250,25 -19-29SEP87

18. Install choke control bracket (A) and fasten with two screws.



-UN-08JAN90
M46019

5M4,T1250,26 -19-29SEP87

50
8

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Dial Indicator	Measure governor gear backlash
Outside Micrometer	Measure governor shaft
Inside Micrometer	Measure fuel control linkage bore
Press	Remove and install governor shaft.

5M4,T1255,1 -19-12OCT87

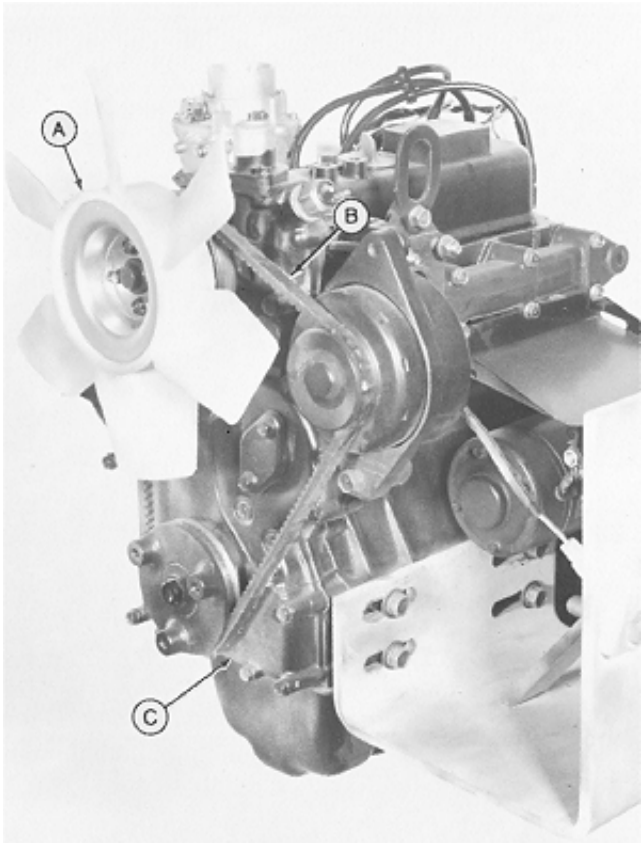
REMOVE AND INSPECT GOVERNOR

1. Remove engine. (See Section 20 in Machine Technical Manual.)

2. Remove fan (A).

3. Loosen alternator and remove alternator belt (B).

4. Remove timing gear cover (C). (See Group 35 in this manual.)

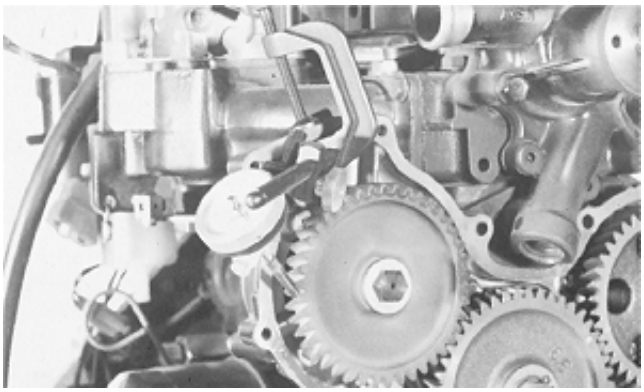


M46043 -UN-08JAN90

5M4,T1255,2 -19-29SEP87

5. Measure governor gear backlash using a dial indicator. New backlash specification is 0.11 to 0.30 mm (0.004 in. to 0.012 in.)

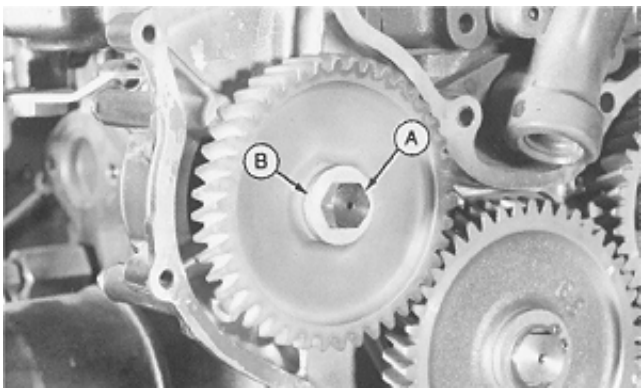
If backlash exceeds 0.38 mm (0.015 in.), replace gear.



5M4,T1255,3 -19-29SEP87

NOTE: A shop towel in the gear teeth will prevent gears from turning.

6. Remove special bolt (A) and washer (B) to remove gear.



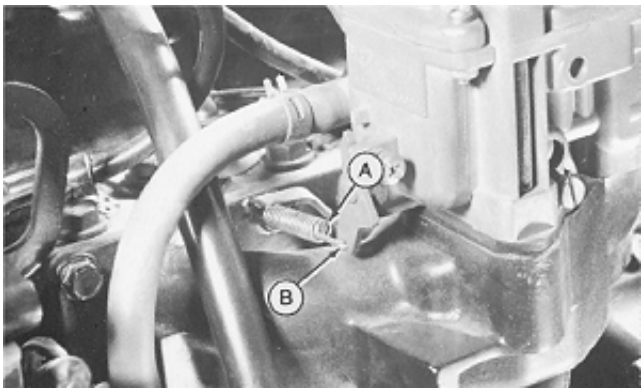
5M4,T1255,4 -19-29SEP87

7. Disconnect spring (A) and link (B).

8. Disconnect spring (C).

9. Remove four cap screws to remove governor linkage and housing assembly (D).

A—Spring
B—Link
C—Spring
D—Governor Linkage and Housing Assembly



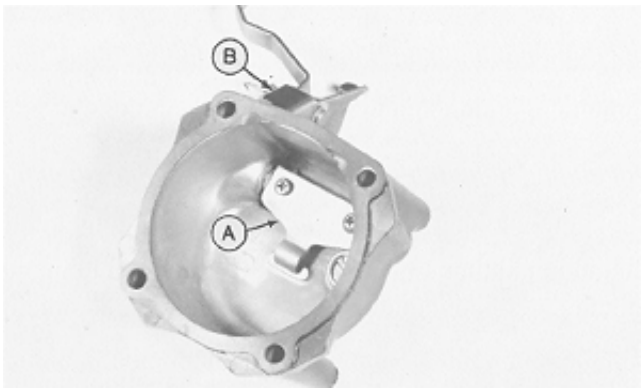
5M4,T1255,5 -19-29SEP87

55
2

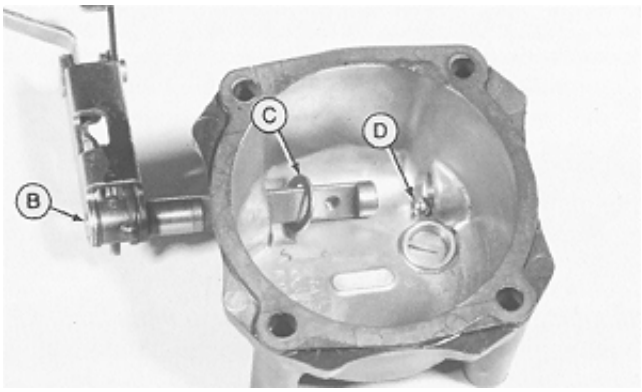
10. Remove two screws to remove lever yoke (A).

11. Remove linkage assembly (B), shim (C), and ball (D).

A—Lever Yoke
B—Linkage Assembly
C—Shim
D—Ball



-UN-08JAN90
M46048

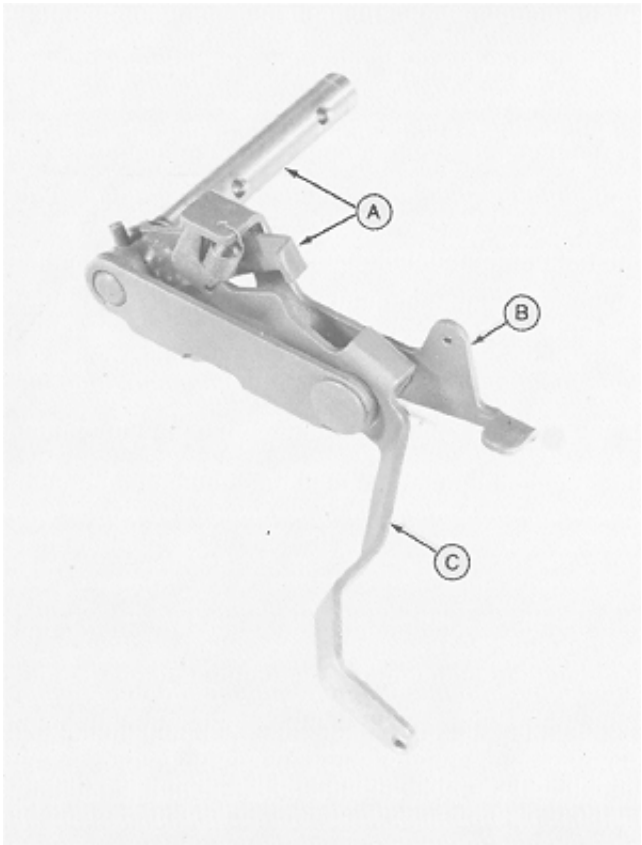


-UN-08JAN90
M46049

5M4,T1255,6 -19-29SEP87

12. Disassemble and inspect linkage assembly. Replace parts as required.

A—Push Lever Assembly
B—Tension Lever
C—Governor Lever



-UN-08JAN90
M46050

5M4,T1255,7 -19-12OCT87

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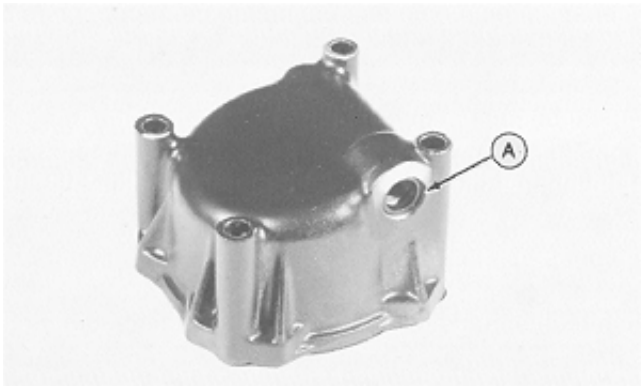
3

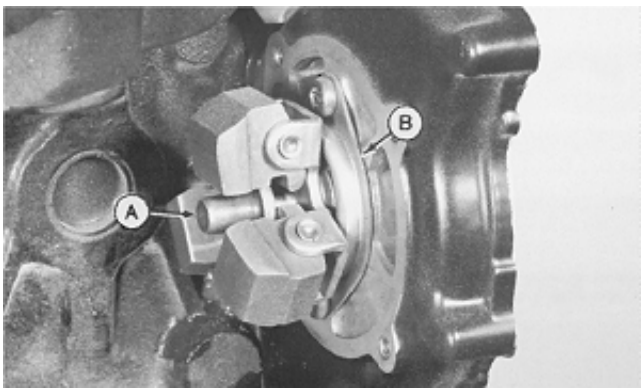
13. Inspect oil seal (A). Replace if necessary.



5M4,T1255,8 -19-12OCT87

14. Remove spindle (A).

15. Remove two screws to remove governor weight assembly (B).



5M4,T1255,9 -19-29SEP87

16. Measure fuel control linkage bore inside diameter.

FUEL CONTROL LINKAGE BORE SPECIFICATIONS

Bore Diameter (Maximum) . . . . . 8.15 mm (0.321 in.)

If bore diameter is greater than 8.15 mm (0.321 in.) replace fuel control linkage assembly.

17. Measure governor shaft outside diameter.

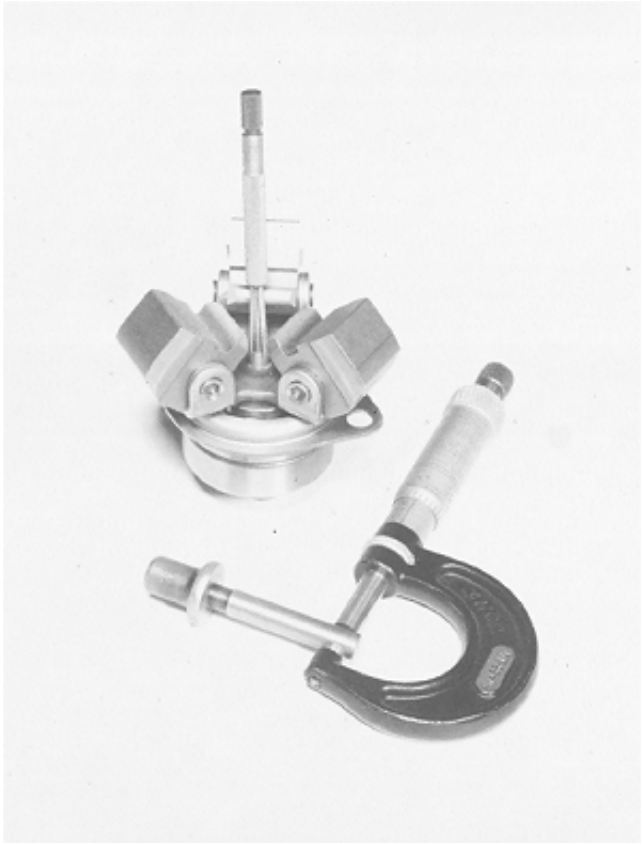
GOVERNOR SHAFT SPECIFICATIONS

Shaft Diameter (Minimum) . . . . . 7.90 mm (0.311 in.)

If diameter is less than 7.90 mm (0.311 in.) replace governor shaft.

18. Determine governor shaft clearance (fuel control linkage bore diameter minus governor shaft diameter). Governor shaft clearance is 0.18 mm (0.0071 in.).

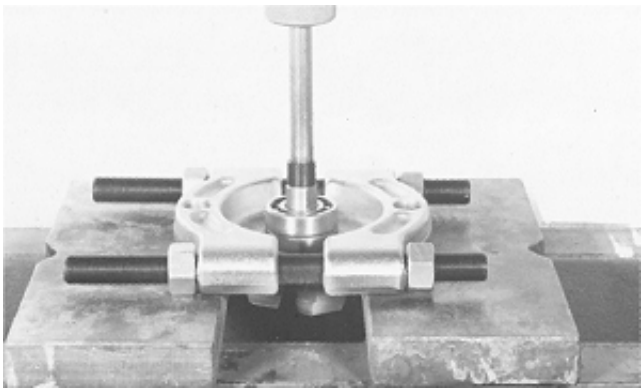
If clearance is greater than 0.18 mm (0.0071 in.), replace governor shaft, fuel control linkage assembly, or both.



5M4,T1255,10 -19-29SEP87

55
4

19. Support bearings on knife edge puller and press shaft from bearings.



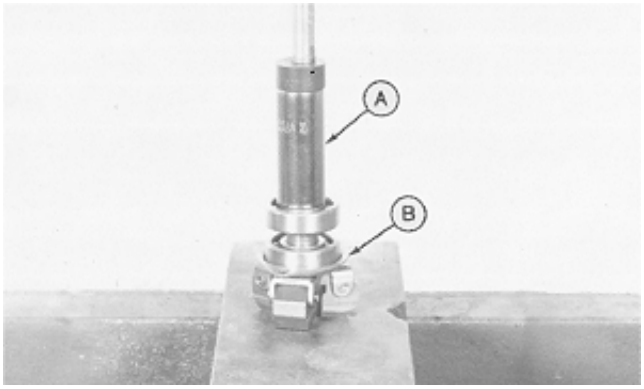
M46054 -UN-08JAN90

5M4,T1255,11 -19-29SEP87

ASSEMBLE AND INSTALL GOVERNOR

1. Install retainer (B).

2. Press bearing onto shaft using a deepwell socket (A).

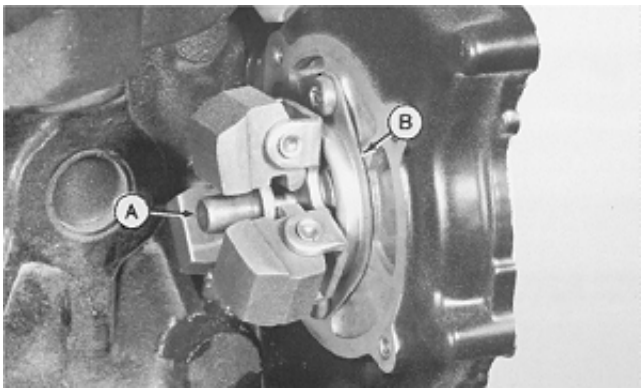


M46055 -UN-08JAN90

5M4,T1255,12 -19-29SEP87

3. Install governor weight assembly. Fasten retainer (B) to gear housing using two screws.

4. Install spindle (A).



M46052 -UN-08JAN90

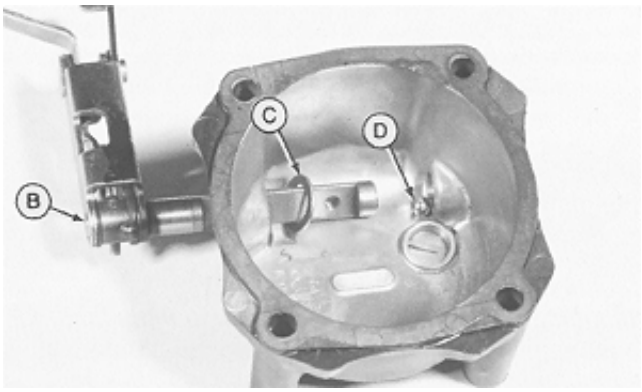
5M4,T1255,13 -19-29SEP87

55

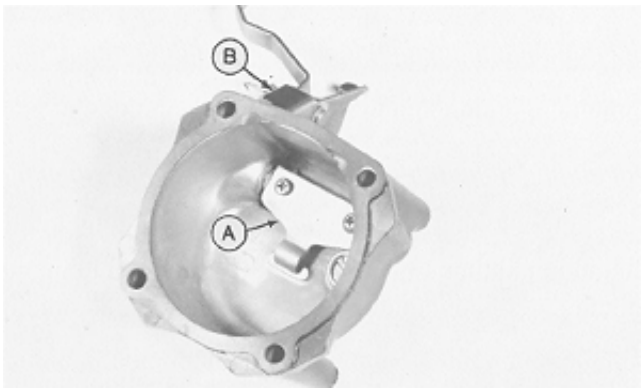
5. Install linkage assembly (B), shim (C), and ball (D).

