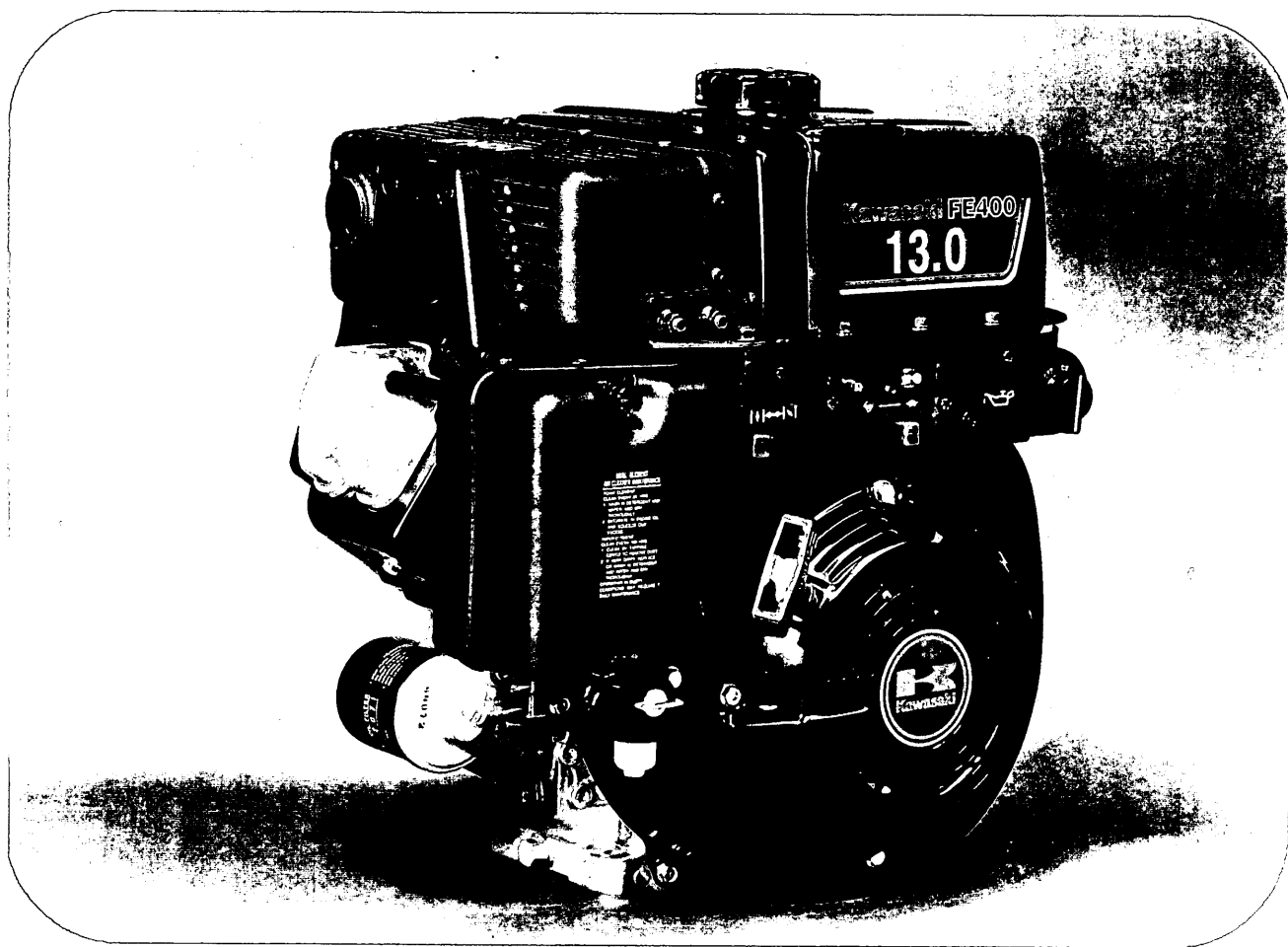


Kawasaki

FE120 FE170

FE250 FE290

FE350 FE400



4-stroke air-cooled gasoline engine
Service Manual

Quick Reference Guide

General Information	1
Service Data	2
Disassembly, Reassembly, Inspection, and Maintenance	3

This quick reference guide will assist you in locating a desired topic or procedure.

- Bend the pages back to match the black tab of the desired chapter number with the black tab on the edge at each table of contents page.
- Refer to the sectional table of contents for the exact pages to locate the specific topic required.



FE120 FE170
FE250 FE290
FE350 FE400

4-stroke air-cooled gasoline engine

Service Manual

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No liability can be accepted for any inaccuracies or omissions in this publication, although every possible care has been taken to make it as complete and accurate as possible.

The right is reserved to make changes at any time without prior notice and without incurring an obligation to make such changes to products manufactured previously.

All information contained in this publication is based on the latest product information available at the time of publication. Illustrations and photographs in this publication are intended for reference use only and may not depict actual model component parts.

LIST OF ABBREVIATIONS

A	ampere(s)	lb	pound(s)
ABDC	after bottom dead center	m	meter(s)
AC	alternating current	min	minute(s)
ATDC	after top dead center	N	newton(s)
BBDC	before bottom dead center	Pa	pascal(s)
BDC	bottom dead center	PS	horsepower
BTDC	before top dead center	psi	pound(s) per square inch
°C	degree(s) Celsius	r	revolution
DC	direct current	rpm	revolution(s) per minute
F	farad(s)	TDC	top dead center
°F	degree(s) Fahrenheit	TIR	total indicator reading
ft	foot, feet	V	volt(s)
g	gram(s)	W	watt(s)
h	hour(s)	Ω	ohm(s)
L	liter(s)		

Read OWNER'S MANUAL before operating.

EMISSION CONTROL INFORMATION

To protect the environment in which we live, Kawasaki has incorporated crankcase emission (1) and exhaust emission (2) control systems in compliance with applicable regulations of the United States Environmental Protection Agency and the California Air Resources Board.

1. Crankcase Emission Control System

A sealed-type crankcase emission control system is used to eliminate blow-by gasses. The blow-by gasses are led to a breather chamber through the crankcase and from there to the air cleaner.

Oil is separated from the gasses while passing through the inside of the breather chamber from the crankcase, and then returned to the bottom of the crankcase.

2. Exhaust Emission Control System

The exhaust emission control system applied to this engine consists of a carburetor and an ignition system having optimum ignition timing characteristics.

The carburetor has been calibrated to provide lean air/fuel mixture characteristics and optimum fuel economy with a suitable air cleaner and exhaust system.

TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

Federal law and California State law prohibits the following acts or the causing thereof: (1) the removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new engine for the purpose of emission control prior to its sale or delivery to the ultimate purchaser or while it is in use, or (2) the use of the engine after such device or element of design has been removed or rendered inoperative by any person.

Among those acts presumed to constitute tampering are the acts listed below:

Do not tamper with the original emission related part.

- Carburetor and internal parts
- Spark plugs
- Magneto or electronic ignition system
- Fuel filter element
- Air cleaner elements
- Crankcase
- Cylinder heads
- Breather chamber and internal parts
- Intake pipe and tube

Foreword

This manual is designed primarily for use by trained mechanics in a properly equipped shop. However, it contains enough detail and basic information to make it useful to the owner who desires to perform his own basic maintenance and repair work. A basic knowledge of mechanics, the proper use of tools, and workshop procedures must be understood in order to carry out maintenance and repair satisfactorily. Whenever the owner has insufficient experience or doubts as to his ability to do the work, all adjustments, maintenance, and repair should be carried out only by qualified mechanics.

In order to perform the work efficiently and to avoid costly mistakes, read the text, thoroughly familiarize yourself with the procedures before starting work, and then do the work carefully in a clean area. Whenever special tools or equipment are specified, do not use makeshift tools or equipment. Precision measurements can only be made if the proper instruments are used, and the use of substitute tools may adversely affect safe operation.

To get the longest life out of your engine:

- Follow the Periodic Maintenance Chart in the Service Manual.
- Be alert for problems and non-scheduled maintenance.
- Use proper tools and genuine Kawasaki engine parts. Genuine parts provided as spare parts are listed in the Parts Catalog.
- Follow the procedures in this manual carefully. Don't take shortcuts.
- Remember to keep complete records of maintenance and repair with dates and any new parts installed.

How to Use This Manual

In preparing this manual, we divided the product into its major systems. These systems became the manual's chapters. All information for a particular system from adjustment through disassembly and inspection is located in a single chapter.

The Quick Reference Guide shows you all of the product's system and assists in locating their chapters. Each chapter in turn has its own comprehensive Table of Contents.

The Periodic Maintenance Chart is located in the General Information chapter. The chart gives a time schedule for required maintenance operations.

If you want spark plug information, for example, go to the Periodic Maintenance Chart first. The chart tells you how frequently to clean and gap the plug. Next, use the Quick Reference Guide to locate the Electrical System chapter. Then, use the Table of Contents on the first page of the chapter to find the Spark Plug section.

Whenever you see these WARNING and CAUTION symbols, heed their instructions! Always follow safe operating and maintenance practices.

▲ WARNING

This warning symbol identifies special instructions or procedures which, if not correctly followed, could result in personal injury, or loss of life.

CAUTION

This caution symbol identifies special instructions or procedures which, if not strictly observed, could result in damage to or destruction of equipment.

This manual contains four more symbols (in addition to WARNING and CAUTION) which will help you distinguish different types of information.

NOTE

○ *This note symbol indicates points of particular interest for more efficient and convenient operation.*

- Indicates a procedural step or work to be done.
- Indicates a procedural sub-step or how to do the work of the procedural step it follows. It also precedes the text of a WARNING, CAUTION, or NOTE.
- ★ Indicates a conditional step or what action to take based on the results of the test or inspection in the procedural step or sub-step it follows.

In most chapters an exploded view illustration of the system components follows the Table of Contents. In these illustrations you will find the instructions indicating which parts require specified tightening torque, oil, grease or a locking agent during assembly.

General Information

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Before Servicing.....	1-2
General Specifications.....	1-4
Periodic Maintenance Chart.....	1-6
Special Tools.....	1-7
Exploded View.....	1-8

1-2 GENERAL INFORMATION

Before Servicing

Before starting to service the engine, carefully read the applicable section to eliminate unnecessary work. Photographs, diagrams, notes, cautions, warnings, and detailed descriptions have been included wherever necessary. Nevertheless, even a detailed account has limitations, a certain amount of basic knowledge is required for successful work.

Especially note the following:

(1) Dirt

Before removal and disassembly, clean the engine. Any dirt entering the engine, carburetor, or other parts, will work as an abrasive and shorten the life of engine. For the same reason, before installing a new part, clean off any dust or metal filings.

(2) Battery Ground

Remove the ground (—) lead from the battery before performing any disassembly operations on the equipment. This prevents:

(a) the possibility of accidentally turning the engine over while partially disassembled.

(b) sparks at electrical connections which will occur when they are disconnected.

(c) damage to electrical parts.

(3) Tightening Sequence

Generally, when installing a part with several bolts, nuts, or screws, start them all in their holes and tighten them to a snug fit. Then tighten them evenly, in a staggered sequence. This is to avoid distortion of the part and/or causing gas or oil leakage. Conversely, when loosening the bolts, nuts, or screws, first loosen all of them by about a quarter of a turn and then remove them. Where there is a tightening sequence indication in this Service Manual, the bolts, nuts, or screws must be tightened in the order and method indicated.

(4) Torque

When torque values are given in this Service Manual, use them. Either too little or too much torque may lead to serious damage. Use a good quality, reliable torque wrench.

(5) Force

Common sense should dictate how much force is necessary in assembly and disassembly. If a part seems especially difficult to remove or install, stop and examine what may be causing the problem. Whenever tapping is necessary, tap lightly using a wooden or plastic-faced mallet. Use an impact driver for screws (particularly for the removal of screws held by a locking agent) in order to avoid damaging the heads.

(6) Edges

Watch for sharp edges, especially during major engine disassembly and assembly. Protect your hands with gloves or a piece of thick cloth when lifting the engine or turning it over.

(7) High-Flash Point Solvent

A high-flash point solvent is recommended to reduce fire danger. A commercial solvent commonly available in North America is Standard solvent (generic name). Always follow manufacturer and container directions regarding the use of any solvent.

(8) Gasket, O-Ring

Do not reuse a gasket or O-ring once it has been in service. The mating surfaces around the gasket should be free of foreign matter and perfectly smooth to avoid oil or compression leaks.

(9) Liquid Gasket, Non-Permanent Locking Agent

Follow manufacturer's directions for cleaning and preparing surfaces where these compounds will be used. Apply sparingly. Excessive amounts may block engine oil passages and cause serious damage. An example of a non-permanent locking agent commonly available in North America is Loctite Lock'n Seal (Blue).

(10) Press

A part installed using a press or driver, such as a journal, should first be coated with oil on its outer or inner circumference so that it will go into place smoothly.

(11) Ball Bearing

When installing a ball bearing, the bearing race which is affected by friction should be pushed by a suitable driver. This prevents severe stress on the balls and races, and prevents races and balls from being dented. Press a ball bearing until it stops at the stop in the hole or on the shaft.

(12) Oil Seal and Grease Seal

Replace any oil or grease seals that were removed with new ones, as removal generally damages seals.

When pressing in a seal which has manufacturer's marks, press it in with the marks facing out. Seals should be pressed into place using a suitable driver, which contacts evenly with the side of seal, until the face of the seal is even with the end of the hole.

(13) Seal Guide

A seal guide is required for certain oil or grease seals during installation to avoid damage to the seal lips. Before a shaft passes through a seal, apply a little oil, preferably high temperature grease on the lips to reduce rubber to metal friction.

(14) Circlip, Retaining Ring

Replace any circlips and retaining rings that were removed with new ones, as removal weakens and deforms them. When installing circlips and retaining rings, take care to compress or expand them only enough to install them and no more.

Before Servicing

(15) Cotter Pin

Replace any cotter pins that were removed with new ones, as removal deforms and breaks them.

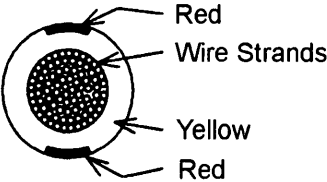
(16) Lubrication

Engine wear is generally at its maximum while the engine is warming up and before all the rubbing surfaces have an adequate lubricative film. During assembly, oil or grease (whichever is more suitable) should be applied to any rubbing surface which has lost its lubricative film. Old grease and dirty oil should be cleaned off. Deteriorated grease has lost its lubricative quality and may contain abrasive foreign particles.

Don't use just any oil or grease. Some oils and greases in particular should be used only in certain applications and may be harmful if used in an application for which they are not intended. This manual makes reference to molybdenum disulfide grease (MoS₂) in the assembly of certain engine parts. Always check manufacturer recommendations before using such special lubricants.

(17) Electrical Wires

All the electrical wires are either single-color or two-color and, with only a few exceptions, must be connected to wires of the same color. On any of the two-color wires there is a greater amount of one color and a lesser amount of a second color, so a two-color wire is identified by first the primary color and then the secondary color. For example, a yellow wire with thin red stripes is referred to as a "yellow/red" wire; it would be a "red/yellow" wire if the colors were reversed to make red the main color.

Wire (cross-section)	Name of Wire Color
	Yellow/Red

(18) Replacement Parts

When there is a replacement instruction, replace these parts with new ones every time they are removed. These replacement parts will be damaged or lose their original function once removed.

(19) Inspection

When parts have been disassembled, visually inspect these parts for the following conditions or other damage. If there is any doubt as to the condition of them, replace them with new ones.

Abrasion	Crack	Hardening	Warp
Bent	Dent	Scratch	Wear
Color change	Deterioration	Seizure	

(20) Specifications

Specification terms are defined as follows:

"Standards" show dimensions or performances which brand-new parts or systems have.

"Service Limits" indicate the usable limits. If the measurement shows excessive wear or deteriorated performance, replace the damaged parts.

1-4 GENERAL INFORMATION

General Specifications

Item	FE120		FE170	
	Type D	Type G	Type D	Type G
Dimensions:				
L × W × H	mm	291 × 349 × 344		300 × 354 × 370
	in	11.46 × 13.43 × 19.54		11.81 × 13.94 × 14.57
Dry Weight	kg	14.5		16.8
Engine:				
Type of engine	Air cooled, 4-stroke, OHV, Single cylinder, Gasoline engine			
Number of Cylinder	1			
Bore × Stroke	mm	60 × 44		66 × 50
	in	2.36 × 1.73		2.60 × 1.97
Displacement	mL	124		171
	cu.in	7.6		10.4
Direction of rotation	Counterclockwise facing PTO Shaft			
Fast Idle Speed	rpm	4000		
Slow Idle Speed	rpm	1600		
Fuel information	Unleaded Gasoline			
Fuel tank capacity	L	2.5		3.4
Lubrication system	Splash			
Engine Oil	SAE 10W30 (SF, SG, SH, or SJ)			
Oil Pan Capacity	Max.	0.6 L		0.6 L
	Min.	0.35 L		0.35 L
Carburetor	Float, Butterfly Type			
Ignition system	Transistor Flywheel Magneto			
Spark Plug	NGK BPR 5ES			
Starting system	Recoil starter with ACR or electric starter			
Governor	Mechanical flyweight			
Type of Reduction	---	1/2 gear reduction	---	1/2 gear reduction
Air Cleaner	Dual Element			

Specifications are subject to change without notice, and may not apply to every country.

GENERAL INFORMATION 1-5

General Specifications

Item	FE250		FE290		FE350		FE400		
	Type D	Type G	Type D	Type G	Type D	Type G	Type D	Type G	
Dimensions:									
L × W × H	mm	344.5 × 395 × 432		363 × 408 × 441		378 × 422 × 454		378 × 422 × 459	
	in	13.56 × 15.55 × 17.01		14.29 × 16.06 × 17.36		14.88 × 16.61 × 17.87		14.88 × 16.61 × 18.07	
Dry Weight									
With recoil starter	kg	26.8		30.4		34.4		34.5	
With erectic starter	kg	30.0		33.6		38.2		38.5	
Engine:									
Type of engine	Air cooled, 4-stroke, OHV, Single cylinder, Gasoline engine								
Number of Cylinder	1								
Bore × Stroke	mm	76 × 55		78 × 60		83 × 65		87 × 67.5	
	in	2.99 × 2.17		3.07 × 2.36		3.27 × 2.56		3.43 × 2.66	
Displacement	mL	249		286		351		401	
	cu.in	15.2		17.5		21.4		24.5	
Direction of rotation	Counterclockwise facing PTO Shaft								
Fast Idle Speed	rpm	4000							
Slow Idle Speed	rpm	1300							
Fuel information	Unleaded Gasoline								
Fuel tank capacity	L	5.3		6.0		6.4		6.4	
Lubrication system	Splash		Pressurized lubrication with oil filter						
Engine Oil	SAE 10W30 (SF, SG, SH, or SJ)								
Oil Pan Capacity	Max.	1.1 L		1.1 L		1.3 L		1.3 L	
	Min.	0.8 L		0.8 L		1.0 L		1.0 L	
Carburetor	Float, Butterfly Type								
Ignition system	Transistor flywheel magneto								
Spark Plug	NGK BPR 5ES								
Starting system	Recoil starter with ACR or electric starter								
Governor	Mechanical flyweight								
Type of Reduction	-	1/2 gear reduction		-	1/2 gear reduction		-	1/2 gear reduction	
Air Cleaner	Dual Element								

Specifications are subject to change without notice, and may not apply to every country.

1-6 GENERAL INFORMATION

Periodic Maintenance Chart

To ensure satisfactory operation over an extended period of time, any engine requires normal maintenance regular intervals. The Periodic Maintenance Chart below shows periodic inspection and maintenance items and suitable intervals. The bullet mark (•) designates that the corresponding item should be performed at that interval.

Some adjustments require the use of special tools or other equipment. An electronic tachometer will facilitate setting idle and running speeds.

▲WARNING

Always remove the spark plug cap from spark plug when servicing the engine to prevent accidental starting.

MAINTENANCE	INTERVAL						
	Daily	First 8 hr.	Every 25 hr.	Every 50 hr.	Every 100 hr.	Every 200 hr.	Every 300 hr.
Check and add engine oil,	●						
Check for loose or lost nuts and screws	●						
Check for fuel and oil leakage	●						
Check battery electrolyte level	●						
Check or clean air intake screen	●						
Tighten nuts and screws			●				
★ Clean air cleaner foam element			●				
★ Clean air cleaner paper element					●		
Clean fuel filter element				●			
Change engine oil (without oil filter)		●		●			
Change engine oil (with oil filter)		●			●		
Clean and regap spark plug					●		
Change oil filter						●	
★ Replace air cleaner paper element							●
★ Clean dust and dirt from cylinder and cylinder head fins							●
K Clean combustion chamber							●
K Check and adjust valve clearance							●
K Clean and lap valve seating surface							●

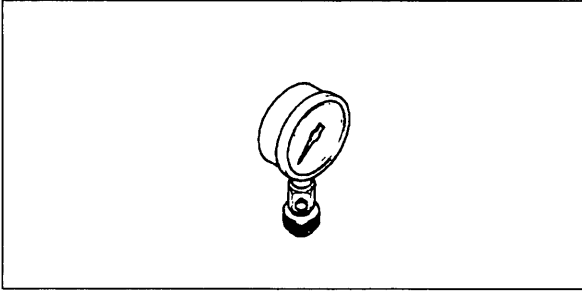
NOTE: The service intervals indicated are to be used as a guide. Service should be performed more frequently as necessary by operating condition.

★: Service more frequently under dusty conditions.

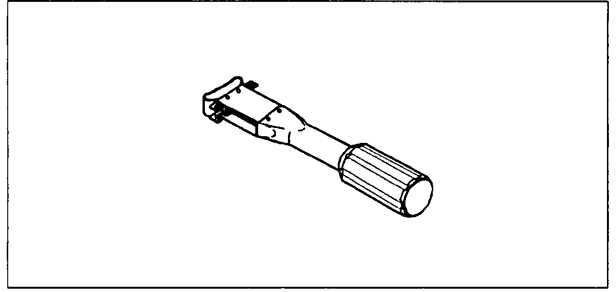
K: Have an authorized Kawasaki engine dealer perform those services.

Special Tools

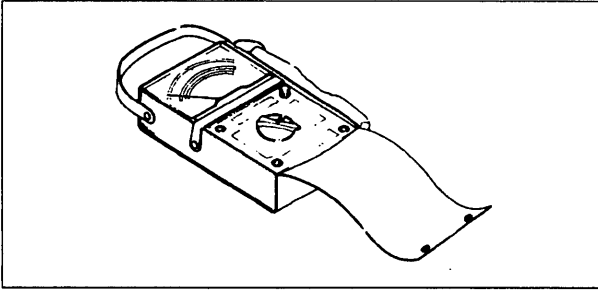
Compression Gauge: 57001-221



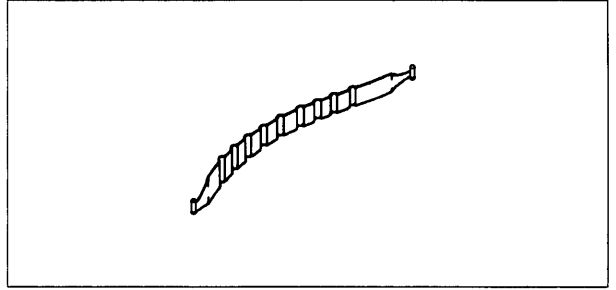
Piston Ring Compression Grip: 57001-1095



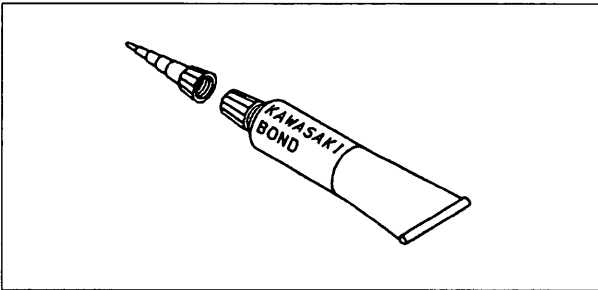
Hand Tester: 57001-1394



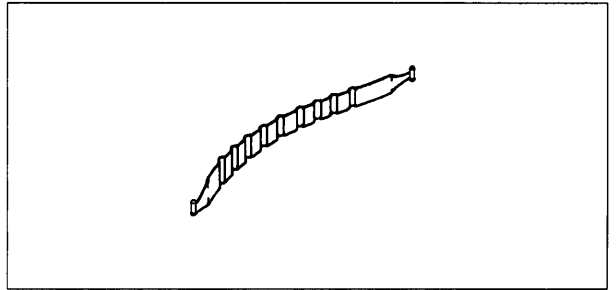
Piston Ring Compression Belt, $\phi 50-\phi 67$: 57001-1096



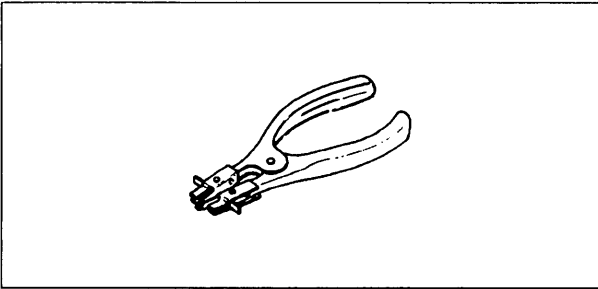
Kawasaki Bond (Silicone Sealand): 56019-120



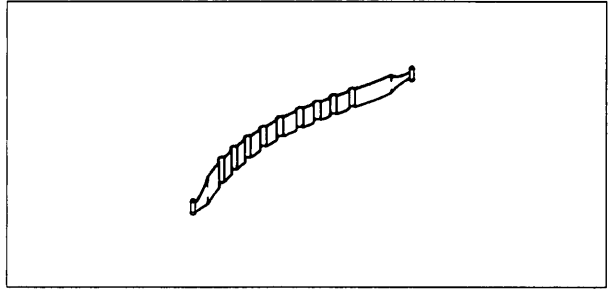
Piston Ring Compression Belt, $\phi 67-\phi 79$: 57001-1097



Piston Ring Pliers: 57001-115



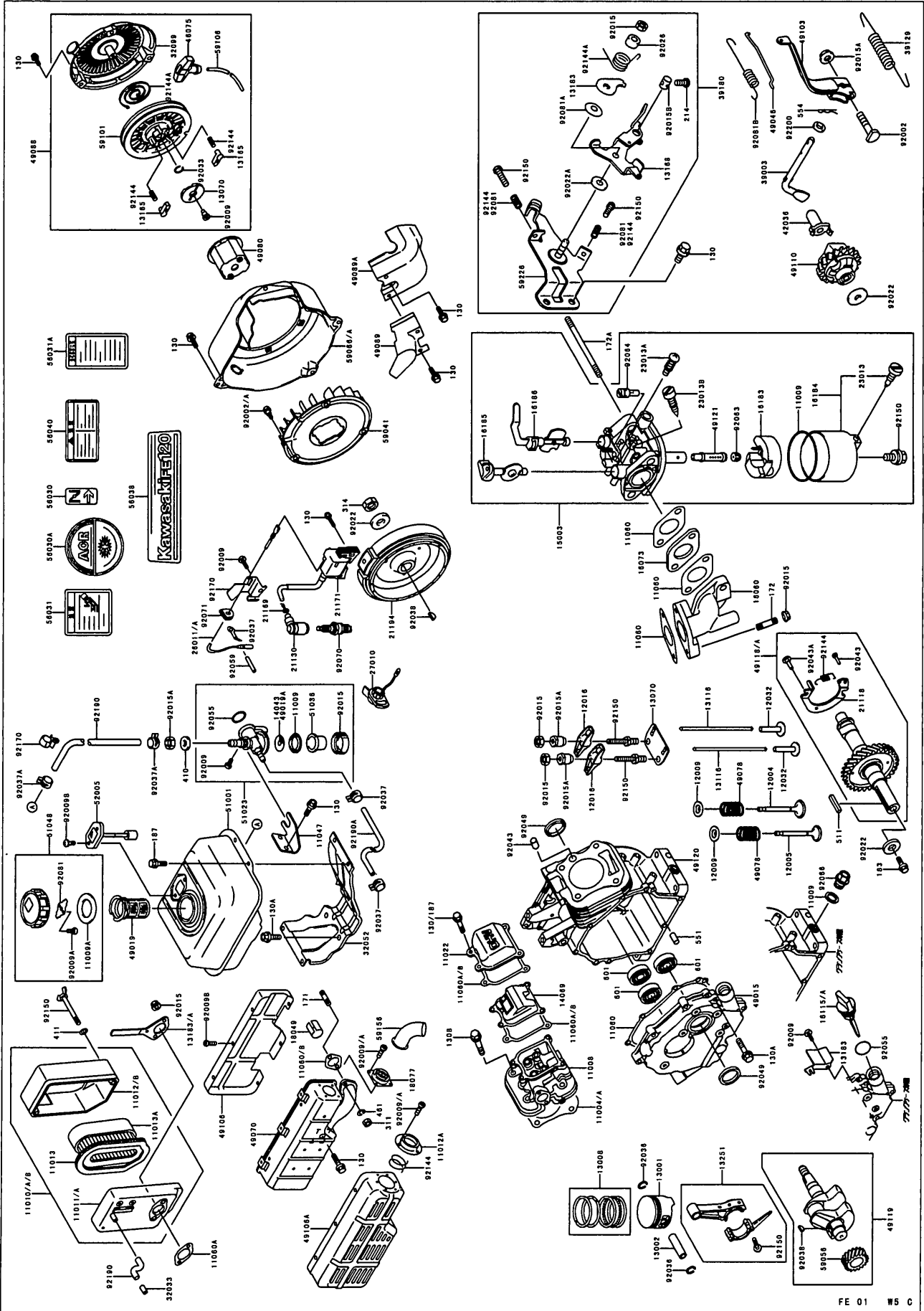
Piston Ring Compression Belt, $\phi 80-\phi 91$: 57001-1320



1-8 GENERAL INFORMATION

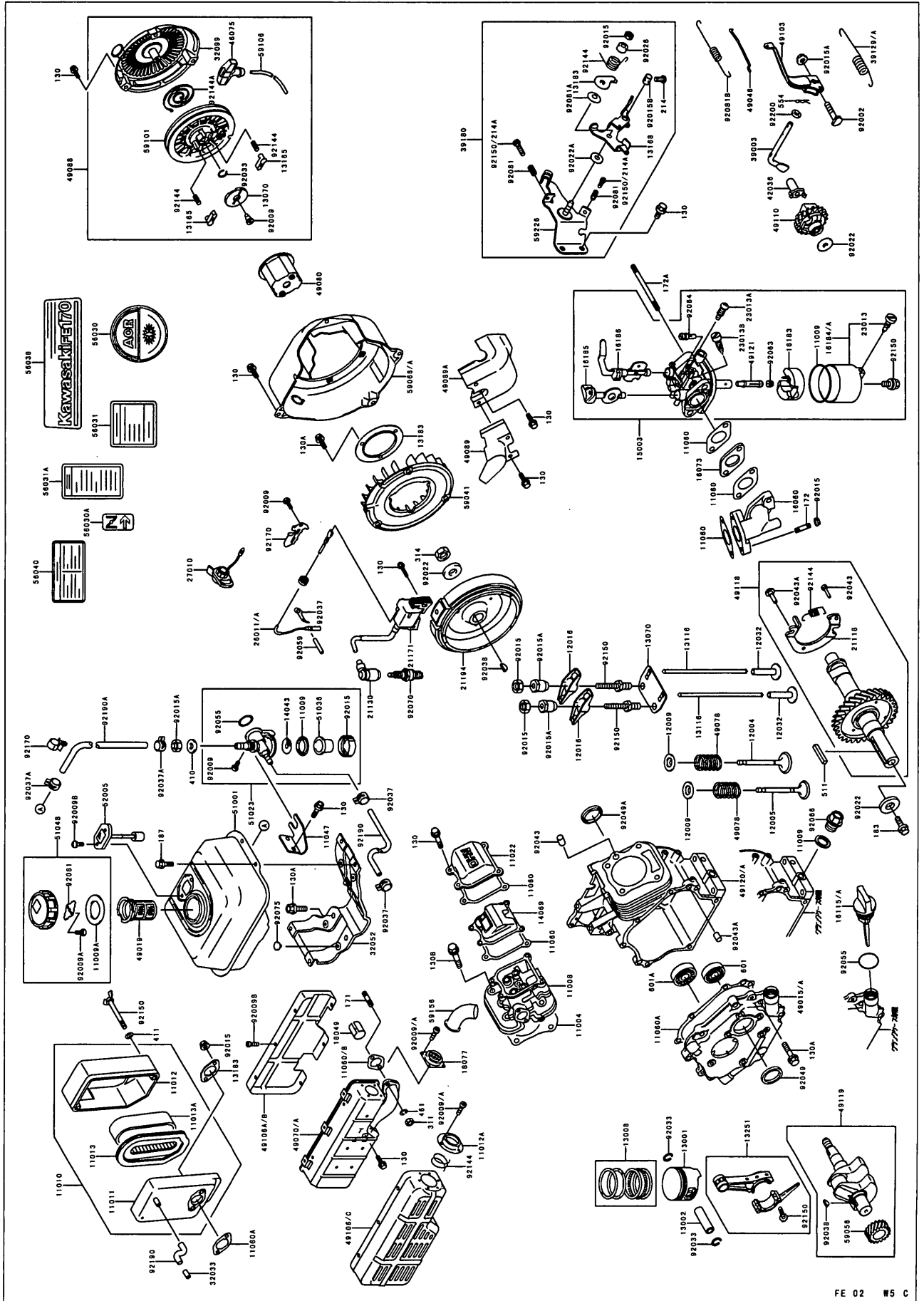
Exploded View

FE120



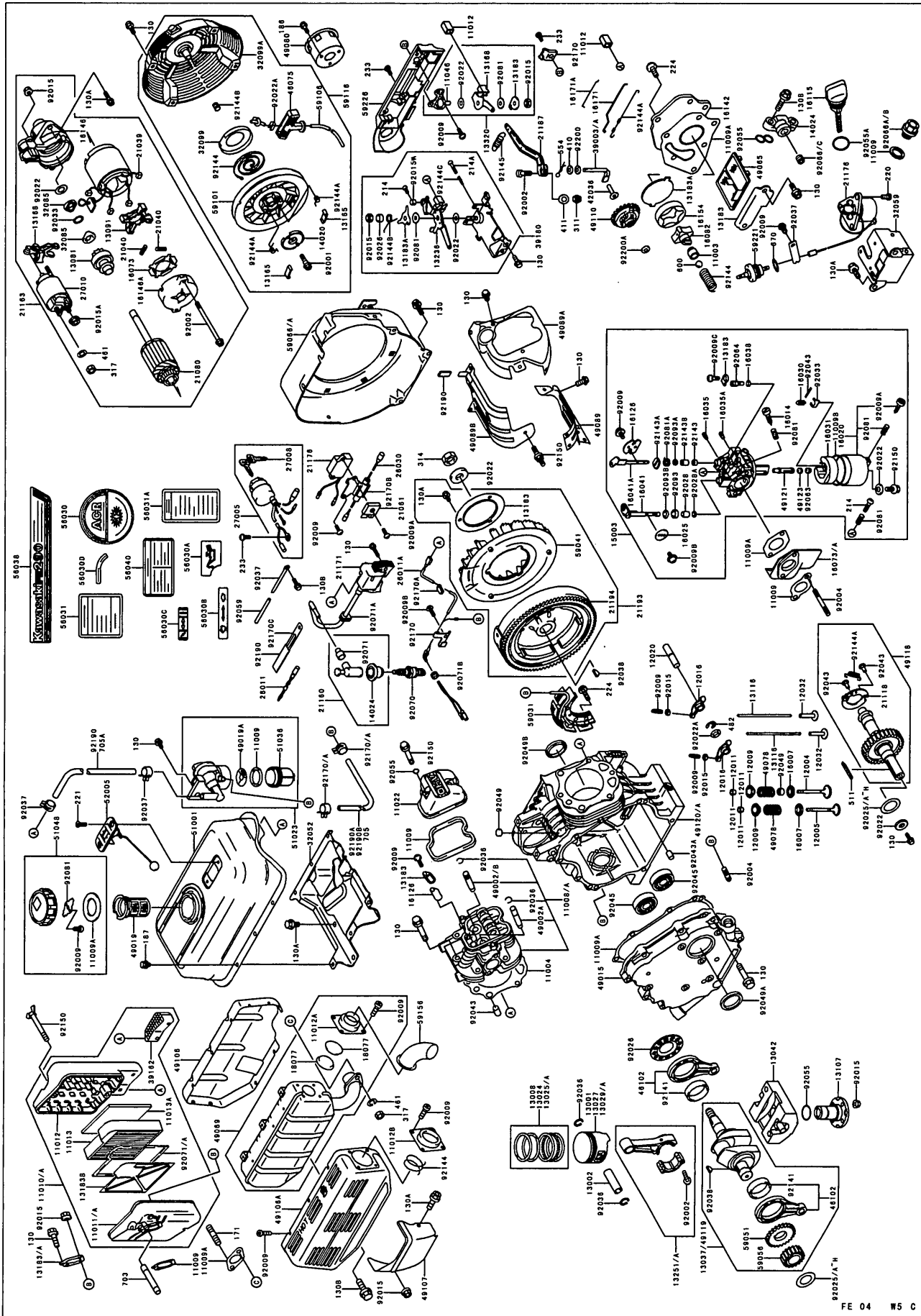
Exploded View

FE170



Exploded View

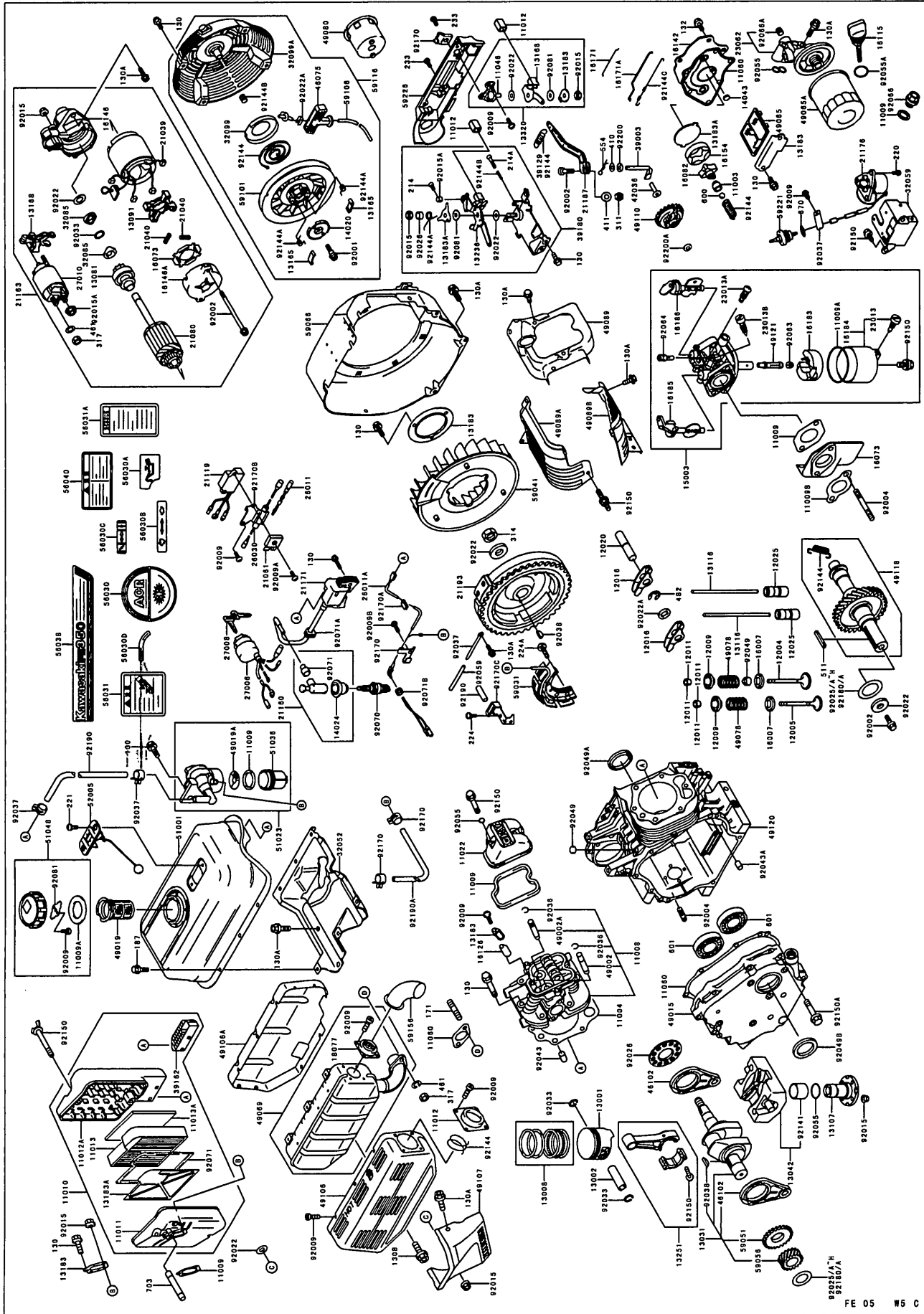
FE290



1-12 GENERAL INFORMATION

Exploded View

FE350



Service Data

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2-2 SERVICE DATA

Service Specifications

Item	Service Limit (mm)					
	FE120		FE170		FE250	
	Type D	Type G	Type D	Type G	Type D	Type G
Compression (minimum) with Recoil Starter	290 kPa (3 kg/cm ² , 42 psi)		←		←	
with Electric Starter	390 kPa (4 kg/cm ² , 57 psi)		←		←	
Cylinder						
Bore (maximum)	60.067 (2.3648 in)		66.067 (2.3648 in)		76.070 (2.9949 in)	
Roundness (maximum)	0.056 (0.0022 in)		←		←	
Boring Size (oversize)	0.50 (0.0120 in)		←		←	
Crankcase Area						
Crankshaft Bearing Bore (maximum)	---		---		---	
Camshaft Bearing Bore (maximum)	15.063 (0.593 in)		16.063 (0.6324 in)		20.063 (0.7899 in)	
Balancer Shaft Bearing Bore (maximum)	---		15.063 (0.5930 in)		---	
Oil Pump Housing Bore (maximum)	---		---		---	
Oil Pump Housing Depth (maximum)	---		---		---	
Oil Pump Shaft Bearing Bore (maximum)	---		---		---	
Crankcase Cover						
Camshaft Bearing Bore (maximum)	15.063 (0.5930 in)	---	16.063 (0.6324 in)	---	20.063 (0.7899 in)	---
Crankshaft						
Crankpin Diameter (minimum)	25.944 (1.0214 in)		28.944 (1.1395 in)		33.944 (1.3363 in)	
Crankshaft Journal Diameter PTO Side (minimum)	19.930 (0.7846 in)		24.930 (0.9815 in)		29.930 (1.1783 in)	
Flywheel Side (minimum)	19.930 (0.7846 in)		24.930 (0.9815 in)		29.930 (1.1783 in)	
Balancer Link Rod Journal (minimum)	---		---		---	
Shaft Runout: TIR (maximum)	0.05 (0.0020 in)		←		←	
Axial Play (maximum)	0.5 (0.0197 in) (standard: 0 ~ 0.24) (0 ~ 0.0094 in)		← (standard: 0.03 ~ 0.30) (0.0012 ~ 0.0119 in)		0.35 (0.0138 in) (standard: 0.05 ~ 0.17) (0.0020 ~ 0.0067 in)	
Camshaft						
Camshaft Journal Diameter PTO Side (minimum)	14.910 (0.5870 in)	19.930 (0.7846 in)	15.910 (0.6264 in)	24.930 (0.9815 in)	19.927 (0.7845 in)	29.930 (1.1783 in)
Flywheel Side (minimum)	14.910 (0.5870 in)		15.910 (0.6264 in)		19.927 (0.7845 in)	
Cam Lobe Height: Intake, Exhaust (minimum)	26.157 (1.0298 in)		30.024 (1.1820 in)		31.040 (1.2220 in)	
Axial Play (maximum)	---	0.50 (0.0197 in) (standard: 0.08 ~ 0.34) (0.0031 ~ 0.0134 in)	---	0.50 (0.0197 in) (standard: 0.08 ~ 0.34) (0.0031 ~ 0.0134 in)	0.35 (0.0138 in) (standard: 0.05 ~ 0.23) (0.0020 ~ 0.0091 in)	0.35 (0.0138 in) (standard: 0.05 ~ 0.17) (0.0020 ~ 0.0067 in)

