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WORKSHOP MANUAL
DIESEL ENGINES

03-M-DI SERIES

Kubota

TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of KUBOTA Diesel Engine 03-M-DI Series. It is divided into two parts, "Mechanism" and "Servicing" for each section.

■ Mechanism

Information on the Features and New Mechanisms are described. This information should be understood before proceeding with troubleshooting, disassembling and servicing.

■ Servicing

The heading "General" includes general precautions, check and maintenance and special tools. There are troubleshooting, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

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

Due to covering many models of this manual, illustration being used, have not been specified as one model.

March 2002

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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 attempt 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

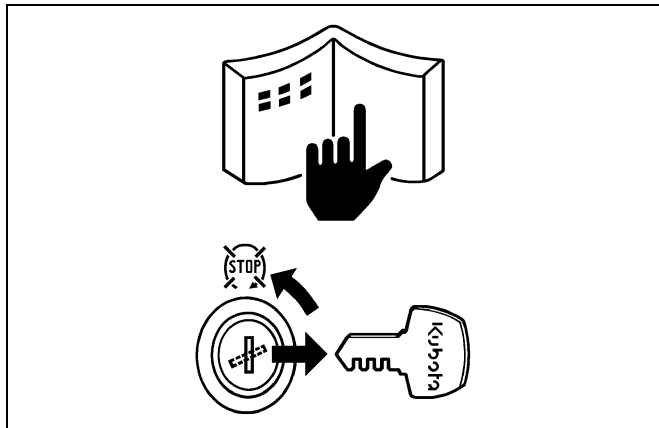
: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

■ IMPORTANT

: Indicates that equipment or property damage could result if instructions are not followed.

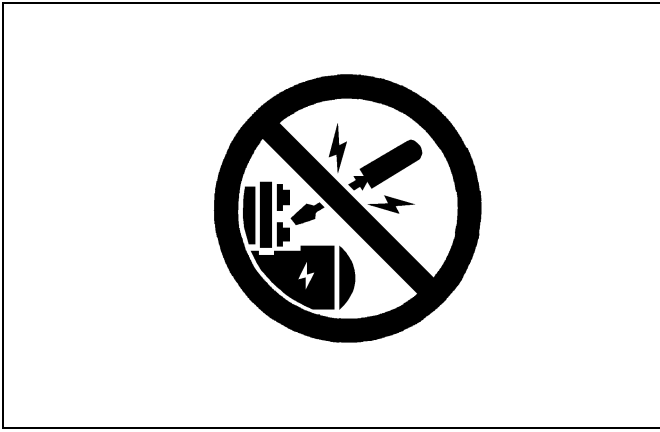
■ NOTE

: Gives helpful information.



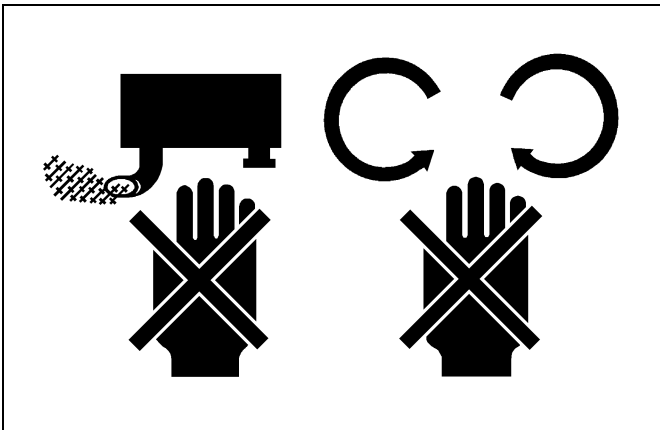
BEFORE SERVICING AND REPAIRING

- 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 firm and level ground.
- Allow the engine to cool before proceeding.
- Stop the engine, and remove the key.
- Disconnect the battery negative cable.
- Hang a "**DO NOT OPERATE**" tag in operator station.



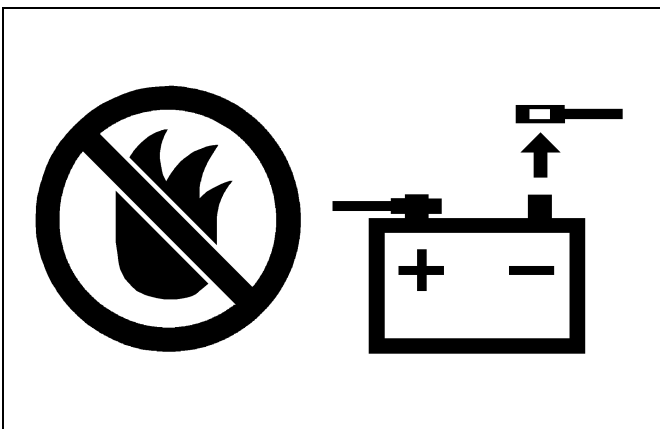
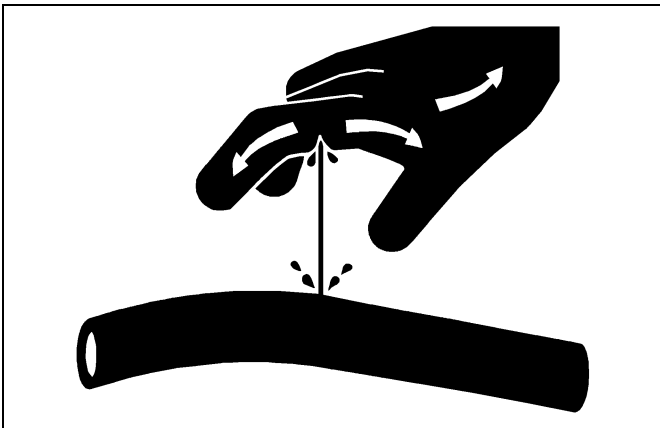
SAFETY STARTING

- Do not start the engine by shorting across starter terminals or bypassing the safety start switch.
- Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.



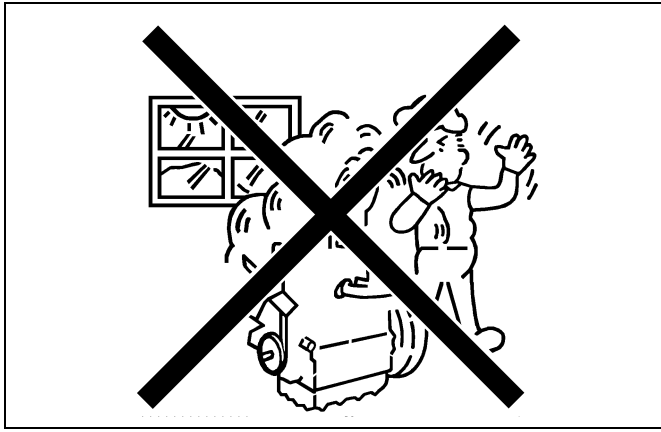
SAFETY WORKING

- Do not work on the machine while under the influence of alcohol, medication, or other substances or while fatigued.
- Wear close fitting clothing and safety equipment appropriate to the job.
- Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Do not touch the rotating or hot parts while the engine is running.
- Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Only remove radiator cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve pressure before removing completely.
- Escaping fluid (fuel or hydraulic oil) under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or fuel lines. Tighten all connections before applying pressure.
- Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



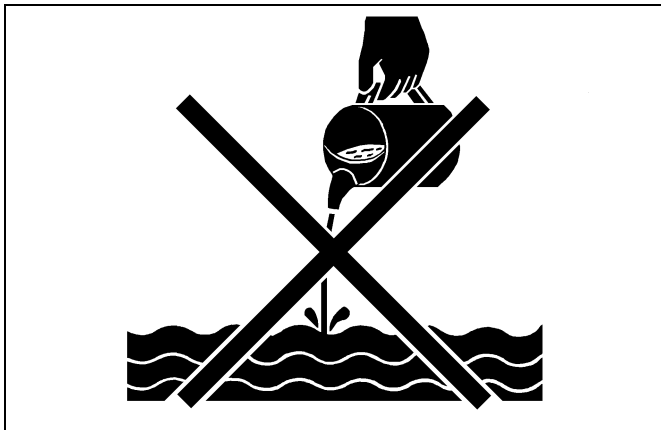
AVOID FIRES

- Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
- To avoid sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
- Make sure that no fuel has been spilled on the engine.



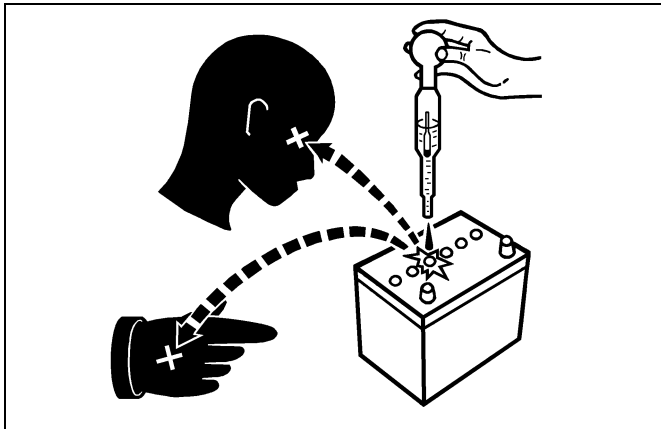
VENTILATE WORK AREA

- If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.



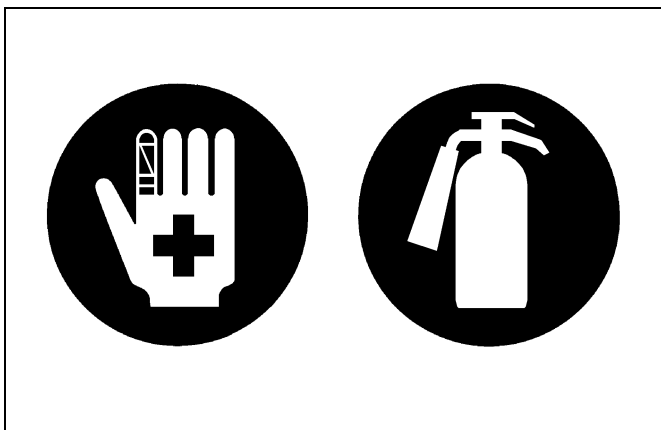
DISPOSE OF FLUIDS PROPERLY

- Do not pour fluids into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, electrolyte and other harmful waste.



PREVENT ACID BURNS

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.



PREPARE FOR EMERGENCIES

- Keep a first aid kit and fire extinguisher handy at all times.
- Keep emergency numbers for doctors, ambulance service, hospital and fire department near your telephone.

SPECIFICATIONS

Model		D1503-M-DI	D1503-M-DI-T	D1703-M-DI	D1803-M-DI
Number of Cylinders		3			
Type		Vertical, Water-cooled, 4 cycle DI diesel engine			
Bore × Stroke mm × mm (in. × in.)		83 × 92.4 (3.26 × 3.64)		87 × 92.4 (3.43 × 3.64)	87 × 102.4 (3.43 × 4.04)
Total Displacement cm ³ (cu.in.)		1499 (91.47)		1647 (100.51)	1826 (111.43)
SAE Net Cont. kW/min ⁻¹ (rpm) (HP/min ⁻¹ (rpm))		20.1 / 2800 (27.0 / 2800)	27.2 / 2800 (36.5 / 2800)	22.7 / 2800 (30.4 / 2800)	23.9 / 2600 (32.1 / 2600)
SAE Net Intermittent kW/min ⁻¹ (rpm) (HP/min ⁻¹ (rpm))		23.5 / 2800 (31.5 / 2800)	31.3 / 2800 (42.0 / 2800)	26.1 / 2800 (35.0 / 2800)	27.2 / 2600 (36.5 / 2600)
SAE Gross Intermittent kW/min ⁻¹ (rpm) (HP/min ⁻¹ (rpm))		24.8 / 2800 (33.2 / 2800)	32.7 / 2800 (43.8 / 2800)	27.4 / 2800 (36.7 / 2800)	28.4 / 2600 (38.1 / 2600)
Maximum Bare Speed min ⁻¹ (rpm)		3000			2800
Maximum Idling Speed min ⁻¹ (rpm)		750 to 850			
Combustion Chamber		Troiddal 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		0.201 rad (11.5 °) Before T.D.C.		0.175 rad (10 °) Before T.D.C.	
Firing Order		1-2-3			
Injection Pressure	1st. Stage	18.6 MPa (190 kgf/cm ² , 2702 psi)			
	2nd. Stage	22.6 MPa (230 kgf/cm ² , 3271 psi)			
Compression Ratio		20	19	20	
Lubricating System		Forced Lubrication by Trochoid Pump			
Cooling System		Pressurized radiation, forced circulation with water pump			
Starting System		Electric Starting with Starter			
		12 V, 1.4 kW			
Starting Support Device		Pre-heating by Glow Plug in Combustion Chamber			
Battery		12 V, 60 A (75D31R)			12 V, 88 A (115E41R)
Charging Alternator		12 V, 360 W		12 V, 480 W	
Fuel		Diesel Fuel No.2-D or No.2-DLS			
Lubricating Oil		Better than CD class (API)			
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.54 in.)	5.6 L (1.48 U.S.gals)			
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.85 U.S.gals)			
Weight (Dry) BB spec. kg (lbs)		148 (326)	152 (335)	148 (326)	151 (333)

* 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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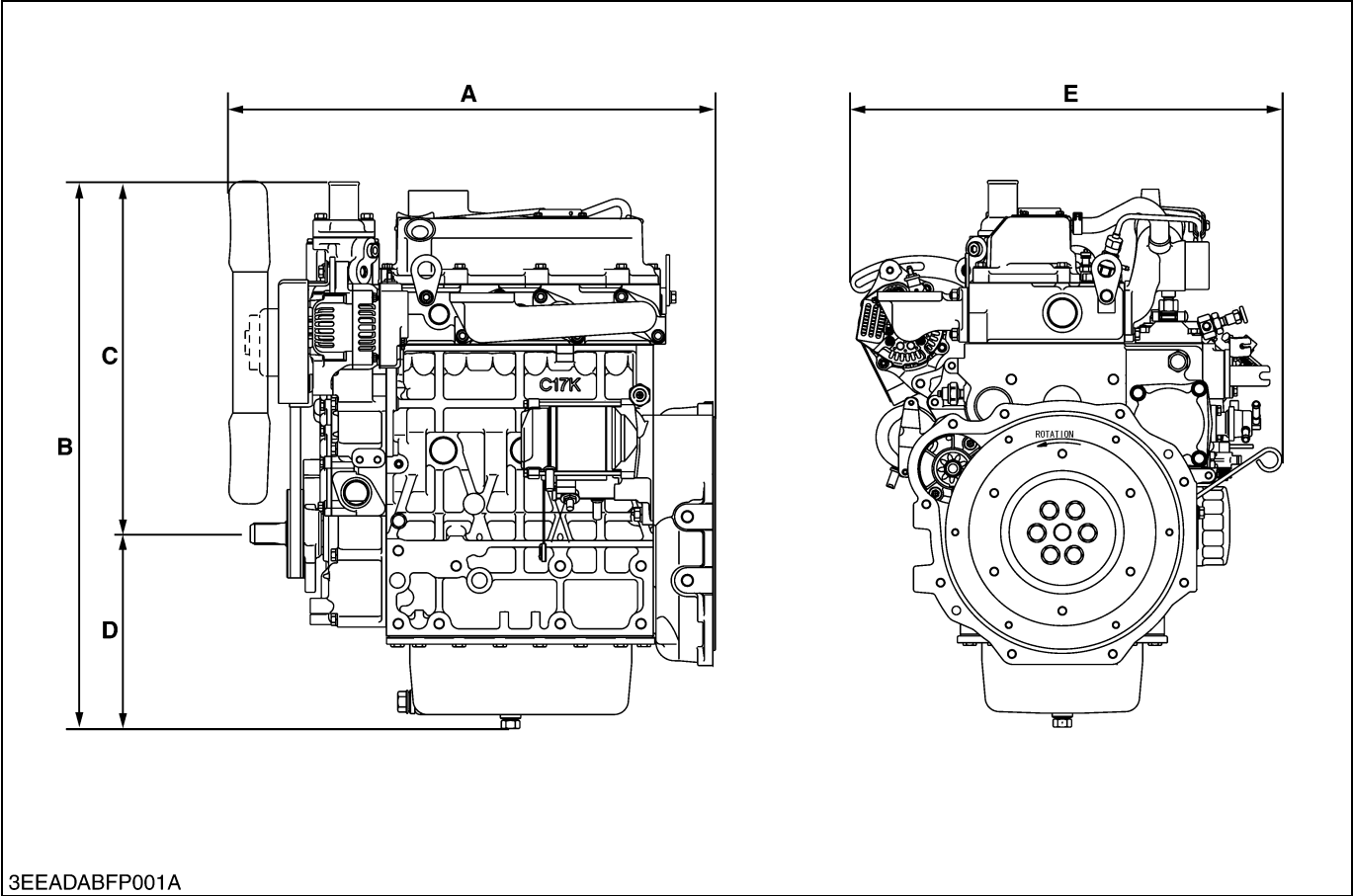
Model		V2203-M-DI	V2403-M-DI
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle DI diesel engine	
Bore × Stroke	mm × mm (in. × in.)	87 × 92.4 (3.43 × 3.64)	87 × 102.4 (3.43 × 4.04)
Total Displacement	cm ³ (cu.in.)	2197 (134.07)	2434 (148.53)
SAE Net Cont.	kW/min ⁻¹ (rpm) (HP/min ⁻¹ (rpm))	30.2 / 2800 (40.5 / 2800)	31.8 / 2600 (42.6 / 2600)
SAE Net Intermittent	kW/min ⁻¹ (rpm) (HP/min ⁻¹ (rpm))	34.8 / 2800 (46.7 / 2800)	36.6 / 2600 (34.8 / 2800)
SAE Gross Intermittent	kW/min ⁻¹ (rpm) (HP/min ⁻¹ (rpm))	36.4 / 2800 (48.8 / 2800)	38.0 / 2600 (51.0 / 2600)
Maximum Bare Speed	min ⁻¹ (rpm)	3000	3000
Maximum Idling Speed	min ⁻¹ (rpm)	750 to 850	
Combustion Chamber		Troiddal 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		0.192 rad (11 °) Before T.D.C.	
Firing Order		1-3-4-2	
Injection Pressure	1st. Stage	18.6 MPa (190 kgf/cm ² , 2702 psi)	
	2nd. Stage	22.6 MPa (230 kgf/cm ² , 3271 psi)	
Compression Ratio		20	
Lubricating System		Forced Lubrication by Trochoid Pump	
Cooling System		Pressurized radiation, forced circulation with water pump	
Starting System		Electric Starting with Starter	
		12 V, 1.4 kW	12 V, 2.0 kW
Starting Suport Device		Pre-heating by Glow Plug in Combustion Chamber	
Battery		12 V, 88 A (115E41R)	12 V, 92 A (130E41R)
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D or No.2-DLS	
Lubricating Oil		Better than CD class (API)	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.54 in.)	7.6 L (2.01 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.51 U.S.gals)	
Weight (Dry) BB spec.	kg (lbs)	180 (397)	184 (406)

* The specification described above is of the standard engine of each model.

* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

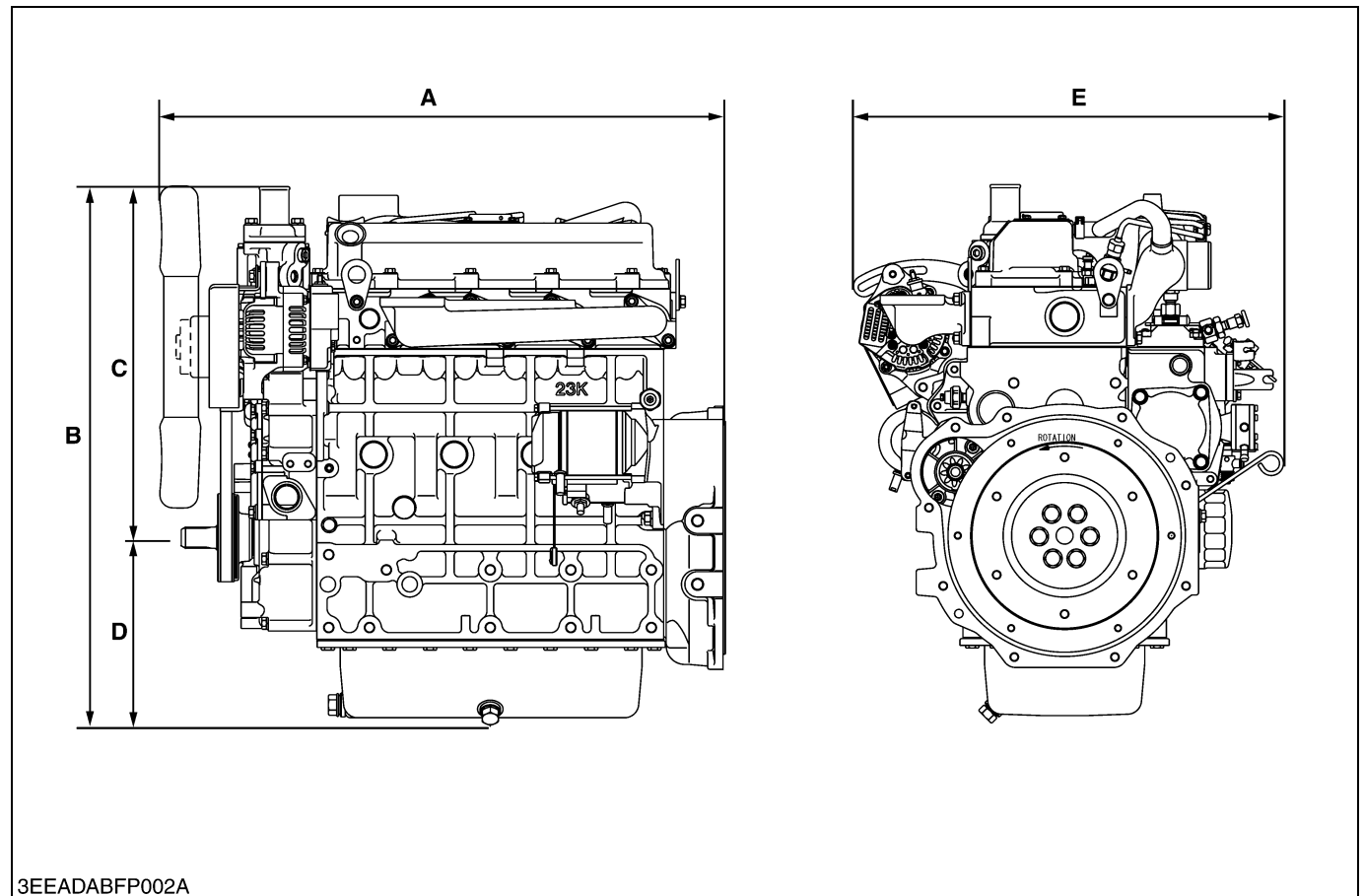
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DIMENSIONS



	D1503-M-DI	D1503-M-DI-T	D1703-M-DI	D1803-M-DI
A	599.2 mm (23.59 in.)	599.2 mm (23.59 in.)	572.1 mm (22.52 in.)	575.9 mm (22.67 in.)
B	643.5 mm (25.33 in.)	644.0 mm (25.35 in.)	643.3 mm (25.33 in.)	685.0 mm (26.97 in.)
C	414.2 mm (16.31 in.)	414.2 mm (16.31 in.)	414.0 mm (16.30 in.)	419.0 mm (16.50 in.)
D	229.3 mm (9.03 in.)	229.8 mm (9.05 in.)	229.3 mm (9.03 in.)	266.0 mm (10.47 in.)
E	514.4 mm (20.25 in.)	514.4 mm (20.25 in.)	507.1 mm (19.96 in.)	499.0 mm (19.65 in.)

W1031045



	V2203-M-DI	V2403-M-DI
A	667.1 mm (26.26 in.)	670.9 mm (26.41 in.)
B	635.0 mm (25.00 in.)	684.5 mm (26.95 in.)
C	414.0 mm (16.30 in.)	419.0 mm (16.50 in.)
D	221.0 mm (8.70 in.)	265.5 mm (10.45 in.)
E	507.1 mm (19.96 in.)	499.0 mm (19.65 in.)

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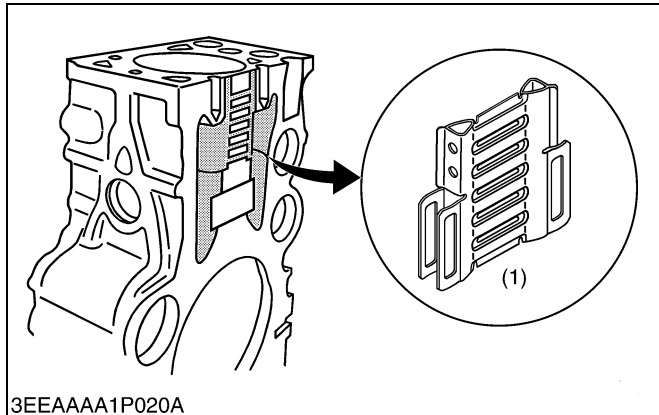
MECHANISM

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1. ENGINE BODY

[1] HOLLOW CORE



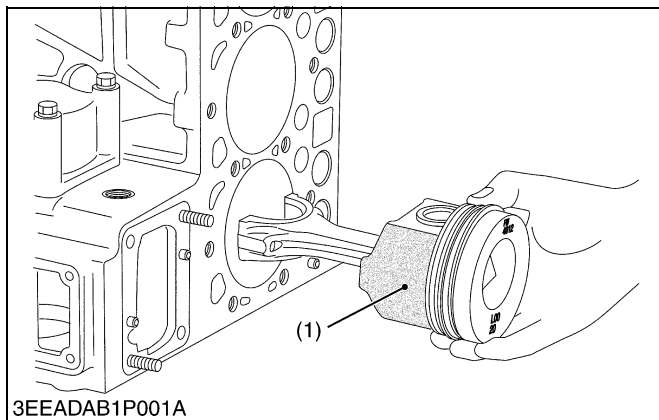
The cylinder block has a hollow core (1) already cast inside the cylinder-to-cylinder water jacket.

In this core, there is a pair of vertical cooling passages (right and left) as well as multiple horizontal cooling channels that interconnect these cooling passages. This design allows smoother cooling water flow through the cylinder block, which cools down a wider range between the cylinders more effectively.

(1) Hollow Core

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[2] PISTON



Piston's skirt is coated with **molybdenum disulfide★**, which reduces the piston slap noise and thus the entire operating noise.

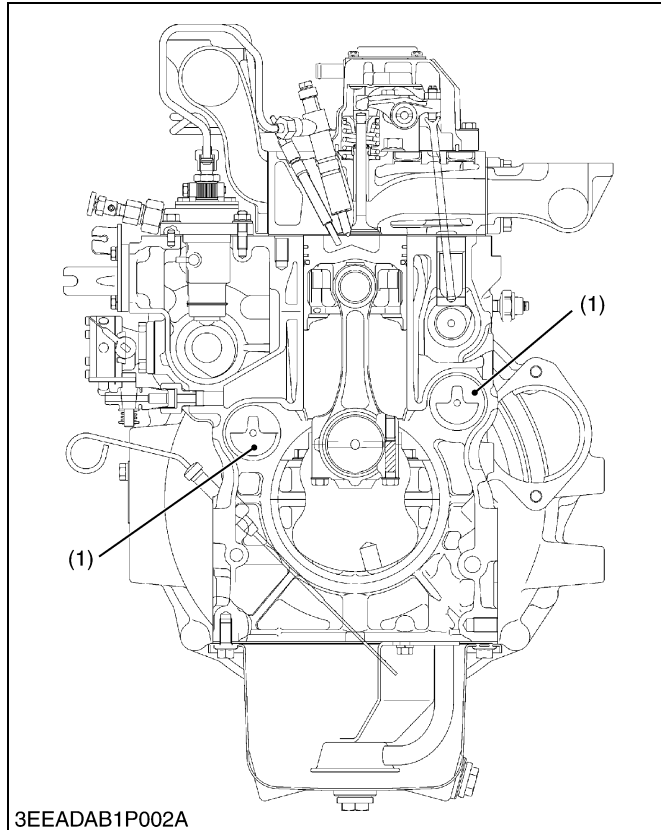
★Molybdenum disulfide (MoS₂)

The molybdenum disulfide (1) serves as a solid lubricant, like a Graphite or Teflon. This material helps resist metal wears even with little lube oil.

(1) Molybdenum Disulfide

W1013114

[3] BUILT-IN DYNAMIC BALANCER (BALANCER MODEL ONLY)



Engine are sure to vibrate by piston's reciprocation. Theoretically, three-cylinder engines are much less prone to cause vibration than four-cylinder ones (second inertia, etc.). However, any engine has many moving parts in addition to its pistons and cannot be completely free from vibration.

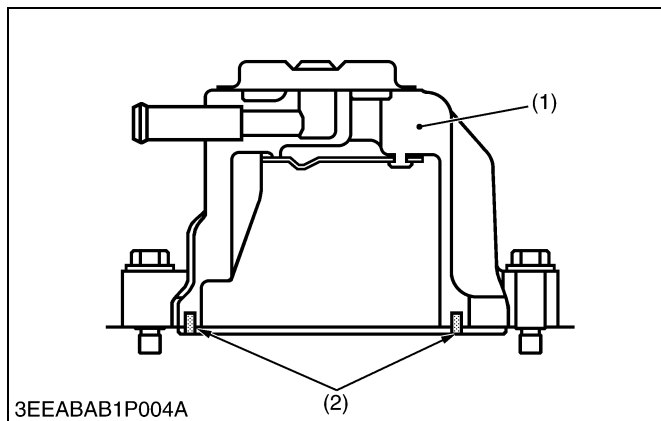
The four cylinders engine V2203 and V2403 can be fitted with balance weight on crankcase to absorb the second inertia mentioned above and reduce vibration.

This engine is internally provide with two balancers (1), one at the suction side and the other at the exhaust side.

(1) Balancer

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[4] HALF-FLOATING HEAD COVER



The rubber packing (2) is fitted in to maintain the cylinder head cover (1) 0.5 mm or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

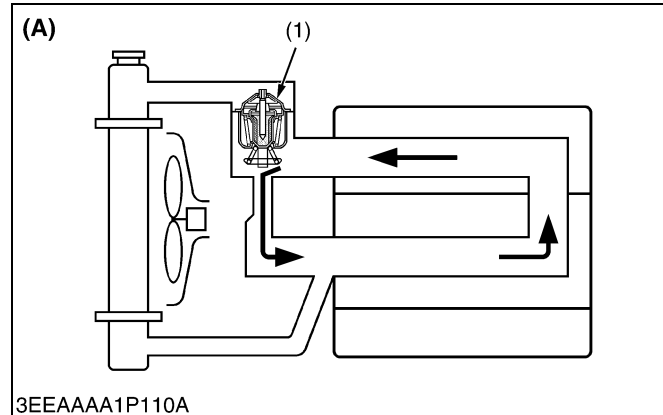
(1) Cylinder Head Cover

(2) Rubber Packing

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2. COOLING SYSTEM

[1] BOTTOM BYPASS SYSTEM



Bottom bypass system is introduced in 03-M-DI Series for improving the cooling performance of the radiator.

While the temperature of coolant in the engine is low, the thermostat (1) is held closed and the coolant is allowed to flow through the bypass pipe and to circulate in the engine.

When the temperature exceeds the thermostat valve opening level, the thermostat (1) fully opens itself to prevent the hot coolant from flowing through the bypass into the engine.

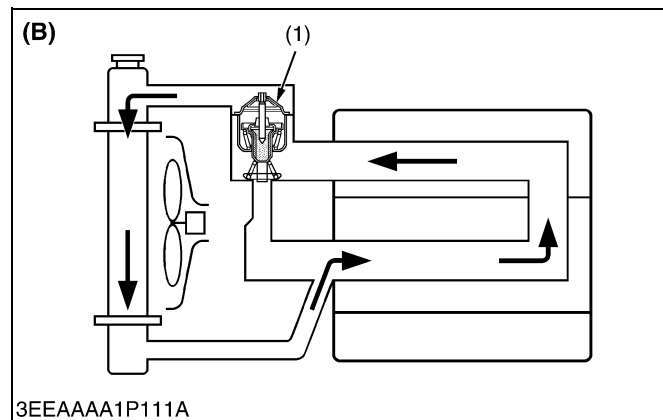
In this way, the radiator can increase its cooling performance.

(1) Thermostat

(A) Bypass Opened

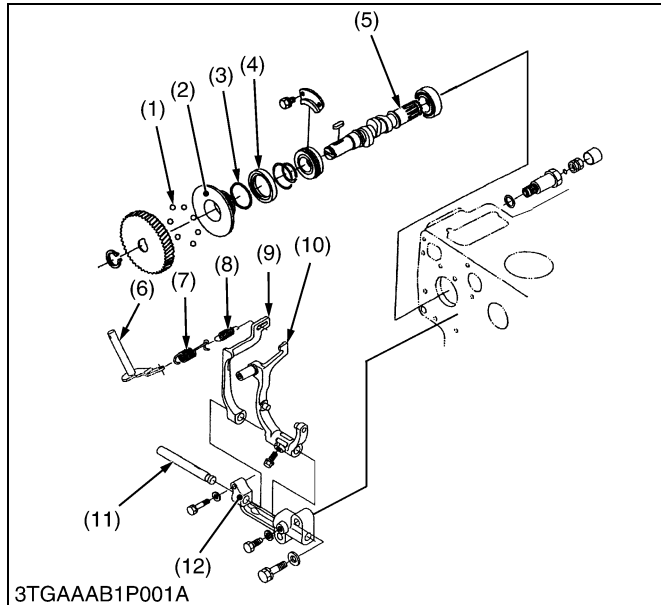
(B) Bypass Closed

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3. FUEL SYSTEM

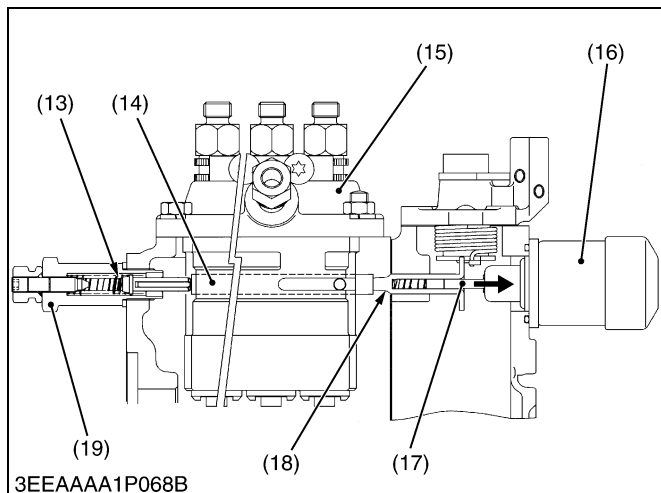
[1] GOVERNOR



The governor serves to keep engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. This engine employs an all-speed governor which controls the centrifugal force of the steel ball (1) weight, produced by rotation of the fuel camshaft (5), and the tension of the governor spring 1 (7) and 2 (8) are balanced.

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

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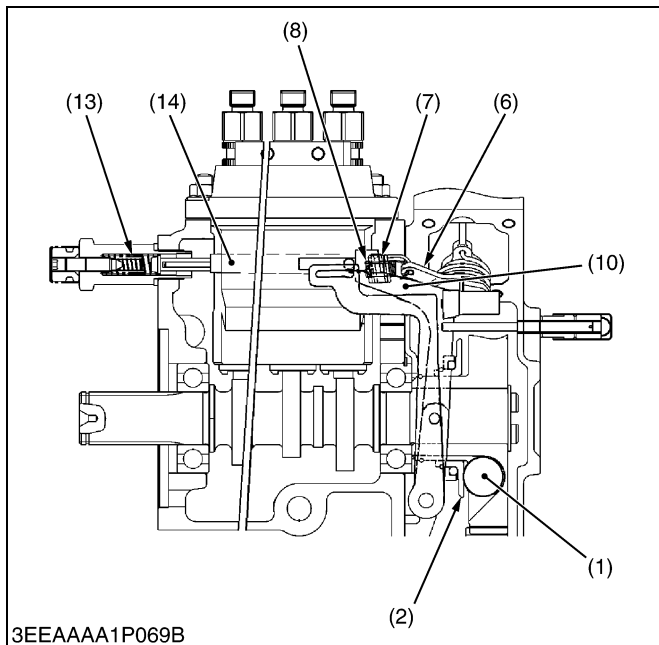
■ At Start

Flowing of the battery current into the engine stop solenoid (16), the plunger (17) is actuated to arrow direction.

Since the steel ball (1) have no centrifugal force, the control rack (14) is pushed to the right by the start spring (13). Accordingly, the control rack (14) moves to the maximum injection position to assure easy starting.

- | | |
|---------------------------|-----------------------|
| (13) Start Spring | (17) Plunger |
| (14) Control Rack | (18) Guide |
| (15) Injection Pump | (19) Idling Apparatus |
| (16) Engine Stop Solenoid | |

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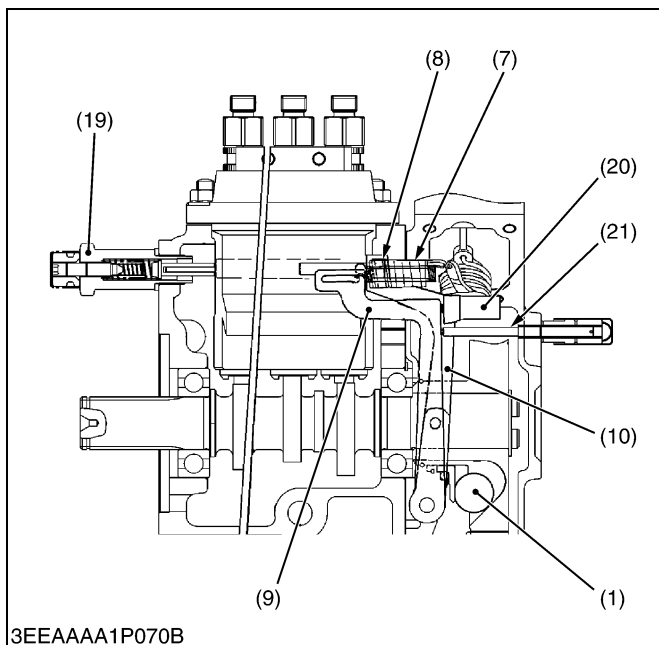
■ At Idling

When the speed control lever is set at the idling position after the engine starts, the governor spring 1 (7) does not work at all and the governor spring 2 (8) does only act slightly. The governor sleeve (2) is pushed leftward by a centrifugal force of steel ball (1).

Therefore, the fork lever 1 (10) and control rack (14) are moved to the left by the governor sleeve (2) and then the start spring (13) is compressed by the control rack (14). As a result, the control rack (14) is kept at a position where a centrifugal force of steel ball (1) and forces of start spring (13), governor spring 2 (8) are balanced, providing stable idling.

- | | |
|-----------------------|-----------------------|
| (1) Steel Ball | (8) Governor Spring 2 |
| (2) Governor Sleeve | (10) Fork Lever 1 |
| (6) Governor Lever | (13) Start Spring |
| (7) Governor Spring 1 | (14) Control Rack |

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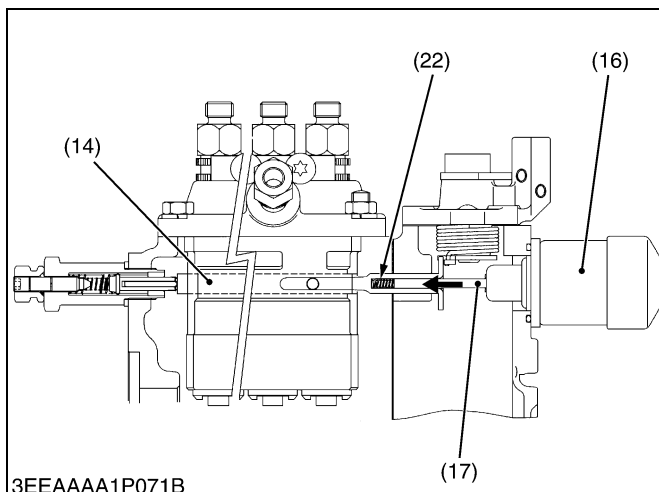
■ At High Speed Running with Overload

When an overload is applied to the engine running at a high speed, the centrifugal force of steel ball (1) becomes small as the engine speed is dropped, and fork lever 2 (9) is pulled to the right by the governor springs 1 (7) and 2 (8), increasing fuel injection. Though, fork lever 2 (9) becomes ineffective in increasing fuel injection when it is stopped by the adjusting screw (21).

After that, when the force of torque spring (20) becomes greater than the centrifugal force of the steel ball (1), fork lever 1 (10) moves rightward to increase fuel injection, causing the engine to run continuously at a high torque.

- | | |
|-----------------------|-----------------------|
| (1) Steel Ball | (10) Fork Lever 1 |
| (7) Governor Spring 1 | (19) Idling Apparatus |
| (8) Governor Spring 2 | (20) Torque Spring |
| (9) Fork Lever 2 | (21) Adjusting Screw |

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■ To Stop Engine

When the battery current stops, the plunger (17) of engine stop solenoid (16) is returned to the original position, the spring (22) to keep the control rack (14) in "No fuel injection" position.

- | | |
|---------------------------|--------------|
| (14) Control Rack | (17) Plunger |
| (16) Engine Stop Solenoid | (22) Spring |

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4. ELECTRICAL SYSTEM

[1] STARTER AUTO REDUCTION UNIT

(1) General

The starter auto reduction unit (7) is designed to start the machine equipped with engine more reliably. This unit has the following function by integrating an alternator (1) that puts out rpm-proportional pulses.

1. Fail-Safe Functions

- a) Preventing the starter pinion from getting in mesh while the engine is running.

With the engine running, pulses from the alternator terminal **P** are constantly detected. Even if key switch (2) is wrongly operated or the wiring gets short-circuited, the starter (5) can stay off, the starter (5) and flywheel ring gear are effectively protected.

- b) Starter auto reduction at a start of the engine.

When the engine has got started and the alternator (1) has reached the specified rpm, the electrical current to the starter (5) is automatically cut off, even if the key switch (2) is at the **START** position.

- c) Safety mechanism in case of engine stall.

If the engine stalls with the key switch (2) at **AC** or **START** position, the key must be set once to **OFF** position for added safety. The starter (5) is thus kept from turning on unexpectedly.

2. Other Features and Functions

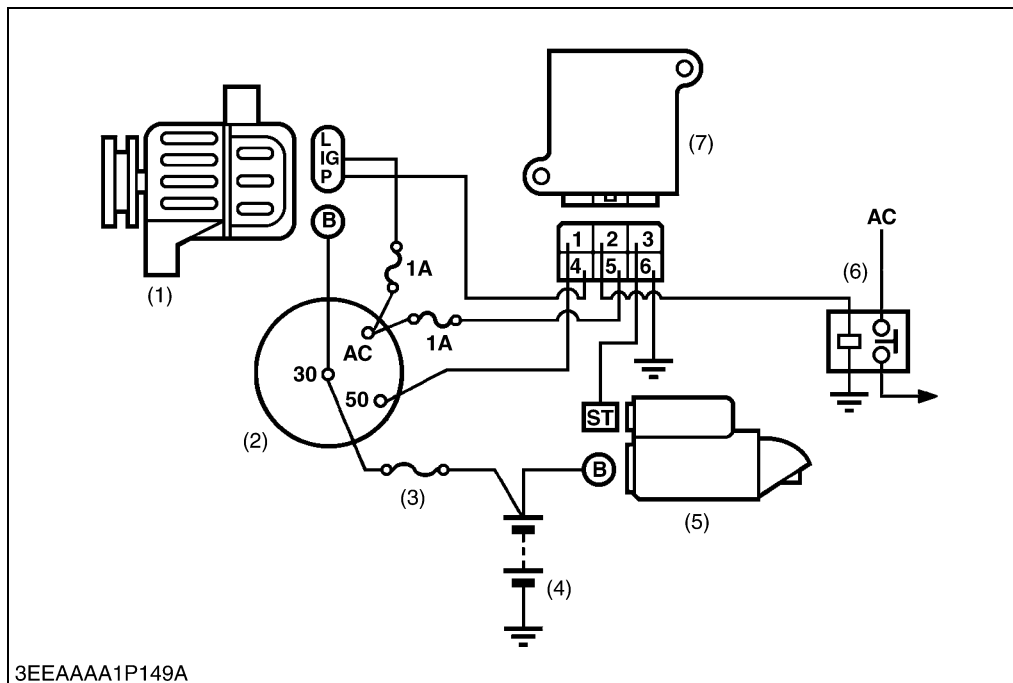
- a) Simplified wiring with built-in power relay.

