WSM

WORKSHOP MANUAL
DIESEL ENGINE

03-M-DI-E4B SERIES,
03-M-E4BG SERIES

Kubota

KiSC issued 08, 2022 A

TO THE READER

This Workshop Manual tells the servicing personnel about the mechanism, servicing and maintenance of the 03-M-DI-E4B and 03-M-E4BG series. It contains 4 parts: **"Information"**, **"General"**, **"Mechanism"** and **"Servicing"**.

■ **Information**

This section contains information below.

- Safety First
- Specification
- Performance Curve
- Dimensions
- Wiring Diagram

■ **General**

This section contains information below.

- Engine Identification
- General Precautions
- Maintenance Check List
- Check and Maintenance
- Special Tools

■ **Mechanism**

This section contains information on the structure and the function of the unit. Before you continue with the subsequent sections, make sure that you read this section.

Refer to Workshop Manual (Code No. 9Y021-01870) for the diesel engine mechanism that this workshop manual does not include.

■ **Servicing**

This section contains information below.

- Troubleshooting
- Servicing Specifications
- Tightening Torques
- Checking, Disassembling and Servicing

All illustrations, photographs and specifications contained in this manual are of the newest information available at the time of publication.

KUBOTA reserves the right to change all information at any time without notice.

Since this manual includes many models, information or illustrations and photographs can show more than one model.

May 2013

Record of Revisions

For pdf, use search function {Search word} to find all the revised locations.

Last digit of the Code No.	Month of Revision	Main Revised Point and Corrective Measures {Search word}	Reference Page
1	May 2014	2. SPECIFICATION [1] MODEL NAME AND ENGINE SERIAL NUMBER and others	I-4 G-1 and others
2	July 2017	Corrected typo • Crank Pulley → Fan Drive Pulley • Oil sensor → Oil switch • Correction of instruction number	 G-37 1-S7 1-S44, 1-S60
3	August 2018	Added the information of stage V EU regulation • [2] E4B ENGINE Added the information of compression tester adaptor **K** • Compression Tester Adaptor **K** Added the information of oversize piston assembly • Cylinder Correction (Oversize)	 G-3 G-34 1-S83
4	April 2020	Revised due to design change • Tightening torque of fan drive pulley mounting nut	 1-S17 1-S50
5	June 2020	Added the information of glow lead mounting nut • Tightening torque of glow lead mounting nut	 1-S17
6	February 2021	Corrected the dimension of special tool	G-34
7	March 2022	Corrected the service specification of regulating voltage at no load Added the description to the table of top ring for D1503-M-E4BG Added the assembling and disassembling procedure of oil pump equipped gear case side Updated measuring fan belt tension	1-S34 1-S11 1-S76 1-S51 G-13 G-22 1-S22

I INFORMATION

INFORMATION

CONTENTS

1. SAFETY FIRST

⚠ SAFETY FIRST

- **This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.**
- **It is essential that you read the instructions and safety regulations before you try to repair or use this unit.**

⚠ DANGER
- **Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.**

⚠ WARNING
- **Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ CAUTION
- **Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.**

■ IMPORTANT
- **Indicates that equipment or property damage could result if instructions are not followed.**

■ NOTE
- **Gives helpful information.**

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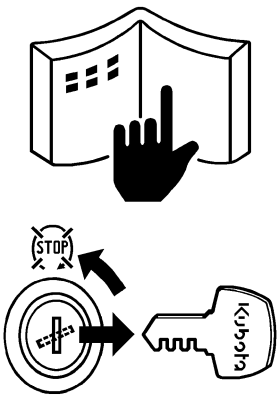

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BEFORE YOU START SERVICE

- Read all instructions and safety instructions in this manual and on your engine safety decals.
- Clean the work area and engine.
- Park the machine on a stable and level ground.
- Let the temperature of the engine decrease before you start a job.
- Stop the engine, then remove the key.
- Disconnect the battery negative cable.
- Hang a **"DO NOT OPERATE"** tag in the operator station.

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START SAFELY

- Do not do the procedures below when you start the engine.
  - short across starter terminals
  - bypass the safety start switch
- Do not make unauthorized modifications to the engine. This can cause damage and decrease the engine life.

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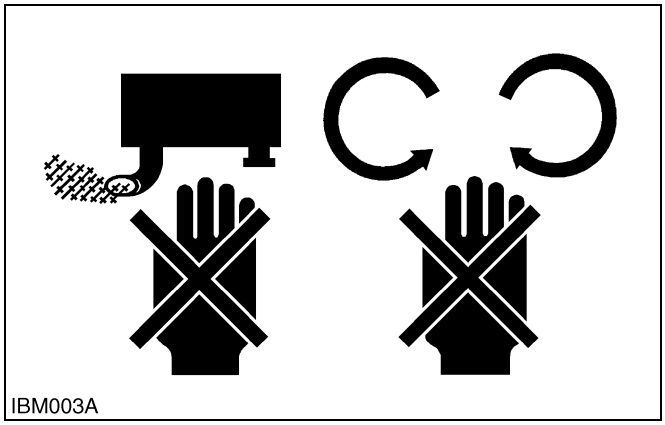
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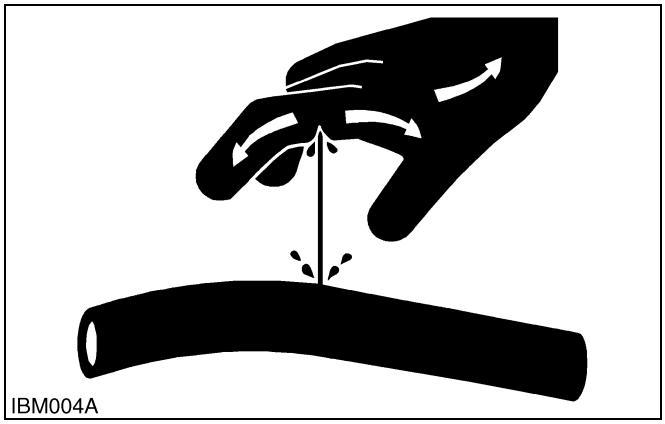
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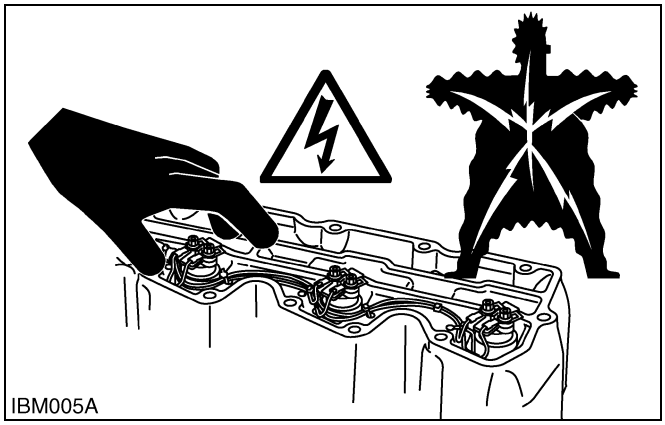
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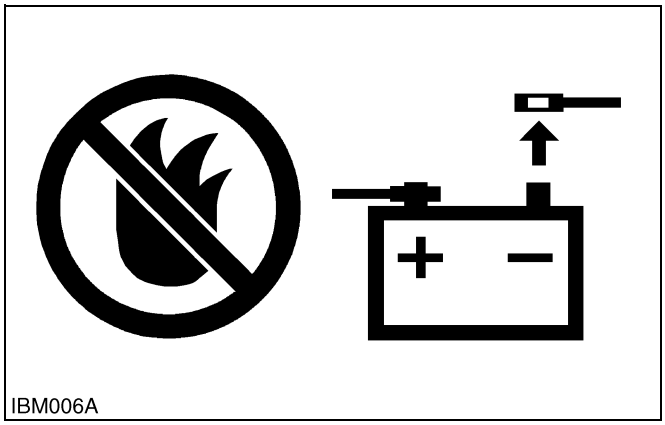
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OPERATE SAFELY

- Do not use the machine after you consume alcohol or medication or when you are tired.
- Put on applicable clothing and safety equipment.
- Use applicable tools only. Do not use alternative tools or parts.
- When 2 or more persons do servicing, make sure that you do it safely.
- Do not touch the hot parts or parts that turn when the engine operates.
- Do not remove the radiator cap when the engine operates, or immediately after it stops. If not, hot water can spout out from the radiator. Only remove the radiator cap when it is at a sufficiently low temperature to touch with bare hands. Slowly loosen the cap to release the pressure before you remove it fully.
- Released fluid (fuel or hydraulic oil) under pressure can cause damage to the skin and cause serious injury. Release the pressure before you disconnect hydraulic or fuel lines. Tighten all connections before you apply the pressure.
- Do not open a fuel system under high pressure. The fluid under high pressure that stays in fuel lines can cause serious injury. Do not disconnect or repair the fuel lines, sensors, or any other components between the fuel pump and injectors on engines with a common rail fuel system under high pressure.
- Put on an applicable ear protective device (earmuffs or earplugs) to prevent injury against loud noises.
- Be careful about electric shock. The engine generates a high voltage of more than DC100 V in the ECU and is applied to the injector.

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PREVENT A FIRE

- Fuel is very flammable and explosive under some conditions. Do not smoke or let flames or sparks in your work area.
- To prevent sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- The battery gas can cause an explosion. Keep the sparks and open flame away from the top of battery, especially when you charge the battery.
- Make sure that you do not spill fuel on the engine.

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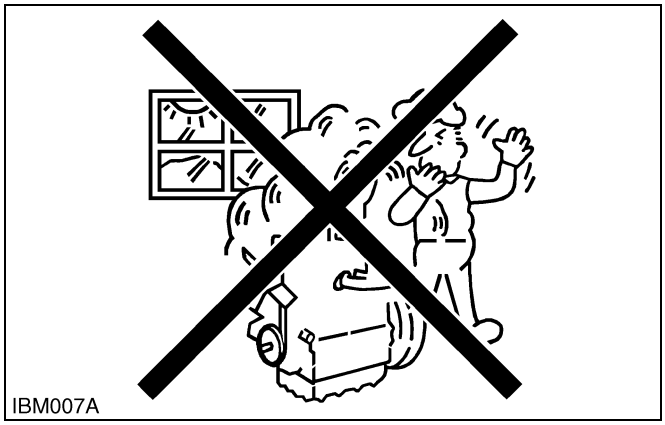
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KEEP A GOOD AIRFLOW IN THE WORK AREA

- If the engine is in operation, make sure that the area has good airflow. Do not operate the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

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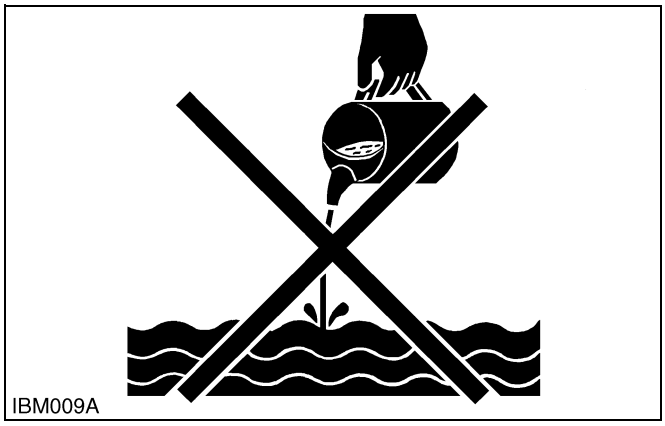
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DISCARD FLUIDS CORRECTLY

- Do not discard fluids on the ground, down the drain, into a stream, pond, or lake. Obey related environmental protection regulations when you discard oil, fuel, coolant, electrolyte and other dangerous waste.

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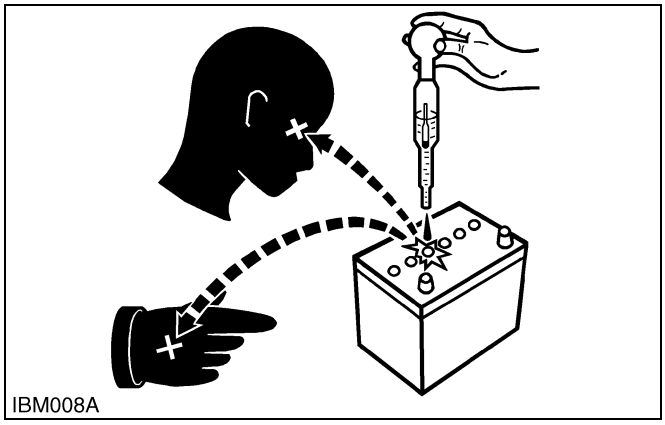
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PREVENT ACID BURNS

- Keep electrolyte away from your eyes, hands and clothing. Sulfuric acid in battery electrolyte is poisonous and it can burn your skin and clothing and cause blindness. If you spill electrolyte on yourself, clean yourself with water, and get medical aid immediately.

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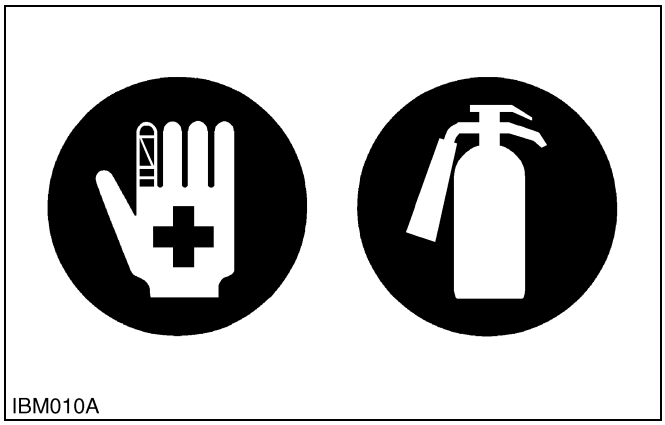
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PREPARE FOR EMERGENCIES

- Keep a first aid kit and fire extinguisher ready at all times.
- Keep the emergency contact telephone numbers near your telephone at all times.

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2. SPECIFICATION

Model		D1703-M-DI-E4B
Number of Cylinders		3
Type		Vertical, Water-cooled, 4 cycle diesel engine
Bore × Stroke		87.0 × 92.4 mm (3.43 × 3.64 in.)
Total Displacement		1647 cm^3 (100.5 cu.in.)
ISO Net Continuous		15.5 kW / 2200 min^{-1} (rpm) (20.8 HP / 2200 min^{-1} (rpm))
ISO/SAE Net Intermittent		17.8 kW / 2200 min^{-1} (rpm) (23.9 HP / 2200 min^{-1} (rpm))
SAE Gross Intermittent		18.5 kW / 2200 min^{-1} (rpm) (24.8 HP / 2200 min^{-1} (rpm))
Maximum Bare Speed		2450 to 2470 min^{-1} (rpm)
Minimum Bare Idling Speed		1050 to 1150 min^{-1} (rpm)
Combustion Chamber		Reentrant Type (Direct Injection)
Fuel Injection Pump		Bosch "**K**" Type Mini Pump
Governor		Centrifugal Ball Type, All Speed Mechanical Governor
Direction of Rotation		Counter-Clockwise (viewed from flywheel side)
Injection Nozzle		Bosch "**P**" Type Hole Nozzle
Injection Timing		0.0568 to 0.0829 rad (3.25 to 4.75°) Before T.D.C.
Firing Order		1-2-3
Injection Pressure	1st Stage	18.6 MPa (190 kgf/cm^2, 2700 psi)
	2nd Stage	22.6 MPa (230 kgf/cm^2, 3270 psi)
Compression Ratio		20.5
Lubricating System		Forced Lubrication by Trochoid Pump
Cooling System		Pressurized radiator, forced circulation with water pump
Starting System		Electric Starting with Starter
Starting Motor		12 V, 1.2 kW
Starting Support Device		Pre-heating by Glow Plug in Combustion Chamber
EGR		NONE
Battery		12 V, 60 AH (75D26R)
Charging Alternator		12 V, 360 W
Fuel		Diesel Fuel No.2-D (or No.2-DLS)
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, G-10.
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	5.6 L (1.5 U.S.gals)
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.8 U.S.gals)
Weight (Dry)		148 kg (326 lbs)

*The specification described above is of the standard engine of each model.
*Conversion Formula: HP = 0.746 kW, PS = 0.7355 kW

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Model		D1503-M-E4BG
Number of Cylinders		3
Type		Vertical, Water-cooled, 4 cycle diesel engine
Bore × Stroke		83.0 × 92.4 mm (3.27 × 3.64 in.)
Total Displacement		1499 cm^3 (91.47 cu.in.)
STANDBY	ISO 3046	15.5 kW / 1800 min^{-1} (rpm)
	SAE J-1349	20.8 HP / 1800 min^{-1} (rpm)
NET Continuous	ISO 3046	13.7 kW / 1800 min^{-1} (rpm)
	SAE J-1349	18.4 HP / 1800 min^{-1} (rpm)
Governor Regulation		Less than 5 %
Combustion Chamber		Spherical Type (E-TVCS)
Fuel Injection Pump		PFR 3M Type Mini Pump (DENSO)
Governor		Centrifugal Ball Type, All Speed Mechanical Governor + Electronic Governor
Direction of Rotation		Counter-Clockwise (viewed from flywheel side)
Injection Nozzle		OPD Mini Nozzle (DENSO)
Injection Timing		0.236 to 0.261 rad (13.5 to 15.0°) Before T.D.C.
Firing Order		1-2-3
Injection Pressure		13.7 MPa (140 kgf/cm^2, 1990 psi)
Compression Ratio		22.8
Lubricating System		Forced Lubrication by Trochoid Pump
Cooling System		Pressurized radiator, forced circulation with water pump
Starting System		Electric Starting with Starter
Starting Motor		12 V, 1.4 kW
Starting Support Device		By glow plug in combustion chamber
EGR		NONE
Battery		12 V, 60 AH (75D31R)
Charging Alternator		12 V, 480 W
Fuel		Diesel Fuel No.2-D (or No.2-DLS)
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, G-10.
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	5.6 L (1.5 U.S.gals)
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.8 U.S.gals)
Weight (Dry)		178 kg (392 lbs)

*The specification described above is of the standard engine of each model.
*Conversion Formula: HP = 0.746 kW, PS = 0.7355 kW

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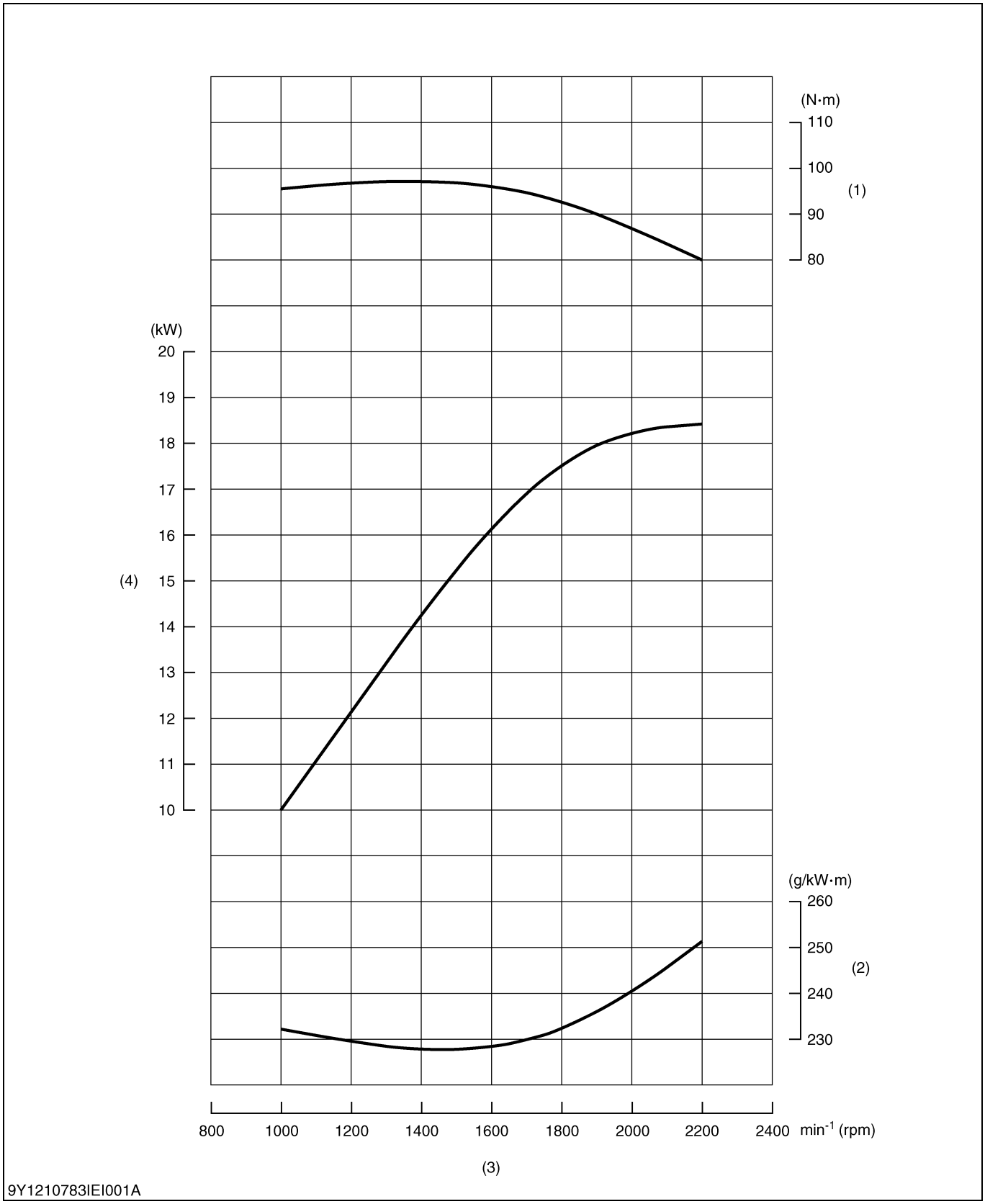
3. PERFORMANCE CURVE

D1703-M-DI-E4B



(1) Torque
(2) B.S.F.C. (Brake Specific Fuel Consumption)
(3) Engine Speed
(4) Brake Horsepower

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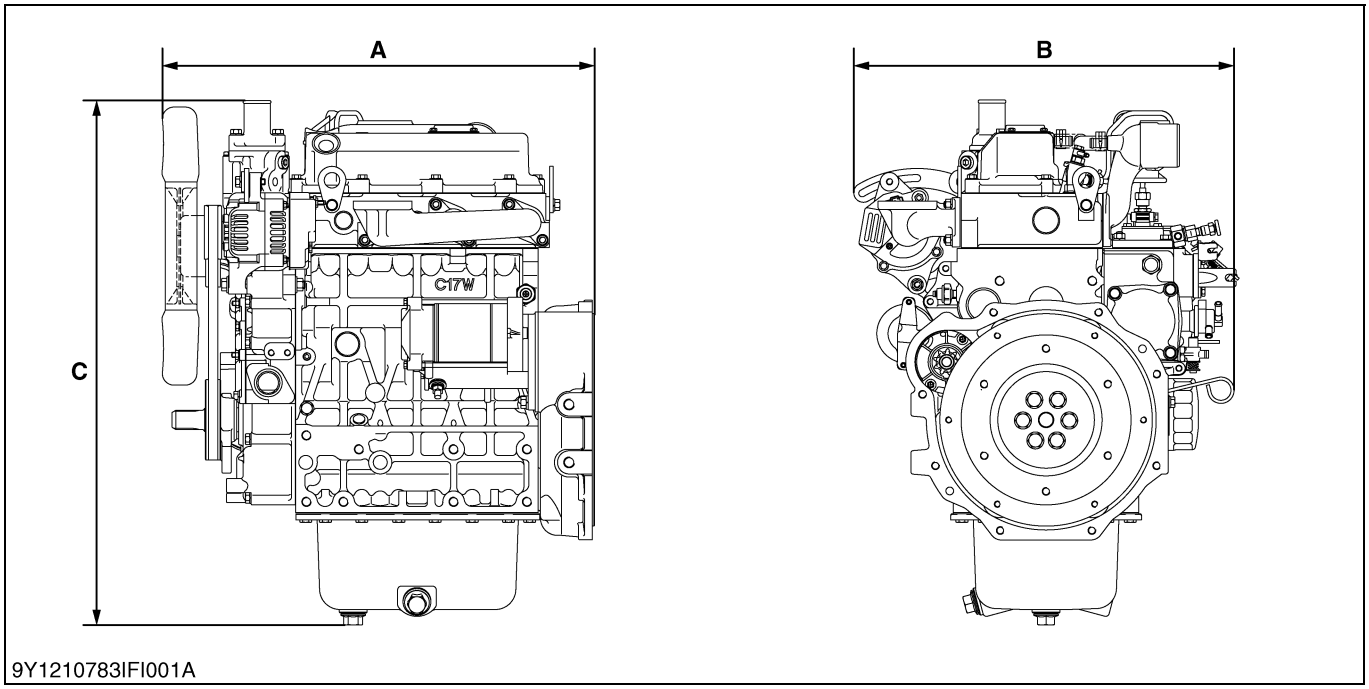
4. DIMENSIONS



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	D1703-M-DI-E4B
A	560.10 mm (22.051 in.)
B	499.00 mm (19.646 in.)
C	678.98 mm (26.731 in.)

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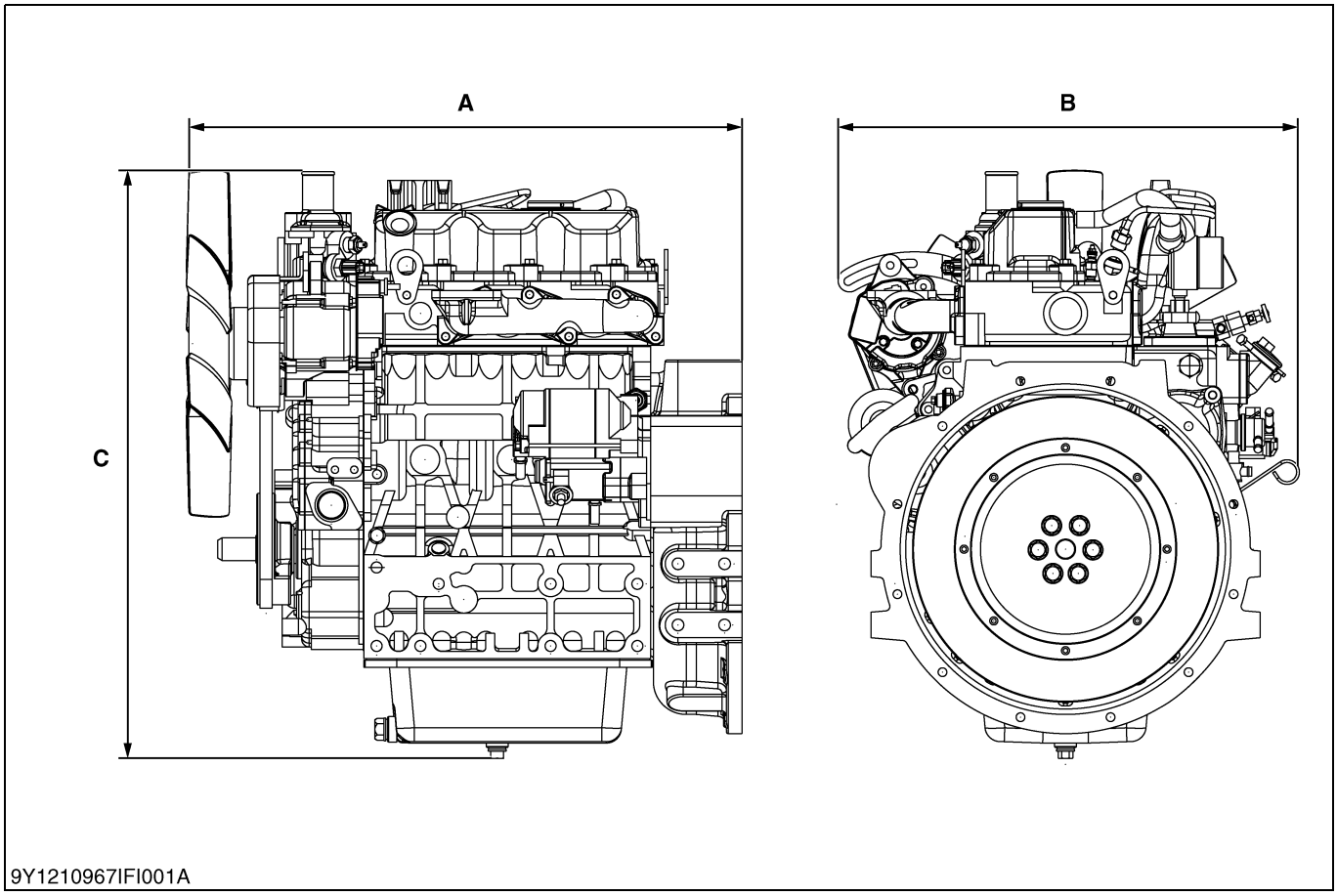

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	D1503-M-E4BG
A	605.6 mm (23.84 in.)
B	505.0 mm (19.88 in.)
C	642.8 mm (25.31 in.)

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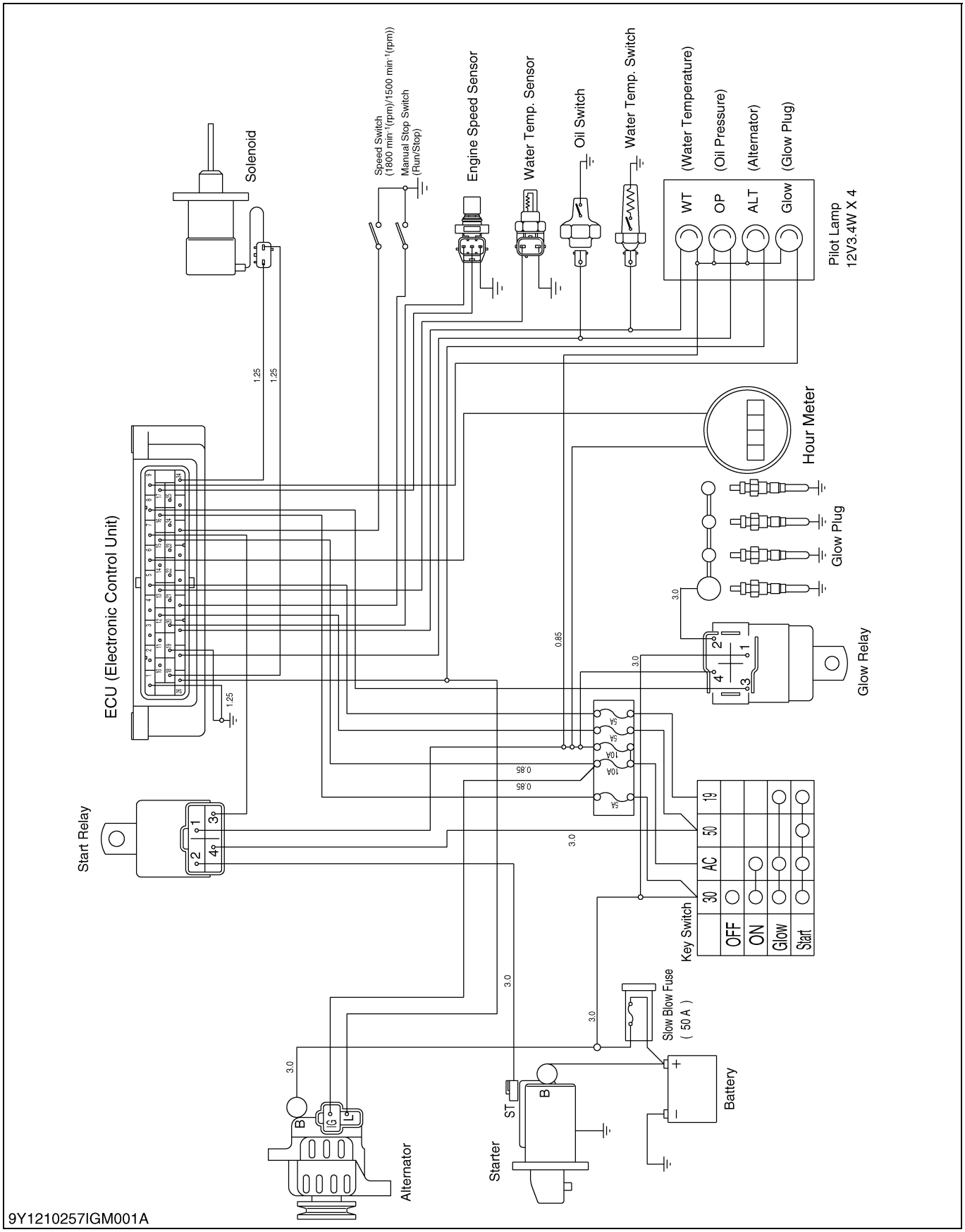
5. WIRING DIAGRAM



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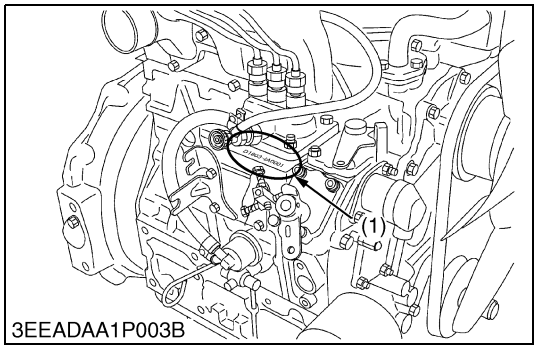
G GENERAL

GENERAL

CONTENTS

1. ENGINE IDENTIFICATION

[1] MODEL NAME AND ENGINE SERIAL NUMBER



You must identify the engine model name and serial number before you start a job. When you get in touch with the manufacturer, always tell your engine model name and serial number.

Engine Serial Number

The engine serial number is an identified number for the engine.
It appears after the engine model name.
It shows the month and year of manufacture as below.

Engine Series

Number or Alphabet	Series	Number or Alphabet	Series
1	05 (include: WG)	7	03
2	V3	8	07
3	08	A	EA, RK
4	SM (include: WG)	B	03 (KET Production)
5	Air Cooled Gasoline	C	V3, 07 (KEW Production)
6	GZ, OC, AC, EA, E		

Production Year

Alphabet or Number	Year	Alphabet or Number	Year
1	2001	F	2015
2	2002	G	2016
3	2003	H	2017
4	2004	J	2018
5	2005	K	2019
6	2006	L	2020
7	2007	M	2021
8	2008	N	2022
9	2009	P	2023
A	2010	R	2024
B	2011	S	2025
C	2012	T	2026
D	2013	V	2027
E	2014		

(1) Engine Model Name and Serial Number

(To be continued)

(Continued)

Month of manufacture

Month	Engine Lot Number	
January	A0001 ~ A9999	B0001 ~ BZ999
February	C0001 ~ C9999	D0001 ~ DZ999
March	E0001 ~ E9999	F0001 ~ FZ999
April	G0001 ~ G9999	H0001 ~ HZ999
May	J0001 ~ J9999	K0001 ~ KZ999
June	L0001 ~ L9999	M0001 ~ MZ999
July	N0001 ~ N9999	P0001 ~ PZ999
August	Q0001 ~ Q9999	R0001 ~ RZ999
September	S0001 ~ S9999	T0001 ~ TZ999
October	U0001 ~ U9999	V0001 ~ VZ999
November	W0001 ~ W9999	X0001 ~ XZ999
December	Y0001 ~ Y9999	Z0001 ~ ZZ999

* Alphabetical letters **"I"** and **"O"** are not used.

(a) (b)(c)(d) (e)
e.g. D1703 - 7 D G A001

(a) **D1703**: Engine Model Name
(b) **7**: Engine Series (03 series)
(c) **D**: Production Year (2013)
(d) **G**: Production Month (April)
(e) **A001**: Lot Number: (**0001 ~ 9999** or **A001 ~ Z999**)

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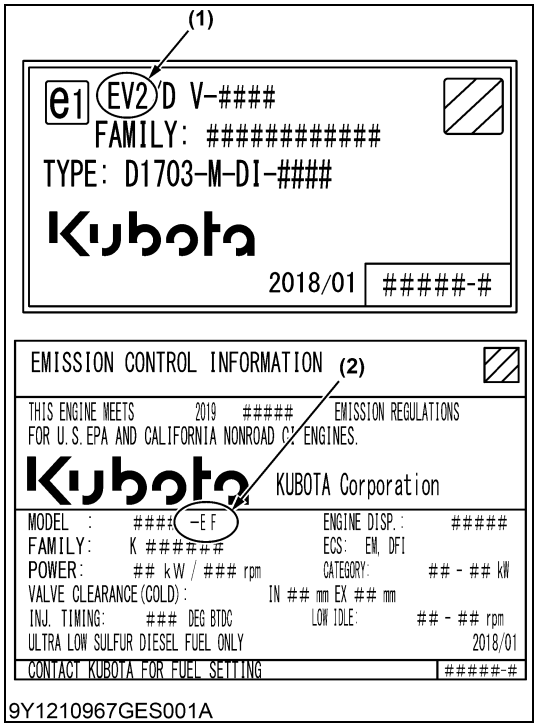
[2] E4B ENGINE

[Example: Engine Model Name D1703-M-DI-E4B-XXXX or D1503-M-E4BG-XXXX]

The emission controls previously implemented in various countries to prevent air pollution will be stepped up as Nonroad Emission Standards continue to change. The timing or applicable date of the specific Nonroad Emission regulations depends on the engine output classification.

Over the past several years, KUBOTA has been supplying diesel engines that comply with regulations in the respective countries affected by Nonroad Emission regulations. For KUBOTA Engines, E4B will be the designation that identifies engine models affected by the next emission phase (See the table below).

When servicing or repairing ###-E4B series engines, use only replacement parts for that specific E4B engine, designated by the appropriate E4B KUBOTA Parts List and perform all maintenance services listed in the appropriate KUBOTA Operator's Manual or in the appropriate E4B KUBOTA Workshop Manual. Use of incorrect replacement parts or replacement parts from other emission level engines (for example: E3B engines), may result in emission levels out of compliance with the original E4B design and EPA or other applicable regulations.Please refer to the emission label located on the engine head cover to identify Output classification and Emission Control Information. E4B engines are identified with "EF" at the end of the Model designation, on the US EPA label. Please note: E4B is not marked on the engine.



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Category (1)	Engine output classification	EU regulation
EV1	Less than 8 kW	Stage V
EV2	From 8 to less than 19 kW	Stage V

Category (2)	Engine output classification	EPA regulation
EF	Less than 19kW	Tier 4

(1) Engine Category Identification Code
(2) "E4B" engines are identified with "EF" at the end of the Model designation, on the US EPA label.
"E4B" designates some Tier 4 models, depending on engine output classification.

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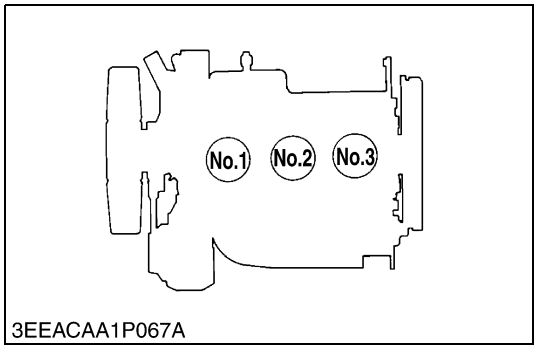
[3] CYLINDER NUMBER



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You can see the cylinder numbers of KUBOTA diesel engine in the figure. The sequence of cylinder numbers is No.1, No.2 and No.3 and it starts from the gear case side.

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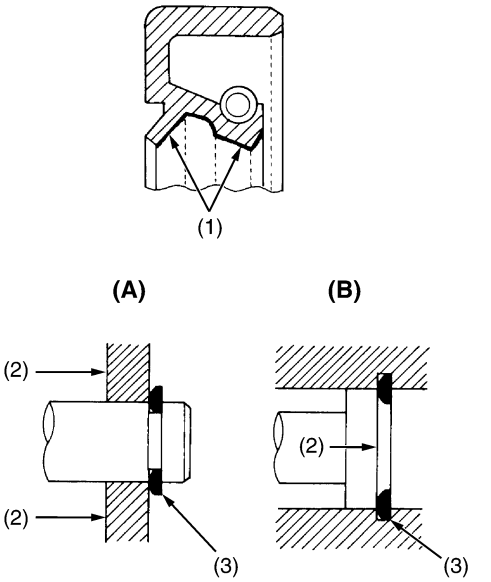
2. GENERAL PRECAUTIONS



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- When you disassemble, carefully put the parts in a clean area to make it easy to find the parts. You must install the screws, bolts and nuts in their initial position to prevent the reassembly errors.
- When it is necessary to use special tools, use KUBOTA special tools. Refer to the drawings when you make special tools that you do not use frequently.
- Before you disassemble or repair machine, make sure that you always disconnect the ground cable from the battery first.
- Remove oil and dirt from parts before you measure.
- Use only KUBOTA genuine parts for replacement to keep the machine performance and to make sure of safety.
- You must replace the gaskets and O-rings when you assemble again. Apply grease (1) to new O-rings or oil seals before you assemble.
- When you assemble the external or internal snap rings, make sure that the sharp edge (3) faces against the direction from which force (2) is applied.
- Make sure that you try to operate the engine after you repair or assemble it. Do not try to give a heavy load immediately, if not, you can cause serious damage to the engine.

(1) Grease
(2) Force
(3) Sharp Edge
(A) External Snap Ring
(B) Internal Snap Ring

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3. MAINTENANCE CHECK LIST

To make sure that the engine operates safely for a long time, refer to the table below to do regular inspections.

[D1703-M-DI-E4B]

	Item		Service Interval										
			Every										
			50 hrs	100 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
*	Check of fuel hoses and clamp bands		☆										
	Change of engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆								
		(2) Oil pan depth (124 mm, 4.88 in.)	★			☆							
*	Cleaning of air cleaner element (replace the element after 6-times cleanings)			☆									
*	Cleaning of fuel filter (Element type)			☆									
	Check of battery electrolyte level			☆									
	Check of fan belt tension and damage			☆									
	Replacement of oil filter cartridge	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆								
		(2) Oil pan depth (124 mm, 4.88 in.)	★			☆							
	Check of radiator hoses and clamp bands				☆								
*	Check of intake air line				☆								
	Replacement of fuel filter cartridge					☆							
	Cleaning of fuel tank inside						☆						
	Cleaning of water jacket and radiator interior						☆						
	Replacement of fan belt						☆						
	Recharge of battery							☆					
*	Replacement of air cleaner element								☆				
	Check of valve clearance									☆			
*	Check of injection nozzle										☆		
*	Check of turbocharger											☆	
*	Check of injection pump											☆	
*	Replacement of intake air line												☆
	Replacement of battery												☆
	Replacement of radiator hoses and clamp bands												☆
*	Replacement of fuel hoses and clamps												☆
	Change of radiator coolant (L.L.C.)												☆

★ Change the engine oil and replace the oil filter cartridge after the first 50 hours of operation.

* The items above (* marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the owner of the engine, you are responsible for the performance of the required maintenance above.

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[D1503-M-E4BG]

	Item		Service Interval											
			Every											
			50 hrs	100 hrs	150 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
*	Check of fuel hoses and clamp bands		☆											
	Change of engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆									
		(2) Oil pan depth (124 mm, 4.88 in.)	★			☆								
*	Cleaning of air cleaner element (replace the element after 6-times cleanings)			☆										
*	Cleaning of fuel filter (Element type)			☆										
	Check of battery electrolyte level			☆										
	Check of fan belt tension and damage			☆										
	Replacement of oil filter cartridge	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆									
		(2) Oil pan depth (124 mm, 4.88 in.)	★			☆								
	Check of radiator hoses and clamp bands					☆								
*	Check of intake air line					☆								
	Replacement of fuel filter cartridge						☆							
	Cleaning of fuel tank inside							☆						
	Cleaning of water jacket and radiator interior							☆						
	Replacement of fan belt							☆						
	Recharge of battery								☆					
*	Replacement of air cleaner element									☆				
	Check of valve clearance										☆			
*	Check of injection nozzle											☆		
*	Check of turbocharger												☆	
*	Check of injection pump												☆	
*	Replacement of intake air line													☆
	Replacement of battery													☆
	Replacement of radiator hoses and clamp bands													☆
*	Replacement of fuel hoses and clamps													☆
	Change of radiator coolant (L.L.C.)													☆

★ Change the engine oil and replace the oil filter cartridge after the first 50 hours of operation.
* The items above (* marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the owner of the engine, you are responsible for the performance of the required maintenance above.

9Y1210967GEG0067US0

CAUTION
- **When changing or inspecting, be sure to level and stop the engine.**

NOTE

Engine oil
- **Refer to the following table for the suitable American Petroleum Institute (API) classification of engine oil according to the engine type (with external EGR or non-EGR) and the Fuel Type Used: (Low Sulfur, Ultra Low Sulfur or High Sulfur Fuels).**

Fuel Type	Engine oil classification (API classification)	
	Engines with non-EGR	Engines with external EGR
High Sulfur Fuel [0.05 % (500 ppm) ≤ Sulfur Content < 0.50 % (5000 ppm)]	**CF** (If the "CF-4, CG-4, CH-4, or CI-4" engine oil is used with a high-sulfur fuel, change the engine oil at shorter intervals. (approximately half))	–
Low Sulfur Fuel [Sulfur Content < 0.05 % (500 ppm)] or Ultra Low Sulfur Fuel [Sulfur Content < 0.0015 % (15 ppm)]	**CF**, **CF-4**, **CG-4**, **CH-4** or **CI-4**	**CF** or **CI-4** (Class CF-4, CG-4 and CH-4 engine oils cannot be used on EGR type engines.)

EGR: Exhaust Gas Re-circulation
- **The CJ-4 grade engine oil is of DPF (Diesel Particulate Filter) specification, and is unusable as it contains incompatible additives for non DPF engines.**
- **Oil used in the engine should have API classification and Proper SAE Engine Oil Viscosity according to the ambient temperatures where the engine is operated.**
- **With strict emission control regulations now in effect, the CF-4 and CG-4 engine oils have been developed for use with low sulfur fuels, for On-Highway vehicle engines. When a Nonroad engine operates on high sulfur fuel, it is advisable to use a "CF or better" classification engine oil with a high Total Base Number (a minimum TBN of 10 is recommended).**

Fuel
- **Cetane Rating: The minimum recommended Fuel Cetane Rating is 45. A cetane rating greater than 50 is preferred, especially for ambient temperatures below −20 °C (−4 °F) or elevations above 1500 m (5000 ft).**
- **Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.**
- **Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.**
- **If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half)**
- **DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).**
- **Diesel fuels specified to EN 590 or ASTM D975 are recommended.**
- **No.2-D is a distillate fuel of lower volatility for engines in industrial and heavy mobile service. (SAE J313 JUN87)**
- **Since KUBOTA diesel engines of less than 56 kW (75 hp) use EPA Tier 4 and Interim Tier 4 standards, the use of low sulfur fuel or ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S500 or S15 diesel fuel as an alternative to No.2-D, and use No.1-D S500 or S15 diesel fuel as an alternative to No.1-D for ambient temperatures below −10 °C (14 °F).**

1) SAE: Society of Automotive Engineers
2) EN: European Norm
3) ASTM: American Society of Testing and Materials
4) US EPA: United States Environmental Protection Agency
5) No.1-D or No.2-D, S500: Low Sulfur Diesel (LSD) less than 500 ppm or 0.05 wt.%
   No.1-D or No.2-D, S15: Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt.%

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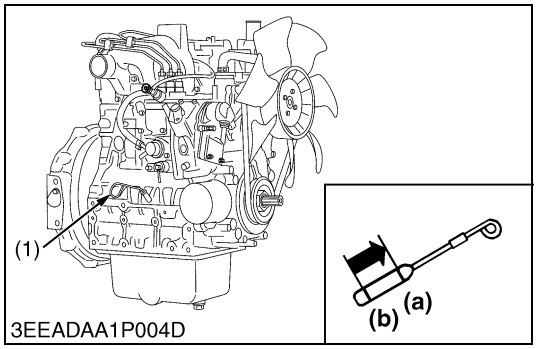
4. CHECK AND MAINTENANCE

[1] DAILY CHECK POINTS



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Check of Engine Oil Level

1. Make the engine level.
2. Pull out the dipstick (1) and clean it.
3. Put in and pull it out again.
   Make sure that the oil level is between the 2 notches.
4. If the level is too low, add new oil to the specified level.

■ **IMPORTANT**

- **When you use an oil of different brand or viscosity from the previous, drain the remaining oil. Do not mix 2 different types of oil.**

■ **NOTE**

- **When you check the engine oil level, make sure that you put it in a level position. If not, you cannot measure oil quantity accurately.**
- **Make sure that you keep the oil level between the upper and lower lines of the dipstick. Too much oil can decrease the output or cause too much blow-by gas. On the closed breather type engine, the port absorbs the mist and too much oil can cause oil hammer. But if the oil level is not sufficient, the moving parts of engine can get a seizure.**

(1) Dipstick
(a) Upper Line
(b) Lower Line

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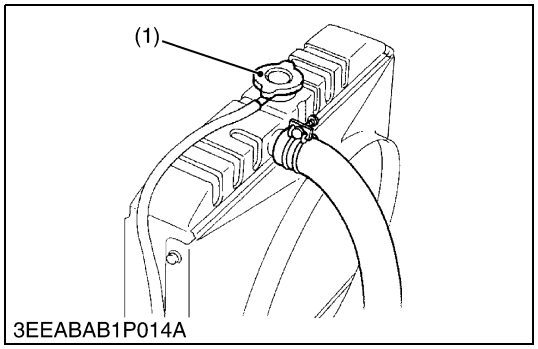

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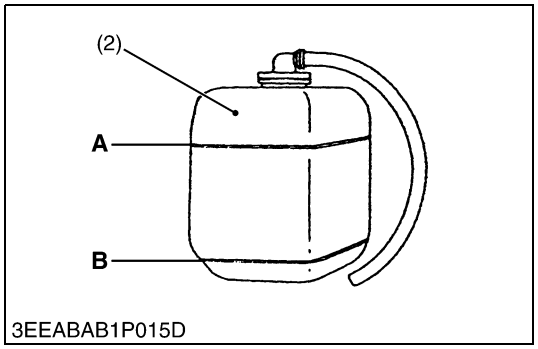

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Check of Coolant Level and Replenishment

CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen the cap slightly to release unwanted pressure before you remove the cap fully.**

1. **Without recovery tank**:
   Remove the radiator cap (1) and make sure that the coolant level is immediately below the port.
   With recovery tank:
   Make sure that the coolant level is between **FULL A** and **LOW B**.
2. If the coolant level is too low, find out the cause that there is less coolant.
   Case 1
   If the coolant decreases by evaporation, add only clean and soft water.
   Case 2
   If the coolant decreases by leak, add coolant of the same manufacturer and brand in the specified mixture ratio (clean, soft water and L.L.C.). If you cannot identify the coolant brand, drain all the remaining coolant and add a new brand of coolant mix.

IMPORTANT

- **When you add the coolant, release the air from the engine coolant channels. The engine releases the air when it shakes the radiator upper and lower hoses.**
- **Make sure that you close the radiator cap correctly. If the cap is loose or incorrectly closed, coolant can flow out and the engine can overheat.**
- **Do not use an anti-freeze and scale inhibitor at the same time.**
- **Do not mix the different type or brand of L.L.C..**

(1) Radiator Cap
(2) Recovery Tank

A: FULL
B: LOW

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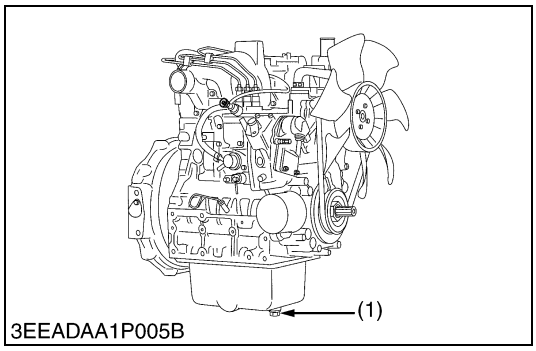
[2] CHECK POINTS FOR THE INITIAL 50 HOURS



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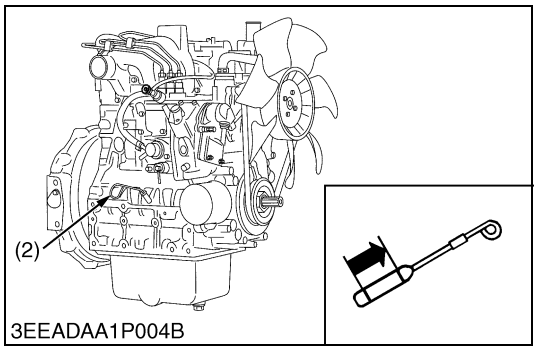

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Change of Engine Oil

CAUTION

- **Make sure that you stop the engine before you change the engine oil.**

1. Start and warm-up the engine for approximately 5 minutes.
2. Put an oil pan below the engine.
3. Remove the drain plug (1) at the bottom of the engine and drain the oil fully.
4. Tighten the drain plug (1).
5. Fill new oil until the upper line on the dipstick (2).

IMPORTANT

- **When you use an oil of different brand or viscosity from the previous, drain the remaining oil. Do not mix 2 different types of oil.**
- **Engine oil must have the properties of API classification CF/CF-4/CG-4/CH-4/CI-4.**
- **Use the correct SAE Engine Oil by reference to the ambient temperature.**

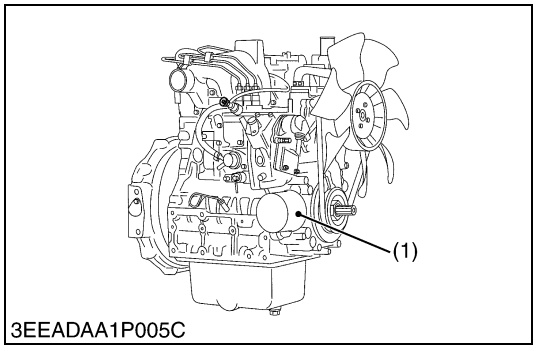
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30, SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30, SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30, SAE 10W-40

Models	Oil Pan Depth	
	124 mm (4.88 in.)	*90 mm (3.5 in.)
D1703-M-DI-E4B, D1503-M-E4BG	7.0 L 1.8 U.S.gals	5.6 L 1.5 U.S.gals

*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

9Y1210967GEG0071US0



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Replacement of Oil Filter Cartridge

CAUTION

- **Make sure that you stop the engine before you replace the oil filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a thin layer of oil on the new cartridge gasket.
3. Install the new cartridge by hand. Do not tighten too much because it can cause deformation of the rubber gasket.
4. After you replace the cartridge, the engine oil usually decrease by a small level. Make sure that the engine oil does not flow through the seal and read the oil level on the dipstick.
5. Fill the engine oil until the specified level.

