

# **John Deere K Series Air-Cooled Engines**

**John Deere Horicon Works  
CTM5 (20OCT92)**

# Introduction

## FOREWORD

This manual is written for an experienced technician. Essential tools required in performing certain service work are identified in this manual and are recommended for use.

Live with safety: Read the safety messages in the General Information Section of this manual and the cautions presented throughout the text of the manual.



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.

Use this component technical manual in conjunction with the machine technical manual. An application listing in the beginning of each section identifies product-model/component type-model relationship. See the machine technical manual for information on component removal and installation, and gaining access to the components.

Information is organized in groups for the various components requiring service instruction. At the beginning of each group are summary listings of all applicable essential tools, other materials needed to do the job, and service parts kits.

Group 00, in the beginning of each section—Repair Specifications, consist of all applicable specifications, wear tolerances and specific torque values for various components on each engine.

Binders, binder labels, and tab sets can be ordered by John Deere dealers direct from the John Deere Distribution Service Center.

This manual is part of a total product 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 type of failures and their causes. FOS Manuals are for training new personnel and for reference by experienced technicians.

Technical Manuals are concise guides for specific machines. Technical manuals are on-the-job guides containing only the vital information needed for diagnosis, analysis, testing, and repair.

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

# Dealer Presentation Sheet

## JOHN DEERE DEALERS

This is a complete revision to CTM5.

Discard your old CTM5, dated 26 JUN 91.

New information added to this manual includes:

1. The basic engine specifications have been updated to include the new FC400V, 12.5 hp engine.

2. The engine applications charts have been updated to include the new products introduced in 1992:

- 14ST and 14PT 21-Inch Walk-Behind Mowers
- 38-Inch Walk-Behind Commercial Mower
- GX95 Riding Mower
- 245 Lawn and Garden Tractor
- GT242 Lawn and Garden Tractor
- Gator 4 X 2

MX,CTM5,DPS -19-21OCT92

CTM5 (20OCT92)

K Series Air Cooled Engine

*Dealer Presentation Sheet*

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## RECOGNIZE SAFETY INFORMATION

This is the safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

Follow recommended precautions and safe operating practices.



DX,ALERT -19-04JUN90

10  
05  
1  
-UN-07DEC88  
T81389

## UNDERSTAND SIGNAL WORDS

A signal word—DANGER, WARNING, or CAUTION—is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.



DX,SIGNAL -19-09JAN92

-19-30SEP88  
TS187

## HANDLE FLUIDS SAFELY—AVOID FIRES

When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; they can ignite and burn spontaneously.



DX,FLAME -19-04JUN90

-UN-23AUG88  
TS227

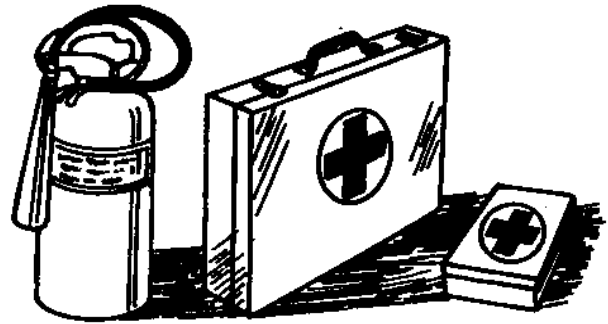
10  
05  
2

## PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



DX,FIRE2 -19-04JUN90

TS291 -UN-23AUG88

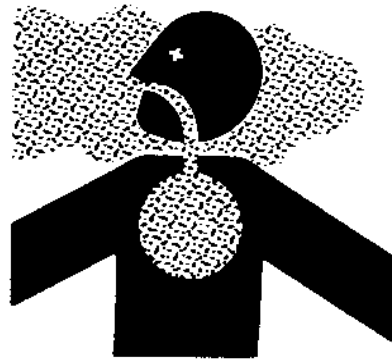
## AVOID HARMFUL ASBESTOS DUST

Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos.

Keep bystanders away from the area.



DX,DUST -19-15MAR91

TS220 -UN-23AUG88

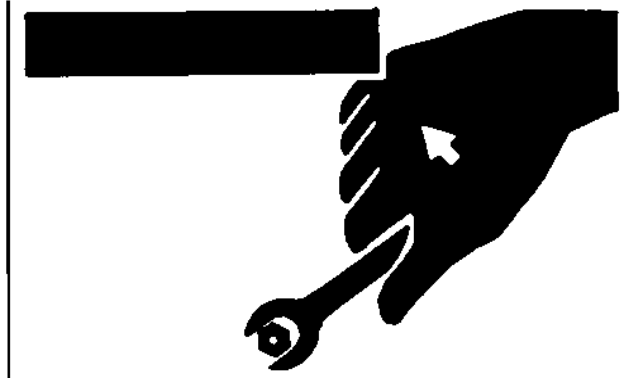
## USE PROPER TOOLS

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards.

Use power tools only to loosen threaded parts and fasteners.

For loosening and tightening hardware, use the correct size tools. **DO NOT** use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only service parts meeting John Deere specifications.



DX,REPAIR -19-04JUN90

10  
3  
5  
-UN-08NOV89  
TS779

## DISPOSE OF WASTE PROPERLY

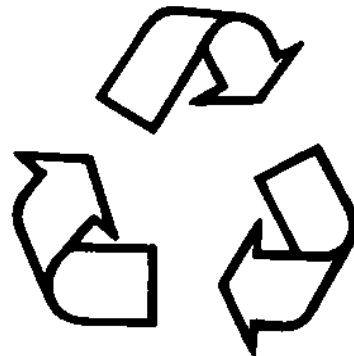
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Air conditioning refrigerants escaping into the air can damage the Earth's atmosphere. Government regulations may require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.



DX,DRAIN -19-09AUG91

-UN-26NOV90  
TS1133





**BASIC ENGINE SPECIFICATIONS**

ENGINE	FA130D	FG150D/ FG150G	FC150V	FA210D	FA210V	KF82D/ FZ340D
CYLINDER	1	1	1	1	1	1
CYCLE	4	4	4	4	4	4
BORE	62 mm (2.44 in.)	64 mm (2.51 in.)	65 mm (2.56 in.)	72 mm (2.83 in.)	72 mm (2.83 in.)	80 mm (3.15 in.)
STROKE	43 mm (1.69 in.)	47 mm (1.85 in.)	46 mm (1.81 in.)	51 mm (2.01 in.)	51 mm (2.01 in.)	68 mm (2.68 in.)
DISPLACE- MENT	129 cm <sup>3</sup> (7.92 cu. in.)	151 cm <sup>3</sup> (9.21 cu. in.)	153 cm <sup>3</sup> (9.30 cu. in.)	207 cm <sup>3</sup> (12.7 cu. in.)	207 cm <sup>3</sup> (12.7 cu. in.)	341 cm <sup>3</sup> (20.9 cu. in.)
HORSE- POWER	2.3 kW (3.1 HP)	2.7 kW (3.6 HP)	3.4 kW (4.5 HP)	3.9 kW (5.2 HP)	4.5 kW (6 HP)	6.3 kW (8.5 HP)
ENGINE	FC290V	FE290D/ FE290R	FB460V	FC400V	FC420V	FC540V
CYLINDER	1	1	1	1	1	1
CYCLE	4	4	4	4	4	4
BORE	78 mm (3.07 in.)	78 mm (3.07 in.)	89 mm (3.50 in.)	87 mm (3.43 in.)	89 mm (3.50 in.)	89 mm (3.50 in.)
STROKE	60 mm (2.36 in.)	60 mm (2.36 in.)	74 mm (2.91 in.)	68 mm (2.68 in.)	68 mm (2.68 in.)	86 mm (3.39 in.)
DISPLACE- MENT	286 cm <sup>3</sup> (17.5 cu. in.)	286 cm <sup>3</sup> (17.5 cu. in.)	460 cm <sup>3</sup> (28.1 cu. in.)	400 cm <sup>3</sup> (24.4 cu. in.)	423 cm <sup>3</sup> (25.8 cu. in.)	535 cm <sup>3</sup> (32.6 cu. in.)
HORSE- POWER	6.7 kW (9 HP)	7.5 kW (10 HP)	9.3 kW (12.5 HP)	9.3 kW (12.5 HP)	10.4 kW (14 HP)	12.7 kW (17 HP)

MX,1010A1,A1 -19-21OCT92

## BASIC ENGINE APPLICATIONS CHART

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

### WALK-BEHIND PRODUCTS

Machine	Engine Model No.
20SR7 Reel Mower . . . . .	FA130D
3K Lawn Edger . . . . .	FA130D
E35 Lawn Edger . . . . .	FA130D
14PB 21-Inch Rear Discharge Mower . . . . .	FC150V
14SB 21-Inch Rear Discharge Mower . . . . .	FC150V
14SE 21-Inch Rear Discharge Mower . . . . .	FC150V
14SC 21-Inch Rear Discharge Mower . . . . .	FC150V
14ST 21-Inch Rear Discharge Mower . . . . .	FC150V
14PT 21-Inch Rear Discharge Mower . . . . .	FC150V
32/36/48/52-Inch Commercial Mower . . . . .	FB460V
48/52-Inch Commercial Mower . . . . .	FC540V
48/54-Inch Commercial Mower . . . . .	FC420V or FC540V
38-Inch Commercial Mower . . . . .	FC400V

### RIDING MOWERS

Machine	Engine Model No.
RX63 . . . . .	FA210V
RX73 . . . . .	FC290V
RX75 . . . . .	FC290V
RX95 . . . . .	FB460V
SX75 . . . . .	FC290V
SX95 . . . . .	FB460V
GX70 . . . . .	FC290V
GX75 . . . . .	FC290V
SRX75 . . . . .	FC290V
SRX95 . . . . .	FB460V
GX95 . . . . .	FB460V

### LAWN TRACTORS

Machine	Engine Model No.
112L . . . . .	FB460V
130 . . . . .	FC290V
160 . . . . .	FB460V
165 . . . . .	FB460V
170 . . . . .	FC420V
175 . . . . .	FC420V
180 . . . . .	FC540V
185 . . . . .	FC540V
LX172 . . . . .	FC420V
LX176 . . . . .	FC420V
LX186 . . . . .	FC540V

MX,1010A1,A2 -19-21OCT92

10  
10  
2

**BASIC ENGINE APPLICATIONS  
CHART—CONTINUED**

**LAWN AND GARDEN TRACTORS**

Machine	Engine Model No.
240 .....	FC420V
245 .....	FC420V
260 .....	FC540V
265 .....	FC540V
GT262 .....	FC540V
GT242 .....	FC420V

**FRONT MOWERS**

Machine	Engine Model No.
F710 .....	FC540V

**GOLF AND TURF EQUIPMENT**

Machine	Engine Model No.
22 Greensmower .....	FG150G
22R Greensmower .....	FG150D
519 Walk-Behind Vertical Mower .....	FA210D
529 Vacuum Blower .....	FA210D
1200 Bunker and Field Rake .....	FE290R

**MISCELLANEOUS**

Machine	Engine Model No.
1000 Generator .....	FA130D
1400 Generator .....	FA130D
Power Pak Material Collection System .....	FA210D

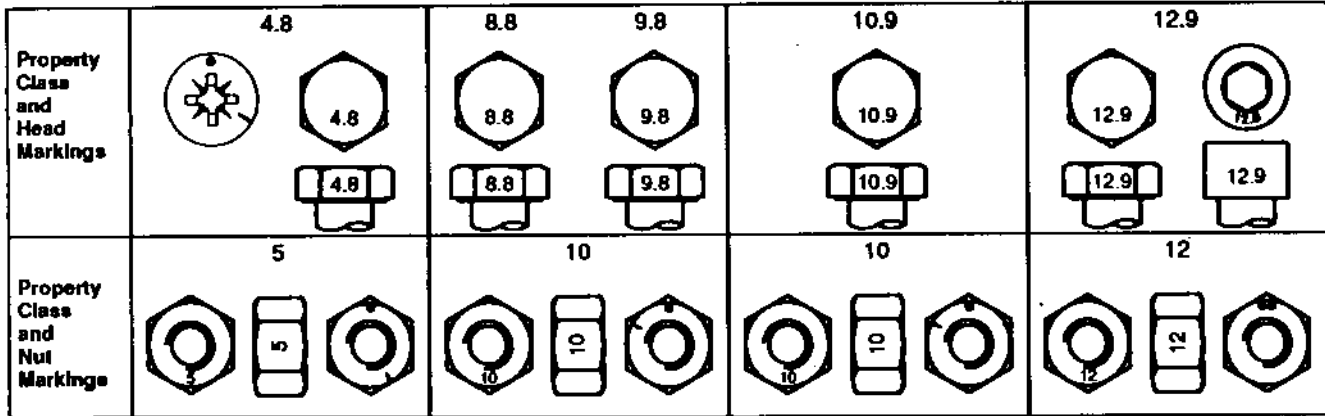
**UTILITY VEHICLES**

Machine	Engine Model No.
AMT600 .....	KF82D/FZ340D
AMT622 .....	FE290D
AMT626 .....	FE290D
Gator 4x2 .....	FE290D

MX,1010A1,A3 -19-21OCT92

**METRIC BOLT AND CAP SCREW TORQUE VALUES**

10  
10  
4



TS1163 -19-04/MAR91

Size	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated <sup>a</sup>		Dry <sup>a</sup>		Lubricated <sup>a</sup>		Dry <sup>a</sup>		Lubricated <sup>a</sup>		Dry <sup>a</sup>		Lubricated <sup>a</sup>		Dry <sup>a</sup>	
	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	190
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class.

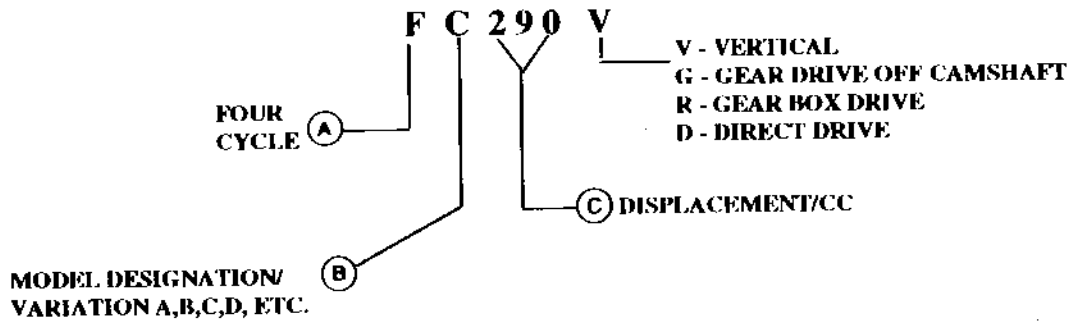
Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original.

<sup>a</sup> "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

ENGINE DESIGNATION (KAWASAKI)

KAWASAKI ENGINE DESIGNATION



M46856

A—Four Cycle  
B—Model Designation

C—Displacement  
D—Direct Drive

R—Gear Box Drive  
G—Gear Drive Off Camshaft

V—Vertical

MX1020A1,A12 -19-21OCT92

10  
15  
1  
M46856 -19-15OCT92

## ENGINE SERIAL NUMBER LOCATION

The complete serial number (A) is used to identify the engine model, series, configuration, and serial number range. Have this number available when referring to a particular engine or requesting parts or service information.



FA130D

M80492 -UN-07JUN91



FA210D

M80493 -UN-07JUN91



FA210V

M80494 -UN-07JUN91



FG150D/FG150G

M80495 -UN-07JUN91

MX,1015A1,A1 -19-21OCT92

## SERIAL NUMBER LOCATION—CONTINUED

A—Serial Number Location



FC150V

M80496 -UN-07JUN91



KF82D/FZ340D

M80497 -UN-07JUN91



FC290V

M80498 -UN-07JUN91



FC400V/FC420V

M80499 -UN-07JUN91

MX,1015A1,A2 -19-21OCT92



### SERIAL NUMBER LOCATION—CONTINUED

A—Serial Number Location



FC540V

M80500 -UN-07JUN91



FE290D/FE290R

M80501 -UN-07JUN91



FB460V

M80502 -UN-07JUN91

MX,1015A1,A3 -19-21OCT92

10  
15  
4

## CARBURETOR SERIAL NUMBER LOCATION

*NOTE: FA130D carburetor shown is used on FA130D-AS16/AS19 and FA210D-AS20 engines. FA130D-AN00 carburetor not shown.*

*FA210D carburetor shown is used on FA210D-AS17/BS17/CS17 engines. FA210D-AS19-01 carburetor not shown.*

The serial number (A) is used to identify the carburetor. Have this number available when requesting parts or service information.



FA130D



FA210D



FA210V



FG150G/FG150D

10  
5  
1  
-UN-07-JUN91  
M80503  
-UN-07-JUN91  
M80504  
-UN-07-JUN91  
M80505  
-UN-07-JUN91  
M80506

# CARBURETOR SERIAL NUMBER LOCATION—CONTINUED

A—Serial Number Location



FC150V

M80507 -UN-07JUN91



KF82D/FZ340D

M80508 -UN-07JUN91



FC290V

M80509 -UN-07JUN91



FC400V/FC420V

M80510 -UN-07JUN91

MX,1015A1,A5 -19-21OCT92

### CARBURETOR SERIAL NUMBER LOCATION—CONTINUED

A—Serial Number Location



FC540V



FE290D/FE290R



FB460V

MX,1015A1,A6 -19-21OCT92

1510  
-UN-07JUN91  
M80511  
-UN-07JUN91  
M80512  
-UN-07JUN91  
M80513



### FA130D ENGINE FEATURES

- 2.3 kW (3.1 hp)
- Pulse Pump carburetor (FA130D-AS16/AS19)  
Float type carburetor (FA130D-AN00)
- Two stage air filter with dry paper filter  
and foam precleaner (FA130D-AS16)  
Single stage foam air filter (FA130D-AN00)
- Side valves
- Horizontal crankshaft
- Aluminum block
- Splash lubrication
- Low oil level sensor (FA130D-AN00)
- Electronic ignition
- Recoil starter



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1  
-UN-07.JUN91  
M80514

MX,1020A1,A1 -19-21OCT92

### FA210D ENGINE FEATURES

- 3.9 kW (5.2 hp)
- Fuel pump (FA210D-AS17/BS17/CS17)
- Pulse pump carburetor (FA210D-AS20)  
Float type carburetor  
(FA210D-AS17/BS17/CS17 & FA210D-AS19-01)
- Two stage air filter with dry paper  
filter and foam precleaner
- Side valves
- Compression release mechanism  
(FA210D-AS20)
- Horizontal crankshaft
- Aluminum block
- Splash lubrication
- Electronic ignition
- Recoil starter



-UN-07.JUN91  
M80515

MX,1020A1,A2 -19-21OCT92

### FA210V ENGINE FEATURES

- 4.5 kW (6 hp)
- Float type carburetor
- Two stage air filter with dry paper filter and foam precleaner
- Side valves
- Compression release mechanism
- Vertical crankshaft
- Aluminum block
- Splash lubrication
- Electronic ignition
- Recoil starter



M80516  
-UN-07JUN91

MX,1020A1,A3 -19-21OCT92

### FG150G/FG150D ENGINE FEATURES

*NOTE: Engines are the same except FG150G engine is camshaft driven and FG150D engine is crankshaft driven.*

- 2.7 kW (3.6 hp)
- Float type carburetor
- Two stage air filter with dry paper filter and foam precleaner
- Side valves
- Horizontal crankshaft
- Aluminum block
- Cast-iron cylinder liner
- Electronic ignition
- Recoil starter



M80517  
-UN-07JUN91

FG150G Shown  
MX,1020A1,A4 -19-21OCT92

## FC150V ENGINE FEATURES

- 3.4 kW (4.5 hp)
- 3.7 kW (5.0 hp) (FS01 and ES06)
- Float type carburetor
- Two stage air filter with dry paper filter and foam precleaner
- Flywheel brake (option)
- Overhead valves
- Compression release mechanism
- Vertical crankshaft
- Aluminum block
- Cast-iron cylinder liner
- Splash (AS00 and AS01)
- Full pressure lubrication
- Oil filter (optional)
- Electronic ignition
- Regulated charging system
- Recoil starter
- Electric starter (option)



MX,1020A1,A5 -19-21OCT92

## KF82D/FZ340D ENGINE FEATURES

- 6.3 kW (8.5 hp)
- Float type carburetor
- Two stage air filter with dry paper filter and foam precleaner
- Side valves
- Horizontal crankshaft
- Dynamic balancer shaft
- Cast-iron cylinder block
- Aluminum crankcase
- Splash lubrication
- CDI ignition
- Regulated charging system
- Electric starter



MX,1020A1,A6 -19-21OCT92



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### FC290V ENGINE FEATURES

- 6.7 kW (9 hp)
- Float type carburetor
- Two stage air filter with dry paper filter and foam precleaner
- Overhead valves
- Compression release mechanism
- Vertical crankshaft with reciprocating balancer
- Aluminum block
- Cast-iron cylinder liner
- Splash lubrication
- Electronic ignition
- Regulated charging system
- Recoil starter
- Electric starter (optional)



MX,1020A1,A7 -19-21OCT92

-UN-19JUN91

M80213

### FC400V ENGINE FEATURES

- 9.3 kW (12.5 hp)
- Float type carburetor
- Two stage air-filter with dry paper filter and foam precleaner
- Overhead valves
- Compression release mechanism
- Vertical crankshaft with reciprocating balancer
- Aluminum block
- Cast-iron cylinder liner
- Full pressure lubrication
- Oil filter
- Solid-state ignition
- Regulated charging system
- Recoil start
- Electric starter (optional)



MX,1020A1,A8 -19-21OCT92

-UN-19JUN91

M80214

## FC420V ENGINE FEATURES

- 10.4 kW (14 hp)
- Float type carburetor
- Two stage air-filter with dry paper filter and foam precleaner
- Overhead valves
- Compression release mechanism
- Vertical crankshaft with reciprocating balancer
- Aluminum block
- Cast-iron cylinder liner
- Full pressure lubrication
- Oil filter
- Solid-state ignition
- Regulated charging system
- Recoil start
- Electric starter (optional)



MX,1020A1,A8A -19-21OCT92

## FC540V ENGINE FEATURES

- 12.6 kW (17 hp)
- 13 kW (17.5 hp) (Engine version AS12)
- Float type carburetor
- Two stage air filter with dry paper filter and foam precleaner
- Overhead valves
- Compression release mechanism
- Vertical crankshaft with reciprocating balancer
- Aluminum block
- Cast-iron cylinder liner
- Full pressure lubrication
- Oil filter
- Solid-state ignition
- Regulated charging system
- Electric starter



MX,1020A1,A9 -19-21OCT92

## FE290D/FE290R ENGINE FEATURES

*NOTE: Engines are the same except, FE290R can be equipped with a reduction gearbox. Gearbox attaches to crankcase cover.*

- 7.5 kW (10 hp)
- Float type carburetor
- Overhead valves
- Compression release mechanism
- Horizontal crankshaft with reciprocating balancer
- Aluminum block
- Cast-iron cylinder liner
- Full pressure lubrication
- Oil filter (optional)
- Solid-state ignition
- Regulated charging system
- Recoil starter (optional)
- Electric starter



-UN-19JUN91

M80216

MX,1020A1,A10 -19-21OCT92

## FB460V ENGINE FEATURES

- 9.3 kW (12.5 hp)
- Fuel pump
- Float type carburetor
- Two stage air filter with dry paper filter and foam precleaner
- Side valves
- Compression release mechanism
- Vertical crankshaft with reciprocating balancer
- Aluminum block
- Cast-iron cylinder liner
- Full pressure lubrication
- Oil filter (optional)
- Electronic ignition
- Regulated charging system
- Recoil starter
- Electric starter (optional)

MX,1020A1,A11 -19-21OCT92

# Section 20

## FA130D and FA210D

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**ENGINE APPLICATIONS CHART**

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

<b>Machine</b>	<b>Engine Model No.</b>
3K Lawn Edger . . . . .	FA130D-AS16
E35 Lawn Edger . . . . .	FA130D-AS19
1000/1400 Generators . . . . .	FA130D-AN00
20SR7 Reel Mower . . . . .	FA130D-AS16
519 Walk-Behind Vertical Mower . . . . .	FA210D-AS20
529 Vacuum Blower . . . . .	FA210D-AS19-01
<b>Power Pak Material Collection System</b>	
(Engine S.N. —254693) . . . . .	FA210D-AS17
(Engine S.N. 254694—289197) . . . . .	FA210D-BS17
(Engine S.N. 289198— ) . . . . .	FA210D-CS17

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## FA130D REPAIR SPECIFICATIONS

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Item	Specification
Flywheel Nut Torque . . . . .	60 N·m (44 lb-ft)

### GROUP 15—CYLINDER HEAD

Cylinder Head	
Maximum Cylinder Head Warp . . . . .	0.25 mm (0.010 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	10 N·m (89 lb-in.)
Final Torque . . . . .	21 N·m (186 lb-in.)
Spark Plug Torque . . . . .	17 N·m (156 lb-in.)

### GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS

Valve Clearance (cold)	
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)
Exhaust . . . . .	0.10—0.34 mm (0.004—0.013 in.)

Valves and Springs	
Minimum Spring Free Length . . . . .	23.50 mm (0.930 in.)
Maximum Valve Guide I.D.	
Intake . . . . .	6.10 mm (0.2401 in.)
Exhaust . . . . .	6.09 mm (0.2397 in.)
Minimum Valve Stem Diameter . . . . .	5.95 mm (0.234 in.)

Valve Clearance (cold)	
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)
Exhaust . . . . .	0.10—0.34 mm (0.004—0.013 in.)

Valves and Springs	
Minimum Spring Free Length . . . . .	23.50 mm (0.930 in.)
Maximum Valve Guide I.D.	
Intake . . . . .	6.10 mm (0.2401 in.)
Exhaust . . . . .	6.09 mm (0.2397 in.)
Minimum Valve Stem Diameter . . . . .	5.95 mm (0.234 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seating Surface Angle . . . . .	45°
Valve Seating Width . . . . .	1.00—1.60 mm (0.039—0.063 in.)
Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

Continued on next page

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**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Crankcase Cover</b>	
Oil Capacity . . . . .	0.5 L (1.06 pt)
Cap Screw Torque . . . . .	6 N·m (53 lb-in.)
Drain Plug Torque . . . . .	14 N·m (121 lb-in.)
<b>Camshaft</b>	
Minimum End Journals O.D. . . . .	11.94 mm (0.469 in.)
Minimum Lobe Height . . . . .	23.25 mm (0.915 in.)
Maximum Cover and Crankcase Bearing I.D. . . . .	12.04 mm (0.474 in.)
<b>Piston</b>	
Maximum Ring Groove Clearance . . . . .	0.15 mm (0.006 in.)
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap . . . . .	1.00 mm (0.039 in.)
Minimum Pin O.D. . . . .	12.98 mm (0.511 in.)
Maximum Pin Bore I.D. . . . .	13.04 mm (0.513 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Minimum Piston O.D. . . . .	61.86—61.89 mm (2.435—2.437 in.)
Piston-to-Cylinder Bore Clearance	
Maximum . . . . .	0.25 mm (0.0098 in.)
Standard . . . . .	0.087—0.137 mm (0.0034—0.0054 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	24.05 mm (0.947 in.)
Maximum Piston Pin Bearing I.D. . . . .	13.04 mm (0.513 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.10 mm (0.004 in.)
End-Cap Screw Torque . . . . .	12 N·m (106 lb-in.)
<b>Crankshaft</b>	
Minimum Flywheel Side Journal O.D. . . . .	21.97 mm (0.865 in.)
Minimum Connecting Rod Journal O.D. . . . .	23.95 mm (0.943 in.)
Maximum Crankcase Plain Bearing I.D. . . . .	22.10 mm (0.869 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0—0.30 mm (0—0.012 in.)
PTO Side Oil Seal Depth . . . . .	4 mm (0.158 in.)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D. . . . .	61.90—62.00 mm (2.439—2.443 in.)
Maximum Cylinder Bore I.D. . . . .	62.07 mm (2.446 in.)
Low Oil Level Sensor Travel . . . . .	9.50—15.50 mm (0.374—0.610 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.50 mm (0.019 in.)
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See Ignition Tests in this Group.

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## FA210D REPAIR SPECIFICATIONS

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Item	Specification
Flywheel Nut Torque . . . . .	60 N·m (44 lb-ft)
Flywheel Screen Gap . . . . .	1—3 mm (0.039—0.118 in.)

### GROUP 15—CYLINDER HEAD

Cylinder Head	
Maximum Cylinder Head Warp . . . . .	0.40 mm (0.015 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	10 N·m (89 lb-ft)
Final Torque . . . . .	21 N·m (186 lb-in)
Spark Plug Torque . . . . .	24 N·m (212 lb-in.)

### GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS

Valve Clearance (cold)	
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)
Exhaust . . . . .	0.12—0.34 mm (0.005—0.013 in.)
Valves and Springs	
Minimum Spring Free Length . . . . .	23.50 mm (0.930 in.)
Maximum Valve Guide I.D.	
Intake . . . . .	6.10 mm (0.240 in.)
Exhaust . . . . .	6.13 mm (0.242 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seat and Face Angle . . . . .	45°
Valve Seating Width . . . . .	1.30 mm (0.050 in.)
Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

Continued on next page

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**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Crankcase Cover</b>	
Oil Capacity . . . . .	0.6 L (1.27 pt)
Cap Screw Torque . . . . .	21 N·m (186 lb-in.)
<b>Camshaft</b>	
Minimum End Journals O.D. . . . .	12.94 mm (0.509 in.)
Minimum Lobe Height	
Intake . . . . .	26.45 mm (1.041 in.)
Exhaust . . . . .	26.35 mm (1.037 in.)
Maximum Bearing I.D. . . . .	13.05 mm (0.514 in.)
<b>Piston</b>	
Maximum Ring Groove Clearance	
Top Ring . . . . .	0.15 mm (0.006 in.)
Second Ring . . . . .	0.13 mm (0.005 in.)
Oil Ring . . . . .	0.12 mm (0.004 in.)
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap . . . . .	1.00 mm (0.039 in.)
Minimum Pin O.D. . . . .	14.98 mm (0.590 in.)
Maximum Pin Bore I.D. . . . .	15.04 mm (0.593 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.06 mm (0.003 in.)
Piston O.D. . . . .	71.86—71.89 mm (2.829—2.830 in.)
Piston-to-Cylinder Bore Clearance	
Maximum . . . . .	0.163 mm (0.0064 in.)
Standard . . . . .	0.087—0.137 mm (0.0034—0.0054 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	27.06 mm (1.065 in.)
Maximum Piston Pin Bearing I.D. . . . .	15.04 mm (0.592 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.06 mm (0.002 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.12 mm (0.005 in.)
End-Cap Screw Torque . . . . .	19 N·m (168 lb-in.)
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	24.96 mm (0.983 in.)
Minimum Flywheel Side Journal O.D. . . . .	24.96 mm (0.983 in.)
Minimum Connecting Rod Journal O.D. . . . .	26.95 mm (1.061 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0—0.30 mm (0—0.012 in.)
PTO Side Oil Seal Depth . . . . .	4 mm (0.158 in.)
Crankcase Plain Bearing . . . . .	25.10 mm (0.988 in.)

MX,2000A1,A5 -19-21OCT92

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**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
Cylinder Bore	
Standard Cylinder Bore I.D. . . . .	71.98—72.00 mm (2.834—2.835 in.)
Maximum Cylinder Bore I.D. . . . .	72.06 mm (2.837 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)
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See Ignition Tests in this Group.

MX,2000A1,A6 -19-21OCT92

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Carburetor Gasket Kit—Engine Number FA130D-AS16

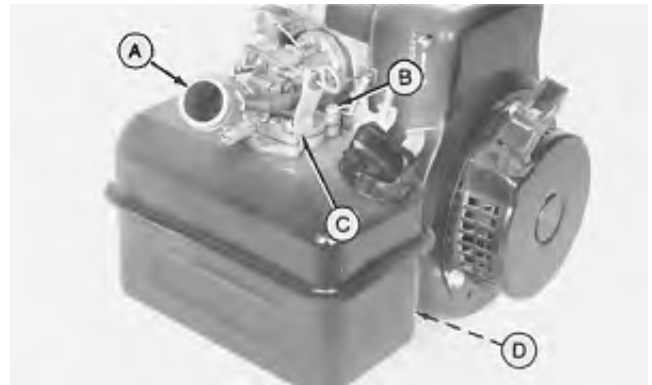
Complete Carburetor

MX,2005A1,A1 -19-21OCT92

## REMOVE, INSPECT AND INSTALL FUEL TANK—FA130D-AS16/AS19

**⚠ CAUTION: Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.**

1. Remove air cleaner assembly or intake manifold and gasket (A).
2. Remove choke lever and linkage (C).
3. Remove screws (B) and cap screw and washer (D). Remove fuel tank and gasket.
4. Inspect fuel tank for cracks or damage. Repair or replace as necessary.
5. Install fuel tank and gasket.
6. Install choke lever and linkage.
7. Install intake manifold and gasket or air cleaner assembly.

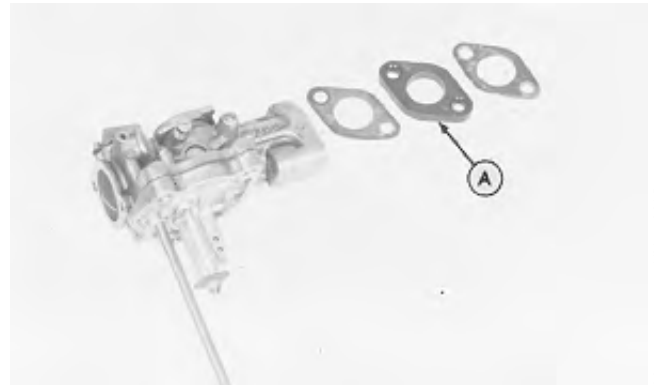
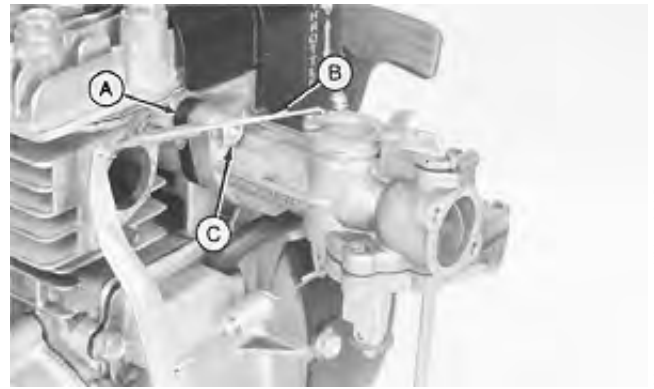


A—Intake Manifold and Gasket  
B—Screw (3 used)  
C—Choke Lever and Linkage  
D—Cap Screw and Washer

MX,2005A1,A2 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR—FA130D-AS16/AS19

1. Remove fuel tank. (See this group.)
2. Remove two nuts and washers (C).
3. Separate carburetor from spacer (A). Remove carburetor.
4. Disconnect throttle control linkage (B).
5. Remove spacer (A) and gaskets.
6. Make repairs as necessary. (See this group.)
7. Install gaskets and spacer.
8. Connect linkage and install carburetor.
9. Install washers and nuts.
10. Install fuel tank.



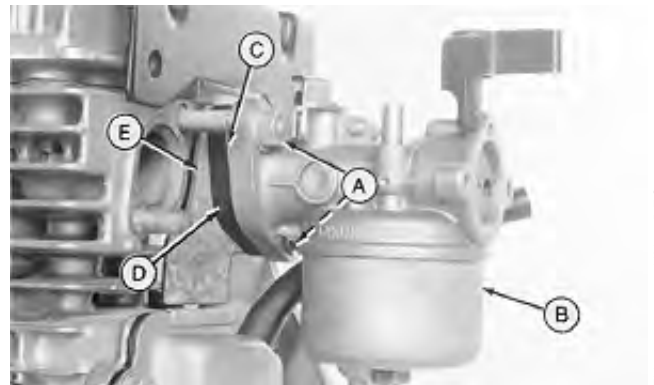
MX,2005A1,A3 -19-21OCT92

M80232 -UN-11MAR91

M80233 -UN-11MAR91

## REMOVE AND INSTALL CARBURETOR—FA130D-AN00

1. Remove air cleaner assembly and gasket.
2. Remove nuts and washers (A).
3. Separate carburetor from spacer (D). Remove carburetor (B).
4. Disconnect throttle control linkage.
5. Remove spacer(D) and gaskets (C and E).
6. Make repairs as necessary. (See this group.)
7. Install gaskets and spacer.
8. Connect linkage and install carburetor.
9. Install washers and nuts.
10. Install air cleaner assembly and gasket.



- A—Mounting Nuts and Washers
- B—Carburetor
- C—Small Gasket
- D—Spacer
- E—Large Gasket

MX,2005A1,A4 -19-21OCT92

TY15011 -UN-06DEC89

## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR—FA130D-AS16/AS19

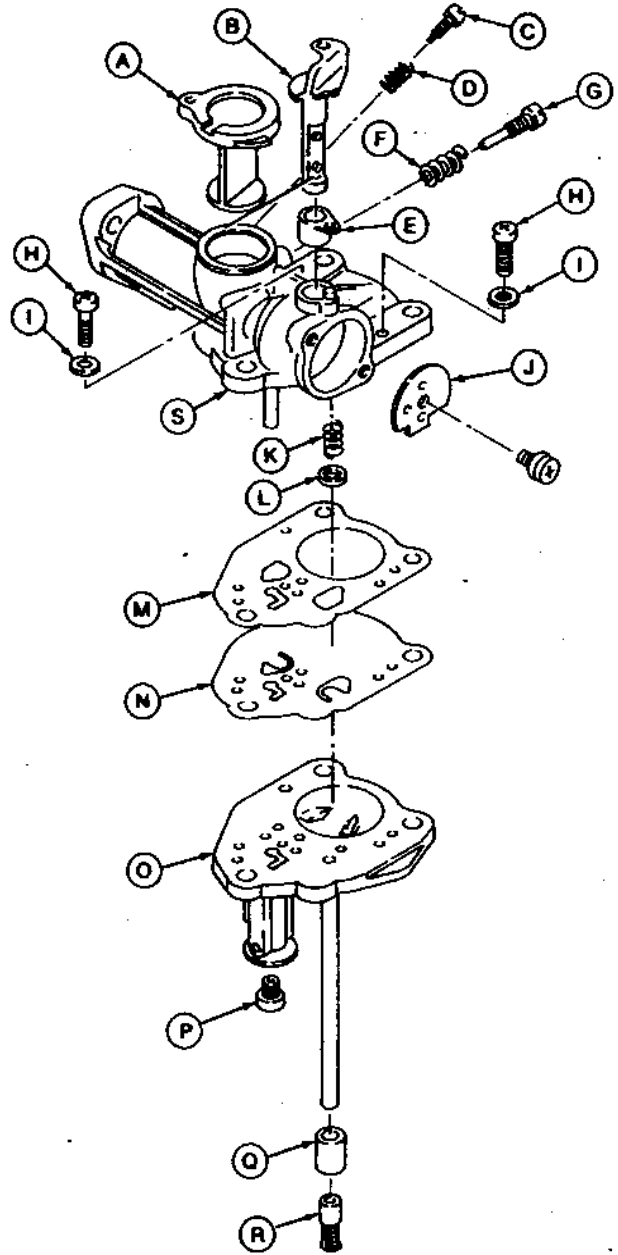
**IMPORTANT:** Do not clean holes or passages with small drill bits or wire.

1. Soak carburetor body and all parts, except gaskets and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

- A—Throttle Shaft
- B—Choke Shaft
- C—Pilot Screw
- D—Spring
- E—Bushing
- F—Spring
- G—Idle Screw
- H—Screw
- I—Gasket
- J—Choke Valve
- K—Spring
- L—Spring Cap
- M—Gasket
- N—Diaphragm
- O—Lower Housing
- P—Main Jet
- Q—Bushing
- R—Strainer
- S—Upper Housing



MX,2005A1,A5 -19-21OCT92

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M51767 -UN-07SEP88

## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR—FA130D-AN00

**IMPORTANT:** To remove float, use a long nosed pliers on end of pin (M). Do not strike opposite end of pin. Damage to pin holder may result.

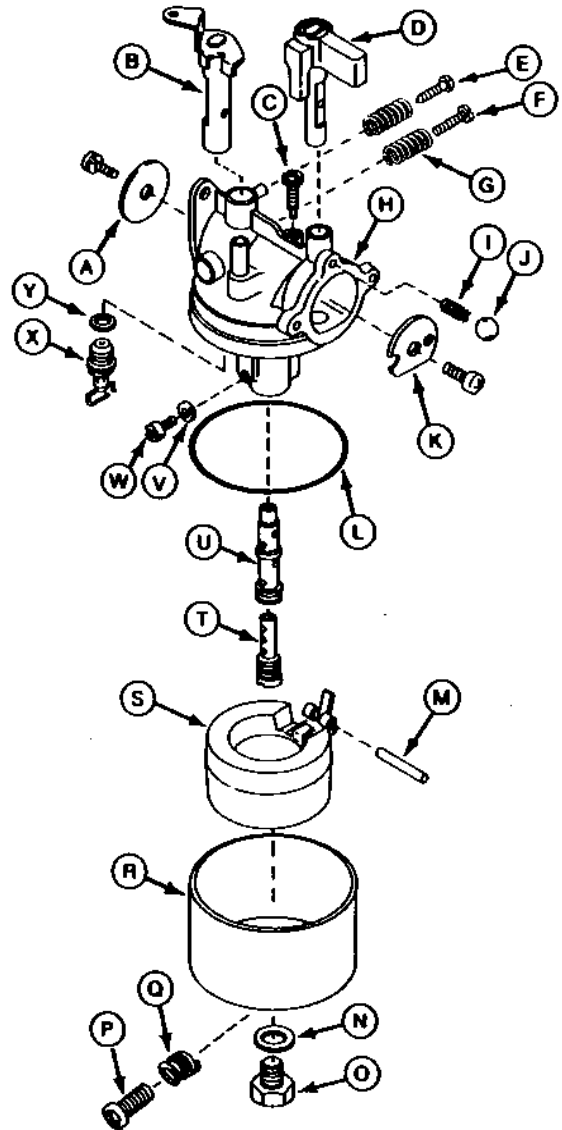
**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

A—Throttle Plate	N—Washer
B—Throttle Shaft	O—Plug
C—Pilot Jet	P—Drain Screw
D—Choke Shaft	Q—Spring
E—Pilot Screw	R—Float Chamber
F—Idle Screw	S—Float
G—Spring (2 used)	T—Bleed Pipe
H—Carburetor Body	U—Main Nozzle
I—Spring	V—Washer
J—Ball	W—Main Jet
K—Choke Plate	X—Needle Valve
L—Gasket	Y—Washer
M—Float Pin	

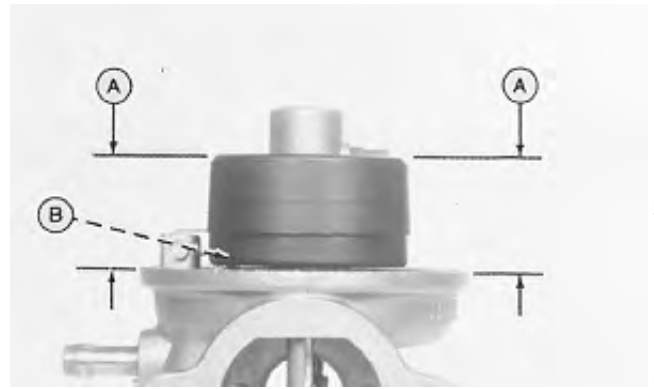


-UN-19MAR91  
M80236

MX,2005A1,A6 -19-21OCT92

**IMPORTANT: Do not push on float or inlet needle valve when adjusting float level.**

5. Adjust float level. With carburetor upside down, float surface must be parallel (A) to carburetor body. Bend tang (B) to adjust float surface angle.



MX,2005A1,A7 -19-21OCT92

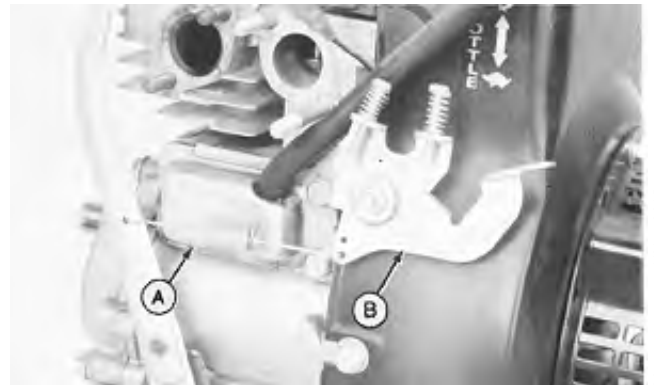
TY15065 -UN-02SEP88

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### SERVICE BREATHER—FA130D-AS16/AS19

*NOTE: The tappet chamber cover is an oil breather.*

1. Remove fuel tank. (See this group.)
2. Remove throttle lever assembly (B).
3. Remove tappet chamber cover/breather and gasket (A).
4. Clean cover/breather and tube. Inspect for cracks or damage. Replace if necessary.
5. Install new gasket and cover/breather.
6. Install throttle lever assembly.
7. Install fuel tank.



MX,2005A1,A8 -19-21OCT92

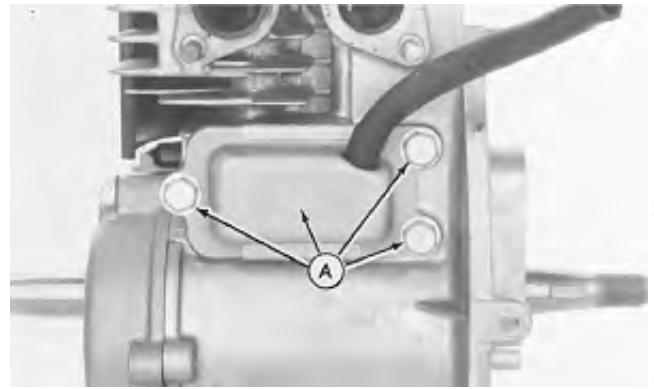
M80238 -JUN-11MAR91



## SERVICE BREATHER—FA130D-AN00

*NOTE: The tappet chamber cover is an oil breather.*

1. Remove carburetor. (See this group.)
2. Remove tappet chamber cover/breather and gasket (A).
3. Clean cover/breather and tube. Inspect for cracks or damage. Replace if necessary.
4. Install new gasket and cover/breather.
5. Install carburetor.



TY15018 -UN-02SEP88

MX,2005A1,A9 -19-21OCT92

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## SERVICE AIR CLEANER

*NOTE: Replace elements yearly or every 25 hours as required.*

1. Remove and disassemble air cleaner.

**IMPORTANT: Do not clean elements with solvent or compressed air.**

2. Wash foam element (A) in detergent and water. Dry element.

3. Put 12—15 drops of engine oil on foam element (A). Squeeze out excess oil.

4. Gently tap paper element (B) to remove dust:  
 —Element is still usable if you can see light through element and paper appears clean.  
 —Install new element if element is oily, dirty, bent, torn, crushed, or obstructed in any way.

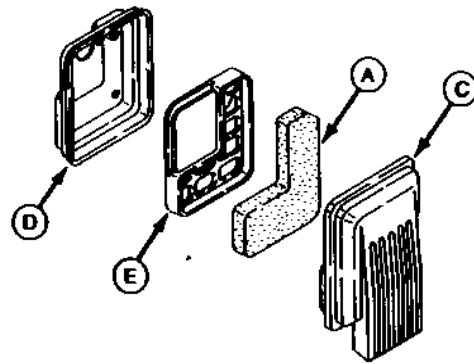
5. Inspect cover (C), body (E), and base (D) for damage. Replace if necessary.

**IMPORTANT: Any time air cleaner base is removed, check for free choke operation during reassembly.**

6. Assemble and install air cleaner.



FA130D-AS16



FA130D-AN00

- A—Foam Element
- B—Paper Element
- C—Cover
- D—Base
- E—Body

M80240 -UN-11MAR91

-UN-06APR91

M80241

MX,2005A1,A10 -19-21OCT92

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Carburetor Gasket Kit:

Engine Number  
FA210D-AS19-01  
FA210D-AS17  
FA210D-BS17  
FA210D-CS17

Main Jet High Altitude Kit:

Engine Number  
FA210D-AS17  
FA210D-BS17  
FA210D-CS17

Complete Carburetor

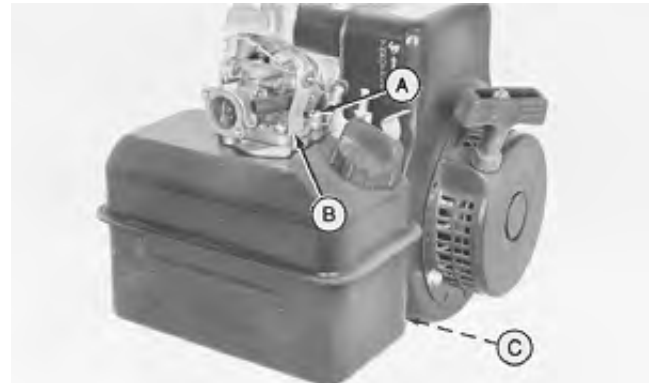
Complete Fuel Pump:  
FA210D-AS17  
FA210D-BS17  
FA210D-CS17

MX,2006A1,A1 -19-21OCT92

## REMOVE, INSPECT AND INSTALL FUEL TANK—FA210D-AS20

**⚠ CAUTION: Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.**

1. Remove air cleaner assembly.
2. Remove choke lever and linkage (B).
3. Remove two screws (A) and cap screw and washer (C). Remove fuel tank and gasket.
4. Inspect fuel tank for cracks or damage. Repair or replace as necessary.
5. Install fuel tank and gasket.
6. Install choke lever and linkage.
7. Install air cleaner assembly.

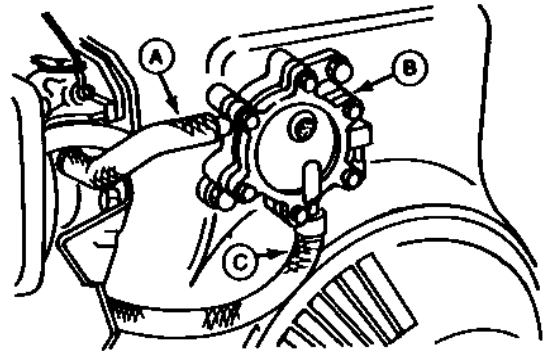


M80289 -UN-11MAR91

MX,2006A1,A2 -19-21OCT92

## REMOVE AND INSTALL FUEL PUMP—FA210D-AS17/BS17/CS17

1. Disconnect fuel hose (A) and vacuum hose (C). Close all openings using caps and plugs.
2. Remove fuel pump (B).
3. Inspect pump for cracks or damage. Replace if necessary.
4. Install fuel pump.
5. Connect hoses.



FA210D-AS17



FA210D-BS17/CS17

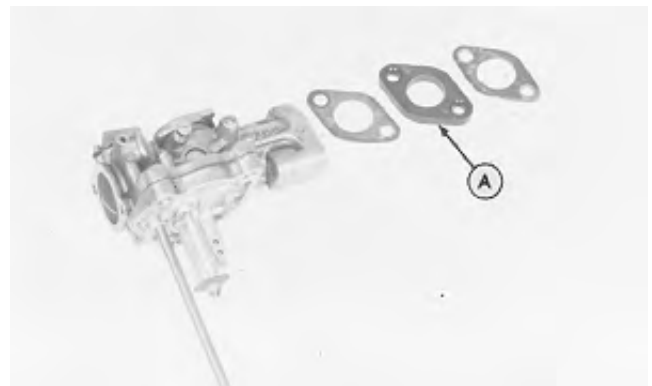
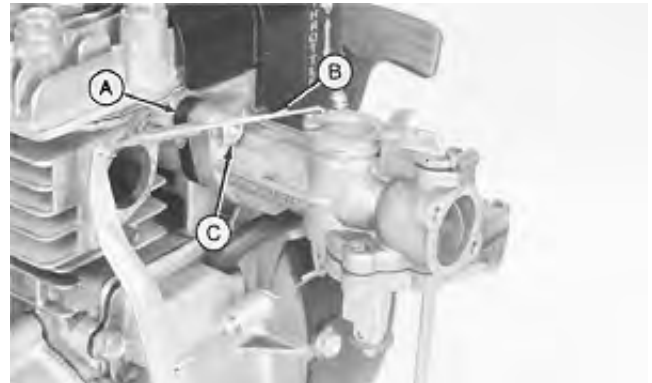
MX,2006A1,A3 -19-21OCT92

M80277 -UN-19MAR91

M80278 -UN-19MAR91

## REMOVE AND INSTALL CARBURETOR—FA210D-AS20

1. Remove fuel tank. (See this group.)
2. Remove two nuts and washers (C).
3. Separate carburetor from spacer (A). Remove carburetor.
4. Disconnect throttle control linkage (B).
5. Remove spacer (A) and gaskets.
6. Make repairs as necessary. (See this group.)
7. Install gaskets and spacer.
8. Connect linkage and install carburetor.
9. Install washers and nuts.
10. Install fuel tank.



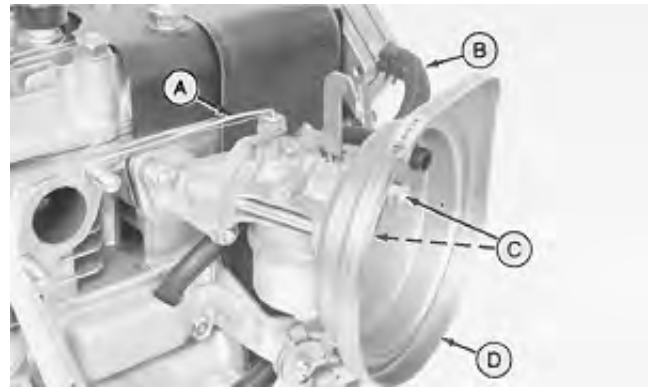
M80232 -UN-11MAR91

M80233 -UN-11MAR91

MX,2006A1,A4 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR—FA210D-AS17/BS17/CS17

1. Remove air cleaner elements.
2. Disconnect hose (B). Close all openings using caps and plugs.
3. Remove cap screws and washers (C), air cleaner base (D) and gasket.
4. Disconnect linkage (A).
5. Remove carburetor and gasket.
6. Make repairs as necessary. (See this group.)
7. Install carburetor and new gasket.
8. Connect throttle linkage.
9. Install new gasket, air cleaner base and cap screws and washers.
10. Connect fuel hose.
11. Install air cleaner elements.



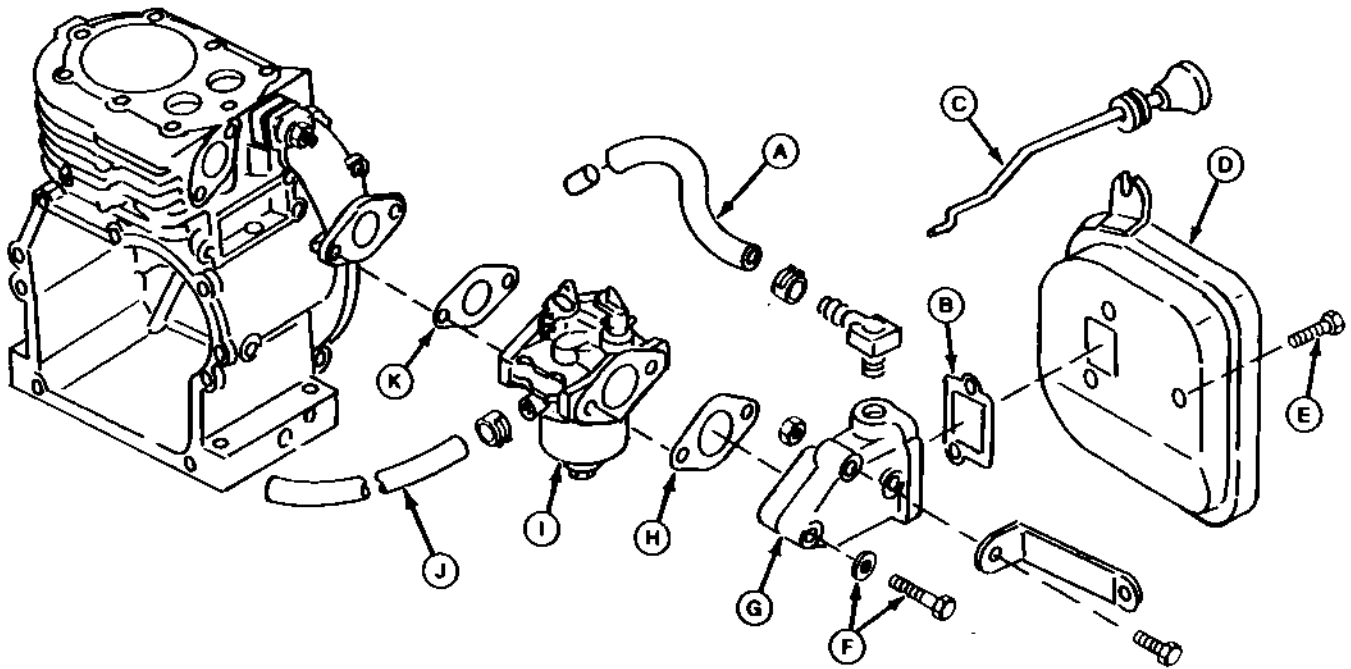
A—Throttle Control Linkage  
B—Fuel Hose  
C—Cap Screws and Washers  
D—Air Cleaner Base

M80279 -UN-11MAR91

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MX,2006A1,A5 -19-21OCT92

**REMOVE AND INSTALL CARBURETOR—FA210D-AS19-01**



A—Crankcase  
Breather-to-Intake Pipe  
Hose  
B—Gasket

C—Choke Control Linkage  
D—Air Cleaner Base  
E—Cap Screw (3 used)  
F—Cap Screw and Washer (2  
used)

G—Intake Pipe  
H—Gasket  
I—Carburetor

J—Fuel Tank-to-Carburetor  
Fuel Hose  
K—Gasket

1. Remove air cleaner elements.
2. Disconnect linkage (C).
3. Remove cap screws (E), air cleaner base (D) and gasket (B).
4. Disconnect hoses (A and J). Close all openings using caps and plugs.
5. Remove cap screws and washers (F), intake pipe (G) and gasket (H).
6. Remove carburetor (I) and gasket (K).
7. Make repairs as necessary. (See this group.)
8. Install carburetor and new gasket.
9. Install intake pipe and new gasket.
10. Connect hoses.
11. Install air cleaner base and new gasket.
12. Connect linkage.
13. Install air cleaner elements.

MX,2006A1,A6 -19-21OCT92

## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR—FA210D-AS20

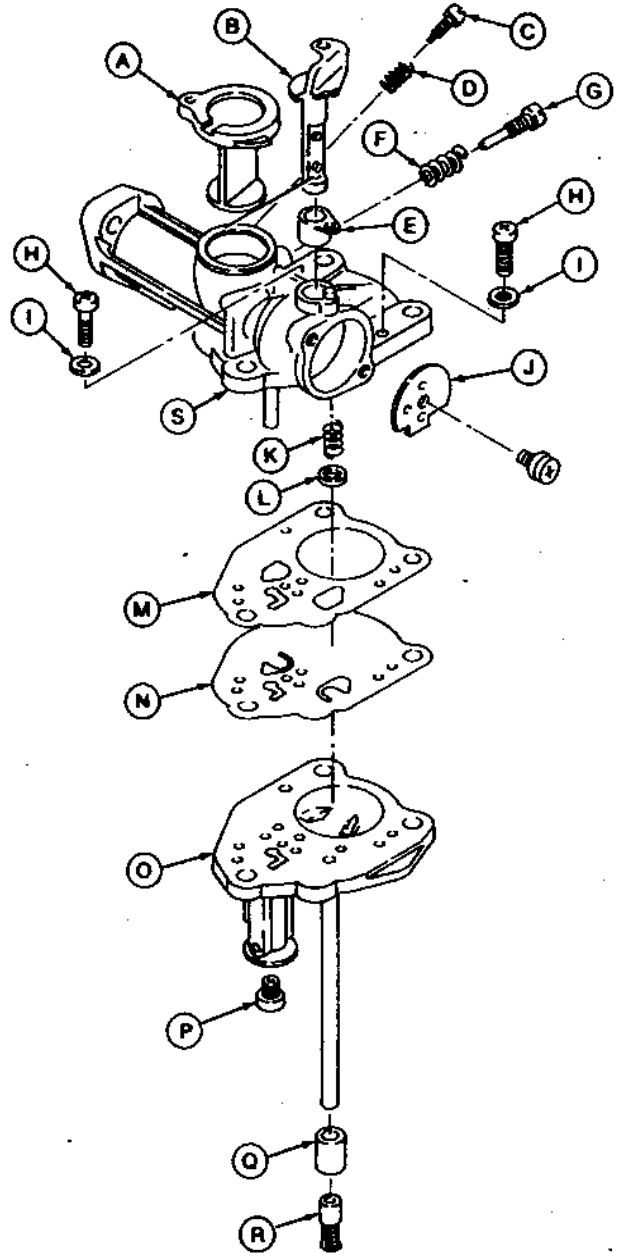
**IMPORTANT:** Do not clean holes or passages with small drill bits or wire.

1. Soak carburetor body and all parts, except gaskets and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

- A—Throttle Shaft
- B—Choke Shaft
- C—Pilot Screw
- D—Spring
- E—Bushing
- F—Spring
- G—Idle Screw
- H—Screw
- I—Gasket
- J—Choke Valve
- K—Spring
- L—Spring Cap
- M—Gasket
- N—Diaphragm
- O—Lower Housing
- P—Main Jet
- Q—Bushing
- R—Strainer
- S—Upper Housing



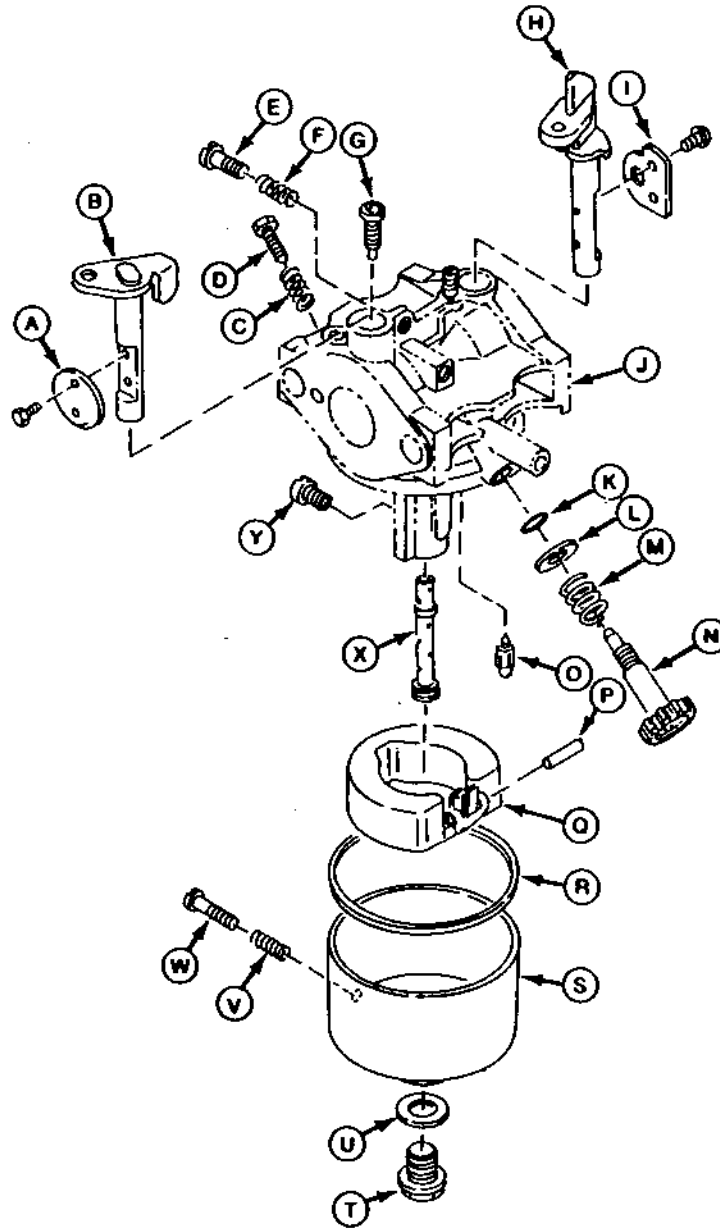
MX,2006A1,A7 -19-21OCT92

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M51767 -UN-07SEP88



**DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE  
CARBURETOR—FA210D-AS19-01/AS17/BS17/CS17**



- |                  |                   |                 |               |
|------------------|-------------------|-----------------|---------------|
| A—Throttle Plate | H—Choke Shaft     | N—Valve         | T—Plug        |
| B—Throttle Shaft | I—Choke Plate     | O—Needle Valve  | U—Washer      |
| C—Spring         | J—Carburetor Body | P—Float Pin     | V—Spring      |
| D—Screw          | K—O-Ring          | Q—Float         | W—Drain Screw |
| E—Idle Screw     | L—Washer          | R—Gasket        | X—Main Nozzle |
| F—Spring         | M—Spring          | S—Float Chamber | Y—Main Jet    |
| G—Pilot Jet      |                   |                 |               |

FA210D-AS19-01

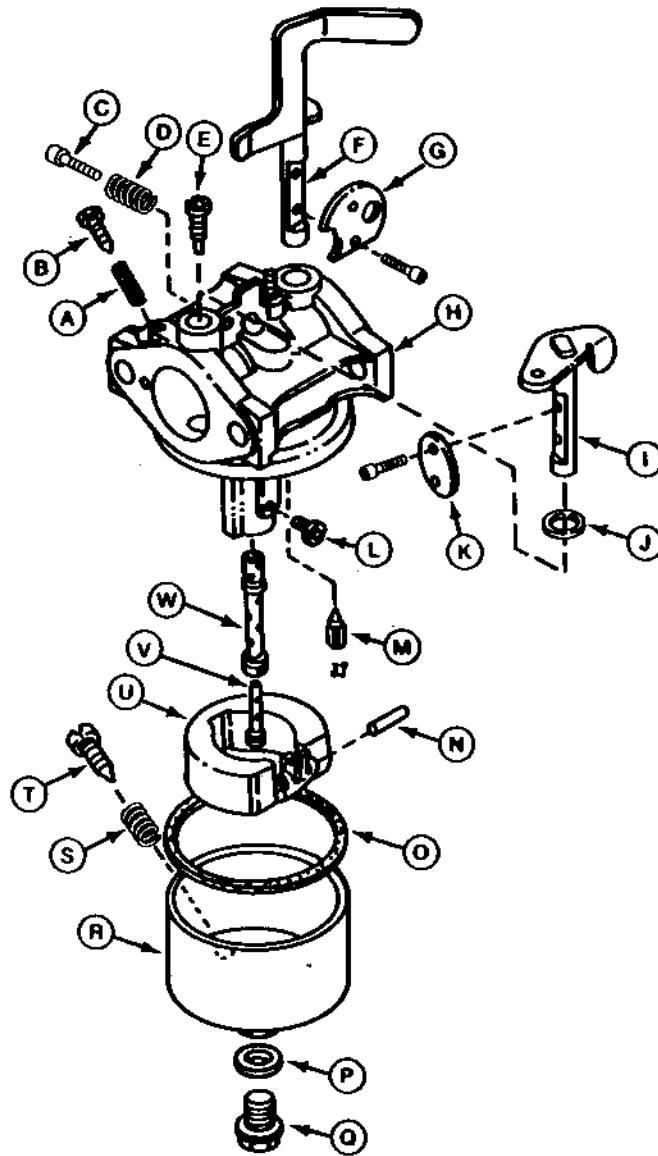
M80281 -JUN-19/MAR91

MX,2006A1,A8 -19-21OCT92

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A—Spring  
B—Screw  
C—Idle Screw  
D—Spring  
E—Pilot Jet  
F—Choke Shaft

G—Choke Plate  
H—Carburetor Body  
I—Throttle Shaft  
J—Seal  
K—Throttle Plate  
L—Main Jet

M—Needle Valve  
N—Float Pin  
O—Gasket  
P—Washer  
Q—Plug  
R—Float Chamber

S—Spring  
T—Drain Screw  
U—Float  
V—Bleed Pipe  
W—Main Nozzle

FA210D-AS17/BS17/CS17

M80282 -JUN-19/MAR91

**IMPORTANT:** To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or papers to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

*NOTE: Main jet high altitude kits are available for FA210D-AS17, BS17 and CS17 engines only.*

MX,2006A1,A10 -19-21OCT92

**IMPORTANT:** Do not push on float or inlet needle valve when adjusting float level.

5. Adjust float level. With carburetor upside down, float surface must be parallel (A) to carburetor body. Bend tang (B) to adjust float surface angle.



MX,2006A1,A11 -19-21OCT92

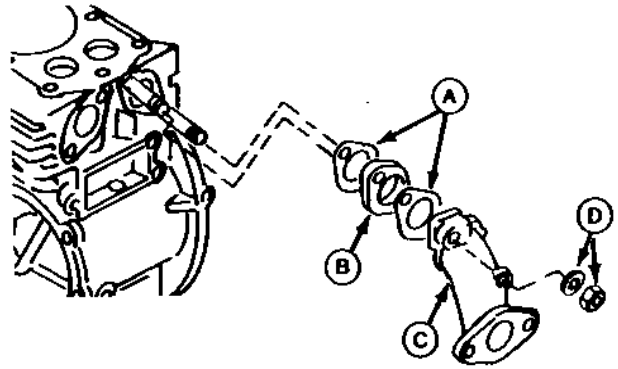
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M80283 -UN-11MAR91

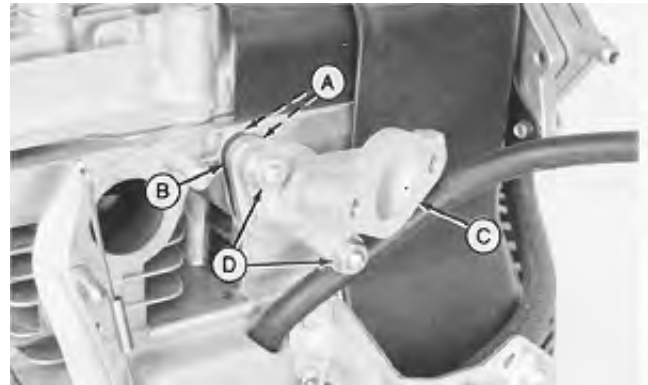
## REMOVE AND INSTALL INTAKE MANIFOLD—FA210D-AS19-01/AS17/BS17/CS17

1. Remove carburetor. (See this group.)
2. Remove nuts and washers (D).
3. Separate manifold (C) from spacer (B). Remove intake manifold, spacer and gaskets (A).
4. Inspect parts for cracks or damage. Replace as necessary.
5. Install new gaskets, spacer and manifold.
6. Install carburetor.

A—Gaskets (2 used)  
 B—Spacer  
 C—Intake Manifold  
 D—Nuts and Washers



FA210D-AS19-01



FA210D-AS17/BS17/CS17

MX,2006A1,A12 -19-21OCT92

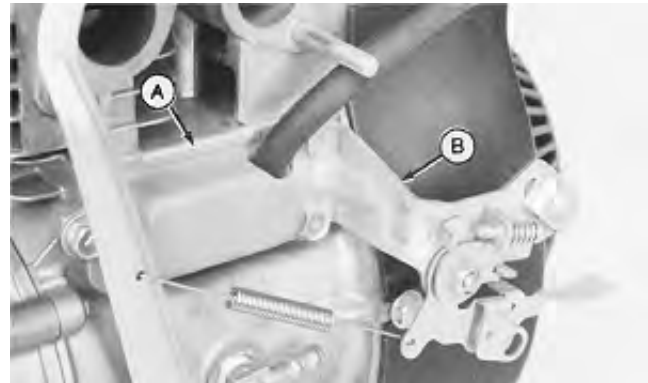
M80284 -UN-06APR91

M80285 -UN-11MAR91

## SERVICE BREATHER—FA210D-AS20

*NOTE: The tappet chamber cover is an oil breather.*

1. Remove fuel tank. (See this group.)
2. Remove throttle lever assembly (B).
3. Remove tappet chamber cover/breather and gasket (A).
4. Clean cover/breather and tube. Inspect for cracks or damage. Replace if necessary.
5. Install new gasket and cover/breather.
6. Install throttle lever assembly.
7. Install fuel tank.



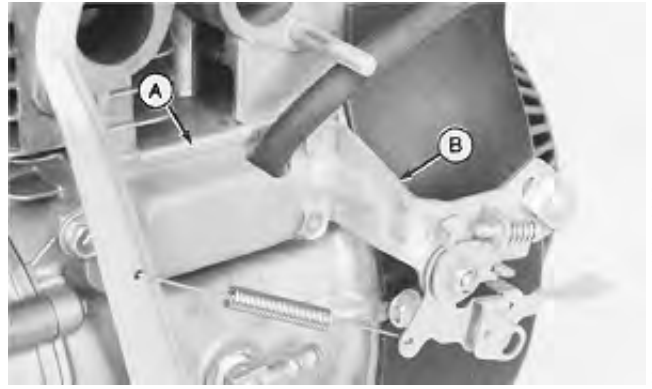
M80286 -UN-11MAR91

MX,2006A1,A13 -19-21OCT92

### SERVICE BREATHER—FA210D-AS19-01

*NOTE: Tappet chamber cover is an oil breather.*

1. Remove intake manifold (See this group.)
2. Remove throttle lever assembly (B).
3. Remove tappet chamber cover/breather and gasket (A).
4. Clean cover/breather and tube. Inspect for cracks or damage. Replace if necessary.
5. Install new gasket and cover/breather.
6. Install throttle lever assembly.
7. Install intake manifold.



M80286 -UN-11MAR91

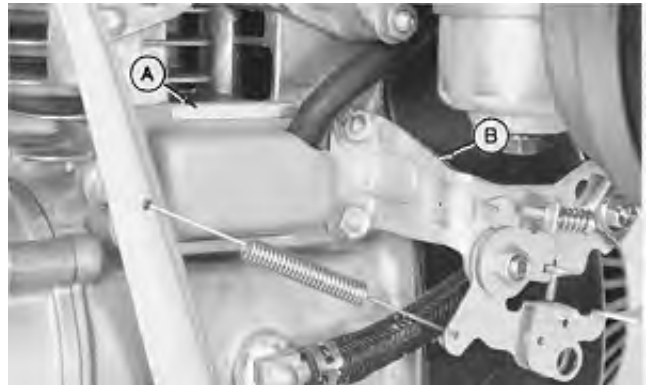
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MX,2006A1,A14 -19-21OCT92

### SERVICE BREATHER—FA210D-AS17/BS17/CS17

*NOTE: Tappet chamber cover is an oil breather.*

1. Remove throttle lever assembly (B).
2. Remove tappet chamber cover/breather and gasket (A).
3. Clean cover/breather and tube. Inspect for cracks or damage. Replace if necessary.
4. Install new gasket and breather/cover.
5. Install throttle lever assembly.



M80287 -UN-11MAR91

MX,2006A1,A15 -19-21OCT92

## SERVICE AIR CLEANER

*NOTE: Replace elements yearly or every 25 hours as required.*

1. Remove and disassemble air cleaner.

**IMPORTANT: Do not clean elements with solvent or compressed air.**

2. Wash foam element (A) in detergent and water. Dry element.

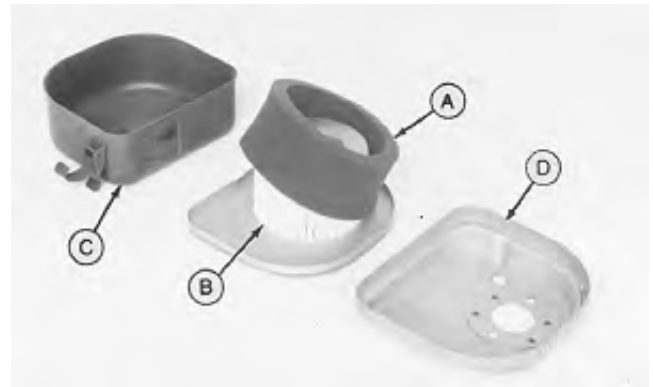
3. Put engine oil on element (A). Squeeze out excess oil.

4. Gently tap paper element (B) to remove dust:  
 —Element is still usable if you can see light through element and paper appears clean.  
 —Install new element if element is oily, dirty, bent, torn, crushed, or obstructed in any way.

5. Inspect cover (C) and base (D) for damage. Replace if necessary.

**IMPORTANT: Any time air cleaner base is removed, check for free choke operation during reassembly.**

6. Assemble and install air cleaner.



FA210D-AS20/AS19-01/AS17/BS17



FA210D-CS17

A—Foam Element  
 B—Paper Element  
 C—Cover  
 D—Base

M80240 -UN-11MAR91

M80288 -UN-11MAR91

MX,2006A1,A16 -19-21OCT92

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## REMOVE AND INSTALL BLOWER HOUSING—FA130D AND FA210D-AS20

*NOTE: It is not necessary to remove recoil starter from housing.*

1. Disconnect spark plug cap (A).
2. Remove fuel tank, if equipped. (See this group.)
3. Disconnect wiring lead (C).
4. Remove blower housing (B).
5. Install blower housing.
6. Connect wiring lead.
7. Install fuel tank, if equipped.
8. Connect spark plug cap.



M80242 -UN-11MAR91

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MX,2010A1,A1 -19-21OCT92

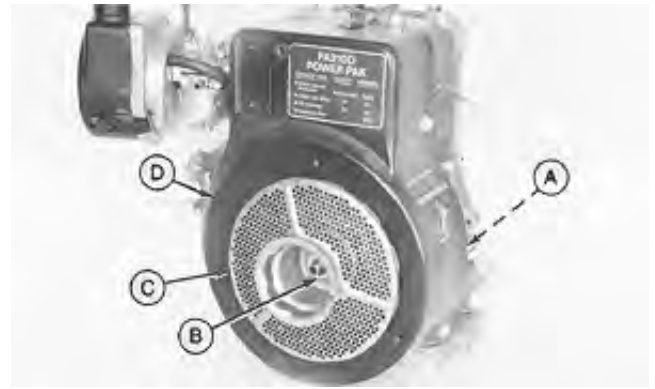


## REMOVE AND INSTALL BLOWER HOUSING—FA210D-AS19-01/AS17/BS17/CS17

1. Remove recoil starter.
2. Remove fuel pump, if equipped. (See Group 05.)
3. Disconnect wiring lead (A), if equipped.
4. Remove nut and washer (B), starter cup/screen assembly (C), and spacer(s).
5. Remove blower housing (D).
6. Install blower housing.
7. Install spacer(s) and starter cup/screen assembly.
8. Adjust flywheel screen. (See this group.)

*NOTE: Install washer with concave side toward flywheel.*

9. Install washer and nut. Tighten nut to 60 N·m (44 lb-ft).
10. Connect wiring lead, if equipped.
11. Install fuel pump, if equipped.
12. Install recoil starter.



A—Wiring Lead  
 B—Nut and Washer  
 C—Starter Cup/Screen Assembly  
 D—Blower Housing

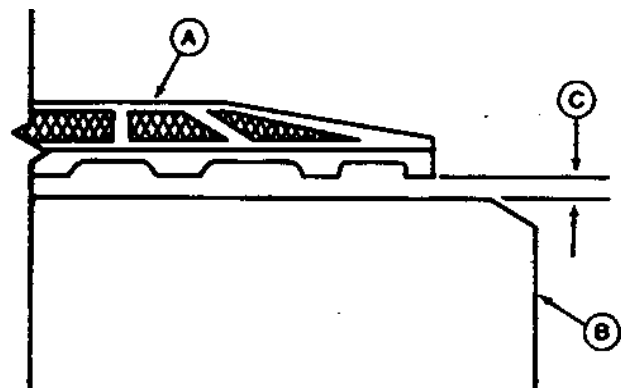
MX,2010A1,A2 -19-21OCT92

## FLYWHEEL SCREEN ADJUSTMENT

Adjust gap (C) between the blades under screen (A) and blower housing (B) to specifications using spacers.

### FLYWHEEL SCREEN ADJUSTMENT

Gap ..... 1—3 mm (0.039—0.118 in.)



MX,2010A1,A3 -19-21OCT92

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10  
2

M80290 -UN-11MAR91

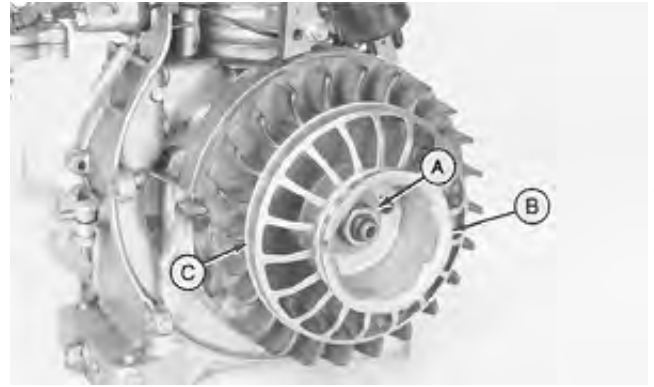
M38037 -UN-29AUG88

### REMOVE AND INSTALL FLYWHEEL—FA130D AND FA210D-AS20

1. Remove blower housing. (See this group.)
2. Hold flywheel and remove nut and washer (A).
3. Remove starter cap (B) and bracket (C), if equipped.
4. Remove flywheel using a flywheel puller.
5. Install flywheel.

*NOTE: Install washer with concave side toward flywheel.*

6. Install bracket, starter cup, washer and nut. Tighten nut to 60 N·m (44 lb-ft).
7. Install blower housing.



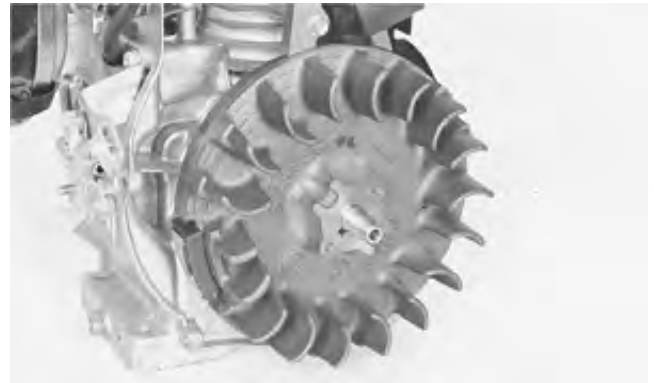
M80243 -UN-11MAR91

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MX,2010A1,A4 -19-21OCT92

### REMOVE AND INSTALL FLYWHEEL—FA210D-AS19-01/AS17/BS17/CS17

1. Remove blower housing. (See this group.)
2. Remove flywheel using a two-jaw puller.
3. Install flywheel.
4. Install blower housing.



M80291 -UN-11MAR91

MX,2010A1,A5 -19-21OCT92



**OTHER MATERIAL**

Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head

*SCOTCH-BRITE is a trade mark of the 3M Company.*

MX,5015A1,A1 -19-21OCT92

20  
15  
1

## REMOVE AND INSTALL CYLINDER HEAD

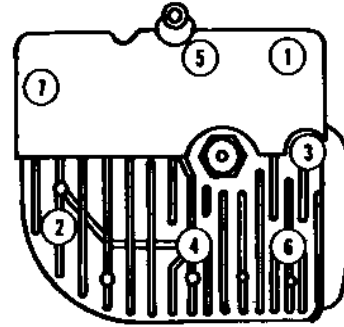
1. Remove blower housing. (See Group 10.)
2. Remove cylinder head cover.
3. Remove spark plug.
4. Remove cylinder head and gasket.
5. Make repairs as necessary. (See procedures in this group.)

**IMPORTANT: Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.**

6. Install cylinder head with new gasket.
7. Install cylinder head cover and cap screws. Tighten finger tight.
8. Tighten cap screws in sequence shown. Tighten to initial torque specifications.
9. Continue in sequence, 4 N-m (35 lb-in.) at a time, until final torque is as specified.
10. Install spark plug and tighten to specification.
11. Install blower housing.

### TORQUE SPECIFICATIONS

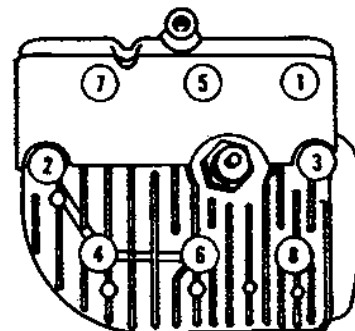
Cylinder Head Cap Screws	
Initial Torque	10 N-m (89 lb-in.)
Final Torque	21 N-m (186 lb-in.)
Spark Plug	
FA130D	17 N-m (156 lb-in.)
FA210D	24 N-m (212 lb-in.)



FA130D-AS16/AS19



FA130D-AN00



FA210D

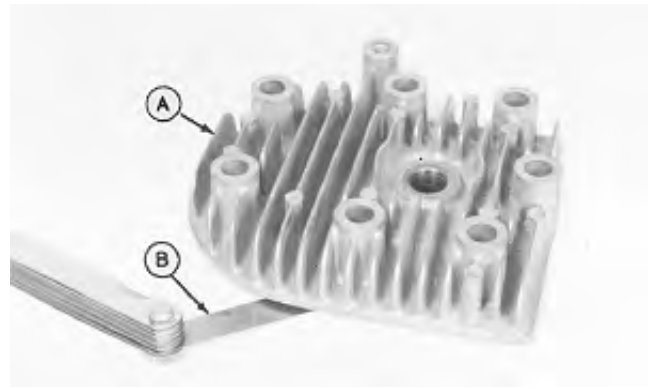
MX,2015A1,A1 -19-21OCT92

## INSPECT CYLINDER HEAD

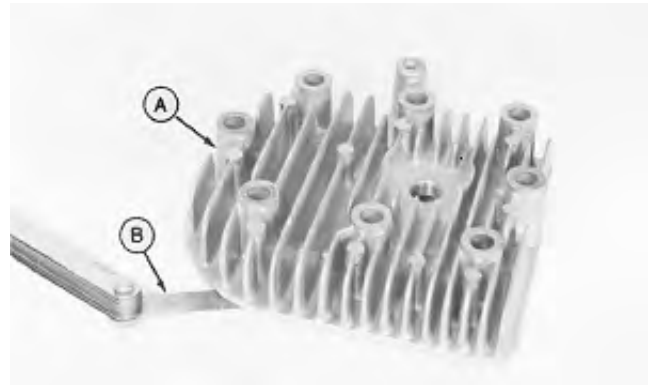
1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Put cylinder head (A) on a surface plate. Check for distortion at several points around the head using a feeler gauge (B). Replace head if distortion is more than specifications.

### CYLINDER HEAD DISTORTION SPECIFICATIONS (MAX)

FA130D . . . . .	0.25 mm (0.010 in.)
FA210D . . . . .	0.40 mm (0.015 in.)



FA130D



FA210D

MX,2015A1,A2 -19-21OCT92

M80245 -UN-11MAR91

M80292 -UN-11MAR91

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15  
3



# Group 20 Cylinder Block, Valves and Internal Components

## OTHER MATERIAL

Number	Name	Use
	Valve Guide Cleaner	Clean valve guides.
	Prussion Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,2020A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalogue.

Oversized Piston Ring Kit

Oversized Pistons

Cylinder Block

Overhaul Gasket Kit

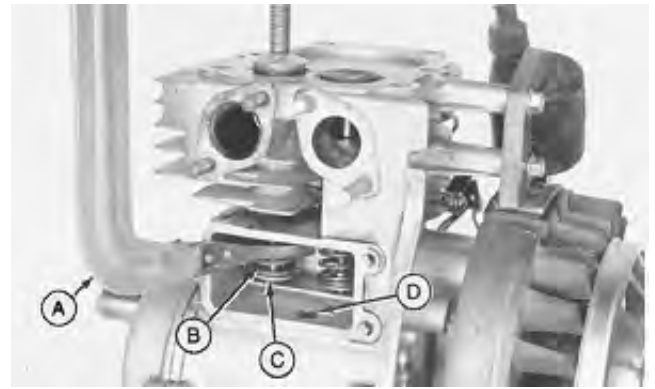
Short Block Kit

MX,2020A1,A2 -19-21OCT92



## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove carburetor. (See Group 05.)
2. Remove cylinder head. (See Group 15.)
3. Remove tappet chamber cover/breather and gasket.
4. Compress valve spring (B) with a spring compressor (A) and move spring retainer (C) so larger hole is around valve stem.
5. Remove compressor, valves, springs and retainers.
6. Inspect and analyze valves. (See Section 100, Group 05.)
7. Inspect springs, valve guides and seats. (See this group.)
8. Check valve-to-tappet clearance. (See this group.)
9. Check that drainback hole (D) is open.
10. Align valve springs, and retainers in tappet chamber.
11. Coat valve stems with oil and install in cylinder block.
12. Compress each spring and position retainer so smaller hole is around valve stem.
13. Install tappet chamber cover/breather and new gasket.
14. Install cylinder head.
15. Install carburetor.



A—Spring Compressor  
B—Valve Spring  
C—Spring Retainer  
D—Drainback Hole

M80246  
-UN-11MAR91

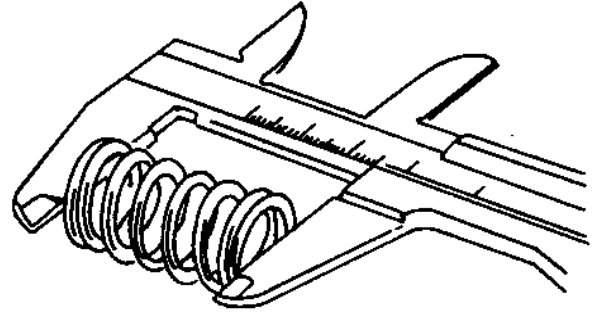
MX,2020A1,A3 -19-21OCT92

### INSPECT VALVE SPRINGS

Inspect valve springs. Replace springs if damaged or if free length is less than specification.

**SPECIFICATION (MIN)**

Valve Spring Free Length . . . . . 23.50 mm (0.930 in.)



MX,2020A1,A4 -19-21OCT92

M50036 -JUN-31AUG88

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3

### INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guides. Replace cylinder block if inside diameter is greater than specifications.

**SPECIFICATION (MAX) I.D.**

FA130D  
 Intake . . . . . 6.10 mm (0.2401 in.)  
 Exhaust . . . . . 6.09 mm (0.2397 in.)  
 FA210D  
 Intake . . . . . 6.10 mm (0.240 in.)  
 Exhaust . . . . . 6.13 mm (0.242 in.)



MX,2020A1,A5 -19-21OCT92

M80247 -JUN-11MAR91

## RECONDITION VALVE SEATS

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.

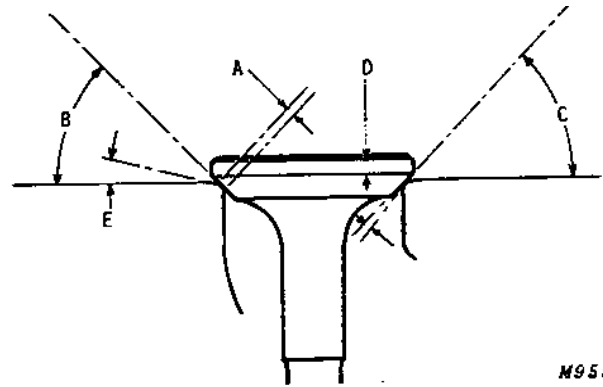
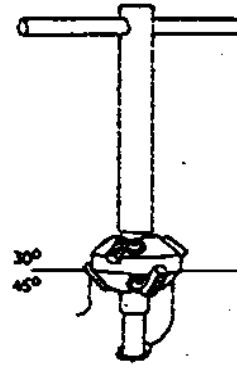
2. To recondition valve seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).

3. Cut valve seating surface (A) as close as possible to specifications.

4. Lap valves to seats after refacing. (See Section 100, Group 05.)

### SPECIFICATIONS

A—Valve Seating Surface:	
FA130D	1.00—1.60 mm (0.039—0.063 in.)
FA210D	1.30 mm (0.050 in.)
B—Valve Seat Angle	45°
C—Valve Face Angle	45°
D—Valve Margin	0.60 mm (0.020 in.)
E—Valve Narrowing Angle	30°



MX,2020A1,A6 -19-21OCT92

-UN-31AUG88  
M51558

-UN-01SEP88

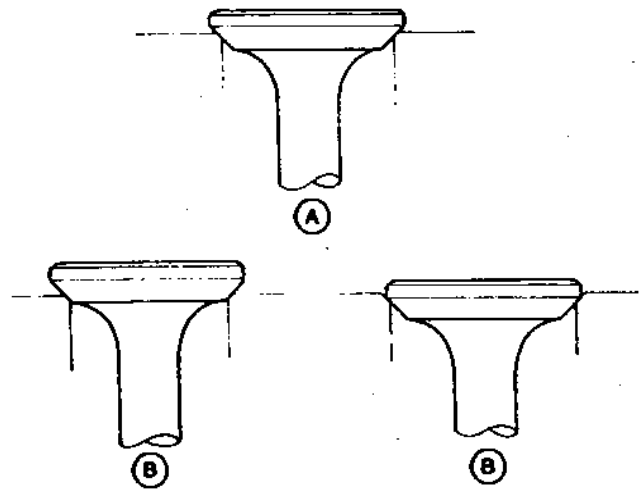
M9552

5. Center valve seat on the valve face:

—(A) shows correct position.

—(B) shows incorrect.

6. Check seat for good contact using Prussian Blue Compound.



MX,3015A1,A9 -19-21OCT92

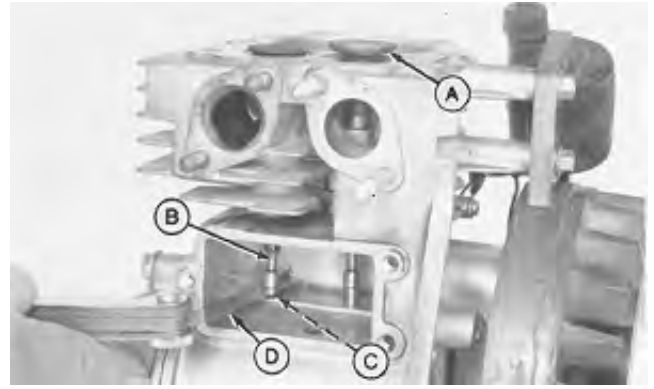
-UN-07SEP88

M118615

## CHECK VALVE-TO-TAPPET CLEARANCE

*NOTE: Valve grinding changes the valve-to-tappet clearance. Check clearance when engine is cold.*

1. Install valves in cylinder block.
2. Turn crankshaft until intake valve (A) is at its highest position. Check clearance between valve (B) and tappet (C), with feeler gauge (D) and compare to specifications.
3. Grind end of valve stem to obtain proper clearance.



M80248 -UN-11MAR91

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5120

### VALVE CLEARANCE SPECIFICATIONS

FA130D	
Exhaust . . . . .	0.10—0.34 mm (0.004—0.013 in.)
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)
FA210D	
Exhaust . . . . .	0.12—0.34 mm (0.005—0.013 in.)
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)

**A—Intake Valve**  
**B—Exhaust Valve**  
**C—Tappet**  
**D—Feeler Gauge**

MX,2020A1,A7 -19-21OCT92

## REMOVE AND INSTALL CRANKCASE COVER

*NOTE: Approximate crankcase oil capacity is:*

FA130D .....0.5L (1.06 pt)  
 FA210D .....0.6L (1.27 pt)

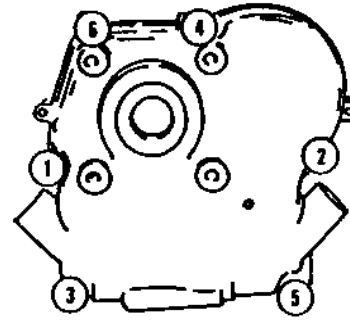
1. Drain crankcase.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

*NOTE: Do not force cover. Gears must mesh for proper positioning.*

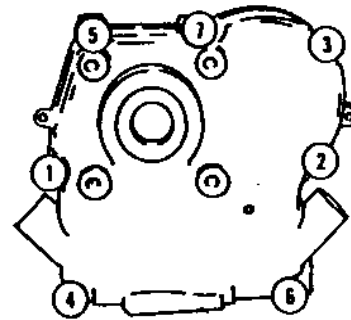
4. Install gasket and cover. Tighten cap screws using the sequence shown.

### TORQUE SPECIFICATIONS

Mounting Cap Screws	
FA130D .....	6 N·m (53 lb-in.)
FA210D .....	21 N·m (186 lb-in.)
Oil Drain Plug .....	14 N·m (121 lb-in.)



FA130D



FA210D

MX,2020A1,A8 -19-21OCT92

M80249 -UN-19MAR91

M80293 -UN-19MAR91

## REMOVE AND INSTALL CAMSHAFT

1. Remove crankcase cover. (See this group.)

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

2. Rotate crankshaft until timing marks (A) align.
3. Remove camshaft (B).
4. Inspect camshaft. (See this group.)
5. Apply clean engine oil to camshaft lobes and journals.
6. Align timing marks and install camshaft.
7. Install crankcase cover.



M80250 -UN-11MAR91

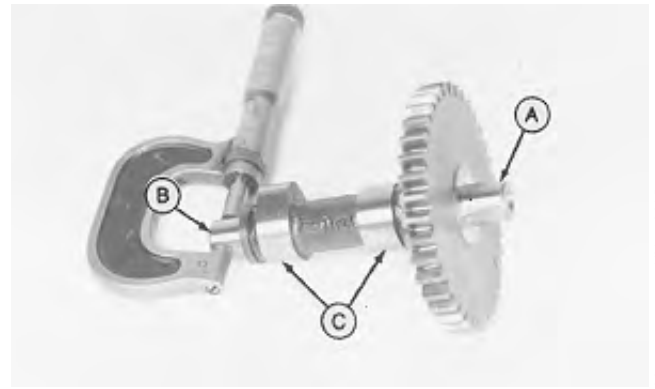
MX,2020A1,A9 -19-21OCT92

## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

**NOTE:** Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.

Measure PTO side journal (A), flywheel side journal (B), and lobes (C). Replace camshaft and tappets if less than specifications.



### SPECIFICATIONS (MIN)

	PTO Side Journal	Flywheel Side Journal	Cam Lobes
FA130D	11.94 mm (0.469 in.)	11.94 mm (0.469 in.)	23.25 mm (0.915 in.)
FA210D	12.94 mm (0.509 in.)	12.94 mm (0.509 in.)	Intake: 26.45 mm (1.041 in.) Exhaust: 26.35 mm (1.037 in.)

MX,2020A1,A10 -19-21OCT92

## INSPECT CAMSHAFT PLAIN BEARINGS

1. Remove camshaft. (See this group.)
2. Measure camshaft bearings in cylinder block and crankcase cover. Replace block or cover if diameter is greater than specification.
3. Install camshaft.

### SPECIFICATIONS (MAX)

	Cylinder Block Bearing	Crankcase Cover Bearing
FA130D	12.04 mm (0.474 in.)	12.04 mm (0.474 in.)
FA210D	13.05 mm (0.514 in.)	13.05 mm (0.514 in.)



Cylinder Block

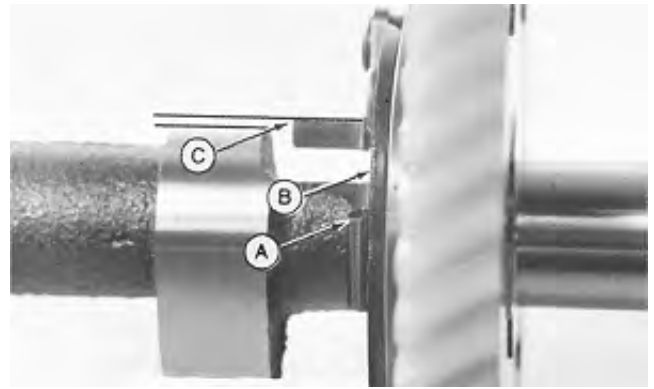


Crankcase Cover

MX,2020A1,A11 -19-21OCT92

## INSPECT AUTOMATIC COMPRESSION RELEASE (A.C.R.)—FA210D-AS20

1. Remove camshaft. (See this group.)
2. Inspect automatic compression release (A.C.R.) for damage.
3. Inspect spring (A). Replace if worn or damaged.
4. Move weight (B) by hand to check for proper operation.
5. Check that tab (C) sits slightly above cam lobe when weight is released. Tab should drop below cam when weight is operated.
6. Replace A.C.R. if it does not operate properly.
7. Install camshaft.



M54493 -UN-09JAN91

MX,2020A1,A12 -19-21OCT92

## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)
- NOTE: Mark tappets so they can be installed in their original bores during assembly.*
2. Remove tappets (A).
  3. Inspect tappets for wear or damage. Replace if necessary.
  4. Apply clean engine oil to tappets and bores.
  5. Install tappets in original bores.
  6. Install camshaft.

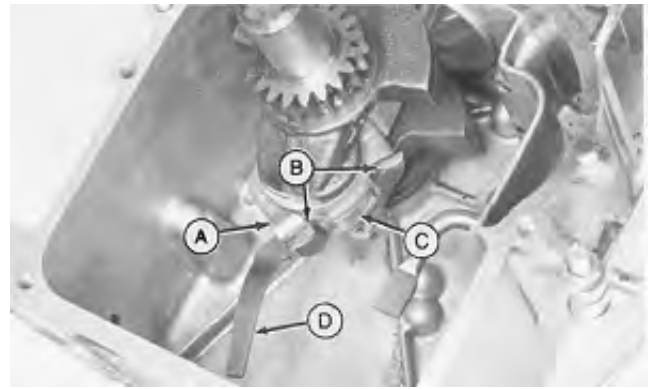


M80254 -UN-11MAR91

MX,2020A1,A13 -19-21OCT92

## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove camshaft. (See this group.)
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
4. Bend open locking tabs (B).
5. Remove cap screws, lock plate (C), oil splasher (D) and connecting rod cap (A).
6. Push piston and connecting rod from cylinder bore.
7. Make repairs as necessary. (See procedures in this group.)



