

WSM

WORKSHOP MANUAL

ZD1511

Kubota

TO THE READER

This Workshop Manual tells the servicing personnel about the mechanism, servicing and maintenance of the *ZD1511*. It contains 4 parts: "*Information*", "*General*", "*Mechanism*", and "*Servicing*".

Information

This section primarily contains information below.

- Safety first
- Safety decal
- Specifications
- Dimensions

General

This section primarily contains information below.

- Engine identification
- Model identification
- General precautions
- Maintenance check list
- Check and maintenance
- Special tools

Mechanism

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

Refer to the latest version of Workshop Manual for diesel engine / tractor mechanism that this manual does not include.

- Booklet: Code No. *9Y021-01870 / 9Y021-18200*
- PDF file in Kubota Web Site: Code No. *9Y011-01870 / 9Y011-18200*

Servicing

This section primarily contains information below.

- Troubleshooting
- Servicing specifications
- Tightening torques
- Checking, disassembling and servicing

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

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

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

November, 2016

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1. INFORMATION

SAFETY FIRST

1. Safety first

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



DANGER

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



WARNING

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



CAUTION

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

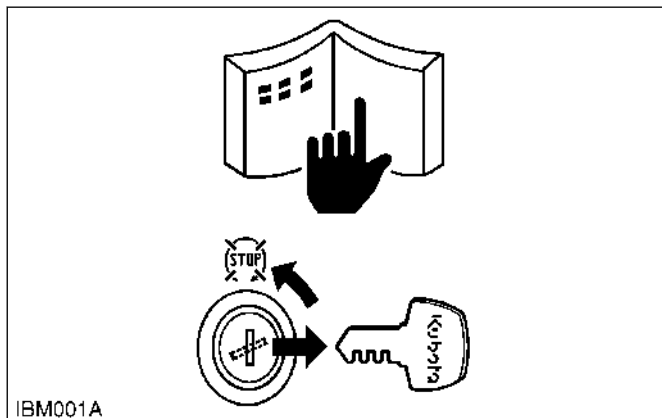
■ IMPORTANT

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

■ NOTE

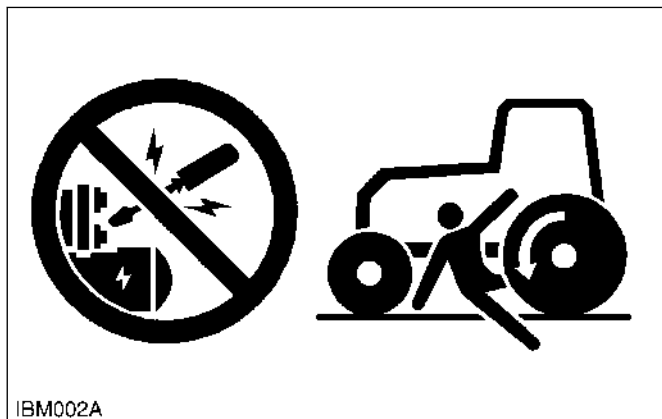
- Gives helpful information.

2. Before you start service



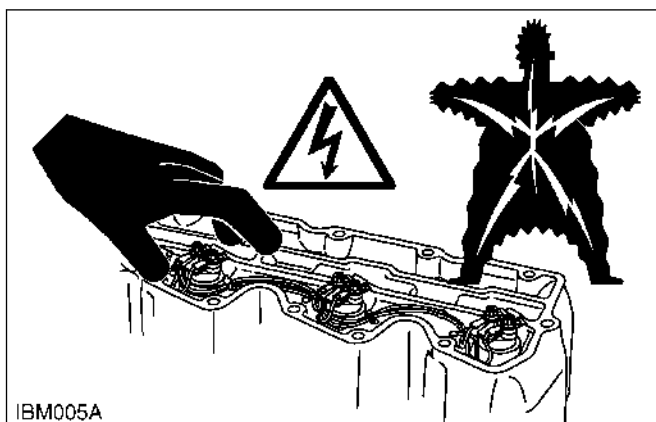
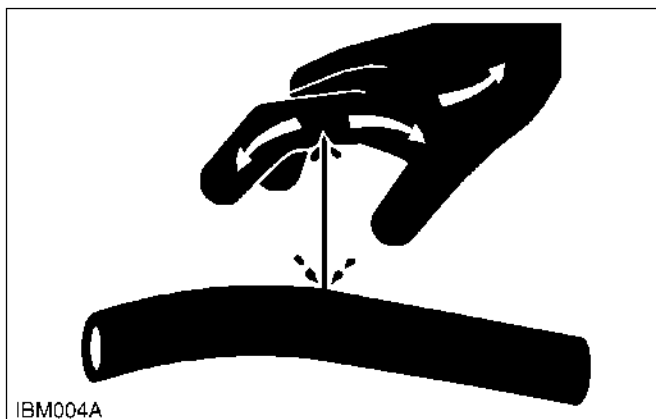
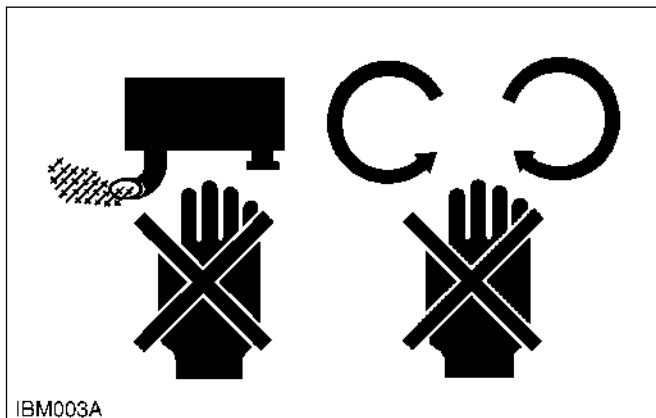
- Read all instructions and safety instructions in this manual and on your machine safety decals.
- Clean the work area and machine.
- Park the machine on a stable and level ground, and set the parking brake.
- Lower the implement to the ground.
- Stop the engine, then remove the key.
- Disconnect the battery negative cable.
- Hang a **"DO NOT OPERATE"** tag in the operator station.

3. Start safely



- Do not do the procedures below when you start the engine.
 1. Short across starter terminals.
 2. Bypass the safety start switch.
- Do not alter or remove any part of machine safety system.
- Before you start the engine, make sure that all shift levers are in neutral positions or in disengaged positions.
- Do not start the engine when you stay on the ground. Start the engine only from operator's seat.

4. Operate safely



- Do not use the machine after you consume alcohol or medication or when you are tired.
- Put on applicable clothing and safety equipment.
- Use applicable tools only. Do not use alternative tools or parts.
- When 2 or more persons do servicing, make sure that you do it safely.
- Do not touch the hot parts or parts that turn when the engine operates.
- Do not remove the radiator cap when the engine operates, or immediately after it stops. If not, hot water can spout out from the radiator. Only remove the radiator cap when it is at a sufficiently low temperature to touch with bare hands. Slowly

loosen the cap to release the pressure before you remove it fully.

- Released fluid (fuel or hydraulic oil) under pressure can cause damage to the skin and cause serious injury. Release the pressure before you disconnect hydraulic or fuel lines. Tighten all connections before you apply the pressure.
- Do not open a fuel system under high pressure. The fluid under high pressure that stays in fuel lines can cause serious injury. Do not disconnect or repair the fuel lines, sensors, or any other components between the fuel pump and injectors on engines with a common rail fuel system under high pressure.
- Put on an applicable ear protective device (earmuffs or earplugs) to prevent injury against loud noises.
- Be careful about electric shock. The engine generates a high voltage of more than DC100 V in the ECU and is applied to the injector.

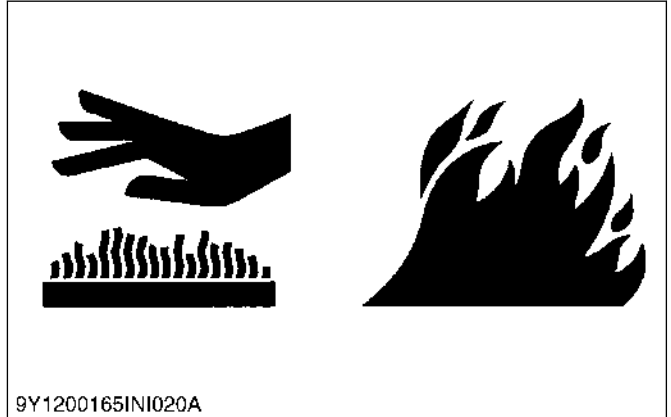
5. Protect against high pressure spray



9Y1200165INI019A

- Spray from high pressure nozzles can penetrate the skin and cause serious injury. Keep spray from contacting hands or body.
- If an accident occurs, see a doctor immediately. Any high pressure spray injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.

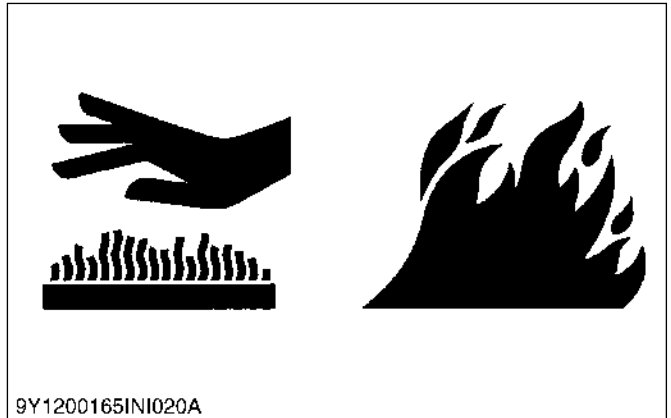
6. Avoid hot exhaust



9Y1200165INI020A

- Servicing machine or attachments with engine operating can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.
- Exhaust parts and streams become very hot during operation. Exhaust gases and components reach temperatures hot enough to burn people, ignite, or melt common materials.

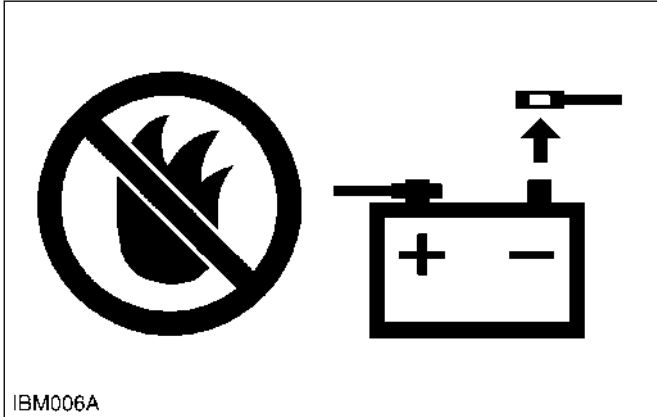
7. Exhaust filter cleaning



9Y1200165INI020A

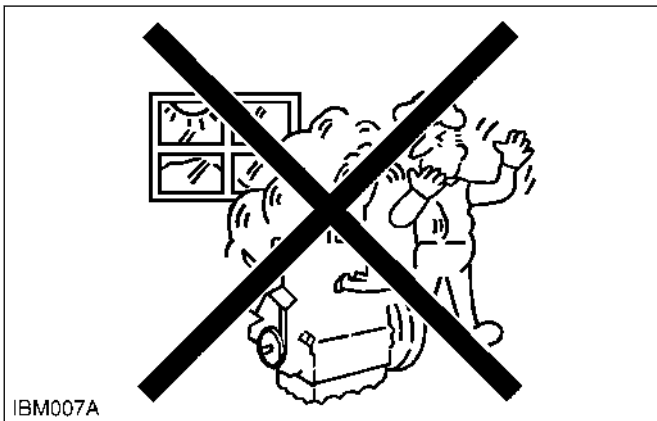
- Servicing machine or attachments during exhaust filter cleaning can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.
- During auto or manual/stationary exhaust filter cleaning operations, the engine will operate at elevated idle and hot temperatures for an extended period of time. Exhaust gases and exhaust filter components reach temperatures hot enough to burn people, or ignite, or melt common materials.

8. Prevent a fire



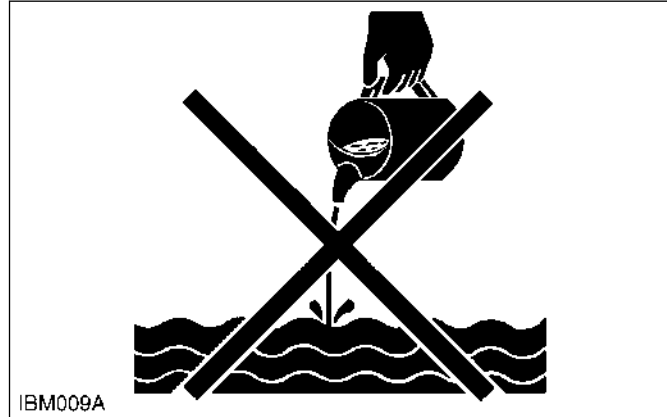
- Fuel is very flammable and explosive under some conditions. Do not smoke or let flames or sparks in your work area.
- To prevent sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- The battery gas can cause an explosion. Keep the sparks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

9. Keep a good airflow in the work area



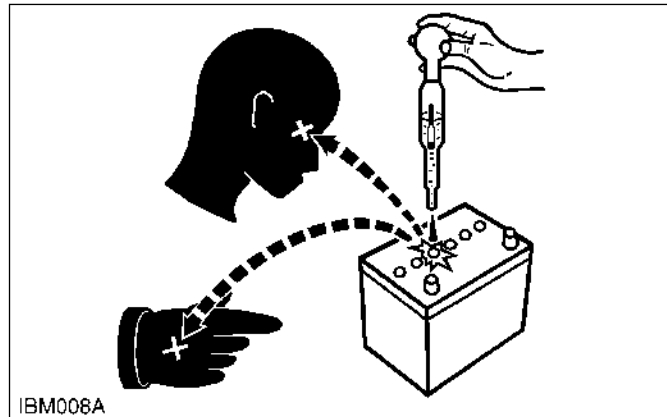
- If the engine is in operation, make sure that the area has good airflow. Do not operate the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

10. Discard fluids correctly



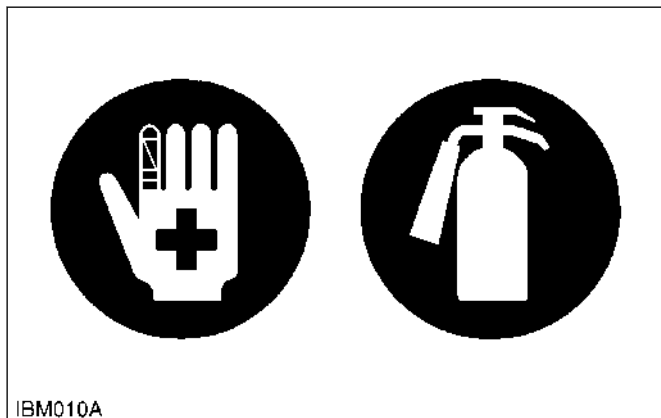
- Do not discard fluids on the ground, down the drain, into a stream, pond, or lake. Obey related environmental protection regulations when you discard oil, fuel, coolant, electrolyte and other dangerous waste.

11. Prevent acid burns



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

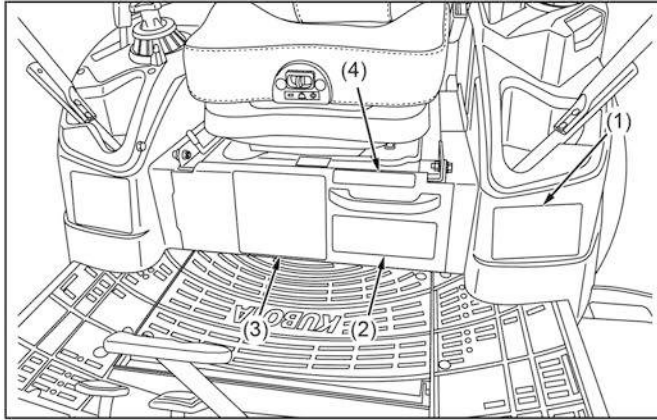
12. Prepare for emergencies



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

SAFETY DECALS

The safety decals are installed on the machine. If a decal becomes damaged, illegible or is not on the machine, replace it. The decal part number is listed in the parts list.



(1) Part No. K3181-6585-1



1BDABCQAP093A

(2) Part No. K3181-6584-1



1BDABCQAP094A

(3) Part No. K3441-6582-1



1BDABEJAP065A

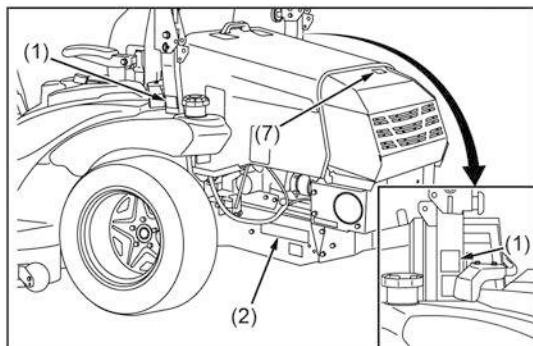
(4) Part No. K3441-6569-1



1BDABEJAP066A

2GXCG00071A01

1. INFORMATION

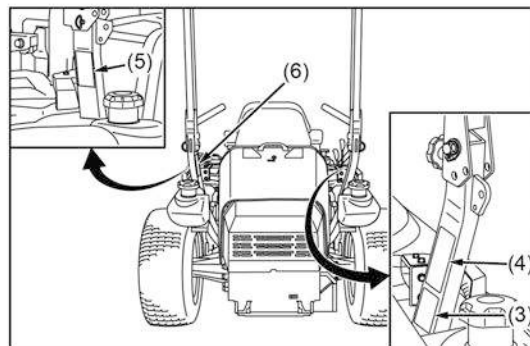


(1) Part No. K3181-6572-1

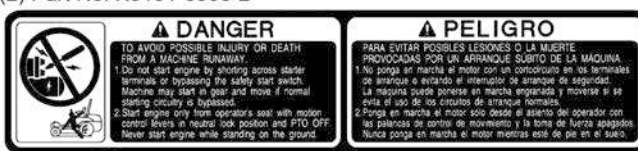
Diesel fuel only No fire



1BDABCQAP178A



(2) Part No. K3181-6583-2



1BDABCQAP103A

(3) Part No. K3441-6566-1



1BDABEJAP067A

(7) Part No. K2110-6573-1

HOT SURFACE,
DO NOT TOUCH



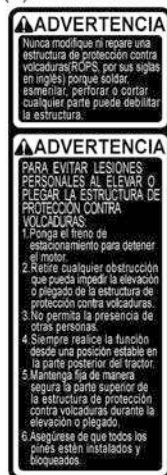
1BDAFAQAP009A

(4) Part No. K3181-6563-1



1BDABCQAP101A

(5) Part No. K3441-6568-1



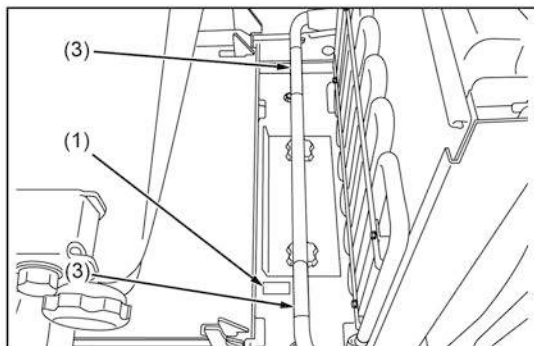
1BDABEJAP068A

(6) Part No. K3181-6565-1



1BDABCQAP134A

2GXCG00072A01

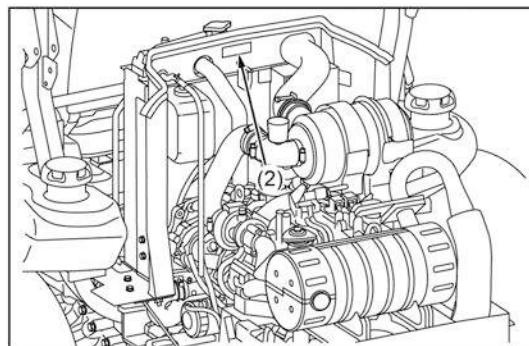


(1) Part No. K3111-6591-1

Do not get your hands close to fan belt.



1BDABCQAP107A



(2) Part No. K3181-6586-1

Do not get your hands close to engine fan and fan belt.



1BDABCQAP108A

(3) Part No. K3441-6593-1



1BDABEJAP108A

2GXCG00073A01

1. INFORMATION

(1) Part No. K7731-6114-2

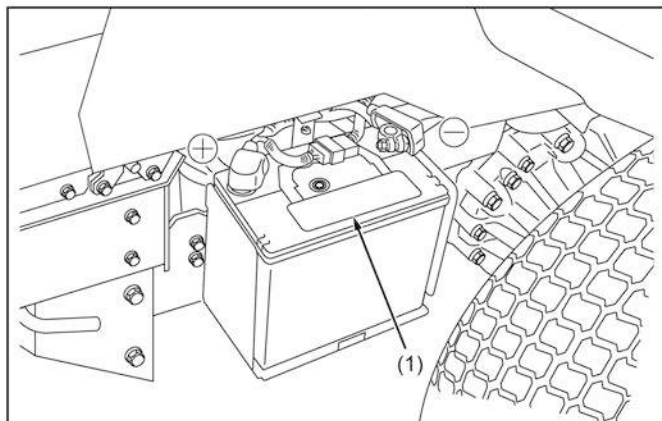
															
DANGER - EXPLOSIVE GASES CIGARETTES, FLAMES OR SPARKS COULD CAUSE BATTERY TO EXPLODE. ALWAYS SHIELD EYES AND FACE FROM BATTERY. DO NOT CHARGE OR USE BOOSTER CABLES OR ADJUST POST CONNECTIONS WITHOUT PROPER INSTRUCTION AND TRAINING. CALIFORNIA PROPOSITION 65 WARNING: Batteries, battery posts, terminals and related accessories contain lead and lead compounds, and other chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. WASH HANDS AFTER HANDLING.			SMF 24R-670 <table border="1"> <tr> <td>NOMINAL VOLTAGE</td> <td>12V</td> </tr> <tr> <td>COLD CRANKING AMPS</td> <td>670</td> </tr> <tr> <td>CRANKING AMPS</td> <td>800</td> </tr> <tr> <td>RESERVE CAPACITY(MINUTES)</td> <td>115</td> </tr> <tr> <td>AMP HOURS(@20 hr Rate)</td> <td>66</td> </tr> </table>			NOMINAL VOLTAGE	12V	COLD CRANKING AMPS	670	CRANKING AMPS	800	RESERVE CAPACITY(MINUTES)	115	AMP HOURS(@20 hr Rate)	66
NOMINAL VOLTAGE	12V														
COLD CRANKING AMPS	670														
CRANKING AMPS	800														
RESERVE CAPACITY(MINUTES)	115														
AMP HOURS(@20 hr Rate)	66														
FITTING DATE: 0 1 2 3 4 5 6 7 8 9 YEAR 1 2 3 4 5 6 7 8 9 10 11 12 MONTH			INDICATOR: ● OK ○ CHARGE ● REPLACE												

1A5AACQAP255A

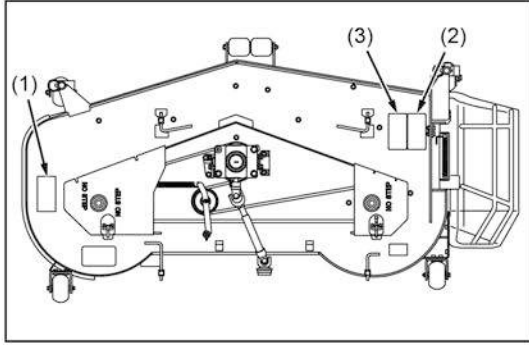
TO AVOID INJURY FROM BATTERY GASES AND ACIDES

-  Keep away cigarettes, flames or sparks.
-  Always shield eyes and face from battery.
-  Keep out of reach of children.
-  Poison causes severe burns.
-  Contains sulfuric acid.
-  Read and understand operator's manual.
-  Danger explosive gases.

1BDAIAEAP0200



2GXCG00074A01



(1) Part No. K5681-7312-2



1BDACAEAP015B

(2) Part No. K5681-7311-2

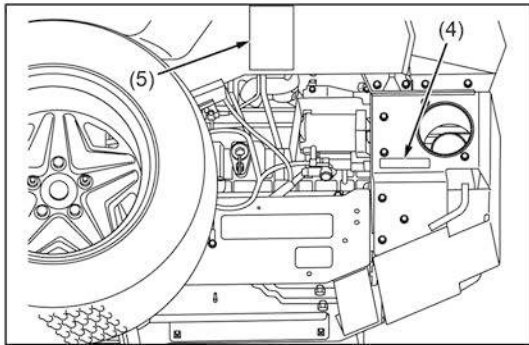


1BDACAEAP016B

(3) Part No. K5681-7310-1



1BDACAEAP017B



(4) Part No. K3441-6532-1



1BDABEJAP069A

(5) Part No. K3615-4721-2



1BDAIAYAP005A

2GXCG00075A01

1. Care of danger, warning and caution labels

- Keep danger, warning and caution labels clean and free from obstructing material.
- Clean danger, warning and caution labels with soap and water, dry with a soft cloth.
- Replace damaged or missing danger, warning and caution labels with new labels.
- If a component with danger, warning and caution label(s) affixed is replaced with new part, make sure new label(s) is (are) attached in the same location(s) as the replace component.
- Mount new danger, warning and caution labels by applying on a clean dry surface and pressing any bubbles to outside edge.

SPECIFICATIONS

(Specifications and design subject to change without notice)

Model				ZD1511LF
Engine	Model			V1505-T
	Maximum engine power (Gross)	kW (HP)		23.0 (30.8)* ¹
	Type			Liquid-cooled
	Number of cylinders			4
	Bore and stroke	mm (in.)		78 x 78.4 (3.07 x 3.09)
	Total displacement	cm ³ (cu. in.)		1498 (91.41)
	Rated revolution	rpm		2500
	Low idling revolution	rpm		1300 to 1400
	Fuel			Diesel fuel No.1 [below -10 °C (14 °F)] Diesel fuel No.2 [above -10 °C(14 °F)]
	Starter			Electric starter with battery, glow plug, 12V, 1.4 kW
	Lubrication			Forced lubrication by gear pump
	Cooling			Liquid with pressurized radiator
	Battery			SMF24R (12V, RC:115min, CCA:670A)
Capacities	Fuel tank	L (U.S.qts.)		49 (12.9)
	Engine crankcase (with filter)	L (U.S.qts.)		6.4 (6.8)
	Engine coolant	L (U.S.qts.)		4.6 (4.9)
	Recovery tank	L (U.S.qts.)		1.1 (1.2)
	Transmission including rear axle gear case	L (U.S.qts.)		12.1 (12.8)* ³
Dimensions	Overall length		mm (in.)	2660 (104.7)
	Overall width without mower deck		mm (in.)	1540 (60.6)
	Overall height	With ROPS upright	mm (in.)	2000 (78.7)
		With ROPS folded	mm (in.)	1640 (64.6)
	Wheel base		mm (in.)	1560 (61.4)
	Minimum ground clearance		mm (in.)	135 (5.31) W/72"
	Tread	Front	mm (in.)	1250 (49.2)
		Rear	mm (in.)	1210 (47.6)
Weight (without fuel, with mower deck)			kg (lbs.)	910 (2006) with 72"
Traveling system	Tires	Front		15 x 6.5 -8 Smooth semi-pneumatic Non flat tire
		Rear		26 x 12.0 -16 4PR Turf Low profile tire
	Traveling speeds	Forward	mph (km/h)	0 to 10.6 (0 to 17.0)* ²
		Reverse	mph (km/h)	0 to 5.3 (0 to 8.5)* ²
	Steering			2 -Hand levers

(Continued)

1. INFORMATION

Model			ZD1511LF
Traveling system	Transmission		2 -HST w / Gear
	Parking brake		Wet multi disk / Foot applied, released
	Min. turning radius	mm (in.)	0 (0)
PTO	Revolution		1 speed (2570 rpm at 2500 engine rpm)
	Drive system		Shaft drive, KUBOTA 10 tooth involute spline
	Clutch type		Wet multi disks
	PTO brake		Wet single disk

*1 Manufacturer's estimate, SAE J1940

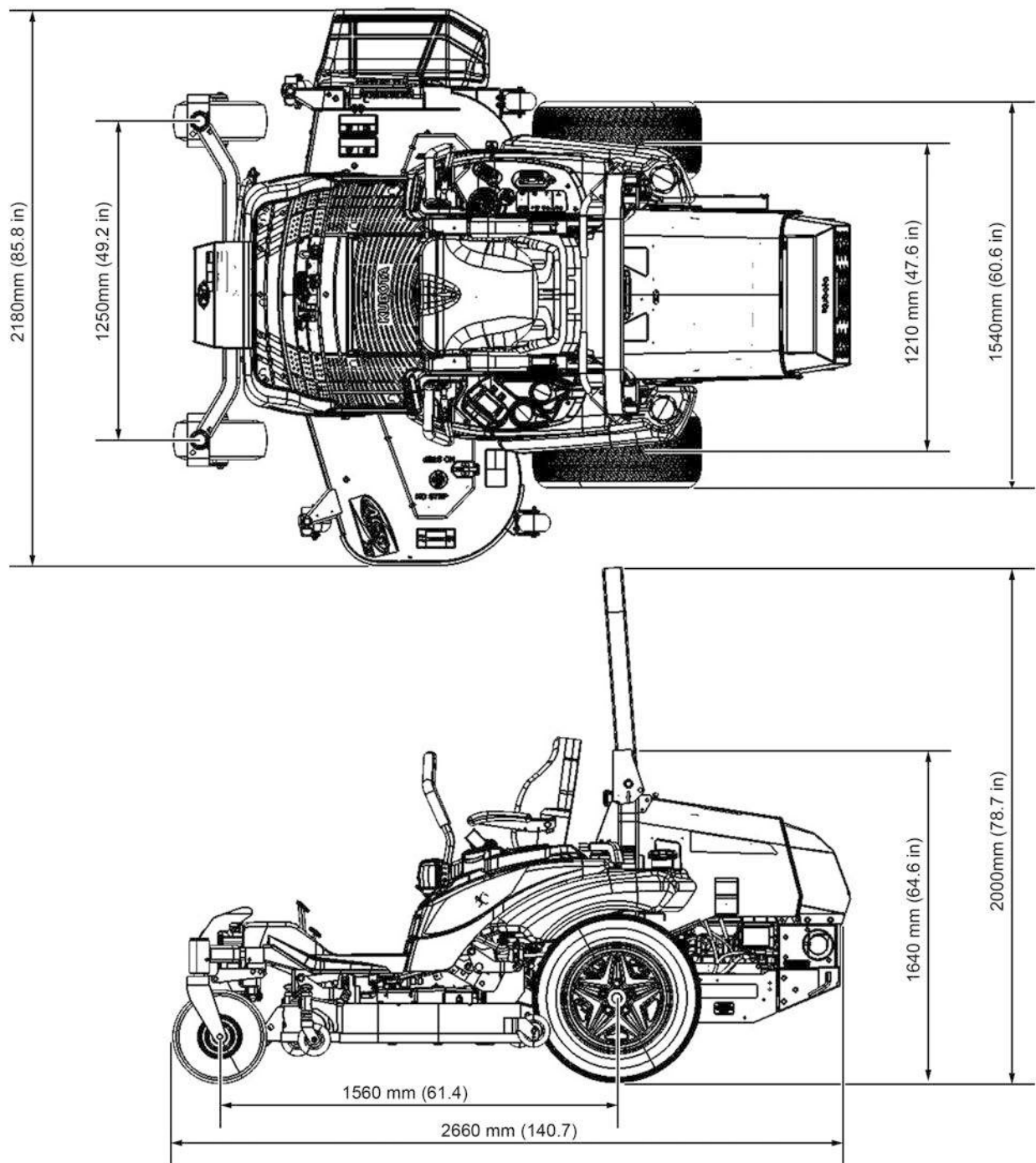
*2 At 2500 engine rpm

*3 Oil amount when the oil level is at the upper level.

Model			RCK72P-1500Z
PRO commercial deck (Fabricated deck)	Suitable machine		ZD1511LF
	Mounting method		Quick joint, parallel linkage
	Adjustment of cutting height		Dial gauge
	Cutting width	mm (in.)	1829 (72.0)
	Cutting height	mm (in.)	25 to 127 (1.0 to 5.0)
	Weight (Approx.)	kg (lbs.)	170 (375)
	Blade spindle speed	r/s (rpm)	46.7 (2800)
	Blade tip velocity	m/s (fpm)	93 (18400) *4
	Blade length	mm (in.)	625 (24.6)
	Number of blades		3
	Dimensions	Total length mm (in.)	1162 (45.8)
		Total width mm (in.)	2180 (85.8)
		Total height mm (in.)	421 (16.6)
	Mower gear box capacity	L (U.S.qts.)	0.5 (0.53)

*4 Engine Max rpm

DIMENSIONS

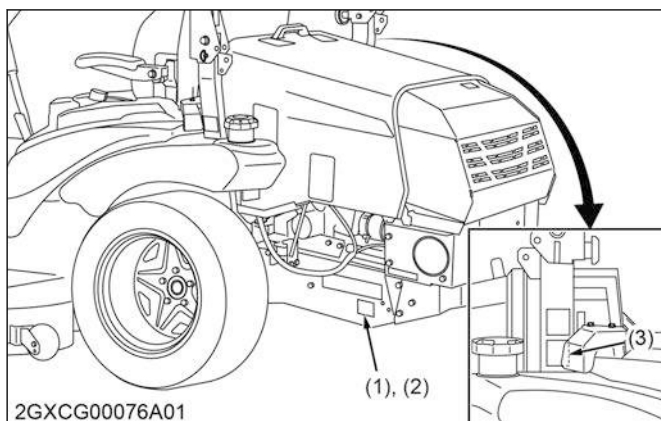


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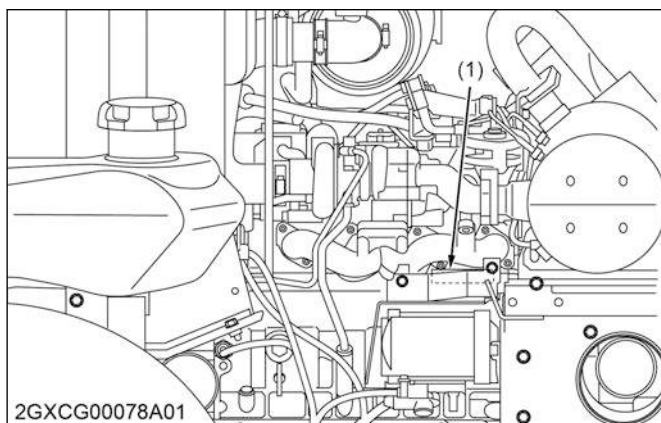
2. GENERAL

IDENTIFICATION

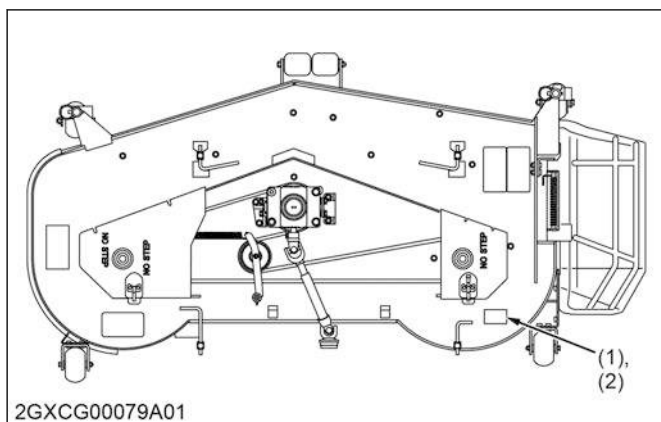
- Identify serial numbers for machine, engine and mower.



- (1) Machine identification plate (3) ROPS serial number
(2) Machine serial number

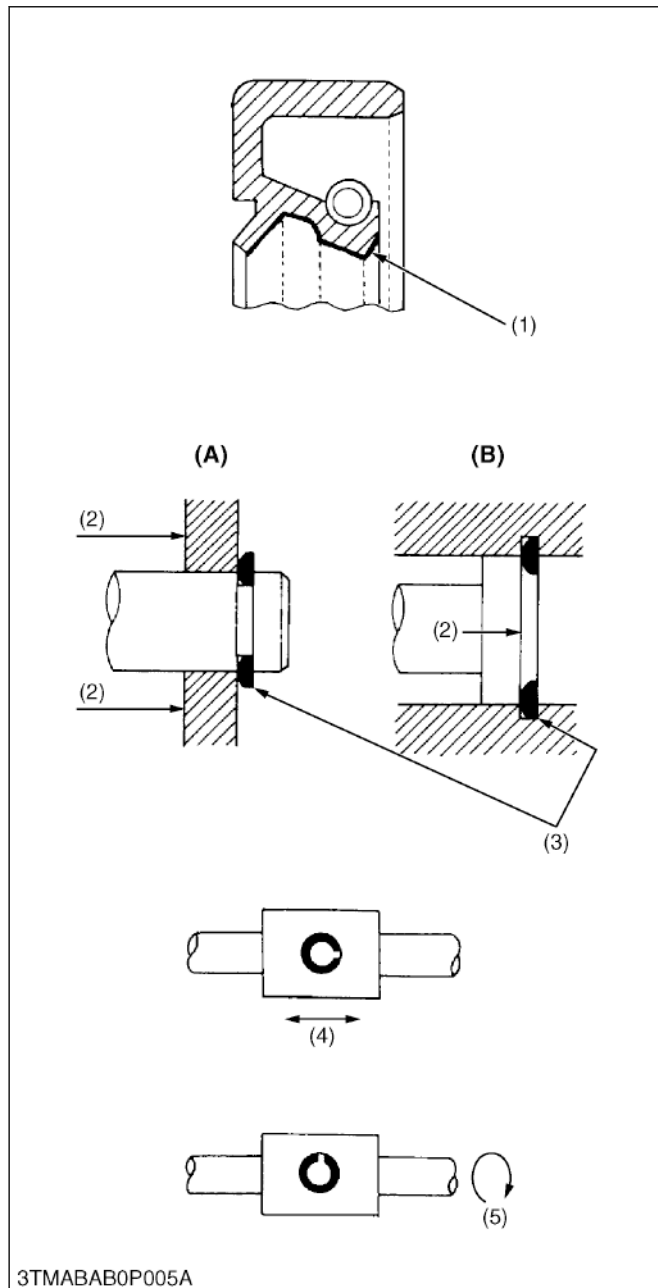


- (1) Engine serial number



- (1) Mower identification plate (2) Mower serial number

GENERAL PRECAUTIONS



- | | |
|-----------------|-----------------------|
| (1) Grease | (5) Rotating movement |
| (2) Force | (A) External circlip |
| (3) Sharp edge | (B) Internal circlip |
| (4) Axial force | |

- When you disassemble, carefully put the parts in a clean area to make it easy to find the parts. You must install the screws, bolts and nuts in their initial position to prevent the reassembly errors.
- When it is necessary to use special tools, use KUBOTA special tools. Refer to the drawings when

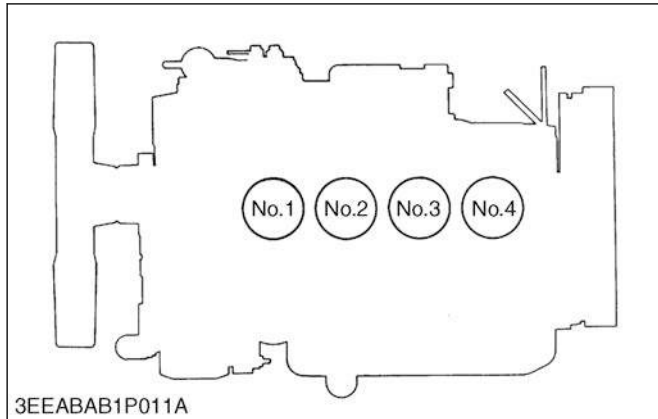
you make special tools that you do not use frequently.

- Before you disassemble or repair machine, make sure that you always disconnect the ground cable from the battery first.
- Remove oil and dirt from parts before you measure.
- Use only KUBOTA genuine parts for replacement to keep the machine performance and to make sure of safety.
- You must replace the gaskets and O-rings when you assemble again. Apply grease (1) to new O-rings or oil seals before you assemble.
- When you assemble the external or internal circlips, make sure that the sharp edge (3) faces against the direction from which force (2) is applied.
- When inserting spring pins, their splits must face the direction from which a force is applied. See the figure on the left side.
- To prevent damage to the hydraulic system, use only specified fluid or equivalent.

