ENGINE BASE

SERVICE MANUAL

KUBOTA
03-M-E2B

HYUNDAI

REFERENCE ONLY
- FORK LIFT(HDF15-18, -5 SERIES)

TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of 03-M-E2B series. It is divided into three parts, "General", "Mechanism" and "Servicing".

■ General

Information on the engine identification, the general precautions, maintenance check list, check and maintenance and special tools are described.

■ Mechanism

Information on the construction and function are included. This part should be understood before proceeding with troubleshooting, disassembling and servicing.

Refer to Diesel Engine Mechanism Workshop Manual (Code No. 97897-01872) for the one which has not been described to this workshop manual.

■ Servicing

Information on the troubleshooting, servicing specification lists, tightening torque, 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, information or picture being used have not been specified as one model.

February 2004

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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.**

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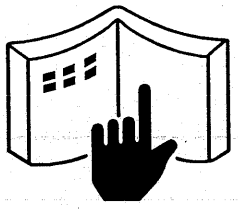

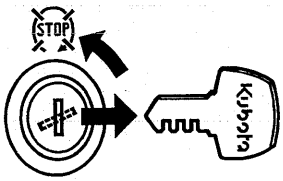

BEFORE SERVICING AND REPAIRING

- 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

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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.

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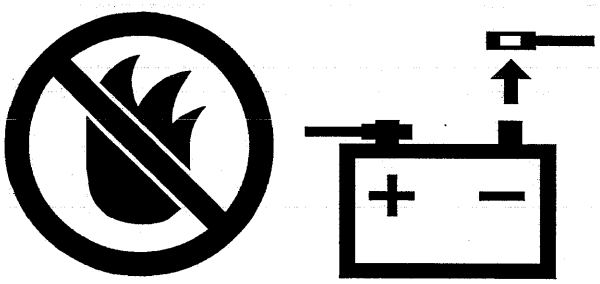

SAFETY WORKING

- 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.

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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.

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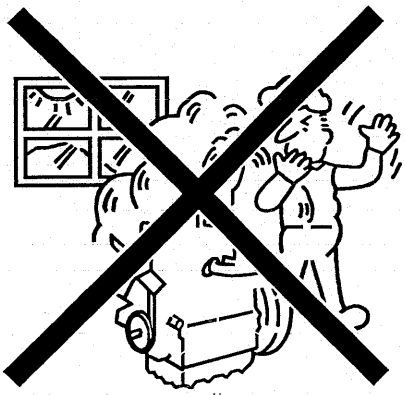

VENTILATE WORK AREA

- 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.

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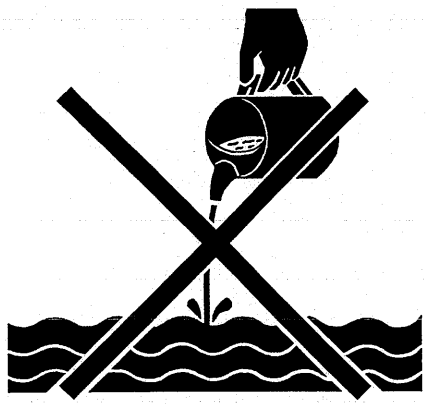

DISPOSE OF FLUIDS PROPERLY

- 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.

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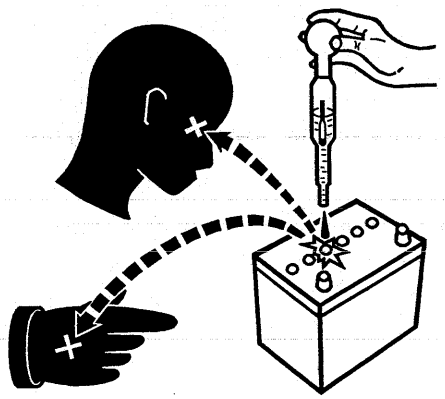

PREVENT ACID BURNS

- 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.

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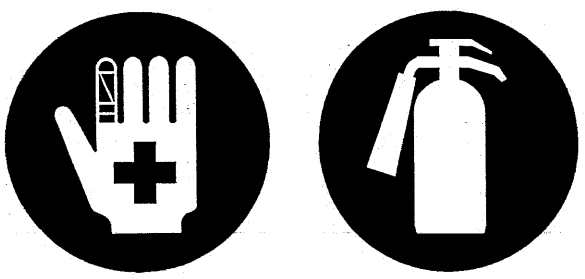

PREPARE FOR EMERGENCIES

- 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.

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SPECIFICATIONS

Model		D1503-M	D1703-M	D1803-M
Number of Cylinders		3		
Type		Vertical, water-cooled, 4-cycle IDI diesel engine		
Bore x Stroke		83 x 92.4 mm (3.26 x 3.64 in.)	87 x 92.4 mm (3.43 x 3.64 in.)	87 x 102.4 mm (3.43 x 4.04 in.)
Total Displacement		1499 cm^3 (91.47 cu.in.)	1647 cm^3 (100.51 cu.in.)	1826 cm^3 (111.43 cu.in.)
SAE Net Continuous		19.8 kW / 2800 min^{-1} (rpm) (26.5 HP / 2800 min^{-1} (rpm))	22.4 kW / 2800 min^{-1} (rpm) (30.0 HP / 2800 min^{-1} (rpm))	23.3 kW / 2600 min^{-1} (rpm) (31.2 HP / 2600 min^{-1} (rpm))
SAE Net Intermittent		22.8 kW / 2800 min^{-1} (rpm) (30.5 HP / 2800 min^{-1} (rpm))	25.7 kW / 2800 min^{-1} (rpm) (34.5 HP / 2800 min^{-1} (rpm))	26.9 kW / 2600 min^{-1} (rpm) (36.1 HP / 2600 min^{-1} (rpm))
SAE Gross Intermittent		24.9 kW / 2800 min^{-1} (rpm) (33.4 HP / 2800 min^{-1} (rpm))	27.4 kW / 2800 min^{-1} (rpm) (36.7 HP / 2800 min^{-1} (rpm))	28.4 kW / 2600 min^{-1} (rpm) (38.1 HP / 2600 min^{-1} (rpm))
Maximum Bare Speed		3000 min^{-1} (rpm)		2800 min^{-1} (rpm)
Minimum Idling Speed		750 to 850 min^{-1} (rpm)		
Combustion Chamber		Spherical Type (E-TVCS)		
Fuel Injection Pump		Bosch Type Mini Pump		
Governor		Centrifugal Ball Type, All Speed Mechanical Governor		
Direction of Rotation		Counter-clockwise (viewed from flywheel side)		
Injection Nozzle		Bosch Throttle Type Mini Nozzle (OPD)		
Injection Timing		0.314 rad (18 °) before T.D.C.		
Firing Order		1 - 2 - 3		
Injection Pressure		13.73 MPa (140 kgf/cm^2, 1991 psi)		
Compression Ratio		23	22.6	23.8
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 Support Device		Pre-heating by Glow Plug in Combustion Chamber		
Battery		12 V, 70 to 80 AH		12 V, 100 to 120 AH
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.)	5.6 L (1.48 U.S.gal, 1.23 Imp.gal)		
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.85 U.S.gal, 1.54 Imp.gal)		
Weight (Dry) BB spec.		148 kg (326.3 lbs)		151 kg (333 lbs)

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Model		V2003-M	V2203-M	V2003-M-T	V2403-M
Number of Cylinders		4			
Type		Vertical, water-cooled, 4-cycle IDI diesel engine			
Bore x Stroke		83 x 92.4 mm (3.26 x 3.64 in.)	87 x 92.4 mm (3.43 x 3.64 in.)	83 x 92.4 mm (3.26 x 3.64 in.)	87 x 102.4 mm (3.43 x 4.04 in.)
Total Displacement		1999 cm^3 (121.99 cu.in.)	2197 cm^3 (134.07 cu.in.)	1999 cm^3 (121.99 cu.in.)	2434 cm^3 (148.53 cu.in.)
SAE Net Continuous		26.4 kW / 2800 min^{-1} (rpm) (35.4 HP / 2800 min^{-1} (rpm))	29.8 kW / 2800 min^{-1} (rpm) (40.0 HP / 2800 min^{-1} (rpm))	35.8 kW / 2800 min^{-1} (rpm) (47.6 HP / 2800 min^{-1} (rpm))	31.1 kW / 2600 min^{-1} (rpm) (41.6 HP / 2600 min^{-1} (rpm))
SAE Net Intermittent		30.4 kW / 2800 min^{-1} (rpm) (40.8 HP / 2800 min^{-1} (rpm))	34.3 kW / 2800 min^{-1} (rpm) (46.0 HP / 2800 min^{-1} (rpm))	41.0 kW / 2800 min^{-1} (rpm) (55.0 HP / 2800 min^{-1} (rpm))	35.8 kW / 2600 min^{-1} (rpm) (48.0 HP / 2600 min^{-1} (rpm))
SAE Gross Intermittent		33.2 kW / 2800 min^{-1} (rpm) (44.5 HP / 2800 min^{-1} (rpm))	36.4 kW / 2800 min^{-1} (rpm) (48.8 HP / 2800 min^{-1} (rpm))	44.0 kW / 2800 min^{-1} (rpm) (59.0 HP / 2800 min^{-1} (rpm))	38.0 kW / 2600 min^{-1} (rpm) (51.0 HP / 2600 min^{-1} (rpm))
Maximum Bare Speed		3000 min^{-1} (rpm)			2800 min^{-1} (rpm)
Minimum Idling Speed		750 to 850 min^{-1} (rpm)		850 to 950 min^{-1} (rpm)	750 to 850 min^{-1} (rpm)
Combustion Chamber		Spherical Type (E-TVCS)			
Fuel Injection Pump		Bosch Type Mini Pump			
Governor		Centrifugal Ball Type, All Speed Mechanical Governor			
Direction of Rotation		Counter-clockwise (viewed from flywheel side)			
Injection Nozzle		Bosch Throttle Type Mini Nozzle (OPD)			
Injection Timing		0.314 rad (18 °) before T.D.C.			
Firing Order		1 - 3 - 2 - 4			
Injection Pressure		13.73 MPa (140 kgf/cm^2, 1991 psi)			
Compression Ratio		23	22.6	22.0	23.8
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 Support Device		Pre-heating by Glow Plug in Combustion Chamber			
Battery		12 V, 100 to 120 AH			
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.gal, 1.67 Imp.gal)			
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.51 U.S.gal, 2.09 Imp.gal)			
Weight (Dry) BB spec.		180 kg (397 lbs)		186 kg (410 lbs)	184 kg (406 lbs)

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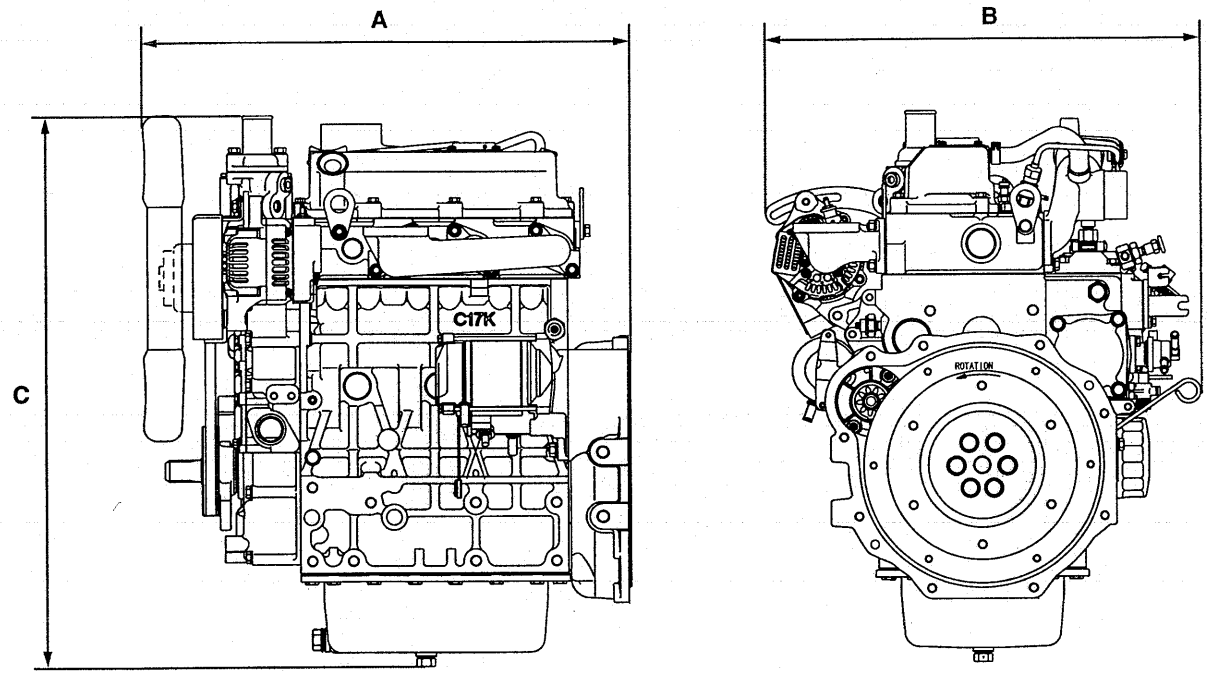
DIMENSIONS



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	D1503-M	D1703-M	D1803-M
A	572.1 mm (22.5 in.)	572.1 mm (22.5 in.)	575.9 mm (22.7 in.)
B	507.1 mm (20.0 in.)	507.1 mm (20.0 in.)	499.0 mm (19.6 in.)
C	643.3 mm (25.3 in.)	643.3 mm (25.3 in.)	685.0 mm (27.0 in.)

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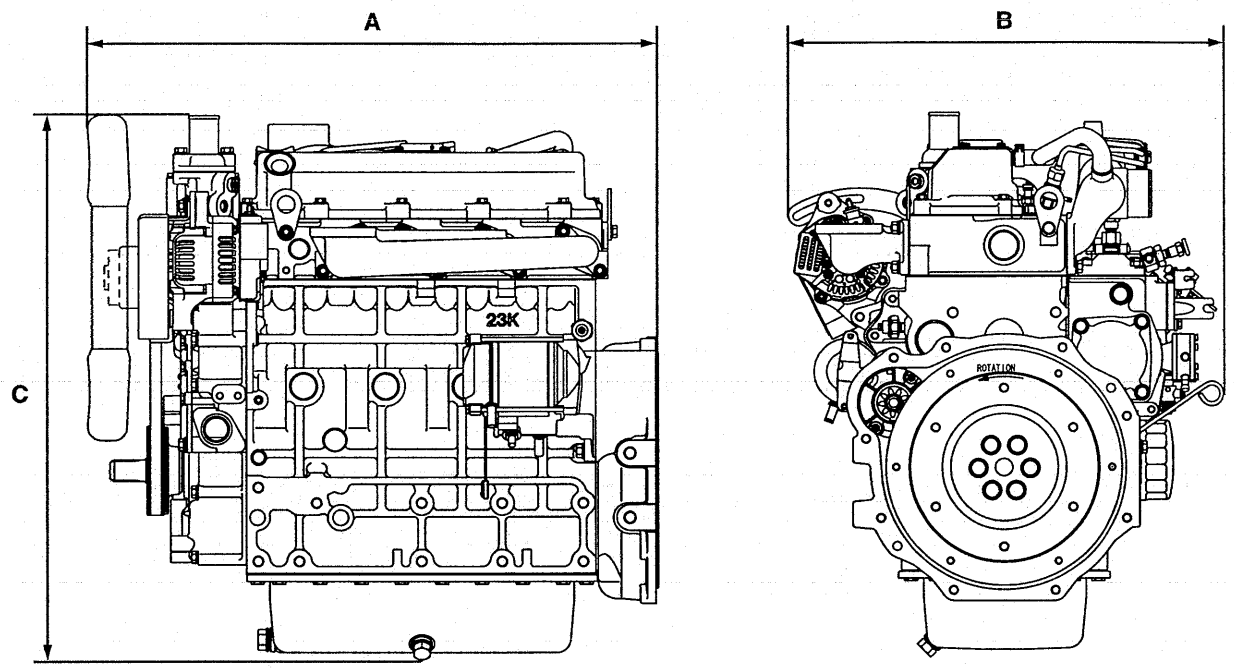

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	V2003-M	V2203-M	V2003-M-T	V2403-M
A	667.1 mm (26.3 in.)	667.1 mm (26.3 in.)	667.1 mm (26.3 in.)	670.9 mm (26.4 in.)
B	507.1 mm (20.0 in.)	507.1 mm (20.0 in.)	507.1 mm (20.0 in.)	499.0 mm (19.6 in.)
C	635.0 mm (25.0 in.)	635.0 mm (25.0 in.)	698.3 mm (27.5 in.)	684.5 mm (26.9 in.)

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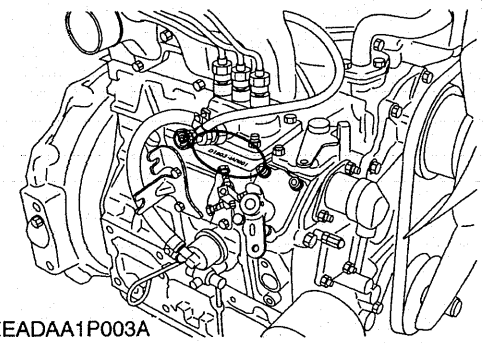
CONTENTS

1. ENGINE IDENTIFICATION

[1] MODEL NAME AND ENGINE SERIAL NUMBER



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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		

(1) Engine Model Name and Serial Number

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● **Month of manufacture**

Month	Engine Serial Number	
	0001 ~ 9999	10000 ~
January	A0001 ~ A9999	B10000 ~
February	C0001 ~ C9999	D10000 ~
March	E0001 ~ E9999	F10000 ~
April	G0001 ~ G9999	H10000 ~
May	J0001 ~ J9999	K10000 ~
June	L0001 ~ L9999	M10000 ~
July	N0001 ~ N9999	P10000 ~
August	Q0001 ~ Q9999	R10000 ~
September	S0001 ~ S9999	T10000 ~
October	U0001 ~ U9999	V10000 ~
November	W0001 ~ W9999	X10000 ~
December	Y0001 ~ Y9999	Z10000 ~

e.g. D1803-3A0001
"3" indicates 2003 and "A" indicates January.
So, 3A indicates that the engine was manufactured on January, 2003.

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[2] E2B ENGINE

[ex.: Model Name D1803-M-**E2B**-XXXX]

The emission controls that have been put into effect in various countries to prevent air pollution will be stepped up. The time to enforce the regulations differs depending on the engine output classifications.

Kubota has been supplying the diesel engines conforming to the emission regulations in respective countries.Exhaust emissions regulations shift to the second stage. Kubota executed the improvement of the engine according to this regulation.

In order to discriminate the engines conforming to Tier 1 / Phase 1 requirements and those conforming to Tier 2 / Phase 2 requirements, we have adopted E2B as a new model name for the engines conforming Tier 2 / Phase 2 regulations.

In the after-sale services for 03-M-E2B series engines, only use the dedicated parts for E2B models and carry out the maintenance services accordingly.

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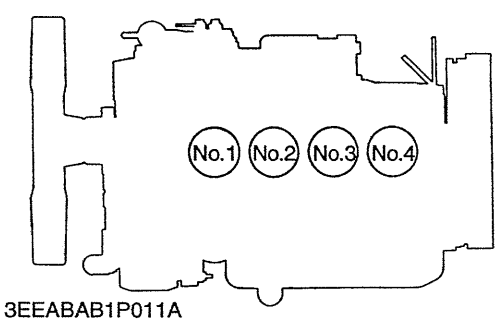
[3] CYLINDER NUMBER



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The cylinder numbers of KUBOTA 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.

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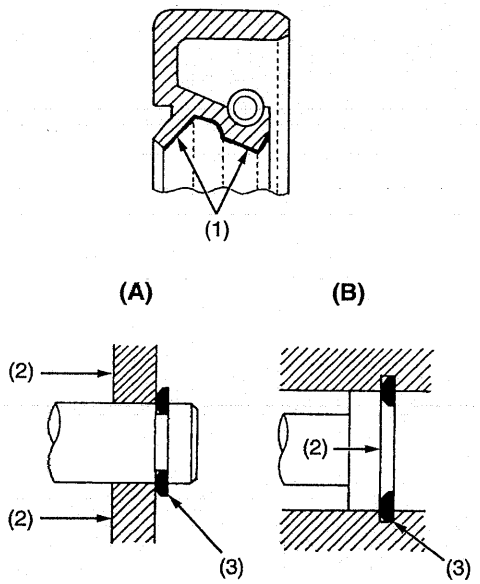
2. GENERAL PRECAUTION



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- 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

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3. 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.

The lubricating oil change intervals listed in the table below are for Classes CF, CE and CD lubricating oils of API classification with a low-sulfur fuel in use. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals than recommended in the table below depending on the operating condition.

Item		Service Interval											
		50 hrs	100 hrs	150 hrs	200 hrs	300 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	2 years
Checking fuel pipes nd 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 pan depth (90 mm, 3.54 in.)					☆							
	(2) Oil pan depth (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 pressure												☆	
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 oil filter cartridge after the first 50 hours of operation.

** Maintenance interval as per EPA instructions.

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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.**

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

O : Recommendable X : Not recommendable

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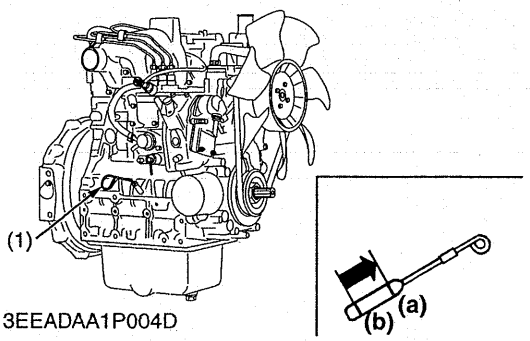
4. CHECK AND MAINTENANCE

[1] DAILY CHECK POINTS



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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, drain old oil. Never mix two different types of oil.**

■ NOTE

- **Be sure to inspect the engine, locating it on a horizontal place. If placed on gradients, accurately, oil quantity may not be measured.**
- **Be sure to keep the oil level between upper and lower limits of the dipstick. Too much oil may cause a drop in output or excessive blow-by gas. On the closed breather type engine in which mist is sucked through port, too much oil may caused oil hammer. While too little oil, may seize the engine's rotating and sliding parts.**

(1) Dipstick
(a) Maximum
(b) Minimum

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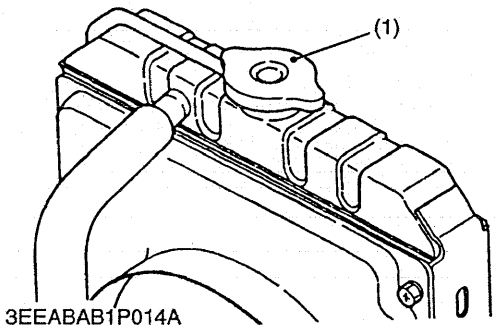

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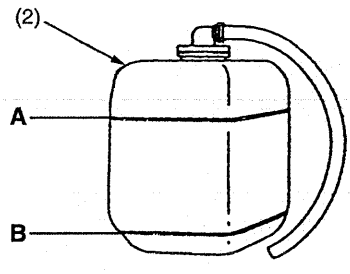

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Checking and Replenish Coolant

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 (2) ;
   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.

⚠ 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

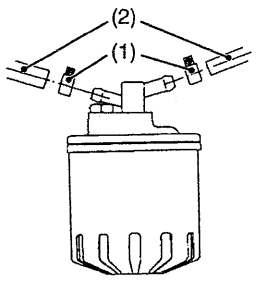
- **During filling the coolant, air must be vented from the engine coolant passages. The air vents by jiggling the radiator upper and lower hoses.**
- **Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and the engine could overheat.**
- **Do not use an antifreeze and scale inhibitor at the same time.**
- **Never mix the different type or brand of L.L.C..**

(1) Radiator Cap
(2) Recovery Tank
(A) FULL
(B) LOW

0000001296E

[2] CHECK POINTS OF EVERY 50 HOURS

[A]



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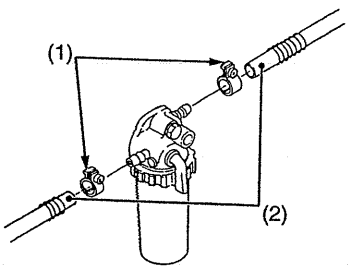
[B]



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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

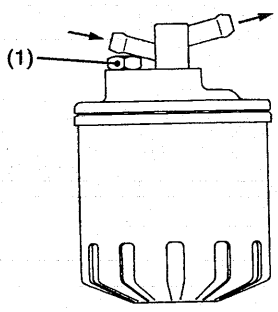
- **Stop the engine when attempting the check and change prescribed above.**

(1) Clamp
(2) Fuel Pipe

[A] Cartridge Type
[B] Normal Type

0000006239E

[A]



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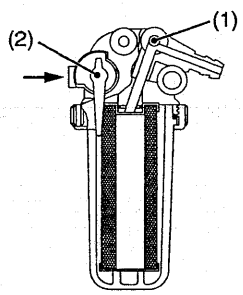
[B]



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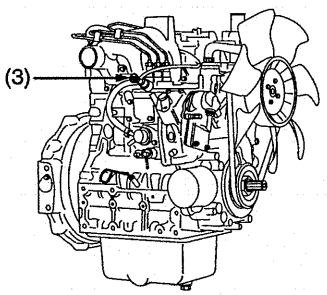

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(When bleeding fuel system)

1. Fill the tank with fuel and open the fuel cock (2). ([B] only)
2. Loosen the air vent plug (1) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. 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.
5. Open the air vent cock (3) on top of the fuel injection pump.
6. Close securely the air vent cock after air bleeding.