The unit is internally provided with a power relay to get simpler wiring than ever before. If the key switch terminal **AC**, ground cable or any other parts is wrongly connected, the starter (5) stays off. This helps identify wrong wiring more easily.

- b) With the output terminal for confirming engine start (Relay drive possible).

The unit has an external output terminal in order to confirm an engine start. An external relay (6) may also be connected to this terminal. (Output current : below 200 mA)

(2) Basic Circuit

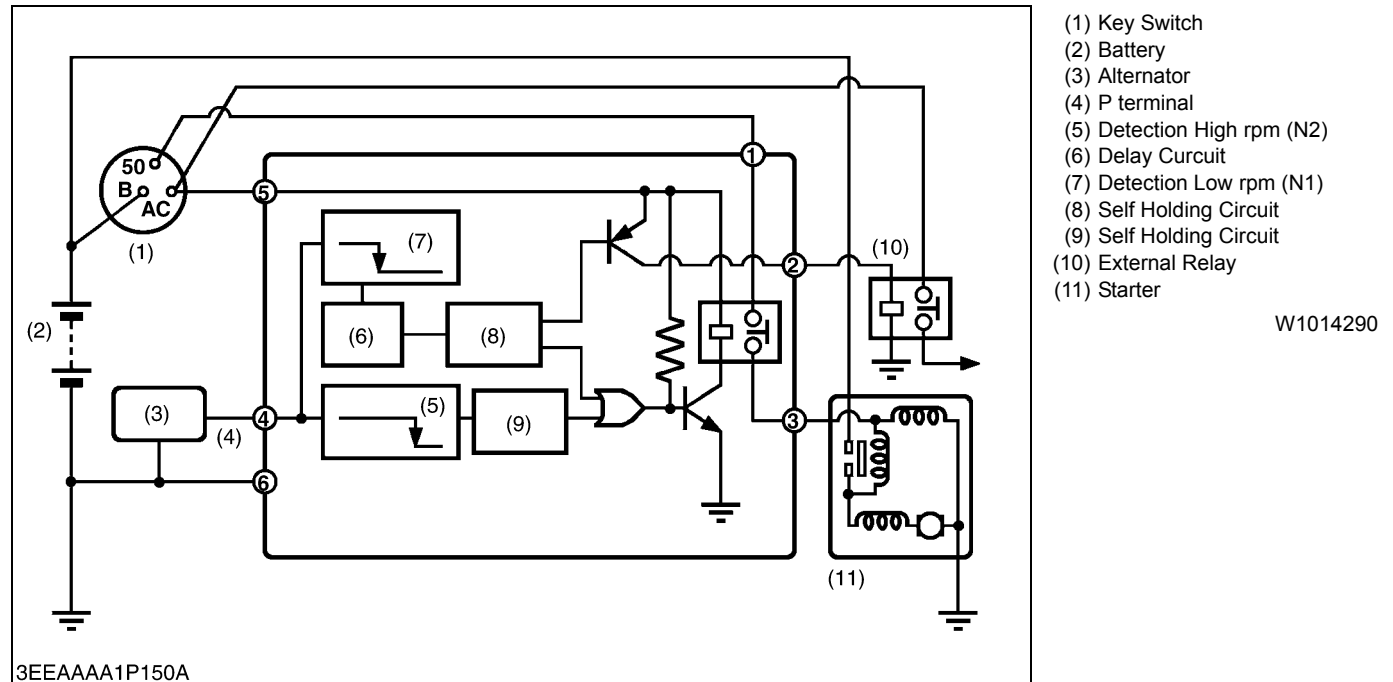


- (1) Alternator
- (2) Key Switch
- (3) Slow Blow Fuse
- (4) Battery
- (5) Starter
- (6) External Relay
- (7) Starter Auto Reduction Unit

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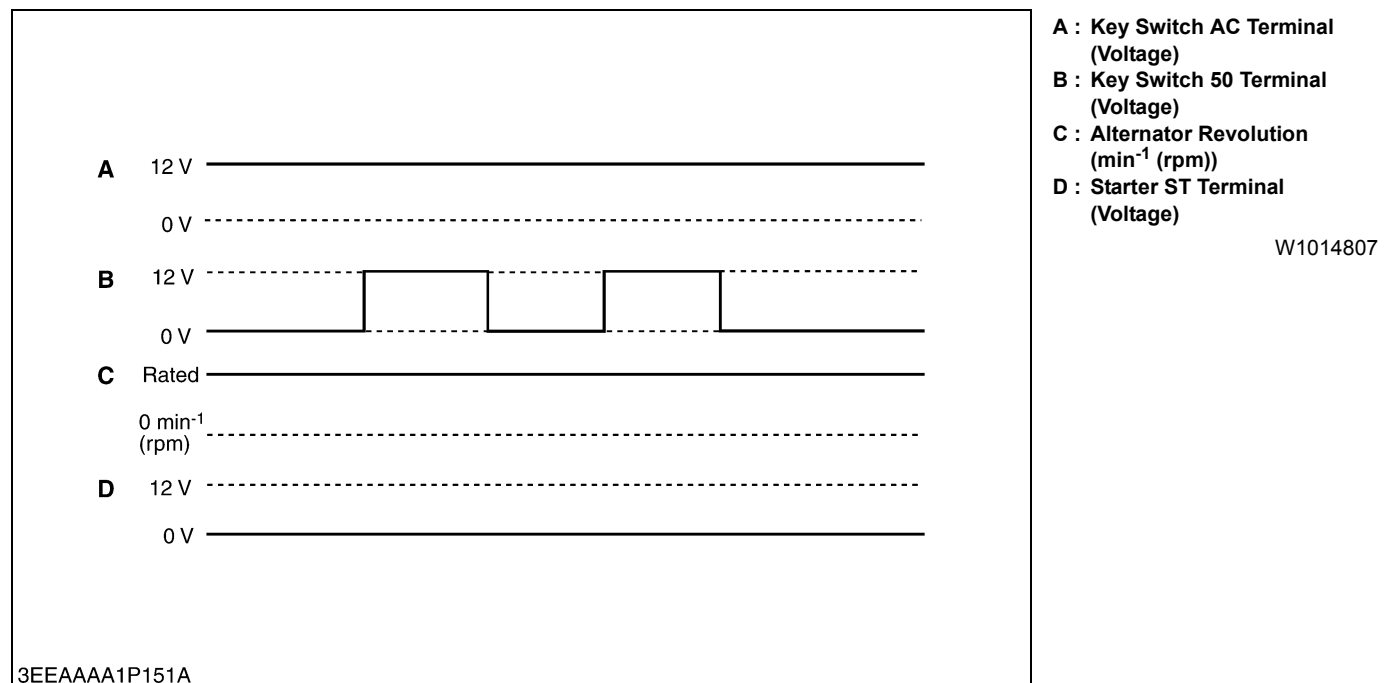
(3) Component



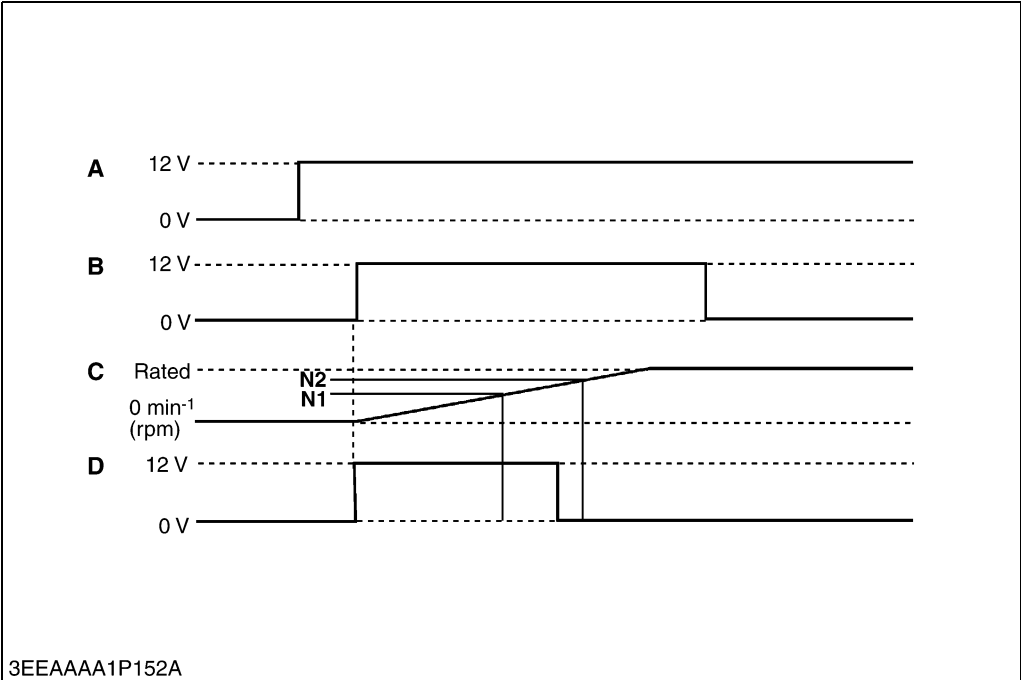
(4) Function

(A) Starter Auto Reduction

a) While Engine is Running

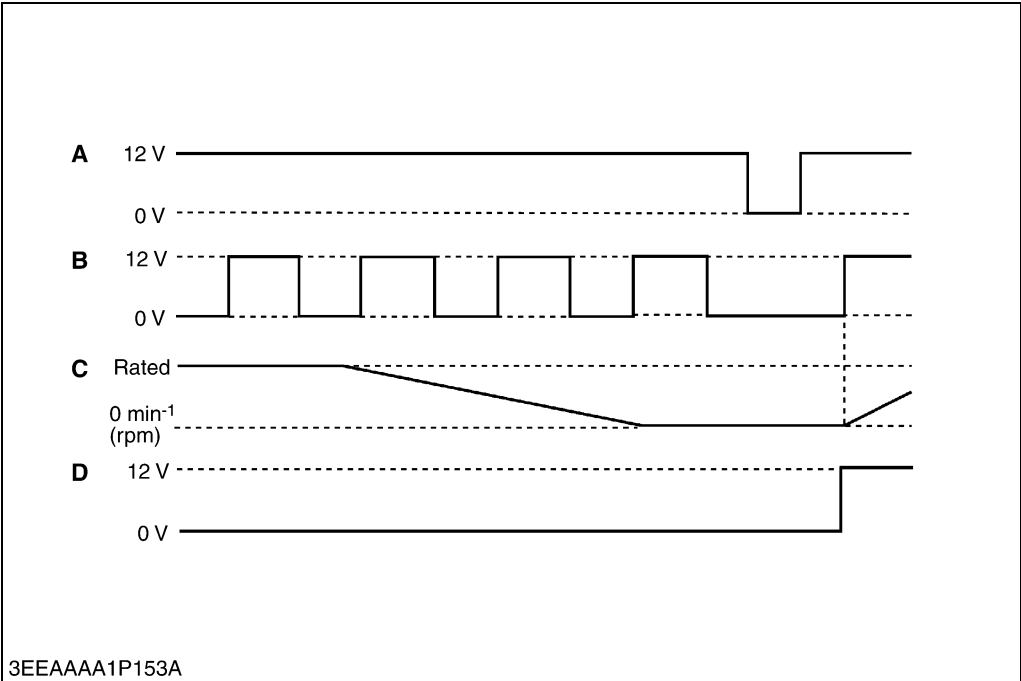


b) When Engine Starts Normally



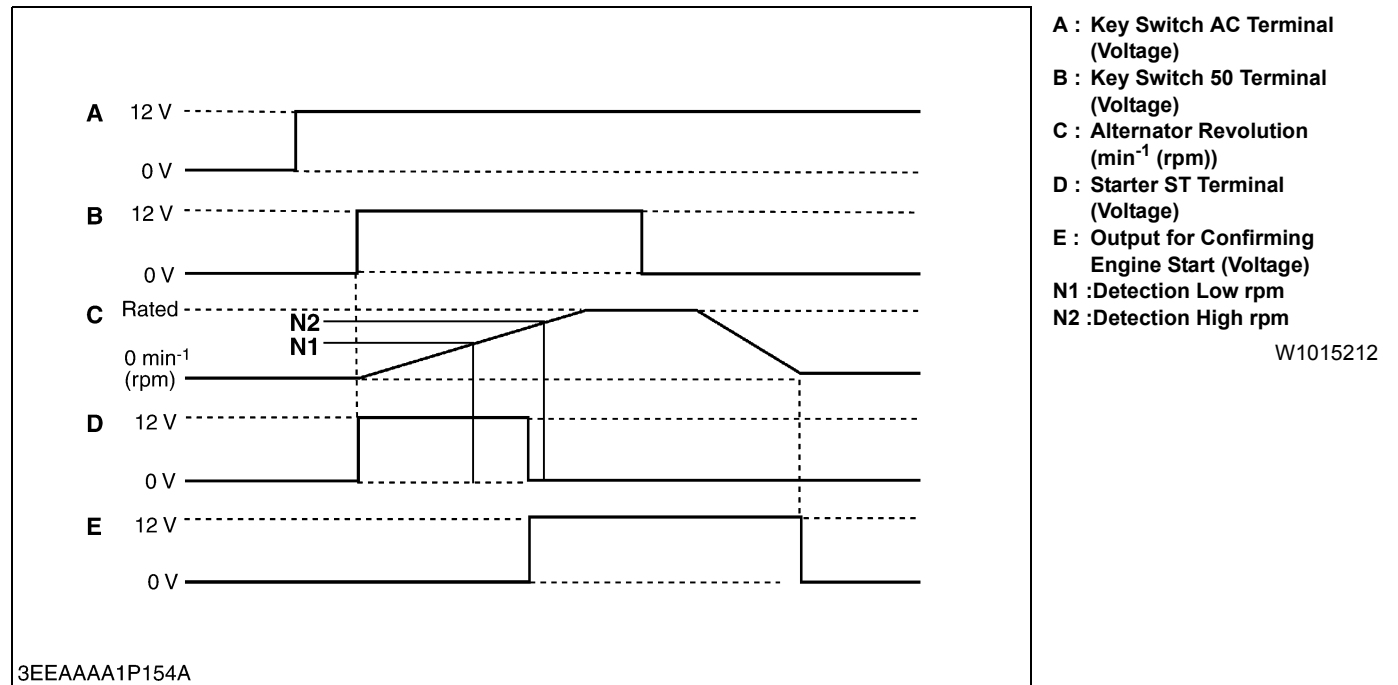
A : Key Switch AC Terminal (Voltage)
B : Key Switch 50 Terminal (Voltage)
C : Alternator Revolution (min⁻¹ (rpm))
D : Starter ST Terminal (Voltage)
N1 :Detection Low rpm
N2 :Detection High rpm
W1014965

c) When Engine Stalls



A : Key Switch AC Terminal (Voltage)
B : Key Switch 50 Terminal (Voltage)
C : Alternator Revolution (min⁻¹ (rpm))
D : Starter ST Terminal (Voltage)
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d) Output Terminal for Confirming Engine Start



SERVICING

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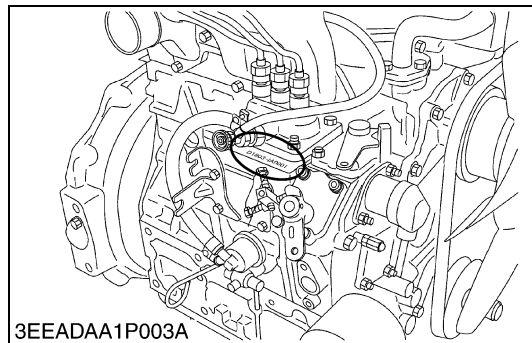
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1. GENERAL

[1] ENGINE IDENTIFICATION

(1) Model Name and Engine Serial Number



When contacting the manufacture, always specify your engine model name and serial number.

The engine model and its serial number need to be identified before the engine can be serviced or parts replaced.

■ Engine Serial Number

The engine serial number is an identified number for the engine. It is marked after the engine model number.

It indicates month and year of manufacture as follows.

• Year of manufacture

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		

• Month of manufacture

Month	Engine Serial Number	
	0001 ~ 9999	10000 ~
January	A0001 ~ A9999	B0001 ~
February	C0001 ~ C9999	D0001 ~
March	E0001 ~ E9999	F0001 ~
April	G0001 ~ G9999	H0001 ~
May	J0001 ~ J9999	K0001 ~
June	L0001 ~ L9999	M0001 ~
July	N0001 ~ N9999	P0001 ~
August	Q0001 ~ Q9999	R0001 ~
September	S0001 ~ S9999	T0001 ~
October	U0001 ~ U9999	V0001 ~
November	W0001 ~ W9999	X0001 ~
December	Y0001 ~ Y9999	Z0001 ~

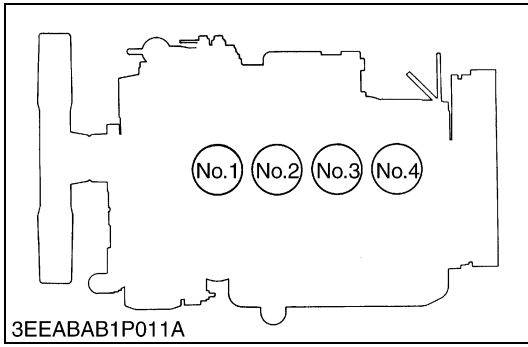
e.g. D1803-1A0001

“1” indicates 2001 and “A” indicates January.

So, 1A indicates that the engine was manufactured on January, 2001.

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(2) Cylinder Number

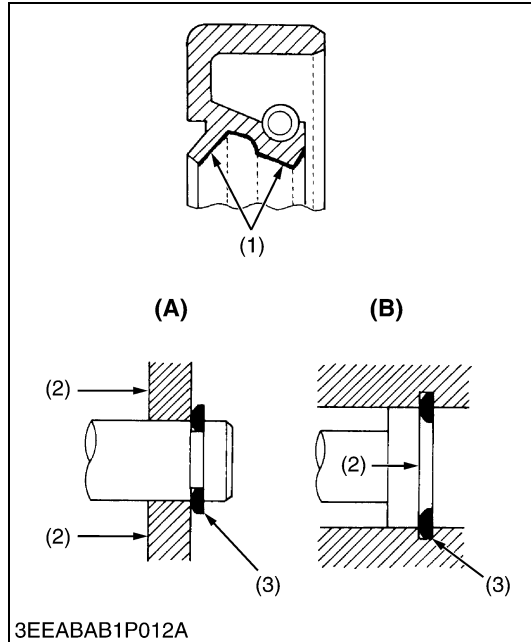


The cylinder numbers of 03-M-DI Series diesel engine are designated as shown in the figure.

The sequence of cylinder numbers is given as No.1, No.2, No.3 and No.4 starting from the gear case side.

W1011077

[2] GENERAL PRECAUTION



- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.
- When special tools are required, use KUBOTA genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only KUBOTA genuine parts for parts replacement to maintain engine performance and to ensure safety.
- Gaskets and O-rings must be replaced during reassembly. Apply grease to new O-rings or oil seals before assembling.
- When reassembling external or internal snap rings, position them so that the sharp edge faces against the direction from which force is applied.
- Be sure to perform run-in the serviced or reassembled engine. Do not attempt to give heavy load at once, or serious damage may result to the engine.

(1) Grease

(2) Force

(3) Place the Sharp Edge against the Direction of Force

(A) External Snap Ring

(B) Internal Snap Ring

W1011734

[3] TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and the proper torque.

(1) Tightening Torques for Special Use Screws, Bolts and Nuts

■ NOTE

- In removing and applying the screws, bolts and nuts marked with “*”, a pneumatic wrench or similar pneumatic tool, if employed, must be used with enough care not to get them seized.
- For “*” marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.
- The letter “M” in Size x Pitch means that the screw, bolt or nut dimension stands for metric. The size is the nominal outside diameter in mm of the threads. The pitch is the nominal distance in mm between two threads.

Item	Size x Pitch	N·m	kgf·m	ft-lbs
Cylinder head cover screw	M6 × 1.0	6.9 to 11.3	0.7 to 1.15	5.1 to 8.32
* Cylinder head screw	M11 × 1.25	93.1 to 98.0	9.5 to 10.0	68.7 to 72.3
* Main bearing case screw 1	M9 × 1.25	46.1 to 50.9	4.7 to 5.2	34.0 to 37.6
* Main bearing case screw 2	M10 × 1.25	68.6 to 73.5	7.0 to 7.5	50.6 to 54.2
* Flywheel screw	M12 × 1.25	98.0 to 107.8	10.0 to 11.0	72.3 to 79.5
* Connecting rod screw	M8 × 1.0	44.1 to 49.0	4.5 to 5.0	32.5 to 36.2
* Rocker arm bracket screw	M8 × 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
* Idle gear shaft screw	M8 × 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Fan drive pulley mounting nut	—	137.3 to 156.9	14.0 to 16.0	101.3 to 115.7
* Bearing case cover screw	M8 × 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Glow plug	M10 × 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle holder clamp screw	—	25.5 to 29.4	2.6 to 3.0	18.8 to 21.7
Oil Switch taper screw	PT 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection pipe retaining nut	M12 × 1.5	14.7 to 24.5	1.5 to 2.5	10.8 to 18.1
Overflow pipe assembly retaining screw	—	9.8 to 11.3	1.0 to 1.15	7.2 to 8.3
Camshaft set screw	M8 × 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Hi-idling body	—	44.1 to 49.0	4.5 to 5.0	32.6 to 36.3

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(2) Tightening Torques for General Use Screws, Bolts and Nuts

Grade Nominal Diameter	Standard Screw and Bolt ④			Special Screw and Bolt ⑦		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

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Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

Punched number	Screw and bolt material grade
None or 4	Standard screw and bolt SS400, S20C
7	Special screw and bolt S43C, S48C (Refined)

W1012705

[4] TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	- No fuel - Air in the fuel system - Water in the fuel system	Replenish fuel Vent air Change fuel and repair or replace fuel system	– S-20 S-20, 21, 25
	- Fuel pipe clogged - Fuel filter clogged - Excessively high viscosity of fuel or engine oil at low temperature - Fuel with low cetane number - Fuel leak due to loose injection pipe retaining nut - Incorrect injection timing - Fuel camshaft worn - Injection nozzle clogged - Injection pump malfunctioning - Seizure of crankshaft, camshaft, piston, cylinder or bearing - Compression leak from cylinder	Clean Clean or change Use specified fuel or engine oil Use specified fuel Tighten retaining nut Adjust Replace Replace Replace Repair or replace Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	S-20 S-21, 25 – – S-44 S-86 S-54 S-88 S-49 – –
(Starter Does Not Run)	- Improper valve timing - Piston ring and cylinder worn	Correct or replace timing gear Replace	S-53 S-42, 56, 57, 71, 72, 79
	- Excessive valve clearance - Battery discharged - Starter malfunctioning - Key switch malfunctioning - Starter auto reduction unit defective - Wiring disconnected	Adjust Charge Repair or replace Repair or replace Replace Connect	S-31 S-29 S-89, 93, 96 – S-92, 100 S-100
Engine Revolution Is Not Smooth	- Fuel filter clogged or dirty - Air cleaner clogged - Fuel leak due to loose injection pipe retaining nut - Injection pump malfunctioning - Incorrect nozzle injection pressure - Injection nozzle stuck or clogged - Governor malfunctioning - Bearing worn out - Shaft bent - Fin or other part damaged due to foreign matters	Clean or change Clean or change Tighten retaining nut Replace Replace Replace Repair Replace the turbocharger assembly Replace the turbocharger assembly Replace the turbocharger assembly	S-21, 25 S-21 S-44 S-49 S-88 S-88 S-50, 54 S-101 S-101 S-101

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Symptom	Probable Cause	Solution	Reference Page
Either White or Blue Exhaust Gas Is Observed	- Excessive engine oil - Piston ring and liner worn or stuck - Incorrect injection timing - Deficient compression	Reduce to specified level Repair or replace Adjust Check the cylinder compression pressure and top clearance	S-19 S-42, 56, 57, 71, 72, 79 S-86 S-42
Oil Leak into Exhaust Pipe or Suction Pipe	- Waste oil pipe clogged or deformed - Piston ring seal faulty	Repair or replace Replace the turbocharger assembly	– S-101
Either Black or Dark Gray Exhaust Gas Is Observed	- Overload - Low grade fuel used - Fuel filter clogged - Air cleaner clogged - Deficient nozzle injection	Lessen load Use specified fuel Clean or change Clean or change Replace nozzle	– – S-21, 25 S-21 S-88
Deficient Output	- Incorrect injection timing - Engine's moving parts seem to be seizing - Injection pump malfunctioning - Deficient nozzle injection - Compression leak - Gas leak from exhaust system - Air leak from compressor discharge side - Air cleaner dirty or clogged - Compressor wheel turning heavily	Adjust Repair or replace Replace Replace nozzle Check the compression pressure and repair Repair or replace Repair or replace Clean or replace Replace the turbocharger assembly	S-86 – S-49 S-88 S-42 S-101 S-101 S-24 S-101
Excessive Lubricant Oil Consumption	- Piston ring's gap facing the same direction - Oil ring worn or stuck - Piston ring groove worn - Valve stem and valve guide worn - Crankshaft bearing, and crank pin bearing worn - Oil leaking due to defective seals or packing	Shift ring gap direction Replace Replace piston Replace Replace Replace	S-56 S-56, 71, 72 S-56, 71, 72 S-48, 62, 63 – –
Fuel Mixed into Lubricant Oil	- Injection pump's plunger worn - Deficient nozzle injection - Injection pump broken	Replace injection pump Replace nozzle Replace	S-49 S-88 S-49
Water Mixed into Lubricant Oil	- Head gasket defective - Cylinder block or cylinder head flawed	Replace Replace	S-46, 47 S-46, 61

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Symptom	Probable Cause	Solution	Reference Page
Low Oil Pressure	- Engine oil insufficient - Oil strainer clogged - Relief valve stuck with dirt - Relief valve spring weaken or broken - Excessive oil clearance of crankshaft bearing - Excessive oil clearance of crankpin bearing - Excessive oil clearance of rocker arm - Oil passage clogged - Different type of oil - Oil pump defective	Replenish Clean Clean Replace Replace Replace Replace Clean Use specified type of oil Repair or replace	S-19 S-55 – – S-60, 75, 76, 77, 78 S-56, 74 S-45, 65 – S-23 S-54, 81, 82
High Oil Pressure	- Different type of oil - Relief valve defective	Use specified type of oil Replace	S-23 –
Engine Overheated	- Engine oil insufficient - Fan belt broken or elongated - Coolant insufficient - Radiator net and radiator fin clogged with dust - Inside of radiator corroded - Coolant flow route corroded - Radiator cap defective - Overload running - Head gasket defective - Incorrect injection timing - Unsuitable fuel used	Replenish Replace or adjust Replenish Clean Clean or replace Clean or replace Replace Loosen load Replace Adjust Use specified fuel	S-19 S-22, 28 S-19 – S-26 – S-84 – S-46, 47 S-86 –
Battery Quickly Discharge	- Battery electrolyte insufficient - Fan belt slips - Wiring disconnected - Rectifier defective - Alternator defective - Battery defective	Replenish distilled water and charge Adjust belt tension or change Connect Replace Replace Change	S-21, 29 S-22, 28 S-100 S-93, 99 S-93 –

W1014322

[5] SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Cylinder Head Surface	Flatness	—	0.05 mm / 500 mm 0.0020 in. / 19.69 in.
Compression Pressure (When Cranking with Starting Motor)		2.94 to 3.24 MPa / 290 min ⁻¹ (rpm) 30 to 33 kgf/cm ² / 290 min ⁻¹ (rpm) 427 to 469 psi / 290 min ⁻¹ (rpm)	2.35 MPa / 290 min ⁻¹ (rpm) 24 kgf/cm ² / 290 min ⁻¹ (rpm) 341 psi / 290 min ⁻¹ (rpm)
Difference among Cylinders		—	10 % or less
Top Clearance		0.60 to 0.70 mm 0.0236 to 0.0276 in.	—
Valve Clearance (When Cold)		0.18 to 0.22 mm 0.0071 to 0.0087 in.	—
Valve Seat	Width (Intake)	2.12 mm 0.0835 in.	—
	Width (Exhaust)	2.12 mm 0.0835 in.	—
Valve Seat	Angle (Intake)	1.047 rad 60 °	—
	Angle (Exhaust)	0.785 rad 45 °	—
Valve Face	Angle (Intake)	1.047 rad 60 °	—
	Angle (Exhaust)	0.785 rad 45 °	—
Valve Stem to Valve Guide	Clearance	0.040 to 0.070 mm 0.0016 to 0.0028 in.	0.1 mm 0.0039 in.
Valve Stem	O.D.	7.960 to 7.975 mm 0.31339 to 0.31398 in.	—
Valve Guide	I.D.	8.015 to 8.030 mm 0.31555 to 0.31614 in.	—
Valve Recessing	Protrusion	0.65 mm 0.026 in.	—
	Recessing	to 0.85 mm 0.033 in.	1.20 mm 0.0472 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Valve Timing (Intake Valve)	Open	0.16 rad (9 °) before T.D.C.	—
	Close	0.79 rad (45 °) after B.D.C.	—
Valve Timing (Exhaust Valve)	Open	0.87 rad (50 °) before B.D.C.	—
	Close	0.21 rad (12 °) after T.D.C.	—
Valve Spring	Free Length	41.7 to 42.2 mm 1.6417 to 1.6614 in.	41.2 mm 1.6220 in.
	Setting Load / Setting Length	117.6 N / 35.0 mm 12.0 kgf / 35.0 mm 26.4 lbs / 1.3780 in.	100.0 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbs / 1.3780 in.
	Tilt	—	1.0 mm 0.039 in.
Rocker Arm Shaft to Rocker Arm	Clearance	0.016 to 0.045 mm 0.00063 to 0.00177 in.	0.1 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 0.55118 to 0.55189 in.	—
Push Rod	Alignment	—	0.25 mm 0.0098 in.
Tappet to Tappet Guide	Clearance	0.020 to 0.062 mm 0.00079 to 0.00244 in.	0.07 mm 0.0028 in.
Tappet	O.D.	23.959 to 23.980 mm 0.94327 to 0.94410 in.	—
Tappet Guide	I.D.	24.000 to 24.021 mm 0.94488 to 0.94571 in.	—

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Timing Gear Crank Gear to Idle Gear	Backlash	0.0415 to 0.1122 mm 0.00163 to 0.00442 in.	0.15 mm 0.0059 in.
	Idle Gear to Cam Gear	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
	Idle Gear to Injection Pump Gear	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
	Crank Gear to Oil Pump Gear	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.	0.15 mm 0.0059 in.
	Idle Gear to Balancer Gear (Balancer Model Only)	Backlash (Intake side) 0.0350 to 0.1160 mm 0.00138 to 0.00457 in.	0.15 mm 0.0059 in.
	Backlash (Exhaust side)	0.0350 to 0.1160 mm 0.00138 to 0.00457 in.	0.15 mm 0.0059 in.
Idle Gear	Side Clearance	0.12 to 0.48 mm 0.0047 to 0.0189 in.	0.9 mm 0.0354 in.
Idle Gear Shaft to Idle Gear Bushing	Clearance	0.025 to 0.066 mm 0.00098 to 0.00260 in.	0.1 mm 0.0039 in.
Idle Gear Shaft	O.D.	37.959 to 37.975 mm 1.49445 to 1.49508 in.	—
Idle Gear Bushing	I.D.	38.000 to 38.025 mm 1.49606 to 1.49705 in.	—
Camshaft	Side Clearance	0.07 to 0.22 mm 0.0028 to 0.0087 in.	0.3 mm 0.0118 in.
Camshaft	Alignment	—	0.01 mm 0.0004 in.
Cam	Height (Intake / Exhaust)	33.90 mm 1.3346 in.	33.85 mm 1.3327 in.
Camshaft Journal to Cylinder Block Bore	Clearance	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.15 mm 0.0059 in.
Camshaft Journal	O.D.	39.934 to 39.950 mm 1.57221 to 1.57284 in.	—
Cylinder Block Bore	I.D.	40.000 to 40.025 mm 1.57480 to 1.57579 in.	—
Balancer Shaft (Balancer Model Only)	Side Clearance	0.07 to 0.22 mm 0.0028 to 0.0087 in.	0.3 mm 0.0118 in.
Balancer Shaft Journal 1 to Balancer Shaft Bearing 1 (Balancer Model Only)	Clearance	0.030 to 0.111 mm 0.00118 to 0.00437 in.	0.2 mm 0.0079 in.
Balancer Shaft Journal 1	O.D.	43.934 to 43.950 mm 1.72968 to 1.73031 in.	—
Balancer Shaft Bearing 1	I.D.	43.980 to 44.045 mm 1.73149 to 1.73405 in.	—

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ENGINE BODY (Continued)

Item			Factory Specification	Allowable Limit
Balancer Shaft Journal 2 to Balancer Shaft Bearing 2 (Balancer Model Only)		Clearance	0.030 to 0.111 mm 0.00118 to 0.00437 in.	0.2 mm 0.0079 in.
	Balancer Shaft Journal 2	O.D.	41.934 to 41.950 mm 1.65094 to 1.65157 in.	—
	Balancer Shaft Bearing 2	I.D.	41.980 to 42.045 mm 1.65275 to 1.65531 in.	—
Balancer Shaft Journal 3 to Balancer Shaft Bearing 3 (Balancer Model Only)		Clearance	0.020 to 0.094 mm 0.00079 to 0.00370 in.	0.2 mm 0.0079 in.
	Balancer Shaft Journal 3	O.D.	21.947 to 21.960 mm 0.86405 to 0.86456 in.	—
	Balancer Shaft Bearing 3	I.D.	21.980 to 22.041 mm 0.86535 to 0.86775 in.	—
Piston Pin Bore		I.D.	25.000 to 25.013 mm 0.98425 to 0.98476 in.	25.05 mm 0.9862 in.
Top Ring to Ring Groove	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	Clearance	0.050 to 0.090 mm 0.0020 to 0.0035 in.	0.2 mm 0.0079 in.
Second Ring to Ring Groove	D1503-M-DI D1503-M-DI-T	Clearance	0.093 to 0.128 mm 0.0037 to 0.0050 in.	0.2 mm 0.0079 in.
	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI		0.050 to 0.090 mm 0.0020 to 0.0035 in.	0.2 mm 0.0079 in.
Oil Ring to Ring Groove	D1503-M-DI D1503-M-DI-T	Clearance	0.020 to 0.060 mm 0.0008 to 0.0021 in.	0.15 mm 0.0059 in.
	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI		0.030 to 0.070 mm 0.0012 to 0.0028 in.	0.15 mm 0.0059 in.
Top Ring		Ring Gap	0.20 to 0.35 mm 0.0079 to 0.0138 in.	1.25 mm 0.0492 in.
Second Ring	D1503-M-DI	Ring Gap	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
	D1503-M-DI-T		0.40 to 0.55 mm 0.0157 to 0.0217 in.	1.25 mm 0.0492 in.
	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI		0.35 to 0.50 mm 0.0138 to 0.0197 in.	1.25 mm 0.0492 in.

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ENGINE BODY (Continued)

Item			Factory Specification	Allowable Limit
Oil Ring	D1503-M-DI D1503-M-DI-T	Ring Gap	0.25 to 0.45 mm 0.0098 to 0.0177 in.	1.25 mm 0.0492 in.
	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI		0.20 to 0.40 mm 0.0079 to 0.0157 in.	1.25 mm 0.0492 in.
Connecting Rod		Alignment	—	0.05 mm 0.0020 in.
Piston Pin to Small End Bushing		Clearance	0.014 to 0.038 mm 0.00055 to 0.00150 in.	0.15 mm 0.0059 in.
Piston Pin		O.D.	25.002 to 25.011 mm 0.98433 to 0.98468 in.	—
Small End Bushing		I.D.	25.025 to 25.040 mm 0.98523 to 0.98582 in.	—
Crankshaft		Alignment	—	0.02 mm 0.00079 in.
Crankshaft Journal to Crankshaft Bearing 1 (Serial No. : below 3R9999)	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI D1803-M-DI V2403-M-DI D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI D1803-M-DI V2403-M-DI	Oil Clearance	0.040 to 0.118 mm 0.00157 to 0.00465 in.	0.2 mm 0.0079 in.
Crankshaft Journal		O.D.	51.921 to 51.940 mm 2.04413 to 2.04488 in.	—
			59.921 to 59.940 mm 2.35909 to 2.35984 in.	—
Crankshaft Bearing 1		I.D.	51.980 to 52.039 mm 2.04646 to 2.04878 in.	—
			59.980 to 60.039 mm 2.36142 to 2.36374 in.	—
Crankshaft Journal to Crankshaft Bearing 1 (Serial No. : above 3S0001)		Oil Clearance	0.040 to 0.118 mm 0.00157 to 0.00465 in.	0.2 mm 0.0079 in.
Crankshaft Journal		O.D.	59.921 to 59.940 mm 2.35909 to 2.35984 in.	—
Crankshaft Bearing 1		I.D.	59.980 to 60.039 mm 2.36142 to 2.36374 in.	—

W1029676

ENGINE BODY (Continued)

Item			Factory Specification	Allowable Limit
Crankshaft Journal to Crankshaft Bearing 2 (Serial No. : below 3R9999)	Crankshaft Journal	Oil Clearance	0.040 to 0.104 mm 0.00157 to 0.00409 in.	0.2 mm 0.0079 in.
		O.D.	51.921 to 51.940 mm 2.04413 to 2.04488 in.	—
	Crankshaft Bearing 2	O.D.	59.921 to 59.940 mm 2.35909 to 2.35984 in.	—
		I.D.	51.980 to 52.025 mm 2.04646 to 2.04823 in.	—
Crankshaft Journal to Crankshaft Bearing 2 (Serial No. : above 3S0001)	Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.35909 to 2.35984 in.	—
		I.D.	59.980 to 60.025 mm 2.36142 to 2.36318 in.	—
	Crankshaft Bearing 2	I.D.	59.980 to 60.025 mm 2.36142 to 2.36318 in.	—
Crankpin to Crankpin Bearing		Oil Clearance	0.025 to 0.087 mm 0.00098 to 0.00343 in.	0.2 mm 0.0079 in.
Crankpin		O.D.	46.959 to 46.975 mm 1.84878 to 1.84941 in.	—
Crankpin Bearing		I.D.	47.000 to 47.046 mm 1.85039 to 1.85220 in.	—
Crankshaft (Serial No. : below 3R9999)	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	Side Clearance	0.15 to 0.35 mm 0.0059 to 0.0138 in.	0.5 mm 0.0197 in.
	D1803-M-DI V2403-M-DI		0.15 to 0.31 mm 0.0059 to 0.0122 in.	0.5 mm 0.0197 in.
Crankshaft (Serial No. : above 3S0001)		Side Clearance	0.15 to 0.31 mm 0.0059 to 0.0122 in.	0.5 mm 0.0197 in.
Crankshaft Sleeve		Wear	—	0.1 mm 0.0039 in.

W1013874

ENGINE BODY (Continued)

Item			Factory Specification	Allowable Limit
Cylinder Bore [Standard]	D1503-M-DI D1503-M-DI-T	I.D.	83.000 to 83.022 mm 3.26772 to 3.26858 in.	83.150 mm 3.2736 in.
	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI		87.000 to 87.022 mm 3.42519 to 3.42606 in.	87.150 mm 3.4311 in.
[Oversize]	D1503-M-DI D1503-M-DI-T	I.D.	83.250 to 83.272 mm 3.27756 to 3.27843 in.	83.400 mm 3.2835 in.
	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI		87.250 to 87.272 mm 3.43503 to 3.43590 in.	87.400 mm 3.4409 in.

W1198742

LUBRICATING SYSTEM

Engine Oil Pressure	At Idle Speed	—	49 kPa 0.5 kgf/cm ² 7 psi
	At Rated Speed	294 to 441 kPa 3.0 to 4.5 kgf/cm ² 42.7 to 64.0 psi	245 kPa 2.5 kgf/cm ² 35.6 psi
Engine Oil Pressure Switch	Working Pressure	49 kPa 0.5 kgf/cm ² 7 psi	—
Inner Rotor to Outer Rotor	Clearance	0.03 to 0.14 mm 0.0012 to 0.0055 in.	0.2 mm 0.0079 in.
Outer Rotor to Pump Body	Clearance	0.11 to 0.19 mm 0.0043 to 0.0075 in.	0.25 mm 0.0098 in.
Inner Rotor to Cover	Clearance	0.105 to 0.150 mm 0.00413 to 0.00591 in.	0.2 mm 0.0079 in.

W1013973

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 lbs) of force	—
Thermostat	Valve Opening Temperature (At Beginning)	69.5 to 72.5 °C 157.1 to 162.5 °F	—
	Valve Opening Temperature (Opened Completely)	85 °C 185 °F	—
Radiator	Water Tightness	No leaks at 137 kPa 1.4 kgf/cm ² 20 psi	—
Radiator Cap	Pressure Falling Time	10 seconds or more for pressure falling from 88 to 59 kPa from 0.9 to 0.6 kgf/cm ² from 13 to 9 psi	—

W1013874

FUEL SYSTEM

Injection Pump	D1503-M-DI D1503-M-DI-T	Injection Timing	0.18 to 0.22 rad (10.5 to 12.5 °) before T.D.C.	—
	D1703-M-DI D1803-M-DI		0.16 to 0.19 rad (9.0 to 11.0 °) before T.D.C.	
	V2203-M-DI V2403-M-DI		0.17 to 0.21 rad (10.0 to 12.0 °) before T.D.C.	
Injection Nozzle		Injection Pressure 1st. stage	18.6 to 20.1 MPa 190 to 205 kgf/cm ² 2702 to 2916 psi	—
Injection Nozzle Valve Seat		Valve Seat Tightness	When the pressure is 16.67 MPa (170 kgf/cm ² , 2418 psi), the valve seat must be fuel tightness.	—

W1013973

ELECTRICAL SYSTEM

Item			Factory Specification	Allowable Limit
Starter	Commutator	O.D.	30.0 mm 1.181 in.	29.0 mm 1.142 in.
	V2403-M-DI		35.0 mm 1.378 in.	34.0 mm 1.339 in.
	Mica	Under Cut	0.50 to 0.80 mm 0.0197 to 0.0315 in.	0.20 mm 0.0079 in.
	V2403-M-DI		0.50 to 0.90 mm 0.0197 to 0.0354 in.	0.20 mm 0.0079 in.
	Brush	Length	15.0 mm 0.591 in.	11.0 mm 0.433 in.
	Brush Holder and Holder Support	Resistance	Infinity	—
Alternator	Stator	No-load voltage	More than 13.5 V	—
			Continuity	—
	Rotor	Resistance	2.9 Ω	—
			2.1 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 0.331 in.
Glow Plug		Resistance	Approx. 1.0 Ω	—
Stop Solenoid Pulling Coil		Resistance	Approx. 0.38 Ω	—
Holding Coil		Resistance	Approx. 15.58 Ω	—

W1075692

[6] MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

Item		Service Interval										
		50 hrs	100 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
Checking fuel pipes and clamp bands		☆										
* Changing Engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm 3.54 in.)	★		☆								
	(2) Oil pan depth (124 mm 4.88 in.)	★			☆							
Cleaning air cleaner element			☆									
Cleaning fuel filter (Normal type)			☆									
Checking battery electrolyte level			☆									
Check fan belt tension and damage			☆									
Checking radiator hoses and clamp bands				☆								
* Replacing oil filter cartridge	(1) Oil pandepth (90 mm 3.54 in.)	★		☆								
	(2) Oil pandepth (124 mm 4.88 in.)	★			☆							
Checking intake air line				☆								
Replacing fuel filter cartridge					☆							
Cleaning fuel tank inside						☆						
Cleaning water jacket and radiator interior						☆						
Replacing fan belt						☆						
Recharging battery							☆					
Replacing air cleaner element								☆				
Checking valve clearance									☆			
**Checking injection nozzle condition										☆		
Checking turbocharger											☆	
Replacing intake air line												☆
Replacing battery												☆
Replacing radiator hoses and clamp bands												☆
Replacing fuel pipes and clamp bands												☆
Changing radiator coolant (L.L.C.)												☆

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

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

W1029462

**CAUTION**

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

NOTE**Lubricating Oil**

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

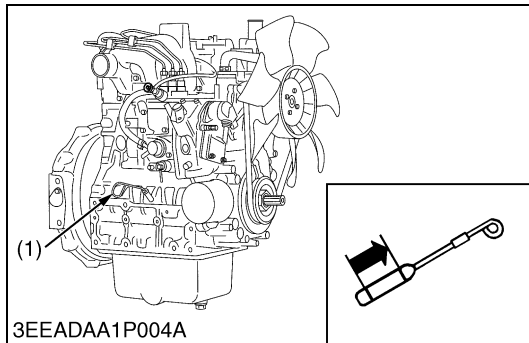
Lubricating oil class	Fuel		Remarks
	Low sulfur (0.5 % $\geq$)	High sulfur	
CF	○	○	TBN $\geq$ 10
CF-4	○	X	
CG-4	○	X	

○ : Recommendable X : Not recommendable

W1035555

[7] CHECK AND MAINTENANCE

(1) Daily Check Points



Checking Engine Oil Level

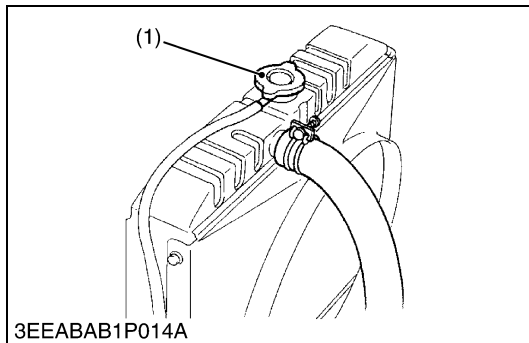
1. Level the engine.
2. To check the oil level, draw out the dipstick (1), wipe it clean, reinsert it, and draw it out again.
Check to see that the oil level lies between the two notches.
3. If the level is too low, add new oil to the specified level.