**A—Connecting Rod Cap**  
**B—Locking Tabs**  
**C—Lock Plate**  
**D—Oil Splasher**

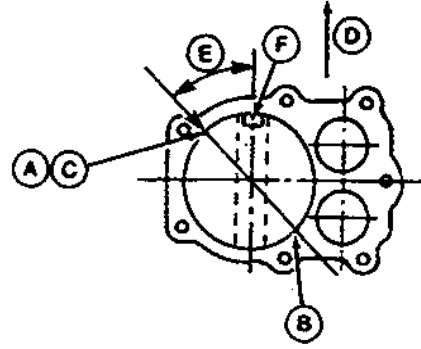
MX,2020A1,A14 -19-21OCT92

M80255 -UN-11MAR91

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9



8. Deglaze cylinder bore. (See Section 100, Group 15.)
9. Align piston assembly to cylinder bore with piston ring end gaps as shown.
10. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
11. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
12. Install piston assembly in cylinder bore with notch on piston head facing flywheel side.
13. Install connecting rod cap, oil splasher and lock plate. Tighten cap screws to specifications.
14. Bend locking tabs over cap screws.
15. Install camshaft.
16. Install cylinder head.



A—First Ring End Gap  
 B—Second Ring End Gap  
 C—Oil Ring End Gap  
 D—Flywheel Side  
 E—45° Angle  
 F—Notch

**TORQUE SPECIFICATIONS**

FA130D . . . . .	12 N·m (106 lb-in.)
FA210D . . . . .	19 N·m (168 lb-in.)

MX,2020A1,A15 -19-21OCT92

**DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD**

1. Remove circlip, piston pin (B) and connecting rod (A).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



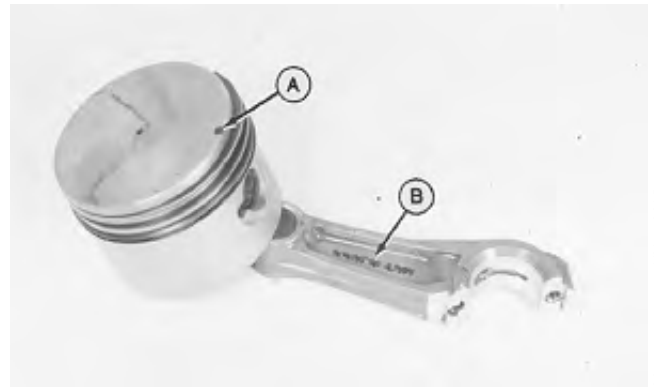
MX,2020A1,A16 -19-21OCT92

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M51530 -UN-31AUG88

M80256 -JUN-11MAR91

4. Align notch (A) on piston head with MADE IN JAPAN (B) on connecting rod.
5. Install piston pin and circlip.



MX,2020A1,A17 -19-21OCT92

M80257 -JUN-11MAR91

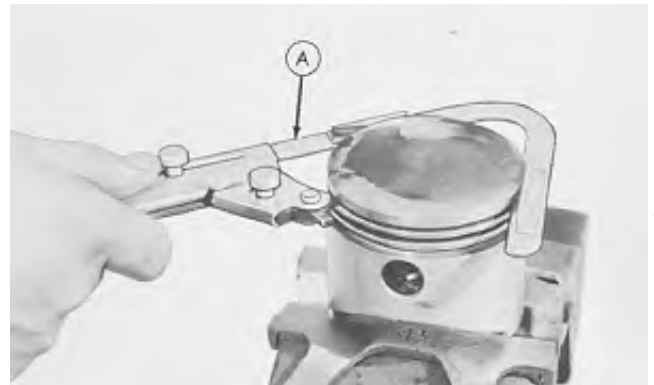
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11

## INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,2020A1,A18 -19-21OCT92

M29946 -JUN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: On FA130D engines, compression rings are tapered and cannot be measured as shown.*

*Inspect clearance visually. Replace piston if clearance appears excessive.*



M38102 -UN-29AUG88

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.

**CLEARANCE SPECIFICATION (MAX)**

	<b>Top Ring</b>	<b>Second Ring</b>	<b>Oil Control Ring</b>
FA130D	—	—	0.15 (0.006 in.)
FA210D	0.15 mm (0.006 in.)	0.13 mm (0.005 in.)	0.12 mm (0.004 in.)

MX,2020A1,A19 -19-21OCT92

8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston pin bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

	<b>Piston Pin O.D. (MIN)</b>	<b>Piston Bore I.D. (MAX)</b>
FA130D	12.98 mm (0.511 in.)	13.04 mm (0.513 in.)
FA210D	14.98 mm (0.590 in.)	15.05 mm (0.593 in.)



M50064 -UN-31AUG88



M80258 -UN-11MAR91

MX,2020A1,A20 -19-21OCT92

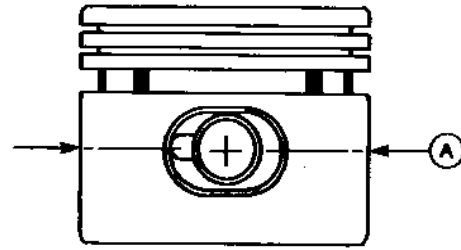
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12

10. Measure piston O.D. (A) perpendicular to piston pin bore.

11. Measure cylinder bore. (See Inspect Block in this group.)

12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.

13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)



**SPECIFICATIONS**

Piston O.D. (A)  
 FA130D . . . . . 61.86—61.89 mm (2.435—2.437 in.)  
 FA210D . . . . . 71.86—71.89 mm (2.829—2.830 in.)

Piston-to-Cylinder Bore Clearance  
 Maximum . . . . . 0.163 mm (0.0064 in.)  
 Standard . . . . . 0.087—0.137 mm (0.0034—0.0054 in.)

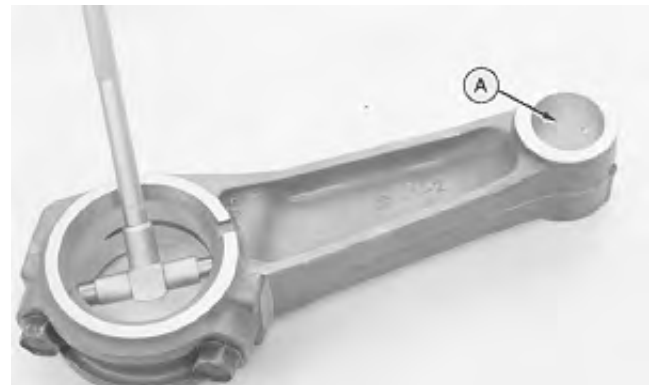
MX,2020A1,A20A -19-21OCT92

M80259 -UN-19MAR91

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20  
13

**INSPECT CONNECTING ROD**

1. Clean and inspect rod. Replace if scored.
2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
3. Install connecting rod cap. Tighten cap screws to specification.
4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



M50066 -UN-31AUG88

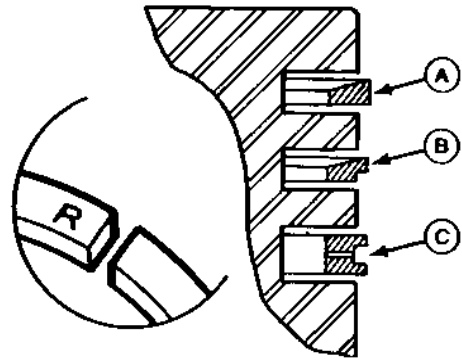
**BEARING I.D. SPECIFICATIONS (MAX)**

	<b>Crankshaft Bearing</b>	<b>Piston Bearing</b>
FA130D	24.05 mm (0.947 in.)	13.04 mm (0.513 in.)
FA210D	27.06 mm (1.065 in.)	15.04 mm (0.592 in.)

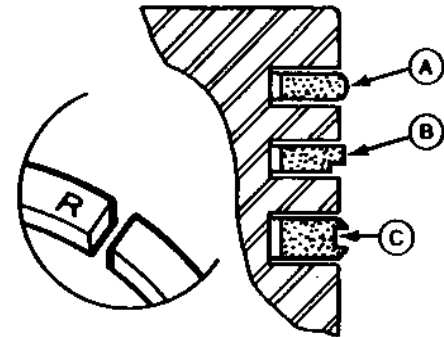
MX,2020A1,A21 -19-21OCT92

## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)
4. Install top ring (A), second ring (B) and oil ring (C) with R or NPR mark facing up. Rings should turn freely in grooves.



FA130D



FA210D

MX,2020A1,A22 -19-21OCT92

M80234 -UN-06APR91

M80260 -UN-19MAR91

M80260

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.

### END GAP SPECIFICATIONS

Minimum End Gap	0.18 mm (0.007 in.)
Maximum End Gap	1.00 mm (0.039 in.)



M80261 -UN-11MAR91

M80261

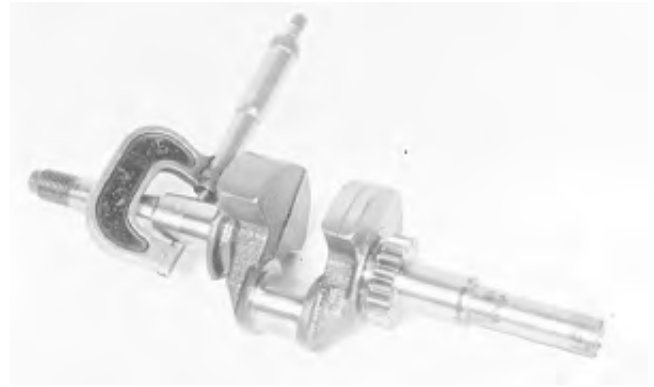
MX,2020A1,A23 -19-21OCT92

## REMOVE, INSPECT AND INSTALL CRANKSHAFT

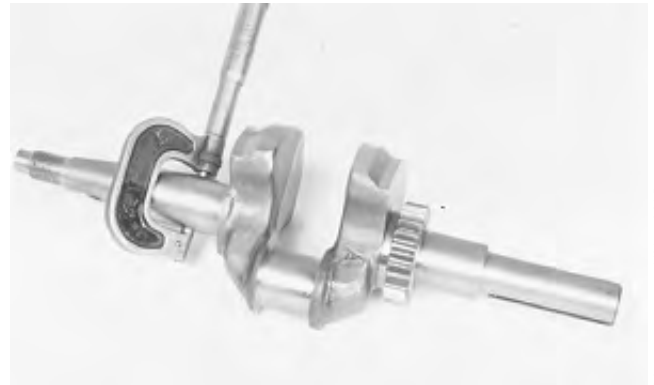
1. Remove piston and connecting rod. (See this group.)
2. Remove crankshaft.

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

3. Check crankshaft alignment (T.I.R.). (See this group.)
4. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
5. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
6. Measure crankshaft main bearing journals and connecting rod journal. Replace crankshaft if measurements are less than specifications.
7. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
8. Apply clean engine oil to crankshaft bearings and journal.
9. Pack lithium based grease in oil seals.
10. Install crankshaft.
11. Install piston and connecting rod.



FA130D



FA210D

### JOURNAL SPECIFICATIONS (MIN)

	Main Bearing Journal		Connecting Rod Journal
	PTO Side	Flywheel Side	
FA130D	—	21.97 mm (0.865 in.)	23.95 mm (0.943 in.)
FA210D	—	24.96 mm (0.983 in.)	26.95 mm (1.061 in.)

MX,2020A1,A24 -19-21OCT92

M80262 -UN-11MAR91

M80295 -UN-11MAR91

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## INSPECT CRANKSHAFT PLAIN BEARING

**NOTE:** Cylinder block is fitted with a replaceable bearing shell.

1. Remove crankshaft. (See this group.)
2. Measure crankshaft bearing in cylinder block. Replace shell, if diameter is greater than specifications. (See this group.)
3. Install crankshaft.

### BEARING I.D. SPECIFICATIONS (MAX)

FA130D .....	22.10 mm (0.869 in.)
FA210D .....	25.10 mm (0.988 in.)

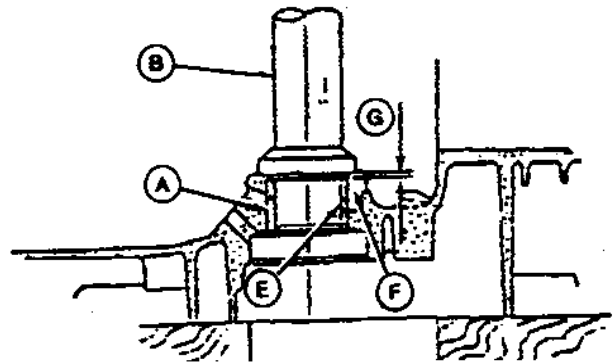


M80263 -UN-11MAR91

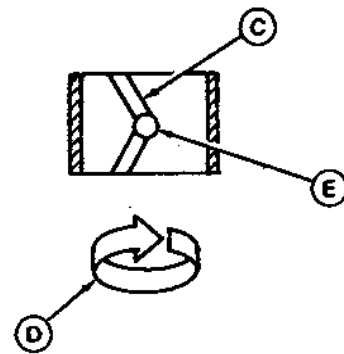
MX,2020A1,A25 -19-21OCT92

## REPLACE CRANKSHAFT BEARING SHELL

1. Drive old bearing (A) from crankcase using an appropriate bushing tool (B) and an arbor press.
2. Align new bearing so arrow head formed by oil grooves (C) points opposite to engine rotation (D). Align oil hole (E) in bearing with oil passage (F) in crankcase.
3. Install new bearing to depth (G) 1 mm (0.039 in.) below flange surface.



- A—Bearing
- B—Bushing Tool
- C—Oil Grooves
- D—Engine Rotation
- E—Oil Hole
- F—Oil Passage
- G—Installation Depth



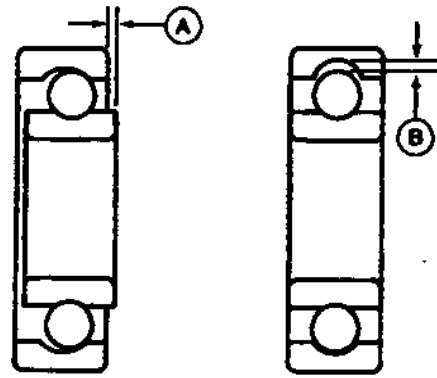
M51527 -UN-31AUG88

M51526 -UN-31AUG88

MX,2020A1,A26 -19-21OCT92

### INSPECT CRANKSHAFT BALL BEARING

1. Remove PTO end oil seal. (See Inspect Oil Seals in this group.)
2. Remove crankshaft bearing from crankcase cover using a bearing, bushing and seal driver set.
3. Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
4. Spin the bearing by hand and check for axial (A) and radial (B) free play.
5. Replace the bearing if it is noisy or has too much play.
6. Install bearing flush to inside of crankcase cover using a bearing, bushing and seal driver set.
7. Install oil seal.



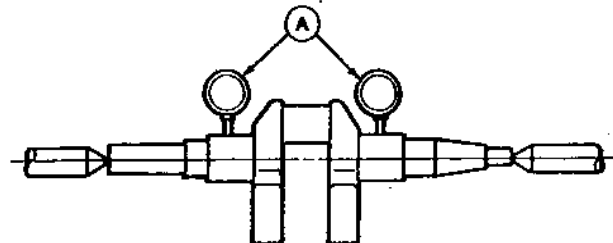
MX,2020A1,A27 -19-21OCT92

M38073 -UN-29AUG88

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17

### CHECK CRANKSHAFT ALIGNMENT (TIR)

Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.



#### SPECIFICATIONS

Maximum TIR . . . . . 0.05 mm (0.002 in.)

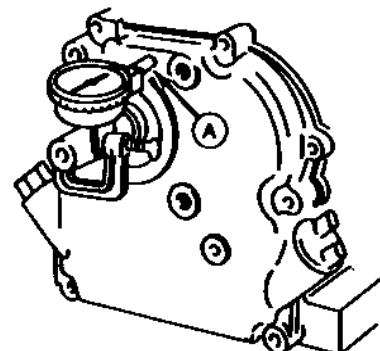
MX,2020A1,A28 -19-21OCT92

-UN-07SEP88

M51761

### MEASURE CRANKSHAFT END PLAY

1. Measure end play using dial indicator (A).
2. Move crankshaft in and out. Record this measurement. Replace block or crankshaft if end play is not within specifications.



#### SPECIFICATIONS

End Play . . . . . 0—0.30 mm (0—0.012 in.)

MX,2020A1,A29 -19-21OCT92

-UN-19MAR91

M80264



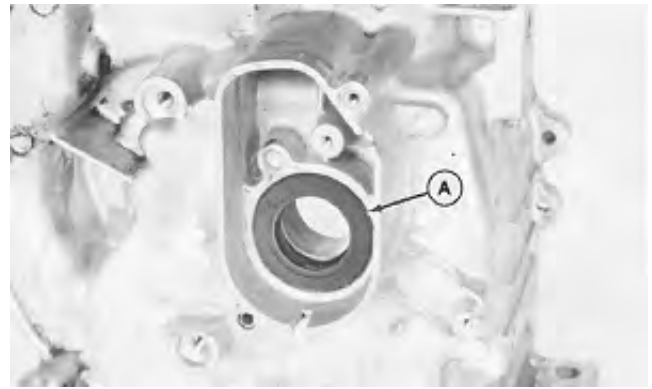
## INSPECT OIL SEALS

*NOTE: Pack lithium base grease in new or used seals.*

1. Remove flywheel. (See Group 10.)
2. Inspect oil seals (A and B) at flywheel end and PTO end for wear or damage. Replace if necessary.
3. Remove crankshaft. (See this group.)
4. Remove worn or damaged seals with a screwdriver.
5. Install seals with lip to inside of engine using a bushing, bearing and seal driver set.  
Press in seal on flywheel side until flush with hub.  
Press in PTO side seal below crankcase cover flange surface, to specification.
6. Install crankshaft.
7. Install flywheel.

### SPECIFICATIONS

Seal Depth . . . . . 4 mm (0.150 in.)



Flywheel Side



PTO Side

M80265 -UN-11MAR91

M80266 -UN-11MAR91

MX,2020A1,A30 -19-21OCT92

## INSPECT CYLINDER BLOCK

1. Remove crankshaft. (See this group.)
2. Clean and check block for cracks.
3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
4. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

MX,2020A1,A31 -19-21OCT92

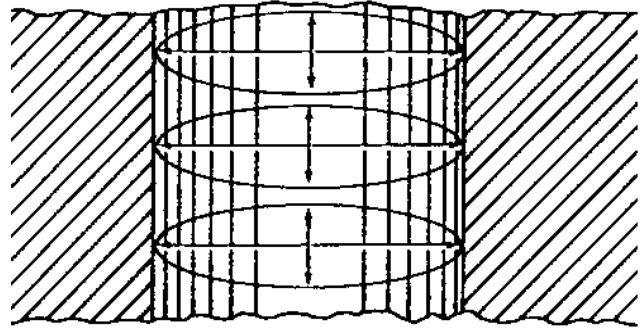
**NOTE:** A bare block is available for service.

5. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

6. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

**NOTE:** If cylinder is rebored, oversize piston and rings must be installed.

7. Install crankshaft.



M51745 -UN-23FEB89

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19

**CYLINDER BORE SPECIFICATIONS**

	<b>Standard</b>	<b>Wear Limit</b>
FA130D	61.98—62.00 mm (2.442—2.443 in.)	62.07 mm (2.446 in.)
FA210D	71.98—72.00 mm (2.834—2.835 in.)	72.06 mm (2.837 in.)



M80267 -UN-11MAR91

MX,2020A1,A32 -19-21OCT92

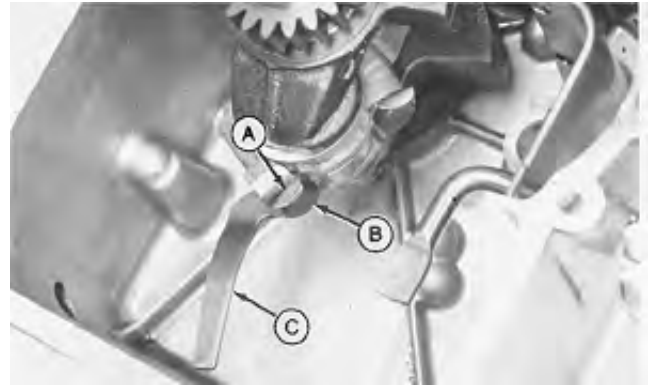
**REBORE CYLINDER BLOCK**

**NOTE:** The cylinder block can be rebored to use 0.25 or 0.50 mm (0.010 or 0.020 in.) oversize pistons and rings. Have a reliable repair shop rebore the block to initial and final bore specifications. The repair shop must have proper equipment to handle cylinders made of high silicon content aluminum.

MX,2020A1,A33 -19-21OCT92

## INSPECT AND REPLACE OIL SPLASHER

1. Remove camshaft. (See this group.)
2. Bend open locking tab (A).
3. Remove cap screw (B).
4. Remove oil splasher (C).
5. Inspect splasher for wear or damage. Replace if necessary.
6. Install splasher and cap screw. Tighten cap screw to specifications.
7. Bend locking tab over cap screw.
8. Install camshaft.



M80268 -UN-11MAR91

### TORQUE SPECIFICATIONS

Cap Screws	
FA130D	12 N·m (106 lb-in.)
FA210D	19 N·m (168 lb-in.)

MX,2020A1,A34 -19-21OCT92

## CHECK LOW OIL LEVEL SENSOR—FA130D-AN00

1. Remove crankcase cover. (See this group.)
2. Remove screws (A) and float cover (B).

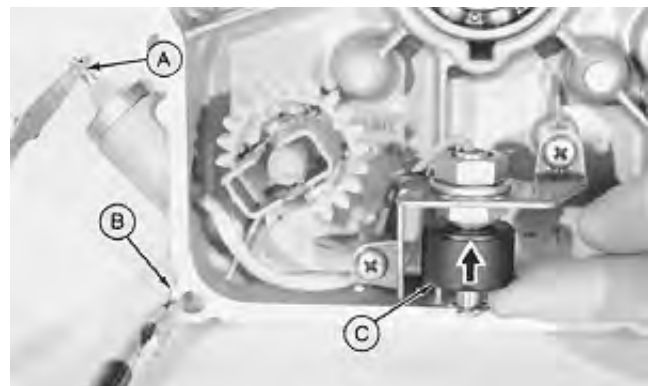


TY15052 -UN-02SEP88

MX,2020A1,A35 -19-21OCT92

3. Connect multimeter test leads to low oil sensor lead (A) and case (B). Set multimeter selector switch to Rx1 ohm position.

Slide float (C) to top of shaft. Multimeter should indicate infinite resistance.



TY15053 -UN-02SEP88

M98,2045A,A11 -19-21OCT92

4. Slowly slide float down shaft until needle of multimeter swings to 0 ohms.

Measure distance (A) with float at point where needle rapidly moves from infinite resistance to 0 ohms. Replace switch if not according to specification.

5. Install cover.

**SPECIFICATIONS**

Distance (A) . . . . . 9.5—15.5 mm (0.374—0.610 in.)



M98,2045A,A12 -19-21OCT92

TY15055 -UN-02SEP88

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21

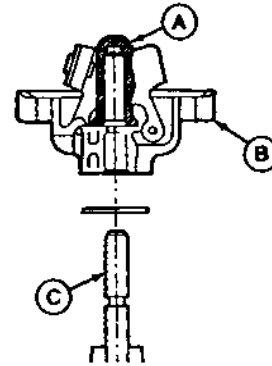
**INSPECT AND REPLACE GOVERNOR**

**IMPORTANT:** Removal damages governor. If not damaged, do not remove.

1. Remove crankcase cover. (See this group.)
2. Inspect governor. If necessary to replace, remove with screwdriver.
3. If removed, press shaft (C) back into block until it protrudes 32.2—32.8 mm (1.267—1.291 in.).

*NOTE: Assemble sleeve and gear before installing assembly on shaft.*

4. Install sleeve (A) onto governor gear (B).
5. Install governor assembly onto shaft. Push down on assembly until it snaps into place.



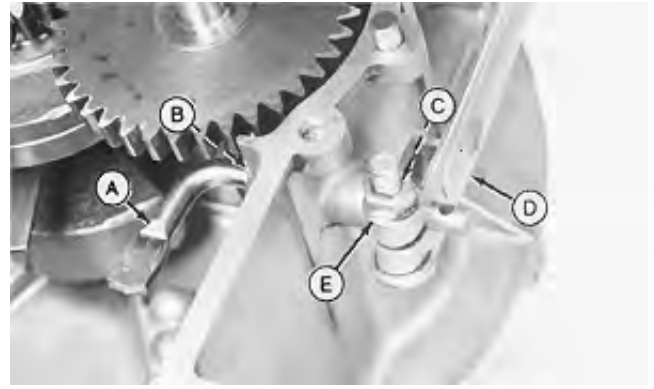
MX,2020A1,A36 -19-21OCT92

M51762 -UN-07SEP88

## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (A). Replace if damaged.
3. To replace shaft, loosen nut (E) on lever (D).
4. Remove retaining pin (C), governor shaft and washer (B).
5. Install washer, shaft and retaining pin. Tighten nut.
6. Install crankcase cover.



A—Governor Shaft  
 B—Washer  
 C—Retaining Pin  
 D—Governor Lever  
 E—Nut

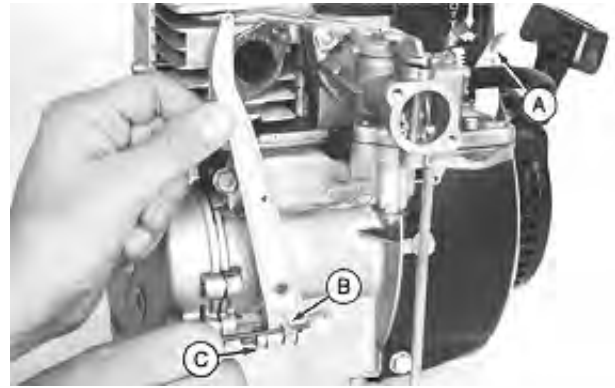
MX,2020A1,A37 -19-21OCT92

M80269 -UN-11MAR91

## GOVERNOR ADJUSTMENT—FA130D-AS16/AS19 AND FA210D-AS20

*NOTE: Fuel tank is removed for photo clarity only.*

1. Move throttle control lever (A) to fast position.
2. Loosen nut (C).
3. Hold governor arm fully clockwise.
4. Using a small pin, rotate shaft (B) clockwise as far as it will go.
5. Tighten nut.



MX,2020A1,A38 -19-21OCT92

M80364 -UN-17MAY91

### GOVERNOR ADJUSTMENT—FA130D-AN00 AND FA210D-AS19-01/AS17/BS17/CS17

1. Move throttle control lever (A) to fast position.
2. Loosen nut (C).
3. Hold governor arm fully clockwise.
4. Using a small pin, rotate shaft (B) clockwise as far as it will go.
5. Tighten nut.



M80366 -UN-17MAY91

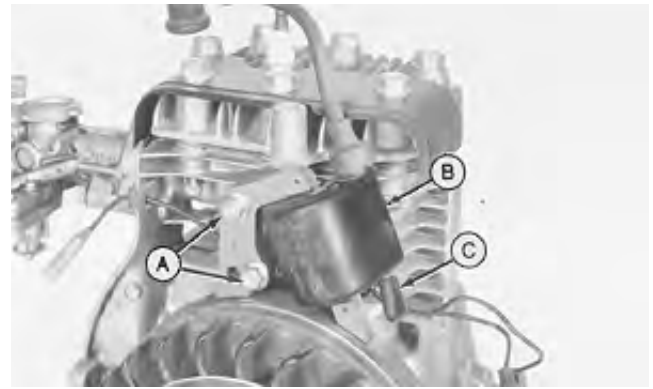
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MX,2020A1,A39 -19-21OCT92

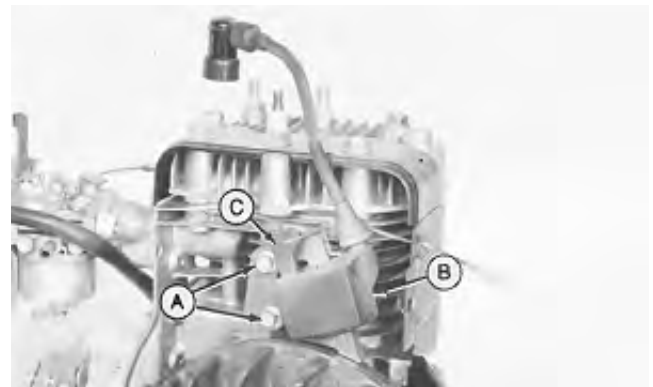


## REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove blower housing. (See Group 10.)
2. Disconnect wiring lead (C).
3. Remove cap screws (A) and armature with coil (B).
4. Loosely install armature with coil.
5. Connect wiring lead.
6. Adjust armature air gap. (See this group.)
7. Install blower housing.



*FA130D and FA210D-AS20*



*FA210D-AS19-01/AS17/BS17/CS17*

MX.2025A1,A1 -19-21OCT92

M80270 -UN-11MAR91

M80297 -UN-11MAR91

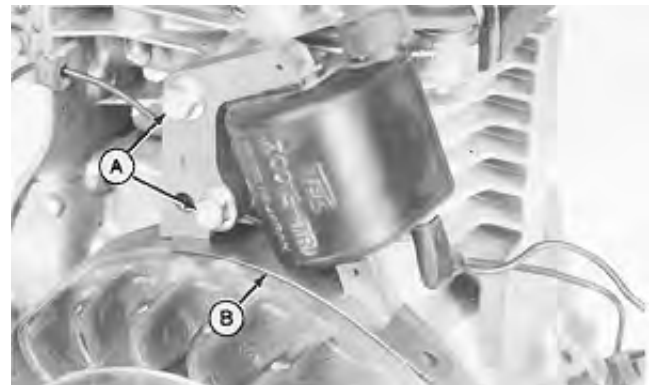
20  
25  
1

## ADJUST ARMATURE AIR GAP

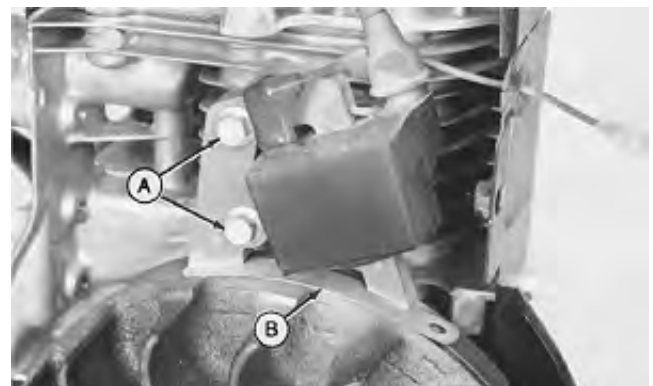
1. Turn flywheel magnet away from armature.
2. Insert feeler gauge blade (B), between flywheel and armature.
3. Push armature against flywheel and tighten screws (A).
4. Turn flywheel to remove gauge.

### AIR GAP SPECIFICATIONS

Feeler Gauge Blade	
FA130D .....	0.50 mm (0.019 in.)
FA210D .....	0.30 mm (0.012 in.)



*FA130D and FA210D-AS20*



*FA210D-AS19-01/AS17/BS17/CS17*

MX.2025A1,A2 -19-21OCT92

M80271 -UN-11MAR91

M80298 -UN-11MAR91

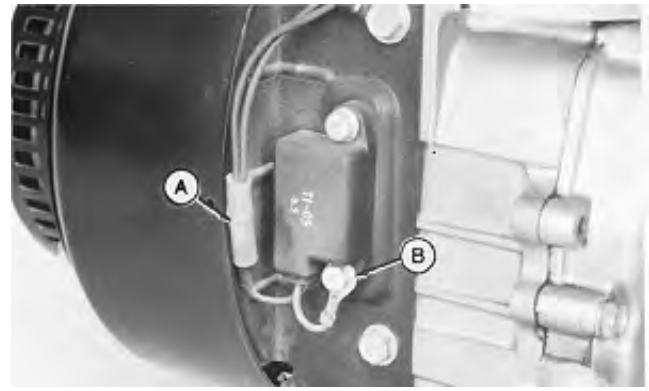


## REPLACE IGNITOR—FA130D AND FA210D-AS20

1. Disconnect wiring lead (A).
2. Remove ignitor.

*NOTE: When installing ignitor, put wiring lead (B) under screw and washer.*

3. Install ignitor.
4. Connect wiring lead.



M80299 -UN-11MAR91

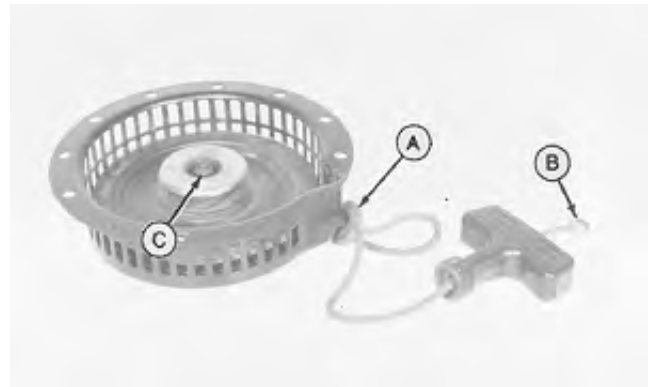
MX,2025A1,A3 -19-21OCT92

### DISASSEMBLE RECOIL STARTER—FA130D-AS16/AS19

1. Remove starter.
2. Pull handle out about 30 cm (1 ft). Tie knot (A) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (A). Slowly release reel tension. Do not let rope get wedged between reel and housing.

**⚠ CAUTION: Wear gloves and protective goggles for remaining steps.**

6. Remove cap screw (C) and ratchet cover.
7. Remove pawl and springs.



M80272 -UN-11MAR91

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1

MX,2030A1,A1 -19-21OCT92

**⚠ CAUTION: A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.**

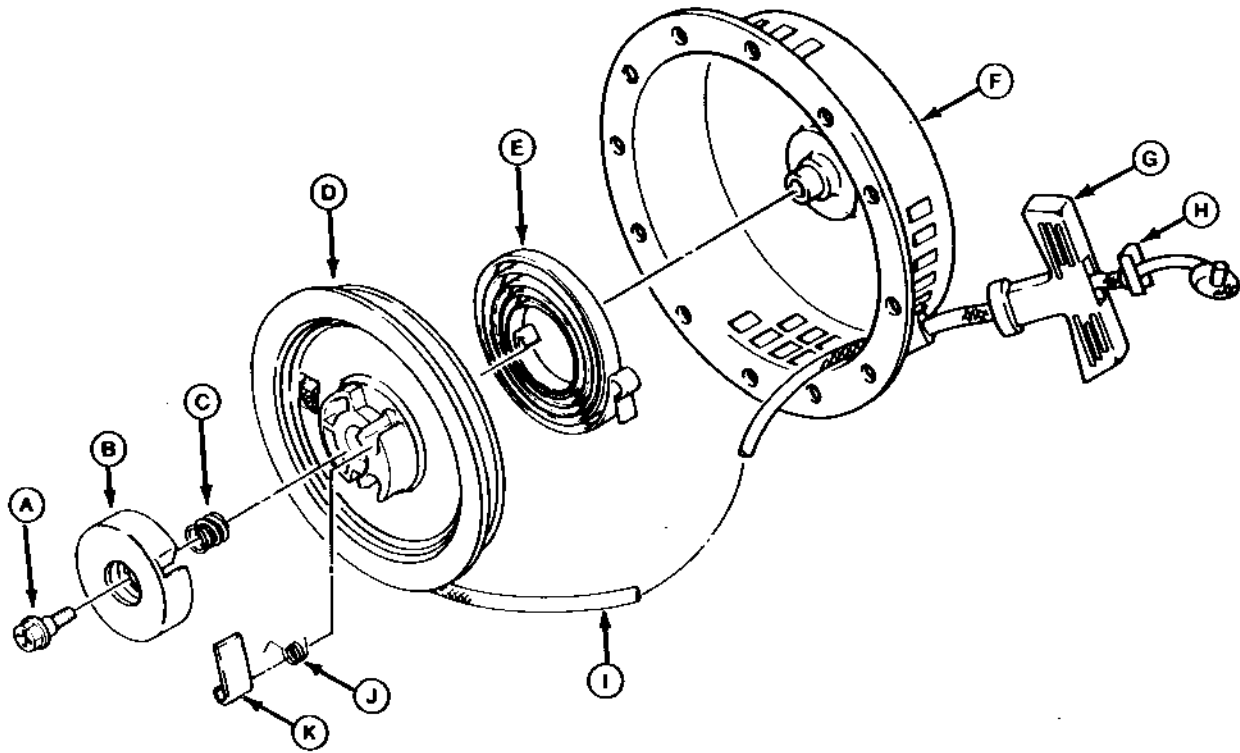
8. Turn the reel one half turn clockwise so no spring tension can be felt.
9. Spring is stored in reel. Carefully remove while holding spring in underside of reel.
10. Inspect starter for wear or damage. (See this group.)



M80273 -UN-11MAR91

MX,2030A1,A2 -19-21OCT92

**INSPECT RECOIL STARTER—FA130D-AS16/AS19**



A—Screw  
B—Retainer  
C—Spring

D—Reel  
E—Spring  
F—Housing

G—Handle  
H—Clip  
I—Rope

J—Spring  
K—Pawl

Inspect all parts for wear or damage. Replace as necessary.

MX,2030A1,A3 -19-21OCT92

M80274 -JUN-19/MAR91

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2

## REPLACE SPRING

**CAUTION:** Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.

1. Working from the center out, carefully unwind spring from reel.
2. Hook outside loop (A) over peg (B) in reel. Wind spring into reel, working toward center.



TY15097 -UN-06DEC89

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3

MX,2030A1,A4 -19-21OCT92

## ASSEMBLE RECOIL STARTER—FA130D-AS16/AS19

1. Wind rope counterclockwise onto reel.
2. Apply multipurpose grease to spring.
3. Install reel with spring in housing. Align inner tang (A) with catch (B).
4. Turn reel counterclockwise until you feel tang hook on catch.



M80275 -UN-11MAR91

MX,2030A1,A5 -19-21OCT92

5. Turn reel two turns counterclockwise to preload spring.
6. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (E) to hold rope.
7. Install handle and secure with knot (D).
8. Remove knot (E).
9. Install spring (B), spring and pawl (A) and ratchet cover (C) with opening in cover over pawl. Check for free movement of pawl.
10. Pull rope to check for proper operation.
11. Install recoil starter on engine.



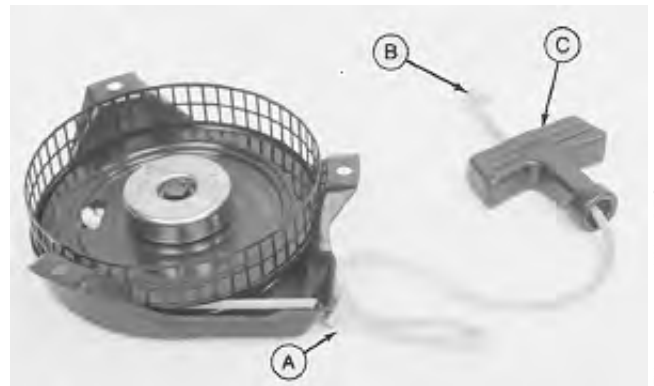
A—Pawl  
B—Spring  
C—Retainer  
D—Knot  
E—Knot

MX,2030A1,A6 -19-21OCT92

M80276 -UN-11MAR91

### DISASSEMBLE RECOIL STARTER—FA130D-AN00

- 1 Remove starter.
2. Pull handle out about 30 cm (1 ft). Tie knot (A) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle (C) and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (A). Slowly release reel tension. Do not let rope get wedged between reel and housing.



MX,2030A1,A7 -19-21OCT92

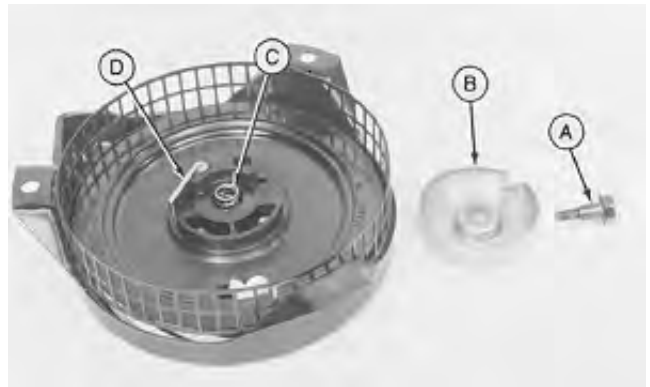
TY15092 -UN-06DEC89

**⚠ CAUTION: Wear gloves and protective goggles for remaining steps.**

6. Remove cap screw (A) and cover (B).
7. Remove spring (C) and pawl and spring (D).

**⚠ CAUTION: A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.**

8. Turn the reel one half turn clockwise so no spring tension can be felt.
9. Spring is stored in reel. Carefully remove while holding spring in underside of reel.
10. Inspect starter for wear or damage. (See this group.)



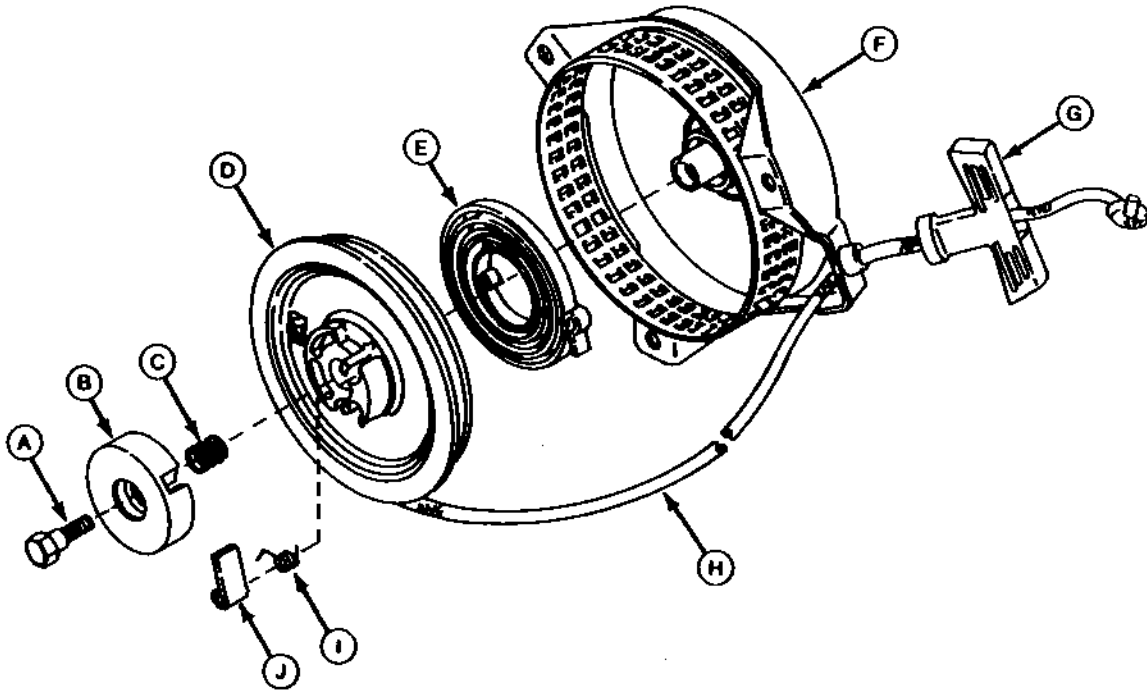
A—Cap Screw  
B—Ratchet Cover  
C—Spring  
D—Pawl and Spring

MX,2030A1,A8 -19-21OCT92

TY15094 -UN-06DEC89

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### INSPECT RECOIL STARTER—FA130D-AN00



A—Screw  
B—Retainer  
C—Spring

D—Reel  
E—Spring  
F—Housing

G—Handle  
H—Rope

I—Spring  
J—Pawl

Inspect all parts for wear or damage. Replace as necessary.

MX,2030A1,A9 -19-21OCT92

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6

M80235 -JN-06APR91

## REPLACE SPRING

**CAUTION:** Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.

1. Working from the center out, carefully unwind spring from reel.
2. Hook outside loop (A) over peg (B) in reel. Wind spring into reel, working toward center.



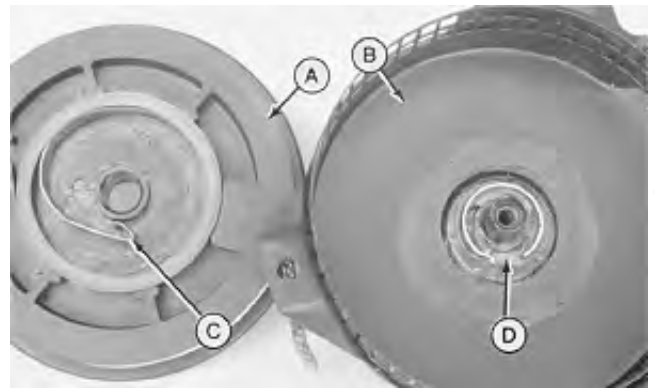
MX,2030A1,A4 -19-21OCT92

TY15097 -UN-06DEC89

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## ASSEMBLE RECOIL STARTER—FA130D-AN00

1. Wind rope counterclockwise onto reel.
2. Apply multipurpose grease to spring.
3. Install reel (A) with spring in housing (B). Align spring hook (C) with slot (D).
4. Turn reel counterclockwise until you feel spring hook on catch.



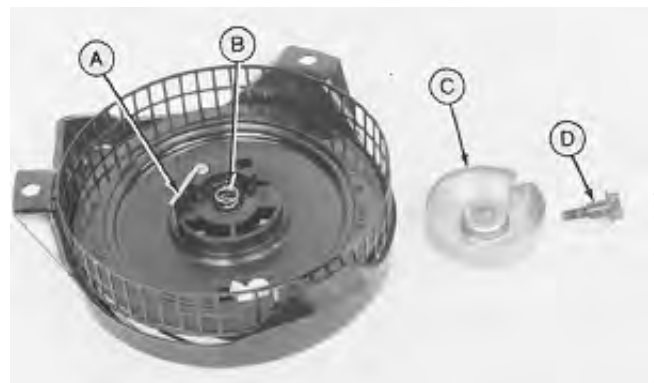
A—Reel  
B—Housing  
C—Spring Hook  
D—Slot

MX,2030A1,A10 -19-21OCT92

TY15099 -UN-06DEC89

5. Install pawl and spring (A).
6. Install spring (B), cover (C) and cap screw (D).
7. Turn reel two turns counterclockwise to preload spring.

A—Pawl and Spring  
B—Spring  
C—Ratchet Cover  
D—Cap Screw

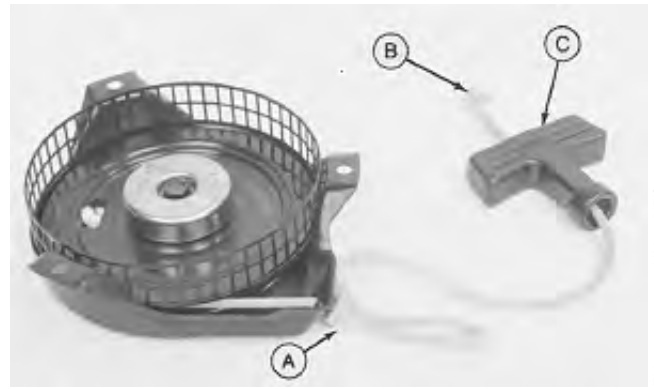


MX,2030A1,A11 -19-21OCT92

TY15100 -UN-06DEC89



8. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (A) to hold rope.
9. Install handle (C) and secure with knot (B).
10. Remove knot (A).
11. Pull rope to check for proper operation.
12. Install recoil starter on engine.



MX,2030A1,A12 -19-21OCT92

TY15092 -UN-06DEC89

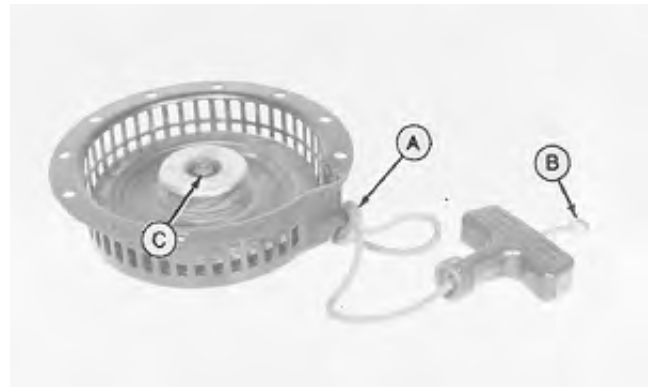
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## DISASSEMBLE RECOIL STARTER

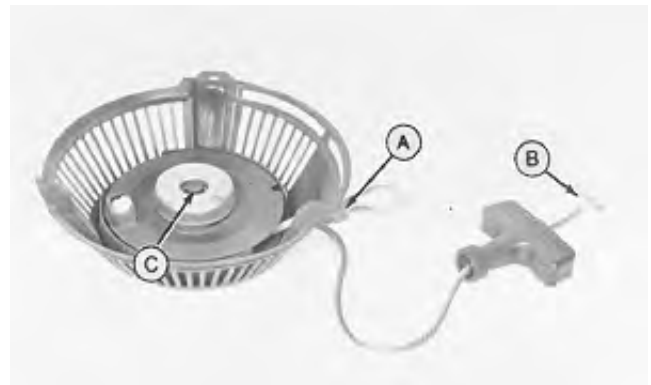
1. Remove starter.
2. Pull handle out about 30 cm (1 ft). Tie knot (A) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (A). Slowly release reel tension. Do not let rope get wedged between reel and housing.

**CAUTION:** Wear gloves and protective goggles for remaining steps.

6. Remove screw (C) and ratchet cover.
7. Remove pawl and springs.



FA210D-AS20



FA210D-AS19-01/AS17/BS17/CS17

MX,2031A1,A1 -19-21OCT92

**CAUTION:** A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.

8. Turn the reel one half turn clockwise so no spring tension can be felt.
9. FA210D-AS20 and AS19-01: Spring is stored in reel. Carefully remove reel while holding spring in underside of reel.



FA210D-AS20



FA210D-AS19-01

MX,2031A1,A2 -19-21OCT92

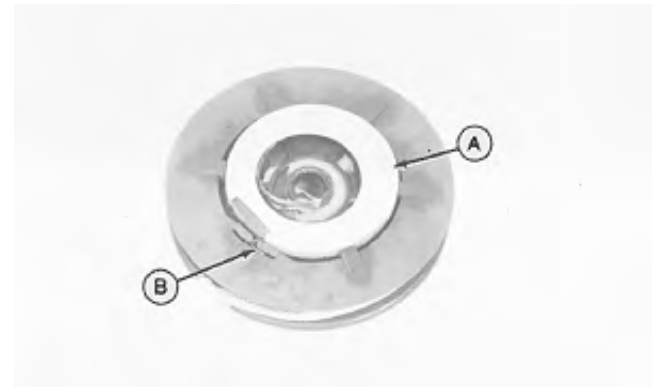
FA210D-AS17/BS17/CS17:

Spring is stored in spring case (A) in reel. Lift reel straight up so spring case remains seated in reel.

—Carefully unhook spring tang (B) from catch.

—Remove spring case from reel.

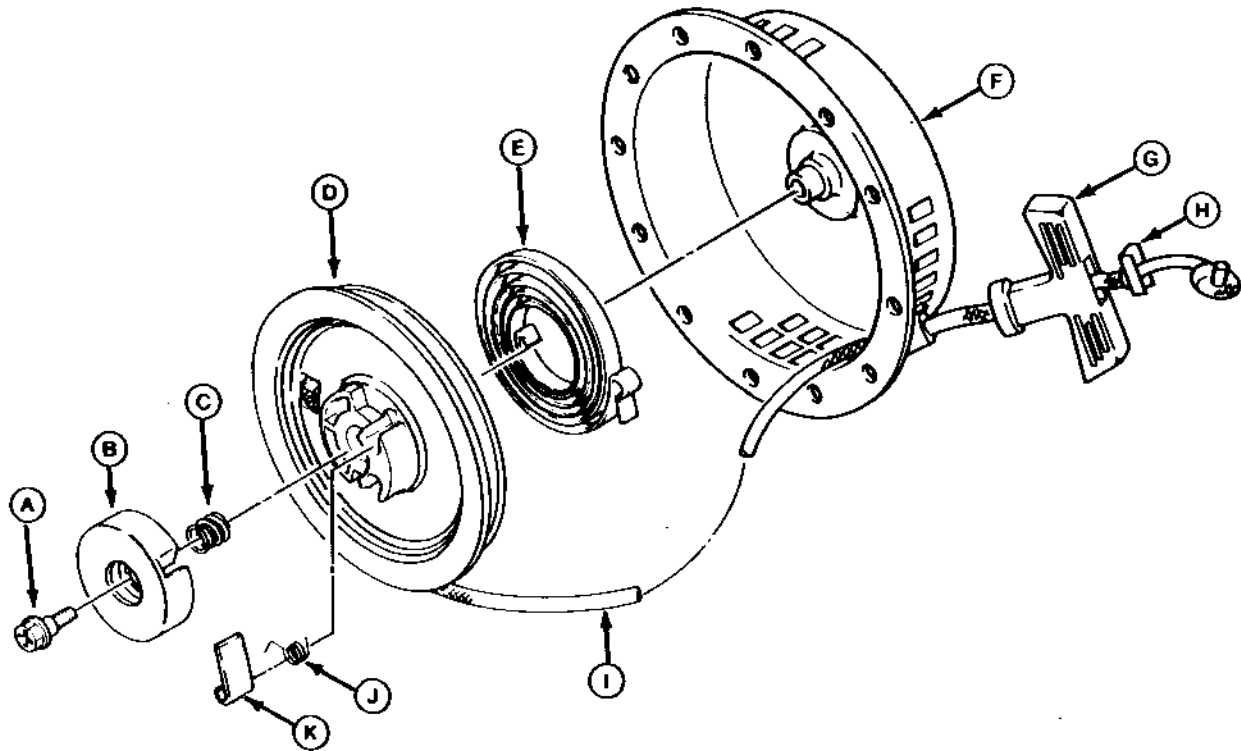
10. Inspect starter for wear or damage. (See this group.)



MX,2031A1,A3 -19-21OCT92

M80301 -UN-11MAR91

**INSPECT RECOIL STARTER**



A—Screw  
B—Retainer  
C—Spring

D—Reel  
E—Spring  
F—Housing

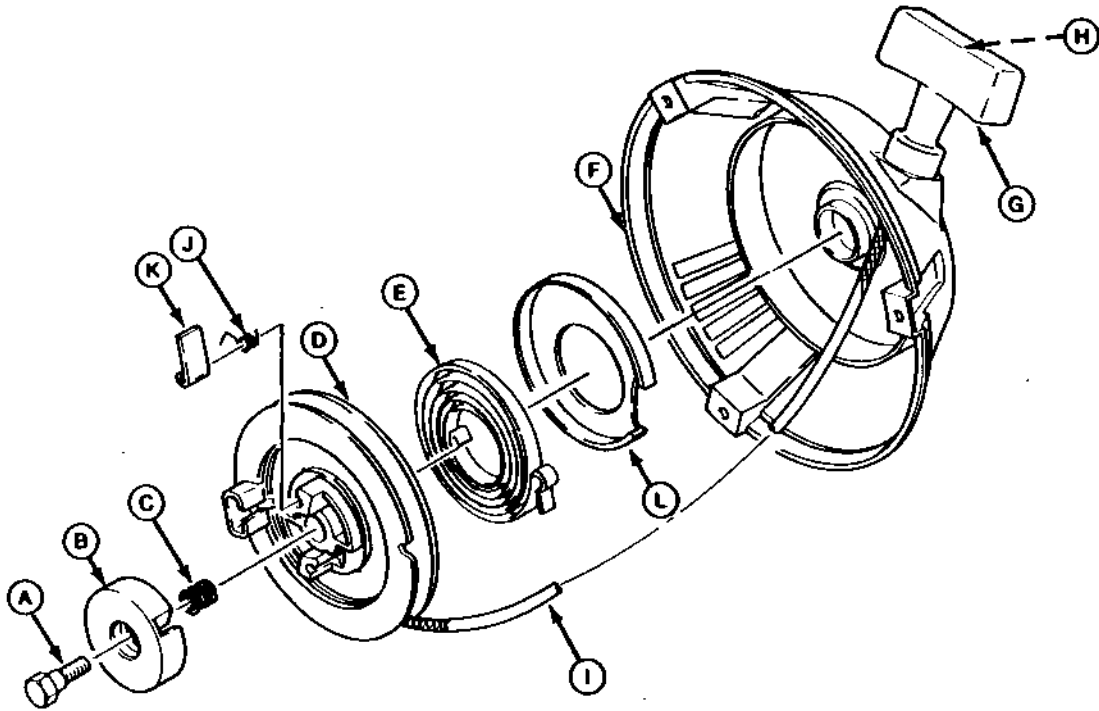
G—Handle  
H—Clip  
I—Rope

J—Spring  
K—Pawl

FA210D-AS20

M80274 -UN-19MAR91

MX,2031A1,A4 -19-21OCT92



A—Screw  
B—Retainer  
C—Spring

D—Reel  
E—Spring  
F—Housing

G—Handle  
H—Clip  
I—Rope

J—Spring  
K—Pawl  
L—Spring Case\*

FA210D-AS19-01/AS17/BS17/CS17

Inspect all parts for wear or damage. Replace as necessary.

\*FA210D—AS17, BS17, CS17 only.

MX,2031A1,A4A -19-21OCT92

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M80302 -UN-19MAR91

## REPLACE SPRING

**⚠ CAUTION:** Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.

1. Working from the center out, carefully unwind spring from spring case or reel.
2. Hook outside spring tang in reel or case. Wind spring into reel or spring case, working toward center.



FA210D-AS20 and AS19-01

M80195 -UN-11FEB91



FA210D-AS17/BS17/CS17

M54497 -UN-09JAN91

MX,2031A1,A5 -19-21OCT92

## ASSEMBLE RECOIL STARTER

1. Wind rope counterclockwise onto reel.
2. Apply multipurpose grease to spring.
3. FA210D-AS20 and AS19-01: Install reel with spring in housing. Align inner tang (A) with catch (B).



M80275 -UN-11MAR91



FA210D-AS19-01

M80303 -UN-11MAR91

MX,2031A1,A6 -19-21OCT92

FA210D-AS17/BS17/CS17:

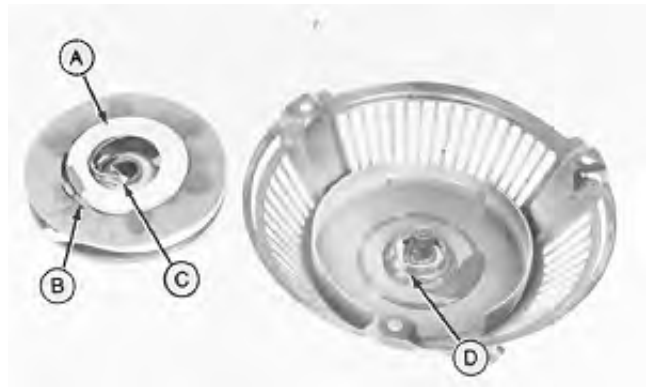
Place spring case (A) into reel with spring tang into catch (B).

—Install reel with spring case into housing, aligning inner tang (C) with catch (D).

4. Turn reel counterclockwise until you feel tang hook on catch.

A—Spring Case  
B—Reel Catch

C—Inner Tang  
D—Housing Catch



MX,2031A1,A7 -19-21OCT92

M80304 -UN-11MAR91

2031

5. Place rope in notch (F), if equipped. Turn reel two turns counterclockwise to preload spring.

6. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (E) to hold rope.

7. Install handle and secure with knot (D).

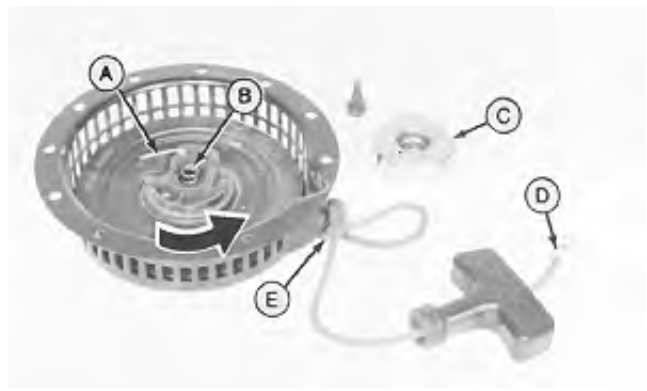
8. Remove knot (E).

9. Install spring (B), spring and pawl (A) and ratchet cover (C) with opening in cover over pawl. Check for free movement of pawl.

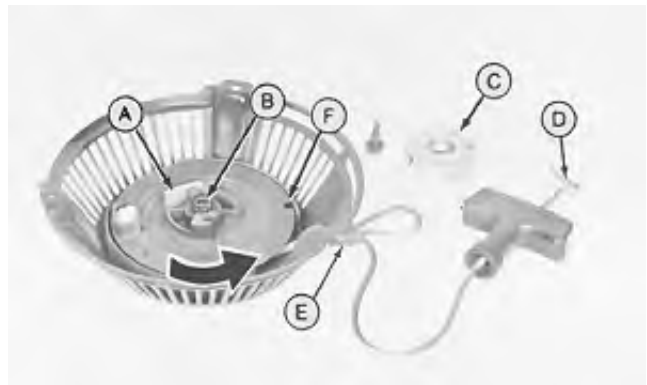
10. Pull rope to check for proper operation.

11. Install recoil starter on engine.

A—Pawl  
B—Spring  
C—Retainer  
D—Knot  
E—Knot  
F—Notch



FA210D-AS20



FA210D-AS19-01/AS17/BS17/CS17

MX,2031A1,A8 -19-21OCT92

M80276 -UN-11MAR91

M80305 -UN-11MAR91



# Section 21

## FA210V

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### ENGINE APPLICATIONS CHART

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

Machine	Engine Model No.
RX63 Riding Mower . . . . .	FA210V-AS00

MX,2100A1,A1 -19-21OCT92

### FA210V REPAIR SPECIFICATIONS

#### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Item	Specification
Flywheel Nut Torque . . . . .	60 N·m (44 lb-ft)
Flywheel Screen Gap . . . . .	1—3 mm (0.039—0.118 in.)

#### GROUP 15—CYLINDER HEAD

Cylinder Head	
Maximum Cylinder Head Warp . . . . .	0.40 mm (0.015 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	10 N·m (89 lb-ft)
Final Torque . . . . .	21 N·m (186 lb-ft)
Spark Plug Torque . . . . .	24 N·m (212 lb-in.)

#### GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS

Valve Clearance (cold)	
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)
Exhaust . . . . .	0.12—0.34 mm (0.005—0.013 in.)
Valves and Springs	
Minimum Spring Free Length . . . . .	23.50 mm (0.930 in.)
Maximum Valve Guide I.D.	
Intake . . . . .	6.117 mm (0.248 in.)
Exhaust . . . . .	6.095 mm (0.240 in.)
Valve Stem Diameter (max.)	
Intake . . . . .	5.960 mm (.2346 in.)
Exhaust . . . . .	6.095 mm (.240 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seat and Face Angle . . . . .	45°
Valve Seating Width . . . . .	1.30 mm (0.050 in.)
Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

Continued on next page

MX,2100A1,A2 -19-21OCT92

**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

<b>Item</b>	<b>Specification</b>
<b>Crankcase Cover</b>	
Oil Capacity . . . . .	0.6 L (1.27 pt)
Cap Screw Torque . . . . .	21 N·m (186 lb-in.)
<b>Camshaft</b>	
Minimum End Journals O.D. . . . .	12.94 mm (0.509 in.)
Minimum Lobe Height	
Intake . . . . .	26.45 mm (1.041 in.)
Exhaust . . . . .	26.35 mm (1.037 in.)
Maximum Bearing I.D. . . . .	13.05 mm (0.514 in.)
<b>Piston</b>	
Maximum Ring Groove Clearance	
Top Ring . . . . .	Not Measured
Second Ring . . . . .	0.13 mm (0.005 in.)
Oil Ring . . . . .	0.17 mm (0.007 in.)
Minimum Ring End Gap . . . . .	0.178 mm (0.007 in.)
Maximum Ring End Gap	
Compression Rings . . . . .	1.00 mm (0.039 in.)
Oil Ring Side Rails . . . . .	1.40 mm (0.055 in.)
Minimum Pin O.D. . . . .	14.98 mm (0.590 in.)
Maximum Pin Bore I.D. . . . .	15.04 mm (0.593 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.06 mm (0.003 in.)
Piston O.D. . . . .	71.86—71.89 mm (2.829—2.836 in.)
Cylinder-to-Bore Clearance (std.) . . . . .	0.087—0.137 mm (0.0034—0.0054 in.)
(max.) . . . . .	0.163 mm (.0064 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	27.06 mm (1.065 in.)
Maximum Piston Pin Bearing I.D. . . . .	15.04 mm (0.592 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.06 mm (0.003 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.12 mm (0.005 in.)
End-Cap Screw Torque . . . . .	19 N·m (168 lb-in.)
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	25.37 mm (0.999 in.)
Minimum Flywheel Side Journal O.D. . . . .	24.96 mm (0.983 in.)
Minimum Connecting Rod Journal O.D. . . . .	26.95 mm (1.061 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0—0.30 mm (0—0.012 in.)
<b>Plain Bearings</b>	
Crankcase Bearing . . . . .	25.10 mm (0.988 in.)
Crankcase Cover Bearing . . . . .	24.50 mm (0.965 in.)

*Continued on next page*

MX,2100A1,A3 -19-21OCT92

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**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
Cylinder Bore	
Standard Cylinder Bore I.D. . . . .	71.98—72.00 mm (2.834—2.835 in.)
Maximum Cylinder Bore I.D. . . . .	72.06 mm (2.837 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)
---------------------------------	---------------------

See Ignition Tests in this Group.

MX,2000A1,A6 -19-21OCT92

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Carburetor Gasket Kit

Main Jet High Altitude Kit

Complete Carburetor

MX,3005A1,A1 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR

1. Remove air cleaner assembly.
2. Remove cap screws and washers (B) and duct and gasket (A).
3. Separate carburetor from heat shield (C). Remove carburetor.
4. Disconnect choke linkage (E) and throttle linkage (D).
5. Remove heat shield (C) and gaskets.
6. Make repairs as necessary. (See procedure in this group.)
7. Install gaskets and heat shield.
8. Connect linkage.
9. Install carburetor, gaskets and duct. Tighten cap screws.
10. Install air cleaner assembly.

A—Duct and Gasket  
B—Cap Screws and Washers  
C—Heat Shield  
D—Throttle Linkage  
E—Choke Linkage



M80306 -JUN-11MAR91



M80307 -JUN-11MAR91

MX,2105A1,A1 -19-21OCT92

## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR

**IMPORTANT:** To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

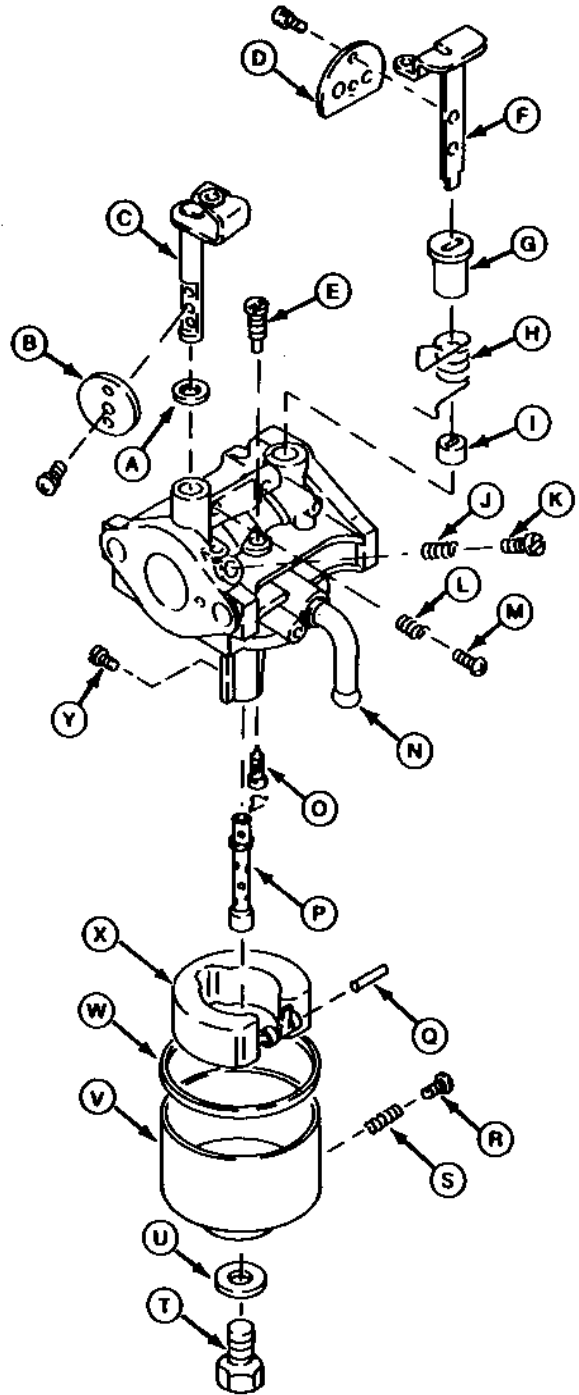
3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.

4. Inspect all parts for wear or damage, replace as necessary.

*NOTE: Main jet high altitude kits are available.*

*Float is plastic. The float cannot be adjusted. Replace if necessary.*

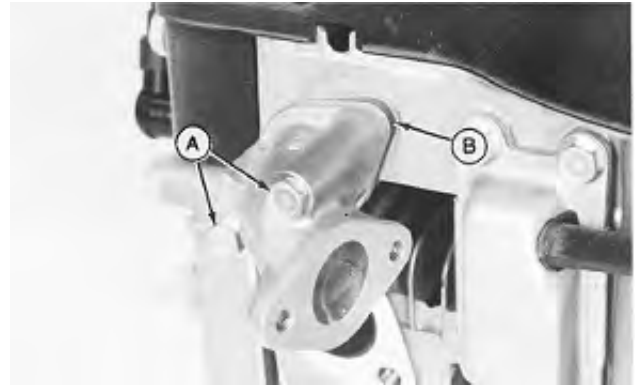
- A—Seal
- B—Throttle Valve
- C—Throttle Shaft
- D—Choke Valve
- E—Pilot Jet
- F—Choke Shaft
- G—Ring
- H—Spring
- I—Ring
- J—Spring
- K—Screw
- L—Spring
- M—Idle Screw
- N—Carburetor Body
- O—Needle Valve
- P—Main Nozzle
- Q—Float Pin
- R—Drain Screw
- S—Spring
- T—Plug
- U—Washer
- V—Float Chamber
- W—Gasket
- X—Float
- Y—Main Jet



MX,2105A1,A2 -19-21OCT92

## REMOVE AND INSTALL INTAKE MANIFOLD

1. Remove carburetor. (See this group.)
2. Remove cap screws (A).
3. Separate manifold from spacer (B). Remove intake manifold, spacer and gaskets.
4. Inspect parts for cracks or damage. Replace as necessary.
5. Install new gaskets, spacer and manifold.
6. Install carburetor.



M80309 -UN-11MAR91

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MX,2105A1,A3 -19-21OCT92

## SERVICE PRIMARY BREATHER

*NOTE: The tappet chamber cover is an oil breather.*

1. Remove carburetor. (See this group.)
2. Remove tappet chamber cover/breather and gasket (A).
3. Clean cover/breather and tube. Inspect for cracks or damage. Replace if necessary.
4. Install new gasket and cover/breather.
5. Install carburetor.



M80310 -UN-11MAR91

MX,2105A1,A4 -19-21OCT92



## SERVICE SECONDARY BREATHER

1. Remove flywheel. (See Group 10.)
2. Remove breather assembly (A).
3. Remove plate (D).
4. Inspect cover (B), plate and gasket (C) for wear or damage. Replace parts if necessary.
5. Check that drainback holes (E, F and G) are open.
6. Install plate.
7. Install breather assembly.
8. Install flywheel.

- A—Oil Breather Assembly
- B—Cover
- C—Gasket
- D—Plate
- E—Small Drainback Hole
- F—Secondary Chamber-to-Primary Chamber
- G—Large Drainback Hole



M80311  
-UN-11MAR91



M80312  
-UN-11MAR91



M80313  
-UN-11MAR91

MX,2105A1,A5 -19-21OCT92

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## SERVICE AIR CLEANER

*NOTE: Replace elements yearly or every 25 hours as required.*

1. Remove and disassemble air cleaner.

**IMPORTANT: Do not clean elements with solvent or compressed air.**

2. Wash foam element (A) in detergent and water. Dry element.

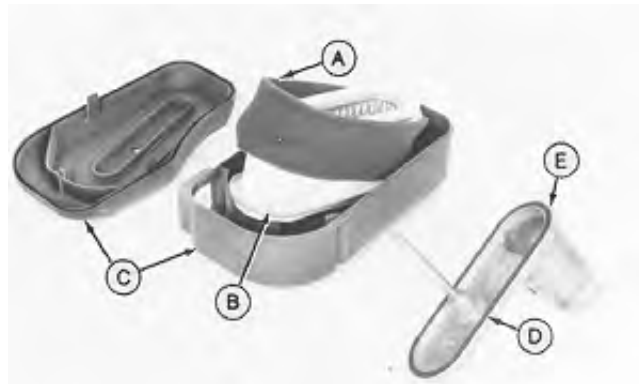
3. Put 12—15 drops of engine oil on foam element (A). Squeeze out excess oil.

4. Replace paper element (B) if:  
 —Element is oily, dirty, bent, torn, crushed, or obstructed in any way.  
 —Gasket is deformed or damaged in any way.  
 —Engine performance is poor.

5. Inspect body (C), gasket (D), and base (E) for damage. Replace if necessary.

**IMPORTANT: Any time air cleaner base is removed, check for free choke operation during reassembly.**

6. Assemble and install air cleaner.



A—Foam Element  
 B—Paper Element  
 C—Body  
 D—Gasket  
 E—Base

M80314 -UN-11MAR91

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MX,2105A1,A6 -19-21OCT92

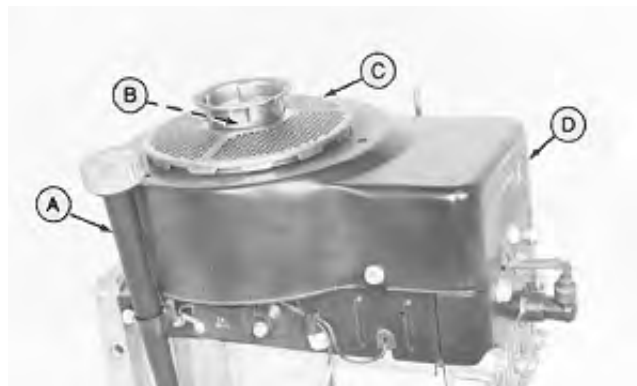
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## REMOVE AND INSTALL BLOWER HOUSING

1. Remove recoil starter.
2. Remove air cleaner assembly.
3. Remove dipstick tube (A).
4. Remove nut and washer (B), starter cup/screen assembly (C) and spacer(s).
5. Remove blower housing (D).
6. Install blower housing.
7. Install spacer(s) and starter cup/screen assembly.
8. Adjust flywheel screen. (See this group.)

*NOTE: Install washer with concave side toward flywheel.*

9. Install washer and nut. Tighten nut to 60 N·m (44 lb-ft).
10. Install dipstick tube.
11. Install air cleaner assembly.
12. Install recoil starter.



A—Dipstick Tube  
B—Nut and Washer  
C—Starter Cup/Screen  
D—Blower Housing

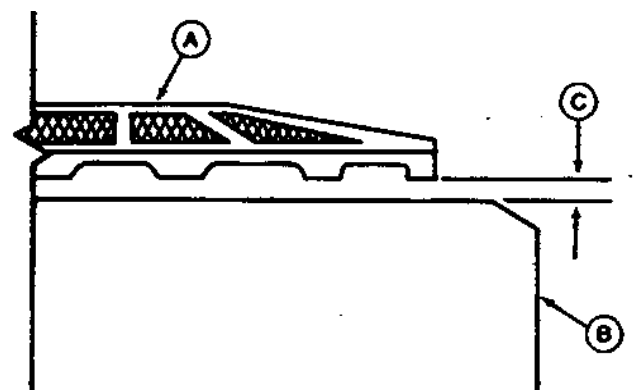
MX,2110A1,A1 -19-21OCT92

## FLYWHEEL SCREEN ADJUSTMENT

Adjust gap (C) between the blades under screen (A) and blower housing (B) to specifications using spacers.

### SPECIFICATIONS

Gap ..... 1—3 mm (0.039—0.118 in.)



MX,2110A1,A2 -19-21OCT92

## REMOVE AND INSTALL FLYWHEEL

1. Remove blower housing. (See this group.)
2. Remove flywheel using a two-jaw puller.
3. Install flywheel.
4. Install blower housing.



M80316 -UN-11MAR91

MX,2110A1,A3 -19-21OCT92

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## OTHER MATERIAL

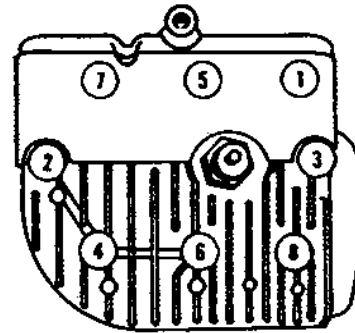
Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head

SCOTCH-BRITE is a trade mark of the 3M Company.

MX,5015A1,A1 -19-21OCT92

## REMOVE AND INSTALL CYLINDER HEAD

1. Remove blower housing. (See Group 10.)
2. Remove cylinder head cover.
3. Remove spark plug.
4. Remove cylinder head and gasket.
5. Make repairs as necessary. (See procedures in this group.)



**IMPORTANT: Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.**

6. Install cylinder head with new gasket.
7. Install cylinder head cover and cap screws. Tighten finger tight.
8. Tighten cap screws in sequence shown. Tighten to initial torque specifications.
9. Continue in sequence, 4 N·m (35 lb-in.) at a time, until final torque is as specified.
10. Install spark plug and tighten to specification.
11. Install blower housing.

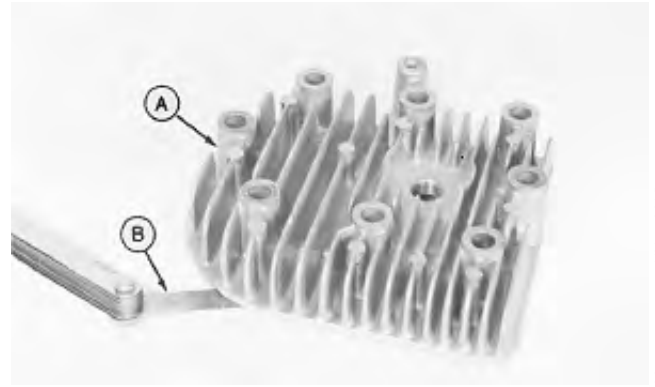
### TORQUE SPECIFICATIONS

Cylinder Head Cap Screws	
Initial Torque	10 N·m (89 lb-in.)
Final Torque	21 N·m (186 lb-in.)
Spark Plug	24 N·m (212 lb-in.)

MX,2115A1,A1 -19-21OCT92

## INSPECT CYLINDER HEAD

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than specifications.



M80292 -UN-11MAR91

### SPECIFICATIONS

Cylinder Head Distortion (Max) . . . . . 0.40 mm (0.015 in.)

MX,2115A1,A2 -19-21OCT92

21  
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# Group 20

## Cylinder Block, Valves and Internal Components

### OTHER MATERIAL

Number	Name	Use
	Valve Guide Cleaner	Clean valve guides.
	Prussion Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,2020A1,A1 -19-21OCT92

### SERVICE PARTS KITS

The following kits are available through your parts catalogue.

Oversized Piston Ring Kit

Oversized Pistons

Cylinder Block

Overhaul Gasket Kit

Short Block Kit

MX,2020A1,A2 -19-21OCT92

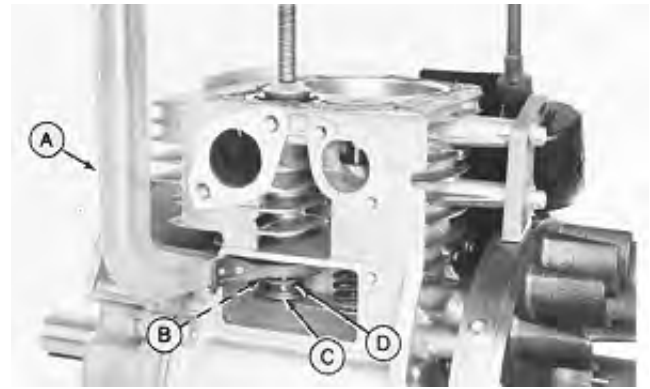


## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove carburetor. (See Group 05.)
2. Remove cylinder head. (See Group 15.)
3. Remove tappet chamber cover/breather and gasket.

**IMPORTANT: Mark and keep springs and valves together.**

4. Compress valve spring (D) with a spring compressor (A) and move spring retainer (C) so larger hole is around valve stem.
5. Remove compressor, valves, spring and retainers.
6. Inspect and analyze valves. (See Section 100, Group 05.)
7. Inspect springs, valve guides and seats. (See this group.)
8. Check valve-to-tappet clearance. (See this group.)
9. Check that drainback hole (B) is open.
10. Align valve springs and retainers in tappet chamber.
11. Coat valve stems with oil and install in cylinder block.
12. Compress each spring and position retainer so smaller hole is around valve stem.
13. Install tappet chamber cover/breather and new gasket.
14. Install cylinder head.
15. Install carburetor.



A—Spring Compressor  
B—Drainback Hole  
C—Spring Retainer  
D—Valve Spring

M80317 -UN-11MAR91

21  
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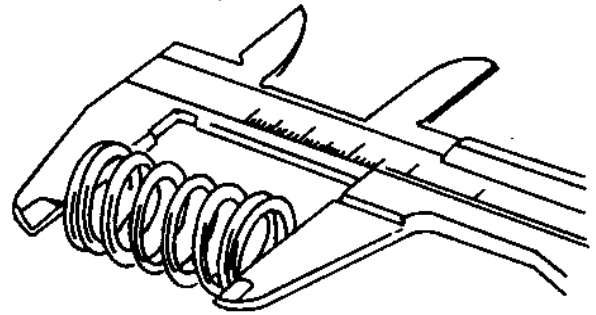
MX,2120A1,A1 -19-21OCT92

### INSPECT VALVE SPRINGS

Inspect valve springs. Replace springs if damaged or if free length is less than specification.

#### SPECIFICATION (MIN)

Valve Spring Free Length . . . . . 23.50 mm (0.930 in.)



MX,2120A1,A2 -19-21OCT92

M50036 -UN-31AUG88

### INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guides. Replace cylinder block if inside diameter is greater than specifications.

#### SPECIFICATIONS (MAX) I.D.

Intake Valve . . . . . 6.10 mm (0.240 in.)  
 Exhaust Valve . . . . . 6.13 mm (0.242 in.)



MX,2120A1,A3 -19-21OCT92

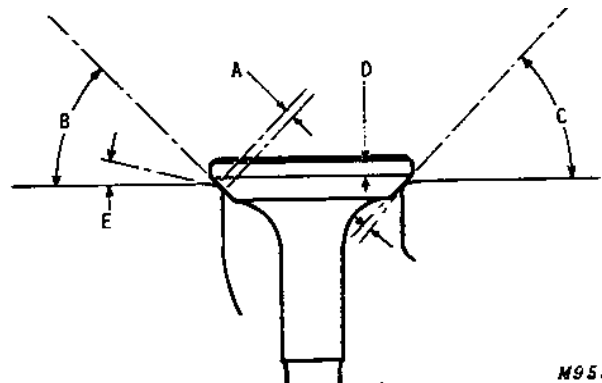
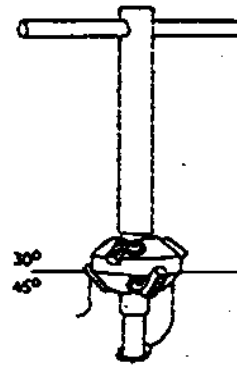
M80247 -UN-11MAR91

### RECONDITION VALVE SEATS

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.
2. To recondition valve seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).
3. Cut valve seating surface (A) as close as possible to specifications.
4. Lap valves to seats after refacing. (See Section 100, Group 05.)

#### SPECIFICATIONS

A—Valve Seating Surface . . . . . 1.30 mm (0.050 in.)  
 B—Valve Seat Angle . . . . . 45°  
 C—Valve Face Angle . . . . . 45°  
 D—Valve Margin . . . . . 0.60 mm (0.020 in.)  
 E—Valve Narrowing Angle . . . . . 30°



M955

MX,2120A1,A4 -19-21OCT92

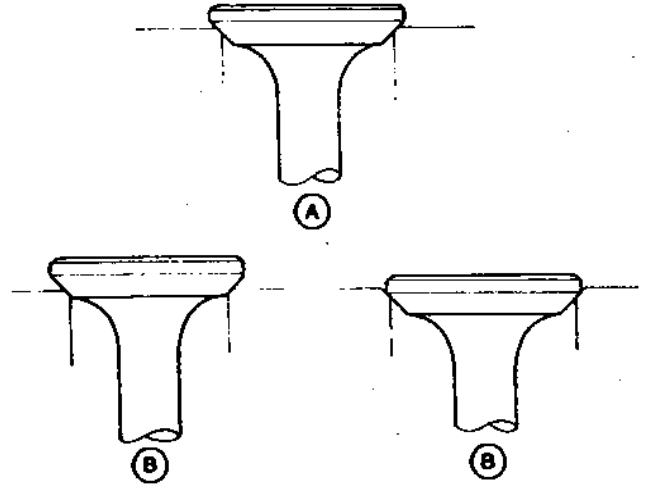
M51558 -UN-31AUG88

M9552 -UN-01SEP88

5. Center valve seat on the valve face:

- (A) shows correct position.
- (B) shows incorrect.

6. Check seat for good contact using Prussian Blue Compound.



MX,3015A1,A9 -19-21OCT92

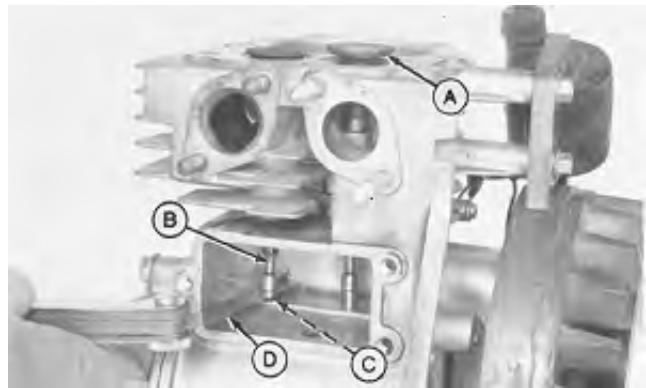
M18615 -UN-07SEP88

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### CHECK VALVE-TO-TAPPET CLEARANCE

*NOTE: Valve grinding changes the valve-to-tappet clearance. Check clearance when engine is cold.*

1. Install valves in cylinder block.
2. Turn crankshaft until intake valve (A) is at its highest position. Check clearance between valve (B) and tappet (C), with feeler gauge (D) and compare to specifications.
3. Grind end of valve stem to obtain proper clearance.



M80248 -UN-11MAR91

#### VALVE CLEARANCE SPECIFICATIONS

Exhaust Valve	0.12—0.34 mm (0.005—0.013 in.)
Intake Valve	0.12—0.18 mm (0.005—0.007 in.)

- A—Intake Valve
- B—Exhaust Valve
- C—Tappet
- D—Feeler Gauge

MX,2120A1,A5 -19-21OCT92

## REMOVE AND INSTALL CRANKCASE COVER

*NOTE: Approximate crankcase oil capacity is 0.6 L (1.27 pt).*

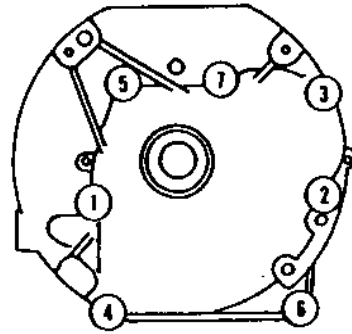
1. Drain crankcase.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

*NOTE: Do not force cover. Gears must mesh for proper positioning.*

4. Install gasket and cover. Tighten cap screws using the sequence shown.

### TORQUE SPECIFICATIONS

Mounting Cap Screws . . . . .	21 N-m (186 lb-in.)
Oil Drain Plug . . . . .	14 N-m (121 lb-in.)



MX,2120A1,A6 -19-21OCT92

M80294 -UN-19MAR91

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## REMOVE AND INSTALL CAMSHAFT

1. Remove crankcase cover. (See this group.)

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

2. Remove washer (A).
3. Rotate crankshaft until timing marks (B) align.
4. Remove camshaft (C).
5. Inspect camshaft. (See this group.)
6. Apply clean engine oil to camshaft lobes and journals.
7. Align timing marks and install camshaft.

*NOTE: Install washer with beveled ID, toward crankshaft.*

8. Install washer.
9. Install crankcase cover.



MX,2120A1,A7 -19-21OCT92

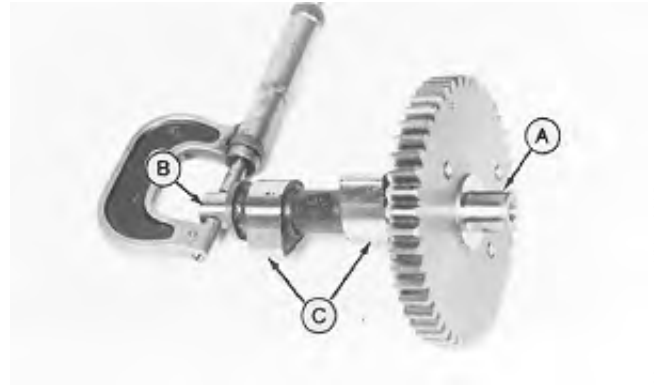
M80318 -UN-11MAR91

## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

**NOTE:** Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.

Measure PTO side journal (A), flywheel side journal (B), and lobes (C). Replace camshaft and tappets if less than specifications.



### SPECIFICATIONS (MIN)

PTO Side Journal	Flywheel Side Journal	Cam Lobes
12.94 mm (0.509 in.)	12.94 mm (0.509 in.)	Intake: 26.45 mm (1.041 in.) Exhaust: 26.35 mm (1.037 in.)

MX,2120A1,A8 -19-21OCT92

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M80319 -UN-11MAR91

## INSPECT CAMSHAFT PLAIN BEARINGS

1. Remove camshaft. (See this group.)
2. Measure camshaft bearings in cylinder block and crankcase cover. Replace block or cover if diameter is greater than specification.
3. Install camshaft.

### SPECIFICATIONS (MAX)

Cylinder Block Bearing	Crankcase Cover Bearing
13.05 mm (0.514 in.)	13.05 mm (0.514 in.)



Cylinder Block



Crankcase Cover

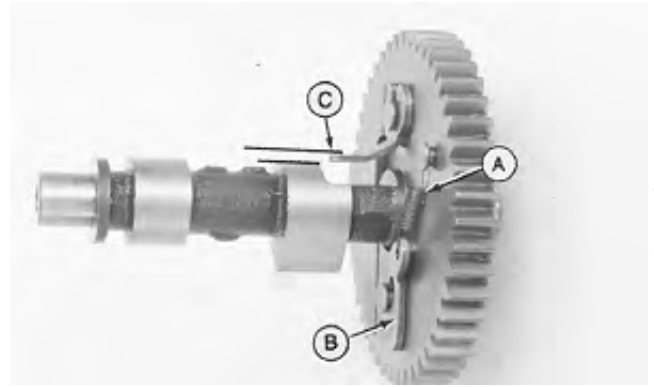
MX,2120A1,A9 -19-21OCT92

M80320 -UN-11MAR91

M80321 -UN-11MAR91

## INSPECT AUTOMATIC COMPRESSION RELEASE (A.C.R.)

1. Remove camshaft. (See this group.)
2. Inspect automatic compression release (A.C.R.) for damage.
3. Inspect spring (A). Replace if worn or damaged.
4. Move weight(s) (B) by hand to check for proper operation.
5. Check that tab (C) sits slightly above cam lobe when weight is released. Tab should drop below cam when weight is operated.
6. Replace A.C.R. if it does not operate properly.
7. Install camshaft.



M51489 -UN-31AUG88

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MX,2120A1,A10 -19-21OCT92

## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)
- NOTE: Mark tappets so they can be installed in their original bores during assembly.*
2. Remove tappets (A).
  3. Inspect tappets for wear or damage. Replace if necessary.
  4. Apply clean engine oil to tappets and bores.
  5. Install tappets in original bores.
  6. Install camshaft.

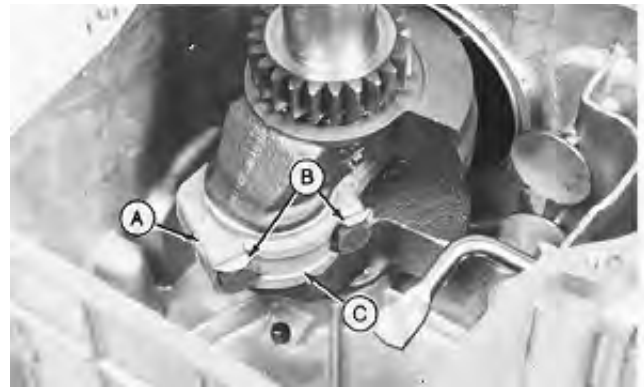


M80322 -UN-11MAR91

MX,2120A1,A11 -19-21OCT92

## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove camshaft. (See this group.)
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
4. Bend open locking tabs (B).
5. Remove cap screws, lock plate (C), and connecting rod cap (A).
6. Push piston and connecting rod from cylinder bore.
7. Make repairs as necessary. (See procedures in this group.)

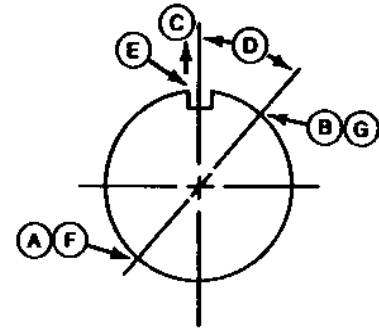


M80323  
-UN-11MAR91

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MX,2120A1,A12 -19-21OCT92

8. Deglaze cylinder bore. (See Section 100, Group 15.)
9. Align piston assembly to cylinder bore with piston ring end gaps as shown.
10. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
11. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
12. Install piston assembly in cylinder bore with notch on piston head facing flywheel side.
13. Install connecting rod cap and lock plate. Tighten cap screws to specifications.
14. Bend locking tabs over cap screws.
15. Install camshaft.
16. Install cylinder head.



- A—First Ring End Gap
- B—Second Ring End Gap
- C—Oil Ring End Gap
- D—Flywheel Side
- E—45° Angle
- F—Notch
- G—Upper Side Rail End Gap
- H—Lower Side Rail End Gap

**TORQUE SPECIFICATIONS**

Connecting Rod Cap Screws . . . . . 19 N·m (168 lb-in.)

MX,2120A1,A13 -19-21OCT92

**DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD**

1. Remove circlip, piston pin (B) and connecting rod (A).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



MX,2120A1,A14 -19-21OCT92



4. Align notch (A) on piston head with MADE IN JAPAN (B) on connecting rod.
5. Install piston pin and circlip.



MX,2120A1,A15 -19-21OCT92

M80326 -UN-11MAR91

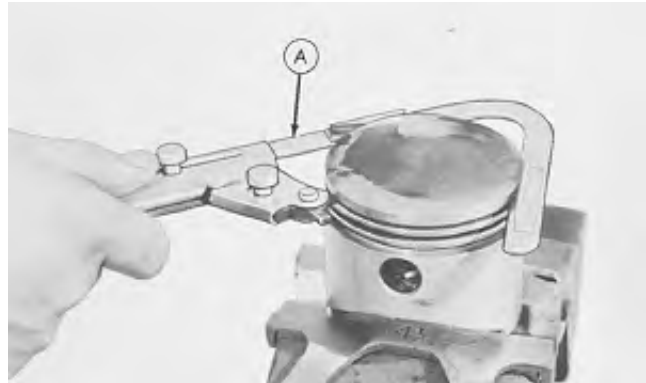
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## INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,2120A1,A16 -19-21OCT92

M29946 -JUN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: Top ring is tapered and cannot be measured as shown.*

*Inspect clearance visually. Replace piston if clearance appears excessive.*

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.



M38102 -UN-29AUG88

**CLEARANCE SPECIFICATION (MAX)**

Top Ring	Second Ring	Oil Control Ring
—	0.13 mm (0.005 in.)	0.17 mm (0.007 in.)

MX,2120A1,A17 -19-21OCT92

21  
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11

8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston pin bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

Piston Pin O.D. (MIN)	Piston Bore I.D. (MAX)
14.98 mm (0.590 in.)	15.05 mm (0.593 in.)



M50064 -UN-31AUG88



M80327 -UN-11MAR91

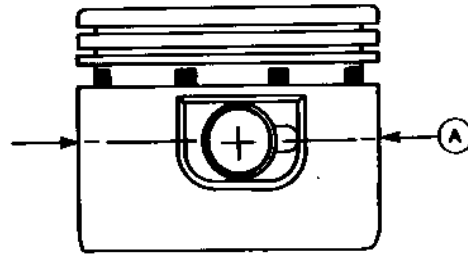
MX,2120A1,A18 -19-21OCT92

10. Measure piston O.D. (A) perpendicular to piston pin bore.

11. Measure cylinder bore. (See Inspect Block in this group.)

12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.

13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)



M80328 -UN-19MAR91

**SPECIFICATIONS**

Piston O.D. (A) . . . . .	71.86—71.89 mm (2.829—2.830 in.)
Piston-to-Cylinder	
Bore Clearance (std.) . . . . .	0.087—0.137 mm (0.0034—0.00
(max.) . . . . .	0.163 mm (0.0064 in.)

MX,2120A1,A18A -19-21OCT92

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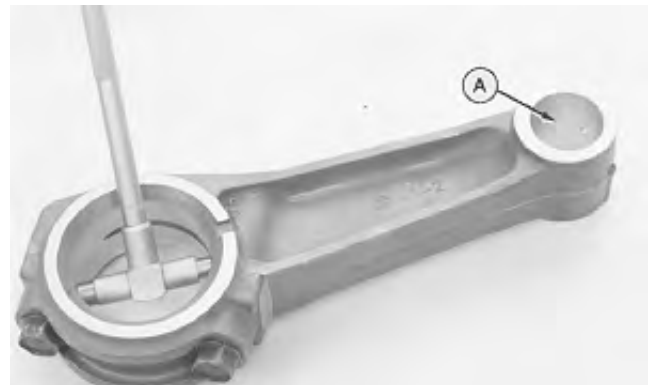
**INSPECT CONNECTING ROD**

1. Clean and inspect rod. Replace if scored.

2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)

3. Install connecting rod cap. Tighten cap screws to 19 N-m (168 lb-in.).

4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



M50066 -UN-31AUG88

**BEARING I.D. SPECIFICATIONS (MAX)**

<b>Crankshaft Bearing</b>	<b>Piston Bearing</b>
27.06 mm (1.065 in.)	15.04 mm (0.592 in.)

MX,2120A1,A19 -19-21OCT92

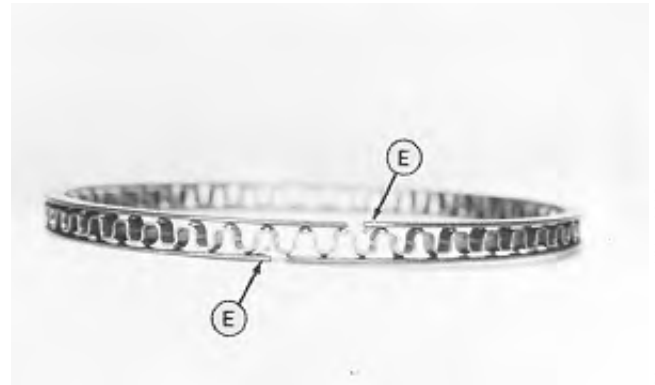
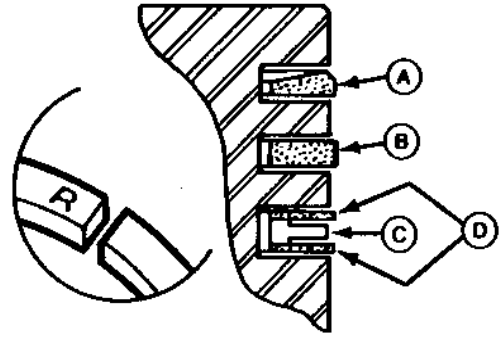
## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)
4. Install top ring (A) and second ring (B) with R or NPR mark facing up. Rings should turn freely in grooves.

*NOTE: Install side rails with prongs (E) facing toward spacer.*

5. Oil ring is an assembly. Install spacer (C), then side rails (D). Put side rail end gaps 180° apart.

- A—Top Ring
- B—Second Ring
- C—Spacer
- D—Side Rails
- E—Prongs



MX,2120A1,A20 -19-21OCT92

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.

### END GAP SPECIFICATIONS

Minimum End Gap	0.18 mm (0.007 in.)
Maximum End Gap	
Compression Rings	1.00 mm (0.039 in.)
Oil Ring Side Rails	1.40 mm (0.055 in.)



MX,2120A1,A21 -19-21OCT92

## REMOVE, INSPECT AND INSTALL CRANKSHAFT

1. Remove piston and connecting rod. (See this group.)
2. Remove crankshaft.

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

3. Check crankshaft alignment (T.I.R.). (See this group.)
4. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
5. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
6. Measure crankshaft main bearing journals and connecting rod journal. Replace crankshaft if measurements are less than specifications.
7. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
8. Apply clean engine oil to crankshaft bearings and journal.
9. Pack lithium based grease in oil seals.
10. Install crankshaft.
11. Install piston and connecting rod.