■ **NOTE**

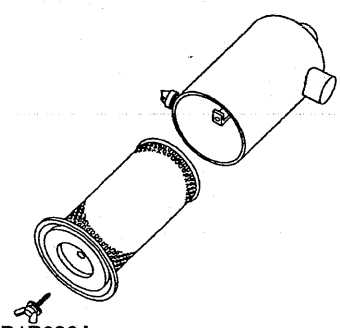
- **Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.**

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

[A] Cartridge Type
[B] Normal Type

0000006240E

[3] CHECK POINTS OF EVERY 100 HOURS



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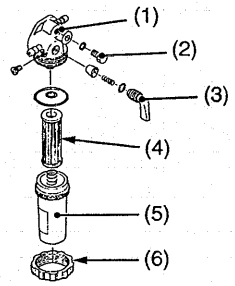
Cleaning Air Cleaner Element

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/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

■ **NOTE**

- **The air cleaner uses a dry element. Never apply oil to it.**
- **Do not run the engine with filter element removed.**
- **Change the element once a year or every 6th cleaning.**

0000001301E



3EEABAB1P023A

Cleaning Fuel Filter (Normal Type only)

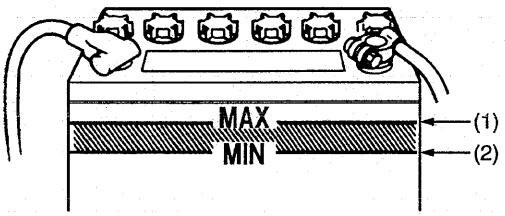
1. Close the fuel cock (3).
2. Unscrew the retaining ring (6) and remove the cup (5), and rinse the inside with kerosene.
3. Take out the element (4) and dip it in the kerosene to rinse.
4. After cleaning, reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

■ 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
(2) Air Vent Plug
(3) Fuel Cock
(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

0000006225E



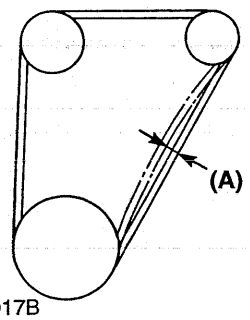
3EEABAB1P024A

Checking Battery Electrolyte

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

0000004824E



3EEABAB1P017B

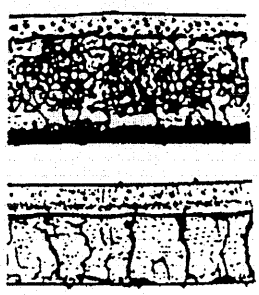
Fan Belt Tension

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 to 9 mm 0.28 to 0.35 in.

(A) Deflection

0000004277E



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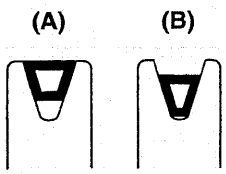
Fan Belt Damage and Wear

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**

0000000920E



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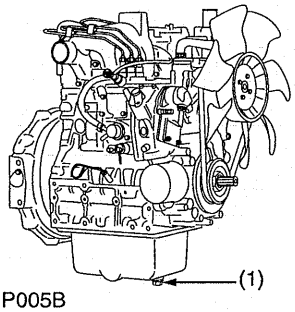
[4] CHECK POINTS OF EVERY 150 HOURS

Changing Engine Oil

1. For 90 mm (3.54 in.) depth oil pan only.
   See the "CHECK POINTS OF EVERY 200 HOURS".

0000006244E

[5] CHECK POINTS OF EVERY 200 HOURS



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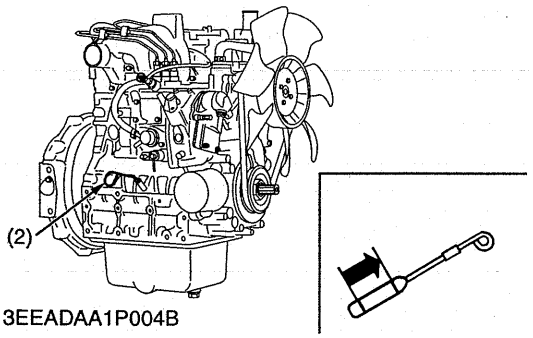

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Changing Engine Oil

⚠ CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ IMPORTANT

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

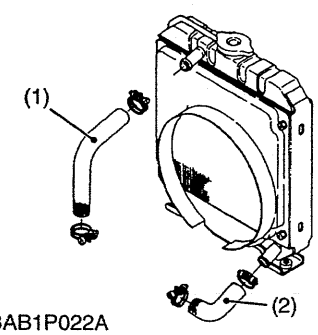
Above 25 °C (77 °F)	SAE30 or SAE10W-30 SAE10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE20 or SAE10W-30 SAE10W-40
Below 0 °C (32 °F)	SAE10W or SAE10W-30 SAE10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	* 90 mm (3.54 in.)
D1503-M D1703-M D1803-M	7.0 L 1.85 U.S.gals 1.54 Imp.gals	5.6 L 1.48 U.S.gals 1.23 Imp.gals
V2003-M V2203-M V2003-M-T V2403-M	9.5 L 2.51 U.S.gals 2.09 Imp.gals	7.6 L 2.01 U.S.gals 1.672 Imp.gals

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

(1) Drain Plug (2) Dipstick

0000006247E



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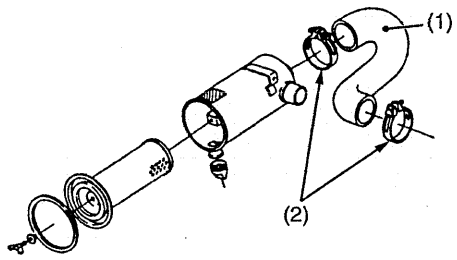
Checking Radiator Hoses and Clamp Bands

1. Check to see if the radiator hoses are properly fixed every 250 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 hose is made of rubber and tends to age. It must be replaced every two years. Also replace the clamp and tighten it securely.

(1) Upper Hose (2) Lower Hose

0000004822E



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Checking Intake Air Line

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

0000001304E

[6] CHECK POINTS OF EVERY 300 HOURS

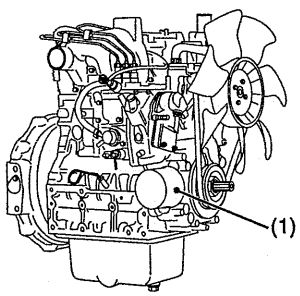
Replacing Oil Filter Cartridge (For 90 mm (3.54 in.) Depth Oil Pan)

1. See the "CHECK POINTS OF EVERY 400 HOURS".

0000006254E

[7] CHECK POINTS OF EVERY 400 HOURS

Replacing Oil Filter Cartridge



3EEADAA1P005C

⚠ CAUTION

- **Be sure to stop the engine before replacing filter cartridge.**

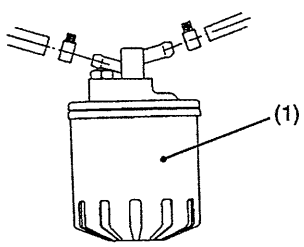
1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

■ IMPORTANT

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

(1) Engine Oil Filter Cartridge

0000001305E



3EEACAA1P057B

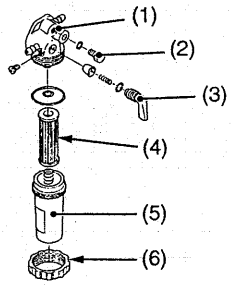
Replacing Fuel Filter Cartridge (Cartridge Type)

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

1. Remove the used filter cartridge 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

0000001306E



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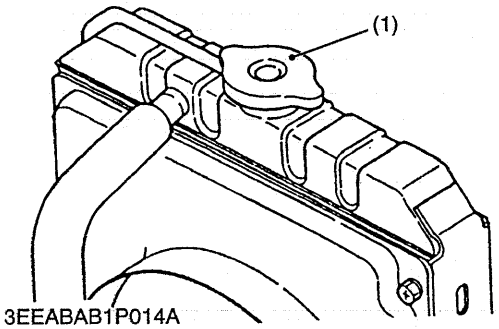
Replacing Fuel Filter Element (Normal Type)

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

0000006258E

[8] CHECK POINTS OF EVERY 500 HOURS



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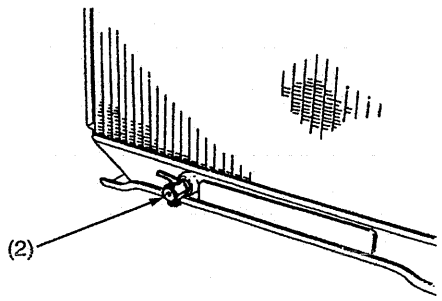

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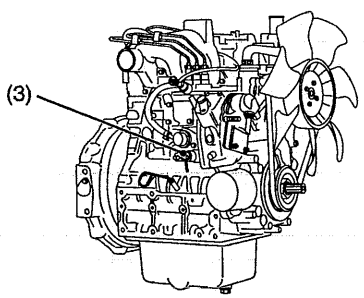

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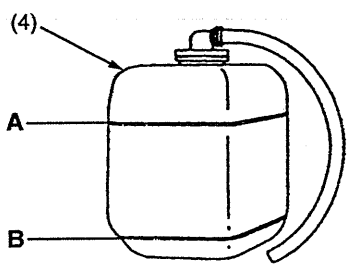

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Cleaning Fuel Tank Inside

0000006260E

Cleaning Water Jacket and Radiator Interior

⚠ CAUTION

- **Do not remove the radiator cap 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. And open the drain cock (3).
3. After all coolant is drained, close the drain plug.
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" (**A**) mark on the recovery tank (4).
8. Start and operate the engine for few minutes.
9. Stop the engine and let cool. Check coolant level of radiator and recovery tank (4) 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.**
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**
- **Securely tighten radiator cap. If the cap is loose or improperly fitted, water may leak out and the engine could overheat.**

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

A : Full
B : Low

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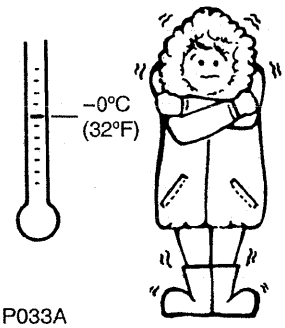

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Anti-Freeze

- 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	Freeze Point		Boiling Point*	
	°C	°F	°C	°F
40	-24	-12	106	222
50	-37	-34	108	226

*At 1.013 x 1000000 Pa (760 mmHg) 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.)

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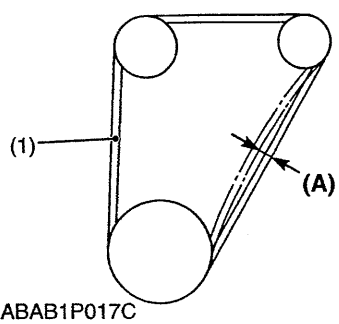

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Replacing Fan Belt

1. Remove the alternator.
2. Remove the fan belt (1).
3. Replace new fan belt.
4. Install the alternator.
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) Fan Belt **(A) Deflection**

0000001310E

[9] 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, charge 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**

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

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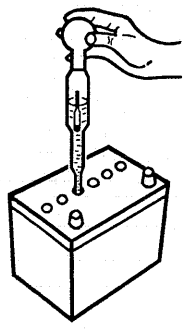

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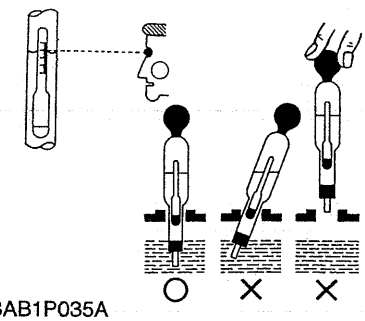

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Battery Specific Gravity

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 ℃ (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 ℃ (0.0004 with a decrease of 1 °F).
  Therefore, using 20 ℃ (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :
  -Specific gravity at 20 ℃ = Measured value + 0.0007 x (electrolyte temperature - 20 ℃)
  -Specific gravity at 68 °F = Measured value + 0.0004 x (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 ℃ (68 °F)

0000001142E

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 storaging the battery mounted on the tractor, disconnect the ground cable from the battery's negative terminal post.

(Reference)

- Self-discharge Rate

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

0000001728E

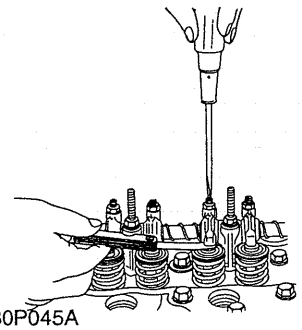
[10]CHECK POINTS OF EVERY YEAR

Replacing Air Cleaner Element

1. See the "CHECK POINTS OF EVERY 100 HOURS".

0000006262E

[11]CHECK POINTS OF EVERY 800 HOURS



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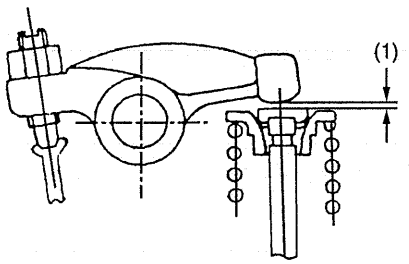

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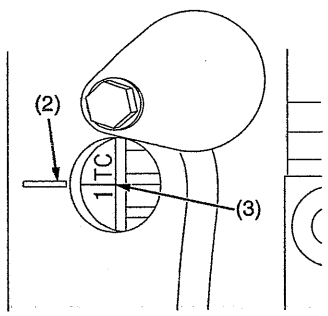


3EEADAA1P007A

Valve Clearance

■ IMPORTANT

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the head cover.
2. 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.
3. Check the following valve clearance (1) marked with "☆" using a feeler gauge.
4. 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 0.0087 in.

■ 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.**

Adjustable cylinder location of piston \ Valve arrangement		D1503-M D1703-M D1803-M		V2003-M V2203-M V2003-M-T V2403-M	
		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

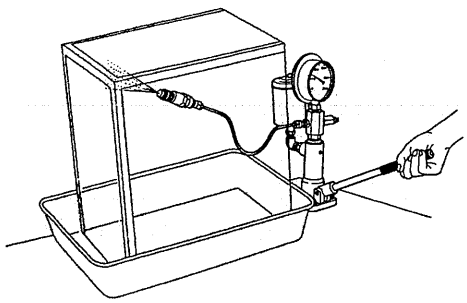
0000006265E

[12]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.**

0000000932E

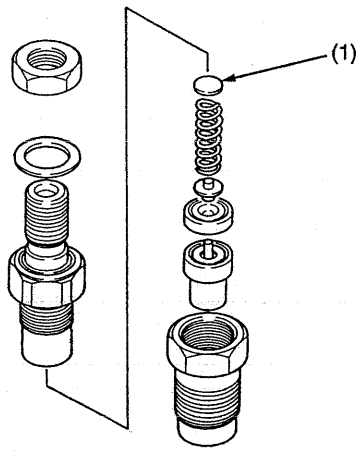


3TLABAB1P040A

Fuel Injection Pressure

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (1) in the nozzle holder to adjust it.
   See the "Disassembling and Assembling" for nozzle holder.

Fuel injection pressure	Factory spec.	13.73 to 14.71 MPa 140 to 150 kgf/cm^2 1991 to 2134 psi



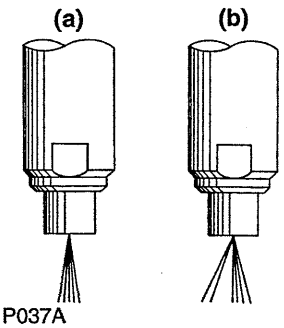
3EEABAB1P171B

(Reference)

- Pressure variation with 0.01 mm (0.0004 in.) difference of adjusting washer thickness.
  Approx. 235 kPa (2.4 kgf/cm^2, 34 psi)

(1) Adjusting Washer

0000004830E



3EEABAB1P037A

Nozzle Spraying Condition

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the nozzle piece.
   See the "Disassembling and Assembling" for nozzle holder.

(a) Good **(b) Bad**

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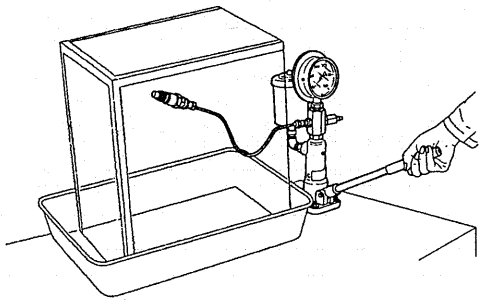


3TLABAB1P041A

Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130 kgf/cm^2, 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.
   See the "Disassembling and Assembling" for nozzle holder.

Valve seat tightness	Factory spec.	No fuel leak at 12.75 MPa 130 kgf/cm^2 1849 psi

0000004832E

[13]CHECK POINTS OF EVERY 2 YEARS

Replacing Intake Air Line

1. See the "CHECK POINTS OF EVERY 200 HOURS".

0000006271E

Replacing Battery

0000006272E

Replacing Radiator Hoses and Clamp Bands

1. See the "CHECK POINTS OF EVERY 200 HOURS".

0000006273E

Replacing Fuel Pipes and Clamp Bands

1. See the "CHECK POINTS OF EVERY 50 HOURS".

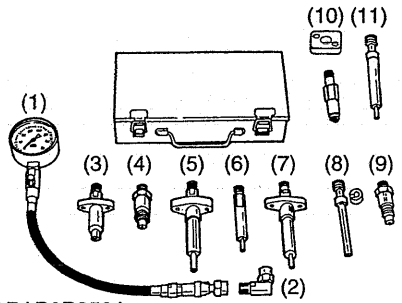
0000006275E

Replacing Radiator Coolant (L.L.C.)

1. See the "CHECK POINTS OF EVERY 500 HOURS".

0000006276E

5. SPECIAL TOOLS



3TMABAB0P052A

Diesel Engine Compression Tester

Code No : 07909-30208 (Assembly) 07909-31251 (G)
07909-30934 (A to F) 07909-31271 (I)
07909-31211 (E and F) 07909-31281 (J)
07909-31231 (H)

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

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

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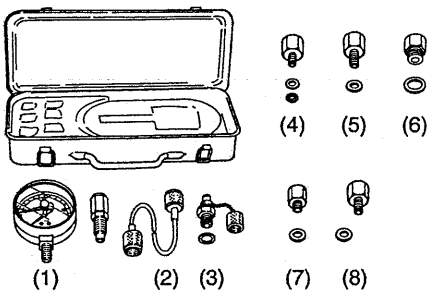


3TMABAB0P053A

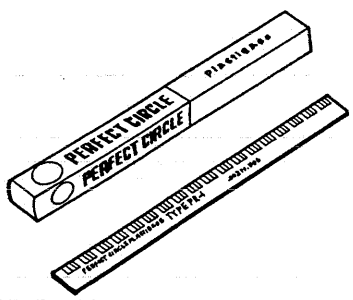
Oil Pressure Tester

Code No : 07916-32032

Application : Use to measure lubricating oil pressure.

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

0000000681E



3TMABAB0P058A

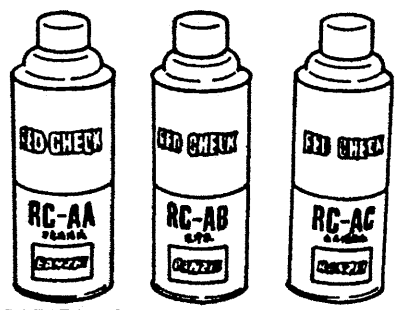
Plastigage

Code No : 07909-30241

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

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

0000000686E



3TMABAB0P059A

Red Check

Code No : 07909-31371

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

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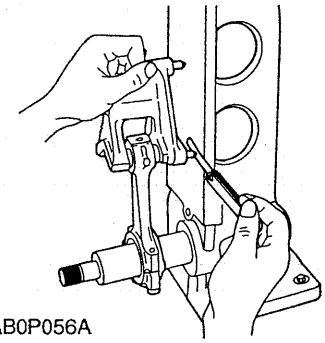
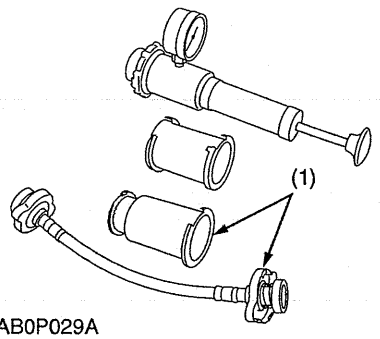


3TMABAB0P056A

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.)

0000000684



3TAAAAB0P029A

Radiator Tester

Code No : 07909-31551
Application : Use to check of radiator cap pressure, and leaks from cooling system.
Remarks : Adaptor (1) BANZAI Code No. RCT-2A-30S.

0000000815E

■ **NOTE**
● **The following special tools are not provided, so make them referring to the figure.**

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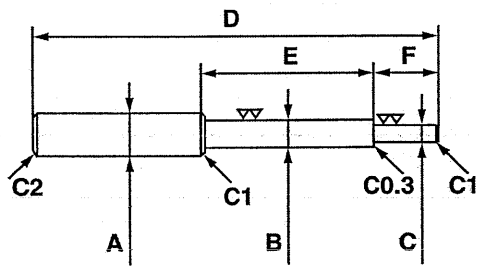

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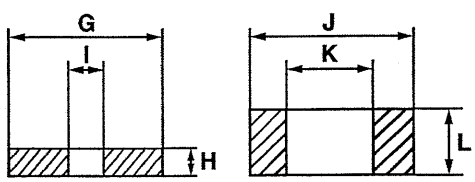


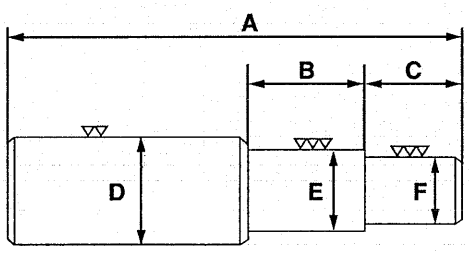
3TMABAB0P064A

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 0.358 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.3 mm (0.012 in.)

0000005170E



3TMABAB0P066A

Bushing Replacing Tools

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

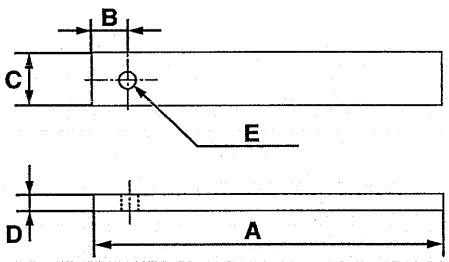
1. For small end bushing

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.)

0000005172E



3TMABAB0P067B

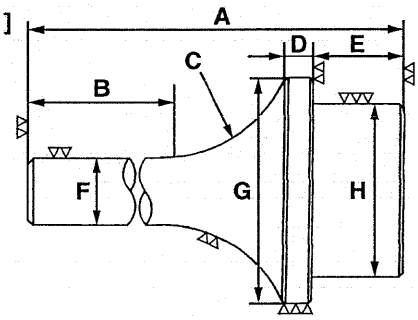
Flywheel Stopper

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.)

0000000818E

[1]



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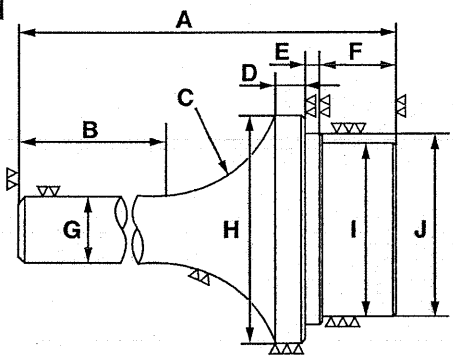


3TMABAB0P068A

Crankshaft Bearing 1 Replacing Tool

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

1. Extracting tool

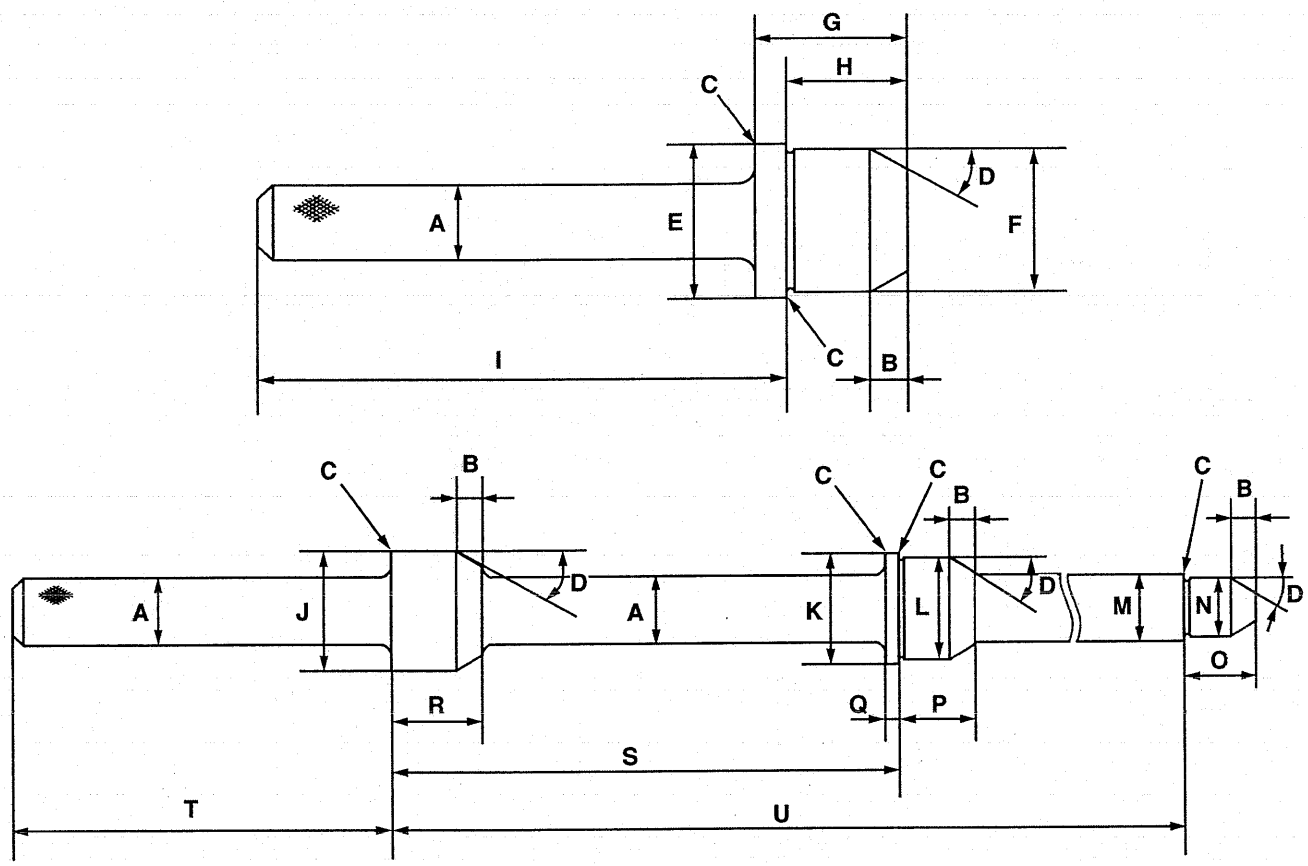
A	135 mm (5.31 in.)
B	72 mm (2.83 in.)
C	R40 mm (R1.57 in.)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	64.8 to 64.9 mm dia. (2.551 to 2.555 in. dia.)
H	59.8 to 59.9 mm dia. (2.354 to 2.358 in. dia.)