IDENTIFYING CYLINDER NUMBER

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

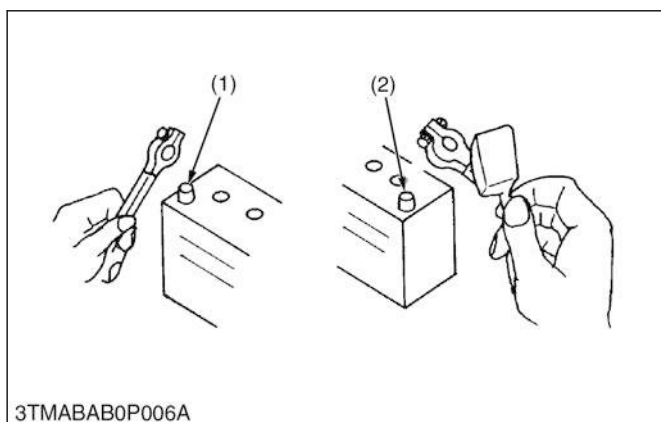
The sequence of cylinder numbers is No. 1, No. 2, No. 3 and No. 4 and it starts from the gear case side.



HANDLING PRECAUTIONS FOR ELECTRICAL PARTS AND WIRING

■ IMPORTANT

- Check electrical wiring for damage and loosened connection every year. To this end, educate the customer to do his or her own check and at the same time recommend the dealer to perform periodic check for a fee.
- Do not attempt to modify or remodel any electrical parts and wiring.
- When removing the battery cables, disconnect the negative cable first. When installing the battery cables, connect the positive cable first.

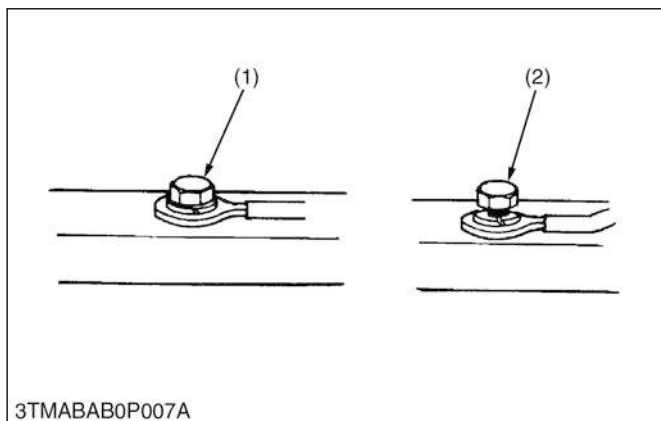


(1) Negative terminal (2) Positive terminal

To ensure safety and prevent damage to the machine and surrounding equipment, heed the following precautions in handling electrical parts and wiring.

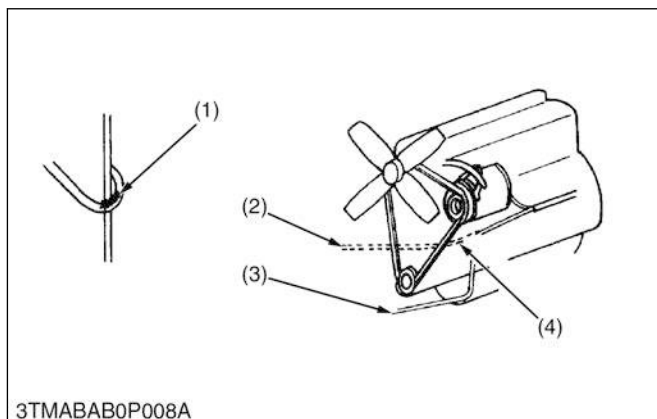
1. Handling of wiring

- Securely tighten wiring terminals.



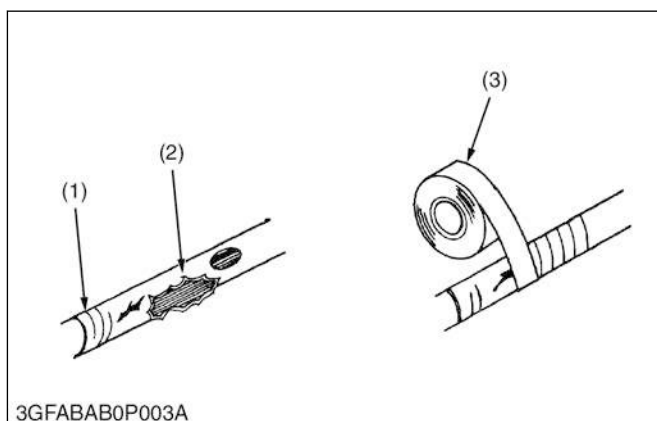
(1) Correct (Securely tighten) (2) Incorrect (Loosening leads to faulty contact)

- Do not let wiring contact dangerous part.



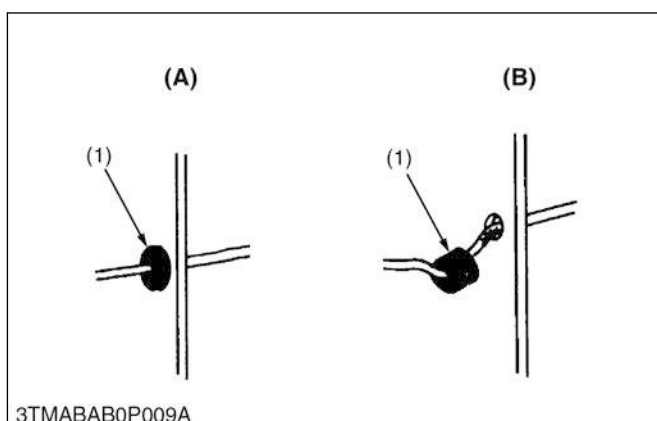
(1) Dangerous part (Sharp edge) (2) Wiring (Incorrect) (3) Wiring (Correct) (4) Dangerous part

- Repair or change torn or aged wiring immediately.



(1) Aged (2) Torn (3) Insulating vinyl tape

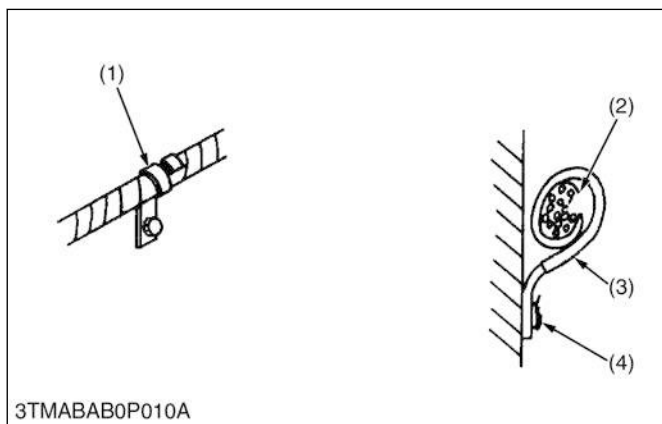
- Securely insert grommet.



(1) Grommet (A) Correct (B) Incorrect

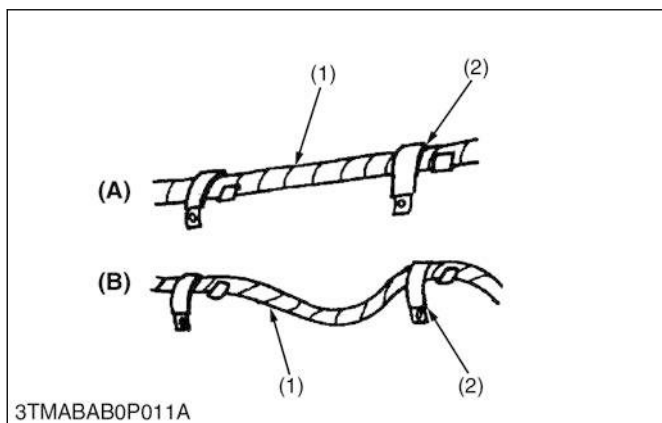
- Securely clamp, being careful not to damage wiring.

2. GENERAL



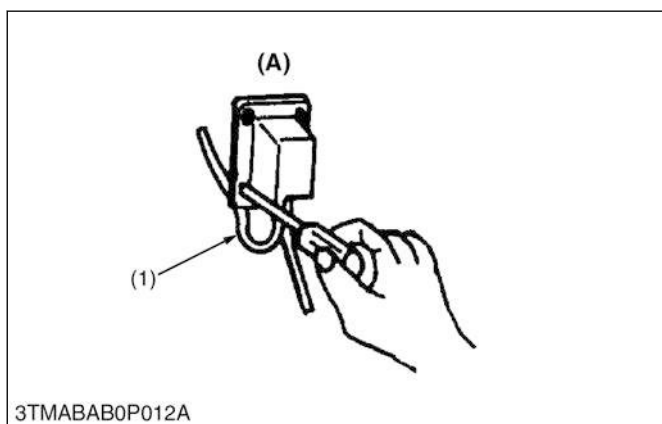
- (1) Clamp (Wind clamp spirally) (4) Welding dent
(2) Wire harness
(3) Clamp

- Clamp wiring so that there is no twist, unnecessary sag, or excessive tension, except for movable part, where sag be required.



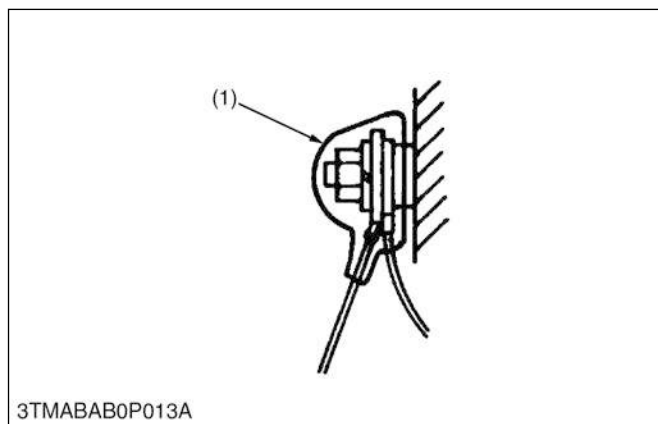
- (1) Wiring (B) Incorrect
(2) Clamp
(A) Correct

- In installing a part, take care not to get wiring caught by it.



- (1) Wiring (A) Incorrect

- After installing wiring, check protection of terminals and clamped condition of wiring, only connect battery.

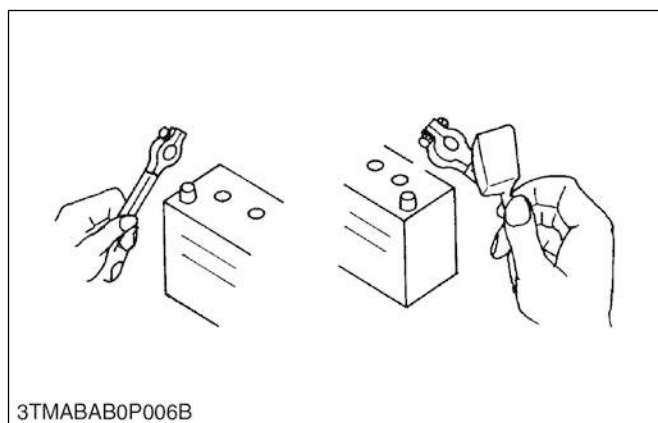


- (1) Cover (Securely install cover)

2. Handling of battery

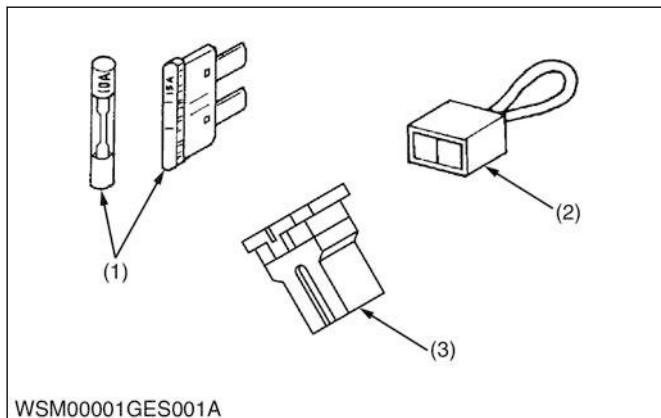
! WARNING

- Take care not to let battery liquid spill on your skin and clothes. If contaminated, wash it off with water immediately.
- Before recharging the battery, remove it from the machine.
- Before recharging, remove cell caps.
- Do recharging in a well-ventilated place where there is no open flame nearby, as hydrogen gas and oxygen are formed.



- Take care not to confuse positive and negative terminal posts.
- When removing battery cables, disconnect negative cable first. When installing battery cables, check for polarity and connect positive cable first.
- Do not install any battery with capacity other than is specified (Ah).
- After connecting cables to battery terminal posts, apply high temperature grease to them and securely install terminal covers on them.
- Do not allow dirt and dust to collect on battery.

3. Handling of fuse

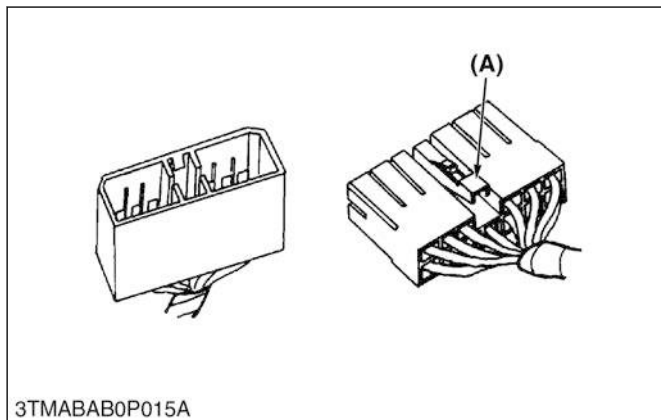


- (1) Fuse (3) Slow blow fuse
(2) Fusible link

- Use fuses with specified capacity. Neither too large or small capacity fuse is acceptable.
- Never use steel or copper wire in place of fuse.
- Do not install working light, radio set, etc. on machine which is not provided with reserve power supply.
- Do not install accessories if fuse capacity of reserve power supply is exceeded.

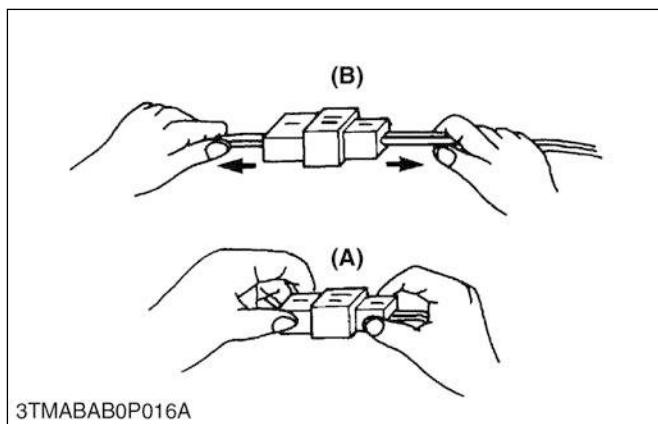
4. Handling of connector

- For connector with lock, push lock to separate.



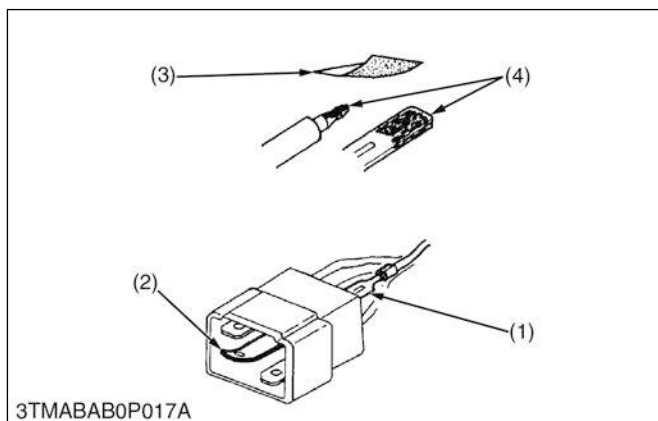
- (A) Push

- In separating connectors, do not pull wire harnesses.
- Hold connector bodies to separate.



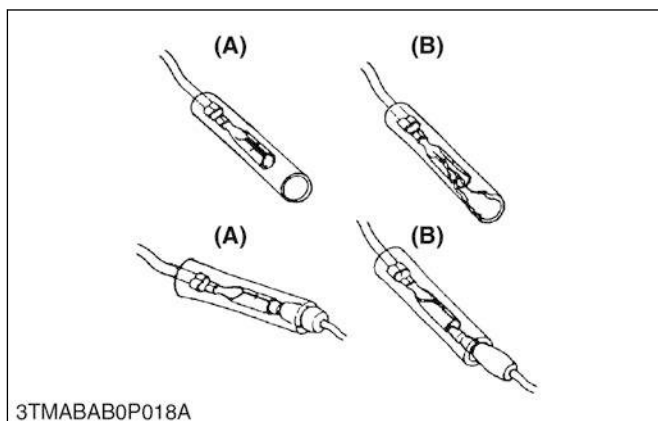
- (A) Correct (B) Incorrect

- Use sandpaper to remove rust from terminals.
- Repair deformed terminal. Make certain there is no terminal being exposed or displaced.



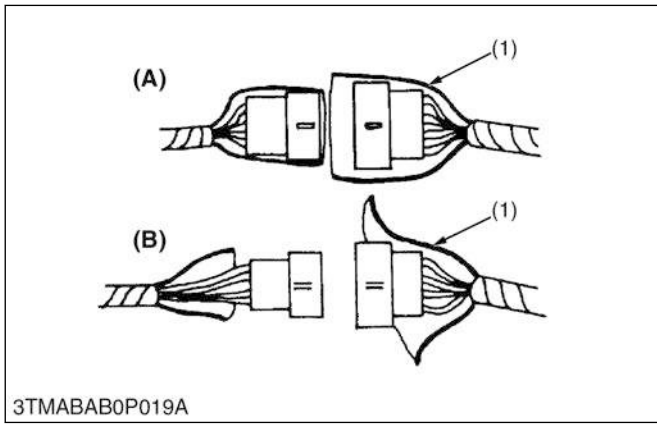
- (1) Exposed terminal (4) Rust
(2) Deformed terminal
(3) Sandpaper

- Make certain that there is no female connector being too open.



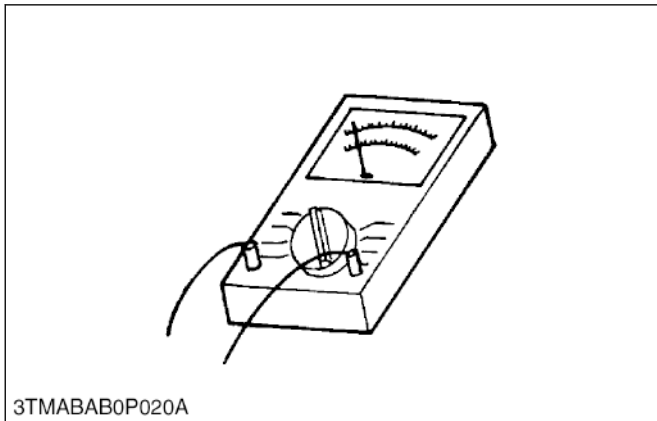
- (A) Correct (B) Incorrect

- Make certain plastic cover is large enough to cover whole connector.



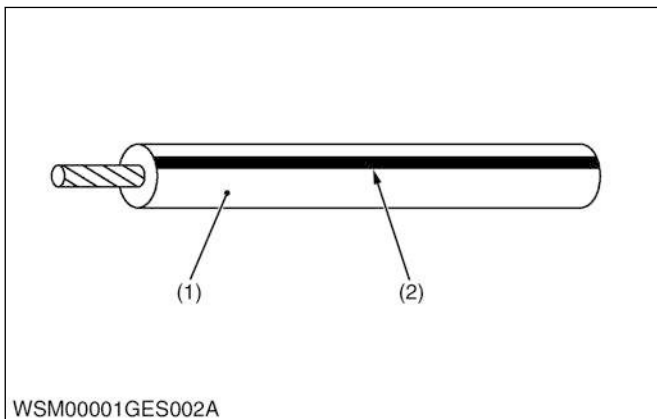
(1) Cover
(A) Correct
(B) Incorrect

5. Handling of circuit tester



- Use tester correctly following manual provided with tester.
- Check for polarity and range.

6. Color of wiring



(1) Wire color
(2) Stripe

- Colors of wire are specified to the color codes.
- This symbol of "/" shows color with stripe(s).

(An example)

W/R:

Red stripe on white color

Color of wiring	Color code
Black	B
Brown	Br
Green	G
Gray	Gy or Gr
Blue	L
Light green	Lg
Orange	Or
Pink	P
Purple	Pu or V
Red	R
Sky blue	Sb
White	W
Yellow	Y

LUBRICANTS, FUEL AND COOLANT

■ IMPORTANT

- To prevent serious damage to hydraulic system, use only KUBOTA genuine fluid or its equivalent.

■ NOTE

Fuel

- Cetane number of 45 is minimum. Cetane number greater than 50 is preferred, especially for temperatures below -20 (-4) or elevations above 1500 m (5000 ft).
- Diesel fuels specified to EN 590 or ASTM D975 are recommended.
- No.2-D is a distillate fuel of lower volatility for engines in industrial and heavy mobile service. (SAE J313 JUN87)

Engine oil

- Oil used in the engine must have an American Petroleum Institute (API) service classification and Proper SAE Engine Oil according to the ambient temperatures as shown above:
- Refer to the following table for the suitable API classification engine oil according to the engine type (with DPF (Diesel Particulate Filter) type engines) and the fuel.

Fuel used	Engine oil classification (API classification)
	Oil class of engines with DPF
Ultra Low Sulfur Fuel [<0.0015% (15 ppm)]	CJ-4

Transmission oil:

- KUBOTA Super UDT-2: For an enhanced ownership experience, we highly recommend Super UDT-2 to be used instead of standard hydraulic/transmission oil. Super UDT-2 is a proprietary KUBOTA formulation that delivers superior performance and protection in all operating conditions. Regular UDT is also permitted for use in this machine.
- Indicated capacities of water and oil are manufacturer's estimate.

2. GENERAL

Place	Capacities	Lubricants
	ZD1511LF	
Fuel	49 L (12.9 U.S.gals.)	No.2-D diesel fuel No.1-D diesel fuel if temperature is below -10 °C(14 ℉)
Coolant	4.6 L (4.9 U.S.qts.)	Fresh clean water with anti-freeze
Recovery tank	1.1 L (1.2 U.S.qts.)	
Engine crankcase	6.4 L (6.8 U.S.qts.)* ¹	Engine oil: API service Classification CJ-4 Above 25 °C...SAE30, SAE10W-30 or 15W-40 (77 ℉) 0 to 25 °C.....SAE20, SAE10W-30 or 15W-40 (32 to 77 ℉) Below 0 °C.....SAE10W, SAE10W-30 or 15W-40 (32 ℉)
Transmission case with filter & hose Rear axle gear case (RH &LH)	12.1 L (12.8 U.S.qts.)	KUBOTA SUPER UDT-2 fluid* ²
Mower gear box	0.5 L (0.52 U.S.qts.)	ZD1511LF Engine oil: API service Classification SH, SJ or higher SAE10W-30
Greasing	No. of greasing points	Type of grease
King pin	2	Multipurpose EP2 Grease (NLGI Grade No.2)
Center pin	1	
Front wheel	2	
Rear mower link bushing	4	
Front mower link bushing	2	
Tilt lever	1	
Universal joint	3	
Seat adjuster	2	
Parking brake lock pedal	1	
Mower		
Universal joint	3	Multipurpose EP2 Grease (NLGI Grade No.2)
Three spindle shafts	3	
Belt tension pulley	1	
Belt tension pivot	1	
Front anti scalp roller pivot boss	2	
Front anti scalp roller	2	

*1 Oil amount when the oil level is at the upper level of the oil level gauge.

*2 The product name of KUBOTA genuine UDT fluid may be different from that in the Operator's Manual depending on countries or territories.

Biodiesel Fuel (BDF)

B0-B5 Biodiesel fuels (BDF): mixed diesel fuels containing 5% or less biodiesel can be utilized under the following conditions.

■ IMPORTANT

- **Concentrations greater than B5 (5%) are NOT approved for common rail engines. Such fuel use can cause damage and reduce engine life.**
- **Refueling and handling fuel should be done with caution in order to avoid contact with the fuel and spillage that could create a potential environmental or fire hazard. Wear appropriate protective equipment when refueling.**

Applicable BDF:

1. BDF concentration must not exceed 5% by volume (B5 blend). Greater concentrations increase the likelihood of corrosion and failure of the aluminum, zinc, rubber, and plastic parts of the fuel system.
2. Any mineral oil diesel fuel, if used, must conform to ASTM D975 (or the European EN590) Standard, as revised. B100 fuel used to make Biodiesel blended fuels must meet ASTM D6751 (or EN14214) Standard, as revised. Straight vegetable oil is NOT allowed in any blended fuel.
3. Kubota strongly recommends that B5 blend be purchased from a BQ-9000 accredited producer or certified marketer. Kubota discourages local blending of BDF, because it is difficult to meet the quality requirements explained above.

Product Warranty, Emission and Other Precautions:

1. The engine emission control system was certified according to current regulations based on the use of non-BDF. When using BDF, the owner is advised to check applicable local and federal emission regulations and comply with all of them.
2. BDF may cause restricted or clogged fuel filters during cold weather conditions, resulting in the engine not operating properly.
3. BDF encourages the growth of microorganisms which may cause degradation of the fuel. This in turn may cause fuel line corrosion or reduce fuel filter flow earlier than expected.
4. BDF inherently absorbs moisture which may cause degradation of the fuel earlier than expected. To avoid this, drain the water separator and fuel filter port often.
5. Do not use Biodiesel concentrations higher than 5% (i.e. greater than B5). Engine performance and fuel consumption will be affected, and degradation of the fuel system components may occur.
6. Do not readjust the engine fuel control system as this will violate emission control levels for which the equipment was approved.
7. Compared with soybean-based and rapeseed-based feedstock, palm oil-based feedstock has a thicker consistency (i.e. higher viscosity) at lower temperatures. Consequently, fuel filter performance may be reduced, particularly during cold weather conditions.
8. The Kubota Warranty, as specified in the Owner's Warranty Information Guide, only covers problems in product materials and workmanship. Accordingly, any problems that may arise due to the use of poor quality fuels that fail to meet the above requirements, whether biodiesel or mineral oil based, are not covered by the Kubota Warranty.

Routine handling:

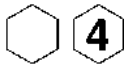
1. Avoid spilling BDF onto painted surfaces as this may damage the finish. If fuel is spilled immediately wipe clean and flush with soapy water to avoid permanent damage.
2. When using BDF, you are advised to maintain a full tank of fuel, especially overnight and during short term storage, to reduce condensation within the tank. Be sure to tighten the fuel cap after refueling to prevent moisture build up within the tank. Water in the Biodiesel mixture will damage fuel filters and may damage engine components.
3. Follow the oil change intervals recommended by referring to the "MAINTENANCE" section. Extended oil change intervals may result in premature wear or engine damage.

Long Term Storage:

1. BDF easily deteriorates due to oxygen, water, heat and foreign substances. Do not store longer than 3 months.
2. When using B5 fuel and storing machine longer than 3 months, drain the fuel from the tanks and replace with light mineral oil diesel fuel. Subsequently, run the engine at least 30 minutes to remove all of the Biodiesel from the fuel lines.

TIGHTENING TORQUES

1. General use screws, bolts and nuts

Indica- tion on top of bolt	 No-grade or 4T						 7T						 9T			
Indica- tion on top of nut	  No-grade or 4T												   6T			
Material of oppo- nent part	Ordinariness			Aluminum			Ordinariness			Aluminum			Ordinariness			
	Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
	M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.8	7.9 to 8.8	0.80 to 0.90	5.8 to 6.5	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31	7.9 to 8.8	0.80 to 0.90	5.8 to 6.5	12.3 to 14.2	1.25 to 1.45	9.05 to 10.4
	M8	18 to 20	1.8 to 2.1	13 to 15	17 to 19	1.7 to 2.0	13 to 14	24 to 27	2.4 to 2.8	18 to 20	18 to 20	1.8 to 2.1	13 to 15	30 to 34	3.0 to 3.5	22 to 25
	M10	40 to 45	4.0 to 4.6	29 to 33	32 to 34	3.2 to 3.5	24 to 25	48 to 55	4.9 to 5.7	36 to 41	40 to 44	4.0 to 4.5	29 to 32	61 to 70	6.2 to 7.2	45 to 52
	M12	63 to 72	6.4 to 7.4	47 to 53	—	—	—	78 to 90	7.9 to 9.2	58 to 66	63 to 72	6.4 to 7.4	47 to 53	103 to 117	10.5 to 12.0	76.0 to 86.7
	M14	108 to 125	11.0 to 12.8	79.6 to 92.5	—	—	—	124 to 147	12.6 to 15.0	91.2 to 108	—	—	—	167 to 196	17.0 to 20.0	123 to 144
	M16	167 to 191	17.0 to 19.5	123 to 141	—	—	—	197 to 225	20.0 to 23.0	145 to 166	—	—	—	260 to 304	26.5 to 31.0	192 to 224
	M18	246 to 284	25.0 to 29.0	181 to 209	—	—	—	275 to 318	28.0 to 32.5	203 to 235	—	—	—	344 to 402	35.0 to 41.0	254 to 296
M20	334 to 392	34.0 to 40.0	246 to 289	—	—	—	368 to 431	37.5 to 44.0	272 to 318	—	—	—	491 to 568	50.0 to 58.0	362 to 419	

2. Stud bolts

Material of oppo- nent part	Ordinariness			Aluminum		
Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
M8	12 to 15	1.2 to 1.6	8.7 to 11	8.9 to 11	0.90 to 1.2	6.5 to 8.6
M10	25 to 31	2.5 to 3.2	18 to 23	20 to 25	2.0 to 2.6	15 to 18
M12	30 to 49	3.0 to 5.0	22 to 36	31	3.2	23
M14	62 to 73	6.3 to 7.5	46 to 54	—	—	—
M16	98.1 to 112	10.0 to 11.5	72.4 to 83.1	—	—	—
M18	172 to 201	17.5 to 20.5	127 to 148	—	—	—

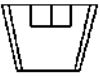
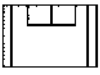
3. Metric screws, bolts and nuts

Grade	 Property class 8.8			 Property class 10.9		
Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
M8	24 to 27	2.4 to 2.8	18 to 20	30 to 34	3.0 to 3.5	22 to 25
M10	48 to 55	4.9 to 5.7	36 to 41	61 to 70	6.2 to 7.2	45 to 52
M12	78 to 90	7.9 to 9.2	58 to 66	103 to 117	10.5 to 12.0	76.0 to 86.7
M14	124 to 147	12.6 to 15.0	91.2 to 108	167 to 196	17.0 to 20.0	123 to 144
M16	197 to 225	20.0 to 23.0	145 to 166	260 to 304	26.5 to 31.0	192 to 224

4. American standard screws, bolts and nuts with UNC or UNF threads

Grade	 SAE GR.5			 SAE GR.8		
Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
1/4	11.7 to 15.7	1.20 to 1.60	8.63 to 11.5	16.3 to 19.7	1.67 to 2.00	12.0 to 14.6
5/16	23.1 to 27.7	2.36 to 2.82	17.0 to 20.5	33 to 39	3.4 to 3.9	25 to 28
3/8	48 to 56	4.9 to 5.7	36 to 41	61 to 73	6.3 to 7.4	45 to 53
1/2	110 to 130	11.3 to 13.2	81.2 to 95.8	150 to 178	15.3 to 18.1	111 to 131
9/16	150 to 178	15.3 to 18.1	111 to 131	217 to 260	22.2 to 26.5	160 to 191
5/8	204 to 244	20.8 to 24.8	151 to 179	299 to 357	30.5 to 36.4	221 to 263

5. Plugs

Shape	Size	Material of opponent part					
		Ordinariness			Aluminum		
		N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
Tapered screw 	R1/8	13 to 21	1.3 to 2.2	9.4 to 15	13 to 19	1.3 to 2.0	9.4 to 14
	R1/4	25 to 44	2.5 to 4.5	18 to 32	25 to 34	2.5 to 3.5	18 to 25
	R3/8	49 to 88	5.0 to 9.0	37 to 65	49 to 58	5.0 to 6.0	37 to 43
	R1/2	58.9 to 107	6.00 to 11.0	43.4 to 79.5	59 to 78	6.0 to 8.0	44 to 57
Straight screw 	G1/4	25 to 34	2.5 to 3.5	18 to 25	—	—	—
	G3/8	62 to 82	6.3 to 8.4	46 to 60	—	—	—
	G1/2	49 to 88	5.0 to 9.0	37 to 65	—	—	—

MAINTENANCE CHECK LIST

■ IMPORTANT

- You must do the following servicing jobs on the machine at the stated running-time intervals.
- The jobs indicated by ★ must be done initially.
- The items listed above (@ marked) are registered as emission related critical parts by KUBOTA in the U.S.EPA non-road emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction. Please see the Warranty Statement in detail.

No.	Item		Service interval												After since	Reference page		
			50	100	150	200	250	300	350	400	450	500	550	600				
1	Engine start system	Check	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	every 50 Hr	2-26		
2	OPC system	Check	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	every 50 Hr	2-27		
3	Mower gear box oil	Check	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	every 50 Hr	2-27		
		Change			☆			☆			☆			☆	every 150 Hr	2-34		
4	Greasing (except mower and mower link bushings)	-	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	every 50 Hr	2-27		
5	Greasing (mower link bushings, pivot)	-		☆		☆		☆		☆		☆		☆	every 100 Hr	2-32		
6	Air cleaner primary element	Clean		☆		☆		☆		☆		☆		☆	every 100 Hr	2-29	*2	@
		Replace													every 1000Hr or 1 year	2-38	*3	
	Secondary element	Replace													every 1000Hr or 1 year	2-38		
7	Fuel filter element	Check		☆		☆		☆		☆		☆		☆	every 100 Hr	2-29		
		Replace								☆					every 400 Hr	2-37		
8	Fan belt	Adjust		☆		☆		☆		☆		☆		☆	every 100 Hr	2-30		
9	Parking brake	Adjust		☆		☆		☆		☆		☆		☆	every 100 Hr	2-31		
10	Battery condition	Check		☆		☆		☆		☆		☆		☆	every 100 Hr	2-32	*6	
11	Engine oil	Change	★			☆				☆				☆	every 200 Hr	2-23	*1	
12	Engine oil filter	Replace	★			☆				☆				☆	every 200 Hr	2-23	*1	
13	Transmission oil filter [HST]	Replace	★			☆				☆				☆	every 200 Hr	2-24	*1	@
14	Front axle pivot	Adjust		★		☆				☆				☆	every 200 Hr	2-24	*7	@

(Continued)

2. GENERAL

No.	Item		Service interval												After since	Reference page		
			50	100	150	200	250	300	350	400	450	500	550	600				
15	Transmission oil and Rear axle gear case (RH & LH) fluid	Change								★					every 400 Hr	2-25		@
16	Hydraulic oil filter	Replace								☆					every 400 Hr	2-37		
17	Engine valve clearance	Adjust													every 800 Hr	2-38		
18	Fuel injection nozzle injection pressure	Check													every 1500 Hr	2-39		@
19	Radiator	Clean													every 2000Hr or 2 years	2-39	*5	
20	Coolant	Change													every 2000Hr or 2 years	2-39	*5	
21	Injection pump	Check													every 3000Hr	2-41		@
22	Turbo charger	Check													every 3000Hr	2-41		@
23	Exhaust manifold	Check													every 1 year	2-42		@
24	Fuel line	Check													every 1 year	2-43	*4	@
		Replace													every 4 years	2-45		
25	Radiator hose and clamp	Check													every 1 year	2-42	*4	
		Replace													every 4 years	2-45		
26	Hydraulic hose	Check													every 1 year	2-42	*4	
		Replace													every 4 years	2-44		
27	Intake air line	Check													every 1 year	2-44	*4	@
		Replace													every 4 years	2-46		
28	Engine breather hose	Check													every 1 year	2-44	*4	
		Replace													every 4 years	2-47		
29	Mower gear box oil seal	Check													every 1 year	2-44	*4	
		Replace													every 4 years	2-47		
30	Fuel system	Bleed													Service as required	2-51		
31	Fuse	Replace														2-48		
32	Blade	Replace														2-49		
33	Mower belt	Replace														2-50		

*1: The initial 50 hours should not be a replacement (change) cycle.

*2: Air cleaner must be cleaned more often in dusty conditions than in normal conditions.

*3: Every 1000 hours or every 1 year whichever comes faster.

*4: Replace if any deterioration (crack, hardening, scar, or deformation) or damage occurred.

*5: Every 2000 hours or every 2 years whichever comes faster.

*6: When the battery is used for less than 100 hours per year, check the battery condition by reading the indicator annually.

*7: The initial 100 hours should not be an adjustment cycle.

CHECK AND MAINTENANCE

1. Daily check

1.1 Checking the machine

To prevent trouble from occurring, it is important to know the condition of the machine. Check the following items before starting.

- Check areas where previous trouble was experienced.
- Walk around the machine.
 1. Tire pressure, wear and damage
 2. Oil and water leak
 3. Engine oil level
 4. Transmission fluid level
 5. Coolant level in the recovery tank
 6. Damage of machine body, tightness of all bolts and nuts
 7. Radiator screen
 8. Bonnet screen
 9. Brake play
 10. Air cleaner primary element
 11. Fuel level
 12. Oiling
- Mower
 1. Oil leak
 2. Make sure blade cap screws are tight.
 3. Check blades for wear or damage.
 4. Check all hardware.
 5. Make sure all pins are in place.
 6. Mower deck cleaning
 7. Greasing
- While sitting in the operator's seat
 1. Motion control lever
 2. Parking brake
- Turning the key switch **ON**
 1. Performance of the Easy Checker™ light
- Starting the engine
 1. Color of the exhaust fumes
 2. Safety start switch, seat safety control and another safety control and another safety devices.
 3. Check for abnormal noise and vibration.
- Others
 1. Check the areas where previous trouble was experienced.

1.2 Checking engine oil level

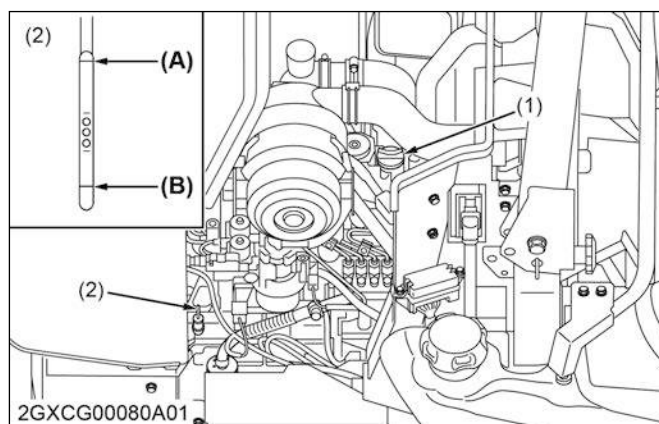


WARNING

To avoid serious injury:

- **Always stop the engine and remove the key before checking oil.**

1. Check engine oil before starting and 5 minutes or more after the engine has stopped.
2. Wipe dipstick area clean.
3. To check the oil level, remove the dipstick, wipe it clean, replace it, and draw it out again. Check to see that the oil level is between the two lines.
4. Add new oil to the prescribed level at the oil port if necessary.



- (1) Engine oil port
(2) Oil level dipstick
(A) Upper level
(B) Lower level

5. When using a different brand or viscosity oil from the previous one, remove all of the old oil and oil filter. Never mix two different types of oil.
6. Use the proper Engine Oil SAE according to the ambient temperatures.

— RELATED PAGE —
[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

1.3 Checking amount of fuel and refueling



WARNING

To avoid serious injury or death:

- **Handle fuel carefully.** If the engine is running, do not fill the fuel tank. If engine is hot, let engine cool several minutes before adding fuel. Do not smoke while filling the fuel tank or servicing the fuel system. Fill fuel tank only to bottom of filler neck.

■ IMPORTANT

- Use diesel fuel only.
- Do not permit dirt or trash or water to get into the fuel system.
- Be careful not to let the fuel tank become empty, otherwise air will enter the fuel system, necessitating bleeding before next engine start.
- Be careful not to spill fuel during refueling. If a spill should occur, wipe it off at once, or it may cause a fire.
- To prevent condensation (water accumulation) in the fuel tank, fill the tank before parking overnight.
- When refueling, basically fill both fuel tanks full.
- In the case you have a small amount of fuel, if fuel is still in the fuel tank R.H., fill the fuel tank L.H. first.
- The fuel gauge shows the fuel level of fuel tank R.H. When the fuel gauge flashes, fill fuel as soon as possible.
- When the fuel gauge flashes, do not fill fuel on a slope. Fuel can absorb air and the engine can stall.