Service Specifications

Item	Service Limit (mm)					
	FE120		FE170		FE250	
	Type D	Type G	Type D	Type G	Type D	Type G
Connecting Rod						
Connecting Rod Big End Bore (maximum)	26.052 (1.0257 in)		29.052 (1.1438 in)		34.067 (1.3412 in)	
Connecting Rod Small End Bore (maximum)	14.042 (0.5528 in)		16.047 (0.6318 in)		18.051 (0.7107 in)	
Connecting Rod Bend and Twist (maximum)	0.15/100 (0.006/100 in)		←		←	
Dynamic Balancer						
Balancer Shaft Journal Diameter						
PTO Side (minimum)	---		14.943 (0.5883 in)		---	
Flywheel Side (minimum)	---		14.933 (0.5883 in)		---	
Weight Guide Hole Bore (maximum)	---		---		26.118 (1.0283 in)	
Balancer Guide Diameter (minimum)	---		---		25.907 (1.0200 in)	
Link Rod Bearing Bore					12.057 (0.4747 in)	
Small End Bore (maximum)	---		---		47.106 (1.8546 in)	
Big End Bore (maximum)	---		---			
Piston						
Piston Ring/Groove Clearance (with new rings)						
Top Ring (maximum)	0.15 (0.0059 in)		←		←	
Second Ring (maximum)	0.12 (0.0047 in)		←		←	
Piston Pin Hole Bore (maximum)	14.033 (0.5525 in)		16.033 (0.6312 in)		18.033 (0.7100 in)	
Piston Pin Diameter (minimum)	13.975 (0.5502 in)		15.975 (0.6289 in)		17.975 (0.7077 in)	

2-4 SERVICE DATA

Service Specifications

Item	Service Limit (mm)					
	FE290		FE350		FE400	
	Type D	Type G	Type D	Type G	Type D	Type G
Compression (minimum) with Recoil Starter	290 kPa (3 kg/cm ² , 42 psi)		←		←	
with Electric Starter	390 kPa (4 kg/cm ² , 57 psi)		←		←	
Cylinder Bore (maximum)	78.067 (3.0735 in)		83.067 (3.2703 in)		87.067 (3.4278 in)	
Roundness (maximum)	0.056 (0.0022 in)		←		←	
Boring Size (oversize)	0.50 (0.0197 in)		←		←	
Crankcase Area Crankshaft Bearing Bore (maximum)	30.075 (1.1841 in)		35.075 (1.3809 in)		←	
Camshaft Bearing Bore (maximum)	23.063 (0.9080 in)		←		←	
Balancer Shaft Bearing Bore (maximum)	---		---		---	
Oil Pump Housing Bore (maximum)	40.766 (1.6050 in)		←		←	
Oil Pump Housing Depth (maximum)	10.170 (0.4004 in)		←		←	
Oil Pump Shaft Bearing Bore (maximum)	12.770 (0.5028 in)		←		←	
Crankcase Cover Camshaft Bearing Bore (maximum)	23.063 (0.9080 in)	---	23.063 (0.9080 in)	---	23.063 (0.9080 in)	---
Crankshaft Crankpin Diameter (minimum)	35.444 (1.3954 in)		37.444 (1.4742 in)		←	
Crankshaft Journal Diameter PTO Side (minimum)	29.930 (1.1783 in)		34.930 (1.3752 in)		←	
Flywheel Side (minimum)	29.930 (1.1783 in)		34.930 (1.3752 in)		←	
Balancer Link Rod Journal (minimum)	46.924 (1.8474 in)		49.924 (1.9655 in)		←	
Shaft Runout: TIR (maximum)	0.05 (0.0020 in)		←		←	
Axial Play (maximum)	0.35 (0.013 in) (standard: 0.09 ~ 0.20) (0.0035 ~ 0.0079 in)		0.35 (0.013 in) (standard: 0.08 ~ 0.22) (0.0031 ~ 0.0089 in)		0.35 (0.013 in) (standard: 0.08 ~ 0.22) (0.0031 ~ 0.0087 in)	
Camshaft Camshaft Journal Diameter PTO Side (minimum)	22.927 (0.9026 in)	29.930 (1.1783 in)	22.927 (0.9026 in)	34.930 (1.3752 in)	22.927 (0.9026 in)	34.930 (1.3752 in)
Flywheel Side (minimum)	22.927 (0.9026 in)		←		←	
Cam Lobe Height: Intake, Exhaust (minimum)	32.700 (1.2874 in)		33.240 (1.3087 in)		←	

Service Specifications

Item	Service Limit (mm)					
	FE290		FE350		FE400	
	Type D	Type G	Type D	Type G	Type D	Type G
Axial Play (maximum)	---	0.35 (0.013 in) (standard: 0.07 - 0.21) (0.0028 - 0.008 in)	0.35 (0.013 in) (standard: 0.06 - 0.24) (0.0024 - 0.009 in)	0.35 (0.013 in) (standard: 0.07 - 0.21) (0.0028 - 0.008 in)	0.06 (0.024) (standard: 0.06 - 0.24) (0.0024 - 0.009 in)	0.35 (0.013 in) (standard: 0.07 - 0.21) (0.0028 - 0.008 in)
Connecting Rod						
Connecting Rod Big End Bore (maximum)	35.567 (1.4003 in)		37.567 (1.4790 in)		←	
Connecting Rod Small End Bore (maximum)	19.051 (0.7500 in)		20.051 (0.7894 in)		←	
Connecting Rod Bend and Twist (maximum)	0.15/100 (0.006/100 in)		←		←	
Dynamic Balancer						
Balancer Shaft Journal Diameter						
PTO Side (minimum)	---		---		---	
Flywheel Side (minimum)	---		---		---	
Weight Guide Hole Bore (maximum)	26.118 (1.0283 in)		26.097 (1.0274 in)		←	
Balancer Guide Diameter (minimum)	25.907 (1.0120 in)		←			
Link Rod Bearing Bore						
Small End Bore (maximum)	12.064 (0.4750 in)		12.057 (0.4747 in)		←	
Big End Bore (maximum)	47.126 (1.8554 in)		50.106 (1.9727 in)		←	
Piston						
Piston Ring/Groove Clearance (with new rings)						
Top Ring (maximum)	0.16 (0.0063 in)		←		←	
Second Ring (maximum)	0.14 (0.0055 in)		←		←	
Piston Pin Hole Bore (maximum)	19.033 (0.7493 in)		20.033 (0.7887 in)		←	
Piston Pin Diameter (minimum)	18.975 (0.7470 in)		19.975 (0.7864 in)		←	

2-6 SERVICE DATA

Service Specifications

Item	Service Limit (mm)					
	FE120		FE170		FE250	
	Type D	Type G	Type D	Type G	Type D	Type G
Piston Ring						
Piston Ring Thickness (minimum)						
Top, Second	1.42 (0.056 in)		←		1.44 (0.057 in)	
Piston Ring End Gap (maximum)						
Top, Second	1.0 (0.039 in)		←		←	
Oil Ring	Visual Inspection		←		←	
Cylinder Head						
Valve Seating Surface Width						
Standard	0.7 (0.028 in)		←		0.8 (0.031 in)	
Maximum	1.7 (0.067 in)		←		1.9 (0.075 in)	
Valve Guide Bore (maximum)						
Intake, Exhaust	5.562 (0.2190 in)		←		6.065 (0.2388 in)	
Rocker Arm Bearing Bore (maximum)	---		---		---	
Gasket Surface Warp (maximum)	0.05 (0.002 in)		←		←	
Rocker Arm Shaft Diameter (minimum)	---		---		---	
Valve						
Valve Stem Diameter						
Intake Valve (minimum)	5.430 (0.2138 in)		←		5.930 (0.2335 in)	
Exhaust Valve (minimum)	5.415 (0.2132 in)		←		5.915 (0.2329 in)	
Valve Stem Runout (maximum)						
Intake, Exhaust	0.05 (0.002 in)		←		0.03 (0.001 in)	
Valve Head Thickness (minimum)						
Intak, Exhaust	0.5 (0.020 in)		←		0.6 (0.024 in)	
Valve Spring Free Length (minimum)						
Intake, Exhaust	31.8 (1.252 in)		←		32.8 (1.291 in)	
Rocker Arm Pushrod Runout (maximum)						
Intak, Exhaust	0.5 (0.020 in)		←		0.3 (0.012 in)	
HLA Device Leak-Dwon Dimension (maximum)						
Intake, Exhaust	---		---		---	
Valve Lift Height by ACR (minimum)						
Exhaust	0.6 (0.024 in)		←		←	
Oil Pump						
Inner Rotor Shaft Diameter (minimum)	---		---		---	
Outer Rotor						
Diameter (minimum)	---		---		---	
Width (minimum)	---		---		---	
Inner/Outer Rotor Clearance (maximum)	---		---		---	
Relief Valve Spring Free Length (minimum)	---		---		---	
Breather Valve Air Gap (maximum)	0.2 (0.008 in)		←		←	
Starter Motor						
Carbon Brush Length (minimum)	*		←		←	
Commutator Diameter (minimum)	*		←		←	
Commutator Groove Depth (minimum)	0.2 (0.008 in)		←		←	

*: Refer to Electric Starter System

Service Specifications

Item	Service Limit (mm)					
	FE290		FE350		FE400	
	Type D	Type G	Type D	Type G	Type D	Type G
Piston Ring						
Piston Ring Thickness (minimum)						
Top, Second	1.44 (0.057 in)		←		←	
Piston Ring End Gap (maximum)						
Top, Second	1.2 (0.047 in)		←		←	
Oil Ring	Visual Inspection		←		←	
Cylinder Head						
Valve Seating Surface Width						
Standard	0.8 (0.031 in)		←		←	
Maximum	1.9 (0.075 in)		←		←	
Valve Guide Bore (maximum)						
Intake, Exhaust	7.065 (0.2781 in)		←		←	
Rocker Arm Bearing Bore (maximum)	12.074 (0.4754 in)		12.3 (0.484 in)		←	
Gasket Surface Warp (maximum)	0.05 (0.002 in)		←		←	
Rocker Arm Shaft Diameter (minimum)	11.949 (0.4704 in)		←		←	
Valve						
Valve Stem Diameter						
Intake Valve (minimum)	6.930 (0.2728 in)		←		←	
Exhaust Valve (minimum)	6.915 (0.2722 in)		←		←	
Valve Stem Runout (maximum)						
Intake, Exhaust	0.03 (0.001 in)		←		←	
Valve Head Thickness (minimum)						
Intak, Exhaust	0.6 (0.024 in)		←		←	
Valve Spring Free Length (minimum)						
Intake, Exhaust	32.8 (1.291 in)		38.1 (1.500 in)		←	
Rocker Arm Pushrod Runout (maximum)						
Intak, Exhaust	0.3 (0.012 in)		0.5 (0.02 in)		←	
HLA Device Leak-Dwon Dimension (maximum)						
Intake, Exhaust	---		0.5 (0.02 in)		←	
Valve Lift Height by ACR (minimum)						
Exhaust	0.6 (0.024 in)		1.0 (0.039 in)		←	
Oil Pump						
Inner Rotor Shaft Diameter (minimum)	12.627 (0.4971 in)		←		←	
Outer Rotor						
Diameter (minimum)	40.467 (1.5932 in)		←		←	
Width (minimum)	9.920 (0.3906 in)		←		←	
Inner/Outer Rotor Clearance (maximum)	0.3 (0.012 in)		←		←	
Relief Valve Spring Free Length (minimum)	19.0 (0.748 in)		←		←	
Breather Valve Air Gap (maximum)	0.2 (0.008 in)		←		←	
Starter Motor						
Carbon Brush Length (minimum)	*		←		←	
Commutator Diameter (minimum)	*		←		←	
Commutator Groove Depth (minimum)	0.2 (0.008 in)		←		←	

*: Refer to Electric Starter System

2-8 SERVICE DATA

Adjustment Specifications

Item	Adjustment Specifications				
	FE120	FE170	FE250	FE290	FE350 FE400
Idle Speed Setting (crankshaft)	1600 rpm		1300 rpm		
No-Load Maximum Speed Setting (crankshaft)	4000 rpm				
Valve Clearance: Intake, Exhaust (clearance on cold engine)	0.12 mm (0.0047 in)				Adjustment unnecessary
Spark Plug Electrode Gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in)				
Ignition Coil Air Gap Standard: Adjustment range:	0.3 mm (0.012 in) 0.25 ~ 0.4 mm (0.010 ~ 0.016 in)				

Tightening Torque Specifications

Tightening Torque Specifications

Unit: N·m (kg·m, ft·lb)

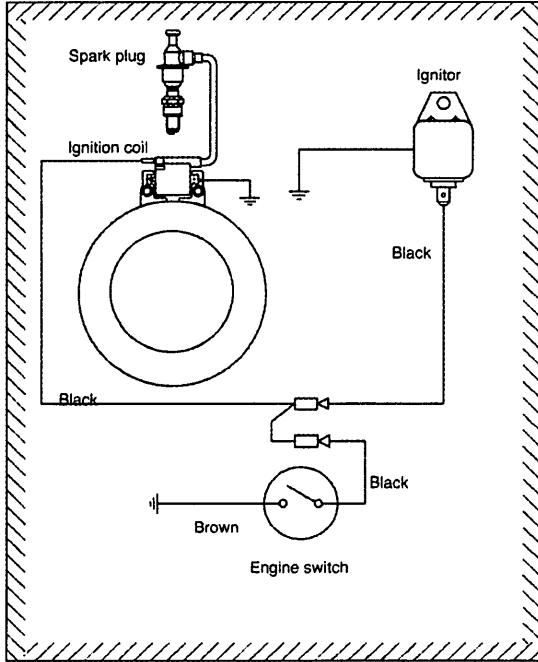
Tightening Location	Tightening Torque				
	FE120	FE170	FE250	FE290	FE350 FE400
Cylinder Head Bolts	25 (2.5, 18)				
Connecting Rod Bolts (Apply Oil to Threads before Tightening)	12 (1.2, 8.9 in·lb)		20 (2.0, 15)		23 (2.3, 17)
Flywheel Retaining Nut (thoroughly degrease tapered area)	64 (6.5, 47)		86 (8.8, 63)		137 (14.0, 101)
Crankcase Cover	9.8 (1.0, 7.2)	22 (2.2, 16)		31 (3.2, 23)	
Rocker Arm Lock Nut	6.9 (0.7, 61 in·lb)			9.8 (1.0, 7.2)	---
Valve Clearance Adjustment Lock Nut	---	---	---	8.8 (0.9, 78 in·lb)	---
Muffler Flange Nut	9.8 (1.0, 7.2)		20 (2.0, 15)		
Fan Retaining or Fan Presser Plate	9.8 (1.0, 7.2)				
Electric Starter Retaining Bolt	15 (1.5, 11)		20 (2.0, 15)		
Oil Drain Plug	32 (3.3, 24)				
Spark Plug	23 (2.3, 17)				
Fuel Tank	9.8 (1.0, 7.2)				
Retaining Bolts for: Fan Housing, Shroud, Recoil Starter	5.9 (0.6, 52 in·lb)		9.8 (1.0, 7.2)		
General Bolts and Nuts:					
M8	15 (1.5, 11)				
M6	5.9 (0.6, 52 in·lb)				
M5	3.4 (0.35, 30 in·lb)				
M4	1.2 (0.12, 11 in·lb)				
Oil Level Sensor Bracket (M6 Tapping Screws)	9.8 (1.0, 7.2)				
Starter Motor Battery Terminal Nut	3.4 (0.35, 30 in·lb)	9.8 (1.0, 7.2)			

2-10 SERVICE DATA

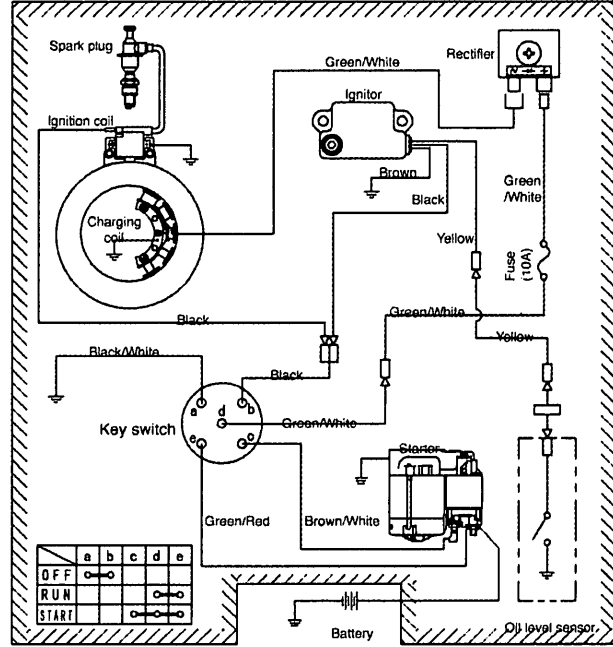
Wiring Diagram

Ignition Coil/Ignition Separate Type

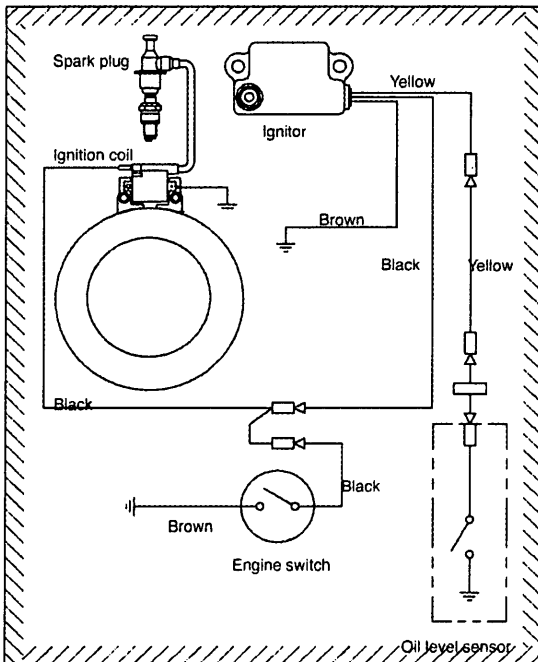
For Recoil Starter Model
(Without oil level Sensor)



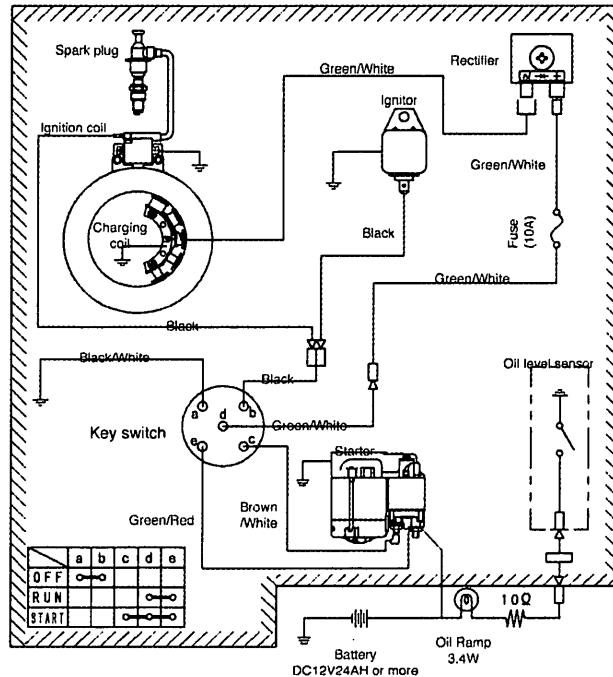
For Electric Starter Model
(With oil level Sensor of Engine Stop Type)



For Recoil Starter Model
(With oil level Sensor of Engine Stop Type)



For Electric Starter Model
(With oil level Sensor of Alarm Indicator Type)



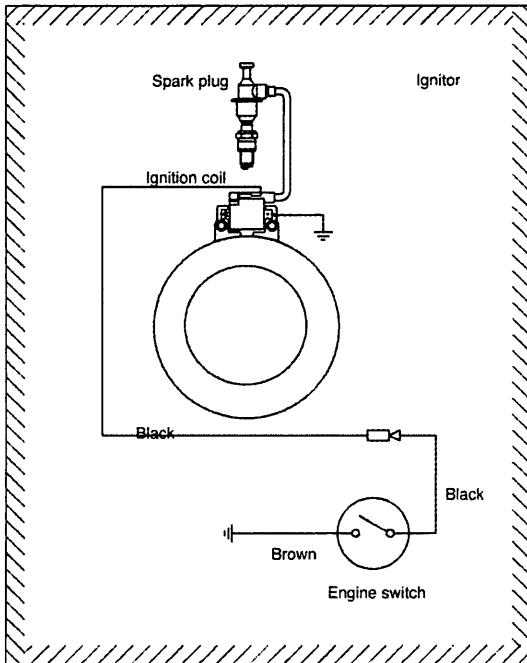
: Shown in the hatched frame are those included in the standard equipment.

The wiring diagrams are common to all models.

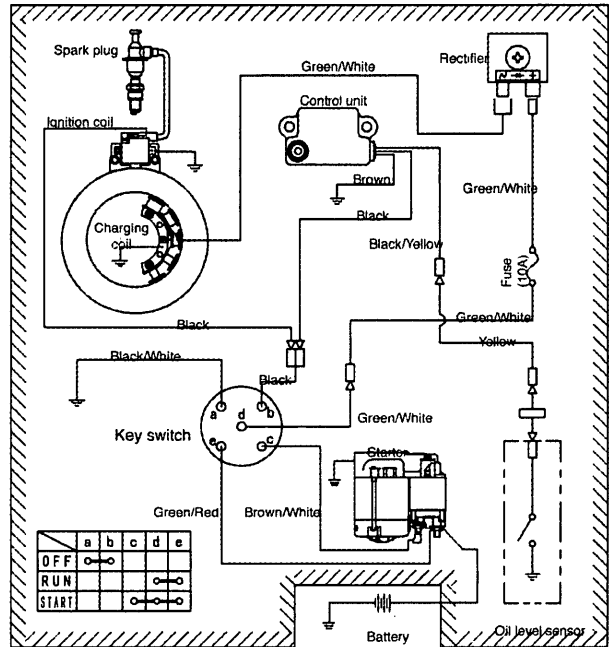
Wiring Diagram

Ignition Coil/Igniter Integrated Type

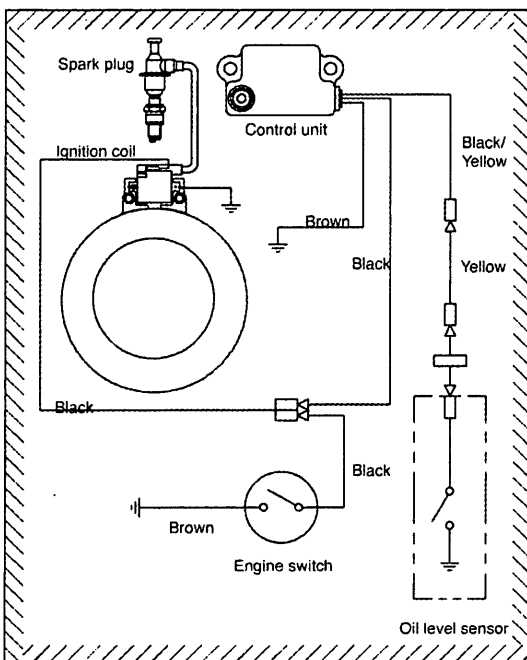
For Recoil Starter Model
(Without oil level Sensor)



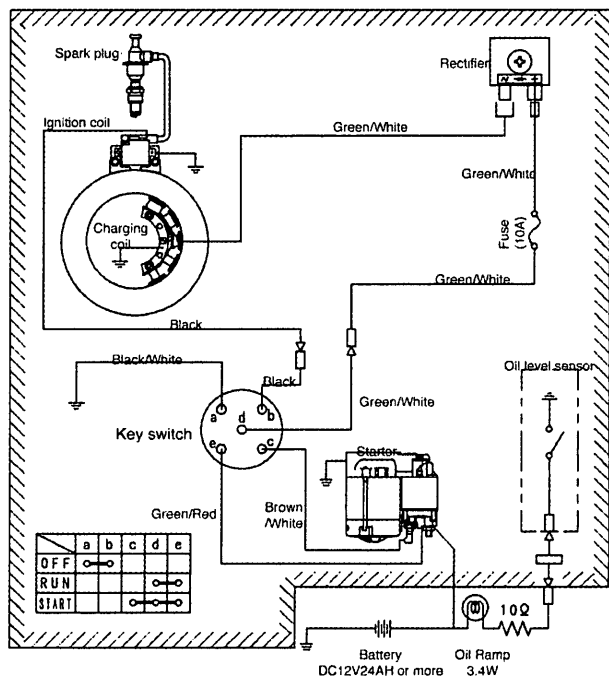
For Electric Starter Model
(With oil level Sensor of Engine Stop Type)



For Recoil Starter Model
(With oil level Sensor of Engine Stop Type)



For Electric Starter Model
(With oil level Sensor of Alarm Indicator Type)



: Shown in the hatched frame are those included in the standard equipment.

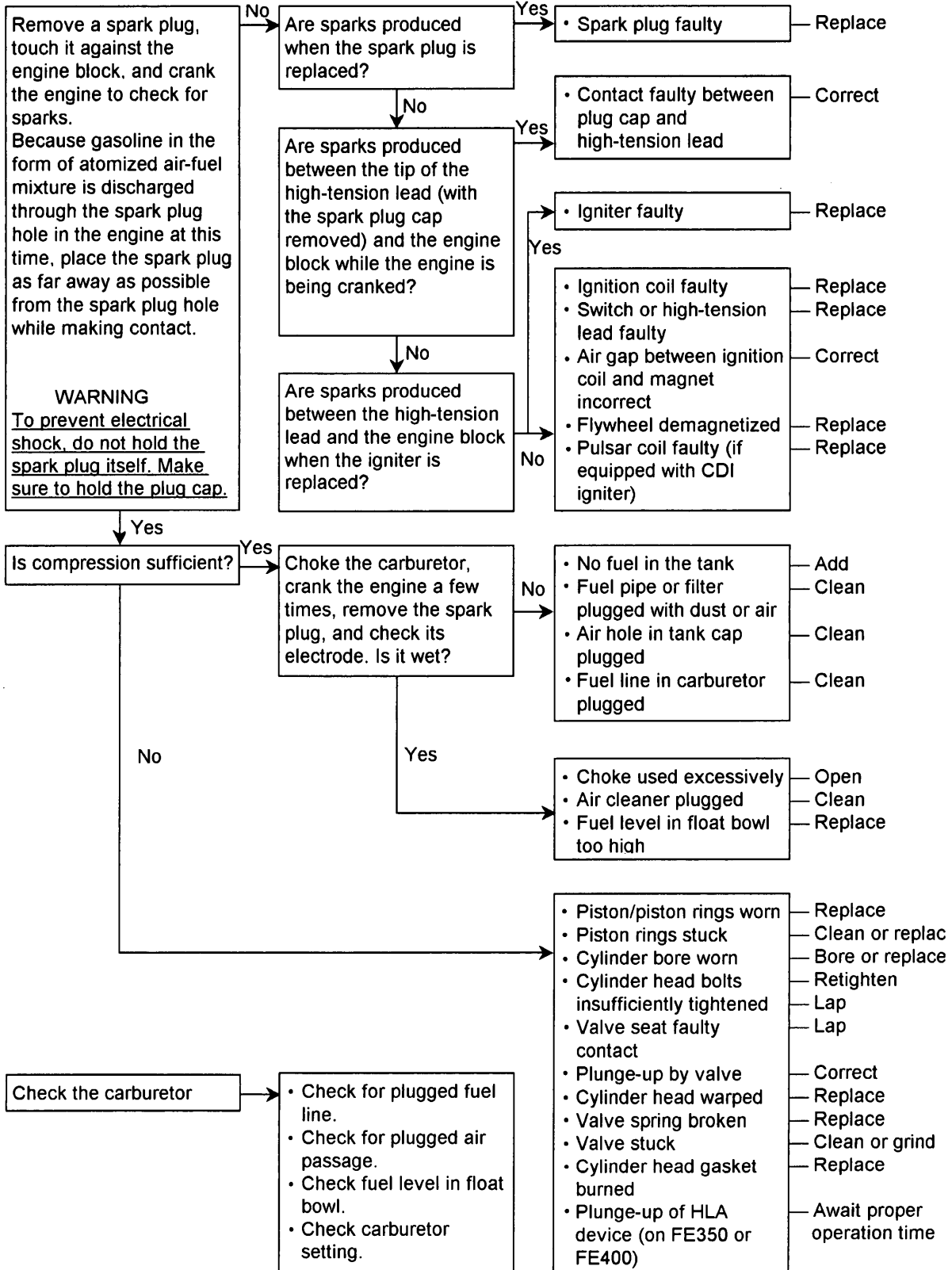
The wiring diagrams are common to all models.

2-12 SERVICE DATA

Troubleshooting

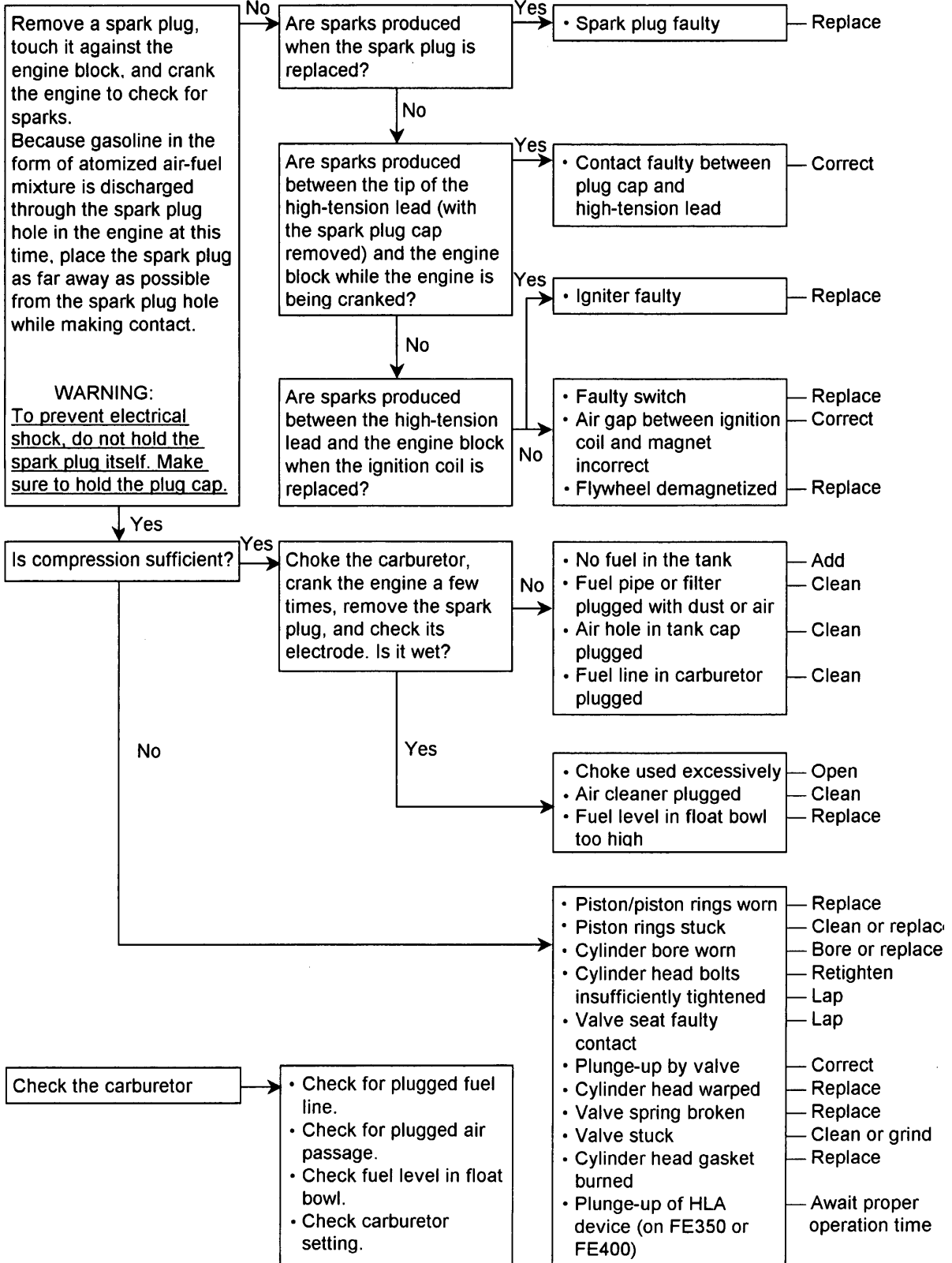
If the engine malfunctions, first check whether the engine has been operated correctly. Then, systematically carry out the troubleshooting procedure starting with simple items. This troubleshooting chart lists typical malfunctions. Do not unnecessarily disassemble any parts before the cause of the problem is identified.