IMPORTANT

- **To prevent serious damage to the engine, use only KUBOTA genuine filters or its equivalent.**

(1) Oil Filter Cartridge

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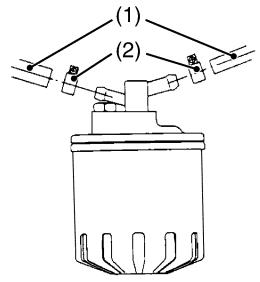
[3] CHECK POINTS FOR EVERY 50 HOURS

[A]



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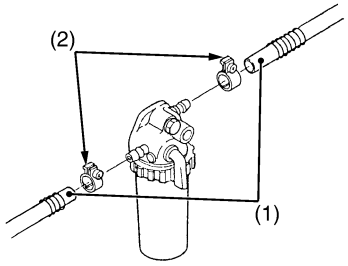
[B]



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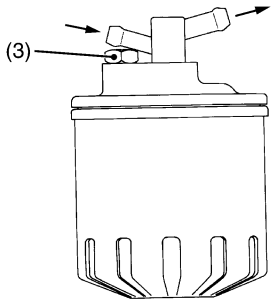
[A]



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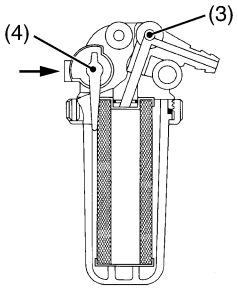
[B]



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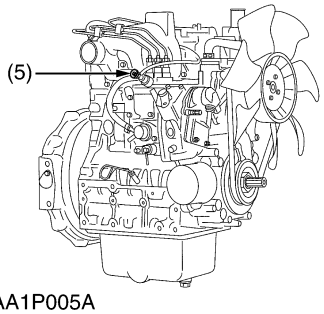

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Check of Fuel Hoses and Clamp Bands

CAUTION

- **Stop the engine before you do the check below.**

1. If the clamp (2) is loose, apply oil to the threads and tighten it again correctly.
2. The fuel hose (1) material is rubber and deteriorates naturally. Replace the fuel hose together with the clamp in a 2-years interval.
3. But if the fuel hose and clamp has damages before 2 years, then replace them.
4. After you replace the fuel hose and the clamp, bleed the fuel system.

(When you bleed the fuel system)

1. Fill the tank with fuel.
2. Open the fuel valve (4). (**[B]** only)
3. Loosen the air vent plug (3) of the fuel filter by a few turns.
4. Tighten the plug when the bubbles do not come up.
5. Open the air vent valve (5) on top of the fuel injection pump.
6. **Engine with the electrical fuel feed pump**
   Turn the key to the AC position and supply the fuel with the pump for 10 to 15 seconds.
   Engine with the mechanical fuel feed pump
   Set the stop lever on STOP position and crank the engine with the starter for 10 to 15 seconds.
7. Close the air vent valve correctly after you bled the air.

■ **NOTE**

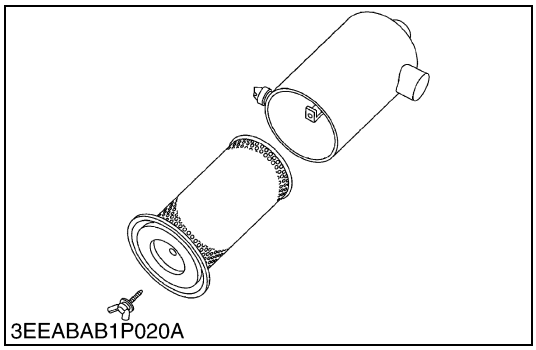
- **Always keep the air vent valve on the fuel injection pump closed unless when you release the air. If not, it can cause the engine to stop.**

(1) Fuel Hose
(2) Clamp
(3) Air Vent Plug
(4) Fuel Valve
(5) Air Vent Valve

[A] Cartridge Type
[B] Element Type

9Y1210967GEG0073US0

[4] CHECK POINTS FOR EVERY 100 HOURS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Cleaning of Air Cleaner Element

1. Remove the air cleaner element.
2. Use clean dry compressed air on the inner side of the element. The pressure of compressed air must be less than 210 kPa (2.1 kgf/cm^2, 30 psi).
   Keep an appropriate distance between the nozzle and the filter.

■ **NOTE**

- **The air cleaner uses a dry element. Do not apply oil to it.**
- **Do not operate the engine without the filter element.**
- **Replace the element once a year or every sixth cleaning.**

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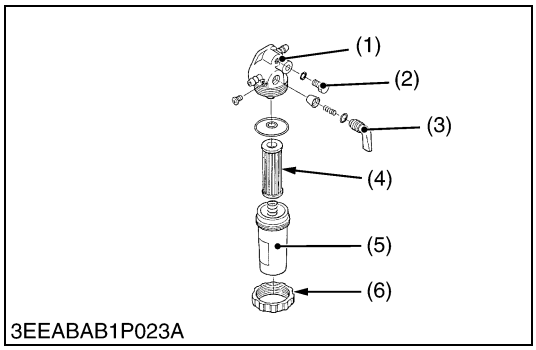

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Cleaning of Fuel Filter (Element Type Only)

1. Close the fuel valve (3).
2. Remove the retaining ring (6).
3. Remove the filter cup (5).
4. Flush the inner side with kerosene.
5. Remove the filter element (4) and clean it in the kerosene.
6. After you clean, assemble the fuel filter again. Make sure that you keep out dust and dirt.
7. Bleed the fuel system.

■ **IMPORTANT**

- **If dust and dirt go into the fuel, the fuel injection pump and injection nozzle can wear out quickly. To prevent this, make sure that you clean the filter cup (5) periodically.**

(1) Valve Body
(2) Air Vent Plug
(3) Fuel Valve
(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

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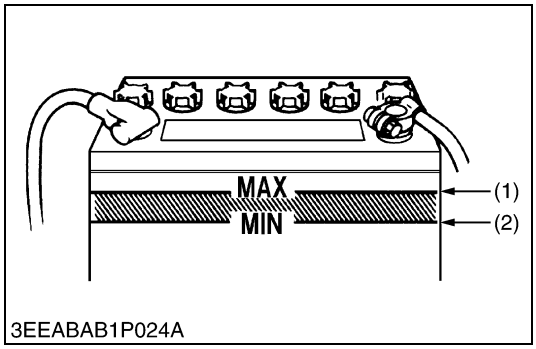

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Check of Battery Electrolyte Level

1. Check the battery electrolyte level.
2. If the level is below the lower level line (2), fill each cell with distilled water until the upper level line.

(1) Upper Level Line
(2) Lower Level Line

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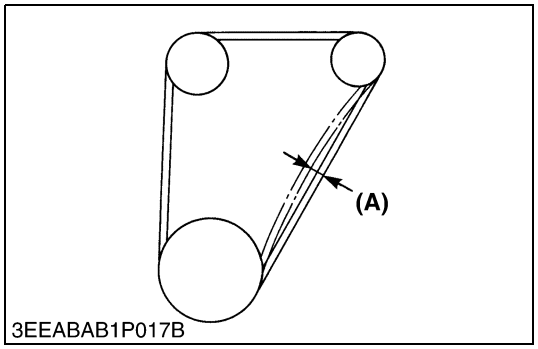

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Fan Belt Tension

1. Check the tension of fan belt halfway (A) between the fan drive pulley and fan pulley with sonic belt tension meter.
2. If the measurement is out of the service specifications, loosen the alternator mounting screws and adjust its position.

Sonic belt tension meter setting value	
Mass (Mass per 1 rib 1 m of belt)	110 g/rib/m
Width (Number of ribs)	1
Span (Distance of between the fan drive pulley and alternator pulley)	measured

Belt tension (Adjustment)	Service specification	237 to 403 N 24.2 to 41.0 kgf 53.3 to 90.5 lbf

(Reference)

1. Push the belt halfway between the fan drive pulley and alternator pulley at a specified force 98 N (10 kgf, 22 lbf) to measure the deflection **(A)**.
2. If the measurement is out of the service specifications, loosen the alternator mounting screws and adjust its position.

Deflection **(A)**	Service specification	10 to 12 mm 0.40 to 0.47 in.

(A) Deflection / Fan Belt Halfway

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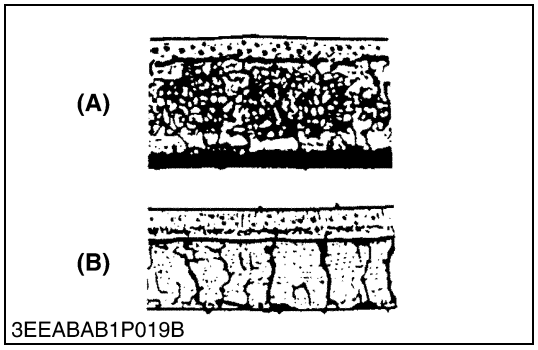

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Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt has a damage, replace it.
3. Check if the fan belt is worn out and sunk in the pulley groove.
4. If it is, replace it.

(A) Good **(B) Bad**

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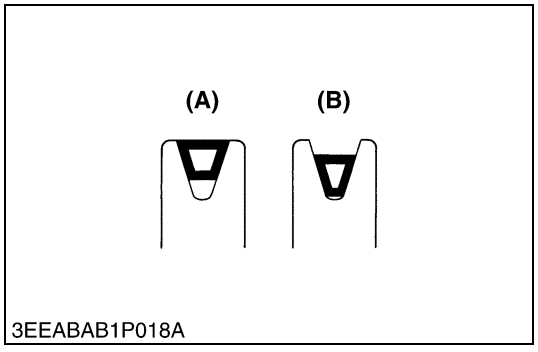

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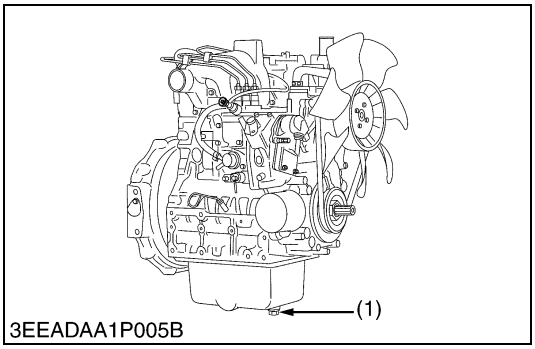
[5] CHECK POINTS FOR EVERY 150 HOURS



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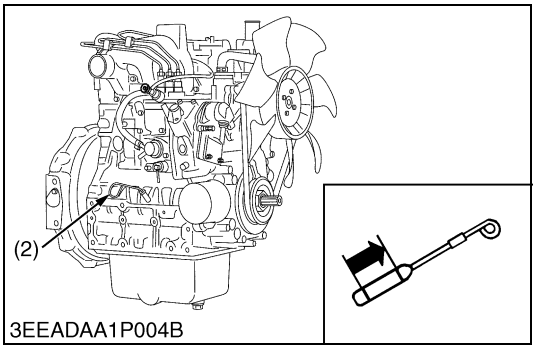

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Change of Engine Oil (for 90 mm (3.5 in.) Depth Oil Pan)

[D1503-M-E4BG]

CAUTION

- **Make sure that you stop the engine before you change the engine oil.**

1. Start and warm-up the engine for approximately 5 minutes.
2. Put an oil pan below the engine.
3. Remove the drain plug (1) at the bottom of the engine and drain the oil fully.
4. Tighten the drain plug (1).
5. Fill new oil until the upper line on the dipstick (2).

IMPORTANT

- **When you use an oil of different brand or viscosity from the previous, drain the remaining oil. Do not mix 2 different types of oil.**
- **Engine oil must have the properties of API classification CF/CF-4/CG-4/CH-4/CI-4.**
- **Use the correct SAE Engine Oil by reference to the ambient temperature.**

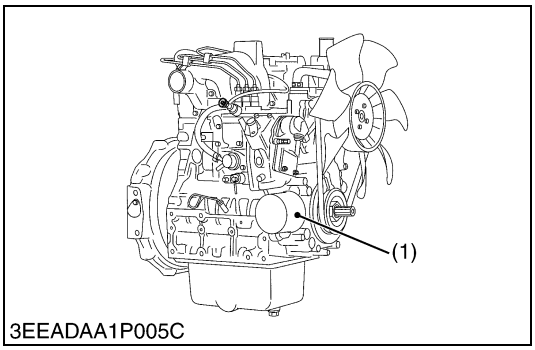
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30, SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30, SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30, SAE 10W-40

Models	Oil Pan Depth
	*90 mm (3.5 in.)
D1503-M-E4BG	5.6 L 1.5 U.S.gals

*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

9Y1210967GEG0079US0



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Replacement of Oil Filter Cartridge (for 90 mm (3.5 in.) Depth Oil Pan)

[D1503-M-E4BG]

CAUTION

- **Make sure that you stop the engine before you replace the oil filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a thin layer of oil on the new cartridge gasket.
3. Install the new cartridge by hand. Do not tighten too much because it can cause deformation of the rubber gasket.
4. After you replace the cartridge, the engine oil usually decrease by a small level. Make sure that the engine oil does not flow through the seal and read the oil level on the dipstick.
5. Fill the engine oil until the specified level.

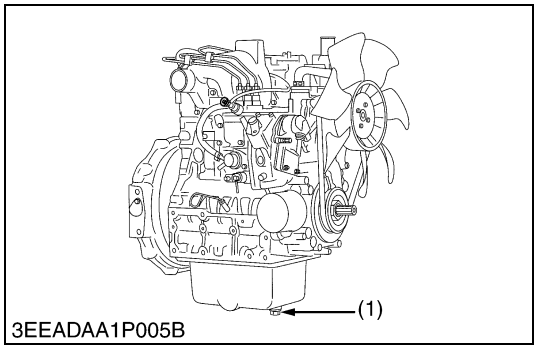
IMPORTANT

- **To prevent serious damage to the engine, use only KUBOTA genuine filters or its equivalent.**

(1) Oil Filter Cartridge

9Y1210967GEG0080US0

[6] CHECK POINTS FOR EVERY 200 HOURS



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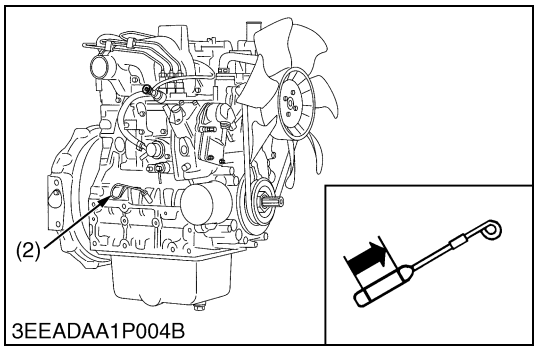

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Change of Engine Oil (for 124 mm (4.88 in.) Depth Oil Pan)

[D1503-M-E4BG]

CAUTION

- **Make sure that you stop the engine before you change the engine oil.**

1. Start and warm-up the engine for approximately 5 minutes.
2. Put an oil pan below the engine.
3. Remove the drain plug (1) at the bottom of the engine and drain the oil fully.
4. Tighten the drain plug (1).
5. Fill new oil until the upper line on the dipstick (2).

IMPORTANT

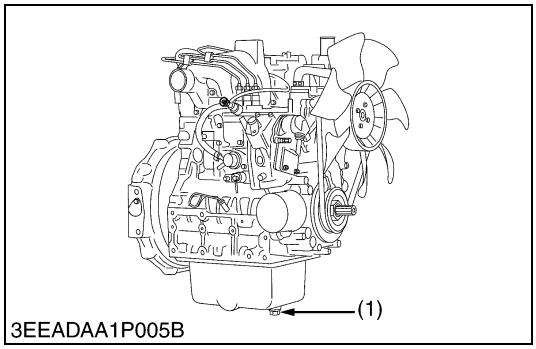
- **When you use an oil of different brand or viscosity from the previous, drain the remaining oil. Do not mix 2 different types of oil.**
- **Engine oil must have the properties of API classification CF/CF-4/CG-4/CH-4/CI-4.**
- **Use the correct SAE Engine Oil by reference to the ambient temperature.**

Above 25 °C (77 °F)	SAE 30 or SAE 10W-30, SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30, SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30, SAE 10W-40

Models	Oil Pan Depth
	124 mm (4.88 in.)
D1503-M-E4BG	7.0 L 1.8 U.S.gals

(1) Drain Plug (2) Dipstick

9Y1210967GEG0081US0



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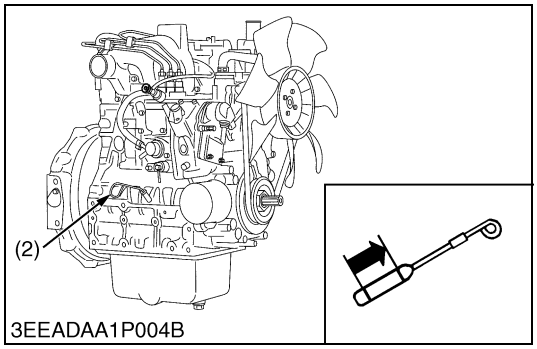


3EEADAA1P004B

Change of Engine Oil (for 90 mm (3.5 in.) Depth Oil Pan)

[D1703-M-DI-E4B]

⚠ CAUTION

- **Make sure that you stop the engine before you change the engine oil.**

1. Start and warm-up the engine for approximately 5 minutes.
2. Put an oil pan below the engine.
3. Remove the drain plug (1) at the bottom of the engine and drain the oil fully.
4. Tighten the drain plug (1).
5. Fill new oil until the upper line on the dipstick (2).

■ IMPORTANT

- **When you use an oil of different brand or viscosity from the previous, drain the remaining oil. Do not mix 2 different types of oil.**
- **Engine oil must have the properties of API classification CF/CF-4/CG-4/CH-4/CI-4.**
- **Use the correct SAE Engine Oil by reference to the ambient temperature.**

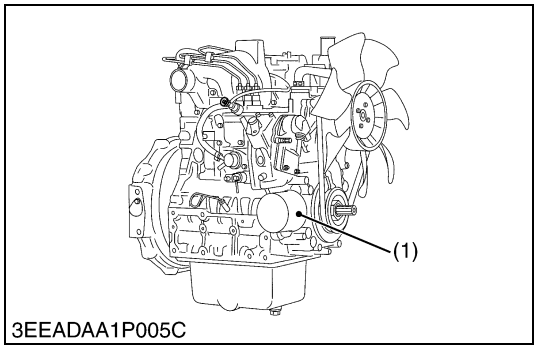
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30, SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30, SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30, SAE 10W-40

Models	**Oil Pan Depth**
	***90 mm (3.5 in.)**
D1703-M-DI-E4B	5.6 L 1.5 U.S.gals

*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

9Y1210967GEG0082US0



3EEADAA1P005C

Replacement of Oil Filter Cartridge (for 124 mm (4.88 in.) Depth Oil Pan)

[D1503-M-E4BG]

CAUTION

- **Make sure that you stop the engine before you replace the oil filter cartridge.**

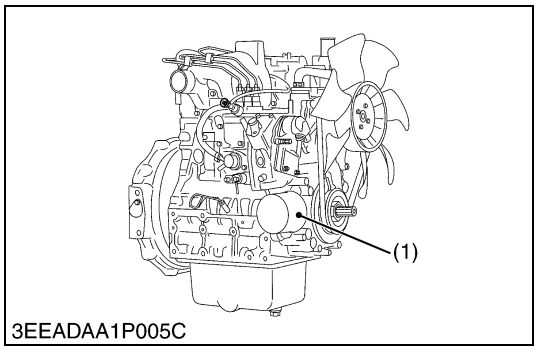
1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a thin layer of oil on the new cartridge gasket.
3. Install the new cartridge by hand. Do not tighten too much because it can cause deformation of the rubber gasket.
4. After you replace the cartridge, the engine oil usually decrease by a small level. Make sure that the engine oil does not flow through the seal and read the oil level on the dipstick.
5. Fill the engine oil until the specified level.

IMPORTANT

- **To prevent serious damage to the engine, use only KUBOTA genuine filters or its equivalent.**

(1) Oil Filter Cartridge

9Y1210967GEG0083US0



3EEADAA1P005C

Replacement of Oil Filter Cartridge (for 90 mm (3.5 in.) Depth Oil Pan)

[D1703-M-DI-E4B]

CAUTION

- **Make sure that you stop the engine before you replace the oil filter cartridge.**

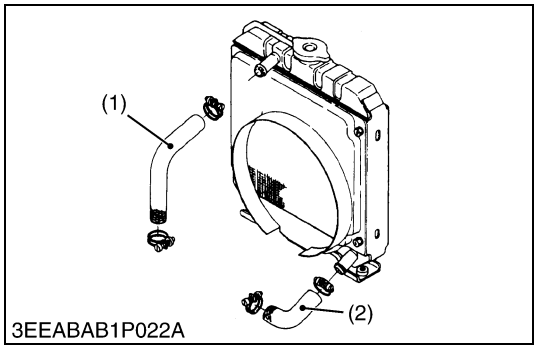
1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a thin layer of oil on the new cartridge gasket.
3. Install the new cartridge by hand. Do not tighten too much because it can cause deformation of the rubber gasket.
4. After you replace the cartridge, the engine oil usually decrease by a small level. Make sure that the engine oil does not flow through the seal and read the oil level on the dipstick.
5. Fill the engine oil until the specified level.

IMPORTANT

- **To prevent serious damage to the engine, use only KUBOTA genuine filters or its equivalent.**

(1) Oil Filter Cartridge

9Y1210967GEG0084US0



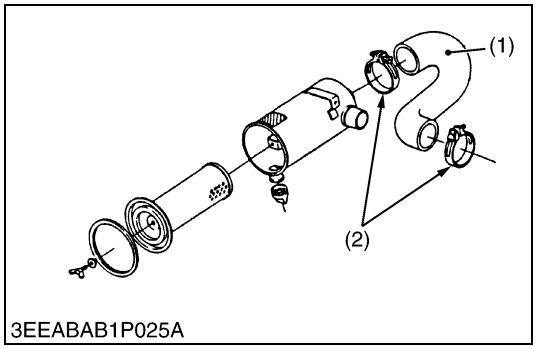
3EEABAB1P022A

Check of Radiator Hoses and Clamp Bands

1. Make sure that the radiator hoses connections are correct for every 200 hours of operation or every 6 months, whichever comes first.
2. If the clamp is loose, apply oil to the threads and tighten it again correctly.
3. The radiator hose material is rubber and deteriorates naturally. You must replace the radiator hose every 2 years. Also replace the clamp and tighten it correctly.

(1) Upper Hose (2) Lower Hose

9Y1210967GEG0085US0



3EEABAB1P025A

Check of Intake Air Line

1. Make sure that the intake air hose(s) connections are correct for every 200 hours of operation.
2. If the clamp is loose, apply oil to the threads and tighten it again correctly.
3. The intake air hose material is rubber and deteriorates naturally. You must replace the intake air hose(s) every 2 years. Also replace the clamp and tighten it correctly.

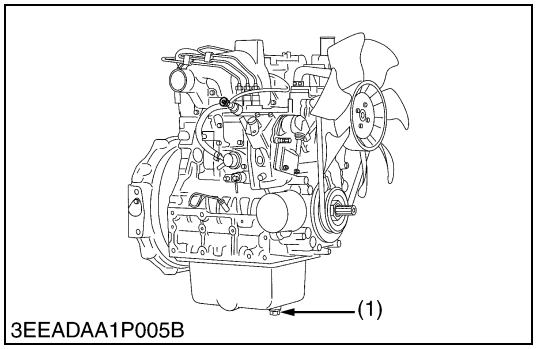
■ **IMPORTANT**

- **To prevent serious damage to the engine, keep out dust in the intake air line.**

(1) Intake Air Hose (2) Clamp

9Y1210967GEG0086US0

[7] CHECK POINTS FOR EVERY 400 HOURS



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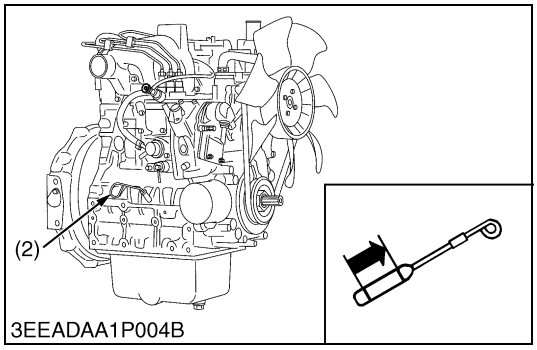


3EEADAA1P004B

Change of Engine Oil (for 124 mm (4.88 in.) Depth Oil Pan)

[D1703-M-DI-E4B]

⚠ CAUTION

- **Make sure that you stop the engine before you change the engine oil.**

1. Start and warm-up the engine for approximately 5 minutes.
2. Put an oil pan below the engine.
3. Remove the drain plug (1) at the bottom of the engine and drain the oil fully.
4. Tighten the drain plug (1).
5. Fill new oil until the upper line on the dipstick (2).

■ **IMPORTANT**

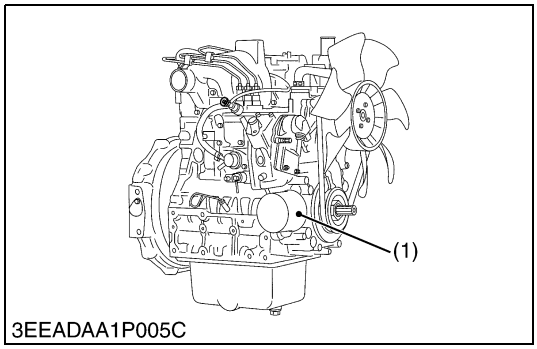
- **When you use an oil of different brand or viscosity from the previous, drain the remaining oil. Do not mix 2 different types of oil.**
- **Engine oil must have the properties of API classification CF/CF-4/CG-4/CH-4/CI-4.**
- **Use the correct SAE Engine Oil by reference to the ambient temperature.**

Above 25 °C (77 °F)	SAE 30 or SAE 10W-30, SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30, SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30, SAE 10W-40

Models	**Oil Pan Depth**
	124 mm (4.88 in.)
D1703-M-DI-E4B	7.0 L 1.8 U.S.gals

(1) Drain Plug (2) Dipstick

9Y1210967GEG0087US0



3EEADAA1P005C

Replacement of Oil Filter Cartridge (for 124 mm (4.88 in.) Depth Oil Pan)

[D1703-M-DI-E4B]

CAUTION

- **Make sure that you stop the engine before you replace the oil filter cartridge.**

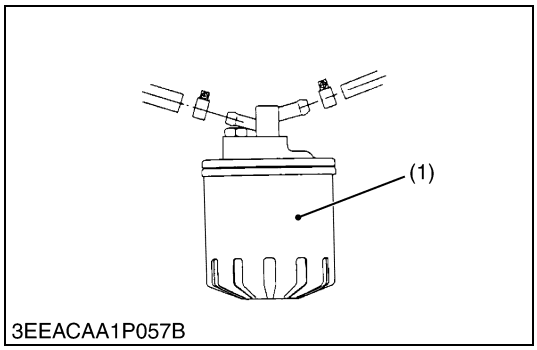
1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a thin layer of oil on the new cartridge gasket.
3. Install the new cartridge by hand. Do not tighten too much because it can cause deformation of the rubber gasket.
4. After you replace the cartridge, the engine oil usually decrease by a small level. Make sure that the engine oil does not flow through the seal and read the oil level on the dipstick.
5. Fill the engine oil until the specified level.

IMPORTANT

- **To prevent serious damage to the engine, use only KUBOTA genuine filters or its equivalent.**

(1) Oil Filter Cartridge

9Y1210967GEG0088US0



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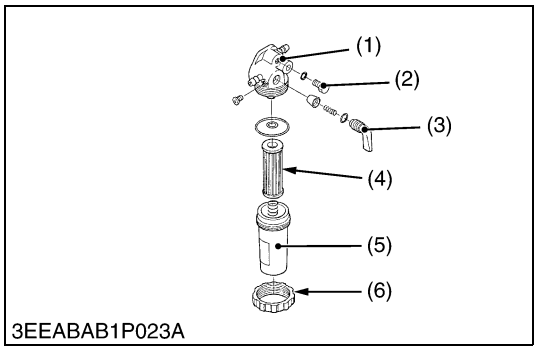
Replacement of Fuel Filter Cartridge (Cartridge Type)

The fuel filter cartridge collects water and dust in the fuel. In service, replace the fuel filter cartridge every 400 hours.

1. Remove the used filter cartridge (1) with filter wrench.
2. Apply a thin layer of fuel to the surface of the new filter cartridge gasket before you put it on.
3. Tighten the new cartridge by hand.
4. Bleed the fuel system.

(1) Fuel Filter Cartridge

9Y1210967GEG0089US0



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Replacement of Fuel Filter Element (Element Type)

1. Close the fuel valve (3).
2. Remove the retaining ring (6).
3. Remove the filter cup (5).
4. Flush the inner side with kerosene.
5. Replace the filter element (4) with a new one.
6. Keep out dust and dirt from work area and then assemble the fuel filter again.
7. Bleed the fuel system.

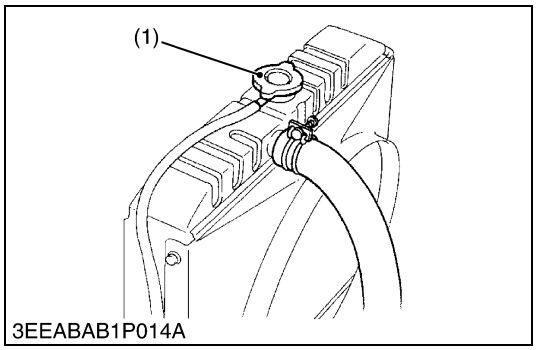
(1) Valve Body
(2) Air Vent Plug
(3) Fuel Valve
(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

9Y1210967GEG0090US0

[8] CHECK POINTS FOR EVERY 500 HOURS

Cleaning of Fuel Tank Inside

9Y1210967GEG0125US0



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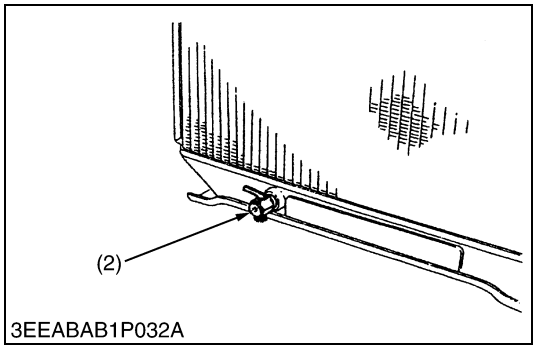

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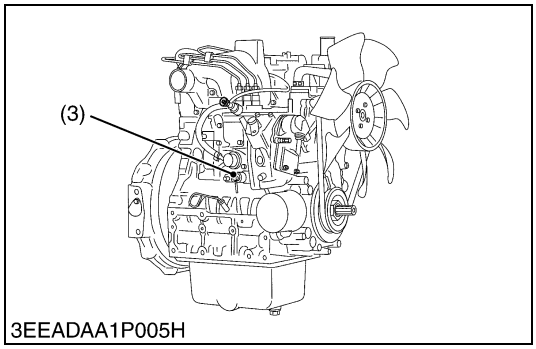

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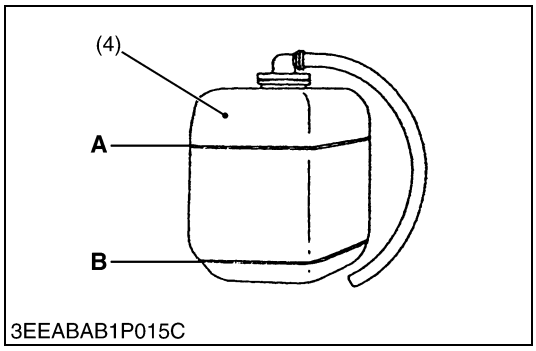

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Cleaning of Water Jacket and Radiator Interior

CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen the cap slightly to release unwanted pressure before you remove the cap fully.**

1. Stop the engine and let the coolant temperature decreases.
2. Remove the radiator cap (1) to drain the coolant fully.
3. Open the drain valve (2) and (3).
4. After you drained all coolant, close the drain valves.
5. Fill with clean water and cooling system cleaner.
6. Obey the directions of the cleaner instruction.
7. After you flush, fill with clean water and anti-freeze until the coolant level is immediately below the port. Install the radiator cap (1) correctly.
8. Fill with the coolant until the "FULL" **A** mark on the recovery tank (4).
9. Start and operate the engine for a few minutes.
10. Stop the engine and let the coolant temperature decreases. Check the coolant level of radiator and recovery tank (4) and add coolant if necessary.

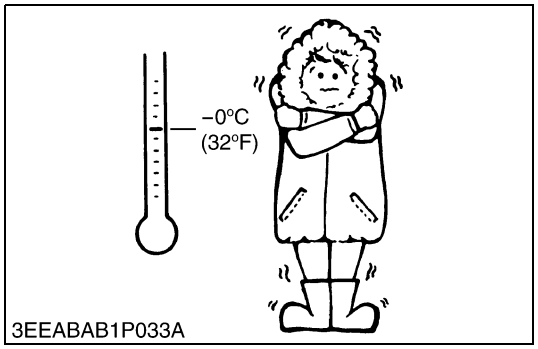
IMPORTANT

- **Do not start the engine without coolant.**
- **Use clean and soft water with anti-freeze to fill the radiator and recovery tank.**
- **Make sure that when you mix the anti-freeze and water, the ratio of anti-freeze is less than 50 %.**
- **Make sure that you close the radiator cap correctly. If the cap is loose or incorrectly closed, coolant can flow out and the engine can overheat.**

(1) Radiator Cap
(2) Drain Valve
(3) Drain Valve
(4) Recovery Tank

A: FULL
B: LOW

9Y1210967GEG0091US0



Anti-freeze

- There are 2 types of anti-freeze available: use the permanent type (PT) for this engine.
- When you add anti-freeze for the first time, flush the water jacket and radiator interior with clean, soft water several times.
- The brand of the anti-freeze and the ambient temperature have an effect on the procedure to mix water and anti-freeze. Refer to the SAE J1034 standard, especially to the SAE J814c.
- Mix the anti-freeze with clean, soft water, and then fill into the radiator.

■ **IMPORTANT**

- **Make sure that when you mix the anti-freeze and water, the ratio of anti-freeze is less than 50 %.**

Vol % Anti-freeze	Freezing Point		Boiling Point*	
	°C	°F	°C	°F
40	−24	−11	106	223
50	−37	−35	108	226

* At 1.01 × 100000 Pa (760 mmHg) pressure (atmospheric). Use a radiator pressure cap that lets the pressure collect in the cooling system to get a higher boiling point.

■ **NOTE**

- **The above data is the industrial standards that shows the minimum glycol content necessary in the concentrated anti-freeze.**
- **When the coolant level decreases because of evaporation, add clean, soft water only to keep the anti-freeze mixing ratio less than 50 %. If there is a leakage, add anti-freeze and clean, soft water in the specified mixing ratio.**
- **The anti-freeze absorbs moisture. Keep new anti-freeze in a tightly sealed container.**
- **Do not use the radiator cleaning agents after you add anti-freeze to the coolant. Anti-freeze contains an anti-corrosive agent, which reacts with the radiator cleaning agent to make sludge and cause damages to the engine parts.**

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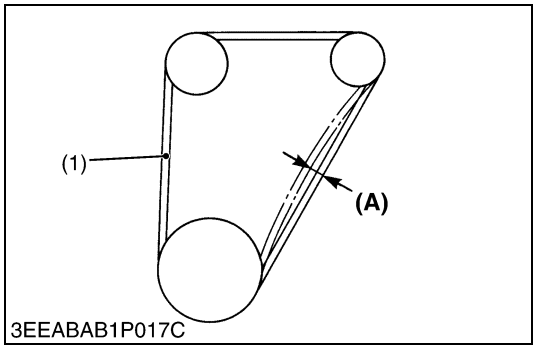


Replacement of Fan Belt

1. Remove the alternator.
2. Remove the fan belt (1).
3. Replace the fan belt with a new one.
4. Install the alternator.
5. Check the fan belt tension.

Sonic belt tension meter setting value	
Mass (Mass per 1 rib 1 m of belt)	110 g/rib/m
Width (Number of ribs)	1
Span (Distance of between the fan drive pulley and alternator pulley)	measured

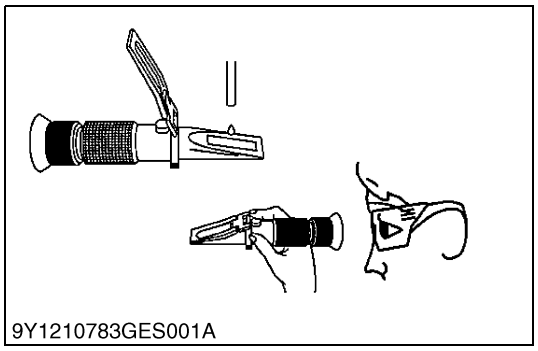
Belt tension (Replacement)	Service specification	460 to 680 N 46.9 to 69.3 kgf 104 to 152 lbf

Deflection **(A)**	Service specification	10 to 12 mm (0.40 to 0.47 in.) deflection at 98 N (10 kgf, 22 lbf) of force

(1) Fan Belt **(A) Deflection**

9Y1210967GEG0093US0

[9] CHECK POINTS FOR EVERY 1 OR 2 MONTHS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Battery Specific Gravity

CAUTION

- **If battery acid (dilute sulfuric acid) gets on you it could cause blindness or burns, or could cause corrosion of machinery and tools so please be careful when handling.**
- **Wear safety glasses and rubber gloves when performing battery maintenance and inspection (measuring specific gravity, filling water, or charging).**
- **If the gas that is generated is ignited by an ignition source, it may explode so be very careful with sparks and fire.**
- **Keep your body and face as far away from the battery as you can when performing maintenance and inspection.**
- **Do not allow people who do not know how to handle a battery or who do not sufficiently understand the danger perform inspection or maintenance.**

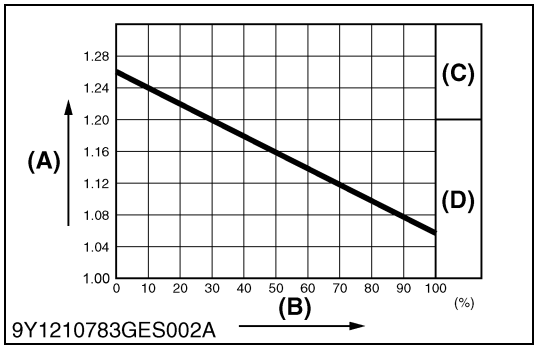
(Measurement items)

■ **Zero adjustment**

1. Open the cover and drip water on the prism surface using the included rod.
2. Close the cover.
3. Aim in a direction that is bright, look into the lens, and adjust the focus until the gradations can be seen clearly.
4. If the boundary line is not on the gradation baseline (0 position), turn the adjustment screw until it matches.
5. When zero adjustment is complete, wipe the prism and cover surface with a soft cloth or tissue paper.

■ **Measurement of test fluid**

1. Open the cover and drip test fluid on the prism surface using the included rod.
2. Close the cover.
3. Aim in a direction that is bright, look into the lens and read the gradation of the blue boundary line.
4. When the measurement is complete, wipe the prism and cover surface with a soft cloth or tissue paper.



9Y1210783GES002A

(Reference)

Electrolyte specific gravity and amount of discharge.
Use the following table as a reference.

(A) Electrolyte Specific Gravity
(B) Discharge
(C) Good
(D) Charging is necessary.

■ **NOTE**

Temperature conversion of electrolyte specific gravity

- **Battery electrolyte specific gravity changes based on temperature.**
- **Insert the value identified on a specific gravity meter into the following conversion equation for temperature correction to learn an accurate specific gravity value. (Standard temperature assumed to be 20 °C (68 °F))**
  D_{20} = Dt + 0.0007 (t - 20)
  D_{20} = specific gravity value converted to standard temperature of 20 °C (68 °F)
  D_t = measured specific gravity value at the electrolyte temperature t °C

9Y1210967GEG0124US0

Recharge of Battery

CAUTION

- **The battery gas can cause an explosion. Keep the sparks and open flames away from the battery at all times, especially when you charge the battery.**
- **When you charge the battery, remove the battery vent plugs.**
- **When you disconnect the cable from the battery, start with the negative terminal first. When you connect the cable to the battery, start with the positive terminal first.**
- **Do not put an object made of metal across the terminals to do a test on the battery charge. Use a voltmeter or hydrometer to do a test on the battery charge.**

1) Slow Charge

1. Add distilled water if the electrolyte level is low. When you charge, the quantity of electrolyte must be lower than the specified level to make sure that it does not spill.
2. Connect the battery to the charging unit, obey the manufacturer instructions.
3. When you charge, remove all vent plugs to release the battery gas.
4. The electrolyte temperature must not be more than 40 °C (104 °F) when you charge.
   If it is more than 40 °C (104 °F), decrease the charging amperage or do not charge for a while.
5. When you charge a few batteries in series, charge at the rate of the smallest battery in the line.

2) Quick Charge

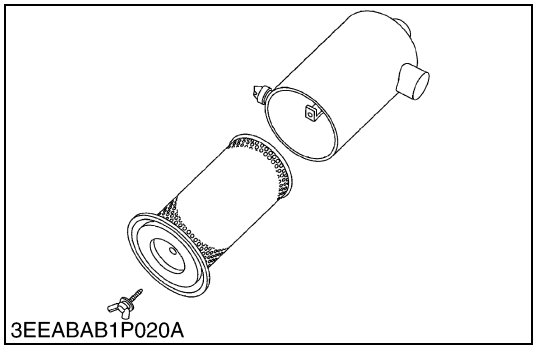
1. Find the correct current and time to charge at with the tester attached to the quick charger.
2. Find the correct current that you charge at as 1/1 of the battery capacity. If the battery capacity is more than 50 Ah, use 50 A as the maximum.

■ **Precaution when you operate a Quick Charger**

- The type of quick charger is different on its operation.
  Refer to the instruction manual.

9Y1210967GEG0094US0

[10] CHECK POINTS FOR EVERY YEAR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Replacement of Air Cleaner Element

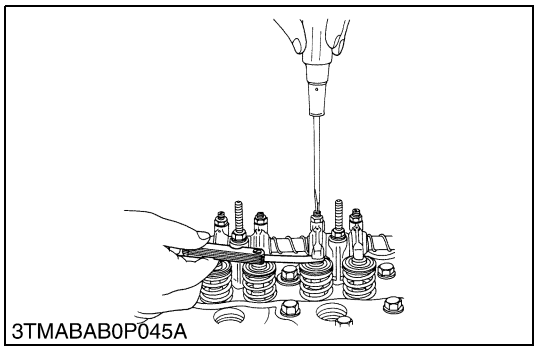
1. Remove used air cleaner element.
2. Replace it with a new one.

■ **NOTE**

- **The air cleaner uses a dry element. Do not apply oil to it.**
- **Do not operate the engine without the filter element.**

9Y1210967GEG0095US0

[11] CHECK POINTS FOR EVERY 800 HOURS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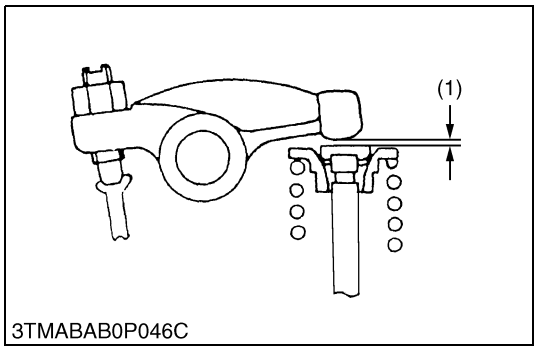

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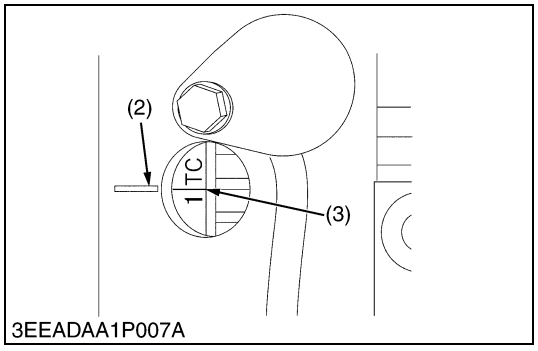

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Valve Clearance

■ **IMPORTANT**

- **You must check and adjust the valve clearance when the engine is cold.**

1. Remove the head cover.
2. Align the **"1TC"** mark line (3) on the flywheel and projection (2) on the housing. Make sure that the No.1 piston comes to the compression or overlap top dead center.
3. Check the subsequent valve clearance (1) at the mark "☆" with a feeler gauge.
4. If the clearance is out of the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory specification	0.18 to 0.22 mm 0.0071 to 0.0086 in.

■ **NOTE**

- **The "1TC" mark line on the flywheel is only for the No. 1 cylinder. There is no "TC" mark for the other cylinders.**
- **Align the "TC" mark with the projection (2) in the window on the flywheel-housing. No. 1 piston is on the top dead center position at this time. Turn the flywheel 0.26 rad (15 °) to see if the piston is at the compression top dead center or the overlap position. Refer to the table below to adjust the valve clearance (1) again. (The piston is at the compression top dead center when both the IN. and EX. valves do not move. The piston is at the overlap position when both the valves move.)**
- **Turn the flywheel 6.28 rad (360°) and align the "1TC" mark line with the projection (2) correctly. Adjust all the other valve clearance if necessary.**
- **After you turn the flywheel counterclockwise 2 or 3 times, check the valve clearance (1) again.**
- **After you adjust the valve clearance (1), tighten the lock nut of the adjusting screw.**

Adjustable Cylinder Location of Piston		**Valve Arrangement**	
		Intake Valve	**Exhaust Valve**
When No. 1 piston is at compression top dead center	No. 1	☆	☆
	No. 2		☆
	No. 3	☆	
When No. 1 piston is at overlap position	No. 1		
	No. 2	☆	
	No. 3		☆

(1) Valve Clearance
(2) Projection
(3) 1TC Mark Line

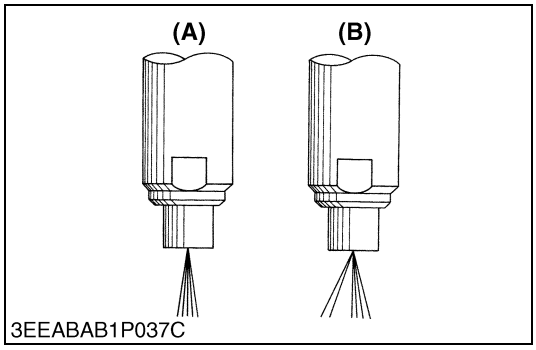
9Y1210967GEG0096US0

[12] CHECK POINTS FOR EVERY 1500 HOURS

CAUTION

- **Check the injection pressure and condition after you make sure that there is no one in the direction of the fumes.**
- **If the fumes from the nozzle directly touches the human body, they can cause damage to the cells and blood poisoning.**

9Y1210967GEG0097US0



3EEABAB1P037C

Nozzle Fume Condition

[D1503-M-E4BG]

1. Set the injection nozzle to a nozzle tester, and check the condition of the fumes from the nozzle.
2. If the fume condition is damaged, replace the nozzle piece.

(A) Good **(B) Bad**

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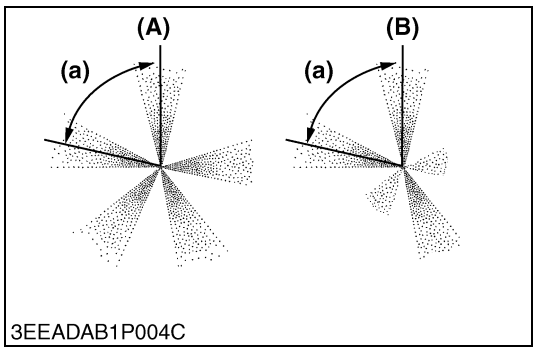


3EEADAB1P004C

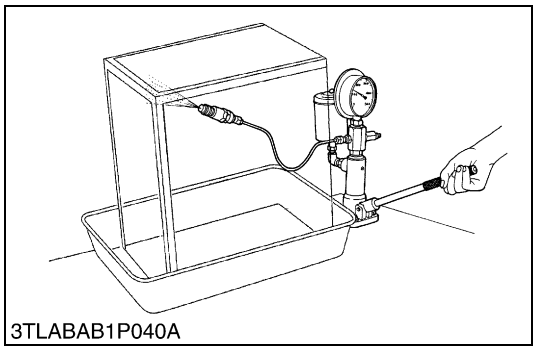
Nozzle Fume Condition

[D1703-M-DI-E4B]

1. Set the injection nozzle to a nozzle tester, and check the condition of the fumes from the nozzle.
2. If the fume condition is damaged, replace the injection nozzle assembly.

(A) Good **(a) 1.3 rad (72°)**
(B) Bad

9Y1210967GEG0099US0


3TLABAB1P040A

Fuel Injection Pressure

[D1503-M-E4BG]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester lever to measure the pressure at which the fuel start to jet out from the nozzle.
3. If the measurement is out of the factory specifications, replace the adjusting washer (1) in the nozzle holder.

(Reference)

- The pressure variation with 0.025 mm (0.00098 in.) difference in washer thickness is approximately 590 kPa (6.0 kgf/cm^2, 85 psi).

Fuel injection pressure	Factory specification	13.8 to 14.7 MPa 140 to 150 kgf/cm^2 2000 to 2130 psi

(1) Adjusting Washer

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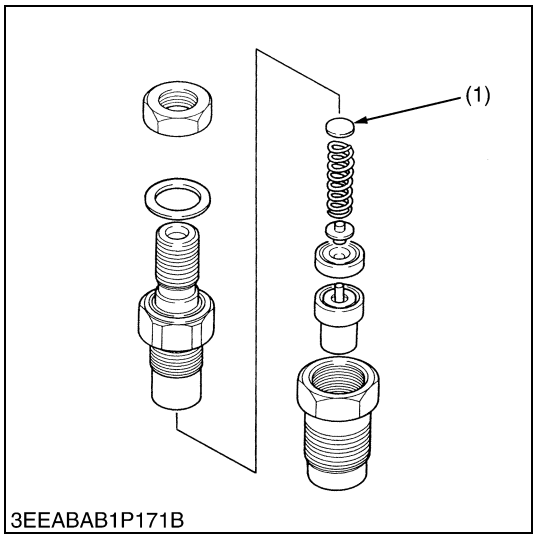

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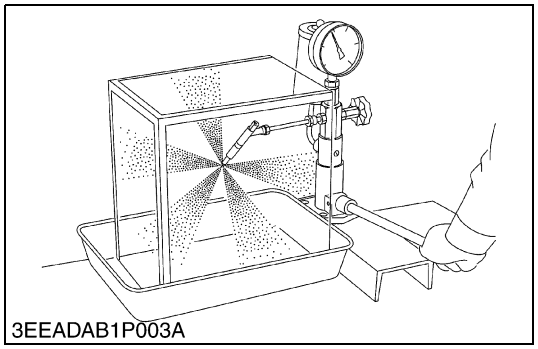
3EEADAB1P003A

Fuel Injection Pressure

[D1703-M-DI-E4B]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester lever to measure the pressure at which the fuel start to jet out from the nozzle.
3. If the measurement is out of the factory specifications, replace the injection nozzle assembly.

Fuel injection pressure (1st stage)	Factory specification	18.7 to 20.1 MPa 190 to 205 kgf/cm^2 2710 to 2910 psi

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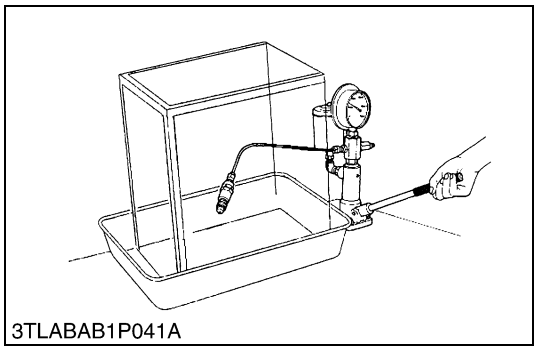
3TLABAB1P041A

Valve Seat Tightness

[D1503-M-E4BG]

1. Set the injection nozzle to a nozzle tester.
2. Increase the fuel pressure, and keep it at 12.7 MPa (130 kgf/cm^2, 1850 psi) for 10 seconds.
3. If you find a fuel leakage, replace the nozzle piece.

Valve seat tightness	Factory specification	No fuel leak at 12.7 MPa 130 kgf/cm^2 1850 psi

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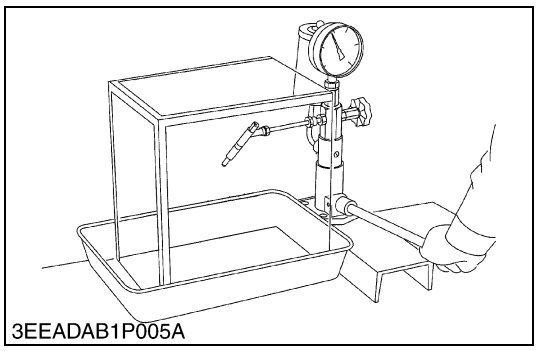
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Valve Seat Tightness

[D1703-M-DI-E4B]

1. Set the injection nozzle to a nozzle tester.
2. Increase the fuel pressure, and keep it at 16.7 MPa (170 kgf/cm^2, 2420 psi) for 10 seconds.
3. If you find a fuel leakage, replace the injection nozzle assembly.

