

3TN and 4TN Series Yanmar Diesel Engines

**John Deere Horicon Works
CTM3 (03JAN90)**

LITHO IN U.S.A.
ENGLISH

3TN and 4TN Series Yanmar Engines

Introduction

This Component Technical Manual contains necessary instructions to repair the engine, engine fuel, and engine electrical systems.

Use this Component Technical Manual in conjunction with the Machine Technical Manual. An engine application listing in the introduction identifies product-model/engine type-model relationship. See the

Machine Technical Manual for information on engine removal and installation, theory of operation, diagnostic, and testing procedures.



CAUTION: THIS IS THE SAFETY-ALERT symbol. When you see this symbol on the machine or in this manual, be alert to the potential for personal injury.

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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.



O53,INTRO2 -19-03JUL8

FEATURES OF THIS TECHNICAL MANUAL

John Deere ILLUSTRATION 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.



O53,INTRO3 -19-07OCT8

ABOUT THIS MANUAL

This Component Technical Manual (CTM-3) covers the recommended repair procedures for all Yanmar Diesel 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.

The repair procedure for the Yanmar diesel engines in this manual are similar. The 3TNA72UJ engine is

shown except where differences are noted by engine model number. Refer to Engine Application Chart in this group to identify product-model/engine type-model relationship.

Read each module completely before performing service to check for differences in procedure or

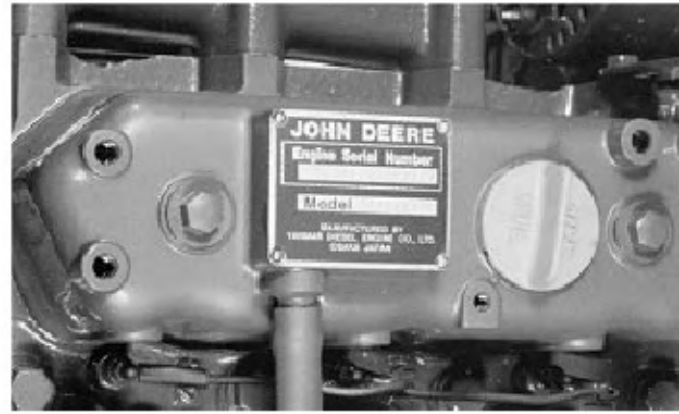
specifications. Follow only the steps that apply to the engine model number you are working on. If only one step is given, that step applies to all Yanmar diesel engines in this manual.

M21,TM305,1 -19-21APR8

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.



M21, TM305.2 -19-21APR8

ENGINE APPLICATION CHART

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

CONSUMER PRODUCTS

Lawn and Garden Tractors

Machine No.	Engine Model
330	3TN66UJ
332	3TN66UJ
430	3TNA72UJ*

Compact Utility Tractors

Machine No.	Engine Model
655	3TN66UJ
670	3TNA72UJX
755	3TNA72UJ
770	3TNA82RJX
855	3TN75RJ
870	3TN84RJX
955	3TN84RJ
970	4TN82RJX
1070	4TN84RJX

Front Mowers

Machine No.	Engine Model
F915	3TN66UJ
F935	3TNA72UJ

Skid Steer Loaders

Machine No.	Engine Model
375	3TN66E-SP
575	3TN82E-SP
675	4TN82E-SP

INDUSTRIAL

Loaders

Machine No.	Engine Model
84	4TN1004J

Excavators

Machine No.	Engine Model
15	3TNA72UJ
25	3TN78RJ
30	3TN82RJ
50	4TN78TRJ

Golf and Turf

Machine No.	Engine Model
756	3TNA72UJ
856	3TN75F
3325	4TN82F

*430 Lawn and Garden Tractors were built with two slightly different versions of 3TNA72UJ engines. In this manual, 3TNA72UJ engines, serial numbers (—5000), are referred to as "Early 3TNA72". Engines with serial numbers (5001—) are referred to as "Later 3TNA72".

ENGLISH TORQUE SPECIFICATIONS

NOTE: Wrench torque tolerance is $\pm 20\%$.

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 -19-11JUL8

METRIC TORQUE SPECIFICATIONS

NOTE: Wrench torque tolerance is $\pm 20\%$.

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 -19-11JUL8

ENGINE: 3TN66

GROUP 10—Valve Train and Camshaft

Item	Standard mm (inches)	Wear Limit mm (in.)
Valve Clearance	0.2 (0.008)	
Rocker Arm		
Shaft O.D.	9.97—9.99 (0.3925—0.3933)	9.95 (0.3917)
Shaft Support I.D.	10.0—10.02 (0.3937—0.3945)	10.1 (0.3937)
Arm I.D.	10.0—10.02 (0.3937—0.3945)	10.1 (0.3937)
Shaft Clearance	0.01—0.05 (0.0004—0.0020)	0.13 (0.0051)
Rocker Arm Assembly Cap Screw and Nut Torque	26 N·m (226 lb-in.)	
Rocker Arm Cover Nut Torque	18 N·m (160 lb-in.)	
Push Rod		
Maximum T.I.R.		0.075 (0.0029)
Length	114—115 (4.488—4.528)	114 (4.488)
Diameter	5 (0.197)	
Cam Follower		
O.D.	17.95—17.968 (0.7067—0.7074)	17.93 (0.7059)
Bore I.D.	18.00—18.018 (0.7087—0.7094)	18.05 (0.7106)
Bore Clearance	0.032—0.068 (0.0013—0.0027)	
Camshaft		
End Play	0.05—0.15 (0.002—0.006)	0.4 (0.0157)
Maximum Gear Backlash Between Each Gear		0.2 (0.0079)
End Journals O.D.	35.94—35.96 (1.415—1.416)	35.85 (1.4114)
Intermediate Journals O.D. Lobe Height	35.91—35.94 (1.414—1.415) 29.97—30.03 (1.180—1.182)	35.81 (1.4094) 29.7 (1.1693)
Bushing I.D. (Gearcase Side)	36.00—36.065 (1.417—1.420)	36.1 (1.4213)
Intermediate and Flywheel End Bores I.D.	36.00—36.025 (1.417—1.418)	36.1 (1.4213)
End Journal Clearance	0.040—0.125 (0.0016—0.0049)	0.18 (0.0071)
Intermediate Journal Clearance	0.065—0.115 (0.0026—0.0045)	0.18 (0.0071)
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	115 N·m (85 lb-ft)	

GROUP 15—Cylinder Head, Valves, and Manifolds

Item	Standard mm (in.)	Wear Limit mm (in.)
Manifold		
Exhaust Manifold Cap Screw Torque	11 N·m (96 lb-in.)	
Intake Manifold Cap Screw Torque	11 N·m (96 lb-in.)	

ENGINE: 3TN66

Item	Standard mm (in.)	Wear Limit mm (in.)
Cylinder Head		
Valve Recession Intake	0.4 (0.016)	0.50 (0.020)
Exhaust	0.85 (0.034)	0.50 (0.020)
Valve Spring Free Length (Approx.)		28 (1.102)
Valve Spring Test Length		17 (0.59)
@ Test Force		125 N (28 lb)
Cylinder Head		
Valve Stem O.D.		
(Intake)	5.460—5.475 (0.215—0.216)	5.40 (0.213)
(Exhaust)	5.445—5.460 (0.214—0.215)	5.40 (0.213)
Valve Guide I.D.	5.5—5.515 (0.2165—0.217)	5.58 (0.220)
Valve Guide-to-Valve Stem Clearance:		
(Replace)		0.20 (0.008)
(Knurl)		0.15—0.20 (0.006—0.008)
Valve Seat Width		
Intake	1.15 (0.045)	1.65 (0.065)
Exhaust	1.41 (0.056)	1.91 (0.075)
Valve Seat Angle		
Intake	120°	
Exhaust	90°	
Cylinder Head Flatness		
(Maximum Distortion)	Less than 0.5 (0.002)	0.15 (0.006)
Mill Cylinder Head No More Than		0.20 (0.008)
Valve Guide Height	7 (0.276)	
Cylinder Head Cap Screw Torque		
In Sequence (Lubricated)	34 N·m (25 lb-ft)	

GROUP 20—Flywheel

Item	Standard mm (in.)	Wear Limit mm (in.)
Stub Shaft		
Maximum T.I.R.		0.2 (0.008)
Flatness		0.05 (0.002)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)	
Flywheel		
Flatness		0.05 (0.002)
Attaching Cap Screw Torque	83 N·m (61 lb-ft)	
Flywheel Housing		
Mounting Plate or Housing		
Cap Screw Torque		
Starter-to-Mounting Plate	49 N·m (36 lb-ft)	
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)	

ENGINE: 3TN66**GROUP 25—Connecting Rods and Pistons**

Item	Standard mm (in.)	Wear Limit mm (in.)
Connecting Rod		
Side Clearance	0.2—0.4 (0.0079—0.0157)	0.55 (0.0217)
End-Cap Screw Torque	23 N·m (200 lb-in.)	
Bearing Clearance (Crankpin)	0.020—0.0072 (0.0008—0.0028) . .	0.15 (0.006)
Bearing Clearance (Piston Pin)	0.025—0.047 (0.0010—0.0019) . . .	0.12 (0.005)
Maximum Twist		0.08 (0.003)
Journal O.D.	35.97—35.98 (1.416—1.417)	35.92 (1.414)
Bearing I.D. (Crankpin)	36.00—36.042 (1.417—1.419)	36.07 (1.420)
Piston		
Ring Groove Clearance		
Top Ring	0.065—0.1 (0.0026—0.0039)	0.2 (0.08)
Second Ring	0.065—0.1 (0.0026—0.0039)	0.2 (0.08)
Oil Ring	0.065—0.1 (0.0026—0.0039)	0.2 (0.08)
Ring End Gap (1st and Oil)	0.15—0.35 (0.006—0.014)	1.5 (0.059)
Ring End Gap (2nd)	0.25—0.40 (0.010—0.016)	1.5 (0.059)
Piston Pin O.D.	19.991—20.0 (0.787—0.7874)	19.9 (0.786)
Pin Bushing I.D.	20.025—20.038 (0.788—0.789)	20.1 (0.791)
Piston Pin Clearance	0—0.17 (0—0.0007)	0.045 (0.0018)
Pin Bore I.D.	20.000—20.008 (0.787—0.788)	20.02 (0.788)
Pin Bore Clearance	0.0.017 (0—0.0007)	0.045 (0.0018)
Piston O.D.	65.927—65.957 (2.596—2.597)	65.85 (2.593)
Cylinder Block Cylinder Bore I.D.	66.00—66.03 (2.599—2.600)	66.20 (2.606)
Maximum Piston Clearance		0.33 (0.013)
Cylinder Out-of-Round		0.02 (0.001)

GROUP 30—Crankshaft and Main Bearings

Item	Standard mm (in.)	Wear Limit mm (in.)
Crankshaft		
End Play	0.095—0.266 (0.004—0.011)	0.33 (0.013)
Main Bearing Cap Screw Torque	54 N·m (40 lb-ft)	
Main Bearing Clearance	0.020—0.072 (0.0008—0.0028) . . .	0.15 (0.0059)
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.)	
Main Bearing Journal O.D.	39.97—39.98 (1.5736—1.5740)	39.9 (1.572)
Main Bearing I.D.	40.00—40.042 (1.575—1.577)	40.07 (1.578)

ENGINE: 3TN66**GROUP 35—Gear Housing**

Item	Standard mm (in.)	Wear Limit mm (in.)
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Gear Housing Cap Screw Torque	9 N·m (78 lb-in.)	
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Crankshaft Pulley Cap Screw Torque . . .	115 N·m (85 lb-ft)	
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Timing Gear Backlash

Fuel Injection Pump	0.04—0.12 (0.0016—0.0047) 0.20 (0.008)
Idler	0.04—0.12 (0.0016—0.0047) 0.20 (0.008)
Camshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Crankshaft	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)
Oil Pump	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)

Timing Gear

Idler Gear Bushing Diameter	20.00—20.021 (0.786—0.788)	. . . . 20.08 (0.791)
Idler Shaft Diameter	19.959—19.980 (0.786—0.787)	. . . . 19.93 (0.785)
Idler Shaft Oil Clearance	0.02—0.062 (0.001—0.002)	. . . . 0.15 (0.006)

GROUP 49—Lubrication System

Item	Standard mm (in.)	Wear Limit mm (in.)
------	-------------------	---------------------

Oil Pump

Gear Backlash	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)
Rotor Recess		0.25 (0.010)
Outer Rotor-to-Pump Body Clearance		0.25 (0.010)
Inner Rotor-to-Outer Rotor Clearance		0.25 (0.010)
Oil Pump Attaching Cap Screw Torque .	25 N·m (18 lb-ft)	

Oil Pressure Regulating Valve

Valve Spring Free Length (Approx.) . . .	21.9—24.5 (0.86—0.96)
Valve Spring Test Length	14.7 (0.58)

Oil Pressure Change Per 1 mm

(0.039 in.) of Shim Thickness	13.8 kPa (2 psi)
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Oil Pan**Strainer Tube Attaching**

Cap Screw Torque	11 N·m (96 lb-in.)
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Oil Pan-to-Block Cap Screw Torque . . .	11 N·m (96 lb-in.)
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Oil Pan-to-Gear Housing

Cover Torque	9 N·m (78 lb-in.)
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ENGINE: 3TN66**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 107 N (24 lb) Force applied midway between pulleys

GROUP 50—Fuel Injection Pump, Camshaft, and Nozzles**Item****Standard mm (in.)****Wear Limit mm (in.)****Fuel Injection Pump**

Pump Mounting Hardware Torque	20 N·m (180 lb-in.)
Gear Backlash	0.04—0.12 (0.0016—0.0047)
Gear Attaching Nut Torque	88 N·m (65 lb-ft)
Pump Camshaft Lobe Height	30.9 (1.217)
Camshaft Bearing Screw Torque	20 N·m (180 lb-in.)
Screw Torque	20 N·m (180 lb-in.)

Fuel Injection Nozzles

Nozzle Opening Pressure	11722 ± 480 kPa (1700 ± 70 psi)
Minimum Leakage Time	10 Seconds @ 11032 kPa (1600 psi) Pressure
Retaining Nut-to-Nozzle Body Torque	40 N·m (30 lb-ft)
Nozzle-to-Cylinder Head Torque	50 N·m (37 lb-ft)
Leak-Off Fitting-to-Nozzle Torque	40 N·m (30 lb-ft)

GROUP 55—Fuel Control and Governor Linkage**Item****Standard mm (in.)****Wear Limit mm (in.)****Fuel Control and Governor Linkage**

Governor Shaft O.D.	7.90 (0.311)
Fuel Control Linkage Bore I.D.	8.15 (0.321)
Sleeve Bore I.D.	8.20 (0.323)
Sleeve Shaft O.D.	7.90 (0.311)
Sleeve Oil Clearance (Sleeve Bore I.D. Minus Shaft O.D.)	0.150 (0.006)
Governor Shaft Clearance Linkage Bore Minus Shaft O.D.	0.18 (0.0071)

GROUP 60—Starter

See Starter Specifications in this Group

GROUP 65—Alternator

See Alternator Specifications in this Group

ENGINE: 3TNA72**GROUP 10—Valve Train and Camshaft**

Item	Standard mm (in.)	Wear Limit mm (in.)
Valve Clearance	0.20 (0.008)	
Rocker Arm		
Shaft O.D.	11.966—11.984 (0.471—0.472) . . .	11.96 (0.471)
Shaft Support I.D.	12.00—12.02 (0.472—0.473)	12.09 (0.476)
Arm I.D.	12.00—12.02 (0.472—0.473)	12.09 (0.476)
Shaft Clearance	0.016—0.054	0.13 (0.005)
Rocker Arm Assembly Cap Screw and Nut Torque	26 N·m (226 lb-in.)	
Rocker Arm Cover Nut Torque	18 N·m (160 lb-in.)	
Push Rod		
Maximum T.I.R.		0.075 (0.003)
Length	141—142 (5.55—5.59)	141.0 (5.55)
Diameter	5 (0.197)	
Cam Follower		
O.D.	20.927—20.960 (0.824—0.825) . . .	20.93 (0.824)
Bore I.D.	21.0—21.021 (0.827—0.828)	21.05 (0.829)
Bore Clearance	0.04—0.094 (0.0016—0.0037)	
Camshaft		
End Play	0.05—0.15 (0.002—0.006)	0.40 (0.016)
Maximum Gear Backlash Between Each Gear		0.2 (0.008)
Journal O.D. (Gearcase Side)	39.94—39.96 (1.572—1.573)	39.85 (1.569)
Journal O.D. (Intermediate) Flywheel Side)	39.94—39.96 (1.572—1.573)	39.85 (1.569)
Lobe Height	33.95—34.05 (1.337—1.341)	33.75 (1.329)
Bushing I.D. (Gearcase Side)	40.0—40.065 (1.575—1.577)	40.10 (1.579)
Bore I.D. (Intermediate and Flywheel Side)	40.0—40.065 (1.575—1.577)	40.10 (1.579)
End Journal Clearance	0.040—0.085 (0.0016—0.0033) . . .	0.18 (0.007)
Intermediate Journal Clearance	0.065—0.115 (0.0026—0.0045)	
Attaching Cap Screw Torque	11 N·m (96 lb-in.)	
Gear Housing Cover Cap Screw Torque	9 N·m (78 lb-in.)	
Fuel Shut-Off Solenoid Bracket Cap Screw Torque (Early Units)		
Crankshaft Pulley Cap Screw Torque . .	115 N·m (85 lb-ft)	

GROUP 15—Cylinder Head, Valves, and Manifolds

Item	Standard mm (in.)	Wear Limit mm (in.)
Manifold		
Exhaust Manifold Cap Scrw Torque . . .	26 N·m (226 lb-in.)	
Intake Manifold Cap Screw Torque . . .	11 N·m (96 lb-in.)	

ENGINE: 3TNA72

Item	Standard mm (in.)	Wear Limit mm (in.)
Cylinder Head		
Valve Recession		
Intake	0.50 (0.020)	
Exhaust	0.85 (0.033)	
Valve Spring Free Length (Approx.)	37.4 (1.472)	
Valve Spring Test Length		22.5 (0.87)
Valve Stem O.D.	6.945—6.960 (0.273—0.274)	6.90 (0.272)
Valve Guide I.D.	7.005—7.020 (0.2758—0.2764)	6.90 (0.272)
Valve Guide-to-Valve Stem Clearance:		
(Replace)		0.20 (0.008)
(Knurl)		0.15—0.20 (0.006—0.008)
Valve Seat Width		
Intake	1.44 (0.057)	1.98 (0.078)
Exhaust	1.77 (0.070)	2.27 (0.089)
Valve Seat Angle		
Intake	120°	
Exhaust	90°	
Cylinder Head Flatness		
(Maximum Distortion)	Less than 0.5 (0.002)	0.15 (0.006)
Mill Cylinder Head No More Than		0.20 (0.008)
Valve Guide Height	9.00 (0.354)	
Cylinder Head Cap Screw Torque		
In Sequence (Lubricated)	61 N·m (45 lb-ft)	

GROUP 20—Flywheel

Item	Standard mm (in.)	Wear Limit mm (in.)
Stub Shaft (If Equipped)		
Maximum T.I.R.		0.20 (0.008)
Flatness		0.05 (0.002)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)	
Flywheel		
Flatness		0.05 (0.002)
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	88 N·m (65 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)	

ENGINE: 3TNA72**GROUP 25—Connecting Rods and Pistons**

Item	Standard mm (in.)	Wear Limit mm (in.)
Connecting Rod		
Side Clearance	0.2—0.4 (0.0079—0.0158)	0.55 (0.022)
End-Cap Screw Torque	23 N·m (200 lb-in.)	
Bearing Clearance (Crankpin)	0.020—0.072 (0.0008—0.0028)	0.15 (0.006)
Bearing Clearance (Piston Pin)	0.025—0.047 (0.0010—0.0019)	0.11 (0.0043)
Maximum Twist		0.08 (0.003)
Minimum Journal O.D. (Crankpin)	39.97—39.98 (1.5736—1.574)	39.92 (1.572)
Bearing I.D. (Crankpin)	40.0—40.042 (1.575—1.579)	40.07 (1.578)
Piston		
Ring Groove Clearance		
All Rings	0.075—0.11 (0.0030—0.0043)	0.20 (0.008)
Ring End Gap (1st)	0.1—0.25 (0.004—0.010)	1.5 (0.059)
Ring End Gap (2nd)	0.25—0.80 (0.010—0.016)	1.5 (0.059)
Ring End Gap (oil)	0.15—0.35 (0.006—0.014)	1.5 (0.059)
Pin O.D.	20.991—21.0 (0.826—0.827)	20.98 (0.826)
Pin Bushing I.D.	21.025—21.038 (0.8278—0.8282)	21.10 (0.831)
Pin Bushing Clearance	0.025—0.047 (0.0010—0.0019)	0.11 (0.004)
Pin Bore I.D.	21.0—21.009 (0.8268—0.8271)	21.02 (0.828)
Pin Bore Clearance	0—0.018 (0—0.0007)	0.045 (0.0018)
Piston O.D.	71.922—71.952 (2.832—2.833)	71.81 (2.827)
Cylinder Block		
Cylinder Bore I.D.	72.0—72.03 (2.835—2.836)	72.20 (2.843)
Maximum Piston Clearance		0.28 (0.011)
Cylinder Out-of-Round		0.02 (0.001)

GROUP 30—Crankshaft and Main Bearings

Item	Standard mm (in.)	Wear Limit mm (in.)
Crankshaft		
End Play	0.09—0.271 (0.004—0.011)	0.33 (0.013)
Main Bearing Cap Screw Torque	79 N·m (58 lb-ft)	
Main Bearing Clearance	0.020—0.072 (0.008—0.0028)	0.15 (0.006)
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.)	9 N·m (78 lb-in.)
Main Bearing Journal O.D.	43.97—43.98 (1.731—1.732)	43.92 (1.729)
Main Bearing I.D.	44.0—44.042 (1.732—1.734)	44.07 (1.735)

ENGINE: 3TNA72**GROUP 35—Gear Housing**

Item	Standard mm (in.)	Wear Limit mm (in.)
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Gear Housing Cap Screw Torque	9 N·m (78 lb-in.)	
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Crankshaft Pulley Cap Screw Torque . . .	115 N·m (85 lb-ft)	
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Timing Gear Backlash

Fuel Injection Pump	0.04—0.12 (0.0016—0.0047) 0.20 (0.008)
Idler	0.04—0.12 (0.0016—0.0047) 0.20 (0.008)
Camshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Crankshaft	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)
Oil Pump	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)

Timing Gear Wear Specifications

Idler Gear Bushing Diameter	20.0—20.021 (0.786—0.788)	. . . . 20.08 (0.791)
Idler Shaft Diameter	19.959—19.980 (0.786—0.787)	. . . . 19.93 (0.785)
Idler Shaft Oil Clearance	0.02—0.062 (0.001—0.002) 0.15 (0.006)

GROUP 40—Lubrication System

Item	Standard mm (in.)	Wear Limit mm (in.)
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Oil Pump (Later 3TNA72)

Gear Backlash		
3TNA72	0.11—0.19 (0.004—0.0075) 0.25 (0.010)
3TNA72-UJB Only	0.11—0.19 (0.0043—0.0075) 0.20 (0.008)
Rotor Recess, Maximum		0.25 (0.010)
Outer Rotor-to-Pump Clearance		0.25 (0.010)
Inner Rotor-to-Outer Rotor Clearance		
3TNA72		0.25 (0.010)
3TNA72-UJB Only		0.15 (0.006)
Oil Pump Attaching Cap Screw Torque .	25 N·m (18 lb-ft)	

Oil Pump (Early 3TNA72)

Gear Backlash	0.11—0.19 (0.004—0.0075)	. . . . 0.25 (0.010)
Rotor Recess		0.25 (0.010)
Outer Rotor-to-Pump Body Clearance . .		0.25 (0.010)
Inner Rotor-to-Outer Rotor Clearance . .		0.25 (0.010)
Rotor Shaft Diameter		12.65 (0.498)
Shaft Bore Diameter Maximum		12.80 (0.504)
Shaft-to-Bore Clearance		0.1 (0.004)

Oil Pump Attaching Cap Screw Torque .	9 N·m (78 lb-in.)	
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ENGINE: 3TNA72**Item****Specification****Oil Pressure Regulating Valve (Later 3TNA72)**

Valve Spring Free Length 43.5—48.5 mm (1.71—1.91 in.)

Valve Spring Test Length 27.5 mm (1.08 in.)

@ 20.5 ± 3.1 N (4.6 ± 0.7 lb) Force

Oil Pressure Change Per 1 mm

(0.039 in.) of Shim Thickness 10.9 kPa (1.6 psi)

Oil Pressure Regulating Valve (3TNA72-UJB Only)

Valve Spring Free Length (Approx.) 46 mm (1.81 in.)

Valve Spring Test Length 24.5 mm (0.96 in.)

@ 27.2 N (6.1 lb) Force

Oil Pressure Regulating Valve (Early 3TNA72)

Valve Spring Free Length 39.5—40.5 mm (1.55—1.59 in.)

Valve Spring Test Length 30 mm (1.18 in.)

@ 29.4 ± 3.1 N (6.6 ± 0.7 lb) Force

Oil Pressure Change per 1 mm

(0.039 in.) of Shim Thickness 28 kPa (4 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.)

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 3TNA72 20 N·m (180 lb-in.)

3TNA72-UJB (Only) 26 N·m (226 lb-in.)

Water Pump

Plate Screws Torque

3TNA72 9 N·m (78 lb-in.)

3TNA72-UJB (Only) 11 N·m (96 lb-in.)

Attaching Cap Screws 26 N·m (226 lb-in.)

Alternator Belt Deflection 13 mm (0.5 in.) @ 107 N (24 lb) Force applied midway between pulley

Pulley Cap Screws Torque 11 N·m (96 lb-in.)

ENGINE: 3TNA72**GROUP 50—Fuel Injection Pump, Camshaft, and Nozzles**

Item	Standard mm (in.)	Wear Limit mm (in.)
Fuel Injection Pump		
Pump Mounting Hardware Torque		
3TNA72	20 N·m (180 lb-in.)	
3TNA72-UJB (Only)	27 N·m (20 lb-ft)	
Maximum Gear Backlash	0.04—0.12 (0.0016—0.0047)	0.2 (0.008)
Gear Attaching Nut Torque	88 N·m (65 lb-ft)	
Pump Camshaft Minimum Lobe Height		30.9 (1.217)
Camshaft Bearing Retaining Screw Torque		
3TNA72	20 N·m (180 lb-in.)	
3TNA72-UJB (Only)	11 N·m (96 lb-in.)	
Fuel Injection Nozzles		
Nozzle Opening Pressure	11722 ± 480 kPa (1700 ± 70 psi)	
Minimum Leakage Time	10 Seconds	
.	@ 11032 kPa (1600 psi) Pressure	
. . . . .	. . . . . (1600 psi) Pressure	
Retaining Nut-to-Nozzle Body Torque		
3TNA72	40 N·m (28 lb-ft)	
3TNA72-UJB (Only)	51 N·m (38 lb-ft)	
Nozzle-to-Cylinder Head Attaching Torque		
3TNA72	50 N·m (37 lb-ft)	
3TNA72-UJB (Only)	37 N·m (28 lb-ft)	
Fuel Leak-Off Fitting-to-Nozzle Torque		
3TNA72	40 N·m (30 lb-ft)	
3TNA72-UJB (Only)	15 N·m (130 lb-in.)	

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ENGINE: 3TNA72**GROUP 55—Fuel Control and Governor Linkage**

Item	Standard mm (in.)	Wear Limit mm (in.)
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Fuel Control and Governor Linkage

(Later 3TNA72)

Governor Shaft O.D. 7.90 (0.311)

Fuel Control Linkage Bore I.D. 8.15 (0.321)

Governor Shaft Clearance

(Fuel Control Linkage Bore

Minus Shaft O.D.) 0.18 (0.007)

Sleeve Bore I.D. 8.20 (0.323)

Sleeve Shaft O.D. 7.90 (0.311)

Sleeve Oil Clearance

(Sleeve Bore I.D. Minus Shaft O.D.) 0.15 (0.006)

Fuel Control and Governor Linkage

(Early 3TNA72)

Governor Shaft O.D. 7.90 (0.311)

Fuel Control Linkage Bore I.D. 8.15 (0.321)

Governor Shaft Clearance

Bore I.D. Minus Shaft O.D. 0.18 (0.007)

Sleeve Bore I.D. 9.20 (0.362)

Inner Rotor Shaft O.D. 8.90 (0.350)

Inner Rotor Shaft Clearance

(Sleeve Bore I.D. Minus Shaft O.D.) 0.15 mm (0.006)

Governor Shaft Torque 49 N·m (36 lb-ft)

Governor Cover Cap Screw Torque 9 N·m (78 lb-in.)

GROUP 60—Starter

See Starter Specifications in this Group

GROUP 65—Alternator

See Alternator Specifications in this Group

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ENGINE: 3TN75**GROUP 10—Valve Train and Camshaft**

Item	Standard mm (in.)	Wear Limit mm (in.)
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Valve Clearance	0.20 (0.008)	
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Rocker Arm

Shaft O.D.	15.966—15.984 (0.6286—0.6293)	15.955 (0.628)
Shaft Support I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Arm I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Shaft Clearance	0.016—0.054 90.0006—0.0021)	0.13 (0.005)

Rocker Arm Assembly Cap Screw

and Nut Torque 26 N·m (226 lb-in.)

Rocker Arm Cover Nut Torque 18 N·m (160 lb-in.)

Push Rod

Maximum T.I.R.		0.075 (0.003)
Length	146.65—147.35 (5.774—5.801)	146.6 (5.77)
Diameter	8 (0.315)	

Cam Follower

O.D.	11.975—11.990 (0.471—0.472)	11.93 (0.470)
Bore I.D.	12.0—12.018 (0.472—0.473)	12.05 (0.474)
Bore Clearance	0.010—0.043 (0.0003—0.0016)	

Camshaft

End Play	0.05—0.20 (0.002—0.008)	0.40 (0.016)
Maximum Gear Backlash Between Each Gear		0.2 (0.008)

End Journals O.D.	44.925—44.959 (1.768—1.770)	44.89 (1.764)
Intermediate Journal O.D.	44.916—44.935 (1.768—1.769)	44.89 (1.764)
Lobe Height	38.635—38.765 (1.521—1.526)	38.40 (1.512)
Bushing I.D.	44.990—45.055 (1.771—1.774)	45.10 (1.776)

Intermediate and Flywheel

End Bores I.D.	45.0—45.025 (1.772—1.773)	45.10 (1.776)
PTO Journal Clearance	0.040—0.130 (0.0015—0.0050)	0.2 (0.0078)
Intermediate Journal Clearance	0.065—0.115 (0.0025—0.0045)	0.2 (0.0078)
Flywheel Journal Clearance	0.050—0.100 (0.0019—0.0039)	0.2 (0.0078)
Idle Gear Shaft Cap Screw Torque	26 N·m (226 lb-in.)	
Attaching Cap Screw Torque	26 N·m (226 lb-in.)	
Gear Housing Cover Cap Screw Torque	26 N·m (226 lb-in.)	
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-ft)	

GROUP 15—Cylinder Head, Valves, and Manifolds

Item	Standard mm (in.)	Wear Limit mm (in.)
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Manifold

Exhaust Manifold Cap Screw Torque	26 N·m (226 lb-in.)	
Intake Manifold Cap Screw Torque	26 N·m (226 lb-in.)	

ENGINE: 3TN75

Item	Standard mm (in.)	Wear Limit mm (in.)
Cylinder Head		
Intake and Exhaust Valve Recession	0.30—0.59 (0.012—0.020)	1.0 (0.039)
Valve Spring Free Length (Approx.)		41.5 (1.63)
Valve Spring Test Length		25.2 (0.99)
Valve Stem O.D.	6.945—6.960 (0.273—0.274)	6.90 (0.272)
Valve Guide-to-Valve Stem Clearance:		
(Replace)		0.20 (0.008)
(Knurl)		0.15—0.20 (0.006—0.008)
Valve Seat Width		
Intake	1.36—1.53 (0.054—0.060)	1.98 (0.078)
Exhaust	1.66—1.87 (0.065—0.074)	2.27 (0.089)
Valve Seat Angle		
Intake	120°	
Exhaust	90°	
Cylinder Head Flatness	Less than 0.05 (0.002)	0.15 (0.006)
Mill Cylinder Head No More Than		0.2 (0.008)
Valve Guide Height		12.00 (0.472)
Cylinder Head Cap Screw Torque		
In Sequence (Lubricated)	69 N·m (51 lb-ft)	

GROUP 20—Flywheel

Item	Standard mm (in.)	Wear Limit mm (in.)
Stub Shaft (If Equipped)		
Maximum T.I.R.		0.20 (0.008)
Flatness		0.05 (0.002)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)	
Flywheel		
Flatness		0.05 (0.002)
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	88 N·m (65 lb-ft)	
Flywheel Housing or Shield		
Cap Screw or Nut Torque		
M10	49 N·m (36 lb-ft)	
M8	26 N·m (22 lb-in.)	
M12 Nut	88 N·m (65 lb-ft)	

ENGINE: 3TN75**GROUP 25—Connecting Rods and Pistons**

Item	Standard mm (in.)	Wear Limit mm (in.)
Connecting Rod		
Side Clearance	0.2—0.4 (0.0079—0.0158)	0.55 (0.22)
End-Cap Screw Torque	39 N·m (29 lb-ft)	
Bearing Clearance (Crankpin)	0.038—0.090 (0.0015—0.0035)	0.16 (0.006)
Bearing Clearance (Piston Pin)	0.025—0.047 (0.0010—0.0019)	0.11 (0.0043)
Maximum Twist		0.08 (0.003)
Journal O.D.	42.952—42.962 (1.691—1.6914)	42.91 (1.689)
Bearing I.D. (Crankpin)	43.0—43.042 (1.693—1.695)	43.07 (1.696)
Piston		
Ring Groove Clearance		
Top Ring	0.070—0.105 (0.0028—0.0041)	0.25 (0.010)
Second Ring	0.035—0.070 (0.0014—0.0028)	0.25 (0.010)
Oil Ring	0.030—0.060 (0.0012—0.0024)	0.20 (0.008)
Ring End Gap	0.2—0.4 (0.008—0.016)	1.50 (0.059)
Pin O.D.	22.991—23.0 (0.905—0.906)	22.90 (0.902)
Pin Bushing I.D.	23.025—23.038 (0.9065—0.9070)	23.10 (0.909)
Pin Bushing Clearance	0.025—0.047 (0.0010—0.0019)	0.11 (0.004)
Pin Bore I.D.	23.0—23.009 (0.9055—0.9059)	23.02 (0.906)
Pin Bore Clearance	0—0.018 (0—0.0007)	0.05 (0.002)
Piston O.D.	74.913—74.943 (2.949—2.951)	74.81 (2.945)
Cylinder Block		
Cylinder Bore I.D.	75.0—75.03 (2.953—2.954)	75.20 (2.961)
Maximum Piston Clearance		0.22 (0.009)
Cylinder Out-of-Round		0.02 (0.008)

GROUP 30—Crankshaft and Main Bearings

Item	Standard mm (in.)	Wear Limit mm (in.)
Crankshaft		
End Play	0.09—0.271 (0.004—0.011)	0.33 (0.013)
Main Bearing Cap Cap Screw Torque	78 N·m (57 lb-ft)	
Main Bearing Clearance	0.038—0.093 (0.0015—0.0037)	0.15 (0.006)
Oil Seal Case Cap Screw Torque		
Seal Case to Block	26 N·m (226 lb-in.)	
Oil Pan to Seal Case	9 N·m (78 lb-in.)	
Main Bearing Journal O.D.	46.952—46.962 (1.8485—1.8489)	46.91 (1.847)
Main Bearing I.D.	47.0—47.045 (1.850—1.852)	47.10 (1.854)

ENGINE: 3TN75**GROUP 35—Gear Housing**

Item	Standard mm (in.)	Wear Limit mm (in.)
Gear Housing Cap Screw Torque	26 N·m (226 lb-in.)	
Crankshaft Pulley Cap Screw Torque . . .	115 N·m (85 lb-ft)	
Timing Gear Backlash		
Fuel Injection Pump	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Idler	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Camshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Crankshaft	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)
Oil Pump	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)

Timing Gear Wear Specifications

Idler Gear Bushing Diameter	46.0—46.025 (1.811—1.812)	. . . . 46.03 (1.812)
Idler Shaft Diameter	45.950—45.975 (1.809—1.810)	. . . . 45.93 (1.808)
Idler Shaft Oil Clearance	0.025—0.075 (0.0009—0.0029)	. . . . 0.15 (0.006)

GROUP 40—Lubrication System

Item	Standard mm (in.)	Wear Limit mm (in.)
Oil Pump		
Gear Backlash	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.0079)
Rotor Recess		0.13 (0.005)
Outer Rotor-to-Pump Body Clearance		0.25 (0.010)
Inner Rotor-to-Outer Rotor Clearance		0.25 (0.010)
Oil Pump Attaching Cap Screw Torque .	25 N·m (18 lb-ft)	
Oil Pressure Regulating Valve		
Valve Spring Free Length (Approx.) . . .	46.0 (1.81)	
Valve Spring Test Length	27.5 (1.08)	
	@ 20.5 N (4.6 lb) Force	
Oil Pressure Change Per 1 mm (0.039 in.) of Shim Thickness	15.6 kPa (2.3 psi)	
Oil Pan		
Strainer Tube Attaching		
Cap Screw Torque	26 N·m (226 lb-in.)	
Oil Pan-to-Block Cap Screw Torque . . .	26 N·m (226 lb-in.)	
Oil Pan-to-Gear Housing Cover Torque .	26 N·m (226 lb-in.)	

ENGINE: 3TN75

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	20 N·m (180 lb-in.)
Water Pump	
Bottom of Pulley Flange-to-Housing Distance	17 mm (0.67 in.)
Distance Top of Impeller is Below Housing	2.0 mm (0.08 in.)
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 pulley

GROUP 50—Fuel Injection Pump, Camshaft, and Nozzles

Item	Standard mm (in.)	Wear Limit mm (in.)
Fuel Injection Pump		
Pump Mounting Hardware Torque	27 N·m (20 lb-ft)	
Gear Backlash	0.04—0.12 (0.0016—0.0047)	0.2 (0.008)
Gear Attaching Nut Torque	88 N·m (65 lb-ft)	
Fuel Injection Nozzles		
Nozzle Opening Pressure	19600 ± 480 kPa (2843 ± 70 psi)	
Minimum Leakage Time	5 Seconds	
	@ 17640 kPa (2550 psi) Pressure	
Retaining Nut-to-Nozzle Body Torque	43 N·m (31 lb-ft)	
Nozzle-to-Cylinder Head		
Attaching Torque	45 N·m (39 lb-in.)	
Fuel Leak-Off		
Fitting-to-Nozzle Torque	15 N·m (130 lb-in.)	

GROUP 60—Starter

See Starter Specifications in this Group

GROUP 65—Alternator

See Alternator Specifications in this Group

ENGINE: 3TN78 & 4TN78**GROUP 10—Valve Train and Camshaft**

Item	Standard mm (in.)	Wear Limit mm (in.)
Valve Clearance	0.20 (0.008)	
Rocker Arm		
Shaft O.D.	15.966—15.984 (0.6286—0.6293)	15.955 (0.628)
Shaft Support I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Arm I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Shaft Clearance	0.016—0.054 90.0006—0.0021)	0.13 (0.005)
Rocker Arm Assembly Cap Screw and Nut Torque	26 N·m (226 lb-in.)	
Rocker Arm Cover Nut Torque	18 N·m (160 lb-in.)	
Push Rod		
Maximum T.I.R.		0.075 (0.003)
Length	146.65—147.35 (5.774—5.801)	146.6 (5.77)
Diameter	8 (0.315)	
Cam Follower		
O.D.	11.975—11.990 (0.471—0.472)	11.93 (0.470)
Bore I.D.	12.0—12.018 (0.472—0.473)	12.05 (0.474)
Bore Clearance	0.010—0.043 (0.0003—0.0016)	
Camshaft		
End Play	0.05—0.20 (0.002—0.008)	0.40 (0.016)
Maximum Gear Backlash between each gear		0.2 (0.008)
End Journals O.D.	44.925—44.950 (1.768—1.770)	44.80 (1.764)
Intermediate Journal O.D.	44.910—44.935 (1.768—1.769)	44.80 (1.764)
Lobe Height	38.635—38.765 (1.521—1.526)	38.40 (1.512)
Bushing I.D.	44.990—45.055 (1.771—1.774)	45.10 (1.776)
Intermediate and Flywheel		
End Bores I.D.	45.0—45.025 (1.772—1.773)	45.10 (1.776)
PTO Journal Clearance	0.040—0.130 (0.0015—0.0050)	0.2 (0.0078)
Intermediate Journal Clearance	0.065—0.115 (0.0025—0.0045)	0.2 (0.0078)
Flywheel Journal Clearance	0.050—0.100 (0.0019—0.0039)	0.2 (0.0078)
Idle Gear Shaft Cap Screw Torque	26 N·m (226 lb-in.)	
Attaching Cap Screw Torque	26 N·m (226 lb-in.)	
Gear Housing Cover Cap Screw Torque	26 N·m (226 lb-in.)	
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-ft)	

GROUP 15—Cylinder Head, Valves, and Manifold

Item	Standard mm (in.)	Wear Limit mm (in.)
Manifold		
Exhaust Manifold Cap Screw Torque	26 N·m (226 lb-in.)	
Intake Manifold Cap Screw Torque	26 N·m (226 lb-in.)	

ENGINE: 3TN78 & 4TN78

Item	Standard mm (in.)	Wear Limit mm (in.)
Cylinder Head		
Intake and Exhaust Valve Recession	0.30—0.59 (0.012—0.020)	1.0 (0.039)
Valve Spring Free Length (Approx.)		41.5 (1.63)
Valve Spring Test Length		25.2 (0.99) @ 313 N (70 lb) Force
Valve Stem O.D.	6.945—6.960 (0.273—0.274)	6.90 (0.272)
Valve Guide-to-Valve Stem Clearance:		
(Replace)		0.20 (0.008)
(Knurl)		0.15—0.20 (0.006—0.008)
Valve Seat Width		
Intake	1.36—1.53 (0.054—0.060)	1.98 (0.078)
Exhaust	1.66—1.87 (0.065—0.074)	2.27 (0.089)
Valve Seat Angle		
Intake	120°	
Exhaust	90°	
Cylinder Head Flatness	Less than 0.05 (0.002)	0.15 (0.006)
Mill Cylinder Head No More Than		0.2 (0.008)
Valve Guide Height		12.00 (0.472)
Cylinder Head Cap Screw Torque		
In Sequence (Lubricated)	69 N·m (51 lb-ft)	

GROUP 20—Flywheel

Item	Standard mm (in.)	Wear Limit mm (in.)
Stub Shaft (If Equipped)		
Maximum T.I.R.		0.20 (0.008)
Flatness		0.05 (0.002)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)	
Flywheel		
Flatness		0.05 (0.002)
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	88 N·m (65 lb-ft)	
Flywheel Housing or Shield		
Cap Screw or Nut Torque		
M10	49 N·m (36 lb-ft)	
M8	26 N·m (22 lb-in.)	
M12 Nut	88 N·m (65 lb-ft)	

ENGINE: 3TN78 & 4TN78**GROUP 25—Connecting Rods and Pistons**

Item	Standard mm (in.)	Wear Limit mm (in.)
Connecting Rod		
Side Clearance	0.2—0.4 (0.0079—0.0158)	0.55 (0.22)
End-Cap Screw Torque	39 N·m (29 lb-ft)	
Bearing Clearance (Crankpin)	0.038—0.090 (0.0015—0.0035)	0.16 (0.006)
Bearing Clearance (Piston Pin)	0.025—0.047 (0.0010—0.0019)	0.11 (0.0043)
Maximum Twist		0.08 (0.003)
Journal O.D.	42.952—42.962 (1.691—1.6914)	42.91 (1.689)
Bearing I.D. (Crankpin)	43.0—43.042 (1.693—1.695)	43.07 (1.696)
Piston		
Ring Groove Clearance		
Top Ring	0.070—0.105 (0.0028—0.0041)	0.25 (0.010)
Second Ring	0.035—0.070 (0.0014—0.0028)	0.25 (0.010)
Oil Ring	0.030—0.060 (0.0012—0.0024)	0.20 (0.008)
Ring End Gap	0.2—0.4 (0.008—0.016)	1.50 (0.059)
Pin O.D.	22.991—23.0 (0.905—0.906)	22.90 (0.902)
Pin Bushing I.D.	23.025—23.038 (0.9065—0.9070)	23.10 (0.909)
Pin Bushing Clearance	0.025—0.047 (0.0010—0.0019)	0.11 (0.004)
Pin Bore I.D.	23.0—23.009 (0.9055—0.9059)	23.02 (0.906)
Pin Bore Clearance	0—0.018 (0—0.0007)	0.05 (0.002)
Piston O.D.	77.895—77.925 (3.067—3.068)	77.81 (3.063)
Cylinder Block		
Cylinder Bore I.D.	78.0—78.03 (3.071—3.072)	78.20 (3.079)
Maximum Piston Clearance		0.22 (0.009)
Cylinder Out-of-Round		0.02 (0.008)

GROUP 30—Crankshaft and Main Bearings

Item	Standard mm (in.)	Wear Limit mm (in.)
Crankshaft		
End Play	0.09—0.271 (0.004—0.011)	0.33 (0.013)
Main Bearing Cap Cap Screw Torque	78 N·m (57 lb-ft)	
Main Bearing Clearance	0.038—0.093 (0.0015—0.0037)	0.15 (0.006)
Oil Seal Case Cap Screw Torque		
Seal Case to Block	26 N·m (226 lb-in.)	
Oil Pan to Seal Case	9 N·m (78 lb-in.)	
Main Bearing Journal O.D.	46.952—46.962 (1.8485—1.8489)	46.91 (1.847)
Main Bearing I.D.	47.0—47.045 (1.850—1.852)	47.10 (1.854)

ENGINE: 3TN78 & 4TN78**GROUP 35—Gear Housing**

Item	Standard mm (in.)	Wear Limit mm (in.)
Gear Housing Cap Screw Torque	26 N·m (226 lb-in.)	
Crankshaft Pulley Cap Screw Torque . . .	115 N·m (85 lb-ft)	
Timing Gear Backlash		
Fuel Injection Pump	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Idler	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Camshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Crankshaft	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)
Oil Pump	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.008)

Timing Gear Wear Specifications

Idler Gear Bushing Diameter	46.0—46.025 (1.811—1.812)	. . . . 46.03 (1.812)
Idler Shaft Diameter	45.950—45.975 (1.809—1.810)	. . . . 45.93 (1.808)
Idler Shaft Oil Clearance	0.025—0.075 (0.0009—0.0029)	. . . . 0.15 (0.006)

GROUP 40—Lubrication System

Item	Standard mm (in.)	Wear Limit mm (in.)
Oil Pump		
Gear Backlash	0.11—0.19 (0.0043—0.0075)	. . . . 0.20 (0.0079)
Rotor Recess		0.13 (0.005)
Outer Rotor-to-Pump Body Clearance		0.25 (0.010)
Inner Rotor-to-Outer Rotor Clearance		0.25 (0.010)
Oil Pump Attaching Cap Screw Torque .	25 N·m (18 lb-ft)	
Oil Pressure Regulating Valve		
Valve Spring Free Length (Approx.)		
3TN78	46.0 (1.81)	
4TN78	48.5 (1.91)	
Valve Spring Test Length		
3TN78	24.5 (0.96)	
	@ 27.2 N (6.1 lb) Force	
4TN78	33 (1.30)	
	@ 80 N (18 lb) Force	
Oil Pan		
Strainer Tube Attaching		
Cap Screw Torque	26 N·m (226 lb-in.)	
Oil Pan-to-Block Cap Screw Torque .	26 N·m (226 lb-in.)	
Oil Pan-to-Gear Housing Cover Torque :	26 N·m (226 lb-in.)	

ENGINE: 3TN78 & 4TN78

GROUP 45—Cooling System

Item	Specification
Thermostat	
Begin Opening Temperature	71°C (160°F)
Fully Open Temperature	85°C (184°F)
Housing Plate Cap Screw Torque	26 N·m (226 lb-in)
Housing Attaching Cap Screw Torque	26 N·m (226 lb-in)
Housing Cover Cap Screw Torque	26 N·m (226 lb-in)

Water Pump	
Plate Screws Torque	11 N·m (96 lb-in)
Pulley Cap Screws Torque	11 N·m (96 lb-in)
Attaching Cap Screws	11 N·m (96 lb-in)
Alternator Belt Deflection	13 mm (0.5 in.) at 107N (24 lb) Force applied midway between pulley

GROUP 50—Fuel Injection Pump, Camshaft, and Nozzles

Item	Standard mm (in.)	Wear Limit mm (in.)
Fuel Injection Pump		
Pump Mounting Hardware Torque	27 N·m (20 lb-ft)	
Gear Backlash	0.04—0.12 (0.0016—0.0047)	0.2 (0.008)
Gear Attaching Nut Torque	59 N·m (43 lb-ft)	
Fuel Injection Nozzles		
Nozzle Opening Pressure	19600 ± 480 kPa (2843 ± 70 psi)	
Minimum Leakage Time	5 Seconds	
	@ 17640 kPa (2550 psi) Pressure	
Retaining Nut-to-Nozzle Body Torque	43 N·m (31 lb-ft)	
Nozzle-to-Cylinder Head		
Attaching Torque	4.5 N·m (39 lb-in.)	
Fuel Leak-Off		
Fitting-to-Nozzle Torque	15 N·m (130 lb-in.)	

GROUP 60—Starter
See Starter Specifications in this Group

GROUP 65—Alternator
See Alternator Specifications in this Group

ENGINE: 3TN82 & 4TN82**GROUP 10—Valve Train and Camshaft**

Item	Standard mm (in.)	Wear Limit mm (in.)
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Valve Clearance	0.20 (0.008)	
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Rocker Arm

Shaft O.D.	15.966—15.984 (0.6286—0.6293)	15.955 (0.628)
Shaft Support I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Arm I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Shaft Clearance	0.016—0.054 90.0006—0.0021)	0.13 (0.005)

Rocker Arm Assembly Cap Screw

and Nut Torque 26 N·m (226 lb-in.)

Rocker Arm Cover Nut Torque 18 N·m (160 lb-in.)

Push Rod

Maximum T.I.R.		0.075 (0.003)
Length	178.25—178.75 (7.018—7.037)	178.2 (7.02)
Diameter	8 (0.315)	

Cam Follower

O.D.	11.975—11.990 (0.471—0.472)	11.93 (0.470)
Bore I.D.	12.0—12.018 (0.472—0.473)	12.05 (0.474)
Bore Clearance	0.010—0.043 (0.0003—0.0016)	

Camshaft

End Play	0.05—0.20 (0.002—0.008)	0.40 (0.016)
Maximum Gear Backlash between each gear		0.2 (0.008)
End Journals O.D.	44.925—44.950 (1.769—1.770)	44.80 (1.764)
Intermediate Journal O.D.	44.910—44.935 (1.768—1.769)	44.80 (1.764)
Lobe Height	38.835—38.785 (1.529—1.528)	38.40 (1.512)
Bushing I.D.	44.990—45.055 (1.771—1.774)	45.10 (1.776)
Intermediate and Flywheel End Bores I.D.	45.0—45.025 (1.772—1.773)	45.10 (1.776)
PTO Journal Clearance	0.040—0.130 (0.0015—0.0050)	0.2 (0.0078)
Intermediate Journal Clearance	0.065—0.115 (0.0025—0.0045)	0.2 (0.0078)
Flywheel Journal Clearance	0.050—0.100 (0.0019—0.0039)	0.2 (0.0078)
Idle Gear Shaft Cap Screw Torque	26 N·m (226 lb-in.)	
Attaching Cap Screw Torque	26 N·m (226 lb-in.)	
Gear Housing Cover Cap Screw Torque	26 N·m (226 lb-in.)	
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-ft)	

GROUP 15—Cylinder Head, Valves, and Manifolds

Item	Standard mm (in.)	Wear Limit mm (in.)
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Manifold

Exhaust Manifold Cap Screw Torque	26 N·m (226 lb-in.)	
Intake Manifold Cap Screw Torque	26 N·m (226 lb-in.)	

ENGINE: 3TN82 & 4TN82

Item	Standard mm (in.)	Wear Limit mm (in.)
Cylinder Head (Continued)		
Cylinder Head		
Intake and Exhaust Valve Recession . . .	0.30—0.50 (0.012—0.020)	1.0 (0.039)
Valve Spring Free Length (Approx.) . . .	40 (1.575)	39.5 (1.55)
Valve Spring Test Length	24.0 (0.95)	
	@ 319 N (72 lb) Force	
Valve Stem O.D.	7.960—7.975 (0.313—0.314)	7.90 (0.311)
Valve Guide I.D.	8.010—8.030 (0.3154—0.3160)	8.10 (0.319)
Valve Guide-to-Valve Stem Clearance:		
(Replace)		0.20 (0.008)
(Knurl)		0.15—0.20 (0.006—0.008)
Valve Seat Width		
Intake	1.07—1.24 (0.042—0.049)	1.74 (0.069)
Exhaust	1.24—1.45 (0.049—0.057)	1.94 (0.076)
Valve Seat Angle		
Intake		120°
Exhaust		90°
Cylinder Head Flatness	Less than 0.05 (0.002)	0.15 (0.006)
Mill Cylinder Head No More Than		0.20 (0.008)
Valve Guide Height	15.00 (0.591)	
Cylinder Head Cap Screw Torque		
In Sequence (Lubricated)	78 N·m (58 lb-ft)	

GROUP 20—Flywheel

Item	Standard mm (in.)	Wear Limit mm (in.)
Stub Shaft (If Equipped)		
Maximum T.I.R.		0.20 (0.008)
Flatness		0.05 (0.002)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)	
Flywheel		
Flatness		0.05 (0.002)
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	88 N·m (65 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)	

ENGINE: 3TN82 & 4TN82**GROUP 25—Connecting Rods and Pistons**

Item	Standard mm (in.)	Wear Limit mm (in.)
Connecting Rod		
Side Clearance	0.2—0.4 (0.0079—0.0158)	0.55 (0.022)
End-Cap Screw Torque	47 N·m (35 lb-ft)	
Bearing Clearance (Crankpin)	0.038—0.090 (0.0015—0.0035)	0.16 (0.006)
Bearing Clearance (Piston Pin)	0.025—0.047 (0.0010—0.0019)	0.11 (0.0043)
Maximum Twist		0.08 (0.003)
Journal O.D.	47.952—47.962 (1.8879—1.8883)	47.91 (1.886)
Bearing I.D. (Crankpin)	48.0—48.042 (1.888—1.891)	48.07 (1.893)
Piston		
Ring Groove Clearance		
Top Ring	0.075—0.105 (0.0028—0.0041)	0.25 (0.010)
Second Ring	0.045—0.080 (0.0018—0.0031)	0.25 (0.010)
Oil Ring	0.025—0.060 (0.0010—0.0024)	0.20 (0.008)
Ring End Gap (1st Ring)	0.25—0.40 (0.010—0.016)	1.50 (0.059)
Ring End Gap (2nd and Oil Rings)	0.20—0.35 (0.008—0.014)	1.50 (0.059)
Pin O.D.	25.987—26.0 (1.023—1.024)	25.90 (1.020)
Pin Bushing I.D.	26.025—26.038 (1.0246—1.0251)	26.10 (0.028)
Pin Bushing Clearance	0.025—0.051 (0.0010—0.0020)	0.11 (0.004)
Pin Bore I.D.	26.0—26.009 (1.0236—1.0240)	26.02 (1.024)
Pin Bore Clearance	0—0.022 (0—0.0009)	0.05 (0.002)
Piston O.D.	81.898—81.928 (3.224—3.226)	81.80 (3.220)
Cylinder Block		
Cylinder Bore I.D.	82.0—82.03 (3.228—3.230)	82.20 (3.236)
Maximum Piston Clearance		0.35 (0.014)
Cylinder Out-of-Round		0.02 (0.008)

GROUP 30—Crankshaft and Main Bearings

Item	Standard mm (in.)	Wear Limit mm (in.)
Crankshaft		
End Play	0.090—0.271 (0.004—0.011)	0.33 (0.013)
Main Bearing Cap Screw Torque	98 N·m (72 lb-ft)	
Main Bearing Clearance	0.038—0.093 (0.0015—0.0037)	0.15 (0.006)
Oil Seal Case Cap Screw Torque		
Seal Case to Block	26 N·m (226 lb-in.)	
Oil Pan to Seal Case	9 N·m (78 lb-in.)	
Main Bearing Journal O.D.	49.952—49.962 (1.9666—1.9670)	49.90 (1.965)
Main Bearing I.D.	50.0—50.045 (1.969—1.970)	50.10 (1.972)

ENGINE: 3TN82 & 4TN82**GROUP 35—Gear Housing**

Item	Standard mm (in.)	Wear Limit mm (in.)
Gear Housing Cap Screw Torque	26 N·m (226 lb-in.)	
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-ft)	
Timing Gear Backlash		
Fuel Injection Pump	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Idler	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Camshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Crankshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Oil Pump	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)

Timing Gear Wear Specifications

Idler Gear Bushing Diameter	46.0—46.025 (1.811—1.812)	. . . . 46.03 (1.812)
Idler Shaft Diameter	45.950—45.975 (1.809—1.810)	. . . . 45.93 (1.808)
Idler Shaft Oil Clearance	0.025—0.075 (0.0009—0.0029)	. . . . 0.15 (0.006)

GROUP 40—Lubrication System

Item	Standard mm (in.)	Wear Limit mm (in.)
Oil Pump		
Gear Backlash	0.04 (0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Rotor Recess		0.13 (0.005)
Outer Rotor-to-Pump Body Clearance		0.25 (0.010)
Inner Rotor-to-Outer Rotor Clearance		0.15 (0.006)
Oil Pump Attaching Cap Screw Torque	25 N·m (18 lb-ft)	
Oil Pressure Regulating Valve		
Valve Spring Free Length (Approx.)		
3TN82-RJB (only)	46.0 (1.81)	
3TN82/4TN82	46.0 (1.81)	
Valve Spring Test Length		
3TN82-RJB (only)	24.5 (0.96) @ 27.2 N (6.1 lb) Force	
3TN82/4TN82	27.5 (1.08) @ 20.5 N (4.6 lb) Force	
Oil Pressure Change Per 1 mm (0.039 in.) of Shim Thickness	15.6 kPa (2.3 psi)	
Oil Pan		
Strainer Tube Attaching		
Cap Screw Torque	26 N·m (226 lb-in.)	
Oil Pan-to-Block Cap Screw Torque	26 N·m (226 lb-in.)	
Oil Pan-to-Gear Housing Cover Torque	26 N·m (226 lb-in.)	

ENGINE: 3TN82 & 4TN82**GROUP 45—Cooling System****Item****Specification****Thermostat**

Begin Opening Temperature	71°C (160°F)
Fully Open Temperature	85°C (184°F)
Housing Plate Cap Screw Torque	26 N·m (226 lb-in.)
Housing Attaching Cap Screw Torque	26 N·m (226 lb-in.)
Housing Cover Cap Screw Torque	20 N·m (180 lb-in.)

Water Pump

Plate Screws Torque	11 N·m (96 lb-in.)
Pulley Cap Screws Torque	11 N·m (96 lb-in.)
Attaching Cap Screws	11 N·m (96 lb-in.)
Alternator Belt Deflection	13 mm (0.5 in.) at 107 N (24 lb) Force applied midway between pulley

GROUP 50—Fuel Injection Pump, Camshaft, and Nozzles**Item****Standard mm (in.)****Wear Limit mm (in.)****Fuel Injection Pump**

Pump Mounting Hardware Torque	27 N·m (20 lb-ft)
Maximum Gear Backlash	0.04—0.12 (0.0016—0.0047)
Gear Attaching Nut Torque	59 N·m (43 lb-ft)

Fuel Injection Nozzles

Nozzle Opening Pressure	19600 ± 480 kPa (2843 ± 70 psi)
Minimum Leakage Time	5 Seconds
	@ 17640 kPa (2550 psi) Pressure
Retaining Nut-to-Nozzle Body Torque	43 N·m (31 lb-ft)
Nozzle-to-Cylinder Head	
Attaching Torque	4.5 N·m (39 lb-in.)
Fuel Leak-Off	
Fitting-to-Nozzle Torque	15 N·m (130 lb-in.)

GROUP 55—Fuel Control and Governor Linkage**GROUP 60—Starter**

See Starter Specifications in this Group

GROUP 65—Alternator

See Alternator Specifications in this Group

ENGINE: 3TN84 & 4TN84**GROUP 10—Valve Train and Camshaft**

Item	Standard mm (in.)	Wear Limit mm (in.)
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Valve Clearance	0.20 (0.008)	
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Rocker Arm

Shaft O.D.	15.966—15.984 (0.6286—0.6293)	15.955 (0.628)
Shaft Support I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Arm I.D.	16.0—16.02 (0.630—0.631)	16.09 (0.633)
Shaft Clearance	0.016—0.054 90.0006—0.0021)	0.13 (0.005)

Rocker Arm Assembly Cap Screw

and Nut Torque 26 N·m (226 lb-in.)

Rocker Arm Cover Nut Torque 18 N·m (160 lb-in.)

Push Rod

Maximum T.I.R.		0.075 (0.003)
Length	178.25—178.75 (7.018—7.037)	178.2 (7.02)
Diameter	8 (0.315)	

Cam Follower

O.D.	11.975—11.990 (0.471—0.472)	11.93 (0.470)
Bore I.D.	12.0—12.018 (0.472—0.473)	12.05 (0.474)
Bore Clearance	0.010—0.043 (0.0003—0.0016)	

Camshaft

End Play	0.05—0.20 (0.002—0.008)	0.40 (0.016)
Maximum Gear Backlash between each gear		0.2 (0.008)
End Journals O.D.	44.925—44.950 (1.769—1.770)	44.80 (1.764)
Intermediate Journal O.D.	44.910—44.935 (1.768—1.769)	44.80 (1.764)
Lobe Height	38.835—38.785 (1.529—1.528)	38.40 (1.512)
Bushing I.D.	44.990—45.055 (1.771—1.774)	45.10 (1.776)
Intermediate and Flywheel End Bores I.D.	45.0—45.025 (1.772—1.773)	45.10 (1.776)
PTO Journal Clearance	0.040—0.130 (0.0015—0.0050)	0.2 (0.0078)
Intermediate Journal Clearance	0.065—0.115 (0.0025—0.0045)	0.2 (0.0078)
Flywheel Journal Clearance	0.050—0.100 (0.0019—0.0039)	0.2 (0.0078)
Idler Gear Shaft Cap Screw Torque	26 N·m (226 lb-in.)	
Attaching Cap Screw Torque	26 N·m (226 lb-in.)	
Gear Housing Cover Cap Screw Torque	26 N·m (226 lb-in.)	
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-ft)	

GROUP 15—Cylinder Head, Valves, and Manifolds

Item	Standard mm (in.)	Wear Limit mm (in.)
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Manifold

Exhaust Manifold Cap Screw Torque	26 N·m (226 lb-in.)	
Intake Manifold Cap Screw Torque	26 N·m (226 lb-in.)	

ENGINE: 3TN84 & 4TN84

Item	Standard mm (in.)	Wear Limit mm (in.)
Cylinder Head (Continued)		
Cylinder Head		
Intake and Exhaust Valve Recession . . .	0.30—0.50 mm (0.012—0.020 in.)	
Valve Spring Free Length (Approx.) . . .	41.5 mm (1.63 in.)	
Valve Spring Test Length	24.0 mm (0.95 in.)	
Valve Stem O.D.	7.960—7.975 (0.313—0.314)	7.90 (0.311)
Valve Guide I.D.	8.010—8.030 (0.3154—0.3160)	8.10 (0.319)
Valve Guide-to-Valve Stem Clearance:		
(Replace)		0.20 (0.008)
(Knurl)		0.15—0.20 (0.006—0.008)
Valve Seat Width		
Intake	1.07—1.24 (0.042—0.049)	1.74 (0.069)
Exhaust	1.24—1.35 (0.049—0.053)	1.94 (0.076)
Valve Seat Angle		
Intake		120°
Exhaust		90°
Cylinder Head Flatness	Less than 0.05 (0.002)	0.15 (0.006)
Mill Cylinder Head No More Than		0.20 (0.008)
Valve Guide Height	15.00 (0.591)	
Cylinder Head Cap Screw Torque		
In Sequence (Lubricated)	78 N·m (58 lb-ft)	

GROUP 20—Flywheel

Item	Standard mm (in.)	Wear Limit mm (in.)
Stub Shaft (If Equipped)		
Maximum T.I.R.		0.20 (0.008)
Flatness		0.05 (0.002)
Attaching Cap Screw Torque	59 N·m (44 lb-ft)	
Flywheel		
Flatness		0.05 (0.002)
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	88 N·m (65 lb-ft)	
Flywheel Housing or Shield		
Cap Screw or Nut Torque		
M10	49 N·m (36 lb-ft)	
M8	26 N·m (22 lb-in.)	
M12 Nut	88 N·m (65 lb-ft)	

ENGINE: 3TN84 & 4TN84**GROUP 25—Connecting Rods and Pistons**

Item	Standard mm (in.)	Wear Limit mm (in.)
Connecting Rod		
Side Clearance	0.2—0.4 (0.0079—0.0158)	0.55 (0.022)
End-Cap Screw Torque	47 N·m (35 lb-ft)	
Bearing Clearance (Crankpin)	0.038—0.090 (0.0015—0.0035)	0.16 (0.006)
Bearing Clearance (Piston Pin)	0.025—0.047 (0.0010—0.0019)	0.11 (0.0043)
Maximum Twist		0.08 (0.003)
Journal O.D.	47.952—47.962 (1.8879—1.8883)	47.91 (1.886)
Bearing I.D. (Crankpin)	48.0—48.042 (1.888—1.891)	48.07 (1.893)
Piston		
Ring Groove Clearance		
Top Ring	0.075—0.105 (0.0028—0.0041)	0.25 (0.010)
Second Ring	0.045—0.080 (0.0018—0.0031)	0.25 (0.010)
Oil Ring	0.025—0.060 (0.0010—0.0024)	0.20 (0.008)
Ring End Gap (1st and 2nd Rings)	0.20—0.40 (0.008—0.016)	1.50 (0.059)
Ring End Gap (Oil Ring)	0.25—0.45 (0.010—0.018)	1.5 (0.059)
Pin O.D.	25.987—26.0 (1.023—1.024)	25.90 (1.020)
Pin Bushing I.D.	26.025—26.038 (1.0246—1.0251)	26.10 (0.028)
Pin Bushing Clearance	0.025—0.051 (0.0010—0.0020)	0.11 (0.004)
Pin Bore I.D.	26.0—26.009 (1.0236—1.0240)	26.02 (1.024)
Pin Bore Clearance	0—0.022 (0—0.0009)	0.05 (0.002)
Piston O.D.	83.898—83.928 (3.303—3.304)	83.80 (3.299)
Cylinder Block		
Cylinder Bore I.D.	84.0—84.03 (3.307—3.308)	84.20 (3.315)
Maximum Piston Clearance		0.35 (0.014)
Cylinder Out-of-Round		0.02 (0.008)

GROUP 30—Crankshaft and Main Bearings

Item	Standard mm (in.)	Wear Limit mm (in.)
Crankshaft		
End Play	0.090—0.271 (0.004—0.011)	0.33 (0.013)
Main Bearing Cap Screw Torque	98 N·m (72 lb-ft)	
Main Bearing Clearance	0.038—0.093 (0.0015—0.0037)	0.15 (0.006)
Oil Seal Case Cap Screw Torque		
Seal Case to Block	26 N·m (226 lb-in.)	
Oil Pan to Seal Case	9 N·m (78 lb-in.)	
Main Bearing Journal O.D.	49.952—49.962 (1.9666—1.9670)	49.90 (1.965)
Main Bearing I.D.	50.0—50.045 (1.969—1.970)	50.10 (1.972)

ENGINE: 3TN84 & 4TN84**GROUP 35—Gear Housing**

Item	Standard mm (in.)	Wear Limit mm (in.)
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Gear Housing Cap Screw Torque	26 N·m (226 lb-in.)	
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Crankshaft Pulley Cap Screw Torque . . .	115 N·m (85 lb-ft)	
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Timing Gear Backlash

Fuel Injection Pump	0.04—0.12 (0.0016—0.0047) 0.20 (0.008)
Idler	0.04—0.12 (0.0016—0.0047) 0.20 (0.008)
Camshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Crankshaft	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)
Oil Pump	0.04—0.12 (0.0016—0.0047)	. . . . 0.20 (0.008)

Timing Gear Wear Specifications

Idler Gear Bushing Diameter	46.0—46.025 (1.811—1.812)	. . . . 46.03 (1.812)
Idler Shaft Diameter	45.950—45.975 (1.809—1.810)	. . . 45.93 (1.808)
Idler Shaft Oil Clearance	0.025—0.075 (0.0009—0.0029)	. . . 0.15 (0.006)

GROUP 40—Lubrication System

Item	Standard mm (in.)	Wear Limit mm (in.)
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Oil Pump

Gear Backlash	0.04 (0.12 (0.0016—0.0047) 0.20 (0.008)
Rotor Recess		0.13 (0.005)
Outer Rotor-to-Pump Body Clearance		0.25 (0.010)
Inner Rotor-to-Outer Rotor Clearance		0.15 (0.006)
Oil Pump Attaching Cap Screw Torque .	25 N·m (18 lb-ft)	

Oil Pressure Regulating Valve

Valve Spring Free Length	46.0 (1.81)	
Valve Spring Test Length	27.5 (1.08) @ 20.5 N (4.6 lb) Force	
Oil Pressure Change Per 1 mm (0.039 in.) of Shim Thickness	15.6 kPa (2.3 psi)	

Oil Pan**Strainer Tube Attaching**

Cap Screw Torque	26 N·m (226 lb-in.)	
Oil Pan-to-Block Cap Screw Torque . . .	26 N·m (226 lb-in.)	
Oil Pan-to-Gear Housing Cover Torque .	26 N·m (226 lb-in.)	

ENGINE: 3TN84 & 4TN84**GROUP 45—Cooling System****Item****Specification****Thermostat**

Begin Opening Temperature	71°C (160°F)
Fully Open Temperature	85°C (184°F)
Housing Plate Cap Screw Torque	26 N·m (226 lb-in.)
Housing Attaching Cap Screw Torque	26 N·m (226 lb-in.)
Housing Cover Cap Screw Torque	20 N·m (180 lb-in.)

Water Pump

Plate Screws Torque	11 N·m (96 lb-in.)
Pulley Cap Screws Torque	11 N·m (96 lb-in.)
Attaching Cap Screws	11 N·m (96 lb-in.)
Alternator Belt Deflection	13 mm (0.5 in.) at 107 N (24 lb) Force applied midway between pulley

GROUP 50—Fuel Injection Pump, Camshaft, and Nozzles**Item****Standard mm (in.)****Wear Limit mm (in.)****Fuel Injection Pump**

Pump Mounting Hardware Torque	27 N·m (20 lb-ft)
Maximum Gear Backlash	0.04—0.12 (0.0016—0.0047)
Gear Attaching Nut Torque	59 N·m (43 lb-ft)

Fuel Injection Nozzles

Nozzle Opening Pressure	19600 ± 480 kPa (2843 ± 70 psi)
Minimum Leakage Time	5 Seconds
	@ 17640 kPa (2550 psi) Pressure
Retaining Nut-to-Nozzle Body Torque	43 N·m (31 lb-ft)
Nozzle-to-Cylinder Head	
Attaching Torque	4.5 N·m (39 lb-in.)
Fuel Leak-Off	
Fitting-to-Nozzle Torque	15 N·m (130 lb-in.)

GROUP 55—Fuel Control and Governor Linkage**GROUP 60—Starter**

See Starter Specifications in this Group

GROUP 65—Alternator

See Alternator Specifications in this Group

ENGINE: 4TN100**GROUP 10—Valve Train and Camshaft**

Item	Specification
Valve Clearance	0.30 mm (0.012 in)
Rocker Arm	
Minimum Shaft O.D.	18.35 mm (0.722 in)
Maximum Shaft Support I.D.	18.60 mm (0.732 in)
Maximum Arm I.D.	18.60 mm (0.732 in)
Maximum Shaft Clearance	0.06 mm (0.002 in)
Rocker Arm Assembly Cap Screw and Nut Torque	26 N·m (226 lb-in)
Rocker Arm Cover Nut Torque	18 N·m (160 lb-in)
Push Rod	
Maximum T.I.R.	0.30 mm (0.012 in)
Minimum Length	182.0 mm (7.17 in)
Cam Follower	
Minimum O.D.	14.17 mm (0.558 in)
Maximum Bore I.D.	14.30 mm (0.563 in)
Maximum Clearance	0.05 mm (0.002 in)
Camshaft	
Maximum End Play	0.29 mm (0.011 in)
Maximum Gear Backlash	0.25 mm (0.010 in)
Minimum Journal O.D.	56.80 mm (2.236 in)
Minimum Lobe Height	46.10 mm (1.815 in)
Maximum Bushing I.D.	57.10 mm (2.248 in)
Maximum Intermediate and Flywheel	
End Bores I.D.	57.10 mm (2.248 in)
Maximum Journal Clearance	0.14 mm (0.006 in)
Gear Case End	0.12 mm (0.005 in)
Intermediate and Flywheel End	0.12 mm (0.005 in)
Attaching Cap Screw Torque	26 N·m (226 lb-in)
Gear Housing Cover Cap Screw Torque	26 N·m (226 lb-in)
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-in)

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	26 N·m (226 lb-in)

ENGINE: 4TN100**Item****Specification****Cylinder Head**

Intake and Exhaust Valve Recession	1.80 mm (0.071 in)
Valve Spring Free Length (Approx.)	42.5 mm (1.67 in)
Valve Spring Test Length	41.5 mm (1.63 in) @ 12.6 N (2.8 lb) Force
Minimum Valve Stem O.D.	8.90 mm (0.350 in)
Exhaust Valve Angle	45°
Intake Valve Angle	30°
Maximum Valve Guide I.D.	9.10 mm (0.358 in)
Valve Guide-to-Valve Stem Clearance:	
(Replace)	0.20 mm (0.008 in)
(Knurl)	0.15—0.20 mm (0.006—0.008 in)
Maximum Valve Seat Width	
Intake	2.12 mm (0.084 in)
Exhaust	2.73 mm (0.108 in)
Valve Seat Angle	
Intake	30°
Exhaust	45°
Cylinder Head Flatness	0.05 mm (0.002 in)
Mill Cylinder Head No More Than	0.20 mm (0.008 in)
Valve Guide Height	11.50 mm (0.453 in)
Cylinder Head Cap Screw Torque	
In Sequence (Lubricated)	157 N·m (116 lb-ft)

GROUP 20—Flywheel**Item****Specification****Flywheel**

Flatness	0.05 mm (0.002 in)
Attaching Cap Screw Torque	196 N·m (145 lb-ft)

Flywheel Housing

Mounting Plate or Housing	
Cap Screw Torque	49 N·m (36 lb-ft)
Starter-to-Mounting Plate	
Cap Screw Torque	88 N·m (65 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)

ENGINE: 4TN100**GROUP 25—Connecting Rods and Pistons**

Item	Specification
Connecting Rod	
Maximum Side Play	0.45 mm (0.018 in)
End-Cap Screw Torque	93 N·m (69 lb-ft)
Maximum Bearing Clearance	0.09 mm (0.004 in)
Minimum Journal O.D.	59.90 mm (2.358 in)
Maximum Bearing I.D.	60.10 mm (2.366 in)
Piston	
Maximum Ring Groove Clearance	
Top Ring	0.20 mm (0.008 in)
Second Ring	0.15 mm (0.006 in)
Oil Ring	0.15 mm (0.006 in)
Maximum Ring End Gap	1.50 mm (0.059 in)
Minimum Pin O.D.	33.99 mm (1.338 in)
Maximum Pin Bushing I.D.	34.10 mm (1.343 in)
Maximum Pin Bushing Clearance	0.06 mm (0.0024 in)
Maximum Pin Bore I.D.	34.01 mm (1.339 in)
Maximum Pin Bore Clearance	0.02 mm (0.001 in)
Minimum Piston O.D.	99.79 mm (3.929 in)
Maximum Cylinder Bore I.D.	100.20 mm (3.945 in)
Maximum Piston Clearance	0.35 mm (0.014 in)

GROUP 30—Crankshaft and Main Bearings

Item	Specification
Crankshaft	
Maximum End Play	0.29 mm (0.011 in)
Main Bearing Cap Screw Torque	196 N·m (145 lb-ft)
Maximum Main Bearing Clearance	0.09 mm (0.004 in)
Oil Seal Case Cap Screw Torque	
Seal Case to Block	26 N·m (226 lb-in)
Oil Pan to Seal Case	21 N·m (180 lb-in)
Minimum Main Bearing Journal O.D.	69.90 mm (2.752 in)
Maximum Main Bearing I.D.	70.10 mm (2.760 in)

ENGINE: 4TN100**GROUP 35—Gear Housing**

Item	Specification
Gear Housing Cap Screw Torque	26 N·m (226 lb-in)
Crankshaft Pulley Cap Screw Torque	115 N·m (85 lb-in)
Timing Gear Backlash	
Fuel Injection Pump	0.25 mm (0.010 in)
Idler	0.25 mm (0.010 in)
Camshaft	0.25 mm (0.010 in)
Crankshaft	0.25 mm (0.010 in)
Oil Pump	0.25 mm (0.010 in)
Timing Gear Wear Specifications	
Idler Gear Bushing Diameter	46.08 mm (1.814 in)
Idler Shaft Diameter	45.93 mm (1.808 in)
Idler Shaft Oil Clearance	0.15 mm (0.006 in)

GROUP 40—Lubrication System

Item	Specification
Oil Pump	
Gear Backlash, Maximum	0.25 mm (0.010 in)
Rotor Recess, Maximum	
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)
Shaft-to-Bore Clearance, Maximum	0.2 mm (0.008 in)
Oil Pump Body Cap Screw Torque	6 N·m (53 lb-in)
Oil Pump Attaching Cap Screw Torque	25 N·m (221 lb-in)
Oil Pressure Regulating Valve	
Valve Spring Free Length (Approx.)	51.0 mm (2.01 in)
Valve Spring Test Length	50.0 mm (1.97 in) @ 5.4 N·m (1.2 lb) Force
Oil Pan	
Strainer Tube Attaching Cap Screw Torque	26 N·m (226 lb-in)
Oil Pan-to-Block Cap Screw Torque	26 N·m (226 lb-in)
Oil Pan-to-Gear Housing Cover Torque	21 N·m (180 lb-in)
Oil Pan Spacer-to-Block Cap Screw Torque	
M8	26 N·m (226 lb-in)
M12	88 N·m (65 lb-in)
Oil Pan Spacer-to-Crankshaft Seal Case	21 N·m (180 lb-in)

ENGINE: 4TN100**GROUP 40—Lubrication System (Continued)**

Item	Specification
Oil Cooler-to-Oil Cooler Housing Nuts Torque	49 N·m (36 lb-ft)
Oil Cooler Housing Cap Screw Torque	24 N·m (212 lb-in)
By-Pass Valve Spring Free Length (Approx.)	63.0 mm (2.48 in)
By-Pass Valve Spring Test Length	37.0 mm (1.45 in) @ 3.75 N (0.84 lb) Force

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	20 N·m (180 lb-in)
Water Pump	
Bottom of Pulley Flange-to-Housing Distance	13 mm (0.50 in)
Clearance Between Impeller and Pump Body	0.3—1.1 mm (0.012—0.043 in)
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—Fuel Injection Pump, Camshaft, and Nozzles

Item	Specification
Fuel Injection Pump	
Pump Mounting Hardware Torque	27 N·m (20 lb-ft)
Maximum Gear Backlash	0.2 mm (0.008 in)
Gear Attaching Nut Torque	88 N·m (65 lb-ft)
Fuel Injection Nozzles	
Nozzle Opening Pressure	20100 ± 490 kPa (2915 ± 71 psi)
Minimum Leakage Time	5 Seconds @ 18100 kPa (2625 psi) Pressure
Retaining Nut-to-Nozzle Body Torque	43 N·m (31 lb-ft)
Nozzle-to-Cylinder Head Attaching Torque	4.5 N·m (39 lb-in)

GROUP 55—Fuel Control and Governor Linkage

Fuel Supply Pump	
Pump Mounting Nuts Torque	11 N·m (96 lb-in)

GROUP 60—Starter
See Starter Specifications in this Group

GROUP 65—Alternator
See Alternator Specifications in this Group

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 -19-05FEB8

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 -19-23JUL8

SERVICE PARTS KITS

The following kits are available through your parts catalog:

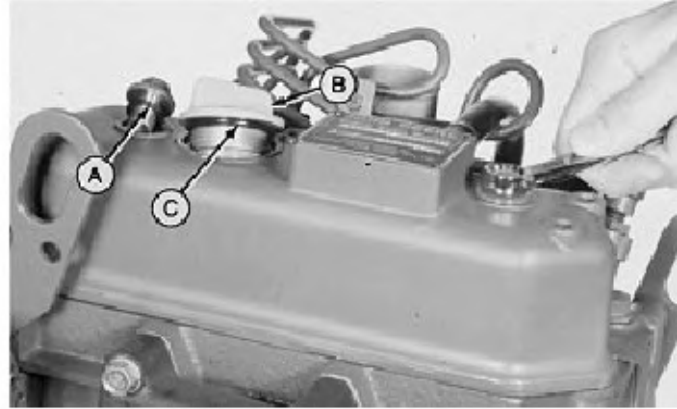
Cylinder Block Gasket Kit.

Cylinder Head Gasket Kit.

M21,TM310,3 -19-17MAR88

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).



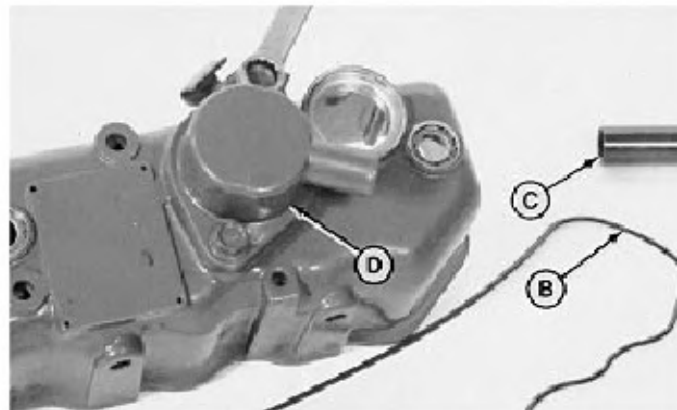
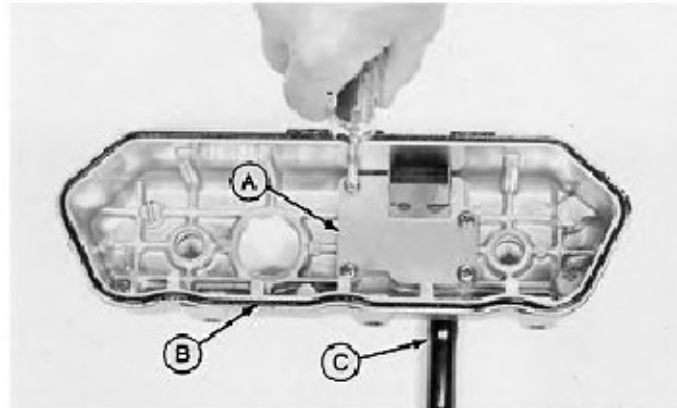
M21,TM310,7 -19-04AUG87

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

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

Remove crankcase breather cover (D).

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

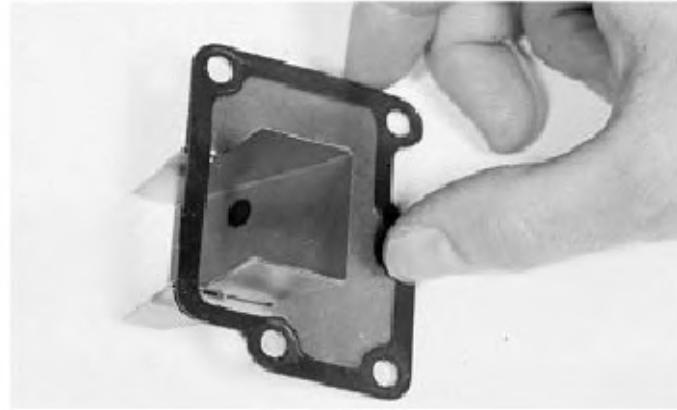


3TN75 Shown

M21,TM310,8 -19-23JUL87

6. Remove gasket from baffle.

Remove screen, packing (A) and O-ring (B). Wash packing in a safe solvent and blow dry with air pressure. If packing comes apart or is deteriorated, replace it.



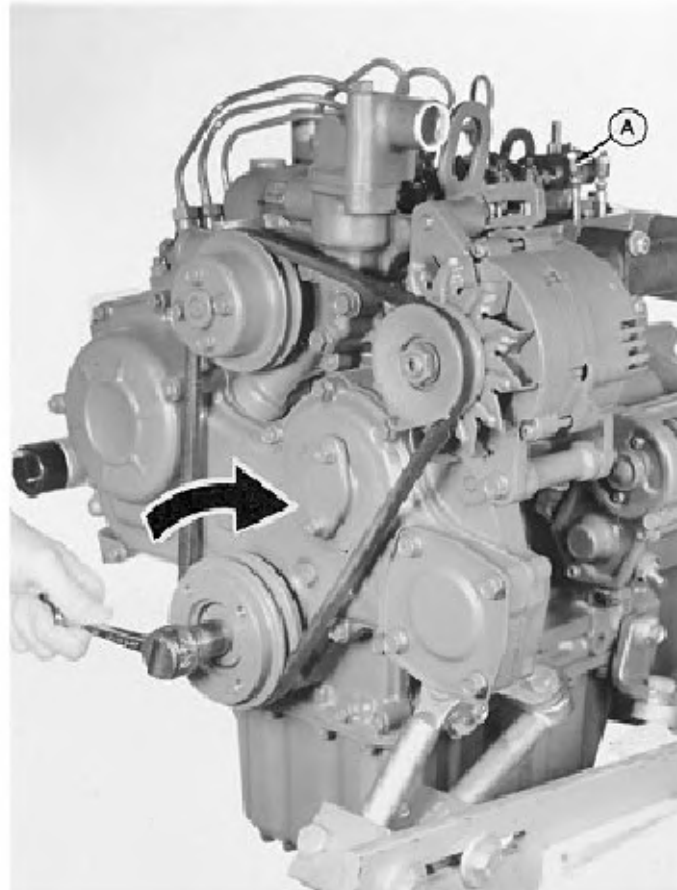
3TN75 Shown

M21,TM310,9 -19-23JUL8

MEASURE AND ADJUST VALVE CLEARANCE (ALL EXCEPT 4TN100)

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

NOTE: Number one cylinder is closest to the flywheel end.

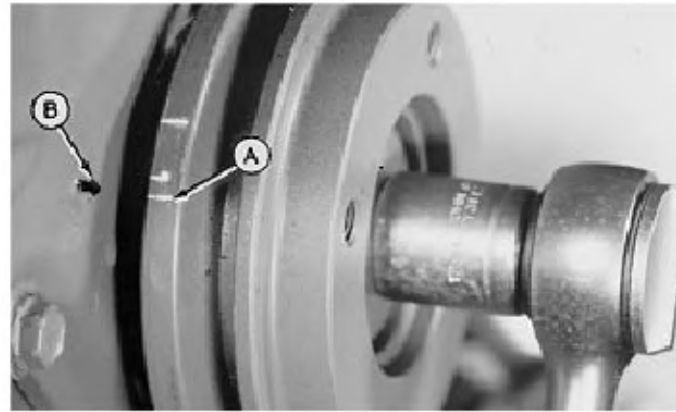


M21,TM310,10 -19-24JUL8

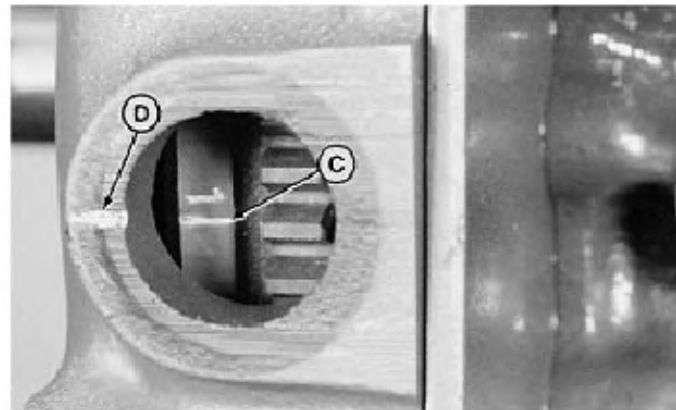
NOTE: TDC—Top Dead Center (the piston at its highest point).

2. Continue turning crankshaft until No. 1 timing mark lines up with index mark. (TDC on compression stroke).

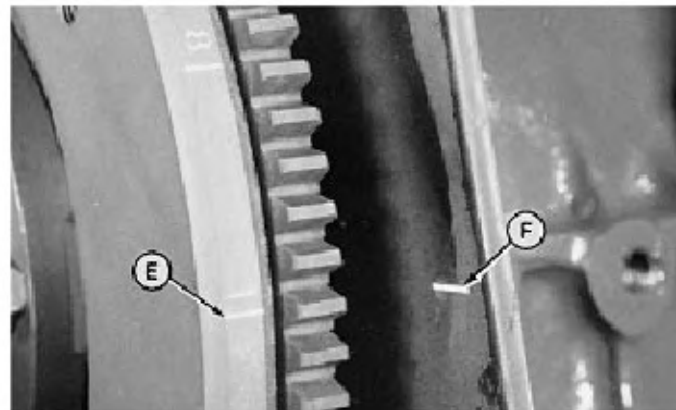
- A—No. 1 Timing Mark
- B—Index Arrow
- C—No. 1 Timing Mark
- D—Index Mark on Flywheel Housing
- E—No. 1 Timing Mark
- F—Index Mark



3TNA72UJ Engine (Early Units)



Engines with Flywheel Housing



Engines Without Flywheel Housing

M21.TM310.11 -19-14SEP8

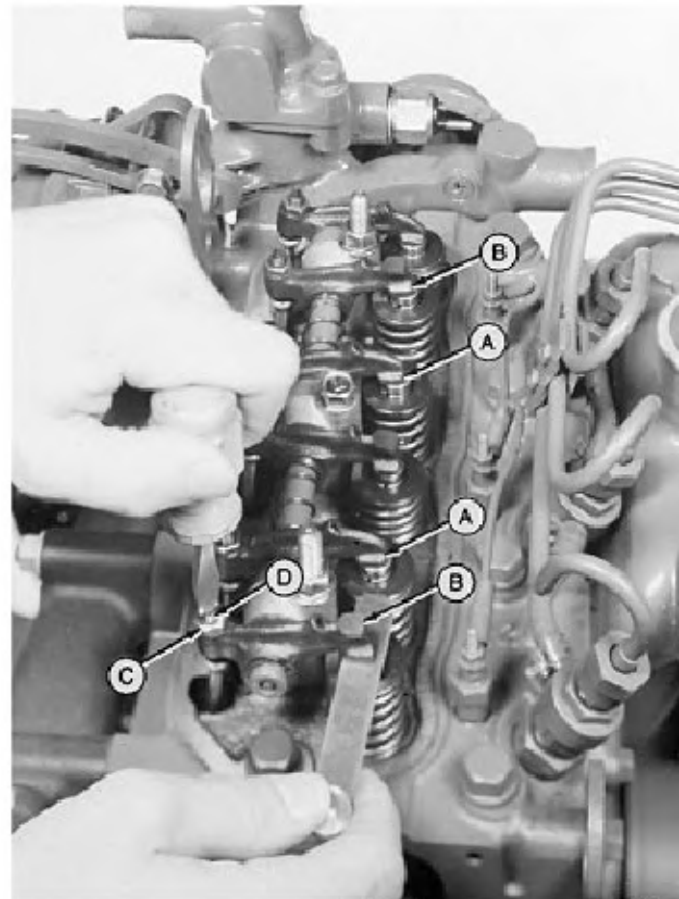
3. Measure valve clearance.

VALVE CLEARANCE SPECIFICATIONS

Intake valves (A) 0.20 mm (0.008 in.)
Exhaust valves (B) 0.20 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.

- A—Intake Valve
- B—Exhaust Valve
- C—Nut
- D—Adjusting Screw



View From Flywheel End

M21,TM310,12 -19-17FEB8

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

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

For 4 cylinder engine, turn crankshaft until No. 4 cylinder intake valve opens.

b. For 3TNA72UJ engine (early unit), continue turning crankshaft to align the No. 2 timing mark on crankshaft pulley with arrow on gear housing cover.

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

For 4 cylinder engine, continue turning crankshaft to align the No. 4 timing mark on flywheel with mark on mounting plate.

c. See Step 4 to adjust intake and exhaust valve.



View From Flywheel End

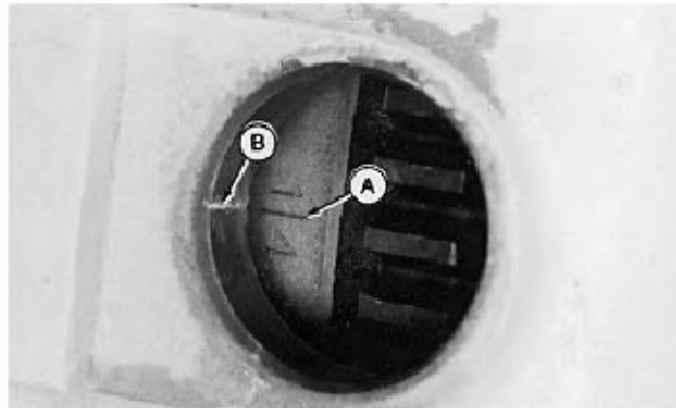
M21,TM310,13 -19-27JUL8

MEASURE AND ADJUST VALVE CLEARANCE (4TN100)

1. Remove plug from timing hole on flywheel housing.

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

2. Turn crankshaft pulley cap screw clockwise until No. 1 cylinder TDC mark (A) aligns with the timing mark (3) on the flywheel housing.



M21,TM310,A1 -19-27JUL8

3. Remove rocker arm cover.

NOTE: No. 1 cylinder is the closest to the flywheel.

4. Try to move both No. 1 cylinder rocker arms or push rods.

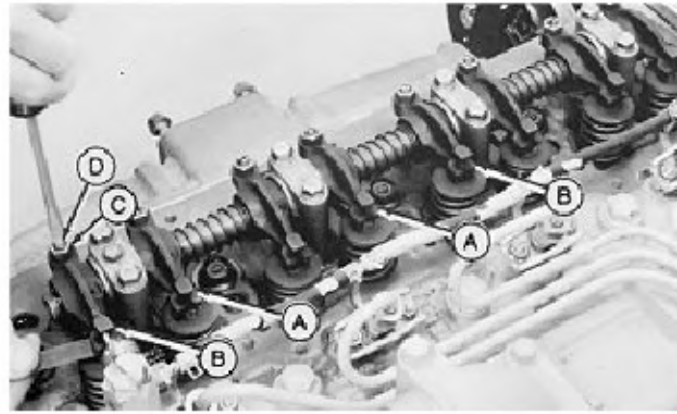
If rocker arm pushrods are not loose, rotate flywheel one revolution (360°). If both rocker arm push rods are loose the piston is at TDC on compression stroke.

5. Measure intake (A) and exhaust (B) valve clearance.

VALVE CLEARANCE SPECIFICATIONS

Intake valves (A)	0.30 mm (0.012 in.)
Exhaust valves (B)	0.30 mm (0.012 in.)

6. To adjust valves, loosen nut (C) and turn adjusting screw (D) until proper clearance is obtained. Hold screw while tightening lock nut.



A—Intake Valve
B—Exhaust Valve
C—Nut
D—Adjusting Screw

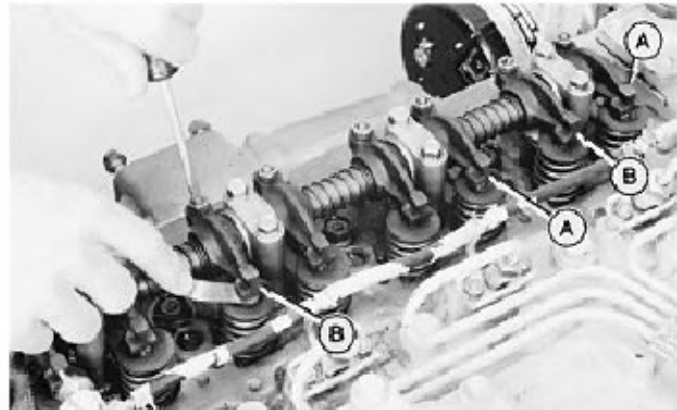
M21,TM310,A2 -19-28AUG87

7. Turn crankshaft pulley cap screw clockwise to turn flywheel one revolution (360°). This puts No. 4 cylinder at TDC on compression stroke.

8. Measure intake (A) and Exhaust (B) valve clearances. See Step 5 to adjust valves.

9. Install rocker arm cover and gasket.

10. Install plug in timing hole on flywheel housing.



M21,TM310,A3 -19-27JUL87

REMOVE AND DISASSEMBLE ROCKER ARM ASSEMBLY

1. Remove rocker arm assembly.



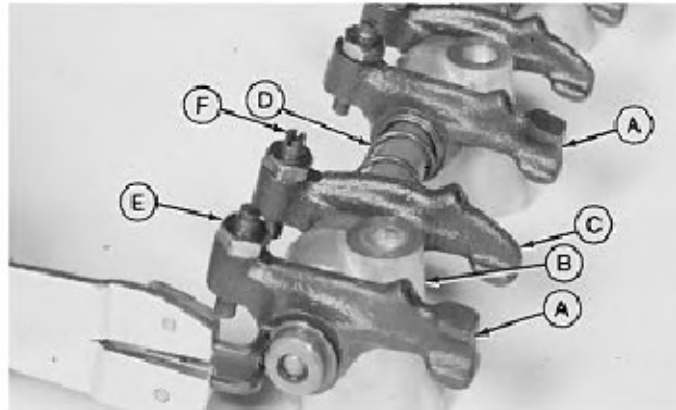
3TN75 Shown

M21, TM310, 14 -19-27JUL87

NOTE: For all engines except 3TN66/3TNA72, go to Step 4.