M80332 -UN-11MAR91

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### JOURNAL SPECIFICATIONS (MIN)

Main Bearing Journal		Connecting Rod Journal
PTO Side	Flywheel Side	
25.37 mm (0.999 in.)	24.96 mm (0.983 in.)	26.95 mm (1.061 in.)

MX,2120A1,A22 -19-21OCT92

## INSPECT CRANKSHAFT PLAIN BEARINGS

*NOTE: Cylinder block is fitted with a replaceable shell.*

1. Remove crankshaft. (See this group.)
2. Measure crankshaft bearings in cylinder block and crankcase cover. Replace cover or shell, if equipped, if diameter is greater than specifications. (See this group.)
3. Install crankshaft.

### BEARING I.D. SPECIFICATIONS (MAX)

#### Cylinder Block Bearing

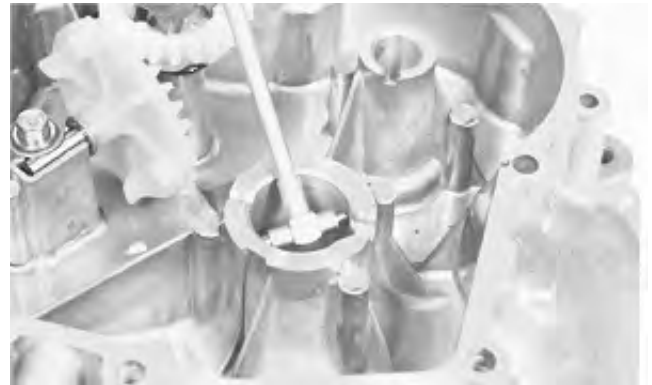
25.10 mm  
(0.988 in.)

#### Crankcase Cover Bearing

24.50 mm  
(0.965 in.)



Cylinder Block



Crankcase Cover

MX,2120A1,A23 -19-21OCT92

M80263 -UN-11MAR91

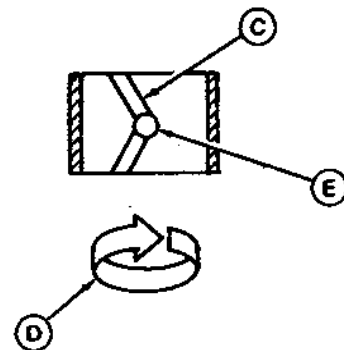
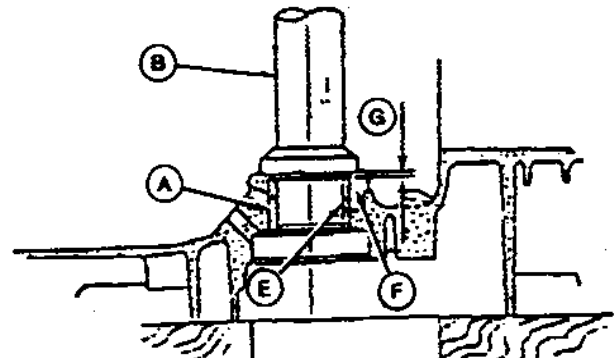
M80333 -UN-11MAR91

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## REPLACE CRANKSHAFT BEARING SHELL

1. Drive old bearing (A) from crankcase using an appropriate bushing tool (B) and an arbor press.
2. Align new bearing so arrow head formed by oil grooves (C) points opposite to engine rotation (D). Align oil hole (E) in bearing with oil passage (F) in crankcase.
3. Install new bearing to depth (G) 1 mm (0.039 in.) below flange surface.

- A—Bearing
- B—Bushing Tool
- C—Oil Grooves
- D—Engine Rotation
- E—Oil Hole
- F—Oil Passage
- G—Installation Depth



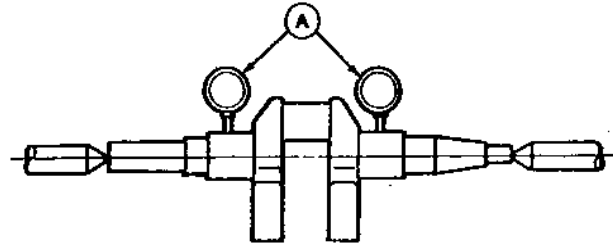
M51527 -UN-31AUG88

M51526 -UN-31AUG88

MX,2120A1,A24 -19-21OCT92

### CHECK CRANKSHAFT ALIGNMENT (TIR)

Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.



#### SPECIFICATIONS

Maximum TIR . . . . . 0.05 mm (0.002 in.)

MX,2120A1,A25 -19-21OCT92

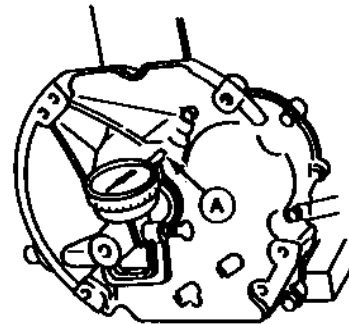
M51761  
-UN-07SEP88

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### MEASURE CRANKSHAFT END PLAY

1. Measure end play using dial indicator (A).
2. Move crankshaft in and out. Record this measurement.

Replace block or crankshaft if end play is not within specifications.



#### SPECIFICATIONS

End Play . . . . . 0—0.30 mm (0—0.012 in.)

MX,2120A1,A26 -19-21OCT92

M80296  
-JUN-19MAR91

## INSPECT OIL SEALS

*NOTE: Pack lithium base grease in new or used seals. Flywheel side seal is located in secondary breather assembly.*

1. Remove flywheel. (See Group 10.)
2. Inspect oil seals (A and B) at flywheel end and PTO end for wear or damage. Replace if necessary.
3. Remove secondary breather assembly. (See Group 05.)
4. Remove crankcase cover. (See this group.)
5. Remove worn or damaged seals with a screwdriver.
6. Install seals with lip toward inside of engine using a bearing, bushing and seal driver set. Press seals in until flush with hub.
7. Install crankcase cover.
8. Install secondary breather.



Flywheel Side/Breather Assembly



PTO Side

MX,2120A1,A27 -19-21OCT92

## INSPECT CYLINDER BLOCK

1. Remove crankshaft. (See this group.)
2. Clean and check block for cracks.
3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
4. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

MX,2120A1,A28 -19-21OCT92



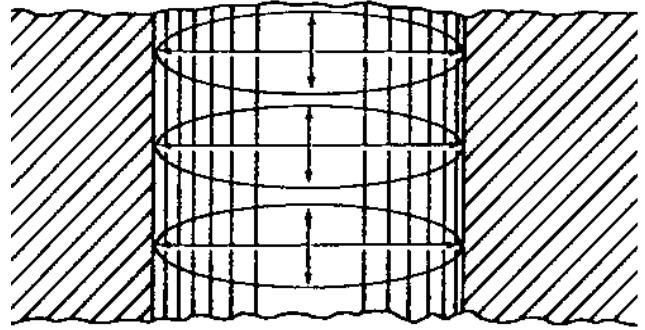
*NOTE: A bare block is available for service.*

5. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

6. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

7. Install crankshaft.

*NOTE: If cylinder is rebored, oversize piston and rings must be installed.*



M51745 -UN-23FEB89

**CYLINDER BORE SPECIFICATIONS**

Standard	Wear Limit
71.98—72.00 mm (2.834—2.835 in.)	72.06 mm (2.837 in.)



M80336 -UN-11MAR91

MX,2120A1,A29 -19-21OCT92

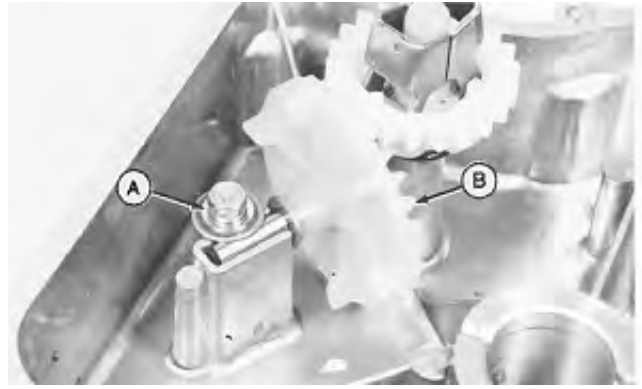
**REBORE CYLINDER BLOCK**

*NOTE: The cylinder block can be rebored to use 0.25 or 0.50 mm (0.010 or 0.020 in.) oversize pistons and rings. Have a reliable repair shop rebore the block to initial and final bore specifications. The repair shop must have proper equipment to handle cylinders made of high silicon content aluminum.*

MX,2120A1,A30 -19-21OCT92

## INSPECT AND REPLACE OIL SLINGER

1. Remove crankcase cover. (See this group.)
2. Remove cap screw and washer (A).
3. Remove oil slinger (B).
4. Inspect for wear or damage. Replace if necessary.
5. Install oil slinger, washer and cap screw.
6. Install crankcase cover.



M80337  
-UN-11MAR91

MX,2120A1,A31 -19-21OCT92

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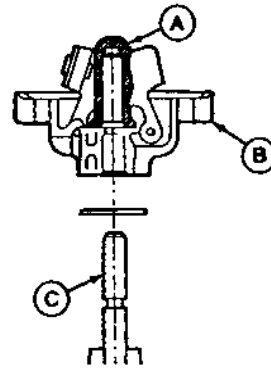
## INSPECT AND REPLACE GOVERNOR

**IMPORTANT:** Removal damages governor. If not damaged, do not remove.

1. Remove crankcase cover. (See this group.)
2. Inspect governor. If necessary to replace, remove with screwdriver.
3. If removed, press shaft (C) back into block until it protrudes 32.2—32.8 mm (1.267—1.291 in.).

*NOTE: Assemble sleeve and gear before installing assembly on shaft.*

4. Install sleeve (A) into governor gear (B).
5. Install governor assembly onto shaft. Push down on assembly until it snaps into place.



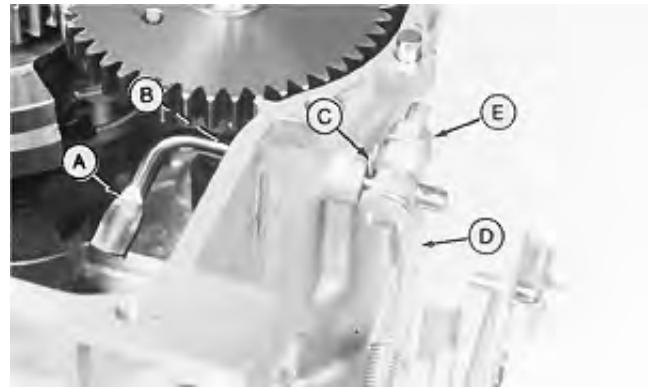
M51762  
-UN-07SEP88

MX,2120A1,A32 -19-21OCT92

## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (A). Replace if damaged.
3. To replace shaft, loosen nut (E) on lever (D).
4. Remove retaining pin (C), governor shaft and washer (B).
5. Install washer, shaft and retaining pin. Tighten nut.
6. Install crankcase cover.



**A—Governor Shaft**  
**B—Washer**  
**C—Retaining Pin**  
**D—Governor Lever**  
**E—Nut**

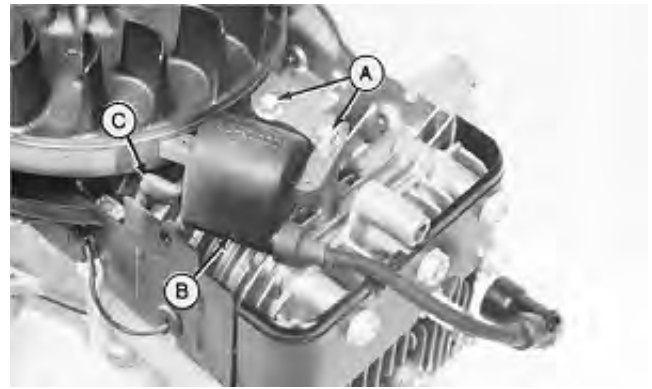
MX,2120A1,A33 -19-21OCT92

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M80338 -UN-11MAR91

## REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove blower housing. (See Group 10.)
2. Disconnect wiring lead (C).
3. Remove cap screws (A) and armature with coil (B).
4. Loosely install armature with coil.
5. Connect wiring lead.
6. Adjust armature air gap. (See this group.)
7. Install blower housing.

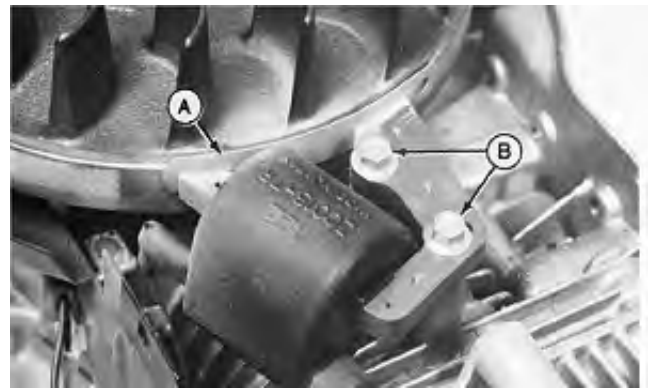


M80339 -UN-11MAR91

MX,2125A1,A1 -19-21OCT92

## ADJUST ARMATURE AIR GAP

1. Turn flywheel magnet away from armature.
2. Insert feeler gauge blade (A) between flywheel and armature.
3. Push armature against flywheel and tighten screws (B).
4. Turn flywheel to remove feeler gauge.



M80340 -UN-11MAR91

### AIR GAP SPECIFICATIONS

Feeler Gauge Blade . . . . . 0.30 mm (0.012 in.)

MX,2125A1,A2 -19-21OCT92

## REPLACE IGNITOR

1. Disconnect wiring lead (A).
2. Remove ignitor.

*NOTE: When installing ignitor, put wiring lead (B) under screw and washer.*

3. Install ignitor.
4. Connect wiring lead.



M80341 -UN-11MAR91

MX,2125A1,A3 -19-21OCT92

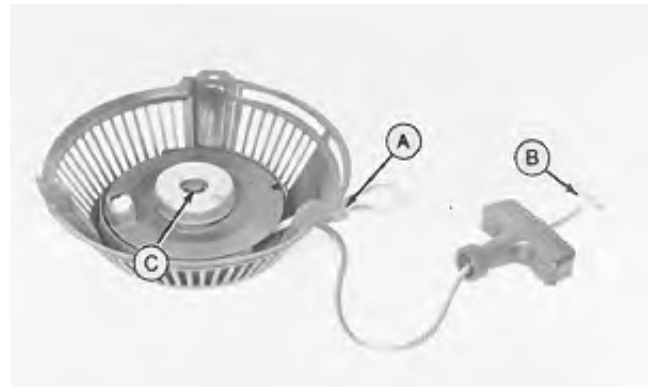


## DISASSEMBLE RECOIL STARTER

1. Remove starter.
2. Pull handle out about 30 cm ( 1 ft). Tie knot (A) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (A). Slowly release reel tension. Do not let rope get wedged between reel and housing.

**⚠ CAUTION: Wear gloves and protective goggles for remaining steps.**

6. Remove screw (C) and ratchet cover.
7. Remove pawl and springs.



M80300 -UN-11MAR91

21  
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MX,2130A1,A1 -19-21OCT92

**⚠ CAUTION: A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.**

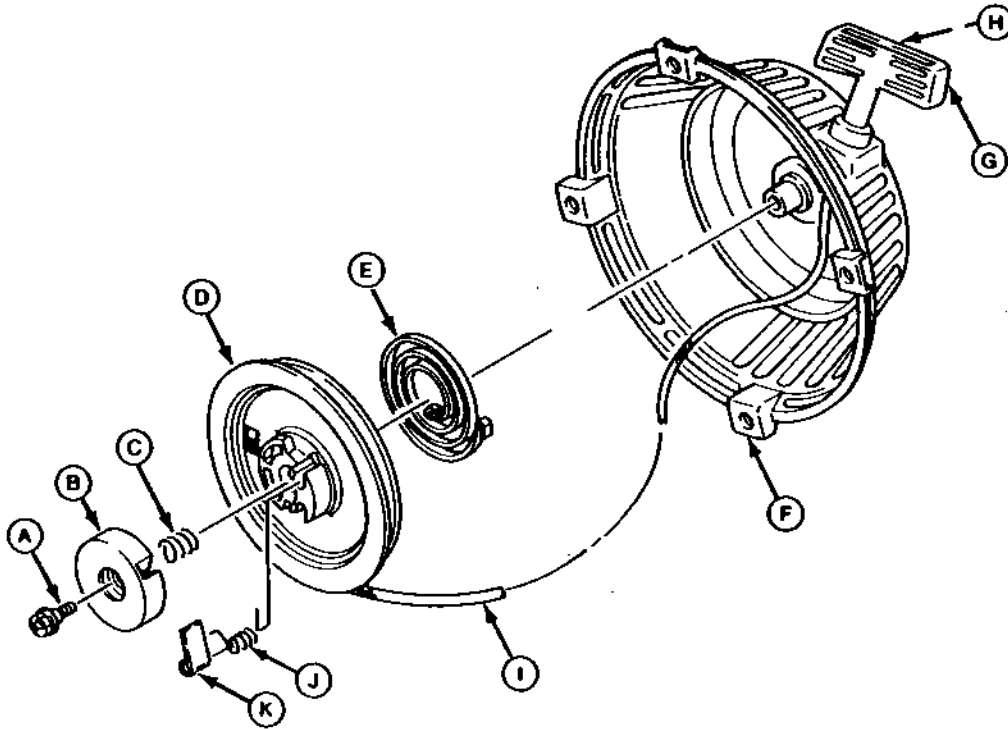
8. Turn the reel one half turn clockwise so no spring tension can be felt.
9. Spring is stored in reel. Carefully remove reel while holding spring in underside of reel.



M51551 -UN-31AUG88

MX,2130A1,A2 -19-21OCT92

**INSPECT RECOIL STARTER**



A—Screw  
B—Retainer  
C—Spring

D—Reel  
E—Spring  
F—Housing

G—Handle  
H—Clip  
I—Rope

J—Spring  
K—Pawl

Inspect all parts for wear or damage. Replace as necessary.

MX,2130A1,A3 -19-21OCT92

21  
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M80342 -JUN-19/MAR91

## REPLACE SPRING

**⚠ CAUTION: Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.**

1. Working from the center out, carefully unwind spring from reel.
2. Hook outside spring tang in reel. Wind spring into reel, working toward center.



M80195 -UN-11FEB91

MX,2130A1,A4 -19-21OCT92

## ASSEMBLE RECOIL STARTER

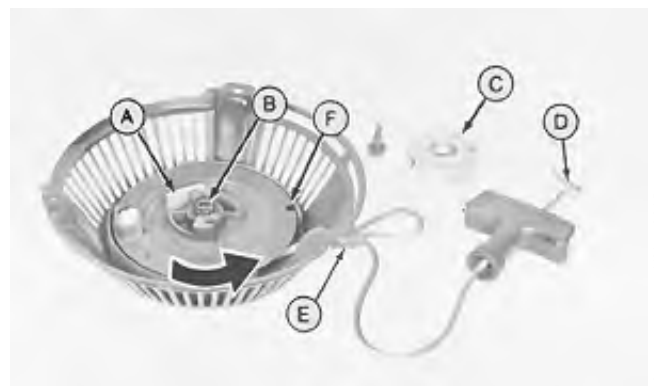
1. Wind rope counterclockwise onto reel.
2. Apply multipurpose grease to spring.
3. Install reel with spring in housing. Align inner tang (A) with catch (B).
4. Turn reel counterclockwise until you feel tang hook on catch.



M80303 -UN-11MAR91

MX,2130A1,A5 -19-21OCT92

5. Place rope in notch (F) and turn reel two turns counterclockwise to preload spring.
6. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (E) to hold rope.
7. Install handle and secure with knot (D).
8. Remove knot (E).
9. Install spring (B) spring and pawl (A) and ratchet cover (C) with opening in cover over pawl. Check for free movement of pawls.
10. Pull rope to check for proper operation.
11. Install recoil starter on engine.



M80305 -UN-11MAR91

A—Pawl  
B—Spring  
C—Retainer  
D—Knot  
E—Knot

MX,2130A1,A6 -19-21OCT92



21  
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4

# Section 25

## FG150G/FG150D

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25



### ENGINE APPLICATIONS CHART

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

Machine	Engine Model No.
22 Greensmower . . . . .	FG150G-BH90 or FG150G-BH90-01
22R Greensmower . . . . .	FG150D-BH90

MX,2500A1,A1 -19-21OCT92

### FG150G/FG150D REPAIR SPECIFICATIONS

#### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Item	Specification
Flywheel Nut Torque . . . . .	60 N·m (44 lb-ft)

#### GROUP 15—CYLINDER HEAD

Cylinder Head	
Maximum Cylinder Head Warp . . . . .	0.30 mm (0.012 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	10 N·m (89 lb-in.)
Final Torque . . . . .	24 N·m (212 lb-in.)
Spark Plug Torque . . . . .	27 N·m (20 lb-ft)

#### GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS

Valve Clearance (cold)	
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)
Exhaust . . . . .	0.21—0.23 mm (0.008—0.009 in.)
Valves and Springs	
Minimum Spring Free Length . . . . .	32 mm (1.260 in.)
Maximum Valve Guide I.D. . . . .	6.08 mm (0.239 in.)
Minimum Valve Stem Diameter . . . . .	5.95 mm (0.234 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Seat and Face Angle . . . . .	45°
Valve Seating Width . . . . .	1.00—1.60 mm (0.039—0.063 in.)
Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

*Continued on next page*

MX,2500A1,A2 -19-21OCT92

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GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED

Item	Specification
<b>Crankcase Cover</b>	
Oil Capacity . . . . .	0.5 L (1.06 pt)
Cap Screw Torque . . . . .	9 N·m (84 lb-in.)
Drain Plug Torque . . . . .	14 N·m (121 lb-in.)
<b>Camshaft</b>	
Minimum End Journal O.D. . . . .	14.94 mm (0.588 in.)
Minimum Lobe Height	
Intake . . . . .	27.30 mm (1.070 in.)
Exhaust . . . . .	27.10 mm (1.060 in.)
Maximum Crankcase Bearing I.D. . . . .	15.04 mm (0.592 in.)
<b>Piston</b>	
Maximum Ring Groove Clearance	
Top Ring . . . . .	0.17 mm (0.007 in.)
Second Ring . . . . .	0.16 mm (0.006 in.)
Oil Ring Assembly . . . . .	Not Measured
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap . . . . .	0.80 mm (0.032 in.)
Minimum Pin O.D. . . . .	12.99 mm (0.511 in.)
Maximum Pin Bore I.D. . . . .	13.04 mm (0.513 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Piston O.D. . . . .	63.86—63.88 mm (2.516—2.5168 in.)
Piston-to-Cylinder Bore Clearance (std.) . . . . .	0.12 mm (0.005 in.)
(max.) . . . . .	0.1375 mm (0.0054 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	24.55 mm (0.967 in.)
Maximum Piston Pin Bearing I.D. . . . .	13.04 mm (0.514 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.10 mm (0.004 in.)
End-Cap Screw Torque . . . . .	20 N·m (177 lb-in.)
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	19.96 mm (0.786 in.)
Minimum Flywheel Side Journal O.D. . . . .	19.96 mm (0.786 in.)
Minimum Connecting Rod Journal O.D. . . . .	24.45 mm (0.963 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D. . . . .	63.98—64.00 mm (2.521—2.522 in.)
Maximum Cylinder Bore I.D. . . . .	64.05 mm (2.524 in.)
Maximum Out-of-Round . . . . .	0.045 mm (0.0018 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.25 mm . . . . .	64.21—64.23 mm (2.530—2.531 in.)
0.50 mm . . . . .	64.46—64.48 mm (2.540—2.541 in.)

Continued on next page

MX,2500A1,A3 -19-21OCT92

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Item	Specification
Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)

See Ignition Tests in this Group.

**GROUP 30—STARTING SYSTEMS**

Electric Starter  
See Starter Specifications in this Group.

MX,2500A1,A3A -19-21OCT92

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Carburetor Gasket Kit—FG150D (Carburetor S.N. 840001— )

Complete Carburetor

Complete Fuel Filter/Shutoff Valve

MX,2505A1,A1 -19-21OCT92

## REMOVE, INSPECT AND INSTALL FUEL TANK

*NOTE: The approximate fuel tank capacity is 3 L (3.16 U.S. qt).*

**⚠ CAUTION: Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.**

1. Disconnect hose (A). Close all openings using caps and plugs.
2. Remove nuts and washers (B) from both sides of fuel tank.
3. Remove fuel tank.
4. Inspect tank for cracks or damage. Repair or replace as necessary.
5. Install fuel tank.
6. Install washers and nuts.
7. Connect fuel hose.



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-JUN-02APR91  
M80343

MX,2505A1,A2 -19-21OCT92



## REPLACE FUEL FILTER/SHUTOFF VALVE

**⚠ CAUTION: Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.**

1. Disconnect hoses (A and B). Close all openings using caps and plugs.
2. Remove fuel filter/shutoff assembly.
3. Install fuel filter/shutoff assembly.
4. Connect hoses.



M80344 -UN-02APR91

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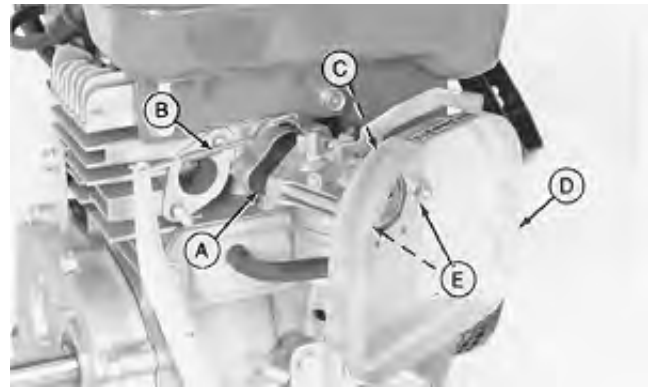
MX,2505A1,A3 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR

1. Remove air cleaner elements.
2. Close fuel shutoff.
3. Remove two nuts (E).
4. Remove air cleaner base (D) and gasket.
5. Disconnect hose (C). Close all openings using caps and plugs.
6. Separate carburetor from spacer (A). Remove carburetor.
7. Disconnect throttle control linkage (B).
8. Remove spacer (A) and gaskets.
9. Make repairs as necessary. (See this group.)

*NOTE: Install spacer (A) with flat side toward carburetor.*

10. Install spacer and gaskets.
11. Connect throttle control linkage.
12. Install carburetor.
13. Connect fuel hose.
14. Install new gasket, air cleaner base and nuts.
15. Install air cleaner elements.



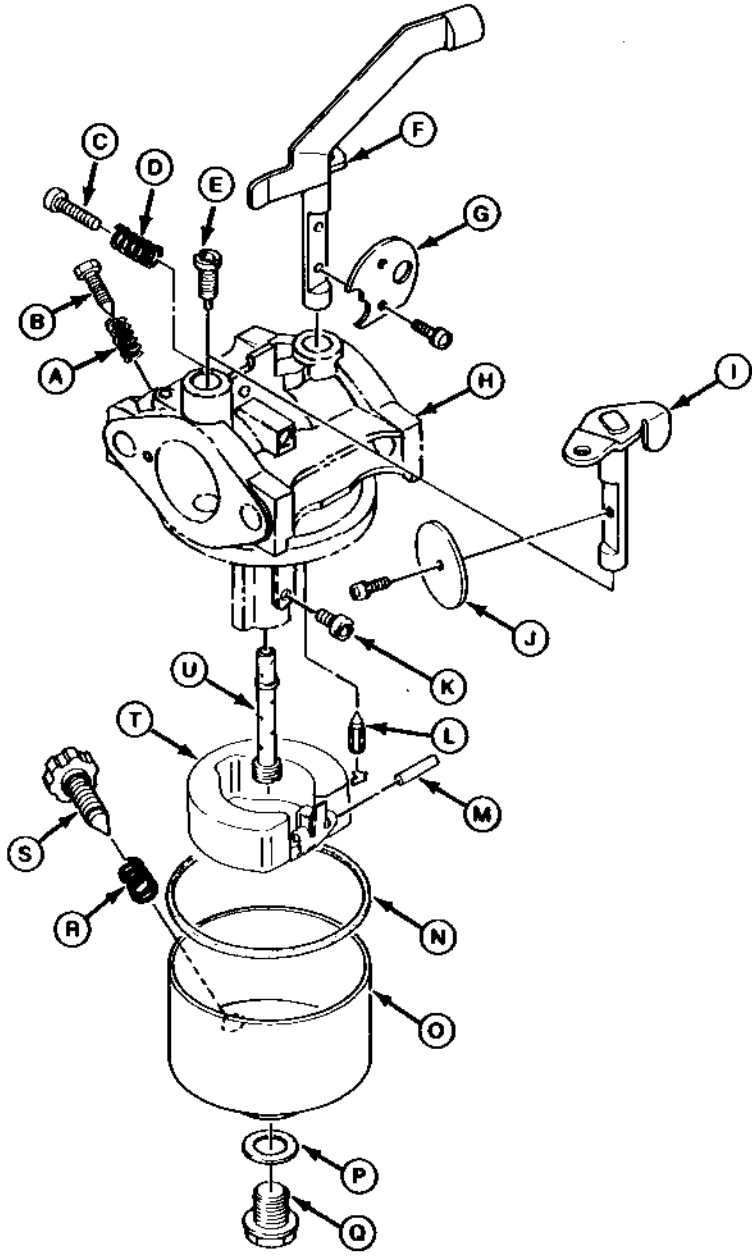
A—Spacer  
B—Throttle Control Linkage  
C—Fuel Hose  
D—Air Cleaner Base  
E—Nuts

M80345 -UN-02APR91

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MX,2505A1,A4 -19-21OCT92

**DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR**



- |               |                   |                 |               |
|---------------|-------------------|-----------------|---------------|
| A—Spring      | G—Choke Plate     | L—Needle Valve  | Q—Plug        |
| B—Pilot Screw | H—Carburetor Body | M—Float Pin     | R—Spring      |
| C—Idle Screw  | I—Throttle Shaft  | N—Gasket        | S—Drain Screw |
| D—Spring      | J—Throttle Plate  | O—Float Chamber | T—Float       |
| E—Pilot Jet   | K—Main Jet        | P—Washer        | U—Main Nozzle |
| F—Choke Shaft |                   |                 |               |

FG150D (Carb S.N. 840001— )

M80347 -JUN-06APR91

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**IMPORTANT:** To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

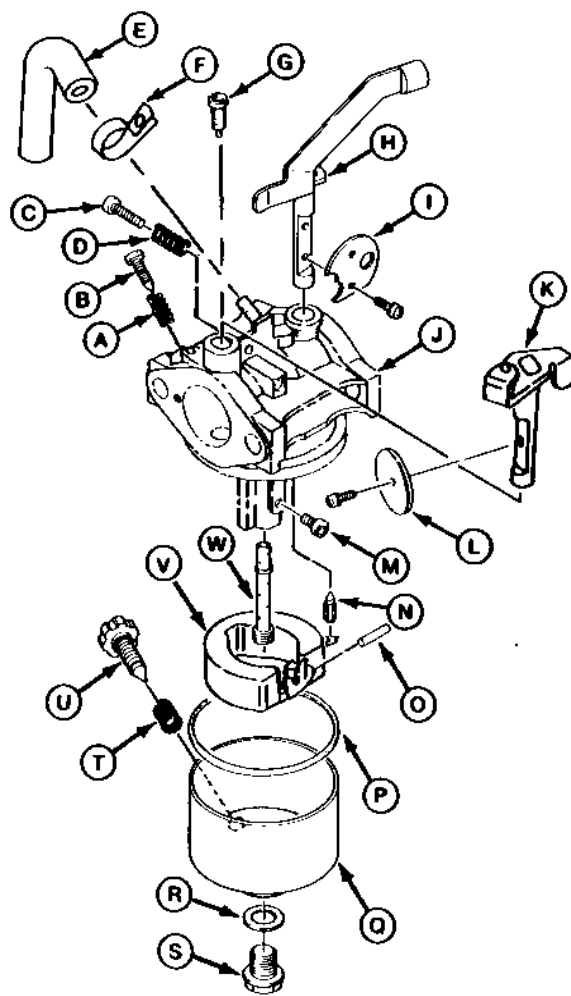
**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

*NOTE: Float is plastic. The float cannot be adjusted. Replace if necessary.*

FG150D (Carb S.N. —840000) and FG150G shown.

- |                   |                 |
|-------------------|-----------------|
| A—Spring          | M—Main Jet      |
| B—Pilot Screw     | N—Needle Valve  |
| C—Idle Screw      | O—Float Pin     |
| D—Spring          | P—Gasket        |
| E—Hose            | Q—Float Chamber |
| F—Clamp           | R—Washer        |
| G—Pilot Jet       | S—Plug          |
| H—Choke Shaft     | T—Spring        |
| I—Choke Plate     | U—Drain Screw   |
| J—Carburetor Body | V—Float         |
| K—Throttle Shaft  | W—Main Nozzle   |
| L—Throttle Plate  |                 |



MX,2505A1,A6 -19-21OCT92

M80348 -UN-06APR91

## SERVICE BREATHER

*NOTE: Tappet chamber cover is an oil breather.*

1. Remove carburetor. (See this group.)
2. Remove tappet chamber cover/breather and gasket (A).
3. Clean cover/breather and tube. Inspect for cracks or damage. Replace if necessary.
4. Install new gasket and cover/breather.
5. Install carburetor.



M80349 -UN-02APR91

MX,2505A1,A7 -19-21OCT92

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## SERVICE AIR CLEANER

*NOTE: Replace elements yearly or every 25 hours as required.*

1. Remove and disassemble air cleaner.

**IMPORTANT: Do not clean elements with solvent or compressed air.**

2. Wash foam element (A) in detergent and water. Dry element.
3. Put 12—15 drops of engine oil on foam element (A). Squeeze out excess oil.
4. Replace paper element (B) if:
  - Element is oily, dirty, bent, torn, crushed, or obstructed in any way.
  - Seal is damaged.
  - Engine performance is poor.
5. Inspect cover (C) and base (D) for damage. Replace if necessary.

**IMPORTANT: Any time air cleaner base is removed, check for free choke operation during reassembly.**

6. Assemble and install air cleaner.



A—Foam Element  
B—Paper Element  
C—Cover  
D—Base

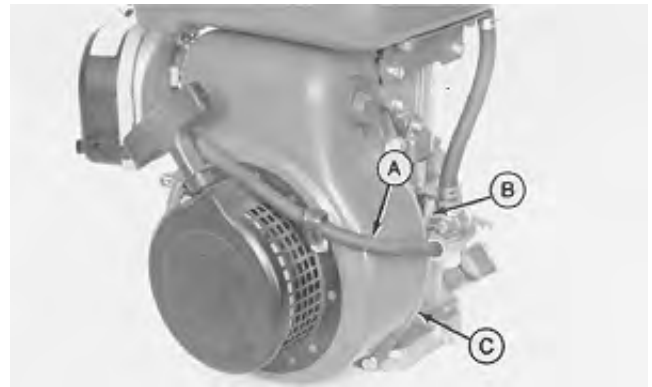
M80240 -UN-11MAR91

MX,2505A1,A8 -19-21OCT92

## REMOVE AND INSTALL BLOWER HOUSING

*NOTE: It is not necessary to remove recoil starter from blower housing.*

1. Close fuel shutoff valve.
2. Disconnect hose (A).
3. Cut wire tie and disconnect wiring lead (B).
4. Remove blower housing (C).
5. Install blower housing.
6. Connect wiring lead.
7. Install wire tie.
8. Connect fuel hose.



M80350 -UN-02APR91

MX,2510A1,A1 -19-21OCT92

## REMOVE AND INSTALL FLYWHEEL

1. Remove blower housing. (See this group.)
2. Hold flywheel and remove nut and washer (A).
3. Remove starter cup (B).
4. Remove flywheel using a two-jaw puller.
5. Install flywheel.

*NOTE: Install washer with concave side toward flywheel.*

6. Install starter cup, washer and nut. Tighten nut to 60 N·m (44 lb-ft).
7. Install blower housing.



M80351 -UN-02APR91

MX,2510A1,A2 -19-21OCT92



**SPECIAL OR ESSENTIAL TOOLS**

*NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).*

DX,TOOLS -19-05JUN91

Valve Guide Driver Tool . . . . . JDG504

Replace valve guide bushings.

MX,JDG504 -19-21OCT92

**OTHER MATERIAL**

Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head

*SCOTCH-BRITE is a trade mark of the 3M Company.*

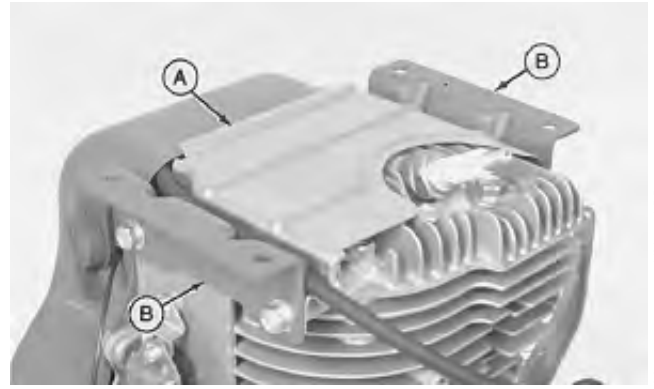
MX,5015A1,A1 -19-21OCT92

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## REMOVE AND INSTALL CYLINDER HEAD

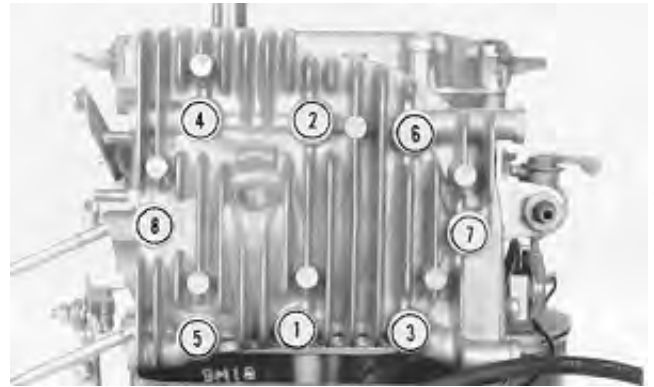
1. Disconnect spark plug wiring lead.
2. Remove fuel tank. (See Group 05.)
3. Remove brackets (B).
4. Remove shield (A).
5. Remove spark plug.
6. Remove cylinder head and gasket.
7. Make repairs as necessary. (See procedures in this group.)



M80352 -UN-02APR91

**IMPORTANT: Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.**

8. Install cylinder head with new gasket. Install cap screws and tighten finger tight.
9. Tighten cap screws in sequence shown. Tighten to initial torque specifications.
10. Continue in sequence, 4 N·m (35 lb-in.) at a time, until final torque is as specified.
11. Install spark plug and tighten to specification.
12. Install heat shield.
13. Install fuel tank brackets.
14. Install fuel tank.



M80353 -UN-02APR91

### TORQUE SPECIFICATIONS

Initial Torque	10 N·m (89 lb-in.)
Final Torque	24 N·m (212 lb-in.)
Spark Plug	27 N·m (20 lb-ft)

MX,2515A1,A1 -19-21OCT92

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## INSPECT CYLINDER HEAD

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than specifications.



M80354 -UN-02APR91

### SPECIFICATIONS

Cylinder Head Distortion (Max) . . . . . 0.30 mm (0.012 in.)

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MX,2515A1,A2 -19-21OCT92



# Group 20 Cylinder Block, Valves and Internal Components

## OTHER MATERIAL

Number	Name	Use
	Valve Guide Cleaner	Clean valve guides
	Stanisol (or Kerosene)	Finish ream valve guide
	Prussian Blue Compound	Check valve seat contact
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,5020A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalogue.

Oversized Piston Ring Kit

Oversized Pistons

Cylinder Block

Overhaul Gasket Kit

Short Block Kit

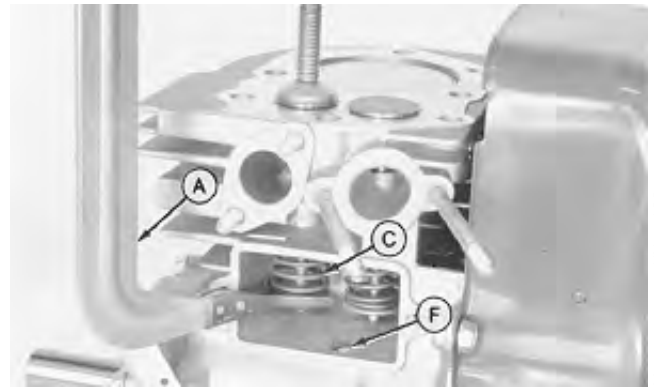
MX,2020A1,A2 -19-21OCT92

## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove carburetor. (See Group 05.)
2. Remove cylinder head. (See Group 15.)
3. Remove tappet chamber cover/breather.

**IMPORTANT: Mark and keep springs and valves together.**

4. Compress valve spring (C) with a spring compressor (A) and remove valve sleeve (E).
5. Remove compressor, valves, springs and retainers.
6. Inspect and analyze valves. (See Section 100, Group 05.)
7. Inspect springs, valve guides and seats. (See this group.)
8. Check valve-to-tappet clearance. (See this group.)
9. Check that drainback hole (F) is open.
10. Align valve springs and retainers in tappet chamber.
11. Coat valve stems with oil and install in cylinder block.
12. Compress each spring and install valve sleeves.
13. Install tappet chamber cover/breather and new gasket.
14. Install cylinder head.
15. Install carburetor.



A—Spring Compressor  
B—Valve  
C—Spring  
D—Spring Retainer  
E—Valve Sleeve  
F—Drainback Hole

M80355 -UN-02APR91

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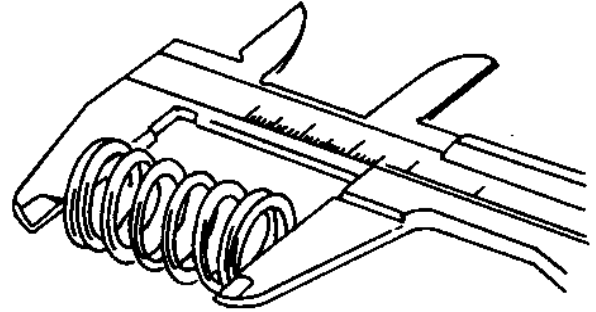
MX,2520A1,A1 -19-21OCT92

### INSPECT VALVE SPRINGS

Inspect valve springs. Replace springs if damaged or if free length is less than specification.

**SPECIFICATION (MIN)**

Valve Spring Free Length . . . . . 32.00 mm (1.260 in.)



MX,2520A1,A2 -19-21OCT92

M50036 -UN-31AUG88

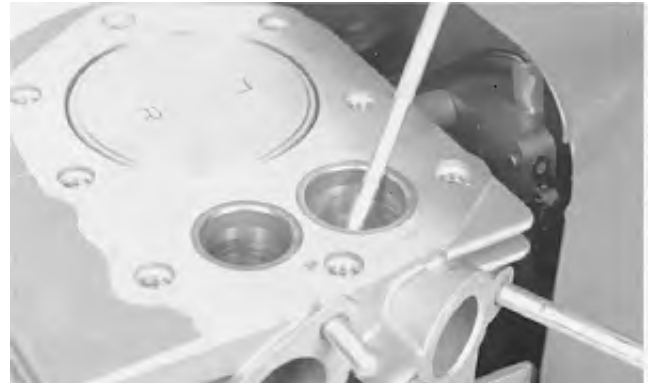
### INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guide bushings. Replace bushings if inside diameter is greater than specifications. (See this group.)

**SPECIFICATIONS (MAX) I.D.**

Intake and Exhaust . . . . . 6.08 mm (0.239 in.)

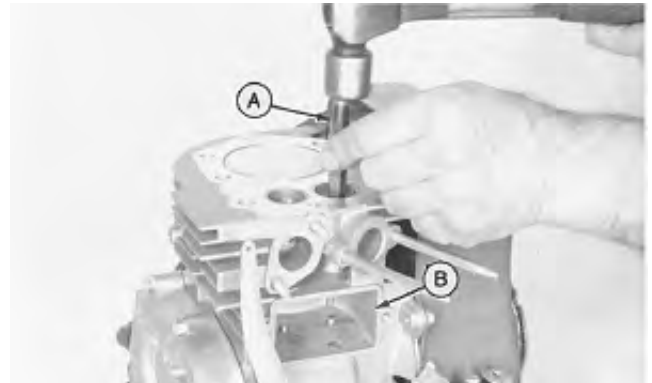


MX,2515A1,A3 -19-21OCT92

M80356 -UN-02APR91

### REPLACE VALVE GUIDE BUSHING

1. Use JDG-504 Valve Guide Driver (A) to drive bushing into tappet chamber (B). Use locking pliers to crush end of bushing in chamber. Drive remaining portion of bushing into chamber and remove.



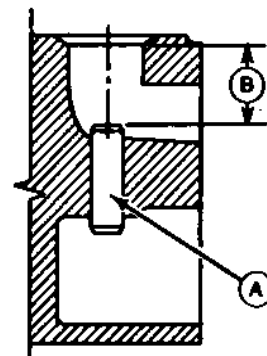
MX,2520A1,A4 -19-21OCT92

M80357 -UN-02APR91

2. Use valve guide driver to install new bushing (A). Drive bushing into cylinder body until distance from valve seat counterbore to top of bushing (B) is according to specifications.

**SPECIFICATIONS**

Distance (B) . . . . . 23 mm (0.910 in.)



MX,2520A1,A5 -19-21OCT92

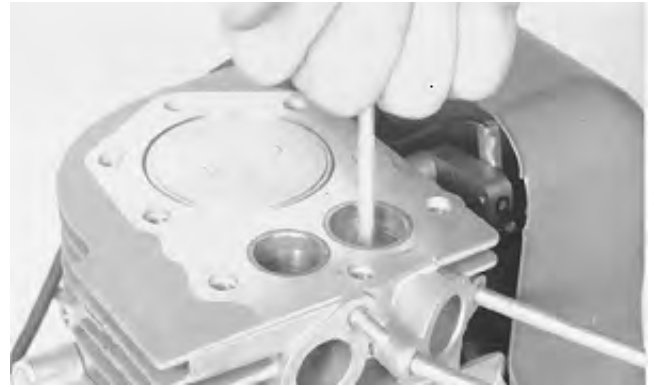
M80358 -UN-06APR91

3. Finish reaming valve guide according to specifications, with stanisol or kerosene lubricant and a 6 mm valve guide reamer. Turn reamer clockwise.

4. Thoroughly clean valve area before assembly.

**SPECIFICATIONS**

Bushing Finished I.D. . . . . . 6—6.02 mm (0.236—0.237 in.)



M80359 -UN-02APR91

MX,2520A1,A6 -19-21OCT92

**RECONDITION VALVE SEATS**

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder block. Pitted or worn seats can be refaced using a seat cutter.

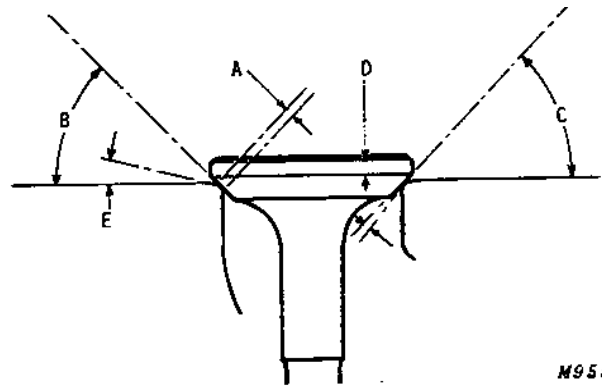
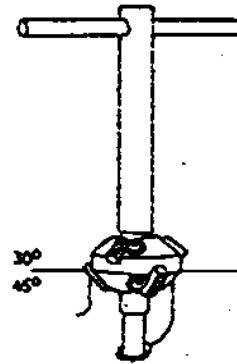
2. To recondition valve seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).

3. Cut valve seating surface (A) as close as possible to specifications.

4. Lap valves to seats after refacing. (See Section 100, Group 05.)

**SPECIFICATIONS**

A—Valve Seating Surface . . . . . 1.00—1.60 mm (0.039—0.063 in.)  
 B—Valve Seat Angle . . . . . 45°  
 C—Valve Face Angle . . . . . 45°  
 D—Valve Margin . . . . . 0.60 mm (0.020 in.)  
 E—Valve Narrowing Angle . . . . . 30°



M955

MX,2520A1,A7 -19-21OCT92

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-UN-31AUG88

M51558

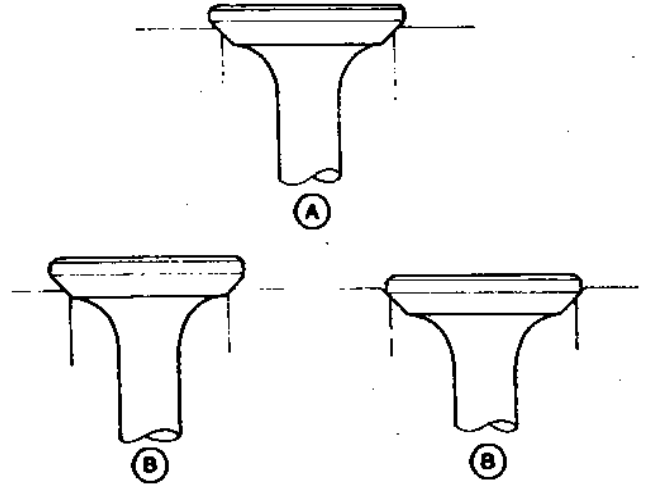
-UN-01SEP88

M9552

5. Center valve seat on the valve face:

- (A) shows correct position.
- (B) shows incorrect.

6. Check seat for good contact using Prussian Blue Compound.



MX,3015A1,A9 -19-21OCT92

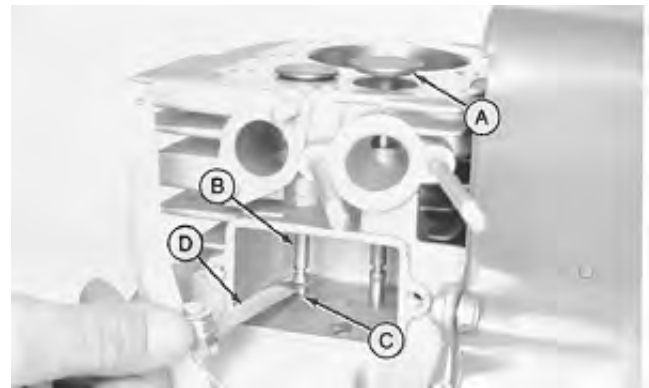
M18615 -UN-07SEP88

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## CHECK VALVE-TO-TAPPET CLEARANCE

*NOTE: Valve grinding changes the valve-to-tappet clearance. Check clearance when engine is cold.*

1. Install valves in cylinder block.
2. Turn flywheel until intake valve (A) is at its highest position. Check clearance between valve (B) and tappet (C), with feeler gauge (D) and compare to specification.
3. Perform same procedure for exhaust valve (B).
4. Grind end of valve stem to obtain proper clearance.



- A—Intake Valve
- B—Exhaust Valve
- C—Tappet
- D—Feeler Gauge

### VALVE CLEARANCE SPECIFICATIONS

Exhaust . . . . .	0.21—0.23 mm (0.008—0.009 in.)
Intake . . . . .	0.12—0.18 mm (0.005—0.007 in.)

MX,2520A1,A8 -19-21OCT92

M80360 -UN-02APR91



## REMOVE AND INSTALL CRANKCASE COVER

*NOTE: Approximate crankcase oil capacity is 0.5 L (1.06 pt).*

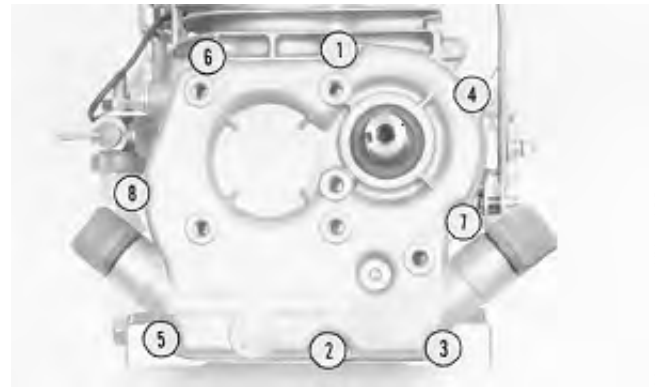
1. Drain crankcase.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

*NOTE: Do not force cover. Gears must mesh for proper positioning.*

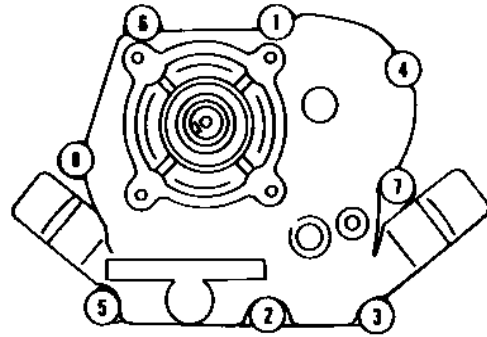
4. Install gasket and cover. Tighten cap screws using the sequence shown.

### TORQUE SPECIFICATIONS

Mounting Cap Screws	9 N·m (84 lb-in.)
Oil Drain Plug	14 N·m (121 lb-in.)



FG150G



FG150D

MX,2520A1,A9 -19-21OCT92

M80361 -UN-06APR91

M80362 -UN-06APR91

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## REMOVE AND INSTALL CAMSHAFT

1. Remove crankcase cover. (See this group.)

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

2. Rotate crankshaft until timing marks (A) align.
3. Remove camshaft (B).
4. Inspect camshaft. (See this group.)
5. Apply clean engine oil to camshaft lobes and journals.
6. Align timing marks and install camshaft.
7. Install crankcase cover.



FG150G Shown

MX,2520A1,A10 -19-21OCT92

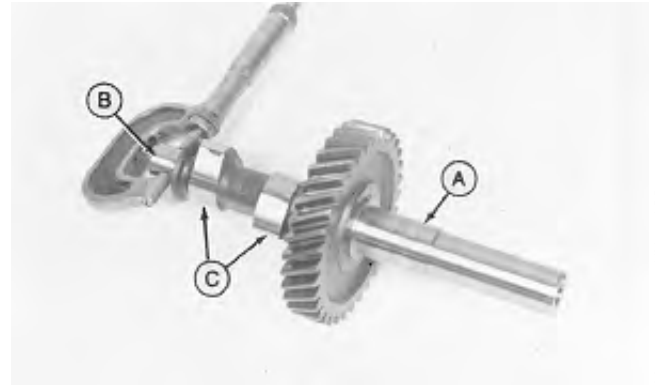
M80363 -UN-02APR91

## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

*NOTE: Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.*

Measure PTO side journal (A), flywheel side journal (B), and lobes (C). Replace camshaft and tappets if less than specifications.



FG150G Shown

### SPECIFICATIONS (MIN)

	PTO Side Journal	Flywheel Side Journal	Cam Lobes
FG150G	—	14.94 mm (0.588 in.)	Intake: 27.30 mm (1.070 in.) Exhaust: 27.10 mm (1.060 in.)
FG150D	14.94 mm (0.588 in.)	14.94 mm (0.588 in.)	Intake: 27.30 mm (1.070 in.) Exhaust: 27.10 mm (1.060 in.)

MX,2520A1,A11 -19-21OCT92

M80365 -UN-02APR91

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## INSPECT CAMSHAFT PLAIN BEARINGS

**NOTE:** FG150G crankcase cover is equipped with a ball bearing.

1. Remove camshaft. (See this group.)
2. Measure camshaft bearings in cylinder block and crankcase cover, if equipped. Replace block or cover if diameter is greater than specification.
3. Install camshaft.



Cylinder Block

M80367  
-UN-02APR91

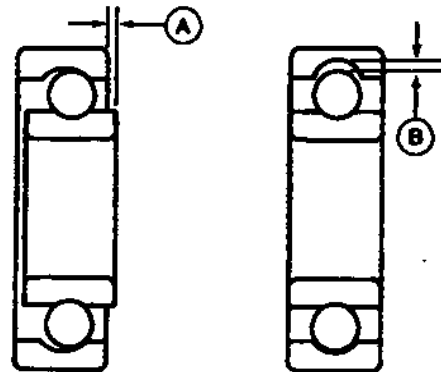
### SPECIFICATIONS (MAX)

	Cylinder Block Bearing	Crankcase Cover Bearing
FG150G	15.04 mm (0.592 in.)	—
FG150D	15.04 mm (0.592 in.)	15.04 mm (0.592 in.)

MX,2520A1,A12 -19-21OCT92

## INSPECT CAMSHAFT BALL BEARING—FG150G

1. Remove PTO end oil seal. (See Inspect Oil Seals in this group.)
2. Remove camshaft bearing from crankcase cover using a bearing, bushing and seal driver set.
3. Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
4. Spin the bearing by hand and check for axial (A) and radial (B) free play.
5. Replace bearing if it is noisy or has too much play.
6. Install bearing flush to inside of crankcase cover using a bearing, bushing and seal driver set.
7. Install oil seal.



M38073  
-UN-29AUG88

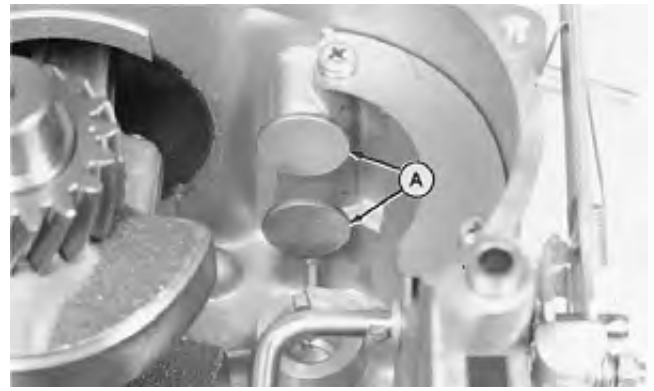
MX,2520A1,A13 -19-21OCT92

## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)

*NOTE: Mark tappets so they can be installed in their original bores during assembly.*

2. Remove tappets (A).
3. Inspect tappets for wear or damage. Replace if necessary.
4. Apply clean engine oil to tappets and bores.
5. Install tappets in original bores.
6. Install camshaft.



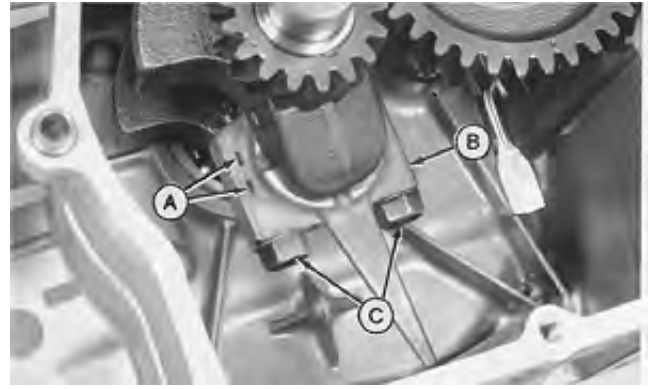
M80369 -UN-02APR91

MX,2520A1,A14 -19-21OCT92

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## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove crankcase cover. (See this group.)
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
4. Remove cap screws (C) and connecting rod cap (B).
5. Push piston and connecting rod from cylinder bore.
6. Make repairs as necessary. (See procedures in this group.)
7. Deglaze cylinder bore. (See Section 100, Group 15.)
8. Stagger piston ring end gaps 180° apart, but do not align with oil ring side rail end gaps.
9. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
10. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
11. Install piston assembly in cylinder bore with engraved "L" on piston head facing flywheel side of engine.
12. Align marks (A) on connecting rod and cap. Install connecting rod cap and cap screws. Tighten cap screws to specifications.



M80370 -UN-02APR91

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### TORQUE SPECIFICATIONS

Connecting Rod Cap Screws . . . . . 20 N·m (177 lb-in.)

MX,2520A1,A15 -19-21OCT92

## DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD

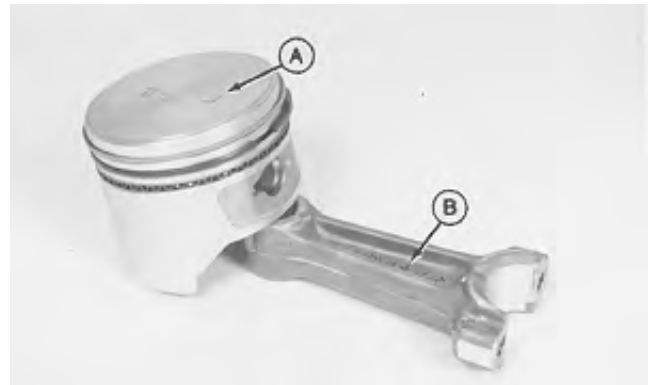
1. Remove circlip, piston pin (B) and connecting rod (A).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



MX,2520A1,A16 -19-21OCT92

M80371 -UN-02APR91

4. Align "L" mark (A) on piston head with the Japanese characters (B) on the connecting rod.
5. Install piston pin and circlip.



MX,2520A1,A17 -19-21OCT92

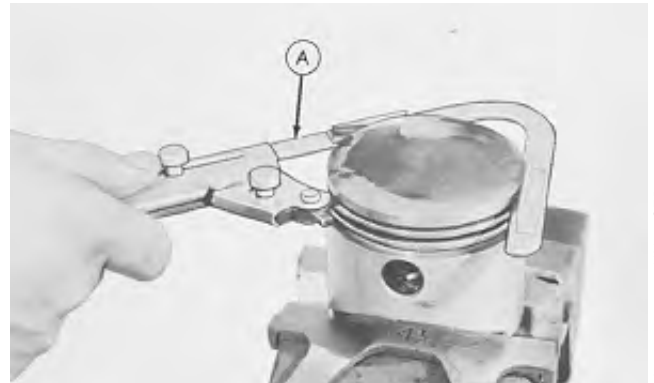
M80372 -UN-02APR91

## INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,2520A1,A18 -19-21OCT92

M29946 -UN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: Inspect clearance visually. Replace piston if clearance appears excessive.*

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.

**CLEARANCE SPECIFICATION (MAX)**

Top Ring	Second Ring	Oil Control Ring
0.17 mm (0.007 in.)	0.16 mm (0.006 in.)	—



M38102 -UN-29AUG88

MX,2520A1,A19 -19-21OCT92

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12

8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston pin bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

Piston Pin O.D. (MIN)	Piston Bore I.D. (MAX)
12.99 mm (0.511 in.)	13.04 mm (0.513 in.)



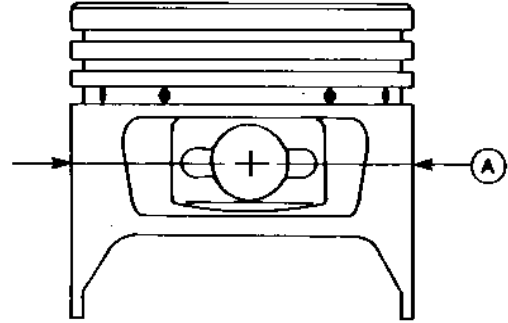
M50064 -UN-31AUG88



M80373 -UN-02APR91

MX,2520A1,A20 -19-21OCT92

10. Measure piston O.D. (A) perpendicular to piston pin bore.
11. Measure cylinder bore. (See Inspect Block in this group.)
12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.
13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)



M80374 -UN-06APR91

**SPECIFICATIONS**

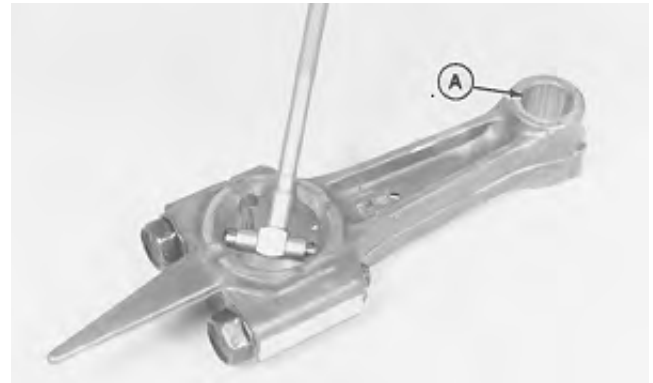
Piston O.D. (A) . . . . .	63.86—63.88 mm (2.516—2.5168 in.)
Piston-to-Cylinder Bore Clearance (std.) . . . . .	0.12 mm (0.005 in.)
(max.) . . . . .	0.1375 mm (0.0054 in.)

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MX,2520A1,A20A -19-21OCT92

**INSPECT CONNECTING ROD**

1. Clean and inspect rod. Replace if scored.
2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
3. Install connecting rod cap. Tighten to 20 N·m (177 lb-in.).
4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



M80375 -UN-02APR91

**BEARING I.D. SPECIFICATIONS (MAX)**

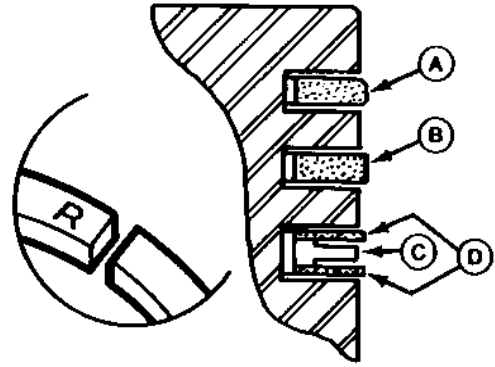
<b>Crankshaft Bearing</b>	<b>Piston Bearing</b>
24.55 mm (0.967 in.)	13.04 mm (0.514 in.)

MX,2520A1,A21 -19-21OCT92



## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)
4. Install top ring (A) and second ring (B) with R or NPR mark facing up. Rings should turn freely in grooves.
5. Oil ring is an assembly. Install spacer (C), then side rails (D). Put side rail end gaps 180° apart.



A—Top Ring  
B—Second Ring  
C—Spacer  
D—Side Rails

MX,2520A1,A22 -19-21OCT92

M80376 -UN-06APR91

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14

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.

### END GAP SPECIFICATIONS

Minimum End Gap	0.18 mm (0.007 in.)
Maximum End Gap	0.80 mm (0.032 in.)



M80377 -UN-02APR91

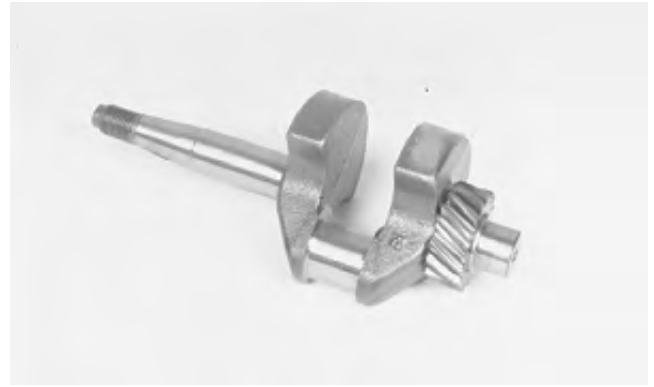
MX,2520A1,A23 -19-21OCT92

## REMOVE, INSPECT AND INSTALL CRANKSHAFT

1. Remove flywheel. (See Group 10.)
2. Remove camshaft. (See this group.)
3. Remove piston and connecting rod. (See this group.)
4. Remove crankshaft.

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

5. Check crankshaft alignment (T.I.R.). (See this group.)
6. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
7. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
8. Measure crankshaft connecting rod journal. Replace crankshaft if measurement is less than specifications.
9. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
10. Apply clean engine oil to crankshaft bearings and journal.
11. Pack lithium based grease in oil seals.
12. Install crankshaft.
13. Install piston and connecting rod.
14. Install crankshaft.
15. Install flywheel.



FG150G Shown

M80378 -UN-02APR91

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### JOURNAL SPECIFICATIONS (MIN)

Main Bearing Journal		Connecting Rod Journal
PTO Side	Flywheel Side	
19.963 mm (0.786 in.)	19.963 mm (0.786 in.)	24.45 mm (0.963 in.)

MX,2520A1,A24 -19-21OCT92

## INSPECT CRANKSHAFT BALL BEARINGS—FG150G

1. Remove flywheel end oil seal. (See Inspect Oil Seals in this group.)

2. Remove crankshaft bearing from cylinder block using a bearing, bushing and seal driver set.

Remove bearing from crankcase cover using a blind hole puller set.

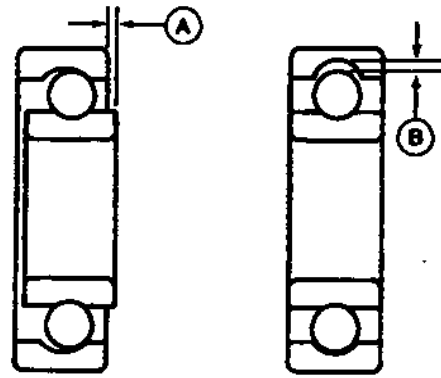
3. Thoroughly clean bearings in solvent. Dip bearings in light weight oil.

4. Spin each bearing by hand and check for axial (A) and radial (B) free play.

5. Replace bearings if noisy or too much play.

6. Install bearings flush to inside of crankcase cover or cylinder block using a bearing, bushing and seal driver set.

7. Install oil seal.



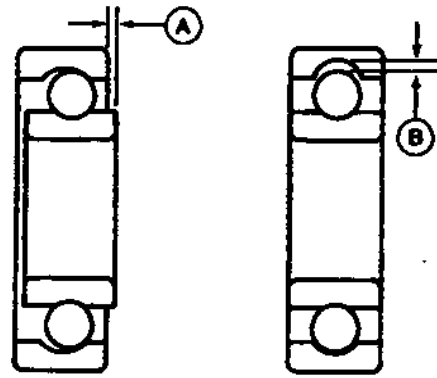
M38073 -UN-29AUG88

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MX,2520A1,A25 -19-21OCT92

### INSPECT CRANKSHAFT BALL BEARINGS—FG150D

1. Remove oil seals. (See Inspect Oil Seals in this group.)
2. Remove crankshaft bearings using a bearing, bushing and seal driver set.
3. Thoroughly clean bearings in solvent. Dip bearings in light weight oil.
4. Spin each bearing by hand and check for axial (A) and radial (B) free play.
5. Replace bearings if noisy or too much play.
6. Install bearings flush to inside of crankcase cover or cylinder block using a bearing, bushing and seal driver set.
7. Install oil seals.



M38073 -UN-29AUG88

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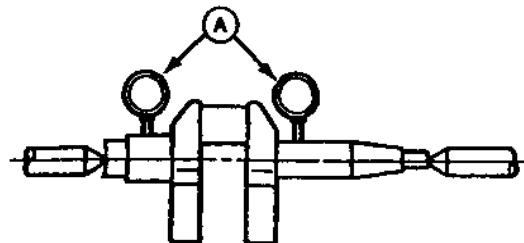
MX,2520A1,A26 -19-21OCT92

### CHECK CRANKSHAFT ALIGNMENT (TIR)

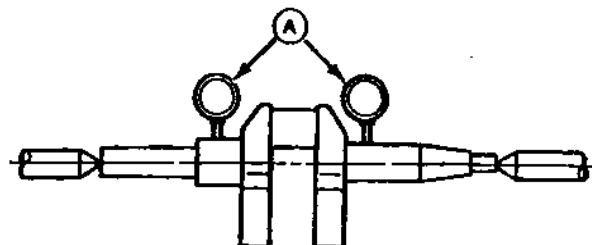
Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.

#### SPECIFICATIONS

Maximum TIR . . . . . 0.05 mm (0.002 in.)



FG150G



FG150D

-UN-06APR91

M80380

-UN-06APR91

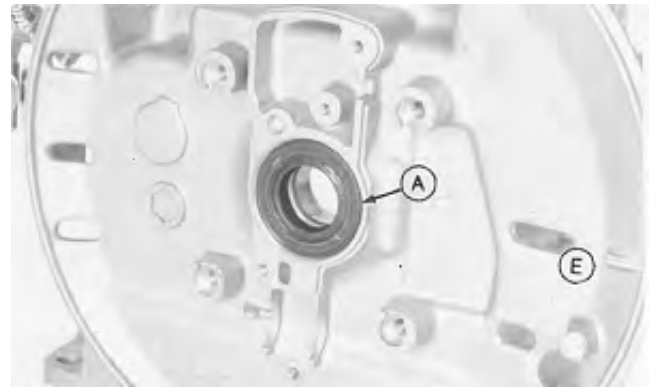
M80381

MX,2520A1,A27 -19-21OCT92

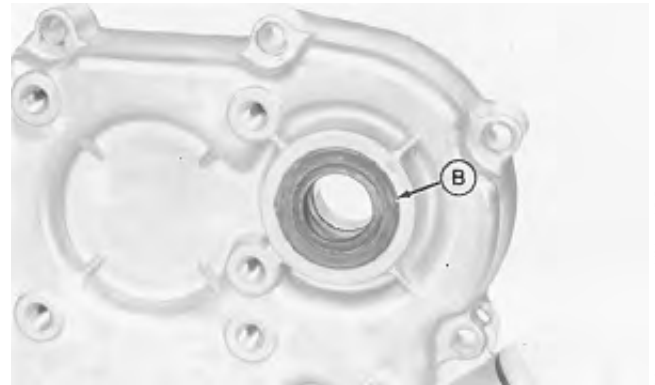
## INSPECT OIL SEALS

*NOTE: FG150G PTO is driven by the camshaft, FG150D PTO is driven by the crankshaft.*

1. Remove flywheel. (See Group 10.)
2. Inspect oil seals (A and B) at flywheel end and PTO end for wear or damage. Replace if necessary.
3. Remove crankshaft. (See this group.)
4. Remove worn or damaged seals with a screwdriver.
5. Install seals with lip to inside of engine using bearing, bushing and seal driver set. Press seals in until flush with hub.
6. Install crankshaft.
7. Install flywheel.



Flywheel Side



PTO Side—FG150G Shown

MX,2520A1,A28 -19-21OCT92

M80382 -UN-02APR91

M80383 -UN-02APR91

## INSPECT CYLINDER BLOCK

1. Remove crankshaft. (See this group.)
2. Clean and check block for cracks.
3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
4. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

MX,2520A1,A29 -19-21OCT92

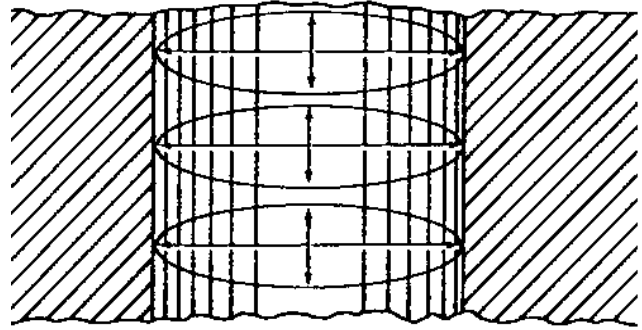
*NOTE: A bare block is available for service.*

5. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

6. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

*NOTE: If cylinder is rebored, oversize piston and rings must be installed.*

7. Install crankshaft.



M51745 -UN-23FEB89

**CYLINDER BORE SPECIFICATIONS**

Standard . . . . .	63.98—64.00 mm (2.521—2.522 in.)
Wear Limit . . . . .	64.05 mm (2.524 in.)
Out-of-Round (Max) . . . . .	0.045 mm (0.0018 in.)



M80385 -UN-02APR91

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MX,2520A1,A30 -19-21OCT92

## REBORE CYLINDER BLOCK

**NOTE:** The cylinder block can be rebored to use 0.25, or 0.50 mm (0.010 or 0.020 in.) oversize pistons and rings. Have a reliable repair shop rebore the block, or use the drill press and honing tool.

1. Rebore cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from 200—250 rpm.
3. Lower and raise hone until ends extend 20—25 mm (0.75—1.0 in.) past ends of cylinder.
4. Turn adjusting nut on one hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately 20 times per minute.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

**NOTE:** Finish should not be smooth, but have a 40—60° cross-hatch pattern.

**IMPORTANT: Check stone for wear or damage. Use correct stone for the job.**

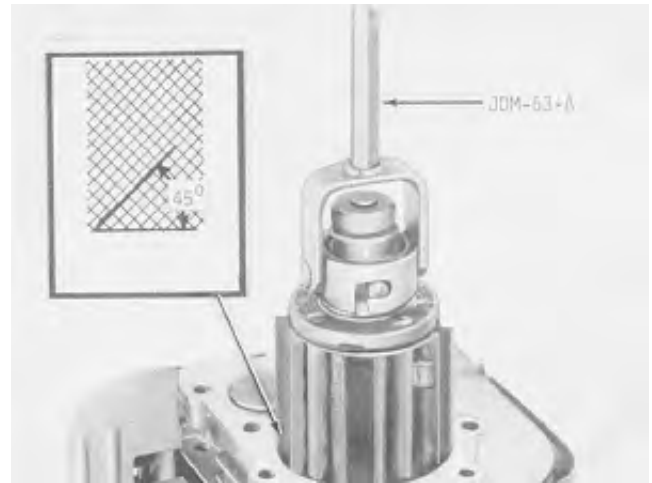
### CYLINDER INITIAL BORE SPECIFICATIONS

**Piston Oversize:**  
0.25 mm  
(0.010 in.)

64.21—64.23 mm  
(2.530—2.531 in.)

**Piston Oversize:**  
0.50 mm  
(0.020 in.)

64.46—64.48 mm  
(2.540—2.541 in.)



M24711 -UN-25AUG88

MX,2520A1,A31 -19-21OCT92

8. Hone the cylinder an additional 0.028—0.030 mm (0.0011—0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

**IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.**

9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

10. Dry the cylinder. Apply engine oil to cylinder wall.

M98,2040A,A9 -19-21OCT92

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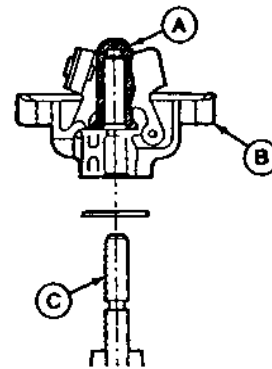
## INSPECT AND REPLACE GOVERNOR

**IMPORTANT: Removal damages governor. If not damaged, do not remove.**

1. Remove crankcase cover. (See this group.)
2. Remove governor cover.
3. Inspect governor. If necessary to replace, remove with screwdriver.
4. If removed, press shaft (C) back into block until it protrudes 32.2—32.8 mm (1.267—1.291 in.).

*NOTE: Assemble sleeve and gear before installing assembly on shaft.*

5. Install sleeve (A) onto governor gear (B).
6. Install governor assembly onto shaft. Push down on assembly until it snaps into place.
7. Install governor cover.
8. Install crankcase cover.



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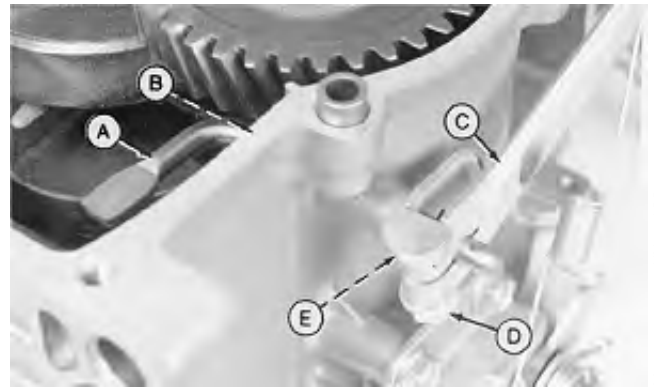
MX,2520A1,A32 -19-21OCT92



## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (A). Replace if damaged.
3. To replace shaft, loosen nut (D) on lever (C).
4. Remove retaining pin (E), governor shaft and washer (B).
5. Install washer, shaft and retaining pin. Tighten nut.
6. Install crankcase cover.



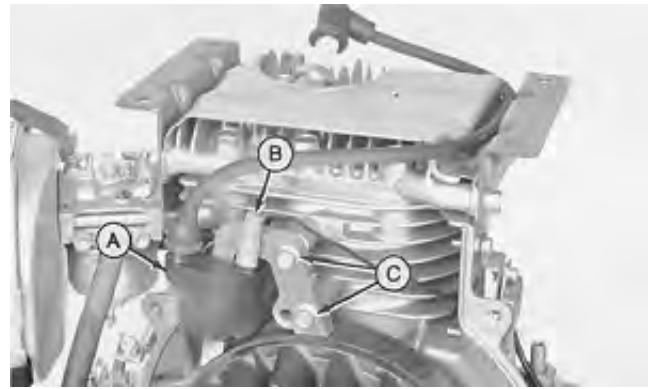
**A—Governor Shaft**  
**B—Washer**  
**C—Governor Lever**  
**D—Nut**  
**E—Retaining Pin**

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MX,2520A1,A33 -19-21OCT92

### REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove blower housing. (See Group 10.)
2. Remove fuel tank. (See Group 05.)
3. Disconnect wiring lead (B).
4. Remove cap screws (C) and armature with coil (A).
5. Loosely install armature with coil.
6. Connect wiring lead.
7. Adjust armature air gap. (See this group.)
8. Install fuel tank.
9. Install blower housing.

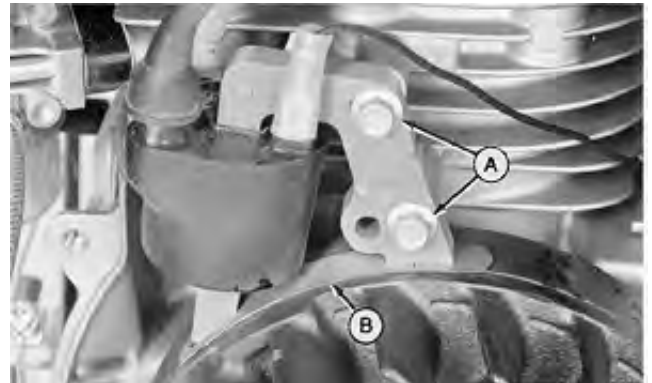


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MX,2525A1,A1 -19-21OCT92

### ADJUST ARMATURE AIR GAP

1. Turn flywheel magnet away from armature.
2. Insert feeler gauge blade (B) between flywheel and armature.
3. Push armature against flywheel and tighten screws (A).
4. Turn flywheel to remove feeler gauge.



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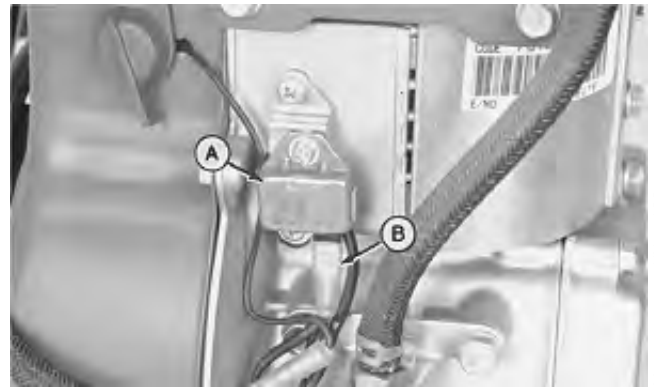
#### AIR GAP SPECIFICATIONS

Feeler Gauge Blade . . . . . 0.30 mm (0.012 in.)

MX,2525A1,A2 -19-21OCT92

## REPLACE IGNITOR

1. Disconnect wiring lead (B).
2. Remove ignitor (A).
3. Install ignitor.
4. Connect wiring lead.



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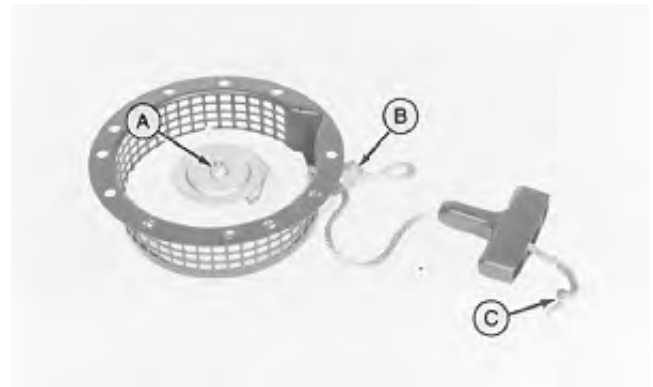
MX,2525A1,A3 -19-21OCT92

## DISASSEMBLE RECOIL STARTER

1. Remove starter.
2. Pull handle out about 30 cm ( 1 ft). Tie knot (B) to prevent rope from winding back onto reel.
3. Pry knot (C) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (B). Slowly release reel tension. Do not let rope get wedged between reel and housing.

**CAUTION: Wear gloves and protective goggles for remaining steps.**

6. Remove nut (A) and ratchet cover.



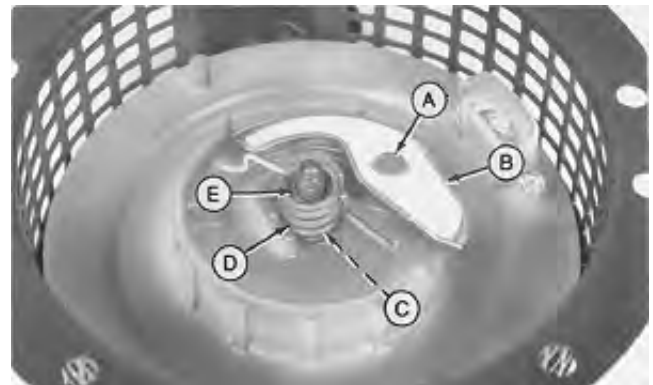
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**CAUTION: A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.**

7. Turn the reel one half turn counterclockwise so no spring tension can be felt.
8. Remove spring (D), collar (E), and nylon washer (C).
9. Remove pawl assembly (B) and pivot pin (A).

A—Pivot Pin  
B—Pawl Assembly  
C—Nylon Washer  
D—Spring  
E—Collar



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MX,2530A1,A1A -19-21OCT92

10. Spring is stored in reel. Carefully remove while holding spring in underside of reel.

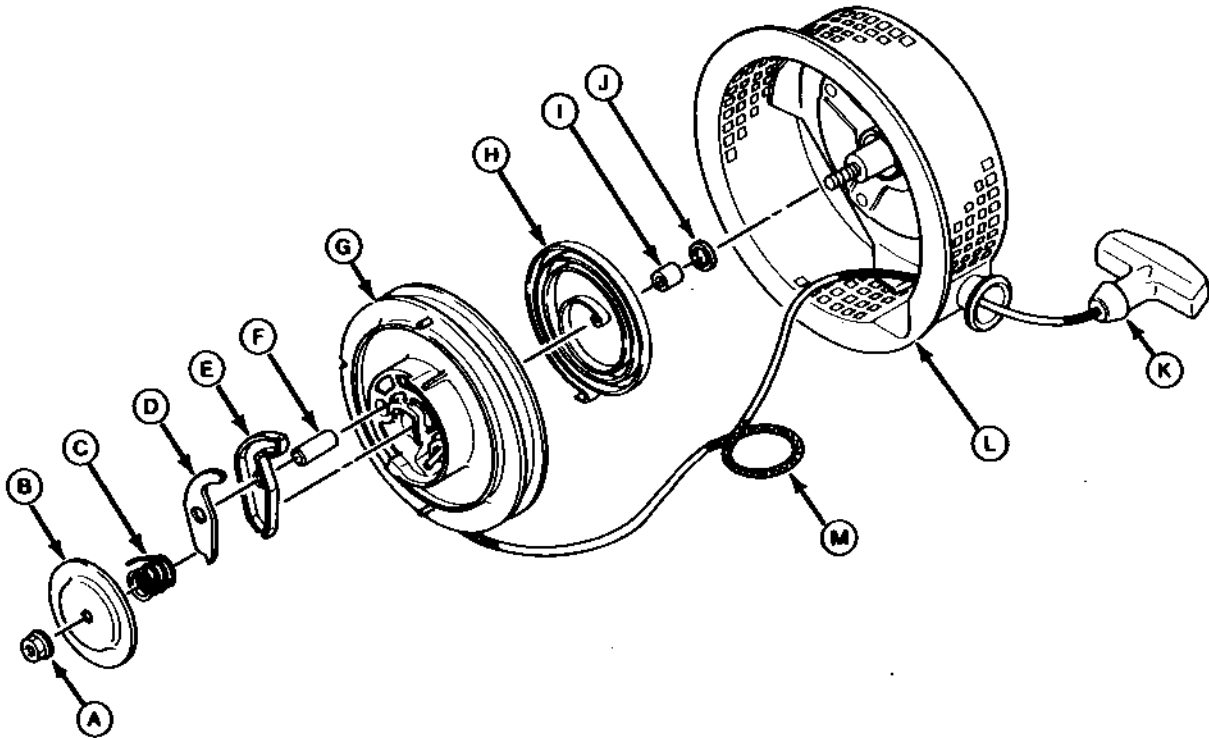
11. Inspect starter for wear or damage. (See this group.)



MX,2530A1,A2 -19-21OCT92

M80392 -UN-02APR91

## INSPECT RECOIL STARTER



A—Nut  
B—Ratchet Cover  
C—Spring  
D—Nylon Pawl

E—Pawl  
F—Pivot Pin  
G—Reel

H—Spring  
I—Collar  
J—Nylon Washer

K—Handle  
L—Housing  
M—Rope

Inspect all parts for wear or damage. Replace as necessary.

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M80393 -UN-06APR91

## REPLACE SPRING

**⚠ CAUTION: Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.**

1. Working from the center out, carefully unwind spring from reel.
2. Hook outside spring tang in reel. Wind spring into reel, working toward center.



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## ASSEMBLE RECOIL STARTER

1. Wind rope clockwise onto reel.
2. Apply multipurpose grease to spring.
3. Install reel with spring in housing. Align inner tang (A) with catch (B).
4. Turn reel clockwise until you feel tang hook on catch.

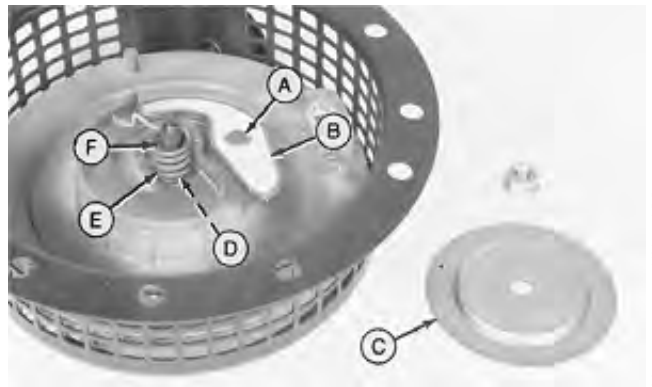


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5. Install pivot pin (A) and pawl assembly (B).
6. Install nylon washer (D), collar (F) and spring (E).
7. Install ratchet cover (C) and nut.

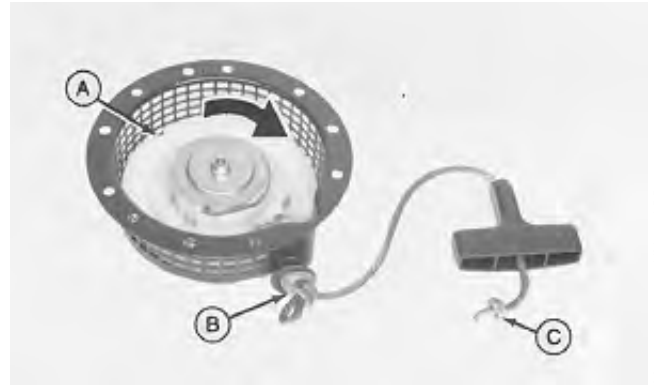
A—Pivot Pin  
B—Pawl Assembly  
C—Ratchet Cover  
D—Nylon Washer  
E—Spring  
F—Collar



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MX,2530A1,A6 -19-21OCT92

8. Place rope in notch (A). Turn reel two turns clockwise to preload spring.
9. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (B) to hold rope.
10. Install handle and secure with knot (C).
11. Remove knot (B).
12. Pull rope to check for proper operation.
13. Install recoil starter on engine.



- A—Knot
- B—Knot
- C—Spring
- D—Pawls
- E—Retainer

MX,2530A1,A7 -19-21OCT92

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# Section 30 FC150V

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# Group 00

## Engine Application and Repair Specifications

### ENGINE APPLICATIONS CHART

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

#### 21-INCH REAR DISCHARGE WALK-BEHIND MOWERS (S.N. 450001— ) (S.N. 050001- )

Machine	Engine Model No.
14PB .....	FC150V-AS02
14SB .....	FC150V-AS00
14SE .....	FC150V-AS01

#### 21-INCH REAR DISCHARGE WALK-BEHIND MOWERS (S.N. GXXXXX010001— )

Machine	Engine Model No.
14PB (Engine S.N. —103663) .....	FC150V-BS00
14SB (Engine S.N. 103664—225603) .....	FC150V-CS00
(Engine S.N. A00002— ) .....	FC150V-ES00
14SE (Engine S.N. 047346—221774) .....	FC150V-BS01
(Engine S.N. A05501— ) .....	FC150V-ES01
14SE (Engine S.N. 221775— ) (5 HP) .....	FC150V-FS01
14SC (5 HP) .....	FC150V-ES06
14ST (5 HP) .....	FC150V-ES09

NOTE: 1992 MODELS, both Push or Self-Propelled, start with SN 050001-.

NOTE: SERIAL NUMBER PREFIX FOR PUSH MOWER IS GX14PTA (1992- )

NOTE: SERIAL NUMBER PREFIX FOR SELF-PROPELLED IS GX14STA (1992- )

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## FC150V REPAIR SPECIFICATIONS

### GROUP 05—FUEL AND AIR SYSTEMS

Item	Specification
Breather	
Maximum Air Gap . . . . .	0.20 mm (0.008 in.)

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Flywheel Nut Torque . . . . .	45 N·m (33 lb-ft)
Minimum Flywheel Screen Gap . . . . .	1.50 mm (0.059 in.)

### GROUP 15—CYLINDER HEAD AND VALVES

Valve Clearance . . . . .	0.12 mm (0.005 in.)
---------------------------	---------------------

Rocker Arm	
Stud and Nut Torque . . . . .	7 N·m (62 lb-in.)

Push Rod	
Maximum Bend . . . . .	0.60 mm (0.024 in.)

Valves and Springs	
Minimum Spring Free Length . . . . .	31.50 mm (1.240 in.)
Maximum Valve Guide I.D.	
Intake . . . . .	5.55 mm (0.218 in.)
Exhaust . . . . .	5.56 mm (0.219 in.)
Minimum Valve Stem O.D.	
Intake . . . . .	5.44 mm (0.214 in.)
Exhaust . . . . .	5.42 mm (0.213 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Minimum Valve Stem End Length . . . . .	3.80 mm (0.150 in.)
Valve Seating Surface . . . . .	0.50—1.10 mm (0.020—0.043 in.)
Valve Seat and Face Angle . . . . .	45°
Minimum Valve Margin . . . . .	0.50 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

Cylinder Head	
Cylinder Head Flatness . . . . .	0.07 mm (0.003 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	18 N·m (159 lb-in.)
Final Torque . . . . .	24 N·m (212 lb-in.)

Spark Plug Torque . . . . .	20 N·m (177 lb-in.)
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**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS**

Item	Specification
<b>Crankcase Cover</b>	
Oil Capacity . . . . .	0.6 L (1.27 pt)
Cap Screw Torque . . . . .	7 N·m (62 lb-in.)
Drain Plug Torque . . . . .	21 N·m (186 lb-in.)
<b>Camshaft</b>	
Minimum End Journals O.D. . . . .	13.92 mm (0.548 in.)
Minimum Lobe Height . . . . .	22.80 mm (0.898 in.)
Maximum Cover and Crankcase Bearing I.D. . . . .	14.07 mm (0.554 in.)
<b>Piston</b>	
Maximum Ring Groove Clearance . . . . .	0.10 mm (0.004 in.)
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap	
Compression Rings . . . . .	1.00 mm (0.039 in.)
Oil Ring Side Rails . . . . .	1.50 mm (0.059 in.)
Minimum Pin O.D. . . . .	14.98 mm (0.590 in.)
Maximum Pin Bore I.D. . . . .	15.05 mm (0.593 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.07 mm (0.003 in.)
Piston O.D. . . . .	64.90 mm (2.555 in.)
Piston-to-Cylinder Bore Clearance	
Standard Clearance . . . . .	0.06—0.10 mm (0.0024—0.0039 in.)
Wear Limit . . . . .	0.1375 mm (0.0054 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	28.07 mm (1.105 in.)
Maximum Piston Pin Bearing I.D. . . . .	15.05 mm (0.593 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.07 mm (0.003 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.15 mm (0.006 in.)
End-Cap Screw Torque . . . . .	12 N·m (106 lb-in.)
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	24.92 mm (0.981 in.)
Minimum Connecting Rod Journal O.D. . . . .	27.92 mm (1.099 in.)
Maximum Crankcase Cover Plain Bearing I.D. . . . .	25.10 mm (0.988 in.)
Maximum T.I.R. . . . .	0.20 mm (0.008 in.)
End Play . . . . .	0—0.050 mm (0—0.020 in.)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D. . . . .	64.90—65.00 mm (2.557—2.561 in.)
Maximum Cylinder Bore I.D. . . . .	65.06 mm (2.563 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.25 mm . . . . .	65.21—65.23 mm (2.567—2.568 in.)
0.50 mm . . . . .	65.46—65.48 mm (2.577—2.578 in.)
0.75 mm . . . . .	65.71—65.73 mm (2.587—2.588 in.)

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**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
Oil Pump	
Minimum Rotor Shaft O.D. . . . .	9.01 mm (0.355 in.)
Maximum Rotor Shaft Bearing I.D. . . . .	9.14 mm (0.360 in.)
Minimum Outer Rotor Thickness . . . . .	11.95 mm (0.471 in.)
Maximum Outer Rotor Bore Depth . . . . .	12.10 mm (0.476 in.)
Minimum Outer Rotor O.D. . . . .	22.93 mm (0.903 in.)
Maximum Outer Rotor Bearing I.D. . . . .	23.17 mm (0.912 in.)
Minimum Valve Spring Free Length	
(Engine S.N. 047346—072217) . . . . .	17.00 mm (0.669 in.)
(Engine S.N. 072218—) . . . . .	19 mm (0.748 in.)
Governor Arm Nut Torque . . . . .	7 N·m (62 lb-in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)
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See Ignition Tests in this Group.

**GROUP 30—STARTING SYSTEMS**

Recoil and Electric Starter

See Starter Specifications in this Group.

MX,3000A1,A4 -19-21OCT92

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Carburetor Gasket Kit

Main Jet High Altitude Kit

Complete Carburetor

MX,3005A1,A1 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR

1. Close fuel shut off valve on fuel tank.
2. Drain fuel from carburetor.
3. Disconnect hoses (A and B).
4. Remove duct (C) and collars (F).
5. Disconnect linkage (D and E) and remove carburetor, gaskets and insulator (G).

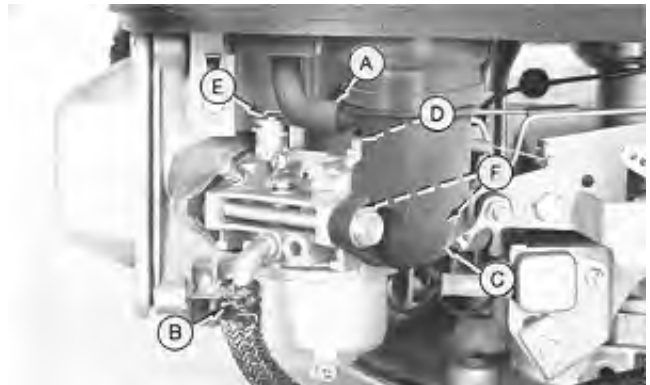
6. Make repairs as necessary. (See procedure in this group.)

*NOTE: Install carburetor and gaskets with convex side of insulator (G) toward cylinder head and tab (H) pointing down.*

7. Install gaskets, insulator and carburetor. Connect linkage.

8. Install collars, duct and cap screws.

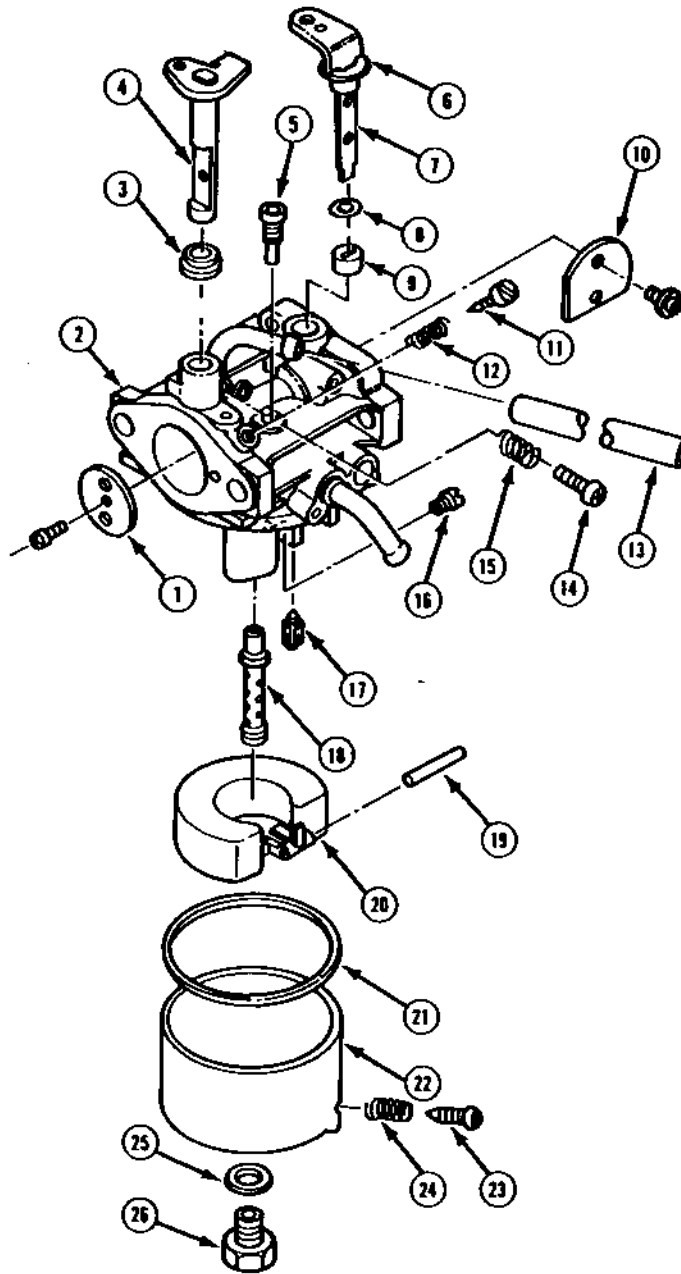
9. Connect hoses.