Valve seat tightness	Factory specification	No fuel leak at 16.7 MPa 170 kgf/cm^2 2420 psi

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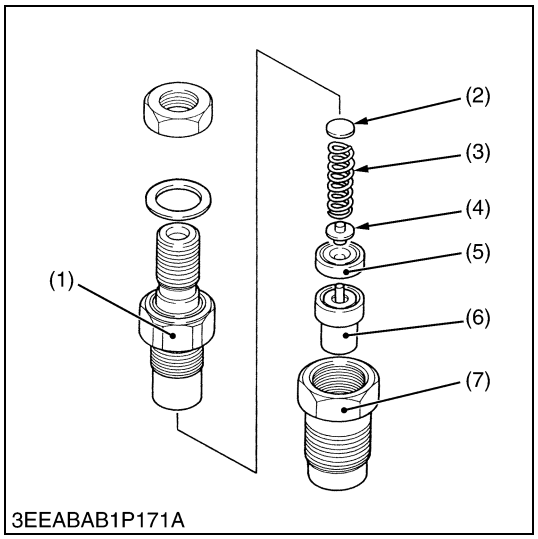

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Nozzle Holder

[D1503-M-E4BG]

1. Hold the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1) and internal parts.

(When reassembling)

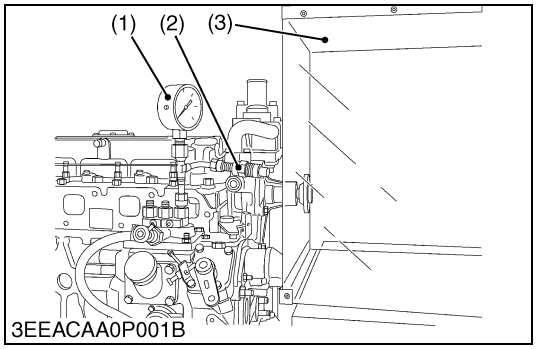
- Assemble the nozzle in clean fuel oil.
- Install the push rod (4) correctly in its direction.
- After you assemble the nozzle, adjust the fuel injection pressure.

Tightening torque	Nozzle holder	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Overflow pipe retaining nut	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft

(1) Nozzle Holder
(2) Adjusting Washer
(3) Nozzle Spring
(4) Push Rod
(5) Distance Piece
(6) Nozzle Piece
(7) Nozzle Retaining Nut

9Y1210967GEG0104US0

[13] CHECK POINTS FOR EVERY 3000 HOURS



Check of Injection Pump

[D1503-M-E4BG]

Fuel Tightness of Pump Element

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the injection pump pressure tester to the injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Crank the engine with the starter to increase the pressure.
7. If the pressure is lower than the allowable limit, replace the pump with a new one.
   You can also repair the pump at a Kubota-authorized pump service shop.

Fuel Tightness of Delivery Valve

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the pressure tester to the fuel injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1).
5. Crank the engine with the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. Then turn the flywheel manually and increase the pressure to approximately 13.7 MPa (140 kgf/cm^2, 1990 psi).
7. Turn the flywheel back about half a turn (to keep the plunger free) and keep the flywheel at this position.
8. Measure the time for the pressure to decrease from 13.7 to 12.7 MPa (from 140 to 130 kgf/cm^2, from 1990 to 1850 psi).
9. If the measurement is less than allowable limit, replace the pump with a new one.
   You can also repair the pump at a Kubota-authorized pump service shop.

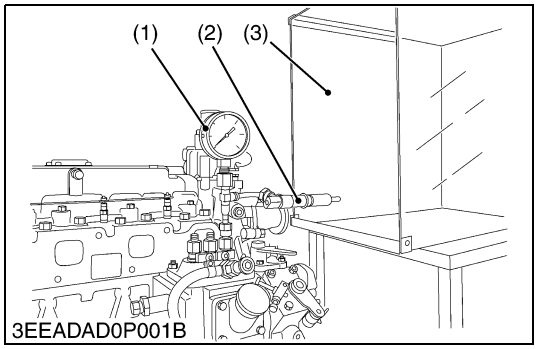
Fuel tightness of pump element	Allowable limit	13.7 MPa 140 kgf/cm^2 1990 psi
Fuel tightness of delivery valve	Factory specification	10 seconds 13.7 → 12.7 MPa 140 → 130 kgf/cm^2 1990 → 1850 psi
	Allowable limit	5 seconds 13.7 → 12.7 MPa 140 → 130 kgf/cm^2 1990 → 1850 psi

■ **NOTE**

- **Do not try to disassemble the injection pump assembly. Repair the pump at a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

9Y1210967GEG0105US0



Check of Injection Pump

[D1703-M-DI-E4B]

Fuel Tightness of Pump Element

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the injection pump pressure tester to the injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Crank the engine with the starter to increase the pressure.
7. If the pressure is lower than the allowable limit, replace the pump with a new one.
   You can also repair the pump at a Kubota-authorized pump service shop.

Fuel Tightness of Delivery Valve

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the pressure tester to the fuel injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1).
5. Crank the engine with the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. Then turn the flywheel manually and increase the pressure to approximately 18.6 MPa (190 kgf/cm^2, 2700 psi).
7. Turn the flywheel back about half a turn (to keep the plunger free) and keep the flywheel at this position.
8. Measure the time for the pressure to decrease from 18.6 to 17.7 MPa (from 190 to 180 kgf/cm^2, from 2700 to 2560 psi).
9. If the measurement is less than allowable limit, replace the pump with a new one.
   You can also repair the pump at a Kubota-authorized pump service shop.

Fuel tightness of pump element	Allowable limit	18.6 MPa 190 kgf/cm^2 2700 psi
Fuel tightness of delivery valve	Factory specification	10 seconds 18.6 → 17.7 MPa 190 → 180 kgf/cm^2 2700 → 2560 psi
	Allowable limit	5 seconds 18.6 → 17.7 MPa 190 → 180 kgf/cm^2 2700 → 2560 psi

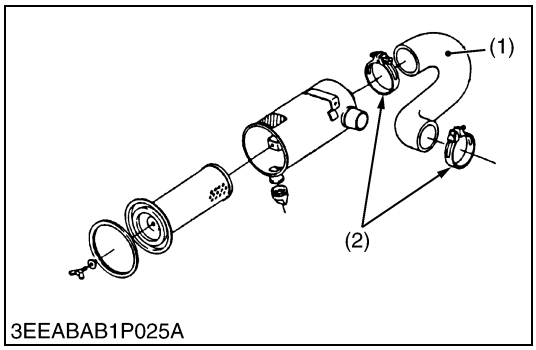
■ **NOTE**

- **Do not try to disassemble the injection pump assembly. Repair the pump at a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

9Y1210967GEG0106US0

[14] CHECK POINTS FOR EVERY 2 YEARS



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Replacement of Intake Air Line

1. Loosen the clamp (2).
2. Remove the intake air hose (1) and clamp (2).
3. Replace the intake air hose (1) and clamp (2) with new ones.
4. Tighten the clamp (2) correctly.

■ **NOTE**

- **To prevent serious damage to the engine, keep out dust in the intake air line.**

(1) Intake Air Hose (2) Clamp

9Y1210967GEG0107US0

Replacement of Battery

CAUTION

- **The battery gas can cause an explosion. Keep the sparks and open flames away from the battery at all times, especially when you charge the battery.**
- **When you charge the battery, remove the battery vent plugs.**
- **When you disconnect the cable from the battery, start with the negative terminal first. When you connect the cable to the battery, start with the positive terminal first.**
- **Do not put an object made of metal across the terminals to do a test on the battery charge. Use a voltmeter or hydrometer to do a test on the battery charge.**

1. Disconnect the negative terminal and positive terminal.
2. Remove the battery holder.
3. Remove the used battery.
4. Replace the battery with a new one.
5. Tighten the battery holder.
6. Connect the positive terminal.
7. Connect the negative terminal.

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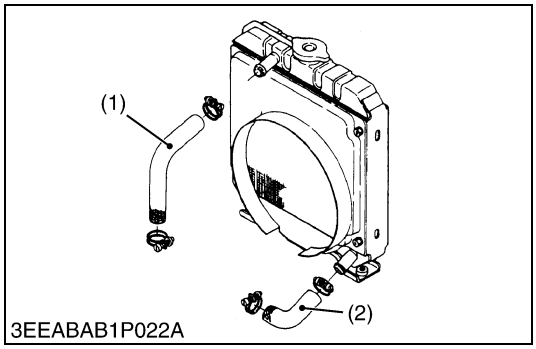

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Replacement of Radiator Hoses and Clamp Bands

CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen the cap to the stop to release unwanted pressure before you remove the cap fully.**

1. Drain the coolant.
2. Loosen the clamp bands.
3. Remove the upper hose (1) and lower hose (2).
4. Replace the upper / lower hose (1), (2) and clamp bands with new ones.
5. Tighten the clamp bands correctly.
6. Fill with clean water and anti-freeze until the coolant level is immediately below the port. Install the radiator cap correctly.

(1) Upper Hose (2) Lower Hose

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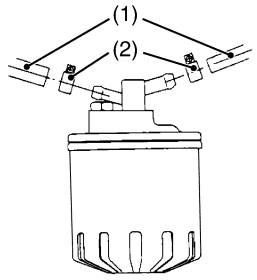
[A]



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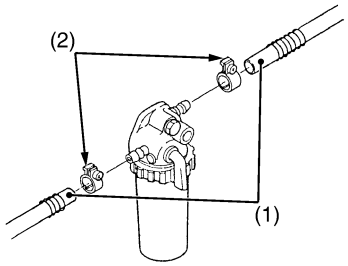
[B]



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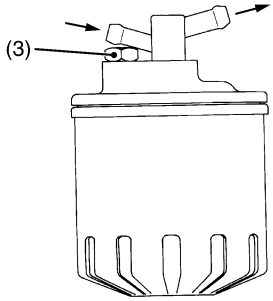
[A]



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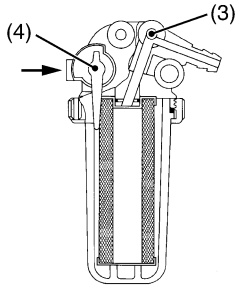
[B]



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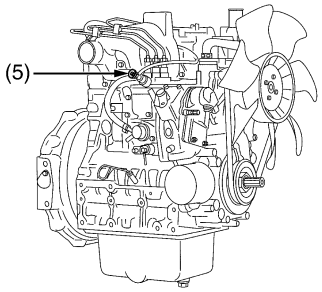

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Replacement of Fuel Hoses and Clamp Bands

CAUTION

- **Stop the engine before you do the check below.**

1. Loosen the clamp (2) and remove the fuel hose (1).
2. Replace the fuel hose (1) and clamp (2) with new ones.
3. Tighten the clamp (2) correctly.

(When you bleed the fuel system)

1. Fill the tank with fuel.
2. Open the fuel valve (4). (**[B]** only)
3. Loosen the air vent plug (3) of the fuel filter by a few turns.
4. Tighten the plug when the bubbles do not come up.
5. Open the air vent valve (5) on top of the fuel injection pump.
6. **Engine with the electrical fuel feed pump**
   Turn the key to the AC position and supply the fuel with the pump for 10 to 15 seconds.
   Engine with the mechanical fuel feed pump
   Set the stop lever on STOP position and crank the engine with the starter for 10 to 15 seconds.
7. Close the air vent valve correctly after you bled the air.

NOTE

- **Always keep the air vent valve on the fuel injection pump closed unless when you release the air. If not, it can cause the engine to stop.**

(1) Fuel Hose
(2) Clamp
(3) Air Vent Plug
(4) Fuel Valve
(5) Air Vent Valve

[A] Cartridge Type
[B] Element Type

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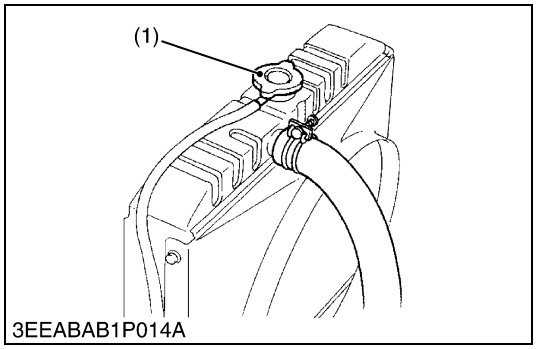

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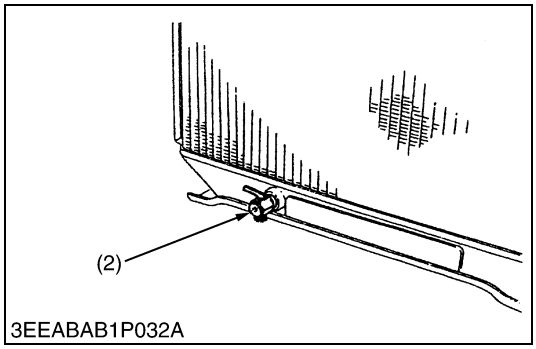

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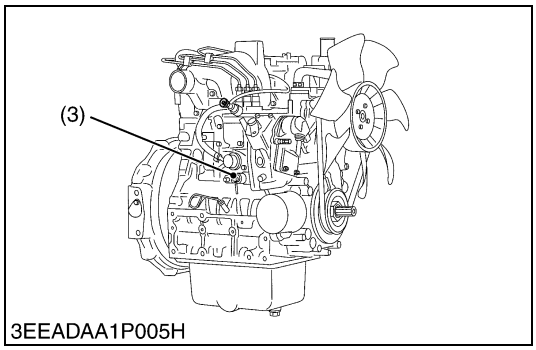

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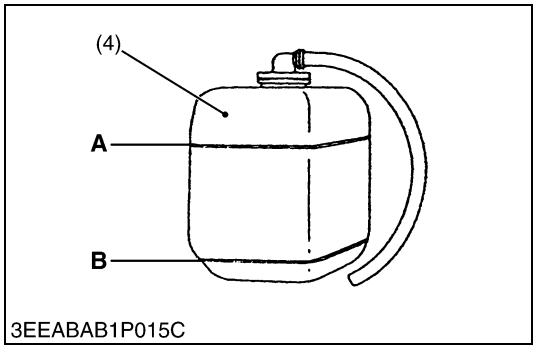

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Change of Radiator Coolant (L.L.C.)

⚠ CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen the cap slightly to release unwanted pressure before you remove the cap fully.**

1. Stop the engine and let the coolant temperature decreases.
2. Remove the radiator cap (1) to drain the coolant fully.
3. Open the drain valve (2) and (3).
4. After you drained all coolant, close the drain valves.
5. Fill with clean water and cooling system cleaner.
6. Obey the directions of the cleaner instruction.
7. After you flush, fill with clean water and anti-freeze until the coolant level is immediately below the port. Install the radiator cap (1) correctly.
8. Fill with the coolant until the "FULL" **A** mark on the recovery tank (4).
9. Start and operate the engine for a few minutes.
10. Stop the engine and let the coolant temperature decreases. Check the coolant level of radiator and recovery tank (4) and add coolant if necessary.

■ **IMPORTANT**

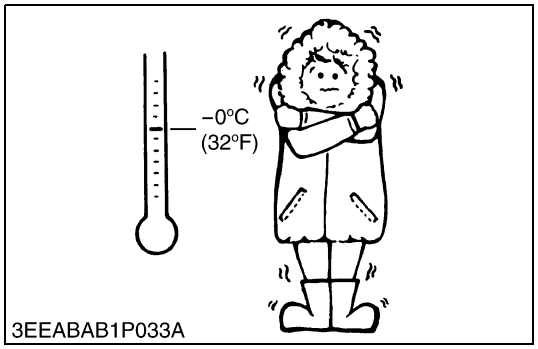
- **Do not start the engine without coolant.**
- **Use clean and soft water with anti-freeze to fill the radiator and recovery tank.**
- **Make sure that when you mix the anti-freeze and water, the ratio of anti-freeze is less than 50 %.**
- **Make sure that you close the radiator cap correctly. If the cap is loose or incorrectly closed, coolant can flow out and the engine can overheat.**

(1) Radiator Cap
(2) Drain Valve
(3) Drain Valve
(4) Recovery Tank

A: FULL
B: LOW

(To be continued)

(Continued)



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■ **Anti-freeze**

- There are 2 types of anti-freeze available: use the permanent type (PT) for this engine.
- When you add anti-freeze for the first time, flush the water jacket and radiator interior with clean, soft water several times.
- The brand of the anti-freeze and the ambient temperature have an effect on the procedure to mix water and anti-freeze. Refer to the SAE J1034 standard, especially to the SAE J814c.
- Mix the anti-freeze with clean, soft water, and then fill into the radiator.

■ **IMPORTANT**

- **Make sure that when you mix the anti-freeze and water, the ratio of anti-freeze is less than 50 %.**

Vol % Anti-freeze	Freezing Point		Boiling Point*	
	°C	°F	°C	°F
40	−24	−11	106	223
50	−37	−35	108	226

* At 1.01 × 100000 Pa (760 mmHg) pressure (atmospheric). Use a radiator pressure cap that lets the pressure collect in the cooling system to get a higher boiling point.

■ **NOTE**

- **The above data is the industrial standards that shows the minimum glycol content necessary in the concentrated anti-freeze.**
- **When the coolant level decreases because of evaporation, add clean, soft water only to keep the anti-freeze mixing ratio less than 50 %. If there is a leakage, add anti-freeze and clean, soft water in the specified mixing ratio.**
- **The anti-freeze absorbs moisture. Keep new anti-freeze in a tightly sealed container.**
- **Do not use the radiator cleaning agents after you add anti-freeze to the coolant. Anti-freeze contains an anti-corrosive agent, which reacts with the radiator cleaning agent to make sludge and cause damages to the engine parts.**

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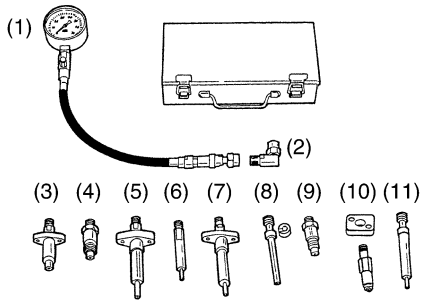
5. SPECIAL TOOLS



3EEABAE0P002A

Diesel Engine Compression Tester (for Injection Nozzle)

[D1503-M-E4BG]

Code No.

- 07909-30208 (Assembly)
- 07909-30934 (**A** to **F**)
- 07909-31211 (**E** and **F**)
- 07909-31231 (**H**)
- 07909-31251 (**G**)
- 07909-31271 (**I**)
- 07909-31281 (**J**)

Application

- To measure the diesel engine compression and to make a decision for a large overhaul if necessary.

Adaptor

- The adaptor **H** is necessary for the D1503-M-E4BG.

(1) Gauge
(2) **L** Joint
(3) Adaptor **A**
(4) Adaptor **B**
(5) Adaptor **C**
(6) Adaptor **E**
(7) Adaptor **F**
(8) Adaptor **G**
(9) Adaptor **H**
(10) Adaptor **I**
(11) Adaptor **J**

9Y1210967GEG0112US0

■ **NOTE**

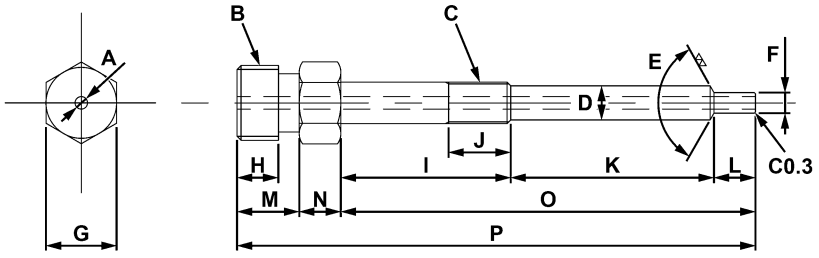
- **You do not have the special tools below. Refer to the figure to make them yourselves.**

9Y1210967GEG0115US0

Compression Tester Adapter K

Application

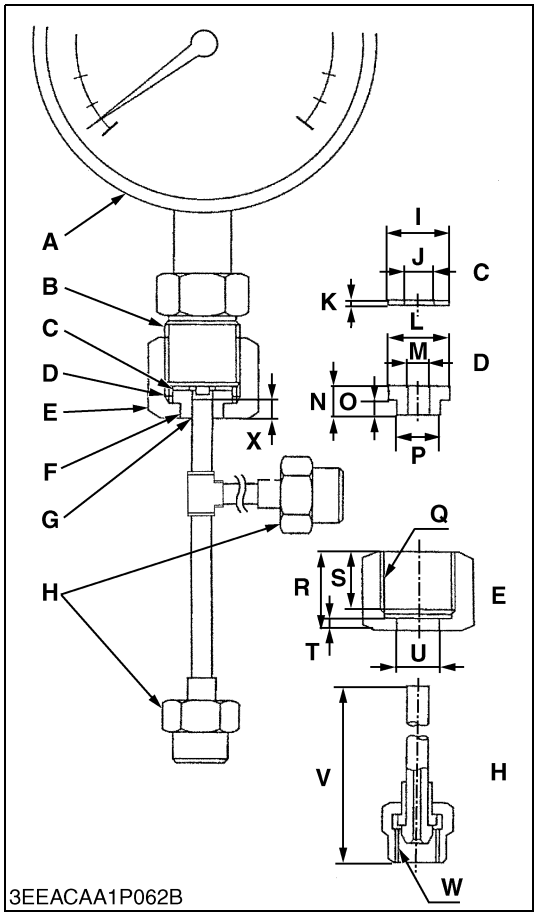
- To check the compression pressure through glow plug hole.



9Y1210967GES002A

A	3 mm dia. (0.1 in. dia.) through hole	**J**	15 mm (0.59 in.)
B	5/8-18UNF	**K**	49 mm (1.9 in.)
C	M10 × P1.25	**L**	10 mm (0.39 in.)
D	8.0 to 8.2 mm dia. (0.31 to 0.32 in. dia.)	**M**	15 mm (0.59 in.)
E	2.06 to 2.09 rad (118 to 120°)	**N**	10 mm (0.39 in.)
F	4.8 to 5.2 mm dia. (0.19 to 0.20 in. dia.)	**O**	100 mm (3.94 in.)
G	17 mm (0.67 in.)	**P**	125 mm (4.92 in.)
H	10 mm (0.39 in.)	**C0.3**	Chamfer 0.3 mm (0.01 in.)
I	41 mm (1.6 in.)		

9Y1210967GEG0127US0



3EEACAA1P062B

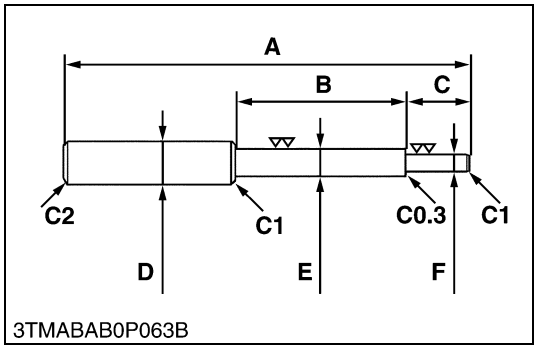
Injection Pump Pressure Tester

Application

- To check the fuel tightness of injection pumps.

A	Pressure gauge full scale: More than 29.4 MPa (300 kgf/cm^2, 4267 psi)
B	PF 1/2
C	Copper gasket
D	Flange (Material: Steel)
E	Hex. nut 27 mm (1.1 in.) across the plat
F	Adhesive application
G	Fillet welding on the enter circumference
H	Retaining nut
I	17 mm dia. (0.67 in. dia.)
J	8 mm dia. (0.3 in. dia.)
K	1.0 mm (0.039 in.)
L	17 mm dia. (0.67 in. dia.)
M	6.10 to 6.20 mm dia. (0.241 to 0.244 in. dia.)
N	8 mm (0.3 in.)
O	4 mm (0.2 in.)
P	11.97 to 11.99 mm dia. (0.4713 to 0.4720 in. dia.)
Q	PF 1/2
R	23 mm (0.91 in.)
S	17 mm (0.67 in.)
T	4 mm (0.2 in.)
U	12.00 to 12.02 mm dia. (0.4725 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5 mm (0.2 in.)

9Y1210967GEG0116US0



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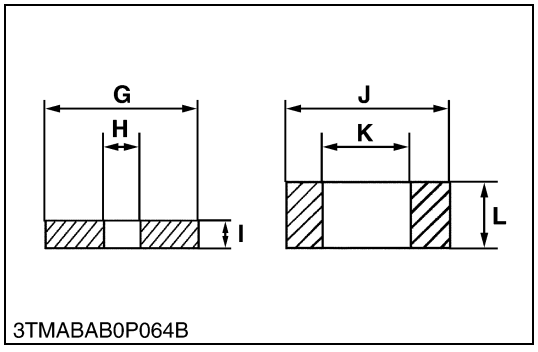


3TMABAB0P064B

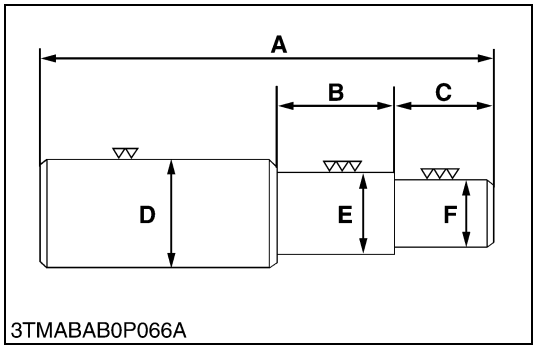
Valve Guide Replacing Tool

Application

- To press out and press fit the valve guide.

A	225 mm (8.86 in.)
B	70 mm (2.8 in.)
C	45 mm (1.8 in.)
D	20 mm dia. (0.79 in. dia.)
E	12.7 to 12.9 mm dia. (0.500 to 0.507 in. dia.)
F	7.50 to 7.60 mm dia. (0.296 to 0.299 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	7.70 to 8.00 mm dia. (0.304 to 0.314 in. dia.)
I	5 mm (0.2 in.)
J	20 mm dia. (0.79 in. dia.)
K	13.5 to 13.8 mm dia. (0.532 to 0.543 in. dia.)
L	8.90 to 9.10 mm (0.351 to 0.358 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.3 mm (0.01 in.)

9Y1210967GEG0117US0



3TMABAB0P066A

Bushing Replacing Tools

Application

- To press out and press fit the bushing.

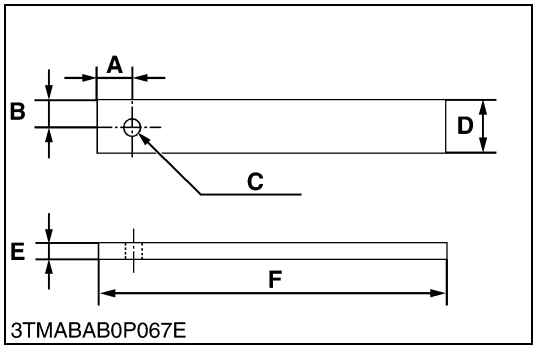
1) For small end bushing

A	162 mm (6.38 in.)
B	35 mm (1.4 in.)
C	27 mm (1.1 in.)
D	35 mm dia. (1.4 in. dia.)
E	27.90 to 27.95 mm dia. (1.099 to 1.100 in. dia.)
F	25.00 to 25.01 mm dia. (0.9843 to 0.9846 in. dia.)

2) For idle gear bushing

A	175 mm (6.89 in.)
B	40 mm (1.6 in.)
C	38 mm (1.5 in.)
D	45 mm dia. (1.8 in. dia.)
E	41.90 to 41.95 mm dia. (1.650 to 1.651 in. dia.)
F	37.950 to 37.970 mm dia. (1.4941 to 1.4948 in. dia.)

9Y1210967GEG0118US0



3TMABAB0P067E

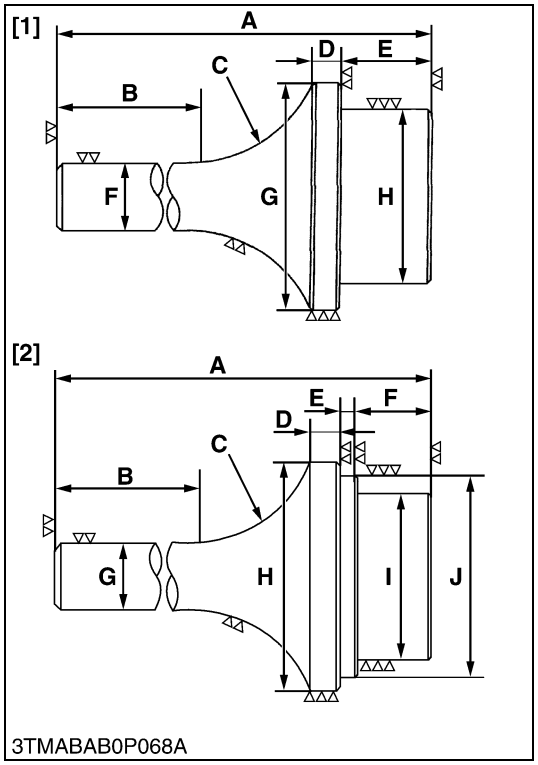
Flywheel Stopper

Application

- To loosen and tighten the flywheel screw.

A	20 mm (0.79 in.)
B	15 mm (0.59 in.)
C	10 mm dia. (0.39 in. dia.)
D	30 mm (1.2 in.)
E	8 mm (0.3 in.)
F	200 mm (7.87 in.)

9Y1210967GEG0119US0



3TMABAB0P068A

Crankshaft Bearing 1 Replacing Tool

Application

- To press out and press fit the crankshaft bearing 1.

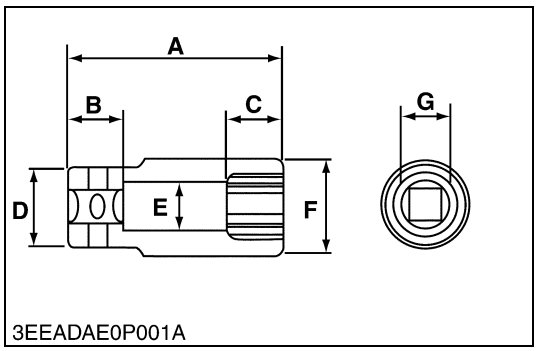
[1] Extracting tool

A	135 mm (5.31 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	64.80 to 64.90 mm dia. (2.552 to 2.555 in. dia.)
H	59.80 to 59.90 mm dia. (2.355 to 2.358 in. dia.)

[2] Inserting tool

A	130 mm (5.12 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	9 mm (0.4 in.)
E	4 mm (0.2 in.)
F	20 mm (0.79 in.)
G	20 mm dia. (0.79 in. dia.)
H	68 mm dia. (2.7 in. dia.)
I	59.80 to 59.90 mm dia. (2.355 to 2.358 in. dia.)
J	64.80 to 64.90 mm dia. (2.552 to 2.555 in. dia.)

9Y1210967GEG0120US0



3EEADAE0P001A

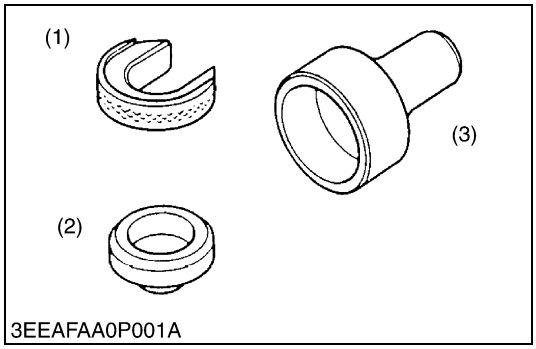
Socket Wrench for Fan Drive Pulley Nut (46 mm Deep Socket Wrench)

Application

- To loosen and tighten the mounting nut of fan drive pulley.

A	100 mm (3.94 in.)
B	25.0 mm (0.984 in.)
C	27.0 mm (1.06 in.)
D	45.0 mm dia. (1.77 in. dia.)
E	35.0 mm dia. (1.38 in. dia.)
F	62.5 mm dia. (2.46 in. dia.)
G	46.0 mm (1.81 in.)

9Y1210967GEG0121US0



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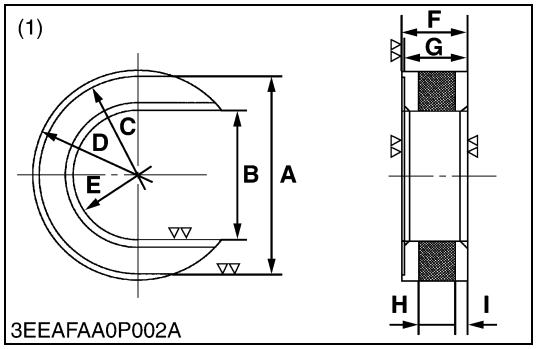


3EEAFAA0P002A

Auxiliary Socket for Fixing Crankshaft Sleeve

Application

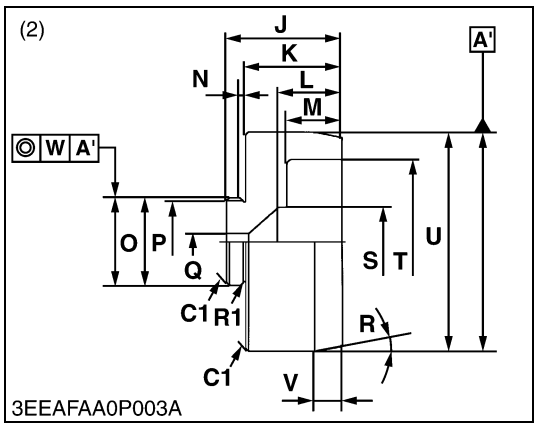
- To fix the crankshaft sleeve of the diesel engine.

A	80.0 mm (3.15 in.)
B	60.10 to 60.30 mm (2.367 to 2.374 in.)
C	80.0 mm dia. (3.15 in. dia.)
D	85.0 mm dia. (3.35 in. dia.)
E	60.10 to 60.30 mm dia. (2.367 to 2.374 in. dia.)
F	26.30 to 26.40 mm (1.036 to 1.039 in.)
G	25.85 to 25.90 mm (1.018 to 1.019 in.)
H	15.0 mm (0.591 in.)
I	5.0 mm (0.20 in.)

(1) Stopper
(2) Sleeve Guide
(3) Auxiliary Socket for Pushing

(To be continued)

(Continued)



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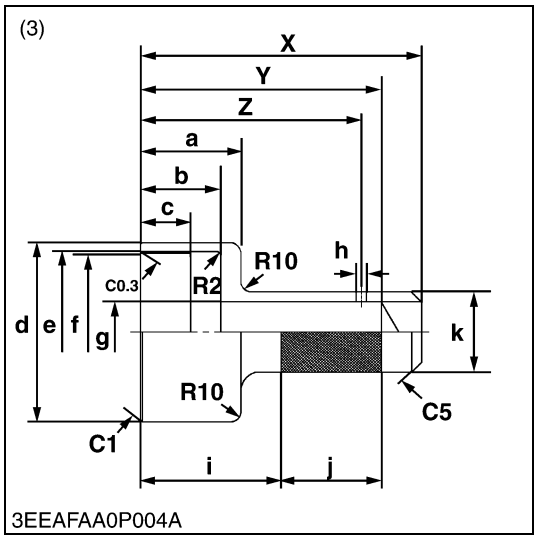

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Application

- To fix the crankshaft sleeve of the diesel engine.

J	42.0 mm (1.65 in.)
K	30.50 to 30.60 mm (1.201 to 1.204 in.)
L	23.0 mm (0.906 in.)
M	20.0 mm (0.787 in.)
N	2.0 mm (0.079 in.)
O	31.911 to 31.950 mm dia. (1.2564 to 1.2578 in. dia.)
P	30.0 mm dia. (1.18 in. dia.)
Q	5.0 mm dia. (0.20 in. dia.)
R	0.09 rad (5°)
S	25.0 mm dia. (0.984 in. dia.)
T	60.0 mm dia. (2.36 in. dia.)
U	79.80 to 79.85 mm dia. (3.142 to 3.143 in. dia.)
V	10.0 mm (0.394 in.)
W	0.04 mm dia. (0.002 in. dia.)
X	140 mm (5.51 in.)
Y	120 mm (4.72 in.)
Z	110 mm (4.33 in.)
a	50.0 mm (1.97 in.)
b	39.90 to 40.00 mm (1.571 to 1.574 in.)
c	25.0 mm (0.984 in.)
d	90.0 mm dia. (3.54 in. dia.)
e	81.0 mm dia. (3.19 in. dia.)
f	80.10 to 80.15 mm dia. (3.154 to 3.155 in. dia.)
g	30.0 mm dia. (1.18 in. dia.)
h	5.0 mm dia. (0.20 in. dia.)
i	70.0 mm (2.76 in.)
j	50.0 mm (1.97 in.)
k	40.0 mm dia. (1.57 in. dia.)
C1	Chamfer 1.0 mm (0.039 in.)
C5	Chamfer 5.0 mm (0.20 in.)
C0.3	Chamfer 0.3 mm (0.01 in.)
R1	1.0 mm radius (0.039 in. radius)
R2	2.0 mm radius (0.079 in. radius)
R10	10.0 mm radius (0.394 in. radius)

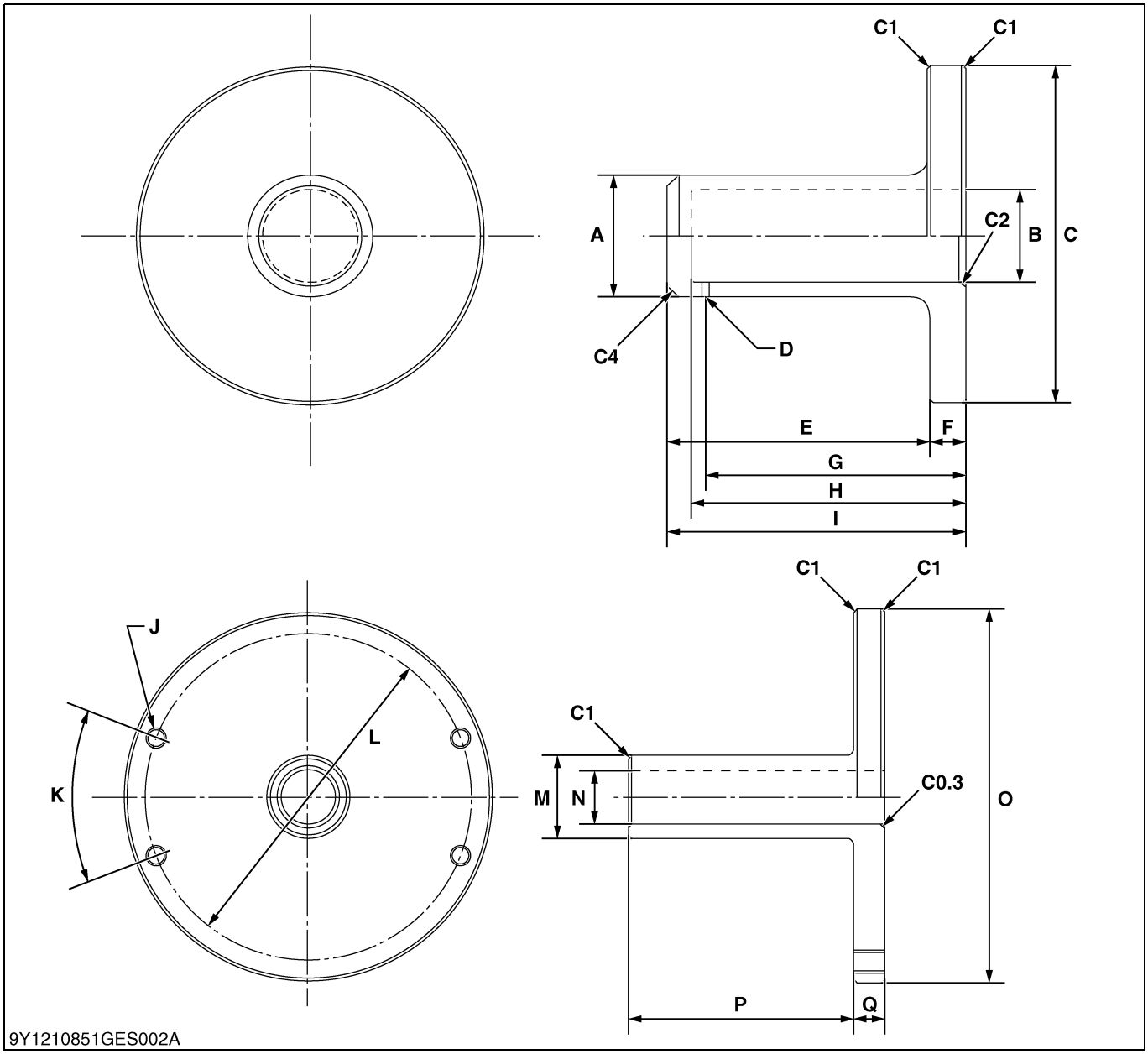
(2) Sleeve Guide (3) Auxiliary Socket for Pushing

9Y1210967GEG0122US0

Bearing Case Cover Oil Seal Replacing Tool

Application

- To install bearing case cover oil seal.



A	42 mm dia. (1.7 in. dia.)	**L**	129 mm dia. (5.08 in. dia.)
B	32.000 to 32.025 mm dia. (1.2599 to 1.2608 in. dia.)	**M**	31.950 to 31.975 mm dia. (1.2579 to 1.2588 in. dia.)
C	116 mm dia. (4.57 in. dia.)	**N**	22 mm dia. (0.87 in. dia.)
D	3 mm dia. (0.1 in. dia.)	**O**	145 mm dia. (5.71 in. dia.)
E	88 mm (3.5 in.)	**P**	90 mm (3.5 in.)
F	12 mm (0.47 in.)	**Q**	12 mm (0.47 in.)
G	88 mm (3.5 in.)	**C0.3**	Chamfer 0.3 mm (0.01 in.)
H	92 mm (3.6 in.)	**C1**	Chamfer 1.0 mm (0.039 in.)
I	100 mm (3.94 in.)	**C2**	Chamfer 2.0 mm (0.079 in.)
J	M8 × Pitch 1.25	**C4**	Chamfer 4.0 mm (0.16 in.)
K	0.70 rad (40°)		

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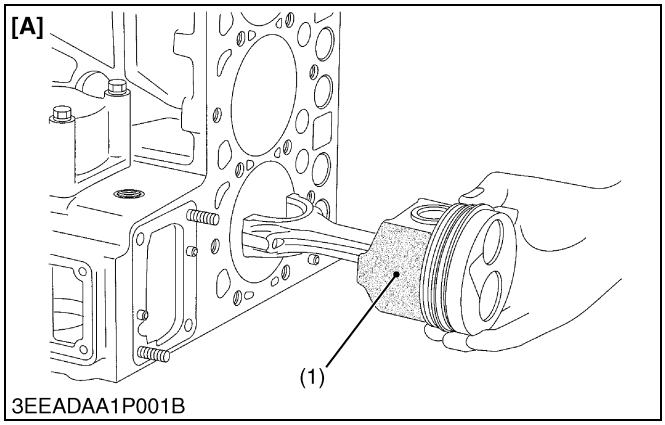
1 ENGINE

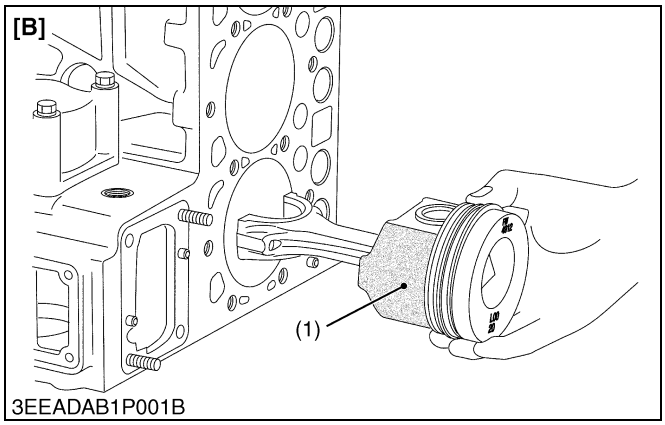
MECHANISM

CONTENTS

1. ENGINE BODY

[1] PISTON





The piston skirt has a layer of **molybdenum disulfide ★**, which decreases the piston slap noise and thus the all the engine noise.

★ Molybdenum disulfide (MoS_2)

The molybdenum disulfide (1) is a solid lubricant, like Graphite or Teflon. This material helps not to wear the metal even with little lube oil.

(1) Molybdenum Disulfide

[A] D1503-M-E4BG
[B] D1703-M-DI-E4B

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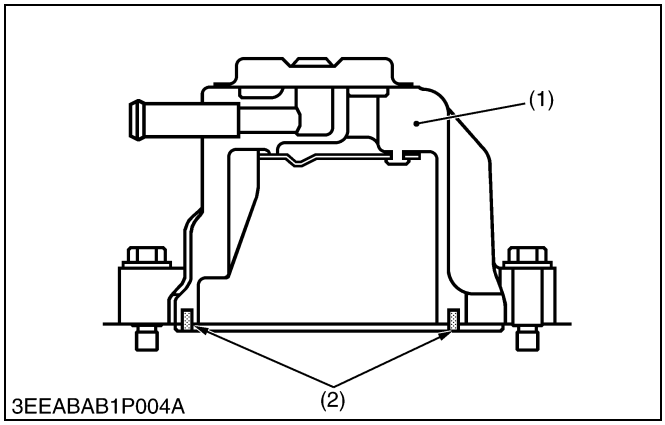
[2] HALF-FLOATING HEAD COVER



The rubber packing (2) is attached to keep the cylinder head cover (1) approximately 0.5 mm (0.02 in.) off the cylinder head. This decreases the noise from the cylinder head.

(1) Cylinder Head Cover (2) Rubber Packing

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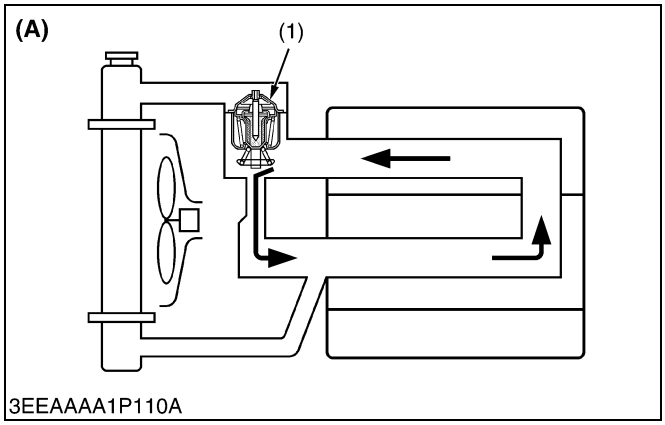
2. COOLING SYSTEM

[1] BOTTOM BYPASS SYSTEM



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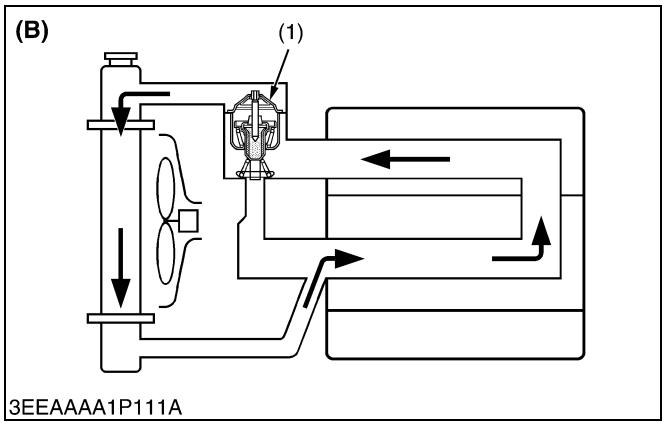

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The 03-M Series have a bottom bypass system to enhance the cooling performance.

When the temperature of the coolant in the engine is low, the thermostat (1) stays closed. This lets the coolant flow through the bypass pipe and around the engine.

When the temperature is more than the thermostat valve opening level, the thermostat (1) opens up fully. The hot coolant cannot flow through the bypass into the engine and can flow into the radiator all. Thus, the radiator can decrease the temperature of the coolant more easily.

(1) Thermostat

(A) Bypass Opened
(B) Bypass Closed

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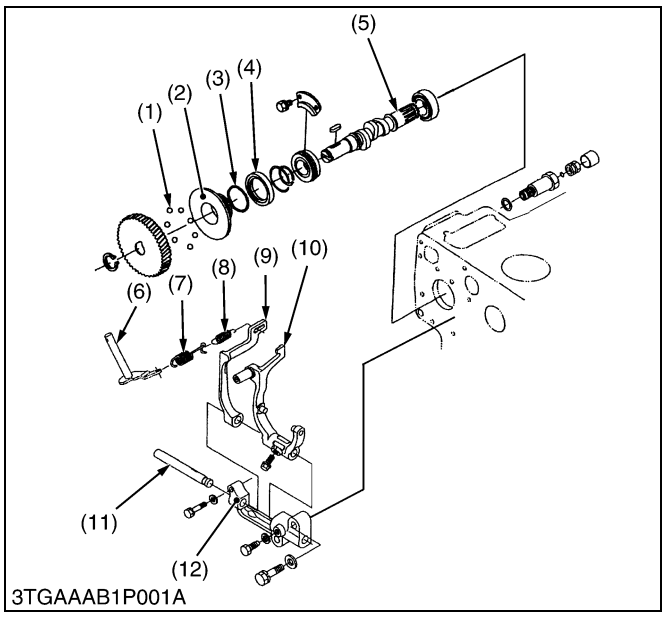
3. FUEL SYSTEM

[1] GOVERNOR



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The governor refers to the load changes to adjust the fuel quantity supplied to the engine automatically. This make sure that the engine speed stays constant. This engine uses an all-speed governor that controls the centrifugal force of the steel ball (1) weight. The fuel camshaft (5) turns and makes this centrifugal force, which balances the tension of the governor spring 1 (7) and 2 (8).

(1) Steel Ball
(2) Governor Sleeve
(3) Steel Ball
(4) Governor Ball Case
(5) Fuel Camshaft
(6) Governor Lever
(7) Governor Spring 1
(8) Governor Spring 2
(9) Fork Lever 2
(10) Fork Lever 1
(11) Fork Lever Shaft
(12) Fork Lever Holder

9Y1210967ENM0004US0

SERVICING

CONTENTS

1. TROUBLESHOOTING

[1] ENGINE BODY

Symptom	Probable Cause	Solution	Reference Page
The engine does not start	No fuel	Fill up the fuel	G-11
	Air in the fuel system	Bleed the air	G-11
	Water in the fuel system	Change the fuel and repair or replace the fuel system	–
	The fuel hose is clogged	Clean or replace	G-11
	The fuel filter is clogged	Replace	G-19
	The viscosity of fuel or engine oil at low temperature is too high	Use the specified fuel or engine oil	I-4, G-10
	The cetane number of fuel is low	Use the specified fuel	I-4
	Fuel leakage because of loose injection pipe retaining nut	Tighten the retaining nut	1-S41
	Incorrect injection timing	Adjust	1-S24, 1-S25
	The fuel camshaft is worn out	Replace	1-S52
	The injection nozzle is clogged	Clean or replace (IDI)	1-S29, 1-S30, 1-S30, 1-S42
		Repair or replace (DI)	1-S29, 1-S30, 1-S42
	The injection pump is damaged	Repair or replace	1-S26, 1-S27, 1-S28, 1-S47
	Seizure of the crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	1-S51, 1-S52, 1-S53, 1-S54, 1-S55, 1-S56, 1-S57, 1-S77, 1-S78, 1-S79, 1-S80, 1-S81, 1-S82, 1-S83
	Compression leakage from the cylinder	Replace the head gasket, tighten the cylinder head screw, glow plug and nozzle holder	1-S41, 1-S42, 1-S42, 1-S44

Symptom	Probable Cause	Solution	Reference Page
The engine does not start	Incorrect valve timing	Correct or replace the timing gear	1-S51
	Piston ring and cylinder are worn out	Replace	1-S18, 1-S19, 1-S54, 1-S55, 1-S56, 1-S57, 1-S75, 1-S76, 1-S82
	Incorrect valve clearance	Adjust	1-S20
	The solenoid is damaged	Replace	1-S35, 1-S47
The starter does not operate	Discharged battery	Charge	G-23, G-24
	Starter is damaged	Repair or replace	1-S33, 1-S41, 1-S61, 1-S84, 1-S85, 1-S85, 1-S86
	The key switch is damaged	Replace	–
	The connection of the wires is incorrect	Connect	–
The engine revolution is not smooth	The fuel filter is clogged or dirty	Replace	G-19
	The air cleaner is clogged	Clean or replace	G-12, G-18, G-24
	Fuel leakage because of loose injection pipe retaining nut	Tighten the retaining nut	1-S41
	The injection pump is damaged	Repair or replace	1-S26, 1-S27, 1-S28, 1-S47
	The nozzle injection pressure is incorrect	Adjust (IDI)	1-S29, 1-S42
		Repair or replace (DI)	1-S30, 1-S42
	The injection nozzle is clogged	Repair or replace	1-S29, 1-S30, 1-S42
	The governor is damaged	Repair	1-S48, 1-S52

Symptom	Probable Cause	Solution	Reference Page
The exhaust gas is white or blue	Too much engine oil	Reduce it to the specified level	G-8
	The piston ring and cylinder is worn out or the piston ring cannot move	Repair or replace	1-S18, 1-S19, 1-S54, 1-S55, 1-S56, 1-S57, 1-S75, 1-S76, 1-S82
	The injection timing is incorrect	Adjust	1-S24, 1-S25
The exhaust gas is black or dark gray	Overload	Decrease the load	–
	The grade of the fuel is low	Use the specified fuel	I-4
	The fuel filter is clogged	Replace	G-19
	The air cleaner is clogged	Clean or replace	G-12, G-18, G-24
	The injection nozzle is damaged	Repair or replace the nozzle	1-S29, 1-S30, 1-S42
The output is deficient	The injection timing is incorrect	Adjust	1-S24, 1-S25
	The moving parts of engine have a seizure	Repair or replace	–
	The injection pump is damaged	Repair or replace	1-S26, 1-S27, 1-S28, 1-S47
	The injection nozzle is damaged	Repair or replace the nozzle	1-S29, 1-S30, 1-S30, 1-S42
	There is compression leakage	Check the compression pressure and repair	1-S18, 1-S19
	The air cleaner is dirty or clogged	Clean or replace	G-12, G-18, G-24

Symptom	Probable Cause	Solution	Reference Page
The lubricant oil consumption is too much	The gap of the piston ring points to the same direction	Move the ring gap direction	1-S54, 1-S55
	The oil ring is worn out or cannot move	Replace	1-S56, 1-S57, 1-S75, 1-S76
	The piston ring groove is worn out	Replace the piston	1-S56, 1-S57, 1-S76
	The valve stem and valve guide are worn out	Replace	1-S46, 1-S65
	The crankshaft bearing and the crankpin bearing is worn out	Replace	1-S54, 1-S55, 1-S60, 1-S78, 1-S79, 1-S80,
	There is an oil leakage because of the seal or packing is damaged	Replace	–
The fuel is mixed into the lubricant oil	The plunger of the injection pump is worn out	Repair or replace	1-S26, 1-S27, 1-S28, 1-S47
	The injection nozzle is damaged	Repair or replace the nozzle	1-S29, 1-S30, 1-S30, 1-S42
	The injection pump is damaged	Replace	1-S47
Water is mixed into the lubricant oil	The head gasket is damaged	Replace	1-S44
	The cylinder block or cylinder head is damaged	Replace	1-S44, 1-S64
The oil pressure is low	The engine oil is not sufficient	Fill up again	G-8
	The oil strainer is clogged	Clean	1-S53
	The relief valve does not operate with dirt	Clean	–
	The relief valve spring is weak or damaged	Replace	–
	The oil clearance of the crankshaft bearing is too much	Replace	1-S59, 1-S79, 1-S80
	The oil clearance of the crankpin bearing is too much	Replace	1-S54, 1-S55, 1-S78
	The oil clearance of the rocker arm is too much	Replace	1-S43, 1-S69
	The oil passage is clogged	Clean	–
	The type of oil used is incorrect	Use the specified type of oil	I-4, G-10
	The oil pump is damaged	Replace	1-S21, 1-S52, 1-S84

Symptom	Probable Cause	Solution	Reference Page
The oil pressure is high	The type of oil used is incorrect	Use the specified type of oil	I-4, G-10
	The relief valve is damaged	Replace	–
The engine is overheated	The engine oil is not sufficient	Fill up again	G-10
	The fan belt is broken or the fan belt tension is too loose	Replace or adjust	G-13, G-22
	The coolant is not sufficient	Fill up again	G-9
	The radiator net and the radiator fin are clogged with dust	Clean	–
	There is corrosion in the inner side of the radiator	Clean or replace	G-20
	There is corrosion in the coolant flow route	Clean or replace	G-20, G-22
	The radiator cap is damaged	Replace	1-S23
	The load is too much	Reduce the load	–
	The head gasket is damaged	Replace	1-S44
	The injection timing is incorrect	Adjust	1-S24, 1-S25
	The fuel used is incorrect	Use the specified fuel	I-4
The battery is discharged quickly	The battery electrolyte is not sufficient	Fill in distilled water and charge	G-12, G-24
	The fan belt slips	Adjust belt tension or replace	G-13, G-13, G-22
	The wires connection is incorrect	Connect again	–
	The rectifier is damaged	Replace	1-S62, 1-S88
	The alternator is damaged	Replace	1-S62, 1-S86, 1-S87, 1-S88
	The battery is damaged	Replace	–

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[2] ELECTRONIC GOVERNOR

■ **IMPORTANT**

- **The engine trouble divides into an electronic governor, the main body of the engine, and the operating constancy.**
  This manual describes it concerning the check of an electronic governor.
  Refer to WSM of engine and operator's manual if you cannot find trouble related to an electronic governor by checking an electronic governor.