Engine hard to start (separate ignition coil and igniter)



Troubleshooting

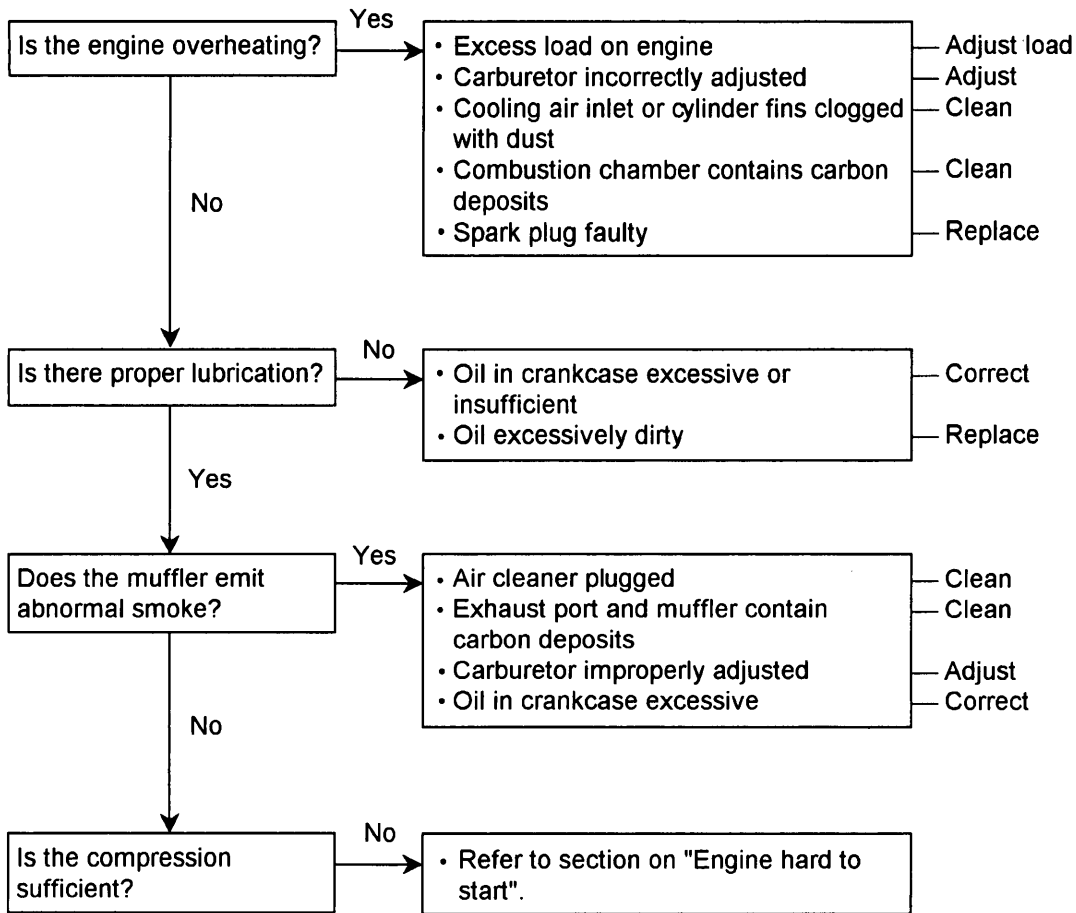
Engine hard to start (integrated ignition coil and igniter)



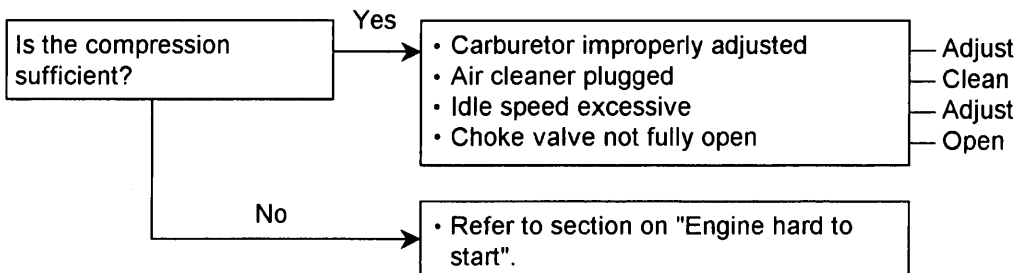
2-14 SERVICE DATA

Troubleshooting

Insufficient engine power output

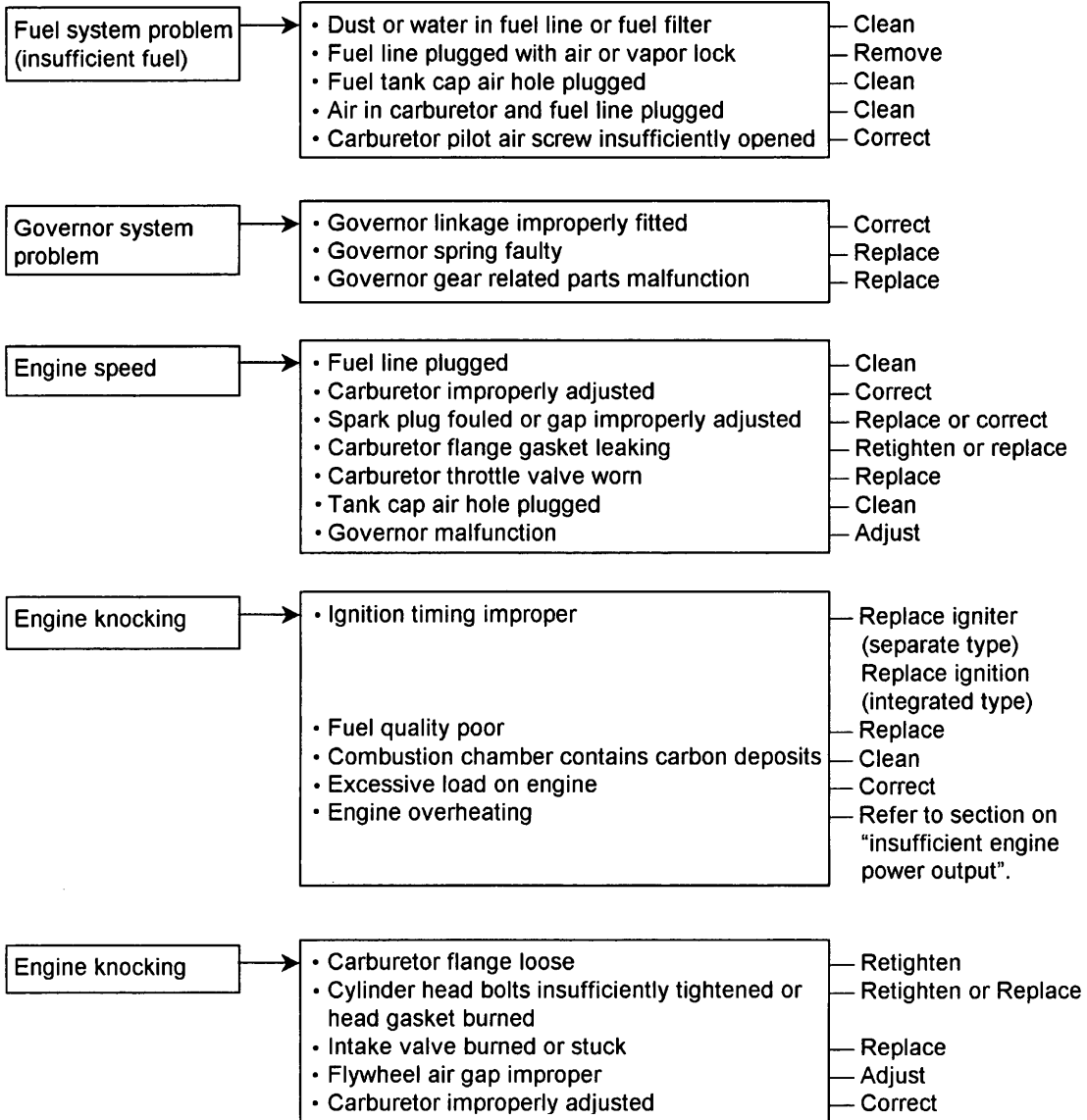


Fuel consumption excessive

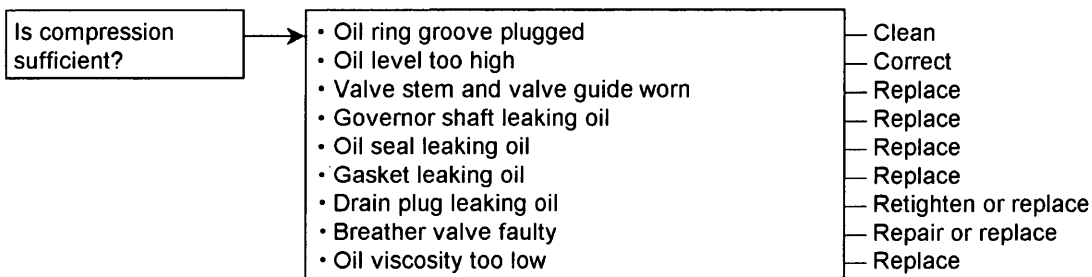


Troubleshooting

Engine runs poorly



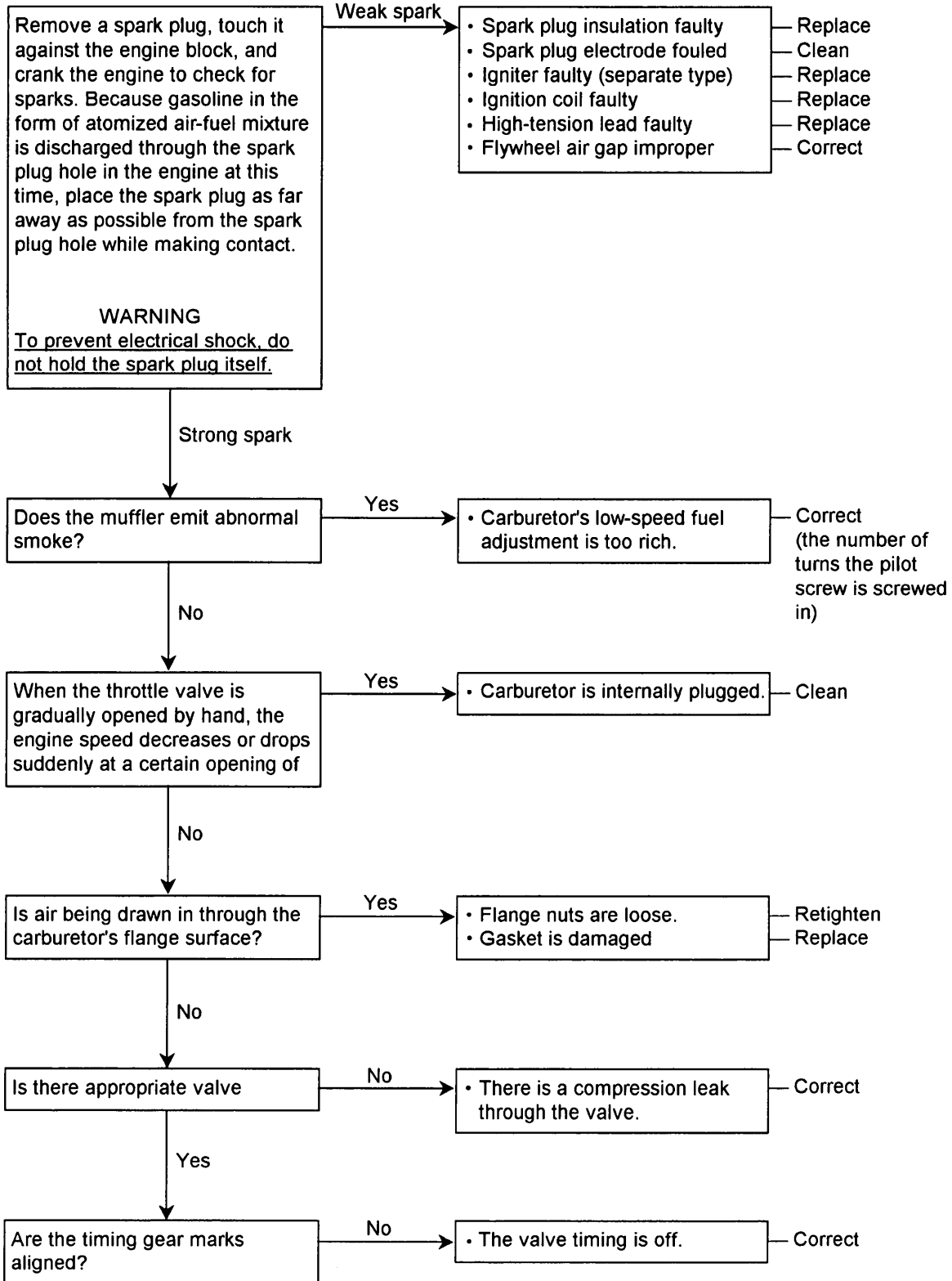
Engine oil consumption excessive



2-16 SERVICE DATA

Troubleshooting

Engine runs poorly at low speeds



Troubleshooting

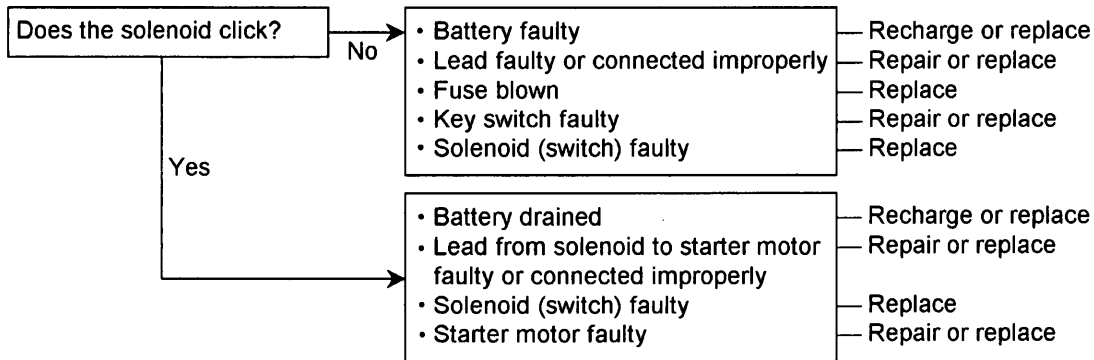
Starter Motor Troubleshooting and Actions

- Remove the spark plug cap and ground the high-tension lead terminal.
- Perform an inspection by turning the key switch to the START position.

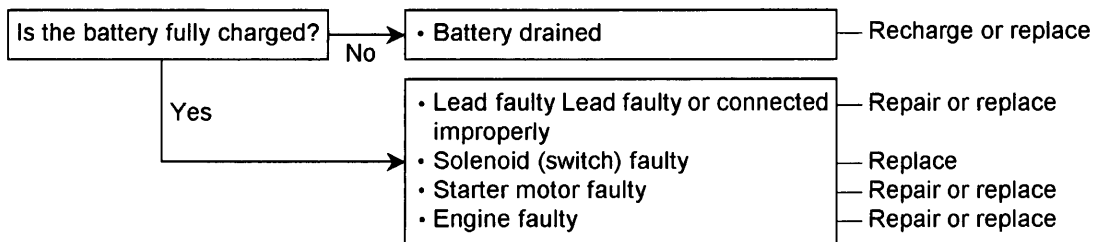
CAUTION

Do not touch the parts or accessories other than the starter motor when troubleshooting the starter motor.
 If the starter motor does not stop even when the key switch is turned OFF, quickly disconnect the negative (-) lead from the battery.

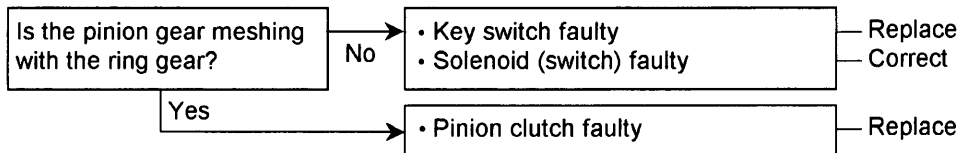
Starter motor does not spin.



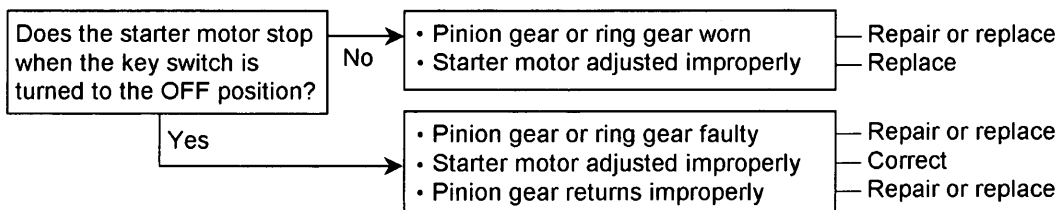
Starter motor spins slowly.



Starter motor spins but does not crank the engine.



Starter motor does not stop when the key switch is turned to the off position?



2-18 SERVICE DATA

Disassembly Sequence (FE120, 170)

Disassembly	Precaution	Bolt to be removed for tool	
		Name	Quantity
Drain Plug	Warm up engine and drain oil.	14 across flats	
Fuel Tap, Fuel Tank	Drain fuel before disassembly.	17 across flats (tap)	1
		M6 bolt (tank)	4
Spark Plug		21 across flats	
Shroud		M6 bolt	6
Muffler Assembly	Remove flange retaining nuts.	M6 nut	2
	Remove stay retaining bolt.	M8 bolt	1
Air Cleaner		M5 butterfly bolt	2
Carburetor	Tighten it together with air cleaner case.	M6 nut	2
Governor Arm, Control Panel		M6 nut	1
		M6 bolt	2
Fan Housing	Disconnect wire to stop switch.	M6 bolt	5
		(FE120 = 4)	
Electrical:			
• Ignition Coil	* FE120 uses M6 bolts.	M5 bolt	2
• Flywheel		M14 nut	1
Cylinder Head:			
• Rocker Case		M6 bolt	4
• Cylinder Head	Loosen bolts evenly in the reverse order of tightening.	M8 bolt	4
Valve System:			
• Pushrods	Identify intake and exhaust.		
• Rocker Arms	Identify intake and exhaust.	M6 nut	2
• Exhaust Valve			
Crankcase Cover	Loosen bolt evenly in the reverse order of tightening.		
	for FE120	M6 bolt	8
	for FE170	M8 bolt	7
Camshaft	Remove shaft from a position where cam gear marks are aligned.		
Tappets	Identify intake and exhaust.		
Governor Shaft (Arm Pivot)	Remove snap ring and pull it out of crankcase.	Snap ring	2
Connecting Rod Cap		10 across (bolt)	2
Crankshaft	Remove from a position where it does not interfere with connecting rod.		
Piston/Connecting Rod Assembly	Pull it downward from cylinder bore.		
Connecting Rod	Remove snap ring and pull piston pin out.	Snap ring	2

Assembly sequence (for FE120, 17):

Assembly parts in the reverse order of disassembly.

Disassembly Sequence (FE250, 290, 350, 400)

Disassembly Area	Precaution	Bolt to be removed for tool	
		Name	Quantity
Drain Plug	Warm up engine and drain oil.	14 across	
Fuel Tap, Fuel Tank	Drain fuel before disassembly.	M6 bolt (tap)	1
		M6 bolt (tank)	6
Spark Plug		21 across	
Muffler Assembly	Remove the exhaust pipe cover.	M6 bolt	2
		M6 nut (with washer)	1
	Remove the muffler assembly.	M8 nut	2
		M8 bolt	1
Wiring Related	Disconnect ground wire.	M8 nut	1
	Disconnect connecting terminals.		
Panel Control	Remove it from tank bracket.	M5 screw	4
Tank Bracket		M8 bolt	4
Control Related:			
• Link Rod and Spring		M6 nut	1
• Governor Arm		M6 bolt	2
• Control Panel Assembly		M8 bolt	2
Starter Motor		M6 butterfly bolt	2
Air Cleaner		M6 nut	2
Carburetor	Also remove insulator.	M6 bolt	1
		M6 bolt	15
Three-piece Shroud and Fan Housing		M6 tower bolt	1
Electrical:	Remove clamp and lead.	M5 tapping screw	2
• Ignition Coil		M5 bolt	2
• Flywheel	* FE350, 400 use M18 nut.	*M16 nut	1
• ACG		M6 screw	2 or 4
Cylinder Head:			
• Rocker Case		M6 bolt	2
• Cylinder Head	Loosen bolts evenly in reverse of tightening.	M8 bolt	6
Valve System:			
• Pushrods	Identify intake and exhaust. (Identification unnecessary for FE350, 400.)		
	Identify intake and exhaust.		
	* for FE250	M6 nut	2
	* for FE290, 350, 400	E-ring	1
• Exhaust Valve			
Crankcase Cover			
Shaft Adjust Shims	Identify shims for crankshaft and camshaft.	M8 bolt	8
Camshaft	Remove shaft from a position where cam gear marks are aligned.		
Tappets (FE250, 290) or HLA Devices (FE350, 400)	Identify intake and exhaust.		
Governor Shaft (arm pivot)	Face snap ring side of HLA device upward.	Snap ring	1
Balancer Guide		M6 nut	4
Connecting Rod Gap		12 across flats (bolt)	2
Crankshaft	Remove from to a position where it does not interfere with connecting rod.		
Piston/Connecting Rod Assembly	Pull it downward from cylinder bore.	Snap ring	2
Connecting Rod	Remove snap ring and pll piston pin out.	M6 bolt	6
Oil Pump		M5 bolt	2
Oil Filter	Remove plate.		

Assembly sequence (for FE250, 290, 350, 400)

Assemble parts in the reverse order of disassembly.

Disassembly, Reassembly, Inspection, and Maintenance

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3-2 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Carburetor

Construction and Function

The function of a carburetor is to mix fuel and air by applying the principle of an atomizer, thus creating an appropriate air-fuel mixture in accordance with load fluctuations. The major functions of a carburetor consist of the following four systems.

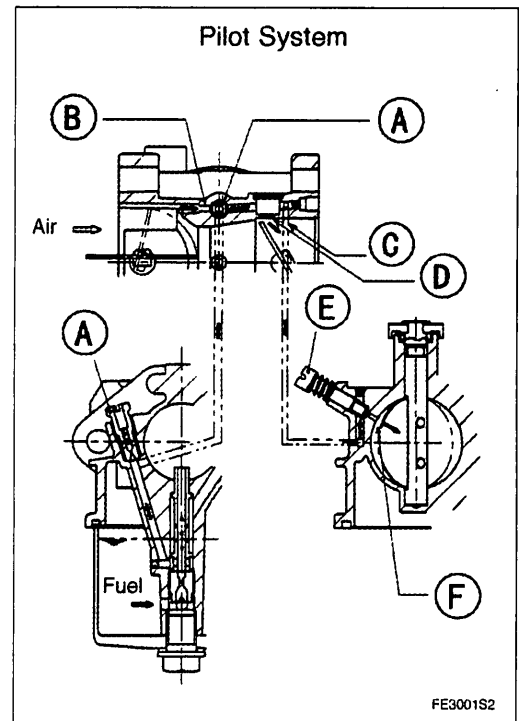
Pilot System

The function of this system is to supply fuel during the idling and the low-speed, light-load operating conditions.

The fuel that is regulated by the pilot jet mixes with the air that is regulated by the pilot air jet, and the resulting mixture is supplied via the pilot port and bypass port to the engine.

The fuel that is used during idling is supplied primarily via the pilot port.

- A: Pilot Jet
- B: Pilot Air Jet (Body Jet)
- C: Pilot Port
- D: Bypass Port
- E: Pilot Screw
- F: Pilot Port



Main system

The function of this system is to supply fuel during medium- to high-speed, high-load operating conditions. Fuel is regulated by the main jet and flows through the main nozzle.

The air that is regulated by the main air jet intermixes with the fuel via the bleed hole of the main nozzle, and is discharged into the venturi in an emulsion form (in which the liquid is intermixed with air bubbles).

In the venturi, the airflow from the air cleaner causes the fuel to become atomized, and the resulting air-fuel mixture is fed into the cylinder.

Choke System

Closing the choke valve decreases the volume of air intake and increases the intake vacuum during the intake stroke. As a result, a greater volume of fuel than normal is discharged from the pilot and main systems to facilitate the starting of a cold engine.

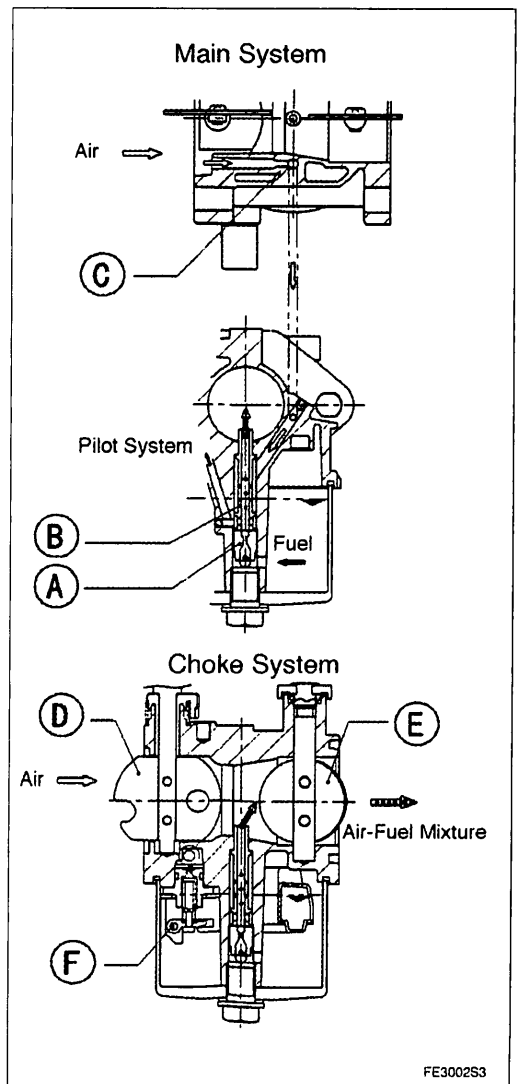
Float System

The function of the float is to maintain the fuel in the float chamber of the carburetor at a constant level so that the proper amount of fuel can be supplied to the engine.

Setting the fuel level in the float chamber to low makes it more difficult for the carburetor to draw the fuel up to the venturi, resulting in a leaner air-fuel mixture.

Setting the fuel level to high increases the volume of fuel that is drawn up to the venturi, resulting in a richer air-fuel mixture

- A: Main Jet
- B: Main Nozzle
- C: Main Air Jet (body jet)
- D: Chocke Valve
- E: Throttle Valve
- F: Float Hinge Pin



DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-3

Carburetor

An optimal fuel level is prescribed at the time the carburetor is designed. Along with the fluctuations in the fuel level, the float moves up and down in order to open and close the float valve. The flow of fuel into the float chamber is enabled or stopped in this manner in order to maintain the fuel level at the prescribed level.

CAUTION

The fuel level of the carburetor of the FE series engines cannot be adjusted. Replace the float if it is defective.

The air pressure in the float chamber is constantly maintained at atmospheric pressure via the air vent.

- A: Float
- B: Float Valve
- C: Air Vent
- D: Float Chamber

Disassembly, Cleaning, and Reassembly Precautions

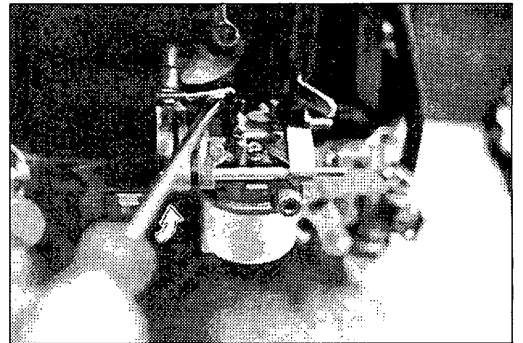
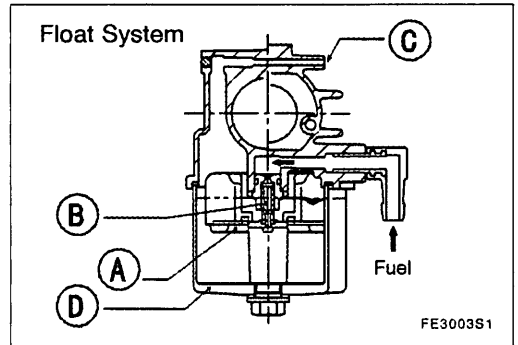
- Here are the instructions for removing and reinstalling the link rod and the linkage spring that connect the carburetor to the governor arm: With the carburetor mounted on the engine, insert a flat-blade screwdriver between the throttle lever at the carburetor and the link rod, and gently twist the screwdriver to pry up on the link rod, thus removing the link rod from the hole in the throttle lever. To reinstall the link rod, use your fingers to press the link rod into the hole. Use a pair of pliers or a flat-blade screwdriver to remove and reinstall the linkage spring.
- During disassembly, carefully note the orientation (top, bottom, right, left, etc.) of the gaskets so that they can be replaced correctly during reassembly. All gaskets must be replaced with new ones.
- Use a solvent with a high flash point to wash the carburetor and make sure to prevent contamination by foreign matter.

CAUTION

Gasoline is extremely dangerous due to its high volatility. Handle it away from sparks or fire and ensure proper ventilation.

NOTE

- Do not use a solvent with rubber or plastic parts.
- Spray carburetor cleaner into the internal holes in the carburetor to ensure their opening. Then, wash the carburetor in hot water, allow it to dry naturally, and blow clean compressed air through the holes if necessary.



3-4 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Carburetor

- Check how the float valve spring is fitted. Make sure that the first coil of the float valve spring is completely wrapped in both spring grooves that are provided at the two ear-shaped protrusions on the float valve body.

NOTE

- Do not unnecessarily disassemble the float valve spring because this could damage the valve spring.

CAUTION

Do not use large tools to apply excessive force in order to tighten the screws. Make sure to use a tool that is appropriate for the respective part and carefully tighten the screws.

- The screws used for retaining the throttle valve and the choke valve are crimped at their threaded ends to prevent them from loosening. Therefore, do not disassemble them unnecessarily.

- A: Spring
- B: Float Valve
- C: Ear-Shaped Protrusion
- D: Spring Groove

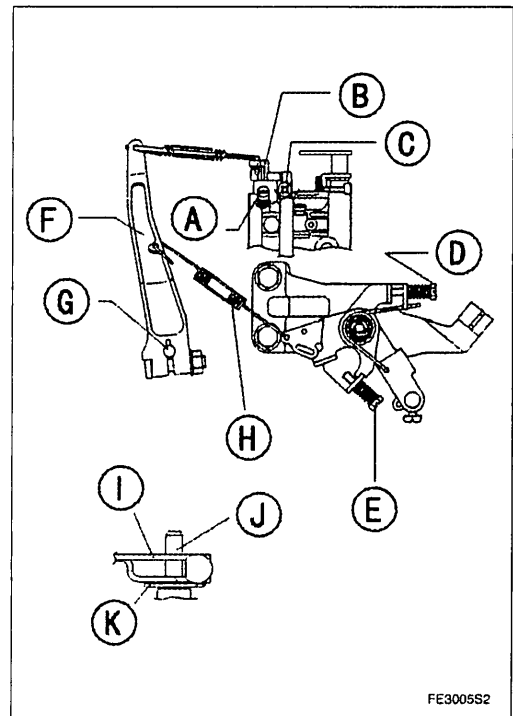
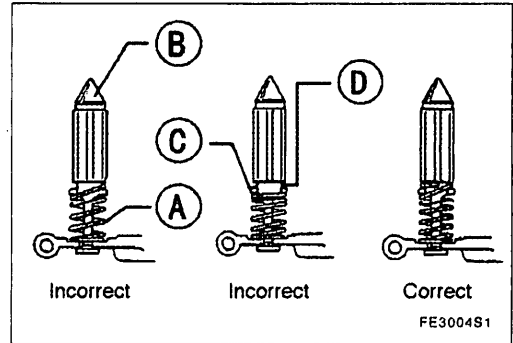
Adjustment

Ordinarily, it is not necessary to adjust the carburetor because it is adjusted at the factory to an optimal fuel setting. However, if the engine runs poorly, follow the procedures given below to adjust the carburetor.

Pilot Screw Adjustment

- Slowly turn the pilot screw in the clockwise direction until a slight resistance is felt.
- Then, back out the pilot screw two turns counterclockwise (for tentative setting).
- Install the air cleaner in the normal manner and warm up the engine by operating it without a load.
- Set the speed adjustment lever to the low-speed (idling) position.
- Keep the throttle lever on the carburetor pushed gently to the fully closed position, and turn the idle adjustment screw so that the engine attains the idle speed.
- Keep the throttle lever pushed to the fully closed position, and turn the pilot screw in and out to find the position in which the idle speed of the engine is at the highest rpm. From that position, back out the pilot screw one-quarter of a turn in the counterclockwise direction. This completes the pilot screw adjustment.

- A: Pilot Screw
- B: Throttle Lever
- C: Idle Adjustment Screw
- D: Low-Speed Set Screw
- E: High-Speed Set Screw
- F: Governor Arm
- G: Pivot Arm
- H: Governor Spring
- I: Governor Arm
- J: Pivot Arm
- K: Snap Pin



Carburetor

Minimum No-Load Speed Adjustment

- After completing the pilot screw adjustment, the minimum no-load adjustment must be adjusted.
- Keep the throttle lever on the carburetor pushed gently to the fully closed position, and turn the idle adjustment screw so that the engine runs at 100 rpm lower than the set idle speed. (This is called the "carburetor's idle speed setting".)
- Release the throttle lever of the carburetor to free the speed adjustment lever. Turn the low-speed set screw on the control panel to set the engine speed to the minimum no-load speed.

Minimum No-Load Speed (idling) Setting (crankshaft speed)

FE120, 170:	1600 rpm
FE250, 290, 350, 400:	1300 rpm

NOTE

- If the minimum no-load speed is specified for a particular piece of equipment, follow that specification.

Maximum No-Load Speed Adjustment

- After completing the minimum no-load speed, it is necessary to adjust the maximum no-load speed.
- Keep the speed adjustment lever to the high-speed side, and turn the high-speed set screw on the control panel to set the engine speed to the specified maximum no-load speed. (If the maximum no-load speed is specified for a particular piece of equipment, follow that specification.)

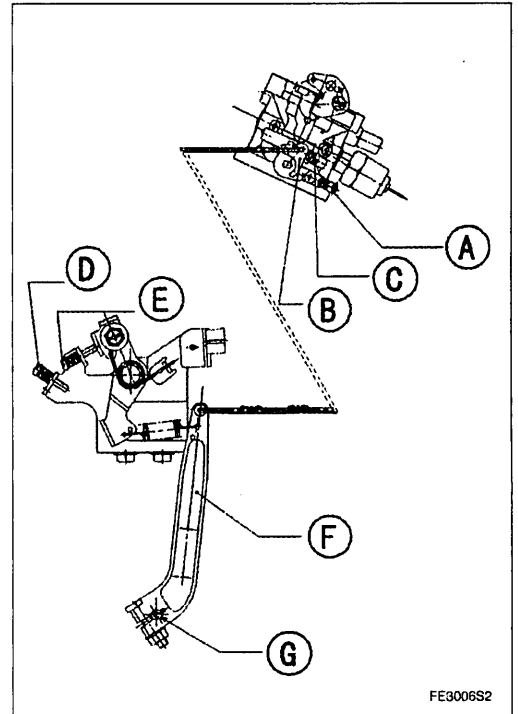
Maximum No-Load Speed Setting

4000 rpm (crankshaft)

NOTE

- All adjustments described in steps "1." through "3." must be performed on a warm engine and do not change their adjustment sequence.

- A: Pilot Screw
- B: Throttle Lever
- C: Idle Adjustment Screw
- D: High-Speed Set Screw
- E: Low-Speed Set Screw
- F: Governor Arm
- G: Pivot Arm



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3-6 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

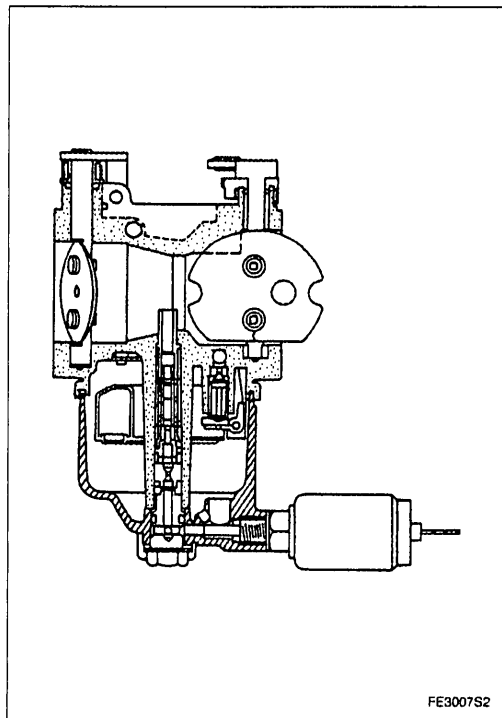
Carburetor

Carburetor with Fuel Cutoff Valve

To prevent after-burns that occur in the form of combustion in the muffler when the engine is stopped, the float chamber of this carburetor is provided with a solenoid-actuated fuel cutoff valve.

When the engine switch is turned to the STOP position, the solenoid operates the fuel shut off solenoid valve to stop the flow of the fuel that is supplied to the main jet.

When the engine switch is turned to the START or RUN position, the fuel shut off solenoid valve opens automatically to supply the fuel.



FE3007S2

Inspect the fuel shut off solenoid valve as follows:

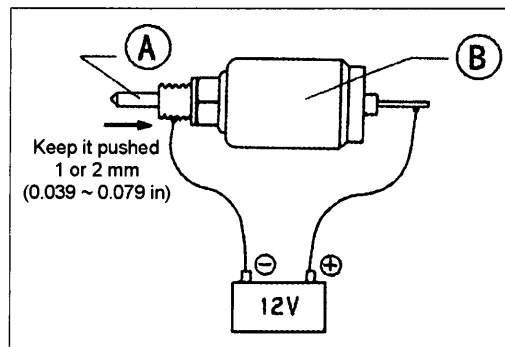
- Remove the fuel shut off solenoid valve by turning it counterclockwise.
- Keep the tip of the fuel shut off solenoid valve pushed 1 to 2 mm, and connect 12 V DC current as shown in the diagram.
- If the fuel shut off solenoid valve does not retract when the power is connected, the solenoid is defective. In this case, the fuel shut off solenoid valve must be replaced.

NOTE

- To enable the shut off solenoid valve to retract, the tip of the shut off solenoid valve must be pushed slightly.

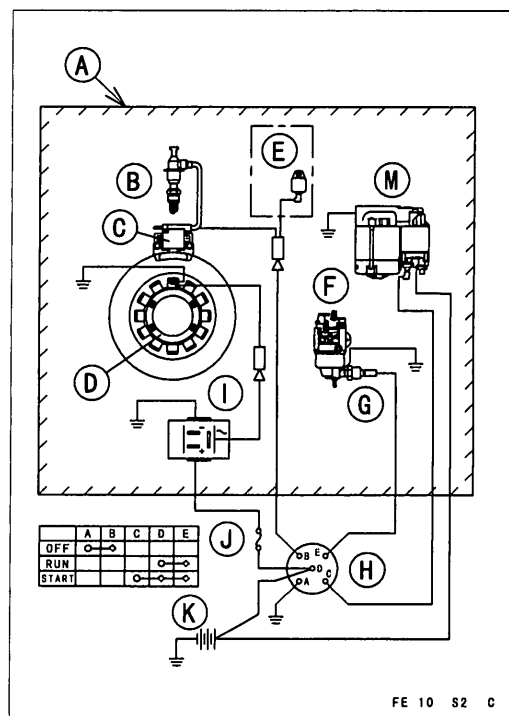
A: Shut off Solenoid Valve

B: Solenoid



A wiring diagram for the carburetor with a fuel shut off solenoid valve is shown on the right.

- A: Engine
- B: Spark Plug
- C: Ignition Coil
- D: ACD
- E: Igniter (separate type)
- F: Carburetor
- G: Fuel Shut off Solenoid Valve
- H: Key Switch
- I: Regulator
- J: Fuse
- K: Battery
- M: Starter Motor



FE 10 S2 C

DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-7

Governor Mechanism

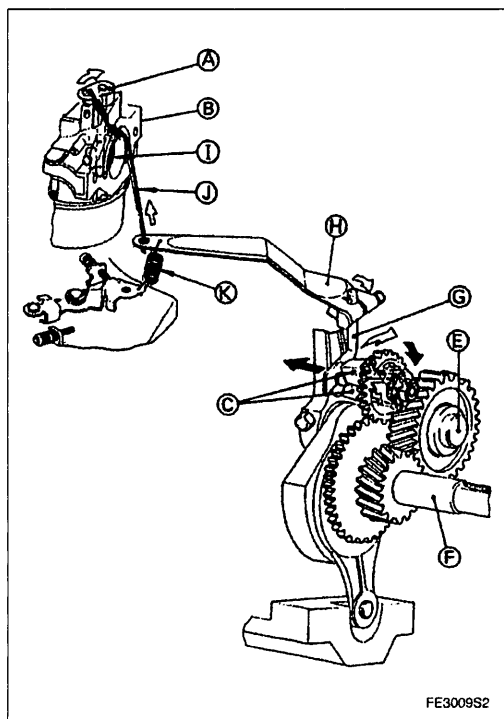
Governor Operating Mechanism

Connected to the throttle lever on the carburetor via a link rod, the governor operates automatically in accordance with load fluctuations in order to maintain a constant engine speed.

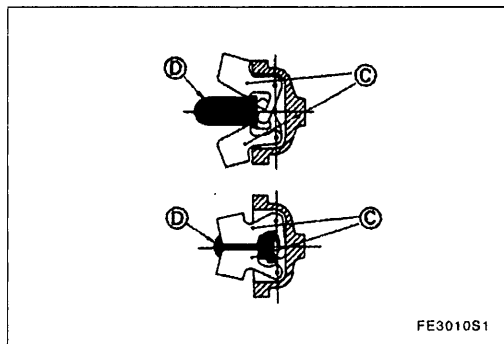
The governor relies on centrifugal force for its operation. When the engine speed increases, the governor weight (which is attached to the governor gear that is meshed to the crankshaft gear) opens outward by centrifugal force. This movement pushes the sleeve outward, which moves the governor lever in the direction to close the throttle valve. Conversely, when the engine speed decreases, the governor lever moves in the direction to open the throttle valve.

Ordinarily, fluctuations in the load that is applied to the engine also cause the engine speed to fluctuate. When the load decreases suddenly, the engine speed increases momentarily, but because the governor weight moves the throttle valve in the closing direction, the engine speed is kept constant. When the load increases suddenly, the engine speed decreases momentarily, but because the governor arm is retracted by the governor spring, the throttle moves in the opening direction to keep the engine speed constant.

- A: Throttle Lever
- B: Carburetor
- C: Governor Weight
- D: Sleeve
- E: Camshaft
- F: Crankshaft
- G: Governor Shaft
- H: Governor Arm
- I: Throttle Valve
- J: Link Rod
- K: Governor Spring



FE3009S2



FE3010S1

3-8 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Governor Mechanism

Governor Gear Assembly Installation

CAUTION

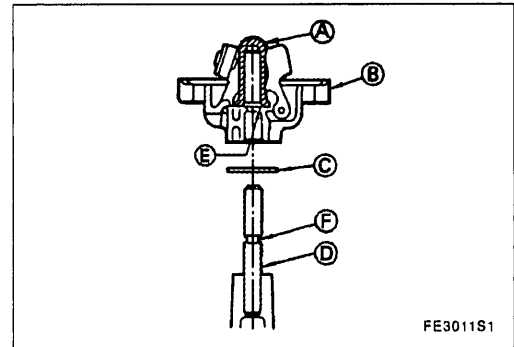
Do not remove the governor gear assembly unless the parts are to be replaced. The parts cannot be reused once they are removed.

- Use two screwdrivers of an appropriate size to remove the governor gear assembly. Protect the surface of the gasket on the crankcase cover to prevent it from becoming damaged during the removal of the governor gear assembly.
- Install the sleeve on the governor gear assembly before the installation of the governor gear assembly.

NOTE

- *The sleeve cannot be installed after the governor gear assembly has been installed.*
- To install, first place the thrust washer over the shaft. Then, install the governor gear assembly (with the sleeve attached) on the shaft so that step [E] is fitted securely in groove [F].
- After installing the assembly, gently turn the governor by hand to make sure that the governor weight and the sleeve move smoothly.