6. Install lever yoke (A) and two screws.

A—Lever yoke
B—Linkage Assembly
C—Shim
D—Ball



-UN-08JAN90
M46049



-UN-08JAN90
M46048

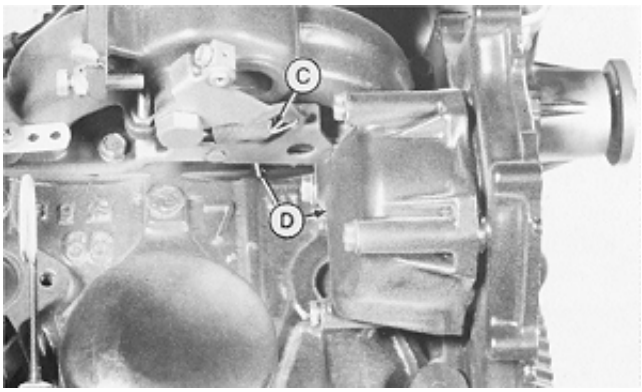
5M4,T1255,14 -19-29SEP87

7. Install governor linkage and housing assembly (D). Fasten with four cap screws.

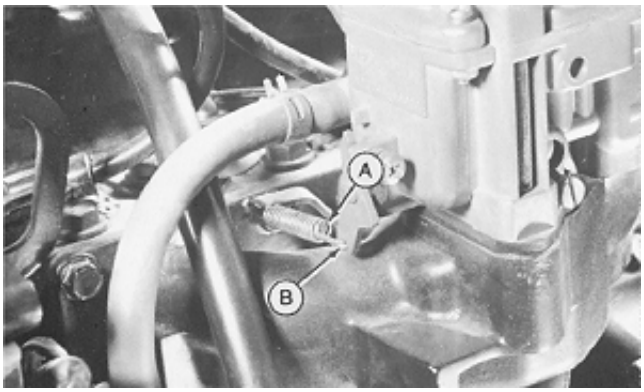
8. Connect spring (C).

9. Connect link (B) and spring (A).

A—Spring
B—Link
C—Spring
D—Governor Linkage and Housing Assembly



-UN-08JAN90
M46047



-UN-08JAN90
M46046

5M4,T1255,15 -19-29SEP87

55
6

NOTE: A shop towel in the gear teeth will prevent gears from turning.

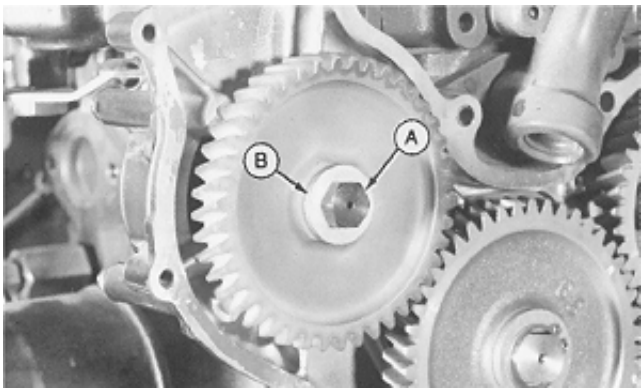
10. Install gear, washer (B), and special bolt (A).

11. Install timing gear cover. (See Group 35 in this manual.)

12. Install alternator belt. Check belt tension, belt must deflect 13 mm (0.5 in.) at 107 N (24 lb) force applied halfway between pulleys.

13. Install fan.

14. Install engine. (See Section 20 in Machine Technical Manual.)



M46045 -UN-08JAN90

5M4,T1255,16 -19-12OCT87

55
7

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Volt-Ohm-Amp Meter	Check continuity
Armature Growler	Check starter armature
13-Ton Puller Set	Remove armature shaft bearings

M21,4010R,1 -19-14JUN85

STARTER SPECIFICATIONS

	Specification	
	Hitachi	Nippon Denso
Starter	0.8 kw	1.0 kw
Brush Length (minimum)	7.7 mm (0.30 in.)	8.5 mm (0.33 in.)
Mounting Cap Screw Torque	49 N·m (36 lb-ft)	88 N·m (65 lb-ft)

5M4,T1260,2 -19-12OCT87

STARTER APPLICATION CHART

The various starters covered in this group are identified by manufacturer and output rating.

To help identify the Nippon Denso starters, measure the outside diameter of the Motor yoke.

Manufacturer	Rated Output	Motor Yoke Outside Diameter
Hitachi	0.8 kw	
Nippon Denso	1.0 kw	68 mm (2.68 in.)

60
1

5M4,T1260,1 -19-12OCT87

BENCH TEST STARTER

1. Remove starter from engine.

2. Turn pinion gear by hand. It should turn freely clockwise only. If gear turns freely both directions, clutch assembly is defective.

3. If pinion turns freely, perform starter no load running test.

M21,TM360,1 -19-14AUG87

NOTE: Do not conduct the no-load test unless the armature turns freely.

4. Connect a 12-volt battery (A) to starter battery terminal (B) and starter frame (C). Use heavy duty cables.

5. Connect a remote start switch (D) between switch terminal (E) and battery terminal (B).

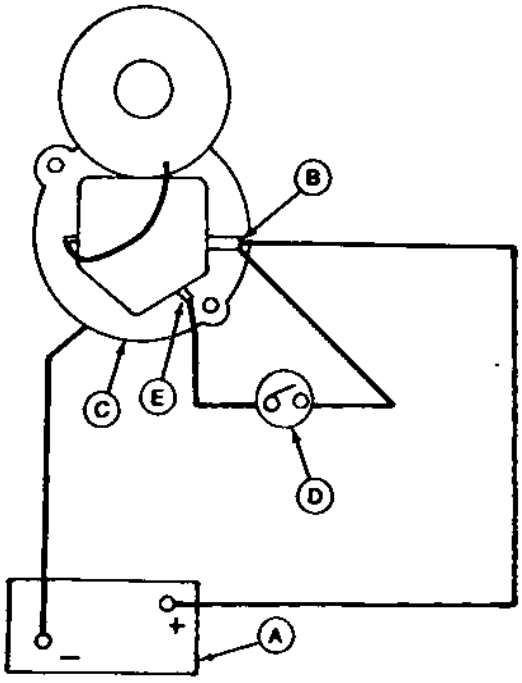
NOTE: A short piece of wire with a small clip on the end will allow a more positive connection at the switch terminal.

6. When switch is activated, starter should engage and run.

7. If solenoid only chatters, hold-in winding is open-circuited. If nothing happens, either the pull-in winding is open-circuited or mechanical parts are sticking. To check for sticking, remove solenoid end cover and push plunger by hand.

8. If solenoid engages properly, but motor does not run, check main contact points, bearings, brushes, reduction gears, armature, and field windings.

NOTE: The solenoid cannot be repaired although mechanical parts may be replaced. Disassemble solenoid to determine cause of problem.



RW2159 -UN-01DEC88

A—12-Volt Battery
B—Battery Terminal
C—Starter Frame
D—Remote Start Switch
E—Switch Terminal

M21,4010R,5 -19-14JUN85

DISASSEMBLE AND SERVICE HITACHI 0.8 KILOWATT STARTER

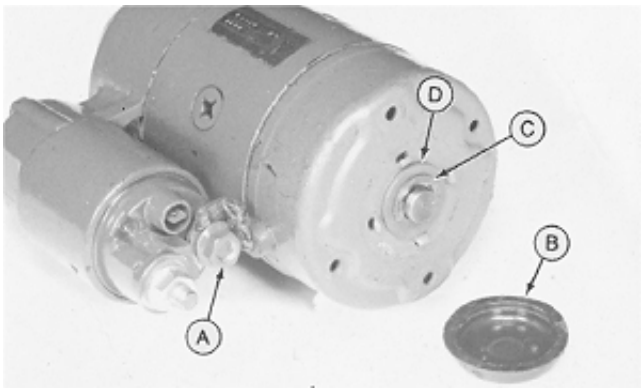
1. Disconnect wire (A) from solenoid.

2. Remove the two phillips screws and two through bolts from rear cover.

3. Pry plastic cap (B) from rear cover.

4. Remove “E” clip (C) and shim pack (D). Remove cover.

A—Solenoid Wire
B—Plastic Cap
C—E-Clip
D—Shim Pack

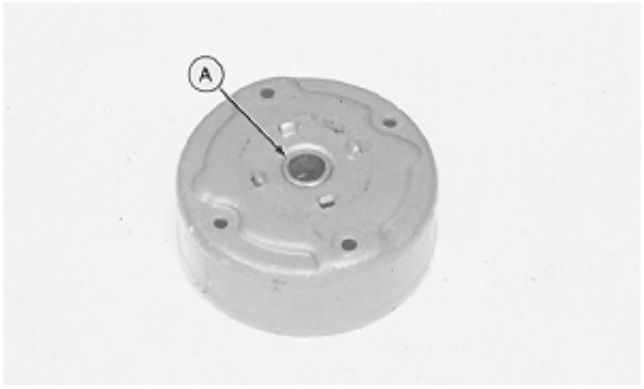


-UN-29AUG88
M37873

M21,TM360,22 -19-14AUG87

5. If necessary, remove cover bushing (A) with blind hole puller.

Install new bushing with suitable size driver disks until bushing bottoms in cover.

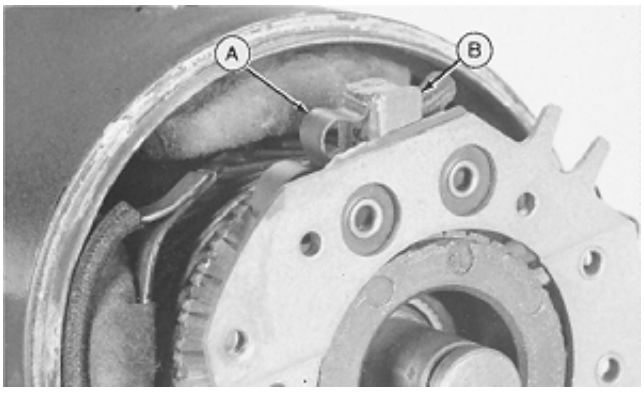


-UN-29AUG88
M37874

M21,TM360,23 -19-15FEB86

6. Pry brush spring (A) away and pull negative brush (B) up enough to allow spring to hold in place.

7. Remove the two field coil brushes from holders and remove brush holder assembly.

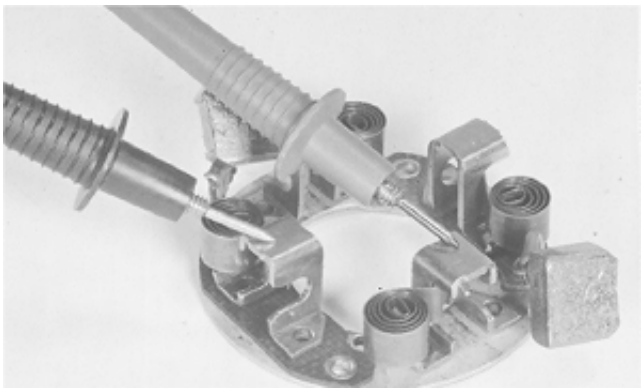


-UN-29AUG88
M37875

M21,TM360,24 -19-15FEB86

8. Test the brush holder using an ohmmeter or test light. Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.

Inspect springs; replace if weak or distorted.



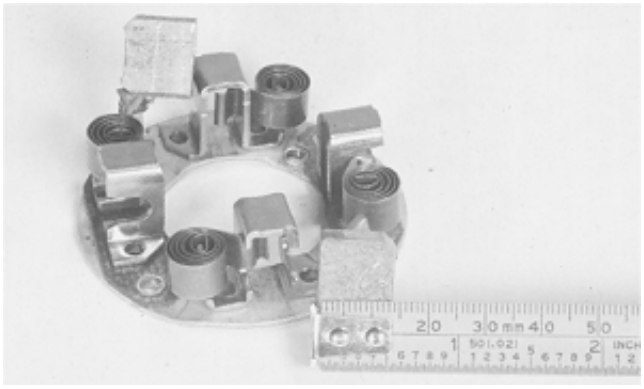
M36756 -UN-29AUG88

M21,4010R,10 -19-14JUN85

9. Measure brush length. Replace if worn below minimum length of 7.7 mm (0.30 in.).

If negative side brushes mounted on brush holder are worn, replace the entire brush holder.

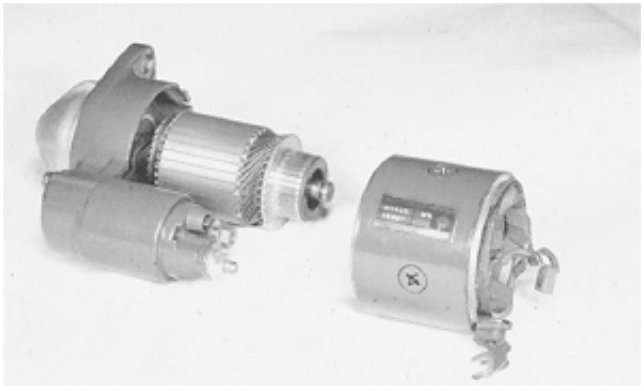
If field coil brushes are worn, the entire field coil assembly must be replaced.



M36755 -UN-29AUG88

M21,TM360,37 -19-08APR86

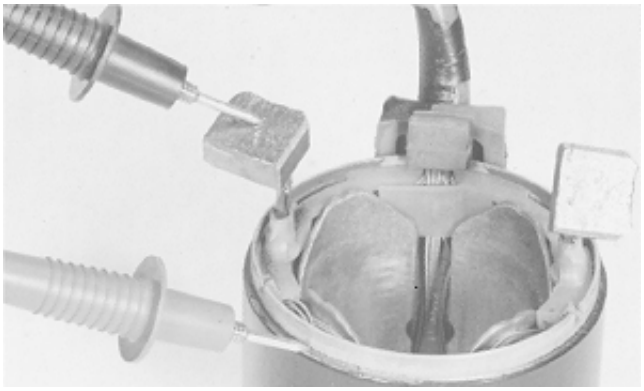
10. Remove field coil housing from armature.



M37876 -UN-29AUG88

M21,TM360,25 -19-15FEB86

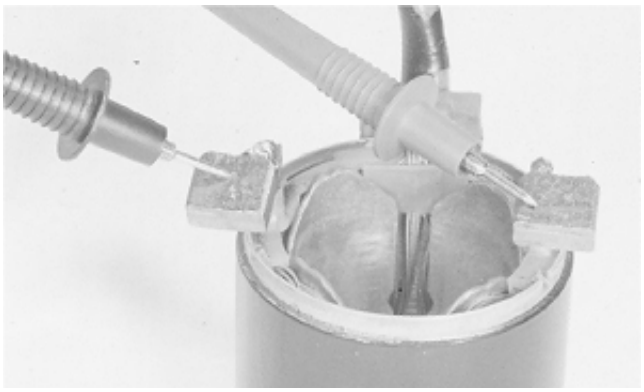
11. Test for grounded field winding using an ohmmeter or test lights. Touch one probe of tester to field coil brush and other probe to field frame. Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field frame assembly must be replaced.



M36757 -UN-29AUG88

M21,TM360,39 -19-15FEB86

12. Test for open field coil by touching a probe to each field coil brush, if there is not continuity, the field coil is open and the field frame assembly must be replaced.

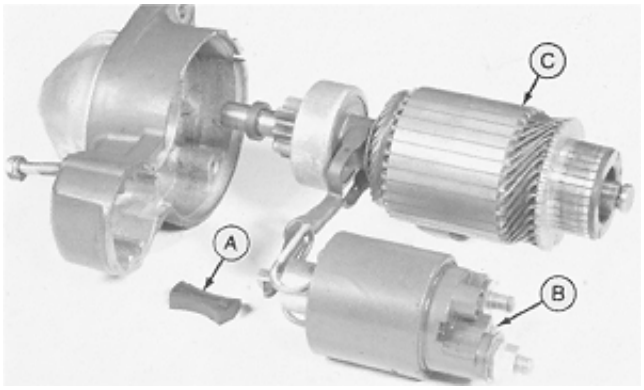


M21,TM360,40 -19-15FEB86

13. Remove the two solenoid attaching cap screw.

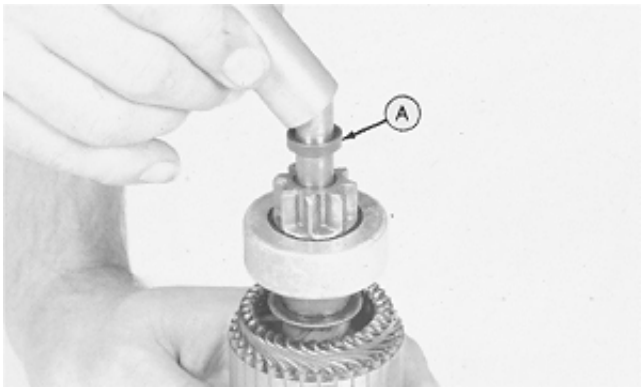
14. Remove rubber plug (A).

15. Pull solenoid (B) and armature assemblies (C) from housing.



M21,TM360,26 -19-15FEB86

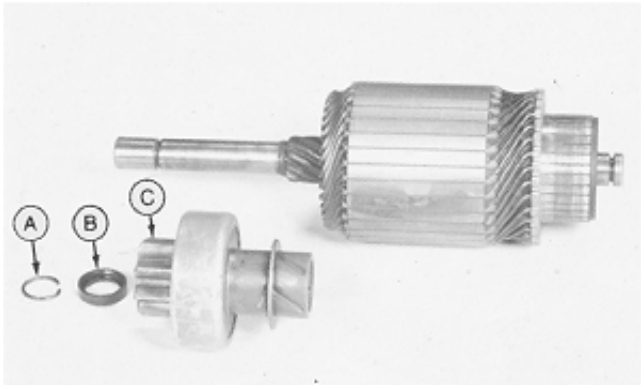
16. Use a piece of pipe or a deep well socket to drive pinion stopper (A) down from retaining wire.