**■ IMPORTANT**

1. Use No. 2-D diesel fuel.
 2. Use No. 1-D diesel fuel if the temperature is below -10°C (14°F).
 3. Always use a strainer when refueling to prevent fuel injection pump contamination.
1. Check the fuel level. Be careful that the fuel tank does not become empty.

Fuel tank	Capacity	49 L 12.9 U.S.gals 11 Imp.gals
-----------	----------	--------------------------------------

1.4 Checking transmission fluid level**! WARNING**

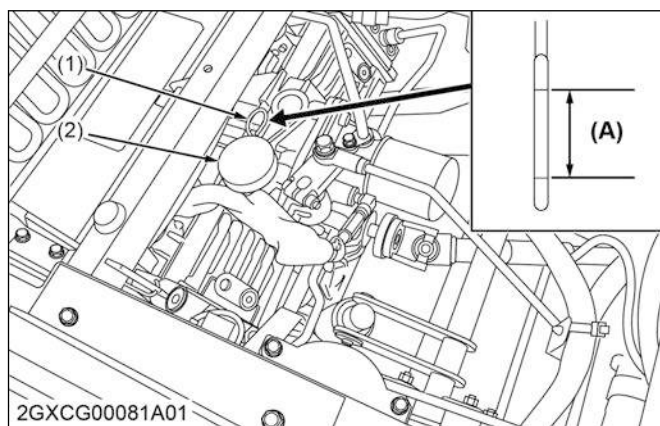
To avoid serious injury or death:

- Allow the transmission case to cool down sufficiently when cleaning its surface.

■ IMPORTANT

- If oil level is low, do not run engine.

1. Park the machine on a flat surface, lower the implement to the ground.
2. Allow machine to idle 1-3 minutes.
3. Shut off engine and remove the key.
4. Raise and lock the operator's seat.
5. To check the oil level, draw out the dipstick, wipe it clean, replace 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 prescribed level at the oil inlet.



- (1) Oil level dipstick
(2) Oil plug and breather cup

(A) Oil level is acceptable within this range.

— RELATED PAGE —

[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

1.5 Checking coolant level**! WARNING**

To avoid serious injury or death:

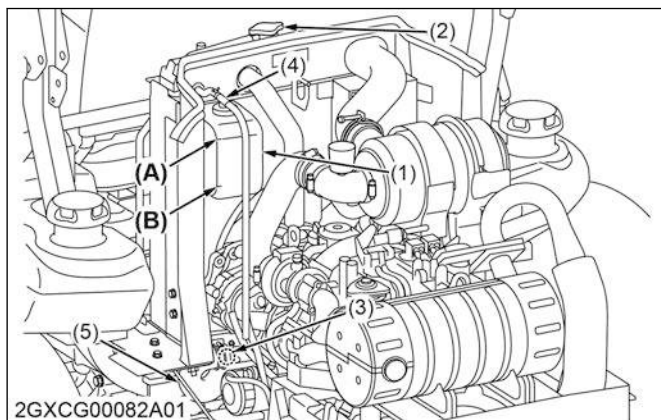
- Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.

■ IMPORTANT

- Check the coolant level daily both the radiator and the recovery tank before starting engine.
- If the radiator cap has to be removed, follow the caution above and securely re-tighten the cap.
- Use clean, distilled water and anti-freeze to fill the recovery tank.

Check the coolant level daily both the radiator and the recovery tank before starting engine.

1. Remove the radiator cap and check to see that the coolant level is just below the fill port.
2. Check to see that the coolant level is between the "FULL" and "LOW" marks of recovery tank.
3. When the coolant level drops due to evaporation, add water only up to just below the fill port of the radiator and the full level of the recovery tank. In case of leakage, add anti-freeze and water in the specified mixing ratio up to the full level.
4. Check radiator hoses for wear, cracks, bubbles or leaks. If any such are found, repair immediately.



- | | |
|-----------------------|------------------|
| (1) Recovery tank | (5) Radiator cap |
| (2) Radiator cap | A: "FULL" |
| (3) Lower hose band | B: "LOW" |
| (4) Recovery tank cap | |

— RELATED PAGE —

[13.1 Flushing cooling system and changing coolant on page 2-39](#)

1.6 Checking and cleaning radiator to prevent overheating



WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before checking and cleaning.
- Engine components can get extremely hot from operation. To prevent severe burns, do not touch these areas while the engine is running, or immediately after it is turned off.
- Never operate the engine without heat shields or guards.

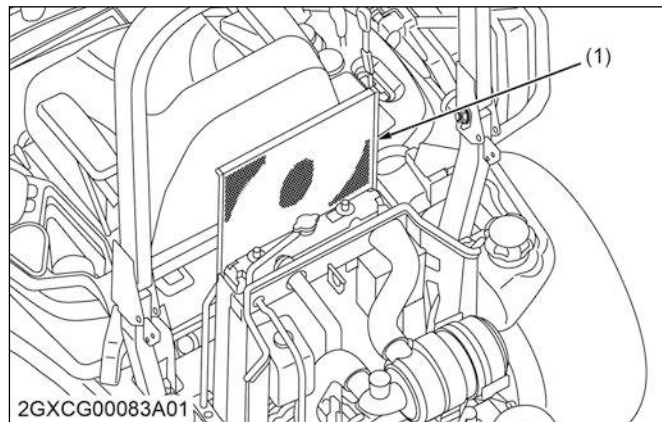
IMPORTANT

- The air intake area must be clear of debris to prevent the engine from overheating.

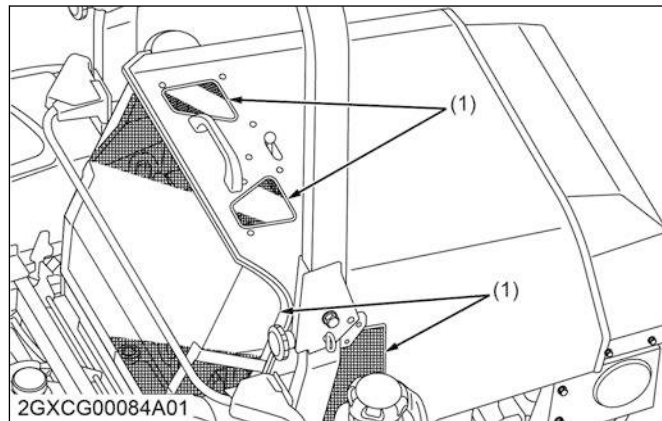
Daily or after every 5 hours of operation, check to be sure the radiator screen and the hood screen are clean (required more often in dusty conditions). Dirt or chaff

on the radiator screen, hood screen or radiator decrease cooling performance.

1. Remove the radiator screen and bonnet screen, and remove all foreign material.
2. Remove the dust from between the fins and the tube.
3. Tighten the fan drive belt as necessary.
4. If scale forms in the tube, clean with the scale inhibitor or its equivalent.
5. Each time the panel screen is covered with grass during operation, rub it off the screen with hand. Check the radiator screen from time to time if grass accumulates.
6. If the dust or chaff has accumulated inside of the bonnet, remove the radiator screen and clean inside completely. After cleaning, replace the radiator screens properly.
7. Check the radiator for dust or chaff build up. If the dust or chaff has accumulated in the radiator, clear with air pressure (not to exceed 30 psi) or a hose.



(1) Radiator screen



(1) Hood screen

— RELATED PAGE —

[6.3 Adjusting fan belt tension on page 2-30](#)

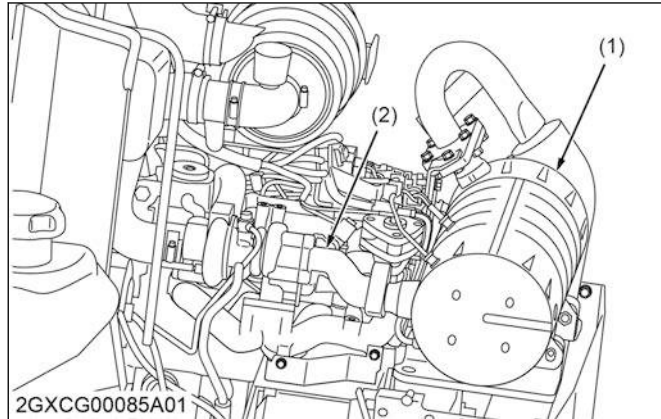
1.7 Checking and cleaning DPF muffler and its surroundings

WARNING

To avoid serious injury or death:

- Before checking or cleaning the DPF muffler, stop the engine and wait long enough until it is cooled down.

1. Check the DPF muffler and its surroundings for build-up of anything flammable. Otherwise a fire may result.



(1) DPF muffler

(2) Surrounding parts

1.8 Checking tire pressure

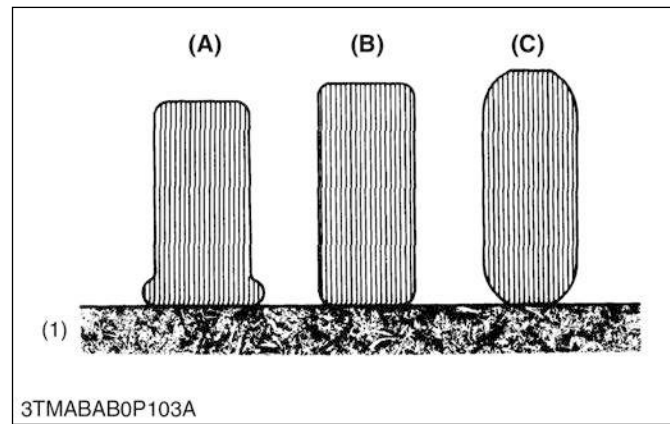
WARNING

To avoid serious injury or death:

- Do not try to mount a tire on a rim. This should be done by a qualified person with the proper equipment.
- Always keep the correct tire pressure.
- Inflation pressure in front tires rises quickly when using compressed air.
- Do not inflate tires above the recommended pressure shown in the Operator's Manual.

IMPORTANT

- Do not use tires larger than specified.



(1) Ground
(A) Insufficient

(B) Normal
(C) Excessive

Inflation pressure

1. Though the inflation pressure is factory-set to the prescribed level, it naturally drops slowly in the course of time. Thus, check it and inflate as necessary.

	Tire sizes	Recommended inflation pressure
Front	15 × 6.5 -8, Smooth semipneumatic Non flat tire	—
Rear	26 x 12.0 -16, 4PR Turf Low profile tire	83 kPa (0.84 kgf/cm ² , 12 psi)

Checking movable parts

- If any of the movable parts, such as levers and pedals, is not smoothly moved because of rust or anything sticky, do not attempt to force it into motion.
- In the above case, remove the rust or the sticky object, and apply oil or grease on the relevant spot. Otherwise, the machine may get damaged.

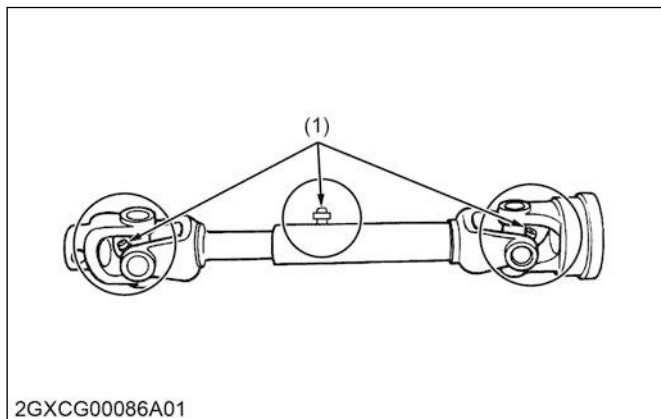
1.9 Greasing (Mower)

WARNING

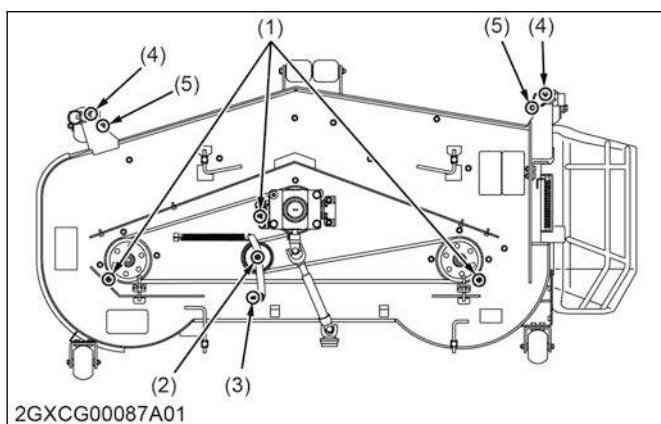
To avoid serious injury or death:

- Be sure to stop the engine and remove the key before greasing.

1. Apply grease to the following position as figures.

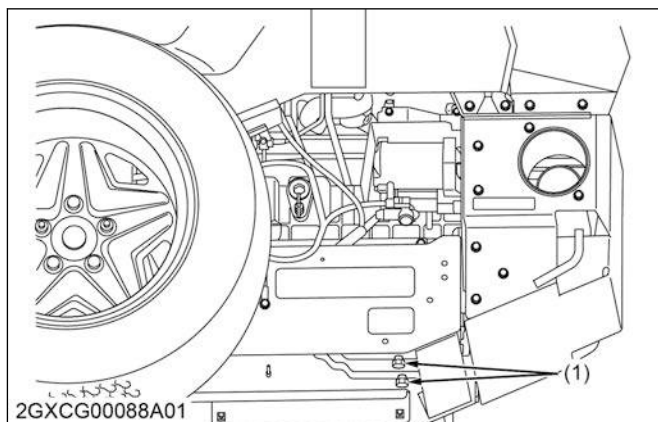


(1) Mower universal joint



- (1) Spindle shaft (5) Front side anti-scalp roller
(2) Belt tension pulley
(3) Belt tension pivot
(4) Front anti-scalp roller pivot boss

1. To change the used oil, remove the drain plug at the bottom of the engine and drain the oil completely. The used oil can be drained out more easily if the engine is warm.
2. Fill with the new oil up to the upper notch on the dipstick.



(1) Drain plug

3. To change the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw in the drain plug (1).
5. Fill with the new oil up to upper line on the dipstick.

Engine oil	Capacity	6.4 L 6.8 U.S.qts 5.6 Imp.qts
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— RELATED PAGE —
[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

2. Check points of initial 50 hours

With a new machine, be sure to do the servicing, as discussed below, after the first 50 operating hours.

2.1 Changing engine oil

WARNING

To avoid serious injury or death:

- Be sure to stop the engine before changing oil.
- Allow engine to cool down sufficiently; oil can be hot and may cause burns.

IMPORTANT

- When using oil of different manufacture or viscosity from the previous one, remove all of the old oil.
- Never mix two different type of oil.
- Use the proper SAE engine oil according to ambient temperatures.

2.2 Replacing engine oil filter

WARNING

To avoid serious injury or death:

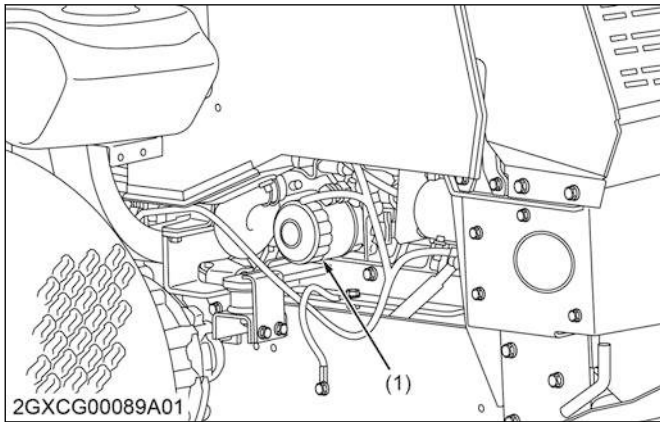
- Be sure to stop the engine before changing the oil filter.
- Allow engine to cool down sufficiently, oil can be hot and may cause burns.

IMPORTANT

- To prevent serious damage to the engine, element of recommended type must be used. Use only a genuine KUBOTA filter or its equivalent.

1. Remove the engine oil filter (1) with the filter wrench.
2. Apply a slight coat of oil onto the rubber gasket of new filter.

3. Tighten the filter quickly until it contacts the mounting surface. Tighten filter by hand an additional 1/2 turn only.
4. After the filter has been replaced, the engine oil level normally lowers a little. Add engine oil to proper level. Check for oil leaks around filter gasket.



(1) Engine oil filter

2.3 Replacing HST transmission oil filter

WARNING

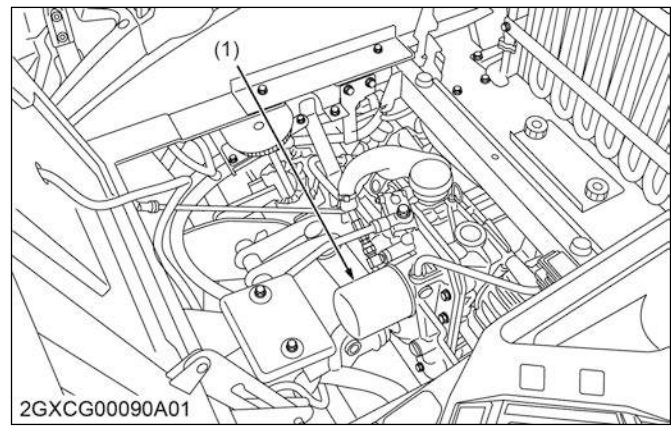
To avoid serious injury or death:

- Be sure to stop the engine before changing the oil filter.
- Allow transmission case to cool down sufficiently; oil can be hot and may cause burns.

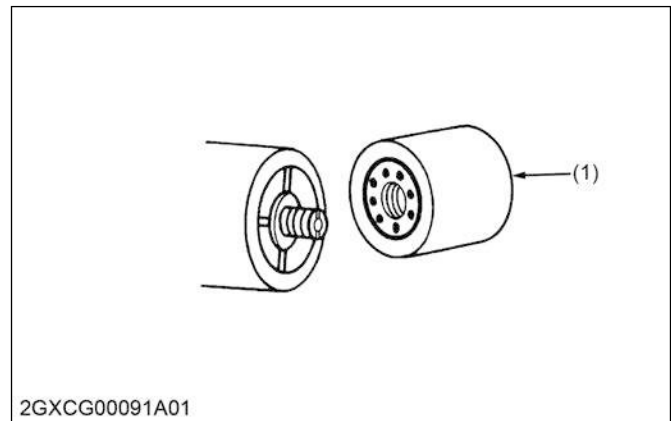
IMPORTANT

- To prevent serious damage or premature failure to the hydraulic system, use only a KUBOTA genuine filter.

1. Place an oil pan underneath the oil filter cartridge. (Do not drain oil.)
2. Remove the oil filter cartridge by using the filter wrench.
3. Apply a slight coat of oil onto the cartridge gasket.
4. Tighten the filter quickly until it contacts the mounting surface. Tighten filter by hand an additional 1/2 turn only.
5. After the new cartridge has been replaced, the transmission fluid level normally lowers a little. Add fluid to proper level. Check for oil leaks around filter gasket.



(1) Transmission oil filter [HST]



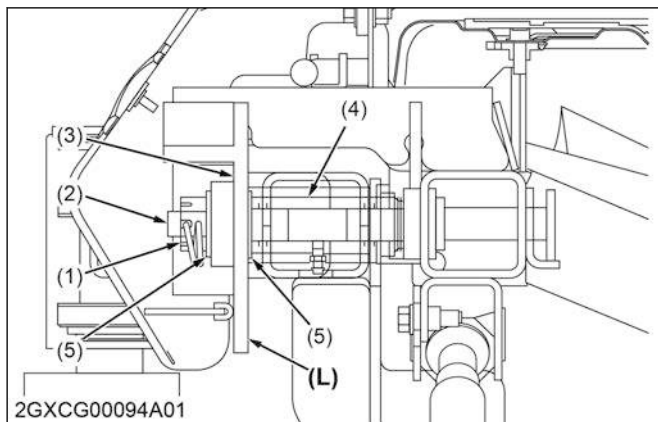
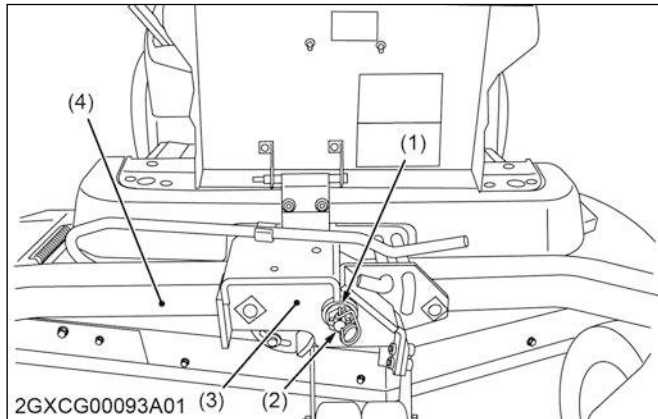
(1) HST transmission oil filter cartridge

3. Check point of initial 100 hours

3.1 Adjusting front axle pivot

1. Lift up and securely block the front of the machine.
2. Measure the clearance (L) between the front axle (4) and front axle support (3).

3. If the measurement exceeds the allowable limit, remove the set spring and adjust the end play by slotted nut (1).



- (1) Slotted nut
(2) Center pin
(3) Front axle support
(4) Front axle
(5) Plain washer
(L) Front axle end play

NOTE

- When fastening the center pin (2), tighten the nut (1) so that the front axle may be oscillated smoothly by hand.

Front axle end play (L)	Factory specification	0 to 0.2 mm 0 to 0.008 in.
	Allowable limit	0.5 mm 0.02 in.

4. Check point of initial 400 hours

4.1 Changing transmission fluid and rear axle gear case oil (R.H. and L.H.)



WARNING

To avoid serious injury or death:

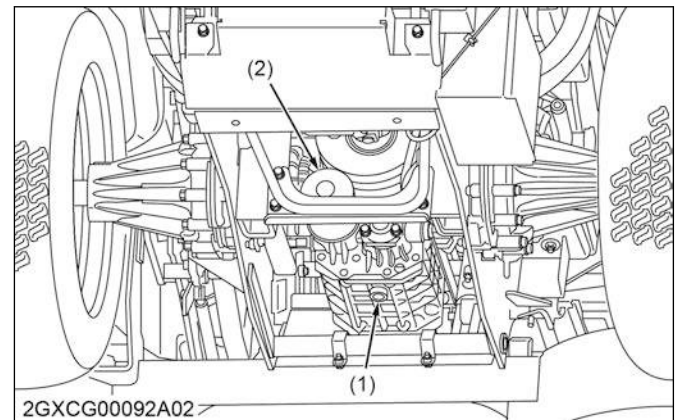
- Be sure to stop the engine and remove the key before changing or checking the oil.

- Allow transmission case to cool down sufficiently; oil can be hot and may cause burns.

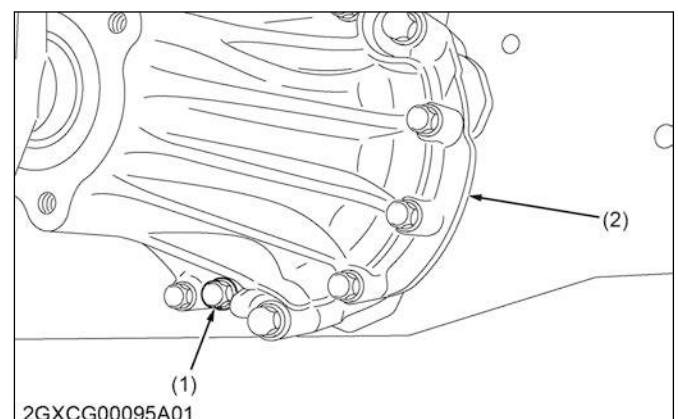
IMPORTANT

- Operate only at low RPM's immediately after changing the transmission fluid and filter cartridge.
- Keep the engine at medium speed for a few minutes to ensure proper lubrication of all parts so there is no damage to transmission.
- Do not mix different brands oil together.
- The fluid in the transmission case is also used for the hydrostatic drive system.

- To drain the transmission oil, place oil pan underneath the transmission case and the rear axle gear case (R.H. and L.H.) and remove the drain plug at the bottom of the transmission case and the rear axle gear case (R.H. and L.H.).
- After draining, reinstall the drain plugs.

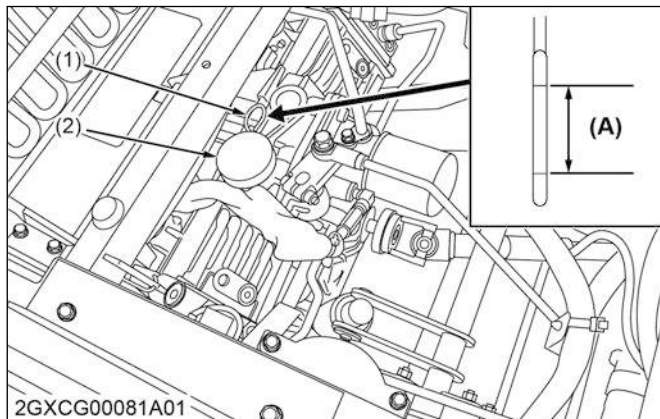


- (1) Drain plug
(2) Hydraulic oil filter



- (1) Drain plug
(2) Rear axle gear case L.H.

3. Fill with UDT, SUPER UDT hydrostatic transmission fluid or its equivalent up to the upper line of the gauge.



- (1) Oil level dipstick
(2) Oil plug and breather cup
(A) Oil level is acceptable within this range.

■ IMPORTANT

- It takes time to have the oil poured from the transmission case reach the rear axle case (R.H. and L.H.). Pour the regulated amount of oil slowly.

Transmission fluid (with filter and hose)	Capacity	12.1 L 12.8 U.S.qts 10.6 Imp.qts
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4. After running the engine for a few minutes, stop it and check the oil level again; add oil to the prescribed level.

— RELATED PAGE —

[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

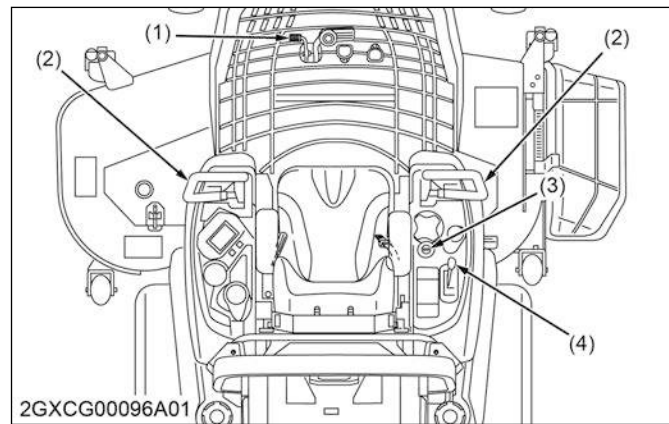
5. Check points of every 50 hours

5.1 Checking engine start system

⚠ WARNING

To avoid serious injury or death:

- Park the machine on a firm and level surface.
- Do not allow anyone near the machine while testing.
- If the machine does not pass one of the following tests, do not operate the machine.
- Sit on operator's seat for all tests except for Test 1.



- (1) Parking brake lock pedal
(2) Motion control lever
(3) Key switch
(4) PTO lever

Test 1 (Operator not on the seat)

- Securely set the parking brake.
- Shift the PTO lever (4) to DISENGAGE (OFF) position.
- Set the motion control levers (2) to the NEUTRAL LOCK position.
- Turn the key switch (3) to START position.
- The engine must not crank.

Test 2 (Operator on the seat)

- Do not set the parking brake. (Release it from test 1.)
- Shift the PTO lever (4) to DISENGAGE (OFF) position.
- Set the motion control levers (2) to the NEUTRAL LOCK position.
- Turn the key switch (3) to START position.
- The engine must not crank.

Test 3 (Operator on the seat)

- Securely set the parking brake.
- Shift the PTO lever (4) to DISENGAGE (OFF) position.
- Grasp the motion control levers (2) and move then inward from NEUTRAL LOCK position to NEUTRAL position and then release the levers.
- Turn the key switch (3) to START position.
- The engine must not crank.

Test 4 (Operator on the seat)

- Securely set the parking brake.
- Shift the PTO lever (4) to ENGAGE (ON) position.
- Grasp the motion control levers (2) to the NEUTRAL LOCK position to NEUTRAL position.
- Turn the key switch (3) to START position.
- The engine must not crank.

Test 5 (Operator on the seat)

■ IMPORTANT

- For this test only, the engine will shut off in a few seconds.

- Start the engine.
- Keep the parking brake securely set.

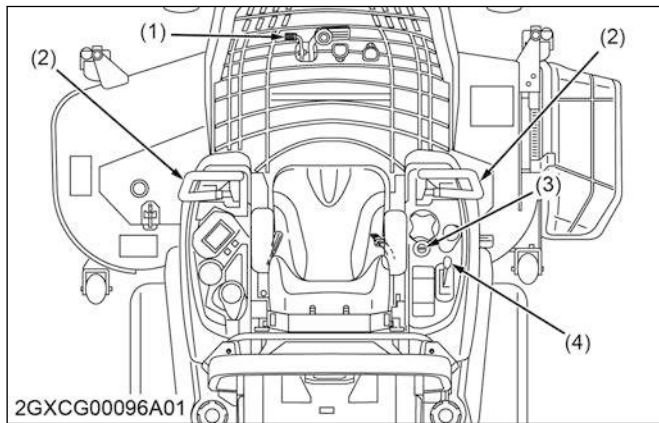
3. Shift the PTO lever (4) to DISENGAGE (OFF) position.
4. Grasp the motion control levers (2) and move them inward from NEUTRAL LOCK position to NEUTRAL position and then release the levers.
5. The engine must shut off after a short time delay.

5.2 Checking OPC system

WARNING

To avoid serious injury or death:

- Park the machine on a firm and level surface.
- Do not allow anyone near the machine while testing.
- If the machine does not pass one of the following tests, do not operate the machine. See your local KUBOTA Dealer.



- | | |
|------------------------------|----------------|
| (1) Parking brake lock pedal | (3) Key switch |
| (2) Motion control lever | (4) PTO lever |

The OPC (Operator Presence Control) system in your machine are designed to protect you while operating. Please check these OPC system periodically. It is recommended to check the OPC system before daily operation.

Test 1 (Operator on the seat)

1. Start the engine.
2. Do not set the parking brake.
3. Shift the PTO lever (4) to DISENGAGE (OFF) position.
4. Grasp the motion control levers (2) and move them inward from NEUTRAL LOCK position to NEUTRAL position and then release the levers.
5. Stand up. (Do not get off the machine.)
6. The engine must shut off.

Test 2 (Operator on the seat)

1. Start the engine.
2. Do not set the parking brake.
3. Shift the PTO lever (4) to ENGAGE (ON) position.
4. Stand up. (Do not get off the machine.)
5. The engine must shut off.

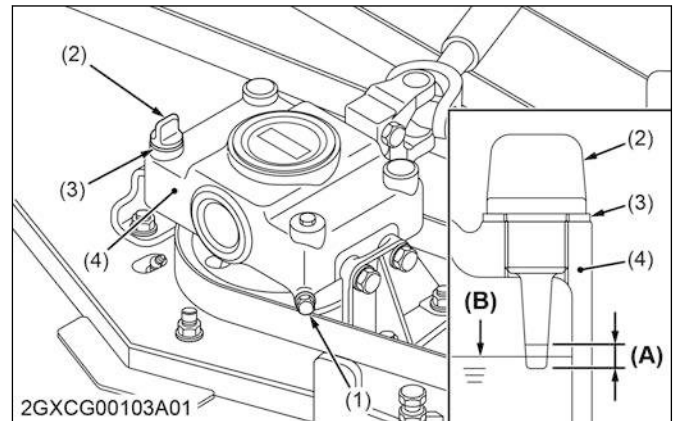
5.3 Checking gear box oil level

WARNING

To avoid serious injury or death:

- Always stop the engine and remove the key before checking oil.

1. Park the machine on a flat surface and lower the mower to the ground.
2. Loosen the oil inlet plug with gauge (2), clean it, reinstall it and loosen it again.
3. Check to see if the oil level is between the notch and tip.
4. If the level is too low, add new oil to the prescribed level at the oil inlet.
5. After checking, reinstall the oil inlet plug with gauge correctly.



- | | |
|-------------------------------|--|
| (1) Drain plug | (A) Oil level is acceptable within this range. |
| (2) Oil inlet plug with gauge | (B) Oil level |
| (3) Seal washer | |
| (4) Gear case | |

— RELATED PAGE —
[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

5.4 Greasing

WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before greasing.

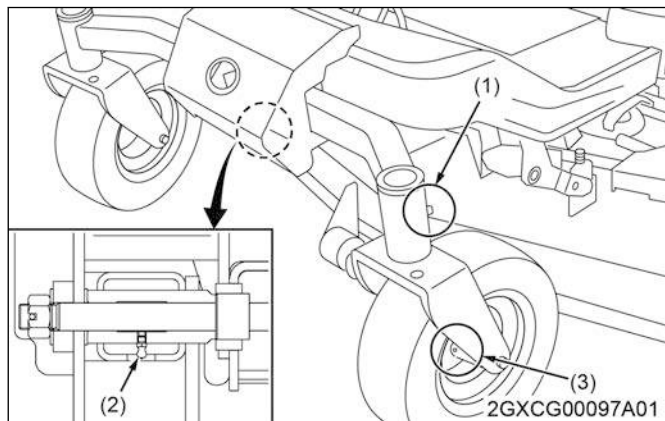
■ IMPORTANT

- Put grease into front wheel until grease overflows from both ends of the front wheel.

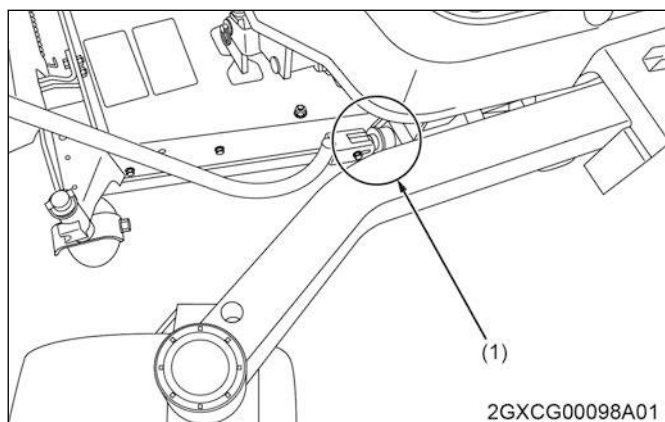
2. GENERAL

CHECK AND MAINTENANCE 5. Check points of every 50 hours

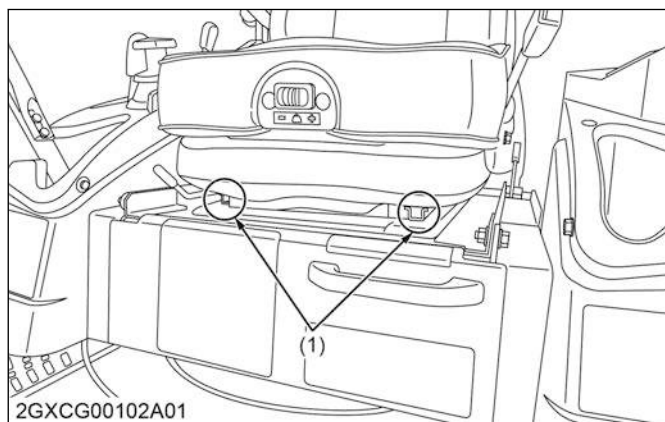
1. Apply a grease to the following position as figures.



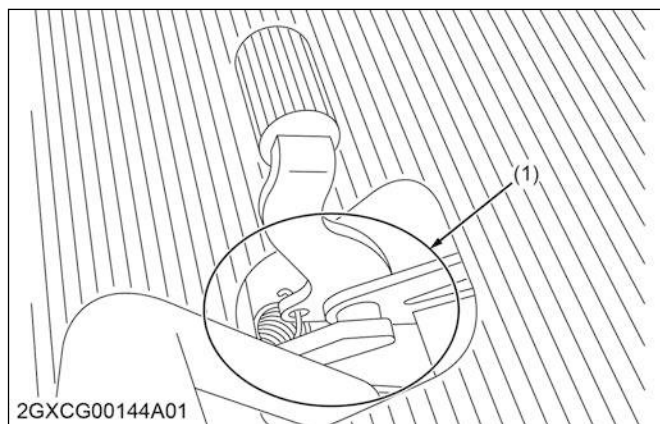
- (1) King pin (L.H., R.H.)
(2) Center pin
(3) Front wheel (L.H., R.H.)



- (1) Tilt lever

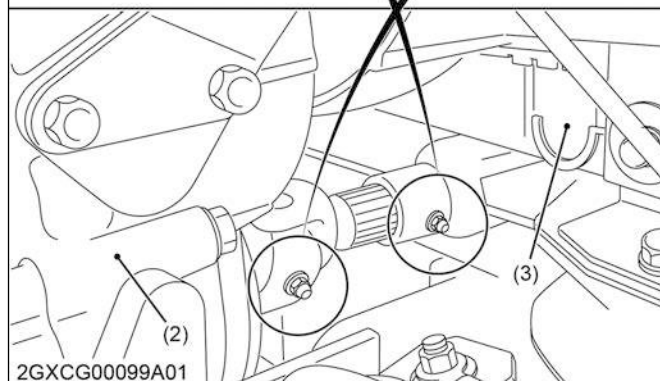
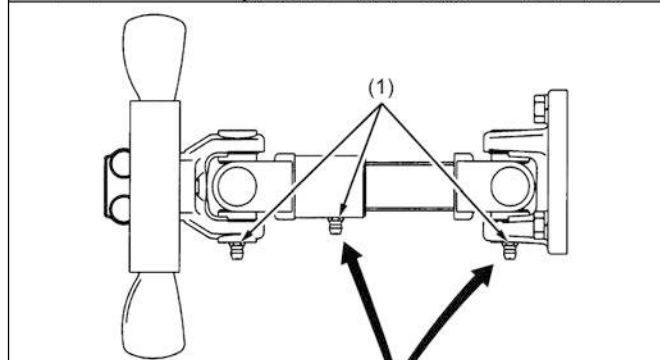
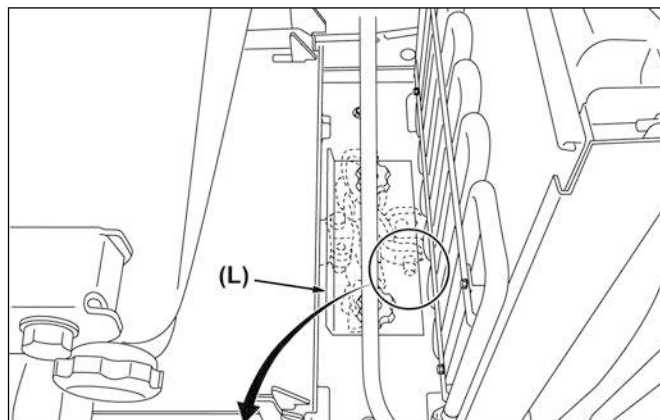


- (1) Seat adjuster



- (1) Parking brake lock pedal

2. When you put grease to the machine universal joint, remove the L-plate. When reassembling, make sure to install it in the direction shown in the figure.



- (1) Machine universal joint
(2) Engine
(3) Radiator
(L) L-plate

6. Check points of every 100 hours

6.1 Cleaning air cleaner primary element



WARNING

To avoid serious injury or death:

- Be sure to stop engine and remove the key before cleaning air cleaner element.

IMPORTANT

- The air cleaner uses a dry element, do not apply oil.
- Do not operate the engine with filter element removed.
- Align the arrow marks when reinstalling the air cleaner cover.
- Do not touch the secondary element except in cases where replacing is necessary.

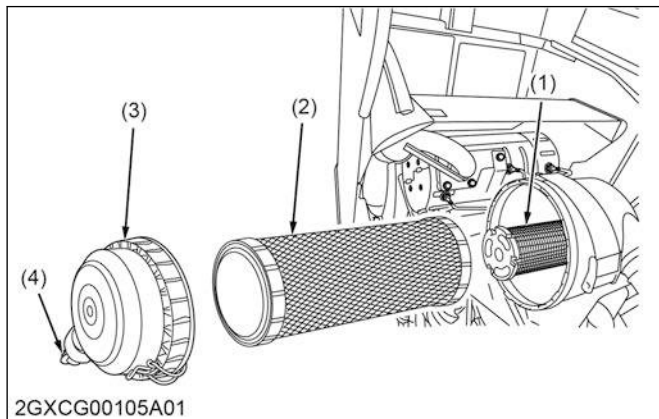
NOTE

- Check to see if the evacuator valve is blocked with dust.

Evacuator valve

Open the evacuator valve once a week under ordinary conditions -or daily when used in a dusty place -to get rid of large particles of dust and dirt.

