

# WSM

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## WORKSHOP MANUAL **DIESEL ENGINE**

### D1703-M-E2BG-ONAN-1

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**Kubota**

# TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of D1703-M-E2BG-ONAN-1.

## ■ General

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

Please refer to the operators manual of ONAN for the maintenance interval and maintenance method.

## ■ 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. 97897-01870) 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.

**July 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**

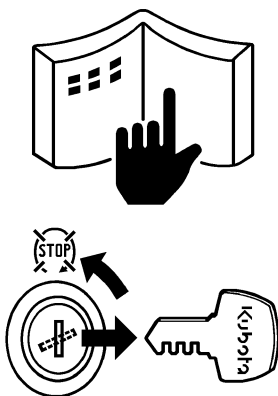
- Gives helpful information.

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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

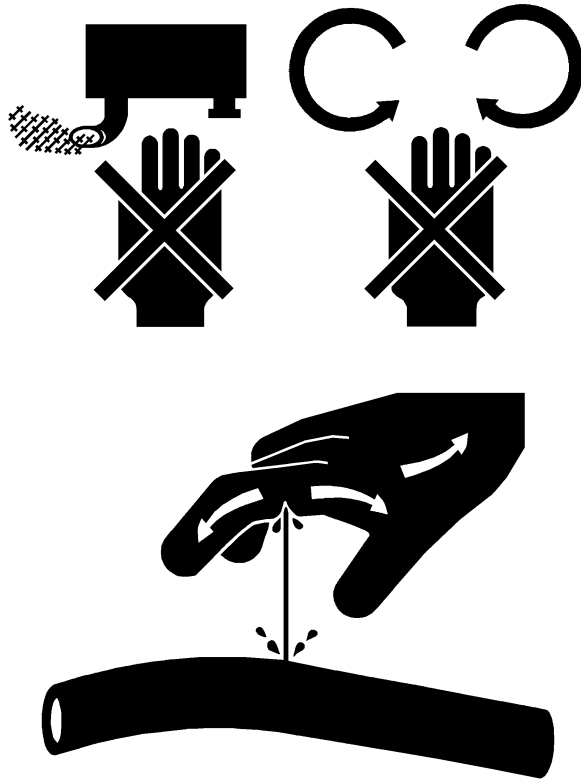
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#### SAFETY STARTING

- 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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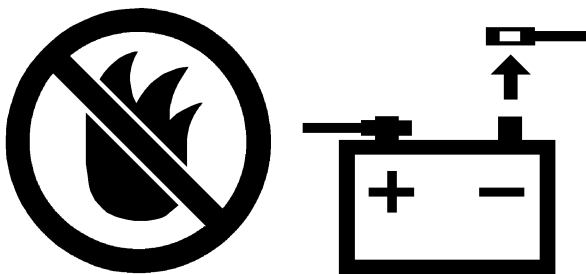


### SAFETY WORKING

- 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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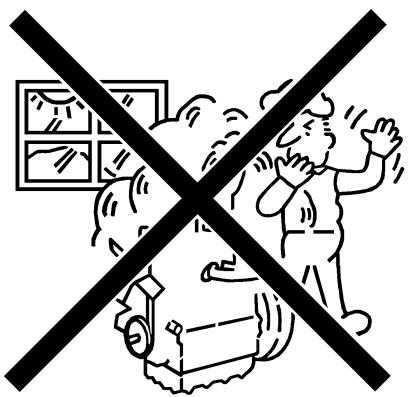
### AVOID FIRES



- 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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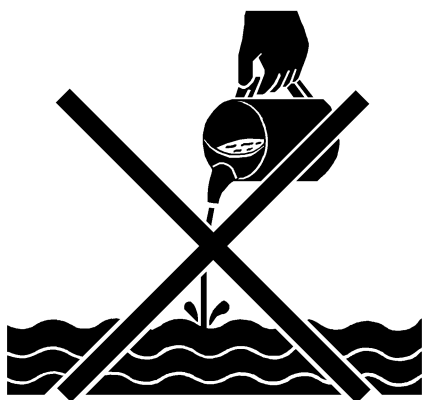




### VENTILATE WORK AREA

- 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.

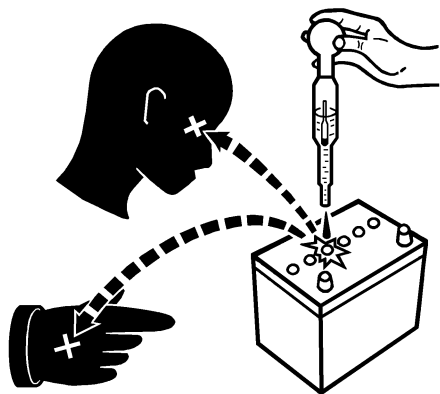
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### DISPOSE OF FLUIDS PROPERLY

- 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

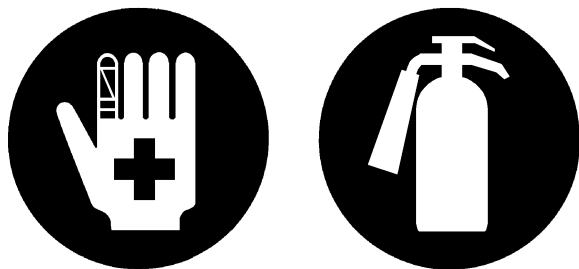
- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.

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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		D1703-M-E2BG-ONAN-1
Type		Vertical, water-cooled, 3-cycle IDI diesel engine
Number of Cylinders		3
Bore x Stroke		87 x 92.4 mm (3.43 x 3.64 in.)
Total Displacement		1647 cm <sup>3</sup> (100.51 cu.in.)
Brake Horsepower	SAE Intermittent H.P.	20.2 (27.5) kW (HP) / 1800 min <sup>-1</sup> (rpm)
Maximum Bare Speed		2120 min <sup>-1</sup> (rpm)
Combustion Chamber		Spherical Type (E-TVCS)
Injection Pump		Bosch Type Mini Pump
Governor		Centrifugal Ball Mechanical Governor
Injection Nozzle		Bosch Type Mini Nozzle
Injection Timing (Inpressurized)		14.5 ° before T.D.C.
Firing Order		1 - 2 - 3
Injection Pressure		13.73 MPa (140 kgf/cm <sup>2</sup> , 1991 psi)
Compression Ratio		22.6 : 1
Lubricating System		Forced Lubrication by Pump
Oil Pressure Indication		Electric Type Switch
Lubricating Filter		Full Flow Paper Filter (Cartridge Type)
Cooling System		Pressurized radiation, forced circulation with water pump
Starting System		Electric Starting with Starter Motor (Adapted with ONAN)
Alternator		12 V, 240 W
Starting Support Device		By Glow Plug in Combustion Chamber
Fuel		Diesel Fuel No.2-D (ASTM D975)
Lubricating Oil		*Quality better than CF class (API), ASE 10W-30 If this class of lubricating oil is not available use class CD or CE lubricating oil.
Lubricating Oil Capacity		5.6 L (1.48 U.S.gal)
Weight (Dry and without Flywheel)		148 kg (326.3 lbs)

\* 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 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.

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Fuel	Low-sulfur	High-sulfur	Remarks
Lubricating oil class			
CF	O	O	TBN ≥ 10
CF-4	O	X	
CG-4	O	X	

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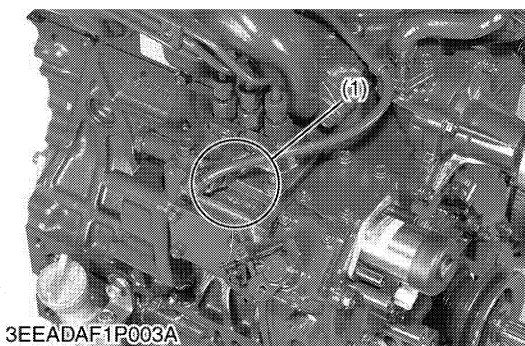
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# 1. ENGINE IDENTIFICATION

## [1] MODEL NAME AND ENGINE SERIAL NUMBER



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

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

### ■ Engine Serial Number

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

It indicates month and year of manufacture as follows.

#### ● Year of manufacture

Alphabet or Number	Year	Alphabet or Number	Year
1	2001	8	2008
2	2002	9	2009
3	2003	A	2010
4	2004	B	2011
5	2005	C	2012
6	2006	D	2013
7	2007	E	2014

(1) Engine Model Name and Serial Number

#### ● Mounth of manufacture

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

e.g. D1703-4A0001

"4" indicates 2004 and "A" indicates January.

So, 4A indicates that the engine was manufactured on January, 2004.

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## [2] E2B ENGINE

[ex.: Model Name D1703-M-E2BG-ONAN-1]

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 E2 as a new model name for the engines conforming Tier 2 / Phase 2 regulations.

In the after-sale services for D1703-M-E2BG-ONAN-1 engine, only use the dedicated parts for E2B models and carry out the maintenance services accordingly.

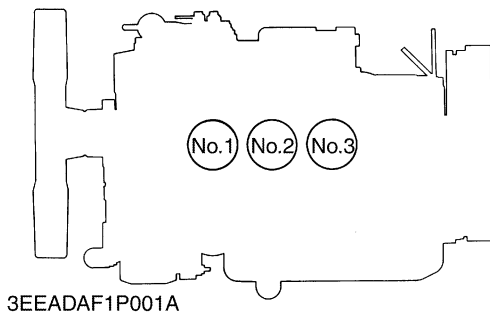
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## [3] CYLINDER NUMBER

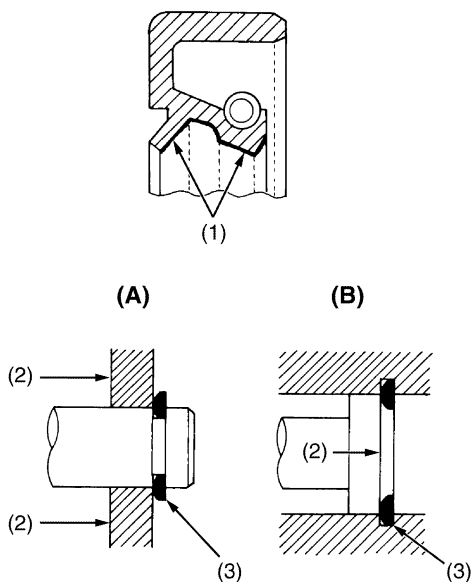
The cylinder numbers of KUBOTA diesel engine are designated as shown in the figure.

The sequence of cylinder numbers is given as No.1, No.2 and No.3 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 and clamp bands	☆											
*Changing engine oil (depending on the oil pan)			☆									
[ 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 ]					☆							
[ 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 hose 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.

#### ■ NOTE

- Parts have been described by [ ] are the ONAN adopting parts.

Please refer to the operator's manual of ONAN to the maintenance interval and maintenance method.

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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.**

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

O : Recommendable    X : Not recommendable

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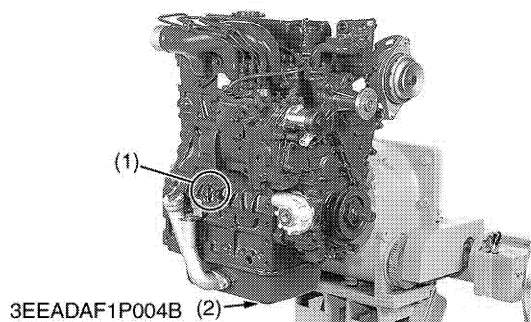
## 4. CHECK AND MAINTENANCE

### ■ NOTE

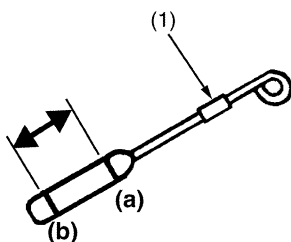
- Parts have been described by [ ] are the ONAN adopting parts.  
Please refer to the operator's manual of ONAN to the maintenance interval and maintenance method.

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### [1] DAILY CHECK POINTS



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#### Checking Engine Oil Level

- Level the engine.
- 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.
- 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.

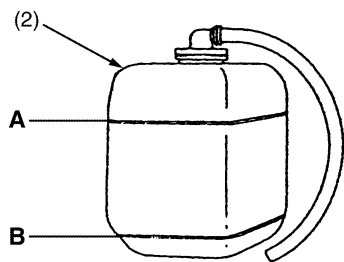
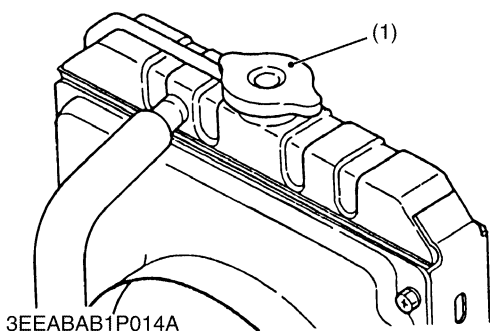
### ■ NOTE

- 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  
(2) Drain Plug

- (a) Maximum  
(b) Minimum

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### [ Checking and Replenish Coolant (Adapted with ONAN) ]

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..

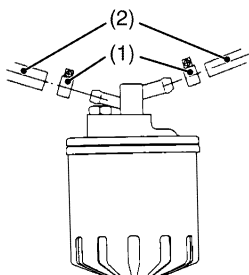
- (1) Radiator Cap  
(2) Recovery Tank

- (A) FULL  
(B) LOW

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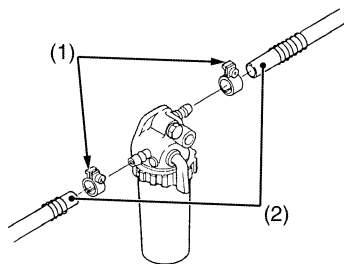
## [2] CHECK POINTS OF EVERY 50 HOURS

[A]



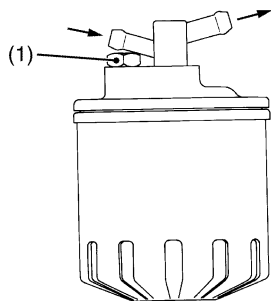
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[B]



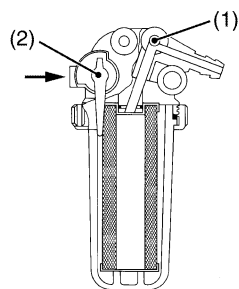
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[A]



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[B]



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### [ Checking Fuel Hose (Adapted with ONAN) ]

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

[A] Cartridge Type

[B] Normal Type

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### [ (When bleeding fuel system) Adapted with ONAN ]

1. Fill the tank with fuel and open the fuel cock (2).
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. Close securely the air vent cock after air bleeding.

### NOTE

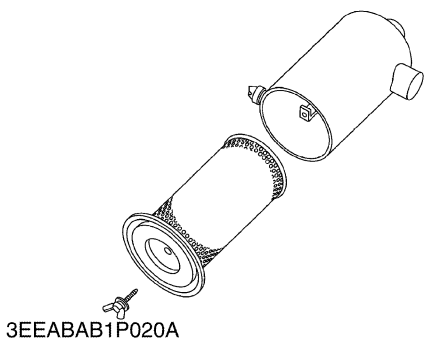
- Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.

(1) Air Vent Plug

(2) Fuel Cock

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### [3] CHECK POINTS OF EVERY 100 HOURS



#### [ Cleaning Air Cleaner Element (Adapted with ONAN) ]

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<sup>2</sup>, 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.

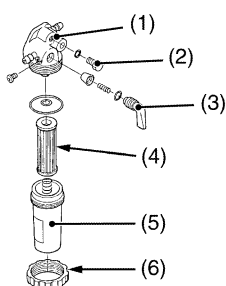
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#### [ Cleaning Fuel Filter (Adapted with ONAN) ]

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.



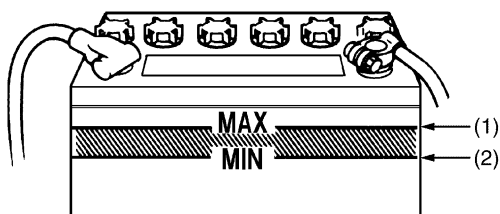
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- |                   |                    |
|-------------------|--------------------|
| (1) Cock Body     | (4) Filter Element |
| (2) Air Vent Plug | (5) Filter Cup     |
| (3) Fuel Cock     | (6) Retaining Ring |

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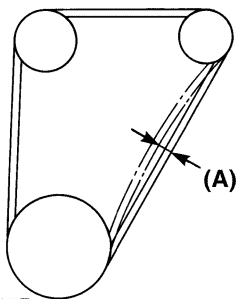
#### [ Checking Battery Electrolyte Level (Adapted with ONAN) ]

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 |
|----------------------|----------------------|

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[ Fan Belt Tension (Adapted with ONAN) ]

- 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 <b>(A)</b>	Factory spec.	7 to 9 mm 0.28 to 0.35 in.
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**(A) Deflection**

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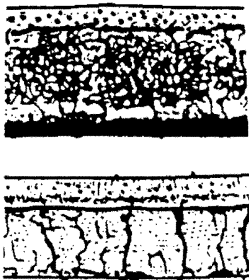
[ Fan Belt Damage and Wear (Adapted with ONAN) ]

- 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.

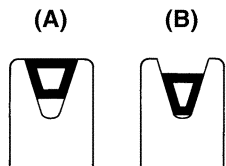
**(A) Good**

**(B) Bad**

0000007659E



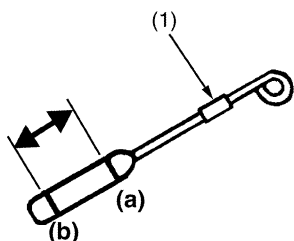
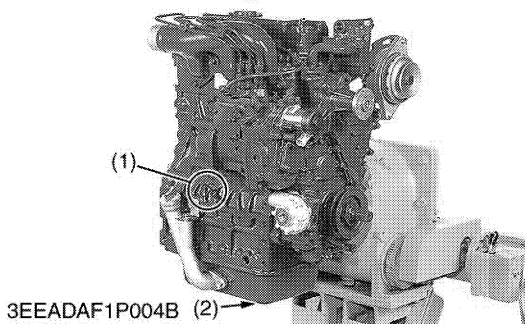
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## [4] CHECK POINTS OF EVERY 150 HOURS

### Changing Engine Oil



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### ! 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 (2) at the bottom of the engine and drain the oil completely.
  4. Screw the drain plug (2).
  5. Fill new oil up to upper line on the dipstick (1).