M21,TM360,27 -19-15FEB86

17. Remove retaining wire (A), pinion stopper (B) and clutch assembly (C) from armature shaft.

18. Inspect clutch gear for damage it should rotate only in one direction. Replace clutch assembly as needed.

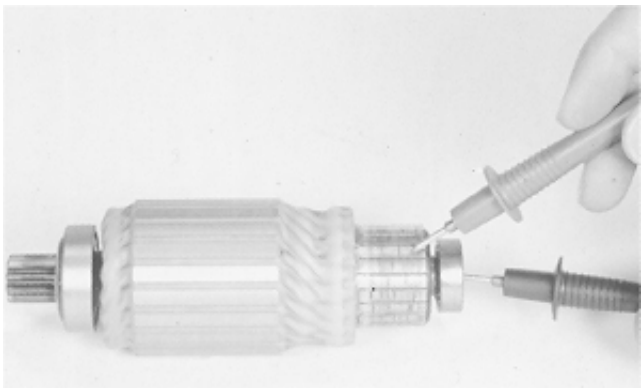


M21,TM360,28 -19-15FEB86

19. Test for grounded windings using an ohmmeter or test light.

Touch probes on commutator bar and armature shaft. Armature windings are connected in series, so only one commutator bar needs to be checked.

If test shows continuity, a winding is ground and the armature must be replaced.

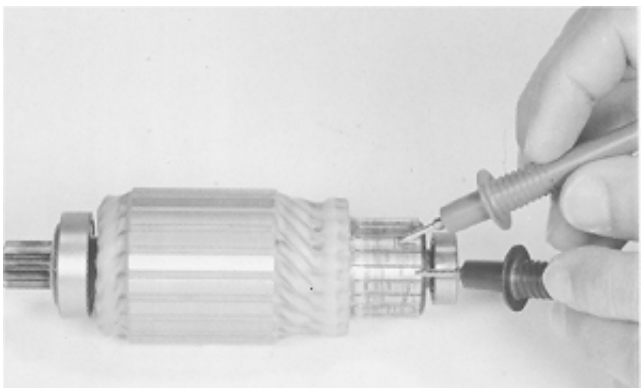


-UN-29AUG88
M36760

M21,TM360,29 -19-15FEB86

20. Test for open circuited windings using an ohmmeter or test light.

Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.



-UN-29AUG88
M36761

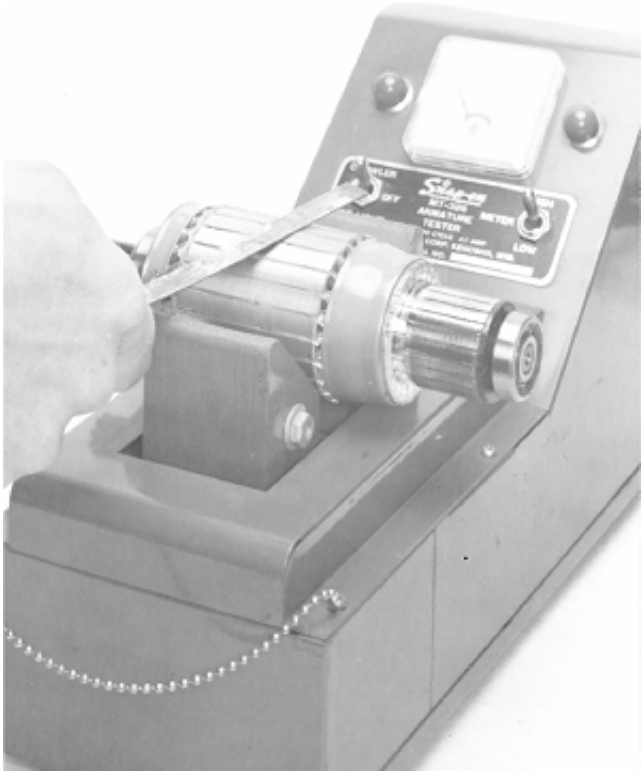
M21,TM360,30 -19-15FEB86

21. Test for short circuited windings using a growler. Put armature in growler and hold a hacksaw blade above each slot while slowly rotating armature.

If coil is shorted, the blade will vibrate on the slot.

NOTE: A short circuit most often occurs because of copper dust or filings between tow commutator segments.

22. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.



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RW2168

M21,TM360,31 -19-15FEB86

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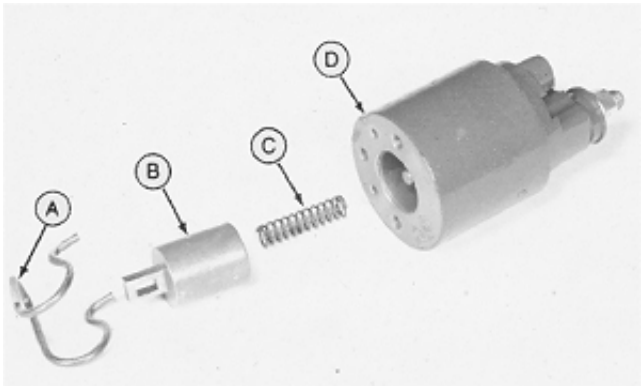
6

23. Remove and inspect solenoid components.

Assemble in reverse order.

24. Replace solenoid if indicated in bench test, earlier in this group.

A—Clutch Fork Pivot
B—Solenoid Plunger
C—Spring
D—Solenoid

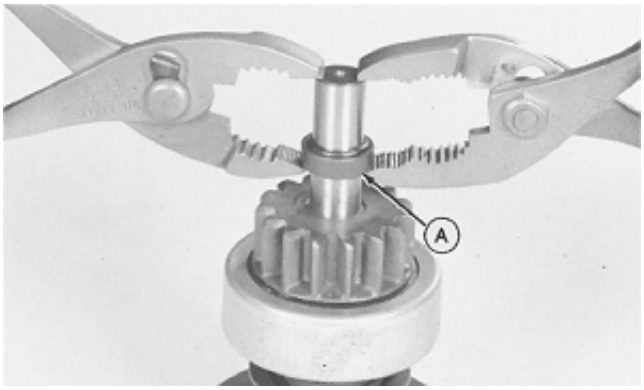


M21,TM360,32 -19-23APR86

ASSEMBLE HITACHI 0.8 KILOWATT STARTER

1. Install clutch assembly on armature.

2. Install pinion stopper over shaft. Install retaining wire and use two pliers to press pinion stopper (A) over retaining wire.



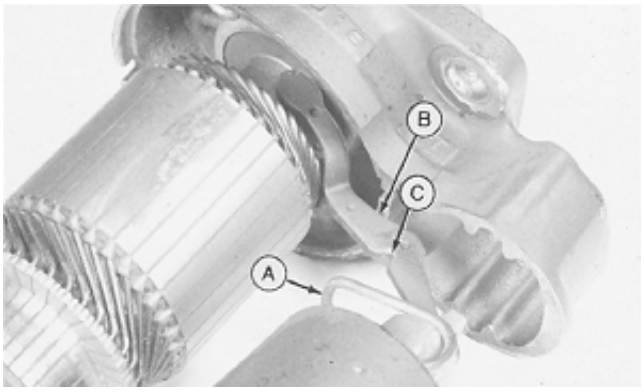
M21,TM360,33 -19-01SEP87

3. Place armature with clutch assembly into housing.

4. Be sure spring pivot (A) is installed in solenoid and install clutch fork (B) over clutch and through solenoid plunger.

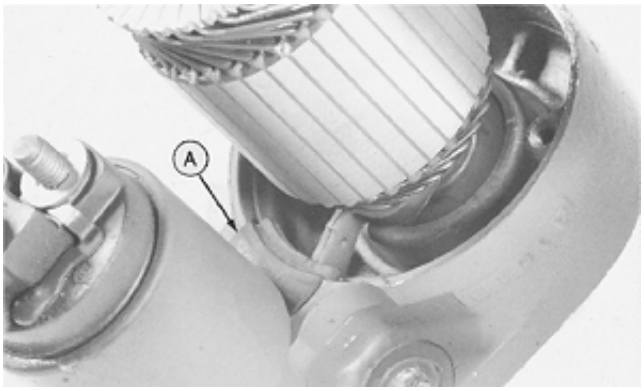
5. Install solenoid making sure spring pivot seats in notch (C) in clutch fork.

6. Install two solenoid attaching cap screws.



M21,TM360,34 -19-15FEB86

7. Install rubber plug (A) in notched area of housing.



M21,TM360,35 -19-24MAR86

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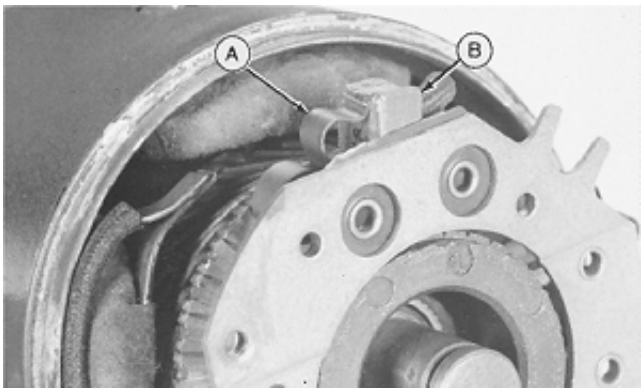
7

8. Install field coil housing. Install field coil brushes (B) in brush holder. Hold springs (A) back to keep brushes off armature.

9. Install brush holder over armature and release springs to allow brushes to seat on commutator ring.



M21,TM360,36 -19-15FEB86

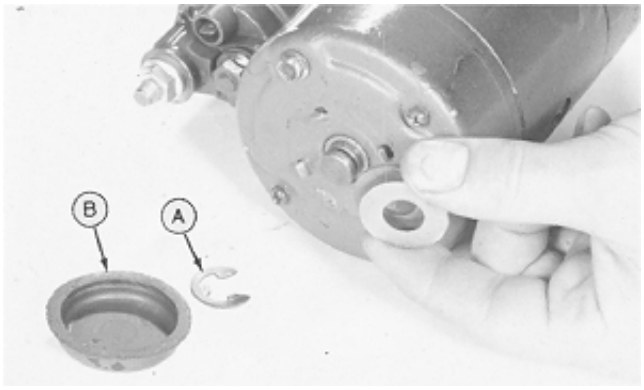
10. Install rear cover two through bolts. Install two phillips screws to secure brush holder.

11. Install wiring onto solenoid.

12. Install same number and thickness of shims as removed.

13. Install “E” clip (A) and plastic cover (B).

14. Install starter on engine. Tighten hardware to 49 N·m (36 lb-ft).

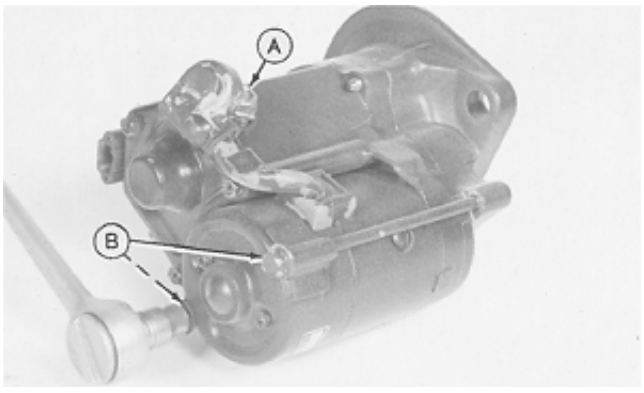


M21,TM360,38 -19-15FEB86

DISASSEMBLE AND SERVICE NIPPON DENSO 1.0 KILOWATT STARTER

1. Disconnect field lead (A).

2. Remove two bolts (B) and separate motor from solenoid. Remove armature assembly.



M21,4010R,6 -19-14AUG87

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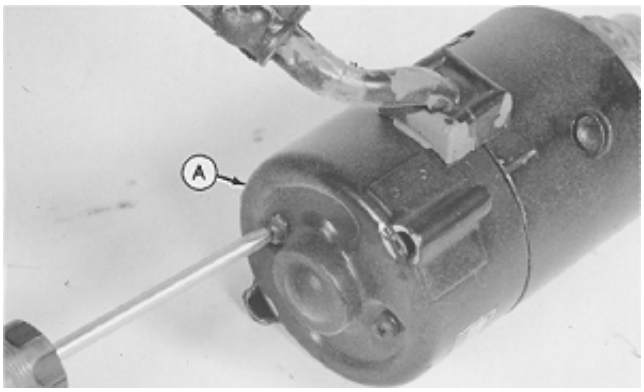
8

3. Remove two screws to remove end frame (A). Brush assembly will remain attached to field coil.

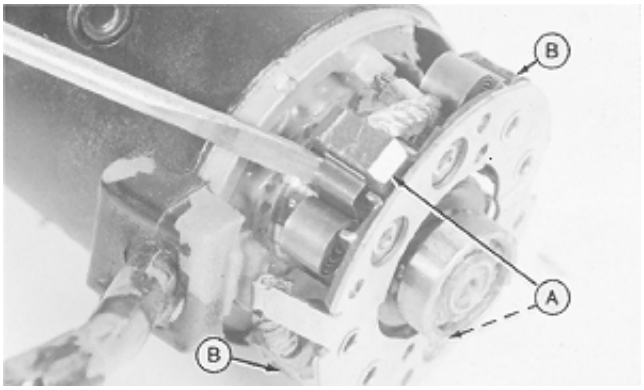


M21,4010R,7 -19-14JUN85

4. Use a screwdriver to pry springs away. Remove field coil brushes (A) from brush holder.

5. Pry springs away and pull negative side brushes (B) back about 6 mm (0.25 in.). Release springs to hold negative brushes in place.

6. Remove brush holder assembly from field coil assembly.

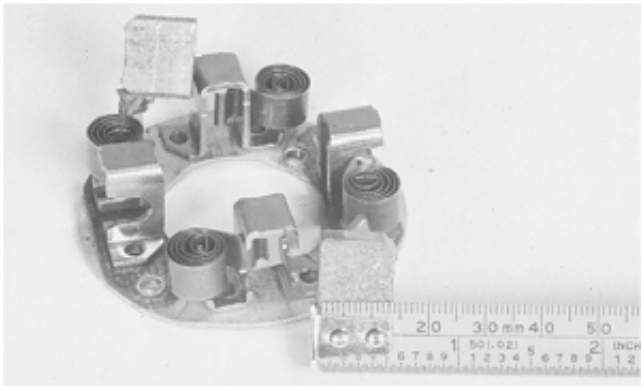


M21,4010R,8 -19-14JUN85

7. Measure brush length. Replace if worn below minimum length of 8.5 mm (0.30 in.).

If negative side brushes mounted on brush holder are worn, replace the entire brush holder.

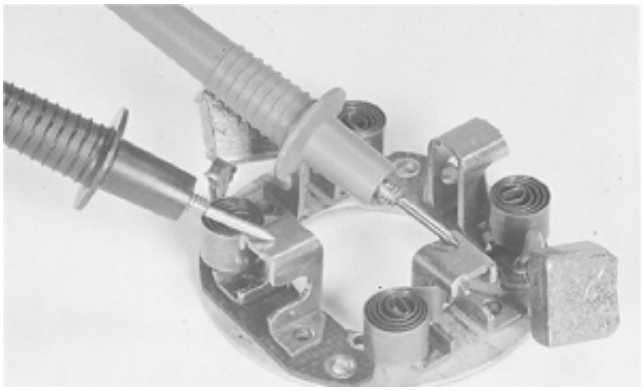
If field coil brushes are worn, the entire field coil assembly must be replaced.



M21,4010R,9 -19-14JUN85

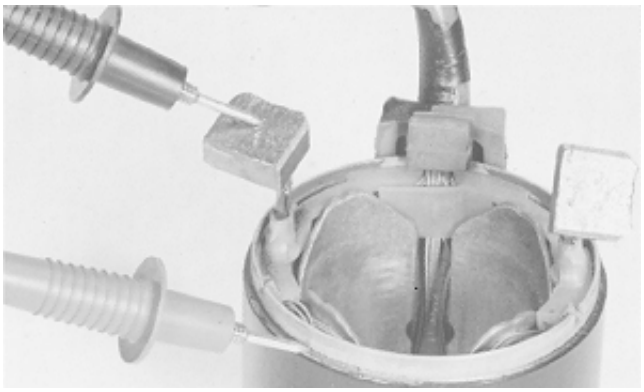
8. Test the brush holder using an ohmmeter or test light. Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.

Inspect springs; replace if weak or distorted.



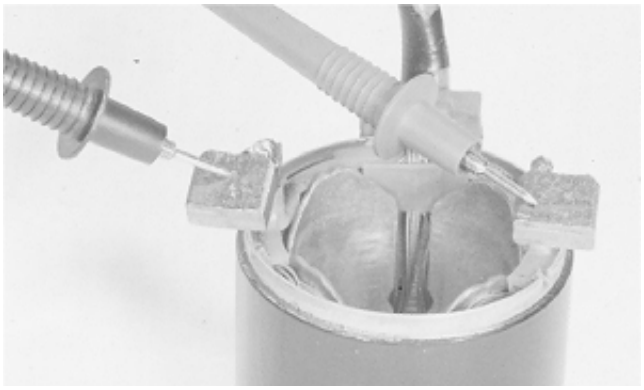
M21,4010R,10 -19-14JUN85

9. Test for grounded field winding using an ohmmeter or test light. Touch one probe of tester to field coil brush and other probe to field frame. Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field frame assembly must be replaced.



M21,4010R,11 -19-14JUN85

10. Test for open field coil by touching a probe to each field coil brush. If there is no continuity, the field coil is open and the field frame assembly must be replaced.

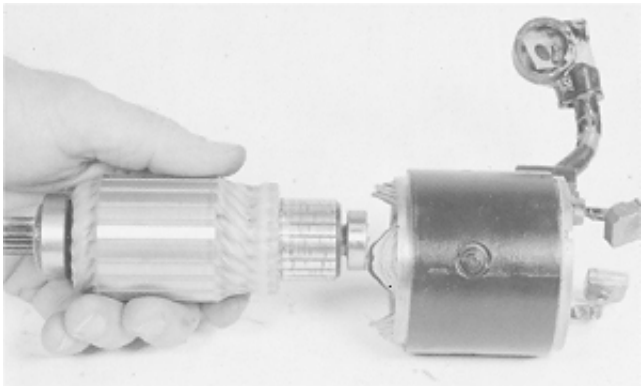


M21,4010R,12 -19-14JUN85

IMPORTANT: Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

11. Inspect armature. Look for signs of dragging against pole shoes.

12. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400 sandpaper. NEVER use emery cloth. Clean all dust from armature when finished.