2. Inserting tool

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.)

0000006284E

Balancer Metal Replacing Tool (for Removing)
Application:Use to remove the metal bearing.

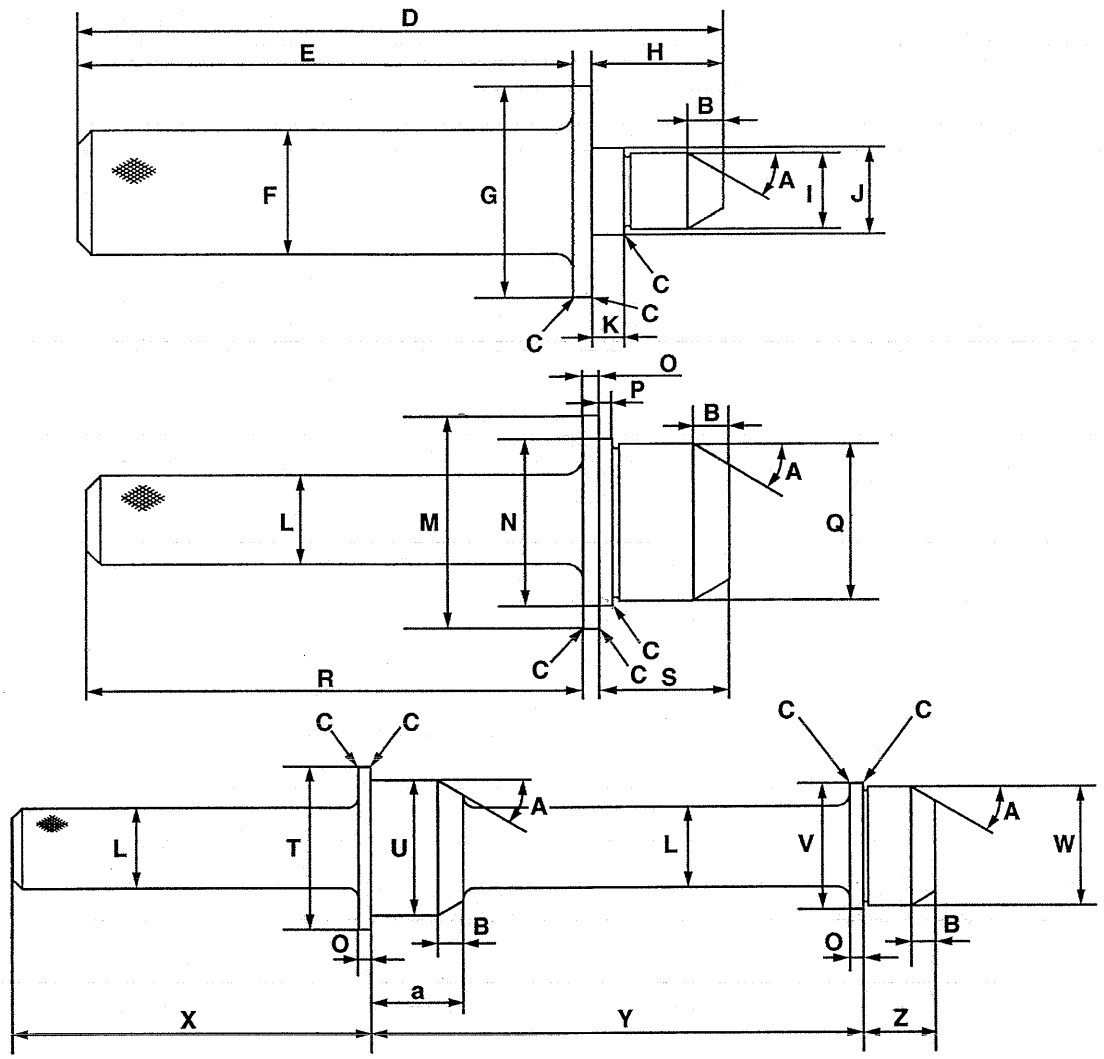


3TMABAB0P069A

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.)		

0000006285E

Balancer Metal Replacing Tool (for Fitting)
Application:Use to press fit the metal bearing.



3TMABAB0P070A

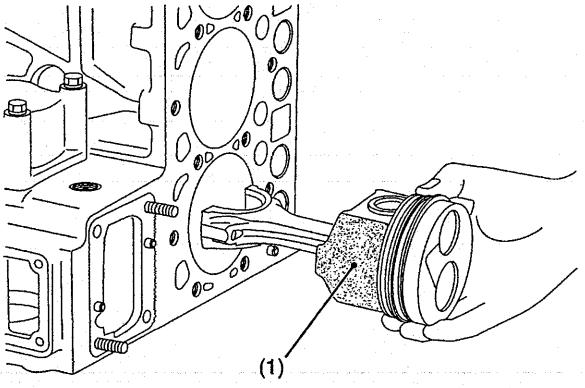
A	0.52 rad (30 °)	O	5 mm (0.20 in.)
B	10 mm (0.39 in.)	P	3.3 to 3.7 mm (0.130 to 0.146 in.)
C	Chamfer 0.3 mm (0.01 in.)	Q	43.934 to 43.950 mm dia. (1.7297 to 1.7303 in. dia.)
D	182 mm (7.16 in.)	R	140 mm (5.51 in.)
E	140 mm (5.51in.)	S	36 mm (1.42 in.)
F	35 mm dia. (1.38 in dia.)	T	60 mm dia. (2.36 in. 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.)		

0000006288E

CONTENTS

1. ENGINE BODY

[1] PISTON



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

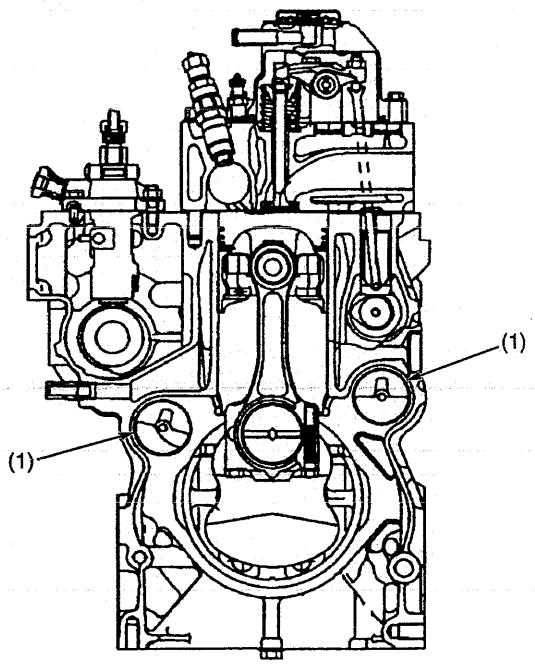
*** Molybdenum disulfide (MoS_2)**

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

0000006291E

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



3EEADAA1P002A

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.

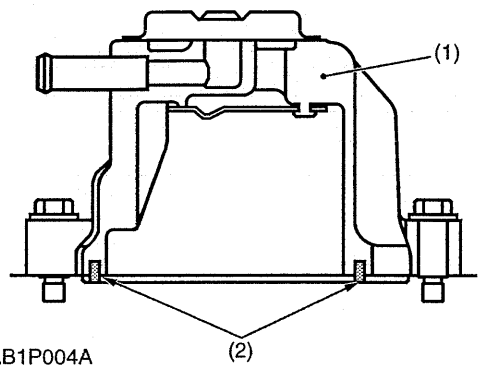
The four cylinders engine can be fitted with balance weight on crankcase to absorb the second inertia mentioned above and reduce vibration.

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

(1) Balancer

0000006292E

[3] HALF-FLOATING HEAD COVER



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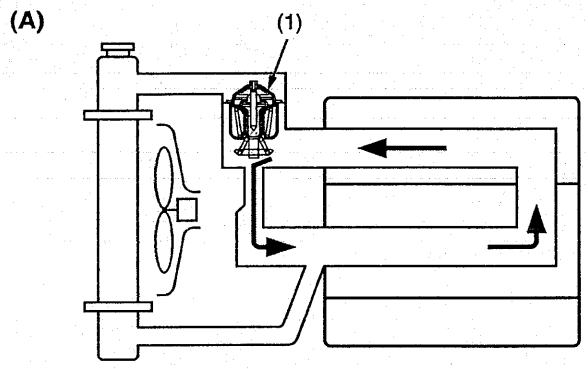
The rubber packing is fitting in to maintain the head cover 0.5 mm or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

(1) Cylinder Head Cover (2) Rubber Packing

0000004839E

2. COOLING SYSTEM

[1] BOTTOM BYPASS SYSTEM



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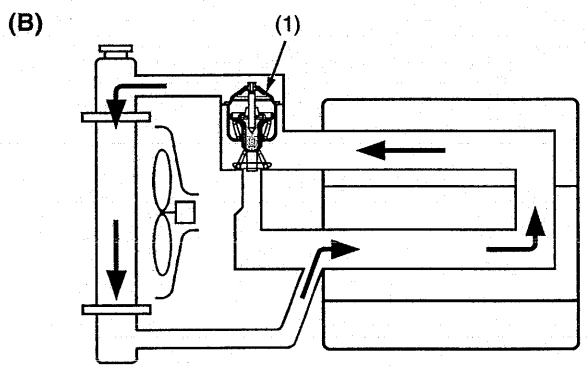

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Bottom bypass system is introduced in 03-M Series for improving the cooling performance of the radiator.

While the temperature of coolant in the engine is low, the thermostat 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 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) Thermostat Closed

(B) Thermostat Open

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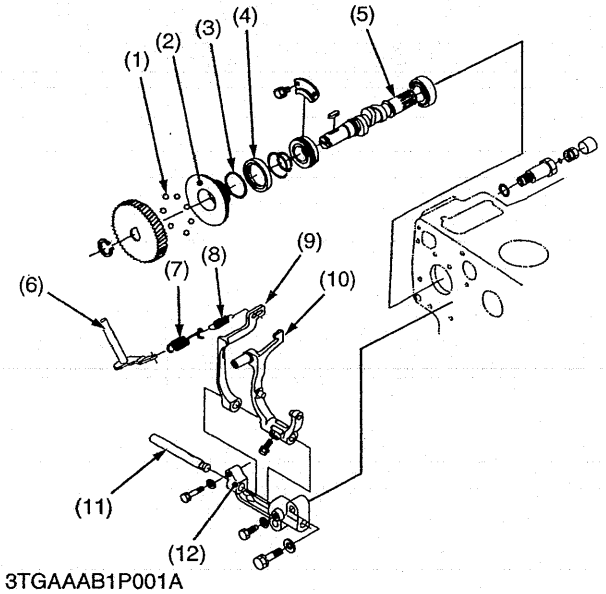
3. FUEL SYSTEM

[1] GOVERNOR



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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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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 runnning.

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 electical 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)

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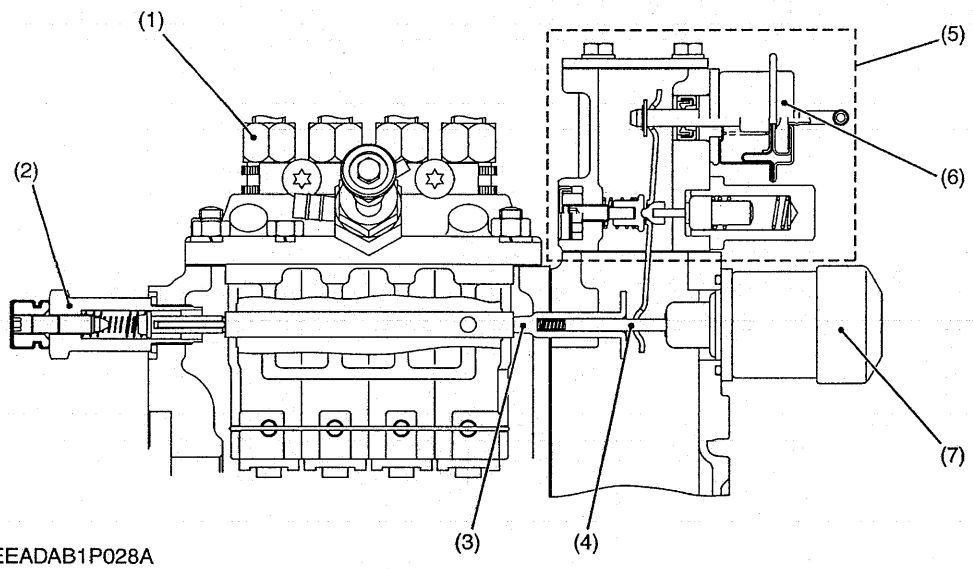
5. TURBOCHARGER SYSTEM

[1] BOOST COMPENSATOR



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(1) Injection Pump Assembly
(2) Hi-Idling Body
(3) Stop Solenoid Guide
(4) Plunger
(5) Boost Compensator Assembly
(6) Actuator
(7) Stop Solenoid

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The higher the boost pressure rises, the more fuel is fed. In this way, the turbocharger proves itself for high-power performance.

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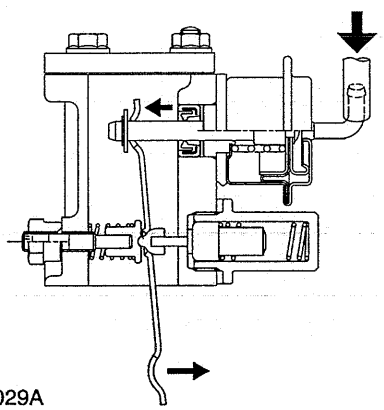

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When the boost pressure drops, excess fuel is cut down, allowing much less black emission.

The system is tremendously efficient in cutting down on the emission; under low boost pressures at quick speed-up or start-up, in particular.

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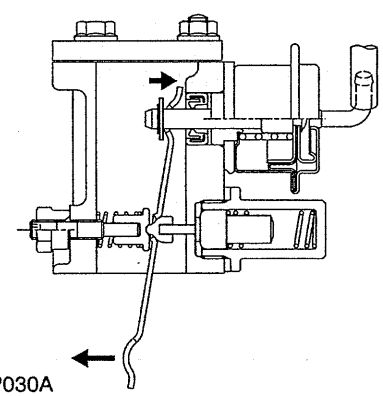

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CONTENTS

1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	● No fuel	Replenish fuel	—
	● Air in the fuel system	Vent air	G-9
	● Water in the fuel system	Change fuel and repair or replace fuel system	G-9, 10, 13, 14
	● Fuel pipe clogged	Clean	G-8
	● Fuel filter clogged	Replace	G-10, 13, 14
	● Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	4, 5
	● Fuel with low cetane number	Use specified fuel	4, 5
	● Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-29
	● Incorrect injection timing	Adjust	S-20
	● Fuel camshaft worn	Replace	S-40
	● Injection nozzle clogged	Clean or replace	S-21
	● Injection pump malfunctioning	Repair or replace	S-34, 35
	● Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	—
	● Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	S-30, 32
	● Improper valve timing	Correct or replace timing gear	S-40
	● Piston ring and cylinder worn	Replace	S-15, 44, 45, 66, 67, 73
	● Excessive valve clearance	Adjust	G-20
	● Stop solenoid mulfunctioning	Replace	S-26
(Starter Does Not Run)	● Battery discharged	Charge	G-17
	● Starter malfunctioning	Repair or replace	S-23, 50, 75
	● Key switch malfunctioning	Replace	—
	● Starter auto reduction unit defective	Replace	S-27, 80
	● Wiring disconnected	Connect	S-80

Symptom	Probable Cause	Solution	Reference Page
Engine Revolution Is Not Smooth	● Fuel filter clogged or dirty	Replace	G-10, 13, 14
	● Air cleaner clogged	Clean or replace	G-9
	● Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-29
	● Injection pump malfunctioning	Repair or replace	S-34, 35
	● Incorrect nozzle opening pressure	Adjust	S-21
	● Injection nozzle stuck or clogged	Repair or replace	S-21
	● Governor malfunctioning	Repair	S-37, 42
	● Bearing worn out	Replace the turbocharger assembly	S-54
	● Turbocharger shaft bent	Replace the turbocharger assembly	S-54
	● Turbocharger fin or other part damaged due to foreign matters	Replace the turbocharger assembly	S-54
Either White or Blue Exhaust Gas Is Observed	● Excessive engine oil	Reduce to specified level	G-6
	● Piston ring and cylinder worn or stuck	Repair or replace	S-15, 44, 45, 66, 67, 73
	● Incorrect injection timing	Adjust	S-20
	● Deficient compression	Adjust top clearance	S-15
Oil Leak into Exhaust Pipe or Suction Pipe	● Waste oil pipe clogged or deformed	Repair or replace	S-54
	● Piston ring seal faulty	Replace the turbocharger assembly	S-54
Either Black or Dark Gray Exhaust Gas Is Observed	● Overload	Lessen the load	—
	● Low grade fuel used	Use specified fuel	4, 5
	● Fuel filter clogged	Replace	G-10, 13, 14
	● Air cleaner clogged	Clean or replace	G-9
	● Deficient nozzle injection	Repair or replace nozzle	S-21

Symptom	Probable Cause	Solution	Reference Page
Deficient Output	● Incorrect injection timing	Adjust	S-20
	● Engine's moving parts seem to be seizing	Repair or replace	—
	● Injection pump malfunctioning	Repair or replace	S-34, 35
	● Deficient nozzle injection	Repair or replace nozzle	S-21
	● Compression leak	Check the compression pressure and repair	S-15
	● Gas leak from exhaust system	Repair or replace	S-27
	● Air leak from compressor discharge side	Repair or replace	S-27
	● Air cleaner dirty or clogged	Clean or replace	G-9
	● Compressor wheel turning heavily	Replace the turbocharger assembly	S-54
Excessive Lubricant Oil Consumption	● Piston ring's gap facing the same direction	Shift ring gap direction	S-44
	● Oil ring worn or stuck	Replace	S-44, 66, 67
	● Piston ring groove worn	Replace piston	S-44, 66, 67
	● Valve stem and valve guide worn	Replace	S-33, 56, 57
	● Crankshaft bearing, and crank pin bearing worn	Replace	S-69, 70, 71
	● Oil leaking due to defective seals or packing	Replace	—
Fuel Mixed into Lubricant Oil	● Injection pump's plunger worn	Replace injection pump	S-34, 35
	● Deficient nozzle injection	Repair or replace nozzle	S-21
	● Injection pump broken	Replace	S-34, 35
Water Mixed into Lubricant Oil	● Head gasket defective	Replace	S-32
	● Cylinder block or cylinder head flawed	Replace	S-32, 55
Low Oil Pressure	● Engine oil insufficient	Replenish	G-6
	● Oil strainer clogged	Clean	S-43
	● Relief valve stuck with dirt	Clean	—
	● Relief valve spring weaken or broken	Replace	—
	● Excessive oil clearance of crankshaft bearing	Replace	S-48, 70, 71
	● Excessive oil clearance of crankpin bearing	Replace	S-44, 69
	● Excessive oil clearance of rocker arm	Replace	S-33, 59
	● Oil passage clogged	Clean	—
	● Different type of oil	Use specified type of oil	4, 5, G-12
	● Oil pump defective	Repair or replace	S-17, 42, 74

Symptom	Probable Cause	Solution	Reference Page
High Oil Pressure	● Different type of oil	Use specified type of oil	4, 5, G-12
	● Relief valve defective	Replace	—
Engine Overheated	● Engine oil insufficient	Replenish	G-6
	● Fan belt broken or elongated	Replace or adjust	G-11, 16
	● Coolant insufficient	Replenish	G-7
	● Radiator net and radiator fin clogged with dust	Clean	—
	● Inside of radiator corroded	Clean or replace	G-15
	● Coolant flow route corroded	Clean or replace	—
	● Radiator cap defective	Replace	S-18
	● Overload running	Reduce the load	—
	● Head gasket defective	Replace	S-32
	● Incorrect injection timing	Adjust	S-20
	● Unsuitable fuel used	Use specified fuel	4, 5
Battery Quickly Discharged	● Battery electrolyte insufficient	Replenish distilled water and charge	G-10, 17
	● Fan belt slips	Adjust belt tension or replace	G-10, 16
	● Wiring disconnected	Connect	S-80
	● Rectifier defective	Replace	S-52, 79
	● Alternator defective	Replace	S-51, 78
	● Battery defective	Replace	—

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2. 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)	—	3.53 to 4.02 MPa / 290 min^{-1} (rpm) 36 to 41 kgf/cm^2 / 290 min^{-1} (rpm) 512 to 583 psi / 290 min^{-1} (rpm)	2.55 MPa / 290 min^{-1} (rpm) 26 kgf/cm^2 / 290 min^{-1} (rpm) 370 psi / 290 min^{-1} (rpm)
	Difference among Cylinders	—	10 % or less
Top Clearance		0.55 to 0.70 mm 0.0217 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 0.00157 to 0.00276 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	0.05 mm 0.0020 in.	—
	Recessing	0.15 mm 0.0059 in.	0.4 mm 0.0157 in.

Item		Factory Specification	Allowable Limit
Valve Timing (Intake Valve)	D1503-M (Open)	0.14 rad (8 °) before T.D.C.	—
	D1503-M (Close)	0.35 rad (20 °) after B.D.C.	—
	D1703-M (Open) D1803-M V2003-M V2203-M V2403-M	0.21 rad (12 °) before T.D.C.	—
	D1703-M (Close) D1803-M V2003-M V2203-M V2403-M	0.63 rad (36 °) after B.D.C.	—
	V2003-M-T (Open)	0.35 rad (20 °) before T.D.C.	—
	V2003-M-T (Close)	0.79 rad (45 °) after B.D.C.	—
Valve Timing (Exhaust Valve)	D1503-M (Open)	1.05 rad (60 °) before B.D.C.	—
	D1503-M (Close)	0.21 rad (12 °) after T.D.C.	—
	D1703-M (Open) D1803-M V2003-M V2203-M V2403-M	1.05 rad (60 °) before B.D.C.	—
	D1703-M (Close) D1803-M V2003-M V2203-M V2403-M	0.21 rad (12 °) after T.D.C.	—
	V2003-M-T (Open)	0.96 rad (55 °) before B.D.C.	—
	V2003-M-T (Close)	0.24 rad (14 °) 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.

Item		Factory Specification	Allowable Limit
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.	—
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 (Backlash)	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
	Idle Gear to Injection Pump Gear (Backlash)	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
	Crank Gear to Oil Pump Gear (Backlash)	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.	0.15 mm 0.0059 in.
	Idle Gear to Balancer Gear (Backlash) (Balancer Model Only)	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 1.49704 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.

Item		Factory Specification	Allowable Limit
Camshaft Journal to Cylinder Block Bore	Clearance	0.050 to 0.091 mm 0.00197 to 0.00358 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 Journal 1 (I.D.)	43.980 to 44.045 mm 1.73149 to 1.73405 in.	—
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 Journal 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 Journal 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.
Second Ring to Ring Groove	Clearance	0.093 to 0.128 mm 0.0037 to 0.0050 in.	0.2 mm 0.0079 in.
Oil Ring to Ring Groove	Clearance	0.020 to 0.060 mm 0.0008 to 0.0021 in.	0.15 mm 0.0059 in.
Top Ring	D1503-M V2003-M V2003-M-T (Ring Gap)	0.20 to 0.35 mm 0.0079 to 0.0138 in.	1.25 mm 0.0492 in.
	D1703-M D1803-M V2203-M V2403-M (Ring Gap)	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.25 mm 0.0492 in.

Item		Factory Specification	Allowable Limit
Second Ring	D1503-M D1703-M D1803-M V2203-M V2403-M (Ring Gap)	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
	V2003-M V2003-M-T (Ring Gap)	0.40 to 0.55 mm 0.0157 to 0.0217 in.	1.25 mm 0.0492 in.
Oil Ring	Ring Gap	0.25 to 0.45 mm 0.0098 to 0.0177 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	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.	—
Crankshaft Journal to Crankshaft Bearing 2	Oil Clearance	0.040 to 0.104 mm 0.00157 to 0.00409 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 2 (I.D.)	59.980 to 60.025 mm 2.36142 to 2.36374 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	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.

Item		Factory Specification	Allowable Limit
Cylinder Bore [Standard]	D1503-M V2003-M V2003-M-T (I.D.)	83.000 to 83.022 mm 3.26772 to 3.26858 in.	+ 0.15 mm + 0.0059 in.
	D1703-M D1803-M V2203-M V2403-M (I.D.)	87.000 to 87.022 mm 3.42519 to 3.42606 in.	+ 0.15 mm + 0.0059 in.
Cylinder Bore [Oversize]	D1503-M V2003-M V2003-M-T (I.D.)	83.250 to 83.272 mm 3.27756 to 3.27843 in.	+ 0.15 mm + 0.0059 in.
	D1703-M D1803-M V2203-M V2403-M (I.D.)	87.250 to 87.272 mm 3.43503 to 3.43590 in.	+ 0.15 mm + 0.0059 in.

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LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	98 kPa or more 1.0 kgf/cm^2 or more 14 psi or more	49 kPa 0.5 kgf/cm^2 7 psi
	At Rated Speed	294 to 441 kPa 3.0 to 4.5 kgf/cm^2 43 to 64 psi	245 kPa 2.5 kgf/cm^2 36 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.