- A: Sleeve
- B: Governor Gear Assembly
- C: Thrust Washer
- D: Shaft
- E: Step
- F: Groove



FE3011S1

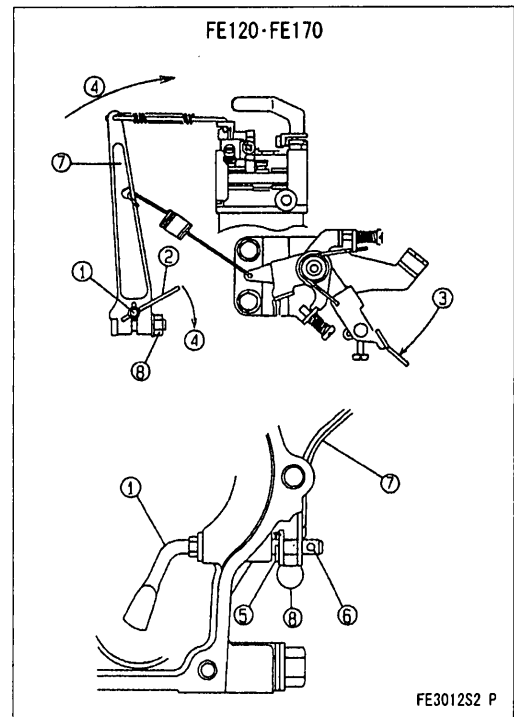
Governor Arm Installation (Setting the Governor)

- Install the throttle linkage and the spring on the governor arm.
- Install the governor arm on the governor shaft and hand-tighten the clamp nut.
- Loosen the clamp nut, and turn the end of the governor arm all the way in the direction indicated below to keep the throttle valve fully open. Meanwhile, insert the pin into the hole at the end of the governor shaft, turn the end of the governor shaft all the way in the direction indicated below, and tighten the clamp nut.

Direction of Rotation for Tightening the Governor Arm and the Governor Shaft

FE120, 170: Clockwise
FE250, 290, 350, 400: Counterclockwise

1. Governor Shaft
2. Pin
3. Idling Position
4. Clockwise
5. Clip
6. End Hole
7. Governor Arm
8. Clamp Nut

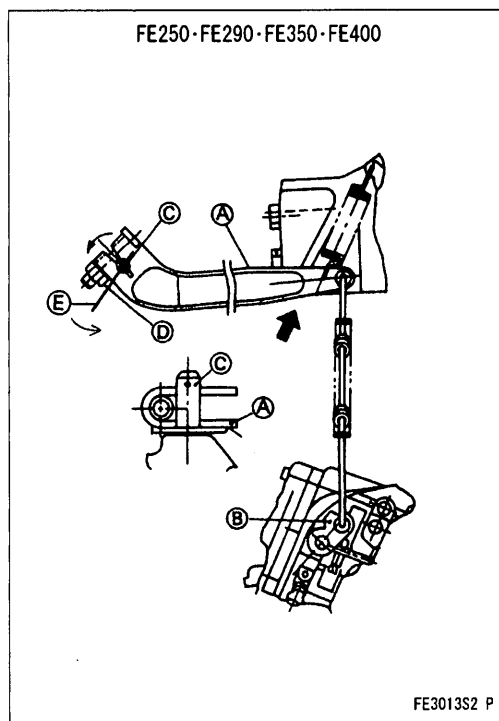


FE3012S2 P

DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-9

Governor Mechanism

- A: Governor Arm
- B: Throttle Valve
- C: Governor Shaft
- D: Clamp Nut
- E: Pin



3-10 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Air Cleaner

The quality of the inspection or maintenance of the air cleaner significantly affects the durability and the performance of the engine. If the engine is used in a dusty area, the air cleaner element should be cleaned more frequently than the regular inspection intervals.

Element Cleaning

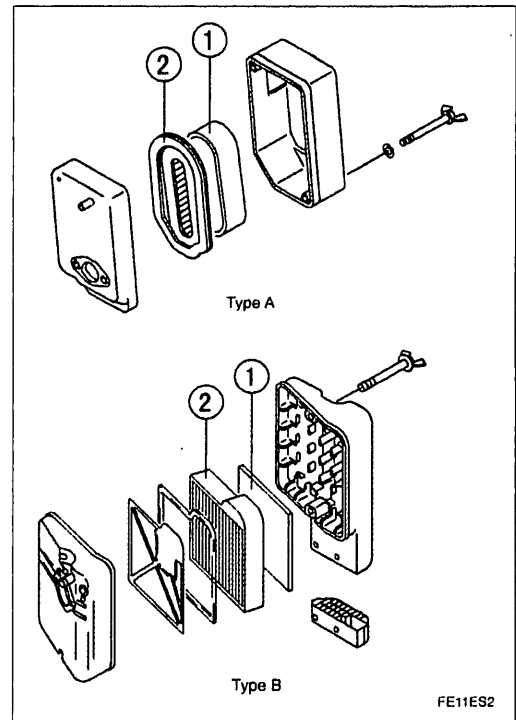
- The sponge element should be used slightly wet with oil. To clean the sponge element, first wash it thoroughly in cold or warm water that contains detergent. Then, rinse it in plain water and allow it to dry. Immerse the element in fresh engine oil, wrap it in a clean cloth, squeeze the oil out of it, and install the element while it retains some oil.
- To clean the paper element, gently tap on the steel end plate of the element to remove the dust. Otherwise, wash it in a soap solution by shaking it, rinse it in water, and allow it to air dry. If the element is extremely dirty, replace it with a new one.

Type A: for FE120, 170

Type B: for FE250, 290, 350, 400

1. Sponge Element

2. Paper Element



DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-11

Cooling System

All the cooling fans of the FE series engines are the separate type that can be separated from the flywheel.

FE290 type:

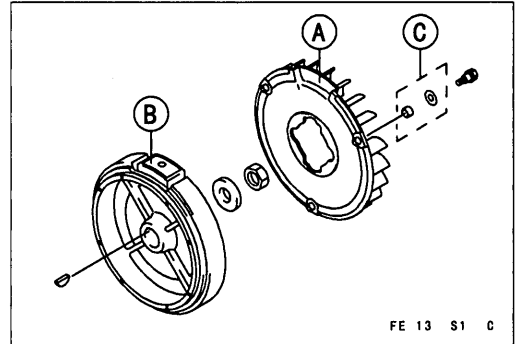
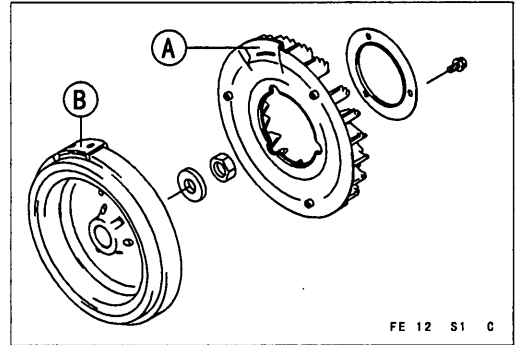
NOTE

- On the engine produced before May 1996, the flywheel and the cooling fan are integrated and cannot be disassembled.
- A separate type cooling fan can be assembled by aligning the concave portions along the circumference of the fan with the magnets on the flywheel.
- Clean the cooling fan blades if they have debris or dust on them.
- If the fan blades are damaged, replace the cooling fan with a new one.

A: Convex Area of Cooling Fan

B: Magnet Portion

C: FE120D-AB00 only



3-12 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Fuel Tank and Filter

- Place an appropriate container under the fuel filter to catch the fuel. Remove the filter pot, turn the fuel tap ON, and completely drain the fuel from the fuel tank and the fuel line.
- ★ If the drained fuel contains dust or water, the fuel line from the fuel filter to the carburetor must be inspected and cleaned.

CAUTION

Gasoline is extremely dangerous due to its high volatility. Handle it away from sparks or fire and ensure proper ventilation.

- If the fuel tank is deformed, cracked, or rusted, replace it with a new one.
- After draining the fuel from the tank, pour a cleaning solvent into the tank and shake it well. Discard dust and sediments together with the cleaning solvent.
- Using compressed air, thoroughly dry the inside of the fuel tank and the fuel filter before installing them.
- Make sure that the fuel gauge operates smoothly, and replace it with a new one if it is defective.
- Inspect the breather hole in the tank cap and the air passage to make sure that they are not plugged.
- Remove retaining screw [8] on the inside of the tank cap and remove spring plate [7].

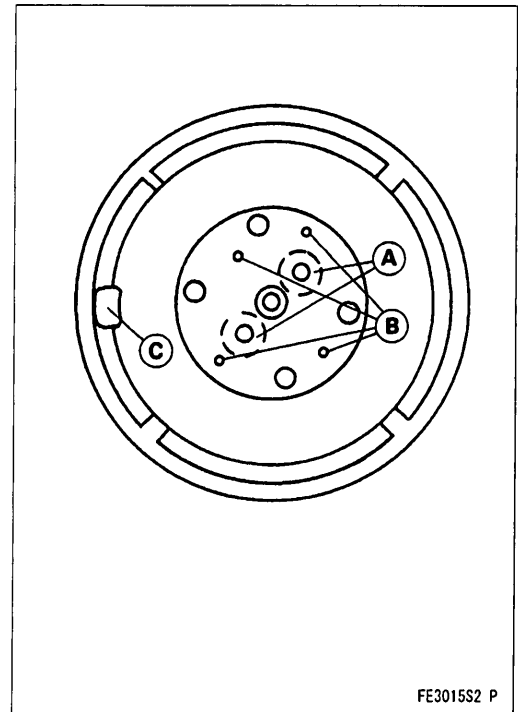
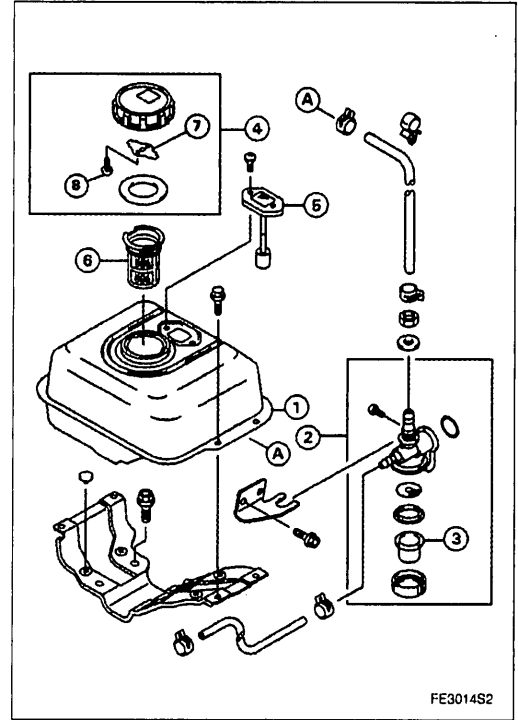
NOTE

- Retaining screw [8] is a tapping screw, so make sure not to crush the threads. It is best not to overtighten the screw.

1. Fuel Tank
2. Fuel Filter (fuel tap)
3. Filter Pot
4. Tank Cap
5. Fuel Gauge
6. Filter (strainer)
7. Spring Plate
8. Retaining Screw

- Use adhesive tape to cover hole [A] from which the screw was removed. Place your mouth on air hole [B] to blow air into it and verify that air comes out with great force from air passage [C].
- ★ If air does not come out of the air passage or if it is weak, replace the tank cap with a new one.

- A: Thread Hole
- B: Air Hole
- C: Air Passage



Ignition System

Description of Function

The ignition mechanism is the transistorized type and consists of the following parts:

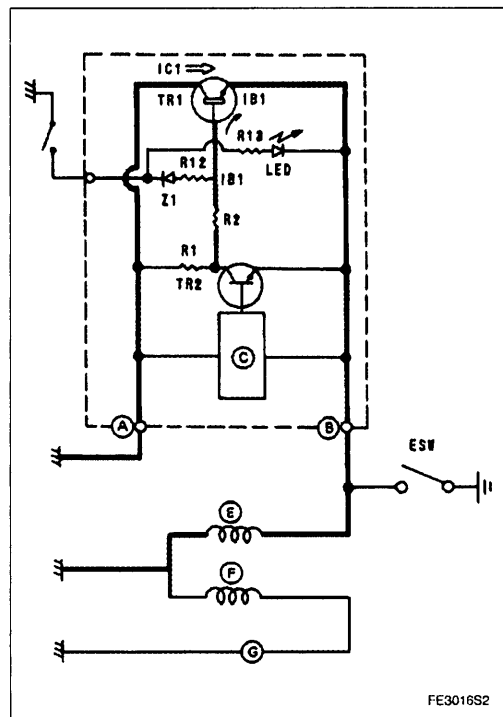
- Ignition Coil
- Igniter
- Flywheel (with permanent magnet)

These components do not contain mechanical contact parts and do not require regular inspection.

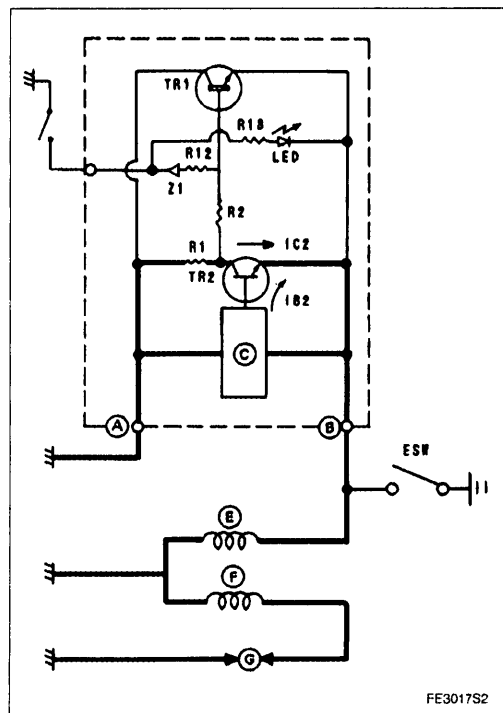
Electronic Ignition Device

- The revolution of the flywheel generates voltage between terminals [A] and [B], causing base current $IB1$ to flow from TR1. Then, current $IC1$ that is amplified by TR1 flows to form the primary circuit.
- The flywheel revolves further and the voltage that is generated between terminals [A] and [B] increases. When the flywheel reaches the position of the ignition timing, signal base current $IB2$ flows from automatic ignition advance circuit C to transistor TR2. At that instant, the current changes into collector current $IC2$, which is amplified by transistor TR2.
- In the meantime, because the internal resistance of TR2 is considerably lower than TR1, $IB1$ that was flowing through TR1 until then will turn into $IC2$, thus changing its direction to flow via TR2.
- In this manner, base current $IB1$ of TR1 will not momentarily flow, thus causing large current $IC1$ that was flowing between terminals [A] and [B] until then to stop suddenly.
- Due to the sudden change in the current in the primary circuit, a high voltage is generated in secondary side [F], causing spark plug [G] to spark.

- A, B: Igniter Terminal
- C: Automatic Ignition Advance Circuit
- E: Primary Coil
- F: Secondary Coil
- G: Spark Plug
- ESW: Engine Switch



FE3016S2



FE3017S2

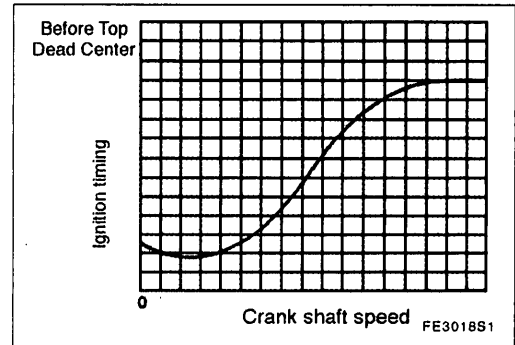
3-14 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Ignition System

Automatic Ignition Advance Device

This device enables the engine to achieve appropriate ignition timing in all speed ranges. The ignition timing must be retarded slightly when the engine is started and at the low- to medium-speed range. On the other hand, the ignition timing must be advanced in the high-speed range in order to generate the sparks early on, because the intervals of the air-fuel mixture ignition and expansion are shorter.

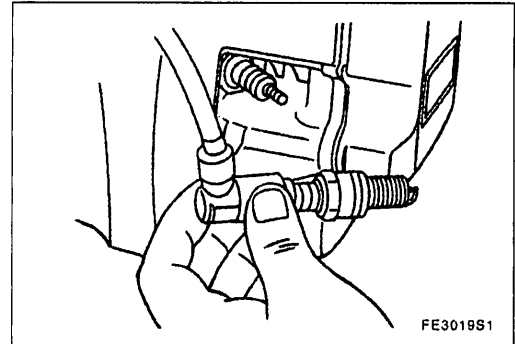
The diagram on the right shows the relationship between the crankshaft speed and the ignition timing (degrees before the top dead center) of the automatic ignition timing device of the FE series.



Spark Inspection

Check for sparks as follows:

- Remove the spark plug, connect it to the plug cap that is attached to the high-tension lead, and place the spark plug in contact with the engine block. When doing so, place the spark plug as far away as possible from the spark plug hole and make contact at an area that does not contain gasoline.



CAUTION

Perform the spark inspection after making sure that there is no presence of gasoline in the area in order to prevent unintended ignition.

- Turn the stop switch or the key switch ON to turn the crankshaft, and check if sparks are generated at the electrode of the spark plug.
- ★ If there are no sparks or the sparks are weak, clean the spark plug, adjust the spark plug electrode gap to between 0.7 and 0.8 mm, and check for sparks again.
- ★ If there are no sparks or the sparks are weak even after cleaning the spark plug and adjusting its electrode gap, replace the spark plug with a new one and check for sparks again.
- ★ If there are no sparks or the sparks are weak even after installing a new spark plug, inspect the ignition system.

Spark Plug Cleaning and Inspection

- Using a wire brush, remove the carbon deposits from the spark plug. If the spark plug is contaminated with oil, wash it in a cleaning solvent.
- If the electrode is worn or the insulator is cracked, replace the spark plug.
- Using a gap gauge, measure the electrode gap of the spark plug. If the gap is incorrect, adjust it to the correct gap by bending the horizontal electrode.

Spark Plug Electrode Gap

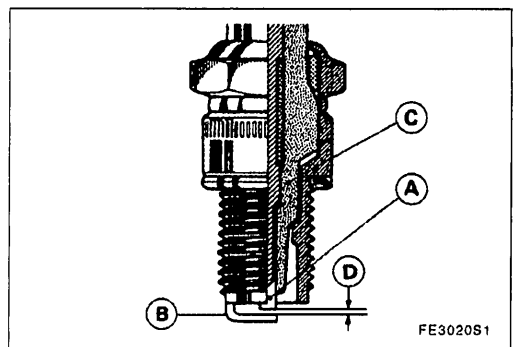
Standard: 0.7 ~ 0.8 mm (0.030 ~ 0.032 in)

- Tighten the spark plug to the specified torque.

Ignition Plug Specification Tightening Torque

23 N·m (2.3 kg·m, 17 ft·lb)

- A: Center Electrode
- B: Horizontal Electrode
- C: Insulator
- D: Electrode Gap



Ignition System

Ignition Coil Inspection

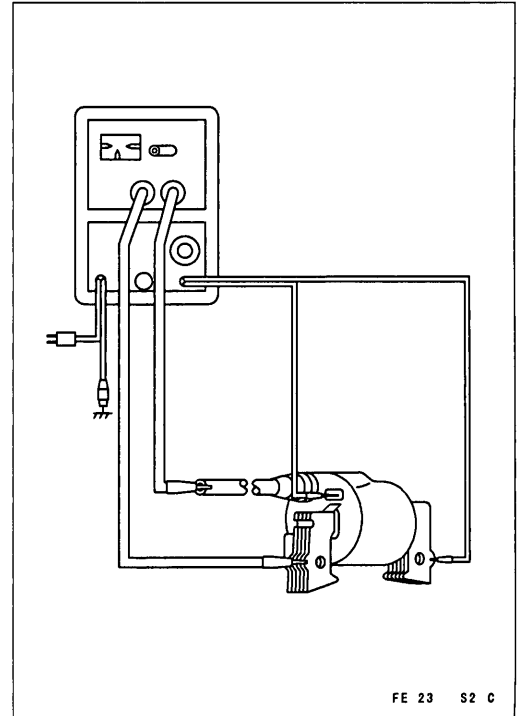
Spark Characteristics Measurement

- Connect the ignition coil to a coil tester to measure its spark characteristics. Follow the measurement instructions provided by the tester manufacturer for the proper measurement procedure. (For testing purposes, remove the plug cap from the ignition coil.)

Ignition Coil Spark Characteristics (three-wire spark gap)

Standard: 7 mm (0.28 in) minimum

- ★ If the spark characteristics are below the standard, the ignition coil is defective. If the spark characteristics are normal, the plug cap is defective.



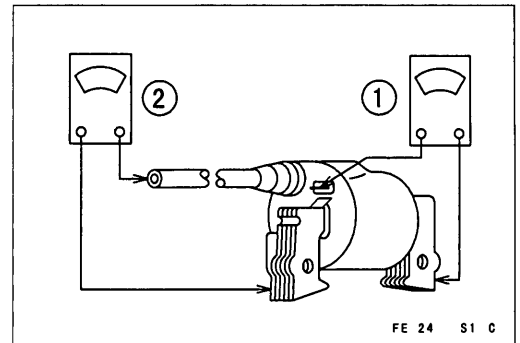
Ignition Coil Resistance Measurement

If a coil tester is unavailable, use a hand tester (P/N 57001-1394) to measure the internal resistance of the coil. Although this test is not sufficient to determine the integrity of the coil, it will serve as a criterion for making a judgment.

- Connect the hand tester as shown in the diagram on the right, set it to the measurement ranges listed in the table below, and measure the resistance values. 2 Ignition Coil Internal Resistance (separate igniter type)

Ignition Coil Internal Resistance (separate igniter type) (Ω)

Measurement Area	Measurement Range	Resistance
Primary Coil	R × 1	0.6 ~ 1.10
Secondary Coil	R × 1 k	6.0 ~ 10.0 k



Ignition Coil Internal Resistance (integrated igniter type) (Ω)

Measurement Area	Measurement Range	Resistance
Primary Coil	R × 1	0.6 ~ 1.4
Secondary Coil	R × 1 k	6.0 ~ 11.0 k

- ★ If the measured value is within the range given above or greater, the coil is normal. If the measured value is lower than the above, the coil is defective and it must be replaced with a good one.

1. Measurement of Primary Coil Resistance
2. Measurement of Secondary Coil Resistance
3. Ignition Coil

3-16 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

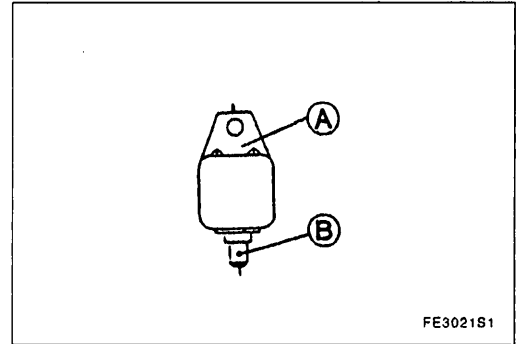
Ignition System

Igniter Inspection

Measure the internal resistance of the igniter.

Individual Igniter Inspection

- To test the individual igniter shown in the diagram on the right, set the measurement range of the hand tester to $R \times 100 \Omega$ and measure the resistance.



Individual Igniter Resistance

(k Ω)

Tester negative (-) Terminal	Tester positive (+) terminal	
	Case (A)	Terminal (B)
Case (A)	---	0.1 ~ 1.0
Terminal (B)	1 ~ 10	---

- ★ If the measured value differs from the above, replace the igniter.

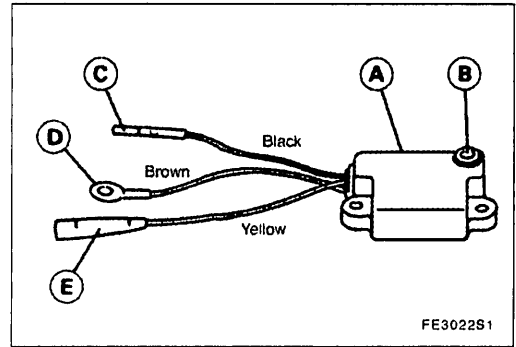
Igniter (with Oil Warning Light) Measurement

- Set the measurement range of the hand tester to $R \times 100 \Omega$ in order to measure the resistance at the areas given in the table below.

Igniter (with Oil Warning Light) Resistance

(k Ω)

Tester Negative (-) Terminal	Tester Positive (+) Terminal		
	D (brown)	C (black)	E (yellow)
D (brown)	---	0.1 ~ 1.0	1 ~ 10
C (black)	1 ~ 10	---	5 ~ 20
E (yellow)	10 ~ ∞	10 ~ ∞	---



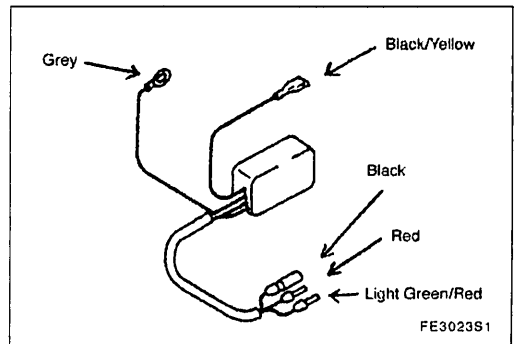
- ★ If the measured value differs from the table above, replace the igniter.

- ★ To inspect the oil warning light (LED), refer to the section on the lubrication system.

- A: Igniter
- B: Oil Warning Light
- C: Primary Terminal
- D: Ground Terminal
- E: Oil Level Sensor Terminal

CDI Igniter Measurement

- Set the measurement range of the hand tester to $R \times 100 \Omega$ in order to measure the resistance at the areas given in the table below.
- ★ If the measured value differs from the table above, the igniter is defective and it must be replaced.



CDI Igniter Resistance

(Ω)

Tester Negative (-) Terminal	Tester Positive (+) Terminal				
	Black (switch)	Red (exciter)	Light Green/ Red (pulser)	Grey (ground)	Black/Yellow (ignition)
Black (switch)	---	10 ~ ∞	10 ~ ∞	10 ~ ∞	10 ~ ∞
Red (exciter)	200 ~ 2 k	---	10 ~ ∞	10 ~ ∞	10 ~ ∞
Light Green/ Red (pulser)	10 ~ ∞	10 ~ ∞	---	10 ~ ∞	10 ~ ∞
Grey (ground)	1 k ~ 10 k	200 k ~ 2 k	10 ~ ∞	---	10 ~ ∞
Black/Yellow (ignition)	10 ~ ∞	10 ~ ∞	10 ~ ∞	10 ~ ∞	---

Ignition System

Controller (with Warning Light) Measurement

- Set the measurement range of the hand tester to $R \times 1 \text{ k}\Omega$ and measure the resistance at the areas given in the table below.

Controller (without ground) Resistance (k Ω)

Tester (-) Negative Terminal	Tester Positive (+) Terminal	
	C (black)	D (black/yellow)
C (black)	---	50 ~ ∞
D (black/yellow)	1 ~ 7	---

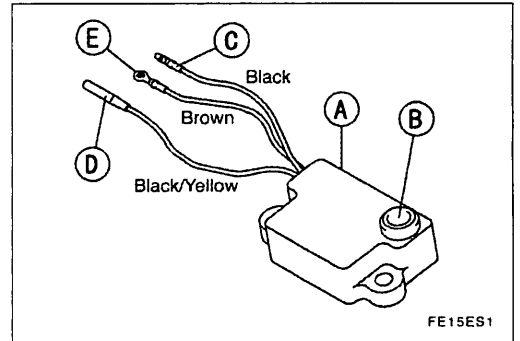
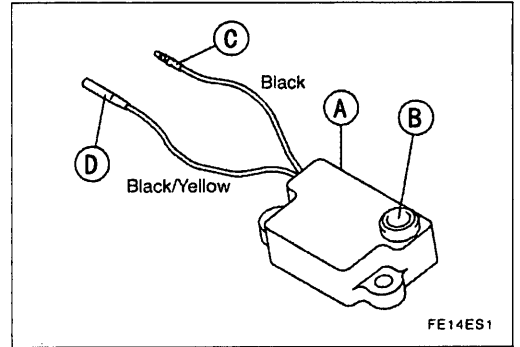
Controller (with ground) Resistance (k Ω)

Tester (-) Negative Terminal	Tester Positive (+) Terminal		
	C (black)	D (black/yellow)	E (brown)
C (black)	---	50 ~ ∞	50 ~ ∞
D (black/yellow)	1 ~ 7	---	50 ~ ∞
E (brown)	50 ~ ∞	50 ~ ∞	---

- ★ If the measured value differs from the table above, replace the controller.

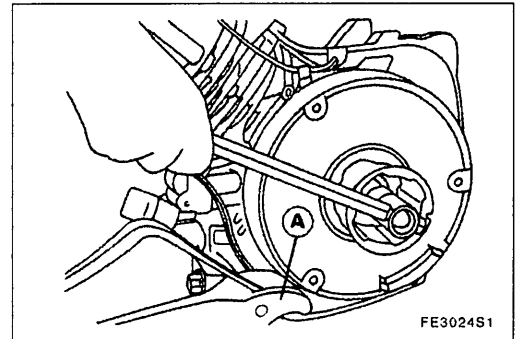
- ★ To inspect the oil warning light (LED), refer to the section on the lubrication system.

- A: Igniter
- B: Oil Warning Light
- C: Primary Terminal
- D: Oil Level Sensor Terminal
- E: Ground Terminal



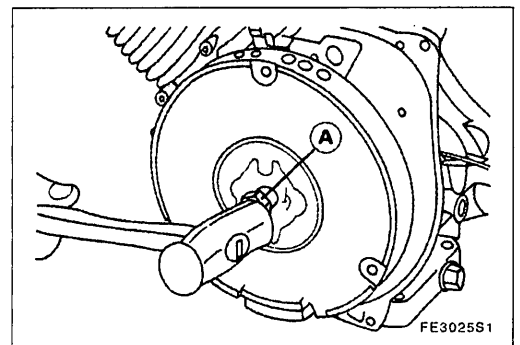
Flywheel Disassembly and Reassembly

- Using a strap wrench, hold the flywheel and remove the flywheel retaining nut.
- Use a flywheel puller to remove the flywheel.
 - A: Strap Wrench



NOTE

- If an appropriate flywheel puller is unavailable, position the flywheel nut flush with the crankshaft end, and strike it with a mallet to remove the flywheel.
- Before reassembly, wipe the flywheel and the tapered portion of the crankshaft to remove any dust or oil.
- Make sure that the woodruff key is installed correctly in the groove of the crankshaft, install the flywheel, and install the retaining nut.
- Using a strap wrench, hold the flywheel, and tighten the flywheel nut to the specified torque. (Refer to the Tightening Torque Specifications table.)
 - A: Flywheel Nut



3-18 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Ignition System

Ignition Coil Reassembly (Air Gap Adjustment)

- Rotate the flywheel so that the magnet on the flywheel is on the opposite side of the area in which the ignition coil is to be installed.
- Use two bolts to hand-tighten the ignition coil to the area in which the coil is to be installed, and slide a 0.3 mm gap gauge between the foot of the coil and the periphery of the flywheel.
- Keep the ignition coil pressed towards the flywheel and evenly tighten the coil retaining bolts to the specified torque.

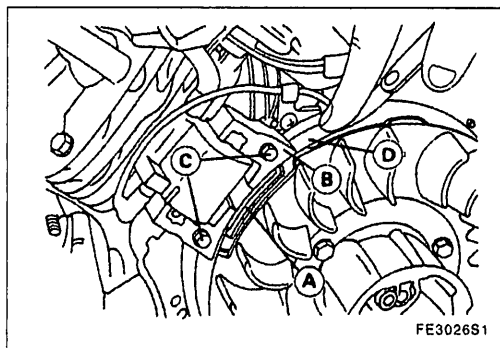
Ignition Coil Air Gap

Standard:	0.3 mm (0.012 in)
Adjustable Range:	0.25 ~ 0.4 mm (0.010 ~ 0.016 in)

Ignition Coil Retaining Bolt Specified Tightening Torque

FE120 (M6 bolt):	6.0 N·m (0.6 kg·m, 53 in·lb)
FE170, 250, 290, 350, 400:	3.5 N·m (0.35 kg·m, 31 in·lb)

- A: Magnet
- B: Coil Foot
- C: Coil Retaining Bolts
- D: Gap Gauge



Key Switch (engine switch) Inspection

- Set the measurement range of the hand tester to $Rx1\Omega$ and check whether the lead from the key switch exhibits the continuity indicated in the table on the right.
- ★ If the leads exhibit the continuity indicated in the table on the right, the key switch is good.

Key Switch Position	Lead Color				
	Black	Black/White	Green/Red	Green/White	Brown/White
OFF	○—○				
RUN			○—○		
START			○—○	○—○	○—○

○—○ : Continuity

FE3027S1

DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-19

Charging System

The state of charge of the battery must be determined by measuring the terminal voltage of the individual battery.

Individual Battery's Terminal Voltage

Standard: 12 V

- ★ If the terminal voltage is below the standard, the battery must be recharged.

Charging System Inspection

Fully recharge the battery before inspecting the charging system.

- Warm up the engine.
- Connect a voltmeter to the battery terminals to measure the voltage.
- ★ When the engine speed is low, the voltmeter reads the battery voltage. The voltage increases with an increase in the engine speed, although the voltage fluctuation range will be within the specified values.
- ★ If the output voltage is higher than the specified value, the rectifier is damaged or the lead is disconnected.
- ★ If the output voltage does not increase with an increase in the engine speed, the rectifier is damaged or the alternator output is insufficient for the applied load.

Rectifier Output Specified Voltage

Specified Value: Battery Voltage ~ 15 V

ACG Inspection

- Disconnect the connectors from the alternator, connect a hand tester to the lead of the charging coil and the ground in order to measure the internal resistance of the charging coil.

ACG Internal Resistance

Coil Type	Specified Range (Ω)
12 V - 2 A	0.40 ~ 0.67
12 V - 4 A	0.82 ~ 1.38
12 V - 13 A	0.26 ~ 0.44

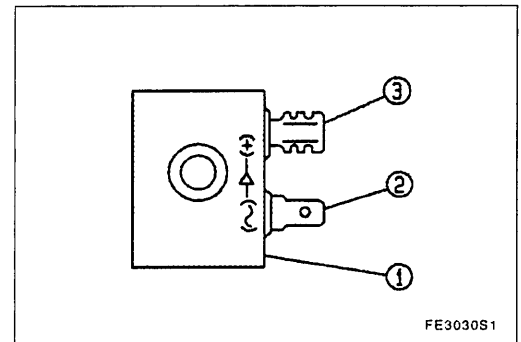
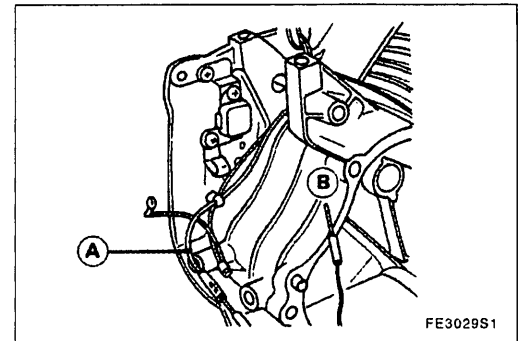
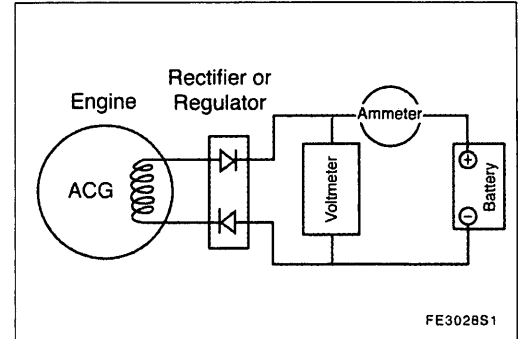
- ★ If the measured value is out of the specified range, replace the charging coil.
- ★ If the resistance of the coil is normal but there is no voltage, the rotor's magnetic force has diminished, so the rotor must be replaced.

A: ACG Lead (green/white)

B: Ground

Rectifier Inspection

- Set the resistance measurement range of the hand tester to $R \times 1$ k Ω .
- Measure the resistance between the male and female connectors in both positive and negative directions.
- ★ If the measured values are lower in one direction, and the other direction is ∞ , the rectifier is normal. The lower value should generally be between 0 and the halfway point of the scale, although this could vary from tester to tester.
- ★ If the measured value differs from the above, the rectifier is defective, so it must be replaced with a good one.
 1. Rectifier
 2. Male Connector
 3. Female Connector



3-20 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Charging System

Regulator Inspection

- Disconnect the connector from the regulator.
- Set the measurement range of the hand tester to $R \times 1 \text{ k}\Omega$ and measure the resistance at the areas given in the table below.
- Although this test is not sufficient to determine the integrity of the regulator, it will serve as a criterion for making a judgment.

Regulator Internal Resistance

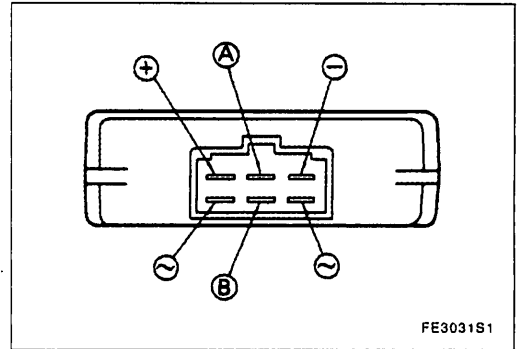
(k Ω)

Tester Negative (-) Terminal	Tester Positive (+) Terminal					
	+	A	-	~	~	B
+	---	∞	∞	∞	∞	∞
A	4 ~ 20	---	0.2 ~ 1	1 ~ 5	1 ~ 5	200 ~ ∞
-	3 ~ 15	0.2 ~ 1	---	1 ~ 5	1 ~ 5	200 ~ ∞
~	1 ~ 5	∞	∞	---	∞	∞
~	1 ~ 5	∞	∞	∞	---	∞
B	10 ~ 50	1 ~ 5	1.5 ~ 7.5	4 ~ 20	4 ~ 20	---

★ If the measured resistance differs from the table above, replace the regulator.

A: Key Switch

B: Charging Indicator Light



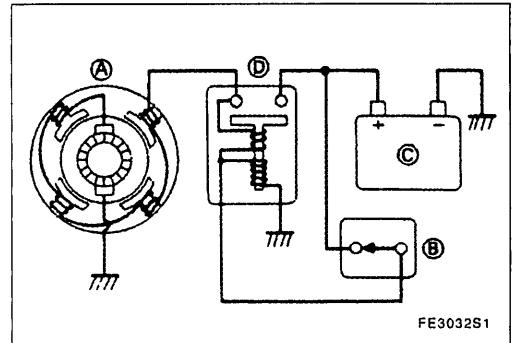
Starter System

Starter Motor Construction

An FE series engine comes with a Bendix type or shift-lever type starter motor.

The electrical circuit of a starter motor consists of a key switch (engine switch), solenoid (or solenoid switch on the Bendix type), battery, and starter motor.

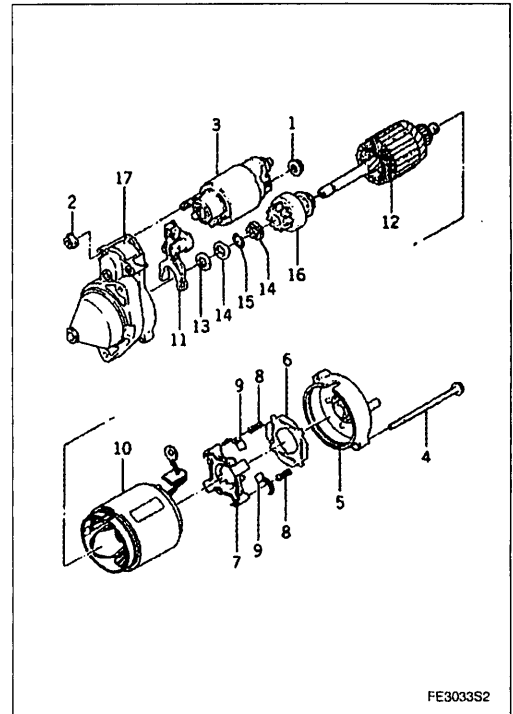
- A: Starter Motor
- B: Key Switch
- C: Battery
- D: Solenoid



With the shift lever type, turning the key switch to the START position causes a small amount of current to flow to the solenoid, which actuates the plunger, which in turn moves the shift lever in order to engage the pinion gear of the starter motor with the ring gear of the flywheel. At the same time, a large amount of driving current flows to rotate the motor, which transmits the rotational movement to the crankshaft.

With the Bendix type, turning the key switch to the START position causes a small amount of current to flow to the solenoid switch, thus causing the solenoid to actuate and the solenoid switch to close. This causes a large current to flow to the starter motor, enabling the starter motor to start rotating. When the starter motor starts rotating, the pinion moves by inertia to the ring gear (outer side) along the free-sliding threads that are cut on the armature's outer periphery and on the inside of the pinion gear. As the pinion gear meshes with the ring gear in this manner, the rotational movement of the starter motor is transmitted to the crankshaft.

When the engine starts and the key switch is turned to the ON (run) position, the current to the solenoid is cut off, causing the plunger and the solenoid switch to return to their original positions. On the shift lever type, the pinion gear separates from the ring gear and returns to its original position, simultaneously with the return of the plunger. On the Bendix type, the inertia of the ring gear causes the pinion gear to return to the starter (inner side) along the free-sliding threads, thus returning to its original position.



CAUTION

Do not operate the starter motor continuously for more than 5 seconds. Turn OFF the switch after 5 seconds, then allow approximately 15 seconds to elapse before operating the starter again.