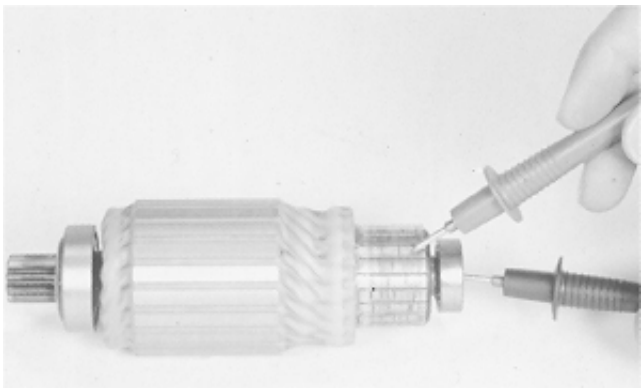


M21,4010R,13 -19-17JUL85

13. Test for grounded windings using an ohmmeter or test light.

Touch probes on commutator bar and armature shaft. Armature windings are connected in series, so only one commutator bar needs to be checked.

If test shows continuity, a winding is grounded and the armature must be replaced.



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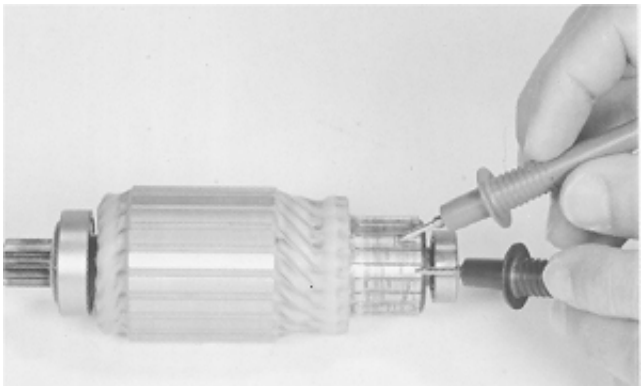
M36760

M21,4010R,14 -19-14JUN85

14. Test for open circuited windings using an ohmmeter or test light.

Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.



-UN-29AUG88
M36761

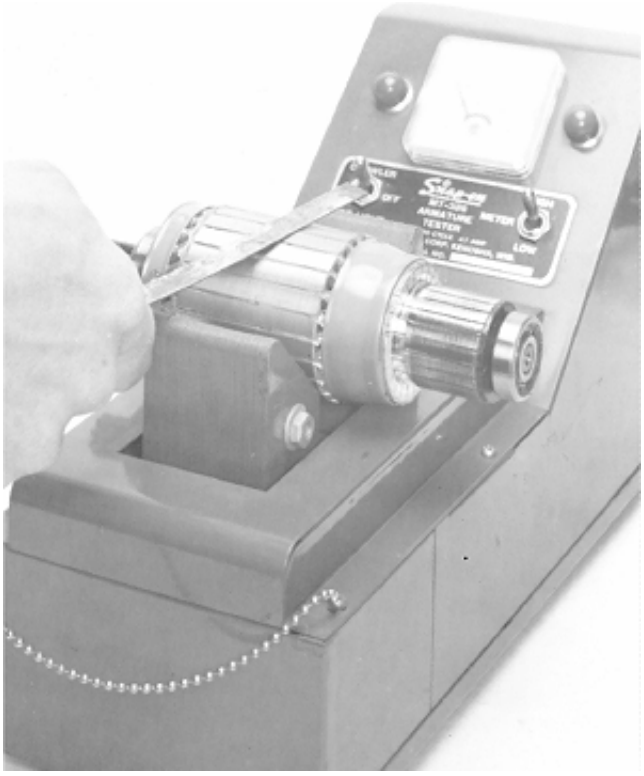
M21,4010R,15 -19-14JUN85

15. Test for short circuited windings using a growler. Put armature in growler and hold a hacksaw blade above each slot while slowly rotating armature.

If coil is shorted, the blade will vibrate on the slot.

NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

16. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.



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RW2168

M21,4010R,16 -19-14JUN85

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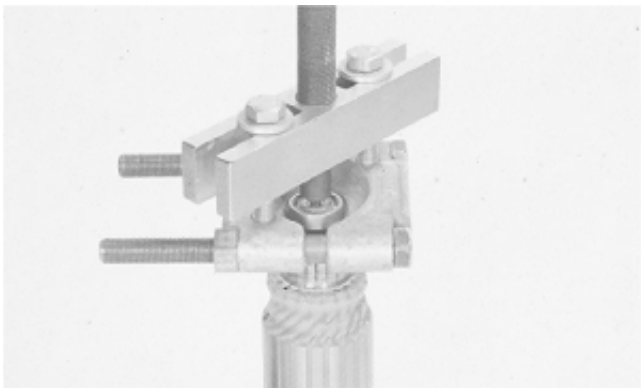
11

17. Inspect front and rear armature bearings for smooth quiet operation. Replace if defective.

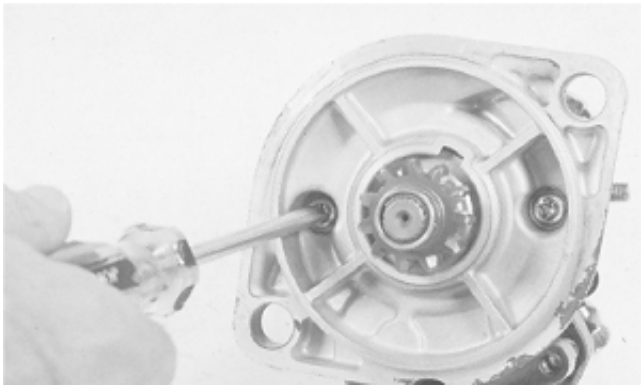
18. Remove bearings by using a knife edge bearing puller.



M21,4010R,17 -19-14JUN85

INSPECT AND REPAIR GEAR TRAIN AND OVERRUNNING CLUTCH (NIPPON DENSO 1.0 KILOWATT)

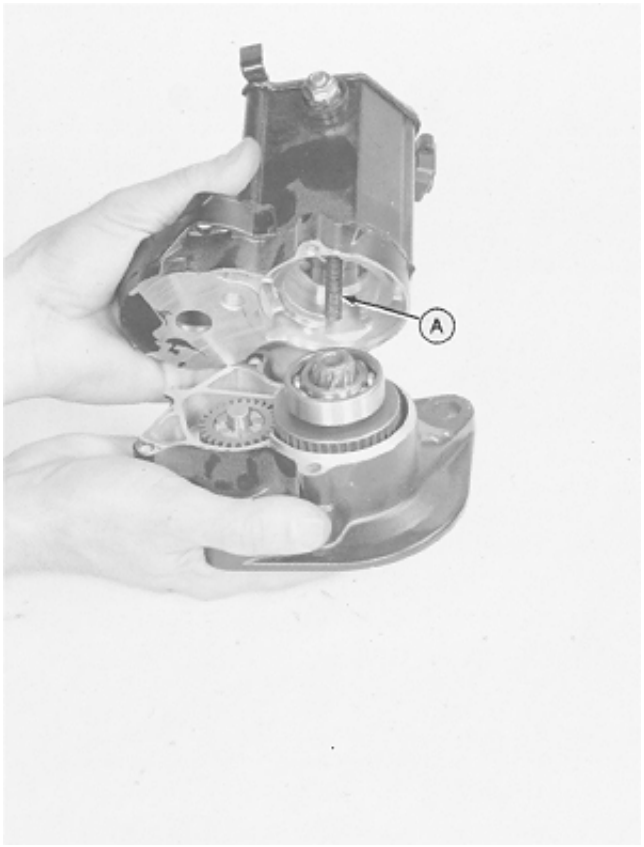
1. Remove two screws.



M21,4010R,18 -19-14AUG87

2. Hold clutch housing as shown and lift solenoid housing from clutch.

3. Remove plunger spring (A).



M21,4010R,19 -19-14JUN85

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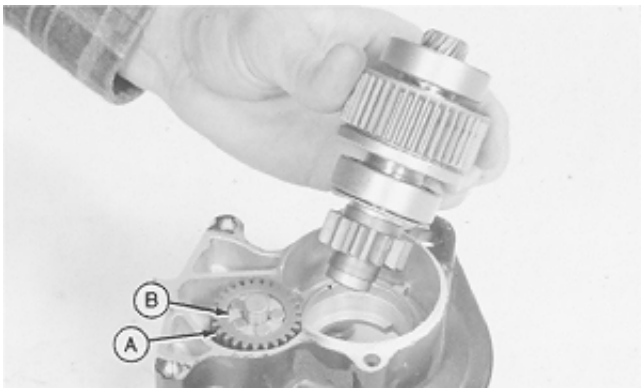
12

4. Remove clutch assembly from housing.

5. Remove pinion (A), retainer (B), and five rollers.

Inspect pinion, rollers, and retainer. Replace if worn or pitted.



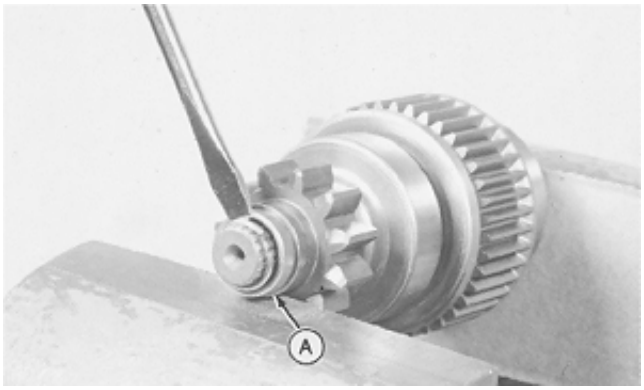
M21,4010R,20 -19-14JUN85

6. Remove steel ball from end of clutch shaft.

7. Put clutch assembly in a soft jaw vise. Be sure rear vise jaw is against shaft and front jaw is against pinion.

8. Tighten vise slowly until pinion compresses.

9. Push retainer (A) back until snap ring is exposed. Remove snap ring and retainer.



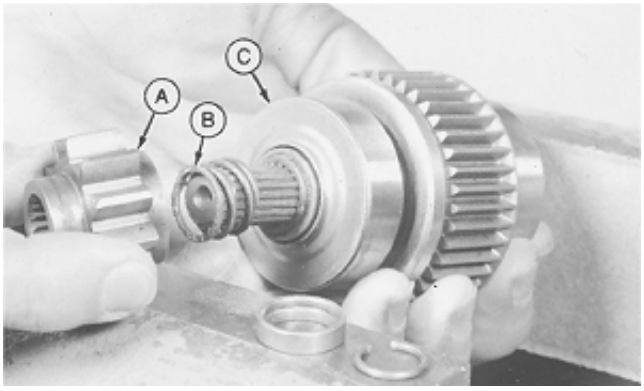
M21,4010R,21 -19-14JUN85

CAUTION: Shaft could be propelled from clutch unit with considerable force if spring is not allowed to extend fully while in vise.

10. While holding clutch assembly, slowly open vise until all spring compression is relieved.

11. Remove pinion (A), spring (B), and washer (C).

Inspect pinion for excessive wear or damage. Replace if defective. Replace spring if broken or distorted.



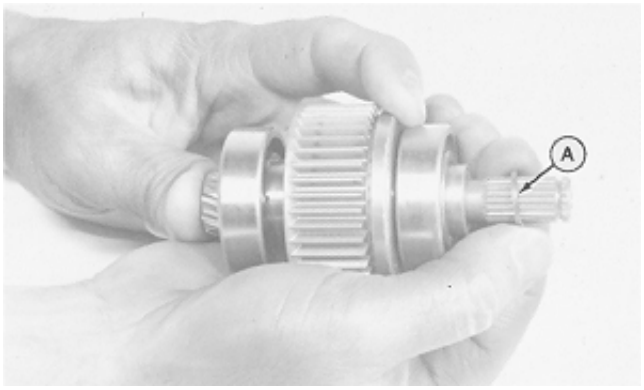
M21,4010R,22 -19-14JUN85

12. Push shaft against spring in clutch assembly. Turn toothed washer (A) to remove it from shaft. Remove shaft and spring from clutch.

Inspect clutch bearings for flat spots in rotation. Replace entire assembly if bearings are defective.

Inspect shaft spring and replace if broken or distorted.

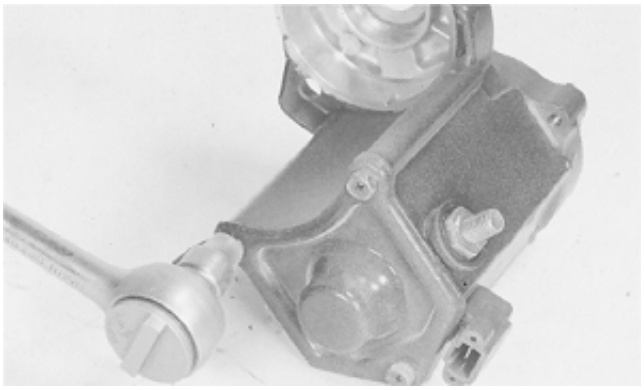
Inspect shaft for excessive wear or damage. Replace if defective.



M21,4010R,23 -19-14JUN85

INSPECT AND REPAIR SOLENOID (NIPPON DENSO 1.0 KW)

1. Remove three screws to remove cover and gasket.



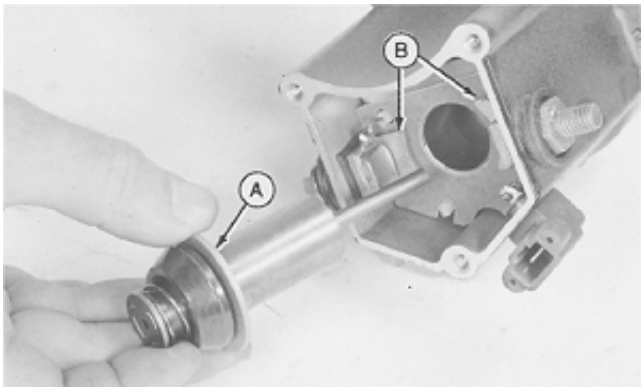
M21,40104,24 -19-14JUN85

2. Remove plunger.

Inspect plunger spring. Replace plunger if broken.

Inspect copper washer (A) on plunger and contact plates (B) on solenoid. Clean burnt areas to improve electrical contact. Replace contacts or plunger if either shows excessive burning or pitting.

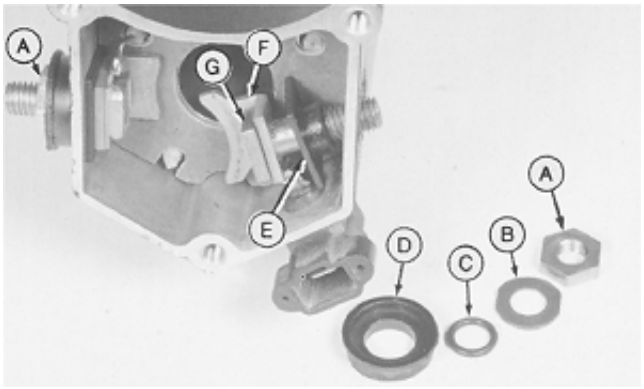
The solenoid is not serviceable. If it is defective, replace the solenoid housing assembly.



M21,4010R,25 -19-14JUN85

3. If it is necessary to replace contact plates, remove terminals. Remove parts in order as shown from each terminal:

A—Nut
B—Washer
C—O-Ring
D—Insulator
E—Bushing
F—Contact Plate
G—Terminal Bolt



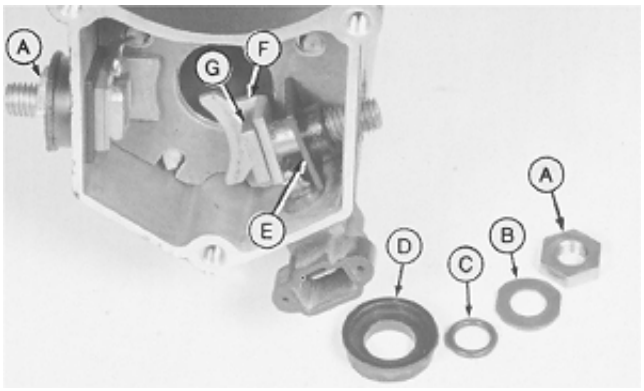
M21,4010R,26 -19-14JUN85

ASSEMBLE NIPPON DENSO 1.0 KILOWATT STARTER

Assemble Solenoid

NOTE: The assembly sequence of the left and right terminals is similar. Be sure solenoid terminal lead (H) is installed between bolt (G) and contact plate (F). Be sure smaller contact plate is on left side.

1. Install parts (A—H).

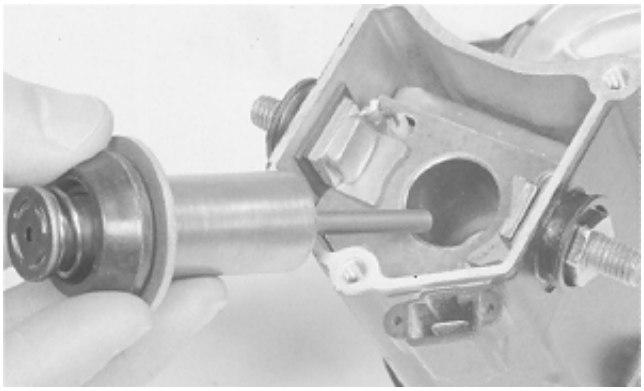


M36771 -UN-29AUG88

A—Nut
B—Washer
C—O-Ring
D—Insulator
E—Bushing
F—Contact Plate
G—Terminal Bolt
H—Solenoid Lead Terminal

M21,4010R,27 -19-01SEP87

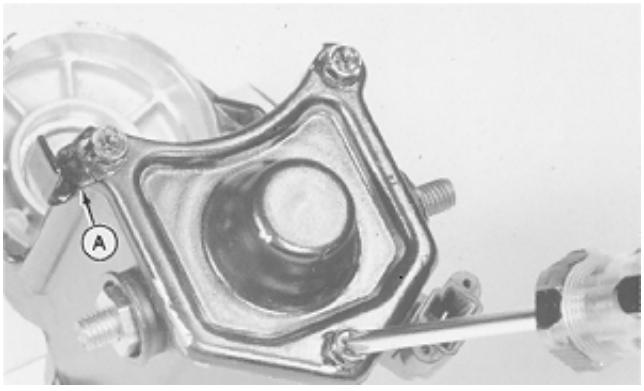
2. Install solenoid plunger.