A—Oil Breather Hose	E—Throttle Linkage
B—Fuel Hose	F—Collar
C—Air Intake Duct	G—Insulator
D—Choke Linkage	H—Tab

MX,3005A1,A2 -19-21OCT92

**DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR**



- 1—Throttle Plate
- 2—Carburetor Body
- 3—Bushing
- 4—Throttle Shaft
- 5—Pilot Jet
- 6—Bushing
- 7—Choke Shaft

- 8—Washer
- 9—Collar
- 10—Choke Plate
- 11—Pilot Screw
- 12—Spring
- 13—Hose
- 14—Idle Screw

- 15—Spring
- 16—Main Jet
- 17—Needle Valve
- 18—Main Nozzle
- 19—Float Pin
- 20—Float

- 21—Gasket
- 22—Float Chamber
- 23—Drain Screw
- 24—Spring
- 25—Washer
- 26—Plug

30-05-2

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**IMPORTANT:** To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

*NOTE: Main jet high altitude kits are available.*

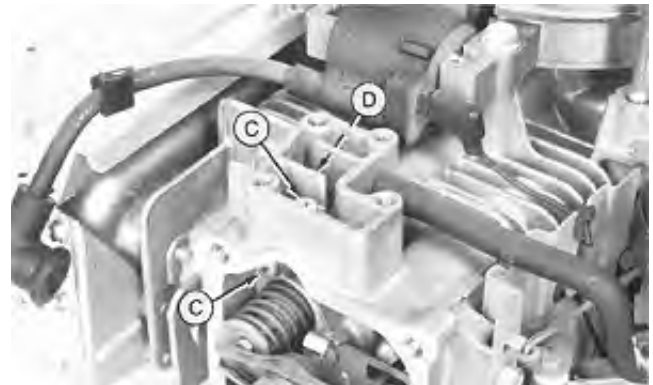
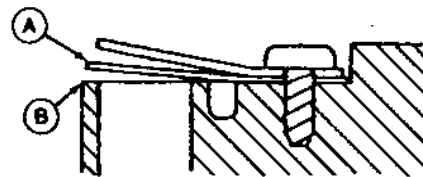
*Float is plastic. The float cannot be adjusted. Replace if necessary.*

MX,3005A1,A4 -19-21OCT92

## SERVICE BREATHER

*NOTE: Breather is located in cylinder head.*

1. Remove engine cover. (See Group 10.)
2. Remove breather cover and gasket.
3. Remove rocker arm cover.
4. Measure air gap between reed valve (A) and valve seat (B) at valve tip. Replace reed valve if gap exceeds specification.
5. Remove breather valve (C).
6. Inspect breather for sticking, binding, cracks or distortion. Replace breather if worn or damaged.
7. Inspect valve seating surface. Surface must be free of nicks or burrs.
8. Check that drain back hole (D) in breather chamber is open.
9. Install breather assembly, gasket and cover.



### SPECIFICATIONS

Air Gap (MAX) . . . . . 0.20 mm (0.008 in.)

- A—Reed Valve
- B—Valve Seat
- C—Breather Valve (2 used)
- D—Drain Back Hole

MX,3005A1,A5 -19-21OCT92

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05  
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-UN-07SEP88  
M51757  
-UN-07SEP88  
M51755



## SERVICE AIR CLEANER

1. Remove cover (D) and disassemble the filter elements.

**IMPORTANT: Do not clean paper element.**

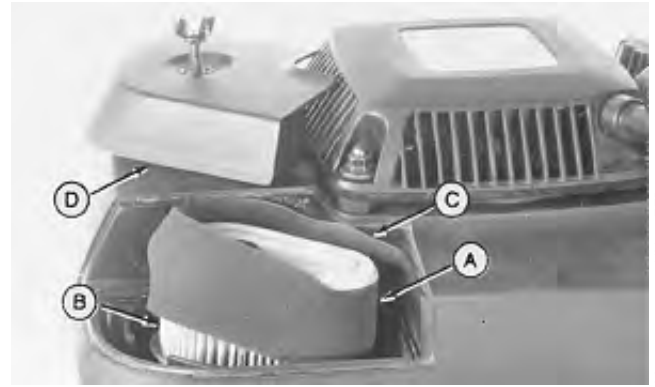
2. Wash foam element (A) in detergent and water. Dry element.

3. Put 12—15 drops of engine oil on foam element (A). Squeeze out excess oil.

4. Replace paper element (B) if:  
—Element is oily, dirty, bent, torn, crushed, or obstructed in any way.  
—Seal is damaged.  
—Engine performance is poor.

5. Inspect housing (C), and cover (D) for damage. Replace if necessary.

6. Assemble and install air cleaner elements.



A—Foam Element  
B—Paper Element  
C—Housing  
D—Cover

M80165 -UN-11FEB91

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MX,3005A1,A6 -19-21OCT92

**OTHER MATERIAL**

Number	Name	Use
T43512	Thread Lock and Sealer (Medium Strength)	Engine cover mounting stud.

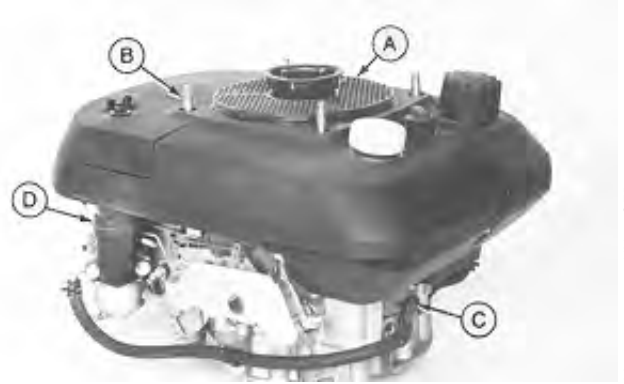
MX,3010A1,A1 -19-21OCT92

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1

## REMOVE AND INSTALL ENGINE COVER

*NOTE: Fuel tank assembly is removed with engine cover.*

1. Close fuel shut-off valve.
2. Disconnect fuel hose (C). Close all openings using caps and plugs.
3. Remove recoil starter.
4. Remove flywheel nut, cup and screen assembly (A) and spacers, if equipped.
5. Remove oil filler cap and collars (B).
6. Disconnect adapter (D).
7. Remove engine cover.
8. Inspect cover for wear or damage. Replace if necessary.
9. Install engine cover and cup and screen assembly.
10. Adjust flywheel screen. (See this group.)
11. Connect adapter.
12. Install collars and filler cap.
13. Install spacers, if equipped, cup and screen assembly and flywheel nut. Tighten nut to 45 N·m (33 lb-ft).
14. Install recoil starter.
15. Connect fuel hose and open shut-off valve.



**A—Cup and Screen Assembly**  
**B—Collar (4 used)**  
**C—Fuel Hose**  
**D—Adapter**

M51746 -UN-07SEP88

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2

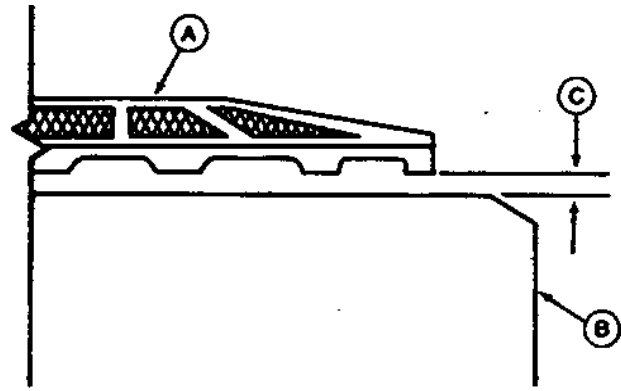
MX,3010A1,A2 -19-21OCT92

## FLYWHEEL SCREEN ADJUSTMENT

Adjust gap (C) between the blades under screen (A) and engine cover (B) to specifications using spacers.

### SPECIFICATIONS

Gap (Min) . . . . . 1.5 mm (0.059 in.)



M38037 -UN-29AUG88

MX,3010A1,A3 -19-21OCT92

## REMOVE AND INSTALL BRAKE BAND—ZONE START MODELS

1. Remove engine cover. (See this group.)
2. Remove oil fill tube.
3. Pry spring arm (A) over stop.
4. Remove pin and washer (B).

*NOTE: Remove engine cover mount stud when replacing brake band only.*



M51754 -JUN-07SEP88

5. Inspect band for wear or damage. Replace if necessary.
  - Remove engine cover mount stud on end of band.
  - Replace brake band.
  - Apply thread lock and sealer (medium strength) on threads of engine cover mount stud.
  - Install brake band and stud.
6. Install brake band, washer and pin.
7. Install spring arm in front of stop.
8. Install oil fill tube.
9. Install engine cover.

MX,3010A1,A4 -19-21OCT92

## REMOVE AND INSTALL FLYWHEEL

1. Remove engine cover. (See this group.)
2. Remove armature with coil. (See Group 25.)
3. Remove brake band, if equipped. (See this group.)
4. Remove flywheel using a two-jaw puller.
5. Inspect flywheel for wear or damage. Replace if necessary.
6. Install flywheel.
7. Install brake band, if equipped.
8. Install armature with coil.
9. Install engine cover.



M80166 -UN-11FEB91

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10  
4

MX,3010A1,A5 -19-21OCT92

### OTHER MATERIAL

Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean Cylinder Head
	Valve Guide Cleaner	Clean Valve Guides
	Stanisol (or Kerosene)	Finish Ream Valve Guide
	Prussian Blue Compound	Check Valve Seat Contact

*SCOTCH-BRITE is a trade mark of the 3M Company.*

MX,4015A1,A1 -19-21OCT92

### SERVICE PARTS KITS

The following kits are available through your parts catalog:

Overhaul Gasket Kit

Intake & Exhaust Valve Kit

Rocker Arm Kit

MX,3015A1,A0 -19-21OCT92

30  
15  
1

## REMOVE, INSPECT AND INSTALL ROCKER ARM ASSEMBLY

1. Remove rocker arm cover.
2. Turn crankshaft until piston is at highest position in compression stroke.
3. Remove nut (C) and pivot (D) to remove arm (A).

**IMPORTANT: Mark push rods for reassembly in original locations.**

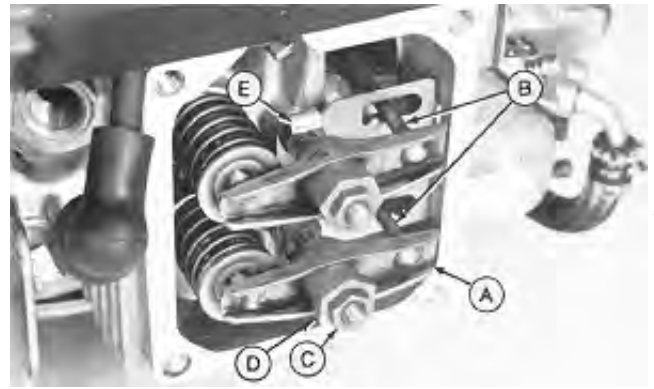
4. Remove push rods (B).
5. Bend open lock tabs (E). Remove rocker arm studs and support plate.
6. Inspect parts for wear or damage. Replace as necessary.
7. Inspect push rods for bends using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is greater than specifications.
8. Install support plate and studs. Tighten studs to specifications. Bend over lock tabs.

**IMPORTANT: Align rocker arms over push rods during assembly.**

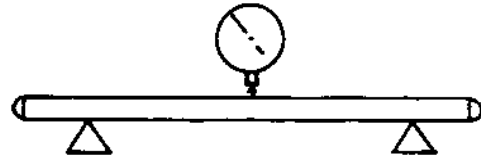
9. Install push rods, rocker arms, pivots and nuts.
10. Check valve clearance. (See this group.)
11. Install rocker arm cover.

### SPECIFICATIONS

Push Rod Bend (Max) . . . . . 0.30 mm (0.012 in.)  
 Rocker Arm Stud Torque . . . . . 7 N·m (62 lb-in.)



M51747 -UN-07SEP88



M50044 -UN-31AUG88

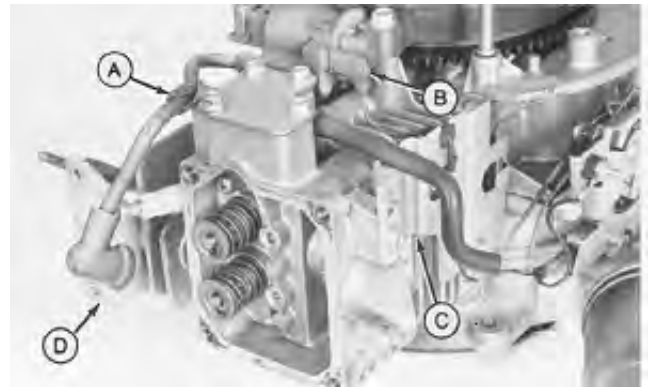
- A—Rocker Arm (2 used)
- B—Push Rods
- C—Nut (2 used)
- D—Pivot (2 used)
- E—Lock Tab

MX,3015A1,A1 -19-21OCT92

30  
15  
2

## REMOVE AND INSTALL CYLINDER HEAD ASSEMBLY

1. Remove engine cover. (See Group 10.)
2. Remove carburetor. (See Group 05.)
3. Remove rocker arm assembly. (See this group.)
4. Remove muffler shield, muffler and gasket.
5. Disconnect wiring lead (B).
6. Remove heat shields (C and D).
7. Disconnect spark plug wiring lead and remove from clamp (A).
8. Remove spark plug.
9. Remove cylinder head assembly.
10. Make repairs as necessary. (See procedures in this group.)



A—Clamp  
B—Wiring Lead  
C—Heat Shield  
D—Heat Shield

M80167 -UN-11FEB91

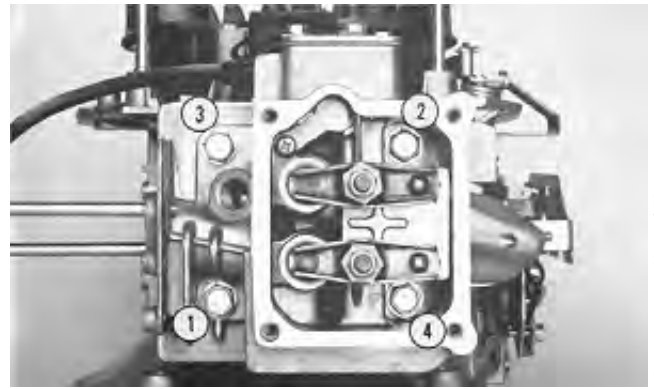
MX,3015A1,A2 -19-21OCT92

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3



**IMPORTANT: Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.**

11. Install cylinder head assembly with new gasket. Install cap screws and tighten finger tight.
12. Tighten cap screws in sequence shown. Tighten to initial torque specifications.
13. Continue in sequence, 3 N·m (27 lb-in.) at a time, until final torque is as specified.
14. Install spark plug and tighten to specification.
15. Connect spark plug wiring lead.
16. Install heat shields.
17. Connect armature wiring lead.
18. Install new gasket, muffler and muffler shield.
19. Install rocker arm assembly.
20. Install carburetor.
21. Install engine cover.



M51748 -UN-07SEP88

**TORQUE SPECIFICATIONS**

Initial Torque . . . . .	18 N·m (159 lb-in.)
Final Torque . . . . .	24 N·m (212 lb-in.)
Spark Plug . . . . .	20 N·m (177 lb-in.)

MX,3015A1,A3 -19-21OCT92

30  
15  
4

## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove cylinder head. (See this group.)
2. Support valves from below and press down on spring retainers (A).
3. Remove retainers, springs and valves.
4. Inspect and analyze valves. (See Section 100, Group 05.)
5. Inspect springs, valves, guides and seats. (See procedures in this group.)
6. Install valves, springs, and retainers.
7. Install cylinder head.



M51749 -UN-07SEP88

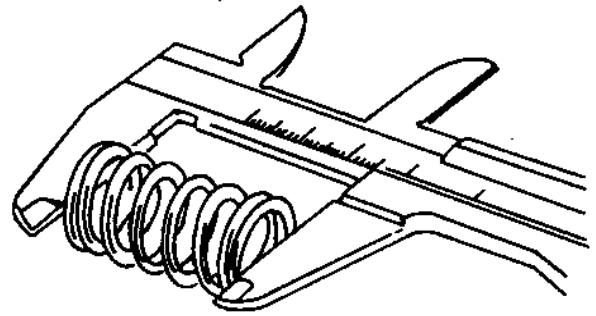
MX,3015A1,A4 -19-21OCT92

## INSPECT SPRINGS

Inspect spring free length. Replace if damaged or if less than specifications.

### SPECIFICATIONS

Free Length (Min) . . . . . 31.50 mm (1.240 in.)

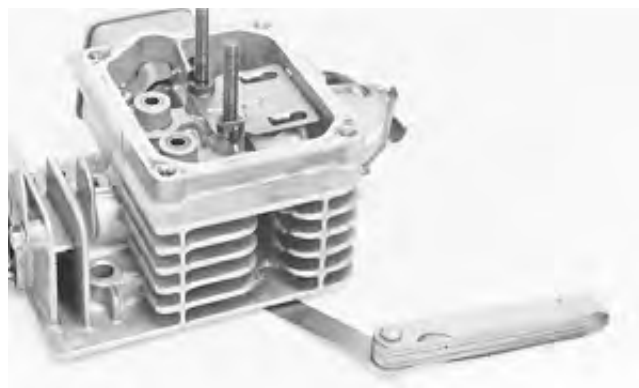


M50036 -UN-31AUG88

MX,3015A1,A5 -19-21OCT92

## INSPECT CYLINDER HEAD

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Check that oil drainback passages are not plugged.
7. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than specifications.



M80168 -UN-11FEB91

### SPECIFICATIONS

Cylinder Head Distortion (Max) . . . . . 0.07 mm (0.003 in.)

MX,3015A1,A6 -19-21OCT92

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6

## INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guides. Replace cylinder head if inside diameter is greater than specifications. (See this group.)

### SPECIFICATIONS (MAX) I.D.

Intake . . . . . 5.55 mm (0.218 in.)  
 Exhaust . . . . . 5.56 mm (0.219 in.)



M80169 -UN-11FEB91

MX,3015A1,A7 -19-21OCT92

## RECONDITION VALVE SEATS

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.

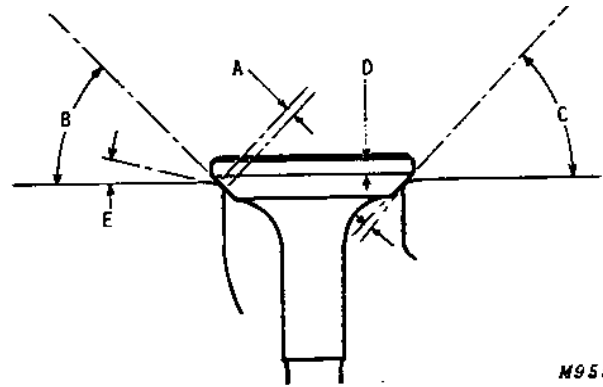
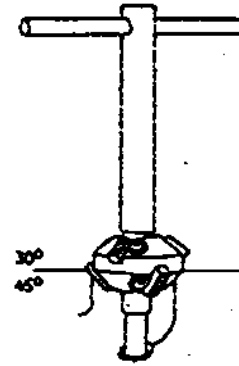
2. To recondition valve seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).

3. Cut valve seating surface (A) as close as possible to specifications.

4. Lap valves to seats after refacing. (See Section 100, Group 05.)

### SPECIFICATIONS

A—Valve Seating Surface	0.80 mm (0.031 in.)
B—Valve Seat Angle	45°
C—Valve Face Angle	45°
D—Valve Margin	0.60 mm (0.020 in.)
E—Valve Narrowing Angle	30°



M955

MX,3015A1,A8 -19-21OCT92

-UN-31AUG88  
M51558

-UN-01SEP88

M9552

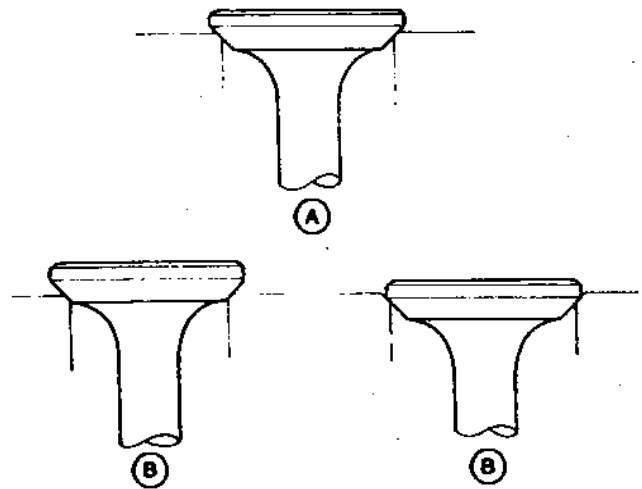
30  
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5. Center valve seat on the valve face:

—(A) shows correct position.

—(B) shows incorrect.

6. Check seat for good contact using Prussian Blue Compound.



MX,3015A1,A9 -19-21OCT92

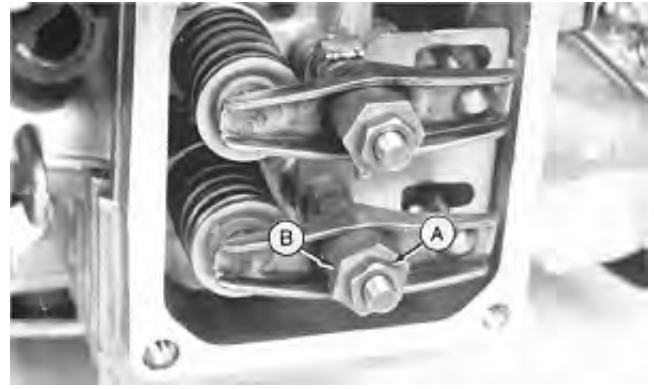
-UN-07SEP88

M118615

## CHECK VALVE CLEARANCE

*NOTE: Valve repair changes valve clearance. Check valve clearance. Adjust if needed.*

1. Turn crankshaft until piston is at highest position in compression stroke.
2. Measure clearance.
3. If necessary, adjust clearance to specifications. Loosen nut (A) and turn pivot (B) in or out to adjust clearance. Tighten nut to specifications.



M51750 -UN-07SEP88

### SPECIFICATIONS

Valve Clearance . . . . . 0.12 mm (0.005 in.)  
Nut Torque . . . . . 7 N·m (62 lb-in.)

MX,3015A1,A10 -19-21OCT92

# Group 20 Cylinder Block and Internal Components

## OTHER MATERIAL

Number	Name	Use
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,4020A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalogue.

- Piston Ring Kit
- Oversized Pistons
- Oversized Piston Rings
- Undersized Connecting Rod
- Cylinder Block
- Overhaul Gasket Kit
- Short Block Kit

MX,3020A1,A1 -19-21OCT92

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1

## REMOVE AND INSTALL CRANKCASE COVER

*NOTE: Approximate crankcase oil capacity is 0.6 L (1.27 pt).*

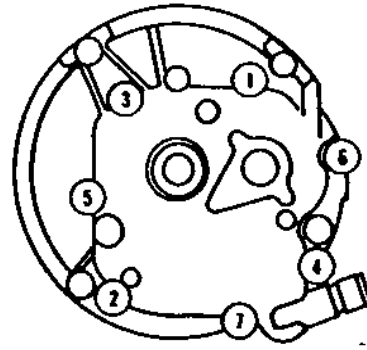
1. Drain crankcase.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

*NOTE: Do not force cover. Gears must mesh for proper positioning.*

4. Install gasket and cover. Tighten cap screws using the sequence shown.

### TORQUE SPECIFICATIONS

Mounting Cap Screws . . . . .	7 N·m (62 lb-in.)
Oil Drain Plug . . . . .	21 N·m (186 lb-in.)



M80170 -UN-11FEB91

MX,3020A1,A1A -19-21OCT92

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## REMOVE AND INSTALL CAMSHAFT

1. Remove crankcase cover. (See this group.)

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

2. Rotate crankshaft until timing marks (A) align.
3. Remove camshaft (B).
4. Inspect camshaft. (See this group.)
5. Apply clean engine oil to camshaft lobes and journals.
6. Align timing marks and install camshaft.
7. Install crankcase cover.



M80171 -UN-11FEB91

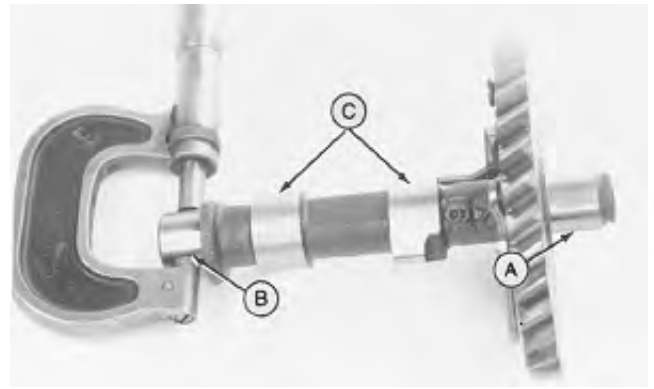
MX,3020A1,A2 -19-21OCT92

## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

**NOTE:** Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.

Measure PTO side journal (A), flywheel side journal (B), and lobes (C). Replace camshaft and tappets if less than specifications.



M80172 -UN-11FEB91

### SPECIFICATIONS (MIN)

PTO Side Journal	Flywheel Side Journal	Cam Lobes
13.92 mm (0.548 in.)	13.92 mm (0.548 in.)	22.80 mm (0.898 in.)

MX,3020A1,A3 -19-21OCT92

## INSPECT CAMSHAFT PLAIN BEARINGS

1. Remove camshaft. (See this group.)
2. Measure camshaft bearings in cylinder block and crankcase cover. Replace block or cover if diameter is greater than specification.
3. Install camshaft.

### SPECIFICATIONS (MIN)

Cylinder Block Bearing	Crankcase Cover Bearing
14.07 mm (0.554 in.)	14.07 mm (0.554 in.)



Cylinder Block



Crankcase Cover

MX,3020A1,A4 -19-21OCT92

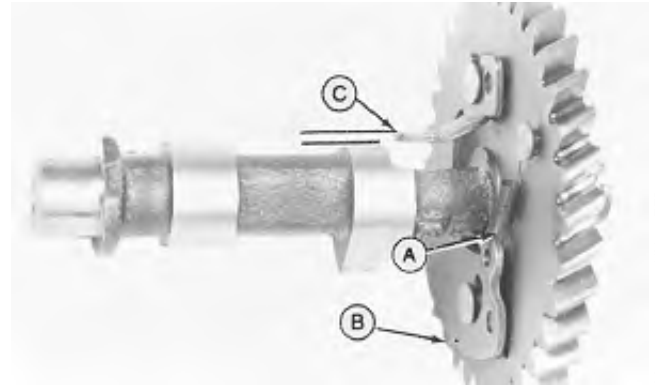
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M80173 -UN-11FEB91

M80174 -UN-11FEB91



## INSPECT AUTOMATIC COMPRESSION RELEASE (A.C.R.)

1. Remove camshaft. (See this group.)
2. Inspect automatic compression release mechanism (A.C.R.) for damage.
3. Inspect spring (A). Replace if worn or damaged.
4. Move weight (B) by hand to check for proper operation.
5. Check that tab (C) sits slightly above cam lobe when weight is released. Tab should drop below cam when weight is operated.
6. Replace A.C.R. if it does not operate properly.
7. Install camshaft.

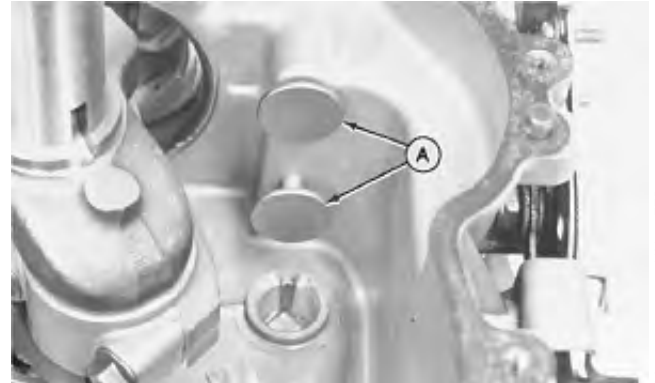


M80175 -UN-11FEB91

MX,3020A1,A5 -19-21OCT92

## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)
- NOTE: Mark tappets so they can be installed in their original bores during assembly.*
2. Remove tappets (A).
  3. Inspect tappets for wear or damage. Replace if necessary.
  4. Apply clean engine oil to tappets and bores.
  5. Install tappets in original bores.
  6. Install camshaft.

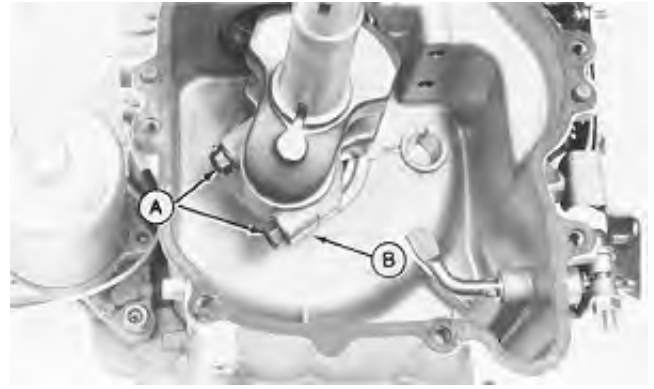


M80176 -UN-11FEB91

MX,3020A1,A6 -19-21OCT92

## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove crankcase cover. (See this group.)
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
4. Remove cap screws (A) and connecting rod cap (B).
5. Push piston and connecting rod from cylinder bore.
6. Make repairs as necessary. (See procedures in this group.)



M80177 -UN-11FEB91

MX,3020A1,A7 -19-21OCT92

7. Deglaze cylinder bore. (See Section 100, Group 15.)
8. Stagger piston ring end gaps 180° apart, but do not align with oil ring side rail end gaps.
9. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
10. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
11. Install piston assembly in cylinder bore with engraved match mark/arrow on piston head facing flywheel side of engine.
12. Install connecting rod cap and cap screws. Tighten cap screws to 12 N·m (106 lb-in.).



M50074 -UN-31AUG88

MX,3020A1,A8 -19-21OCT92

## DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD

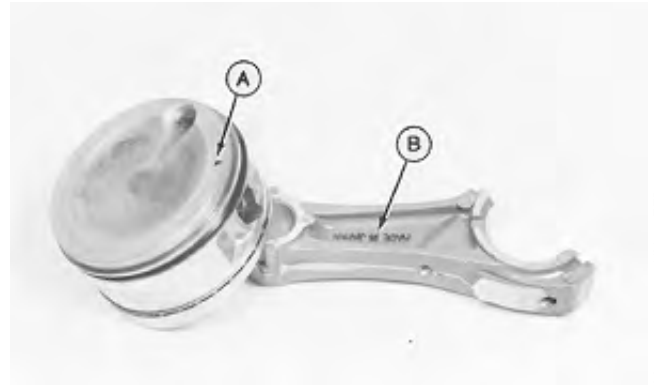
1. Remove circlip (C), piston pin (B) and connecting rod (A).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



M80178 -UN-11FEB91

MX,3020A1,A9 -19-21OCT92

4. Align arrow match mark (A) on piston head with MADE IN JAPAN (B) on connecting rod.
5. Install piston pin and circlip.



MX,3020A1,A10 -19-21OCT92

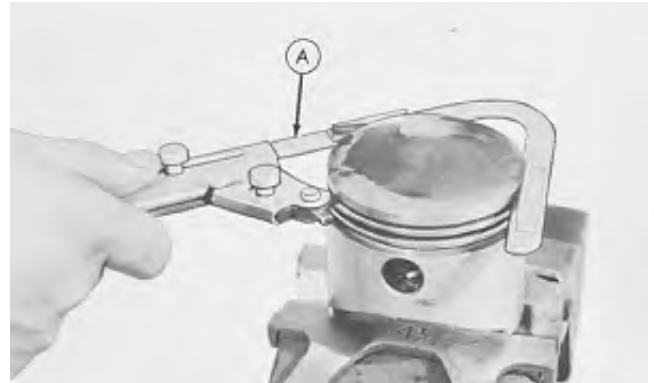
M80179 -UN-11FEB91

### INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,3020A1,A11 -19-21OCT92

M29946 -UN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: Inspect clearance visually. Replace piston if clearance appears excessive.*

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.

#### CLEARANCE SPECIFICATION (MAX)

Top Ring	Second Ring	Oil Control Ring
0.10 mm (0.004 in.)	0.10 mm (0.004 in.)	0.10 mm (0.004 in.)



MX,3020A1,A12 -19-21OCT92

M38102 -UN-29AUG88

8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

**Piston Pin O.D.  
(MIN)**

14.98 mm  
(0.590 in.)

**Piston Bore I.D.  
(MAX)**

15.05 mm  
(0.593 in.)



MX,3020A1,A13 -19-21OCT92

M50064 -UN-31AUG88

M80180 -UN-11FEB91

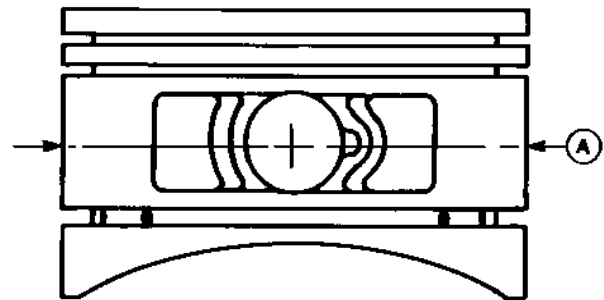
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10. Measure piston O.D. (A) perpendicular to piston pin bore.

11. Measure cylinder bore. (See Inspect Block in this group.)

12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.

13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)



**SPECIFICATIONS**

Piston O.D. (A) . . . . . 64.90 mm (2.555 in.)

Piston-to-Cylinder Bore Clearance

Standard . . . . . 0.06—0.10 mm (0.0024—0.0039 in.)

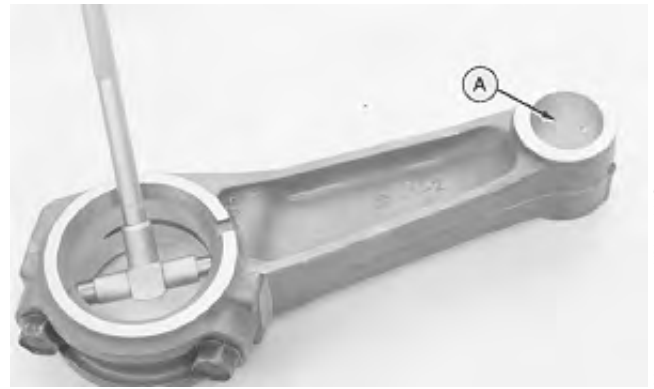
Wear Limit . . . . . 0.1375 mm (0.0054 i

MX,3020A1,A14 -19-21OCT92

M80181 -UN-11FEB91

## INSPECT CONNECTING ROD

1. Clean and inspect rod. Replace if scored.
2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
3. Install connecting rod cap. Tighten to 12 N-m (106 lb-in.).
4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



M50066 -UN-31AUG88

### BEARING I.D. SPECIFICATIONS (MAX)

Crankshaft Bearing	Piston Bearing
28.07 mm (1.105 in.)	15.05 mm (0.593 in.)

30  
20  
8

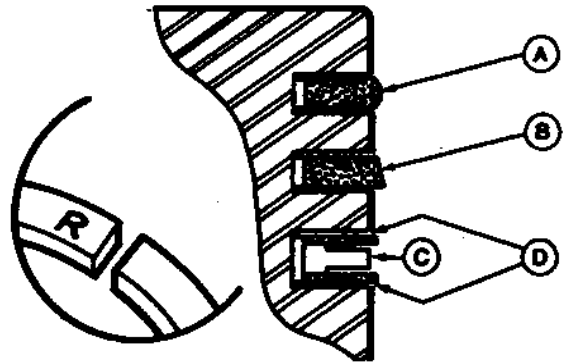
MX,3020A1,A15 -19-21OCT92

## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)
4. Install top ring (A) and second ring (B) with R or NPR mark facing up. Rings should turn freely in grooves.

*NOTE: Oil ring assembly is located near bottom of piston.*

5. Oil ring is an assembly. Install spacer (C), then side rails (D). Put side rail end gaps 180° apart.



A—Top Ring  
B—Second Ring  
C—Spacer  
D—Side Rails

M38074 -UN-29AUG88

MX,3020A1,A16 -19-21OCT92

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.

### END GAP SPECIFICATIONS

Minimum End Gap	0.18 mm (0.007 in.)
Maximum End Gap	
Compression Rings	1.00 mm (0.039 in.)
Oil Ring Side Rails	1.50 mm (0.059 in.)



M80182 -UN-11FEB91

MX,3020A1,A17 -19-21OCT92

## REMOVE, INSPECT AND INSTALL CRANKSHAFT

1. Remove camshaft. (See this group.)
2. Remove piston and connecting rod. (See this group.)
3. Remove crankshaft.

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

4. Check crankshaft alignment (T.I.R.). (See this group.)
5. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
6. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
7. Measure crankshaft main bearing journals and connecting rod journal. Replace crankshaft if measurements are less than specifications.

### JOURNAL SPECIFICATIONS (MIN)

Main Bearing PTO Side	Journal Flywheel Side	Connecting Rod Journal
24.92 mm (0.981 in.)	24.92 mm (0.981 in.)	27.92 mm (1.099 in.)

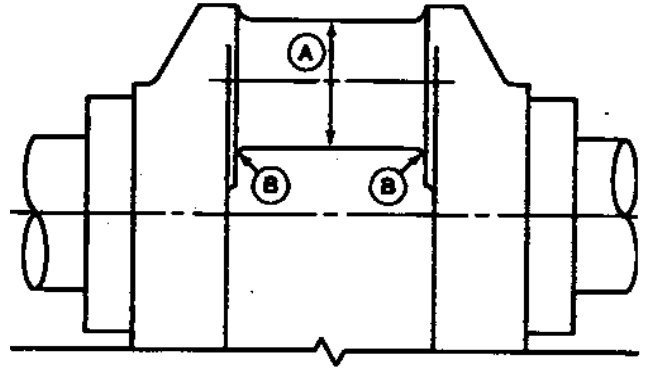


M80183 -UN-11FEB91

MX,3020A1,A18 -19-21OCT92

*NOTE: An undersized connecting rod is available through the parts catalog, if necessary.*

8. Connecting rod journal (A) can be resized to accept under-sized rod. Have grinding done by a reliable repair shop. Before sending crankshaft for grinding, inspect journal radii (B) for cracks.
9. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
10. Put a light film of oil on crankshaft bearing surfaces.
11. Pack grease in oil seals and install crankshaft.
12. Install piston and connecting rod.
13. Install camshaft.



M38036 -UN-29AUG88

MX.3020A1,A19 -19-21OCT92

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10

### INSPECT CRANKSHAFT PLAIN BEARING

1. Remove crankshaft. (See this group.)
2. Measure crankshaft bearing in crankcase cover. Replace cover if diameter is greater than specifications. (See this group.)
3. Install crankshaft.

#### SPECIFICATIONS

Bearing I.D. (Max) . . . . . 25.10 mm (0.988 in.)

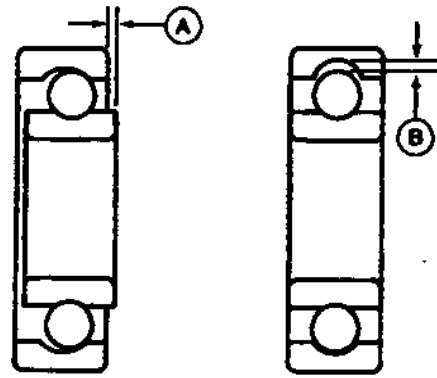


M80184 -UN-11FEB91

MX.3020A1,A19A -19-21OCT92

### INSPECT CRANKSHAFT BALL BEARING

1. Remove flywheel end oil seal. (See Inspect Oil Seals in this group.)
2. Remove crankshaft bearing using a bearing, bushing and seal driver set.
3. Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
4. Spin the bearing by hand and check for axial (A) and radial (B) free play.
5. Replace the bearing if it is noisy or has too much play.
6. Install bearing flush to inside of crankcase using a bearing, bushing and seal driver set.
7. Install oil seal.



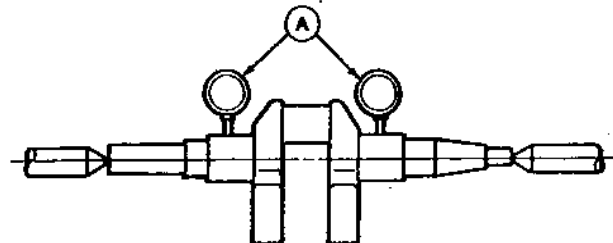
M38073 -UN-29AUG88

MX,3020A1,A20 -19-21OCT92

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11

### CHECK CRANKSHAFT ALIGNMENT (TIR)

Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.



#### SPECIFICATIONS

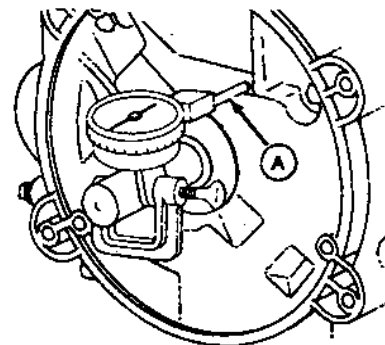
TIR (Max) ..... 0.20 mm (0.008 in.)

M51761 -UN-07SEP88

MX,3020A1,A21 -19-21OCT92

### MEASURE CRANKSHAFT END PLAY

1. Measure end play using dial indicator (A). Record this measurement.
2. Move crankshaft in and out. Replace block or crankshaft if end play is not within specifications.



#### SPECIFICATIONS

End Play ..... 0—0.50 mm (0—0.020 in.)

M30048 -UN-06SEP88

MX,3020A1,A22 -19-21OCT92

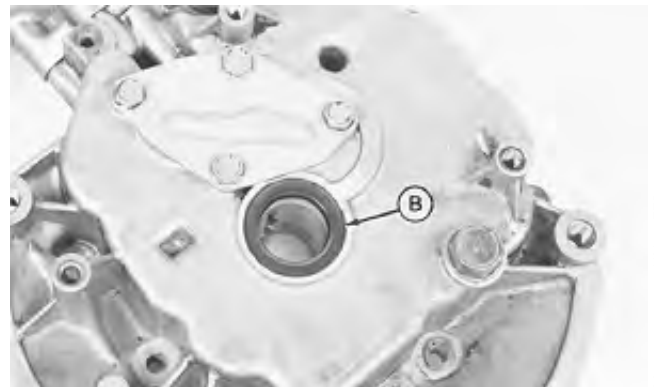


## INSPECT OIL SEALS

1. Remove flywheel. (See Group 10.)
2. Inspect oil seals (A and B) at flywheel end and PTO end for wear or damage. Replace if necessary.
3. Remove crankshaft. (See this group.)
4. Remove worn or damaged seals with a screwdriver.
5. Install seals with lip to inside of engine using a bearing, bushing and seal driver set. Press seals in until flush with hub.
6. Install crankshaft.
7. Install flywheel.



Flywheel End



PTO End

MX,3020A1,A23 -19-21OCT92

## INSPECT CYLINDER BLOCK

1. Remove crankshaft. (See this group.)
2. Clean and check block for cracks.
3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
4. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

MX,3020A1,A24 -19-21OCT92

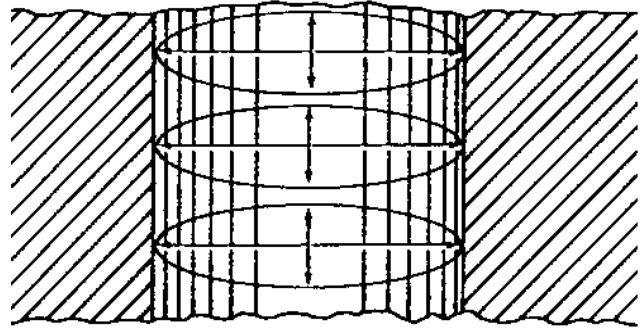
*NOTE: A bare block is available for service.*

5. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

6. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

*NOTE: If cylinder is rebored, oversize piston and rings must be installed.*

7. Install crankshaft.



M51745 -UN-23FEB89

**CYLINDER BORE SPECIFICATIONS**

Standard	Wear Limit
64.90—65.00 mm (2.557—2.561 in.)	65.06 mm (2.563 in.)



M80187 -UN-11FEB91

MX,3020A1,A25 -19-21OCT92

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13

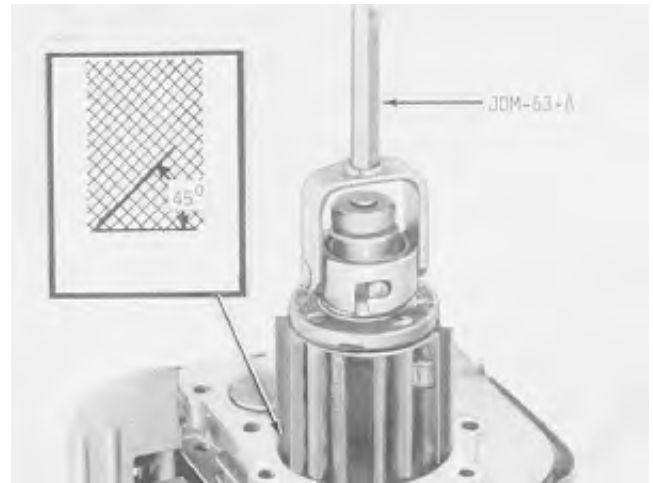
## REBORE CYLINDER BLOCK

**NOTE:** The cylinder block can be rebored to use 0.25, 0.50 or 0.75 mm (0.010, 0.020 or 0.030 in.) oversize pistons and rings. Have a reliable repair shop rebore the block, or use the drill press and honing tool.

1. Rebore cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from 200—250 rpm.
3. Lower and raise hone until ends extend 20—25 mm (0.75—1.0 in.) past ends of cylinder.
4. Turn adjusting nut on one hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately 20 times per minute.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

**NOTE:** Finish should not be smooth, but have a 40—60° cross-hatch pattern.

**IMPORTANT:** Check stone for wear or damage. Use correct stone for the job.



M24711 -UN-25AUG88

### CYLINDER INITIAL BORE SPECIFICATIONS

**Piston Oversize:**  
0.25 mm  
(0.010 in.)

65.21—65.23 mm  
(2.567—2.568 in.)

**Piston Oversize:**  
0.50 mm  
(0.020 in.)

65.46—65.48 mm  
(2.577—2.578 in.)

**Piston Oversize:**  
0.75 mm  
(0.030 in.)

65.71—65.73 mm  
(2.587—2.588 in.)

MX,3020A1,A26 -19-21OCT92

8. Hone the cylinder an additional 0.028—0.030 mm (0.0011—0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

**IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.**

9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

10. Dry the cylinder. Apply engine oil to cylinder wall.

M98,2040A,A9 -19-21OCT92

### INSPECT AND REPLACE OIL SLINGER—IF EQUIPPED

1. Remove crankcase cover. (See this group.)
2. Remove oil slinger (A).
3. Inspect oil slinger. Replace if worn or damaged.
4. Install oil slinger.



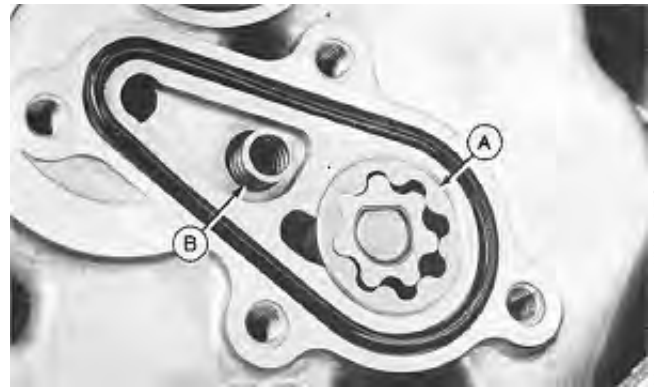
MX,3020A1,A28 -19-21OCT92

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15

M50078  
-UN-31AUG88

### DISASSEMBLE AND ASSEMBLE OIL PUMP—IF EQUIPPED

1. Remove cover and gasket.
2. Remove oil pump assembly (A), relief spring and ball (B).
3. Inspect all parts. (See this group.)
4. Install oil pump assembly, gasket and cover. Tighten the cap screws using the sequence shown.



M52443 -UN-06DEC88



M52444 -UN-06DEC88

MX,3020A1,A29 -19-21OCT92

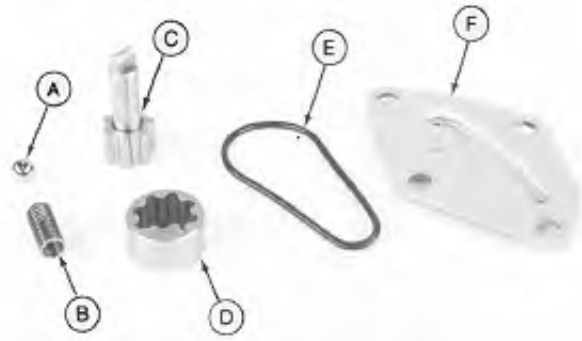
30  
20  
16

### INSPECT OIL PUMP

*NOTE: Oil screen not shown. To inspect or clean screen, remove crankcase cover. (See this group.)*

1. Inspect all parts for wear or damage. Replace as necessary.

- |                 |               |
|-----------------|---------------|
| A—Check Ball    | D—Outer Rotor |
| B—Relief Spring | E—Gasket      |
| C—Rotor Shaft   | F—Cover       |



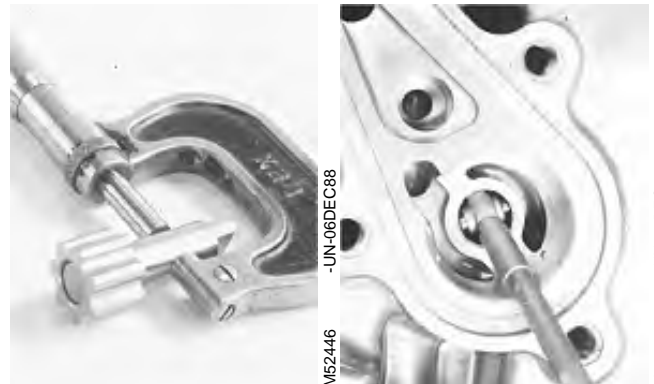
M52445 -UN-06DEC88

MX,3020A1,A30 -19-21OCT92

2. Measure outside diameter of shaft. Replace both shaft and outer rotor if less than specifications.
3. Measure rotor shaft bearing. Replace crankcase cover if greater than specifications.

#### ROTOR SHAFT SPECIFICATIONS

Shaft O.D. (Min)	9.01 mm (0.335 in.)
Bearing I.D. (Mix)	9.14 mm (0.360 in.)



M52446 -UN-06DEC88

M52447 -UN-06DEC88

MX,3020A1,A31 -19-21OCT92

4. Measure thickness of outer rotor. Replace both outer rotor and shaft if less than specification.

5. Measure outer rotor bearing depth. Replace crankcase cover if greater than specification.

**OUTER ROTOR SPECIFICATIONS**

Rotor Thickness (Min) . . . . . 11.95 mm (0.471 in.)  
 Bearing Depth (Max) . . . . . 12.10 mm (0.476 in.)



M52448  
-UN-06DEC88

M52449  
-UN-06DEC88

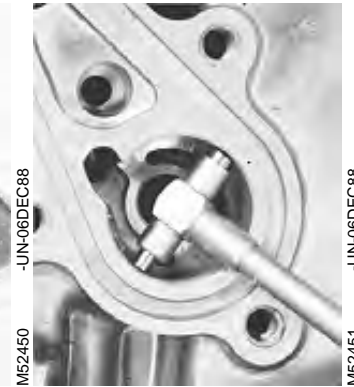
MX,3020A1,A32 -19-21OCT92

6. Measure outside diameter of outer rotor. Replace both outer rotor and shaft if less than specification.

7. Measure inside diameter of rotor bearing. Replace crankcase cover if greater than specification.

**OUTER ROTOR SPECIFICATIONS**

Rotor O.D. (Min) . . . . . 22.93 mm (0.903 in.)  
 Bearing I.D. (Max) . . . . . 23.17 mm (0.912 in.)



M52450  
-UN-06DEC88

M52451  
-UN-06DEC88

MX,3020A1,A33 -19-21OCT92

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17

8. Measure relief valve spring. Replace if free length is less than 18 mm (0.700 in.).

**SPRING FREE LENGTH SPECIFICATIONS (MIN)**

Relief Valve Spring  
 (Engine S.N. 047346—072217) . . . . . 17 mm (0.669 in.)  
 (Engine S.N. 072218— ) . . . . . 19 mm (0.748 in.)



M50083  
-UN-31AUG88

MX,3020A1,A34 -19-21OCT92

## REMOVE, INSPECT AND INSTALL OIL FILTER MANIFOLD—IF EQUIPPED

1. Remove oil filter and manifold.
2. Inspect oil filter. Replace if excessively contaminated or damaged.
3. Inspect oil passages for clogs. Clean if needed.
4. Inspect gasket (A) for wear or damage. Replace if necessary.
5. Install filter and manifold.



M80188 -UN-11FEB91

MX,3020A1,A35 -19-21OCT92

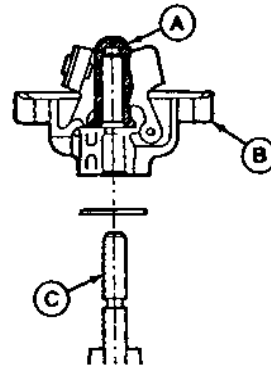
## INSPECT AND REPLACE GOVERNOR

**IMPORTANT:** Removal damages governor. If not damaged, do not remove.

1. Remove crankcase cover. (See this group.)
2. Inspect governor. If necessary to replace, remove with screwdriver.
3. If removed, press shaft (C) back into block until it protrudes 32.2—32.8 mm (1.267—1.291 in.).

*NOTE: Assemble sleeve and gear before installing assembly on shaft.*

4. Install sleeve (A) onto governor gear (B).
5. Install governor assembly onto shaft. Push down on assembly until it snaps into place.



M51762 -UN-07SEP88

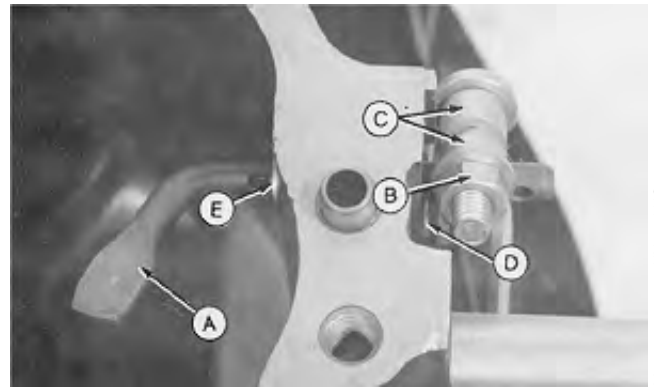
MX,3020A1,A36 -19-21OCT92

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18

## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (A). Replace if damaged.
3. To replace shaft, loosen nut (B) on lever (C).
4. Remove retaining pin (D), governor shaft and washer (E).
5. Install washer, shaft and retaining pin. Tighten nut to 7 N·m (62 lb-in.).



A—Governor Shaft  
B—Nut  
C—Governor Lever  
D—Retaining Pin  
E—Washer

MX,3020A1,A37 -19-21OCT92

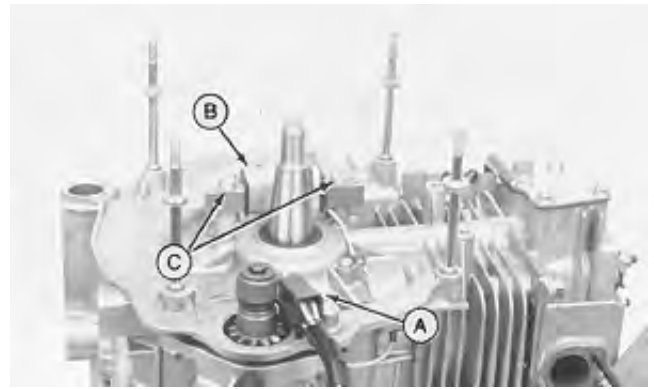
M50094 -UN-31AUG88



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20

## REMOVE AND INSTALL STATOR

1. Remove flywheel. (See Group 10.)
2. Disconnect stator lead from wiring connector (A).
3. Remove screws (C) and stator (B).
4. Install stator.
5. Connect stator lead.
6. Install flywheel.

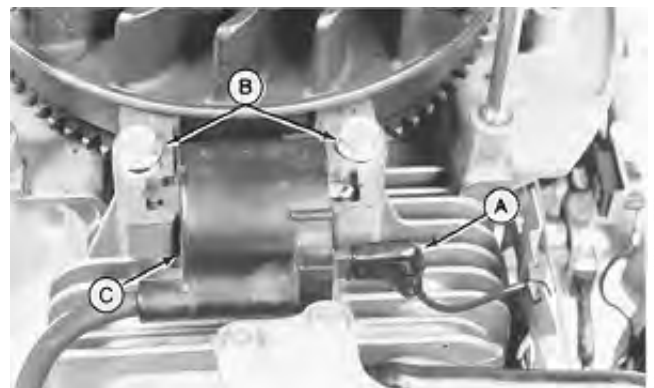


M80189  
-UN-11FEB91

MX,3025A1,A1 -19-21OCT92

## REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove engine cover. (See Group 10.)
2. Disconnect wiring lead (A).
3. Remove cap screws (B) and armature with coil (C).
4. Loosely install armature with coil.
5. Connect wiring lead.
6. Adjust armature air gap. (See this group.)
7. Install engine cover.



M80190  
-UN-11FEB91

MX,3025A1,A2 -19-21OCT92

## ADJUST ARMATURE AIR GAP

1. Turn flywheel magnet away from armature.
2. Insert feeler gauge, between flywheel and armature.
3. Push armature against flywheel and tighten screws (A).
4. Turn flywheel to remove feeler gauge.

### AIR GAP SPECIFICATIONS

Feeler Gauge Blade . . . . . 0.30 mm (0.012 in.)



M80191 -UN-11FEB91

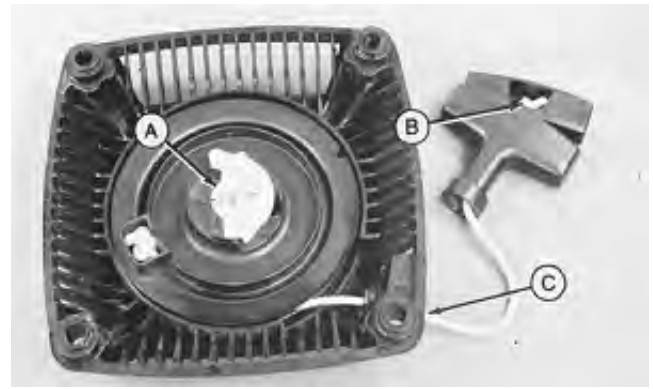
MX,3025A1,A3 -19-21OCT92

## DISASSEMBLE RECOIL STARTER

1. Remove starter.
2. Pull handle out about 30 cm ( 1 ft). Tie knot (C) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (C). Slowly release reel tension. Do not let rope get wedged between reel and housing.

**⚠ CAUTION: Wear gloves and protective goggles for remaining steps.**

6. Remove screw, washer and retainer (A).
7. Remove pawl and spring.



M80192 -UN-11FEB91

MX,3030A1,A1 -19-21OCT92

**⚠ CAUTION: A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.**

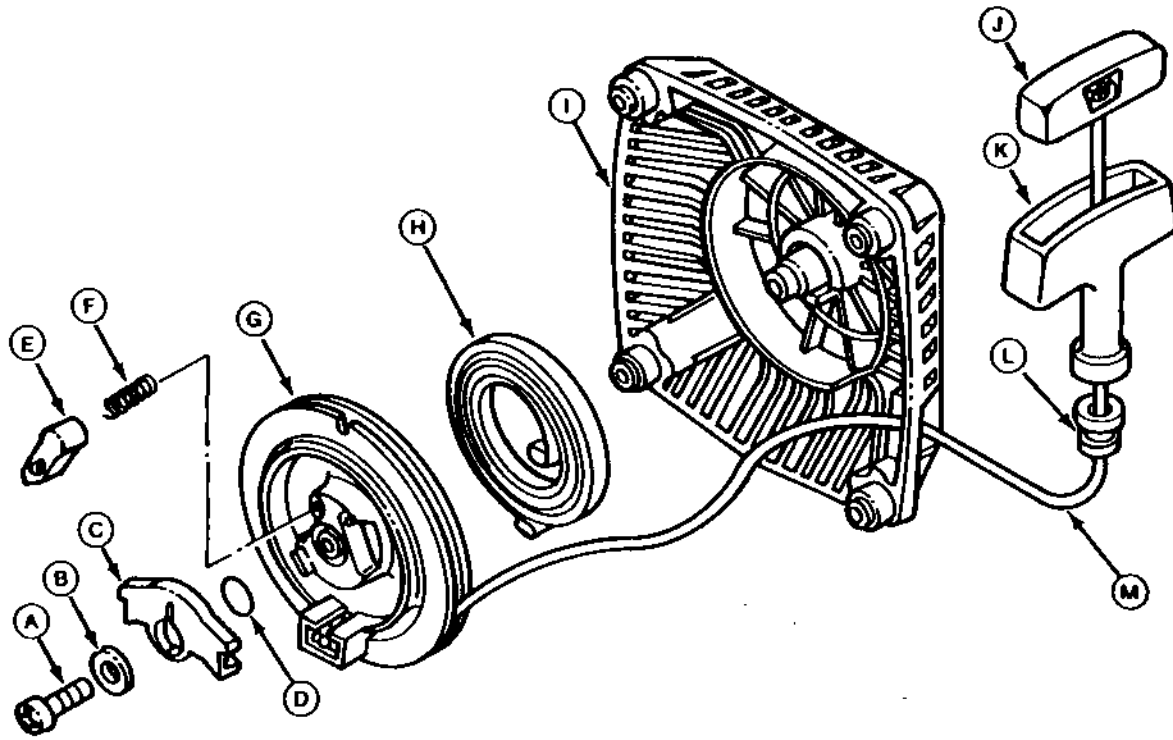
8. Turn the reel one half turn clockwise so no spring tension can be felt.
9. Spring is stored in reel. Carefully remove while holding spring in underside of reel.
10. Inspect starter for wear or damage. (See this group.)



M80193 -UN-11FEB91

MX,3030A1,A2 -19-21OCT92

**INSPECT RECOIL STARTER**



A—Screw  
B—Washer  
C—Retainer

D—Spring  
E—Pawl  
F—Spring

G—Reel  
H—Torsion Spring  
I—Housing

J—Cap  
K—Handle  
L—Guide

Inspect all parts for wear or damage. Replace as necessary.

MX,3030A1,A3 -19-21OCT92

M80194 -JUN-11FEB91

## REPLACE SPRING

**⚠ CAUTION:** Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.

1. Working from the center out, carefully unwind spring from reel.
2. Hook outside spring tang in reel. Wind spring into reel, working toward center.

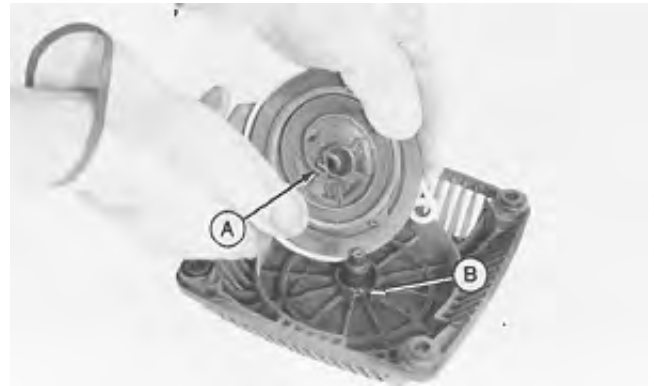


M80195 -UN-11FEB91

MX,3030A1,A4 -19-21OCT92

## ASSEMBLE RECOIL STARTER

1. Wind rope counterclockwise onto reel.
2. Apply multipurpose grease to spring.
3. Install reel with spring in housing. Align inner tang (A) with catch (B).



M80196 -UN-11FEB91

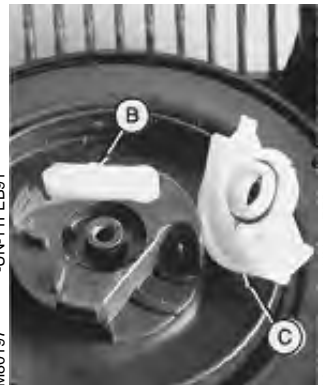
MX,3030A1,A5 -19-21OCT92

*NOTE: Install spring and pawl on side of retainer marked "R".*

4. Install spring (A), pawl (B) and retainer (C).
5. Install washer and screw.



M80197 -UN-11FEB91



M80198 -UN-11FEB91

MX,3030A1,A6 -19-21OCT92

6. Place rope in notch (A). Turn reel counterclockwise until you feel tang hook on catch.
7. Turn reel two turns counterclockwise to preload spring.
8. While holding reel to keep it from unwinding, feed end of rope through guide. Tie knot (B) to hold rope.
9. Install handle and secure with knot (C).
10. Remove knot (B).
11. Pull rope to check for proper operation.
12. Install recoil starter on engine.



M80199 -JUN-11FEB91

MX,3030A1,A7 -19-21OCT92

## ANALYZE ELECTRIC STARTER CONDITION

1. The starter overheats because of:
  - Long cranking.
  - Armature binding.
2. The starter operates poorly because of:
  - Armature binding.
  - Dirty or damaged starter drive.
  - Badly worn brushes or weak brush springs.
  - Excessive voltage drop in cranking system.
  - Battery or wiring defective.
  - Shorts, opens, or grounds in armature.

*NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.*

MX,3030A1,A8 -19-21OCT92

## CHECK STARTER ARMATURE ROTATION

1. Remove starter.
2. Rotate armature (A).
3. If armature does not rotate freely, armature may be bent or bearings may be worn. Disassemble, inspect and clean starter. (See this group.)



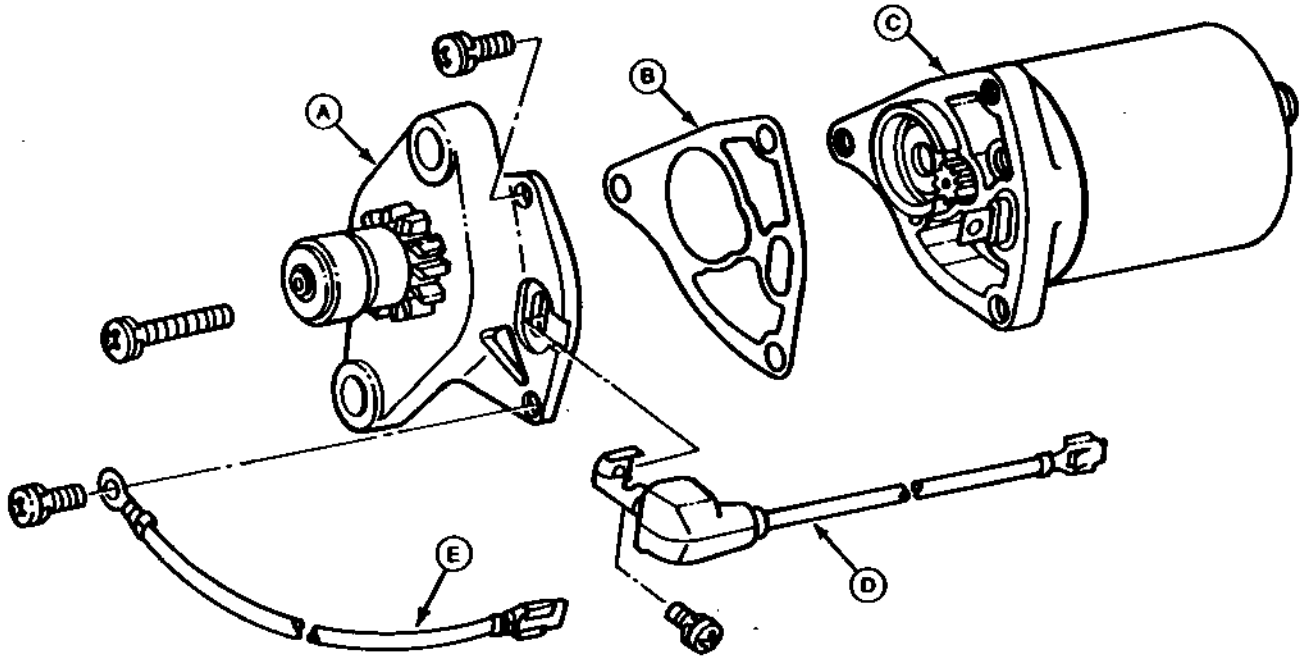
M80200 -UN-11FEB91

MX,3030A1,A9 -19-21OCT92

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30  
5



## INSPECT ELECTRIC STARTER



A—End Cover Assembly  
B—Gasket

C—Electric Motor Assembly

D—Wiring Lead

E—Wiring Lead

*NOTE: Wiring leads (D and E) are removed when starter is removed from engine.*

1. Mark body and cover for correct alignment during reassembly.
2. Remove end cover assembly (A).
3. Inspect all parts for wear or damage. Replace as necessary.

4. Apply a thin coat of multipurpose grease to:
  - sliding surfaces of armature.
  - armature shaft spline.
  - points where shaft contacts cover.
5. Assemble starter.

MX.3030A1.A10 -19-21OCT92

M80201 -JUN-11FEB91

# Section 35

## KF82D/FZ340D

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Other Materials . . . . .	35-15-1	Remove, Inspect and Install . . . . .	35-20-16
Cylinder Head		Inspect Ball Bearings . . . . .	35-20-17
Remove and Install . . . . .	35-15-1	Check Alignment (TIR) . . . . .	35-20-17
Inspect . . . . .	35-15-2	Measure and Adjust End Play . . . . .	35-20-18
<b>Group 20—Cylinder Block, Valves and Internal Components</b>			
Other Material . . . . .	35-20-1	Inspect Oil Seals . . . . .	35-20-18
Service Parts Kits . . . . .	35-20-1	Remove and Install Cylinder Block . . . . .	35-20-19
Remove and Install Valves and Springs . . . . .	35-20-2	Replace Crankcase/Block Studs . . . . .	35-20-19
Inspect Valve Springs . . . . .	35-20-2	Cylinder Block	
Inspect Valve Guides . . . . .	35-20-3	Inspect . . . . .	35-20-20
Recondition Valve Seats . . . . .	35-20-3	Rebore . . . . .	35-20-21
Check Valve-To-Tappet Clearance . . . . .	35-20-4	Inspect and Replace	
Change Tappet Caps . . . . .	35-20-5	Oil Splasher . . . . .	35-20-22
Remove and Install Crankcase Cover . . . . .	35-20-6	Governor . . . . .	35-20-23
Camshaft		Governor Shaft . . . . .	35-20-23
Remove and Install . . . . .	35-20-6	<b>Group 25—Ignition and Charging System</b>	
Inspect . . . . .	35-20-7	Remove and Install	
Inspect Ball Bearings . . . . .	35-20-7	Stator and Pulser Coil . . . . .	35-25-1
Remove, Inspect and Install Tappets . . . . .	35-20-8	Armature with Coil . . . . .	35-25-2
Adjust Camshaft End Play . . . . .	35-20-8	<b>Group 30—Starting Systems</b>	



**ENGINE APPLICATIONS CHART**

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

<b>Machine</b>	<b>Engine Model No.</b>
AMT600	
(Engine S.N. —118372) .....	KF82D
(Engine S.N.118373— ) .....	FZ340D-BS10

MX,3500A1,A1 -19-21OCT92

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## KF82D/FZ340D REPAIR SPECIFICATIONS

### GROUP 05—FUEL AND AIR SYSTEMS

Item	Specification
Float-to-Carburetor Body Adjustment . . . . .	5—8 mm (0.200—0.310 in.)

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Flywheel Nut Torque . . . . .	83 N·m (61 lb-ft)
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### GROUP 15—CYLINDER HEAD

Maximum Cylinder Head Warp . . . . .	0.40 mm (0.015 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	10 N·m (89 lb-in.)
Final Torque . . . . .	24 N·m (212 lb-in.)
Spark Plug Torque . . . . .	24 N·m (212 lb-in.)

### GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS

Valve Clearance (cold) . . . . .	0.17—0.27 mm (0.007—0.011 in.)
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#### Valves and Springs

Minimum Spring Free Length . . . . .	40 mm (1.570 in.)
Maximum Valve Guide I.D.	
Exhaust . . . . .	8.08 mm (0.318 in.)
Intake . . . . .	8.00 mm (0.315 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seat and Face Angle . . . . .	45°
Valve Seating Width . . . . .	1.30 mm (0.050 in.)
Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

#### Crankcase Cover

Oil Capacity . . . . .	1.0 L (2.11 pt)
Cap Screw Torque . . . . .	21 N·m (186 lb-in.)

#### Camshaft

Minimum Lobe Height . . . . .	36.72 mm (1.447 in.)
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Continued on next page

MX,3500A1,A2 -19-21OCT92

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**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Piston</b>	
Maximum Ring Groove Clearance . . . . .	0.15 mm (0.006 in.)
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap . . . . .	1.00 mm (0.039 in.)
Minimum Pin O.D. . . . .	17.98 mm (0.708 in.)
Maximum Pin Bore I.D. . . . .	18.03 mm (0.710 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Piston O.D. . . . .	79.77—79.79 mm (3.140—3.141 in.)
Piston-to-Cylinder Bore Clearance . . . . .	0.195—0.235 mm (0.0077—0.009 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	32.06 mm (1.262 in.)
Maximum Piston Pin Bearing I.D. . . . .	18.04 mm (0.710 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.06 mm (0.002 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.11 mm (0.004 in.)
End-Cap Screw Torque . . . . .	21 N·m (186 lb-in.)
<b>Crankshaft</b>	
Minimum Connecting Rod Journal O.D. . . . .	31.95 mm (1.259 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0.05—0.20 mm (0.002—0.008 in.)
<b>Cylinder Block</b>	
Crankcase/Block Stud Torque . . . . .	36 N·m (27 lb-ft)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D. . . . .	79.91—79.98 mm (3.146—3.149 in.)
Maximum Cylinder Bore I.D. . . . .	80.09 mm (3.155 in.)
Maximum Out-of-Round . . . . .	0.063 mm (0.0025 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.50 mm . . . . .	80.46—80.48 mm (3.168—3.169 in.)

**GROUP 30—STARTING SYSTEMS**

**Electric Starter**

See Starter Specifications in this Group.

MX,3500A1,A3 -19-21OCT92

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Main Jet High Altitude Kit—Standard Air Cleaner

Main Jet High Altitude Kit—Heavy Duty Air Cleaner

Complete Carburetor

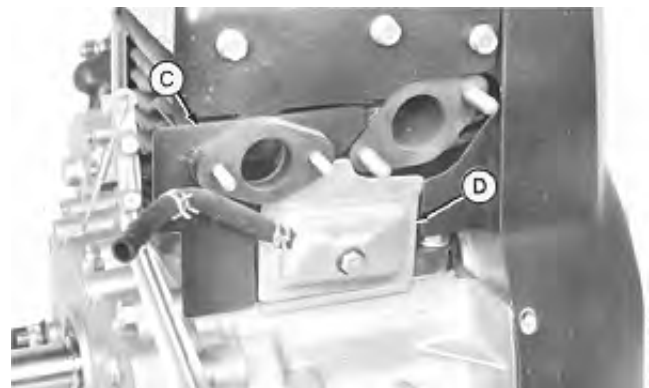
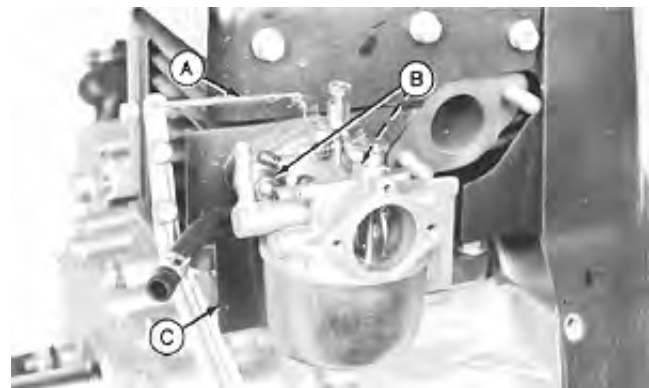
Gasket Kit

Air Cleaner Assembly

MX,3505A1,A1 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR

1. Remove air cleaner base and gasket.
  2. Remove nuts and washers (B).
  3. Separate carburetor from spacer (C).
  4. Disconnect linkage (A) and remove carburetor.
  5. Remove tappet chamber cover and gasket (D).
  6. Remove spacer and gaskets.
  7. Make repairs as necessary. (See procedures in this group.)
  8. Install spacer and gaskets.
- NOTE: Install tappet chamber cover gasket with large slot facing down.*
9. Install tappet chamber cover and gasket.
  10. Install carburetor and connect linkage.
  11. Install nuts and washers. Tighten nuts.
  12. Install air cleaner base and gasket.



- A—Throttle Control Linkage
- B—Nuts and Washers
- C—Spacer
- D—Tappet Chamber Cover and Gasket

MX,3505A1,A2 -19-21OCT92



## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR

**IMPORTANT:** To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.

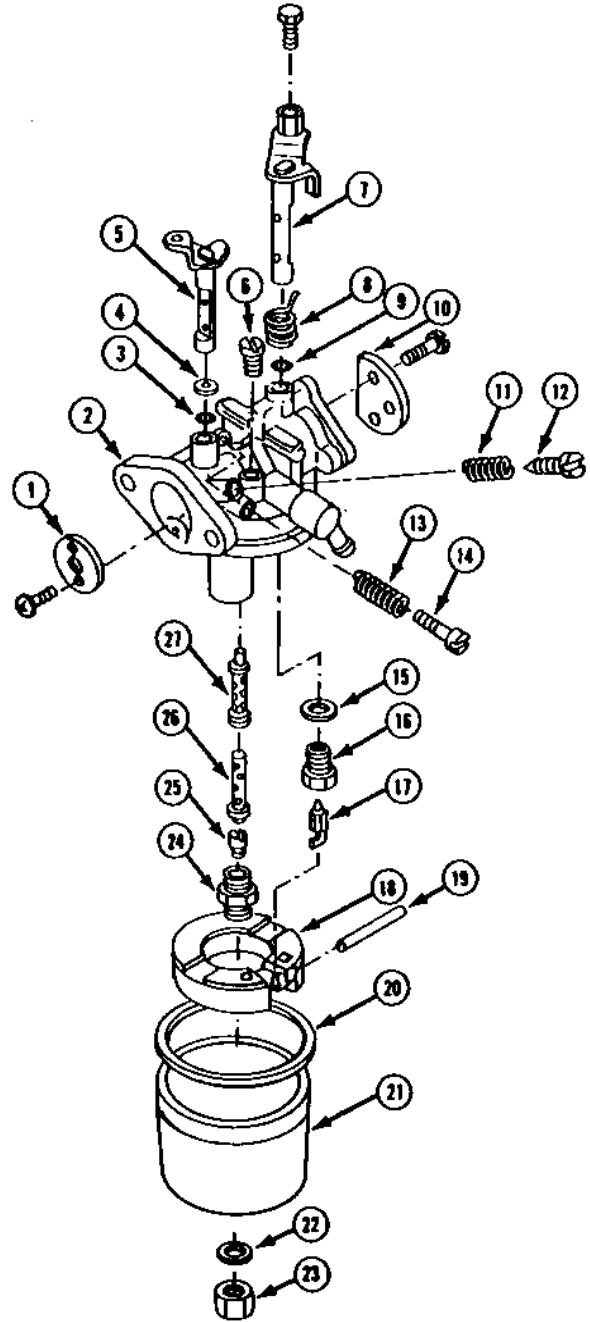
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.

4. Inspect all parts for wear or damage, replace as necessary.

*NOTE: Main jet high altitude kits are available.*



- 1—Throttle Plate
- 2—Carburetor Body
- 3—Seal\*
- 4—Felt Washer\*\*
- 5—Throttle Shaft
- 6—Pilot Jet
- 7—Choke Shaft
- 8—Spring
- 9—Seal\*
- 10—Choke Plate
- 11—Spring
- 12—Idle Adjustment Screw
- 13—Spring
- 14—Speed Adjustment Screw
- 15—Washer
- 16—Needle Valve Seat
- 17—Needle Valve
- 18—Float
- 19—Float Pin
- 20—Gasket
- 21—Float Chamber
- 22—Washer
- 23—Nut
- 24—Nozzle Holder
- 25—Main Jet
- 26—Bleed Pipe
- 27—Nozzle

\*Equipped on newer models only.

\*\*Equipped on older models only.

M80452 -UN-17MAY91

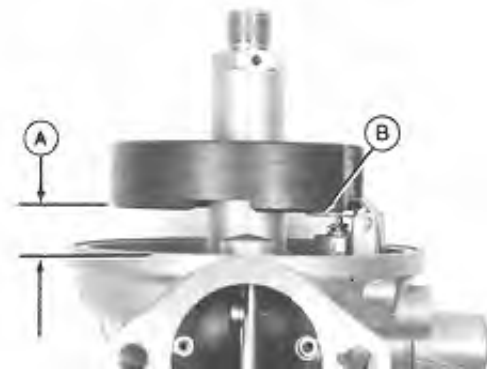
MX,3505A1,A3 -19-21OCT92

**IMPORTANT: Do not push on float or inlet needle valve when adjusting float level.**

5. Adjust float level. With carburetor upside down, support float so surface touches the needle valve. Do not compress the needle valve spring. Measure the distance from carburetor body to bottom of float surface (A). If not according to specifications, bend tang (B) to adjust float surface angle.

**FLOAT SPECIFICATIONS**

Distance (A) . . . . . 5—8 mm (0.200—0.310 in.)

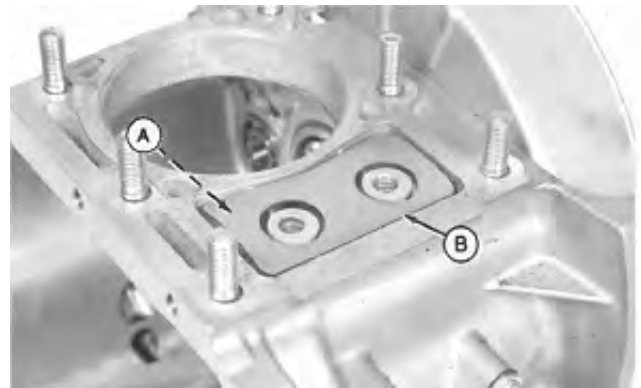


M80453 -UN-17MAY91

MX,3505A1,A4 -19-21OCT92

**SERVICE BREATHER**

1. Remove cylinder block. (See Group 20.)
2. Remove breather plate (B).
3. Inspect plate for cracks or damage. Replace if necessary.
4. Make sure oil drain back hole (A) is open.
5. Install breather plate.
6. Install cylinder block.



M80454 -UN-17MAY91

MX,3505A1,A5 -19-21OCT92

## SERVICE AIR CLEANER

*NOTE: Replace elements yearly or every 25 hours as required.*

1. Remove and disassemble air cleaner.

**IMPORTANT: Do not clean elements with solvent or compressed air.**

2. Wash foam element (A) in detergent and water. Dry element.

3. Put 12—15 drops of engine oil on foam element (A). Squeeze out excess oil.

4. Replace paper element (B) if:  
 —Element is oily, dirty, bent, torn, crushed, or obstructed in any way.  
 —Engine performance is poor.  
 —Seal is damaged in any way.

5. Inspect cover (C), and base (D) for damage. Replace if necessary.

**IMPORTANT: Any time air cleaner base is removed, check for free choke operation during reassembly.**

6. Assemble and install air cleaner.



A—Foam Element  
 B—Paper Element  
 C—Cover  
 D—Base

M80455 -UN-17MAY91

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MX,3505A1,A6 -19-21OCT92

## REMOVE AND INSTALL BLOWER HOUSING

1. Disconnect spark plug wiring lead (A).
2. Remove cover (B).
3. Disconnect wiring connector (C).
4. Remove blower housing (D).
5. Install blower housing.
6. Connect wiring connector.
7. Install cylinder head cover.
8. Connect spark plug wiring lead.



A—Spark Plug Wiring Lead  
B—Cylinder Head Cover  
C—Wiring Connector  
D—Blower Housing

MX,3510A1,A1 -19-21OCT92

M80456 -UN-17MAY91

## REMOVE AND INSTALL FLYWHEEL

1. Remove blower housing. (See this group.)
- NOTE: Flywheel nut has left-hand thread.*
2. Hold flywheel and remove nut and washer (A).
3. Remove flywheel using a flywheel puller.
4. Install flywheel.

*NOTE: Install washer with concave side toward flywheel.*

5. Install washer and nut. Tighten nut to 83 N·m (61 lb-ft).
6. Install blower housing.



MX,3510A1,A2 -19-21OCT92

M80457 -UN-17MAY91

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## OTHER MATERIAL

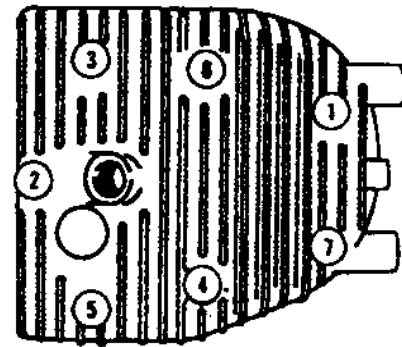
Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head

SCOTCH-BRITE is a trade mark of the 3M Company.

MX,5015A1,A1 -19-21OCT92

## REMOVE AND INSTALL CYLINDER HEAD

1. Remove blower housing. (See Group 10.)
2. Remove spark plug.
3. Remove cylinder head and gasket.
4. Make repairs as necessary. (See procedures in this group.)
5. Install cylinder head with new gasket. Install cap screws and tighten finger tight.
6. Tighten cap screws in sequence shown. Tighten to initial torque specifications.
7. Continue in sequence, 4 N·m (35 lb-in.) at a time, until final torque is as specified.
8. Install spark plug and tighten to specification.
9. Install blower housing.



M851536 -JUN-31AUG88

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### TORQUE SPECIFICATIONS

Initial Torque . . . . .	10 N·m (89 lb-in.)
Final Torque . . . . .	24 N·m (212 lb-in.)
Spark Plug . . . . .	24 N·m (212 lb-in.)

MX,3515A1,A1 -19-21OCT92

## INSPECT CYLINDER HEAD

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Put cylinder head (A) on a surface plate. Check for distortion at several points around the head using a feeler gauge (B). Replace head if distortion is more than specifications.



M80458 -UN-17MAY91

### SPECIFICATIONS

Cylinder Head Distortion (Max) . . . . . 0.40 mm (0.015 in.)

MX,3515A1,A2 -19-21OCT92

# Group 20 Cylinder Block, Valves and Internal Components

## OTHER MATERIAL

Number	Name	Use
	Valve Guide Cleaner	Clean valve guides
	Prussian Blue Compound	Check valve seat contact
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,3520A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalog.

Tappet Cap Kit

Camshaft Axial Play Shim Kit

Oversized Pistons

Oversized Piston Rings

Undersized Connecting Rod

Cylinder Block

Short Block Kit

Crankshaft End Play Shim Kit

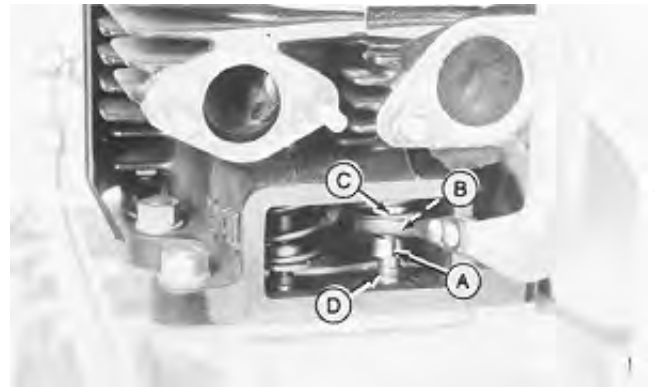
MX,3520A1,A2 -19-21OCT92

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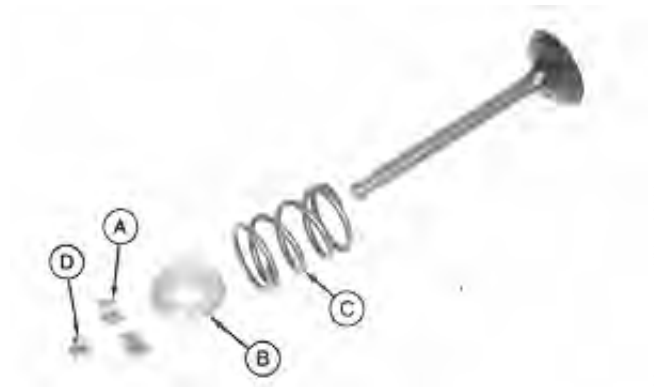


## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove carburetor. (See Group 05.)
2. Remove cylinder head. (See Group 15.)
3. Compress valve spring (C) with a valve spring compressor.
4. Remove collet halves (A).
5. Slowly release compressor and remove valve.
6. Remove spring, retainer (B) and tappet cap (D).
7. Inspect and analyze valves. (See Section 100, Group 05.)
8. Inspect springs, valve guides and seats. (See this group.)
9. Check valve-to-tappet clearance. (See this group.)
10. Install tappet caps.
11. Align valve springs and retainers in tappet chamber.
12. Coat valve stems with oil and install in cylinder block.
13. Compress each spring and install collet halves.
14. Install cylinder head.
15. Install carburetor.



M51487 -UN-31AUG88



M80459 -UN-17MAY91

A—Collet Halves  
B—Spring Retainer  
C—Spring  
D—Tappet Cap

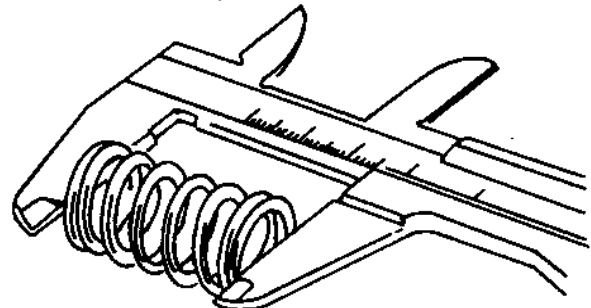
MX,3520A1,A3 -19-21OCT92

## INSPECT VALVE SPRINGS

Inspect valve springs. Replace springs if damaged or if free length is less than specification.

### SPECIFICATION

Spring Free Length (MIN) . . . . . 40.00 mm (1.570 in.)



M50036 -UN-31AUG88

MX,3520A1,A4 -19-21OCT92

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## INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guides. Replace cylinder block if inside diameters are greater than specifications. (See this group.)

### SPECIFICATIONS (MAX) I.D.

Intake Valve Guide	8.00 mm (0.315 in.)
Exhaust Valve Guide	8.08 mm (0.318 in.)



MX,3520A1,A5 -19-21OCT92

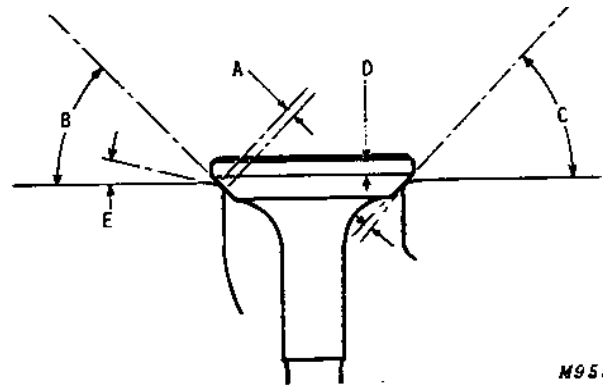
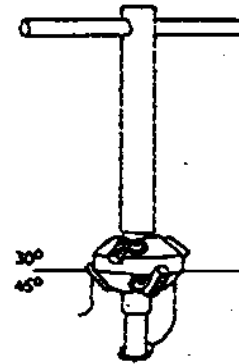
M80460 -UN-17MAY91

## RECONDITION VALVE SEATS

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.
2. To recondition valve seat, cut a 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).
3. Cut valve seating surface (A) as close as possible to specifications.
4. Lap valves to seats after refacing. (See Section 100, Group 05.)

### SPECIFICATIONS

A—Valve Seating Surface	1.30 mm (0.050 in.)
B—Valve Seat Angle	45°
C—Valve Face Angle	45°
D—Valve Margin	0.60 mm (0.020 in.)
E—Valve Narrowing Angle	30°



M955

MX,3520A1,A6 -19-21OCT92

-UN-31AUG88

M51558

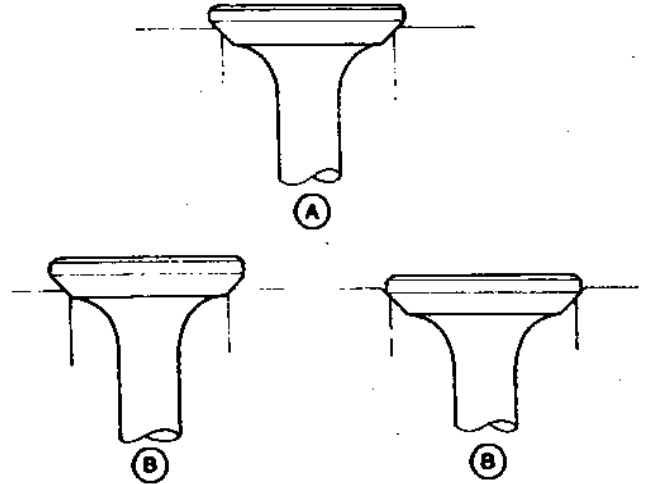
-UN-01SEP88

M9552

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5. Center valve seat on the valve face:  
—(A) shows correct position.  
—(B) shows incorrect.

6. Check seat for good contact using Prussian Blue Compound.

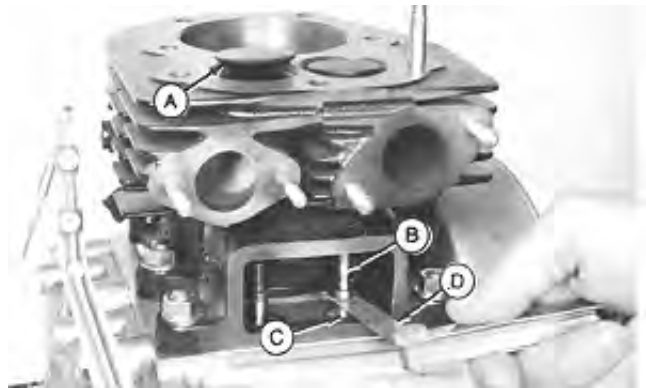


M18615 -UN-07SEP88

MX,3015A1,A9 -19-21OCT92

### CHECK VALVE-TO-TAPPET CLEARANCE

1. Install tappet caps on tappets.
2. Install valves in cylinder block.
3. Turn crankshaft until intake valve (A) is at its highest position. Check clearance between valve (B) and tappet cap (C), with feeler gauge (D) and compare to specifications.
4. Change tappet caps to obtain proper clearance. (See this group.)



M80461 -UN-17MAY91

#### SPECIFICATIONS

Valve Clearance . . . . . 0.17—0.27 mm (0.007—0.011 in.)

- A—Intake Valve
- B—Exhaust Valve
- C—Tappet Cap
- D—Feeler Gauge

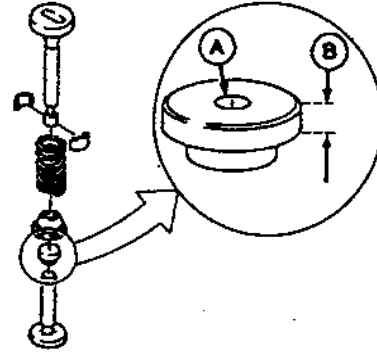
MX,3520A1,A7 -19-21OCT92

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## CHANGE TAPPET CAPS

Determine thickness (B) of old cap by finding its stamp (A) in the table.

Install a thicker or thinner cap as needed for proper valve clearance.



Stamp	Thickness
1	2.70 mm (0.106 in.)
2	2.75 mm (0.108 in.)
3	2.80 mm (0.110 in.)
4	2.85 mm (0.112 in.)
5	2.90 mm (0.114 in.)
6	2.95 mm (0.116 in.)
7	3.00 mm (0.118 in.)
8	3.05 mm (0.120 in.)
9	3.10 mm (0.122 in.)
10	3.15 mm (0.124 in.)
11	3.20 mm (0.125 in.)
12	3.25 mm (0.128 in.)
13	3.30 mm (0.130 in.)
14	3.35 mm (0.132 in.)
15	3.40 mm (0.134 in.)
16	3.45 mm (0.136 in.)
17	3.50 mm (0.138 in.)
18	3.55 mm (0.140 in.)
19	3.60 mm (0.142 in.)
20	3.65 mm (0.144 in.)

M51539 -UN-31AUG88

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MX,3520A1,A8 -19-21OCT92

## REMOVE AND INSTALL CRANKCASE COVER

*NOTE: Approximate crankcase oil capacity is 1.0 L (2.11 pt).*

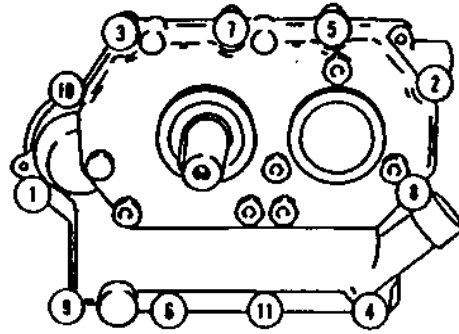
1. Drain crankcase.
2. Disconnect governor arm return spring.
3. Remove crankcase cover and gasket.
4. Clean crankcase and crankcase cover gasket surfaces.

*NOTE: Install stud & bracket at position (1).*

5. Install gasket and cover. Tighten cap screws using the sequence shown.
6. Connect governor arm return spring.

### TORQUE SPECIFICATIONS

Mounting Cap Screws . . . . . 21 N·m (186 lb-in.)



M80462 -UN-17MAY91

MX,3520A1,A9 -19-21OCT92

## REMOVE AND INSTALL CAMSHAFT

*NOTE: Governor is attached to camshaft.*

1. Remove crankcase cover. (See this group.)

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

2. Rotate crankshaft until timing marks (A) align.
3. Remove camshaft (B).
4. Inspect camshaft. (See this group.)
5. Apply clean engine oil to camshaft lobes and journals.
6. Align timing marks and install camshaft.
7. Install crankcase cover.



M80463 -UN-17MAY91

MX,3520A1,A10 -19-21OCT92

35  
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## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

*NOTE: Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.*

*Camshaft side journals rotate in ball bearings.  
Side journals are not measured.*

Measure lobes (A). Replace camshaft and tappets if less than specifications.



### SPECIFICATIONS (MIN)

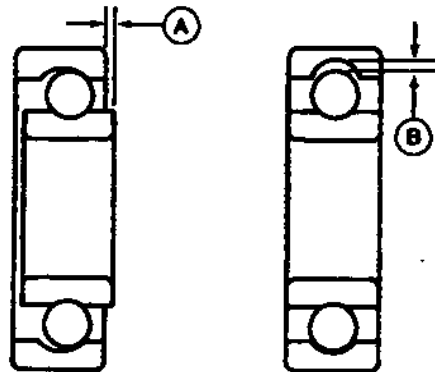
PTO Side Journal	Flywheel Side Journal	Cam Lobes
—	—	36.72 mm (1.447 in.)

MX,3520A1,A11 -19-21OCT92

M80464 -UN-17MAY91

## INSPECT CAMSHAFT BALL BEARINGS

1. Remove camshaft. (See this group.)
2. Remove bearings using a blind hole puller set.
3. Thoroughly clean bearings in solvent. Dip bearings in light weight oil.
4. Spin the bearings by hand and check for axial (A) and radial (B) free play.
5. Replace bearings if noisy or too much play.
6. Install bearings flush to inside of crankcase or crankcase cover using a bearing, bushing and seal driver set.
7. Install camshaft.



MX,3520A1,A12 -19-21OCT92

M38073 -UN-29AUG88

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## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)

*NOTE: Mark tappets so they can be installed in their original bores during assembly.*

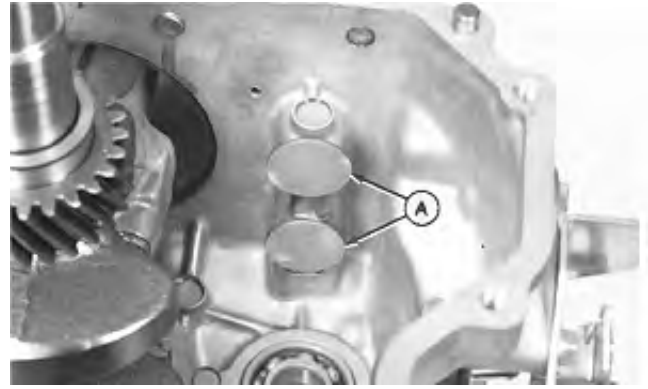
2. Remove tappets (A).