2. Remove snap ring and parts (A—F).

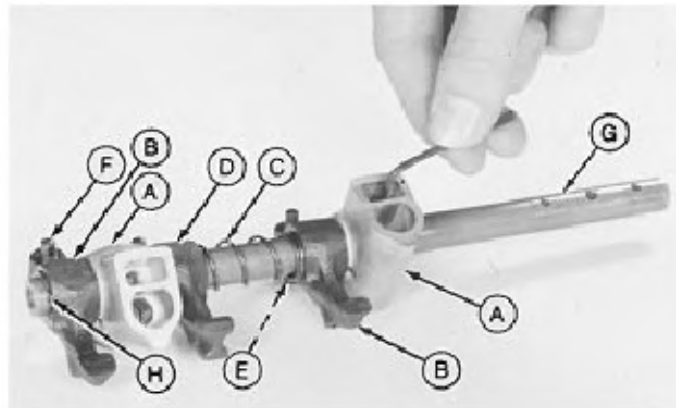
A—Exhaust Rocker Arm
B—Support
C—Intake Rocker Arm
D—Spring
E—Nut
F—Adjusting Screw



M21, TM310, 15 -19-27JUL87

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

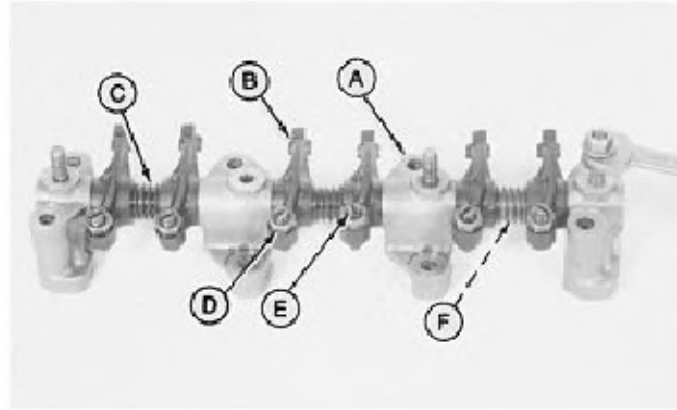


M21, TM310, 16 -19-17FEB88

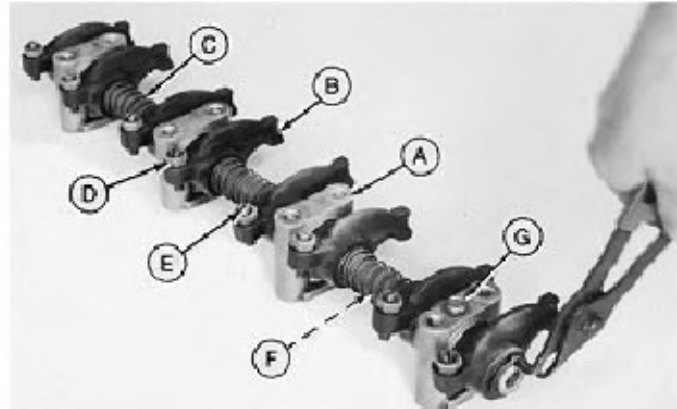
4. Remove three studs using two M8 nuts. Remove parts (A—F).

Remove snap ring and cap screw (G). Remove parts (A—F).

- A—Support
- B—Rocker Arm
- C—Spring
- D—Nut
- E—Adjusting Screw
- F—Rocker Arm Shaft
- G—Cap Screw



All except 3TN66/3TNA72/4TN100



M21,TM310,17 -19-14SEP87

5. Measure shaft at each rocker arm location.

ROCKER ARM SHAFT O.D. SPECIFICATIONS (MIN)

3TN66	9.96 mm (0.392 in.)
3TNA72	11.96 mm (0.471 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	15.96 mm (0.628 in.)
4TN100	18.35 mm (0.722 in.)

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



M21,TM310,18 -19-14SEP87

6. Measure each support.

ROCKER ARM SHAFT SUPPORT I.D. SPECIFICATIONS (MAX)

3TN66	10.09 mm (0.397 in.)
3TNA72	12.09 mm (0.476 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	16.09 mm (0.633 in.)
4TN100	18.60 mm (0.732 in.)

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



M21.TM310.19 -19-28AUG8

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

Arm I.D. (Max)

3TN66	10.09 mm (0.397 in.)
3TNA72	12.09 mm (0.476 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	16.09 mm (0.633 in.)
4TN100	18.60 mm (0.732 in.)

Shaft Clearance (Max)

All except 4TN100	0.13 mm (0.005 in.)
4TN100	0.06 mm (0.002 in.)

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

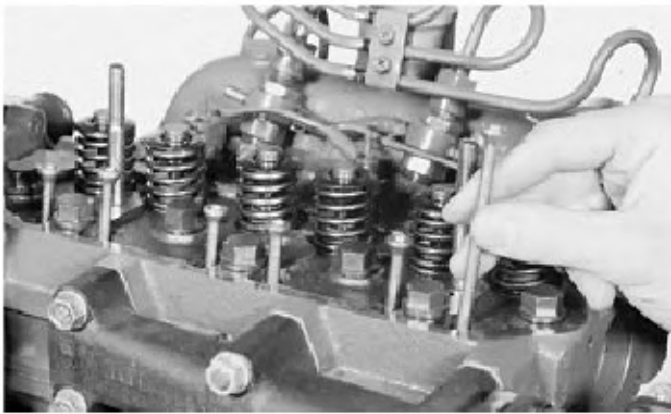
If shaft clearance exceeds wear tolerance, replace rocker arm shaft, rocker arm, or both.



M21.TM310.20 -19-04AUG8

REMOVE AND INSPECT PUSHRODS AND CAM FOLLOWERS

1. Remove pushrods.



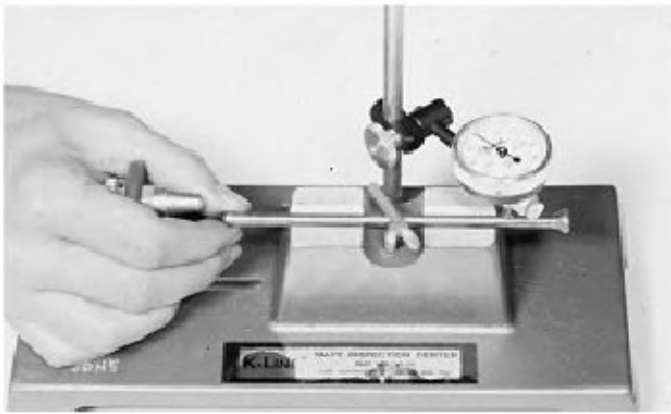
M21,TM310,21 -19-17FEB8

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.



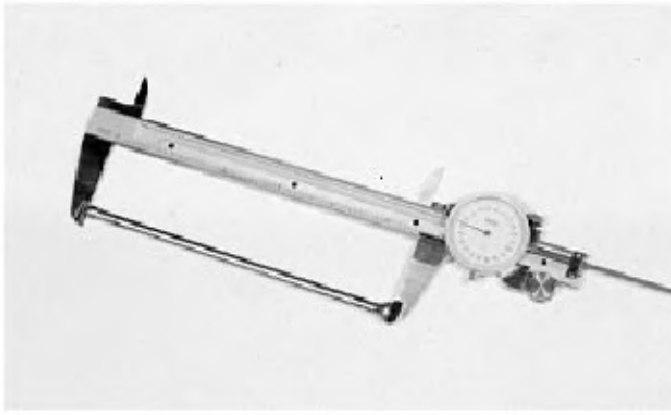
M21,TM310,22 -19-22APR8

3. Measure pushrod length.

PUSHROD LENGTH SPECIFICATIONS (MIN)

3TN66	114.0 mm (4.49 in.)
3TNA72	141.0 mm (5.55 in.)
3TN75/3TN78/4TN78	146.6 mm (5.77 in.)
3TN82/3TN84/ 4TN82/4TN84	178.2 mm (7.02 in.)
4TN100	182.0 mm (7.17 in.)

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



M21,TM310,23 -19-04AUG8

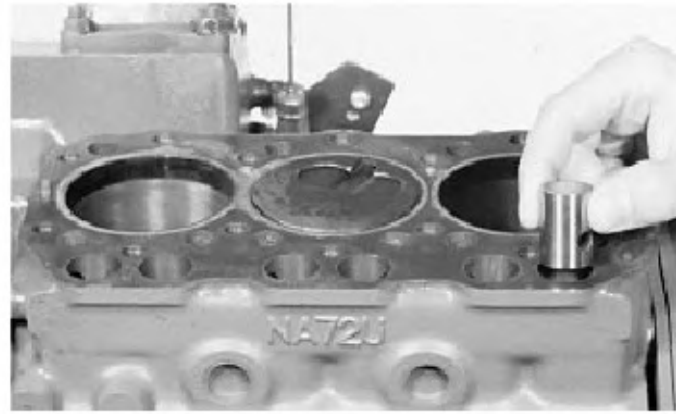
4. For 3TN66 or 3TNA72 engine only, remove cylinder head. (See Group 15 in this manual).

5. For all other engines, remove camshaft and oil pan. (See Group 10 and 40 in this manual.)

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

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

7. Remove cam followers.



3TN75 Shown

M21.TM310.24 -19-04AUG87

8. Measure cam followers outside diameter.

CAM FOLLOWER O.D. SPECIFICATIONS (MIN)

3TN66	17.93 mm (0.706 in.)
3TNA72	20.93 mm (0.824 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	11.93 mm (0.470 in.)
4TN100	14.17 mm (0.558 in.)

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

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



3TN75 Shown

M21.TM310.25 -19-28AUG87

10. 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

Bore I.D. (Max)

3TN66	18.05 mm (0.711 in.)
3TNA72	21.05 mm (0.829 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	12.05 mm (0.474 in.)
4TN100	14.30 mm (0.563 in.)

Clearance (Max)

All except 3TNA72/4TN100	0.10 mm (0.004 in.)
3TNA72	0.15 mm (0.006 in.)
4TN100	0.05 mm (0.002 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.



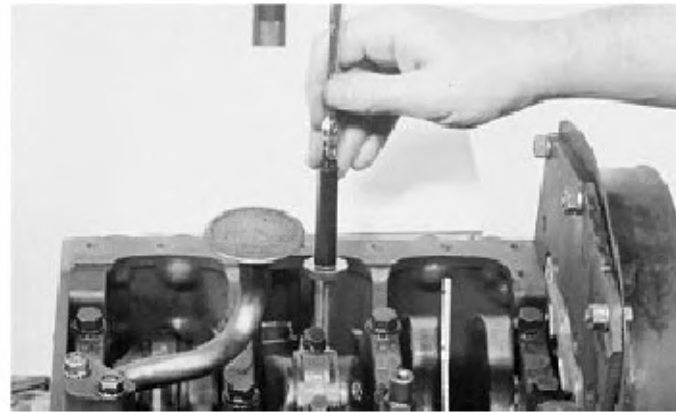
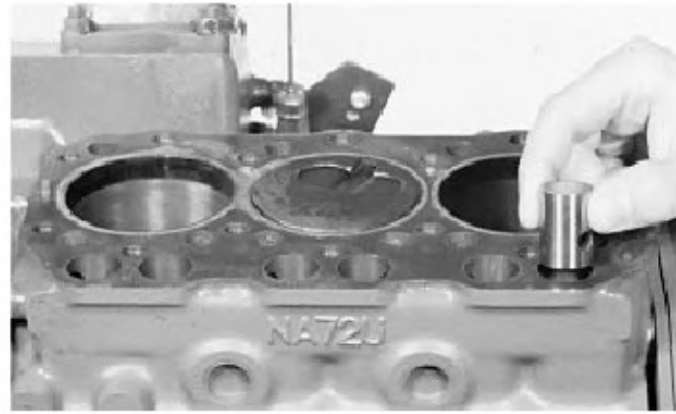
M21,TM310,26 -19-04AUG8

INSTALL PUSH RODS AND CAM FOLLOWERS

1. Put clean engine oil on cam followers.

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

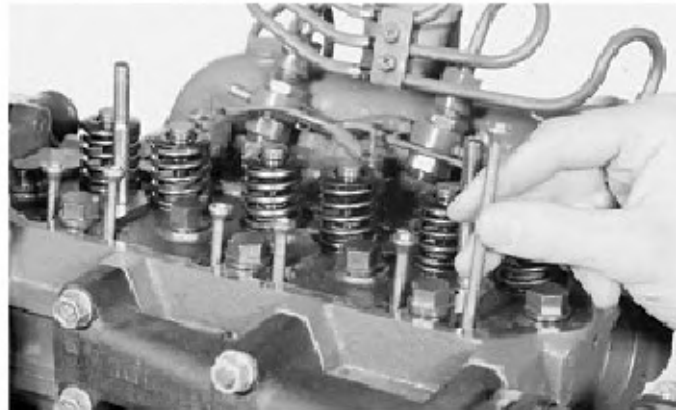
2. Install cam followers.
3. For 3TN66/3TNA72 engines only, install cylinder head. (See Group 15 in this manual.)
4. For all other engines, install camshaft and oil pan. (See Groups 10 and 40 in this manual.)



3TN75 Shown

M21,TM310,27 -19-28AUG87

5. Install the pushrods.



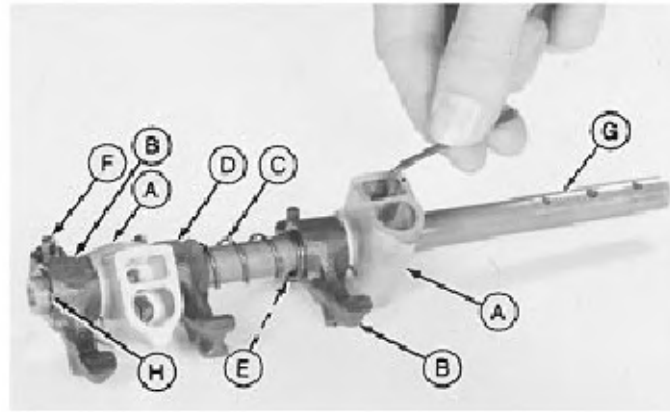
M21,TM310,28 -19-17FEB88

ASSEMBLE AND INSTALL ROCKER ARM ASSEMBLY

NOTE: For all engines except 3TN66/3TNA72, go to step 5.

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.

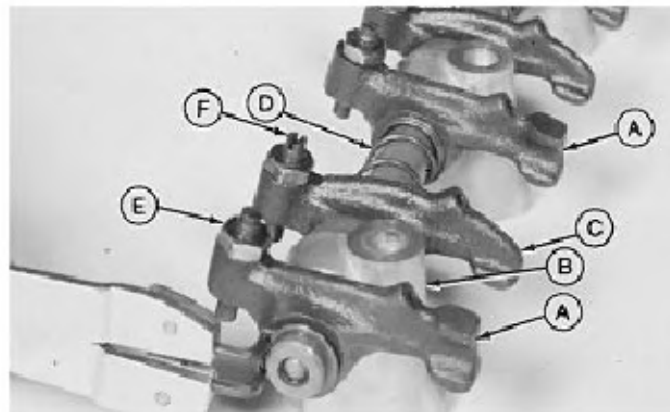
A—Support
B—Intake Rocker Arm
C—Spring
D—Exhaust Rocker Arm
E—Nut
F—Adjusting Screw
G—Rocker Arm Shaft
H—Snap Ring



M21,TM310,29 -19-08AUG8

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

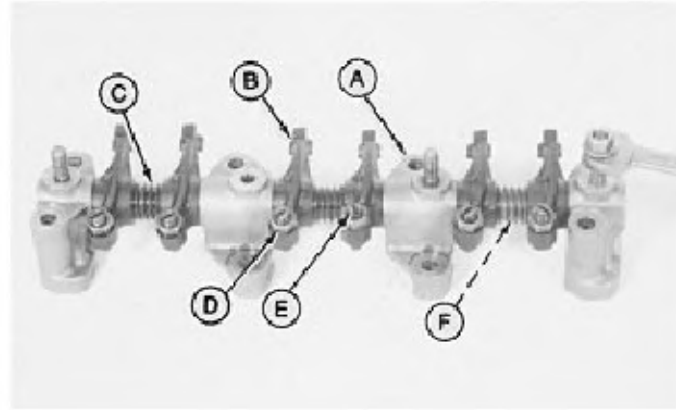


M21,TM310,30 -19-17FEB8

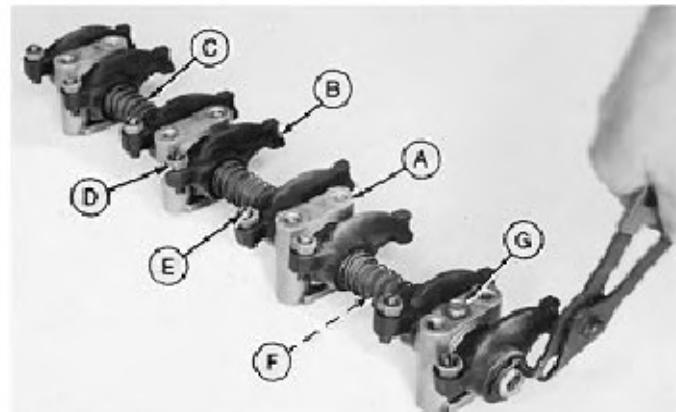
5. Install parts (A—F) on rocker arm shaft. Install and tighten three studs using two M8 nuts.

Align hole in last support with hole in rocker arm shaft. Install and tighten cap screw (G). Install snap ring.

- A—Support
- B—Rocker Arm
- C—Spring
- D—Nut
- E—Adjusting Screw
- F—Rocker Arm Shaft
- G—Cap Screw



All except 3TN66/3TNA72/4TN100



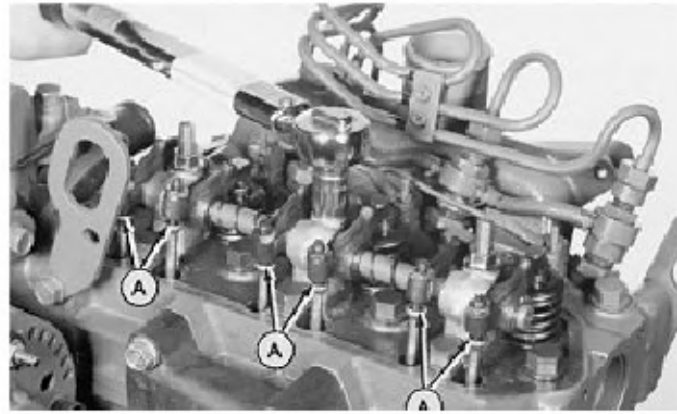
4TN100

M21,TM310,31 -19-28AUG87

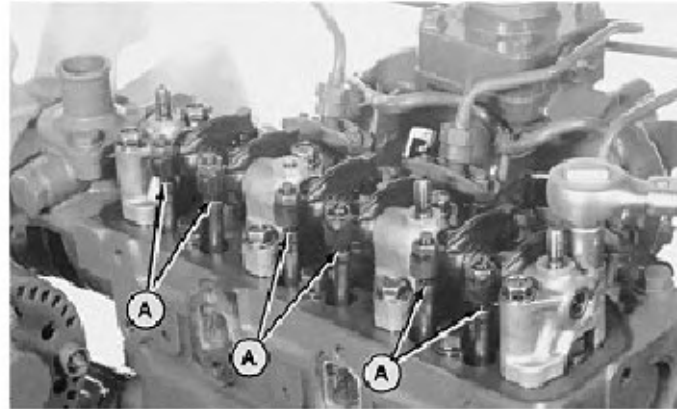
7. Install rocker arm assembly. Be sure adjusting screws (A) are in push rod sockets.

8. Install and tighten two nuts and cap screw to 26 N·m (226 lb-in.).

Install and tighten eight cap screws to 26 N·m (226 lb-in.).



All except 3TN66/3TNA72



M21,TM310,32 -19-28AUG87

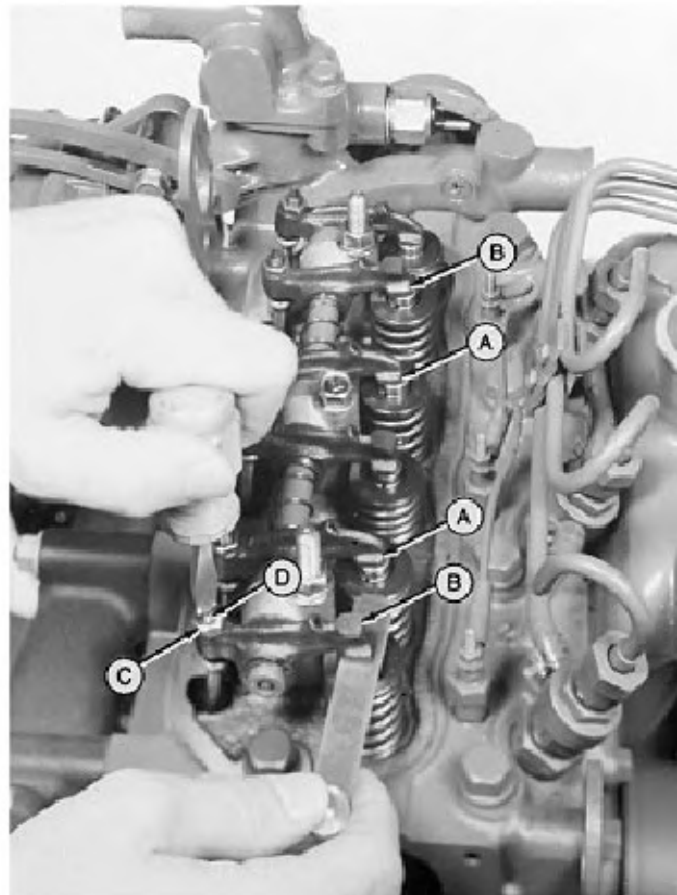
9. Measure valve clearance. (See Measure and Adjust Valve Clearance in this section.)

VALVE CLEARANCE SPECIFICATIONS

All Except 4TN100
 Intake Valves (A) 0.20 mm (0.008 in.)
 Exhaust Valves (B) 0.20 mm (0.008 in.)

4TN100
 Intake Valves (A) 0.30 mm (0.012 in.)
 Exhaust Valves (B) 0.30 mm (0.012 in.)

A—Intake Valve
B—Exhaust Valve
C—Nut
D—Adjusting Screw



M21,TM310,33 -19-17FEB88

ASSEMBLE AND INSTALL ROCKER ARM COVER

1. Install a new gasket on baffle.

Install a new O-ring (B) in crankcase breather cover.

Install packing (A) and screen.



3TN75 Shown

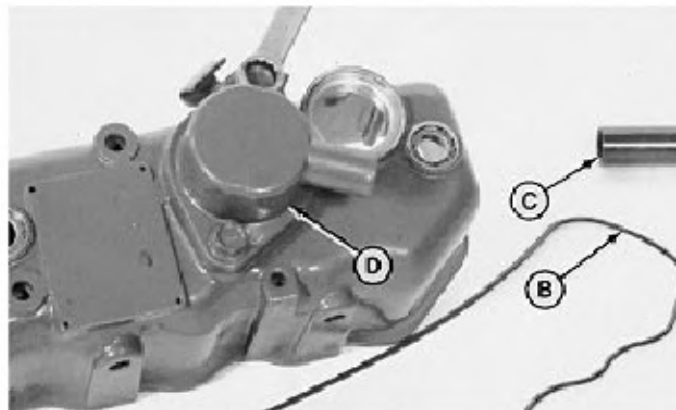
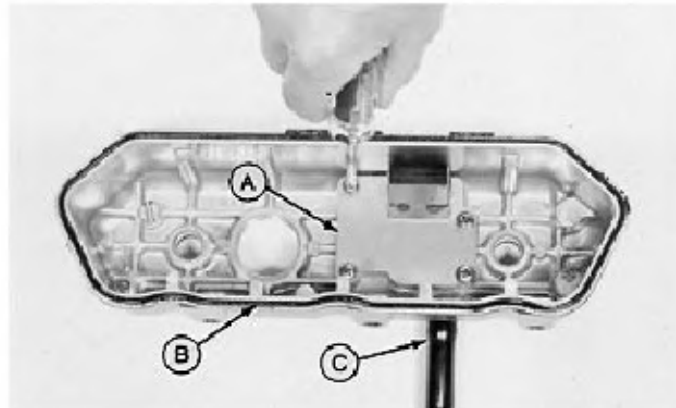
M21,TM310,34 -19-04AUG8

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

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

Install crankcase breather cover (D) and fasten with two cap screws.

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



3TN75 Shown

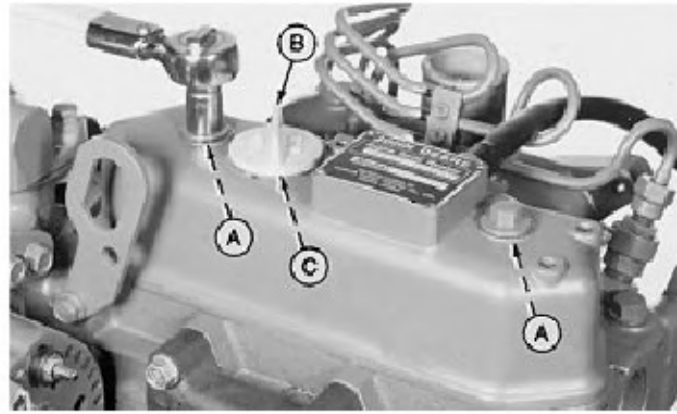
M21,TM310,35 -19-04AUG8

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. For all engines except 4TN100, install special nuts and tighten to specification.

For 4TN100 engine, install cap screws and tighten to specification.

TORQUE SPECIFICATIONS

All except 4TN100	18 N·m (160 lb-in.)
4TN100	26 N·m (226 lb-in.)



M21.TM310.36 -19-28AUG87

REMOVE CAMSHAFT

1. Remove engine. (See Machine Technical Manual.)
2. Remove fan, if equipped, alternator belt, and alternator.
3. Remove rocker arm cover, rocker arm assembly, and pushrods. (See Group 10 in this manual.)
4. Remove timing gear cover. (See Group 35 in this manual.)



M21.TM310.37A -19-04AUG87

5. Measure camshaft end play. If end play exceeds specifications, replace camshaft thrust plate.

CAMSHAFT END PLAY SPECIFICATIONS (MAX)

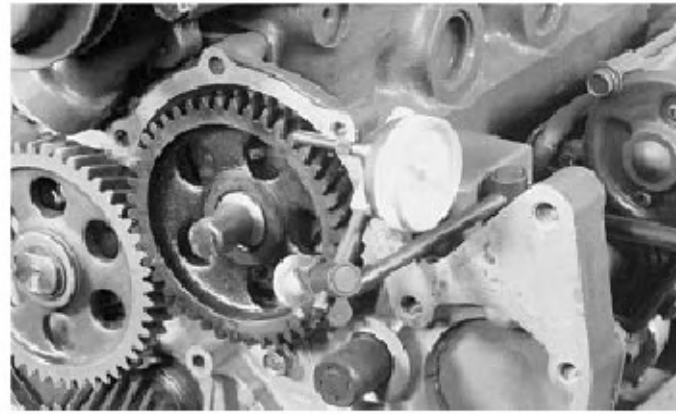
All except 4TN100	0.40 mm (0.016 in.)
4TN100	0.29 mm (0.011 in.)



M21.TM310.43A -19-05AUG87

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.)



M21.TM310.44A -19-05AUG87

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 JT01783.



M21.TM310.45A -19-05AUG87

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.



M21.TM310.46A -19-05AUG87

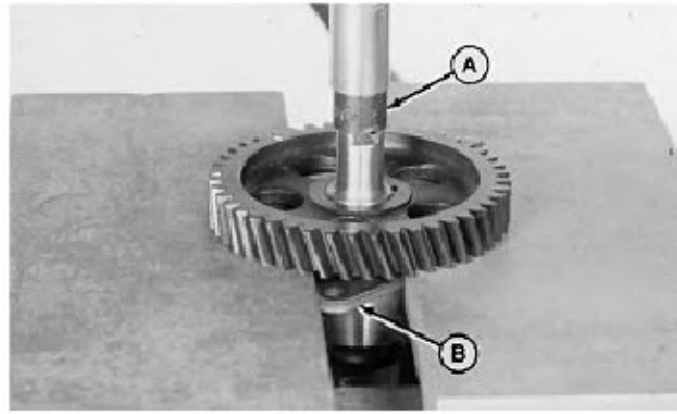
DISASSEMBLE AND INSPECT CAMSHAFT

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).



M21,TM310,47 -19-18FEB8

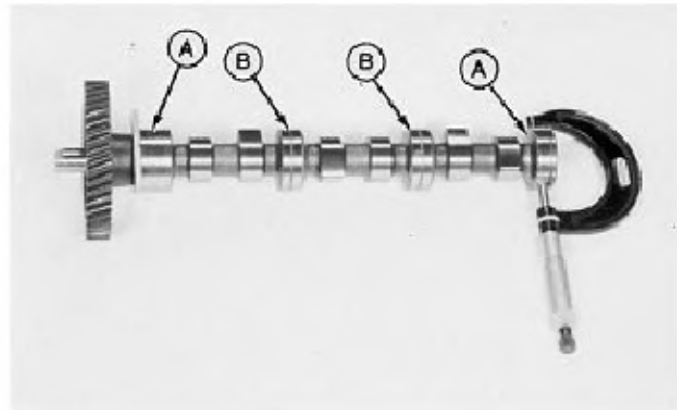
4. Measure camshaft end journal diameter (A), and intermediate journal diameter (B).

NOTE: For some engines, the camshaft has only one intermediate journal.

CAMSHAFT END AND INTERMEDIATE JOURNAL O.D.**SPECIFICATIONS (MIN)**

3TN66	35.85 mm (1.411 in.)
3TNA72	39.85 mm (1.569 in.)
3TNA72 (Flywheel End)	40.1 (1.579 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	44.80 mm (1.764 in.)
4TN100	56.80 mm (2.236 in.)

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



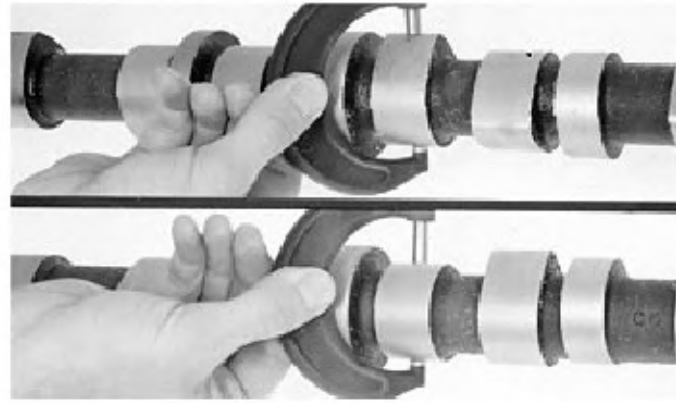
M21,TM310,48 -19-28AUG8

5. Measure camshaft lobe height.

CAMSHAFT LOBE HEIGHT SPECIFICATIONS (MIN)

3TN66	29.75 mm (1.171 in.)
3TNA72	33.75 mm (1.329 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	38.40 mm (1.512 in.)
4TN100	46.10 mm (1.815 in.)

If height is less than wear tolerance, replace camshaft.



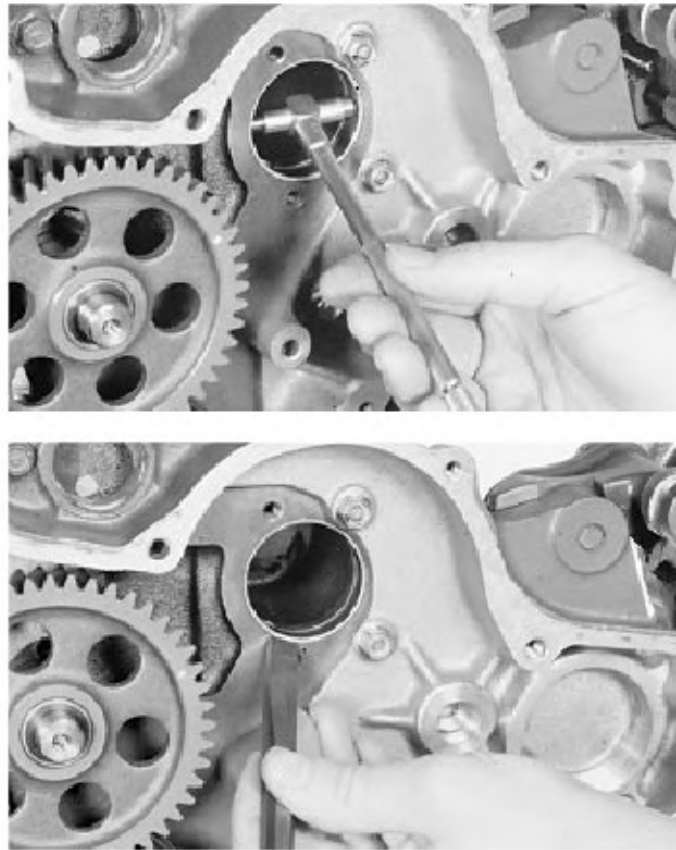
M21.TM310.49 -19-28AUG87

6. Measure gear housing side camshaft bushing diameter.

CAMSHAFT BUSHING I.D. SPECIFICATIONS (MAX)

3TN66	36.10 mm (1.421 in.)
3TNA72	40.10 mm (1.579 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	45.10 mm (1.776 in.)
4TN100	57.10 mm (2.248 in.)

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



M21.TM310.50 -19-28AUG87

7. Measure camshaft intermediate bore diameter.

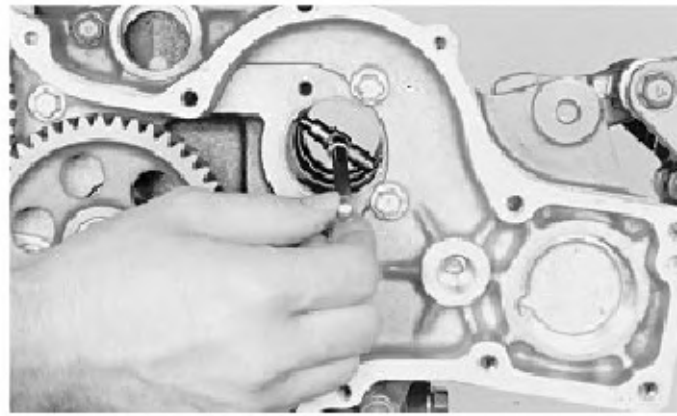
CAMSHAFT BORE I.D. SPECIFICATIONS (MAX)

3TN66	36.10 mm (1.421 in.)
3TNA72	40.10 mm (1.579 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	45.10 mm (1.776 in.)
4TN100	57.10 mm (2.248 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.)



M21,TM310,64 -19-28AUG87

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



M21,TM310,51 -19-18FEB88

NOTE: Some engines do not have an intermediate journal on the flywheel side.

c. Measure intermediate and flywheel side camshaft bore diameters.

CAMSHAFT BORE I.D. SPECIFICATIONS (MAX)

3TN66	36.10 mm (1.421 in.)
3TNA72	40.10 mm (1.579 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	45.10 mm (1.776 in.)
4TN100	57.10 mm (2.248 in.)

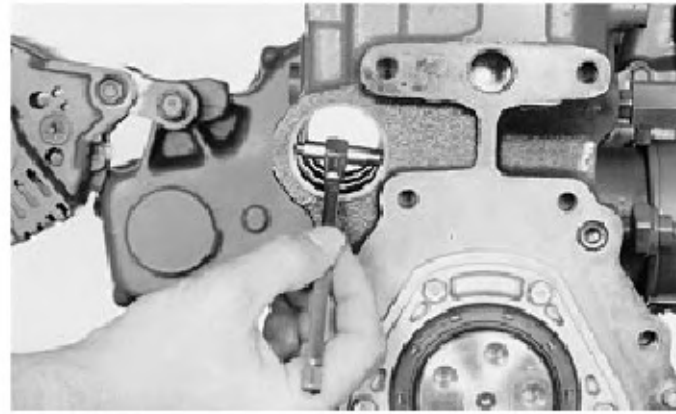
d. Determine camshaft journal clearance (bushing, or bore diameter minus journal diameter).

CAMSHAFT JOURNAL CLEARANCE SPECIFICATIONS (MAX)

All except 4TN100	0.18 mm (0.007 in.)
4TN100	
Gearcase End	0.14 mm (0.006 in.)
Intermediate and Flywheel End Clearance	0.12 mm (0.005 in.)

If diameter exceeds wear tolerance, replace cylinder block.

If clearance exceeds wear tolerance replace camshaft, cylinder block, or both.



M21,TM310,52 -19-28AUG8

ASSEMBLE CAMSHAFT

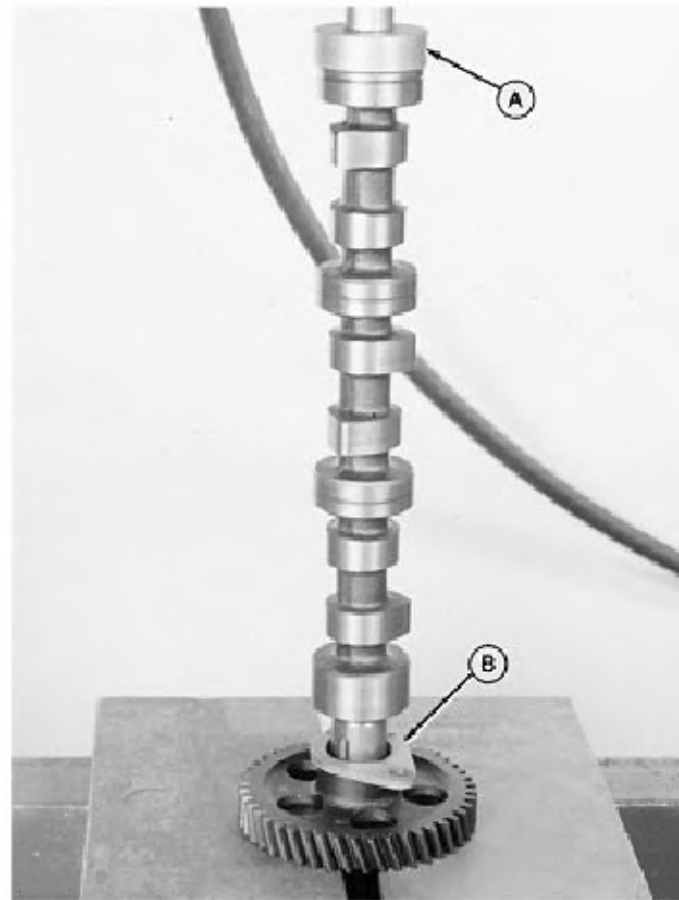
- ⚠ CAUTION: DO NOT** heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.



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.



M21.TM310.53 -19-28AUG8

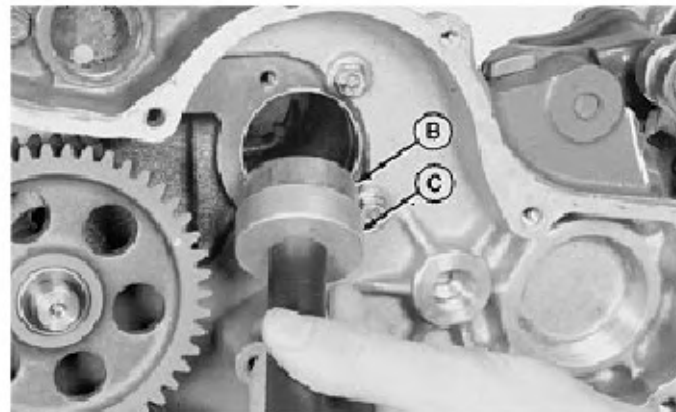
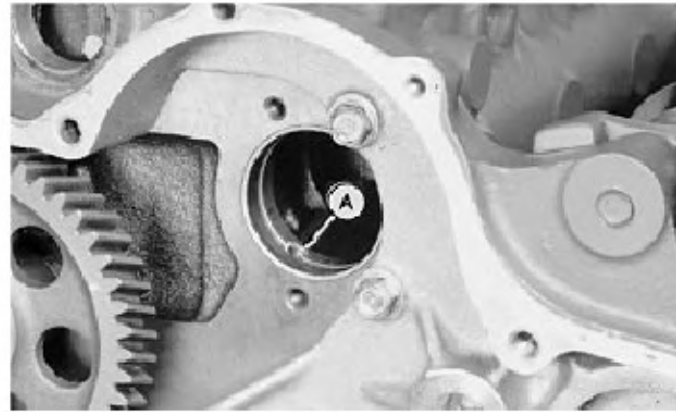
INSTALL CAMSHAFT

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.



M21.TM310.54 -19-19FEB8

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).

**DISK DIAMETERS**

Engine	Size (in.)	
	(B)	(C)
3TN66	1 7/16	1 1/2
3TNA72	1 9/16	1 11/16
3TN75/3TN78/3TN82/ 3TN84/4TN78/ 4TN82/4TN84	1 3/4	1 7/8
4TN100	2 1/4	2 3/8

M21,TM310,55 -19-28AUG87

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 idler gear (B).

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

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

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

Install washer and snap ring.

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

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

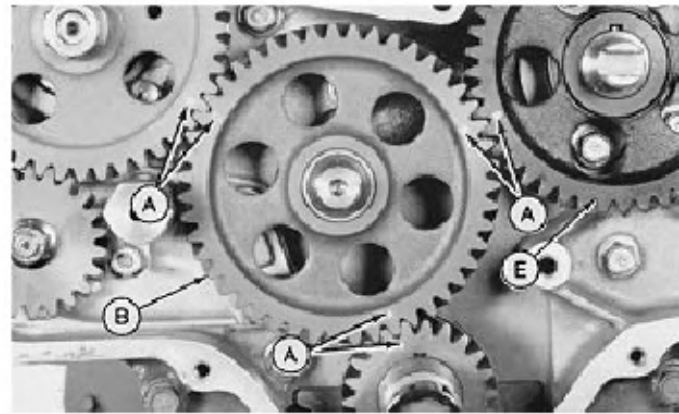
Install washer and snap ring.

Remove two cap screws (F) to remove idler gear shaft (G) and idler gear (B).

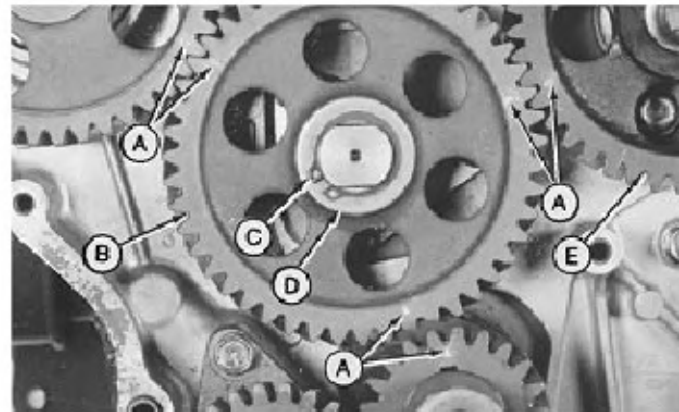
Carefully install camshaft (E). Align timing marks (A) and install idler gear.

Install idler gear shaft. Install and tighten two cap screws to 26 N·m (226 lb-in.)

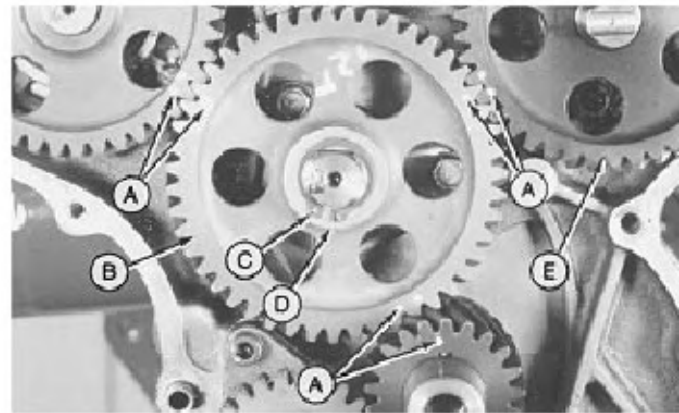
A—Timing Marks
B—Idler Gear
C—Snap Ring
D—Washer
E—Camshaft
F—Cap Screws
G—Idler Gear Shaft



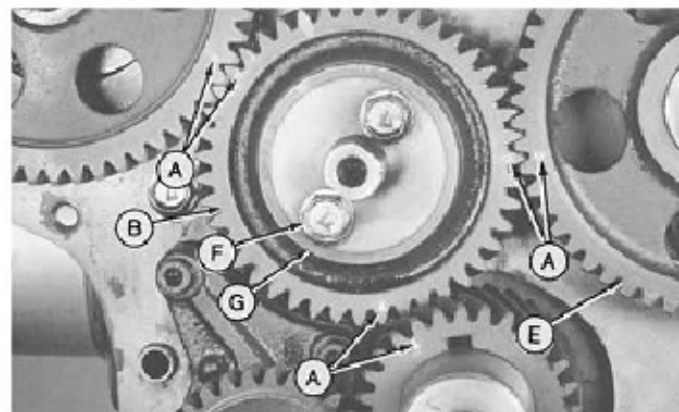
3TNA72 (Early Units)



3TNA72



3TN66



All except 3TN66/3TNA72

9. Install and tighten two cap screws to specifications.

CAMSHAFT CAP SCREW TORQUE SPECIFICATIONS

3TN66/3TNA72 11 N·m (96 lb-in.)

All except 3TN66/3TNA72 26 N·m (226 lb-in.)

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

11. Install push rods, rocker arm assembly, and rocker arm cover. (See Group 10 in this manual.)



M21.TM310.57A -19-28AUG87

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
D-20018WI	Valve Guide Knurler	To knurl valve guides on 3TNA72/3TN75 engines
D-20019WI	Valve Guide Knurler	To knurl valve guides on 3TN82/3TN84/4TN82/4TN84 engines
D-20020WI	Valve Guide Reamer	To ream valve guides on 3TNA72/3TN75 engines
D-20021WI	Valve Guide Reamer	To ream valve guides on 3TN82/3TN84/4TN82/4TN84 engines
JDE-118	Valve Guide Driver	Remove and install valve guide on 3TNA72/3TN75/3TN82/3TN84/4TN82/4TN84 engines
JDG-504	Valve Guide Driver	Remove and install valve guides on 3TN66 engines
	9 mm Knurler	To knurl valve guides on 4TN100 engine
	9 mm Reamer	To ream valve guides on 4TN100 engine

M21,TM315,1 -19-05AUG87

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 -19-22APR88

SERVICE PART KITS

The following kits are available through your parts catalog:

Cylinder Head Gasket Kit

M21,TM315.3 -19-19FEB88

REMOVE, REPAIR, AND INSTALL EXHAUST MANIFOLD

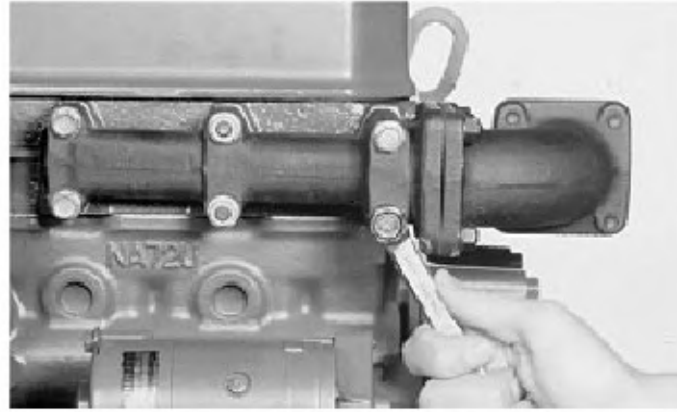
1. Remove four nuts to remove exhaust pipe or muffler and gasket (A).



M21,TM315.6 -19-19FEB88

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

2. Remove cap screws, nuts, and exhaust manifold.
3. Remove gasket material.
4. Inspect manifold and gasket for cracks and holes. Replace or repair as necessary.

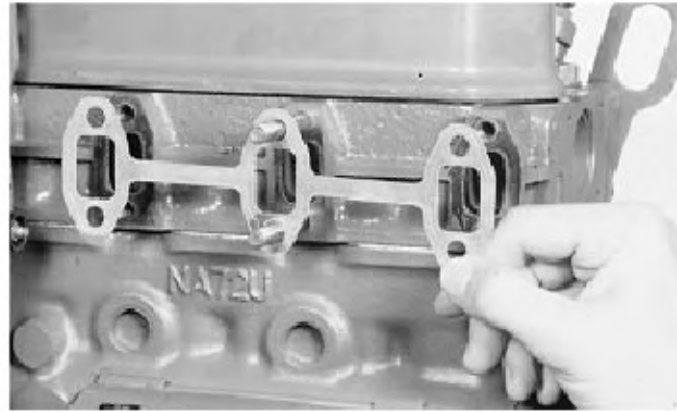


M21,TM315.7 -19-19FEB88

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

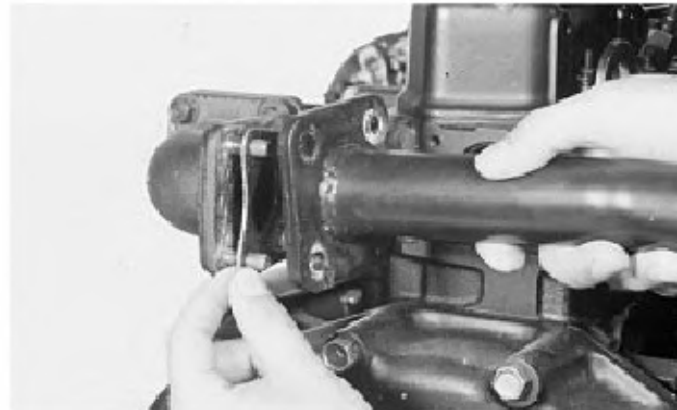
EXHAUST MANIFOLD CAP SCREW AND NUT TORQUE SPECIFICATIONS

3TN66	11 N·m (96 lb-in.)
All except 3TN66	26 N·m (226 lb-in.)



M21,TM315.8 -19-05AUG88

6. Install a new gasket (A).
7. Fasten exhaust pipe or muffler with four nuts. Tighten nuts.
8. Start engine and check exhaust system for leaks. After engine is at normal operating temperature, retighten exhaust manifold cap screws and nuts to specifications.

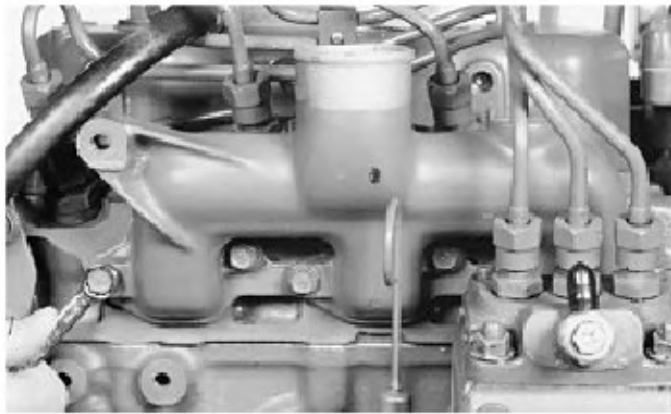


M21,TM315.9 -19-22APR88

REMOVE, REPAIR, AND INSTALL INTAKE MANIFOLD

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

1. Remove cap screws and intake manifold.
2. Remove gasket material.
3. Inspect manifold for cracks and holes. Replace or repair as necessary.

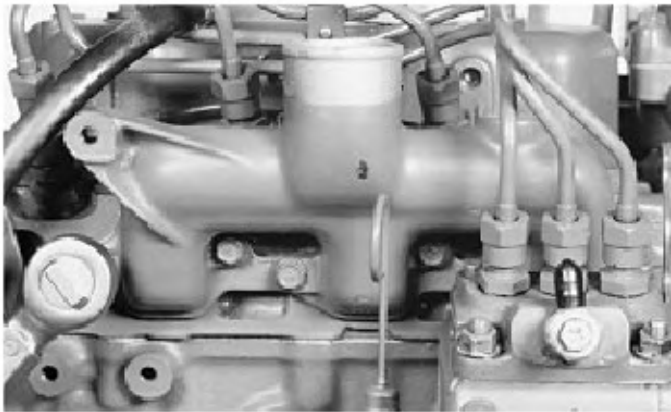
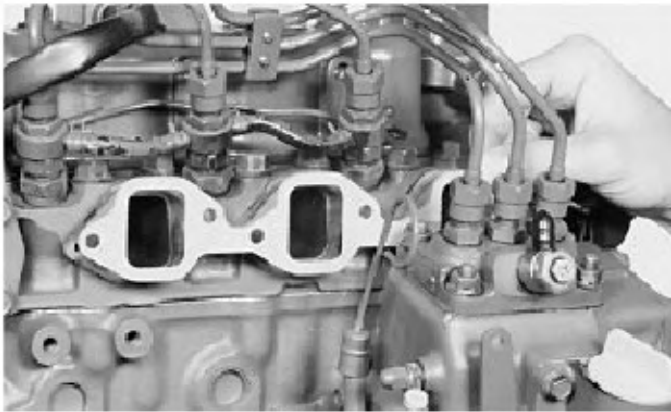


M21,TM315,10 -19-19FEB8

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

INTAKE MANIFOLD CAP SCREW TORQUE SPECIFICATIONS

3TN66/3TNA72	11 N·m (96 lb-in.)
All except 3TN66/3TNA72	26 N·m (226 lb-in.)



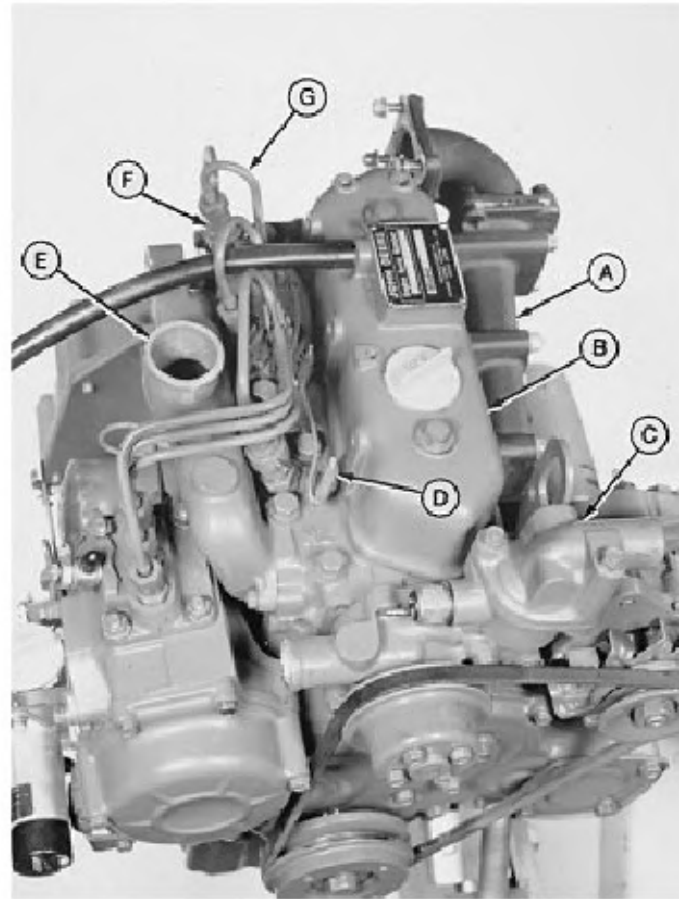
M21,TM315,11 -19-05AUG8

REMOVE CYLINDER HEAD

NOTE: Cylinder head can be removed with engine in the tractor. If cylinder head is removed for valve service only, do not remove parts (A, D, E, and F).

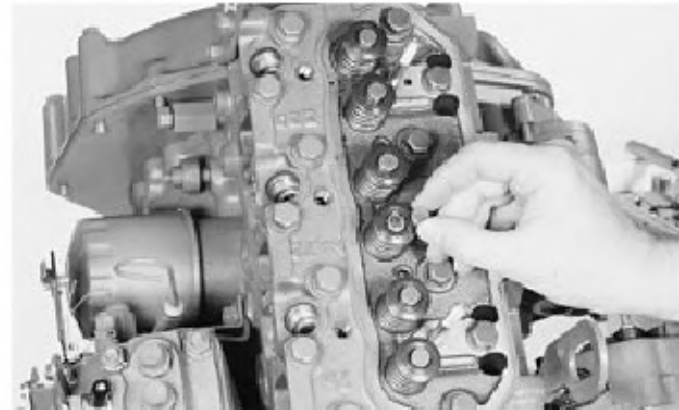
1. Remove manifold (A). (See Group 15 in this manual.)
2. Remove pump (C). (See Group 45 in this manual.)
3. Remove lines (G) and nozzles (F). (See Group 50 in this manual.)
4. Remove glow plugs (D), if equipped.
5. Remove manifold (E). (See Group 15 in this manual.)
6. Remove cover (B), rocker arm assembly, and pushrods. (See Group 10 in this manual.)

A—Exhaust Manifold	E—Intake Manifold
B—Rocker Arm Cover	F—Fuel Injection
C—Water Pump	Nozzles
D—Glow Plugs	G—Fuel Injection Lines



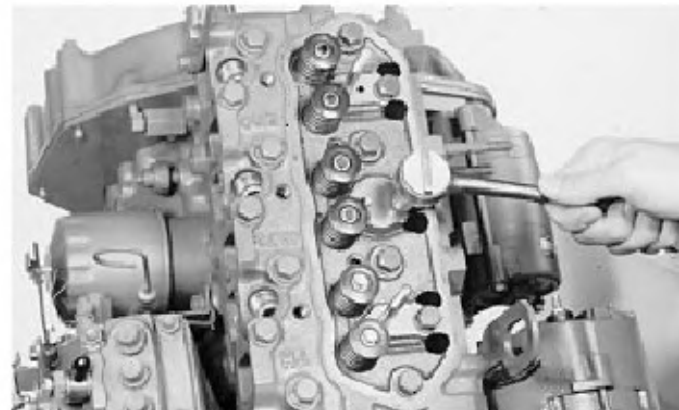
M21,TM315,12 -19-05AUG87

7. Remove valve caps, if equipped.



M21,TM315,13 -19-19FEB88

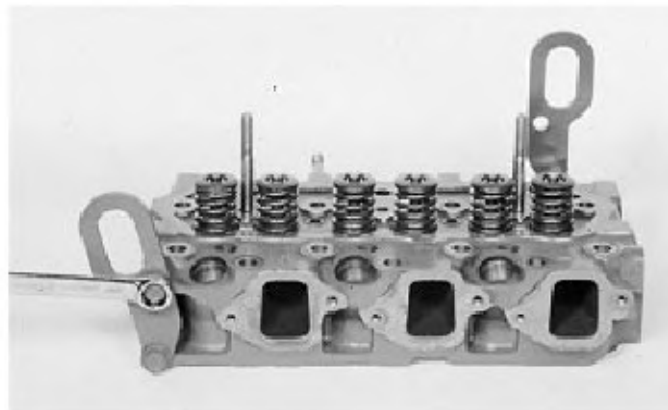
8. Remove cap screws to remove cylinder head and gasket.



M21,TM315,14 -19-19FEB88

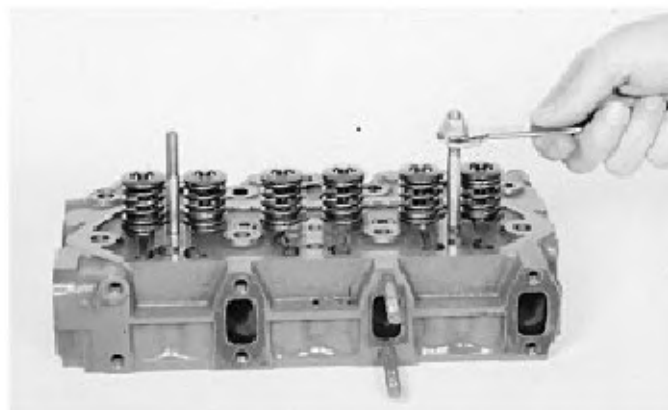
DISASSEMBLE CYLINDER HEAD

1. Remove two lifting brackets.



M21.TM315.15 -19-05AUG87

2. If equipped, remove studs using exhaust manifold nuts.

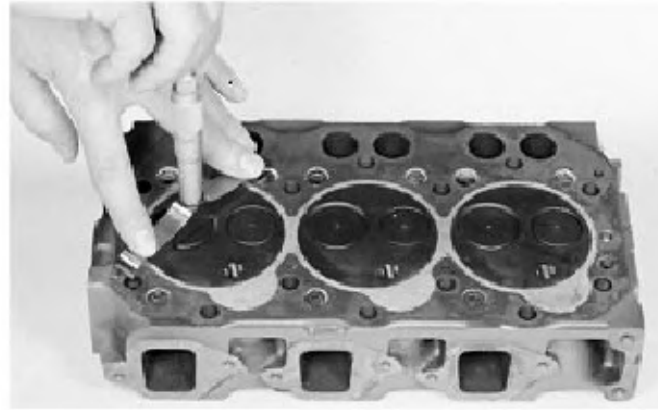


M21.TM315.16 -19-05AUG87

3. Measure valve recession.

VALVE RECESSION SPECIFICATIONS

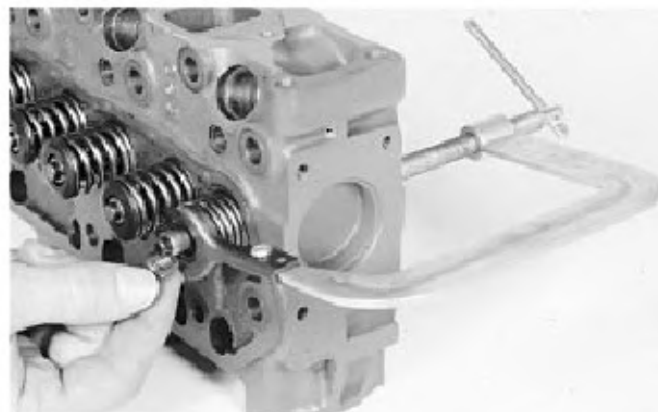
Intake	Standard	Wear Tolerance (MAX)
3TN66	0.40 mm (0.016 in.)	
3TNA72	0.50 mm (0.020 in.)	
3TN75/3TN78/ 3TN82/3TN84/ 4TN78/4TN82/ 4TN84	0.30—0.50 mm (0.012—0.020 in.)	1.00 mm (0.039 in.)
4TN100	1.80 mm (0.071 in.)	
Exhaust	Standard	Wear Tolerance (MAX)
3TN66	0.85 mm (0.033 in.)	
3TNA72	0.85 mm (0.033 in.)	
3TN75/3TN78/ 3TN82/3TN84/ 4TN78/4TN82/ 4TN84	0.30—0.50 mm (0.012—0.020 in.)	1.00 mm (0.039 in.)
4TN100	1.80 mm (0.071 in.)	



M21,TM315,17 -19-28AUG87

4. Compress valve springs using a valve spring compressor. Remove retainers. 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.



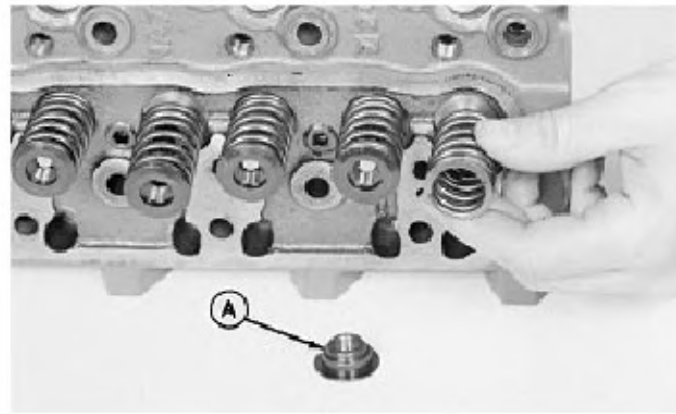
M21,TM315,18 -19-19FEB88

5. Remove spring retainers (A) and springs.

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 (MAX)
3TN66	Free length (approx)	27.5 mm (1.083 in.)
	Test length at 125 N (28 lb) Force	17 mm (0.591 in.)
3TNA72	Free length (approx)	36.9 mm (1.453 in.)
	Test length at 299 N (67 lb) Force	22.5 mm (0.886 in.)
3TN75/ 3TN78/ 4TN78	Free length (approx)	41.5 mm (1.634 in.)
	Test length at 313 N (70 lb) Force	25.2 mm (0.992 in.)
3TN82/3TN84/ 4TN82/4TN84	Free length (approx)	41.5 mm (1.634 in.)
	Test length at 319 N (72 lb) Force	24 mm (0.945 in.)
4TN100	Free length (approx.)	42.5 mm (1.673 in.)
	Test length at 12.8 N (5.7 lb) Force	41.5 mm (1.634 in.)



M21,TM315,19 -19-28AUG87

7. Remove intake and exhaust valves.



M21,TM315,20 -19-19FEB88

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.



M21,TM315,21 -19-19FEB88

12. Measure valve stem diameter.

VALVE STEM O.D. SPECIFICATIONS (MIN)

3TN66	5.40 mm (0.213 in.)
3TNA72/3TN75/3TN78/4TN78	6.90 mm (0.272 in.)
3TN82/4TN82/4TN84	7.90 mm (0.311 in.)
4TN100	8.90 mm (0.350 in.)

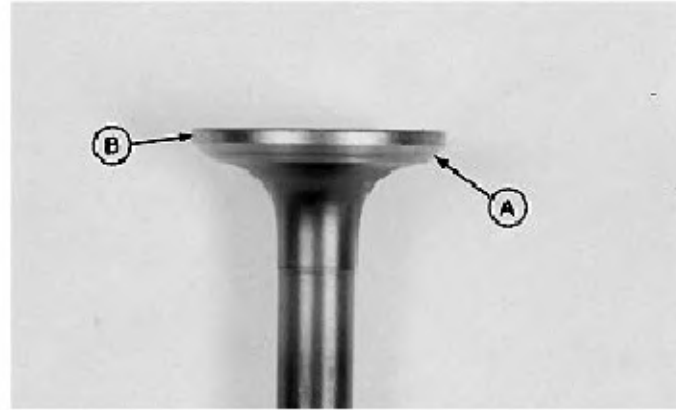


M21,TM315,22 -19-28AUG87

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

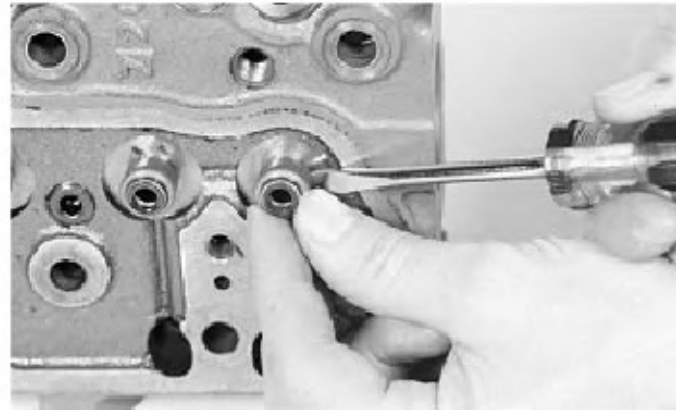
Exhaust Valve	45°
Intake Valve	30°



M21,TM315,23 -19-22APR8

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

14. If necessary, remove valve stem seal and discard.



M21,TM315,24 -19-22APR8

15. Clean valve guides using a valve guide brush.



M21,TM315,25 -19-19FEB8

16. Measure valve guide diameter.

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

VALVE GUIDE SPECIFICATIONS

Guide I.D. (MAX)	
3TN66	5.58 mm (0.220 in.)
3TNA72/3TN75/3TN78/4TN78	7.08 mm (0.279 in.)
3TN82/3TN84/	
4TN82/4TN84	8.10 mm (0.319 in.)
4TN100	9.10 mm (0.358 in.)

Clearance (MAX)	
All Engines	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.



M21,TM315,26 -19-05AUG87

18. Knurl valve guide using a valve guide knurler. Follow tool manufacture's instructions.

VALVE GUIDE KNURLERS

Engine	Number	Item
3TN72/	D-20018WI	Knurler
3TN75/3TN78/		
4TN78	D-20020WI	Reamer
3TN82/3TN84/	D-20019WI	Knurler
4TN82/4TN84	D-20021WI	Reamer
4TN100	9 mm	Knurler
	9 mm	Reamer



M21,TM315,27 -19-28AUG87

19. If necessary, remove valve guides using JDE-118 or JDG-504 (3TN66UJ Engine only) Valve Guide Driver.



M21,TM315,28 -19-20FEB88

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

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

22. Measure valve seat width.



VALVE SEAT WIDTH SPECIFICATIONS

Engine	Valve	Nominal	Wear Limit (MAX)
3TN66	Intake	1.15 mm (0.045 in.)	1.65 mm (0.065 in.)
	Exhaust	1.41 mm (0.056 in.)	1.91 mm (0.075 in.)
3TNA72/ 3TN75/3TN78/ 4TN78	Intake	1.44 mm (0.057 in.)	1.98 mm (0.078 in.)
	Exhaust	1.77 mm (0.070 in.)	2.27 mm (0.089 in.)
3TN82/	Intake	1.16 mm (0.046 in.)	1.74 mm (0.069 in.)
3TN84/ 4TN82/4TN84	Exhaust	1.35 mm (0.053 in.)	1.94 mm (0.076 in.)
4TN100	Intake	1.47 mm (0.058 in.)	2.12 mm (0.084 in.)
	Exhaust	2.01 mm (0.079 in.)	2.73 mm (0.108 in.)

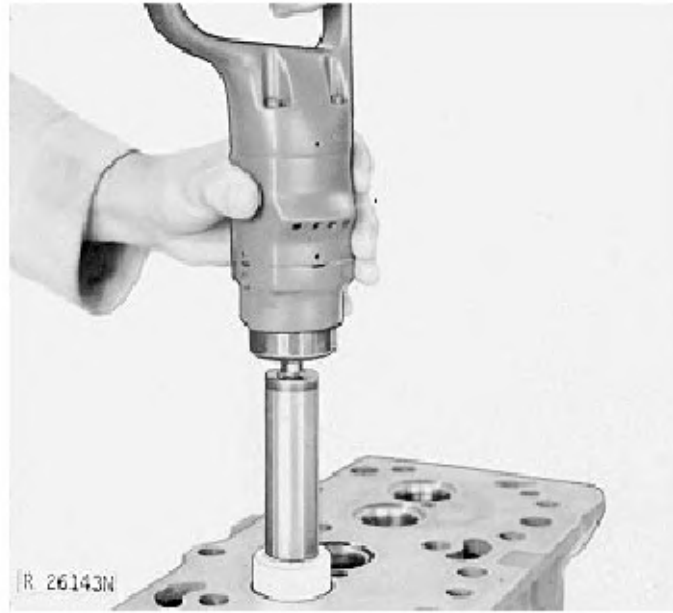
If necessary, grind valve seats to recondition or to meet specifications.

M21,TM315,29 -19-28AUG87

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.



M21, TM315,30 -19-22APR8

24. Measure valve seat width after grinding.

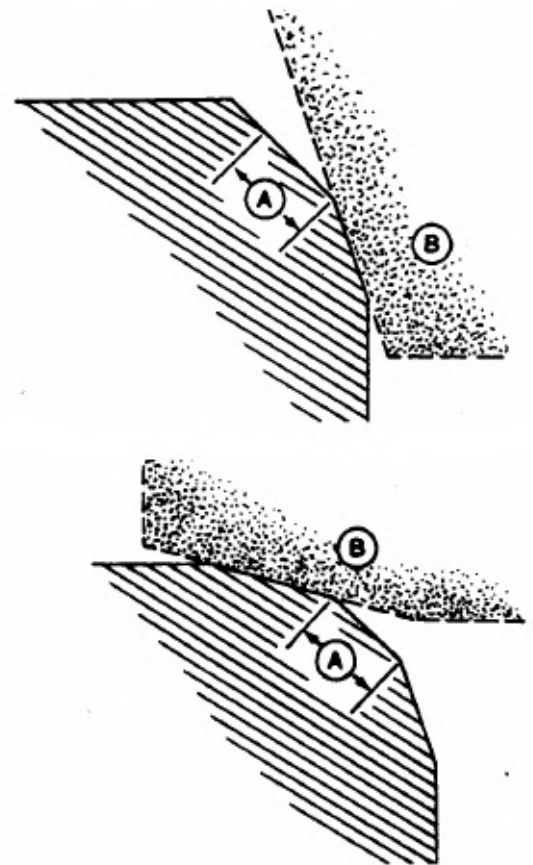
25. If seat is too wide after grinding, grind lower seat surface using a 70° seat grinder (B) until seat width (A) is close to specifications.

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.



M21, TM315,31 -19-22APR8

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.

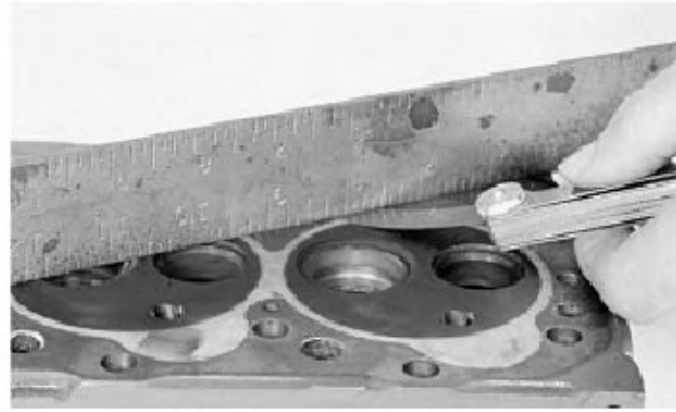
CYLINDER HEAD FLATNESS SPECIFICATIONS (MAX)

All except 4TN100 0.15 mm (0.006 in.)

4TN100 0.05 mm (0.002 in.)

If cylinder head distortion exceeds specification, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat; but do not remove more than 0.20 mm (0.008 in.).

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



M21,TM315,32 -19-28AUG87

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 JDE-118 or JDG-504 (3TN66 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 HEIGHT SPECIFICATIONS

3TN66 7.00 mm (0.276 in.)

3TNA72 9.00 mm (0.354 in.)

3TN75/3TN78/4TN78 12.00 mm (0.472 in.)

3TN82/3TN84/
4TN82/4TN84 15.00 mm (0.591 in.)

4TN100 11.50 mm (0.453 in.)



M21,TM315,33 -19-29AUG87

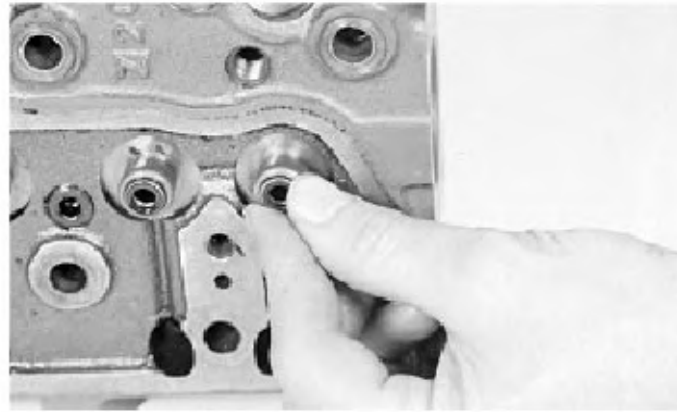
3. Measure new valve guide diameter.
4. If necessary, ream inside diameter of valve guides to specifications using a valve guide reamer.



M21,TM315,34 -19-20FEB88

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

5. Install new valve stem seals.



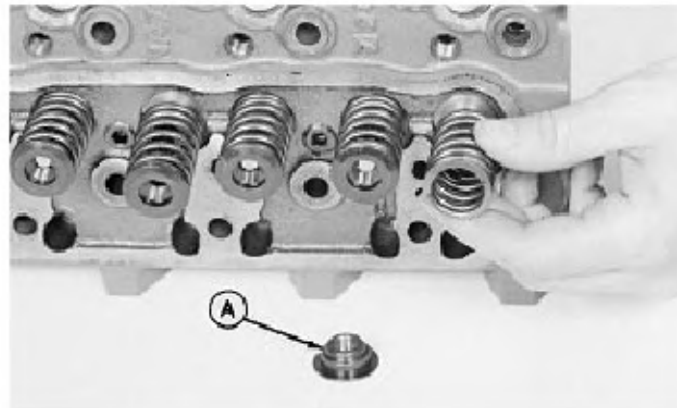
M21,TM315,35 -19-20FEB88

6. Put clean engine oil on valve stems.
 7. Install intake and exhaust valves
- If new valves are installed, measure valve recession.
Grind valve seats as required.



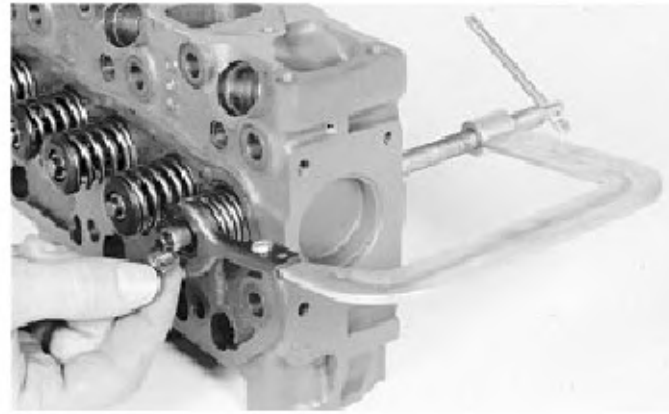
M21,TM315,36 -19-20FEB88

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



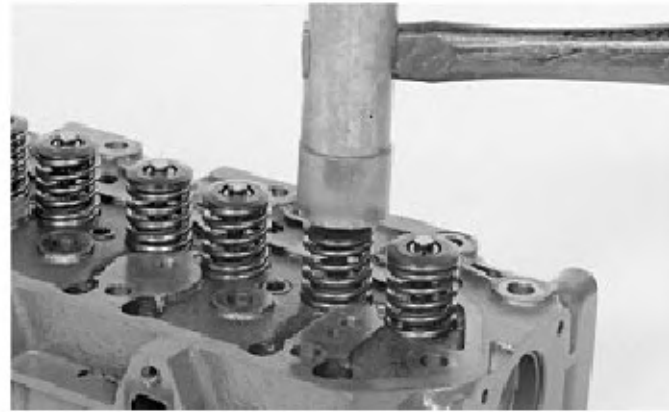
M21,TM315,37 -19-20FEB88

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



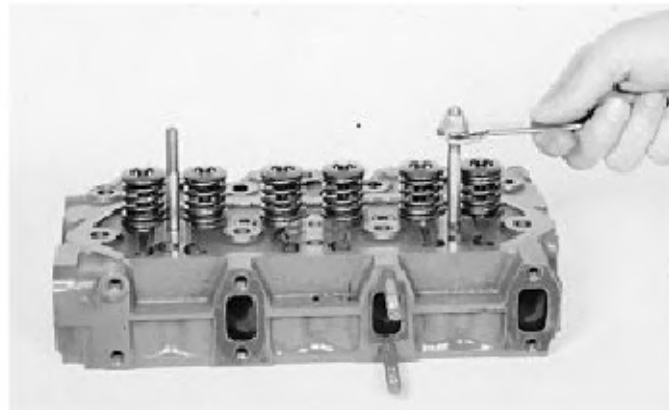
M21,TM315,38 -19-20FEB88

10. Hit valve stems lightly to seat the retainers.



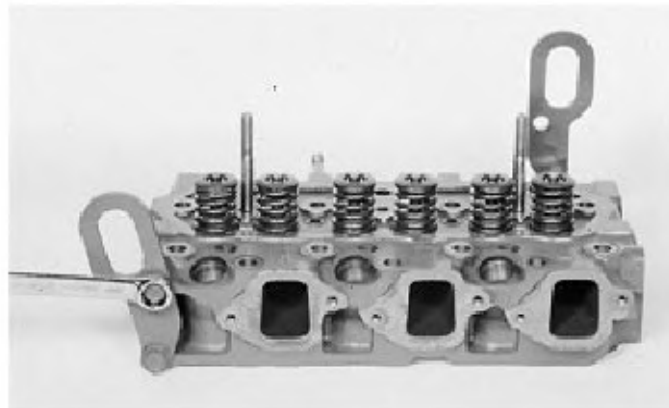
M21,TM315,39 -19-20FEB88

11. If used, install studs, with short threaded end in cylinder head. Use exhaust manifold nuts to turn studs until studs bottom out.



M21,TM315,40 -19-06AUG87

12. Install two lifting brackets.

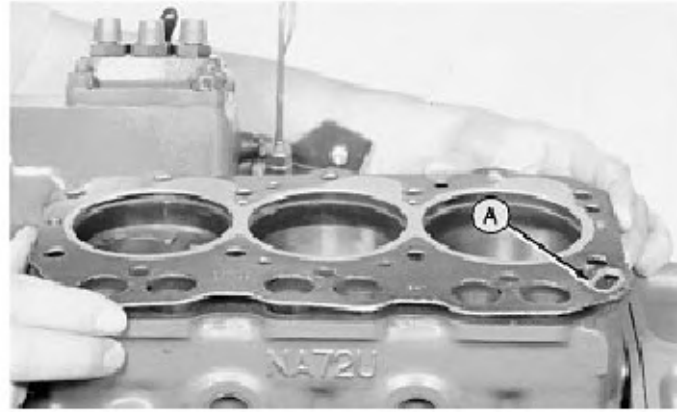


M21,TM315,41 -19-06AUG87

INSTALL CYLINDER HEAD

IMPORTANT: Oil passage (A) in gasket must be located over oil passage in block.

1. Install new gasket on cylinder block. Be sure to keep gasket dry.



M21, TM315.42 -19-22APR88

2. Install cylinder head on cylinder block.

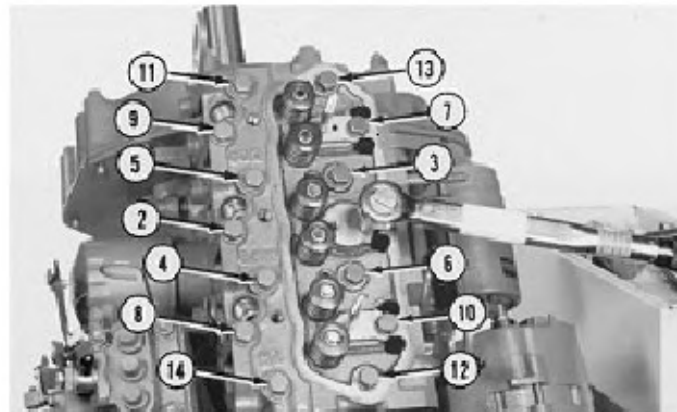
3. Dip entire cylinder head cap screws in clean engine oil. Install cap screws. Tighten cap screws, in the sequence shown, in three stages of gradually-increasing torque:

- First stage—tighten all cap screws to 31% of specified torque.
- Second stage—tighten all cap screws to 62% of specified torque.
- Third stage—tighten all cap screws to final specified torque.

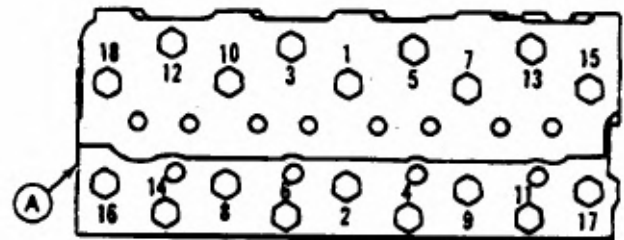
IMPORTANT: Cylinder head cap screws must be checked for proper torque after 50 hours of engine operation.

CYLINDER HEAD CAP SCREW TORQUE SPECIFICATIONS

3TN66	34 N·m (25 lb-ft)
3TNA72	61 N·m (45 lb-ft)
3TN75/3TN78/4TN78	69 N·m (51 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	78 N·m (58 lb-ft)
4TN100	157 N·m (116 lb-ft)



3-Cylinder Engines

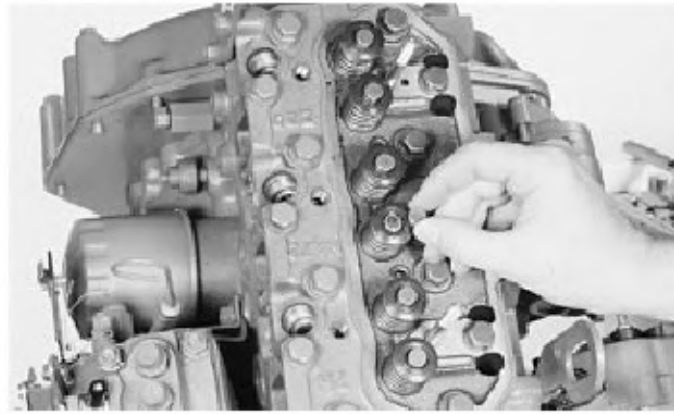


4-Cylinder Engines

A—Flywheel End

M21, TM315.43 -19-06AUG88

4. If equipped, install valve caps.



M21.TM315.44 -19-06AUG87

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

6. Install manifold (E). (See Group 15 in this manual.)

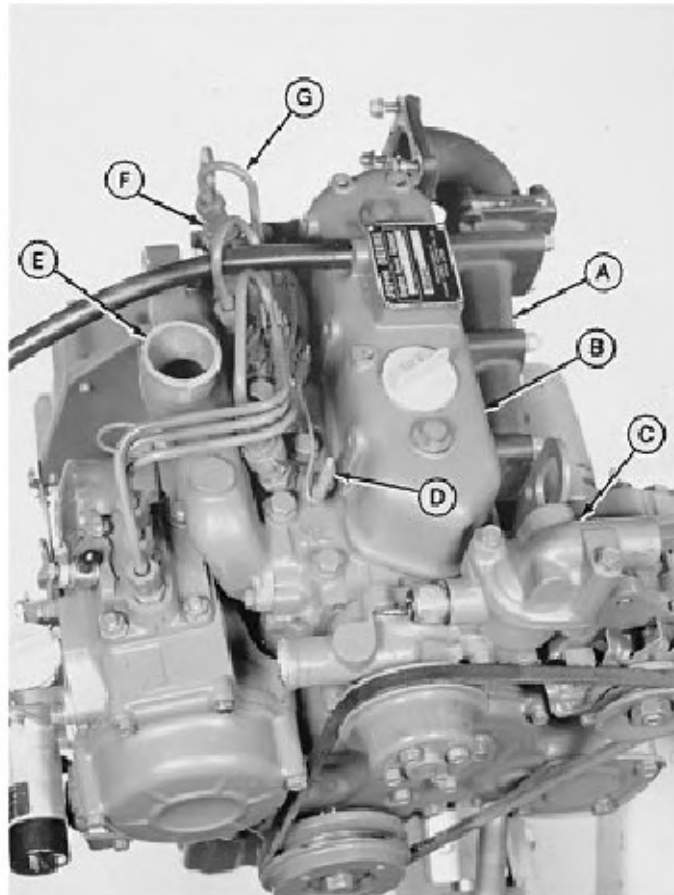
7. Install glow plugs (D).

8. Install nozzles (F) and lines (G). (See Group 50 in this manual.)

9. Install pump (C). (See Group 45 in this manual.)

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

- A—Exhaust Manifold
- B—Rocker Arm Cover
- C—Water Pump
- D—Glow Plugs
- E—Intake Manifold
- F—Fuel Injection Nozzles
- G—Fuel Injection Lines



M21.TM315.45 -19-20FEB88

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 -19-22APR88

REMOVE FLYWHEEL HOUSING AND FLYWHEEL

1. Remove engine (See Machine Technical Manual.)
2. If equipped, remove electric clutch assembly. (See Machine Technical Manual.)
3. If equipped, remove nuts and cap screws to remove flywheel housing or flywheel shield.

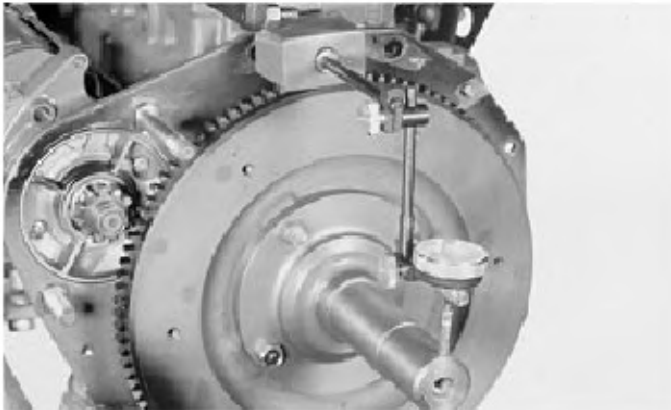


M21,TM320.3 -19-06AUG87

4. While turning crankshaft, measure stub shaft TIR (total indicator runout) using a dial indicator. Maximum TIR is 0.20 mm (0.008 in.).

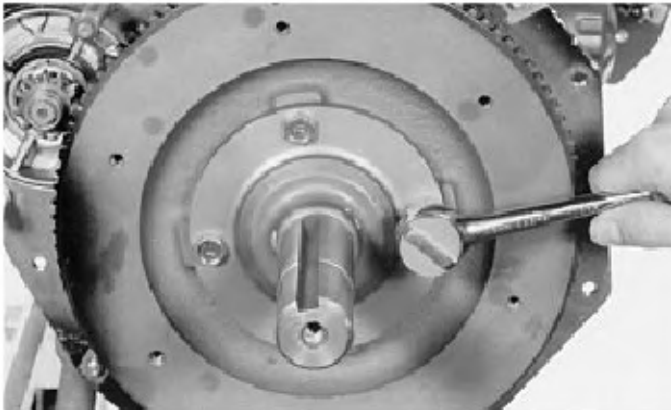
NOTE: Turn engine crankshaft using crankshaft pulley cap screw.

If stub shaft TIR exceeds 0.20 mm (0.008 in.), replace stub shaft.



M21,TM320.4 -19-06AUG87

5. If equipped, remove four cap screws to remove stub shaft.



M21,TM320.5 -19-06AUG87

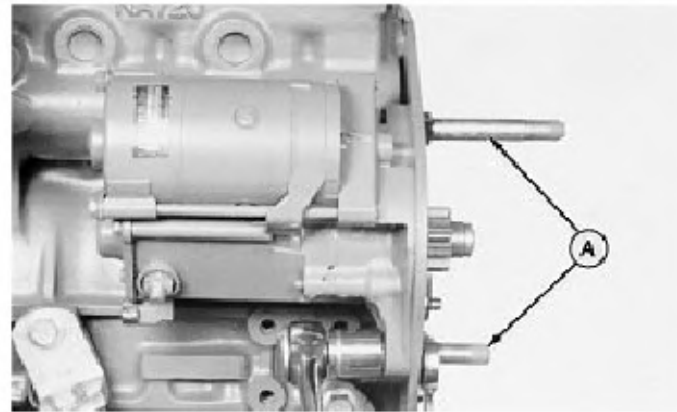
6. Remove cap screws to remove flywheel.



M21,TM320.6 -19-03MAR88

7. Remove nuts or cap screws to remove starter.

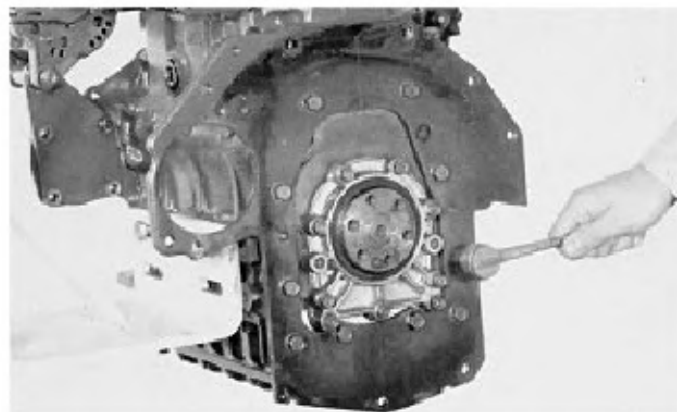
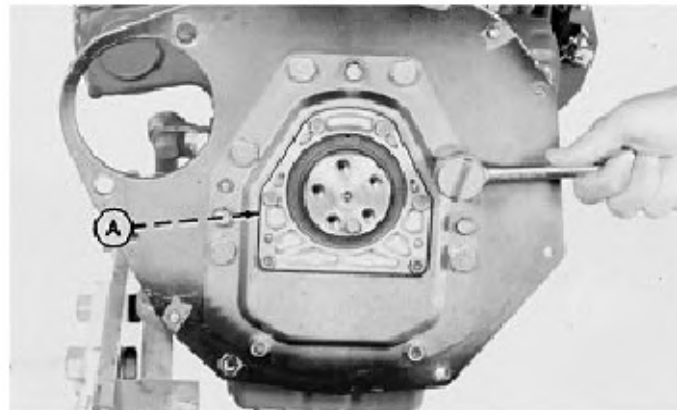
8. If equipped remove two pins or studs (A).



M21,TM320.7 -19-06AUG88

9. Remove large-headed cap screws to remove mounting plate and seal (A).

Remove large-headed cap screws to remove mounting plate or housing.

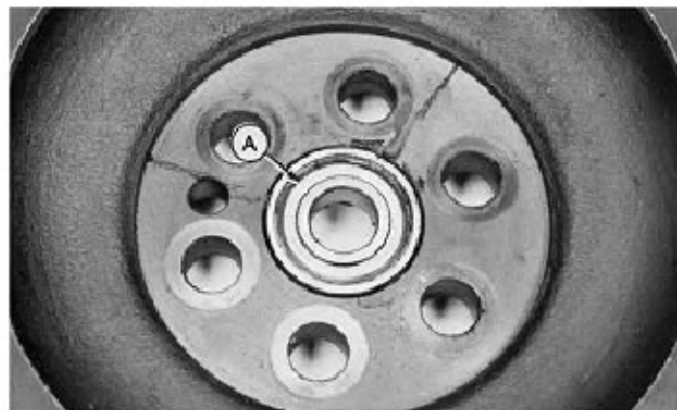
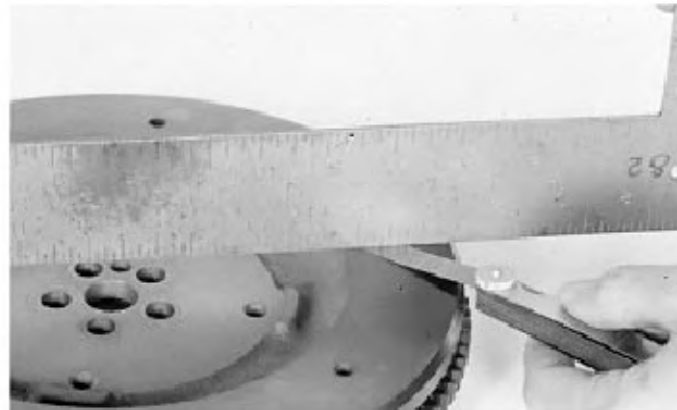
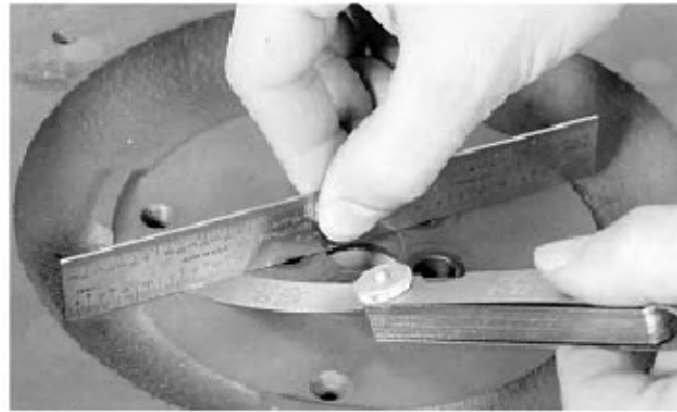


3TN75 Shown

M21,TM320.8 -19-06AUG88

INSPECT FLYWHEEL AND STUB SHAFT

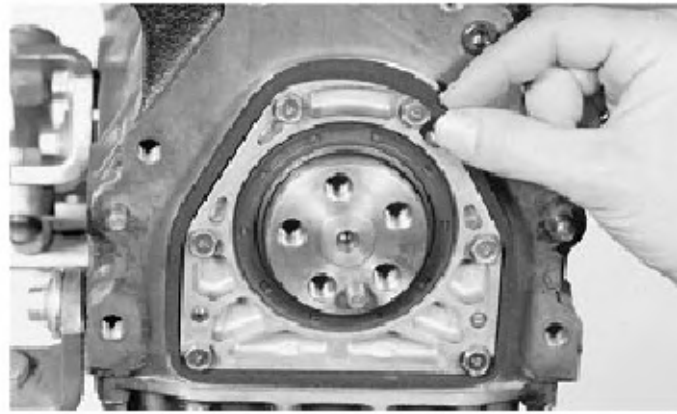
1. Check flywheel and stub shaft flatness using a straight edge and feeler gauge.
2. New part flatness specification is 0.05 mm (0.002 in.) for stub shaft and 0.02 mm (0.0008 in.) for flywheel.
3. Inspect flywheel ring gear for chipped or broken teeth. Replace flywheel as necessary.
4. For 4TN100 engine, inspect pilot bearing (A) for wear and smooth rotation. Replace bearing as necessary.



INSTALL FLYWHEEL AND FLYWHEEL HOUSING

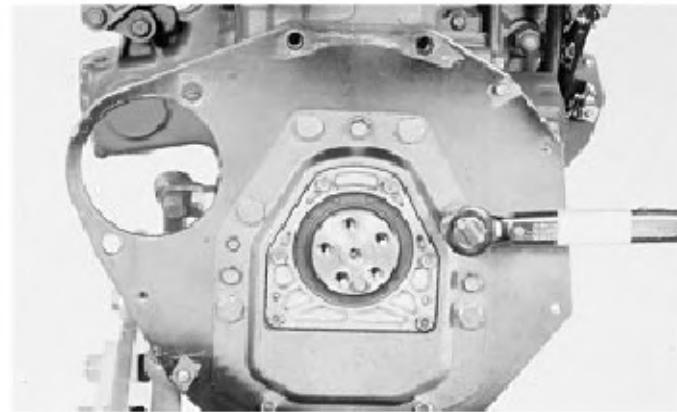
1. Install foam seal (3TN66/3TNA72 engines only).