M36783 -UN-29AUG88

M21,4010R,28 -19-14JUN85

3. Install gasket and cover. Fasten with three screws. Be sure wire retaining clip (A) is installed as shown.



M36773 -UN-29AUG88

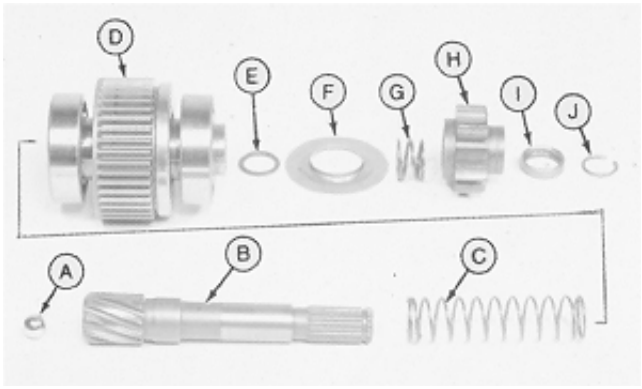
M21,4010R,29 -19-14JUN85

ASSEMBLE GEAR TRAIN AND OVERRUNNING CLUTCH (NIPPON DENSO 1.0 KILOWATT)

1. Apply bearing grease to the steel ball, shaft, springs, and bearings.

Assemble parts (A—J) in sequence order.

A—Steel Ball
B—Shaft
C—Clutch Spring
D—Clutch
E—Toothed Washer
F—Washer
G—Pinion Spring
H—Pinion
I—Retainer
J—Snap Ring

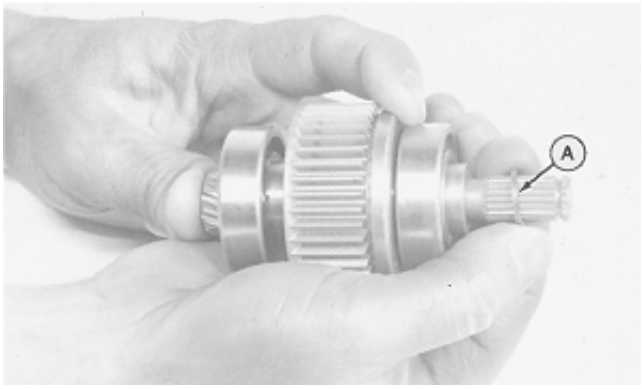


-UN-29AUG88
M36774

M21,4010R,30 -19-14AUG87

2. Install steel ball in end of shaft. Use grease to hold it in place.

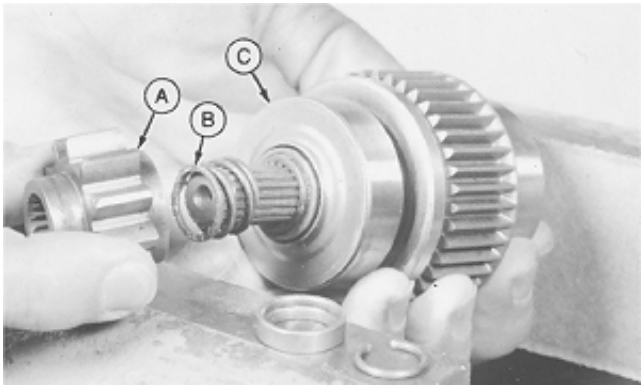
3. Install clutch spring and clutch assembly on shaft. Push shaft against spring and install toothed washer (A). Turn toothed washer below the shaft splines to hold clutch in place.



-UN-29AUG88
M36768

M21,4010R,31 -19-14AUG87

4. Install washer (C), pinion spring (B), and pinion (A). Be sure flange on washer is pointing outward.



-UN-29AUG88
M36767

M21,4010R,32 -19-14JUN85

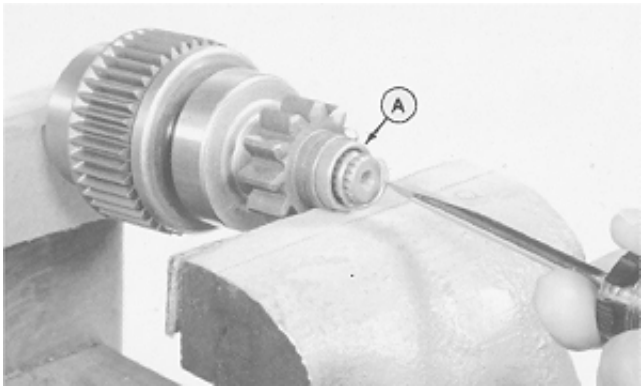
60
16

5. Put clutch assembly in a soft jaw vise. Be sure rear vise jaw is against shaft and front jaw is against pinion.

6. Tighten vise slowly until pinion compresses.

7. Install retainer (A) with the cupped side outward. Install snap ring.

8. Slide the retainer over the snap ring. Hold clutch assembly and slowly open vise.



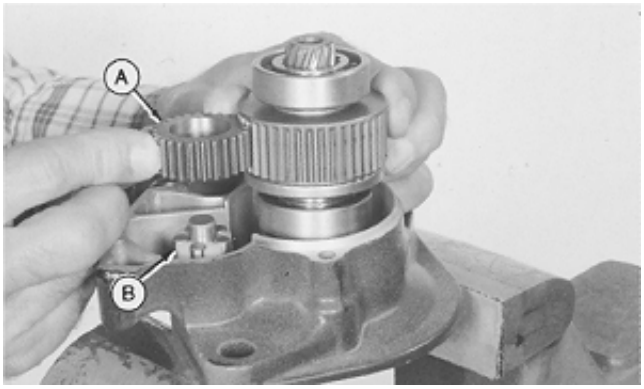
-UN-29AUG88
M36775

M21,4010R,33 -19-14JUN85

9. Apply grease to pinion (A), retainer (B), and five rollers.

10. Install retainer and five rollers.

11. Hold pinion (A) and clutch assembly with teeth meshed. Install both into housing at the same time.

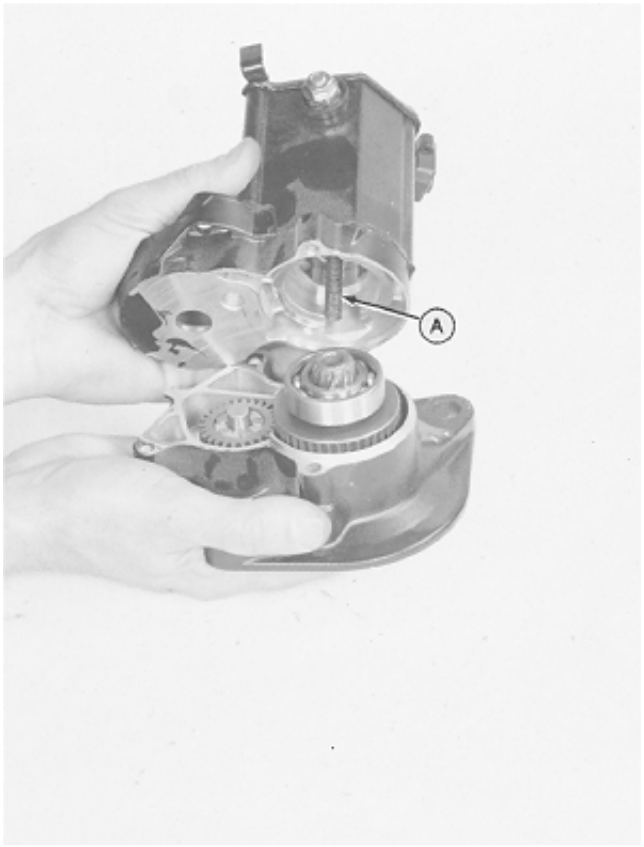


-UN-29AUG88
M36776

M21,4010R,34 -19-14JUN85

NOTE: Be sure steel ball is in the end of the clutch shaft.

12. Install plunger spring (A). Assemble solenoid housing to clutch housing.



-UN-29AUG88
M36764

M21,4010R,35 -19-18JUN85

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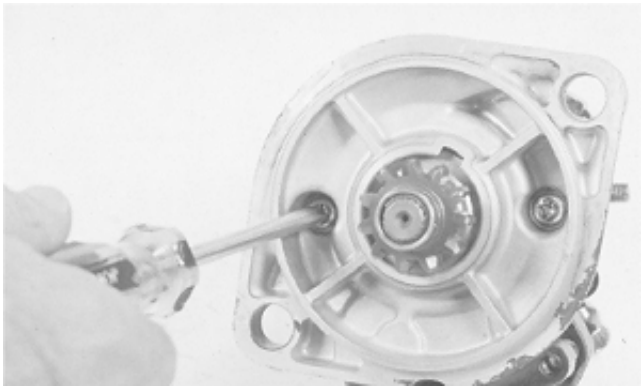
17

13. Fasten with two screws.



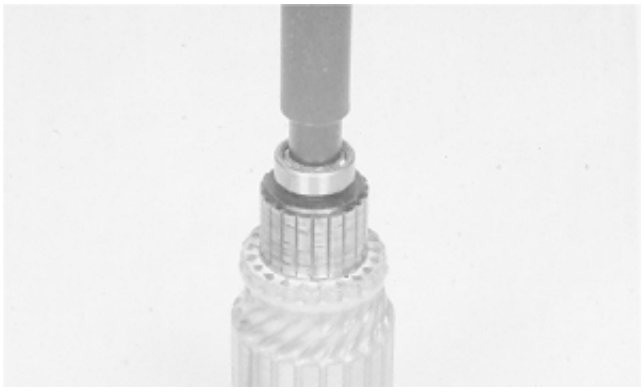
M21,4010R,36 -19-14JUN85

IMPORTANT: Install both armature bearings with the sealed side toward the armature.

14. Install new bearing on splined end of armature shaft using a piece of 5/8-in. I.D. pipe. Be sure to drive only on inner race. Make sure bearing is tight against shoulder of shaft.

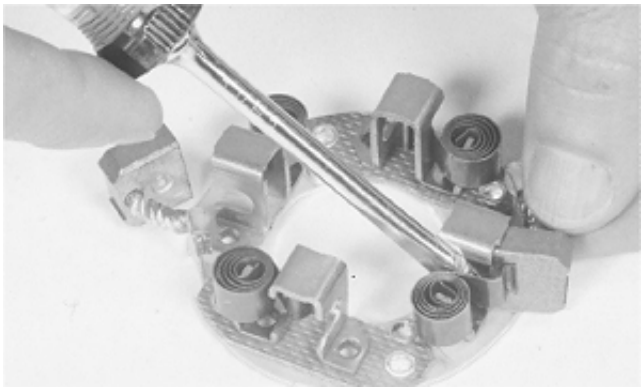
M21,4010R,37 -19-17JUL85

15. Install bearing on commutator end of armature shaft with sealed side of bearing toward commutator. Use a 1/2 in. driver to install bearing tight against shoulder of shaft.



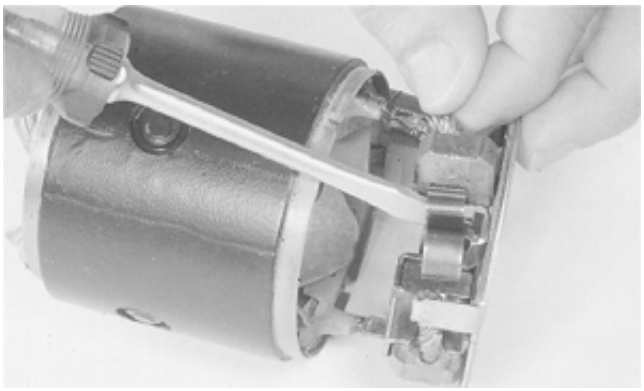
M21,4010R,38 -19-14JUN85

16. Use a screwdriver to pry springs away from brush holder. Install brushes. Replace springs to hold brushes in place.



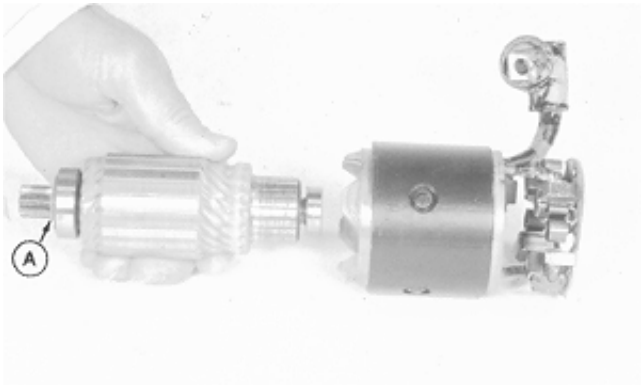
M21,4010R,39 -19-14JUN85

17. Use a screwdriver to pry springs away. Install field coil brushes in brush holder. Release springs to hold brushes in place.



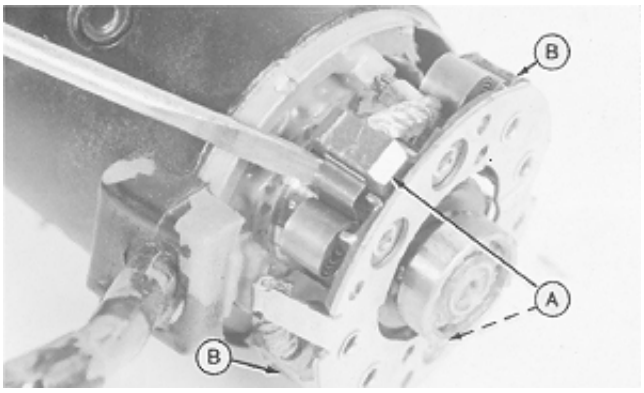
M21,4010R,40 -19-14JUN85

18. Install armature in field coil. Be sure felt washer (A) is in place on spline end of armature. Apply a light film of grease to the felt washer.



M21,4010R,41 -19-10JUN85

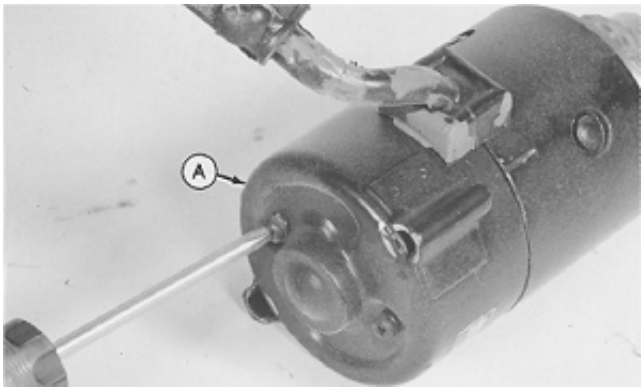
19. Release brush springs to allow field coil brushes (A) and negative side brushes (B) to contact commutator.



M21,4010R,42 -19-14JUN85

IMPORTANT: When installing end frame, be sure field coil brush wires do not touch end frame. Turn brush holder slightly to take up slack in brush wires. Press wires inward to clear the end frame.

20. Apply grease to the bearing cup inside the end frame. Install end frame (A) and fasten with two screws.



M21,4010R,43 -19-14JUN85

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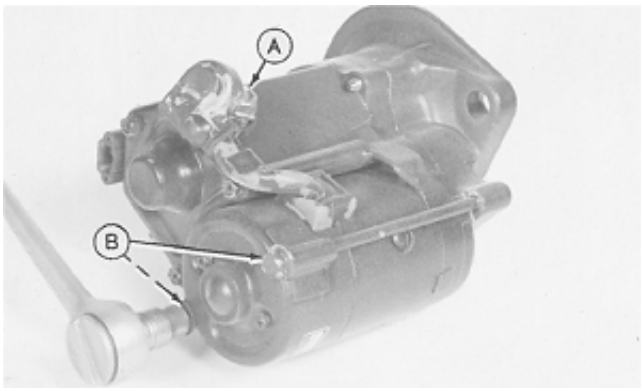
21. Fasten motor to clutch assembly with two bolts (B).

22. Connect field lead (A).

23. Install starter. Tighten nuts to 88 N·m (65 lb-ft).



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M36752

M21,4010R,44 -19-14FEB86

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
Volt-Ohm-Amp Meter	Check continuity
13-Ton Puller Set	Remove rotor shaft bearing

M21,4005R,1 -19-17JUL85

ALTERNATOR SPECIFICATIONS

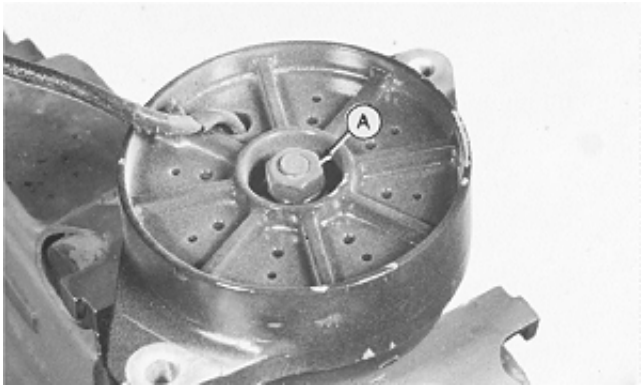
Item	Alternator	Specification
Minimum Exposed Brush Length	All	5.5 mm (0.22 in.)
Maximum Exposed New Brush Length	Nippon Denso 35A	13 mm (0.50 in.)
Distance From Stator-to Rectifier	Nippon Denso 35A	33.5 mm (1.30 in.)
Pulley Nut Torque	Nippon Denso 35A	54 N·m (40 lb-ft)
	Kokasan 20A	27 N·m (20 lb-ft)
Belt Deflection	All	13 mm (1/2 in.) at 107 N (24 lb) force between pulleys.