■ IMPORTANT

- When using an oil of different maker or viscosity from the previous one, drain old oil. Never mix two different types of oil.

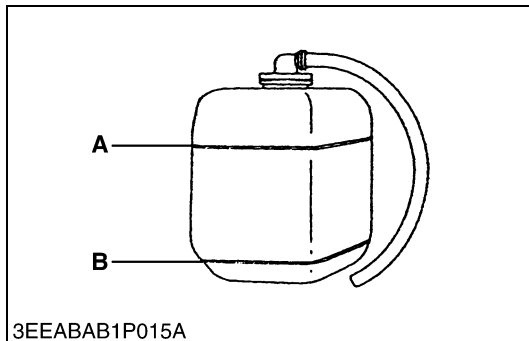
(1) Dipstick

W1035676



Checking and Replenish Coolant

1. Without recovery tank ;
Remove the radiator cap (1) and check to see that the coolant level is just below the port.
With recovery tank :
Check to see that the coolant level lies between **FULL A** and **LOW B**.
2. If coolant level is too low, check the reason for decreasing coolant.
Case 1) If coolant is decreasing by evaporation, replenish only fresh, soft water.
Case 2) If coolant is decreasing by leak, replenish coolant of the same manufacture and type in the specified mixture ratio (fresh, soft water and L.L.C.).
If the coolant brand cannot be identified, drain out all of the remaining coolant and refill with a totally new brand of coolant mix. (See page S-26, 27.)



CAUTION

- Do not remove the radiator cap until coolant temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.
- **IMPORTANT**
- During filling the coolant, air must be vented from the engine coolant passages. The air vents by jiggling the radiator upper and lower hoses.
- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and the engine could overheat.
- Do not use an antifreeze and scale inhibitor at the same time.
- Never mix the different type or brand of L.L.C..

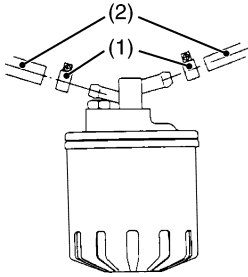
(1) Radiator Cap

A: FULL
B: LOW

W1035779

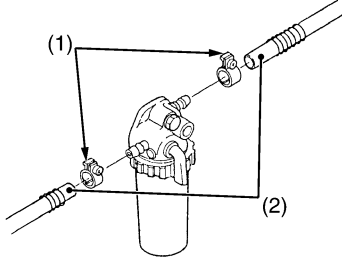
(2) Check Points of Every 50 Hours

[A]



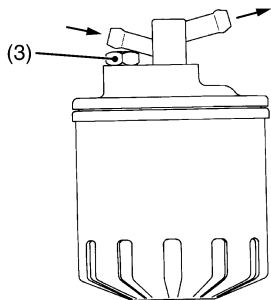
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[B]



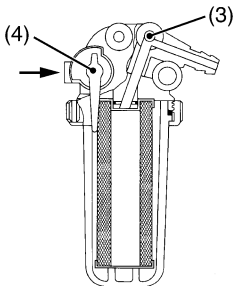
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[A]



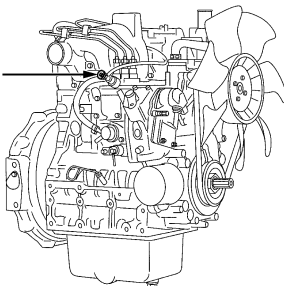
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[B]



3EEACAA1P060A

(5)



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Checking Fuel Pipe

1. If the clamp (1) is loose, apply oil to the threads and securely retighten it.
2. The fuel pipe (2) is made of rubber and ages regardless of the period service.
Change the fuel pipe together with the clamp every two years.
3. However, if the fuel pipe and clamp are found to be damaged or deteriorate earlier than two years, then change or remedy.
4. After the fuel pipe and the clamp have been changed, bleed the fuel system.



CAUTION

- Stop the engine when attempting the check and change prescribed above.

- (1) Clamp
(2) Fuel Pipe

[A] Cartridge Type

[B] Normal Type

W1035921

(When bleeding fuel system)

1. Fill the tank with fuel and open the fuel cock (4). ([B] only)
2. Loosen the air vent plug (3) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent cock (5) on top of the fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key to AC position and pump the fuel up for 10 to 15 seconds.
If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent cock after air bleeding.

NOTE

- Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.

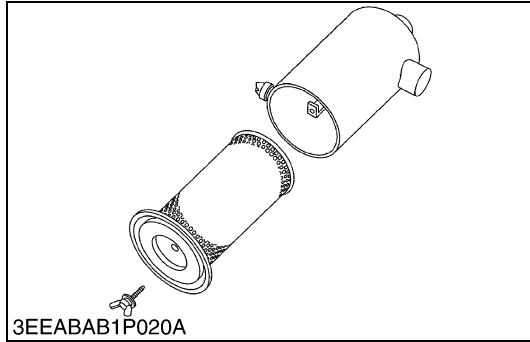
- (3) Air Vent Plug
(4) Fuel Cock
(5) Air Vent Cock

[A] Cartridge Type

[B] Normal Type

W1188557

(3) Check Points of Every 100 Hours



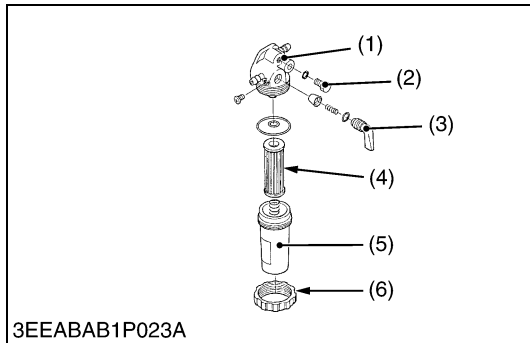
Cleaning Air Cleaner Element

1. Remove the air cleaner element.
2. Use clean dry compressed air on the inside of the element. Pressure of compressed air must be under 205 kPa (2.1 kgf/cm², 30 psi). Maintain reasonable distance between the nozzle and the filter.

■ NOTE

- The air cleaner uses a dry element. Never apply oil to it.
- Be sure to refit the dust cup with arrow ↑ (on the rear) upright. If the dust cup is improperly fitted, dust passes by the dust cup and directly adheres to the element.
- Do not run the engine with filter element removed.
- Change the element once a year or every 6th cleaning.

W1045746



Cleaning Fuel Filter (Normal Type only)

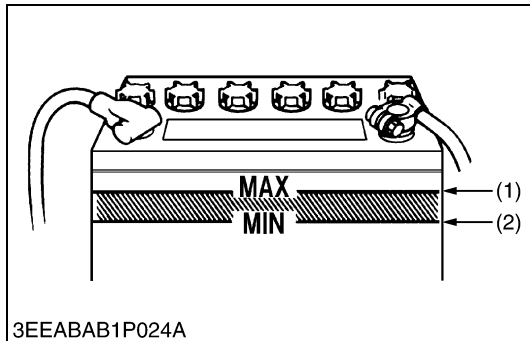
1. Close the fuel cock (3).
2. Unscrew the retaining ring (6) and remove the cup (5), and rinse the inside with kerosene.
3. Take out the element (4) and dip it in the kerosene to rinse.
4. After cleaning, reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

■ IMPORTANT

- If dust and dirt enter the fuel, the fuel injection pump and injection nozzle will wear quickly. To prevent this, be sure to clean the fuel filter cup (5) periodically.

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

W1046058

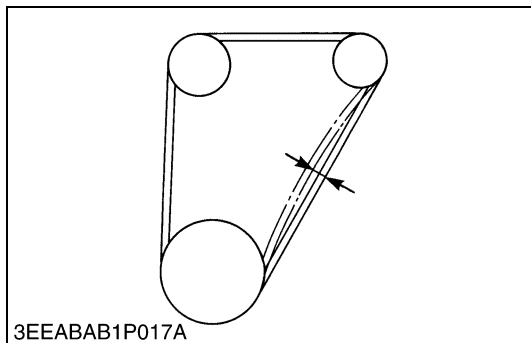


Checking Battery Electrolyte Level

1. Check the battery electrolyte level.
2. If the level is below than lower level line (2), and the distilled water to pour level of each cell.

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

W1047154



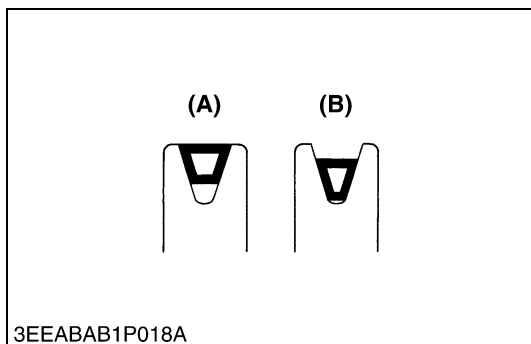
Checking Fan Belt Tension

1. Press the fan belt between fan pulley and pulley at force of 98 N (10 kgf, 22 lbs).
Check if the fan belt deflection is 7 to 9 mm (0.28 to 0.35 in.).
2. If the deflection is not within the factory specifications, adjust with the tension pulley adjusting bolts.

(A) Good

(B) Bad

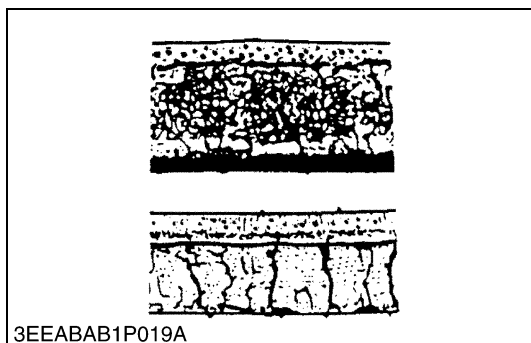
W1057138



Checking Fan Belt Damage

1. Check the fan belt for damage.
2. Check if the fan belt is worn and sunk in the pulley groove.
3. Replace the fan belt if the belt is damaged or nearly worn out and deeply sunk in the pulley groove.

W1057475



(4) Check Point of Every 200 Hours

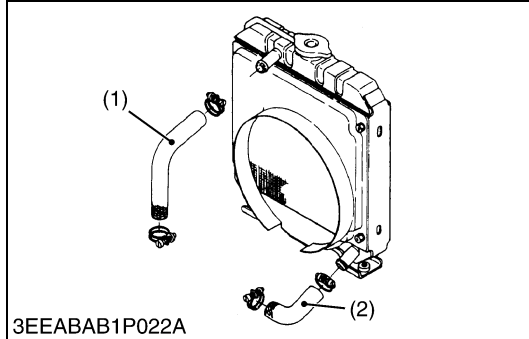
Changing Engine Oil (For 90 mm (3.54 in.) depth oil pan)

See page S-24.

Replacing Oil Filter Cartridge (For 90 mm (3.54 in.) depth oil pan)

See page S-25.

W1036826



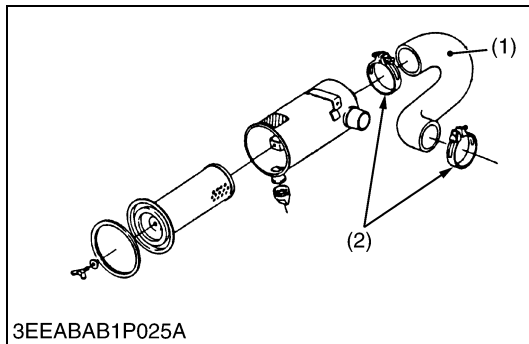
Checking Radiator Hoses

1. Check to see if the radiator hoses are properly fixed every 200 hours of operation or every six months, whichever comes first.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The water pipe is made of rubber and tends to age. It must be changed every two years. Also change the clamp and tighten it securely.

(1) Upper Hose

(2) Lower Hose

W1050147



Checking Intake Air Line

1. Check to see if the intake air hose(s) (1) are properly fixed every 200 hours of operation.
2. If the clamp (2) is loose, apply oil to the threads and retighten it securely.
3. The intake air hose(s) (1) is made of rubber and tends to age. It must be changed every two years. Also change the clamp (2) and tighten it securely.

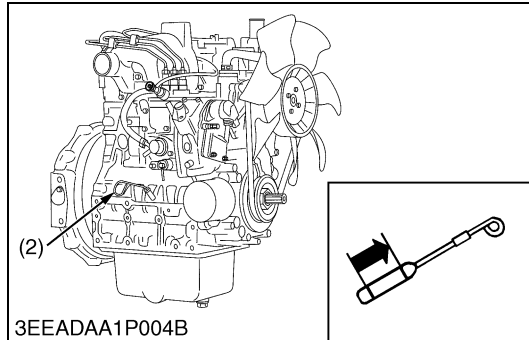
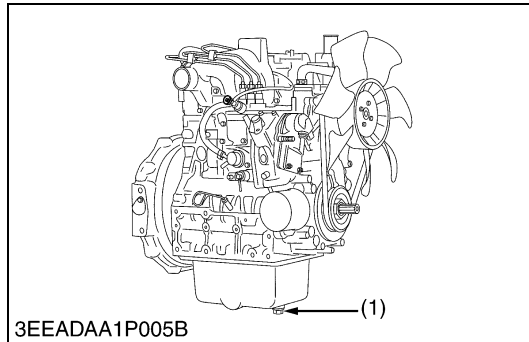
■ IMPORTANT

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

(1) Intake Air Hose

(2) Clamp

W1050335

(5) Check Points of Every 400 Hours**Changing Engine Oil (For 124 mm (4.88 in.) depth oil pan)****CAUTION**

- **Be sure to stop the engine before changing the engine oil.**
1. After warming up, stop the engine.
 2. Place an oil pan underneath the engine.
 3. Remove the drain plug (1) to drain the dirty engine oil completely.
 4. Inspect the drain plug gasket. Replace it damaged.
 5. Reinstall the drain plug.
 6. Fill the new engine oil up to the upper mark on the dipstick (2).

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
D1503-M-DI D1503-M-DI-T D1703-M-DI D1803-M-DI	7.0 L 1.85 U.S.gal. 1.54 Imp.gal.	5.6 L 1.48 U.S.gal. 1.23 Imp.gal.
V2203-M-DI V2403-M-DI	9.5 L 2.51 U.S.gal. 2.09 Imp.gal.	7.6 L 2.01 U.S.gal. 1.672 Imp.gal.

*90 mm (3.54 in.) oil pan depth is optional.

IMPORTANT

- **When using an oil of difference maker or viscosity from the previous one, drain an old oil completely.**
- **Never mix two different types of oil.**
- **Engine oil should be MIL-L-46152 / MIL-L-2104C or have properties of API classification CD / CE / CF / CF-4 / CG-4.**
- **Use the proper SAE Engine oil according to ambient temperature.**
 Above 25 °C (77 °F).....SAE 30 or 10W-30
 0 °C to 25 °C (32 °F to 77 °F)....SAE 20 or 10W-30
 Below 0 °C (32 °F).....SAE 10W or 10W-30

NOTE**Lubricating Oil**

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CD, CE or CF lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

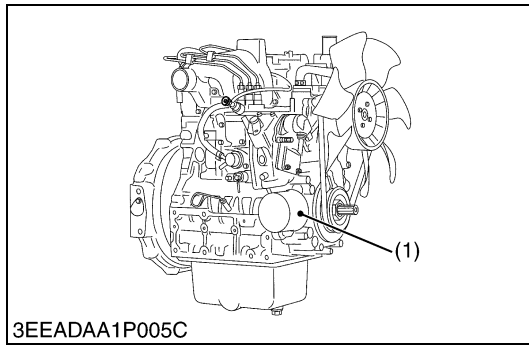
Lubricating oil class \ Fuel	Fuel		Remarks
	Low sulfur (0.5 % ≤)	High sulfur	
CF	○	○	TBN ≥ 10
CF-4	○	X	
CG-4	○	X	

○ : Recommendable X : Not recommendable

(1) Drain Plug

(2) Dipstick

W1056838



Replacing Oil Filter Cartridge (For 124 mm (4.88 in.) depth oil pan)

⚠ CAUTION

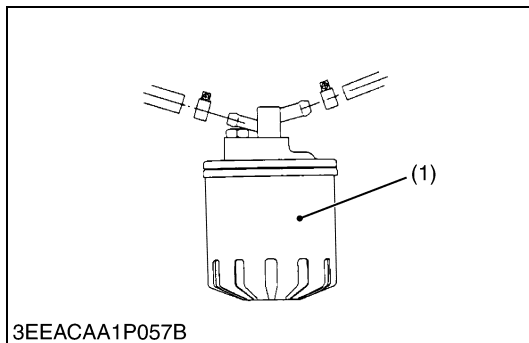
- **Be sure to stop the engine before changing the engine oil filter cartridge (1).**
1. Remove the engine oil filter cartridge (1) with the filter wrench.
 2. Apply engine oil slightly to the rubber gasket of new cartridge.
 3. Install the new cartridge, screwing it in by hand.
 4. After the cartridge has been changed, the engine oil level normally lowers a little. Add engine oil to proper level.

■ IMPORTANT

- **To prevent serious damage to the engine, replacement engine oil filter cartridge (1) must be highly efficient. Use only a genuine KUBOTA filter cartridge or its equivalent.**

(1) Engine Oil Filter Cartridge

W1037215



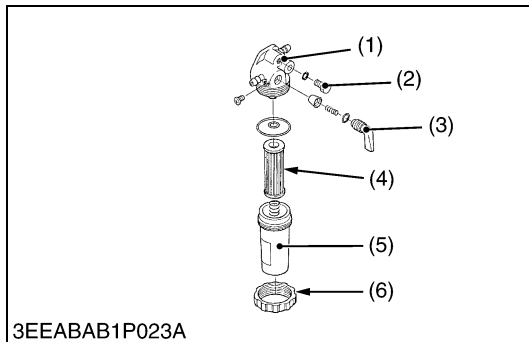
Replacing Fuel Filter Cartridge (Cartridge Type)

Water and dust in fuel are collected in the filter cartridge (1). So, change the filter cartridge (1) every 400 hours service.

1. Remove the used filter cartridge (1) with filter wrench.
2. Apply a thin film of fuel to the surface of new filter cartridge gasket before screwing on.
3. Then tighten enough by hand.
4. Loosen the air vent plug to let the air out.
5. Start engine and check for fuel leakage.

(1) Fuel Filter Cartridge

W1050548



Replacing Fuel Filter Element (Normal Type)

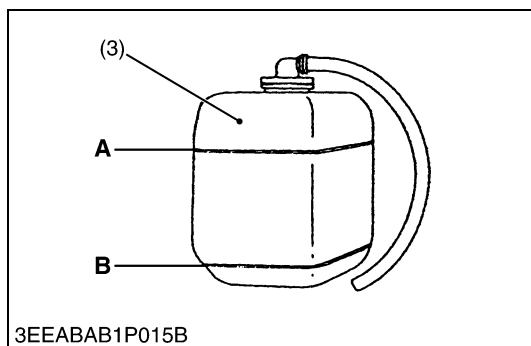
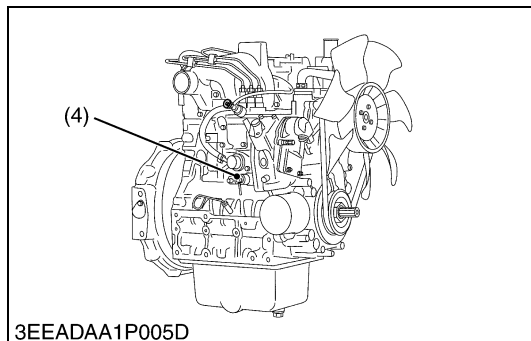
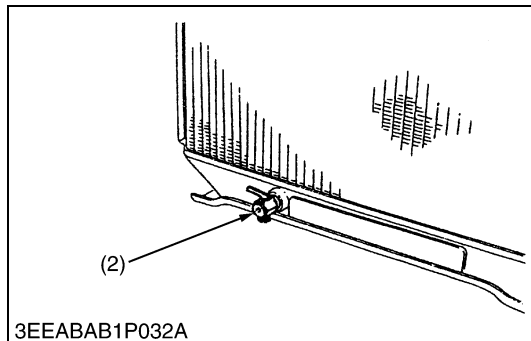
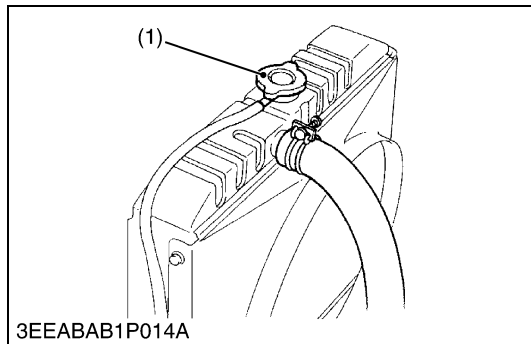
1. Close the fuel cock (3).
2. Unscrew the retaining ring (6) and remove the filter cup (5), and rinse the inside with kerosene.
3. Replace the filter element (4).
4. Reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

(1) Cock Body
(2) Air Vent Plug
(3) Fuel Cock

(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

W1220708

(6) Check Points of 500 Hours



Cleaning Fuel Tank Inside

W1051414

Cleaning Water Jacket and Radiator Interior



CAUTION

- **Do not remove the radiator cap (1) when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**
1. Stop the engine and let cool down.
 2. To drain the coolant, open the radiator drain plug (2) and remove the radiator cap (1). Then radiator cap (1) must be removed to completely drain the coolant
 3. After all coolant is drained, close the drain plug (2).
 4. Fill with clean water and cooling system cleaner.
 5. Follow directions of the cleaner instruction.
 6. After flushing, fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap (1) securely.
 7. Fill with coolant up to "FULL" mark on the recovery tank (3).
 8. Start and operate the engine for few minutes.
 9. Stop the engine and let cool. Check coolant level of recovery tank (3) and add coolant if necessary.

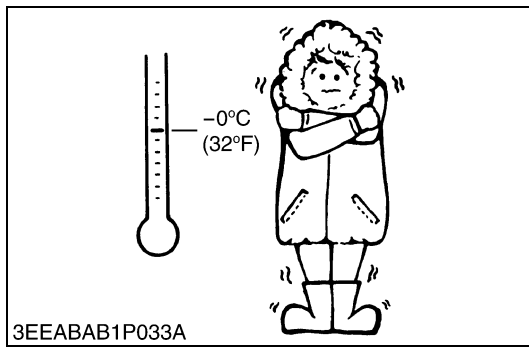
■ IMPORTANT

- **Do not start engine without coolant.**
- **Use clean, fresh, soft water and anti-freeze to fill the radiator and recovery tank (3).**
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**
- **Securely tighten radiator cap (1). If the cap is loose or improperly fitted, water may leak out and the engine could overheat.**

- (1) Radiator Cap
 (2) Drain Plug
 (3) Recovery Tank
 (4) Drain Cock

A : Full
 B : Low

W1038102



Anti-Freeze

- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Before adding anti-freeze for the first time, clean the radiator interior by pouring fresh, soft water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Basically, it should be referred to SAE J1034 standard, more specifically also to SAE J814c.
- Mix the anti-freeze with fresh, soft water, and then fill into the radiator.

■ IMPORTANT

- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**

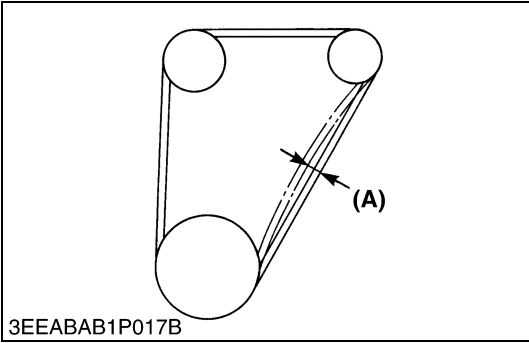
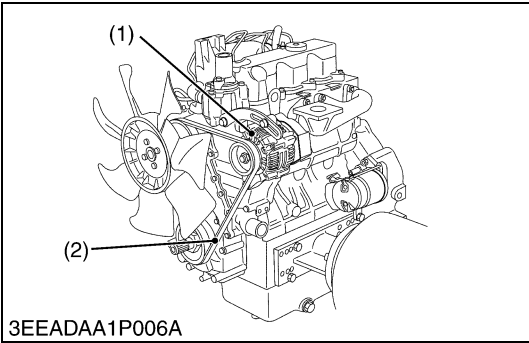
Vol % anti-freeze	Freezing point		Boiling point	
	°C	°F	°C	°F
40	-24	-12	106	222
50	-37	-34	108	226

* At $1.013 \times 10^5 \text{ Pa}$ (1.033 kgf/cm^2) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

■ NOTE

- The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.
- When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and fresh, soft water in the specified mixing ratio.
- Anti-freeze absorbs moisture. Keep unused anti-freeze in a tightly sealed container.
- Do not use radiator cleaning agents when anti-freeze has been added to the coolant.
(Anti-freeze contains an anti-corrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine parts.)

W1039218



Replacing Fan Belt

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

Deflection (A)	Factory spec.	7.0 to 9.0 mm / 98 N or 10 kgf 0.28 to 0.35 in. / 98 N or 22 lbs.
----------------	---------------	--

- (1) Alternator
- (2) Fan Belt

(A) Deflection

W1052220

(7) Check Points of Every 1 or 2 Months

Recharging



CAUTION

- When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.
- When charging battery, remove battery vent plugs.
- When disconnecting the cable from the battery, start with the negative terminal first. When connecting the cable to the battery, start with the positive terminal first.
- Never check battery charge by placing a metal object across the posts.

Use a voltmeter or hydrometer.

1) Slow Charging

1. Add distilled water if the electrolyte level is low. When charging, the amount of electrolyte should be slightly lower than the specified level to prevent overflow.
2. Connect the battery to the charging unit, following the manufacture's instructions.
3. As the electrolyte generates gas while charging, remove all port caps.
4. The electrolyte temperature must not exceed 40 °C (105 °F) during charging.
If it exceed 40 °C (105 °F), decrease the charging amperage or stop charging for a while.
5. When charging several batteries in series, charging at the rate of the smallest battery in the line.

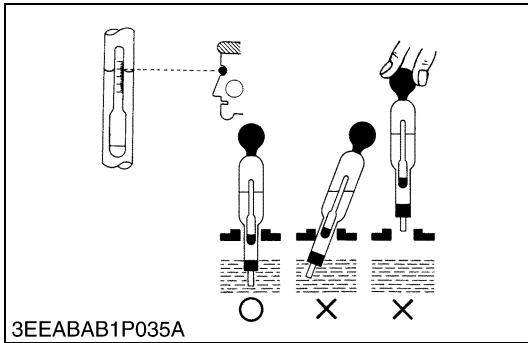
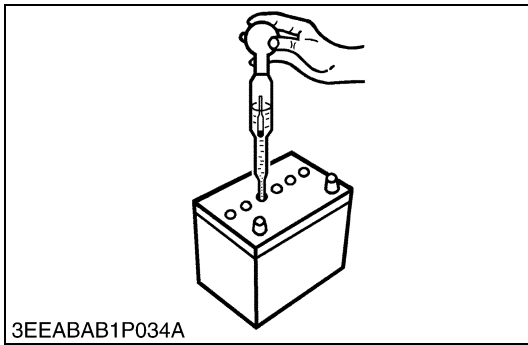
2) Quick Charging

1. Determine the proper charging current and charging time with the tester attached to the quick charger.
2. Determine the proper charging current as 1/1 of the battery capacity. If the battery capacity exceeds 50 Ah, consider 50 A as the maximum.

■ Precaution for Operating a Quick Charger

- Operating with a quick charger differs according to the type.
Consult the instruction manual and use accordingly.

W1052658



Battery Specific Gravity

1. Check the specific gravity of the electrolyte in each cell with a hydrometer.
2. When the electrolyte temperature differs from that at which the hydrometer was calibrated, correct the specific gravity reading following the formula mentioned in (Reference).
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity differs between any two cells by more than 0.05, replace the battery.

NOTE

- Hold the hydrometer tube vertical without removing it from the electrolyte.
- Do not suck too much electrolyte into the tube.
- Allow the float to move freely and hold the hydrometer at eye level.
- The hydrometer reading must be taken at the highest electrolyte level.

(Reference)

- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 °C (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 °C (0.0004 with a decrease of 1 °F).

Therefore, using 20 °C (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :

- Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature : 20 °C)
- Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature : 68 °F)

Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

W1012763

Directions for Storage

1. When shutting down the tractor for long periods of time, remove the battery from the tractor, adjust the electrolyte to the proper level, and after fully charging, store the battery in a well ventilated placed where it is not exposed to direct sunlight.
2. Since the battery self-discharges by approx. 0.5 % per day even in storage, it must be once every two months in cold season.
3. When storing the battery mounted on the tractor, disconnect the ground cable from the battery's negative terminal post.

Self-discharge Rate

Temperature	Self-discharge rate
30 °C (86 °F)	Approx. 1.0 % per day
20 °C (68 °F)	Approx. 0.5 % per day
10 °C (50 °F)	Approx. 0.25 % per day

W1053636

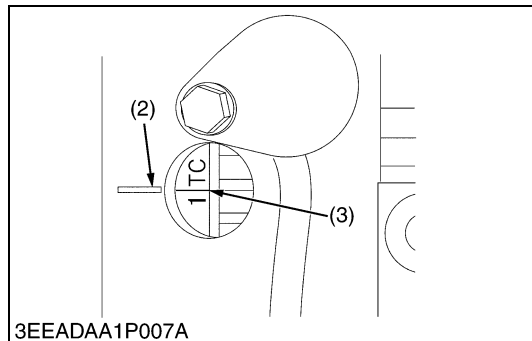
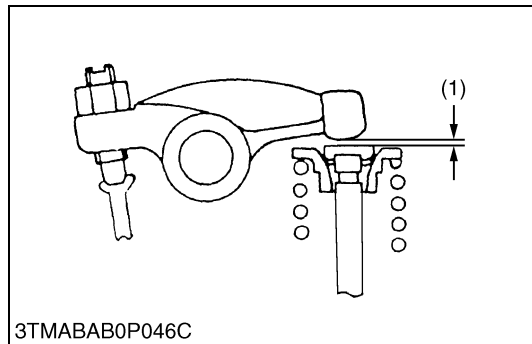
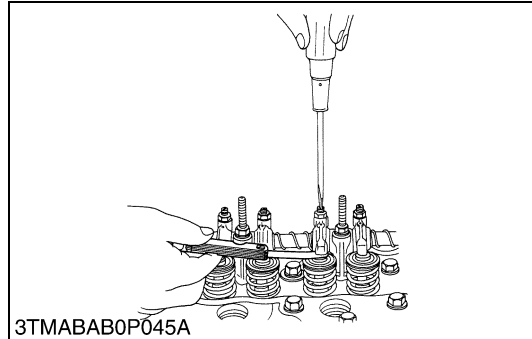
(8) Check Point of Every Year

Replacing Air Cleaner Element

See page S-21.

W1054408

(9) Check Point of Every 800 Hours



Valve Clearance

■ IMPORTANT

- Valve clearance must be checked and adjusted when engine is cold.
- Remove the head cover.
 - Align the "1TC" mark line (3) on the flywheel and projection (2) on the housing so that the No. 1 piston comes to the compression or overlap top dead center.
 - Check the following valve clearance (1) marked with "☆" using a feeler gauge.
 - If the clearance is not within the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory spec.	0.18 to 0.22 mm 0.0071 to 0.0086 in.
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■ NOTE

- The "TC" marking line on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.
- No. 1 piston comes to the top dead center position when the "TC" marking is aligned with the projection (2) in the window on flywheel-housing. Turn the flywheel 0.26 rad (15°) clockwise and counterclockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance (1). (The piston is at the top dead center when both the IN. and EX. valves do not move; it is at the overlap position when both the valves move.)
- Finally turn the flywheel 6.28 rad (360°) and align the "TC" marking and the projection (2) perfectly. Adjust all the other valve clearance as required.
- After turning the flywheel counterclockwise twice or three times, recheck the valve clearance (1).
- After adjusting the valve clearance (1), firmly tighten the lock nut of the adjusting screw.

Valve arrangement Adjustable cylinder location of piston		D1503-M-DI D1503-M-DI-T D1703-M-DI D1803-M-DI		V2203-M-DI V2403-M-DI	
		IN.	EX.	IN.	EX.
When No. 1 piston is compression top dead center	No. 1	☆	☆	☆	☆
	No. 2		☆	☆	
	No. 3	☆			☆
	No. 4	—	—		
When No. 1 piston is overlap position	No. 1				
	No. 2	☆			☆
	No. 3		☆	☆	
	No. 4	—	—	☆	☆

(1) Valve Clearance
(2) Projection

(3) TC Mark Line

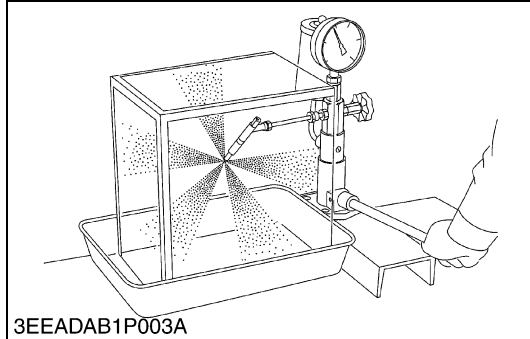
W10113200

(10) Check Points of Every 1500 Hours



CAUTION

- Check the injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.
If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.

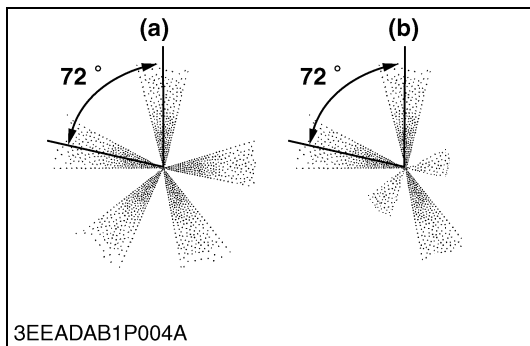


Fuel Injection Pressure

- Set the injection nozzle to a nozzle tester (Code No. 07909-31361).
- Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
- If the measurement is not within the factory specifications, replace the injection nozzle assembly.

Fuel injection pressure 1st. stage	Factory spec.	18.6 to 20.1 MPa 190 to 205 kgf/cm ² 2702 to 2916 psi
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W10408820



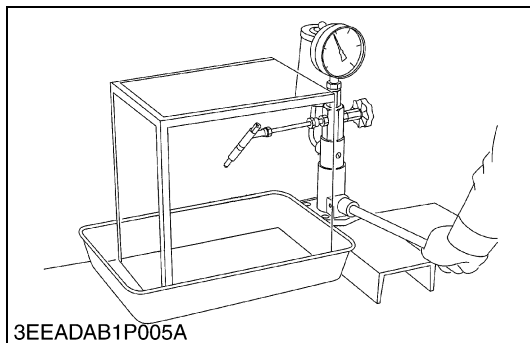
Nozzle Spraying Condition

- Set the injection nozzle to a nozzle tester (Code No. 07909-31361), and check the nozzle spraying condition.
- If the spraying condition is defective, replace the injection nozzle assembly.

(a) Good

(b) Bad

W10411400



Valve Seat Tightness

- Set the injection nozzle to a nozzle tester (Code No. 07909-31361).
- Raise the fuel pressure, and keep at 16.67 MPa (170 kgf/cm², 2418 psi) for 10 seconds.
- If any fuel leak is found, replace the injection nozzle assembly.

Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170 kgf/cm ² 2418 psi
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W10412730

(11) Check Point of Every 3000 Hours**Checking Turbocharger**

See page S-101.

W1056274

(12) Check Points of Every 2 Years**Replacing Intake Air Line**

See page S-23.

W1117974

Replacing Battery

See page S-21, 30.

W1056352

Replacing Radiator Hoses and Clamp Bands

See page S-23.

W1056385

Replacing Fuel Pipes and Clamp Bands

See page S-20.

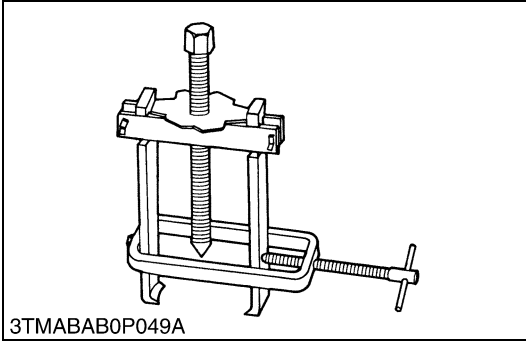
W1056418

Changing Radiator Coolant (L.L.C.)

See page S-26, 27.

W1056536

[8] SPECIAL TOOLS

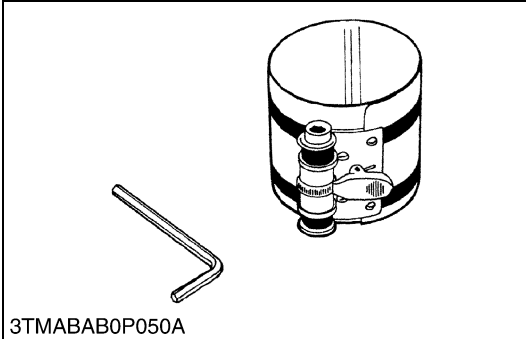


Special Use Puller Set

Code No: 07916-09032

Application: Use exclusively for pulling out bearing, gears and other parts with ease.

W1024050

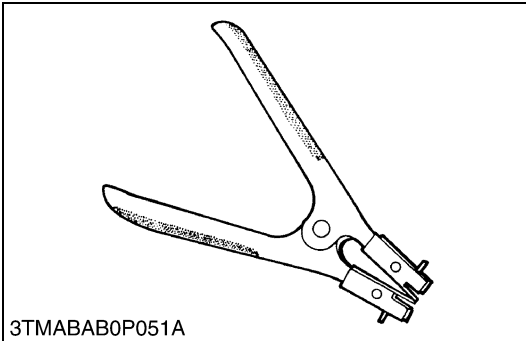


Piston Ring Compressor

Code No: 07909-32111

Application: Use exclusively for pushing in the piston with piston rings into the cylinder.

W1024100

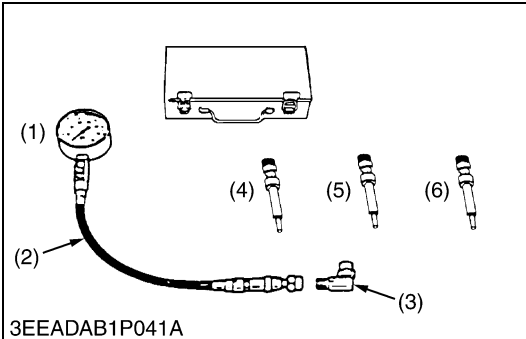


Piston Ring Tool

Code No: 07909-32121

Application: Use exclusively for removing or installing the piston ring with ease.

W1024150



Diesel Engine Compression Tester (for Glow Plug)

Code No: 07909-39081 (Assembly)

07909-31291 (**K**)

07909-31301 (**L**)

07979-31311 (**M**)

Application: Use to measure diesel engine compression and diagnosis of need for major overhaul.

Adaptor: The adaptor **K** is required for V2203-EDI.

(1) Gauge

(2) Hose Assembly

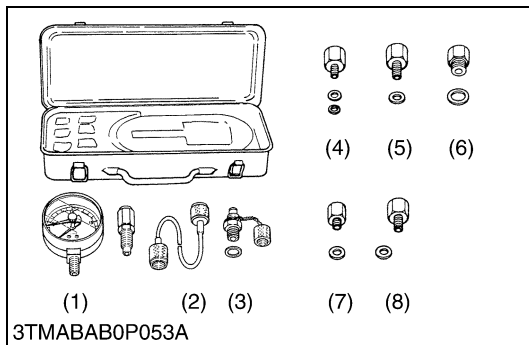
(3) L Joint

(4) Adaptor **K**

(5) Adaptor **L**

(6) Adaptor **M**

W1206183

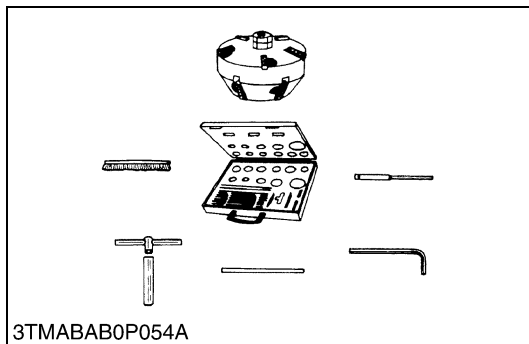
**Oil Pressure Tester**

Code No: 07916-32032

Application: Use to measure lubricating oil pressure.

- | | |
|--------------------|---------------|
| (1) Gauge | (5) Adaptor 2 |
| (2) Cable | (6) Adaptor 3 |
| (3) Threaded Joint | (7) Adaptor 4 |
| (4) Adaptor 1 | (8) Adaptor 5 |

W1024318

**Valve Seat Cutter**

Code No: 07909-33102

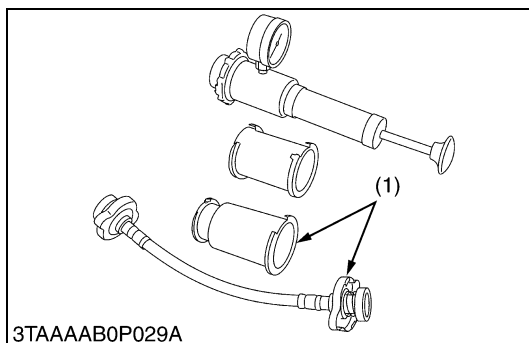
Application: Use to reseal valves.

Angle: 0.785 rad (45°)

0.262 rad (15°)

Diameter:	28.6 mm (1.126 in.)	38.0 mm (1.496 in.)
	31.6 mm (1.244 in.)	41.3 mm (1.626 in.)
	35.0 mm (1.378 in.)	50.8 mm (2.000 in.)

W1024458

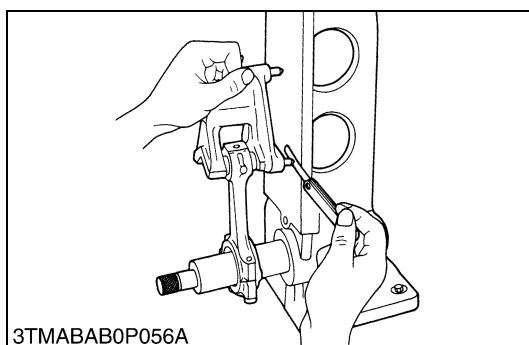
**Radiator Tester**

Code No: 07909-31551

Application: Use to check of radiator cap pressure, and leaks from cooling system.

Remarks: Adapter (1) BANZAI Code No. RCT-2A-30S

W1024532

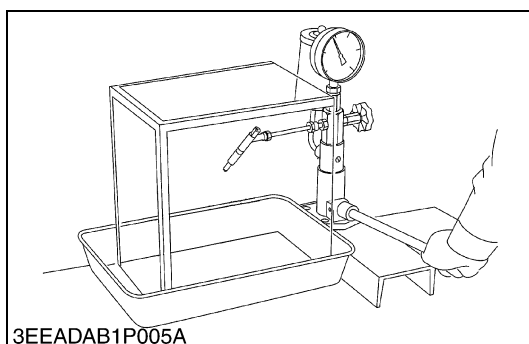
**Connecting Rod Alignment Tool**

Code No: 07909-31661

Application: Use to check the connecting rod alignment.

Applicable: Connecting rod big end I.D.
 range 30 to 75 mm (1.18 to 2.95 in.) dia.
 Connecting rod length
 65 to 300 mm (2.56 to 11.81 in.)