### ■ 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

D1703-M	5.6 L 1.48 U.S.gals 1.23 Imp.gals
---------	---

(1) Dipstick

(a) Maximum

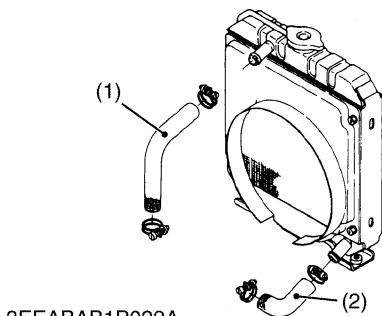
(2) Drain Plug

(b) Minimum

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## [5] CHECK POINTS OF EVERY 200 HOURS

### [ Checking Radiator Hoses and Clamp Bands (Adapted with ONAN) ]



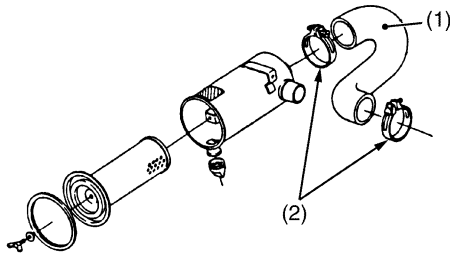
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1. Check to see if the radiator hoses are properly fixed every 250 hours of operation or every six months, whichever comes first.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The water hose is made of rubber and tends to age. It must be replaced every two years. Also replace the clamp and tighten it securely.

(1) Upper Hose

(2) Lower Hose

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#### [ Checking Intake Air Line (Adapted with ONAN) ]

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

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## [6] CHECK POINTS OF EVERY 300 HOURS

#### [ Replacing Oil Filter Cartridge ]



#### 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

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## [7] CHECK POINTS OF EVERY 400 HOURS

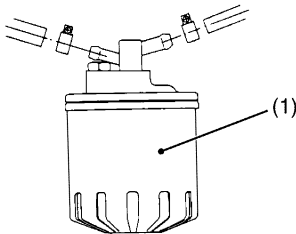
#### [ Replacing Fuel Filter Cartridge (Cartridge Type) (Adapted with ONAN) ]

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.

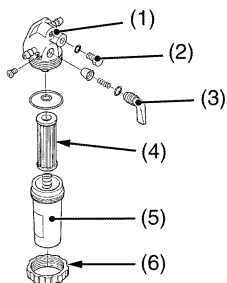
(1) Fuel Filter Cartridge

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[ Replacing Fuel Filter Element (Normal Type) (Adapted with ONAN) ]

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

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## [8] CHECK POINTS OF EVERY 500 HOURS

### [ Cleaning Fuel Tank Inside (Adapted with ONAN) ]

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### [ Cleaning Water Jacket and Radiator Interior (Adapted with ONAN) ]



#### 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.

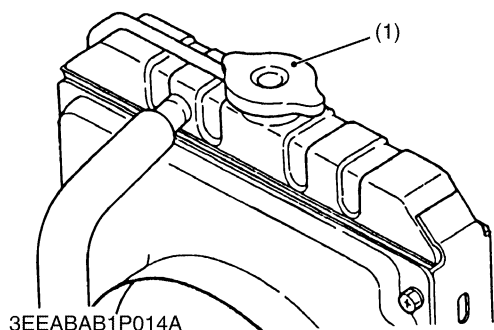
#### ■ IMPORTANT

- 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.

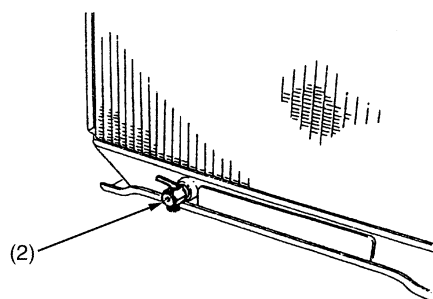
- (1) Radiator Cap  
(2) Drain Plug  
(3) Drain Cock  
(4) Recovery Tank

A : Full  
B : Low

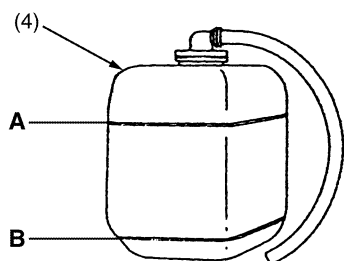
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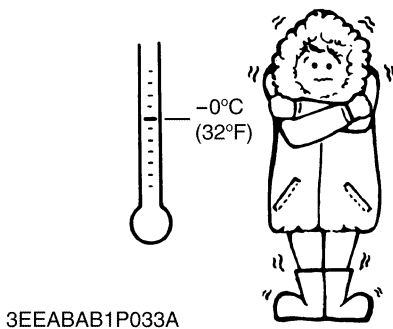
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### Anti-Freeze

- 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

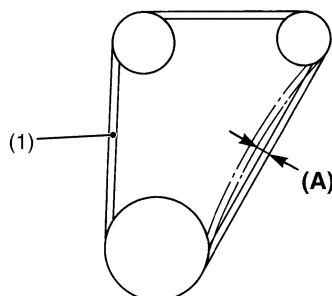
- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.**
- **When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and 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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### [ Replacing Fan Belt (Adapted with ONAN) ]

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.



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

(A) Deflection

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## [9] CHECK POINTS OF EVERY 1 OR 2 MONTHS

[ Recharging Battery (Adapted with ONAN) ]



### 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.

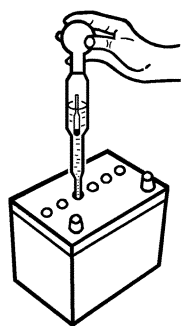
#### 2) Quick Charging

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.

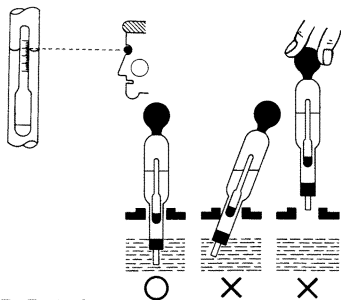
#### ■ Precaution for Operating a Quick Charger

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

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#### [ Battery Specific Gravity (Adapted with ONAN) ]

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

#### ■ NOTE

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

#### (Reference)

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

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

-Specific gravity at 20 °C = Measured value + 0.0007 x (electrolyte temperature - 20 °C)

-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 °C (68 °F)

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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 place where it is not exposed to direct sunlight.
2. Since the battery self-discharges by approx. 0.5 % per day even in storage, it must be once every two months in cold season.
3. When storing the battery mounted on the tractor, disconnect the ground cable from the battery's negative terminal post.

**(Reference)**

## ● Self-discharge Rate

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

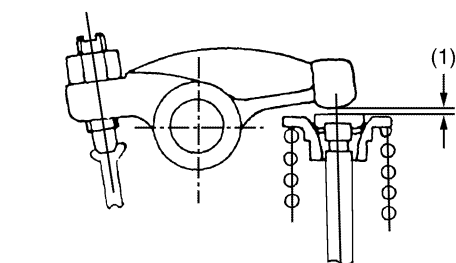
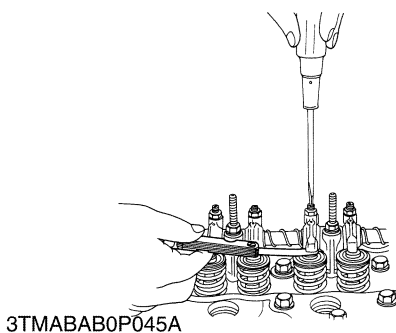
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**[10]CHECK POINTS OF EVERY YEAR**[ Replacing Air Cleaner Element (Adapted with ONAN) ]

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

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## [11]CHECK POINTS OF EVERY 800 HOURS



### 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.
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#### ■ NOTE

- The "TC" marking line on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.
- No. 1 piston comes to the top dead center position when the "TC" marking is aligned with the mark 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 mark perfectly. Adjust all the other valve clearance as required.
- After turning the flywheel counterclockwise twice or three times, recheck the valve clearance (1).
- After adjusting the valve clearance (1), firmly tighten the lock nut of the adjusting screw.

Valve arrangement		IN.	EX.
Adjustable cylinder location of piston	No. 1	☆	☆
	No. 2		☆
	No. 3	☆	
	No. 1		
	No. 2	☆	
	No. 3		☆

(1) Valve Clearance

0000007442E

## [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.

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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.

See the "Disassembling and Assembling" for nozzle holder.

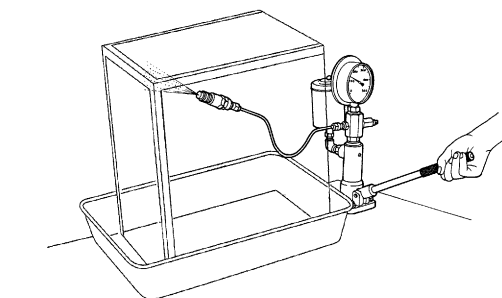
Fuel injection pressure	Factory spec.	13.73 to 14.71 MPa 140 to 150 kgf/cm <sup>2</sup> 1991 to 2134 psi
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### (Reference)

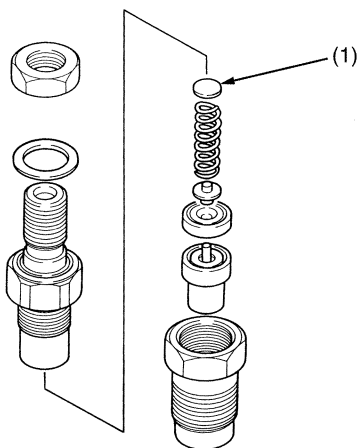
- Pressure variation with 0.01 mm (0.0004 in.) difference of adjusting washer thickness.  
Approx. 235 kPa (2.4 kgf/cm<sup>2</sup>, 34 psi)

(1) Adjusting Washer

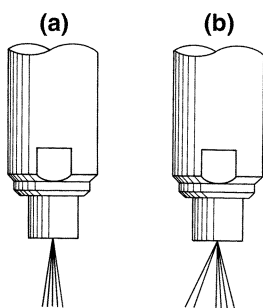
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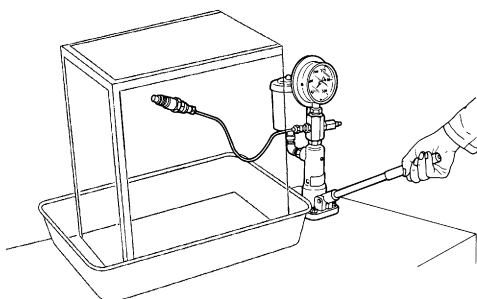
### Nozzle Spraying Condition

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.  
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<sup>2</sup>, 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 <sup>2</sup> 1849 psi
----------------------	---------------	---

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**[13]CHECK POINTS OF EVERY 2 YEARS**[ Replacing Intake Air Line (Adapted with ONAN) ]

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

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[ Replacing Battery (Adapted with ONAN) ]

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[ Replacing Radiator Hoses and Clamp Bands (Adapted with ONAN) ]

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

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[ Replacing Fuel Pipes and Clamp Bands (Adapted with ONAN) ]

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

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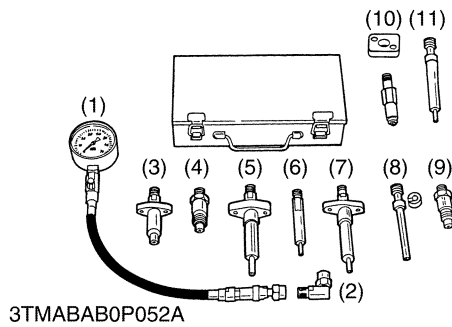
Replacing Radiator Coolant (L.L.C.)

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

0000006276E



## 5. SPECIAL TOOLS



### 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) (for D1703-M)

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

- |                      |                                  |
|----------------------|----------------------------------|
| (1) Gauge            | (7) Adaptor <b>F</b>             |
| (2) L Joint          | (8) Adaptor <b>G</b>             |
| (3) Adaptor <b>A</b> | (9) Adaptor <b>H</b> for D1703-M |
| (4) Adaptor <b>B</b> | (10) Adaptor <b>I</b>            |
| (5) Adaptor <b>C</b> | (11) Adaptor <b>J</b>            |
| (6) Adaptor <b>E</b> |                                  |

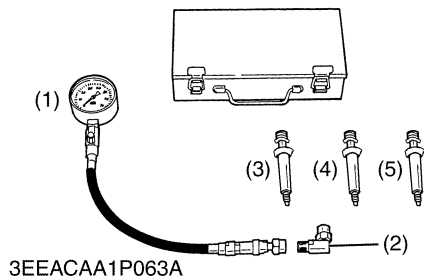
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### Diesel Engine Compression Tester (for Glow Plug Hole)

Code No : 07909-39081 (Assembly) 07909-31301 (L)  
 07909-31291 (K) 07909-31311 (M)

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

Adaptor : **M** for D1703-M Series



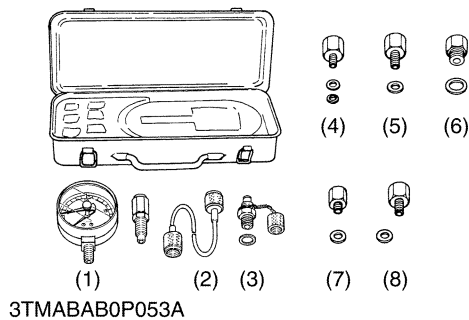
- |                               |   |
|-------------------------------|---|
| (1) Gauge                     | (4) Adaptor <b>L</b> (NSM, 05 : M8 X 1.0) |
| (2) L Joint                   | (5) Adaptor <b>M</b>                      |
| (3) Adaptor <b>K</b> (03M-DI) | (03, 03M : M10 X 1.25)                    |

0000007679E

### Oil Pressure Tester

Code No : 07916-32032

Application : Use to measure lubricating oil pressure.



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

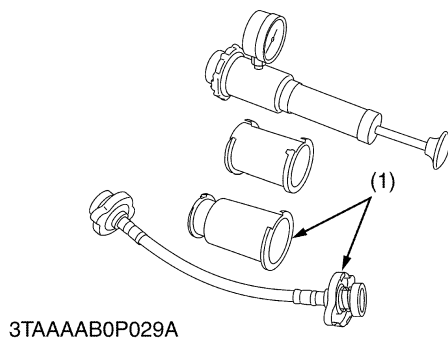
0000000681E

### 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.



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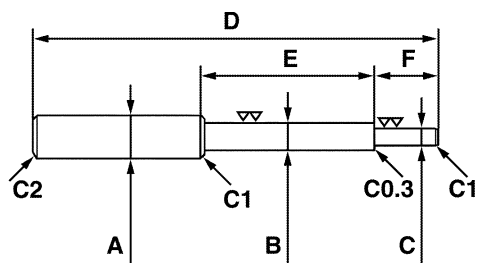
# ■ NOTE

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

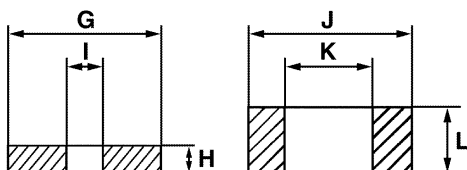
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## Valve Guide Replacing Tool

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



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3TMABAB0P064A

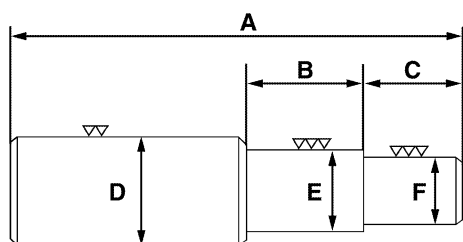
A	20 mm dia. (0.79 in. dia.)
B	11.7 to 11.9 mm dia. (0.460 to 0.468 in.dia.)
C	6.5 to 6.6 mm dia. (0.256 to 0.259 in.dia.)
D	225 mm (8.86 in.)
E	70 mm (2.76 in.)
F	45 mm (1.77 in.)
G	25 mm (0.98 in.)
H	5 mm (0.197 in.)
I	6.7 to 7.0 mm dia. (0.263 to 0.275 in.dia.)
J	20 mm dia. (0.787 in.dia.)
K	12.5 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

## Bushing Replacing Tools

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

### 1. For small end bushing



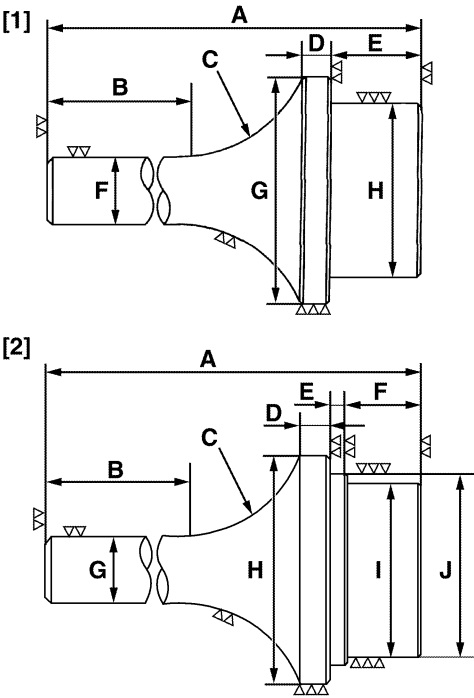
3TMABAB0P066A

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.)

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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.)