5M4,T1265,3 -19-13OCT87

SERVICE 20A KOKOSAN ALTERNATOR

1. Remove alternator from engine.

2. Clamp pulley in a soft jaw vise. Remove nut (A) and washers.



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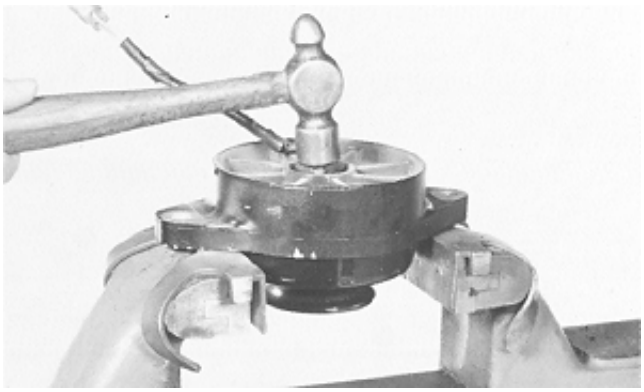
M46059

M21,TM365,1 -19-01SEP87

3. Support alternator on open jaws of vise. Tap shaft and flywheel from body.

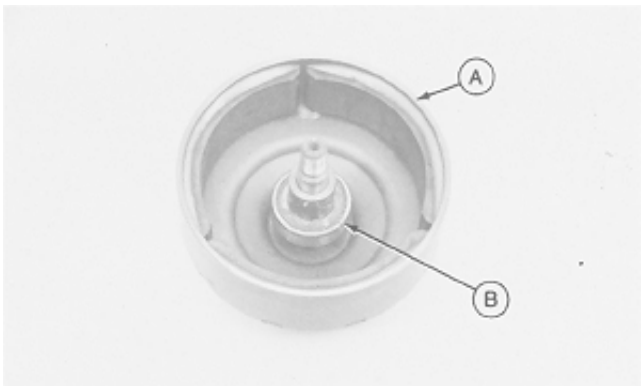


-UN-08JAN90
M46060

5M4,T1265,1 -19-29SEP87

4. Inspect magnets (A) in flywheel. Replace flywheel if magnets are missing or damaged.

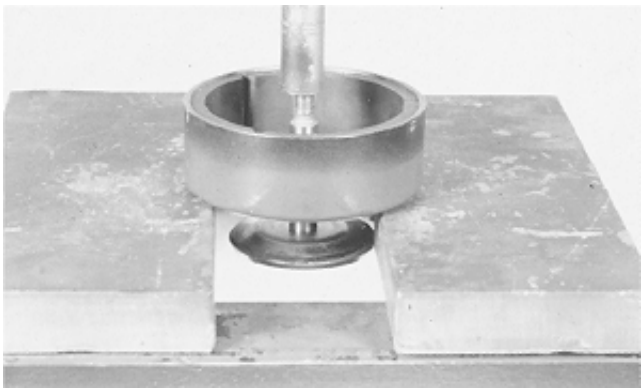
5. Inspect bearing (B) for damage or tight spots in rotation.



-UN-15DEC88
RW120

M21,TM365,3 -19-15FEB86

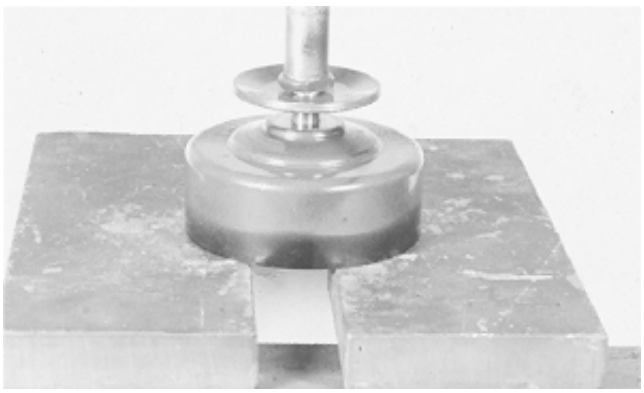
6. If necessary to replace bearing, support flywheel on press and push shaft from bearing and flywheel.



-UN-29AUG88
M37814

M21,TM365,4 -19-15FEB86

7. Support flywheel on press. Install shaft with pulley until pulley bottoms on flywheel face.



-UN-29AUG88
M37815

M21,TM365,5 -19-15FEB86

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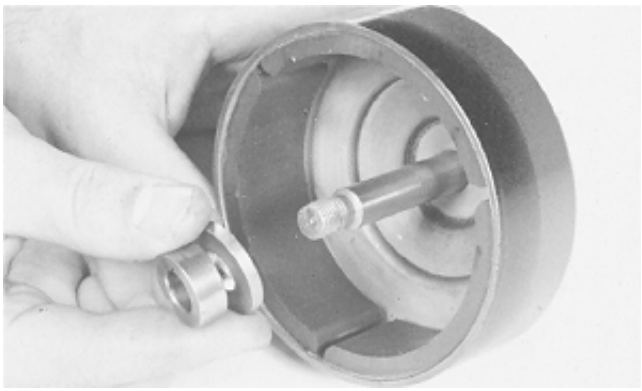
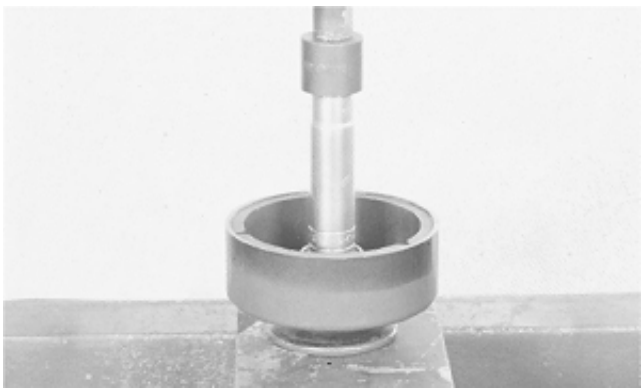
8. Install washer and spacer over shaft.



M21,TM365,6 -19-15FEB86

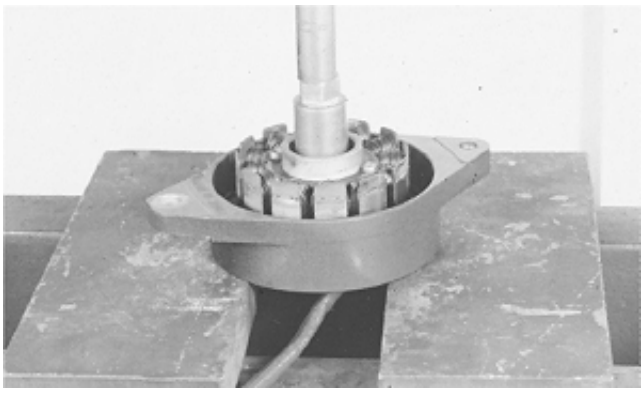
9. Support flywheel on press. Use a 9/16 in., 1/2 in.-drive deep socket TURNED UPSIDE DOWN to press new bearing onto shaft until it bottoms on spacer.



M21,TM365,7 -19-15FEB86

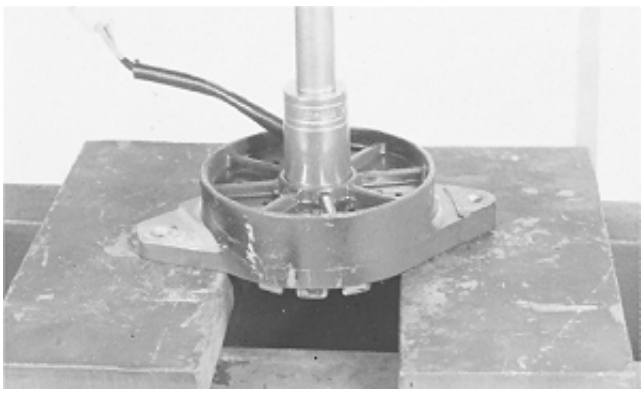
10. If necessary to replace coil plate bearing, use a press and a spark plug socket to remove bearing.

NOTE: Bearing will be damaged when removed, always install a new bearing.



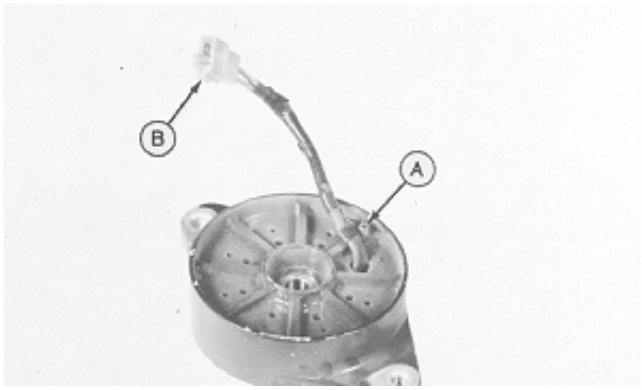
M21,TM365,8 -19-15FEB86

11. Support coil plate on press. Use a 1 in. socket to press new bearing into coil plate until it bottoms in bore.



M21,TM365,9 -19-23APR86

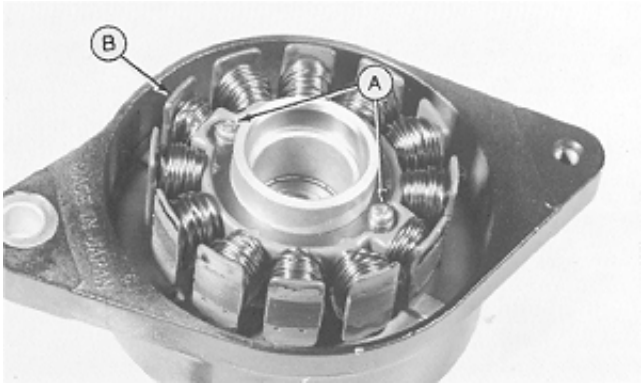
12. If necessary to replace stator, remove harness clamp (A) and remove connector (B) from leads.



-UN-08SEP88
M46061

M21,TM365,10 -19-17AUG87

13. Remove two screws (A) and remove stator (B).



-UN-08JAN90
M46062

5M4,T1265,2 -19-29SEP87

14. Install stator with two screws and install harness connector.

15. Install flywheel onto coil plate. Install two washers and tighten nut to 27 N·m (20 lb-ft).

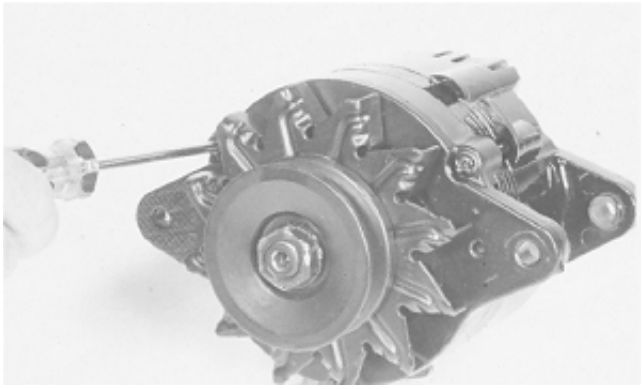
16. Test alternator output as instructed in Section 240 of the Machine Technical Manual.

M21,TM365,12 -19-15FEB86

REPLACE VOLTAGE REGULATOR (NIPPON DENSO ALTERNATOR)

1. Remove alternator from engine.

2. Remove three attaching screws as shown.



-UN-29AUG88
M36725

M21,4005R,4 -19-01SEP87

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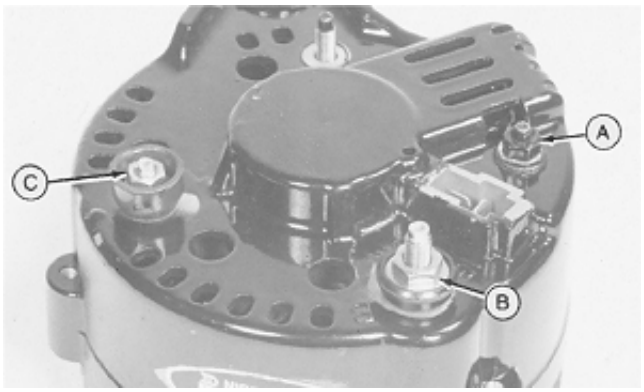
4

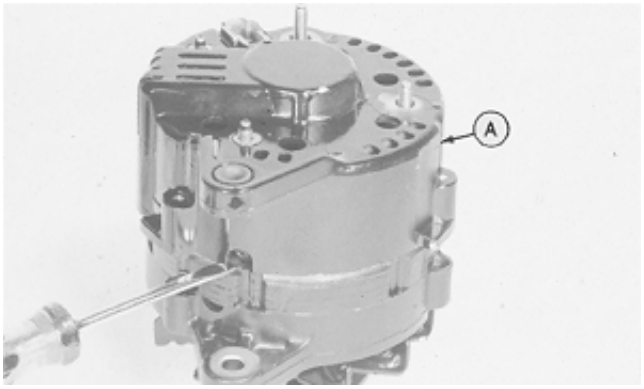
3. Remove nut (A) and nuts with insulators (B and C).



M21,4005R,5 -19-15FEB86

IMPORTANT: Do not pry against stator wires.

4. Use a screwdriver to pry end frame (A) from alternator. Do not separate stator from drive end assembly.

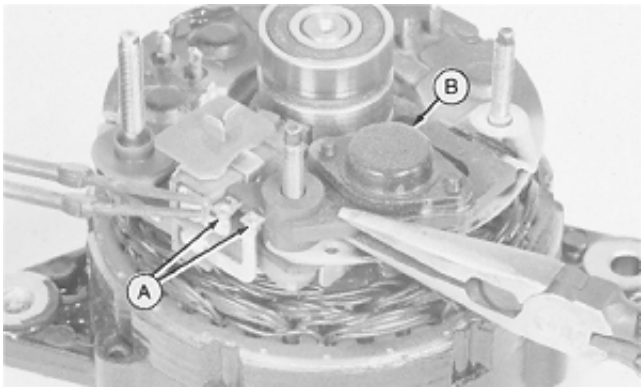


M21,4005R,6 -19-14JUN85

5. Use a soldering gun with at least 120 watt capacity to disconnect two terminals (A). Remove voltage regulator (B).

6. Install new voltage regulator and solder the terminals.

NOTE: If additional solder is needed, use ONLY 60-40 rosin-core solder.



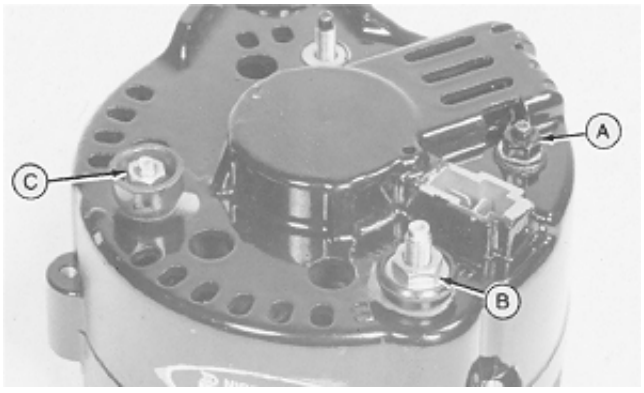
M21,4005R,7 -19-14JUN85

7. Install insulting washers on terminals (B and C) before installing end frame.

8. Install end frame.

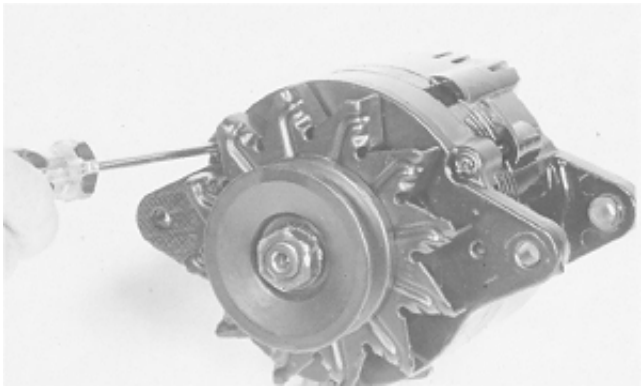
9. Install insulators and nuts (B and C).

10. Install nut (A).



M21,4005R,8 -19-17JUL85

11. Install and tighten three screws.

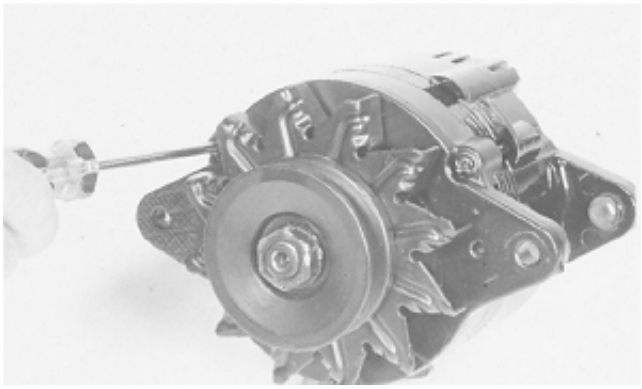


M36725 -UN-29AUG88

M21,4005R,9 -19-17JUL85

DISASSEMBLE NIPPON DENSO ALTERNATOR

1. Remove screws.

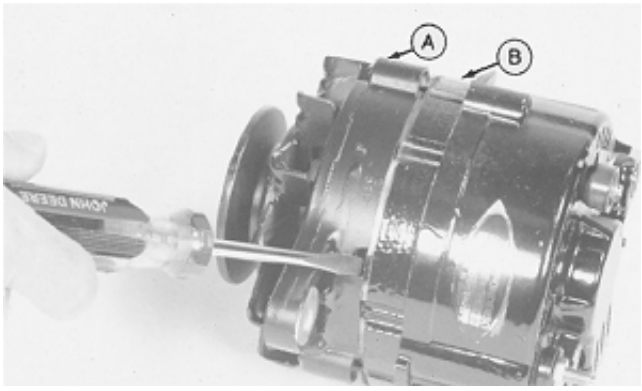


M36725 -UN-29AUG88

M21,4005R,10 -19-01SEP87

IMPORTANT: Do not pry against stator wires.

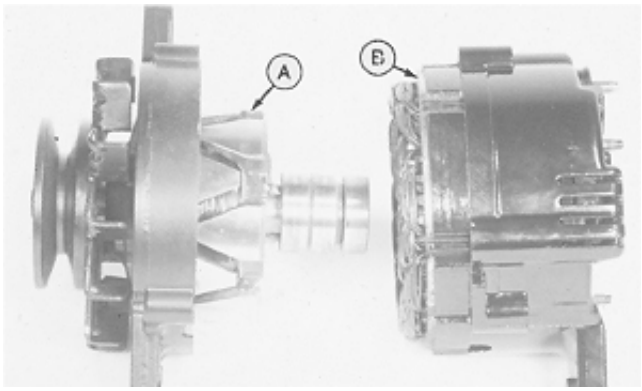
2. Use a screwdriver to separate drive end frame (A) from stator housing (B).