W1024583

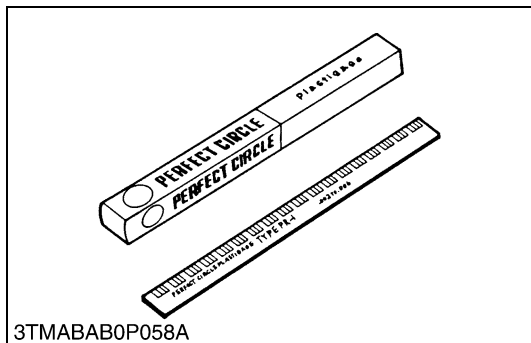
**Nozzle Tester**

Code No: 07909-31361

Application: Use to check the fuel injection pressure and spray pattern of nozzle.

Measuring: 0 to 50 MPa
 range (0 to 500 kgf/cm², 0 to 7000 psi)

W1024653



3TMABAB0P058A

Plastigage

Code No: 07909-30241

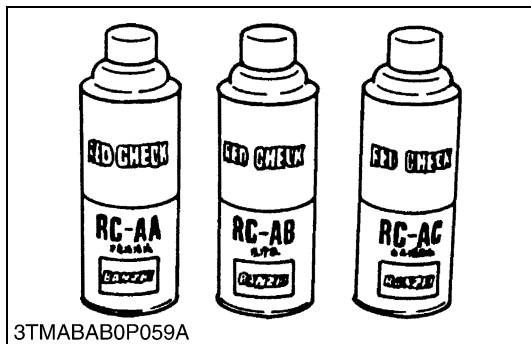
Application: Use to check the oil clearance between crankshaft and bearing, etc.

Measuring: Green 0.025 to 0.076 mm (0.001 to 0.003 in.)

range Red 0.051 to 0.152 mm (0.002 to 0.006 in.)

Blue 0.102 to 0.229 mm (0.004 to 0.009 in.)

W1024719



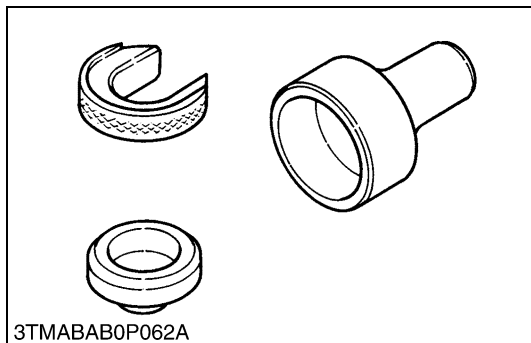
3TMABAB0P059A

Red Check

Code No: 07909-31371

Application: Use to check cracks on cylinder head, cylinder block, etc.

W1024909



3TMABAB0P062A

Auxiliary Socket For Fixing Crankshaft Sleeve

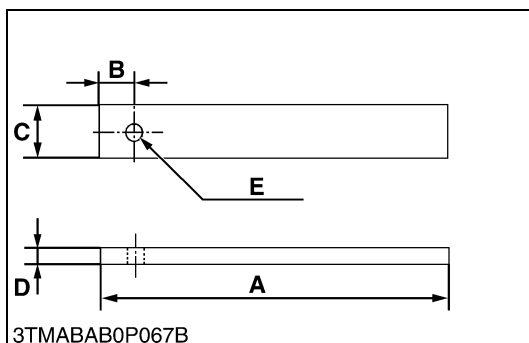
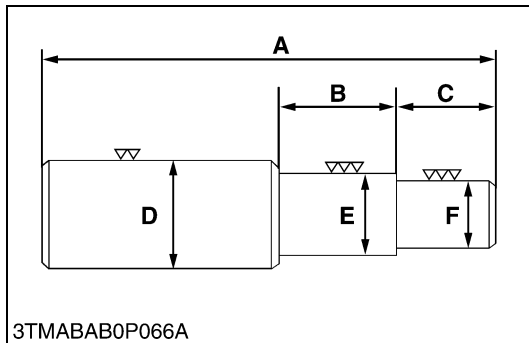
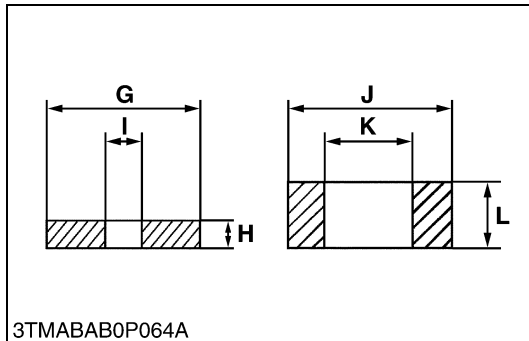
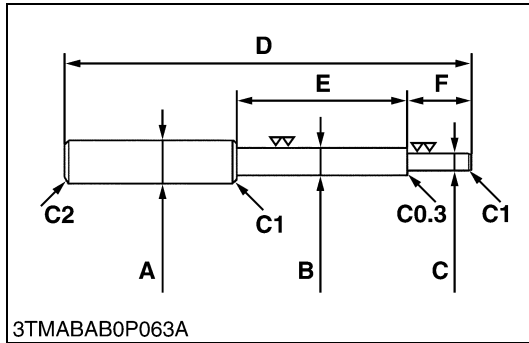
Code No: 07916-32091

Application: Use to fix the crankshaft sleeve of the diesel engine.

W1077114

■ NOTE

- The following special tools are not provided, so make them referring to the figure.



Valve Guide Replacing Tool

Application: Use to press out and press fit the valve guide.

A	20 mm dia. (0.79 in. dia.)
B	11.7 to 11.9 mm dia. (0.460 to 0.468 in. dia.)
C	6.5 to 6.6 mm dia. (0.256 to 0.259 in. dia.)
D	225 mm (8.86 in.)
E	70 mm (2.76 in.)
F	45 mm (1.77 in.)
G	25 mm (0.98 in.)
H	5 mm (0.197 in.)
I	6.7 to 7.0 mm dia. (0.263 to 0.275 in. dia.)
J	20 mm dia. (0.787 in. dia.)
K	12.5 to 12.8 mm dia. (0.492 to 0.504 in. dia.)
L	8.9 to 9.1 mm (0.350 to 358 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.3 mm (0.012 in.)

W1025017

Bushing Replacing Tools

Application: Use to press out and to press fit the bushing.

(1) For small end bushing

A	162 mm (6.38 in.)
B	35 mm (1.38 in.)
C	27 mm (1.06 in.)
D	35 mm dia. (1.38 in. dia.)
E	27.90 to 27.95 mm dia. (1.098 to 1.100 in. dia.)
F	25.00 to 25.01 mm dia. (0.984 to 0.985 in. dia.)

(2) For idle gear bushing

A	175 mm (6.89 in.)
B	40 mm (1.57 in.)
C	38 mm (1.49 in.)
D	45 mm dia. (1.77 in. dia.)
E	41.90 to 41.95 mm dia. (1.650 to 1.652 in. dia.)
F	37.95 to 37.97 mm dia. (1.494 to 1.495 in. dia.)

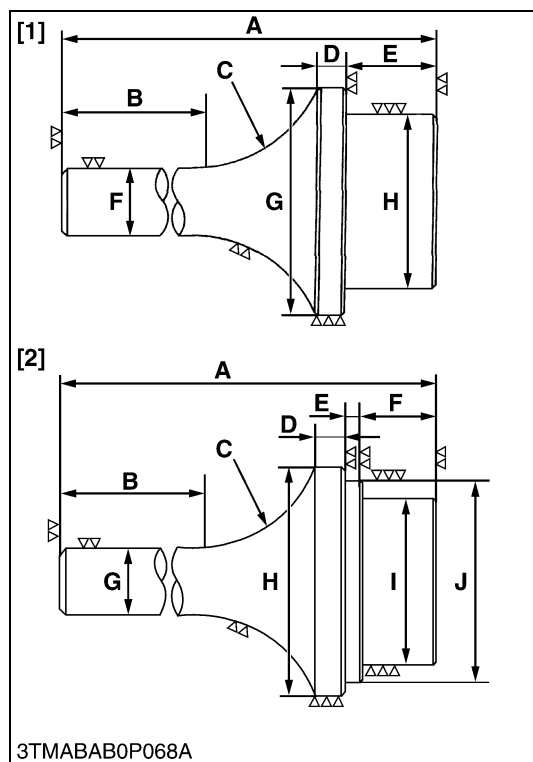
W1025500

Flywheel Stopper

Application: Use to loosen and tighten the flywheel screw.

A	200 mm (7.87 in.)
B	20 mm (0.79 in.)
C	30 mm (1.18 in.)
D	8 mm (0.31 in.)
E	10 mm dia. (0.39 in. dia.)

W1025948



Crankshaft Bearing 1 Replacing Tool

Application: Use to press out and press fit the crankshaft bearing 1.

1. Extracting tool

(D1503, D1703, V2203 : Serial No. : below 3R9999)

A	135 mm (5.31 in.)
B	72 mm (2.83 in.)
C	R40 mm (R1.57 in.)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	56.8 to 56.9 mm dia. (2.236 to 2.240 in. dia.)
H	51.8 to 51.9 mm dia. (2.039 to 2.043 in. dia.)

2. Inserting tool

(D1503, D1703, V2203 : Serial No. : below 3R9999)

A	130 mm (5.12 in.)
B	72 mm (2.83 in.)
C	R40 mm (R1.57 in.)
D	9 mm (0.35 in.)
E	4 mm (0.16 in.)
F	20 mm (0.79 in.)
G	20 mm dia. (0.79 in. dia.)
H	68 mm dia. (2.68 in. dia.)
I	51.8 to 51.9 mm dia. (2.039 to 2.043 in. dia.)
J	56.8 to 56.9 mm dia. (2.236 to 2.240 in. dia.)

1. Extracting tool (D1803, V2403 : Serial No. : below 3R9999)

(Serial No. : above 3S0001)

A	135 mm (5.31 in.)
B	72 mm (2.83 in.)
C	R40 mm (R1.57 in.)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	64.8 to 64.9 mm dia. (2.551 to 2.555 in. dia.)
H	59.8 to 59.9 mm dia. (2.354 to 2.358 in. dia.)

2. Inserting tool (D1803, V2403 : Serial No. : below 3R9999)

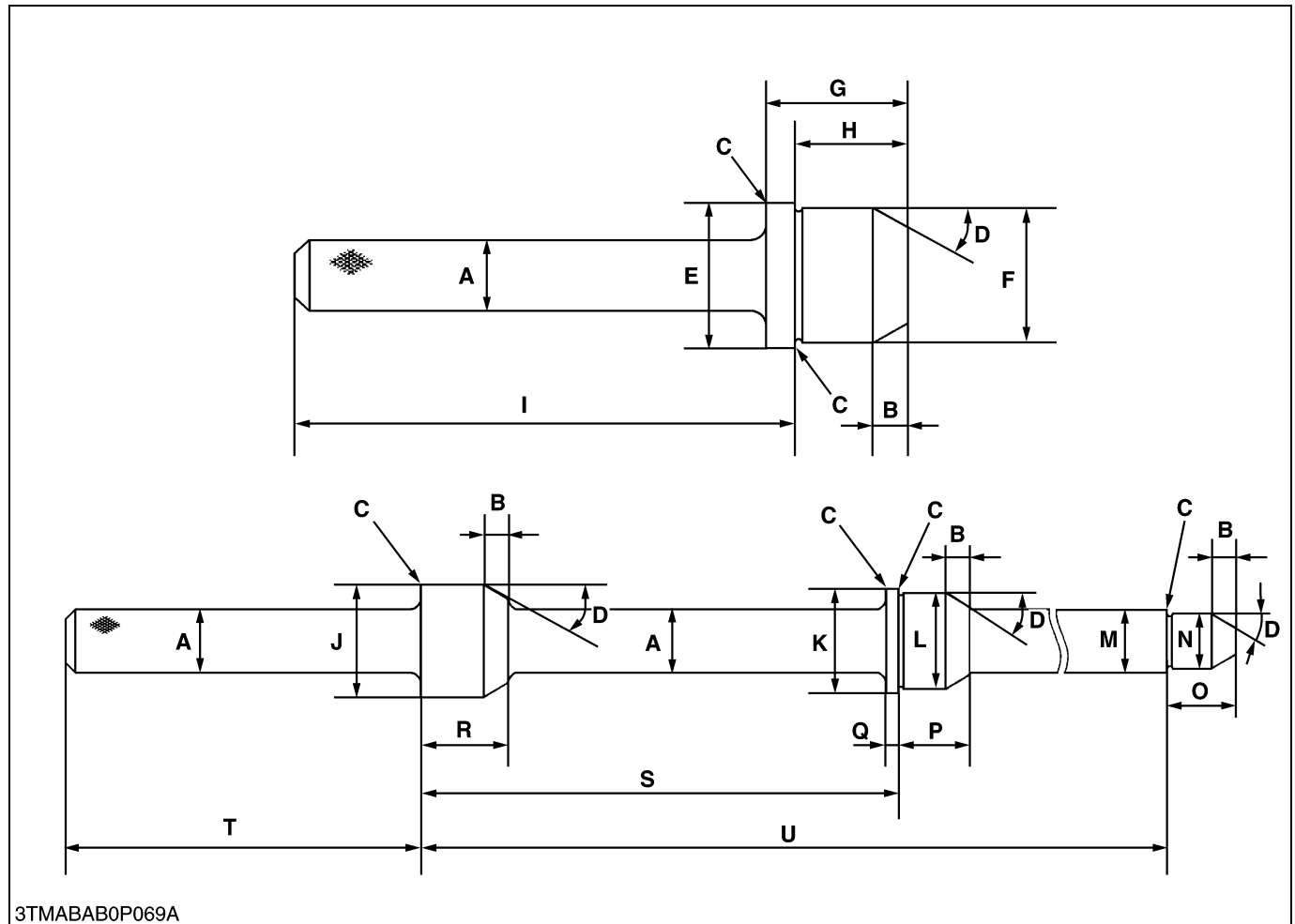
(Serial No. : above 3S0001)

A	130 mm (5.12 in.)
B	72 mm (2.83 in.)
C	R40 mm (R1.57 in.)
D	9 mm (0.35 in.)
E	4 mm (0.16 in.)
F	20 mm (0.79 in.)
G	20 mm dia. (0.79 in. dia.)
H	68 mm dia. (2.68 in. dia.)
I	59.8 to 59.9 mm dia. (2.354 to 2.358 in. dia.)
J	64.8 to 64.9 mm dia. (2.551 to 2.555 in. dia.)

W1026139

Balancer Metal Replacing Tool (for Removing)

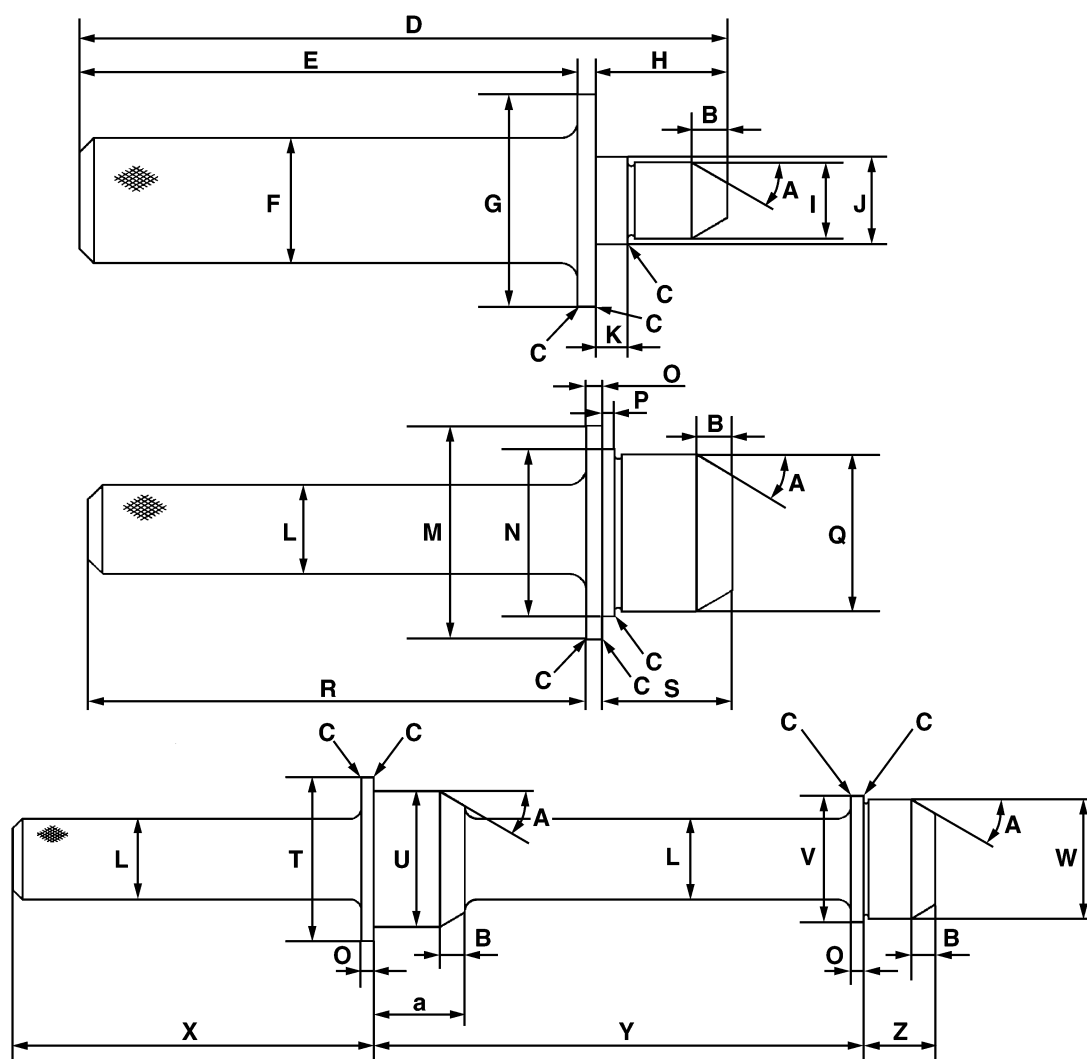
Application: Use to remove the metal bearing.



A	25 mm (0.98 in. dia.)	L	41.934 to 41.950 mm dia. (1.6509 to 1.6516 in. dia.)
B	10 mm (0.39 in.)	M	24.959 to 24.980 mm dia. (0.9826 to 0.9835 in. dia.)
C	Chamfer 0.3 mm (0.01 in.)	N	21.947 to 21.960 mm dia. (0.8641 to 0.8646 in. dia.)
D	0.52 rad (30 °)	O	28 mm (1.10 in.)
E	46.950 to 46.975 mm dia. (1.8484 to 1.8494 in. dia.)	P	29 mm (1.14 in.)
F	43.934 to 43.950 mm dia. (1.7297 to 1.7303 in. dia.)	Q	5 mm (0.20 in.)
G	41 mm (1.61 in.)	R	36 mm (1.42 in.)
H	32.5 mm (1.28 in.)	S	195.25 to 195.75 mm (7.687 to 7.707 in.)
I	148.5 mm (5.85 in.)	T	145 mm (5.71 in.)
J	46.50 to 46.75 mm dia. (1.831 to 1.841 in. dia.)	U	384.75 to 385.25 mm (15.148 to 15.167 in.)
K	44.950 to 44.975 mm dia. (1.7697 to 1.7707 in. dia.)		

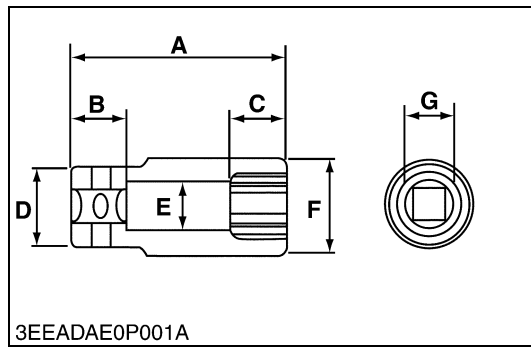
Balancer Metal Replacing Tool (for Fitting)

Application: Use to press fit the metal bearing.



3TMABAB0P070A

A	0.52 rad (30 °)	O	5 mm (0.20 in.)
B	10 mm (0.39 in.)	P	3.3 to 3.7 mm (0.130 to 0.146 in.)
C	Chamfer 0.3 mm (0.01 in.)	Q	43.934 to 43.950 mm dia. (1.7297 to 1.7303 in. dia.)
D	182 mm (7.16 in.)	R	140 mm (5.51 in.)
E	140 mm (5.51 in.)	S	36 mm (1.42 in.)
F	35 mm dia. (1.38 in. dia.)	T	60 mm dia. (2.36 in. dia.)
G	60 mm dia. (2.36 in. dia.)	U	46.950 to 46.975 mm dia. (1.8484 to 1.8494 in. dia.)
H	37 mm (1.46 in.)	V	44.950 to 44.975 mm dia. (1.7697 to 1.7707 in. dia.)
I	21.947 to 21.960 mm dia. (0.8641 to 0.8646 in. dia.)	W	41.934 to 41.950 mm dia. (1.6509 to 1.6516 in. dia.)
J	24.959 to 24.980 mm dia. (0.9826 to 0.9835 in. dia.)	X	145 mm (5.71 in.)
K	8.8 to 9.2 mm (0.346 to 0.362 in.)	Y	195.25 to 195.75 mm (7.687 to 7.707 in.)
L	25 mm dia. (0.98 in. dia.)	Z	29 mm (1.14 in.)
M	60 mm dia. (2.36 in. dia.)	a	36 mm (1.42 in.)
N	46.950 to 46.975 mm dia. (1.8484 to 1.8494 in. dia.)		



Socket Wrench for Crank Pulley Nut (46 mm Deep Socket Wrench)

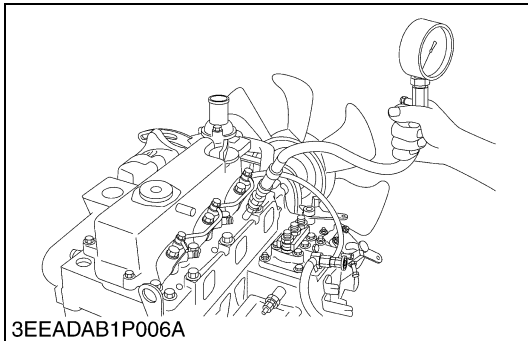
Application: Use to loosen and tighten the fan drive pulley mounting nut.

A	100 mm (3.94 in.)
B	25.0 mm (0.98 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.)

W1044361

2. ENGINE BODY

[1] CHECKING AND ADJUSTING



Compression Pressure

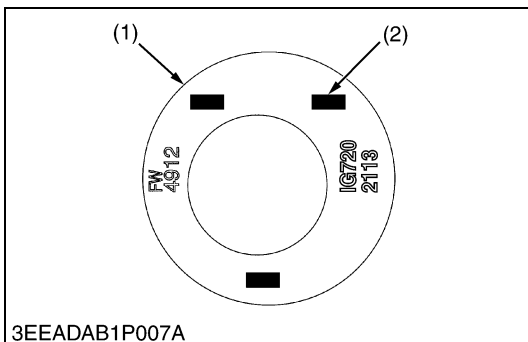
1. Run the engine until it is warmed up.
2. Stop the engine and disconnect the **2P** connector from the stop solenoid in order not to inject fuel.
3. Remove the air cleaner, the muffler and all glow plugs.
4. Set a compression tester with the adaptor **K** to the glow plug hole.
5. While cranking the engine with the starter, measure the compression pressure.
6. Repeat steps 4 through 6 for each cylinder.
7. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the glow plug hole and measure the compression pressure again.
8. If the compression pressure is still less than the allowable limit, check the top clearance, valve and cylinder head.
9. If the compression pressure increases after applying 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 performing this test.
- Variances in cylinder compression values should be under 10 %.

Compression pressure	Factory spec.	2.94 to 3.24 MPa 30 to 33 kgf/cm ² 427 to 469 psi
	Allowable limit	2.35 MPa 24 kgf/cm ² 341 psi

W1018639



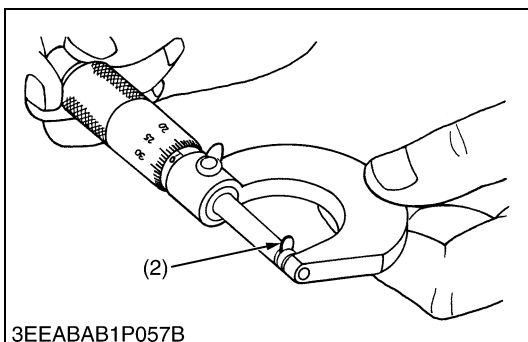
Top Clearance

1. Remove the cylinder head.
2. Move the piston up and stick a strip of fuse (2) on the piston head at three position with grease.
3. Lower the piston and install the cylinder head. (Use a new cylinder head gasket and tighten with a specified tightening torque.)
4. Turn the flywheel until the piston (1) passes through the top dead center.
5. Remove the cylinder head and measure the thickness of the fuses.
6. If the measurement is not within the factory specifications, check the oil clearances between the crankpin and bearing and between the piston pin and bushing.

Top clearance	Factory spec.	0.60 to 0.70 mm 0.0236 to 0.0276 in.
Tightening torque	Cylinder head screws	93.1 to 98.0 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft-lbs

(1) Piston

(2) Fuse



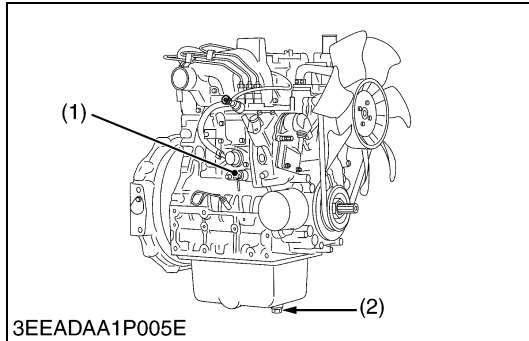
W1020190

[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Coolant and Oil

■ NOTE

- Some types of gearcases are provided with an oil filter port. When the cylinder head has been reassembled or when the valve clearance has been readjusted, apply an enough amount of oil to the intake and exhaust valves, push rod and rocker arm just before fitting the head cover in position.



Draining Coolant and Engine Oil

⚠ CAUTION

- Never remove radiator cap until coolant temperature is below its boiling point. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.

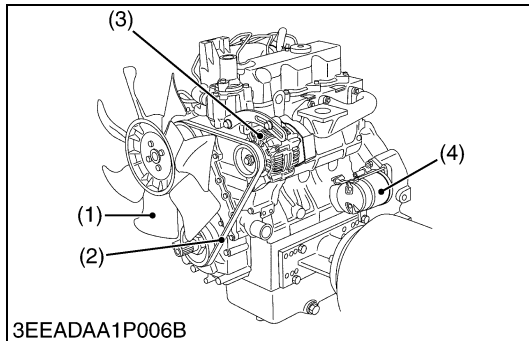
- Prepare a bucket. Open the coolant drain cock (1) to drain coolant.
- Prepare an oil pan. Remove the oil drain plug (2) to drain engine oil in the pan.
See page S-24, 26.

(1) Coolant Drain Cock

(2) Oil Drain Plug

W1060189

(2) External Components



Air Cleaner, Muffler and Others

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

(When reassembling)

- Check to see that there are no cracks on the belt surface.

■ IMPORTANT

- After reassembling the fan belt, be sure to adjust the fan belt tension. See page S-28.
- Do not confuse the direction of the fan.

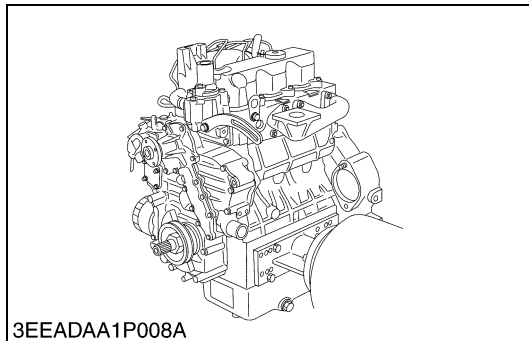
(1) Fan

(3) Alternator

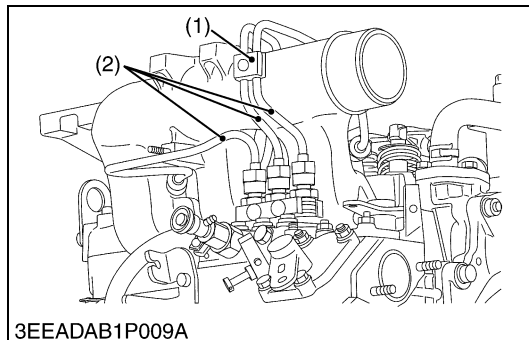
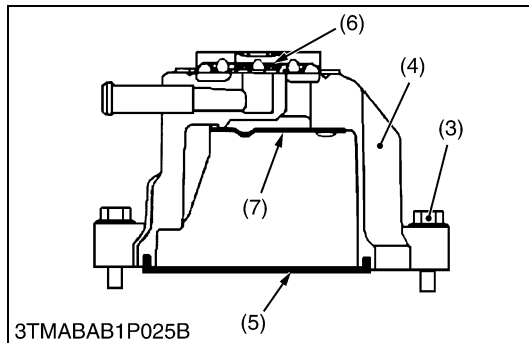
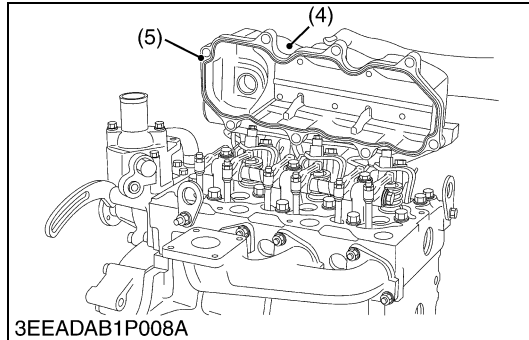
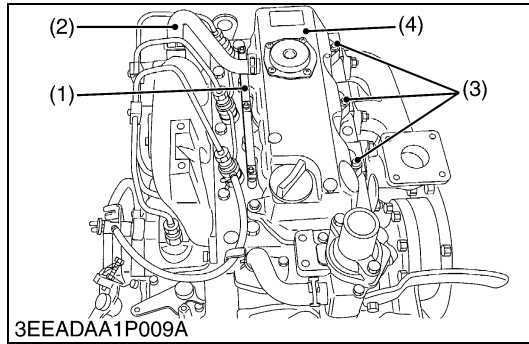
(2) Fan Belt

(4) Starter

W1060302



(3) Cylinder Head and Valves



Cylinder Head Cover

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

(When reassembling)

- Check to see if the cylinder head cover gasket (5) is not defective.

Tightening torque	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
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- | | |
|-------------------------|--------------------------------|
| (1) Lead | (5) Cylinder Head Cover Gasket |
| (2) Breather Hose | (6) Breather Valve |
| (3) Head Cover Screw | (7) Plate |
| (4) Cylinder Head Cover | |

W1060460

Injection Pipes

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

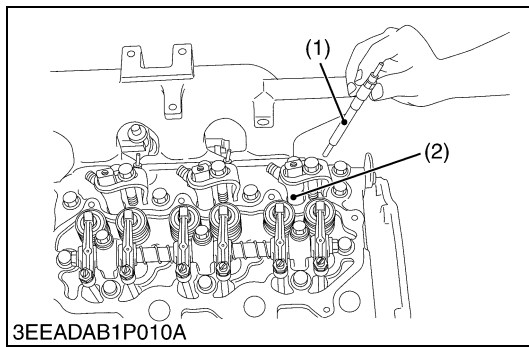
(When reassembling)

- Blow out dust inside the pipes.

Tightening torque	Injection pipe retaining nut	14.7 to 24.5 N·m 1.5 to 2.5 kgf·m 10.8 to 18.1 ft-lbs
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- | | |
|----------------|--------------------|
| (1) Pipe Clamp | (2) Injection Pipe |
|----------------|--------------------|

W1060970



Nozzle Holder Assembly and Glow Plug

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

(When reassembling)

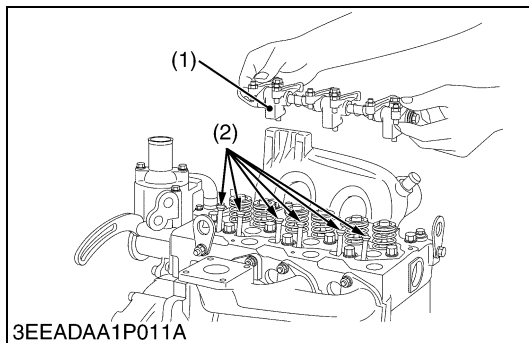
- Replace the copper gasket with new one.

Tightening torque	Nozzle holder clamp screw	25.5 to 29.4 N·m 2.6 to 3.0 kgf·m 18.8 to 21.7 ft-lbs
	Overflow pipe assembly retaining screw	9.8 to 11.3 N·m 1.00 to 1.15 kgf·m 7.2 to 8.3 ft-lbs
	Glow plug	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Glow Plug

(2) Nozzle Holder Assembly

W1020917



Rocker Arm and Push Rod

1. Remove the rocker arm bracket mounting bolts.
2. Detach the rocker arm assembly (1).
3. Remove the push rods (2).

(When reassembling)

- When putting the push rods (2) onto the tappets (3), check to see if their ends are properly engaged with the dimples.

■ IMPORTANT

- **After installing the rocker arm, be sure to adjust the valve clearance. See page S-31.**

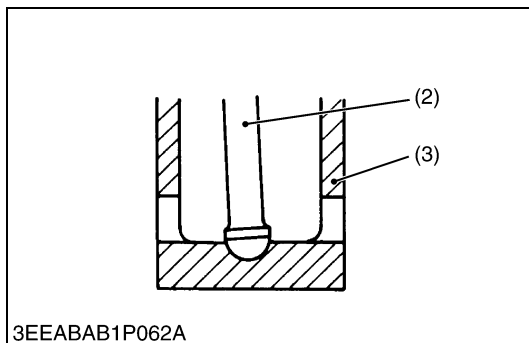
Tightening torque	Rocker arm bracket mounting bolt	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
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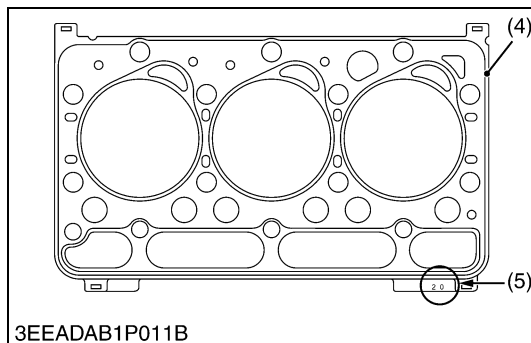
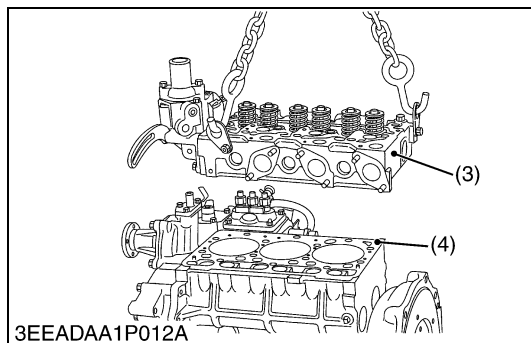
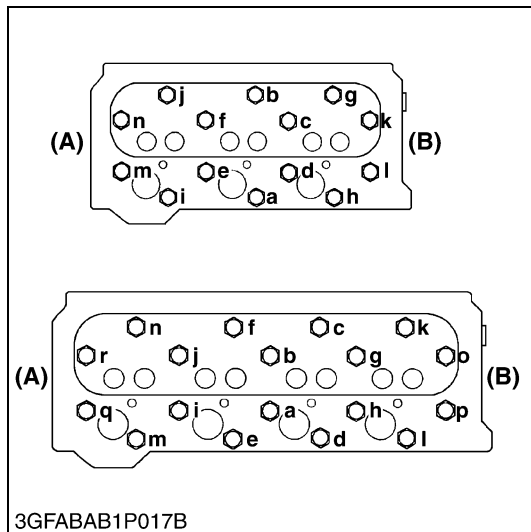
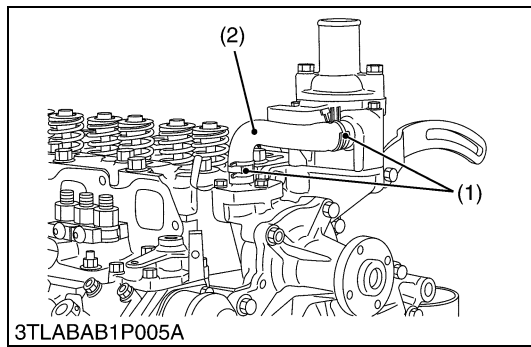
(1) Rocker Arm Assembly

(3) Tappet

(2) Push Rod

W1021437





Cylinder Head

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

(When reassembling)

- Replace the cylinder head gasket (4) with a new one.
- Tighten the cylinder head screws after applying sufficient oil.
- Tighten the cylinder head screws in diagonal sequence starting from the center in the order of **(a) to (n or r)**.
- Tighten them uniformly, or the head may deform in the long run.

Tightening torque	Cylinder head screw	93.1 to 98.0 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft-lbs
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■ IMPORTANT

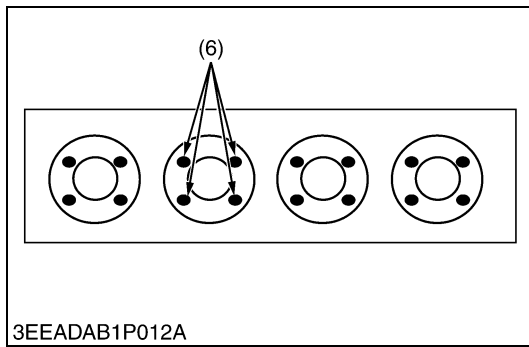
- To replace the cylinder head gasket (4), in advance make sure the marking (5) of cylinder head gasket in the original engine, and replace the same marking as the original cylinder head gasket.

Model	D1503-M-DI D1503-M-DI-T	D1703-M-DI D1803-M-DI	V2203-M-DI V2403-M-DI
Gasket Marking & Code Number			
15	1G720-03601	1G750-03601	1G790-03601
20	1G720-03311	1G750-03311	1G790-03311
25	1G720-03611	1G750-03611	1G790-03611
30	1G720-03621	1G750-03621	1G790-03621
35	1G720-03631	1G750-03631	1G790-03631

- (1) Pipe Clamp
- (2) Return Pipe
- (3) Cylinder Head
- (4) Cylinder Head Gasket
- (5) Marking

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

W1021755



Cylinder Head (Continued)

■ IMPORTANT

- When replacing piston, piston pin, small end bushing, connecting rod, or crankpin bearings, measure piston head's protrusion or recessing from the level of crankcase cylinder face (average of 4 pistons) after installing the pistons, and select the cylinder head gasket following the below table.

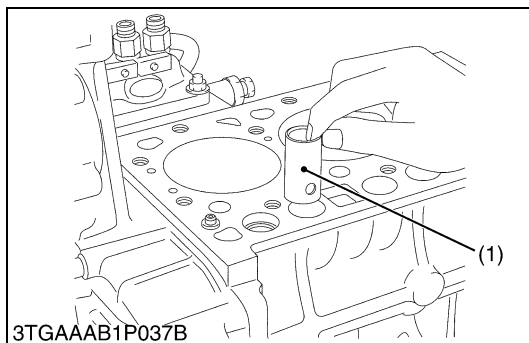
Selecting the cylinder head gasket

- Measure the piston head's protrusion or recessing from the crankcase cylinder face 4 spots per each piston (average of four pistons) using the dial gauge.
- Select the suitable cylinder head gasket refer to the table below.

Gasket Size (Number)	Piston Protrusion
15	0.475 to 0.525 mm 0.0187 to 0.0207 in.
20	0.525 to 0.575 mm 0.0207 to 0.0226 in.
25	0.575 to 0.625 mm 0.0226 to 0.0246 in.
30	0.625 to 0.675 mm 0.0246 to 0.0266 in.
35	0.675 to 0.725 mm 0.0266 to 0.0285 in.

(6) Measuring Points

W1085632



Tappets

- Remove the tappets (1) from the crankcase.

(When reassembling)

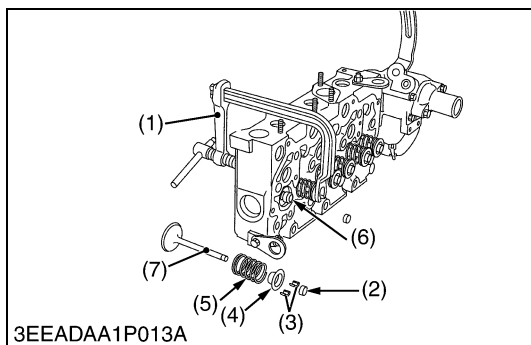
- Visually check the contact between tappets (1) and cams for proper rotation. If defect is found, replace tappets.
- Before installing the tappets (1), apply engine oil thinly around them.

■ IMPORTANT

- Do not change the combination of tappet (1) and tappet guide of the crankcase.

(1) Tappet

W1022001



Valves

1. Remove the valve caps (2).
2. Remove the valve spring collet (3), pushing the valve spring retainer (4) by valve spring replacer (1).
3. Remove the valve spring retainer (4), valve spring (5) and valve stem seal (6).
4. Remove the valve (7).

(When reassembling)

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets (3), lightly tap the stem to assure proper fit with a plastic hammer.

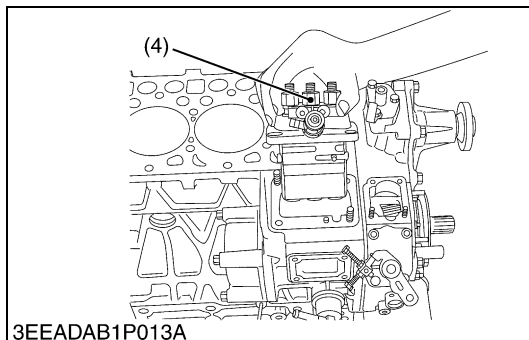
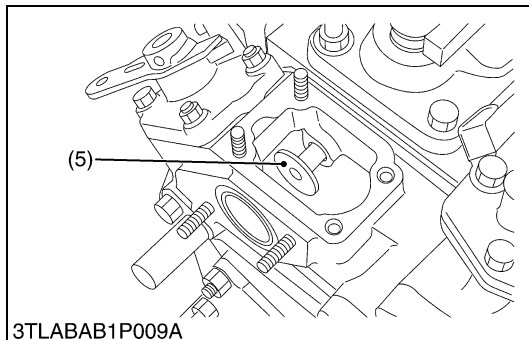
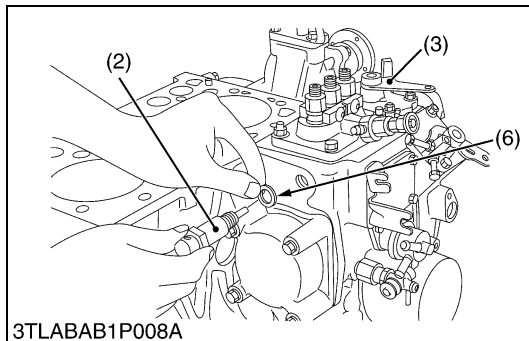
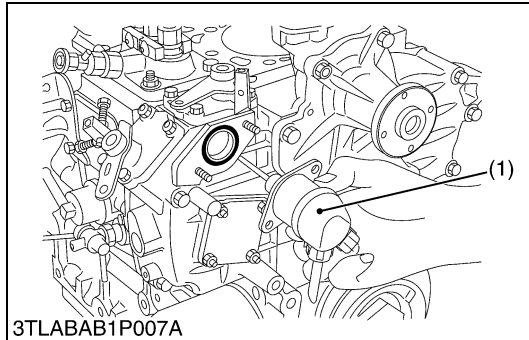
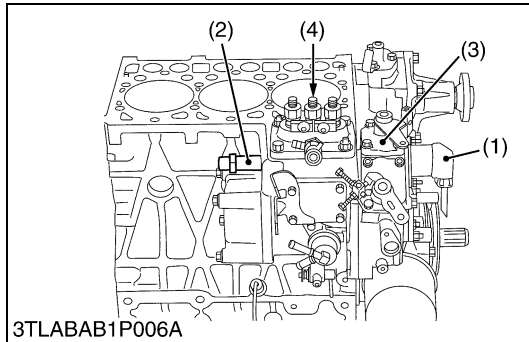
■ IMPORTANT

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

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

W1022102

(4) Timing Gears, Camshaft and Fuel Camshaft



Injection Pump

1. Remove the stop solenoid (1) and hi-idling body (2).
2. Remove the engine stop lever (3) and stop solenoid guide (5).
3. Remove the fuel injection pump assembly (4).