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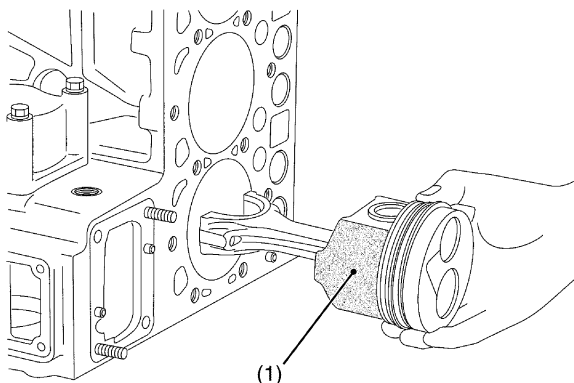
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# 1. ENGINE BODY

## [1] PISTON



3EEADAA1P001A

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

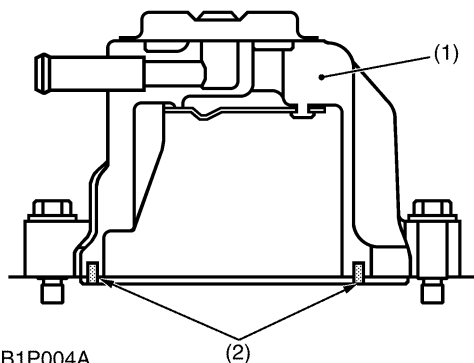
### \* Molybdenum disulfide ( $\text{MoS}_2$ )

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

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## [2] HALF-FLOATING HEAD COVER



3EEABAB1P004A

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.

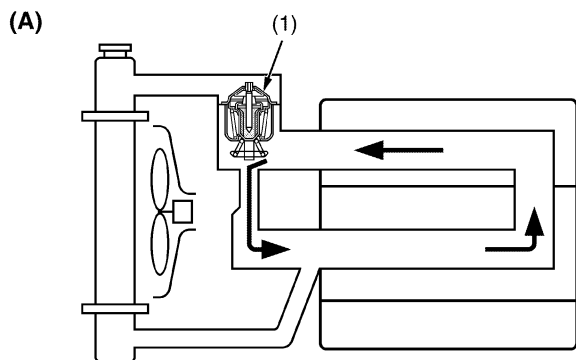
(1) Cylinder Head Cover

(2) Rubber Packing

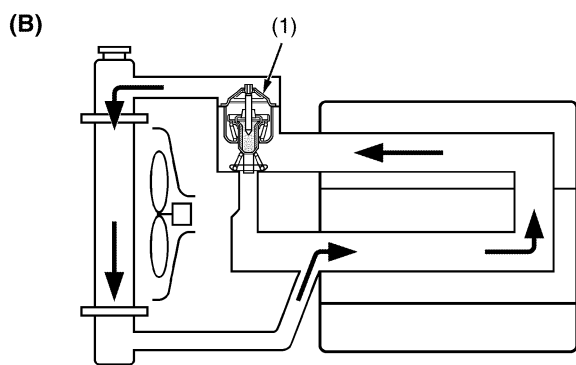
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## 2. COOLING SYSTEM

### [1] BOTTOM BYPASS SYSTEM



3EEAAA1P110A



3EEAAA1P111A

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

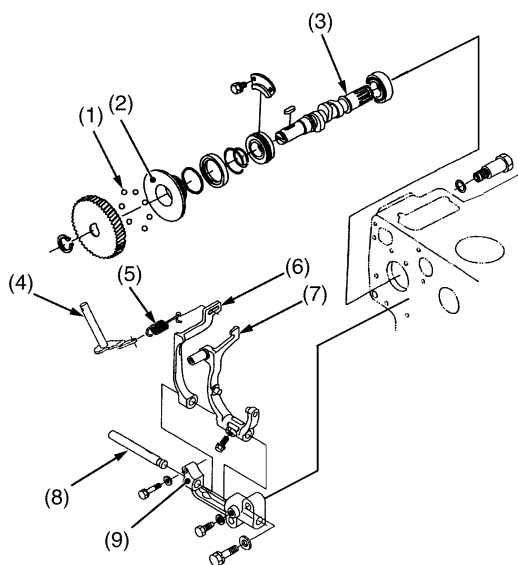
(A) **Thermostat Closed**

(B) **Thermostat Open**

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### 3. FUEL SYSTEM

#### [1] GOVERNOR



3EEADAF1P006A

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 (3), and the tension of the governor spring (5) are balanced.

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

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# 1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
<b>Engine Does Not Start</b>	● No fuel	Replenish fuel	—
	● Air in the fuel system	Vent air	G-8
	● Water in the fuel system	Change fuel and repair or replace fuel system	G-8, 9, 12, 13
	● Fuel pipe clogged	Clean	G-8
	● Fuel filter clogged	Replace	G-9, 12, 13
	● Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	G-11
	● Fuel with low cetane number	Use specified fuel	—
	● Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-25
	● Incorrect injection timing	Adjust	S-17
	● Fuel camshaft worn	Replace	—
	● Injection nozzle clogged	Clean or replace	S-18
	● Injection pump malfunctioning	Repair or replace	—
	● 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-13
	● Improper valve timing	Correct or replace timing gear	S-34
	● Piston ring and cylinder worn	Replace	S-51, 57
	● Excessive valve clearance	Adjust	G-19
	● Actuator malfunctioning	Replace	S-23
<b>(Starter Does Not Run)</b>	● Battery discharged	Charge	G-16
	● Starter malfunctioning	Repair or replace	S-21
	● Key switch malfunctioning	Replace	—
	● Wiring disconnected	Connect	—

Symptom	Probable Cause	Solution	Reference Page
<b>Engine Revolution Is Not Smooth</b>	● Fuel filter clogged or dirty	Replace	G-9, 12, 13
	● Air cleaner clogged	Clean or replace	G-12
	● Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-25
	● Injection pump malfunctioning	Repair or replace	—
	● Incorrect nozzle opening pressure	Adjust	S-18
	● Injection nozzle stuck or clogged	Repair or replace	S-18
	● Governor malfunctioning	Repair	S-31, 32
<b>Either White or Blue Exhaust Gas Is Observed</b>	● Excessive engine oil	Reduce to specified level	G-6
	● Piston ring and cylinder worn or stuck	Repair or replace	S-51, 57
	● Incorrect injection timing	Adjust	S-17
	● Deficient compression	Adjust top clearance	S-13
<b>Either Black or Dark Gray Exhaust Gas Is Observed</b>	● Overload	Lessen the load	—
	● Low grade fuel used	Use specified fuel	—
	● Fuel filter clogged	Replace	G-9, 12, 13
	● Air cleaner clogged	Clean or replace	G-9, 12
	● Deficient nozzle injection	Repair or replace nozzle	S-18, 19
<b>Deficient Output</b>	● Incorrect injection timing	Adjust	S-17
	● Engine's moving parts seem to be seizing	Repair or replace	—
	● Injection pump malfunctioning	Repair or replace	—
	● Deficient nozzle injection	Repair or replace nozzle	S-18, 19
	● Compression leak	Check the compression pressure and repair	S-13
	● Air cleaner dirty or clogged	Clean or replace	G-9, 12
<b>Excessive Lubricant Oil Consumption</b>	● Piston ring's gap facing the same direction	Shift ring gap direction	S-37
	● Oil ring worn or stuck	Replace	S-51
	● Piston ring groove worn	Replace piston	S-51
	● Valve stem and valve guide worn	Replace	S-44
	● Crankshaft bearing, and crank pin bearing worn	Replace	S-55
	● Oil leaking due to defective seals or packing	Replace	—

Symptom	Probable Cause	Solution	Reference Page
<b>Fuel Mixed into Lubricant Oil</b>	● Injection pump's plunger worn	Replace injection pump	—
	● Deficient nozzle injection	Repair or replace nozzle	S-18, 19
	● Injection pump broken	Replace	—
<b>Water Mixed into Lubricant Oil</b>	● Head gasket defective	Replace	S-27
	● Cylinder block or cylinder head flawed	Replace	S-43
<b>Low Oil Pressure</b>	● Engine oil insufficient	Replenish	G-6, 11
	● Oil strainer clogged	Clean	S-36
	● Relief valve stuck with dirt	Clean	—
	● Relief valve spring weaken or broken	Replace	—
	● Excessive oil clearance of crankshaft bearing	Replace	S-55
	● Excessive oil clearance of crankpin bearing	Replace	S-53
	● Excessive oil clearance of rocker arm	Replace	S-47
	● Oil passage clogged	Clean	—
	● Different type of oil	Use specified type of oil	G-6, 11
	● Oil pump defective	Repair or replace	S-14
<b>High Oil Pressure</b>	● Different type of oil	Use specified type of oil	G-6, 11
	● Relief valve defective	Replace	—
<b>Engine Overheated</b>	● Engine oil insufficient	Replenish	G-6
	● Fan belt broken or elongated	Replace or adjust	G-10
	● Coolant insufficient	Replenish	G-14, 15
	● Radiator net and radiator fin clogged with dust	Clean	—
	● Inside of radiator corroded	Clean or replace	G-7, 14
	● Coolant flow route corroded	Clean or replace	—
	● Radiator cap defective	Replace	S-15
	● Overload running	Reduce the load	—
	● Head gasket defective	Replace	S-27
	● Incorrect injection timing	Adjust	S-17
	● Unsuitable fuel used	Use specified fuel	—

Symptom	Probable Cause	Solution	Reference Page
<b>Battery Quickly Discharged</b>	● Battery electrolyte insufficient	Replenish distilled water and charge	—
	● Fan belt slips	Adjust belt tension or replace	G-10
	● Wiring disconnected	Connect	—
	● Alternator defective	Replace	S-21
	● 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 <sup>-1</sup> (rpm) 36 to 41 kgf/cm <sup>2</sup> / 290 min <sup>-1</sup> (rpm) 512 to 583 psi / 290 min <sup>-1</sup> (rpm)	2.55 MPa / 290 min <sup>-1</sup> (rpm) 26 kgf/cm <sup>2</sup> / 290 min <sup>-1</sup> (rpm) 370 psi / 290 min <sup>-1</sup> (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.
Valve Timing (Intake Valve)	Open	0.21 rad (12 °) before T.D.C.	—
	Close	0.63 rad (36 °) after B.D.C.	—

Item		Factory Specification	Allowable Limit
Valve Timing (Exhaust Valve)	Open	0.99 rad (57 °) before B.D.C.	—
	Close	0.21 rad (12 °) after T.D.C.	—
Valve Spring	Free Length	41.7 to 42.2 mm 1.6417 to 1.6614 in.	41.2 mm 1.6220 in.
	Setting Load / Setting Length	117.6 N / 35.0 mm 12.0 kgf / 35.0 mm 26.4 lbs / 1.3780 in.	100.0 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbs / 1.3780 in.
	Tilt	—	1.0 mm 0.039 in.
Rocker Arm Shaft to Rocker Arm	Clearance	0.016 to 0.045 mm 0.00063 to 0.00177 in.	0.1 mm 0.0039 in.
	Rocker Arm Shaft (O.D.)	13.973 to 13.984 mm 0.55012 to 0.55055 in.	—
	Rocker Arm (I.D.)	14.000 to 14.018 mm 0.55118 to 0.55189 in.	—
Push Rod	Alignment	—	0.25 mm 0.0098 in.
Tappet to Tappet Guide	Clearance	0.020 to 0.062 mm 0.00079 to 0.00244 in.	0.07 mm 0.0028 in.
	Tappet (O.D.)	23.959 to 23.980 mm 0.94327 to 0.94410 in.	—
	Tappet Guide (I.D.)	24.000 to 24.021 mm 0.94488 to 0.94571 in.	—
Gear Backlash	Crank Gear to Idle Gear 1	0.0415 to 0.1122 mm 0.00163 to 0.00442 in.	0.15 mm 0.0059 in.
	Idle Gear 1 to Cam Gear	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
	Idle Gear to Injection Pump Gear	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
	Crank Gear to Oil Pump Gear	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.	0.15 mm 0.0059 in.
Idle Gear	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.
	Alignment	—	0.01 mm 0.0004 in.

Item		Factory Specification	Allowable Limit
Cam	Height (Intake / Exhaust)	33.90 mm 1.3346 in.	33.85 mm 1.3327 in.
Camshaft Journal to Cylinder Block Bore	Clearance	0.050 to 0.091 mm 0.00197 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.	—
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.
Piston Ring Gap	Top Ring	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.25 mm 0.0492 in.
	Second Ring	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
	Oil Ring	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.
	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.
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.	—

Item		Factory Specification	Allowable Limit
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 2.36319 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.	—
Cylinder Bore [Standard]	I.D.	87.000 to 87.022 mm 3.42519 to 3.42606 in.	87.172 mm 3.43197 in.
Cylinder Bore [Oversize]	I.D.	87.250 to 87.272 mm 3.43503 to 3.43590 in.	87.422 mm 3.41181 in.

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**LUBRICATING SYSTEM**

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	—	49 kPa 0.5 kgf/cm <sup>2</sup> 7 psi
	At Rated Speed	294 to 441 kPa 3.0 to 4.5 kgf/cm <sup>2</sup> 42.7 to 64.0 psi	245 kPa 2.5 kgf/cm <sup>2</sup> 35.6 psi
Engine Oil Pressure Switch	Working Pressure	49 kPa 0.5 kgf/cm <sup>2</sup> 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 (Adapted with ONAN) ]	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 (Adapted with ONAN) ]	Water Tightness	[ No leaks at 137 kPa 1.4 kgf/cm <sup>2</sup> 20 psi ]	—
[ Radiator Cap (Adapted with ONAN) ]	Pressure Falling Time	[ more than 10 seconds for pressure fall from 88 to 59 kPa (from 0.9 to 0.6 kgf/cm <sup>2</sup> from 13 to 9 psi) ]	—

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**FUEL SYSTEM**

Item		Factory Specification	Allowable Limit
Injection Pump	Injection Timing	0.236 to 0.271 rad (13.5 to 15.5 °) before T.D.C.	—
Injection Nozzle	Injection Pressure	13.73 to 14.71 MPa 140 to 150 kgf/cm <sup>2</sup> 1991 to 2133 psi	—
Injection Nozzle Valve Seat	Valve Seat Tightness	When the pressure is 12.75 MPa (130 kgf/cm <sup>2</sup> , 1849 psi), the valve seat must be fuel tightness.	—

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**ELECTRICAL SYSTEM**

<b>Item</b>		<b>Factory Specification</b>	<b>Allowable Limit</b>
[ Starter (Adapted with ONAN) ]	Commutator (O.D.)	30.0 mm 1.181 in.	29.0 mm 1.142 in.
	Mica Under Cut	0.45 to 0.75 mm 0.0177 to 0.0295 in.	0.20 mm 0.0079 in.
	Brush Length	15.0 mm 0.591 in.	11.0 mm 0.433 in.
	Brush Holder and Holder Support (Resistance)	Infinity	—
Alternator	No-load voltage	More than 13.5 V / 5000 rpm	—
Glow Plug	Resistance	Approx. 0.9 $\Omega$	—
Actuator	Resistance	Approx. 2.8 $\Omega$ at 20 °C (68 F)	—

**■ NOTE**

- Numerical values of parts described by [ ] are numerical values of Kubota parts.  
Follow the instruction manual of ONAN about numerical values of ONAN adopting parts.

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### 3. TIGHTNING 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.

Nominal Diameter	Grade	Standard Screw and Bolt ④			Special Screw and Bolt ⑦		
	Unit	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
<b>M6</b>		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
<b>M8</b>		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
<b>M10</b>		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
<b>M12</b>		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.
- Numerical values of [Flywheel Screw] is recommended tightening torque of Kubota.

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

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## 4. CHECKING, DISASSEMBLING AND SERVICING

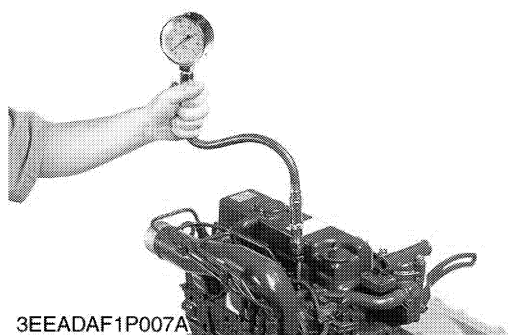
### ■ NOTE

- Numerical values of parts described by [ ] are numerical values of Kubota.  
Follow the instruction of ONAN about numerical values of ONAN adopting parts.

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### [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 connector from the actuator solenoid in order to inject fuel.
3. Remove the air cleaner, the muffler and all injection nozzles.
4. Set a compression tester with the adaptor to the glow plug hole (or nozzle hole).  
Nozzle Hole : Adaptor H  
Glow Plug Hole : Adaptor M
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.

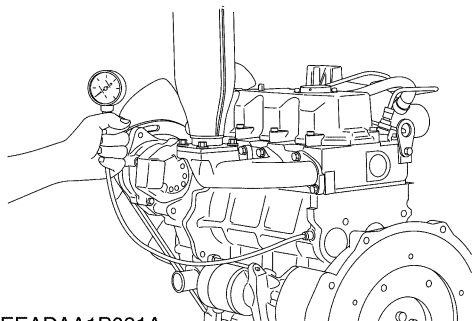
### ■ NOTE

- 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 <sup>2</sup> 512 to 583 psi
	Allowable limit	2.55 MPa 26 kgf/cm <sup>2</sup> 370 psi

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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. (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	Allowable limit	49 kPa 0.5 kgf/cm <sup>2</sup> 7 psi
	At rated speed	Factory spec.	294 to 441 kPa 3.0 to 4.5 kgf/cm <sup>2</sup> 42.7 to 64.0 psi
		Allowable limit	245 kPa 2.5 kgf/cm <sup>2</sup> 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 <sup>2</sup> 10.8 to 14.5 ft-lbs
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### Relief Valve

1. Remove the oil filter base.
2. Check the relief valve for dirt, and the seat and ball for damage.
3. If damaged, replace.
4. Check the free length of spring.
5. If less than the allowable limit, replace.

Spring free length	Factory spec.	35 mm 1.38 in.
	Allowable limit	30 mm 1.18 in.