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Engine will not start.

Cause	Corrections	Refer to Checking
Starter Operating but Not Cranking the Engine	Check operation of the solenoid	Solenoid
	Check harness of the solenoid	Solenoid
	Check harness of the glow plug	Glow plug
Starter Does Not Operate	Check emergency stop switch	Emergency stop switch

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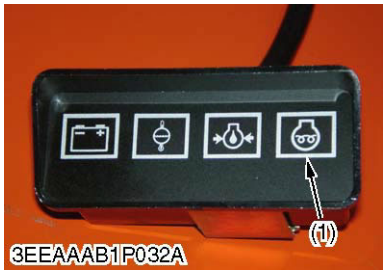
Engine stopped automatically. Engine can be started again and stops again 10 seconds later.

Cause	Corrections	Refer to Checking
Trouble in the electronic governor composition parts	Check blinking pattern of the glow lamp (1) 	Signal pattern sheet (1) Glow Lamp

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Engine speed cannot be controlled.

Cause	Corrections	Refer to Checking
Engine speed does not increase / decrease	Check slow down switch	Slow down switch
	Check speed switch	Speed switch
	Check operation of the solenoid	Solenoid
	Check harness of speed sensor	Harness
Engine operates rough	Check operation of the solenoid	Solenoid
	Check harness of speed sensor	Harness

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Blinking Pattern of Glow Lamp	Cause	Refer to Checking
(1-Long and 1-Short)  3EEAAAB1P005A	Overrunning (more than 115 %)	Solenoid
(1-Long and 2-Short)  3EEAAAB1P006A	Low oil pressure	Oil switch
(1-Long and 3-Short)  3EEAAAB1P007A	Problem of alternator	Alternator
(1-Long and 4-Short)  3EEAAAB1P008A	Coolant temperature is abnormal	Water temperature sensor
(1-Long and 5-Short)  3EEAAAB1P009A	Emergency stop switch operated	Emergency stop switch
(2-Long and 1-Short)  3EEAAAB1P010A	Abnormality of speed sensor	Speed sensor
(2-Long and 2-Short)  3EEAAAB1P011A	Solenoid malfunction	Solenoid
(2-Long and 4-Short)  3EEAAAB1P012A	Disconnection of water temperature sensor	Water temperature sensor
(2-Long and 5-Short)  3EEAAAB1P013A	Short circuit of water temperature sensor	Water temperature sensor
(2-Long and 6-Short)  3EEAAAB1P014A	Disconnection of alternator **L** Terminal	Alternator **L** Terminal

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2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Valve Clearance (When Cold)		0.18 to 0.22 mm 0.0071 to 0.0086 in.	–
Compression Pressure (When You Crank the Engine with the Starter) **[D1503-M-E4BG]**		3.24 to 3.72 MPa / 290 min^{-1} (rpm) 33.0 to 38.0 kgf/cm^2 / 290 min^{-1} (rpm) 470 to 540 psi / 290 min^{-1} (rpm)	2.55 MPa / 290 min^{-1} (rpm) 26.0 kgf/cm^2 / 290 min^{-1} (rpm) 370 psi / 290 min^{-1} (rpm)
Compression Pressure (When You Crank the Engine with the Starter) **[D1703-M-DI-E4B]**		2.95 to 3.23 MPa / 290 min^{-1} (rpm) 30.0 to 33.0 kgf/cm^2 / 290 min^{-1} (rpm) 427 to 469 psi / 290 min^{-1} (rpm)	2.35 MPa / 290 min^{-1} (rpm) 24.0 kgf/cm^2 / 290 min^{-1} (rpm) 341 psi / 290 min^{-1} (rpm)
Difference among Cylinders		–	10 % or less
Top Clearance **[D1503-M-E4BG]**		0.575 to 0.675 mm 0.0227 to 0.0265 in.	–
Top Clearance **[D1703-M-DI-E4B]**		0.60 to 0.70 mm 0.024 to 0.027 in.	–
Cylinder Head Surface	Flatness	–	0.05 mm / 500 mm 0.002 in. / 19.7 in.
Valve Recessing (Protrusion to Recessing) **[D1503-M-E4BG]**	Protrusion	0.05 mm 0.002 in.	–
	Recessing	0.15 mm 0.0059 in.	0.40 mm 0.016 in.
Valve Recessing **[D1703-M-DI-E4B]**	Recessing	0.65 to 0.85 mm 0.026 to 0.033 in.	1.20 mm 0.0472 in.
Valve Stem to Valve Guide	Clearance	0.040 to 0.070 mm 0.0016 to 0.0027 in.	0.10 mm 0.0039 in.
• Valve Stem	O.D.	7.960 to 7.975 mm 0.3134 to 0.3139 in.	–
• Valve Guide	I.D.	8.015 to 8.030 mm 0.3156 to 0.3161 in.	–
Valve Face **[D1503-M-E4BG]**	Angle (Intake)	1.0 rad 60°	–
	Angle (Exhaust)	0.79 rad 45°	–
Valve Face **[D1703-M-DI-E4B]**	Angle (Intake)	0.79 rad 45°	–
	Angle (Exhaust)	0.79 rad 45°	–

Item		Factory Specification	Allowable Limit
Valve Seat	Width (Intake)	2.12 mm 0.0835 in.	–
	Width (Exhaust)	2.12 mm 0.0835 in.	–
Valve Seat **[D1503-M-E4BG]**	Angle (Intake)	1.0 rad 60°	–
	Angle (Exhaust)	0.79 rad 45°	–
Valve Seat **[D1703-M-DI-E4B]**	Angle (Intake)	0.79 rad 45°	–
	Angle (Exhaust)	0.79 rad 45°	–
Valve Timing (Intake Valve) **[D1503-M-E4BG, D1703-M-DI-E4B]**	Open	0.1 rad (8°) before T.D.C.	–
	Close	0.35 rad (20°) after B.D.C.	–
Valve Timing (Exhaust Valve) **[D1503-M-E4BG]**	Open	0.87 rad (50°) before B.D.C.	–
	Close	0 rad (0°) after T.D.C.	–
Valve Timing (Exhaust Valve) **[D1703-M-DI-E4B]**	Open	0.49 rad (28°) before B.D.C.	–
	Close	0.1 rad (8°) before T.D.C.	–
Valve Spring	Free Length	41.7 to 42.2 mm 1.65 to 1.66 in.	41.2 mm 1.62 in.
	Setting Load / Setting Length	118 N / 35.0 mm 12.0 kgf / 35.0 mm 26.5 lbf / 1.38 in.	100 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbf /1.38 in.
	Tilt	–	1.0 mm 0.039 in.
Rocker Arm Shaft to Rocker Arm	Oil Clearance	0.016 to 0.045 mm 0.00063 to 0.0017 in.	0.10 mm 0.0039 in.
• Rocker Arm Shaft	O.D.	13.973 to 13.984 mm 0.55012 to 0.55055 in.	–
• Rocker Arm	I.D.	14.000 to 14.018 mm 0.55119 to 0.55188 in.	–
Push Rod	Bend	–	0.25 mm 0.0098 in.

Item		Factory Specification	Allowable Limit
Tappet to Tappet Guide	Oil Clearance	0.020 to 0.062 mm 0.00079 to 0.0024 in.	0.07 mm 0.003 in.
• Tappet	O.D.	23.959 to 23.980 mm 0.94327 to 0.94409 in.	–
• Tappet Guide	I.D.	24.000 to 24.021 mm 0.94489 to 0.94570 in.	–
Timing Gear • Crank Gear to Idle Gear	Backlash	0.04150 to 0.1122 mm 0.001634 to 0.004417 in.	0.15 mm 0.0059 in.
• Idle Gear to Cam Gear	Backlash	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.	0.15 mm 0.0059 in.
• Idle Gear to Injection Pump Gear	Backlash	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.	0.15 mm 0.0059 in.
• Crank Gear to Oil Pump Gear	Backlash	0.04840 to 0.2455 mm 0.001906 to 0.009665 in.	0.30 mm 0.012 in.
Idle Gear	Side Clearance	0.15 to 0.25 mm 0.0059 to 0.0098 in.	0.9 mm 0.04 in.
Idle Gear Shaft to Idle Gear Bushing	Oil Clearance	0.025 to 0.066 mm 0.00099 to 0.0025 in.	0.10 mm 0.0039 in.
• Idle Gear Shaft	O.D.	37.959 to 37.975 mm 1.4945 to 1.4950 in.	–
• Idle Gear Bushing	I.D.	38.000 to 38.025 mm 1.4961 to 1.4970 in.	–
Camshaft	Side Clearance	0.070 to 0.22 mm 0.0028 to 0.0086 in.	0.30 mm 0.012 in.
Camshaft	Bend	–	0.01 mm 0.0004 in.
Cam **[D1503-M-E4BG]**	Height (Intake)	33.27 mm 1.310 in.	33.22 mm 1.308 in.
	Height (Exhaust)	33.00 mm 1.299 in.	32.95 mm 1.297 in.
Cam **[D1703-M-DI-E4B]**	Height (Intake)	32.20 mm 1.268 in.	32.15 mm 1.266 in.
	Height (Exhaust)	31.80 mm 1.252 in.	31.75 mm 1.250 in.
Camshaft Journal to Cylinder Block Bore	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
• Camshaft Journal	O.D.	39.934 to 39.950 mm 1.5722 to 1.5728 in.	–
• Cylinder Block Bore	I.D.	40.000 to 40.025 mm 1.5748 to 1.5757 in.	–
Piston Pin Bore	I.D.	25.000 to 25.013 mm 0.98426 to 0.98476 in.	25.05 mm 0.9862 in.

Item		Factory Specification	Allowable Limit
Top Ring to Ring Groove **[D1503-M-E4BG]**	Clearance	–	–
Top Ring to Ring Groove **[D1703-M-DI-E4B]**	Clearance	0.050 to 0.090 mm 0.0020 to 0.0035 in.	0.20 mm 0.0079 in.
Second Ring to Ring Groove **[D1503-M-E4BG]**	Clearance	0.0930 to 0.128 mm 0.00367 to 0.00503 in.	0.20 mm 0.0079 in.
Second Ring to Ring Groove **[D1703-M-DI-E4B]**	Clearance	0.0780 to 0.110 mm 0.00307 to 0.00433 in.	0.20 mm 0.0079 in.
Oil Ring to Ring Groove **[D1503-M-E4BG]**	Clearance	0.020 to 0.060 mm 0.00079 to 0.0023 in.	0.15 mm 0.0059 in.
Oil Ring to Ring Groove **[D1703-M-DI-E4B]**	Clearance	0.030 to 0.070 mm 0.0012 to 0.0027 in.	0.15 mm 0.0059 in.
Top Ring **[D1503-M-E4BG, D1703-M-DI-E4B]**	Ring Gap	0.20 to 0.35 mm 0.0079 to 0.013 in.	1.25 mm 0.0492 in.
Second Ring **[D1503-M-E4BG]**	Ring Gap	0.40 to 0.55 mm 0.016 to 0.021 in.	1.25 mm 0.0492 in.
Second Ring **[D1703-M-DI-E4B]**	Ring Gap	0.30 to 0.45 mm 0.012 to 0.017 in.	1.25 mm 0.0492 in.
Oil Ring **[D1503-M-E4BG]**	Ring Gap	0.25 to 0.45 mm 0.0099 to 0.017 in.	1.25 mm 0.0492 in.
Oil Ring **[D1703-M-DI-E4B]**	Ring Gap	0.20 to 0.40 mm 0.0079 to 0.015 in.	1.25 mm 0.0492 in.
Connecting Rod	Alignment	–	0.05 mm 0.002 in.
Piston Pin to Small End Bushing	Oil Clearance	0.014 to 0.036 mm 0.00056 to 0.0014 in.	0.15 mm 0.0059 in.
• Piston Pin	O.D.	25.004 to 25.011 mm 0.98441 to 0.98468 in.	–
• Small End Bushing	I.D.	25.025 to 25.040 mm 0.98524 to 0.98582 in.	–
Crankshaft	Bend	–	0.02 mm 0.0008 in.
Crankshaft Journal to Crankshaft Bearing 1	Oil Clearance	0.0400 to 0.118 mm 0.00158 to 0.00464 in.	0.20 mm 0.0079 in.
• Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.3591 to 2.3598 in.	–
• Crankshaft Bearing 1	I.D.	59.980 to 60.039 mm 2.3615 to 2.3637 in.	–
Crankshaft Journal to Crankshaft Bearing 2	Oil Clearance	0.0400 to 0.104 mm 0.00158 to 0.00409 in.	0.20 mm 0.0079 in.
• Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.3591 to 2.3598 in.	–
• Crankshaft Bearing 2	I.D.	59.980 to 60.025 mm 2.3615 to 2.3631 in.	–

Item		Factory Specification	Allowable Limit
Crankpin to Crankpin Bearing	Oil Clearance	0.025 to 0.087 mm 0.00099 to 0.0034 in.	0.20 mm 0.0079 in.
• Crankpin	O.D.	46.959 to 46.975 mm 1.8488 to 1.8494 in.	–
• Crankpin Bearing	I.D.	47.000 to 47.046 mm 1.8504 to 1.8522 in.	–
Crankshaft	Side Clearance	0.15 to 0.31 mm 0.0059 to 0.012 in.	0.5 mm 0.02 in.
Cylinder Bore (Standard) **[D1503-M-E4BG]**	I.D.	83.000 to 83.022 mm 3.2678 to 3.2685 in.	83.170 mm 3.2744 in.
Cylinder Bore (Standard) **[D1703-M-DI-E4B]**	I.D.	87.000 to 87.022 mm 3.4252 to 3.4260 in.	87.170 mm 3.4319 in.
Cylinder Bore (Oversize) **[D1503-M-E4BG]**	I.D.	83.250 to 83.272 mm 3.2776 to 3.2784 in.	83.420 mm 3.2843 in.
Cylinder Bore (Oversize) **[D1703-M-DI-E4B]**	I.D.	87.250 to 87.272 mm 3.4351 to 3.4359 in.	87.420 mm 3.4417 in.
Cylinder Maximum I.D. to Cylinder Minimum I.D.	Difference	–	0.15 mm 0.0059 in.

LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	More than 98 kPa 1.0 kgf/cm^2 14 psi	50 kPa 0.5 kgf/cm^2 7 psi
	At Rated Speed	300 to 440 kPa 3.0 to 4.5 kgf/cm^2 43 to 64 psi	250 kPa 2.5 kgf/cm^2 36 psi
Engine Oil Pressure Switch	Working Pressure	50 kPa 0.5 kgf/cm^2 7 psi	–
Inner Rotor to Outer Rotor	Clearance	0.030 to 0.14 mm 0.0012 to 0.0055 in.	0.2 mm 0.008 in.
Outer Rotor to Pump Body	Clearance	0.11 to 0.19 mm 0.0044 to 0.0074 in.	0.25 mm 0.0098 in.
Inner Rotor to Cover	Clearance	0.105 to 0.150 mm 0.00414 to 0.00590 in.	0.20 mm 0.008 in.

COOLING SYSTEM

Item		Factory Specification	Allowable Limit
Fan Belt	Tension	7.0 to 9.0 mm (0.28 to 0.35 in.) deflection at 98 N (10 kgf, 22 lbf) of force	–
Thermostat Valve **[D1503-M-E4BG]**	Opening-Temperature (When the valve starts to open)	69.5 to 72.5 °C 157.1 to 162.5 °F	–
	Opening-Temperature (When the valve opened completely)	85 °C 185 °F	–
Thermostat Valve **[D1703-M-DI-E4B]**	Opening-Temperature (When the valve starts to open)	80.5 to 83.5 °C 176.9 to 182.3 °F	–
	Opening-Temperature (When the valve opened completely)	95 °C 203 °F	–
Radiator	Water Tightness	No leak at specified pressure	–
Radiator Cap	Pressure Decreasing Time	More than 10 seconds for pressure decrease from 90 to 60 kPa from 0.9 to 0.6 kgf/cm^2 from 10 to 9 psi	–

FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Pump **[D1503-M-E4BG]**	Injection Timing	0.236 to 0.261 rad (13.5 to 15.0°) before T.D.C.	–
Injection Pump **[D1703-M-DI-E4B]**	Injection Timing	0.0568 to 0.0829 rad (3.25 to 4.75°) before T.D.C.	–
Pump Element **[D1503-M-E4BG]**	Fuel Tightness	–	13.7 MPa 140 kgf/cm^2 1990 psi
Pump Element **[D1703-M-DI-E4B]**	Fuel Tightness	–	18.6 MPa 190 kgf/cm^2 2700 psi
Delivery Valve **[D1503-M-E4BG]**	Fuel Tightness	10 seconds 13.7 → 12.7 MPa 140 → 130 kgf/cm^2 1990 → 1850 psi	5 seconds 13.7 → 12.7 MPa 140 → 130 kgf/cm^2 1990 → 1850 psi
Delivery Valve **[D1703-M-DI-E4B]**	Fuel Tightness	10 seconds 18.6 → 17.7 MPa 190 → 180 kgf/cm^2 2700 → 2560 psi	5 seconds 18.6 →17.7 MPa 190 → 180 kgf/cm^2 2700 → 2560 psi
Injection Nozzle **[D1503-M-E4BG]**	Injection Pressure	13.8 to 14.7 MPa 140 to 150 kgf/cm^2 2000 to 2130 psi	–
Injection Nozzle **[D1703-M-DI-E4B]**	Injection Pressure (1st Stage)	18.7 to 20.1 MPa 190 to 205 kgf/cm^2 2710 to 2910 psi	–
Injection Nozzle Valve Seat **[D1503-M-E4BG]**	Valve Seat Tightness	No fuel leak at 12.7 MPa 130 kgf/cm^2 1850 psi	–
Injection Nozzle Valve Seat **[D1703-M-DI-E4B]**	Valve Seat Tightness	No fuel leak at 16.7 MPa 170 kgf/cm^2 2420 psi	–

ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Starter • Commutator **[D1503-M-E4BG, D1703-M-DI-E4B]**	O.D.	30.0 mm 1.18 in.	29.0 mm 1.14 in.
• Mica **[D1503-M-E4BG, D1703-M-DI-E4B]**	Undercut	0.45 to 0.75 mm 0.018 to 0.029 in.	0.20 mm 0.0079 in.
• Brush **[D1503-M-E4BG, D1703-M-DI-E4B]**	Length	15.0 mm 0.591 in.	11.0 mm 0.433 in.
• Brush Holder and Holder Support	Resistance	Infinity	–
Alternator	No-load voltage	More than 13.5 V	–
• Stator	Resistance	Less than 1.0 Ω	–
• Rotor	Resistance	2.9 Ω	–
• Slip Ring	O.D.	14.4 mm 0.567 in.	14.0 mm 0.551 in.
• Brush	Length	10.5 mm 0.413 in.	8.4 mm 0.33 in.
Glow Plug	Resistance	Approx. 0.9 Ω	–

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3. TIGHTENING TORQUES

Use a torque wrench to tighten the screws, bolts and nuts to the specified torque. Tighten the screws, bolts and nuts used, such as on the cylinder head in the correct sequence and torque.

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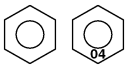
[1] TIGHTENING TORQUES OF SCREWS, BOLTS AND NUTS FOR GENERAL USE

If the tightening torque is not specified, refer to the table below for the none specified torques values.

Indication on top of bolt	 No-grade or 4T			 7T		
Indication on top of nut	 No-grade or 4T					
Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.8	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
M8	18 to 20	1.8 to 2.1	13 to 15	24 to 27	2.4 to 2.8	18 to 20
M10	40 to 45	4.0 to 4.6	29 to 33	49 to 55	5.0 to 5.7	37 to 41
M12	63 to 72	6.4 to 7.4	47 to 53	78 to 90	7.9 to 9.2	58 to 66

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[2] TIGHTENING TORQUES OF THE SCREWS, BOLTS AND NUTS FOR SPECIAL USE

■ **NOTE**

- **For the screws, bolts and nuts with the mark "*", apply engine oil to their threads and seats before you tighten.**
- **The alphabet "M" in Dimension × Pitch shows that the screw, bolt or nut dimensions are in the metric system. The dimension is the nominal external diameter in mm of the threads. The pitch is the nominal distance in mm between 2 threads.**

Item	Dimension × Pitch	N·m	kgf·m	lbf·ft
Cylinder head cover screw	M6 × 1.0	6.87 to 11.2	0.700 to 1.15	5.07 to 8.31
*Cylinder head screw	M11 × 1.25	93.2 to 98.0	9.50 to 10.0	68.8 to 72.3
*Screw 1 of main bearing case	M9 × 1.25	46 to 50	4.7 to 5.2	34 to 37
*Screw 2 of main bearing case	M10 × 1.25	69 to 73	7.0 to 7.5	51 to 54
*Flywheel screw	M12 × 1.25	98.1 to 107	10.0 to 11.0	72.4 to 79.5
*Connecting rod screw	M8 × 1.0	41 to 45	4.1 to 4.6	30 to 33
*Rocker arm bracket screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
*Idle gear shaft screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Mounting nut of fan drive pulley	M30 × 1.5	167 to 205	17.1 to 20.9	124 to 151
*Mounting screw of bearing case cover	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Glow plug	M10 × 1.25	15 to 19	1.5 to 2.0	11 to 14
Glow lead mounting nut	M4 × 0.7	0.98 to 1.77	0.10 to 0.18	0.72 to 1.30
Nozzle holder assembly (IDI)	M20 × 1.5	49 to 68	5.0 to 7.0	37 to 50
Nozzle holder (IDI)	–	35 to 39	3.5 to 4.0	26 to 28
Nozzle holder clamp screw (DI)	M10 × 1.25	26 to 29	2.6 to 3.0	19 to 21
Oil pressure switch	R 1/8	15 to 19	1.5 to 2.0	11 to 14
Injection pipe retaining nut	M12 × 1.5	25 to 34	2.5 to 3.5	18 to 25
Retaining nut of overflow pipe assembly (IDI)	M12 × 1.5	20 to 24	2.0 to 2.5	15 to 18
Retaining screw of overflow pipe assembly (DI)	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Camshaft set screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Hi-idling body	M14 × 1.0	45 to 49	4.5 to 5.0	33 to 36
Pulley nut of alternator	–	58.4 to 78.9	5.95 to 8.05	43.1 to 58.2
B terminal nut of starter	M8	5.9 to 11	0.60 to 1.2	4.4 to 8.6

IDI: D1503-M-E4BG
DI: D1703-M-DI-E4B

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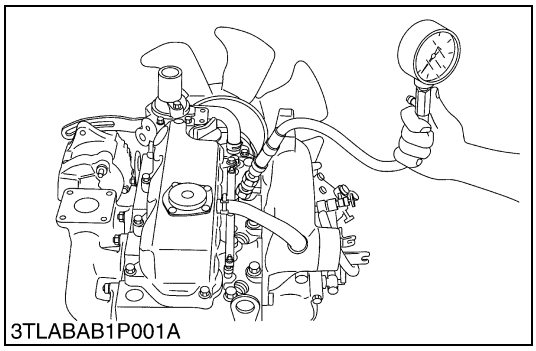
4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body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Compression Pressure

[D1503-M-E4BG]

1. Operate the engine for warming-up.
2. Stop the engine.
3. Disconnect the **2P** connector from the stop solenoid to stop the fuel supply.
4. Remove the air cleaner, the muffler and all injection nozzles.
5. Set a compression tester (Code No. 07909-30208) with the adaptor (Adaptor **H**, code No. 07909-31231) to the nozzle hole.
6. Make sure that the stop lever is set at the stop position (non-injection).
7. Crank the engine with the starter to measure the compression pressure.
8. Do the steps 5 through 7 again for each cylinder.
9. If the measurement is below the allowable limit, apply a small quantity of oil to the cylinder wall through the nozzle hole. Then measure the compression pressure again.
10. If the compression pressure stays below the allowable limit, check the top clearance, valve and cylinder head.
11. If the compression pressure increases after you apply oil, check the cylinder wall and piston rings.

■ **NOTE**

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for you do this test.**
- **Variances in cylinder compression values must be less than 10 %.**

Compression pressure	Factory specification	3.24 to 3.72 MPa / 200min^{-1}(rpm) 33.0 to 38.0 kgf/cm^2 / 200min^{-1}(rpm) 470 to 540 psi / 200min^{-1}(rpm)
	Allowable limit	2.55 MPa / 200min^{-1}(rpm) 26.0 kgf/cm^2 / 200min^{-1}(rpm) 370 psi / 200min^{-1}(rpm)

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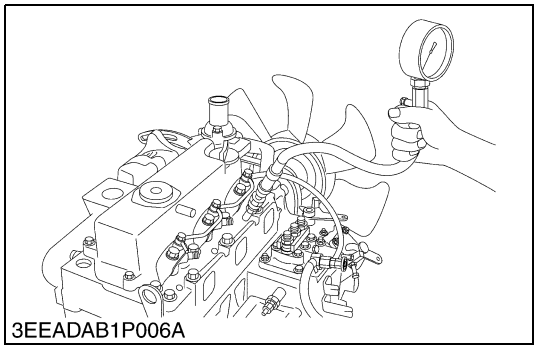
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Compression Pressure

[D1703-M-DI-E4B]

1. Operate the engine for warming-up.
2. Stop the engine.
3. Disconnect the **2P** connector from the stop solenoid to stop the fuel supply.
4. Remove the air cleaner, the muffler and all glow plugs.
5. Set a compression tester with the adaptor **K** (See page "SPECIAL TOOLS") to the glow plug hole.
6. Crank the engine with the starter to measure the compression pressure.
7. Do the steps 5 through 6 again for each cylinder.
8. If the measurement is below the allowable limit, check the cylinder wall and piston rings.

■ **NOTE**

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for you do this test.**
- **Variances in cylinder compression values must be less than 10 %.**

Compression pressure	Factory specification	2.95 to 3.23 MPa / 200min^{-1}(rpm) 30.0 to 33.0 kgf/cm^2 / 200min^{-1}(rpm) 427 to 469 psi / 200min^{-1}(rpm)
	Allowable limit	2.35 MPa / 200min^{-1}(rpm) 24.0 kgf/cm^2 / 200min^{-1}(rpm) 341 psi / 200min^{-1}(rpm)

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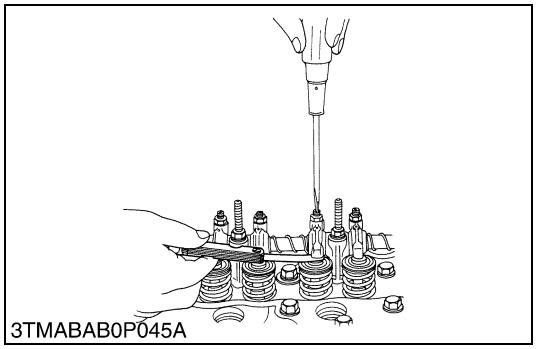
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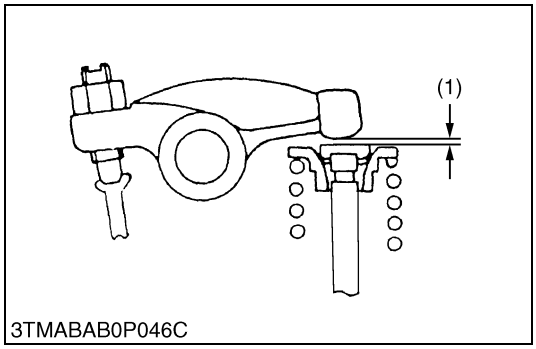

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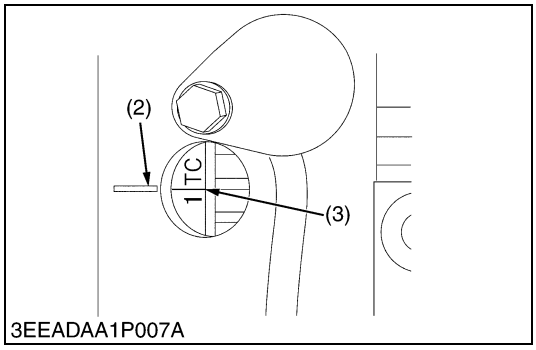

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Valve Clearance

■ **IMPORTANT**

- **You must check and adjust the valve clearance when the engine is cold.**

1. Remove the head cover.
2. Align the **"1TC"** mark line (3) on the flywheel and projection (2) on the housing. Make sure that the No.1 piston comes to the compression or overlap top dead center.
3. Check the subsequent valve clearance (1) at the mark "☆" with a feeler gauge.
4. If the clearance is out of the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory specification	0.18 to 0.22 mm 0.0071 to 0.0086 in.

■ **NOTE**

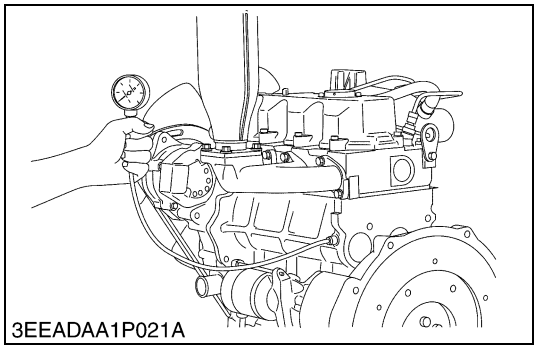
- **The "1TC" mark line on the flywheel is only for the No. 1 cylinder. There is no "TC" mark for the other cylinders.**
- **Align the "TC" mark with the projection (2) in the window on the flywheel-housing. No. 1 piston is on the top dead center position at this time. Turn the flywheel 0.26 rad (15 °) to see if the piston is at the compression top dead center or the overlap position. Refer to the table below to adjust the valve clearance (1) again. (The piston is at the compression top dead center when both the IN. and EX. valves do not move. The piston is at the overlap position when both the valves move.)**
- **Turn the flywheel 6.28 rad (360°) and align the "1TC" mark line with the projection (2) correctly. Adjust all the other valve clearance if necessary.**
- **After you turn the flywheel counterclockwise 2 or 3 times, check the valve clearance (1) again.**
- **After you adjust the valve clearance (1), tighten the lock nut of the adjusting screw.**

Adjustable Cylinder Location of Piston		**Valve Arrangement**	
		Intake Valve	**Exhaust Valve**
When No. 1 piston is at compression top dead center	No. 1	☆	☆
	No. 2		☆
	No. 3	☆	
When No. 1 piston is at overlap position	No. 1		
	No. 2	☆	
	No. 3		☆

(1) Valve Clearance
(2) Projection
(3) 1TC Mark Line

9Y1210967ENS0013US0

(2) Lubricating System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Engine Oil Pressure

1. Remove the engine oil pressure switch, and set the oil pressure tester (Code No.: 07916-80380). (Adaptor screw: PT 1/8)
2. Operate the engine for warming-up.
3. Measure the oil pressure at the idle speed and rated speed.
4. If the oil pressure is less than the allowable limit, do a check below.
   - Engine oil level
   - Oil pump
   - Oil strainer
   - Oil filter cartridge
   - Oil passage
   - Oil clearance
   - Relief valve

Engine oil pressure	At idle speed	Factory specification	More than 98 kPa 1.0 kgf/cm^2 14 psi
		Allowable limit	50 kPa 0.5 kgf/cm^2 7 psi
	At rated speed	Factory specification	300 to 440 kPa 3.0 to 4.5 kgf/cm^2 43 to 64 psi
		Allowable limit	250 kPa 2.5 kgf/cm^2 36 psi

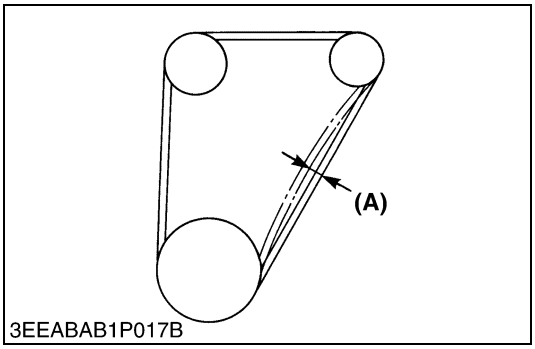
(When reassembling)

- After you check the oil pressure of the engine, tighten its oil pressure switch to the specified torque.

Tightening torque	Oil pressure switch	15 to 19 N·m 1.5 to 2.0 kgf·m 11 to 14 lbf·ft

9Y1210967ENS0014US0

(3) Cooling System



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Fan Belt Tension

1. Check the tension of fan belt halfway (A) between the fan drive pulley and fan pulley with sonic belt tension meter.
2. If the measurement is out of the service specifications, loosen the alternator mounting screws and adjust its position.

Sonic belt tension meter setting value	
Mass (Mass per 1 rib 1 m of belt)	110 g/rib/m
Width (Number of ribs)	1
Span (Distance of between the fan drive pulley and alternator pulley)	measured

Belt tension (Adjustment)	Service specification	237 to 403 N 24.2 to 41.0 kgf 53.3 to 90.5 lbf
Belt tension (Replacement)		460 to 680 N 46.9 to 69.3 kgf 104 to 152 lbf

(Reference)

1. Push the belt halfway between the fan drive pulley and alternator pulley at a specified force 98 N (10 kgf, 22 lbf) to measure the deflection **(A)**.
2. If the measurement is out of the factory specifications, loosen the alternator mounting screws and adjust its position.

Deflection **(A)**	Service specification	10 to 12 mm 0.40 to 0.47 in.

(A) Deflection / Fan Belt Halfway

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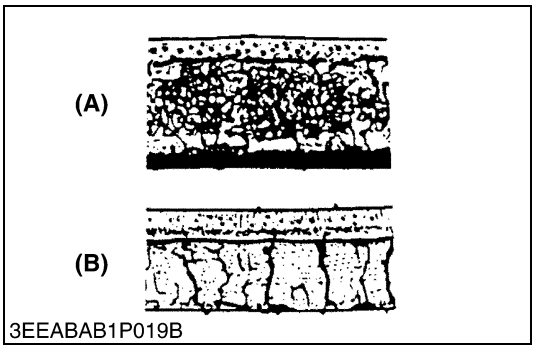

3EEABAB1P019B

Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt has a damage, replace it.
3. Check if the fan belt is worn out and sunk in the pulley groove.
4. If it is, replace it.

(A) Good **(B) Bad**

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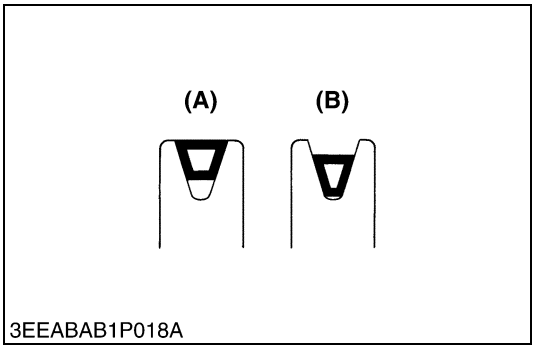

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CAUTION

- **Remove the radiator cap only after you stop the engine for a minimum of 10 minutes to decrease its temperature. If not, hot water can gush out and cause injury.**

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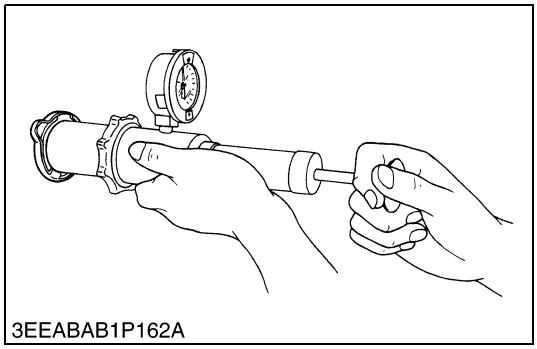
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Radiator Cap Air Leakage

1. Set a radiator tester and an adaptor on the radiator cap.
2. Apply the specified pressure 90 kPa (0.9 kgf/cm^2, 10 psi), and measure the time for the pressure to decrease to 60 kPa (0.6 kgf/cm^2, 9 psi).
3. If the measurement is less than the factory specification, replace the radiator cap.

Pressure decreasing time	Factory specification	More than 10 seconds for pressure decrease from 90 to 60 kPa (from 0.9 to 0.6 kgf/cm^2, from 10 to 9 psi)

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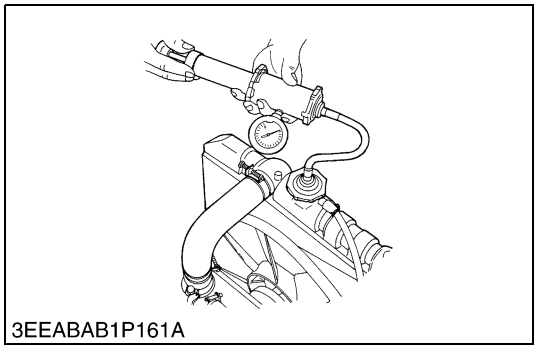
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Radiator Water Leakage

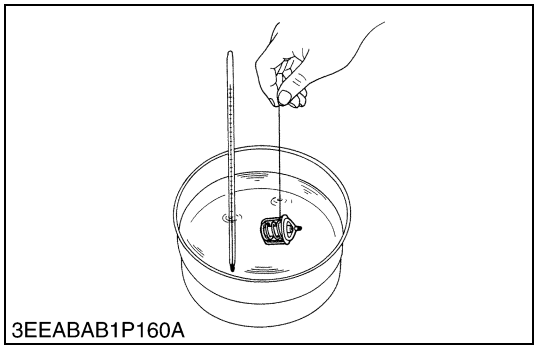
1. Fill a specified quantity of water into the radiator.
2. Increase the water pressure to the specified pressure with the radiator tester and adaptor.
3. Check the radiator for water leakage.
4. For water leakages from the pinhole, replace the radiator or repair with the radiator cement. When water leak is too much, replace the radiator.

Radiator water leakage test	Factory specification	No leak at specified pressure

■ **NOTE**

- **The pressure of the leak test is different for each radiator specification. Thus, refer to the test pressure of each radiator specification to do the leakage test.**

9Y1210967ENS0019US0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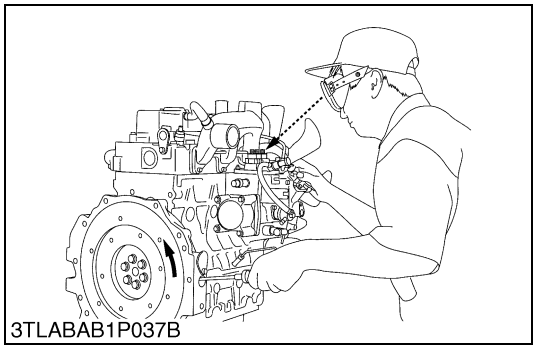
Opening-temperature of Thermostat Valve

1. Hang the thermostat in the water by a string with its end put between the valve and the seat.
2. Increase the temperature of the water gradually, read the temperature when the valve opens and disconnects the string.
3. Continue to increase the temperature and read the temperature when the valve opens approximately 6 mm (0.2 in.).
4. If the measurement is out of the factory specifications, replace the thermostat.

Opening-temperature (When the valve starts to open)	Factory specification	D1503-M-E4BG	69.5 to 72.5 °C 157.1 to 162.5 °F
		D1703-M-DI-E4B	80.5 to 83.5 °C 176.9 to 182.3 °F
Opening-temperature (When the valve opened completely)	Factory specification	D1503-M-E4BG	85 °C 185 °F
		D1703-M-DI-E4B	95 °C 203 °F

9Y1210967ENS0020US0

(4) Fuel System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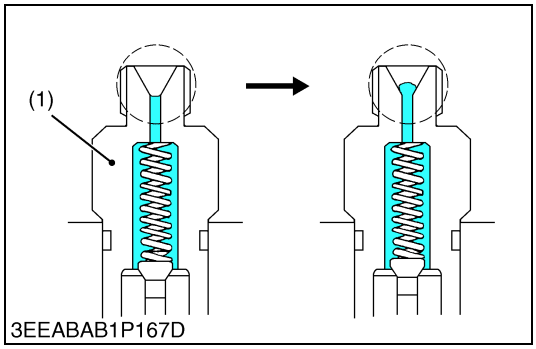

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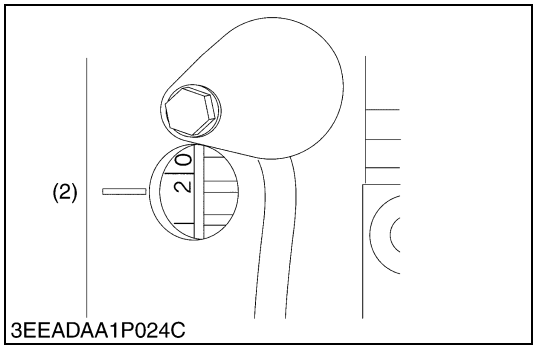

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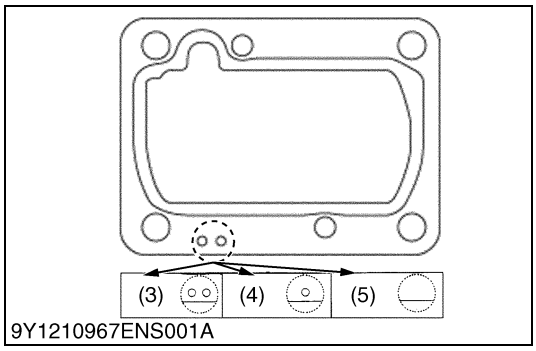

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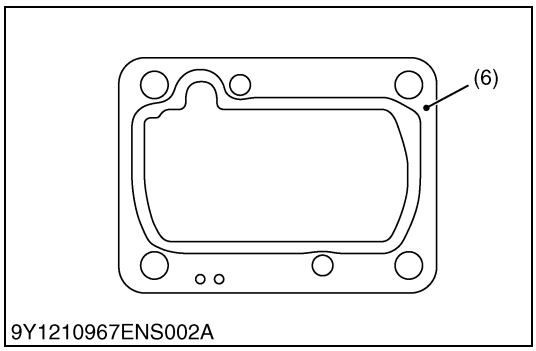


9Y1210967ENS002A

Injection Timing

[D1503-M-E4BG]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the speed control lever to the position of maximum fuel discharge.

(Reference)

- Turn the flywheel with a screwdriver.

4. Turn the flywheel counterclockwise (refer to the figure) until the fuel comes to the hole of the delivery valve holder for the first cylinder.
5. Turn the flywheel more and stop when the fuel starts to flow out, to get the injection timing.
6. Calculate the angle at which the center of the window points out. (The flywheel has a mark 1TC and 4 lines that shows every 0.09 rad (5°) of crank angle from 0.17 rad (10°) to 0.44 rad (25°) before mark 1TC.)
7. If the result is different from specified injection timing, add or remove the shim to adjust.

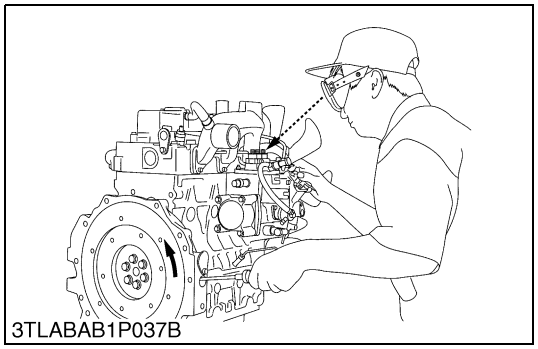
■ **NOTE**

- **The sealant is applied to the 2 sides of the soft metal gasket shim. The liquid gasket is not necessary to assemble.**
- **The shims are available in thickness of 0.175 mm (0.00689 in.) (6), 0.20 mm (0.0079 in.) (3), 0.25 mm (0.0098 in.) (4) and 0.30 mm (0.012 in.) (5). Make a combination of these shims for adjustment.**
- **The 0.175 mm (0.00689 in.) (6) thick shim has only a thin layer on the lower face. Thus, do not use the 0.175 mm (0.00689 in.) (6) thick shim as the top shim of the combination (injection pump side). If not, it can cause oil leakage.**
- **Addition or reduction of shim (0.05 mm, 0.002 in.) delays or advances the injection timing by approx. 0.009 rad (0.5°).**
- **When you disassemble or replace, make sure that you use the same number of new gasket shims with the same thickness.**

Injection timing	Factory specification	D1503-M-E4BG	0.236 to 0.261 rad (13.5 to 15.0°) before T.D.C.

(1) Delivery Valve Holder
(2) Timing Mark
(3) 2-Holes: 0.20 mm (0.0079 in.) Shim
(4) 1-Hole: 0.25 mm (0.0098 in.) Shim
(5) Without Hole: 0.30 mm (0.012 in.) Shim
(6) 2-Holes: 0.175 mm (0.00689 in.) Shim

9Y1210967ENS0021US0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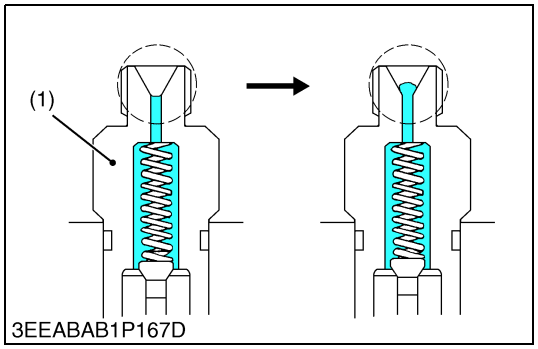

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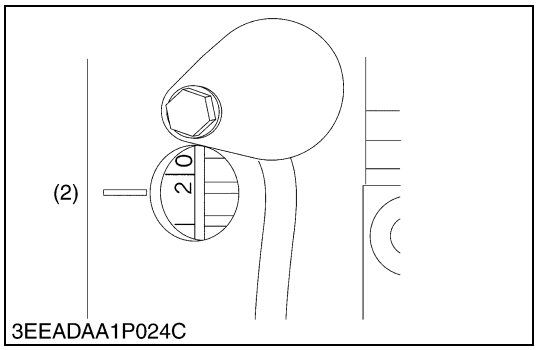

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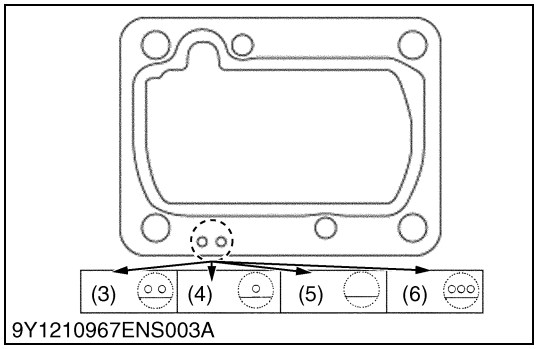

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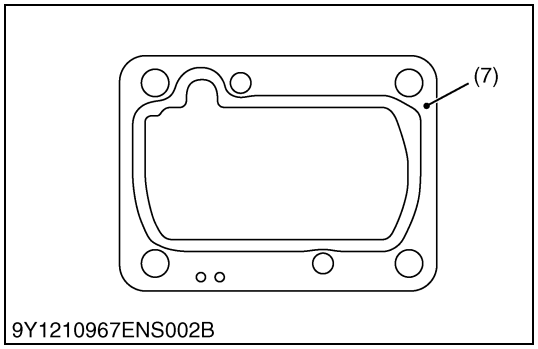


9Y1210967ENS002B

Injection Timing

[D1703-M-DI-E4B]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the speed control lever to the position of maximum fuel discharge.

(Reference)

- Turn the flywheel with screwdriver.

4. Turn the flywheel counterclockwise (refer to the figure) until the fuel comes to the hole of the delivery valve holder for the first cylinder.
5. Turn the flywheel more and stop when the fuel starts to flow out, to get the injection timing.
6. Calculate the angle at which the center of the window points out. (The flywheel has a mark 1TC and 4 lines that shows every 0.09 rad (5°) of crank angle from 0.17 rad (10°) to 0.44 rad (25°) before mark 1TC.)
7. If the result is different from specified injection timing, add or remove the shim to adjust.

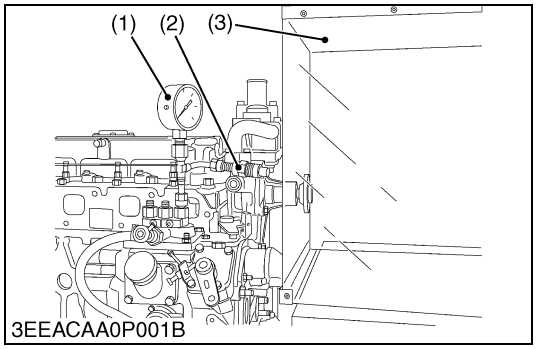
Injection timing	Factory specification	D1703-M-DI-E4B	0.0568 to 0.0829 rad (3.25 to 4.75°) before T.D.C.

■ **NOTE**

- **The sealant is applied to the 2 sides of the soft metal gasket shim. The liquid gasket is not necessary to assemble.**
- **The shims are available in thickness of 0.175 mm (0.00689 in.) (7), 0.20 mm (0.0079 in.) (3), 0.25 mm (0.0098 in.) (4), 0.30 mm (0.012 in.) (5) and 0.35 mm (0.014 in.) (6). Make a combination of these shims for adjustment.**
- **The 0.175 mm (0.00689 in.) (7) thick shim has only a thin layer on the lower face. Thus, do not use the 0.175 mm (0.00689 in.) (7) thick shim as the top shim of the combination (injection pump side). If not, it can cause oil leakage.**
- **Addition or reduction of shim (0.05 mm, 0.002 in.) delays or advances the injection timing by approx. 0.009 rad (0.5°).**
- **When you disassemble or replace, make sure that you use the same number of new gasket shims with the same thickness.**

(1) Delivery Valve Holder
(2) Timing Mark
(3) 2-Holes: 0.20 mm (0.0079 in.) Shim
(4) 1-Hole: 0.25 mm (0.0098 in.) Shim
(5) Without Hole: 0.30 mm (0.012 in.) Shim
(6) 3-Holes: 0.35 mm (0.014 in.) Shim
(7) 2-Holes: 0.175 mm (0.00689 in.) Shim

9Y1210967ENS0022US0



Fuel Tightness of Pump Element

[D1503-M-E4BG]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the injection pump pressure tester to the injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Crank the engine with the starter to increase the pressure.
7. If the pressure is lower than the allowable limit, replace the pump with a new one.
   You can also repair the pump at a KUBOTA-authorized pump service shop.

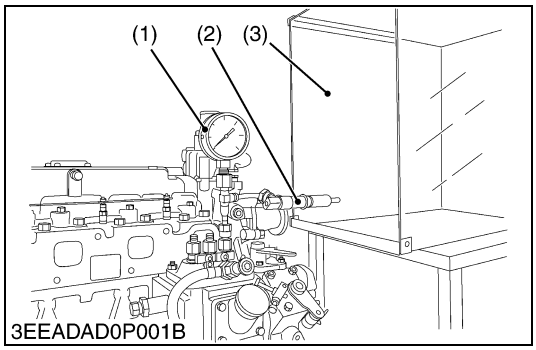
Fuel tightness of pump element	Allowable limit	13.7 MPa 140 kgf/cm^2 1990 psi

■ **NOTE**

- **Do not try to disassemble the injection pump assembly. Repair the pump at a KUBOTA-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

9Y1210967ENS0023US0



Fuel Tightness of Pump Element

[D1703-M-DI-E4B]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the injection pump pressure tester to the injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Crank the engine with the starter to increase the pressure.
7. If the pressure is lower than the allowable limit, replace the pump with a new one.
   You can also repair the pump at a KUBOTA-authorized pump service shop.