M36729 -UN-29AUG88

M21,4005R,11 -19-14JUN85

3. Remove rotor assembly (A) from stator assembly (B).



M36730 -UN-29AUG88

M21,4005R,12 -19-14JUN85

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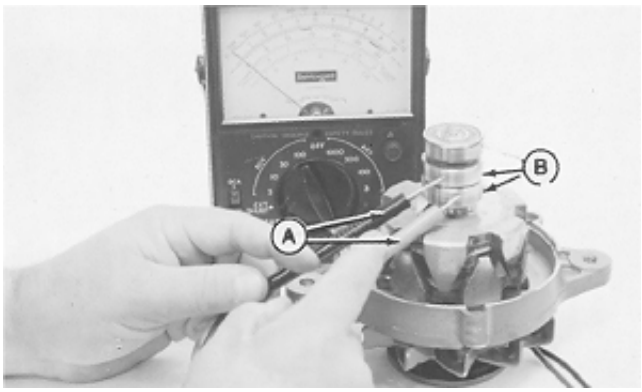
6

DISASSEMBLE AND TEST ROTOR

1. Inspect the rotor slip rings for dirt build-up, rough spots, or out of roundness. If necessary, polish the surface of the slip rings using No. 00 sandpaper or 400-grit silicon carbide paper.

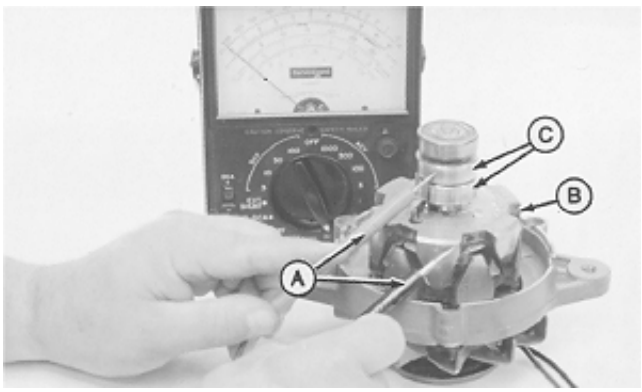
2. Touch the probes of an ohmmeter (A) to slip rings (B). Replace rotor if test indicates no continuity (no needle movement).



RW10033 -UN-01DEC88

M21,4005R,13 -19-14JUN85

3. Touch the probes of the ohmmeter (A) to the shaft (B) and one of the slip rings (C). Repeat for other slip ring. Replace rotor if test shows continuity (needle movement).

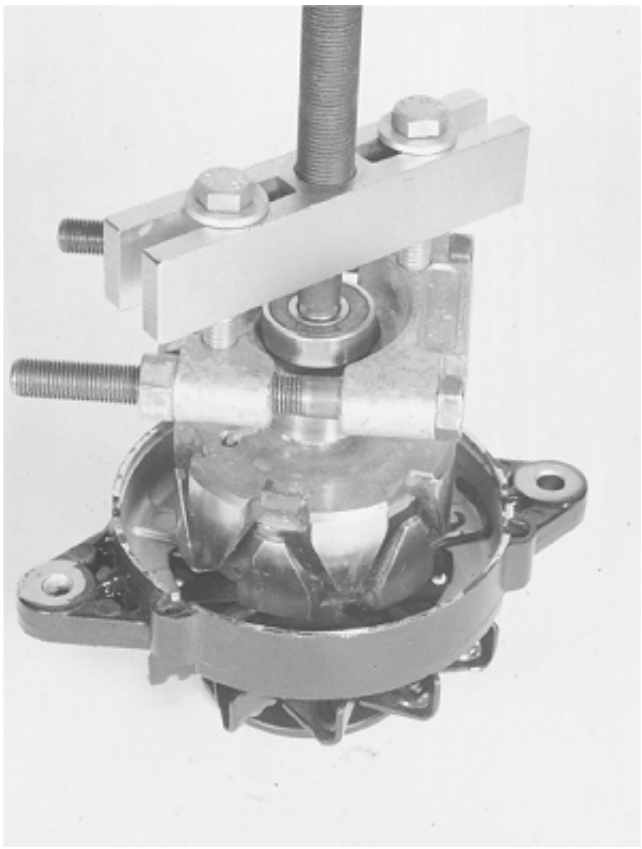


RW10034 -UN-01DEC88

M21,4005R,14 -19-14JUN85

4. Inspect rotor shaft rear bearing by spinning bearing on shaft. Listen for any sounds indicating bearing failure. Replace bearing if defective.

5. To replace bearing, pull bearing from shaft.

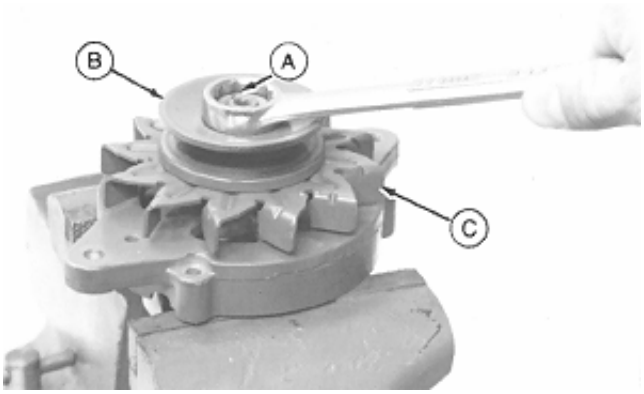


M36731 -UN-29AUG88

M21,4005R,15 -19-14JUN85

6. Inspect rotor shaft front bearing by spinning rotor in housing. Listen for any sounds indicating bearing failure. Replace bearing is defective.

7. To replace bearing, put rotor in a soft-jaw vise. Remove nut (A), lock washer, pulley (B), and fan (C).



-UN-01DEC88
RW2126

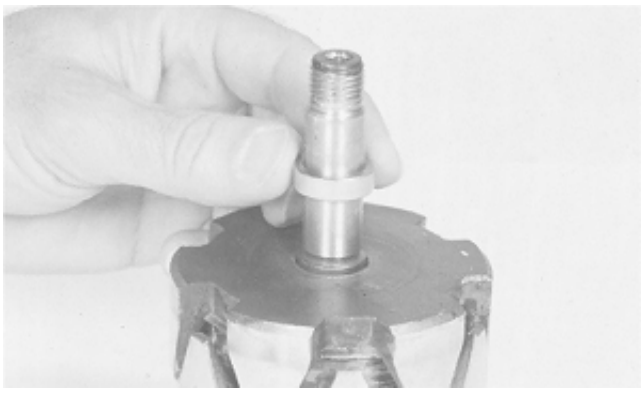
M21,4005R,16 -19-14JUN85

8. If necessary, put front frame on open jaws of vise. Use a soft hammer to remove rotor shaft.

-UN-01DEC88
RW10038

M21,4005R,17 -19-15AUG87

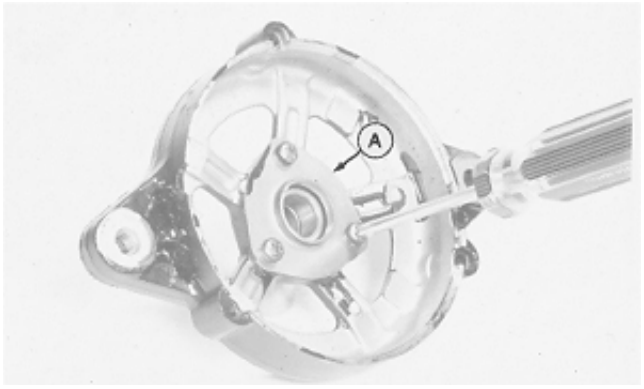
9. Remove spacer from rotor shaft.



-UN-29AUG88
M36732

M21,4005R,18 -19-14JUN85

10. Remove three screws to remove bearing retainer (A).



-UN-29AUG88
M36733

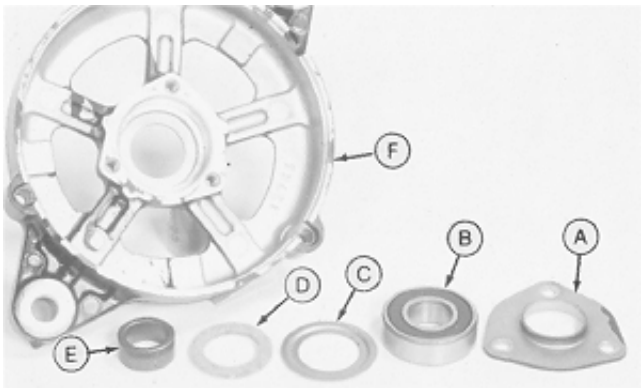
M21,4005R,19 -19-14JUN85

11. Remove retainer (A), bearing (B), washer (C), felt washer (D), and bushing (E) from front frame (F).

Inspect bearing for tight spots in rotation. Replace if defective.

Inspect other parts and service as necessary.

A—Retainer
B—Bearing
C—Washer
D—Felt Washer
E—Bushing
F—Front Frame



-UN-29AUG88
M36734

M21,4005R,20 -19-14JUN85

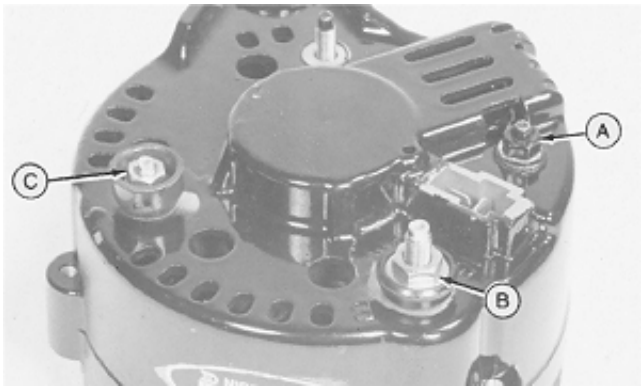
DISASSEMBLE AND TEST STATOR AND RECTIFIER

1. Remove nut (A).

2. Remove nuts and insulators (B and C).

IMPORTANT: Do not pry against stator wires.

3. Use a screwdriver to pry end frame from stator.



-UN-29AUG88
M36726

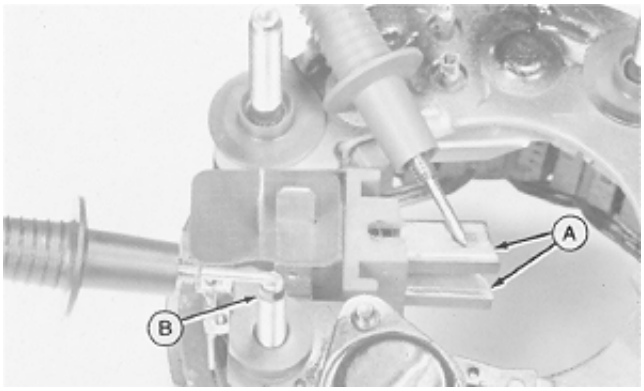
M21,4005R,21 -19-14JUN85

4. Inspect brush holder and brushes for damage. Brushes must slide freely and the springs must hold the brushes firmly against the slip ring of the rotor.

5. Measure brushes for wear. Minimum exposed length must be 5.5 mm (0.22 in.) Replace.

M21,4005R,22 -19-14JUN85

6. Use an ohmmeter or a test light to check for continuity. Check between the two brushes (A) and between each brush and ground (B). There should be no continuity. Replace brush holder-rectifier assembly if there is no continuity.



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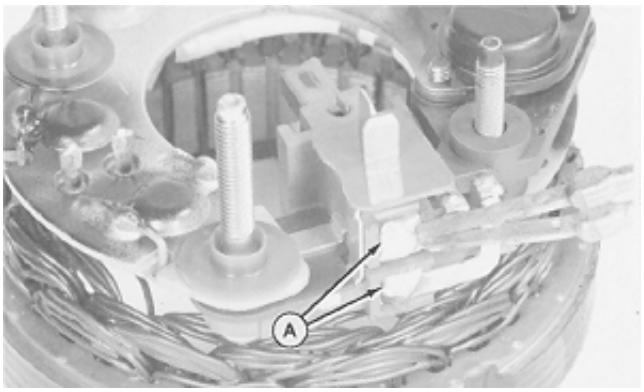
M36736

M21,4005R,23 -19-14JUN85

7. To replace brushes, melt solder from brush lead connections (A) and remove brushes and springs.

8. Inspect springs to be sure they are not broken collapsed. Replace as needed.



M21,4005R,24 -19-14JUN85

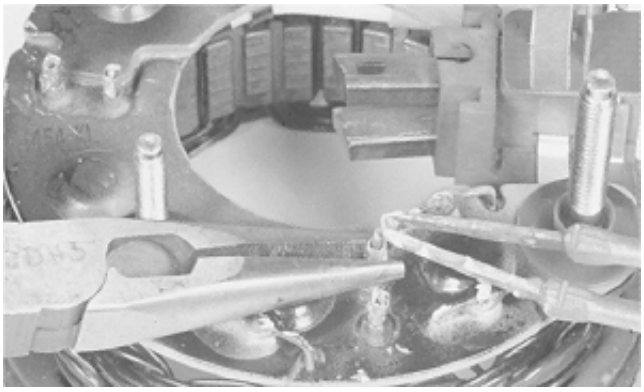
IMPORTANT: Do not heat connections longer than necessary to melt solder as excess heat will damage rectifier assembly.

9. Melt solder joints (A) to remove voltage regulator (B). Use soldering gun with at least a 120 watt capacity.

M21,4005R,25 -19-14JUN85

NOTE: Stator must be removed from rectifier to test.

10. Melt solder inside the connecting pipes. While solder is hot, open the flattened pipe with a needle nose pliers. Pull stator wire from pipe.

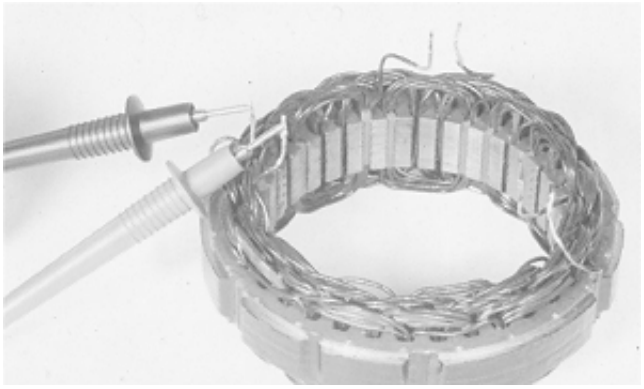


M21,4005R,26 -19-14JUN85

11. Inspect stator for defective insulation, discoloration or a burned odor. If any of these defects are found, replace stator.

NOTE: Use an ohmmeter that is sensitive to resistance of 0 to 1 ohm.

12. Touch the probes of an ohmmeter to each pair of stator wires. Equal continuity readings should be observed between each pair of leads. If readings are not equal, replace stator.



M21,4005R,27 -19-14JUN85

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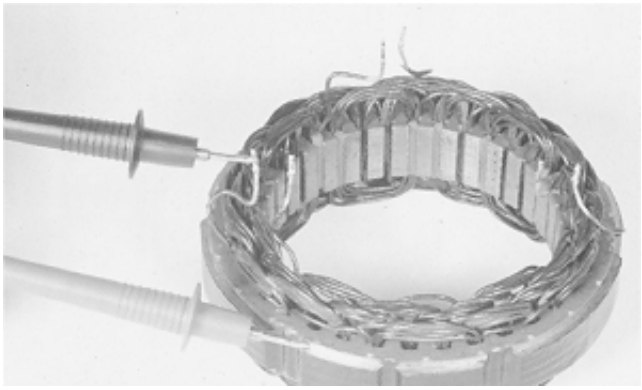
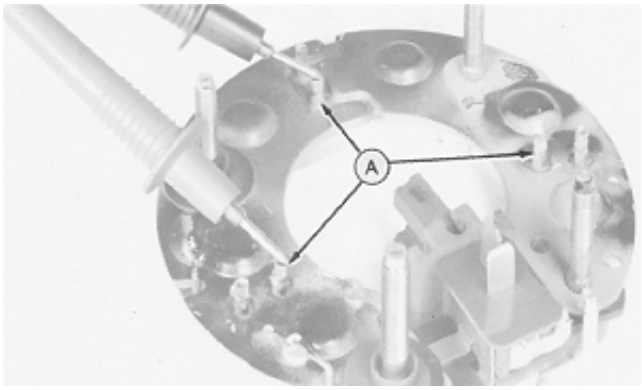
13. Touch one probe of the ohmmeter to the bare metal surface of stator and the other probe to a bare stator lead wire. Repeat for each wire. Replace stator if test indicates continuity.



M21,4005R,28 -19-14JUN85

NOTE: The three inner terminals (A) are connected by a printed circuit in the rectifier.

14. Test the three inner terminals (A) using an ohmmeter. Move probes so all terminals are cross checked. Replace the rectifier if test shows no continuity.

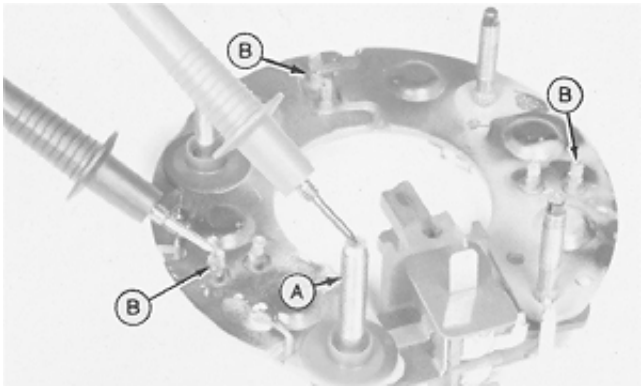


M21,4005R,29 -19-14JUN85

NOTE: Each of the three outer terminals (B) on the rectifier is connected to two diodes permitting current flow in only one direction.

15. Test the diodes by touching probes to output post (A) and the three outer terminals (B).

16. Switch the probes and check each terminal again. There should be continuity in only one direction between each terminal (B) and the output post (A).