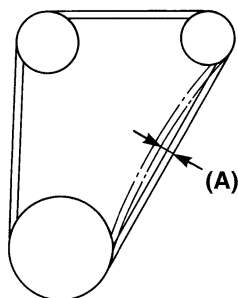
Tightening torque	Joint	39.2 to 49.0 N·m 4.0 to 5.0 kgf·m 29.0 to 36.3 ft-lbs
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(1) Relief Valve

(2) Joint

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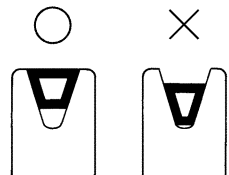
### (3) Cooling System



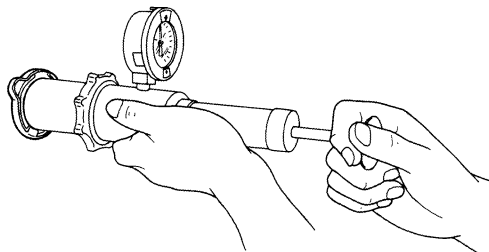
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3EEABAB1P019A



3EEABAB1P018B



3EEABAB1P162A

#### [ Fan Belt Tension (Adapted with ONAN) ]

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 <b>(A)</b>	Factory spec.	7 to 9 mm 0.28 to 0.35 in.
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#### **(A) Deflection**

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#### [ Fan Belt Damage and Wear (Adapted with ONAN) ]

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.

O : Good

X : Bad

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#### [ Radiator Cap Air Leakage (Adapted with ONAN) ]

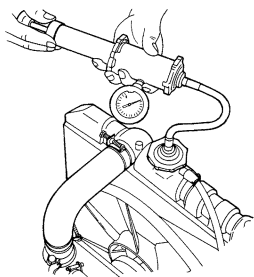


#### **CAUTION**

- When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.
1. Set a radiator tester on the radiator cap.
  2. Apply the specified pressure (88 kPa, 0.9 kgf/cm<sup>2</sup>, 13 psi), and measure the time for the pressure to fall to 59 kPa (0.6 kgf/cm<sup>2</sup>, 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 <sup>2</sup> from 13 to 9 psi)
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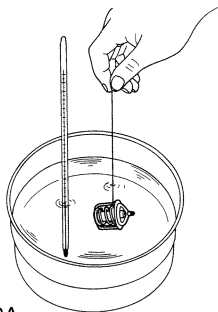
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[ Radiator Water Leakage (adapted with ONAN) ]

- 1. Pour a specified amount of water into the radiator.
- 2. Set a radiator tester with an adaptor 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.	No leaks at 137 kPa 1.4 kgf/cm <sup>2</sup> 20 psi
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Thermostat Valve Opening Temperature

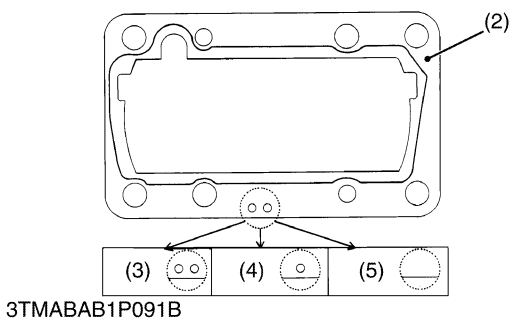
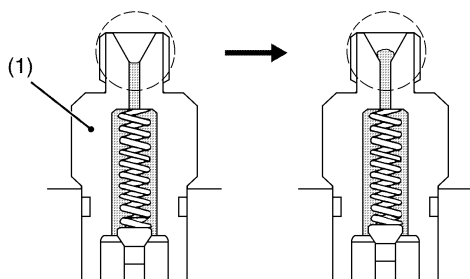
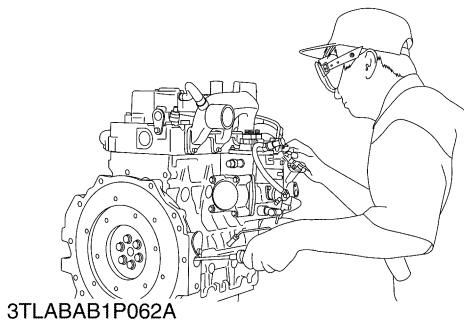
- 1. Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
- 2. Heating the water gradually, read the temperature when the valve opens and leaves the string.
- 3. Continue heating and read the temperature when the valve opens approx. 6 mm (0.236 in.).
- 4.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



### Injection Timing

1. Remove the actuator.
2. Remove the injection pipes and nozzle.
3. Set the speed control lever to maximum speed position 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. If the calculation differs from specified injection timing, add or remove the shim to adjust.

### (Injection Timing)

Injection timing	Factory spec.	0.236 to 0.271 rad 13.5 ° to 15.5 ° B.T.D.C.
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### ■ 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 °).

### ■ IMPORTANT

- injection timing is set by shims with in the range from 13.5 to 15.5 degrees.

**When replace or change the shim, 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.

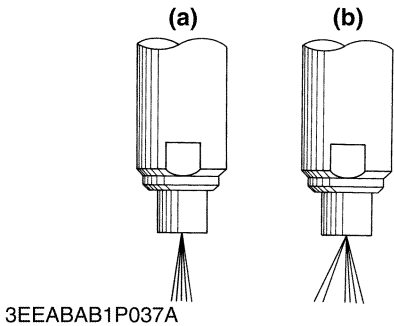
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Nozzle Spraying Condition

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

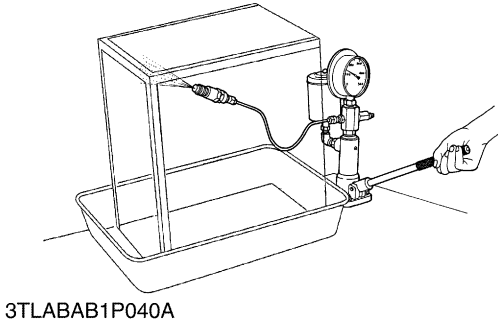
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Fuel Injection Pressure

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 <sup>2</sup> 1991 to 2134 psi
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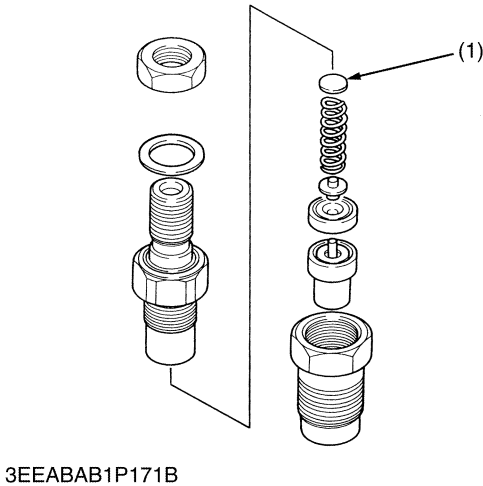


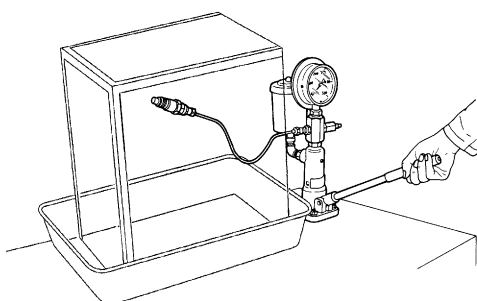
(Reference)

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

(1) Adjusting Washer

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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<sup>2</sup>, 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 <sup>2</sup> 1849 psi
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## (5) Electrical System



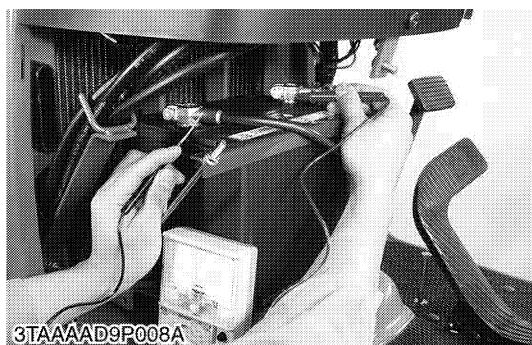
### CAUTION

- 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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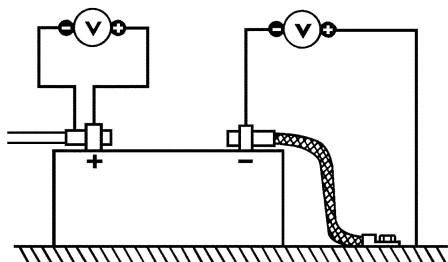


### [ Battery Voltage (Adapted with ONAN) ]

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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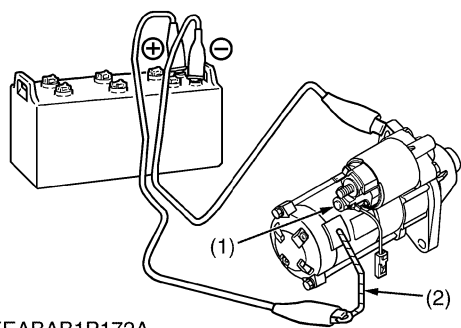
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### Battery Terminal Connection

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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[ Motor Test (Adapted with ONAN) ]**CAUTION**

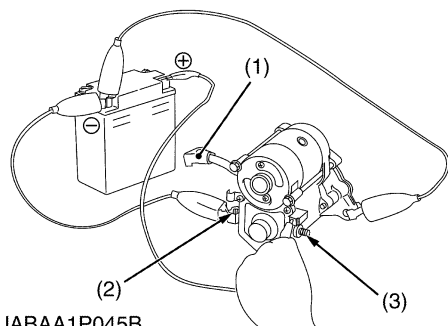
- **Secure the starter to prevent it from jumping up and down while testing the motor.**

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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[ Magnet Switch Test (Adapted with ONAN) ]

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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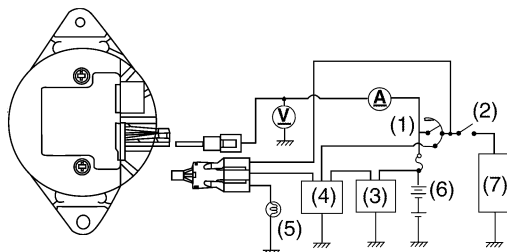
**(Precaution when checking)**

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

**NOTE**

- **Check the alternator with alternator test bench.**

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### Regulating Voltage

1. Make the connections as shown in the figure, and turn on key switch.
2. Increase the alternator speed to  $5000 \text{ min}^{-1}$  (rpm).
3. Turn on switch.
4. Check that the voltage reading on the voltmeter is within the factory specifications.

Regulating voltage	Factory spec.	13.5 to 14.5 V
--------------------	---------------	----------------

- |                |                              |
|----------------|------------------------------|
| (1) Key Switch | (5) Charge Lamp 12 V / 3.4 W |
| (2) Switch     | (6) Battery                  |
| (3) Starter    | (7) Load                     |
| (4) Relay      |                              |

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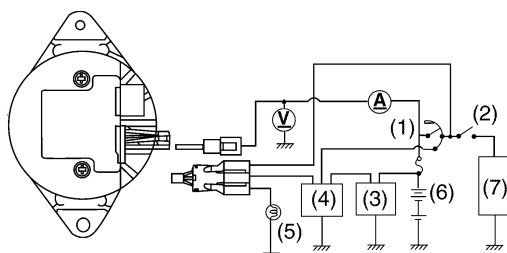
### Output Characteristics

1. Make the connection as shown in the figure, and turn on key switch and switch.
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 key switch and switch.

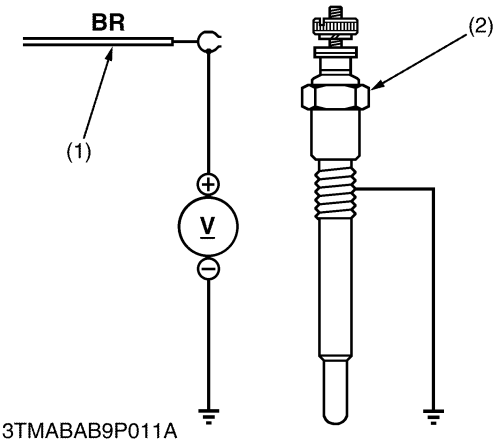
Output characteristics	Factory spec.	20 to 21.5 A or more at 13.5 V, $5000 \text{ min}^{-1}$ (rpm)
------------------------	---------------	---

- |                |                              |
|----------------|------------------------------|
| (1) Key Switch | (5) Charge Lamp 12 V / 3.4 W |
| (2) Switch     | (6) Battery                  |
| (3) Starter    | (7) Load                     |
| (4) Relay      |                              |

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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

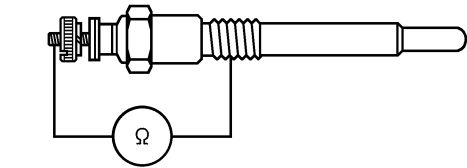
(1) Wiring Lead (Positive)                      (2) Glow Plug

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Glow Plug Continuity

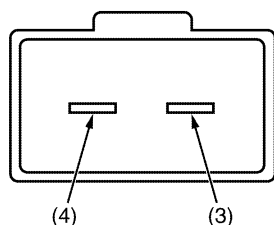
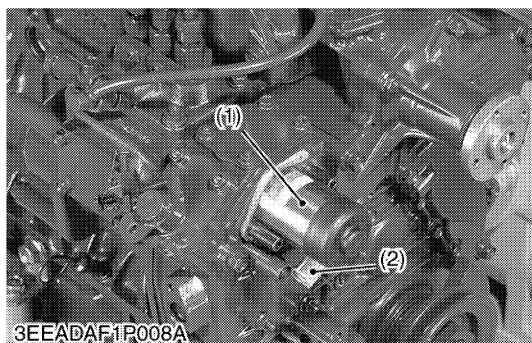
- 1. Disconnect the lead from the glow plugs.
- 2. Measure the resistance between the glow plug terminal and the chassis.
- 3. If 0 ohm is indicated, the screw at the tip of the glow plug and the housing are short-circuited.
- 4. If the factory specification is not indicated, the glow plug is faulty.

Glow plug resistance	Factory spec.	Approx. 0.9 Ω
----------------------	---------------	---------------

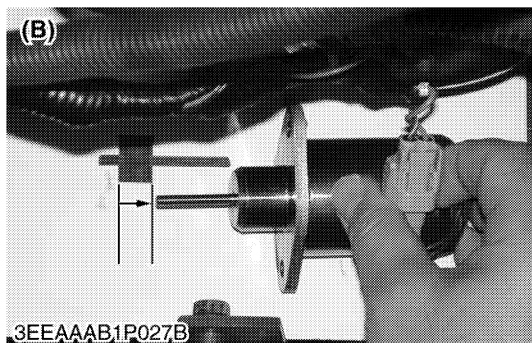
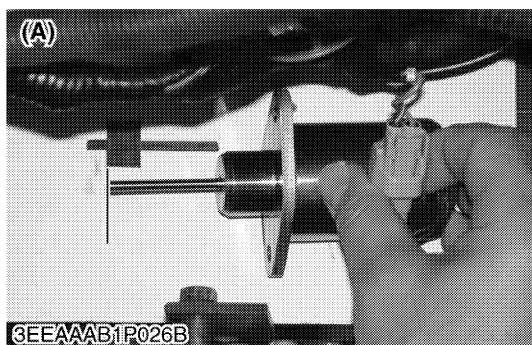


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### Actuator

1. Check the state of the harness and if it is abnormal, please exchange it.
2. Remove the connector of the actuator (2P).
3. Turn the key switch to the ACC position.
4. Measure the voltage between the terminals of the connector (harness side).

Resistance	Terminal 1 - Terminal 2	12 V
------------	-------------------------	------

5. **(a)** when the measurements are the above table value  
The electronic governor is normal. Check the actuator according to the procedure of confirming the actuator's movement.
- (b)** when the measurements are out of the above table value  
The electronic governor is failure, then please exchange it.

- (1) Actuator (3) Terminal 1 (+)  
(2) Actuator Connection Harness (4) Terminal 2 (-)

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### (Reference)

- The procedure of confirming the actuator's movement
1. Measure the resistance between the terminals of the actuator's connector.

Resistance	Terminal 1 - Terminal 2	2 to 4 $\Omega$
------------	-------------------------	-----------------

2. **(a)** when the measurements are the above table value  
The actuator is normal electrically. Check the actuator's movement.
- (b)** when the measurements are out of the above table value  
The actuator is failure, then please exchange it.
3. Remove the actuator from the engine.
4. Supply the voltage (12 V) to the actuator.
5. **(a)** when the rod of the actuator moves smoothly  
The actuator is normal.
- (b)** when the rod of the actuator does not move smoothly  
The actuator is failure, then please exchange it.



### CAUTION

- Please note handling, the actuator becomes a high temperature.

(A) Key Switch OFF Position

(B) Key Switch ON Position

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## [2] DISASSEMBLING AND ASSEMBLING

### ■ NOTE

- Parts have been described by [ ] are the ONAN adapting goods. The numerical value which has been described is a tightening torque servicing spec. of Kubota parts that Kubota recommends.  
Please follow the instruction of ONAN about the tightening torque of the ONAN adopting parts.

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### (1) Draining Coolant and Oil

#### Draining Engine Oil and 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.

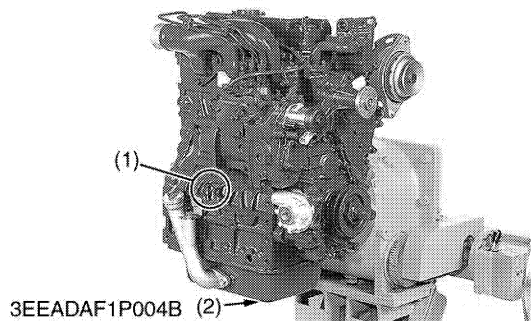
- Start and warm up the engine for approx. 5 minutes.
- Place an oil pan underneath the engine.
- Remove the drain plug (2) to drain oil.
- After draining, screw in the drain plug.
- Prepare a bucket. Open the coolant drain cock.

#### (When refilling)

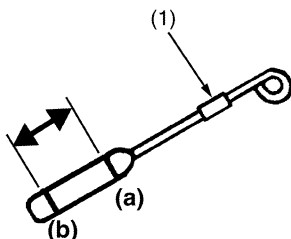
- Fill the engine oil up to the upper line on the dipstick (1)
- ### ■ IMPORTANT
- Never mix two different type of oil.
  - Use the proper SAE Engine Oil according to ambient temperature.