3TN66/3TNA72

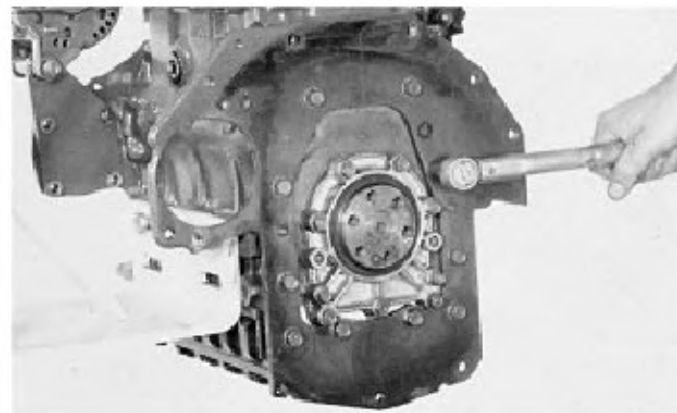


M21.TM320.10 -19-06AUG8

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



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



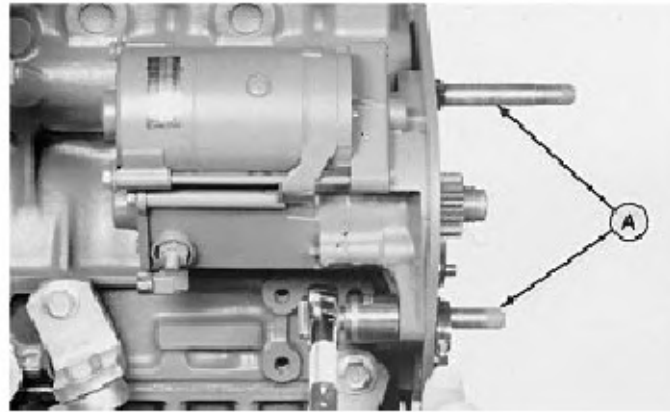
3TN75 Shown

M21.TM320.11 -19-06AUG8

3. If equipped, install two pins or studs (A).
4. Install starter and two nuts or cap screws. Tighten nuts or cap screws to specifications.

STARTER CAP SCREW OR NUT TORQUE SPECIFICATIONS

3TN66	49 N·m (36 lb-ft)
All except 3TN66	88 N·m (65 lb-ft)



M21.TM320.12 -19-28AUG87

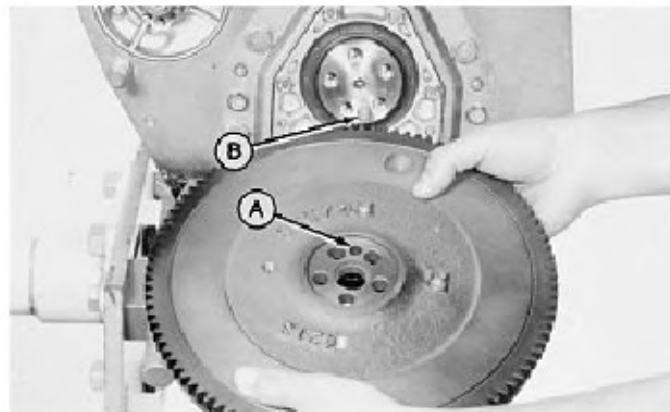
5. Align hole (A) in flywheel with pin (B) in crankshaft.

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

6. Apply clean engine oil to cap screw threads and under head. Install flywheel and cap screws. Tighten cap screws to specifications.

FLYWHEEL CAP SCREW TORQUE SPECIFICATIONS

All except 4TN100	83 N·m (61 lb-ft)
4TN100	196 N·m (145 lb-ft)

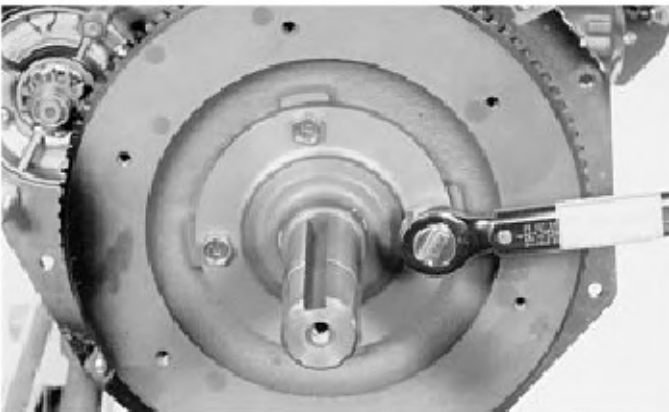


M21.TM320.13 -19-06AUG87

7. If equipped, install stub shaft and four cap screws. Tighten cap screws to specification.

STUB SHAFT CAP SCREW TORQUE SPECIFICATION

All Engines 59 N·m (44 lb-ft)



M21.TM320.14 -19-06AUG8

8. If equipped, install flywheel housing or flywheel shields, nuts, and cap screws.

FLYWHEEL HOUSING OR SHIELD TORQUE

Engine	Item	Specification
3TN66	Cap Screw (A) (2 used)	49 N·m (36 lb-ft)
	Cap Screw (B) (6 used)	26 N·m (226 lb-in.)
3TNA72	Cap Screw (A) (2 used)	49 N·m (36 lb-ft)
	Cap Screw (B) (5 used)	26 N·m (226 lb-in.)
	Nut (C) (2 used)	88 N·m (65 lb-ft)
3TN75	Cap Screw (A) (5 used)	49 N·m (36 lb-ft)
	Cap Screw (B) (3 used)	26 N·m (226 lb-in.)



M21.TM320.15 -19-06AUG8

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

OTHER MATERIALS

Name	Use
PLASTIGAGE®	Measure connecting rod bearing clearance

PLASTIGAGE is a trademark of the TRW Corporation

M21,TM325,2 -19-22APR88

SERVICE PART KITS

The following kits are available through your parts catalog:

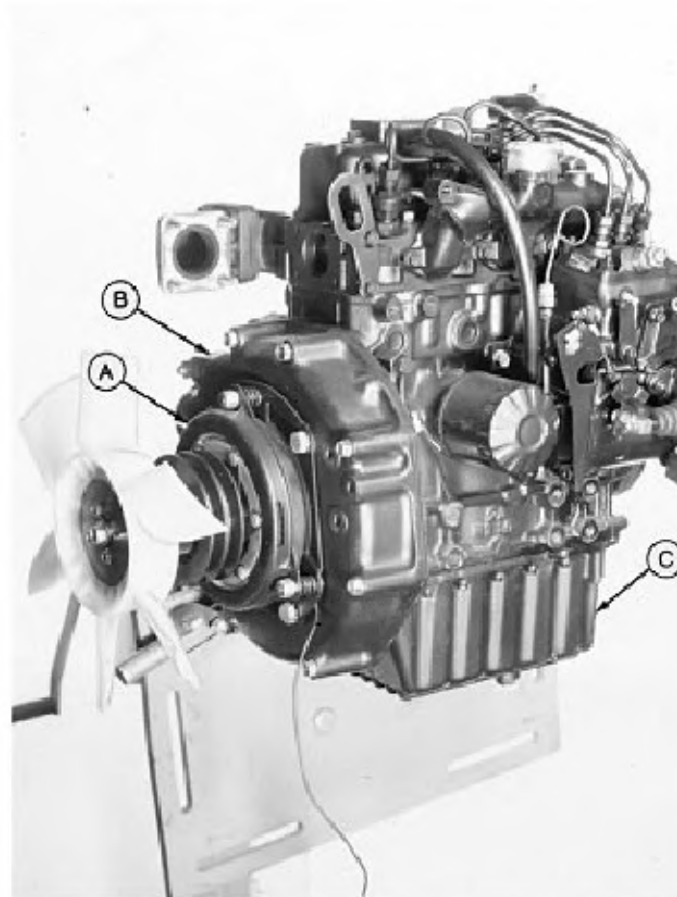
Cylinder Block Gasket Kit.

Cylinder Head Gasket Kit.

M21,TM325,3 -19-03MAR88

MEASURE CONNECTING ROD SIDE PLAY

1. Remove engine. (See Machine Technical Manual.)
2. If equipped, remove electric clutch assembly (A). (See Machine Technical Manual.)
3. Remove flywheel assembly (B). (See Group 20 in this manual.)
4. Remove oil pan (C). (See Group 40 in this manual.)



M21,TM325,9 -19-06AUG8

5. Measure connecting rod side play.

CONNECTING ROD SIDE PLAY SPECIFICATIONS (MAX)

All except 4TN100	0.55 mm (0.022 in.)
4TN100	0.45 mm (0.018 in.)

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



M21,TM325,10 -19-28AUG8

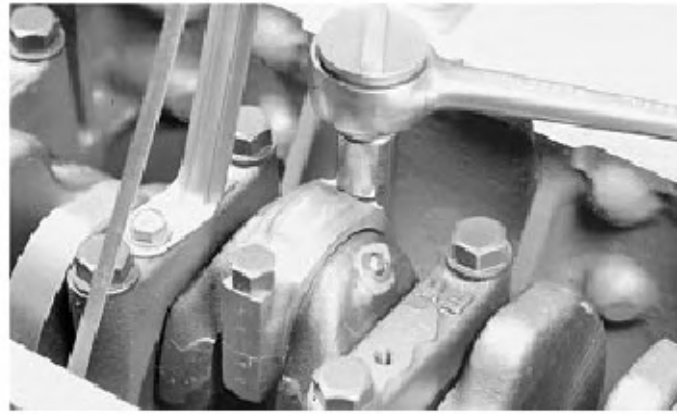
MEASURE CONNECTING ROD BEARING CLEARANCE

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

PLASTIGAGE Method

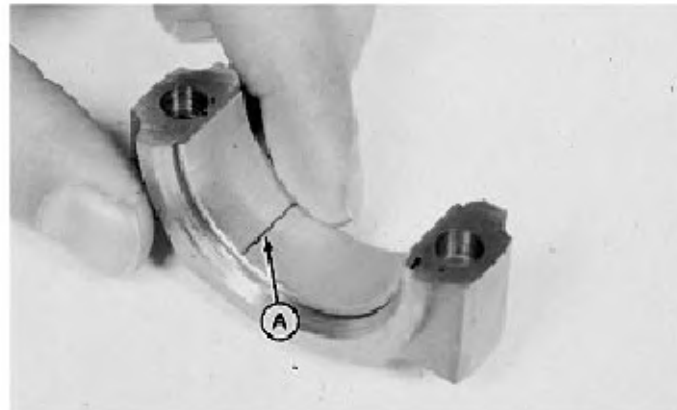
IMPORTANT: Connecting rod end caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.



M21,TM325,11 -19-22APR8

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 -19-03MAR8

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 SPECIFICATIONS

3TN66/3TNA72	23 N·m (200 lb-in.)
3TN75/3TN78/4TN78	39 N·m (29 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	47 N·m (35 lb-ft)
4TN100	93 N·m (69 lb-ft)



M21,TM325,13 -19-06AUG8

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 inches or in millimeters depending on which side of the envelope is used. Remove PLASTIGAGE.

CONNECTING ROD BEARING CLEARANCE SPECIFICATIONS

3TN66/3TNA72	0.15 mm (0.006 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	0.16 mm (0.006 in.)
4TN100	0.09 mm (0.004 in.)

If clearance exceeds wear tolerance, replace bearings.

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



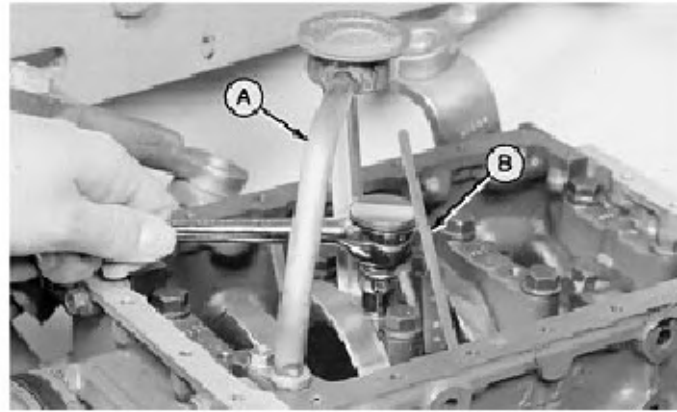
M21,TM325,14 -19-28AUG87

REMOVE PISTONS AND CONNECTING RODS

1. Remove engine. (See Machine Technical Manual.)
2. If equipped, remove electric clutch assembly (A). (See Machine Technical Manual.)
3. Remove flywheel assembly (B). (See Group 20 in this manual.)
4. Remove oil pan (C). (See Group 40 in this manual.)
Remove cylinder head. (See Group 15 in this manual.)

M21,TM325,15 -19-04MAR88

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



M21,TM325,16 -19-04MAR88

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

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

M21,TM325,17 -19-04MAR88

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

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



M21,TM325,18 -19-04FEB88

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



M21,TM325,19 -19-22APR88

INSPECT PISTONS AND CONNECTING RODS

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

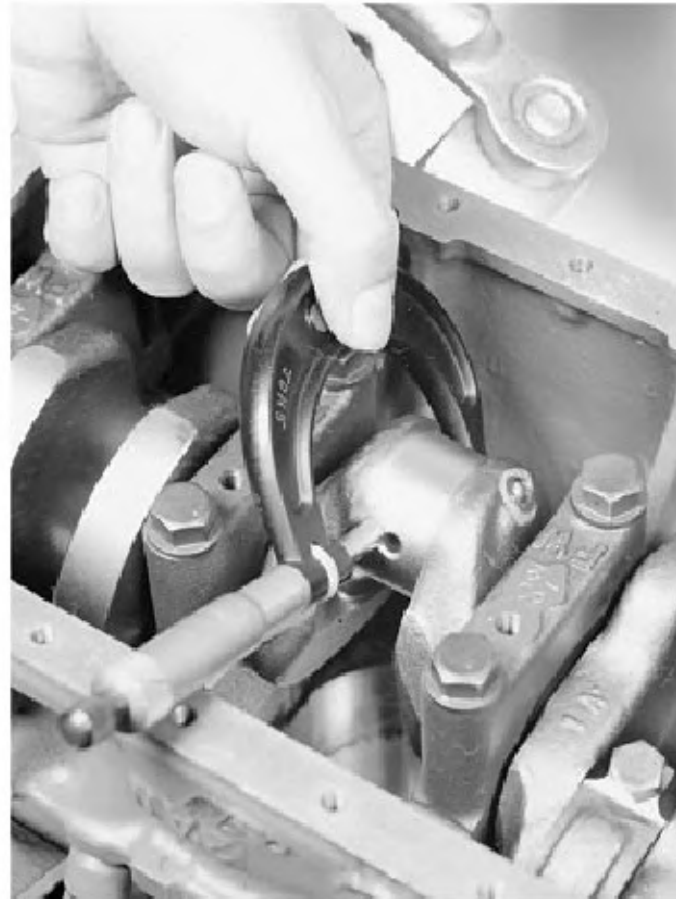
NOTE: If engine has had a previous major overhaul, connecting rod journals may have been ground and undersize bearing inserts installed.

CONNECTING ROD JOURNAL O.D. SPECIFICATIONS (MIN)

3TN66	35.92 mm (1.414 in.)
3TNA72	39.92 mm (1.572 in.)
3TN75/3TN78/4TN78	42.91 mm (1.689 in.)
3TN82/3TN84/ 4TN82/4TN84	47.91 mm (1.886 in.)
4TN100	59.90 mm (2.358 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.



M21,TM325,20 -19-06AUG87

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 SPECIFICATIONS

3TN66/3TNA72	23 N·m (200 lb-in.)
3TN75/3TN78/4TN78	39 N·m (29 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	47 N·m (35 lb-ft)
4TN100	93 N·m (69 lb-ft)

CONNECTING ROD BEARING SPECIFICATIONS

Bearing I.D. (MAX)

3TN66	36.07 mm (1.420 in.)
3TNA72	40.07 mm (1.578 in.)
3TN75/3TN78/4TN78	43.07 mm (1.696 in.)
3TN82/3TN84/ 4TN82/4TN84	48.07 mm (1.893 in.)
4TN100	60.10 mm (2.366 in.)

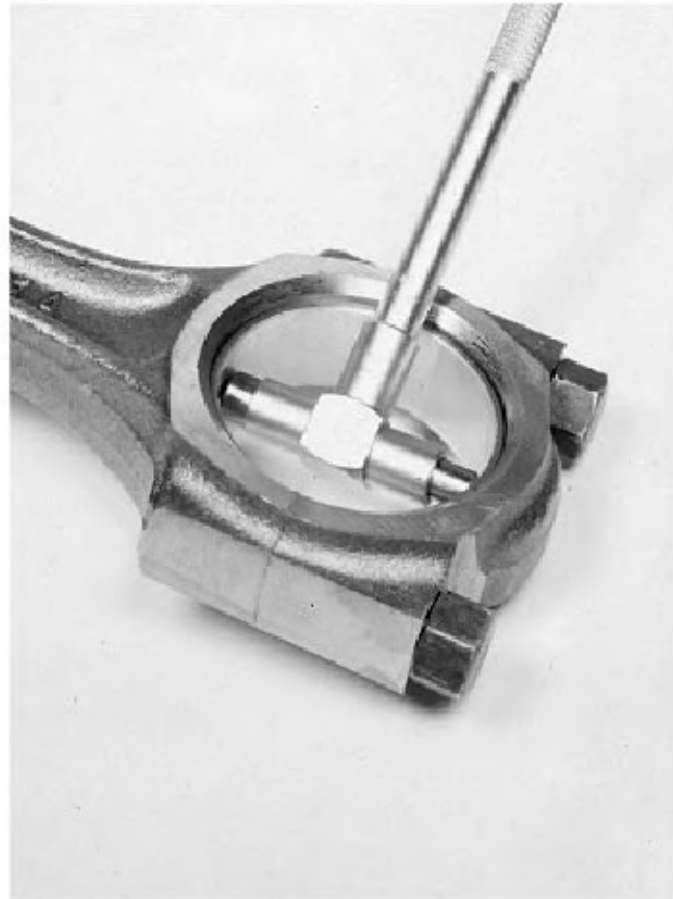
Clearance (MAX)

3TN66/3TNA72	0.15 mm (0.006 in.)
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	0.16 mm (0.006 in.)
4TN100	0.09 mm (0.004 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.



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

PISTON RING GROOVE CLEARANCE SPECIFICATIONS

Engine	Measurement	Wear Tolerance (MAX)
3TN66/ 3TN72	(All Rings)	0.20 mm (0.008 in.)
3TN75/3TN78/3TN82/ 3TN84/4TN78/ 4TN82/4TN84	(Top Ring and Second Ring) (Oil Ring)	0.25 mm (0.010 in.) 0.20 mm (0.008 in.)
4TN100	(Top Ring) (Second and Oil Rings)	0.20 mm (0.008 in.) 0.15 mm (0.006 in.)

If clearance exceeds wear tolerance, replace rings or piston.



M21,TM325,22 -19-28AUG8

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.



M21,TM325,23 -19-04FEB8

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 END GAP SPECIFICATIONS (MAX)

All Engines 1.50 mm (0.059 in.)

If end gap exceeds wear tolerance, replace rings.



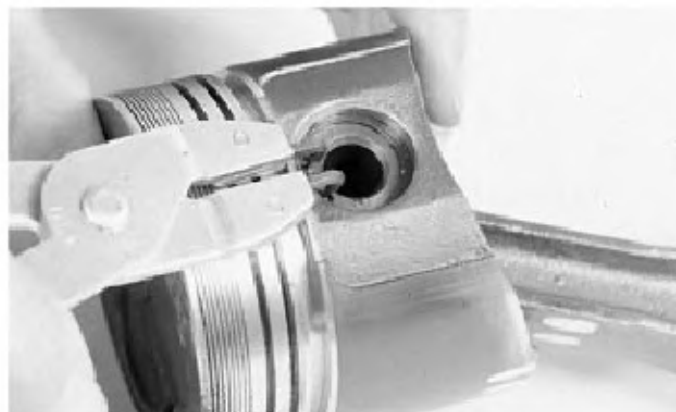
M21.TM325.24 -19-28AUG87

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 -19-04MAR87

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. SPECIFICATIONS (MIN)

3TN66	19.98 mm (0.786 in.)
3TNA72	20.98 mm (0.826 in.)
3TN75/3TN78/4TN78	22.90 mm (0.902 in.)
3TN82/3TN84/ 4TN82/4TN84	25.90 mm (1.020 in.)
4TN100	33.99 mm (1.338 in.)

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



M21.TM325.26 -19-28AUG87

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

PISTON PIN BUSHING SPECIFICATIONS

Bushing I.D. (MAX)

3TN66	20.10 mm (0.791 in.)
3TNA72	21.10 mm (0.831 in.)
3TN75/3TN78/4TN78	23.10 mm (0.909 in.)
3TN82/3TN84/ 4TN82/4TN84	26.10 mm (1.028 in.)
4TN100	34.10 mm (1.343 in.)

Clearance (MAX)

All except 4TN100	0.11 mm (0.004 in.)
4TN100	0.060 mm (0.0024 in.)

If bushing diameter exceeds wear tolerance, replace bushing.

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



M21.TM325.27 -19-28AUG87

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

PISTON PIN BORE SPECIFICATIONS

Bore I.D. (MAX)

3TN66	20.02 mm (0.788 in.)
3TNA72	21.02 mm (0.828 in.)
3TN75/3TN78/4TN78	23.02 mm (0.906 in.)
3TN82/3TN84/ 4TN82/4TN84	26.02 mm (1.024 in.)
4TN100	34.01 mm (1.339 in.)

Clearance (MAX)

All except 4TN100	0.05 mm (0.002 in.)
4TN100	0.02 mm (0.001 in.)

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

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



M21,TM325,28 -19-06AUG8

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

DISKS FOR BUSHING REMOVAL

Engine	Size (in.)	
	(A)	(B)
3TN66	13/16	3/4
3TNA72	15/16	13/16
3TN75/3TN78/4TN78	15/16	7/8
3TN82/3TN84/ 4TN82/4TN84	1 1/16	1
4TN100	1 3/8	1 5/16



M21,TM325,29 -19-28AUG8

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

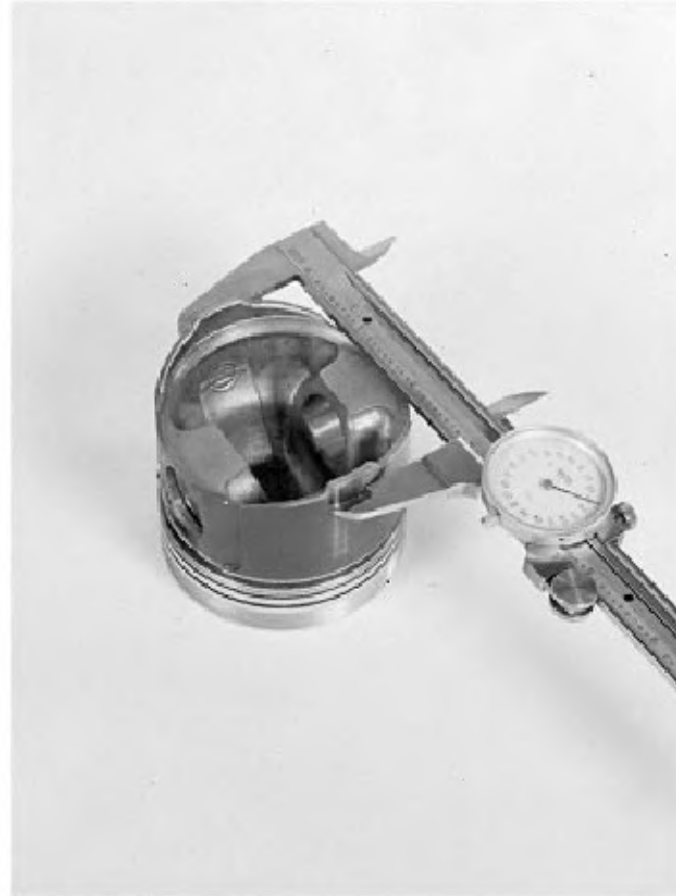
NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

PISTON (STANDARD) SPECIFICATIONS

Engine	Measurement	Wear Tolerance (MIN)
3TN66	O.D. at 5.00 mm (0.197 in.)	65.85 mm (2.593 in.)
3TNA72	O.D. at 8.00 mm (0.315 in.)	71.81 mm (2.827 in.)
3TN75	O.D. at 12.50 mm (0.492 in.)	74.81 mm (2.945 in.)
3TN78/4TN78	O.D. at 22.00 mm (0.866 in.)	77.81 mm (3.063 in.)
3TN82/4TN82	O.D. at 22.00 mm (0.866 in.)	81.80 mm (3.220 in.)
3TN84/4TN84	O.D. at 29.00 mm (1.142 in.)	83.80 mm (3.299 in.)
4TN100	O.D. at 25.50 mm (1.004 in.)	99.79 mm (3.929 in.)

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

Inspect piston for cracks at ring lands, skirts, and pin bores. Inspect piston for scuffing or scoring; replace as necessary.



M21.TM325.30 -19-06AUG8

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

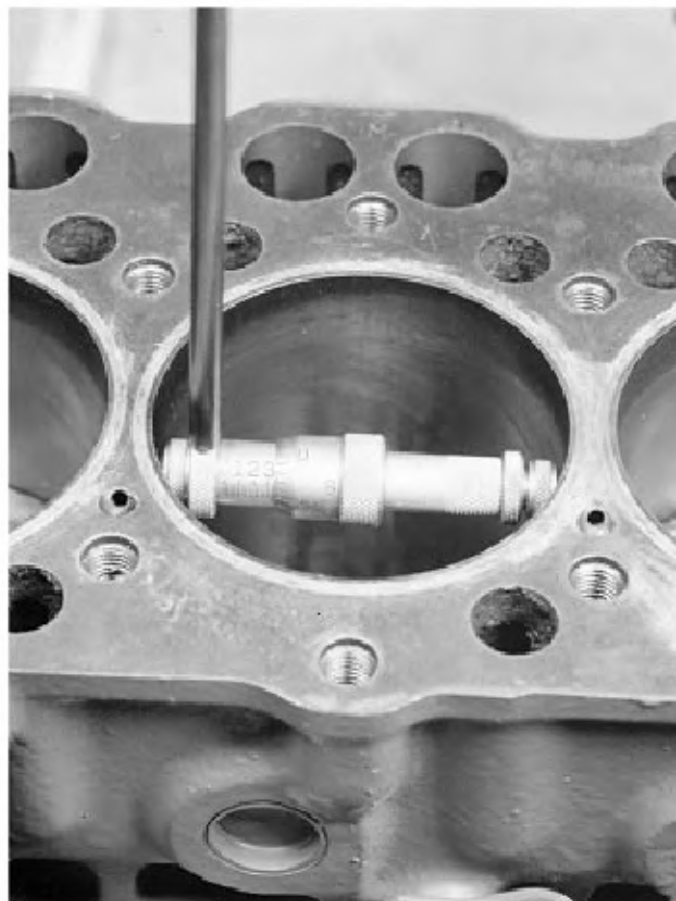
NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed.

CYLINDER BORE I.D. (STANDARD) SPECIFICATIONS

Engine	Nominal	Wear Tolerance (MAX)
3TN66	66.00—66.03 mm (2.598—2.600 in.)	66.20 mm (2.606 in.)
3TNA72	72.00—72.03 mm (2.835—2.836 in.)	72.20 mm (2.843 in.)
3TN75	75.00—75.03 mm (2.953—2.954 in.)	75.20 mm (2.961 in.)
3TN78/4TN78	78.00—78.03 mm (3.071—3.072 in.)	78.20 mm (3.079 in.)
3TN82/4TN82	82.00—82.03 mm (3.228—3.230 in.)	82.20 mm (3.236 in.)
3TN84/4TN84	84.00—84.03 mm (3.307—3.308 in.)	84.20 mm (3.315 in.)
4TN100	100.00—100.03 mm (3.937—3.938 in.)	100.20 mm (3.945 in.)

CYLINDER BORE I.D. (OVERSIZE) SPECIFICATIONS

Engine	Nominal	Wear Tolerance (MAX)
3TN66	66.25 mm (2.608 in.)	66.45 mm (2.616 in.)
3TNA72	72.25 mm (2.844 in.)	72.45 mm (2.852 in.)
3TN75	75.25 mm (2.963 in.)	75.45 mm (2.970 in.)
3TN78/ 4TN78	78.25 mm (3.081 in.)	78.45 mm (3.089 in.)
3TN82/ 4TN82	82.25 mm (3.238 in.)	82.45 mm (3.246 in.)
3TN84/ 4TN84	84.25 mm (3.317 in.)	84.45 mm (3.325 in.)
4TN100	100.25 mm (3.947 in.)	100.45 mm (3.955 in.)



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

PISTON/CYLINDER BORE CLEARANCE SPECIFICATIONS (MAX)

3TN66	0.25 mm (0.010 in.)
3TNA72	0.28 mm (0.011 in.)
3TN75	0.22 mm (0.009 in.)
3TN78/3TN82/3TN84/4TN78/ 4TN82/4TN84	0.30 mm (0.012 in.)
4TN100	0.35 mm (0.014 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.

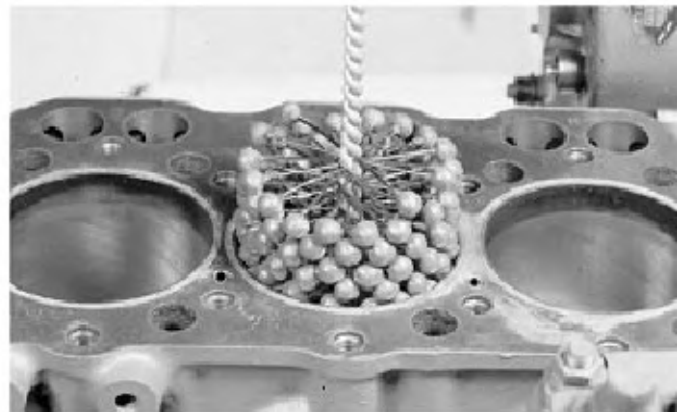
If piston clearance exceeds wear tolerance, replace cylinder block, piston or both; or rebore cylinder and install oversize piston and rings.

MX,TM325,A1 -19-25MAY8

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 with 180 grit stones.

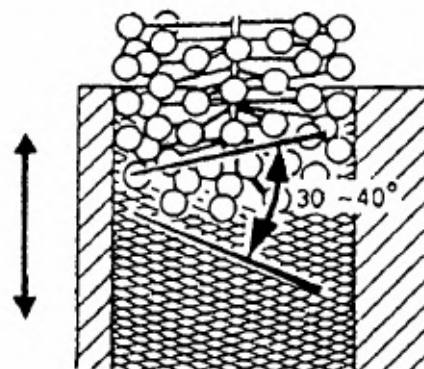


M21,TM325,32 -19-04MAR8

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.



M21.TM325.33 -19-04MAR8

REBORE CYLINDER BLOCK

NOTE: The cylinder block can be rebored to use 0.25 mm (0.010 in.) oversize pistons and rings. (See this group for cylinder bore I.D. specifications.)

1. Align center of bore to drill press center.

IMPORTANT: Check stone for wear or damage. Use a rigid hone with 300 grit stones.

2. Adjust hone so lower end is even with lower end of cylinder bore.

3. Adjust rigid hone stones until they contact narrowest point of cylinder.

4. Coat cylinder with honing oil. Hone should turn by hand. Adjust if too tight.

5. Run drill press at about 250 RPM. Move hone up and down in order to obtain a 30—40° crosshatch pattern.

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter several times during rebores procedure.

NOTE: Finish should not be smooth. It should have a 30—40° crosshatch pattern.

7. Remove rigid hone when cylinder is within 0.03 mm (0.001 in.) of desired size.

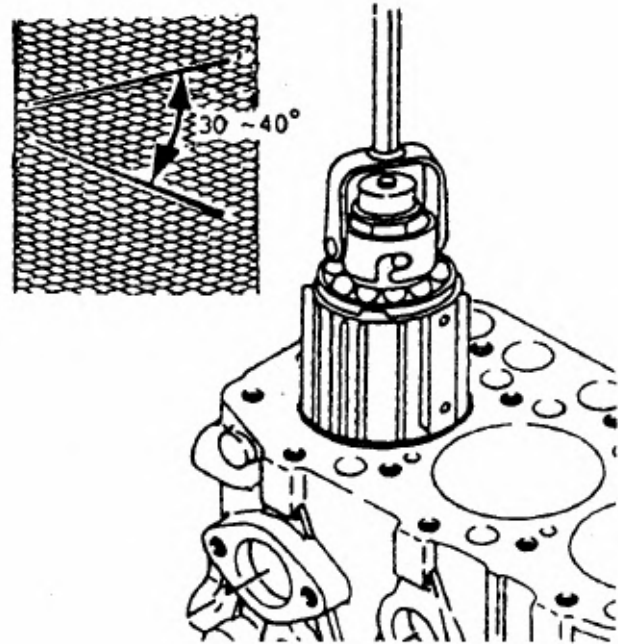
8. Use a flex hone with 180 grit stones for honing to final size.

9. Check bore for size, taper and out-of-round. (See this group.)

IMPORTANT: Do not use solvents to clean cylinder bore. Solvents will not remove all metal particles and abrasives produced during honing.

10. Clean cylinder thoroughly using warm soapy water until clean white rags show no discoloration.

11. Dry cylinder and apply engine oil.

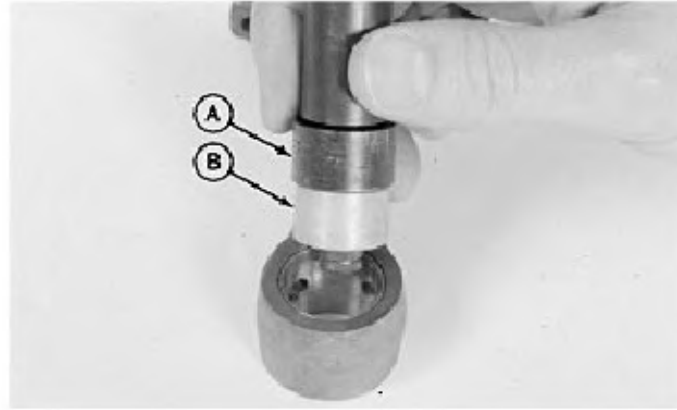


ASSEMBLE PISTONS AND CONNECTING RODS

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

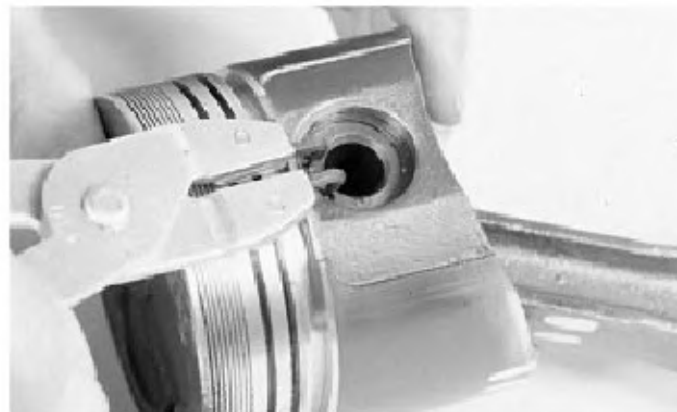
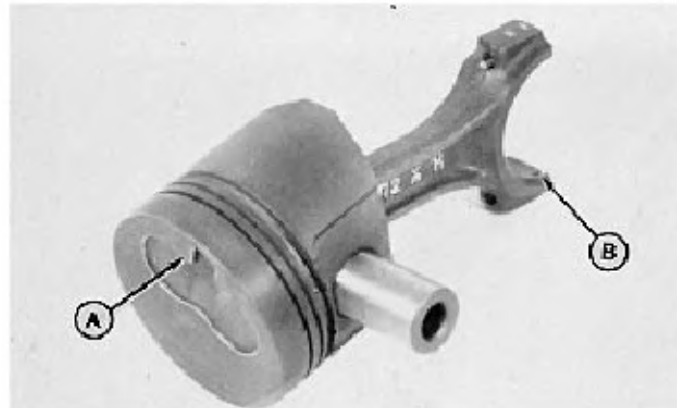
Engine	Size (in.)	
	(A)	(B)
3TN66	1	3/4
3TNA72	1	13/16
3TN75/3TN78/4TN78	1 1/4	7/8
3TN82/3TN84/ 4TN82/4TN84	1 5/16	1
4TN100	1 1/2	1 5/16



M21,TM325,34 -19-06AUG8

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.



M21,TM325,35 -19-04MAR8

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.

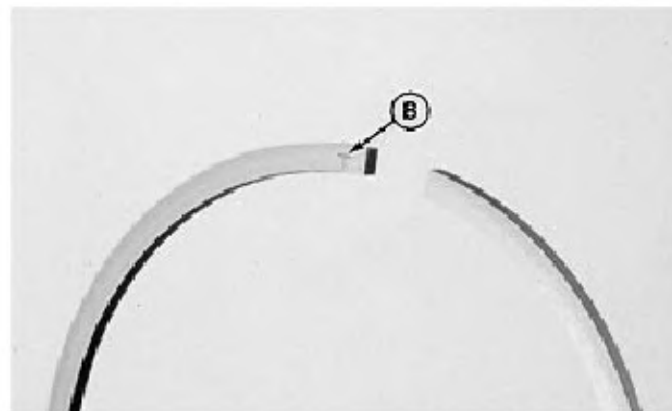
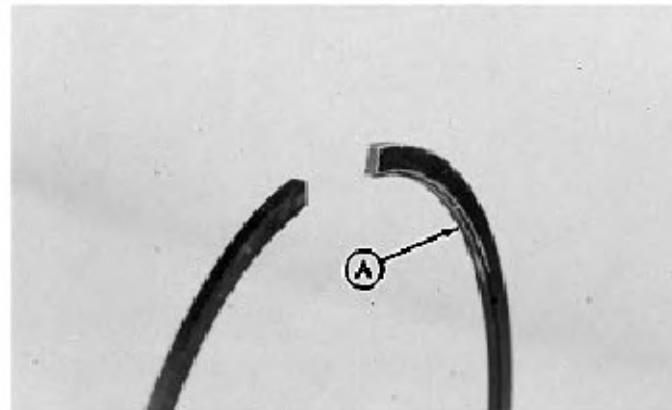


M21.TM325.36 -19-04MAR88

IMPORTANT: Piston rings must be installed with chamfer (A), if present, toward top of piston. Install rings with identification mark (B) toward top of piston. Identification mark (B) may be a "T", "R", or "RN".

8. Install second ring in middle groove. Turn ring until gap is 120° away from second ring gap.

Install chrome ring in top groove. Turn ring until gap is 120° away from second ring gap.



M21.TM325.37 -19-28AUG88

INSTALL PISTONS AND CONNECTING RODS

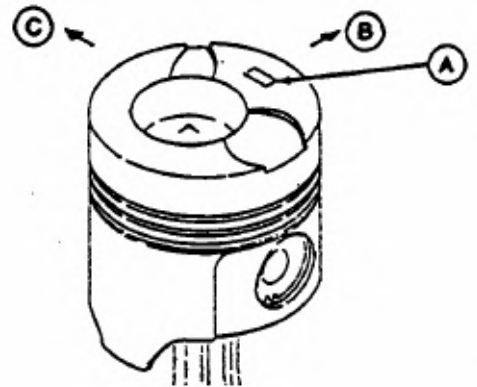
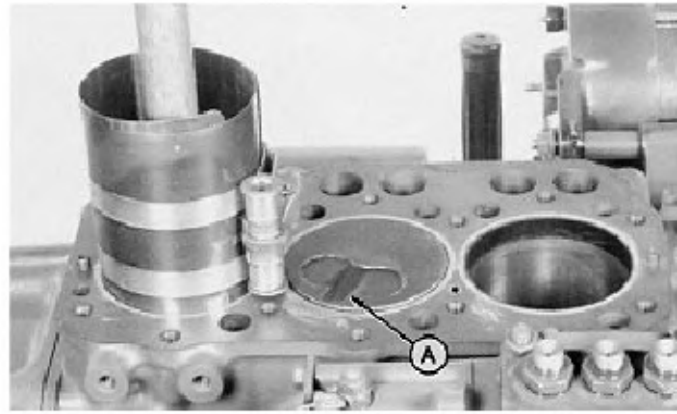
IMPORTANT: Pistons must be installed in cylinders from which they were removed and in the same direction. Be careful not to damage crankshaft rod journal while installing piston.

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

2. Install pistons with piston recess (A) toward fuel injection pump using a piston ring compressor. Push pistons down until top ring is in cylinder.

For 4TN100 engine, insert piston with size mark (A) toward camshaft.

A—Piston Size Mark
B—Fuel Injection Pump Side
C—Gear Case Side



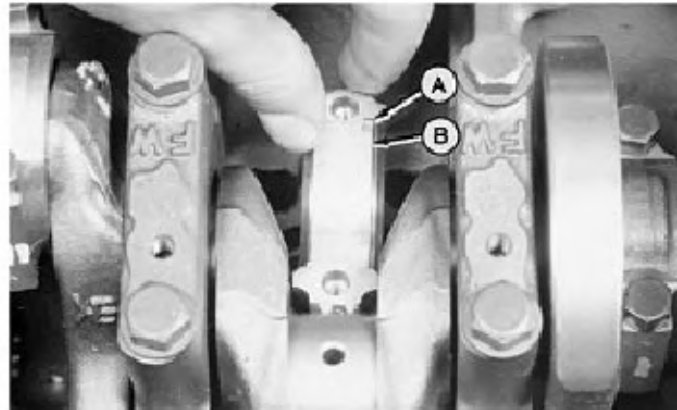
M21.TM325.38 -19-06AUG87

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.

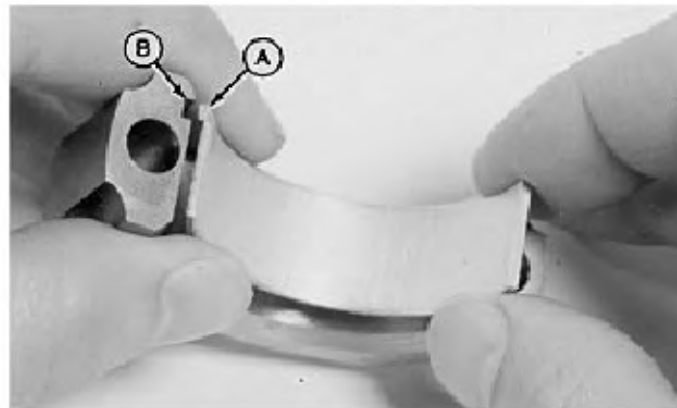


M21.TM325.39 -19-04MAR88

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).

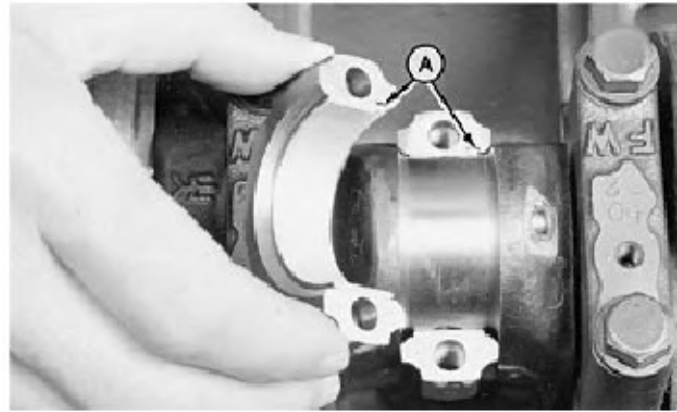
7. Put clean engine oil on insert.



M21.TM325.40 -19-04MAR88

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.



M21.TM325.41 -19-04MAR88

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 SPECIFICATIONS

3TN66/3TNA72	23 N·m (200 lb-in.)
3TN75/3TN78/4TN78	39 N·m (29 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	47 N·m (35 lb-ft)
4TN100	98 N·m (69 lb-ft)



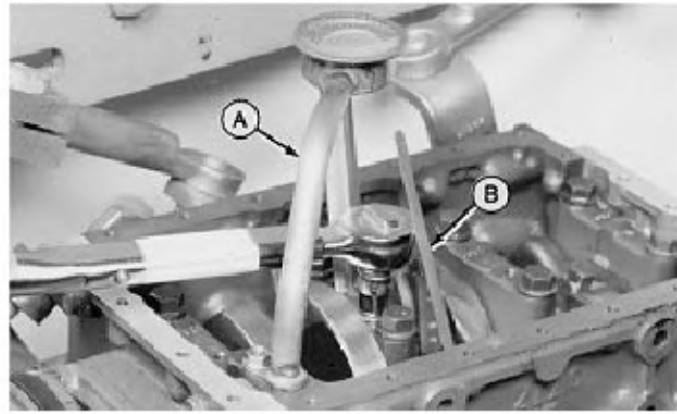
M21.TM325.42 -19-28AUG88

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.



M21.TM325.43 -19-04MAR88

12. Install dipstick (B), oil suction strainer (A), and two cap screws.
13. Install oil pan. (See Group 40 in this manual.)
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.)

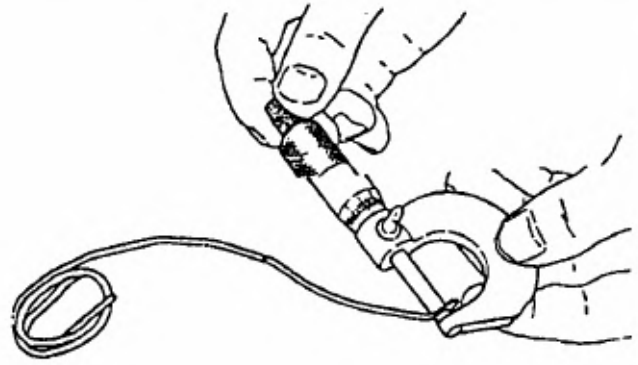


M21,TM325,44 -19-23APR8

MEASURE PISTON-TO-CYLINDER HEAD CLEARANCE

1. Place three 10 mm (0.4 in.)-long pieces of 1.5 mm (0.06 in.) diameter soft wire (A) in three positions on flat part of piston crown.
2. Install cylinder head and gasket to engine block. Tighten cylinder head cap screws in proper sequence to specified torque. (See Group 15.)
3. Slowly turn crankshaft one complete revolution.
4. Remove cylinder head. (See Group 15.)
5. Measure thickness of flattened section of each piece of wire. Compute average thickness of wires and compare to specifications.

If clearance is below specification replace parts as necessary to correct.



PISTON TO CYLINDER HEAD CLEARANCE SPECIFICATIONS (NOMINAL)

3TN66	0.59—0.74 mm (0.023—0.029 in.)
3TNA72	0.61—0.79 mm (0.024—0.031 in.)
3TN75	0.59—0.77 mm (0.023—0.030 in.)
3TN78/4TN78/	0.63—0.77 mm (0.025—0.030 in.)
3TN82/4TN82/3TN84/4TN84	0.64—0.82 mm (0.025—0.032 in.)
4TN100	0.71—0.89 mm (0.028—0.035 in.)

MX, TM325, A3 -19-25MAY8

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 -19-05MAR8

SERVICE PART KITS

The following kits are available through your parts catalog:

- Cylinder Block Gasket Kit
- Cylinder head Gasket Kit

M21,TM330,2 -19-23APR8

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 -19-06AUG8

MEASURE CRANKSHAFT END PLAY

1. Fasten dial indicator to engine.

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

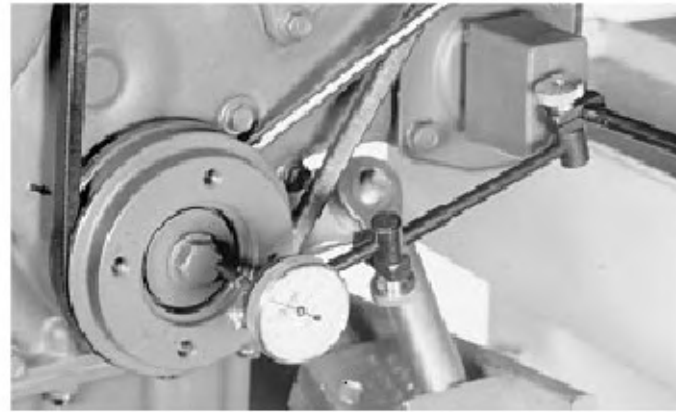
2. Push crankshaft toward front then toward rear.
3. Measure crankshaft end play.

CRANKSHAFT END PLAY SPECIFICATIONS (MAX)

All except 4TN100 0.33 mm (0.013 in.)

4TN100 0.29 mm (0.011 in.)

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

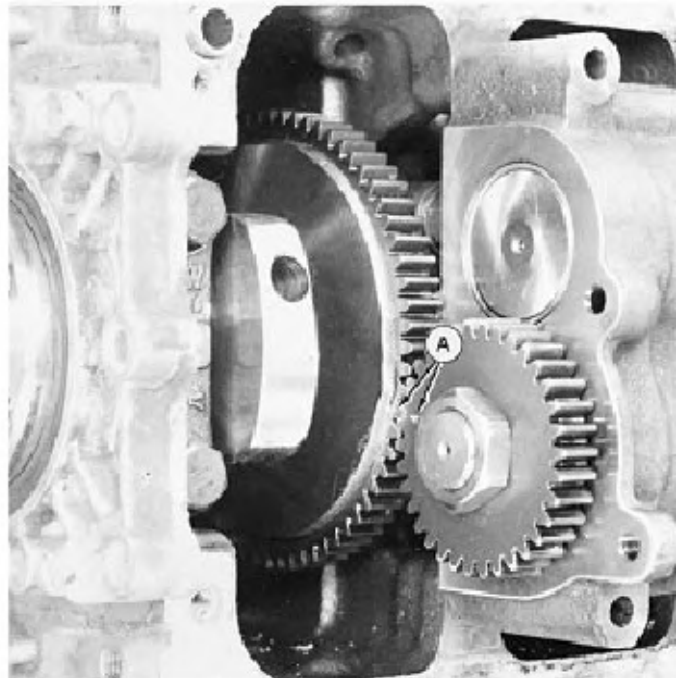


M21,TM330,6 -19-28AUG8

REMOVE ENGINE BALANCER ASSEMBLY—4TN82/84

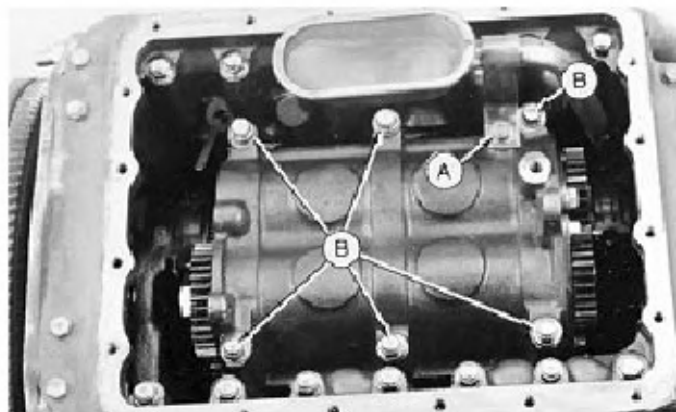
1. Drain engine oil.
2. Remove oil pan.
3. Locate and align balancer-to-crankshaft timing marks (A). (Extension housing removed for photographic purposes).

IMPORTANT: Rotate crankshaft to find marks or mark a tooth on balancer gear and crankshaft gear before removing balancer.



MX,TM330Z,1 -19-06OCT8

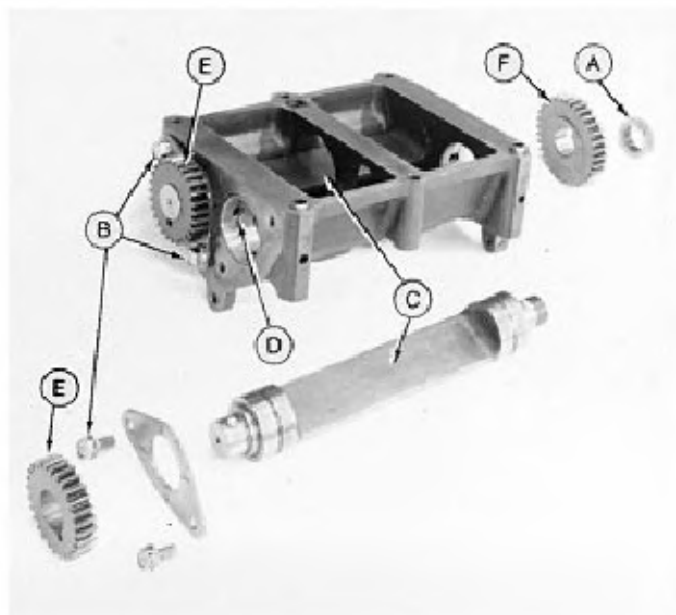
4. Remove oil pickup cap screws (A).
5. Remove cap screws (B). Carefully remove balancer.



MX, TM330Z, 2 -19-06OCT8

DISASSEMBLE AND INSPECT BALANCER—4TN82/84

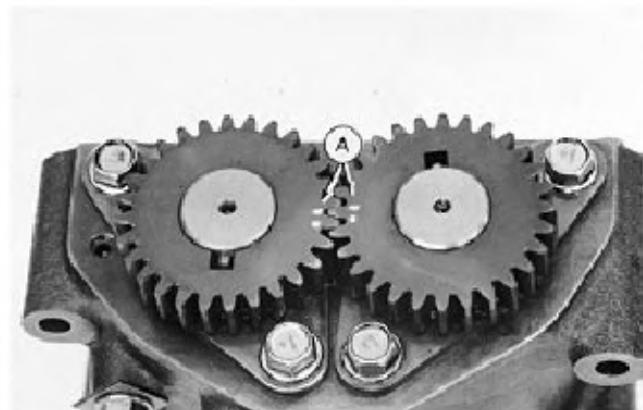
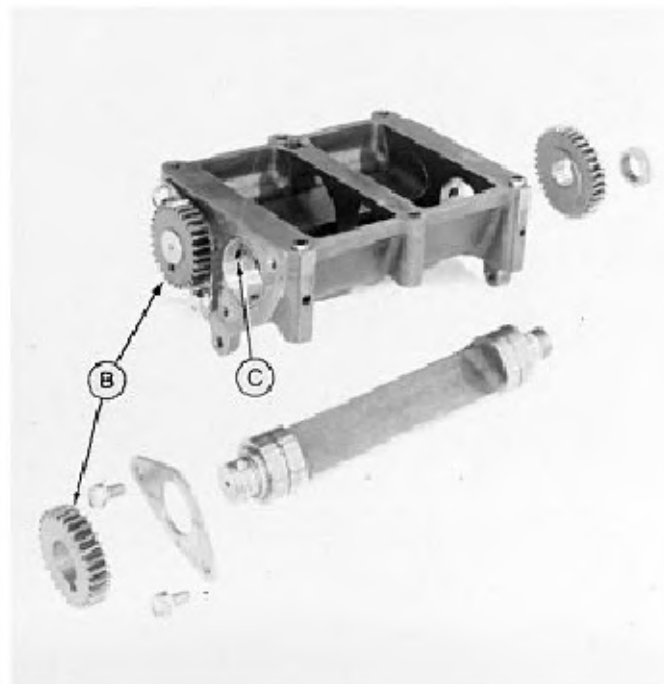
1. Disassemble balancer by removing nut (A), cap screws (B) and shafts (C).
2. Inspect bushing (D) for signs of wear or scoring. Clean and check oil passages for debris or blockage.
3. Check gear teeth for chipping or excessive wear. Balancer gears (E) are pressed on shafts. If gear (F) is damaged, check crankshaft gear and replace as necessary. See crankshaft removal.



MX, TM330Z, 3 -19-06OCT8

ASSEMBLE AND INSTALL BALANCER

1. Press gears (B) on shaft, flush with beveled edge.
2. When installing new bushings, align hole in bushings with oil passage ports (C).
3. Coat bushings with oil and install balancer shafts, aligning timing marks (A). Tighten retaining bolts to 27 N·m (20 lb-ft).



MX,TM330Z,4 -19-01OCT8

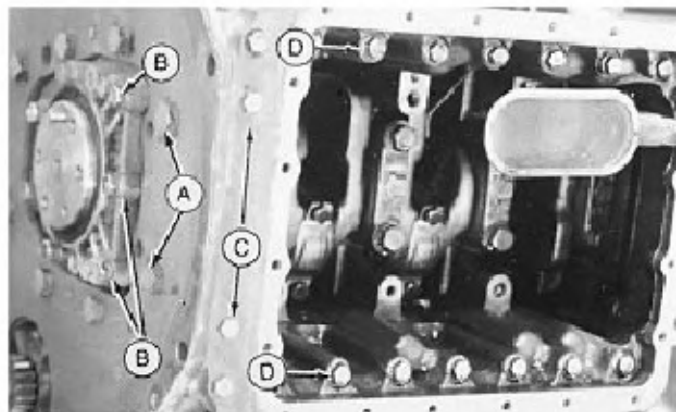
4. Install drive gear and nut (A). Tighten nut to 106 N·m (78 lb-ft).
5. Install new o-ring (B). Install balancer assembly and tighten cap screws to 27 N·m (20 lb-ft).



MX,TM330Z,5 -19-06OCT8

REMOVE AND INSTALL CRANKCASE EXTENSION HOUSING

1. Remove two rear plate-to-extension housing cap screws (A).
2. Remove three rear bearing-to-extension housing cap screws (B).
3. Remove all external cap screws (C). (Front extension housing-to-timing gear cover cap screws not shown).
4. Remove all internal cap screws (D) and remove housing.
5. Clean gasket surfaces. Apply a bead of Form-in-Place Gasket or equivalent on sealing surface and reinstall housing.



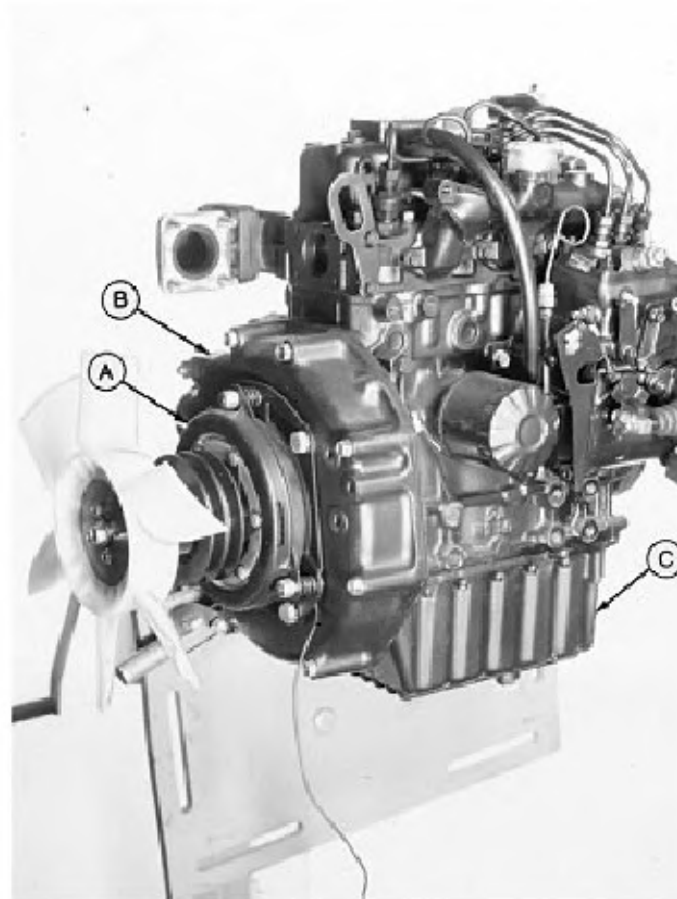
TORQUE SPECIFICATIONS

Extension housing-to-block	27 N·m (20 lb-ft)
Extension housing-to-timing cover	22 N·m (16 lb-ft)
Rear bearing housing-to- extension housing	27 N·m (20 lb-ft)
Rear plate-to-extension housing	49 N·m (36 lb-ft)
Oil pan cap screws	27 N·m (20 lb-ft)

MX,TM330Z,6 -19-06OCT8

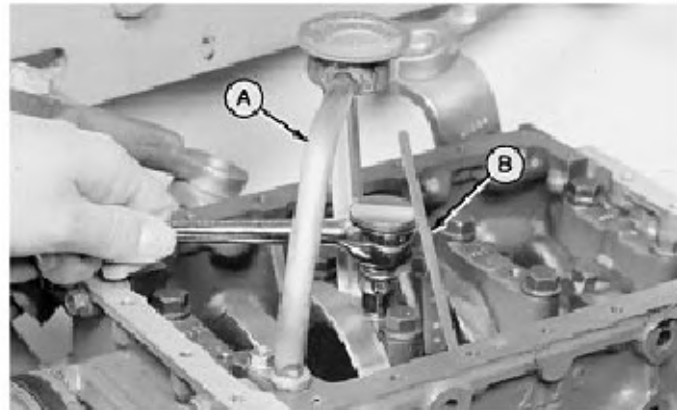
MEASURE CRANKSHAFT BEARING CLEARANCE

1. Remove engine. (See Machine Technical Manual.)
2. If equipped, remove electric clutch assembly (A). (See Machine Technical Manual).
3. Remove flywheel assembly (B). (See Group 20 in this manual.)
4. Remove oil pan (C). (See Group 40 in this manual.)



M21,TM330,7 -19-05MAR8

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



M21,TM330,8 -19-06AUG8

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

PLASTIGAGE method:

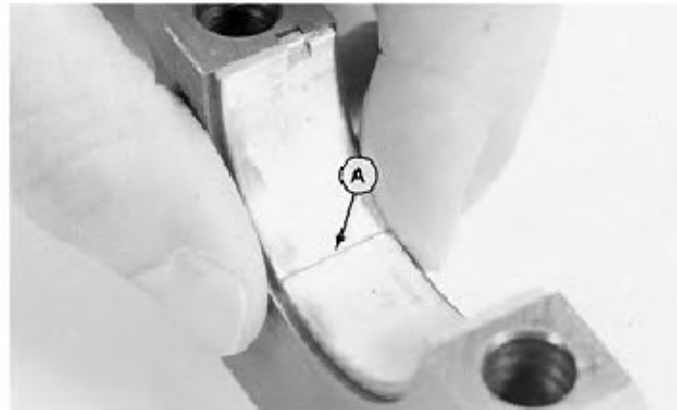
IMPORTANT: Main bearing caps must be installed on the same main bearing from which they were removed. Arrows on bearing caps point toward flywheel end of block.

- a. Remove main bearing cap.
- b. Wipe oil from bearing insert and crankshaft journal.



M21,TM330,9 -19-05MAR8

- 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.



M21,TM330,10 -19-05MAR8

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

MAIN BEARING CAP SCREW TORQUE SPECIFICATIONS

3TN66	54 N·m (40 lb-ft)
3TN75/3TNA72/3TN78/4TN78	79 N·m (58 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	98 N·m (72 lb-ft)
4TN100	196 N·m (145 lb-ft)



M21,TM330,11 -19-28AUG8

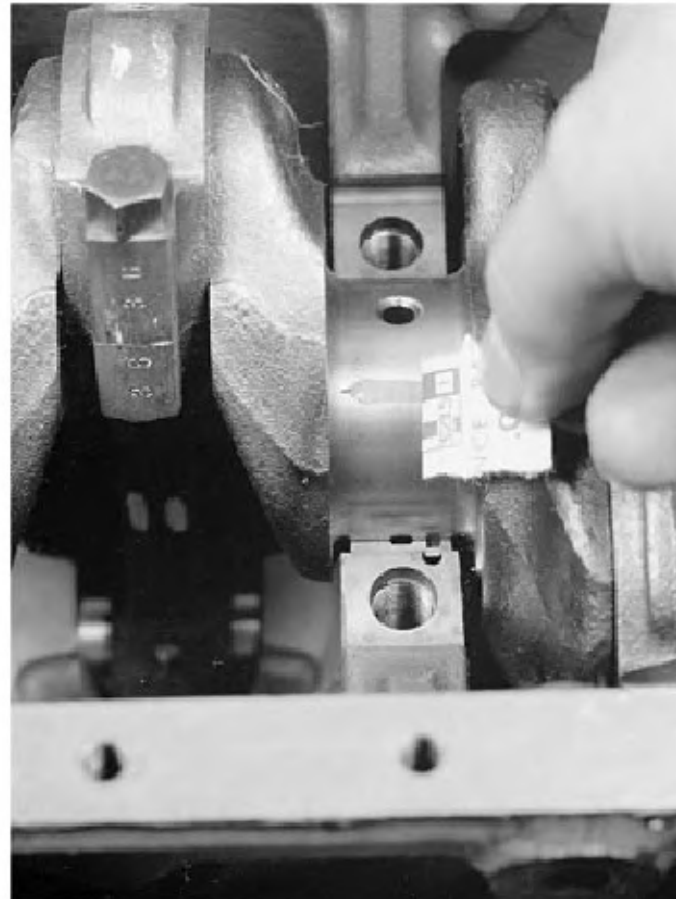
- e. Remove cap screws and main bearing cap.
- f. The flattened PLASTIGAGE will be found on either the bearing or crankshaft journal.
- g. Use the graduation marks on the envelope to compare the width of the flattened PLASTIGAGE at its WIDEST point.
- h. Determine main bearing clearance. The number within 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 SPECIFICATIONS

3TN66/3TNA72	0.15 mm (0.006 in.)
3TN75/3TN78/4TN78/ 3TN82/4TN82/ 3TN84/4TN84	0.16 mm (0.006 in.)
4TN100	0.09 mm (0.004 in.)

If clearance exceeds wear tolerance, remove crankshaft.

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



M21,TM330,12 -19-28AUG8

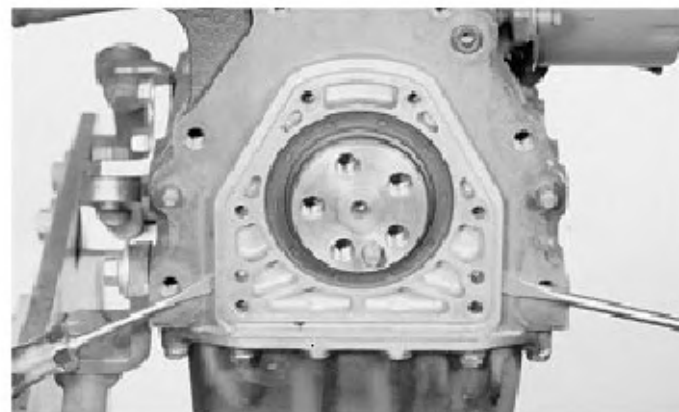
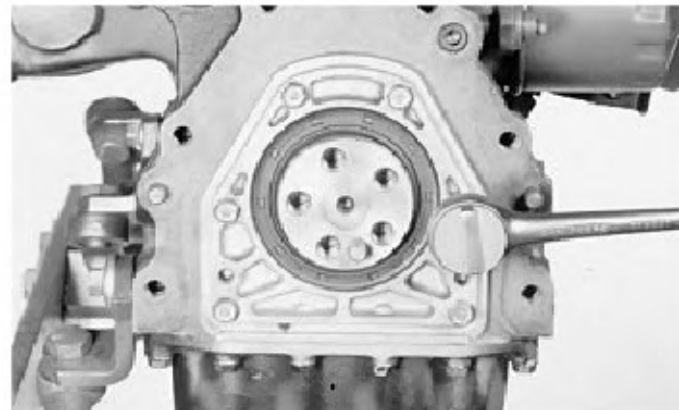
REMOVE CRANKSHAFT OIL SEAL

1. Remove engine. (See Machine Technical Manual.)
2. If equipped, remove electric clutch (A). (See Machine Technical Manual).
3. Remove flywheel assembly (B). (See Group 20 in this manual.)



M21,TM330,13 -19-05MAR88

4. Remove attaching cap screws.
5. Remove oil seal case.

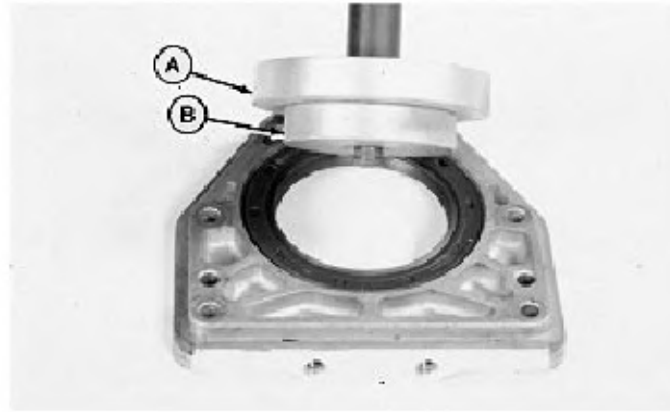


M21,TM330,14 -19-05MAR88

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)	(B)
3TN66/3TNA72	3-13/16	2-5/16
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	3-1/2	2-7/8
4TN100	4-1/2	3-3/4



M21.TM330.15 -19-06AUG87

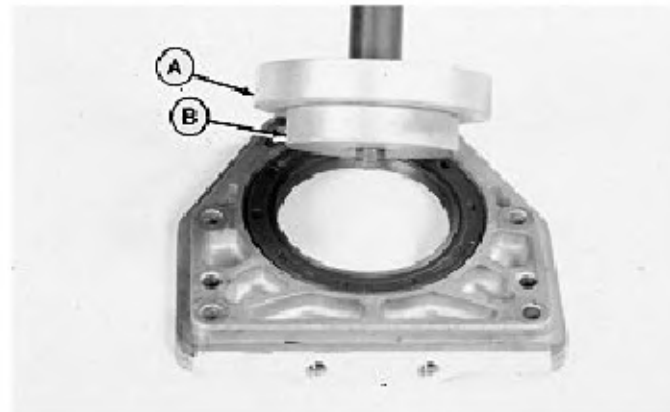
INSTALL CRANKSHAFT OIL SEAL

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 3.0 mm (0.12 in.) farther into oil seal case.

DISKS FOR SEAL INSTALLATION

Engine	Size (in.)	
	(A)	(B)
3TN66/3TNA72	3-13/16	2-5/16
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	3-1/2	2-7/8
4TN100	4-1/2	3-3/4



M21.TM330.16 -19-06AUG87

2. Apply RTV rubber silicone sealant 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.

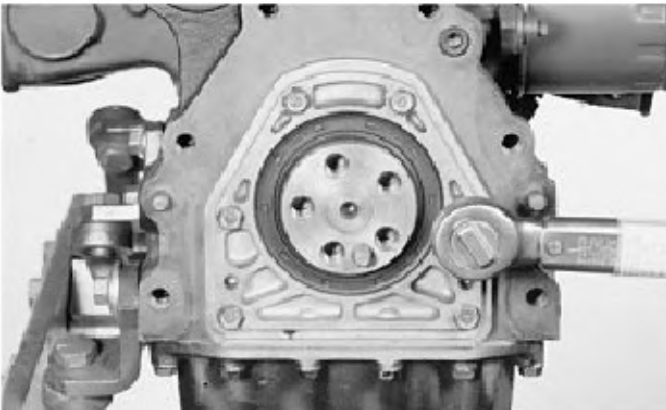
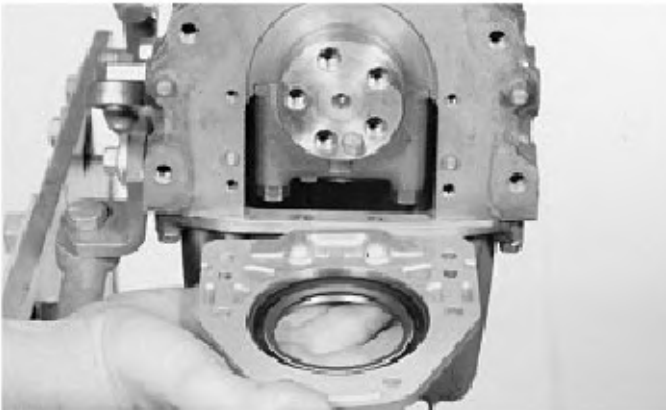
OIL SEAL CASE CAP SCREW TORQUE SPECIFICATIONS

Engine	Item	Specification
3TN66/3TNA72	Seal case to block	11 N·m (96 lb-in.)
	Oil pan to seal case	9 N·m (78 lb-in.)
3TN75/3TN78/ 3TN82/3TN84/ 4TN78/4TN82/ 4TN84	Seal case to block	26 N·m (226 lb-in.)
4TN100	Oil pan to seal case	21 N·m (180 lb-in.)

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

6. If equipped, install electric clutch. (See Machine Technical Manual).

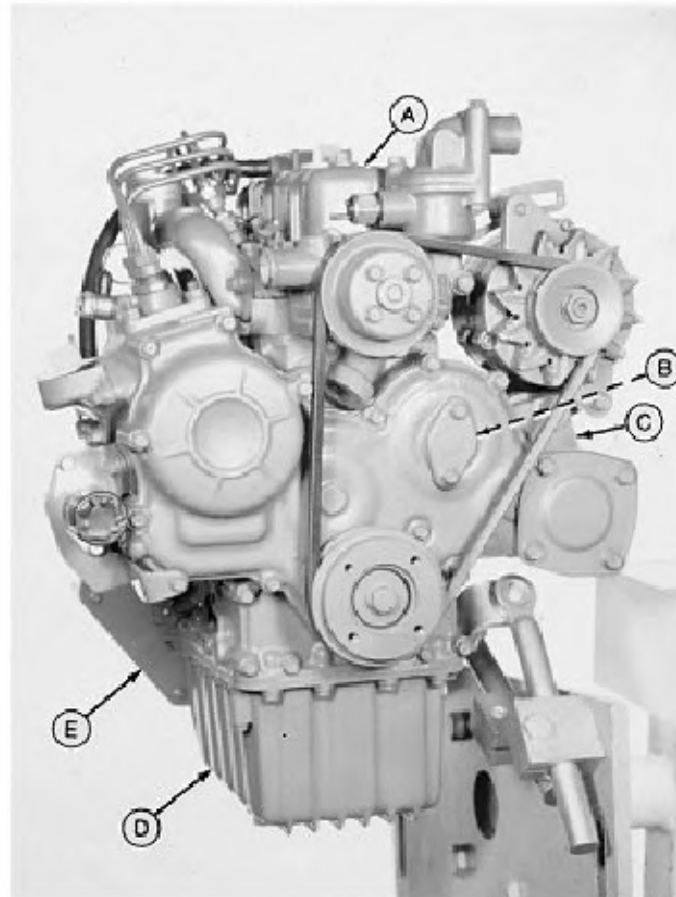
7. Install engine. (See Machine Technical Manual.)



M21,TM330,17 -19-06AUG8

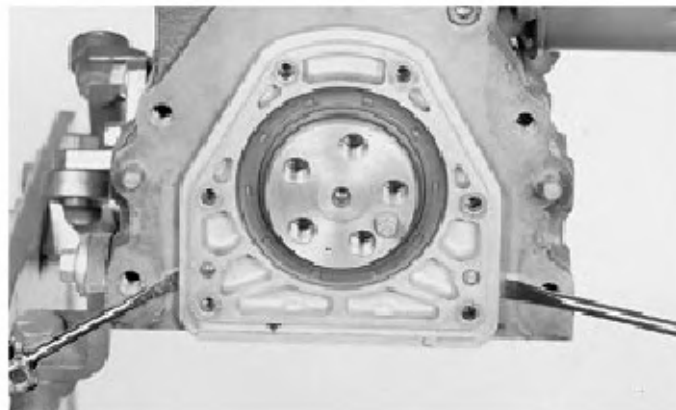
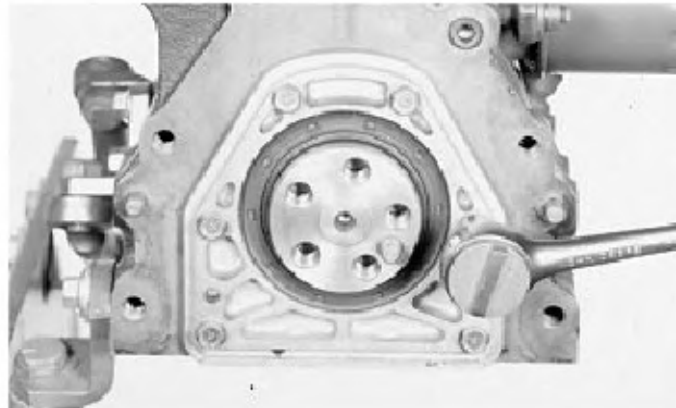
REMOVE CRANKSHAFT

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). (See Group 40 in this manual.)



M21,TM330,18 -19-23APR8

8. Remove attaching cap screws.
9. Remove oil seal case.



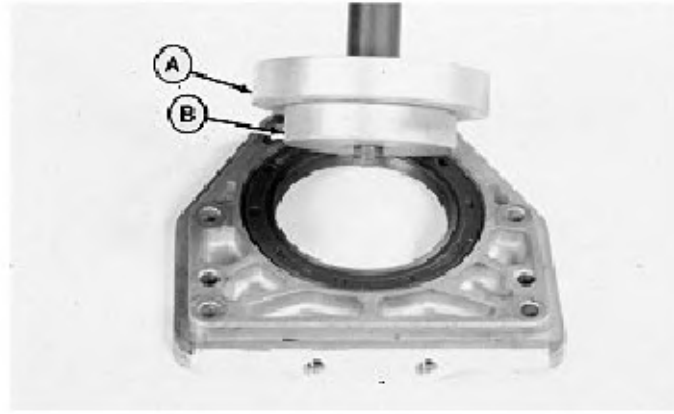
M21,TM330,19 -19-05MAR8

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

11. Remove old gasket material from plate.

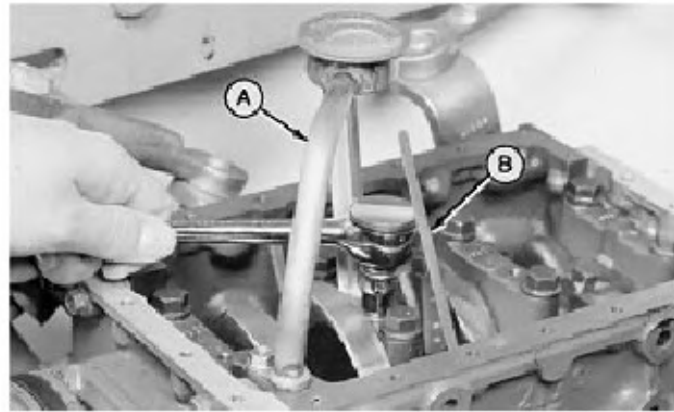
DISKS FOR SEAL REMOVAL

Engine	Size (in.)	
	(A)	(B)
3TN66/3TNA72	3-13/16	2-5/16
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	3-1/2	2-7/8
4TN100	4-1/2	3-3/4



M21,TM330,20 -19-07AUG87

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



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.

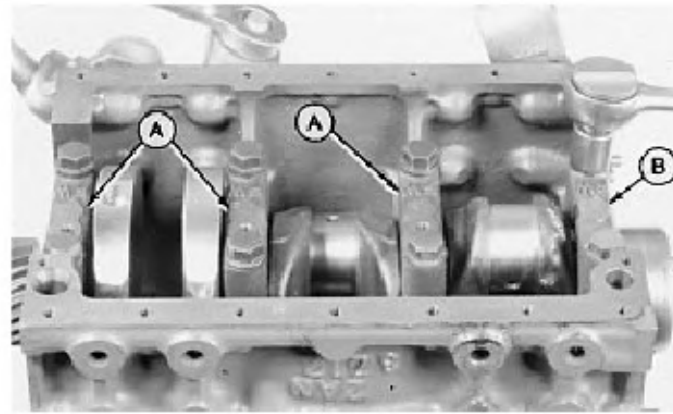


M21,TM330,22 -19-05MAR88

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

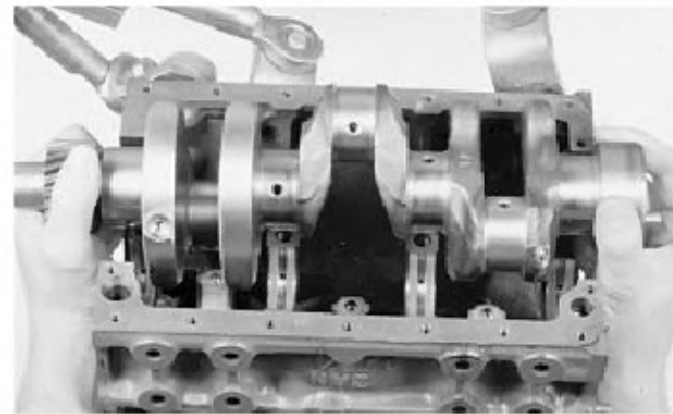
15. Remove cap screws and main bearing caps (A).

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



M21.TM330.23 -19-07AUG8

17. Remove crankshaft.



M21.TM330.24 -19-05MAR8

18. Remove thrust bearings.



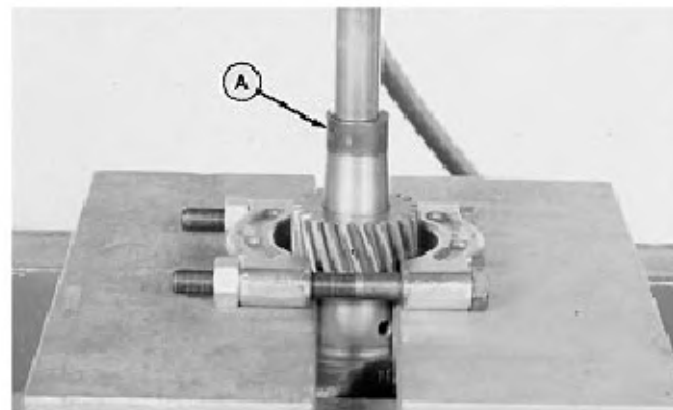
M21.TM330.25 -19-05MAR8

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.

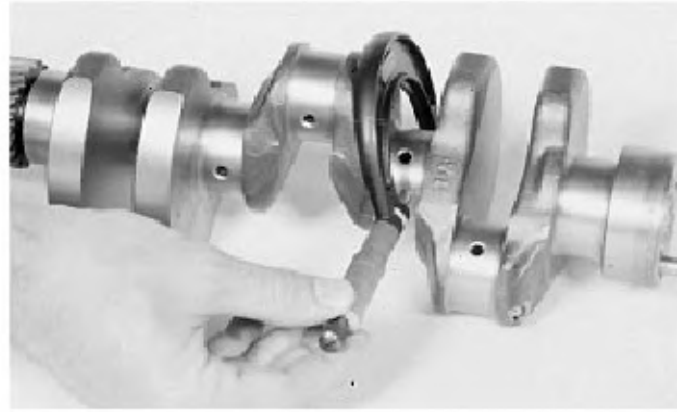


M21.TM330.26 -19-05MAR8

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.

**MAIN BEARING JOURNAL O.D. SPECIFICATIONS (MIN)**

3TN66	39.92 mm (1.572 in.)
3TNA72	43.92 mm (1.729 in.)
3TN75/3TN78/4TN78	46.91 mm (1.847 in.)
3TN82/3TN84/ 4TN82/4TN84	49.90 mm (1.965 in.)
4TN100	69.90 mm (2.752 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.

M21,TM330,27 -19-07AUG8

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 SPECIFICATIONS

3TN66	54 N·m (40 lb-ft)
3TNA72/3TN75/3TN78/4TN78	79 N·m (58 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	98 N·m (72 lb-ft)
4TN100	196 N·m (145 lb-ft)

MAIN BEARING SPECIFICATIONS

Bearing I.D. (MAX)

3TN66	40.07 mm (1.578 in.)
3TNA72	44.07 mm (1.735 in.)
3TN75/3TN78/4TN78	47.10 mm (1.854 in.)
3TN82/3TN84/ 4TN82/4TN84	50.10 mm (1.972 in.)
4TN100	0.09 mm (0.004 in.)

Clearance (MAX)

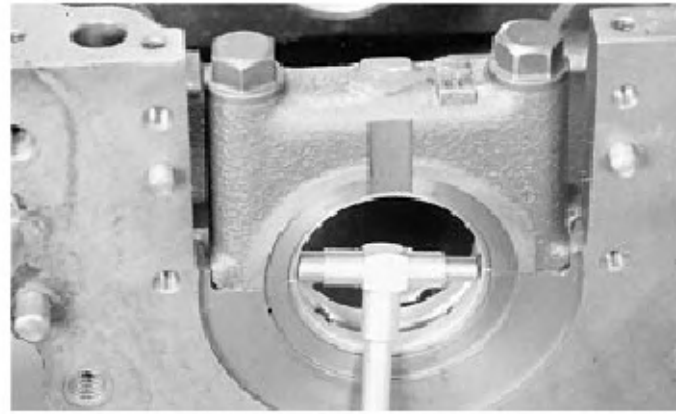
All except 4TN100	0.15 mm (0.006 in.)
4TN100	0.09 mm (0.004 in.)

If bearing diameter exceeds wear tolerance, replace bearing inserts.

If bearing clearance 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.



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.



M21.TM330.29 -19-05MAR88

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.



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 -19-28AUG88

INSTALL CRANKSHAFT

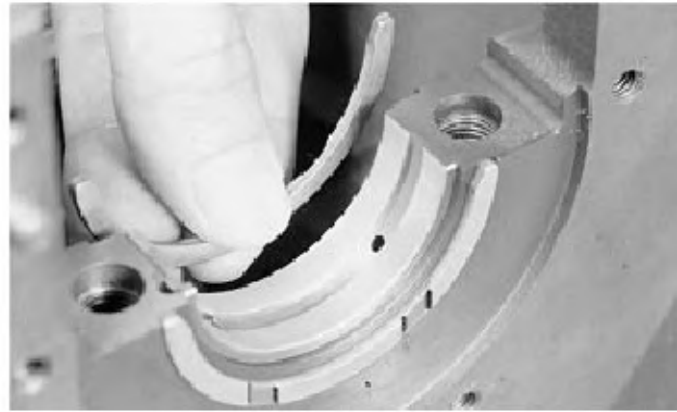
IMPORTANT: Do not touch the bearing insert surface. Oil and acid from your finger will corrode the bearing surface.

1. Install bearing inserts in crankshaft bearing bores with tang (A) in groove (B).
2. Put clean engine oil on inserts.



M21.TM330.31 -19-05MAR88

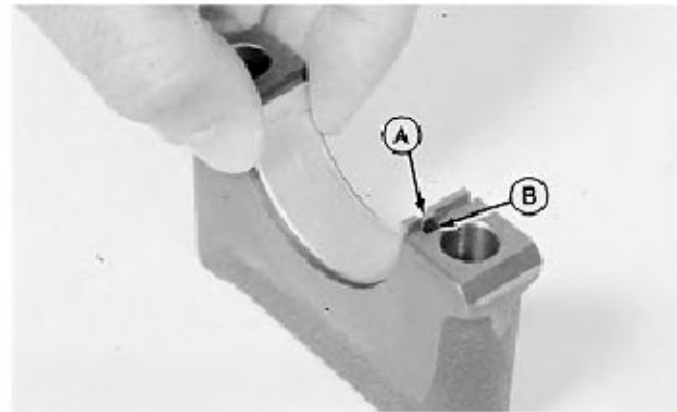
3. Install thrust bearings, with oil grooves to the outside, in the number "1" main bearing bore.



M21.TM330.32 -19-05MAR88

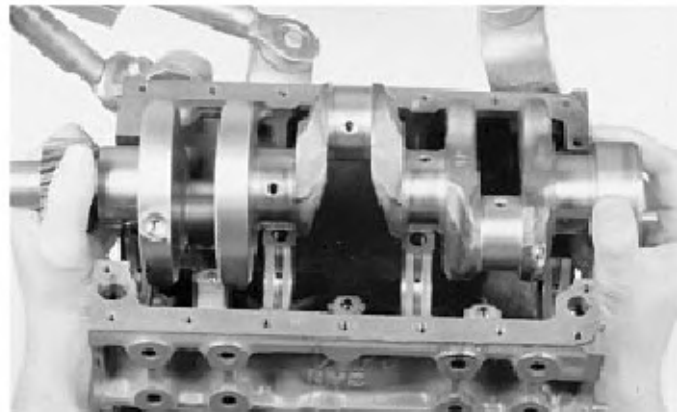
IMPORTANT: Do not touch the bearing insert surface. Oil and acid from your finger will corrode the bearing surface.

4. Install bearing inserts in main bearing caps with tang (A) in groove (B).
5. Put clean engine oil on insert.



M21.TM330.33 -19-05MAR88

6. Put clean engine oil on crankshaft main bearing journals.
7. Install crankshaft in cylinder block.



M21.TM330.34 -19-05MAR88

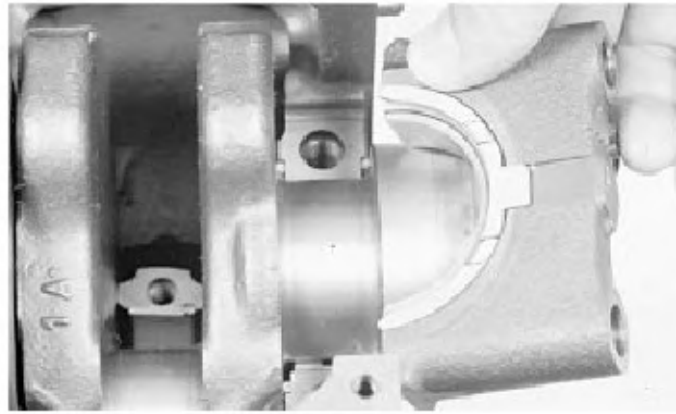
IMPORTANT: Main bearing caps must be installed on the same main bearing from which they were removed. Main bearing caps and cylinder block are numbered.

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.

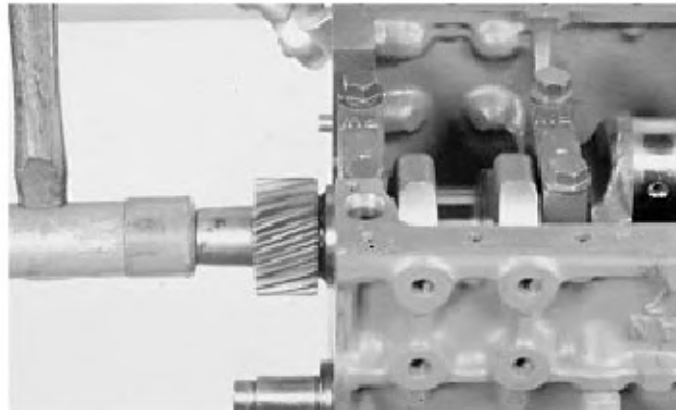
10. Dip entire main bearing cap screws in clean engine oil.

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



M21,TM330,35 -19-05MAR8

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.



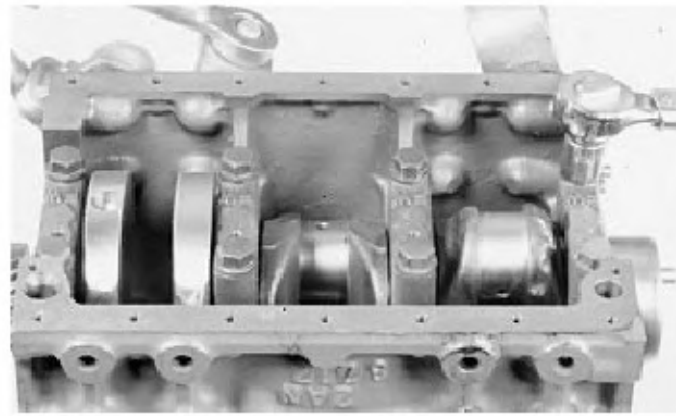
M21,TM330,36 -19-05MAR8

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 SPECIFICATIONS

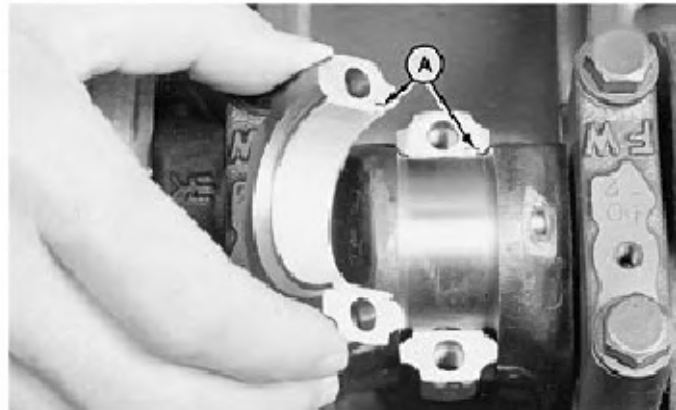
3TN66	54 N·m (40 lb-ft)
3TNA72/3TN75/3TN78/4TN78	79 N·m (58 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	98 N·m (72 lb-ft)
4TN100	196 N·m (145 lb-ft)



M21,TM330,37 -19-07AUG87

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.



M21,TM330,38 -19-05MAR88

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.

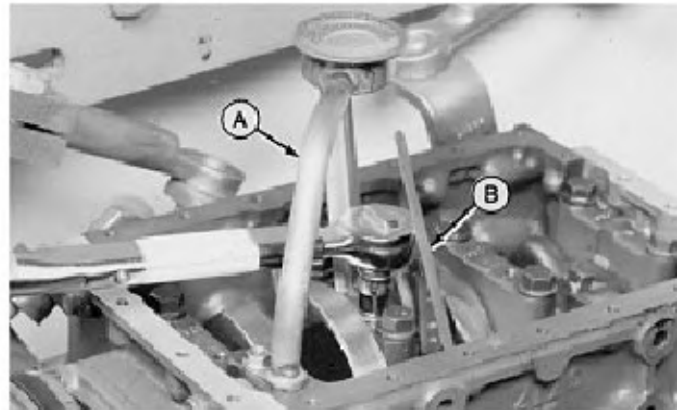
CONNECTING ROD CAP SCREW TORQUE SPECIFICATIONS

3TN66/3TNA72	23 N·m (200 lb-in.)
3TN75/3TN78/4TN78	39 N·m (29 lb-ft)
3TN82/3TN84/ 4TN82/4TN84	47 N·m (35 lb-ft)
4TN100	93 N·m (69 lb-ft)



M21,TM330,39 -19-28AUG87

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



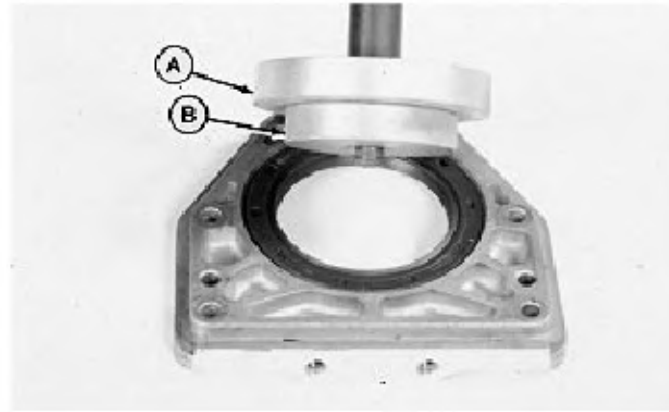
M21,TM330,40 -19-07AUG87

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 3.0 mm (0.12 in.) farther into oil seal case.

DISKS FOR SEAL INSTALLATION

Engine	Size (in.)	
	(A)	(B)
3TN66/3TNA72	3-13/16	2-5/16
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	3-1/2	2-7/8
4TN100	4-1/2	3-3/4



19. Apply RTV rubber silicone sealant 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 TORQUE

Engine	Item	Specification
3TN66/3TNA72	Seal case to block	11 N·m (96 lb-in.)
	Oil pan to seal case	9 N·m (78 lb-in.)
All except 3TN66/3TNA72	Seal case to block	26 N·m (226 lb-in.)

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

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

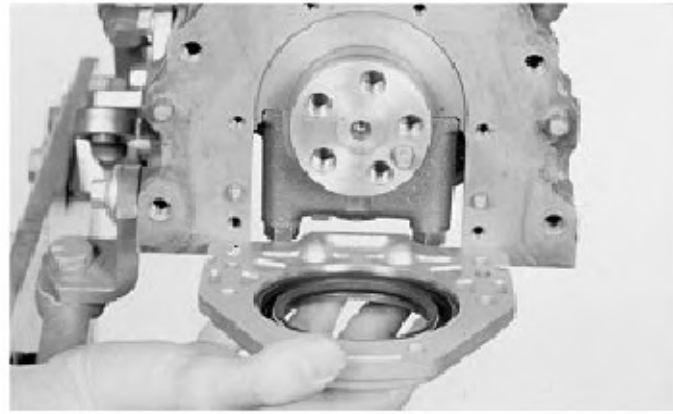
24. If equipped, install electric clutch assembly. (See Machine Technical Manual.)

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.)



M21,TM330,42 -19-28AUG8

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 -19-23MAY8

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.

LOCTITE is a trademark of the LOCTITE Corp.

M21,TM335,2 -19-07AUG8

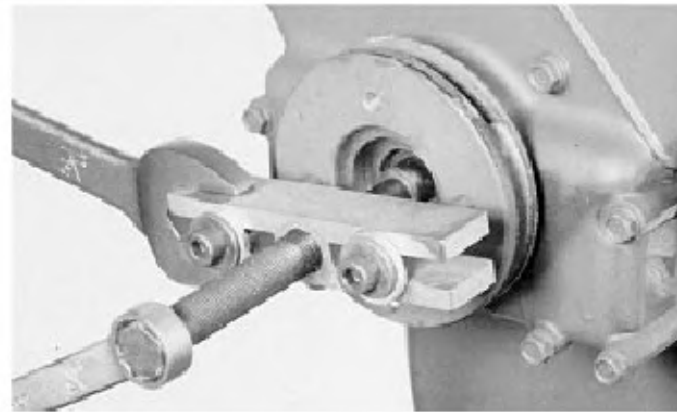
REMOVE TIMING GEAR COVER

1. Remove engine. (See Machine Technical Manual.)
2. Remove fan, if equipped.
3. Remove alternator belt and alternator.
4. Hold crankshaft pulley using a strap wrench. Remove cap screw and washer.