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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	—

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FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Pump	Injection Timing	0.297 to 0.331 rad (17 to 19 °) before T.D.C.	—
Injection Nozzle	Injection Pressure	13.73 to 14.71 MPa 140 to 150 kgf/cm^2 1991 to 2133 psi	—
Injection Nozzle Valve Seat	Valve Seat Tightness	When the pressure is 12.75 MPa (130 kgf/cm^2, 1849 psi), the valve seat must be fuel tightness.	—

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ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Starter	Commutator D1503-M D1703-M V2003-M V2003-M-T V2203-M (O.D.)	30.0 mm 1.181 in.	29.0 mm 1.142 in.
	Commutator D1803-M V2403-M (O.D.)	35.0 mm 1.378 in.	34.0 mm 1.339 in.
	Mica (Under Cut)	0.45 to 0.75 mm 0.0177 to 0.0295 in.	0.20 mm 0.0079 in.
	Brush D1503-M D1703-M V2003-M V2003-M-T V2203-M (Length)	15.0 mm 0.591 in.	11.0 mm 0.433 in.
	Brush D1803-M V2403-M (Length)	15.0 mm 0.591 in.	9.0 mm 0.354 in.
	Brush Holder and Holder Support (Resistance)	Infinity	—
Alternator	No-load voltage	More than 13.5 V	—
	Stator (Resistance)	Less than 1.0 Ω	—
	Rotor (Resistance)	2.9 Ω	—
	Slip Ring (O.D.)	14.4 mm 0.567 in.	14.0 mm 0.551 in.
	Brush (Length)	10.5 mm 0.413 in.	8.4 mm 0.331 in.
Glow Plug	Resistance	Approx. 0.9 Ω	—
Stop Solenoid	Pulling Coil (Resistance)	Approx. 0.375 Ω	—
	Holding Coil (Resistance)	Approx. 15.6 Ω	—

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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.

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

When the tightening torques are not specified, tighten the screws, bolts and nuts according to the table below.

Grade / Nominal Diameter / Unit	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

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 SS41, S20C
7	Special screw and bolt S43C, S48C (Refined)

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[2] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLT AND NUTS

■ **NOTE**

- **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 x 1.0	6.9 to 11.3	0.7 to 1.15	5.1 to 8.32
*Cylinder head screw	M11 x 1.25	93.1 to 98.0	9.5 to 10.0	68.7 to 72.3
*Main bearing case screw 1	M9 x 1.25	46.1 to 50.9	4.7 to 5.2	34.0 to 37.6
*Main bearing case screw 2	M10 x 1.25	68.6 to 73.5	7.0 to 7.5	50.6 to 54.2
*Flywheel screw	M12 x 1.25	98.0 to 107.8	10.0 to 11.0	72.3 to 79.5
*Connecting rod screw	M8 x 1.0	44.1 to 49.0	4.5 to 5.0	32.5 to 36.2
*Rocker arm bracket screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
*Idle gear shaft screw	M8 x 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 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Glow plugs	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle holder assembly	M20 x 1.5	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
Oil pressure switch	R 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection pipe retaining nut	M12 x 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
Overflow pipe assembly retaining nut	—	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Camshaft set screw	M8 x 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	32.5 to 36.2
Balancer shaft set bolt	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Alternator pulley nut	—	58.3 to 78.9	5.95 to 8.05	43.0 to 58.2

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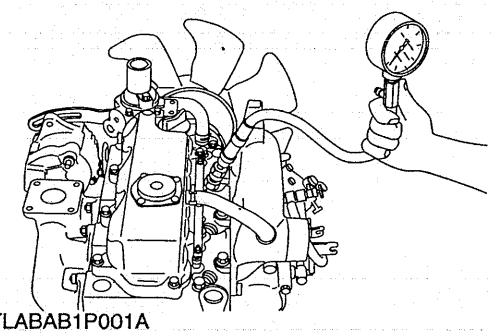
4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body



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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 to inject fuel.
3. Remove the air cleaner, the muffler and all injection nozzles.
4. Set a compression tester (Code No. 07909-30208) with the adaptor to the nozzle hole.
5. Keep the engine stop lever at **"Stop Position"**.
6. While cranking the engine with the starter, measure the compression pressure.
7. Repeat steps 4 through 6 for each cylinder.
8. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the nozzle hole and measure the compression pressure again.
9. If the compression pressure is still less than the allowable limit, check the top clearance, valve and cylinder head.
10. 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.	3.53 to 4.02 MPa 36 to 41 kgf/cm^2 512 to 583 psi
	Allowable limit	2.55 MPa 26 kgf/cm^2 370 psi

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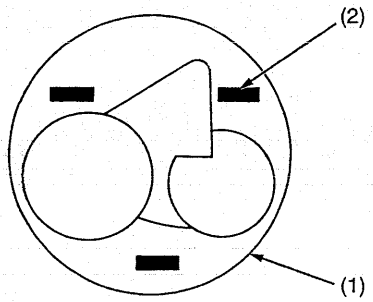

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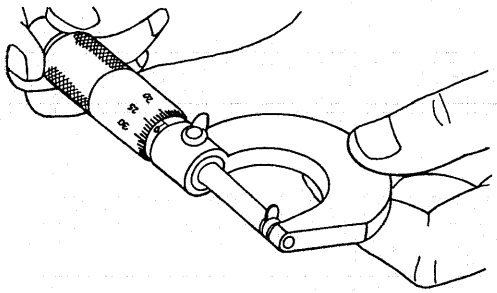

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Top Clearance

1. Remove the cylinder head.
2. Move the piston and stick a strip of fuse on the piston head at three positions 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 passes through the T.D.C..
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 clearance between the crankpin and bearing and between the piston pin and bushing.

■ **NOTE**

- **After checking the top clearance, be sure to assemble the cylinder head with a new cylinder head gasket.**

Top clearance	Factory spec.	0.55 to 0.70 mm 0.0217 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

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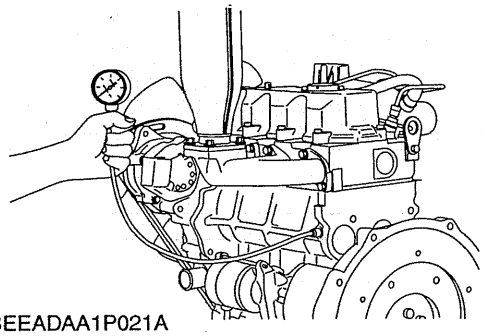
(2) Lubricating System



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Engine Oil Pressure

1. Remove the engine oil pressure switch, and set an oil pressure tester (Code No. 07916-32032). (Adaptor screw size : PT 1/8)
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	Factory spec.	More than 98 kPa 1.0 kgf/cm^2 14 psi
		Allowable limit	49 kPa 0.5 kgf/cm^2 7 psi
	At rated speed	Factory spec.	294 to 441 kPa 3.0 to 4.5 kgf/cm^2 42.7 to 64.0 psi
		Allowable limit	245 kPa 2.5 kgf/cm^2 35.6 psi

(When reassembling)

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

Tightening torque	Oil pressure switch	14.7 to 19.6 N·m 1.5 to 2.0 kgf/cm^2 10.8 to 14.5 ft-lbs

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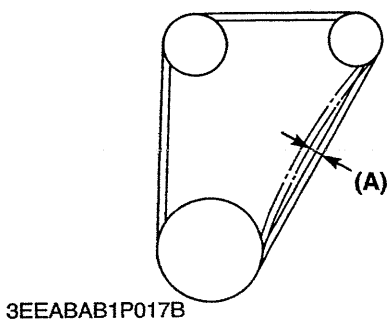
(3) Cooling System



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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 to 9 mm 0.28 to 0.35 in.

(A) Deflection

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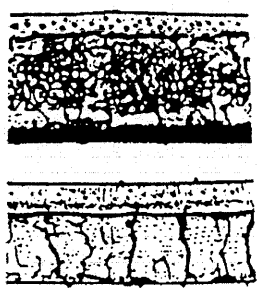

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Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt 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.

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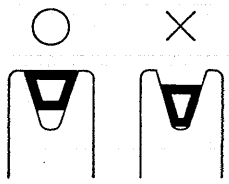

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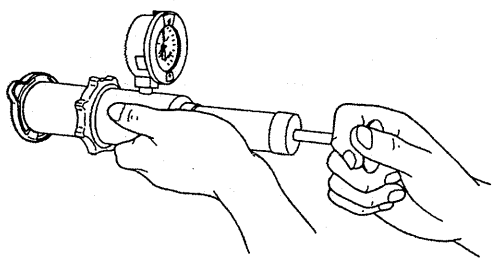
Radiator Cap Air Leakage

CAUTION

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



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1. Set a radiator tester (Code No. 07909-31551) on the radiator cap.
2. Apply the specified pressure (88 kPa, 0.9 kgf/cm^2, 13 psi), and measure the time for the pressure to fall to 59 kPa (0.6 kgf/cm^2, 9 psi).
3. 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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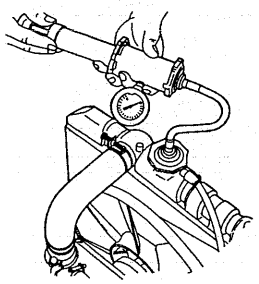

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Radiator Water Leakage

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

Radiator water leakage test pressure	Factory spec.	137 kPa 1.4 kgf/cm^2 20 psi

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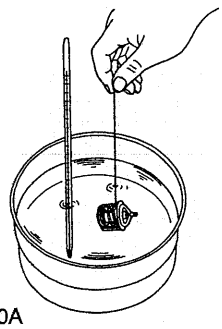

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Thermostat Valve Opening Temperature

1. Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
2. Heating the water gradually, read the temperature when the valve opens and leaves the string.
3. Continue heating and read the temperature when the valve opens approx. 6 mm (0.236 in.).
4. 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

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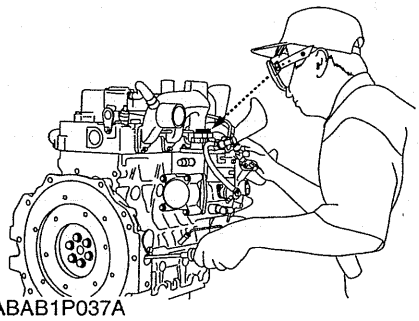
(4) Fuel System



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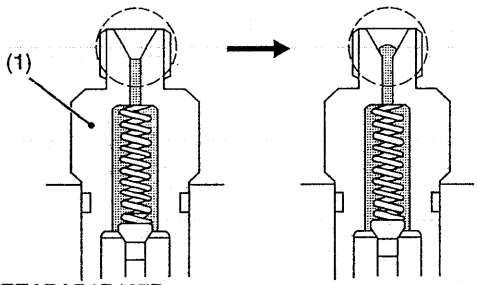

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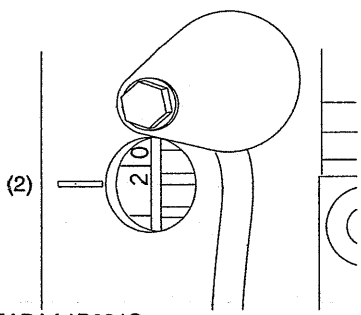

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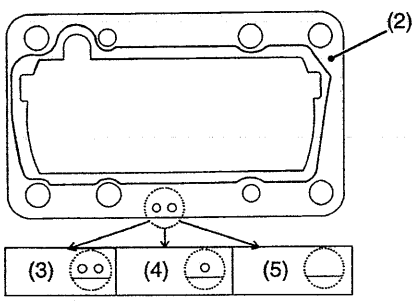

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Injection Timing

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.

4. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up to the hole of the delivery valve holder for 1st cylinder.
5. Turn the flywheel further and stop turning when the fuel begins to flow over, to get the present injection timing.
6. (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.

(Injection Timing)

Injection timing	Factory spec.	0.297 to 0.331 rad 17 ° to 19 ° B.T.D.C.

■ 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, 0.25mm and 0.30 mm. Combine these shims for adjustment.**
- **Addition or reduction of shim (0.05mm, 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) Delivery Valve Holder
(2) Timing Mark
(3) 2-Holes : 0.20 mm (Shim)
(4) 1-Hole : 0.25 mm (Shim)
(5) Without Hole : 0.30 mm (Shim)

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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.**

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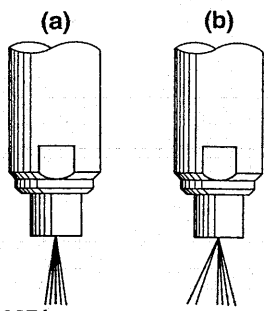

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Nozzle Spraying Condition

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the nozzle piece.

(a) **Good** (b) **Bad**

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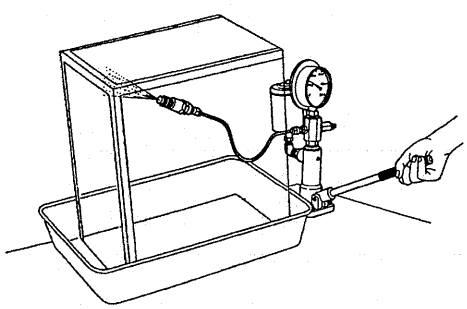

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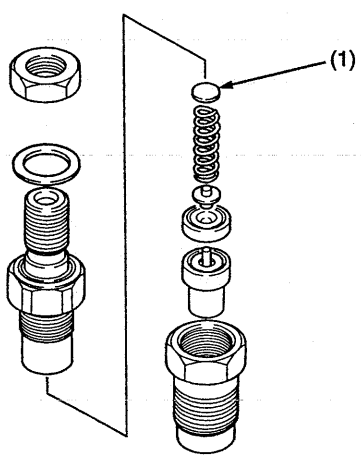
Fuel Injection Pressure

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (1) in the nozzle holder to adjust it.

Fuel injection pressure	Factory spec.	13.73 to 14.71 MPa 140 to 150 kgf/cm^2 1991 to 2134 psi

(Reference)

- Pressure variation with 0.01 mm (0.0004 in.) difference of adjusting washer thickness.
  Approx. 235 kPa (2.4 kgf/cm^2, 34 psi)



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(1) Adjusting Washer

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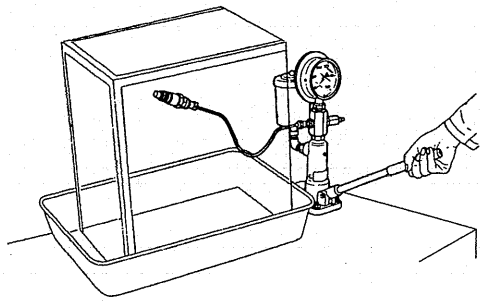

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Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130 kgf/cm^2, 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.

Injection pressure	Factory spec.	No fuel leak at 12.75 MPa 130 kgf/cm^2 1849 psi

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(5) Electrical System

CAUTION

- **To avoid accidental short circuit, be sure to attach the positive cable to the positive terminal before the negative cable is attached to the negative terminal.**
- **Never remove the battery cap while the engine is running.**
- **Keep electrolyte away from eyes, hands and clothes. If you are spattered with it, wash it away completely with water immediately.**
- **Keep open sparks and flames away from the battery at all times. Hydrogen gas mixed with oxygen becomes very explosive.**

IMPORTANT

- **If the machine is to be operated for a short time without battery (using a slave battery for starting), use additional current (lights) while engine is running and insulate terminal of battery. If this advice is disregarded, damage to alternator and regulator may result.**
- **Insulate terminal of battery. If this advice is disregarded, damage to alternator and regulator may result.**

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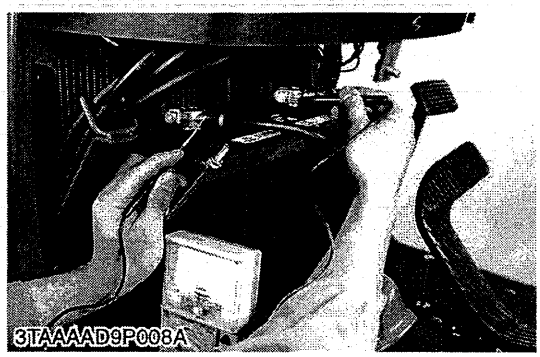

Battery Voltage

1. Stop the engine and turn the main switch off.
2. Connect the COM (-) lead of the voltmeter to the battery's negative terminal post and the (+) lead to the positive terminal post, and measure the battery voltage.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

Battery voltage	Factory spec.	More than 12 V

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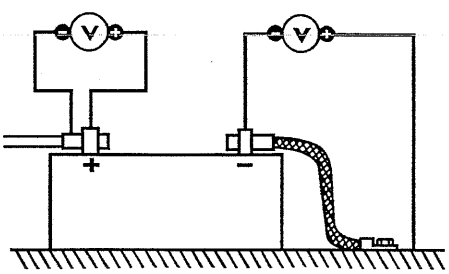

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Battery Terminal Connection

1. Turn the main switch on, and turn on the head light or all accessories.
2. Measure the voltage with a voltmeter across the battery's positive terminal post and the cable terminal, and the voltage across the battery's negative terminal post and the chassis.
3. If the measurement exceeds the factory specification, clean the battery terminal posts and cable clamps, and tighten them firmly.

Potential difference	Factory spec.	Less than 0.1 V

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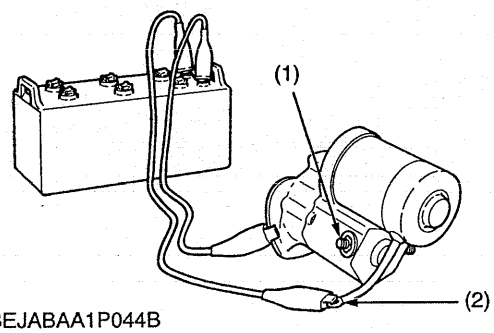

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Motor Test

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 **C** terminal (1).
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 does not run, check the motor.

(1) **C** Terminal (2) Connecting Lead

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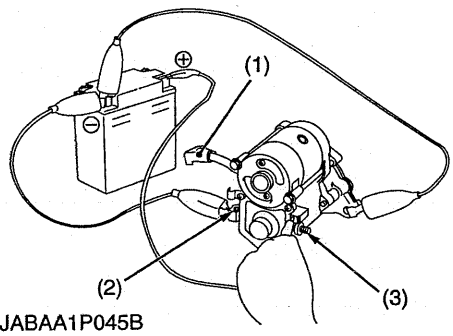

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Magnet Switch Test

1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable and the leads from the starter **M** 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 does 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

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(Precaution when checking)

- If disconnect the **B** terminal or coupler, engine will stop by emergency device.
- Do not directory 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.**

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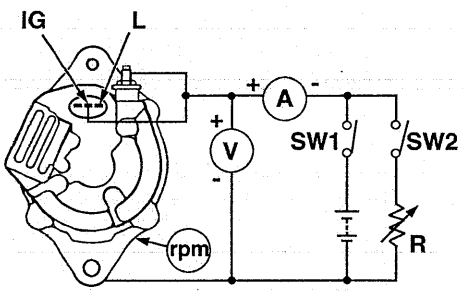

3EJABAA1P046A

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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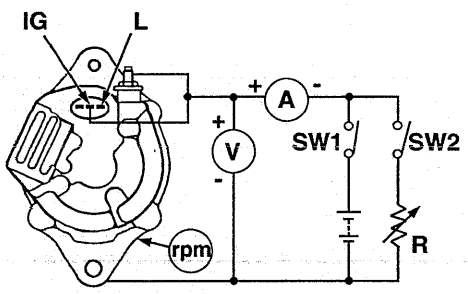

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No-load Characteristics

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 witch 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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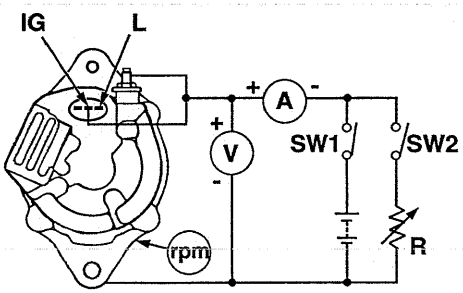

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Output Characteristics

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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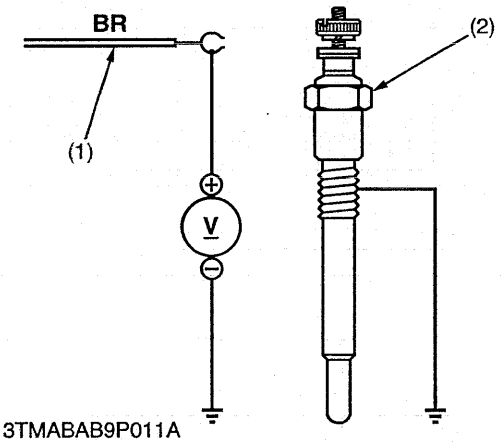

3TMABAB9P011A

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 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 - Chassis)	Main switch key at "**PREHEAT**"	Approx. battery voltage
	Main switch key at "**START**"	Approx. battery voltage

(1) Wiring Lead (Positive) (2) Glow Plug

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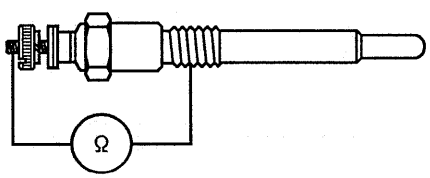

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Glow Plug Continuity

1. Disconnect the lead from the glow plugs.
2. Measure the resistance between the glow plug terminal and the chassis.
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. 0.9 Ω

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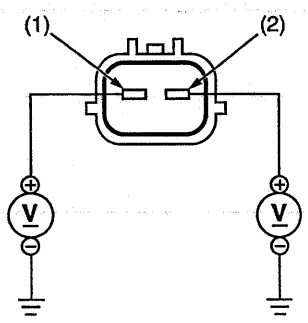

3TGAAAB9P021A

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 between the terminal **1**, terminal **2** 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**

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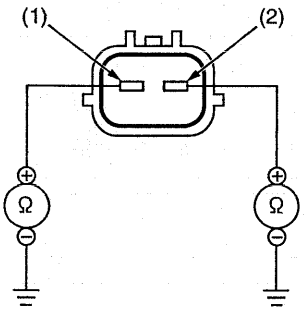

3TGAAAB9P021B

Stop Solenoid Coil

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

Resistance	Terminal **1** - Body	Approx. 0.375 Ω
	Terminal **2** - Body	Approx. 15.6 Ω

(1) Terminal **1** (Pulling Coil) (1) Terminal **2** (Holding Coil)

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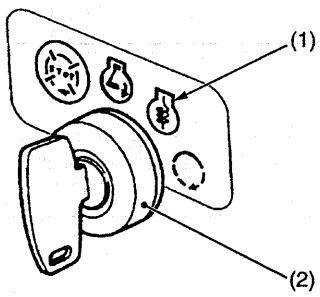

3TGAAAB9P022A

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

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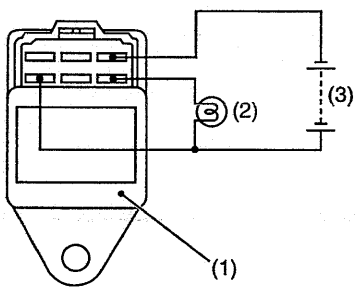

3TGAAAB9P023A

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

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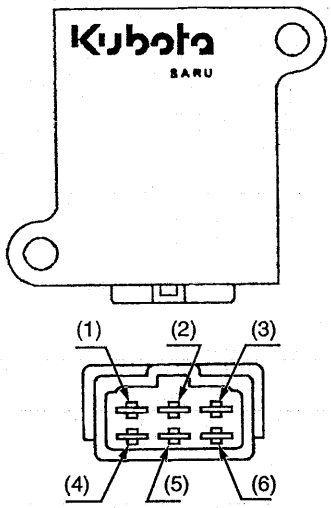

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Continuity

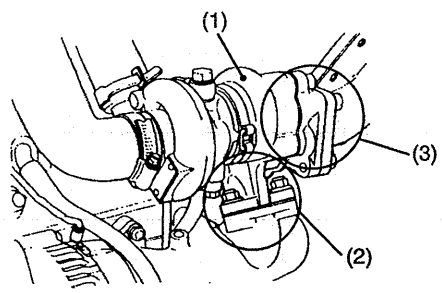
1. Disconnect the **6P** connector from the starter auto reduction unit.
2. Remove the starter auto reduction unit from the machine.
3. Measure the resistance according to below the matrix chart by circuit tester.

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

(1) Input Terminal from Key Switch **50** Terminal
(2) Output Terminal for an External Relay
(3) Output Terminal for Starter **ST** Terminal
(4) Input Terminal from Alternator **P** Terminal
(5) Input Terminal from Key Switch **AC** Terminal
(6) Output Terminal for Ground

0000006430E

(6) Turbocharger



3EEABAB1P199C

Turbine Side

1. Check the exhaust port (3) and inlet port (2) side of 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

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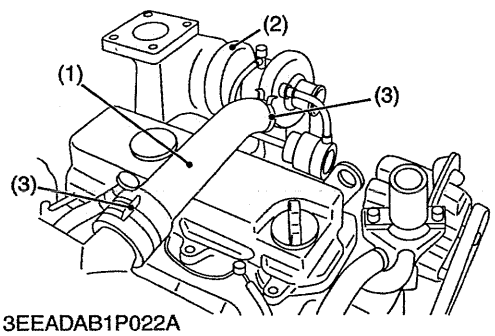

3EEADAB1P022A

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

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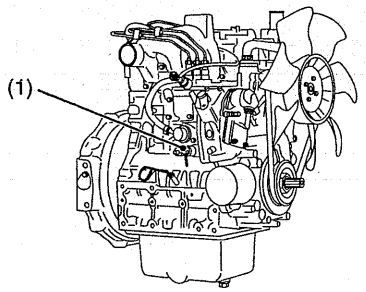
[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Coolant and Oil



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Draining Coolant

CAUTION

- **Never remove radiator cap while operating or immediately after stopping. Otherwise, hot water will spout out from the radiator. Wait for more than ten minutes to cool the radiator, before opening the cap.**

1. Prepare a bucket. Open the coolant drain cock.

(1) Coolant Drain Cock

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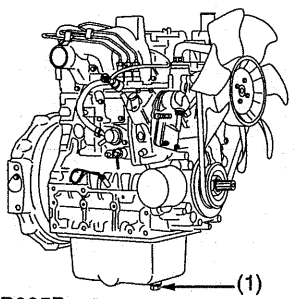

3EEADAA1P005B

Draining Engine Oil

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. Remove the drain plug (1) to drain oil.
4. After draining, screw in the drain plug.