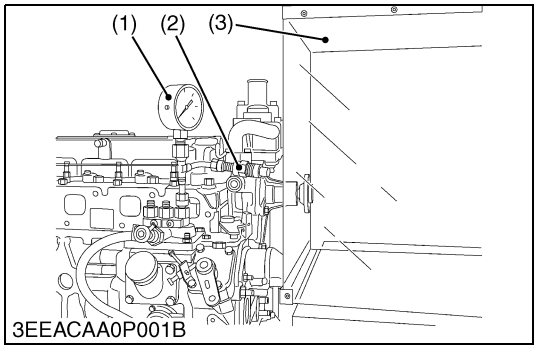
Fuel tightness of pump element	Allowable limit	18.6 MPa 190 kgf/cm^2 2700 psi

■ **NOTE**

- **Do not try to disassemble the injection pump assembly. Repair the pump at a KUBOTA-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

9Y1210967ENS0024US0



Fuel Tightness of Delivery Valve

[D1503-M-E4BG]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the injection pump pressure tester to the injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1).
5. Crank the engine with the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. Then turn the flywheel manually and increase the pressure to approx. 13.7 MPa (140 kgf/cm^2, 1990 psi).
7. Turn the flywheel back about half a turn (to keep the plunger free) and keep the flywheel at this position.
8. Measure the time for the pressure to decrease from 13.7 to 12.7 MPa (140 to 130 kgf/cm^2, 1990 to 1850 psi).
9. If the measurement is less than allowable limit, replace the pump with a new one.
   You can also repair the pump at a KUBOTA-authorized pump service shop.

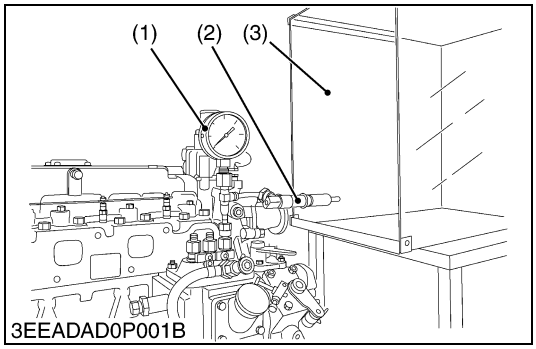
Fuel tightness of delivery valve	Factory specification	10 seconds 13.7 → 12.7 MPa 140 → 130 kgf/cm^2 1990 → 1850 psi
	Allowable limit	5 seconds 13.7 → 12.7 MPa 140 → 130 kgf/cm^2 1990 → 1850 psi

■ **NOTE**

- **Do not try to disassemble the injection pump assembly. Repair the pump at a KUBOTA-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

9Y1210967ENS0025US0



Fuel Tightness of Delivery Valve

[D1703-M-DI-E4B]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set the injection pump pressure tester to the injection pump.
4. Set the injection nozzle (2) jetted with the correct injection pressure to the injection pump pressure tester (1).
5. Crank the engine with the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. Then turn the flywheel manually and increase the pressure to approx. 18.6 MPa (190 kgf/cm^2, 2700 psi).
7. Turn the flywheel back about half a turn (to keep the plunger free) and keep the flywheel at this position.
8. Measure the time for the pressure to decrease from 18.6 to 17.7 MPa (190 to 180 kgf/cm^2, 2700 to 2560 psi).
9. If the measurement is less than allowable limit, replace the pump with a new one.
   You can also repair the pump at a KUBOTA-authorized pump service shop.

Fuel tightness of delivery valve	Factory specification	10 seconds 18.6 → 17.7 MPa 190 → 180 kgf/cm^2 2700 → 2560 psi
	Allowable limit	5 seconds 18.6 → 17.7 MPa 190 → 180 kgf/cm^2 2700 → 2560 psi

■ **NOTE**

- **Do not try to disassemble the injection pump assembly. Repair the pump at a KUBOTA-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

9Y1210967ENS0026US0

CAUTION

- **Check the injection pressure and condition after you make sure that there is no one in the direction of the fumes.**
- **If the fumes from the nozzle directly touches the human body, they can cause damage to the cells and blood poisoning.**

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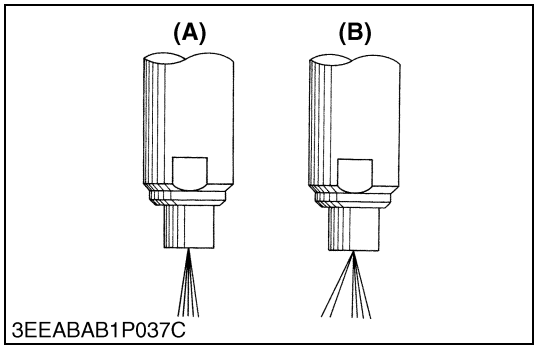

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Nozzle Fume Condition

[D1503-M-E4BG]

1. Set the injection nozzle to a nozzle tester, and check the condition of the fumes from the nozzle.
2. If the fume condition is damaged, replace the nozzle piece.

(A) Good **(B) Bad**

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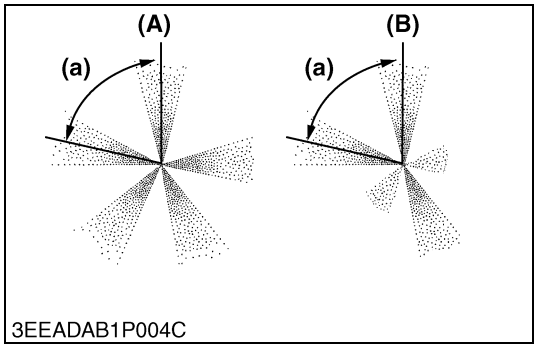

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Nozzle Fume Condition

[D1703-M-DI-E4B]

1. Set the injection nozzle to a nozzle tester, and check the condition of the fumes from the nozzle.
2. If the fume condition is damaged, replace the injection nozzle assembly.

(A) Good **(a) 1.3 rad (72°)**
(B) Bad

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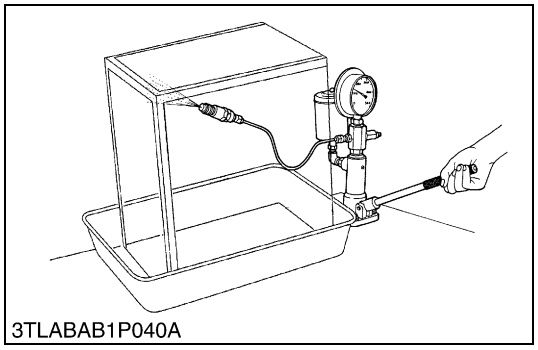

3TLABAB1P040A

Fuel Injection Pressure

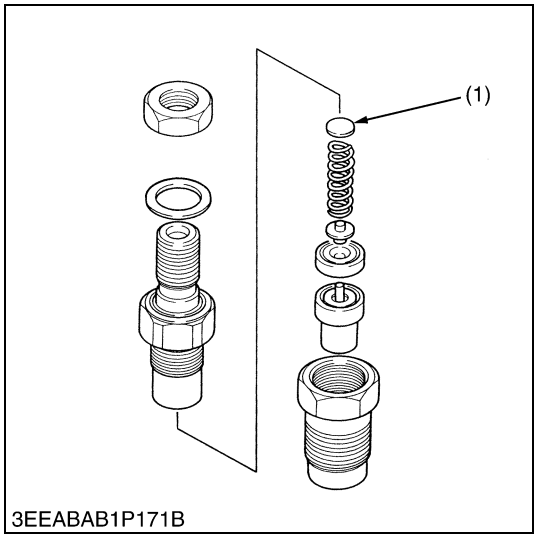
[D1503-M-E4BG]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester lever to measure the pressure at which the fuel start to jet out from the nozzle.
3. If the measurement is out of the factory specifications, replace the adjusting washer (1) in the nozzle holder.

(Reference)

- The pressure variation with 0.025 mm (0.00098 in.) difference in washer thickness is approximately 590 kPa (6.0 kgf/cm^2, 85 psi).

Fuel injection pressure	Factory specification	13.8 to 14.7 MPa 140 to 150 kgf/cm^2 2000 to 2130 psi



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(1) Adjusting Washer

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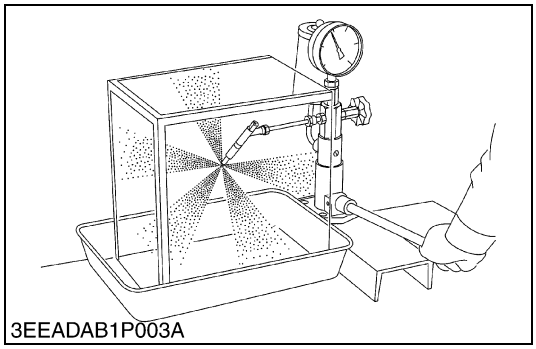
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Fuel Injection Pressure

[D1703-M-DI-E4B]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester lever to measure the pressure at which the fuel start to jet out from the nozzle.
3. If the measurement is out of the factory specifications, replace the injection nozzle assembly.

Fuel injection pressure (1st stage)	Factory specification	18.7 to 20.1 MPa 190 to 205 kgf/cm^2 2710 to 2910 psi

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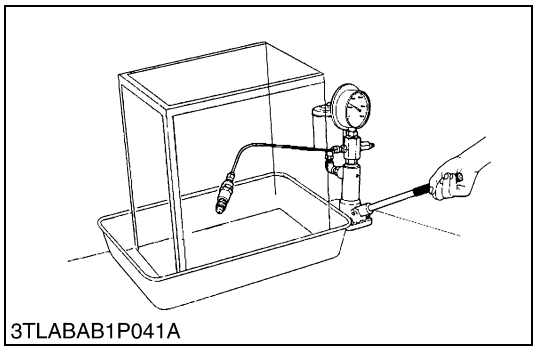
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Valve Seat Tightness

[D1503-M-E4BG]

1. Set the injection nozzle to a nozzle tester.
2. Increase the fuel pressure, and keep it at 12.7 MPa (130 kgf/cm^2, 1850 psi) for 10 seconds.
3. If you find a fuel leakage, replace the nozzle piece.

Valve seat tightness	Factory specification	No fuel leak at 12.7 MPa 130 kgf/cm^2 1850 psi

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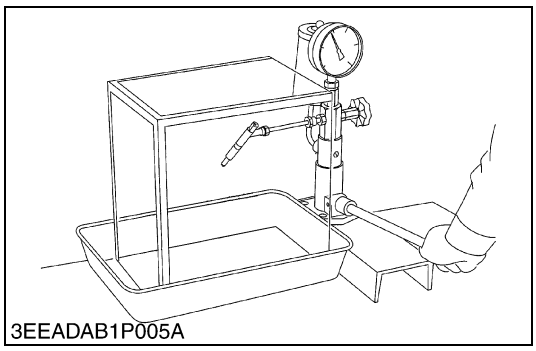
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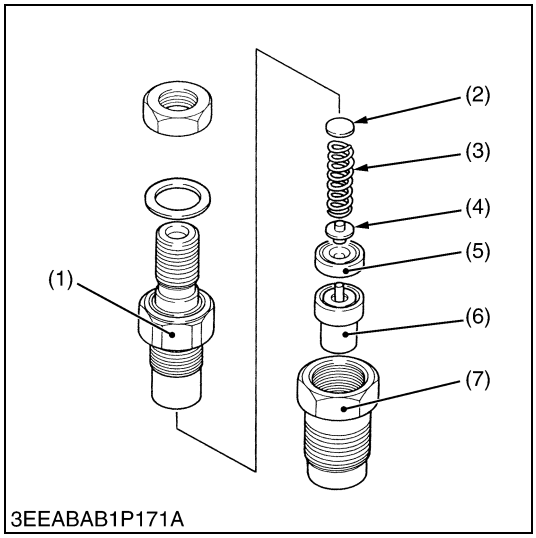
Valve Seat Tightness

[D1703-M-DI-E4B]

1. Set the injection nozzle to a nozzle tester.
2. Increase the fuel pressure, and keep it at 16.7 MPa (170 kgf/cm^2, 2420 psi) for 10 seconds.
3. If you find a fuel leakage, replace the injection nozzle assembly.

Valve seat tightness	Factory specification	No fuel leak at 16.7 MPa 170 kgf/cm^2 2420 psi

9Y1210967ENS0033US0



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Nozzle Holder

[D1503-M-E4BG]

1. Hold the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1) and internal parts.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod (4) correctly in its direction.
- After you assemble the nozzle, adjust the fuel injection pressure.

Tightening torque	Nozzle holder	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Overflow pipe retaining nut	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft

(1) Nozzle Holder
(2) Adjusting Washer
(3) Nozzle Spring
(4) Push Rod
(5) Distance Piece
(6) Nozzle Piece
(7) Nozzle Retaining Nut

9Y1210967ENS0034US0

(5) Electrical System

CAUTION

- **To prevent an accidental short circuit, attach the positive cable to the positive terminal before the negative cable is attached to the negative terminal.**
- **Do not remove the battery cap while the engine operates.**
- **Keep electrolyte away from eyes, hands and clothes. If you are spattered with it, clean with water immediately.**
- **Keep open sparks and flames away from the battery at all times. Hydrogen gas mixed with oxygen becomes very explosive.**

IMPORTANT

- **Do not disconnect or remove the battery when you operate engine.**

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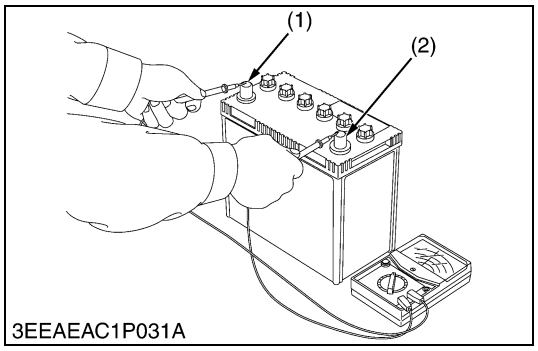

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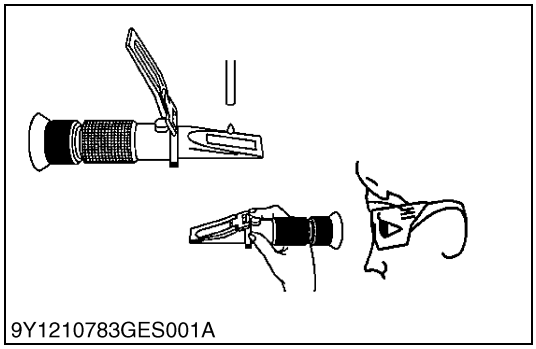
Battery Voltage

1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and charge the battery.

Battery voltage	Factory specification	More than 12 V

(1) Positive Terminal (2) Negative Terminal

9Y1210967ENS0036US0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Battery Specific Gravity

CAUTION

- **If battery acid (dilute sulfuric acid) gets on you it could cause blindness or burns, or could cause corrosion of machinery and tools so please be careful when handling.**
- **Wear safety glasses and rubber gloves when performing battery maintenance and inspection (measuring specific gravity, filling water, or charging).**
- **If the gas that is generated is ignited by an ignition source, it may explode so be very careful with sparks and fire.**
- **Keep your body and face as far away from the battery as you can when performing maintenance and inspection.**
- **Do not allow people who do not know how to handle a battery or who do not sufficiently understand the danger perform inspection or maintenance.**

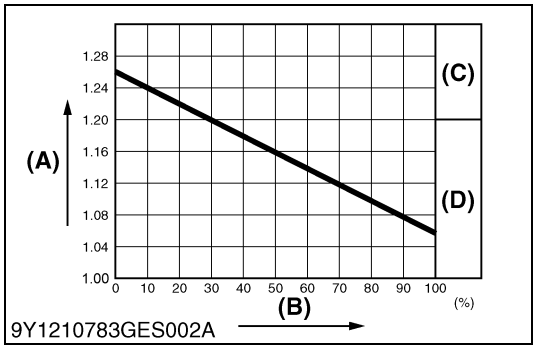
(Measurement items)

■ **Zero adjustment**

1. Open the cover and drip water on the prism surface using the included rod.
2. Close the cover.
3. Aim in a direction that is bright, look into the lens, and adjust the focus until the gradations can be seen clearly.
4. If the boundary line is not on the gradation baseline (0 position), turn the adjustment screw until it matches.
5. When zero adjustment is complete, wipe the prism and cover surface with a soft cloth or tissue paper.

■ **Measurement of test fluid**

1. Open the cover and drip test fluid on the prism surface using the included rod.
2. Close the cover.
3. Aim in a direction that is bright, look into the lens and read the gradation of the blue boundary line.
4. When the measurement is complete, wipe the prism and cover surface with a soft cloth or tissue paper.



9Y1210783GES002A

(Reference)

Electrolyte specific gravity and amount of discharge.
Use the following table as a reference.

(A) Electrolyte Specific Gravity	**(C) Good**
(B) Discharge	**(D) Charging is necessary.**

■ **NOTE**

Temperature conversion of electrolyte specific gravity

- **Battery electrolyte specific gravity changes based on temperature.**
- **Insert the value identified on a specific gravity meter into the following conversion equation for temperature correction to learn an accurate specific gravity value. (Standard temperature assumed to be 20 °C (68 °F))**
  D_{20} = Dt + 0.0007 (t - 20)
  D_{20} = specific gravity value converted to standard temperature of 20 °C (68 °F)
  D_t = measured specific gravity value at the electrolyte temperature t °C

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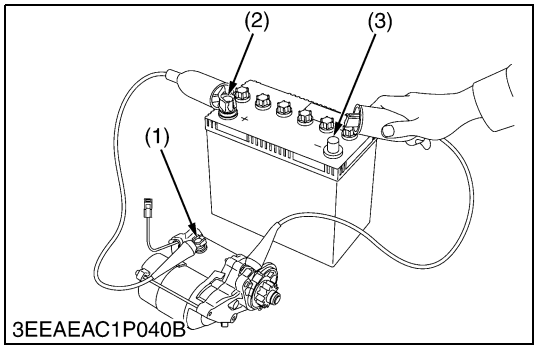


Motor Test

CAUTION

- **Hold the starter to prevent its movement when you do a test on the motor.**

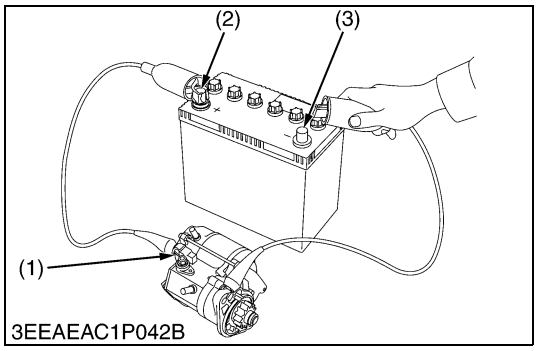
1. Disconnect the negative cable from the battery.
2. Disconnect the positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **C** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter body and the battery negative terminal (3).
7. If the motor does not operate, starter is damaged. Repair or replace the starter.

NOTE

- **B terminal: It is the terminal that connects the cable from the battery to the starter.**
- **C terminal: It is the terminal that connects the cable from the motor to the magnet switch.**

(1) **C** Terminal
(2) Positive Terminal
(3) Negative Terminal

9Y1210967ENS0038US0



Magnetic Switch Test

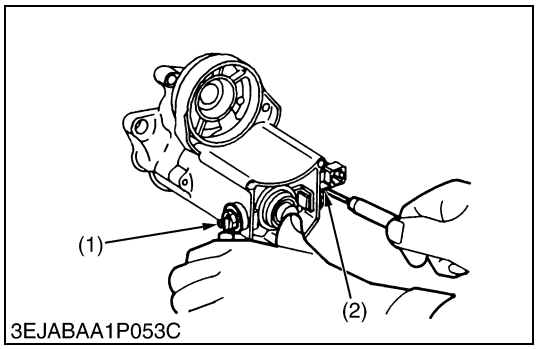
1. Disconnect the negative cable from the battery.
2. Disconnect the positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **S** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter body and the battery negative terminal (3).
7. If the pinion gear does not come out, the magnetic switch is damaged. Repair or replace the starter.

NOTE

- **B terminal: It is the terminal that connects the cable from the battery to the starter.**
- **S terminal: It is the terminal that connects the cable from the starter switch to the magnetic switch.**

(1) **S** Terminal
(2) Positive Terminal
(3) Negative Terminal

9Y1210967ENS0039US0

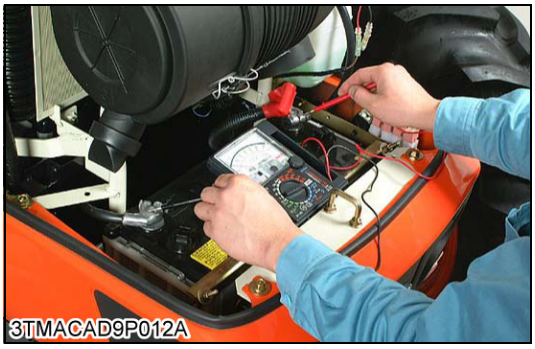


Magnetic Switch Continuity Test

1. Push in the plunger. Then check the continuity across the **C** terminal (1) and the **B** terminal (2) with a circuit tester.
2. If it is not continuous or it shows a value, replace the magnetic switch.

(1) **C** Terminal
(2) **B** Terminal

9Y1210967ENS0040US0



Alternator-on Unit Test

Before testing

- Before the alternator-on unit test, do a check of the list below:
  - Battery terminal connections
  - Circuit connection
  - Fan belt tension
  - Charge indicator lamp
  - Fuses on the circuit
  - Abnormal noise from the alternator
- Prepare full charged battery for the test.

■ **NOTE**

- **Do not touch the engine parts that turns while the engine operates.**
  Keep a safety distance from the engine parts that turn.

1. Start the engine.
2. When the engine operates, measure the voltage between battery terminals. If the voltage is between 13.8 V and 14.8 V, the alternator operates correctly.
3. If the results of alternator-on unit test are not in the service specifications, disassemble the alternator. Check each component part to find out the problem. Refer to "DISASSEMBLING AND ASSEMBLING" and "SERVICING" for the alternator.

Regulating voltage at no load	Service specification	Approx. 13.0 to 15.0 V at 25 °C (77 °F)

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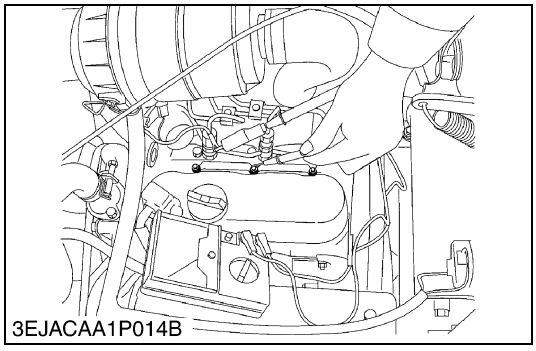
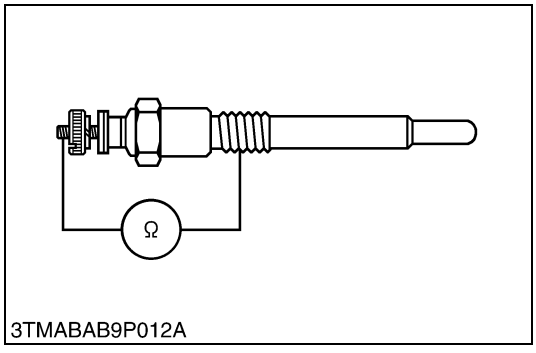


Glow Plug Lead Terminal Voltage

1. Turn the key switch to the "**GLOW** (or **PREHEAT**)" position. Then measure the voltage with a circuit tester between the lead terminal and the engine body.
2. If the voltage is different from the battery voltage, the wiring harness or main switch is damaged.

Voltage (Main switch key at **GLOW** (or **PREHEAT**))	Factory specification	Approx. battery voltage

9Y1210967ENS0042US0



Glow Plug Continuity

1. Remove the glow plug.
2. Measure the resistance with a circuit tester between the glow plug terminal and the glow plug housing.
3. If the measurement does not show the factory specification, the glow plug is damaged.

Resistance	Factory specification	Approx. 0.9 Ω

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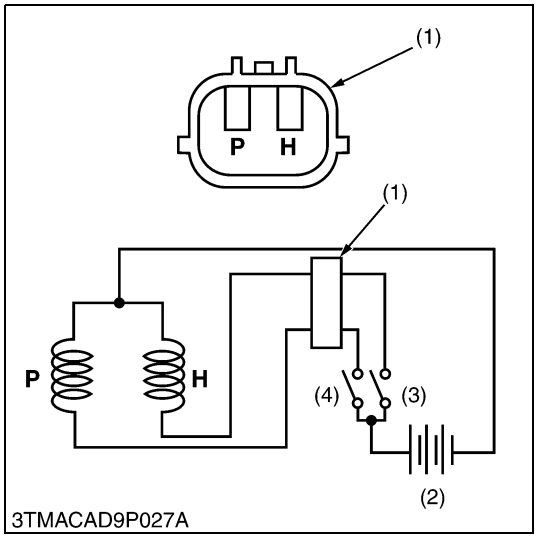

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Engine Stop Solenoid

1. Remove the engine stop solenoid from the engine.
2. Connect the jumper leads from the pulling coil **P** terminal to the switch (4). Then connect from the switch (4) to the battery positive terminal.
3. Connect the jumper leads from the holding coil **H** terminal to the switch (3). Then connect from the switch (3) to the battery positive terminal.
4. Connect the jumper leads from the engine stop solenoid body to the battery negative terminal.
5. After you turn on the switch (4), the solenoid body pulls in the plunger. Then turn off the switch (4) and the plunger comes out.
6. Turn on the switch (3), then turn on the switch (4). The solenoid body pulls in the plunger and keep it in the holding position after you turn off the switch (4).
7. If the solenoid do not attract the plunger, the solenoid is damaged.

■ **IMPORTANT**

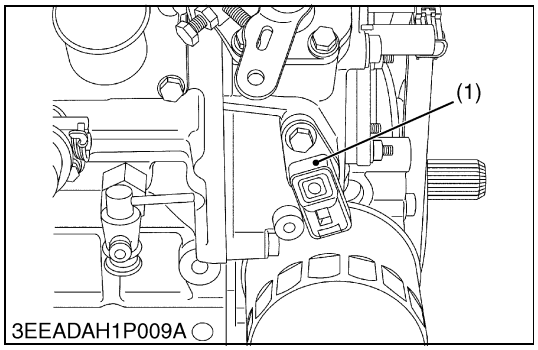
- **Do not apply the current to the pulling coil for more than 2 seconds when you check.**

(1) Connector
(2) Battery
(3) Switch for Holding Coil
(4) Switch for Pulling Coil

P: Terminal for Pulling Coil
H: Terminal for Holding Coil

9Y1210967ENS0044US0

(6) Electronic Governor



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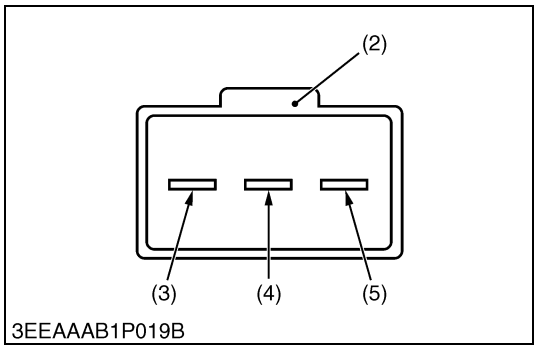

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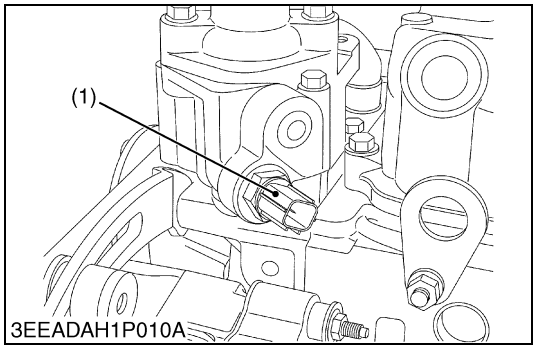
Speed Sensor

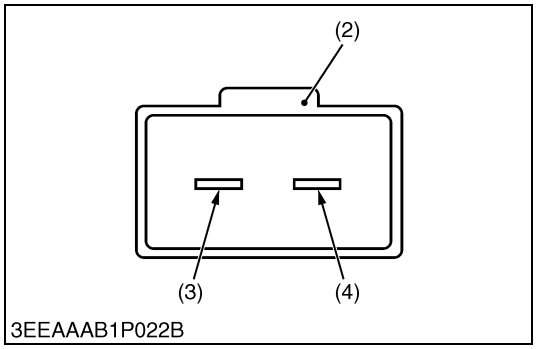
1. Disconnect the connector of the speed sensor (1) (3P).
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one. Then replace the ECU with a new one.
4. Turn the key switch to the ACC position.
5. Measure the voltage between the terminals of the connector (2) (harness side).
6. If the measurements are not in the factory specifications, the ECU is damaged.
7. If the measurements are in the factory specifications, the ECU is correct.
   In this case, the speed sensor is damaged. Then replace it with a new one.

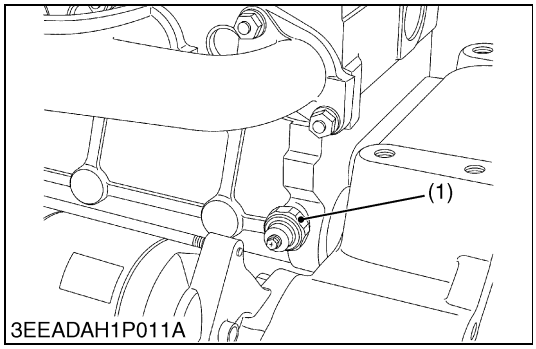
Voltage	Factory specification	Terminal **1** – Terminal **3**	12 V
		Terminal **1** – Terminal **2**	5 V

(1) Speed Sensor
(2) Connector (Harness Side)
(3) Terminal **3** (+)
(4) Terminal **2** (Signal)
(5) Terminal **1** (GND)

9Y1210967ENS0045US0







Water Temperature Sensor

1. Disconnect the connector of the water temperature sensor (1) (2P).
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Turn the key switch to the ACC position.
5. Measure the voltage between the terminals of the connector (2) (harness side).
6. If the measurement is not in the factory specification, the ECU is damaged. Then replace the ECU with a new one.
7. If the measurement is in the factory specification, the ECU is correct.
   In this case, the water temperature sensor is damaged. Then replace it with a new one.

Voltage	Factory specification	Terminal **1** – Terminal **2**	5 V

(1) Water Temperature Sensor
(2) Connector (Harness Side)
(3) Terminal **2** (−)
(4) Terminal **1** (+)

9Y1210967ENS0046US0

Oil Pressure Switch

1. Disconnect the connector of the oil pressure switch (1) (1P).
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Measure the resistance between the terminal of the connector (harness side) and chassis.
5. If the measurement is not in the factory specification, the ECU is damaged. Then replace the ECU with a new one.
6. If the measurement is in the factory specification, the ECU is correct.
   In this case, the oil pressure switch is damaged. Then replace it with a new one.

Resistance	Factory specification	Terminal **1** – Chassis	Infinity

(1) Oil Pressure Switch

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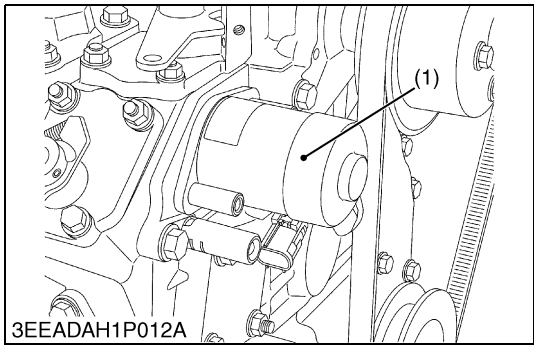

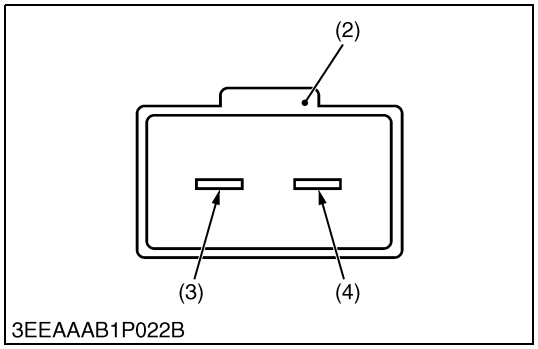

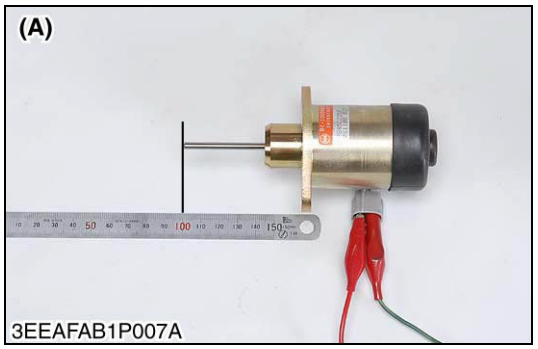

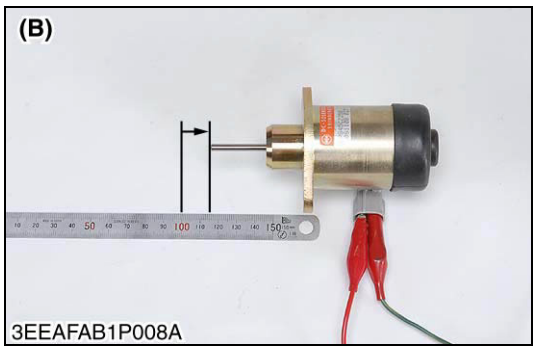

Solenoid

1. Disconnect the connector of the solenoid (1) (2P).
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Turn the key switch to the ACC position.
5. Measure the voltage between the terminals of the connector (2) (harness side).
6. If the measurement is not in the factory specification, the ECU is damaged. Then replace the ECU with a new one.
7. If the measurement is in the factory specification, the ECU is correct.
   In this case, check the solenoid in the procedure below.

Voltage	Factory specification	Terminal **1** – Terminal **2**	12 V

(Reference)

1. Measure the resistance between the terminals of the connector (solenoid side).
2. If the measurement is not in the factory specification, the solenoid is damaged. Then replace the solenoid with a new one.
3. If the measurement is in the factory specification, the solenoid is correct electrically. Then check the movement of the solenoid.
4. Remove the solenoid (1) from the engine.
5. Apply the voltage of 12 V to the solenoid.
6. If the rod of the solenoid does not move smoothly, the solenoid is damaged. Then replace the solenoid with a new one.
7. If the rod of the solenoid moves smoothly, the solenoid is correct.

Resistance	Factory specification	Terminal **1** – Terminal **2**	2 to 4 Ω

(1) Solenoid
(2) Connector (Harness Side)
(3) Terminal **2** (−)
(4) Terminal **1** (+)

(A) Key Switch OFF Position
(B) Key Switch ON Position

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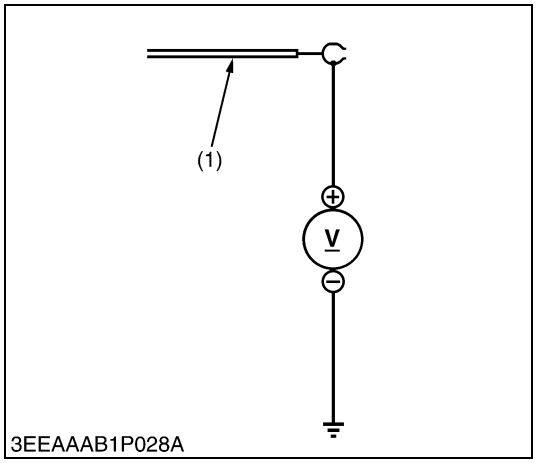

3EEAAAB1P028A

Glow Plug Harness

1. Disconnect the wiring (1) of the glow plug.
2. Check the condition of the wiring.
3. If the wiring is damaged, replace it with a new one.
4. Turn the key switch to the ACC position.
5. Measure the voltage between the wiring (1) and chassis.
6. If the measurement is not in the factory specification, the ECU is damaged. Then replace the ECU with a new one.
7. If the measurement is in the factory specification, the ECU is correct.
   In this case, the glow plugs are damaged.
   Check each glow plug, and replace the damaged glow plug with a new one.

Voltage	Factory specification	Terminal – Chassis	12 V

(1) Wiring of Glow Plug

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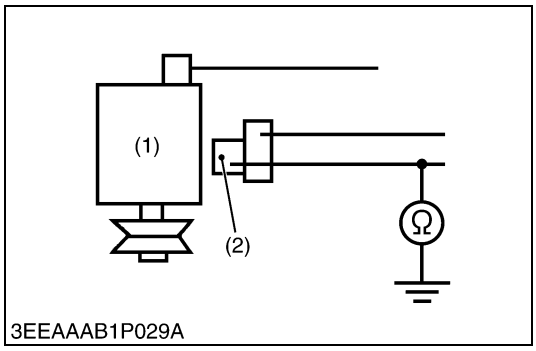

3EEAAAB1P029A

Alternator

1. Disconnect the terminal **L** (2) of the alternator (2P).
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Measure the resistance between the terminal **L** (2) of the connector (harness side) and chassis.
5. If the measurement is not in the factory specification, the ECU is damaged. Then replace the ECU with a new one.
6. If the measurement is in the factory specification, the ECU is correct.
   In this case, the alternator is damaged. Then replace it with a new one.

Resistance	Factory specification	Terminal **L** - Chassis	Infinity

(1) Alternator (2) Terminal **L** (Harness Side)

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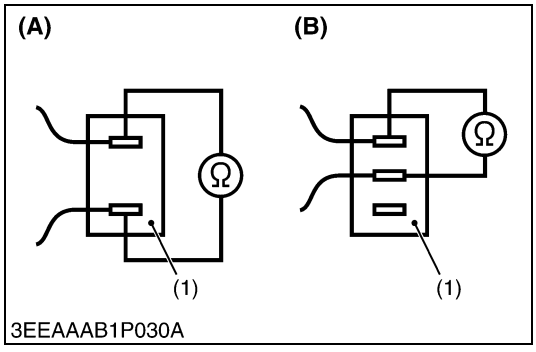

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Speed Switch

1. Disconnect the connector of the speed switch.
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Measure the resistance between the terminals of the speed switch when the speed switch turn on or off.
5. If the measurements are in the factory specifications, the ECU is damaged. Then replace the ECU with a new one.
6. If the measurements are not in the factory specifications, the speed switch is damaged. Then replace the speed switch with a new one.

Resistance	Factory specification	**ON**	0 Ω
		OFF	Infinity

(1) Speed Switch (Switch Side)
(A) Single Pole, Single Throw
(B) Single Pole, Double Throw

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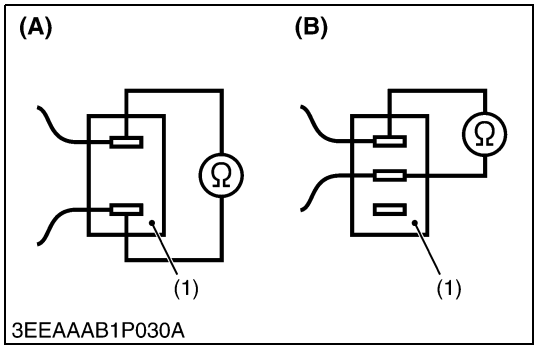

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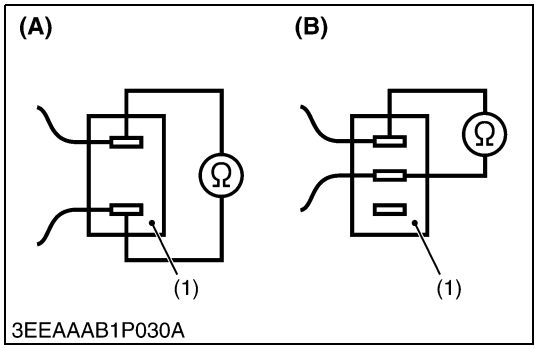
Emergency Stop Switch

1. Disconnect the connector of the emergency stop switch.
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Measure the resistance between the terminals of the emergency stop switch when the emergency stop switch turn on or off.
5. If the measurements are in the factory specifications, the ECU is damaged. Then replace the ECU with a new one.
6. If the measurements are not in the factory specifications, the emergency stop switch is damaged. Then replace the emergency stop switch with a new one.

Resistance	Factory specification	**ON**	0 Ω
		OFF	Infinity

(1) Emergency Stop Switch (Switch Side)
(A) Single Pole, Single Throw
(B) Single Pole, Double Throw

9Y1210967ENS0052US0



3EEAAAB1P030A

Slow Down Switch

1. Disconnect the connector of the slow down switch.
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Measure the resistance between the terminals of the slow down switch when the slow down switch turn on or off.
5. If the measurements are in the factory specifications, the ECU is damaged. Then replace the ECU with a new one.
6. If the measurements are not in the factory specifications, the slow down switch is damaged. Then replace the slow down switch with a new one.

Resistance	Factory specification	**ON**	0 Ω
		OFF	Infinity

(1) Slow Down Switch (Switch Side)
(A) Single Pole, Single Throw
(B) Single Pole, Double Throw

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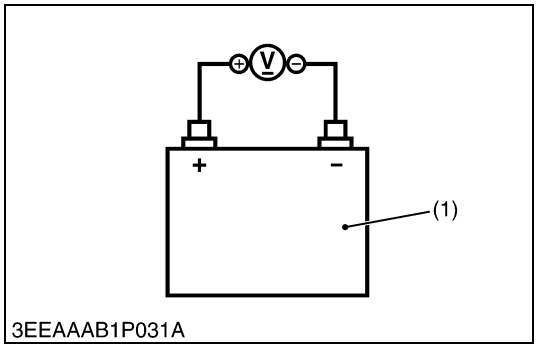

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Battery

1. Measure the voltage of the battery (1).
2. If the measurement is less than the factory specification, charge the battery or replace the battery with a new one.
3. If the measurement is in the factory specification, the ECU is damaged. Then replace the ECU with a new one.

Voltage	Factory specification	**+** terminal – **−** terminal	12 V

(1) Battery

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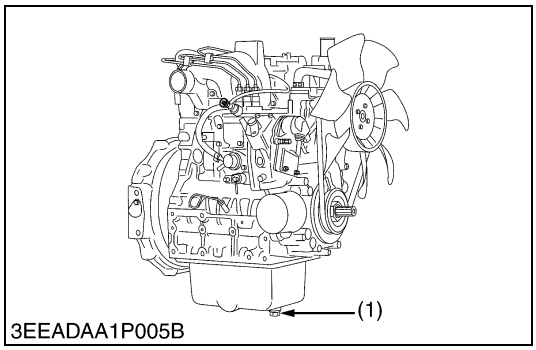
[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Engine Oil and Coolant



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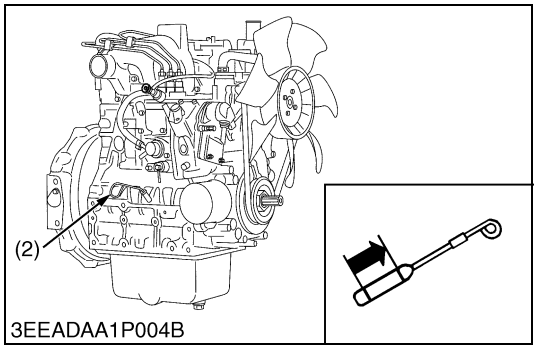

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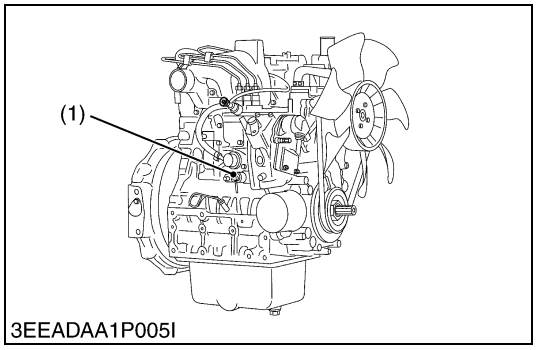

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Draining Engine Oil

1. Start and increase the temperature of the engine for approximately 5 minutes.
2. Put an oil pan below the engine.
3. Remove the drain plug (1) to drain the oil.
4. After you drain, tighten the drain plug.

(When reassembling)

- Fill the engine oil until the upper line on the dipstick (2).

■ **IMPORTANT**

- **Do not mix different types of oil.**
- **Use the correct SAE Engine Oil by reference to the ambient temperature.**

(1) Drain Plug (2) Dipstick

9Y1210967ENS0055US0

Draining Coolant

CAUTION

- **Do not remove the radiator cap while you operate or immediately after you stop the engine. If not, hot water can flow out from the radiator. Only open the cap after more than 10 minutes for the temperature of the radiator to decrease.**

1. Prepare a bucket.
2. Open the drain valve (1) to drain the coolant.
3. After you drain, close the drain valve.

(1) Drain Valve

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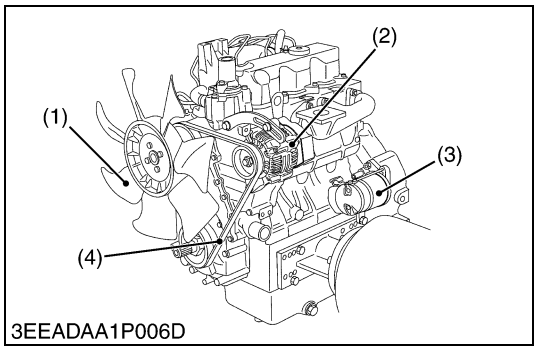
(2) External Components



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Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. Remove the fan (1), fan belt (4), alternator (2) and starter (3).

(When reassembling)

- Check for cracks on the belt surface.

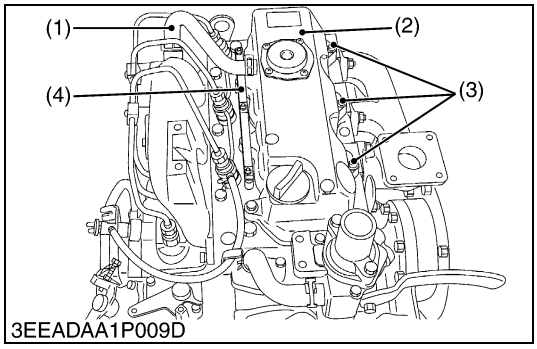
■ **IMPORTANT**

- **After you assemble the fan belt, adjust the fan belt tension.**
- **Do not put the fan in the incorrect direction.**

(1) Fan
(2) Alternator
(3) Starter
(4) Fan Belt

9Y1210967ENS0057US0

(3) Cylinder Head and Valves



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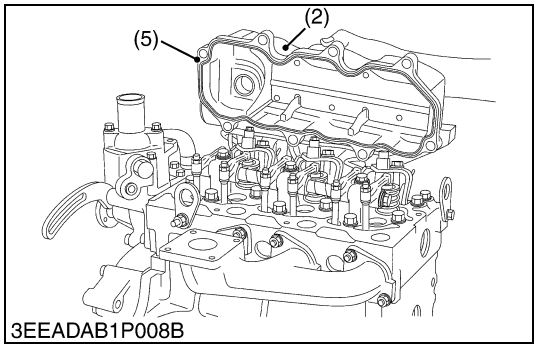

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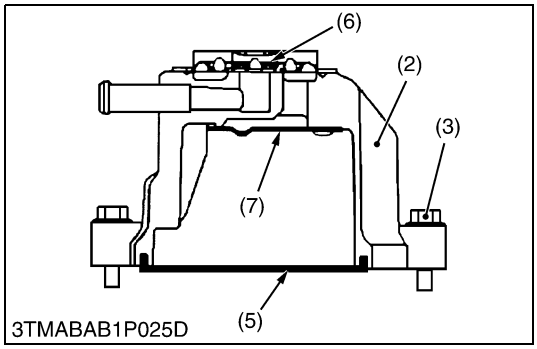

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Cylinder Head Cover

1. Remove the lead (4).
2. Remove the breather hose (1).
3. Remove the head cover screws (3).
4. Remove the cylinder head cover (2).

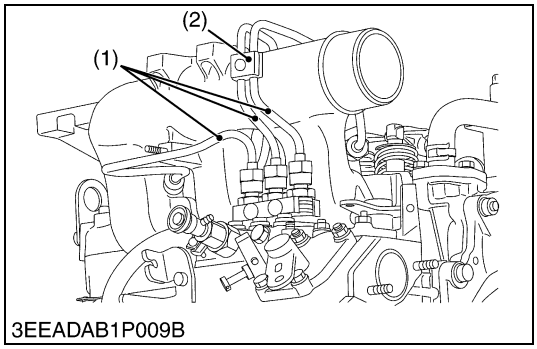
(When reassembling)

- Make sure that the cylinder head cover gasket (5) is not damaged.

Tightening torque	Cylinder head cover screw	6.87 to 11.2 N·m 0.700 to 1.15 kgf·m 5.07 to 8.31 lbf·ft

(1) Breather Hose
(2) Cylinder Head Cover
(3) Head Cover Screw
(4) Lead
(5) Cylinder Head Cover Gasket
(6) Breather Valve
(7) Plate

9Y1210967ENS0058US0



3EEADAB1P009B

Injection Pipes

1. Loosen the screws on the pipe clamps (2).
2. Remove the injection pipes (1).

(When reassembling)

- Blow out dust in the pipes.

Tightening torque	Injection pipe retaining nut	25 to 34 N·m 2.5 to 3.5 kgf·m 18 to 25 lbf·ft

(1) Injection Pipe
(2) Pipe Clamp

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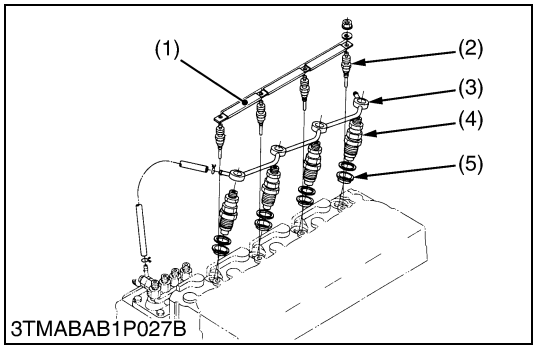


3TMABAB1P027B

Nozzle Holder Assembly and Glow Plug

[D1503-M-E4BG]

1. Remove the overflow pipe assembly (3).
2. Remove the nozzle holder assemblies (4) with a 21 mm-deep socket wrench.
3. Remove the copper gasket and heat seal (5).
4. Remove the glow plugs (2).

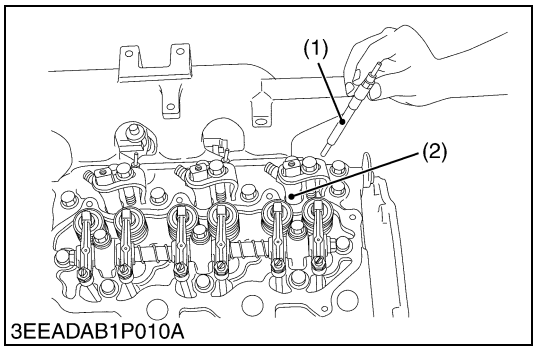
(When reassembling)

- Replace the copper gasket and heat seal with new ones.

Tightening torque	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft
	Retaining nut of overflow pipe assembly	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Glow plug	15 to 19 N·m 1.5 to 2.0 kgf·m 11 to 14 lbf·ft

(1) Lead
(2) Glow Plug
(3) Overflow Pipe Assembly
(4) Nozzle Holder Assembly
(5) Heat Seal

9Y1210967ENS0060US0



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Nozzle Holder Assembly and Glow Plug

[D1703-M-DI-E4B]

1. Remove the overflow pipe assembly.
2. Remove the nozzle holder assemblies (2).
3. Remove the glow plugs (1).

(When reassembling)

- Replace the copper gasket with a new one.

Tightening torque	Nozzle holder clamp screw	26 to 29 N·m 2.6 to 3.0 kgf·m 19 to 21 lbf·ft
	Retaining screw of overflow pipe assembly	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
	Glow plug	15 to 19 N·m 1.5 to 2.0 kgf·m 11 to 14 lbf·ft

(1) Glow Plug
(2) Nozzle Holder Assembly

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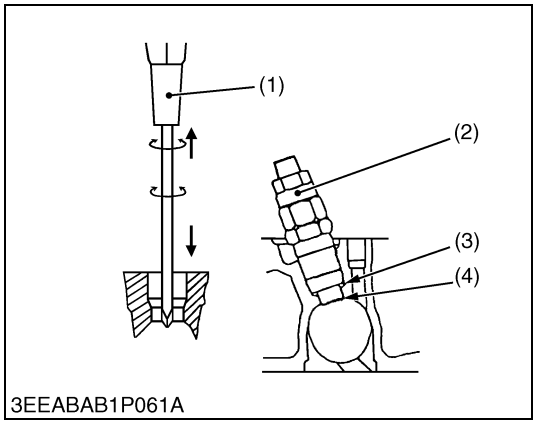

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Service Procedure of Nozzle Heat Seal

[D1503-M-E4BG]

■ **IMPORTANT**

- **Use a plus (phillips head) screwdriver (1) that has a diameter larger than the heat seal hole (Approximately 6 mm (1/4 in.)).**

1. Put the screwdriver (1) lightly into the heat seal hole.
2. Turn screwdriver 3 or 4 times each way.
3. While you turn the screwdriver, slowly pull the heat seal (4) out together with the injection nozzle gasket (3).
4. If the heat seal falls, do the above procedure again.

(When reassembling)

- Change the heat seal and injection nozzle gasket when you remove the injection nozzle to clean or for servicing.

(1) Plus Screwdriver
(2) Injection Nozzle
(3) Injection Nozzle Gasket
(4) Heat Seal

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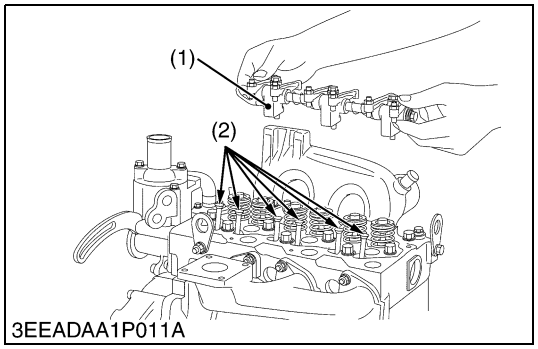

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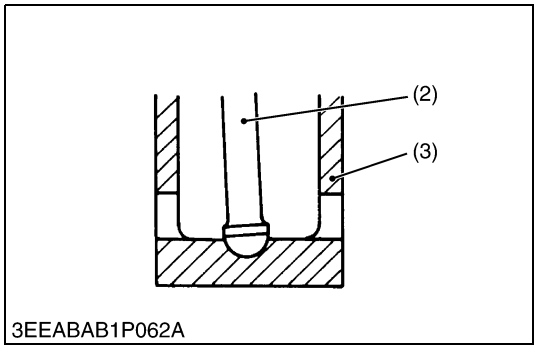

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Rocker Arm and Push Rod

1. Remove the screws of the rocker arm bracket.
2. Remove the rocker arm assembly (1).
3. Remove the push rods (2).

(When reassembling)

- When you put the push rods (2) on the tappets (3), make sure that their ends are correctly engaged with the grooves.