M21.TM335.5 -19-07AUG87

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



M21.TM310.38 -19-18FEB88

NOTE: For all engines except 3TNA72UJ (Early Units) go to step 8.

6. Remove cotter pin and washer (A) to disconnect fuel shut-off solenoid linkage.



M21.TM310.39 -19-18FEB88

7. Remove two nuts and one cap screw to remove bracket and fuel shut-off solenoid.



M21.TM310.40 -19-18FEB88

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

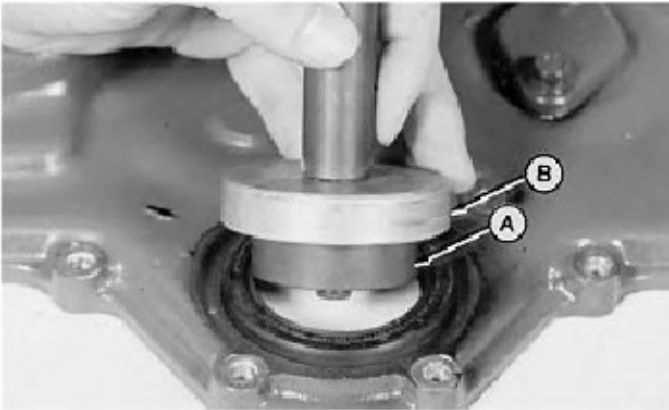


M21,TM310,41 -19-18FEB8

9. Remove seal using the correct driver disks (A and B) or screwdriver.

DISKS FOR SEAL REMOVAL

Engine	Size (in.)	
	(A)	(B)
3TN66	1 11/16	2 3/8
3TNA72	1 3/4	2 7/16
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	2 1/8	2 3/4
4TN100	1 5/8	2 3/8



M21,TM310,42 -19-07AUG8

INSTALL TIMING GEAR COVERS

- 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)
3TN66	1 11/16	2 1/2
3TNA72	1 3/4	2 9/16
3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84	2 1/8	2 7/8
4TN100	1 5/8	2 1/2

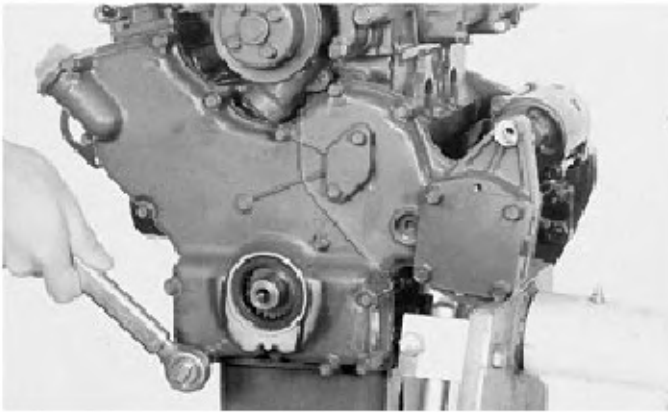


M21,TM335.6 -19-07AUG8

- 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

3TN66/3TNA72	9 N·m (78 lb-in.)
All except 3TN66/3TNA72	26 N·m (226 lb-in.)



M21,TM335.7 -19-07AUG8

NOTE: For all engines except 3TNA72UJ (Early Units), go to step 7.

5. Install bracket and fuel shut-off solenoid. Install and tighten two nuts and cap screws to 9 N·m (78 lb-in.).



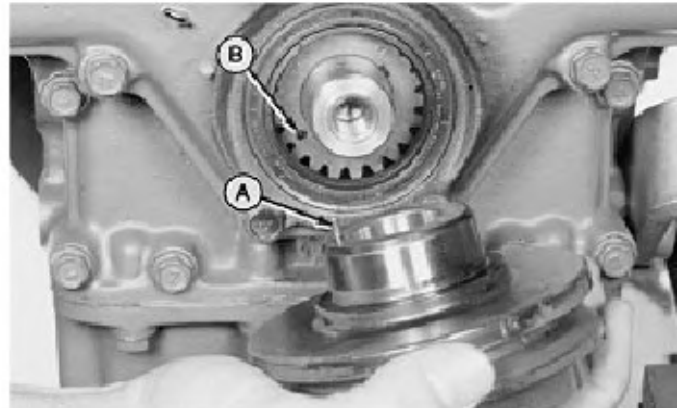
M21,TM335.8 -19-07AUG8

6. Fasten fuel shut-off solenoid linkage with washer and cotter pin.



M21,TM335.9 -19-01SEP8

7. Align pin (A) (if equipped) in crankshaft pulley with hole (B). Install pulley.

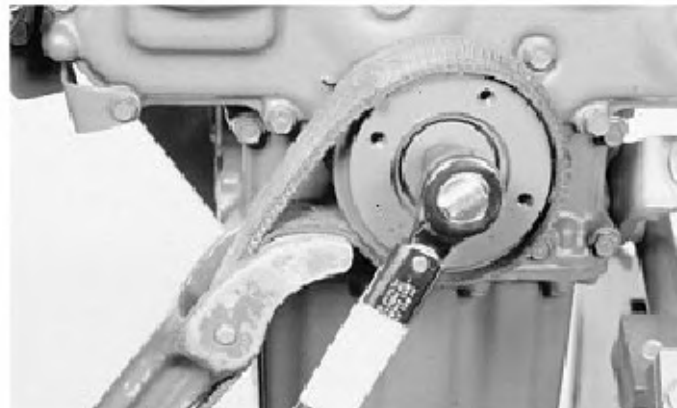


M21,TM335.10 -19-01SEP8

8. 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).

9. Install alternator, alternator belt, and fan, if equipped.

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



M21,TM335.11 -19-07AUG8

REMOVE AND INSPECT TIMING GEARS (EARLY 3TNA72UJ)

1. Measure backlash between gears.

TIMING GEAR BACKLASH SPECIFICATIONS (MAX)

Fuel Injection Pump (A)	0.20 mm (0.008 in.)
Idler (B)	0.20 mm (0.008 in.)
Camshaft (C)	0.20 mm (0.008 in.)
Crankshaft (D)	0.20 mm (0.008 in.)
Oil Pump (E)	0.25 mm (0.010 in.)

If backlash exceeds the wear tolerance specifications, replace gears as necessary.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. Number one cylinder is closest to the flywheel.



M21.TM335.12 -19-23APR88

2. Remove idler gear. Inspect gear for chipped or broken teeth; replace if necessary.



M21.TM335.13 -19-07FEB88

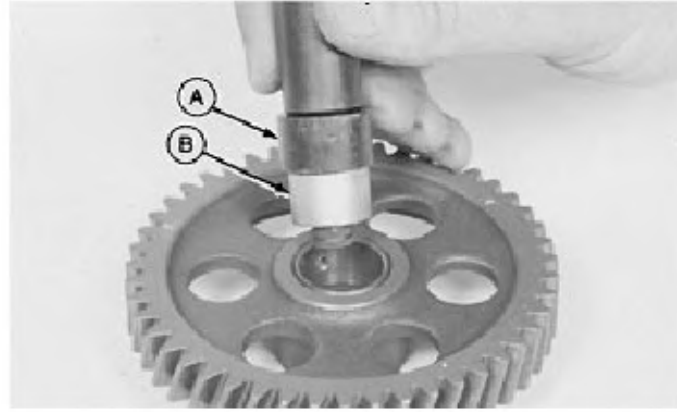
3. Measure bushing inside diameter.

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



M21.TM335.14 -19-07FEB88

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



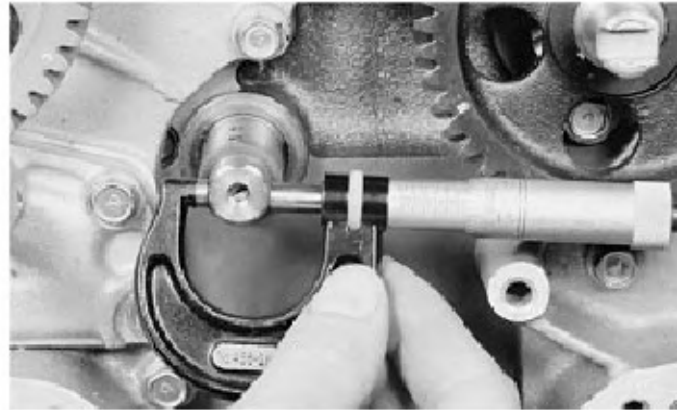
M21,TM335,15 -19-07FEB88

5. Measure idler shaft diameter.

If diameter is less than 19.3 mm (0.785 in.), replace idler shaft.

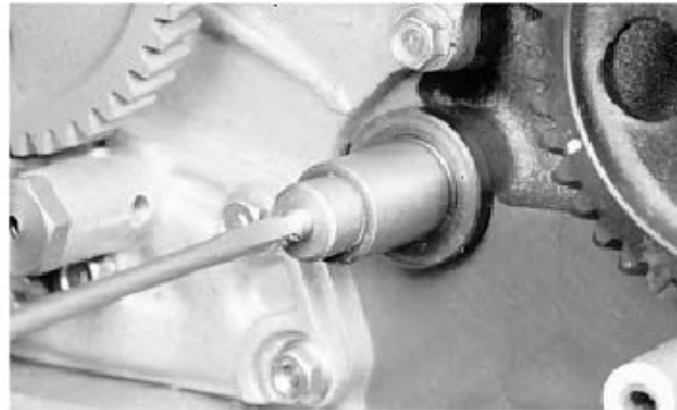
6. Determine idler shaft clearance (bushing diameter minus shaft diameter).

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



M21,TM335,16 -19-07FEB88

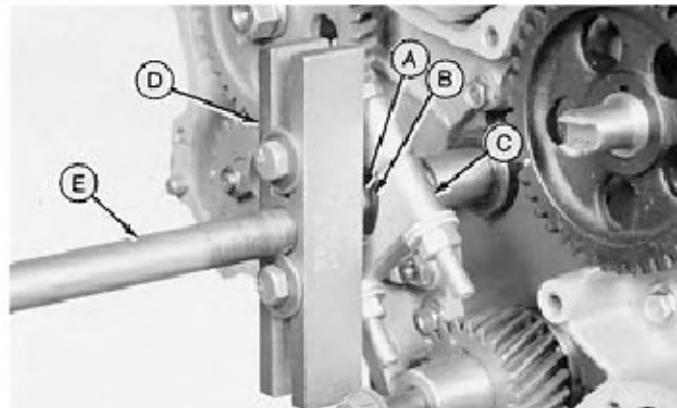
7. Remove set screw.



M21,TM335,17 -19-07FEB88

8. Remove idler shaft using a slide hammer and puller.

- A—Gear Housing Cover Cap Screw
- B—Washer
- C—Bearing Puller
- D—H-Bar
- E—Slide Hammer



M21,TM335,18 -19-07FEB88

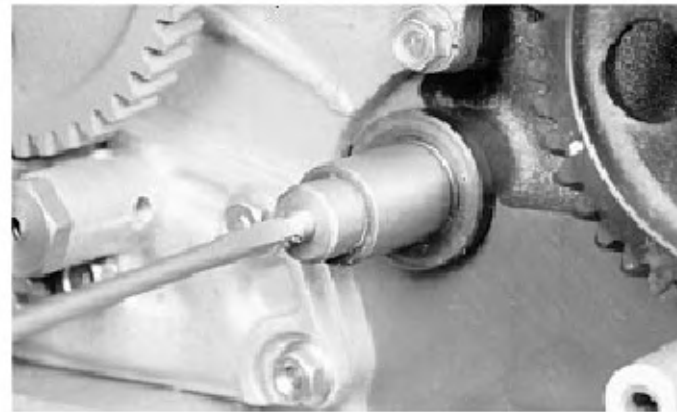
INSTALL TIMING GEARS (EARLY 3TNA72UJ)

1. Thoroughly clean and dry all parts.
2. Install idler shaft with flange toward cylinder block. Idler shaft flange must be tight against bottom of cylinder block bore.



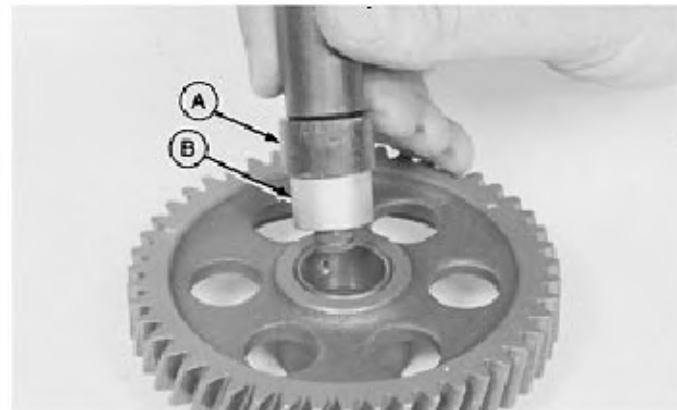
M21.TM335.19 -19-07FEB8

3. Install and tighten set screw.



M21.TM335.20 -19-07FEB8

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



M21.TM335.21 -19-07FEB8

6. Install gears, if removed.
7. Align timing marks between crankshaft, idler, fuel injection pump, and camshaft gears.

NOTE: Number one cylinder is closest to flywheel.

8. Carefully install idler gear.

TIMING MARKS

Timing Mark	Gear
"A—A"	Crankshaft-to-idler
"B—B"	Engine Camshaft-to-idler
"C—C"	Fuel Injection Pump Camshaft-to-Idler



M21,TM335,22 -19-23APR88

REMOVE AND INSPECT TIMING GEARS (3TN66/LATER 3TNA72)

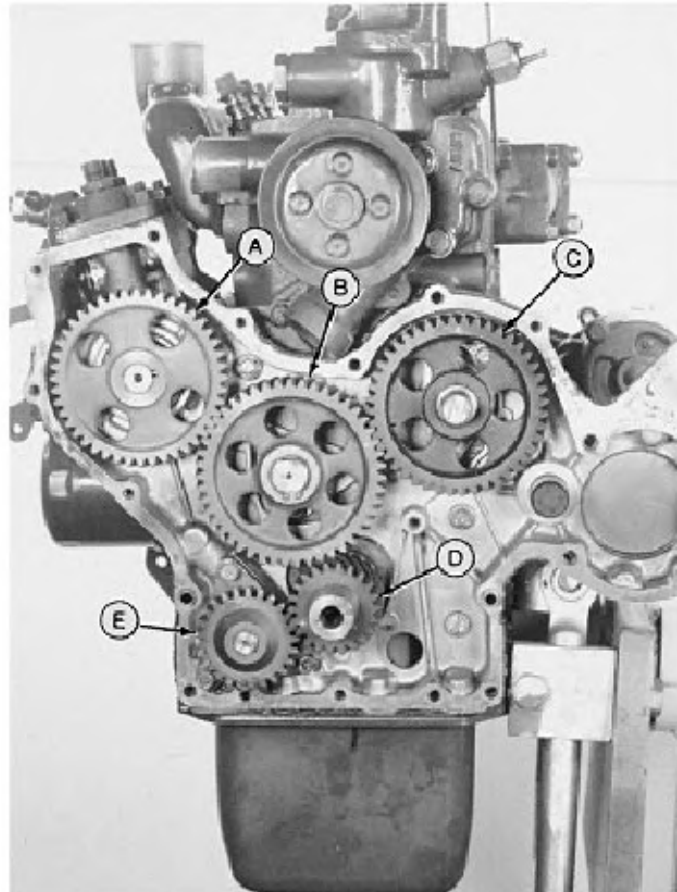
1. Measure backlash between gear.

TIMING GEAR BACKLASH SPECIFICATIONS (MAX)

Fuel Injection Pump (A)	0.20 mm (0.008 in.)
Idler (B)	0.20 mm (0.008 in.)
Camshaft (C)	0.20 mm (0.008 in.)
Crankshaft (D)	0.20 mm (0.008 in.)
Oil Pump (E)	0.25 mm (0.010 in.)

If backlash exceeds the wear tolerance specifications, replace gears as required.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. Number one cylinder is closest to the flywheel.



M21,TM335,23 -19-08AUG88

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



M21.TM335.24 -19-07FEB88

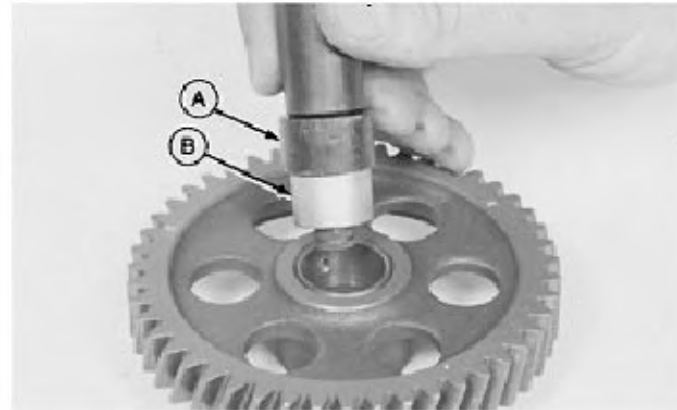
3. Measure bushing inside diameter.

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



M21.TM335.14 -19-07FEB88

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



M21.TM335.15 -19-07FEB88

5. Measure idler shaft diameter.

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

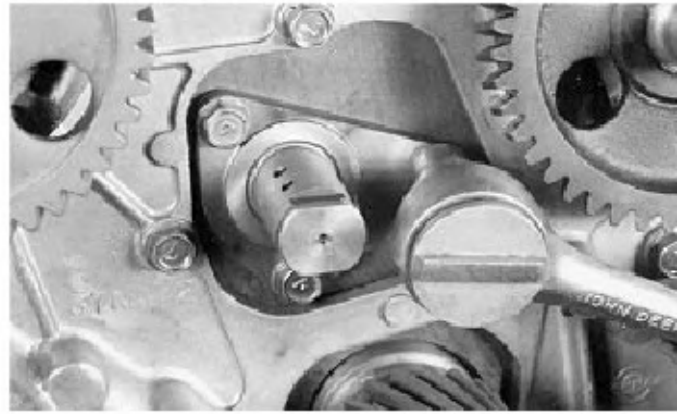
6. Determine idler shaft oil clearance (bushing diameter minus shaft diameter).

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



M21.TM335.25 -19-23APR88

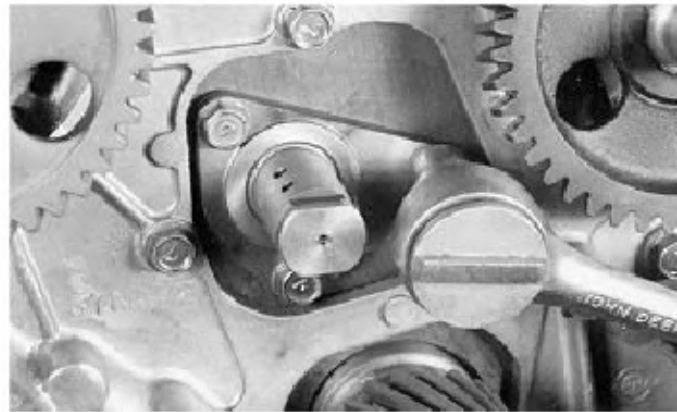
7. Remove three cap screws to remove idler shaft.



M21,TM335,26 -19-07FEB88

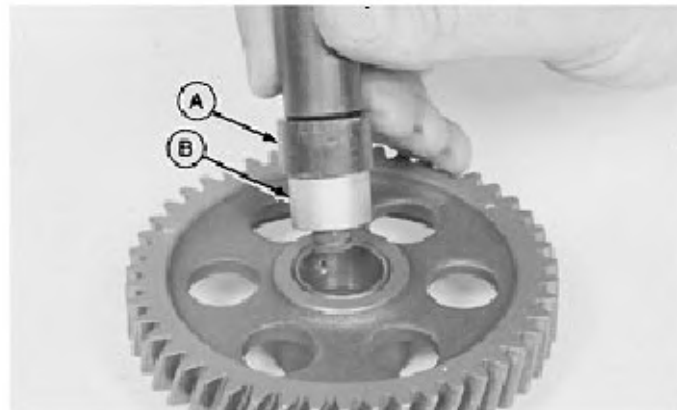
INSTALL TIMING GEARS (3TN66/LATER 3TNA72)

1. Thoroughly clean and dry all parts.
2. Install idler shaft and three cap screws. Tighten cap screws.



M21,TM335,27 -19-08AUG88

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).

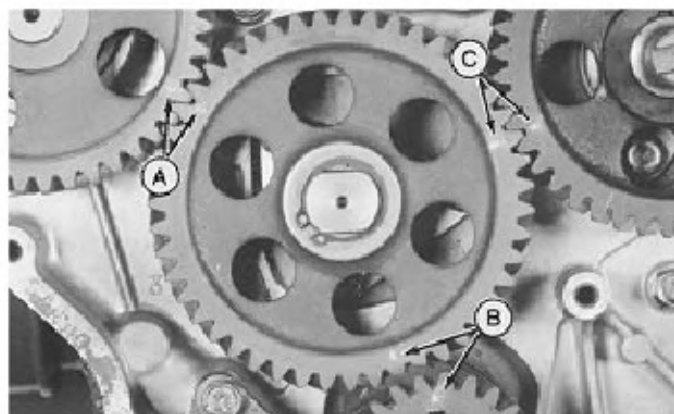


M21,TM335,28 -19-07FEB88

5. Install gears, if removed.
6. Align timing marks (A, B, and C) between crankshaft, idler, fuel injection pump and camshaft gears.

NOTE: Number one cylinder is closest to the flywheel.

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



(Later 3TNA72UJ)



(3TN66UJ)

M21,TM335,29 -19-23APR8

REMOVE AND INSPECT TIMING GEARS (ALL EXCEPT 3TN66/3TNA72)

1. Measure backlash between gears.

TIMING GEAR BACKLASH SPECIFICATIONS (MAX)

3TN75/3TN78/3TN82/3TN84/4TN78/4TN82/4TN84

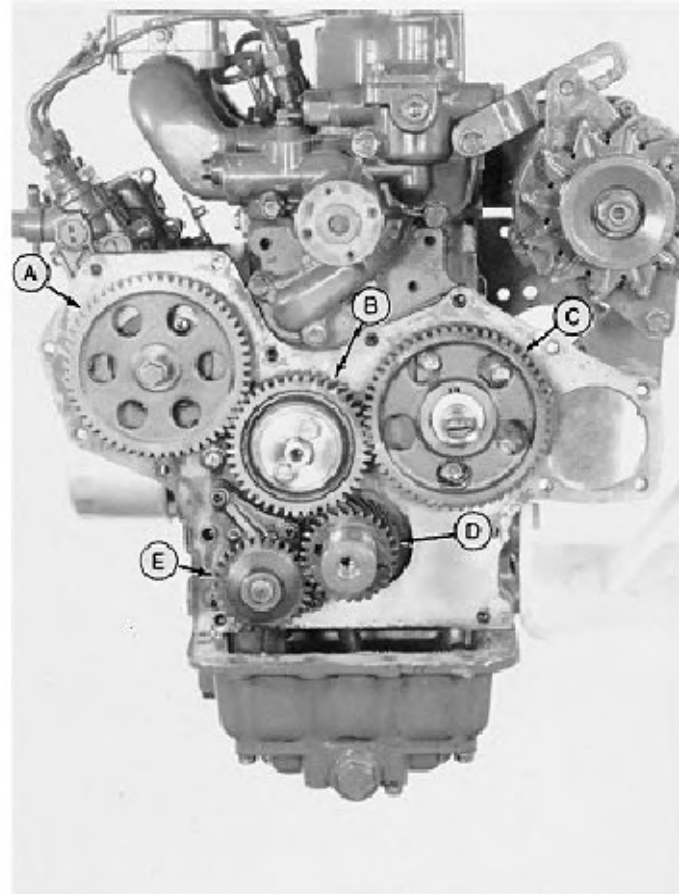
Fuel Injection Pump (A)	0.20 mm (0.008 in.)
Idler (B)	0.20 mm (0.008 in.)
Camshaft (C)	0.20 mm (0.008 in.)
Crankshaft (D)	0.20 mm (0.008 in.)
Oil Pump (E)	0.20 mm (0.008 in.)

4TN100

Fuel Injection Pump (A)	0.25 mm (0.010 in.)
Idler (B)	0.25 mm (0.010 in.)
Camshaft (C)	0.25 mm (0.010 in.)
Crankshaft (D)	0.25 mm (0.010 in.)
Oil Pump (E)	0.25 mm (0.010 in.)

If backlash exceeds the wear tolerance specifications, replace gears as required.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. Number one cylinder is closest to the flywheel.



M21.TM335.30 -19-08AUG8

2. Remove two cap screws to remove idler shaft and idler gear. Inspect gear for chipped or broken teeth; replace if necessary.



M21.TM335.31 -19-07FEB8

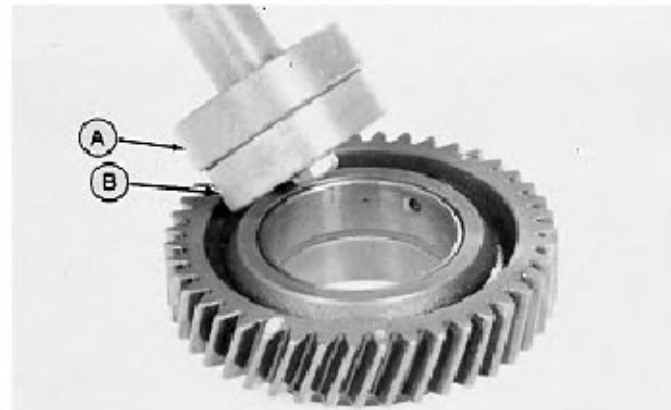
3. Measure bushing inside diameter.

If diameter exceeds 46.08 mm (1.814 in.), replace bushing.



M21.TM335.32 -19-23APR8

4. If necessary, remove bushing using a 1 15/16 in. driver disk (A) and 1 13/16 in. driver disk (B).



M21.TM335.33 -19-07FEB8

5. Measure idler shaft diameter.

If diameter is less than 45.93 mm (1.808 in.), replace idler shaft.

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

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



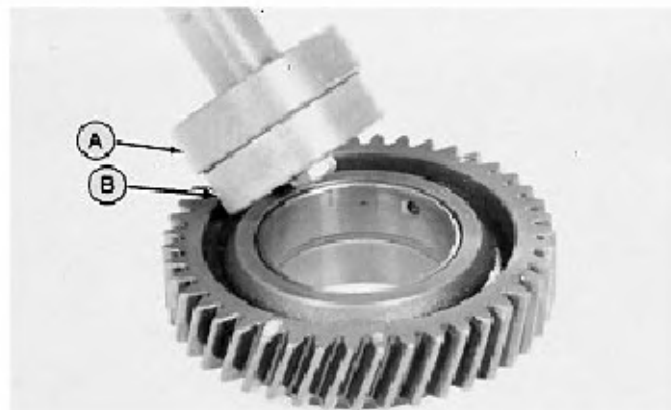
M21.TM335.34 -19-07FEB8

INSTALL TIMING GEARS (ALL EXCEPT 3TN66/3TNA72)

1. Thoroughly clean and dry all parts.

2. Align oil holes in bushing and idler gear.

3. Install bushing even with surface of idler gear using a 2 1/4 in. driver disk (A) and 1 13/16 in. driver disk (B).



M21.TM335.35 -19-10AUG8

4. Install gears, if removed.
5. Align timing marks (A, B, and C) between crankshaft, idler, fuel injection pump, and camshaft gear.
6. Carefully install idler gear.
7. Install idler shaft and two cap screws. Tighten cap screws

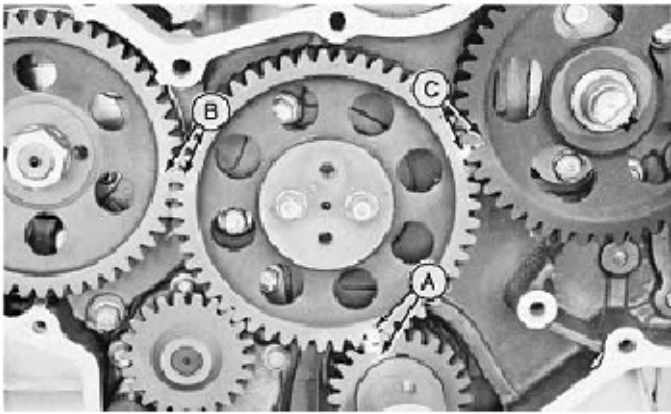
TIMING MARKS

Timing Mark	Gear
"A—A"	Engine Camshaft-to-idler
"B—B"	Fuel Injection Pump-to-idler
"C—C"	Crankshaft-to-idler

"A—A"	Crankshaft-to-idler
"B—B"	Fuel Injection Pump-to-idler
"C—C"	Engine camshaft-to-idler



3TN75, 78, 82, 84/4TN78, 82, 84



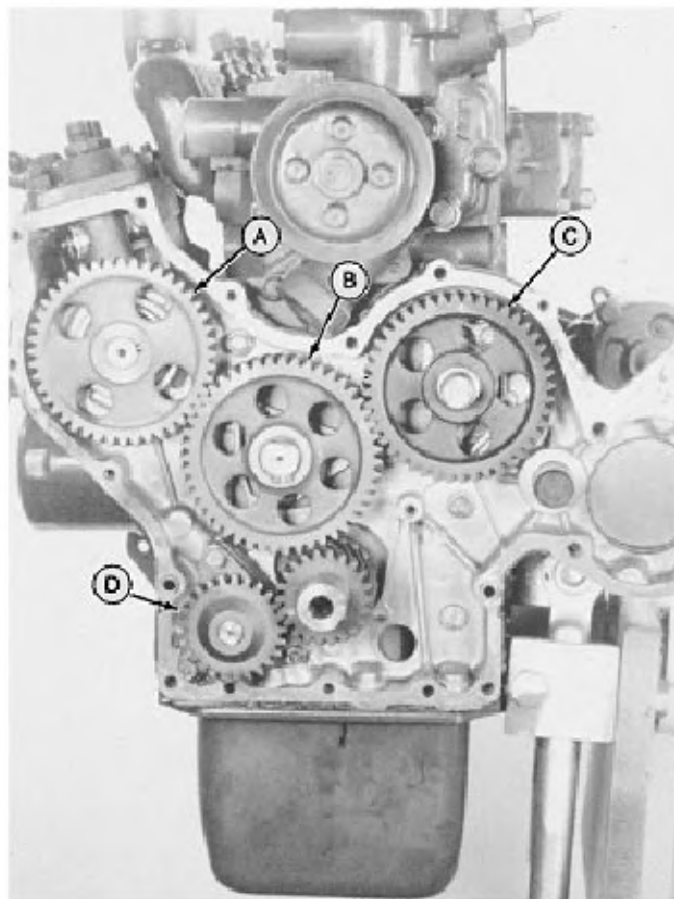
4TN100

M21, TM335, 36 -19-10AUG87

REMOVE GEAR HOUSING

1. Remove timing gear cover. (See Group 35 in this manual).
2. Remove fuel injection pump and camshaft (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—Injection Pump Camshaft/Gear
 B—Idler Gear
 C—Engine Camshaft/Gear
 D—Oil Pump/Gear



Later 3TNA72UJ Shown

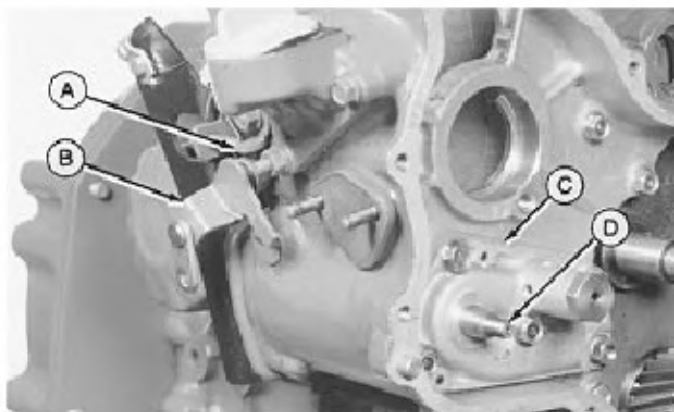
35
16

M21,TM335,37 -19-10AUG87

NOTE: For all engines except early 3TNA72U go to step 12.

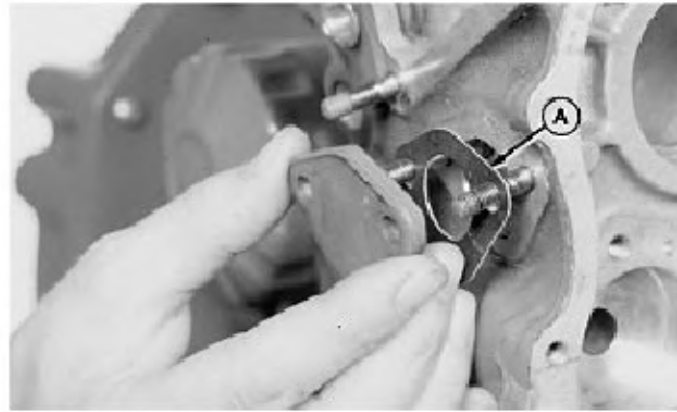
6. Remove throttle linkage (A). (See Group 55 in this manual).
7. Remove governor linkage (B). See Group 55 in this manual.)
8. Remove oil pump cover (C) and oil pump (D). (See Group 40 in this manual.)

A—Throttle Linkage
 B—Governor Linkage
 C—Oil Pump Cover
 D—Oil pump



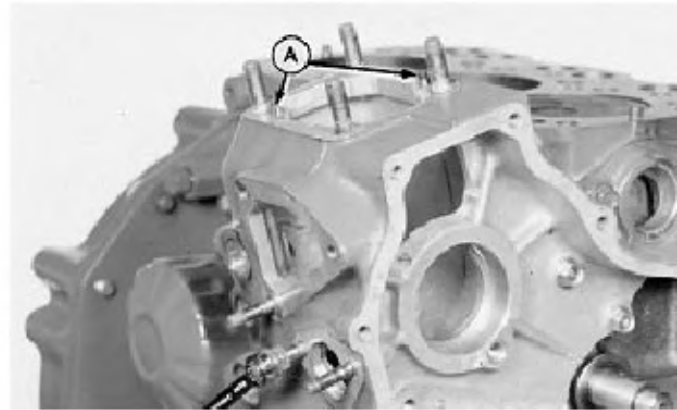
M21,TM335,38 -19-07FEB88

9. Remove cover and gasket (A).



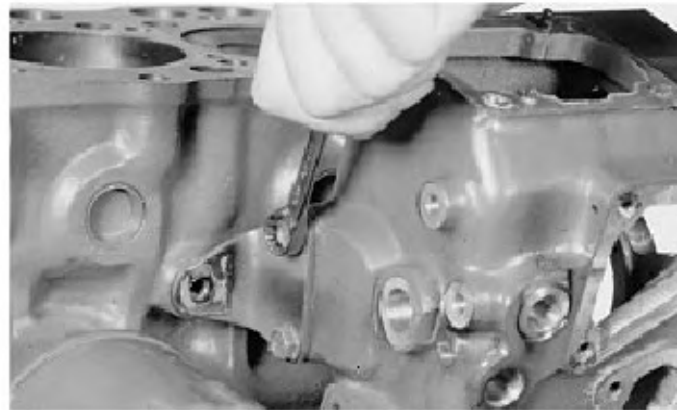
M21,TM335.39 -19-07FEB8

10. Remove seven studs and two spring pins (A).



M21,TM335.40 -19-11MAR8

11. Remove two cap screws to remove bracket.

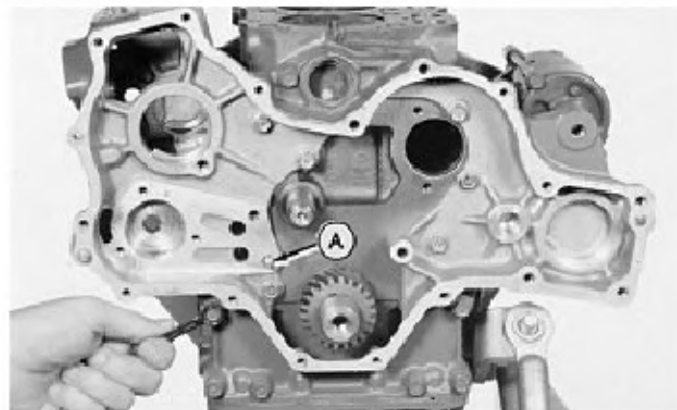


M21,TM335.41 -19-07FEB8

NOTE: Early 3TNA72UJ: be careful not to lose special screws (A) while removing gear housing.

12. Remove cap screws to remove gear housing.

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



3TNA72UJ Shown

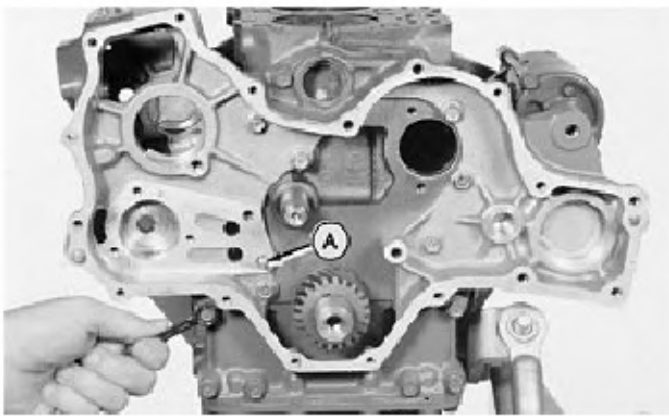
M21,TM335.42 -19-07FEB8

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.
- NOTE: Early 3TNA72: Install special screw (A) before installing gear housing.*
- 3. Align gear housing holes with dowel pins on the cylinder block. Install gear housing.
- 4. Install and tighten cap screws.

CAP SCREW TORQUE SPECIFICATIONS

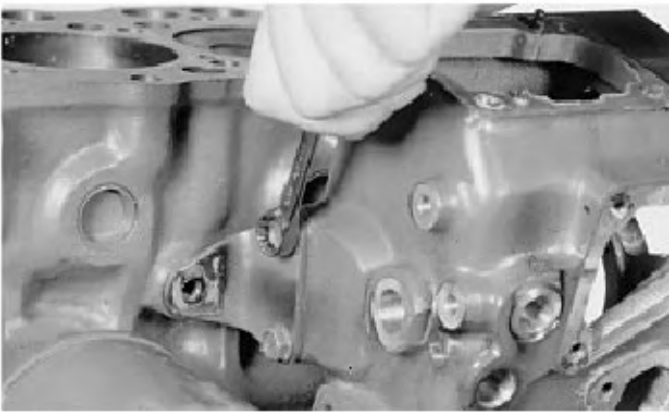
3TN66/3TNA72	
Cast Iron	11 N·m (96 lb-in.)
Aluminum	9 N·m (78 lb-in.)
All except 3TN66/3TNA72	
Cast Iron	25 N·m (220 lb-in.)
Aluminum	20 N·m (177 lb-in.)



M21,TM335,43 -19-10AUG87

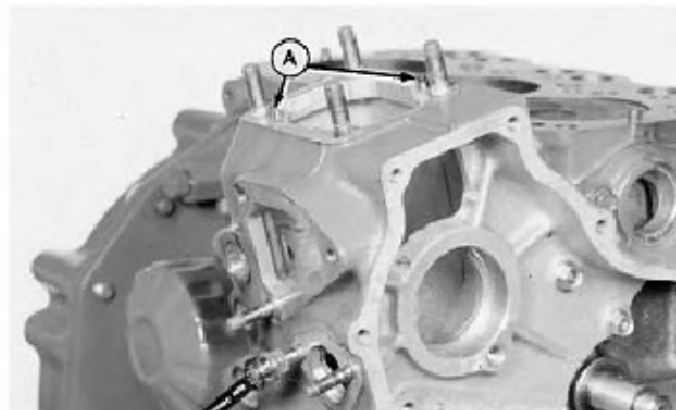
NOTE: For all engines except early 3TNA72UJ go to step 13.

- 5. Install bracket and fasten with two cap screws.



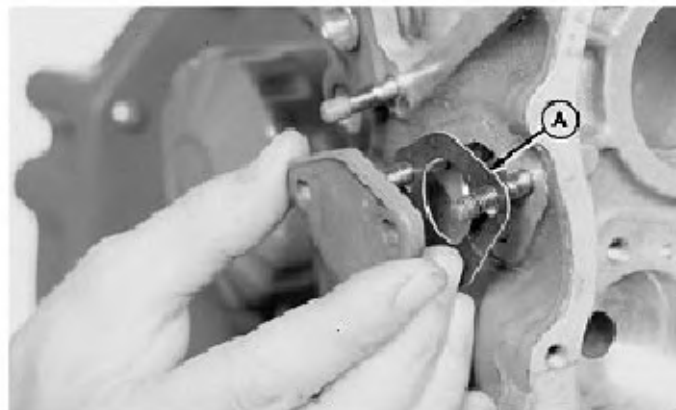
M21,TM335,44 -19-07FEB88

6. Install two spring pins (A).
7. Apply thread lock and sealer (low strength) on the threads of studs.
8. Install seven studs with short-threaded end in gear housing.



M21.TM335.45 -19-07FEB88

9. Install new gasket (A) and cover.



M21.TM335.46 -19-07FEB88

10. Install oil pump (D) and oil pump cover (C). (See Group 40 in this manual.)
11. Install governor linkage (B). (See Group 55 in this manual.)
12. Install throttle linkage (A). (See Group 55 in manual.)

A—Throttle Linkage
B—Governor Linkage
C—Oil Pump Cover
D—Oil Pump



M21.TM335.47 -19-23APR88

13. 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.

14. Install injection pump camshaft (C). (See Group 50 in this manual.)

15. Install camshaft (B). (See Group 10 in this manual.)

16. Install idler gear (A). (See Group 35 in this manual.)

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



A—Idler Gear
B—Engine Camshaft/Gear
C—Injection Pump Camshaft/Gear
D—Oil Pump/Gear

M21,TM335.48 -19-07FEB8

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

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 INSTALL OIL PAN

1. Drain engine oil. (See Machine Technical Manual for engine oil capacity specifications.)
2. Remove engine oil dipstick.
3. Remove cap screws (A and B) to remove oil pan.
4. Remove cap screws to remove oil strainer tube and seal.

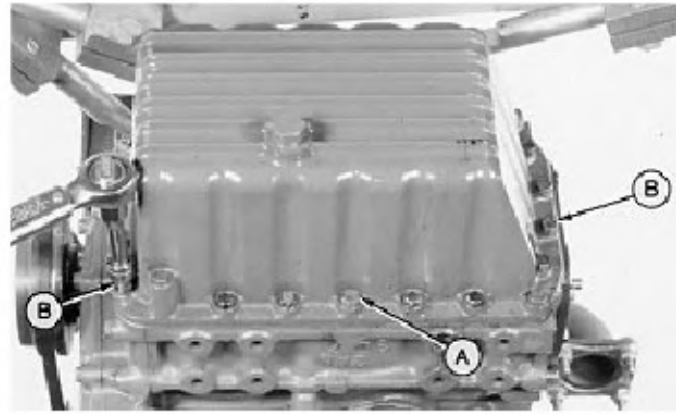
NOTE: For all engines except 4TN100, go to step 9.

5. Remove cap screws to remove oil pan spacer.
6. Remove old gasket material from spacer and engine block. Clean and dry gasket application surfaces.
7. Apply plastic gasket, or an equivalent, to spacer.
8. Install spacer. Tighten cap screws to specifications.

IMPORTANT: DO NOT reuse oil strainer tube seal. To avoid oil leakage install new seal.

9. Install seal and oil strainer tube. Tighten cap screws to specifications.

10. Remove old gasket material from oil pan and engine block (or spacer). Clean and dry gasket application surfaces.



3TNA72 Shown



3TNA72 Shown

11. Apply plastic gasket, or an equivalent, to oil pan.
12. Install oil pan. Tighten cap screws to specifications.
13. Install dipstick. Fill engine with oil to specifications.
(See Machine Technical Manual for type and capacity of engine oil.)

CAP SCREW TORQUE SPECIFICATIONS

Strainer Tube

3TN66/3TNA72	11 N·m (96 lb-in.)
All except 3TN66/3TNA72	26 N·m (226 lb-in.)

Oil Pan-to-Block

3TN66/3TNA72	11 N·m (96 lb-in.)
All except 3TN66/3TNA72	26 N·m (226 lb-in.)

Oil Pan-to-Gear Housing Cover

3TN66/3TNA72	9 N·m (78 lb-in.)
3TN75/3TN78/3TN82/3TN84/	

4TN78/4TN82/4TN84	26 N·m (226 lb-in.)
4TN100	21 N·m (180 lb-in.)

Oil Pan Spacer-to-Block

4TN100	
M8	26 N·m (226 lb-in.)
M12	88 N·m (65 lb-ft)

Oil Pan Spacer-to-Crankshaft Seal Case

4TN100	21 N·m (180 lb-in.)
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MX,TM340,A14A -19-12JUL8

REMOVE OIL PUMP (EARLY 3TNA72UJ ENGINES)

1. Remove engine. (See Section 20 in Machine Technical Manual.)
2. Remove fuel injection lines (A) and fuel injection pump (B) as instructed in Group 50.
3. Remove alternator belt.



M21,TM340,5 -19-23APR8

4. Remove crankshaft pulley cap screw and washer.
5. Remove crankshaft pulley. Use a puller, shaft protector, two cap screws from water pump, and a strap wrench.



M21.TM340.6 -19-05MAR88

6. Disconnect shut-off linkage. Remove two nuts and cap screw to remove fuel shut-off solenoid bracket.



M21.TM340.7 -19-05MAR88

7. Remove 17 cap screws to remove gear housing cover. Remove old gasket material from cover and gear housing.



M21.TM340.8 -19-05MAR88

8. Measure oil pump gear backlash using a dial indicator. New backlash specification is 0.11—0.19 mm (0.004—0.008 in.)
9. If backlash exceeds 0.20 mm (0.008 in.), replace gear.
10. Check backlash of other gears in gear housing. (See Group 35 in this manual.)



M21.TM340.9 -19-05MAR88

11. Put a shop towel between gear teeth. Loosen lock nut.



M21.TM340.10 -19-05MAR88

12. Remove idler gear.



M21.TM340.11 -19-05MAR88

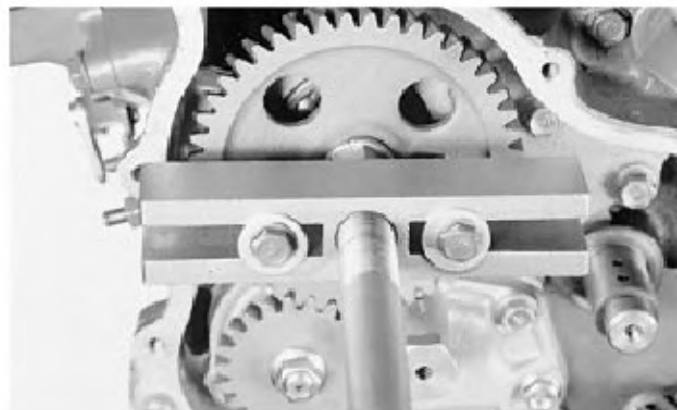
13. Remove bearing retaining screw.



M21.TM340.12 -19-05MAR88

IMPORTANT: DO NOT allow fuel injection pump camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces may be damaged.

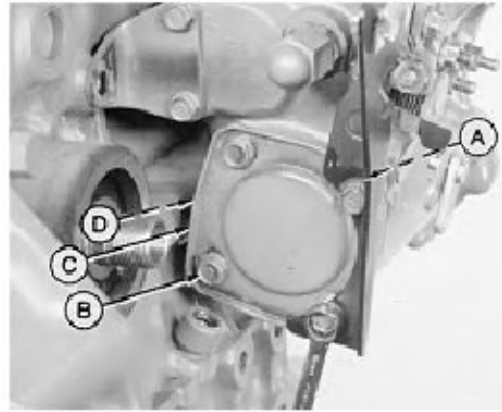
14. Carefully remove injection pump camshaft assembly. Use a slide hammer puller and two cap screws from the housing cover.



M21.TM340.13 -19-23APR88

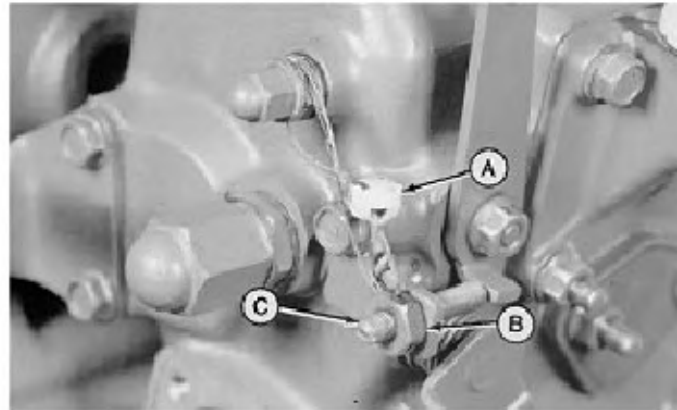
15. Remove oil filter and oil dipstick tube.
16. Remove two cap screws to remove bracket and four washers (A).
17. Remove two cap screws (B) to remove cover (C) and gasket (D).

A—Washer (4 used)
B—Cap Screw (4 used)
C—Cover
D—Gasket



M21.TM340.14 -19-23APR88

18. Remove sealing wire (A).
19. Loosen nut (B). Turn slow idle adjusting screw (C) counterclockwise several turns.



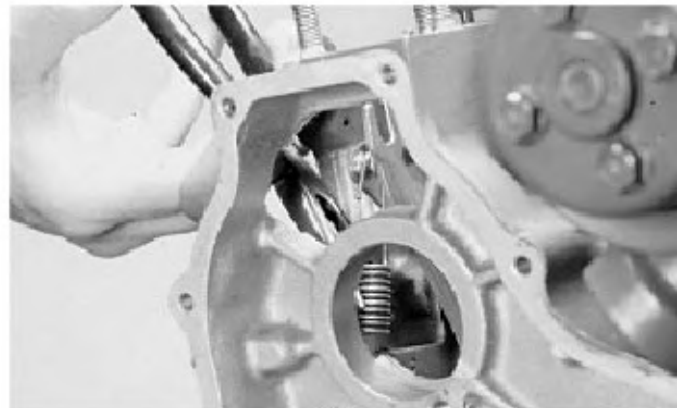
M21.TM340.15 -19-05MAR88

20. Remove two cap screws and nut to remove cover and gasket (A).



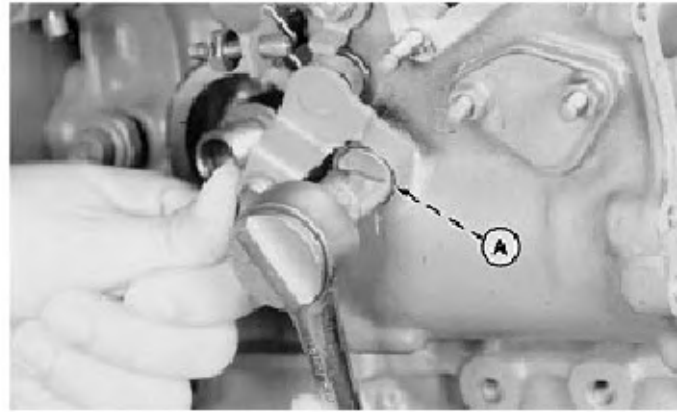
M21.TM340.16 -19-05MAR88

21. Disconnect spring from governor linkage.



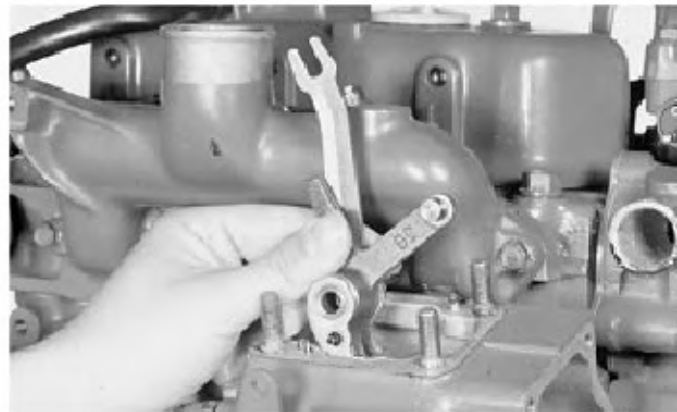
M21.TM340.17 -19-05MAR88

22. Remove governor shaft and washer (A).



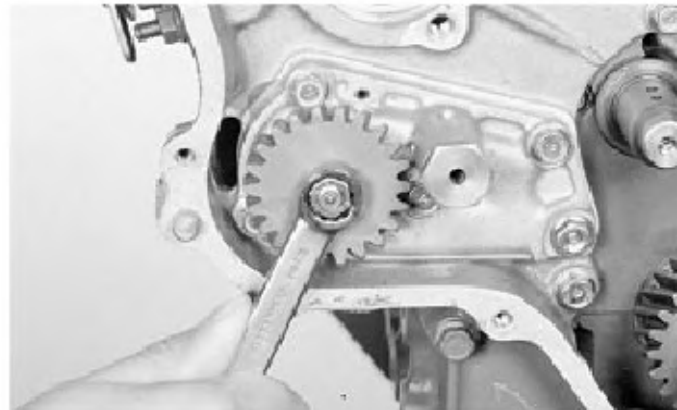
M21.TM340.18 -19-05MAR88

23. Remove governor shaft lever.



M21.TM340.19 -19-05MAR88

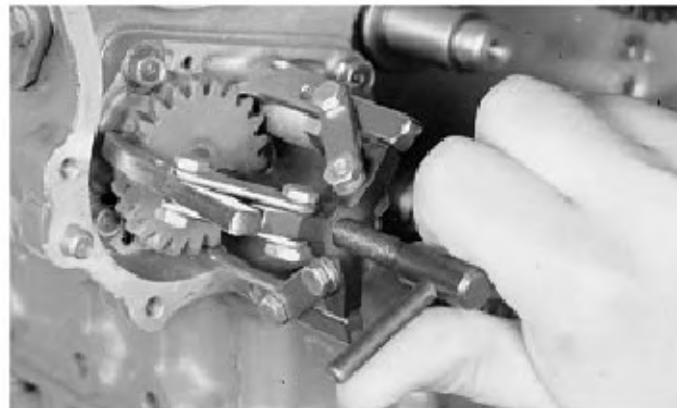
24. Remove nut.



M21.TM340.20 -19-05MAR88

25. Remove oil pump gear using a three-jaw puller.

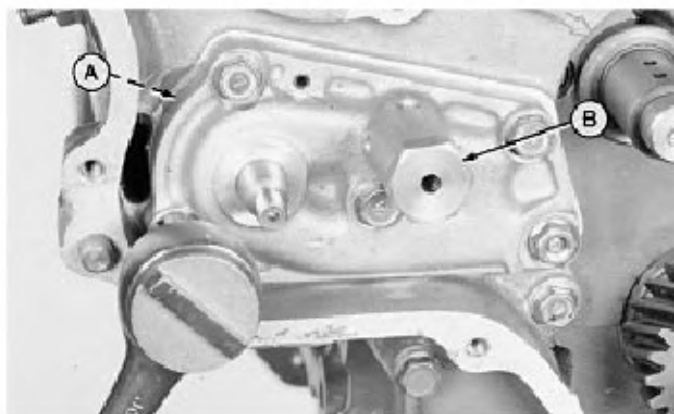
26. Inspect gear for chipped or broken teeth. Replace as necessary.



M21.TM340.21 -19-05MAR88

27. Remove four cap screws and nut to remove oil pump cover and gasket (A).

NOTE: For repair of oil pressure regulating valve (B), see Remove Oil Pressure Regulating Valve in this group.



M21,TM340,22 -19-05MAR88

28. Remove oil pump assembly.



M21,TM340,23 -19-05MAR88

INSPECT OIL PUMP ASSEMBLY (EARLY 3TNA72UJ)

1. Measure rotor-to-pump body clearance (pump body depth minus rotor depth).

ROTOR-TO-PUMP BODY SPECIFICATIONS

Difference of two measurements
(new parts) 0.08—0.15 mm
(0.003—0.006 in.)

Maximum difference allowed 0.25 mm
(0.010 in.)

*NOTE: The measurement between 0.15—0.25 mm
(0.006—0.010 in.) indicates a tolerable wear
difference that could affect pump efficiency.*

If rotor clearance exceeds the maximum specification,
replace gear housing.



M21,TM340,24 -19-10AUG88

2. Measure rotor ring-to-pump body clearance (pump body diameter minus rotor ring diameter).

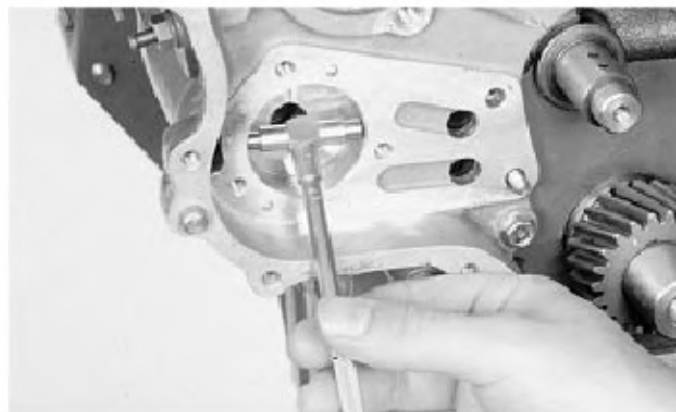
ROTOR RING-TO-PUMP BODY SPECIFICATIONS

Difference of two measurements
(new parts) 0.10—0.15 mm
(0.004—0.006 in.)

Maximum difference allowed 0.25 mm
(0.010 in.)

NOTE: The measurement between 0.15—0.25 mm (0.006—0.010 in.) indicates a tolerable wear difference that could affect pump efficiency.

If rotor ring clearance exceeds the maximum specification, replace gear housing.



M21,TM340,25 -19-05MAR88

3. Measure inner rotor-to-rotor ring clearance (rotor ring diameter minus inner rotor diameter).

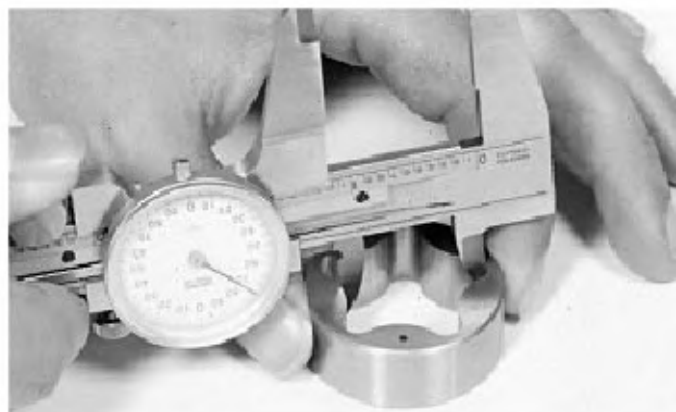
INNER ROTOR-TO-ROTOR RING SPECIFICATIONS

Difference of two measurements
(new parts) 0.10—0.15 mm
(0.004—0.006 in.)

Maximum difference allowed 0.25 mm
(0.010 in.)

NOTE: The measurement between 0.15—0.25 mm (0.006—0.010 in.) indicates a tolerable wear difference that could affect pump efficiency.

If inner rotor clearance exceeds the maximum specification, replace oil pump assembly.



M21,TM340,26 -19-06MAR88

4. Measure inner rotor shaft diameter.

INNER ROTOR SHAFT SPECIFICATIONS

Shaft Diameter (new parts)	12.67—12.685 mm (0.4988—0.499 in.)
Shaft Diameter (minimum)	12.65 mm (0.4980 in.)

If shaft diameter is less than the minimum specification, replace oil pump assembly.



M21.TM340.27 -19-06MAR8

5. Measure oil pump bore diameter.

OIL PUMP BORE SPECIFICATIONS

Bore diameter (new parts)	12.7—12.718 mm (0.5—0.5007 in.)
Bore diameter (maximum)	12.8 mm (0.504 in.)

If bore diameter exceeds the maximum specification, replace gear housing.

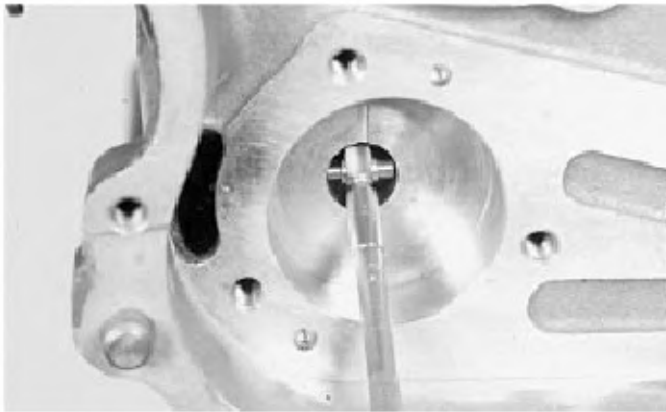
6. Measure inner rotor shaft clearance (oil pump bore diameter minus inner rotor shaft diameter).

INNER ROTOR SHAFT CLEARANCE SPECIFICATIONS

Difference of two measurements (new parts)	0.015—0.048 mm (0.0006—0.0019 in.)
Maximum difference allowed	0.100 mm (0.0039 in.)

NOTE: The measurement between 0.048—0.100 mm (0.0019—0.0039 in.) indicates a tolerable wear difference that could affect pump efficiency.

If inner rotor shaft clearance exceeds specifications, replace gear housing and oil pump assembly.



M21.TM340.28 -19-06MAR8

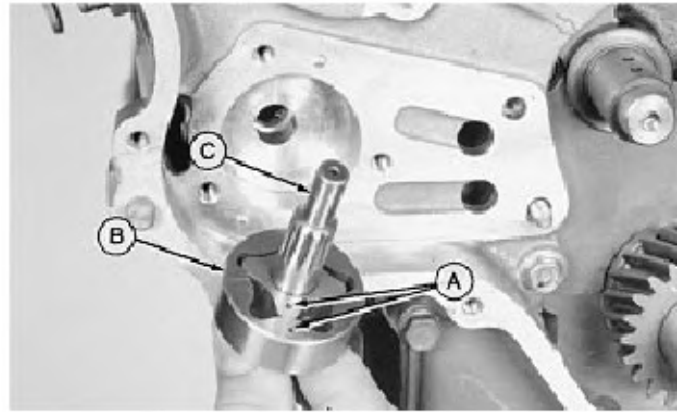
INSTALL OIL PUMP (EARLY 3TNA72UJ)

1. Thoroughly clean and dry all parts. Use new gaskets and seals when assembling the engine.

2. Put clean engine oil on all sides and surfaces of oil pump rotors.

IMPORTANT: Marks (A) on inner rotor and rotor ring must be installed toward gear housing.

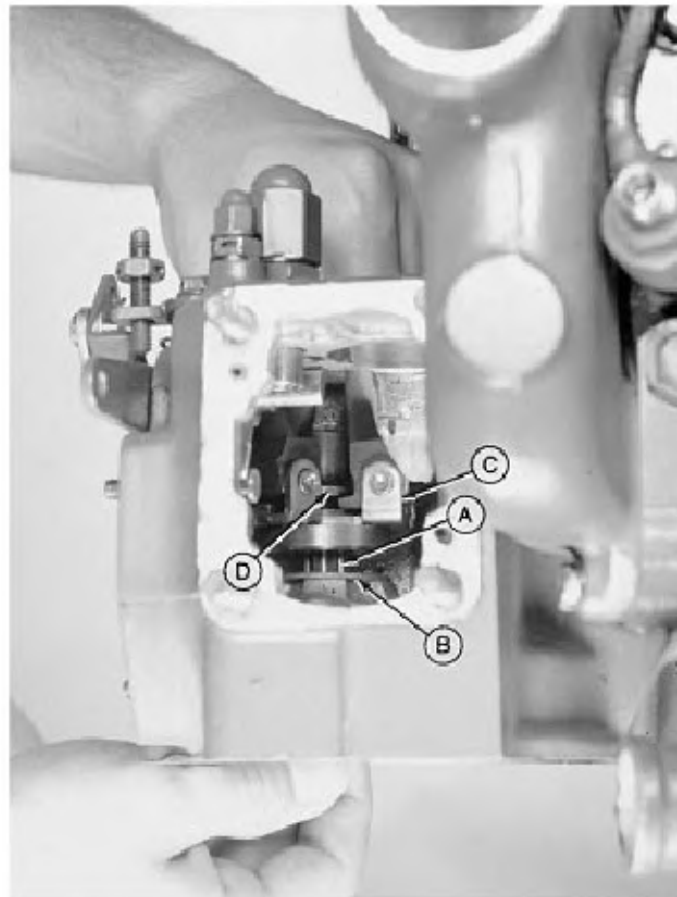
3. Install rotor ring (B) and inner rotor shaft (C) in gear housing.



M21.TM340.29 -19-10AUG8

4. Align splines on inner rotor shaft (A) with splines in thrust washer (B) and governor weights (C). Install thrust washer, governor weights, and sleeve (D) on rotor shaft.

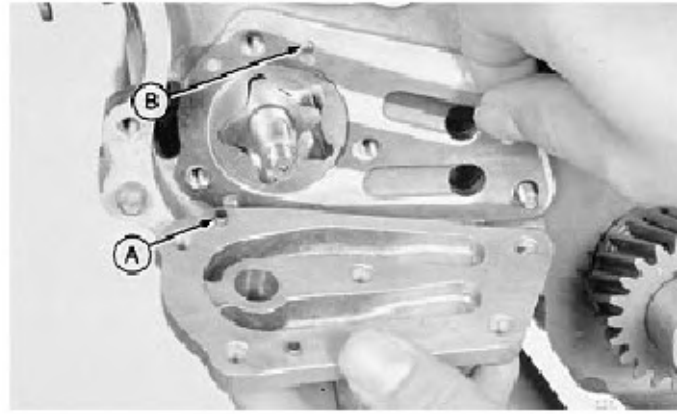
A—Inner Rotor Shaft
B—Thrust Washer
C—Governor Weights
D—Sleeve



M21.TM340.30 -19-06MAR8

5. Install gasket.

6. Align spring pins (A) in cover with holes (B) in gear housing. Install oil pump cover.



M21.TM340.31 -19-06MAR88

7. Install and tighten four cap screws and nut to 9 N·m (78 lb-in.).



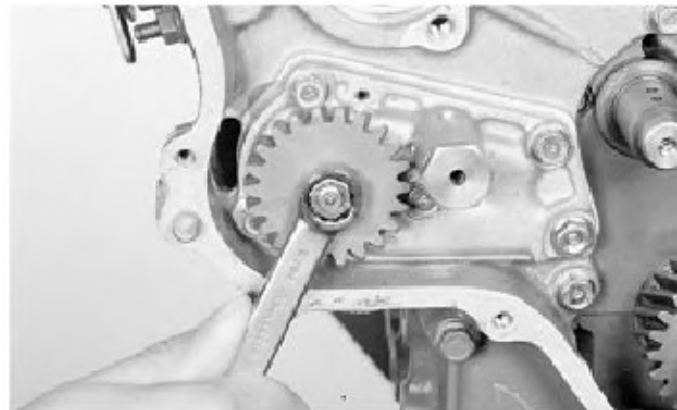
M21.TM340.32 -19-28AUG88

8. Install oil pump gear.



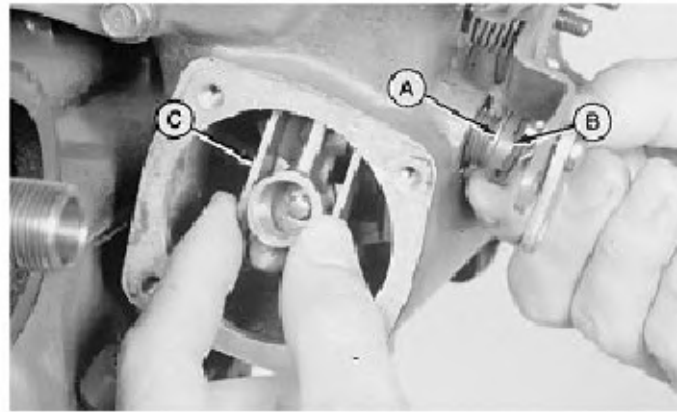
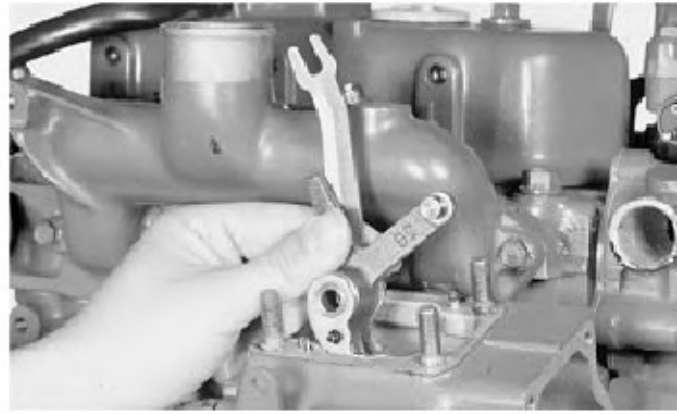
M21.TM340.33 -19-06MAR88

9. Install nut.



M21.TM340.34 -19-06MAR88

10. Install washer (A) on governor shaft (B).
11. Install governor shaft lever (C).
12. Install governor shaft through governor shaft lever.



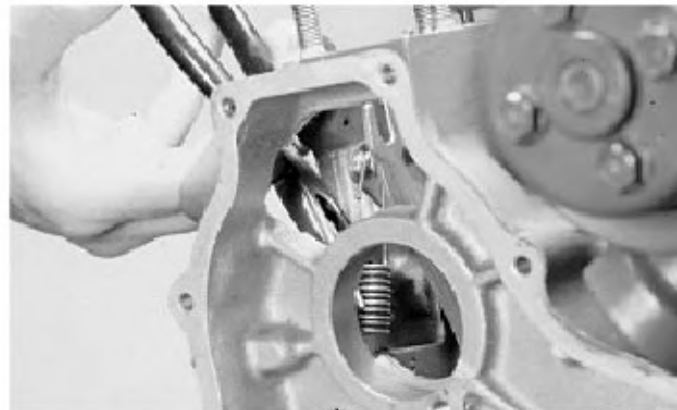
M21.TM340.35 -19-06MAR88

13. Tighten governor shaft to 49 N·m (430 lb-in.).



M21.TM340.36 -19-28AUG88

14. Connect spring to internal lever and then to governor assembly.



M21.TM340.37 -19-06MAR88

15. Install gasket.

16. Install cover and fasten with two cap screws and nut. Tighten cap screws and nut to 9 N·m (78 lb-in.).



M21.TM340.38 -19-10AUG87

17. Install gasket, cover, and two cap screws (A).

18. Install four washers (B), bracket (C), and two cap screws (D). Put washers between cover and bracket; two each over hole location. Tighten four cap screws to 9 N·m (78 lb-in.).

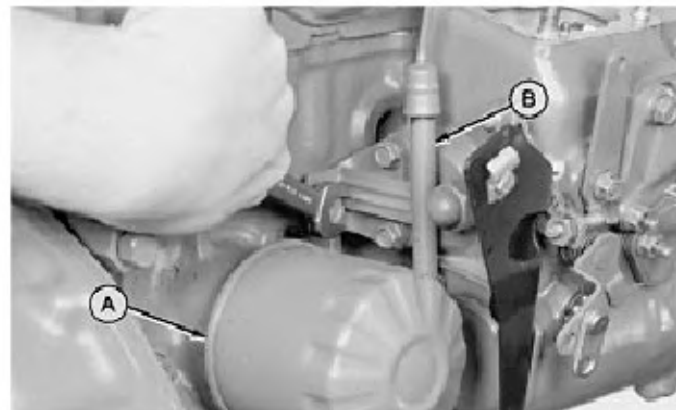
- A—Cap Screw (2 used)
- B—Washer (4 used)
- C—Bracket
- D—Cap Screw (2 used)



M21.TM340.39 -19-10AUG87

19. Install dipstick tube (B) and fasten with cap screw.

20. Install oil filter (A).

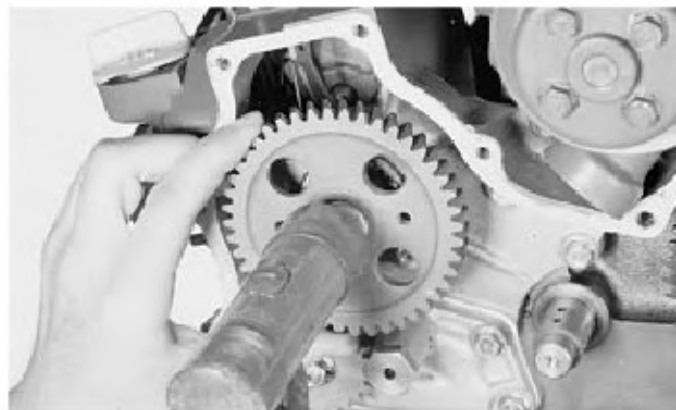


M21.TM340.40 -19-06MAR88

21. Apply clean engine oil on fuel injection pump camshaft bearings.

IMPORTANT: DO NOT allow fuel injection pump camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces may be damaged.

22. Carefully install fuel injection pump camshaft assembly. Push bearings to bottom of gear housing bore.



M21.TM340.41 -19-06MAR88

23. Install and tighten bearing retaining screw to 20 N·m (180 lb-in.).



M21,TM340,42 -19-10AUG87

24. Align timing marks between crankshaft, idler, fuel injection pump, and camshaft gears.

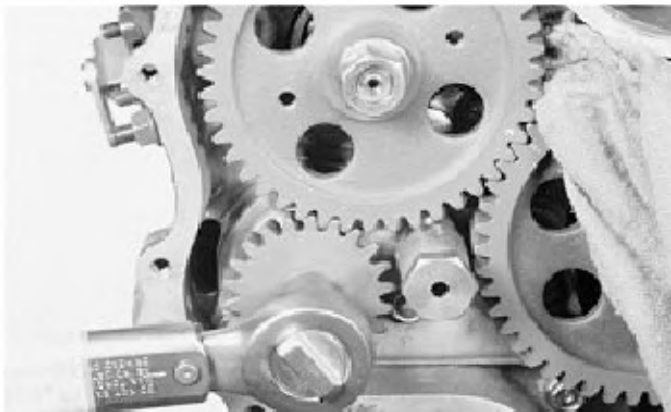
25. Carefully install idler gear.

Timing Marks	
Timing Mark	Gear
"A—A"	Crankshaft-to-Idler
"B—B"	Camshaft-to-Idler
"C—C"	Fuel Injection Pump Camshaft-to-Idler



M21,TM340,43 -19-06MAR88

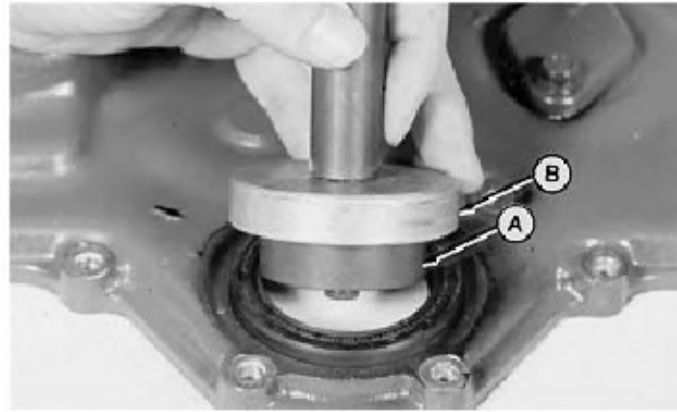
26. Put a shop towel between gear teeth. Tighten lock nut to 88 N·m (65 lb-ft).



M21,TM340,44 -19-10AUG87

27. If necessary, replace front crankshaft oil seal using a 1-3/4 in. driver disk (A) and 2-3/8 in. driver disk (B).

Install new seal with lip toward inside of gear housing.
Install flush with face of housing cover.



M21.TM340.45 -19-06MAR88

28. Apply plastic gasket or an equivalent on gear housing cover.

29. Install gear housing cover and fasten with 17 cap screws. Tighten cap screws to 9 N·m (78 lb-in.).



M21.TM340.46 -19-28AUG87

30. Install fuel shut-off solenoid bracket. Install and tighten two nuts and cap screw to 9 N·m (78 lb-in.).



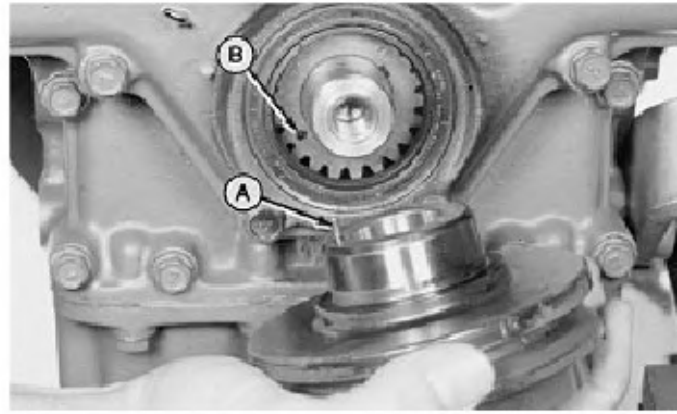
M21.TM340.47 -19-28AUG87

31. Connect fuel shut-off solenoid linkage. Fasten linkage with washer (A) and cotter pin.



M21.TM340.48 -19-06MAR88

32. Align pin (A) in crankshaft pulley with hole (B) in crankshaft. Install pulley.



M21.TM340.49 -19-06MAR88

33. Hold crankshaft pulley using a strap wrench. Apply thread lock and sealer (medium strength) on threads of cap screw. Install washer and cap screw. Tighten cap screw to 88 N·m (65 lb-ft).



M21.TM340.50 -19-10AUG88

34. Install alternator belt.

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

35. Apply force against alternator housing and tighten cap screw.

36. 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.



M21.TM340.51 -19-06MAR88

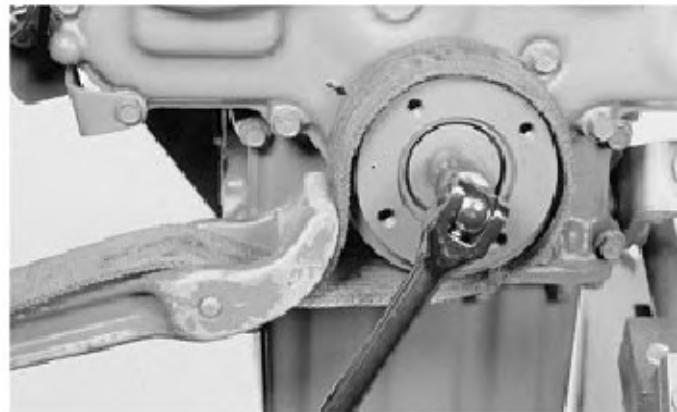
37. Install fuel injection pump (B) and fuel injection lines (A). (See Group 50 in this manual.)
38. Install engine. (See Machine Technical Manual.)
39. Bleed fuel injection system. (See Machine Technical Manual.)
40. Check and adjust slow idle setting. (See Section 230 in Machine Technical Manual.)



M21.TM340.52 -19-06MAR88

REMOVE OIL PRESSURE REGULATING VALVE (EARLY 3TNA72UJ)

1. Remove engine. (See Section 20 in Machine Technical Manual.)
2. Remove fan belt.
3. Hold crankshaft pulley with strap wrench. Remove cap screw and washer.



M21.TM340.53 -19-10AUG88

4. Remove crankshaft pulley. Use a puller, shaft protector, two cap screws from water pump, and a strap wrench.



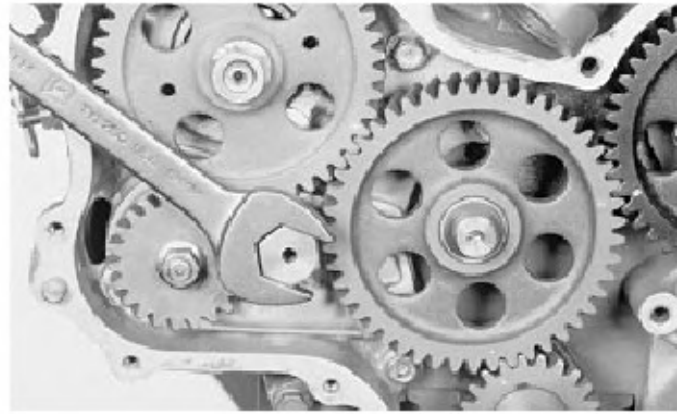
M21.TM340.54 -19-06MAR88

5. Disconnect fuel shut-off linkage. Remove two nuts and cap screw to remove fuel shut-off solenoid bracket.
6. Remove 17 gear housing cap screws and remove gear housing cover.



M21.TM340.55 -19-06MAR88

7. Remove spring retainer.



M21.TM340.56 -19-06MAR88

IMPORTANT: If oil pressure regulating valve is being disassembled to be cleaned, the same number and thicknesses of shims must be installed when assembled.

8. Remove shims (A), if equipped, spring (B), and valve (C).

9. Check spring (B) using spring compression tester.

NEW SPRING SPECIFICATIONS

Free Length 39.5—40.5 mm
(1.55—1.59 in.)

Test Length at Force of
29.4 ± 3.1 N (6.6 ± 0.7 lb) 30.0 mm (1.18 in.)

10. Inspect valve and housing bore for wear or damage. Valve must slide freely in bore. Replace parts as necessary.



M21.TM340.57 -19-06MAR88

INSTALL OIL PRESSURE REGULATING VALVE (EARLY 3TNA72UJ)

1. Thoroughly clean and dry all parts.
2. Apply clean engine oil on valve.
3. Install valve (C) and spring (B) in housing bore.

IMPORTANT: If oil pressure regulating valve was disassembled to be cleaned, the same number and thicknesses of shims must be installed.

4. Install the required amount of shims (A) from shim pack, until the oil pressure is 365 ± 69 kPa (53 ± 10 psi). After assembling the oil pressure regulating valve, check the oil pressure. (See Section 220 in Machine Technical Manual.)

SHIM PACK

Shim Size	Approximate Pressure Change
0.20 mm (0.008 in.)	6 kPa (0.85 psi)
0.30 mm (0.012 in.)	9 kPa (1.3 psi)

NOTE: For every 0.20 mm (0.008 in.) of shim thickness, there is approximately a 6 kPa (0.85 psi) change in oil pressure.



M21,TM340,58 -19-28AUG87

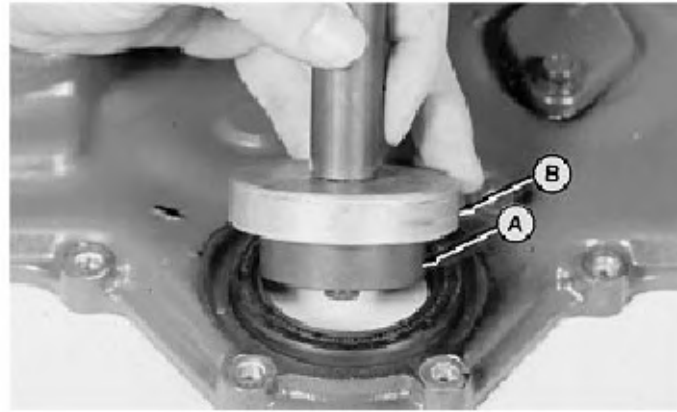
5. Install and tighten spring retainer.



M21,TM340,59 -19-06MAR88

6. If necessary, replace front crankshaft oil seal using a 1 3/4 in. driver disk (A) and a 2 3/8 in. disk (B).

Install new seal with lip facing inside of gear housing. Press seal flush with face of housing cover.



M21.TM340.60 -19-06MAR88

7. Apply plastic gasket or an equivalent on gear housing cover.

8. Install gear housing cover and fasten with 17 cap screws. Tighten cap screws to 9 N·m (78 lb-in.).



M21.TM340.61 -19-10AUG87

9. Install fuel shut-off solenoid with bracket and connect shut-off linkage.



M21.TM340.62 -19-06MAR88

10. Align pin (A) in crankshaft pulley with hole (B) in crankshaft. Install pulley.



M21.TM340.63 -19-06MAR88

11. Hold crankshaft pulley using a strap wrench. Apply thread lock and sealer (medium strength) on threads of cap screw.
12. Install washer and cap screw. Tighten cap screw to 88 N·m (65 lb-ft).



M21.TM340.64 -19-06MAR8

13. Install alternator belt.

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

14. Apply force against alternator housing and tighten cap screw.
15. 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.
16. Install engine. (See Section 20 of Machine Technical Manual.)
17. Check and adjust engine oil pressure. (See Section 220 of Machine Technical Manual.)



M21.TM340.65 -19-23APR8

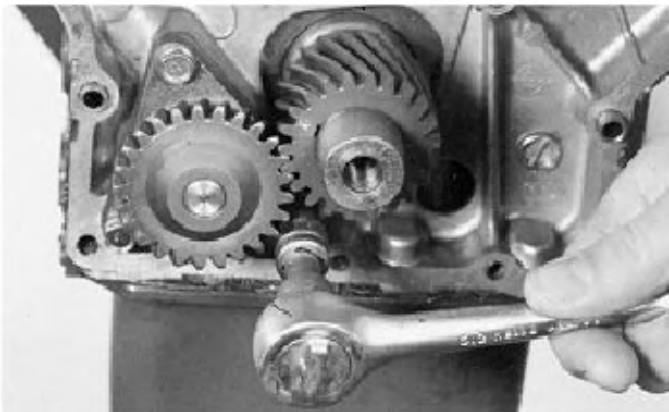
REMOVE AND INSPECT OIL PUMP (ALL EXCEPT EARLY 3TNA72UJ/4TN100)

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 0.25 mm (0.010 in.).



M21.TM340.66 -19-28AUG8

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



M21.TM340.67 -19-06MAR88

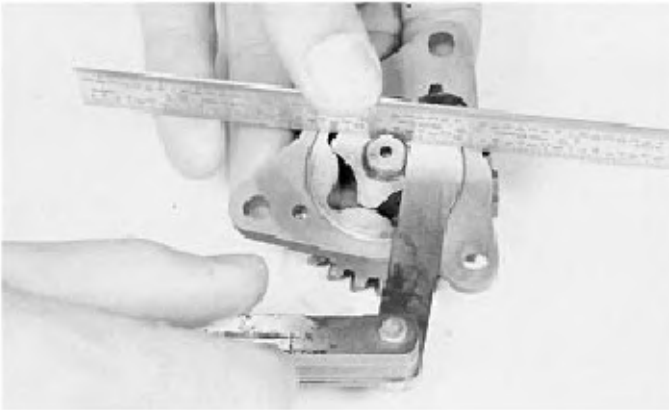
4. Carefully remove backing plate from pump.



M21.TM340.68 -19-06MAR88

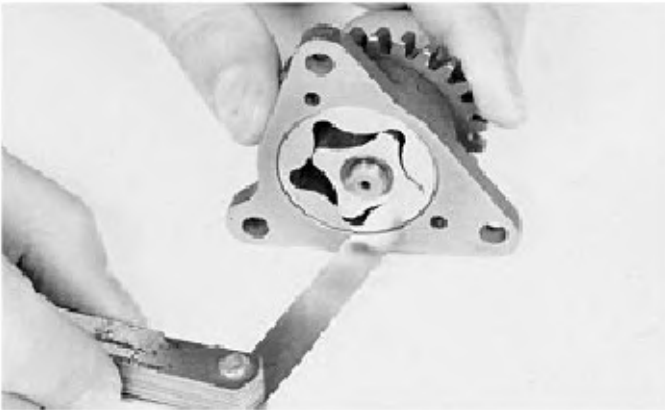
5. Check rotor recess. If rotors are recessed below face of pump housing more than listed below, replace rotor assembly.

Engine	Maximum Recess
3TN66UJ/3TNA72UJ/3TNA72-UJB/ 3TN78-RJB/3TN82-RJB/4TN78T-RJB	0.25 mm (0.10 in.)
3TN75RJ/3TN82ESP/3TN84/ 4TN82ESP/4TN84	0.13 mm (0.005 in.)



M21.TM340.69 -19-28AUG87

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 -19-06MAR88

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.)

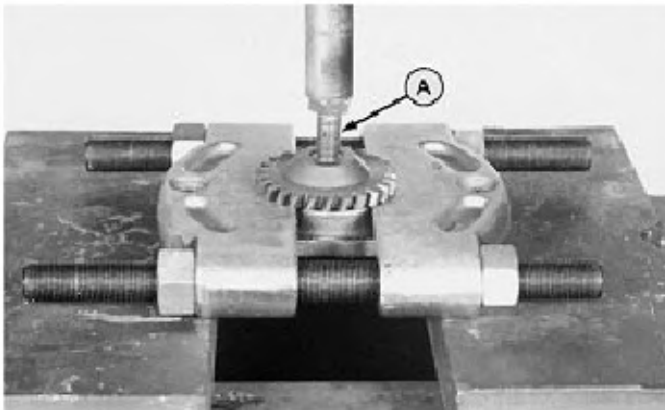


M21.TM340.71 -19-28AUG88

8. Remove outer rotor from pump body.

IMPORTANT: Hold oil pump shaft while pressing from gear.

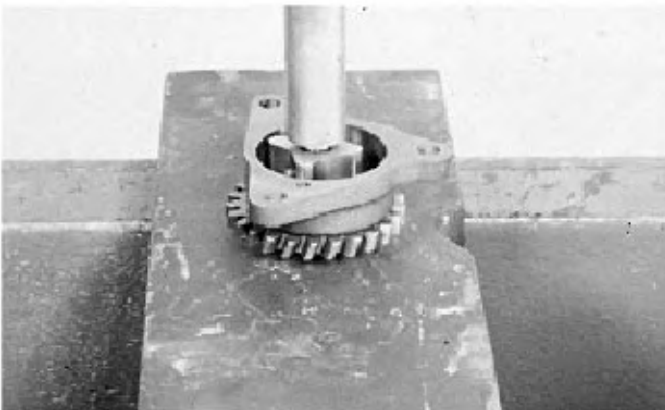
9. Support oil pump gear on a knife edge puller. Use a cap screw (A) to press shaft from gear.



M21.TM340.72 -19-23APR88

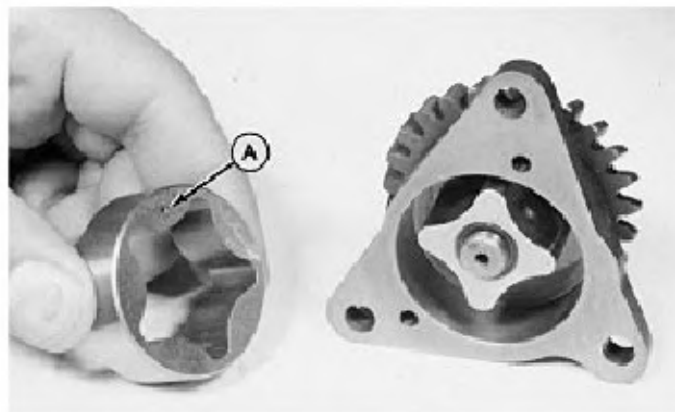
ASSEMBLE AND INSTALL OIL PUMP (ALL EXCEPT EARLY 3TNA72UJ/4TN100)

1. Place gear on flat surface. Press shaft with rotor and pump body into gear until it bottoms.



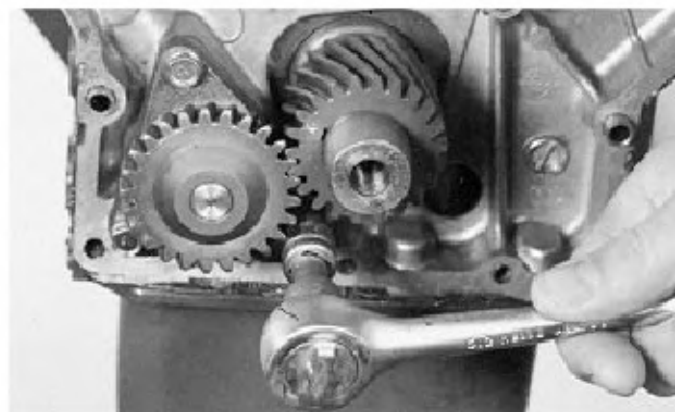
M21.TM340.73 -19-10AUG88

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 -19-06MAR88

4. Install oil pump on engine using new gasket. Tighten hardware to 25 N·m (18 lb-ft).



M21.TM340.75 -19-01SEP88

SERVICE OIL PRESSURE REGULATING VALVE (3TN66UJ/LATER 3TNA72UJ/ 3TNA72-UJB/3TN75RJ/3TN78-RJB/3TN82E-SP/ 3TN84/4TN78T-RJB/4TN82E-SP4TN84

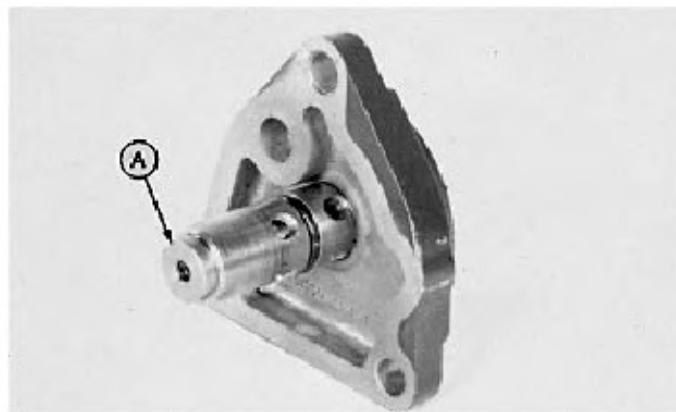
1. Remove oil filter.
2. Remove three attaching cap screws (A). Remove housing with valve from engine.



M21.TM340.76 -19-01SEP88

3. If adjusting pressure only, remove cap (A) and add shims to inside of cap. Each 1 mm (0.039 in.) of shim thickness increases oil pressure as listed:

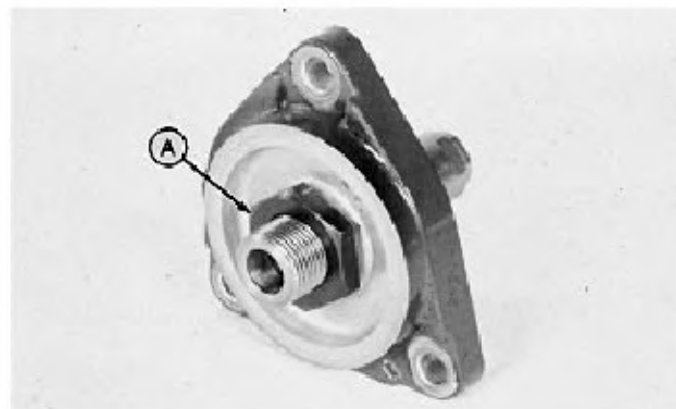
Engine	Pressure Increase
3TN66UJ	13.8 kPa (2.0 psi)
3TNA72UJ	10.9 kPa (1.6 psi)
3TN75RJ/3TN82ESP/3TN84/ 4TN82ESP/4TN84	15.6 kPa (2.3 psi)



M21.TM340.77 -19-23APR8

4. Remove valve attaching nut (A). Remove valve from housing.

NOTE: If removing valve to adjust engine oil pressure, attaching nut need not be removed.

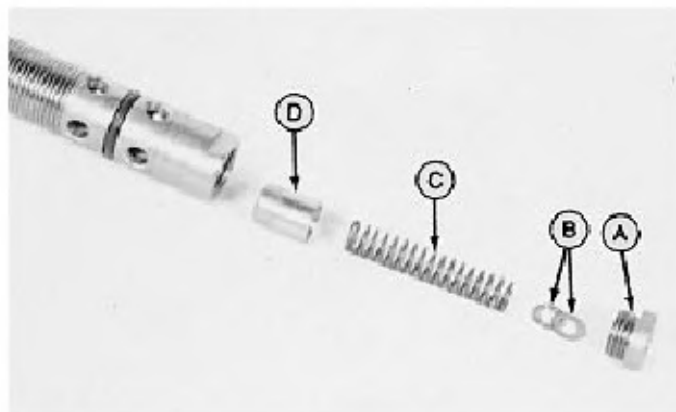


M21.TM340.78 -19-06MAR8

5. Remove valve plug (A), shims (B), spring (C), and valve (D) from valve body.

6. Inspect parts for wear or damage.

7. Check spring free and compressed length.



A—Valve Cap
B—Shims
C—Spring
D—Valve

FREE LENGTH SPECIFICATIONS

Engine	Specification
3TN66	21.9—24.5 mm (0.86—0.96 in.)
Later 3TNA72	43.5—48.5 mm (1.71—1.91 in.)
3TNA72-UJB/3TN78-RJB/3TN75/ 3TN82/3TN82-RJB/3TN84/ 4TN82/4TN84	46.0 mm (1.81 in.)
4TN78T-RJB	48.5 mm (1.91 in.)

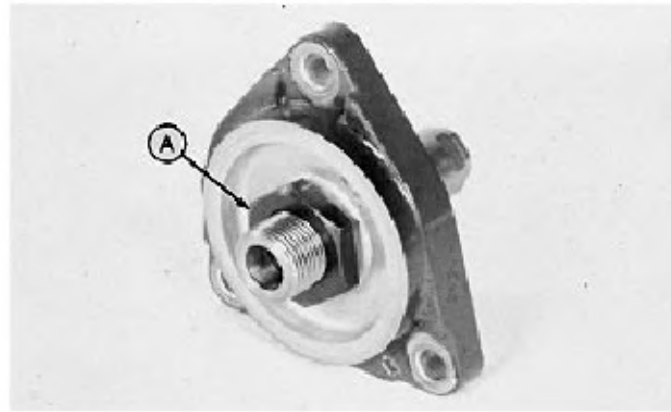
COMPRESSED LENGTH SPECIFICATIONS

Engine	Specification
3TN66	14.7 mm (0.58 in.) at 12.0 N (2.7 lb) Force
Later 3TNA72/3TN75/3TN82ESP/ 3TN84/4TN82/4TN84	27.5 mm (1.08 in.) at 20.5 N (4.6 lb) Force
3TNA72-UJB/3TN78-RJB/ 3TN82-RJB	24.5 mm (0.96 in.) at 16.1 N (3.6 lb) Force
4TN78T-RJB	33.0 mm (1.30 in.) at 80 N (18 lb) Force

NOTE: Valve components are not serviced individually.
Replace complete regulating valve if any
components are defective.