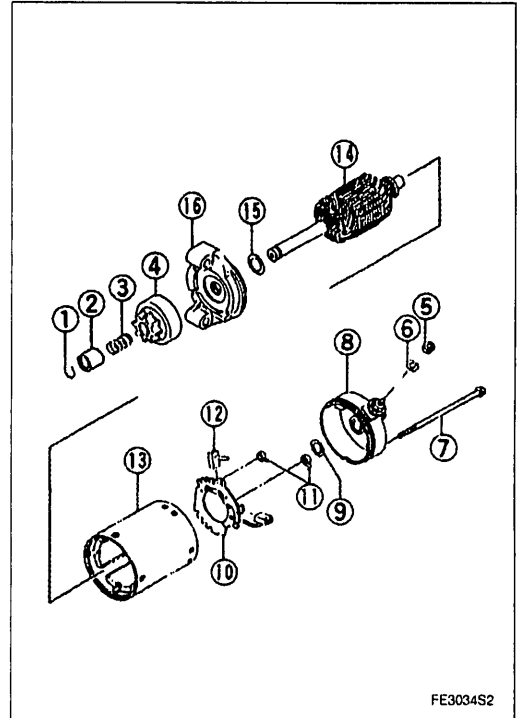
Operating the starter for a long time could drain the battery and burn the starter motor.

1. Nut
2. Nut
3. Solenoid
4. Bolt
5. Rear Cover
6. Insulator
7. Brush Holder
8. Brush Spring
9. Brush
10. Yoke Assembly
11. Shift Lever
12. Armature
13. Washer
14. Stopper
15. Snap Ring
16. Clutch Assembly
17. Front Cover

3-22 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Starter System

1. Snap Ring
2. Collar
3. Spring
4. Clutch Assembly
5. Nut
6. Spring Washer
7. Bolt
8. Rear Cover
9. Washer
10. Brush Holder
11. Brush Spring
12. Brush
13. Yoke Assembly
14. Armature
15. Washer
16. Front Cover

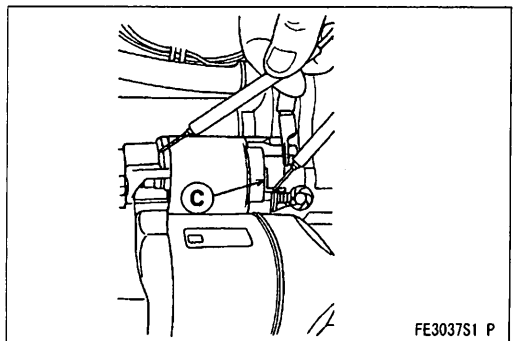
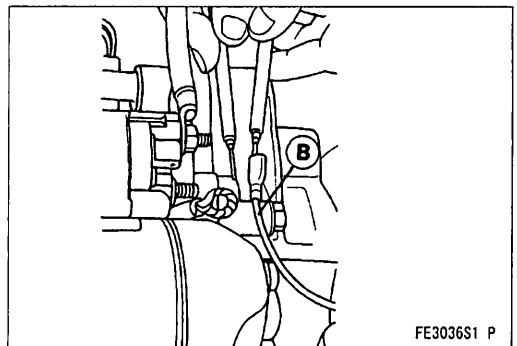
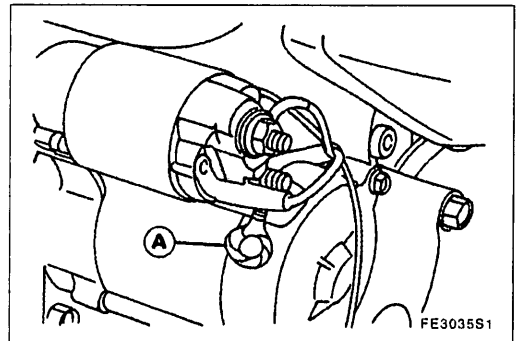


Solenoid (Starter Motor) Wiring Inspection

Although the following procedure gives the steps for inspecting the shift-lever type starter motor, it can also be applied to the Bendix type by replacing the word "solenoid" with "solenoid switch".

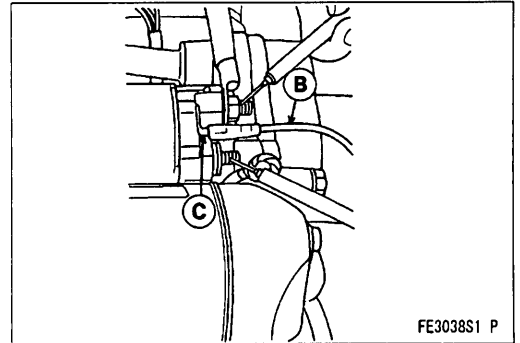
NOTE

- First check the battery and make sure that it is fully charged.
- Detach lead [A] from the solenoid terminal of the starter motor, and keep it away from the solenoid terminal.
- Detach lead [B] that connects the key switch to the solenoid, set the measurement range of the tester to DC25 V, and connect it to lead [B] and a ground on the unit. Turn the key switch to the START position and read the voltage on the tester.
- ★ If the voltage is 0 or lower than the battery voltage, inspect the key switch and the wiring. (Refer to the switch section of the Ignition System.)
- ★ If the voltage is the same as the battery voltage, it is normal.
- Set the measurement range of the tester to Rx1 Ω , and read the resistance between terminal [C] and a ground on the unit.
- ★ The solenoid is normal if the resistance is approximately 0 Ω . If it is not, replace the solenoid.



Starter System

- Connect lead [B] to terminal [C]. Set the measurement range of the tester to $R \times 1 \Omega$, and connect it to the two terminals on the solenoid. Turn the key switch to the START position to read the tester.
- ★ If the solenoid clicks once, the tester reads 0Ω , and the pinion gear advances forward, the solenoid and the wiring are normal.
- ★ If the solenoid does not make a clicking sound, and the reading on the tester is greater than 0Ω , the solenoid is defective and it must be replaced.
- ★ If the solenoid clicks once and the reading on the tester is greater than 0Ω , the solenoid is defective and it must be replaced.



Starter Motor Inspection

CAUTION

Make sure that there are no flammable substances in the work area. Always keep the pinion gear of the starter motor away from your body.

- Disconnect the leads at the battery before removing the starter motor.

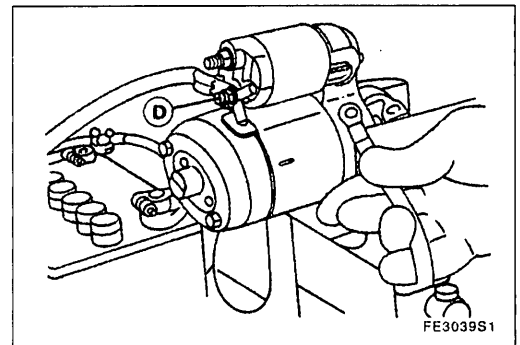
NOTE

- First disconnect the negative [-] lead of the battery, followed by the positive [+] lead, to prevent sparks from being created during the operation.

- Remove the starter motor from the engine.
- Secure the starter motor on a vise.

NOTE

- Be careful not to deform the starter motor when securing the starter motor on a vise.
- Connect the positive [+] lead of the battery to terminal [D] of the solenoid.
- Momentarily place the negative [-] lead of the battery in contact with a non-painted area of the starter motor body.
- ★ If the pinion gear does not spin, repair or replace the starter motor.



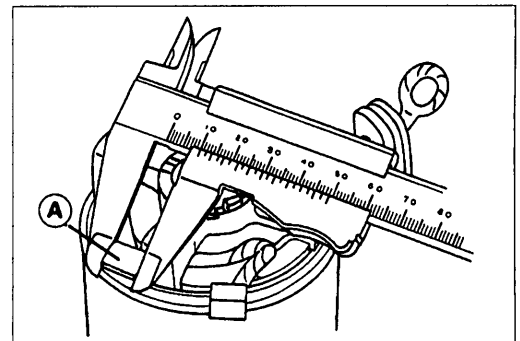
Brush Overall Length Measurement

Measure the overall length of the brushes.

- ★ If the brushes are shorter than their service limit, replace them with new ones.

Brush Overall Length Service Limit (minimum)

Sift Lever Type:	P/N 21163-2089, 2095	6.0 mm (0.24 in)
Bendix Type:	P/N 21163-2108	3.5 mm (0.14 in)
Bendix Type:	P/N 21163-2096	8.5 mm (0.33 in)



3-24 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Starter System

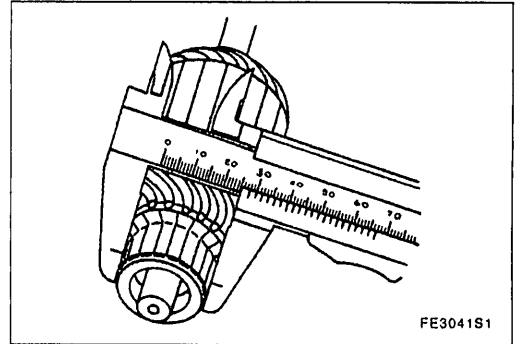
Commutator Diameter Measurement

Measure the diameter of the commutator at several areas.

★ If the diameter is smaller than the service limit, replace the armature.

Commutator Diameter Service Limit (minimum)

Sift Lever Type:	P/N 21163-2089, 2095	27 mm (1.06 in)
Bendix Type:	P/N 21163-2108	23 mm (0.91 in)
Bendix Type:	P/N 21163-2096	27 mm (1.06 in)



Commutator Groove Depth

Measure the depth of the grooves between the segments of the commutator.

★ If the groove depth is smaller than the service limit, use a thin file or a piece of steel to file the insulation portion to the standard depth.

Commutator Groove Depth

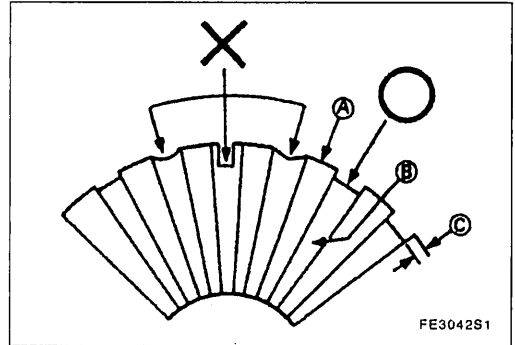
Standard: 0.5 ~ 0.8 mm (0.020 ~ 0.032 in)

Service Limit: 0.2 mm (0.008 in)

A: Segment

B: Insulation Portion

C: Groove Depth



Recoil Starter

CAUTION

The recoil spring is stored in the reel under high tension. Hold it firmly when handling so that the spring does not jump out.

Disassembly

- Pull the rope out approximately 350 mm, and tentatively tie a knot at that position.
- Pull out the knot of the rope that is pushed into the recess in the handle, undo the knot, and remove the handle.
- While holding the reel with your hand, undo the knot of the rope, and pull the rope out through the hole in the case. Hook the rope on the cutout of the reel, and slowly allow the reel to retract in a direction that will relieve the tension of the coil spring.
- Remove the retaining screw from the center of the reel, and remove the parts while making sure not to allow the recoil spring to jump out.
- To remove the recoil spring, make sure that the tension of the spring has been completely relieved. Then, remove the reel by carefully pulling the reel straight up. The recoil spring remains retracted in the reel or spring case.
- During the removal of the recoil spring, carefully separate it from the reel, while retracting it outward from the center of the spring.

NOTE

- On the FE120, 170, 250, 290, 350, and 400 also, handle the recoil spring carefully to prevent it from jumping out, and do not reverse the winding direction of the recoil spring and the rope.

T1: Tightening Torque 10 N·m (1.0 kg·m, 7.2 ft·lb)

T2: Tightening Torque 6 N·m (0.6 kg·m, 4.3 ft·lb)

G: Apply grease.

L: Apply non-coagulating thread lock

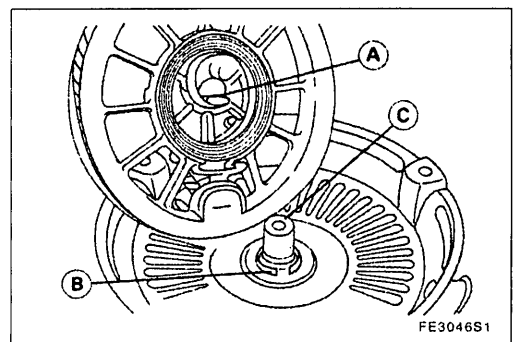
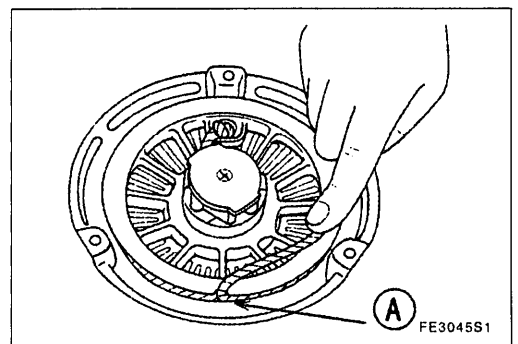
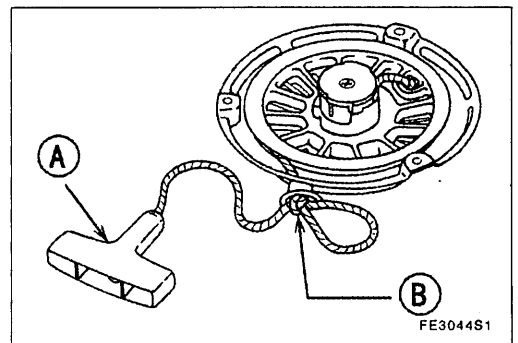
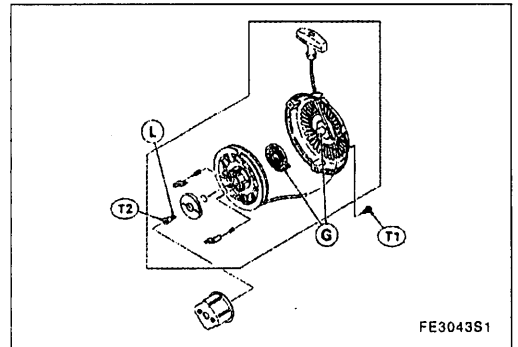
Reassembly

- Do not reverse the direction of the coil spring during reassembly. Apply grease to the recoil spring and the case shaft before reassembly.
- Attach the reel to the case so that the inner hook of the recoil spring engages securely with the case hook.
- Assemble the tab, tab spring, and guide plate in their original positions. Apply a non-coagulating type thread lock on the threaded portion of the retaining screw and tighten the screw.
- To apply an initial load to the recoil spring, rotate the reel two turns in a direction that compresses the recoil spring. Hold the reel, pass the end of the rope through the hole in the case, and make a tentative knot.
- Insert the end of the rope into the handle, make the final knot there, and undo the tentative knot.
- Pull on the rope and make sure that the tab operates normally.

A: Recoil Spring Inner Hook

B: Case Hook

C: Case Shaft



3-26 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Cylinder Head

Compression Inspection

- After warming up the engine, stop the engine. Remove the spark plug and connect a compression gauge to the spark plug hole.

NOTE

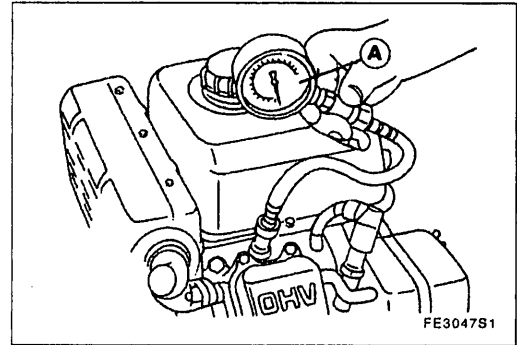
- Connect the spark plug cap to the removed spark plug and ground the spark plug against the engine body. Make sure that there are no flammable substances in the surrounding area.
- If the engine is equipped with an electric starter, make sure that the battery is fully charged.
- Fully open the engine throttle and the choke valve. Operate the recoil starter or electric starter and read the maximum compression.

Compression (minimum)

- with Recoil Starter: 290 kPa (3 kg/cm², 42 psi)
- with Electric Starter: 390 kPa (4 kg/cm², 57 psi)

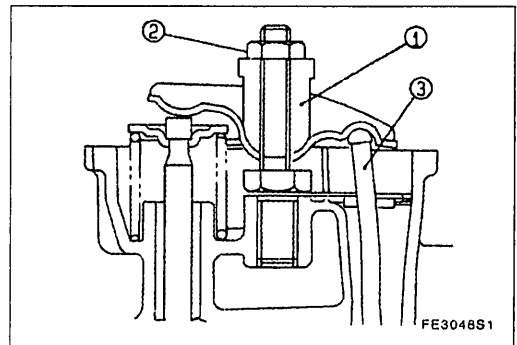
- ★ If the compression reading is lower than the minimum value given above, refer to the Troubleshooting section in order to repair the engine.

A: Installing the compression gauge



Disassembly

- Remove the retaining bolts from the rocker cover and remove the rocker cover together with the breather pipe.
- Remove the rocker arm.
- ★ Bring the piston to the top-dead-center of the compression stroke. This will allow the rocker arm to move freely (except FE350 and 400).
- ★ On the FE120, 170, and 250, loosen the lock nut on the rocker arm pivot to remove the lock nut and the rocker arm pivot. Then, remove the rocker arm.
- ★ On the FE290, 350, and 400, remove the E-ring, push the rocker shaft towards the exhaust side, and remove the washer and the rocker arm.
- Remove the pushrods.



NOTE

- Mark the pushrods to prevent the intake and exhaust positions from becoming interchanged during reassembly. This is not necessary on the FE350 and 400.

1. Rocker Arm Pivot
2. Lock Nut
3. Pushrod

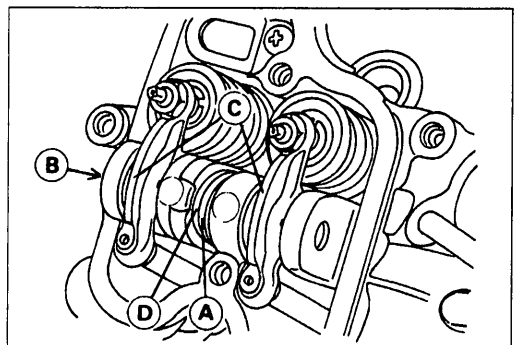
- Loosen the cylinder head retaining bolts little by little, evenly in the reverse order of tightening, to remove the cylinder head.

CAUTION

The cylinder head could become warped if the head bolts are not loosened evenly.

- ★ To ensure the proper loosening sequence, refer to the tightening sequence on the next page.

- A: E-ring
- B: Rocker Shaft
- C: Rocker Arm
- D: Washer



Cylinder Head

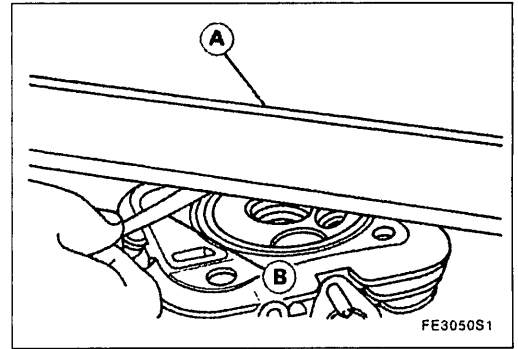
Cleaning and Inspection

- Inspect the cylinder head for the presence of any cracks or missing fins. Replace the cylinder head if any of those conditions exist.
- Clean the carbon deposits off the combustion chamber and the exhaust port, and wash the cylinder head in a cleaning solvent.
- Place a straightedge against the combustion chamber side of the cylinder head and use a gap gauge to inspect for warpage.
- ★ If the warpage exceeds the service limit, replace the cylinder head.

Cylinder Head Warpage (maximum)

Service Limit: 0.05 mm (0.002 in)

- Inspect the breather valve. (Refer to the breather section in Lubrication System.)
 - A: Straightedge
 - B: Gap Gauge

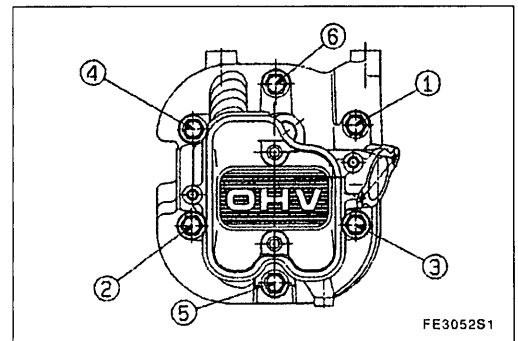
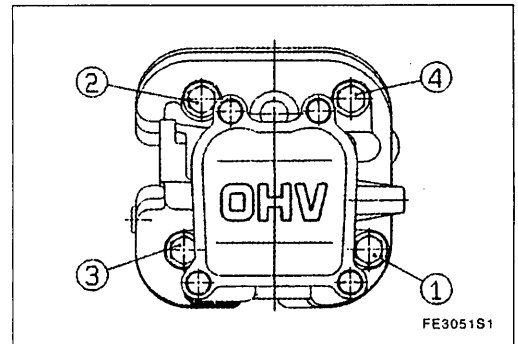


Reassembly

CAUTION

Make sure that the piston is in the top-dead-center of the compression stroke.

- Clean the mating surfaces of the cylinder and the cylinder head, and replace the gasket with a new one.
- Place the pushrods in their original positions in the cylinder block and install the cylinder head.
- ★ At this time, make sure that each end of a pushrod is properly fitted in the recessed area of the tappet and the rocker arm.
- Tighten the cylinder head retaining bolts little by little, evenly in accordance with the tightening sequence given in the diagram on the right, to their specified torque. (Refer to the section on Tightening Torque Specifications.)



3-28 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Valve System

Hydraulic Lash Adjuster (HLA)

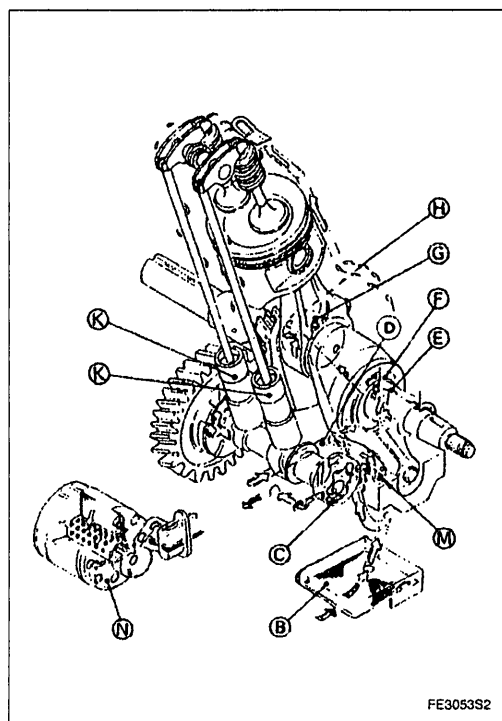
The FE350 and 400 are equipped with a Hydraulic Lash Adjuster (HLA) to automatically adjust the valve train to zero clearance through hydraulic means.

Purpose of the HLA

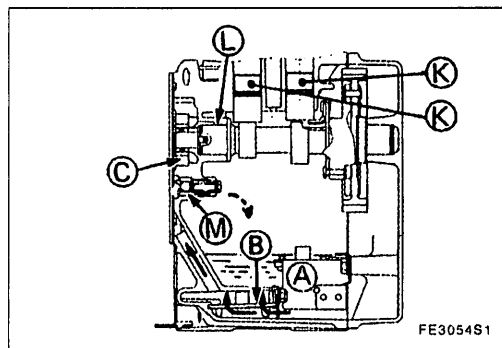
The HLA hydraulically adjusts the valve train to zero clearance by automatically absorbing the changes in the clearance that are created through thermal expansion or wear. The purpose of the HLA is to eliminate the need to adjust the clearance of the valve train, reduce the noise generated by the valve train, and stabilize the performance of the engine.

HLA Position and Oil Supply Path

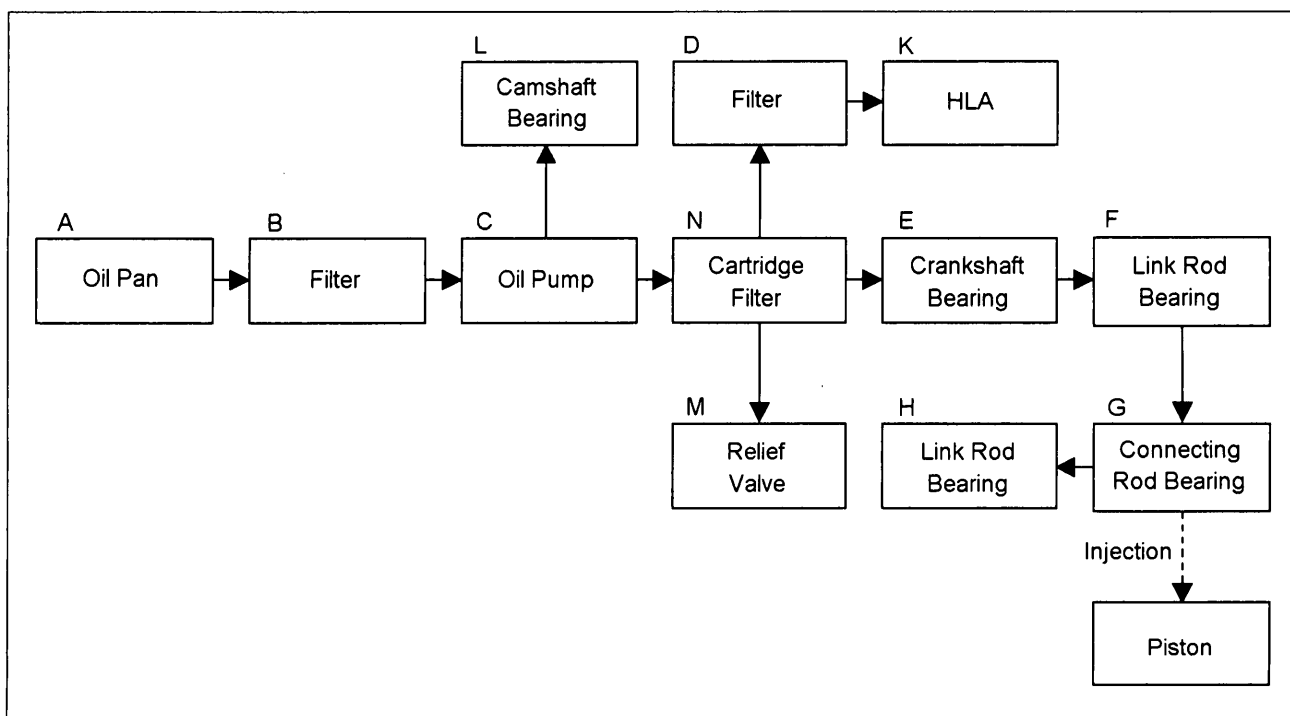
The HLA needs the pressurized oil from the oil pump. The diagram shows the position in which the HLA is installed and the oil supply path.



FE3053S2



FE3054S1

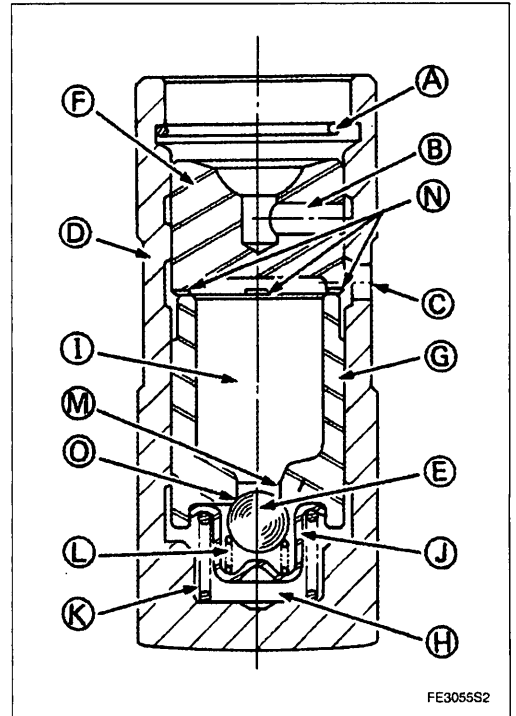


Valve System

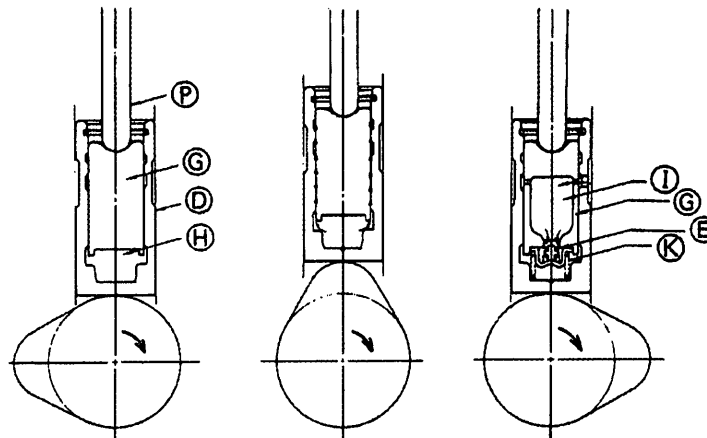
HLA Construction and Operation

- When the cam pushes the HLA upward, the oil in the high-pressure chamber [H] tries to flow back to the oil pool [I] of the plunger [G] by passing through the passage [M], but because the check ball [E] closes the passage [M], the oil cannot flow back and it causes the hydraulic pressure in the high-pressure chamber [H] to rise.
- The oil of the high-pressure chamber [H] in which the hydraulic pressure has risen leaks little by little through the gap (leak-down rand) between the plunger [G] and the HLA body [D]. As a result, the HLA shrinks slightly and pushes the pushrod [P] upward.
- When the rotation of the cam causes the HLA to descend to the cam base circle, the pressurized oil from the oil pump passes through the oil hole [C] in the HLA body [D], travels through the oil groove [N] that is cut into the socket [F], and enters the oil pool [I] in the plunger [G].
- After filling the oil pool [I], the oil pushes open the check ball [E], and flows into the lifter cage [J] and the high-pressure chamber [H], in order to correct the valve train to achieve zero clearance.

- A: Snap Ring
- B: Oil Metering Hole
- K: Plunger
- L: Check Valve Spring
- O: Check Valve Seat
- P: Pushrod



FE3055S2



FE3056W2

3-30 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Valve System

HLA Removal

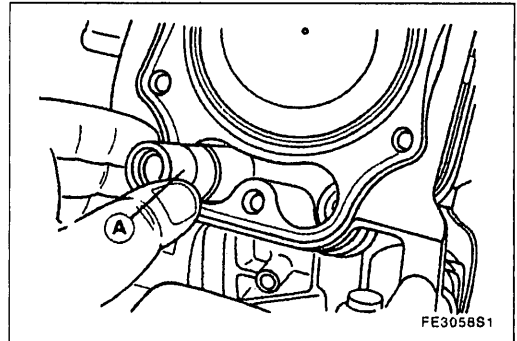
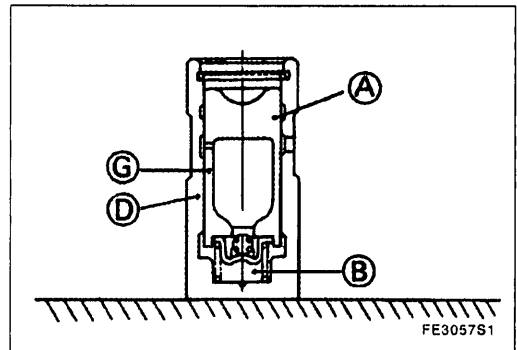
CAUTION

Always keep the HLA upright, with the end of the HLA on which the snap ring is visible facing up (socket "A" faces up). If it is placed on its side or upside down, the oil that is sealed in the high-pressure chamber [B] could leak out, disabling the HLA function.

CAUTION

Do not disassemble the HLA because it is extremely difficult to replenish the oil that is sealed in it.

- Make sure that the piston is in the top-dead-center of the compression stroke.
- Pull the HLA [A] out towards the cylinder head.



HLA Inspection

If the valve train noise does not go away after the engine is started, it could be due to the following reasons:

- Wear at the clearance between the HLA body [D] and the plunger [G].
- Debris wedged in the HLA body between the check ball [E] and the check valve seat [O].
- A drop in the hydraulic pressure of the oil supply path for some reason (refer to the section on the Lubrication System).

NOTE

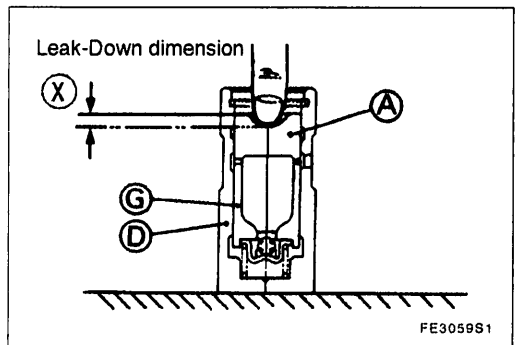
- If debris becomes wedged in the HLA body between the check ball [E] and the check valve seat [O], it is structurally unfeasible to perform a repair. Therefore, it is very important to prevent contamination when changing the engine oil or repairing the engine.

To inspect the HLA, perform a leak-down test as follows:

- Place the HLA with its snap ring facing up on a surface plate and measure the leak-down dimension.
- Using your finger or a rod with a rounded tip, firmly press the socket [A] down. Measure the extent of the recess of the socket [A], which is the leak-down dimension.
- If the leak-down dimension is greater than the service limit, replace the HLA with a new one.

HLA Leak-Down Dimension (maximum)

Service Limit: 0.5 mm (0.002 in)



Valve System

HLA Reassembly

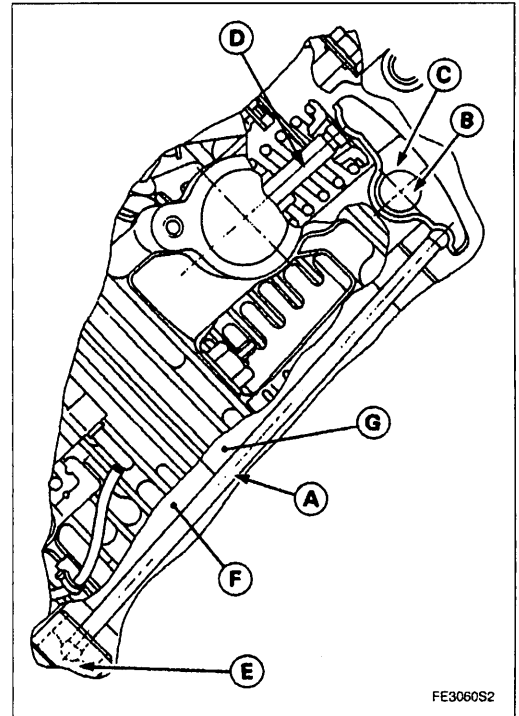
- Make sure that the piston is at the top-dead-center of the compression stroke.

CAUTION

Make sure to apply engine oil to all the sliding areas of the HLA, pushrod, rocker arm, rocker shaft, and valve before reassembly.

- Insert the HLA (with its end on which the snap ring is visible facing up) from the cylinder head side of the engine block.
- Mate the tip of the pushrod to the recess in the HLA, and the other end with the recess in the rocker arm, and install the cylinder head.

- A: Pushrod
- B: Rocker Shaft
- C: Rocker Arm
- D: Valve
- E: HLA
- F: Engine Block
- G: Cylinder Head



FE3060S2

HLA Operation Precaution

The HLA comes filled with low-viscosity oil.

Once the engine starts, the low-viscosity oil is gradually replaced with the engine oil.

- ★ After an engine that has previously operated is rebuilt, the valve takes approximately 20 minutes to seat itself. Therefore, start a rebuilt engine 20 minutes after it has been rebuilt. This prevents the engine from starting poorly due to a compression leak.
- ★ If the engine is restarted after the HLA has been replaced with a new one, the valve could be noisy, but the noise will go away after the engine is operated for a while in the medium speed range.

Valve Clearance Inspection and Adjustment

NOTE

○ Inspect and adjust the valve clearance on a cold engine.

- Rotate the crankshaft in the normal direction in order to bring the piston to the top-dead-center of its compression stroke.
- Using a gap gauge, measure the clearance of the intake and exhaust valves.
- If the clearance differs from the specified value, adjust it to the specified value.

Specified Valve Clearance on Cold Engine

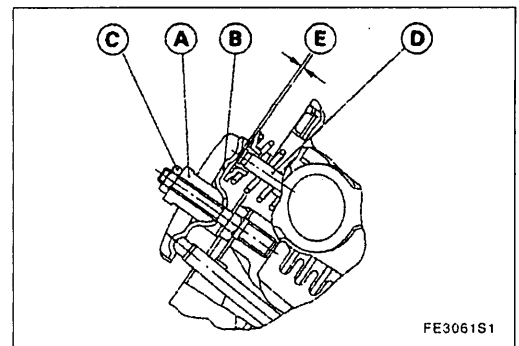
Intake: 0.12 mm (0.005 in)

Exhaust: 0.12 mm (0.005 in)

- Loosen the lock nut. Turn the rocker arm pivot in or out to attain the specified clearance. (FE120, 170, 250)
- ★ On the FE290, use a pair of pliers to hold the adjustment bolt, and then loosen the lock nut. Turn the adjustment bolt in or out to attain the specified clearance.

For FE120, 170, 250

- A: Rocker Arm Pivot
- B: Rocker Arm
- C: Locknut
- D: Valve
- E: Valve Clearance

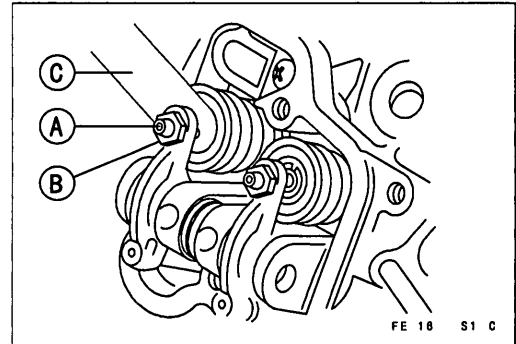


FE3061S1

3-32 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Valve System

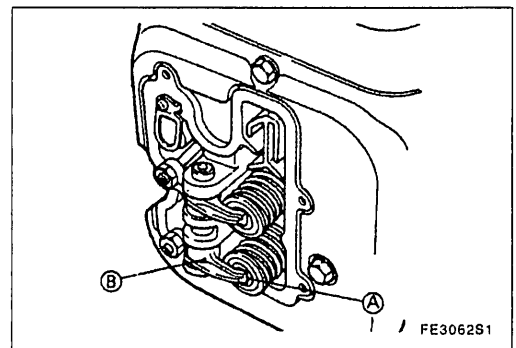
- Using a wrench, secure the rocker arm pivot, and tighten the lock nut to the specified torque. (Refer to the section on Tightening Torque Specifications.)
- ★ On the FE290, use a pair of pliers to hold the adjustment bolt, and tighten the lock nut to the specified torque. (Refer to the section on Tightening Torque Specifications.)
 - A: Adjustment Bolt
 - B: Locknut
 - C: Gap Gauge



Automatic Compression Release (ACR) Device Inspection

The ACR reduces the compression of the cylinder in order to facilitate the revolution of the crankshaft during the starting of the engine.

- Detach the rocker cover and remove the spark plug.
- Check whether the valves have the specified clearance.
- Slowly turn the crankshaft in the direction of the engine rotation and observe the movement of the exhaust valve [A] and the rocker arm [B].
- ★ Immediately after the intake valve has closed, the rocker arm [B] should push open the exhaust valve [A] to attain a lift that is greater than the service limit given below. If the exhaust valve does not lift to that height, the ACR that is provided on the camshaft is faulty. (Refer to the section on Camshaft Inspection.)



Valve Lift Height Service Limit (minimum) by ACR - for Exhaust

FE120, 170, 250, 290:	0.6 mm (0.024 in)
FE350, 400:	1.0 mm (0.039 in)

Valve Disassembly and Reassembly

For FE120, 170:

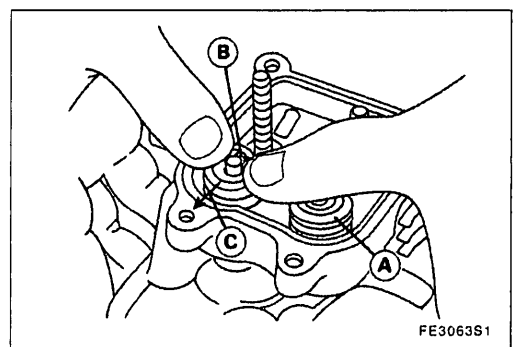
Disassembly

- Place an appropriate receiving plate on the combustion chamber side of the cylinder head.
- Using your thumbs, push down the spring retainer, slide the retainer towards the side hole, and remove the retainer.
- Remove the spring and the valve.

Reassembly

- Verify that the valve seat is making proper contact and that the valve stem moves smoothly in the guide.
- The reassembly is the opposite of the disassembly.
- Apply engine oil to the valve stem before reassembling the valve.