- (1) Dipstick  
(2) Drain Plug

- (a) Maximum  
(b) Minimum



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### (2) External Components

#### [ Dynamo and others ]

- Remove the dynamo.
- Remove the fan belt and others.

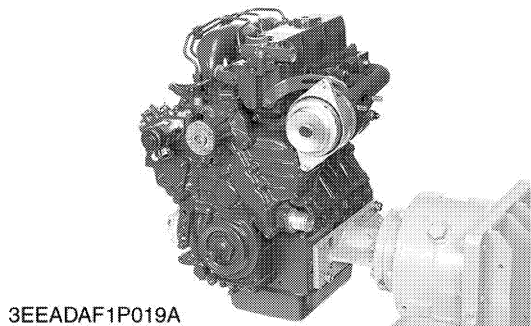
#### (When reassembling)

- 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.

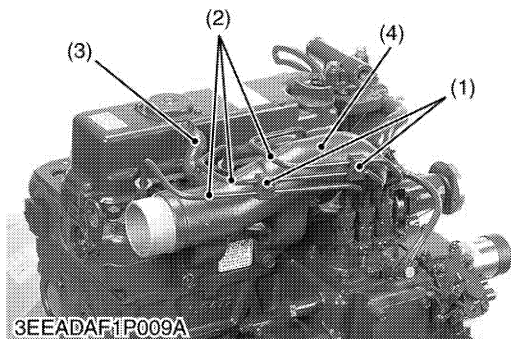
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### (3) Cylinder Head and Valves



#### Inlet Manifold

1. Loosen the pipe clamp screw (1).
2. Remove the injection pipe (2).
3. Disconnect the breather hose (3).
4. Remove the inlet manifold (4).

#### ■ NOTE

- Do not bent the injection pipe (2) , when disassembling and reassembling the pipe.
- Tighten the injection pipe retaining nut to specified torques.

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
-------------------	------------------------------	---

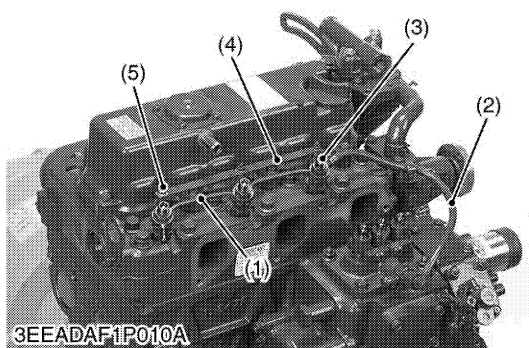
(1) Pipe Clamp Screw

(3) Breather Hose

(2) Injection Pipe

(4) Inlet Manifold

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#### Nozzle and Glow Plug

1. Remove the over flow pipe (1) and hose (2).
2. Remove the nozzle holder assy (3).
3. Remove the glow plug cord (4).
4. Remove the glow plug (5).

#### ■ NOTE

- Tighten the nozzle holder assy, glow plug nut and glow plug to specified torques.

Tightening torque	Over flow pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Nozzle holder assy	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 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) Over Flow Pipe

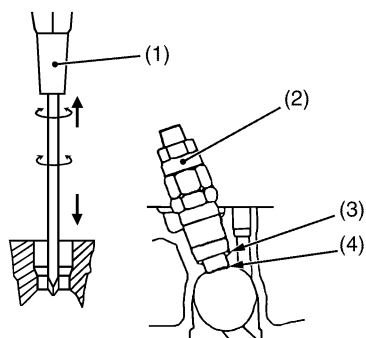
(4) Glow Plug Cord

(2) Over Flow Hose

(5) Glow Plug

(3) Nozzle Holder Assy

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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

(3) Copper Gasket

(2) Nozzle Holder

(4) Heat Seal

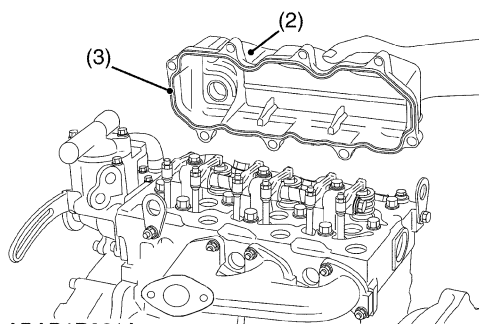
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### Cylinder Head Cover

1. Remove the head cover screw (1).
2. Remove the cylinder head cover (2).

#### (When reassembling)

- Check to see that the cylinder head cover gasket (3) is not defective.
- Tighten the head cover screw to specified torque.



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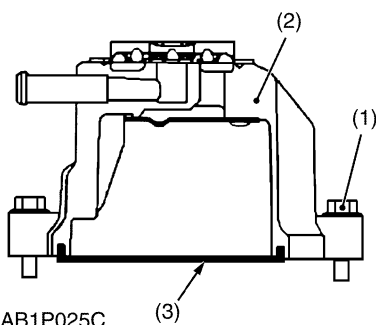
Tightening torque	Head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
-------------------	------------------	--

(1) Head Cover Screw

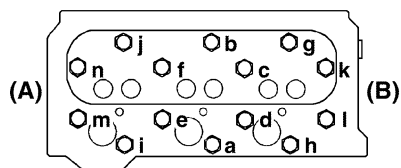
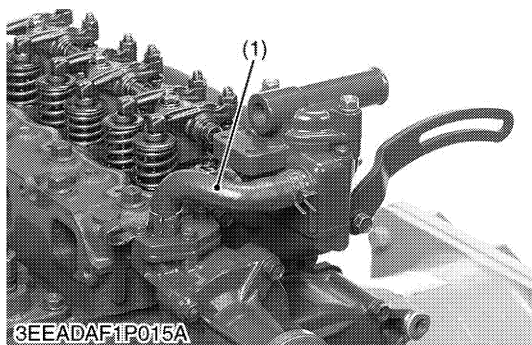
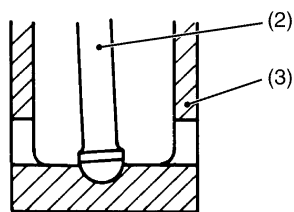
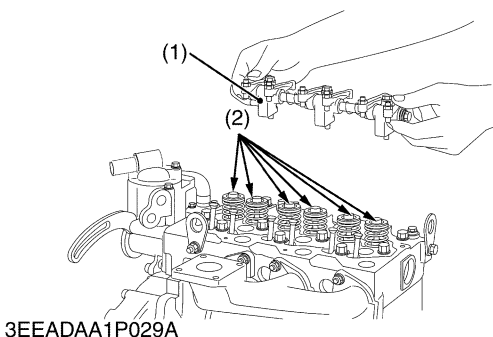
(3) Head Cover Gasket

(2) Cylinder Head Cover

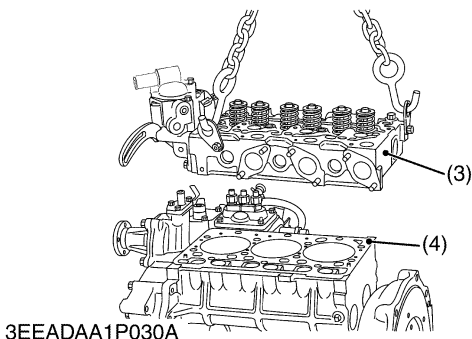
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### Rocker Arm and Push Rod

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

(3) Tappet

(2) Push Rod

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### Cylinder Head

1. Disconnect the water return hose (1).
2. Remove the cylinder head screw in the order of (n) to (a).
3. Lift up the cylinder head (2) to detach.
4. Remove the cylinder head gasket (3).

#### (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).
- 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) Return Hose

(n) to (a) : To Loosen

(2) Cylinder Head

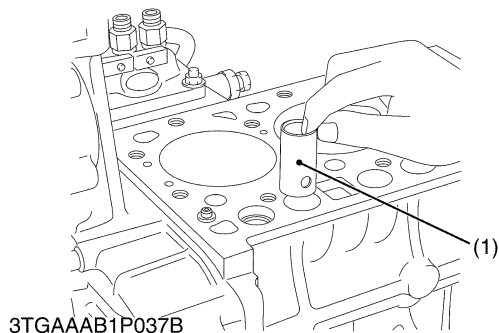
(a) to (n) : To Tighten

(3) Cylinder Head Gasket

(A) Gear Case Side

(B) Flywheel Side

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### Tappets

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

#### **(When reassembling)**

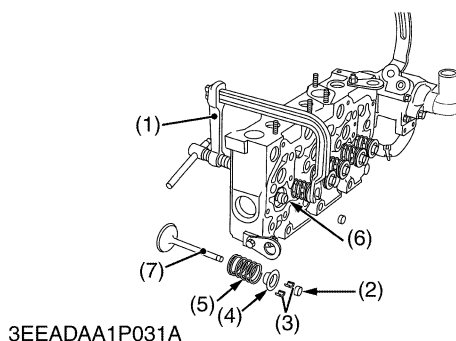
- Visually check the contact between tappets and cams for proper rotation. If defect is found, replace tappets.
- Before installing the tappets, apply engine oil thinly around them.

#### **■ IMPORTANT**

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

(1) Tappet

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### 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)**

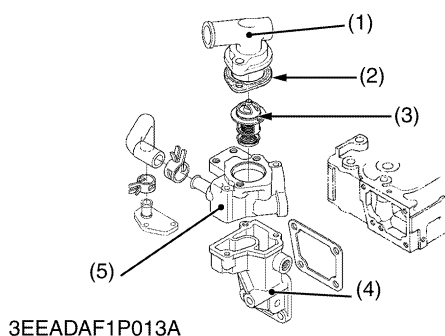
- Wash the valve stem seal and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

#### **■ IMPORTANT**

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

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

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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).

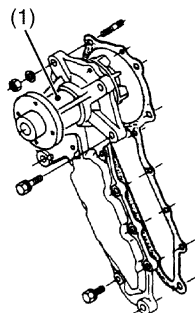
#### **(When reassembling)**

- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the thermostat cover gasket (2).
- Apply a liquid gasket (Three Bond 1215 or equivalent) to the thermostat flange 1 and flange 2.

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

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#### (4) Timing Gears, Camshaft and Fuel Camshaft



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##### Water Pump Assembly

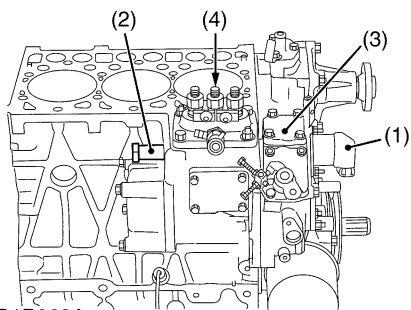
1. Remove the water pump assembly (1) from the gear case cover.

##### **(When reassembling)**

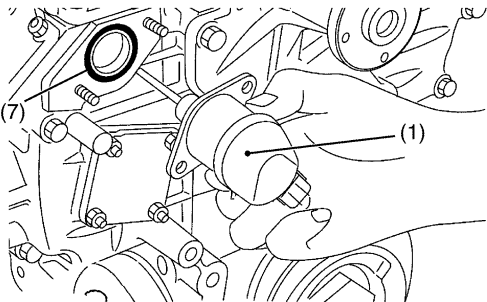
- Apply a liquid gasket (Three Bond 1215 or equivalent) to the both sides of gasket.

(1) Water Pump Assembly

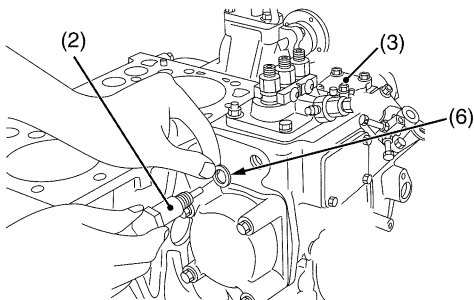
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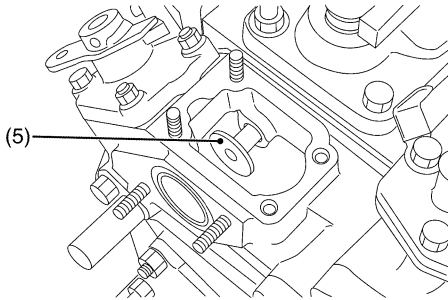
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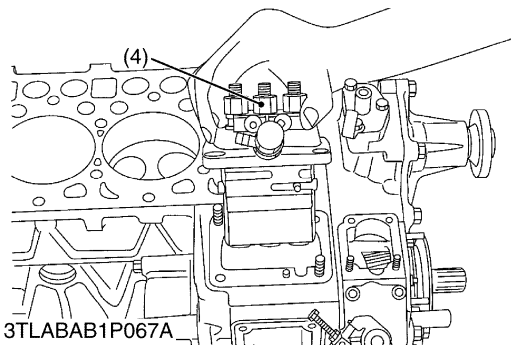
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Injection Pump

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

■ **IMPORTANT**

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

**(When reassembling)**

- Before attaching the actuator (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 actuator (1), be careful to keep the O-ring (7) in place.
- Be sure to insert the push rod of the actuator 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) Actuator                | (5) Solenoid Guide        |
| (2) Hi-idling Body          | (6) Hi-idling Body Gasket |
| (3) Cover                   | (7) O-ring                |
| (4) Injection Pump Assembly |                           |

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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.).**

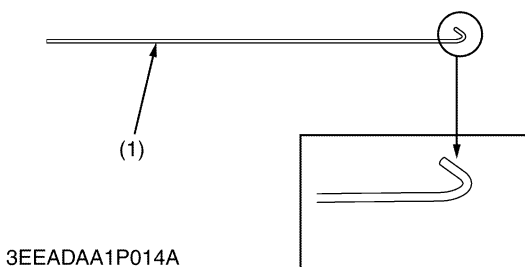
**The tip of wire is bent like the hook to hang governor springs.**

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

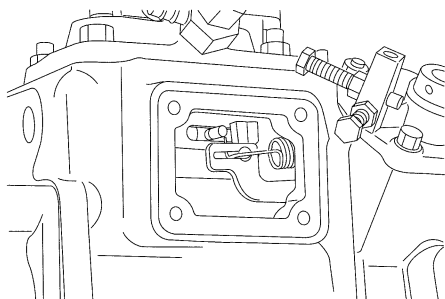
- (1) Specific Tool  
(2) Governor Spring  
(3) Fork Lever

- (4) Speed Control Lever  
(5) Speed Control Plate

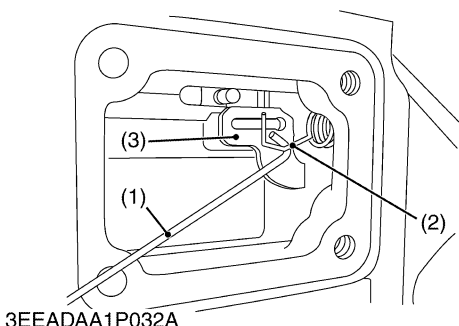
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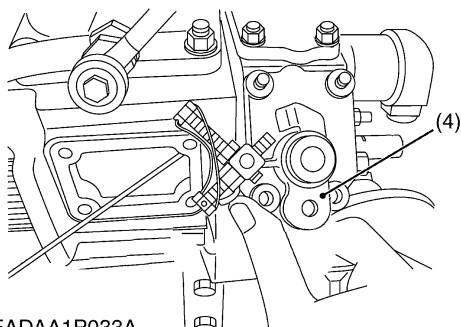
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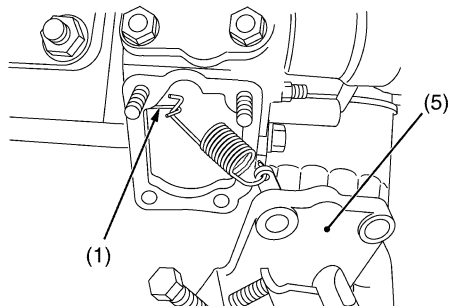
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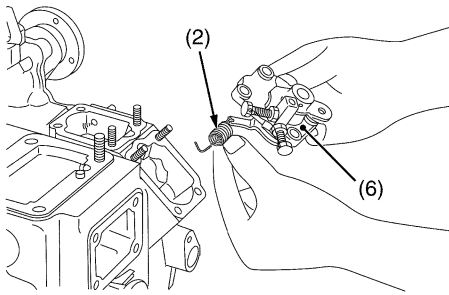
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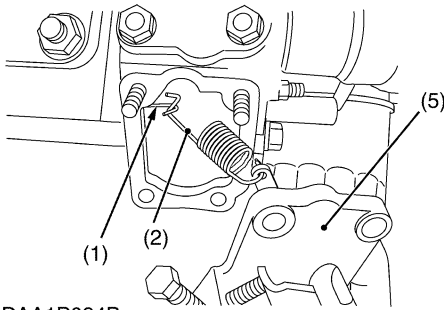
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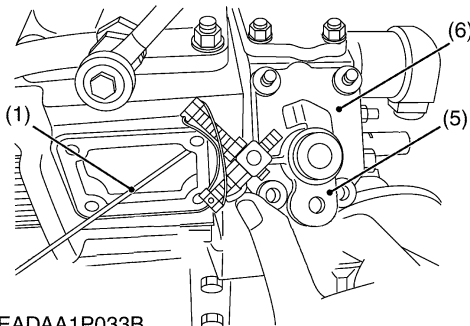
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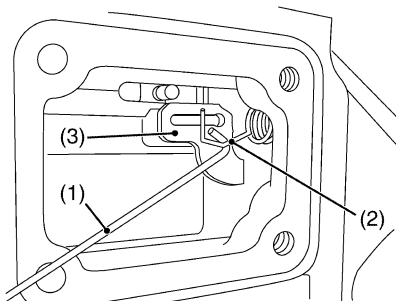
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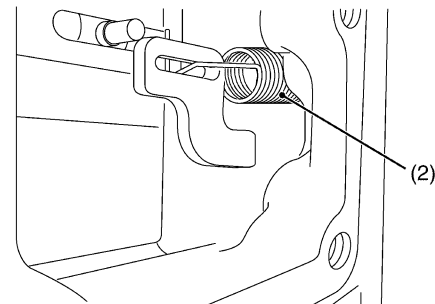
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### Governor Springs and Speed Control Plate (Continued)

#### (When reassembling)

- Put the specific tool (1) from the injection pump side to catch the governor spring (2). Keep this spring slightly extended and place the speed control plate (6) in its specified position.