■ IMPORTANT

- Before removing the injection pump assembly (4), be sure to remove the stop solenoid (1), hi-idling body (2), engine stop lever (3) and stop solenoid guide (5).

(When reassembling)

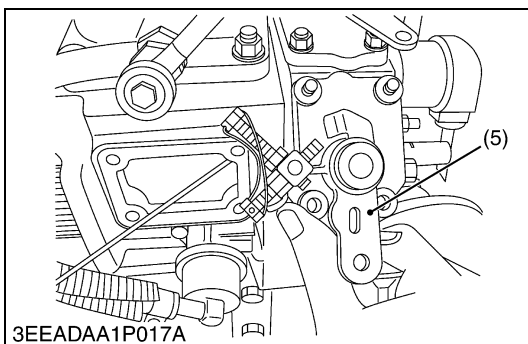
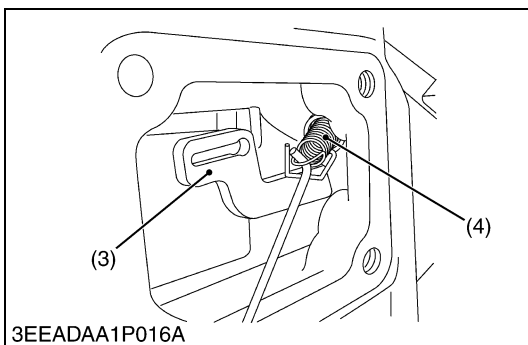
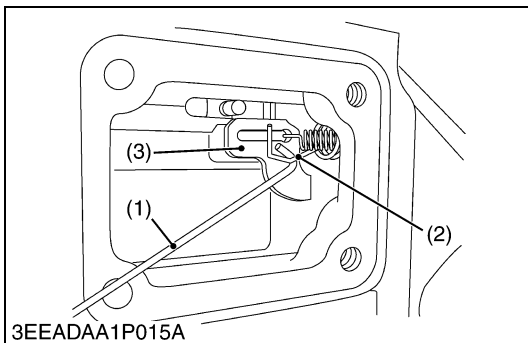
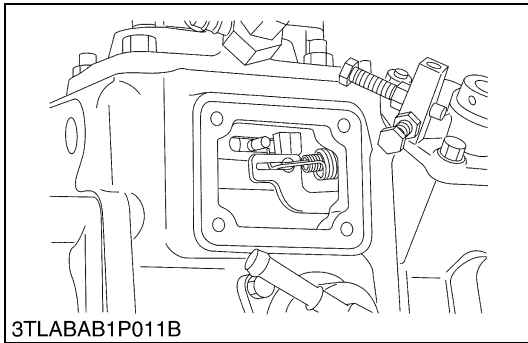
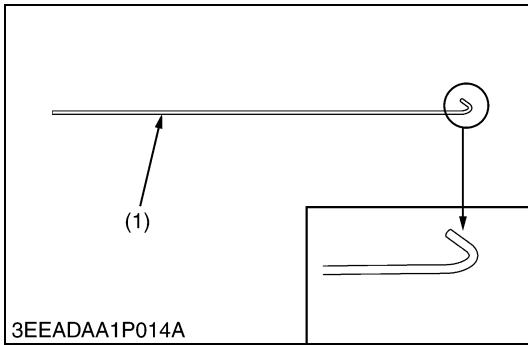
- Before attaching the stop solenoid (1), hi-idling body (2) and stop solenoid guide (5), install the injection pump first into position.
- Replace the hi-idling body gasket (6) with a new one.
- Before fitting the stop lever (3) to the gear case, install the stop solenoid guide (5) first into position. Then attach the stop lever and use it to see if it functions well.
- Before fitting the idling limiter in place, attach the stop solenoid guide (5) and the engine stop lever (3) in their respective positions.
- When installing the stop solenoid (1), be careful to keep the O-ring in place.
- Be sure to insert the push rod of the stop solenoid into the hole at the center of the solenoid guide (5).

Tightening torque	Hi-idling body	44.1 to 49.0 N·m 4.5 to 5.0 kgf·m 32.6 to 36.3 ft·lbs
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- (1) Stop Solenoid
(2) Hi-idling Body
(3) Stop Lever

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

W1023686



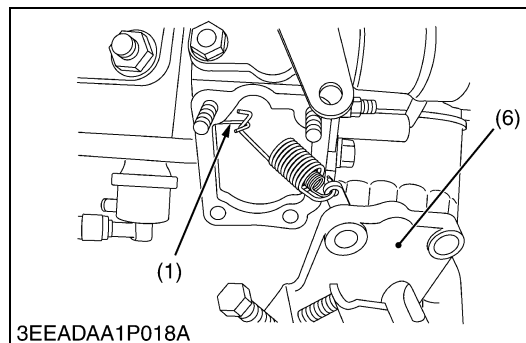
Governor Springs and Speed Control Plate

NOTE

- Specific tool (1) :
1.2 mm diameter hard wire with its end hooked, overall length 200 mm (7.87 in.).

The tip of wire is bent like the hook to hang governor springs.

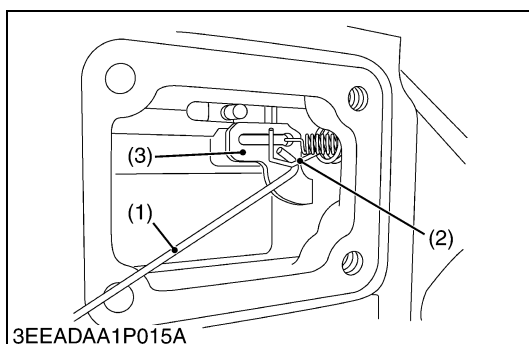
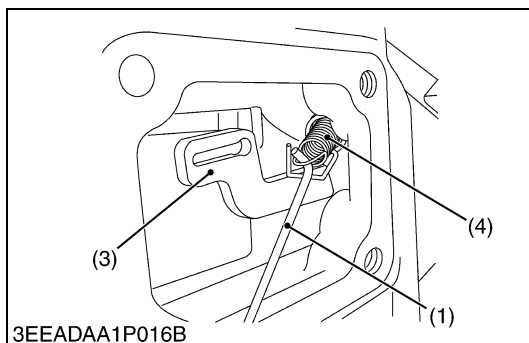
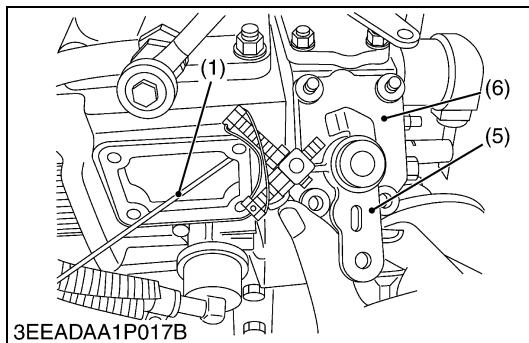
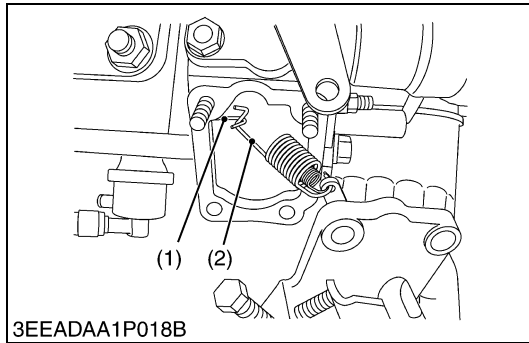
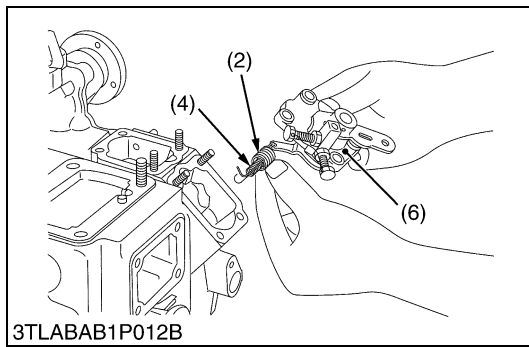
- Remove the injection pump cover.
- Remove the speed control plate (6) mounting nuts and bolts.
- Using the specific tool (1), undo the large governor spring (2) from the fork lever (3).
- Using the specific tool (1), undo the small governor spring (4) from the fork lever (3).
- Set the speed control lever (5) as the figure.
- Take out the speed control plate (6) with care not to let the large (2) and small (4) governor springs come off this plate and fall in to the gear case.



- (1) Specific Tool
(2) Large Governor Spring
(3) Fork Lever

- (4) Small Governor Spring
(5) Speed Control Lever
(6) Speed Control Plate

W1148604



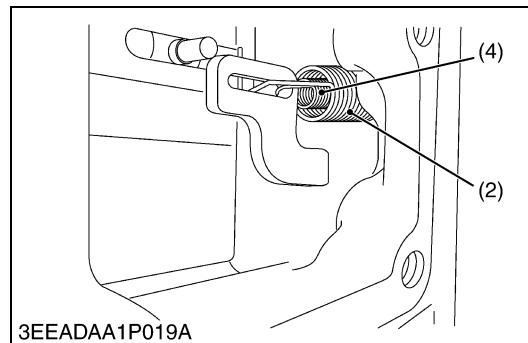
Governor Springs and Speed Control Plate (Continued)

(When reassembling)

- Hook the small spring (4) first and then the large governor spring (2) on the speed control plate (6).
- Put the specific tool (1) from the injection pump side to catch the large governor spring (2). Keep this spring slightly extended and place the speed control plate (6) in its specified position.
- Using the specific tool (1), hook the small governor spring (4) onto the fork lever (3).

■ NOTE

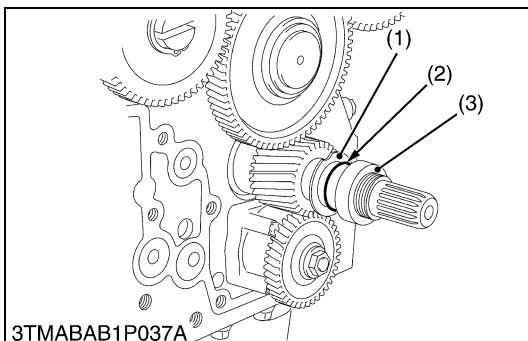
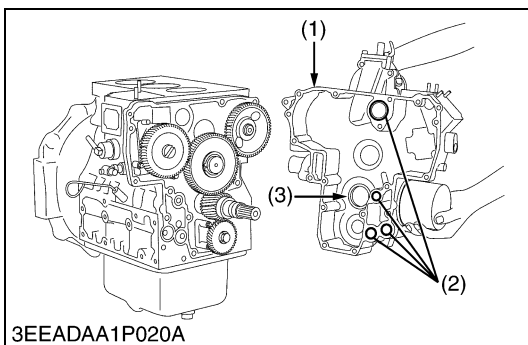
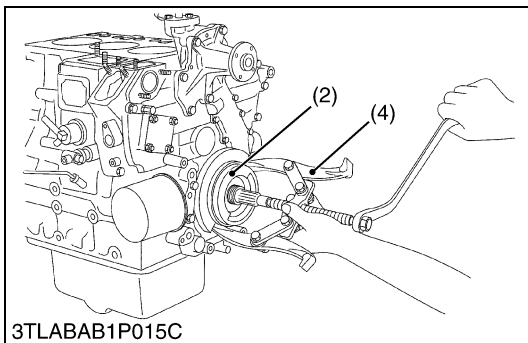
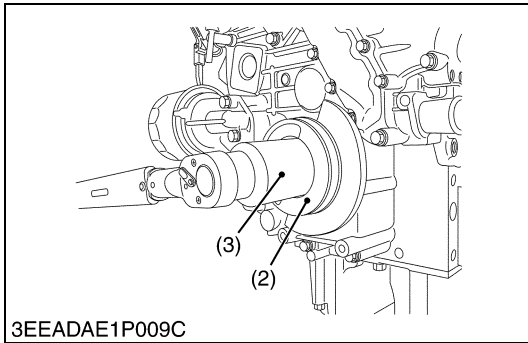
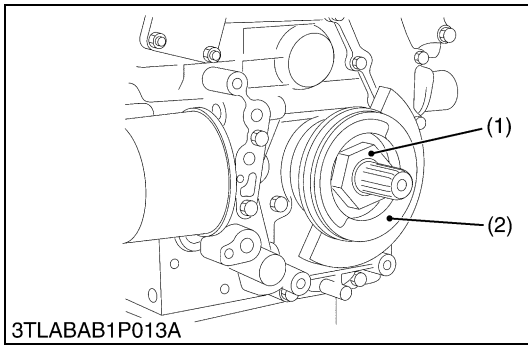
- Be careful not to stretch the small governor spring (4) too long because otherwise it may get deformed permanently.
- Using the specific tool (1), hook the large governor spring (2) onto the fork lever (3).
- Make sure both the governor springs (2), (4) are tight on the fork lever (3).
- Apply and tighten up the two bolts and two nuts on the speed control plate (6).
- Check that the speed control lever (5) positions low idle, after assembling governor springs.
- Check that the speed control lever (5) returns to the high idle position rather than the low idle position, after moving the lever to the maximum speed position.
- Finally attach the injection pump cover in position.



- (1) Specific Tool
(2) Large Governor Spring
(3) Fork Lever

- (4) Small Governor Spring
(5) Speed Control Lever
(6) Speed Control Plate

W1152334



Fan Drive Pulley

1. Lock the flywheel not to turn using the flywheel stopper.
2. Remove the fan drive pulley mounting nut (1) using 46 mm deep socket wrench (3).
3. Remove the fan drive pulley (2) with gear puller (4).
4. Remove the feather key.

(When reassembling)

- Apply grease to the splines of coupling.

Tightening torque	Fan drive pulley mounting nut	137.3 to 156.9 N·m 14.0 to 16.0 kgf·m 101.3 to 115.7 ft·lbs
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(1) Nut

(2) Fan Drive Pulley

(3) 46 mm Deep Socket Wrench

(4) Gear Puller

W1024348

Gear Case

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

(When reassembling)

- Apply liquid gasket (Three Bond 1215 or equivalent) to both side of hour meter gear case gasket (if equipped).
- Check to see if there are four O-rings (2) inside the gear case (1).
- Apply a thin film of engine oil to the oil seal (3), and install it, noting the lip come off.
- Before installing the gear case gasket, apply a non-drying adhesive.

(1) Gear Case

(2) O-ring

(3) Oil Seal

W1024531

Crankshaft Oil Slinger

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

(When reassembling)

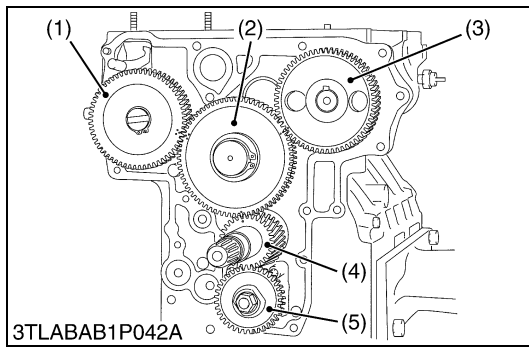
- Insert the crankshaft collar (3) after install the gear case to cylinder body.

(1) Crankshaft Oil Slinger

(2) O-ring

(3) Crankshaft Collar

W1024731

**Idle Gear**

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

(When reassembling)

- Check to see each gear is aligned with its aligning 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

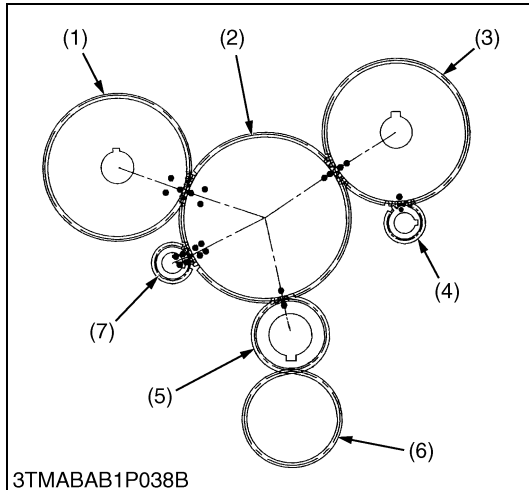
(4) Crank Gear

(2) Idle Gear

(5) Oil Pump Drive Gear

(3) Cam Gear

W1024941

**Idle Gear (For Balancer Model)**

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

(When reassembling)

- Check to see each gear is aligned with its aligning mark:
 - Idle gear (2) and crank gear (5), cam gear (3) and balancer gear (4)
 - Cam gear (3) and idle gear (2)
 - Idle gear (2) and injection pump gear (1)
 - Idle gear (2) and balancer gear (7)

(1) Injection Pump Gear

(5) Crank Gear

(2) Idle Gear

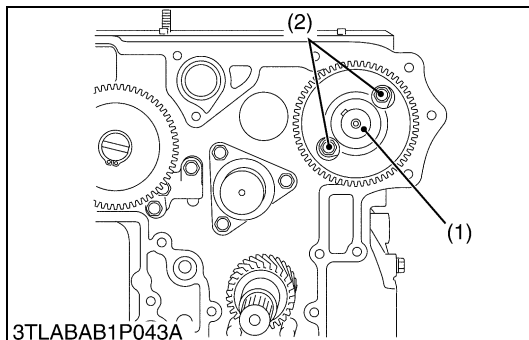
(6) Oil Pump Drive Gear

(3) Cam Gear

(7) Balancer Gear

(4) Balancer Gear

W1097988

**Camshaft**

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

(When reassembling)

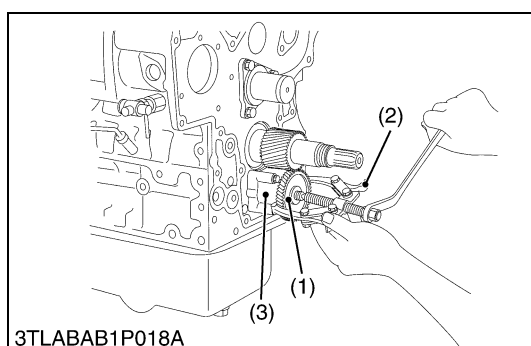
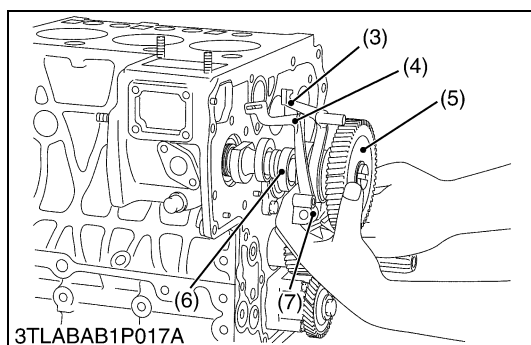
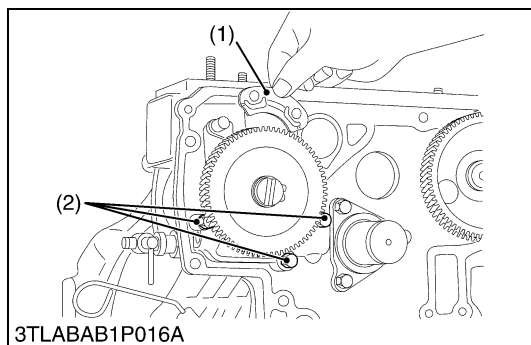
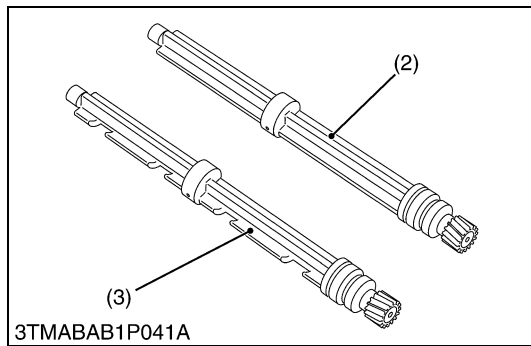
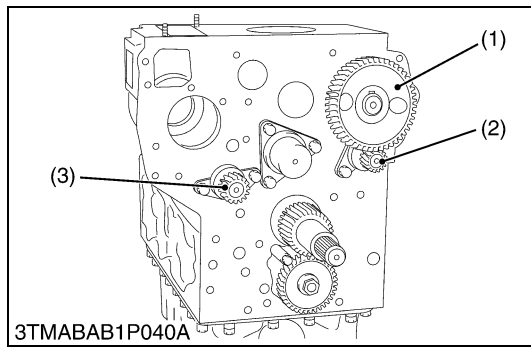
- When installing the idle gear, be sure to align the alignment marks on gears.

Tightening torque	Camshaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
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(1) Camshaft

(2) Camshaft Set Screw

W1025098



Camshaft and Balancer Shaft (For Balancer Model)

1. Remove the camshaft set bolts and draw out the camshaft (1).
2. Remove the balancer shaft 1 (2) set bolts and draw out the balancer shaft 1 (2).
3. Remove the balancer shaft 2 (3) set bolts and draw out the balancer shaft 2 (3).

(When reassembling)

- When install the balancer shaft 1 (2) and 2 (3), be sure to place the 1st and 4th cylinders piston at the top dead center in compression then, align all mating marks on each gear to assemble the timing gears, set the idle gear last.

Tightening torque	Camshaft set bolt	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Balancer shaft set bolt	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Camshaft

(3) Balancer Shaft 2

(2) Balancer Shaft 1

W1099079

Fuel Camshaft and Fork Lever Assembly

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

(When reassembling)

- After installation, check to see that the fork lever 1 (3) and 2 (4) are fixed to the fork lever shaft, and that they can turn smoothly in the holder (7).

(1) Fuel Camshaft Stopper

(5) Injection Pump Gear

(2) Fork Lever Holder Mounting Screws

(6) Fuel Camshaft

(3) Fork Lever 1

(7) Fork Lever Holder

(4) Fork Lever 2

W1025309

Oil Pump

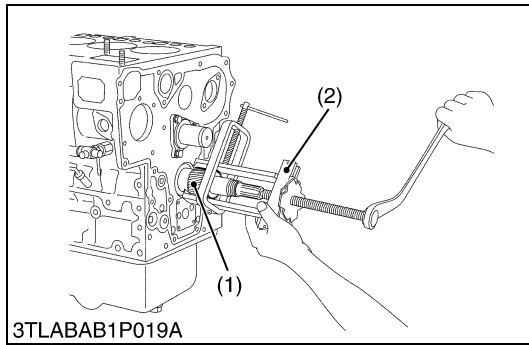
1. Remove the nut.
2. Draw out the oil pump drive gear (1) with gear puller (2).
3. Remove the four oil pump mounting screws. Detach the oil pump (3).

(1) Oil Pump Drive Gear

(3) Oil Pump

(2) Gear Puller

W1025581

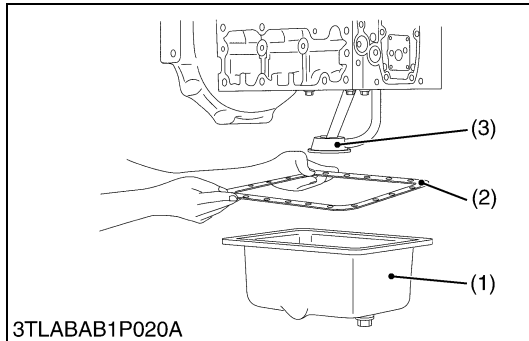
**Crank Gear**

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

(1) Crank Gear

(2) Gear Puller

W1025476

(5) Piston and Connecting Rod**Oil Pan and Oil Strainer**

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

(When reassembling)

- After cleaning the oil strainer (3), check to see that the filter mesh is clean, and install it.
- Visually check the O-ring (4), apply engine oil, and install it.
- Securely fit the O-ring (4) to the oil strainer (3).
- Apply a liquid gasket (Three Bond 1215 or equivalent) to the oil pan side of the oil pan gasket (2).
- To avoid uneven tightening, tighten oil pan mounting screws in diagonal order from the center.

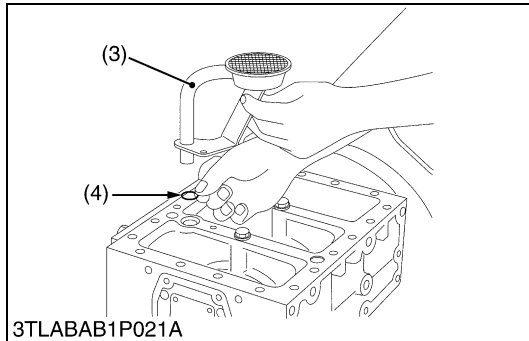
(1) Oil Pan

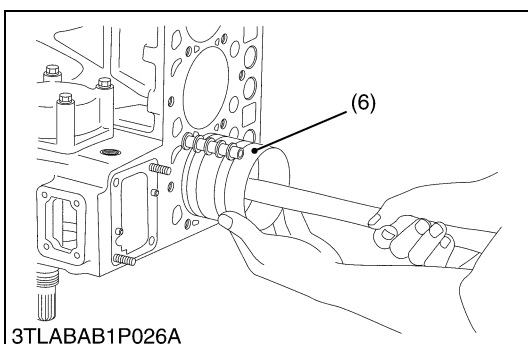
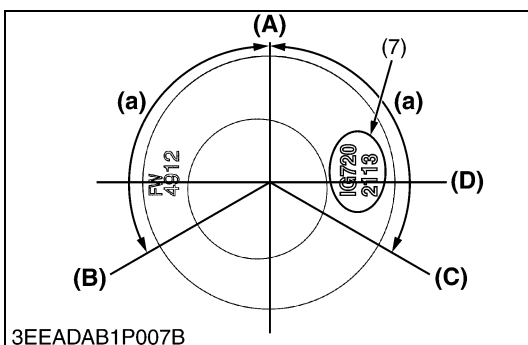
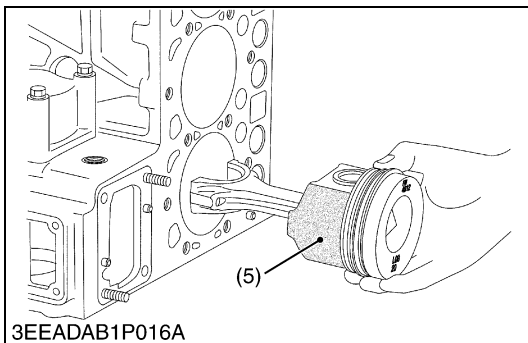
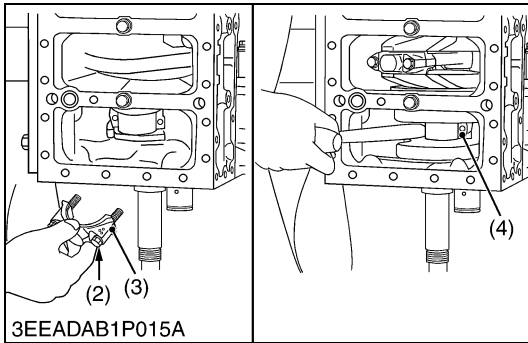
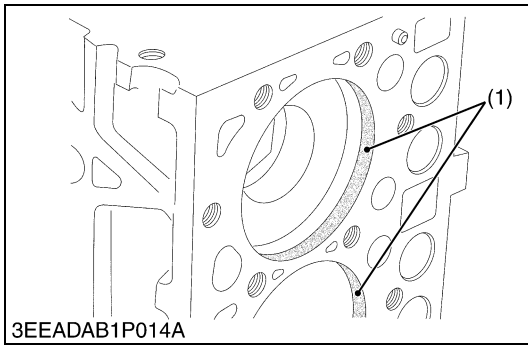
(3) Oil Strainer

(2) Oil Pan Gasket

(4) O-ring

W1025687





Pistons

1. Completely clean carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and bring the piston to top dead center.
4. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
5. Draw out the other piston in the same method as above.

(When reassembling)

- Before inserting piston into the cylinder, apply enough engine oil to the piston.
- When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

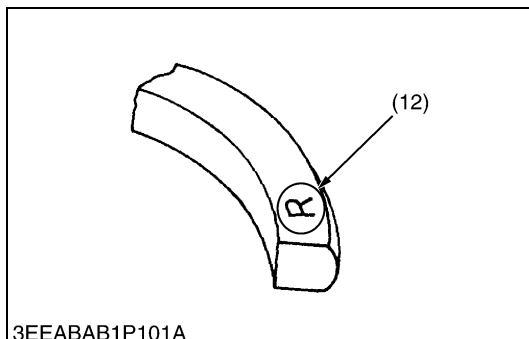
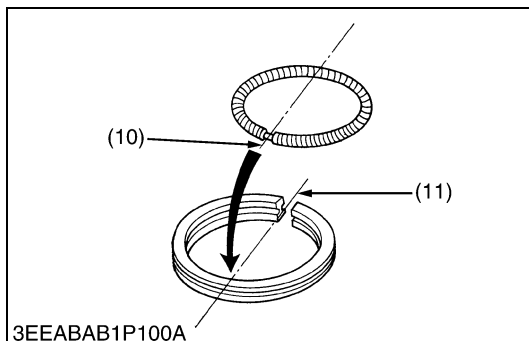
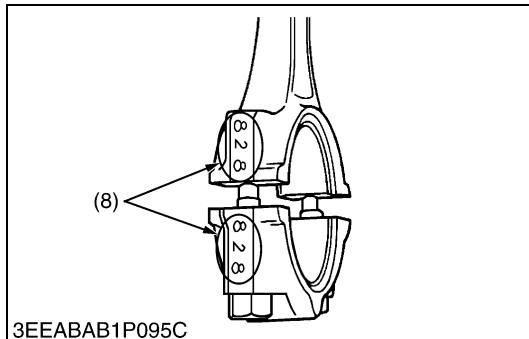
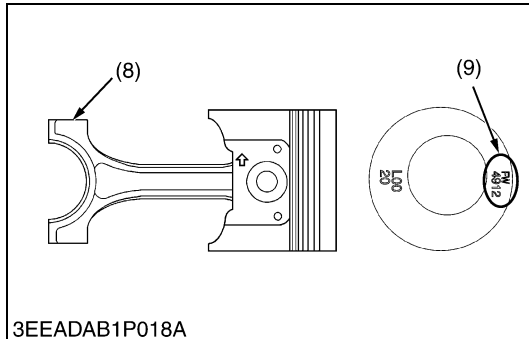
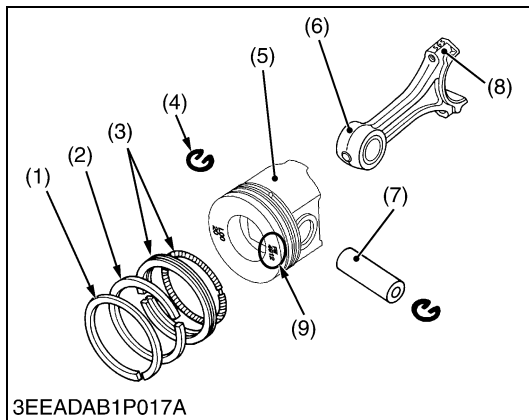
■ IMPORTANT

- Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 piston.
- Place the piston rings with their gaps at 2.09 rad (120 °) from the piston pin's direction as shown in the figure.
- Carefully insert the pistons using a piston ring compressor (6).
- When inserting the piston in place, be careful not to get the molybdenum disulfide coating torn off its skirt. This coating is useful in minimizing the clearance with the cylinder liner. Just after the piston pin has been press-fitted, in particular, the piston is still hot and the coating is easy to peel off. Wait until the piston cools down.
- When replacing the piston, look at the code number (7) marked on top of the piston. Use a replacement piston with the same code number.

Tightening torque	Connecting rod screw	44.1 to 49.0 N·m
		4.5 to 5.0 kgf·m
		32.5 to 36.2 ft·lbs

- | | |
|--|----------------------|
| (1) Carbon | (A) Top Ring Gap |
| (2) Connecting Rod Screw | (B) Second Ring Gap |
| (3) Connecting Rod Cap | (C) Oil Ring Gap |
| (4) Connecting Rod | (D) Piston Pin Hole |
| (5) Molybdenum Disulfide Coating in Piston Skirt | (a) 2.09 rad (120 °) |
| (6) Piston Ring Compressor | |
| (7) Code Number | |

W1026141



Piston Ring and Connecting Rod

1. Remove the piston rings (1), (2), (3) using a piston ring tool (Code No. 07909-32121).
2. Remove the piston pin (7), and separate the connecting rod (6) from the piston (5).

(When reassembling)

- When installing the ring, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston (5).
- When installing the oil ring (3) onto the piston (5), place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin (7).
- When installing the connecting rod (6) to the piston (5), immerse the piston (5) in 80 °C (176 °F) oil for 10 to 15 minutes and insert the piston pin (7) to the piston (5).

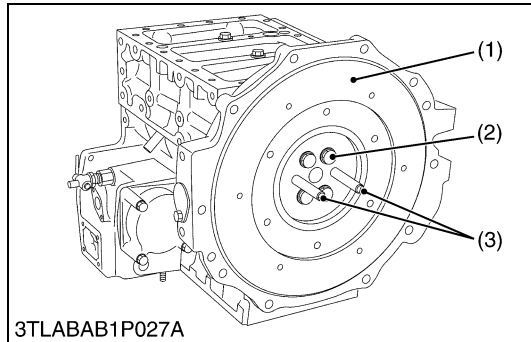
■ NOTE

- Assemble the piston (5) to the connecting rod (6) with the FW mark (9) facing the flywheel side and the connecting rod mark (8) facing the injection pump side.
- Mark the same number on the connecting rod (6) and the piston (5) so as not to change the combination.

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

W1026376

(6) Crankshaft



Flywheel

1. Fit the stopper to the flywheel (1).
2. At first, remove two pieces of the flywheel screws (2).
3. Insert two pieces of the flywheel guide screws (3) in the holes.
4. Remove the all flywheel screws (2).
5. Remove the flywheel (1) slowly along the flywheel guide screws (3).

(When reassembling)

- Insert two pieces of the flywheel guide screws (3).
- Check to see that there are no metal particles left on the flywheel mounting surfaces.
- Apply engine oil to the threads and the undercut surface of the flywheel bolt and fit the bolt.

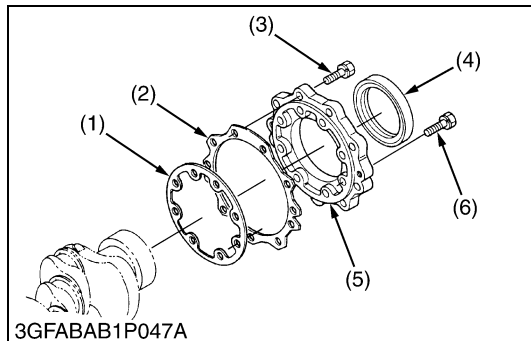
Tightening torque	Flywheel screws	98.0 to 107.8 N·m 10.0 to 11.0 kgf·m 72.3 to 79.5 ft-lbs
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(1) Flywheel

(2) Flywheel Screw

(3) Flywheel Guide Screws

W1026863



Bearing Case Cover

1. Remove the bearing case cover mounting screws. First, remove inside screws (6) and then outside screws (3).
2. Screw two removed screws into the screw hole of bearing case cover (5) to remove it.

■ IMPORTANT

- The length of inside screws (6) and outside screws (3) are different. Do not take a mistake using inside screws and outside screws.

(When reassembling)

- Fit the bearing case gasket (1) and the bearing case cover gasket (2) with correct directions.
- Install the bearing case cover (5) to position the casting mark "UP" on it upward.
- Apply engine oil to the oil seal lip and take care that it is not rolled when installing.
- Tighten the bearing case cover mounting screws with even force on the diagonal line.

Tightening torque	Bearing case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
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(1) Bearing Case Gasket

(2) Bearing Case Cover Gasket

(3) Bearing Case Cover Mounting Screw

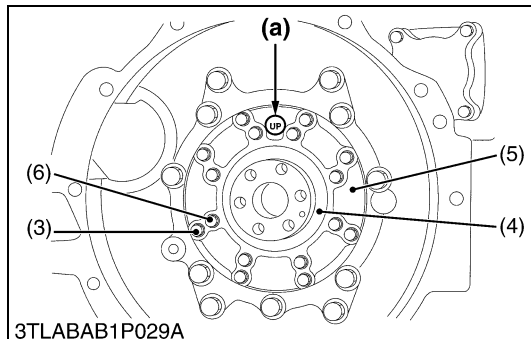
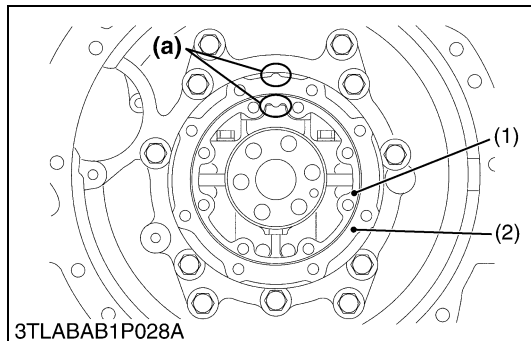
(4) Oil Seal

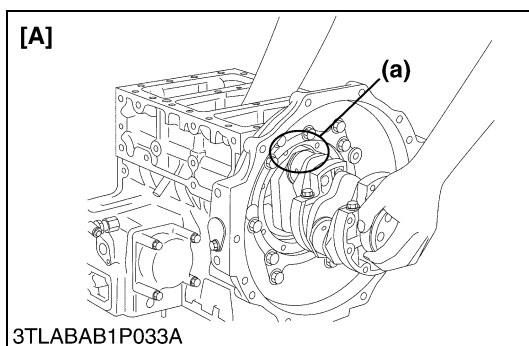
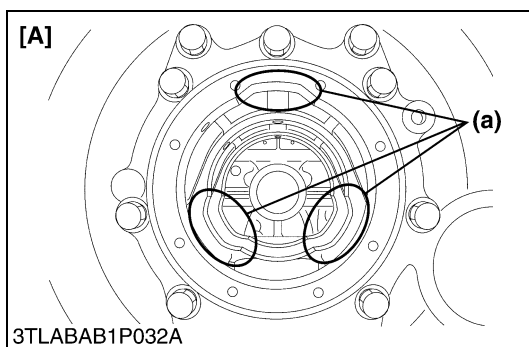
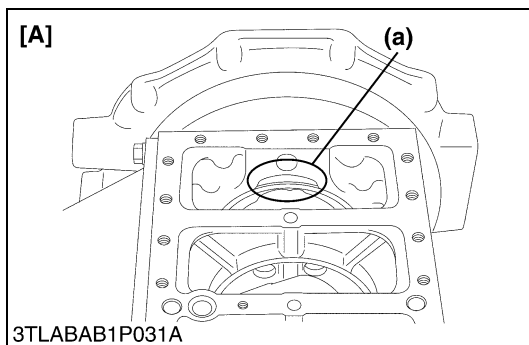
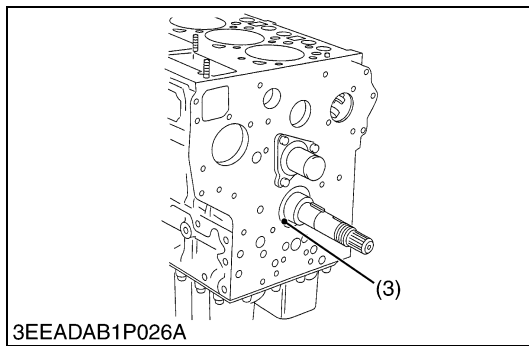
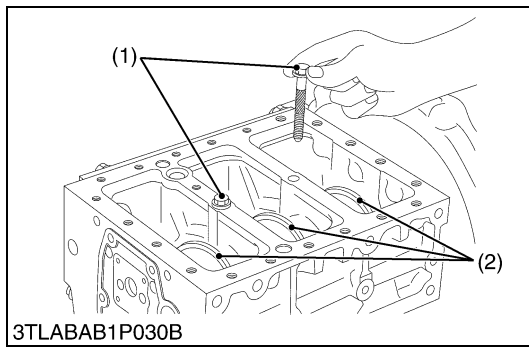
(5) Bearing Case Cover

(6) Bearing Case Cover Mounting Screw

(a) Upside

W10292140





Crankshaft

NOTE

- Before disassembling, check the side clearance of crankshaft. Also check it during reassembling.

For D1503-M-DI, D1503-M-DI-T, D1703-M-DI and V2203-M-DI

- Remove the main bearing case screw 2 (1).
- Pull out the crankshaft assembly, taking care not to damage the crankshaft bearing 1 (3).

For D1803-M-DI

- Remove the main bearing case screw 2 (1).
- Turn the crankshaft to set the crank pin of the third cylinder to the bottom dead center. Then draw out the crankshaft until the crank pin of the second cylinder comes to the center of the third cylinder.
- Turn the crankshaft by 2.09 rad (120 °) counterclockwise to set the crank pin of the second cylinder to the bottom dead center. Draw out the crankshaft until the crank pin of the first cylinder comes to the center of the third cylinder.
- Repeat the above steps to draw out all the crankshaft.

For V2403-M-DI

- Remove the main bearing case screw 2 (1).
- Turn the crankshaft to set the crank pin of the 4th cylinder to the horizontal directions (Right or Left). Then draw out all the crankshaft, holding the crank pins to the horizontal directions (Right or Left).

(When reassembling)

IMPORTANT

- Install the crankshaft sub assembly, aligning the screw hole of main bearing case 2 (2) with the screw hole of cylinder block.
- When tightening the main bearing case screw 2 (1), apply oil to the screw and screw by hand before tightening the specific torque.

If not smooth to screw by hand, align the screw holes between the cylinder block and the main bearing case.

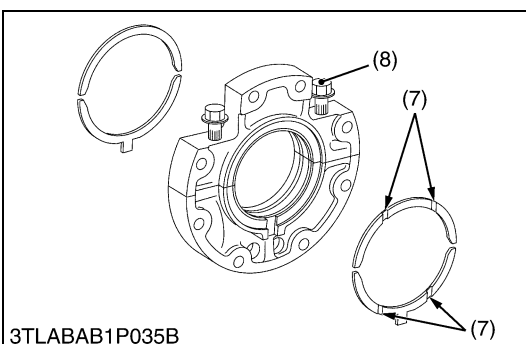
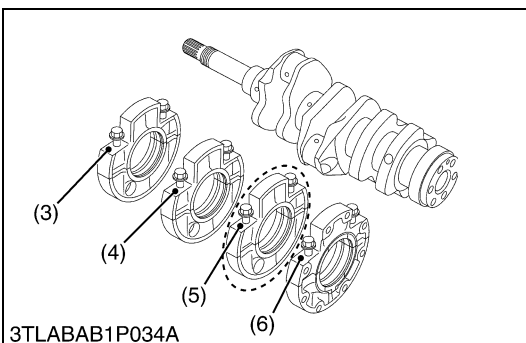
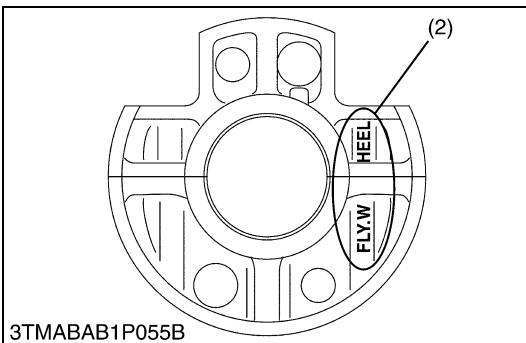
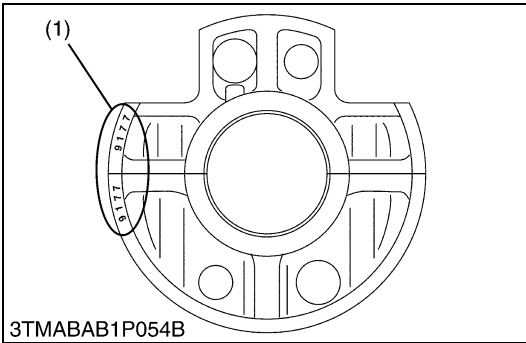
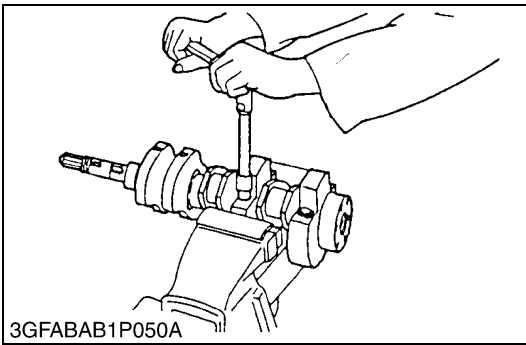
Tightening torque	Main bearing case screws	68.6 to 73.5 N·m
	2	7.0 to 7.5 kgf·m 50.6 to 54.2 ft·lbs

- Main Bearing Case Screw 2
- Main Bearing Case 2
- Crankshaft Bearing 1

(a) Cut place for removing and installing the crankshaft

[A] D1803-M-DI

W1066311



Main Bearing Case Assembly

1. Remove the two main bearing case screws 1 (8), and remove the main bearing case assembly being careful with thrust bearing and crankshaft bearing.
2. Remove the main bearing case 1, 2 as above.