(When refilling)

- Fill the engine oil up to the upper line on the dipstick (2)

■ IMPORTANT

- **Never mix two different type of oil.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

(1) Drain Plug (2) Dipstick

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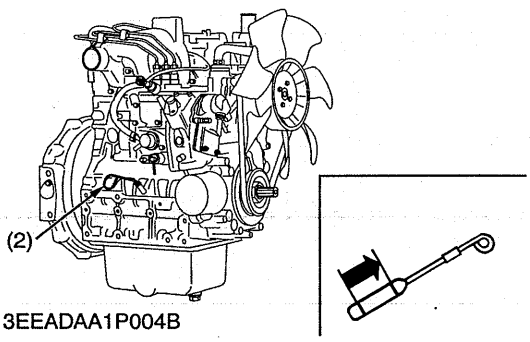

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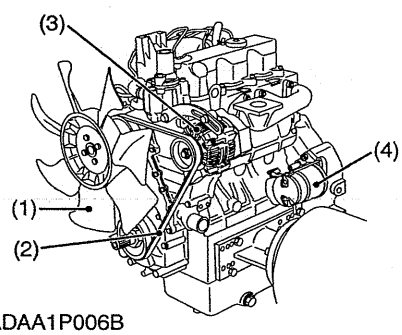
(2) External Components



3EEADAA1P006B

Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. 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.**
- **Do not confuse the direction of the fan. Attach the fan with its "1C010" marking facing frontward (toward the radiator).**

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

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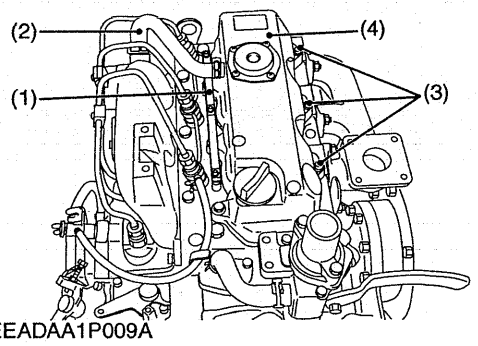
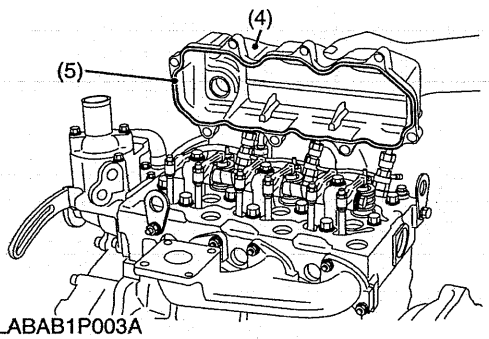
(3) Cylinder Head and Valves



3EEADAA1P009A



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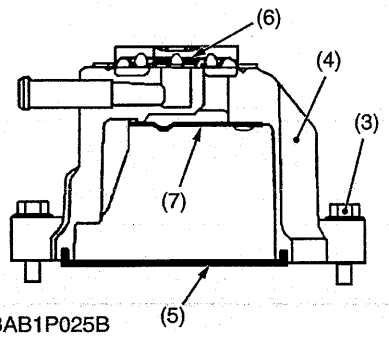

3TMABAB1P025B

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 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

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

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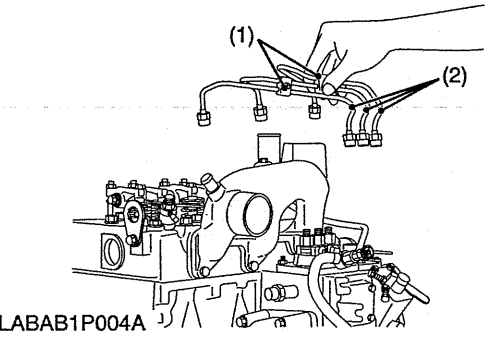

3TLABAB1P004A

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	24.5 to 34.3 N·m 2.5 to 3.5 kgf·m 18.1 to 25.3 ft-lbs

(1) Pipe Clamp
(2) Injection Pipe

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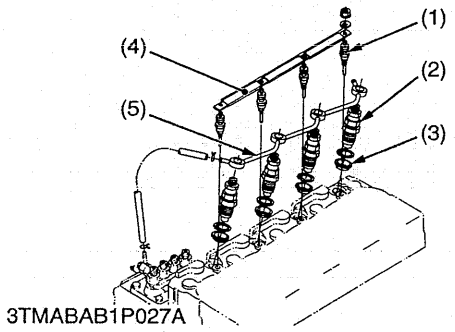

3TMABAB1P027A

Nozzle Holder Assembly and Glow Plug

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

(When reassembling)

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

Tightening torque	Nozzle holder assembly	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs
	Overflow pipe assembly retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 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
(3) Heat Seal
(4) Lead
(5) Overflow Pipe Assembly

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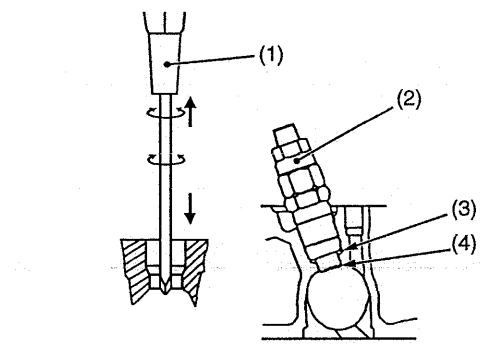

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Nozzle Heat Seal Service Removal Procedure

■ IMPORTANT

- **Use a plus (phillips head) screw driver (1) that has a Dia. which is bigger than the heat seal hole (Approx. 6 mm) 1/4 in.**

1. Drove screw driver (1) lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal (4) out together with the copper gasket (3).
4. If the heat seal drops, repeat the above procedure.

(When reassembling)

- Heat seal and copper gasket must be changed when the injection nozzle is removed for cleaning or for service.

(1) Plus Screw Driver
(2) Nozzle Holder
(3) Copper Gasket
(4) Heat Seal

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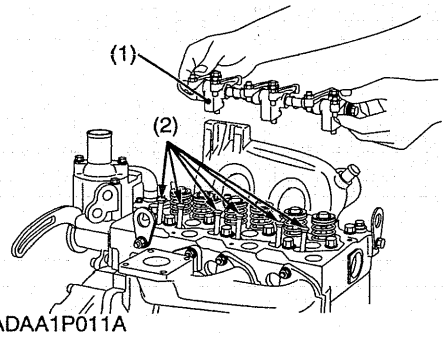

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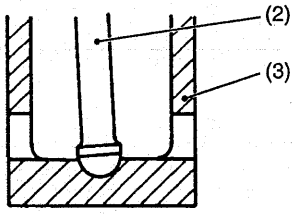

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Rocker Arm and Push Rod

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 grooves.

■ IMPORTANT

- **After installing the rocker arm, be sure to adjust the valve clearance.**

Tightening torque	Rocker arm bracket screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

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

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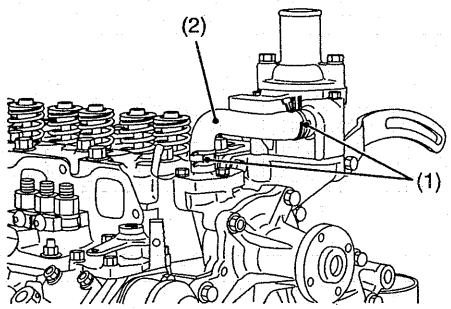

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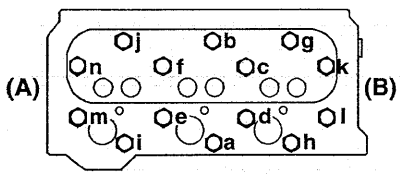

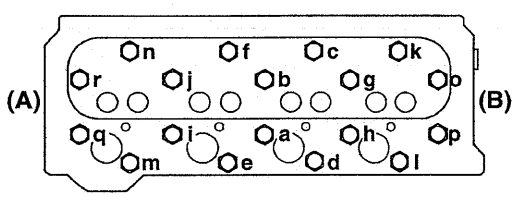

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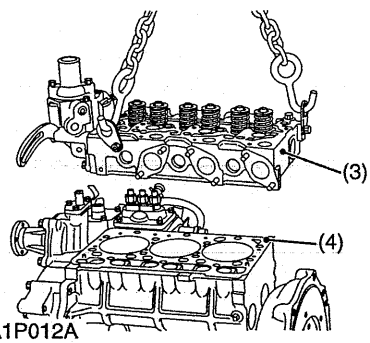

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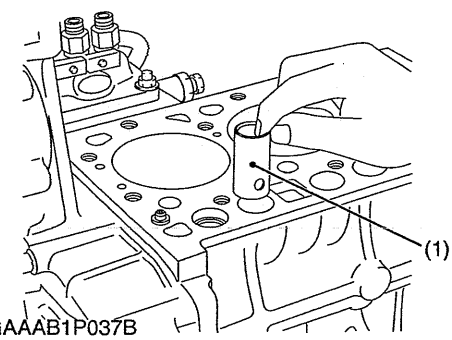

3TGAAAB1P037B

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 (**r** or **n**) 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

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

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

0000006435E

Tappets

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

(When reassembling)

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

■ IMPORTANT

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

(1) Tappet

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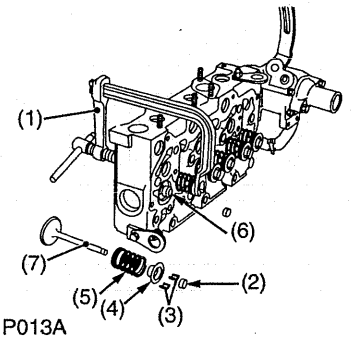

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Valves

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

■ IMPORTANT

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

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

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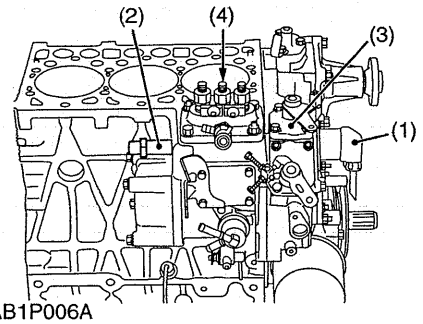
(4) Timing Gears, Camshaft and Fuel Camshaft



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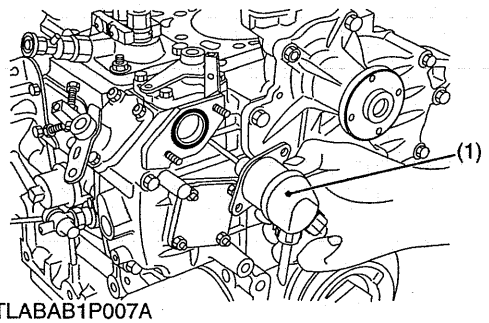

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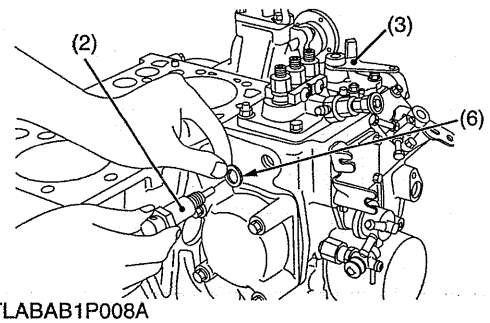

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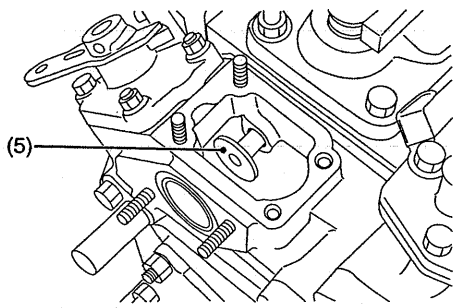

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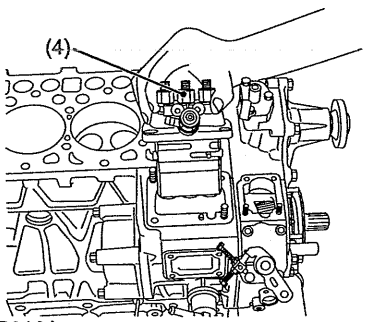

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Injection Pump (for Non Turbocharger Model)

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 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 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 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 36.2 ft-lbs

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

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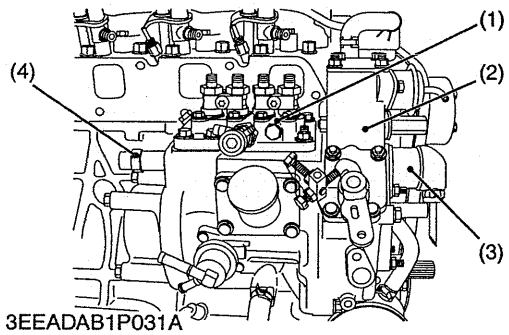

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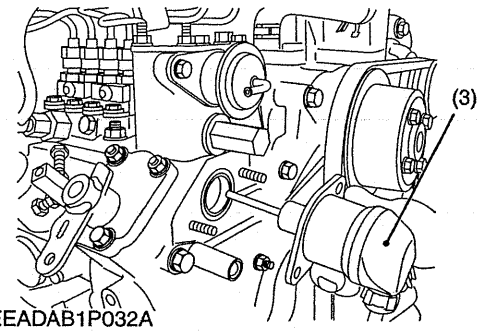

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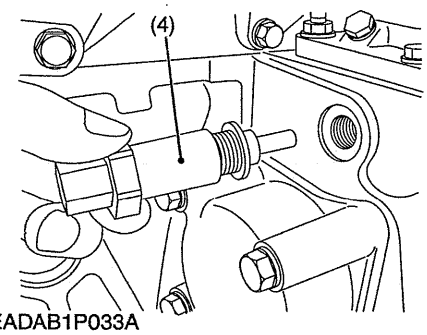

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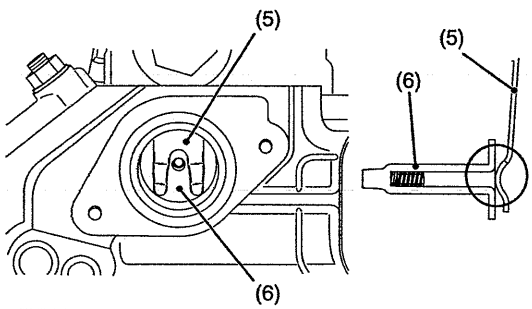

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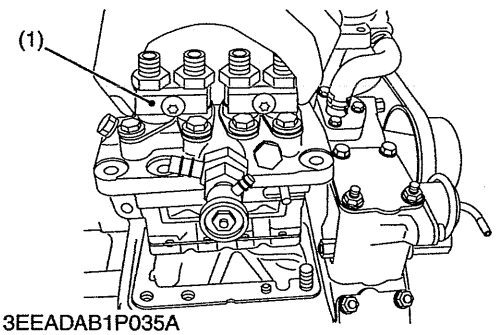

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Injection Pump (for Turbocharger Model)

1. Remove the stop solenoid (3).
2. Remove the high-idling body (4).

■ **NOTE**

- **Do not remove the boost compensator assembly (2) from gear case.**

3. Check to see if the stop solenoid guide (6) touches boost lever (5). If not, push the control rack from the mounting hole of high-idling body to make the solenoid guide (6) touched boost lever (5). (See figure.)
4. Remove the injection pump assembly (1).

■ **IMPORTANT**

- **Before removing the injection pump assembly (1), be sure to remove the stop solenoid (3) and hi-idling body (4). And check to see if the stop solenoid guide (6) touches boost lever (5).**

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

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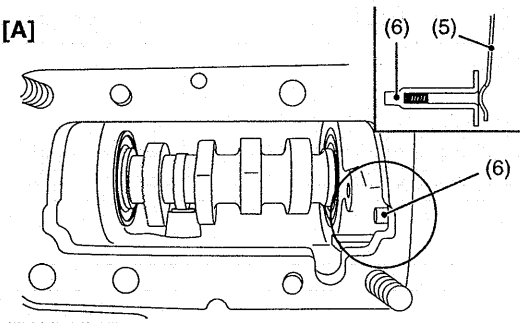
[A]



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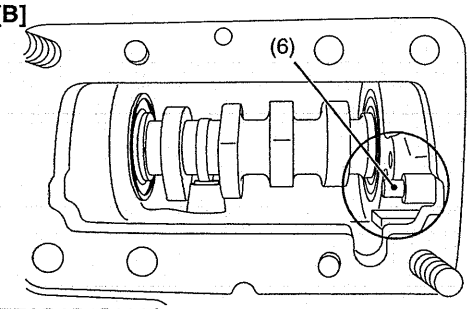
[B]



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Injection Pump (for Turbocharger Model) (Continued)

(When reassembling)

- Check to see if the stop solenoid guide (6) touches boost lever (5). If not, push the solenoid guide (6) to make the solenoid guide (6) touched boost lever (5). (See figure **[A]**.)
- Install the injection pump assembly into position.
- Tighten the injection pump assembly mounting bolts and nuts with specified torque.

1. Install the high-idling body and new gasket, and tighten them with specified torque.
2. Install the stop solenoid and tighten it with specified torque.

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

(5) Boost Lever **[A] Correct**

(6) Stop Solenoid Guide **[B] Incorrect**

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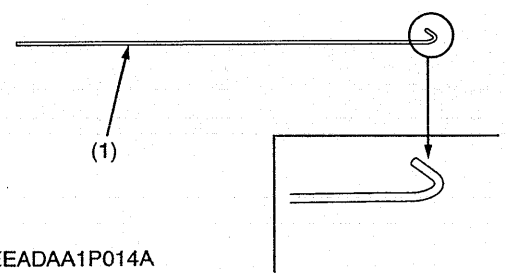

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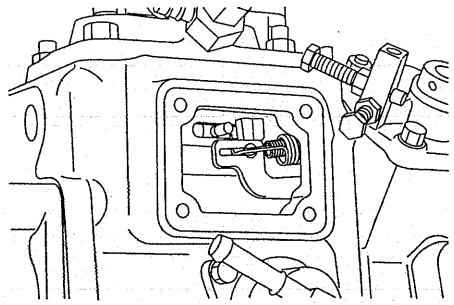

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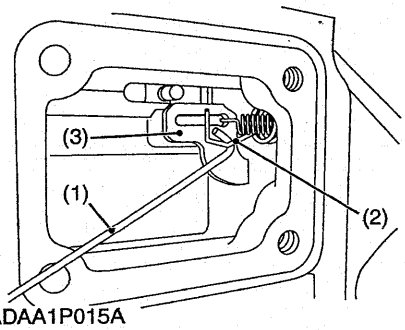

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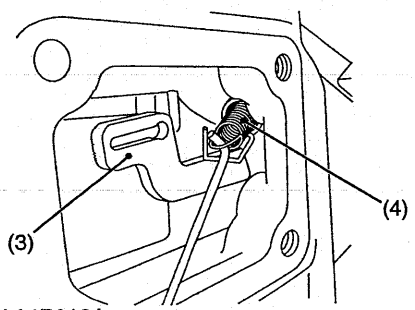

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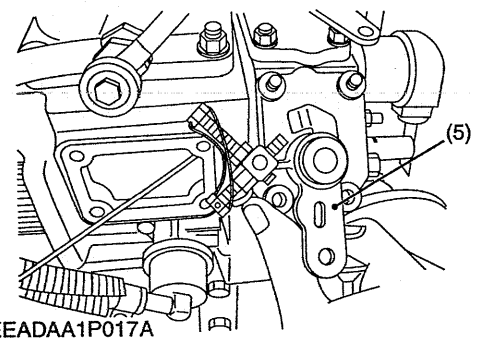

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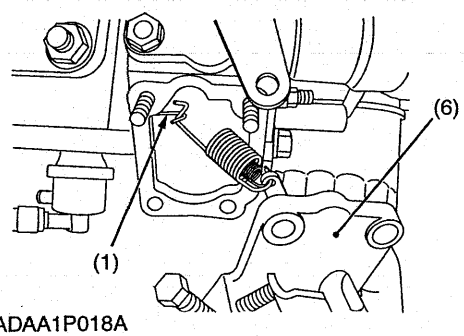
Governor Springs and Speed Control Plate

■ **NOTE**

- **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.

1. Remove the injection pump cover.
2. Remove the speed control plate (6) mounting nuts and bolts.
3. Using the specific tool (1), undo the large governor spring (2) from the fork lever (3).
4. Using the specific tool (1), undo the small governor spring (4) from the fork lever (3).
5. Set the speed control lever (5) as the figure.
6. 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 into the gear case.



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

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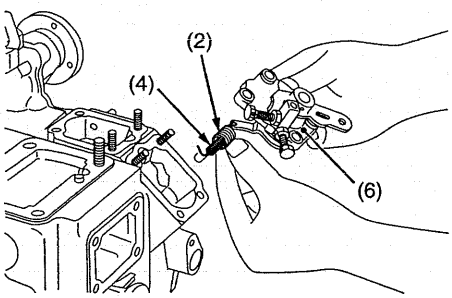

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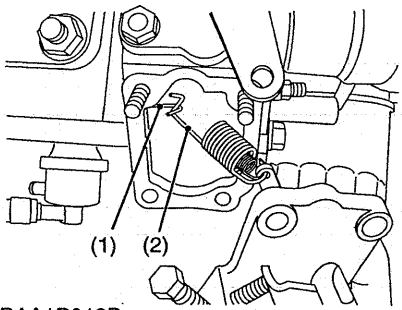

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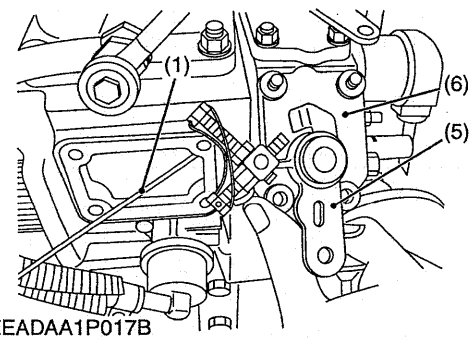

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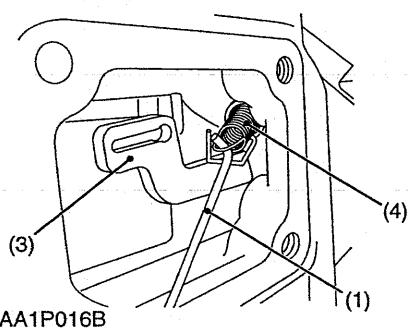

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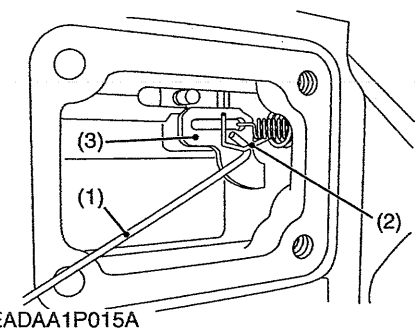

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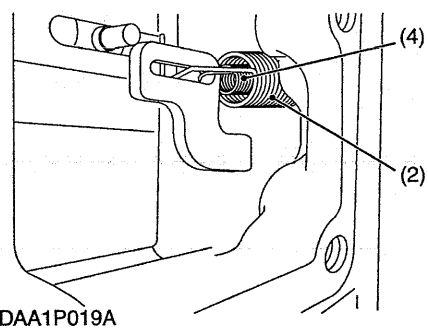
Governor Springs and Speed Control Plate (Continued)

(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.**



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

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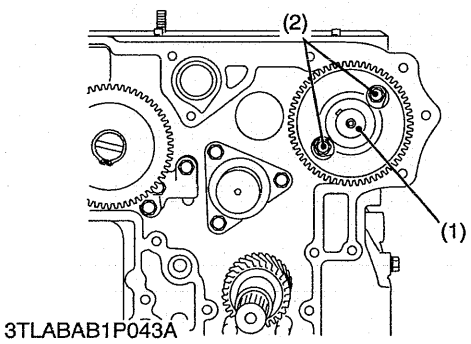

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Camshaft

1. Remove the camshaft set bolts (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 bolt	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Camshaft (2) Camshaft Set Bolt

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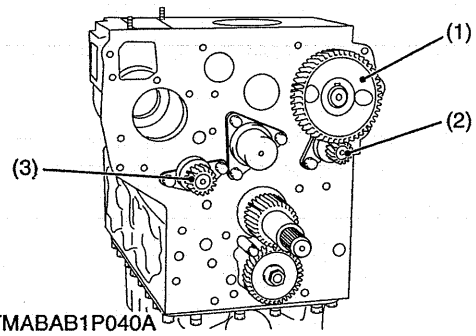

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Camshaft and Balancer Shaft (For Balancer Model)

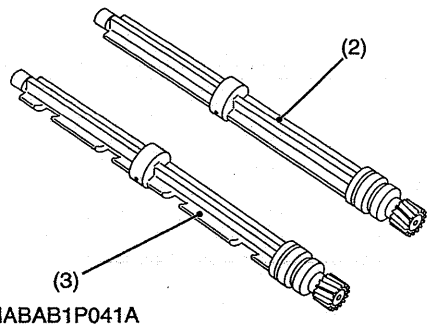
1. Remove the camshaft set bolts and draw out the camshaft (1).
2. Remove the balancer shaft 1 (2) set bolts and draw out the balancer shaft 1 (2).
3. Remove the balancer shaft 2 (3) set bolts and draw out the balancer shaft 2 (3).

(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



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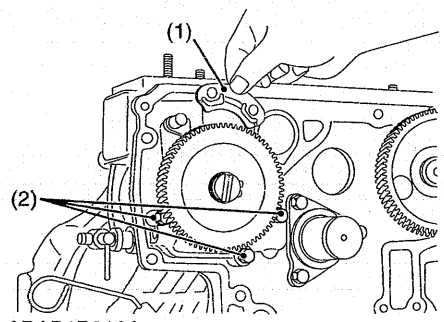

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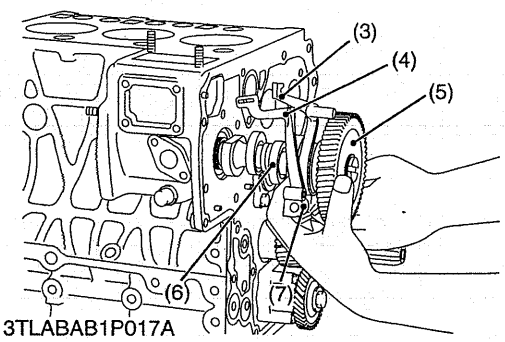

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Fuel Camshaft and Fork Lever Assembly

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 (4) are fixed to the fork lever shaft, and that they can turn smoothly in the holder (7).