3. Inspect tappets for wear or damage. Replace if necessary.

4. Apply clean engine oil to tappets and bores.

5. Install tappets in original bores.

6. Install camshaft.



M80465 -UN-17MAY91

MX,3520A1,A13 -19-21OCT92

## ADJUST CAMSHAFT END PLAY

*NOTE: Measure camshaft end play without crankcase cover gasket installed.*

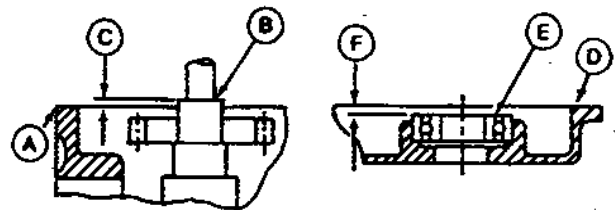
1. Measure from crankcase machined surface (A) to cam gear timing flange (B). Record this measurement (C).

2. Measure from crankcase cover mounting face (D) to camshaft bearing inner race surface (E). Record this measurement (F).

3. Subtract measurement (C) from measurement (F).

Install shims having total thickness indicated on chart.

- A—Crankcase Machined Surface
- B—Camshaft Timing Flange
- C—Measurement
- D—Crankcase Cover Machined Surface
- E—Bearing Inner Race
- F—Measurement



M51556 -UN-31AUG88

Difference (F-C) in mm	Total Thickness of Shims
1.90-1.94 mm	2.10 mm
1.95-1.99 mm	2.15 mm
2.00-2.04 mm	2.20 mm
2.05-2.09 mm	2.25 mm
2.10-2.14 mm	2.30 mm
2.15-2.19 mm	2.35 mm
2.20-2.24 mm	2.40 mm
2.25-2.29 mm	2.45 mm
2.30-2.34 mm	2.50 mm
2.35-2.39 mm	2.55 mm
2.40-2.44 mm	2.60 mm

M51557 -19-14MAR89

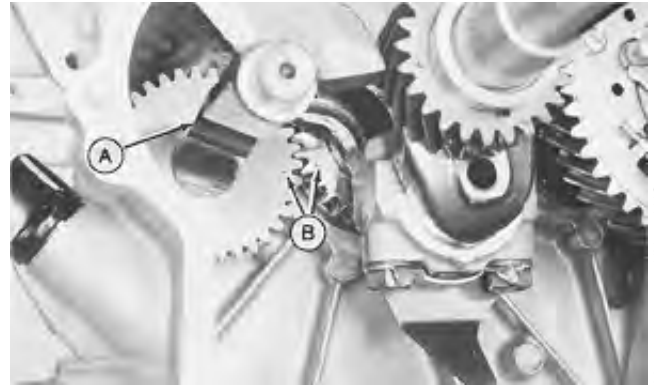
MX,3520A1,A14 -19-21OCT92

## REMOVE, INSPECT AND INSTALL DYNAMIC BALANCER

1. Remove crankcase cover. (See this group.)
2. Rotate crankshaft until match marks (B) align.
3. Remove dynamic balancer (A).
4. Inspect balancer for wear or damage. Replace if necessary.

**IMPORTANT: Align match marks exactly or balancer will not function correctly.**

5. Install balancer with match marks aligned.
6. Install crankcase cover.

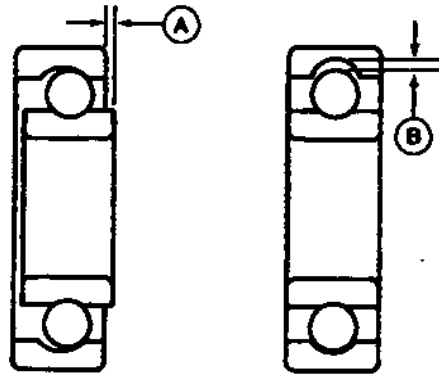


M51534 -UN-31AUG88

MX,3520A1,A15 -19-21OCT92

## INSPECT BALANCER BALL BEARINGS

1. Remove balancer. (See this group.)
2. Remove bearings using a blind hole puller set.
3. Thoroughly clean bearings in solvent. Dip bearing in light weight oil.
4. Spin the bearings by hand and check for axial (A) and radial (B) free play.
5. Replace the bearings if it is noisy or has too much play.
6. Install bearings flush to inside of crankcase or crankcase cover using a bearing, bushing and seal driver set.
7. Install oil seal.



M38073 -UN-29AUG88

MX,3520A1,A16 -19-21OCT92



## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove crankcase cover. (See this group.)
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
4. Bend open locking tabs (B).
5. Remove cap screws, lock plate (D), oil splasher (A) and connecting rod cap (C).
6. Push piston and connecting rod from cylinder bore.
7. Make repairs as necessary. (See procedures in this group.)

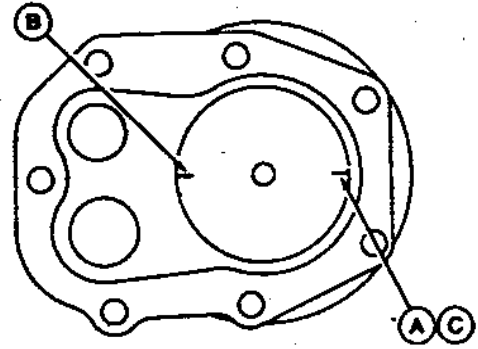


M80466 -UN-17MAY91

A—Oil Splasher  
B—Locking Tabs  
C—Connecting Rod Cap  
D—Lock Plate

MX,3520A1,A17 -19-21OCT92

8. Deglaze cylinder bore. (See Section 100, Group 15.)
9. Align piston assembly to cylinder bore with piston ring end gaps as shown.
10. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
11. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
12. Install piston assembly in cylinder bore with "R" on piston head facing flywheel side.
13. Align marks (D) on connecting rod and cap. Install connecting rod cap, oil splasher and lock plate. Tighten cap screws to specifications.
14. Bend locking tabs over cap screws.
15. Install crankcase cover.
16. Install cylinder head.



**SPECIFICATIONS.**

Cap Screw Torque . . . . . 21 N·m (186 lb-in.)

- A—First Ring End Gap
- B—Second Ring End Gap
- C—Oil Ring End Gap
- D—Alignment Marks

MX,3520A1,A18 -19-21OCT92

**DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD**

1. Remove circlip, piston pin (B) and connecting rod (A).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



MX,3520A1,A19 -19-21OCT92

4. Align the R on the piston head with the Japanese characters (A) on the connecting rod.
5. Install piston pin and circlip.



MX,3520A1,A20 -19-21OCT92

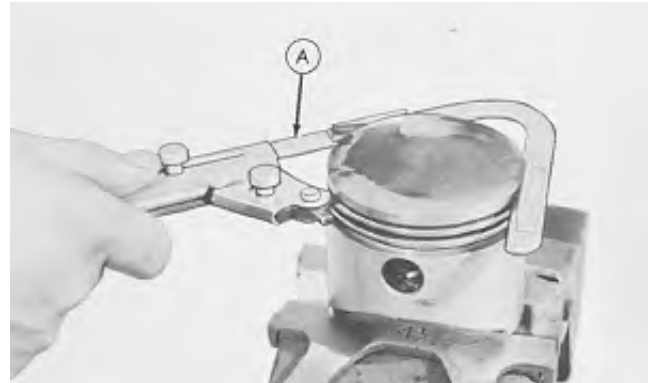
M80469 -UN-17MAY91

## INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,3520A1,A21 -19-21OCT92

M29946 -UN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: Inspect clearance visually. Replace piston if clearance appears excessive.*

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.

### CLEARANCE SPECIFICATION (MAX)

Top Ring	Second Ring	Oil Control Ring
0.15 mm (0.006 in.)	0.15 mm (0.006 in.)	0.15 mm (0.006 in.)



MX,3520A1,A22 -19-21OCT92

M38102 -UN-29AUG88

8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston pin bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

Piston Pin O.D. (MIN)	Piston Bore I.D. (MAX)
20.98 mm (0.827 in.)	21.03 mm (0.829 in.)



M50064 -UN-31AUG88



M80470 -UN-17MAY91

MX,3520A1,A23 -19-21OCT92

10. Measure piston O.D. (A) perpendicular to piston pin bore.

11. Measure cylinder bore. (See Inspect Block in this group.)

12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.

13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)

**SPECIFICATIONS**

Piston O.D. (A) . . . . .	79.77—79.79 mm (3.140—3.141 in.)
Piston-to-Cylinder Bore Clearance . . . . .	0.195—0.235 mm (0.0077—0.009 in.)



M80471 -UN-17MAY91

MX,3520A1,A24 -19-21OCT92

## INSPECT CONNECTING ROD

1. Clean and inspect rod. Replace if scored.
2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
3. Install connecting rod cap. Tighten to 20 N-m (177 lb-in.)
4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



### BEARING I.D. SPECIFICATIONS (MAX)

Crankshaft Bearing	Piston Bearing
32.06 mm (1.262 in.)	18.04 mm (0.710 in.)

MX,3520A1,A25 -19-21OCT92

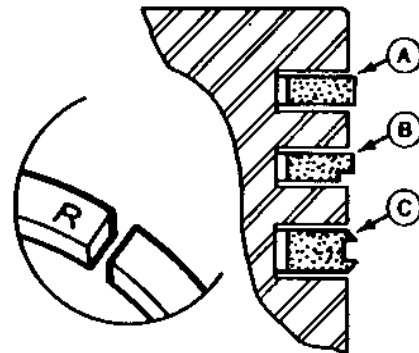
M80472 -UN-17MAY91

## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)

*NOTE: Service rings may not be marked. If not marked, compression rings have no top side and can be installed in either direction.*

4. Install top ring (A), second ring (B) and oil ring (C) with NPR mark facing up. Rings should turn freely in grooves.



MX,3520A1,A26 -19-21OCT92

M80473 -UN-17MAY91

35  
20  
14

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.

### END GAP SPECIFICATIONS

Minimum End Gap . . . . . 0.18 mm (0.007 in.)  
Maximum End Gap . . . . . 1.00 mm (0.039 in.)



M80474 -UN-17MAY91

MX,3520A1,A27 -19-21OCT92

## REMOVE, INSPECT AND INSTALL CRANKSHAFT

1. Remove camshaft. (See this group.)
2. Remove piston and connecting rod. (See this group.)
3. Remove balancer. (See this group.)
4. Remove crankshaft.

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

5. Check crankshaft alignment (T.I.R.). (See this group.)
6. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
7. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)

*NOTE: Crankshaft rotates on ball bearings. Crankshaft main bearing journals are not measured.*

8. Measure connecting rod journal. Replace crankshaft if measurement is less than specifications.
9. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
10. Apply clean engine oil to crankshaft bearings and journal.
11. Pack lithium based grease in oil seals.
12. Install crankshaft.
13. Install balancer.
14. Install piston and connecting rod.
15. Install camshaft.



M80475 -UN-17MAY91

35  
20  
16

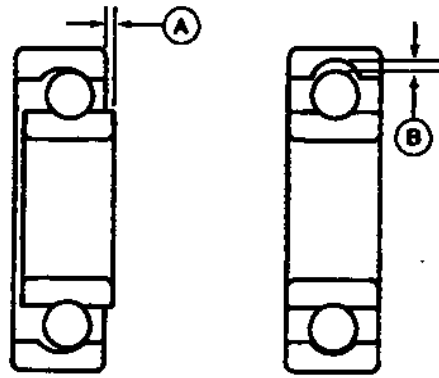
### JOURNAL SPECIFICATIONS (MIN)

Main Bearing Journal		Connecting Rod Journal
PTO Side	Flywheel Side	
—	—	31.95 mm (1.259 in.)

MX,3520A1,A28 -19-21OCT92

### INSPECT CRANKSHAFT BALL BEARINGS

1. Remove oil seals. (See Inspect Oil Seals in this group.)
2. Remove bearings using a bearing, bushing and seal driver set.
3. Thoroughly clean bearings in solvent. Dip bearings in light weight oil.
4. Spin bearings by hand and check for axial (A) and radial (B) free play.
5. Replace bearings if noisy or too much play.
6. Install bearings flush to inside of crankcase or crankcase cover using a bearing, bushing and seal driver set.
7. Install oil seals.



MX,3520A1,A29 -19-21OCT92

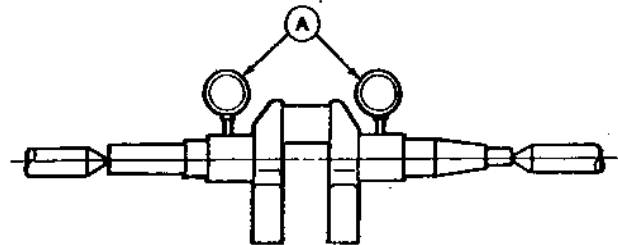
M38073 -UN-29AUG88

### CHECK CRANKSHAFT ALIGNMENT (TIR)

Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.

#### SPECIFICATIONS

Maximum TIR . . . . . 0.05 mm (0.002 in.)



MX,3520A1,A30 -19-21OCT92

M51761 -UN-07SEP88

35  
20  
17



## MEASURE AND ADJUST CRANKSHAFT END PLAY

1. Measure end play using dial indicator (A).
2. Move crankshaft in and out. Record this measurement. If end play is not within specifications, remove crankcase cover and add or subtract shims as necessary.

### SPECIFICATIONS

End Play . . . . . 0.05—0.20 mm (0.002—0.008 in.)



M80476  
-UN-17MAY91

MX,3520A1,A31 -19-21OCT92

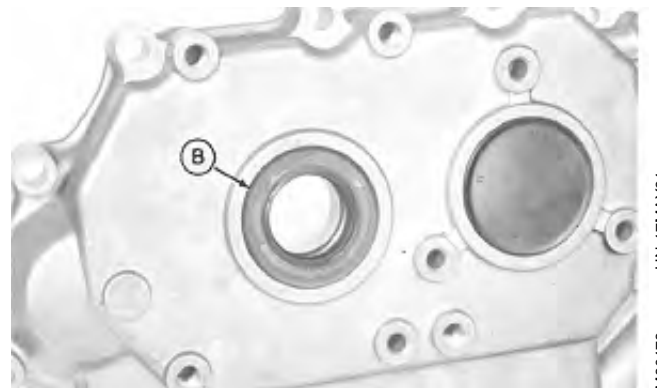
## INSPECT OIL SEALS

*NOTE: Pack lithium base grease in new or used seals.*

1. Remove flywheel. (See Group 10.)
2. Inspect oil seals (A and B) at flywheel end and PTO end for wear or damage. Replace if necessary.
3. Remove stator. (See Group 25.)
4. Remove crankshaft. (See this group.)
5. Remove worn or damaged seals with a screwdriver.
6. Install seals with lip to inside of engine using a bushing, bearing and seal driver set. Press in seals until flush with hub.
7. Install crankshaft.
8. Install stator.
9. Install flywheel.



Flywheel Side



PTO Side

M80477  
-UN-17MAY91

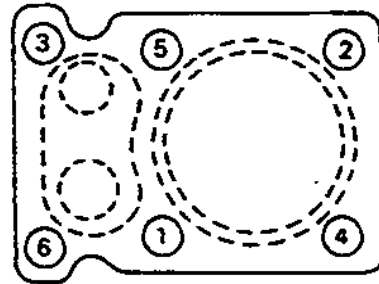
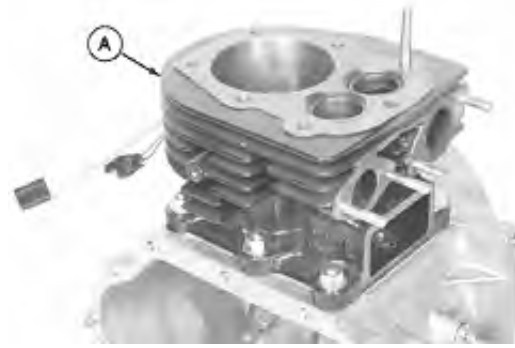
M80478  
-UN-17MAY91

MX,3520A1,A32 -19-21OCT92

35  
20  
18

## REMOVE AND INSTALL CYLINDER BLOCK

1. Remove crankshaft. (See this group.)
2. Remove cylinder block and gasket (A).
3. Remove breather plate. (See Group 05.)
4. Inspect block. (See this group.)
5. Replace crankcase/block studs, if necessary. (See this group.)
6. Install breather plate.
7. Install new gasket and cylinder block. Tighten nuts in sequence shown to specification.
8. Install crankshaft.



### TORQUE SPECIFICATIONS

Cylinder Block Nuts . . . . . 36 N·m (27 lb-ft)

MX,3520A1,A33 -19-21OCT92

-UN-17MAY91  
M80479

-UN-31AUG88

M51528

## REPLACE CRANKCASE/BLOCK STUDS

1. Remove cylinder block. (See this group.)
2. Inspect studs for cracks or wear. Replace if necessary.
3. Install two nuts on stud and tighten together. Remove stud.
4. Put thread lock and sealer (medium strength) on threads of stud and install in block. Tighten to specification.
5. Install cylinder block.



### TORQUE SPECIFICATIONS

Crankcase-to-Block Studs . . . . . 36 N·m (27 lb-ft)

MX,3520A1,A34 -19-21OCT92

35  
20  
19

-UN-17MAY91

M80480

## INSPECT CYLINDER BLOCK

1. Clean and check block for cracks.
2. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
3. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

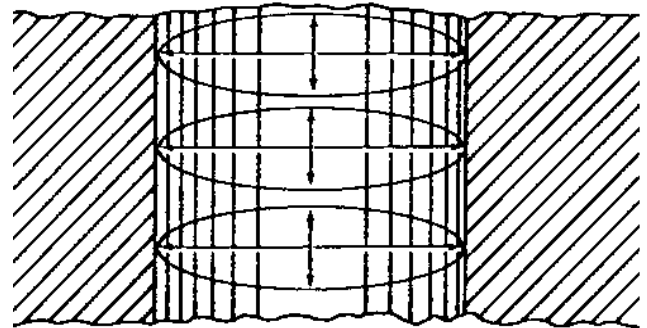
MX,3520A1,A35 -19-21OCT92

*NOTE: A bare block is available for service.*

4. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

5. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

*NOTE: If cylinder is rebored, oversize piston and rings must be installed.*



M51745 -UN-23FEB89

### CYLINDER BORE SPECIFICATIONS

Standard . . . . .	79.91—79.98 mm (3.146—3.149 in.)
Wear Limit . . . . .	80.09 mm (3.155 in.)
Out-of-Round (Max) . . . . .	0.063 mm (0.0025 in.)



M80481 -UN-17MAY91

MX,3520A1,A36 -19-21OCT92

35  
20  
20

## REBORE CYLINDER BLOCK

*NOTE: The cylinder block can be rebored to use a 0.50 mm (0.020 in.) oversize pistons and rings. Have a reliable repair shop rebores the block, or use the drill press and honing tool.*

1. Rebores cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from 200—250 rpm.
3. Lower and raise hone until ends extend 20—25 mm (0.75—1.0 in.) past ends of cylinder.
4. Turn adjusting nut on one hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately 20 times per minute.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

*NOTE: Finish should not be smooth, but have a 40—60° cross-hatch pattern.*

**IMPORTANT: Check stone for wear or damage. Use correct stone for the job.**

### CYLINDER INITIAL BORE SPECIFICATIONS

**Piston Oversize:**  
0.50 mm (0.020 in.)

80.46—80.48 mm (3.168—3.169 in.)

MX,3520A1,A37 -19-21OCT92

35  
20  
21

8. Hone the cylinder an additional 0.028—0.030 mm (0.0011—0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

**IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.**

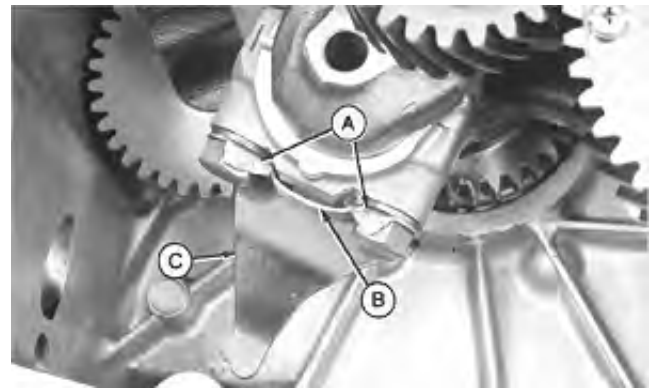
9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

10. Dry the cylinder. Apply engine oil to cylinder wall.

M98,2040A,A9 -19-21OCT92

### INSPECT AND REPLACE OIL SPLASHER

1. Remove crankcase cover. (See this group.)
2. Bend open locking tabs (A).
3. Remove cap screws, lock plate (B), and oil splasher (C).
4. Inspect splasher for wear or damage. Replace if necessary.
5. Install splasher, lock plate and cap screws. Tighten cap screws to specifications.
6. Bend locking tabs over cap screws.
7. Install crankcase cover.



M80482 -UN-17MAY91

#### SPECIFICATIONS

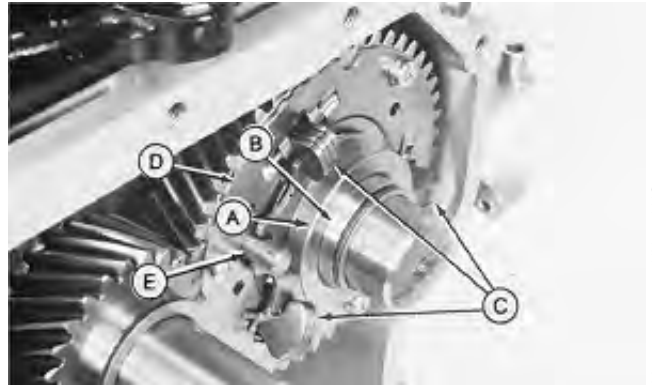
Cap Screw Torque . . . . . 21 N·m (186 lb-in.)

MX,3520A1,A38 -19-21OCT92

35  
20  
22

## INSPECT AND REPLACE GOVERNOR

1. Remove crankcase cover. (See this group.)
2. Remove sleeve (A).
3. Inspect bearing surfaces inside sleeve and on camshaft (B) for damage or wear. Replace parts as necessary.
4. Check that weights (C) move freely. Replace entire weight assembly plate (D) if damaged.
5. Install plate (D), if removed, and governor sleeve. Align lower flange of governor sleeve with locator pin (E) and insert into notches in weights.
6. Install crankcase cover.



A—Governor Sleeve  
 B—Camshaft  
 C—Weights  
 D—Weight Assembly Plate  
 E—Locator Pin

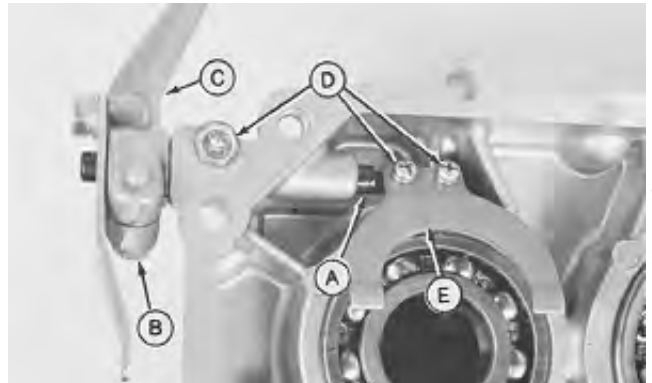
M51523 -UN-31AUG88

MX,3520A1,A39 -19-21OCT92

## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (A). Replace if damaged.
3. To replace shaft, loosen cap screw (B) on lever (C).
4. Remove screws (D), clevis (E) and shaft.
5. Install shaft, clevis and screws.
6. Tighten cap screw on governor lever.
7. Install crankcase cover.



A—Governor Shaft  
 B—Cap Screw  
 C—Governor Lever  
 D—Screws  
 E—Clevis

M51523 -UN-31AUG88

MX,3520A1,A40 -19-21OCT92

35  
20  
23

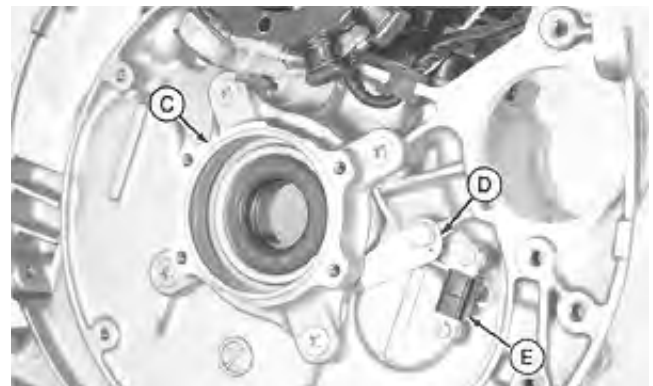


## REMOVE AND INSTALL STATOR AND PULSER COIL

*NOTE: Stator and pulser coil must be replaced as an assembly.*

1. Remove flywheel. (See Group 10.)
2. Remove housing (B).
3. Remove screws and stator (A).
4. Remove base plate (C).
5. Remove bracket (D).
6. Remove screws and pulser coil (E).
7. Remove stator and pulser coil assembly.
8. Install stator and pulser coil assembly.
9. Install pulser coil and bracket.
10. Install base plate.
11. Install stator.
12. Install cover.
13. Install flywheel.

A—Stator  
B—Housing  
C—Base Plate  
D—Bracket  
E—Pulser Coil



MX,3525A1,A1 -19-21OCT92

-JUN-17MAY91

M80483

-JUN-17MAY91

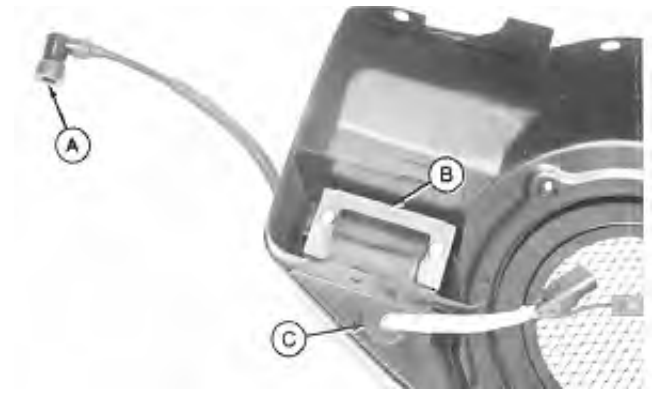
M80484

35  
25  
1



## REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove blower housing. (See Group 10.)
2. Remove rubber grommet (C).
3. Remove spark plug cap (A).
4. Remove cap screws and armature with coil (B).
5. Install armature with coil.
6. Install spark plug cap.
7. Install rubber grommet.
8. Install blower housing.



M80485  
-UN-17MAY91

MX,3525A1,A2 -19-21OCT92

## OTHER MATERIAL

Number	Name	Use
	Mineral Spirits	Clean armature.
	Multipurpose Grease	Grease starter parts.

MX,3530A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Electric Starter  
Complete Starter  
Brush Kit  
Complete Solenoid

MX,3530A1,A2 -19-21OCT92

## ANALYZE ELECTRIC STARTER CONDITION

1. The starter overheats because of:

- Long cranking.
- Armature binding.

2. The starter operates poorly because of:

- Armature binding.
- Dirty or damaged starter drive.
- Badly worn brushes or weak brush springs.
- Excessive voltage drop in cranking system.
- Battery or wiring defective.
- Shorts, opens, or grounds in armature.

*NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.*

MX,3530A1,A3 -19-21OCT92

**BENCH TEST SOLENOID DRIVE STARTER**

*NOTE: Perform bench test before disassembling starter motor to determine cause of problem.*

**IMPORTANT: Never operate motor longer than 20 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive operation, will seriously damage starting motor.**

1. Disconnect battery leads from battery.
2. Remove starter from engine.
3. Connect 12-volt battery (A) to starter battery terminal (B) and starter frame (C) using heavy duty cables.
4. Connect 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.*

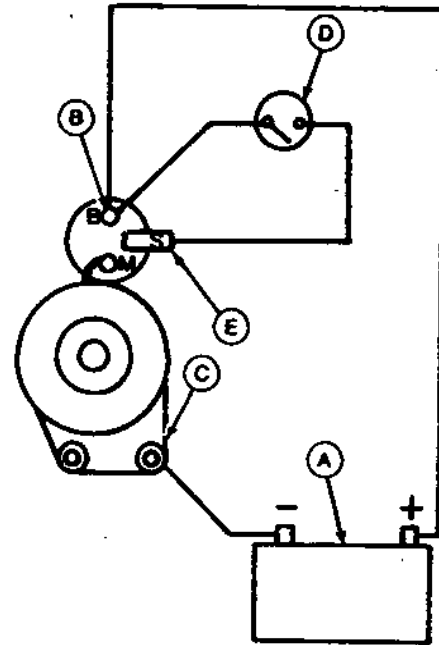
When switch is activated, starter should engage and run.

IF SOLENOID CHATTERS; hold-in winding is open-circuited.

IF NOTHING HAPPENS; either the solenoid pull-in winding is open-circuited or mechanical parts are sticking.

IF SOLENOID ENGAGES, BUT MOTOR DOES NOT RUN; check solenoid switch continuity, brushes, armature and field windings.

Solenoid cannot be repaired, replace it.



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

MX,3530A1,A4 -19-21OCT92

-JUN-29AUG88

M37149

35  
30  
2

## TEST SOLENOID

*NOTE: If bench test indicated solenoid problems, use an ohmmeter or test light to check solenoid.*

1. Test solenoid terminals (A and B) for continuity. There should be no continuity.
2. Depress switch arm (C). There should be continuity when arm is fully depressed.
3. Test for open circuits between terminal (B) and tang (D). There should be continuity.
4. Test for open circuits between tang (D) and body (E). There should be continuity.

If solenoid fails any test, it is defective and must be replaced.



A—Terminal  
 B—Terminal  
 C—Switch Arm  
 D—Tang  
 E—Solenoid Body

MX,3530A1,A5 -19-21OCT92

M80486 -UN-17MAY91

## CHECK STARTER ARMATURE ROTATION

1. Remove starter.
2. Rotate armature (A).
3. If armature does not rotate freely, armature may be bent or bearings may be worn. Disassemble and inspect starter. (See this group.)
4. Install starter.

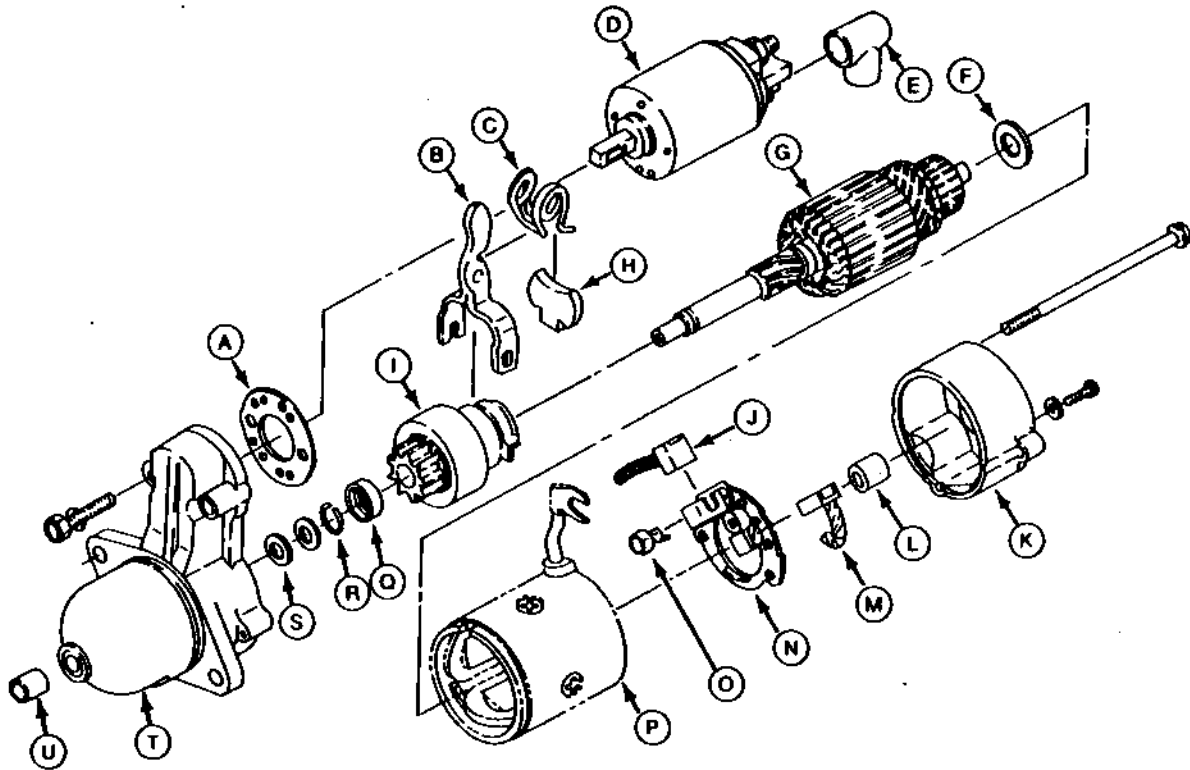


MX,3530A1,A6 -19-21OCT92

M80487 -UN-17MAY91

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## INSPECT STARTER



A—Cover  
 B—Shift Lever  
 C—Spring  
 D—Solenoid  
 E—Cap  
 F—Washer

G—Armature  
 H—Cover  
 I—Pinion  
 J—Brush  
 K—End Cover

L—Bushing  
 M—Brush  
 N—Brush Holder  
 O—Spring (2 used)  
 P—Body

Q—Pinion Stopper  
 R—Retaining Clip  
 S—Washer (2 used)  
 T—Front Cover  
 U—Bushing

1. Mark body and covers for correct alignment during reassembly.

2. Push pinion stopper (Q) toward pinion (I) to remove retaining clip (R).

3. Inspect parts for wear or damage.

**IMPORTANT:** If front or rear armature bushings (U,L) must be replaced, ream new bushings to an inside diameter of 9.5 mm (+0.015, -0.00 mm).

4. Measure brushes. Replace brushes as a set if length of any one is less than 10 mm (0.394 in.).

5. Test starter armature and brushes. (See this group.)

6. Apply a thin coat of multipurpose grease to:  
 —sliding surfaces of armature and solenoid shift lever.  
 —armature shaft spline.  
 —points where shaft contacts cover.

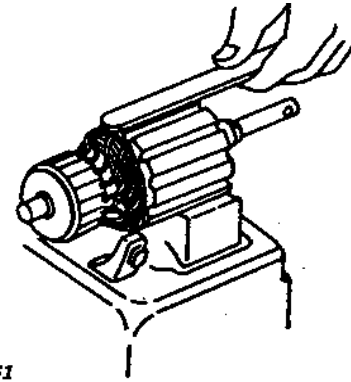
7. Assemble starter.

## TEST STARTER ARMATURE

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

1. Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.
2. Shorts been bars are sometimes caused by dirt or copper between bars. Inspect for this condition.
3. If test indicates short circuited windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.

M24861



M24861 -UN-25AUG88

MX,3530A1,A8 -19-21OCT92

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

Armature windings are connected in parallel, so each commutator bar needs to be checked.

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



M98,2030A,AH -19-21OCT92

M50112 -UN-31AUG88

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

If test shows no continuity, there is an open circuit and armature must be replaced.



M98,2030A,M -19-21OCT92

M50113 -JUN-31AUG88

## TEST FIELD COIL

1. Test for continuity between brush to housing. Replace field coil if there is no continuity.



MX,3530A1,A9 -19-21OCT92

M80489 -UN-17MAY91

2. Test for continuity between negative brush holder (A) and brush plate. Replace brush holder assembly if there is continuity.

3. Test for continuity between positive brush holder (B) and brush plate. Replace brush holder assembly if there is no continuity.



MX,3530A1,A10 -19-21OCT92

M80490 -UN-17MAY91

## REPLACE BRUSHES

1. Melt solder from brush lead connection to replace field coil brush. Cut off old brush to replace brush (A) on brush plate assembly.

2. Install new brushes using only 60—40 rosin core solder. Newly installed wire should be approximately same length as original.



MX,3530A1,A11 -19-21OCT92

M80491 -UN-17MAY91

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# Section 40

## FC290V/FC400V/FC420V/FC540V

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# Group 00

## Engine Application and Repair Specifications

### ENGINE APPLICATIONS CHART

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

#### LAWN TRACTORS

Machine	Engine Model No.
130 (Engine S.N. —060824) . . . . .	FC290V-AS00
(Engine S.N. 060825— ) . . . . .	FC290V-BS00
170/175 (Engine S.N. —006515) . . . . .	FC420V-AS00
(Engine S.N. 006516—009053) . . . . .	FC420V-BS00
(Engine S.N. 009054—028504) . . . . .	FC420V-CS00
(Engine S.N. 028505— ) . . . . .	FC420V-DS00
180/185 (Engine S.N. —058710) . . . . .	FC540V-AS00
(Engine S.N. 058711—105580) . . . . .	FC540V-BS00
(Engine S.N. 105581— ) . . . . .	FC540V-CS00
LX172/176 . . . . .	FC420V-AS10
LX186 . . . . .	FC540V-AS10

#### LAWN AND GARDEN TRACTORS

GT242 . . . . .	FC420V-AS10
240 (Engine S.N. —028504) . . . . .	FC420V-CS00
(Engine S.N. 028505—124169) . . . . .	FC420V-DS00
(Engine S.N. 124170— ) . . . . .	FC420V-ES00
245 . . . . .	FC420V-FS00
260/265 (Engine S.N. —105580) . . . . .	FC540V-BS00
(Engine S.N. 105581—163399) . . . . .	FC540V-CS00
(Engine S.N. 163400— ) . . . . .	FC540V-DS00
GT262 . . . . .	FC540V-AS10

#### RIDING MOWERS

RX73 (Engine S.N. —061534) . . . . .	FC290V-AS01
(Engine S.N. 061535—106800) . . . . .	FC290V-BS01
(Engine S.N. 106801— ) . . . . .	FC290V-CS01
RX75 (Engine S.N. —060604) . . . . .	FC290V-AS02
(Engine S.N. 080518—113843) . . . . .	FC290V-AS10
(Engine S.N. 113944— ) . . . . .	FC290V-BS10
SX75 (Engine S.N. —060604) . . . . .	FC290V-AS02
(Engine S.N. 060605—113943) . . . . .	FC290V-BS02 or FC290V-BS02-01
(Engine S.N. 113944— ) . . . . .	FC290V-BS10
GX70/75 . . . . .	FC290V-BS10
SRX75 . . . . .	FC290V-CS10

#### COMMERCIAL WALK-BEHIND MOWERS

38/48-Inch . . . . .	FC400V-AS05
48/52-Inch (Engine S.N. —067591) . . . . .	FC540V-AS01
(Engine S.N. 067592— ) . . . . .	FC540V-BS01
48/54-Inch . . . . .	FC420V-AS11 or FC540V-AS11

#### FRONT MOUNT MOWERS

F710 . . . . .	FC540V-AS12
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MX,4000A1,1 -19-21OCT92

## FC290V REPAIR SPECIFICATIONS

### GROUP 05—FUEL AND AIR SYSTEMS

Item	Specification
Breather	
Maximum Air Gap . . . . .	0.20 mm (0.008 in.)

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Flywheel Nut Torque . . . . .	85 N-m (63 lb-ft)
Minimum Flywheel Screen Gap . . . . .	1.50 mm (0.059 in.)

### GROUP 15—CYLINDER HEAD AND VALVES

Valve Clearance . . . . .	0.15 mm (0.006 in.)
---------------------------	---------------------

#### Rocker Arm

Minimum Shaft O.D. . . . .	12.94 mm (0.509 in.)
Maximum Bearing I.D. . . . .	13.07 mm (0.515 in.)

#### Push Rod

Maximum Bend . . . . .	0.30 mm (0.012 in.)
Intake Pushrod Lift . . . . .	5.313 mm (0.2092 in.)
	(wear min.) 5.048 mm (0.1987 in.)
Exhaust Pushrod Lift . . . . .	5.388 mm (0.2121 in.)
	(wear min.) 5.118 mm (0.2015 in.)

#### Valves and Springs

Minimum Spring Free Length . . . . .	31.00 mm (1.220 in.)
Valve Guide I.D. . . . .	(min.) 7.000 mm (0.2756 in.)
	(max.) 7.015 mm (0.2762 in.)
Intake Valve Stem O.D. . . . .	(min.) 6.960 mm (0.2740 in.)
	(max.) 6.975 mm (0.2746 in.)
Intake Valve-To-Guide Clearance . . . . .	(min.) 0.025 mm (0.0010 in.)
	(max.) 0.055 mm (0.0022 in.)
Exhaust Valve Stem O.D. . . . .	(min.) 6.950 mm (0.2736 in.)
	(max.) 6.965 mm (0.2742 in.)
Exhaust Valve-To-Guide Clearance . . . . .	(min.) 0.035 mm (0.0014 in.)
	(max.) 0.065 mm (0.0026 in.)
Intake Valve Lift (W/Clearance set at 0.00) . . . . .	6.923 mm (0.2726 in.)
	(wear min.) 6.578 mm (0.2590 in.)
Exhaust Valve Lift (W/Clearance set at 0.00) . . . . .	7.021 mm (0.2764 in.)
	(wear min.) 6.670 mm (0.2626 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seating Surface . . . . .	0.50—1.10 mm (0.020—0.043 in.)
Valve Seat and Face Angle . . . . .	45°
Minimum Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

Continued on next page

MX,4000A1,A2 -19-21OCT92

**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS**

Item	Specification
<b>Cylinder Head</b>	
Cylinder Head Flatness . . . . .	0.05 mm (0.002 in.)
Cap Screw Torque In Sequence (Lubricated)	
Initial Torque . . . . .	18 N·m (159 lb-in.)
Final Torque . . . . .	24 N·m (212 lb-in.)
Spark Plug Torque . . . . .	20 N·m (177 lb-in.)
<b>Crankcase Cover</b>	
Oil Capacity . . . . .	1.0 L (2.11 pt)
Cap Screw Torque . . . . .	20 N·m (177 lb-in.)
<b>Camshaft</b>	
Minimum End Journal O.D.	
PTO Side . . . . .	13.92 mm (0.548 in.)
Flywheel Side . . . . .	15.92 mm (0.627 in.)
Minimum Lobe Height . . . . .	27.08 mm (1.066 in.)
Maximum Bearing I.D.	
Crankcase . . . . .	16.06 mm (0.632 in.)
Crankcase Cover . . . . .	14.05 mm (0.553 in.)
<b>Reciprocating Balancer</b>	
Link Rod	
Minimum Journal O.D. . . . .	46.86 mm (1.845 in.)
Maximum Small End I.D. . . . .	12.06 mm (0.475 in.)
Maximum Large End I.D. . . . .	47.12 mm (1.855 in.)
Bushing Depth . . . . .	1 mm (0.040 in.)
<b>Balancer Weight</b>	
Maximum Bearing I.D. . . . .	26.10 mm (1.027 in.)
<b>Support Shaft</b>	
Minimum Shaft O.D. . . . .	25.93 mm (1.021 in.)
Balancer Bushing Assembly Torque . . . . .	7.3 N·m (65 lb-in.)
<b>Piston</b>	
Maximum Ring Groove Clearance	
Top Ring . . . . .	0.16 mm (0.006 in.)
Second Ring . . . . .	0.14 mm (0.005 in.)
Oil Control Ring . . . . .	0.19 mm (0.007 in.)
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap	
Compression Rings . . . . .	0.71 mm (0.028 in.)
Oil Ring Side Rails . . . . .	1.20 mm (0.047 in.)
Minimum Pin O.D. . . . .	18.98 mm (0.747 in.)
Maximum Pin Bore I.D. . . . .	19.03 mm (0.749 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Piston O.D. . . . .	77.85—77.87 mm (3.0649—3.0657 in.)
Piston-to-Cylinder Bore Clearance . . . . .	0.110—0.142 mm (0.0043—0.0056 in.)

Continued on next page

MX,4000A1,A3 -19-21OCT92

**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	35.57 mm (1.400 in.)
Maximum Piston Pin Bearing I.D. . . . .	19.06 mm (0.750 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.08 mm (0.003 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.14 mm (0.006 in.)
End-Cap Screw Torque . . . . .	20 N·m (177 lb-in.)
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	29.92 mm (1.178 in.)
Minimum Connecting Rod Journal O.D. . . . .	35.43 mm (1.395 in.)
Maximum Crankcase Cover Plain Bearing I.D. . . . .	30.13 mm (1.186 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0.09—0.22 mm (0.004—0.009 in.)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D. . . . .	77.98—78.00 mm (3.070—3.071 in.)
Maximum Cylinder Bore I.D. . . . .	78.07 mm (3.074 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.25 mm . . . . .	78.21—78.23 mm (3.079—3.080 in.)
0.50 mm . . . . .	78.46—78.48 mm (3.089—3.090 in.)
0.75 mm . . . . .	78.71—78.73 mm (3.099—3.100 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . . 0.30 mm (0.012 in.)

See Ignition Tests in this Group.

**GROUP 30—STARTING SYSTEMS**

Electric Starter  
See Starter Specifications in this Group.

MX,4000A1,A4 -19-21OCT92

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## FC400V/FC420V REPAIR SPECIFICATIONS

### GROUP 05—FUEL AND AIR SYSTEMS

Item	Specification
Breather	
Air Gap . . . . .	1—2 mm (0.040—0.080 in.)

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Flywheel Nut Torque . . . . .	137 N·m (101 lb-ft)
Minimum Flywheel Screen Gap . . . . .	1.50 mm (0.059 in.)

### GROUP 15—CYLINDER HEAD AND VALVES

Valve Clearance . . . . .	0.15 mm (0.006 in.)
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#### Rocker Arm

Minimum Shaft O.D. . . . .	12.94 mm (0.509 in.)
Maximum Bearing I.D. . . . .	13.07 mm (0.515 in.)

#### Push Rod

Intake Pushrod Lift . . . . .	6.903 mm (0.2718 in.)
	(wear min.) 6.558 mm (0.2582 in.)
Exhaust Pushrod Lift . . . . .	6.903 mm (0.2718 in.)
	(wear min.) 6.558 mm (0.2582 in.)
Maximum Bend . . . . .	0.30 mm (0.012 in.)

#### Valves and Springs

Minimum Spring Free Length . . . . .	37.50 mm (1.476 in.)
Valve Guide I.D. . . . .	(min.) 7.000 mm (0.2756 in.)
	(max.) 7.015 mm (0.2762 in.)

Intake Valve Stem O.D. . . . .	(min.) 6.972 mm (0.2745 in.)
	(max.) 6.987 mm (0.2751 in.)

Intake Valve-To-Guide Clearance . . . . .	(min.) 0.013 mm (0.0005 in.)
	(max.) 0.043 mm (0.0017 in.)

Exhaust Valve Stem O.D. . . . .	(min.) 6.965 mm (0.2742 in.)
	(max.) 6.980 mm (0.2748 in.)

Exhaust Valve-To-Guide Clearance . . . . .	(min.) 0.020 mm (0.0008 in.)
	(max.) 0.050 mm (0.0020 in.)

Intake Valve Lift (W/Clearance set at 0.00) . . . . .	8.995 mm (0.3541 in.)
	(wear min.) 8.545 mm (0.3365 in.)

Exhaust Valve lift (W/Clearance set at 0.00) . . . . .	8.995 mm (0.3541 in.)
	(wear min.) 8.545 mm (0.3365 in.)

Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
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Valve Seating Surface . . . . .	1.10—1.46 mm (0.043—0.057 in.)
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Valve Seat and Face Angle . . . . .	45°
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Minimum Valve Margin . . . . .	0.60 mm (0.020 in.)
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Valve Narrowing Angle . . . . .	30°
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Continued on next page

MX,4000A1,A5 -19-21OCT92

**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS**

Item	Specification
Cylinder Head	
Cylinder Head Flatness . . . . .	0.05 mm (0.002 in.)
Cap Screw Torque In Sequence (Lubricated)	
Initial Torque . . . . .	32 N·m (24 lb-ft)
Final Torque . . . . .	52 N·m (38 lb-ft)
Spark Plug Torque . . . . .	20 N·m (177 lb-in.)
Crankcase Cover	
Oil Capacity	
With Filter . . . . .	1.5 L (3.17 pt)
Without Filter . . . . .	1.3 L (2.75 pt)
Cap Screw Torque . . . . .	26 N·m (230 lb-in.)
Camshaft	
Minimum End Journal O.D.	
PTO Side . . . . .	20.91 mm (0.823 in.)
Flywheel Side . . . . .	19.91 mm (0.784 in.)
Minimum Lobe Height . . . . .	36.75 mm (1.447 in.)
Maximum Bearing I.D.	
Crankcase . . . . .	20.08 mm (0.790 in.)
Crankcase Cover . . . . .	21.08 mm (0.830 in.)
Reciprocating Balancer	
Link Rod	
Minimum Journal O.D. . . . .	53.95 mm (2.124 in.)
Maximum Small End I.D. . . . .	12.60 mm (0.475 in.)
Maximum Large End I.D. . . . .	54.12 mm (2.131 in.)
Bushing Depth . . . . .	0.50 mm (0.020 in.)
Balancer Weight	
Maximum Bearing I.D. . . . .	26.10 mm (1.027 in.)
Support Shaft	
Minimum Shaft O.D. . . . .	25.93 mm (1.021 in.)
Piston	
Maximum Ring Groove Clearance	
Top Ring . . . . .	0.17 mm (0.007 in.)
Second Ring . . . . .	0.15 mm (0.006 in.)
Oil Ring . . . . .	0.20 mm (0.008 in.)
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap	
Compression Rings . . . . .	0.90 mm (0.035 in.)
Oil Ring Side Rails . . . . .	1.30 mm (0.051 in.)
Minimum Pin O.D. . . . .	21.98 mm (0.865 in.)
Maximum Pin Bore I.D. . . . .	22.04 mm (0.868 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.06 mm (0.002 in.)
Piston O.D.—FC400V . . . . .	86.83—86.85 mm (3.4185—3.4192 in.)
Piston O.D.—FC420V . . . . .	88.83—88.85 mm (3.4885—3.498 in.)
Piston-to-Cylinder Bore Clearance . . . . .	0.13—0.17 mm (0.005—0.0067 in.)

Continued on next page

MX,4000A1,A6 -19-21OCT92

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**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	41.07 mm (1.617 in.)
Maximum Piston Pin Bearing I.D. . . . .	22.06 mm (0.868 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.08 mm (0.003 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.14 mm (0.006 in.)
End-Cap Screw Torque . . . . .	20 N·m (177 lb-in.)
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	34.92 mm (1.376 in.)
Minimum Connecting Rod Journal O.D. . . . .	40.93 mm (1.611 in.)
Maximum Crankcase Cover Plain Bearing I.D. . . . .	35.06 mm (1.380 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0.09—0.22 mm (0.004—0.009 in.)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D.—FC400V . . . . .	86.98—87.00 mm (3.424—3.425 in.)
Standard Cylinder Bore I.D.—FC420V . . . . .	88.98—89.00 mm (3.503—3.504 in.)
Maximum Cylinder Bore I.D.—FC400V . . . . .	87.08 mm (3.428 in.)
Maximum Cylinder Bore I.D.—FC420V . . . . .	89.08 mm (3.507 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.25 mm . . . . .	89.23—89.25 mm (3.513—3.514 in.)
0.50 mm . . . . .	89.48—89.50 mm (3.523—3.524 in.)
0.75 mm . . . . .	89.73—89.75 mm (3.533—3.534 in.)
<b>Oil Pump</b>	
Minimum Rotor Shaft O.D.	
Large O.D. . . . .	12.63 mm (0.497 in.)
Small O.D. . . . .	7.94 mm (0.313 in.)
Maximum Rotor Shaft Bearing I.D.	
Oil Pump Cover . . . . .	12.76 mm (0.502 in.)
Crankcase Cover . . . . .	8.07 mm (0.318 in.)
Outer Rotor	
Minimum Thickness . . . . .	11.92 mm (0.470 in.)
Minimum O.D. . . . .	28.95 mm (1.140 in.)
Outer Rotor Bearing	
Maximum Depth . . . . .	12.14 mm (0.478 in.)
Maximum I.D. . . . .	29.20 mm (1.149 in.)
Minimum Valve Spring Free Length . . . . .	19.00 mm (0.750 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)
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See Ignition Tests in this Group.

**GROUP 30—STARTING SYSTEMS**

Electric Starter

See Starter Specifications in this Group.



## FC540V REPAIR SPECIFICATIONS

### GROUP 05—FUEL AND AIR SYSTEMS

Item	Specification
Breather	
Air Gap . . . . .	1—2 mm (0.040—0.080 in.)

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Flywheel Nut Torque . . . . .	172 N·m (127 lb-ft)
Minimum Flywheel Screen Gap . . . . .	1.5 mm (0.059 in.)

### GROUP 15—CYLINDER HEAD AND VALVES

Valve Clearance . . . . .	0.15 mm (0.006 in.)
Rocker Arm	
Minimum Shaft O.D. . . . .	12.94 mm (0.509 in.)
Maximum Bearing I.D. . . . .	13.07 mm (0.515 in.)
Push Rod	
Intake Pushrod Lift . . . . .	7.240 mm (0.2850 in.)
	(wear min.) 6.878 mm (0.2708 in.)
Exhaust Pushrod Lift . . . . .	7.240 mm (0.2850 in.)
	(wear min.) 6.878 mm (0.2708 in.)
Maximum Bend . . . . .	0.30 mm (0.012 in.)
Valves and Springs	
Intake Valve Lift (W/Clearance set at 0.00) . . . . .	9.343 mm (0.3714 in.)
	(wear min.) 8.962 mm (0.3528 in.)
Exhaust Valve Lift (W/Clearance set at 0.00) . . . . .	9.343 mm (0.3714 in.)
	(wear min.) 8.962 mm (0.3528 in.)
Minimum Spring Free Length . . . . .	37.50 mm (1.476 in.)
Maximum Valve Guide I.D. . . . .	7.07 mm (0.278 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seating Surface . . . . .	1.10—1.46 mm (0.043—0.057 in.)
Valve Seat and Face Angle . . . . .	45°
Minimum Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

Continued on next page

MX,4000A1,A8 -19-21OCT92

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**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS**

Item	Specification
<b>Cylinder Head</b>	
Cylinder Head Flatness . . . . .	0.05 mm (0.002 in.)
Cap Screw Torque In Sequence (Lubricated)	
Initial Torque . . . . .	32 N·m (24 lb-ft)
Final Torque . . . . .	52 N·m (38 lb-ft)
Spark Plug Torque . . . . .	20 N·m (177 lb-in.)
<b>Crankcase Cover</b>	
Oil Capacity	
With Filter . . . . .	1.8 L (3.80 pt)
Without Filter . . . . .	1.6 L (3.40 pt)
Cap Screw Torque . . . . .	20 N·m (177 lb-in.)
<b>Camshaft</b>	
Minimum End Journal O.D. . . . .	20.91 mm (0.823 in.)
Minimum Lobe Height . . . . .	37.10 mm (1.461 in.)
Maximum Bearing I.D. . . . .	21.08 mm (0.830 in.)
<b>Reciprocating Balancer</b>	
Link Rod	
Minimum Journal O.D. . . . .	57.94 mm (2.281 in.)
Maximum Small End I.D. . . . .	12.60 mm (0.475 in.)
Maximum Large End I.D. . . . .	58.15 mm (2.289 in.)
Bushing Depth . . . . .	1.00 mm (0.040 in.)
<b>Balancer Weight</b>	
Maximum Bearing I.D. . . . .	26.10 mm (1.027 in.)
Bushing Depth . . . . .	0.50 mm (0.02 in.)
<b>Support Shaft</b>	
Minimum Shaft O.D. . . . .	25.93 mm (1.021 in.)
Balancer Bushing Assy. Torque . . . . .	7.3 N·m (65 lb-in.)
<b>Piston</b>	
Maximum Ring Groove Clearance	
Top Ring . . . . .	0.17 mm (0.007 in.)
Second Ring . . . . .	0.15 mm (0.006 in.)
Oil Ring . . . . .	1.30 mm (0.051 in.)
Minimum Ring End Gap . . . . .	0.8 mm (0.007 in.)
Maximum Ring End Gap	
Compression Rings . . . . .	0.90 mm (0.035 in.)
Oil Ring Side Rails . . . . .	0.20 mm (0.008 in.)
Minimum Pin O.D. . . . .	21.98 mm (0.865 in.)
Maximum Pin Bore I.D. . . . .	22.04 mm (0.868 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.06 mm (0.003 in.)
Piston O.D. . . . .	88.83—88.864 mm (3.4885—3.4984 in.)
Piston-to-Cylinder Bore Clearance . . . . .	0.110—0.151 mm (0.0043—0.0059 in.)

Continued on next page

MX,4000A1,A9 -19-21OCT92

**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	41.07 mm (1.617 in.)
Maximum Piston Pin Bearing I.D. . . . .	22.06 mm (0.868 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.08 mm (0.003 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.14 mm (0.006 in.)
End-Cap Screw Torque . . . . .	20 N·m (177 lb-in.)
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	37.90 mm (1.492 in.)
Minimum Connecting Rod Journal O.D. . . . .	40.93 mm (1.611 in.)
Maximum Crankcase Cover Plain Bearing I.D. . . . .	38.06 mm (1.498 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0.09—0.22 mm (0.004—0.009 in.)
PTO Side Oil Seal Depth . . . . .	0.50 mm (0.020 in.)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D. . . . .	89.98—89.00 mm (3.503—3.504 in.)
Maximum Cylinder Bore I.D. . . . .	89.08 mm (3.507 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.25 mm . . . . .	89.21—89.23 mm (3.512—3.513 in.)
0.50 mm . . . . .	89.46—89.48 mm (3.522—3.523 in.)
0.75 mm . . . . .	89.71—89.73 mm (3.532—3.533 in.)
<b>Oil Pump</b>	
Minimum Rotor Shaft O.D. . . . .	12.63 mm (0.497 in.)
Maximum Rotor Shaft Bearing I.D. . . . .	12.76 mm (0.502 in.)
<b>Outer Rotor</b>	
Minimum Thickness . . . . .	9.92 mm (0.391 in.)
Minimum O.D. . . . .	40.47 mm (1.596 in.)
<b>Outer Rotor Bearing</b>	
Minimum Depth . . . . .	10.17 mm (0.401 in.)
Maximum I.D. . . . .	40.77 mm (1.605 in.)
Minimum Valve Spring Free Length . . . . .	19.00 mm (0.750 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)
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See Ignition Tests in this Group.

**GROUP 30—STARTING SYSTEMS**

Electric Starter

See Starter Specifications in this Group.

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Fuel Pump Gasket Kit—FC400V/FC420V/FC540V

Carburetor

Gasket Kit

Needle Valve

Float Kit

Choke Shaft Kit

Throttle Shaft Kit

Breather Valve Kit

Air Cleaner Assembly

Main Jet High Altitude Kit

MX,4005A1,A1 -19-21OCT92

## REMOVE AND INSTALL FUEL PUMP

**CAUTION:** Gasoline is dangerous. Avoid fires due to smoking or careless maintenance practices.

1. Disconnect vacuum line (A) and fuel lines (B). Close all openings using caps and plugs.
2. Remove fuel pump.
3. Inspect pump for wear or damage. Repair or replace as necessary.
4. Install fuel pump.
5. Connect vacuum and fuel lines.

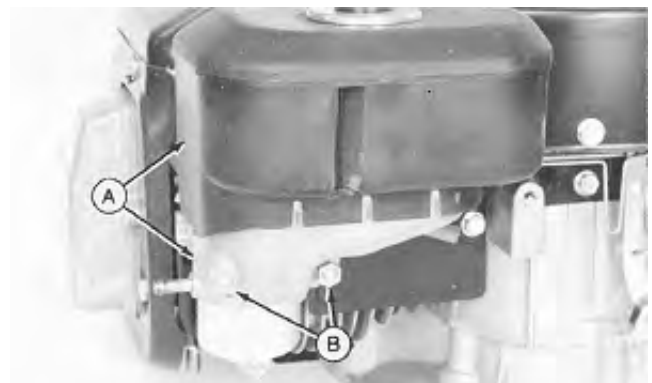


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-UN-25SEP90

MX,4005A1,A2 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR—FC290V

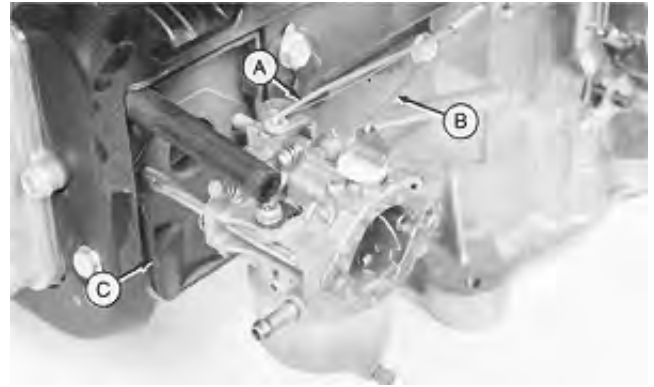
1. Remove two nuts (B) and air cleaner assembly (A).



M80000  
-UN-09JAN91

MX,4005A1,A3 -19-21OCT92

2. Separate carburetor from heat shield (C). Remove carburetor.
3. Disconnect choke linkage (B) and throttle linkage (A).
4. Remove heat shield (C) and gaskets.
5. Make repairs as necessary. (See procedure in this group.)
6. Install gaskets and heat shield.
7. Connect linkage and install carburetor.
8. Install air cleaner assembly.



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-UN-09JAN91



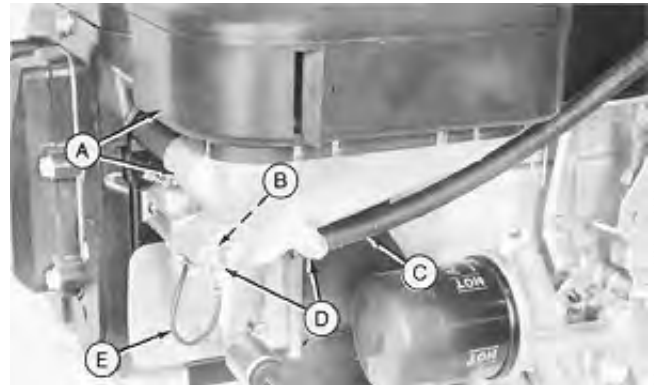
M80002  
-UN-09JAN91

MX,4005A1,A4 -19-21OCT92

### REMOVE AND INSTALL CARBURETOR—FC400V/FC420V

1. Disconnect fuel hose (C).
2. Remove two nuts (D) and washer (B).
3. Disconnect wiring lead (E).
4. Remove air cleaner assembly (A).

A—Air Cleaner Assembly  
B—Washer  
C—Fuel Hose  
D—Nuts  
E—Ground Wiring Lead



M80003  
-UN-09JAN91

MX,4005A1,A5 -19-21OCT92

5. Separate carburetor from heat shield (C). Remove carburetor.

6. Disconnect choke linkage (B) and throttle control linkage (A).

7. Remove heat shield (C) and gaskets.

8. Make repairs as necessary. (See procedure in this group.)

9. Install gaskets and heat shield.

10. Connect linkage and install carburetor.

*NOTE: Install gasket (D) with hole (E) pointing toward fuel inlet side of carburetor and tab (F) pointing up.*

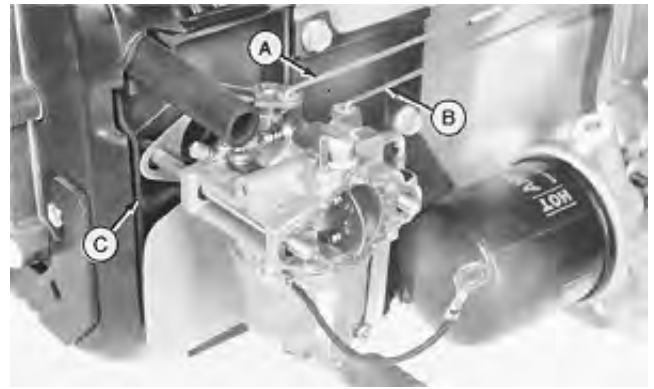
11. Install gasket (D) and air cleaner assembly.

12. Connect wiring lead.

13. Install washer and two nuts.

14. Connect fuel hose.

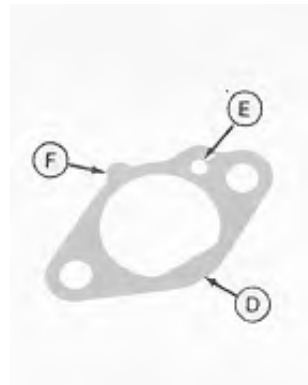
- A—Throttle Control Linkage
- B—Choke Linkage
- C—Heat Shield
- D—Gasket
- E—Hole
- F—Tab



M80004 -UN-09JAN91



M80005 -UN-09JAN91

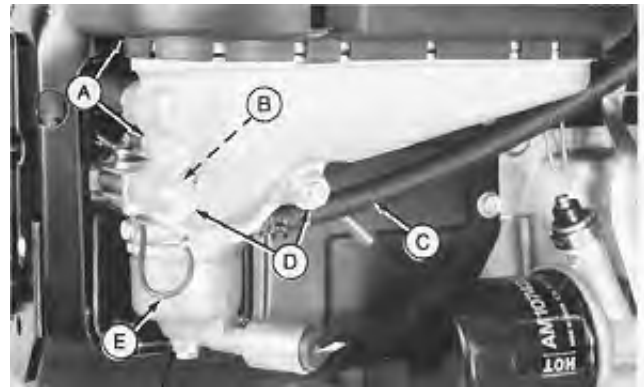


M80006 -UN-09JAN91

## REMOVE AND INSTALL CARBURETOR—FC540V

1. Disconnect fuel hose (C).
2. Remove two nuts (D) and washer (B).
3. Disconnect wiring lead (E).
4. Remove air cleaner assembly (A).

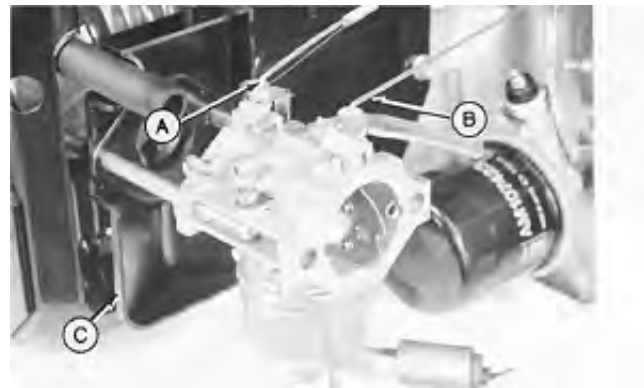
A—Air Cleaner Assembly  
 B—Washer  
 C—Fuel Hose  
 D—Nuts  
 E—Ground Wiring Lead



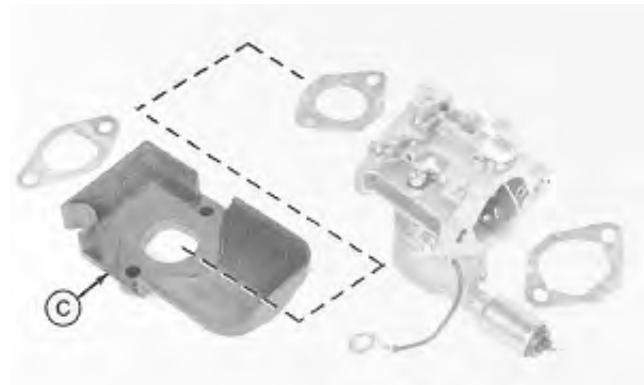
-UN-09JAN91  
M54484

MX,4005A1,A7 -19-21OCT92

5. Separate carburetor from heat shield (C). Remove carburetor.
6. Disconnect choke linkage (B) and throttle control linkage (A).
7. Remove heat shield (C) and gaskets.
8. Make repairs as necessary. (See procedure in this group.)
9. Install gaskets and heat shield.
10. Connect linkage and install carburetor.
11. Install air cleaner assembly.
12. Connect wiring lead.
13. Install washer and two nuts.
14. Connect fuel hose.



-UN-09JAN91  
M54485



-UN-20DEC90  
M80007

MX,4005A1,A8 -19-21OCT92

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## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR

*NOTE: FC400V, FC420V and FC540V engines are equipped with a fuel control solenoid.*

*FC540V engines with engine tag number BS00, pilot jet is pressed in.*

**IMPORTANT: To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.**

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.

2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT: Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.**

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.

4. Inspect all parts for wear or damage, replace as necessary.

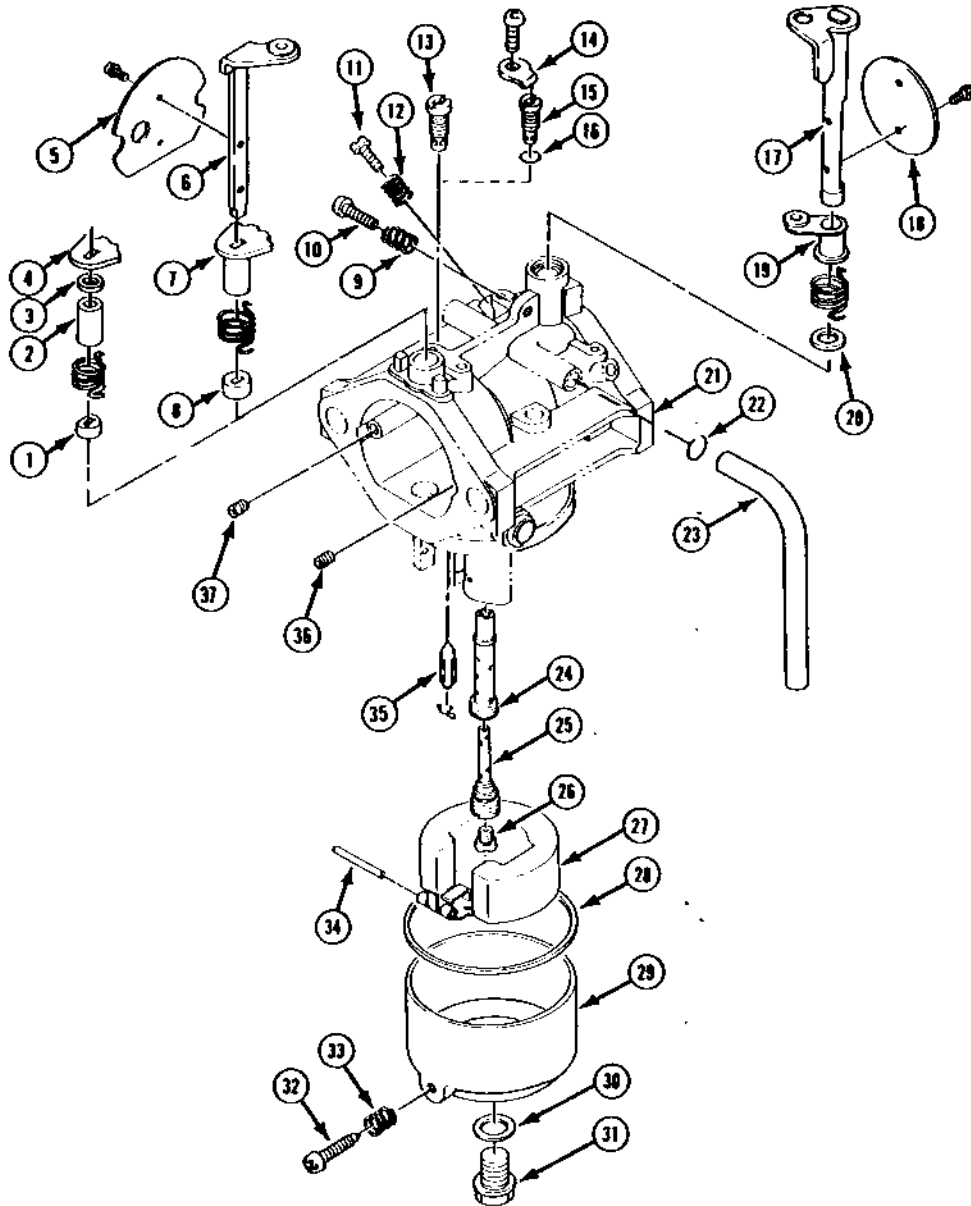
*NOTE: Main jet high altitude kits are available.*

*Float is plastic. The float cannot be adjusted. Replace if necessary.*

*Use this procedure when referring to the following three exploded views.*

MX,4005A1,A12 -19-21OCT92





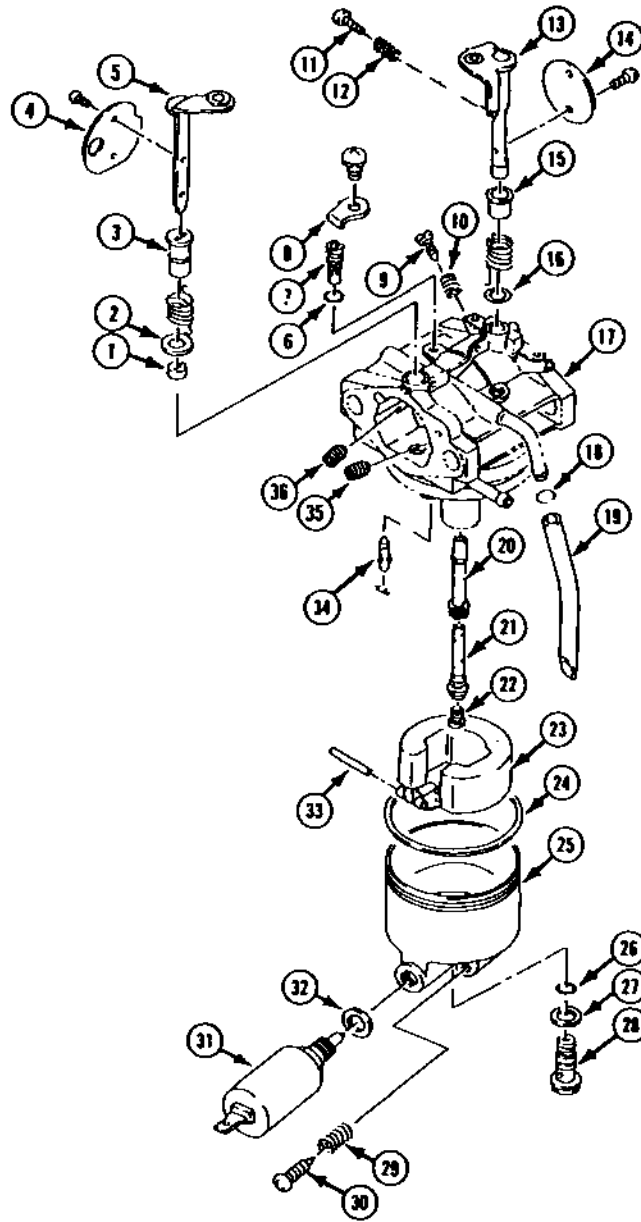
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|---------------|----------------------|--------------------|------------------|
| 1—Collar*     | 11—Pilot Screw       | 20—Seal            | 29—Float Chamber |
| 2—Collar      | 12—Spring            | 21—Carburetor Body | 30—Washer        |
| 3—Seal        | 13—Pilot Jet*        | 22—Clamp           | 31—Plug          |
| 4—Plate*      | 14—Plate             | 23—Hose            | 32—Drain Screw   |
| 5—Choke Plate | 15—Fixed Pilot Jet** | 24—Main Nozzle     | 33—Spring        |
| 6—Choke Shaft | 16—O-Ring            | 25—Bleed Pipe      | 34—Float Pin     |
| 7—Plate**     | 17—Throttle Shaft    | 26—Main Jet        | 35—Needle Valve  |
| 8—Collar**    | 18—Throttle Plate    | 27—Float           | 36—Air Jet       |
| 9—Spring      | 19—Ring              | 28—Gasket          | 37—Pilot Air Jet |
| 10—Idle Screw |                      |                    |                  |

FC290V

\* Used without fixed pilot jet

\*\* Used with fixed pilot jet

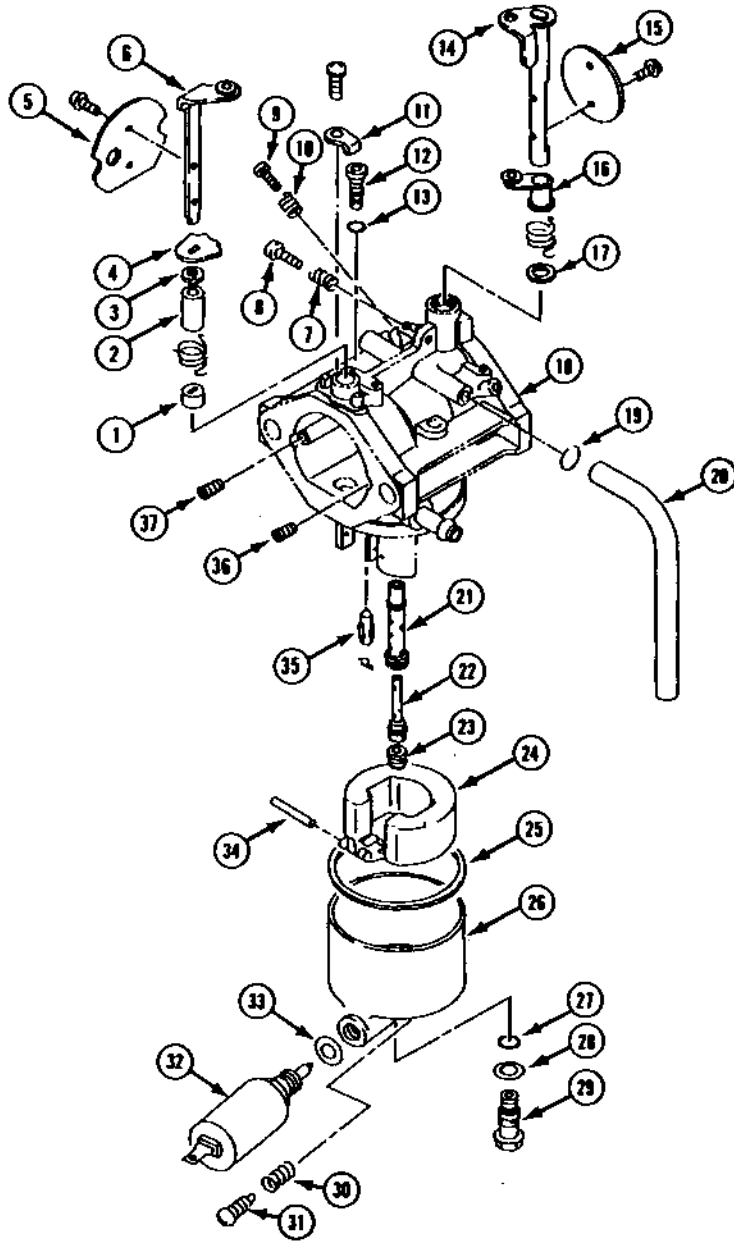
M80008 -JUN-09/JAN91



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|---------------|--------------------|------------------|--------------------------|
| 1—Collar      | 10—Spring          | 19—Hose          | 28—Plug                  |
| 2—Seal        | 11—Idle Screw      | 20—Main Nozzle   | 29—Spring                |
| 3—Collar      | 12—Spring          | 21—Bleed Pipe    | 30—Drain Screw           |
| 4—Choke Plate | 13—Throttle Shaft  | 22—Main Jet      | 31—Fuel Shutoff Solenoid |
| 5—Choke Shaft | 14—Throttle Plate  | 23—Float         | 32—Washer                |
| 6—O-Ring      | 15—Ring            | 24—Gasket        | 33—Float Pin             |
| 7—Pilot Jet   | 16—Seal            | 25—Float Chamber | 34—Needle Valve          |
| 8—Plate       | 17—Carburetor Body | 26—O-Ring        | 35—Air Jet               |
| 9—Pilot Screw | 18—Clamp           | 27—Washer        | 36—Pilot Air Jet         |

FC400V/FC420V

JUN-09/JAN-91  
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M80009



- |               |                    |                  |                          |
|---------------|--------------------|------------------|--------------------------|
| 1—Collar      | 11—Plate           | 20—Hose          | 29—Plug                  |
| 2—Collar      | 12—Pilot Jet       | 21—Main Nozzle   | 30—Spring                |
| 3—Seal        | 13—O-Ring          | 22—Bleed Pipe    | 31—Drain Screw           |
| 4—Plate       | 14—Throttle Shaft  | 23—Main Jet      | 32—Fuel Shutoff Solenoid |
| 5—Choke Plate | 15—Throttle Plate  | 24—Float         | 33—Washer                |
| 6—Choke Shaft | 16—Ring            | 25—Gasket        | 34—Float Pin             |
| 7—Spring      | 17—Seal            | 26—Float Chamber | 35—Needle Valve          |
| 8—Idle Screw  | 18—Carburetor Body | 27—O-Ring        | 36—Air Jet               |
| 9—Pilot Screw | 19—Clamp           | 28—Washer        | 37—Pilot Air Jet         |
| 10—Spring     |                    |                  |                          |

FC540V

MX,4005A1,A11 -19-21OCT92

## SERVICE BREATHER

**NOTE:** Breather is located in cylinder block of FC290V engine, and in cylinder heads of FC400V, FC420V and FC540V engines.

1. FC290V: Remove blower housing. (See Group 10.)

Remove breather cover.

FC400V/FC420V/FC540V: Remove rocker arm cover.

2. Measure air gap between reed valve (A) and valve seat (B) at valve tip. Replace reed valve if gap exceeds specification.

3. Remove breather valve (C).

4. Inspect breather for sticking, binding, cracks or distortion. Replace breather if worn or damaged.

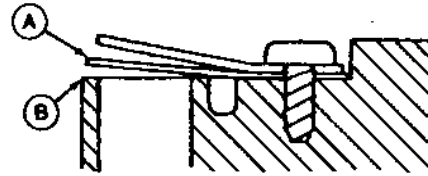
5. Inspect valve seating surface. Surface must be free of nicks or burrs.

**NOTE:** On FC290V engine, check that drain back slot in breather chamber is open.

6. Install breather assembly.

### AIR GAP SPECIFICATIONS (MAX)

FC290V	0.20 mm (0.008 in.)
FC400V/FC420V/FC540V	1—2 mm (0.040—0.080 in.)



FC290V



FC400V/FC420V/FC540V

MX,4005A1,A13 -19-21OCT92

-UN-07SEP88

M51757

-UN-09JAN91

M54498

-UN-09JAN91

M54486

40510

## SERVICE AIR CLEANER

*NOTE: Replace elements yearly or every 25 hours as required.*

1. Remove and disassemble air cleaner.

**IMPORTANT: Do not clean elements with solvent or compressed air.**

2. Wash foam element (A) in detergent and water. Dry element.

3. Put 12—15 drops of engine oil on foam element (A). Squeeze out excess oil.

4. Gently tap paper element (B) to remove dust:  
 —Element is still usable if you can see light through element and paper appears clean.  
 —Install new element if element is oily, dirty, bent, torn, crushed, or obstructed in any way.

5. Inspect body (C), gasket (D), and base (E) for damage. Replace if necessary.

**IMPORTANT: Any time air cleaner base is removed, check for free choke operation during reassembly.**

6. Assemble and install air cleaner.



FC290V



FC400V/FC420V/FC540V

- A—Foam Element
- B—Paper Element
- C—Body
- D—Gasket
- E—Base

-UN-09JAN91  
M54487

-UN-09JAN91  
M80157

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MX,4005A1,A14 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Blower Housing Engine Cover Kit

Decal Kit

Flywheel Screen and Spacer Kit

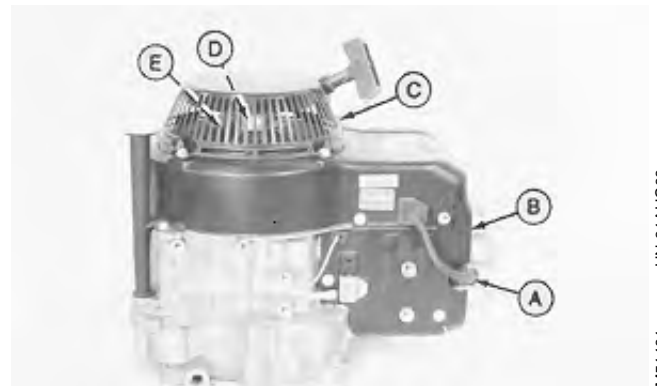
Dipstick Tube Kit

MX,4010A1,A0 -19-21OCT92

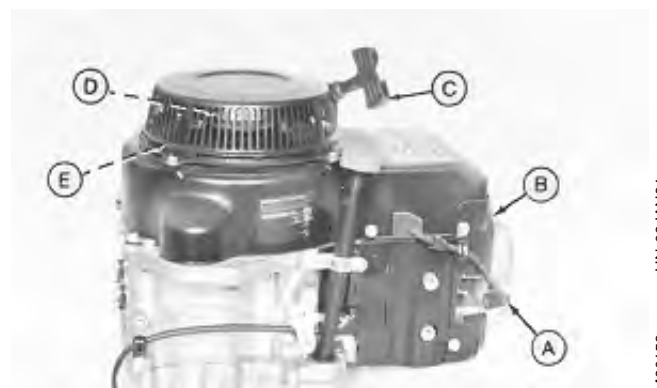
## REMOVE AND INSTALL BLOWER HOUSING—RECOIL START

1. Disconnect spark plug cap (A).
2. Remove air cleaner assembly.
3. FC400V/FC420V: Remove fuel pump. (See Group 05.)
4. Remove cover (B).
5. Remove recoil starter (C), cup (D), screen (E) and spacer(s).
6. Remove blower housing and dipstick tube.
7. Install dipstick tube, blower housing, spacer(s) screen and cup.
8. Adjust flywheel screen. (See this group.)
9. Install recoil starter and cylinder head cover.
10. FC400V/FC420V: Install fuel pump.
11. Install air cleaner assembly.

A—Spark Plug Cap  
B—Cover  
C—Recoil Starter  
D—Starter Cup  
E—Screen



FC290V



FC400V/FC420V

M51481 -UN-31AUG88

M80158 -UN-09JAN91

40  
10  
1

## REMOVE AND INSTALL BLOWER HOUSING—ELECTRIC START

1. Disconnect spark plug cap (A).
2. Remove air cleaner assembly.
3. Remove fuel pump. (See Group 05.)
4. Remove cover (B).

*NOTE: On FC290V, remove dipstick tube after blower housing removal.*

5. Remove dipstick tube (C).
6. Remove protector (D) and screen (E).
7. Remove blower housing (F).
8. Install blower housing, screen and protector.
9. Adjust flywheel screen. (See this group.)
10. Install cylinder head cover and dipstick tube.
11. Install fuel pump.
12. Install air cleaner assembly.



FC290V



FC400V/FC420V/FC540V

- A—Spark Plug Cap
- B—Cylinder Head Cover
- C—Dipstick Tube
- D—Protector
- E—Screen
- F—Blower Housing

MX,4010A1,A2 -19-21OCT92

M80159 -UN-09JAN91

M50026 -UN-31AUG88

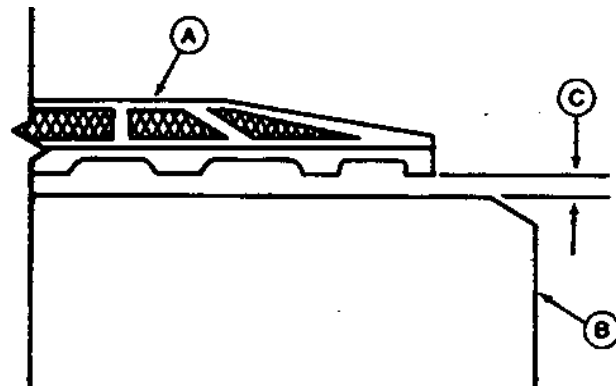
40  
10  
2

## FLYWHEEL SCREEN ADJUSTMENT

Adjust gap (C) between the blades under screen (A) and blower housing (B) to specifications using spacers.

### SPECIFICATIONS

Minimum Gap . . . . . 1.5 mm (0.059 in.)

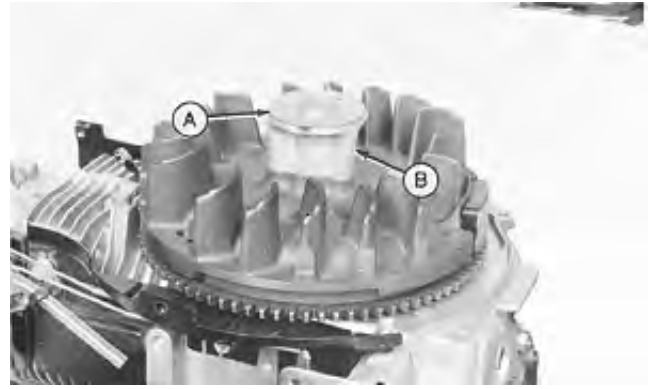


MX,4010A1,A2A -19-21OCT92

M38037 -UN-29AUG88

### REMOVE AND INSTALL FLYWHEEL—FC290V

1. Remove armature with coil. (See Group 25.)
2. Remove shims (A) and bracket (B).
3. Hold flywheel and remove nut and washer.
4. Remove flywheel using a flywheel puller.
5. Install flywheel, washer and nut. Tighten nut to 85 N·m (63 lb-ft).
6. Install bracket and shims.
7. Install armature with coil.



M80160 -UN-09JAN91

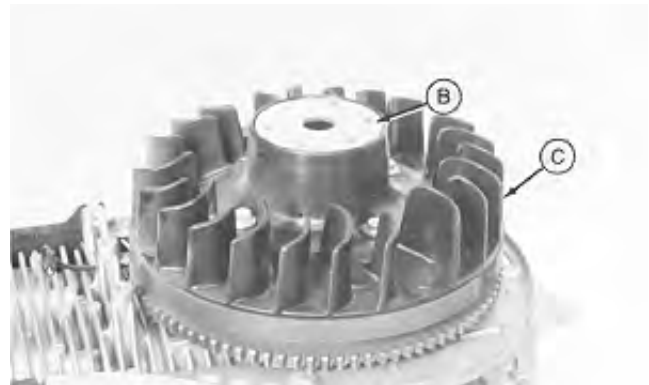
MX,4010A1,A3 -19-21OCT92

### REMOVE AND INSTALL FLYWHEEL—FC400V/FC420V/FC540V

1. Remove armature with coil. (See Group 25.)
2. Remove shims (B).
3. Hold flywheel and remove nut.
4. Remove bracket (A) or fan (C), if equipped.
5. Remove flywheel using a flywheel puller.
6. Install flywheel and bracket, if equipped.
7. Install nut. Tighten nut to specifications.
8. Install fan, if equipped.
9. Install shims.
10. Install armature with coil.



M50051 -UN-31AUG88



M80161 -UN-09JAN91

#### TORQUE SPECIFICATIONS

FC400V/FC420V . . . . .	137 N·m (101 lb-ft)
FC540V . . . . .	172 N·m (127 lb-ft)

MX,4010A1,A3A -19-21OCT92





## SPECIAL OR ESSENTIAL TOOLS

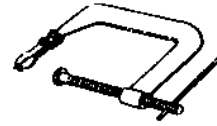
*NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).*

DX,TOOLS -19-05JUN91

Valve Spring Compressor . . . . . JDM70

M51896 -UN-26SEP88

Remove and install valve springs.



MX,JDM70 -19-21OCT92

Valve Guide Driver Tool . . . . . JDG504

Replace valve guide bushings.

MX,JDG504 -19-21OCT92

## OTHER MATERIAL

Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean Cylinder Head
	Valve Guide Cleaner	Clean Valve Guides
	Stanisol (or Kerosene)	Finish Ream Valve Guide
	Prussian Blue Compound	Check Valve Seat Contact

*SCOTCH-BRITE is a trade mark of the 3M Company.*

MX,4015A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Rocker Arm and Shaft Kit

Intake Valve Kit

Exhaust Valve Kit

MX,4015A1,A1 -19-21OCT92

## REMOVE AND INSTALL ROCKER ARM ASSEMBLY

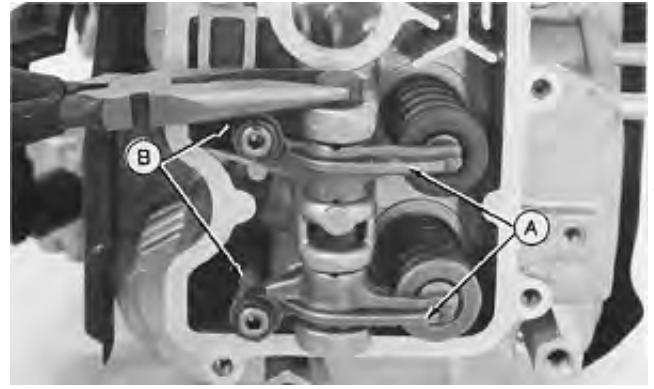
1. Remove rocker arm cover.
2. Turn crankshaft until piston is at highest position in compression stroke.
3. Remove rocker shaft and arms (A).

**IMPORTANT: Mark push rods for reassembly in original locations.**

4. Remove push rods (B).

**IMPORTANT: Align rocker arms over push rods during assembly.**

5. Install push rods and rocker arm assemblies.
6. Check valve clearance. (See this group.)



M50027 -UN-31AUG88

MX,4015A1,A2 -19-21OCT92

## INSPECT ROCKER ARM ASSEMBLY

Measure outside diameter of rocker shaft and inside diameter of rocker arm bearing. Replace if not according to specifications.

### SPECIFICATIONS

Minimum Shaft O.D. . . . . .	12.94 mm (0.509 in.)
Maximum Arm I.D. . . . . .	13.07 mm (0.515 in.)



M50028 -UN-31AUG88



M50029 -UN-31AUG88

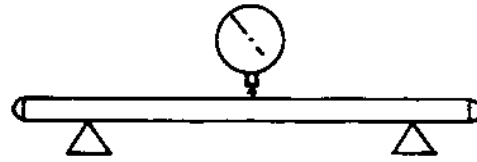
MX,4015A1,A3 -19-21OCT92

40  
15  
2

Inspect push rod for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is greater than specification.

**SPECIFICATION**

Push Rod Bend (MAX) . . . . . 0.30 mm (0.012 in.)



MX,4015A1,A3A -19-21OCT92

M50044 -UN-31AUG88

**REMOVE AND INSTALL CYLINDER HEAD ASSEMBLY**

1. Remove blower housing. (See Group 10.)
2. Remove carburetor. (See Group 05.)
3. Remove rocker arm assembly. (See this group.)
4. Remove shields (A and B).
5. Remove spark plug.
6. Remove cylinder head assembly.
7. Make repairs as necessary. (See procedures in this group.)



FC290V



FC400V/FC420V/FC540V

MX,4015A1,A4 -19-21OCT92

M54488 -UN-09JAN91

M80162 -UN-09JAN91

40  
15  
3

**IMPORTANT: Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.**

8. Install cylinder head assembly with new gasket. Install cap screws and tighten finger tight.

9. Tighten cap screws in sequence shown. Tighten to initial torque specifications.

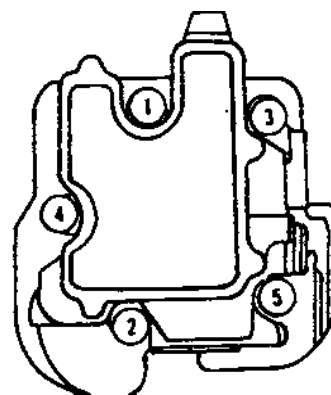
10. On FC290V continue in sequence, 3 N·m (27 lb-in.) at a time, until final torque is as specified.

On FC400V, FC420V and FC540V, continue in sequence, 7 N·m (62 lb-in.) at a time, until final torque is as specified.

11. Install spark plug and tighten to specification.

12. Install shields.

13. Check valve clearance. (See this group.)



M50046 -UN-31AUG88

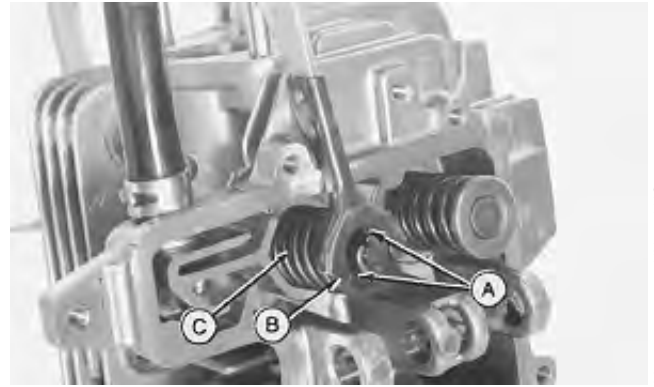
**TORQUE SPECIFICATIONS**

Initial Torque	
FC290V . . . . .	18 N·m (159 lb-in.)
FC400V/FC420V/FC540V . . . . .	32 N·m (24 lb-ft)
Final Torque	
FC290V . . . . .	24 N·m (212 lb-in.)
FC400V/FC420V/FC540V . . . . .	52 N·m (38 lb-ft)
Spark Plug . . . . .	20 N·m (177 lb-in.)

MX,4015A1,A5 -19-21OCT92

## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove cylinder head. (See this group.)
2. Compress intake valve spring with JDM70 Valve Spring Compressor and remove collet halves (A).
3. Remove spring retainer (B) and spring (C).
4. Remove exhaust valve rotator with a magnet.
5. Support exhaust valve from below and press down on spring retainer.
6. Remove retainer, spring and valves.
7. Inspect and replace stem seals as necessary. (See this group.)
8. Inspect and analyze valves. (See Section 100, Group 05.)
9. Inspect springs, valves, guides and seats. (See procedures in this group.)
10. Install valves, springs, and retainers.



M50033 -UN-31AUG88



M50034 -UN-31AUG88

MX,4015A1,A6 -19-21OCT92

## INSPECT AND REPLACE STEM SEALS

Remove valves and springs. (See this group.)

**IMPORTANT: Bottom spring retainer can only be removed with valve stem seal. Removal of retainer or seal damages stem seal. Inspect seal. If seal is not damaged, do not remove it.**

If necessary to replace stem seal, remove with screwdriver.



M50111 -UN-31AUG88

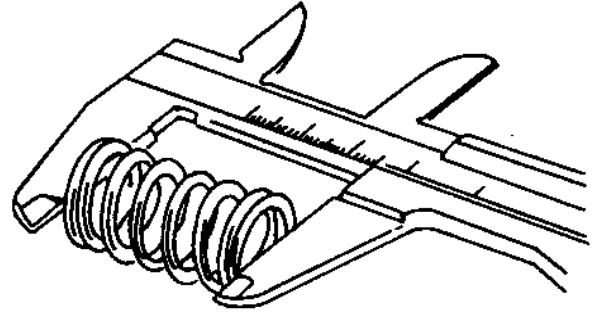
MX,4015A1,A7 -19-21OCT92

## INSPECT SPRINGS

Inspect spring free length. Replace if damaged or if less than specifications.

### FREE LENGTH SPECIFICATIONS (MIN)

FC290V . . . . .	31.00 mm (1.220 in.)
FC400V/FC420V/FC540V . . . . .	37.50 mm (1.476 in.)



M50036  
-UN-31AUG88

MX,4015A1,A8 -19-21OCT92

## INSPECT CYLINDER HEAD

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Check that oil drainback passages are not plugged.
7. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than specifications.



M50032  
-UN-31AUG88

### SPECIFICATIONS

Cylinder Head Distortion (Max) . . . . .	0.05 mm (0.002 in.)
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MX,4015A1,A9 -19-21OCT92

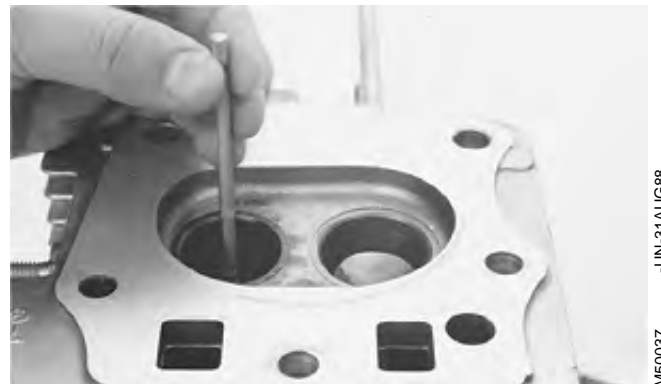
## INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guides or bushings. Replace bushing if inside diameter is greater than specifications. (See this group.)

### SPECIFICATIONS (MAX) I.D.

Intake and Exhaust . . . . .	7.07 mm (0.278 in.)
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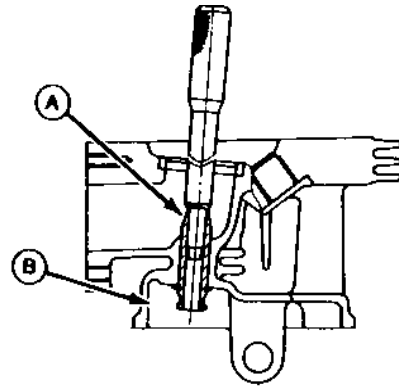
M50037  
-UN-31AUG88

MX,4015A1,A10 -19-21OCT92

40  
15  
6

## REPLACE VALVE GUIDE BUSHINGS

1. Drive valve guide bushing (A) into valve chamber (B) using JDG-504 Valve Guide Driver.

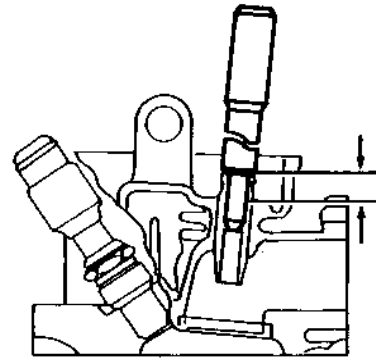


MX,4015A1,A10A -19-21OCT92

M50038 -UN-06APR91

2. Clean carbon deposits from valve guide port.

3. Install new bushing with valve guide driver. Drive in from valve chamber side to an installation depth of 12 mm (0.472 in.) for the FC400V/FC420V and 9.5 mm (0.37 in.) for the FC540V.