- A: Spring Retainer
- B: Side Hole
- C: Sliding Direction



Valve System

For FE250, 290, 350, 400:

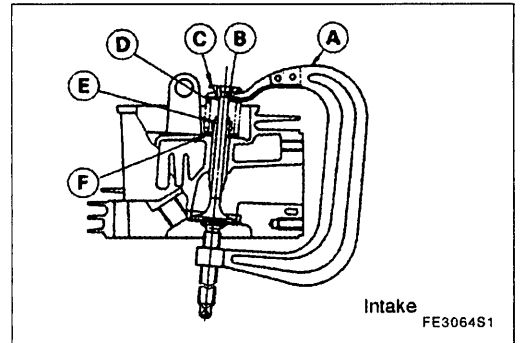
Disassembly

- Use a valve spring compressor to compress the valve spring and remove the collet.
- Remove the valve spring compressor.
- Remove the retainer, valve spring, and valve.
- If the stem seal that is provided on the intake side of the FE290, 350, or 400 is damaged, replace the stem seal with a new one.

NOTE

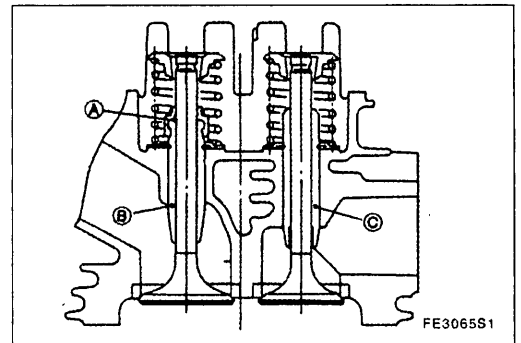
- Do not remove the stem seal unless it is necessary to do so.

- A: Valve Spring Compressor
- B: Collet
- C: Retainer
- D: Valve Spring
- E: Stem Seal
- F: Spring Seat



Reassembly

- Verify that the valve seat is making proper contact and that the valve stem moves smoothly in the guide.
- The reassembly is the opposite of the disassembly.
- Apply engine oil to the valve guide and the lip of the valve stem seal before reassembling the valve.



Valve Guide Inspection

- Use a bore micrometer to measure the bore of the valve guide.

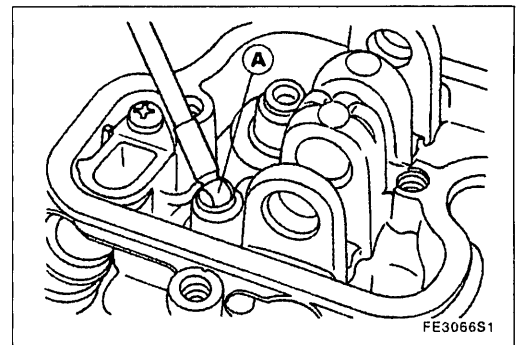
Valve Guide Bore Service Limit (maximum)

- for both Intake and Exhaust

FE120:	5.562 mm (0.2190 in)
FE170:	5.562 mm (0.2190 in)
FE250:	6.065 mm (0.2388 in)
FE290, 350, 400:	7.065 mm (0.2782 in)

- ★ If the measured value exceeds the service limit, replace the valve guide with a new one.

A: Bore Micrometer



Valve Inspection

- Inspect the valve head for the presence of any abnormal deposits or gas leakage.
- Use a wire brush to remove any deposits from the valve.
- Inspect the valve for any depression in its contact surface [A], and whether the thickness of the valve head [B] is below the service limit.

Valve Head Thickness Service Limit (minimum)

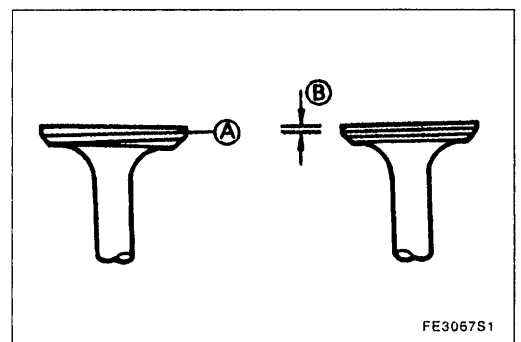
- for both Intake and Exhaust

FE120, 170:	0.5 mm (0.020 in)
FE250, 290, 350, 400:	0.6 mm (0.024 in)

- ★ If the valve head is smaller than the service limit given above, replace the valve with a new one. 4. Inspect the valve stem for the presence of any gummy deposits, discoloration due to seizure, or corrosion.

NOTE

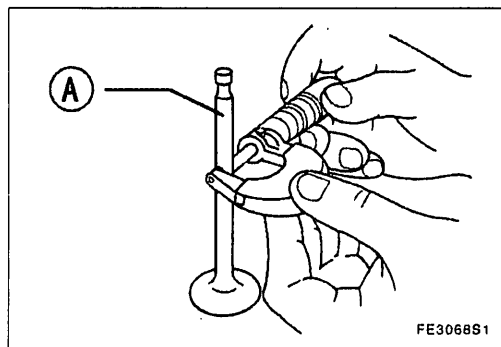
- Gummy deposits are caused by the use of old, deteriorated gasoline. Instruct the user to use fresh, unleaded gasoline.



3-34 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Valve System

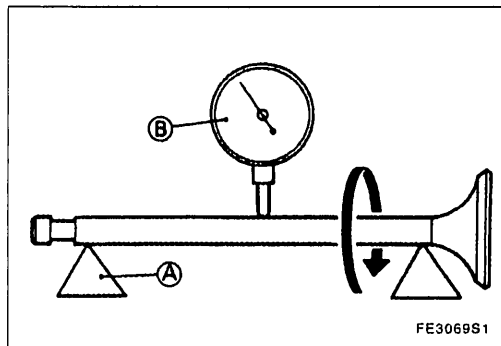
- ★ Use a wire brush to remove the deposits from the valve stem. If the valve stem does not move smoothly in the valve guide or the stem shows abnormal wear, replace the valve with a new one.
- Using a micrometer, measure the valve stem diameter in several places.
- ★ If the measured value is smaller than the service limit, replace the valve with a new one.



Valve Stem Diameter Service Limit (minimum)

	Intake Valve	Exhaust Valve
FE120, 170:	5.430 mm (0.2138 in)	5.415 mm (0.2132 in)
FE250:	5.930 mm (0.2335 in)	5.915 mm (0.2329 in)
FE290, 350, 400:	6.930 mm (0.2728 in)	6.915 mm (0.2722 in)

- Support both ends of the valve stem on V blocks [A] as shown in the diagram. Place a dial gauge [B] against the center, and gently rotate the valve stem to measure the bend of the stem (by reading the entire fluctuation of the dial gauge).



Valve Stem Bend Service Limit (maximum)

– for both Intake and Exhaust

FE120, 170:	0.05 mm (0.0020 in)
FE250, 290, 350, 400:	0.03 mm (0.0012 in)

- ★ If the measured value is greater than the service limit, replace the valve with a new one.

Valve Spring Inspection

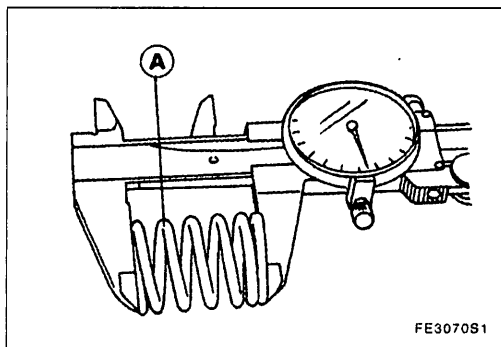
- Inspect the valve spring for the presence of corrosion or cracks, and replace it with a new one if necessary.
- Using a vernier caliper, measure the free length of the valve spring.

Valve Spring Free Length Service Limit (minium)

- for both Intake and Exhaust

FE120, 170:	31.8 mm (1.25 in)
FE250, 290:	32.8 mm (1.29 in)
FE350, 400:	38.1 mm (1.50 in)

- ★ If the free length is shorter than the service limit, replace the valve spring with a new one.



NOTE

- During reassembly, beware that the spring pitch is smaller at the valve seat side of the valve spring on the FE250, 290, 350, and 400. For both intake and exhaust valves.

A: Valve Spring

Valve System

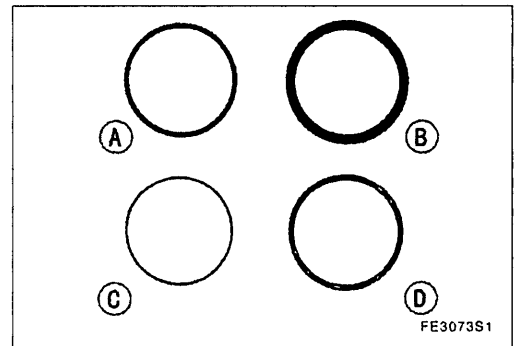
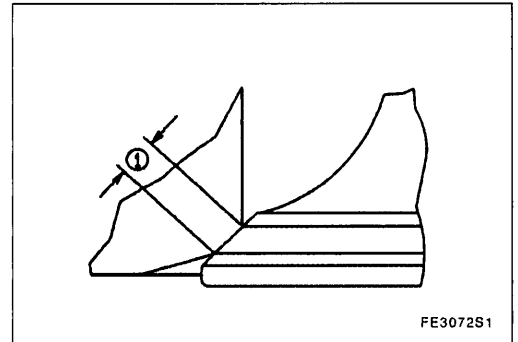
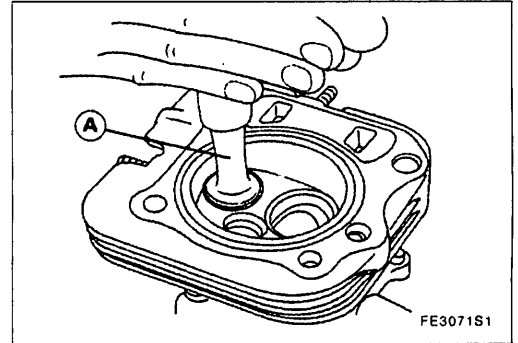
Valve Seat Inspection and Lapping

A prerequisite for inspecting the valve seat contact is that the valve guide and the valve stem are normal.

- Apply a thin layer of fine lapping compound on the contact surface of the valve.
- Using a lapper [A], lap the valve against the seat by rotating the valve.
- Pull out the valve and inspect whether there is an even contact at the valve seat along its entire circumference. If not, lap the valve and the valve seat.
- Lap 8 to 10 times and inspect the contact each time. Repeat this process until there is contact along the entire circumference.
- After completing the lapping, completely wash off the compound from all parts and allow the cylinder head to dry.

A: Lapper

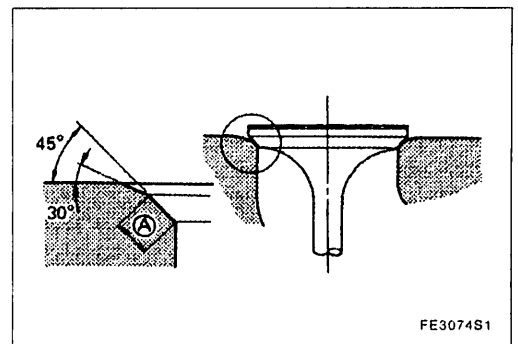
1. Valve Seat Contact Width



Valve Seat Correction

If the contact width of the valve seat is nearing the service limit, or there are small depressions or wear on the valve seat, correct the valve seat.

- Using a 45° (30° only for the intake on FE350 and 400) valve seat cutter, apply a light force to smoothly cut the valve seat to create a concentric circle.
- Using a 30° (15° only for the intake on FE350 and 400) valve seat cutter, make a shallow cut so that the valve seat contact [A] will have the standard width.



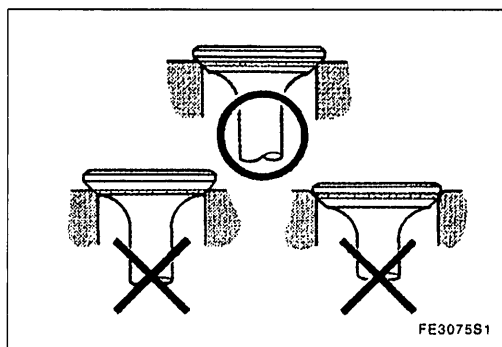
3-36 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Valve System

Valve Seat Contact Standard Width and Service Limit (minimum) – for both Intake and Exhaust

	Standart	Service Limit
FE120, 170:	0.7 mm (0.028 in)	1.7 mm (0.067 in)
FE250, 290, 350,	0.8 mm (0.031 in)	1.9 mm (0.075 in)

- Using a 45° (30° only for the intake on FE350 and 400) valve seat cutter, apply a light force to remove the burrs from the seat.
- Use a marker (blue ink) on the valve seat to inspect the contact between the valve and the valve seat. The valve and the seat must make contact in the center of the contact surface along the entire circumference as shown in the diagram.
- If the contact width is inadequate, cut the seat again and lap the valve.



Rocker Arm and Rocker Shaft

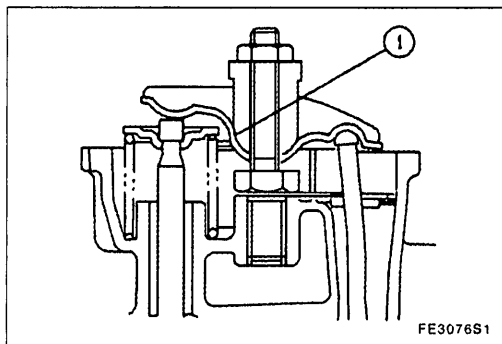
For FE120, 170, 250

- If abnormal wear is present on the ball surface of the rocker arm, or the surface that comes in contact with the valve stem and the pushrod, replace the rocker arm with a new one.

For FE290, 350, 400

- Using an inside micrometer, measure the bore of the rocker arm bearing in several places. Because the rocker arm of the FE350 and 400 is made of sheet metal, use a vernier caliper to measure its bore.

1. Ball surface of rocker arm

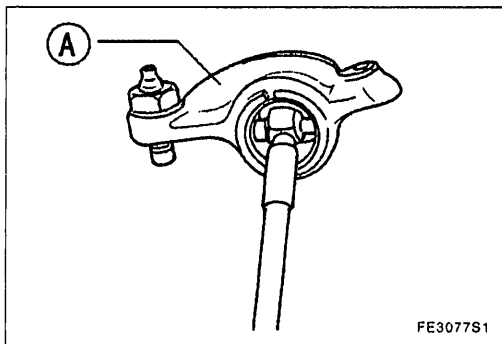


Rocker Arm Bearing Bore Service Limit (maximum)

FE290:	12.074 mm (0.4754 in)
FE350, 400:	12.3 mm (0.4843 in)

- ★ If the measured value is greater than the service limit, replace the rocker arm.
- Using a micrometer, measure the diameter of the rocker shaft in several places.

A: Rocker Arm

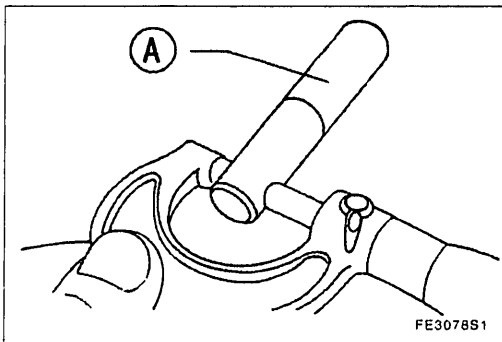


Rocker Shaft Diameter Service Limit (minimum)

FE290, 350, 400:	11.949 mm (0.4704 in)
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- ★ If the measured value is smaller than the service limit, replace the rocker shaft

A: Rocker Shaft

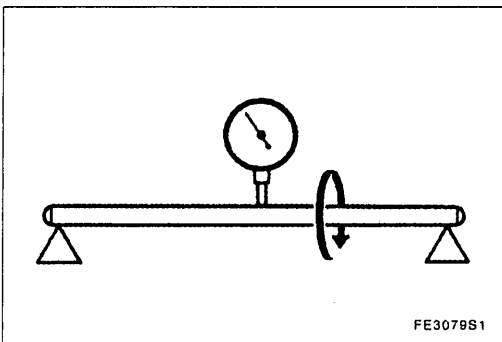


Pushrod Inspection

- Support both ends of the pushrod on V blocks and place a dial gauge against the center.
- Gently rotate the pushrod to measure its bend through the fluctuation of the dial gauge.

Pushrod Bend - for both Intake and Exhaust

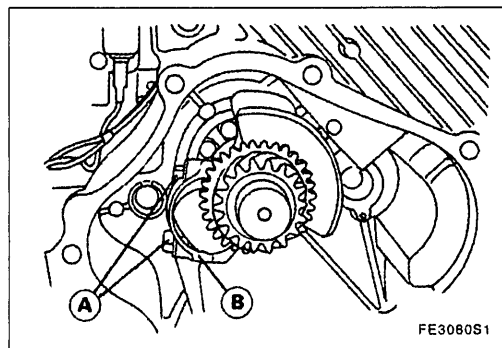
FE290, 170:	0.5 mm (0.020 in)
FE250, 290:	0.3 mm (0.012 in)
FE350, 400:	0.5 mm (0.020 in)



Piston and Connecting Rod

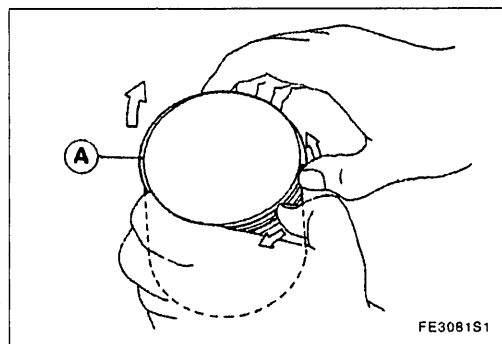
Disassembly

- Drain the engine oil into an appropriate container.
- Remove the retaining bolts from the crankcase cover. Using a wooden or a plastic mallet, gently tap on the crankcase cover at the area where the cover is fastened to the crankcase, and remove the crankcase cover. (Refer to the section on Crankcase Cover Disassembly.)
- Refer to the section on Camshaft Disassembly and remove the camshaft and the tappet. * When working on the FE170 that is equipped with a uniaxial rotation balancer, remove the balancer.
- Turn the crankshaft to a position in which the cap bolt [A] is easily visible.
- Remove the two cap bolts and remove the connecting rod cap [B].
- Push the big end of the connecting rod towards the cylinder head and push out the piston and connecting rod assembly.



NOTE

- Clean off the carbon from the cylinder bore before pushing out the piston and connecting rod assembly.
- Remove the snap ring from the piston, pull out the piston pin, and take out the piston.
- Using your fingers, open the piston ring [A] at the area where its ends meet, and push up the piston ring at the opposite end to remove it from above the piston.



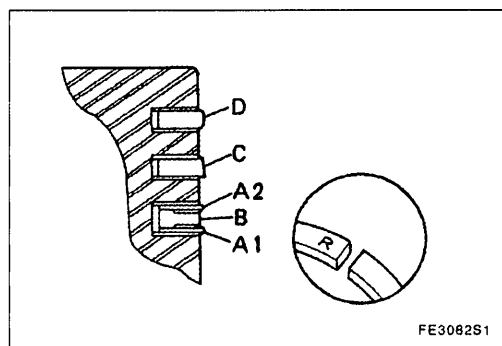
Reassembly

The reassembly is the opposite of the assembly.

- Reassemble the piston rings in the following sequence: lower rail [A1] → spacer [B] → upper rail [A2] → second ring [C] → top ring [D]

NOTE

- Install the top ring and the second ring so that their marked side faces the top of the piston.
- Beware of the proper direction of the piston when reassembling the piston with the connecting rod.



NOTE

- Apply engine oil to the piston pin holes of the piston and the connecting rod before assembling them.

3-38 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

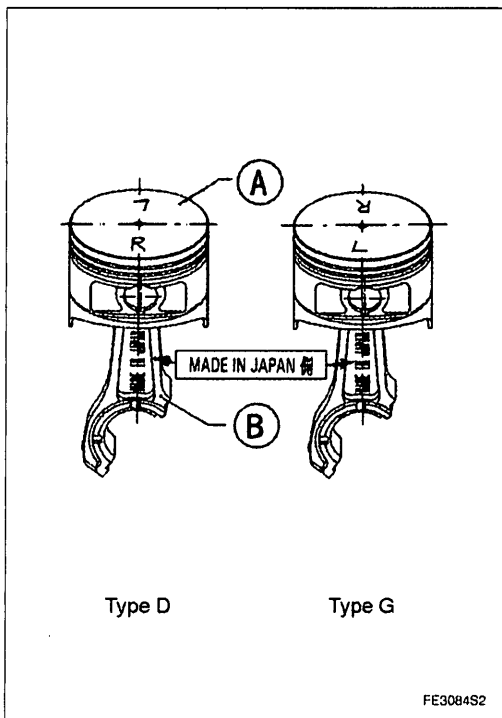
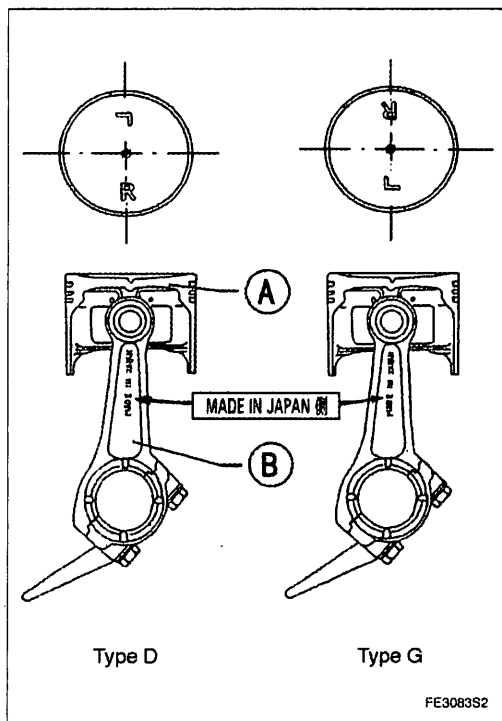
Piston and Connecting Rod

For FE120, 170, 250, 350, 400

- On type D, face the "R" mark on the top of the piston towards the side of the connecting rod marked "MADE IN JAPAN".
- On type G, face the "L" mark on the top of the piston towards the side of the connecting rod marked "MADE IN JAPAN".

A: Piston

B: Connecting Rod



Piston and Connecting Rod

For FE290

- On type D, face the arrow on the top of the piston opposite to the side of the connecting rod marked "MADE IN JAPAN".
- On type G, face the arrow on the top of the piston towards the side of the connecting rod marked "MADE IN JAPAN".
- Replace the snap ring for the piston pin with a new one and fit it securely into the groove of the piston pin hole.

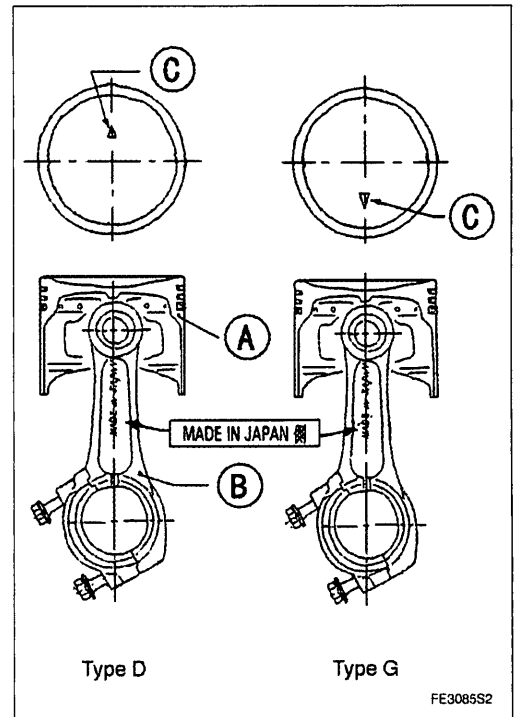
NOTE

- Do not reuse an old snap ring. Once a snap ring is removed, it could be deformed or it could have lost its tension. If it is reused, it could fall out while the engine is running, and damage the cylinder wall.
- When installing the piston and connecting rod assembly into the cylinder, beware of the direction of the "MADE IN JAPAN" side of the connecting rod.

NOTE

- Apply engine oil to the cylinder bore, crank pin area, connecting rod big end, and connecting rod bolts before reassembly.

- A: Piston
- B: Connecting Rod
- C: Arrow



For FE120, 170, 250, 350, 400

- On both types D and G, the "MADE IN JAPAN" side of the connecting rod must face the magneto.

For FE290

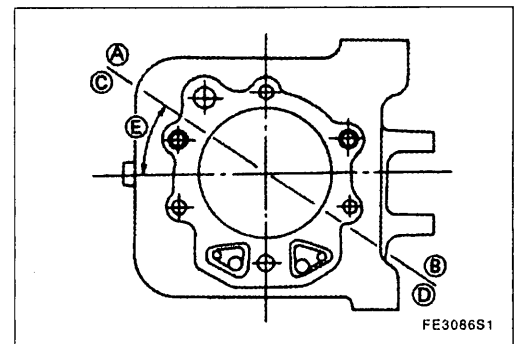
On both types D and G, the "MADE IN JAPAN" side of the connecting rod must face the output shaft.

- Arrange the gaps of the piston rings as shown in the diagram, and use a ring compressor to install the piston from the cylinder head side.
- Mate the connecting rod cap to the big end of the connecting rod and tighten the connecting rod bolts to the specified torque. (Refer to the section on Tightening Torque Specifications.)

NOTE

- After tightening the bolts, make sure that the connecting rod moves easily in the axial direction along the crank pin.

- A: Top Ring Gap Position
- B: Second Ring Gap Position
- C: Upper Side Rail Gap Position
- D: Lower Side Rail Gap Position
- E: 30 ~ 45°



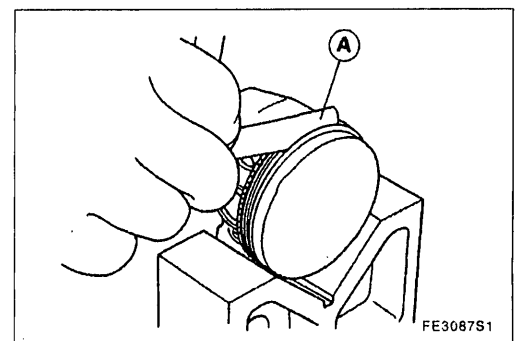
Piston Inspection

- Clean the carbon deposits off the piston.
- Using a new piston ring, use a gap gauge [A] to measure the clearance between the ring groove and the ring.

Piston Ring Groove Clearance Service Limit (maximum)

	Top Ring	Second Ring
FE120, 170, 250:	0.15 mm (0.0059 in)	0.12 mm (0.0047 in)
FE290, 350, 400:	0.16 mm (0.0063 in)	0.14 mm (0.0055 in)

- ★ If the measured value is greater than the service limit, replace the piston with a new one.



3-40 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

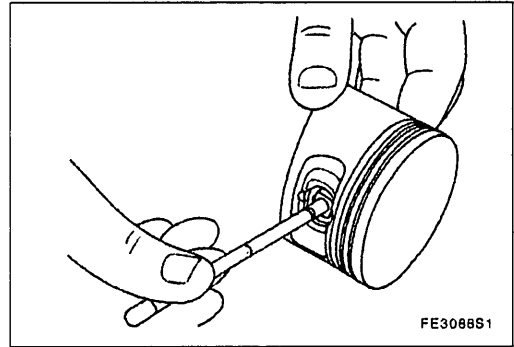
Piston and Connecting Rod

- Using an inside micrometer, measure the pin hole bore of the piston in several places.

Piston Pin Hole Bore Service Limit (maximum)

FE120:	14.033 mm (0.5525 in)
FE170:	16.033 mm (0.6312 in)
FE250:	18.033 mm (0.7100 in)
FE290:	19.033 mm (0.7493 in)
FE350, 400:	20.033 mm (0.7890 in)

- ★ If the measured value is greater than the service limit, replace the piston with a new one.



Piston Pin Inspection

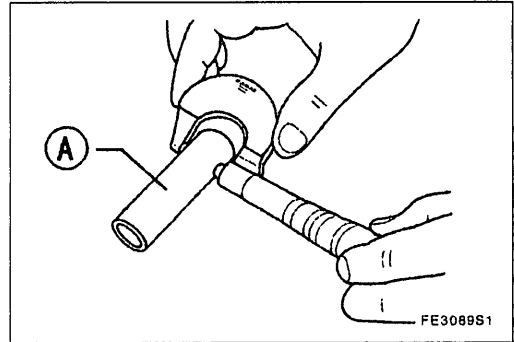
- Using a micrometer, measure the piston pin diameter in several places.

Piston Pin Diameter Service Limit (minimum)

FE120:	13.975 mm (0.5502 in)
FE170:	15.975 mm (0.6290 in)
FE250:	17.975 mm (0.7077 in)
FE290:	18.975 mm (0.7470 in)
FE350, 400:	19.975 mm (0.7864 in)

- ★ If the measured value is smaller than the service limit, replace the piston pin with a new one.

A: Piston Pin



Piston Ring Inspection

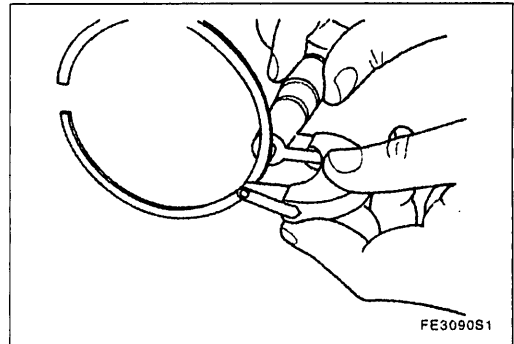
- Using a micrometer, measure the thickness of the piston ring in several places.

Piston Ring Thickness Service Limit (minimum)

- for both Top and Second Rings

FE120, 170:	1.42 mm (0.056 in)
FE250, 290, 350, 400:	1.44 mm (0.057 in)

- ★ If the measured value is smaller than the service limit, replace the piston rings as a set.



- Fit the piston ring inside the cylinder, and use the top of the piston to insert the piston ring perpendicularly to the skirt area at the bottom of the cylinder. Then, use a gap gauge to measure the clearance of the ring gap.

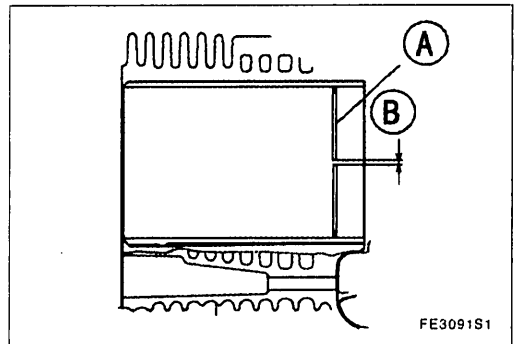
Piston Ring Gap Clearance Service Limit (maximum)

	Top Ring	Second Ring
FE120, 170:	1.0 mm (0.039 in)	1.0 mm (0.039 in)
FE290, 350, 400:	1.2 mm (0.047 in)	1.2 mm (0.047 in)

- ★ If the measured value is greater than the service limit, replace the piston rings as a set. (This is because of the difficulty in properly measuring the oil ring.)

A: Piston Ring

B: Ring Gap Clearance



Piston and Connecting Rod

Connecting Rod Inspection

- Inspect the big end of the connecting rod for wear or any traces of seizure scratches or discoloration.
 - ★ Abnormal wear or scratches could be caused by the presence of foreign particles in the engine oil.
 - ★ Vertical scratches or discoloration on the bearing surface is a symptom that results from insufficient lubrication or overheating.
 - ★ Clean the inside of the engine and change the engine oil.
 - ★ Inspect and clean the cooling system.
 - ★ Inspect the oil pump, oil filter, and oil passage and repair or replace as needed.
 - ★ When reusing the connecting rod or the crankshaft, carefully file off any protrusions from their bearing surface.
- Using an inside micrometer, measure the bore of the bearing area of the small end in several places.

Connecting Rod Small End Bearing Area Bore Service Limit (maximum)

FE120:	14.042 mm (0.5528 in)
FE170:	16.047 mm (0.6318 in)
FE250:	18.051 mm (0.7107 in)
FE290:	19.051 mm (0.7500 in)
FE350, 400:	20.051 mm (0.7894 in)

- ★ If the measured value is greater than the service limit, replace the connecting rod with a new one.
- Mate the connecting rod cap to the big end of the connecting rod and tighten the connecting rod bolts to the specified torque. Make sure to apply engine oil to the threaded portion of the connecting rod bolts before tightening them. (Refer to the section on Tightening Torque Specifications.)
- Using an inside micrometer, measure the bore of the bearing area of the big end in several places.

Connecting Rod Big End Bearing Area Bore Service Limit (maximum)

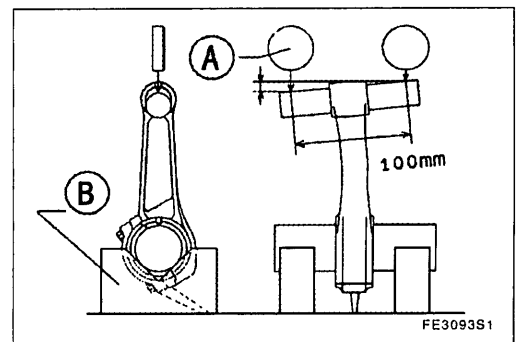
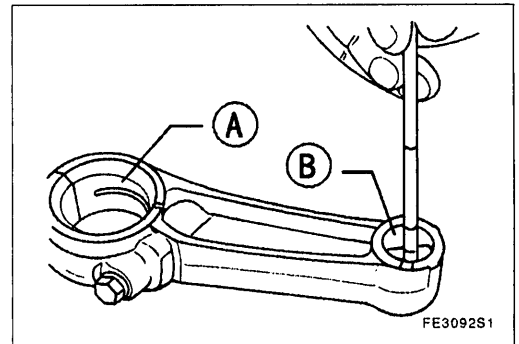
FE120:	26.052 mm (1.0257 in)
FE170:	29.052 mm (1.1438 in)
FE250:	34.067 mm (1.3412 in)
FE290:	35.567 mm (1.4003 in)
FE350, 400:	37.567 mm (1.4790 in)

- ★ If the measured value is greater than the service limit, replace the connecting rod with a new one.
- Insert a bar each, measuring approximately 100 mm in length and almost the same diameter as the respective bore into both the big and small ends of the connecting rod. Then, set the V block and the dial gauge as shown in the diagram in order to measure the bend and twist of the connecting rod.
- ★ If the measured value is greater than the service limit, replace the connecting rod with a new one.

Connecting Rod Bend and Twist Service Limit (maximum)

Service Limit: 0.15/100 mm (0.006/100 in)

- A: Big End Bearing Area
- B: Small End Bearing Area

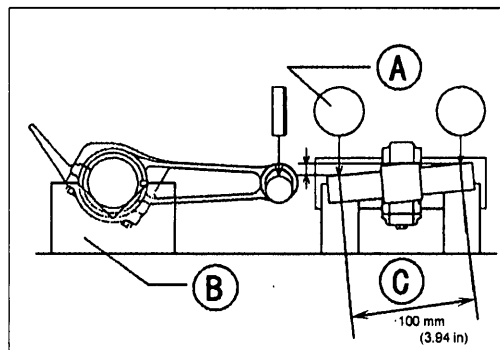


3-42 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Piston and Connecting Rod

A: Dial Gauge

B: V Block



DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-43

Cylinder Block and Crankcase Cover

Cylinder Inspection

- Inspect the cylinder wall for the presence of any scratches, the cylinder exterior for any broken fins, and for any other damage.
- ★ If the cylinder has non-repairable damage, replace the cylinder block with a new one.
- Using a cylinder gauge, measure the cylinder bore in the longitudinal and latitudinal directions at the locations given in the diagram on the right.

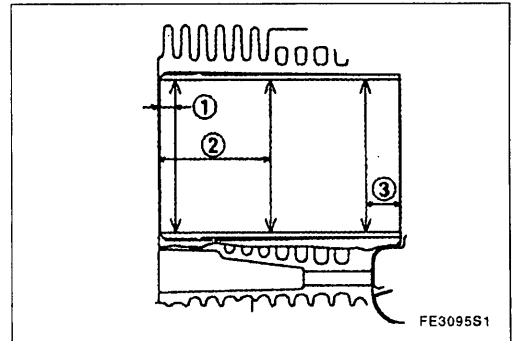
Cylinder Bore Service Limit (maximum)

FE120:	60.067 mm (2.3648 in)
FE170:	66.067 mm (2.6011 in)
FE250:	76.067 mm (2.9948 in)
FE290:	78.067 mm (3.0735 in)
FE350:	83.067 mm (3.2703 in)
FE400:	87.067 mm (3.4278 in)

Cylinder Bore Roundness (maximum)

Service Limit: 0.56 mm (0.0220 in)

- ★ If the measurement shows that even one area of the cylinder has a greater bore or roundness than the service limit, bore the cylinder to an oversize or replace the cylinder block.
- ★ The oversize piston and piston rings come in + 0.50 mm (0.020 in) oversize.
 1. 10 mm (0.394 in)
 2. Center Point
 3. 8 mm (0.315 in)

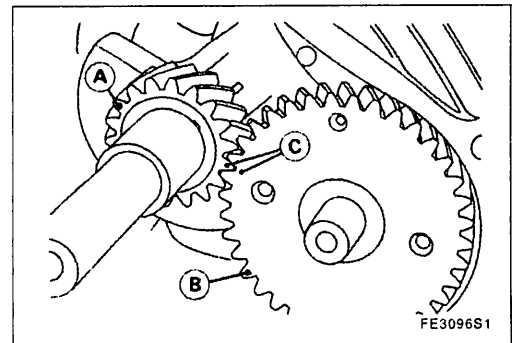


Crankcase Cover

Disassembly

- Drain the engine oil into an appropriate container.
- Loosen the crankcase cover retaining bolts in the reverse sequence of the tightening sequence given on the next page. Using a hammer or a plastic mallet, gently tap on the crankcase cover at the area where the cover is fastened to the engine, and remove the crankcase cover.

- A: Crankshaft Gear
- B: Camshaft Gear
- C: Timing Mark



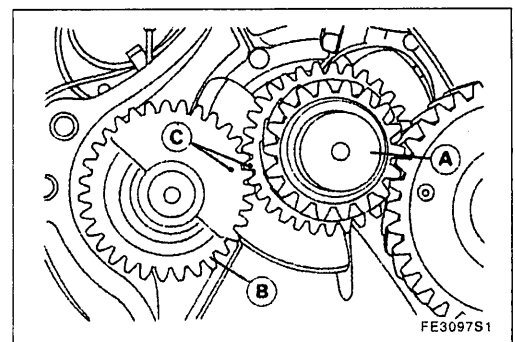
Reassembly

- Clean the mating surface and place a new gasket on it.
- Apply high-temperature grease to the area in which the oil seal lip faces the rotating shaft. Apply engine oil to the bearing areas.
- Verify that the respective timing marks on the crankshaft gear and the camshaft gear, as well as on the crankshaft gear and the balancer gear (optional equipment on FE170) are properly aligned.

CAUTION

Make sure to remove the oil pump before installing the camshaft. Serious damage to the engine will result if the camshaft is installed with the oil pump in place.

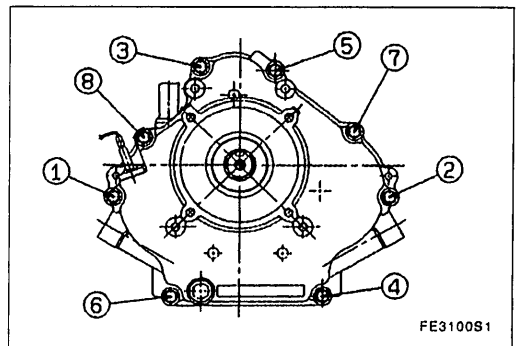
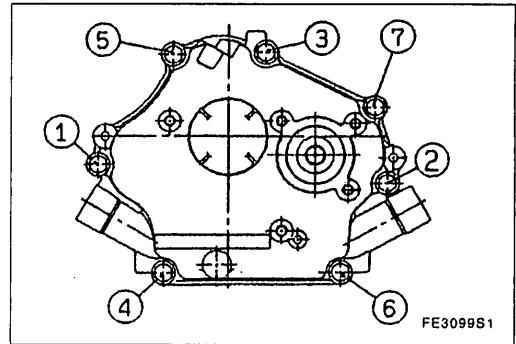
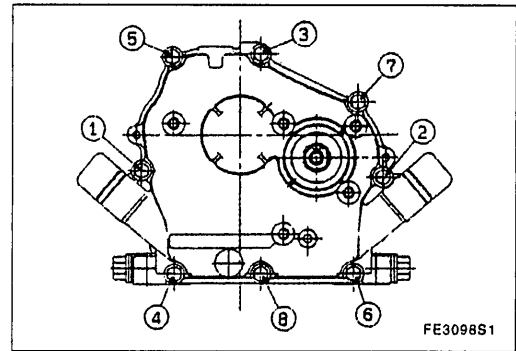
- A: Crankshaft
- B: Timing Mark
- C: Balancer Gear



3-44 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Cylinder Block and Crankcase Cover

- Verify that a crankshaft or the camshaft that requires an axial play adjustment shim is provided with an adjustment shim. (Refer to the section on Axial Play Adjustment.)
- Verify that the governor weight is closed. Also verify that the governor arm is positioned so that its front receives the end of the governor sleeve. (Refer to the section on Governor Mechanism.)
- Install the crankcase cover while paying attention to the meshing of the governor gear, evenly tighten the retaining bolts in the sequence given in the diagram, and tighten them to the specified torque. (Refer to the section on Tightening Torque Specifications.)