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

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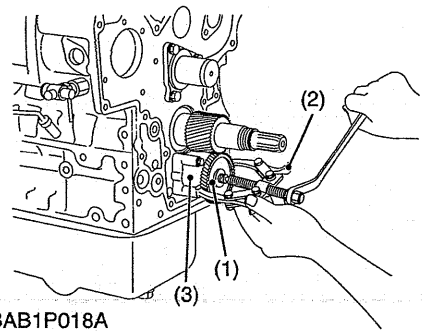

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Oil Pump

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
(2) Gear Puller
(3) Oil Pump

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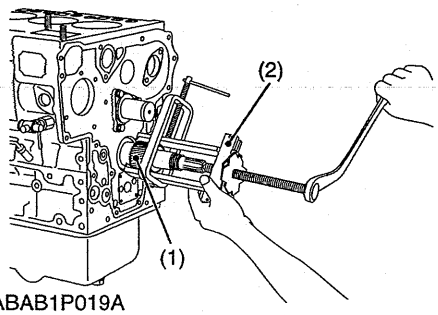

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Crank Gear

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

(1) Crank Gear
(2) Gear Puller

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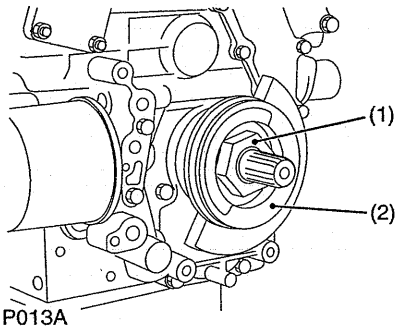

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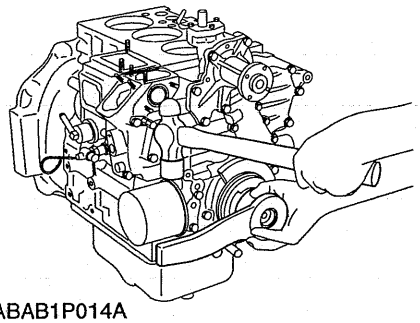
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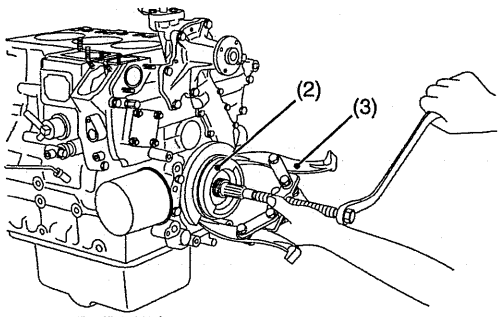

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Fan Drive Pulley

1. Lock the flywheel not to turn using the flywheel stopper.
2. Remove the fan drive pulley mounting nut (1).
3. Remove the fan drive pulley (2) with gear puller (3).
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

(1) Nut
(2) Fan Drive Pulley
(3) Gear Puller

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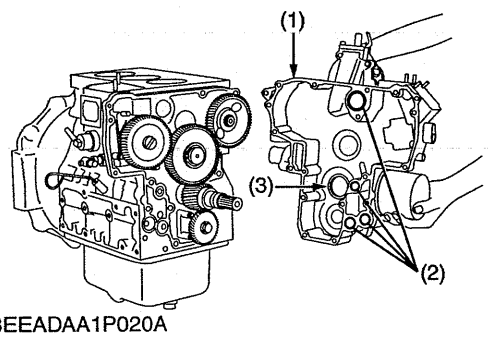

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Gear Case

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 sides of hour meter gear case gasket.
- 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

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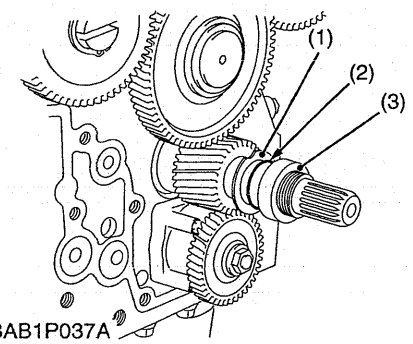

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Crankshaft Oil Slinger

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

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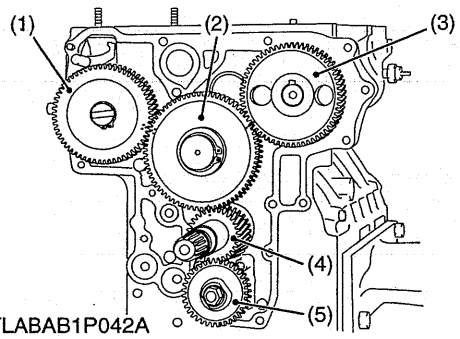

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Idle Gear

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 camshaft gear (3)
  - Idle gear (2) and injection pump gear (1)

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

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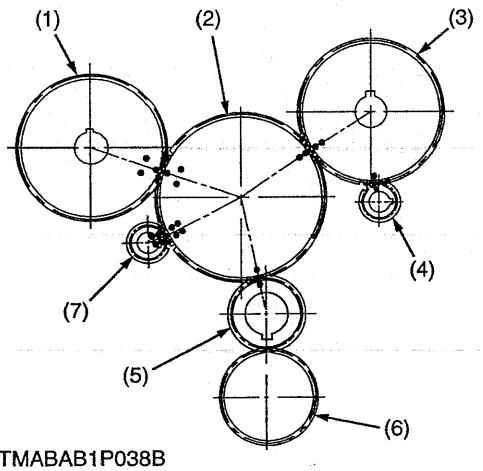

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Idle Gear (For Balancer Model)

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
(2) Idle Gear
(3) Cam Gear
(4) Balancer Gear
(5) Crank Gear
(6) Oil Pump Drive Gear
(7) Balancer Gear

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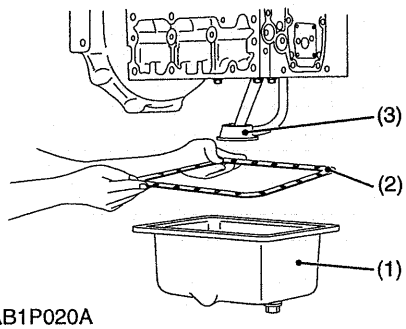
(5) Piston and Connecting Rod



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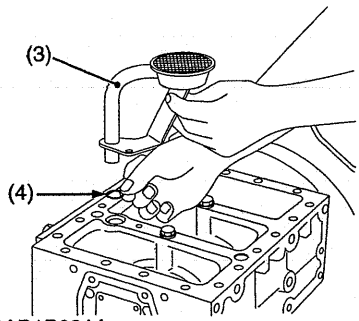

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Oil Pan and Oil Strainer

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

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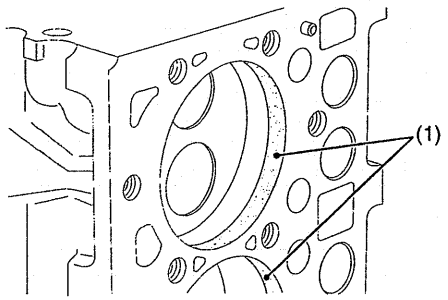

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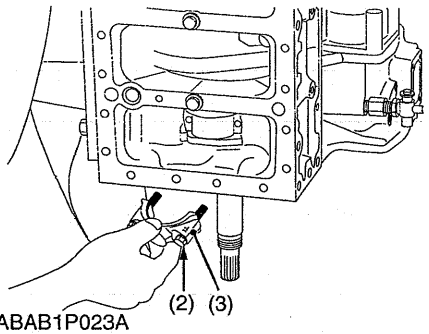

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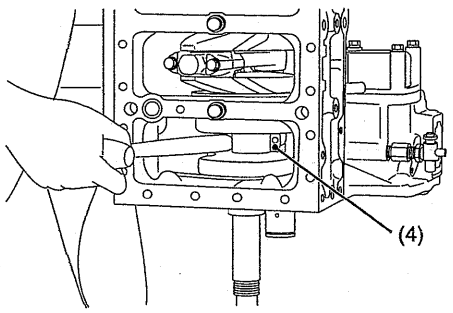

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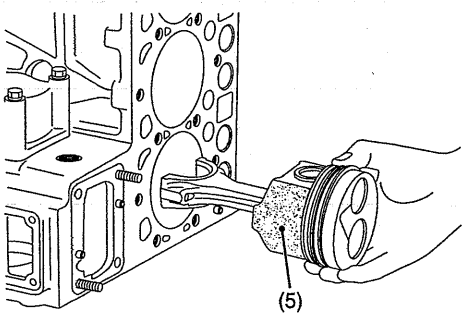

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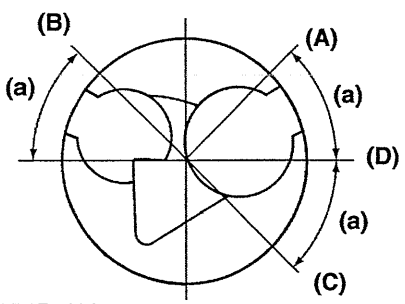

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Pistons

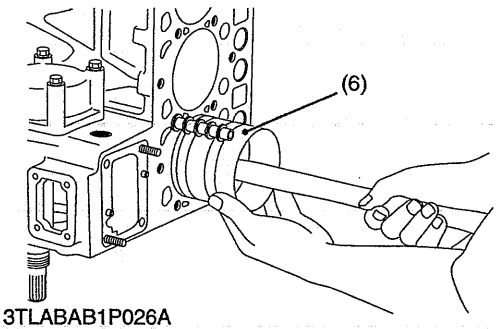
1. Completely clean carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and bring the piston to top dead center.
4. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
5. Draw out the other piston in the same 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 0.79 rad (45 °) 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.**



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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
(2) Connecting Rod Screw
(3) Connecting Rod Cap
(4) Connecting Rod
(5) Molybdenum Disulfide Coating in Piston Skirt
(6) Piston Ring Compressor

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

(a) 0.79 rad (45 °)

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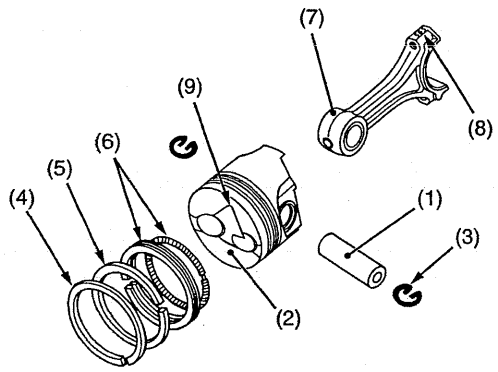

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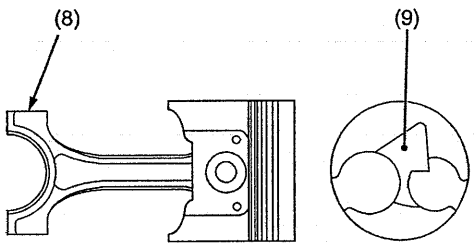

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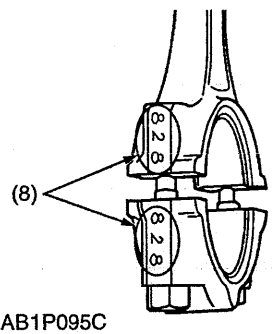

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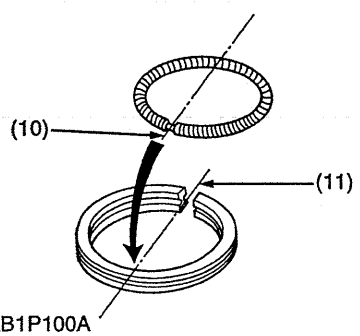

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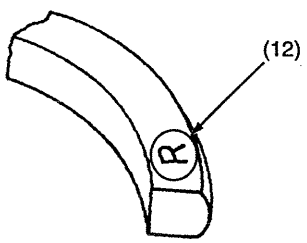

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Piston Ring and Connecting Rod

1. Remove the piston rings (4), (5), (6) using a piston ring tool (Code No. 07909-32121).
2. Remove the piston pin (1), and separate the connecting rod (7) from the piston (2).

(When reassembling)

- When installing the rings, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston (2).
- When installing the oil ring (6) onto the piston (2), place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin.
- When installing the piston pin (1), immerse the piston (2) in 80 °C (176 °F) oil for 10 to 15 minutes and insert the piston pin (1) to the piston (2).
- When installing the connecting rod (7) to the piston (2), align the mark (8) on the connecting rod (7) to the fan-shaped concave (9).

■ NOTE

- **Mark the same number on the connecting rod (7) and the piston (2) so as not to change the combination.**

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

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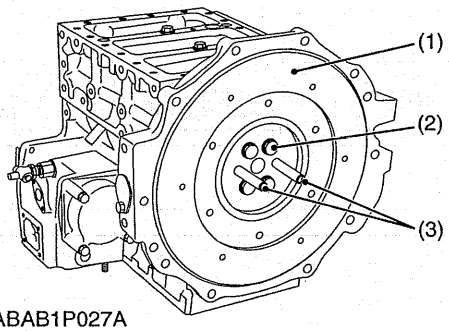
(6) Crankshaft



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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.
- 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

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

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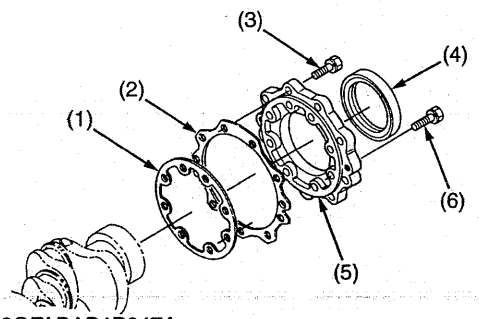

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Bearing Case Cover

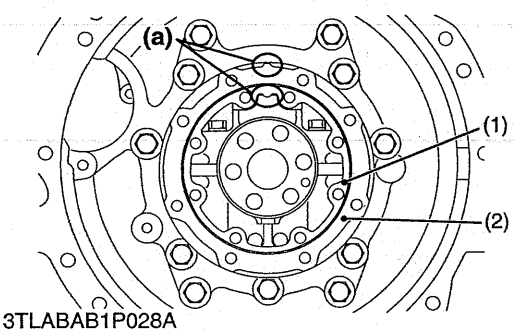
1. Remove the bearing case cover mounting screws. First, remove inside screws (6) and then outside screws (3).
2. Screw two removed screws into the screw hole of bearing case cover (5) to remove it.

■ 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.



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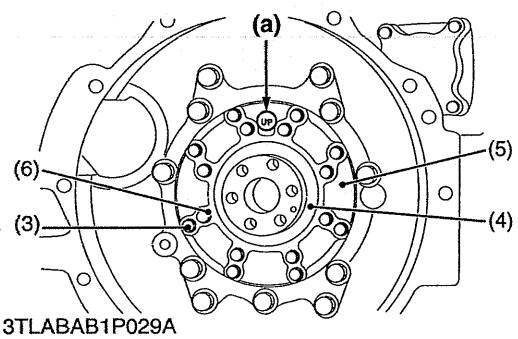
Tightening torque	Bearing case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs



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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

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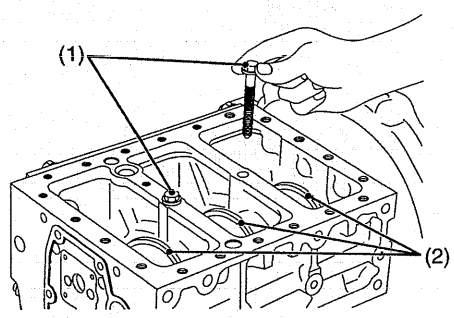

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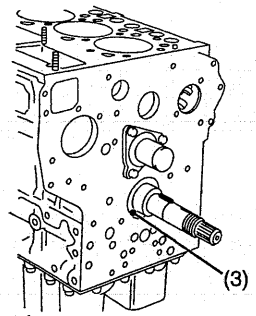

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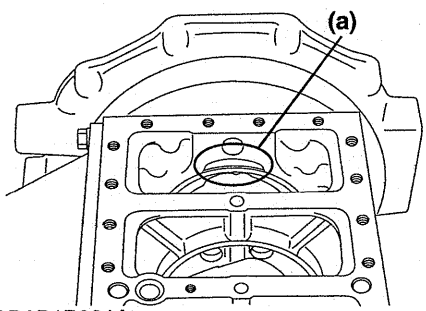

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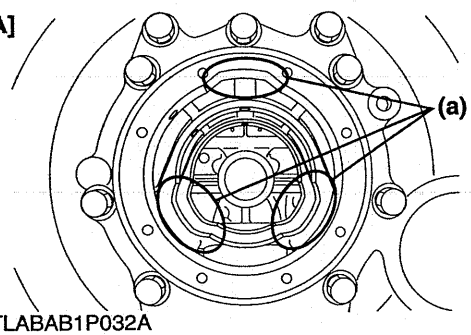

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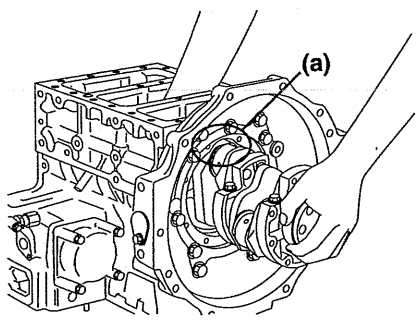

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Crankshaft

■ **NOTE**

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

For D1503-M, D1703-M, V2003-M, V2003-M-T and V2203-M

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

For D1803-M

1. Remove the main bearing case screw 2 (1).
2. 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.
3. 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.
4. Repeat the above steps to draw out all the crankshaft.

For V2403-M

1. Remove the main bearing case screw 2 (1).
2. 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 2	68.6 to 73.5 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 ft-lbs

(1) Main Bearing Case Screw 2
(2) Main Bearing Case 2
(3) Crankshaft bearing 1
(a) **Cut place for removing and installing the crankshaft**
[A] **D1803-M**

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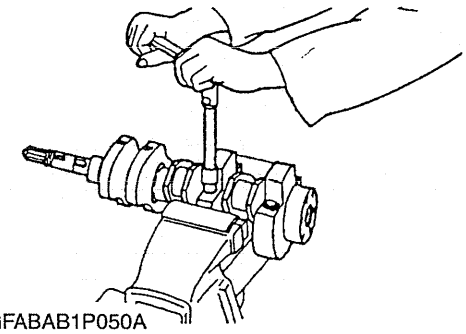
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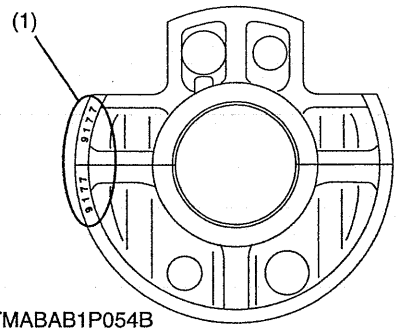

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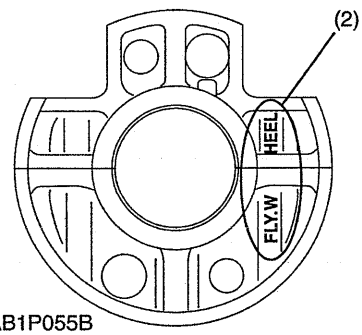

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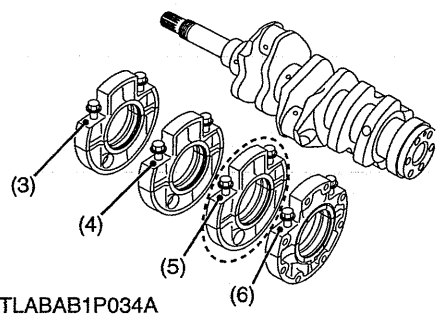

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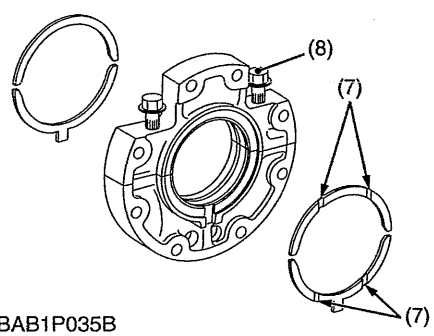

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Main Bearing Case Assembly

1. Remove the 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 (6) 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

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

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(7) Thermostat and Water Pump

CAUTION

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

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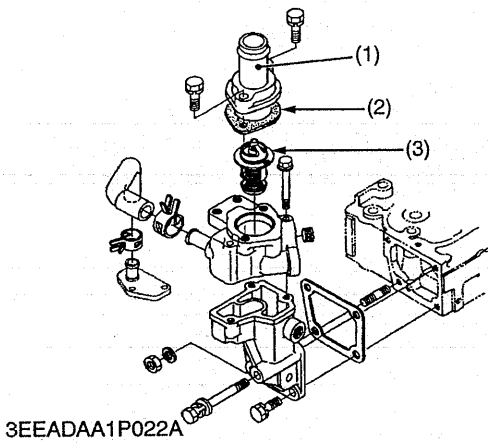

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Thermostat Assembly

1. Remove the thermostat cover mounting screws, and remove the thermostat cover (1).
2. 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

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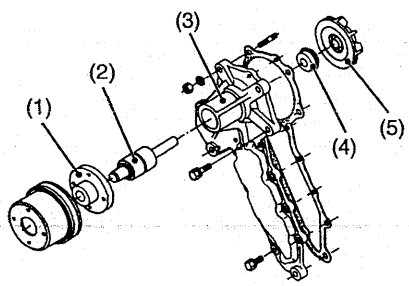

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Water Pump Assembly

1. Loosen the alternator mounting bolts, and remove the fan belt.
2. Remove the fan and fan pulley.
3. Remove the water pump assembly from the gear case cover.
4. Remove the water pump flange (1).
5. Press out the water pump shaft (2) with the impeller (5) on it.
6. Remove the impeller from the water pump shaft (2).
7. 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

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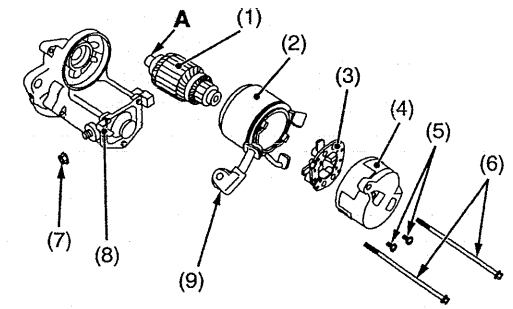
(8) Starter



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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).

(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

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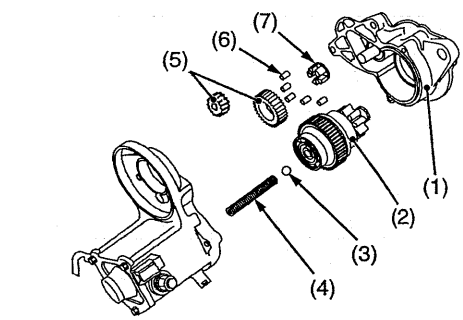

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Disassembling Magnet Switch

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

(When reassembling)

- Apply grease to the gear teeth of the gears (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

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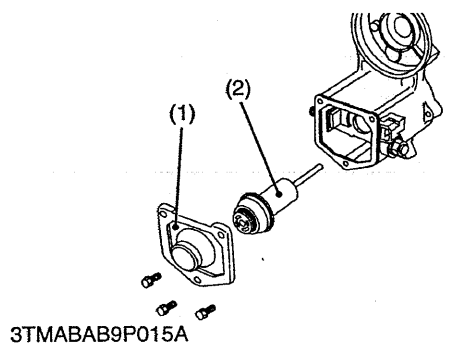

3TMABAB9P015A

Plunger

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

(1) End Cover
(2) Plunger

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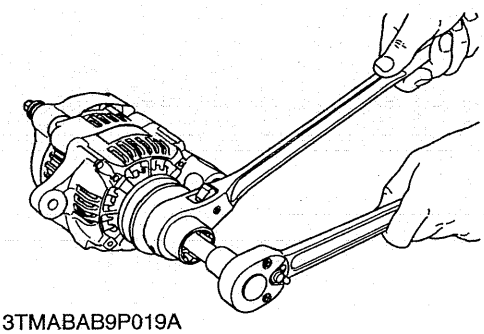
(9) Alternator



3TMABAB9P019A

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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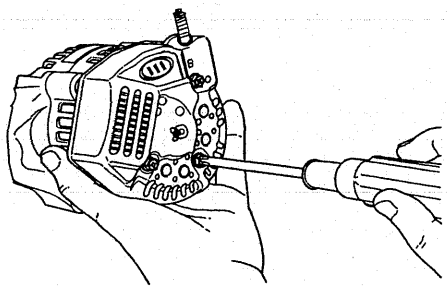

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Rear End Cover

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

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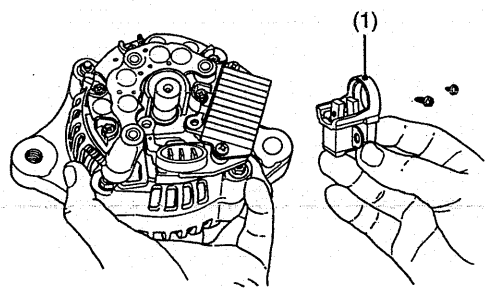

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Brush Holder

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

(1) Brush Holder

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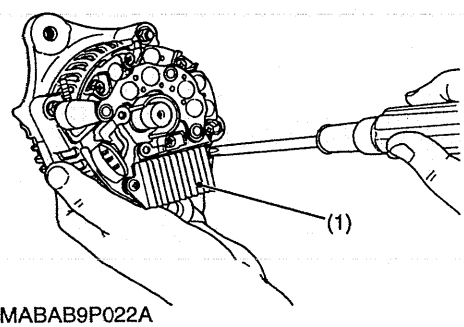

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IC Regulator

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

(1) IC Regulator

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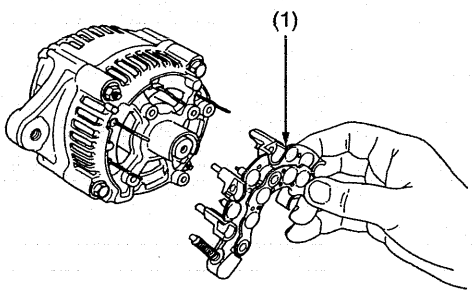

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Rectifier

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

(1) Rectifier

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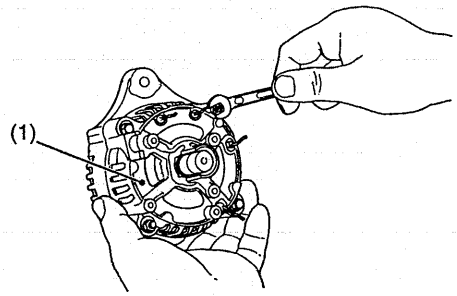