■ **IMPORTANT**

- **After you install the rocker arm, adjust the valve clearance.**

Tightening torque	Rocker arm bracket screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft

(1) Rocker Arm Assembly
(2) Push Rod
(3) Tappet

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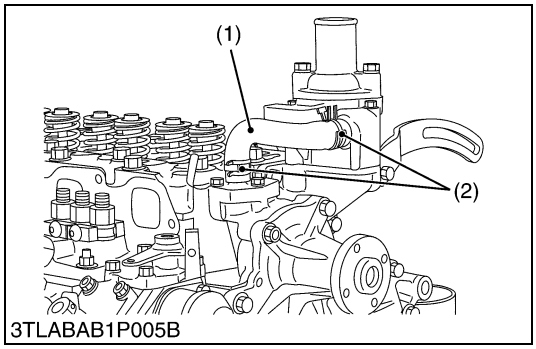

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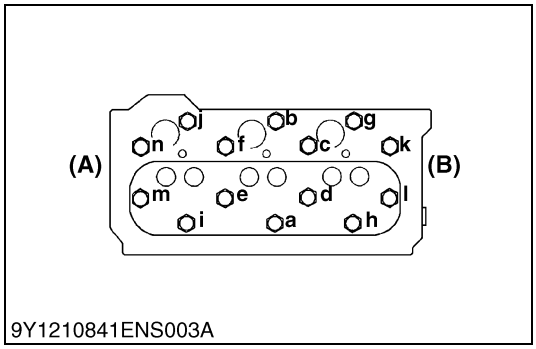

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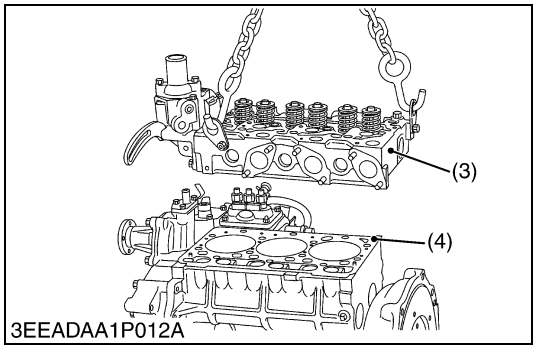

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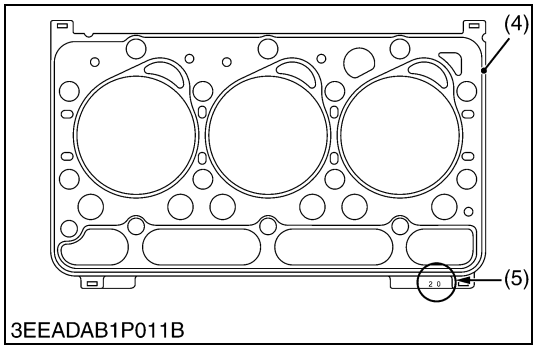

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Cylinder Head

1. Loosen the pipe clamp (2) and remove the water return pipe (1).
2. Remove the cylinder head screw in the sequence of **(n)** to **(a)**.
3. Lift up the cylinder head (3) to remove.
4. Remove the cylinder head gasket (4).

(When reassembling)

- Replace the cylinder head gasket (4) with a new one.
- Apply sufficient oil and tighten the cylinder head screws.
- Tighten the cylinder head screws in a diagonal sequence. Start from the center in the sequence of **(a)** to **(n)**.
- Tighten them equally, or the shape of the head changes after some time.

Tightening torque	Cylinder head screw	93.2 to 98.0 N·m 9.50 to 10.0 kgf·m 68.8 to 72.3 lbf·ft

■ **IMPORTANT**

- **Before you replace the cylinder head gasket (4), record the mark (5) on the cylinder head gasket of the engine. Then replace a cylinder head gasket with same mark.**

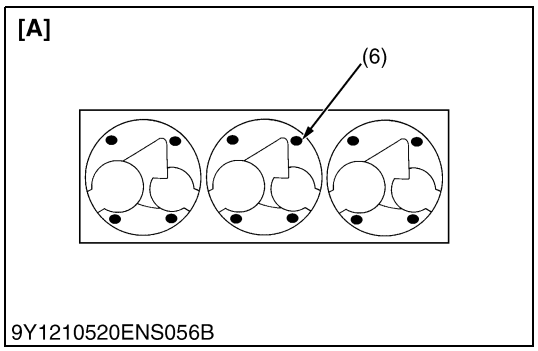
Gasket Mark and Code Number	Model	
	D1503-M-E4BG	D1703-M-DI-E4B
15	1G720-03600	1G750-03600
20	1G720-03310	1G750-03310
25	1G720-03610	1G750-03610
30	1G720-03620	1G750-03620
35	1G720-03630	1G750-03630

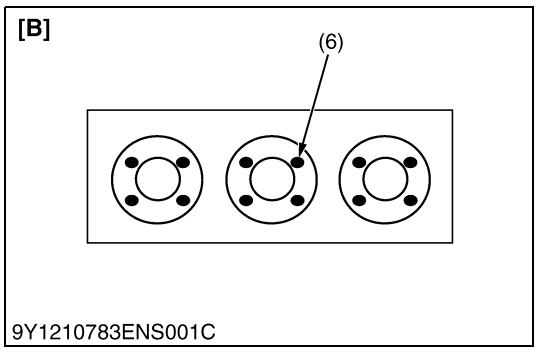
(1) Water Return Pipe
(2) Pipe Clamp
(3) Cylinder Head
(4) Cylinder Head Gasket
(5) Mark

(n) to (a): To Loosen
(a) to (n): To Tighten
(A) Gear Case Side
(B) Flywheel Side

(To be continued)

(Continued)





■ **IMPORTANT**

- **After you replace an item below, you have to select a cylinder head gasket.**
  - **Piston**
  - **Piston pin**
  - **Small end bushing**
  - **Connecting rod**
  - **Crankpin bearings**

To select the cylinder head gasket

1. Measure the protrusion or recess of the piston head from the level of crankcase cylinder face at 4 points per each piston with a dial gauge.
2. Get the average of the measurements.
3. Use the table below to select an applicable cylinder head gasket.

Gasket Dimension (Number)	Piston Protrusion	
	D1503-M-E4BG	D1703-M-DI-E4B
15	0.500 to 0.540 mm 0.0197 to 0.0212 in.	0.475 to 0.525 mm 0.0187 to 0.0206 in.
20	0.550 to 0.590 mm 0.0217 to 0.0232 in.	0.525 to 0.575 mm 0.0206 to 0.0227 in.
25	0.600 to 0.640 mm 0.0237 to 0.0251 in.	0.575 to 0.625 mm 0.0227 to 0.0246 in.
30	0.650 to 0.690 mm 0.0256 to 0.0271 in.	0.625 to 0.675 mm 0.0246 to 0.0266 in.
35	0.700 to 0.740 mm 0.0276 to 0.0291 in.	0.675 to 0.725 mm 0.0266 to 0.0285 in.

(6) Points of Measurement **[A] D1503-M-E4BG** **[B] D1703-M-DI-E4B**

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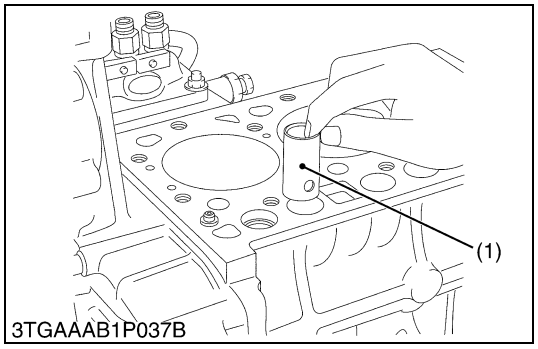

Tappets

1. Remove the tappets (1) from the crankcase.

(When reassembling)

- Before you install the tappets, apply a thin layer of engine oil around them.
- Check the contact between tappets and cams that it turns correctly. If it is damaged, replace the tappets.

■ **IMPORTANT**

- **Do not change the combination of tappet and tappet guide.**

(1) Tappet

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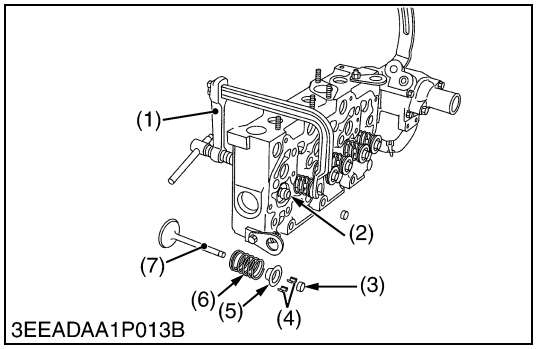

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Valves

1. Remove the valve caps (3).
2. Push the valve spring retainer with the valve spring replacer (1) and remove the valve spring collets (4).
3. Remove the valve spring retainer (5) and valve spring (6).
4. Remove the valve (7).

(When reassembling)

- Clean the valve stem and the valve guide hole, and apply engine oil sufficiently.
- After you install the valve spring collets (4), lightly tap the stem tip to attach it correctly with the plastic hammer.

■ **IMPORTANT**

- **Do not change the combination of valve and valve guide.**

(1) Valve Spring Replacer
(2) Valve Stem Seal
(3) Valve Cap
(4) Valve Spring Collet
(5) Valve Spring Retainer
(6) Valve Spring
(7) Valve

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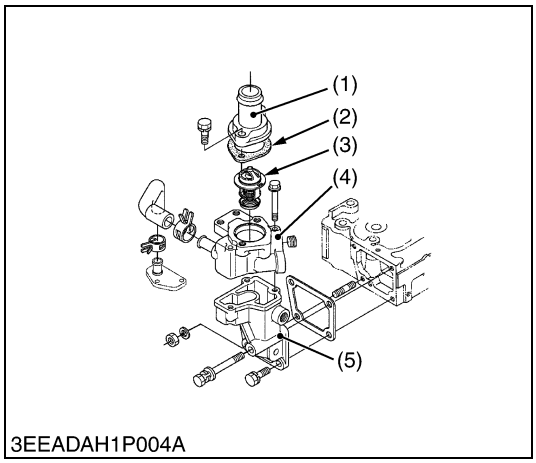

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Thermostat Assembly

1. Remove the thermostat cover mounting screws and thermostat cover (1).
2. Remove the thermostat assembly (3).

(When reassembling)

- Replace the thermostat cover gasket (2) with a new one.
- Apply a liquid gasket (Three Bond 1215 or equivalent) to the water flange 1 (4) and flange 2 (5).

(1) Thermostat Cover
(2) Thermostat Cover Gasket
(3) Thermostat Assembly
(4) Water Flange 1
(5) Water Flange 2

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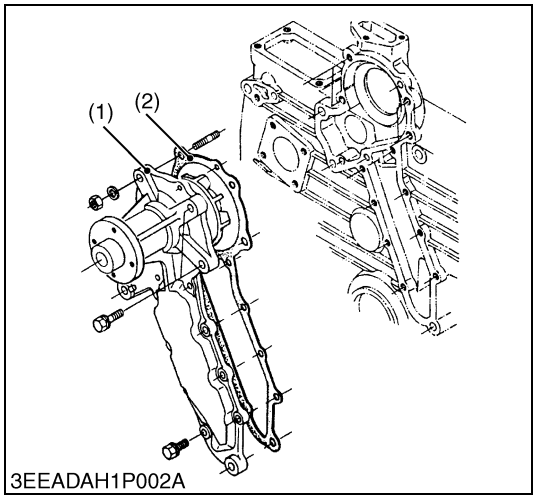

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Water Pump Assembly (If Necessary)

1. Remove the water pump assembly (1) from the gear case.

(When reassembling)

- Replace the gasket (2) with a new one.

(1) Water Pump Assembly
(2) Gasket

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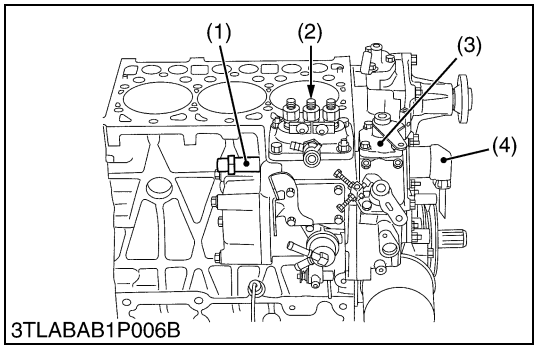
(4) Gear Case and Timing Gears



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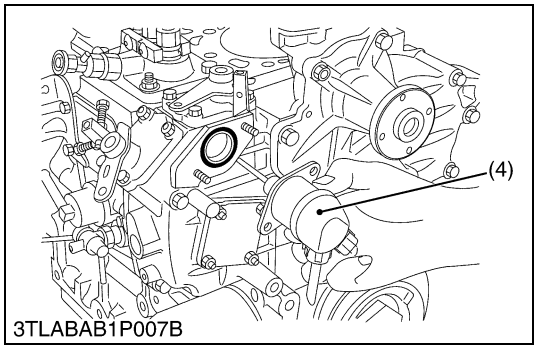

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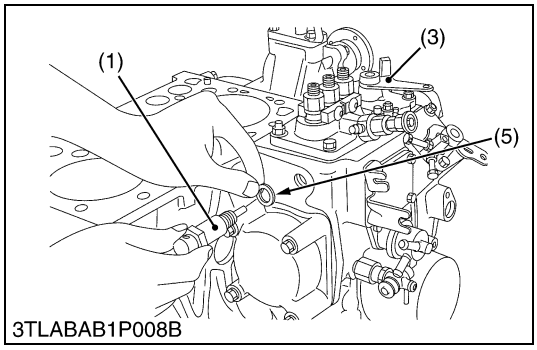

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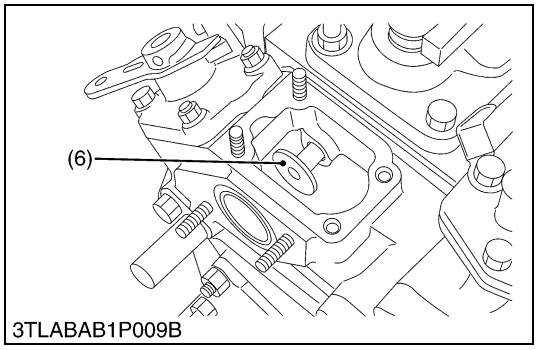

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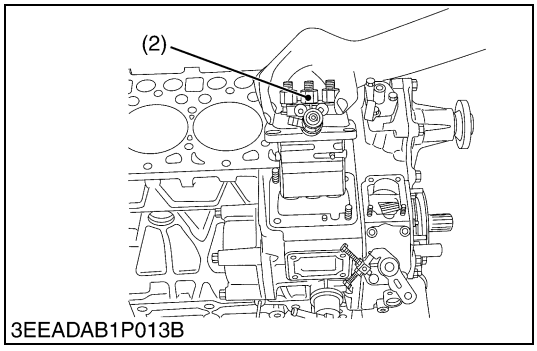

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Injection Pump

■ **IMPORTANT**

- **Before you remove the injection pump assembly (2), remove the solenoid (4), hi-idling body (1), engine stop lever (3) and solenoid guide (6).**

1. Remove the solenoid (4) and hi-idling body (1).
2. Remove the engine stop lever (3) and solenoid guide (6).
3. Remove the injection pump assembly (2).

(When reassembling)

- Before you attach the solenoid (4), hi-idling body (1) and solenoid guide (6), install the injection pump first into position.
- Replace the hi-idling body gasket (5) with a new one.
- Before you attach the stop lever (3) to the gear case, install the solenoid guide (6) first into position. Then attach the stop lever and monitor how it operates.
- When you install the solenoid (4), keep the O-ring in position.
- Put the push rod of the solenoid into the hole at the center of the solenoid guide (6).

Tightening torque	Hi-idling body	45 to 49 N·m 4.5 to 5.0 kgf·m 33 to 36 lbf·ft

(1) Hi-idling Body
(2) Injection Pump Assembly
(3) Stop Lever
(4) Solenoid
(5) Hi-idling Body Gasket
(6) Solenoid Guide

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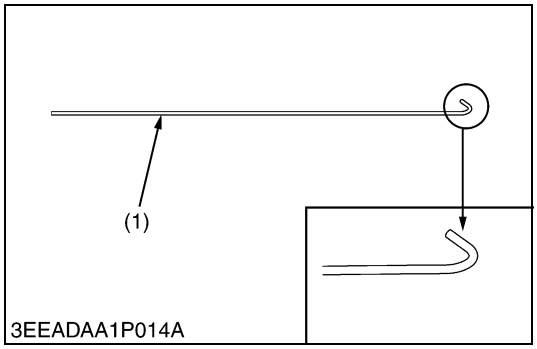

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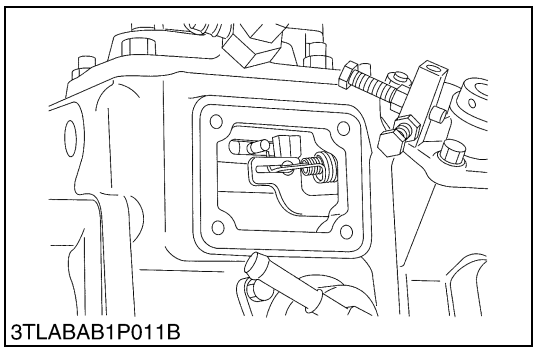
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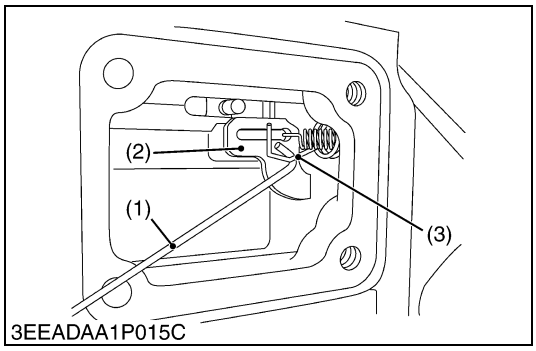

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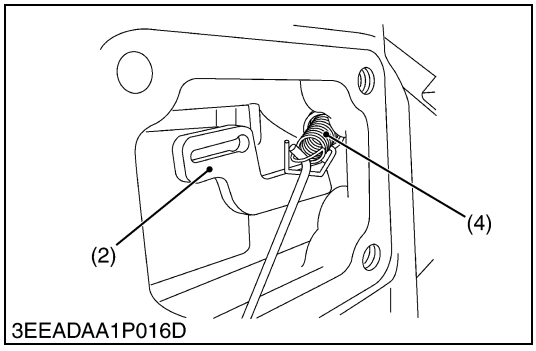

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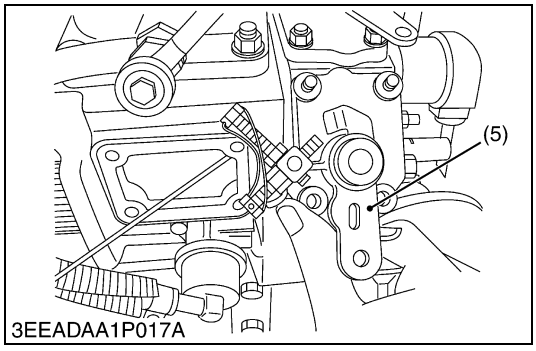

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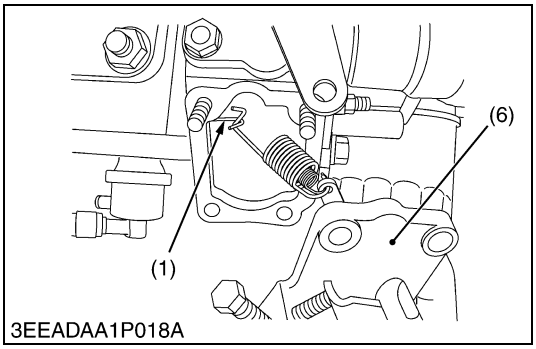
Governor Springs and Speed Control Plate

■ **NOTE**

- **Specified tool (1)**
  1.2 mm (0.047 in.) diameter hard wire with its end hooked, total length 200 mm (7.87 in.).
  The point of the wire is bent like a hook to hang the governor springs.

1. Remove the injection pump cover.
2. Remove the mounting nuts and bolts of the speed control plate (6).
3. Use the specific tool (1) to release the large governor spring (3) from the fork lever (2).
4. Use the specific tool (1) to release the small governor spring (4) from the fork lever (2).
5. Set the speed control lever (5) as you can see in the figure.
6. Remove the speed control plate (6). Do not let the large (3) and small (4) governor springs come off this plate and fall in the gear case.



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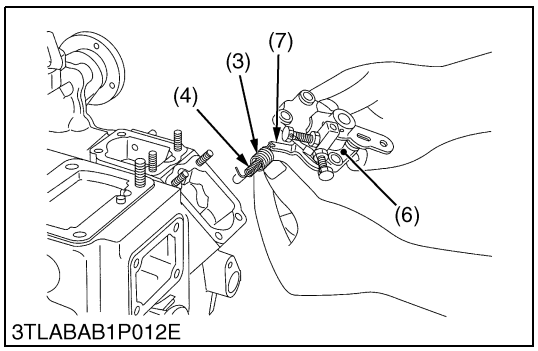
(1) Specific Tool
(2) Fork Lever
(3) Large Governor Spring
(4) Small Governor Spring
(5) Speed Control Lever
(6) Speed Control Plate

(To be continued)

(Continued)



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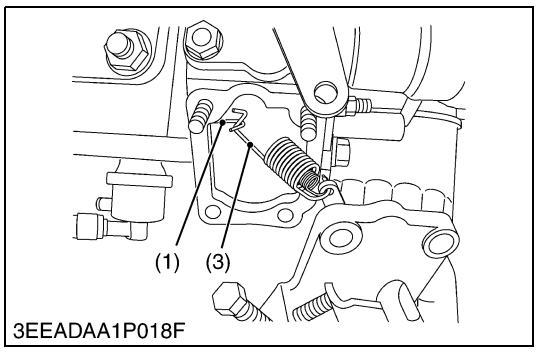

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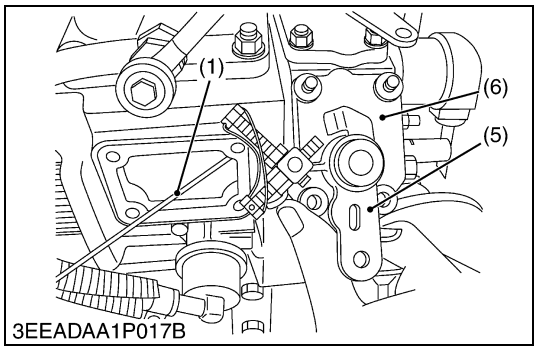

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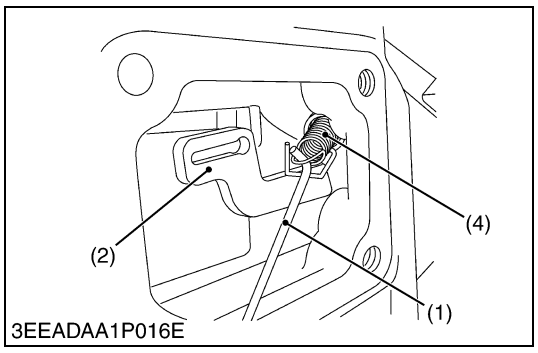

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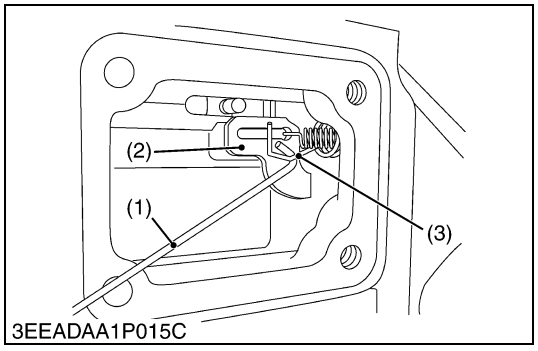

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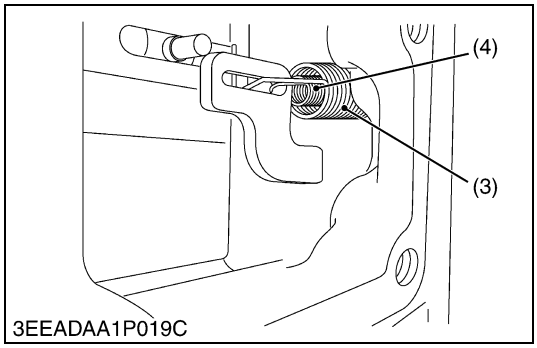
(When reassembling)

- Set the end with less clearance (color painted) of small governor spring (4) to the governor lever (7).
- Set the large governor spring (3) to the governor lever (7).
- Put the specific tool (1) from the injection pump cover side to catch the large governor spring (3). Keep this spring in an extended position and put the speed control plate (6) in its specified position.
- Use the specific tool (1), set the small governor spring (4) on the fork lever (2).
- Use the specific tool (1), set the large governor spring (3) on the fork lever (2).

■ **NOTE**

- **Do not stretch the small governor spring (4) too much because it can cause permanent deformation.**
- **Make sure that the 2 governor springs (3), (4) are tight on the fork lever (2).**
- **Tighten the 2 bolts and 2 nuts on the speed control plate (6).**
- **After you assemble the governor springs, make sure that the speed control lever (5) is at the low-idle position.**
- **After you move the speed control lever (5) to the maximum speed position, make sure that it goes back to the high-idle position.**
- **Attach the injection pump cover in position.**



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(1) Specific Tool
(2) Fork Lever
(3) Large Governor Spring
(4) Small Governor Spring
(5) Speed Control Lever
(6) Speed Control Plate
(7) Governor Lever

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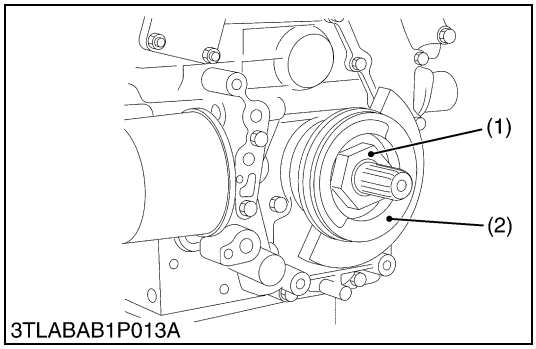

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Fan Drive Pulley

1. Lock the flywheel with the flywheel stopper.
2. Remove the mounting nut (1) of the fan drive pulley with a 46 mm (1.8 in.) deep socket wrench (3).
3. Remove the fan drive pulley (2) with a gear puller (4).
4. Remove the feather key.
5. Remove the oil seal cover. (Oil pump is mounted gear case model)

(When reassembling)

- Apply grease to the splines of coupling.

Tightening torque	Mounting nut of fan drive pulley	167 to 205 N·m 17.1 to 20.9 kgf·m 124 to 151 lbf·ft

(1) Nut
(2) Fan Drive Pulley
(3) 46 mm (1.8 in.) Deep Socket Wrench
(4) Gear Puller

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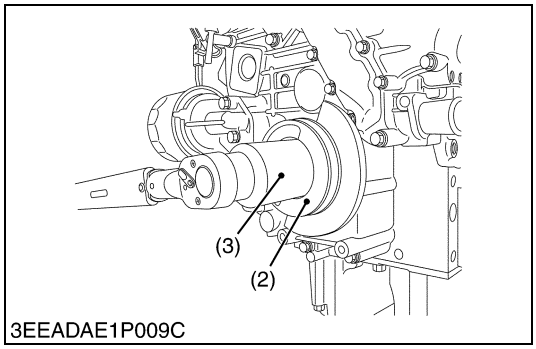

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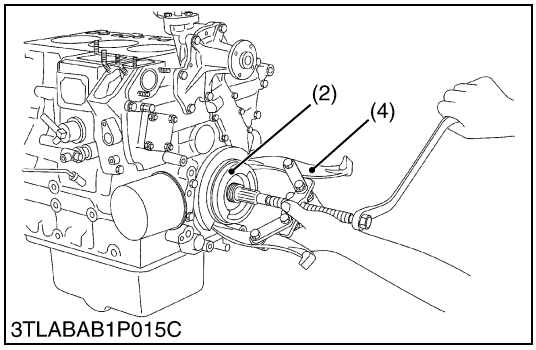

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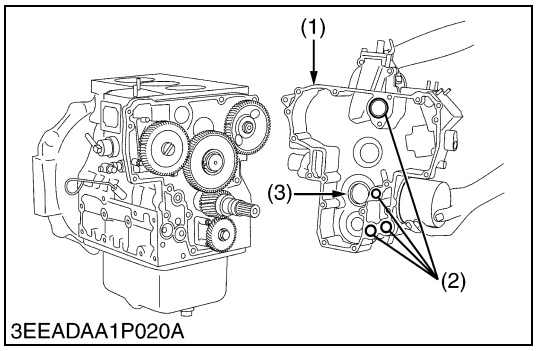

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Gear Case

1. Remove the hour meter gear case (if attached).
2. Remove the gear case (1).
3. Remove the O-rings (2).

(When reassembling)

- Replace the gear case gasket and O-rings (2).
- Replace the hour meter gear case gasket with a new one.
- Make sure that there are 4 O-rings (2) in the gear case (1).
- Apply a thin layer of engine oil to the oil seal. Then install the oil seal not to come off the lip.
- Before you install the gear case gasket, apply an adhesive that does not become dry.

(1) Gear Case
(2) O-ring
(3) Oil Seal

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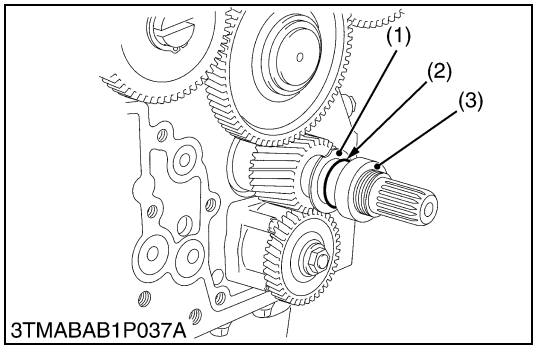

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Crankshaft Oil Slinger (Oil pump is mounted crankcase model)

1. Remove the crankshaft collar (3).
2. Remove the O-ring (2).
3. Remove the crankshaft oil slinger (1).

(When reassembling)

- Attach the crankshaft collar (3) after you install the gear case to the cylinder body.

(1) Crankshaft Oil Slinger
(2) O-ring
(3) Crankshaft Collar

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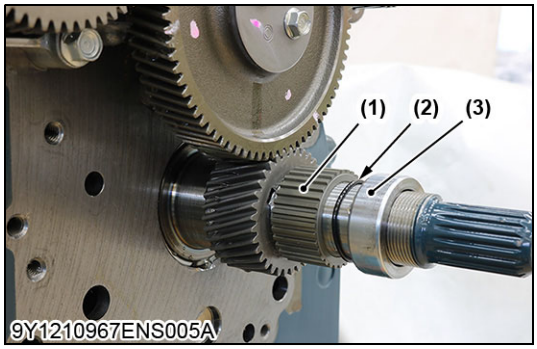

Oil Pump Drive Gear (Oil pump is mounted gear case model)

1. Remove the crankshaft collar (3).
2. Remove the O-ring (2).
3. Remove the oil pump drive gear (1).

(When reassembling)

- Attach the crankshaft collar (3) after you install the gear case cover to the crankcase.

(1) Oil Pump Drive Gear
(2) O-ring
(3) Crankshaft Collar

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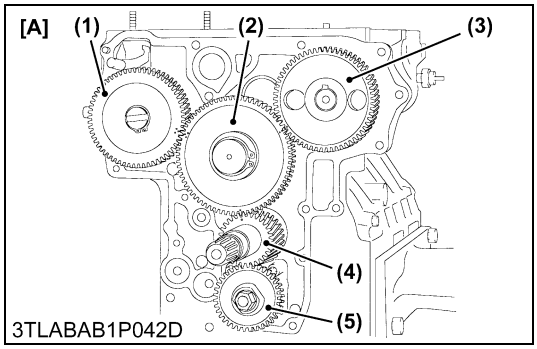


Idle Gear

[A] Oil pump is mounted crankcase model

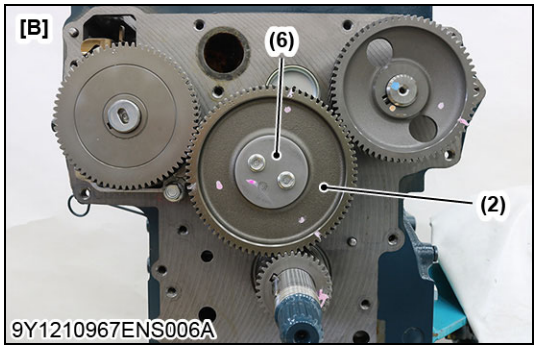
1. Remove the external snap ring.
2. Remove the idle gear collar.
3. Remove the idle gear (2).

[B]Oil pump is mounted gear case model

1. Remove the idle gear screw and the idle gear collar (6).
2. Remove the idle gear (2).

(When reassembling)

- Align each gear with its mark.
  - Idle gear (2) and crank gear (4)
  - Idle gear (2) and cam gear (3)
  - Idle gear (2) and injection pump gear (1)



(1) Injection Pump Gear
(2) Idle Gear
(3) Cam Gear
(4) Crank Gear
(5) Oil Pump Drive Gear
(6) Idle Gear Collar

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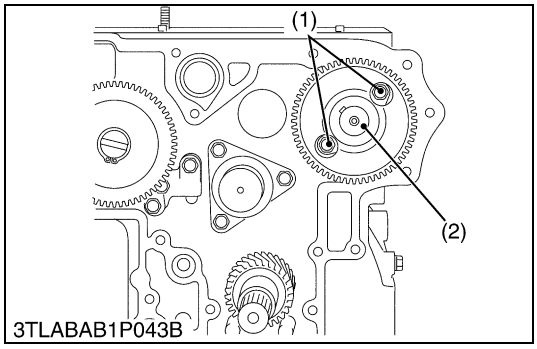

Camshaft

1. Remove the camshaft set screws (1) and pull out the camshaft (2).

(When reassembling)

- When you install the idle gear, align the marks on the gears.

Tightening torque	Camshaft set screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft

(1) Camshaft Set Screw
(2) Camshaft

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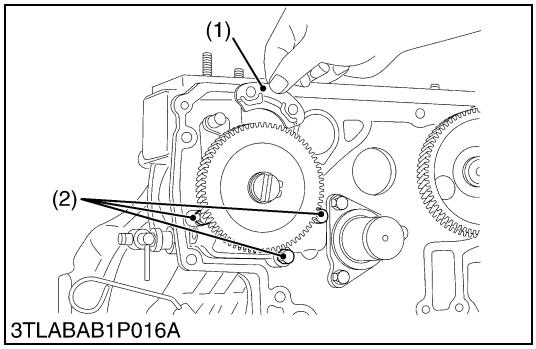
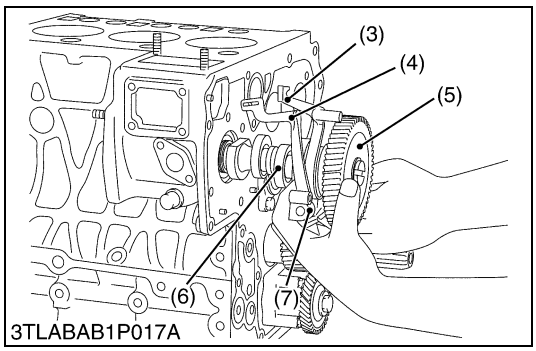


Fuel Camshaft and Fork Lever Assembly

1. Remove the fuel feed pump.
2. Remove the fuel camshaft stopper (1).
3. Remove the 3 mounting screws (2) of the fork lever holder.
4. Pull out the fuel camshaft assembly (5), (6) and fork lever assembly (3), (4), (7) at the same time.

(When reassembling)

- After installation, make sure that the fork levers (3) and (4) are attached to the fork lever shaft. Make sure also that they can turn smoothly in the holder (7).



(1) Fuel Camshaft Stopper
(2) Mounting Screw of Fork Lever Holder
(3) Fork Lever 1
(4) Fork Lever 2
(5) Injection Pump Gear
(6) Fuel Camshaft
(7) Fork Lever Holder

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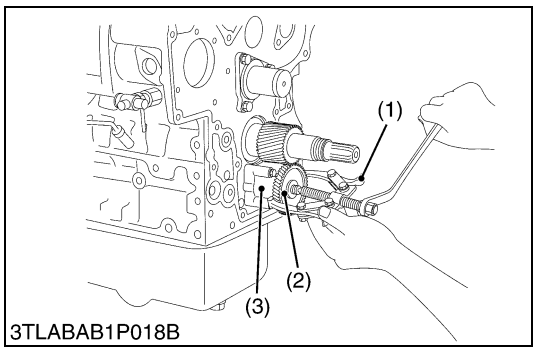

Oil Pump (Mounted crankcase model)

1. Remove the nut.
2. Pull out the oil pump drive gear (2) with a gear puller (1).
3. Remove the 4 mounting screws of the oil pump. Remove the oil pump (3).

(1) Gear Puller
(2) Oil Pump Drive Gear
(3) Oil Pump

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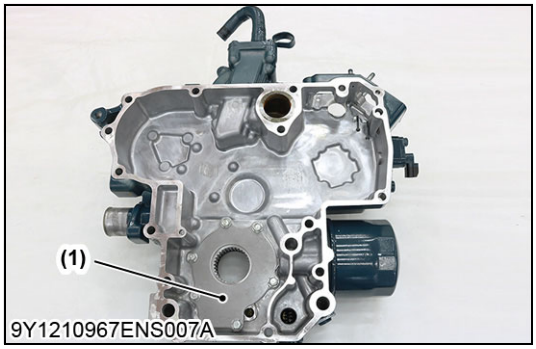

Oil Pump (Mounted gear case model)

1. Remove the oil pump cover (1).
2. Remove the inner rotor (3) and outer rotor (2).

(1) Oil Pump Cover
(2) Outer Roter
(3) Inner Rotor

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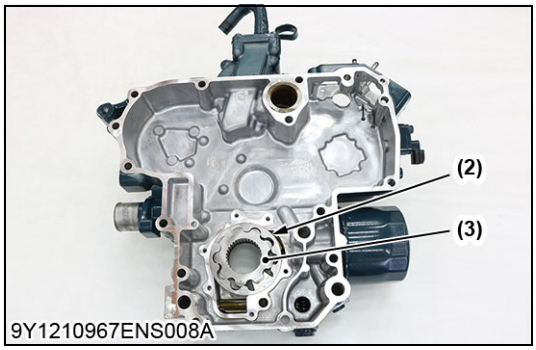

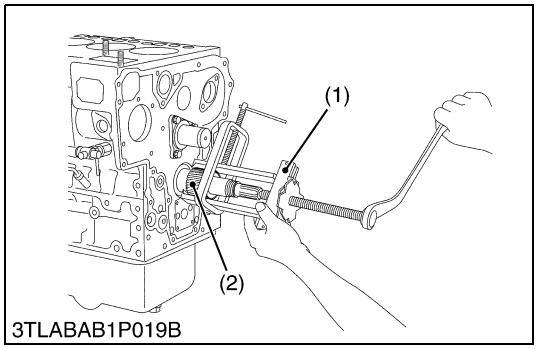

Crank Gear

1. Pull out the crank gear (2) with a puller (1).
2. Remove the feather key.

(1) Puller (2) Crank Gear

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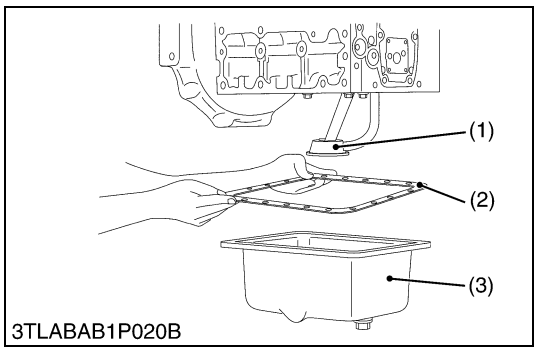
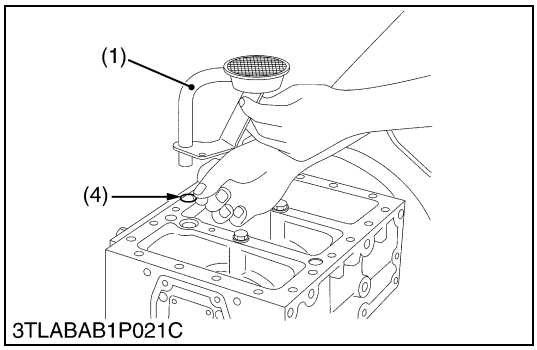
(5) Piston and Connecting Rod





Oil Pan and Oil Strainer

1. Remove the mounting screws of the oil pan.
2. Tap lightly on the rim of the pan with a wooden hammer to remove the oil pan (3).
3. Remove the oil pan gasket (2).
4. Remove the oil strainer (1) and O-ring (4).

(When reassembling)

- After you clean the oil strainer (1), make sure that the filter mesh is clean and install it.
- Visually check the O-ring (4), apply engine oil and install it.
- Install the O-ring (4) to the oil strainer (1) certainly.
- Replace the oil pan gasket (2) with a new one.
- Tighten the mounting screws of the oil pan in diagonal sequence from the center to tighten equally.

(1) Oil Strainer (3) Oil Pan
(2) Oil Pan Gasket (4) O-ring

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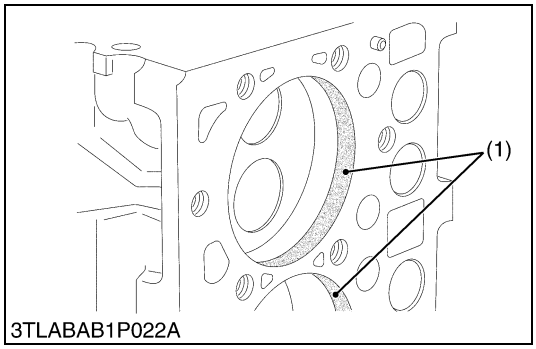

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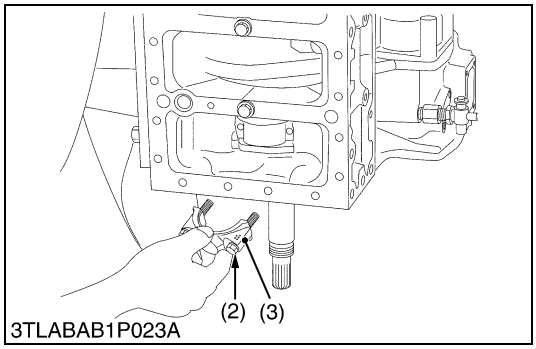

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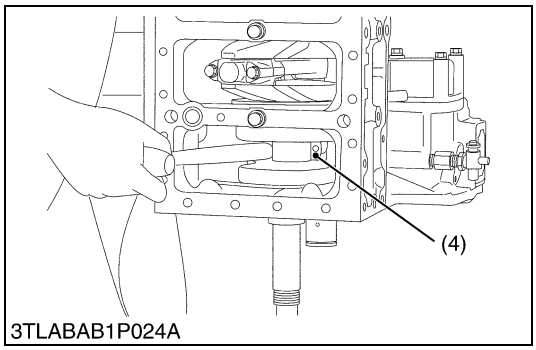

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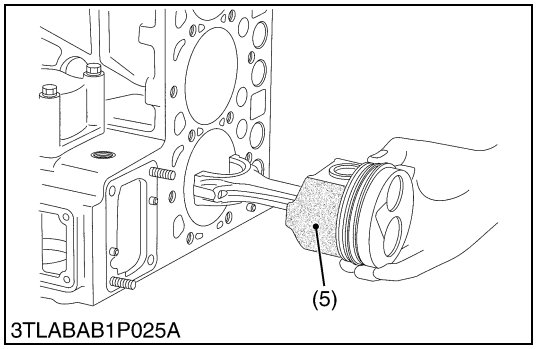

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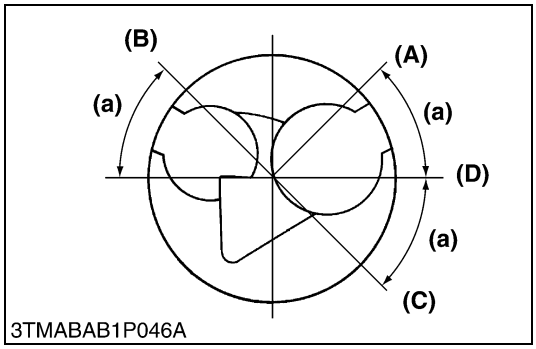

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Pistons

[D1503-M-E4BG]

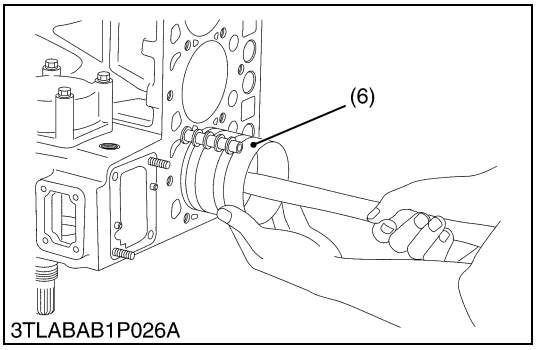
1. Fully clean the carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and move the piston to the top dead center.
4. Lightly tap the piston from the bottom of the crankcase with the grip of a hammer to pull the piston out.
5. Pull out the other piston in the same procedure as above.

(When reassembling)

- Before you install the piston into the cylinder, apply sufficient engine oil to the piston.
- When you install the piston into the cylinder, point the mark on the connecting rod to the injection pump.

■ **IMPORTANT**

- **Do not change the combination of cylinder and piston. Align the position of each piston by the its mark. For example, mark "1" on the No. 1 piston.**
- **Set the piston rings with their gaps at 0.79 rad (45°) from the direction of the piston pin (see the figure).**
- **Install the pistons with a piston ring compressor (6) carefully.**
- **When you install the piston in position, do not give a damage to the layer of molybdenum disulfide on the piston skirt. This layer can decrease the clearance with the cylinder liner. Immediately after you press-fit the piston pin, the piston is hot and the layer comes off easily. Only put in the piston after its temperature decreases.**



3TLABAB1P026A

Tightening torque	Connecting rod screw	41 to 45 N·m 4.1 to 4.6 kgf·m 30 to 33 lbf·ft

(1) Carbon
(2) Connecting Rod Screw
(3) Connecting Rod Cap
(4) Connecting Rod
(5) Layer of Molybdenum Disulfide
(6) Piston Ring Compressor

(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole

(a) 0.79 rad (45°)

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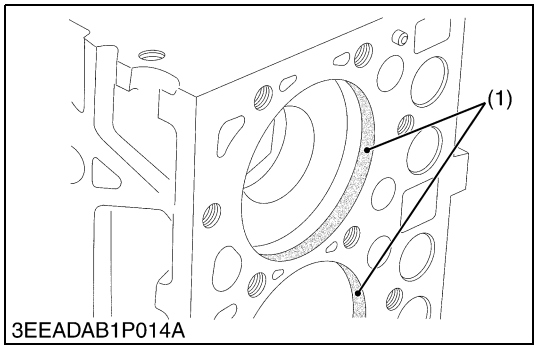

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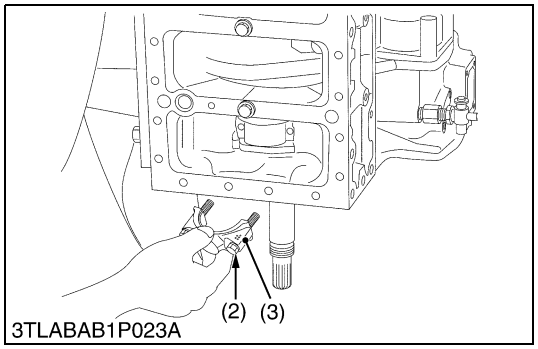

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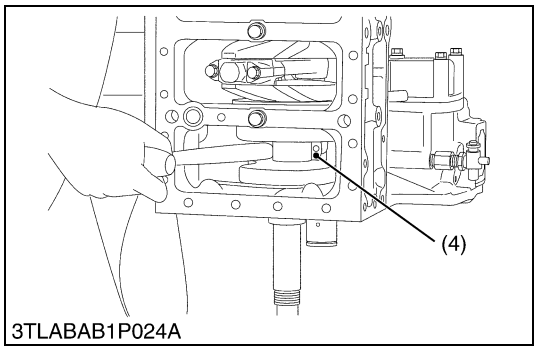

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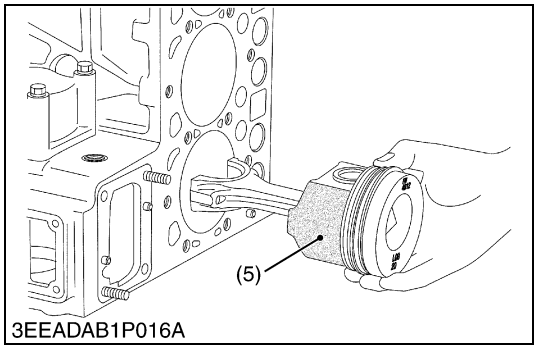

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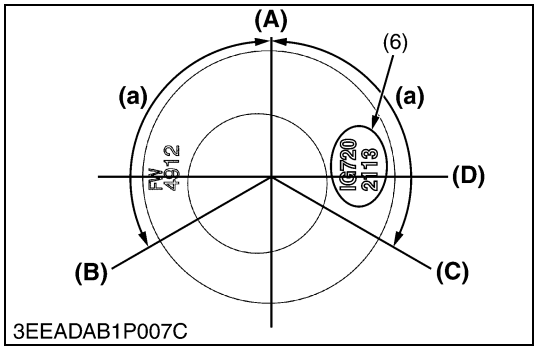

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Pistons

[D1703-M-DI-E4B]

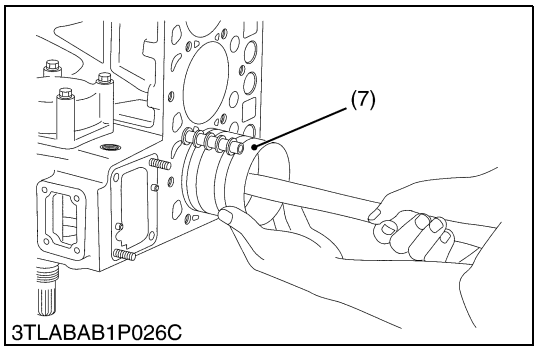
1. Fully clean the carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and move the piston to top dead center.
4. Lightly tap the piston from the bottom of the crankcase with the grip of a hammer to pull the piston out.
5. Pull out the other piston in the same procedure as above.

(When reassembling)

- Before you install the piston into the cylinder, apply sufficient engine oil to the piston.
- When you install the piston into the cylinder, point the mark on the connecting rod to the injection pump.

■ **IMPORTANT**

- **Do not change the combination of cylinder and piston. Align the position of each piston by its mark. For example, mark "1" on the No. 1 piston.**
- **Set the top ring with its gap (A) at 1.6 rad (90°) from the direction of the piston pin.**
  Then set the second ring and the oil ring with their gaps (B), (C) at 2.09 rad (120°) from the top ring gap (A). (See the figure.)
- **Install the pistons with a piston ring compressor (7) carefully.**
- **When you install the piston in position, do not give a damage to the layer of molybdenum disulfide on the piston skirt. This layer can decrease the clearance with the cylinder liner. Immediately after you press-fit the piston pin, the piston is hot and the layer comes off easily. Only put in the piston after its temperature decreases.**
- **When you replace the piston, look at the code number (6) on top of the piston. Use a replacement piston with the same code number.**



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Tightening torque	Connecting rod screw	41 to 45 N·m 4.1 to 4.6 kgf·m 30 to 33 lbf·ft

(1) Carbon
(2) Connecting Rod Screw
(3) Connecting Rod Cap
(4) Connecting Rod
(5) Layer of Molybdenum Disulfide
(6) Code Number
(7) Piston Ring Compressor

(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole

(a) 2.09 rad (120°)

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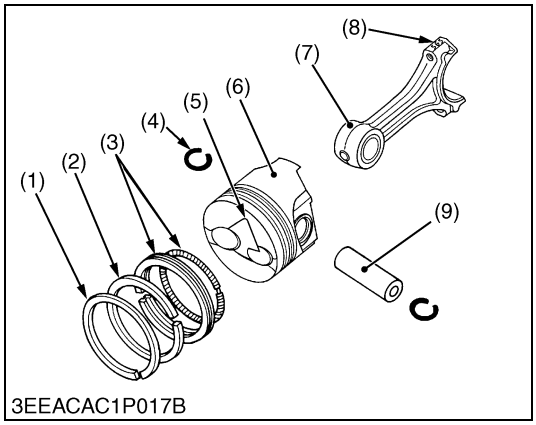

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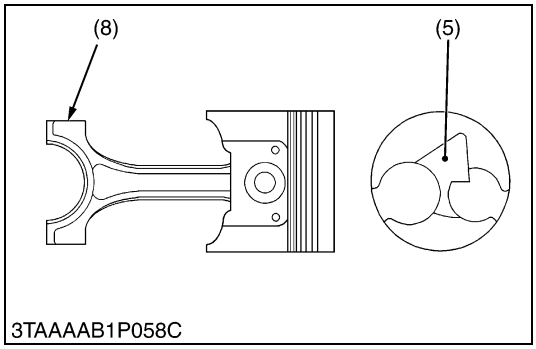

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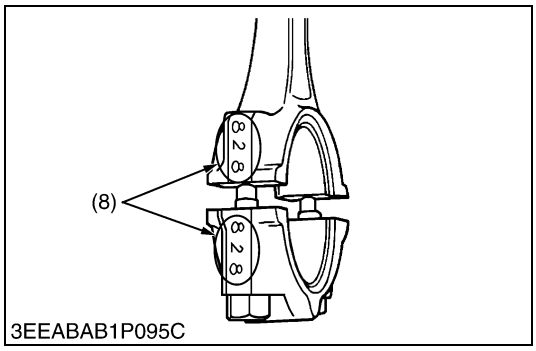

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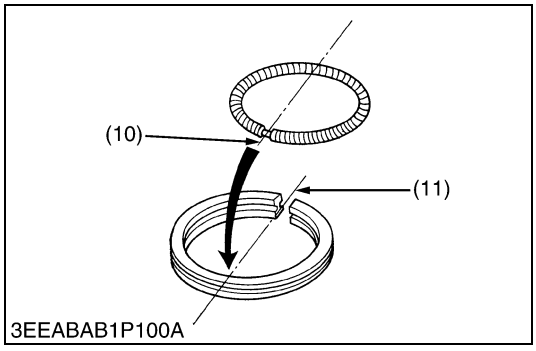

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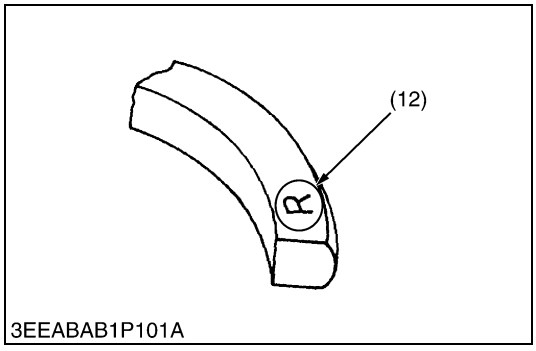

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Piston Ring and Connecting Rod

[D1503-M-E4BG]

1. Remove the piston rings (1), (2) and (3) with a piston ring tool.
2. Remove the piston pin (9) to disconnect the connecting rod (7) from the piston (6).