(When reassembling)

- Clean the oil passage in the main bearing case.
- Apply clean engine oil on the bearings.
- Install the main bearing case assemblies in the original positions. Since diameters of main bearing cases vary, install them in order of makings (A, B for 3 cylinders and A, B, C for 4 cylinders) from the gear case side.
- Match the alignment numbers (1) and mark (2) on the main bearing case.
- When installing the main bearing case 1 and 2, face the mark "FLYWHEEL" to the flywheel.
- Install the thrust bearing with its oil groove facing (7) outward.
- Confirm that the main bearing case moves smoothly after tightening the main bearing case screw 1 (8) to the specified torque.

Tightening torque	Main bearing case screw 1	46.1 to 50.9 N·m 4.7 to 5.2 kgf·m 34.0 to 37.6 ft-lbs
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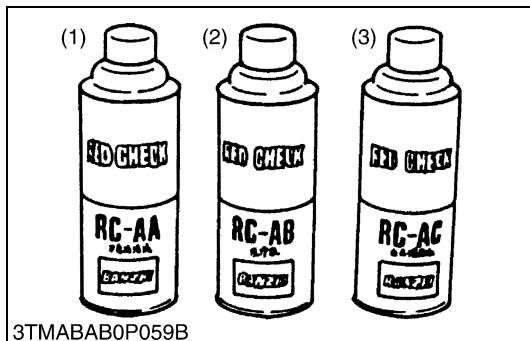
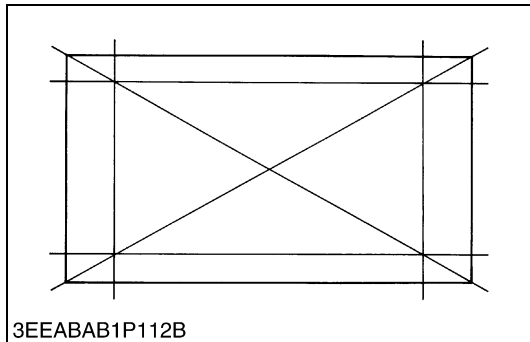
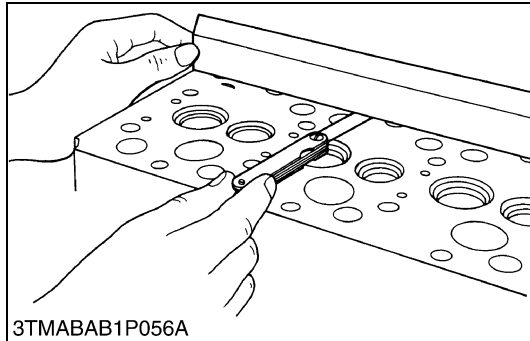
- (1) Alignment Number
(2) Alignment Mark
(3) A
(4) B

- (5) C
(6) No Mark
(7) Oil Groove
(8) Main Bearing Case Screw 1

W1027366

[3] SERVICING

(1) Cylinder Head and Valves



Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the figure.
3. Measure the clearance with a feeler gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ IMPORTANT

- Do not place the straightedge on the combustion chamber.
- Be sure to check the valve recessing after correcting.

Cylinder head surface flatness	Factory spec.	0.05 mm / 500 mm 0.0020 in. / 19.69 in.
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W1027737

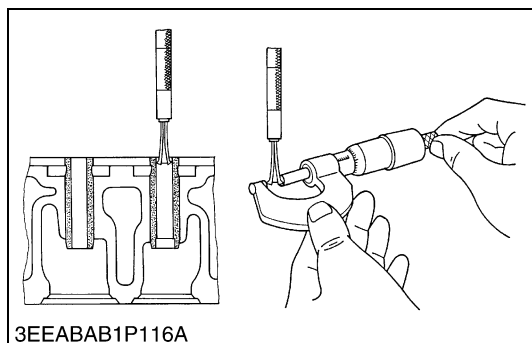
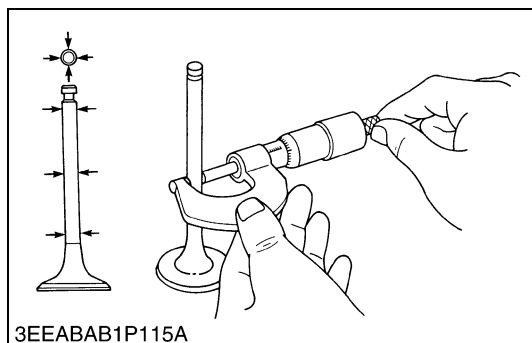
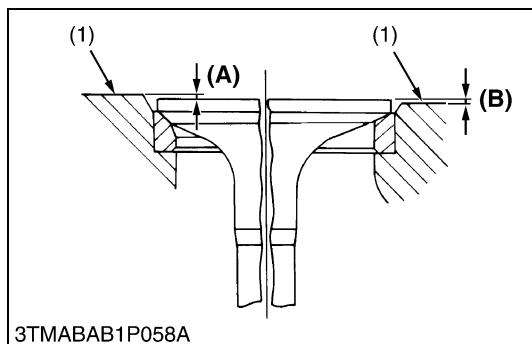
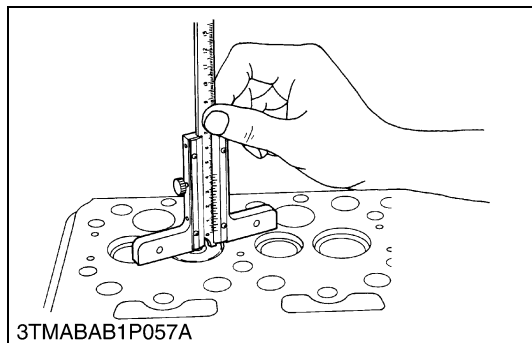
Cylinder Head Flaw

1. Prepare an air spray red check (Code No. 07909-31371).
2. Clean the surface of the cylinder head with detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with white developer (3).
6. If flawed, it can be identified as red marks.

- (1) Red Permeative Liquid
(2) Detergent

- (3) White Developer

W1076542



Valve Recessing

1. Clean the cylinder head surface (1), valve face and valve seat.
2. Insert the valve into the valve guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit, replace the valve.
5. If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

Valve recessing	Factory spec.	0.65 (protrusion) to 0.85 (recessing) mm 0.026 (protrusion) to 0.033 (recessing) in.
	Allowable limit	1.20 (recessing) mm 0.0472 (recessing) in.

(1) Cylinder Head Surface

(A) Recessing

(B) Protrusion

W1076880

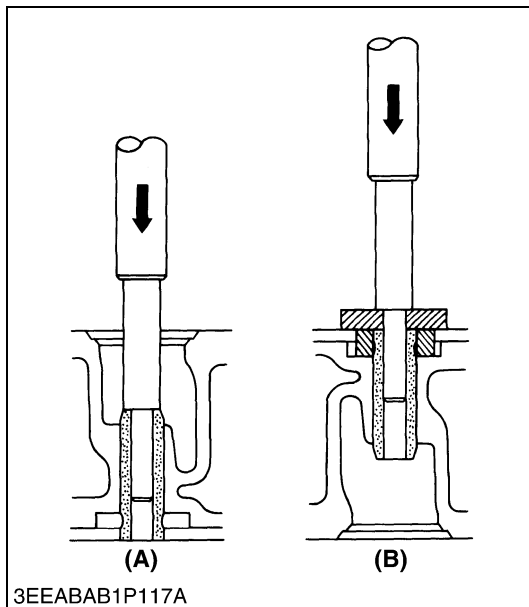
Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valves.
If it still exceeds the allowable limit, replace the valve guide.

Clearance between valve stem and guide	Factory spec.	0.040 to 0.070 mm 0.0016 to 0.0028 in.
	Allowable limit	0.1 mm 0.0039 in.

Valve stem O.D.	Factory spec.	7.960 to 7.975 mm 0.31339 to 0.314398 in.
Valve guide I.D.	Factory spec.	8.015 to 8.030 mm 0.31555 to 0.31614 in.

W1077495



Replacing Valve Guide

(A) (When removing)

1. Press out the used valve guide using a valve guide replacing tool.

(B) (When installing)

1. Clean a new valve guide and valve guide bore, and apply engine oil to them.
2. Press in a new valve guide using a valve guide replacing tool.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

Valve guide I.D. (Intake and exhaust)	Factory spec.	8.015 to 8.030 mm 0.31555 to 0.31614 in.
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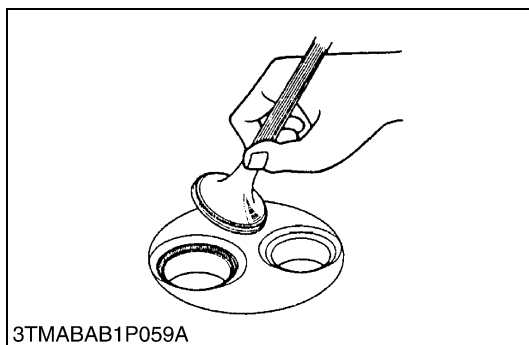
■ IMPORTANT

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

(A) When Removing

(B) When Installing

W1027889



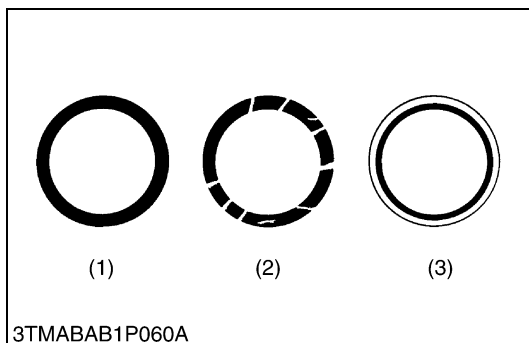
Valve Seating

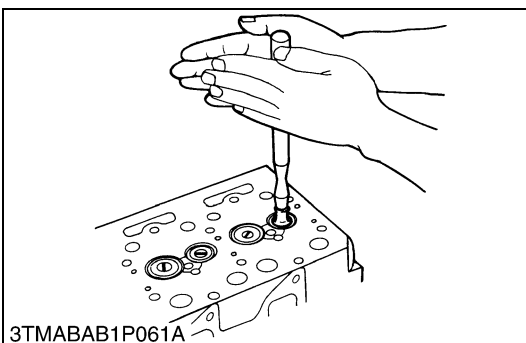
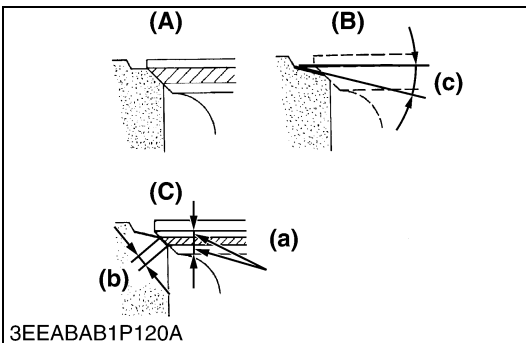
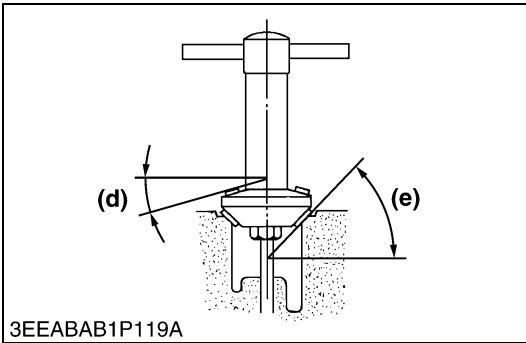
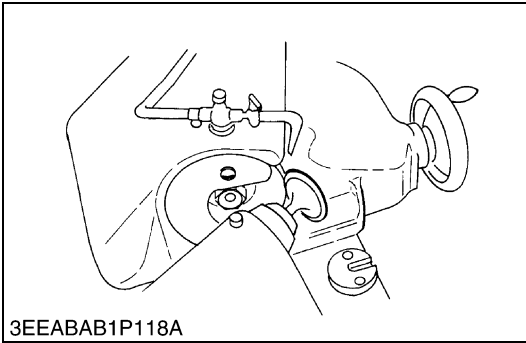
1. Coat the valve face lightly with prussian blue and put the valve on its seat to check the contact.
2. If the valve does not seat all the way around the valve seat or the valve contact is less than 70 %, correct the valve seating as follows.
3. If the valve contact does not comply with the reference value, replace the valve or correct the contact of valve seating.

- (1) Correct
(2) Incorrect

(3) Incorrect

W1028219





Correcting Valve and Valve Seat

■ NOTE

- Before correcting the valve and seat, check the valve stem and the I.D. of valve guide section, and repair them if necessary.
- After correcting the valve seat, be sure to check the valve recessing.

1) Correcting Valve

1. Correct the valve with a valve refacer.

2) Correcting Valve Seat

1. Slightly correct the seat surface with a 1.047 rad (60 °) (intake valve) or 0.785 rad (45 °) (exhaust valve) seat cutter (Code No. 07909-33102).
2. Resurface the seat surface with a 0.523 rad (30 °) valve seat cutter to intake valve seat and with a 0.262 rad (15 °) valve seat cutter to exhaust valve seat so that the width is close to specified valve seat width (2.12 mm, 0.0835 in.)
3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compound between the valve face and valve seat, and fit them with valve lapping tool.
4. Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

(a) Identical Dimensions

A: Check Correct

(b) Valve Seat Width

B: Correct Seat Width

(c) 0.523 rad (30 °) or 0.262 rad (15 °)

C: Check Contact

(d) 0.262 rad (15 °) or 0.523 rad (30 °)

(e) 0.785 rad (45 °) or 1.047 rad (60 °)

W1028350

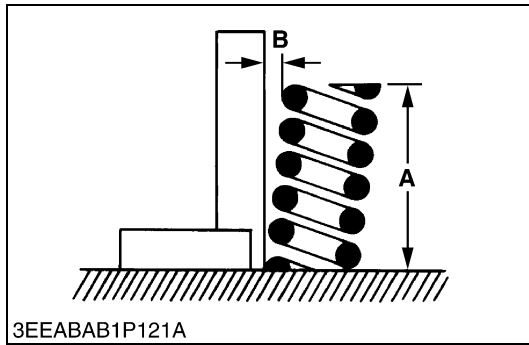
Valve Lapping

1. Apply compound evenly to the valve lapping surface.
2. Insert the valve into the valve guide. Lap the valve onto its seat with a valve flapper or screwdriver.
3. After lapping the valve, wash the compound away and apply oil, then repeat valve lapping with oil.
4. Apply prussian blue to the contact surface to check the seated rate. If it is less than 70 %, repeat valve lapping again.

■ IMPORTANT

- When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.

W1028814



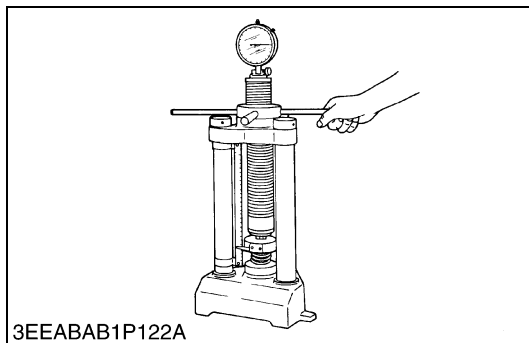
Free Length and Tilt of Valve Spring

1. Measure the free length **A** of valve spring with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the valve spring on a surface plate, place a square on the side of the valve spring.
3. Check to see if the entire side is in contact with the square. Rotate the valve spring and measure the maximum tilt **B**. Check the entire surface of the valve spring for scratches. If there is any defect, replace it.

Free length A	Factory spec.	41.7 to 42.2 mm 1.6417 to 1.6614 in.
	Allowable limit	41.2 mm 1.6220 in.

Tilt B	Allowable limit	1.0 mm 0.039 in.
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W1028935

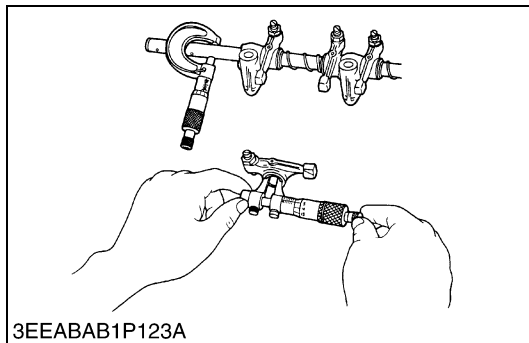


Valve Spring Setting Load

1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load / Setting length	Factory spec.	117.6 N / 35 mm 12.0 kgf / 35 mm 26.4 lbs / 1.3780 in.
	Allowable limit	100.0 N / 35 mm 10.2 kgf / 35 mm 22.5 lbs / 1.3780 in.

W1078436



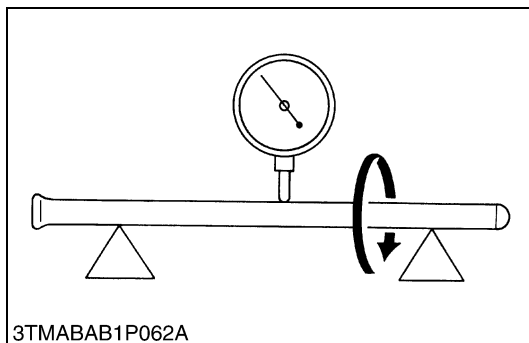
Oil Clearance between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm shaft O.D. with an outside micrometer.
2. Measure the rocker arm I.D. with an inside micrometer, and then calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Oil clearance between rocker arm and rocker arm shaft	Factory spec.	0.016 to 0.045 mm 0.00063 to 0.00177 in.
	Allowable limit	0.10 mm 0.0039 in.

Rocker arm shaft O.D.	Factory spec.	13.973 to 13.984 mm 0.55012 to 0.55055 in.
Rocker arm I.D.	Factory spec.	14.000 to 14.018 mm 0.55118 to 0.55189 in.

W1029150

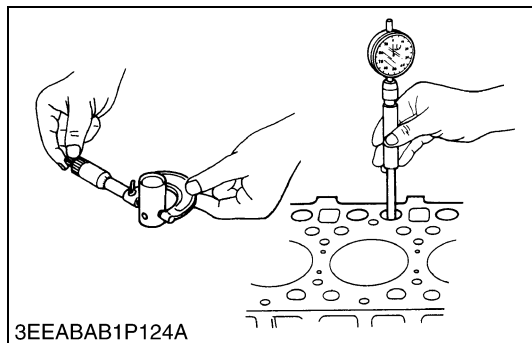


Push Rod Alignment

1. Place the push rod on V blocks.
2. Measure the push rod alignment.
3. If the measurement exceeds the allowable limit, replace the push rod.

Push rod alignment	Allowable limit	0.25 mm 0.0098 in.
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W1029290



Oil Clearance between Tappet and Tappet Guide Bore

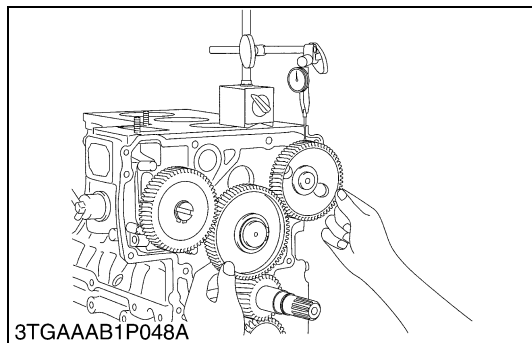
1. Measure the tappet O.D. with an outside micrometer.
2. Measure the I.D. of the tappet guide bore with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit or the tappet is damaged, replace the tappet.

Oil Clearance between tappet and tappet guide bore	Factory spec.	0.020 to 0.062 mm 0.00079 to 0.00244 in.
	Allowable limit	0.07 mm 0.0028 in.

Tappet O.D.	Factory spec.	23.959 to 23.980 mm 0.94327 to 0.94410 in.
Tappet guide bore I.D.	Factory spec.	24.000 to 24.021 mm 0.94488 to 0.94571 in.

W1029366

(2) Timing Gears, Camshaft and Fuel Camshaft



Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and the gear.
4. If the oil clearance is proper, replace the gear.

Backlash between idle gear and crank gear	Factory spec.	0.0415 to 0.1122 mm 0.00163 to 0.00442 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear and cam gear	Factory spec.	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear and injection pump gear	Factory spec.	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.
	Allowable limit	0.15 mm 0.0059 in.

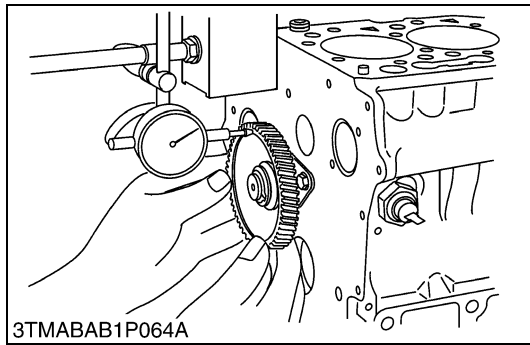
Backlash between crank gear and oil pump gear	Factory spec.	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.
	Allowable limit	0.15 mm 0.0059 in.

For Balancer Model Only

Backlash between idle gear and balancer gear (IN. side)	Factory spec.	0.0350 to 0.1160 mm 0.00138 to 0.00457 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between cam gear and balancer gear (EX. side)	Factory spec.	0.0350 to 0.1160 mm 0.00138 to 0.00457 in.
	Allowable limit	0.15 mm 0.0059 in.

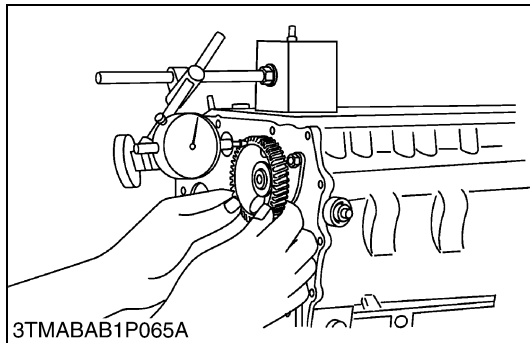
W1029564

**Idle Gear Side Clearance**

1. Set a dial indicator with its tip on the idle gear.
2. Measure the side clearance by moving the idle gear to the front and rear.
3. If the measurement exceeds the allowable limit, replace the idle gear collar.

Idle gear side clearance	Factory spec.	0.12 to 0.48 mm 0.0047 to 0.0189 in.
	Allowable limit	0.9 mm 0.0354 in.

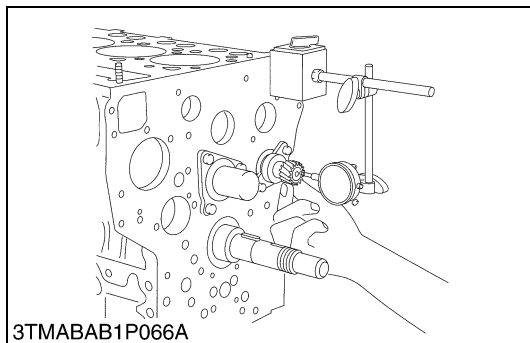
W1029843

**Camshaft Side Clearance**

1. Set a dial indicator with its tip on the camshaft.
2. Measure the side clearance by moving the cam gear to the front and rear.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper.

Camshaft side clearance	Factory spec.	0.07 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable limit	0.30 mm 0.0118 in.

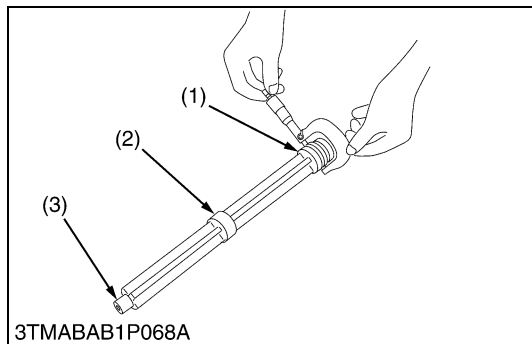
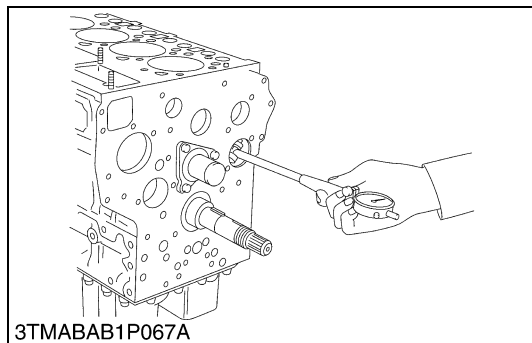
W1030012

**Balancer Shaft Side Clearance (For Balancer Model Only)**

1. Set a dial indicator with tip on the balancer shaft.
2. Measure the side clearance by moving the balancer shaft to the front and rear.
3. If the measurement exceeds the allowable limit, replace the balancer shaft.

Side clearance of balancer shaft	Factory spec.	0.07 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable limit	0.3 mm 0.0118 in.

W1030111



Oil Clearance of Balancer Shaft Journal (For Balancer Model Only)

1. Measure the balancer shaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for balancer shaft with an inside micrometer or cylinder gauge.
3. If the clearance exceeds the allowable limit, replace the balancer shaft.

Oil clearance of balancer shaft journal 1	Factory spec.	0.030 to 0.111 mm 0.00118 to 0.00437 in.
	Allowable limit	0.2 mm 0.0079 in.

Balancer shaft journal 1 O.D.	Factory spec.	43.934 to 43.950 mm 1.72968 to 1.73031 in.
Balancer shaft bearing 1 I.D.	Factory spec.	43.980 to 44.045 mm 1.73149 to 1.73405 in.

Oil clearance of balancer shaft journal 2	Factory spec.	0.030 to 0.111 mm 0.00118 to 0.00437 in.
	Allowable limit	0.2 mm 0.0079 in.

Balancer shaft journal 2 O.D.	Factory spec.	41.934 to 41.950 mm 1.65094 to 1.65157 in.
Balancer shaft bearing 2 I.D.	Factory spec.	41.980 to 42.045 mm 1.65275 to 1.65531 in.

Oil clearance of balancer shaft journal 3	Factory spec.	0.020 to 0.094 mm 0.00079 to 0.00370 in.
	Allowable limit	0.2 mm 0.0079 in.

Balancer shaft journal 3 O.D.	Factory spec.	21.947 to 21.960 mm 0.86405 to 0.86456 in.
Balancer shaft bearing 3 I.D.	Factory spec.	21.980 to 22.041 mm 0.86535 to 0.86775 in.

(1) Balancer Shaft Journal 1
(2) Balancer Shaft Journal 2

(3) Balancer Shaft Journal 3

W1030206

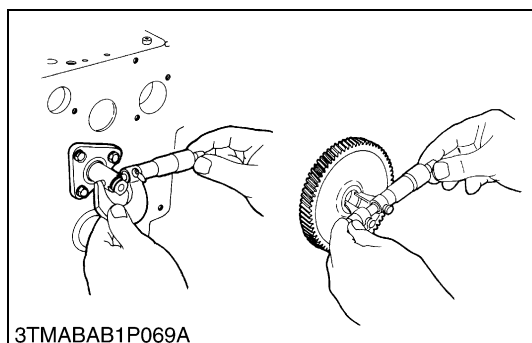
Oil Clearance between Idle Gear Shaft and Idle Gear Bushing

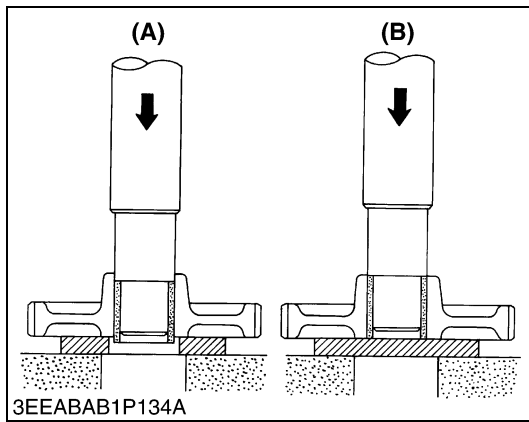
1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing.

Clearance between idle gear shaft and idle gear bushing	Factory spec.	0.025 to 0.066 mm 0.00098 to 0.00260 in.
	Allowable limit	0.1 mm 0.0039 in.

Idle gear shaft O.D.	Factory spec.	37.959 to 37.975 mm 1.49445 to 1.49508 in.
Idle gear bushing I.D.	Factory spec.	38.000 to 38.025 mm 1.49606 to 1.49704 in.

W1030933





Replacing Idle Gear Bushing

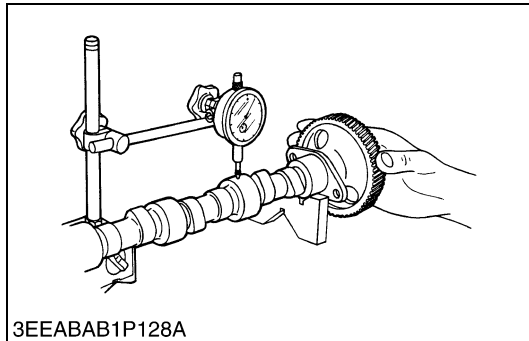
(A) (When removing)

1. Using an idle gear bushing replacing tool, press out the used bushing.

(B) (When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Using an idle gear bushing replacing tool, press in a new bushing (service parts) to the specified dimension. (See figure.)

W1031083

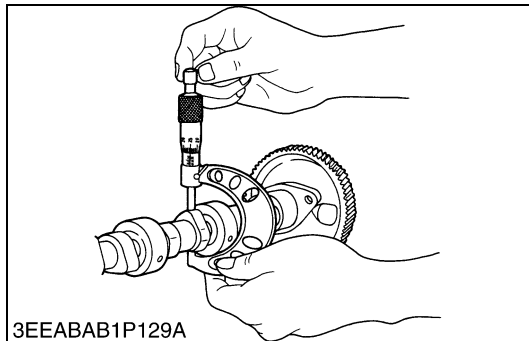


Camshaft Alignment

1. Support the camshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the camshaft alignment.
4. If the measurement exceeds the allowable limit, replace the camshaft.

Camshaft alignment	Allowable limit	0.01 mm 0.0004 in.
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W1031413



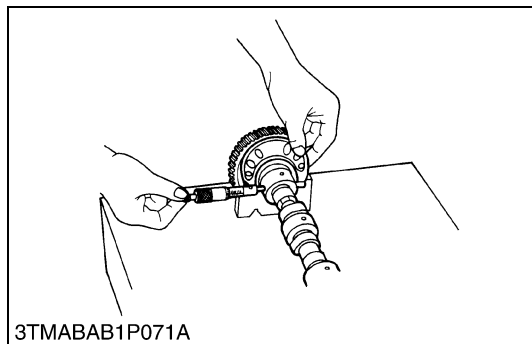
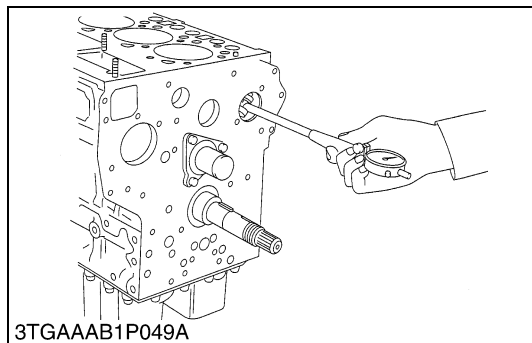
Cam Height

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

Cam height of intake	Factory spec.	33.90 mm 1.3346 in.
	Allowable limit	33.85 mm 1.3327 in.

Cam height of exhaust	Factory spec.	33.90 mm 1.3346 in.
	Allowable limit	33.85 mm 1.3327 in.

W1031532



Oil Clearance of Camshaft Journal

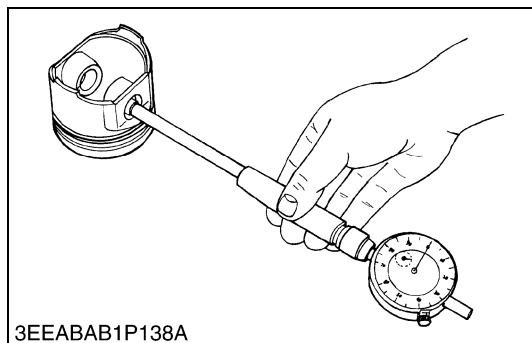
1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory spec.	0.050 to 0.091 mm 0.0020 to 0.0036 in.
	Allowable limit	0.15 mm 0.0059 in.

Camshaft journal O.D.	Factory spec.	39.934 to 39.950 mm 1.57221 to 1.57284 in.
Cylinder block bore I.D.	Factory spec.	40.000 to 40.025 mm 1.57480 to 1.57579 in.

W1031662

(3) Piston and Connecting Rod

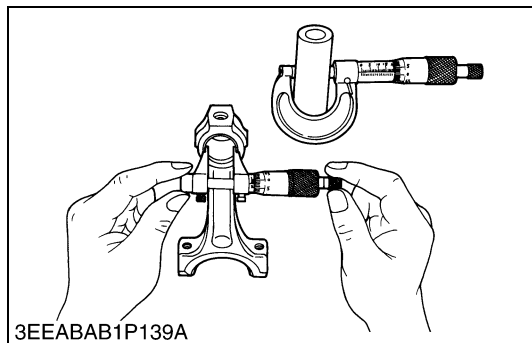


Piston Pin Bore I.D.

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

Piston pin bore I.D.	Factory spec.	25.000 to 25.013 mm 0.98425 to 0.98476 in.
	Allowable limit	25.05 mm 0.9862 in.

W1031817



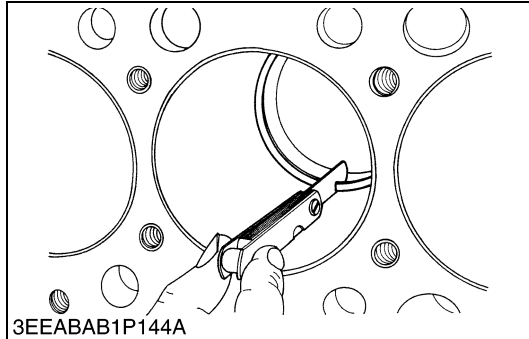
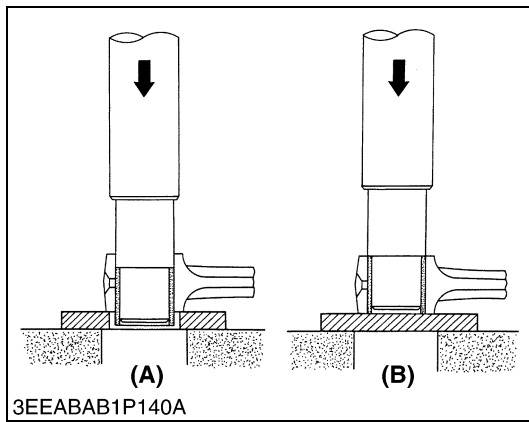
Oil Clearance between Piston Pin and Small End Bushing

1. Measure the piston pin O.D. where it contacts the bushing with an outside micrometer.
2. Measure the small end bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory spec.	0.014 to 0.038 mm 0.00055 to 0.00150 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory spec.	25.002 to 25.011 mm 0.98433 to 0.98468 in.
Small end bushing I.D.	Factory spec.	25.025 to 25.040 mm 0.98523 to 0.98582 in.

W1031982



Replacing Connecting Rod Small End Bushing

(A) (When removing)

1. Press out the small end bushing with a connecting rod small end bushing replacing tool.

(B) (When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Press fit a new bushing, taking due care to see that the connecting rod hole matches the bushing hole.

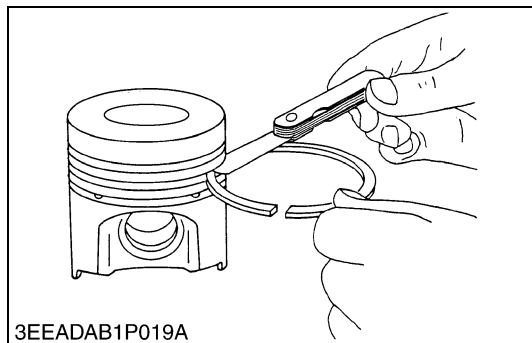
W1032140

Piston Ring Gap

1. Insert 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 gap exceeds the allowable limit, replace the ring.

Top ring	Factory spec.	0.20 to 0.35 mm 0.0079 to 0.0138 in.
	Allowable limit	1.25 mm 0.0492 in.
Second ring	Factory spec.	D1503-M-DI 0.30 to 0.45 mm 0.012 to 0.018 in.
		D1503-M-DI-T 0.40 to 0.55 mm 0.016 to 0.022 in.
		D1703-M-DI 0.35 to 0.50 mm D1803-M-DI 0.014 to 0.020 in. V2203-M-DI V2403-M-DI
	Allowable limit	1.25 mm 0.0492 in.
Oil ring	Factory spec.	D1503-M-DI 0.25 to 0.45 mm D1503-M-DI-T 0.0098 to 0.0177 in.
		D1703-M-DI 0.20 to 0.40 mm D1803-M-DI 0.0079 to 0.0157 in. V2203-M-DI V2403-M-DI
	Allowable limit	1.25 mm 0.0492 in.

W1032246



Clearance between Piston Ring and Groove

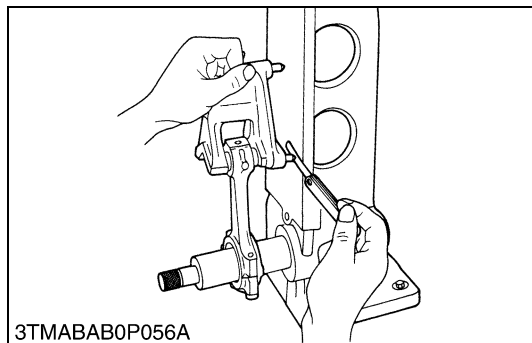
1. Remove carbon from the ring grooves.
2. Measure the clearance between the ring and the groove with a feeler gauge.
3. If the clearance exceeds allowable limit, replace the ring since compression leak and oil shortage result.
4. If the clearance still exceeds the allowable limit after replacing the ring, replace the piston.

Top Ring	Factory spec.	D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	0.050 to 0.090 mm 0.0020 to 0.0035 in.
	Allowable limit		0.2 mm 0.0079 in.

Second ring	Factory spec.	D1503-M-DI D1503-M-DI-T	0.093 to 0.128 mm 0.0037 to 0.0050 in.
		D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	0.050 to 0.090 mm 0.0020 to 0.0035 in.
	Allowable limit		0.2 mm 0.0079 in.

Oil ring	Factory spec.	D1503-M-DI D1503-M-DI-T	0.020 to 0.060 mm 0.00079 to 0.00236 in.
		D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	0.030 to 0.070 mm 0.0012 to 0.0028 in.
	Allowable limit		0.15 mm 0.0059 in.

W1032489



Connecting Rod Alignment

■ NOTE

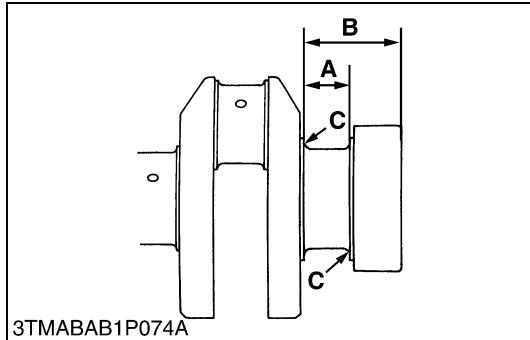
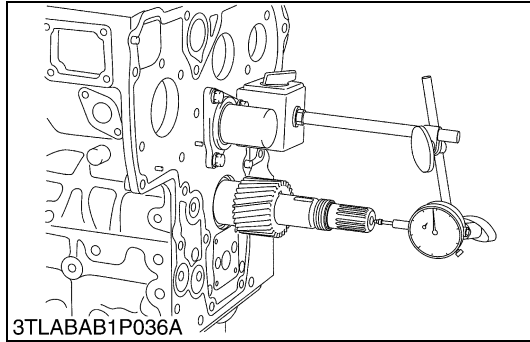
- Since the I.D. of the connecting rod small end bushing is the basis of this check, check bushing for wear beforehand.

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

Connecting rod alignment	Allowable limit	0.05 mm 0.0020 in.
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W1032720

(4) Crankshaft



Side Clearance of Crankshaft

1. Move the crankshaft to the flywheel side.
2. Set a dial indicator to the crankshaft.
3. Measure the end play by pulling the crankshaft toward the crank gear.
4. If the measurement exceeds the allowable limit, replace the thrust bearing 1 and 2.

(Serial No : below 3R9999)

Crankshaft side clearance	Factory spec.	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	0.15 to 0.35 mm 0.0059 to 0.0138 in.
		D1803-M-DI V2403-M-DI	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit		0.5 mm 0.0197 in.

(Serial No : above 3S0001)

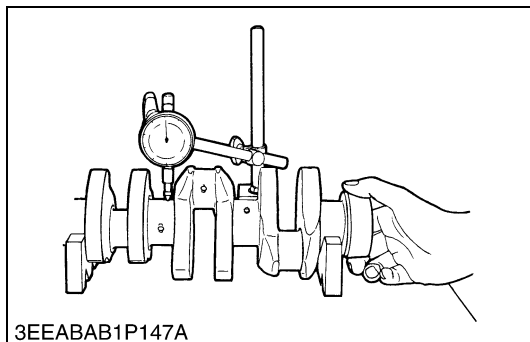
Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.5 mm 0.0197 in.

(Reference)

- Oversize dimensions of crankshaft journal

Dimension	Oversize	
	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	26.20 to 26.25 mm 1.0315 to 1.0335 in.	26.40 to 26.45 mm 1.0394 to 1.0413 in.
B	54.5 to 54.7 mm 2.1456 to 2.1535 in.	54.6 to 54.8 mm 2.1496 to 2.1574 in.
C	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
(0.4-S) The crankshaft journal must be fine-finished to higher than ∇∇∇∇		

W1032880

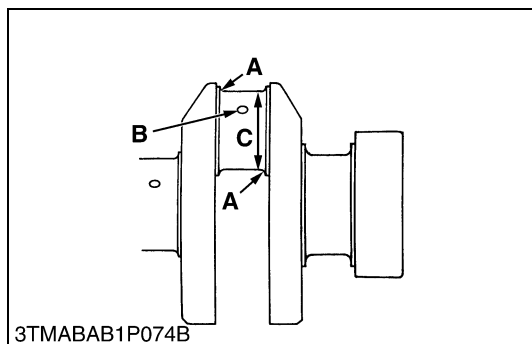
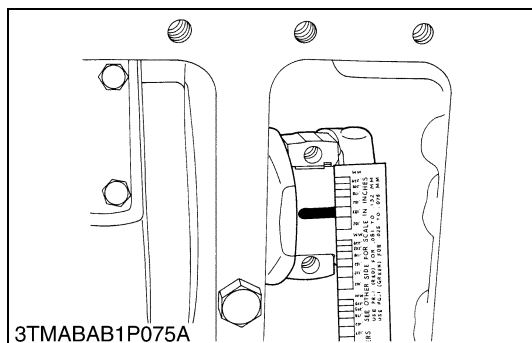


Crankshaft Alignment

1. Support the crankshaft with V blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.00079 in.
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W1033001



Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage (Code No.: 07909-30241) on the center of the crankpin in each direction as shown in the figure.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
5. If the oil clearance exceeds the allowable limit, replace the crankpin bearing.
6. If the same size bearing is useless because of the crankpin wear, replace it with an undersize one referring to the table and figure.

■ NOTE

- **Never insert the plastigage into the crankpin oil hole.**
- **Be sure not to move the crankshaft while the connecting rod screws are tightened.**

Oil clearance between crankpin and crankpin bearing	Factory spec.	0.025 to 0.087 mm 0.00098 to 0.00343 in.
	Allowable limit	0.2 mm 0.0079 in.