MX,4515A1,A9A -19-21OCT92

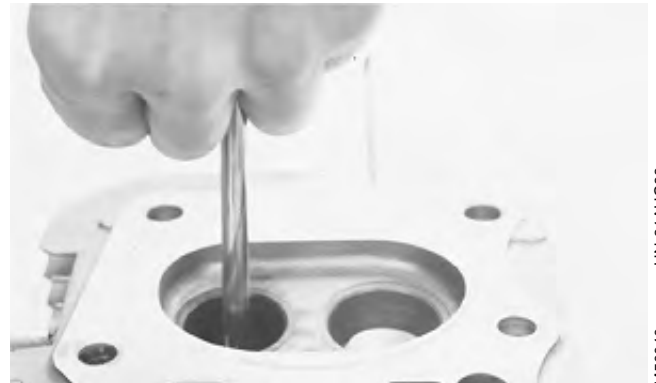
M50039 -UN-15OCT92

4. Finish reaming valve guide bushings with stanisol or kerosene lubricant and a 7 mm valve guide reamer. Turn reamer clockwise.

5. Thoroughly clean valve area before assembly.

### BUSHING FINISHED I.D. SPECIFICATIONS

Valve Guide . . . . . 7—7.02 mm (0.275—0.276 in.)



M98,2015A,A21 -19-21OCT92

M50040 -UN-31AUG88

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15  
7

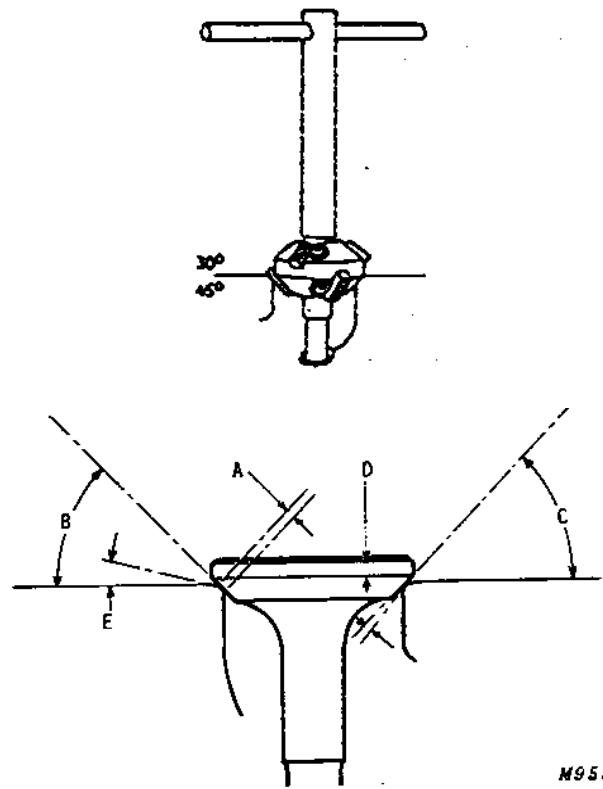


## RECONDITION VALVE SEATS

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.
2. To recondition valve seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).
3. Cut valve seating surface (A) as close as possible to specifications.
4. Lap valves to seats after refacing. (See Section 100, Group 05.)

### SPECIFICATIONS

A—Valve Seating Surface:	
FC290V	0.50—1.10 mm (0.020—0.043 in.)
FC400V/FC420V	1.10—1.46 mm (0.043—0.057 in.)
FC540V	1.10—1.46 mm (0.043—0.057 in.)
B—Valve Seat Angle	45°
C—Valve Face Angle	45°
D—Valve Margin	0.60 mm (0.020 in.)
E—Valve Narrowing Angle	30°



-UN-31AUG88 M51558

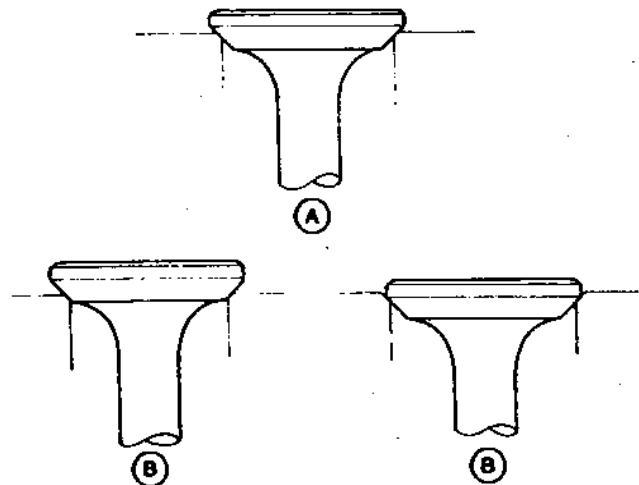
-UN-01SEP88

M9552

MX,4015A1,A11 -19-21OCT92

40  
15  
8

5. Center valve seat on the valve face:  
—(A) shows correct position.  
—(B) shows incorrect.
6. Check seat for good contact using Prussion Blue Compound.



-JUN-07SEP88

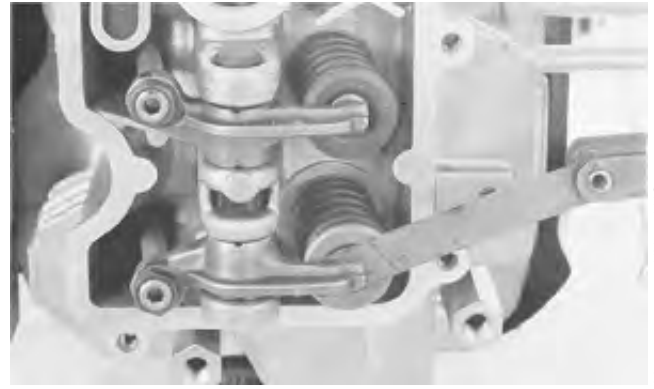
M18615

MX,4015A1,A11A -19-21OCT92

### CHECK VALVE CLEARANCE

*NOTE: Valve repair changes valve clearance. Check valve clearance. Adjust if needed.*

1. Turn crankshaft until piston is at highest position in compression stroke.
2. Measure clearance.



M50048  
-JUN-31AUG88

M98,2015A,AJ -19-26MAR86

3. If necessary, adjust clearance to specifications.

#### SPECIFICATIONS

Valve Clearance . . . . . 0.15 mm (0.006 in.)



M50049  
-JUN-31AUG88

MX,4015A1,A12 -19-21OCT92



### OTHER MATERIAL

Number	Name	Use
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,4020A1,A1 -19-21OCT92

### SERVICE PARTS KITS

The following kits are available through your parts catalogue.

Camshaft and Tappet Kt

Camshaft Axial Play Shim Kit—FC290V and FC540V

Piston Ring Kit

Oversized Pistons

Oversized Piston Rings

Undersized Connecting Rod

Crankshaft End Play Shim Kit

Cylinder Block

Overhaul Gasket Kit

Short Block Kit

Oil Slinger Kit—FC290V

Oil Pump Kit—FC400V, FC420V and FC540V

Governor and Shaft Kit

MX,4020A1,A2 -19-21OCT92

40  
20  
1

## REMOVE AND INSTALL CRANKCASE COVER

**NOTE:** Approximate crankcase oil capacity is:

FC290V .....	1.0L (2.11 pt)
FC400V/FC420V	
Without Filter .....	1.3L (2.74 pt)
With Filter .....	1.5L (3.17 pt)
FC540V	
Without Filter .....	1.6L (3.38 pt)
With Filter .....	1.8L (3.80 pt)

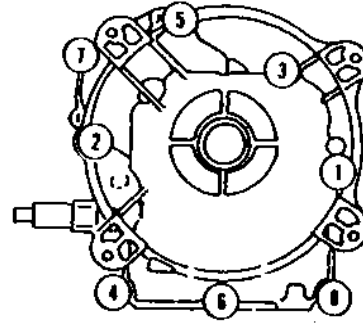
1. Drain crankcase.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

**NOTE:** Do not force cover. Gears must mesh for proper positioning.

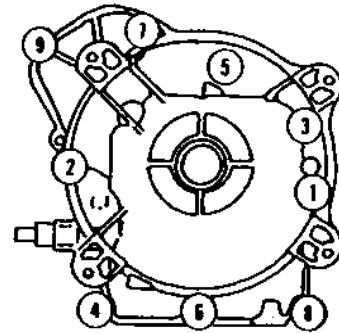
4. Install gasket and cover. Tighten cap screws using the sequence shown.

### TORQUE SPECIFICATIONS

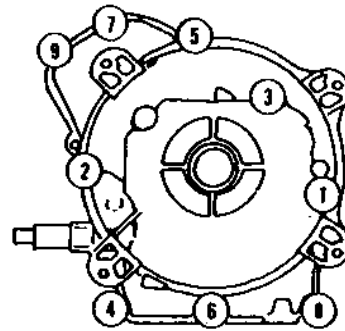
Mounting Cap Screws	
FC290V .....	20 N·m (177 lb-in.)
FC400V/FC420V/FC540V .....	26 N·m (230 lb-in.)
Oil Drain Plug .....	23 N·m (200 lb-in.)



FC290V



FC400V/FC420V



FC540V

MX,4020A1,A3 -19-21OCT92

M54489 -UN-09JAN91

M54490 -UN-09JAN91

M80237 -UN-06APR91

## REMOVE AND INSTALL CAMSHAFT

1. Remove crankcase cover. (See this group.)

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

2. Rotate crankshaft until timing marks (A) align.

3. Remove camshaft (B).

4. Inspect camshaft. (See this group.)

5. Apply clean engine oil to camshaft lobes and journals.

6. Align timing marks and install camshaft.

7. On FC540V (S/N —014454) and FC290V engines, adjust camshaft axial play. (See this group.)

8. Install crankcase cover.



M50056 -UN-31AUG88

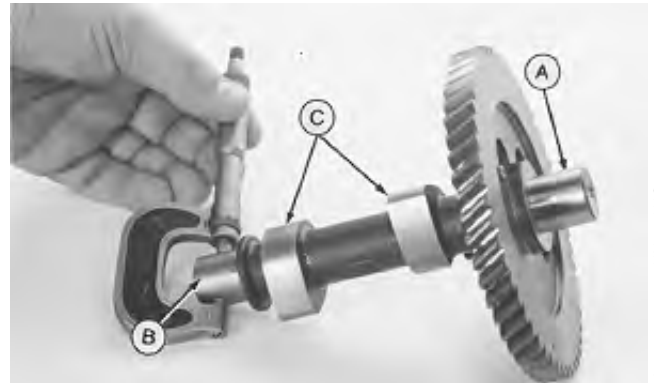
MX,4020A1,A4 -19-21OCT92

## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

*NOTE: Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.*

Measure PTO side journal (A), flywheel side journal (B), and lobes (C). Replace camshaft and tappets if less than specifications.



M50057 -UN-31AUG88

### SPECIFICATIONS (MIN)

	PTO Side Journal	Flywheel Side Journal	Cam Lobes
FC290V	13.92 mm (0.548 in.)	15.92 mm (0.627 in.)	27.08 mm (1.066 in.)
FC400V/ FC420V	20.91 mm (0.823 in.)	19.91 mm (0.784 in.)	36.75 mm (1.447 in.)
FC540V	20.91 mm (0.823 in.)	20.91 mm (0.823 in.)	37.10 mm (1.461 in.)

MX,4020A1,A5 -19-21OCT92

## INSPECT CAMSHAFT PLAIN BEARINGS

1. Remove camshaft. (See this group.)
2. Measure camshaft bearings in cylinder block and crankcase cover. Replace block or cover if diameter is greater than specification.
3. Install camshaft.

### SPECIFICATIONS (MAX)

	Cylinder Block Bearing	Crankcase Cover Bearing
FC290V	16.06 mm (0.632 in.)	14.05 mm (0.553 in.)
FC400V/ FC420V	20.08 mm (0.790 in.)	21.08 mm (0.830 in.)
FC540V	21.08 mm (0.830 in.)	21.08 mm (0.830 in.)



Cylinder Block



Crankcase Cover

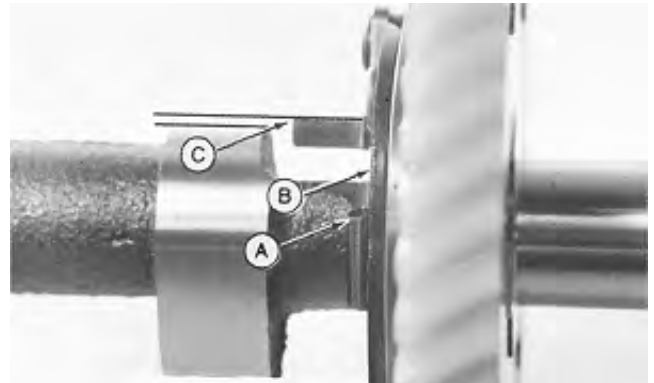
MX,4020A1,A6 -19-21OCT92

M54492 -UN-09JAN91

M54491 -UN-09JAN91

## INSPECT AUTOMATIC COMPRESSION RELEASE (A.C.R.)

1. Remove camshaft. (See this group.)
2. Inspect automatic compression release (A.C.R.) for damage.
3. Inspect spring (A). Replace if worn or damaged.
4. Move weight(s) (B) by hand to check for proper operation.
5. On FC400V, FC420V and FC540V engines, check that tab (C) sits slightly above cam lobe when weights are released. Tab should drop below cam when weights are operated.



MX,4020A1,A7 -19-21OCT92

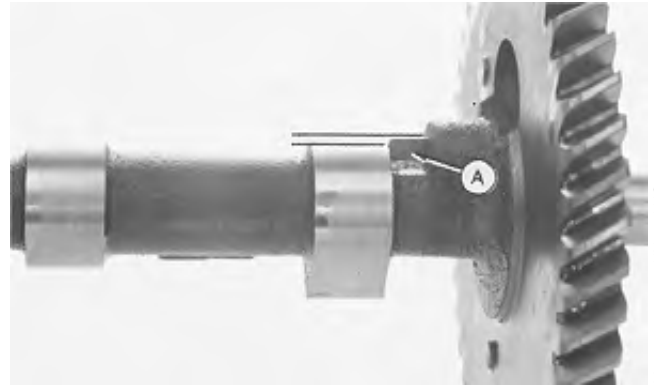
M54493 -UN-09JAN91

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20  
4

6. On FC290V engines, check that tab (A) sits just above cam lobe when weight is released. Tab should rotate 90° and drop below cam lobe when weight is operated.

7. Replace camshaft if it does not operate properly.

8. Install camshaft.



MX,4020A1,A8 -19-21OCT92

M50058  
-UN-31AUG88

## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)

*NOTE: Mark tappets so they can be installed in their original bores during assembly.*

2. Remove tappets (A).

3. Inspect tappets for wear or damage. Replace if necessary.

4. Apply clean engine oil to tappets and bores.

5. Install tappets in original bores.

6. Install camshaft.



MX,4020A1,A9 -19-21OCT92

M38092  
-JUN-29AUG88

40  
20

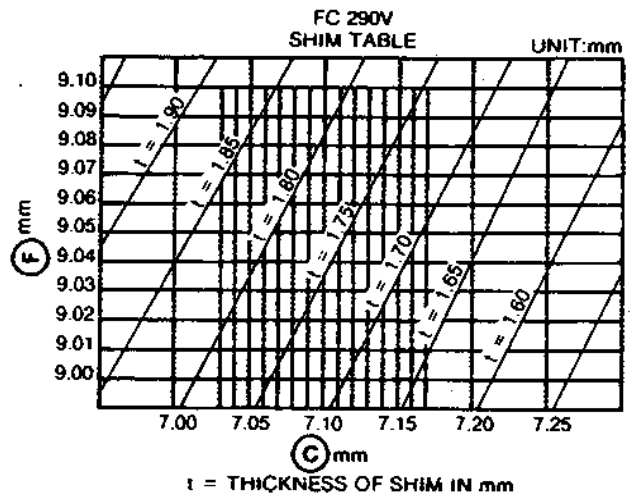
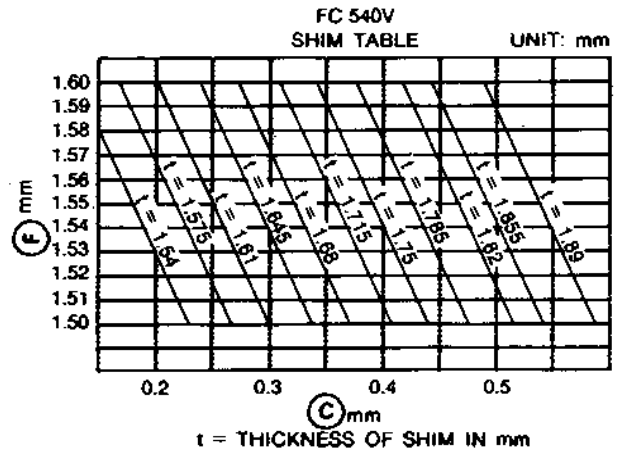
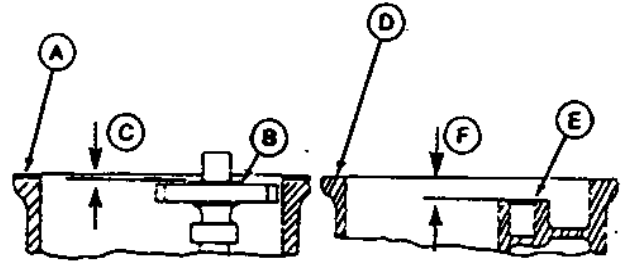


## ADJUST CAMSHAFT AXIAL PLAY—FC290V AND FC540V

1. With gasket (A) installed on crankcase, measure from gasket surface to cam gear timing flange (B). Record this measurement (C).
2. Measure from crankcase cover mounting face (D) to camshaft bearing end (E). Record this measurement (F).
3. Locate measurements on appropriate table. Follow lines to where recorded measurements intersect. Choose the next smaller shim from the table.

Install shim to cam gear timing flange (B).

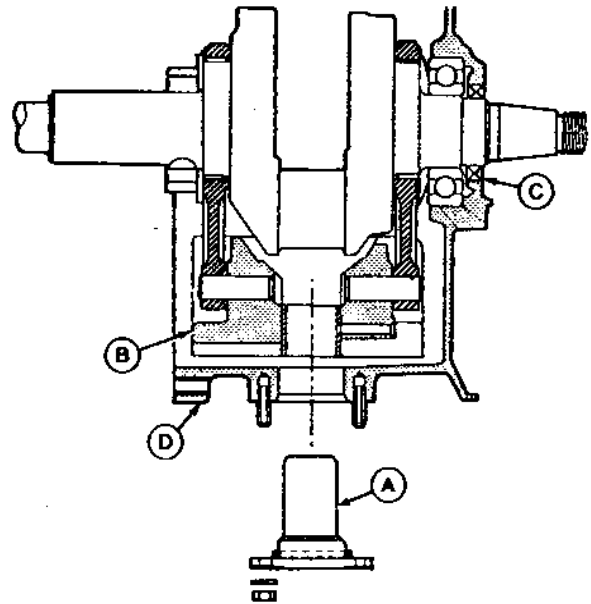
- A—Gasket
- B—Timing Flange
- C—Measurement
- D—Cover Mounting Face
- E—Bearing End
- F—Measurement



MX.4020A1.A10 -19-21OCT92

## REMOVE AND INSTALL RECIPROCATING BALANCER

1. Remove flywheel. (See Group 10.)
2. Remove camshaft. (See this group.)
3. Remove piston. (See this group.)
4. Remove support shaft (A).
5. Remove crankshaft with balancer assembly (B).
6. Make repairs as necessary. (See procedures in this group.)
7. Inspect oil seals. (See this group.)
8. Cover keyway on flywheel end of crankshaft with tape to prevent damage to seal (C) when installing assembly.
9. Put light film of oil on crankshaft bearing surfaces.
10. Install balancer assembly with crankshaft into crankcase (D).
11. Tighten balancer nut to 7 N·m (65 lb-in.).
12. Align balancer weight in crankcase and install support shaft.
13. Adjust crankshaft end play. (See this group.)



A—Support Shaft  
 B—Balancer Assembly  
 C—Seal  
 D—Crankcase

M51758 -JUN-07SEP88

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MX,4020A1,A11 -19-21OCT92

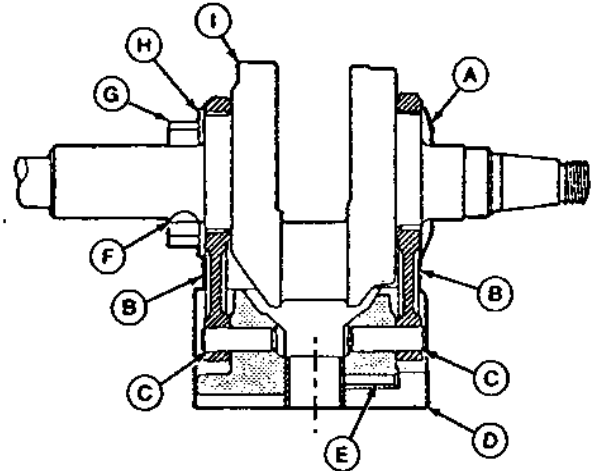
## DISASSEMBLE AND ASSEMBLE RECIPROCATING BALANCER

*NOTE: On FC290V engine, spacer (H) is governor drive gear.*

1. Remove collar (A), gear (G) key (F) and gear or spacer (H).
2. Remove rods (B) and crankshaft (I).
3. Inspect crankshaft. (See this group.)
4. Inspect balancer assembly. (See this group.)
5. Put a light film of oil on bearing surfaces.

*NOTE: Oil grooves of link rods (B) must face away from crankwebs.*

6. Install balance weight to crankshaft with oil hole (E), if equipped, facing flywheel side.
7. Install collar (A).
8. Install gear or spacer (H) with chamfered face toward link rod.
9. Install key and crank gear.



- A—Collar
- B—Link Rod
- C—Wrist Pin
- D—Balance Weight
- E—Oil Hole
- F—Woodruff Key
- G—Crank Gear
- H—Spacer or Gear
- I—Crankshaft

-JUN-07SEP88

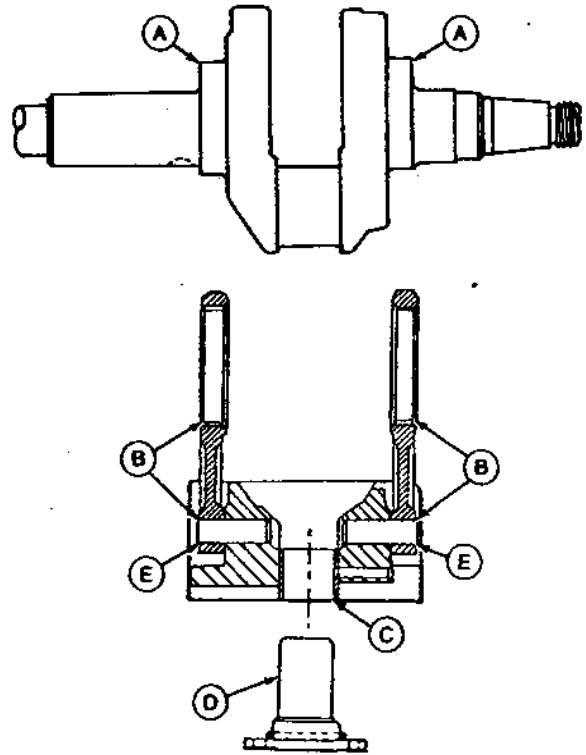
M51759

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MX,4020A1,A12 -19-21OCT92

## INSPECT BALANCER ASSEMBLY

1. Clean and inspect all parts for wear or damage. Replace parts, if necessary.
  2. Measure crankshaft journals (A). Replace crankshaft if diameter is less than specifications.
  3. Measure inside diameter of bearings (B). Replace link rod if small end is greater than specifications. Replace bushing if large end is greater than specifications. (See this group.)
- NOTE: FC290V engine is not equipped with a replaceable support shaft bushing. If bearing is worn, replace weight.*
4. Measure inside diameter of support shaft bearing (C). If bearing is greater than specifications, replace bushing, if equipped. (See this group.)
  5. Measure support shaft diameter (D). Replace shaft if diameter is less than specification.
  6. Inspect wrist pins (E) for any damage. If necessary, replace weight.



### DIAMETER SPECIFICATIONS

Link Rod Journal O.D. (MIN)	
FC290V	46.86 mm (1.845 in.)
FC400V/FC420V	53.95 mm (2.124 in.)
FC540V	57.94 mm (2.281 in.)
Link Rod Small End I.D. (MAX)	
All	12.06 mm (0.475 in.)
Link Rod Large End I.D. (MAX)	
FC290V	47.12 mm (1.855 in.)
FC400V/FC420V	54.12 mm (2.131 in.)
FC540V	58.15 mm (2.289 in.)
Support Shaft O.D. (MIN)	
All	25.93 mm (1.021 in.)
Support Shaft Bearing I.D. (MAX)	
All	26.10 mm (1.027 in.)

A—Link Rod Journals  
 B—Link Rod Bearings  
 C—Shaft Bearing  
 D—Support Shaft  
 E—Wrist Pins

MX,4020A1,A13 -19-21OCT92

M51760 -JUN-07SEP88

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## REPLACE BALANCER BUSHINGS

**NOTE:** Remove bushings with a bearing driver or a press.

Remove link rod bushings with oil groove side facing up.

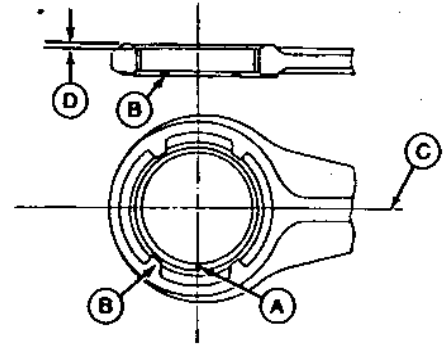
1. Remove bushings.
2. Install link rod bushings with seam (A) at a 90° angle to centerline (C).

**NOTE:** On FC400V, FC420V and FC540V engines, install bushing from opposite side of oil grooves (B).

3. Install bushing below surface to specifications.

### SPECIFICATIONS

Bushing Depth (D) . . . . . 1.00 mm (0.040 in.)



A—Bushing Seam  
B—Oil Grooves  
C—Link Rod Centerline  
D—Measurement

M51681 -UN-31AUG88

MX,4020A1,A14 -19-21OCT92

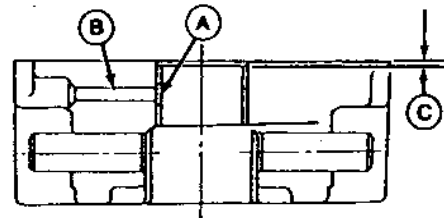
FC400V, FC420V and FC540V:

4. Align oil hole (A) in bushing and oil passage (B) in weight. Install bushing.

5. Install bushing below surface to specifications.

### SPECIFICATIONS

Bushing Depth (C) . . . . . 0.50 mm (0.020 in.)



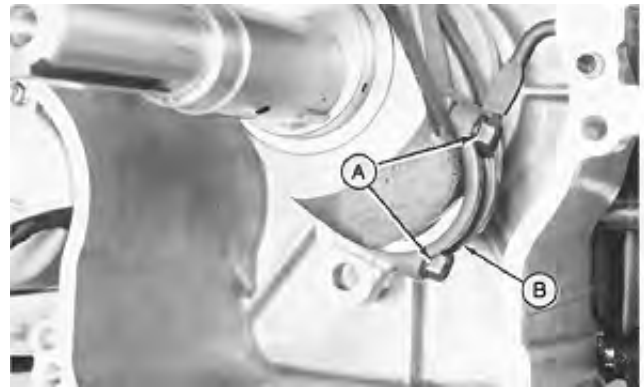
M51725 -UN-07SEP88

M98,2030A,A7 -19-21OCT92

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## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove crankcase cover. (See this group.)
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
4. Remove cap screws (A) and connecting rod cap (B).
5. Push piston and connecting rod from cylinder bore.
6. Make repairs as necessary. (See procedures in this group.)



M54494  
-UN-09JAN91

MX,4020A1,A15 -19-21OCT92

7. Deglaze cylinder bore. (See Section 100, Group 15.)
8. Stagger piston ring end gaps 180° apart, but do not align with oil ring side rail end gaps.
9. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
10. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
11. Install piston assembly in cylinder bore with engraved match mark/arrow on piston head facing flywheel side of engine.
12. Install connecting rod cap and cap screws. Tighten cap screws to specifications.



M50074  
-UN-31AUG88

### TORQUE SPECIFICATIONS

All . . . . . 20 N·m (177 lb-in.)

MX,4020A1,A16 -19-21OCT92

## DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD

1. Remove circlip, piston pin (A) and connecting rod (B).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



MX,4020A1,A17 -19-21OCT92

M50063 -UN-31AUG88

4. Align arrow match mark (A) on piston head with MADE IN JAPAN (B) on connecting rod, or if piston is marked with R and L align the R on the piston with the Japanese characters on the connecting rod.
5. Install piston pin and circlip.



MX,4020A1,A18 -19-21OCT92

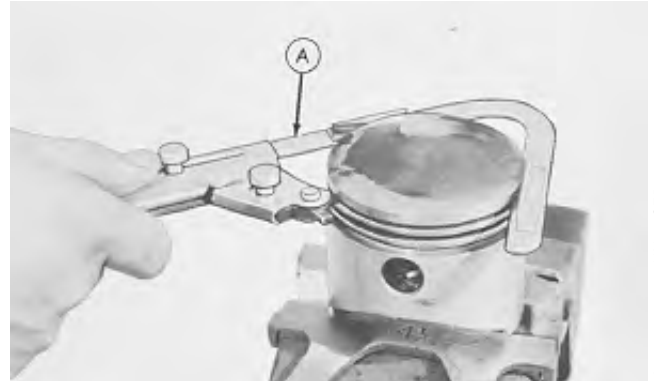
M38111 -UN-29AUG88

## INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,4020A1,A19 -19-21OCT92

M29946 -UN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: Inspect clearance visually. Replace piston if clearance appears excessive.*

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.



M38102 -UN-29AUG88

**CLEARANCE SPECIFICATION (MAX)**

	<b>Top Ring</b>	<b>Second Ring</b>	<b>Oil Control Ring</b>
FC290V	0.16 mm (0.006 in.)	0.14 mm (0.005 in.)	0.19 mm (0.007 in.)
FC400V/ FC420V/ FC540V	0.17 mm (0.007 in.)	0.15 mm (0.006 in.)	0.20 mm (0.008 in.)

MX,4020A1,A20 -19-21OCT92

8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston pin bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

	<b>Piston Pin O.D. (MIN)</b>	<b>Piston Bore I.D. (MAX)</b>
FC290V	18.98 mm (0.747 in.)	19.03 mm (0.749 in.)
FC400V/ FC420V/ FC540V	21.98 mm (0.865 in.)	22.04 mm (0.868 in.)



M50064 -UN-31AUG88

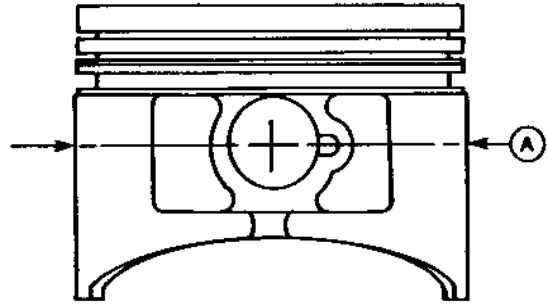


M50065 -UN-31AUG88

MX,4020A1,A21 -19-21OCT92



10. Measure piston O.D. (A) perpendicular to piston pin bore.
11. Measure cylinder bore. (See Inspect Block in this group.)
12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.
13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)



M80398 -UN-06APR91

**SPECIFICATIONS**

**Piston O.D. (A)**

FC290V	77.85—77.87 mm (3.0649—3.0657 in.)
FC400V	86.83—86.864 mm (3.4185—3.4192 in.)
FC420V	88.83—88.85 mm (3.4885—3.498 in.)
FC540V	88.83—88.864 mm (3.4885—3.4984 in.)

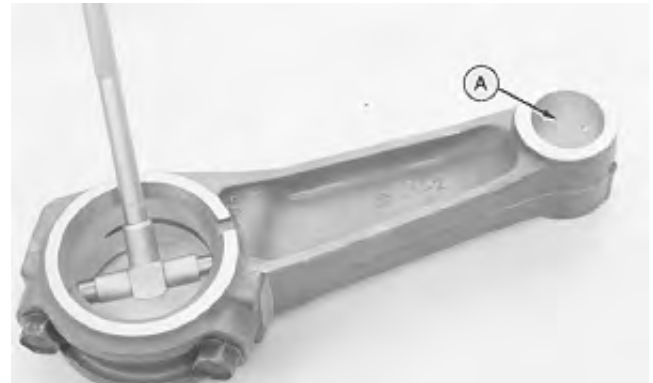
**Piston-to-Cylinder Bore Clearance**

FC290V	0.142 mm (0.0056 in.)
FC400V	0.13—0.151 mm (0.005—0.0059 in.)
FC420V	0.13—0.151 mm (0.005—0.0059 in.)
FC540V	0.110—0.151 mm (0.0043—0.0059 in.)

MX,4020A1,A21A -19-21OCT92

**INSPECT CONNECTING ROD**

1. Clean and inspect rod. Replace if scored.
2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
3. Install connecting rod cap. Tighten to 20 N·m (177 lb-in.).
4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



M50066 -UN-31AUG88

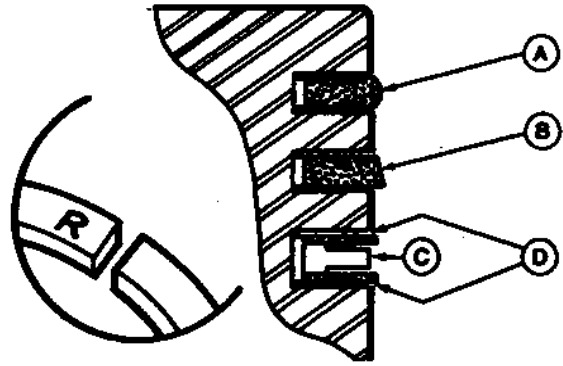
**BEARING I.D. SPECIFICATIONS (MAX)**

	<b>Crankshaft Bearing</b>	<b>Piston Bearing</b>
FC290V	35.57 mm (1.400 in.)	19.06 mm (0.750 in.)
FC400V/ FC420V/ FC540V	41.07 mm (1.617 in.)	22.06 mm (0.868 in.)

MX,4020A1,A22 -19-21OCT92

## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)
4. Install top ring (A) and second ring (B) with R or NPR mark facing up. Rings should turn freely in grooves.
5. Oil ring is an assembly. Install spacer (C), then side rails (D). Put side rail end gaps 180° apart.



A—Top Ring  
B—Second Ring  
C—Spacer  
D—Side Rails

MX,4020A1,A23 -19-21OCT92

M38074 -UN-29AUG88

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.



### END GAP SPECIFICATIONS

Minimum End Gap	0.18 mm (0.007 in.)
Maximum End Gap	
Compression Rings	
FC290V	0.71 mm (0.028 in.)
FC400V/FC420V/FC540V	0.90 mm (0.035 in.)
Oil Ring Side Rails	
FC290V	1.20 mm (0.047 in.)
FC400V/FC420V/FC540V	1.30 mm (0.051 in.)

MX,4020A1,A24 -19-21OCT92

M50073 -UN-31AUG88

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## REMOVE, INSPECT AND INSTALL CRANKSHAFT

1. Remove camshaft. (See this group.)
2. Remove piston and connecting rod. (See this group.)
3. Remove balancer. (See this group.)
4. Remove crankshaft.

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

5. Check crankshaft alignment (T.I.R.). (See this group.)
6. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
7. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
8. Measure crankshaft main bearing journals and connecting rod journal. Replace crankshaft if measurements are less than specifications.



-UN-09JAN91  
M54495

### JOURNAL SPECIFICATIONS (MIN)

	Main Bearing Journal		Connecting Rod Journal
	PTO Side	Flywheel Side	
FC290V	29.92 mm (1.178 in.)	—	35.43 mm (1.395 in.)
FC400V/ FC420V	34.92 mm (1.376 in.)	—	40.93 mm (1.611 in.)
FC540V	37.90 mm (1.492 in.)	—	40.93 mm (1.611 in.)

MX,4020A1,A25 -19-21OCT92

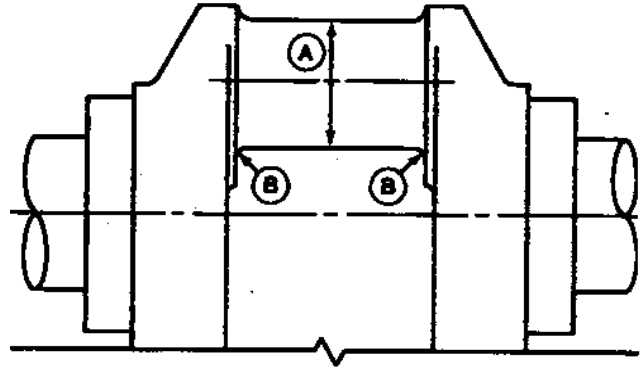
*NOTE: An under-sized connecting rod is available through the parts catalog, if necessary.*

9. Connecting rod journal (A) can be resized to accept under-sized rod. Have grinding done by a reliable repair shop. Before sending crankshaft for grinding, inspect journal radii (B) for cracks.

10. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.

11. Put a light film of oil on crankshaft bearing surfaces.

12. Pack grease in oil seals and install crankshaft.



M38036 -UN-29AUG88

MX,4020A1,A25A -19-21OCT92

### INSPECT CRANKSHAFT PLAIN BEARING

*NOTE: FC290V crankcase cover is fitted with a replaceable shell.*

1. Remove crankshaft. (See this group.)
2. Measure crankshaft bearing in crankcase cover. Replace cover or shell, if equipped, if diameter is greater than specifications. (See this group.)
3. Install crankshaft.



M50072 -UN-31AUG88

#### BEARING I.D. SPECIFICATIONS (MAX)

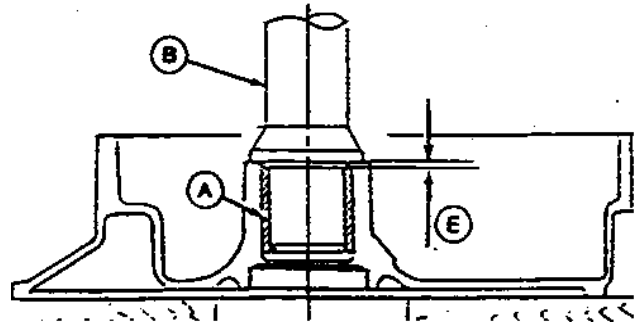
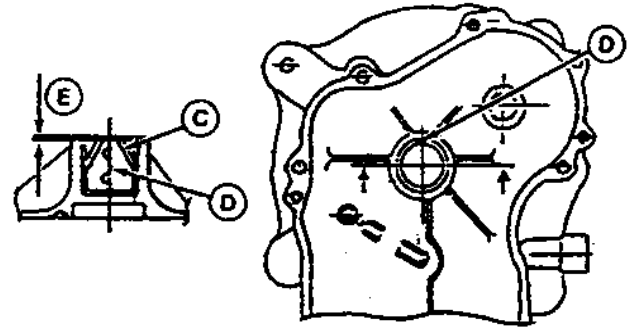
FC290V . . . . .	30.13 mm (1.186 in.)
FC400V/FC420V . . . . .	35.07 mm (1.381 in.)
FC540V . . . . .	38.06 mm (1.498 in.)

MX,4020A1,A26 -19-21OCT92

## REPLACE CRANKSHAFT BEARING SHELL—FC290V

1. Remove oil seal. (See Inspect Oil Seals in this group.)
2. Drive old bearing (A) from cover using an appropriate bushing tool (B) and an arbor press.
3. Align new bearing with oil grooves (C) facing out of cover and with seam (D) facing top of cover
4. Install new bearing to depth (E) 1 mm (0.039 in.) below flange surface.
5. Install new oil seal.

A—Bearing Shell  
 B—Bushing Tool  
 C—Oil Grooves  
 D—Seam  
 E—Installation Depth



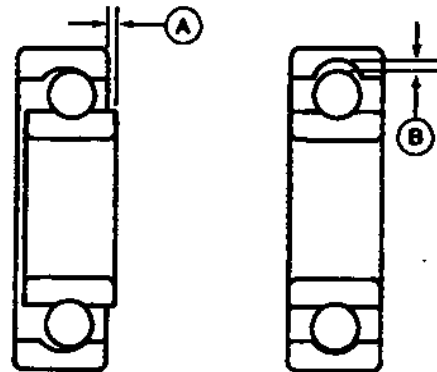
MX,4020A1,A27 -19-21OCT92

M51524 -UN-31AUG88

M51525 -UN-31AUG88

## INSPECT CRANKSHAFT BALL BEARING

1. Remove flywheel and oil seal. (See Inspect Oil Seals in this group.)
2. Remove crankshaft bearing using a bearing, bushing and seal driver set.
3. Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
4. Spin the bearing by hand and check for axial (A) and radial (B) free play.
5. Replace the bearing if it is noisy or has too much play.
6. Install bearing flush to inside of crankcase using a bearing, bushing and seal driver set.
7. Install oil seal.



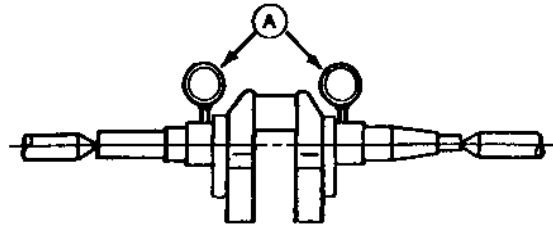
MX,4020A1,A28 -19-21OCT92

M38073 -UN-29AUG88

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### CHECK CRANKSHAFT ALIGNMENT (TIR)

Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.



**SPECIFICATIONS**

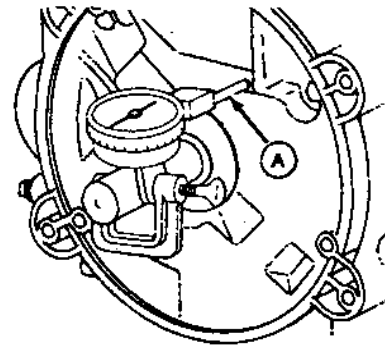
Maximum TIR . . . . . 0.05 mm (0.002 in.)

MX,4020A1,A29 -19-21OCT92

M80432 -UN-08MAY91

### MEASURE CRANKSHAFT END PLAY

1. Measure end play using dial indicator (A). Record this measurement.
2. Move crankshaft in and out. Remove crankcase cover and adjust end play if not within specifications. (See this group.)



**SPECIFICATIONS**

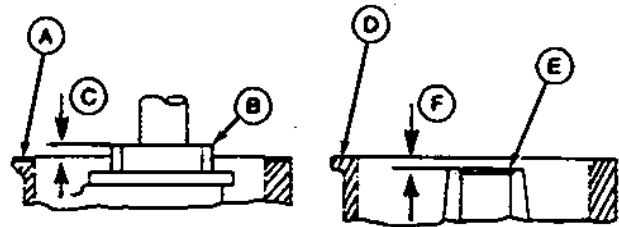
End Play . . . . . 0.09—0.22 mm (0.004—0.009 in.)

MX,4020A1,A30 -19-21OCT92

M30048 -UN-06SEP88

### ADJUST CRANKSHAFT END PLAY

1. With gasket (A) installed on crankcase, measure from gasket surface to crankshaft gear surface (B). Record measurement (C).
2. Measure from crankcase cover mounting face (D) to PTO bearing end (E). Record measurement (F).



- A—Gasket
- B—Crank Gear Surface
- C—Measurement
- D—Crankcase Cover Mounting Face
- E—PTO Bearing End
- F—Measurement

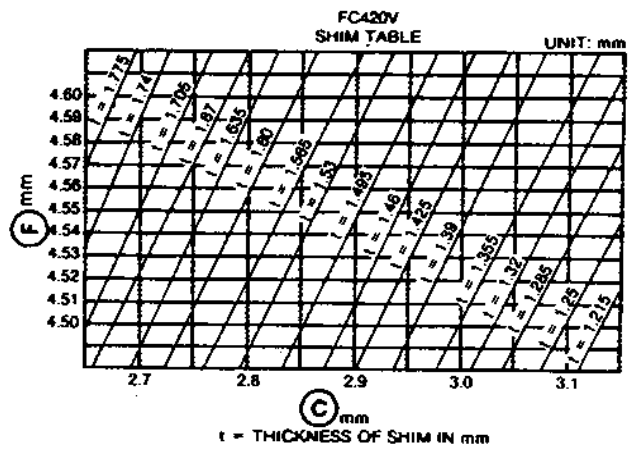
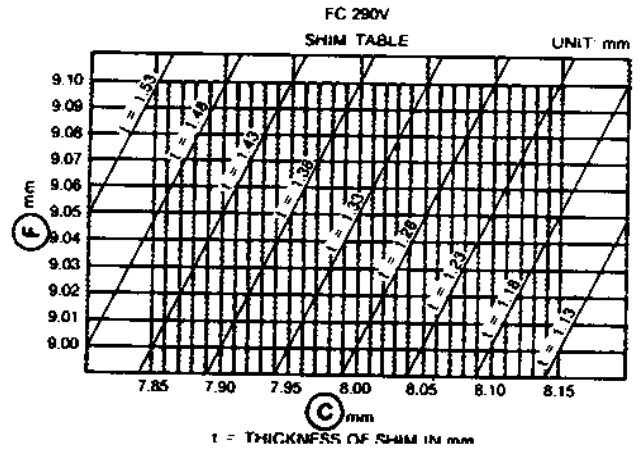
MX,4020A1,A31 -19-21OCT92

M51545 -UN-31AUG88

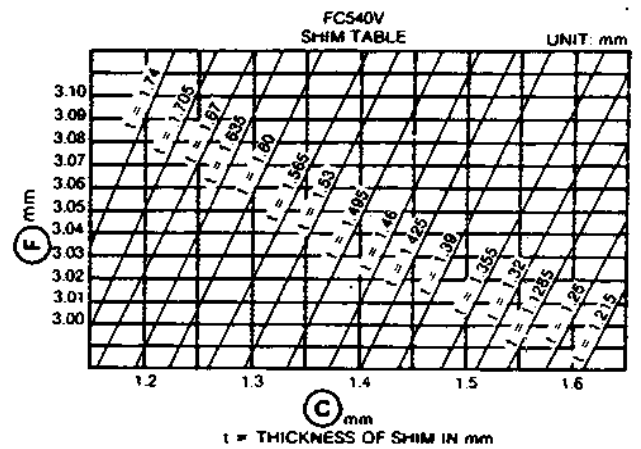
3. Locate measurements on appropriate table. Follow lines to where recorded measurements intersect. Choose the next smaller shim from the table.

4. Install shim on PTO shaft.

5. Install crankcase cover. (See this group.)



Also FC400V



MX.4020A1,A31A -19-21OCT92

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M51548 -19-14MAR89

M51548 -19-14MAR89

M51546 -19-14MAR89

## INSPECT OIL SEALS

*NOTE: Pack lithium base grease in new or used seals.*

1. Remove flywheel. (See Group 10.)
2. Inspect oil seals (A and B) at flywheel end and PTO end. Replace if necessary.
3. Remove crankshaft. (See this group.)
4. Remove worn or damaged seals with a screwdriver.
5. Install seals with lip to inside of engine using a bearing, bushing and seal driver set. Press seals in until flush with hub.

On FC540V engine, press in seal on PTO side to specification, below crankcase cover flange surface.

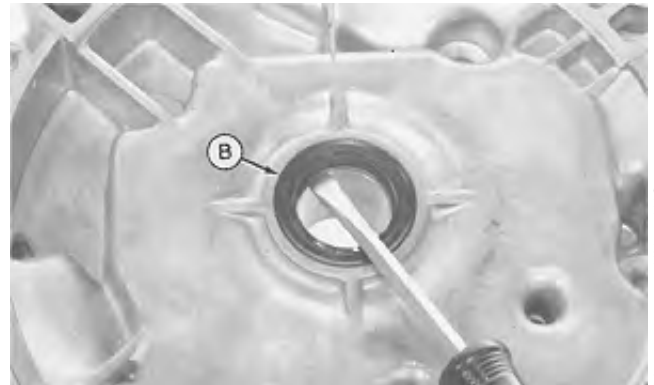
6. Install crankshaft.

### SPECIFICATIONS

FC540V Seal Depth . . . . . 0.50 mm (0.020 in.)



Flywheel End



PTO End

MX,4020A1,A32 -19-21OCT92

M38104 -UN-29AUG88

M50071 -UN-31AUG88

## INSPECT CYLINDER BLOCK

1. Remove crankshaft.
2. Clean and check block for cracks.
3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
4. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

MX,4020A1,A33 -19-21OCT92

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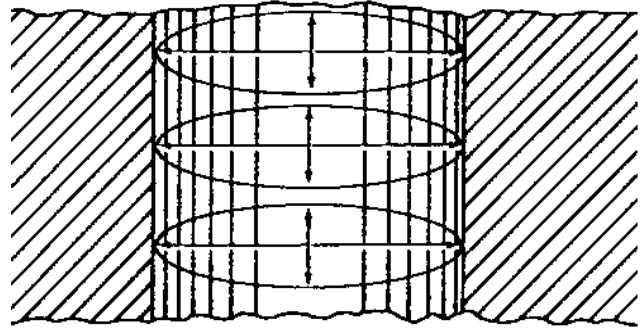
*NOTE: A bare block is available for service.*

5. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

6. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

*NOTE: If cylinder is rebored, oversize piston and rings must be installed.*

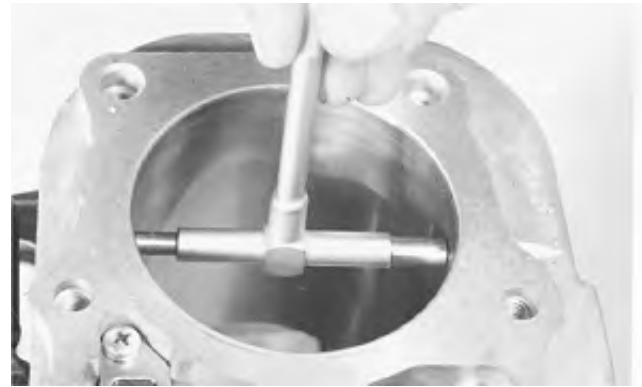
7. Install crankshaft.



M51745 -UN-23FEB89

**CYLINDER BORE SPECIFICATIONS**

	<b>Standard</b>	<b>Wear Limit</b>
FC290V	77.98—78.00 mm (3.070—3.071 in.)	78.07 mm (3.074 in.)
FC400V	86.98—87.00 mm (3.424—3.425 in.)	87.08 mm (3.428 in.)
FC420V	88.98—89.00 mm (3.503—3.504 in.)	89.08 mm (3.507 in.)
FC540V	88.98—89.00 mm (3.503—3.504 in.)	89.08 mm (3.507 in.)



M54496 -UN-09JAN91

MX,4020A1,A34 -19-21OCT92

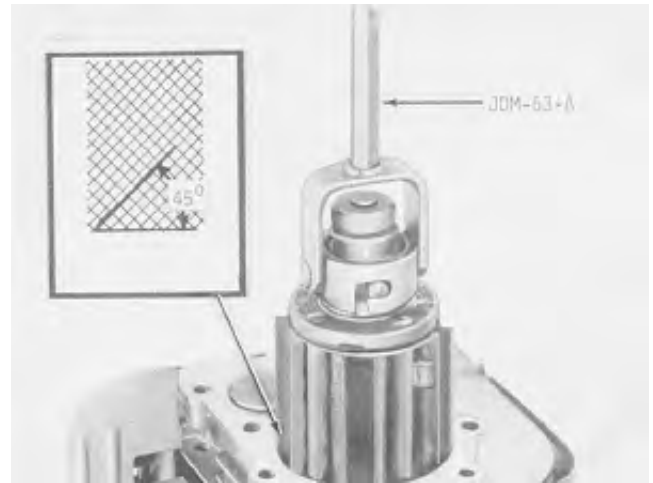
## REBORE CYLINDER BLOCK

*NOTE: The cylinder block can be rebored to use 0.25, 0.50 or 0.75 mm (0.010, 0.020 or 0.030 in.) oversize pistons and rings. Have a reliable repair shop rebore the block, or use the drill press and honing tool.*

1. Rebore cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from 200—250 rpm.
3. Lower and raise hone until ends extend 20—25 mm (0.75—1.0 in.) past ends of cylinder.
4. Turn adjusting nut on one hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately 20 times per minute.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

*NOTE: Finish should not be smooth, but have a 40—60° cross-hatch pattern.*

**IMPORTANT: Check stone for wear or damage. Use correct stone for the job.**



MX,4020A1,A35 -19-21OCT92

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CYLINDER INITIAL BORE SPECIFICATIONS

**Piston Oversize:**  
**0.25 mm**  
**(0.010 in.)**

**Piston Oversize:**  
**0.50 mm**  
**(0.020 in.)**

**Piston Oversize:**  
**0.75 mm**  
**(0.030 in.)**

FC290V  
 78.21—78.23 mm  
 (3.079—3.080 in.)

78.46—78.48 mm  
 (3.089—3.090 in.)

78.71—78.73 mm  
 (3.099—3.100 in.)

FC400V  
 87.23—87.25 mm  
 (3.434—3.435 in.)

87.48—87.50 mm  
 (3.444—3.4448 in.)

87.73—87.75 mm  
 (3.453—3.454 in.)

FC420V  
 89.23—89.25 mm  
 (3.513—3.514 in.)

89.48—89.50 mm  
 (3.523—3.524 in.)

89.73—89.75 mm  
 (3.533—3.534 in.)

FC540V  
 89.21—89.23 mm  
 (3.512—3.513 in.)

89.46—89.48 mm  
 (3.522—3.523 in.)

89.72—89.73 mm  
 (3.532—3.533 in.)

MX,4020A1,A36 -19-21OCT92

8. Hone the cylinder an additional 0.028—0.030 mm (0.0011—0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

**IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.**

9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

10. Dry the cylinder. Apply engine oil to cylinder wall.

M98,2040A,A9 -19-21OCT92

40  
20  
24

### INSPECT AND REPLACE OIL SLINGER—FC290V

1. Remove crankcase cover. (See this group.)
2. Remove oil slinger (A).
3. Inspect oil slinger. Replace if worn or damaged.
4. Install oil slinger.



M50078 -UN-31AUG88

MX,4020A1,A37 -19-21OCT92

### DISASSEMBLE AND ASSEMBLE OIL PUMP—FC400V/FC420V

1. Remove crankcase cover. (See this group.)
2. Remove oil pump gear (A).

**IMPORTANT:** Remove rotor shaft and oil pump cover together to avoid damaging governor.

3. Remove oil pump assembly (B).
4. Remove relief spring and ball (C).
5. Inspect all parts. (See this group.)

*NOTE:* Install gear (A) with recess facing away from crankcase cover.

6. Install oil pump assembly.



M80018 -UN-09JAN91

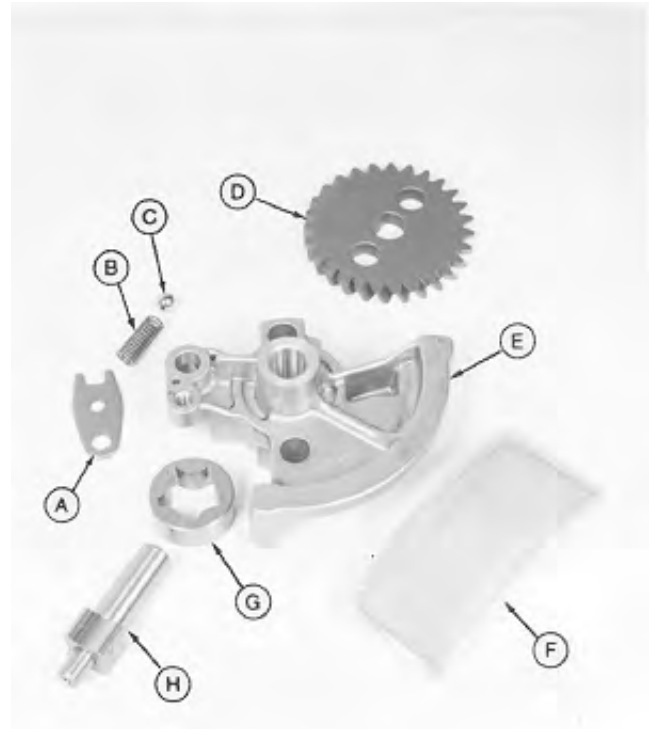
MX,4020A1,A38 -19-21OCT92

40  
20  
25

### INSPECT OIL PUMP—FC400V/FC420V

1. Inspect all parts for wear or damage. Replace as necessary.

- A—Plate
- B—Spring
- C—Ball
- D—Gear
- E—Cover
- F—Screen
- G—Outer Rotor
- H—Rotor Shaft



-UN-09JAN91

M80019

MX,4020A1,A39 -19-21OCT92

2. Measure outside diameters of shaft. Replace both shaft and outer rotor if less than specification.

#### SPECIFICATIONS

Minimum Shaft O.D.	
Large O.D. ....	12.63 mm (0.497 in.)
Small O.D. ....	7.94 mm (0.313 in.)



-UN-09JAN91

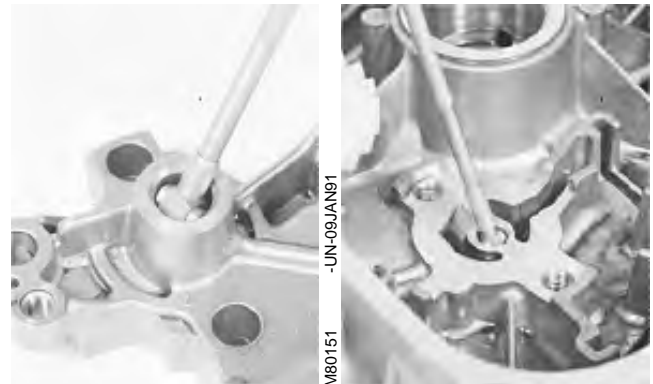
M80150

MX,4020A1,A40 -19-21OCT92

3. Measure rotor shaft bearings. Replace oil pump cover or crankcase cover if greater than specifications.

#### SPECIFICATIONS

Maximum Rotor Shaft Bearing I.D.	
Oil Pump Cover ....	12.76 mm (0.502 in.)
Crankcase Cover ....	8.07 mm (0.318 in.)



-UN-09JAN91

M80151

-UN-09JAN91

M80152

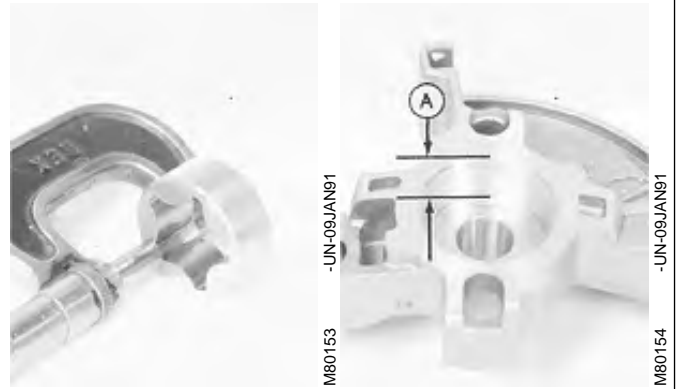
MX,4020A1,A41 -19-21OCT92

4. Measure thickness of outer rotor. Replace both outer rotor and shaft if less than specifications.

5. Measure out rotor bearing depth (A). Replace oil pump cover if greater than specifications.

**OUTER ROTOR SPECIFICATIONS**

Minimum Rotor Thickness . . . . . 11.92 mm (0.470 in.)  
 Maximum Bearing Depth . . . . . 12.14 mm (0.478 in.)



M80153  
-JUN-09/JAN91

M80154  
-JUN-09/JAN91

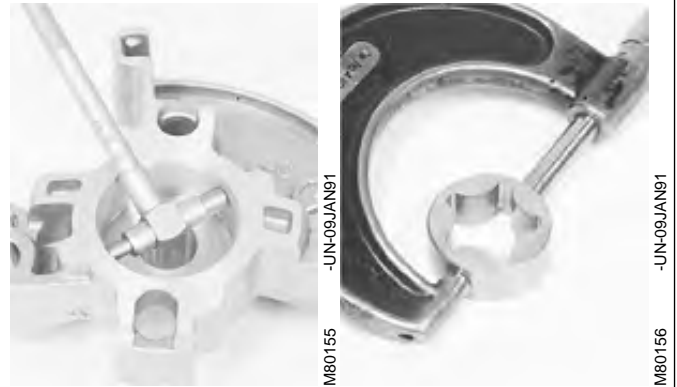
MX,4020A1,A42 -19-21OCT92

6. Measure inside diameter of rotor bearing. Replace oil pump cover if greater than specifications.

7. Measure outside diameter of rotor. Replace both rotor and shaft if less than specifications.

**OUTER ROTOR SPECIFICATIONS**

Maximum Bearing I.D. . . . . 29.20 mm (1.149 in.)  
 Minimum Rotor O.D. . . . . 28.95 mm (1.140 in.)



M80155  
-JUN-09/JAN91

M80156  
-JUN-09/JAN91

MX,4020A1,A43 -19-21OCT92

8. Measure relief valve spring. Replace if free length is less than specification.

**SPECIFICATIONS**

Minimum Spring Length . . . . . 19.00 mm (0.750 in.)



M50083  
-JUN-31/AUG88

MX,4020A1,A44 -19-21OCT92

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20  
27

## DISASSEMBLE AND ASSEMBLE OIL PUMP—FC540V

1. Remove crankcase cover. (See this group.)
2. Remove oil pump gear (A).

**IMPORTANT: Remove rotor shaft and oil pump cover together to avoid damaging governor.**

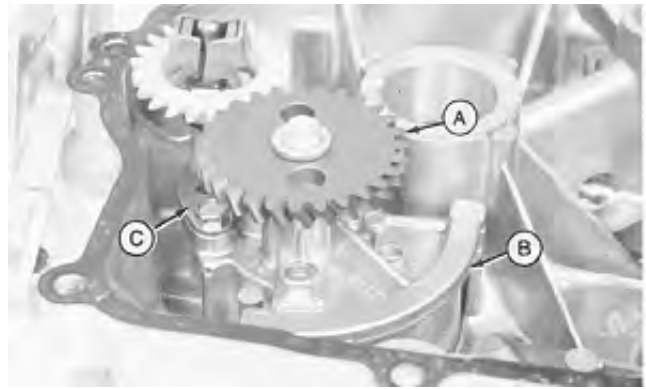
3. Remove oil pump assembly (B).
4. Remove relief spring and ball (C).
5. Inspect all parts. (See this group.)

**IMPORTANT: Install outer rotor with dimple (D) facing away from crankcase cover, to avoid oil pump damage.**

*NOTE: Install gear (A) with recess facing away from crankcase cover.*

6. Install oil pump assembly.

A—Oil Pump Gear  
B—Oil Pump Assembly  
C—Relief Spring and Ball  
D—Dimple



M80011  
-UN-09JAN91



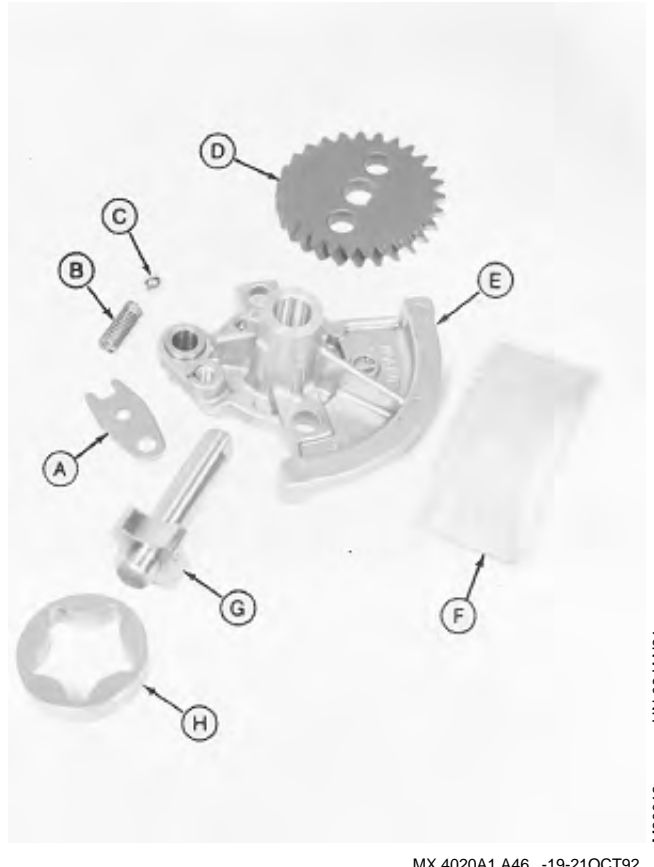
M80012  
-UN-09JAN91

MX,4020A1,A45 -19-21OCT92

### INSPECT OIL PUMP—FC540V

1. Inspect all parts for wear or damage. Replace as necessary.

- A—Plate
- B—Spring
- C—Ball
- D—Gear
- E—Cover
- F—Screen
- G—Rotor Shaft
- H—Outer Rotor



MX,4020A1,A46 -19-21OCT92

M80013 -JUN-09/JAN91

2. Measure outside diameters of shaft. Replace both shaft and outer rotor if less than specification.

#### SPECIFICATIONS

Minimum Shaft O.D. . . . . . 12.63 mm (0.497 in.)



MX,4020A1,A47 -19-21OCT92

M50084 -JUN-31/AUG88

40  
20  
29



3. Measure rotor shaft bearings. Replace oil pump cover or crankcase cover if greater than specifications.

**SPECIFICATIONS**

Maximum Rotor Shaft Bearing I.D. . . . . . 12.76 mm (0.502 in.)



M50089 -UN-31AUG88



M80014 -UN-09JAN91

MX,4020A1,A48 -19-21OCT92

4. Measure thickness of outer rotor. Replace both outer rotor and shaft if less than specifications.

5. Measure outer rotor bearing depth (A). Replace crankcase cover if greater than specifications.

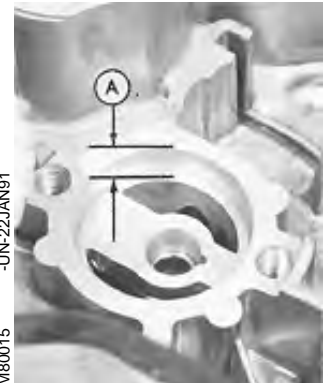
**OUTER ROTOR SPECIFICATIONS**

Minimum Rotor Thickness . . . . . 9.92 mm (0.391 in.)

Maximum Bearing Depth . . . . . 10.17 mm (0.401 in.)



M80015 -UN-22JAN91



M80016 -UN-09JAN91

MX,4020A1,A49 -19-21OCT92

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6. Measure inside diameter of rotor bearing. Replace crankcase cover if greater than specifications.

7. Measure outside diameter of rotor. Replace both rotor and shaft if less than specifications.

**OUTER ROTOR SPECIFICATIONS**

Maximum Bearing I.D. . . . . . 40.77 mm (1.605 in.)  
Minimum Rotor O.D. . . . . . 40.47 mm (1.596 in.)



M50090 -UN-31AUG88



M80017 -UN-09JAN91

MX,4020A1,A50 -19-21OCT92

8. Measure relief valve spring. Replace if free length is less than specification.

**SPECIFICATIONS**

Minimum Spring Length . . . . . 19.00 mm (0.750 in.)



M50083 -UN-31AUG88

MX,4020A1,A44 -19-21OCT92

40  
20  
31

## REMOVE, INSPECT AND INSTALL OIL FILTER MANIFOLD—IF EQUIPPED

1. Remove oil filter and manifold.
2. Inspect oil filter. Replace if excessively contaminated or damaged.
3. Inspect oil passages for clogs. Clean if needed.
4. Inspect rubber gaskets. Replace if worn or damaged.
5. Install filter and manifold.



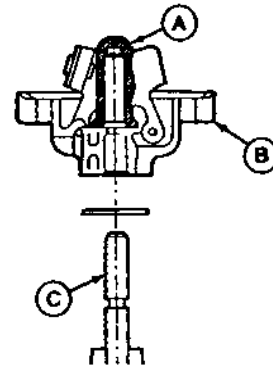
M50077 -UN-31AUG88

MX,4020A1,A51 -19-21OCT92

## INSPECT AND REPLACE GOVERNOR

**IMPORTANT:** Removal damages governor. If not damaged, do not remove.

1. Remove crankcase cover. (See this group.)
2. Inspect governor. If necessary to replace, remove with screwdriver.
3. If removed, press shaft (C) back into block until it protrudes 32.2—32.8 mm (1.267—1.291 in.).



M51762 -UN-07SEP88

*NOTE: Assemble sleeve and gear before installing assembly on shaft.*

4. Install sleeve (A) onto governor gear (B).
5. Install governor assembly onto shaft. Push down on assembly until it snaps into place.

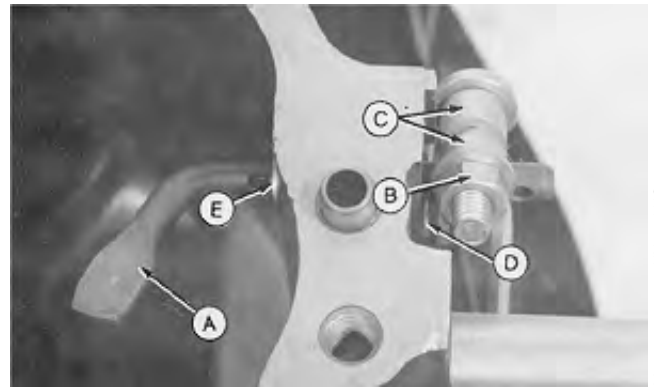
MX,4020A1,A52 -19-21OCT92

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20  
32

## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (A). Replace if damaged.
3. To replace shaft, loosen nut (B) on lever (C).
4. Remove retaining pin (D), governor shaft and washer (E).
5. Install washer, shaft and retaining pin. Tighten nut.



A—Governor Shaft  
B—Nut  
C—Governor Lever  
D—Retaining Pin  
E—Washer

MX,4020A1,A53 -19-21OCT92

M50094 -UN-31AUG88



## REMOVE AND INSTALL STATOR

1. Remove flywheel. (See Group 10.)
2. Disconnect stator lead.
3. Remove screws (A) and stator (B).
4. Install stator.
5. Connect stator lead.
6. Install flywheel.

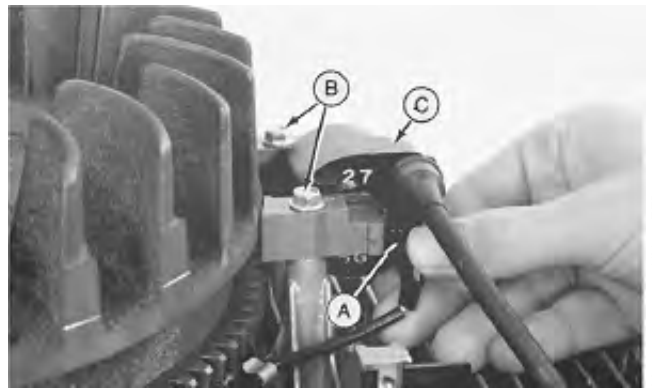


M50146  
-UN-31AUG88

MX,4025A1,A1 -19-21OCT92

## REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove blower housing. (See Group 10.)
2. Disconnect wiring lead (A).
3. Remove cap screws (B) and armature with coil (C).
4. Loosely install armature with coil.
5. Connect wiring lead.
6. Adjust armature air gap. (See this group.)
7. Install blower housing.

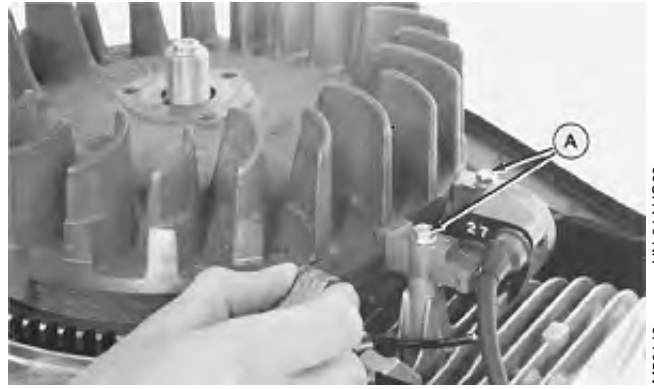


M50147  
-UN-23FEB89

MX,4025A1,A2 -19-21OCT92

### ADJUST ARMATURE AIR GAP

1. Turn flywheel magnet away from armature.
2. Insert feeler gauge, between flywheel and armature.
3. Push armature against flywheel and tighten screws (A).
4. Turn flywheel to remove feeler gauge.



M50148 -UN-31AUG88

#### AIR GAP SPECIFICATIONS

Feeler Gauge Blade . . . . . 0.30 mm (0.012 in.)

MX,4025A1,A3 -19-21OCT92

**OTHER MATERIAL**

<b>Number</b>	<b>Name</b>	<b>Use</b>
	Mineral Spirits	Clean Armature
	Multipurpose Grease	Grease Starter Parts

M98,2030A,ZB -19-21OCT92

**SERVICE PARTS KITS**

The following kits are available through your parts catalog:

Recoil Starter—FC290V  
Spring and Case  
Pawl and Spring Kit  
Complete Starter

Recoil Starter—FC400V/FC420V

Electric Starter  
Brush Kit  
Clutch Kit  
Complete Starter  
Complete Solenoid—FC400V/FC420V/FC540V

MX,4030A1,A0 -19-21OCT92

40  
30  
1



## DISASSEMBLE RECOIL STARTER—FC290V/FC400V/FC420V

1. Remove starter.
2. Pull handle out about 30 cm (1 ft). Tie knot (A) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (A). Slowly release reel tension. Do not let rope get wedged between reel and housing.

**CAUTION:** Wear gloves and protective goggles for remaining steps.

6. Remove screw (C) and ratchet cover.



TY13495 -UN-23FEB89

MX,4030A1,A1 -19-21OCT92

**CAUTION:** A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.

7. Turn the reel one half turn clockwise so no spring tension can be felt.



FC290V



FC400V/FC420V

-UN-09JAN91

M54499

-UN-23FEB89

TY13496

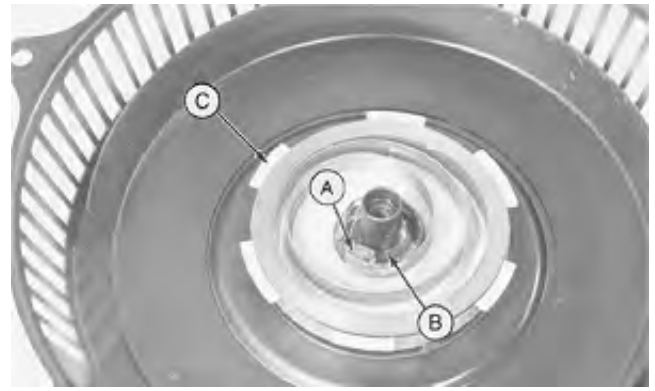
MX,4030A1,A1 -19-21OCT92

40  
30  
2

8. Spring is stored in spring case (C) in housing. Lift reel straight up so spring remains seated in housing.

9. Carefully unhook spring tang (A) from catch (B).

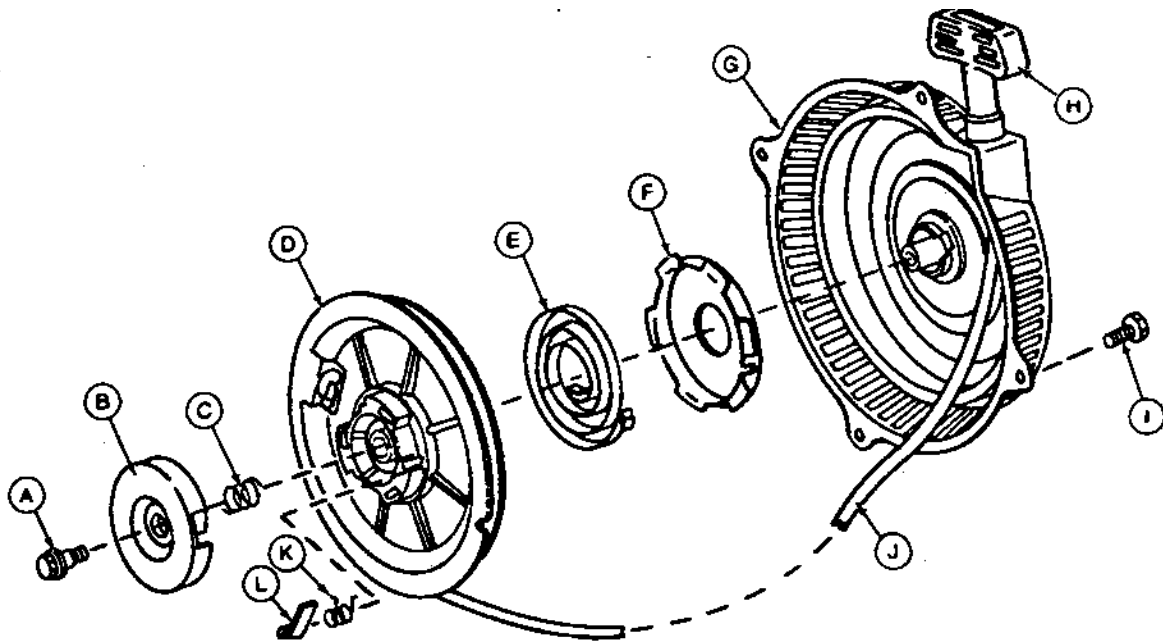
10. Remove spring case from housing.



MX,4030A1,A2 -19-21OCT92

TY13497 -UN-23FEB89

### INSPECT RECOIL STARTER—FC290V/FC400V/FC420V



A—Screw  
B—Retainer  
C—Spring  
D—Reel

E—Spring  
F—Case (If Equipped)  
G—Housing  
H—Handle

I—Screw (4 used)  
J—Rope  
K—Spring (2 used—FC290V)  
(3 used—FC400V/420V)

L—Pawl (2 used—FC290V)  
(3 used—FC400V/420V)

Inspect and replace all damaged or worn parts.

MX,4030A1,A3 -19-21OCT92

TY13498 -UN-23FEB89

40  
30

## REPLACE SPRING

**⚠ CAUTION:** Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.

1. Working from the center out, carefully unwind spring from spring case or reel.
2. Hook outside spring tang in reel or case. Wind spring into reel or spring case, working toward center.

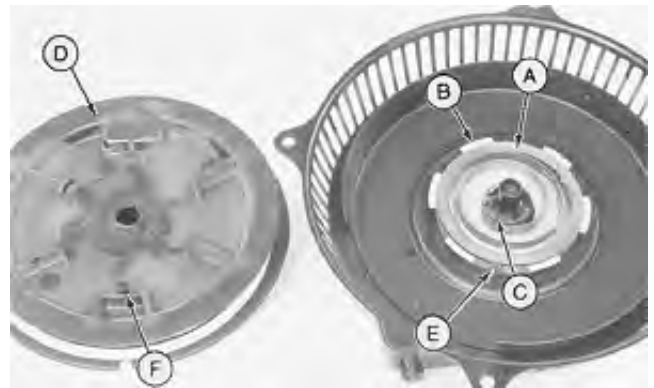


M54497 -UN-09JAN91

MX,4030A1,A4 -19-21OCT92

## ASSEMBLE RECOIL STARTER—FC290V/FC400V/FC420V

1. Wind rope counterclockwise onto reel.
2. Place spring case (B) into housing with spring tang over catch (C).
3. Install reel in spring case, with round peg (E) aligned with end of spring (F).
4. Turn reel counterclockwise until you feel tang hook on catch.



TY13499 -UN-23FEB89

- A—Spring
- B—Case
- C—Catch
- D—Reel
- E—Round Peg
- F—End of Spring

MX,4030A1,A5 -19-21OCT92

40  
30  
4

5. Turn reel two turns counterclockwise to preload spring.
6. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (A) to hold rope.
7. Install handle and secure with knot (B).
8. Remove knot (A).
9. Install spring (C) and ratchet cover (E) with opening(s) in cover over pawl(s) (D). Check for free movement of pawls.
10. Pull rope to check for proper operation.
11. Install recoil starter on engine.

- A—Knot
- B—Knot
- C—Spring
- D—Pawls
- E—Retainer



FC290V



FC400V/FC420V

MX,4030A1,A5A -19-21OCT92

M54500 -JUN-09/JAN91

TY13500 -JUN-23/FEB89

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## ANALYZE ELECTRIC STARTER CONDITION

1. The starter overheats because of:

- Long cranking.
- Armature binding.

2. The starter operates poorly because of:

- Armature binding.
- Dirty or damaged starter drive.
- Badly worn brushes or weak brush springs.
- Excessive voltage drop in cranking system.
- Battery or wiring defective.
- Shorts, opens, or grounds in armature.

*NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.*

MX,4030A1,A6 -19-21OCT92

## BENCH TEST SOLENOID DRIVE STARTER—FC400V/FC420V/FC540V

*NOTE: Perform bench test before disassembling starter motor to determine cause of problem.*

**IMPORTANT: Never operate motor longer than 20 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive operation, will seriously damage starting motor.**

1. Disconnect battery leads from battery.
2. Remove starter from engine.
3. Connect 12-volt battery (A) to starter battery terminal (B) and starter frame (C) using heavy duty cables.
4. Connect 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.*

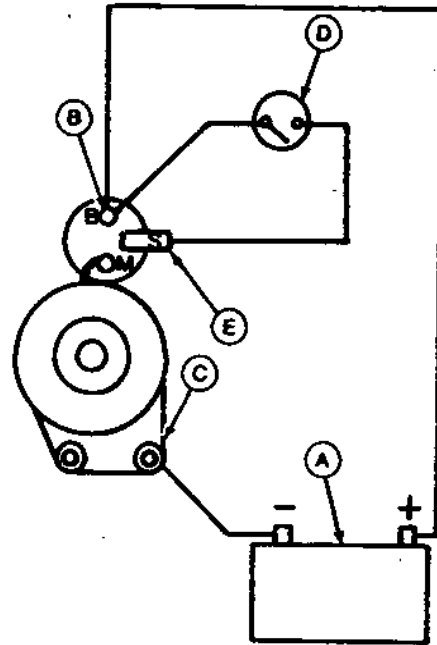
When switch is activated, starter should engage and run.

IF SOLENOID CHATTERS; hold-in winding is open-circuited.

IF NOTHING HAPPENS; either the solenoid pull-in winding is open-circuited or mechanical parts are sticking.

IF SOLENOID ENGAGES, BUT MOTOR DOES NOT RUN; check solenoid switch continuity, brushes, armature and field windings.

Solenoid cannot be repaired, replace it.



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

MX,4030A1,A7 -19-21OCT92

-JUN-29AUG88

M37149

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7

### TEST SOLENOID—FC400V/FC420V/FC540V

*NOTE: If bench test indicated solenoid problems, use an ohmmeter or test light to check solenoid.*

1. Test solenoid terminals (A and B) for continuity. There should be no continuity.
2. Depress switch arm (C). There should be continuity when arm is fully depressed.
3. Test for open circuits between terminal (B) and tang (D). There should be continuity.
4. Test for open circuits between tang (D) and body (E). There should be continuity.

If solenoid fails any test, it is defective and must be replaced.



- A—Terminal
- B—Terminal
- C—Switch Arm
- D—Tang
- E—Solenoid Body

M51705 -UN-31AUG88

MX,4030A1,A8 -19-21OCT92

### CHECK STARTER ARMATURE ROTATION

1. FC290V: Remove air cleaner and blower housing. (See Groups 05 and 10.)
2. Remove starter.
3. Rotate armature (A).

If armature does not rotate freely, armature may be bent or bearings may be worn. Disassemble, inspect and clean starter. (See this group.)



FC290V



FC400V/FC420V/FC540V

M80163 -UN-09JAN91

M80163

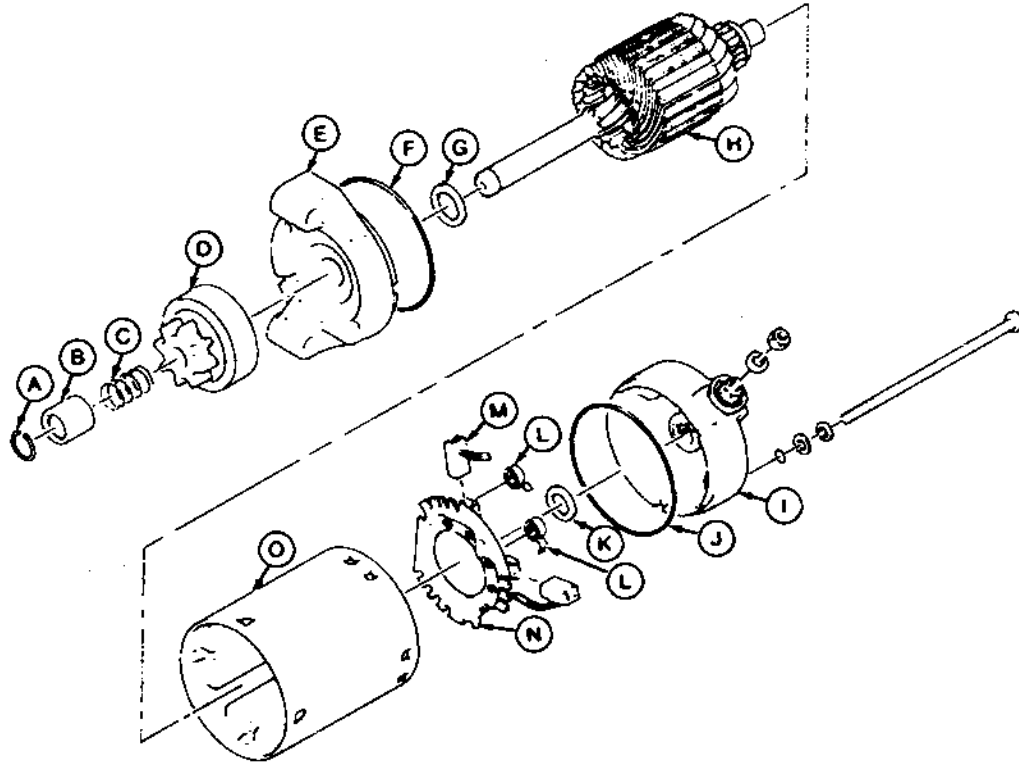
M53972 -UN-18APR90

M53972

MX,4030A1,A9 -19-21OCT92

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30  
8

**INSPECT STARTER—FC290V**



A—Snap Ring  
 B—Pinion Stopper  
 C—Spring  
 D—Pinion Assembly

E—Front Cover  
 F—O-Ring  
 G—Washer  
 H—Armature

I—End Cover  
 J—O-ring  
 K—Washer  
 L—Brush Spring

M—Brush  
 N—Brush Holder  
 O—Body

1. Mark body and covers for correct alignment during reassembly.
2. Remove nuts and washers from terminal to remove end cover (I).
3. Push pinion stopper (B) toward pinion (D) to remove snap ring (A).
4. Inspect parts for wear or damage.
5. Check magnets in body (O). Replace body if magnetic pull is weak.

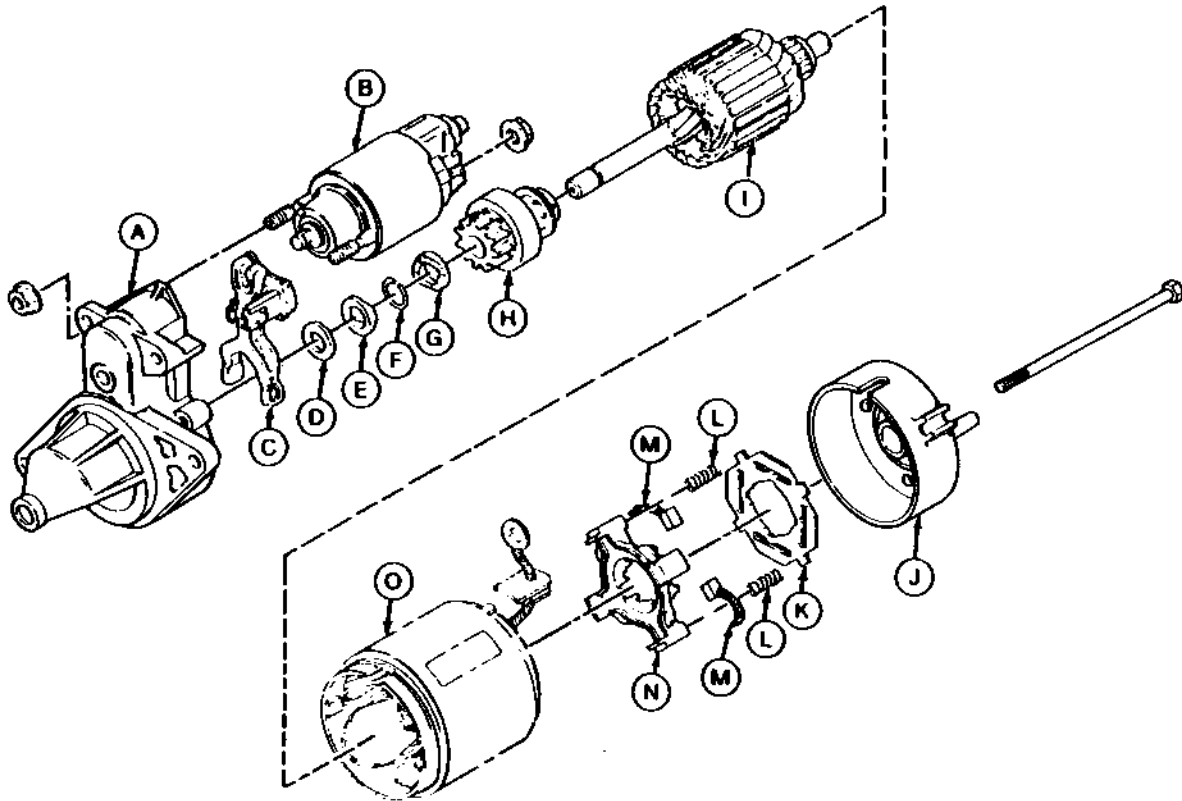
6. Measure brushes. Replace brushes as a set if length of any one is less than 8.5 mm (0.335 in.).
7. Test starter armature and brushes. (See this group.)
8. Apply a thin coat of multipurpose grease to:
  - sliding surfaces of armature.
  - armature shaft spline.
  - points where shaft contacts cover.
9. Assemble starter.

M50128 -UN-31AUG88

40  
30  
9



**INSPECT STARTER—FC400V/FC420V**



A—Front Cover  
B—Solenoid  
C—Shift Lever  
D—Washer

E—Pinion Stopper Half  
F—Retaining Clip  
G—Pinion Stopper Half  
H—Pinion

I—Armature  
J—End Cover  
K—Insulator  
L—Brush Spring

M—Brush  
N—Brush Holder  
O—Body

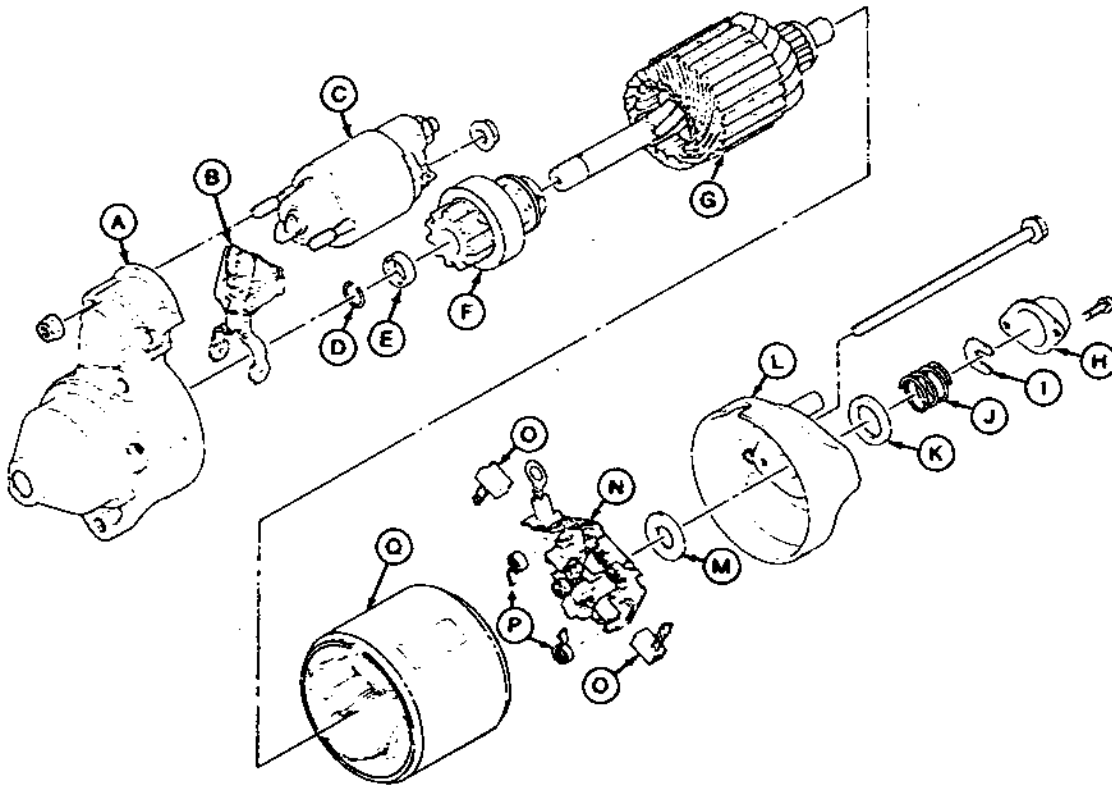
1. Mark body and covers for correct alignment during reassembly.
2. Separate pinion stopper halves (E and G) to remove retaining clip (F).
3. Inspect parts for wear or damage.
4. Measure brushes. Replace brushes as a set if length of any one is less than 6 mm (0.240 in.).

5. Test starter armature and brushes. (See this group.)
6. Apply a thin coat of multipurpose grease to:
  - sliding surfaces of armature and solenoid shift lever.
  - armature shaft spline.
  - points where shaft contacts cover.
7. Assemble starter.

MX,4030A1,A11 -19-21OCT92

M55943 -JUN-19-JUN90

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30  
10

**INSPECT STARTER—FC540V**

A—Front Cover  
 B—Shift Lever  
 C—Solenoid  
 D—Retaining Clip  
 E—Pinion Stopper

F—Pinion  
 G—Armature  
 H—Dust Cap  
 I—Clip

J—Spring  
 K—Washer  
 L—End Cover  
 M—Washer

N—Brush Holder  
 O—Brush  
 P—Brush Spring  
 Q—Body

1. Mark body and covers for correct alignment during reassembly.
2. Push pinion stopper (E) toward pinion (F) to remove retaining clip (D).
3. Inspect parts for wear or damage.
4. Measure brushes. Replace brushes as a set if length of any one is less than 10.5 mm (0.413 in.).

5. Test starter armature and brushes. (See this group.)
6. Apply a thin coat of multipurpose grease to:
  - sliding surfaces of armature and solenoid shift lever.
  - armature shaft spline.
  - points where shaft contacts cover.
7. Assemble starter.

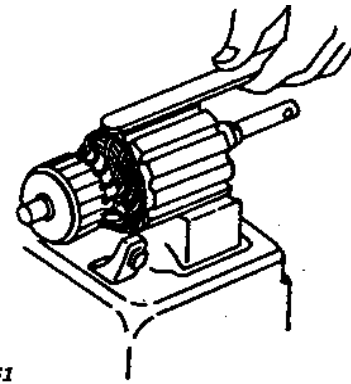
M50120  
 -JUN-31AUG88

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## TEST STARTER ARMATURE

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

1. Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.
2. Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.
3. If test indicates short circuited windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.



M24861

-UN-25AUG88  
M24861

M98,2030A,K -19-21OCT92

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

Armature windings are connected in parallel, so each commutator bar needs to be checked.

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



M98,2030A,AH -19-21OCT92

-UN-31AUG88  
M50112

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

If test shows no continuity, there is an open circuit and armature must be replaced.



M98,2030A,M -19-21OCT92

-JUN-31AUG88  
M50113

## TEST FIELD COIL

*NOTE: Continuity tests are similar for all units.  
Illustrations are representative only.*

If equipped with brushes on body:

Replace field coil if not according to specifications.

### CONTINUITY TEST

Brush-to-Housing ..... Continuity  
 Brush-to-Brush ..... Continuity



M50115 -UN-31AUG88



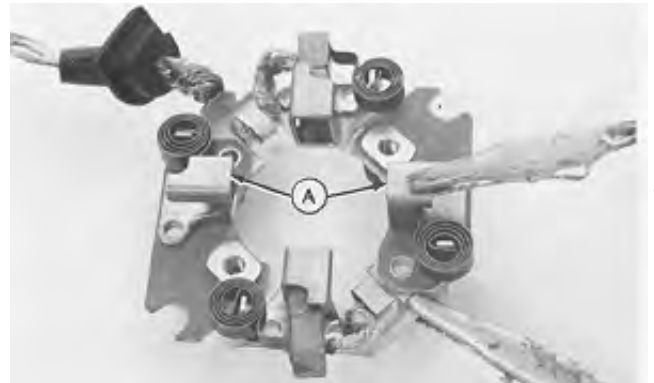
M50116 -UN-31AUG88

MX,4030A1,A13 -19-21OCT92

FC290V:

Test for continuity between each negative brush holder (A) and brush plate. Replace brush holder assembly if there is continuity.

Test for continuity between each positive brush holder and brush plate. Replace brush holder assembly if there is not continuity.



M50114 -UN-31AUG88

MX,4030A1,A14 -19-21OCT92

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# Section 45

## FE290D and FE290R

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**ENGINE APPLICATIONS CHART**

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

<b>Machine</b>	<b>Engine Model No.</b>
AMT622	
(Engine S.N. —010272) .....	FE290D-AS00
(Engine S.N. 010273— ) .....	FE290D-BS00
(Engine S.N. —025000) .....	FE290D-AS00
(Engine S.N. 025001— ) .....	FE290D-BS00
AMT626 .....	FE290D-BS00
1200 Bunker and Field Rake .....	FE290R-AS00
Gator 4 X 2 .....	FE290D-AS08

MX,4500A1,A1 -19-21OCT92

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## FE290D/FE290R REPAIR SPECIFICATIONS

### GROUP 05—FUEL AND AIR SYSTEMS

Item	Specification
Breather	
Maximum Air Gap . . . . .	0.20 mm (0.008 in.)

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Flywheel Nut Torque . . . . .	85 N·m (63 lb-ft)
-------------------------------	-------------------

### GROUP 15—CYLINDER HEAD AND VALVES

Valve Clearance . . . . .	0.12 mm (0.005 in.)
---------------------------	---------------------

#### Rocker Arm

Minimum Shaft O.D. . . . .	11.95 mm (0.470 in.)
Maximum Bearing I.D. . . . .	12.07 mm (0.475 in.)
Adjusting Nut Torque . . . . .	9 N·m (79 lb-in.)

#### Push Rod

Maximum Bend . . . . .	0.30 mm (0.012 in.)
------------------------	---------------------

#### Valves and Springs

Minimum Spring Free Length . . . . .	32.75 mm (1.289 in.)
Maximum Valve Guide I.D. . . . .	7.07 mm (0.278 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seating Surface . . . . .	0.50—1.10 mm (0.020—0.043 in.)
Valve Seat and Face Angle . . . . .	45°
Minimum Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

#### Cylinder Head

Cylinder Head Flatness . . . . .	0.05 mm (0.002 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	18 N·m (159 lb-in.)
Final Torque . . . . .	24 N·m (212 lb-in.)

Spark Plug Torque . . . . .	20 N·m (177 lb-in.)
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MX,4500A1,A2 -19-21OCT92

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**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS**

Item	Specification
<b>Crankcase Cover</b>	
Oil Capacity . . . . .	1.1 L (2.33 pt)
Cap Screw Torque . . . . .	26 N·m (230 lb-in.)
Drain Plug Torque . . . . .	21 N·m (186 lb-in.)
<b>Camshaft</b>	
Minimum End Journals O.D. . . . .	22.93 mm (0.903 in.)
Minimum Lobe Height . . . . .	32.70 mm (1.287 in.)
Maximum Cover and Crankcase Bearing I.D. . . . .	23.06 mm (0.908 in.)
<b>Reciprocating Balancer</b>	
<b>Link Rod</b>	
Minimum Journal O.D. . . . .	46.86 mm (1.845 in.)
Maximum Small End I.D. . . . .	12.06 mm (0.475 in.)
Maximum Large End I.D. . . . .	47.12 mm (1.855 in.)
Bushing Depth . . . . .	1 mm (0.040 in.)
<b>Balancer Weight</b>	
Maximum Bearing I.D. . . . .	26.10 mm (1.027 in.)
<b>Support Shaft</b>	
Minimum Shaft O.D. . . . .	25.93 mm (1.021 in.)
<b>Piston</b>	
<b>Maximum Ring Groove Clearance</b>	
Top Ring . . . . .	0.16 mm (0.006 in.)
Second Ring . . . . .	0.14 mm (0.005 in.)
Oil Control Rings . . . . .	Not Measured
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
<b>Maximum Ring End Gap</b>	
Compression Rings . . . . .	1.20 mm (0.047 in.)
Oil Control Rings . . . . .	Not Measured
Minimum Pin O.D. . . . .	18.98 mm (0.747 in.)
Maximum Pin Bore I.D. . . . .	19.03 mm (0.749 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Piston O.D. . . . .	77.85—77.87 mm (3.0649—3.0657 in.)
Piston-to-Cylinder Bore Clearance . . . . .	0.051—0.089 mm (0.002—0.0035 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	35.57 mm (1.400 in.)
Maximum Piston Pin Bearing I.D. . . . .	19.06 mm (0.750 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.08 mm (0.003 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.14 mm (0.006 in.)
End-Cap Screw Torque . . . . .	20 N·m (177 lb-in.)