#### ■ NOTE

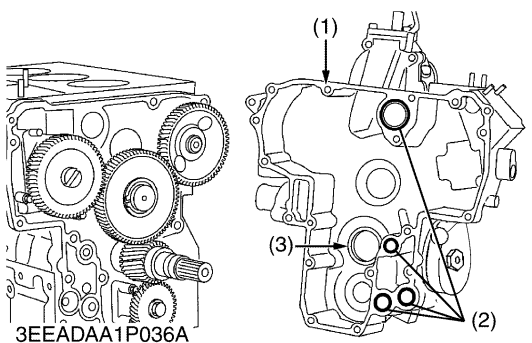
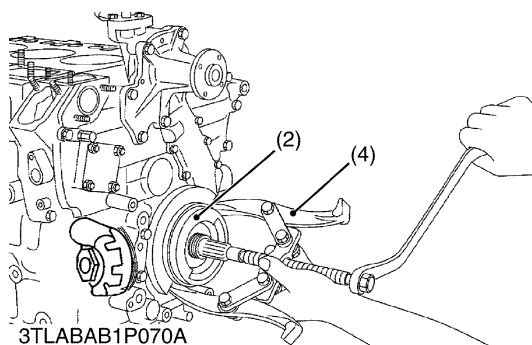
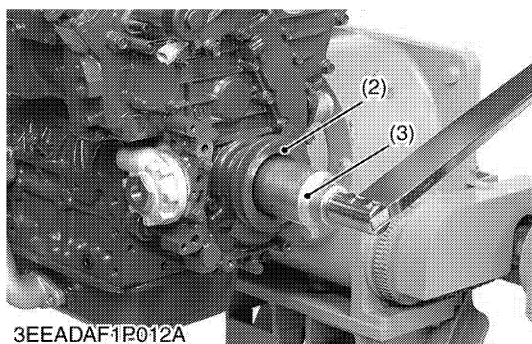
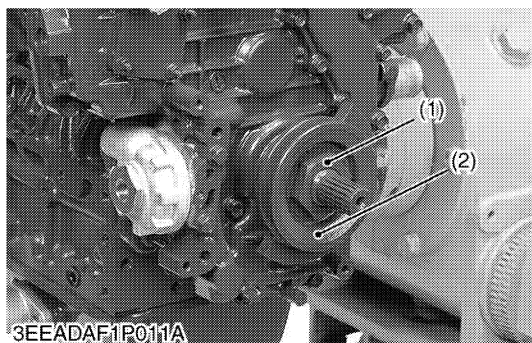
- Using the specific tool (1), hook the governor spring (2) onto the fork lever (3).
- Make sure the governor spring (2) is tight on the fork lever (3).
- Apply and tighten up the two bolts and two nuts on the speed control plate (6).
- Check that the speed control lever (5) positions low idle, after assembling governor springs.
- Check that the speed control lever (5) returns to the high idle position rather than the low idle position, after moving the lever to the maximum speed position.
- Finally attach the injection pump cover in position.

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

- (5) Speed Control Lever  
(6) Speed Control Plate

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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 (4).
4. Remove the feather key.

#### (When reassembling)

- Apply grease to the splines of coupling.

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

(1) Nut

(3) Socket Wrench 46 mm

(2) Fan Drive Pulley

(4) Gear Puller

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### Gear Case

1. Remove the gear case (1).
2. Remove the O-rings (2).

#### (When reassembling)

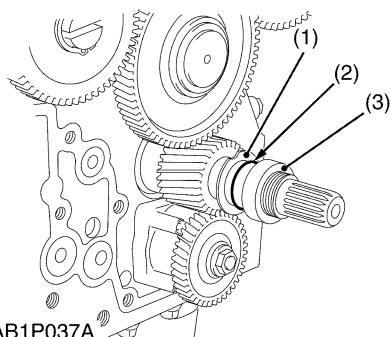
- Apply liquid gasket (Three Bond 1215 or equivalent) to both sides of hour meter gear case gasket.
- Check to see if there are four O-rings (2) inside the gear case (1).
- Apply a thin film of engine oil to the oil seal (3), and install it, noting the lip come off.
- Before installing the gear case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

(1) Gear Case

(3) Oil Seal

(2) O-ring

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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)**

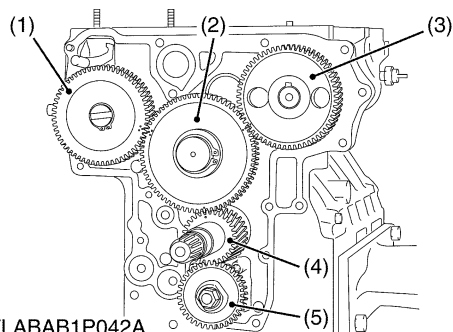
- Insert the crankshaft collar (3) after install the gear case to cylinder body.

(1) Crankshaft Oil Slinger

(3) Crankshaft Collar

(2) O-ring

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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

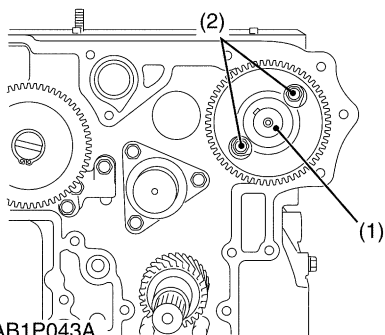
(4) Crank Gear

(2) Idle Gear

(5) Oil Pump Drive Gear

(3) Cam Gear

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**Camshaft**

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

**(When reassembling)**

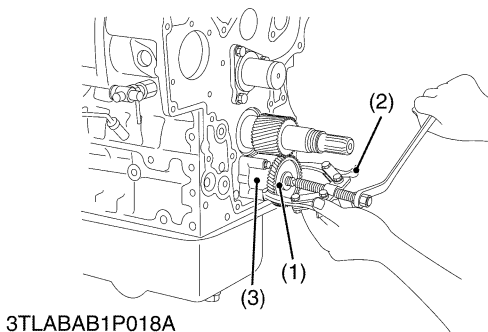
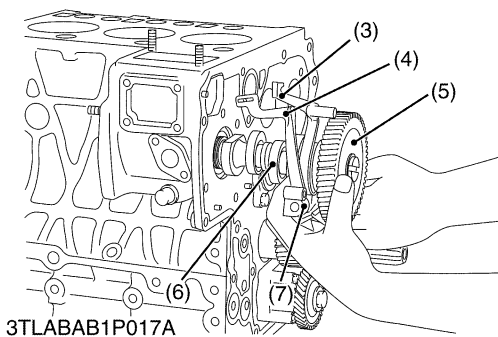
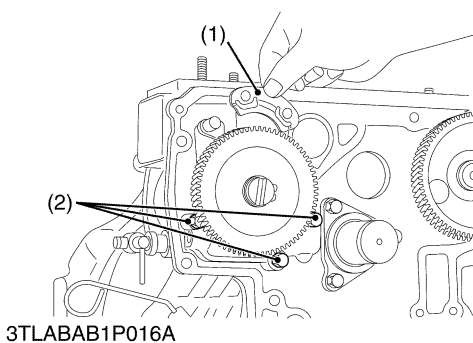
- When installing the idle gear, be sure to align the alignment marks on gears.

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

(1) Camshaft

(2) Camshaft Set Screw

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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 lever 2 (4) are fixed to the fork lever shaft, and that they can turn smoothly in the holder (7).

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

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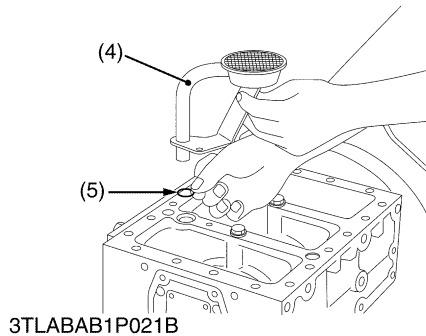
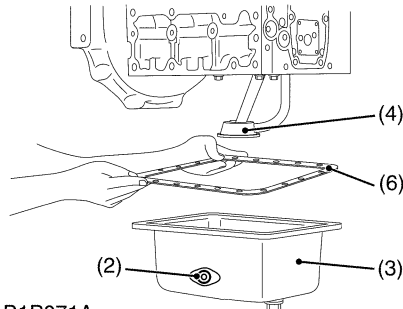
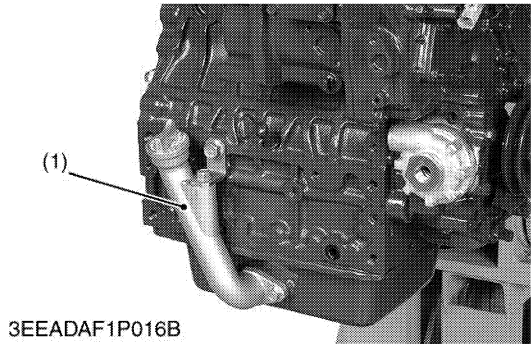
### Oil Pump

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 | (3) Oil Pump |
| (2) Gear Puller         |              |

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## (5) Piston and Connecting Rod



### Oil Pan and Oil Strainer

1. Remove the oil filler flange (1) and flange oring (2).
2. Remove the oil pan mounting screws.
3. Remove the oil pan (3).
4. Remove the oil strainer (4) and O-ring (5).

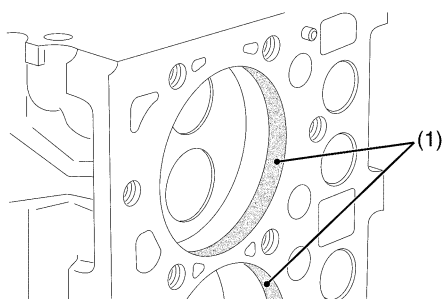
#### (When reassembling)

- After cleaning the oil strainer (3), check to see that the filter mesh is clean, and install it.
- Visually check the O-ring (2) (5), apply engine oil, and install it.
- Securely fit the O-ring (2) (5) to the oil strainer (4) and oil filler flange (1).
- Apply a liquid gasket (Three Bond 1215 or equivalent) to the oil pan side of the oil pan gasket (6).
- To avoid uneven tightening, tighten oil pan mounting screws in diagonal order from the center.

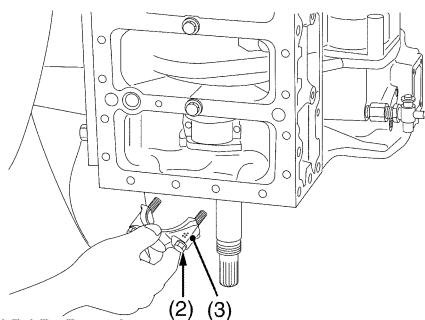
- (1) Oil Filler Flange  
(2) Flange O-ring  
(3) Oil Pan

- (4) Oil Strainer  
(5) O-ring  
(6) Oil Pan Gasket

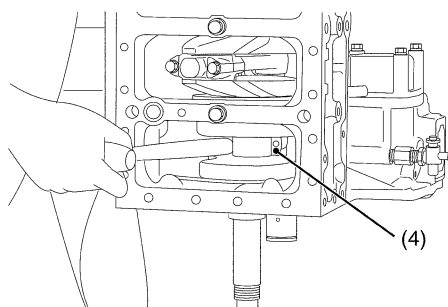
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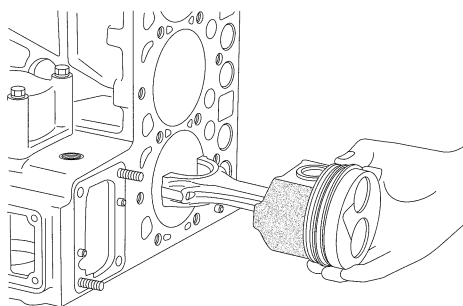
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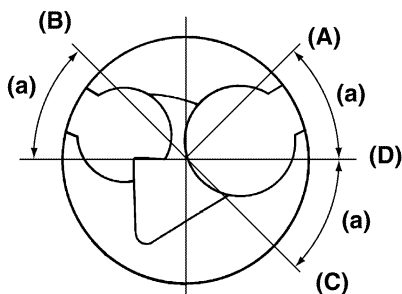
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### Pistons

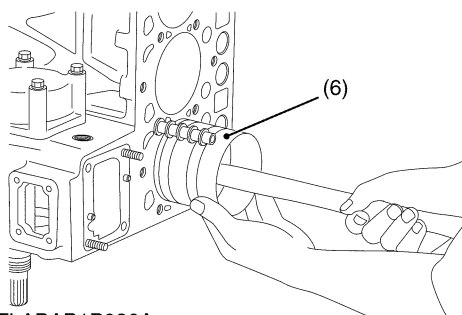
1. Completely clean carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and bring the piston to top dead center.
4. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
5. Draw out the other piston in the same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



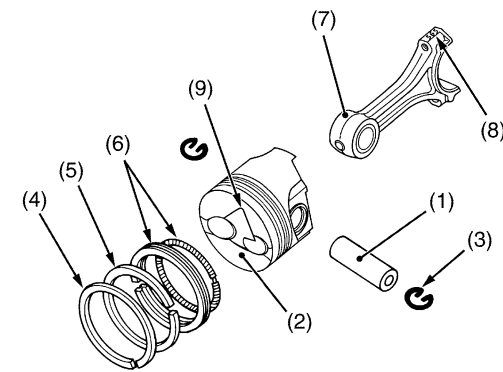
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Tightening torque	Connecting rod screw	44.1 to 49.0 N·m 4.5 to 5.0 kgf·m 32.5 to 36.2 ft-lbs
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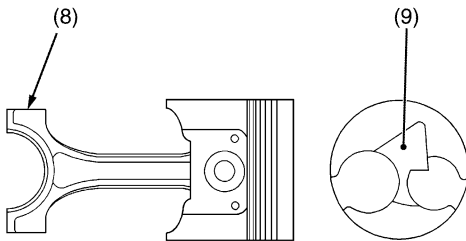
- (1) Carbon
- (2) Connecting Rod Screw
- (3) Connecting Rod Cap
- (4) Connecting Rod
- (5) Piston Ring Compressor

- (A) Top Ring Gap
  - (B) Second Ring Gap
  - (C) Oil Ring Gap
  - (D) Piston Pin Hole
- (a) 0.79 rad (45 °)

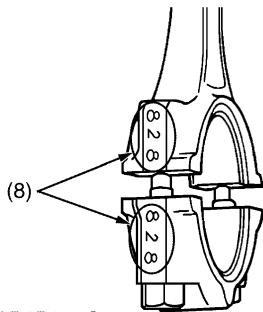
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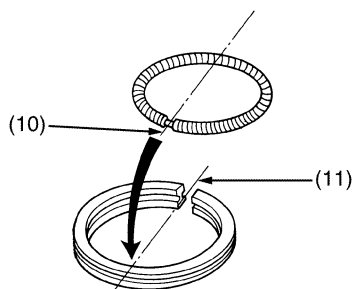
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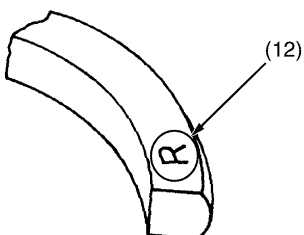
3TAAAB1P058A



3EEABAB1P095C



3EEABAB1P100A



3EEABAB1P101A

### Piston Ring and Connecting Rod

1. Remove the piston rings (4), (5), (6) using a piston ring tool.
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 5 to 10 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).

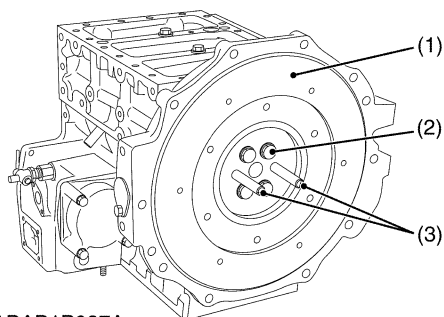
#### ■ NOTE

- **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 (Adapted with ONAN) ]

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.

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

(3) Flywheel Guide Screw

(2) Flywheel Screw

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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.

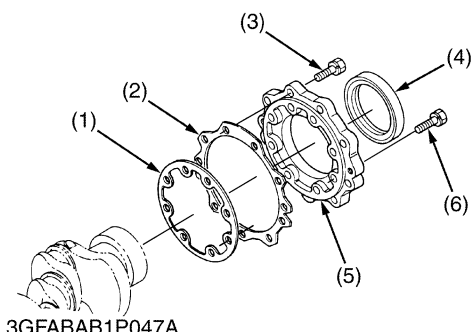
### ■ IMPORTANT

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

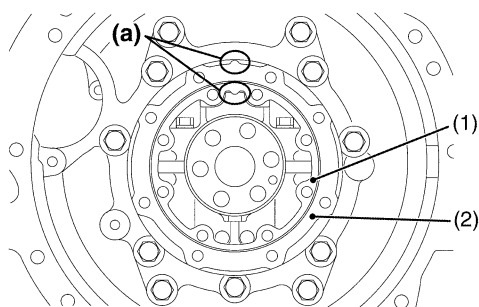
### (When reassembling)

- 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.