M21,TM340,79 -19-01SEP87

8. Install valve, spring, and shims into valve body. Install valve cap and stake to valve body.
9. If removed, screw valve body into housing. Install retaining nut (A) and tighten to 30 N·m (22 lb-ft).
10. Install housing with valve onto engine. Install oil filter.

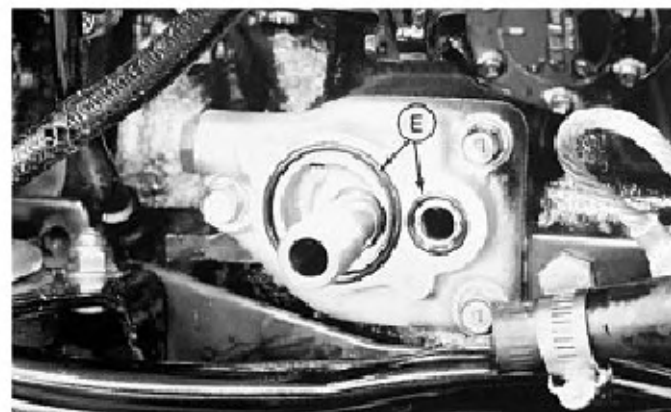
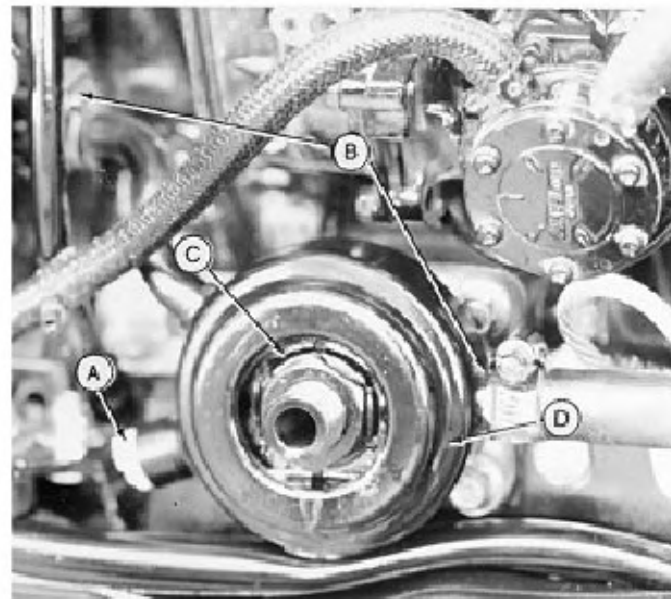


M21.TM340.80 -19-06MAR8

REMOVE, INSPECT AND INSTALL OIL COOLER (ETN84UJ)

1. Drain cooling system (A).
2. Remove engine oil filter.
3. Remove clamps (B) from coolant hoses.
4. Remove nut (C) and oil cooler (D).
5. Inspect rear of oil cooler for pitting in sealing area. Pressure test cooler for leaks. (See this group).
6. Replace o-rings (E).
7. Install cooler. Tighten nut to 30 N·m (22 lb-ft).
8. Reinstall hoses and clamps. Refill cooling system and check for leaks.

A—Coolant Drain
B—Hose Clamps
C—Cooler Nut
D—Oil Cooler
E—O-Rings



MX,TM340Z.1 -19-24OCT8

ENGINE OIL COOLER LEAK TEST

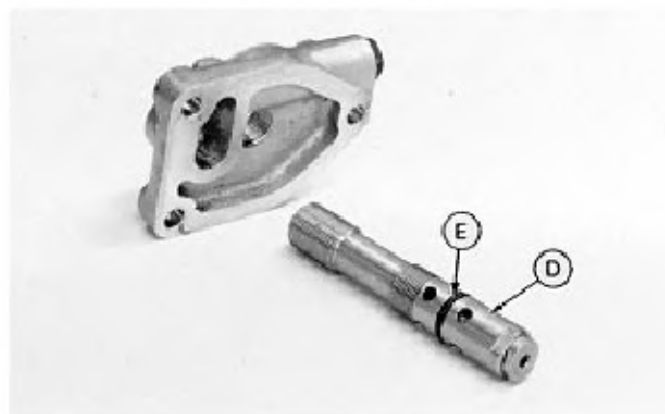
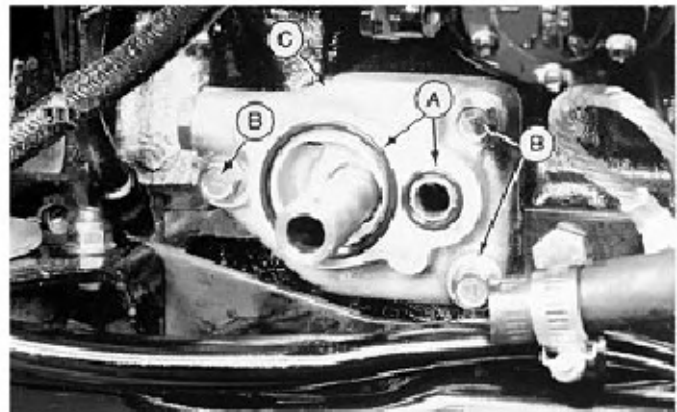
1. Plug one of the coolant inlet or outlet passages.
2. Apply regulated air pressure 206—483 kPa (30—70 psi) to the other coolant passage.
3. Dip oil cooler into water. Check for regular intervals of air bubbles, indicating a leak. Leave in water several minutes to disperse air that may have been trapped.
Optional test: If leak did not appear, use hot water bath to possibly open crack.

MX, TM340Z, 2 -19-24OCT8

REMOVE, INSPECT, AND INSTALL OIL PRESSURE CONTROL VALVE

1. Remove oil cooler. (See this group.)
2. Remove and replace o-rings (A).
3. Remove three cap screws (B) and pressure control valve housing (C).
4. Remove control valve (D) from housing. If malfunction exists, replace control valve. Individual parts are not available. Control valve is serviced as an assembly.
5. Replace o-ring (E). Coat with oil before installing.
6. Install new gasket between control valve housing and block.
7. Install control valve housing. Tighten cap screws to 27 N·m (20 lb-ft).
8. Install new o-rings and oil cooler. Tighten cooler nut to 27—34 N·m (20—25 lb-ft).

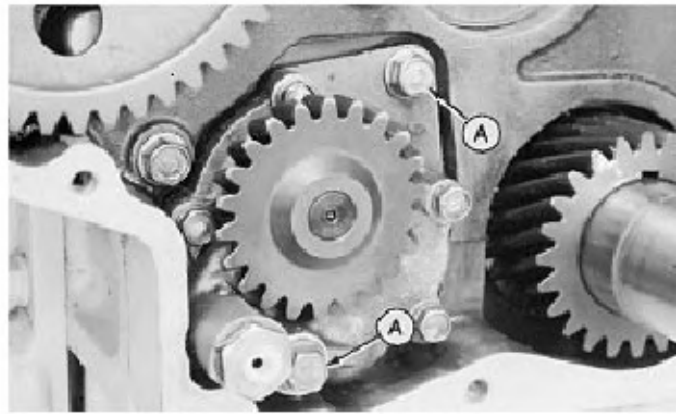
A—O-Ring
B—Cap Screws
C—Control Valve Housing
D—Control Valve
E—O-Ring



MX, TM340Z, 3 -19-24OCT8

REMOVE AND INSPECT OIL PUMP (4TN100-RJF)

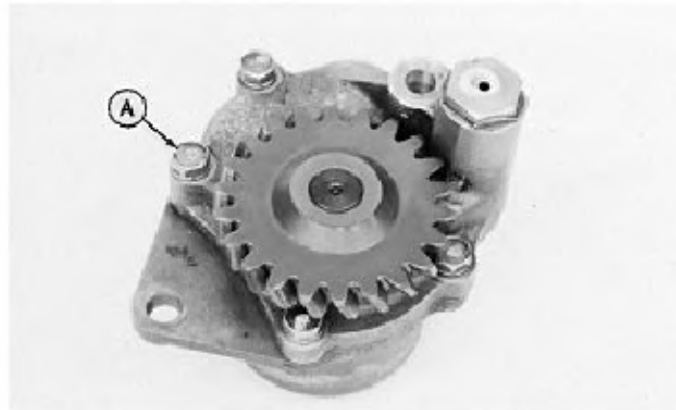
1. Remove gear housing cover and idler gear as instructed in Remove Timing Gears, Group 35.
2. Check oil pump gear backlash. Replace gear if backlash is more than 0.25 mm (0.010 in.).
3. Remove cap screws (A) to remove oil pump and gasket from engine.



M21.TM340.A1 -19-01SEP8

NOTE: Do not remove gear to remove cap screws.

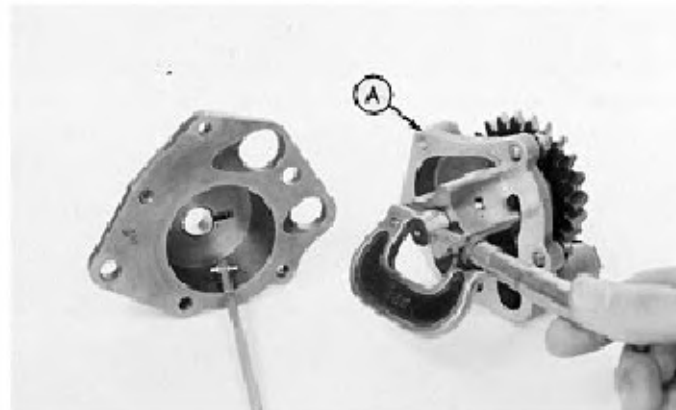
4. Remove four cap screws (A) to separate pump from housing.



M21.TM340.A2 -19-01SEP8

NOTE: Do not disassemble rotor shaft assembly (A); if worn or damaged, replace as an assembly.

5. Check rotor shaft outer diameter and the rotor cover hole diameter. If clearance is more than 0.20 mm (0.008 in.), replace entire assembly.



M21.TM340.A3 -19-10AUG8

6. Check rotor recess. If rotor is below face of pump housing more than 0.25 mm (0.010 in.), replace rotor.



M21.TM340.A4 -19-10AUG8

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



M21.TM340.A5 -19-10AUG8

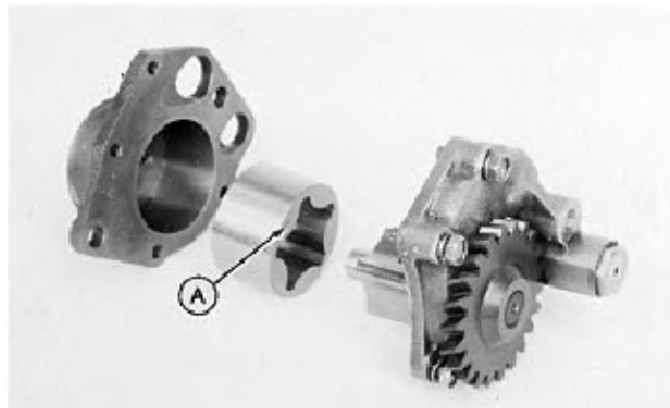
8. Check inner-to-outer rotor clearance. If clearance is more than 0.25 mm (0.010 in.), replace rotor assembly.



M21.TM340.A6 -19-10AUG8

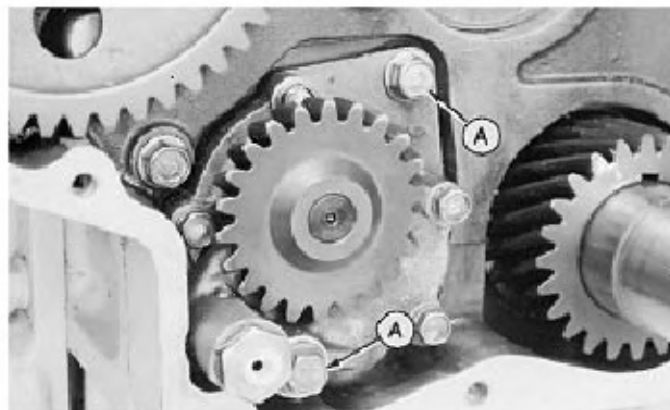
ASSEMBLE AND INSTALL OIL PUMP (4TN100-RJF)

1. Coat all parts with clean engine oil. Install outer rotor with identification mark (A) facing toward rotor shaft assembly.
2. Install rotor shaft assembly onto pump housing and tighten cap screws to 6 N·m (53 lb-in.).



M21.TM340.A7 -19-10AUG8

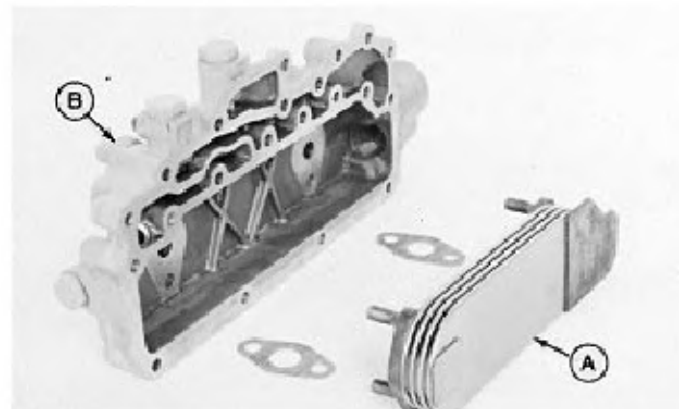
3. Install new gasket and oil pump. Tighten cap screws (A) to 25 N·m (18 lb-ft).
4. Install idler gear and gear housing cover as instructed in Install Timing Gears, Group 35.



M21.TM340.A8 -19-10AUG8

REMOVE AND INSPECT OIL COOLER (4TN100-RJF)

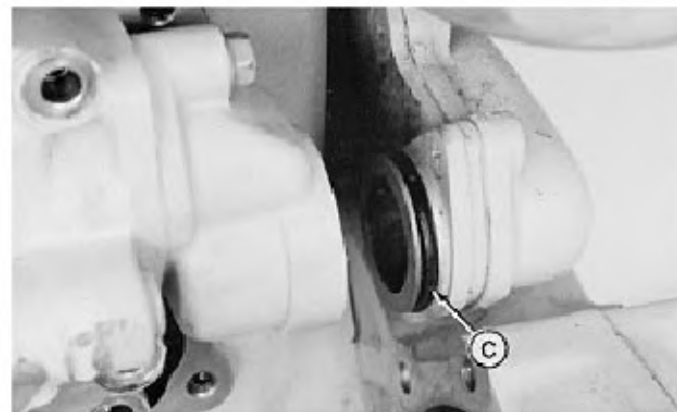
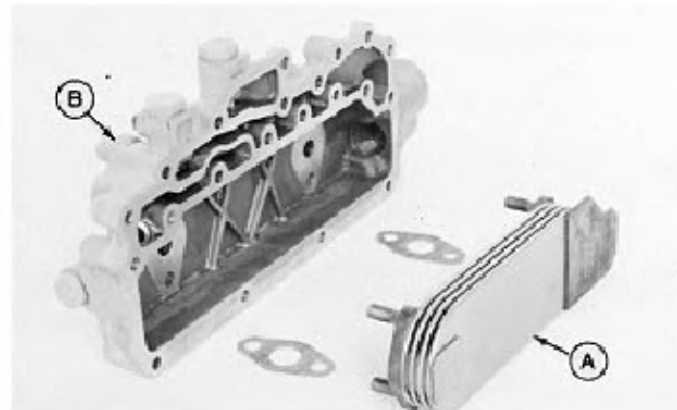
1. Remove fuel injection pump as instructed in Remove Fuel Injection Pump, Group 50.
2. Remove 21 caps screws to remove oil cooler assembly from engine.
3. Remove four nuts to separate oil cooler (A) from housing (B).
4. Inspect oil cooler for leaks or cracks; replace if necessary.



M21,TM340,A9 -19-01SEP87

ASSEMBLE AND INSTALL OIL COOLER (4TN100-RJF)

1. Install oil cooler (A) and gaskets in housing (B). Tighten nuts to 49 N·m (36 lb-ft).
2. Replace O-ring (C) if damaged. Push oil cooler on water pump.
3. Install oil cooler and gasket on engine. Tighten cap screws to 24 N·m (18 lb-ft).
4. Install fuel injection pump as instructed in Install Fuel Injection Pump, Group 50.



M21,TM340,A10 -19-10AUG87

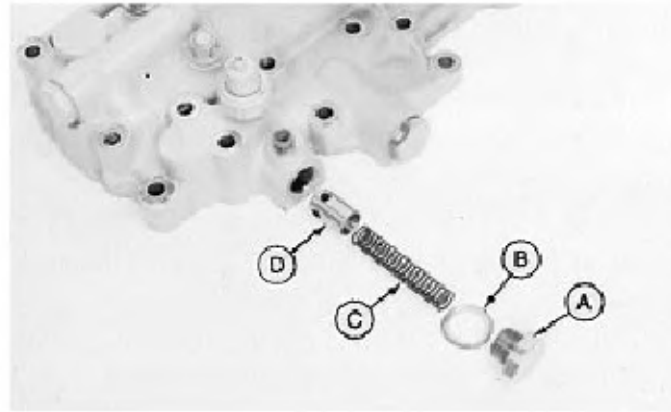
INSPECT OIL COOLER BY-PASS VALVE (4TN100-RJF)

1. Remove plug (A), washer (B), spring (C), and valve (D).
2. Inspect parts for wear or damage. Check valve seat surfaces for nicks or scratches. Replace parts as needed.
3. Check spring free and compressed lengths.

SPRING LENGTH SPECIFICATION

Length	Specification
Free	63.0 mm (2.48 in.)
Compressed	37.0 mm (1.45 in.) @ 3.75 N (0.84 lb) Force

4. Install valve, spring, washer, and valve plug in oil cooler.



Oil Cooler Removed for Clarity

A—Valve Plug
B—Washer
C—Spring
D—Valve

M21,TM340,A11 -19-10AUG87

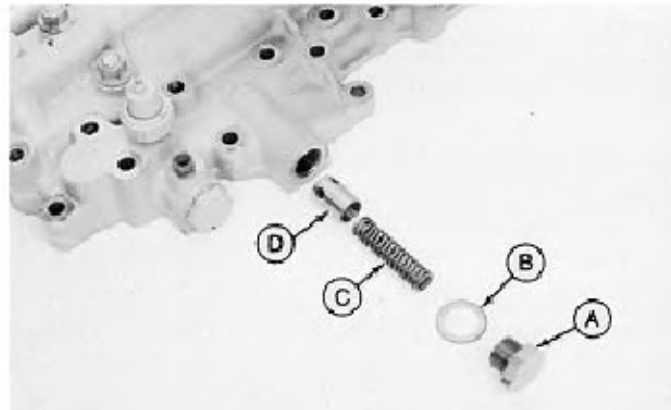
INSPECT OIL PRESSURE CONTROL VALVE (4TN100-RJF)

1. Remove plug (A), washer (B), spring (C), and valve (D). Check for shims between spring and plug.
2. Inspect parts for wear or damage. Check valve seat surfaces for nicks or scratches. Replace parts as needed.
3. Check spring free and compressed lengths.

SPRING LENGTH SPECIFICATION

Length	Specification
Free	51.0 mm (2.01 in.)
Compressed	50.0 mm (1.97 in.) @ 5.4 N (1.2 lb) Force

4. Install valve, spring, washer, and plug in oil cooler. If shims are used, install between spring and plug.



Oil Cooler Removed for Clarity

A—Valve Plug
B—Washer
C—Spring
D—Valve

M21,TM340,A12 -19-01SEP87

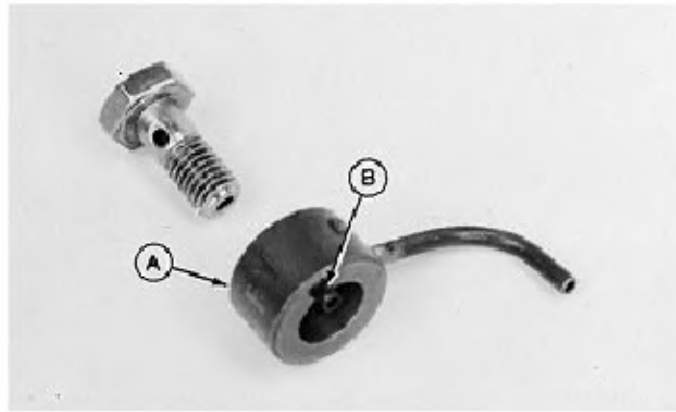
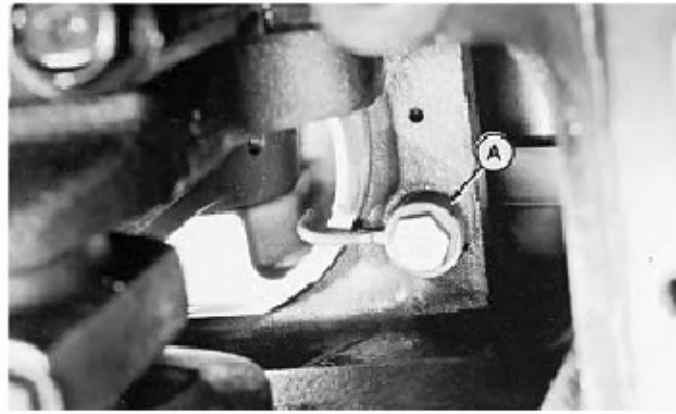
INSPECT PISTON COOLING NOZZLES (4TN100-RJF)

1. Remove oil pan and spacer. (See Group 40 in this manual.)
2. Remove piston cooling nozzle (A).
3. Inspect nozzle hole for dirt or other foreign material. Clean if necessary.

Check the nozzle piping for looseness, for damage or cracks. Replace if necessary.

4. Install nozzle with pin (B) in locating hole of cylinder block. Tighten cap screw.

5. Install oil pan spacer and oil pan. (See Group 40 in this manual.)



M21,TM340,A13 -19-10AUG87

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-152	Bearing Driver	Remove and install water pump bearing shaft on 3TN75H/early 3TNA72UJ engines.
JDG-506	Bearing Driver	Remove and install water pump bearing shaft on 3TN66UJ/3TNA72UJ/3TN82E-SP/3TN84/4TN82E-SP/4TN84 engines.

M21.TM345.1 -19-23APR8

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.

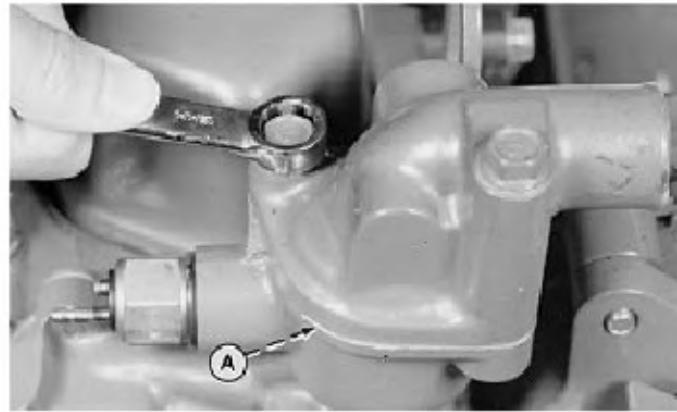
Name	Use
Thermostat Tester	Check thermostat opening temperature
Strap Wrench	Hold water pump pulley
13-Ton Puller Set	Remove water pump pulley flange
Press	Remove and install water pump components
O-ring Seal Tool Set	Remove and install water pump seals and O-rings
Bushing, Bearing, and Seal Driver Set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

M21.TM345.2 -19-23APR8

REMOVE THERMOSTAT AND THERMOSTAT HOUSING

⚠ 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 thermostat cover and gasket (A).



4TN82E-SP

M21,TM345,5 -19-11AUG8

NOTE: Gasket is only used on some engines.

4. Remove thermostat and gasket (A), if equipped.



4TN82E-SP

M21,TM345,6 -19-11OCT8

5. 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.



M21,TM345,7 -19-06MAR88

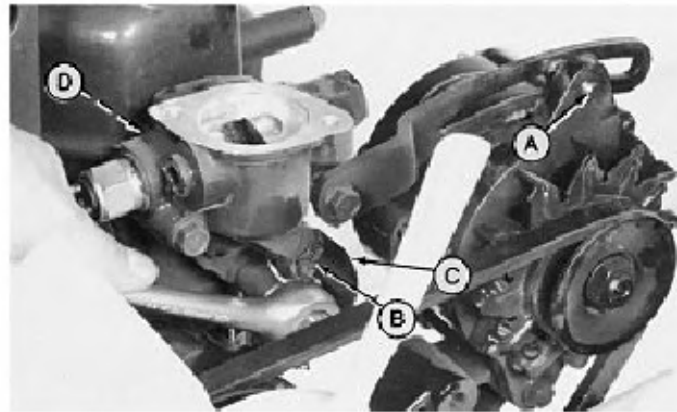
NOTE: Steps 6—10 apply to 4TN82E-SP engines only.

6. Loosen cap screw (A) to loosen alternator belt.

7. Loosen clamp (B) and remove hose (C).

8. Disconnect temperature sender wiring lead.

9. Remove three cap screws to remove thermostat housing and gasket (D).



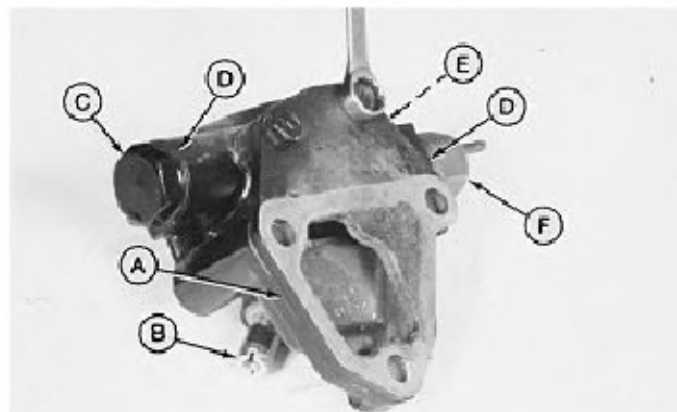
4TN82E-SP

- A—Cap Screw
- B—Clamp
- C—Hose
- D—Gasket

M21,TM345,8 -19-23APR88

10. Remove two cap screws to remove plate and gasket (A).

11. If necessary, remove parts (B—F).



4TN82E-SP

- A—Gasket
- B—Fitting
- C—Plug
- D—Washer (2 used)
- E—Plug
- F—Temperature Sender

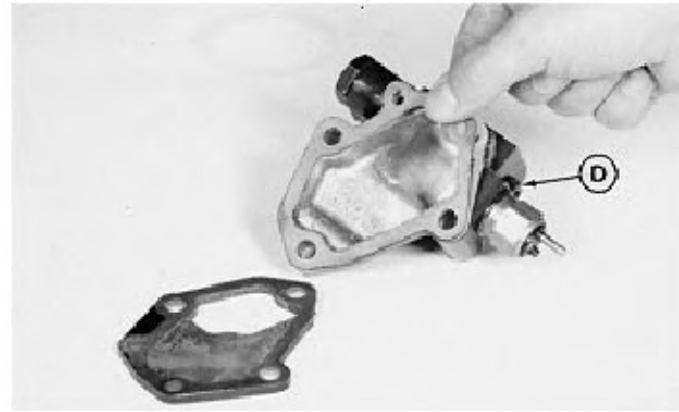
M21,TM345,9 -19-06MAR88

INSTALL THERMOSTAT AND THERMOSTAT HOUSING

1. Thoroughly clean and dry all parts.

NOTE: For all engines except 4TN82E-SP, go to step 11.

2. Apply pipe sealant on threads of fitting (A).
3. Install parts (A—E).
4. Install a new gasket on thermostat housing.
5. Install plate and two cap screws. Tighten cap screws to 9 N·m (78 lb-in.).

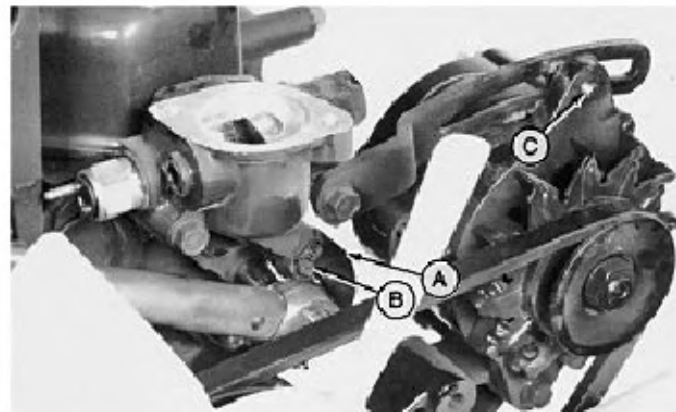


4TN82E-SP

A—Fitting
B—Plug
C—Washer (2 used)
D—Plug
E—Temperature Sender

M21,TM345,10 -19-11OCT8

6. Install a new gasket.
7. Install thermostat housing and three cap screws. Tighten cap screws to 26 N·m (226 lb-in.).
8. Connect temperature sender wiring lead. Connect hose (A) and fasten with clamp (B).
9. Pull alternator to tighten belt and tighten cap screw (C).
10. 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.



4TN82E-SP

M21,TM345,11 -19-11OCT8

NOTE: Gasket is only used on some engines.

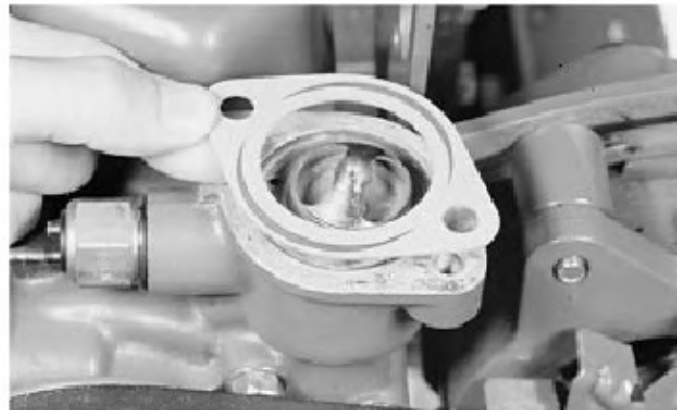
11. Install new gasket (A), if equipped and thermostat.



4TN82R-SE

M21.TM345.12 -19-11OCT8

12. Install new gasket.



4TN82E-SP

M21.TM345.13 -19-06MAR8

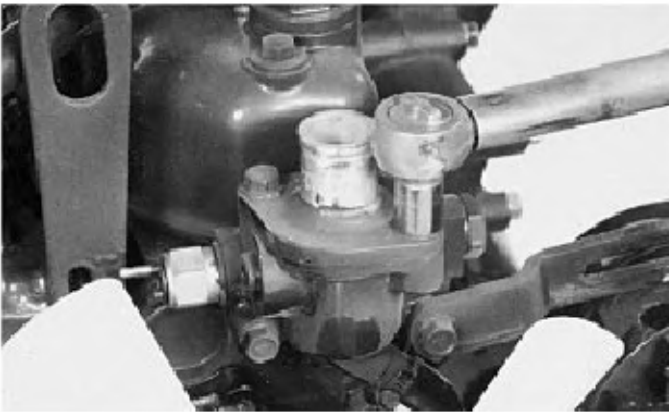
13. Install thermostat housing. Tighten cap screws to specifications.

THERMOSTAT HOUSING CAP SCREW TORQUE SPECIFICATIONS

3TN66UJ	9 N·m (78 lb-in.)
3TNA72-UJB/3TN78-RJB/ 3TN82-RJB/4TN78T-RJB	26 N·m (226 lb-in.)
3TNA72UJ/3TN75RJ/3TN82E-SP/ 3TN84/4TN82E-SP/4TN84/ 4TN100-RJF	20.3 N·m (180 lb-in.)

14. Connect water pump outlet hose. Tighten hose clamp.

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



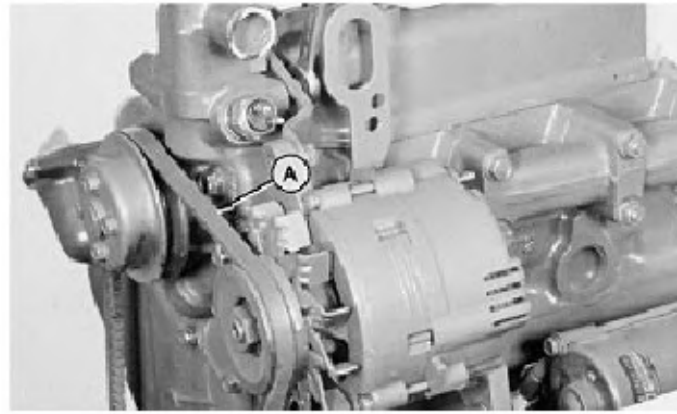
4TN82E-SP

M21,TM345,14 -19-01SEP8

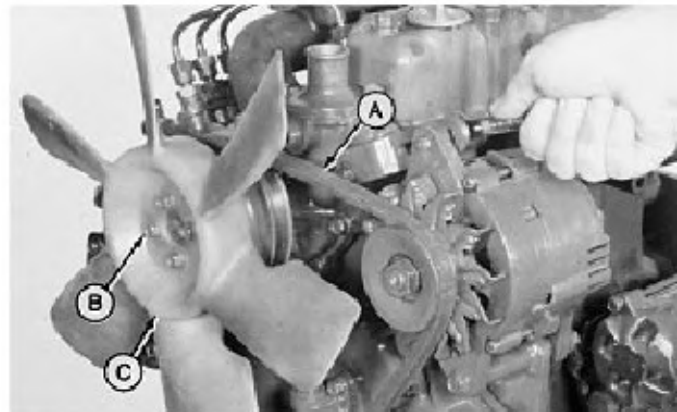
REMOVE WATER PUMP

⚠ 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) if equipped.



3TNA72UJ Shown



3TN75RJ Shown

M21,TM345,15 -19-01SEP8

6. Remove four (three for 3TN66, five for 4TN100) cap screws to remove water pump and gasket (A).

Loosen hose clamp (B) and remove hose (C).



4TN82E-SP



4TN100

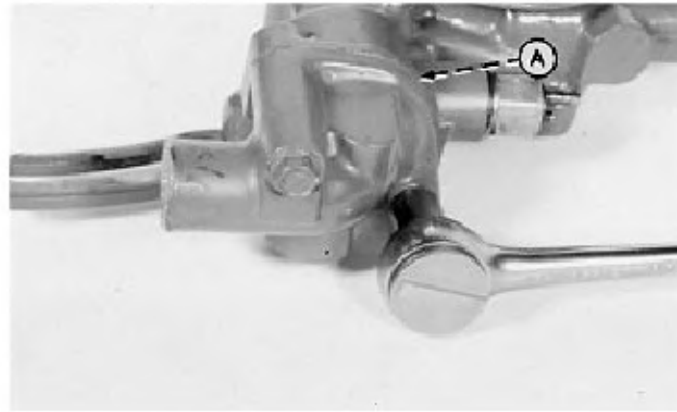
M21.TM345,16 -19-11AUG8

DISASSEMBLE WATER PUMP

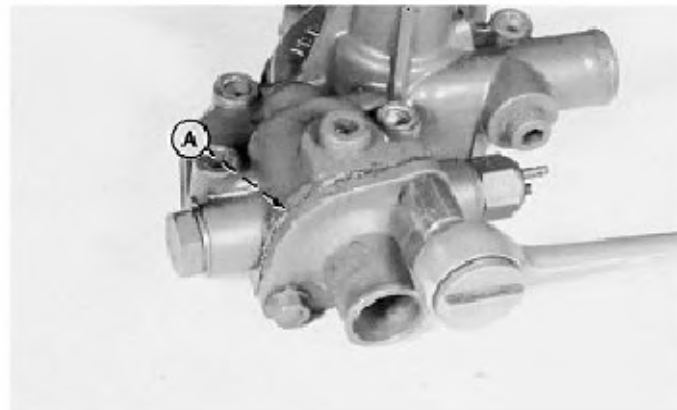
1. Remove thermostat housing and gasket (A).

NOTE: Water pump housings differ slightly, but the disassembly procedure is the same.

NOTE: For 4TN82E-SP engines, go to step 5



3TNA72UJ Shown

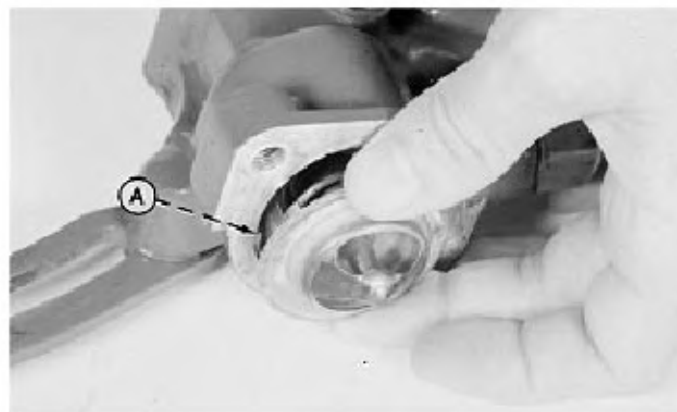


3TN75RJ Shown

M21,TM345,17 -19-11AUG8

NOTE: Gasket is only used on some engines.

2. Remove thermostat and gasket (A), if equipped.



M21,TM345,18 -19-11AUG8

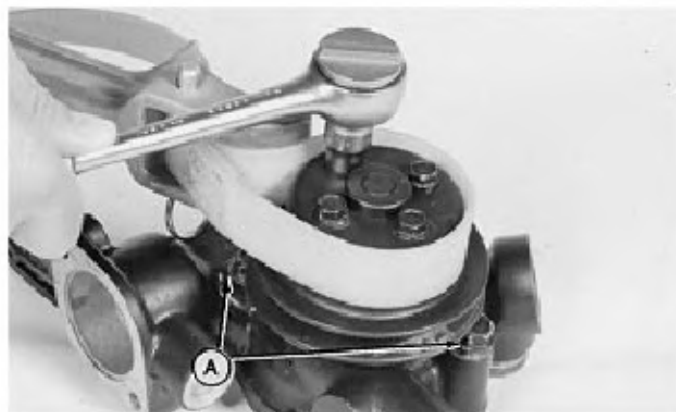
3. Remove temperature sender and washer (A).



3TNA72UJ Shown

M21,TM345,19 -19-11AUG8

4. Hold pulley using a strap wrench. Remove four cap screws to remove pulley. Remove cap screws (A).

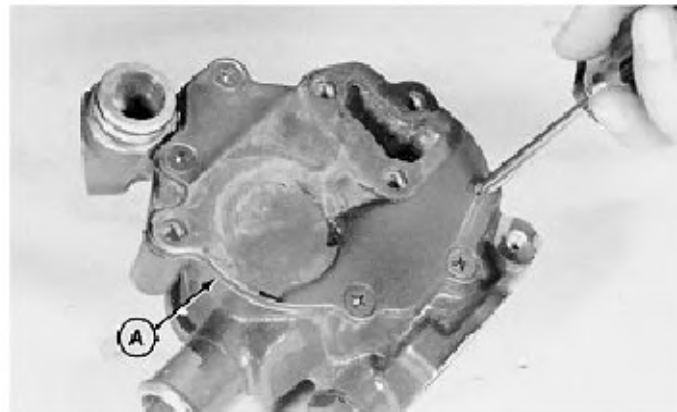


M21,TM345,20 -19-10MAR8

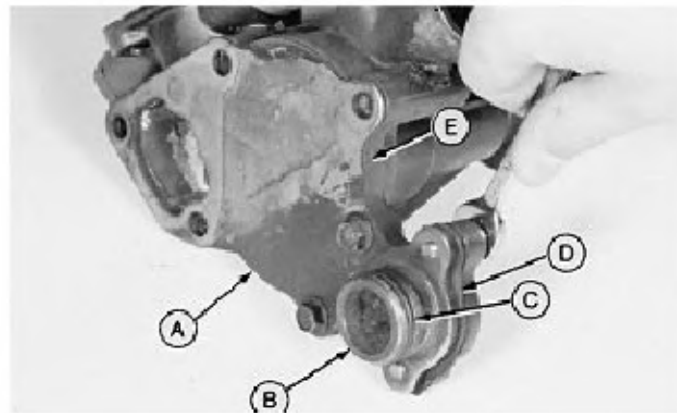
3TN75RJ/3TN82-ESP/3&4TN84/4TN100RJF



Early 3TNA72UJ



3TN66UJ/3TNA72UJ

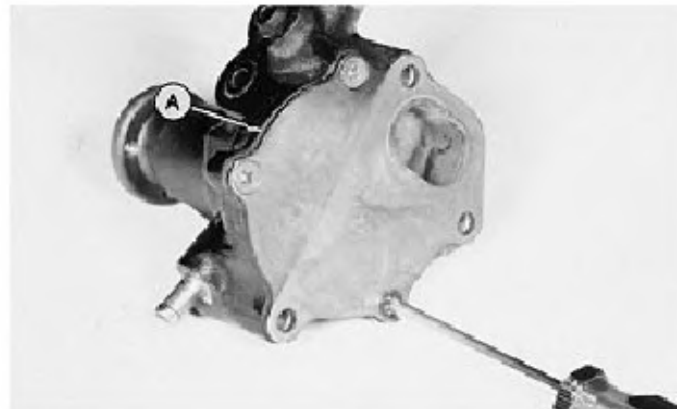


5. Remove three screws to remove plate and gasket (A).

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

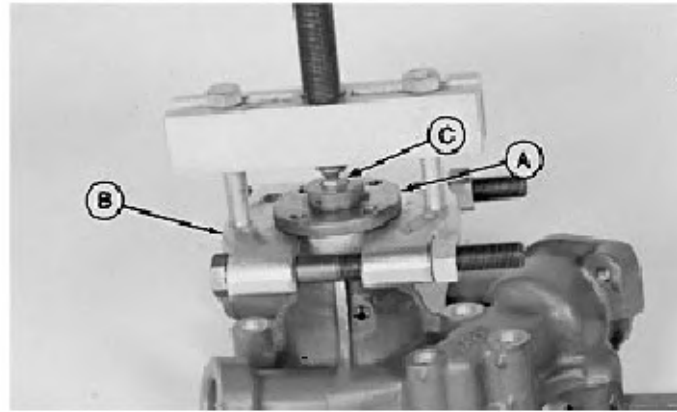
Remove four (eight for 3TN82E-SP 3TN84/4TN84 Engines, 10 for 4TN100RJF Engine) cap screws and remove parts (A—E).

Remove three screws to remove plate and gasket (A).



4TN82E-SP

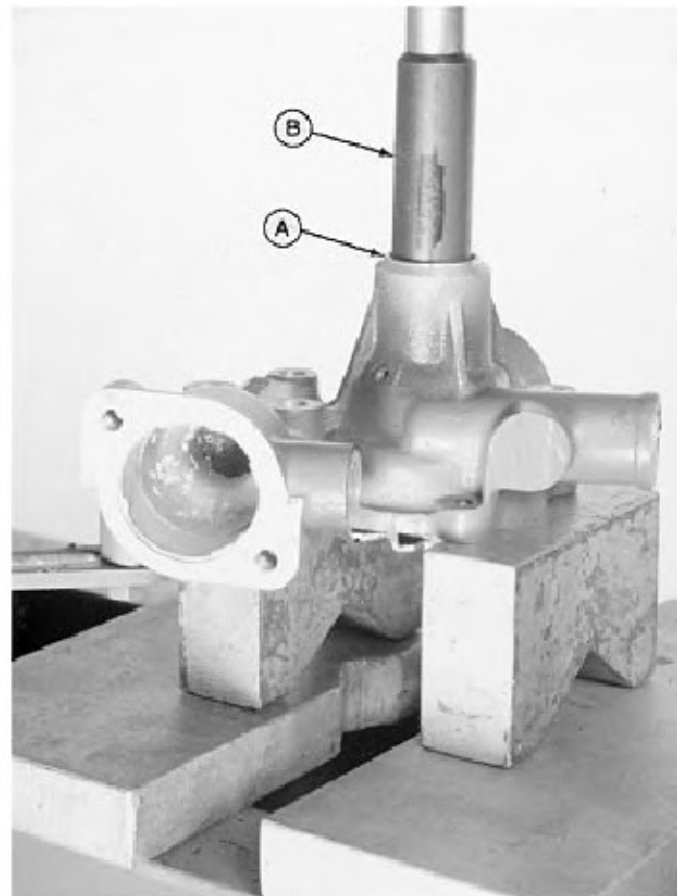
6. Remove pulley flange (A) using a puller (B) and small nuts (C).



M21.TM345.22 -19-10MAR88

NOTE: Be sure press blocks do not hit impeller.

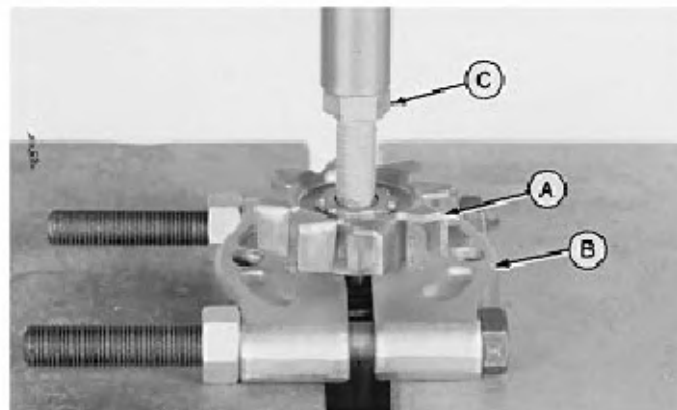
7. Remove bearing shaft (A) using the correct size bearing driver (B). (Use JDE-152 or JDG-506 Bearing Driver.)



M21.TM345.23 -19-11AUG88

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.



M21.TM345.24 -19-10MAR88

9. Remove shaft seal.



M21.TM345.25 -19-10MAR88

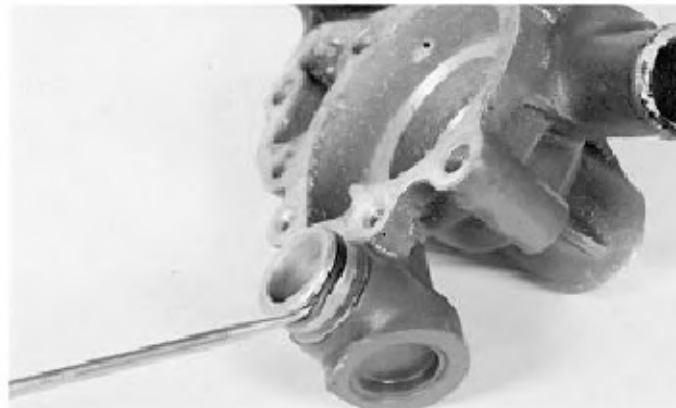
10. Remove ceramic seal.



M21.TM345.26 -19-10MAR88

11. Remove O-ring, if equipped.

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



M21.TM345.27 -19-10MAR88

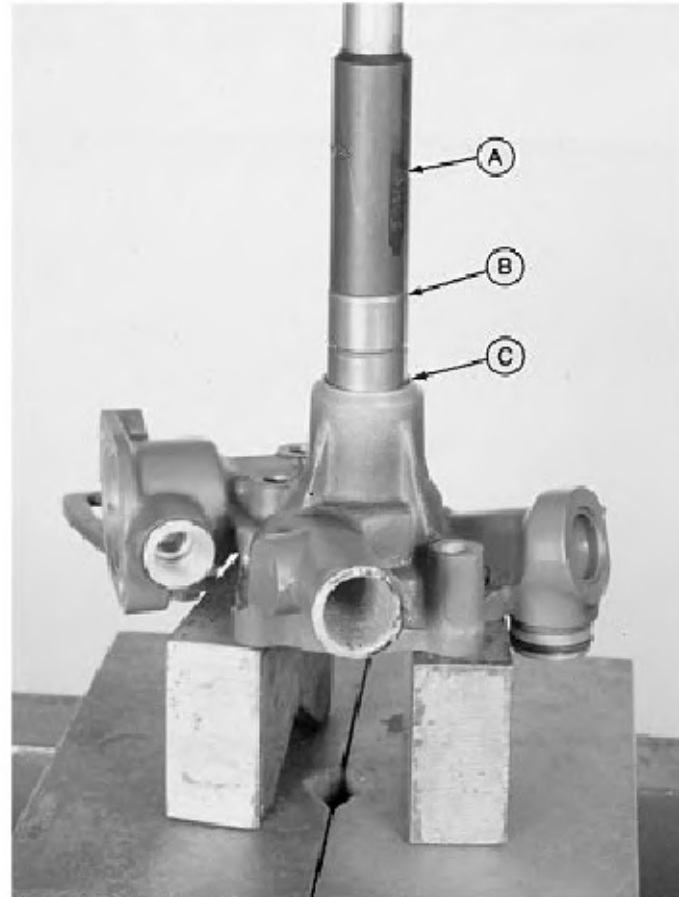
ASSEMBLE WATER PUMP

1. Install new O-ring, if equipped.



M21.TM345.28 -19-10MAR88

2. Install bearing shaft, long end down, using correct size bearing driver (A) and a press. (Use JDE-152 or JDG-506 Bearing Driver.)
3. Press shaft into pump body until bearing surface (B) is flush with housing surface (C).



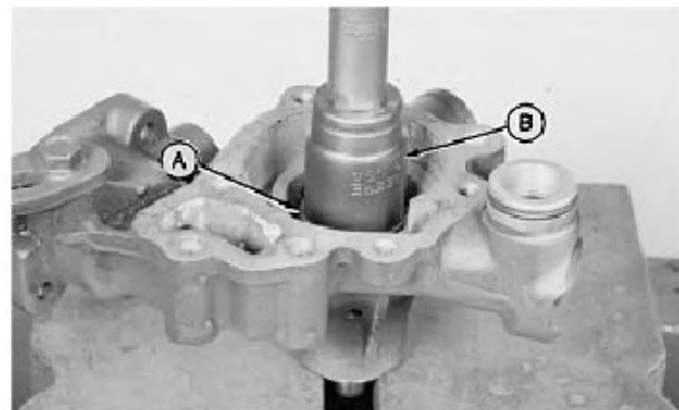
M21.TM345.29 -19-11AUG8

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



M21.TM345.30 -19-10MAR8

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 -19-10MAR8

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

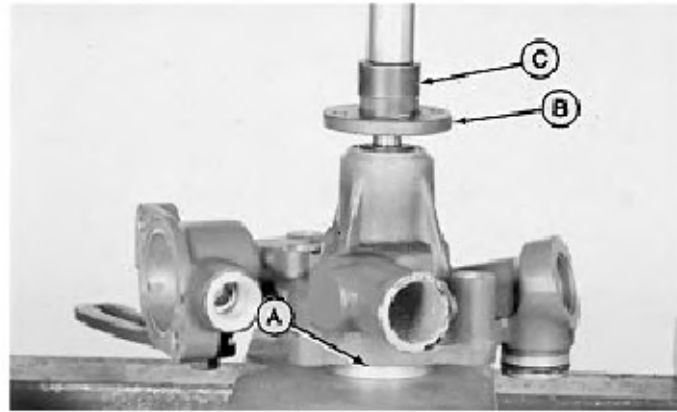
6. Support pump on bearing shaft using a driver disk (A).

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

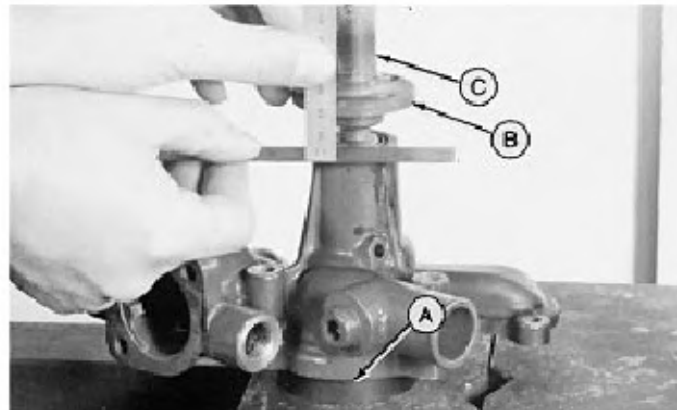
Push pulley flange (B) on bearing shaft until bottom of flange is 17 mm (0.67 in.) from top of housing. Use a ram adapter (C) and a press.

For 4TN100RJF, push pulley flange (B) on bearing shaft until bottom of flange is 13 mm (0.50 in.) from top of housing.

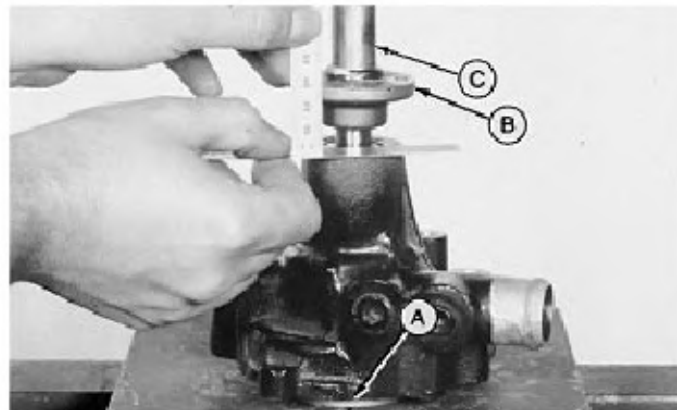
Push pulley flange (B) on bearing shaft until top of flange is 27 mm (1.06 in.) from top of housing. Use a ram adapter (C) and a press.



3TN66/3TNA72



3TN75RJ/3TN82E-SP/3TN84/4TN84



4TN82E-SP

M21.TM345.32 -19-11AUG8

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 -19-10MAR8

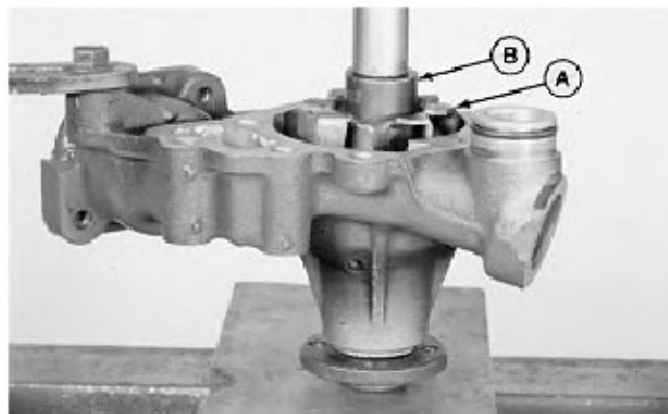
9. Install impeller (A) with ceramic seal toward the shaft seal.

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.

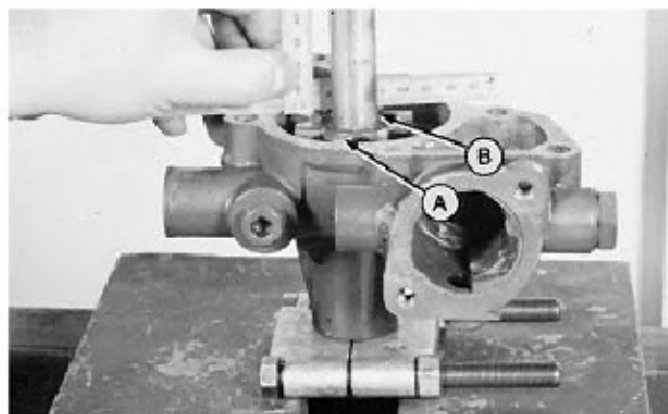
Push impeller on bearing shaft until top of impeller is 2 mm (0.08 in.) below housing. Use a ram adapter (B) and a press.

Push impeller on bearing shaft until top of impeller is 1 mm (0.04 in.) below housing. Use a ram adapter (B) and a press.

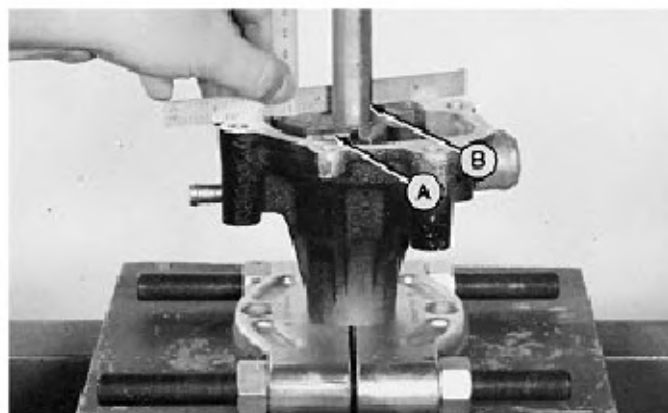
Use a ram adapter and a press to push impeller on bearing shaft until clearance between impeller and pump body is 0.3—1.1 mm (0.012—0.043 in.)



3TN66UJ/3TNA72UJ



3TN75RJ/3TN82E-SP/3TN84/4TN84

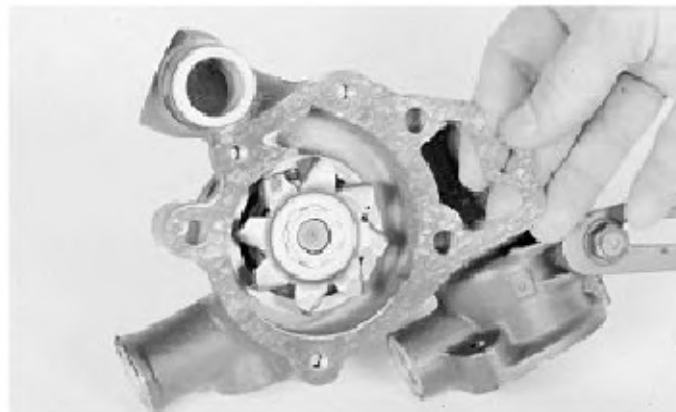


4TN82E-SP



4TN100RJF

11. Install new gasket on water pump housing.



4TN82E-SP

M21,TM345,35 -19-10MAR8

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

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

Install parts (A—D). Install and tighten four (eight for 3TN82E-SP/3TN84/4TN84 Engines, 10 for 4TN100 RJF Engine) cap screws to 9 N·m (78 lb-in.).

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

NOTE: For 4TN82E-SP engines, steps 13—17 are not used.

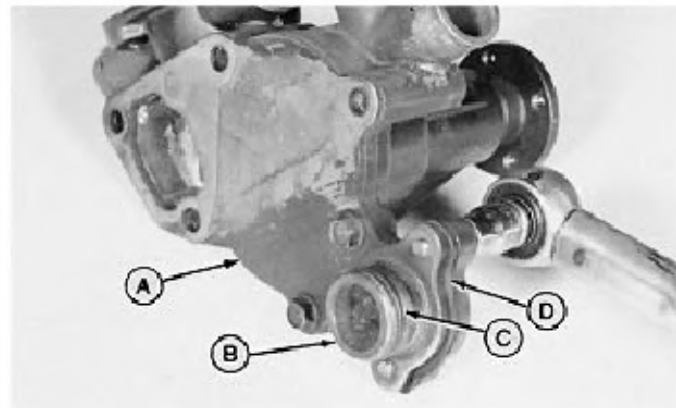
A—Plate
B—Adapter
C—O-Ring
D—Gasket



Early 3TNA72UJ



3TN66UJ/3TNA72UJ



3TN75RJ/3TN82ESP/3&4TN84/4TN100RJF



4TN82E-SP Engine

13. Install cap screws (A). Install pulley and four cap screws. Hold pulley using strap wrench. Tighten cap screws to 11 N·m (96 lb-in.).



M21.TM345.37 -19-11AUG8

14. Install washer (A) and temperature sender.

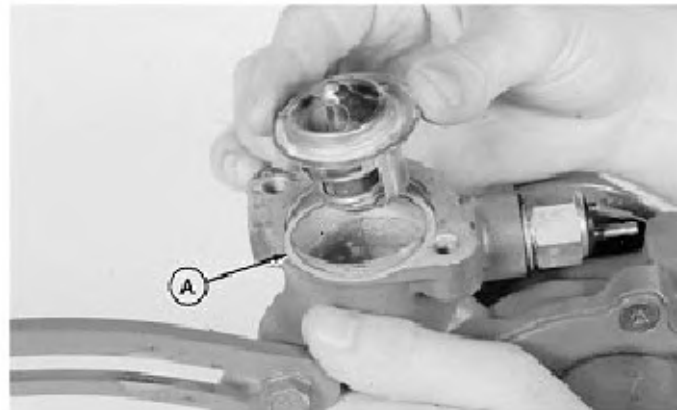


3TNA72UJ Shown

M21.TM345.38 -19-11AUG8

NOTE: Gasket is only used on some engines.

15. Install new gasket (A), if equipped and thermostat.

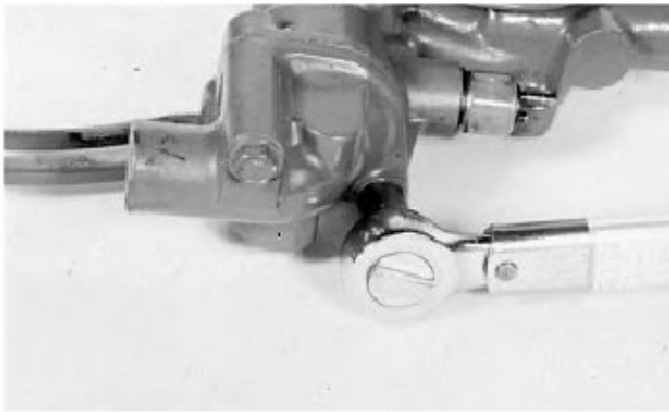


M21.TM345.39 -19-11AUG8

- 16. Install new gasket.
- 17. Install thermostat housing. Tighten cap screws to specifications.

THERMOSTAT HOUSING CAP SCREW SPECIFICATIONS

Engine	Measurement	Specifications
3TN66UJ	Torque	9 N·m (78 lb-in.)
3TNA72UJ/3TN75RJ/ 3TN82E-SP/ 3TN84/ 4TN82E-SP/4TN84/ 4TN100RJF	Torque	20 N·m (180 lb-in.)
3TNA72-UJB/3TN78-RJB/ 3TN82-RJB/ 4TN78T-RJB	Torque	26 N·m (226 lb-in.)



3TNA72UJ Shown



3TN75RJ Shown

M21.TM345.40 -19-01SEP8

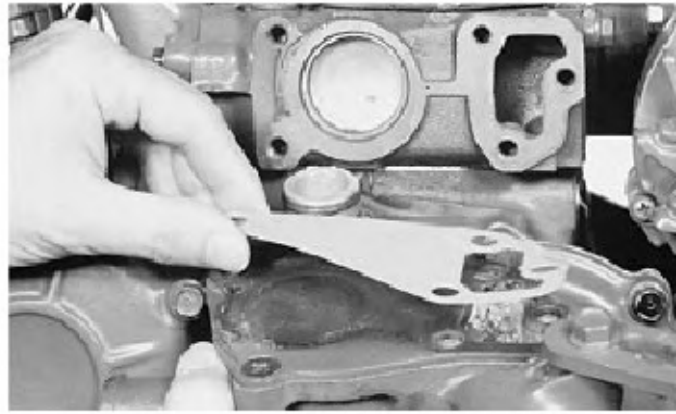
INSTALL WATER PUMP

1. Thoroughly clean and dry all parts.
2. Install new gasket.
3. Install water pump. Tighten cap screws to 26 N·m (226 lb-in.).

Install new gasket.

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

Install hose (A) and fasten with hose clamp (B).

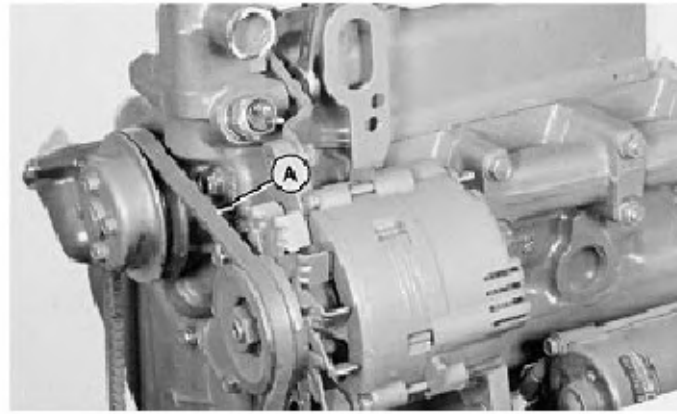


4TN82E-SP

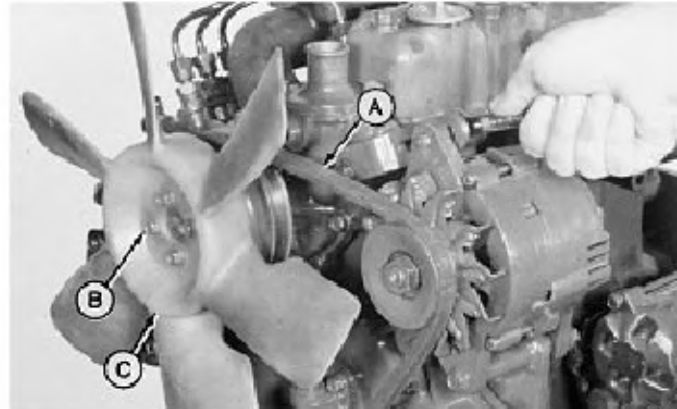


4TN82E-SP

4. Install fan (C) if equipped 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.



3TNA72UJ Shown

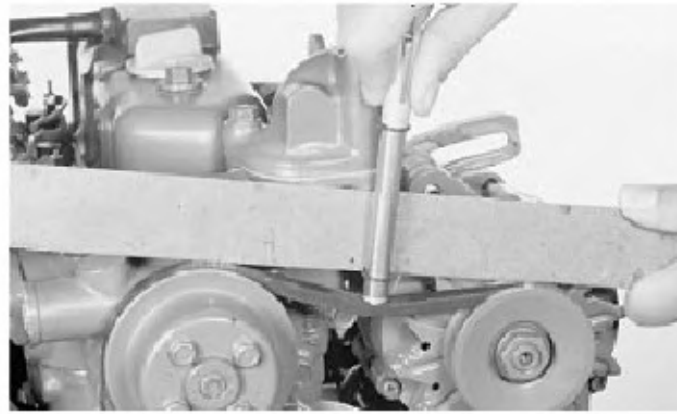


3TN75RJ Shown

M21,TM345,42 -19-01SEP8

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.



M21,TM345,43 -19-10MAR8

Fuel Injection Pump, Camshaft, and Nozzles

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
D—01109AA	Diesel Fuel Injection Nozzle Tester	To test nozzles
D—01110AA	Adapter Set	To connect nozzle to nozzle tester
23622	Straight Adapter	To connect nozzle to nozzle tester

M21,TM350,1 -19-23APR8

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	To hold crankshaft pulley
13-Ton Puller Set	To remove crankshaft pulley and to service fuel injection pump camshaft
Bushing, Bearing, and Seal Driver Set	To service bushing, bearings, and oil seals
Press	To service fuel injection pump camshaft
Dial Indicator	Measure fuel injection pump camshaft gear backlash
Outside Micrometer	Measure fuel injection pump camshaft lobe height

M21,TM350,2 -19-23APR8

OTHER MATERIAL

Number	Name	Use
PT94	John Deere Form-In-Place Gasket (RTV rubber silicone sealant)	To seal gear housing cover
T43512	John Deere LOCTITE Thread Lock and Sealer (medium strength)	Apply on threads of Crankshaft pulley cap screw

LOCTITE is a trademark of the Loctite Corp.

M21,TM350,3 -19-01SEP8

SERVICE PART KITS

The following kits are available through your parts catalog.

Cylinder Block Gasket Kit
 Fuel Injection Pump Shim Pack
 Fuel Injection Nozzle Shim Pack

M21,TM350,4 -19-07FEB8

REMOVE FUEL INJECTION PUMP (3TN66/3TNA72)

NOTE: If the fuel injection pump is being removed to check timing. See *Fuel Injection Pump Timing Adjustment in Machine Technical Manual, Section 220.*

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.



M21,TM350.6 -19-01SEP87

IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump lines, and area around the pump using a parts cleaning solvent or steam cleaner.
2. Remove two screws and clamp from injection lines.

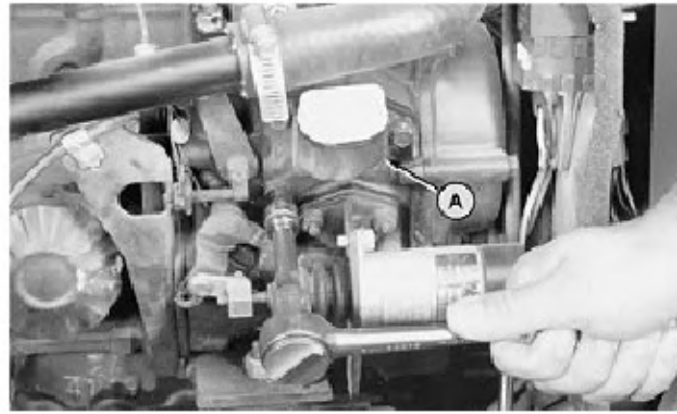
IMPORTANT: When removing injection lines, **DO NOT** turn pump delivery valve fittings. Turning fittings may damage pump internally.

3. Loosen fuel injection line connectors slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep injectors from loosening.
4. Remove fuel injection lines. Close all openings with caps and plugs to keep dirt out of the fuel system.

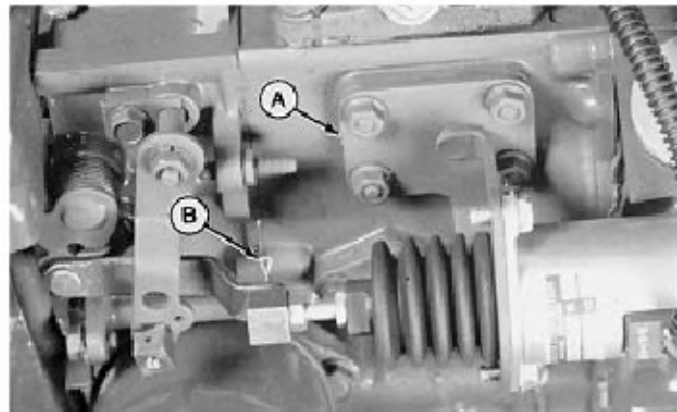


M21,TM350.7 -19-23APR88

5. Remove two cap screws and nut. Remove cover and gasket (A).
6. Remove cotter pin (B) to disconnect solenoid linkage.
7. Remove four nuts to remove cover (A) with solenoid.



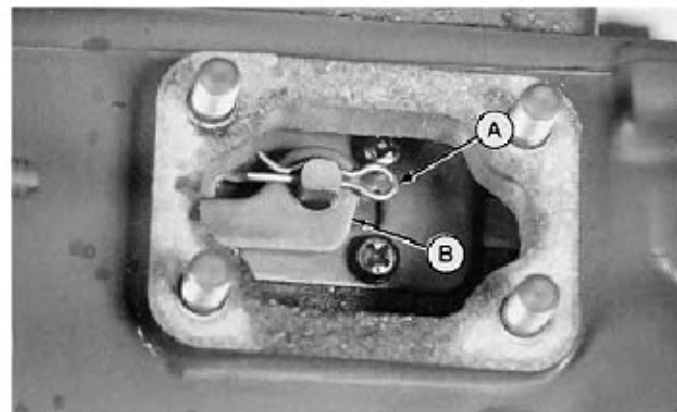
Early 3TNA72UJ



3TN66UJ/Later 3TNA72UJ

M21,TM350,8 -19-23APR8

8. Remove pin (A) to disconnect linkage (B).



M21,TM350,9 -19-08FEB8

IMPORTANT: If injection pump is being removed to be serviced or replaced, the same number and thickness of new shims must be installed when pump is assembled.

9. Remove four nuts to remove fuel injection pump and shims (A).

IMPORTANT: DO NOT disassemble fuel injection pump except for fuel delivery valves. If repair is necessary, have the pump serviced only by a qualified fuel injection repair shop, or replace pump.



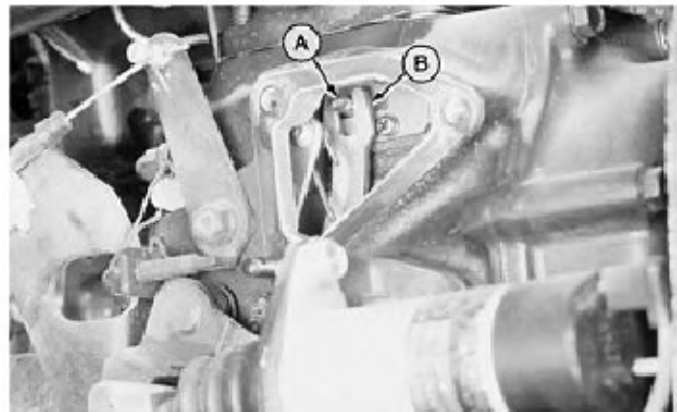
M21,TM350,10 -19-08FEB8

INSTALL FUEL INJECTION PUMP (3TN66/3TNA72)

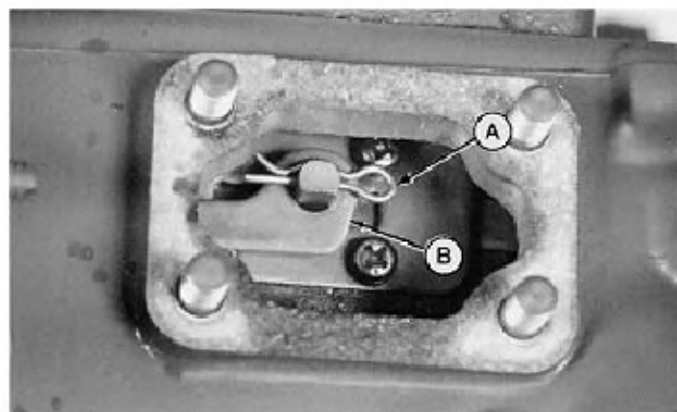
IMPORTANT: If a serviced or replacement fuel injection pump is installed, measure old shim thickness and install new shims of the same thickness.

1. Install fuel injection pump and shims into housing. Align controller rack (A) and governor linkage fork (B).

Install governor linkage (B) over arm on injection pump rack and fasten with pin (A).



Early 3TNA72UJ



3TN66UJ/Later 3TNA72UJ

M21,TM350,11 -19-23APR8

2. Install and tighten four nuts to 20 N·m (180 lb-in.)

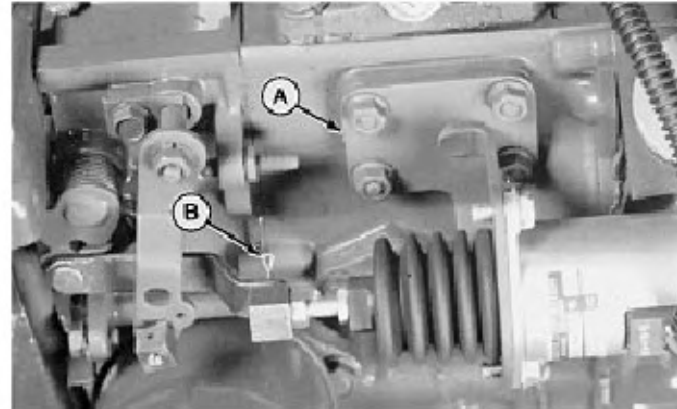


M21,TM350.12 -19-08FEB8

3. Install new gasket.
 4. Install cover and fasten with two cap screws and nut.
- Install cover (A) with fuel shut-off solenoid and fasten with four stud nuts.
- Connect fuel shut-off linkage and fasten with cotter pin (B).



Early 3TNA72UJ



3TN66UJ/Later 3TNA72UJ

M21,TM350.13 -19-23APR8

IMPORTANT: When installing injection lines, **DO NOT** turn pump delivery valve fittings. Turning fittings may damage pump internally.

5. Install injection lines using two wrenches.
6. Connect fuel inlet hose.
7. Bleed fuel system and check injection pump timing. See Section 220 of the appropriate Machine Technical Manual.



M21.TM350.14 -19-01SEP8

REMOVE FUEL INJECTION PUMP (3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84)

IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

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

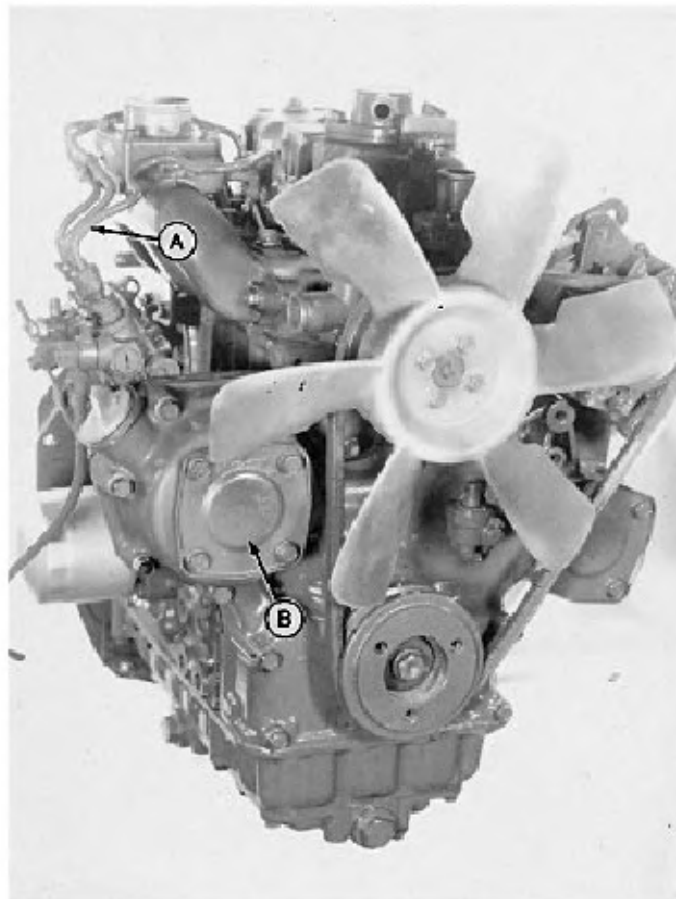
CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

2. Loosen fuel injection line connectors slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep injectors from loosening.

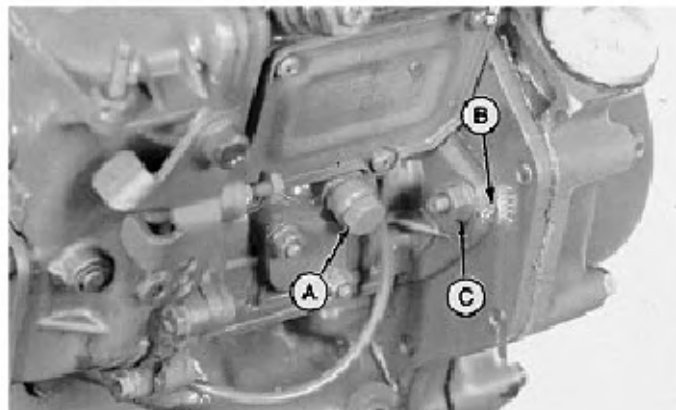


3. Remove injection lines (A) and access cover (B).



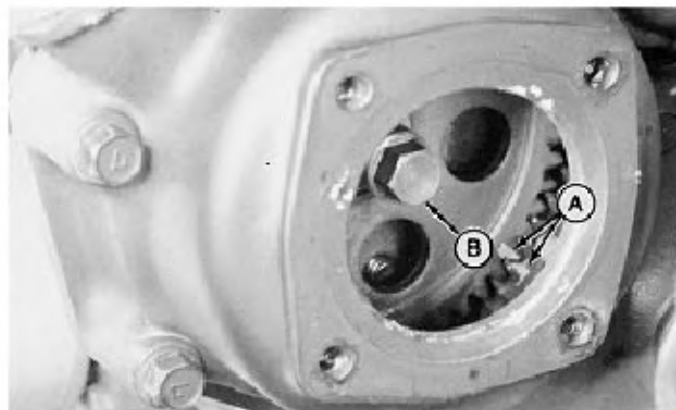
M21.TM350.16 -19-08FEB8

4. Disconnect external lube line (A).
5. Note position of timing mark (B) for installation.
6. Remove the 3 attaching stud nuts (C).



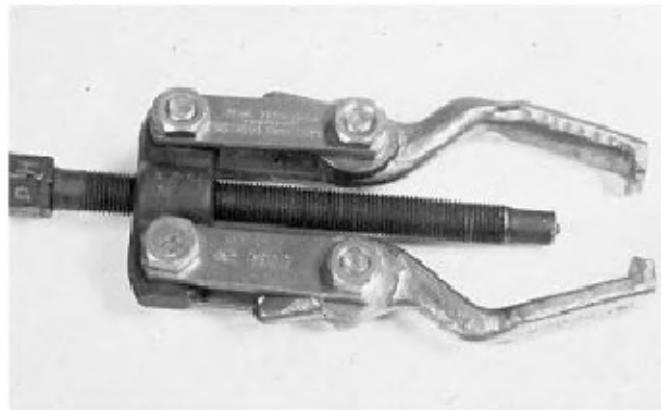
M21.TM350.17 -19-08FEB8

7. Use chalk or paint to mark injection pump gear to idler gear (A).
8. Remove special nut (B).



M21.TM350.18 -19-23APR8

9. Assemble a suitable two jaw puller similar to the one shown.



M21.TM350.19 -19-23APR8

10. Install puller onto injection pump gear through access hole. Pull gear from shaft.

11. Remove injection pump.

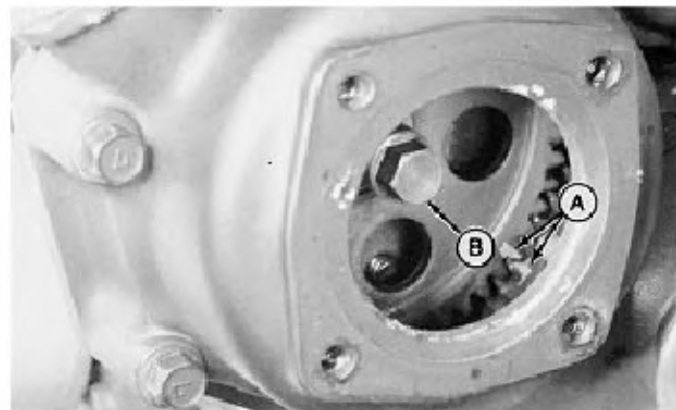


M21.TM350.20 -19-08FEB8

INSTALL INJECTION PUMP (3TN75/3TN78/3TN82/3TN84/ 4TN78/4TN82/4TN84)

1. Put injection pump onto back of gear housing. Align key on shaft with keyway in gear. Be sure to align gear timing marks (A) made during removal.

2. Install special nut (B). Tighten to 90 N·m (66 lb-ft).



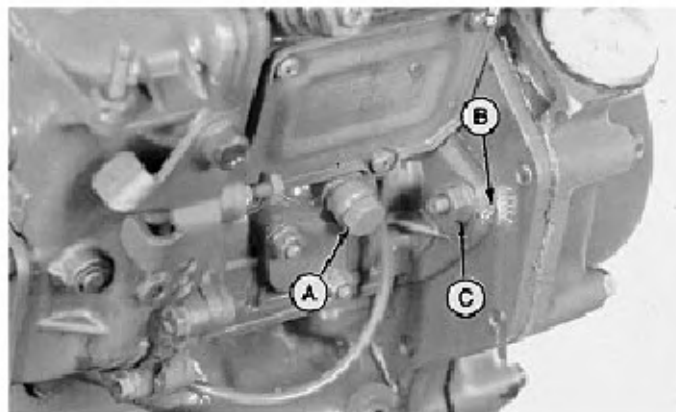
M21.TM350.21 -19-13AUG8

3. Install external lube line (A).
4. Align timing marks to same place as when removed.

If new injection pump is being installed, check and adjust timing as instructed in Section 220 of the Machine Technical Manual.

5. Install the three mounting stud nuts (C). Tighten to 26 N·m (19 lb-ft).

6. Install injection lines and gear access cover. Bleed fuel system as instructed in Machine Technical Manual.



M21.TM350.22 -19-01SEP8

REMOVE FUEL INJECTION PUMP (4TN100RJF)

IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump

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

! CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

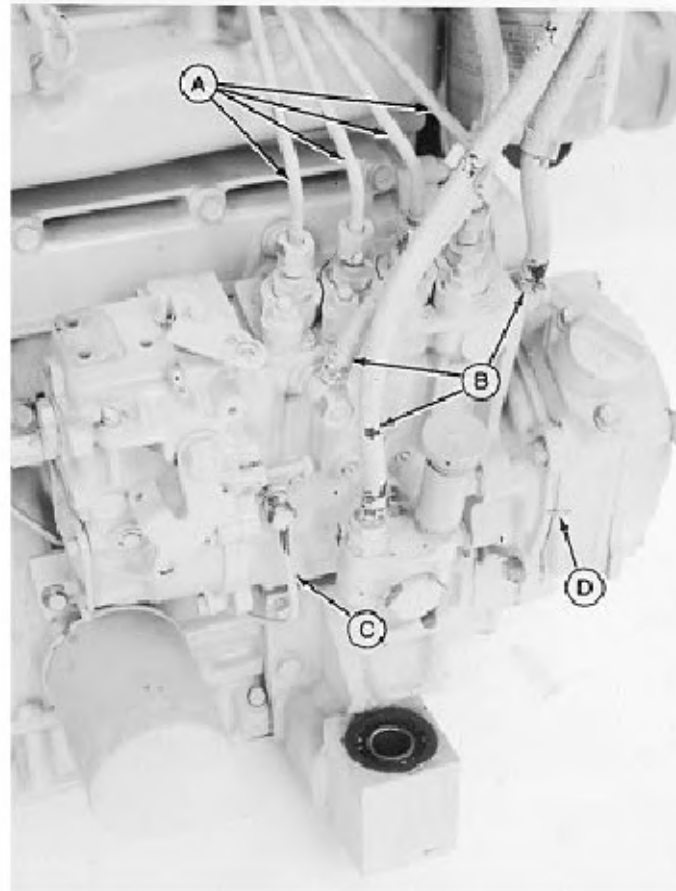
If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

2. Loosen fuel injection line connectors slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep injectors from loosening.

3. Remove injection lines (A), fuel filter hoses (B) and external lube line (C).

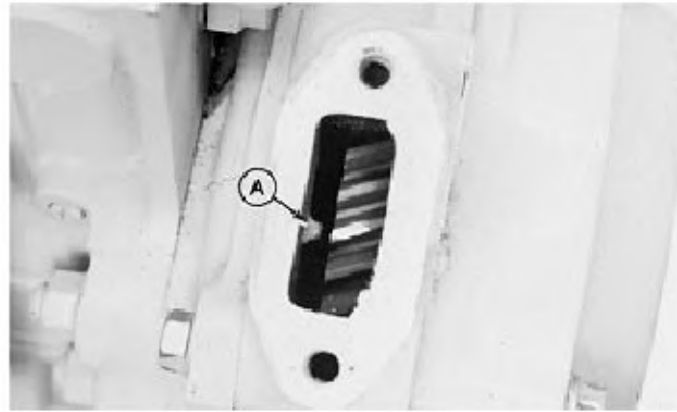
4. Score a line (D) to mark injection pump position on gear case housing.

A—Injection Lines
B—Hoses
C—Lube-Line
D—Line



M21, TM350, A1 -19-01SEP8

5. Remove oil filler neck assembly.
6. Use chalk or paint to mark injection pump gear to notch (A) on gear case housing.



M21.TM350.A2 -19-13AUG8

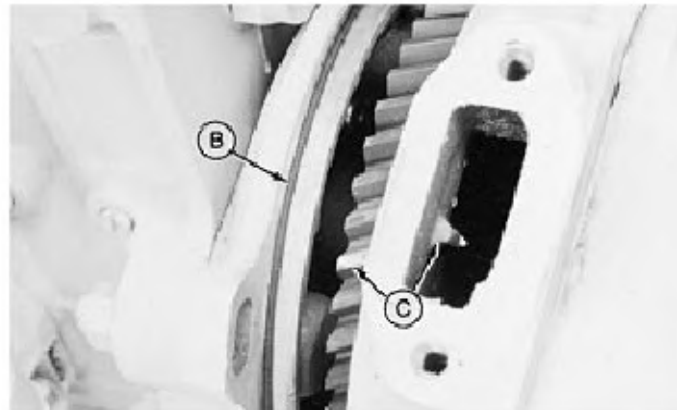
7. Remove six cap screw (A) to remove injection pump.



M21.TM350.A3 -19-13AUG8

INSTALL FUEL INJECTION PUMP (4TN100RJF)

1. Install O-ring (B) on injection pump. Put injection pump onto gear housing. Align gear timing marks (C) made during removal.
2. Install six cap screws (A).
3. Install oil filler neck and gasket.



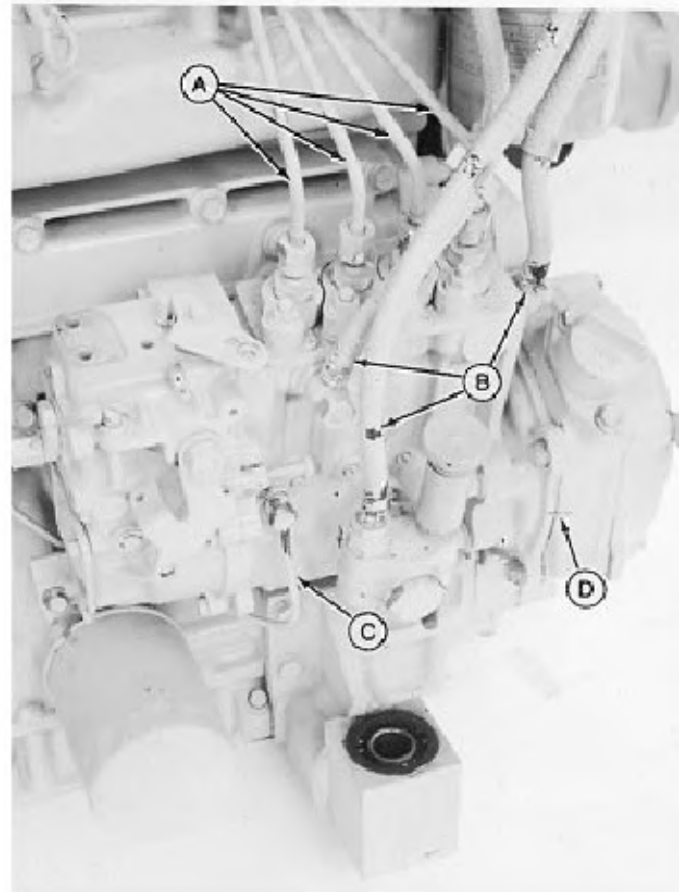
M21.TM350.A4 -19-13AUG8

4. Install external lube line (C).
5. Align marks (D) to same place as when removed.
Tighten mounting cap screws to 27 N·m (20 lb-ft).

If new injection pump is being installed, check and adjust timing as instructed in Section 230 or 9010 of the Machine Technical Manual.

6. Install injection lines. Bleed fuel system as instructed in Machine Technical Manual.

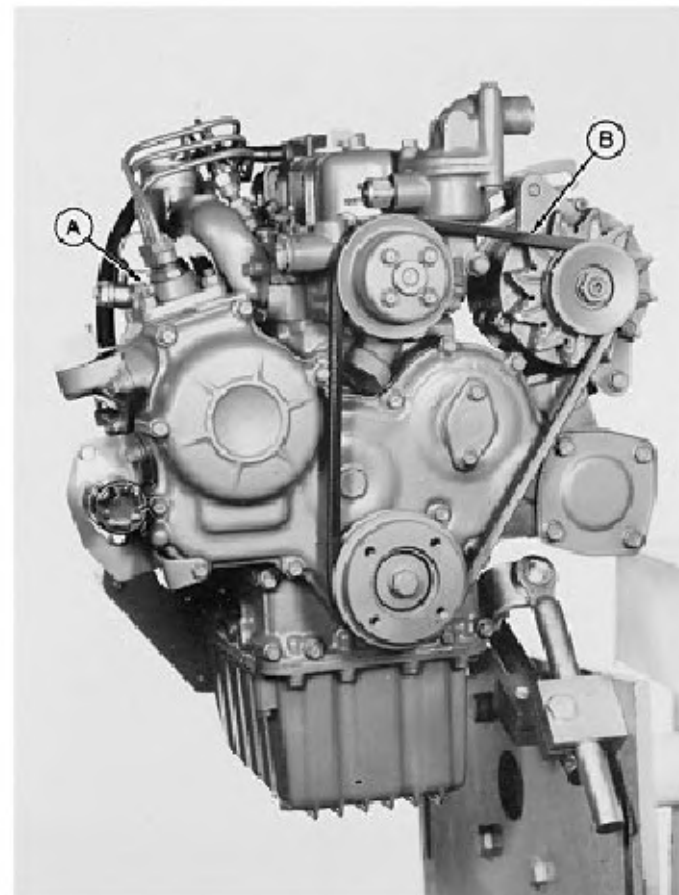
A—Injection
B—Hoses
C—Lube Line
D—Line



M21,TM350,A5 -19-01SEP87

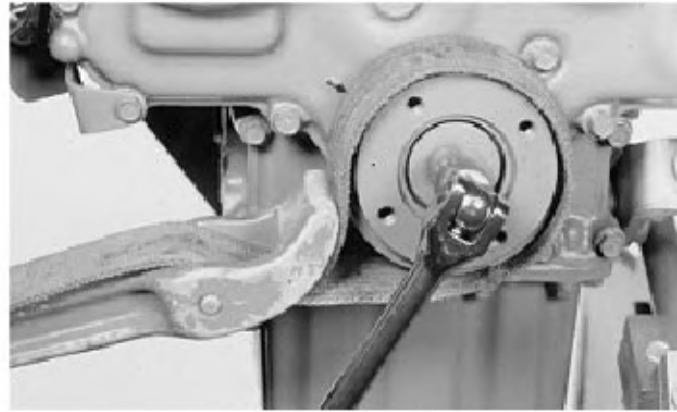
REMOVE FUEL INJECTION PUMP CAMSHAFT (EARLY 3TNA72UJ)

1. Remove engine. (See Section 20 in Machine Technical Manual.)
2. Remove fuel injection pump (A), as instructed earlier in this group.
3. Loosen alternator and remove alternator belt (B).



M21,TM350,23 -19-13AUG87

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



M21.TM350.24 -19-24MAR88

5. Remove crankshaft pulley using puller, shaft protector, two cap screws from water pump, and strap wrench.



M21.TM350.25 -19-24MAR88

6. Remove cotter pin and washer (A) to disconnect fuel shut-off solenoid linkage.



M21.TM350.26 -19-24MAR88

7. Remove two nuts and one cap screw to remove bracket and fuel shut-off solenoid.



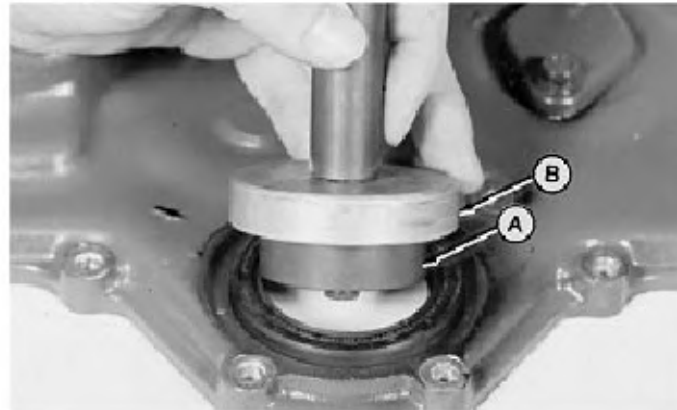
M21.TM350.27 -19-24MAR88

8. Remove 17 cap screws to remove gear housing cover. Remove old gasket material from cover and gear housing.



M21.TM350.28 -19-24MAR88

9. Remove seal using 1 3/4 in. driver disk (A) and 2 3/8 in. driver disk (B).



M21.TM350.29 -19-24MAR88

10. Measure fuel injection pump gear backlash using a dial indicator. New backlash specification is 0.04—0.12 mm (0.002—0.005 in.).

If backlash exceeds 0.20 mm (0.008 in.), replace gear.



M21.TM350.30 -19-24MAR88

11. Put a shop towel between gear teeth. Loosen lock nut.



M21.TM350.31 -19-24MAR88

12. Remove idler gear.



M21,TM350,32 -19-24MAR88

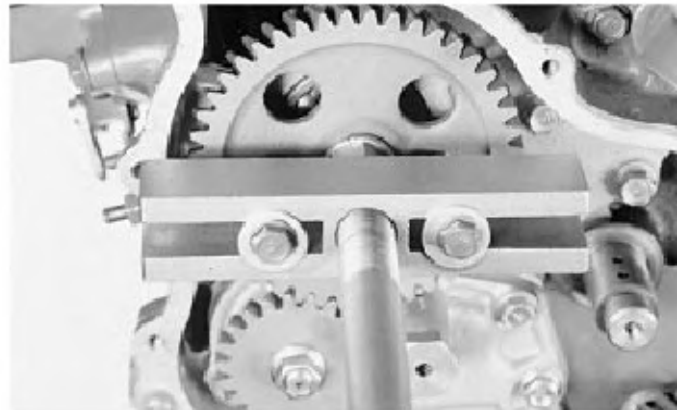
13. Remove special screw.



M21,TM350,33 -19-24MAR88

IMPORTANT: DO NOT allow fuel injection pump camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces may be damaged.

14. Carefully remove fuel injection pump camshaft assembly. Use a slide hammer puller and two cap screws from the gear housing cover.



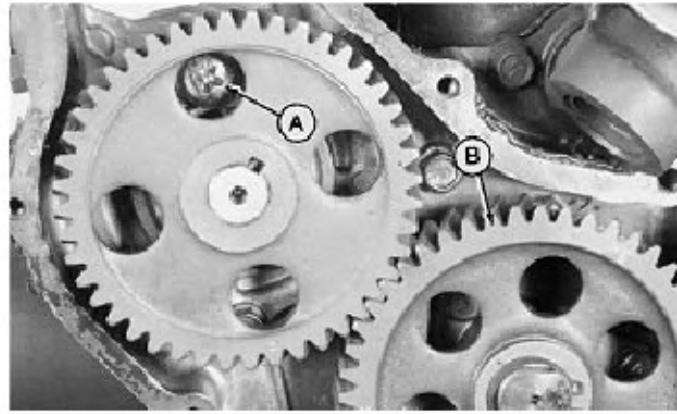
M21,TM350,34 -19-24MAR88

REMOVE FUEL INJECTION PUMP CAMSHAFT (3TN66/LATER 3TNA72)

1. Remove fuel injection pump as instructed earlier in this group.
2. Remove gear housing cover.
3. Remove governor housing and flyweight assembly as instructed in Group 60.