1. Remove the air cleaner cover and primary element.
2. Clean the primary element:
 - When dry dust adheres to the element, blow compressed air from the inside, turning the element. Pressure of compressed air must be under 205 kPa (2.1 kgf/cm², 30 psi).



- (1) Secondary element (4) Evacuator valve
(2) Primary element
(3) Cover

— RELATED PAGE —

[11.1 Replacing air cleaner primary element and secondary element on page 2-38](#)

6.2 Checking fuel filter



WARNING

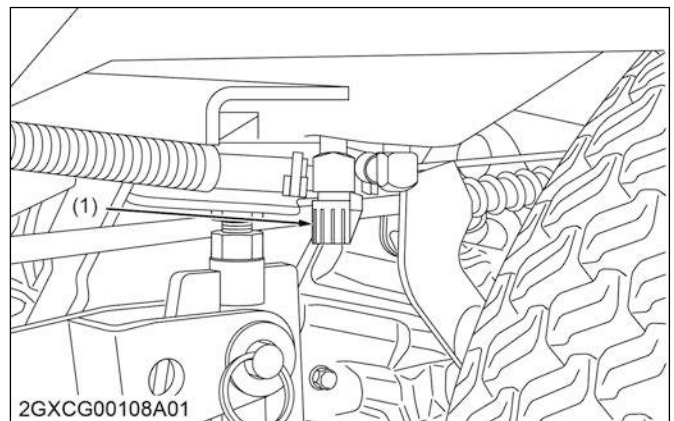
To avoid serious injury or death:

- Be sure to stop the engine and remove the key when attempting to make the following checks and changes.
- Never fail to check the fuel lines periodically. The fuel lines are subject to wear and age. Fuel may leak out onto the running engine, causing a fire.

IMPORTANT

- When the fuel line is disconnected for maintenance or repair, close both ends of the fuel line with a piece of clean cloth or paper to prevent dust and dirt from entering. In addition, particular care must be taken not to admit dust and dirt into the fuel pump. Entrance of dust and dirt causes malfunction of the fuel pump and injector components.
- If replacing fuel filter or fuel lines, you must bleed fuel line.

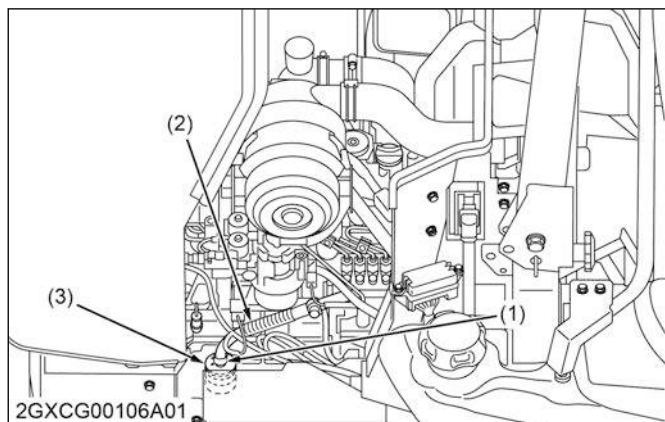
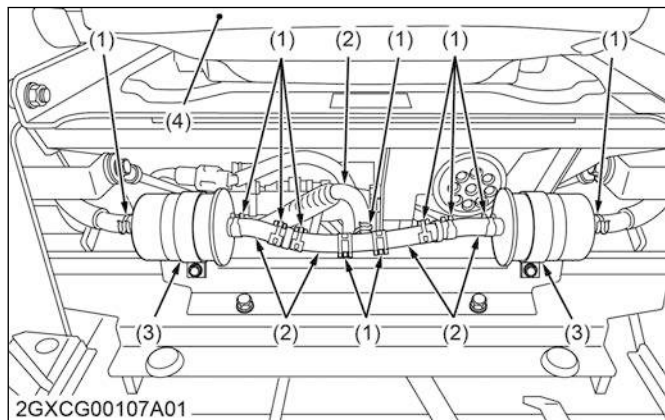
1. Open the center step and bonnet.
2. Close the fuel valves to both fuel tanks R.H. and L.H.



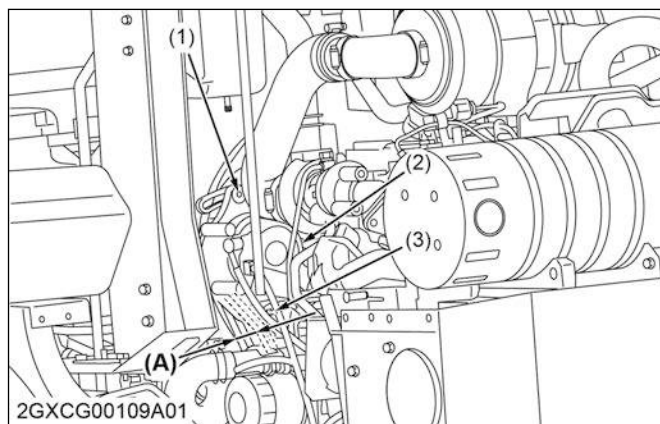
- (1) Fuel valve

3. The fuel line is made of rubber and ages regardless of service period.
4. If the fuel line and clamps are found damaged or deteriorated, replace them.

5. Check fuel filter, if it is clogged by debris or contaminated with water, replace it.



- (1) Pipe clamps
(2) Fuel line
(3) Fuel filter
(4) Seat



- (1) Tension bolt
(2) Alternator
(3) Adjustment bolt
(A) 10 mm (0.4 in.)

Moderate belt tension:

Fan belt tension (A)	Factory specification	Approx. 10 mm 0.4 in.

— RELATED PAGE —
[17.5 Bleeding fuel system on page 2-51](#)

6.3 Adjusting fan belt tension

WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before checking belt tension.

1. If the fan drive belt becomes loose, the engine may overheat.
2. To adjust, loosen bolts and turn the alternator to tighten the belt.
3. After adjustment, securely tighten the bolts.

6.4 Adjusting parking brake



WARNING

To avoid serious injury or death:

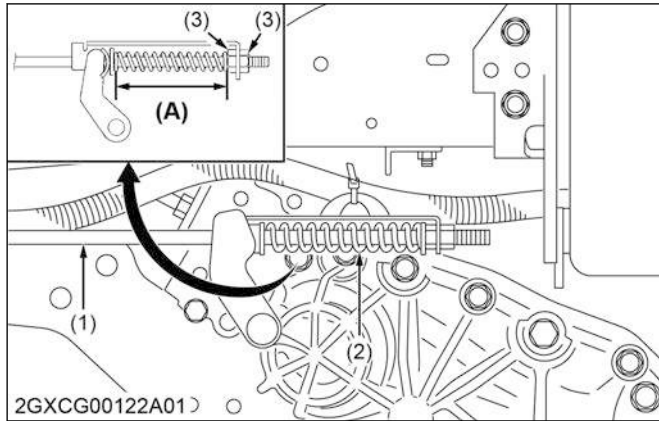
- Park the machine on a hard and level surface.
- Stop the engine and chock the wheels before checking or adjusting.

IMPORTANT

- Wrong adjustment may cause machine damage.

Check brake spring

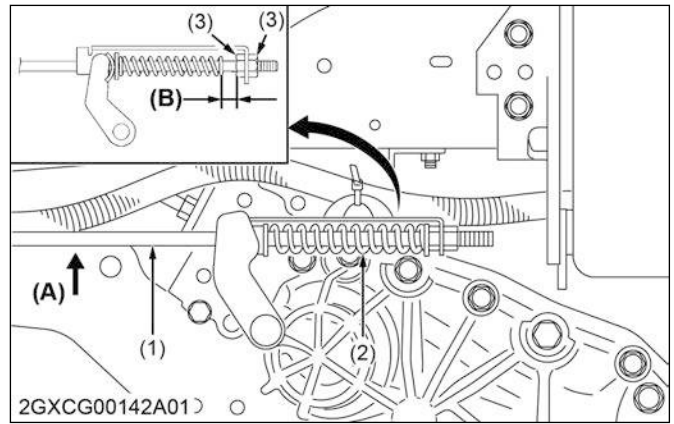
1. Place the motion control levers to **NEUTRAL LOCK** position.
2. Be sure to chock the rear wheels.
3. Apply the parking brake to the lock position.
4. Check the length of the brake springs on both sides.



- (1) Brake rod
(2) Brake spring
(3) Lock nut
- (A) Parking brake spring length

Proper brake spring length with the brake applied to the lock position	Factory specification	115 to 117 mm 4.53 to 4.61 in.
--	-----------------------	-----------------------------------

5. If the length of the brake spring is not correct, adjust it.
6. Release the parking brake completely.
7. Hold the brake rod lightly.
8. Check the brake spring play.



- (1) Brake rod
(2) Brake spring
(3) Lock nut
- (A) Hold the brake rod
(B) Parking brake spring play

Proper brake spring play	Factory specification	0.5 to 1.0 mm 0.02 to 0.04 in.
--------------------------	-----------------------	-----------------------------------

Adjustment of brake spring play

1. Place the motion control lever to the **NEUTRAL LOCK** position.
2. Be sure to chock the rear wheels.
3. Release the parking brake completely.
4. Loosen the lock nuts.
5. Hold the brake rod by hand.
6. Tighten the nut to the correct space between the end of the spring and the nut.
7. Lock the nuts.
8. Adjust the other side spring to the same dimension.

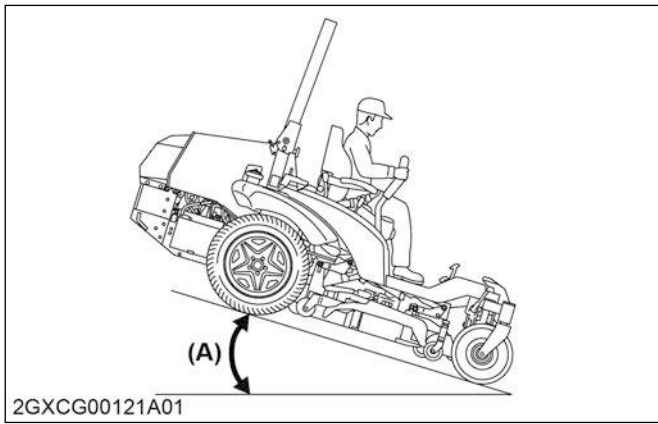
Adjustment of brake spring length

1. Place the motion control lever to the **NEUTRAL LOCK** position.
2. Apply the parking brake to the lock position.
3. Loosen the lock nuts.
4. Adjust the spring length to the recommendation.
5. Lock the nuts.
6. Check the brake spring play to the recommendation. If there is no play, adjust the brake spring play again. (See "Adjustment of brake spring play")
7. Adjust the other side spring to the same dimension.

6.5 Check on slope

NOTE

- For parking brake test purposes only use 17° ramp.



(A) Under 17° ramp

1. Place the machine on a 17° ramp.
2. Apply the parking brake.
3. Place the motion control levers in "NEUTRAL LOCK" position and shut off the engine.
4. Check that the machine does not move.

6.6 Greasing mower link bushing

WARNING

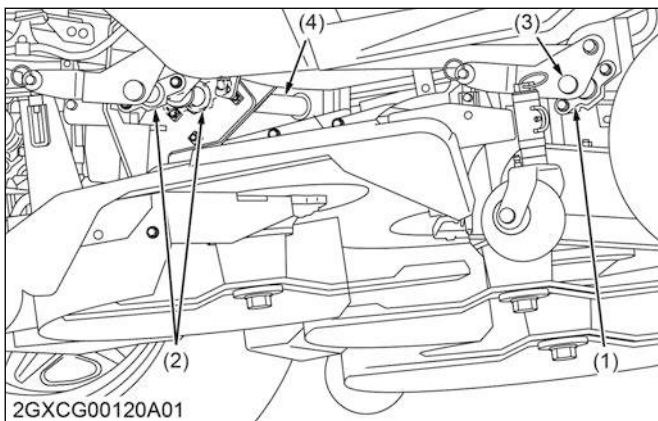
To avoid serious injury or death:

- Be sure to stop the engine and remove the key before greasing.

IMPORTANT

- If you operated the machine in extremely wet and muddy conditions, lubricate grease fittings more often.

1. Grease the following locations (1), (2).



- | | |
|---|----------------------|
| (1) Front mower link bushing (L.H., R.H.) | (3) Front mower link |
| (2) Rear mower link bushing (L.H., R.H.) | (4) Rear mower link |

6.7 Checking battery condition

DANGER

To avoid the possibility of battery explosion:

For the refillable type battery, follow the instructions below.

- Do not use or charge the refillable type battery if the fluid level is below the LOWER (lower limit level) mark. Otherwise, the battery component parts may prematurely deteriorate, which may shorten the battery's service life or cause an explosion.
- Check the fluid level regularly and add distilled water as required so that the fluid level is between the UPPER and LOWER levels.

DANGER

To avoid serious injury or death:

- 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.

WARNING

To avoid serious injury or death:

- Batteries, battery posts, terminals and related accessories contain lead and lead compounds, and other chemicals known to the State of California to cause cancer and birth problems or other reproductive harm. **WASH HANDS AFTER HANDLING.**
- Never remove the battery cap while the engine is running.
- Keep electrolyte away from eyes, hands and clothes. If you are splattered with it, wash it away completely with water immediately and get medical attention.
- Wear eye protection and rubber gloves when working around battery.

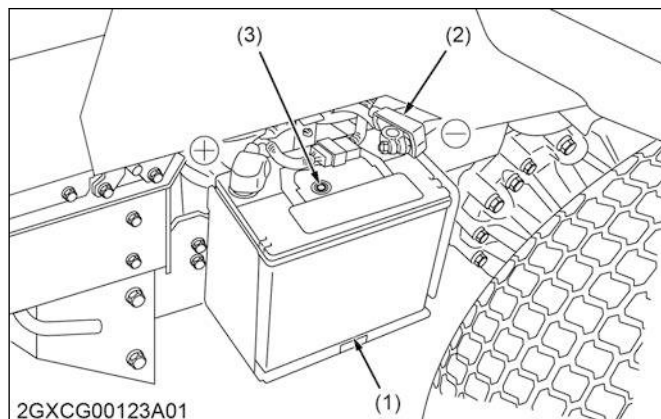
IMPORTANT

- Mishandling the battery shortens the service life and adds to maintenance costs.
- The original battery is maintenance free, but needs some servicing.
- If the battery is weak, the engine will be difficult to start and the lights will be dim. It is important to check the battery periodically.
- When exchanging an old battery for new one, use battery of equal specification in table below.

NOTE

- The factory-installed battery is of non-refillable type. If the battery is weak, charge the battery or replace it with new one.

Battery type	Volts (V)	Reserve Capacity (min)	Cold Cranking Amps	Normal Charging Rate (A)
24R	12	115	670	6.6



- (1) Battery (3) Indicator
(2) Ground cable

- If the battery is weak, the engine will be difficult to start and the lights will become dim. It is important to check the battery periodically.

How to read the indicator

- Check the battery condition by reading the indicator.

State of indicator display	
Green	Specific gravity of electrolyte and quality of electrolyte are both in good condition.
Black	Needs charging battery.
White	Needs replacing battery.

6.8 Charging battery



DANGER

To avoid serious injury or death:

- 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.

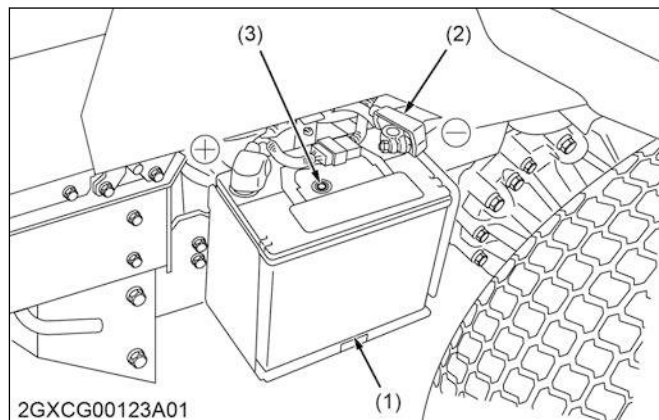


WARNING

To avoid serious injury or death:

- When disconnecting the cables from the battery, start with the negative terminal first.

- When connecting the cables 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.
- Wear eye protection and rubber gloves when working around battery.



- (1) Battery (2) Ground cable (3) Indicator
(+) Positive terminal (-) Negative terminal

- To slow charge the battery, connect the battery positive terminal to the charger positive terminal and the negative to the negative, then charge for at least 1 hour at 4.5 amperes.
- A boost charge is only for emergencies. It will partially charge the battery at a higher rate and in a short time. When using a boost-charged battery, it is necessary to recharge the battery as soon as possible.
- When the specific gravity of electrolyte reaches 1.27 to 1.29, charge has completed.
- When exchanging an old battery with new one, use a battery of equal specification.
- For non-accessible maintenance-free type batteries. Maintenance-free, non-accessible batteries are designed to eliminate the need to add water. Yet the volume of electrolyte above plates may eventually become depleted due to abnormal conditions such as high heat or improper regulator setting. Use LCD monitor or a voltmeter to check the state of charge. (See reference chart below to determine if charging is necessary.)

Battery for storage

- When storing the machine for a long period, remove the battery from machine, adjust the electrolyte to the proper level and store in a dry place out of direct sunlight.
- The battery self-discharges while it is stored. Recharge it once every 3 months in hot seasons and once every 6 months in cold seasons.

Battery voltage	Reference state of charge
12.6	100% (Full charge)
12.4	75%
12.2	50%
12.0	25%
11.8	0%

— RELATED PAGE —
[SPECIFICATIONS on page 1-13](#)

7. Check point of every 150 hours

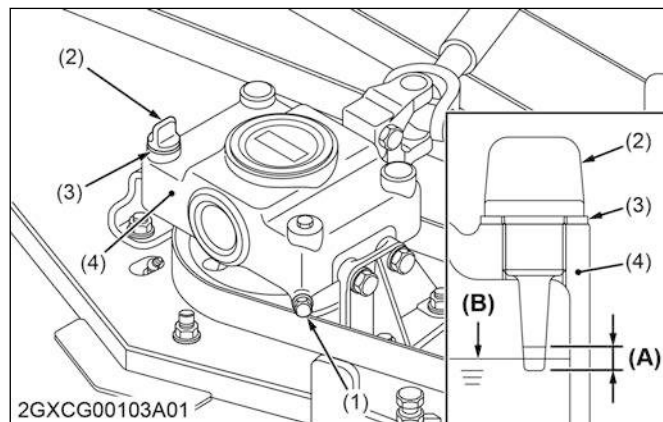
7.1 Changing gear box oil level

WARNING

To avoid serious injury or death:

- Always stop the engine and remove the key before checking oil.

1. To drain the used oil, remove the drain plug and oil inlet plug with gauge at the gear box and drain the oil completely into the oil pan.
2. After draining, reinstall the drain plug.
3. Fill with the new oil up to the check plug port.
4. After filling, reinstall the check plug and oil inlet plug with gauge securely.



- | | |
|-------------------------------|--|
| (1) Drain plug | (A) Oil level is acceptable within this range. |
| (2) Oil inlet plug with gauge | (B) Oil level |
| (3) Seal washer | |
| (4) Gear case | |

— RELATED PAGE —
[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

8. Check points of every 200 hours

8.1 Changing engine oil

WARNING

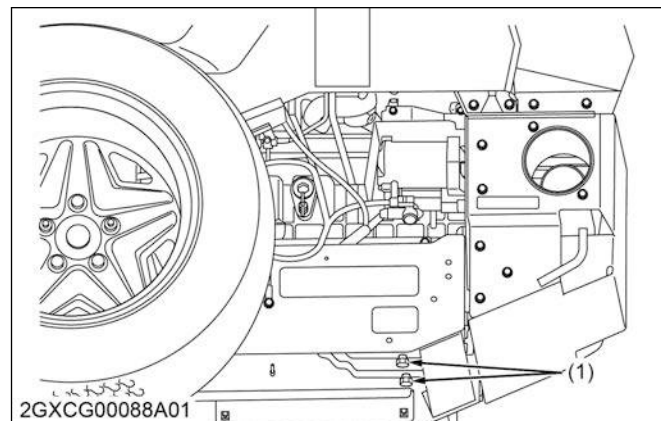
To avoid serious injury or death:

- Be sure to stop the engine before changing oil.
- Allow engine to cool down sufficiently; oil can be hot and may cause burns.

■ IMPORTANT

- When using oil of different manufacture or viscosity from the previous one, remove all of the old oil.
- Never mix two different type of oil.
- Use the proper SAE engine oil according to ambient temperatures.

1. To change the used oil, remove the drain plug at the bottom of the engine and drain the oil completely. The used oil can be drained out more easily if the engine is warm.
2. Fill with the new oil up to the upper notch on the dipstick.



- (1) Drain plug

3. To change the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw in the drain plug (1).
5. Fill with the new oil up to upper line on the dipstick.

Engine oil	Capacity	6.4 L 6.8 U.S.qts 5.6 Imp.qts
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8.2 Replacing engine oil filter

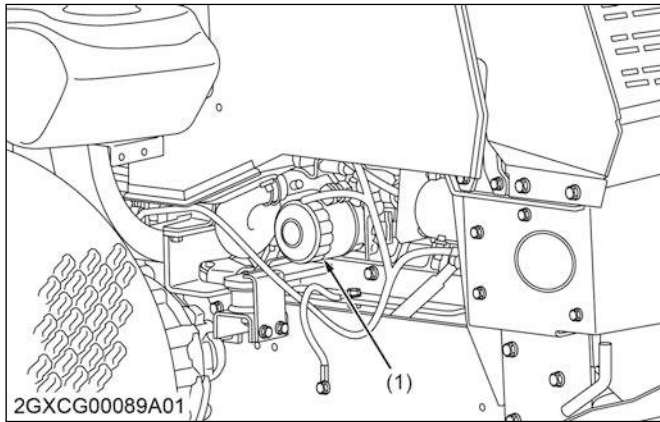
WARNING

To avoid serious injury or death:

- Be sure to stop the engine before changing the oil filter.
- Allow engine to cool down sufficiently, oil can be hot and may cause burns.

■ **IMPORTANT**

- To prevent serious damage to the engine, element of recommended type must be used. Use only a genuine KUBOTA filter or its equivalent.
1. Remove the engine oil filter (1) with the filter wrench.
 2. Apply a slight coat of oil onto the rubber gasket of new filter.
 3. Tighten the filter quickly until it contacts the mounting surface. Tighten filter by hand an additional 1/2 turn only.
 4. After the filter has been replaced, the engine oil level normally lowers a little. Add engine oil to proper level. Check for oil leaks around filter gasket.



(1) Engine oil filter

8.3 Replacing HST transmission oil filter



WARNING

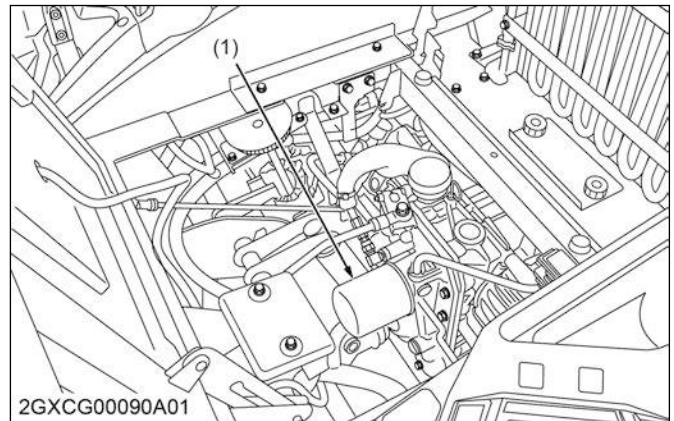
To avoid serious injury or death:

- Be sure to stop the engine before changing the oil filter.
- Allow transmission case to cool down sufficiently; oil can be hot and may cause burns.

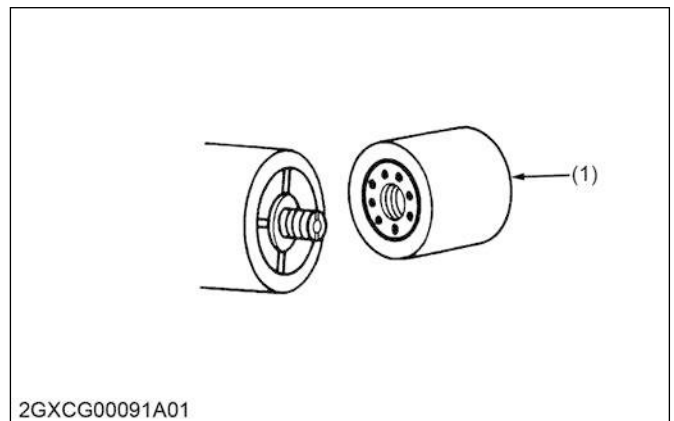
■ **IMPORTANT**

- To prevent serious damage or premature failure to the hydraulic system, use only a KUBOTA genuine filter.
1. Place an oil pan underneath the oil filter cartridge. (Do not drain oil.)

2. Remove the oil filter cartridge by using the filter wrench.
3. Apply a slight coat of oil onto the cartridge gasket.
4. Tighten the filter quickly until it contacts the mounting surface. Tighten filter by hand an additional 1/2 turn only.
5. After the new cartridge has been replaced, the transmission fluid level normally lowers a little. Add fluid to proper level. Check for oil leaks around filter gasket.



(1) Transmission oil filter [HST]

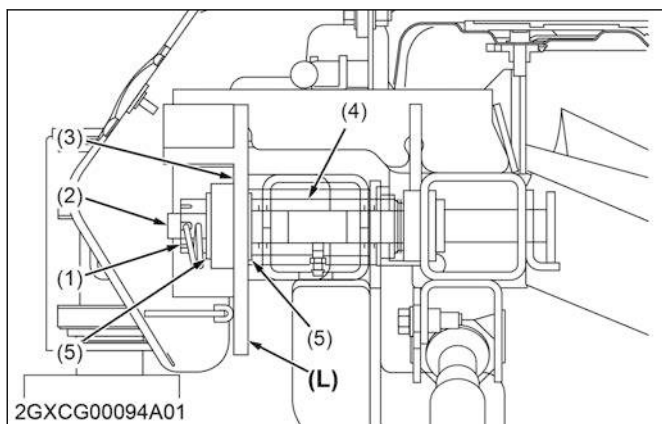
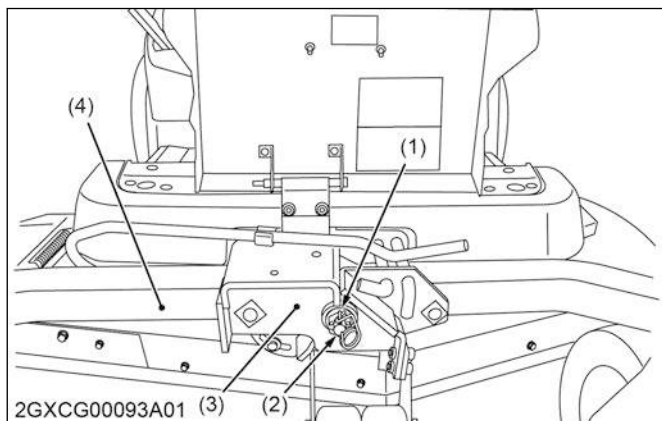


(1) HST transmission oil filter cartridge

8.4 Adjusting front axle pivot

1. Lift up and securely block the front of the machine.
2. Measure the clearance (L) between the front axle (4) and front axle support (3).

3. If the measurement exceeds the allowable limit, remove the set spring and adjust the end play by slotted nut (1).



- (1) Slotted nut
(2) Center pin
(3) Front axle support
(4) Front axle
(5) Plain washer
(L) Front axle end play

NOTE

- When fastening the center pin (2), tighten the nut (1) so that the front axle may be oscillated smoothly by hand.

Front axle end play (L)	Factory specification	0 to 0.2 mm 0 to 0.008 in.
	Allowable limit	0.5 mm 0.02 in.

9. Check points of every 400 hours

9.1 Changing transmission fluid and rear axle gear case oil (R.H. and L.H.)



WARNING

To avoid serious injury or death:

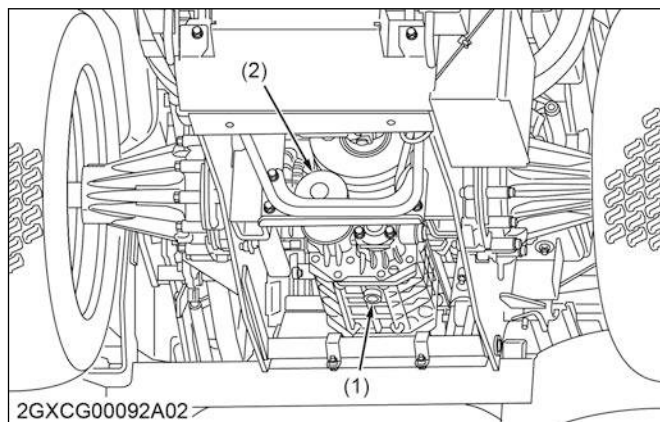
- Be sure to stop the engine and remove the key before changing or checking the oil.

- Allow transmission case to cool down sufficiently; oil can be hot and may cause burns.

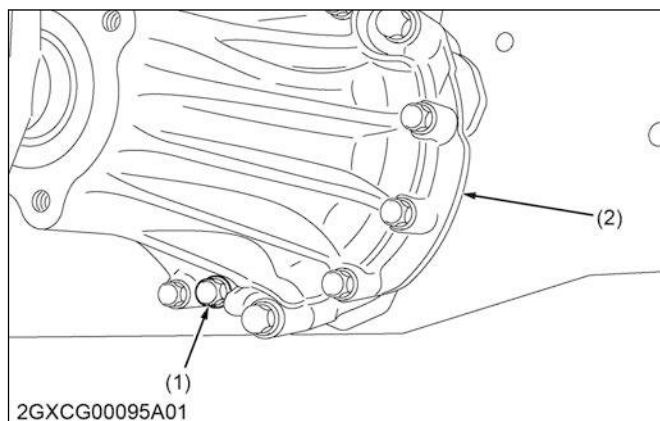
IMPORTANT

- Operate only at low RPM's immediately after changing the transmission fluid and filter cartridge.
- Keep the engine at medium speed for a few minutes to ensure proper lubrication of all parts so there is no damage to transmission.
- Do not mix different brands oil together.
- The fluid in the transmission case is also used for the hydrostatic drive system.

- To drain the transmission oil, place oil pan underneath the transmission case and the rear axle gear case (R.H. and L.H.) and remove the drain plug at the bottom of the transmission case and the rear axle gear case (R.H. and L.H.).
- After draining, reinstall the drain plugs.

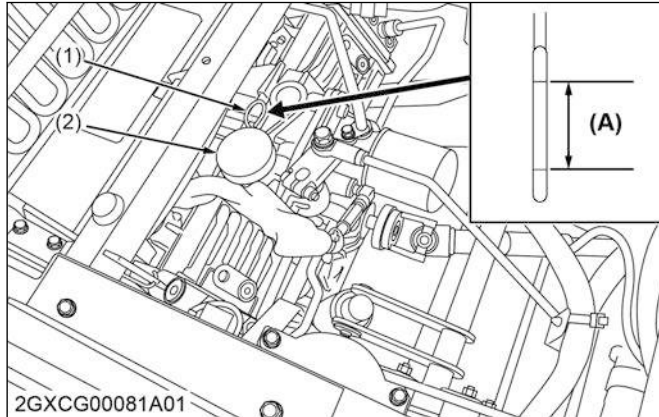


- (1) Drain plug
(2) Hydraulic oil filter



- (1) Drain plug
(2) Rear axle gear case L.H.

3. Fill with UDT, SUPER UDT hydrostatic transmission fluid or its equivalent up to the upper line of the gauge.



- (1) Oil level dipstick (A) Oil level is acceptable within this range.
(2) Oil plug and breather cup

■ **IMPORTANT**

- It takes time to have the oil poured from the transmission case reach the rear axle case (R.H. and L.H.). Pour the regulated amount of oil slowly.

Transmission fluid (with filter and hose)	Capacity	12.1 L 12.8 U.S.qts 10.6 Imp.qts
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4. After running the engine for a few minutes, stop it and check the oil level again; add oil to the prescribed level.

9.2 Replacing hydraulic filter



WARNING

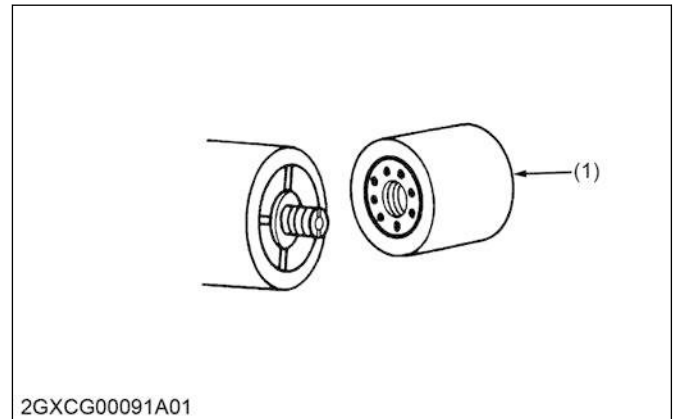
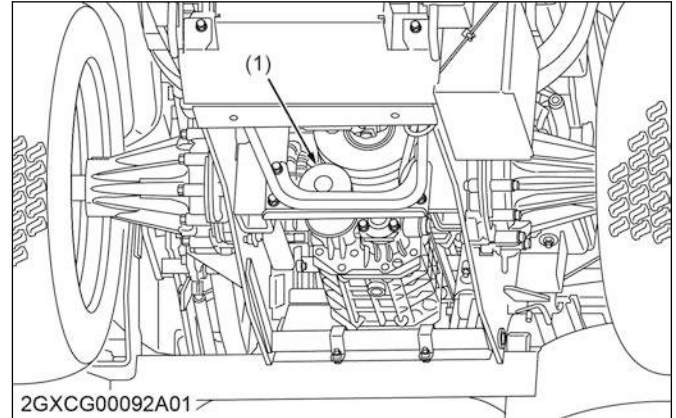
To avoid serious injury or death:

- Be sure to stop the engine before changing the oil filter.
- Allow transmission case to cool down sufficiently; oil can be hot and may cause burns.

■ **IMPORTANT**

- To prevent serious damage or premature failure to the hydraulic system, use only a KUBOTA genuine filter.
1. To drain the transmission oil, place oil pan underneath the transmission case and the rear axle gear case (R.H. and L.H.) and remove the drain plug at the bottom of the transmission case and the rear axle gear case (R.H. and L.H.).
 2. After draining, reinstall the drain plugs.
 3. Remove the oil filter by using the filter wrench.
 4. Apply a slight coat of oil onto the filter gasket.

5. Tighten the filter quickly until it contacts the mounting surface. Tighten filter by hand an additional 1/2 turn only.
6. After the new filter has been replaced, the transmission fluid level normally lowers a little. Add fluid to proper level. Check for oil leaks around filter gasket.



- (1) Hydraulic filter

9.3 Replacing fuel filter



WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key when attempting to make the following checks and changes.
- Never fail to check the fuel lines periodically. The fuel lines are subject to wear and age. Fuel may leak out onto the running engine, causing a fire.

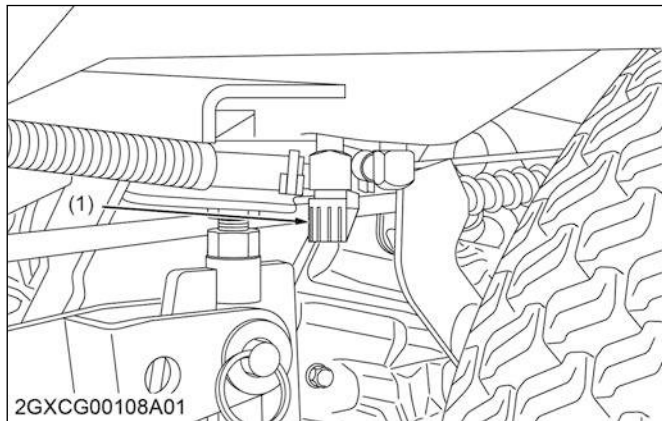
■ **IMPORTANT**

- When the fuel line is disconnected for maintenance or repair, close both ends of the fuel line with a piece of clean cloth or paper to prevent dust and dirt from entering. In addition, particular care must be taken not to admit dust and dirt into the fuel pump. Entrance of dust

and dirt causes malfunction of the fuel pump and injector components.

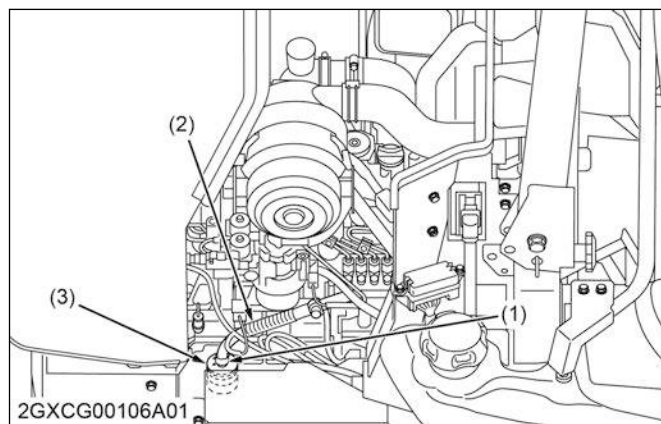
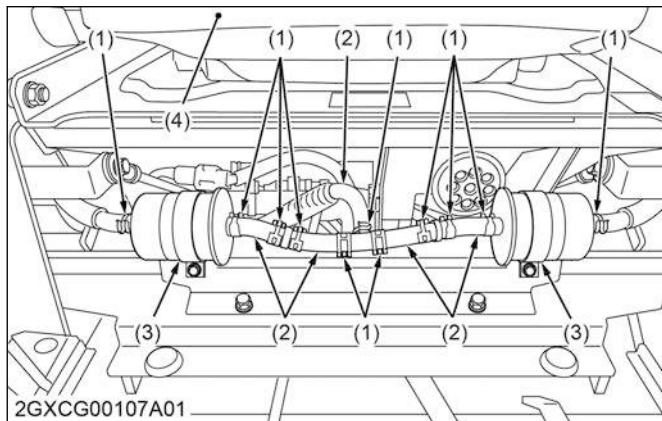
- If replacing fuel filter or fuel lines, you must bleed fuel line.

1. Open the center step and bonnet.
2. Close the fuel valves to both fuel tanks R.H. and L.H.



(1) Fuel valve

3. The fuel line is made of rubber and ages regardless of service period.
4. If the fuel line and clamps are found damaged or deteriorated, replace them.
5. Check fuel filter, if it is clogged by debris or contaminated with water, replace it.



(1) Pipe clamps
(2) Fuel line
(3) Fuel filter
(4) Seat

— RELATED PAGE —

[17.5 Bleeding fuel system on page 2-51](#)

10. Check points of every 800 hours

10.1 Adjusting engine valve clearance

1. Adjust engine valve clearance if needed.

— RELATED PAGE —

[4.1.2 Checking valve clearance on page 3-29](#)

11. Check points of every 1000 hours or 1 year

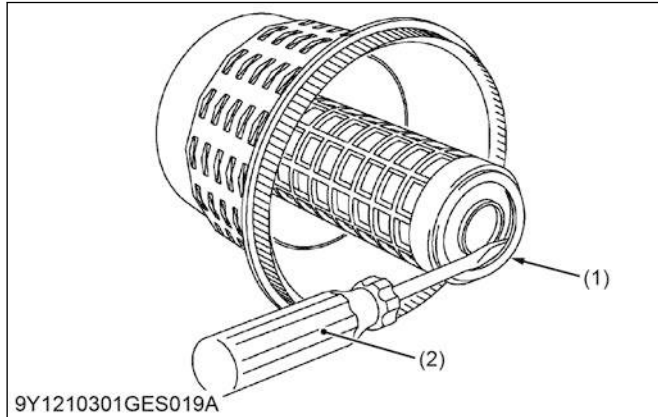
11.1 Replacing air cleaner primary element and secondary element

■ IMPORTANT

- To prevent serious damage to the engine, use only a Kubota genuine filter.
- Pull out the tabs only when replacing the secondary element.