Continued on next page

MX,4500A1,A3 -19-21OCT92

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**GROUP 20—CYLINDER BLOCK AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . . .	29.92 mm (1.178 in.)
Minimum Connecting Rod Journal O.D. . . . . .	35.43 mm (1.395 in.)
Maximum Crankcase Plain Bearing I.D. . . . . .	30.08 mm (1.184 in.)
Maximum T.I.R. . . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0.09—0.22 mm (0.004—0.009 in.)
<b>Oil Seal Depth</b>	
PTO End . . . . .	4 mm (0.158 in.)
Governor Shaft . . . . .	1.42 mm (0.056 in.)
<b>Cylinder Bore</b>	
Standard I.D. . . . . .	77.98—78.00 mm (3.070—3.071 in.)
Maximum I.D. . . . . .	78.07 mm (3.074 in.)
Maximum Out-of-Round . . . . .	0.056 mm (0.0022 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.25 mm (.010 in.) . . . . .	78.21-78.23 mm (3.079-.080 in.)
0.50 mm (.019 in.) . . . . .	78.48-78.50 mm (3.089-.090 in.)
0.75 mm (.029 in.) . . . . .	78.71-78.73 mm (3.099-.100 in.)
<b>Oil Pump</b>	
Minimum Rotor Shaft O.D. . . . . .	12.63 mm (0.497 in.)
Maximum Rotor Shaft Bearing I.D. . . . . .	12.77 mm (0.503 in.)
Minimum Outer Rotor Thickness . . . . .	9.92 mm (0.391 in.)
Maximum Outer Rotor Bore Depth . . . . .	10.17 mm (0.400 in.)
Minimum Outer Rotor O.D. . . . . .	40.47 mm (1.596 in.)
Maximum Outer Rotor Bearing I.D. . . . . .	40.77 mm (1.605 in.)
Minimum Valve Spring Free Length . . . . .	19.00 mm (0.750 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)
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See Ignition Tests in this Group.

**GROUP 30—STARTING SYSTEMS**

Recoil and Electric Starter

See Starter Specifications in this Group.

MX,4500A1,A4 -19-21OCT92

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## **SERVICE PARTS KITS**

The following kits are available through your parts catalog:

### **FE290D**

- Carburetor Gasket Kit
- Main Jet High Altitude Kit—Standard Air Cleaner
- Main Air Jet—Standard Air Cleaner
- Main Jet Low Temperature—Heavy Duty Air Cleaner
- Main Jet High Temperature/High Altitude Kit—Heavy Duty Air Cleaner
- Main Air Jet—Heavy Duty Air Cleaner
- Complete Carburetor

### **FE290R**

- Carburetor Gasket Kit
- Main Jet High Altitude Kit
- Complete Carburetor

MX,4505A1,A1 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR

1. Drain fuel from carburetor.
2. Disconnect hose (B).
3. Disconnect spring (D).
4. Remove duct (A), bracket (E) and gaskets (F).
5. Disconnect linkage (C).
6. Separate carburetor from heat shield (H). Remove carburetor.
7. Remove heat shield (H) and gaskets.
8. Make repairs as necessary. (See procedure in this group.)

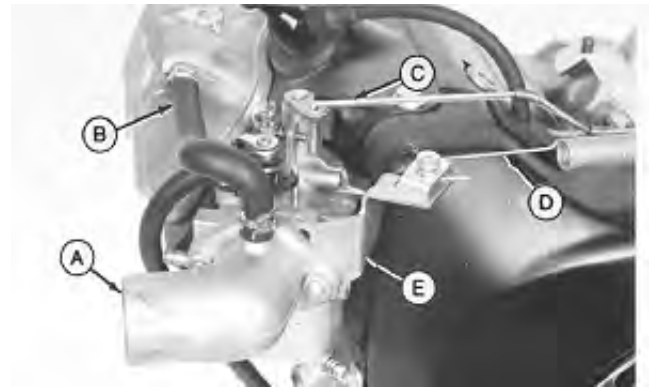
*NOTE: Install gasket (I) with tab pointing up on fuel inlet side of carburetor.*

9. Install gaskets and heat shield.
10. Install carburetor.
11. Connect linkage.

*NOTE: Install gaskets (F) with hole (J) pointing away from fuel inlet side of carburetor.*

12. Install gaskets, bracket and duct.
13. Connect return spring.
14. Connect breather hose.

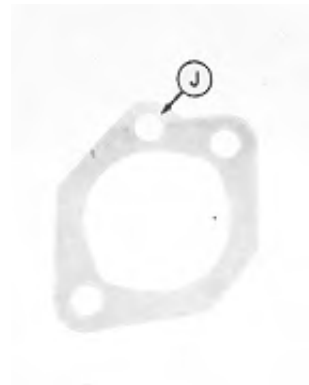
- A—Air Intake Duct
- B—Breather Hose
- C—Throttle Control Linkage
- D—Return Spring
- E—Bracket
- F—Gaskets
- G—Gasket
- H—Heat Shield
- I—Gasket
- J—Hole



M80399 -UN-25APR91



M80400 -UN-25APR91



M80401 -UN-25APR91



## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR

**IMPORTANT:** To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

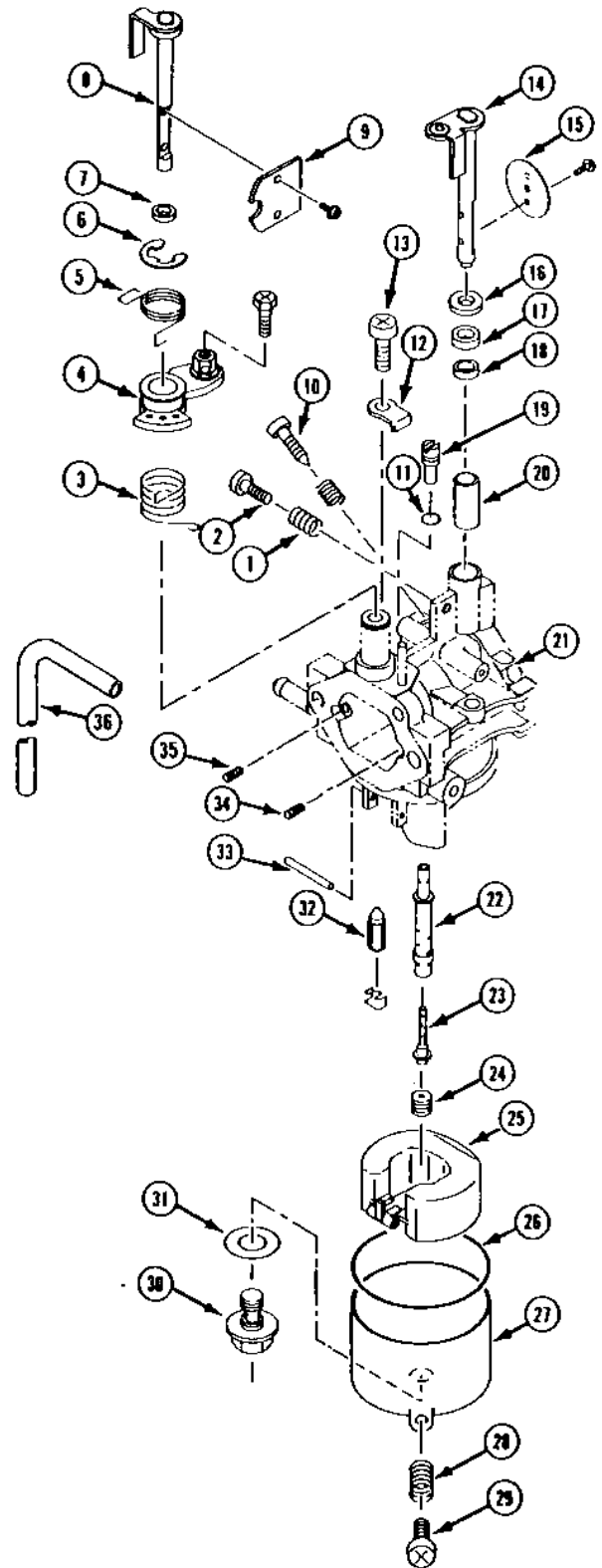
*NOTE: Float is plastic. The float cannot be adjusted. Replace if necessary.*

*FE290D: Main jet high altitude kits and main air jet kits for standard or heavy duty air cleaners are available through the parts catalog.*

*FE290R: Main jet high altitude kits are available through the parts catalog.*

MX,4505A1,A3 -19-21OCT92

- 1—Spring (2 used)
- 2—Idle Screw
- 3—Spring
- 4—Lever
- 5—Spring
- 6—E-Clip
- 7—Seal
- 8—Choke Shaft
- 9—Choke Valve
- 10—Pilot Screw
- 11—O-Ring
- 12—Lock Plate
- 13—Screw
- 14—Throttle Shaft
- 15—Throttle Valve
- 16—Washer
- 17—Seal
- 18—Bushing
- 19—Pilot Jet
- 20—Bushing
- 21—Carburetor Body
- 22—Main Nozzle
- 23—Bleed Pipe
- 24—Main Jet
- 25—Float
- 26—Gasket
- 27—Float Chamber
- 28—Spring
- 29—Drain Screw
- 30—Plug
- 31—Washer
- 32—Needle Valve
- 33—Float Pin
- 34—Main Air Jet
- 35—Pilot Air Jet



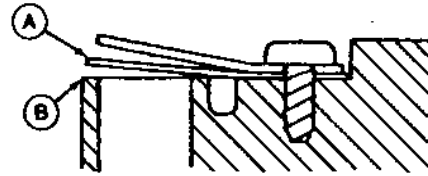
MX,4505A1,A3A -19-21OCT92

M80402 -UN-08MAY91



## SERVICE BREATHER

1. Remove rocker arm cover.
2. Measure air gap between reed valve (A) and valve seat (B) at valve tip. Replace reed valve if gap exceeds specification.
3. Remove breather valve assembly (C).
4. Inspect breather for sticking, binding, cracks or distortion. Replace breather if worn or damaged.
5. Inspect valve seating surface. Surface must be free of nicks or burrs.
6. Install breather assembly.
7. Install rocker arm cover.



### SPECIFICATIONS

Air Gap (MAX) ..... 0.20 mm (0.008 in.)

-UN-07SEP88

M51757

-UN-25APR91

M80403

MX,4505A1,A4 -19-21OCT92

## REMOVE AND INSTALL BLOWER HOUSING

*NOTE: It is not necessary to remove recoil starter, if equipped, from blower housing.*

1. Disconnect spark plug lead.
2. Disconnect breather hose (A).
3. Remove covers (B).
4. Remove blower housing (C).
5. Install blower housing and covers.
6. Connect hose and spark plug lead.



M53063 -UN-11APR89

MX,4510A1,A1 -19-21OCT92

## REMOVE AND INSTALL FLYWHEEL

1. Remove armature with coil. (See Group 25.)
2. Hold flywheel and remove nut and washer (A).
3. Remove starter cup, if equipped.
4. Remove flywheel using a flywheel puller.
5. Install flywheel and cup, if equipped.

*NOTE: Install washer with concave side toward flywheel.*

6. Install washer and nut. Tighten nut to 85 N·m (63 lb-ft).
7. Install armature with coil.



M80404 -UN-25APR91

MX,4510A1,A2 -19-21OCT92

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## SPECIAL OR ESSENTIAL TOOLS

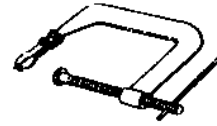
*NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).*

DX,TOOLS -19-05JUN91

Valve Spring Compressor . . . . . JDM70

M51896 -UN-26SEP88

Remove and install valve springs.



MX,JDM70 -19-21OCT92

Valve Guide Driver Tool . . . . . JDG504

Replace valve guide bushings.

MX,JDG504 -19-21OCT92

## OTHER MATERIAL

Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean Cylinder Head
	Valve Guide Cleaner	Clean Valve Guides
	Stanisol (or Kerosene)	Finish Ream Valve Guide
	Prussian Blue Compound	Check Valve Seat Contact

*SCOTCH-BRITE is a trade mark of the 3M Company.*

MX,4015A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalog:

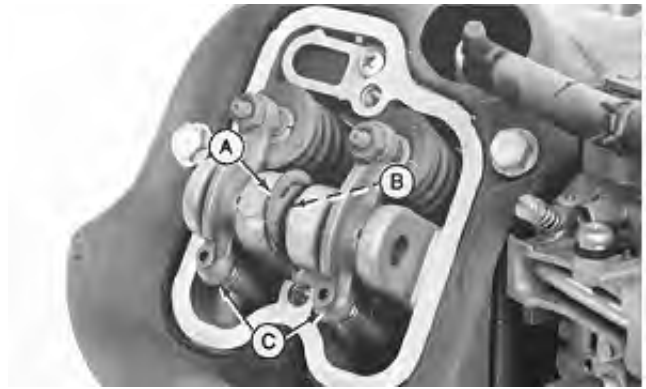
Overhaul Gasket Kit

M98,2015A,ZD -19-21OCT92

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## REMOVE AND INSTALL ROCKER ARM ASSEMBLY

1. Remove rocker arm cover and gasket.
2. Turn crankshaft until piston is at highest position in compression stroke.
3. Remove e-clip (A).
4. Remove rocker shaft, washer (B) and arms (C).



M80405 -UN-25APR91

**IMPORTANT: Mark push rods for reassembly in original locations.**

5. Remove push rods.
6. Inspect parts for wear or damage. (See this group.)

**IMPORTANT: Align rocker arms over push rods during assembly.**

7. Install push rods and rocker arm assemblies.
8. Install washer, rocker shaft and e-clip.
9. Check valve clearance. (See this group.)
10. Install rocker arm cover and gasket.

MX,4515A1,A1 -19-21OCT92

## INSPECT ROCKER ARM ASSEMBLY

Measure outside diameter of rocker shaft and inside diameter of rocker arm bearing. Replace if not according to specifications.

### SPECIFICATIONS

Minimum Shaft O.D. . . . . .	11.95 mm (0.470 in.)
Maximum Arm I.D. . . . . .	12.07 mm (0.475 in.)



M80406 -UN-25APR91



M80407 -UN-25APR91

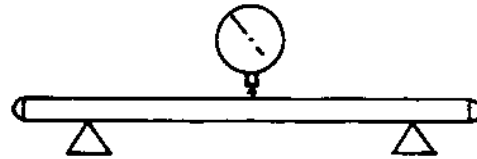
MX,4515A1,A2 -19-21OCT92

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Inspect push rod for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is greater than specification.

**SPECIFICATION**

Push Rod Bend (MAX) . . . . . 0.30 mm (0.012 in.)

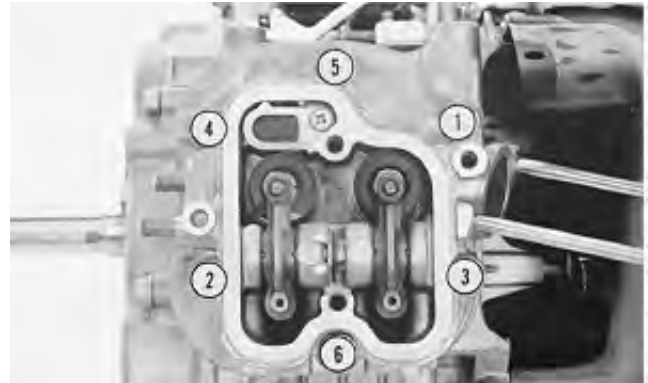


MX,4015A1,A3A -19-21OCT92

M50044 -UN-31AUG88

**REMOVE AND INSTALL CYLINDER HEAD ASSEMBLY**

1. Remove blower housing. (See Group 10.)
2. Remove carburetor. (See Group 05.)
3. Remove rocker arm assembly. (See this group.)
4. Remove spark plug.
5. Remove cylinder head assembly.
6. Make repairs as necessary. (See procedures in this group.)
7. Install cylinder head assembly with new gasket. Install cap screws and tighten finger tight.
8. Tighten cap screws in sequence shown. Tighten to initial torque specifications.
9. Continue in sequence, 3 N·m (27 lb-in.) at a time, until final torque is as specified.
10. Install spark plug and tighten to specification.
11. Install rocker arm assembly.
12. Install carburetor.
13. Install blower housing.



M53065 -JUN-11APR89

**TORQUE SPECIFICATIONS**

Initial Torque . . . . . 18 N·m (159 lb-in.)  
 Final Torque . . . . . 24 N·m (212 lb-in.)  
 Spark Plug . . . . . 20 N·m (177 lb-in.)

MX,4515A1,A3 -19-21OCT92

## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove cylinder head. (See this group.)
2. Compress intake valve spring with JDM70 Valve Spring Compressor and remove collet halves (A).
3. Remove spring retainer (B), spring (C) and valve.
4. Inspect and replace intake valve stem seal if necessary. (See this group.)
5. Inspect and analyze valves. (See Section 100, Group 05.)
6. Inspect springs, valves, guides and seats. (See procedures in this group.)
7. Install valves, springs, retainers, and collet halves.
8. Install cylinder head.



M53066  
-UN-11APR89

MX,4515A1,A4 -19-21OCT92

## INSPECT AND REPLACE INTAKE VALVE STEM SEAL

1. Remove valves and springs. (See this group.)

**IMPORTANT: Bottom spring retainer (B) can only be removed with valve stem seal. Removal of retainer or seal damages stem seal. Inspect seal. If seal is not damaged, do not remove it.**

2. If necessary to replace stem seal (A), remove with screwdriver.



M80408  
-UN-25APR91

MX,4515A1,A5 -19-21OCT92

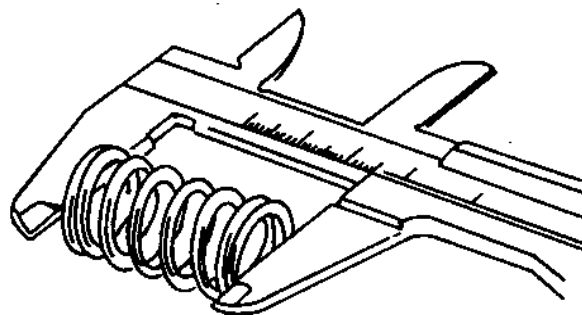
45  
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4

## INSPECT SPRINGS

Inspect spring free length. Replace if damaged or if less than specifications.

### SPECIFICATIONS (MIN)

Spring Free Length . . . . . 32.75 mm (1.289 in.)



MX,4515A1,A6 -19-21OCT92

M50036 -UN-31AUG88

## INSPECT CYLINDER HEAD

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Check that oil drainback passages are not plugged.
7. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than specifications.

### SPECIFICATIONS

Cylinder Head Distortion (Max) . . . . . 0.05 mm (0.002 in.)



MX,4515A1,A7 -19-21OCT92

M80409 -UN-25APR91

## INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guides or bushings. Replace bushing if inside diameter is greater than specifications. (See this group.)

### SPECIFICATIONS (MAX) I.D.

Intake and Exhaust . . . . . 7.07 mm (0.278 in.)



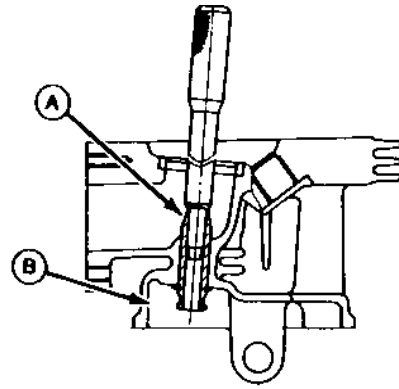
MX,4515A1,A8 -19-21OCT92

M80410 -UN-25APR91



## REPLACE VALVE GUIDE BUSHINGS

1. Drive valve guide bushing (A) into valve chamber (B) using JDG-504 Valve Guide Driver.

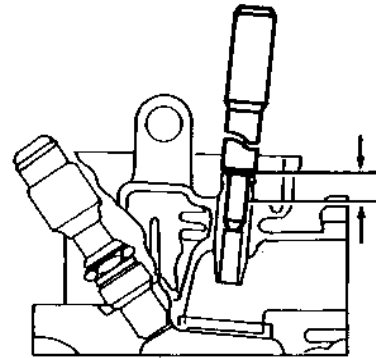


MX,4515A1,A9 -19-21OCT92

M50038 -UN-06APR91

2. Clean carbon deposits from valve guide port.

3. Install new bushing with valve guide driver. Drive in from valve chamber side to an installation depth of 12 mm (0.472 in.) for the FC400V/FC420V and 9.5 mm (0.37 in.) for the FC540V.



MX,4515A1,A9A -19-21OCT92

M50039 -UN-15OCT92

4. Finish reaming valve guide bushings with stanisol or kerosene lubricant and a 7 mm valve guide reamer. Turn reamer clockwise.

5. Thoroughly clean valve area before assembly.

### BUSHING FINISHED I.D. SPECIFICATIONS

Valve Guide . . . . . 7—7.02 mm (0.275—0.276 in.)



MX,4515A1,A10 -19-21OCT92

M80411 -UN-25APR91

## RECONDITION VALVE SEATS

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.

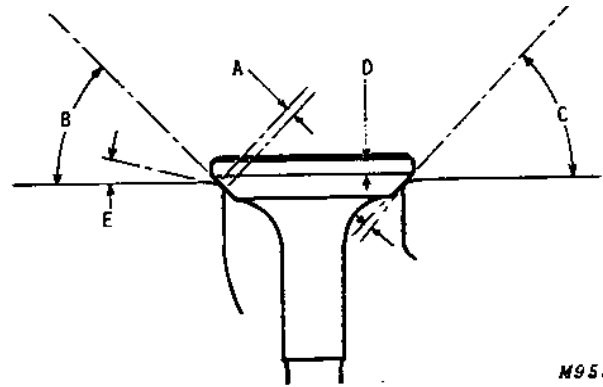
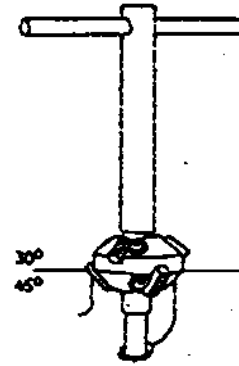
2. To recondition valve seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).

3. Cut valve seating surface (A) as close as possible to specifications.

4. Lap valves to seats after refacing. (See Section 100, Group 05.)

### SPECIFICATIONS

A—Valve Seating Surface	0.50—1.10 mm (0.020—0.043 in.)
B—Valve Seat Angle	45°
C—Valve Face Angle	45°
D—Valve Margin	0.60 mm (0.020 in.)
E—Valve Narrowing Angle	30°



M955

MX,4515A1,A11 -19-21OCT92

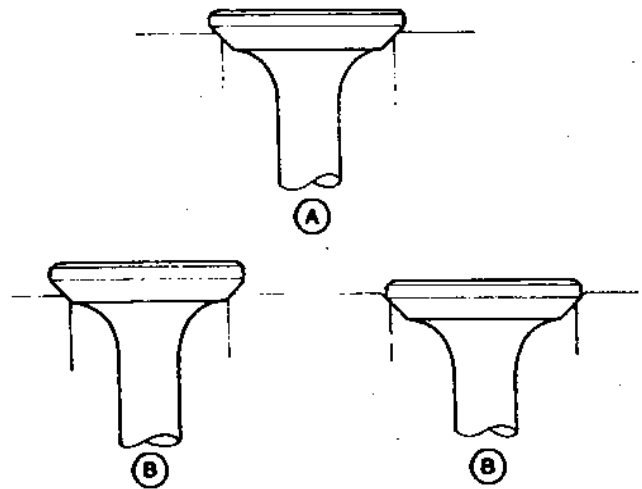
-UN-31AUG88  
M51558

-UN-01SEP88

M9552

5. Center valve seat on the valve face:  
—(A) shows correct position.  
—(B) shows incorrect.

6. Check seat for good contact using Prussion Blue Compound.



MX,4015A1,A11A -19-21OCT92

-UN-07SEP88  
M118615

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7

## CHECK VALVE CLEARANCE

*NOTE: Valve repair changes valve clearance. Check valve clearance. Adjust if needed.*

1. Turn crankshaft until piston is at highest position in compression stroke.
2. Measure clearance.
3. If necessary, loosen nut (A) and turn stud in or out to adjust clearance to specifications. Tighten nut to specifications.



M53067  
-UN-11APR89

### SPECIFICATIONS

Valve Clearance . . . . . 0.12 mm (0.005 in.)  
Adjusting Nut Torque . . . . . 9 N·m (79 lb-in.)

MX,4515A1,A12 -19-21OCT92

# Group 20 Cylinder Block and Internal Components

## OTHER MATERIAL

Number	Name	Use
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,4020A1,A1 -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalog.

Piston Ring Kit

Oversized Pistons

Undersized Connecting Rod

Crankshaft End Play Shim Kit

Cylinder Block

Overhaul Gasket Kit

Short Block Kit

MX,4520A1,A1 -19-21OCT92

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1

## REMOVE AND INSTALL CRANKCASE COVER

*NOTE: Approximate crankcase oil capacity is 1.1 L (2.33 pt).*

1. Drain crankcase.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

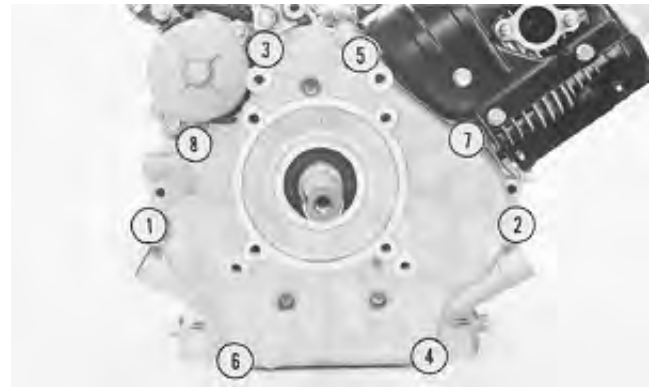
*NOTE: Do not force cover. Gears must mesh for proper positioning.*

*FE290D: Install stud in position (1).*

4. Install gasket and cover. Tighten cap screws using the sequence shown.

### TORQUE SPECIFICATIONS

Mounting Cap Screws . . . . . 26 N·m (230 lb-in.)  
 Oil Drain Plug . . . . . 21 N·m (186 lb-in.)



M53069 -UN-11APR89

MX,4520A1,A2 -19-21OCT92

## REMOVE AND INSTALL CAMSHAFT

1. Remove crankcase cover. (See this group.)
2. Remove crankshaft shim(s) (A).

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

3. Rotate crankshaft until timing marks (B) align.
4. Remove camshaft (C).
5. Inspect camshaft. (See this group.)
6. Apply clean engine oil to camshaft lobes and journals.
7. Align timing marks and install camshaft.
8. Install shim(s) on crankshaft.
9. Install crankcase cover.



M80412 -UN-25APR91

MX,4520A1,A3 -19-21OCT92

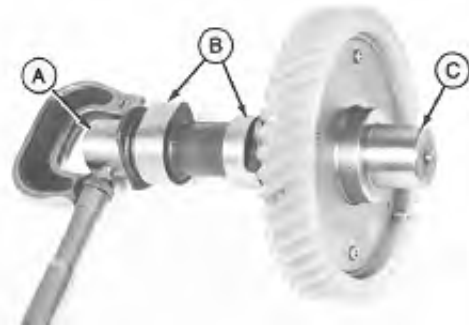
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## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

**NOTE:** Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.

Measure PTO side journal (C), flywheel side journal (A), and lobes (B). Replace camshaft and tappets if less than specifications.



### SPECIFICATIONS (MIN)

PTO Side Journal	Flywheel Side Journal	Cam Lobes
22.93 mm (0.903 in.)	22.93 mm (0.903 in.)	32.70 mm (1.287 in.)

MX,4520A1,A4 -19-21OCT92

M80413 -UN-25APR91

## INSPECT CAMSHAFT PLAIN BEARINGS

1. Remove camshaft. (See this group.)
2. Measure camshaft bearings in cylinder block and crankcase cover. Replace block or cover if diameter is greater than specification.
3. Install camshaft.

### SPECIFICATIONS (MAX)

Cylinder Block Bearing	Crankcase Cover Bearing
23.06 mm (0.908 in.)	23.06 mm (0.908 in.)



Cylinder Block



Crankcase Cover

MX,4520A1,A5 -19-21OCT92

M80414 -UN-25APR91

M80415 -UN-25APR91

## INSPECT AUTOMATIC COMPRESSION RELEASE (A.C.R.)

1. Remove camshaft. (See this group.)
2. Inspect automatic compression release (A.C.R.) for damage.
3. Inspect spring (C). Replace if worn or damaged.
4. Move weight(s) (B) by hand to check for proper operation.
5. Check that top of tab (A) sits slightly above cam lobe when weights are released. Tab should drop below cam when weights are operated.
6. Replace A.C.R. if it does not operate properly.
7. Install camshaft.

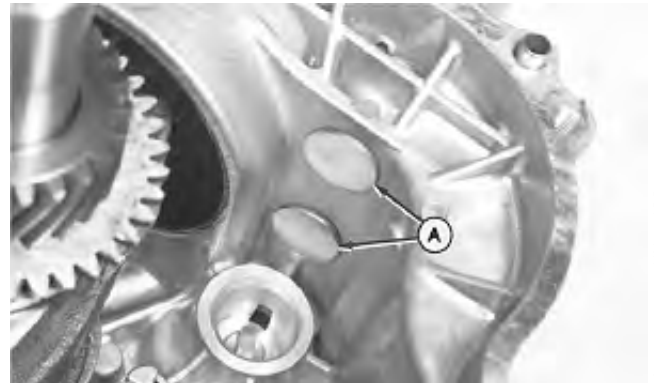


M80416 -UN-25APR91

MX,4520A1,A6 -19-21OCT92

## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)
- NOTE: Mark tappets so they can be installed in their original bores during assembly.*
2. Remove tappets (A).
  3. Inspect tappets for wear or damage. Replace if necessary.
  4. Apply clean engine oil to tappets and bores.
  5. Install tappets in original bores.
  6. Install camshaft.

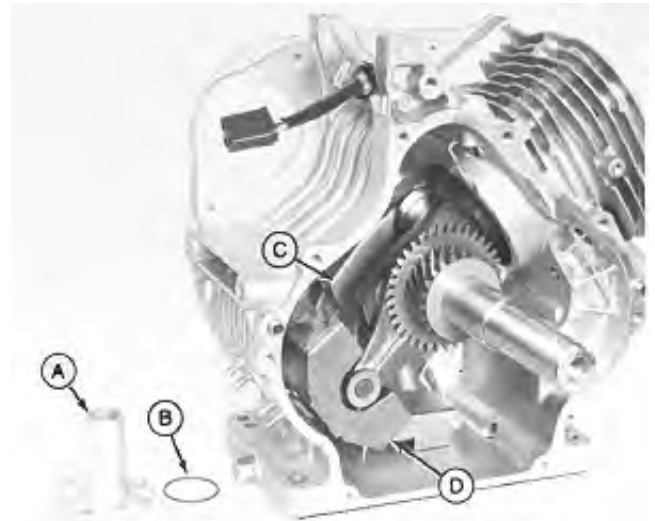


M80417 -UN-25APR91

MX,4520A1,A7 -19-21OCT92

## REMOVE AND INSTALL RECIPROCATING BALANCER

1. Remove flywheel. (See Group 10.)
2. Remove camshaft. (See this group.)
3. Remove piston. (See this group.)
4. Remove support shaft (A) and O-ring (B).
5. Remove crankshaft with balancer assembly (C).
6. Make repairs as necessary. (See procedures in this group.)
7. Inspect oil seals. (See this group.)
8. Cover keyway on flywheel end of crankshaft with tape to prevent damage to oil seal when installing assembly.
9. Put light film of oil on crankshaft bearing surfaces.
10. Install balancer assembly with crankshaft into crankcase.
11. Align balancer weight (D) in crankcase and install support shaft and O-ring.
12. Adjust crankshaft end play. (See this group.)
13. Tighten balancer bushing assembly to 7.3 N-m (65 lb-in.).
14. Install piston.
15. Install camshaft.
16. Install flywheel.



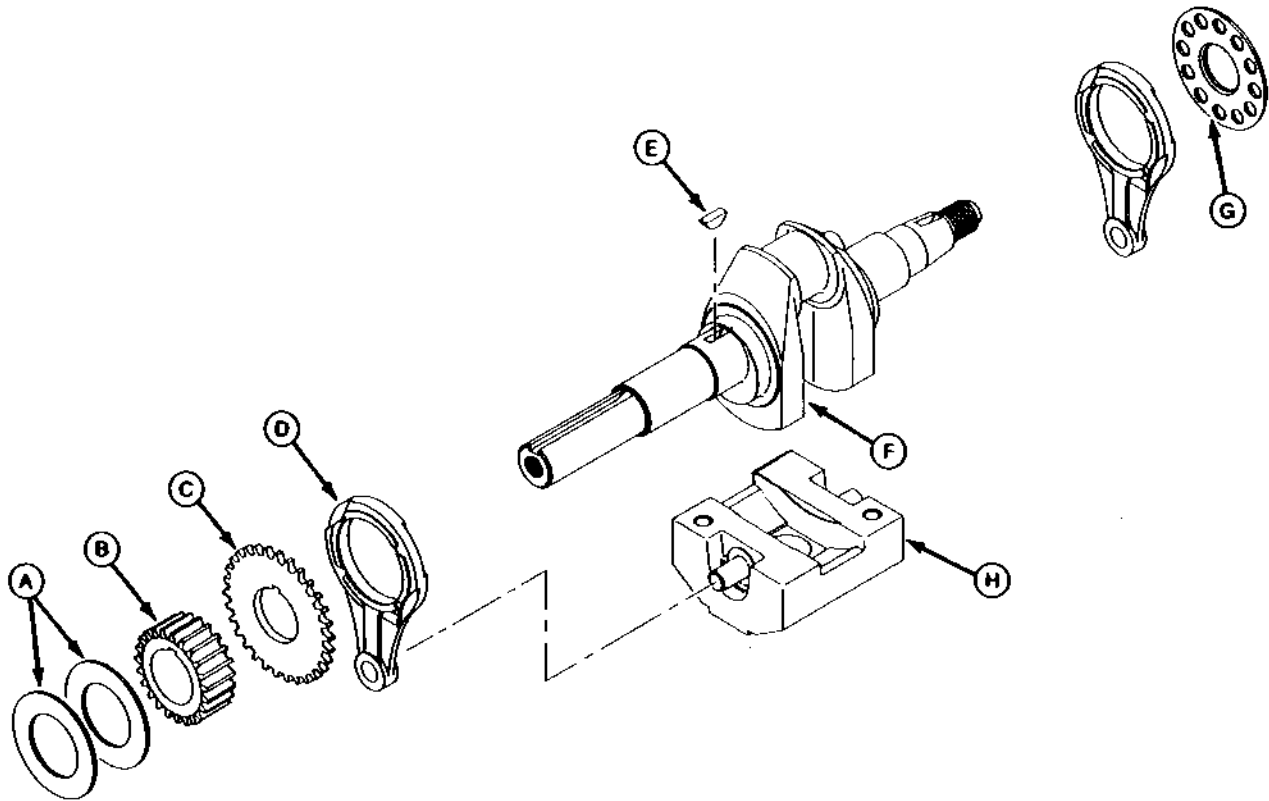
A—Support Shaft  
B—O-Ring  
C—Balancer Assembly  
D—Balancer Weight

M80418 -JUN-25APR91

MX,4520A1,A8 -19-21OCT92



## DISASSEMBLE AND ASSEMBLE RECIPROCATING BALANCER



A—Shim(s) (as required)  
B—Crank Gear

C—Governor Drive Gear  
D—Link Rod (2 used)

E—Woodruff Key  
F—Crankshaft

G—Collar  
H—Balancer Weight

1. Remove collar (G), gear (B), gear (C) and key (E).
2. Remove rods (D) and crankshaft (F).
3. Inspect crankshaft. (See this group.)
4. Inspect balancer assembly. (See this group.)
5. Put a light film of oil on bearing surfaces.
6. Install link rods on balancer weight (H) and crankshaft.
7. Install collar (G) with flat face toward link rod.
8. Install key and gear (C) with chamfered face toward link rod.
9. Install crank gear (B) with flat face toward governor drive gear.

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M60419 -JUN-08MAY91

MX,4520A1,A9 -19-21OCT92

## INSPECT BALANCER ASSEMBLY

1. Clean and inspect all parts for wear or damage. Replace parts, if necessary.
2. Measure link rod journals on crankshaft. Replace crankshaft if diameter is less than specifications.
3. Measure inside diameter of link rod bearings. Replace link rod if small end is greater than specifications. Replace bushing if large end is greater than specifications. (See this group.)
4. Measure inside diameter of support shaft bearing in balancer weight. If bearing is greater than specifications, replace balancer weight.
5. Inspect wrist pins for any damage. If necessary, replace balancer weight.
6. Measure support shaft diameter. Replace shaft if diameter is less than specification.

### DIAMETER SPECIFICATIONS

Link Rod Journal O.D. (MIN)	46.86 mm (1.845 in.)
Link Rod Small End I.D. (MAX)	12.06 mm (0.475 in.)
Link Rod Large End I.D. (MAX)	47.12 mm (1.855 in.)
Support Shaft Bearing I.D. (MAX)	26.10 mm (1.027 in.)
Support Shaft O.D. (MIN)	25.93 mm (1.021 in.)



Crankshaft

M80420 -UN-25APR91



Link Rod

M80421 -UN-25APR91



Balancer Weight

M80422 -UN-25APR91



Support Shaft

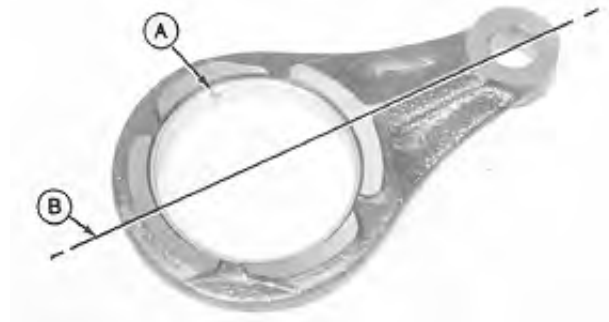
M80423 -UN-25APR91

MX,4520A1,A10 -19-21OCT92

## REPLACE LINK ROD BUSHINGS

*NOTE: Replace bushings using a bearing, bushing and seal driver set and a press.*

1. Remove bushings using a bushing, bearing and seal driver set and a press.
2. Install link rod bushings with seam (A) at a 90° angle to centerline (B).
3. Install bushing below surface to specifications.



M80424 -UN-25APR91

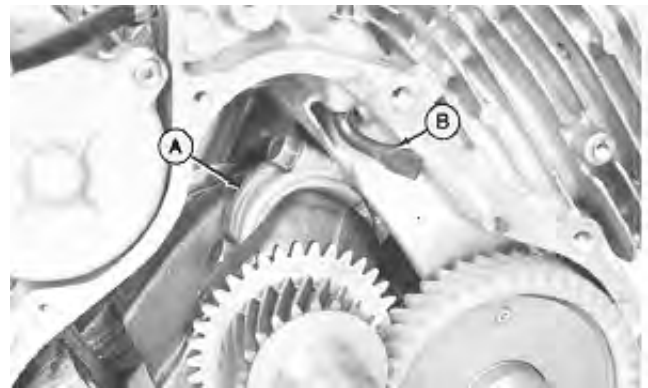
### SPECIFICATIONS

Bushing Depth . . . . . 1.00 mm (0.040 in.)

MX,4520A1,A11 -19-21OCT92

## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove crankcase cover. (See this group.)
3. Loosen governor arm nut and rotate governor shaft (B).
4. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
5. Remove cap screws and connecting rod cap (A).
6. Push piston and connecting rod from cylinder bore.
7. Make repairs as necessary. (See procedures in this group.)



M80425 -UN-25APR91

MX,4520A1,A12 -19-21OCT92

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8

8. Deglaze cylinder bore. (See Section 100, Group 15.)
9. Stagger piston ring end gaps 180° apart, but do not align with oil ring side rail end gaps.
10. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
11. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
12. Install piston assembly in cylinder bore with engraved match mark/arrow on piston head facing flywheel side of engine.
13. Install connecting rod cap and cap screws. Tighten cap screws to specifications.
14. Rotate governor shaft and tighten nut.
15. Install crankcase cover.
16. Install cylinder head.



M50074  
-UN-31AUG88

**TORQUE SPECIFICATIONS**

Connecting Rod Cap Screws . . . . . 20 N·m (177 lb-in.)

MX,4520A1,A13 -19-21OCT92

**DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD**

1. Remove circlip, piston pin (A) and connecting rod (B).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



M50063  
-UN-31AUG88  
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MX,4520A1,A14 -19-21OCT92

4. Align arrow match mark (A) on piston head opposite MADE IN JAPAN (B) on connecting rod.
5. Install piston pin and circlip.



MX,4520A1,A15 -19-21OCT92

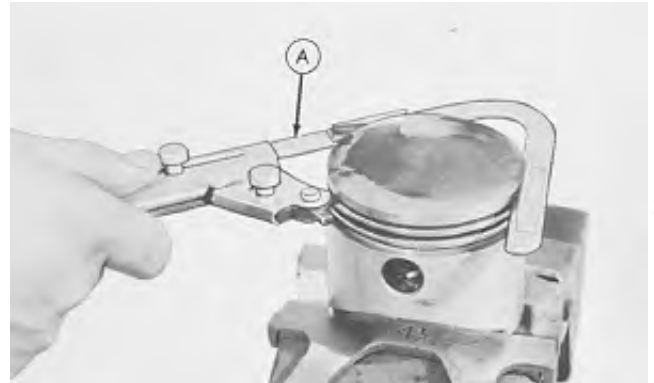
M80426 -UN-25APR91

### INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,4520A1,A16 -19-21OCT92

M29946 -JUN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: Inspect clearance visually. Replace piston if clearance appears excessive.*

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.

#### CLEARANCE SPECIFICATION (MAX)

Top Ring	Second Ring	Oil Control Ring
0.16 mm (0.006 in.)	0.14 mm (0.005 in.)	—



MX,4520A1,A17 -19-21OCT92

M38102 -JUN-29AUG88

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8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston pin bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

**Piston Pin O.D.  
(MIN)**

18.98 mm  
(0.747 in.)

**Piston Bore I.D.  
(MAX)**

19.03 mm  
(0.749 in.)



M50064 -UN-31AUG88



M80427 -UN-25APR91

MX,4520A1,A18 -19-21OCT92

10. Measure piston O.D. (A) perpendicular to piston pin bore.

11. Measure cylinder bore. (See Inspect Block in this group.)

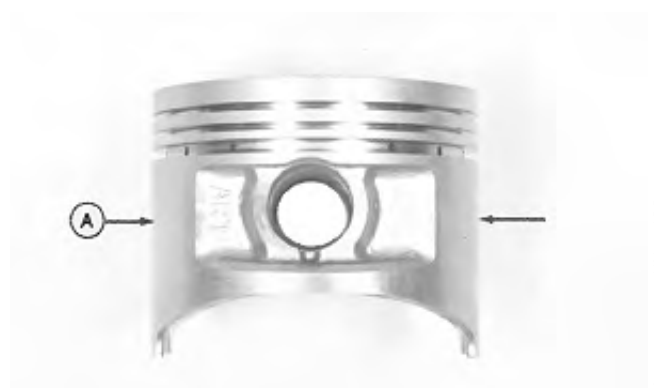
12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.

13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)

**SPECIFICATIONS**

Piston O.D. (A) . . . . . 77.85—77.87 mm (3.0649—3.0657 in.)

Piston-to-Cylinder  
Bore Clearance . . . . . 0.051—0.089 mm (0.002—0.0035 in.)

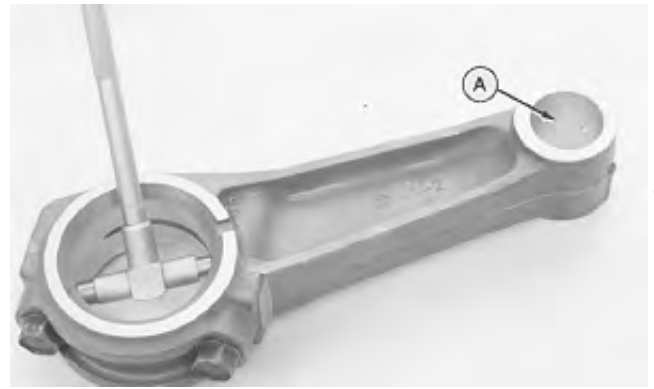


M80428 -UN-25APR91

MX,4520A1,A18A -19-21OCT92

## INSPECT CONNECTING ROD

1. Clean and inspect rod. Replace if scored.
2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
3. Install connecting rod cap. Tighten to 20 N-m (177 lb-in.).
4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



M50066 -UN-31AUG88

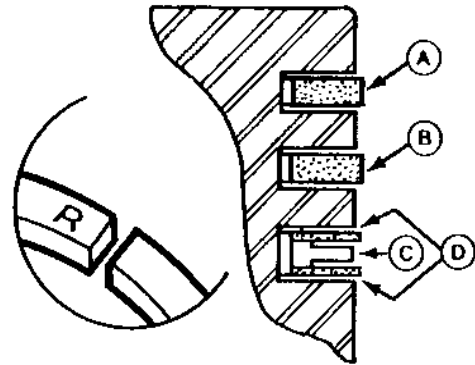
### BEARING I.D. SPECIFICATIONS (MAX)

Crankshaft Bearing	Piston Bearing
35.57 mm (1.400 in.) . . . . .	19.06 mm (0.750 in.)

MX,4520A1,A19 -19-21OCT92

## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)
4. Install top ring (A) and second ring (B) with R or NPR mark facing up. Rings should turn freely in grooves.
5. Oil ring is an assembly. Install spacer (C), then side rails (D). Put side rail end gaps 180° apart.



- A—Top Ring
- B—Second Ring
- C—Spacer
- D—Side Rails

M80429 -UN-08MAY91

MX,4520A1,A20 -19-21OCT92

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12

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.

### END GAP SPECIFICATIONS

Minimum End Gap	0.18 mm (0.007 in.)
Maximum End Gap	
Compression Rings	1.20 mm (0.047 in.)
Oil Ring Side Rails	Not Measured



M80430  
-UN-25APR91

MX,4520A1,A21 -19-21OCT92

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## REMOVE, INSPECT AND INSTALL CRANKSHAFT

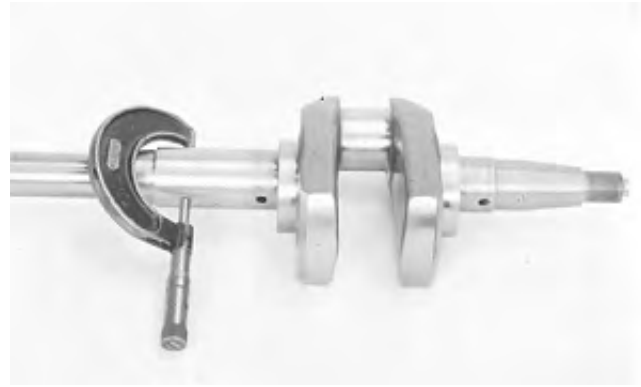
1. Remove camshaft. (See this group.)
2. Remove piston and connecting rod. (See this group.)
3. Remove balancer. (See this group.)
4. Remove crankshaft.

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

5. Check crankshaft alignment (T.I.R.). (See this group.)
6. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
7. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
8. Measure crankshaft main bearing journals and connecting rod journal. Replace crankshaft if measurements are less than specifications.

### JOURNAL SPECIFICATIONS (MIN)

Main Bearing Journal		Connecting Rod Journal
PTO Side	Flywheel Side	
29.92 mm (1.178 in.)	—	35.43 mm (1.395 in.)



M54495 -UN-09JAN91

*NOTE: An under-sized connecting rod is available through the parts catalog, if necessary.*

9. Connecting rod journal (A) can be resized to accept under-sized rod. Have grinding done by a reliable repair shop. Before sending crankshaft for grinding, inspect journal radii (B) for cracks.

10. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.

11. Put a light film of oil on crankshaft bearing surfaces.

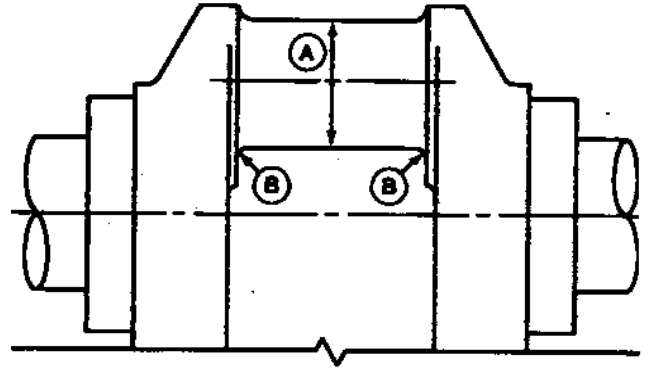
12. Pack grease in oil seals and install crankshaft.

13. Install balancer assembly on crankshaft.

14. Install crankshaft.

15. Install piston and connecting rod.

16. Install camshaft.



M38036 -UN-29AUG88

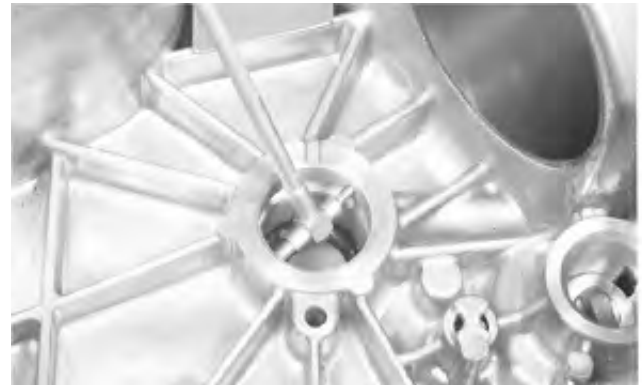
MX,4520A1,A23 -19-21OCT92

### INSPECT CRANKSHAFT PLAIN BEARING

1. Remove crankshaft. (See this group.)
2. Measure crankshaft bearing in crankcase. Replace crankcase, if diameter is greater than specifications. (See this group.)
3. Install crankshaft.

#### SPECIFICATIONS

Bearing I.D. (MAX) . . . . . 30.08 mm (1.184 in.)



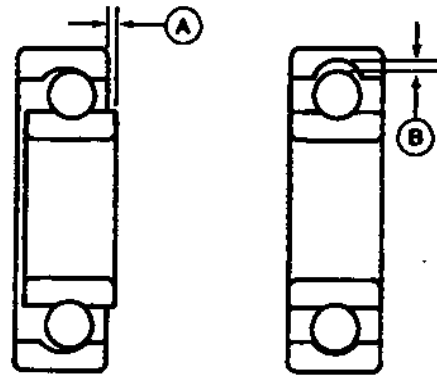
M80431 -UN-25APR91

MX,4520A1,A24 -19-21OCT92

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### INSPECT CRANKSHAFT BALL BEARING

1. Remove crankcase cover and oil seal. (See Inspect Oil Seals in this group.)
2. Remove crankshaft bearing using a bearing, bushing and seal driver set.
3. Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
4. Spin the bearing by hand and check for axial (A) and radial (B) free play.
5. Replace the bearing if it is noisy or has too much play.
6. Install bearing flush to inside of crankcase cover using a bearing, bushing and seal driver set.
7. Install oil seal.
8. Install crankcase cover.

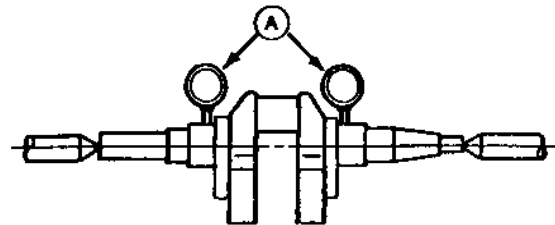


MX,4520A1,A25 -19-21OCT92

M38073 -UN-29AUG88

### CHECK CRANKSHAFT ALIGNMENT (TIR)

Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.



#### SPECIFICATIONS

Maximum TIR . . . . . 0.05 mm (0.002 in.)

MX,4520A1,A26 -19-21OCT92

M80432 -UN-08MAY91

### MEASURE CRANKSHAFT END PLAY

1. Measure end play using dial indicator (A). Record this measurement.
2. Move crankshaft in and out. Remove crankcase cover and adjust end play if not within specifications. (See this group.)



#### SPECIFICATIONS

End Play . . . . . 0.09—0.22 mm (0.004—0.009 in.)

MX,4520A1,A27 -19-21OCT92

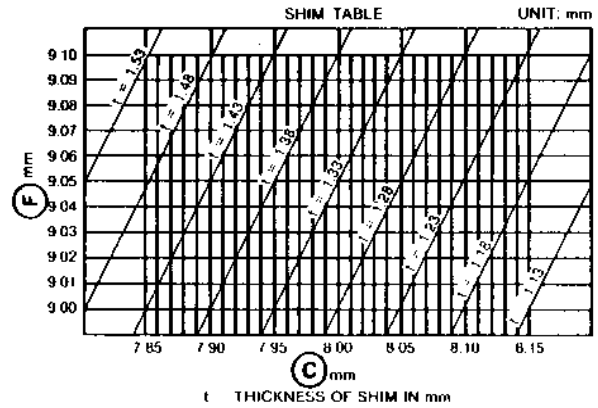
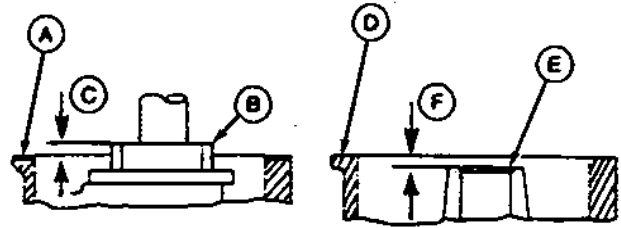
M80433 -UN-25APR91

45  
20  
16

### ADJUST CRANKSHAFT END PLAY

1. With gasket (A) installed on crankcase, measure from gasket surface to crankshaft gear surface (B). Record measurement (C).
2. Measure from crankcase cover mounting face (D) to PTO bearing end (E). Record measurement (F).
3. Locate measurements on appropriate table. Follow lines to where recorded measurements intersect. Choose the next smaller shim from the table.
4. Install shim on PTO shaft.
5. Install crankcase cover. (See this group.)

- A—Gasket
- B—Crank Gear Surface
- C—Measurement
- D—Crankcase Cover Mounting Face
- E—PTO Bearing End
- F—Measurement



MX,4520A1,A28 -19-21OCT92

-UN-31AUG88

M51545

-19-25APR91

M80434

## INSPECT OIL SEALS

*NOTE: Pack lithium base grease in new or used seals.*

1. Remove flywheel. (See Group 10.)
  2. Remove governor shaft. (See this group.)
  3. Inspect oil seals (A, B and C). Replace if necessary.
  4. Remove crankshaft. (See this group.)
  5. Remove worn or damaged seals with a screwdriver.
  6. Install seals with lip to inside of engine using a bearing, bushing and seal driver set. Press in seal on flywheel end until flush with hub.
- Press in seal on PTO end to specification, below crankcase cover flange surface.
- Press in governor shaft seal to specification, below flange surface.
7. Install crankshaft.
  8. Install flywheel.
  9. Install governor shaft.

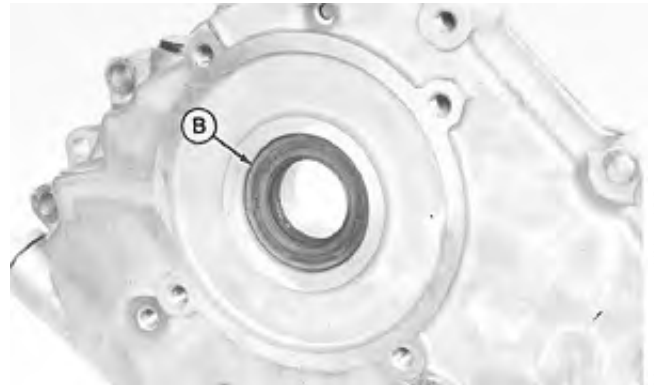
### SEAL DEPTH SPECIFICATIONS

PTO End . . . . .	4 mm (0.158 in.)
Governor Shaft . . . . .	1.42 mm (0.056 in.)



Flywheel End

M80435 -JUN-25APR91



PTO End

M80436 -JUN-25APR91



Governor Shaft

M80437 -JUN-25APR91

MX,4520A1,A29 -19-21OCT92

## INSPECT CYLINDER BLOCK

1. Remove crankshaft.
2. Clean and check block for cracks.
3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
4. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

MX,4520A1,A30 -19-21OCT92

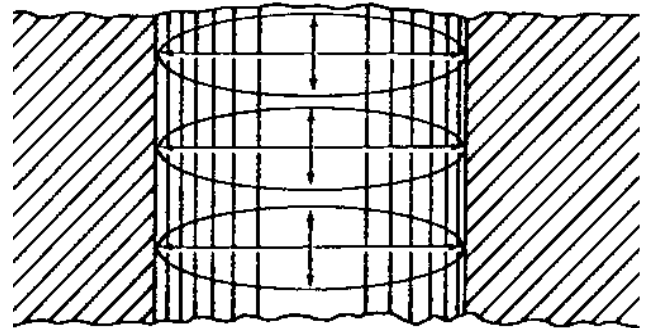
*NOTE: A bare block is available for service.*

5. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

6. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

*NOTE: If cylinder is rebored, oversize piston and rings must be installed.*

7. Install crankshaft.



M51745 -UN-23FEB89

### CYLINDER BORE SPECIFICATIONS

Standard . . . . .	77.98—78.00 mm (3.070—3.071 in)
Wear Limit . . . . .	78.07 mm (3.074 in.)
Out-of-Round (Max) . . . . .	0.056 mm (00022 in.)



M54799 -UN-25APR91

45  
20  
19

MX,4520A1,A31 -19-21OCT92

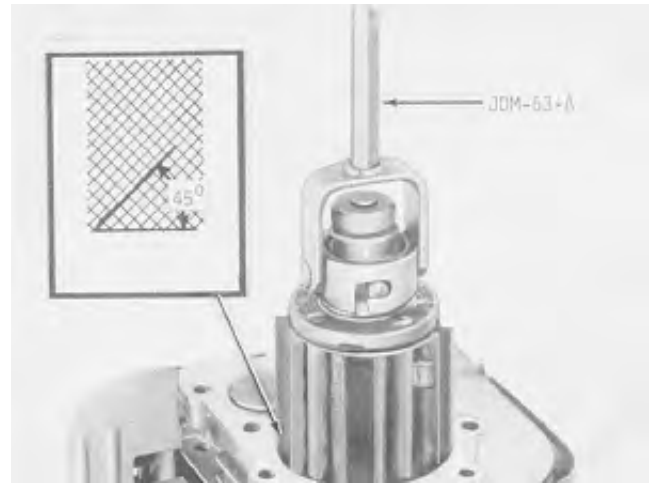
## REBORE CYLINDER BLOCK

**NOTE:** The cylinder block can be rebored to use 0.25, 0.50 or 0.75 mm (0.010, 0.020 or 0.030 in.) oversize pistons and rings. Have a reliable repair shop rebore the block, or use the drill press and honing tool.

1. Rebore cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from 200—250 rpm.
3. Lower and raise hone until ends extend 20—25 mm (0.75—1.0 in.) past ends of cylinder.
4. Turn adjusting nut on one hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately 20 times per minute.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

**NOTE:** Finish should not be smooth, but have a 40—60° cross-hatch pattern.

**IMPORTANT: Check stone for wear or damage. Use correct stone for the job.**



### CYLINDER INITIAL BORE SPECIFICATIONS

**Piston Oversize:**  
0.25 mm  
(0.010 in.)

78.21—78.23 mm  
(3.079—3.080 in.)

**Piston Oversize:**  
0.50 mm  
(0.020 in.)

78.46—78.48 mm  
(3.089—3.090 in.)

**Piston Oversize:**  
0.75 mm  
(0.030 in.)

78.71—78.73 mm  
(3.099—3.100 in.)

MX,4520A1,A32 -19-21OCT92

8. Hone the cylinder an additional 0.028—0.030 mm (0.0011—0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

**IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.**

9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

10. Dry the cylinder. Apply engine oil to cylinder wall.

M98,2040A,A9 -19-21OCT92

### DISASSEMBLE AND ASSEMBLE OIL PUMP

1. Remove stator. (See Group 25.)
2. Remove cover, gasket and plate (A).
3. Remove oil pump assembly (B), relief valve (C), ball and spring (D).
4. Inspect all parts. (See this group.)
5. Install oil pump assembly, relief spring, ball and valve.
6. Install plate, gasket and cover.
7. Install stator.



A—Plate  
B—Oil Pump Assembly  
C—Relief Valve  
D—Relief Spring and Ball

MX,4520A1,A33 -19-21OCT92

M53070 -UN-11APR89

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20  
21

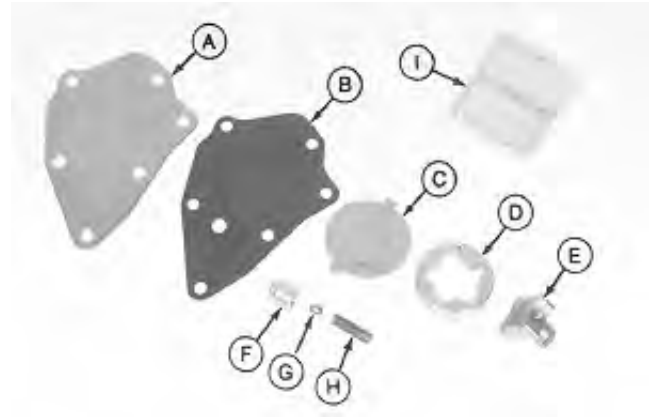


## INSPECT OIL PUMP

**NOTE:** To inspect or clean oil screen (I), remove crankcase cover. (See this group.)

1. Inspect all parts for wear or damage. Replace as necessary.

- A—Cover
- B—Gasket
- C—Rotor Cover
- D—Outer Rotor
- E—Rotor Shaft
- F—Relief Valve
- G—Check Ball
- H—Relief Spring



M80438 -UN-25APR91

MX,4520A1,A34 -19-21OCT92

2. Measure outside diameter of shaft. Replace both shaft and outer rotor if less than specifications.

3. Measure rotor shaft bearing. Replace crankcase cover if greater than specifications.

### ROTOR SHAFT SPECIFICATIONS

Minimum Shaft O.D. . . . . .	12.63 mm (0.497 in.)
Maximum Bearing I.D. . . . . .	12.77 mm (0.503 in.)



M80439 -UN-25APR91



M80440 -UN-25APR91

MX,4520A1,A35 -19-21OCT92

4. Measure thickness of outer rotor. Replace both outer rotor and shaft if less than specification.

5. Measure outer rotor bearing depth (A). Replace crankcase cover if greater than specification.

### OUTER ROTOR SPECIFICATIONS

Minimum Rotor Thickness . . . . .	9.92 mm (0.391 in.)
Maximum Bearing Depth . . . . .	10.17 mm (0.400 in.)



M80015 -UN-22JAN91



M80441 -UN-25APR91

MX,4520A1,A36 -19-21OCT92

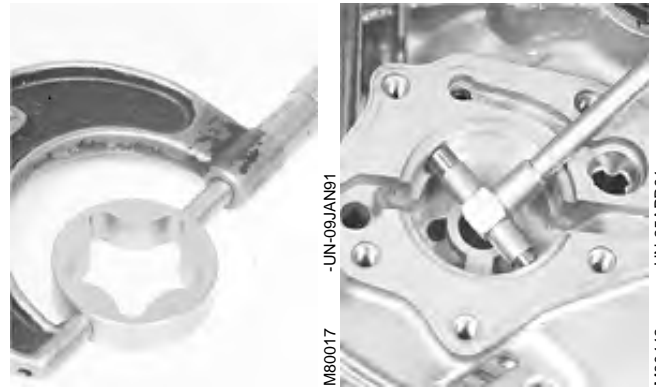
45  
20  
22

6. Measure outside diameter of outer rotor. Replace both outer rotor and shaft if less than specification.

7. Measure inside diameter of rotor bearing. Replace crankcase cover if greater than specification.

**OUTER ROTOR SPECIFICATIONS**

Minimum Rotor O.D. . . . . . 40.47 mm (1.596 in.)  
 Maximum Bearing I.D. . . . . . 40.77 mm (1.605 in.)



MX,4520A1,A37 -19-21OCT92

8. Measure relief valve spring. Replace if length is less than specifications.

**SPECIFICATIONS**

Spring Free Length (MIN) . . . . . 19 mm (0.748 in.)

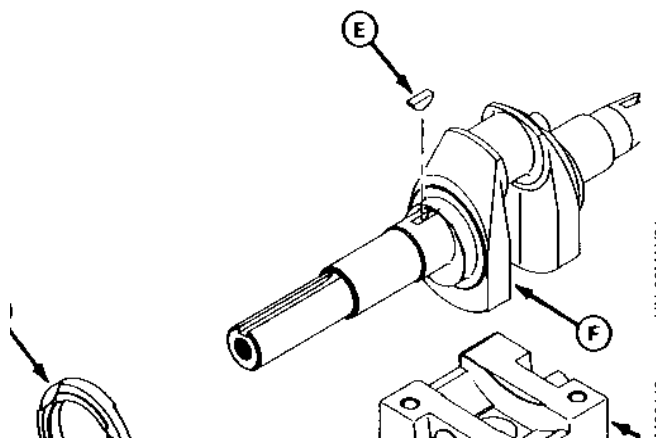


MX,4520A1,A38 -19-21OCT92

**REMOVE, INSPECT AND INSTALL OIL FILTER MANIFOLD—IF EQUIPPED**

1. Remove oil filter and manifold.
2. Inspect oil filter. Replace if excessively contaminated or damaged.
3. Inspect oil passages for clogs. Clean if needed.
4. Inspect rubber gasket (A). Replace if worn or damaged.
5. Install filter and manifold.

- A—Rubber Gasket
- B—Oil Filter Manifold
- C—Plug
- D—Cap Screw (2 used)
- E—Oil Filter



MX,4520A1,A39 -19-21OCT92

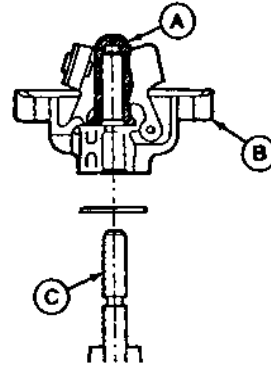
## INSPECT AND REPLACE GOVERNOR

**IMPORTANT:** Removal damages governor. If not damaged, do not remove.

1. Remove crankcase cover. (See this group.)
2. Inspect governor. If necessary to replace, remove with screwdriver.
3. If removed, press shaft (C) back into block until it protrudes 32.2—32.8 mm (1.267—1.291 in.).

*NOTE: Assemble sleeve and gear before installing assembly on shaft.*

4. Install sleeve (A) onto governor gear (B).
5. Install governor assembly onto shaft. Push down on assembly until it snaps into place.
6. Install crankcase cover.



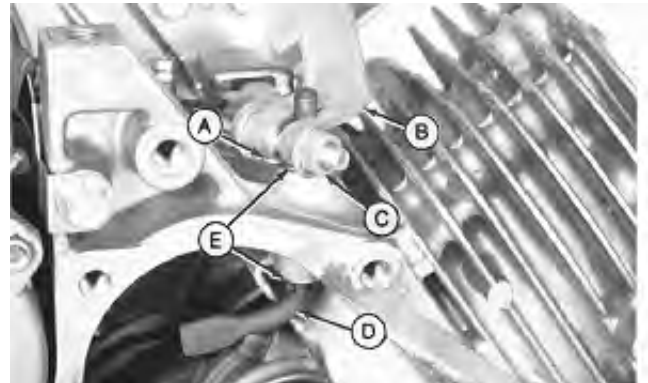
M51762 -UN-07SEP88

MX,4520A1,A40 -19-21OCT92

## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless seal is leaking or shaft is damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (D). Replace if damaged.
3. To replace shaft, loosen nut (C) on lever (B).
4. Remove retaining pin (A), governor shaft and washers (E).
5. Install washers, shaft and retaining pin. Tighten nut.



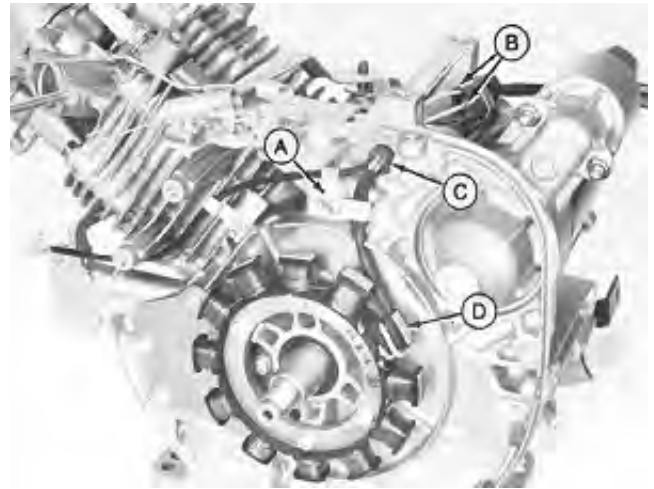
A—Retaining Pin  
B—Governor Lever  
C—Nut  
D—Governor Shaft  
E—Washers

M80444 -UN-25APR91

MX,4520A1,A41 -19-21OCT92

## REMOVE AND INSTALL STATOR

1. Remove flywheel. (See Group 10.)
2. Disconnect stator wiring leads (B).
3. Remove clamp (A).
4. Remove rubber grommet (C) and wiring leads from crankcase.
5. Remove stator (D).
6. Install stator.
7. Install wiring leads and rubber grommet.
8. Install clamp.
9. Connect stator wiring leads.
10. Install flywheel.



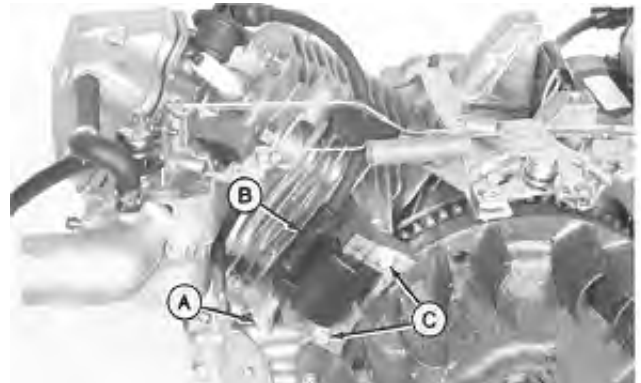
A—Clamp  
B—Wiring Leads  
C—Rubber Grommet  
D—Stator

MX,4525A1,A1 -19-21OCT92

M80445  
-UN-25APR91

## REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove blower housing. (See Group 10.)
2. Disconnect wiring lead (A).
3. Remove cap screws (C) and armature with coil (B).
4. Loosely install armature with coil.
5. Connect wiring lead.
6. Adjust armature air gap. (See this group.)
7. Install blower housing.



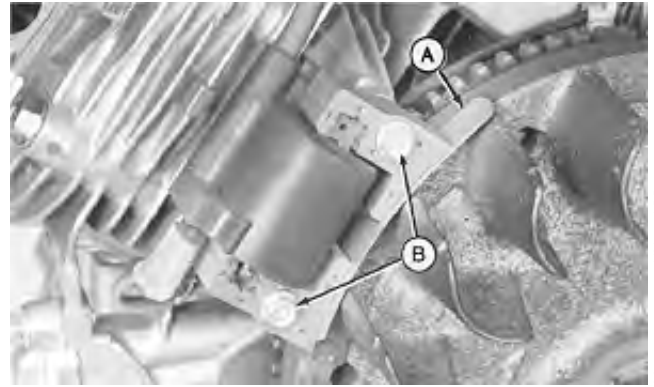
MX,4525A1,A2 -19-21OCT92

M80446  
-UN-25APR91

45  
25  
1

### ADJUST ARMATURE AIR GAP

1. Turn flywheel magnet away from armature.
2. Insert feeler gauge blade (B), between flywheel and armature.
3. Push armature against flywheel and tighten screws (B).
4. Turn flywheel to remove feeler gauge.



M80447 -UN-25APR91

#### AIR GAP SPECIFICATIONS

Feeler Gauge Blade . . . . . 0.30 mm (0.012 in.)

MX,4525A1,A3 -19-21OCT92

### REPLACE IGNITOR

1. Disconnect wiring lead (A).
2. Remove ignitor.
3. Install ignitor.
4. Connect wiring lead.



M80448 -UN-25APR91

MX,4525A1,A4 -19-21OCT92

## **OTHER MATERIAL**

<b>Number</b>	<b>Name</b>	<b>Use</b>
	Mineral Spirits	Clean Armature
	Multipurpose Grease	Grease Starter Parts

M98,2030A,ZB -19-21OCT92

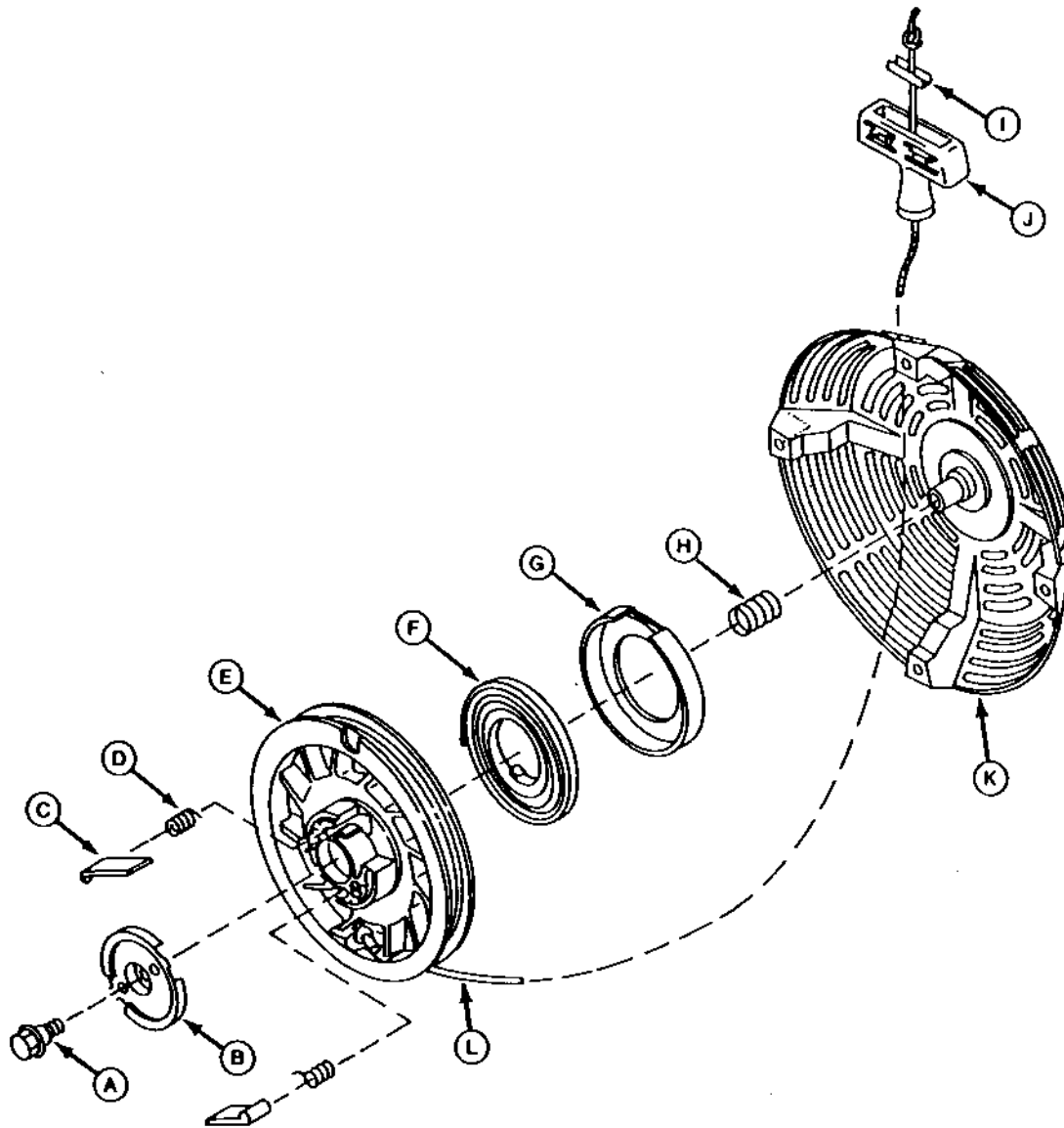
## **SERVICE PARTS KITS**

The following kits are available through your parts catalog:

- Recoil Starter Kit
- Complete Recoil Starter
- Complete Solenoid
- Brush Kit
- Complete Electric Starter

MX,4530A1,A1 -19-21OCT92

**DISASSEMBLE, INSPECT, AND ASSEMBLE RECOIL STARTER—IF EQUIPPED**



- A—Screw
- B—Retainer
- C—Pawl (2 used)

- D—Spring (2 used)
- E—Reel
- F—Spring

- G—Case
- H—Spring
- I—Clip

- J—Handle
- K—Housing
- L—Rope

Inspect all parts for wear or damage. Replace as necessary.

45  
30  
2

M80449 -JUN-08/MAY91

MX,4530A1,A2 -19-21OCT92

## REPLACE SPRING

**⚠ CAUTION:** Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.

1. Working from the center out, carefully unwind spring from spring case.
2. Hook outside spring tang in case. Wind spring into spring case, working toward center.



M54497 -UN-09JAN91

MX,4530A1,A3 -19-21OCT92

## ANALYZE ELECTRIC STARTER CONDITION

1. The starter overheats because of:
  - Long cranking.
  - Armature binding.
2. The starter operates poorly because of:
  - Armature binding.
  - Dirty or damaged starter drive.
  - Badly worn brushes or weak brush springs.
  - Excessive voltage drop in cranking system.
  - Battery or wiring defective.
  - Shorts, opens, or grounds in armature.

*NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.*

MX,4530A1,A4 -19-21OCT92

45  
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3



## BENCH TEST SOLENOID DRIVE STARTER

*NOTE: Perform bench test before disassembling starter motor to determine cause of problem.*

**IMPORTANT: Never operate motor longer than 20 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive operation, will seriously damage starting motor.**

1. Disconnect battery leads from battery.
2. Remove starter from engine.
3. Connect 12-volt battery (A) to starter battery terminal (B) and starter frame (C) using heavy duty cables.
4. Connect 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.*

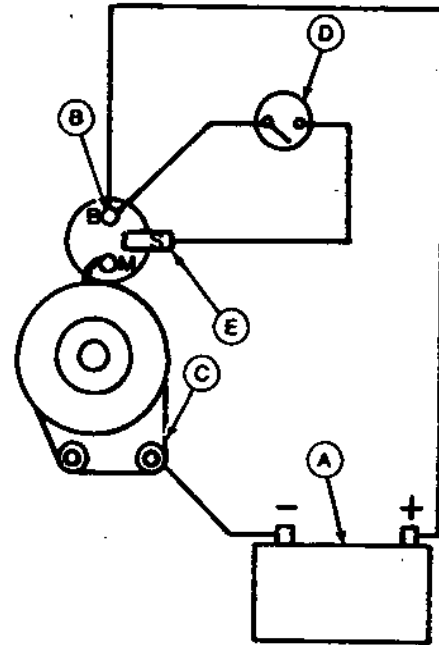
When switch is activated, starter should engage and run.

IF SOLENOID CHATTERS; hold-in winding is open-circuited.

IF NOTHING HAPPENS; either the solenoid pull-in winding is open-circuited or mechanical parts are sticking.

IF SOLENOID ENGAGES, BUT MOTOR DOES NOT RUN; check solenoid switch continuity, brushes, armature and field windings.

Solenoid cannot be repaired, replace it.



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

-JUN-29AUG88

M37149

MX,4530A1,A5 -19-21OCT92

## TEST SOLENOID

*NOTE: If bench test indicated solenoid problems, use an ohmmeter or test light to check solenoid.*

1. Test solenoid terminals (A and B) for continuity. There should be no continuity.
2. Depress switch arm (C). There should be continuity when arm is fully depressed.
3. Test for open circuits between terminal (B) and tang (D). There should be continuity.
4. Test for open circuits between tang (D) and body (E). There should be continuity.

If solenoid fails any test, it is defective and must be replaced.



A—Terminal  
 B—Terminal  
 C—Switch Arm  
 D—Tang  
 E—Solenoid Body

M51705 -UN-31AUG88

MX,4530A1,A6 -19-21OCT92

## CHECK STARTER ARMATURE ROTATION

1. Remove starter.
2. Rotate armature (A).

If armature does not rotate freely, armature may be bent or bearings may be worn. Disassemble, inspect and clean starter. (See this group.)

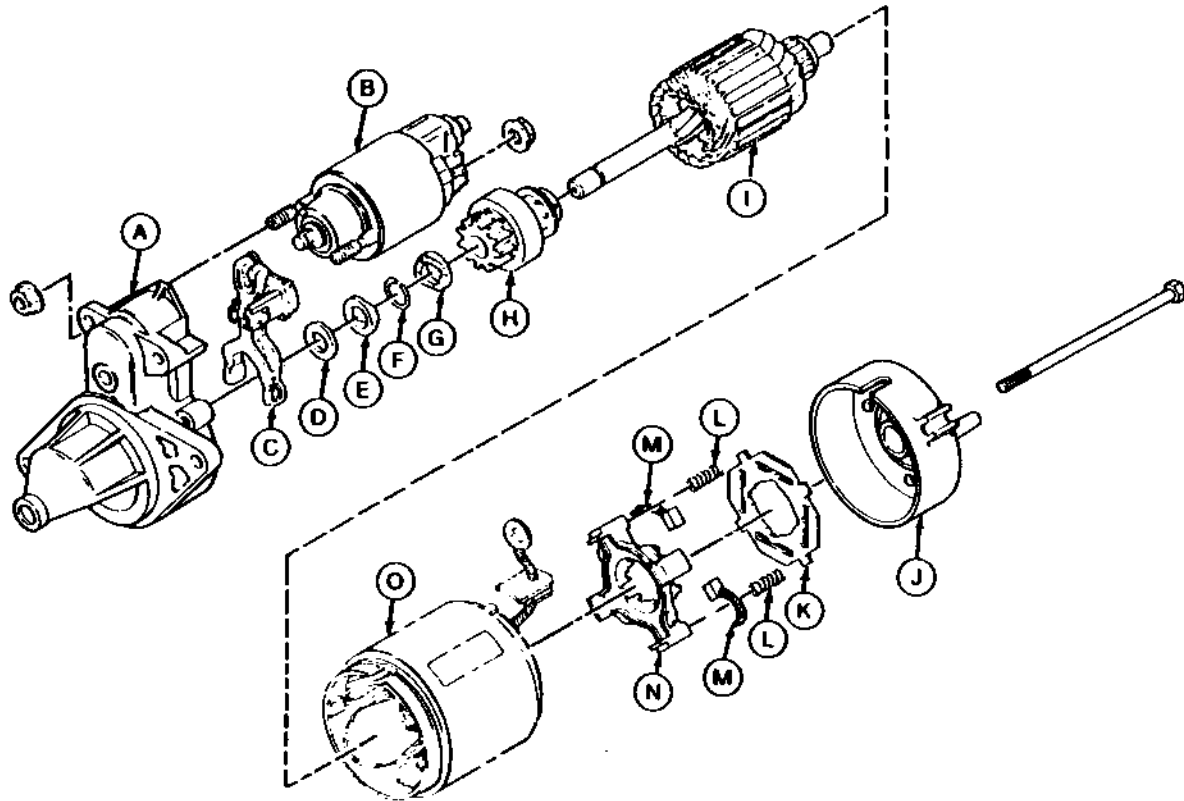


MX,4530A1,A7 -19-21OCT92

M53972 -UN-18APR90

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5

## INSPECT STARTER



A—Front Cover  
B—Solenoid  
C—Shift Lever  
D—Washer

E—Pinion Stopper Half  
F—Retaining Clip  
G—Pinion Stopper Half  
H—Pinion

I—Armature  
J—End Cover  
K—Insulator  
L—Brush Spring

M—Brush  
N—Brush Holder  
O—Body

1. Mark body and covers for correct alignment during reassembly.
2. Separate pinion stopper halves (E and G) to remove retaining clip (F).
3. Inspect parts for wear or damage.
4. Measure brushes. Replace brushes as a set if length of any one is less than 6 mm (0.240 in.).

5. Test starter armature and brushes. (See this group.)
6. Apply a thin coat of multipurpose grease to:
  - sliding surfaces of armature and solenoid shift lever.
  - armature shaft spline.
  - points where shaft contacts cover.
7. Assemble starter.

MX,4530A1,A8 -19-21OCT92

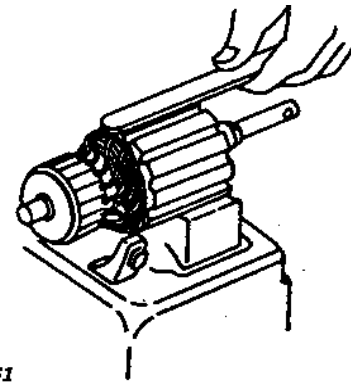
M55943 -JUN-19JUN90

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6

## TEST STARTER ARMATURE

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

1. Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.
2. Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.
3. If test indicates short circuited windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.



M24861

M24861 -UN-25AUG88

MX,4530A1,A9 -19-21OCT92

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

Armature windings are connected in parallel, so each commutator bar needs to be checked.

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



M50112 -UN-31AUG88

M98,2030A,AH -19-21OCT92

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

If test shows no continuity, there is an open circuit and armature must be replaced.



M50113 -UN-31AUG88

M98,2030A,M -19-21OCT92

### TEST FIELD COIL

*NOTE: Continuity tests are similar for all units.  
Illustrations are representative only.*

If equipped with brushes on body:

Replace field coil if not according to specifications.

#### CONTINUITY TEST

Brush-to-Housing ..... Continuity

Brush-to-Brush ..... Continuity



M50115 -UN-31AUG88



M50116 -UN-31AUG88

MX,4530A1,A10 -19-21OCT92

# Section 50 FB460V

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Replace Valve Guide Bushings . . . . .	50-20-4	Inspect . . . . .	50-20-23
Recondition Valve Seats . . . . .	50-20-5	Rebore . . . . .	50-20-25
Check Valve-To-Tappet Clearance . . . . .	50-20-6	Oil Pump	
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Inspect . . . . .	50-20-8	Manifold—If Equipped . . . . .	50-20-28
Inspect Plain Bearings . . . . .	50-20-8	Inspect and Replace	
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Continued on next page

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**Group 30—Starting Systems**

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**ENGINE APPLICATIONS CHART**

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

**LAWN TRACTORS**

<b>Machine</b>	<b>Engine Model No.</b>
112 L .....	FB460V-AS00
160/165 (Engine S.N. —181193) .....	FB460V-BS00
(Engine S.N. 181194— ) .....	FB460V-CS00

**RIDING MOWERS**

RX95 (Engine S.N. —181763) .....	FB460V-AS09
	FB460V-CS09-01
(Engine S.N. 181764—214347) .....	FB460V-BS09
(Engine S.N. 214372—290474) .....	FB460V-AS25
(Engine S.N. 290475— ) .....	FB460V-BS25
SX95 (Engine S.N. —181763) .....	FB460V-AS09
	FB460V-CS09-01
(Engine S.N. 181764—214347) .....	FB460V-BS09
(Engine S.N. 214348—290474) .....	FB460V-CS09
(Engine S.N. 290475— ) .....	FB460V-BS25
SRX95 .....	FB460V-BS25

**COMMERCIAL WALK-BEHIND MOWERS**

32/36/48/52-Inch .....	FB460V-CS02
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MX,5000A1,A1 -19-21OCT92

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## FB460V REPAIR SPECIFICATIONS

### GROUP 10—BLOWER HOUSING AND FLYWHEEL

Item	Specification
Flywheel Nut Torque . . . . .	88 N·m (65 lb-ft)
Flywheel Screen Gap . . . . .	1—3 mm (0.039—0.118 in.)

### GROUP 15—CYLINDER HEAD

Maximum Cylinder Head Warp . . . . .	0.40 mm (0.015 in.)
Cap Screw Torque In Sequence	
Initial Torque . . . . .	23 N·m (203 lb-in.)
Final Torque . . . . .	37 N·m (27 lb-ft)
Spark Plug Torque . . . . .	24 N·m (212 lb-in.)

### GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS

Valve Clearance (cold) . . . . .	0.10—0.16 mm (0.004—0.006 in.)
----------------------------------	--------------------------------

#### Valves and Springs

Minimum Spring Free Length	
Intake . . . . .	43 mm (1.710 in.)
Exhaust . . . . .	39 mm (1.540 in.)
Maximum Valve Guide I.D. . . . .	8.08 mm (0.318 in.)
Valve Guide Bushing Depth . . . . .	30 mm (1.178 in.)
Maximum Valve Stem Bend . . . . .	0.03 mm (0.001 in.)
Valve Seat and Face Angle . . . . .	45°
Valve Seating Width . . . . .	1.30 mm (0.050 in.)
Valve Margin . . . . .	0.60 mm (0.020 in.)
Valve Narrowing Angle . . . . .	30°

Continued on next page

MX,5000A1,A2 -19-21OCT92

**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Crankcase Cover</b>	
Oil Capacity	
With Filter . . . . .	1.6 L (3.38 pt)
Without Filter . . . . .	1.4 L (2.96 pt)
Cap Screw Torque . . . . .	20 N·m (177 lb-in.)
<b>Camshaft</b>	
Minimum End Journal O.D.	
PTO Side . . . . .	19.91 mm (0.784 in.)
Magneto Side . . . . .	15.91 mm (0.627 in.)
Minimum Lobe Height . . . . .	35.40 mm (1.395 in.)
Maximum Bearing I.D.	
Crankcase . . . . .	16.07 mm (0.633 in.)
Oil Pump Cover . . . . .	20.07 mm (0.790 in.)
<b>Reciprocating Balancer</b>	
Link Rod	
Minimum Journal O.D. . . . .	53.95 mm (2.124 in.)
Maximum Small End I.D. . . . .	12.60 mm (0.475 in.)
Maximum Large End I.D. . . . .	54.12 mm (2.132 in.)
Bushing Depth . . . . .	0.50 mm (0.020 in.)
<b>Balancer Weight</b>	
Maximum Bearing I.D. . . . .	26.10 mm (1.027 in.)
<b>Support Shaft</b>	
Minimum Shaft O.D. . . . .	25.93 mm (1.021 in.)
Support Shaft Assy Torque . . . . .	7.3 N·m (65 lb-in.)
<b>Piston</b>	
Maximum Ring Groove Clearance	
Top Ring . . . . .	0.16 mm (0.006 in.)
Second Ring . . . . .	0.14 mm (0.005 in.)
Oil Ring . . . . .	0.19 mm (0.007 in.)
Minimum Ring End Gap . . . . .	0.18 mm (0.007 in.)
Maximum Ring End Gap	
Compression Rings . . . . .	0.70 mm (0.028 in.)
Oil Ring . . . . .	1.20 mm (0.047 in.)
Minimum Pin O.D. . . . .	20.98 mm (0.827 in.)
Maximum Pin Bore I.D. . . . .	21.03 mm (0.829 in.)
Maximum Piston-to-Piston Pin Clearance . . . . .	0.05 mm (0.002 in.)
Piston O.D. . . . .	88.81—88.83 mm (3.4991—3.4999 in.)
Piston-to-Cylinder Bore Clearance . . . . .	0.156 mm (0.0061 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D. . . . .	37.02 mm (1.459 in.)
Maximum Piston Pin Bearing I.D. . . . .	21.01 mm (0.829 in.)
Maximum Connecting Rod-to-Piston Pin Clearance . . . . .	0.03 mm (0.001 in.)
Maximum Connecting Rod-to-Crankpin Clearance . . . . .	0.09 mm (0.004 in.)
End-Cap Screw Torque . . . . .	20 N·m (177 lb-in.)

Continued on next page.

MX,5000A1,A3 -19-21OCT92

**GROUP 20—CYLINDER BLOCK, VALVES AND INTERNAL COMPONENTS—CONTINUED**

Item	Specification
<b>Crankshaft</b>	
Minimum PTO Side Journal O.D. . . . .	34.91 mm (1.374 in.)
Minimum Connecting Rod Journal O.D. . . . .	36.95 mm (1.455 in.)
Maximum Crankcase Cover Plain Bearing I.D. . . . .	35.06 mm (1.380 in.)
Maximum T.I.R. . . . .	0.05 mm (0.002 in.)
End Play . . . . .	0.09—0.22 mm (0.004—0.009 in.)
 PTO Side Oil Seal Depth . . . . .	 0.50 mm (0.020 in.)
<b>Cylinder Block</b>	
Crankcase/Block Stud Torque . . . . .	36 N·m (27 lb-ft)
<b>Cylinder Bore</b>	
Standard Cylinder Bore I.D. . . . .	88.90—89.00 mm (3.500—3.504 in.)
Maximum Cylinder Bore I.D. . . . .	89.06 mm (3.506 in.)
Maximum Out-of-Round . . . . .	0.063 mm (0.0025 in.)
Maximum Taper . . . . .	0.076 mm (0.003 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.25 mm . . . . .	89.21—89.23 mm (3.512—3.513 in.)
0.50 mm . . . . .	89.46—89.48 mm (3.522—3.523 in.)
0.75 mm . . . . .	89.71—89.73 mm (3.532—3.533 in.)
<b>Oil Pump</b>	
Cover Cap Screw Torque . . . . .	17—23 N·m (150—204 lb-in.)
Minimum Rotor Shaft O.D. . . . .	12.63 mm (0.497 in.)
Maximum Rotor Shaft Bearing I.D. . . . .	12.76 mm (0.502 in.)
<b>Outer Rotor</b>	
Minimum Thickness . . . . .	11.92 mm (0.470 in.)
Minimum O.D. . . . .	28.90 mm (1.139 in.)
<b>Outer Rotor Bearing</b>	
Maximum Depth . . . . .	12.14 mm (0.478 in.)
Maximum I.D. . . . .	29.15 mm (1.148 in.)
Minimum Valve Spring Free Length . . . . .	19.00 mm (0.750 in.)

**GROUP 25—IGNITION AND CHARGING SYSTEM**

Ignition Coil Air Gap . . . . .	0.30 mm (0.012 in.)
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See Ignition Tests in this Group.

**GROUP 30—STARTING SYSTEMS**

Electric Starter

See Starter Specifications in this Group.

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## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Fuel Pump Gasket Kit

Complete Fuel Pump

Carburetor Gasket Kit

Main Jet High Altitude Kit

Complete Carburetor

Air Cleaner Assembly

MX,5005A1,A0 -19-21OCT92

## REMOVE AND INSTALL FUEL PUMP



**CAUTION: Gasoline is dangerous. Avoid fires due to smoking or careless maintenance practices.**

1. Disconnect vacuum line (A) and fuel lines (B). Close all openings using caps and plugs.
2. Remove fuel pump.
3. Inspect pump for wear or damage. Repair or replace as necessary.
4. Install fuel pump.
5. Connect vacuum and fuel lines.



M54481 -UN-25SEP90

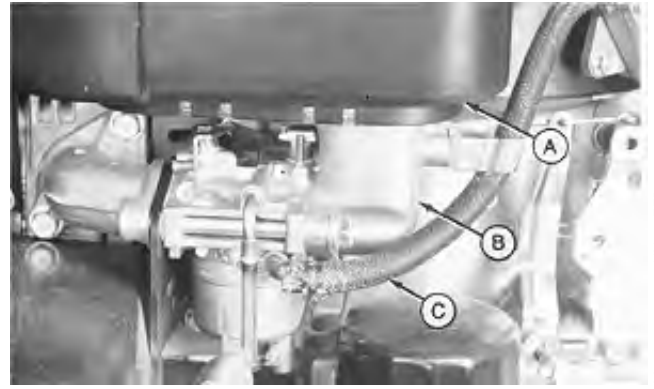
MX,5005A1,A1 -19-21OCT92

## REMOVE AND INSTALL CARBURETOR

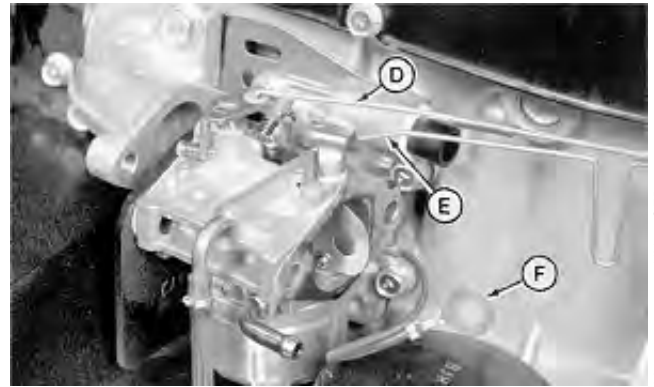
1. Remove air cleaner assembly (A).
2. Disconnect hose (C). Close all openings using caps and plugs.
3. Remove cap screws and duct (B).
4. Disconnect linkage (D and E).
5. Remove carburetor with gaskets.
6. Make repairs as necessary. (See procedures in this group.)
7. Connect linkage.