(When reassembling)

- When you install the rings to the piston (6), set the manufacturer mark (12) upward.
- When you install the oil ring (3) on the piston (6), set the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin (9).
- Put the piston (6) fully in 80 °C (176 °F) oil for 10 to 15 minutes.
- Align the mark (8) on the connecting rod (7) to the fan-shaped concave (5). Then install the piston pin (9) to connect the connecting rod (7) and the piston (6).

■ **NOTE**

- **Put a mark on the connecting rod (7) and the piston (6) with the same number to keep the same combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Ring
(5) Fan-Shaped Concave
(6) Piston
(7) Connecting Rod
(8) Mark
(9) Piston Pin
(10) Expander Joint
(11) Oil Ring Gap
(12) Manufacturer Mark

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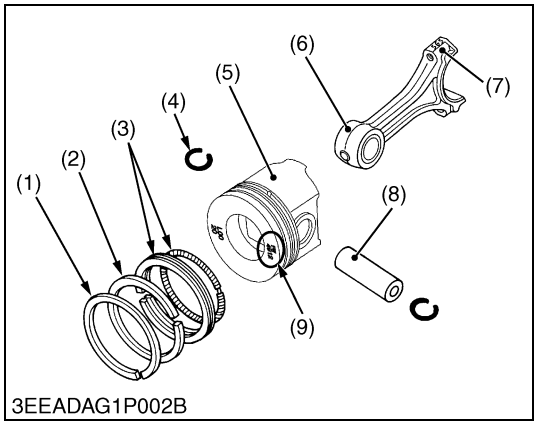

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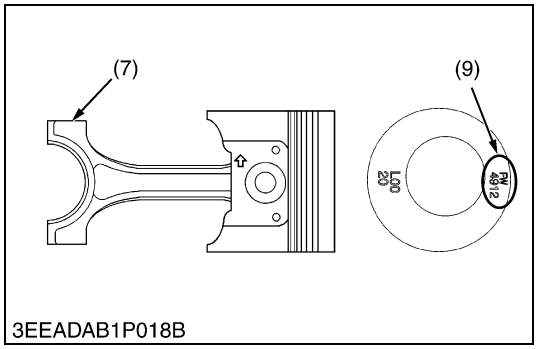

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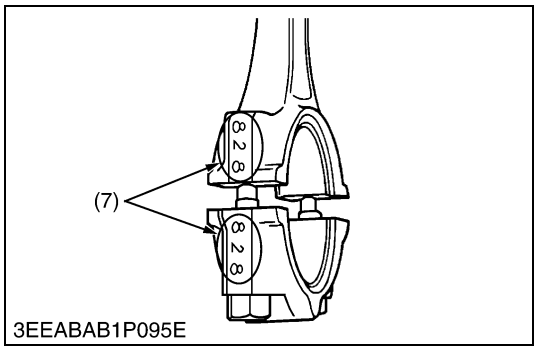

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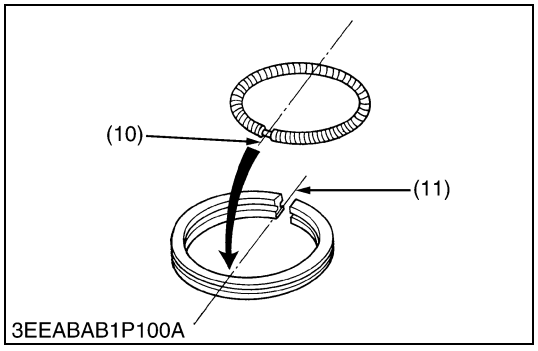

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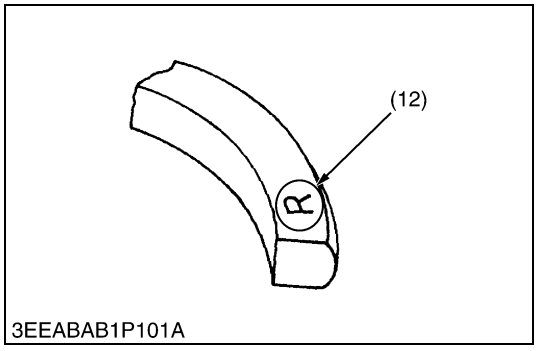

3EEABAB1P101A

Piston Ring and Connecting Rod

[D1703-M-DI-E4B]

1. Remove the piston rings (1), (2) and (3) with a piston ring tool.
2. Remove the piston pin (8) to disconnect the connecting rod (6) from the piston (5).

(When reassembling)

- When you install the rings to the piston (5), set the manufacturer mark (12) upward.
- When you install the oil ring (3) on the piston (5), set the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin (8).
- Put the piston (5) fully in 80 °C (176 °F) oil for 10 to 15 minutes.
- Align the FW mark (9) that points to the flywheel with the mark (7) that points to the injection pump. Then install the piston pin (8) to connect the connecting rod (6) and the piston (5).

■ **NOTE**

- **Put a mark on the connecting rod (6) and the piston (5) with the same number to keep the same combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Ring
(5) Piston
(6) Connecting Rod
(7) Mark
(8) Piston Pin
(9) FW Mark
(10) Expander Joint
(11) Oil Ring Gap
(12) Manufacturer Mark

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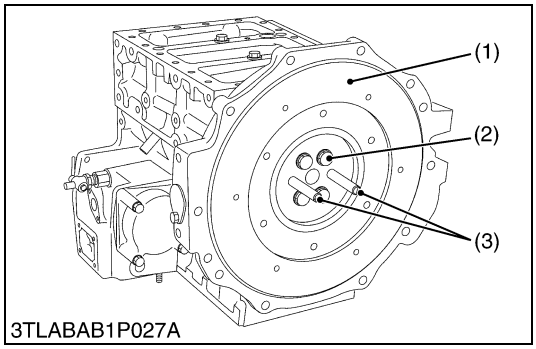
(6) Flywheel and Crankshaft



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Flywheel

1. Attach the stopper to the flywheel (1).
2. Remove 2 flywheel screws (2).
3. Put the 2 flywheel guide screws (3) in the holes.
4. Remove all the flywheel screws (2).
5. Remove the flywheel (1) slowly along the flywheel guide screws (3).

(When reassembling)

- Put in 2 flywheel guide screws (3).
- Check that there are no metal particles that remain on the flywheel mounting surfaces.
- Apply engine oil to the threads and the flange seat face of the flywheel screw. Then attach the screw.

Tightening torque	Flywheel screw	98.1 to 107 N·m 10.0 to 11.0 kgf·m 72.4 to 79.5 lbf·ft

(1) Flywheel
(2) Flywheel Screw
(3) Flywheel Guide Screws

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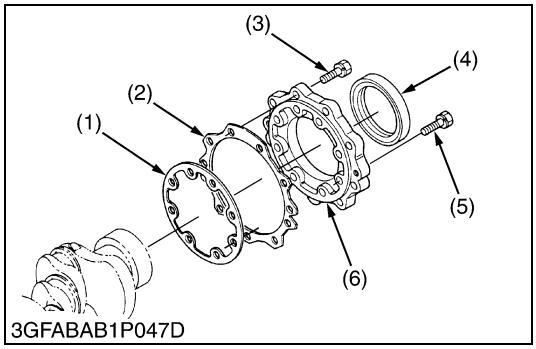


3GFABAB1P047D

Bearing Case Cover

1. Remove the mounting screws of the bearing case cover. First, remove inner screws (5) and then external screws (3).
2. Remove the bearing case cover (6).

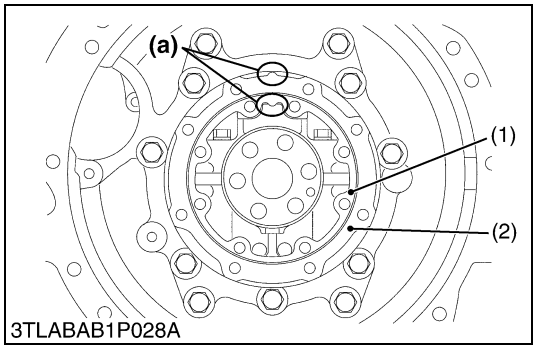
■ **IMPORTANT**

- **The length of inner screws (5) and external screws (3) are different. Make sure that you use the correct one at the correct position.**

(When reassembling)

- Attach the bearing case gasket (1) and the bearing case cover gasket (2) in the correct directions.
- Put the casting mark **"UP"** of the bearing case cover (6) upward, then install the bearing case cover.
- Apply a thin layer of engine oil to the oil seal. Then install the oil seal not to come off the lip.
- Tighten the mounting screws of the bearing case cover with an equal force on the diagonal line.

Tightening torque	Mounting screw of bearing case cover	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft



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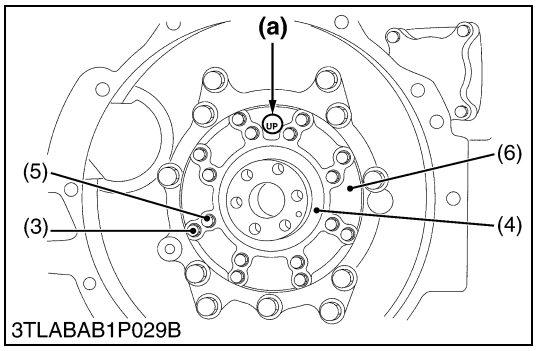

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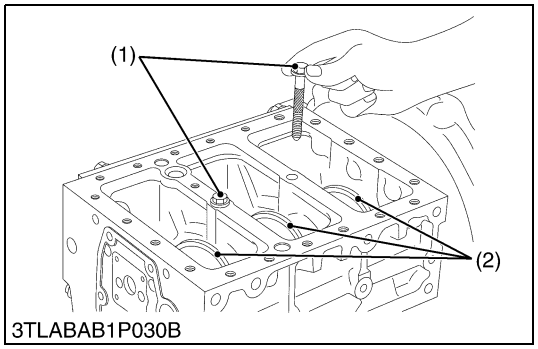
(1) Bearing Case Gasket
(2) Bearing Case Cover Gasket
(3) Mounting Screw of Bearing Case Cover
(4) Oil Seal
(5) Mounting Screw of Bearing Case Cover
(6) Bearing Case Cover
(a) Upside

9Y1210967ENS0085US0



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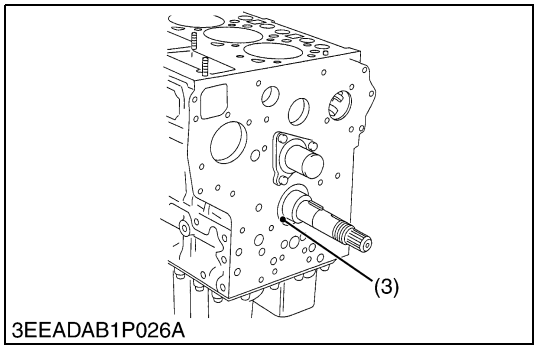

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Crankshaft

■ **NOTE**

- **Before you disassemble, measure the side clearance of crankshaft. Measure it when you assemble again.**

1. Remove the screw 2 (1) of the main bearing case.
2. Pull out the crankshaft assembly not to give a damage to the crankshaft bearing 1 (3).

(When reassembling)

■ **IMPORTANT**

- **When you install the crankshaft assembly, align the screw hole of the main bearing case 2 (2) with the screw hole of the cylinder block.**
- **Apply oil to the screw 2 (1) of the main bearing case and tighten the screw by hand.**
  If you cannot turn the screw 2 smoothly, align the screw holes between the cylinder block and the main bearing case correctly.
  Then tighten the screw 2 to the specified tightening torque with a torque wrench.

Tightening torque	Screw 2 of main bearing case	69 to 73 N·m 7.0 to 7.5 kgf·m 51 to 54 lbf·ft

(1) Screw 2 of Main Bearing Case
(2) Main Bearing Case 2
(3) Crankshaft Bearing 1

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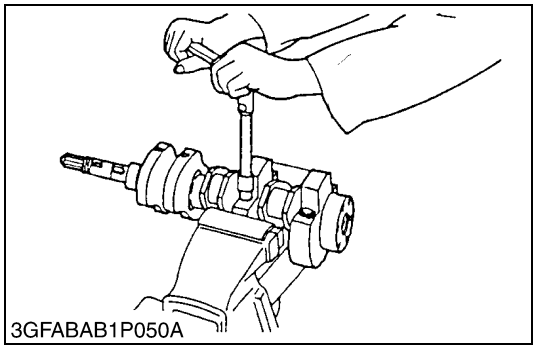
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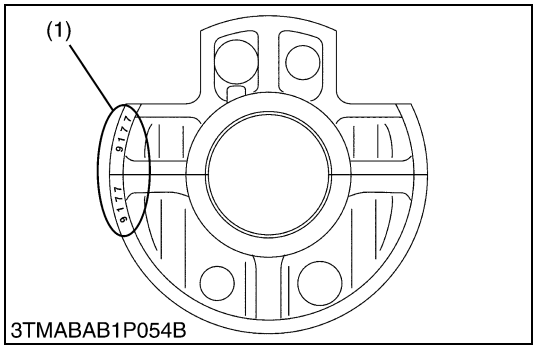

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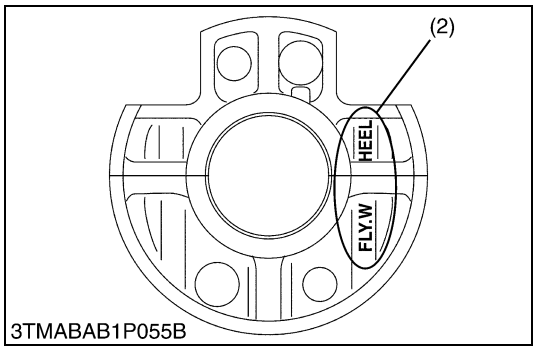

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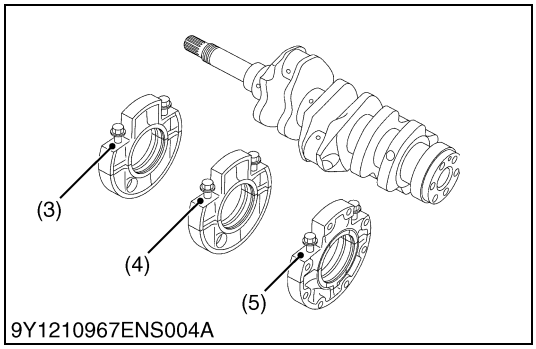

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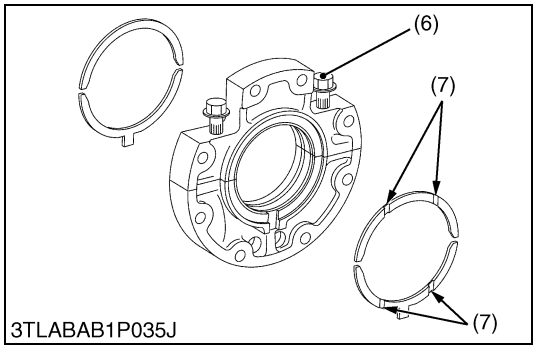

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Main Bearing Case Assembly

1. Remove the screws 1 of the main bearing case (6). Then remove the main bearing case.
2. Remove other main bearing cases as above.

(When reassembling)

- Clean the oil channel in the main bearing case.
- Apply clean engine oil on the bearings.
- Align the numbers (1) and mark (2) on the main bearing case.
- When you install the main bearing case 1 and 2, point the mark **"FLYWHEEL"** to the flywheel.
- When you install the thrust bearing, point the oil groove (7) externally.
- Install the main bearing case assemblies in the initial positions. Since the diameters of the main bearing cases are different, install them in the sequence of their marks (A, B) from the gear case side.
- After you tighten the screw 1 of the main bearing case (6) to the specified torque, make sure that the main bearing case moves smoothly.

Tightening torque	Screw 1 of main bearing case	46 to 50 N·m 4.7 to 5.2 kgf·m 34 to 37 lbf·ft

(1) Alignment Number
(2) Alignment Mark
(3) A
(4) B
(5) No Mark
(6) Screw 1 of Main Bearing Case
(7) Oil Groove

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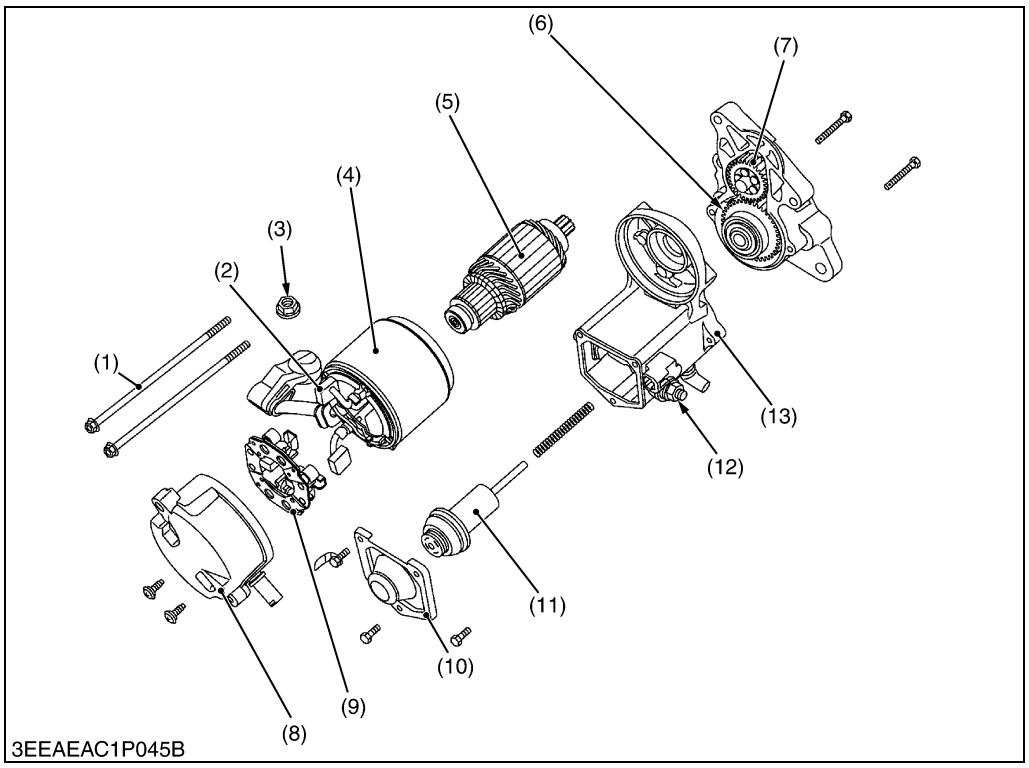
(7) Starter

Starter



(1) Through Bolt
(2) Brush
(3) **C** Terminal Nut
(4) Yoke
(5) Armature
(6) Overrunning Clutch
(7) Idle Gear
(8) End Frame
(9) Brush Holder
(10) Magnet Switch Cover
(11) Plunger
(12) **B** Terminal Nut
(13) Housing

1. Remove the **C** terminal nut (3), and disconnect the connecting lead.
2. Remove the 2 through bolts (1).
3. Remove the motor.
4. Remove the end frame (8).
5. Hold the spring up and remove the brush from the brush holder.
6. Remove the brush holder (9).
7. Pull out the armature (5) from the yoke (4).
8. Remove the housing (13).
9. Remove the idle gear (7) and the overrunning clutch (6).
10. Remove the magnet switch cover (10).
11. Remove the plunger (11).

■ **NOTE**

- **Do not cause damage to the brush and commutator.**

(When reassembling)

- Apply grease (DENSO No. 50 or equivalent) to the idle gear and overrunning clutch parts.

Tightening torque	**B** terminal nut	5.9 to 11 N·m 0.60 to 1.2 kgf·m 4.4 to 8.6 lbf·ft

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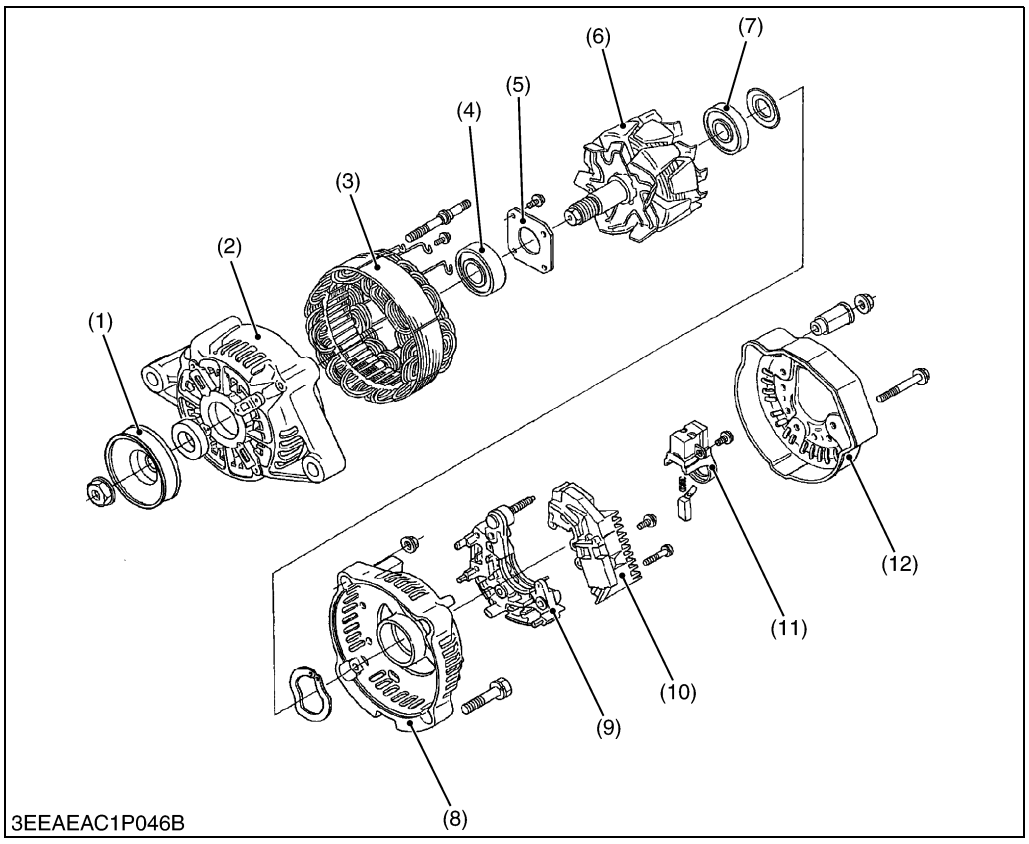
(8) Alternator

Alternator



(1) Pulley
(2) Drive End Frame
(3) Stator
(4) Bearing
(5) Retainer Plate
(6) Rotor
(7) Bearing
(8) Rear End Frame
(9) Rectifier
(10) IC Regulator
(11) Brush Holder
(12) Rear End Cover

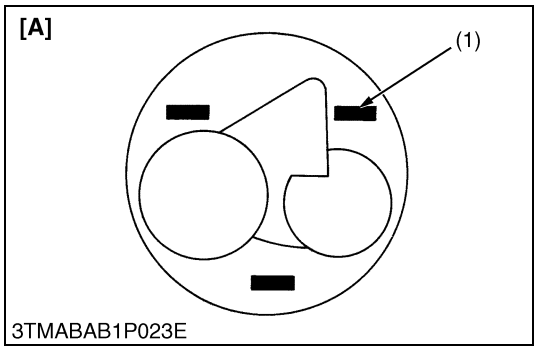
1. Remove the pulley (1).
2. Remove the rear end cover (12).
3. Remove the brush holder (11).
4. Remove the IC regulator (10).
5. Remove the 4 screws that hold the stator lead wires.
6. Remove the rectifier (9).
7. Remove the rear end frame (8).
8. Push out the rotor (6) from the drive end frame (2).
9. Remove the retainer plate (5).
10. Push out the bearing (4) from the drive end frame (2) with a press and jig.
11. Lightly hold the rotor with a vise to prevent damage, and remove the bearing (7) with a puller.

(When reassembling)

Tightening torque	Pulley nut	58.4 to 78.9 N·m 5.95 to 8.05 kgf·m 43.1 to 58.2 lbf·ft

9Y1210967ENS0089US0

[3] SERVICING
(1) Cylinder Head and Valves



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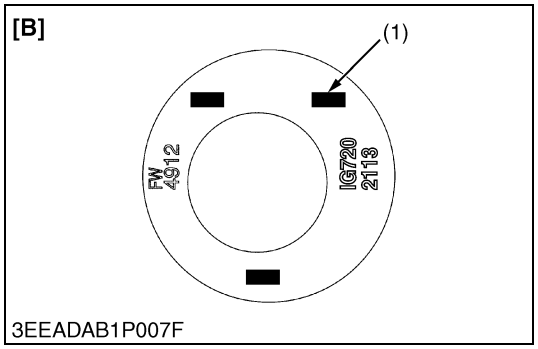

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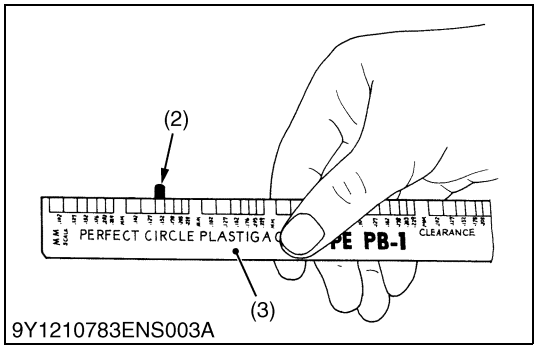

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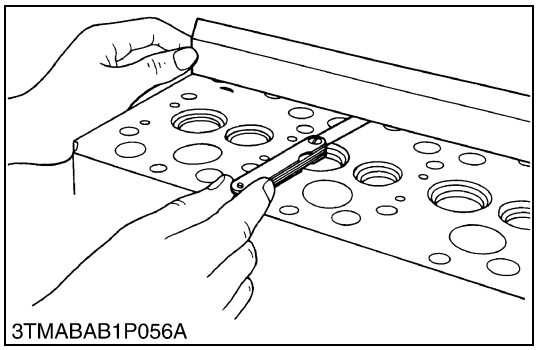
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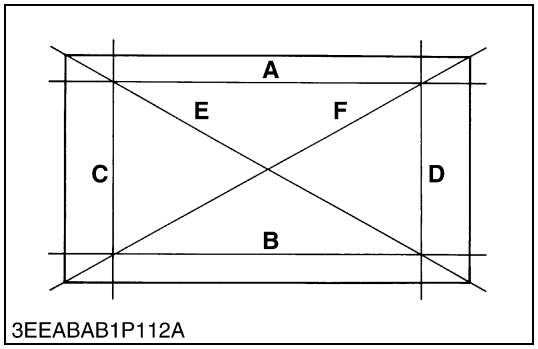

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Top Clearance

1. Remove the cylinder head.
2. With the piston at TDC, use grease to affix three or four plastigauges (1) of a diameter 1.5 mm (0.059 in.) × 5.0 to 7.0 mm (0.20 to 0.27 in.) long to the crown of the piston; keep the gauges away from the intake valve and combustion chamber fittings.
3. Take the piston to an intermediate position, install the cylinder head and tighten the head screws to the specified torque.
4. Turn the crankshaft so the piston goes through TDC.
5. Remove the cylinder head and compare the width of the crushed plastigauges (2) with the scale (3).
6. If they are out of spec, check the oil clearance of the crank pin, journals and piston pin.

■ **NOTE**
- **Top clearance = Width of the crushed plastigauge (2).**

Top clearance	Factory specification	D1503-M-E4BG	0.575 to 0.675 mm 0.0227 to 0.0265 in.
		D1703-M-DI-E4B	0.60 to 0.70 mm 0.024 to 0.027 in.

Tightening torque	Cylinder head screws	93.2 to 98.0 N·m 9.50 to 10.0 kgf·m 68.8 to 72.3 lbf·ft

(1) Plastigauge
(2) Crushed Plastigauge
(3) Scale

[A] D1503-M-E4BG
[B] D1703-M-DI-E4B

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Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Put a straightedge on the cylinder head.
3. Measure the clearance with a feeler gauge at the 6 places (see the figure).
4. If the measurement is more than the allowable limit, Replace the cylinder head.

■ **IMPORTANT**
- **Do not put a straightedge on the combustion chamber.**
- **Check the valve recessing after you replace.**

Cylinder head surface flatness	Allowable limit	0.05 mm 0.002 in.

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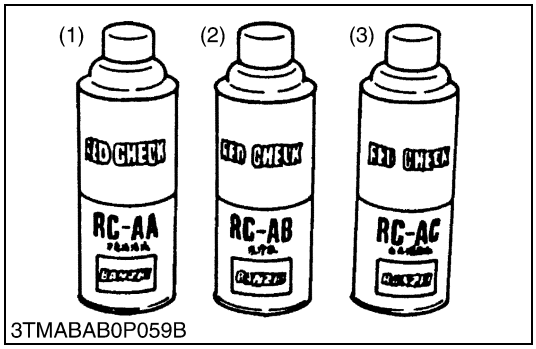

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Cylinder Head Flaw

1. Prepare an air spray red check.
2. Clean the surface of the cylinder head with detergent (2).
3. Apply some red permeative liquid (1) on the cylinder head surface. After you apply, do not touch it for 5 to 10 minutes.
4. Clean away the red permeative liquid on the cylinder head surface with detergent (2).
5. Apply the white developer (3) on the cylinder head surface.
6. If you found a red flaw, replace the cylinder head.

(1) Red Permeative Liquid
(2) Detergent
(3) White Developer

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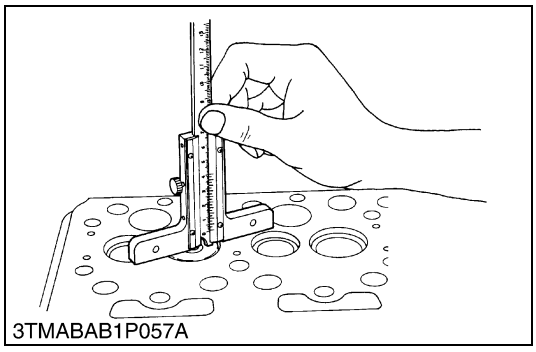
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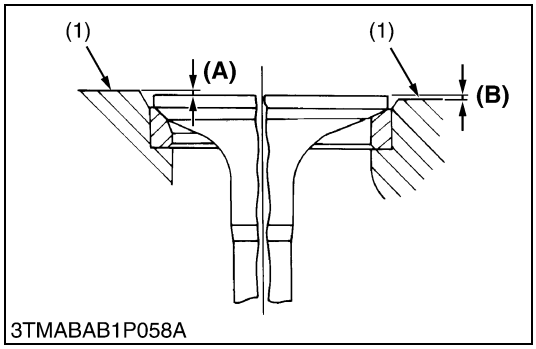

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Valve Recessing

1. Clean the cylinder head surface, valve face and valve seat.
2. Set the valve into the valve guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement is more than the allowable limit, replace the valve.
5. If it stays more than the allowable limit after you replace the valve, replace the cylinder head.

Valve recessing	Factory specification	D1503-M-E4BG	0.05 (protrusion) to 0.15 (recessing) mm 0.002 (protrusion) to 0.0059 (recessing) in.
		D1703-M-DI-E4B	0.65 to 0.85 mm 0.026 to 0.033 in.
	Allowable limit	D1503-M-E4BG	0.40 (recessing) mm 0.016 (recessing) in.
		D1703-M-DI-E4B	1.20 mm 0.0472 in.

(1) Cylinder Head Surface

(A) Recessing
(B) Protrusion

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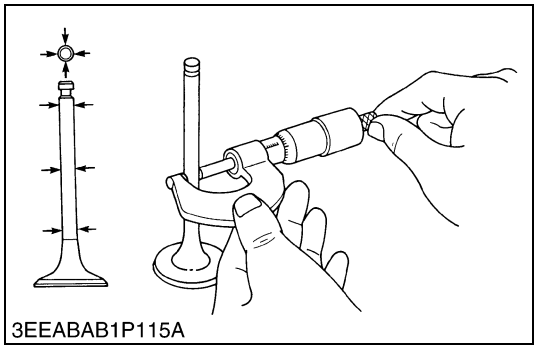
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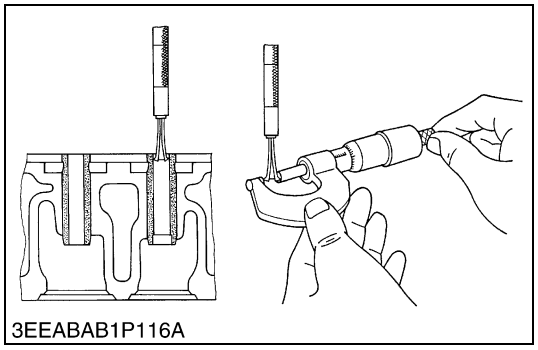
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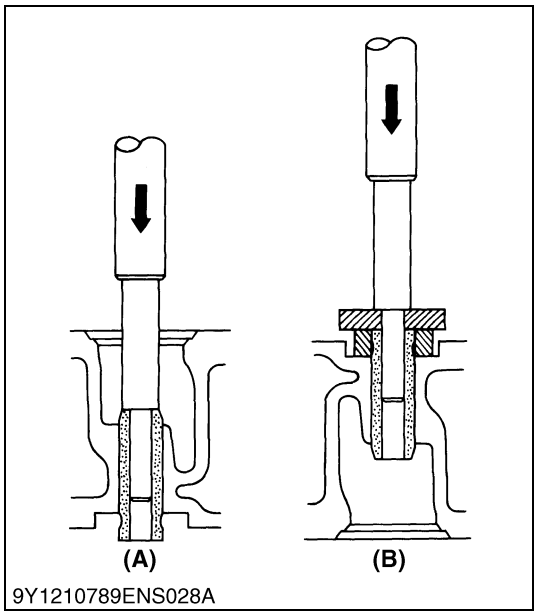

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Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an external micrometer.
3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.
4. If the clearance is more than the allowable limit, replace the valves.
5. If the clearance stays more than the allowable limit, replace the valve guide also.

Clearance between valve stem and valve guide	Factory specification	0.040 to 0.070 mm 0.0016 to 0.0027 in.
	Allowable limit	0.10 mm 0.0039 in.

Valve stem O.D.	Factory specification	7.960 to 7.975 mm 0.3134 to 0.3139 in.
Valve guide I.D.	Factory specification	8.015 to 8.030 mm 0.3156 to 0.3161 in.

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Replacement of Valve Guide

(When removing)

1. Press out the used valve guide with the valve guide replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

1. Clean the new valve guide and valve guide bore, and apply engine oil to them.
2. Press fit the new valve guide with the valve guide replacing tool.
3. Ream accurately the I.D. of the valve guide to the specified dimension.

Valve guide I.D. (Intake and exhaust)	Factory specification	8.015 to 8.030 mm 0.3156 to 0.3161 in.

■ **IMPORTANT**

- **Do not hit the valve guide with a hammer during replacement.**

(A) When Removing **(B) When Installing**

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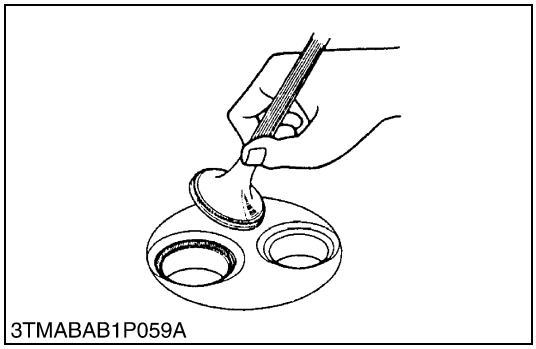

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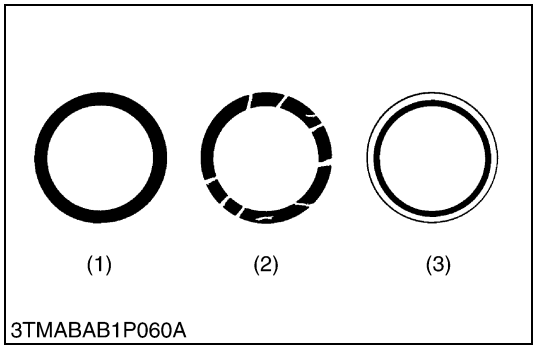

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Valve Seating

1. Apply a thin layer of Prussian Blue on the valve face. Then put the valve on its seat to check the contact.
2. If the valve is not fully around the seat or the contact is less than 70 % of the factory specification, correct the valve seat. See the next section.
3. If the valve contact width cannot get the factory specification, replace the valve or correct the contact of the valve seat.

Valve contact width	Factory specification	2.12 mm 0.0835 in.

(1) Correct
(2) Incorrect
(3) Incorrect

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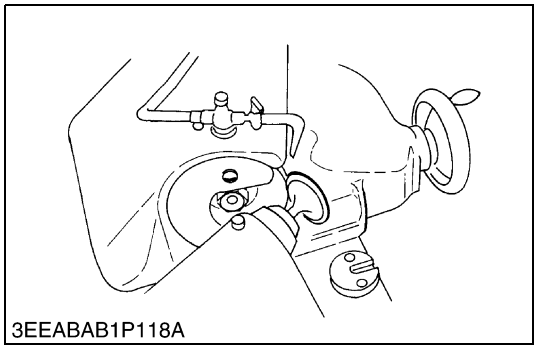
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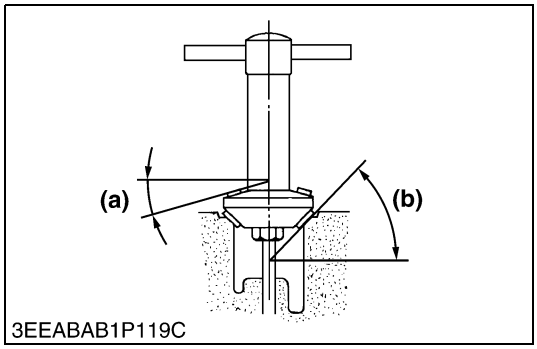

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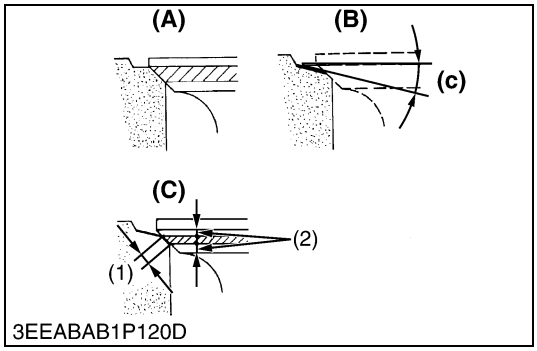

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Correction of Valve and Valve Seat

■ **NOTE**
- **Before you correct the valve and seat, check the valve stem and measure the I.D. of the valve guide section. Repair them if necessary.**
- **After you correct the valve seat, be sure to check the valve recessing.**

1) Correction of valve

1. Correct the valve with a valve refacer.

[D1503-M-E4BG]

Valve face angle	Factory specification	Intake	1.0 rad 60°
		Exhaust	0.79 rad 45°

[D1703-M-DI-E4B]

Valve face angle	Factory specification	Intake	0.79 rad 45°
		Exhaust	0.79 rad 45°

2) Correction of valve seat

1. Slightly correct the seat surface with a 1.0 rad (60°) or 0.79 rad (45°) valve seat cutter.
2. Correct the seat surface with a 0.52 rad (30°) or 0.26 rad (15°) valve seat cutter. The width must be near the specified valve seat width (2.12 mm, 0.0835 in.).
3. After you correct the seat, check that the valve seating is flat. Apply a thin layer of compound between the valve face and valve seat, and lap them with a valve lapping tool.
4. Check the valve seating with Prussian Blue. The valve seating surface must show good contact on all sides.

[D1503-M-E4BG]

Valve seat angle	Factory specification	Intake	1.0 rad 60°
		Exhaust	0.79 rad 45°

[D1703-M-DI-E4B]

Valve seat angle	Factory specification	Intake	0.79 rad 45°
		Exhaust	0.79 rad 45°

(1) Valve Seat Width
(2) Identical Dimensions

(A) Check the Contact
(B) Correct Seat Width
(C) Check the Contact
(a) 0.26 rad (15°) or 0.52 rad (30°)
(b) 0.79 rad (45°) or 1.0 rad (60°)
(c) 0.52 rad (30°) or 0.26 rad (15°)

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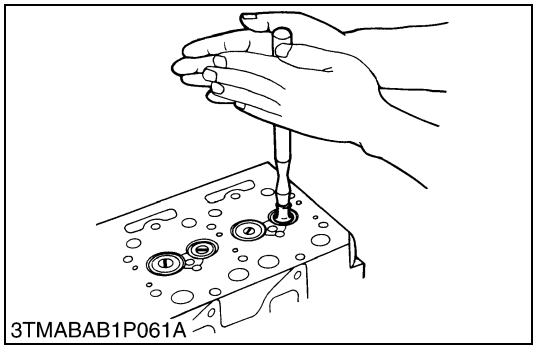
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Valve Lapping

1. Apply the compound equally to the valve lapping surface.
2. Put the valve into the valve guide. Lap the valve on its seat with a valve lapping tool.
3. After you lap the valve, clean away the compound and apply oil, then lap the valve again with oil.
4. Apply Prussian Blue to the contact surface to measure the seated rate.
5. If the seated rate is less than 70 %, lap the valve again.

■ **IMPORTANT**

- **After you complete the valve lapping and assemble the valve, check the valve recessing and adjust the valve clearance.**

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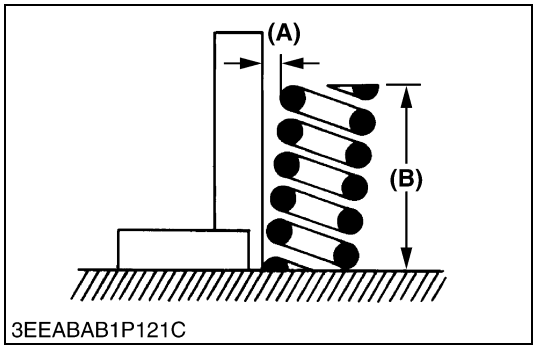

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Free Length and Tilt of Valve Spring

1. Measure the free length **(B)** of valve spring with a vernier calipers.
2. If the measurement is less than the allowable limit, replace it.
3. Put the valve spring on a surface plate, and put a square on the side of the valve spring.
4. Make sure that the full side is in contact with the square.
5. Turn the valve spring to measure the maximum tilt **(A)**.
6. If the measurement is more than the allowable limit, replace it.
7. Check the full surface of the valve spring for scratches.
8. If there is a problem, replace it.

Tilt **(A)**	Allowable limit	1.0 mm 0.039 in.

Free length **(B)**	Factory specification	41.7 to 42.2 mm 1.65 to 1.66 in.
	Allowable limit	41.2 mm 1.62 in.

(A) Tilt **(B) Free Length**

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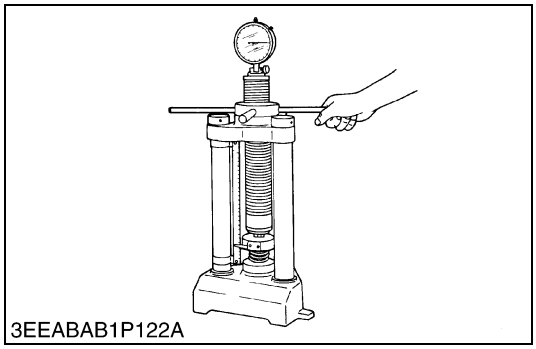
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Setting Load of Valve Spring

1. Put the valve spring on a tester.
2. Compress the valve spring to the specified setting length.
3. Read the compression load on the gauge.
4. If the measurement is less than the allowable limit, replace the valve spring.

Setting load / Setting length	Factory specification	118 N / 35.0 mm 12.0 kgf / 35.0 mm 26.5 lbf / 1.38 in.
	Allowable limit	100 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbf / 1.38 in.

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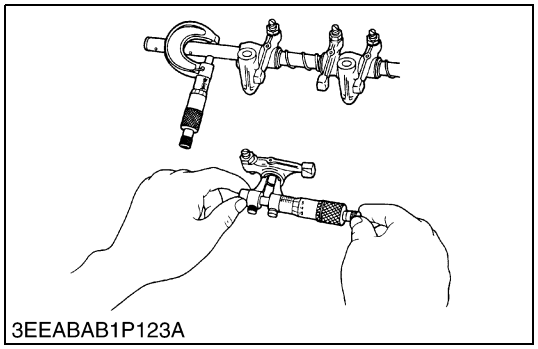
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Oil Clearance between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm shaft O.D. with an external micrometer.
2. Measure the rocker arm I.D. with an internal micrometer.
3. Calculate the oil clearance.
4. If the oil clearance is more than the allowable limit, replace the rocker arm and measure the oil clearance again.
5. If the oil clearance stays more than the allowable limit, replace the rocker arm shaft also.

Oil clearance between rocker arm and rocker arm shaft	Factory specification	0.016 to 0.045 mm 0.00063 to 0.0017 in.
	Allowable limit	0.10 mm 0.0039 in.

Rocker arm shaft O.D.	Factory specification	13.973 to 13.984 mm 0.55012 to 0.55055 in.
Rocker arm I.D.	Factory specification	14.000 to 14.018 mm 0.55119 to 0.55188 in.

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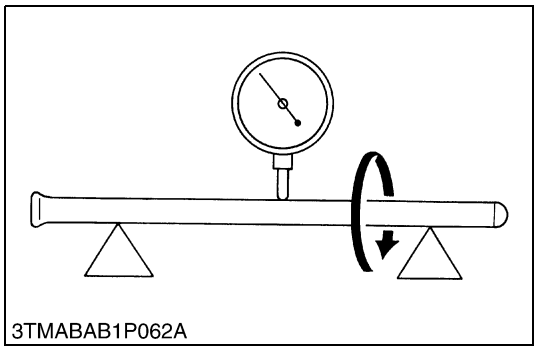
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Push Rod Bend

1. Put the push rod on V blocks.
2. Set a dial indicator with its point on the middle of the push rod.
3. Turn the push rod slowly and read the variation on the indicator.
4. If the measurement is more than the allowable limit, replace the push rod.

Push rod bend	Allowable limit	0.25 mm 0.0098 in.

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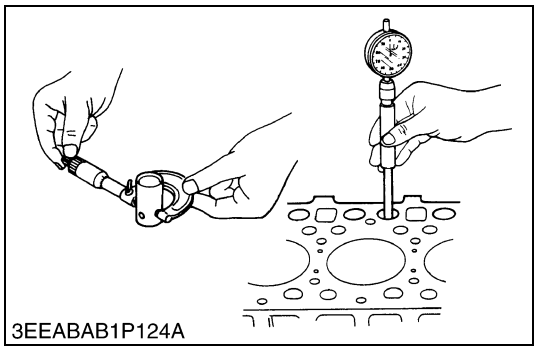
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Oil Clearance between Tappet and Tappet Guide Bore

1. Measure the tappet O.D. with an external micrometer.
2. Measure the tappet guide bore I.D. with a cylinder gauge.
3. Calculate the oil clearance.
4. If the oil clearance is more than the allowable limit or the tappet has a damage, replace the tappet.

Oil Clearance between tappet and tappet guide bore	Factory specification	0.020 to 0.062 mm 0.00079 to 0.0024 in.
	Allowable limit	0.07 mm 0.003 in.

Tappet O.D.	Factory specification	23.959 to 23.980 mm 0.94327 to 0.94409 in.
Tappet guide bore I.D.	Factory specification	24.000 to 24.021 mm 0.94489 to 0.94570 in.

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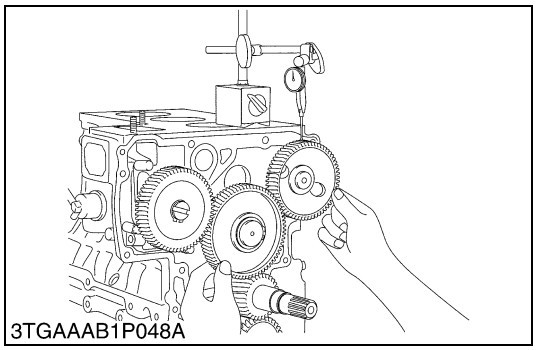
(2) Timing Gears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Timing Gear Backlash

1. Set a dial indicator (lever type) with its point on the gear tooth.
2. Hold the mating gear and move the gear to measure the backlash.
3. If the backlash is more than the allowable limit, measure the oil clearance in the journal part of each shaft.
4. If the oil clearance is correct, replace the gear.

Backlash between idle gear and crank gear	Factory specification	0.04150 to 0.1122 mm 0.001634 to 0.004417 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear and cam gear	Factory specification	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear and injection pump gear	Factory specification	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between crank gear and oil pump gear	Factory specification	0.04840 to 0.2455 mm 0.001906 to 0.009665 in.
	Allowable limit	0.30 mm 0.012 in.

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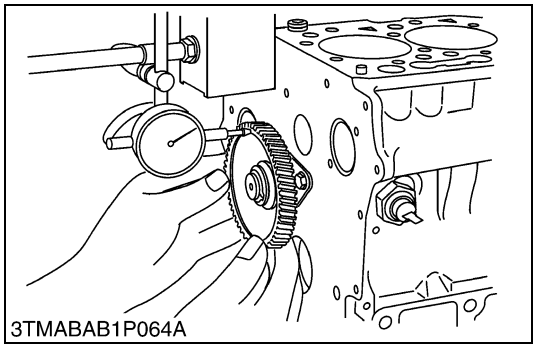
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Side Clearance of Idle Gear

1. Set a dial indicator with its point on the idle gear.
2. Move the idle gear to the front and rear to measure the side clearance.
3. If the measurement is more than the allowable limit, replace the idle gear collar.

Side clearance of idle gear	Factory specification	0.15 to 0.25 mm 0.0059 to 0.0098 in.
	Allowable limit	0.9 mm 0.04 in.

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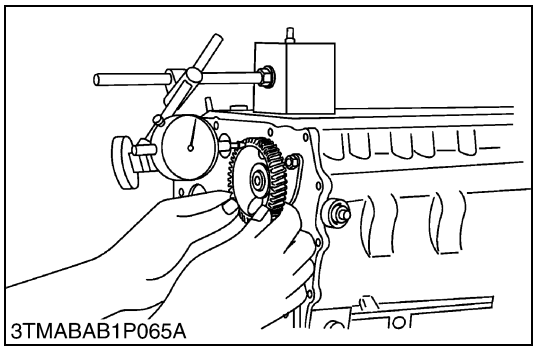
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Side Clearance of Camshaft

1. Set a dial indicator with its point on the camshaft.
2. Move the cam gear to the front and rear to measure the side clearance.
3. If the measurement is more than the allowable limit, replace the camshaft stopper.

Side clearance of camshaft	Factory specification	0.070 to 0.22 mm 0.0028 to 0.0086 in.
	Allowable limit	0.30 mm 0.012 in.

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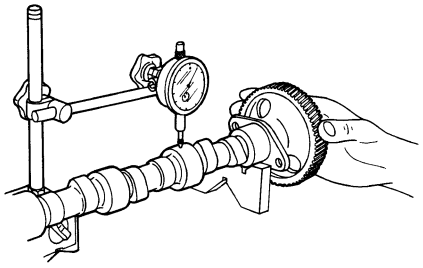

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Camshaft Bend

1. Hold the 2 end journals of camshaft with V blocks on the surface plate.
2. Set a dial indicator with its point on the middle journal.
3. Turn the camshaft slowly and read the variation on the indicator.
4. If the measurement is more than the allowable limit, replace the camshaft.

Camshaft bend	Allowable limit	0.01 mm 0.0004 in.

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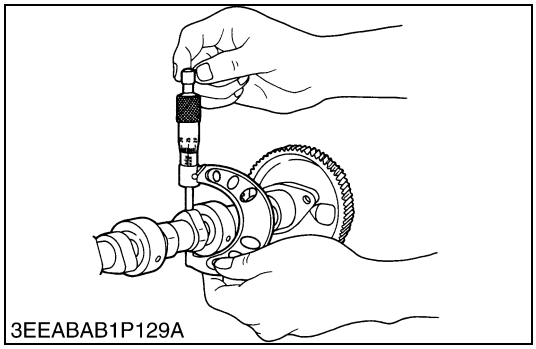
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Cam Height

1. Measure the height of the cam at its highest point with an external micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

Cam height of intake	Factory specification	D1503-M-E4BG	33.27 mm 1.310 in.
		D1703-M-DI-E4B	32.20 mm 1.268 in.
	Allowable limit	D1503-M-E4BG	33.22 mm 1.308 in.
		D1703-M-DI-E4B	32.15 mm 1.266 in.