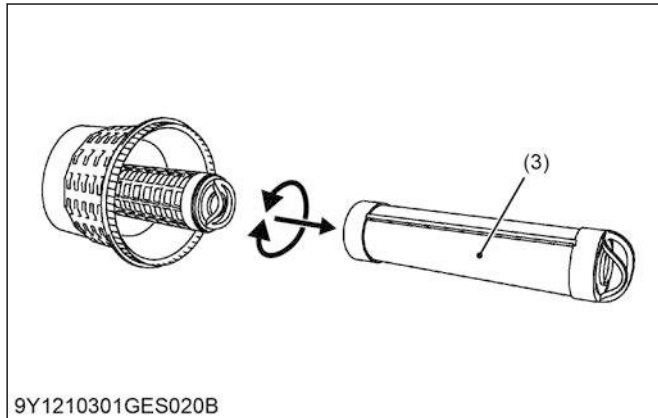
[How to remove the secondary element]

1. Pull out the two tabs of the secondary element using a suitable tool (e.g. Flat-blade screwdriver) as shown in the figure.



(1) Tab (2) Flat-blade screwdriver

2. While turning slightly, pull out the secondary element.



(3) Secondary element

— RELATED PAGE —

[6.1 Cleaning air cleaner primary element on page 2-29](#)

12. Check point of every 1500 hours

12.1 Checking fuel injection nozzle pressure

1. Check the injection nozzle pressure.

— RELATED PAGE —

[4.4.5 Checking fuel injection pressure on page 3-34](#)

13. Check points of every 2000 hours or 2 years

13.1 Flushing cooling system and changing coolant



WARNING

To avoid serious injury or death:

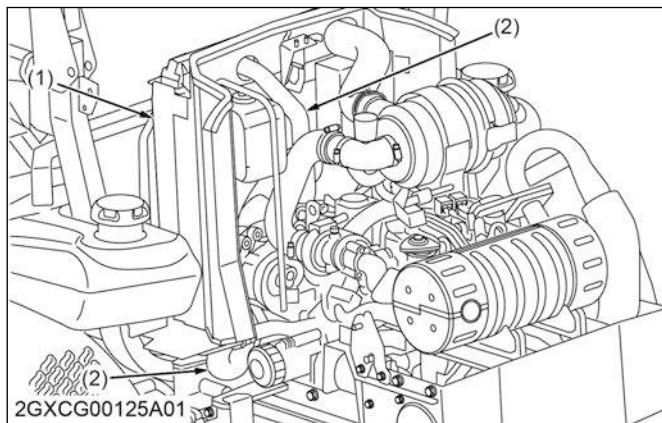
- Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.

IMPORTANT

- Do not start engine without coolant.
- Use clean, fresh water and anti-freeze to fill the radiator and recovery tank.
- When the anti-freeze is mixed with 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.

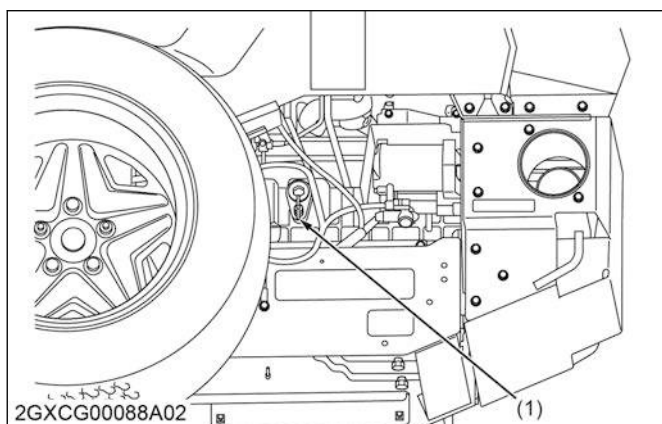
1. Stop the engine and let cool down.
2. To drain the coolant, open the radiator drain valve (See the following figure.) and remove the radiator drain plug and remove radiator cap. For the engine side, disconnect the lower hose and drain the coolant. The radiator cap must be removed to completely drain the coolant.
3. After all coolant is drained, close the drain valve and install 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 fill port on the radiator. Install the radiator cap securely.
7. Fill with coolant up to the FULL mark on the recovery tank.
8. Start and operate the engine for a few minutes.

9. Stop the engine and let cool. Check coolant level of recovery tank and add coolant if necessary.



(1) Recovery tank

(2) Radiator hose



(1) Drain valve

Coolant capacity	Radiator	4.6 L 4.9 U.S.qts 4.0 Imp.qts
	Recovery tank	1.1 L 1.2 U.S.qts 0.97 Imp.qts

— RELATED PAGE —
[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

13.1.1 Anti-freeze

WARNING

To avoid serious injury or death:

- When using anti-freeze, put on some protection such as rubber gloves. (Anti-freeze contains poison.)
- If someone drank anti-freeze, seek immediate medical help. Do NOT make a person throw up unless told to do so by poison control or a health care professional. Use standard first aid and CPR for signs of shock or cardiac arrest.

Call your local Poison Control Center or your local emergency number for further assistance.

- When anti-freeze comes in contact with the skin or clothing, wash it off immediately.
- Do not mix different types of anti-freeze. The mixture can produce chemical reaction causing harmful substances.
- Anti-freeze is extremely flammable and explosive under certain conditions. Keep fire and children away from anti-freeze.
- When draining fluids from the engine, place some container underneath the engine body.
- Do not pour waste onto the grounds, down a drain, or into any water source.
- Also, observe the relevant environmental protection regulations when disposing of anti-freeze.



2GXCG00124A01

NOTE

- Always use a 50/50 mix of long-life coolant and clean soft water in KUBOTA engines.
1. Long-Life Coolant (hereafter LLC) comes in several types. Use Ethylene Glycol (EG) type for this engine.
 2. Before employing LLC-mixed cooling water, fill the radiator with fresh water and empty it again. Repeat this procedure 2 or 3 times to clean up the inside.
 3. Mixing the LLC
Put the LLC in coolant in the percentage (%) for a target temperature. When mixing, stir it up well, and then fill into the radiator.

4. The procedure for the mixing of water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Refer to SAE J1034 standard, more specifically also to SAE J814c.

■ **IMPORTANT**

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

Vol% Anti- freeze	Freeze point		Boiling point*	
	°C	°F	°C	°F
50	-37 °C	-34 °F	108 °C	226 °F

* At 1.013×105 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.

5. Adding the LLC
 - a. Add only water if the mixture reduces in amount by evaporation.
 - b. If there is a mixture leak, add the LLC of the same manufacture and type in the same mixture percentage.
*Never add any long-life coolant of different manufacturer. (Different brands may have different additive components, and the engine may fail to perform as specified.)
6. When the LLC is mixed, do not employ any radiator cleaning agent. The LLC contains anti-corrosive agent. If mixed with the cleaning agent, sludge may build up, adversely affecting the engine parts.
7. KUBOTA's genuine long-life coolant has a service life of 2 years. Be sure to change the coolant every 2 years.

14. Check point of every 3000 hours

14.1 Checking injection pump

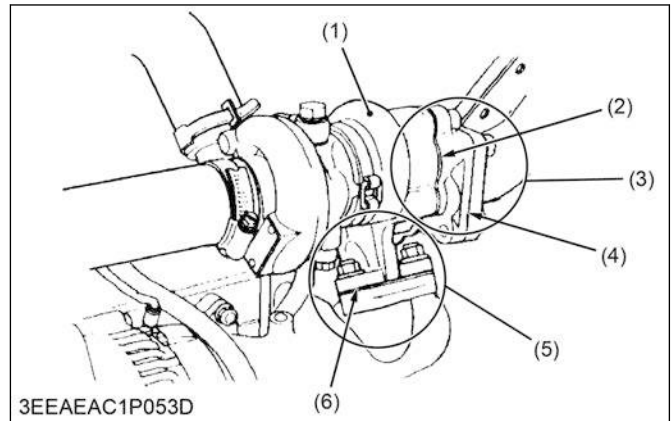
1. Check the injection pump.

— RELATED PAGE —

[4.4.2 Checking fuel tightness of pump element on page 3-33](#)

14.2 Checking turbocharger

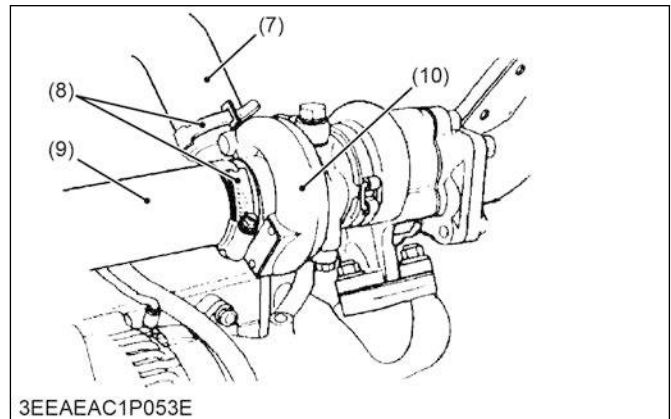
[Turbine side]



- | | |
|---------------------|----------------|
| (1) Turbine housing | (4) Gasket |
| (2) Gasket | (5) Inlet port |
| (3) Exhaust port | (6) Gasket |

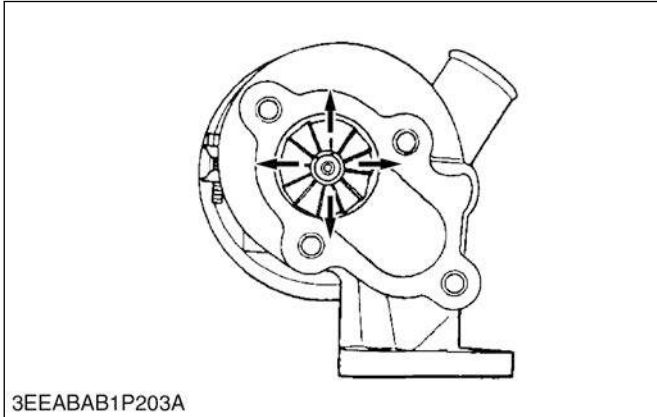
1. Check the exhaust port (3) and inlet port (5) side of turbine housing (1) to see if there is no exhaust gas leak.
2. If any gas leak is found, retighten the bolts and nuts or replace the gasket (2) / (4) / (6) with new one.

[Compressor side]



- | | |
|-----------------|-----------------------|
| (7) Intake hose | (9) Inlet hose |
| (8) Clamp | (10) Compressor cover |

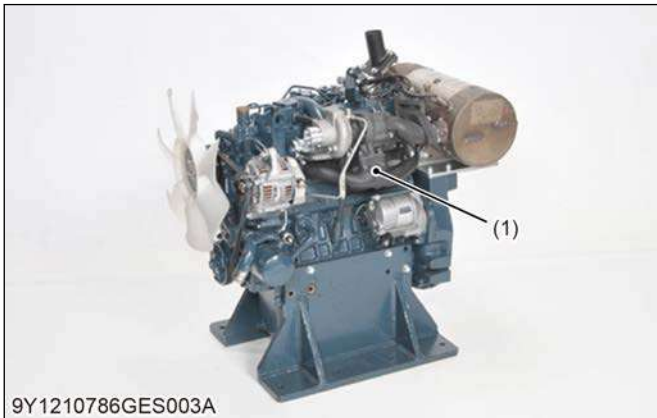
1. Check the inlet hose (9) of the compressor cover (10) to see if there is no air leak.
2. If any air leak is found, change the clamp (8) and / or inlet hoses.
3. Check the intake hose (7) and the clamp to see if there is not loose or crack.
4. If any loose or crack is found, tighten the cramp or change the hose to prevent dust from entry.

[Radial clearance]

1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

15. Check points of every 1 year**15.1 Checking exhaust manifold**

1. Check the exhaust manifold (1) for any crack or damage.



(1) Exhaust manifold

2. If the exhaust manifold (1) is cracked or damaged, replace it with a new one.
3. Check the exhaust manifold mounting screws.
4. If they are loose, tighten them.

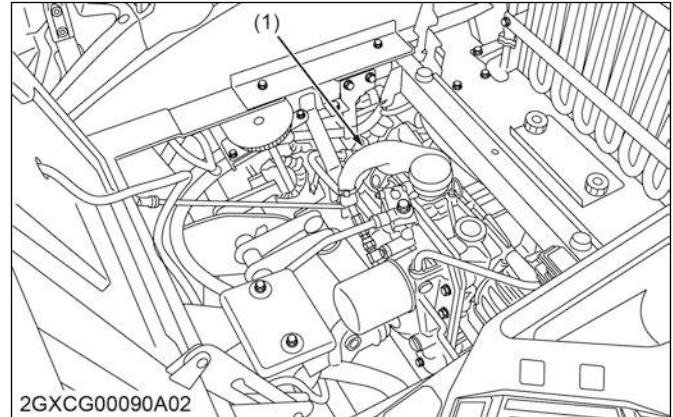
15.2 Checking hydraulic hose**! WARNING**

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before checking and replacing hydraulic hose.
- Allow transmission case to cool down sufficiently; oil can be hot and may cause burns.
- Escaping hydraulic fluid under pressure has sufficient force to penetrate the skin causing serious personal injury. Before disconnecting

lines, be sure to relieve all pressure. Before applying pressure to the system, make sure all connections are tight and that lines, pipes, and hoses are not damaged.

1. Check to see that all lines and hose clamps are tight and not damaged.
2. If hoses and clamps are found worn or damaged, replace or repair them at once.



(1) Mower lift cylinder hose

15.3 Checking radiator hose and clamp**! WARNING**

To avoid serious injury or death:

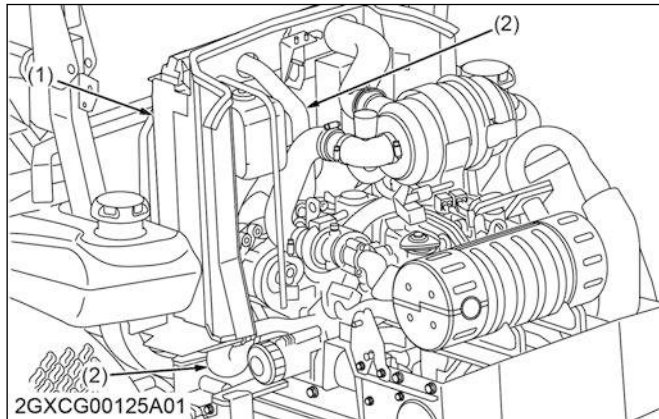
- Be sure to stop the engine and remove the key before checking radiator hose and clamps.

■ NOTE

- Take the following actions in the event the coolant temperature be nearly or more than the boiling point, what is called "Overheating".
- Park the machine in a safe place and keep the engine unloaded idling.
- Do not stop the engine suddenly, but stop it after about 5 minutes of unloaded idling.
- Keep yourself well away from the machine for further 10 minutes or while the steam is blown out.
- Checking that there gets no danger such as burning, get rid of the causes of overheating and then start the engine again.

1. If clamp bands are loose or water leaks, tighten clamp band securely.

2. Replace radiator hoses (2) and tighten hose clamps securely, if radiator hoses (2) are swollen, hardened or cracked.



(1) Radiator core (2) Radiator hose

15.4 Checking fuel lines



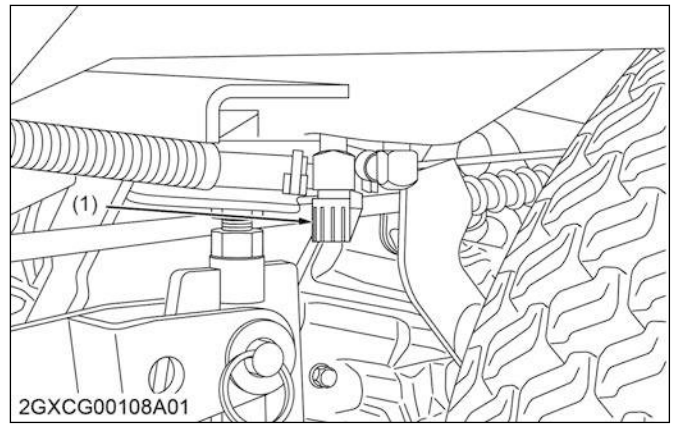
WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key when attempting to make the following checks and changes.
- Never fail to check the fuel lines periodically. The fuel lines are subject to wear and age. Fuel may leak out onto the running engine, causing a fire.

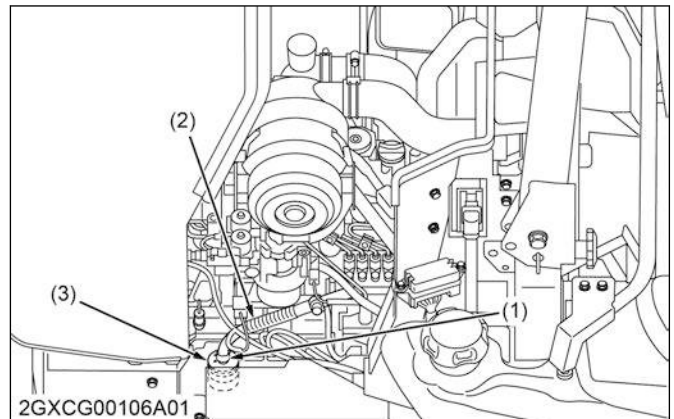
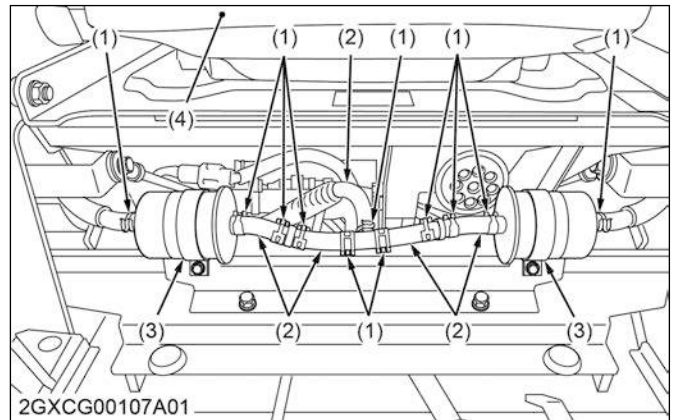
IMPORTANT

- When the fuel line is disconnected for maintenance or repair, close both ends of the fuel line with a piece of clean cloth or paper to prevent dust and dirt from entering. In addition, particular care must be taken not to admit dust and dirt into the fuel pump. Entrance of dust and dirt causes malfunction of the fuel pump and injector components.
 - If replacing fuel filter or fuel lines, you must bleed fuel line.
1. Open the center step and bonnet.
 2. Close the fuel valves to both fuel tanks R.H. and L.H.



(1) Fuel valve

3. The fuel line is made of rubber and ages regardless of service period.
4. If the fuel line and clamps are found damaged or deteriorated, replace them.
5. Check fuel filter, if it is clogged by debris or contaminated with water, replace it.



(1) Pipe clamps (2) Fuel line (3) Fuel filter (4) Seat

— RELATED PAGE —

[17.5 Bleeding fuel system on page 2-51](#)

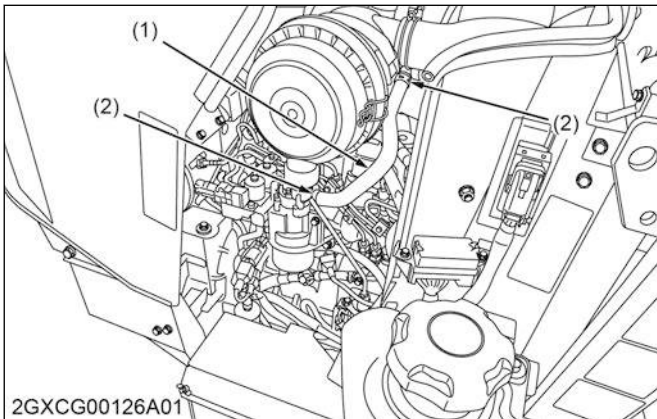
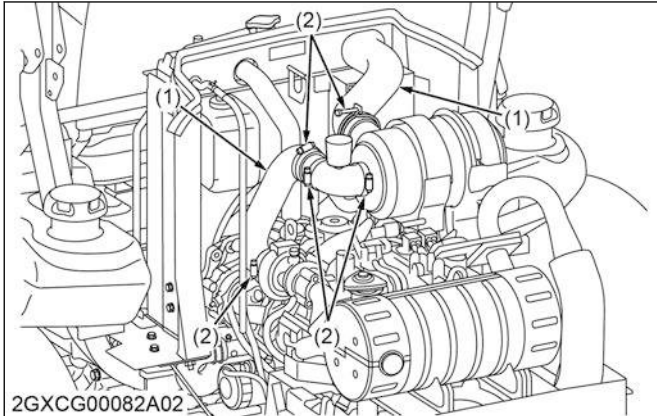
15.5 Checking intake air line

WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before checking intake air line.

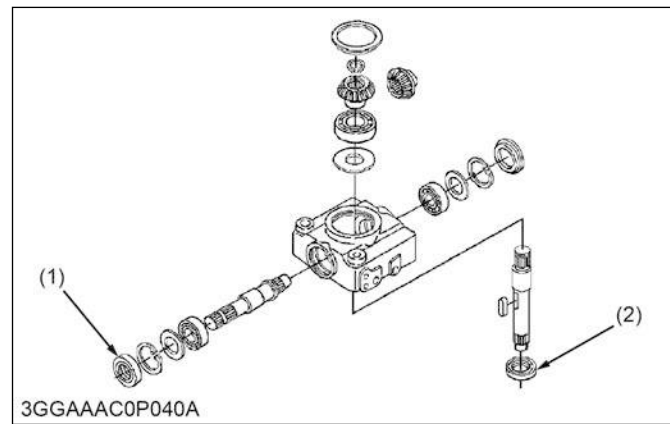
1. Check to see that hoses and hose clamps are tight and not damaged.
2. If hoses and clamps are found worn or damaged, replace or repair them at once.



(1) Hose (2) Clamp

15.6 Checking mower gear box seals

1. Check the mower gear box oil seals (1), (2) for damage.



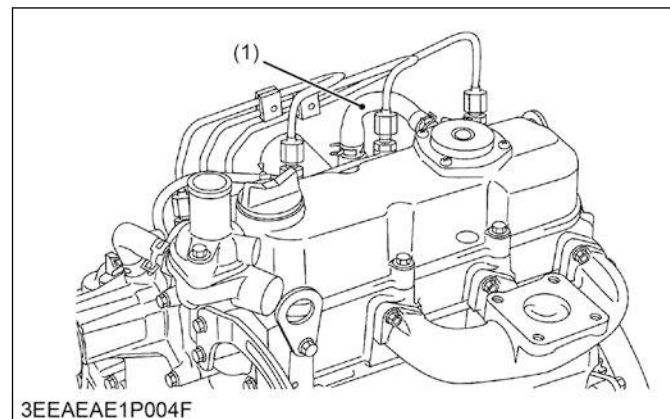
(1) Oil seal (2) Oil seal

— RELATED PAGE —

[5.5 Disassembling gear box on page 8-9](#)

15.7 Checking engine breather hose

1. Check the engine breather hose (1) for damage.
2. If the engine breather hose (1) is damaged, replace it with new one.



(1) Engine breather hose

16. Check point of every 4 years

16.1 Replacing hydraulic hose

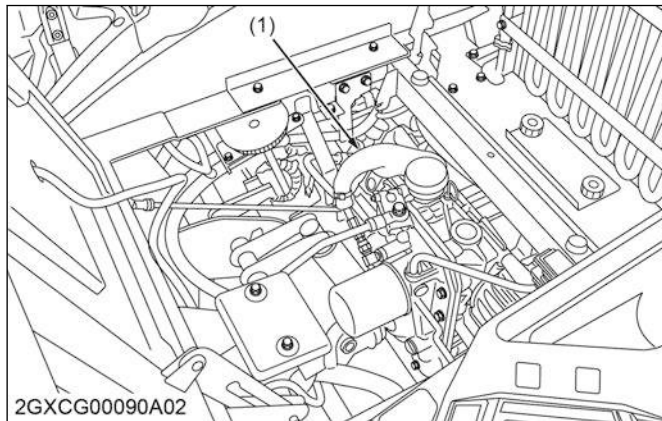
WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before checking and replacing hydraulic hose.
- Allow transmission case to cool down sufficiently; oil can be hot and may cause burns.
- Escaping hydraulic fluid under pressure has sufficient force to penetrate the skin causing serious personal injury. Before disconnecting lines, be sure to relieve all pressure. Before applying pressure to the system, make sure all

connections are tight and that lines, pipes, and hoses are not damaged.

1. Check to see that all lines and hose clamps are tight and not damaged.
2. If hoses and clamps are found worn or damaged, replace or repair them at once.



(1) Mower lift cylinder hose

16.2 Replacing radiator hose

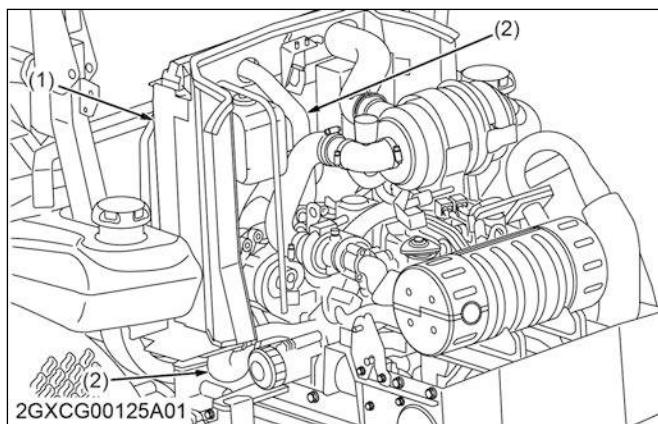
WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before checking radiator hose and clamps.

NOTE

- Take the following actions in the event the coolant temperature be nearly or more than the boiling point, what is called "Overheating".
 - Park the machine in a safe place and keep the engine unloaded idling.
 - Do not stop the engine suddenly, but stop it after about 5 minutes of unloaded idling.
 - Keep yourself well away from the machine for further 10 minutes or while the steam is blown out.
 - Checking that there gets no danger such as burning, get rid of the causes of overheating and then start the engine again.
1. If clamp bands are loose or water leaks, tighten clamp band securely.
 2. Replace radiator hoses (2) and tighten hose clamps securely, if radiator hoses (2) are swollen, hardened or cracked.



(1) Radiator core

(2) Radiator hose

16.3 Replacing fuel lines

WARNING

To avoid serious injury or death:

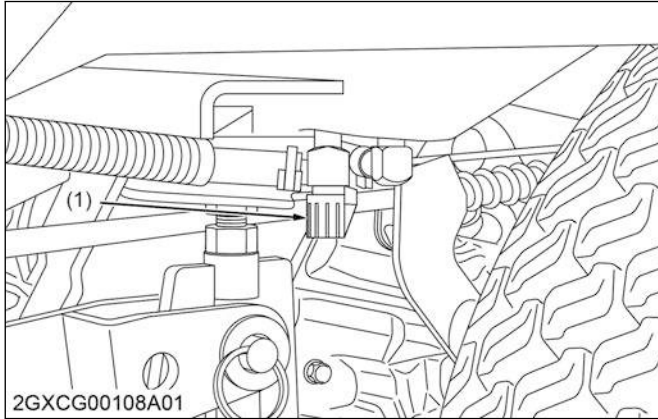
- Be sure to stop the engine and remove the key when attempting to make the following checks and changes.
- Never fail to check the fuel lines periodically. The fuel lines are subject to wear and age. Fuel may leak out onto the running engine, causing a fire.

IMPORTANT

- When the fuel line is disconnected for maintenance or repair, close both ends of the fuel line with a piece of clean cloth or paper to prevent dust and dirt from entering. In addition, particular care must be taken not to admit dust and dirt into the fuel pump. Entrance of dust and dirt causes malfunction of the fuel pump and injector components.
- If replacing fuel filter or fuel lines, you must bleed fuel line.

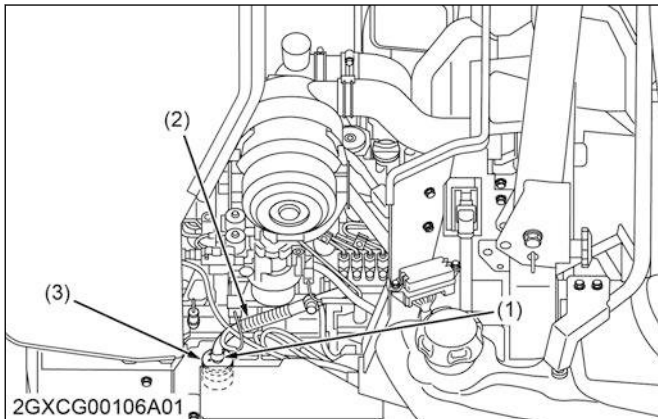
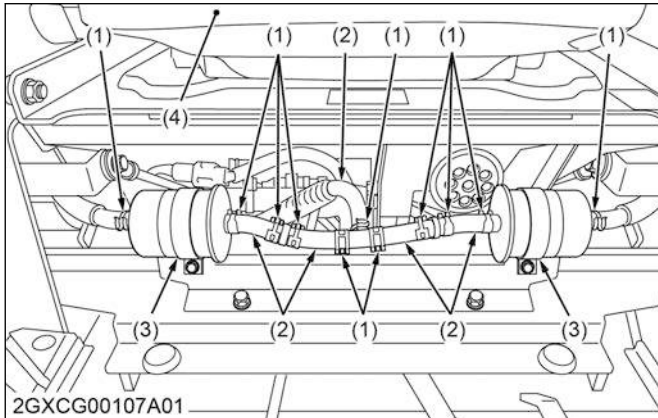
1. Open the center step and bonnet.

- Close the fuel valves to both fuel tanks R.H. and L.H.



(1) Fuel valve

- The fuel line is made of rubber and ages regardless of service period.
- If the fuel line and clamps are found damaged or deteriorated, replace them.
- Check fuel filter, if it is clogged by debris or contaminated with water, replace it.



(1) Pipe clamps
(2) Fuel line
(3) Fuel filter
(4) Seat

16.4 Replacing intake air line

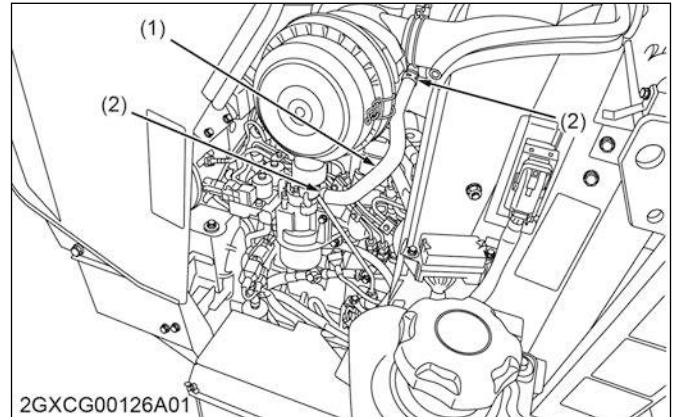
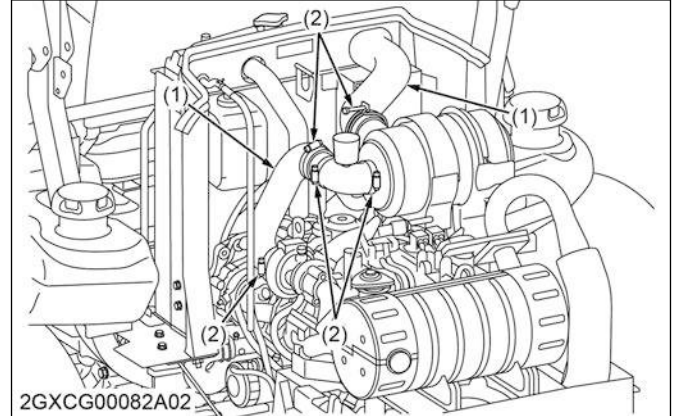


WARNING

To avoid serious injury or death:

- Be sure to stop the engine and remove the key before checking intake air line.

- Check to see that hoses and hose clamps are tight and not damaged.
- If hoses and clamps are found worn or damaged, replace or repair them at once.



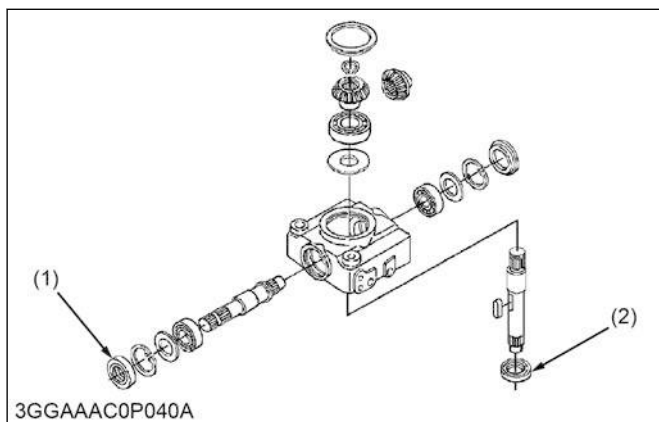
(1) Hose

(2) Clamp

— RELATED PAGE —
[17.5 Bleeding fuel system on page 2-51](#)

16.5 Replacing mower gear box seals

1. Replace the mower gear box oil seals (1), (2) if damaged.



(1) Oil seal

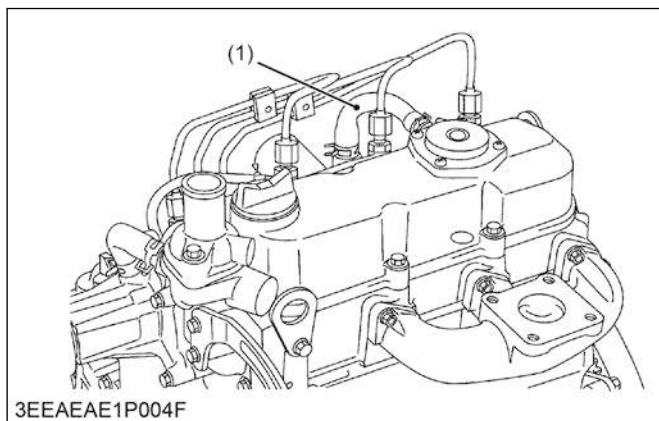
(2) Oil seal

— RELATED PAGE —

[5.5 Disassembling gear box on page 8-9](#)

16.6 Replacing engine breather hose

1. If the engine breather hose (1) is damaged, replace it with new one.



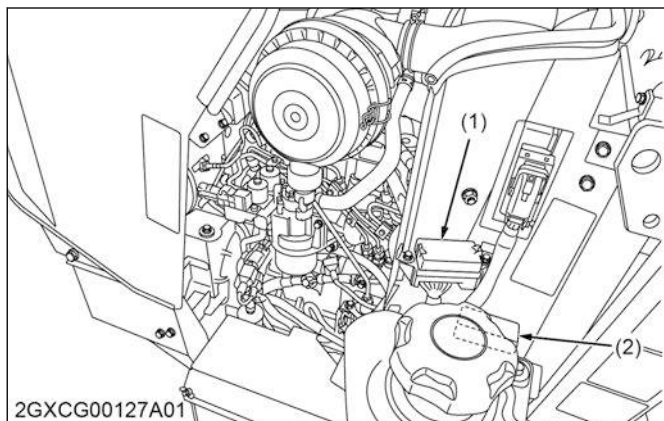
(1) Engine breather hose

17. Others

17.1 Replacing fuses

■ IMPORTANT

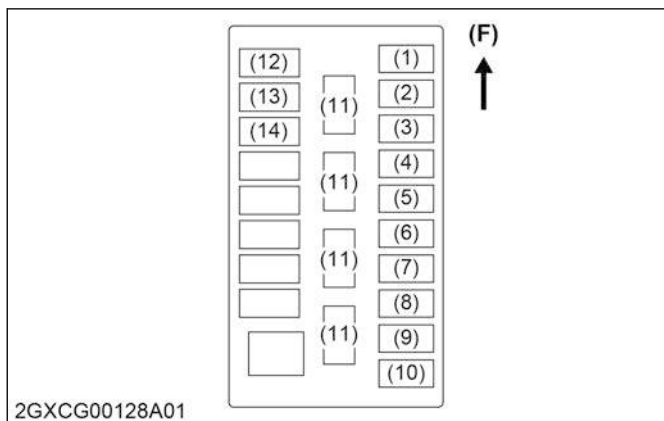
- Before replacing a blown fuse, determine why the fuse blew and make any necessary repairs. Failure to follow this procedure may result in serious damage to the electrical system.
- Never "jump" the fuse with wire or foil, or install a larger capacity fuse than is recommended.



(1) Fuse location

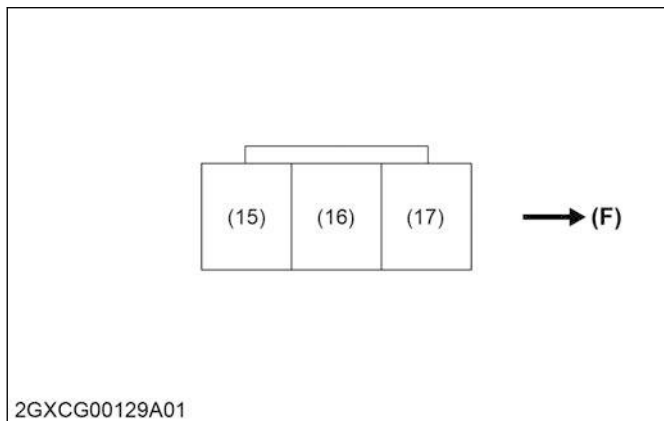
(2) Slow blow fuse

Fuse box



(F) Front

Slow blow fuse box



(F) Front

Protected circuit

Fuse No. (ID label)	Capacity		Protected circuit	Capacity		Protected circuit
Fuse box	(12)	(20A)	(Work light)*1	(1)	5 A	Control system Diag tool
	(13)	10A	Seat compressor	(2)	10 A	ECU
	(14)	5A	Meter (Glow)	(3)	10 A	Alternator Fuel pump Solenoid valve
				(4)	5 A	Engine run (ACC)
				(5)	10 A	Relay (Horn)
				(6)	5 A	Battery meter
				(7)	10 A	Relay (Reformulated glow)
				(8)	20 A	Relay (Auxiliary)
				(9)	5 A	Relay (Starter)
			Fuse puller	(10)	5 A	Relay (Glow)
Slow blow fuse box	(15)	Slow blow fuse 60 A		Alternator		
	(16)	Slow blow fuse 40 A		ECU Glow		
	(17)	Slow blow fuse 40 A		Key switch Starter		

*1 Option: The fuse should be in only when the work light is attached.

1. Check all fuses; if blown replace with new fuse.

17.2 Checking mower blade**WARNING**

To avoid serious injury or death:

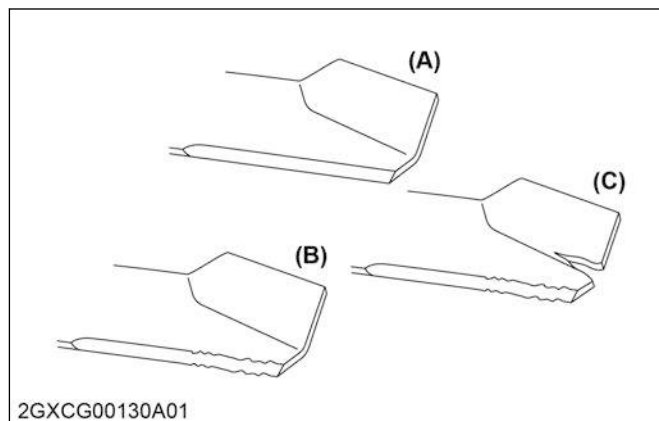
- Be sure to stop the engine and remove the key.
- Blades may be sharp. When you handle blades, wear heavy gloves or wrap end of blade with a rag.

IMPORTANT

- Use the proper metric size box or socket wrench to tighten or loosen the blade mounting bolt.

NOTE

- Before checking or replacing the blade, wipe grass and mud off the top and inside of the mower.
 - Especially clean up the inside of the belt cover, because otherwise the belt life will be reduced.
1. The blade cutting edges must be kept sharp at all times. Sharpen the cutting edges, if they resemble blade (B). Replace the blades if they appear similar to blade (C).



(A) New blade

(B) Worn blade

(C) Cracked blade

17.3 Replacing mower blade**WARNING**

To avoid serious injury or death:

- Be sure to stop the engine and remove the key.
- Blades may be sharp. When you handle blades, wear heavy gloves or wrap end of blade with a rag.

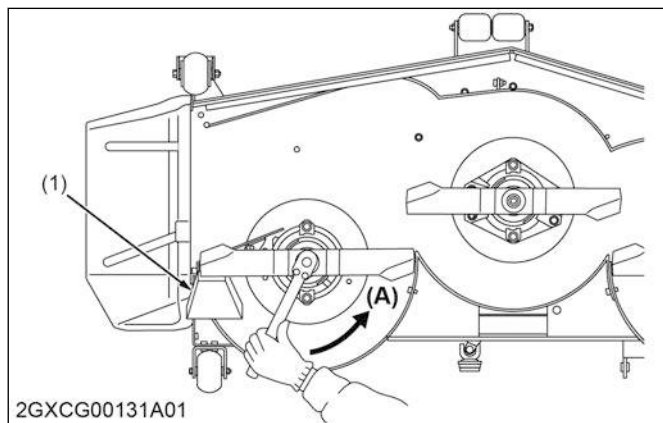
IMPORTANT

- The blade bolts have right hand threads. Turn them counterclockwise to loosen.
- To prolong the service life of the blades, reposition them as shown in the figure to the right periodically.