Ball Bearing

- The table below lists the areas in which ball bearings are used. An empty area signifies that the case acts directly as a plain bearing.

Ball Bearing Areas and Nominal Numbers

		FE120		FE170		FE250		FE290		FE350, 400	
		Type D	Type G	Type D	Type G	Type D	Type G	Type D	Type G	Type D	Type G
Flywheel Side	Crankshaft	6204	6204	6305	6305	6206	6206				
	Camshaft										
	Balancer Shaft	-	-			-	-	-	-	-	-
PTO Side	Crankshaft	6204	6204	6205	6205	6206	6206	6306	6306	6207	6207
	Camshaft		6204		6205		6206		6306		6207
	Balancer Shaft	-	-	6202	6202	-	-	-	-	-	-

Note: The numbers indicate the nominal numbers of the ball bearings.

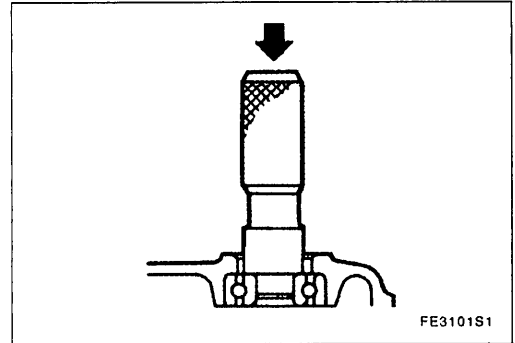
- To inspect a ball bearing, first clean the bearing in solvent and allow it to dry. Then, apply engine oil and gently spin it with your hand.
- ★ If the bearing is noisy, does not spin smoothly, or has excessive play, replace the bearing.

DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-45

Cylinder Block and Crankcase Cover

Replace a ball bearing in the following manner:

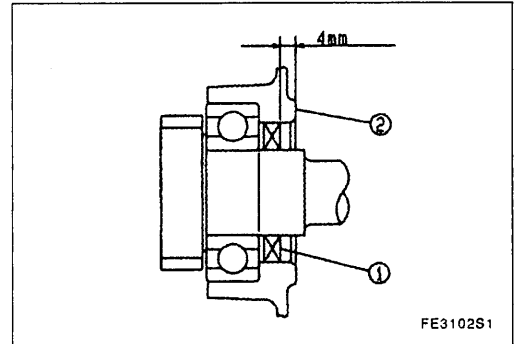
- Remove the oil seal. Do not reuse an oil seal once it has been removed.
- Using a bearing puller as shown in the diagram on the right, remove the bearing.
- Clean the bearing housing and allow it to dry.
- Apply oil to a new bearing.
- Using a bearing driver, drive the bearing in until it is flush with the end face of the housing.



Oil Seal

- Once an oil seal is removed, replace it with a new one.
- To install an oil seal, use a press or a seal driver.
- Only on the PTO side of the type D engine, the oil seal must be driven in 4 mm lower than the crankcase cover surface as shown in the diagram. Other oil seals must be installed flush with the case surface.

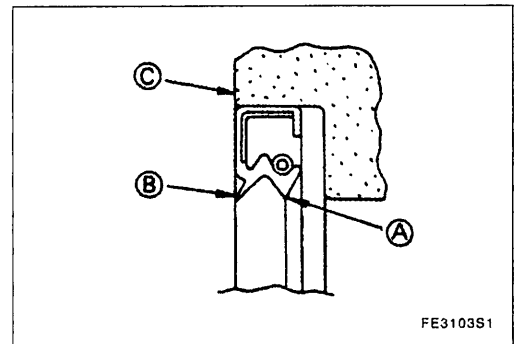
1. Oil Seal
2. Crankcase Cover



- Fill the area between oil seal lips [A] and [B] with high-temperature grease before installing the oil seal.

NOTE

- Use a guide jig to install the oil seal without damaging its lip.
- A: Lip A
B: Lip B
C: Crankcase or Crankcase Cover



Plain Bearing Area Inspection

- Using a cylinder gauge, measure the bore of the plain bearing areas of the cylinder block and the crankcase cover.

Plain Bearing Area Bore Service Limit (maximum)

(Unit: mm)

		FE120		FE170		FE250		FE290		FE350, 400	
		Type D	Type G	Type D	Type G	Type D	Type G	Type D	Type G	Type D	Type G
Flywheel Side (cylinder block)	Crankshaft							30.075 (1.184 in)	30.075 (1.184 in)	35.075 (1.381 in)	35.075 (1.381 in)
	Camshaft	15.063 (0.593 in)	15.063 (0.593 in)	16.063 (0.632 in)	16.063 (0.632 in)	20.063 (0.790 in)	20.063 (0.790 in)	23.063 (0.908 in)	23.063 (0.908 in)	23.063 (0.908 in)	23.063 (0.908 in)
	Balancer Shaft	—		15.063 (0.593 in)	15.063 (0.593 in)	—	—	—	—	—	—
PTO Side (crankcase cover)	Crankshaft										
	Camshaft	15.063 (0.593 in)		16.063 (0.632 in)		20.063 (0.790 in)		23.063 (0.908 in)		23.063 (0.908 in)	
	Balancer Shaft	—	—			—	—	—	—	—	—

Note: An empty area signifies that a ball bearing is used.

- ★ If the measured value is greater than the service limit, replace the part with a new one.

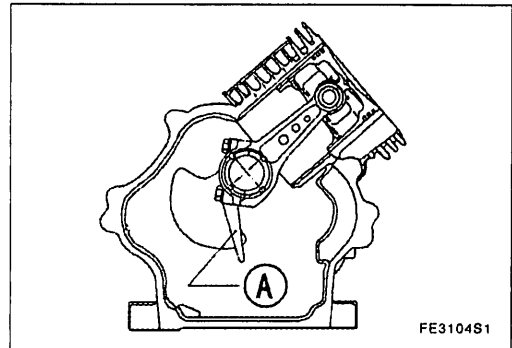
3-46 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Lubrication System

Lubrication Method

For FE120, 170, 250

As shown in the diagram on the right, the revolution of the crankshaft causes the splash arm that is provided at the big end of the connecting rod to pick up the engine oil from the crankshaft chamber and splash it in a spray form to lubricate the internal parts. (Forced splashing type)

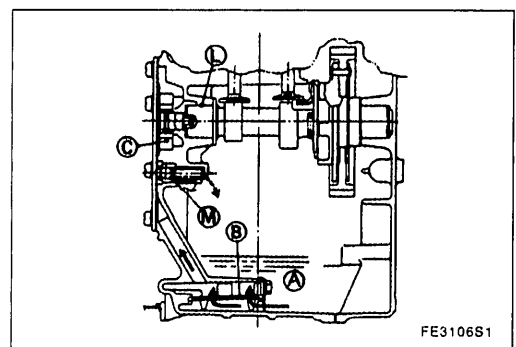
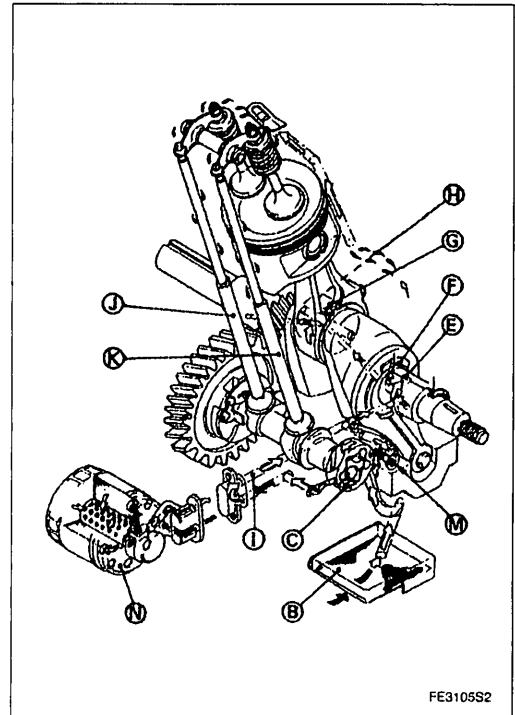


For FE290, 350, 400

A forced pumping lubrication method through the use of an oil pump has been adopted. (Forced pumping type) The oil pump draws in the oil and pumps the oil through the oil passages described below.

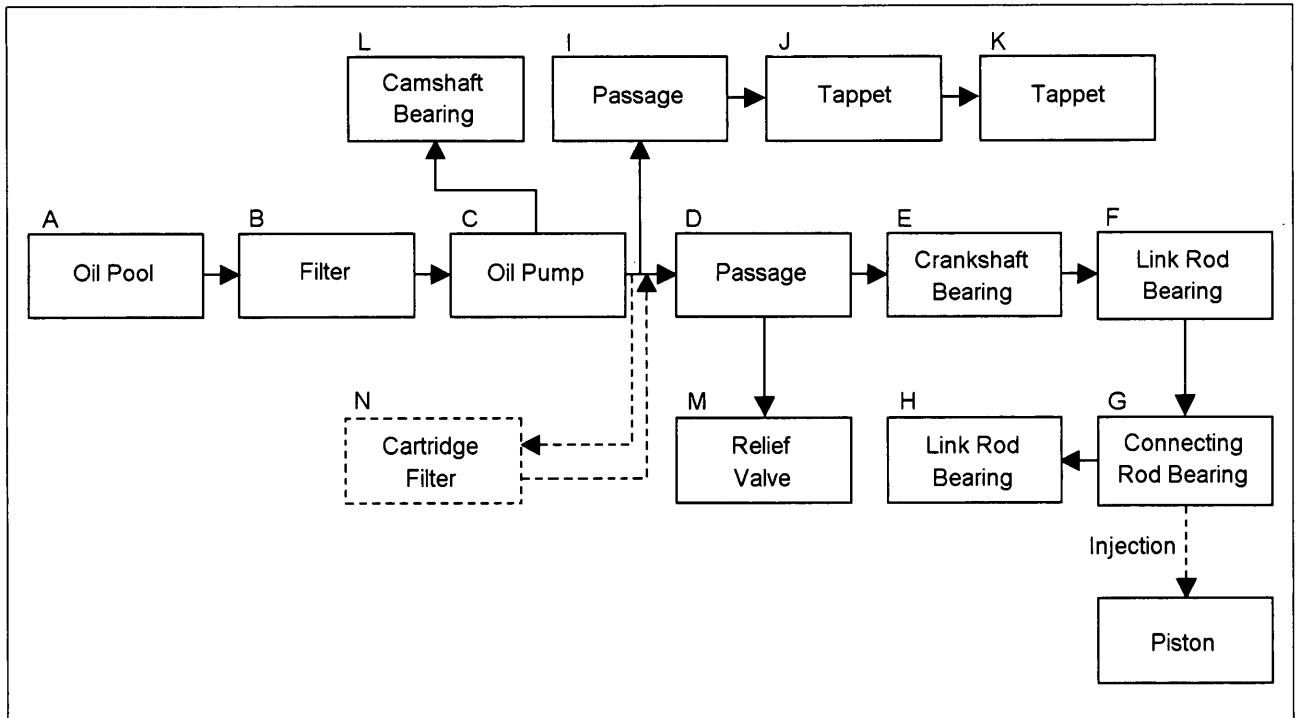
The oil pump is provided with a relief valve at its outlet side. When the oil pressure is higher than the preset pressure of the relief valve, the relief valve opens to discharge the oil into the crankcase. When the oil pressure is lower than the preset pressure, the relief valve closes. If the oil pressure becomes excessively high, it could break the seal in the oil passage, critically damaging the engine.

For the oil passage on the FE350 and 400, refer to the following section: Valve System - HLA.



DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-47

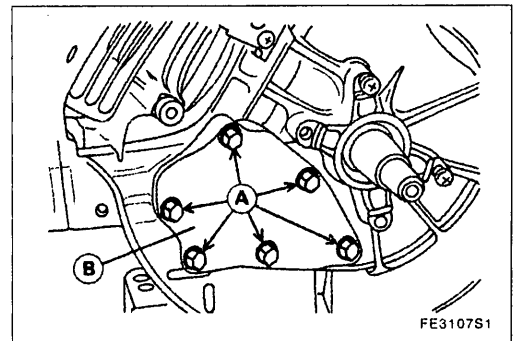
Lubrication System



Oil Pump Disassembly and Reassembly

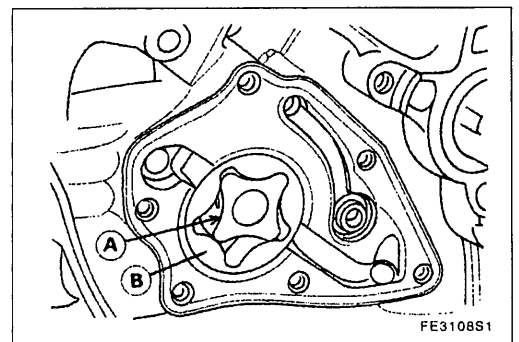
- Remove the six retaining bolts from the oil pump cover and remove the oil pump cover, gasket, and plate, in that order.

A: Retaining Bolts
B: Oil Pump Cover



- Remove the inner rotor and outer rotor, in that order.

A: Inner Rotor
B: Outer Rotor

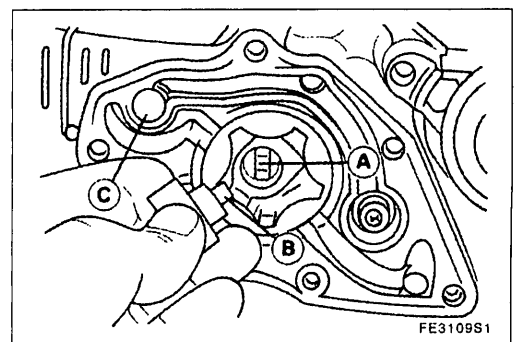


Reassembly

CAUTION

Make sure to install the camshaft before installing the oil pump. If the camshaft is installed with the oil pump already in place, it will cause serious damage to the engine.

A: Cutout at the End of Camshaft
B: Protrusion on the Inner Rotor
C: Oil Filter (FE350, 400 only)



3-48 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

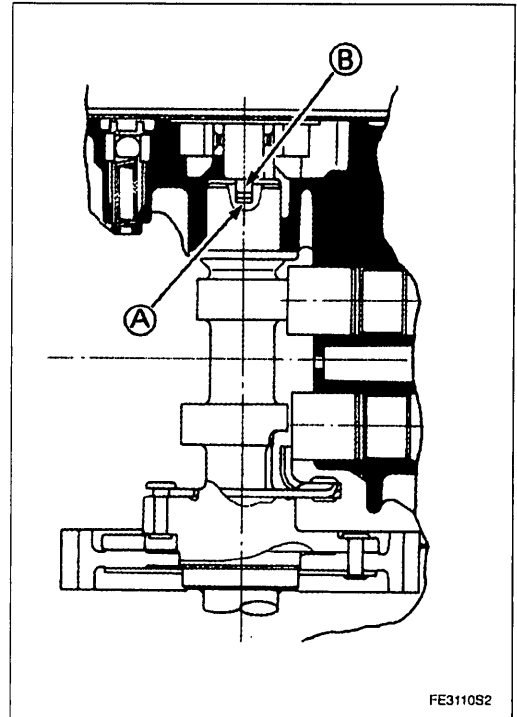
Lubrication System

- The reassembly is the reverse order of disassembly.
- Install the outer rotor and the inner rotor, in that order, making sure to prevent dust from entering the oil pump.

CAUTION

To install the inner rotor, make sure that the protrusion [B] of the inner rotor properly mates with the cutout [A] at the end of the camshaft. If they are not mated correctly, it could cause serious damage.

- On the FE350 and 400, verify that the oil filter [C] is securely fitted.

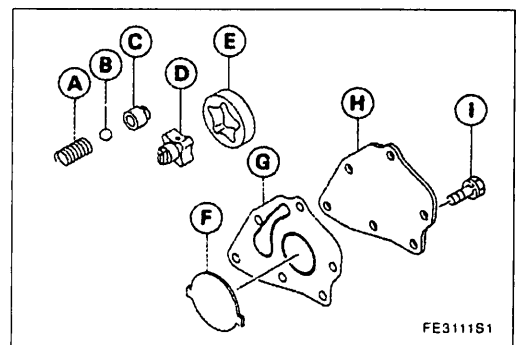


FE3110S2

Oil Pump Inspection

The oil pressure specification is 31.4 kpa (3.2 kg/cm², 0.46 psi) minimum at the maximum no-load speed. If the oil pressure is low, inspect the oil pump and the relief valve.

- A: Spring
- B: Relief Valve
- C: Valve Seat
- D: Inner Rotor
- E: Outer Rotor
- F: Plate
- G: Gasket
- H: Cover
- I: Bolt



FE3111S1

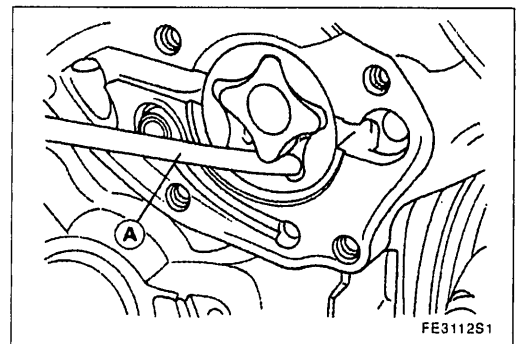
- Using a gap gauge, measure the minimum clearance between the inner and outer rotors.

Inner and Outer Rotor Clearance (maximum) - for FE290, 350, 400

Service Limit: 0.3 mm (0.012 in)

- ★ If the measured value is greater than the service limit, replace the rotors as a set.

- A: Gap Gauge



FE3112S1

DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-49

Lubrication System

- Using a micrometer, measure the following parts:

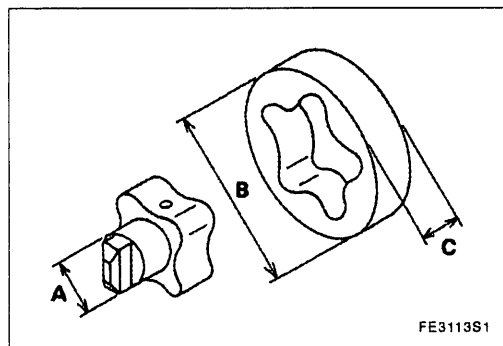
Inner Rotor Shaft Diameter (maximum) - for FE290, 350, 400
Service Limit: 12.627 mm (0.4971 in)

Outer Rotor Diameter (maximum) - for FE290, 350, 400
Service Limit: 40.467 mm (1.5932 in)

Outer Rotor Width (maximum) - for FE290, 350, 400
Service Limit 9.920 mm (0.3906 in)

- ★ Even if one of the measured values is smaller than the service limit, replace the rotors as a set.

- A: Inner Rotor Shaft Diameter
- B: Outer Rotor Diameter
- C: Outer Diameter Width

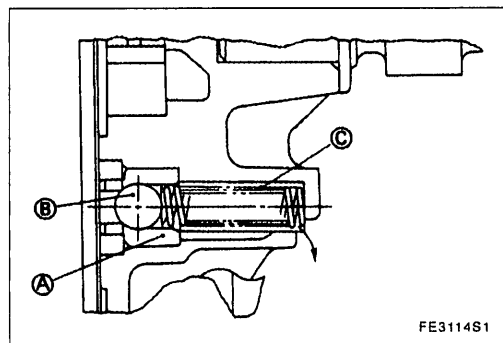


- Inspect the relief valve and the valve seat contact area, and repair or replace it with a new one if any abnormal condition is present.
- Using a vernier caliper, measure the free length of the relief spring.

Relief Spring Free Length (maximum) - for FE290, 350, 400
Service Limit: 19.0 mm (0.75 in)

- ★ If the measured value is smaller than the service limit, replace the spring.

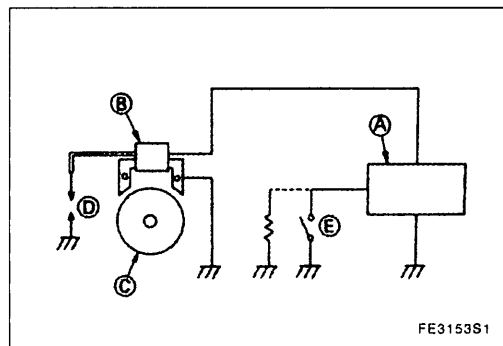
- A: Valve Seat
- B: Relief Valve
- C: Spring



Oil Level Warning Device

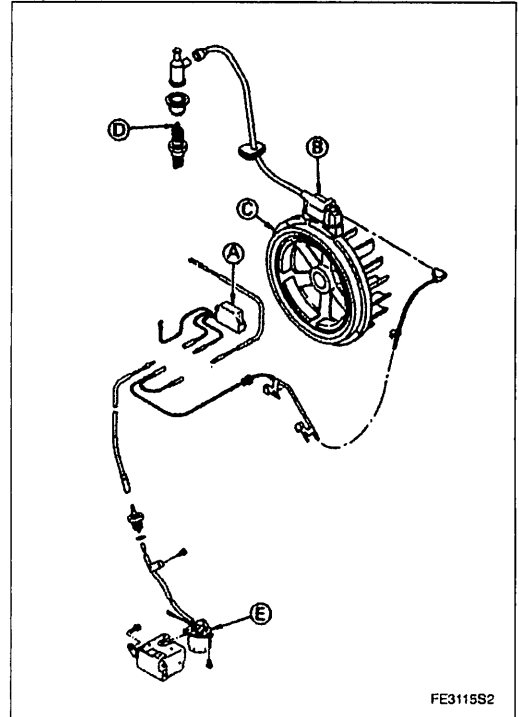
The oil level warning device is incorporated in the electronic ignition circuit. It consists of the following parts:

- A: Igniter (LED: with oil warning light) (separate type)
Controller (LED: with oil warning light) (intergrated type)
- B: Ignitioi Coil
- C: Flywheel
- D: Ignition Plug
- E: Oil Level Sensor Switch



3-50 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Lubrication System



FE3115S2

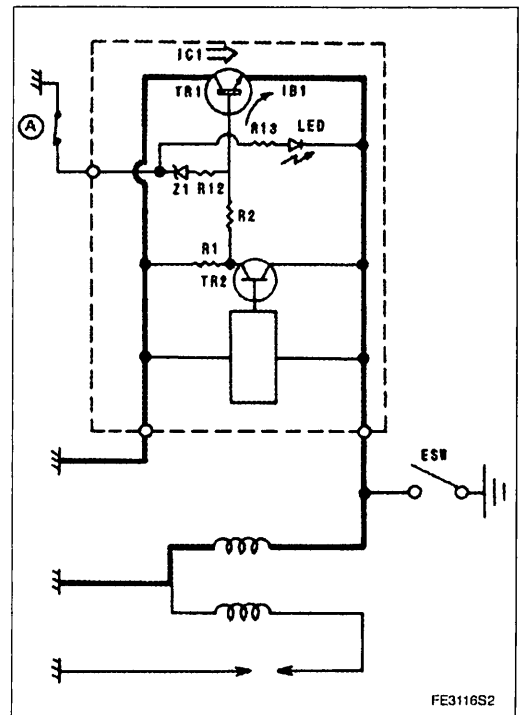
Oil Level Sensor Switch

If the oil level becomes lower than the preset value, the sensor switch [A] closes. As a result, the base current [IB1] passes through the Zener diode [Z1] and the resistor [R12] to flow to [TR1] to maintain the circuit.

The base current [IB1] is held by the amplified collector current [IC1], and as a result, the spark current does not generate, causing the engine to stop. (Refer to the section on Ignition System for comparison.)

A: Oil Level Sensor Switch

ESW: Engine Switch



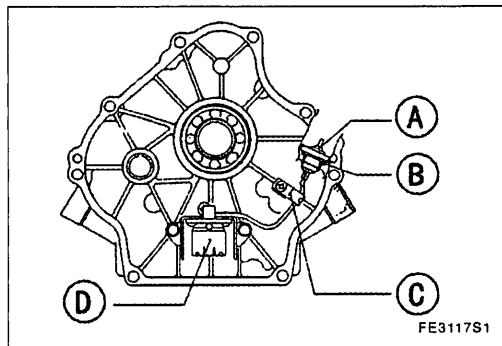
FE3116S2

Inspection method

- Verify that the oil level of the engine is normal.
- Disconnect the wire from the oil level sensor terminal.
- Set the measurement range of the tester to $R \times 1 \Omega$ and connect one of the tester leads to the terminal of the sensor and the other end to ground. The tester should read ∞ .
- ★ If the tester does not read ∞ , the oil level sensor switch is faulty.
- Gently lift the PTO side to tilt the engine.

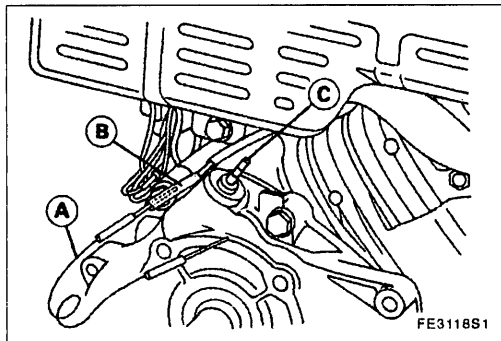
Lubrication System

- When the engine is tilted to a certain angle, the tester should read 0 Ω .
- ★ If the tester does not read 0 Ω , but remains at ∞ , the oil level sensor switch is faulty.
 - A: Terminal
 - B: O-ring
 - C: Clamp
 - D: Oil Level Sensor Switch



Igniter (with oil level warning light) Inspection (separate type)

- Verify that the oil level in the engine is normal.
- Disconnect the wire from the oil level sensor terminal.
- Start the engine and operate it at a low speed.
- Connect one of the test leads to the wire that was disconnected in step 2 above, and the other end to the engine ground to stop the engine.
- ★ If the engine does not stop, inspect the wires and connections.
- ★ If the wires and connections are normal, the igniter (with oil level warning light) is faulty and must be replaced.
- Connect the test leads in the same way as in step 4 above and start the engine again.
- ★ If the oil level warning light illuminates and the engine does not start, the system is normal.
- ★ If the oil level warning light does not illuminate, the oil level warning light (LED) is faulty and the igniter must be replaced.
 - A: Test Lead
 - B: Connection
 - C: Oil Level Sensor Terminal



Controller (with oil level warning light) inspection (integrated type)

- Verify that the oil level in the engine is normal.
- Disconnect the wire from the oil level sensor terminal.
- Start the engine and operate it at a low speed.
- Connect one of the test leads to the wire that was disconnected in step 2 above, and the other end to the engine ground to stop the engine.
- ★ If the engine does not stop, inspect the wires and connections.
- ★ If the wires and connections are normal, the controller (with oil level warning light) is faulty and must be replaced.
- Connect the test leads in the same way as in step 4 above and start the engine again.
- ★ If the oil level warning light illuminates and the engine does not start, the system is normal.
- ★ If the oil level warning light does not illuminate, the oil level warning light (LED) is faulty and the controller must be replaced.

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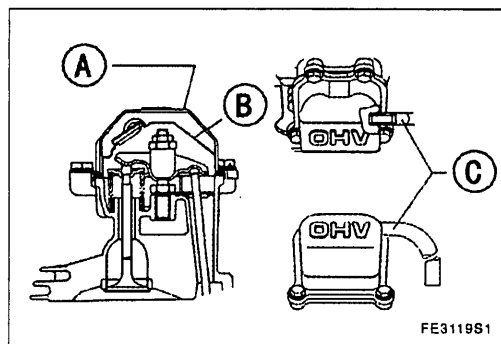
Lubrication System

Breather

The function of the breather is to maintain a vacuum in the crankcase to prevent the engine oil from being discharged outside the engine.

The breather valve regulates the flow of the air that is created by the movement of the piston by allowing the air to flow from the inside of the crankcase to the outside, while preventing the air from the outside of the crankcase to enter inside.

In the rocker case, the maze and the volumetric expansion of the rocker case causes the air containing oil to separate into oil and air. The air from the crankcase ultimately flows to the air cleaner and mixes with the intake air.

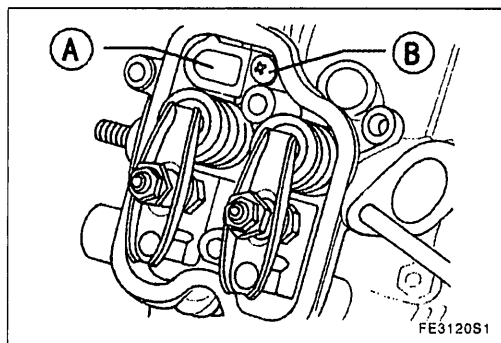


Inspection Method

- With the rocker case installed in place, blow air or apply suction to the breather pipe in order to activate the breather valve. Verify that the breather valve closes when air is blown into the pipe.
- Remove the retaining screws from the breather valve, and inspect the valve and valve seat for the presence of damage, cracks, or wear.
- Using a gap gauge, measure the clearance between the breather valve and valve seat.

A: Rocker Case
B: Breather
C: Oil Level Sensor Terminal

A: Breather Valve
B: Retaining Screw

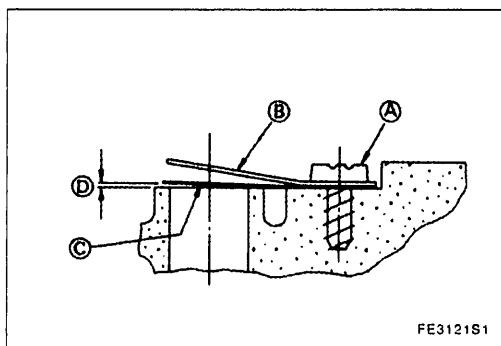


Breather Valve Air Gap (maximum)

Service Limit: 0.2 mm (0.008 in)

- ★ If the air gap is greater than the service limit or if the breather valve is defective, replace the breather valve with a new one.

A: Retaining Screw
B: Backing Plate
C: Breather Valve
D: Air Gap



Air Filter (cartridge type)

With the cartridge type oil filter, the engine oil change interval can be extended to 100 hours. (The engine oil must be changed every 50 hours in an engine without the cartridge type filter.)

Ordinarily, the engine oil flows in the following order: entrance [A] → element [B] → exit [C].

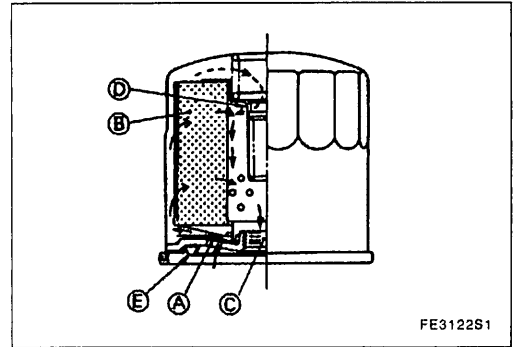
If the element becomes clogged, the oil flows through the bypass [D], thus preventing the engine from operating without oil, although the filtering function is bypassed.

Lubrication System

Oil Filter Replacement Procedure

NOTE

- *Be careful with hot oil to prevent burns.*
- *Always use a genuine Kawasaki oil filter for replacement. Other brands of oil filters may also fit but they may be of poor quality.*
- Drain the engine oil into an appropriate container.
- Remove the oil filter by turning it counterclockwise.
- Apply oil to the seal [E] of the new oil filter.
- Turn the new oil filter clockwise until its seal [E] comes in contact with the mating surface. Then, turn the oil filter by hand an additional 3/4 turn.
- Pour in the specified amount of engine oil.
- Start the engine, operate it approximately 3 minutes, and then stop the engine. Inspect around the oil filter to make sure that there is no oil leak.
- The oil level decreases by an amount that is equivalent to the capacity of the oil filter. Replenish the oil to this amount.



3-54 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

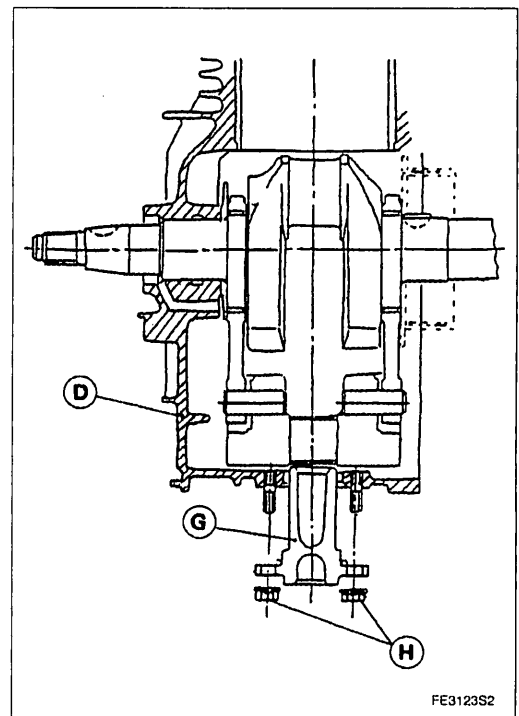
Crankshaft

Disassembly

- Remove the crankcase cover.
- If axial play adjustment shims are provided for the crankshaft and the camshaft, remove the shims and identify them so that they can be installed correctly during reassembly.
- Place the cylinder block on a base so that the flywheel side faces down. Keep the tappet (or the HLA on FE350 or 400) pushed up towards the cylinder head.
- After aligning the matching marks on the crankshaft gear and the camshaft gear, take out the camshaft.
- Remove the tappet (or the HLA on FE350 or 400) from the crankcase and place an identification mark on it so that the tappet can be reinstalled in its original position.
- ★ After taking out the HLA of the FE350 or 400, keep the side in which the snap ring is visible upright. If it is placed on its side or upside down, the oil that is sealed in the HLA unit could leak out, disabling the HLA function.
- On the FE250, 290, 350, or 400 engine, remove the retaining nuts [H] from the balancer guide [G], and pull out the balancer guide from the crankcase [D].
- Remove the connecting rod bolts and the connecting rod cap.
- Remove the crankshaft from the crankcase. If it is equipped with a balancer, take out the complete crankshaft assembly as is from the crankcase.

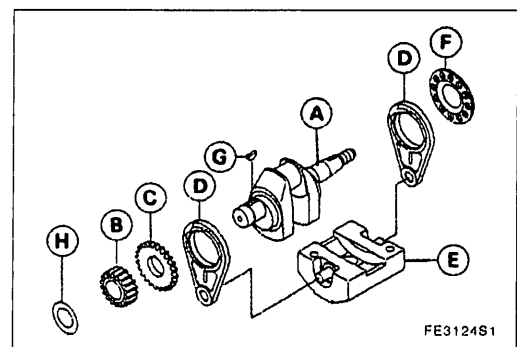
NOTE

- Be careful not to damage the oil seal.



- A: Crankshaft
- B: Crankshaft Gear
- C: Governor Drive Gear
- D: Balancer Link Rod
- E: Balancer Weight
- F: Spacer
- G: Key
- H: Shim

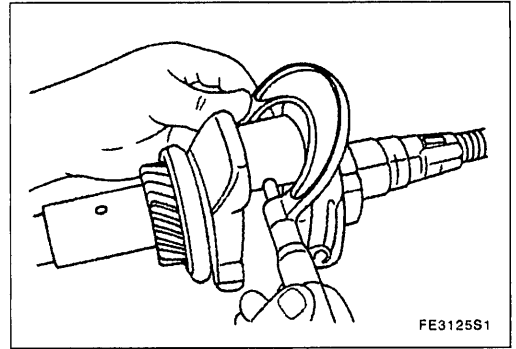
On Type G, however, the link rod on the crankshaft gear side cannot be disassembled because the crankshaft gear is pressed in.



Crankshaft

Crankshaft Inspection

- Inspect the crank pin and the journal for galling, wear, or rust.
- ★ If the crank pin exhibits damage as described above, carefully inspect and repair the big end of the connecting rod, or replace the connecting rod or the crankshaft with a new part.
- Inspect the crankshaft gear for abnormal wear or damaged teeth.
- ★ If the crankshaft gear is worn as described above, replace the crankshaft gear with a new one.
- Using a micrometer, measure the diameter of both journals of the crankshaft, the diameter of the journal for the balancer link rod, and the diameter of the crank pin in several places.
- ★ If the measured value is smaller than the service limit given below, replace the crankshaft with a new one.



Crankshaft Journal Diameter Service Limit (minimum)

(unit: mm)

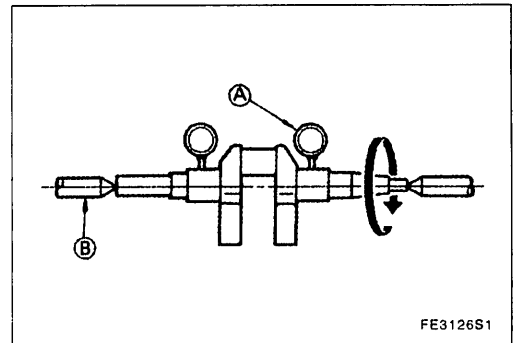
		FE120	FE170	FE250	FE290	FE350, 400
Journal Diameter	TPO Side	19.930 (0.7846 in)	24.930 (0.9815)	29.930 (1.1783 in)	29.930 (1.1783 in)	34.930 (1.3752 in)
	Flywheel Side	19.930 (0.7846 in)	24.930 (0.9815)	29.930 (1.1783 in)	29.930 (1.1783 in)	34.930 (1.3752 in)
	Balancer Link Rod Journal	—	—	46.924 (1.8474 in)	46.924 (1.8474 in)	49.924 (1.9655 in)
Crankpin Diameter		25.944 (1.0214 in)	28.944 (1.1395 in)	33.944 (1.3394 in)	35.444 (1.3954 in)	37.444 (1.4742 in)

- Using center support tools [B] as shown in the diagram, support both ends of the crankshaft. Place a dial gauge [A] on the journal and slowly turn the crankshaft to measure the fluctuation (the variance between the maximum and minimum values) of the dial gauge, which is the runout of the crankshaft.

Crankshaft Runout Service Limit (maximum)

Service Limit: 0.5 mm (0.02 in) (TIR)

- ★ If the measured value is greater than the service limit, replace the crankshaft with a new one.

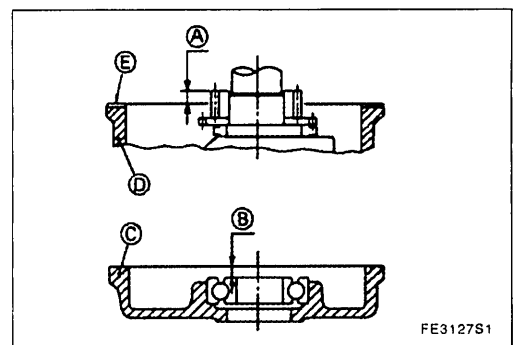


Crankshaft Axial Play Adjustment

If a part that affects the axial play has been replaced, the axial play must be adjusted as described below. Shim adjustment is not available on the FE120 and 170. Note: Except the FE170 for pump application.