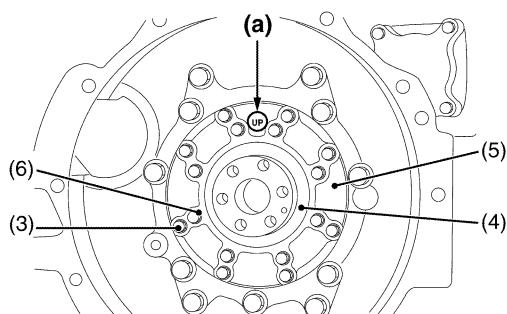
Tightening torque	Bearing case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
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(1) Bearing Case Gasket

(5) Bearing Case Cover

(2) Bearing Case Cover Gasket

(6) Bearing Case Cover Mounting

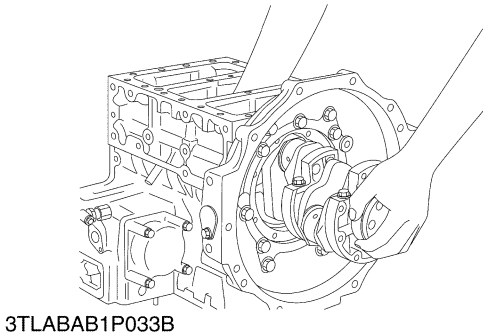
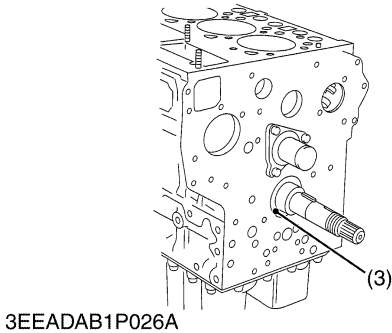
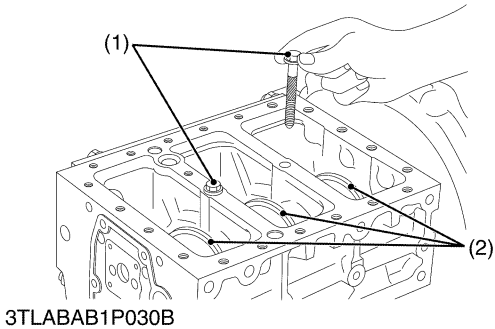
(3) Bearing Case Cover Mounting  
Screw (Outside : M8 X 25 mm)

Screw (Inside : M8 X 28 mm)

(4) Oil Seal

(a) Upside

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Crankshaft

■ **NOTE**

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

(When reassembling)

■ **IMPORTANT**

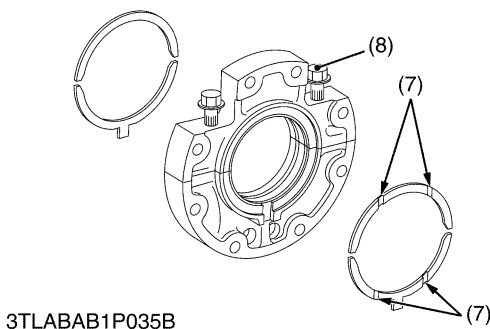
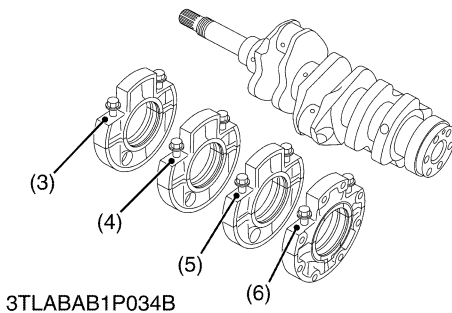
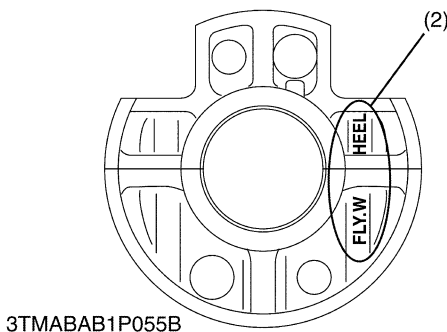
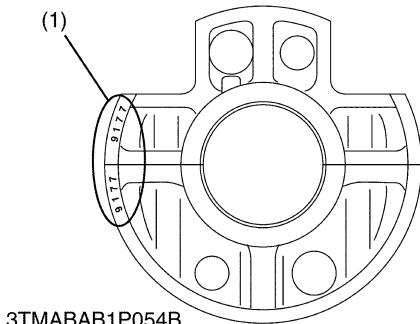
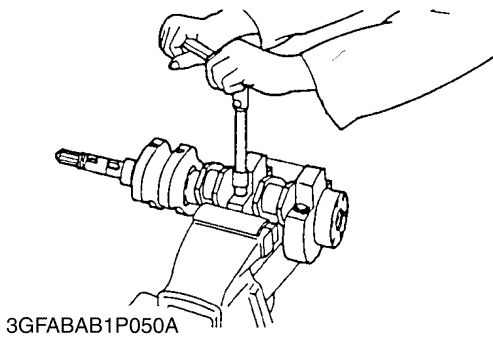
- Install the crankshaft sub assembly, aligning the screw hole of main bearing case 2 (2) with the screw hole of cylinder block.
  - When tightening the main bearing case screw 2 (1), apply oil to the screw and screw by hand before tightening the specific torque.
- If not smooth to screw by hand, align 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
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- (1) Main Bearing Case Screw 2      (a) Cut place for removing and installing the crankshaft
- (2) Main Bearing Case 2
- (3) Crankshaft bearing 1

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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 markings (A, B) from the gear case side.
- Match the alignment numbers (1) and mark (2) on the main bearing case.
- When installing the main bearing case 1 and 2, face the mark "FLYWHEEL" to the flywheel.
- Install the thrust bearing with its oil groove facing (7) outward.
- Confirm that the main bearing case moves smoothly after tightening the main bearing case screw 1 (8) to the specified torque.

Tightening torque	Main bearing case screw 1	46.1 to 50.9 N·m 4.7 to 5.2 kgf·m 34.0 to 37.6 ft·lbs
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(1) Alignment Number

(2) Alignment Mark

(3) Mark "A"

(4) Mark "B"

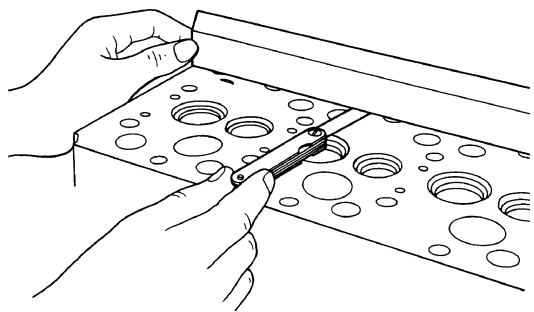
(7) Oil Groove

(8) Main Bearing Case Screw 1

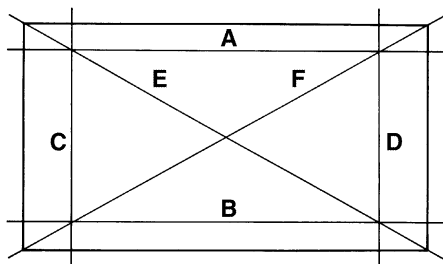
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### [3] SERVICING

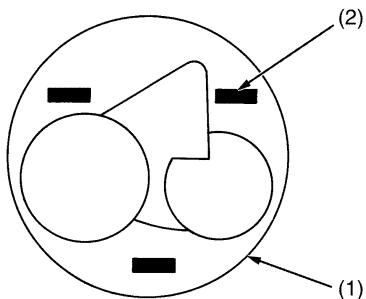
#### (1) Cylinder Head and Valves



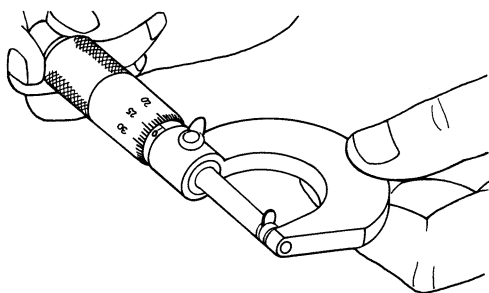
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#### Cylinder Head Surface Flatness

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.
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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.

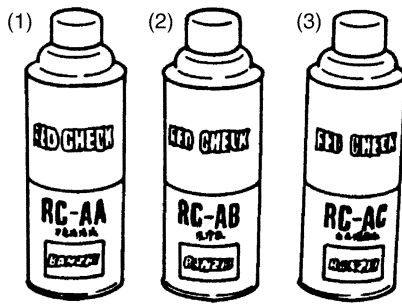
Top clearance	Factory spec.	0.55 to 0.70 mm 0.0217 to 0.0276 in.
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Tightening torque	Cylinder head screws	93.1 to 98.0 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft·lbs
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(1) Piston

(2) Fuse

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3TMABAB0P059B

### Cylinder Head Flaw

1. Prepare an air spray red check.
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 Permeative Liquid

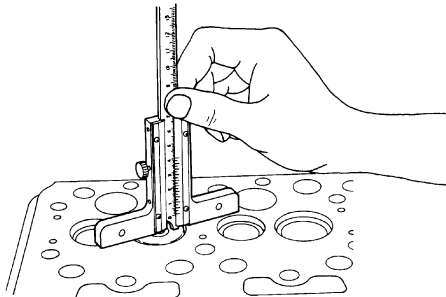
(3) White Developer

(2) Detergent

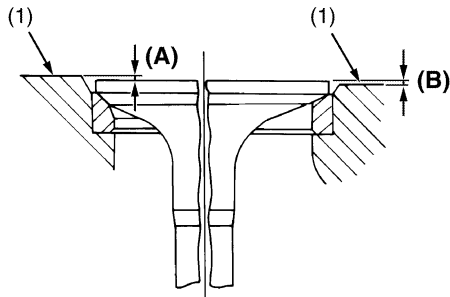
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### Valve Recessing

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.



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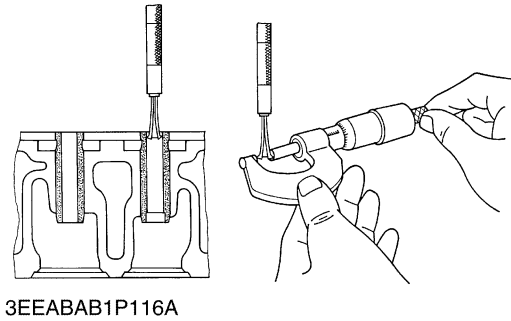
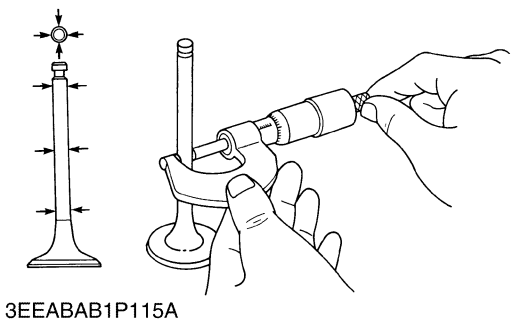
Valve recessing	Factory spec.	0.05 (protrusion) to 0.15 (recessing) mm 0.0020 (protrusion) to 0.0059 (recessing) in.
	Allowable limit	0.40 (recessing) mm 0.0157 (recessing) in.

(1) Cylinder Head Surface

(A) Recessing

(B) Protrusion

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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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Replacing Valve Guide

**(When removing)**

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

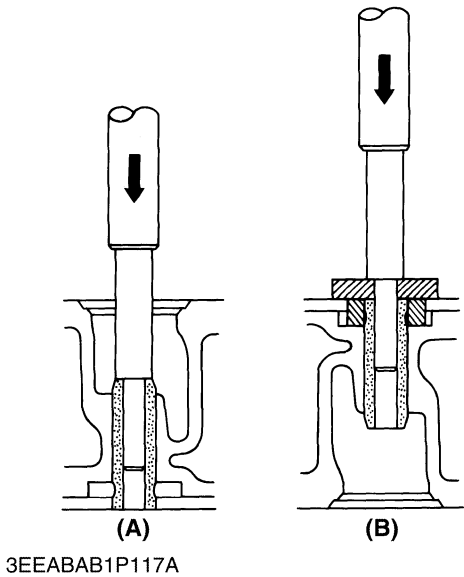
**(When installing)**

- 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.
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**■ IMPORTANT**

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



(A) When Removing

(B) When Installing

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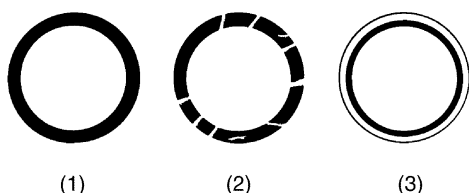
### Valve Seating

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

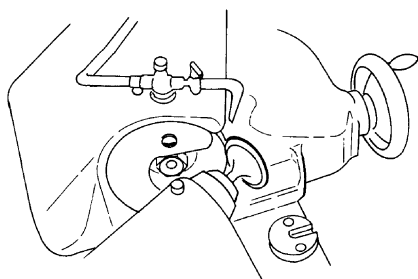
- (1) Correct  
(2) Incorrect

- (3) Incorrect

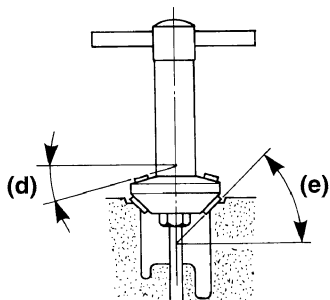
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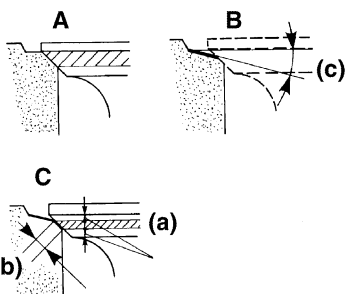
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3EEABAB1P118A



3EEABAB1P119A



3EEABAB1P120A

### 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.
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

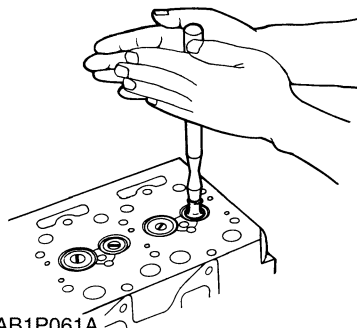
(c) 0.523 rad (30 °) or 0.262 rad (15 °)

C : Check Contact

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

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

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### 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.

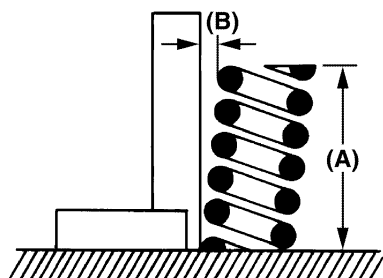
#### ■ IMPORTANT

- 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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### 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.



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Free length <b>(A)</b>	Factory spec.	41.7 to 42.2 mm 1.6417 to 1.6614 in.
	Allowable limit	41.2 mm 1.6220 in.

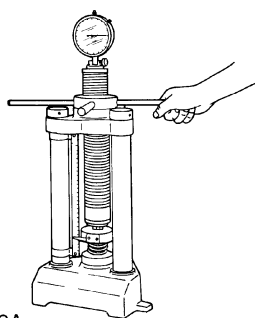
Tilt <b>(B)</b>	Allowable limit	1.0 mm 0.039 in.
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**(A) Free Length****(B) Tilt**

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### Valve Spring Setting Load

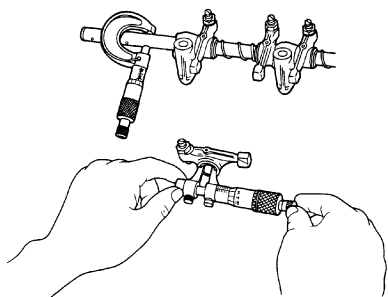
1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.



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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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### 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.

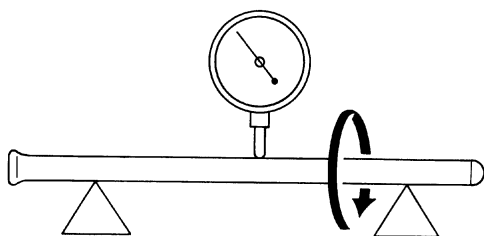
Oil clearance between rocker arm and rocker arm shaft	Factory spec.	0.016 to 0.045 mm 0.00063 to 0.00177 in.
	Allowable limit	0.10 mm 0.0039 in.

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.

0000005476E

### Push Rod Alignment

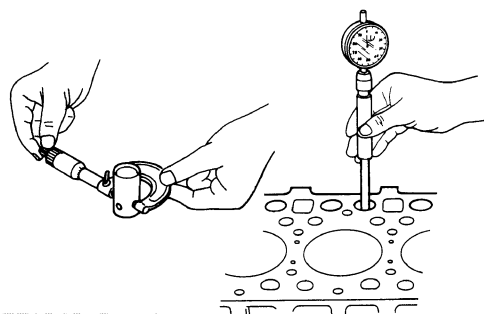
1. Place the push rod on V blocks.
2. Measure the push rod alignment.
3. If the measurement exceeds the allowable limit, replace the push rod.



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Push rod alignment	Allowable limit	0.25 mm 0.0098 in.
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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 0.00244 in.
	Allowable limit	0.07 mm 0.0028 in.

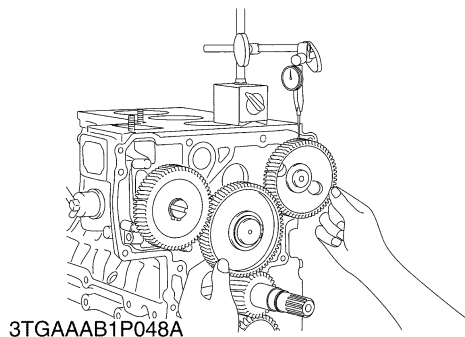
Tappet O.D.	Factory spec.	23.959 to 23.980 mm 0.94327 to 0.94410 in.
Tappet guide bore I.D.	Factory spec.	24.000 to 24.021 mm 0.94488 to 0.94571 in.

0000005477E

## (2) Gears, Camshaft and Fuel Camshaft

### 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.

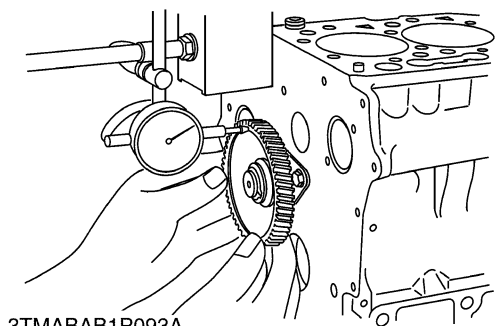
Backlash between idle gear and injection pump gear	Factory spec.	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.
	Allowable limit	0.15 mm 0.0059 in.

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.

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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.