M21,TM350,35 -19-01SEP88

4. Remove camshaft bearing retaining screw (A) and idler gear (B).



M21.TM350.36 -19-08FEB8

5. Tap the rear of camshaft (A) with plastic hammer to remove from housing.



M21.TM350.37 -19-23APR8

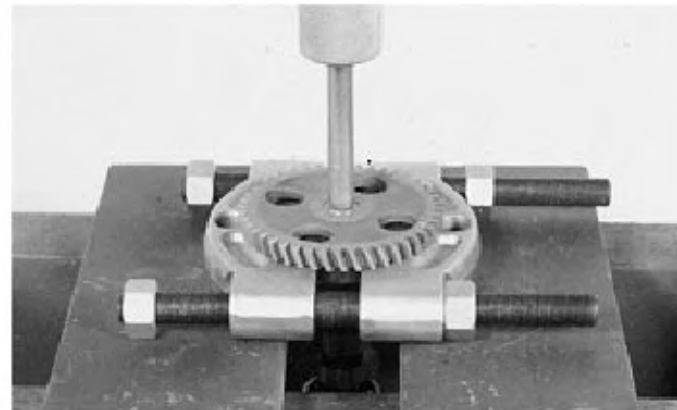
DISASSEMBLE AND INSPECT FUEL INJECTION PUMP CAMSHAFT

1. Inspect camshaft gear for chipped, broken or worn teeth.

IMPORTANT: Hold camshaft while removing gear.

2. Support gear on knife edge puller and press shaft from gear.

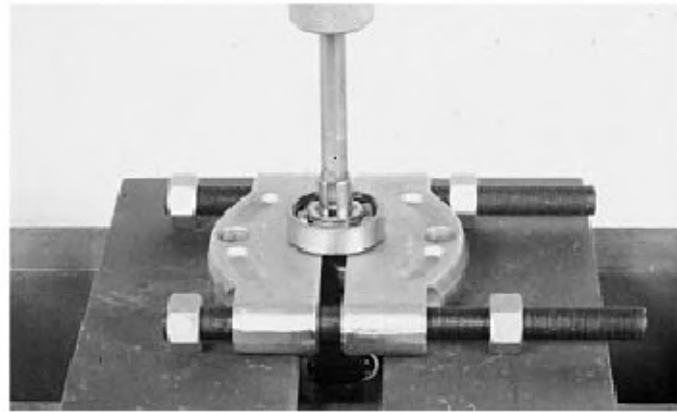
NOTE: Early 3TNA72 injection pump camshafts are tapered on the gear end. Camshafts on 3TN66 and later 3TNA72 engines are not tapered. Service procedures are the same.



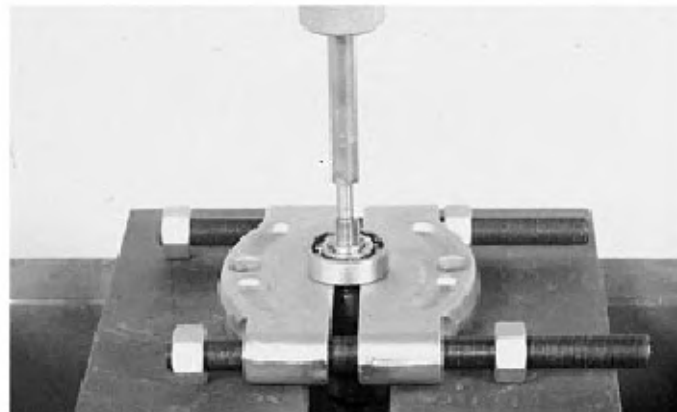
M21.TM350.38 -19-01SEP8

IMPORTANT: Hold camshaft while removing bearings.

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



Front Bearing



Rear Bearing

M21,TM350,39 -19-08FEB8

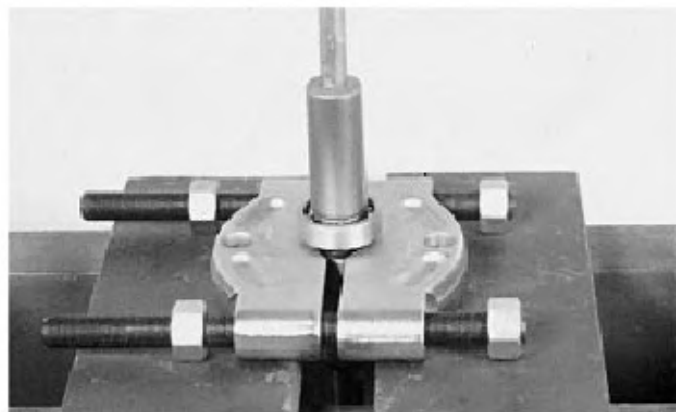
4. Measure height of each camshaft lobe. Replace camshaft if lobe height is less than 30.9 mm (1.217 in.)



M21,TM350,40 -19-08FEB8

ASSEMBLE AND INSTALL FUEL INJECTION PUMP CAMSHAFT

1. Support camshaft in knife edge puller.
2. Press smaller bearing onto rear end of camshaft using a 3/4 in. deep well socket. Press until bearing race bottoms on camshaft shoulder.



M21,TM350.41 -19-08FEB8

3. Support large bearing on a 3/4 in. deep well socket and press camshaft into bearing until it bottoms on bearing race.



M21,TM350.41A -19-19MAR8

4. Put camshaft gear on a flat surface. Press camshaft with bearings into gear.

Press until gear face is flush with end of shaft.

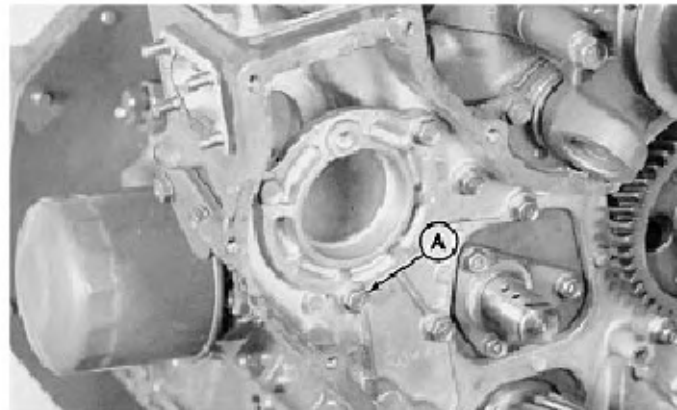


M21.TM350.42 -19-23APR88

5. Inspect camshaft front bearing support. Check for cracks, damage or indications that bearing has spun in support.

6. On 3TN66/late 3TNA72 engines. If necessary, remove three cap screws (A) and replace support.

On early 3TNA72UJ engines, replace gear housing if bearing bores are damaged.



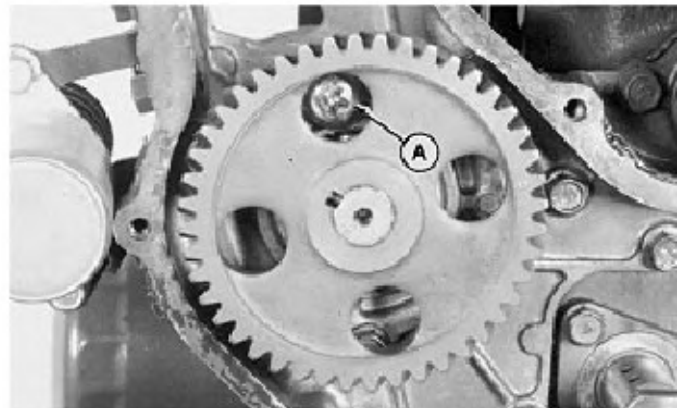
M21.TM350.43 -19-13AUG88

7. Slide camshaft assembly into housing. Tap camshaft gear with plastic hammer to seat bearings in bores.

8. Install bearing retaining screw (A). Tighten to 20 N·m (180 lb-in.).

9. Install governor assembly and flyweights as instructed in Group 60.

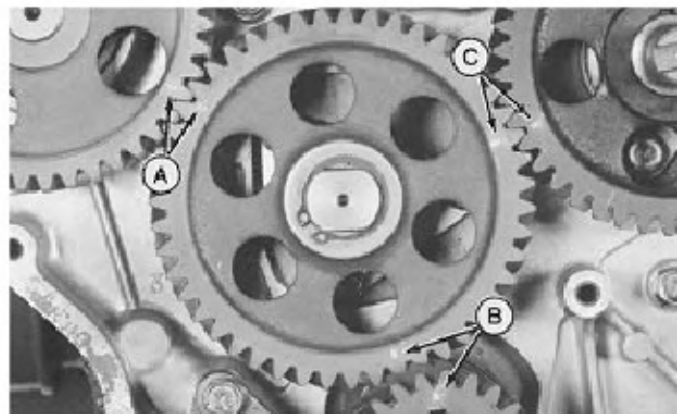
10. Install injection pump as instructed earlier in this group.



M21.TM350.44 -19-08FEB88

11. Install idler gear and align timing marks (A, B, and C).

NOTE: Number one cylinder is closest to flywheel.



3TNA72



3TN66

M21,TM350,45 -19-13AUG87

12. On early 3TNA72UJ engines, put a shop towel between gear teeth. Install lock washer and nut. Tighten to 88 N·m (65 lb-ft).

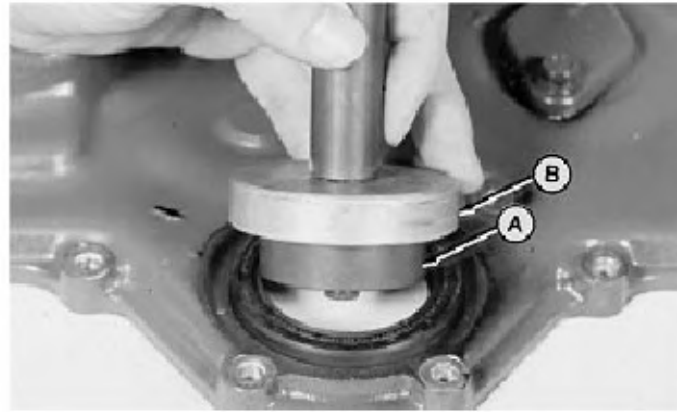


M21,TM350,46 -19-08FEB88

13. If necessary, replace front crankshaft oil seal.

Use 1-3/4 in. disk (A) and 2-3/8 in. disk (B).

Install new seal with lip facing inward. Install flush with front face of gear housing cover.



M21.TM350.47 -19-08FEB8

14. Install gear housing cover. Tighten cap screws to 9 N·m (80 lb-in.)

15. Install and connect fuel shut-off solenoid.



M21.TM350.48 -19-08FEB8

16. If equipped, align index pin (A) with hole in crankshaft gear (B).



M21.TM350.49 -19-08FEB8

17. Apply medium strength thread lock and sealer to pulley cap screw.
18. Hold pulley with strap wrench and tighten cap screw to 88 N·m (65 lb-ft).
19. Install fan and fan belt.
20. Install engine. See section 20 of Machine Technical Manual.
21. Bleed fuel system. See section 230 of Machine Technical Manual.



M21, TM350, 50 -19-08FEB8

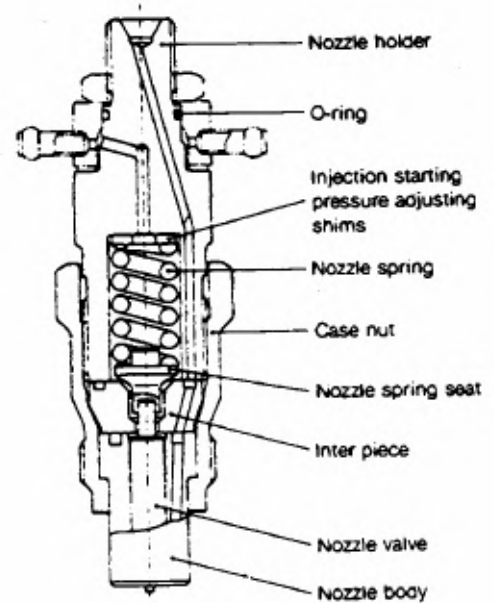
PINTLE TYPE FUEL INJECTION NOZZLE OPERATION (3TN66/3TNA72)

The pintle type nozzle is used on indirect injection engines 3TN66 and 3TNA72. It is different from the hole type nozzle in that it is threaded into the cylinder head.

High pressure fuel from the injection pump flows through a fuel inlet passage. Pressure builds beneath the nozzle valve. When the fuel pressure reaches specified pressure it overcomes the nozzle spring tension. The nozzle valve retracts into the nozzle body and fuel is injected into the engine. The nozzle valve is shim adjustable to regulate the opening pressure.

The nozzle valve is automatically pushed down by the nozzle spring and closed after fuel is injected.

Leakage (return fuel) flows from beyond the nozzle valve and nozzle body to the hole on top of the nozzle spring through the return pipe fitting and back into the fuel tank.



M21, TM350, 51A -19-13AUG8

REMOVE PINTLE TYPE FUEL INJECTION NOZZLES (3TN66/3TNA72)

⚠ CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump, injection nozzles, lines, and area around the nozzles using a parts cleaning solvent or a steam cleaner.



M21,TM350,52A -19-01SEP87

IMPORTANT: When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally.

2. Use two wrenches to loosen fuel line fittings enough to release any pressure in the fuel system.
3. Disconnect fuel lines from injection nozzles and remove lines.
4. Cap all openings to keep dirt out of the fuel system.

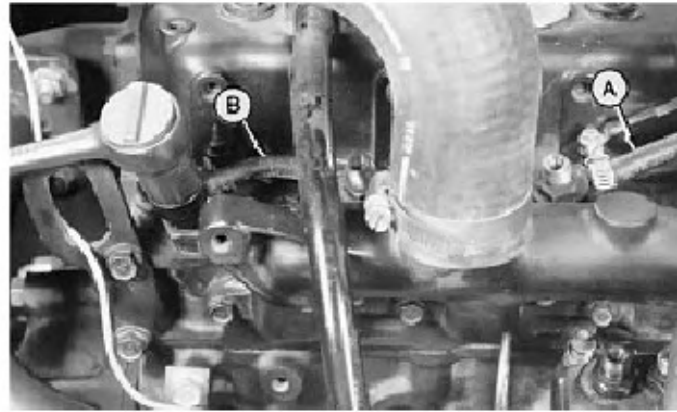


M21,TM350,53 -19-08FEB88

5. Loosen clamp and disconnect fuel return hose (A).
6. Remove three nuts to remove leak-off line (B).

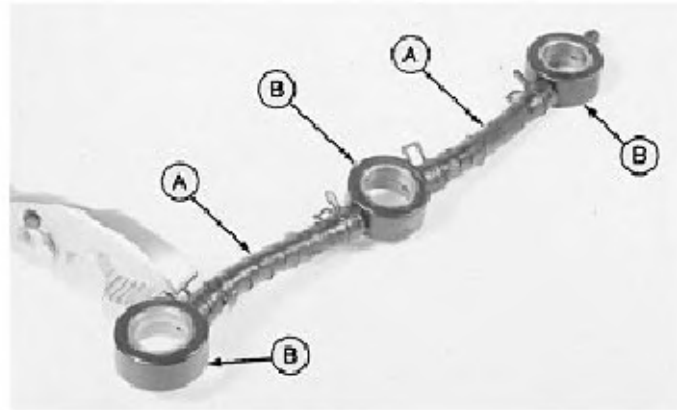
IMPORTANT: To prevent possible leakage DO NOT reuse bronze gasket material.

7. Remove and discard bronze gaskets.



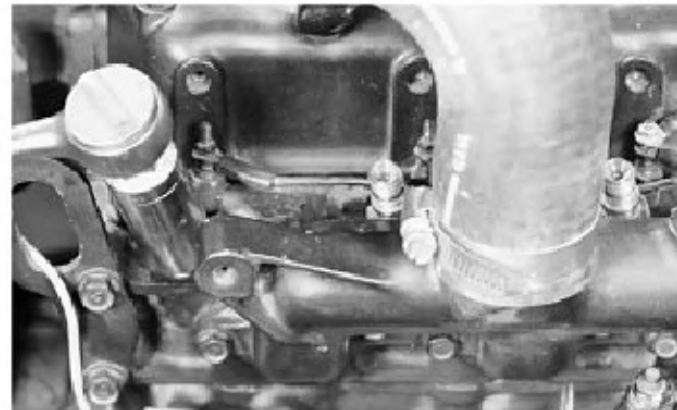
M21.TM350.54 -19-08FEB88

8. Remove clamps to remove hoses (A) and fittings (B).



M21.TM350.55 -19-08FEB88

9. Remove fuel injection nozzles.
10. Remove and discard bronze gaskets.
11. Test injection nozzles.



M21.TM350.56 -19-08FEB88

TEST PINTLE TYPE FUEL INJECTION NOZZLES (3TN66/3TNA72)

This test checks the opening pressure, leakage, chatter, and spray pattern of the fuel injection nozzle. Test the nozzle before disassembly to determine condition and necessary repair.

1. Connect fuel injection nozzle (D) to D-01109AA Diesel Fuel Injection Nozzle Tester (F). Use fittings (A, B, and G) from D-01110AA Adapter Set and fitting (C).

IMPORTANT: Use clean filtered diesel fuel when testing fuel injection nozzles to get best test results.

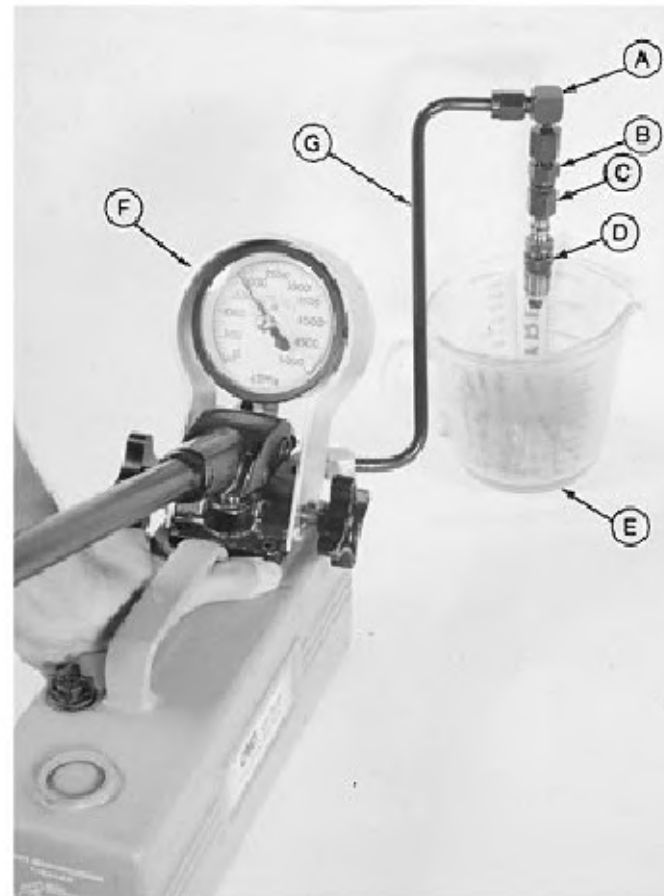
CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

2. Test fuel injection nozzle opening pressure following the tool manufacturer's instructions.
 - a. Record pressure reading when nozzle valve opens.
 - b. If pressure reading does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination or stuck valve. If necessary, add or remove shims to change opening pressure. (See Disassemble Fuel Injection Nozzles in this section.)

NOZZLE VALVE OPENING PRESSURE SPECIFICATIONS

3TN66/3TNA72 11 722 ± 480 kPa
(1700 ± 70 psi)



- A—23617 90° Adapter
- B—23621 Straight Adapter
- C—23622 Straight Adapter
- D—Fuel Injection Nozzle
- E—Container
- F—D-01109AA Diesel Fuel Injection Nozzle Tester
- G—36352 Fuel Line Assembly

3. Test fuel injection nozzle leakage following the tool manufacturer's instructions.

- a. Dry nozzle completely using a lint-free cloth.
- b. Pressurize nozzle to test specifications.
- c. Watch for leakage from nozzle spray orifice

NOZZLE LEAKAGE 3TN66/3TNA72 TEST SPECIFICATIONS

Nozzle Pressure 11 032 kPa (1600 psi)

Minimum Nozzle Leakage Time 10 seconds

d. If nozzle leakage time is low, check nozzle for contamination. Inspect valve seating surface; replace nozzle assembly as required.

M21,TM350,58 -19-08FEB8

4. Test fuel injection nozzle chatter and spray pattern following the tool manufacturer's instructions.

- a. Pressurize nozzle to test specifications.
- b. Listen for "chatter" sound and watch spray pattern.

NOZZLE PRESSURE TEST SPECIFICATIONS

3TN66/3TNA72 11 722 ± 480 kPa
(1700 ± 70 psi)

Slow Hand Lever Movement chatter sound,
fine stream spray
pattern

Fast Hand Lever Movement fine atomized spray
pattern

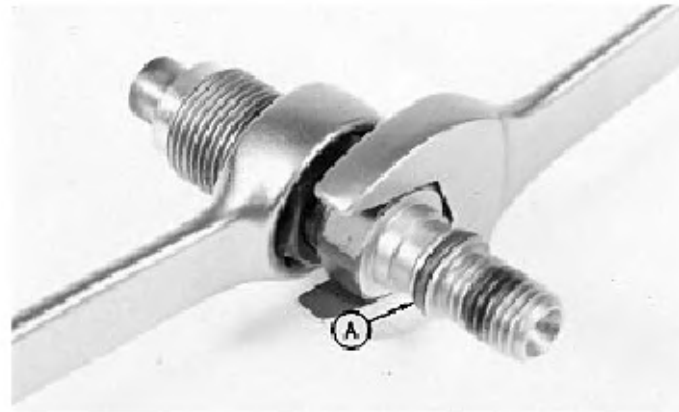
If nozzle does not chatter or spray pattern is toward one side only and not finely atomized, check nozzle for contamination. Inspect valve seating surface; replace nozzle assembly as required.

M21,TM350,59 -19-08FEB8

DISASSEMBLE PINTLE TYPE FUEL INJECTION NOZZLES (3TN66/3TNA72)

NOTE: Disassemble fuel injection nozzles in a clean, lint-free, work area.

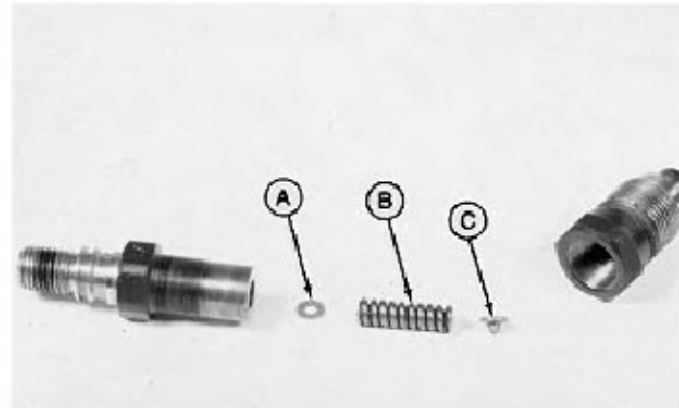
1. Remove O-ring (A).
2. Separate injector assembly.



M21.TM350.60 -19-01SEP8

IMPORTANT: If injector nozzles are being disassembled to be cleaned, the same number and thicknesses of shims must be installed when nozzles are assembled.

3. Remove retainer (C), spring (B), and shims (A).



M21.TM350.61 -19-08FEB8

4. Remove valve (A), valve (B), and nozzle body (C).



M21.TM350.62 -19-08FEB8

5. Inspect 45° valve seating surfaces; replace nozzle assembly as required.

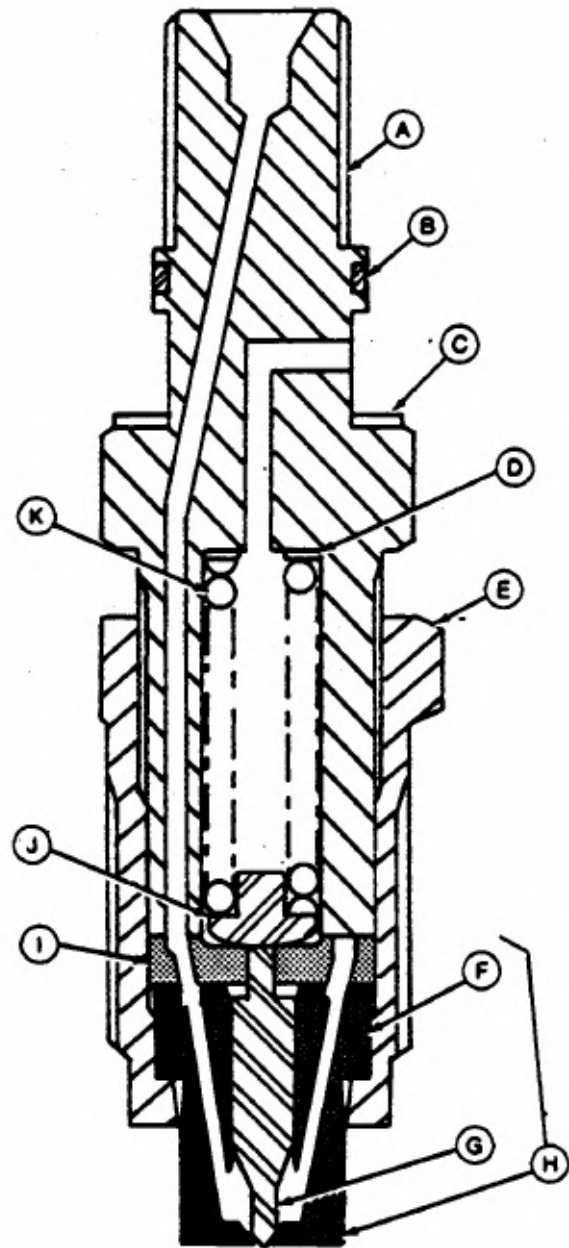
6. All internal service parts must have a shiny surface. If surface is dull, replace part.



M21.TM350.63 -19-08FEB8

CROSS SECTION OF PINTLE TYPE FUEL INJECTION NOZZLE (3TN66/3TNA72)

- A—Injector Body
- B—O-Ring
- C—Bronze Gasket
- D—Shim (as required)
- E—Nozzle Fitting
- F—Nozzle Body
- G—Valve
- H—Nozzle Assembly
- I—Seat
- J—Retainer
- K—Spring



M21.TM350.64 -19-14SEP8

CLEAN AND INSPECT PINTLE TYPE FUEL INJECTION NOZZLES (3TN66/3TNA72)

IMPORTANT: Never use a steel brush or abrasives to clean nozzles. Doing so will damage the spray hole.

1. Remove carbon from used nozzles, and clean by washing in clean diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush from the JDF-13 Nozzle Cleaning Kit.

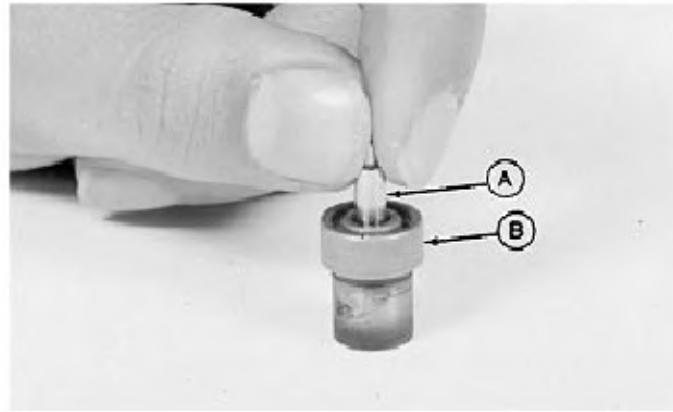
NOTE: A worn, damaged, or contaminated nozzle assembly will cause nozzle leakage. This condition usually will be noticed when testing the fuel injection nozzle.

2. Inspect nozzle assembly components for wear or damage. All internal service parts must have a shiny surface. If surface is dull, replace part.

3. Inspect the nozzle assembly by performing a slide test. Use the following procedure:

- Dip the valve (A) in clean diesel fuel. Insert valve in nozzle body (B).
- Hold nozzle assembly vertical and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat by its own weight.

Always replace a nozzle assembly if the valve does not slide freely to its seat.

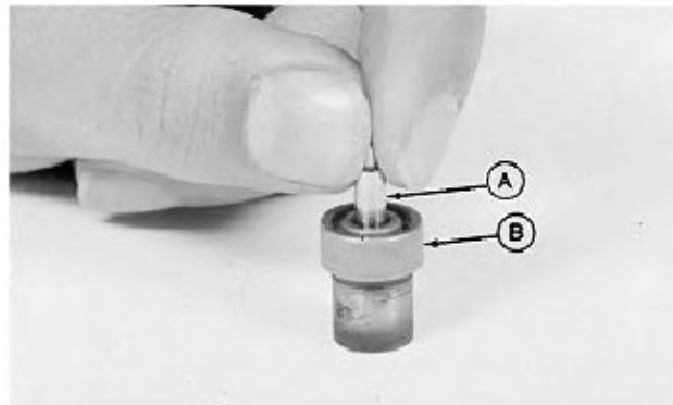


M21,TM350,65 -19-01SEP8

ASSEMBLE PINTLE TYPE FUEL INJECTION NOZZLES (3TN66/3TNA72)

NOTE: Assemble fuel injection nozzles in a clean, lint-free, work area.

- Put clean diesel fuel on all internal parts.
- Install valve (A) in nozzle body (B). Valve must slide freely in nozzle body.



M21,TM350,66 -19-14AUG8

3. Install nozzle assembly (B and C) and seat (A).



M21.TM350.67 -19-24MAR8

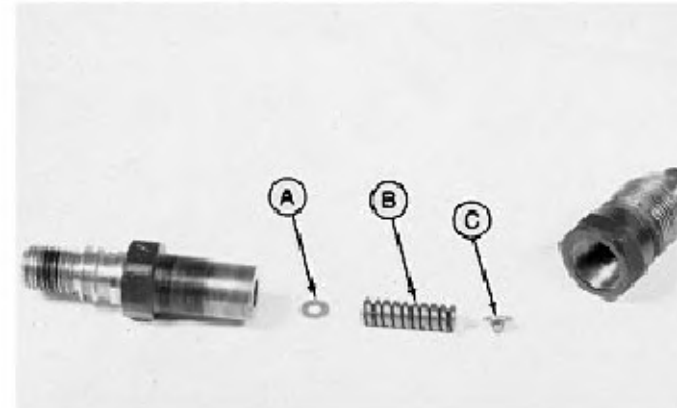
IMPORTANT: If injection nozzles were disassembled to be cleaned, the same number and thicknesses of shims must be installed.

4. Install the required amount of shims (A) from shim pack until the nozzle valve opening pressure is $11\,722 \pm 480$ kPa (1700 ± 70 psi). After assembling fuel injection nozzles, test opening pressure. (See Fuel Injection Nozzle Test in this section.)

SHIM PACK

Shim Size	Approximate Pressure Change
0.15 mm (0.006 in.)	2170 kPa (315 psi)
0.40 mm (0.016 in.)	5790 kPa (840 psi)
0.50 mm (0.020 in.)	7240 kPa (1050 psi)
0.60 mm (0.024 in.)	8690 kPa (1260 psi)
0.70 mm (0.028 in.)	10 140 kPa (1470 psi)
0.80 mm (0.031 in.)	11 580 kPa (1680 psi)

NOTE: For every 0.10 mm (0.004 in.) of shim thickness, there is approximately a 1450 kPa (210 psi) change in nozzle valve opening pressure.



5. Install spring (B) and retainer (C).

50
32

M21.TM350.68 -19-23APR8

6. Assemble nozzle assembly. Tighten to 40 N·m (30 lb-ft).
7. Install new O-ring (A).



M21.TM350.69 -19-14AUG8

INSTALL PINTLE TYPE FUEL INJECTION NOZZLES (3TN66/3TNA72)

1. Install new bronze gaskets.



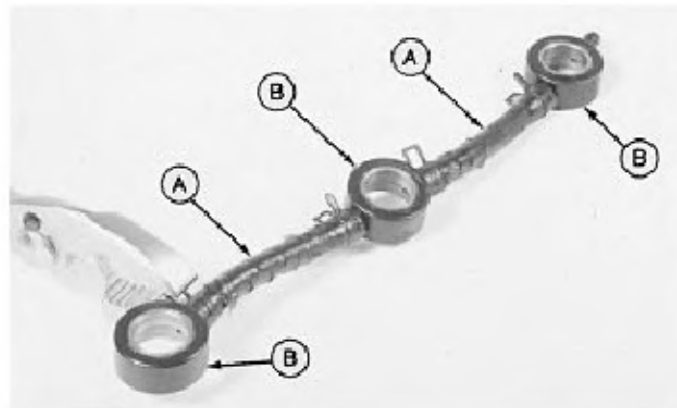
M21.TM350.70 -19-14AUG8

2. Install and tighten injection nozzle into cylinder head to 50 N·m (37 lb-ft).



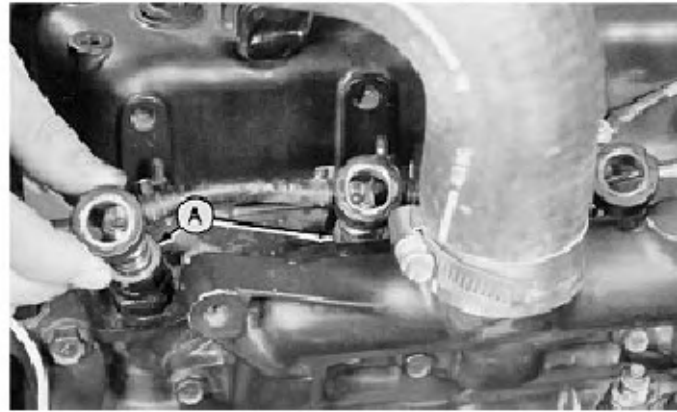
M21.TM350.71 -19-14AUG8

3. Install hoses (A) and fittings (B). Fasten with clamps.



M21.TM350.72 -19-08FEB8

4. Install new bronze gaskets (A).
5. Install fuel leak-off line and nuts. Tighten nuts to no more than 40 N·m (30 lb-ft).
6. Connect fuel return line (B) and fasten with clamp.



M21.TM350.73 -19-14AUG8

IMPORTANT: When installing injection lines, DO NOT turn pump outlet fittings. Turning fittings may damage pump internally.

7. Install injection lines using two wrenches.
8. Install line clamp and two screws.
9. Bleed the fuel system. (See Section 30 of the appropriate Technical Manual.)



M21.TM350.74 -19-08FEB8

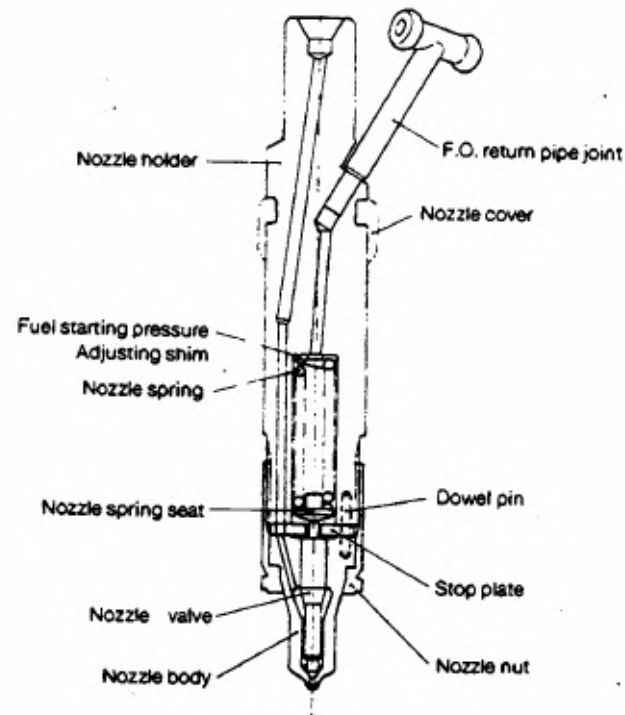
HOLE TYPE FUEL INJECTION NOZZLE OPERATION (ALL EXCEPT 3TN66/3TNA72)

The hole type nozzle is used on direct injection engines 3TN75 and larger. It is different from the pintle type nozzle in that it is held in the cylinder head by a retaining bracket instead of being threaded.

High pressure fuel from the injection pump flows through a fuel inlet passage. Pressure builds beneath the nozzle valve. When the fuel pressure reaches specified pressure it overcomes the nozzle spring tension. The nozzle valve retracts into the nozzle body and fuel is injected into the engine. The nozzle valve is shim adjustable to regulate the opening pressure.

The nozzle valve is automatically pushed down by the nozzle spring and closed after fuel is injected.

Leakage (return fuel) flows from between the nozzle valve and nozzle body to the hole on top of the nozzle spring through the return pipe fitting and back into the fuel tank.



M21,TM350,75A -19-01SEP8

REMOVE HOLE TYPE FUEL INJECTION NOZZLES (ALL EXCEPT 3TN66/3TNA72)

⚠ CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.



If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump, injection nozzles, lines, and area around the nozzles using a parts cleaning solvent or a steam cleaner.

M21,TM350,52B -19-14AUG87

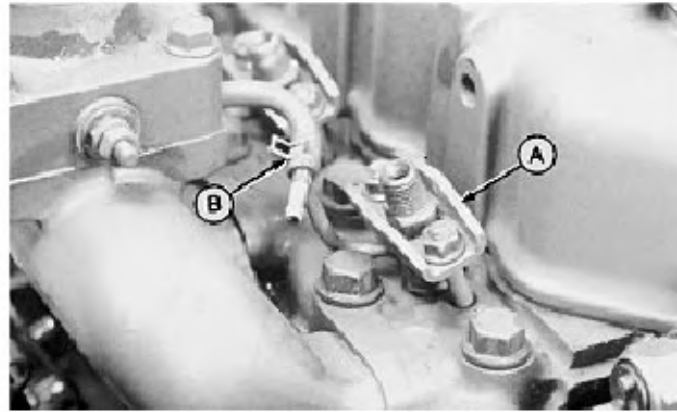
IMPORTANT: When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally.

2. Use two wrenches to loosen fuel line fittings enough to release any pressure in the fuel system.
3. Disconnect fuel lines from injection nozzles and remove lines.
4. Cap all openings to keep dirt out of the fuel system.



M21,TM350,53 -19-08FEB88

5. Remove nuts from studs and remove retaining plates (A) from nozzles.
6. Remove leak-off lines (B).



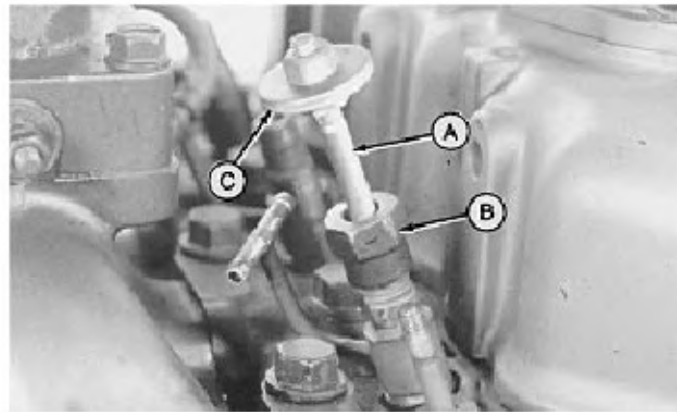
M21.TM350.76 -19-08FEB88

7. If nozzles are stuck in cylinder head:

Grind the head of a cap screw (A) so it fits inside a nut from (B), from an old injection line.

Use double nuts to attach a large flat washer (C) to the cap screw.

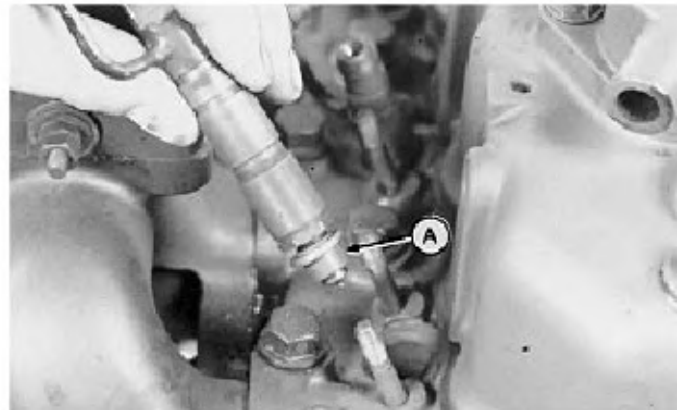
Install the assembly onto nozzle and use a suitable puller and slide hammer to pull nozzles from head.



M21.TM350.77 -19-08FEB88

8. When removing nozzles, check to see if teflon seal and ring (A) is removed with nozzle. If heat protector stays in cylinder head, thread a cap screw into it and pull from cylinder head.

3. Test injection nozzles.



M21.TM350.78 -19-08FEB88

TEST HOLE TYPE FUEL INJECTION NOZZLES (ALL EXCEPT 3TN66/3TNA72)

This test checks the opening pressure, leakage, chatter, and spray pattern of the fuel injection nozzle. Test the nozzle before disassembly to determine condition and necessary repair.

1. Connect fuel injection nozzle (D) to D-01109AA Diesel Fuel Injection Nozzle Tester (F). Use fittings (A, B, and G) from D0110AA Adapter Set and fitting (C).

IMPORTANT: Use clean filtered diesel fuel when testing fuel injection nozzles to get best test results.

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

2. Test fuel injection nozzle opening pressure following the tool manufacturer's instructions.

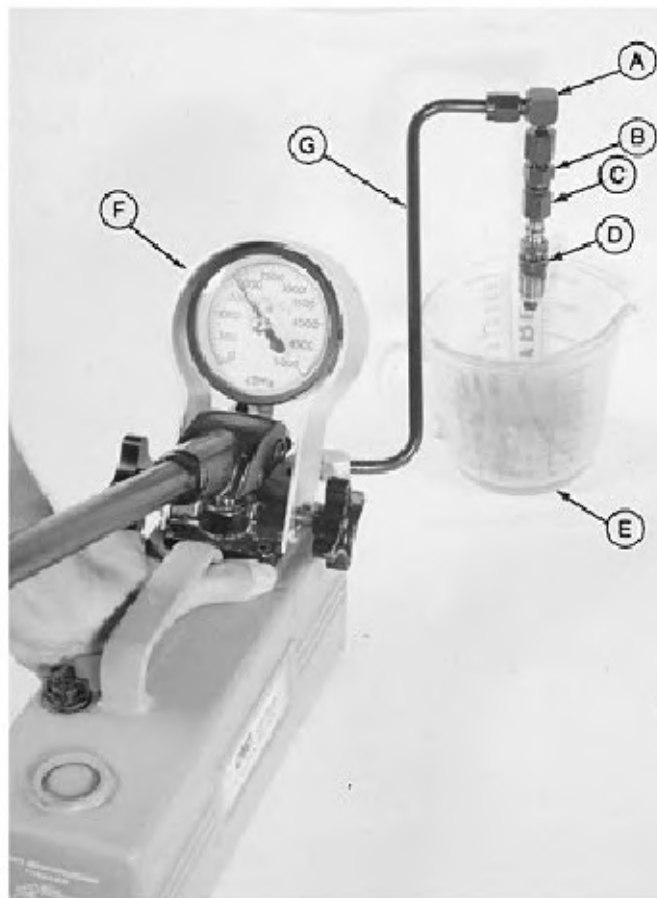
- a. Record pressure reading when nozzle valve opens.
- b. If pressure reading does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination or stuck valve. If necessary, add or remove shims to change opening pressure. (See Disassemble Fuel Injection Nozzles in this section.)

NOZZLE VALVE OPENING PRESSURE SPECIFICATIONS

3TN75/3TN78/3TN82/3TN84/4TN78

4TN82/4TN84 19 600 ± 480 kPa (2843 ± 70 psi)

4TN100 20 100 ± 490 kPa (2915 ± PSI)



A—23617 90° Adapter
B—23621 Straight Adapter
C—23622 Straight Adapter
D—Fuel Injection Nozzle

E—Container
F—D-011-09AA Diesel Fuel Injection Nozzle Tester
G—36352 Fuel Line Assembly

3. Test fuel injection nozzle leakage following the tool manufacturer's instructions.

- a. Dry nozzle completely using a lint-free cloth.
- b. Pressurize nozzle to test specifications.
- c. Watch for leakage from nozzle spray orifice.

NOZZLE LEAKAGE TEST SPECIFICATIONS

3TN75/3TN78/3TN82/3TN84/4TN78/4TN82/4TN84

Nozzle Pressure 17 640 kPa (2550 psi)
Minimum Nozzle Leakage Time 5 seconds

4TN100

Nozzle Pressure 18 100 kPa (2625 psi)
Minimum Nozzle leakage Time 5 seconds

d. If nozzle leakage time is low, check nozzle for contamination. Inspect valve seating surface; replace nozzle assembly as required.

M21,TM350.80 -19-01SEP87

4. Test fuel injection nozzle chatter and spray pattern following the tool manufacturer's instructions.

- a. Pressurize nozzle to test specifications.
- b. Listen for "chatter" sound and watch spray pattern.

NOZZLE PRESSURE TEST SPECIFICATIONS

3TN75/3TN78/3TN82/3TN84/

4TN78/4TN82/4TN84 19 600 ± 480 kPa (2843 ± 70 psi)

4TN100 20 100 ± 490 kPa (2915 ± 71 psi)

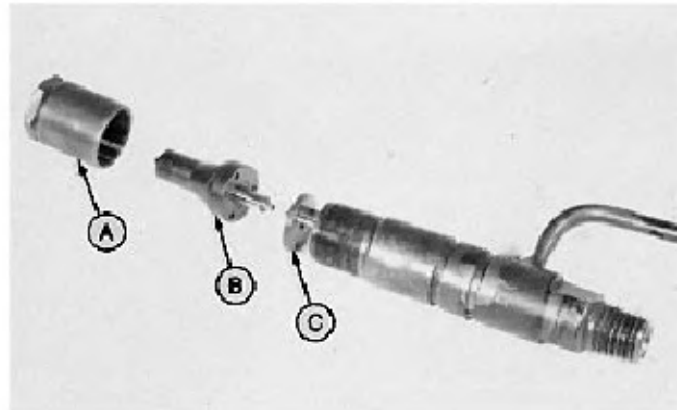
Slow Hand Lever Movement chatter sound
Slow Hand Lever Movement fine stream spray pattern
Fast Hand Lever Movement fine atomized spray pattern

If nozzle does not not chatter or spray pattern is toward one side only and not finely atomized, check nozzle for contamination. Inspect valve seating surface; replace nozzle assembly as required.

M21,TM350.81 -19-01SEP87

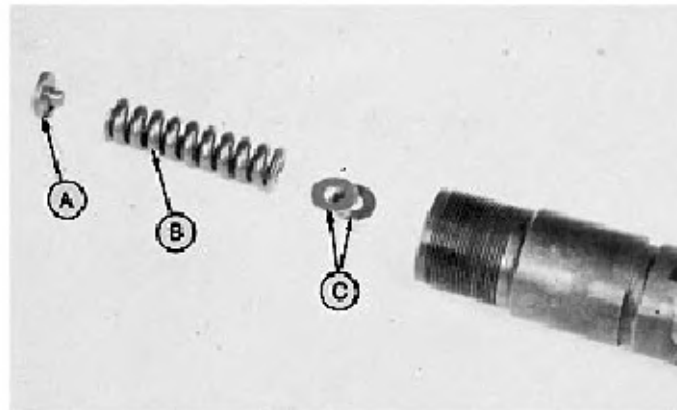
DISASSEMBLE HOLE TYPE FUEL INJECTION NOZZLES (ALL EXCEPT 3TN66/3TNA72)

1. Remove nozzle retaining nut (A).
2. Remove nozzle assembly (B).
3. Remove separator plate and index pins (C).



M21,TM350.82 -19-14AUG8

4. Remove spring seat (A), spring (B), and shims (C).



M21,TM350.83 -19-08FEB8

CLEAN AND INSPECT HOLE TYPE INJECTION NOZZLE COMPONENTS (ALL EXCEPT 3TN66/3TNA72)

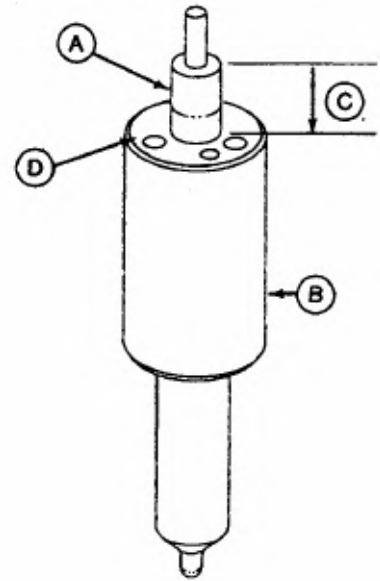
1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.
2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in JDF-13 Nozzle Cleaning Kit).

IMPORTANT: Never use a steel brush to clean nozzles as this will distort the spray hole.

3. After removing carbon or lacquer from the exterior of nozzle, inspect the lapped machine surface (D) for nicks or scratches.
4. Inspect the piston (large) part of nozzle valve (A) to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.
5. Inspect condition of seat for nozzle valve and nozzle. Contact area of seat (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid making the inspection.

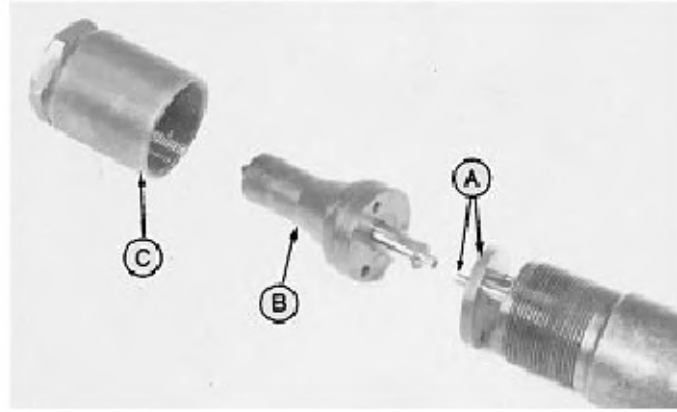
NOTE: A bad nozzle valve seat will cause fuel to drip from the nozzle. This condition usually will be noted when performing "Leakage Test" described in this group.

6. Further inspect the nozzle assembly by performing a slide test. Use the following procedure:
 - a. Dip the nozzle valve (A) in clean diesel fuel. Insert valve in nozzle (B).
 - b. Hold nozzle vertical, and pull valve out about 1/3 of its engaged length (C).
 - c. Release valve. Valve should slide down to its seat by its own weight.
7. Always replace a nozzle assembly if the valve does not slide freely to its seat.



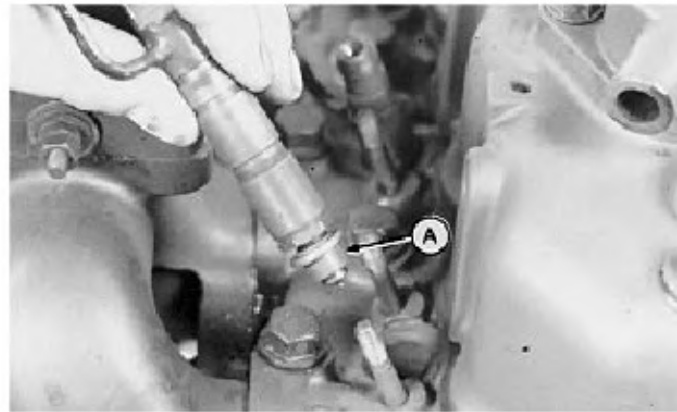
ASSEMBLE AND INSTALL HOLE TYPE FUEL NOZZLES (ALL EXCEPT 3TN66/3TNA72)

1. Install shims as needed into nozzle body.
2. Install spring and spring seat into nozzle body.
3. Install separator plate and index pins (A).
4. Install nozzle assembly (B) and retaining nut (C).
5. Tighten retaining nut to 43 N·m (31 lb-ft).



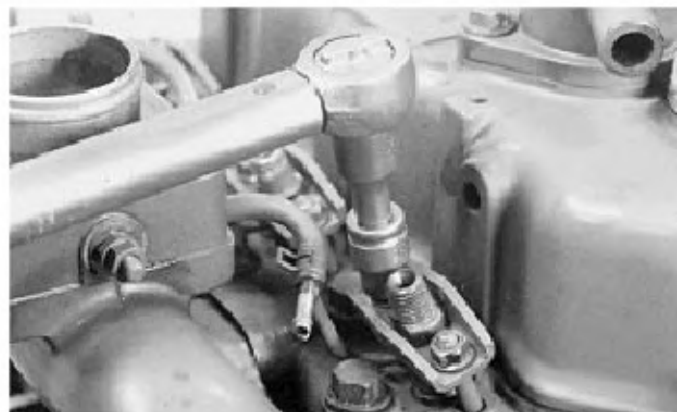
M21,TM350,86 -19-01SEP8

6. Install new teflon seal (A) into old retaining ring.
7. If any parts were replaced, test nozzles and adjust opening pressure.
8. Install nozzles into cylinder head.



M21,TM350,87 -19-08FEB8

9. Install retaining plates and nuts. Tighten nuts to 4.5 N·m (39 lb-in.).
10. Install leak-off lines and injection lines.
11. Bleed fuel system. Refer to section 30 of the appropriate Technical Manual.



M21,TM350,88 -19-08FEB8

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
Blind-Hole Puller Set	To remove throttle lever bushing
Outside Micrometer	To measure speed control linkage component
Telescoping Gage	To measure speed control linkage component
Bushing, Bearing, and Seal Driver Set	To install throttle lever bushing

M21,TM355,1 -19-23APR8

OTHER MATERIAL

Number	Name	Use
AT52853	John Deere LOCTITE® Thread Lock and Sealer (Low Strength)	Apply on threads of fuel shut-off lever set screw

M21,TM355,2 -19-23APR8

SERVICE PART KITS

The following kits are available through your parts catalog:

- Cylinder Block Gasket Kit
- Fuel Injection Pump Shim Pack

M21,TM355,3 -19-08FEB8

REMOVE FUEL CONTROL AND GOVERNOR LINKAGE (EARLY 3TNA72UJ)

1. Remove grille and left side panel.
2. Disconnect battery negative (—) cable.
3. Remove fuel injection pump (A). (See Group 50 in this manual.)
4. Disconnect throttle cable (B).
5. Disconnect fuel shut-off linkage (C).
6. Remove oil filter (D) and dipstick tube (E).

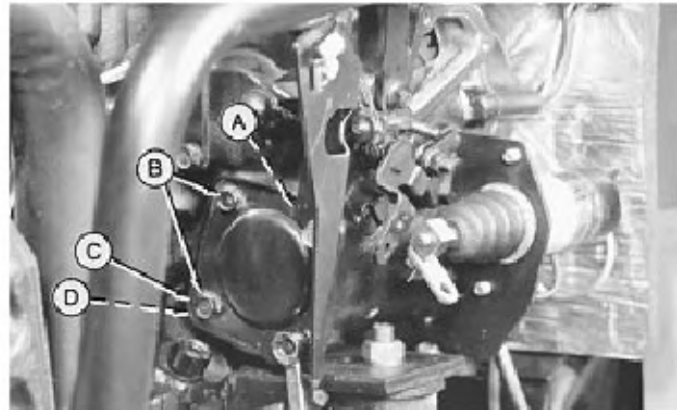
A—Fuel Injection Pump
B—Throttle Cable
C—Fuel Shut-Off Linkage
D—Oil Filter
E—Dipstick Tube



M21.TM355.5 -19-01SEP87

7. Remove two cap screws and four washers (A) to remove bracket.
8. Remove two cap screws (B) to remove cover (C) and gasket (D).

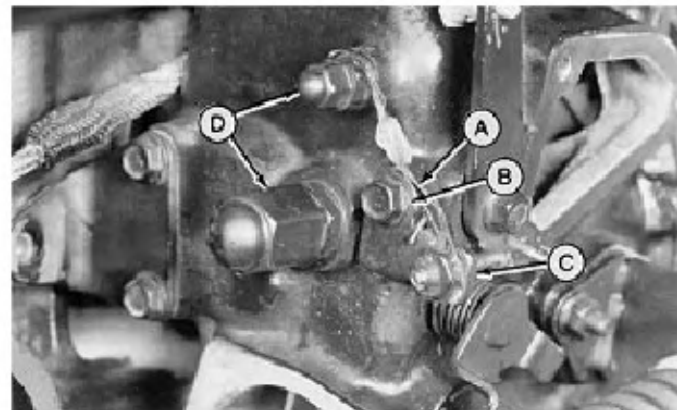
A—Washer (4 used)
B—Cap Screw (2 used)
C—Cover
D—Gasket



M21.TM355.7 -19-14FEB88

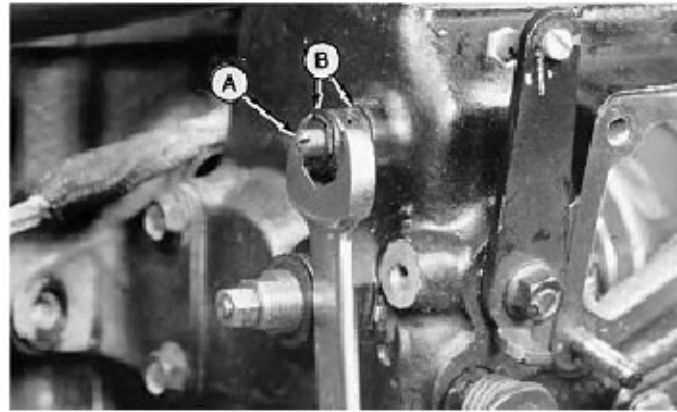
9. Remove sealing wire (A).
10. Remove cap screw (B) to remove slow idle screw bracket (C).
11. Remove cap nuts (D).

A—Sealing Wire
B—Cap Screw
C—Slow Idle Screw Bracket
D—Cap Nuts



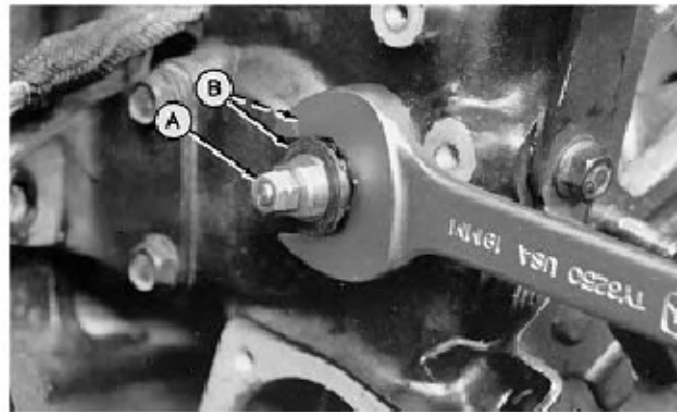
M21.TM355.8 -19-14FEB88

12. Loosen lock nut to remove fast idle adjusting screw (A) and seals (B).



M21,TM355,9 -19-14FEB88

13. Loosen lock nut to remove fuel controller (A) and seals (B).



M21,TM355,10 -19-24MAR88

14. Disconnect spring from throttle lever.



M21,TM355,11 -19-14FEB88

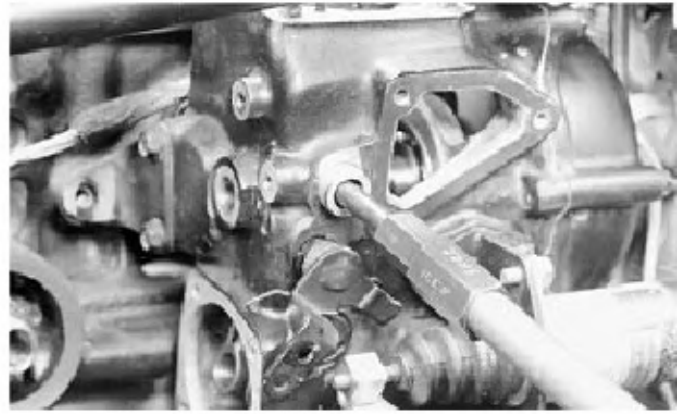
15. Remove nut to remove lever, throttle lever (A), and O-ring.



M21,TM355,12 -19-14FEB88

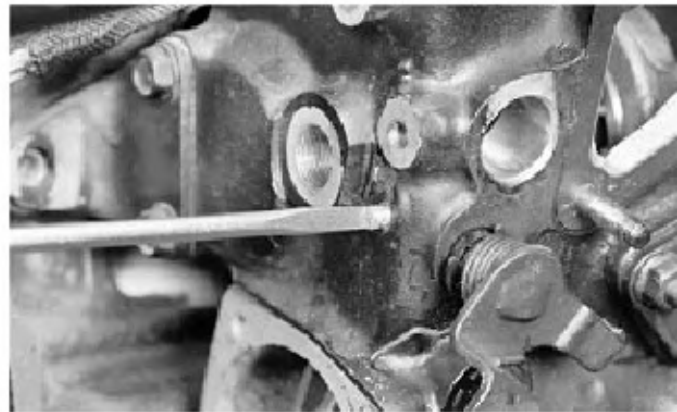
16. Inspect bushing for wear or damage. Do not remove bushing unless replacement is necessary.

17. If necessary, remove bushing using a 7/16-in. blind-hole puller.



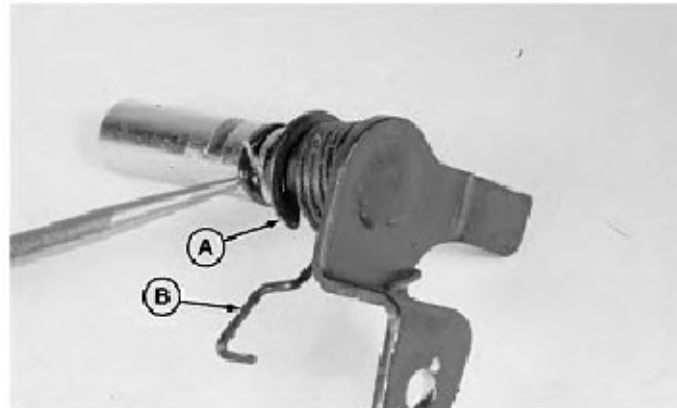
M21,TM355,13 -19-14FEB88

18. Remove set screw to remove fuel shut-off lever.



M21,TM355,14 -19-24MAR88

19. Remove O-ring, snap ring (A), and spring (B).



M21,TM355,15 -19-14FEB88

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4

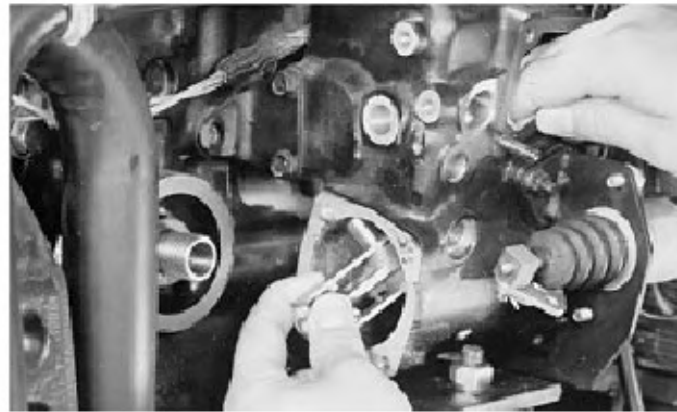
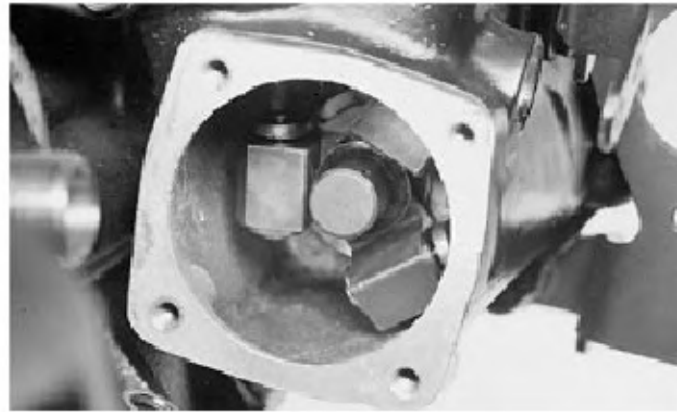
IMPORTANT: DO NOT reuse bronze gasket.

20. Remove governor shaft, bronze gasket, and spacer.



M21,TM355,16 -19-14FEB88

21. Turn governor weights until one weight is toward the engine. Remove fuel control linkage assembly.



M21,TM355,17 -19-14FEB88

22. Measure governor shaft outside diameter.

GOVERNOR SHAFT O.D. SPECIFICATION (MIN)

Shaft Diameter 7.90 mm (0.311 in.)

If diameter is less than minimum specification, replace governor shaft.



M21,TM355,18 -19-14FEB88

23. Measure fuel control linkage bore inside diameter.

FUEL CONTROL LINKAGE BORE I.D. SPECIFICATION (MAX)

Bore Diameter 8.15 mm (0.321 in.)

If bore diameter is greater than maximum specification,
replace fuel control linkage assembly.

24. Determine governor shaft clearance (fuel control
linkage bore diameter minus governor shaft diameter).

GOVERNOR SHAFT CLEARANCE SPECIFICATION (MAX)

Governor Shaft Clearance 0.18 mm (0.007 in.)

If clearance is greater than maximum specification,
replace governor shaft, fuel control linkage assembly, or
both.



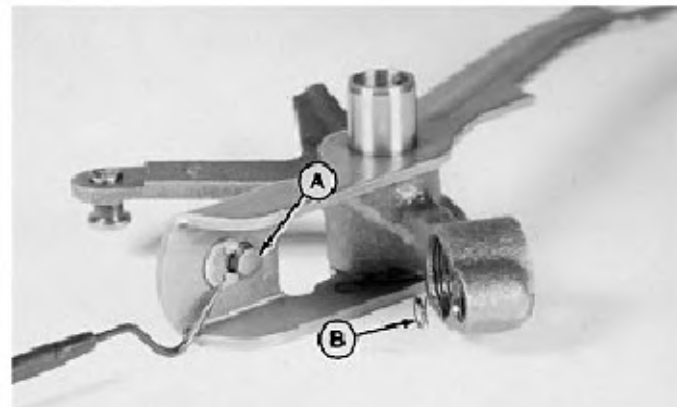
M21,TM355,19 -19-14AUG8

25. Remove spring pin.



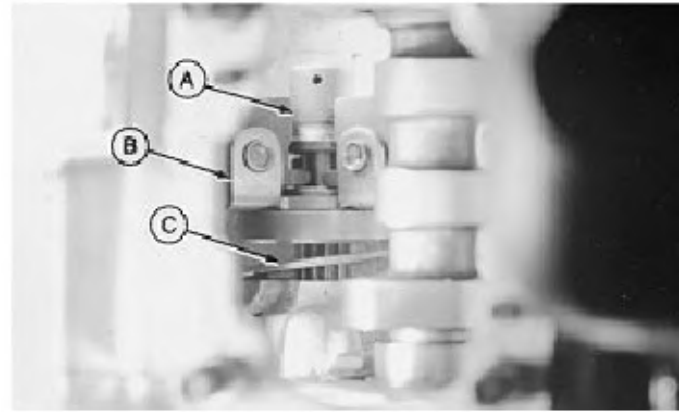
M21,TM355,20 -19-14FEB8

26. Remove snap ring, pin (A), and spring (B).



M21,TM355,21 -19-14FEB8

27. Remove sleeve (A), governor weights (B), and thrust washer (C).



M21,TM355,22 -19-14FEB8

28. Measure sleeve bore inside diameter.

SLEEVE BORE I.D. SPECIFICATION (MAX)

Bore Diameter 9.20 mm (0.362 in.)

If bore diameter is greater than maximum specification, replace sleeve.



M21,TM355,23 -19-14FEB8

29. Measure inner rotor shaft outside diameter.

INNER ROTOR SHAFT O.D. SPECIFICATION (MIN)

Shaft Diameter 8.90 mm (0.350 in.)

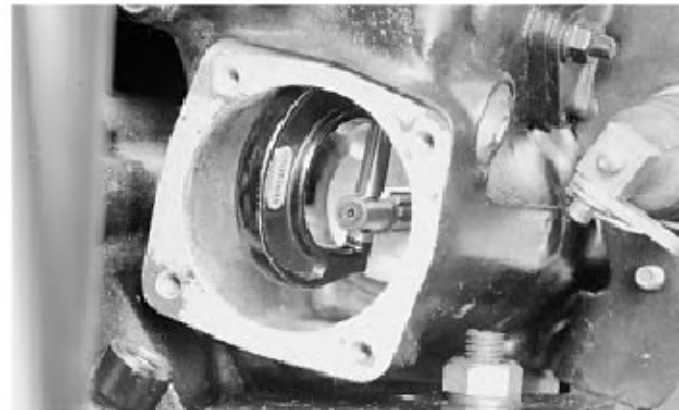
If shaft diameter is less than minimum specification, replace shaft. Inspect splines on shaft for chipped or broken teeth. If necessary, replace shaft. (See Group 40 in manual.)

30. Determine inner rotor shaft clearance (sleeve bore diameter minus inner rotor shaft diameter).

INNER ROTOR SHAFT CLEARANCE SPECIFICATION (MAX)

Shaft Clearance 0.15 mm (0.006 in.)

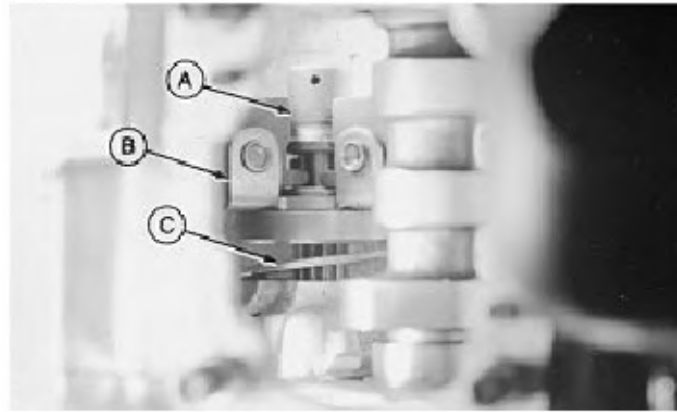
If clearance is greater than maximum specification, replace sleeve, inner rotor shaft, or both.



M21,TM355,24 -19-14AUG8

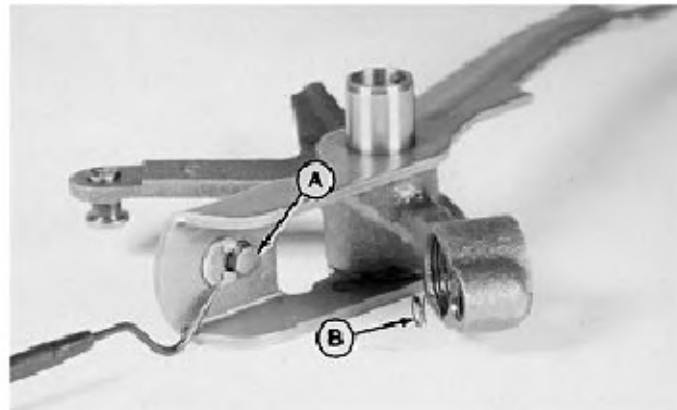
INSTALL FUEL CONTROL AND GOVERNOR LINKAGE (EARLY 3TNA72UJ)

1. Thoroughly clean and dry all parts. Use new gaskets when assembling the engine.
2. Put clean engine oil on all internal parts.
3. Align splines on inner rotor shaft (A) with splines in thrust washer (C) and governor weights (B).
4. Install thrust washer, governor weights, and sleeve on inner rotor shaft.



M21,TM355,25 -19-23APR8

5. Install spring (B).
6. Install pin (A) and fasten with snap ring.



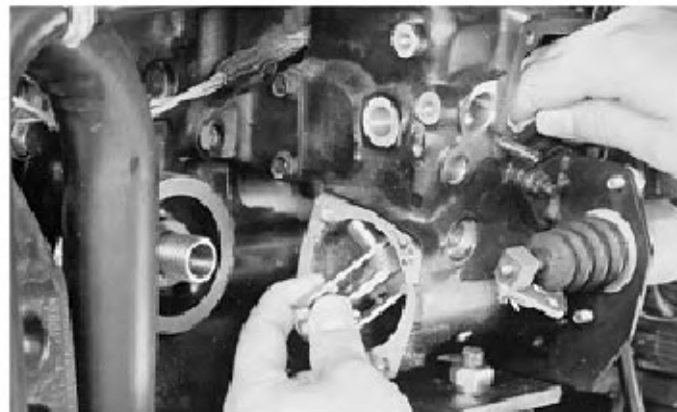
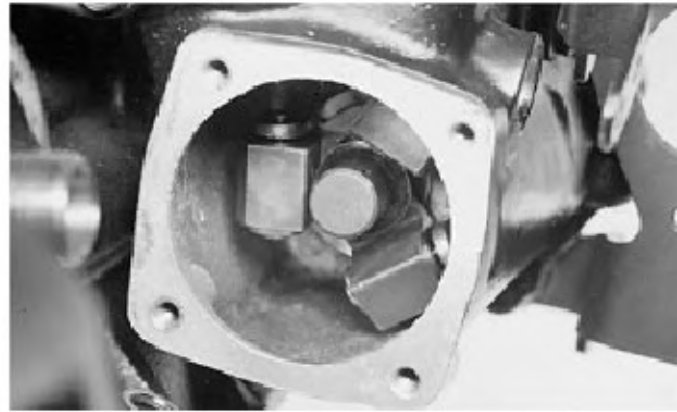
M21,TM355,26 -19-14FEB8

7. Install spring pin.



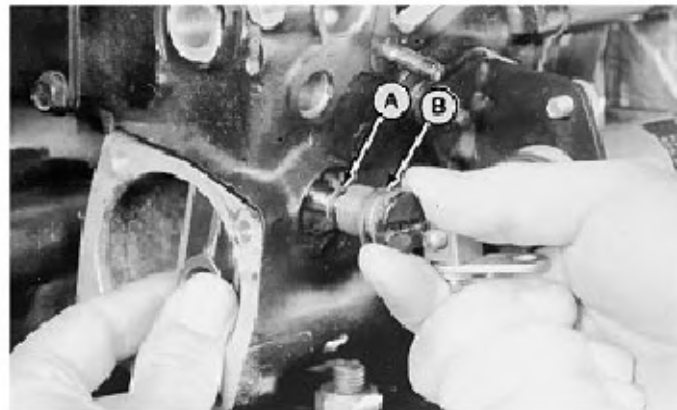
M21,TM355,27 -19-14FEB8

8. Turn governor weights until one weight is toward the engine.
9. Install fuel control linkage assembly.



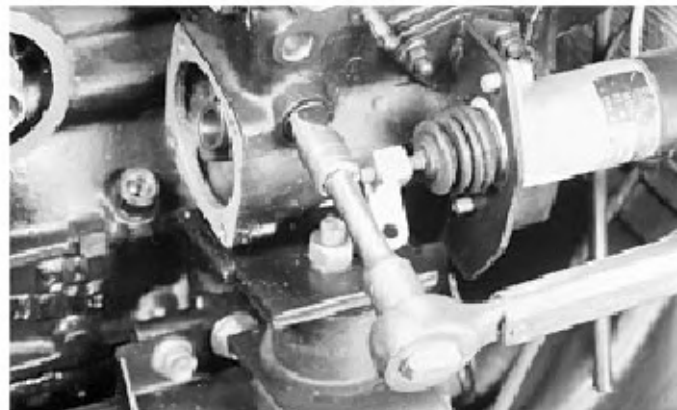
M21,TM355,28 -19-14FEB88

10. Install spacer (A) and new bronze gasket (B) on governor shaft.
11. Install governor shaft through fuel control linkage assembly.



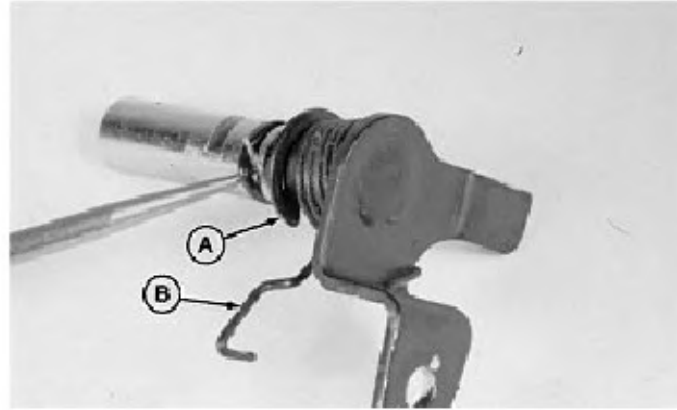
M21,TM355,29 -19-14FEB88

12. Tighten governor shaft to 49 N·m (36 lb-ft).



M21,TM355,30 -19-24APR88

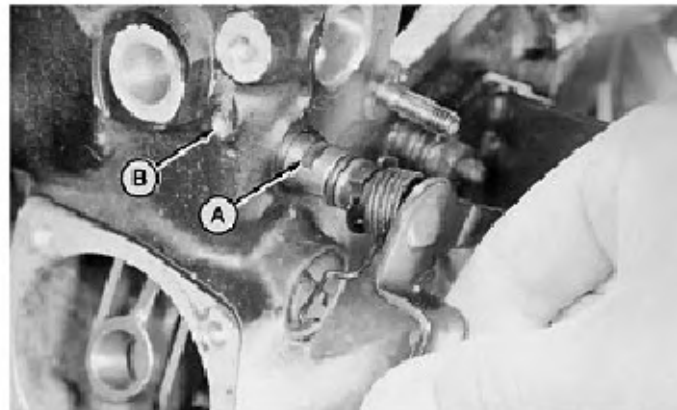
13. Install spring (B), snap ring (A), and new O-ring on fuel shut-off lever.



M21.TM355.31 -19-14FEB88

14. Align groove (A) in fuel shut-off lever with hole (B) in gear housing.

15. Install fuel shut-off lever. Be sure groove is visible through hole (B).



M21.TM355.32 -19-14FEB88

16. Apply thread lock and sealer (low strength) on threads on set screw.

17. Install and tighten set screw.



M21.TM355.33 -19-14FEB88

18. If removed, install bushing, chamfered end first into gear housing using a 7/8-in. driver disk. Push bushing even with surface of gear housing.



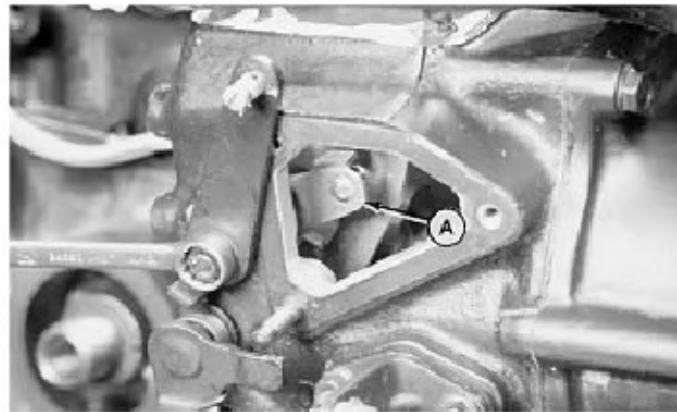
M21.TM355.34 -19-14FEB88

19. Install new O-ring on throttle lever.



M21.TM355.35 -19-24MAR88

20. Install throttle lever (A) and lever. Install and tighten nut.



M21.TM355.36 -19-14FEB88

21. Connect spring to throttle lever and then to fuel control linkage assembly.

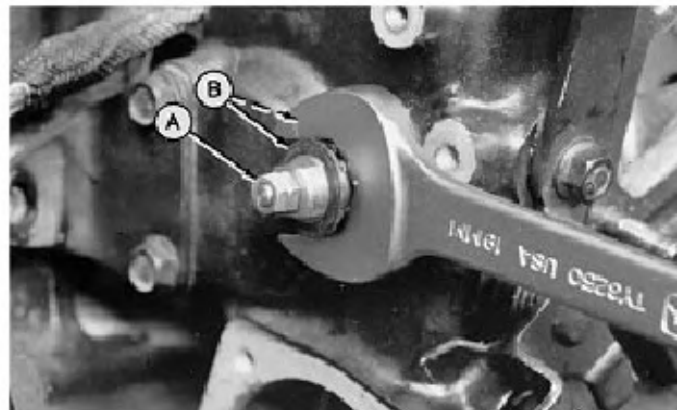


M21.TM355.37 -19-14FEB88

22. Install seals (B) and lock nuts on fuel controller (A).

23. Install fuel controller assembly.

NOTE: DO NOT install cap nut at this time.

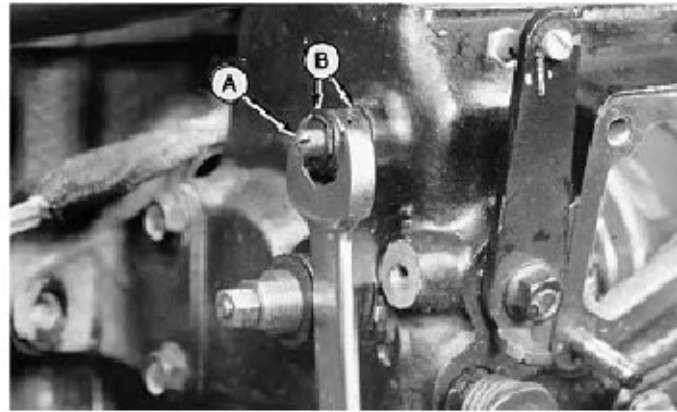


M21.TM355.38 -19-14FEB88

24. Install seals (B) and lock nut on fast idle adjusting screw (A).

25. Install fast idle adjusting screw assembly.

NOTE: DO NOT install cap nut or sealing wire at this time.



M21,TM355,39 -19-14FEB88

26. Install slow idle screw bracket (A) so the stop (B) on the lever contacts the slow idle screw (C). Install and tighten cap screw.

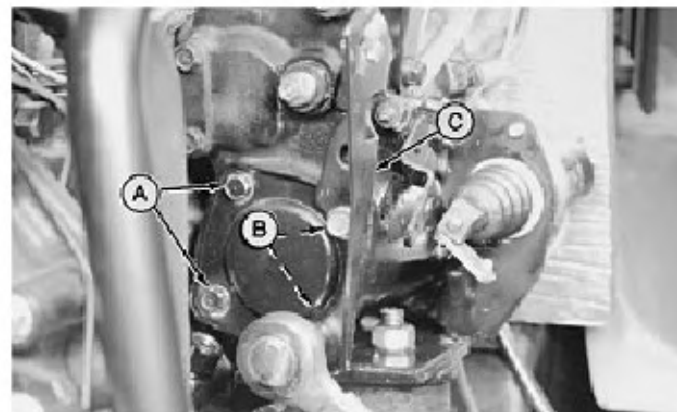
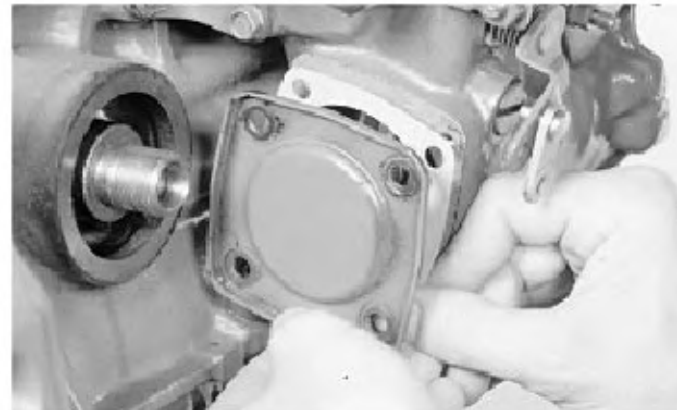
27. Install fuel shut-off lever spring on slow idle screw bracket.



M21,TM355,40 -19-14FEB88

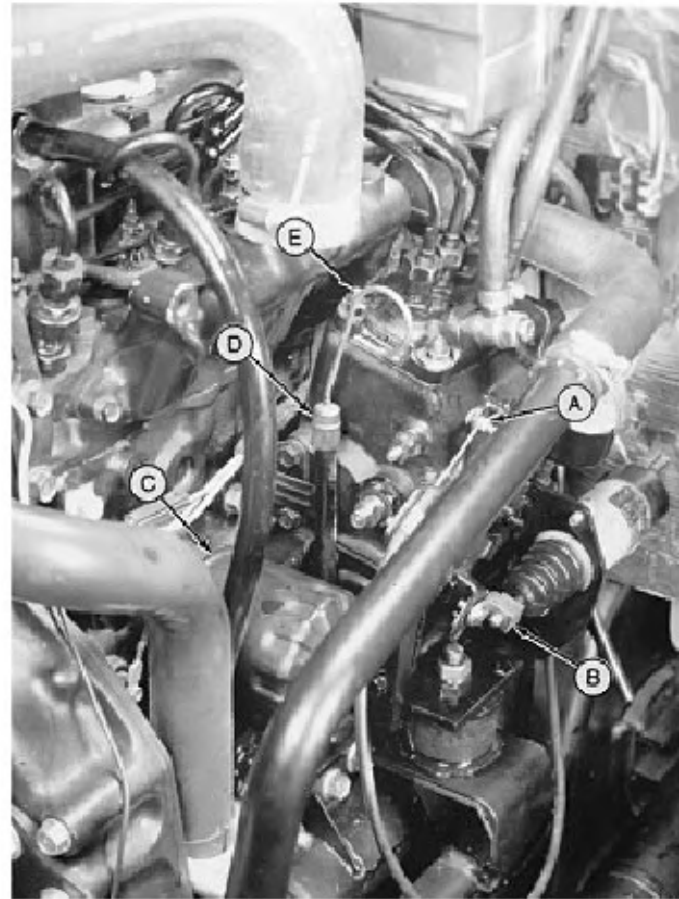
28. Install new gasket, cover, and two cap screws (A).

29. Install two washers (B) between bracket (C) and cover in alignment with holes. Install bracket and two cap screws. Tighten four cap screws to 9 N·m (78 lb-in.).



M21,TM355,41 -19-14AUG88

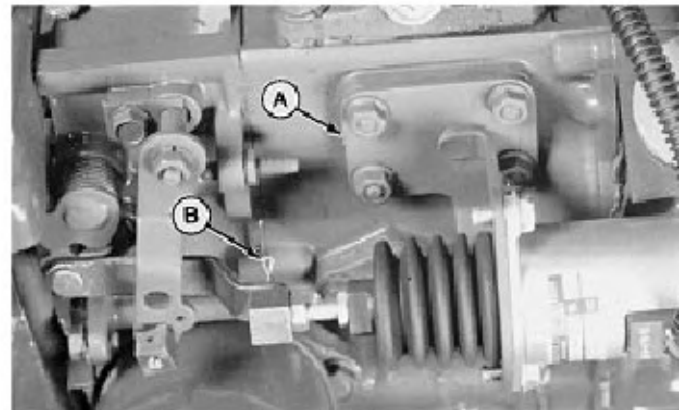
30. Install dipstick tube (D) and fasten with cap screw.
31. Install oil filter (C).
32. Connect fuel shut-off linkage (B).
33. Connect throttle cable (A).
34. Install fuel injection pump (E). (See Group 50 in this manual.)
35. Connect battery negative (—) cable.
36. Bleed fuel injection system. (See Machine Technical Manual.)
37. Check and adjust fuel shut-off lever. (See Technical Manual.)
38. Check and adjust slow and fast idle setting. (See Technical Manual.)



M21.TM355.42 -19-23APR86

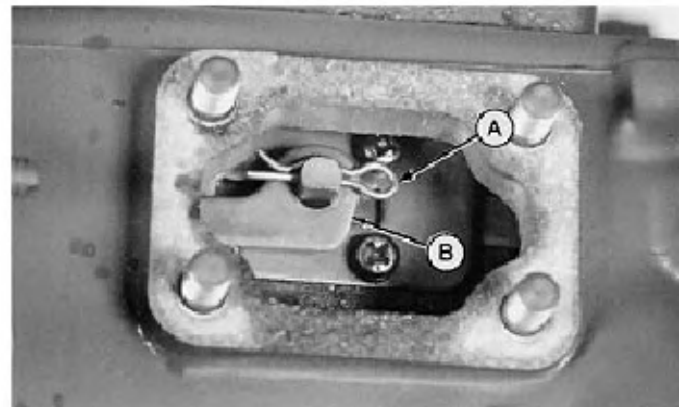
REMOVE FUEL CONTROL AND GOVERNOR LINKAGE (3TN66/LATER 3TNA72)

1. Remove cotter pin (B) to disconnect solenoid.
2. Remove four nuts to remove cover assembly (A).



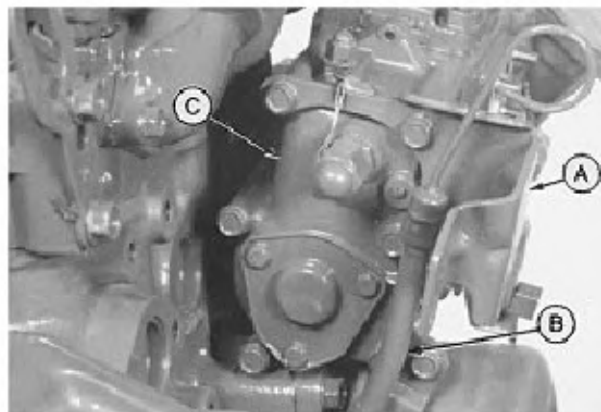
M21.TM355.43 -19-14AUG87

3. Remove pin (A) to disconnect linkage (B).



M21.TM355.44 -19-23APR86

4. Remove cap screw to remove dipstick (B).
5. Remove three cap screws to remove bracket (A).
6. Remove four remaining cap screws to remove the linkage housing (C).



M21,TM355,45 -19-14FEB88

7. Remove sleeve.



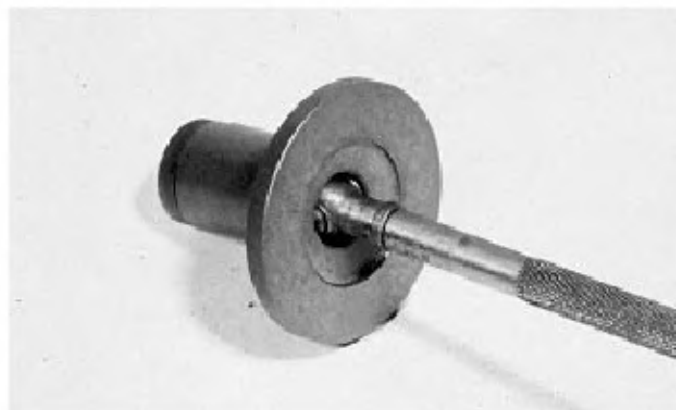
M21,TM355,46 -19-14FEB88

8. Measure sleeve bore inside diameter.

SLEEVE BORE I.D. SPECIFICATION (MAX)

Bore Diameter 8.20 mm (0.323 in.)

If bore diameter is greater than maximum specification,
replace sleeve.



M21,TM355,47 -19-14FEB88

9. Measure shaft outside diameter.

SHAFT O.D. SPECIFICATION (MIN)

Shaft Diameter 7.90 mm (0.311 in.)

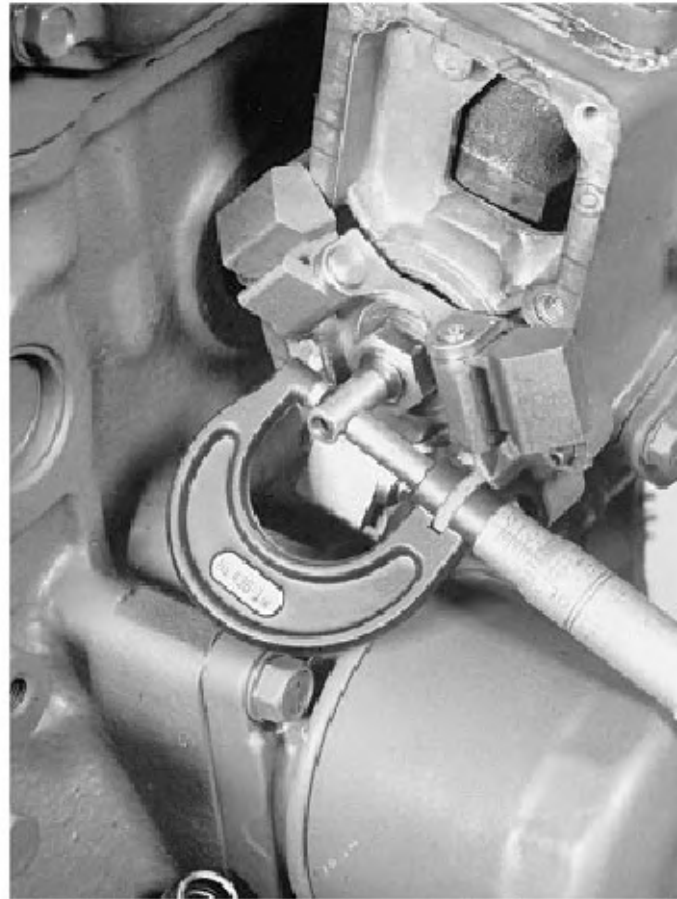
If shaft diameter is less than minimum specification,
replace shaft.

10. Determine oil clearance (sleeve bore diameter minus
shaft diameter).

OIL CLEARANCE SPECIFICATION (MAX)

Oil clearance 0.15 mm (0.006 in.)

If clearance is greater than maximum specification,
replace sleeve, shaft or both.

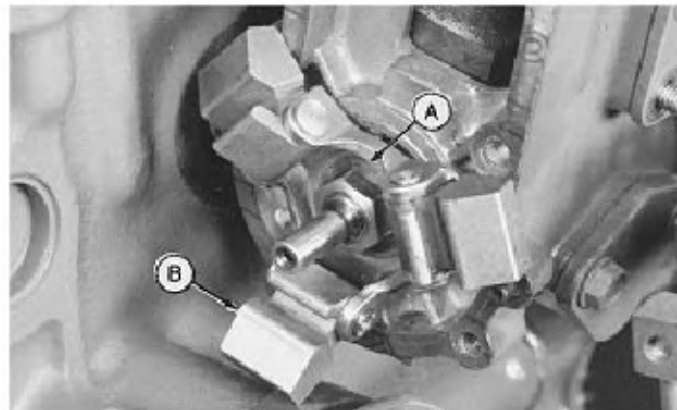


M21.TM355.48 -19-14AUG87

11. Remove nut (A) to remove weights (B).

Inspect governor weights for damage or any binding.

Inspect keyway in shaft and alignment tooth in the
governor weights for wear or damage. Replace if
necessary.

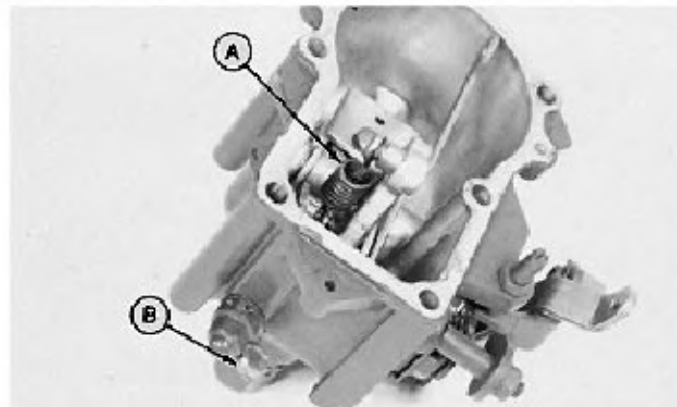


M21.TM355.49 -19-14FEB88

**DISASSEMBLE FUEL CONTROL AND
GOVERNOR LINKAGE (3TN66/LATER
3TNA72)**

1. Remove spring (A).

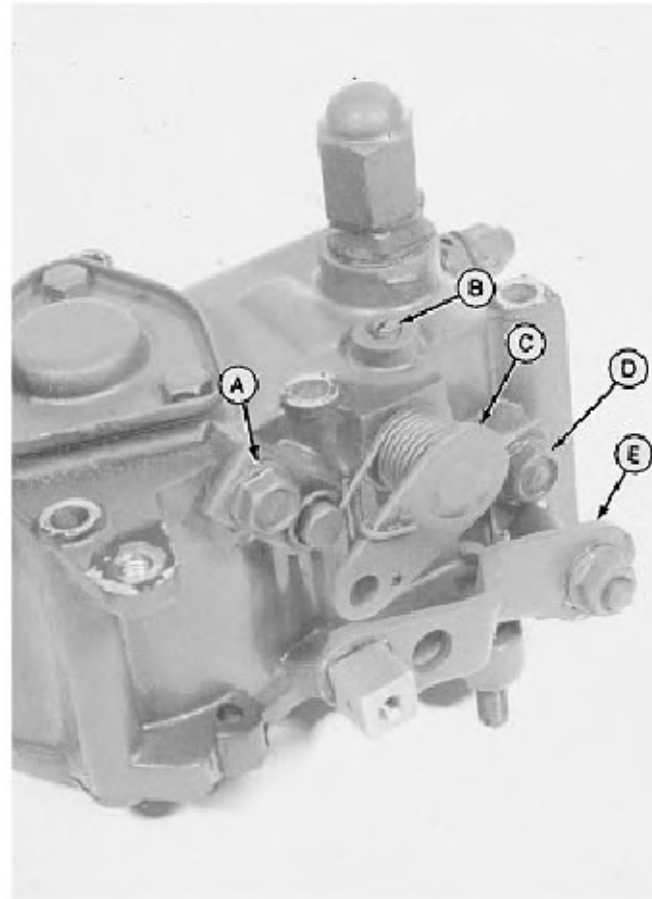
2. Remove seal and sealing wire (B).