*NOTE: When installing cap screws make sure to install ground wire (F), if equipped, between head of cap screw and air intake duct.*

8. Install carburetor, gaskets and duct. Tighten cap screws.
9. Connect fuel hose.
10. Install air cleaner assembly.



M54781 -UN-19FEB91

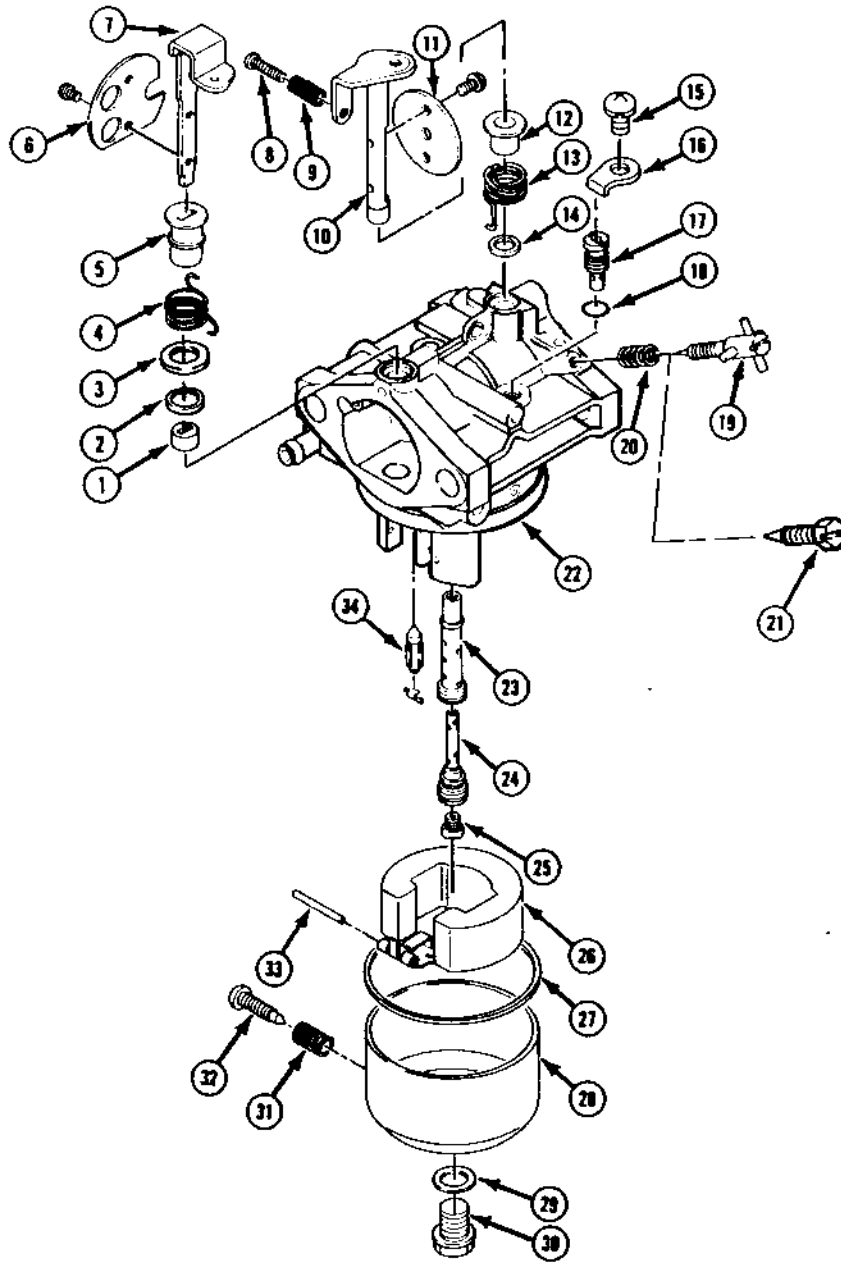


M54575 -UN-21SEP90

- A—Air Cleaner Assembly
- B—Air Intake Duct
- C—Fuel Hose
- D—Throttle Control Linkage
- E—Choke Control Linkage
- F—Ground Wire

MX,5005A1,A2 -19-21OCT92

## DISASSEMBLE, CLEAN, INSPECT AND ASSEMBLE CARBURETOR



- |               |                    |                    |                  |
|---------------|--------------------|--------------------|------------------|
| 1—Collar      | 10—Throttle Shaft  | 19—Screw**         | 27—Gasket        |
| 2—Seal**      | 11—Throttle Plate  | 20—Spring          | 28—Float Chamber |
| 3—Washer**    | 12—Ring            | 21—Screw*          | 29—Washer        |
| 4—Spring      | 13—Spring          | 22—Carburetor Body | 30—Plug          |
| 5—Collar      | 14—Seal            | 23—Main Nozzle     | 31—Spring        |
| 6—Choke Plate | 15—Screw**         | 24—Bleed Pipe      | 32—Drain Screw   |
| 7—Choke Shaft | 16—Plate**         | 25—Main Jet        | 33—Float Pin     |
| 8—Idle Screw  | 17—Fixed Pilot Jet | 26—Float           | 34—Needle Valve  |
| 9—Spring      | 18—O-Ring**        |                    |                  |

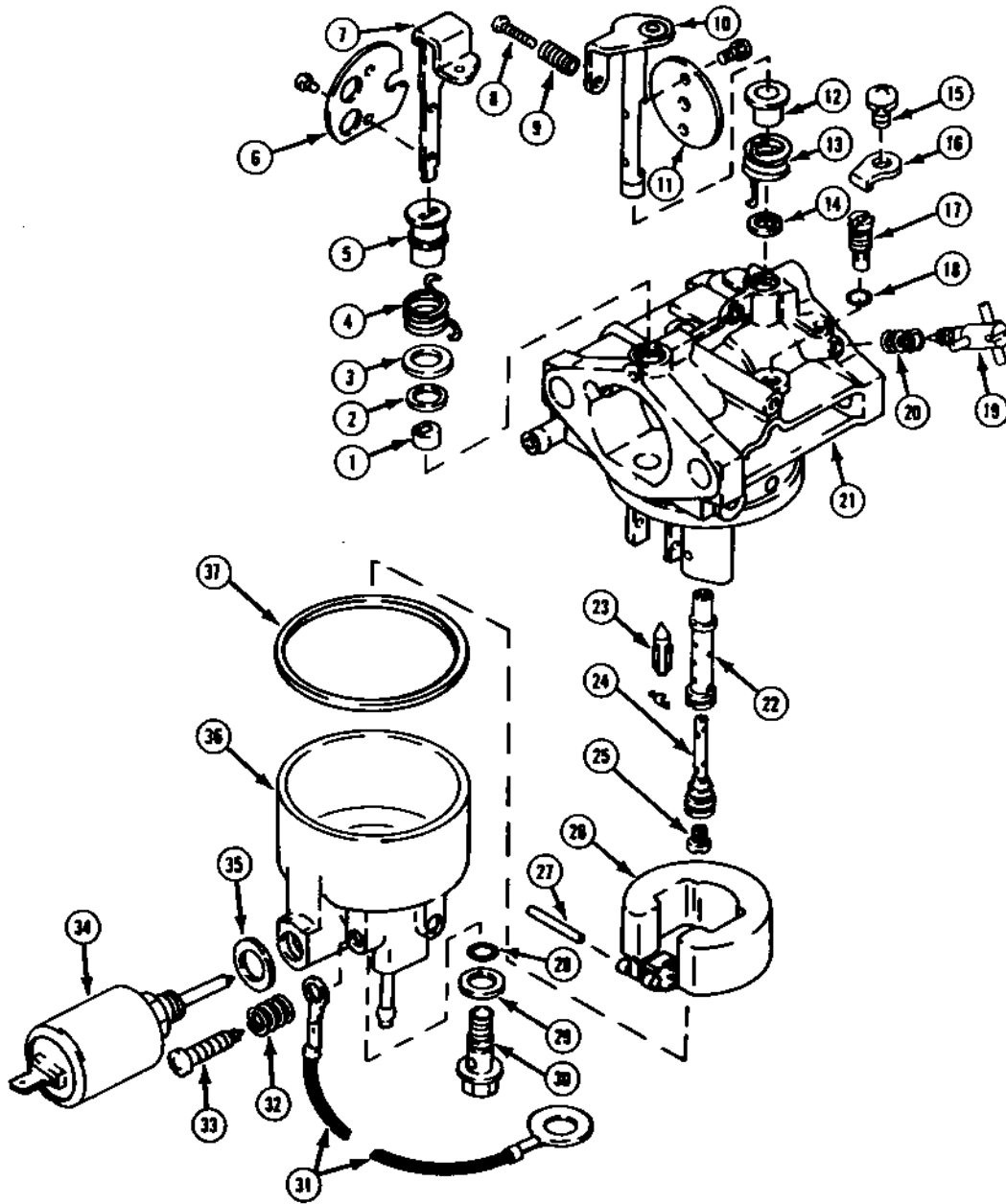
Without Fuel Shutoff Solenoid

\* Used without fixed pilot jet

\*\* Used with fixed pilot jet

M54782 -JUN-19FEB91

50-05-3



- |                   |                    |                    |                          |
|-------------------|--------------------|--------------------|--------------------------|
| 1—Collar          | 11—Throttle Plate  | 20—Spring          | 29—Washer                |
| 2—Seal            | 12—Ring            | 21—Carburetor Body | 30—Plug                  |
| 3—Washer          | 13—Spring          | 22—Main Nozzle     | 31—Ground Wiring Lead    |
| 4—Spring          | 14—Seal            | 23—Needle Valve    | 32—Spring                |
| 5—Collar          | 15—Screw           | 24—Bleed Pipe      | 33—Drain Screw           |
| 6—Choke Plate     | 16—Plate           | 25—Main Jet        | 34—Fuel Shutoff Solenoid |
| 7—Choke Shaft     | 17—Fixed Pilot Jet | 26—Float           | 35—Washer                |
| 8—Idle Screw      | 18—O-Ring          | 27—Float Pin       | 36—Float Chamber         |
| 9—Spring          | 19—Screw           | 28—O-Ring          | 37—Gasket                |
| 10—Throttle Shaft |                    |                    |                          |

With Fuel Shutoff Solenoid

M80202 -JUN-19FEB91

MX,5005A1,A4 -19-21OCT92

**IMPORTANT:** To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

**Do not clean holes or passages with small drill bits or wire.**

1. Soak carburetor body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

**IMPORTANT:** Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts: lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

*NOTE: Main jet high altitude kits are available.*

*Float is plastic. The float cannot be adjusted. Replace if necessary.*

MX,3005A1,A4 -19-21OCT92

## SERVICE BREATHER

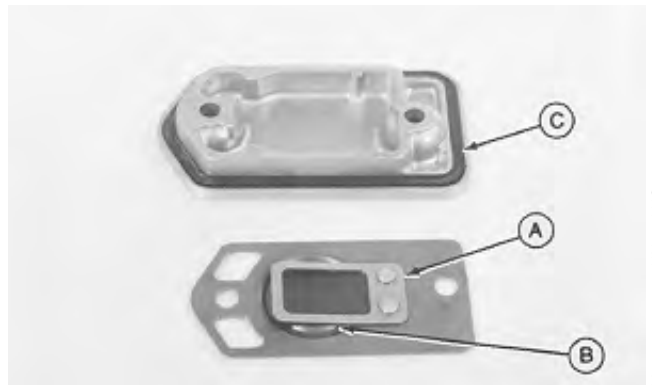
1. Remove flywheel. (See Group 10.)
2. Remove breather cover and valve.



M50144  
-UN-31AUG88

MX,5005A1,A5 -19-21OCT92

3. Inspect breather valve (A), valve seating surface (B) and rubber gasket (C) for wear or damage. Replace parts if necessary.



M38042  
-UN-29AUG88

MX,5005A1,A6 -19-21OCT92



4. Check that drainback hole (A) in bottom breather chamber is open before installing breather valve.
5. Install breather valve, gasket and cover.
6. Install flywheel.



M38043 -UN-29AUG88

MX,5005A1,A7 -19-21OCT92

## SERVICE AIR CLEANER

1. Remove and disassemble air cleaner.

**IMPORTANT: Do not clean paper element.**

2. Wash foam element (A) in detergent and water. Dry element.
3. Put 12—15 drops of engine oil on foam element (A). Squeeze out excess oil.

4. Replace paper element (B) if:
  - Element is oily, dirty, bent, torn, crushed, or obstructed in any way.
  - Seal is damaged.
  - Engine performance is poor.

5. Inspect body (C), gasket (D), and base (E) for damage. Replace if necessary.

**IMPORTANT: Any time air cleaner base is removed, use a silicon sealant (flexible sealant or RTV) on the outside diameter of the breather hose where it is inserted into the aluminum air intake housing.**

6. Assemble and install air cleaner.

*NOTE: After air cleaner assembly is installed, check for free choke operation.*



A—Foam Element  
 B—Paper Element  
 C—Body  
 D—Gasket  
 E—Base

M50023 -UN-31AUG88

MX,5005A1,A8 -19-21OCT92

### REMOVE AND INSTALL BLOWER HOUSING—RECOIL START

1. Disconnect spark plug cap.
2. Remove air cleaner assembly.
3. Remove dipstick tube (B).
4. Remove recoil starter (C) and guard.
5. Remove starter cup (D) and spacer(s).
6. Remove cap screws (A and E) and blower housing.
7. Install blower housing.
8. Install spacer(s) and starter cup.
9. Adjust flywheel screen. (See this group.)
10. Install recoil starter and guard.
11. Install dipstick tube.
12. Install air cleaner assembly.

A—Cap Screws  
B—Dipstick Tube  
C—Recoil Starter  
D—Starter Cup  
E—Cap Screws

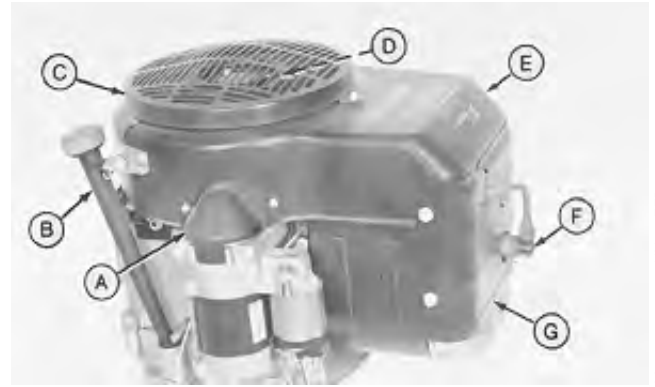


TY13365 -UN-23AUG88

MX,5010A1,A1 -19-21OCT92

## REMOVE AND INSTALL BLOWER HOUSING—ELECTRIC START

1. Disconnect spark plug cap (F).
2. Remove air cleaner assembly.
3. Remove fuel pump. (See Group 05.)
4. Remove cover (G).
5. Remove cover (A).
6. Remove dipstick tube (B).
7. Remove guard (C), screen (D) and spacer(s).
8. Remove blower housing (E).
9. Install blower housing.
10. Install spacer(s), screen and guard.
11. Adjust flywheel screen. (See this group.)
12. Install cylinder head cover and dipstick tube.
13. Install starter cover.
14. Install fuel pump.
15. Install air cleaner assembly.



- A—Starter Cover
- B—Dipstick Tube
- C—Guard
- D—Screen
- E—Blower Housing
- F—Spark Plug Cap
- G—Cylinder Head Cover

M80203 -UN-19FEB91

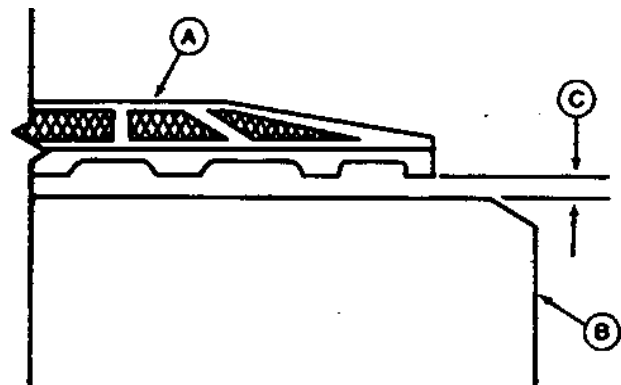
MX,5010A1,A2 -19-21OCT92

## FLYWHEEL SCREEN ADJUSTMENT

Adjust gap (C) between the blades under screen (A) and blower housing (B) to specifications using spacers.

### SPECIFICATIONS

Gap ..... 1—3 mm (0.039—0.118 in.)



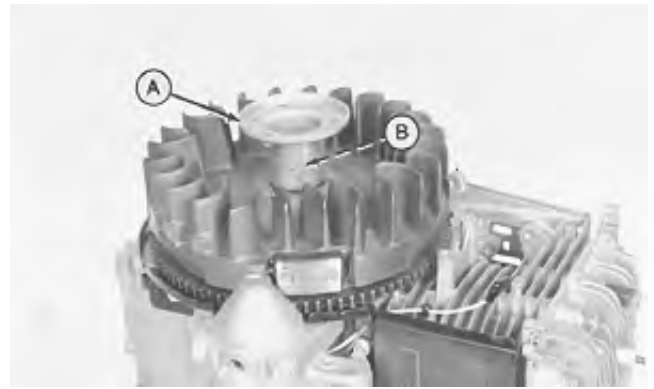
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MX,5010A1,A3 -19-21OCT92

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## REMOVE AND INSTALL FLYWHEEL

1. Remove armature with coil. (See Group 25.)
2. Hold flywheel and remove nut and washer (B).
3. Remove bracket (A), if equipped.
4. Remove flywheel using a flywheel puller.
5. Install flywheel and bracket, if equipped.
6. Install washer and nut. Tighten nut to 88 N·m (65 lb-ft).
7. Install armature with coil.



M54783 -UN-19FEB91

MX,5010A1,A4 -19-21OCT92



## OTHER MATERIAL

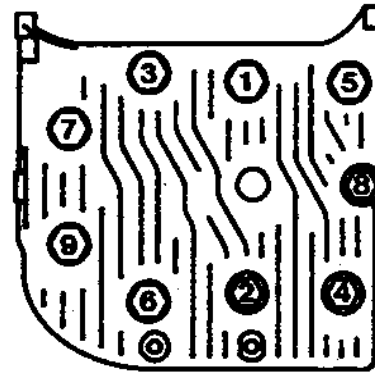
Number	Name	Use
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head

SCOTCH-BRITE is a trade mark of the 3M Company.

MX,5015A1,A1 -19-21OCT92

## REMOVE AND INSTALL CYLINDER HEAD

1. Remove blower housing. (See Group 10.)
2. Remove spark plug.
3. Remove cylinder head and gasket.
4. Make repairs as necessary. (See procedures in this group.)
5. Install cylinder head with new gasket. Install cap screws and tighten finger tight.
6. Tighten cap screws in sequence shown. Tighten to initial torque specifications.
7. Continue in sequence, 4 N·m (35 lb-in.) at a time, until final torque is as specified.
8. Install spark plug and tighten to specification.
9. Install blower housing.



M38035 -JUN-29AUG88

### TORQUE SPECIFICATIONS

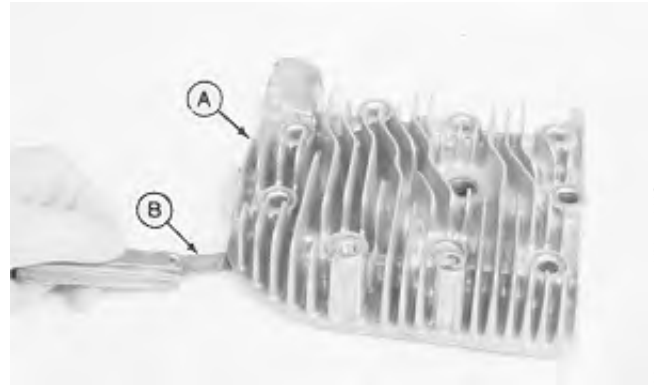
Initial Torque . . . . .	23 N·m (203 lb-in.)
Final Torque . . . . .	37 N·m (27 lb-ft)
Spark Plug . . . . .	24 N·m (212 lb-in.)

MX,5015A1,A2 -19-21OCT92

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## INSPECT CYLINDER HEAD

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Put cylinder head (A) on a surface plate. Check for distortion at several points around the head using a feeler gauge (B). Replace head if distortion is more than specifications.



M38039 -UN-29AUG88

### SPECIFICATIONS

Cylinder Head Distortion (Max) . . . . . 0.40 mm (0.015 in.)

MX,5015A1,A3 -19-21OCT92

# Group 20

## Cylinder Block, Valves and Internal Components

### SPECIAL OR ESSENTIAL TOOLS

*NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).*

DX,TOOLS -19-05JUN91

Valve Guide Driver Tool . . . . . JDG118

Replace valve guide bushings.

MX,JDG118 -19-21OCT92

Valve Guide Reamer . . . . . JDG497

Ream valve guide bushings.

MX,JDG497 -19-21OCT92

### OTHER MATERIAL

Number	Name	Use
	Valve Guide Cleaner	Clean valve guides
	Stanisol (or Kerosene)	Finish ream valve guide
	Prussian Blue Compound	Check valve seat contact
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.

MX,5020A1,A1 -19-21OCT92

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20  
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## **SERVICE PARTS KITS**

The following kits are available through your parts catalogue.

Camshaft and Tappet Kit

Piston Ring Kit

Oversized Pistons

Oversized Piston Rings

Undersized Connecting Rod

Cylinder Block

Overhaul Gasket Kit

Short Block Kit

Crankshaft End Play Shim Kit

Governor Kit

MX,5020A1,A1A -19-21OCT92

## REMOVE AND INSTALL VALVES AND SPRINGS

1. Remove carburetor. (See Group 05.)
2. Remove cylinder head. (See Group 15.)
3. Remove tappet chamber cover and gasket.

**IMPORTANT: Mark and keep springs and valves together.**

4. Compress valve spring (A) with a spring compressor (B) and move spring retainer (C) so larger hole is around valve stem.
5. Remove compressor, valves, springs, retainers and exhaust valve rotator (D).

*NOTE: Exhaust valve spring is shorter than intake valve spring.*

6. Inspect and analyze valves. (See Section 100, Group 05.)

7. Inspect springs, valve guides and seats. (See this group.)

8. Check valve-to-tappet clearance. (See this group.)

9. Check that drainback hole (E) is open.

10. Align valve springs, retainers and valve rotator in tappet chamber.

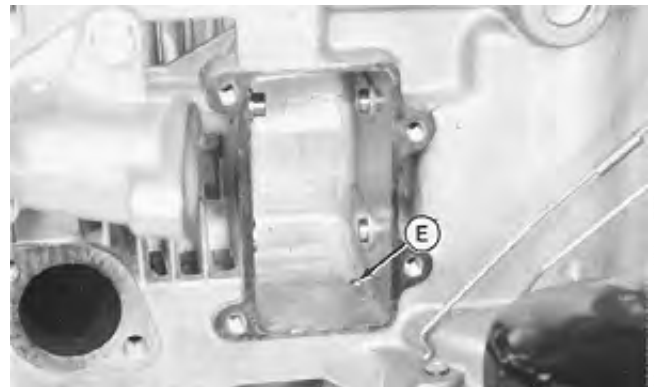
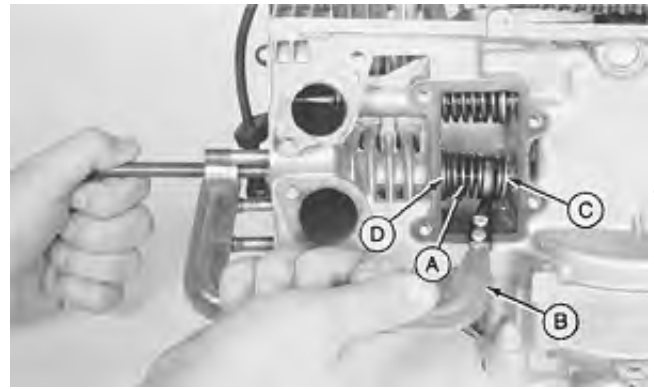
11. Coat valve stems with oil and install in cylinder block.

12. Compress each spring and position retainer so smaller hole is around valve stem.

13. Install tappet chamber cover and new gasket.

14. Install cylinder head.

15. Install carburetor.



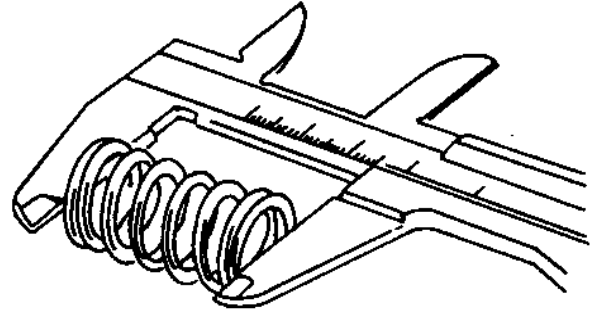
A—Valve Spring  
B—Spring Compressor  
C—Spring Retainer  
D—Valve Rotator  
E—Drainback Hole

### INSPECT VALVE SPRINGS

Inspect valve springs. Replace springs if damaged or if free length is less than specification.

#### FREE LENGTH SPECIFICATION (MIN)

Intake .....	43.30 mm (1.710 in.)
Exhaust .....	39.00 mm (1.540 in.)



MX,5020A1,A3 -19-21OCT92

M50036 -UN-31AUG88

### INSPECT VALVE GUIDES

Clean inside of valve guides with valve guide cleaner.

Measure inside diameter of valve guide bushings (A). Replace bushings if inside diameters are greater than specifications. (See this group.)

#### SPECIFICATIONS (MAX) I.D.

Intake and Exhaust .....	8.08 mm (0.318 in.)
--------------------------	---------------------

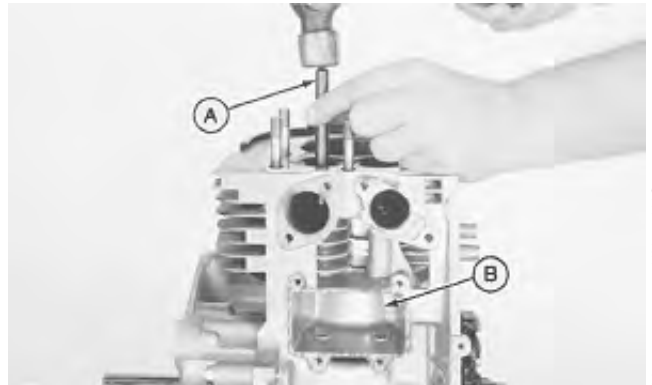


MX,5020A1,A4 -19-21OCT92

M38126 -UN-29AUG88

### REPLACE VALVE GUIDE BUSHINGS

1. Drive valve guide bushing into tappet chamber (B) using JDG118 Valve Guide Driver (A). Use a locking pliers to crush end of bushing in chamber. Drive remaining part of bushing into chamber and remove.



MX,5020A1,A5 -19-21OCT92

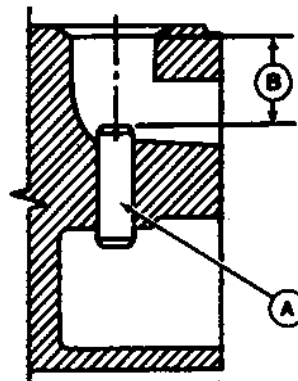
M38127 -UN-29AUG88

2. Use valve guide driver to install new bushing (A).

Drive bushing into cylinder body until distance (B), from valve seat counterbore to top of bushing, is according specifications.

#### SPECIFICATIONS

Distance (B) .....	30 mm (1.178 in.)
--------------------	-------------------



B	IN	30MM
	EX	30MM

MX,5020A1,A6 -19-21OCT92

M38128 -UN-29AUG88

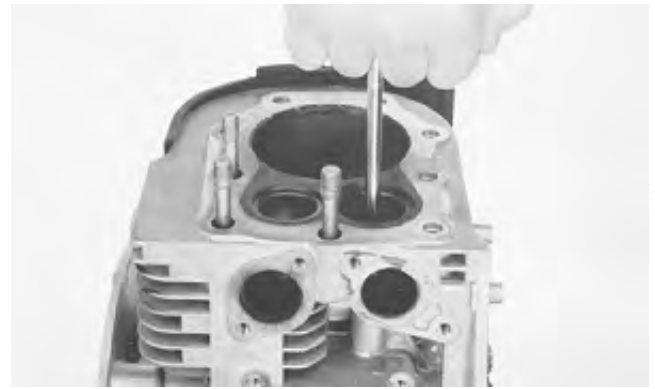
50  
20  
4

3. Finish reaming valve guide bushings with stanisol or kerosene lubricant and a JDG497 8 mm, Valve Guide Reamer. Turn reamer clockwise.

4. Thoroughly clean valve area before assembly.

**FINISHED I.D. SPECIFICATIONS**

Valve Guides . . . . . 8—8.02 mm (0.315—0.316)



M38129 -UN-29AUG88

MX,5020A1,A7 -19-21OCT92

**RECONDITION VALVE SEATS**

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.

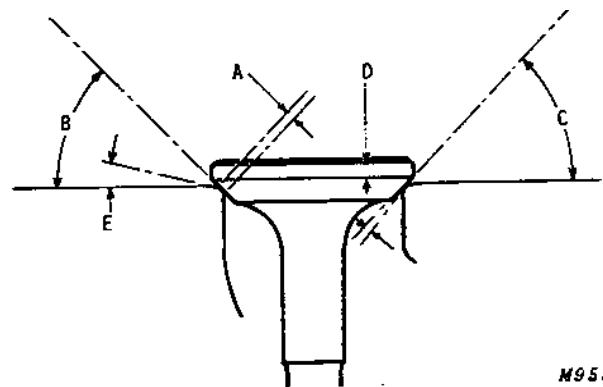
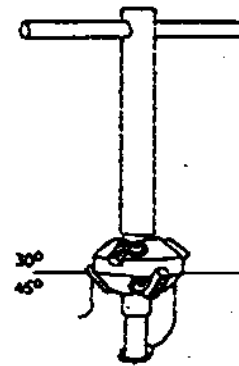
2. To recondition valve seat, cut a 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).

3. Cut valve seating surface (A) as close as possible to specifications.

4. Lap valves to seats after refacing. (See Section 100, Group 05.)

**SPECIFICATIONS**

A—Valve Seating Surface . . . . . 1.30 mm (0.050 in.)  
 B—Valve Seat Angle . . . . . 45°  
 C—Valve Face Angle . . . . . 45°  
 D—Valve Margin . . . . . 0.60 mm (0.020 in.)  
 E—Valve Narrowing Angle . . . . . 30°



M955

-UN-31AUG88

M51558

-UN-01SEP88

M9552

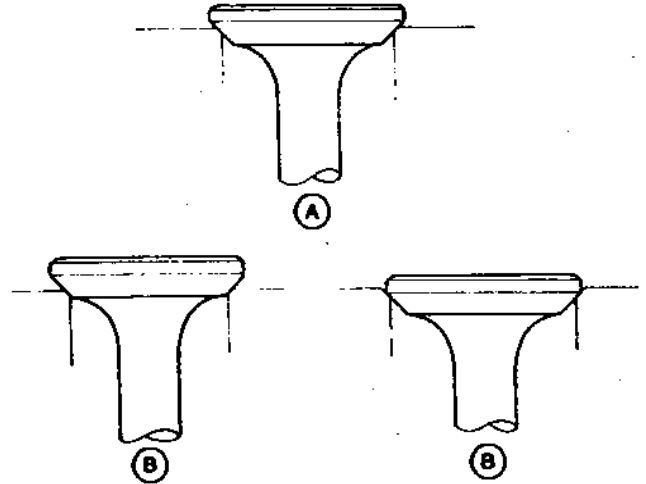
MX,5020A1,A8 -19-21OCT92

50  
20

5. Center valve seat on the valve face:

- (A) shows correct position.
- (B) shows incorrect.

6. Check seat for good contact using Prussian Blue Compound.



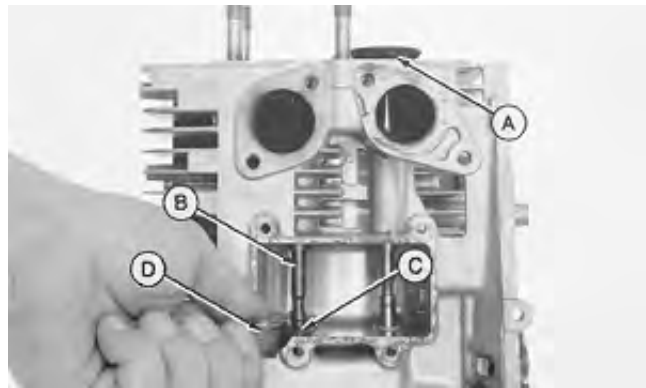
M18615 -UN-07SEP88

MX,3015A1,A9 -19-21OCT92

### CHECK VALVE-TO-TAPPET CLEARANCE

*NOTE: Valve grinding changes the valve-to-tappet clearance. Check clearance when engine is cold.*

1. Install valves in cylinder block.
2. Turn crankshaft until intake valve (A) is at its highest position. Check clearance between valve (B) and tappet (C), with feeler gauge (D) and compare to specifications.
3. Grind end of valve stem to obtain proper clearance.



M38089 -UN-29AUG88

#### VALVE CLEARANCE SPECIFICATIONS

Intake and Exhaust . . . . . 0.10—0.16 mm (0.004—0.006 in.)

- A—Intake Valve
- B—Exhaust Valve
- C—Tappet
- D—Feeler Gauge

MX,5020A1,A9 -19-21OCT92

## REMOVE AND INSTALL CRANKCASE COVER

*NOTE: Approximate crankcase oil capacity is:*

*With Filter .....1.6L (3.38 pt)*  
*Without Filter .....1.4L (2.96 pt)*

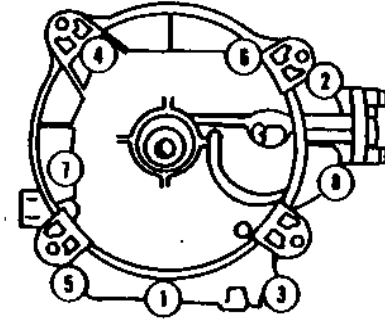
1. Drain crankcase.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

*NOTE: Do not force cover. Gears must mesh for proper positioning.*

4. Install gasket and cover. Tighten cap screws using the sequence shown.

### TORQUE SPECIFICATIONS

Mounting Cap Screws . . . . . 20 N·m (177 lb-in.)



M80205 -UN-19FEB91

MX.5020A1.A10 -19-21OCT92

## REMOVE AND INSTALL CAMSHAFT

1. Remove crankcase cover. (See this group.)

**IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.**

2. Rotate crankshaft until timing marks (A) align.
3. Remove camshaft (B).
4. Inspect camshaft. (See this group.)
5. Apply clean engine oil to camshaft lobes and journals.
6. Align timing marks and install camshaft.
7. Install crankcase cover.



M54784 -UN-19FEB91

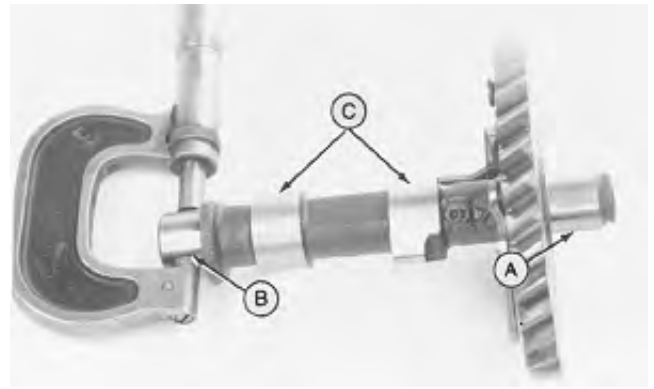
MX.5020A1.A11 -19-21OCT92

## INSPECT CAMSHAFT

Inspect camshaft for worn or broken teeth.

**NOTE:** Camshaft and tappets are a matched set.  
Replace both camshaft and tappets if necessary.

Measure PTO side journal (A), flywheel side journal (B), and lobes (C). Replace camshaft and tappets if less than specifications.



M80172 -UN-11FEB91

### SPECIFICATIONS (MIN)

PTO Side Journal	Flywheel Side Journal	Cam Lobes
19.91 mm (0.784 in.)	15.91 mm (0.627 in.)	35.40 mm (1.395 in.)

MX,5020A1,A12 -19-21OCT92

## INSPECT CAMSHAFT PLAIN BEARINGS

1. Remove camshaft. (See this group.)
2. Measure camshaft bearings in cylinder block and oil pump cover. Replace block or cover if diameter is greater than specification.
3. Install camshaft.

### SPECIFICATIONS (MAX)

Cylinder Block Bearing	Oil Pump Cover Bearing
16.07 mm (0.633 in.)	20.07 mm (0.790 in.)



Cylinder Block

M54785 -UN-19FEB91



Oil Pump Cover

M54786 -UN-19FEB91

MX,5020A1,A13 -19-21OCT92

## REMOVE, INSPECT AND INSTALL TAPPETS

1. Remove camshaft. (See this group.)

*NOTE: Mark tappets so they can be installed in their original bores during assembly.*

2. Remove tappets (A).

3. Inspect tappets for wear or damage. Replace if necessary.

4. Apply clean engine oil to tappets and bores.

5. Install tappets in original bores.

6. Install camshaft.



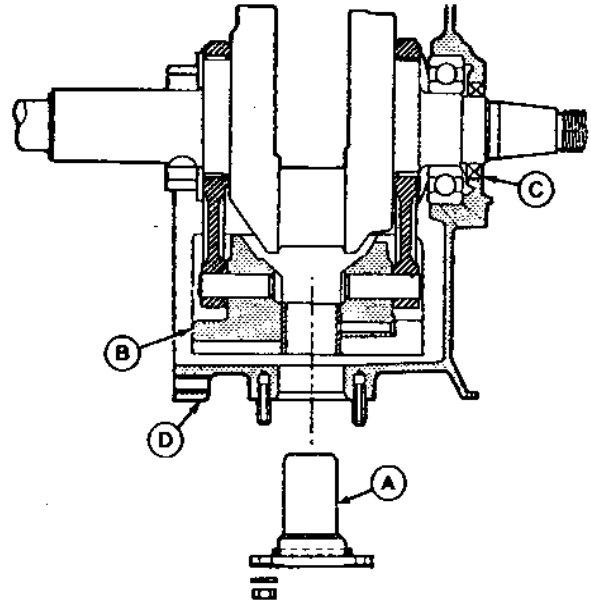
M38092  
-UN-29AUG88

MX,5020A1,A14 -19-21OCT92



## REMOVE AND INSTALL RECIPROCATING BALANCER

1. Remove flywheel. (See Group 10.)
2. Remove camshaft. (See this group.)
3. Remove piston. (See this group.)
4. Remove support shaft (A).
5. Remove crankshaft with balancer assembly (B).
6. Make repairs as necessary. (See procedures in this group.)
7. Inspect oil seals. (See this group.)
8. Cover keyway on flywheel end of crankshaft with tape to prevent damage to seal (C) when installing assembly.
9. Put light film of oil on crankshaft bearing surfaces.
10. Pack lithium based grease in oil seals.
11. Install balancer assembly with crankshaft into crankcase (D).
12. Align balancer weight in crankcase and install support shaft.
13. Adjust crankshaft end play. (See this group.)
14. Install Support shaft bushing nut and torque to 7.3 N·m (65 lb-in.).
15. Install piston.
16. Install camshaft.
16. Install flywheel.



A—Support Shaft  
 B—Balancer Assembly  
 C—Seal  
 D—Crankcase

-JUN-07SEP88

MS1758

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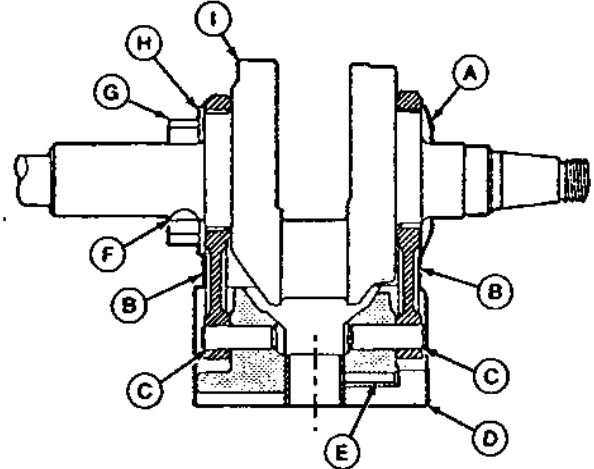
MX,5020A1,A15 -19-21OCT92

## DISASSEMBLE AND ASSEMBLE RECIPROCATING BALANCER

1. Remove collar (A), gear (G), key (F) and spacer (H).
2. Remove rods (B) and crankshaft (I).
3. Inspect crankshaft. (See this group.)
4. Inspect balancer assembly. (See this group.)
5. Put a light film of oil on bearing surfaces.

*NOTE: Oil grooves of link rods (B) must face away from crankwebs.*

6. Install balance weight to crankshaft with oil hole (E), if equipped, facing flywheel side.
7. Install collar (A).
8. Install spacer (H) with chamfered face toward link rod.
9. Install key and crank gear.



- A—Collar
- B—Link Rod
- C—Wrist Pin
- D—Balance Weight
- E—Oil Hole
- F—Woodruff Key
- G—Crank Gear
- H—Spacer
- I—Crankshaft

MX.5020A1,A16 -19-21OCT92

M51759 -JUN-07SEP88

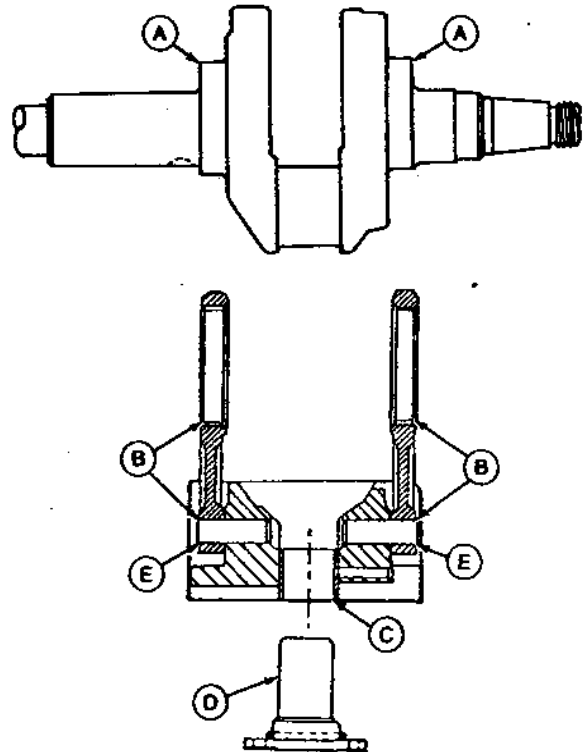
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20  
11

## INSPECT BALANCER ASSEMBLY

1. Clean and inspect all parts for wear or damage. Replace parts, if necessary.
2. Measure crankshaft journals (A). Replace crankshaft if diameter is less than specifications.
3. Measure inside diameter of bearings (B). Replace link rod if small end is greater than specifications. Replace bushing if large end is greater than specifications. (See this group.)
4. Measure inside diameter of support shaft bearing (C). If bearing is greater than specifications, replace bushing. (See this group.)
5. Measure support shaft diameter (D). Replace shaft if diameter is less than specification.
6. Inspect wrist pins (E) for any damage. If necessary, replace weight.

### DIAMETER SPECIFICATIONS

Link Rod Journal O.D. (MIN)	53.95 mm (2.124 in.)
Link Rod Small End I.D. (MAX)	12.06 mm (0.475 in.)
Link Rod Large End I.D. (MAX)	54.12 mm (2.132 in.)
Support Shaft O.D. (MIN)	25.93 mm (1.021 in.)
Support Shaft Bearing I.D. (MAX)	26.10 mm (1.027 in.)



- A—Link Rod Journals
- B—Link Rod Bearings
- C—Shaft Bearing
- D—Support Shaft
- E—Wrist Pins

MX.5020A1,A17 -19-21OCT92

M51760 -JUN-07SEP88

## REPLACE BALANCER BUSHINGS

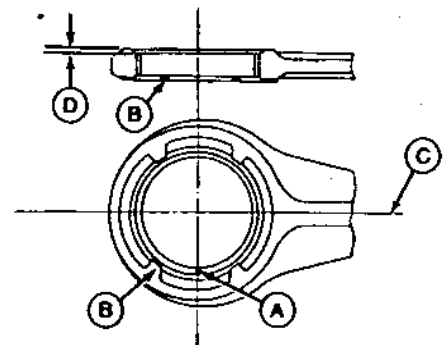
*NOTE: Remove bushings using a bearing, bushing and seal driver set and a press.*

*Remove link rod bushings with oil groove side facing up.*

1. Remove bushings.
2. Install link rod bushings with seam (A) at a 90° angle to centerline (C).
3. Install bushing below surface to specifications.

### SPECIFICATIONS

Bushing Depth (D)	0.50 mm (0.020 in.)
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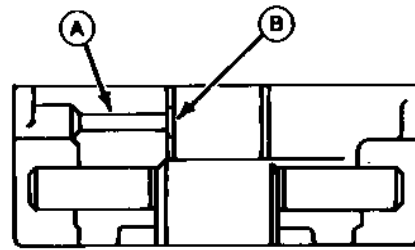
- A—Bushing Seam
- B—Oil Grooves
- C—Link Rod Centerline
- D—Measurement

MX.5020A1,A18 -19-21OCT92

M51681 -JUN-31AUG88

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12

4. Align oil hole (B) in bushing and oil passage (A) in weight. Install bushing flush to outside surface of weight.



MX,5020A1,A19 -19-21OCT92

M80209 -JUN-19FEB91

## REMOVE AND INSTALL PISTON AND CONNECTING ROD

1. Remove cylinder head. (See Group 15.)
2. Remove crankcase cover. (See this group.)
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.
4. Remove cap screws and connecting rod cap (A).
5. Push piston and connecting rod from cylinder bore.
6. Make repairs as necessary. (See procedures in this group.)



MX,5020A1,A20 -19-21OCT92

M54787 -JUN-19FEB91

7. Deglaze cylinder bore. (See Section 100, Group 15.)
8. Stagger piston ring end gaps 180° apart, but do not align with oil ring side rail end gaps.
9. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
10. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
11. Install piston assembly in cylinder bore with engraved match mark/arrow on piston head facing flywheel side of engine.
12. Install connecting rod cap and cap screws. Tighten cap screws to 20 N·m (177 lb-in.).



MX,5020A1,A21 -19-21OCT92

M50074 -JUN-31AUG88

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13

## DISASSEMBLE, INSPECT AND ASSEMBLE PISTON AND CONNECTING ROD

1. Remove circlip, piston pin (A) and connecting rod (B).
2. Inspect all parts for wear or damage. Replace as necessary. (See procedures in this group.)
3. Apply a light film of oil to piston pin and connecting rod bearing.



MX,5020A1,A22 -19-21OCT92

M50063 -UN-31AUG88

4. Align arrow match mark (A) on piston head with MADE IN JAPAN (B) on connecting rod, or if piston is marked with R and L align the R on the piston with the Japanese characters on the connecting rod.
5. Install piston pin and circlip.



MX,4020A1,A18 -19-21OCT92

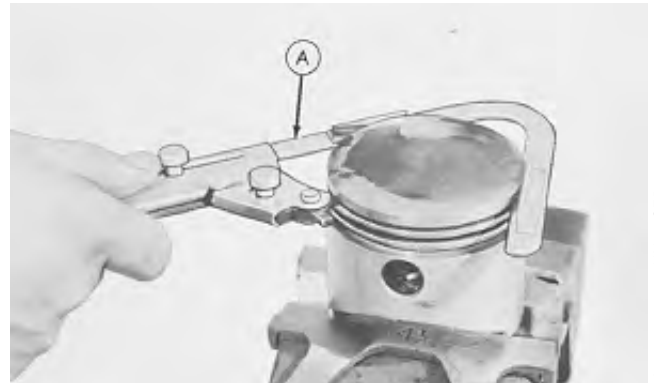
M38111 -UN-29AUG88

## INSPECT PISTON

1. Analyze piston and piston ring wear. (See Section 100, Group 10.)
2. Remove piston rings. (See this group.)

**IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.**

3. Remove all deposits from the piston.
4. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it carefully to clean groove.
5. Check that oil return passages in grooves are open.



MX,5020A1,A23 -19-21OCT92

M29946 -UN-06SEP88

6. Inspect piston for scoring or fractures. Replace piston if damaged.

*NOTE: Inspect clearance visually. Replace piston if clearance appears excessive.*

7. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.

**CLEARANCE SPECIFICATION (MAX)**

Top Ring	Second Ring	Oil Control Ring
0.16 mm (0.006 in.)	0.14 mm (0.005 in.)	0.19 mm (0.007 in.)



M38102 -UN-29AUG88

MX,5020A1,A24 -19-21OCT92

8. Measure piston pin outer diameter. Replace if less than specification.

9. Measure piston pin bore. Replace piston if measurement is greater than specification.

**SPECIFICATIONS**

Piston Pin O.D. (MIN)	Piston Bore I.D. (MAX)
20.98 mm (0.827 in.)	21.03 mm (0.829 in.)



M50064 -UN-31AUG88

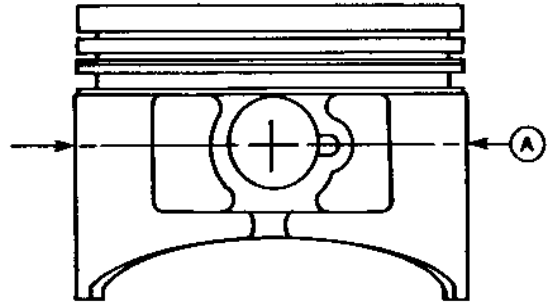


M50065 -UN-31AUG88

MX,5020A1,A25 -19-21OCT92

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15

10. Measure piston O.D. (A) perpendicular to piston pin bore.
11. Measure cylinder bore. (See Inspect Block in this group.)
12. Subtract piston O.D. measurement (A) from cylinder bore measurement to determine piston-to-cylinder bore clearance.
13. Replace piston and/or rebore cylinder block if not within specifications. (See this group.)



M80398 -UN-06APR91

**SPECIFICATIONS**

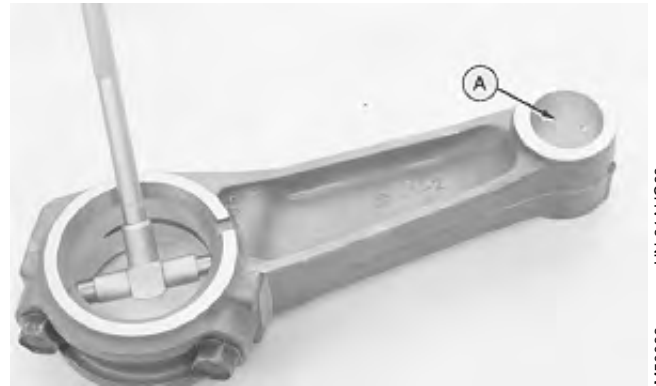
Piston O.D. (A) . . . . . 88.81—88.83 mm (3.4991—3.4999 in.)

Piston-to-Cylinder  
Bore Clearance . . . . . 0.156 mm (0.0061 in.)

MX,5020A1,A26 -19-21OCT92

**INSPECT CONNECTING ROD**

1. Clean and inspect rod. Replace if scored.
2. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
3. Install connecting rod cap. Tighten to 20 N-m (177 lb-in.)
4. Measure connecting rod crankshaft bearing and piston bearing (A). Replace connecting rod if either measurement is greater than specifications.



M50066 -UN-31AUG88

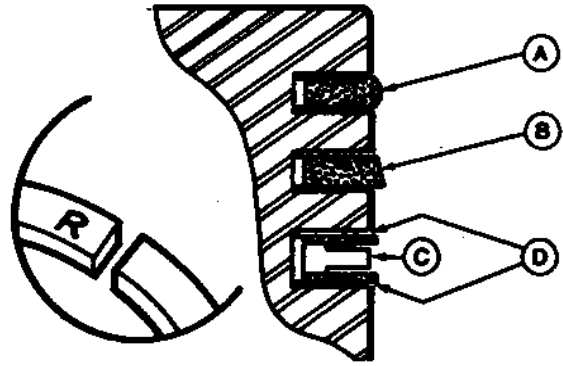
**BEARING I.D. SPECIFICATIONS (MAX)**

<b>Crankshaft Bearing</b>	<b>Piston Bearing</b>
37.02 mm (1.459 in.)	21.01 mm (0.829 in.)

MX,5020A1,A27 -19-21OCT92

## REMOVE AND INSTALL PISTON RINGS

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves. (See this group.)
3. Check piston ring end gap. (See this group.)
4. Install top ring (A) and second ring (B) with R or NPR mark facing up. Rings should turn freely in grooves.
5. Oil ring is an assembly. Install spacer (C), then side rails (D). Put side rail end gaps 180° apart.



A—Top Ring  
B—Second Ring  
C—Spacer  
D—Side Rails

MX,5020A1,A28 -19-21OCT92

M38074 -UN-29AUG88

## CHECK PISTON RING END GAP

1. Before installing rings on piston, check end gap in cylinder bore.
2. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
3. Check end gap. Replace ring if end gap is more than specifications.

### END GAP SPECIFICATIONS (MAX)

Minimum End Gap	0.18 mm (0.007 in.)
Maximum End Gap	
Compression Rings	0.70 mm (0.028 in.)
Oil Ring Side Rails	1.20 mm (0.047 in.)



MX,5020A1,A29 -19-21OCT92

M54788 -UN-19FEB91



## REMOVE, INSPECT AND INSTALL CRANKSHAFT

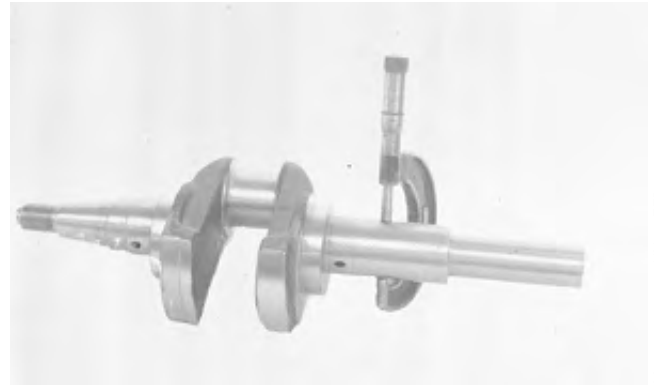
1. Remove camshaft. (See this group.)
2. Remove piston and connecting rod. (See this group.)
3. Remove balancer. (See this group.)
4. Remove crankshaft from balancer. (See Disassemble and Assemble Balancer in this group.)

**IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.**

5. Check crankshaft alignment (T.I.R.). (See this group.)
6. Clean and inspect crankshaft. Replace if parts are scratched or damaged.
7. Analyze crankshaft and connecting rod wear. (See Section 100, Group 10.)
8. Measure crankshaft main bearing journals and connecting rod journal. Replace crankshaft if measurements are less than specifications.

### JOURNAL SPECIFICATIONS (MIN)

Main Bearing Journal		Connecting Rod Journal
PTO Side	Flywheel Side	
34.91 mm (1.374 in.)	—	36.95 mm (1.455 in.)



M54789 -UN-19FEB91

MX,5020A1,A30 -19-21OCT92

*NOTE: An under-sized connecting rod is available through the parts catalog, if necessary.*

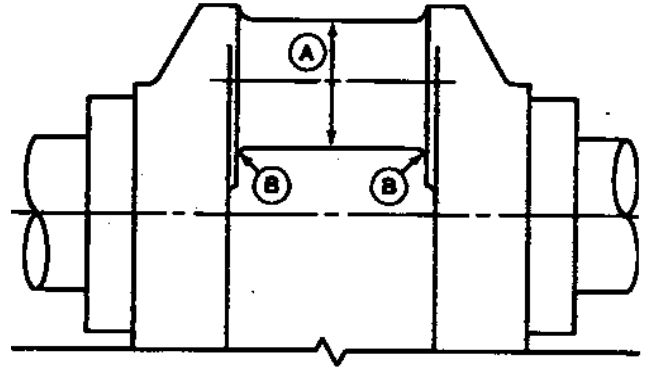
9. Connecting rod journal (A) can be resized to accept under-sized rod. Have grinding done by a reliable repair shop. Before sending crankshaft for grinding, inspect journal radii (B) for cracks.

10. Install balancer on crankshaft.

11. Install balancer.

12. Install piston and connecting rod.

13. Install camshaft.



M38036 -UN-29AUG88

MX,5020A1,A31 -19-21OCT92

### INSPECT CRANKSHAFT PLAIN BEARING

1. Remove crankshaft. (See this group.)
2. Measure crankshaft bearing in crankcase cover. Replace cover if diameter is greater than specifications. (See this group.)
3. Install crankshaft.

#### SPECIFICATIONS

Bearing ID (Max) ..... 35.06 mm (1.380 in.)

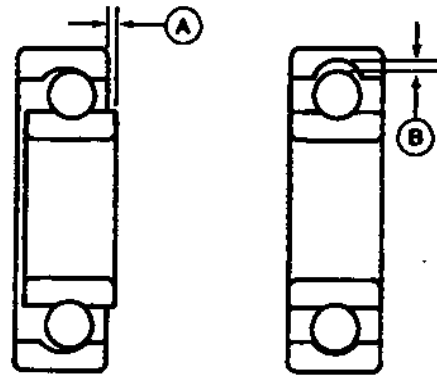


M50072 -UN-31AUG88

MX,5020A1,A32 -19-21OCT92

### INSPECT CRANKSHAFT BALL BEARING

1. Remove flywheel end oil seal. (See Inspect Oil Seals in this group.)
2. Remove crankshaft bearing using a bearing, bushing and seal driver set.
3. Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
4. Spin the bearing by hand and check for axial (A) and radial (B) free play.
5. Replace the bearing if it is noisy or has too much play.
6. Install bearing flush to inside of crankcase using a bearing, bushing and seal driver set.
7. Install oil seal.

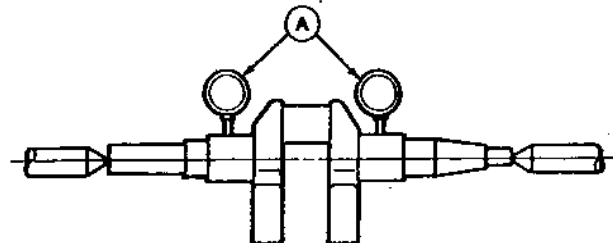


MX,5020A1,A33 -19-21OCT92

M38073 -UN-29AUG88

### CHECK CRANKSHAFT ALIGNMENT (TIR)

Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators (A) to measure maximum total indicated runout (TIR). If not according to specification replace crankshaft.



#### SPECIFICATIONS

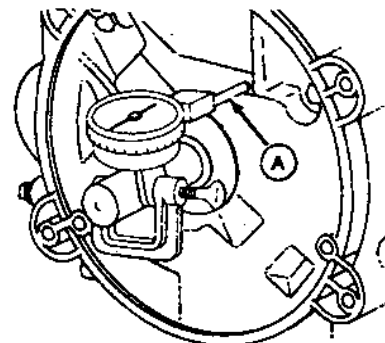
Maximum TIR . . . . . 0.05 mm (0.002 in.)

MX,5020A1,A34 -19-21OCT92

M51761 -UN-07SEP88

### MEASURE CRANKSHAFT END PLAY

1. Measure end play using dial indicator (A). Record this measurement.
2. Move crankshaft in and out. Remove crankcase cover and adjust end play if not within specifications. (See this group.)



#### SPECIFICATIONS

End Play . . . . . 0.09—0.22 mm (0.004—0.009 in.)

MX,5020A1,A35 -19-21OCT92

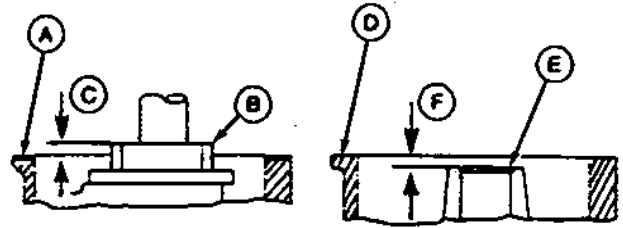
M30048 -UN-06SEP88

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20  
20

### ADJUST CRANKSHAFT END PLAY

1. With gasket (A) installed on crankcase, measure from gasket surface to crankshaft gear surface (B). Record measurement (C).

2. Measure from crankcase cover mounting face (D) to PTO bearing end (E). Record measurement (F).



- A—Gasket
- B—Crank Gear Surface
- C—Measurement
- D—Crankcase Cover Mounting Face
- E—PTO Bearing End
- F—Measurement

MX,5020A1,A36 -19-21OCT92

-UN-31AUG88  
M51545

3. Locate end play measurement in column one of chart. Choose appropriate shim from column two.

4. Install shim on PTO shaft.

5. Install crankcase cover. (See this group.)

DIFFERENCE (a-b)	THICKNESS OF SHIM
0.0755 - 0.0748 in. (1.92 - 1.99) mm	0.0685 in. 1.74 mm
0.0728 - 0.0755 in. (1.85 - 1.92) mm	0.0657 in. 1.67 mm
0.0700 - 0.0728 in. (1.78 - 1.85) mm	0.0629 in. 1.60 mm
0.0673 - 0.0700 in. (1.71 - 1.79) mm	0.0602 in. 1.53 mm
0.0645 - 0.0673 in. (1.64 - 1.71) mm	0.0574 in. 1.46 mm
0.0618 - 0.0645 in. (1.57 - 1.64) mm	0.0547 in. 1.39 mm
0.0590 - 0.0618 in. (1.50 - 1.57) mm	0.0519 in. 1.32 mm
0.0562 - 0.0590 in. (1.43 - 1.50) mm	0.0492 in. 1.25 mm
0.0535 - 0.0562 in. (1.36 - 1.43) mm	0.0464 in. 1.18 mm

MX,5020A1,A37 -19-21OCT92

-19-13MAR89  
M38009

## INSPECT OIL SEALS

*NOTE: Pack lithium base grease in new or used seals.*

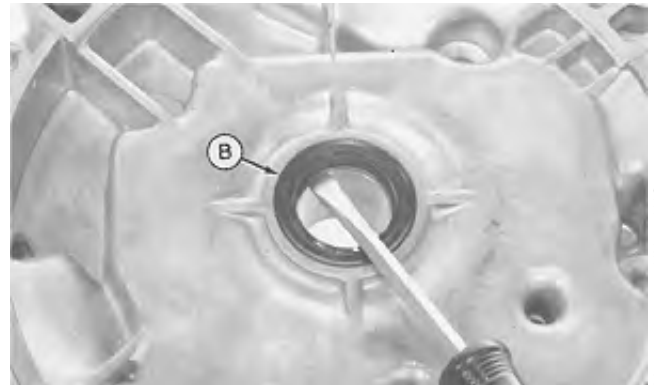
1. Remove flywheel. (See Group 10.)
  2. Inspect oil seals (A and B) at flywheel end and PTO end for wear or damage. Replace if necessary.
  3. Remove crankshaft. (See this group.)
  4. Remove worn or damaged seals with a screwdriver.
  5. Install seals with lip to inside of engine using a bearing, bushing and seal driver set. Press in seal on flywheel side until flush with hub.
- Press in seal on PTO side to specification, below crankcase cover flange surface.
6. Install crankshaft.
  7. Install flywheel.

### SPECIFICATIONS

Seal Depth . . . . . 5 mm (0.200 in.)



Flywheel Side



PTO Side

M38104 -UN-29AUG88

M50071 -UN-31AUG88

MX,5020A1,A38 -19-21OCT92

## REPLACE CYLINDER HEAD/BLOCK STUDS

1. Remove cylinder head. (See Group 15.)
2. Inspect studs for cracks or wear. Replace if necessary.
3. Install two nuts on stud and tighten together. Remove stud.
4. Put thread lock and sealer (medium strength) on threads of stud and install in block. Tighten to specification.
5. Install cylinder head.



M80230  
-UN-19FEB91

### TORQUE SPECIFICATIONS

Cylinder Head-to-Block Studs . . . . . 36 N·m (27 lb-ft)

MX.5020A1,A38A -19-21OCT92

## INSPECT CYLINDER BLOCK

1. Remove crankshaft. (See this group.)
2. Clean and check block for cracks.
3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.
4. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

MX.5020A1,A39 -19-21OCT92

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20  
23

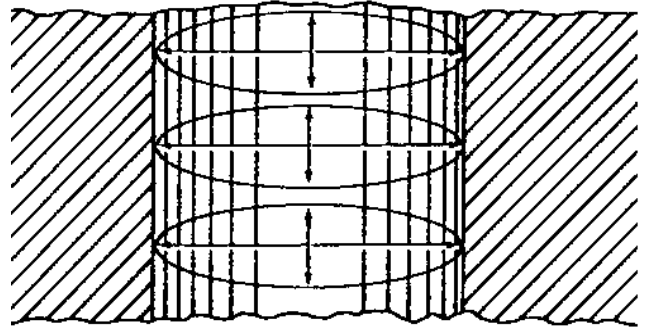
*NOTE: A bare block is available for service.*

5. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.

6. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

*NOTE: If cylinder is rebored, oversize piston and rings must be installed.*

7. Install crankshaft.



M51745 -UN-23FEB89

**CYLINDER BORE SPECIFICATIONS**

Standard . . . . .	88.98—89.00 mm (3.503—3.504 in.)
Wear Limit . . . . .	89.06 mm (3.506 in.)
Out-of-Round (MAX) . . . . .	0.063 mm (0.0025 in.)
Taper (MAX) . . . . .	0.076 mm (0.003 in.)



M80206 -UN-19FEB91

MX.5020A1.A40 -19-21OCT92

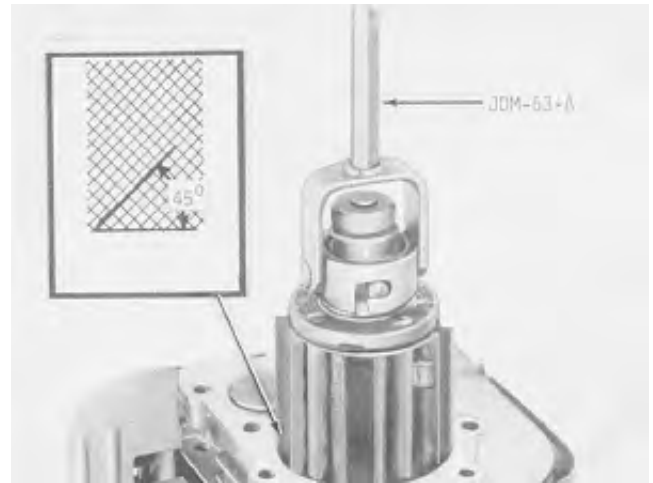
## REBORE CYLINDER BLOCK

**NOTE:** The cylinder block can be rebored to use 0.25, 0.50 or 0.75 mm (0.010, 0.020 or 0.030 in.) oversize pistons and rings. Have a reliable repair shop rebores the block, or use the drill press and honing tool.

1. Rebores cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from 200—250 rpm.
3. Lower and raise hone until ends extend 20—25 mm (0.75—1.0 in.) past ends of cylinder.
4. Turn adjusting nut on one hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately 20 times per minute.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

**NOTE:** Finish should not be smooth, but have a 40—60° cross-hatch pattern.

**IMPORTANT:** Check stone for wear or damage. Use correct stone for the job.



M24711 -UN-25AUG88

### CYLINDER INITIAL BORE SPECIFICATIONS

**Piston Oversize:**  
0.25 mm  
(0.010 in.)

89.21—89.23 mm  
(3.512—3.513 in.)

**Piston Oversize:**  
0.50 mm  
(0.020 in.)

89.46—89.48 mm  
(3.522—3.523 in.)

**Piston Oversize:**  
0.75 mm  
(0.030 in.)

89.72—89.73 mm  
(3.532—3.533 in.)

MX,5020A1,A41 -19-21OCT92

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25



8. Hone the cylinder an additional 0.028—0.030 mm (0.0011—0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

**IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.**

9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

10. Dry the cylinder. Apply engine oil to cylinder wall.

M98,2040A,A9 -19-21OCT92

## DISASSEMBLE AND ASSEMBLE OIL PUMP

1. Remove crankcase cover. (See this group.)
2. Remove oil pump assembly (A).
3. Remove relief spring and ball (B).
4. Inspect all parts. (See this group.)
5. Install oil pump assembly. Tighten pump cover cap screws to specifications.
6. Install relief spring and ball.
7. Install crankcase cover.



M54791 -UN-19FEB91

### TORQUE SPECIFICATIONS

Pump Cover Cap Screws . . . . . 17—23 N·m (150—204 lb-in.)

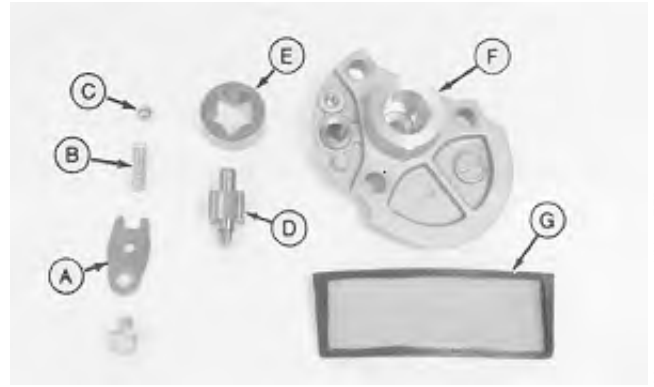
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26

MX,5020A1,A43 -19-21OCT92

### INSPECT OIL PUMP

1. Inspect all parts for wear or damage. Replace as necessary.

- A—Plate
- B—Spring
- C—Ball
- D—Rotor Shaft
- E—Outer Rotor
- F—Cover
- G—Screen



MX,5020A1,A44 -19-21OCT92

M54792 -UN-19FEB91

2. Measure outside diameters of shaft. Replace both shaft and outer rotor if less than specification.

#### SPECIFICATIONS

Minimum Shaft O.D. . . . . . 12.63 mm (0.497 in.)



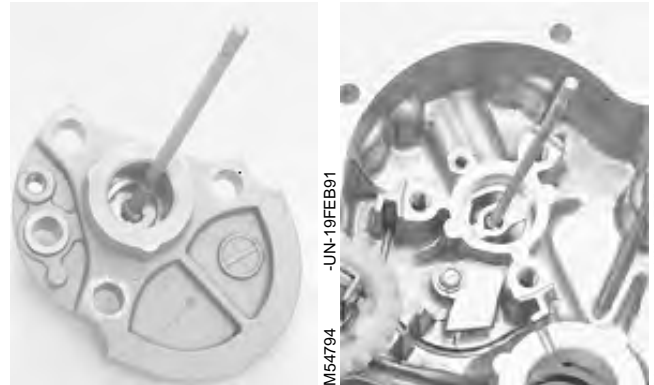
MX,5020A1,A45 -19-21OCT92

M54793 -UN-19FEB91

3. Measure rotor shaft bearings. Replace oil pump cover or crankcase cover if greater than specifications.

#### SPECIFICATIONS

Maximum Rotor Shaft Bearing I.D. . . . . . 12.76 mm (0.502 in.)



MX,5020A1,A46 -19-21OCT92

M54794 -UN-19FEB91

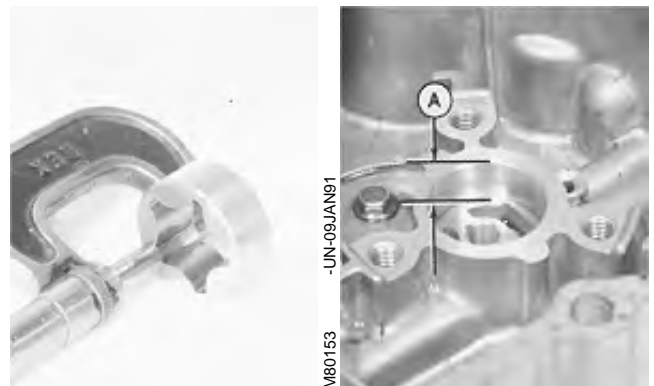
M54795 -UN-19FEB91

4. Measure thickness of outer rotor. Replace both outer rotor and shaft if less than specifications.

5. Measure out rotor bearing depth (A). Replace oil pump cover if greater than specifications.

#### OUTER ROTOR SPECIFICATIONS

Minimum Rotor Thickness . . . . . 11.92 mm (0.470 in.)  
 Maximum Bearing Depth . . . . . 12.14 mm (0.478 in.)



MX,5020A1,A47 -19-21OCT92

M80153 -UN-09JAN91

M80207 -UN-19FEB91

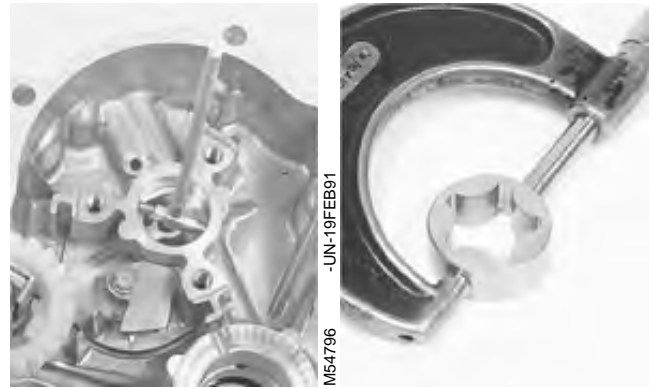
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20  
27

6. Measure inside diameter of rotor bearing. Replace oil pump cover if greater than specifications.

7. Measure outside diameter of rotor. Replace both rotor and shaft if less than specifications.

**OUTER ROTOR SPECIFICATIONS**

Maximum Bearing I.D. . . . . . 29.15 mm (1.148 in.)  
 Minimum Rotor O.D. . . . . . 28.90 mm (1.139 in.)



M54796 -UN-19FEB91

M80156 -UN-09JAN91

MX,5020A1,A48 -19-21OCT92

8. Measure relief valve spring. Replace if free length is less than specification.

**SPECIFICATIONS**

Minimum Spring Length . . . . . 19.00 mm (0.750 in.)



M50083 -UN-31AUG88

MX,5020A1,A49 -19-21OCT92

**REMOVE, INSPECT AND INSTALL OIL FILTER MANIFOLD—IF EQUIPPED**

1. Remove oil filter and manifold.
2. Inspect oil filter. Replace if excessively contaminated or damaged.
3. Inspect oil passages for clogs. Clean if needed.
4. Inspect rubber gasket. Replace if worn or damaged.
5. Install filter and manifold.



M54790 -UN-19FEB91

MX,5020A1,A50 -19-21OCT92

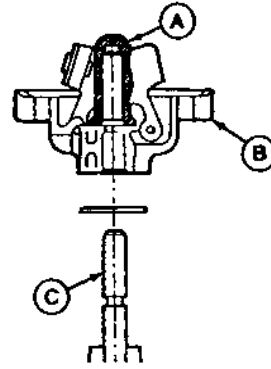
## INSPECT AND REPLACE GOVERNOR

**IMPORTANT:** Removal damages governor. If not damaged, do not remove.

1. Remove crankcase cover. (See this group.)
2. Inspect governor. If necessary to replace, remove with screwdriver.
3. If removed, press shaft (C) back into block until it protrudes 32.2—32.8 mm (1.267—1.291 in.).

*NOTE: Assemble sleeve and gear before installing assembly on shaft.*

4. Install sleeve (A) onto governor gear (B).
5. Install governor assembly onto shaft. Push down on assembly until it snaps into place.



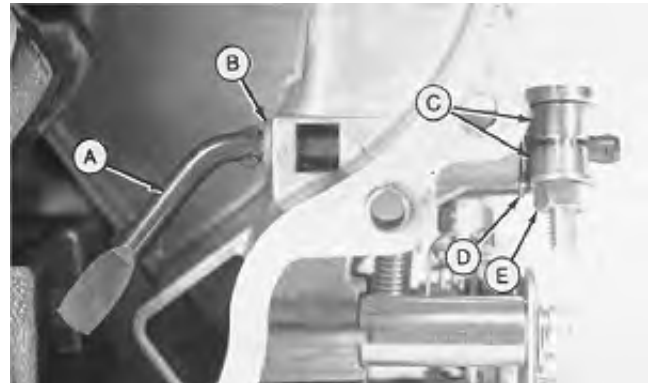
M51762 -UN-07SEP88

MX.5020A1.A51 -19-21OCT92

## INSPECT AND REPLACE GOVERNOR SHAFT

*NOTE: It is not necessary to remove governor shaft unless damaged.*

1. Remove crankcase cover. (See this group.)
2. Inspect shaft (A). Replace if damaged.
3. To replace shaft, loosen nut (E) on lever (C).
4. Remove retaining pin (D), governor shaft and washer (B).
5. Install washer, shaft and retaining pin. Tighten nut to 7 N·m (62 lb-in.).



A—Governor Shaft  
B—Washer  
C—Governor Lever  
D—Retaining Pin  
E—Nut

M54797 -UN-19FEB91

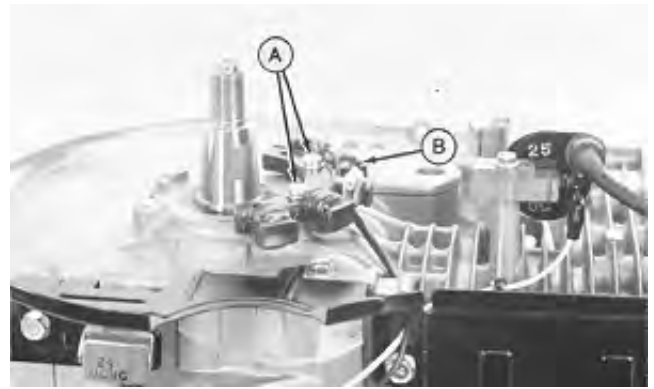
MX.5020A1.A52 -19-21OCT92

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29



## REMOVE AND INSTALL STATOR

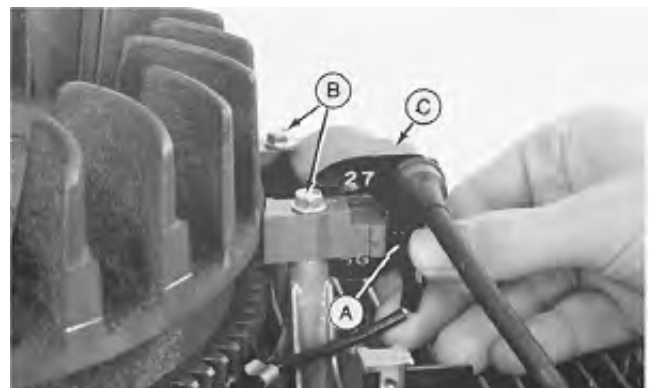
1. Remove flywheel. (See Group 10.)
2. Disconnect stator lead.
3. Remove screws (A) and stator (B).
4. Install stator.
5. Connect stator lead.
6. Install flywheel.



MX,5025A1,A1 -19-21OCT92

## REMOVE AND INSTALL ARMATURE WITH COIL

1. Remove blower housing. (See Group 10.)
2. Disconnect wiring lead (A).
3. Remove cap screws (B) and armature with coil (C).
4. Loosely install armature with coil.
5. Connect wiring lead.
6. Adjust armature air gap. (See this group.)
7. Install blower housing.



MX,5025A1,A2 -19-21OCT92

## ADJUST ARMATURE AIR GAP

1. Turn flywheel magnet away from armature.
2. Insert feeler gauge, between flywheel and armature.
3. Push armature against flywheel and tighten screws (A).
4. Turn flywheel to remove feeler gauge.



M50148  
-UN-31AUG88

### AIR GAP SPECIFICATIONS

Feeler Gauge Blade . . . . . 0.30 mm (0.012 in.)

MX,5025A1,A3 -19-21OCT92

## OTHER MATERIAL

Number	Name	Use
	Mineral Spirits	Clean Armature
	Multipurpose Grease	Grease Starter Parts

M98,2030A,ZB -19-21OCT92

## SERVICE PARTS KITS

The following kits are available through your parts catalog:

Complete Recoil Starter

Electric Starter

Complete Starter

Brush Kit

Clutch Kit

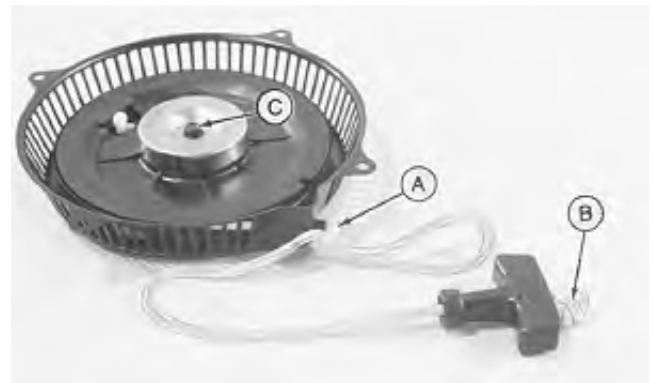
MX,5030A1,A0 -19-21OCT92

## DISASSEMBLE RECOIL STARTER—IF EQUIPPED

1. Remove starter.
2. Pull handle out about 30 cm ( 1 ft). Tie knot (A) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (A). Slowly release reel tension. Do not let rope get wedged between reel and housing.

**CAUTION:** Wear gloves and protective goggles for remaining steps.

6. Remove screw (C) and ratchet cover.



TY13495 -UN-23FEB89

MX,5030A1,A1 -19-21OCT92



**CAUTION:** A loaded spring operates under great pressure. Make sure spring tension between reel and housing is released before removing reel.

7. Turn the reel one half turn clockwise so no spring tension can be felt.



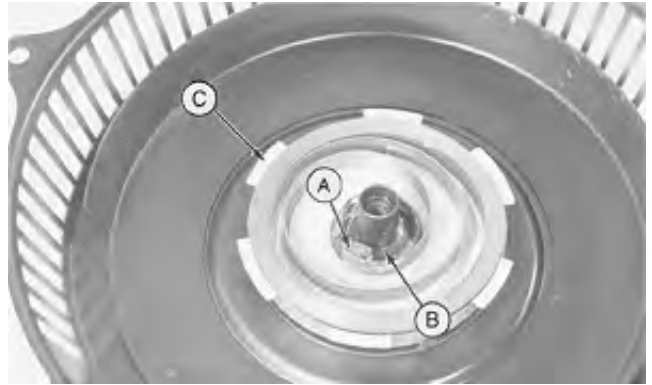
TY13496  
-UN-23FEB89

MX,5030A1,A2 -19-21OCT92

8. Spring is stored in spring case (C) in housing. Lift reel straight up so spring remains seated in housing.

9. Carefully unhook spring tang (A) from catch (B).

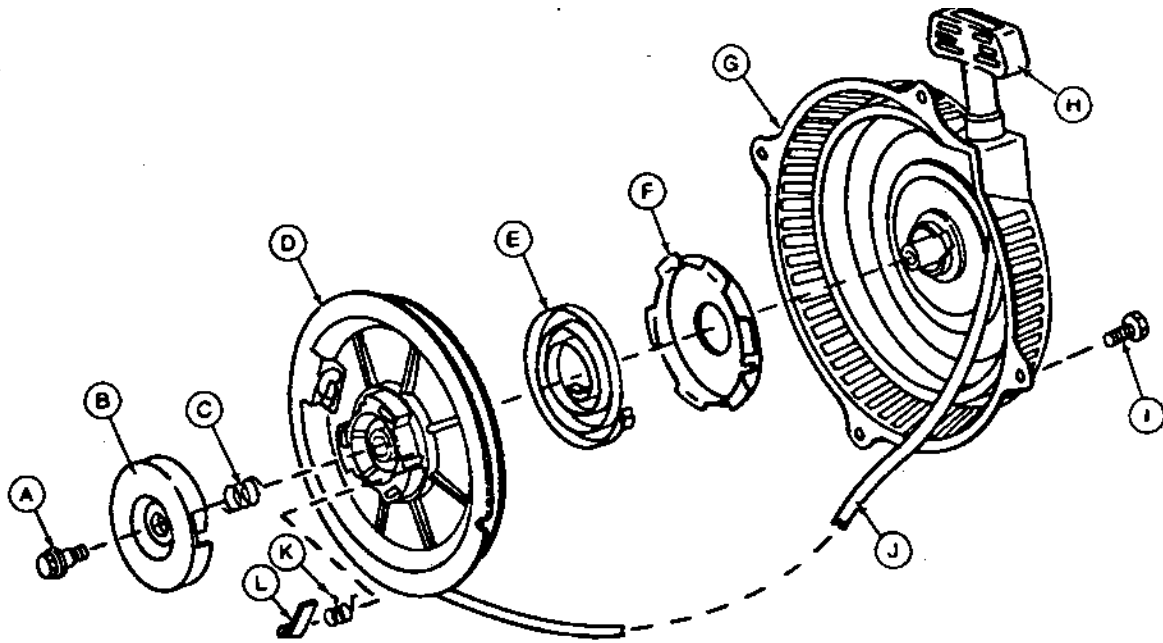
10. Remove spring case from housing.



TY13497  
-UN-23FEB89

MX,4030A1,A2 -19-21OCT92

## INSPECT RECOIL STARTER



A—Screw  
B—Retainer  
C—Spring

D—Reel  
E—Spring  
F—Case

G—Housing  
H—Handle  
I—Screw (4 used)

J—Rope  
K—Spring  
L—Pawl

Inspect and replace all damaged or worn parts.

MX,5030A1,A3 -19-21OCT92

TY13498 -JUN-23FEB89

## REPLACE SPRING

**⚠ CAUTION:** Spring is wound under great tension in reel or spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.

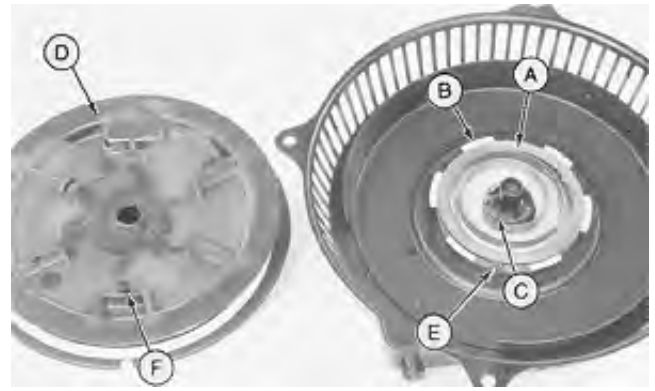
1. Working from the center out, carefully unwind spring from spring case or reel.
2. Hook outside spring tang in reel or case. Wind spring into reel or spring case, working toward center.



MX,5030A1,A4 -19-21OCT92

## ASSEMBLE RECOIL STARTER

1. Wind rope counterclockwise onto reel.
2. Place spring case (B) into housing with spring tang over catch (C).
3. Install reel in spring case, with round peg (E) aligned with end of spring (F).
4. Turn reel counterclockwise until you feel tang hook on catch.



- A—Spring
- B—Case
- C—Catch
- D—Reel
- E—Round Peg
- F—End of Spring

MX,5030A1,A5 -19-21OCT92

TY13499 -UN-23FEB89

5. Turn reel two turns counterclockwise to preload spring.
6. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (A) to hold rope.
7. Install handle and secure with knot (B).
8. Remove knot (A).
9. Install spring (C) and ratchet cover (E) with opening(s) in cover over pawl(s) (D). Check for free movement of pawls.
10. Pull rope to check for proper operation.
11. Install recoil starter on engine.



- A—Knot
- B—Knot
- C—Spring
- D—Pawls
- E—Retainer

MX,5030A1,A6 -19-21OCT92

TY13500 -UN-23FEB89

## ANALYZE ELECTRIC STARTER CONDITION

1. The starter overheats because of:

- Long cranking.
- Armature binding.

2. The starter operates poorly because of:

- Armature binding.
- Dirty or damaged starter drive.
- Badly worn brushes or weak brush springs.
- Excessive voltage drop in cranking system.
- Battery or wiring defective.
- Shorts, opens, or grounds in armature.

*NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.*

MX,5030A1,A7 -19-21OCT92

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5

## BENCH TEST SOLENOID DRIVE STARTER

*NOTE: Perform bench test before disassembling starter motor to determine cause of problem.*

**IMPORTANT: Never operate motor longer than 20 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive operation, will seriously damage starting motor.**

1. Disconnect battery leads from battery.
2. Remove starter from engine.
3. Connect 12-volt battery (A) to starter battery terminal (B) and starter frame (C) using heavy duty cables.
4. Connect 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.*

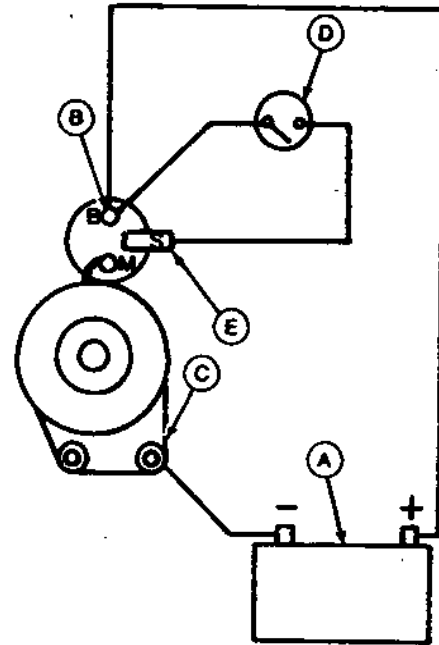
When switch is activated, starter should engage and run.

IF SOLENOID CHATTERS; hold-in winding is open-circuited.

IF NOTHING HAPPENS; either the solenoid pull-in winding is open-circuited or mechanical parts are sticking.

IF SOLENOID ENGAGES, BUT MOTOR DOES NOT RUN; check solenoid switch continuity, brushes, armature and field windings.

Solenoid cannot be repaired, replace it.



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

-JUN-29AUG88

M37149

## TEST SOLENOID

*NOTE: If bench test indicated solenoid problems, use an ohmmeter or test light to check solenoid.*

1. Test solenoid terminals (A and B) for continuity. There should be no continuity.
2. Depress switch arm (C). There should be continuity when arm is fully depressed.
3. Test for open circuits between terminal (B) and tang (D). There should be continuity.
4. Test for open circuits between tang (D) and body (E). There should be continuity.

If solenoid fails any test, it is defective and must be replaced.



A—Terminal  
 B—Terminal  
 C—Switch Arm  
 D—Tang  
 E—Solenoid Body

M51705 -UN-31AUG88

MX,5030A1,A9 -19-21OCT92

## CHECK STARTER ARMATURE ROTATION

1. Remove starter cover.
2. Remove starter.
3. Rotate armature (A).
4. If armature does not rotate freely, armature may be bent or bearings may be worn. Disassemble and inspect starter. (See this group.)
5. Install starter and cover.

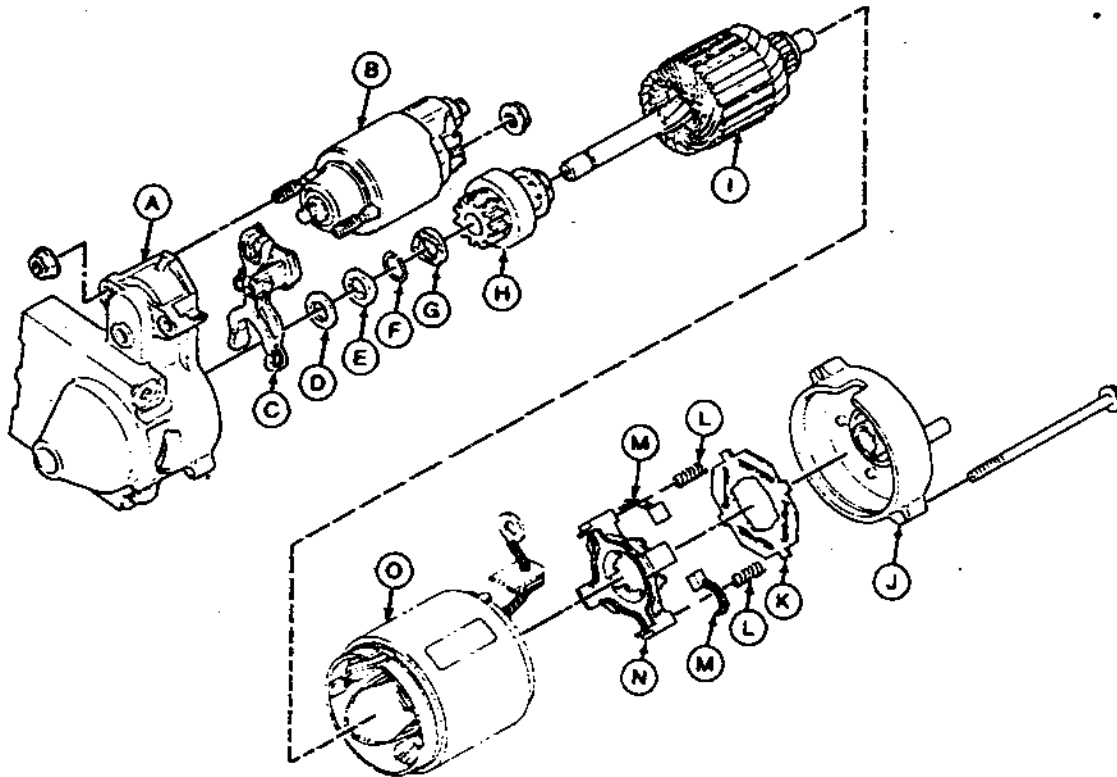


M80208 -UN-19FEB91

MX,5030A1,A10 -19-21OCT92

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7

## INSPECT STARTER



A—Front Cover  
B—Solenoid  
C—Shift Lever  
D—Washer

E—Pinion Stopper Half  
F—Retaining Clip  
G—Pinion Stopper Half  
H—Pinion

I—Armature  
J—End Cover  
K—Insulator  
L—Brush Spring

M—Brush  
N—Brush Holder  
O—Body

1. Mark body and covers for correct alignment during reassembly.
2. Separate pinion stopper halves (E and G) to remove retaining clip (F).
3. Inspect parts for wear or damage.
4. Measure brushes. Replace brushes as a set if length of any one is less than 6 mm (0.240 in.).

5. Test starter armature and brushes. (See this group.)
6. Apply a thin coat of multipurpose grease to:
  - sliding surfaces of armature and solenoid shift lever.
  - armature shaft spline.
  - points where shaft contacts cover.
7. Assemble starter.

M50121 -UN-31AUG88

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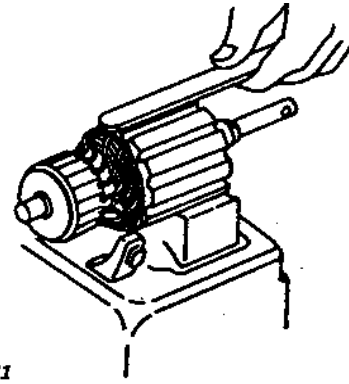
MX.5030A1.A11 -19-21OCT92

## TEST STARTER ARMATURE

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

1. Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.
2. Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.
3. If test indicates short circuited windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.

M24861



MX,5030A1,A12 -19-21OCT92

M24861 -UN-25AUG88

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

Armature windings are connected in parallel, so each commutator bar needs to be checked.

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



M98,2030A,AH -19-21OCT92

M50112 -UN-31AUG88

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

If test shows no continuity, there is an open circuit and armature must be replaced.



M98,2030A,M -19-21OCT92

M50113 -UN-31AUG88



### TEST FIELD COIL

*NOTE: Continuity tests are similar for all units.  
Illustrations are representative only.*

If equipped with brushes on body:

Replace field coil if not according to specifications.

#### CONTINUITY TEST

Brush-to-Housing ..... Continuity

Brush-to-Brush ..... Continuity



M50115 -UN-31AUG88



M50116 -UN-31AUG88

MX,5030A1,A13 -19-21OCT92

# Section 100 COMPONENT ANALYSIS AND GENERAL REPAIR

## Contents

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#### Valves

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Analyze . . . . .	100-05-1
Lap . . . . .	100-05-3

### Group 10—Piston, Piston Rings, Crankshaft and Connecting Rod

#### Analyze

Piston Ring Wear . . . . .	100-10-1
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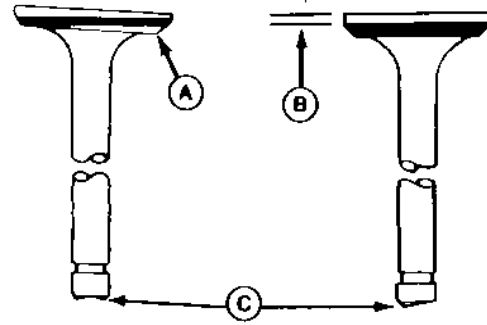
### Group 15—Cylinder Block

Deglaze Cylinder Bore . . . . .	100-15-1
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**INSPECT VALVES**

1. Remove carbon from valve head, face and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.
2. Check valve faces, heads and stems for defects.
3. Replace warped valves (A) or valves with less than 0.6 mm (0.02 in.) margin (B). Valve stem ends (C) should be ground square before you check valve-to-tappet clearance.



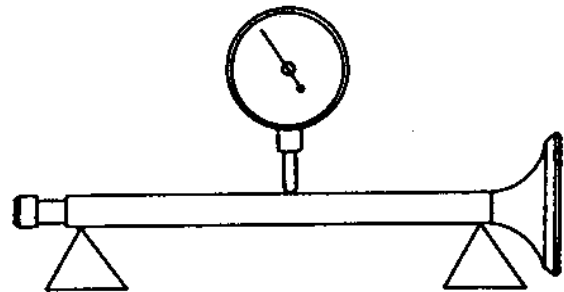
M38087 -UN-21AUG92

MX,10005A1,A1 -19-21OCT92

4. Inspect valve stem for bend using V-blocks and a dial indicator. Turn valve slowly and read variation on indicator. Replace if variation is greater than specification.

**BEND SPECIFICATION (MAX)**

Valve Stem . . . . . 0.03 mm (0.001 in.)



M51753 -UN-07SEP88

M98,2015A,A18 -19-21OCT92

**ANALYZE VALVES**

Lead deposits on the intake valve are caused by exhaust gas leakage past the valve. This indicates that the valve is not seating properly.

**IMPORTANT: Do not grind the exhaust valve or valve life will be shortened.**

Grind intake valve and reface the seat to correct this condition.

*NOTE: Be sure to reset valve-to-tappet clearance after grinding valves.*



M29834 -UN-06SEP88

MX,10005A1,A2 -19-21OCT92

Valve stem corrosion is caused by moisture in the engine. Moisture in the fuel-air-mixture can condense inside the engine when the engine is stopped and cools down.

Valve corrosion can also occur during storage. Fogging or pouring oil in the combustion chamber before storing helps prevent valve corrosion.

Corroded or pitted valves collect deposits and may cause sticking valves. Replace badly corroded or pitted valves.



M5563 -UN-31AUG88

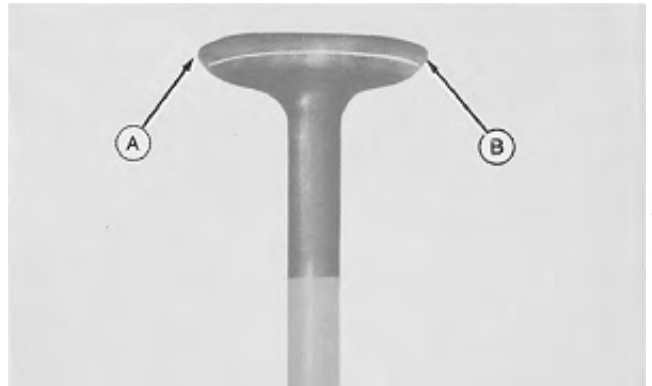
MX,2415G,37 -19-21OCT92

Exhaust valves are designed to function in temperatures exceeding (2760°C) 5000°F. However, when operating at high temperatures for long periods of time, valve burning may occur. Valves running too hot will show a dark discoloration of the valve stem into the area protected by the valve guide. Another indication is distortion of the valve margin (A) and valve face (B). Valve inserts may also begin to burn away.

**IMPORTANT: Do not run the engine with blower housing removed.**

Poor engine cooling due to dirt or obstructions is a common cause for overheating an engine and the valves. Remove blower housing and clean the engine cooling fins.

Other causes for valves running hot are worn valve guides or valve springs, incorrect valve clearance, lean fuel-air mixture and incorrect or overheated spark plug.



M30024 -UN-06SEP88

MX,2415G,38 -19-21OCT92

Using old or stale gasoline is a common cause for sticky valves (A).

This gummy deposit can be seen on the valve. When this condition exists, the carburetor may also contain gum deposits and will require a complete cleaning.

Always use fresh gasoline and drain fuel tank, lines, and carburetor before storing tractor.



M29936 -UN-06SEP88

MX,2415G,39 -19-21OCT92

## LAP VALVES

1. If seat does not make proper contact, lap the valve into the seat.
2. Apply small amount of fine lapping compound to face of valve.
3. Grip top of valve with a vacuum cup tool. Turn valve to lap valve to seat.
4. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.
5. Wash all parts in solvent to remove lapping compound. Dry parts.
6. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.



M50041 -JUN-31AUG88

MX10005A1,A3 -19-21OCT92



### **ANALYZE PISTON RING WEAR**

Rings of the wrong size or rings having improper end gap will not conform to the shape of the cylinder. This results in high oil consumption and excessive blow-by.

Ring end gaps should be staggered on the piston during installation. End gaps in alignment can also cause oil consumption and blow-by.

Light scuffing or scoring (A) of both rings and piston occurs when unusually high friction and combustion temperatures approach the melting point of the piston material.

When this condition exists, it is due to one or more of the following probable causes:

1. Dirty cooling shroud and cylinder head.
2. Lack of cylinder lubrication.
3. Improper combustion.
4. Wrong bearing or piston clearance.
5. Too much oil in crankcase causing fluid friction.



M29943 -UN-06SEP88

MX10010A1,A1 -19-21OCT92

The engine operating at abnormally high temperatures may cause varnish, lacquer or carbon deposits (A) to form in the piston grooves making the rings stick. When this happens, excessive oil consumption and blow-by will occur.

Engine overheating and ring sticking is usually caused by one or more of the following:

1. Overloading.
2. Incorrect ignition timing.
3. Lean fuel mixture.
4. Dirty cooling fins.
5. Incorrect oil.
6. Low oil supply.
7. Stale fuel.



M29944 -UN-06SEP88

MX,2420G,69 -19-21OCT92



Vertical scratches (A) across the piston rings are due to an abrasive in the engine. Abrasives may be airborne, may have been left in the engine during overhaul or may be loose lead and carbon deposits.

When this condition exists, check for one or more of the following:

1. Damaged, collapsed or improperly installed air filter.
2. Loose connection or damaged gasket between air cleaner and carburetor.
3. Air leak around carburetor-to-cylinder block gasket.
4. Air leakage around throttle shaft.
5. Failure to properly clean cylinder bore after reconditioning engine.



M29945 -UN-06SEP88

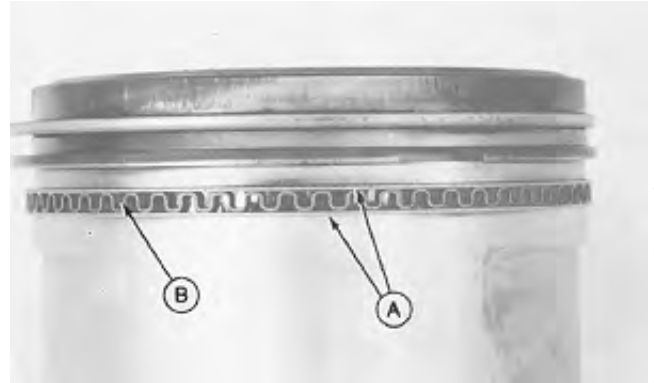
MX,2420G,70 -19-21OCT92

Abrasive particles in engine oil cause scratches on side rails (A) of oil control ring. Inner spacer (B) wear or distortion may cause:

- High oil consumption.
- Increased deposits in combustion chamber.
- Sticking compression rings.

Increased oil consumption may be caused by:

- Worn side rails with low tension.
- Worn or distorted inner spacer.



M38101 -UN-29AUG88

MX,2420G,24 -19-21OCT92

## ANALYZE PISTON WEAR

Detonation, is abnormal combustion causing excessive temperature and pressure in the combustion chamber. Commonly called carbon knock, spark knock or timing knock, detonation occurs as the compressed fuel-air mixture ignites spontaneously to interrupt the normal ignition.

The following is a list of possible causes for detonation:

1. Lean fuel mixture.
2. Low octane fuel.
3. Advanced ignition timing.
4. Engine lugging.
5. Build-up of carbon deposits on piston or cylinder head, causing excessive compression.
6. Wrong cylinder head or milling of head increasing compression ratio.



M29947 -UN-06SEP88

MX10010A1,A2 -19-21OCT92

Pre-ignition is the igniting of the fuel-air mixture prior to regular ignition spark. Pre-ignition causes internal shock, resulting in pings, vibration, detonation and power loss. Severe damage to piston (A), rings and valves results from pre-ignition.

Check the following for causes of pre-ignition:

1. Internal carbon deposits.
2. Incorrect spark plug (high heat range).
3. Broken ceramic in spark plug.
4. Sharp edges on valves.



M30039 -UN-06SEP88

MX,2420G,72 -19-21OCT92

Check rod and piston alignment when piston shows a diagonal wear pattern (A) extending across the skirt of the piston. Contact with the cylinder wall shows on bottom of skirt at left and ring lands on the right.

A cylinder bored at an angle to the crankshaft can also cause improper ring contact with the cylinder.

This condition causes:

1. Rapid piston wear.
2. Uneven piston wear.
3. Excessive oil consumption.



M29948 -UN-06SEP88

MX,2420G.73 -19-21OCT92

A broken retaining ring caused the damage (A) shown.

Retaining rings loosen or break due to:

1. Rod misalignment.
2. Excessive crankshaft end play.
3. Crankshaft journal taper.
4. Weak retaining rings.
5. Incorrectly installed retaining rings.

Inertia can cause a broken retaining ring to beat out the piston and cylinder, causing extensive damage.



M29949 -UN-06SEP88

MX,2420G.74 -19-21OCT92

## **ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR**

Check connecting rod and cap for damage or unusual wear patterns.

Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize the crankshaft.

When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

1. Engine run low on oil or without oil.
2. Oil not changed regularly.
3. Bearing cap installed incorrectly.

MX10010A1,A3 -19-21OCT92



## DEGLAZE CYLINDER BORE

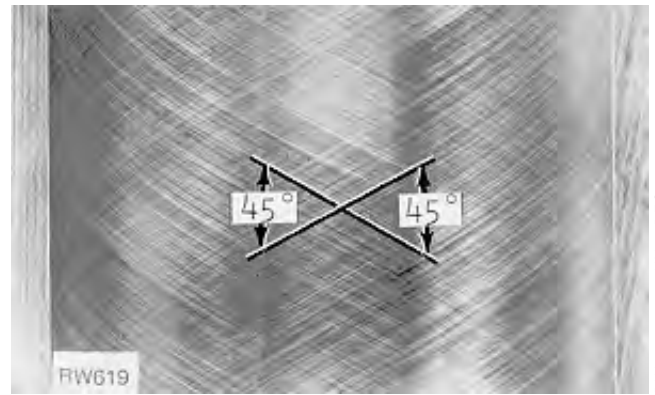
1. Deglaze cylinder bore using a rigid hone with a 220 to 300 grit stone.

*NOTE: A cutaway of a cylinder bore is shown for clarity of photograph.*

2. Use hone as instructed by manufacturer to obtain 45° crosshatch pattern as shown.

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

3. Clean cylinder walls using clean white rags and water. Continue to clean cylinder until white rags show no discoloration.



MX10015A1,A1 -19-21OCT92



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