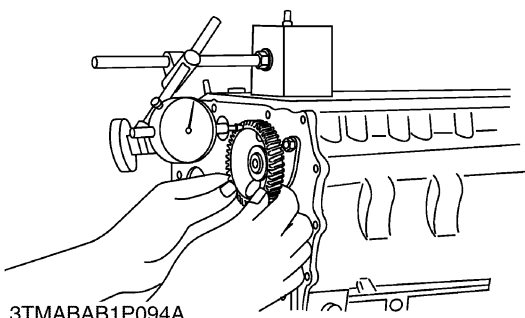


Idle gear side clearance	Factory spec.	0.12 to 0.48 mm 0.0047 to 0.0189 in.
	Allowable limit	0.90 mm 0.0354 in.

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### Camshaft Side Clearance

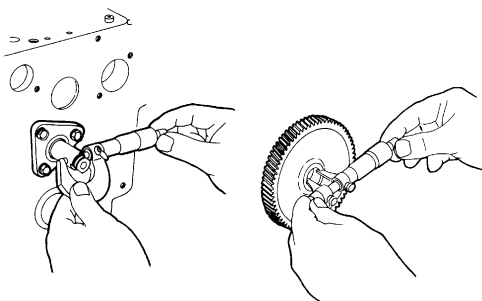
1. Set a dial indicator with its tip on the cam gear.
2. Measure the side clearance by moving the cam gear to the front and rear.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper.



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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### 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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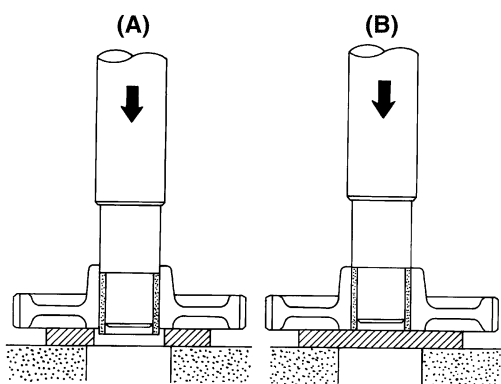
### Replacing Idle Gear Bushing

#### (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.



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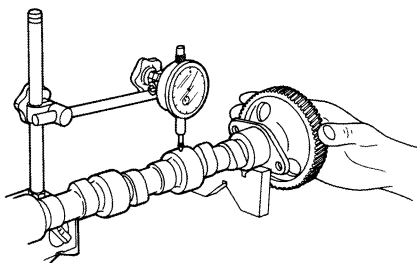
(A) When removing

(B) When installing

0000000895E

### 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.



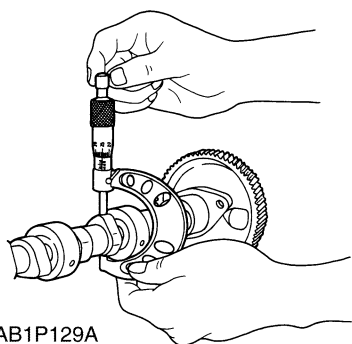
3EEABAB1P128A

Camshaft alignment	Allowable limit	0.01 mm 0.0004 in.
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### Cam Height

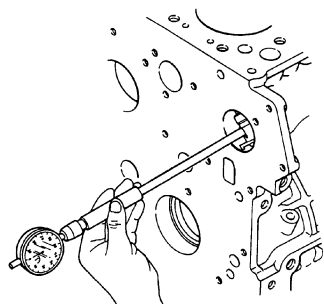
1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.



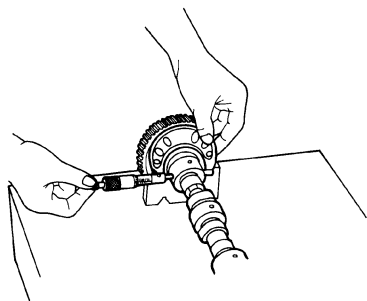
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Cam height of intake and exhaust	Factory spec.	33.90 mm 1.3346 in.
	Allowable limit	33.85 mm 1.3327 in.

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### Oil Clearance of Camshaft Journal

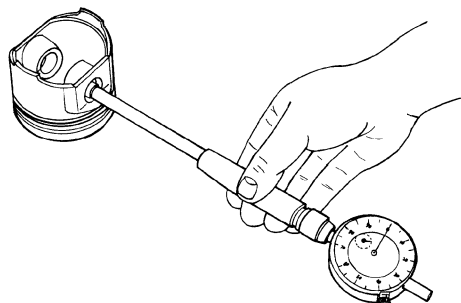
1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the camshaft.

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 0.98476 in.
	Allowable limit	25.05 mm 0.9862 in.

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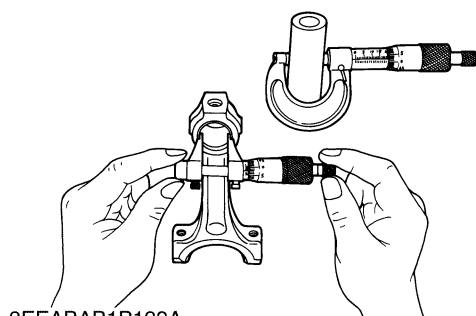
### Oil Clearance between Piston Pin and Small End Bushing

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.

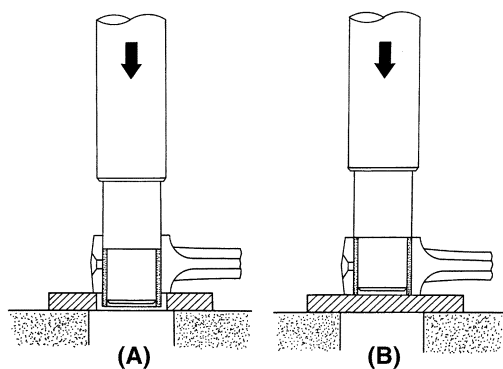
Oil clearance between piston pin and small end bushing	Factory spec.	0.014 to 0.038 mm 0.00055 to 0.00150 in.
	Allowable limit	0.15 mm 0.0059 in.

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.

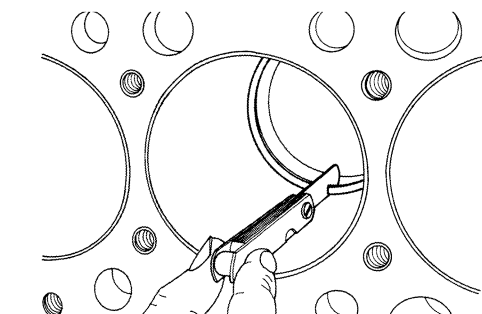
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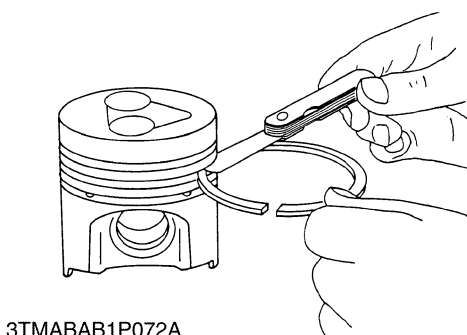
3EEABAB1P139A



3EEABAB1P140A



3EEABAB1P144A



3TMABAB1P072A

### 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 bushing 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.	0.25 to 0.40 mm 0.0098 to 0.0157 in.
	Allowable limit	1.25 mm 0.0492 in.

Second ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 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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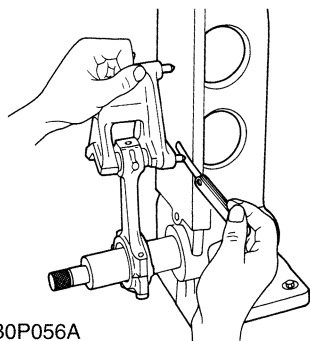
### Clearance between Piston Ring and Groove

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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### Connecting Rod Alignment

#### NOTE

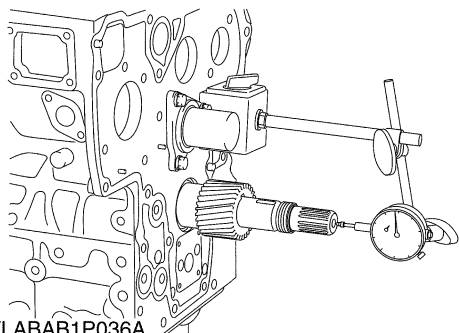
- Since the I.D. of the connecting rod small end bushing is the basis of this check, check bushing for wear beforehand.

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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### 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.

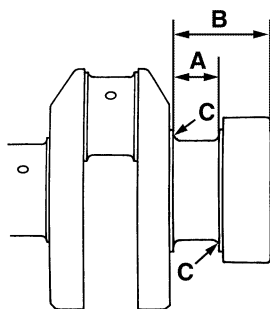
Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.5 mm 0.0197 in.

### (Reference)

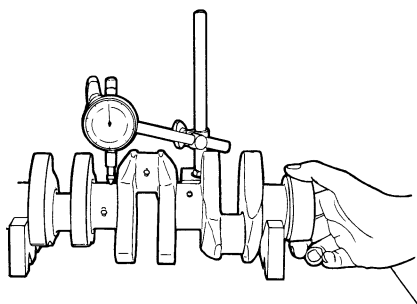
- Oversize dimensions of crankshaft journal

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
(0.8-S) The crankshaft journal must be fine-finished to higher than ▽▽▽		

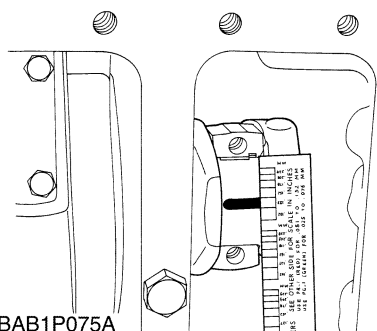
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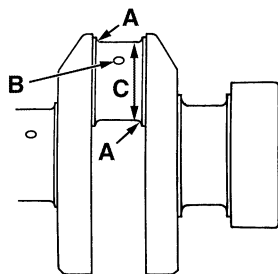
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### Crankshaft Alignment

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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### Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage 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.

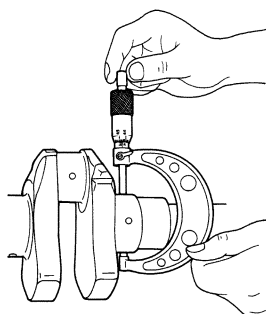
Crankpin O.D.	Factory spec.	46.959 to 46.975 mm 1.84878 to 1.84941 in.
Crankpin bearing I.D.	Factory spec.	47.000 to 47.046 mm 1.85039 to 1.85220 in.

### (Reference)

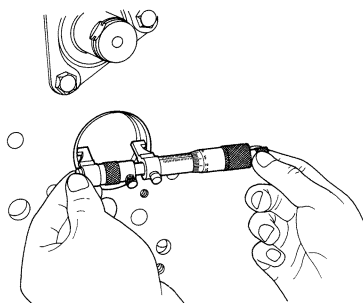
- Undersize dimensions of crankpin

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.
(0.8-S) The crankpin must be fine-finished to higher than ▽▽▽		

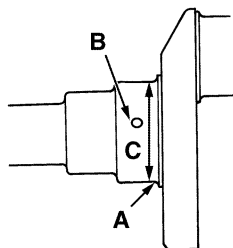
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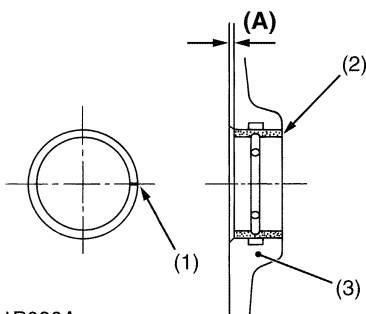
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### Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

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.	Factory spec.	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 dia. 2.35122 to 2.35197 in. dia.	59.521 to 59.540 mm dia. 2.34335 to 2.34409 in. dia.
(0.8-S) The crankshaft journal must be fine-finished to higher than ▽▽▽▽		

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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.
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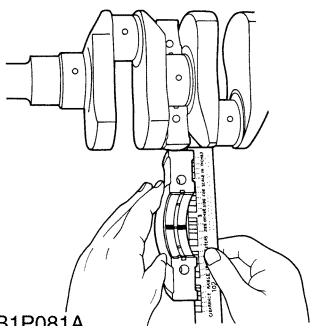
(1) Seam

(3) Cylinder Block

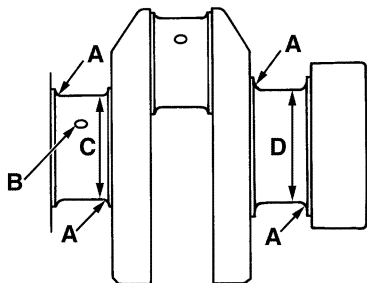
(2) Crankshaft Bearing 1

**(A) Dimension**

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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 2.36319 in.

### (Reference)

- Undersize dimensions of crankshaft journal

Undersize	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, D	59.721 to 59.740 mm dia. 2.35122 to 2.35197 in. dia.	59.521 to 59.540 mm dia. 2.34335 to 2.34409 in. dia.
(0.8-S) The crankshaft journal must be fine-finished to higher than ▽▽▽▽		

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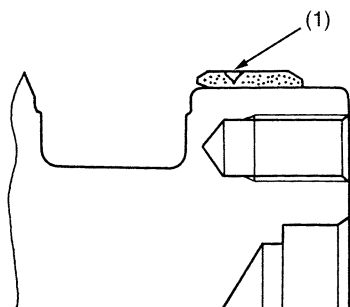
### Crankshaft Sleeve Wear

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.
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(1) Crankshaft Sleeve

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Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve using a special-use puller set.
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**

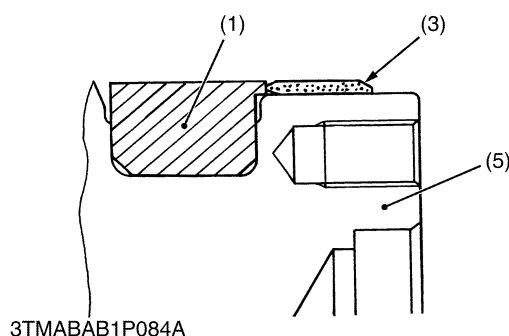
- **Mount the sleeve with its largely chamfered surface facing outward.**

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



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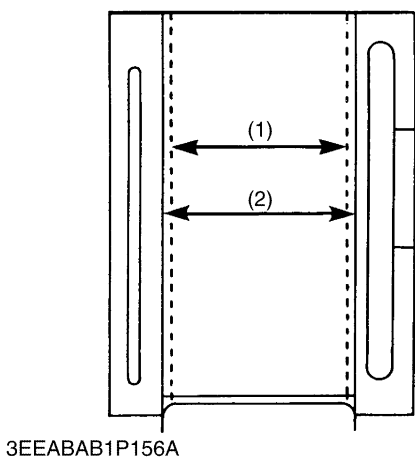
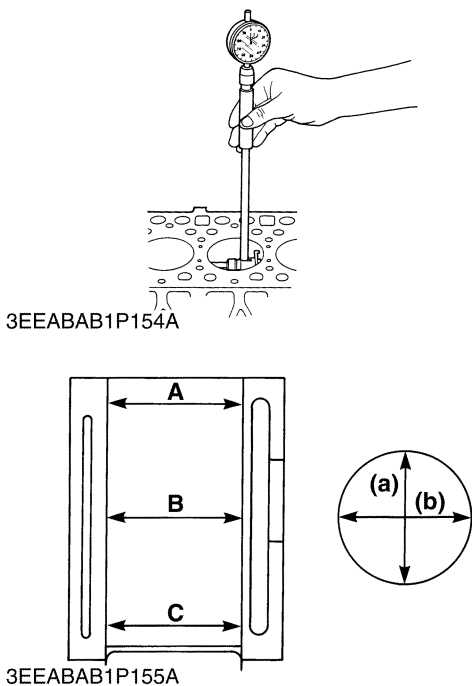
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## (5) Cylinder



### 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.	87.000 to 87.022 mm 3.42519 to 3.42606 in.
Maximum wear	Allowable limit	87.172 mm 3.43197 in.

A : Top

B : Middle

C : Bottom (Skirt)

(a) Right-angled to Piston Pin

(b) Piston Pin Direction

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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.	87.250 to 87.272 mm 3.43503 to 3.43590 in.
Maximum wear	Allowable limit	87.422 mm 3.41181 in.
Finishing	Horn to 2.2 to 3.0 $\mu\text{m}$ 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.

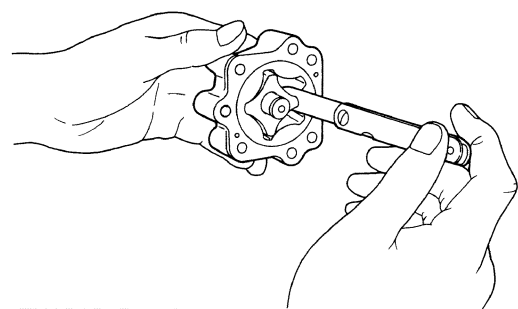
(1) Cylinder I.D.

(Before Correction)

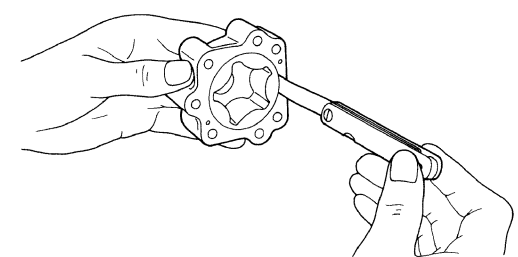
(2) Oversize Cylinder I.D.

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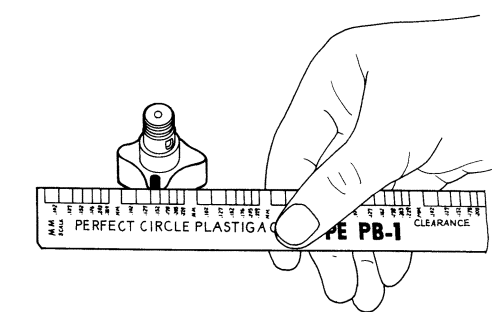
(6) Oil Pump



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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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Clearance between Rotor and Cover

- 1. Put a strip of plastigage 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.

0000007925E

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