3TMABAB9P024A

Rear End Frame

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

(1) Rear End Frame

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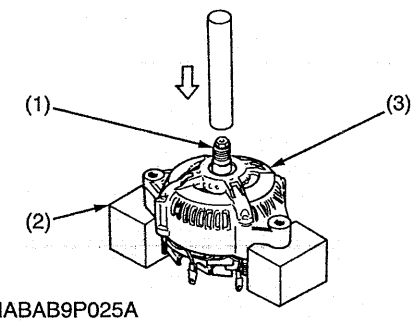

3TMABAB9P025A

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

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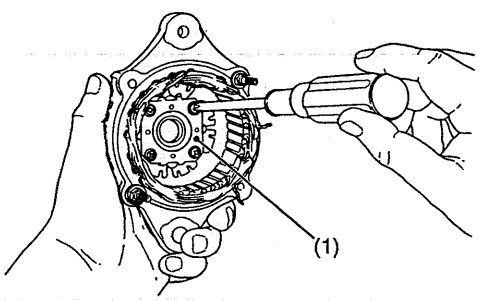

3TMABAB9P026A

Retainer Plate

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

(1) Retainer Plate

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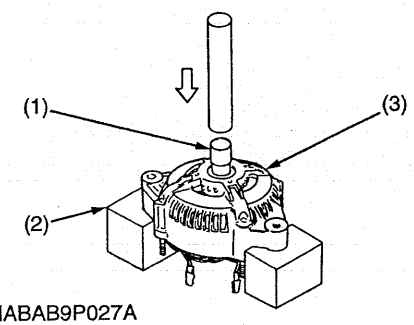

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Bearing on Drive End Side

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

(1) Jig
(2) Block
(3) Drive End Frame

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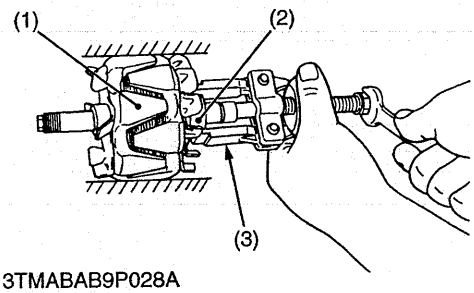

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Bearing at Slip Ring Side

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

0000001767E

(10)Turbocharger

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 filler port of the turbocharger.**
- **Before starting the engine, make sure that the air cleaner is in position.**

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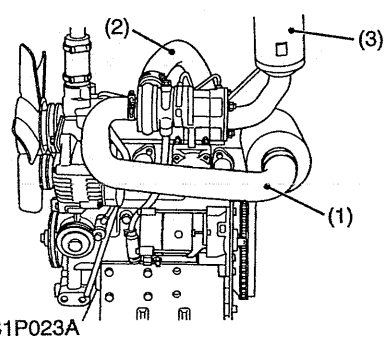

3EEADAB1P023A

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

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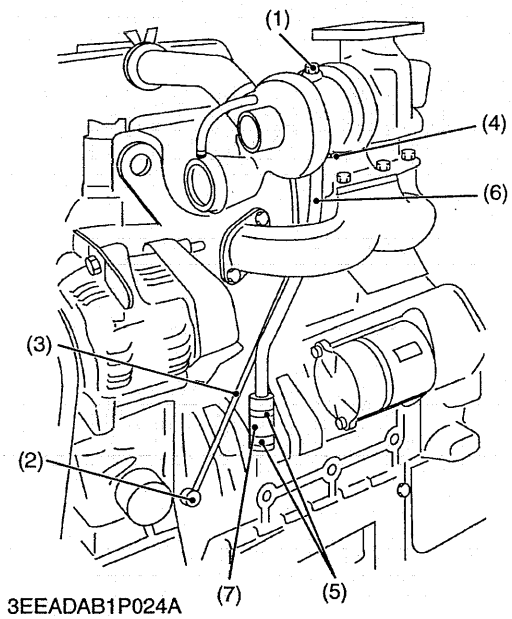


3EEADAB1P024A

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)

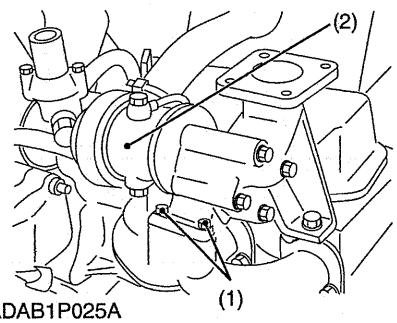
- Pour fresh engine oil through the oil filler port of the turbocharger.
- Replace the gaskets with new one.
- Be careful not to allow dust, dirt and other foreign matters in the oil pipes.

■ 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

0000006761E



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Turbocharger

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

(When reassembling)

- Replace the gasket with new one.

(1) Bolt
(2) Turbocharger Assembly

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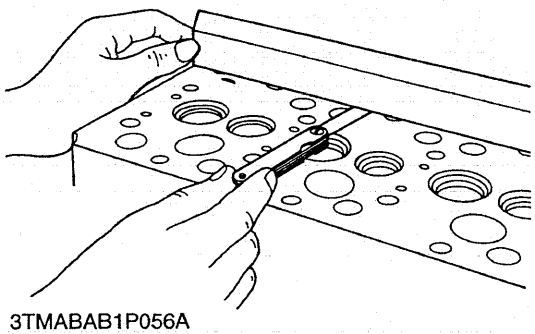
[3] SERVICING

(1) Cylinder Head and Valves



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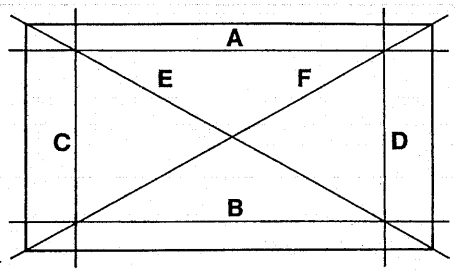

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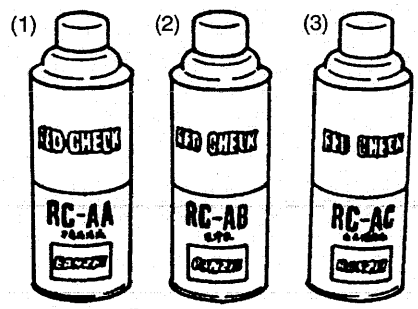

3TMABAB0P059B

Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides (**A**), (**B**), (**C**) and (**D**) and two diagonal (**E**) and (**F**) as shown in the figure.
   Measure the clearance with a feeler gauge.
3. 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	Allowable limit	0.05 mm 0.0020 in.

0000002081E

Cylinder Head Flaw

1. Prepare an air spray red check (Code No. 07909-31371).
2. Clean the surface of the cylinder head with the 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 the white developer (3).
6. If flawed, it can be identified as red marks.

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

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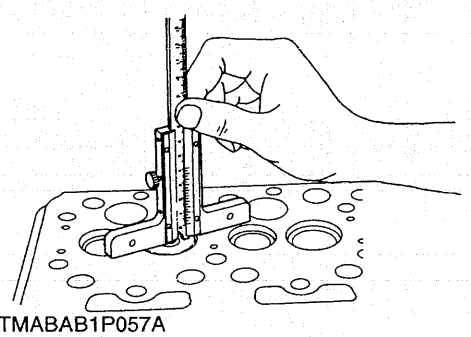

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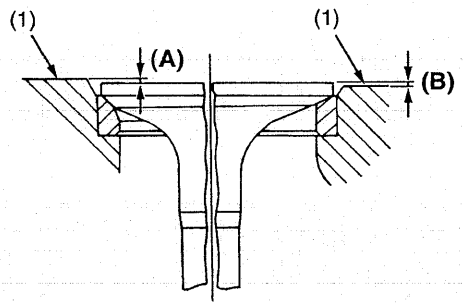

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Valve Recessing

1. Clean the cylinder head surface, valve face and valve seat.
2. 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.	0.05 (protrusion) to 0.15 (recessing) mm 0.0020 (protrusion) to 0.0059 (recessing) in.
	Allowable limit	0.40 (recessing) mm 0.0157 (recessing) in.

(1) Cylinder Head Surface **(A) Recessing**
(B) Protrusion

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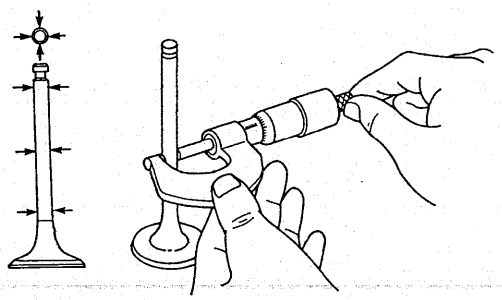

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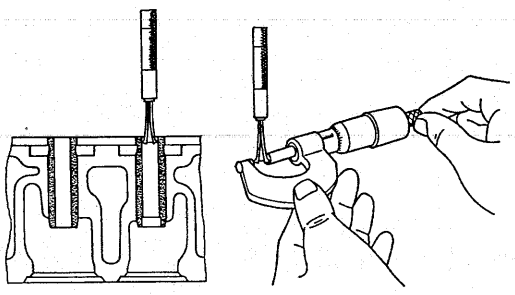

3EEABAB1P116A

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 valve guide	Factory spec.	0.040 to 0.070 mm 0.00157 to 0.00276 in.
	Allowable limit	0.10 mm 0.0039 in.

Valve stem O.D.	Factory spec.	7.960 to 7.975 mm 0.31339 to 0.31398 in.
Valve guide I.D.	Factory spec.	8.015 to 8.030 mm 0.31555 to 0.31614 in.

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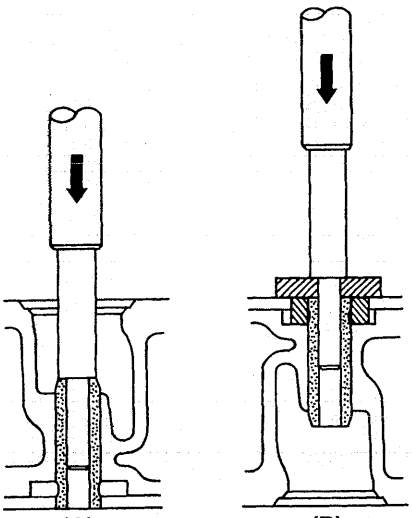

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Replacing Valve Guide

(When removing)

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

(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.

■ IMPORTANT

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

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

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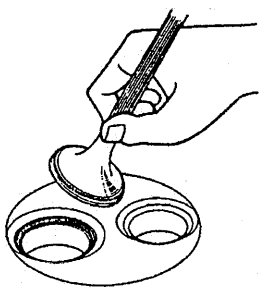

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Valve Seating

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 valve, replace the valve or correct the contact of valve seating

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

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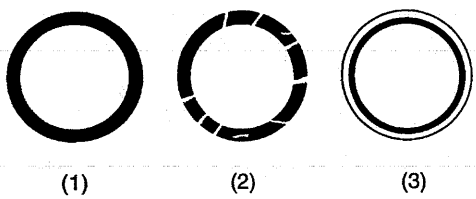

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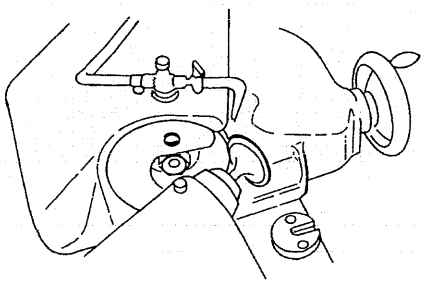

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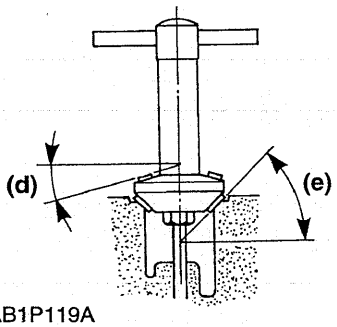

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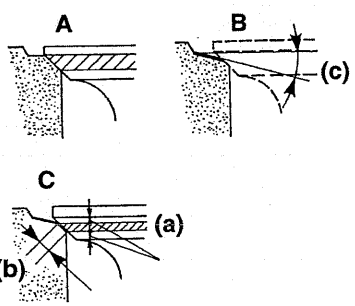

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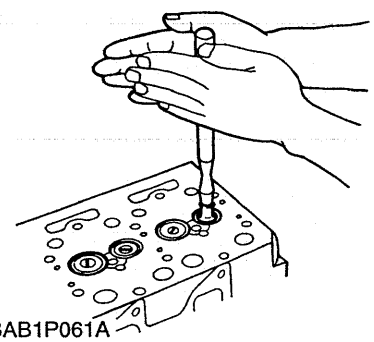

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Correcting Valve and Valve Seat

■ **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 Contact**
(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 °)**		

0000005444E

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.**

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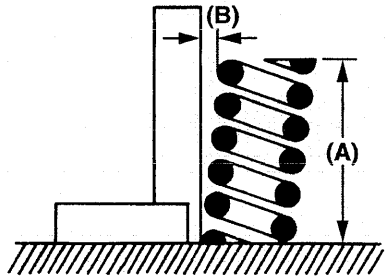

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Free Length and Tilt of Valve Spring

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)**. If the measurement exceeds the allowable limit, replace it.
4. 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.

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

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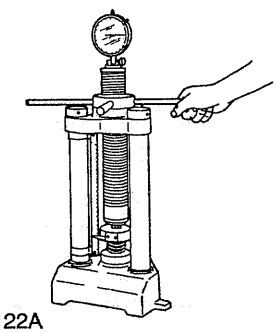

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Valve Spring Setting Load

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 / 35.0 mm 12.0 kgf / 35.0 mm 26.4 lbs / 1.3780 in.
	Allowable limit	100 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbs / 1.3780 in.

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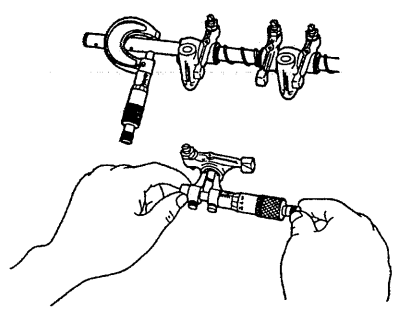

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Oil Clearance between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm shaft O.D. with an 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.

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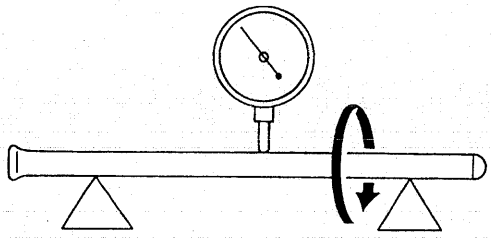

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Push Rod Alignment

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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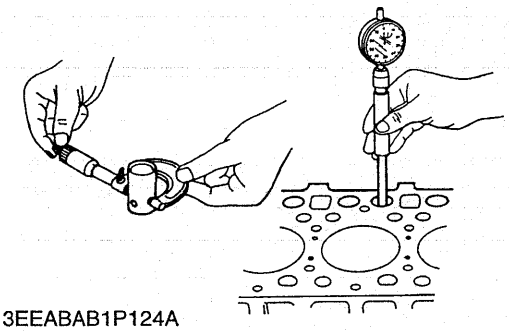

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Oil Clearance between Tappet and Tappet Guide Bore

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 0.11244 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.

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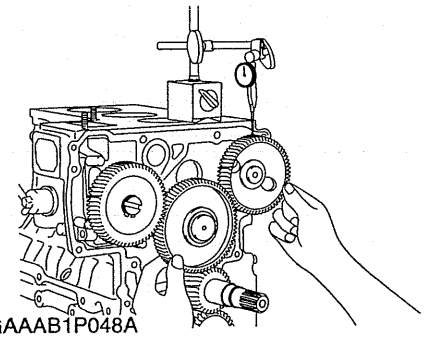
(2) Timing Gears, Camshaft and Fuel Camshaft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Timing Gear Backlash

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 not 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 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	Factory spec.	0.0350 to 0.1160 mm 0.00138 to 0.00457 in.
	Allowable limit	0.15 mm 0.0059 in.

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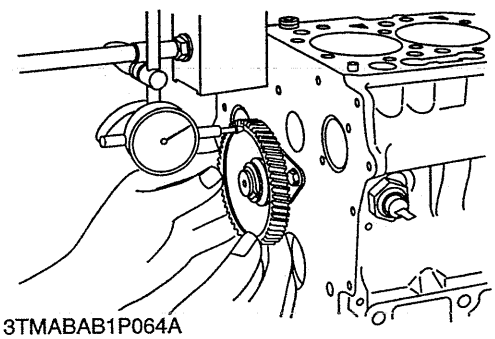
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Idle Gear Side Clearance

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	0.90 mm 0.0354 in.

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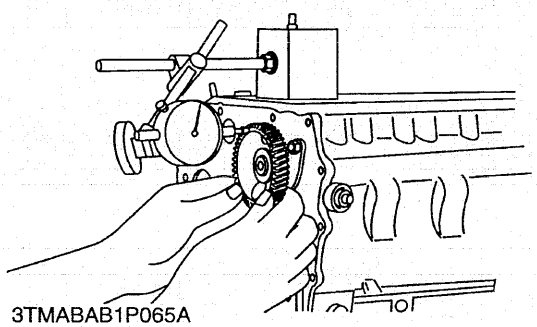
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Camshaft Side Clearance

1. Set a dial indicator with its tip on the cam gear.
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.

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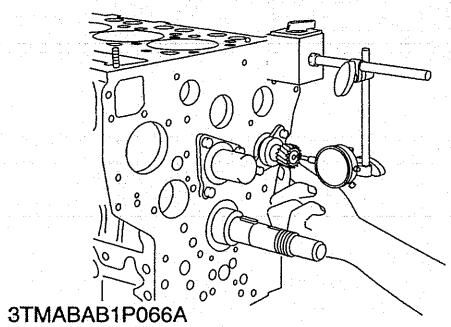
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Balancer Shaft Side Clearance (For Balancer Model Only)

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.

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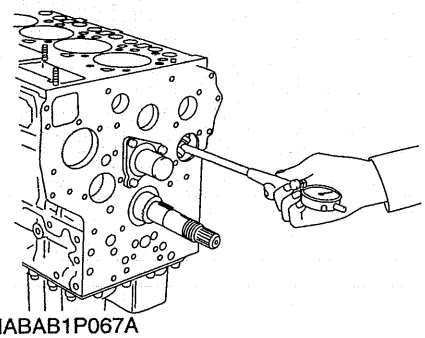

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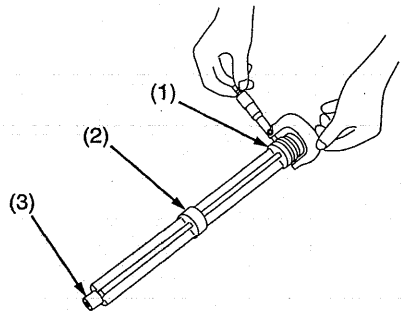

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Oil Clearance of Balancer Shaft Journal (For Balancer Model Only)

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

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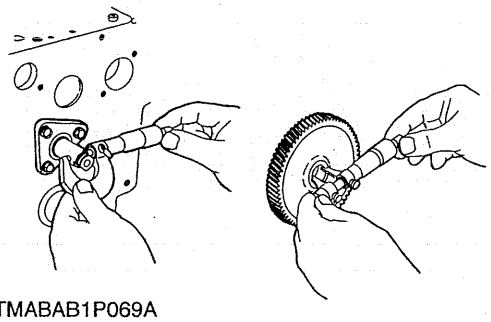

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Oil Clearance between Idle Gear Shaft and Idle Gear Bushing

1. Measure the idle gear shaft O.D. with an 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.
4. If it still exceeds the allowable limit, replace the idle gear shaft.

Oil 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	0.10 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.

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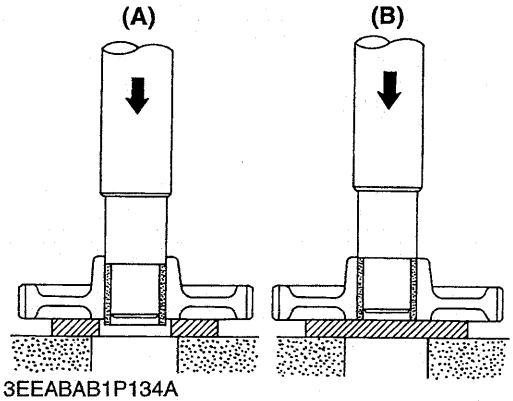

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Replacing Idle Gear Bushing

(When removing)

1. Press out the used idle gear bushing using an idle gear bushing replacing tool.

(When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Press in a new bushing using an idle gear bushing replacing tool, until it is flush with the end of the idle gear.

(A) When removing **(B) When installing**

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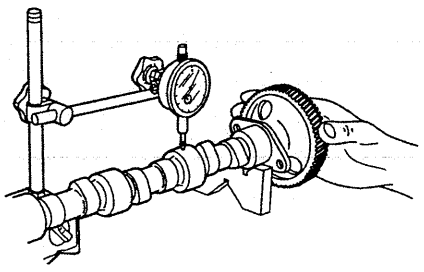

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Camshaft Alignment

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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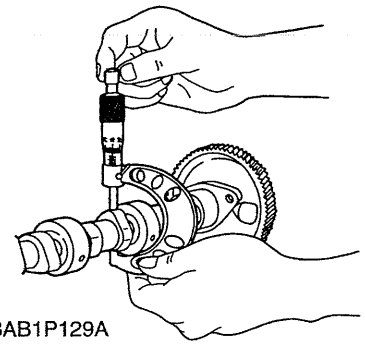

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Cam Height

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 and exhaust	Factory spec.	33.90 mm 1.3346 in.
	Allowable limit	33.85 mm 1.3327 in.

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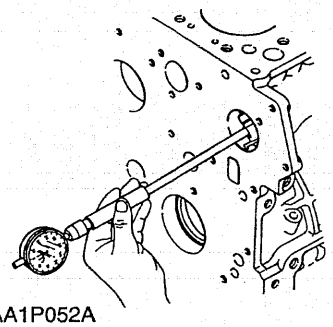

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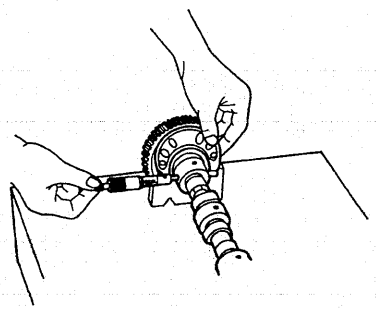

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Oil Clearance of Camshaft Journal

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 0.00197 to 0.00358 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.

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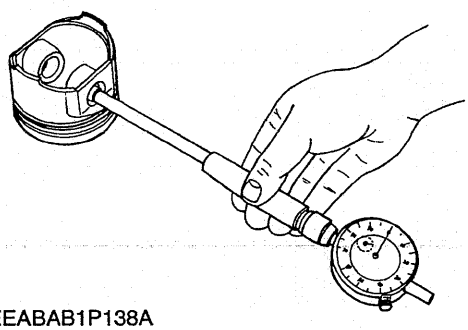
(3) Piston and Connecting Rod



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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 0.98477 in.
	Allowable limit	25.05 mm 0.9862 in.

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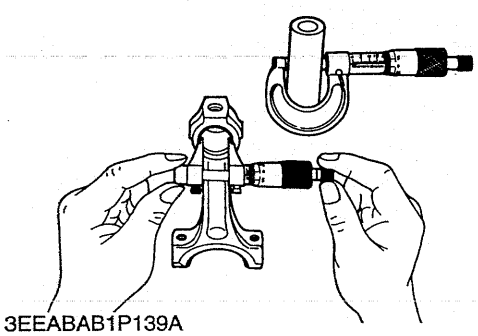

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Oil Clearance between Piston Pin and Small End Bushing

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.

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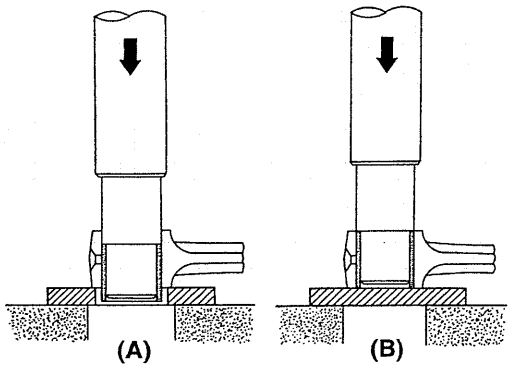

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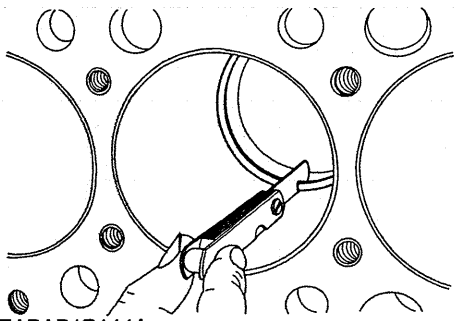
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Replacing Connecting Rod Small End Bushing

(When removing)

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

(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 busing hole.

(A) When removing **(B) When installing**

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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.	D1503-M V2003-M V2003-M-T	0.20 to 0.35 mm 0.0079 to 0.0138 in.
		D1703-M D1803-M V2203-M V2403-M	0.25 to 0.40 mm 0.0098 to 0.0157 in.
	Allowable limit		1.25 mm 0.0492 in.

Second ring	Factory spec.	D1503-M D1703-M D1803-M V2203-M V2403-M	0.30 to 0.45 mm 0.0118 to 0.0179 in.
		V2003-M V2003-M-T	0.40 to 0.55 mm 0.0157 to 0.0217 in.
	Allowable limit		1.25 mm 0.0492 in.

Oil ring	Factory spec.	0.25 to 0.45 mm 0.0098 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

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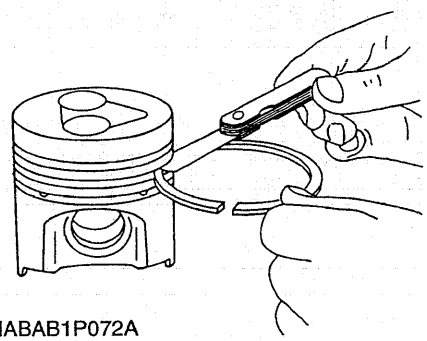

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Clearance between Piston Ring and Groove

1. Remove carbon from the ring grooves.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds the 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.