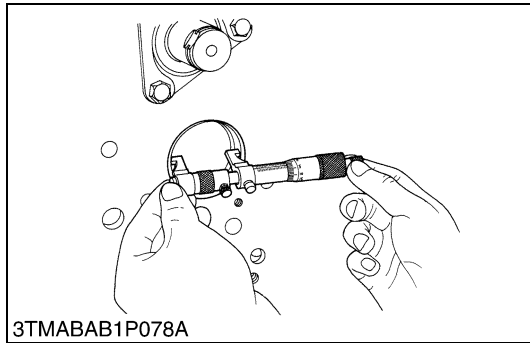
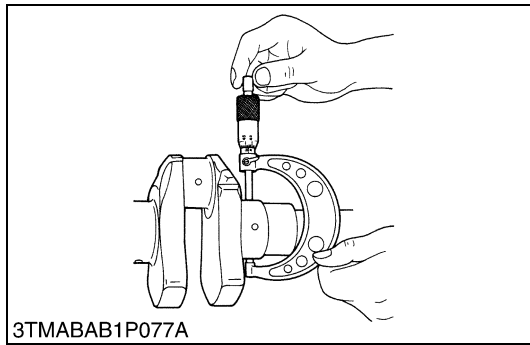
Crankpin O.D.	Factory spec.	46.959 to 46.975 mm 1.84878 to 1.84941 in.
Crankpin bearing I.D.	Factory spec.	47.000 to 47.046 mm 1.85039 to 1.85220 in.

(Reference)

- Undersize dimensions of crankpin

Dimension	Undersize	
	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	3.3 to 3.7 mm radius 0.1299 to 0.1457 in. radius	3.3 to 3.7 mm radius 0.1299 to 0.1457 in. radius
*B	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
C	46.759 to 46.775 mm 1.84091 to 1.84154 in.	46.559 to 46.575 mm 1.83303 to 1.83366 in.
(0.4S) The crankpin must be fine-finished to higher than $\nabla\nabla\nabla\nabla$ *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.		

W1033106



Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the O.D. of the crankshaft journal with an outside micrometer.
2. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer, and calculate oil clearance.
3. If the clearance exceeds the allowable limit, replace the crankshaft bearing 1.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

Oil clearance between crankshaft journal and crankshaft bearing 1	Factory spec.	0.040 to 0.118 mm 0.00157 to 0.00465 in.
	Allowable limit	0.2 mm 0.0079 in.

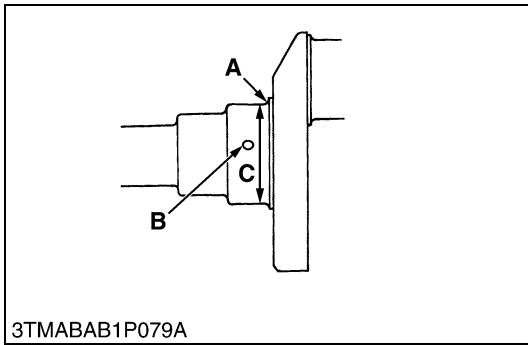
(Serial No. : below 3R9999)

Crankshaft journal O.D.	Factory spec.	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	51.921 to 51.940 mm 2.04413 to 2.04488 in.
		D1803-M-DI V2403-M-DI	59.921 to 59.940 mm 2.35909 to 2.35984 in.
Crankshaft bearing 1 I.D.	Factory spec.	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	51.980 to 52.039 mm 2.04646 to 2.04878 in.
		D1803-M-DI V2403-M-DI	59.980 to 60.039 mm 2.36142 to 2.36374 in.

(Serial No. : above 3S0001)

Crankshaft journal O.D.	Factory spec.	59.921 to 59.940 mm 2.35909 to 2.35984 in.
Crankshaft bearing 1 I.D.	Factory spec.	59.980 to 60.039 mm 2.36142 to 2.36374 in.

W1033717



Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1 (Continued)

(Serial No. : below 3R9999)

(Reference)

- Undersize dimensions of crankshaft journal

Undersize Dimension		0.2 mm 0.008 in.	0.4 mm 0.016 in.
A		2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*B		1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
C	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	51.721 to 51.740 mm 2.03626 to 2.03701 in.	51.521 to 51.540 mm 2.02839 to 2.02913 in.
	D1803-M-DI V2403-M-DI	59.721 to 59.740 mm 2.35122 to 2.35197 in.	59.521 to 59.540 mm 2.34335 to 2.34409 in.
(0.4S) The crankpin must be fine-finished to higher than ▽▽▽▽ *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.			

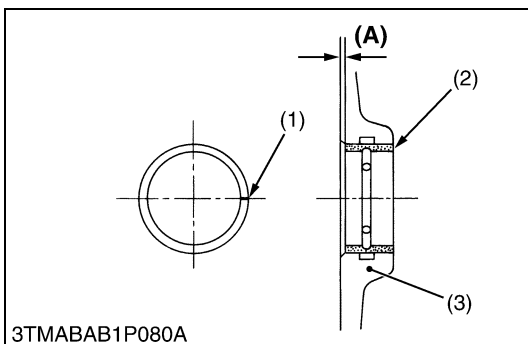
(Serial No. : above 3S0001)

(Reference)

- Undersize dimensions of crankshaft journal

Undersize Dimension		0.2 mm 0.008 in.	0.4 mm 0.016 in.
A		2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*B		1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
C		59.721 to 59.740 mm 2.35122 to 2.35197 in.	59.521 to 59.540 mm 2.34335 to 2.34409 in.
(0.4S) The crankpin must be fine-finished to higher than ▽▽▽▽ *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.			

W1073467



Replacing Crankshaft Bearing 1

(When removing)

1. Press out the used crankshaft bearing 1 (2) using a crankshaft bearing 1 replacing tool.

(When installing)

1. Clean a new crankshaft bearing 1 (2) and crankshaft journal bore, and apply engine oil to them.
2. Using a crankshaft bearing 1 replacing tool, press in a new bearing 1 (2) so that its seam (1) directs toward the exhaust manifold side.

Dimension (A)	Factory spec.	4.2 to 4.5 mm 0.1654 to 0.1772 in.
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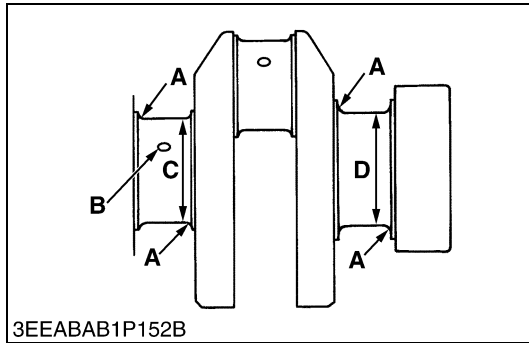
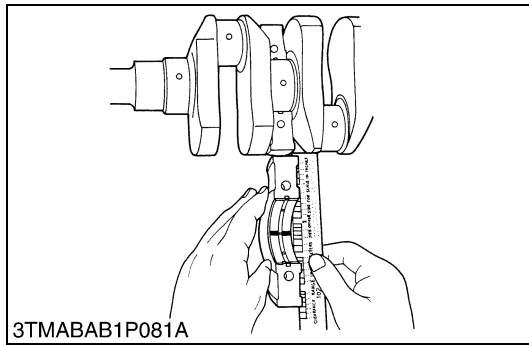
(1) Seam

(2) Crankshaft Bearing 1

(3) Cylinder Block

(A) Dimension

W1033946



Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2

1. Put a strip of plastigage on the center of the journal.
2. Install the bearing case and tighten the bearing case screws 1 to the specified torque, and remove the bearing case again.
3. Measure the amount of the flattening with the scale and get the oil clearance.
4. If the clearance exceeds the allowable limit, replace the crankshaft bearing 2.
5. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

NOTE

- Be sure not to move the crankshaft while the bearing case screws are tightened.

Oil clearance between crankshaft and crankshaft bearing 2	Factory spec.	0.040 to 0.104 mm 0.00157 to 0.00409 in.
	Allowable limit	0.20 mm 0.0079 in.

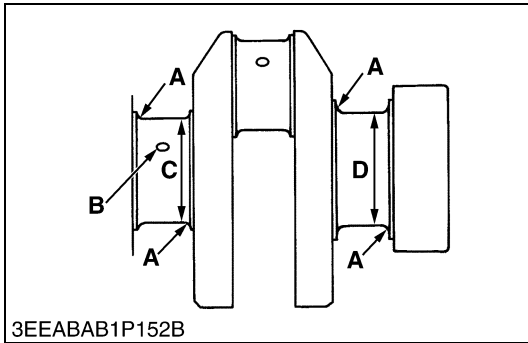
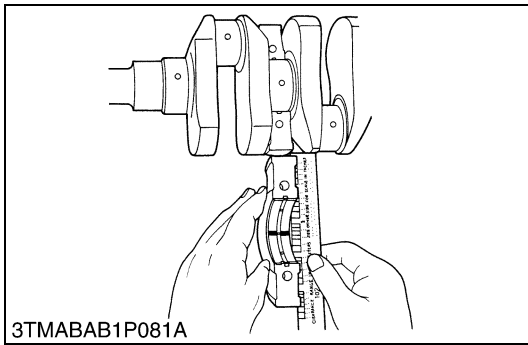
(Serial No. : below 3R9999)

Crankshaft journal O.D.	Factory spec.	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	51.921 to 51.940 mm 2.04413 to 2.04488 in.
		D1803-M-DI V2403-M-DI	59.921 to 59.940 mm 2.35909 to 2.35984 in.
Crankshaft bearing 2 I.D.	Factory spec.	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	51.980 to 52.025 mm 2.04646 to 2.04823 in.
		D1803-M-DI V2403-M-DI	59.980 to 60.025 mm 2.36142 to 2.36318 in.

(Serial No. : above 3S0001)

Crankshaft journal O.D.	Factory spec.	59.921 to 59.940 mm 2.35909 to 2.35984 in.
Crankshaft bearing 2 I.D.	Factory spec.	59.980 to 60.025 mm 2.36142 to 2.36318 in.

W1083821



Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2 (Continued)

(Serial No. : below 3R9999)

(Reference)

- Undersize dimensions of crankshaft journal

Undersize Dimension		0.2 mm 0.008 in.	0.4 mm 0.016 in.
A		2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*B		1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
C, D	D1503-M-DI D1503-M-DI-T D1703-M-DI V2203-M-DI	51.721 to 51.740 mm 2.03626 to 2.03701 in.	51.521 to 51.540 mm 2.02839 to 2.02913 in.
	D1803-M-DI V2403-M-DI	59.721 to 59.740 mm 2.35122 to 2.35197 in.	59.521 to 59.540 mm 2.34335 to 2.34409 in.
(0.4S) The crankpin must be fine-finished to higher than ∇∇∇∇ *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.			

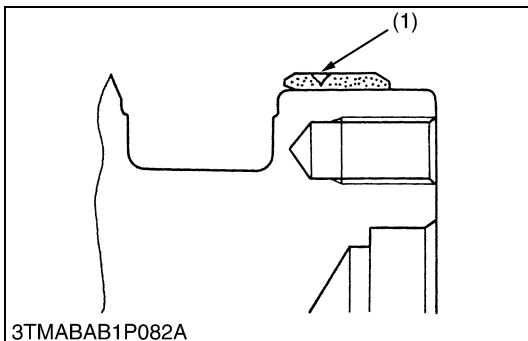
(Serial No. : above 3S0001)

(Reference)

- Undersize dimensions of crankshaft journal

Undersize Dimension		0.2 mm 0.008 in.	0.4 mm 0.016 in.
A		2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*B		1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
C, D		59.721 to 59.740 mm 2.35122 to 2.35197 in.	59.521 to 59.540 mm 2.34335 to 2.34409 in.
(0.4S) The crankpin must be fine-finished to higher than ∇∇∇∇ *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.			

W1034075



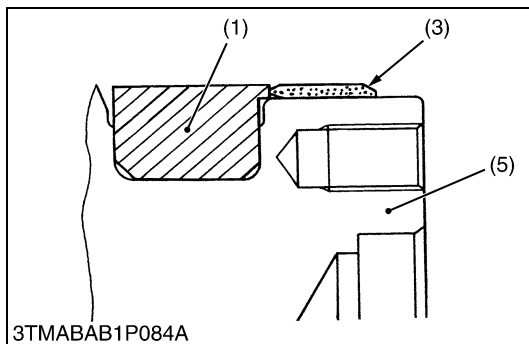
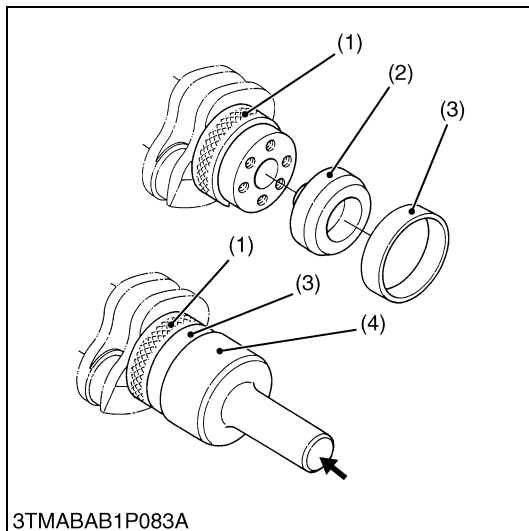
Crankshaft Sleeve Wear

1. Check the wear on the crankshaft sleeve (1).
2. If the wear exceeds the allowable limit or when the engine oil leaks, replace the crankshaft sleeve (1).

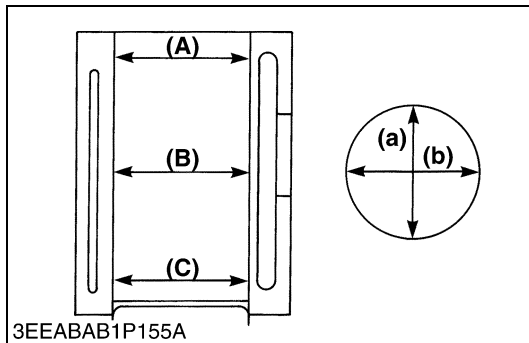
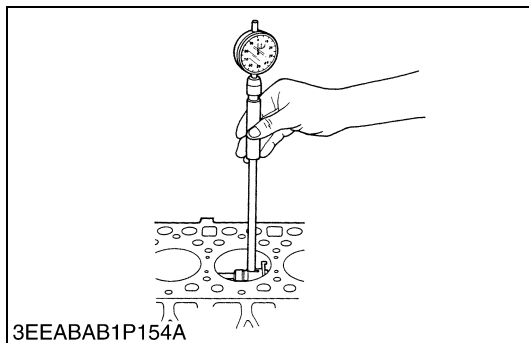
Wear of sleeve	Allowable limit	0.1 mm 0.0039 in.
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(1) Crankshaft Sleeve

W1033354



(5) Cylinder



Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve (3) using a special-use puller set (Code No.: 07916-32091).
2. Set the sleeve guide (2) to the crankshaft (5).
3. Set the stopper (1) to the crankshaft (5) as shown in figure.
4. Heat a new sleeve to a temperature between 150 and 200 °C (302 to 392 °F), and fix the sleeve to the crankshaft (5) as shown in figure.
5. Press fit the sleeve using the auxiliary socket for pushing (4).

NOTE

- **Mount the sleeve with its largely chamfered surface facing outward.**

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

W1033503

Cylinder Wear

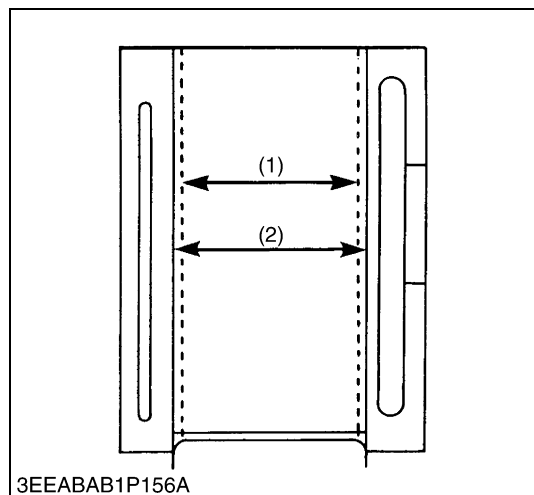
1. Measure the I.D. of the cylinder at the six positions (see figure) with a cylinder gauge to find the maximum and minimum I.D.'s.
2. Get the difference (Maximum wear) between the maximum and the minimum I.D.'s.
3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (Refer to **“Correcting Cylinder”**.)
4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bores. (Refer to **“Correcting Cylinder”**.)

Cylinder I.D.	Factory spec.	D1503-M-DI D1503-M-DI-T	83.000 to 83.022 mm 3.26772 to 3.26858 in.
		D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	87.000 to 87.022 mm 3.42519 to 3.42606 in.
Maximum wear	Allowable limit	D1503-M-DI D1503-M-DI-T	83.150 mm 3.2736 in.
		D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	87.150 mm 3.4311 in.

- A: Top
B: Middle
C: Bottom (Skirt)

- (a) Right-angled to Piston Pin
(b) Piston Pin Direction

W1034389



Correcting Cylinder (Oversize +0.25 mm)

- When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

Oversize cylinder I.D.	Factory spec.	D1503-M-DI D1503-M-DI-T	83.250 to 83.272 mm 3.27756 to 3.27843 in.
		D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	87.250 to 87.272 mm 3.43503 to 3.43590 in.
Maximum wear	Allowable limit	D1503-M-DI D1503-M-DI-T	83.400 mm 3.2835 in.
		D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	87.400 mm 3.4409 in.
Finishing	Hone to 2.2 to 3.0 mm μ R max. $\nabla\nabla\nabla$ (0.00087 to 0.00118 in. μ R max.)		

- Replace the piston and piston rings with oversize (+0.25 mm) ones.

NOTE

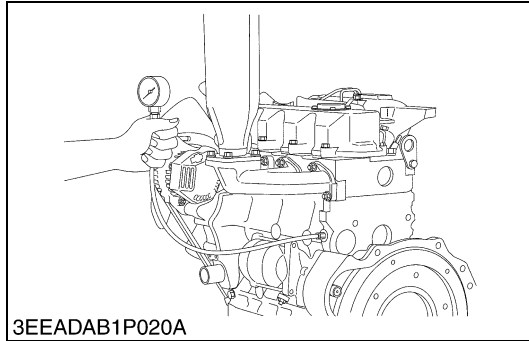
- When replacing the piston with an oversize one, select an oversize piston with the same STD piston number (00, 05 or 10).
- When the oversize cylinder is worn beyond the allowable limit, replace the cylinder block with a new one.

(1) Cylinder I.D. (Before Correction) (2) Oversize Cylinder I.D.

W1034448

3. LUBRICATING SYSTEM

[1] Checking



Engine Oil Pressure

1. Remove the engine oil pressure switch, and set a oil pressure tester (Code No.: 07916-32032).
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.
 - Engine oil insufficient.
 - Oil pump defective
 - Oil strainer clogged
 - Oil filter cartridge clogged
 - Oil gallery clogged
 - Excessive oil clearance
 - Foreign matter in the relief valve

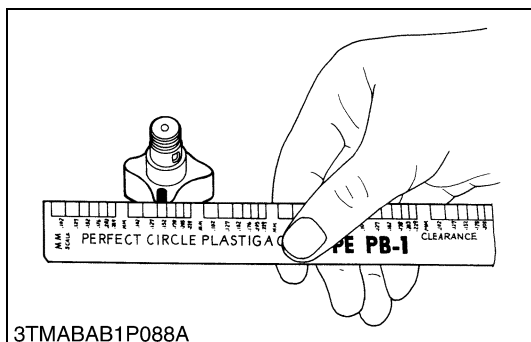
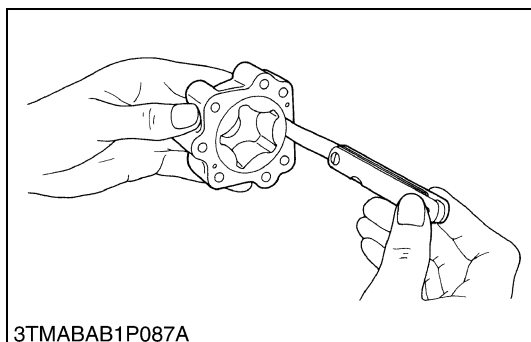
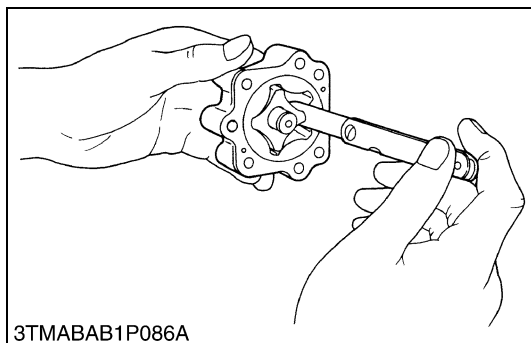
Engine oil pressure	At idle speed	Allowable limit	49 kPa 0.5 kgf/cm ² 7 psi
	At rated speed	Factory spec.	294.2 to 441 kPa 3.0 to 4.5 kgf/cm ² 42.7 to 64 psi
		Allowable limit	245 kPa 2.5 kgf/cm ² 36 psi

(When reassembling)

- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

W1034952

[2] Servicing



Rotor Lobe Clearance

1. Measure the clearance between 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 exceeds the factory specifications, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory spec.	0.03 to 0.14 mm 0.0012 to 0.0055 in.
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Clearance between outer rotor and pump body	Factory spec.	0.11 to 0.19 mm 0.0043 to 0.0075 in.
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W1035296

Clearance between Rotor and Cover

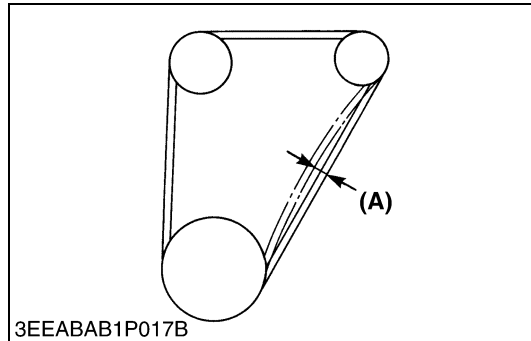
1. Put a strip of plastigage (Code No.: 07909-30241) onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the width of the press gauge with a sheet of gauge.
4. If the clearance exceeds the factory specifications, replace oil pump rotor assembly.

Clearance between inner rotor and cover	Factory spec.	0.105 to 0.150 mm 0.00413 to 0.00591 in.
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W1035444

4. COOLING SYSTEM

[1] CHECKING AND ADJUSTING



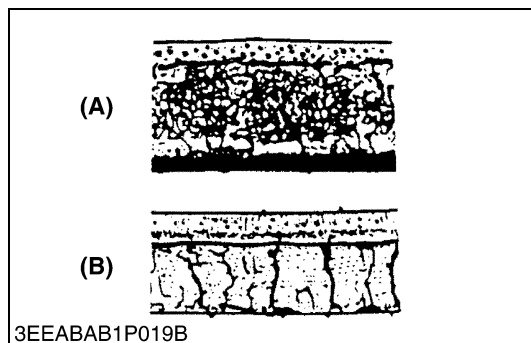
Fan Belt Tension

1. Measure the deflection **(A)**, depressing the belt halfway between the fan drive pulley and alternator pulley at specified force (98 N, 10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection (A)	Factory spec.	7.0 to 9.0 mm / 98 N or 10 kgf 0.28 to 0.35 in. / 98 N or 22 lbs
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(A) Deflection

W1035667



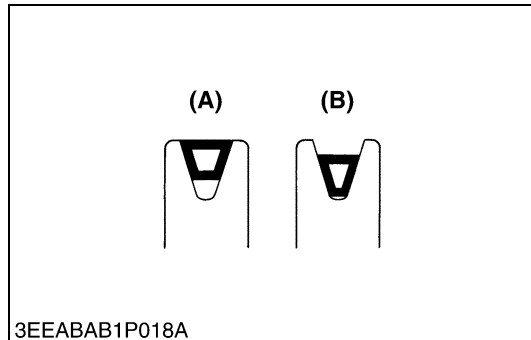
Fan Belt Damage and Wear

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

(A) Good

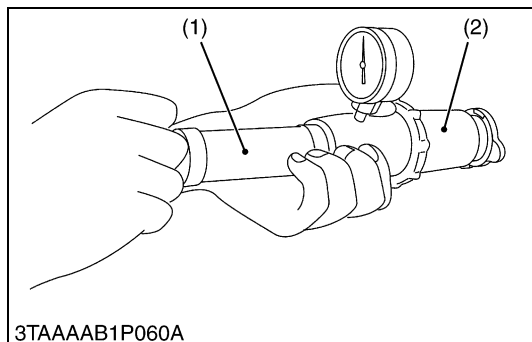
(B) Bad

W1035758



CAUTION

- When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.



Radiator Cap Air Leakage

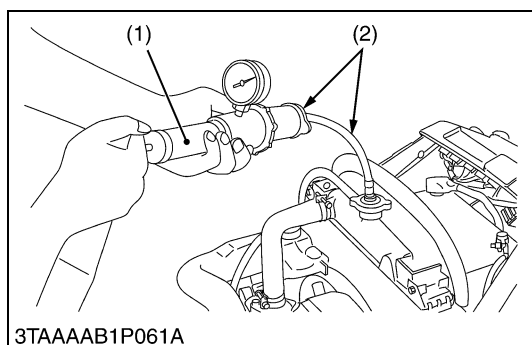
- Set a radiator tester (1) and adaptor (2) (BANZAI Code No. RCT-2A-30S) on the radiator cap.
- Apply the specified pressure (88 kPa, 0.9 kgf/cm², 13 psi), and measure the time for the pressure to fall to 59 kPa (0.6 kgf/cm², 9 psi).
- If the measurement is less than the factory specification, replace the radiator cap.

Pressure falling time	Factory spec.	More than 10 seconds for pressure fall from 88 to 59 kPa (from 0.9 to 0.6 kgf/cm ² , from 13 to 9 psi)
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(1) Radiator Tester

(2) Adaptor

W10387530



Radiator Water Leakage

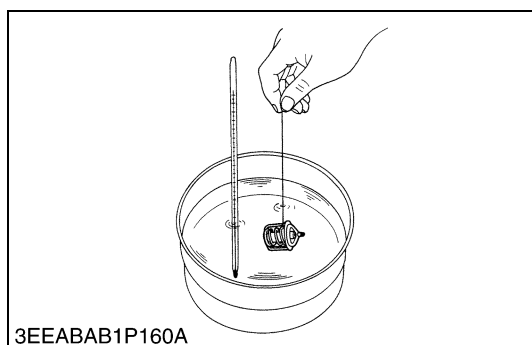
- Pour a specified amount of water into the radiator.
- Set a radiator tester (1) (Code No. 07909-31551) and an adapter (2) (BANZAI Code No. RCT-2A-30S) and raise the water pressure to the specified pressure.
- Check the radiator for water leaks.
- For water leak from the pinhole, repair with the radiator cement. When water leak is excessive, replace the radiator.

Radiator water leakage test pressure	Factory spec.	137 kPa 1.3 kgf/cm ² 19 psi
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(1) Radiator Tester

(2) Adaptor

W10389070



Thermostat Valve Opening Temperature

- Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
- Heating the water gradually, read the temperature when the valve opens and leaves the string.
- Continue heating and read the temperature when the valve opens approx. 6 mm (0.236 in.).
- If the measurement is not within the factory specifications, replace the thermostat.

Thermostat's valve opening temperature	Factory spec.	69.5 to 72.5 °C 157.1 to 162.5 °F
Temperature at which thermostat completely opens	Factory spec.	85 °C 185 °F

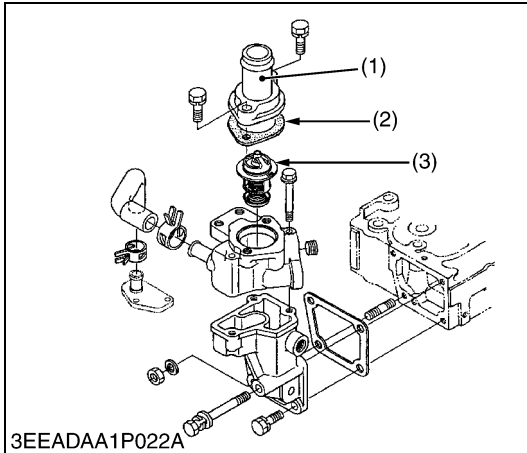
W1035849

[2] DISASSEMBLING AND ASSEMBLING



CAUTION

- When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.



Thermostat Assembly

- Remove the thermostat cover mounting screws, and remove the thermostat cover (1).
- Remove the thermostat assembly (3).

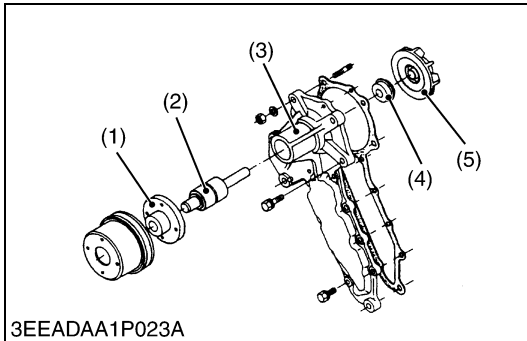
(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the thermostat cover gasket (2).

- (1) Thermostat Cover
(2) Thermostat Cover Gasket

- (3) Thermostat Assembly

W1105115



Water Pump Assembly

- Loosen the alternator mounting bolts, and remove the fan belt.
- Remove the fan and fan pulley.
- Remove the water pump assembly from the gear case cover.
- Remove the water pump flange (1).
- Press out the water pump shaft (2) with the impeller (5) on it.
- Remove the impeller from the water pump shaft (2).
- Remove the mechanical seal (4).

(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) to the both sides of gasket.
- Replace the mechanical seal with new one.

- (1) Water Pump Flange
(2) Water Pump Shaft
(3) Water Pump Body

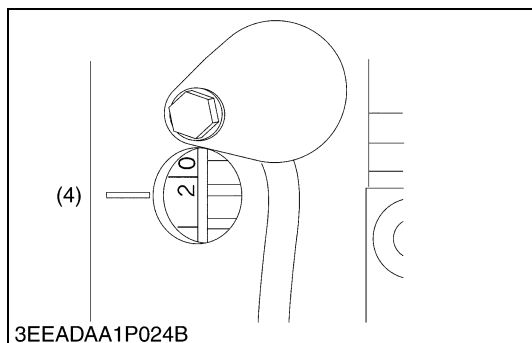
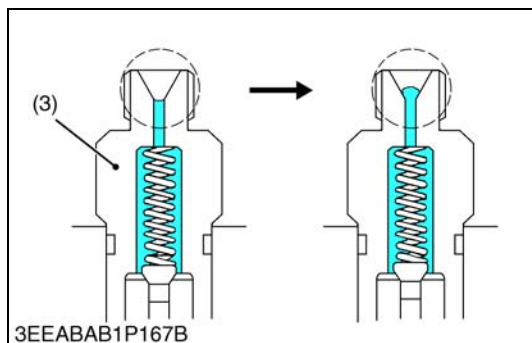
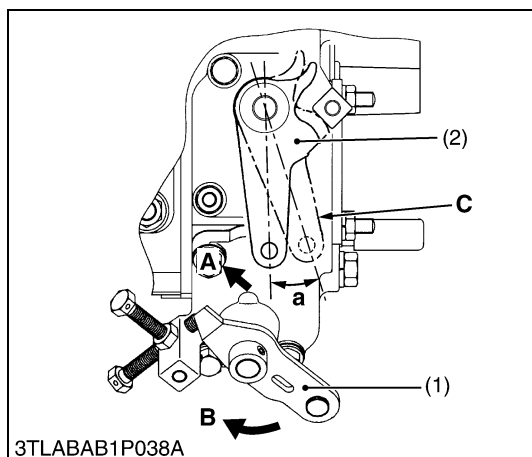
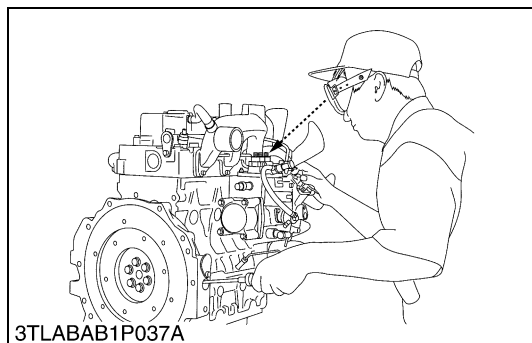
- (4) Mechanical Seal
(5) Impeller

W1105227

5. FUEL SYSTEM

[1] CHECKING AND ADJUSTING

(1) Injection Pump



Injection Timing

1. Remove the stop solenoid.
2. Remove the injection pipes and nozzle.
3. Set the speed control lever to maximum fuel discharge position.

(Reference)

- Turn the flywheel with screwdriver.

NOTE

- For V2203-M and V2403-M, the pumps have a displacement angle. In adjusting the injection timing, pull the stop lever (2) from its free position by 0.267 ± 0.035 rad ($15.3 \pm 2^\circ$) toward the stop position.

1. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up to the hole of the delivery valve holder for 1st cylinder.
2. Turn the flywheel further and stop turning when the fuel begins to flow over, to get the present injection timing.
3. (The flywheel has mark 1TC and four lines indicating every 0.087 rad (5°) of crank angle from 0.175 rad (10°) to 0.436 rad (25°) before mark 1TC) Calculate the angle which the center of the window points out. If the calculation differs from specified injection timing, add or remove the shim to adjust.

Model	Injection Timing
D1503-M-DI D1503-M-DI-T	0.18 to 0.22 rad (10.5° to 12.5°) B.T.D.C.
D1703-M-DI D1803-M-DI	0.16 to 0.19 rad (9.0° to 11.0°) B.T.D.C.
V2203-M-DI V2403-M-DI	0.17 to 0.21 rad (10.0° to 12.0°) B.T.D.C.

- (1) Speed Control Lever
- (2) Stop Lever
- (3) Delivery Valve Holder
- (4) Timing Mark

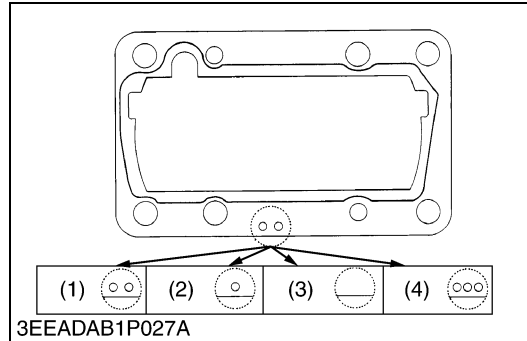
- A: To STOP Position
B: To Max. Speed Position
C: Stop Lever in Free Position

a: 0.267 ± 0.035 rad ($15.3 \pm 2^\circ$)

W1036402

Injection Timing (Continued)**■ NOTE**

- The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.
- Shims are available in thickness of 0.20 mm, 0.25 mm, 0.30 mm and 0.35 mm. Combine these shims for adjustments.
- Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5 °).
- In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.



(1) 2-Holes: 0.20 mm (Shim)
 (2) 1-hole: 0.25 mm (Shim)

(3) Without hole: 0.30 mm (Shim)
 (4) 3-Holes: 0.35 mm (Shim)

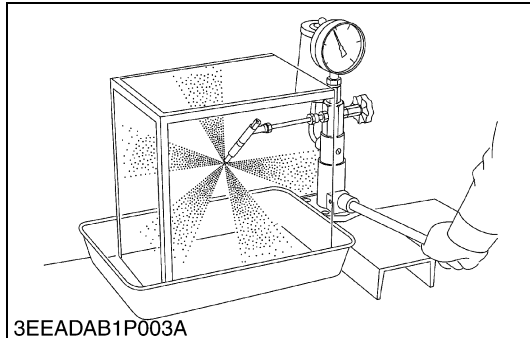
W1111075

(2) Injection Nozzle



CAUTION

- Check the nozzle injection pressure and condition after confirming that there is nobody standing in the direction the fume goes. If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.



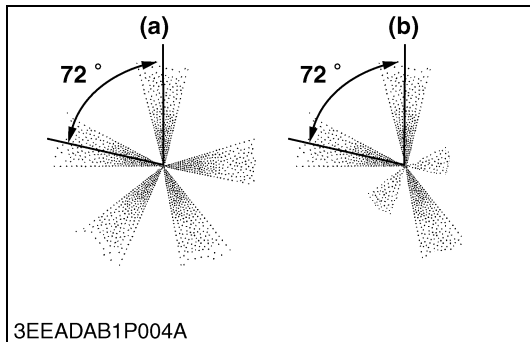
Nozzle Injection Pressure

- Set the injection nozzle to the nozzle tester.
- Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
- If the measurement is not within the factory specifications, replace the injection nozzle assembly.

Fuel injection pressure 1st. stage	Factory spec.	18.6 to 20.1 MPa 190 to 205 kgf/cm ² 2702 to 2916 psi
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(1) Adjusting Washer

W1037197



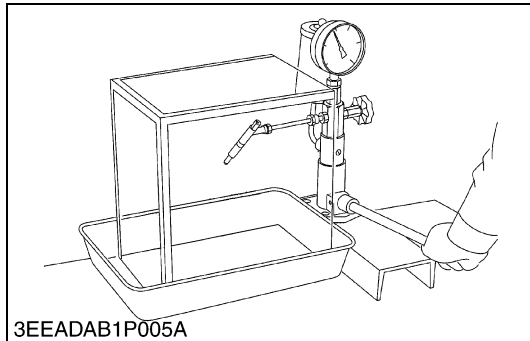
Nozzle Spraying Condition

- Set the injection nozzle to a nozzle tester (Code No. 07909-31361), and check the nozzle spraying condition.
- If the spraying condition is defective, replace the injection nozzle assembly.

(a) Good

(b) Bad

W1037394



Valve Seat Tightness

- Set the injection nozzle to a nozzle tester (Code No. 07909-31361).
- Raise the fuel pressure, and keep at 16.67 MPa (170 kgf/cm², 2418 psi) for 10 seconds.
- If any fuel leak is found, replace the injection nozzle assembly.

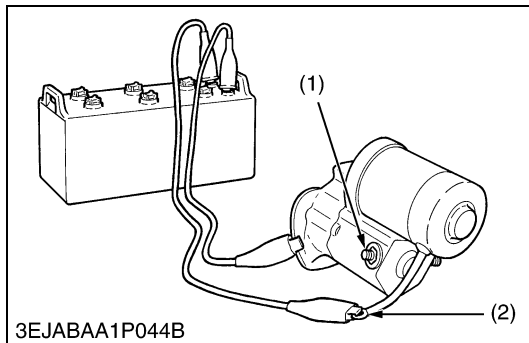
Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170 kgf/cm ² 2418 psi
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W1088949

6. ELECTRICAL SYSTEM

[1] CHECKING

(1) Starter



Motor Test



CAUTION

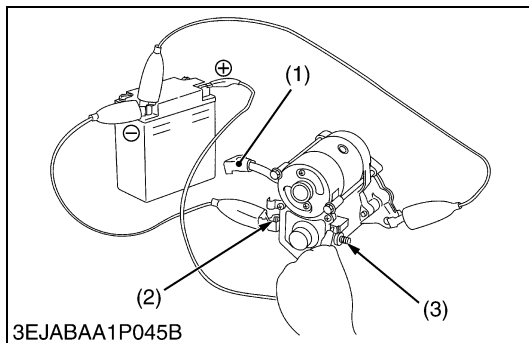
- **Secure the starter to prevent it from jumping up and down while testing the motor.**
1. Disconnect the battery negative cable from the battery.
 2. Disconnect the battery positive cable and the leads from the starter **B** terminal.
 3. Remove the starter from the engine.
 4. Disconnect the connecting lead (2) from the starter **C** terminal (1).
 5. Connect a jumper lead from the connecting lead (2) to the battery positive terminal post.
 6. Connect a jumper lead momentarily between the starter motor housing and the battery negative terminal post.
 7. If the motor dose not run, check the motor.

Tightening torque	B terminal nut	8.8 to 11.8 N·m 0.9 to 1.2 kgf·m 6.5 to 8.7 ft-lbs
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(1) **C** Terminal

(2) Connecting Lead

W1145152



Magnetic Switch Test

1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable and the leads from the starter **B** terminal.
3. Remove the starter from the engine.
4. Disconnect the connecting lead (1) from the starter **C** terminal (2).
5. Connect a jumper lead from the starter **S** terminal (3) to the battery positive terminal post.
6. Connect a jumper lead momentarily between the starter **C** terminal (2) and the battery negative terminal post.
7. If the pinion gear dose not pop out, check the magnetic switch.

NOTE

- **This test should be carried out for a short time, about 3 to 5 seconds.**

(1) Connecting Lead

(3) **S** Terminal

(2) **C** Terminal

W1145350

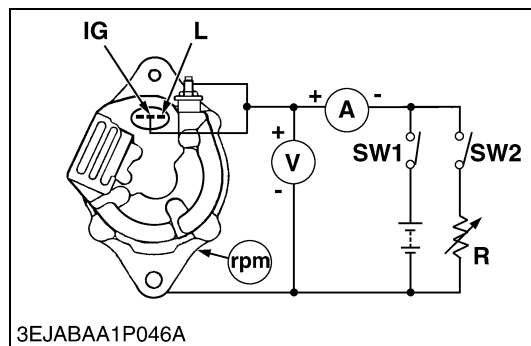
(2) Alternator

(Precaution when checking)

- If disconnect the **B** terminal or coupler, engine will stop by emergency device.
- Do not directly connect the **L** terminal with the **B** terminal. Otherwise the three exciting diodes may be damaged. When connecting the **L** terminal, insert a 3.4 W lamp between the **L** and **B** terminals.
- Always use a full charged battery.
- Be careful to observe the proper polarity of the battery. Never install the battery in the wrong direction.
- Never disconnect the battery while the alternator is operating.

NOTE

- Check the alternator with alternator test bench.

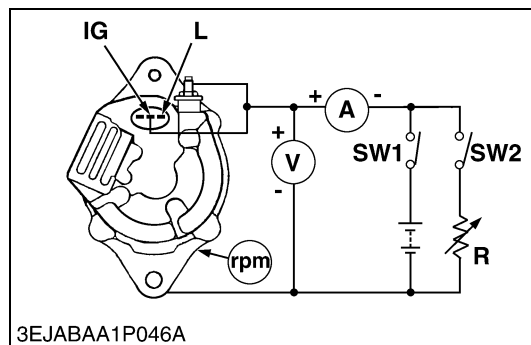


Regulating Voltage

1. Make the connections as shown in the figure, and turn on switch **SW1**.
2. Increase the alternator speed to 5000 min⁻¹ (rpm).
3. Turn on switch **SW2**. Adjust load resistance **R** so that the ammeter shows 10 A.
4. Check that the voltage reading on the voltmeter is within the factory specifications.

Regulating voltage	Factory spec.	14.2 to 14.8 V
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W1150547

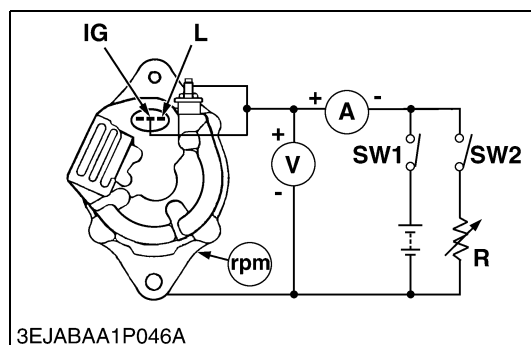


No-load Characteristics

1. Make the connection as shown in the figure, and turn on switch **SW1**.
2. Increase the alternator speed so that the pointer of the ammeter swings to the plus side.
3. Turn on switch **SW1** to decrease the speed, and read the speed at which the voltage is equal to the factory specifications.
4. The speed must be below the factory specifications.

No-load characteristics	Factory spec.	1150 min ⁻¹ (rpm) or less at 13.5 V
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W1150876



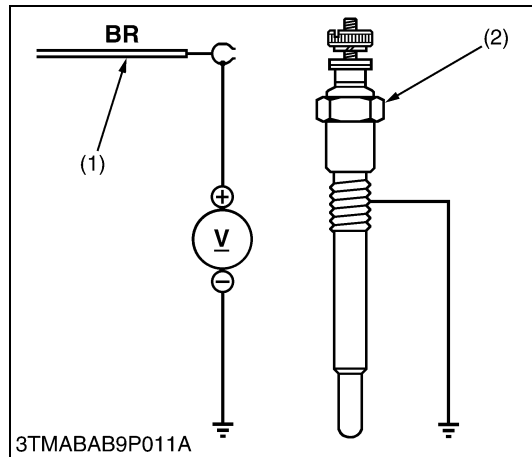
Output Characteristics

1. Make the connection as shown in the figure, and turn on switch **SW1** and **SW2**.
2. Increase the alternator speed while adjusting the load resistance so that the voltage complies with the factory specifications.
3. Read the speed at which the current is equal to the factory specifications.
4. The speed must be below the factory specifications.
5. Decrease the speed so that the current approaches zero, the turn off switches **SW1** and **SW2**.