M21.TM355.50 -19-14AUG87

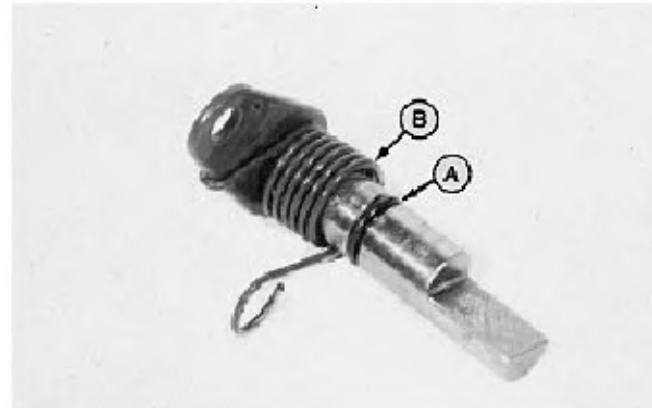
3. Remove nut to remove lever (E). Remove retaining cap screw (D).
4. Remove retaining cap screw (A).
5. Remove set screw (B) to remove fuel shut-off lever (C).

A—Retaining Cap Screw
B—Set Screw
C—Fuel Shut-Off Lever
D—Retaining Cap Screw
E—Lever



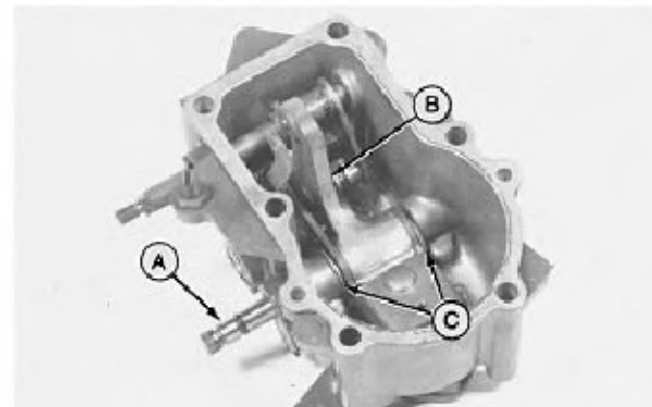
M21,TM355.51 -19-14FEB88

6. Remove O-ring (A) and spring (B).



M21,TM355.52 -19-14FEB88

7. Remove shaft (A), fuel control linkage assembly (B) and shims (C).



M21,TM355.53 -19-14FEB88

8. Measure fuel control linkage bore inside diameter.

FUEL CONTROL LINKAGE BORE I.D. SPECIFICATION (MAX)

Bore Diameter 8.15 mm (0.321 in.)

If bore diameter is greater than maximum specification,
replace fuel control linkage assembly.

9. Measure governor shaft outside diameter.

GOVERNOR SHAFT O.D. SPECIFICATION (MIN)

Shaft Diameter 7.90 mm (0.311 in.)

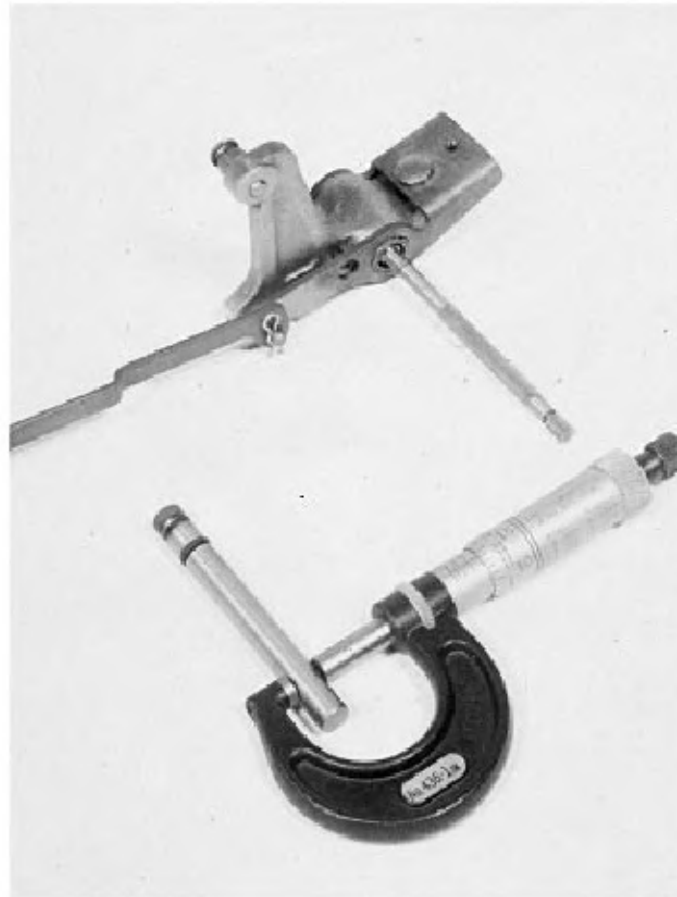
If diameter is less than minimum specification, replace
governor shaft.

10. Determine governor shaft clearance (fuel control
linkage bore diameter minus governor shaft diameter).

GOVERNOR SHAFT CLEARANCE SPECIFICATION (MAX)

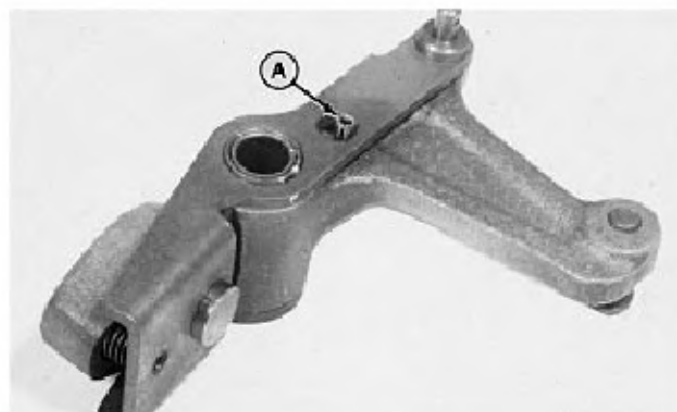
Shaft Clearance 0.18 mm (0.007 in.)

If clearance is greater than maximum specification,
replace governor shaft, fuel control linkage assembly, or
both.



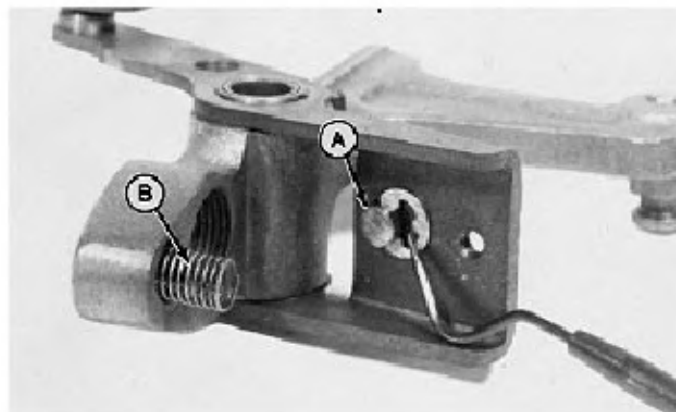
M21,TM355,54 -19-01SEP8

11. Remove spring pin (A).



M21,TM355,55 -19-14FEB8

12. Remove snap ring, pin (A), and spring (B).

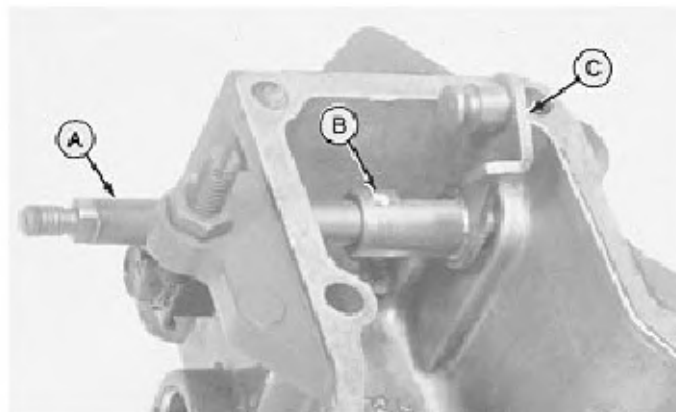


M21.TM355.56 -19-14FEB88

13. Rotate shaft and lever assembly as shown.

14. Remove tapered pin (B) from tapered hole using a punch.

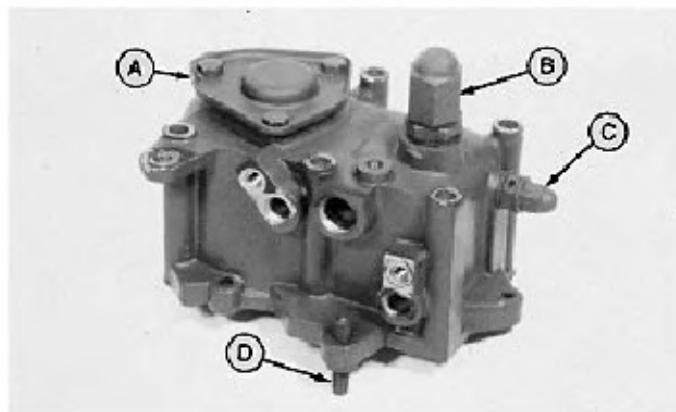
15. Remove shaft (A) and lever (C).



M21.TM355.57 -19-14FEB88

16. Remove cover assembly (A) and fuel control stops (B, C, and D).

A—Cover Assembly
B—Slow Idle Stop
C—Fuel Controller
D—Fast Idle Stop

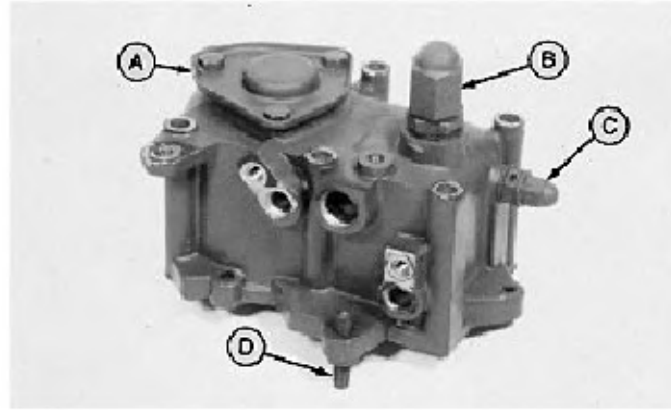


M21.TM355.58 -19-23APR88

ASSEMBLE FUEL CONTROL AND GOVERNOR LINKAGE (3TN66/LATER 3TNA72)

1. Thoroughly clean and dry all parts. Use new gaskets when assembling linkage housing.
2. Put clean engine oil on all internal parts.
3. Install fuel control stops (B, C, and D) and cover assembly (A).

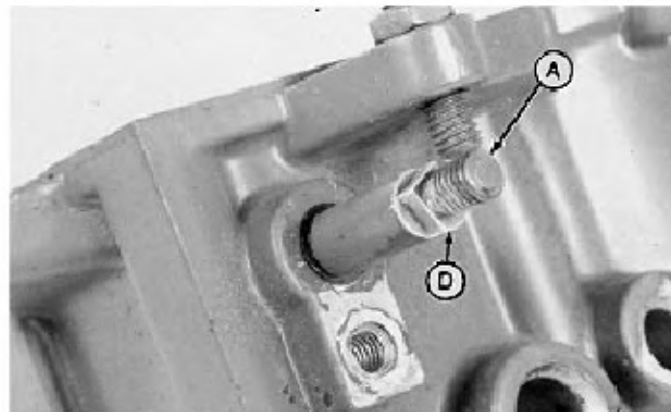
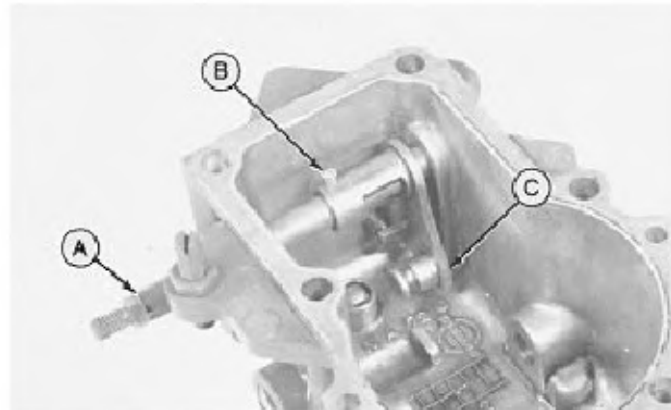
A—Cover Assembly
B—Slow Idle Stop
C—Fuel Controller
D—Fast Idle Stop



M21.TM355.59 -19-01SEP8

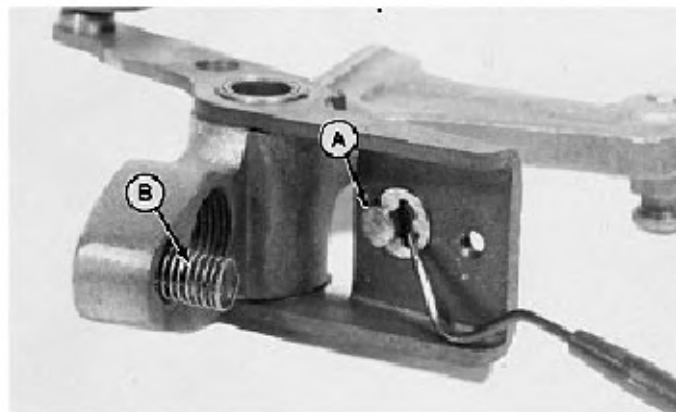
4. Install shaft (A) and lever (C). Rotate shaft (A) until rounded side (D) of shaft is toward the retaining cap screw.
5. Position lever (C) as shown and install tapered pin (B) in tapered hole.

A—Shaft
B—Tapered Pin
C—Lever
D—Rounded Side



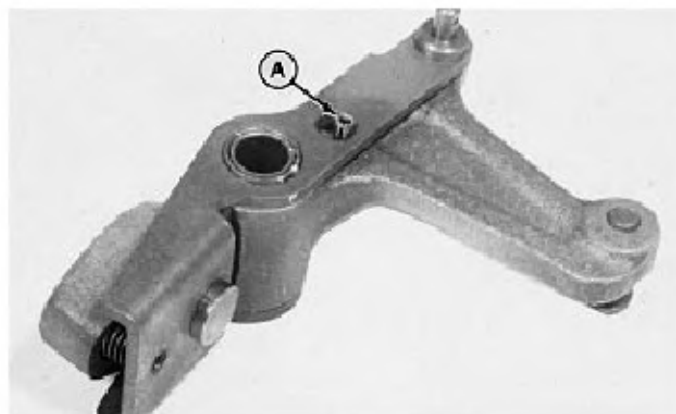
M21.TM355.60 -19-01SEP8

6. Install pin (A), snap ring and spring (B).



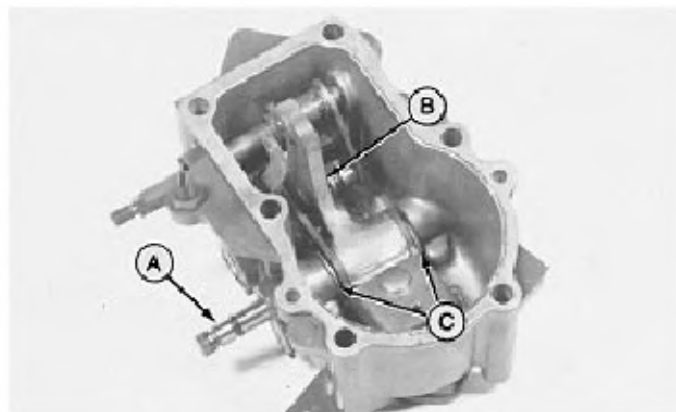
M21,TM355.61 -19-14FEB88

7. Install spring pin (A).



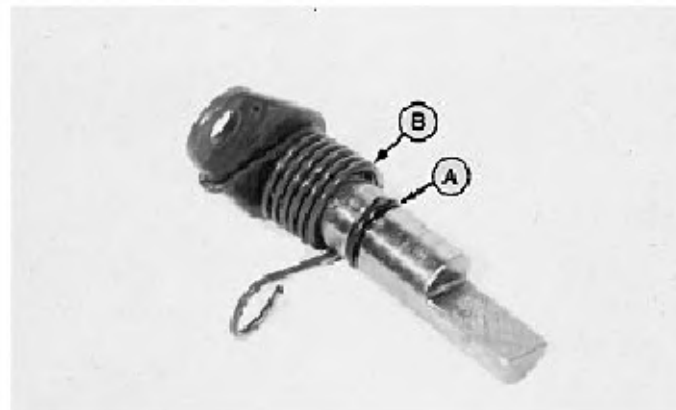
M21,TM355.62 -19-14FEB88

8. Install fuel control linkage assembly (B), shims (C), and shaft (A).



M21,TM355.63 -19-14FEB88

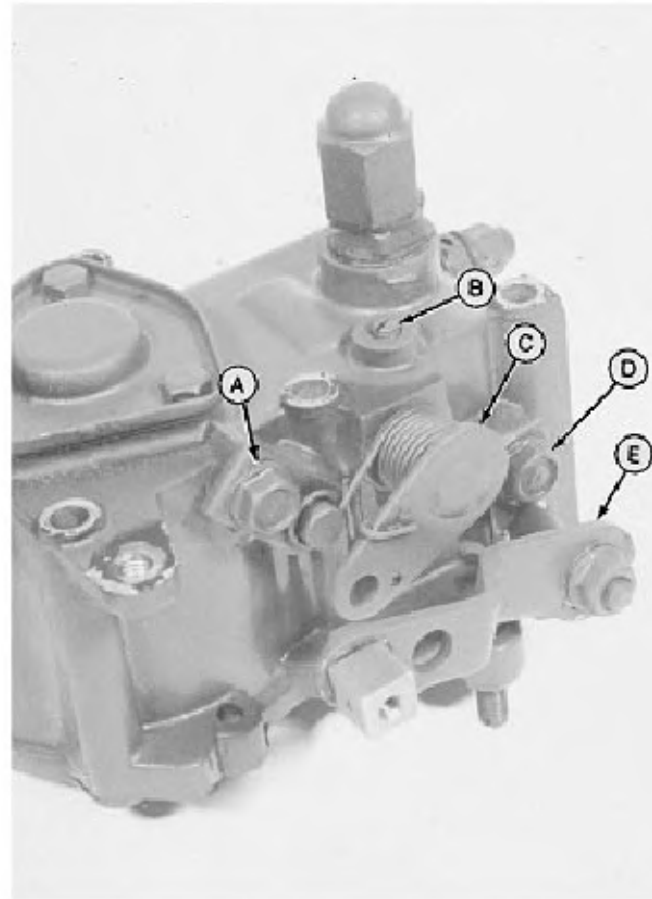
9. Install O-ring (A) and spring (B) on fuel shut-off lever.



M21,TM355.64 -19-14FEB88

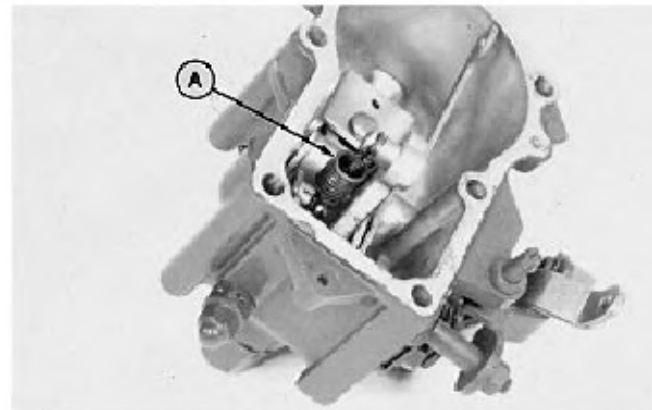
10. Align groove in fuel shut-off lever with set screw hole in housing. Install fuel shut-off lever. Be sure groove is visible through hole.
11. Apply threadlock and sealer (low strength) on threads of set screw.
12. Install and tighten set screw.
13. Install retaining cap screw (A).
14. Install lever (E) and nut. Fasten with retaining cap screw (D).

A—Retaining Cap Screw
B—Set Screw
C—Fuel Shut-Off Lever
D—Retaining Cap Screw
E—Lever



M21.TM355.65 -19-23APR88

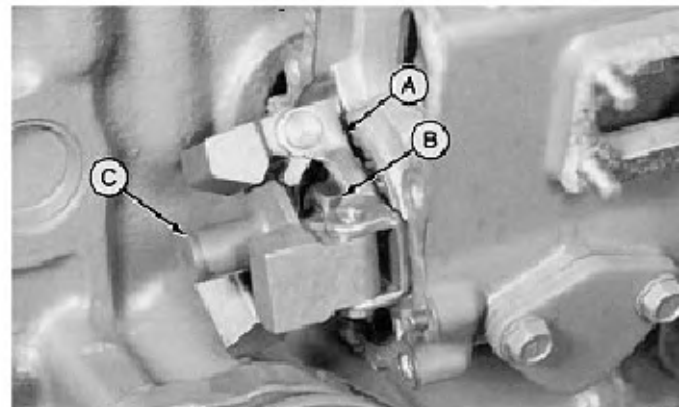
15. Install spring (A).



M21.TM355.66 -19-14FEB88

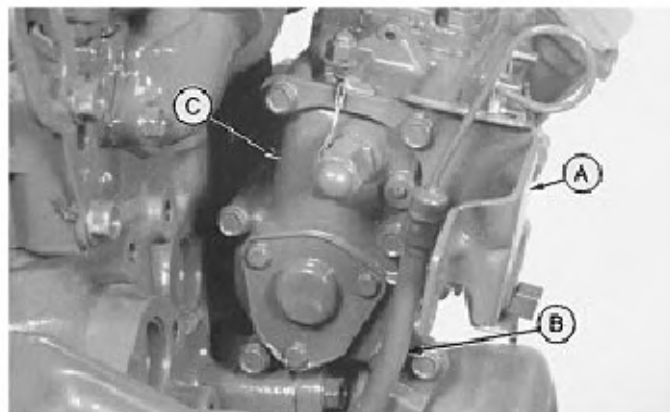
INSTALL FUEL CONTROL LINKAGE (3TN66/LATER 3TNA72)

1. Thoroughly clean and dry all parts. Use new gaskets when assembling the engine.
2. Put clean engine oil all internal parts.
3. Align tooth in governor weight with slot in shaft. Install governor weight (A), nut (B), and sleeve (C).



M21.TM355.67 -19-14AUG88

4. Install linkage housing (C), bracket (A), and dipstick (B). Tighten cap screws.
5. Bleed fuel injection system (See Section 30 in Machine TM).
6. Check and adjust fuel shut-off lever. (See Machine TM).
7. Check and adjust fuel controller. (See Machine TM).
8. Check and adjust slow and fast idle settings. (See Machine TM).
9. After all adjustments are made install new lead seal wire and crimp using JDF-10 Sealing Wire Pliers.



M21,TM355,68 -19-23APR88

SERVICE FUEL CONTROL AND GOVERNOR LINKAGE (ALL EXCEPT 3TN66/3TNA72)

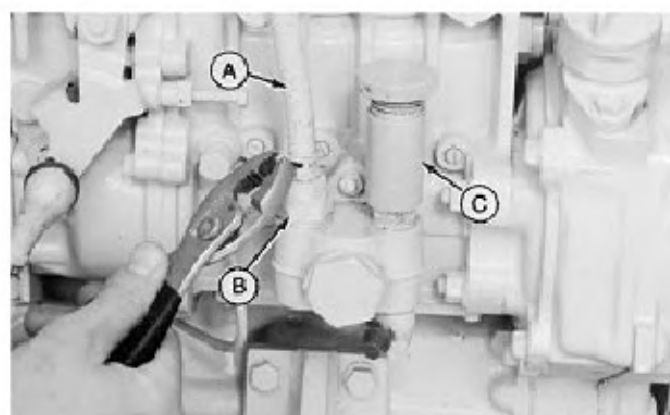
Do not attempt to service the fuel control and governor linkage.

If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop, or the fuel injection pump assembly must be replaced.

M21,TM355,69 -19-14AUG88

REMOVE AND INSPECT FUEL SUPPLY PUMP (4TN100RJF)

1. Thoroughly clean the supply pump body and surrounding area before loosening and fittings, to prevent dirt from entering the fuel system.
2. Remove fuel line (A), fitting (B) and hand primer assembly (C).



M21,TM355,A1 -19-18AUG88

3. Inspect valves and springs for excessive wear or damage.

4. Inspect valve seat surfaces for scratches, nicks, foreign material or pitting.

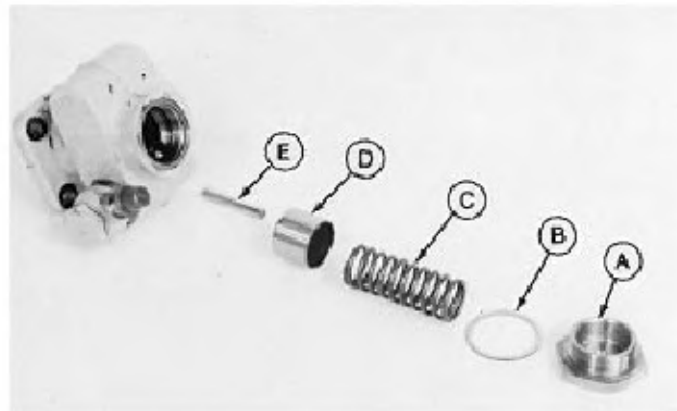
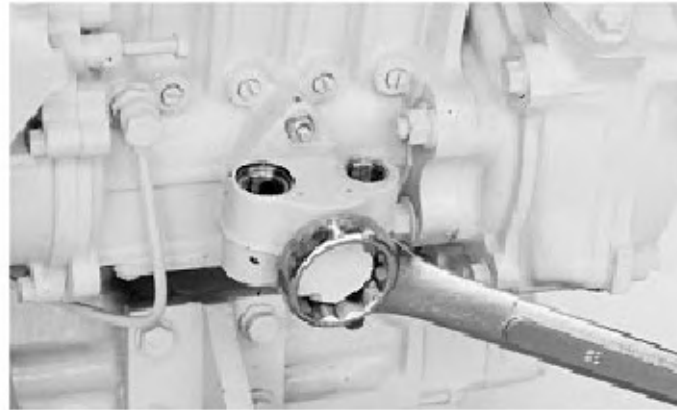


M21.TM355.A2 -19-14AUG8

5. Remove plug (A) and inspect parts (A—E) for wear or damage. Replace if necessary.

6. Remove three mounting nuts to remove pump body from engine.

A—Plug
B—Washer
C—Spring
D—Plunger
E—Rod

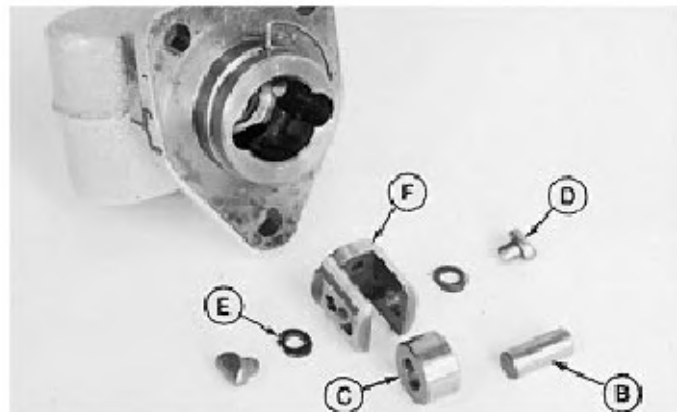
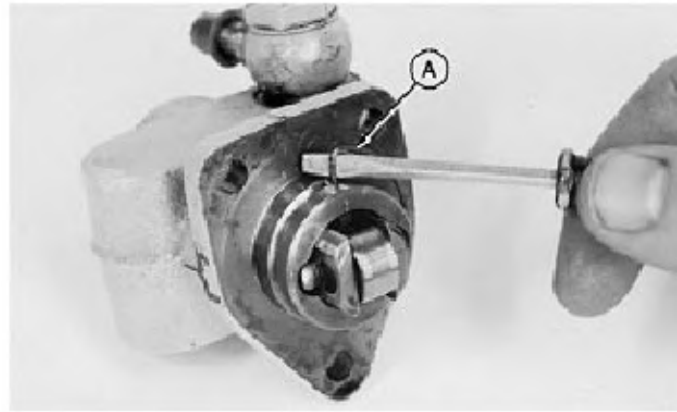


M21.TM355.A3 -19-14AUG8

7. Lift wire retainer (A) to remove pump cam roller assembly.

8. Inspect cam roller assembly (B—F) for wear or damage. Replace if necessary.

- A—Wire Retainer
- B—Shaft
- C—Roller
- D—Slide Pivot (2 used)
- E—Washer (2 used)
- F—Holder



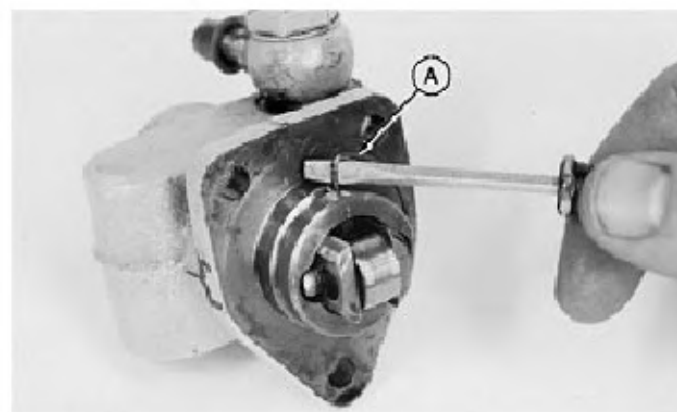
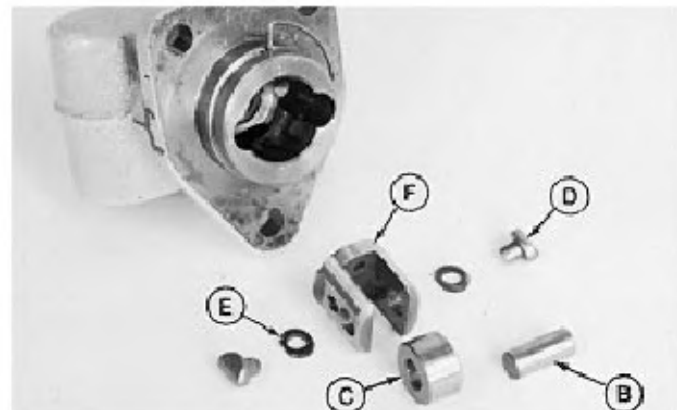
M21,TM355,A4 -19-14AUG87

ASSEMBLE AND INSTALL FUEL SUPPLY PUMP (4TN100RJF)

1. Assemble cam roller assembly (B—F). Install cam roller assembly into pump body with small hole in holder towards bottom of pump body.

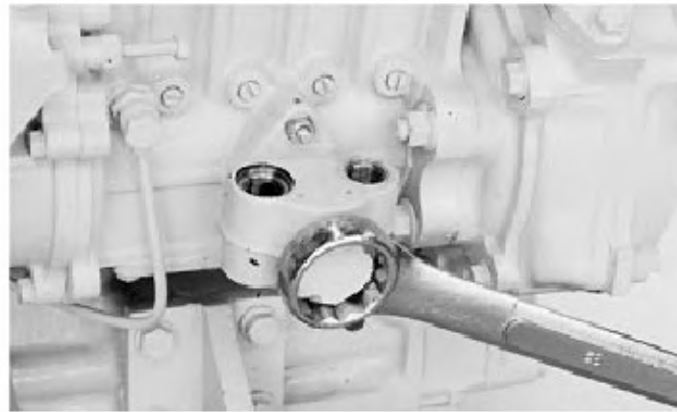
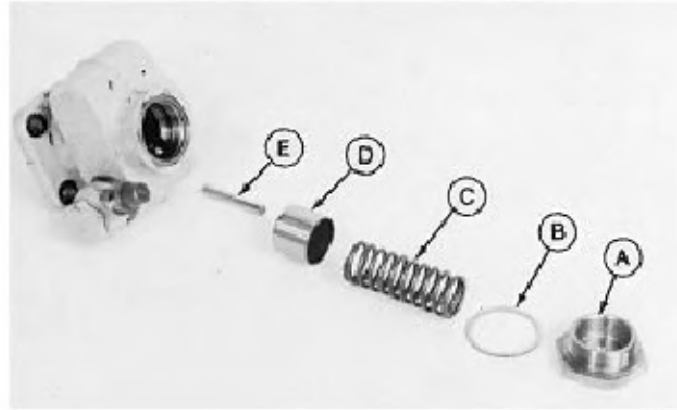
2. Install wire retainer (A).

- A—Wire Retainer
- B—Shaft
- C—Roller
- D—Slide Pivot (2 used)
- E—Washer (2 used)
- F—Holder



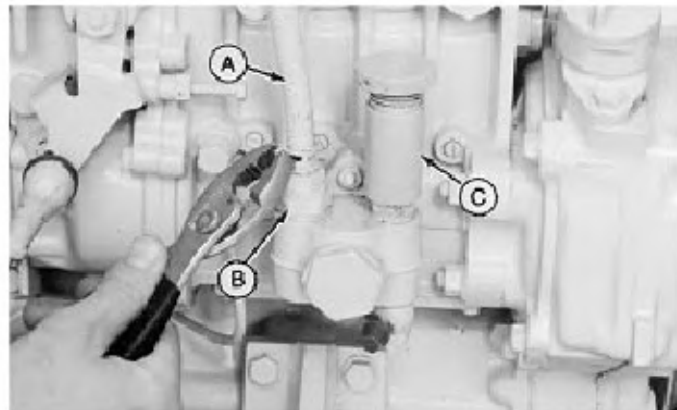
M21,TM355,A5 -19-14AUG87

3. Install plunger parts (A—E) in pump body.
4. Install pump on engine and tighten nuts to 11 N·m (96 lb-in.). Tighten plug (A).



M21,TM355,A6 -19-14AUG8

5. Install hand primer assembly (C), fitting (B) and fuel line (A).



M21,TM355,A7 -19-14AUG8

SERVICE EQUIPMENT AND TOOLS

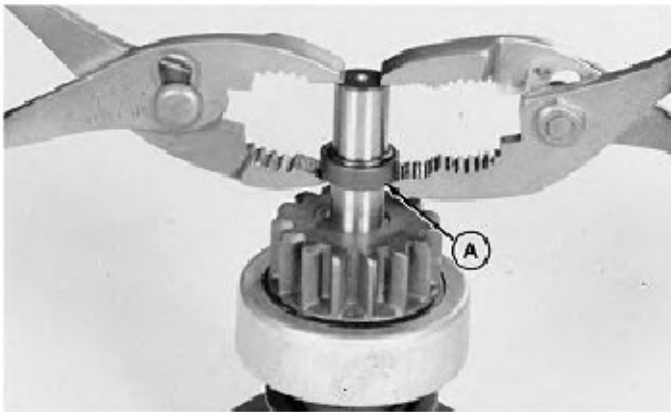
NOTE: Order tools from the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

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

M21,4010R,1 -19-14JUN8

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 -19-01SEP8

STARTER APPLICATION CHART

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

Manufacture	Rated Output	Motor Yoke Outside Diameter
Hitachi	0.8 kW	—
Nippon Denso	1.0 kW	68.0 mm (2.68 in.)
Nippon Denso	1.4 kW	76.0 mm (3.00 in.)

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

M21,TM360,0 -19-01SEP8

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 -19-14AUG8

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).

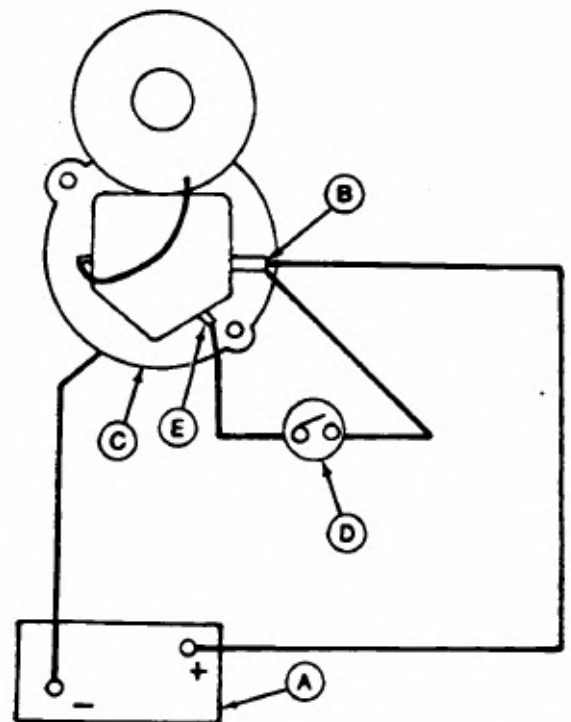
NOTE: A short piece of wire with a small clip on the end will allow a more positive connection at the switch terminal.

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.

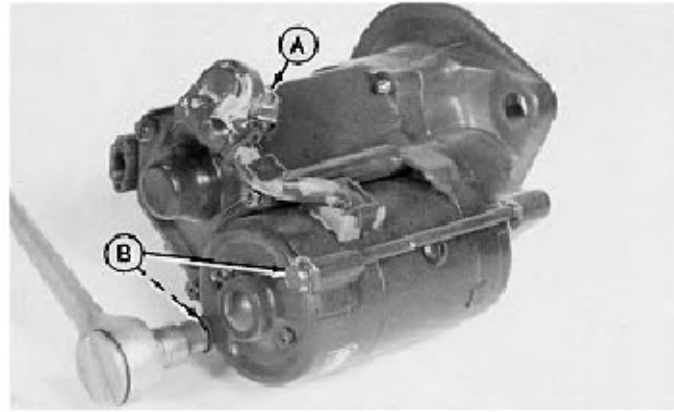


A—12-Volt Battery
B—Battery Terminal
C—Starter Frame
D—Remote Start Switch
E—Switch Terminal

M21,4010R,5 -19-14JUN8

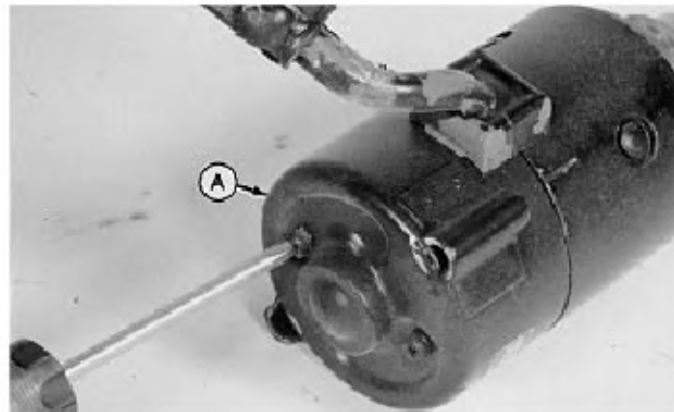
DISASSEMBLE AND SERVICE NIPPON DENSO 1.0 KILOWATT STARTER

1. Disconnect field lead (A).
2. Remove two bolts (B) and separate motor from solenoid. Remove armature assembly.



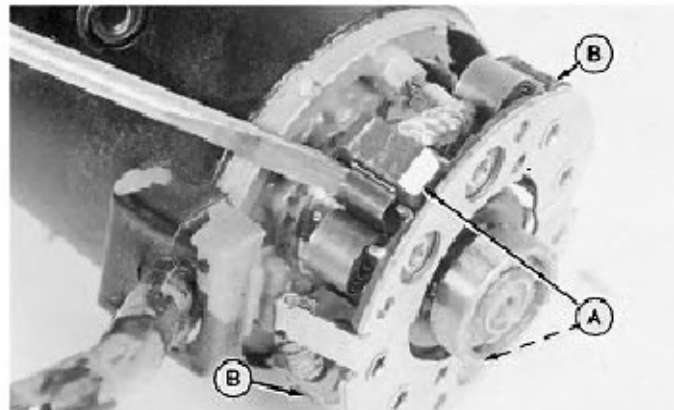
M21.4010R.6 -19-14AUG8

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



M21.4010R.7 -19-14JUN8

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.

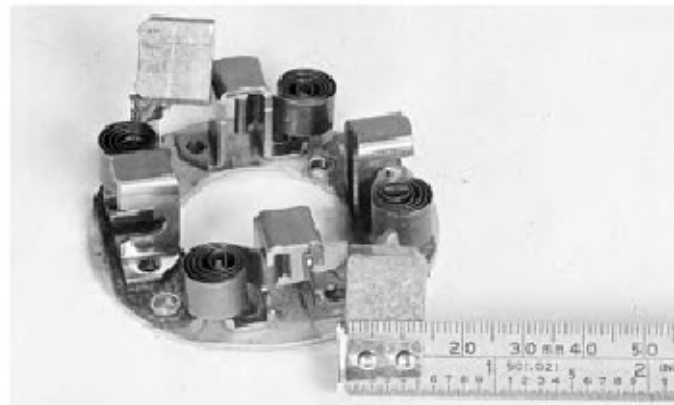


M21.4010R.8 -19-14JUN8

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.

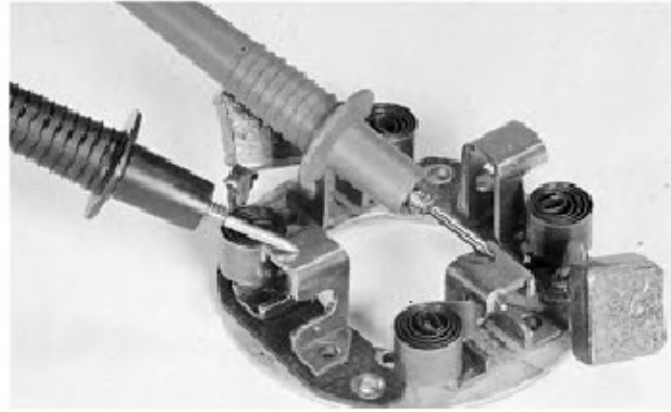
If field coil brushes are worn, the entire field coil assembly must be replaced.



M21.4010R.9 -19-14JUN8

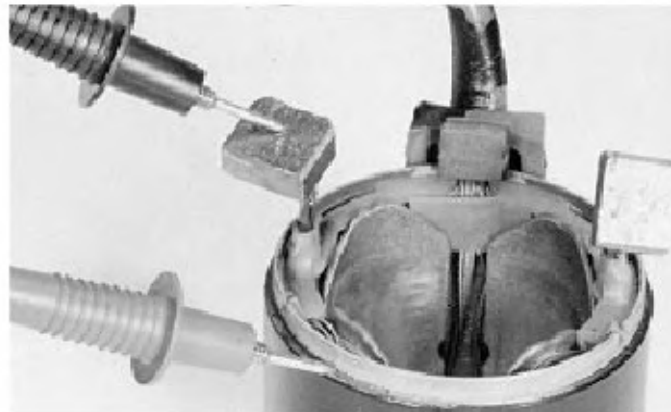
8. Test the brush holder using an ohmmeter or test light. Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.

Inspect springs; replace if weak or distorted.



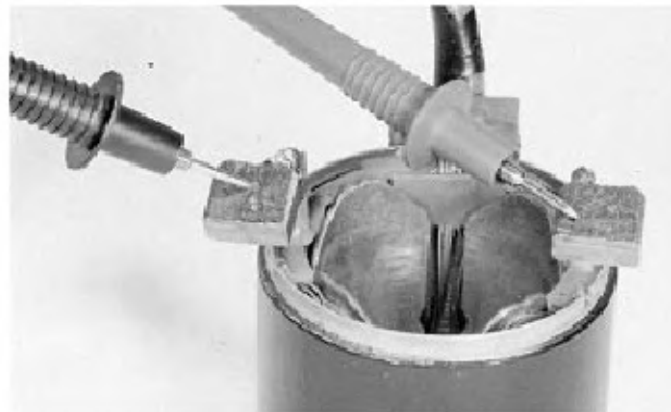
M21.4010R.10 -19-14JUN8

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 -19-14JUN8

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.

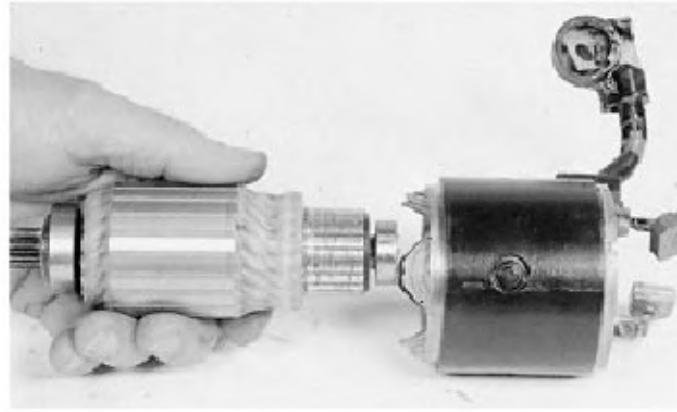


M21.4010R.12 -19-14JUN8

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.

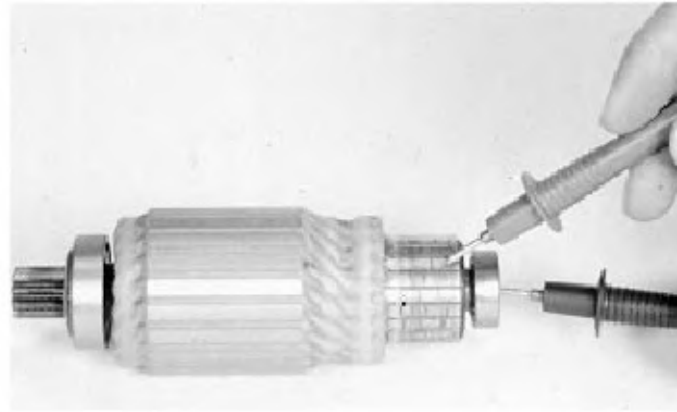


M21,4010R,13 -19-17JUL8

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.

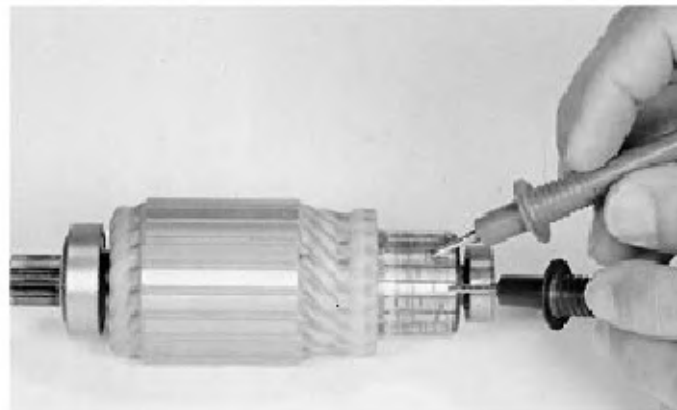
If test shows continuity, a winding is grounded and the armature must be replaced.



M21,4010R,14 -19-14JUN8

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.



M21,4010R,15 -19-14JUN8

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.

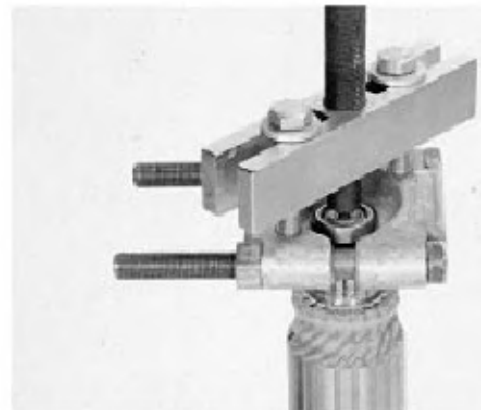
16. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.



M21.4010R.16 -19-14JUN8

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

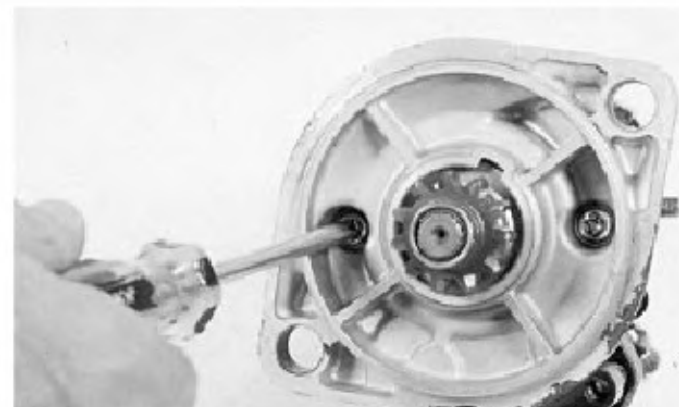
18. Remove bearings by using a knife edge bearing puller.



M21.4010R.17 -19-14JUN8

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

1. Remove two screws.



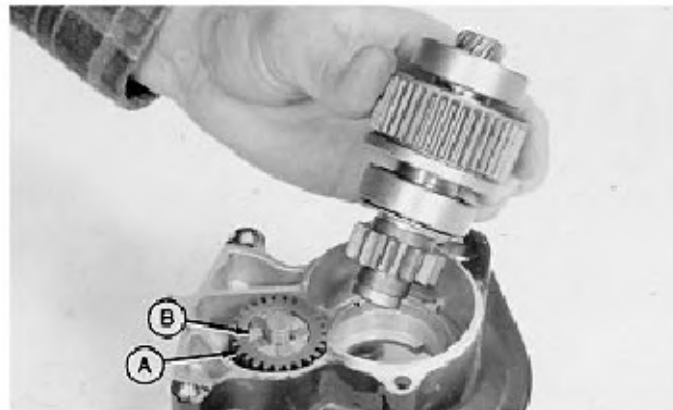
M21.4010R.18 -19-14AUG8

2. Hold clutch housing as shown and lift solenoid housing from clutch.
3. Remove plunger spring (A).



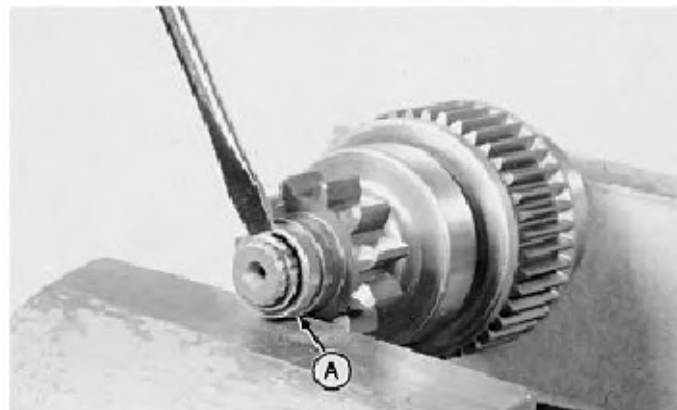
M21.4010R.19 -19-14JUN85

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.



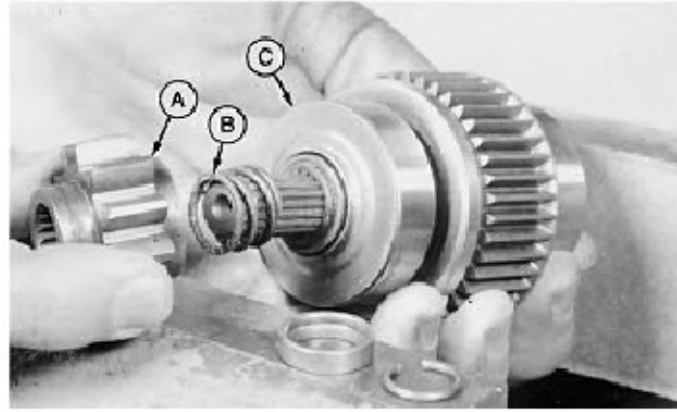
M21.4010R.21 -19-14JUN85

⚠ 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 -19-14JUN8

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.

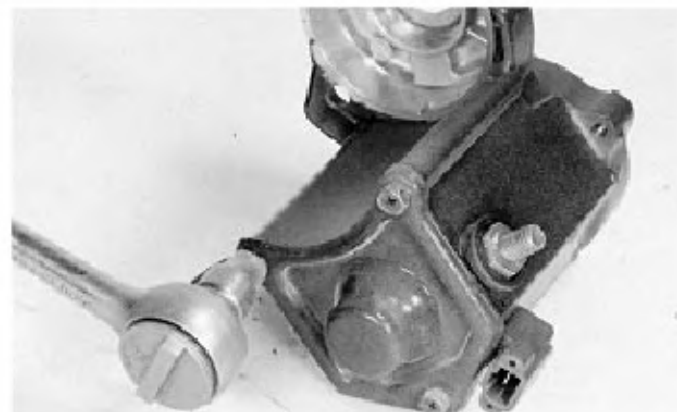
Inspect shaft for excessive wear or damage. Replace if defective.



M21,4010R,23 -19-14JUN8

INSPECT AND REPAIR SOLENOID (NIPPON DENSO 1.0 KILOWATT)

1. Remove three screws to remove cover and gasket.



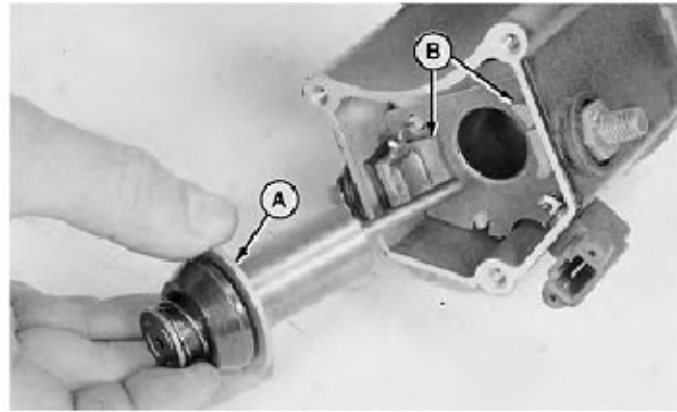
M21,4010R,24 -19-01SEP8

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.

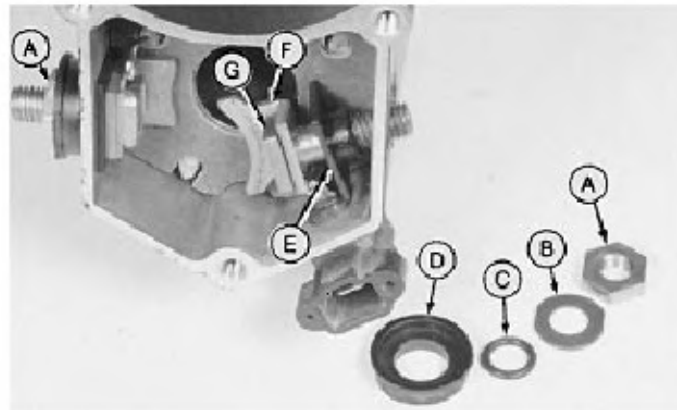
The solenoid is not serviceable. If it is defective, replace the solenoid housing assembly.



M21.4010R.25 -19-14JUN8

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

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



M21.4010R.26 -19-14JUN8

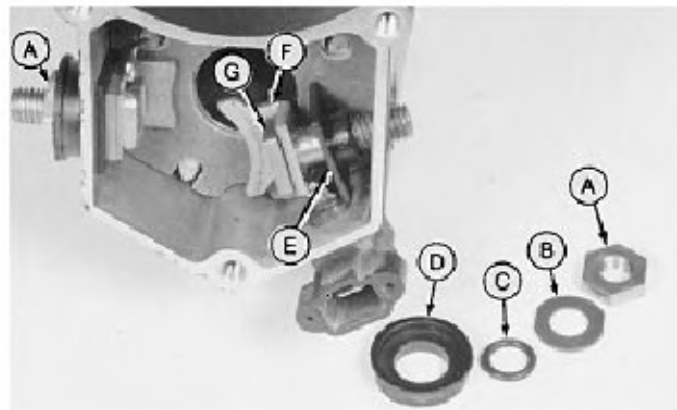
ASSEMBLE NIPPON DENSO 1.0 KILOWATT STARTER

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.

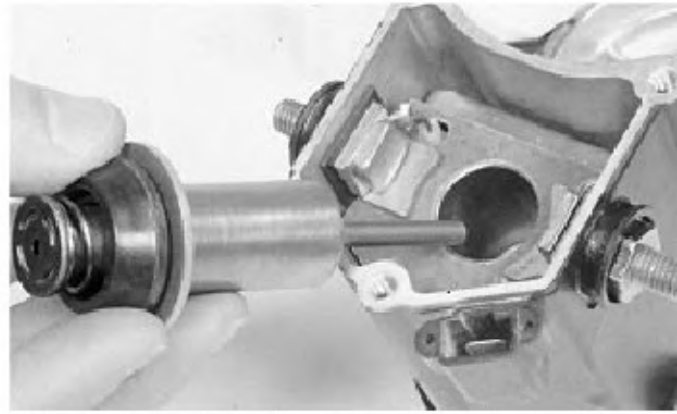
1. Install parts (A—H).

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



M21.4010R.27 -19-01SEP8

2. Install solenoid plunger.



M21.4010R.28 -19-14JUN8

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



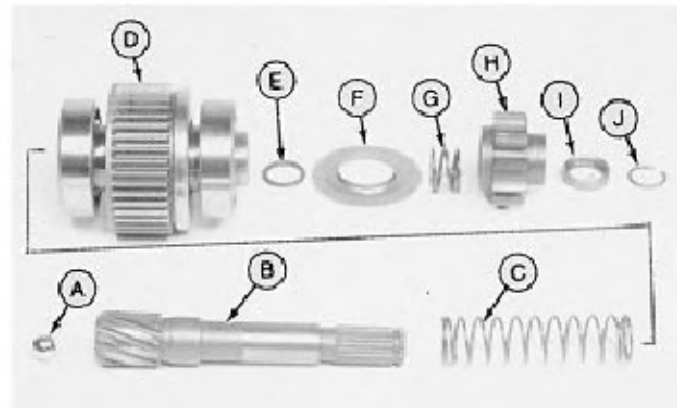
M21.4010R.29 -19-14JUN8

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



M21.4010R.30 -19-14AUG8

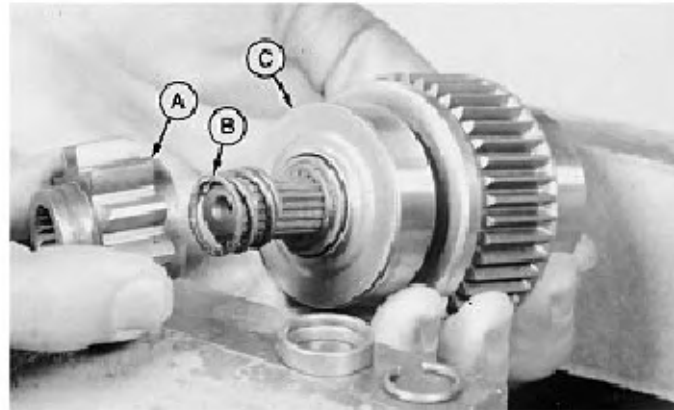
2. Install steel ball in end of shaft. Use grease to hold it in place.

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.



M21.4010R.31 -19-14JUN8

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



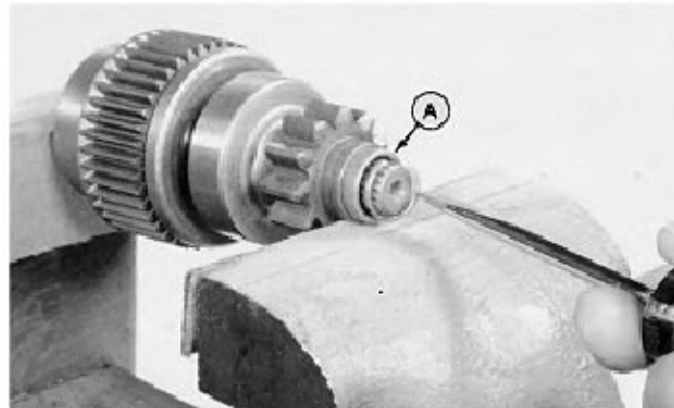
M21.4010R.32 -19-14JUN8

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.

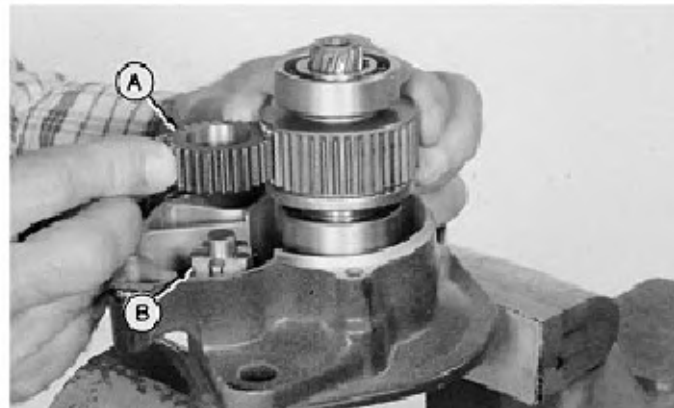


M21.4010R.33 -19-14JUN8

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

10. Install retainer and five rollers.

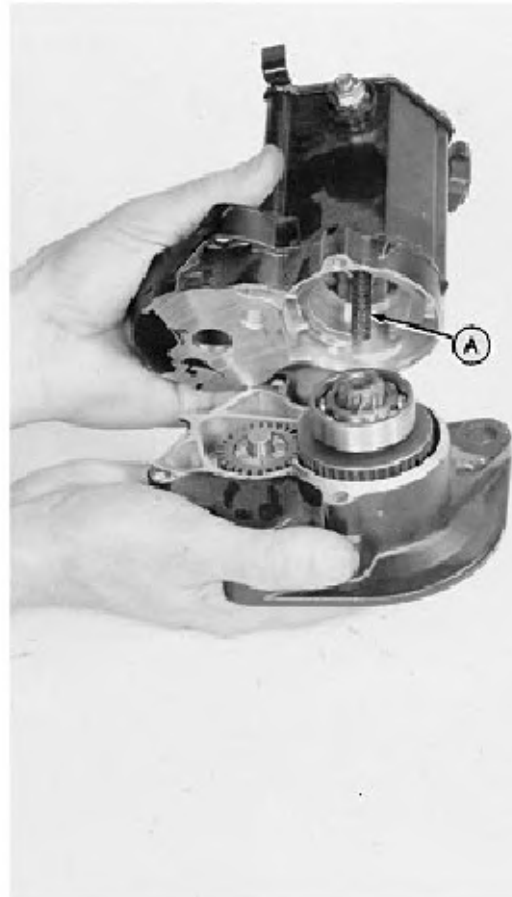
11. Hold pinion (A) and clutch assembly with teeth meshed. Install both into housing at the same time.



M21.4010R.34 -19-14JUN8

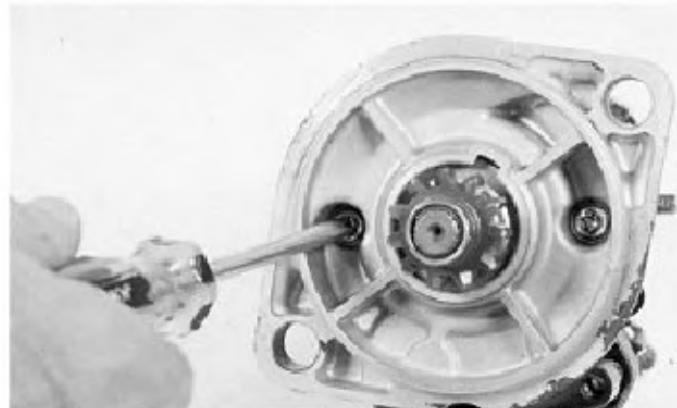
NOTE: Be sure steel ball is in the end of the clutch shaft.

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



M21.4010R.35 -19-18JUN85

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.



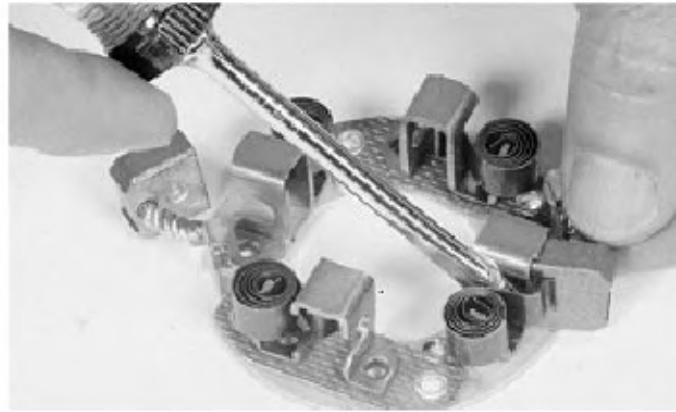
M21.4010R.37 -19-17JUL85

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.



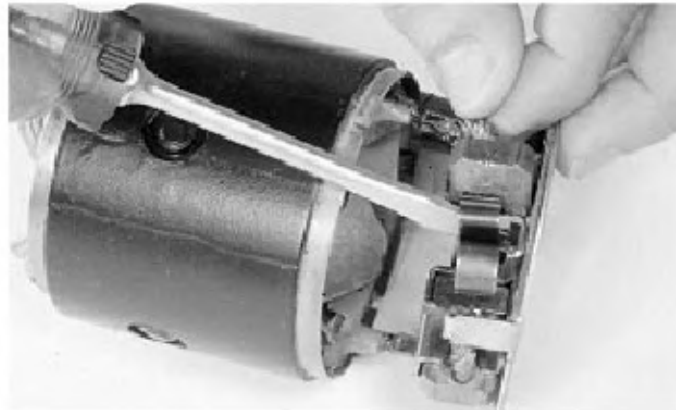
M21.4010R.38 -19-14JUN85

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.



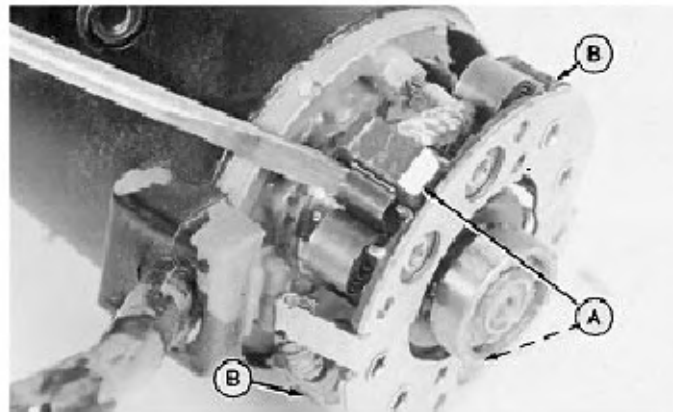
M21.4010R.40 -19-14JUN85

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

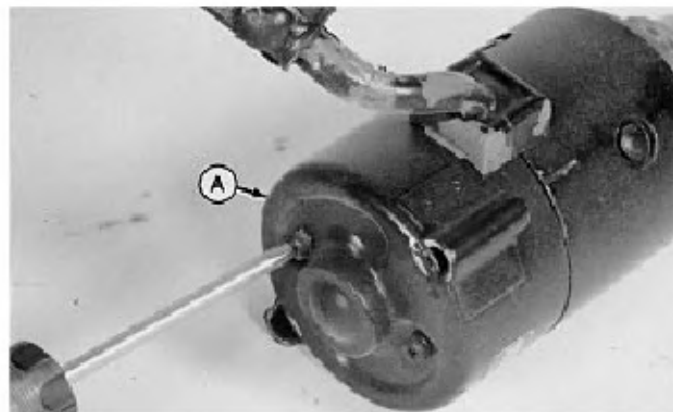
19. Release brush springs to allow field coil brushes (A) and negative side brushes (B) to contact commutator.



M21.4010R.42 -19-14JUN8

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.

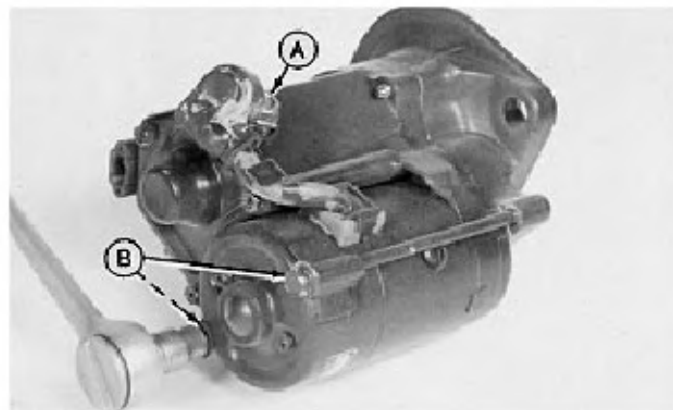


M21.4010R.43 -19-14JUN8

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).

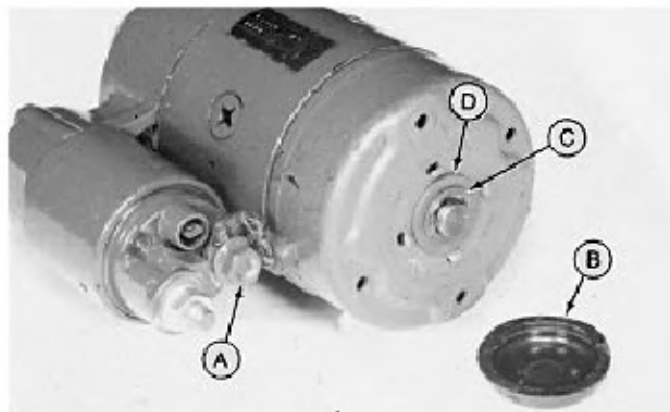


M21.4010R.44 -19-14FEB8

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.

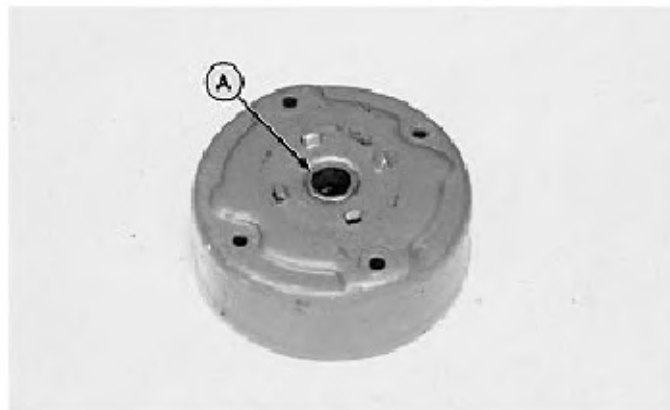
A—Solenoid Wire
B—Plastic Cap
C—E-Clip
D—Shim Pack



M21,TM360,22 -19-14AUG8

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

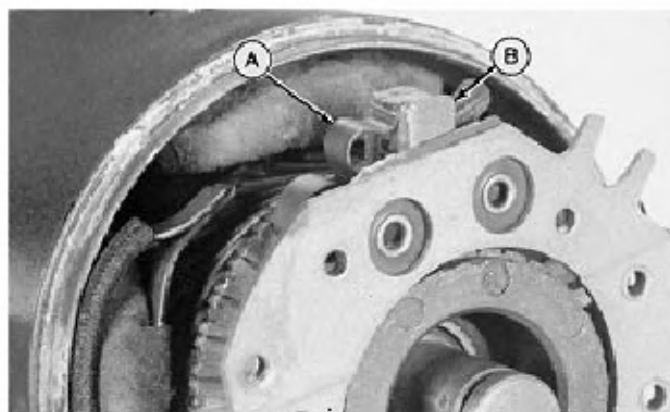
Install new bushing with suitable size driver disks until bushing bottoms in cover.



M21,TM360,23 -19-15FEB8

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

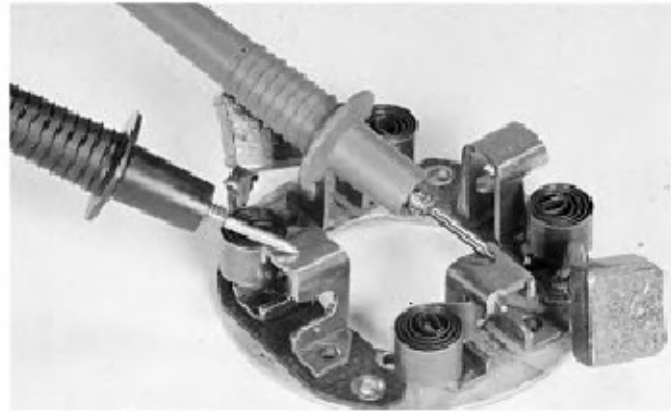
7. Remove the two field coil brushes from holders and remove brush holder assembly.



M21,TM360,24 -19-15FEB8

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.

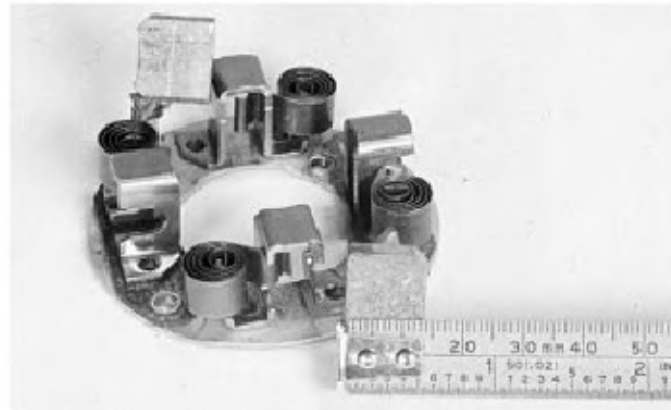


M21.4010R.10 -19-14JUN8

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.



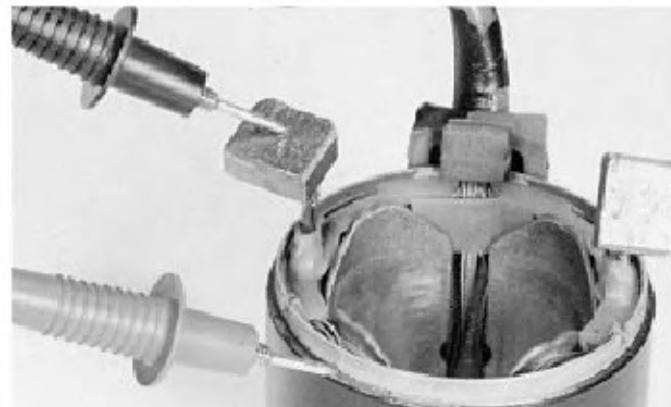
M21.TM360.37 -19-08APR8

10. Remove field coil housing from armature.



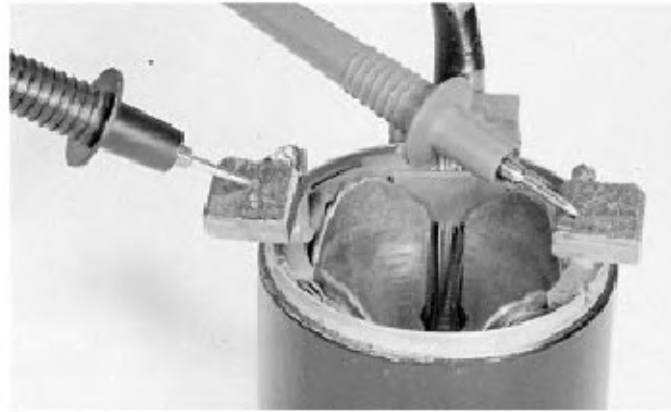
M21.TM360.25 -19-15FEB8

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.



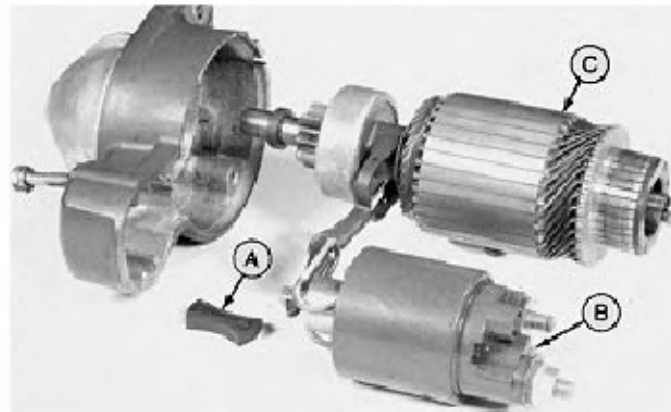
M21.TM360.39 -19-15FEB8

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.



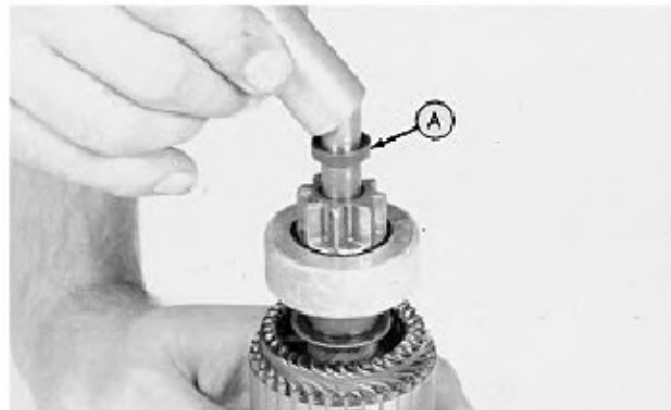
M21,TM360,40 -19-15FEB88

- 13. Remove the two solenoid attaching cap screw.
- 14. Remove rubber plug (A).
- 15. Pull solenoid (B) and armature assemblies (C) from housing.



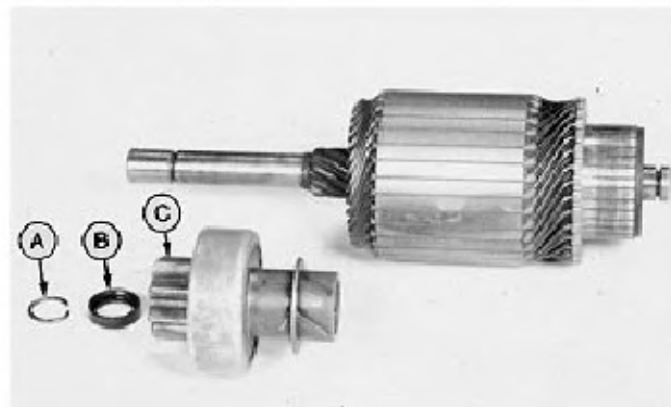
M21,TM360,26 -19-15FEB88

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



M21,TM360,27 -19-15FEB88

- 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.

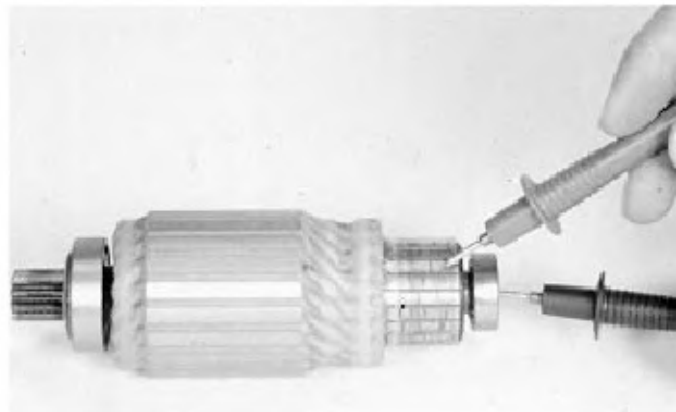


M21,TM360,28 -19-15FEB88

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.

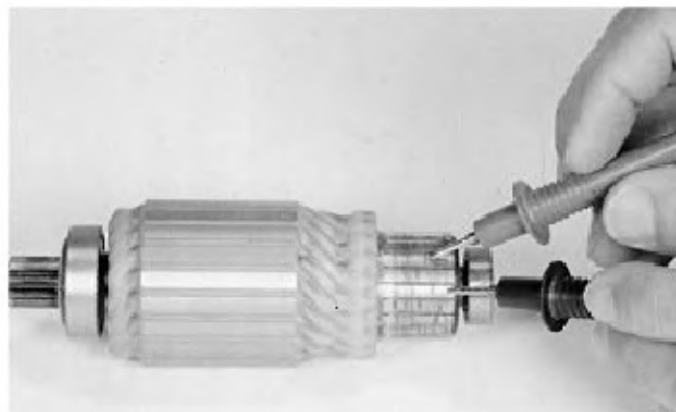
If test shows continuity, a winding is ground and the armature must be replaced.



M21,TM360,29 -19-15FEB88

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.



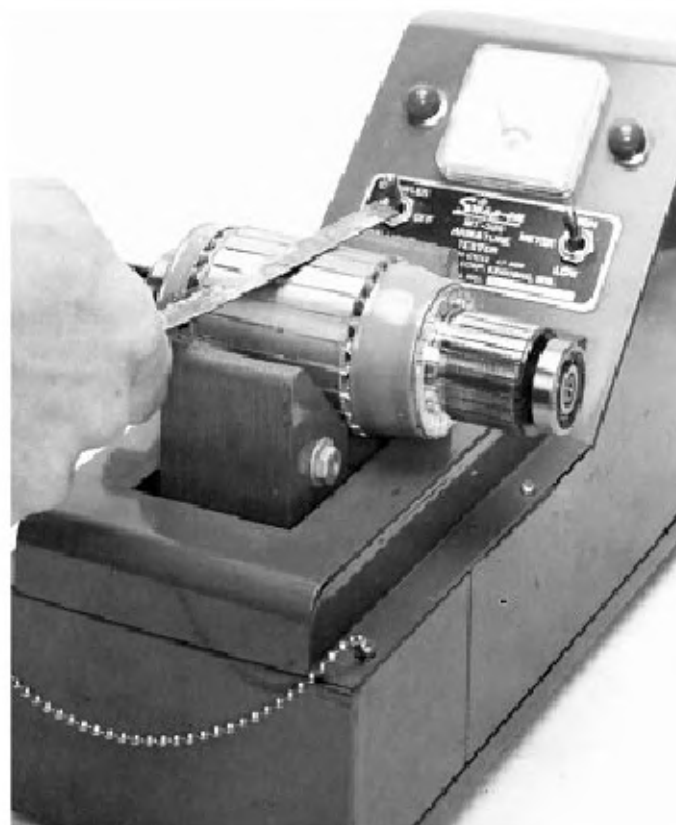
M21,TM360,30 -19-15FEB88

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.



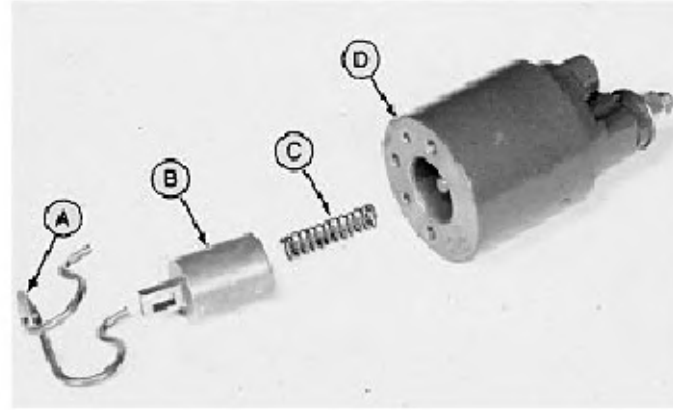
M21,TM360,31 -19-15FEB88

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 -19-23APR88

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.



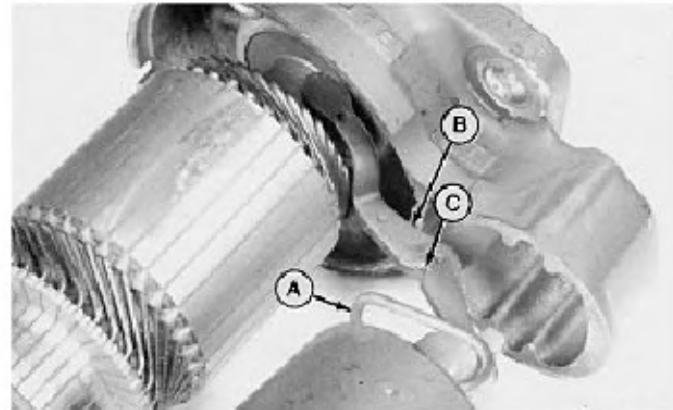
M21.TM360.33 -19-01SEP88

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.

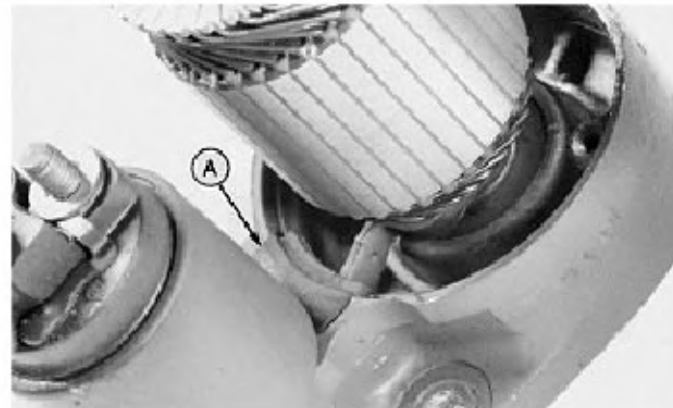
5. Install solenoid making sure spring pivot seats in notch (C) in clutch fork.

6. Install two solenoid attaching cap screws.



M21.TM360.34 -19-15FEB88

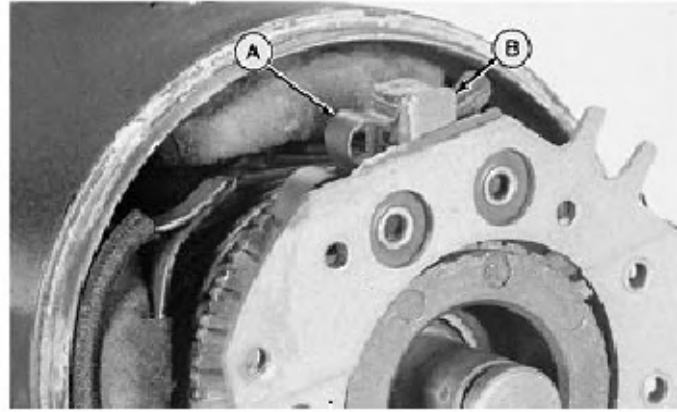
7. Install rubber plug (A) in notched area of housing.



M21.TM360.35 -19-24MAR88

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 -19-15FEB88

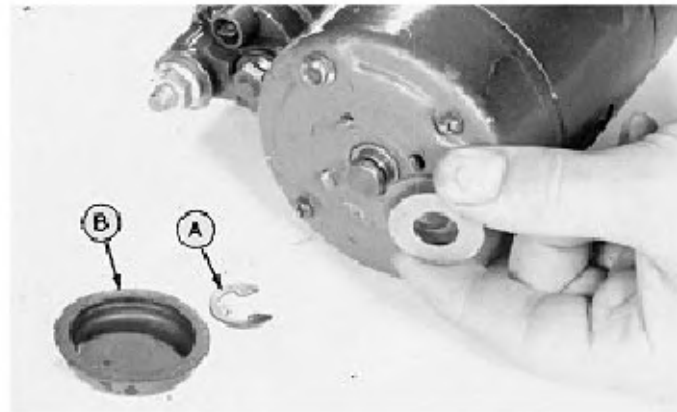
10. Install rear cover two through bolts. Install two phillips screws to secure brush holder.

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).



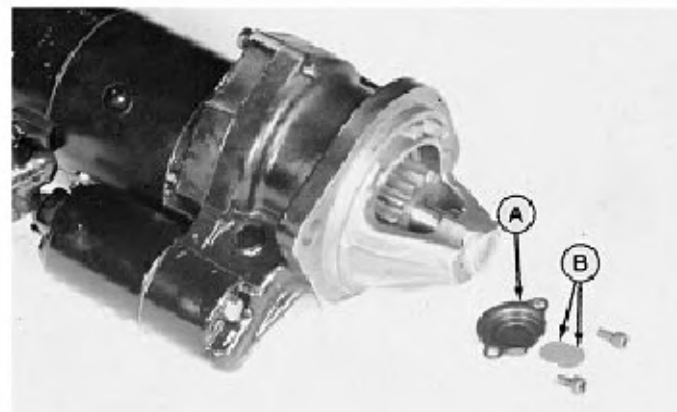
M21,TM360,38 -19-15FEB88

DISASSEMBLE AND SERVICE NIPPON DENSO 1.4 KILOWATT STARTER

1. Remove two hex-head screws and remove end cap (A) and shims (B) as shown.

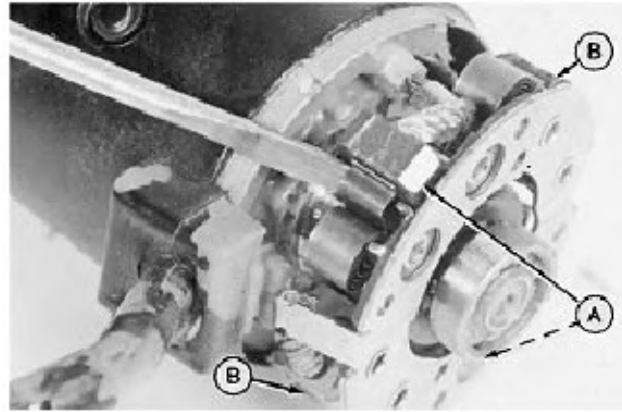
2. Remove two phillips-head screws and two through-bolts from rear of starter. Remove rear cover.

3. Remove motor assembly from starter.



M21,TM360,2 -19-15AUG87

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.

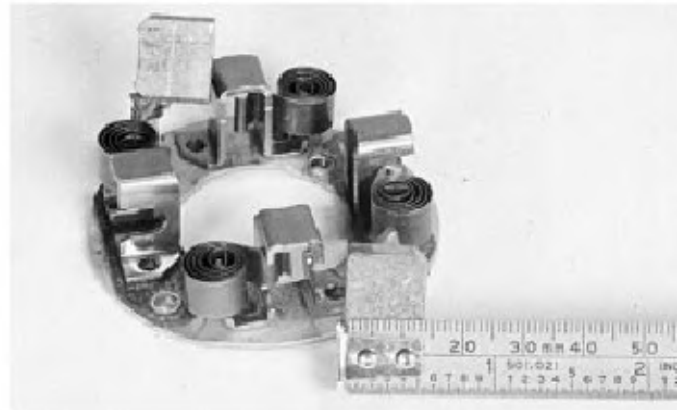


M21.4010R.8 -19-14JUN85

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.

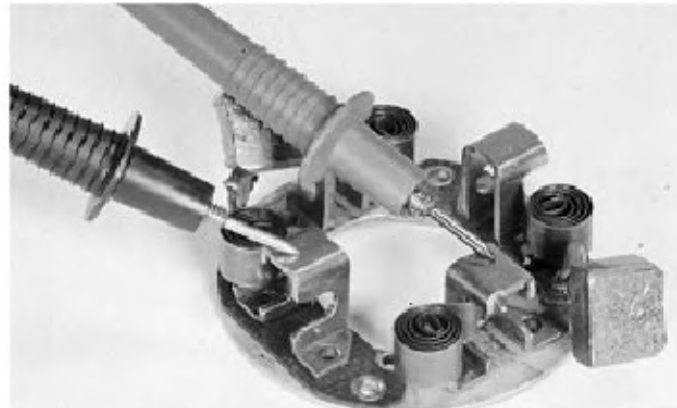
If field coil brushes are worn, the entire field coil assembly must be replaced.



M21.4010R.9 -19-14JUN85

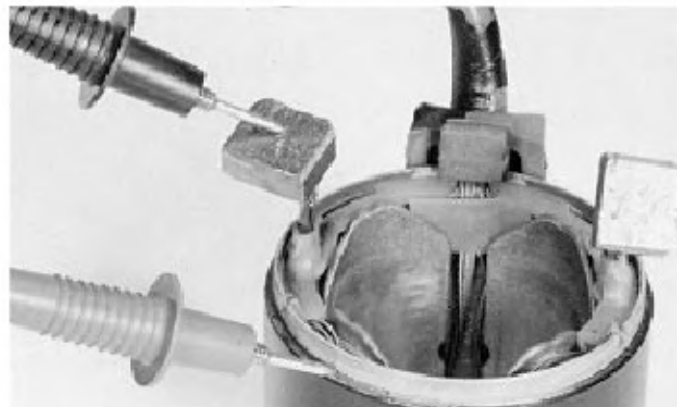
8. Test the brush holder using an ohmmeter or test light. Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.

Inspect springs; replace if weak or distorted.



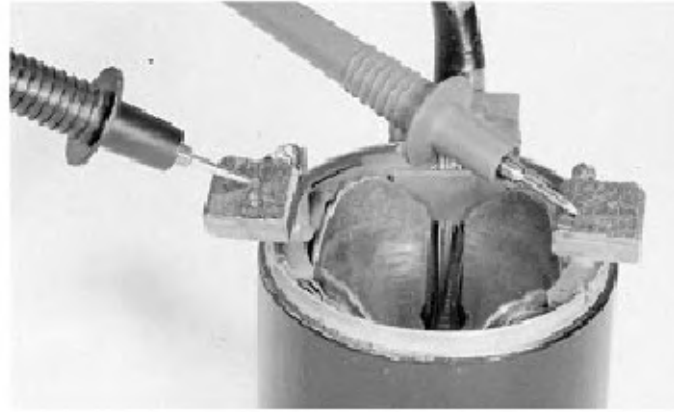
M21.4010R.10 -19-14JUN85

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.

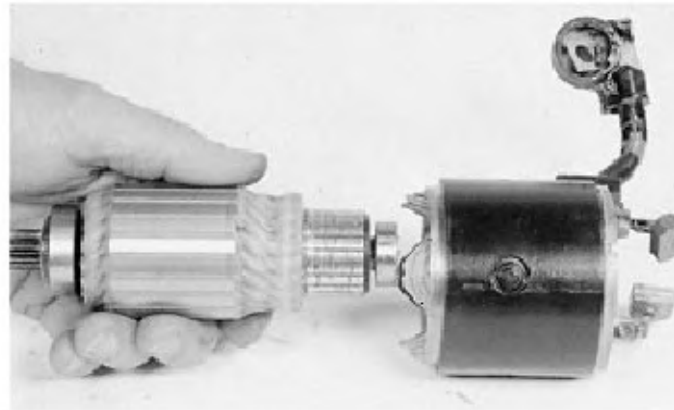


M21,4010R,12 -19-14JUN8

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.

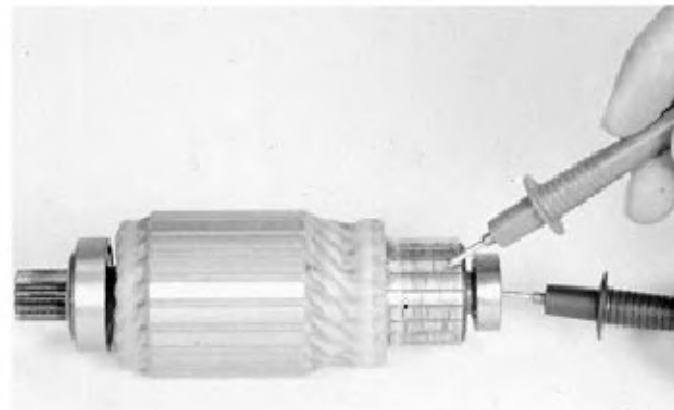


M21,4010R,13 -19-17JUL8

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.

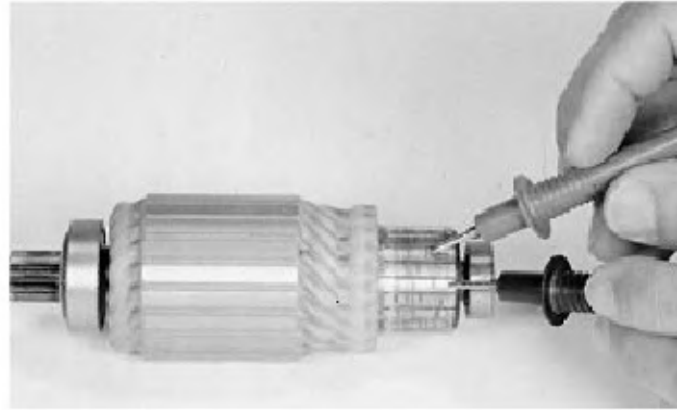
If test shows continuity, a winding is grounded and the armature must be replaced.



M21,4010R,14 -19-14JUN8

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.



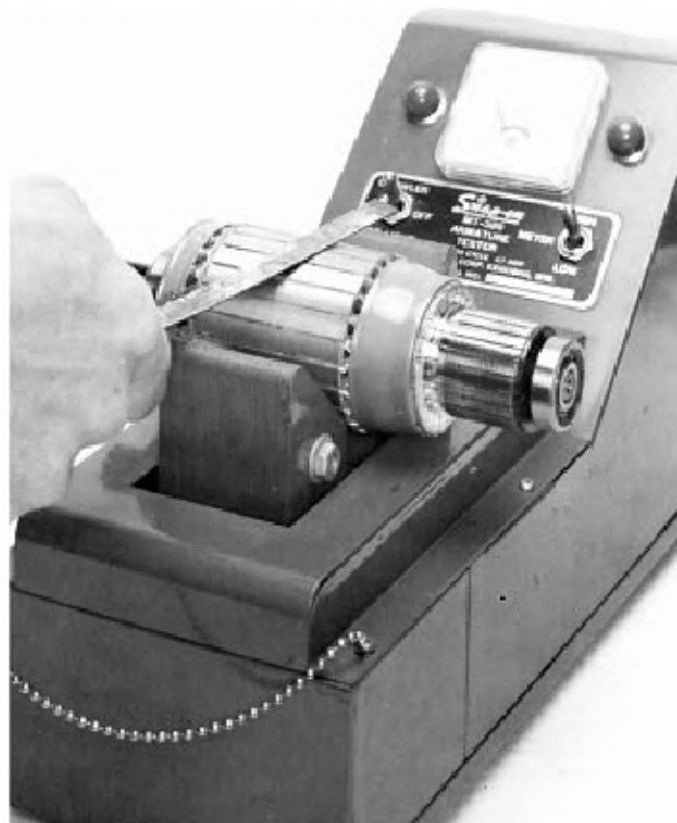
M21.4010R.15 -19-14JUN8

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.