NOTE

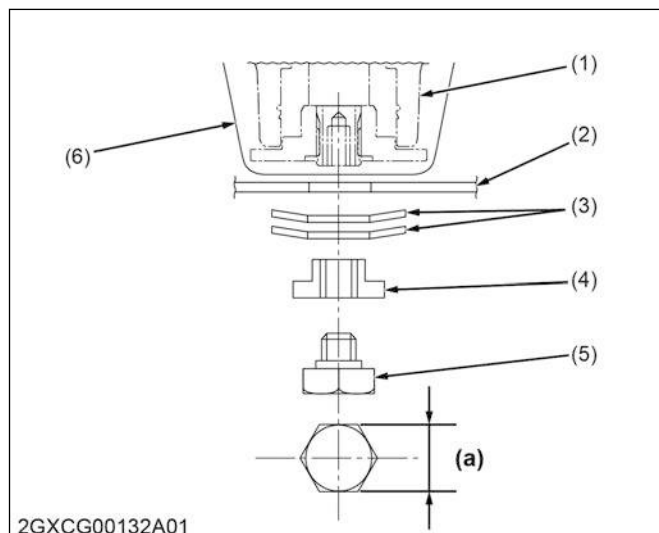
- Make sure that the cup washer is not flattened out or worn; this cause blade to slip excessively.
- Replace the 2 cup washers if either is damaged.

1. Tilt up the mower deck.
2. Wedge a block of wood between the blade and mower housing or use a box wrench over the pulley nut to prevent the spindle from rotating while removing the blade bolts; loosen the blade bolt as illustrated.



(1) Block (A) Loosen

3. To sharpen the blades yourself, clamp the blade securely in a vise. Use a large mill file and file along the original bevel until sharp.
4. To check the blade for balance, place a small rod through the center hole. If the blade is not balanced, file the heavy side of the blade until balance is achieved.
5. Pass the spline boss through the blade and 2 cup washers, and tighten the bolt.



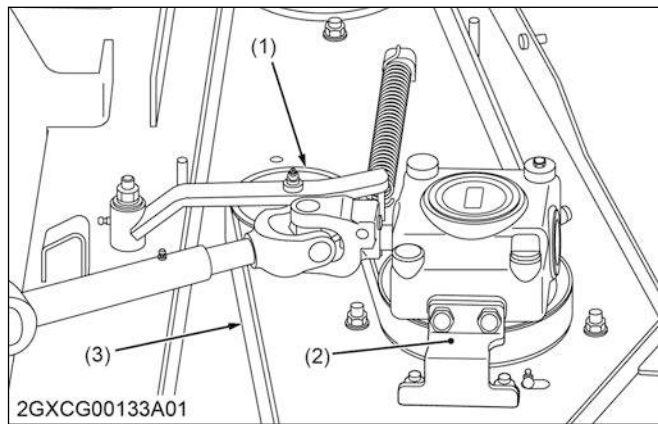
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- (1) Spindle holder
(2) Blade
(3) 2-cup washers
(4) Lock washer
(5) Bolt
(6) Spindle guard
(a) 30 mm

Tightening torque	Mower blade bolt	103 to 118 N · m 10.5 to 12.0 kgf · m 75.9 to 87.0 lbf · ft
-------------------	------------------	---

17.4 Replacing mower belt

1. Remove the mower deck from the machine.
2. Remove the left and right hand shield from the mower deck.
3. Clean around the gear box.
4. Remove the belt from the tension pulley.
5. Remove the right hand bracket which mounts the gear box to the mower deck and slip the belt over the top of the gear box.
6. To install a new belt, reverse the above procedure.



(1) Tension pulley
(2) Bracket (R.H.)
(3) Belt

(When reassembling)

Tightening torque	Bracket mounting bolt	77.6 to 90.2 N·m 8.00 to 9.20 kgf·m 57.1 to 66.5 lbf·ft
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17.5 Bleeding fuel system

■ **IMPORTANT**

Air must be removed:

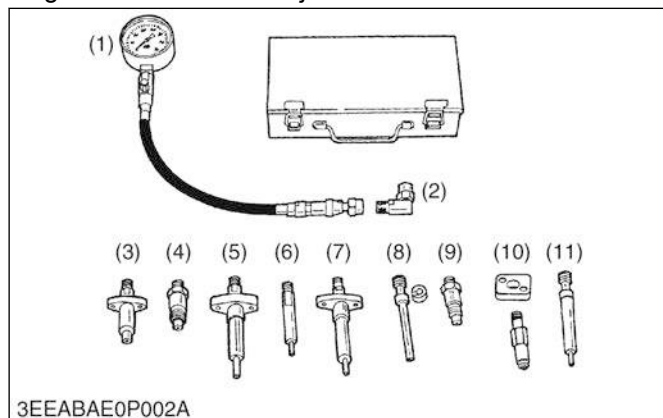
- 1. When the fuel filter or lines are removed.**
 - 2. When tank is completely empty.**
 - 3. After the tractor has not been used for a long period of time.**
1. Fill the fuel tank with fuel.
 2. Start the engine and run for about 30 seconds, and then stop the engine.

SPECIAL TOOLS

1. Special tools for engine

1.1 Diesel engine compression tester (for nozzle hole)

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



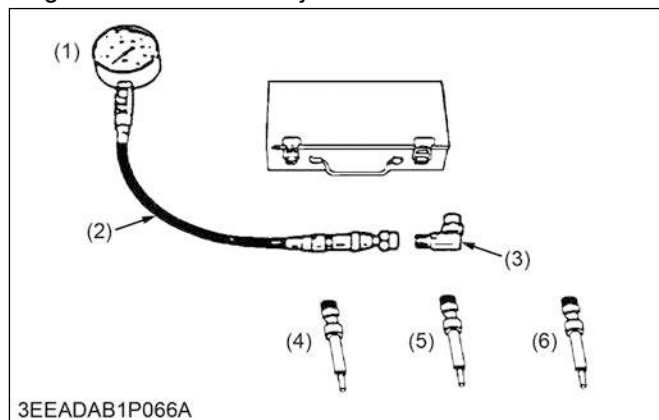
- | | |
|---------------|----------------|
| (1) Gauge | (7) Adaptor F |
| (2) L joint | (8) Adaptor G |
| (3) Adaptor A | (9) Adaptor H |
| (4) Adaptor B | (10) Adaptor I |
| (5) Adaptor C | (11) Adaptor J |
| (6) Adaptor E | |

Code No.

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

1.2 Diesel engine compression tester (for glow plug hole)

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



- | | |
|-------------------|---------------|
| (1) Gauge | (4) Adaptor K |
| (2) Hose assembly | (5) Adaptor L |
| (3) L joint | (6) Adaptor M |

Code No.

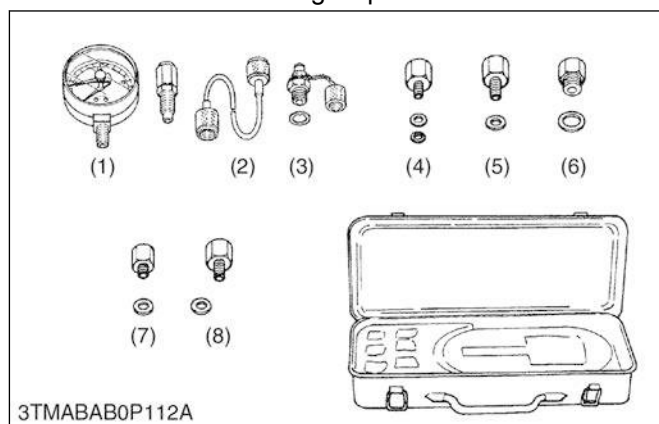
- 07909-39081 (Assembly)
- 07909-31291 (K)
- 07909-31301 (L)
- 07909-31311 (M)

Adaptor

- The adaptor K is necessary.

1.3 Oil pressure tester

Use to measure lubricating oil pressure.



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

Code No.

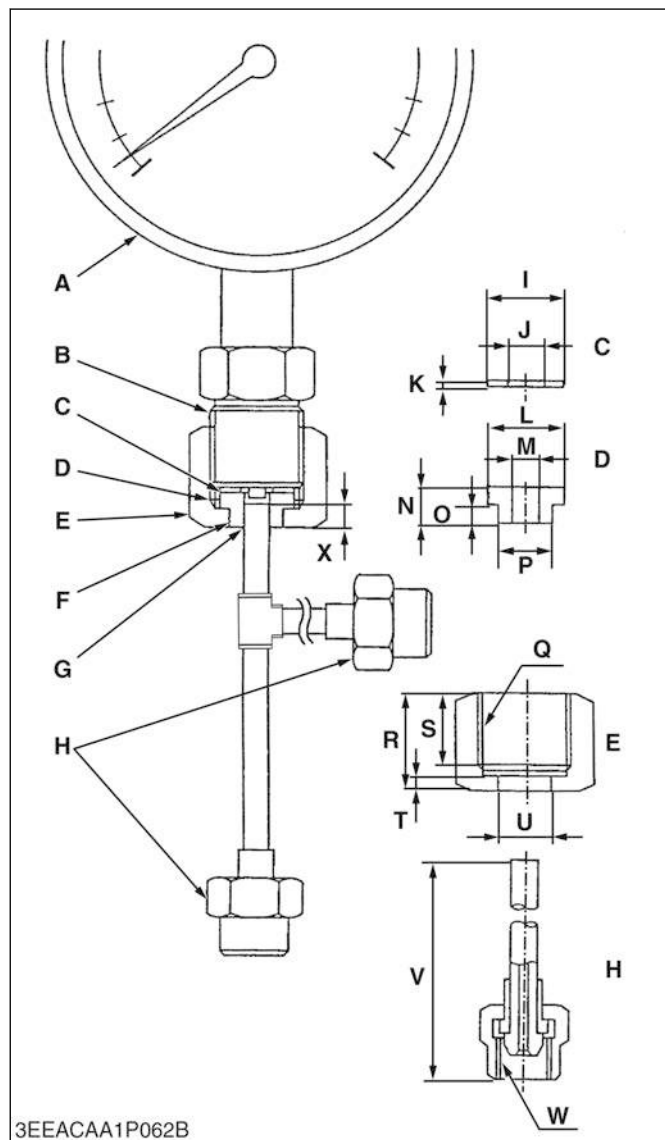
- 07916-32032

1.4 Injection pump pressure tester

Use to check fuel tightness of injection pumps.

■ NOTE

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



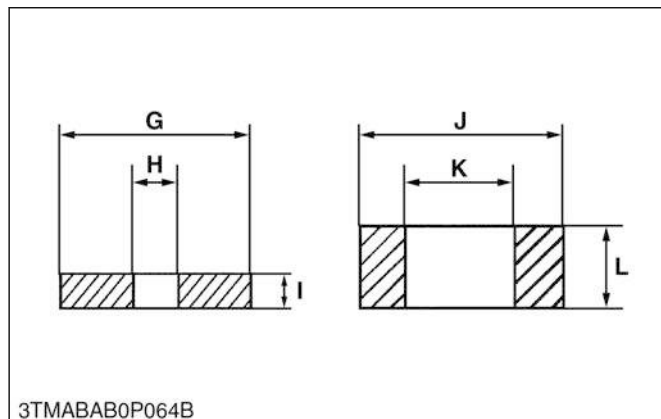
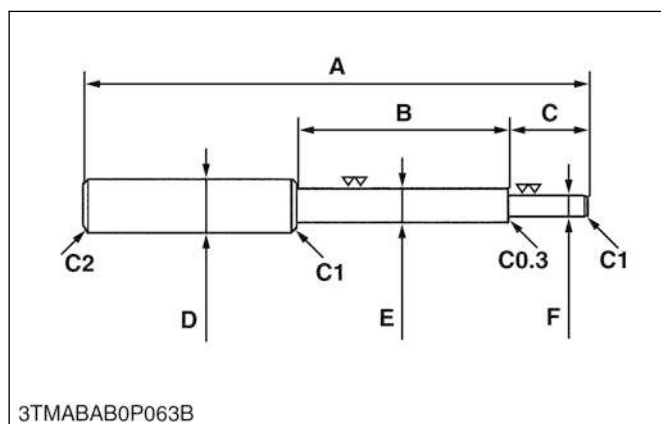
A	Pressure gauge full scale: More than 29.42 MPa (300.0 kgf/cm ² , 4267 psi)
B	PF 1/2
C	Copper gasket
D	Flange (Material: Steel)
E	Hex. nut 27 mm (1.1 in.) across the plat
F	Adhesive application
G	Fillet welding on the enter circumference
H	Retaining nut
I	17 mm dia. (0.67 in. dia.)
J	8.0 mm dia. (0.31 in. dia.)
K	1.0 mm (0.039 in.)
L	17 mm dia. (0.67 in. dia.)
M	6.10 to 6.20 mm dia. (0.241 to 0.244 in. dia.)
N	8.0 mm (0.31 in.)
O	4.0 mm (0.16 in.)
P	11.97 to 11.99 mm dia. (0.4713 to 0.4720 in. dia.)
Q	PF 1/2
R	23 mm (0.91 in.)
S	17 mm (0.67 in.)
T	4.0 mm (0.16 in.)
U	12.00 to 12.02 mm dia. (0.472 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5.0 mm (0.20 in.)

1.5 Valve guide replacing tool

Use to press out and press fit the valve guide.

■ NOTE

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



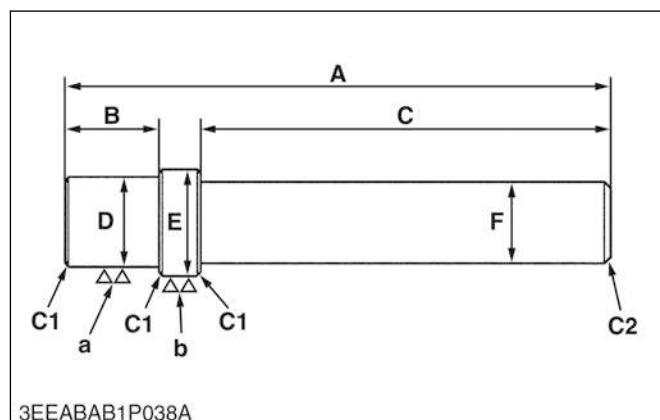
A	225 mm (8.86 in.)
B	70 mm (2.8 in.)
C	45 mm (1.8 in.)
D	20 mm dia. (0.79 in. dia.)
E	11.7 to 11.9 mm dia. (0.461 to 0.468 in. dia.)
F	6.50 to 6.60 mm dia. (0.256 to 0.259 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	6.70 to 7.00 mm dia. (0.264 to 0.275 in. dia.)
I	5.0 mm (0.20 in.)
J	20 mm dia. (0.79 in. dia.)
K	12.5 to 12.8 mm dia. (0.493 to 0.503 in. dia.)
L	8.90 to 9.10 mm (0.351 to 0.358 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.30 mm (0.012 in.)

1.6 Bushing replacing tool

Use to press out and press fit the bushing.

NOTE

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



For small end bushing

A	157 mm (6.18 in.)
B	24 mm (0.94 in.)
C	120 mm (4.72 in.)
D	21.8 to 21.9 mm dia. (0.859 to 0.862 in. dia.)
E	24.8 to 24.9 mm dia. (0.977 to 0.980 in. dia.)
F	20 mm dia. (0.79 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

For idle gear bushing

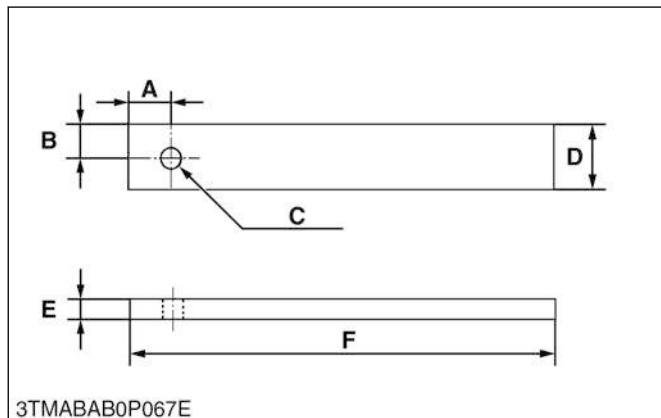
A	196 mm (7.72 in.)
B	26 mm (1.0 in.)
C	150 mm (5.91 in.)
D	25.80 to 25.90 mm dia. (1.016 to 1.019 in. dia.)
E	28.80 to 28.90 mm dia. (1.134 to 1.137 in. dia.)
F	20 mm dia. (0.79 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

1.7 Flywheel stopper

Use to loosen and tighten the flywheel screw.

NOTE

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



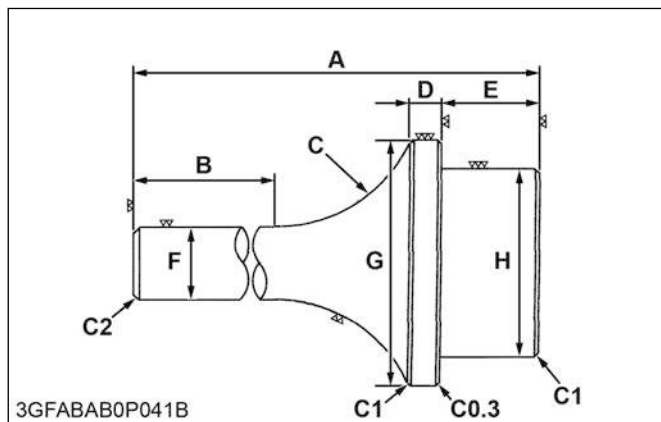
A	20 mm (0.79 in.)
B	15 mm (0.59 in.)
C	10 mm dia. (0.39 in. dia.)
D	30 mm (1.2 in.)
E	8.0 mm (0.31 in.)
F	200 mm (7.87 in.)

1.8 Crankshaft bearing 1 replacing tool

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

NOTE

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



[Press out]

A	135 mm (5.31 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	10 mm (0.39 in.)
E	24 mm (0.94 in.)
F	20 mm dia. (0.79 in. dia.)
G	51.20 to 51.40 mm dia. (2.016 to 2.023 in. dia.)
H	47.30 to 47.50 mm dia. (1.863 to 1.870 in. dia.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.30 mm (0.012 in.)

[Press fit]

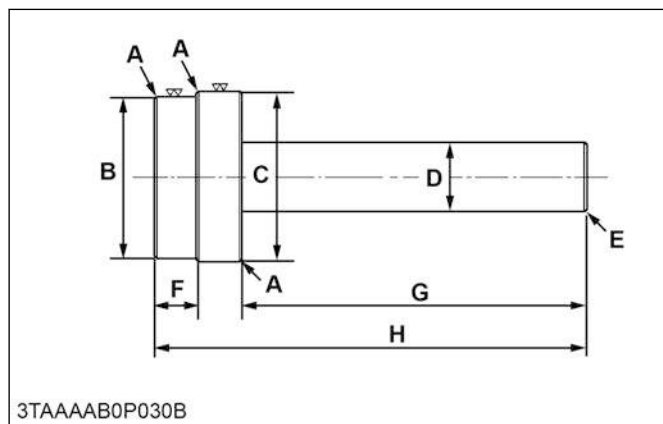
A	135 mm (5.31 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	10 mm (0.39 in.)
E	24 mm (0.94 in.)
F	20 mm dia. (0.79 in. dia.)
G	68 mm dia. (2.7 in. dia.)
H	47.30 to 47.50 mm dia. (1.863 to 1.870 in. dia.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.30 mm (0.012 in.)

1.9 Governor gear holder bushing replacing tool

Use to press out and to press fit the governor gear holder bushing.

NOTE

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



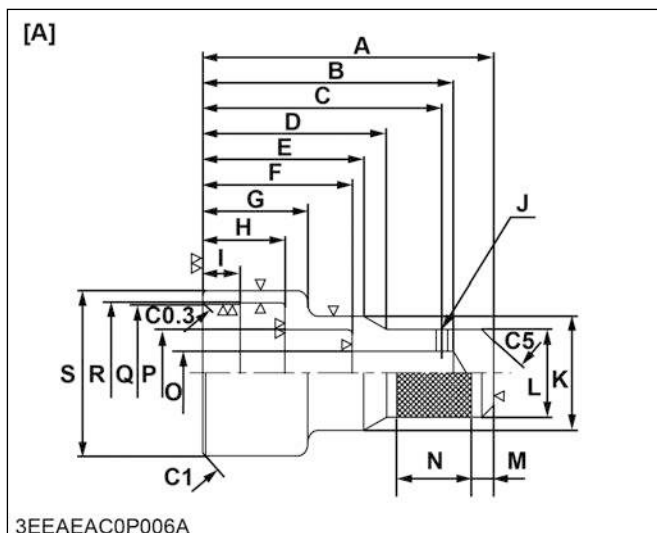
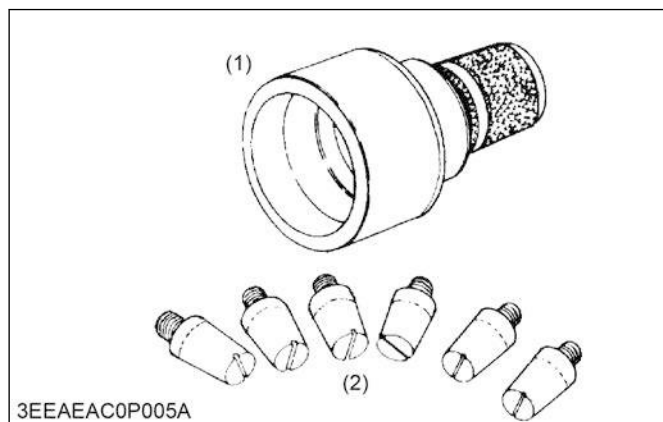
A	C1: Chamfer 1.0 mm (0.039 in.)
B	73.90 to 74.00 mm dia. (2.910 to 2.913 in. dia.)
C	69.80 to 69.90 mm dia. (2.748 to 2.751 in. dia.)
D	30 mm dia. (1.2 in. dia.)
E	C2: Chamfer 2.0 mm (0.079 in.)
F	18 mm (0.71 in.)
G	150 mm (5.91 in.)
H	188 mm (7.40 in.)

1.10 Crank sleeve setter

Use to fix the crankshaft sleeve.

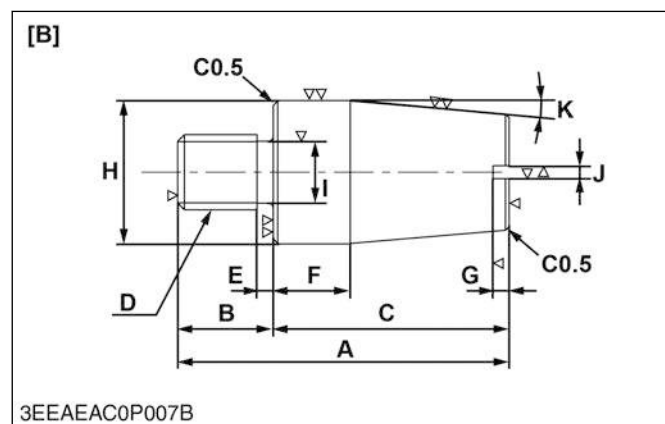
NOTE

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



(1) Auxiliary socket for pushing

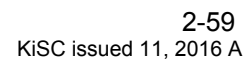
A	130 mm (5.12 in.)
B	112 mm (4.41 in.)
C	107 mm (4.21 in.)
D	82 mm (3.2 in.)
E	72 mm (2.8 in.)
F	67 mm (2.6 in.)
G	47 mm (1.8 in.)
H	36.00 to 36.20 mm (1.418 to 1.425 in.)
I	17 mm (0.67 in.)
J	5.0 mm dia. (0.20 in. dia.)
K	52 mm dia. (2.0 in. dia.)
L	40 mm dia. (1.6 in. dia.)
M	10 mm (0.39 in.)
N	33 mm (1.3 in.)
O	20 mm dia. (0.79 in. dia.)
P	40 mm dia. (1.6 in. dia.)
Q	72.10 to 72.15 mm dia. (2.839 to 2.840 in. dia.)
R	73 mm dia. (2.9 in. dia.)
S	83 mm dia. (3.3 in. dia.)
C0.3	Chamfer 0.30 mm (0.012 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C5	Chamfer 5.0 mm (0.20 in.)

**(2) Sleeve guide**

A	42 mm (1.7 in.)
B	12 mm (0.47 in.)
C	30 mm (1.2 in.)
D	M10 × Pitch 1.25
E	2.0 mm (0.079 in.)
F	10 mm (0.39 in.)
G	2.0 mm (0.079 in.)
H	17.90 to 17.95 mm dia. (0.7048 to 0.7066 in. dia.)
I	8.0 mm dia. (0.31 in. dia.)
J	1.8 mm (0.071 in.)
K	0.09 rad (5°)
C0.5	Chamfer 0.5 mm (0.02 in.)

Use for reading rotation sensor signal.

- This special tool is not provided, so make it referring to the figure.



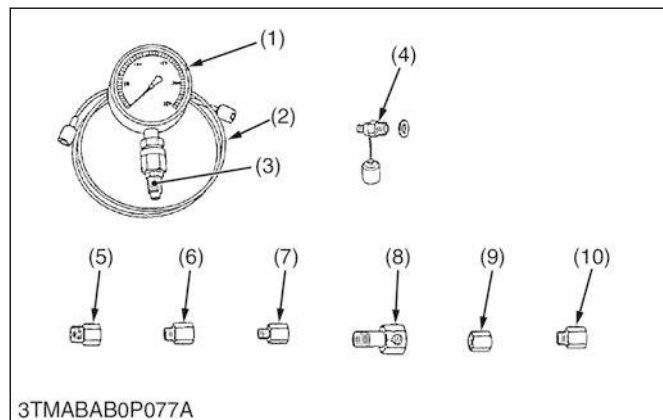
2. Special tools for machine

2.1 Relief valve pressure tester

This allows easy measurement of relief set pressure.

Code No.

07916-50045

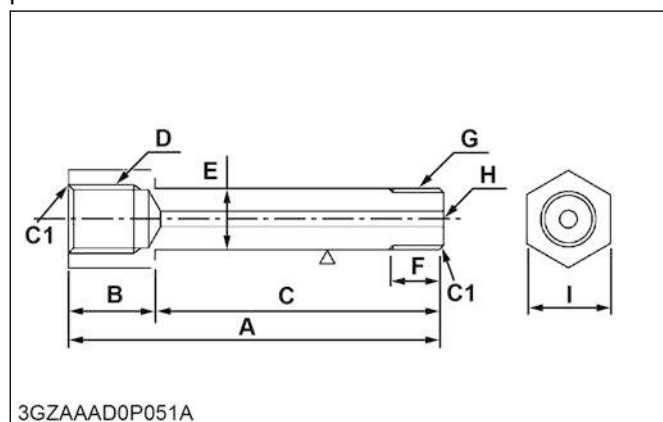


- | | |
|----------------------------|-------------------------|
| (1) Gauge (07916-50322) | (7) Adaptor D (PT1/8) |
| (2) Cable (07916-50331) | (07916-50381) |
| (3) Threaded joint | (8) Adaptor E (PS3/8) |
| (07916-50401) | (07916-50392) |
| (4) Threaded joint | (9) Adaptor F (PF1/2) |
| (07916-50341) | (07916-62601) |
| (5) Adaptor B (M18 × P1.5) | (10) Adaptor 58 (PT1/4) |
| (07916-50361) | (07916-52391) |
| (6) Adaptor C (PS3/8) | |
| (07916-50371) | |

A	80.0 mm (3.15 in.)
B	20 mm (0.79 in.)
C	60.0 mm (2.36 in.)
D	G 1/4 × 15 mm (0.59 in.)
E	12 mm (0.47 in.)
F	13 mm dia. (0.51 in. dia.)
G	G 1/4
H	3.00 mm dia. (0.118 in. dia.)
I	19 mm (0.75 in.)
C1	Chamfer 1.0 mm (0.039 in.)

2.2 HST relief valve adapter

This adapter is used to measure the HST relief valve pressure.



3GZAAAD0P051A

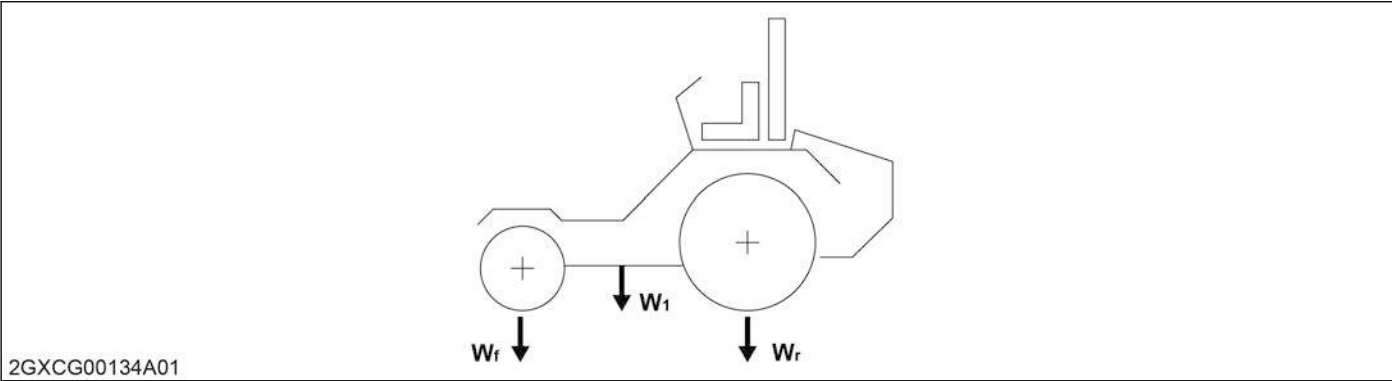
IMPLEMENT LIMITATIONS

The KUBOTA Machine has been thoroughly tested for proper performance with implements sold or approved by KUBOTA. Use with implements below may result in malfunctions or failures of the machine, damage to other property and injury to the operator or others.

- Implements that are not sold or approved by KUBOTA
- Implements that exceed the maximum specifications listed below.
- Implements that are otherwise unfit for use with the KUBOTA Machine

[Any malfunctions or failures of the machine resulting from use with improper implements are not covered by the warranty.]

Unit	Maximum loading weight		Implement weight W1	Maximum total weight
	Front axle Wf	Rear axle Wr		
ZD1511LF	200 kg (440 lbs.)	870 kg (1918 lbs.)	170 kg (970 lbs.)	1070 kg (2359 lbs.)



■ IMPORTANT

- Do not attach attachment or implement such as hitch kit or grass catcher other than standard mower.

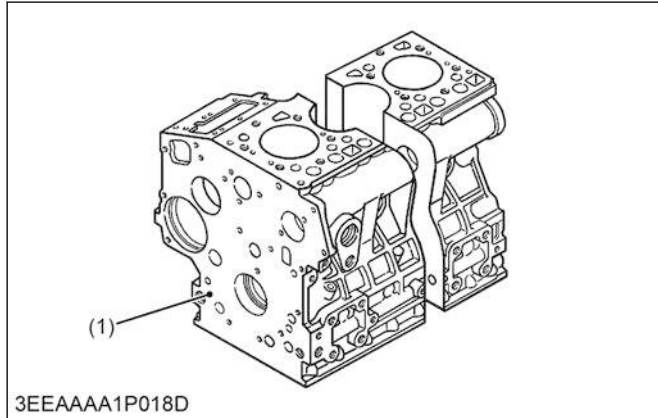
3. ENGINE

MECHANISM

1. Engine body

1.1 Function of cylinder block

The cylinder block is the main housing of engine.



3EEAAA1P018D

(1) Cylinder block

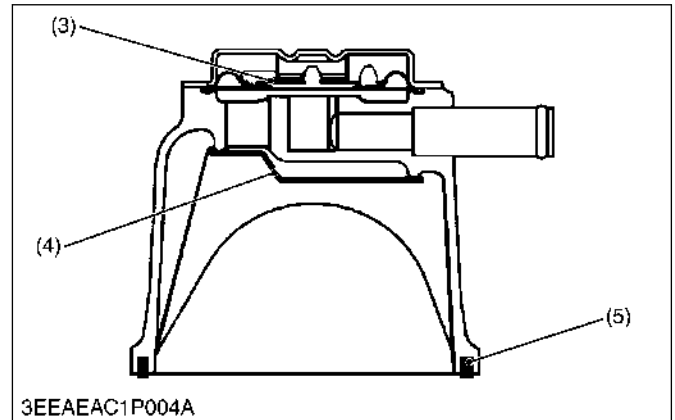
The cylinder block is the main housing of engine and supports the other main parts. The cylinder block is usually of integrated cast iron construction, and includes complete passages for coolant and lubricating oil.

1.2 Function of closed breather

Closed breather system has been adopted to prevent the release of blow-by gas into the atmosphere.



9Y1210786ENM001A

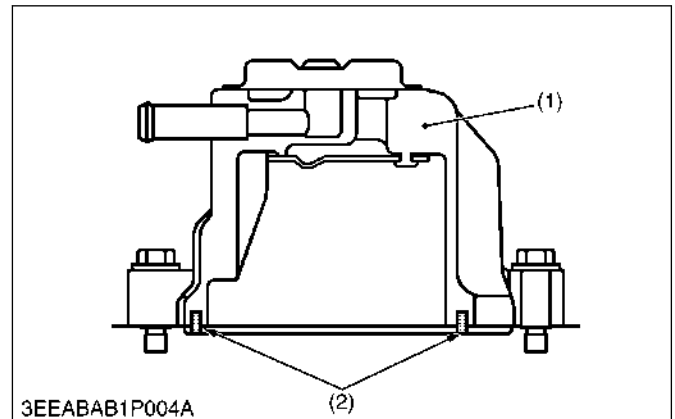


3EEAEAC1P004A

- | | |
|-------------------------|--------------------|
| (1) Breather hose | (4) Oil shield |
| (2) Cylinder head cover | (5) Rubber packing |
| (3) Breather valve | |

After its oil content is filtered by oil shield (4), the blow by gas in fed back to the intake manifold through breather valve (3) to be used for re-combustion.

1.3 Function of half-floating head cover



3EEABAB1P004A

- | | |
|-------------------------|--------------------|
| (1) Cylinder head cover | (2) Rubber packing |
|-------------------------|--------------------|

The rubber packing is fitted in to maintain the cylinder head cover 0.5 mm (0.02 in.) or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

1.4 Function of piston

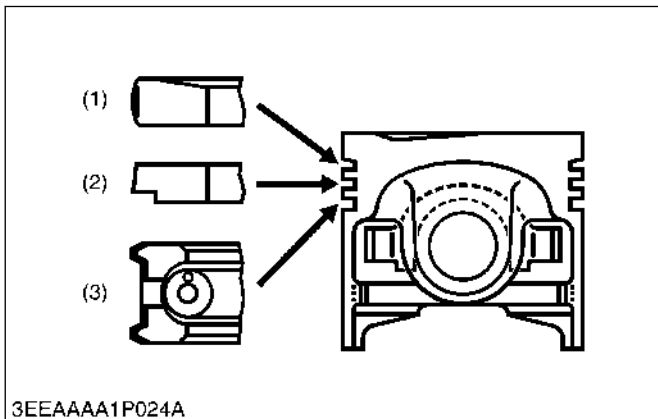
The piston creates the forces for the suction, compression, power and exhaust cycles.



(1) Molybdenum disulfide

The reciprocating motion of a piston in the engine cylinder creates the forces for the suction, compression, power and exhaust cycles. The piston's skirt is coated with molybdenum disulfide (MoS₂) which reduces the piston slap noise and thus the entire operating noise. The molybdenum disulfide (MoS₂) (1) improves the fit of the piston with the cylinder and helps to prevent scorching.. This material helps resist metal wears even with little lube oil.

1.5 Function of piston ring



(1) Top compression ring (3) Oil control ring
(2) Second compression ring

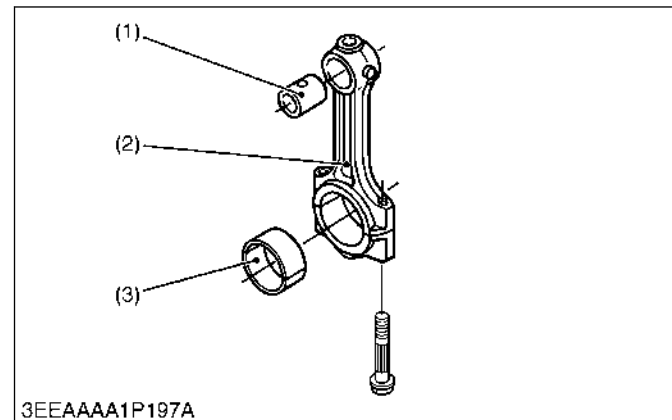
Piston rings are classified as compression and oil control rings. Diesel engine has two or three compression rings around the piston head and one oil ring just below them. The compression rings prevent gases from leaking by the piston during the compression and expansion strokes. They seal by expanding out against the cylinder wall. The rings expand by their own tension and also by combustion pressure behind the rings during the expansion stroke. The compression rings are split for easy assembly on the piston. The piston rings are usually made of

hardened cast iron. To reduce the wear on the ring, they are often plated with chrome on their contact faces, or are coated their contact faces with molybdenum disulfide.

- The top compression ring (1) is a keystone type ring to get durability against heavy load.
- The second compression ring (2) is an undercut ring to prevent shortage of oil.
- The main job of the oil control ring (3) is to wipe the excess oil from the cylinder walls. This oil is fed through slots in the rings to holes in the piston groove, where it returns to the crankcase. For better oil control, spring expanders are often used under the oil control ring.

1.6 Function of connecting rod

The connecting rod connects the piston to the crankshaft.

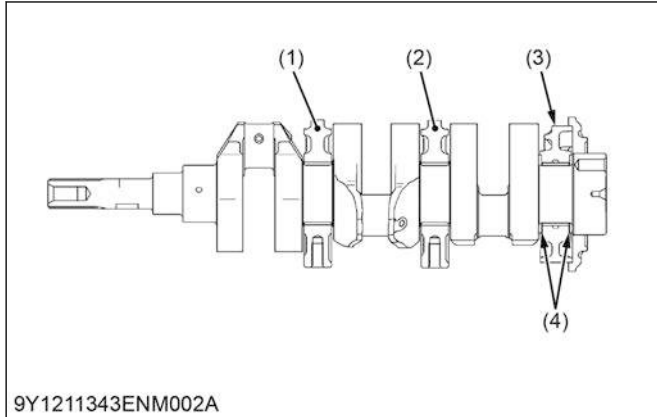


(1) Small end bushing (3) Crankpin bushing
(2) Connecting rod

The connecting rod must be light and yet strong enough to transmit the thrust of the piston to crankshaft. The big end of connecting rod has a crankpin bushing (3) (split type) and the small end has a small end bushing (1) (solid type).

1.7 Function of crankshaft

The crankshaft converts the up-and-down motion of the pistons into rotary motion.

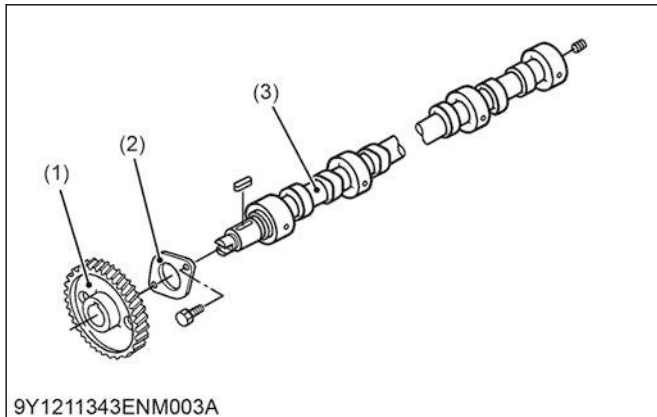


- | | |
|-------------------------------------|-----------------------------|
| (1) Front split type bearing | (3) Rear split type bearing |
| (2) Intermediate split type bearing | (4) Thrust bearings |

The crankshaft converts the up-and-down motion of the pistons into rotary motion. It ties together the reactions of all the pistons into one rotary force that drives the machine. The crankshaft is made of tough special alloy steel, and the journals, pins and oil seal sliding portions are induction hardened to increase the hardness for higher wear resistance. The front journal is supported by a split type (1) and the intermediate journal by a split type (2), and the rear journal by a split type (3) with thrust bearings (4). The crankshaft is provided with an oil gallery, through which engine oil is fed to the crankpin portion, and lubricates it.