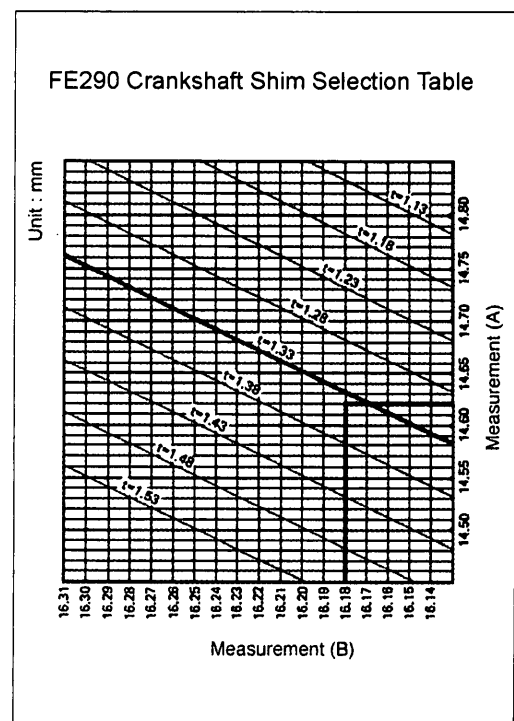
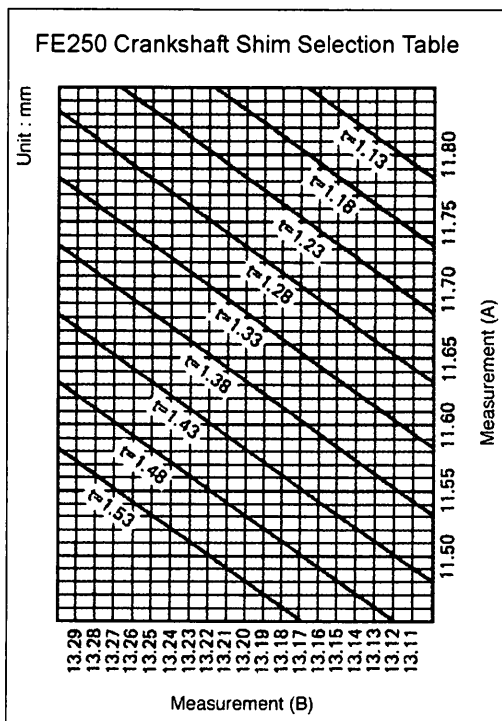
- Place a gasket on the crankcase and measure and record the distance from the gasket surface to the crankshaft gear surface (measurement A).
- Measure and record the distance from the crankcase cover mating surface to the end face of the crankshaft bearing inner race (measurement B).
- Place these measurements on the crankshaft shim selection table, and trace the respective line.
- Select the next thinner shim that appears on the shim selection table.
- ★ For example, on the FE290, if measurement [A] is 14.62 mm (0.576 in) and measurement [B] is 16.18 mm (0.637 in), the correct shim thickness is $t = 1.33$ mm.

- A: Measurement [A]
- B: Measurement [B]
- C: Crankcase Cover
- D: Crankcase
- E: Gasket



3-56 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

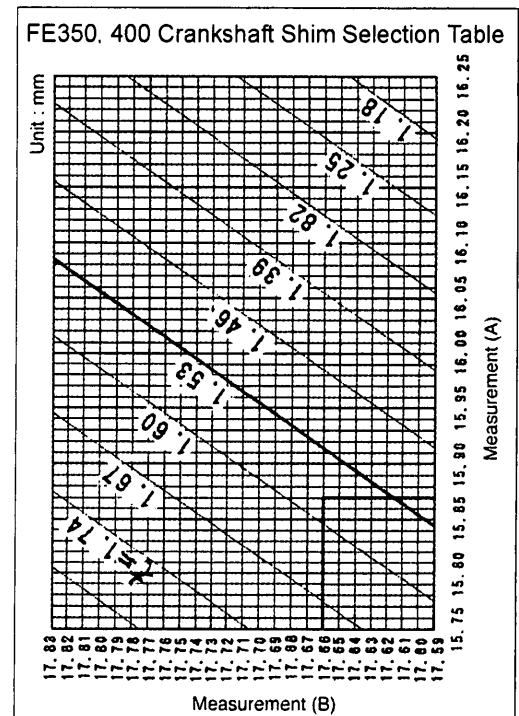
Crankshaft



★ For example, on the FE350, if measurement [A] is 15.87 mm and measurement [B] is 17.66 mm, the correct shim thickness is $t = 1.53$ mm.

Crankshaft Axial Play Standard and Service Limit (maximum) (unit: mm)

	Standard	Service Limit
FE120	0 ~ 0.24 (0 ~ 0.009 in)	0.5 (0.0197 in)
FE170	0.03 ~ 0.30 (0.0011 ~ 0.0118 in)	0.5 (0.0197 in)
FE250	0.05 ~ 0.17 (0.0020 ~ 0.0067 in)	0.35 (0.0138 in)
FE290	0.09 ~ 0.20 (0.0035 ~ 0.0079 in)	0.35 (0.0138 in)
FE350, 400	0.08 ~ 0.22 (0.0031 ~ 0.0087 in)	0.35 (0.0138 in)



Reassembly

The reassembly is the reverse order of disassembly.

- Clean the mating surfaces of the crankcase and the crankcase cover of any residues and install a new gasket.
- Apply high-temperature grease to the lip of the crankcase oil seal. (Refer to the section on Oil Seal.) Apply oil to the journals of each part.
- On the FE221 ~ 400 with a reciprocal movement balancer, install the reciprocal movement balancer parts on the crankshaft. (Refer to the section on Balancer.)
- Install the crankshaft in the crankcase, making sure not to damage the oil seal lip with the key groove at the tapered area of the crankshaft.

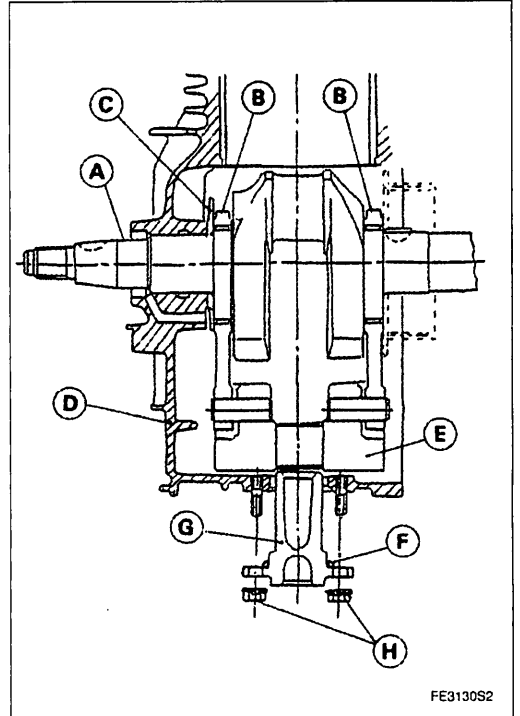
DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-57

Balancer

Engine vibration is generated primarily by the inertia that is created through the reciprocal movement mass such as the piston, piston pin, piston ring, and the small end of the connecting rod.

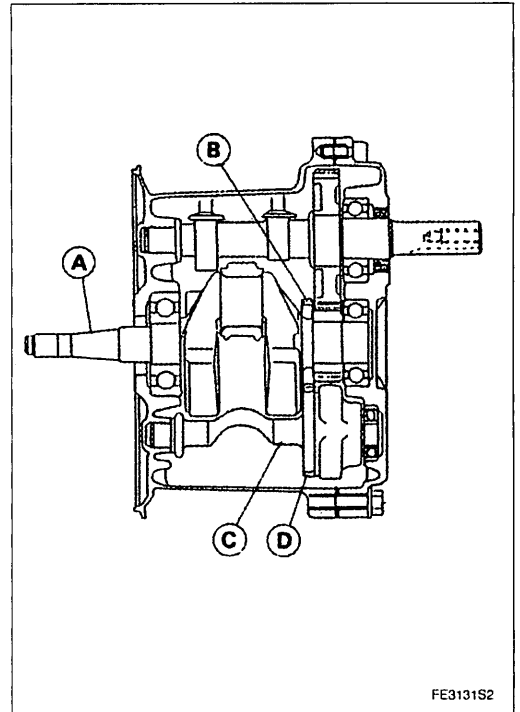
On the FE400, 350, 290, and 250, a reciprocal movement balancer system in which balance weight is linked to the crankshaft has been adopted. This is the most effective method for canceling the inertia that is generated by the reciprocal movement mass, thus reducing vibration.

- A: Crankshaft
- B: Link Rod
- C: Spacer
- D: Crankcase
- E: Balance Weight
- F: O-ring
- G: Balancer Guide
- H: Nut



★The FE170 can be provided with a uniaxial rotation balancer as a factory option.

- A: Crankshaft
- B: Balancer Drive Gear
- C: Balancer Shaft
- D: Balancer Gear



3-58 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Balancer

Reciprocal Movement Balancer (FE400, 350, 290, 250)

Disassembly

- Remove the retaining nuts from the balancer guide and pull out the balancer guide from the crankcase.
- Remove the connecting rod bolt and remove the connecting rod cap.
- Turn the crankshaft to be near the top-dead-center to push the connecting rod up. Then, turn the crankshaft 90° counterclockwise as viewed from the PTO side. Remove the crankshaft (together with the balancer) from the crankcase, through an area in which it does not interfere with the connecting rod.

NOTE

- Be careful not to damage the oil seal when removing the crankshaft.
- Remove the balancer link rod from the crankshaft.

NOTE

- The balancer link rod on the PTO side cannot be disassembled because the crankshaft gear is pressed in.

Inspection and Repair

- Using a micrometer, measure the bearing bore of the big and small ends of the link rod in several places.

Link Rod Bearing Bore Service Limit (maximum) (Unit: mm)

	Small End Bore	Big End Bore
FE250	12.057 (0.4747 in)	47.106 (1.855 in)
FE290	12.064 (0.4750 in)	47.126 (1.855 in)
FE350, 400	12.057 (0.4747 in)	50.106 (1.973 in)

A: Link Rod Big End Bearing Bore

B: Small End Bearing Bore

- ★ If the measured value is greater than the service limit, replace the link rod. On the FE290, the bushing can be replaced.

- ★ Replace the link rod bushing as follows:

- Support the big end of the link rod as described in the diagram, and use a driver to pull the bushing out.

A: Bushing Driver

B: Bushing

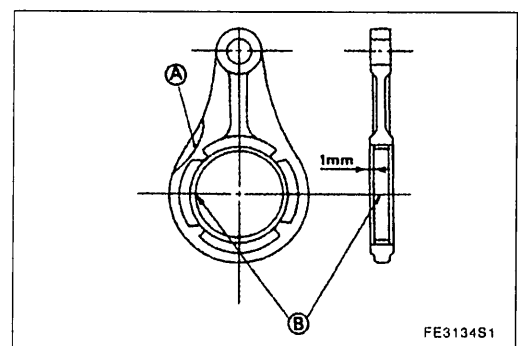
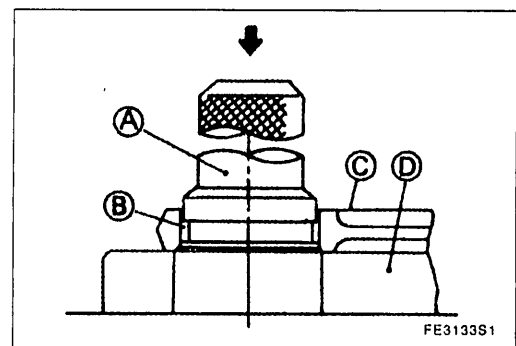
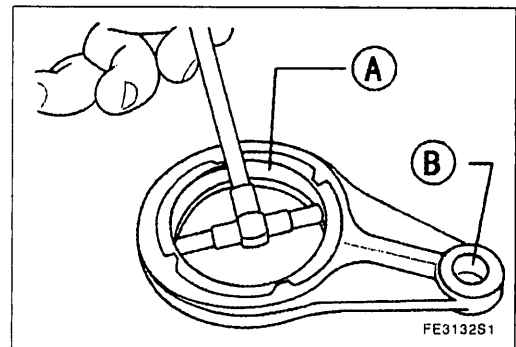
C: Link Rod

D: Tool Base

- Wash the disassembled parts and allow them to dry.
- Apply engine oil to the new bushing.
- Using a bushing driver, install the bushing so that the gap of the bushing is positioned as shown in the diagram. Drive the bushing so that it is 1mm deeper than the end face of the link rod.

A: Depression

B: Bushing Gap



DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-59

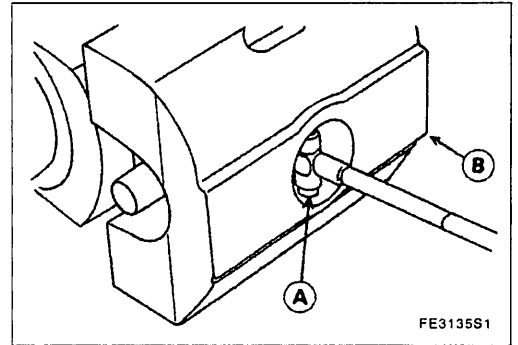
Balancer

- Using a micrometer, measure the balancer guide hole bore of the balance weight in several places.

Balancer Guide Hole Bore Service Limit (maximum)

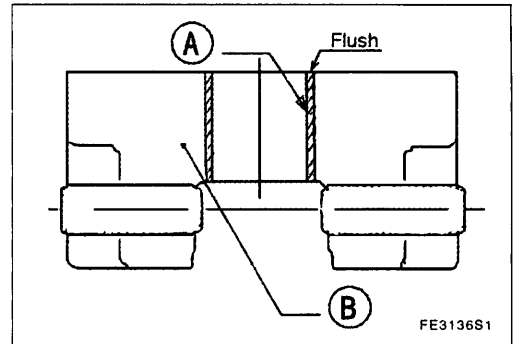
FE250, 290:	26.118 mm (1.0283 in)
FE350, 400:	26.097 mm (1.0274 in)

- ★ If the measured value is greater than the service limit, replace the balance weight. On the FE350 and 400, the bushing can be replaced.
A: Guide Hole
B: Balance Weight



NOTE

- To install a new bushing, drive it in so that the end face of the bushing is flush with the end face of the balance weight as shown in the diagram on the right.
A: Bushing
B: Balance Weight

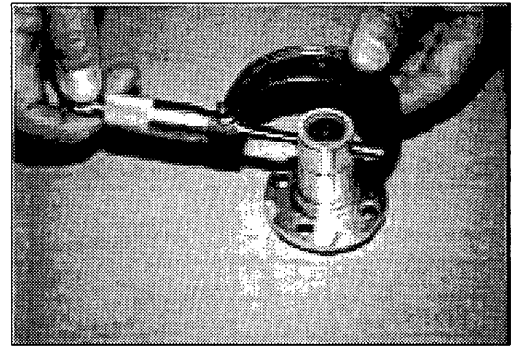


- Using a micrometer, measure the diameter of the balancer guide in several places.

Balancer Guide Diameter Service Limit (minimum)

FE250, 290, 350, 400:	25.907 mm (1.0593 in)
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- ★ If the measured value is smaller than the service limit, replace the balancer guide with a new one.

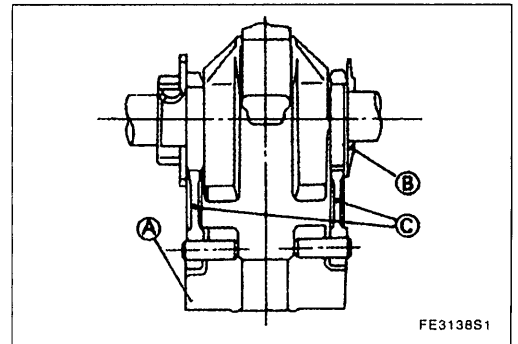


Reassembly

- Make sure to apply fresh engine oil to the sliding and rotating areas.
2. Install the balancer on the crankshaft in the following order:
Balance weight → link rod → spacer

NOTE

- Install the spacer with its chamfered end facing the link rod.
A Balancer Weight
B: Spacer
C: Link Rod



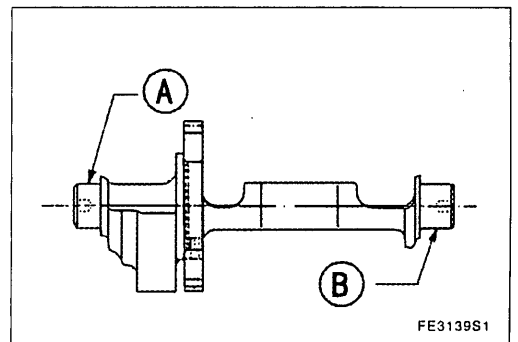
Uniaxial Rotation Balancer (FE170)

Disassembly

- Remove the crankcase cover and align the matching marks on the balance drive gear of the crankshaft and the balance gear.
- Take out the balancer shaft from the crankcase.

Inspection

- Inspect the balancer gear for wear or broken teeth.
- ★ If the gear is excessively worn, replace the balancer shaft.
- Using a micrometer, measure the diameter of the balancer journal in several places.



3-60 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Balancer

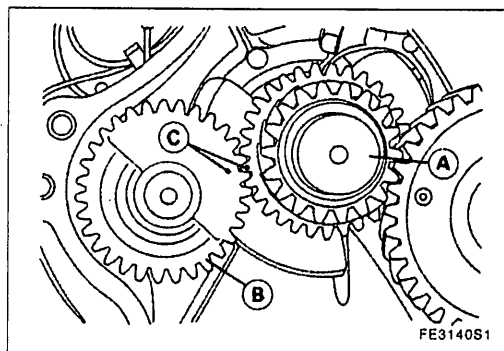
Balancer Shaft Journal Diameter Service Limit (minimum)

	PTO Side	Flywheel Side
FE170:	14.943 mm (0.5883 in)	14.933 mm (0.5879 in)

★ If the measured value is smaller than the service limit, replace the balancer shaft.

★* For details on the bore of the balancer shaft bearing hole, refer to the section on Crankcase/Plain Bearing.

- A: Crankshaft
- B: Balancer Gear
- C: Matching Mark



Reassembly

- Install the balancer shaft in the crankcase by aligning the matching mark on the balancer gear with the matching mark on the balancer drive gear of the crankshaft.

DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-61

Camshaft

Disassembly

- Remove the crankcase cover.
- If axial play adjustment shims are provided for the crankshaft and the camshaft, remove the shims and identify them so that they can be installed correctly during reassembly.
- Place the cylinder block on a base so that the flywheel side faces down. Keep the tappet (or the HLA on FE350 or 400) pushed up towards the cylinder head.
- After aligning the matching marks on the crankshaft gear and the camshaft gear, take out the camshaft.

NOTE

- Clean the mating surfaces of the crankcase and the crankcase cover of any gasket residues.
- Take out the tappet or the HLA from the crankcase.

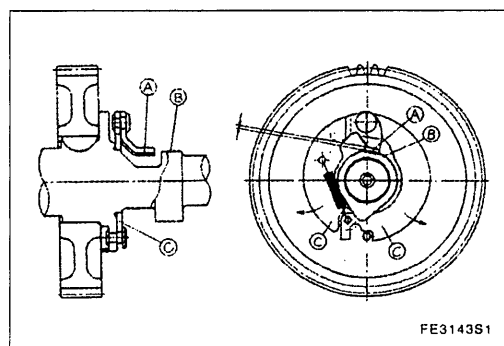
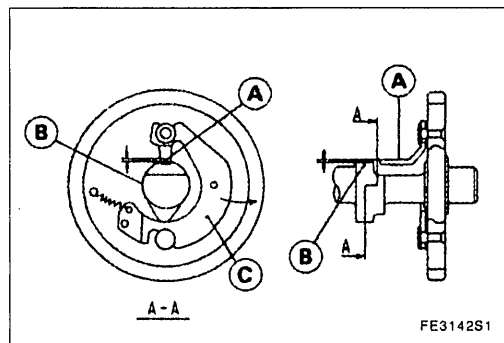
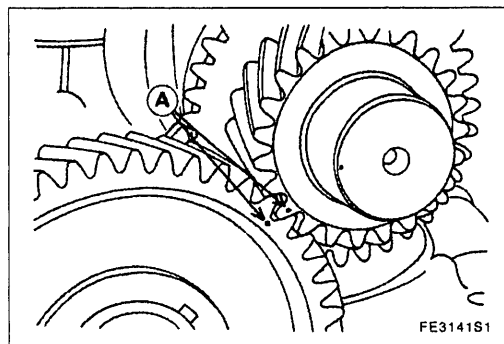
NOTE

- After removing the tappet, place marks on them to identify the intake and exhaust tappets so that they can be reinstalled in their original positions.
- Keep the end of the HLA in which the snap ring is visible upright. If it is placed on its side, the oil that is sealed in the unit could leak out, disabling the HLA function.

A: Matching Marks

Inspection

- Inspect the camshaft and cam gear for any broken teeth or wear.
- ★ If they are abnormally worn or have broken teeth, replace the camshaft with a new one.
- Inspect the camshaft to make sure that its automatic compression Reduction (ACR) function operates smoothly and does not have any damage or abnormal wear.
- ★ When the weight [C] is closed, if the top of the arm [A] is lower than the base [B], replace the ACR with a new one.
- ★ When the weight [C] is pulled entirely outward with your finger, if the top of the arm [A] is higher than the cam base [B], replace the ACR with a new one.
- ★ If ACR parts are worn, replace the ACR with a new one.



3-62 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Camshaft

- Using a micrometer, measure the camshaft journal in several places.

Camshaft Journal Diameter Service Limit (minimum) (Unit: mm)

	PTO Side		Flywheel Side
	Type D	Type G	Type D, G
FE120	14.910 (0.5870 in)	19.930 (0.7846 in)	14.910 (0.5870 in)
FE170	15.910 (0.6264 in)	24.930 (0.9815 in)	15.910 (0.6264 in)
FE250	19.927 (0.7845 in)	29.930 (1.1783 in)	22.927 (0.9026)
FE290	22.927 (0.9026 in)	29.930 (1.783 in)	22.927 (0.9026 in)
FE350, 400	22.927 (0.9026 in)	34.930 (1.3752 in)	22.927 (0.9026 in)

- ★ If the measured value is smaller than the service limit, replace the camshaft with a new one.

- Using a vernier caliper, measure the overall height of the cam of the camshaft.

Cam Overall Height Service Limit (minimum) - for Intake and Exhaust

FE120:	26.157 mm (1.0298 in)
FE170:	30.024 mm (1.1820 in)
FE250:	31.04 mm (1.2220 in)
FE290:	32.70 mm (1.2874 in)
FE350, 400:	33.24 mm (1.3087 in)

- ★ If the measured value is smaller than the service limit, replace the camshaft with a new one.

Reassembly

- Make sure to reinstall the camshaft with the oil pump removed.

CAUTION

If the camshaft is reinstalled with the oil pump attached to it, it will cause serious damage to the engine.

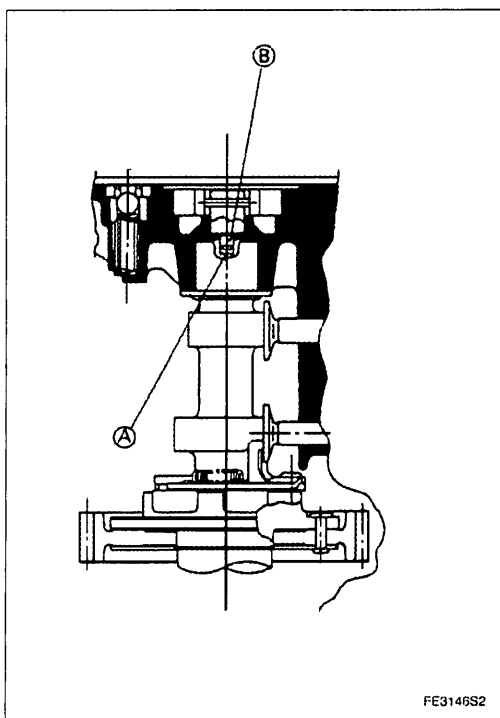
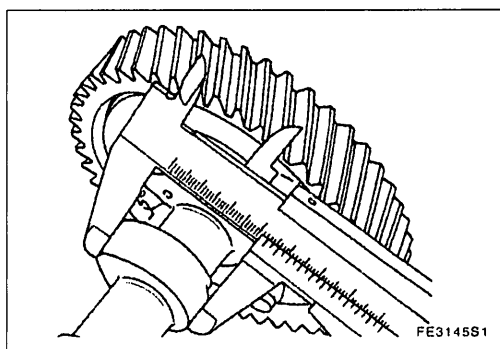
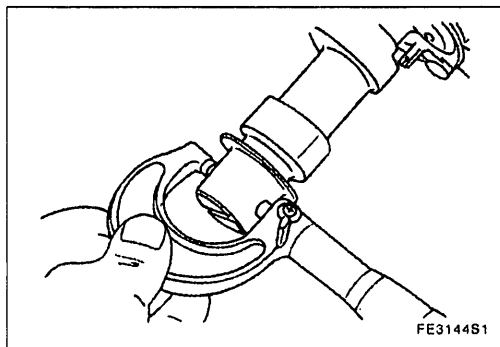
- Place the cylinder block on a base with the flywheel side facing down.
- Reinstall the tappets or the HLAs in their original positions in accordance with the intake and exhaust identification marks. Push the tappets or the HLAs all the way against the cylinder head so that they will not obstruct the installation of the camshaft.
- With the matching marks of the crankshaft gear and the camshaft gear aligned, install the camshaft in the crankcase.

NOTE

- On the FE290, FE350, and FE400, verify that the tab [B] of the oil pump is securely fitted into the groove [A] at the end of the camshaft.

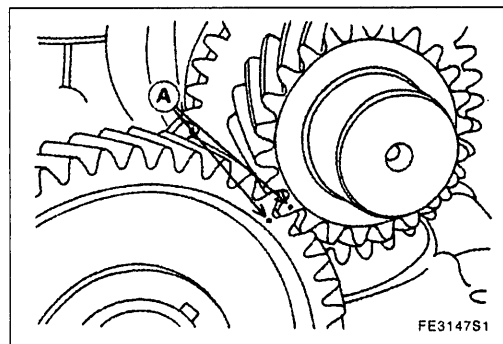
A: Groove at end of camshaft

B: Oil Pump Tab



Camshaft

A: Matching Marks



Camshaft Axial Play Adjustment

If a part that affects the axial play has been replaced, the axial play must be adjusted as described below.

Shim adjustment is not available on the FE120 and 170.

- Place a gasket on the crankcase and measure and record the distance from the gasket surface to the crankshaft gear surface (measurement A).

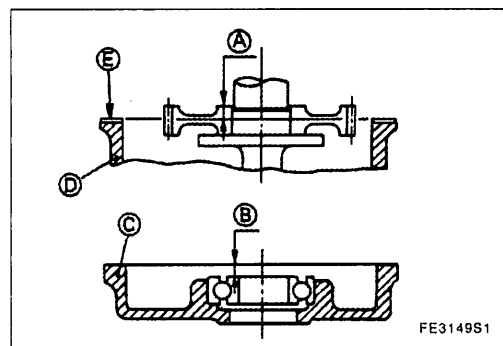
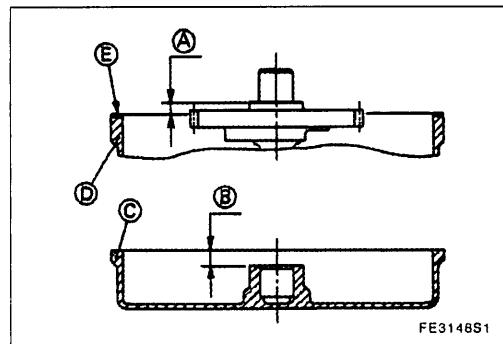
A: Measurement [A]

B: Measurement [B]

C: Crankcase Cover

D: Crankcase

E: Gasket



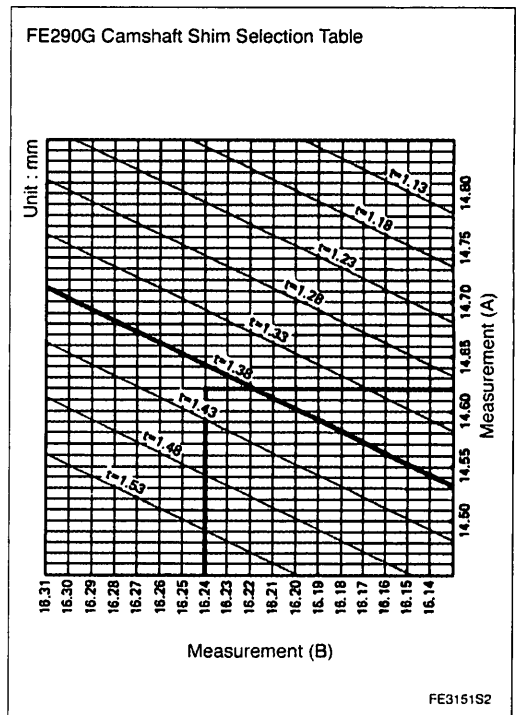
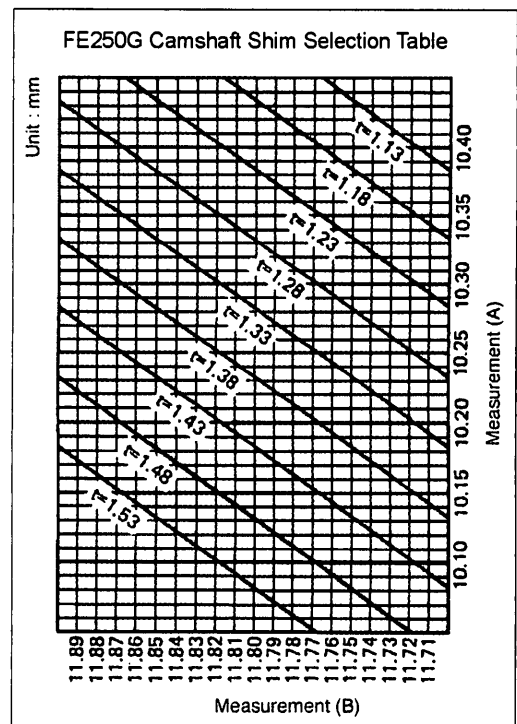
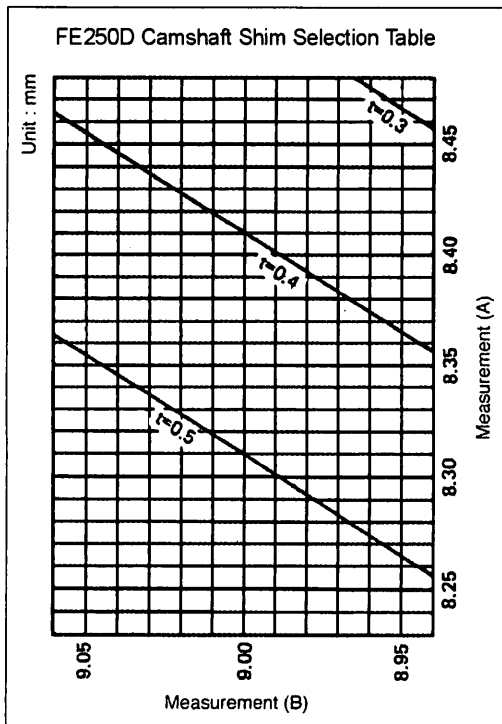
- Measure and record the distance from the crankcase cover mating surface to the end face of the crankshaft bearing inner race (measurement B).
- Apply these measurements on the crankshaft shim selection table, and trace the respective line.
- Select the next thinner shim that appears on the shim selection table.
- ★ For example, on the FE290, if measurement [A] is 14.62 mm and measurement [B] is 16.24 mm, the correct shim thickness is $t = 1.38$ mm.

NOTE

- The FE290D camshaft has no shim adjustment.

3-64 DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE

Camshaft



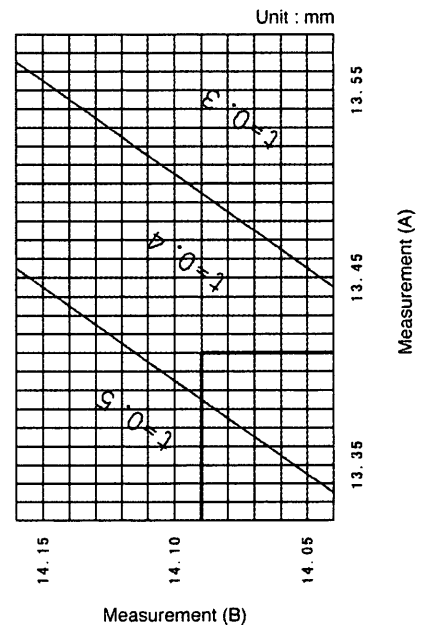
DISASSEMBLY, REASSEMBLY, INSPECTION, AND MAINTENANCE 3-65

Camshaft

Apply these measurements on the crankshaft shim selection table, and select the next thinner shim.

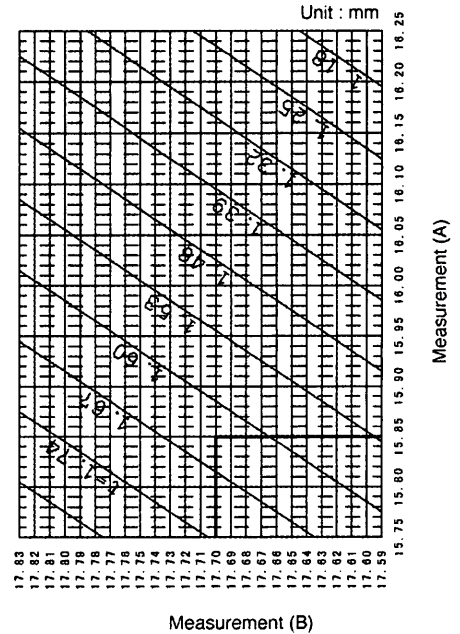
★ For example, on the FE350D, if measurement [A] is 13.41 mm and measurement [B] is 14.09 mm, the correct shim thickness is $t = 0.4$ mm.

FE350D, FE400D Camshaft Shim Selection Table



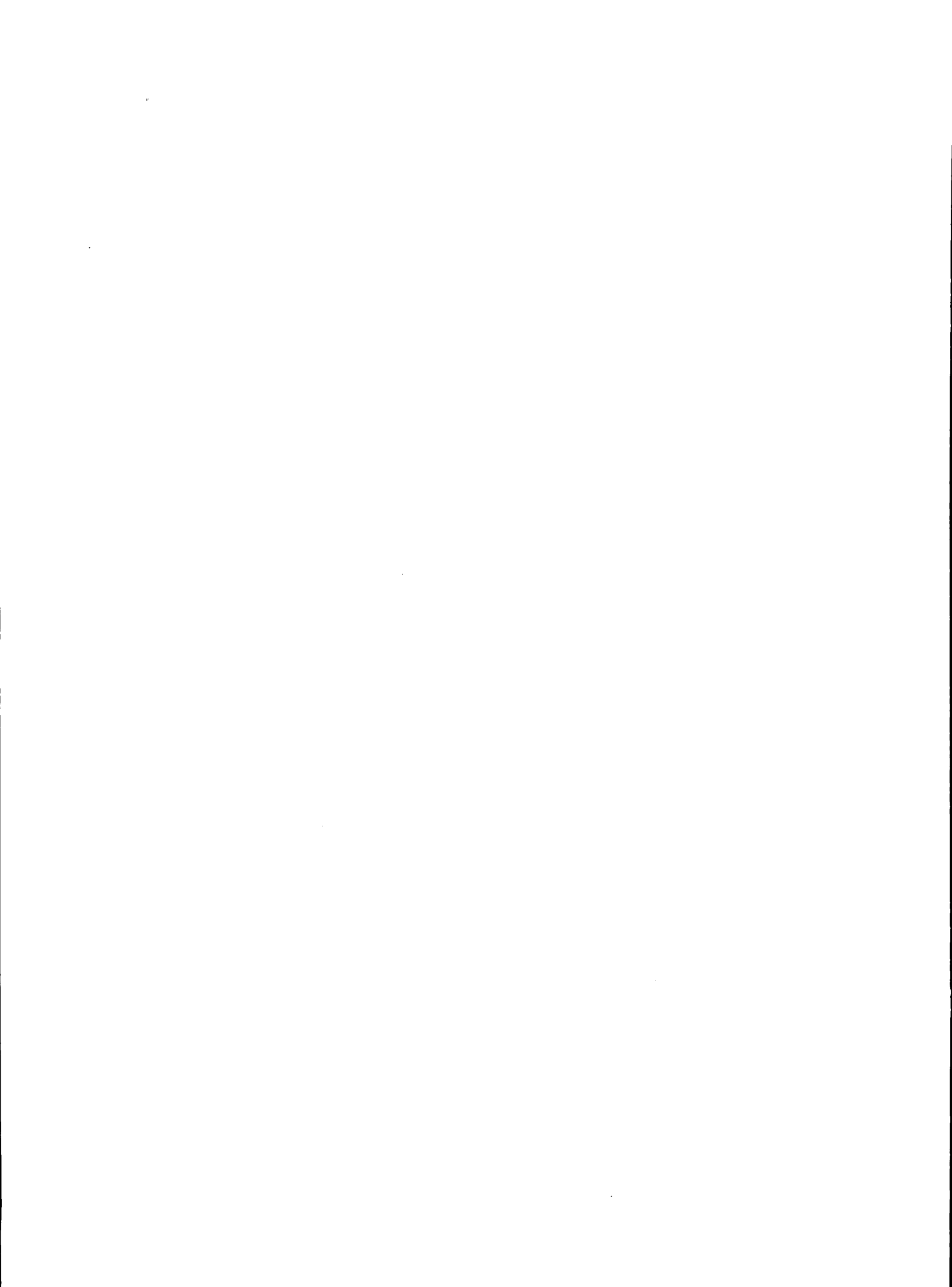
★ For example, on the FE350G, if measurement [A] is 15.85 mm and measurement [B] is 17.70 mm, the correct shim thickness is $t = 1.60$ mm.

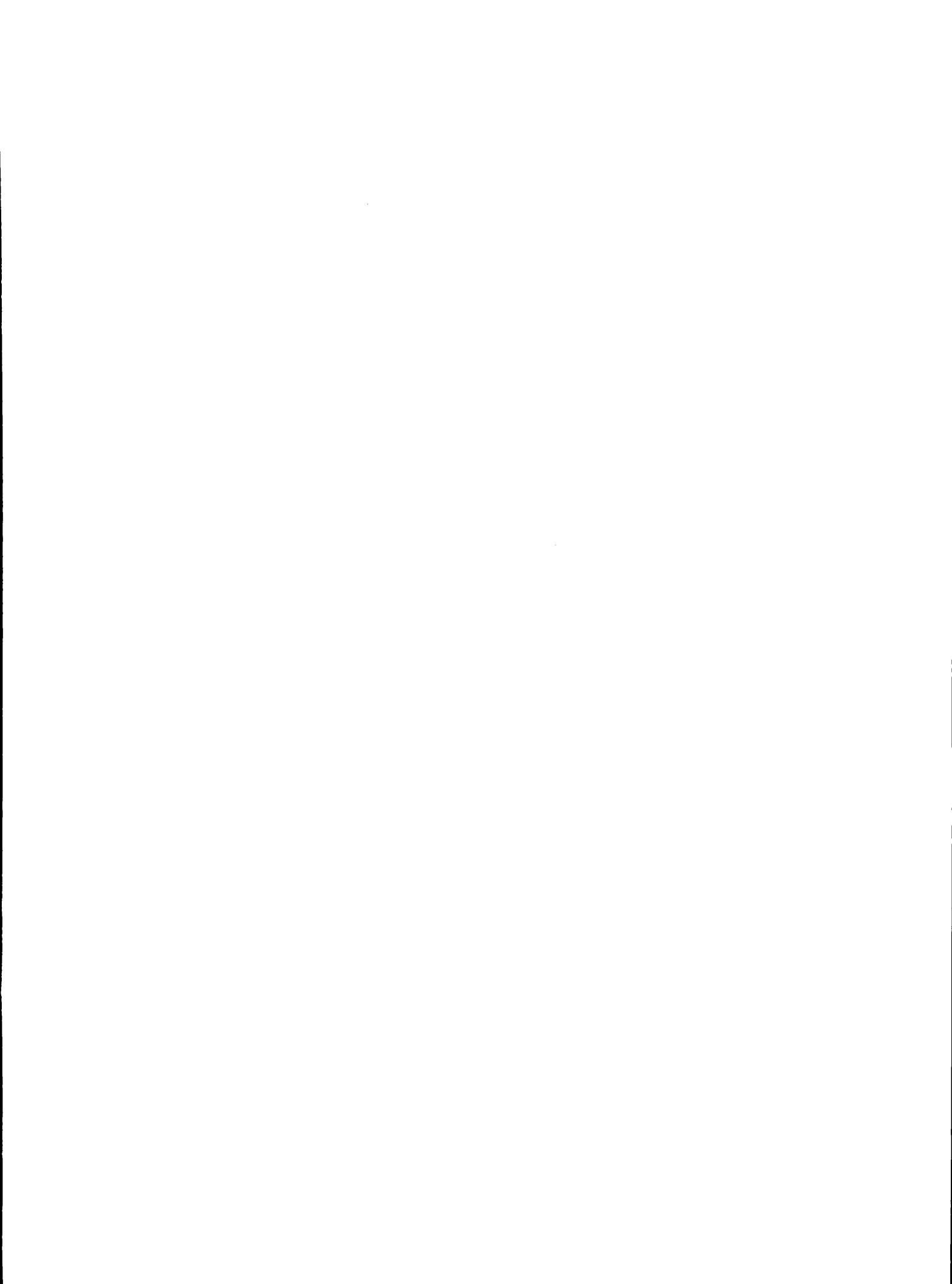
FE350G, FE400G Cam Shaft Shim Selection Table



Cam Shaft Axial Play Standard and Service Limit (maximum)
- for Type G (Unit: mm)

	Standard	Service Limit
FE120, 170	0.08 ~ 0.34 (0.0031 ~ 0.0134 in)	0.50 (0.0197 in)
FE250	0.05 ~ 0.17 (0.0020 ~ 0.0067 in)	0.35 (0.0138 in)
FE290, 350, 400	0.07 ~ 0.21 (0.0028 ~ 0.0083 in)	0.35 (0.0138 in)







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