Cam height of exhaust	Factory specification	D1503-M-E4BG	33.00 mm 1.299 in.
		D1703-M-DI-E4B	31.80 mm 1.252 in.
	Allowable limit	D1503-M-E4BG	32.95 mm 1.297 in.
		D1703-M-DI-E4B	31.75 mm 1.250 in.

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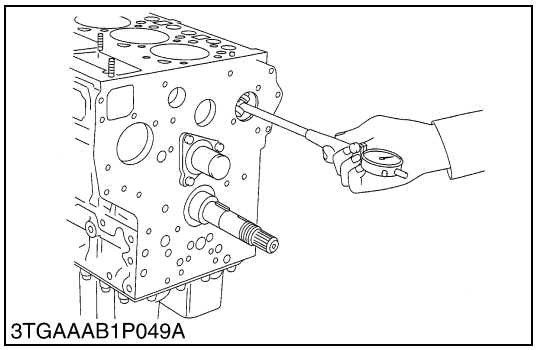
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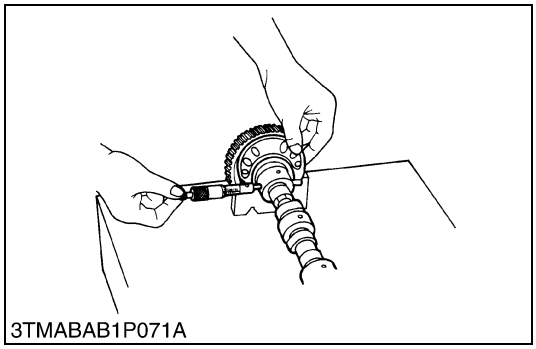
Oil Clearance of Camshaft Journal

1. Measure the camshaft journal O.D. with an external micrometer.
2. Measure the cylinder block bore I.D. for the camshaft with a cylinder gauge.
3. Calculate the oil clearance.
4. If the oil clearance is more than the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory specification	0.050 to 0.091 mm 0.0020 to 0.0035 in.
	Allowable limit	0.15 mm 0.0059 in.

Camshaft journal O.D.	Factory specification	39.934 to 39.950 mm 1.5722 to 1.5728 in.
Cylinder block bore I.D.	Factory specification	40.000 to 40.025 mm 1.5748 to 1.5757 in.

9Y1210967ENS0109US0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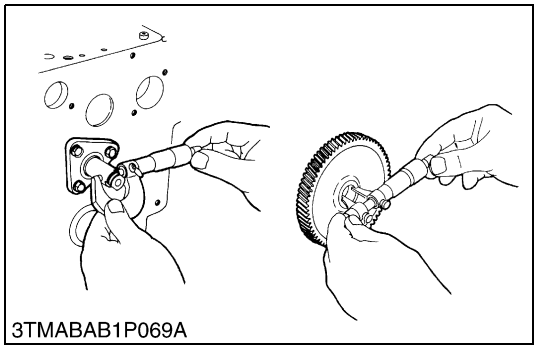
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Oil Clearance between Idle Gear Shaft and Idle Gear Bushing

1. Measure the idle gear shaft O.D. with an external micrometer.
2. Measure the idle gear bushing I.D. with an internal micrometer.
3. Calculate the oil clearance.
4. If the oil clearance is more than the allowable limit, replace the bushing.
5. If the oil clearance stays more than the allowable limit, replace the idle gear shaft also.

Oil clearance between idle gear shaft and idle gear bushing	Factory specification	0.025 to 0.066 mm 0.00099 to 0.0025 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear shaft O.D.	Factory specification	37.959 to 37.975 mm 1.4945 to 1.4950 in.
Idle gear bushing I.D.	Factory specification	38.000 to 38.025 mm 1.4961 to 1.4970 in.

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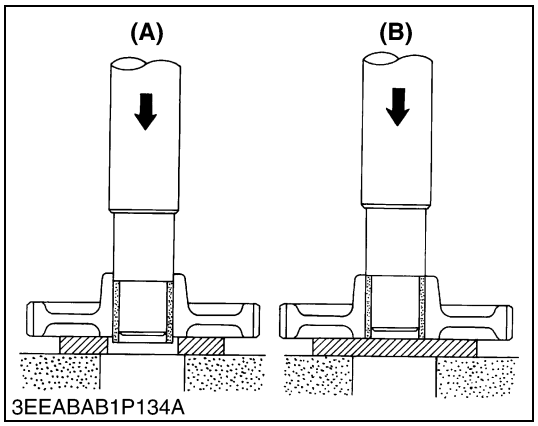

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Replacement of Idle Gear Bushing

(When removing)

1. Press out the used idle gear bushing with the replacing tool. (See page **"SPECIAL TOOLS"**.)

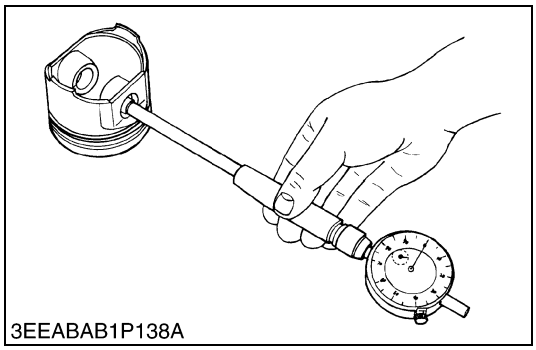
(When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Press fit the new bushing with the replacing tool.
   Make sure that the bushing end aligns the end of the idle gear.

(A) When Removing **(B) When Installing**

9Y1210967ENS0111US0

(3) Piston and Connecting Rod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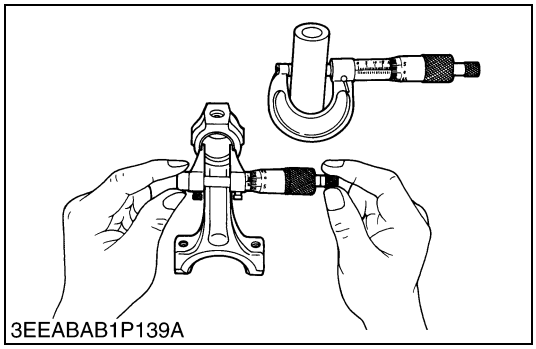
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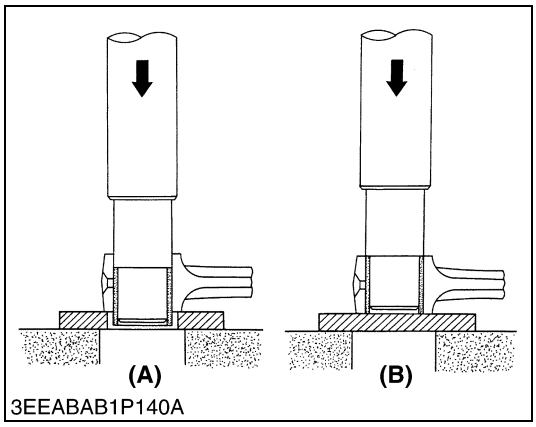

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Piston Pin Bore I.D.

1. Measure the piston pin bore I.D. in the horizontal and vertical directions with a cylinder gauge.
2. If the measurement is more than the allowable limit, replace the piston.

Piston pin bore I.D.	Factory specification	25.000 to 25.013 mm 0.98426 to 0.98476 in.
	Allowable limit	25.05 mm 0.9862 in.

9Y1210967ENS0112US0

Oil Clearance between Piston Pin and Small End Bushing

1. Measure the piston pin O.D. where it touches the bushing with an external micrometer.
2. Measure the small end bushing I.D. with an internal micrometer.
3. Calculate the oil clearance.
4. If the oil clearance is more than the allowable limit, replace the bushing.
5. If the oil clearance stays more than the allowable limit, replace the piston pin also.

Oil clearance between piston pin and small end bushing	Factory specification	0.014 to 0.036 mm 0.00056 to 0.0014 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory specification	25.004 to 25.011 mm 0.98441 to 0.98468 in.
Small end bushing I.D.	Factory specification	25.025 to 25.040 mm 0.98524 to 0.98582 in.

9Y1210967ENS0113US0

Replacement of Small End Bushing

(When removing)

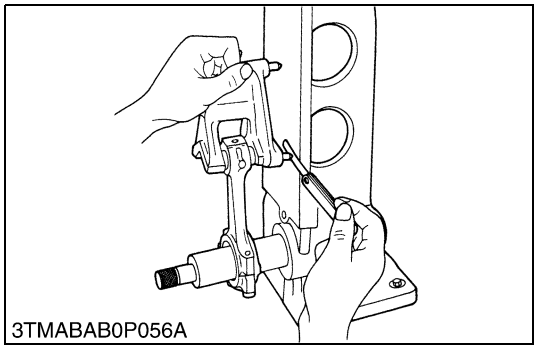
1. Press out the used small end bushing with the replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Make sure that the oil hole of the connecting rod aligns the bushing hole. Then press fit the new bushing with the replacing tool.

(A) When Removing **(B) When Installing**

9Y1210967ENS0114US0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Connecting Rod Alignment

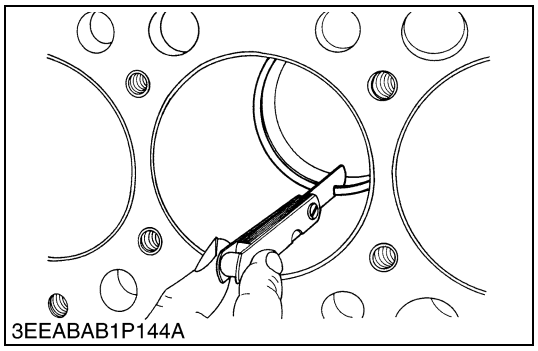
■ **NOTE**

- **Make sure that the oil clearance of the small end bushing is less than the allowable limit.**

1. Install the piston pin into the connecting rod.
2. Install the connecting rod on the alignment tool of the connecting rod.
3. Put a gauge on the piston pin, and move it against the face plate.
4. If the gauge does not touch fully against the face plate, measure the space between the gauge pin and face plate.
5. If the measurement is more than the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.002 in.

9Y1210967ENS0115US0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Piston Ring Gap

1. Put the piston ring into the lower part of the liner (the least worn out part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the ring gap is more than the allowable limit, replace the ring.

Top ring	Factory specification	D1503-M-E4BG, D1703-M-DI-E4B	0.20 to 0.35 mm 0.0079 to 0.013 in.
	Allowable limit		1.25 mm 0.0492 in.
Second ring	Factory specification	D1503-M-E4BG	0.40 to 0.55 mm 0.016 to 0.021 in.
		D1703-M-DI-E4B	0.30 to 0.45 mm 0.012 to 0.017 in.
	Allowable limit		1.25 mm 0.0492 in.
Oil ring	Factory specification	D1503-M-E4BG	0.25 to 0.45 mm 0.0099 to 0.017 in.
		D1703-M-DI-E4B	0.20 to 0.40 mm 0.0079 to 0.015 in.
	Allowable limit		1.25 mm 0.0492 in.

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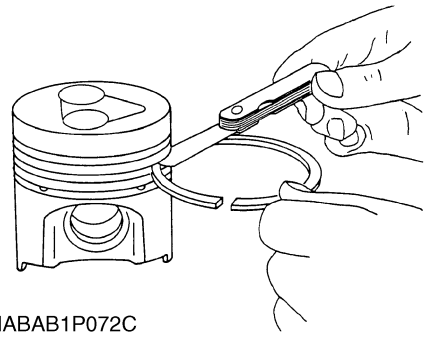
[A]



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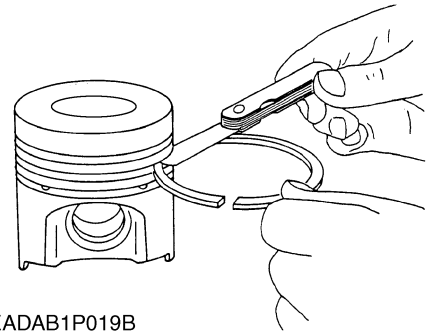
[B]



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Clearance between Piston Ring and Groove

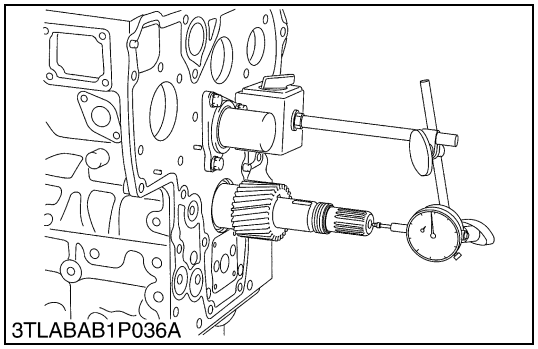
1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance is more than the allowable limit, replace the piston ring.
4. If the clearance stays more than the allowable limit with new ring, replace the piston also.

Top ring	Factory specification	D1703-M-DI-E4B	0.050 to 0.090 mm 0.0020 to 0.0035 in.
	Top ring of D1503-M-E4BG is key stone type.		
	Allowable limit		0.20 mm 0.0079 in.
Second ring	Factory specification	D1503-M-E4BG	0.0930 to 0.128 mm 0.00367 to 0.00503 in.
		D1703-M-DI-E4B	0.0780 to 0.110 mm 0.00307 to 0.00433 in.
	Allowable limit		0.20 mm 0.0079 in.
Oil ring	Factory specification	D1503-M-E4BG	0.020 to 0.060 mm 0.00079 to 0.0023 in.
		D1703-M-DI-E4B	0.030 to 0.070 mm 0.0012 to 0.0027 in.
	Allowable limit		0.15 mm 0.0059 in.

[A] D1503-M-E4BG **[B] D1703-M-DI-E4B**

9Y1210967ENS0117US0

(4) Crankshaft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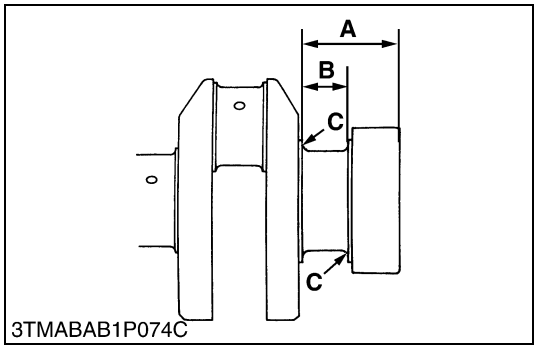

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Side Clearance of Crankshaft

1. Set a dial indicator with its point on the end of the crankshaft.
2. Move the crankshaft to the front and rear to measure the side clearance.
3. If the measurement is more than the allowable limit, replace the thrust bearings.
4. If the same dimension bearing is not applicable because of the crankshaft journal wear, replace it with an oversize one. Refer to the table and figure.

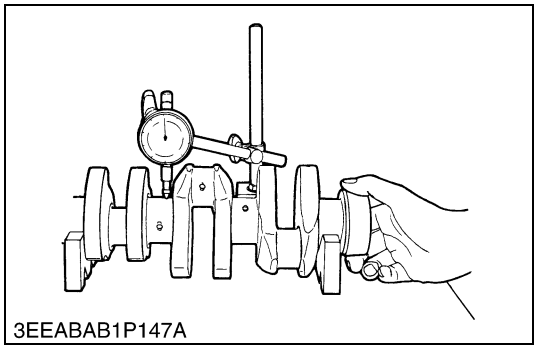
Side clearance of crankshaft	Factory specification	0.15 to 0.31 mm 0.0059 to 0.012 in.
	Allowable limit	0.5 mm 0.02 in.

(Reference)

- Oversize dimensions of crankshaft journal

Oversize	**0.2 mm 0.008 in.**	**0.4 mm 0.02 in.**
Dimension **A**	54.50 to 54.70 mm 2.146 to 2.153 in.	54.60 to 54.80 mm 2.150 to 2.157 in.
Dimension **B**	26.20 to 26.25 mm 1.032 to 1.033 in.	26.40 to 26.45 mm 1.040 to 1.041 in.
Dimension **C**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
The crankshaft journal must be fine-finished to higher than Rmax = 0.4S		

9Y1210967ENS0118US0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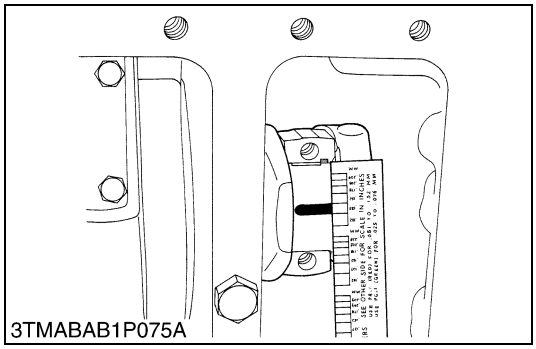
Crankshaft Bend

1. Hold the 2 end journals of crankshaft with V blocks on the surface plate.
2. Set a dial indicator with its point on the middle journal.
3. Turn the crankshaft slowly and read the variation on the indicator.
4. If the measurement is more than the allowable limit, replace the crankshaft.

Crankshaft bend	Allowable limit	0.02 mm 0.0008 in.

9Y1210967ENS0119US0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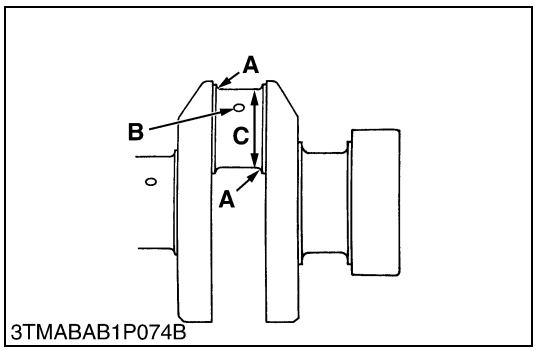

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Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigauge on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the width that it becomes flat with the scale to get the oil clearance.
5. If the oil clearance is more than the allowable limit, replace the crankpin bearing.
6. If the same dimension bearing is not applicable because of the crankpin wear, replace it with an undersize one. Refer to the table and figure.

■ **NOTE**
- **Do not put the plastigauge into the crankpin oil hole.**
- **When you tighten the connecting rod screws, do not move the crankshaft.**

Oil clearance between crankpin and crankpin bearing	Factory specification	0.025 to 0.087 mm 0.00099 to 0.0034 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankpin O.D.	Factory specification	46.959 to 46.975 mm 1.8488 to 1.8494 in.
Crankpin bearing I.D.	Factory specification	47.000 to 47.046 mm 1.8504 to 1.8522 in.

(Reference)
- Undersize dimensions of crankpin

Undersize	**0.2 mm 0.008 in.**	**0.4 mm 0.02 in.**
Dimension **A**	3.3 to 3.7 mm radius 0.13 to 0.14 in. radius	3.3 to 3.7 mm radius 0.13 to 0.14 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C**	46.759 to 46.775 mm dia. 1.8409 to 1.8415 in. dia.	46.559 to 46.575 mm dia. 1.8331 to 1.8336 in. dia.
The crankpin must be fine-finished to higher than Rmax = 0.4S *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

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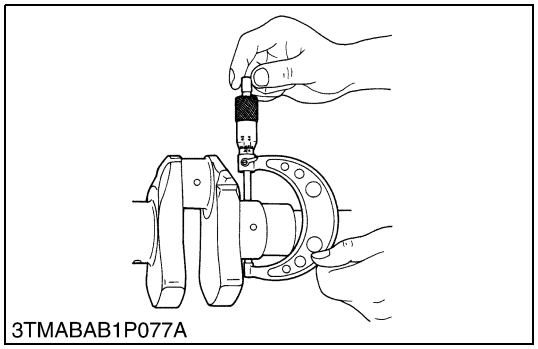
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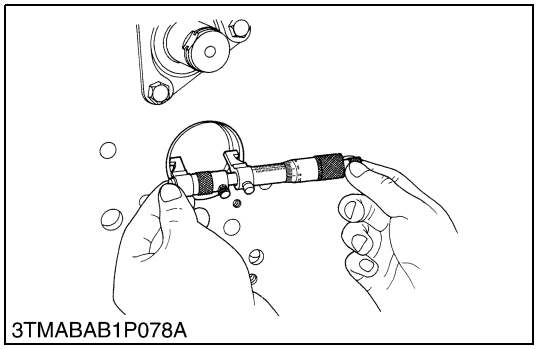
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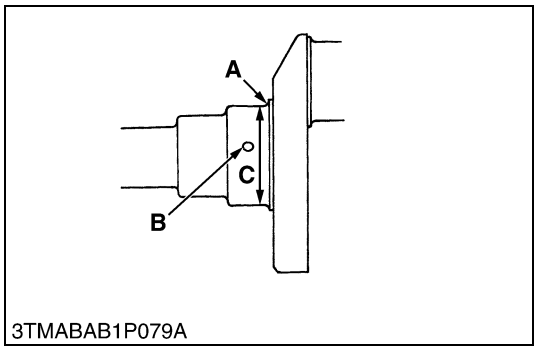

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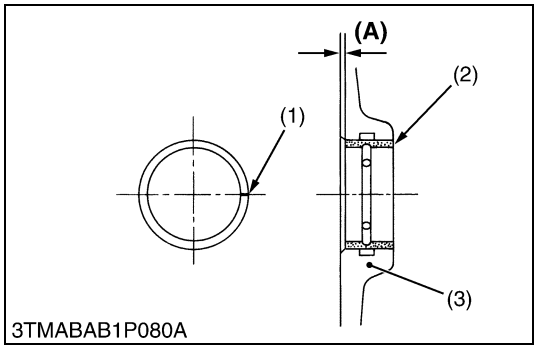

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the O.D. of the crankshaft journal with an external micrometer.
2. Measure the I.D. of the crankshaft bearing 1 with an internal micrometer.
3. Calculate the oil clearance.
4. If the oil clearance is more than the allowable limit, replace the crankshaft bearing 1.
5. If the same dimension bearing is not applicable because of the crankshaft journal wear, replace it with an undersize one. Refer to the table and figure.

Oil clearance between crankshaft journal and crankshaft bearing 1	Factory specification	0.0400 to 0.118 mm 0.00158 to 0.00464 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	Factory specification	59.921 to 59.940 mm 2.3591 to 2.3598 in.
Crankshaft bearing 1 I.D.	Factory specification	59.980 to 60.039 mm 2.3615 to 2.3637 in.

(Reference)

- Undersize dimensions of crankshaft journal

Undersize	**0.2 mm 0.008 in.**	**0.4 mm 0.02 in.**
Dimension **A**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C**	59.721 to 59.740 mm dia. 2.3513 to 2.3519 in. dia.	59.521 to 59.540 mm dia. 2.3434 to 2.3440 in. dia.
The crankshaft journal must be fine-finished to higher than Rmax = 0.4S *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

9Y1210967ENS0121US0

Replacement of Crankshaft Bearing 1

(When removing)

1. Press out the used crankshaft bearing 1 with the replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

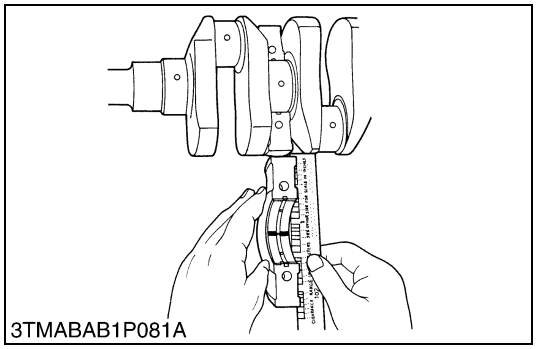
1. Clean a new crankshaft bearing 1 and crankshaft journal bore, and apply engine oil to them.
2. Make sure that the seam (1) of the new bearing 1 (2) points to the exhaust manifold side (see the figure). Then press fit the new bearing 1 (2) with the replacing tool.

Dimension **(A)**	Factory specification	4.20 to 4.50 mm 0.166 to 0.177 in.

(1) Seam
(2) Crankshaft Bearing 1
(3) Cylinder Block

(A) Dimension

9Y1210967ENS0122US0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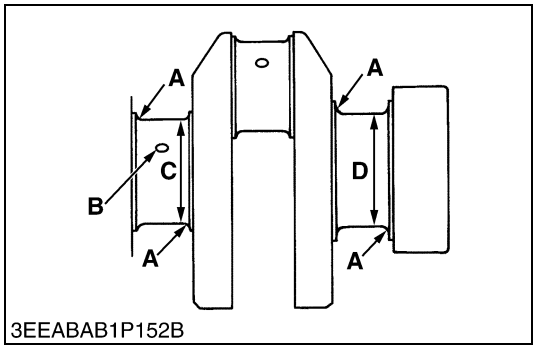

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2

1. Put a strip of plastigauge on the center of the journal.
2. Install the bearing case and tighten the baring case screws 1 to the specified torque, and remove the bearing case again.
3. Measure the width that it becomes flat with the scale to get the oil clearance.
4. If the oil clearance is more than the allowable limit, replace the crankshaft bearing 2.
5. If the same dimension bearing is not applicable because of the crankshaft journal wear, replace it with an undersize one. Refer to the table and figure.

■ **NOTE**

- **When you tighten the bearing case screws, do not move the crankshaft.**

Oil clearance between crankshaft and crankshaft bearing 2	Factory specification	0.0400 to 0.104 mm 0.00158 to 0.00409 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	Factory specification	59.921 to 59.940 mm 2.3591 to 2.3598 in.
Crankshaft bearing 2 I.D.	Factory specification	59.980 to 60.025 mm 2.3615 to 2.3631 in.

(Reference)

- Undersize dimensions of crankshaft journal

Undersize	**0.2 mm 0.008 in.**	**0.4 mm 0.02 in.**
Dimension **A**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C, D**	59.721 to 59.740 mm dia. 2.3513 to 2.3519 in. dia.	59.521 to 59.540 mm dia. 2.3434 to 2.3440 in. dia.
The crankshaft journal must be fine-finished to higher than Rmax = 0.4S *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

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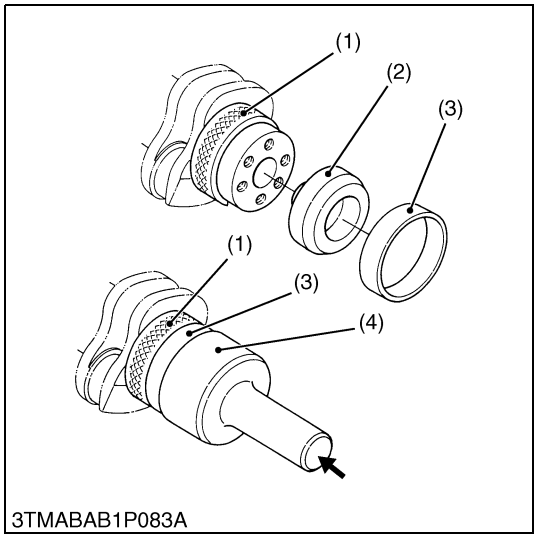

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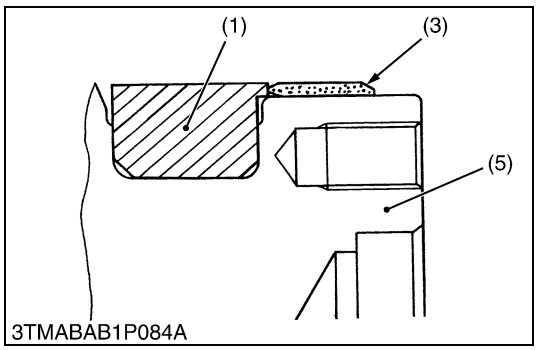

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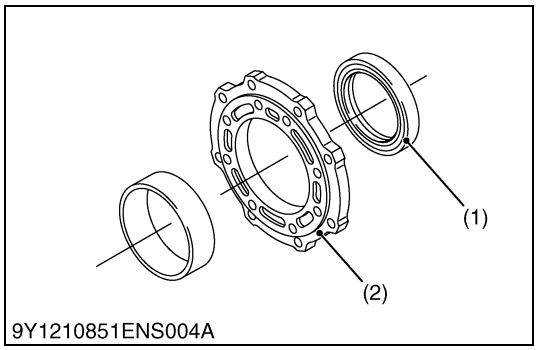

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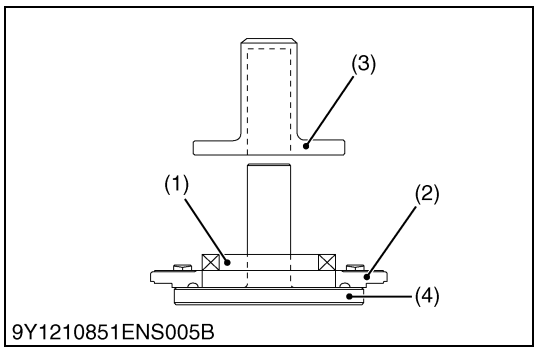

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Replacement of Crankshaft Sleeve

1. Remove the used crankshaft sleeve (3).
2. Set the sleeve guide (2) to the crankshaft (5).
3. Set the stopper (1) to the crankshaft (5) (see the figure).
4. Increase the temperature of a new sleeve to between 150 and 200 °C (302 and 392 °F).
5. Install the sleeve to the crankshaft with the auxiliary socket for pushing (4) (see the figure). (Refer to **"SPECIAL TOOLS"**.)

■ **NOTE**

- **Make sure that the large chamfer of the sleeve points to outward.**
- **If the temperature of the sleeve is not enough to install, the sleeve can get a damage when you install.**

(1) Stopper
(2) Sleeve Guide
(3) Crankshaft Sleeve
(4) Auxiliary Socket for Pushing
(5) Crankshaft

9Y1210967ENS0124US0

Replacement of Bearing Case Cover Oil Seal

(When removing)

1. Remove the used oil seal with the appropriate tool and be careful not to scratch the bearing case cover (2).

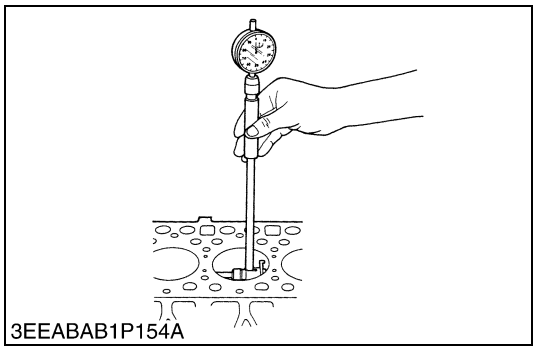
(When installing)

1. Clean a new oil seal (1) and bearing case cover (2).
2. Set the bearing case cover on the replacing tool 1 (4) and fix it with bolts.
3. Apply a layer of engine oil to the seal outer periphery.
4. Install the oil seal into the bearing case cover with the replacing tool 2 (3) as shown in the figure, until it is flash with the bearing case cover.

(1) Oil Seal
(2) Bearing Case Cover
(3) Replacing Tool 2
(4) Replacing Tool 1

9Y1210967ENS0143US0

(5) Cylinder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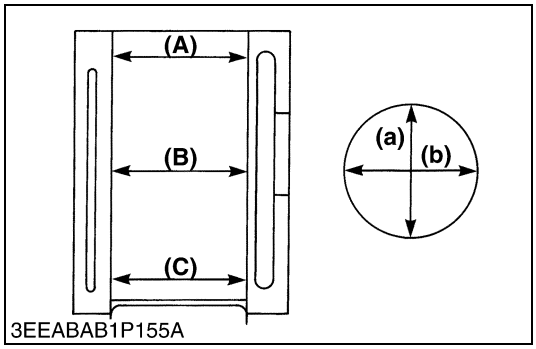

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Cylinder Wear

1. Measure the I.D. of the cylinder at the 6 positions (see figure) with a cylinder gauge.
2. Find the maximum and minimum inner diameters.
3. Find the difference between the maximum and the minimum inner diameters.
4. If the maximum I.D. or the difference is more than the allowable limit, bore and hone it to the oversize dimension. (Refer to **"Cylinder Correction (Oversize)"**.).
5. Check the cylinder wall for scratches. If you find deep scratches, bore the cylinder. (Refer to **"Cylinder Correction (Oversize)"**.)

Cylinder I.D.	Factory specification	D1503-M-E4BG	83.000 to 83.022 mm 3.2678 to 3.2685 in.
		D1703-M-DI-E4B	87.000 to 87.022 mm 3.4252 to 3.4260 in.
	Allowable limit	D1503-M-E4BG	83.170 mm 3.2744 in.
		D1703-M-DI-E4B	87.170 mm 3.4319 in.
Difference between maximum I.D. and minimum I.D.	Allowable limit		0.15 mm 0.0059 in.

(A) Top
(B) Middle
(C) Bottom (Skirt)
(a) Right-angled to Piston Pin
(b) Piston Pin Direction

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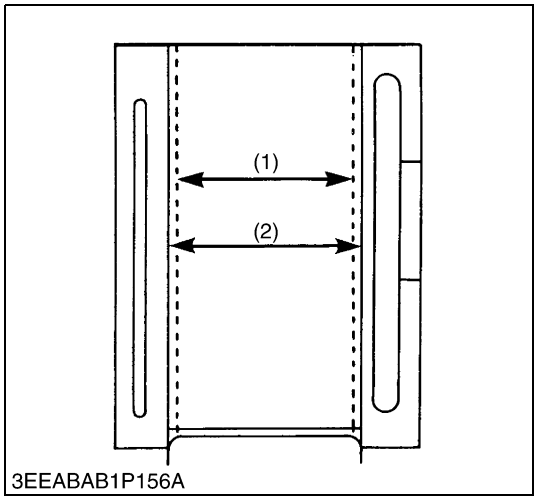

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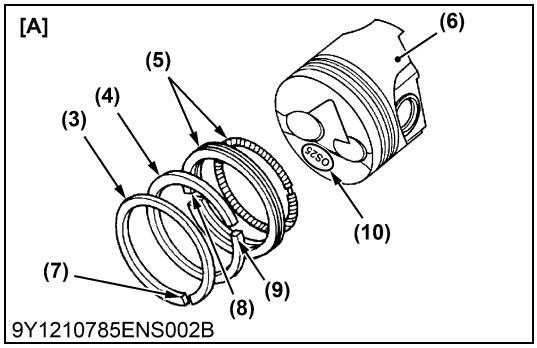

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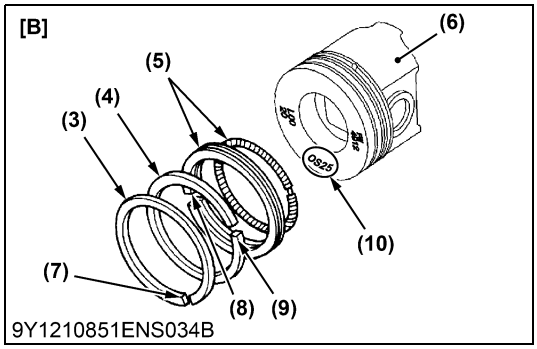

9Y1210851ENS034B

Cylinder Correction (Oversize)

1. If the cylinder wear is more than the allowable limit, bore and hone it to the specified dimension.

Oversize cylinder I.D.	Factory specification	D1503-M-E4BG	83.250 to 83.272 mm 3.2776 to 3.2784 in.
		D1703-M-DI-E4B	87.250 to 87.272 mm 3.4351 to 3.4359 in.
	Allowable limit	D1503-M-E4BG	83.420 mm 3.2843 in.
		D1703-M-DI-E4B	87.420 mm 3.4417 in.
Difference between maximum I.D. and minimum I.D.	Allowable limit		0.15 mm 0.0059 in.
Finishing	Hone to 2.2 to 3.0 μmRz (0.000087 to 0.000118 in.Rz)		

2. Replace the piston and piston rings with oversize ones.
   Oversize: 0.25 mm (0.0098 in.)

Oversize parts item	ID mark
Piston	OS25
Piston ring assembly	25

■ **NOTE**

- **When the oversize cylinder is worn beyond the allowable limit, replace the cylinder block with a new one.**

(1) Cylinder I.D. (Before Correction)
(2) Cylinder I.D. (Oversize)
(3) Top Ring (Oversize)
(4) Second Ring (Oversize)
(5) Oil Ring (Oversize)
(6) Piston (Oversize)
(7) "25" Mark
(8) "25" Mark
(9) "25" Mark
(10) "OS25" Mark

[A] D1503-M-E4BG
[B] D1703-M-DI-E4B

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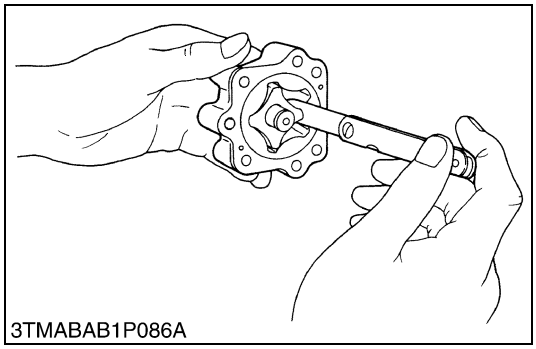
(6) Oil Pump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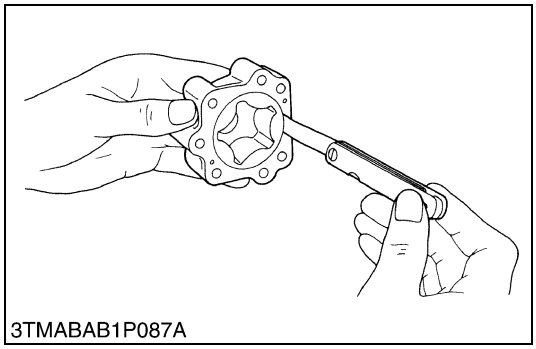
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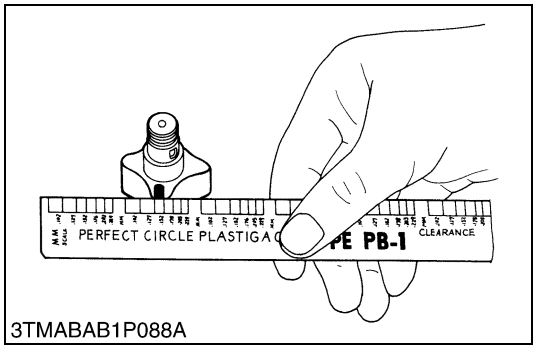

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Rotor Lobe Clearance

1. Measure the clearance between the lobes of the inner rotor and the outer rotor with a feeler gauge.
2. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
3. If the clearance is more than the allowable limit, replace the rotor assembly of the oil pump.

Clearance between inner rotor and outer rotor	Factory specification	0.030 to 0.14 mm 0.0012 to 0.0055 in.
	Allowable limit	0.2 mm 0.008 in.

Clearance between outer rotor and pump body	Factory specification	0.11 to 0.19 mm 0.0044 to 0.0074 in.
	Allowable limit	0.25 mm 0.0098 in.

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Clearance between Rotor and Cover

1. Put a strip of plastigauge on the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully.
4. Measure the width that plastigauge becomes flat with the scale to get the oil clearance.
5. If the clearance is more than the allowable limit, replace the rotor assembly of the oil pump.

Clearance between inner rotor and cover	Factory specification	0.105 to 0.150 mm 0.00414 to 0.00590 in.
	Allowable limit	0.20 mm 0.008 in.

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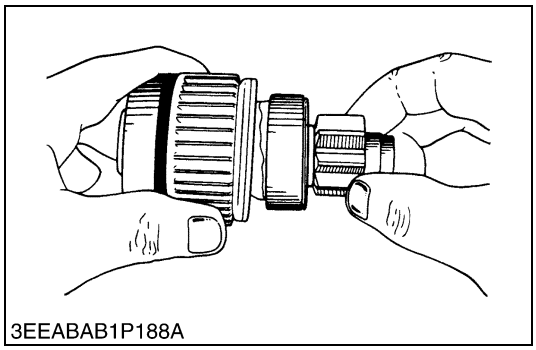
(7) Starter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Overrunning Clutch

1. Check the pinion and if it is worn or damaged, replace the clutch assembly.
2. Check that the pinion turns freely and smoothly in the direction that it overruns. Make sure that it does not slip in the direction that it cranks.
3. If the pinion slips or does not turn in the 2 directions, replace the overrunning clutch assembly.

■ **NOTE**

- **Do not clean off the grease in the overrunning clutch with the chemicals or oils.**

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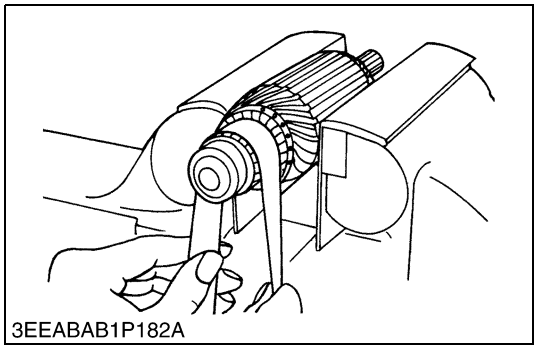
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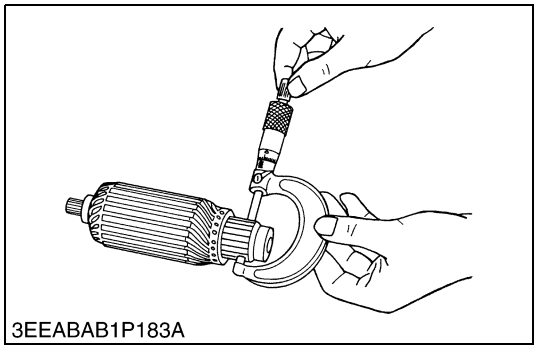
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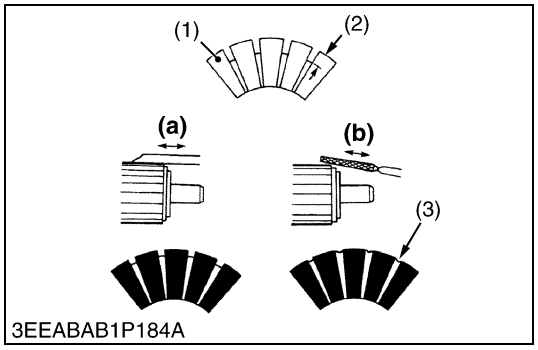

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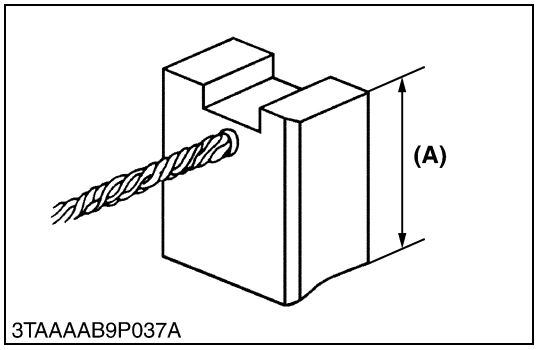

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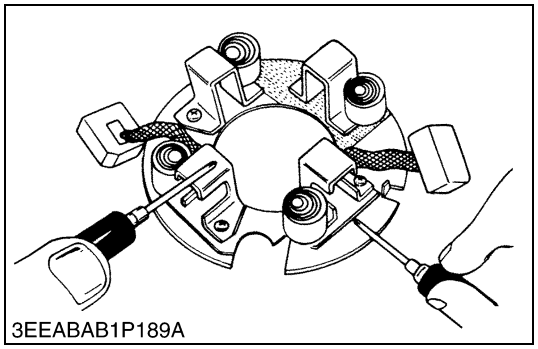
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Commutator and Mica

1. Check the contact of the commutator for wear, and grind the commutator with emery paper if it is lightly worn.
2. Measure the commutator O.D. with an external micrometer at some points.
3. If the minimum O.D. is less than the allowable limit, replace the armature assembly.
4. Calculate the difference of the outer diameters. If it is more than the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

Commutator O.D.	Factory specification	30.0 mm 1.18 in.
	Allowable limit	29.0 mm 1.14 in.

Difference of outer diameters	Factory specification	Less than 0.02 mm 0.0008 in.
	Allowable limit	0.05 mm 0.002 in.

Mica undercut	Factory specification	0.45 to 0.75 mm 0.018 to 0.029 in.
	Allowable limit	0.20 mm 0.0079 in.

(1) Segment
(2) Depth of Mica
(3) Mica

(a) Correct
(b) Incorrect

9Y1210967ENS0130US0

Brush Wear

1. If the contact face of the brush is dirty or dusty, clean it with emery paper.
2. Measure the brush length **(A)** with a vernier caliper.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder assembly.

Brush length **(A)**	Factory specification	15.0 mm 0.591 in.
	Allowable limit	11.0 mm 0.433 in.

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Brush Holder

1. Check the continuity across the brush holder and the holder support with a circuit tester.
2. If electricity flows, replace the brush holder assembly.

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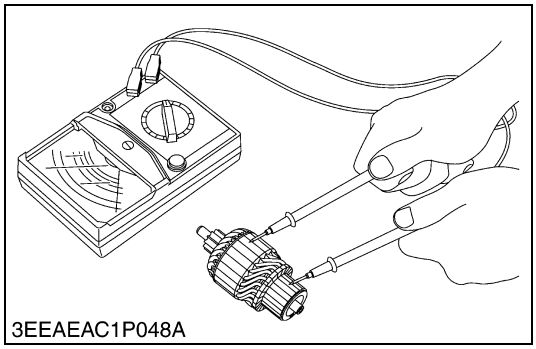
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Armature Coil

1. Check the continuity across the commutator and armature coil core with the resistance range of circuit tester.
2. If electricity flows, replace the armature assembly.
3. Check the continuity across the segments of the commutator with the resistance range of circuit tester.
4. If electricity does not flow, replace the armature assembly.

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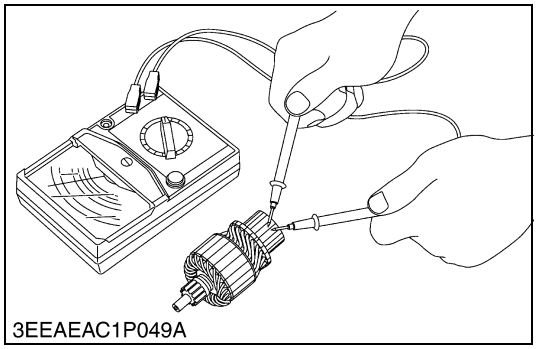
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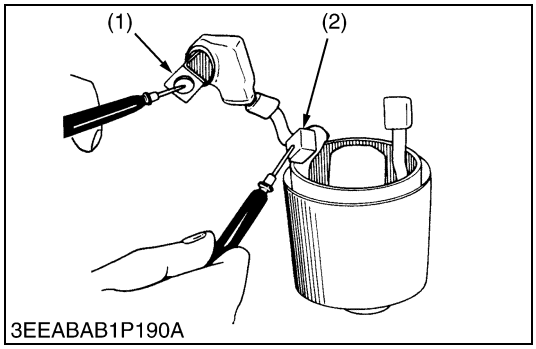

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Field Coil

1. Check the continuity across the lead (1) and brush (2) with a circuit tester.
2. If electricity does not flow, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with a circuit tester.
4. If electricity flows, replace the yoke assembly.

(1) Lead
(2) Brush
(3) Yoke

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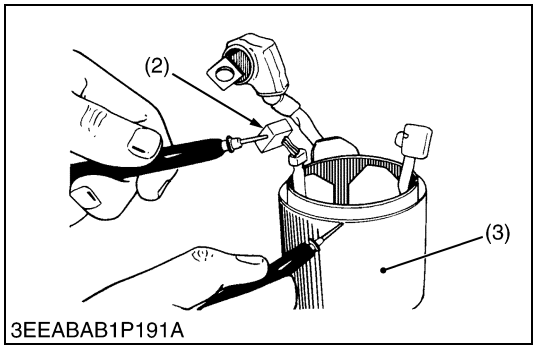

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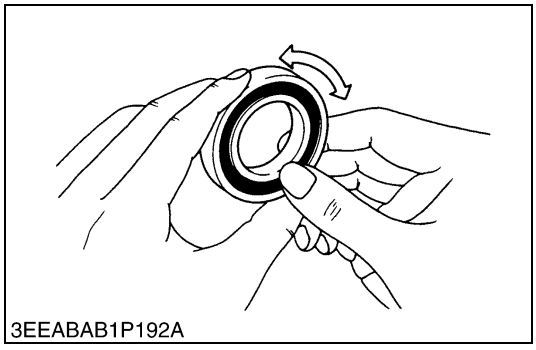
(8) Alternator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Bearing

1. Check that the bearing can turn smoothly.
2. If not, replace it.

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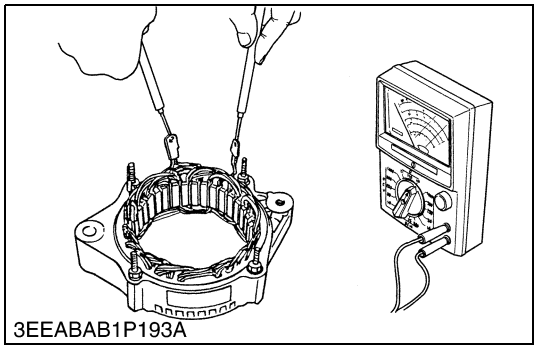
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Stator

1. Measure the resistance across each lead of the stator coil with the resistance range of circuit tester.
2. If the measurement is not in the factory specification, replace the stator assembly.
3. Check the continuity across each stator coil lead and core with the resistance range of circuit tester.
4. If it does not show infinity, replace the stator assembly.

Resistance	Factory specification	Less than 1.0 Ω

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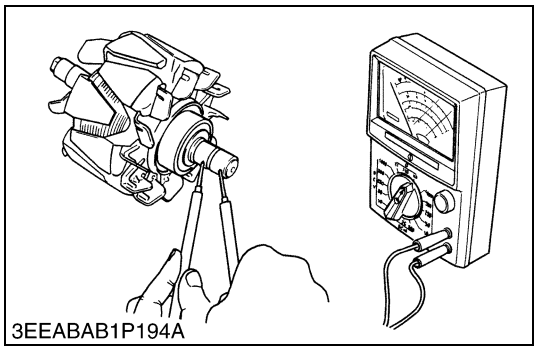
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Rotor

1. Measure the resistance across the slip rings.
2. If the resistance is not in the factory specification, replace the rotor assembly.
3. Check the continuity across the slip ring and core with the resistance range of circuit tester.
4. If it does not show infinity, replace the rotor assembly.

Resistance	Factory specification	2.9 Ω

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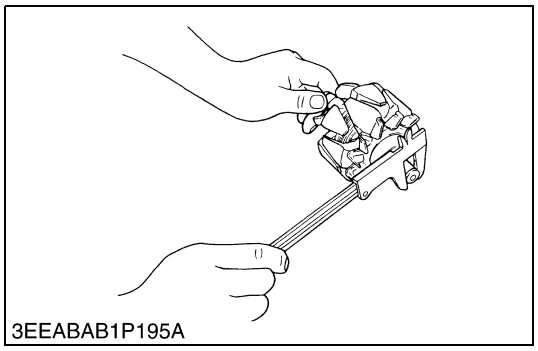
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Slip Ring

1. Check the slip ring for score.
2. If there is score, correct with an emery paper or on a lathe.
3. Measure the O.D. of the slip ring with a vernier calipers.
4. If the measurement is less than the allowable limit, replace the rotor assembly.

Slip ring O.D.	Factory specification	14.4 mm 0.567 in.
	Allowable limit	14.0 mm 0.551 in.

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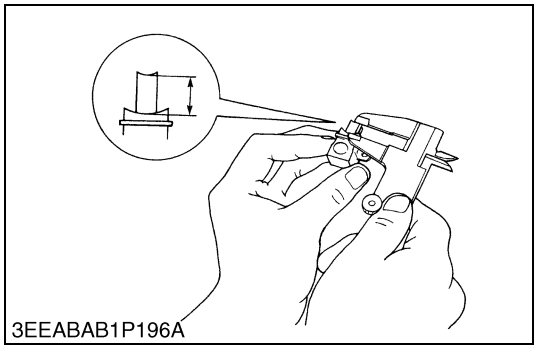
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Brush Wear

1. Measure the brush length with a vernier calipers.
2. If the measurement is less than the allowable limit, replace it.
3. Make sure that the brush moves smoothly.
4. If the brush is damaged, replace it.

Brush length	Factory specification	10.5 mm 0.413 in.
	Allowable limit	8.4 mm 0.33 in.

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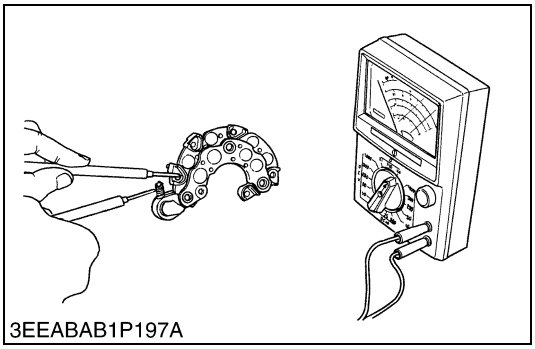
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Rectifier

1. Check the continuity across each diode of rectifier with the resistance range of circuit tester.
2. The rectifier is correct if the diode in the rectifier conducts electricity only in one direction.

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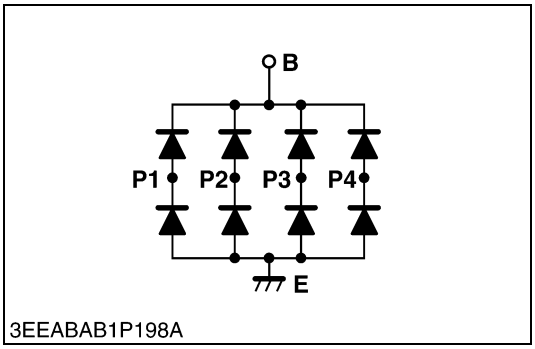

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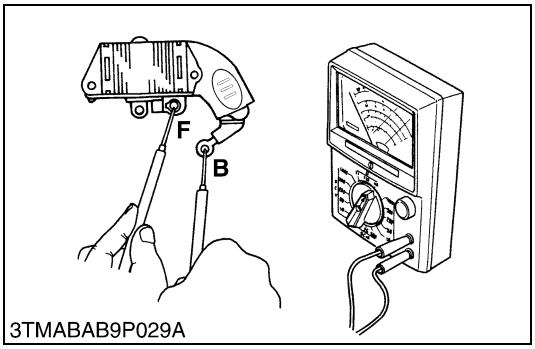

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IC Regulator

1. Check the continuity across the **B** terminal (2) and the **F** terminal (1) of IC regulator with the resistance range of circuit tester.
2. The IC regulator is correct if it conducts electricity only in one direction.

(1) **F** Terminal (2) **B** Terminal

9Y1210967ENS0141US0

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