M21,4005R,30 -19-14JUN85

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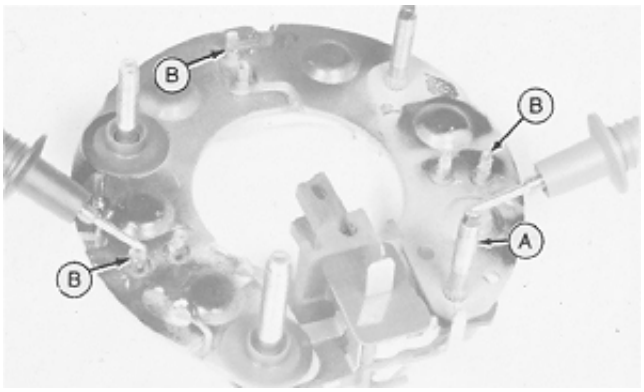
17. Test the diodes by touching probes to ground post (A) and the three outer terminals (B).

18. Switch the probes and check each terminal again. There should be continuity in only one direction between each terminal (B) and the ground post (A).

A shorted diode would have continuity in both directions. An open diode would have no continuity in either direction. Replace the rectifier if any of the six diodes are defective.



-UN-29AUG88
M36744

M21,4005R,31 -19-17JUL85

ASSEMBLE STATOR AND RECTIFIER (NIPPON DENSO ALTERNATOR)

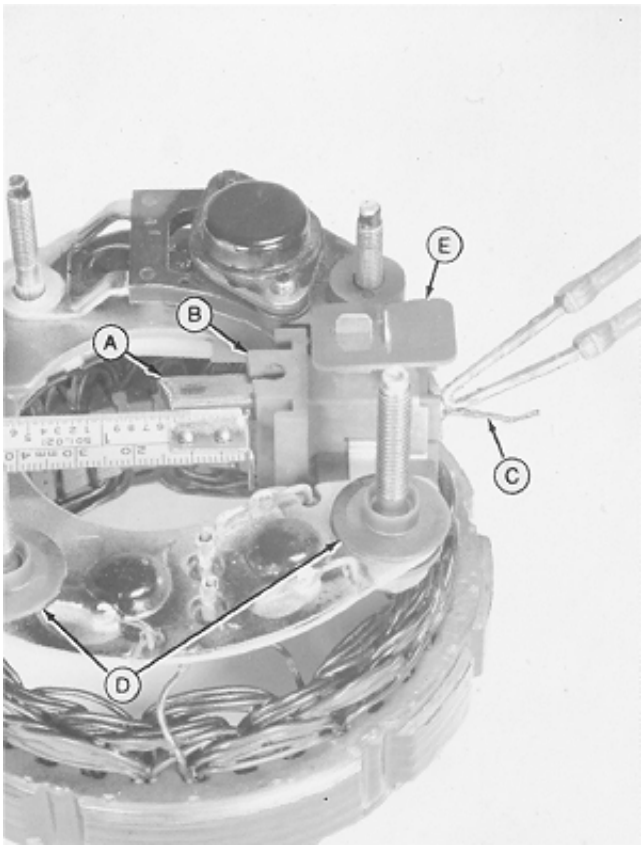
1. Push brush lead wire through spring. Insert spring and brush in brush holder with lead protruding through hole in brush holder. Make sure the longest side of brush (A) is on side of brush holder with raised lip (B).

2. Hold brushes in position so that exposed length is 13 mm (0.50 in.)

3. Solder brush leads in this position. Cut off excess length of leads (C).

4. Be sure insulating washers (D) and insulator (E) are in place.

A—Brush
B—Brush Holder
C—Brush Lead
D—Washers
E—Insulator



-UN-29AUG88
M36745

M21,4005R,32 -19-01SEP87

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12

NOTE: The three pair of lead wires on the stator are not evenly spaced. Rotate the rectifier until the terminal pipes align with the stator leads.

5. Install the three outer lead wires on stator through outer terminal pipes. Install the three inner lead wires on stator through inner terminal pipes.

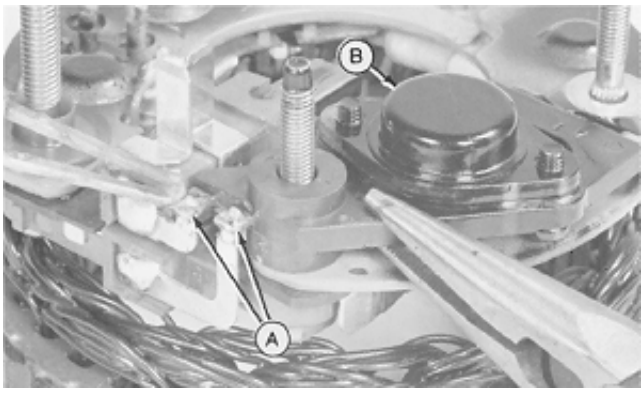
6. Adjust the length of the stator lead wires 33.5 mm (1.30 in.) from stator to rectifier. Connect the six terminals using a soldering gun with at least a 120 watt capacity.

If additional solder is needed, use ONLY 60-40 rosin core solder.

-UN-29AUG88
M36746

M21,4005R,33 -19-14JUN85

7. Install voltage regulator (B). Connect and solder joints (A).



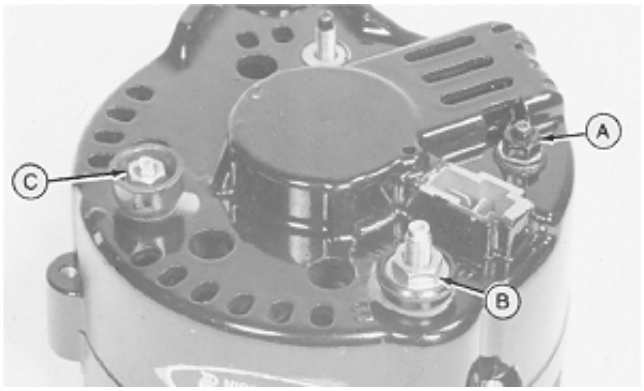
-UN-29AUG88
M36738

M21,4005R,34 -19-14JUN85

IMPORTANT: Be sure six stator lead wires do not contact end frame when installed.

8. Install end frame. Fasten with nut (A).

9. Install insulators and nuts (B and C).



-UN-29AUG88
M36726

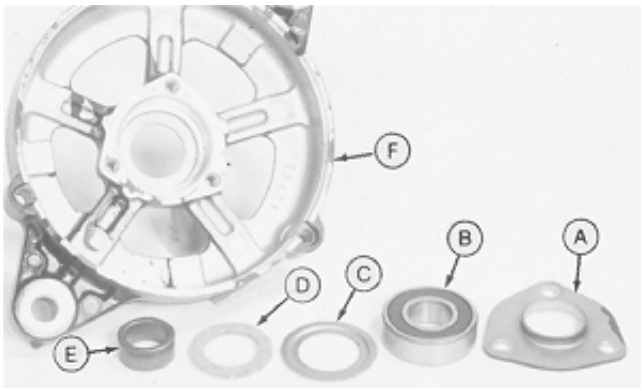
M21,4005R,35 -19-14JUN85

ASSEMBLE ROTOR (NIPPON DENSO ALTERNATOR)

1. Apply a small amount of grease to the left washer (D). Install bushing (E) in felt washer (D). Install bushing and felt washer in front frame (F).

2. Install washer (C), bearing (B), and retainer (A).

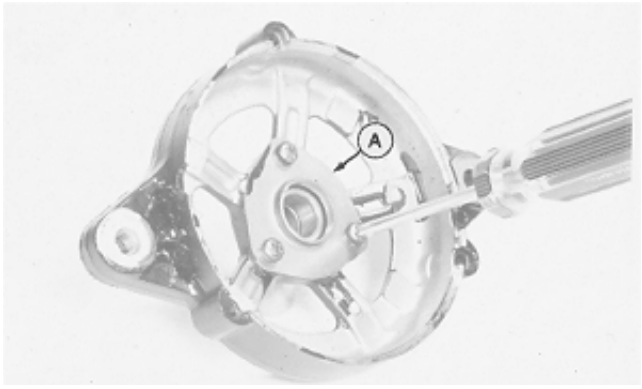
A—Retainer
B—Bearing
C—Washer
D—Felt Washer
E—Bushing
F—Front Frame



-UN-29AUG88
M36734

M21,4005R,16 -19-15AUG87

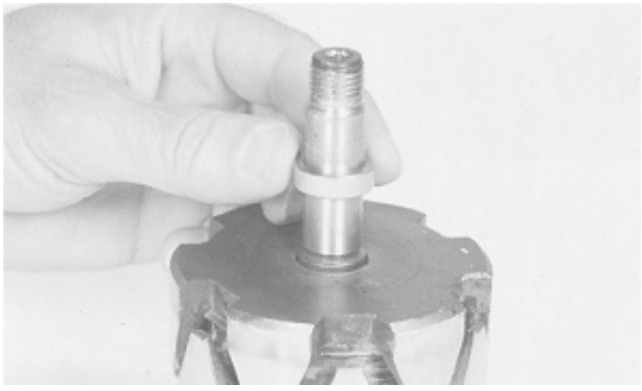
3. Fasten retainer (A) with three screws.



-UN-29AUG88
M36733

M21,4005R,37 -19-17JUL85

4. Install bushing on rotor shaft.



-UN-29AUG88
M36732

M21,4005R,38 -19-14JUN85

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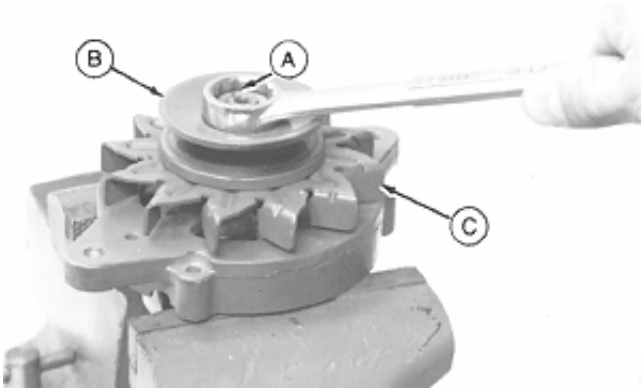
14

5. Install rotor shaft in front frame assembly.

6. Install fan (C), pulley (B), lock washer, and nut (A).

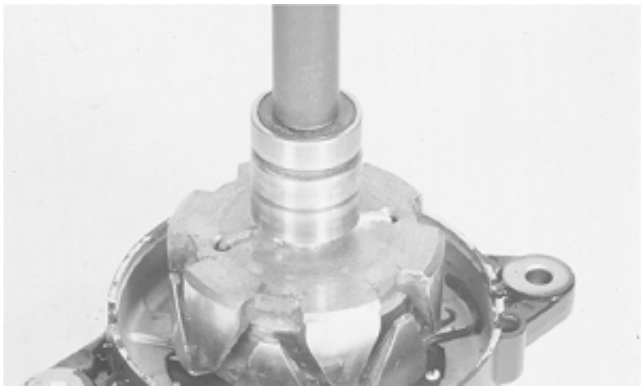
7. Hold rotor in a soft-jaw vise. Tighten nut (A) to 54 N·m (40 lb-ft).



-UN-01DEC88
RW2126

M21,4005R,39 -19-14JUN85

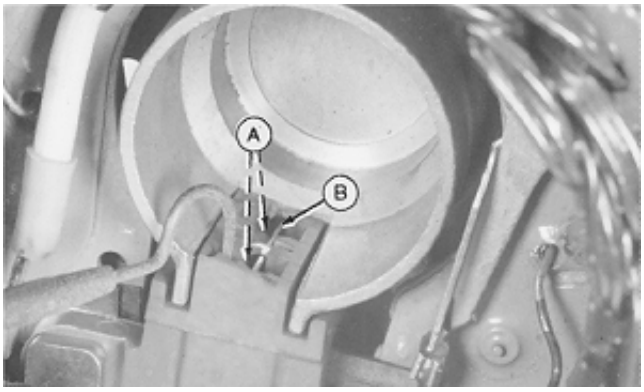
8. Apply a thin film of grease to the bearing. Install bearing on rotor shaft until bearing is flush with end of shaft. Press only on inner race of bearing.



-UN-29AUG88
M36747

M21,4005R,40 -19-14JUN85

9. Push alternator brushes (A) into brush holder. Install a wire (B) through access hole in rear of end frame to lock brushes in place.



-UN-29AUG88
M36748

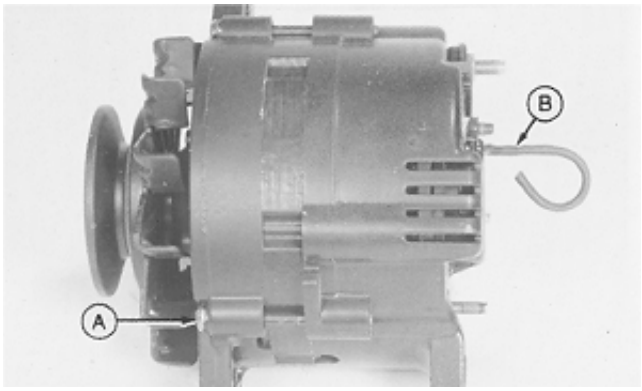
M21,4005R,41 -19-01SEP87

10. Apply a small amount of grease on the rear of the rotor shaft.

11. Assemble the rotor assembly to the stator assembly and fasten with three screws (A).

12. Remove wire (B) from rear of end frame.

13. Install alternator on engine and adjust belt tension.



-UN-29AUG88
M36749

M21,4005R,42 -19-15AUG87

SERVICE IGNITION COILS

1. If engine is in machine, disconnect negative (—) cable from battery.

2. Disconnect spark plug wire(s) (G).

3. Disconnect wires from positive and negative (E and F) sides of coil.

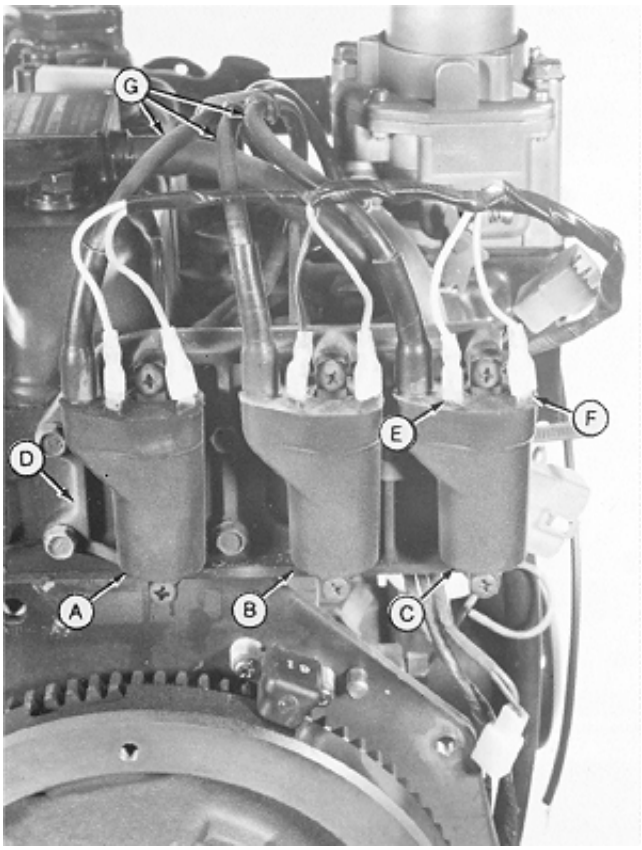
4. Remove two machine screws to remove coil.

5. To remove mounting bracket (D), remove coils and four cap screws.

6. To install mounting bracket (D), tighten four cap screws and install coils (A, B, and C).

7. Connect spark plug wires.

A—Coil—No. 1 Cyl.
B—Coil—No. 2 Cyl.
C—Coil—No. 3 Cyl.
D—Mounting Bracket
E—Negative (—) Side of Coil
F—Positive (+) Side of Coil
G—Spark Plug Wires



M46056 -UN-08JAN90

5M4,T1270,1 -19-29SEP87

SERVICE IGNITION PULSERS

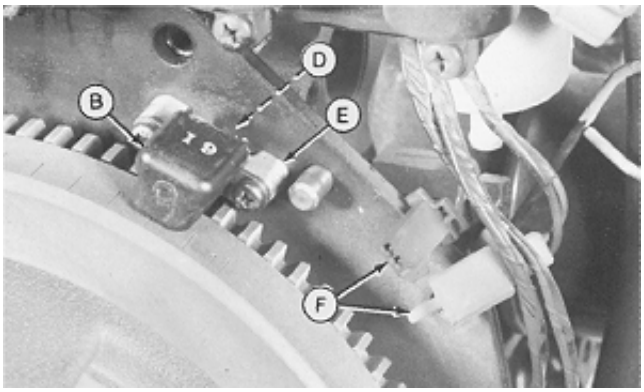
1. If engine is in machine, disconnect negative (—) cable from battery.

2. Disconnect connector (F).

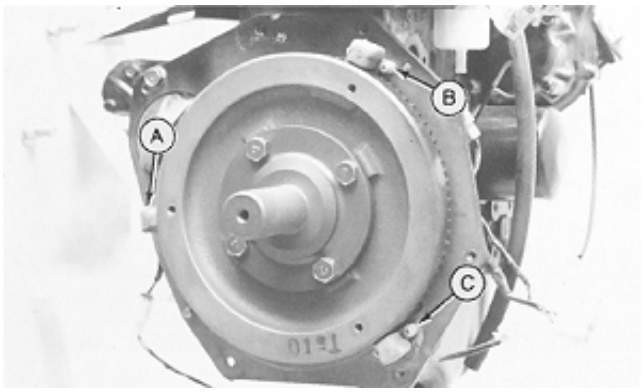
3. Remove two machine screws to remove pulser (B), spacer (E), and rubber grommet (D).

4. Install rubber grommet, spacer, pulser and screws.

A—Pulser—No. 1 Cyl.
B—Pulser—No. 2 Cyl.
C—Pulser—No. 3 Cyl.
D—Rubber Grommet
E—Spacer
F—Connector



M46057 -UN-08JAN90



M46058 -UN-08JAN90

5M4,T1270,2 -19-29SEP87