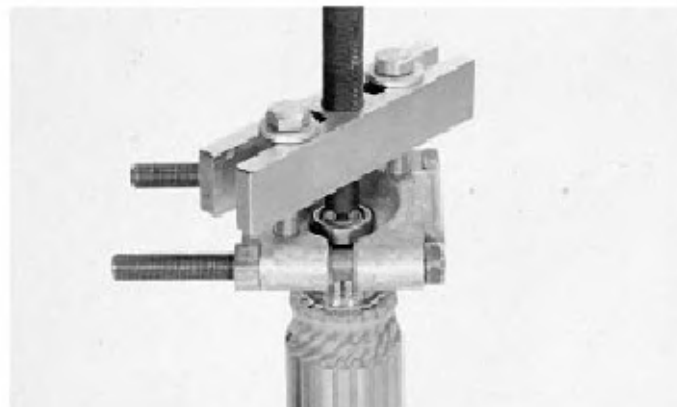
16. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.



M21.4010R.16 -19-14JUN8

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

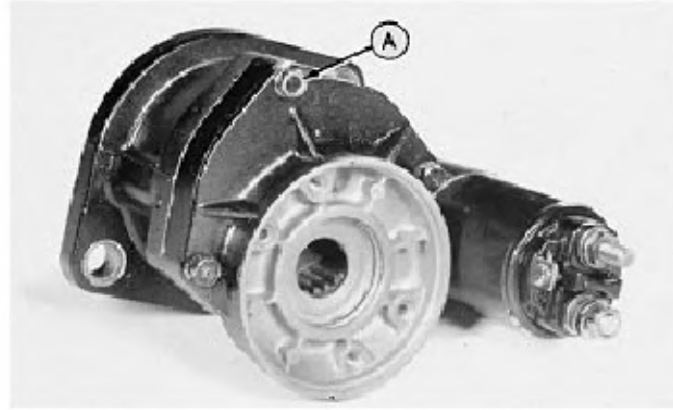
18. Remove bearings by using a knife edge bearing puller.



M21.4010R.17 -19-14JUN8

SERVICE GEAR TRAIN (NIPPON DENSO 1.4 KILOWATT)

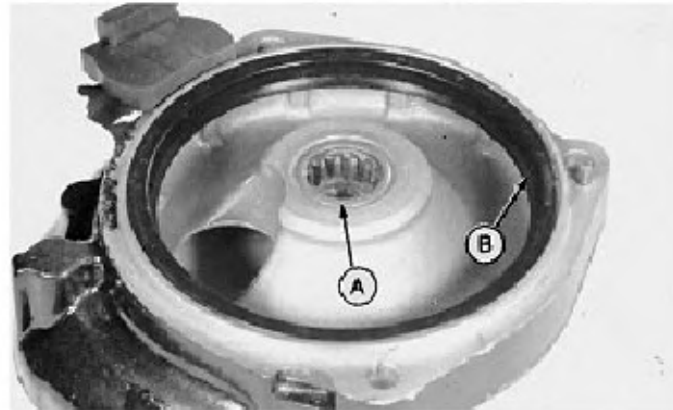
1. Remove three cap screws (A) and remove rear bearing housing.



M21.TM360.3 -19-15AUG8

2. Inspect bearing (A) and seal (B).

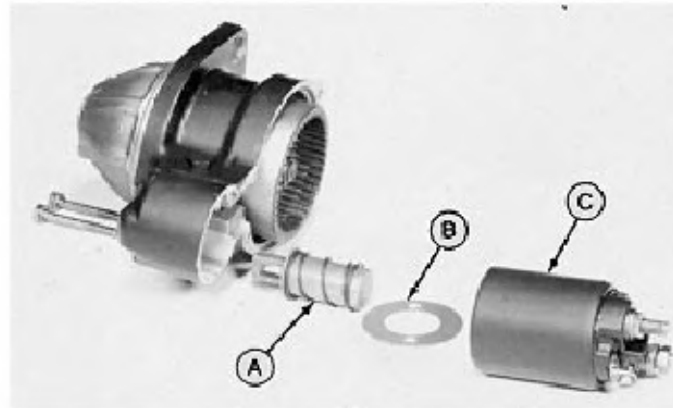
If necessary, remove bearing with a suitable blind hole puller. Install new bearing flush with housing surface.



M21.TM360.4 -19-15FEB8

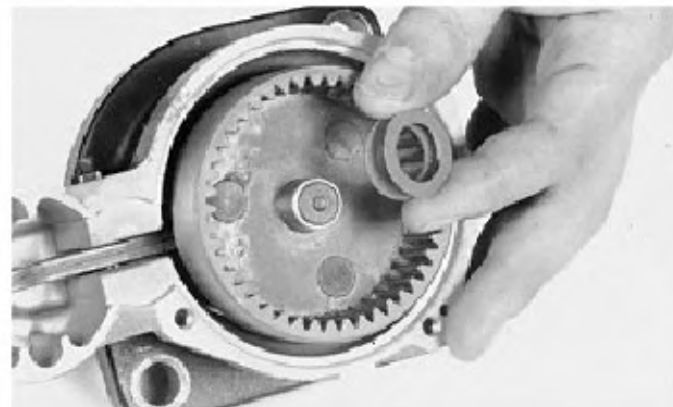
3. Remove two cap screws and remove plunger with spring (A), shims (B), and solenoid (C).

Replace defective parts as needed.



M21.TM360.5 -19-15FEB8

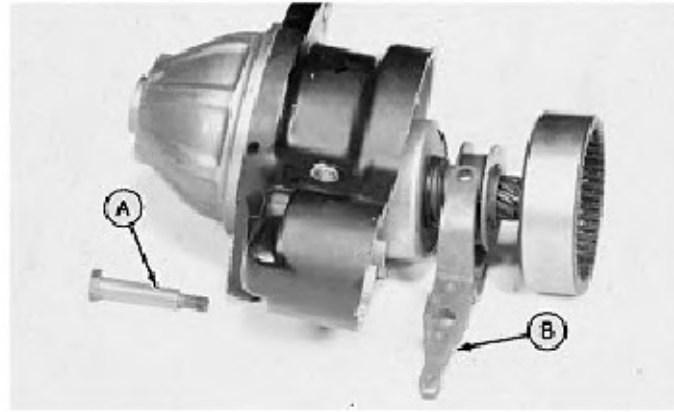
4. Remove shims from ring gear shaft.



M21.TM360.6 -19-15FEB8

5. Remove clutch fork pivot bolt (A) to remove fork and clutch assembly (B).

6. Inspect "SHOES" on clutch fork, replace fork as needed.



M21.TM360.7 -19-23APR8

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

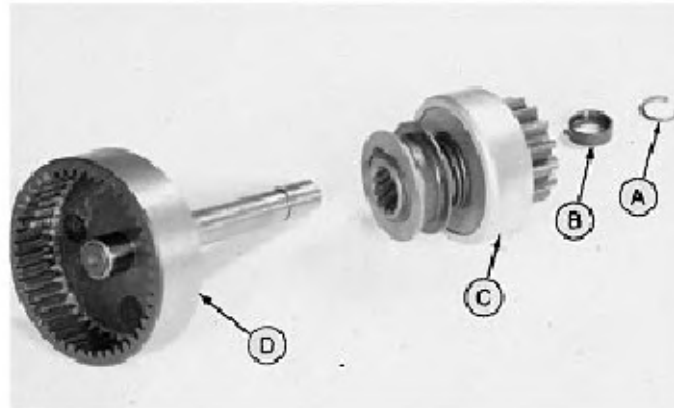


M21.TM360.8 -19-23APR8

8. Remove retaining wire (A), pinion stopper (B), and clutch assembly (C) from ring gear shaft.

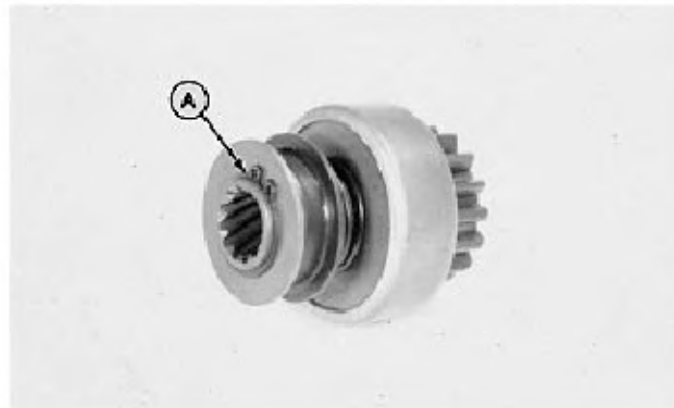
9. Inspect ring gear (D) for chipped or broken teeth. Replace as needed.

- A—Retaining Wire
- B—Pinion Stopper
- C—Clutch Assembly
- D—Ring Gear and Shaft



M21.TM360.9 -19-15FEB8

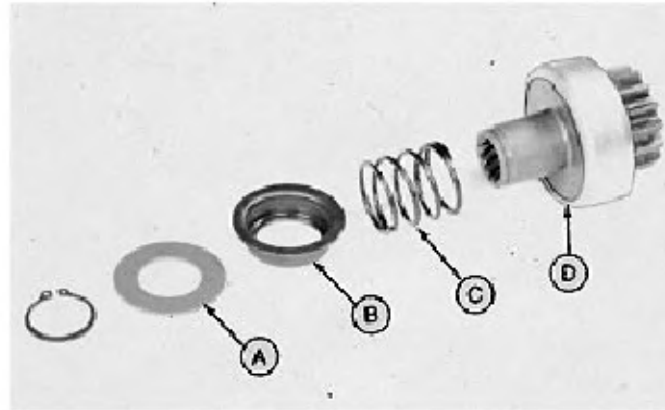
10. Remove snap ring (A) from clutch assembly.



M21.TM360.10 -19-15FEB8

11. Inspect clutch parts and replace as needed.
Assemble in reverse order.

- A—Washer
- B—Spring Cap
- C—Spring
- D—Clutch



M21.TM360.11 -19-15FEB88

12. Install clutch assembly on ring gear shaft.

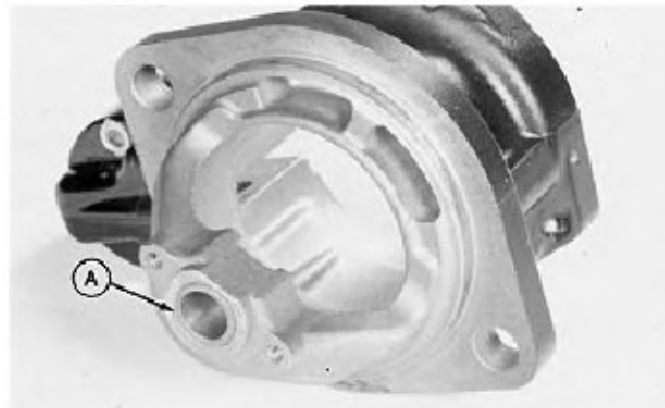
13. Install pinion stopper over shaft. Install retaining wire in groove of shaft.

14. Use two pliers to press pinion stopper (A) over retaining wire.



M21.TM360.12 -19-15FEB88

15. Inspect end frame bushing (A). Replace using suitable size driver disks. Install new bushing flush with face of housing.

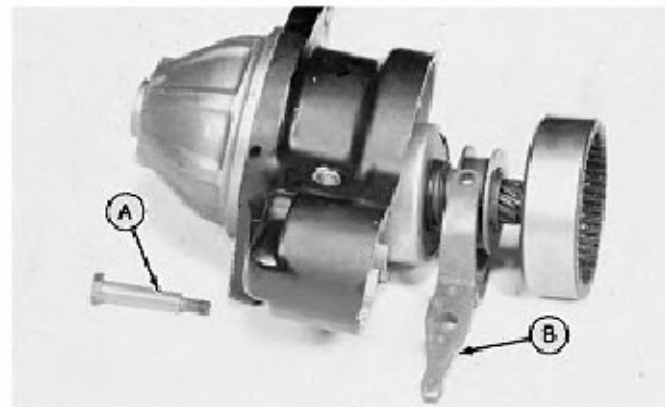


M21.TM360.13 -19-15FEB88

ASSEMBLE NIPPON DENSO 1.4 KILOWATT STARTER

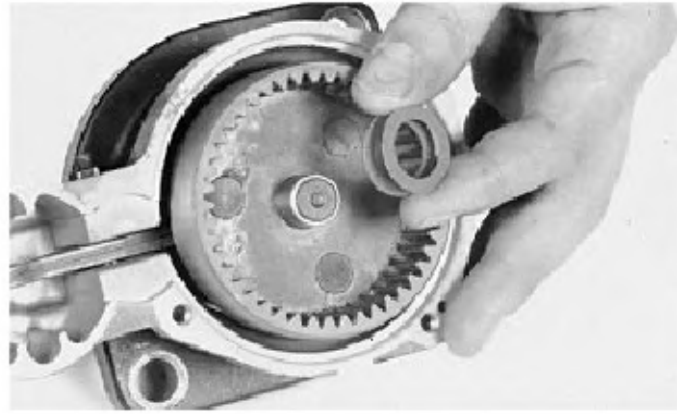
1. Install fork (B) over clutch and install assembly into housing.

2. Install clutch fork pivot bolt (A) and nut.



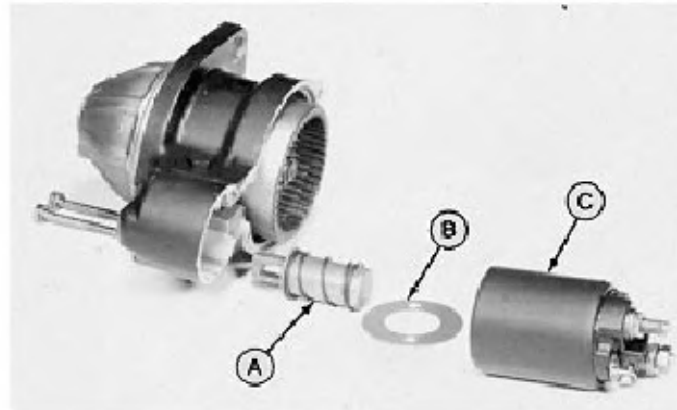
M21.TM360.14 -19-15AUG88

3. Install same number and thickness of ring gear shims as removed.



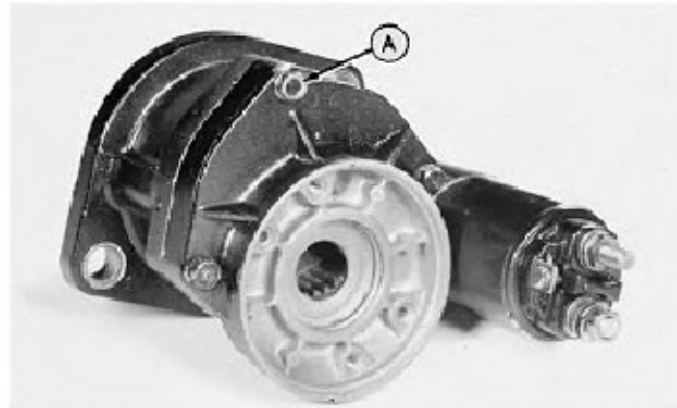
M21,TM360,15 -19-15FEB88

4. Install plunger with spring (A), same shims (B) as removed and solenoid (C). Secure with two cap screws.



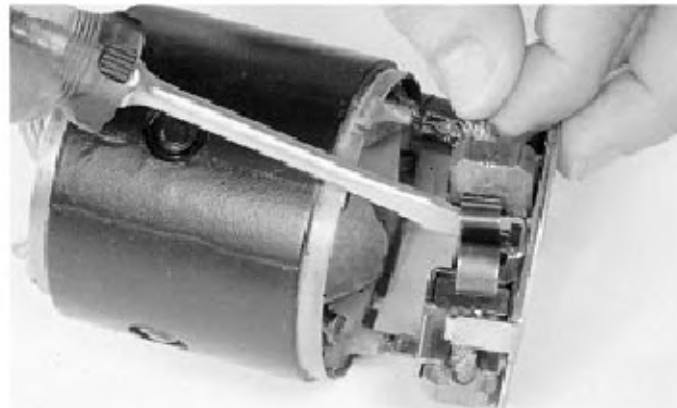
M21,TM360,16 -19-15FEB88

5. Install rear bearing housing. Install three cap screws (A).



M21,TM360,17 -19-15FEB88

6. Pry brush spring back and install field coil brushes into brush holder.



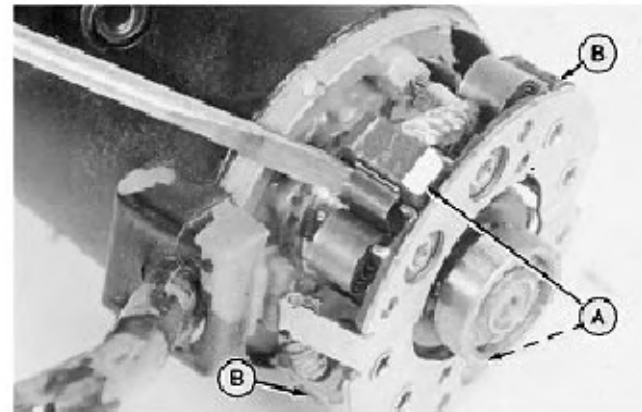
M21,TM360,18 -19-15FEB88

7. Install armature (A) into field coil.



M21,TM360,19 -19-15FEB88

8. Release springs to allow brushes (A and B) to contact commutator.



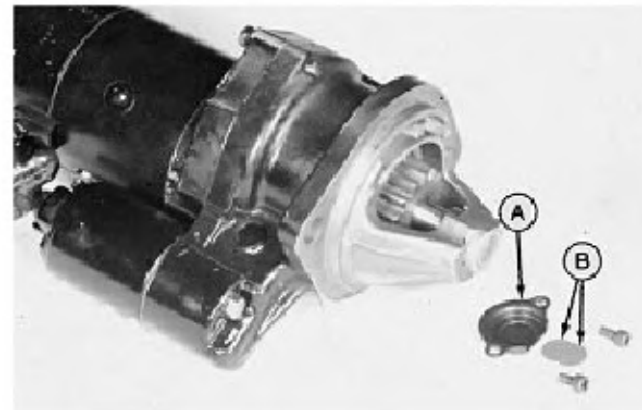
M21,TM360,20 -19-15FEB88

9. Install motor assembly onto gear train. Install the rear cover and secure with two long through-bolts.

10. Install the two phillip-head screws.

11. Install end frame cap (A) with same number and thickness of shims (B) as removed.

12. Install starter on engine. Tighten nut to 88 N·m (65 lb-ft).



M21,TM360,21 -19-15FEB88

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 -19-17JUL8

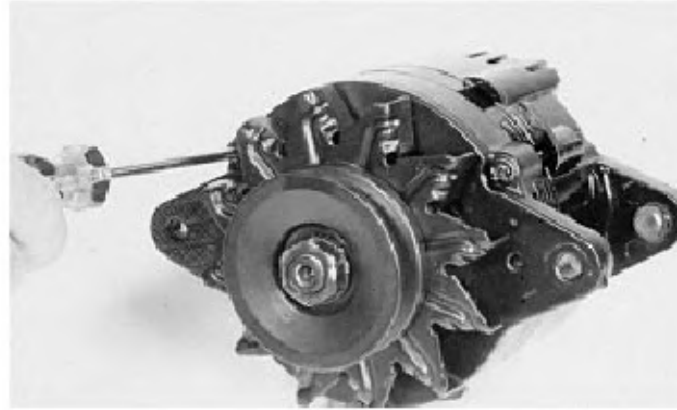
SPECIFICATIONS

Item	Alternator	Specification
Minimum Exposed Brush Length	All	5.5 mm (0.22 in.)
Maximum Exposed New Brush Length	Nippon Denso 35A	13.0 mm (0.50 in.)
Distance From Stator-to- Rectifier	Nippon Denso 35 A Hitachi 25A	33.5 mm (1.30 in.)
Pulley Nut Torque	Nippon Denso 35A	54 N·m (40 lb-ft)
	Kokosan 20A	27 N·m (20 lb-ft)
	Hitachi 25A	
Belt Deflection	All Engines	13 mm (1/2 in.) a 107 N (24 lb) Force between pulleys.

M21,TM365,14A -19-15AUG8

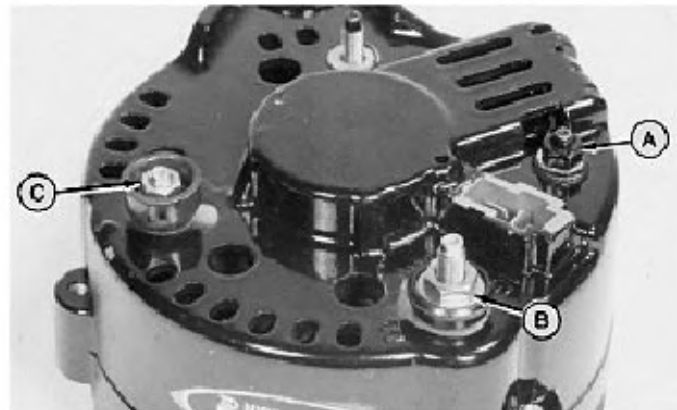
REPLACE VOLTAGE REGULATOR (NIPPON DENSO ALTERNATOR)

1. Remove alternator from engine.
2. Remove three attaching screws as shown.



M21.4005R.4 -19-01SEP87

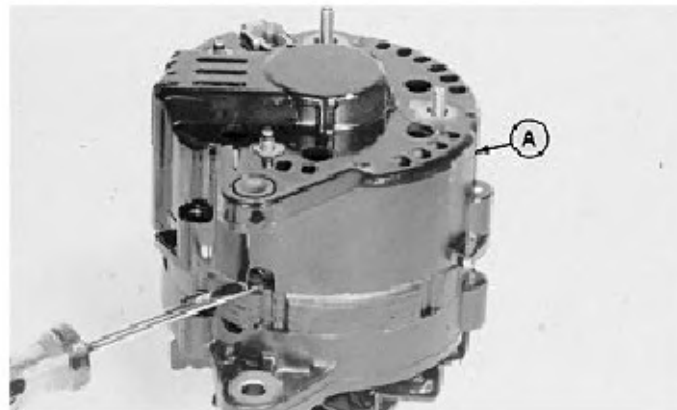
3. Remove nut (A) and nuts with insulators (B and C).



M21.4005R.5 -19-15FEB88

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.

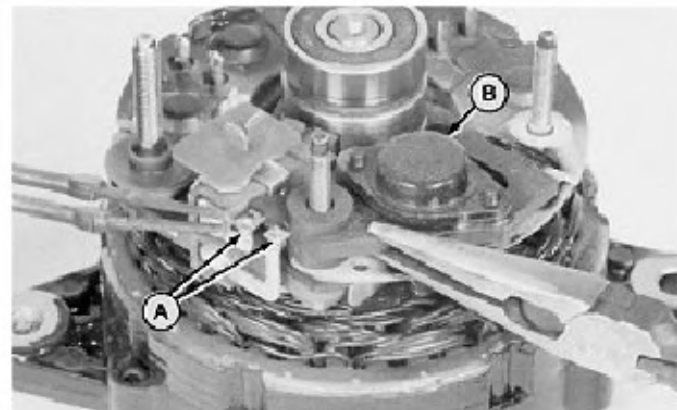


M21.4005R.6 -19-14JUN89

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

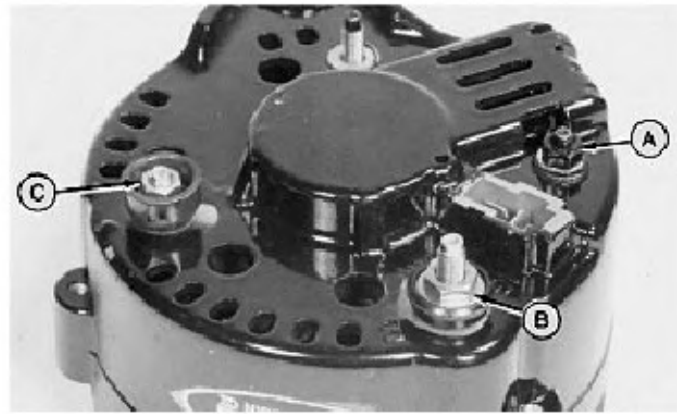
6. Install new voltage regulator and solder the terminals.

NOTE: If additional solder is needed, use ONLY 60—40 rosin-core solder.



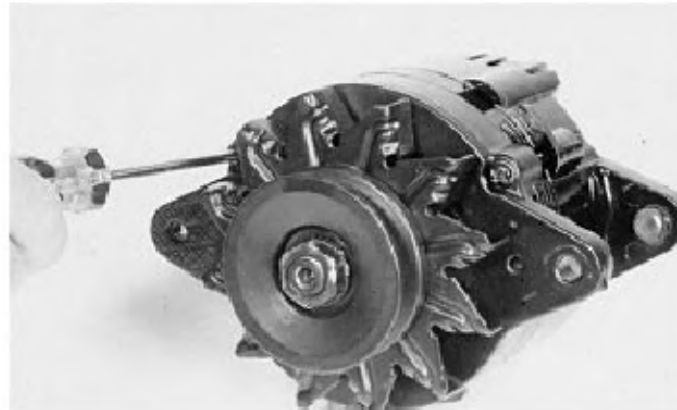
M21.40054.7 -19-14JUN89

7. Install insulating 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 -19-17JUL8

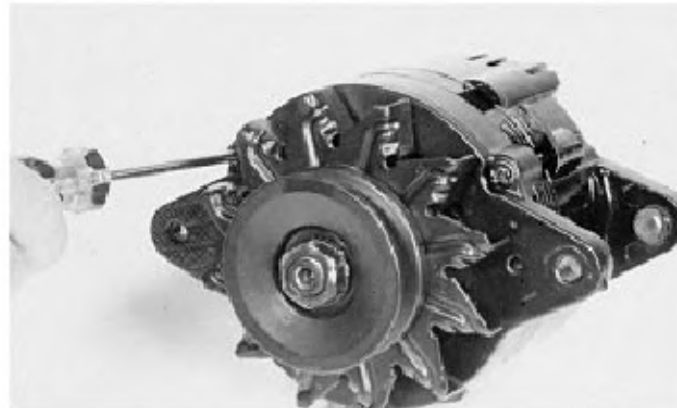
11. Install and tighten three screws.



M21.4005R.9 -19-17JUL8

DISASSEMBLE NIPPON DENSO ALTERNATOR

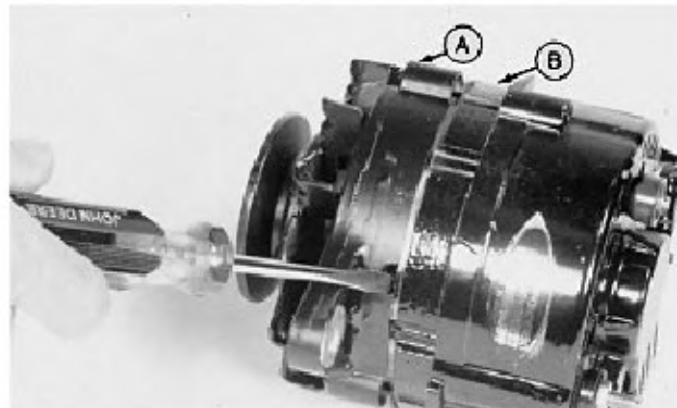
1. Remove screws.



M21.4005R.10 -19-01SEP8

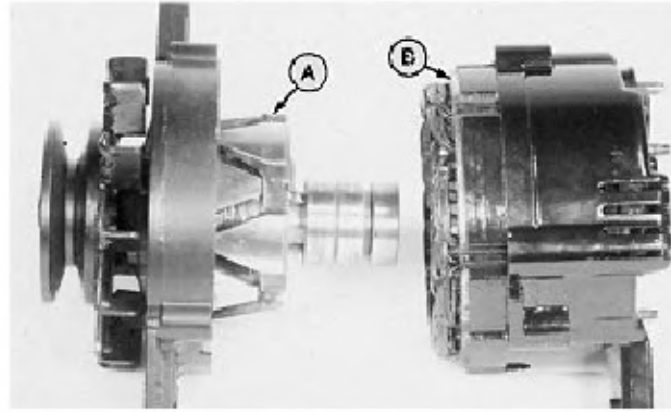
IMPORTANT: Do not pry against stator wires.

2. Use a screwdriver to separate drive end frame (A) from stator housing (B).



M21.4005R.11 -19-14JUN8

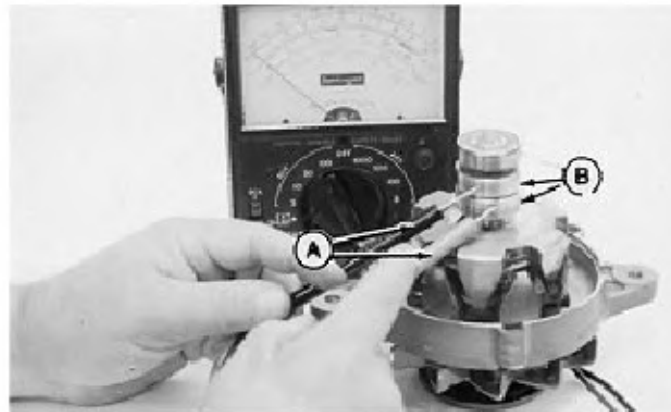
3. Remove rotor assembly (A) from stator assembly (B).



M21.4005R.12 -19-14JUN85

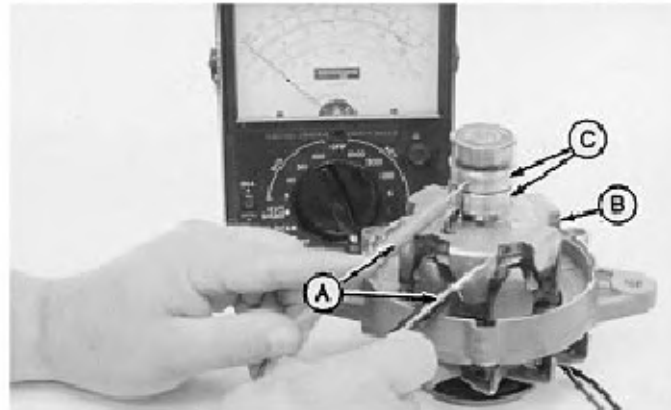
DISASSEMBLE AND TEST ROTOR

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).



M21.4005R.13 -19-14JUN85

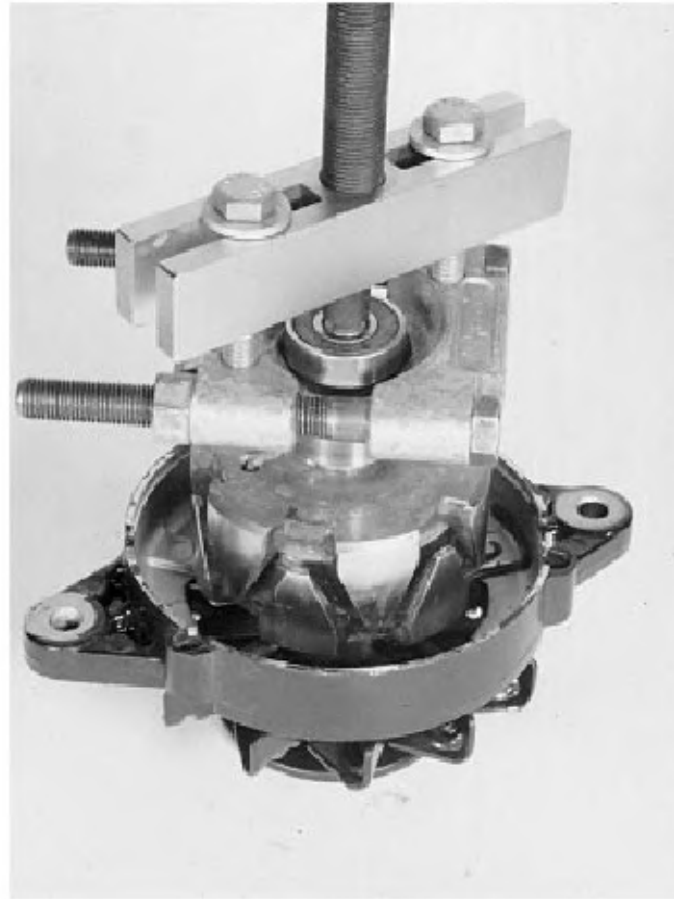
3. Touch the probes of the ohmmeter (A) to the shaft (B) and one of the slip rings (C). Repeat for other slip ring. Replace rotor if test shows continuity (needle movement).



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.

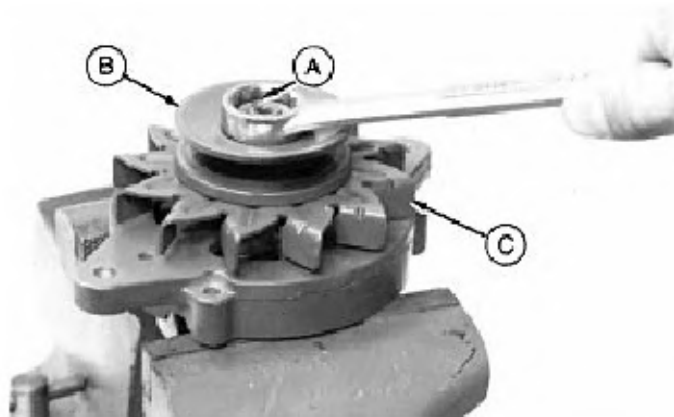
5. To replace bearing, pull bearing from shaft.



M21,4005R.15 -19-14JUN8

6. Inspect rotor shaft front bearing by spinning rotor in housing. Listen for any sounds indicating bearing failure. Replace bearing if defective.

7. To replace bearing, put rotor in a soft-jaw vise. Remove nut (A), lock washer, pulley (B), and fan (C).



M21,4005R.16 -19-14JUN8

8. If necessary, put front frame on open jaws of vise. Use a soft hammer to remove rotor shaft.



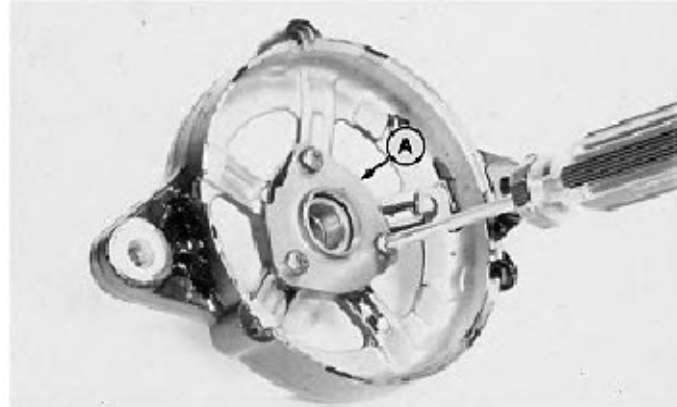
M21,4005R.17 -19-15AUG8

9. Remove spacer from rotor shaft.



M21.4005R.18 -19-14JUN8

10. Remove three screws to remove bearing retainer (A).



M21.4005R.19 -19-14JUN8

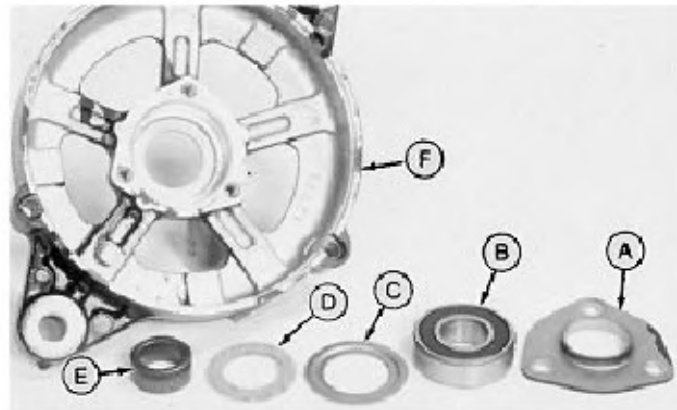
11. Remove retainer (A), bearing (B), washer (C), felt washer (D), and bushing (E) from front frame (F).

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



M21.4005R.20 -19-14JUN8

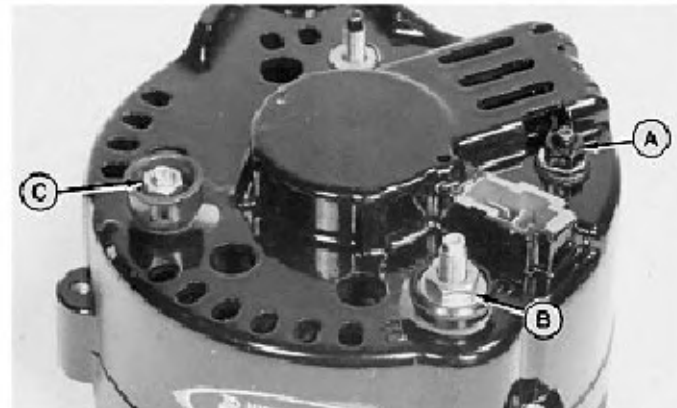
DISASSEMBLE AND TEST STATOR AND RECTIFIER

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.

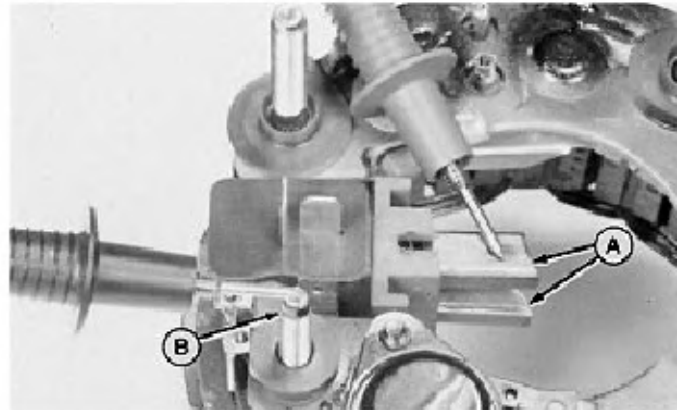


M21.4005R.21 -19-14JUN8

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.

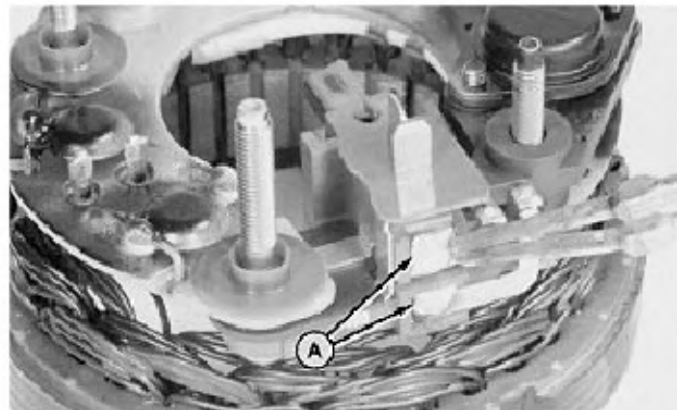
M21.4005R.22 -19-14JUN85

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.



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.

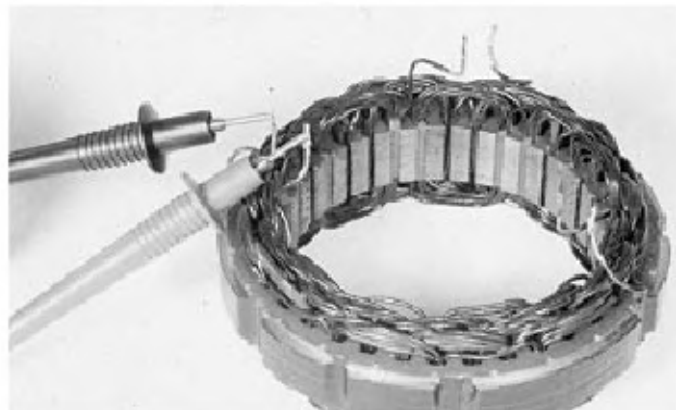


M21.4005R.26 -19-14JUN8

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 -19-14JUN8

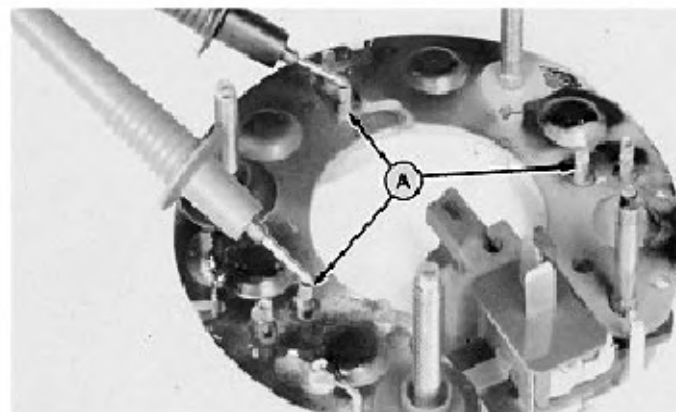
13. Touch one probe of the ohmmeter to the bare metal surface of stator and the other probe to a bare stator lead wire. Repeat for each wire. Replace stator if test indicates continuity.



M21.4005R.28 -19-14JUN8

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.

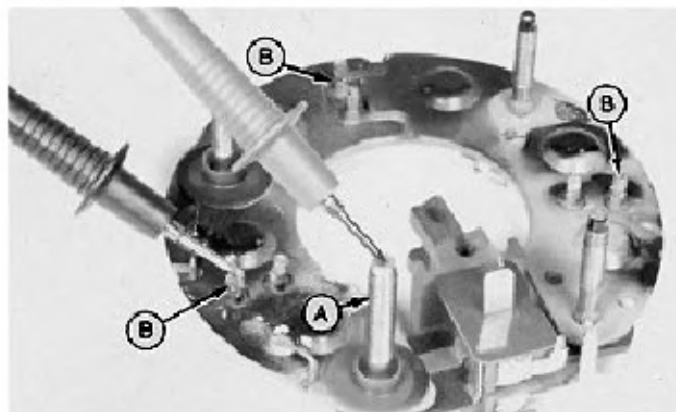


M21.4005R.29 -19-14JUN8

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).

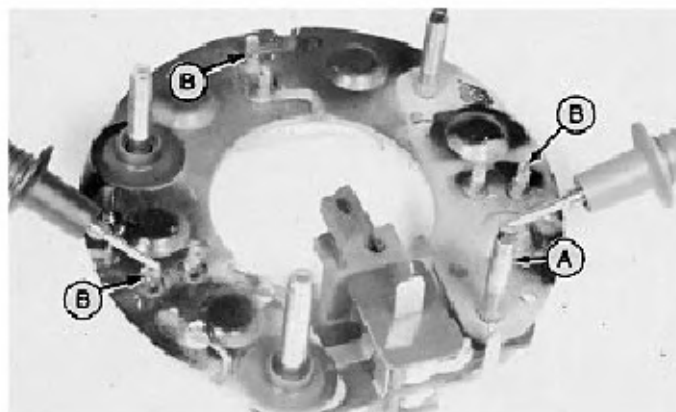


M21,4005R,30 -19-14JUN85

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.

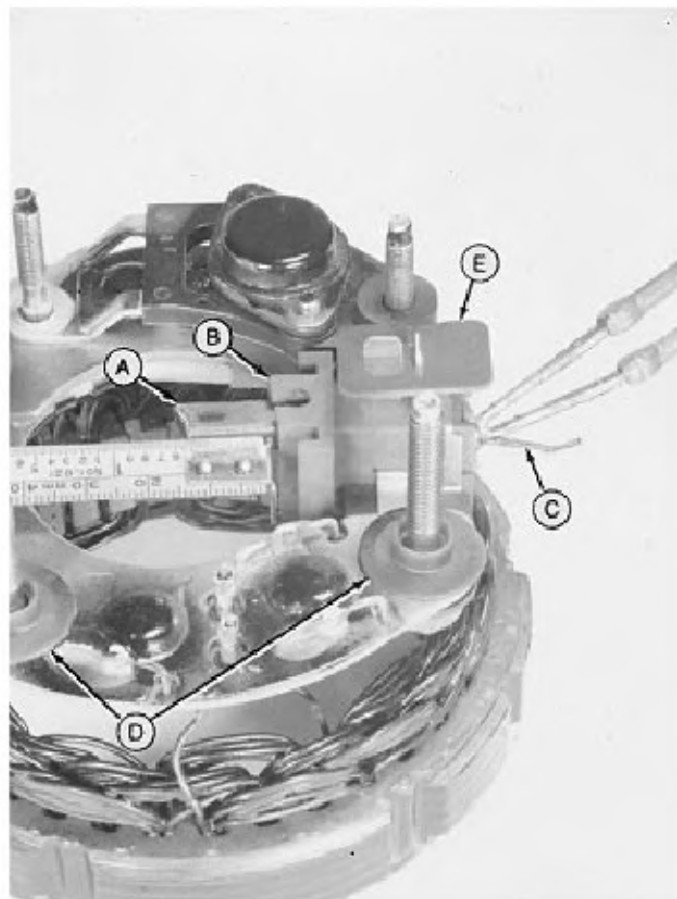


M21,4005R,31 -19-17JUL85

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



M21,4005R.32 -19-01SEP87

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.

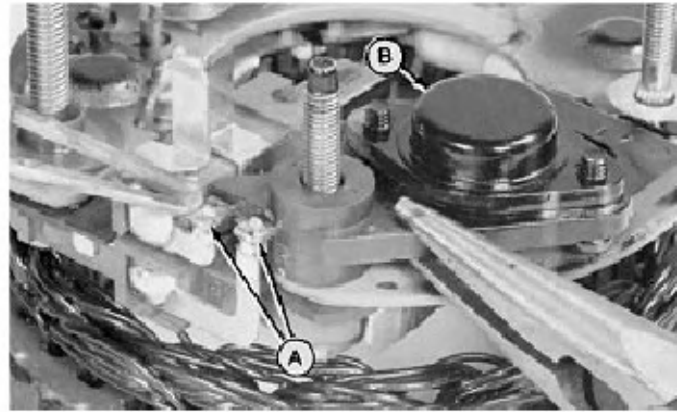
5. Install the three outer lead wires on stator through outer terminal pipes. Install the three inner lead wires on stator through inner terminal pipes.
6. Adjust the length of the stator lead wires 33.5 mm (1.30 in.) from stator to rectifier. Connect the six terminals using a soldering gun with at least a 120 watt capacity.

If additional solder is needed, use ONLY 60-40 rosin core solder.



M21,4005R.33 -19-14JUN87

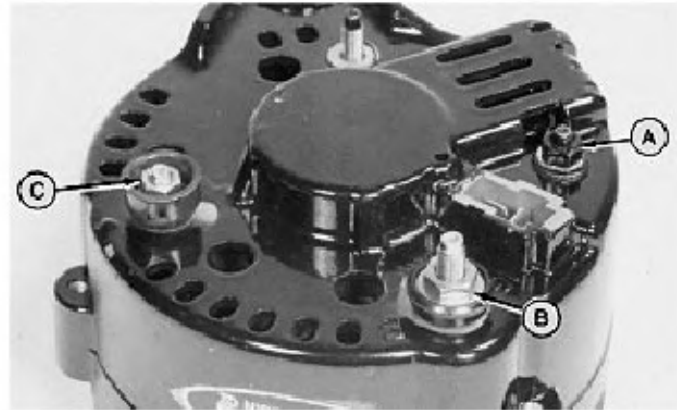
7. Install voltage regulator (B). Connect and solder joints (A).



M21,4005R.34 -19-14JUN8

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).

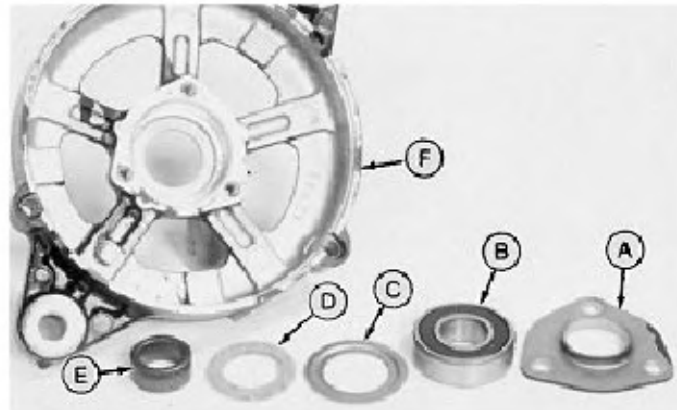


M21,4005R.35 -19-14JUN8

ASSEMBLE ROTOR (NIPPON DENSO ALTERNATOR)

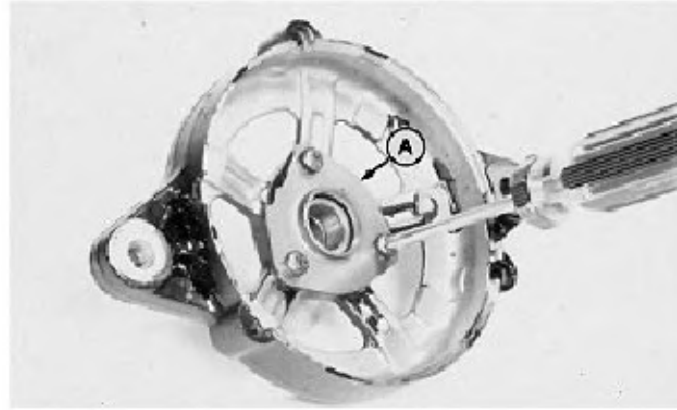
1. Apply a small amount of grease to the felt washer (D). Install bushing (E) in felt washer (D). Install bushing and felt washer in front frame (F).
2. Install washer (C), bearing (B), and retainer (A).

A—Retainer
B—Bearing
C—Washer
D—Felt Washer
E—Bushing
F—Front Frame



M21,4005R.36 -19-15AUG8

3. Fasten retainer (A) with three screws.



M21.4005R.37 -19-17JUL85

4. Install bushing on rotor shaft.

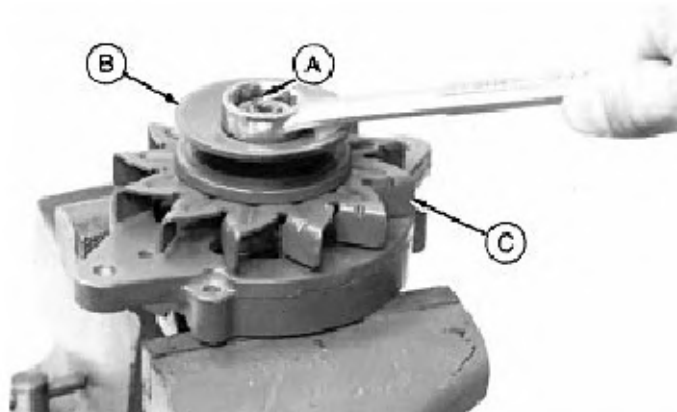


M21.4005R.38 -19-14JUN85

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).



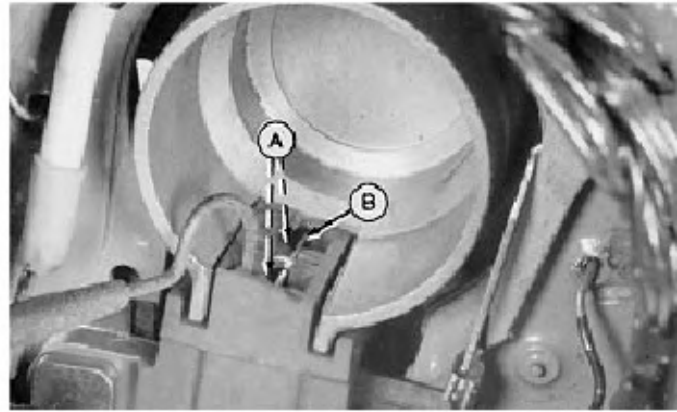
M21.4005R.39 -19-14JUN85

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.



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.



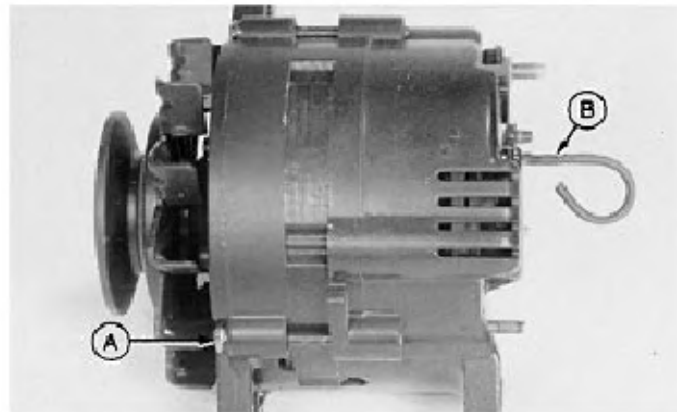
M21,4005R.41 -19-01SEP87

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.

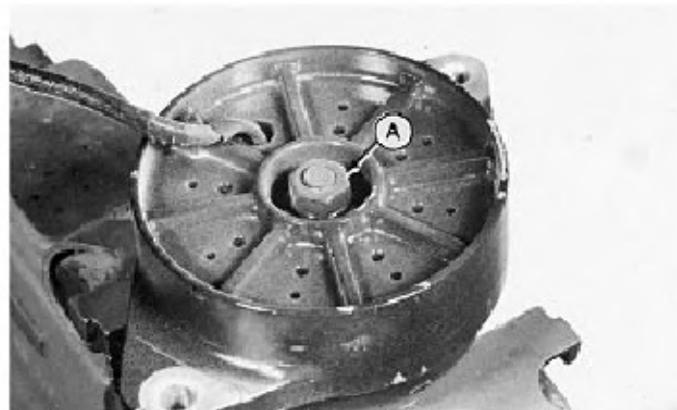


M21,4005R.42 -19-15AUG87

SERVICE 20A KOKOSAN ALTERNATOR

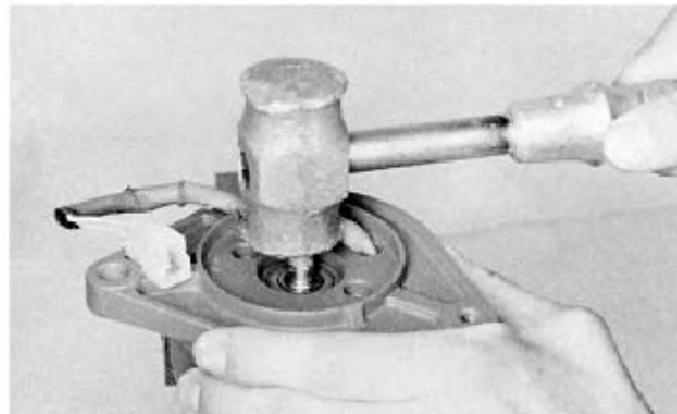
1. Remove alternator from engine.

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



M21, TM365.1 -19-01SEP87

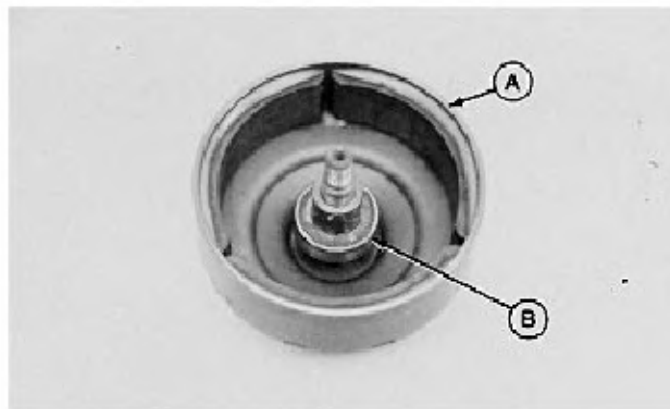
3. Support alternator on open jaws of vise. Use a soft hammer to tap shaft and flywheel from body.



M21, TM365.2 -19-15FEB88

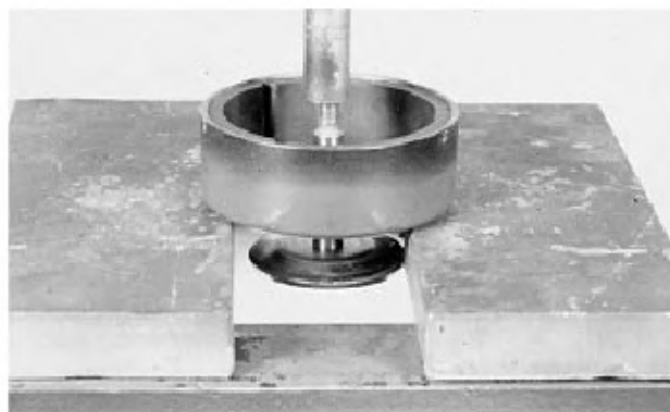
4. Inspect magnets (A) in flywheel. Replace flywheel if magnets are missing or damaged.

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



M21.TM365.3 -19-15FEB88

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



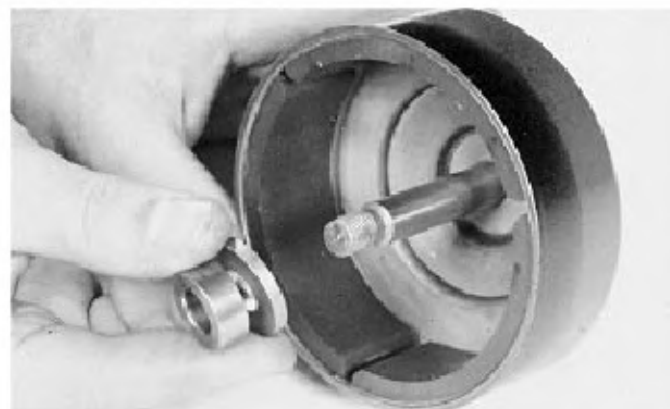
M21.TM365.4 -19-15FEB88

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



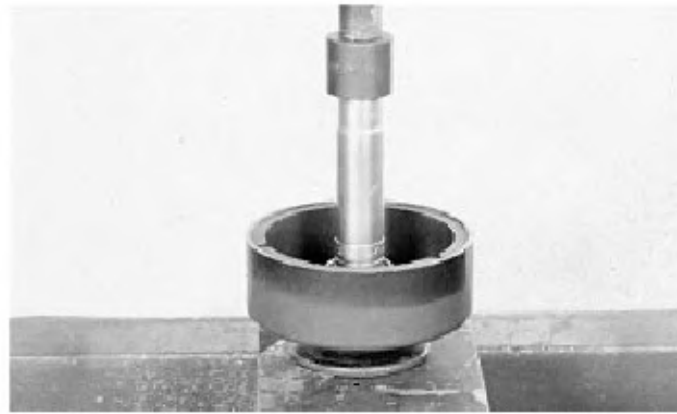
M21.TM365.5 -19-15FEB88

8. Install washer and spacer over shaft.



M21.TM365.6 -19-15FEB88

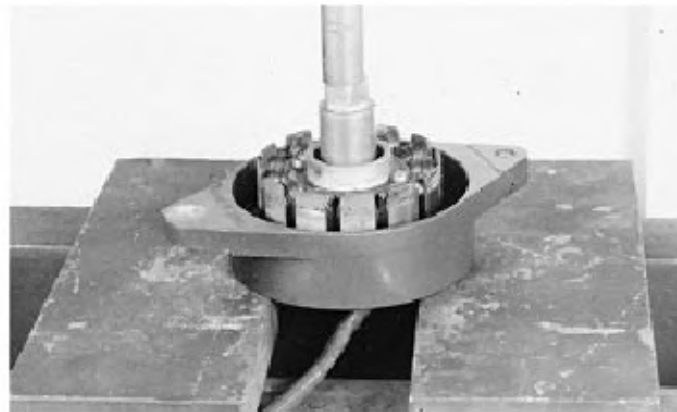
9. Support flywheel on press. Use a 9/16 in., 1/2 in.-drive deep socket TURNED UPSIDE DOWN to press new bearing onto shaft until it bottoms on spacer.



M21.TM365.7 -19-15FEB88

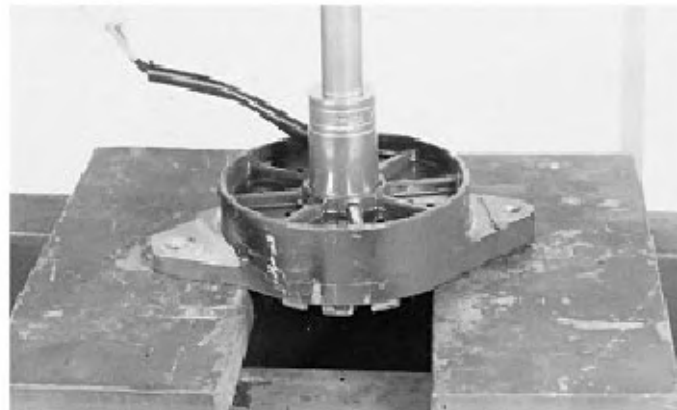
10. If necessary to replace coil plate bearing, use a press and a spark plug socket to remove bearing.

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



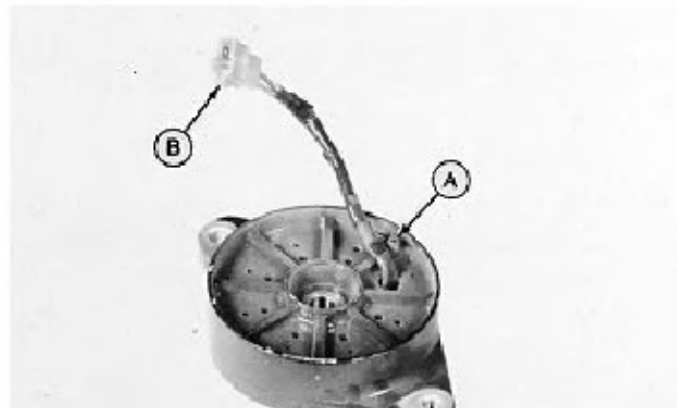
M21.TM365.8 -19-15FEB88

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 -19-23APR88

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



M21.TM365.10 -19-17AUG88

13. Remove two screws and remove stator.



M21.TM365.11 -19-15FEB88

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

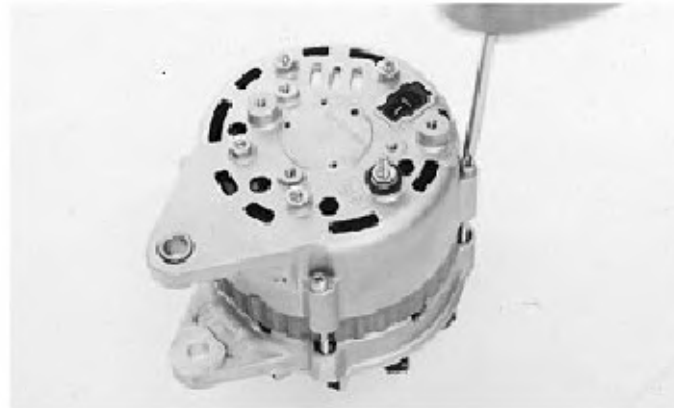
15. Install flywheel onto coil plate. Install two washers and tighten nut to 27 N·m (20 lb-ft).

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

M21.TM365.12 -19-15FEB88

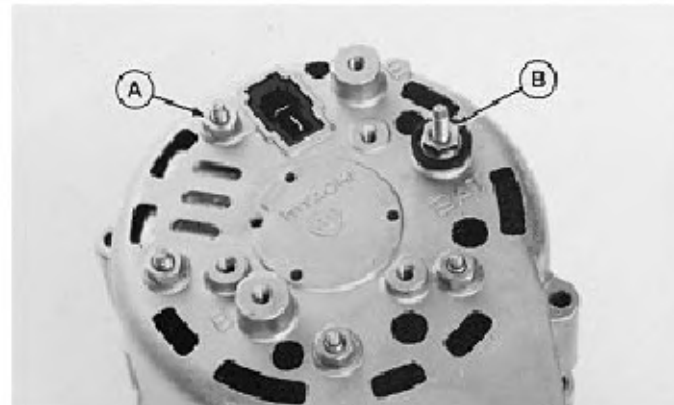
REPLACE VOLTAGE REGULATOR (HITACHI 24V/25A ALTERNATOR)

1. Remove alternator from engine.
2. Remove four attaching screws as shown.



M21.TM365.13 -19-17AUG87

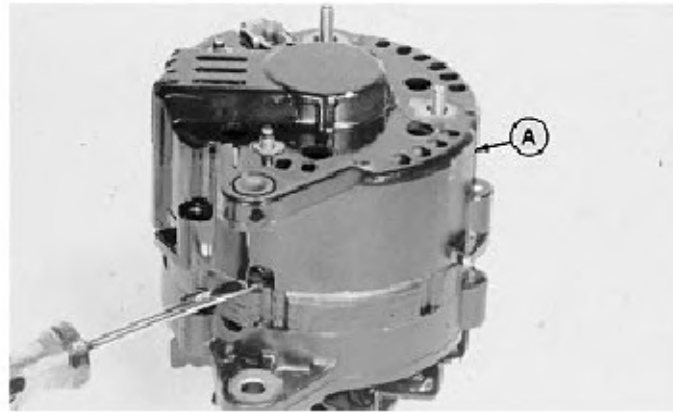
3. Remove four nuts (A) and nut (B) with insulator.



M21.TM365.14 -19-17AUG87

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.



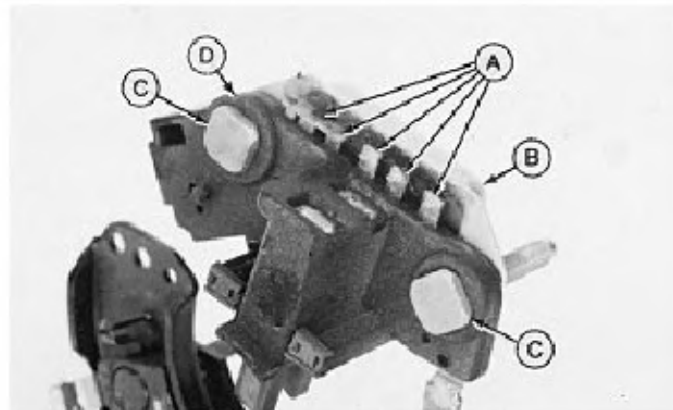
M21,4005R,6 -19-14JUN8

5. Use a soldering gun with at least 120 watt capacity to disconnect five terminals (A). Push two capscrews (C) out of brush housing to remove IC regulator (B). Remove insulator (D).

6. Install new regulator and solder terminals.

NOTE: If additional solder is needed, use ONLY 60-40 rosin-care solder.

A—Regulator Terminals
B—Regulator
C—Cap Screws
D—Insulator



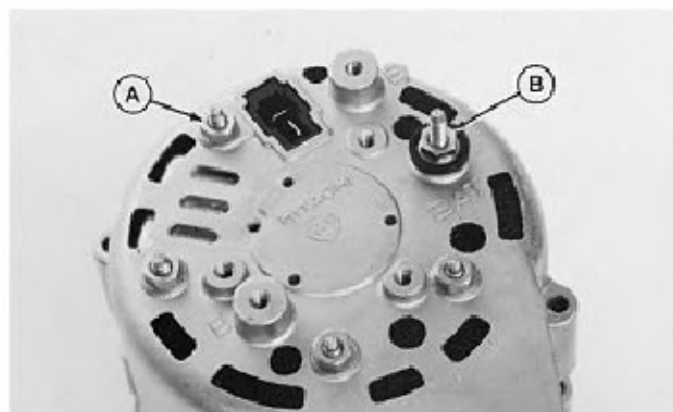
M21,TM365,15 -19-17AUG8

7. Install insulating washer on terminal (B) before installing end frame.

8. Install end frame.

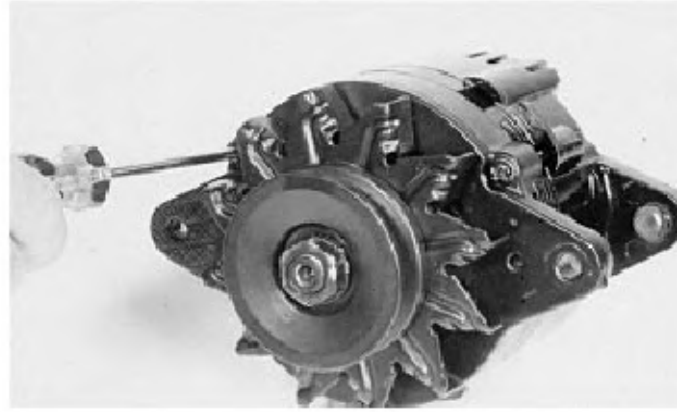
9. Install insulator and nut (B).

10. Install four nuts (A).



M21,TM365,16 -19-17AUG8

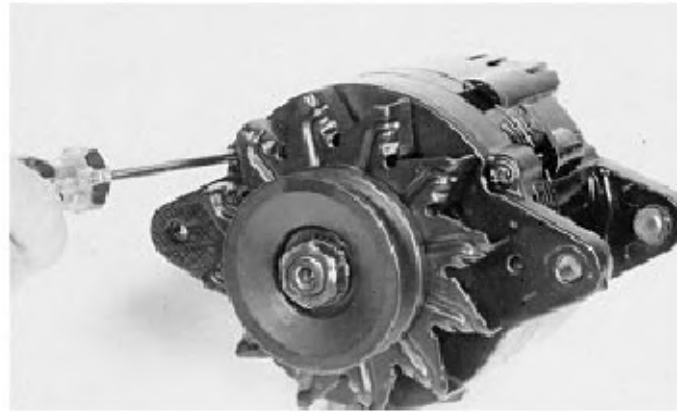
11. Install and tighten four screws.



M21.TM365.17 -19-17AUG87

DISASSEMBLE HITACHI 24V/25A ALTERNATOR

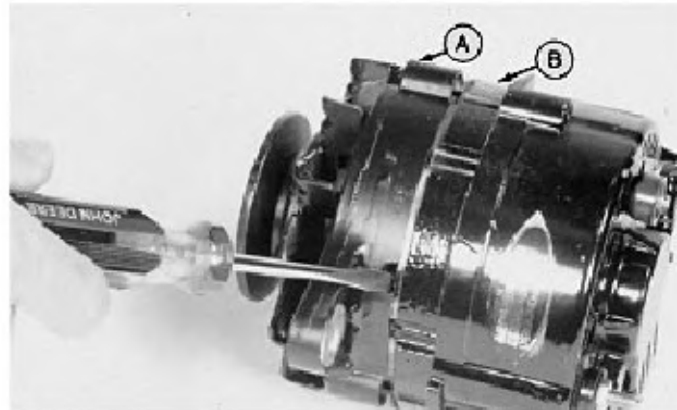
1. Remove four screws.



M21.TM365.18 -19-17AUG87

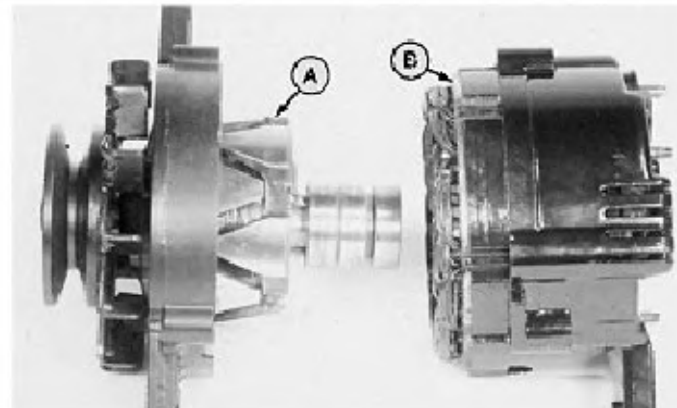
IMPORTANT: Do not pry against stator wires.

2. Use a screwdriver to separate drive end frame (A) from stator housing (B).



M21.4005R.11 -19-14JUN87

3. Remove rotor assembly (A) from stator assembly (B).

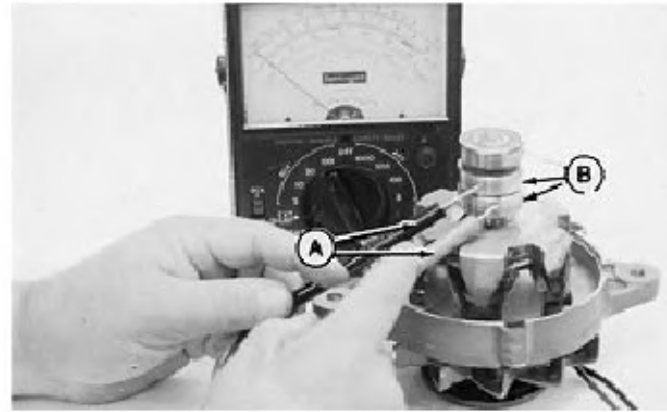


M21.4005R.12 -19-14JUN87

DISASSEMBLE AND TEST ROTOR

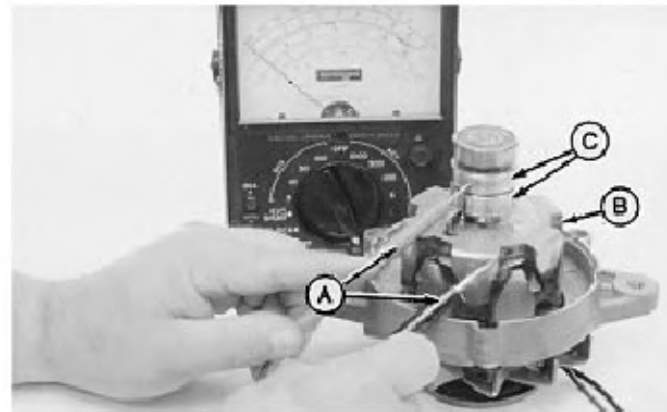
1. Inspect the rotor slip rings for dirt build-up, rough spots, or out of roundness. If necessary, polish the surface of the slip rings using No. 00 sandpaper or 400-grit silicon carbide paper.

2. Touch the probes of an ohmmeter (A) to slip rings (B). Replace rotor if test indicates no continuity (no needle movement).



M21,4005R.13 -19-14JUN8

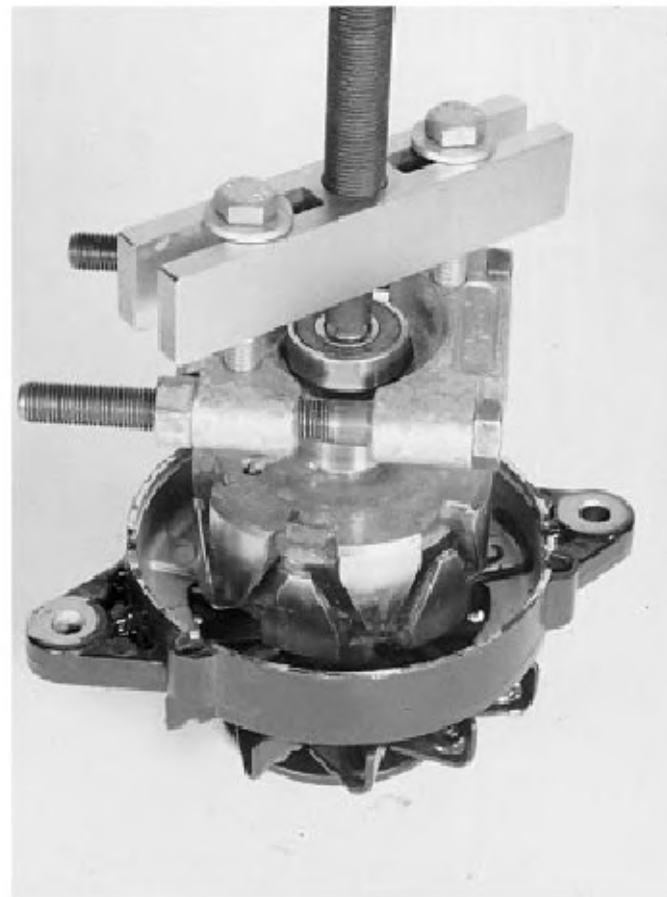
3. Touch the probes of the ohmmeter (A) to the shaft (B) and one of the slip rings (C). Repeat for other slip ring. Replace rotor if test shows continuity (needle movement).



M21,4005R.14 -19-14JUN8

4. Inspect rotor shaft rear bearing by spinning bearing on shaft. Listen for any sounds indicating bearing failure. Replace bearing if defective.

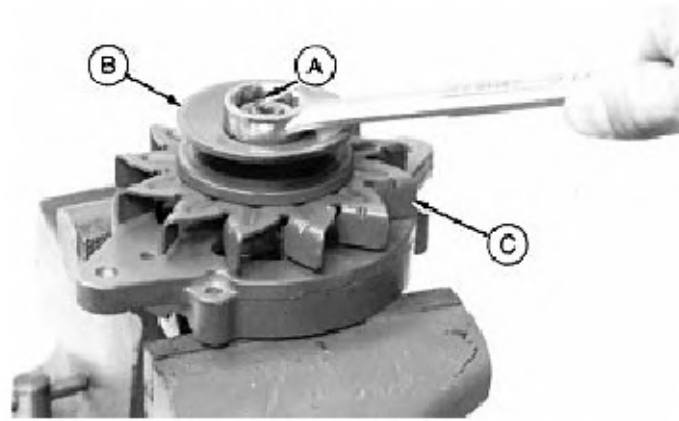
5. To replace bearing, pull bearing from shaft.



M21,4005R.15 -19-14JUN8

6. Inspect rotor shaft front bearing by spinning rotor in housing. Listen for sounds indicating bearing failure. Replace bearing if defective.

7. To replace bearing, put rotor in a soft-jaw vise. Remove nut (A), lock washer, pulley (B), and fan (C). Remove bushing from shaft.



M21,TM365,19 -19-17AUG8

8. If necessary, put front frame on open jaws of vise. Use a soft hammer to remove rotor shaft.



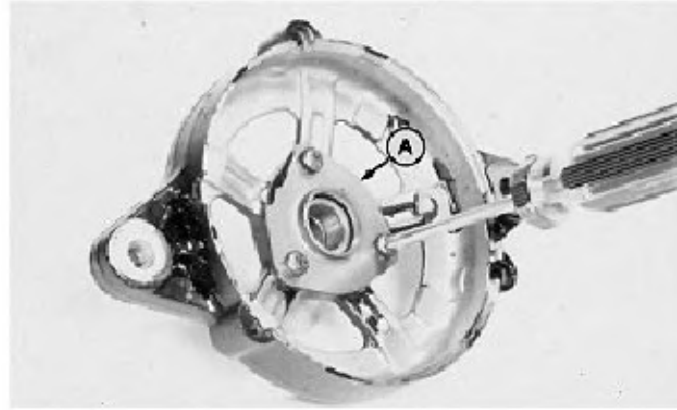
M21,4005R,17 -19-15AUG8

9. Remove spacer from rotor shaft.



M21,4005R,18 -19-14JUN8

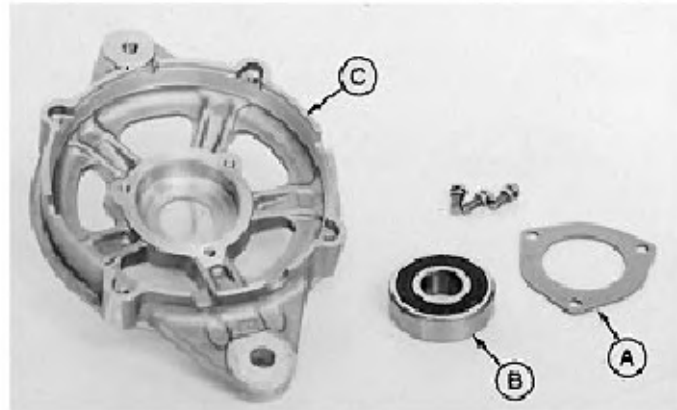
10. Remove three screws to remove bearing retainer (A).



M21.4005R.19 -19-14JUN8

11. Remove retainer (A) and bearing (B) from front frame (C).

Inspect bearing for tight spots in rotation. Replace if defective.



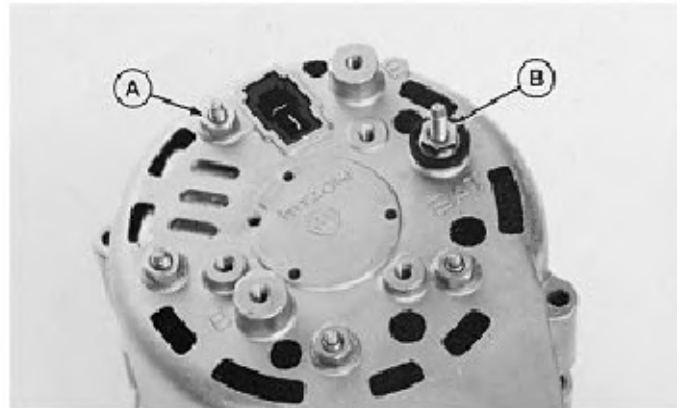
M21.TM365.20 -19-17AUG8

DISASSEMBLE AND TEST STATOR AND RECTIFIER

1. Remove four nuts (A).
2. Remove nut and insulator (B).

IMPORTANT: Do not pry against stator wires.

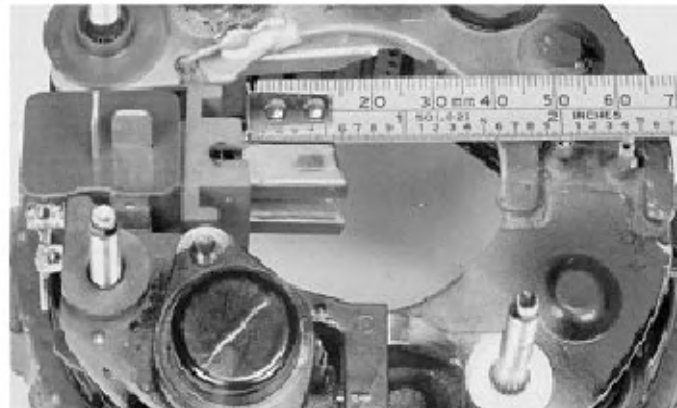
3. Use a screwdriver to pry end frame from stator.



M21.TM365.21 -19-17AUG8

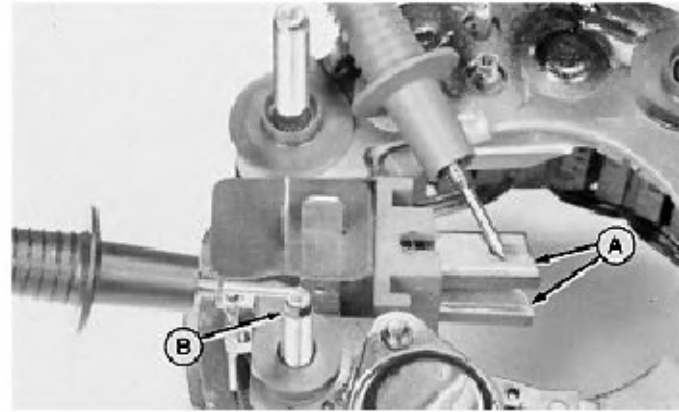
4. Inspect brush holder and brushes for damage. Brushes must slide freely and the springs must hold the brushes firmly against the slip rings of the rotor.

5. Measure brushes for wear. Minimum exposed length must be 5.5 mm (0.22 in.) or to wear limit line on brushes. Replace brushes as necessary.



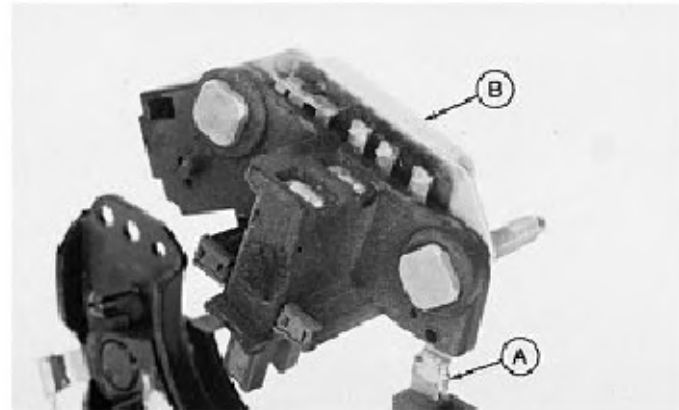
M21.TM365.22 -19-17AUG8

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.



M21,4005R,23 -19-14JUN88

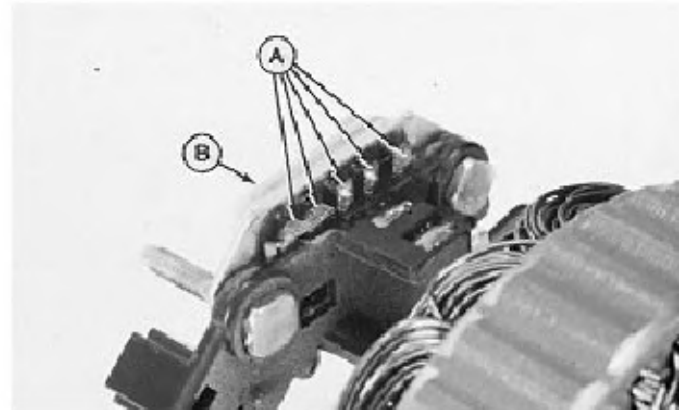
7. To replace brushes, melt solder from connection (A). Remove IC regulator (B) if necessary. See Replace Voltage Regulator in this group.



M21,TM365,23 -19-17AUG88

IMPORTANT: Do not heat connections longer than necessary to melt solder as excess heat will damage rectifier assembly.

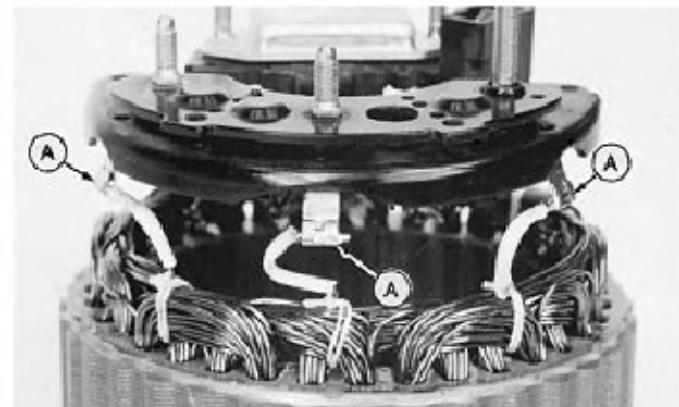
8. Melt five solder joints (A) to remove voltage regulator (B). Use soldering gun with at least a 120 watt capacity.



M21,TM365,24 -19-17AUG88

NOTE: Stator must be removed from rectifier to test.

9. Melt solder at three connections (A) to remove rectifier.

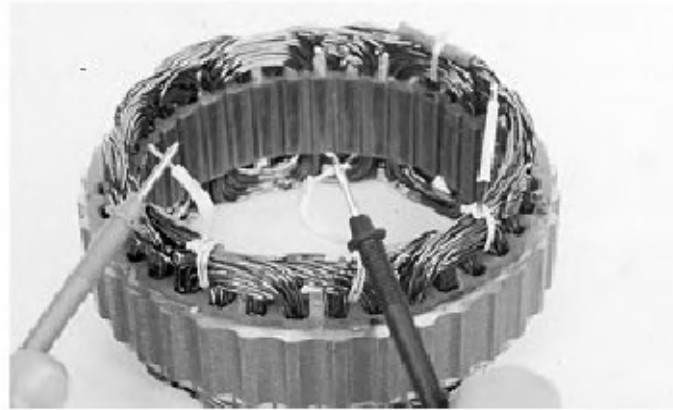


M21,TM365,25 -19-01SEP88

10. 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.

11. Touch probes of an ohmmeter to wires of stator in three possible combinations. Continuity should read approximately 0.26 ohms. If readings are not equal, replace stator.



M21.TM365.26 -19-17AUG87

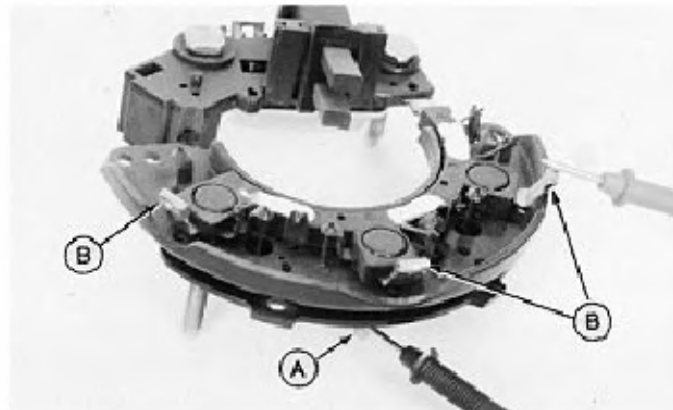
12. Touch one probe of the ohmmeter to the bare metal surface of stator and the other probe to a bare stator lead wire. Repeat for each wire. Replace stator if test indicates continuity.



M21.TM365.27 -19-17AUG87

13. Test the diodes by touching probes to ground post (A) and the three outer terminals (B).

14. Switch the probes and check each terminal again. There should be continuity in only one combination of each terminals (B) and the ground post (A).

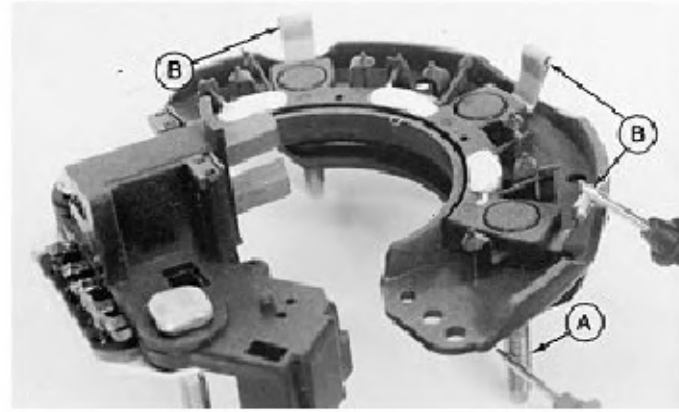


M21.TM365.28 -19-17AUG87

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 combination of each terminal (B) and the output post (A).

A shorted diode would have continuity in both directions. An open diode would have no continuity in either direction. Replace the rectifier assembly if any of the six diodes are defective.

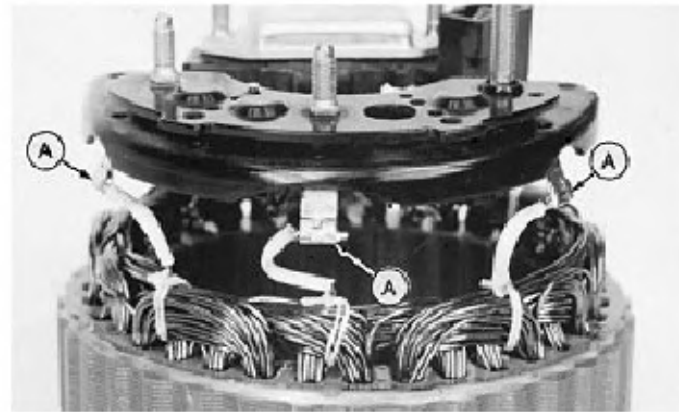


M21,TM365,29 -19-17AUG87

ASSEMBLE STATOR AND RECTIFIER (HITACHI 24V/25A ALTERNATOR)

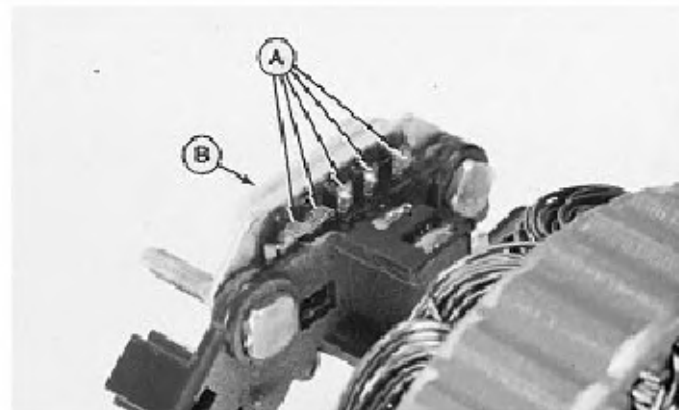
1. Adjust the length of the stator lead wires 33.5 mm (1.30 in.) from stator to rectifier. Connect the three terminals using a soldering gun with at least a 120 watt capacity.

If additional solder is needed, use ONLY 60-40 rosin care solder.



M21,TM365,30 -19-01SEP87

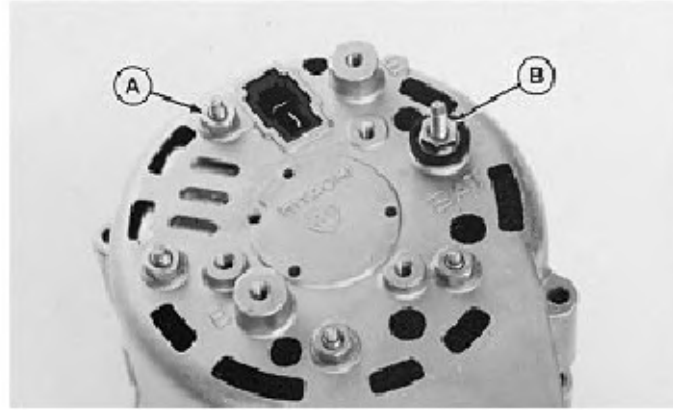
2. If IC regulator (B) was removed, install and solder five connections (A).



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IMPORTANT: Be sure stator lead wires do not contact end frame when installed.

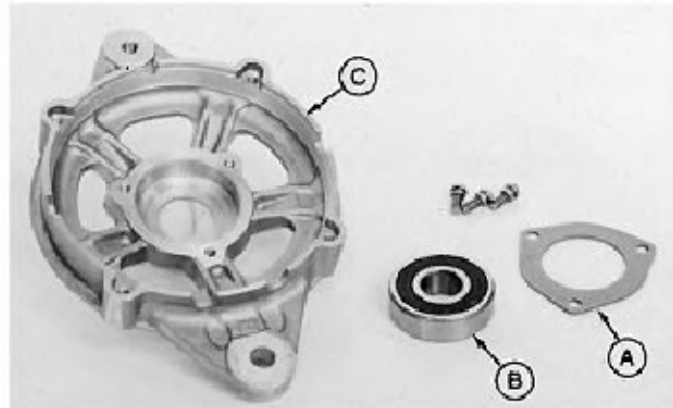
3. Install end frame. Fasten with four nuts (A).
4. Install insulator and nut (B).



M21.TM365.32 -19-12AUG87

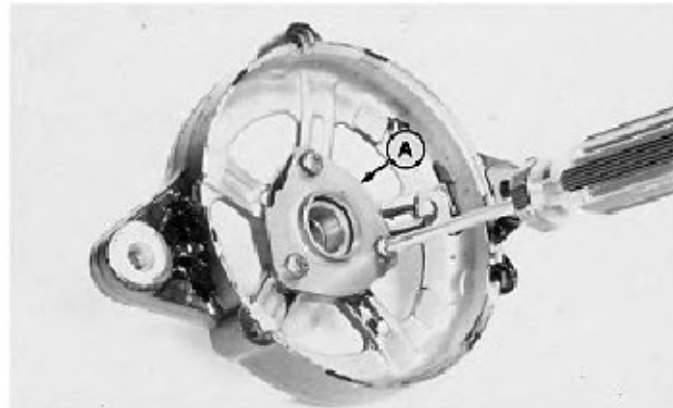
ASSEMBLE ROTOR (HITACHI 24V/25A ALTERNATOR)

1. Install bearing (B) in front frame (C).
2. Install retainer (A).



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3. Fasten retainer (A) with three screws.



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4. Install bushing on rotor shaft.



M21.4005R.38 -19-14JUN87

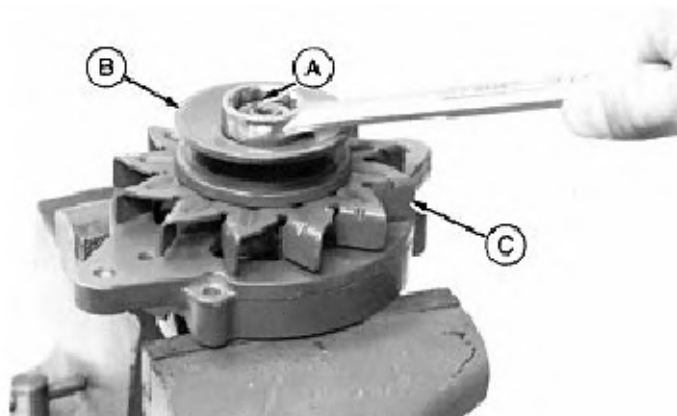
5. Install rotor shaft in front frame assembly. Install bushing.



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6. Install fan (C), pulley (B), lock washer, and nut (A).

7. Hold rotor in a soft-jaw vice. Tighten nut (A) to 54 N·m (40 lb-ft).



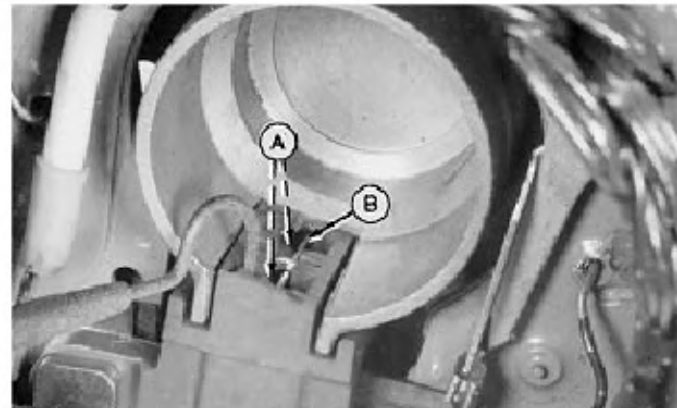
M21.TM365.35 -19-01SEP8

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.



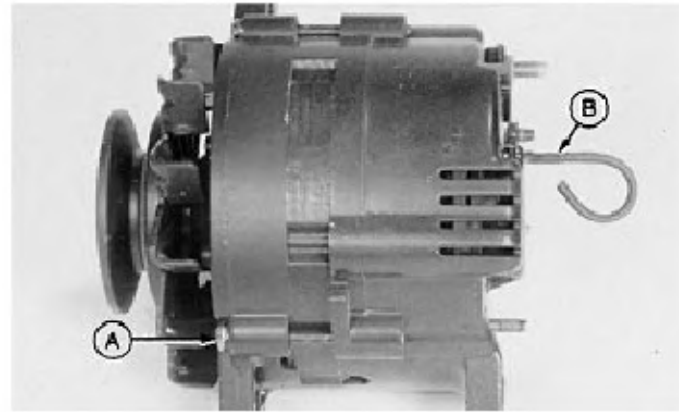
M21.4005R.40 -19-14JUN8

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.



M21.4005R.41 -19-01SEP8

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.



M21,4005R,42 -19-15AUG8