Second ring	Factory spec.	0.093 to 0.128 mm 0.0037 to 0.0050 in.
	Allowable limit	0.2 mm 0.0079 in.

Oil ring	Factory spec.	0.020 to 0.060 mm 0.0008 to 0.0021 in.
	Allowable limit	0.15 mm 0.0059 in.

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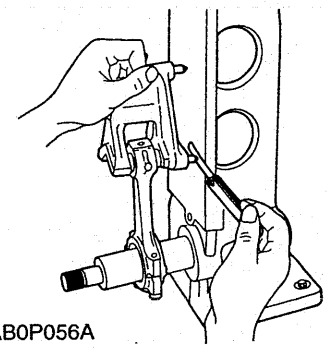

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Connecting Rod Alignment

■ **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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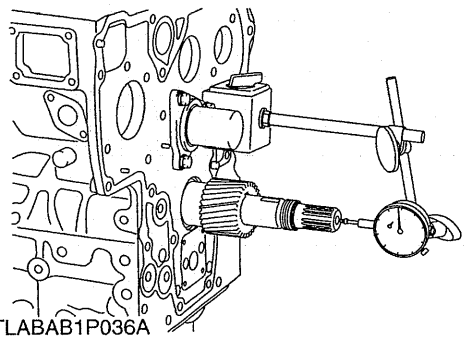
(4) Crankshaft



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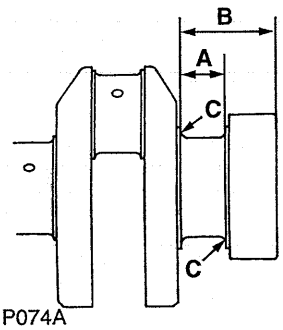

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Side Clearance of Crankshaft

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.

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

Oversize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **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.
Dimension **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.
Dimension **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
The crankshaft journal must be fine-finished to higher than ▽▽▽ (0.8-S)		

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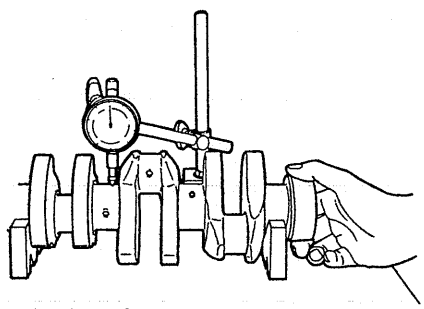

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Crankshaft Alignment

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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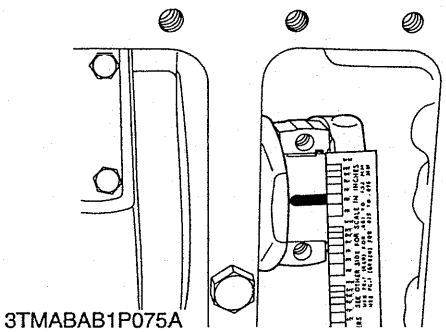
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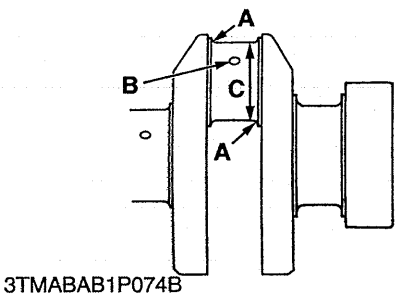

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Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage (Code No. 07909-30241) on the center of the crankpin 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

Undersize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **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
Dimension **B**	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius
Dimension **C**	46.759 to 46.775 mm dia. 1.84091 to 1.84154 in. dia.	46.559 to 46.575 mm dia. 1.83303 to 1.83366 in. dia.
The crankpin must be fine-finished to higher than ▽▽▽ (0.8-S)		

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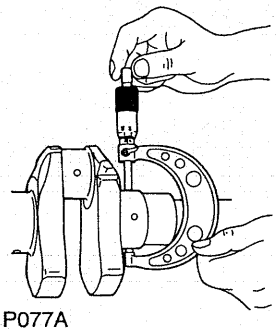

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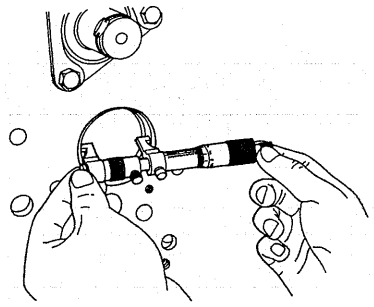

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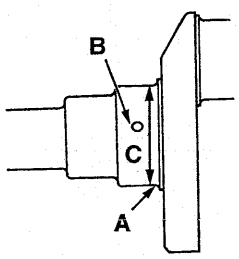

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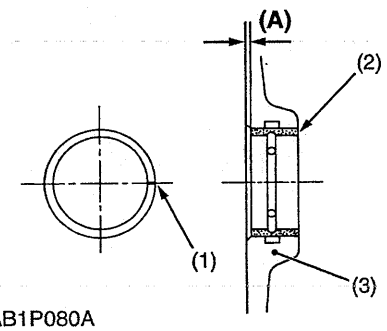

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the O.D. of the crankshaft journal with an 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.

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

(Reference)

- Undersize dimensions of crankshaft journal

Oversize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **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
Dimension **B**	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius
Dimension **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.
The crankshaft journal must be fine-finished to higher than ▽▽▽ (0.8-S)		

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Replacing Crankshaft Bearing 1

(When removing)

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

(When installing)

1. Clean a new crankshaft bearing 1 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.

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

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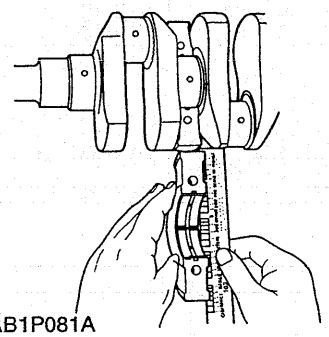

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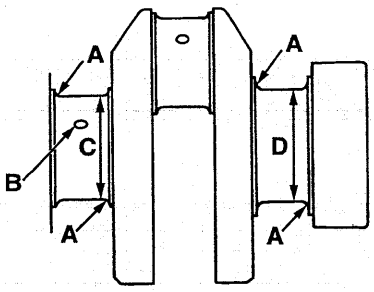

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2

1. Put a strip of plastigage on the centre 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.

Crankshaft 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.

- Undersize dimensions of crankshaft journal

Undersize	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 radius 0.0394 to 0.0591 in. radius	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius
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.
The crankshaft journal must be fine-finished to higher than ▽▽▽ (0.8-S)		

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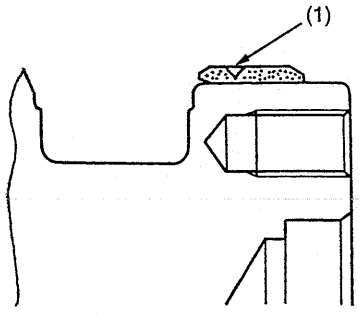

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Crankshaft Sleeve Wear

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.

Wear of sleeve	Allowable limit	0.1 mm 0.0039 in.

(1) Crankshaft Sleeve

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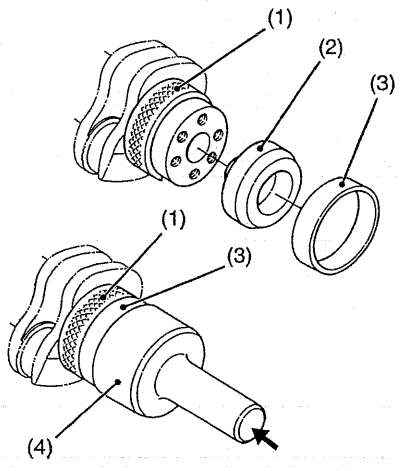

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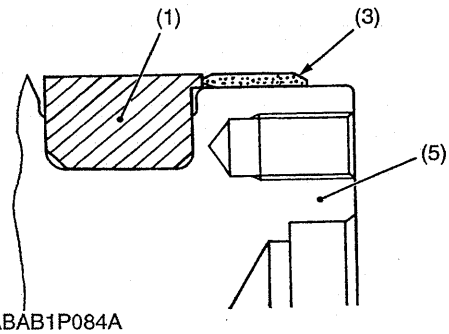

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Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve using a special-use puller set (Code No. 07916-32091).
2. Set the sleeve guide (2) to the crankshaft.
3. Set the stopper (1) to the crankshaft as shown in figure.
4. Heat a new sleeve to a temperature between 150 to 200 °C (302 to 392 °F), and fix the sleeve to the crankshaft 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
(2) Sleeve Guide
(3) Crankshaft Sleeve
(4) Auxiliary Socket for Pushing
(5) Crankshaft

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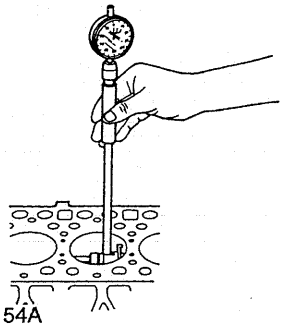
(5) Cylinder



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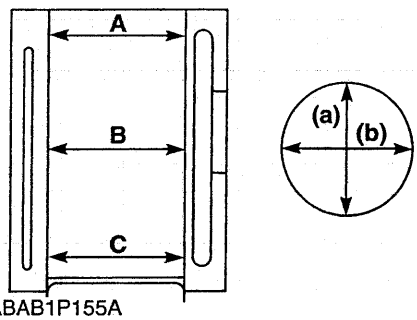

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Cylinder Wear

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 bored. (Refer to **"Correcting Cylinder"**.)

Cylinder I.D.	Factory spec.	D1503-M V2003-M V2003-M-T	83.000 to 83.022 mm 3.26772 to 3.26858 in.
		D1703-M D1803-M V2203-M V2403-M	87.000 to 87.022 mm 3.42519 to 3.42606 in.
Maximum wear	Allowable limit	D1503-M V2003-M V2003-M-T	+0.15 mm +0.0059 in.
		D1703-M D1803-M V2203-M V2403-M	+0.15 mm +0.0059 in.

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

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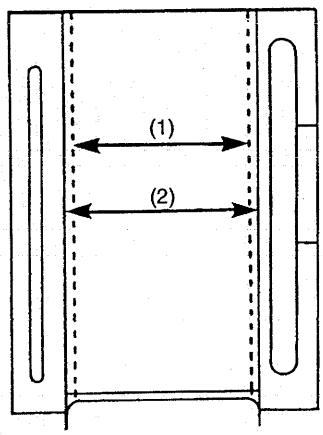

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Correcting Cylinder (Oversize +0.25 mm)

1. 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 V2003-M V2003-M-T	83.250 to 83.272 mm 3.27756 to 3.27843 in.
		D1703-M D1803-M V2203-M V2403-M	87.250 to 87.272 mm 3.43503 to 3.43590 in.
Maximum wear	Allowable limit	D1503-M V2003-M V2003-M-T	+0.15 mm +0.0059 in.
		D1703-M D1803-M V2203-M V2403-M	+0.15 mm +0.0059 in.
Finishing	Horn to 2.2 to 3.0 μm Rmax. ▽▽▽ (0.00087 to 0.00118 in. Rmax.)		

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

■ **NOTE**

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

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

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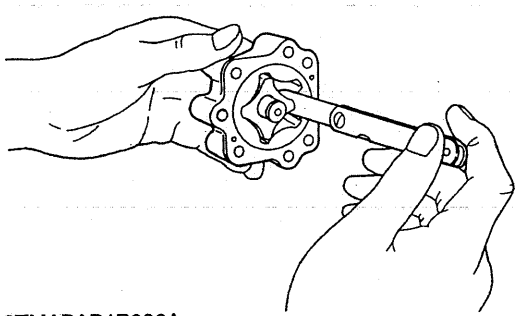
(6) Oil Pump



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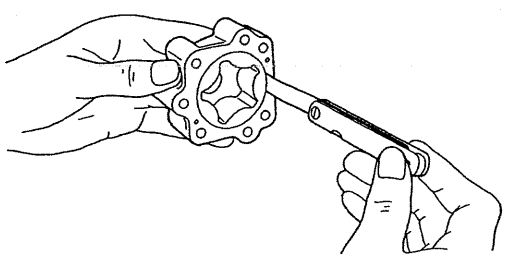

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Rotor Lobe Clearance

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.
	Allowable limit	0.2 mm 0.0079 in.

Clearance between outer rotor and pump body	Factory spec.	0.11 to 0.19 mm 0.0043 to 0.0075 in.
	Allowable limit	0.25 mm 0.0098 in.

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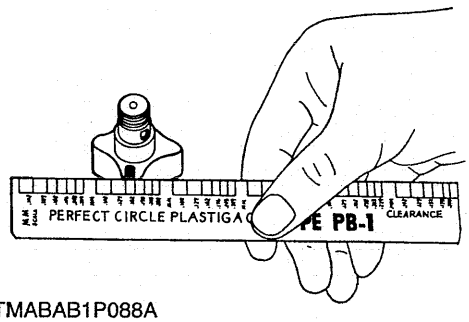

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Clearance between Rotor and Cover

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 the oil pump rotor assembly.

End clearance between inner rotor and cover	Factory spec.	0.105 to 0.150 mm 0.00413 to 0.00591 in.
	Allowable limit	0.2 mm 0.0079 in.

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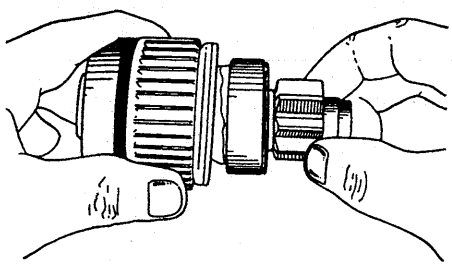
(7) Starter



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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 direction.
4. If the pinion slips or does not rotate in the both directions, replace the overrunning clutch assembly.

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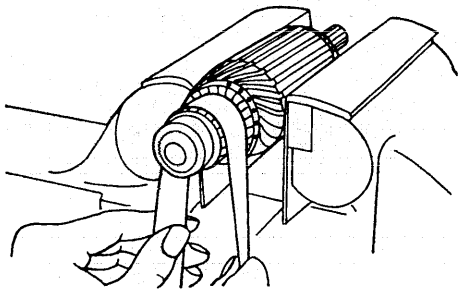

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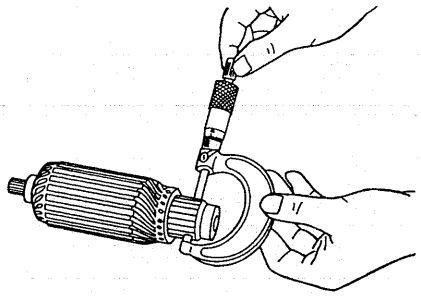

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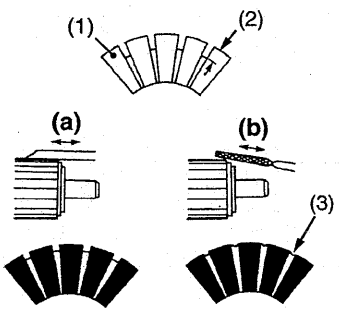

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Commutator and Mica

1. Check the contact face 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 D1703-M V2003-M V2003-M-T V2203-M	30.0 mm 1.181 in.
		D1803-M V2403-M	35.0 mm 1.378 in.
	Allowable limit	D1503-M D1703-M V2003-M V2003-M-T V2203-M	29.0 mm 1.142 in.
		D1803-M V2403-M	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 undercut	Factory spec.	0.45 to 0.75 mm 0.0177 to 0.0295 in.
	Allowable limit	0.20 mm 0.0079 in.

(1) Segment
(2) Undercut
(3) Mica

(a) Correct
(b) incorrect

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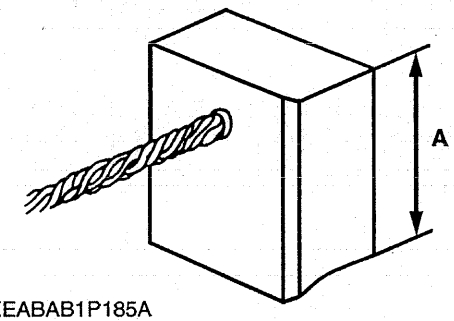

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Brush Wear

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 calipers.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

Brush length (**A**)	Factory spec.	D1503-M D1703-M V2003-M V2003-M-T V2203-M	15.0 mm 0.591 in.
		D1803-M V2403-M	15.0 mm 0.591 in.
	Allowable limit	D1503-M D1703-M V2003-M V2003-M-T V2203-M	11.0 mm 0.433 in.
		D1803-M V2403-M	9.0 mm 0.345 in.

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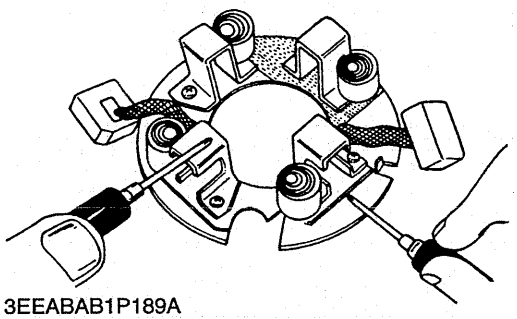

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Brush Holder

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

Resistance	Brush holder - Holder support	Infinity

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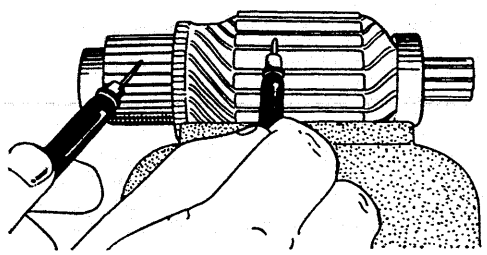

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Armature Coil

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 does not conduct, replace the armature.

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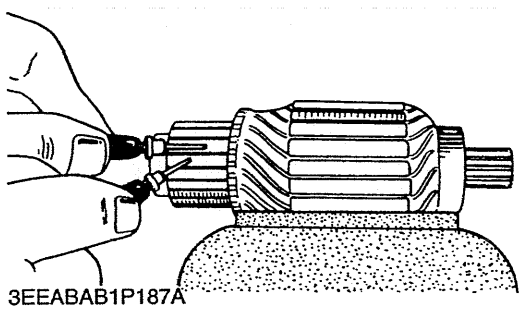

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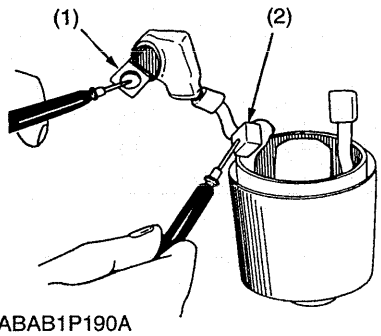

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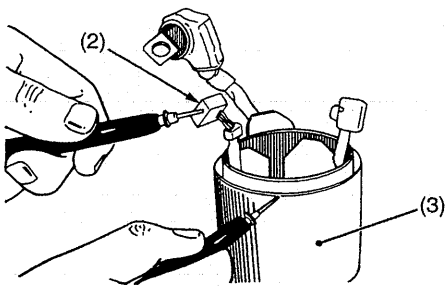

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Field Coil

1. Check the continuity across the lead (1) and brush (2) with an ohmmeter.
2. If it does 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) Brush
(3) Yoke

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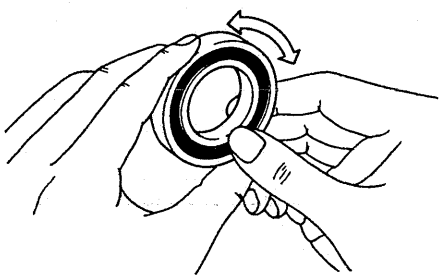
(8) Alternator



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Bearing

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

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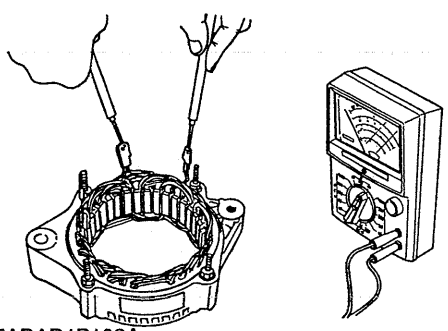

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Stator

1. Measure the resistance across each lead of the stator coil with an ohmmeter.
2. If the measurement is not within factory specification, replace it.
3. Check the continuity across each stator coil lead and core with an ohmmeter.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	Less than 1.0 Ω

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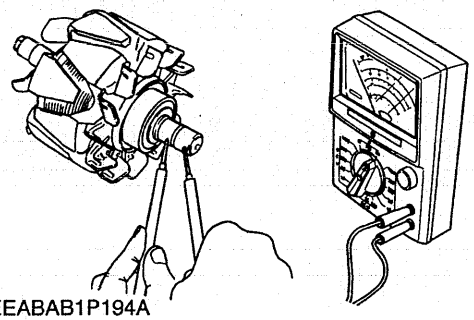

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Rotor

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.	2.9 Ω

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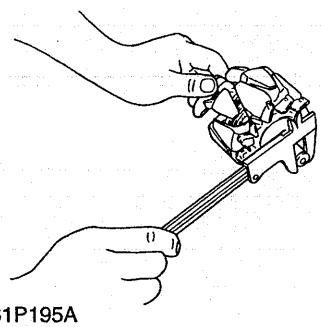

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Slip Ring

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.

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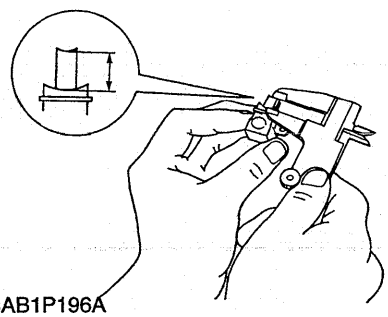

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Brush Wear

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.

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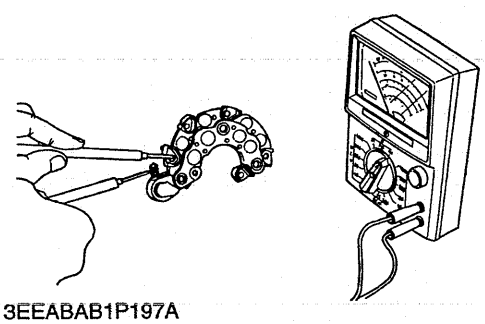

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Rectifier

1. Check the continuity across each diode of rectifier with an analog ohmmeter. Conduct the test in the (R x 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.**

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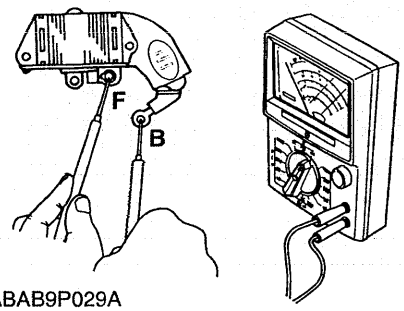

3TMABAB9P029A

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 x 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 itís very hard to check the continuity of IC regulator by using it.**

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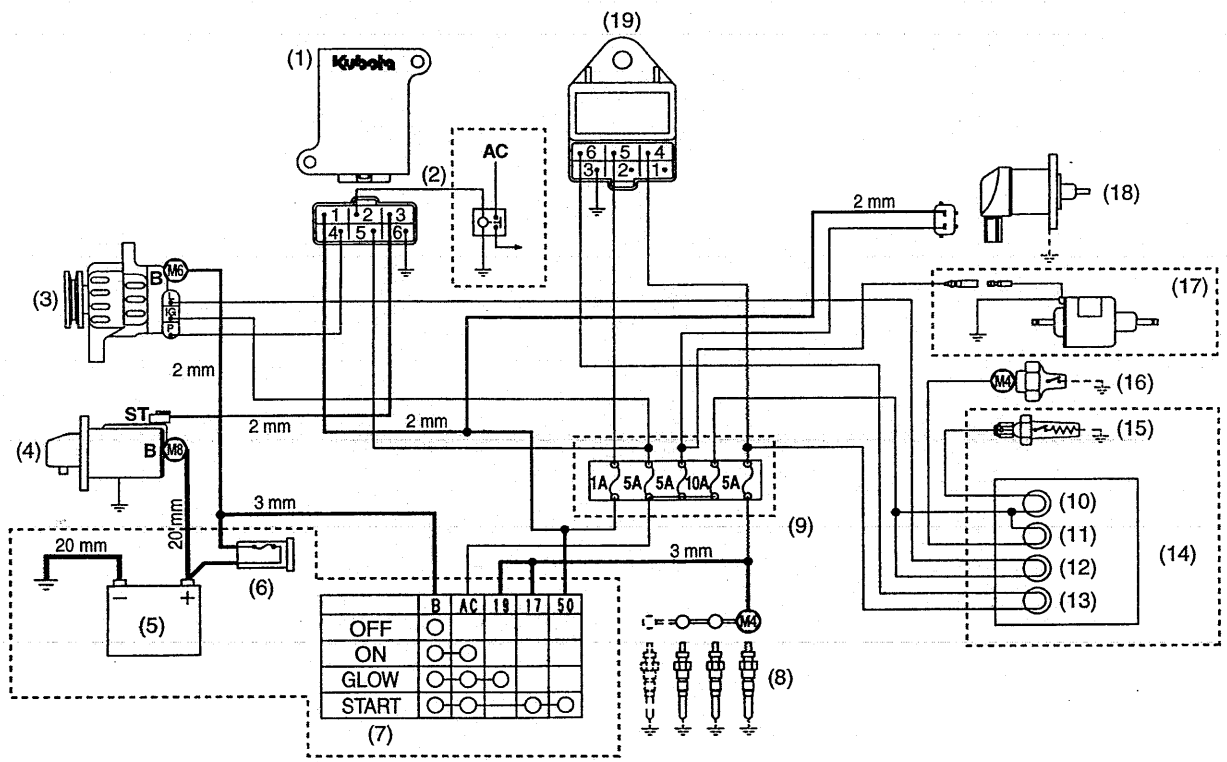
(9) Wiring Diagram



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

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