1.8 Function of camshaft

The camshaft controls the opening and closing of the intake and exhaust valves in the cylinder head.



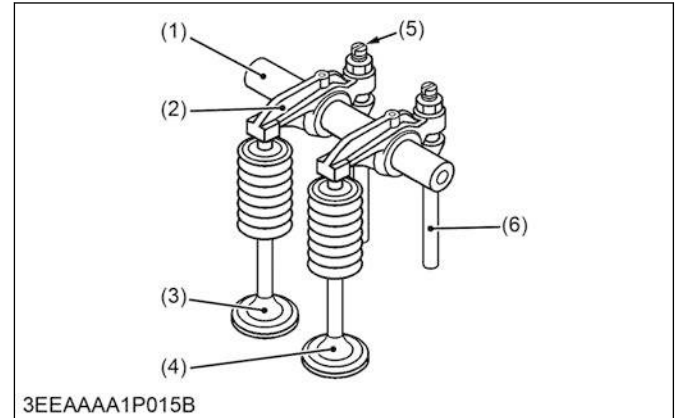
- | | |
|----------------------|--------------|
| (1) Cam gear | (3) Camshaft |
| (2) Camshaft stopper | |

The camshaft controls the opening and closing of the intake and exhaust valves in the cylinder head. The camshaft (3) is normally driven by gearing from the crankshaft. This is made of special cast iron, and the

journal and cam sections are chilled to resist wear. One intake and one exhaust cam is provided for each cylinder. The journal diameters are large to permit removal of the shaft from its bore. The journal sections are force lubricated.

1.9 Function of rocker arm

A rocker arm is an oscillating lever that conveys radial movement from the cam lobe into linear movement.

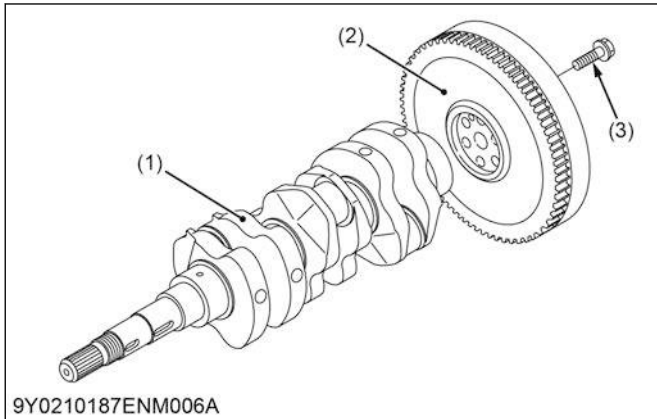


- | | |
|----------------------|---------------------|
| (1) Rocker arm shaft | (4) Intake valve |
| (2) Rocker arm | (5) Adjusting screw |
| (3) Exhaust valve | (6) Push rod |

The rocker arm is an oscillating lever that conveys radial movement from the camshaft lobes into linear movement at the exhaust and intake valves to open and close them. The rocker arms (2) are mounted on a rocker arm shaft (a single hollow shaft) (1) at the top of the engine. When the push rods (6) move up, the mating rocker arm is moved down, contacting its valve stem tip and opening the valve. Lubricating oil pressurized through the rocker arm bracket to the rocker arm shaft, which serves as a fulcrum so that the rocker arm and the entire system are lubricated sufficiently.

1.10 Function of flywheel

A flywheel is a rotating mechanical device that is used to store rotational energy.

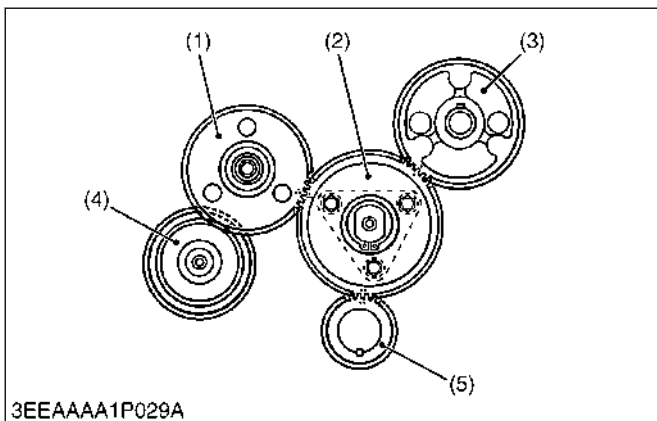


(1) Crankshaft (3) Flywheel screw
(2) Flywheel

The flywheel (2) is generally made of heavy cast iron or steel and has gear teeth around its outer rim, which mesh with the drive pinion of starter. The flywheel stores the rotating force in the combustion stroke as inertial energy, reduces crankshaft rotating speed fluctuation and maintains the smooth rotating conditions. The flywheel periphery is inscribed with the marks showing fuel injection timing angle lines and top dead center mark TC. The flywheel (2) mounted on the rear of the crankshaft (1) is a stabilizer for the whole engine.

1.11 Function of timing gears

The timing gears correctly control fuel injection to the cylinders and valve timing.



(1) Injection pump gear (4) Governor gear
(2) Idle gear (5) Crank gear
(3) Cam gear

The timing gears transmit torque from the crankshaft to the oil pump and injection pump and, at the same time, correctly control fuel injection to the cylinders and valve timing. Each gear has a mating mark inscribed on it for correct and easy assembly and is spherical with teeth

set obliquely to the axis of rotation to rotate smoothly and reduce noise. The crankshaft is the hub around which other parts of the engine can be timed and driven. This is done by the meshing of gears as shown in the figure.

1.12 Definition of engine control system

■ IMPORTANT

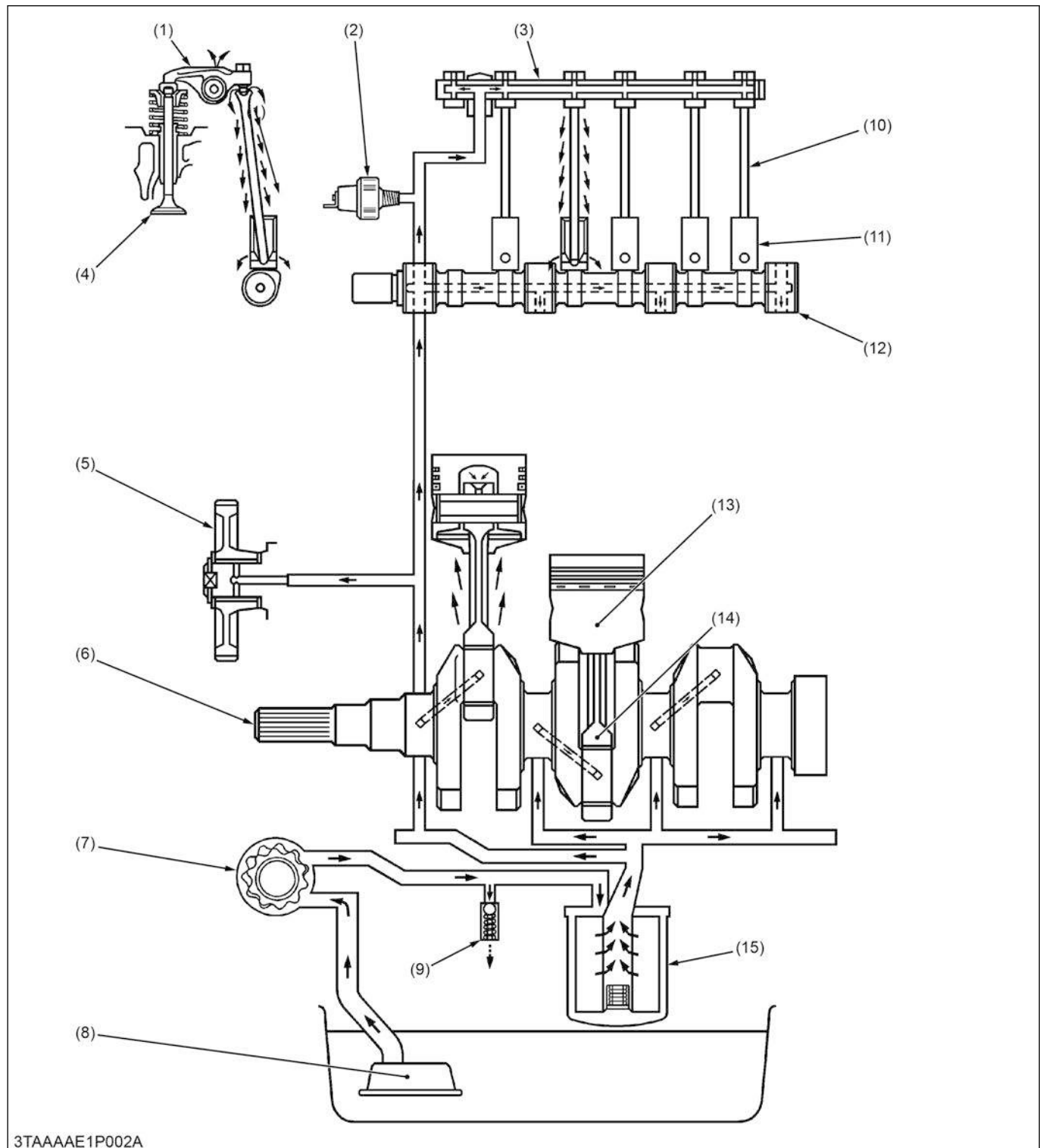
- When replacing ECU, perform DPF manual regeneration to make adjustments to PM estimate sedimentation quantity in ECU and DPF sedimentation quantity.

The ECU will utilize signal inputs, from the engine sensors, to control the fuel metering and speed control, while the engine is running. As well, the ECU will provide diagnostic control.



2. Lubricating system

2.1 Overview of lubricating system



- | | | | |
|-------------------------|------------------|------------------|---------------------------|
| (1) Rocker arm | (5) Idle gear | (9) Relief valve | (13) Piston |
| (2) Oil pressure switch | (6) Crankshaft | (10) Push rod | (14) Connecting rod |
| (3) Rocker arm shaft | (7) Oil pump | (11) Tappet | (15) Oil filter cartridge |
| (4) Valve | (8) Oil strainer | (12) Camshaft | |

This engine's lubricating system consists of oil strainer (8), oil pump (7), relief valve (9), oil filter cartridge (15) and oil pressure switch (2).

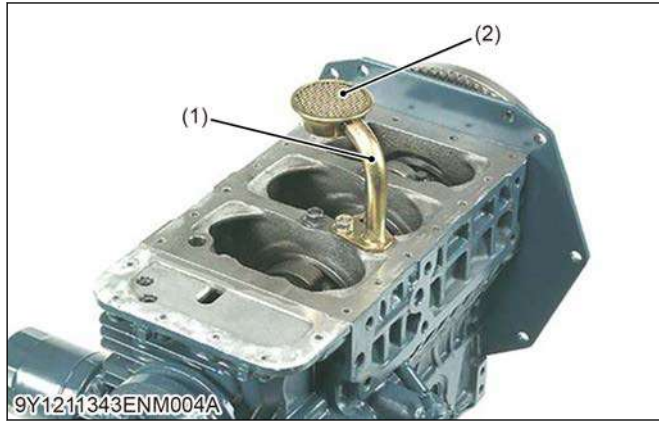
3. ENGINE

The oil pump sucks lubricating oil from the oil pan through the oil strainer and the oil flows down to the filter cartridge, where it is further filtered. Then the oil is forced to crankshaft (6), connecting rods (14), idle gear (5), camshaft (12) and rocker arm shaft (3) to lubricate each part.

Some part of oil, splashed by the crankshaft or leaking and dropping from gaps of each part, lubricates these parts: piston (13), cylinders, small ends or connecting rods, tappets (11), push rods (10), inlet and exhaust valves (4) and timing gears.

2.2 Function of oil strainer

The oil strainer strains large particles from the oil.

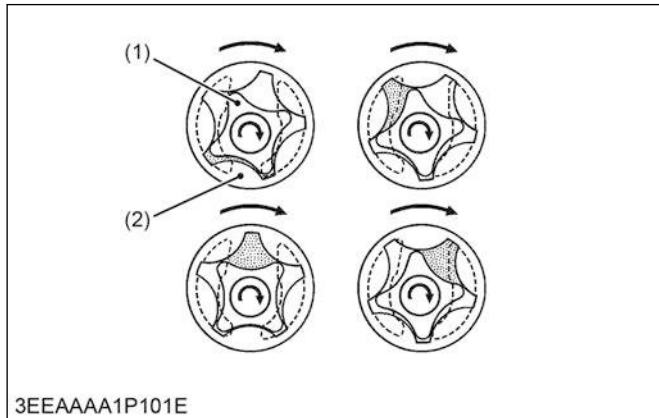


(1) Oil strainer (2) Mesh screen

The strainer (1) has a mesh screen (2) suitable for straining large particles from the oil and yet passes a sufficient quantity of oil to the inlet side of the oil pump. The strainer is located so all oil entering the pump from the oil pan must flow through it.

2.3 Function of oil pump

The oil pump circulates engine oil under pressure to the rotating bearings, the pistons and the camshaft.

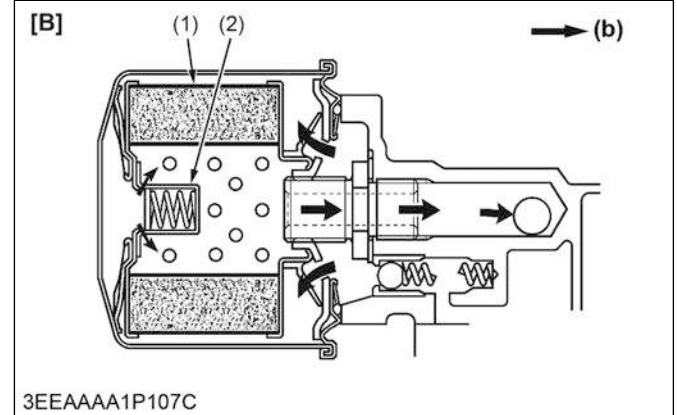
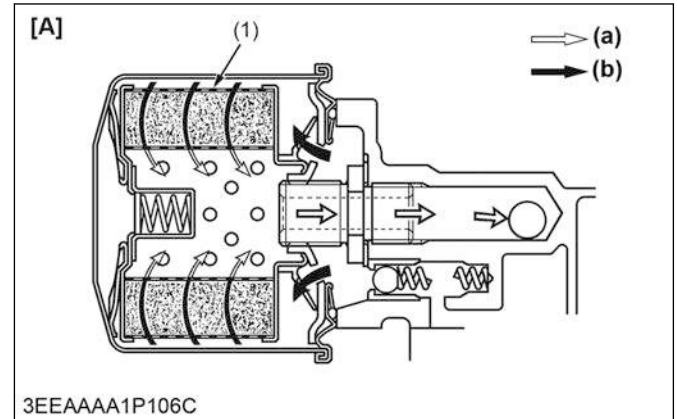


(1) Inner rotor (2) Outer rotor

The oil pump sucks lubricating oil from the oil pan through the oil strainer and the oil flows down to the oil filter. The rotor pump is driven by the crankshaft. This oil pump has an inner rotor (1) and an outer rotor (2). The inner rotor (1), which is driven by crankshaft, rotates the outer rotor (2) in the same direction. The inner rotor (1) has one less lobe than the outer rotor (2), and they are eccentrically engaged with each other.

2.4 Function of oil filter

The oil filter is responsible for filtering impurities from the oil.

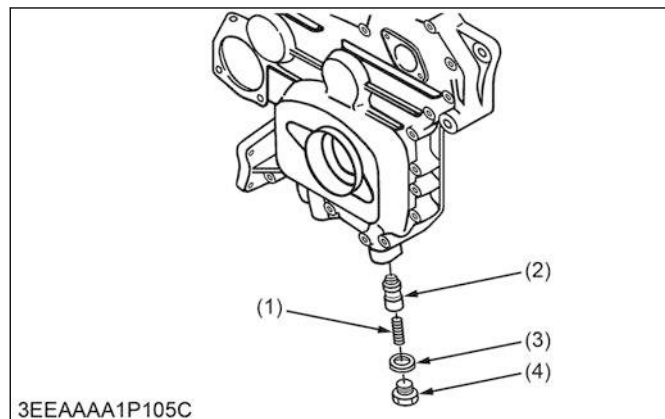


(1) Filter element (b) Unfiltered oil
(2) Bypass valve [A] Bypass valve closed
(a) Filtered oil [B] Bypass valve open

In the filtration system, there is only one oil flow from the oil pump to the oil filter cartridge. After filtering, the oil goes to the lubricating portion, and is returned to the crankcase. When the filter cartridge is new, there is very little pressure drop through the filter element (1). However, if the filter gets clogged, the resulting pressure (the oil pressure in inlet line builds up by 98 kPa (1.0 kgf/cm², 14 psi) more than the outlet line) will open the bypass valve (2) and allow unfiltered oil to bypass to the lubricating portion.

2.5 Function of relief valve

The relief valve prevents the damage of the lubricating system due to high oil pressure.

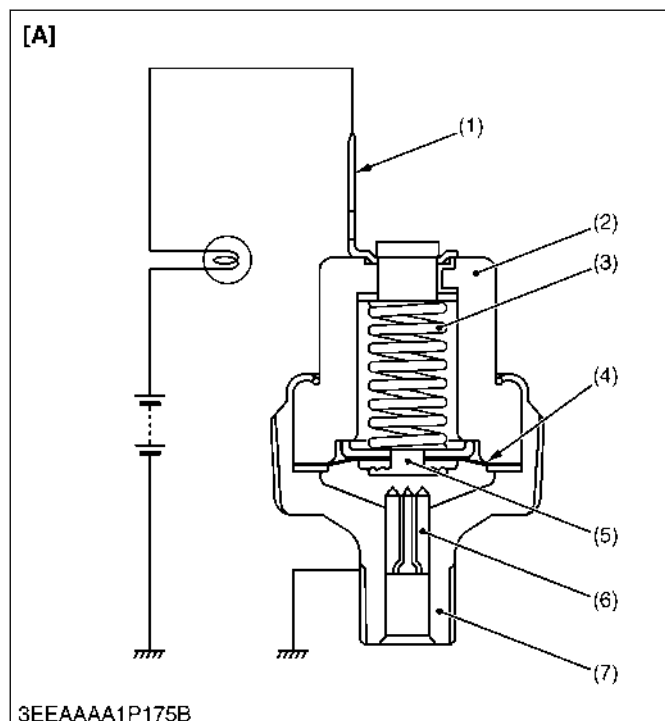


- (1) Spring
- (2) Poppet
- (3) Gasket
- (4) Plug

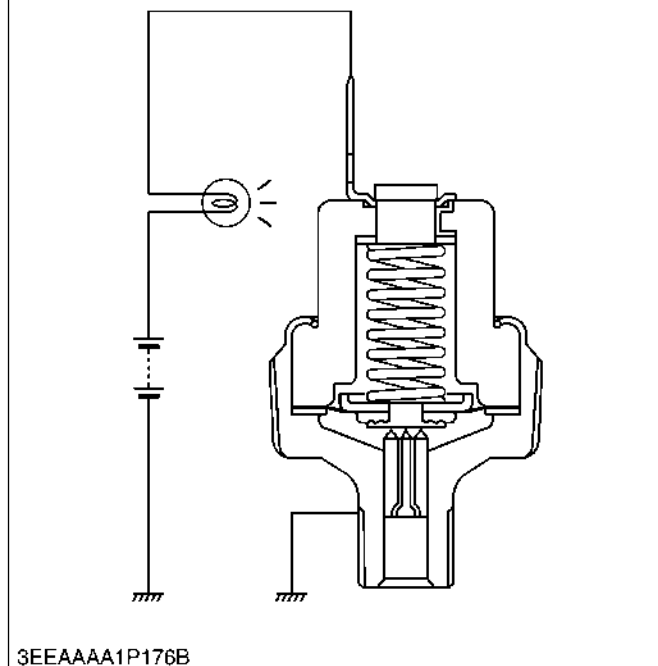
The relief valve prevents the damage of the lubricating system due to high oil pressure. The valve is closed when the spring tension is greater than the oil pressure at the inlet. The spring tension holds poppet (2) securely in position. The valve opens when the oil pressure at the inlet exceeds that of the spring (1). This pushes the poppet off the inlet hole and oil flows through the valve.

2.6 Function of oil pressure switch

The oil pressure switch activates the oil warning light when the oil pressure falls below specified value.



[B]



- (1) Terminal
- (2) Insulator
- (3) Spring
- (4) Diaphragm
- (5) Contact rivet
- (6) Contact
- (7) Oil switch body
- [A] At proper oil pressure
- [B] At lower oil pressure

The oil pressure switch is mounted on the cylinder block and is led to the lubricating oil passage. When the oil pressure falls below the specified value, the oil pressure-warning lamp lights.

[A] At the proper oil pressure

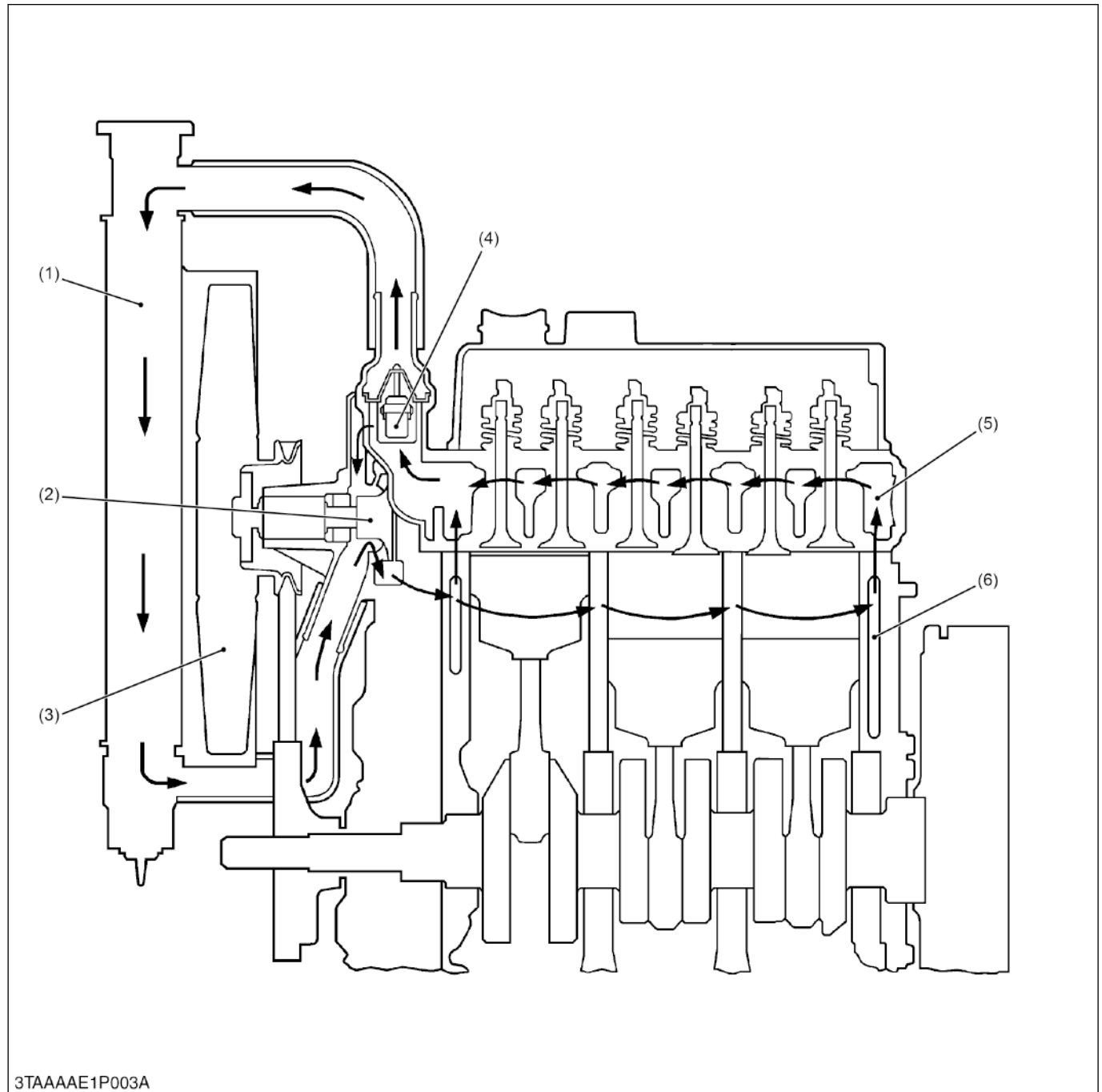
When the engine is started and as the proper oil pressure builds, the diaphragm (4) is pushed up. This separates the contact rivet (5) and breaks the circuit, causing the lamp to go out.

[B] At lower oil pressure

If the oil pressure drops, the resulting deflection of the diaphragm (4) will close the contact rivet (5) and again complete the circuit. The lighted lamp warns that the pressure of the lubricating system has dropped below the pressure setting.

3. Cooling system

3.1 Overview of cooling system



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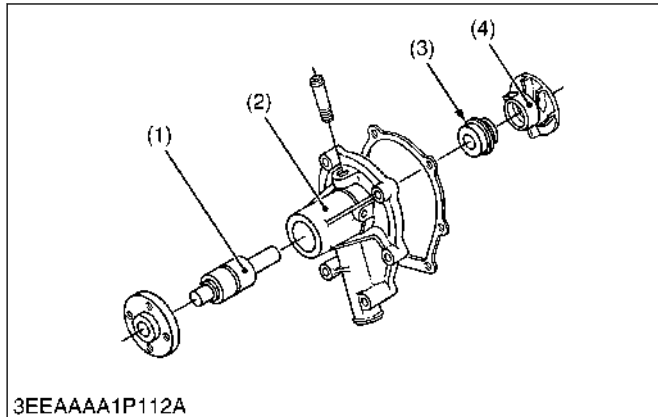
- | | | |
|----------------|-----------------|-------------------|
| (1) Radiator | (3) Cooling fan | (5) Cylinder head |
| (2) Water pump | (4) Thermostat | (6) Cylinder head |

The cooling system cools the engine while it is running to prevent overheating and maintain a proper operating temperature. KUBOTA engines are used pressurized forced-circulation type. This system consists of a radiator (1), water pump (2), cooling fan (3), thermostat (4) and coolant temperature sensor (some models). The coolant is cooled through the radiator core, and the fan set behind the radiator pulls cooling air through the core to improve cooling. When the coolant in the engine is at a low temperature, the thermostat valve is closed so that the coolant is circulated in the engine through the bypass pipe. When the temperature of the coolant becomes the valve opening temperature of thermostat (4), the thermostat (4) opens the valve to return the heated coolant to the radiator (1). The water pump (2) sucks the cooled coolant, forces it into the cylinder block (6) and draws out the hot coolant. Some engines employ

the bottom bypass system to improve the cooling performance of radiator and the three step valve opening type thermostat to reduce thermal shock radically.

3.2 Function of water pump

The water pump circulates the coolant through the system.

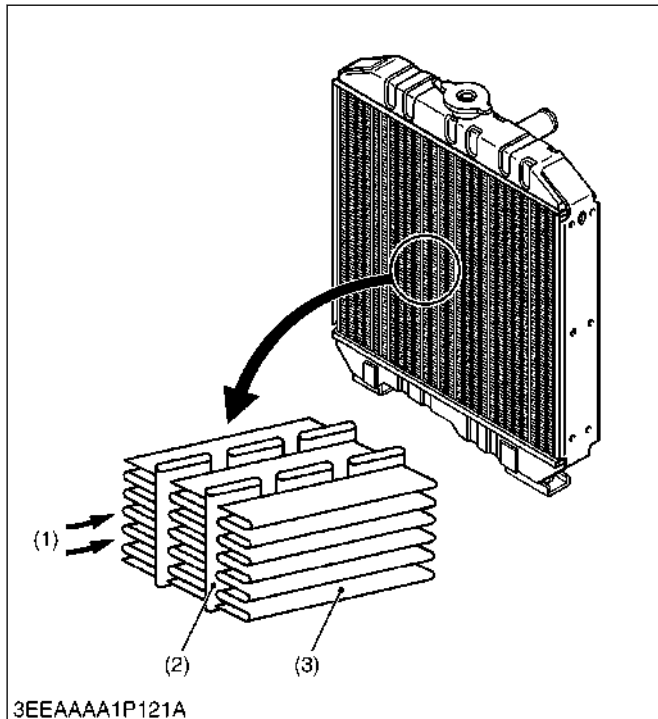


- 3EEAAA1P112A
- | | |
|------------------|---------------------|
| (1) Bearing unit | (3) Mechanical seal |
| (2) Pump body | (4) Impeller |

The water pump circulates the coolant through the system. If the pump fails to circulate the coolant, heat is not removed from the engine and overheating damage may occur. KUBOTA engines use a centrifugal type, and is driven by the crankshaft via a fan belt. It is composed of a pump body (2), impeller (4), mechanical seal (3) and bearing unit (1).

3.3 Function of radiator

The radiator is one of the major components of coolant cooling system.

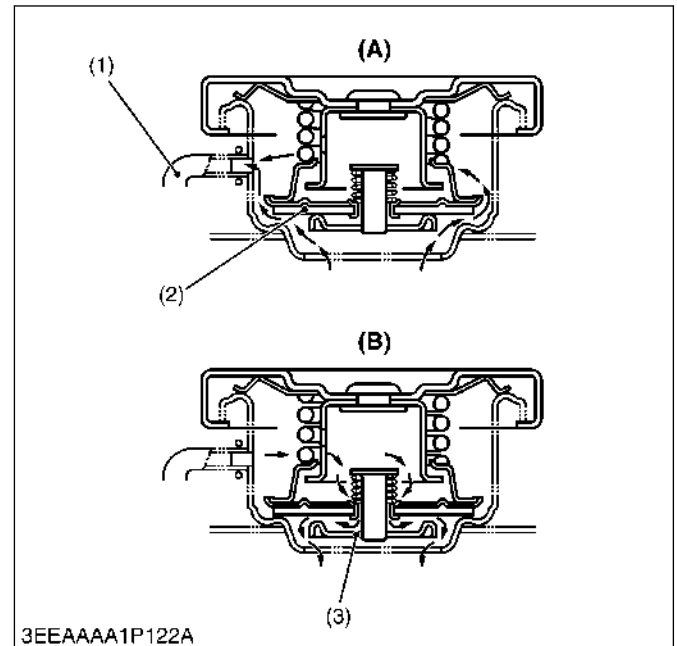


- 3EEAAA1P121A
- | | |
|-----------------|---------|
| (1) Cooling air | (3) Fin |
| (2) Tube | |

The radiator is one of the major components of coolant cooling system. It is here that heat in the coolant is released to the atmosphere. The radiator core consists of water carrying tubes (2) and fins (3) at a right angle to the tubes. KUBOTA engines use corrugated fin type core which has a right weight and high heat transfer rate. Radiators are usually made of copper or brass. Recently, however, aluminum-made radiators are introduced for their light weight.

3.4 Function of radiator cap

The radiator cap keeps coolant from boiling out or evaporating.



- 3EEAAA1P122A
- | | |
|--------------------|-------------------------|
| (1) Overflow tube | (A) Pressure valve open |
| (2) Pressure valve | (B) Vacuum valve open |
| (3) Vacuum valve | |

The pressure system permits operating the engine at a higher temperature without boiling the coolant or losing it by evaporation. The radiator cap consists of a pressure valve (2), vacuum valve (3), valve springs, gasket, and has two functions.

(A) Pressure valve open

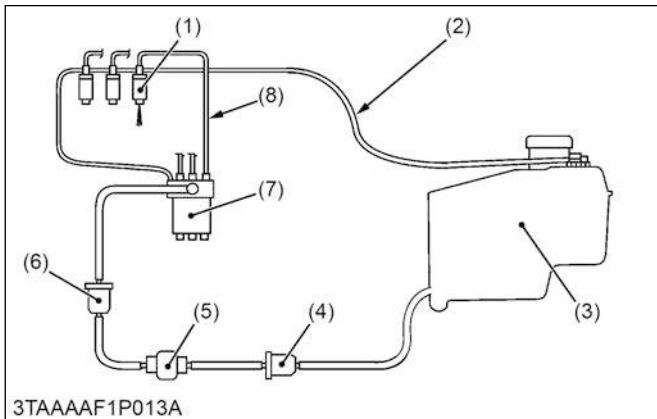
The pressure valve (2) in the cap permits the escape of coolant or steam when the pressure reaches a certain point (88 kPa, 0.90 kgf/cm², 13 psi).

(B) Vacuum valve open

The vacuum valve (3) in the cap opens to prevent a vacuum in the cooling system.

4. Fuel system

4.1 Overview of fuel system

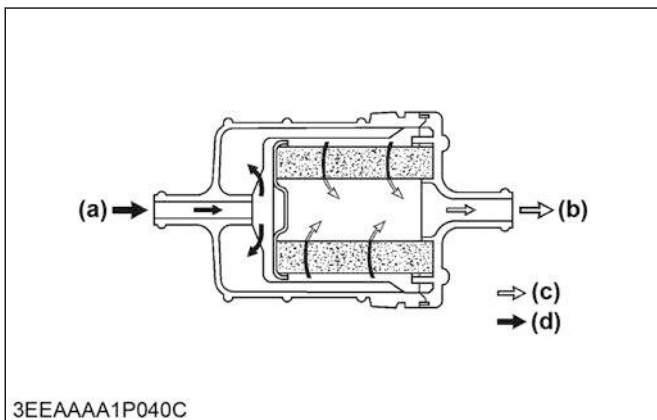


- | | |
|------------------------|--------------------|
| (1) Injection nozzle | (5) Fuel feed pump |
| (2) Fuel overflow pipe | (6) Fuel filter |
| (3) Fuel tank | (7) Injection pump |
| (4) Fuel filter | (8) Injection pipe |

Fuel from the fuel tank (3) passes through the fuel filter (4), and then enters the injection pump (7) after impurities such as dirt, water, etc. are removed. The fuel pressurized by the injection pump to the opening pressure (13.7 to 14.7 MPa, 140 to 150 kgf/cm², 1990 to 2133 psi), of the injection nozzle (1) is injected into the combustion chamber. Part of the fuel fed to the injection nozzle (1) lubricates the moving parts of the needle valve inside the nozzle, then returns to the fuel tank through the fuel overflow pipe (2) from the upper part of the nozzle holder.

4.2 Function of fuel filter

The fuel filter filters impurities from the fuel.

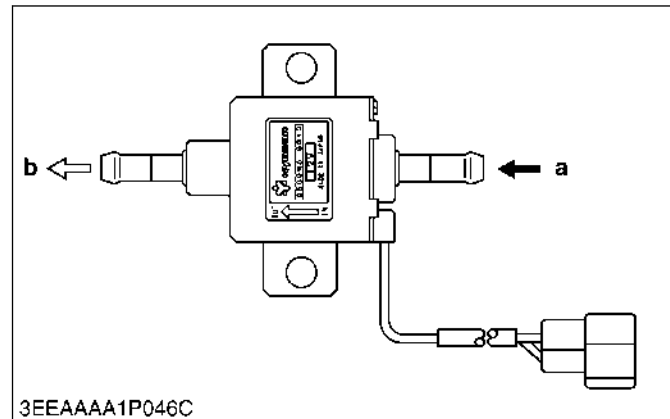


- | | |
|--------------|---------------------|
| (a) Fuel in | (c) Filtered fuel |
| (b) Fuel out | (d) Unfiltered fuel |

In-line filter is installed in the fuel line with an electromagnetic fuel feed pump and is used to filter impurities such as dirt, water, etc.

4.3 Function of fuel feed pump

An electromagnetic fuel feed pump is used when a fuel tank is positioned below the pump of the engine.

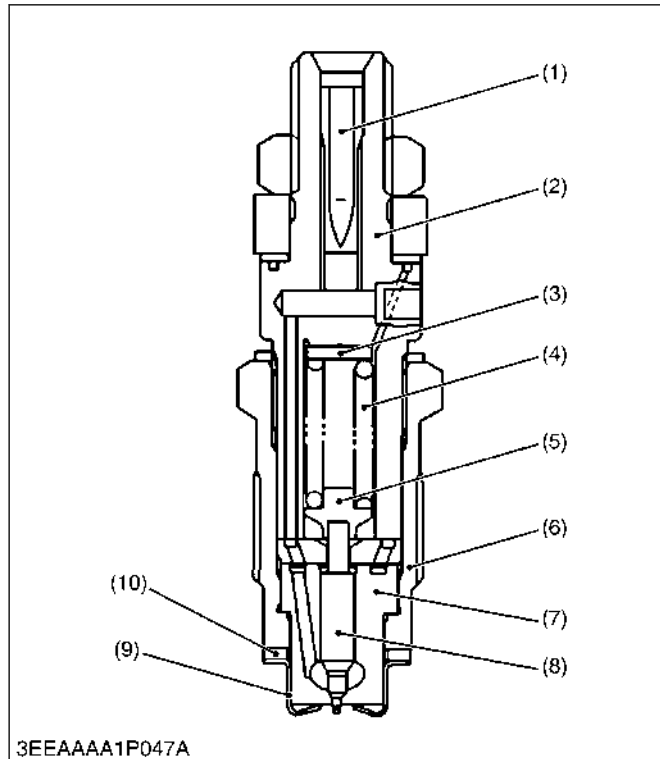


a: Fuel in

b: Fuel out

An electromagnetic fuel feed pump is used when a fuel tank is positioned below the pump of the engine. An electromagnetic fuel feed pump uses a transistor that causes the pump to start pumping fuel when the main switch is turned to the **ON** position. Therefore, fuel is supplied to the injection pump regardless of engine speed. This pump is driven by the battery. It can therefore be operated even with the engine being stopped.

4.4 Function of injection nozzle

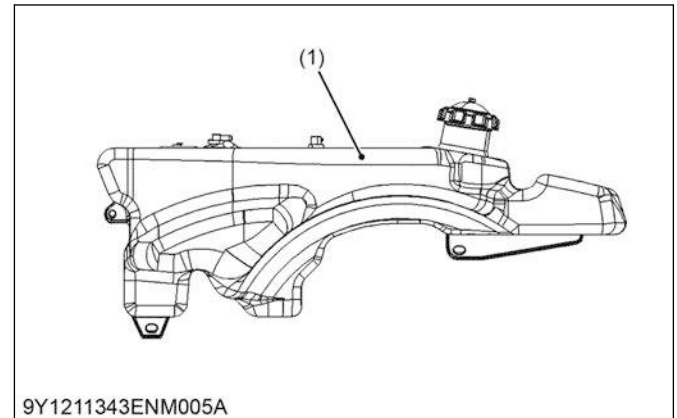


- | | |
|------------------------|-------------------|
| (1) Bar filter | (6) Retaining nut |
| (2) Nozzle holder body | (7) Nozzle piece |
| (3) Adjusting washer | (8) Needle valve |
| (4) Nozzle spring | (9) Heat seal |
| (5) Push rod | (10) Gasket |

Uses as E-TVCS system, the small-sized DENSO made OPD mini nozzle is of a flat-cut-provided double throttle type. This type of nozzle is designed to control the injection quantity when the lift rate is low at start of the injection, and to cut down on the knocking sound caused by excessive fuel injection by giving the needle valve (8) section more taper than before to prevent the rapid increase in the injection quantity when the initial injection turns into the full-force injection. Also, employed to prevent the injection quantity loss in the throttle section caused by carbon, the flat cut provided at the needle valve section helps the throttle withstand long use and reduce as much knocking sound as when it was new. The heat seal (9) is employed to improve the durability and reliability of the nozzle.

4.5 Function of fuel tank

A fuel tank is a safe container for flammable fluids.



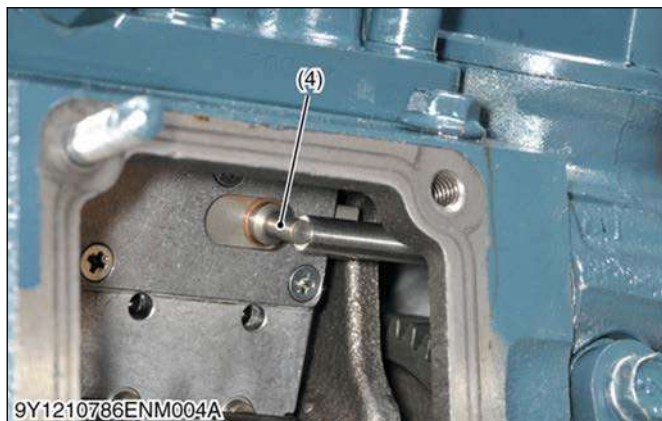
- (1) Fuel tank

A fuel tank (1) is a safe container for flammable fluids.

4.6 Definition of electronic governor

The actuator (1) and rack sensor (2) are placed on either side of the injection pump (3) control rack. Here, the rack sensor (2) is continually pushing on the control rack pin (4). Therefore, the amount of change of the actuator (1) is expressed as the signal output of the rack sensor (2).