Output characteristics	Factory spec.	40 A or more at 13.5 V, 5000 min ⁻¹ (rpm)
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W1151013

(3) Glow Plug



Lead Terminal Voltage

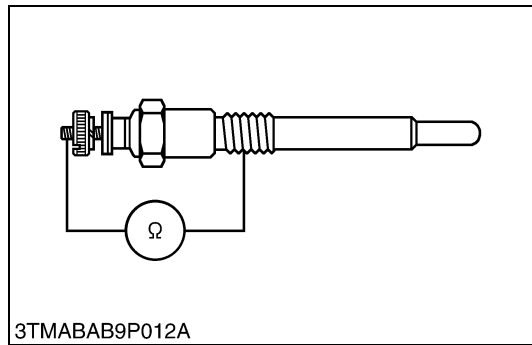
1. Disconnect the wiring lead (1) from the glow plug (2) after turning the main switch off.
2. Turn the main switch key to the **"PREHEAT"** position, and measure the voltage between the lead terminal and the chassis.
3. Turn the main switch key to the **"START"** position, and measure the voltage with a voltmeter between the lead terminal and the chassis.
4. If the voltage at either position differs from the battery voltage, the wiring harness or main switch is faulty.

Voltage (Lead terminal – Engine body)	Main switch key at "PREHEAT"	Approx. battery voltage
	Main switch key at "START"	Approx. battery voltage

(1) Wiring Lead (Positive)

(2) Glow Plug

W1014913



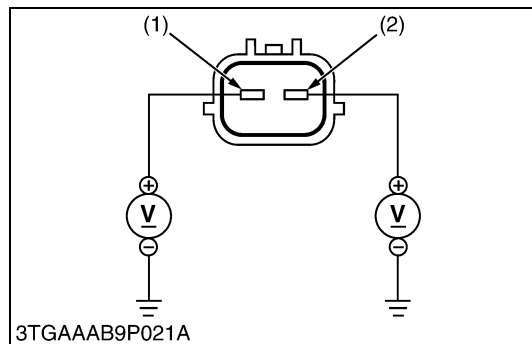
Glow Plug Continuity

1. Disconnect the lead from the glow plugs.
2. Measure the resistance with an ohmmeter between the glow plug terminal and the engine body.
3. If 0 ohm is indicated, the screw at the tip of the glow plug and the housing are short-circuited.
4. If the factory specification is not indicated, the glow plug is faulty.

Glow plug resistance	Factory spec.	Approx. 1.0 Ω
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W1015115

(4) Engine Stop Solenoid



Connector Voltage

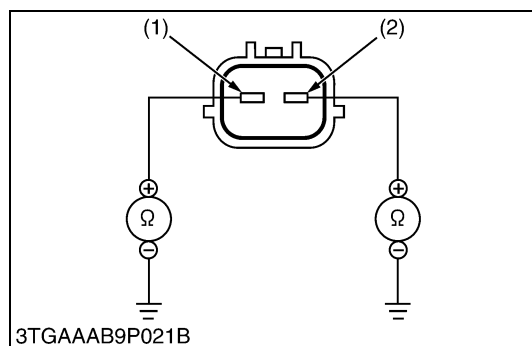
1. Disconnect the **2P** connector from engine stop solenoid.
2. Turn the main switch key to the **"ON"** position.
3. Measure the voltage with voltmeter between the terminal 1 (1) (Black / White), terminal 2 (2) (White / Black) and Body.
4. If the voltage differs from the battery voltage, the wiring harness or main switch is faulty.

Voltage	Terminal 1 – Body	Approx. battery voltage
	Terminal 2 – Body	

(1) Terminal 1

(2) Terminal 2

W1015556



Stop Solenoid Coil

1. Disconnect the **2P** connector from engine stop solenoid.
2. Measure the resistance with an ohmmeter between the terminal 1 (1), terminal 2 (2) and body.
3. If resistance differs from the factory specification, the coil is faulty.

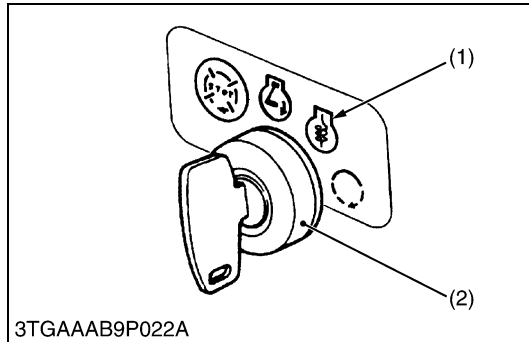
Resistance	Terminal 1 – Body	Approx. 0.38 Ω
	Terminal 2 – Body	Approx. 15.58 Ω

(1) Terminal 1 (Pulling Coil)

(2) Terminal 2 (Holding Coil)

W1015848

(5) Glow Lamp Relay



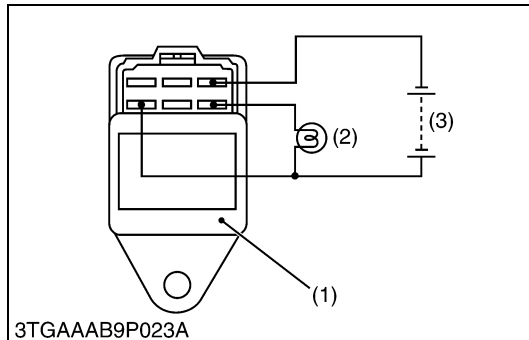
Glow Lamp and Glow Lamp Relay

1. Check the glow lamp indicator lights up then lights off after about 5 seconds when main switch (2) is turned to glow position (1).
2. If the glow lamp indicator does not lights up, the fuse, glow lamp, glow lamp relay or wiring harness is faulty.

(1) Glow Position

(2) Main Switch

W1016072



Glow Lamp Relay

1. Remove the glow lamp relay (1).
2. Connect the jumper leads as shown in the figure left.
3. If the bulb (2) lights up when connecting a jumper lead to battery (3) and go off about 5 seconds late, the glow lamp relay (1) is proper.

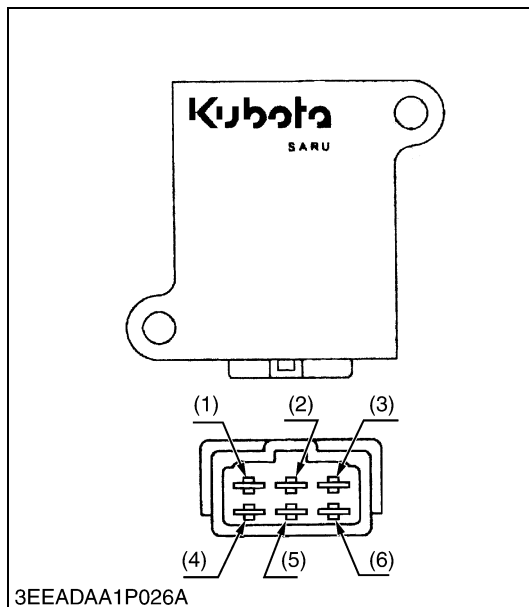
(1) Glow Lamp Relay

(3) Battery (12 V)

(2) Bulb

W1016173

(6) Starter Auto Reduction Unit



Continuity

1. Disconnect the 6P connector from the starter auto reduction unit.
2. Remove the starter auto reduction unit from the machine.
3. Measure the resistance according to below the matrix chart by circuit tester.

	Negative Terminal					
	1	2	3	4	5	6
Positive Terminal	1	∞	∞	∞	∞	∞
	2	∞	∞	155	100	7
	3	∞	∞	∞	∞	∞
	4	∞	∞	∞	∞	∞
	5	∞	∞	∞	∞	∞
	6	∞	55	∞	90	60

Unit : Ω *The value of resistance is approximate.(1) Input Terminal from Key Switch **50** Terminal(4) Input Terminal from Alternator **P** Terminal

(2) Output Terminal for an External Relay

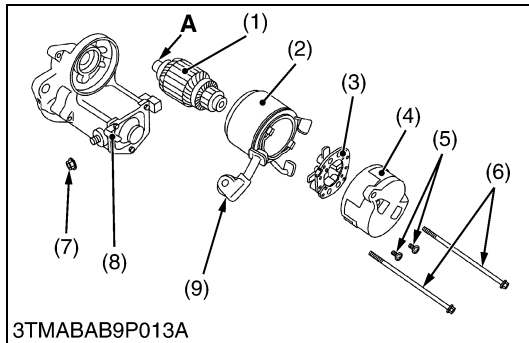
(5) Input Terminal from Key Switch **AC** Terminal(3) Output Terminal for Starter **ST** Terminal

(6) Output Terminal for Ground

W1108872

[2] DISASSEMBLING AND ASSEMBLING

(1) Starter



Disassembling Motor

1. Disconnect the connecting lead (9) from the magnet switch (8).
2. Remove the screws (6), and then separate the end frame (4), yoke (2) and armature (1).
3. Remove the two screws (5), and then take out the brush holder (3) from the end frame (4).

(When reassembling)

- Apply grease to the spline teeth **A** of the armature (1).

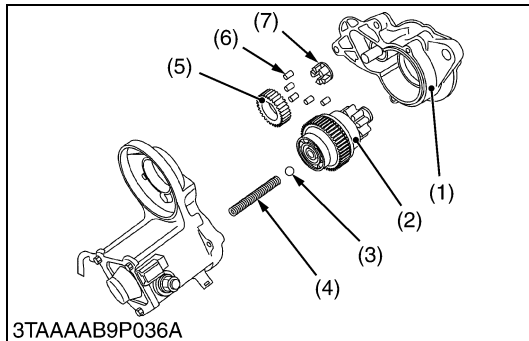
Tightening torque	Nut (7)	5.9 to 11.8 N·m 0.6 to 1.2 kgf·m 4.3 to 8.7 ft·lbs
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- (1) Armature
(2) Yoke
(3) Brush Holder
(4) End Frame
(5) Screw
(6) Screw

- (7) Nut
(8) Magnet Switch
(9) Connecting Lead

A: Spline Teeth

W1016288



Disassembling Magnet Switch

1. Remove the drive end frame (1) mounting screws.
2. Take out the overrunning clutch (2), ball (3), spring (4), gear (5), rollers (6) and retainer (7).

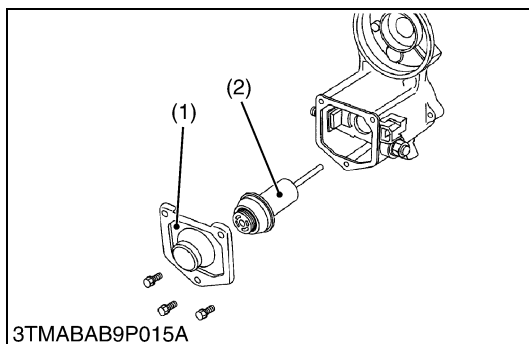
(When reassembling)

- Apply grease to the gear teeth of the gear (5) and overrunning clutch (2), and ball (3).

- (1) Drive End Frame
(2) Overrunning Clutch
(3) Ball
(4) Spring

- (5) Gear
(6) Roller
(7) Retainer

W1016728



Plunger

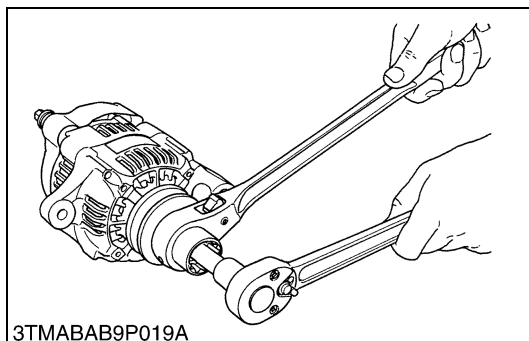
1. Remove the end cover (1).
2. Take out the plunger (2).

- (1) End Cover

- (2) Plunger

W1016883

(2) Alternator



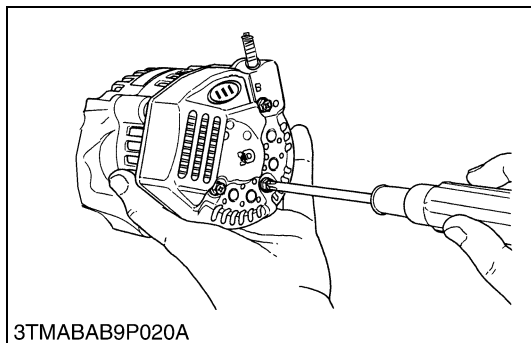
Pulley

1. Secure the hexagonal end of the pulley shaft with a double-ended ratchet wrench as shown in the figure, loosen the pulley nut with a socket wrench and remove it.

(When reassembling)

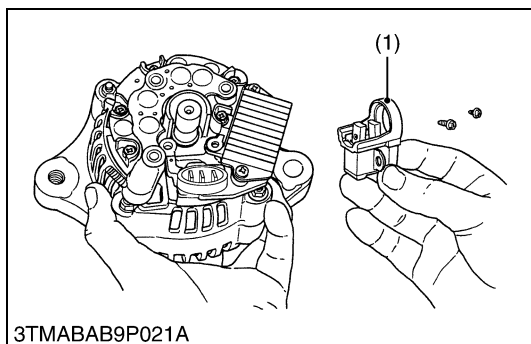
Tightening torque	Pulley nut	58.3 to 78.9 N·m 5.95 to 8.05 kgf·m 43.0 to 58.2 ft·lbs
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W1018728

**Rear End Cover**

1. Unscrew the three rear end cover screws and the **B** terminal nut, and remove the rear end cover.

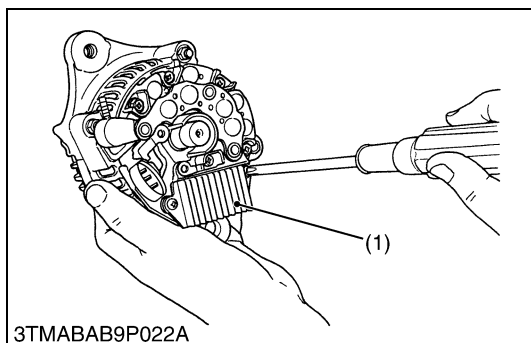
W1018982

**Brush Holder**

1. Unscrew the two screws holding the brush holder (1), and remove the brush holder (1).

(1) Brush Holder

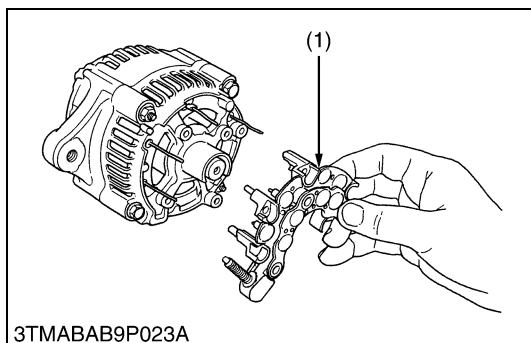
W1019054

**IC Regulator**

1. Unscrew the three screws holding the IC regulator (1), and remove the IC regulator (1).

(1) IC Regulator

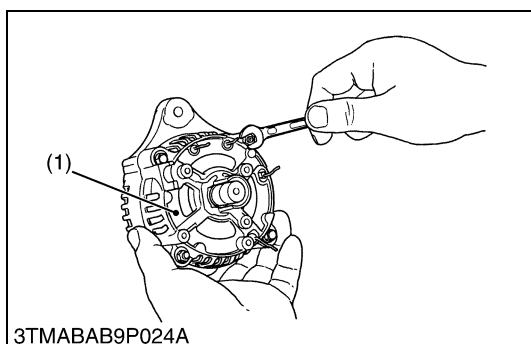
W1019123

**Rectifier**

1. Remove the four screws holding the rectifier (1) and the stator lead wires.
2. Remove the rectifier (1).

(1) Rectifier

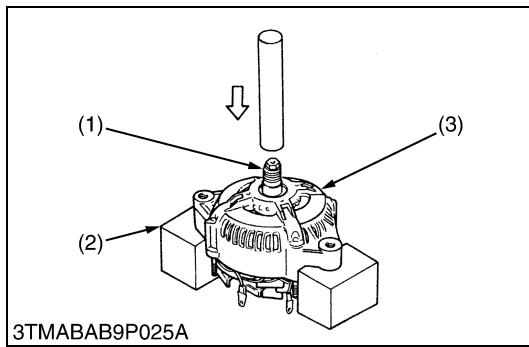
W1019192

**Rear End Frame**

1. Unscrew the two nuts and two screws holding the drive end frame and the rear end frame (1).
2. Remove the rear end frame (1).

(1) Rear End Frame

W1019274

**Rotor**

1. Press out the rotor (1) from drive end frame (3).

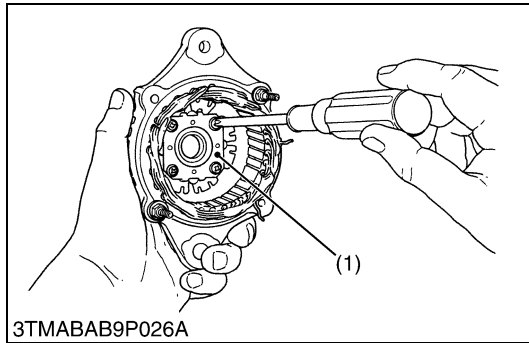
■ IMPORTANT

- Take special care not to drop the rotor and damage the slip ring or fan, etc..

- (1) Rotor
(2) Block

- (3) Drive End Frame

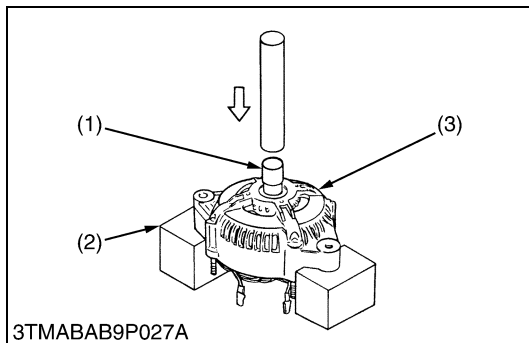
W1019438

**Retainer Plate**

1. Unscrew the four screws holding the retainer plate (1), and remove the retainer plate (1).

- (1) Retainer Plate

W1019542

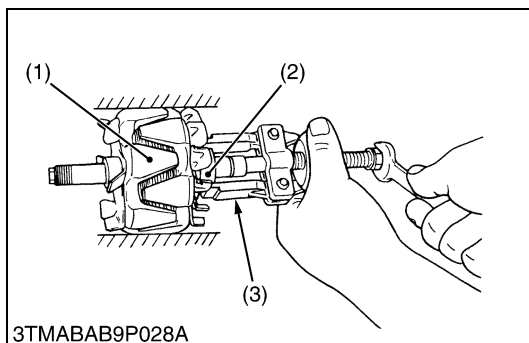
**Bearing on Drive End Side**

1. Press out the bearing from drive end frame (3) with a press and jig (1).

- (1) Jig
(2) Block

- (3) Drive End Frame

W1019611

**Bearing at Slip Ring Side**

1. Lightly secure the rotor (1) with a vise to prevent damage, and remove the bearing (2) with a puller (3).

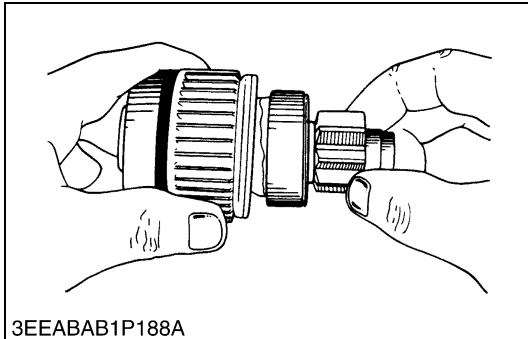
- (1) Rotor
(2) Bearing

- (3) Puller

W1019701

[3] SERVICING

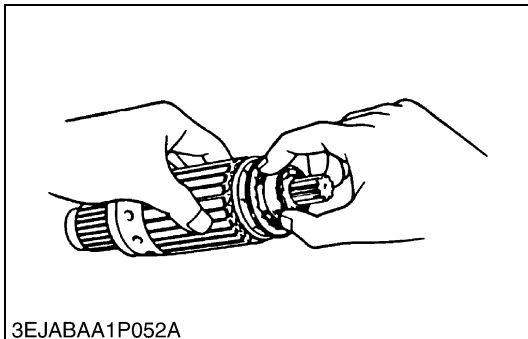
(1) Starter



Overrunning Clutch

1. Inspect the pinion for wear or damage.
2. If there is any defect, replace the overrunning clutch assembly.
3. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking directions.
4. If the pinion slips or does not rotate in the both directions, replace the overrunning clutch assembly.

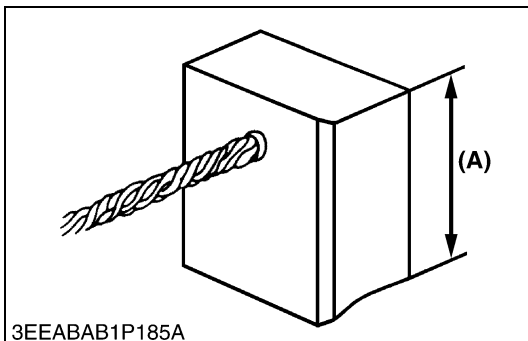
W1156799



Armature Bearing

1. Check the bearing for smooth rotation.
2. If it does not smooth rotation, replace it.

W1156718

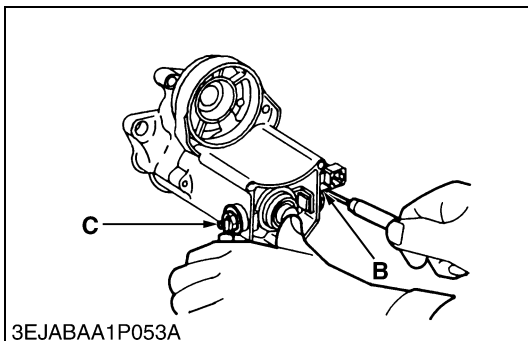


Brush Wear

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

Brush length A	Factory spec.	15.0 mm 0.591 in.
	Allowable limit	11.0 mm 0.433 in.

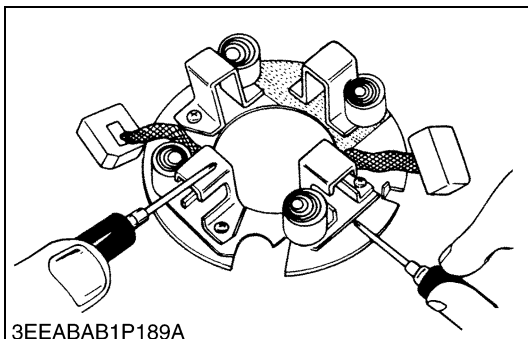
W1156360



Magnet Switch

1. Check the continuity across the "C" terminal and the "B" terminal with an ohmmeter pushing the plunger.
2. If it does not conduct, check the contacts.

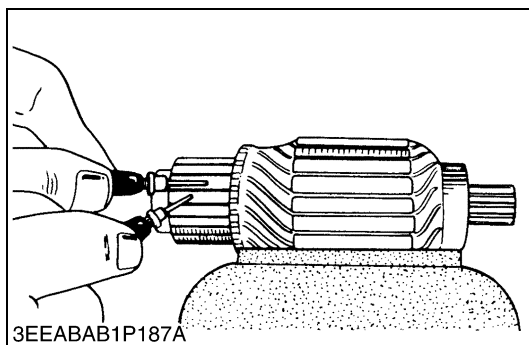
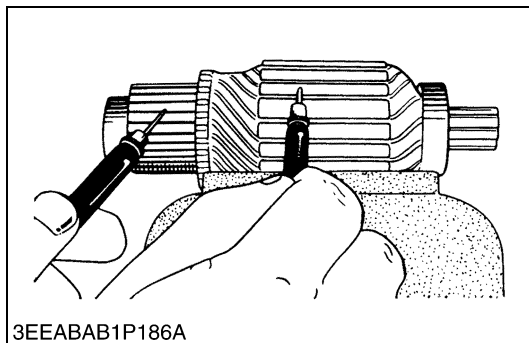
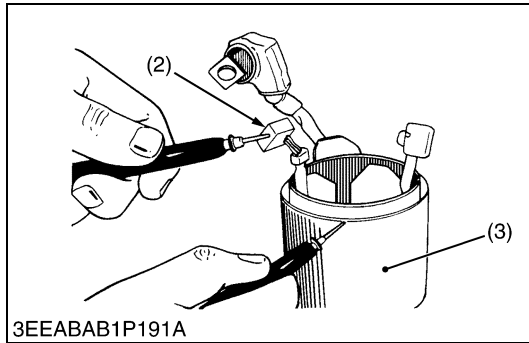
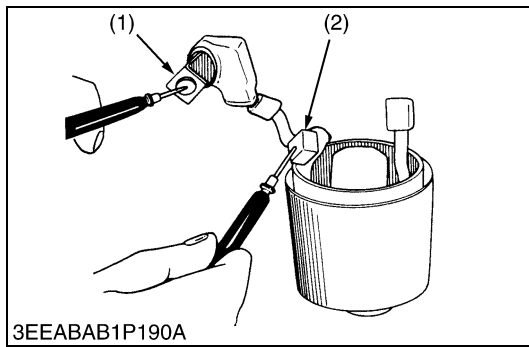
W1157257



Brush Holder

1. Check the continuity across the brush holder and the holder support with an ohmmeter.
2. If it conducts, replace the brush holder.

W1156895



Field Coil

1. Check the continuity across the lead (1) and brush (2) with an ohmmeter.
2. If it dose not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with an ohmmeter.
4. If it conducts, replace the yoke assembly.

(1) Lead
(2) Bush

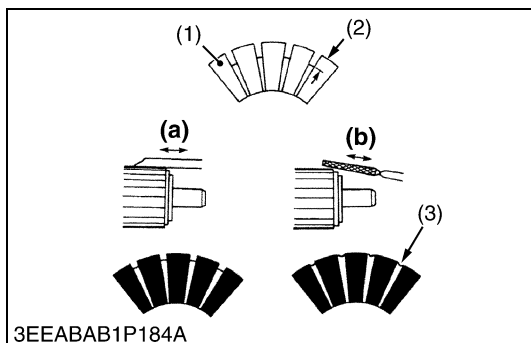
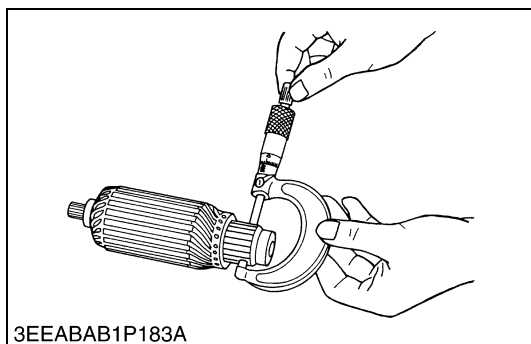
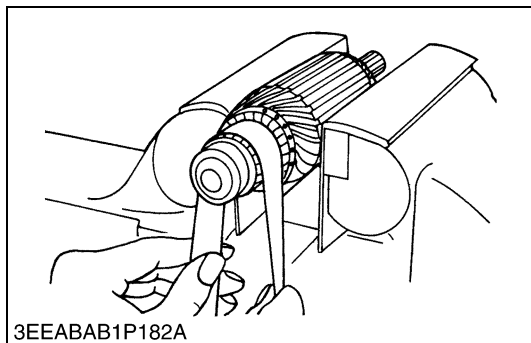
(3) Yoke

W1156968

Armature Coil

1. Check the continuity across the commutator and armature coil core with an ohmmeter.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with an ohmmeter.
4. If it dose not conduct, replace the armature.

W1156507



Commutator and Mica

1. Check the contact of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds 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 spec.	D1503-M-DI D1503-M-DI-T D1703-M-DI D1803-M-DI V2203-M-DI	30.0 mm 1.181 in.
		V2403-M-DI	35.0 mm 1.378 in.
	Allowable limit	D1503-M-DI D1503-M-DI-T D1703-M-DI D1803-M-DI V2203-M-DI	29.0 mm 1.142 in.
		V2403-M-DI	34.0 mm 1.339 in.

Difference of O.D.'s	Factory spec.	Less than 0.02 mm 0.0008 in.
	Allowable limit	0.05 mm 0.0020 in.

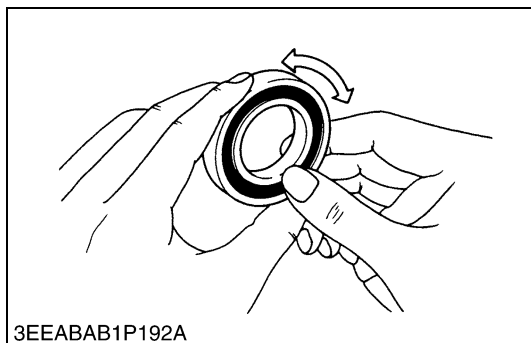
Mica under cut	Factory spec.	D1503-M-DI D1503-M-DI-T D1703-M-DI D1803-M-DI V2203-M-DI	0.50 to 0.80 mm 0.0197 to 0.0315 in.
		V2403-M-DI	0.50 to 0.90 mm 0.0197 to 0.0354 in.
	Allowable limit		0.20 mm 0.0079 in.

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

- (a) Correct
(b) Incorrect

W1155802

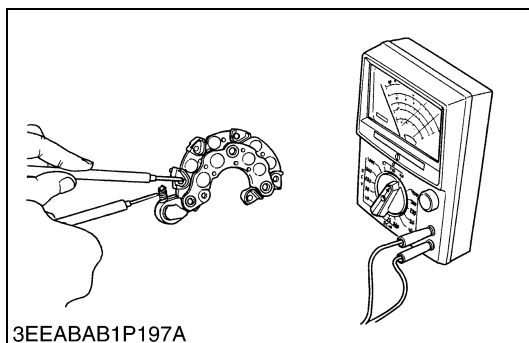
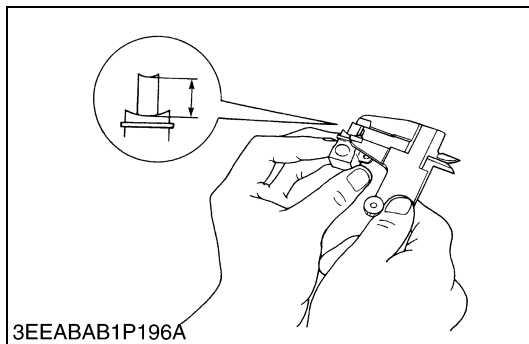
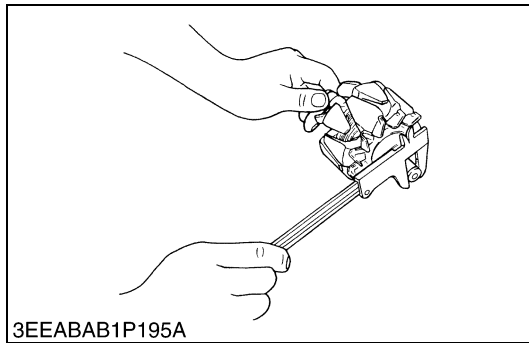
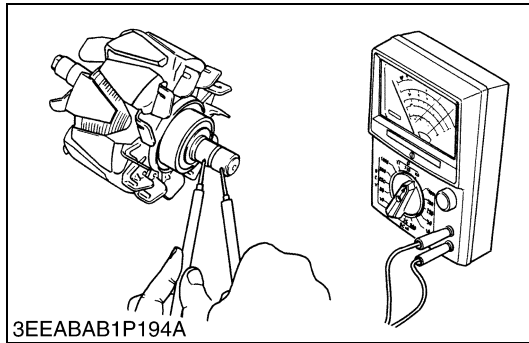
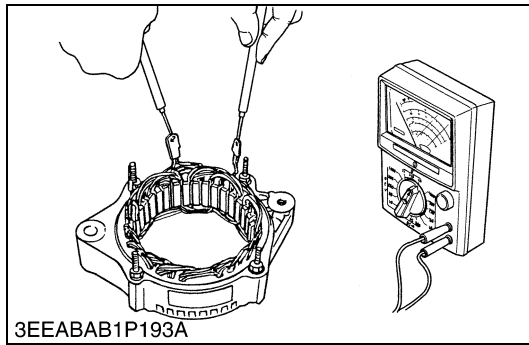
(2) Alternator



Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

W1019790



Stator

1. Check the continuity across each stator coil lead and core with an ohmmeter.
2. If infinity is not indicated, replace it.

Resistance	Factory spec.	Continuity
------------	---------------	------------

W1019964

Rotor

1. Measure the resistance across the slip rings with an ohmmeter.
2. If the resistance is not the factory specification, replace it.
3. Check the continuity across the slip ring and core with an ohmmeter.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	D1503-M-DI	2.9 Ω
		D1503-M-DI-T D1703-M-DI D1803-M-DI V2203-M-DI V2403-M-DI	2.1 Ω

W1020094

Slip Ring

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

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

W1020208

Brush Wear

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

Brush length	Factory spec.	10.5 mm 0.413 in.
	Allowable limit	8.4 mm 0.331 in.

W1020329

Rectifier

1. Check the continuity across each diode of rectifier with an analog ohmmeter. Conduct the test in the ($R \times 1$) setting.
2. The rectifier is normal if the diode in the rectifier conducts in one direction and does not conduct in the reverse direction.

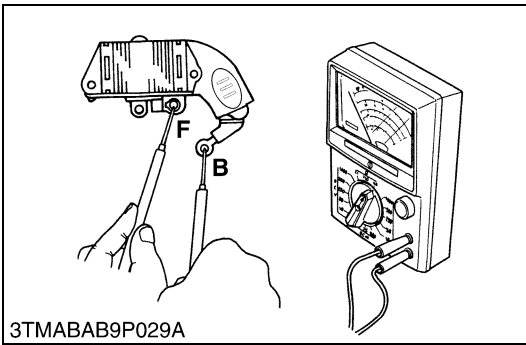
■ IMPORTANT

- Do not use a 500 V megger for measuring because it will destroy the rectifier.

■ NOTE

- Do not use an auto digital multimeter. Because it's very hard to check the continuity of rectifier by using it.

W1020452

**IC Regulator**

1. Check the continuity across the **B** terminal and the **F** terminal of IC regulator with an analog ohmmeter. Conduct the test in the (R × 1) setting.
2. The IC regulator is normal if the IC regulator conducts in one direction and does not conduct in the reverse direction.

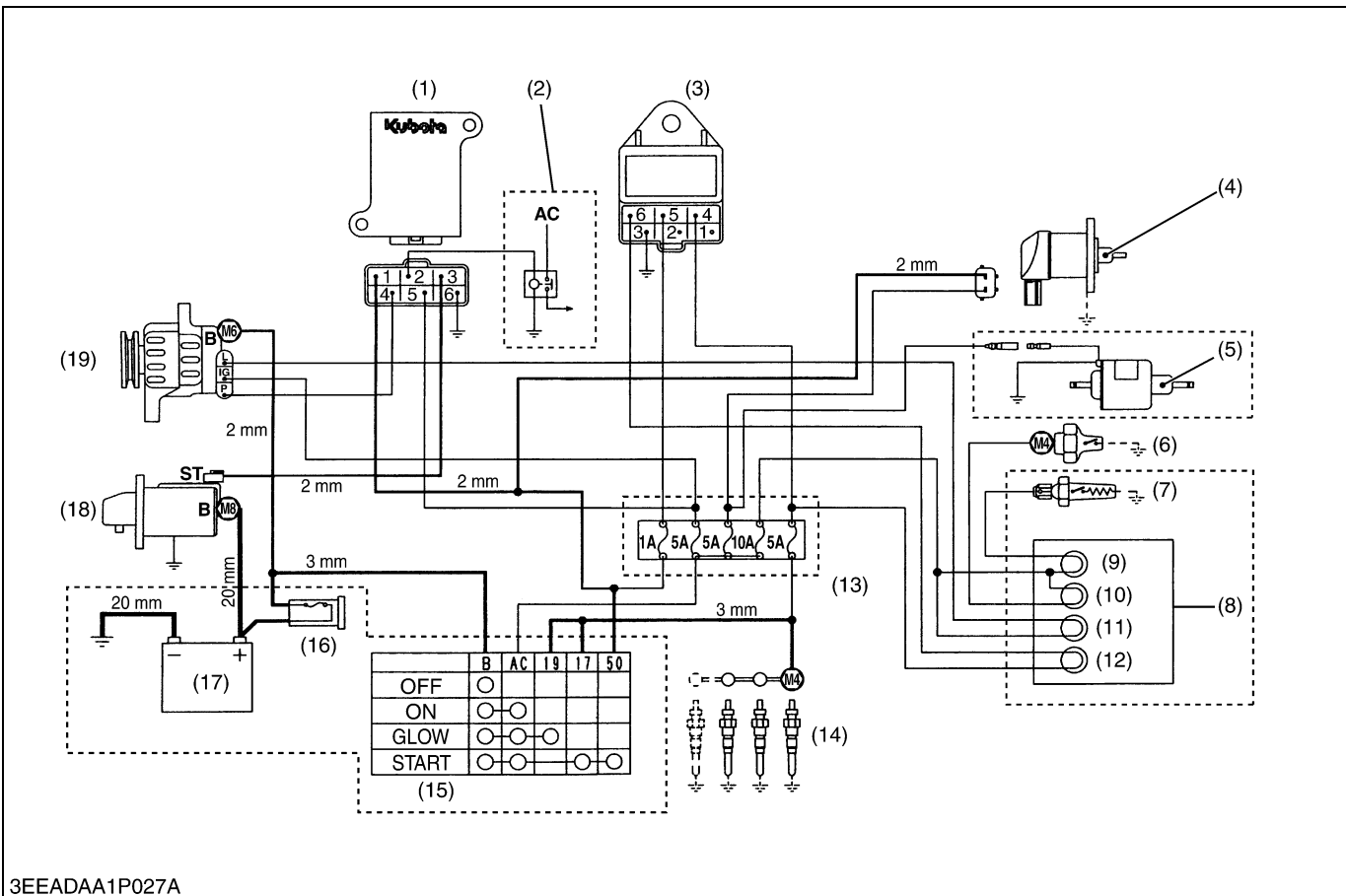
IMPORTANT

- Do not use a 500 V megger for measuring because it will destroy the IC regulator.

NOTE

- Do not use an auto digital multimeter. Because it's very hard to check the continuity of IC regulator by using it.

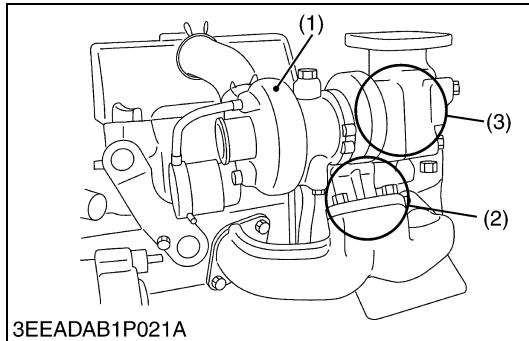
W1020645

(3) Wiring Diagram

- | | | | |
|---------------------------------------|---------------------------------------|-------------------------------|------------------------|
| (1) Starter Auto Reduction Unit | (6) Fuse (3 cyl : 50 A, 4 cyl : 65 A) | (11) Oil Pressure Lamp | (16) Oil Switch |
| (2) External Relay (less than 200 mA) | (7) Key Switch | (12) Charge Lamp | (17) Fuel Feed Pump |
| (3) Alternator | (8) Glow Plugs | (13) Glow Lamp | (18) Stop Solenoid |
| (4) Starter | (9) Fuse Box | (14) Pilot Lamps (12 V, 3.4W) | (19) Timer (Glow Lamp) |
| (5) Battery (12V) | (10) Water Temperature Lamp | (15) Water Temperature Switch | |

7. TURBO CHARGER SYSTEM

[1] CHECKING



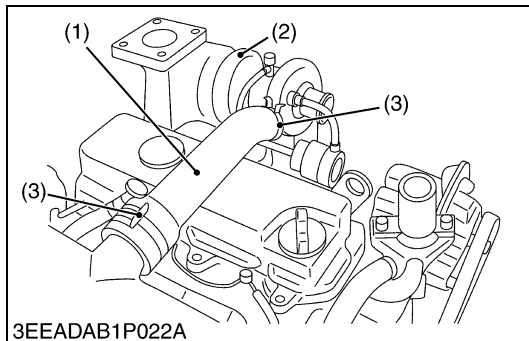
Turbine Side

1. Check the exhaust port (3) and inlet port (2) side of the turbine housing (1) to see if there is no exhaust gas leak.
2. If any gas leak is found, retighten the bolts and nuts or replace the gasket with new one.

(1) Turbine Housing
(2) Inlet Port

(3) Exhaust Port

W1069824



Compressor Side

1. Check the inlet pipe 1 (1) of the compressor cover (2) to see if there is no air leak.
2. Check for loose connections or cracks in the suction side of the intake pipe.
3. If any air leak is found, change the clamp (3) and or inlet pipes.

(1) Inlet Pipe 1
(2) Compressor Cover

(3) Clamp

W1069939

[2] DISASSEMBLING AND ASSEMBLING

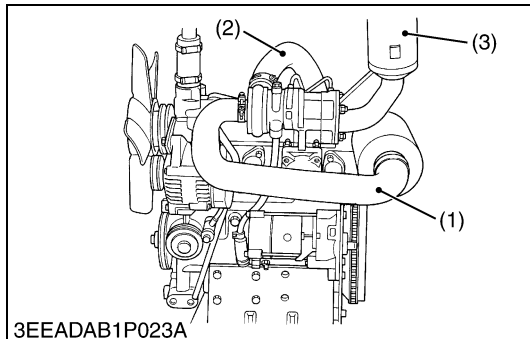


CAUTION

- While the engine is running and or just after it stops, the turbocharger is hot, be careful not to touch the turbocharger.

NOTE

- When detaching and attaching the turbocharger assembly, be very careful not to allow dust, dirt and other foreign matters in the oil pipes.
- When the turbocharger assembly has been replaced, pour fresh engine oil through the oil filter port of the turbocharger.
- Before starting the engine, make sure that the air cleaner is in position.



Air Cleaner and Muffler

1. Remove the intake pipe (1).
2. Remove the inlet pipe 1 (2).
3. Remove the muffler (3).

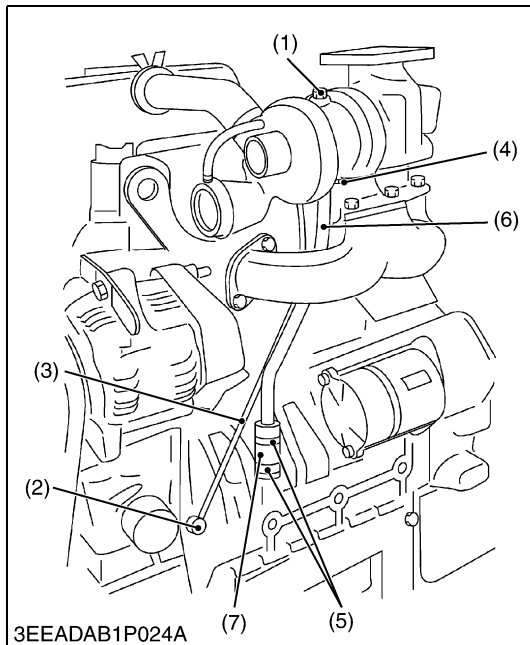
(When reassembling)

- Replace the gasket with new one.

- (1) Intake Pipe
(2) Inlet Pipe 1

- (3) Muffler

W1070719



Oil Pipe

1. Remove the joint bolt (1), (2) and take off the oil pipe 1 (3).
2. Remove the bolts (4) and release the clamp (5).
3. Disconnect the oil pipe 2 (6) and pipe 4 (7).

(When reassembling)

- Pour fresh engine oil through the oil filter port of the turbocharger.
- Replace the gaskets with new one.
- Be careful not to allow dust, dirt and other foreign matters in the oil pipes.

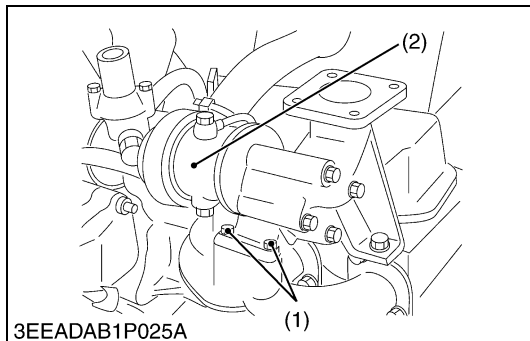
NOTE

- Tape or plug all opening to prevent foreign matters from damaging the oil cavities in the turbocharger.

- (1) Joint Bolt
(2) Joint Bolt
(3) Oil Pipe 1
(4) Bolt

- (5) Clamp
(6) Oil Pipe 2
(7) Oil Pipe 4

W1070836



Turbocharger

1. Remove the bolt (1).
2. Take off the turbocharger assemble (2).

(When reassembling)

- Replace the gasket with new one.

- (1) Bolt

- (2) Turbocharger Assemble

W1071031

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