The ECU regulates the amount of fuel injected through controlling the actuator (1). Also, the ECU monitors the amount of fuel injected using the signal from the rack sensor (2) to estimate the amount of Particulate Matter (PM) deposited in the DPF.



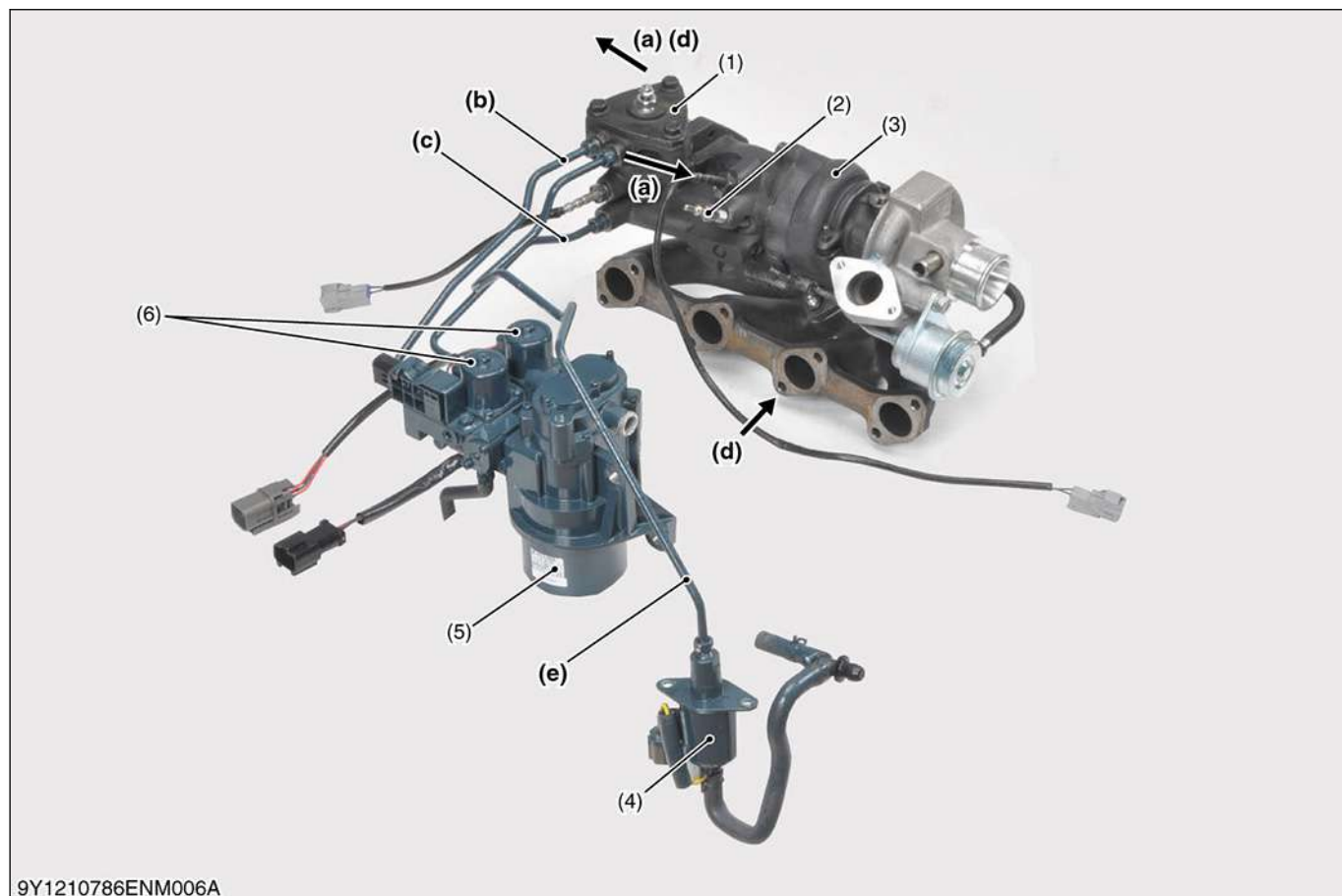
- | | |
|-----------------|----------------------|
| (1) Actuator | (3) Injection pump |
| (2) Rack sensor | (4) Control rack pin |

5. Reformer and after treatment devices

5.1 Definition of reformer

The reformer (1) is a Diesel Particulate Filter (DPF) regeneration device that is not dependent on the combustion method.

Fuel (e) and air (primary air (b)) are supplied to the reformer (1) placed in the reforming catalyst generating reformer gas (a). The reformer gas (a) generated in this manner is combined with exhaust gas (d) and reaches the Diesel Oxidation Catalyst (DOC).



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- | | | | |
|------------------------|---------------------|------------------------|-------------------|
| (1) Reformer | (4) Doser fuel pump | (7) Glow plug (Heater) | (c) Secondary air |
| (2) Glow plug (Burner) | (5) Air blower | (a) Reformer gas | (d) Exhaust gas |
| (3) Turbocharger | (6) Air valve | (b) Primary air | (e) Fuel |

If the exhaust temperature is higher than 250 °C, the reformer gas (a) reacts exothermically with the DOC, raises the exhaust temperature generating a temperature in the DPF enabling regeneration and removes the Particulate Matter (PM) through combustion (normal regeneration).

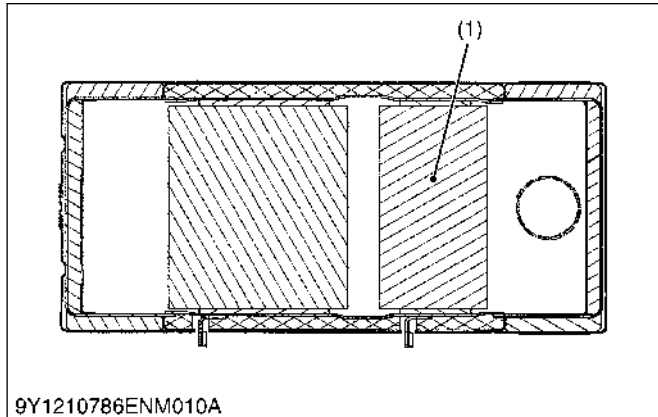


If the exhaust temperature is lower than 250 °C, air (secondary air (c)) is supplied to the reformer gas (a) increasing the amount of oxygen. This is ignited using a glow plug (burner) (2) in this state, flame combusting the reformer gas, raising the exhaust temperature above 250 °C, and then performing normal regeneration.



5.2 Definition of Diesel Oxidation Catalyst (DOC)

An oxidizing catalyst positioned in front of the Diesel Particulate Filter (DPF) step that uses reformer gas to actively regenerate the DPF.

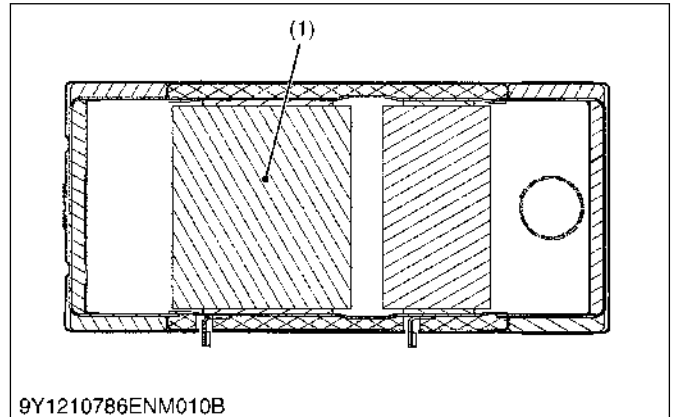
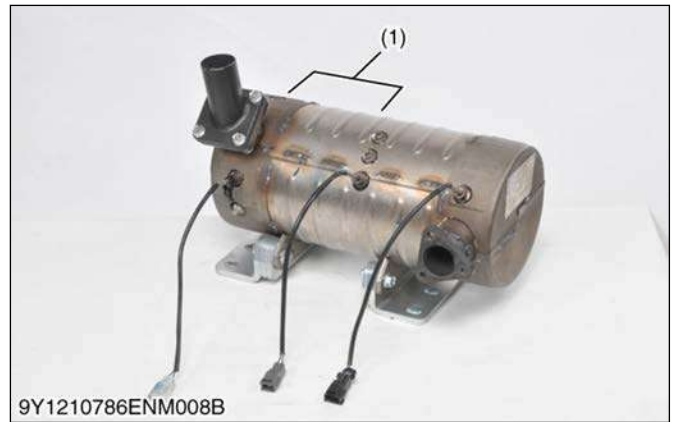


(1) Diesel Oxidation Catalyst (DOC)

5.3 Function of Diesel Particulate Filter (DPF)

The Diesel Particulate Filter (DPF) is a device that captures and combusts PM in the exhaust gas. Physically captures the PM using a filter which spontaneously combusts when exhaust gas temperature is high.

However, while exhaust gas temperature is low PM does not spontaneously combust the pressure differential between the inlet and outlet of the DPF is detected and the PM is combusted using a heat source generated using DOC to regenerate the filter.

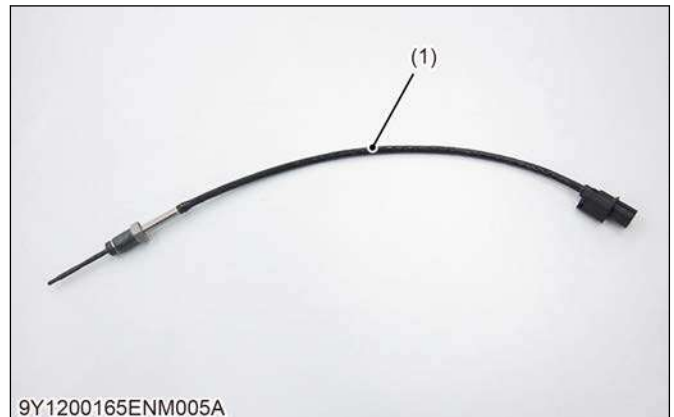


(1) Diesel Particulate Filter (DPF)

5.4 Definition of temperature sensor

The temperature sensor is a sensor that measures the temperature for the post processing system.

It is mounted at the DPF muffler DOC intake, DPF intake, and DPF discharge exhaust, all of which are on the DPF muffler, and it is also mounted at the reforming catalyst and reformer discharge on the reformer.



(1) Temperature sensor

5.5 Definition of differential pressure sensor

The differential pressure sensor is a sensor that detects the pressure differential between the atmosphere and the exhaust gas.



(1) Differential pressure sensor

SERVICING

1. Troubleshooting for engine

Symptom	Probable cause and checking procedure	Solution	Reference page
Engine does not start	1. No fuel	Replenish fuel	2-19
	2. Air in fuel system	Vent air	2-51
	3. Fuel pipe clogged	Clean or replace	2-43
	4. Water in fuel system	Change fuel and repair or replace fuel system	2-43
	5. Fuel filter clogged	Replace	2-29
	6. Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	2-11
	7. Fuel with low cetane number	Use specified fuel	2-11
	8. Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	3-44
	9. Incorrect injection timing	Adjust	3-32
	10. Fuel camshaft worn	Replace	3-49
	11. Injection nozzle clogged	Clean or replace	3-34
	12. Injection pump malfunctioning	Repair or replace	3-47
	13. Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	3-47 to 3-54
	14. Compression leak from cylinder	Replace head gasket, tighten cylinder head screw glow plug and nozzle holder	3-46
	15. Improper valve timing	Correct or replace timing gear	3-49
	16. Piston ring and cylinder worn	Replace	3-51, 3-76
	17. Excessive valve clearance	Adjust	3-29
	18. Solenoid malfunctioning	Replace	—
	19. Rack sensor malfunctioning	Replace	—
Starter does not run	1. Battery discharged	Charge	2-33
	2. Starter malfunctioning	Repair or replace	3-42
	3. Key switch malfunctioning	Replace	—
	4. Wiring disconnected	Connect	—

(Continued)

3. ENGINE

Symptom	Probable cause and checking procedure	Solution	Reference page
Engine revolution is not smooth	1. Fuel filter clogged or dirty	Replace	2-37
	2. Air cleaner clogged	Clean or replace	2-29
	3. Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	3-44
	4. Injection pump malfunctioning	Repair or replace	3-47
	5. Incorrect nozzle opening pressure	Adjust	3-34
	6. Injection nozzle stuck or clogged	Repair or replace	3-34
	7. Solenoid malfunctioning	Replace	—
	8. Rack sensor malfunctioning	Replace	—
	9. Turbocharger bearing worn out	Replace turbocharger assembly	3-43
	10. Turbocharger shaft bent	Replace turbocharger assembly	3-43
	11. Turbocharger fin or other part damaged due to foreign matters	Replace turbocharger assembly	3-43
Either white or blue exhaust gas is observed	1. Excessive engine oil	Reduce to specified amount	3-36
	2. Piston ring and cylinder worn or stuck	Repair or replace	3-51, 3-76
	3. Incorrect injection timing	Adjust	3-32
Oil leak into exhaust pipe or suction pipe	1. Waste oil pipe clogged or deformed	Repair or replace	3-43
	2. Piston ring seal faulty	Replace turbocharger assembly	3-43
Either black or dark gray exhaust gas is observed	1. Overload	Lessen the load	—
	2. Low grade fuel used	Use specified fuel	2-11
	3. Fuel filter clogged	Replace	2-37
	4. Air cleaner clogged	Clean or replace	2-29
	5. Deficient nozzle injection	Repair or replace nozzle	3-34
Deficient output	1. Incorrect injection timing	Adjust	3-32
	2. Engine's moving parts seem to be seizing	Repair or replace	—
	3. Injection pump malfunctioning	Repair or replace	3-47
	4. Deficient nozzle injection	Repair or replace nozzle	3-34
	5. Compression leak	Check the compression pressure and repair	3-29
	6. Gas leak from exhaust system	Repair or replace	2-41

(Continued)

Symptom	Probable cause and checking procedure	Solution	Reference page
Deficient output	7. Air leak from compressor discharge side	Repair or replace	2-41
	8. Air cleaner dirty or clogged	Clean or replace	2-29
	9. Compressor wheel turning heavily	Replace turbocharger assembly	3-43
Excessive lubricant oil consumption	1. Piston ring's gap facing the same direction	Shift ring gap direction	3-51
	2. Oil ring worn or stuck	Replace	3-51
	3. Piston ring groove worn	Replace piston	3-51
	4. Valve stem and valve guide worn	Replace	3-47
	5. Crankshaft bearing and crank pin bearing worn	Replace	3-54
	6. Oil leaking due to damaged seals or packing	Replace	—
Fuel mixed into lubricant oil	1. Injection pump's plunger is worn	Repair or replace	3-47
	2. Deficient nozzle injection	Repair or replace nozzle	3-34
	3. Injection pump broken	Replace	3-47
Water mixed into lubricant oil	1. Head gasket damaged	Replace	3-46
	2. Cylinder block or cylinder head flawed	Replace	3-46
Low oil pressure	1. Engine oil insufficient	Replenish	2-23
	2. Oil strainer clogged	Clean	2-29
	3. Relief valve stuck with dirt	Clean	—
	4. Relief valve spring weak or broken	Replace	—
	5. Excessive oil clearance of crankshaft bearing	Replace	3-52 to 3-54
	6. Excessive oil clearance of crankpin bearing	Replace	3-52 to 3-54
	7. Excessive oil clearance of rocker arm	Replace	3-45
	8. Oil passage clogged	Clean	—
	9. Different type of oil	Different type of oil	2-11
	10. Oil pump damaged	Replace	—
High oil pressure	1. Different type of oil	Different type of oil	2-11
	2. Relief valve damaged	Replace	—

(Continued)

3. ENGINE

Symptom	Probable cause and checking procedure	Solution	Reference page
Engine overheated	1. Engine oil insufficient	Replenish	2-23
	2. Fan belt broken or elongated	Replace or adjust	2-30
	3. Coolant insufficient	Replenish	2-39
	4. Radiator net and radiator fin clogged with dust	Clean	2-21
	5. Inside of radiator corroded	Clean or replace	2-39
	6. Coolant flow route corroded	Clean or replace	2-39
	7. Radiator cap damaged	Replace	—
	8. Overload running	Reduce the load	—
	9. Head gasket damaged	Replace	3-46
	10. Incorrect injection timing	Adjust	3-32
	11. Unsuitable fuel used	Use specified fuel	2-11
Battery quickly discharged	1. Battery electrolyte insufficient	Replenish distilled water and charge	2-32
	2. Fan belt slips	Adjust belt tension or replace	2-30
	3. Wiring disconnected	Connect	—
	4. Rectifier damaged	Replace	—
	5. Alternator damaged	Replace	—
	6. Battery damaged	Replace	—

2. Servicing specifications for engine

Engine body

Item		Factory specification	Allowable limit
Cylinder head surface	Flatness	—	0.005 mm 0.002 in.
Top clearance		0.55 to 0.75 mm 0.022 to 0.029 in.	—
Compression pressure		3.14 to 3.53 MPa 32.0 to 36.0 kgf/cm ² 456 to 512 psi	2.26 MPa 23.0 kgf/cm ² 327 psi
Variance among cylinders		—	10% or less
Valve seat	Angle (Intake)	1.0 rad 60°	—
	Angle (Exhaust)	0.79 rad 45°	—
	Width	2.12 mm 0.0835 in.	—
Valve face	Angle (Intake)	1.0 rad 60°	—
	Angle (Exhaust)	0.79 rad 45°	—
Valve recessing	Intake and Exhaust	-0.050 to 0.25 mm -0.0020 to 0.0098 in.	0.40 mm 0.016 in.
Valve stem to valve guide	Clearance (Intake)	0.035 to 0.065 mm 0.0014 to 0.0025 in.	0.10 mm 0.0039 in.
• Valve stem	O.D.	6.960 to 6.975 mm 0.2741 to 0.2746 in.	—
• Valve guide	I.D.	7.010 to 7.025 mm 0.2760 to 0.2765 in.	—
Valve clearance (Cold)		0.145 to 0.185 mm 0.00571 to 0.00728 in.	—
Valve spring	Free length	35.1 to 35.6 mm 1.39 to 1.40 in.	34.8 mm 1.37 in.
	Tilt	—	1.3 mm 0.051 in.
	Setting load	74 N / 31.0 mm 7.5 kgf / 31.0 mm 17 lbf / 1.22 in.	63 N / 31.0 mm 6.4 kgf / 31.0 mm 14 lbf / 1.22 in.
Rocker arm shaft to rocker arm	Clearance	0.016 to 0.045 mm 0.00063 to 0.0017 in.	0.10 mm 0.0039 in.
• Rocker arm shaft	O.D.	11.973 to 11.984 mm 0.47138 to 0.47181 in.	—
• Rocker arm	I.D.	12.000 to 12.018 mm 0.47244 to 0.47314 in.	—
Push rod	Alignment	—	0.25 mm 0.0098 in.
Tappet to tappet guide	Clearance	0.020 to 0.062 mm 0.00079 to 0.0024 in.	0.07 mm 0.003 in.
• Tappet guide	I.D.	20.000 to 20.021 mm 0.78740 to 0.78822 in.	—

(Continued)

3. ENGINE

Item		Factory specification	Allowable limit
• Tappet	O.D.	19.959 to 19.980 mm 0.78579 to 0.78661 in.	—
Camshaft	Side clearance	0.070 to 0.22 mm 0.0028 to 0.0086 in.	0.30 mm 0.012 in.
	Alignment	—	0.01 mm 0.0004 in.
Cam height	Intake	28.80 mm 1.134 in.	28.75 mm 1.132 in.
	Exhaust	29.00 mm 1.142 in.	28.95 mm 1.140 in.
Camshaft journal to cylinder block bore	Oil clearance	0.050 to 0.091 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
• Camshaft journal	O.D.	35.934 to 35.950 mm 1.4148 to 1.4153 in.	—
• Camshaft block bore	I.D.	36.000 to 36.025 mm 1.4174 to 1.4183 in.	—
Timing gear			
• Crank gear to idle gear 1	Backlash	0.0320 to 0.115 mm 0.00126 to 0.00452 in.	0.15 mm 0.0059 in.
• Idle gear 1 to cam gear	Backlash	0.0360 to 0.114 mm 0.00142 to 0.00448 in.	0.15 mm 0.0059 in.
• Idle gear 1 injection pump gear	Backlash	0.0340 to 0.116 mm 0.00134 to 0.00456 in.	0.15 mm 0.0059 in.
• Idle gear 1 to idle gear 2	Backlash	0.0330 to 0.117 mm 0.00130 to 0.00460 in.	0.15 mm 0.0059 in.
• Idle gear 2 to governor gear	Backlash	0.0300 to 0.117 mm 0.00119 to 0.00460 in.	0.15 mm 0.0059 in.
Governor gear			
• Governor gear to injection pump	Backlash	0.0300 to 0.117 mm 0.00119 to 0.00460 in.	0.15 mm 0.0059 in.
Idle gear shaft to gear bushing			
• Idle gear 1	Clearance	0.020 to 0.054 mm 0.00079 to 0.0021 in.	0.10 mm 0.0039 in.
• Idle gear bushing	I.D.	26.000 to 26.021 mm 1.0237 to 1.0244 in.	—
• Idle gear shaft 1	O.D.	25.967 to 25.980 mm 1.0224 to 1.0228 in.	—
• Idle gear 2	Clearance	0.020 to 0.054 mm 0.00079 to 0.0021 in.	0.10 mm 0.0039 in.
• Idle gear bushing	I.D.	26.000 to 26.021 mm 1.0237 to 1.0244 in.	—
• Idle gear shaft 2	O.D.	25.967 to 25.980 mm 1.0224 to 1.0228 in.	—
Idle gear			
• Idle gear 1	Side clearance	0.20 to 0.51 mm 0.0079 to 0.020 in.	0.80 mm 0.031 in.
• Idle gear 2	Side clearance	0.20 to 0.51 mm 0.0079 to 0.020 in.	0.80 mm 0.031 in.

(Continued)

Item		Factory specification	Allowable limit
Piston pin bore	I.D.	22.000 to 22.013 mm 0.86615 to 0.86665 in.	22.03 mm 0.8673 in.
Piston ring to piston ring groove			
• Second ring	Clearance	0.0850 to 0.122 mm 0.00335 to 0.00480 in.	0.20 mm 0.008 in.
• Oil ring	Clearance	0.02 to 0.06 mm 0.0008 to 0.002 in.	0.15 mm 0.0059 in.
Piston ring gap	Top ring	0.15 to 0.25 mm 0.0059 to 0.0098 in.	1.20 mm 0.0472 in.
	Second ring	0.40 to 0.55 mm 0.016 to 0.021 in.	1.20 mm 0.0472 in.
	Oil ring	0.025 to 0.045 mm 0.0099 to 0.017 in.	1.25 mm 0.0492 in.
Connecting rod	Alignment	—	0.05 mm 0.002 in.
Piston pin to small end bushing	Clearance	0.014 to 0.038 mm 0.00056 to 0.0014 in.	0.15 mm 0.0059 in.
• Piston pin	O.D.	22.002 to 22.011 mm 0.86622 to 0.86657 in.	—
• Small end bushing	I.D.	22.025 to 22.040 mm 0.86713 to 0.86771 in.	—
Crankshaft	Side clearance	0.15 to 0.31 mm 0.0059 to 0.012 in.	0.50 mm 0.020 in.
	Alignment	—	0.02 mm 0.0008 in.
Crankshaft to crankshaft bearing 1	Oil clearance	0.0340 to 0.114 mm 0.00134 to 0.00448 in.	0.20 mm 0.0079 in.
• Crankshaft	O.D.	47.934 to 47.950 mm 1.8872 to 1.8877 in.	—
• Crankshaft bearing 1	I.D.	47.984 to 48.048 mm 1.8892 to 1.8916 in.	—
Crankshaft to crankshaft bearing 2	Oil clearance	0.034 to 0.095 mm 0.0014 to 0.0037 in.	0.20 mm 0.0079 in.
• Crankshaft journal	O.D.	47.934 to 47.950 mm 1.8872 to 1.8877 in.	—
• Crankshaft bearing 2	I.D.	47.984 to 48.029 mm 1.8892 to 1.8908 in.	—
Crankshaft to crankshaft bearing 3	Oil clearance	0.0340 to 0.103 mm 0.00134 to 0.00405 in.	0.20 mm 0.0079 in.
• Crankshaft journal	O.D.	51.921 to 51.940 mm 2.0442 to 2.0448 in.	—
• Crankshaft bearing 2	I.D.	51.974 to 52.024 mm 2.0463 to 2.0481 in.	—
Crankpin to crankpin bearing	Oil clearance	0.029 to 0.091 mm 0.0012 to 0.0035 in.	0.20 mm 0.0079 in.
• Crankpin	O.D.	39.959 to 39.975 mm 1.5732 to 1.5738 in.	—
• Crankpin bearing	I.D.	40.040 to 40.050 mm 1.5764 to 1.5767 in.	—

(Continued)

3. ENGINE

Item	Factory specification	Allowable limit
Cylinder Liner I.D.	78.000 to 78.019 mm 3.0709 to 3.0716 in.	78.15 mm 3.077 in.
Cylinder (oversize)	78.500 to 78.519 mm 3.0906 to 3.0912 in.	78.65 mm 3.096 in.

Lubricating system

Item	Factory specification	Allowable limit
Engine oil pressure	At idle speed 68 kPa 0.69 kgf/cm ² 9.9 psi	—
	At rated speed 196 to 441 kPa 2.0 to 4.49 kgf/cm ² 28.5 to 63.9 psi	147 kPa 1.50 kgf/cm ² 21.3 psi
Inner rotor to outer rotor	Clearance 0.060 to 0.18 mm 0.0024 to 0.0071 in.	—
Outer rotor to pump body	Clearance 0.100 to 0.180 mm 0.00394 to 0.00708 in.	—
Inner rotor to cover	Clearance 0.025 to 0.075 mm 0.00099 to 0.0029 in.	—

Cooling system

Item	Factory specification	Allowable limit
Thermostat	Valve opening temperature (at beginning) 69.5 to 72.5 °C 157.1 to 162.5 °F	—
	Valve opening temperature (opened completely) 85 °C 185 °F	—
Radiator	Water tightness No leak at specified pressure	—
Radiator cap	Air leakage 10 seconds or more 88 → 59 kPa 0.89 → 0.61 kgf/cm ² 12 → 8.6 psi	—
Fan belt	Tension 7 to 9 mm / 98 N 0.28 to 0.35 in. / 98 N (10 kgf, 22 lbf)	—

Fuel system

Item	Factory specification	Allowable limit
Injection pump	Injection timing (3000 min ⁻¹ (rpm)) 0.2837 to 0.3097 rad (16.25 to 17.75°) before T.D.C	—
Pump element	Fuel tightness —	13.73 MPa 140.0 kgf/cm ² 1991 psi
Delivery valve	Fuel tightness 10 seconds 13.73 → 12.75 MPa 140.0 → 130.1 kgf/cm ² 1991 → 1850 psi	5 seconds 13.73 → 12.75 MPa 140.0 → 130.1 kgf/cm ² 1991 → 1850 psi
Injection nozzle	Injection pressure 13.73 to 12.75 MPa 140.0 to 150.0 kgf/cm ² 1991 to 2133 psi	—
Injection nozzle valve seat	Valve seat tightness When the pressure is 12.75 MPa (130.0 kgf/cm ² , 1849 psi), the valve seat must be fuel tightness	—

3. Tightening torques for engine

Tightening torques of screws, bolts and nuts on the table below are especially specified.

NOTE

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

Item	Dimension × Pitch	N · m	kgf · m	lbf · ft
Cylinder head cover screw	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Cylinder head screw	M10 × 1.25	64 to 68	6.5 to 7.0	47 to 50
*Main bearing case screw 1	M8 × 1.25	30 to 34	3.0 to 3.5	37 to 39
*Main bearing case screw 2	M9 × 1.25	49 to 53	5.0 to 5.5	40 to 43
*Flywheel screw	M10 × 1.25	54 to 58	5.5 to 6.0	40 to 43
*Connecting rod screw	M8 × 1.0	42 to 46	4.2 to 4.7	31 to 33
*Rocker arm bracket screw	M7 × 1.0	22 to 26	2.2 to 2.7	16 to 19
*Idle gear shaft screw	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
*Fan drive pulley screw	M14 × 1.5	236 to 245	24 to 25	174 to 180
Bearing case cover mounting screw	M6 × 1.0	10.8 to 12.2	1.10 to 1.25	7.96 to 9.04
Glow plug	M8 × 1.0	7.9 to 14	0.80 to 1.5	5.8 to 10
Nozzle holder assembly	M20 × 1.5	49 to 68	5.0 to 7.0	37 to 50
Nozzle holder	—	35 to 39	3.5 to 4.0	26 to 28
Oil pressure switch	PT 1/8	15 to 19	1.5 to 2.0	11 to 14
Injection pipe retaining nut	M12 × 1.5	25 to 34	2.5 to 3.5	18 to 25
Overflow pipe retaining nut (serial no.: below BTZ999)	M12 × 1.5	20 to 24	2.0 to 2.5	15 to 18
Overflow pipe retaining nut (serial no.: above BU0001)	M12 × 1.5	35 to 39	3.5 to 4.0	26 to 28
Double flare pipe 1-1 retaining nut	M8 × 1.0	16.0 to 22.1	1.64 to 2.25	11.8 to 16.3
Double flare pipe 1-1 retaining nut	M10 × 1.0	8.0 to 11	0.82 to 1.1	5.9 to 8.1
Double flare pipe 1-2 retaining nut	M8 × 1.0	16.0 to 22.1	1.64 to 2.25	11.8 to 16.3
Double flare pipe 1-2 retaining nut	M10 × 1.0	8.0 to 11	0.82 to 1.1	5.9 to 8.1
Double flare pipe 2 retaining nut	M8 × 1.0	16.0 to 22.1	1.64 to 2.25	11.8 to 16.3
Pressure pipe retaining nut	M8 × 1.0	16.0 to 22.1	1.64 to 2.25	11.8 to 16.3
Rack sensor mounting screw	M6 × 1.0	6 to 8	0.62 to 0.81	4.5 to 5.9
Temperature sensor	M12 × 1.25	25 to 35	2.6 to 3.5	19 to 25
Starter's B terminal nut	M8	5.88 to 11.8	0.600 to 1.20	4.34 to 8.70

(Continued)

3. ENGINE

Item	Dimension × Pitch	N · m	kgf · m	lbf · ft
Alternator's pulley nut	—	58.4 to 78.9	5.95 to 8.05	43.1 to 58.2
Drain plug with copper gasket	M12 × 1.25	33 to 37	3.3 to 3.8	24 to 27
Drain plug with rubber coated gasket	M22 × 1.5	45 to 53	4.5 to 5.5	33 to 39

 RELATED PAGE

1. [General use screws, bolts and nuts on page 2-15](#)
-

4. Checking and adjusting

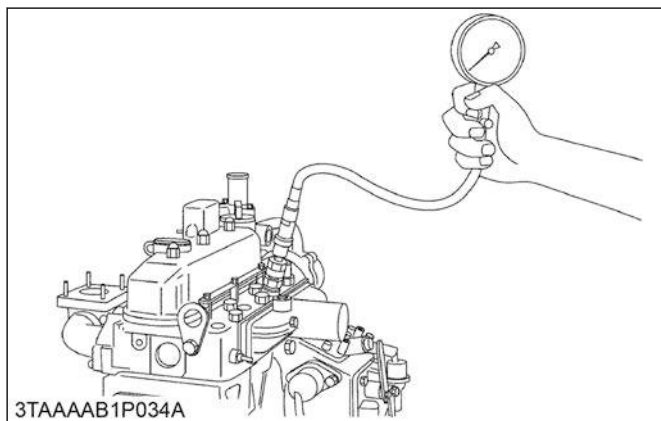
4.1 Engine body

4.1.1 Checking compression pressure

■ 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%.

1. Run the engine until it is warmed up.
2. Stop the engine.
3. Remove the air cleaner, the muffler and all glow plugs (or nozzles).
4. Set a compression tester with the adaptor to the glow plug hole (or nozzle hole).



Nozzle hole:

Adaptor H (07909-31231)

Glow plug hole:

Adaptor L (07909-31301)

5. After disconnecting the solenoid connector, run the engine with the starter and measure the compression pressure.
6. Repeat steps 4 and 5 for each cylinder.
7. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the glow plug hole (or nozzle hole) and measure the compression pressure again.

Compression pressure	Factory specification	3.14 to 3.53 MPa 32.0 to 36.0 kgf/cm ² 456 to 512 psi
	Allowable limit	2.26 MPa 23.0 kgf/cm ² 327 psi

8. If the compression pressure is still less than the allowable limit, check the top clearance, valve clearance and cylinder head.

9. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

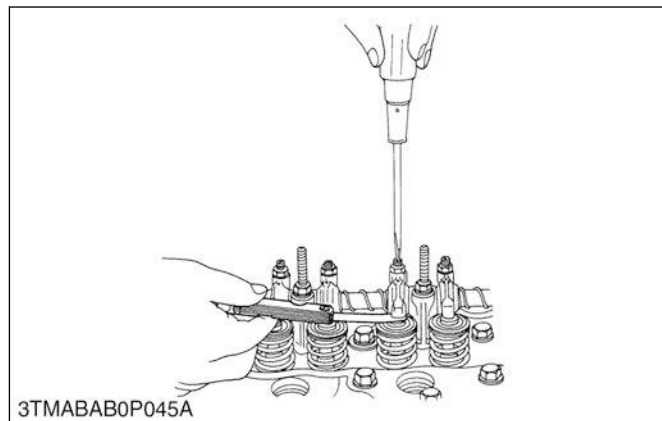
4.1.2 Checking valve clearance

■ IMPORTANT

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

■ NOTE

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



(1) "1TC" mark

(2) Alignment mark

Adjustable cylinder location of piston		4 cylinder	
		IN.	EX.
When No. 1 piston is at compression top dead center.	1	☆	☆
	2	☆	
	3		☆
	4		
When No. 1 piston is at overlap position.	1		
	2		☆
	3	☆	
	4	☆	☆

1. Remove the cylinder head cover and the glow plugs.
2. Align the "1TC" mark (1) on the flywheel and alignment mark (2) on the rear end plate so that the No. 1 piston comes to the compression top dead center.
3. Check the following valve clearance marked with "☆" using a feeler gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory specification	0.145 to 0.185 mm 0.00571 to 0.00728 in.
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5. Then turn the flywheel and align the "1TC" mark (1) on the flywheel and alignment mark (2) on the rear end plate so that the No. 1 piston comes to the overlap position.

Turn flywheel	Factory specification	6.28 rad (360°)
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6. Check the following valve clearance marked with "☆" using a feeler gauge.

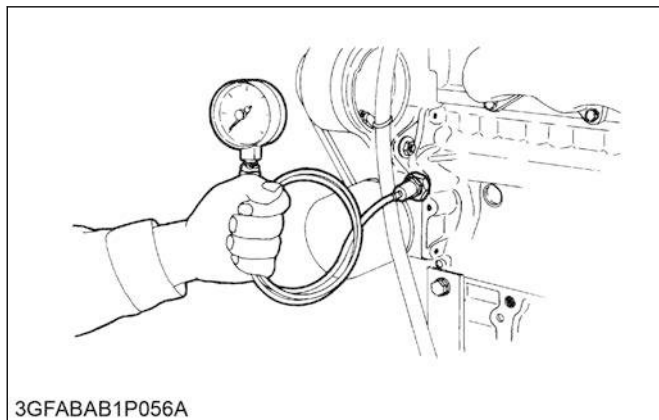
NOTE

- After adjusting the valve clearance, secure the adjusting screw with the lock nut.

4.2 Lubricating system

4.2.1 Checking engine oil pressure

1. Remove the engine oil pressure switch, and set an oil pressure tester.



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 damaged
 - 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 0.50 kgf/cm ² 7.1 psi
	At rated speed	Factory specification	197 to 441 kPa 2.00 to 4.50 kgf/cm ² 28.5 to 64.0 psi
		Allowable limit	147 kPa 1.50 kgf/cm ² 21.3 psi

(When reassembling)

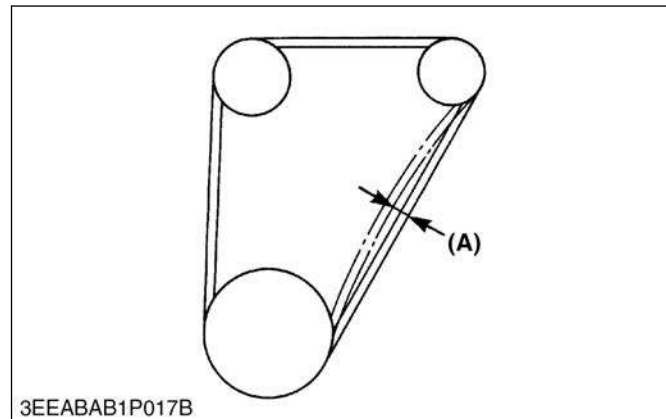
- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

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

4.3.1 Checking fan belt tension

1. Measure the deflection (A), depressing the belt halfway between the fan drive pulley and alternator pulley at specified force.



(A) Deflection

2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

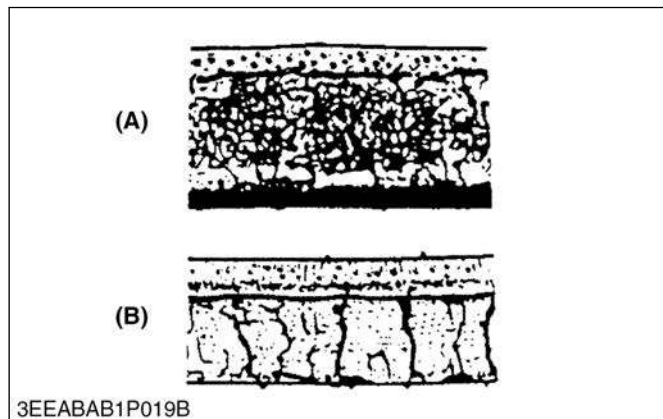
Specified force	Factory specification	98 N 10 kgf 22 lbf
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Deflection (A)	Factory specification	7.0 to 9.0 mm 0.28 to 0.35 in.
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4.3.2 Checking fan belt damage and wear

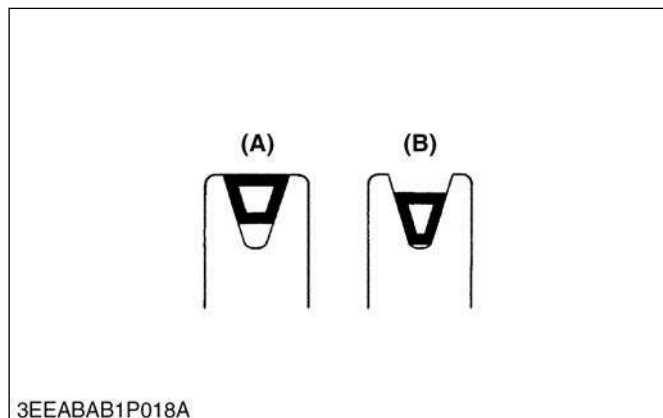
1. Check the fan belt for damage.

2. If the fan belt is damaged, replace it.



(A) Good (B) Bad

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

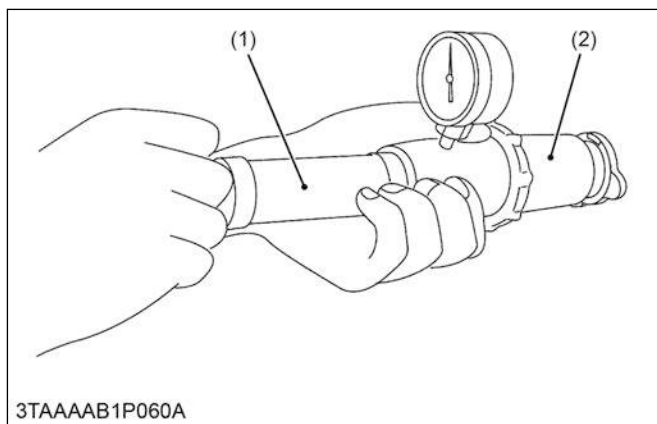
4.3.3 Checking radiator cap air leakage



CAUTION

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

1. Set a radiator tester (1) and an adaptor (2) on the radiator cap.



(1) Radiator tester (2) Adapter

2. Apply the specified pressure, and measure the time for the pressure to fall.
3. If the measurement is less than the factory specification, replace the radiator cap.

Specified pressure		88 kPa 0.89 kgf/cm ² 12 psi
Pressure falling time	Factory specification	More than 10 second for specified pressure to fall to 59 kPa 0.61 kgf/cm ² 8.6 psi

4.3.4 Checking radiator water leakage



CAUTION

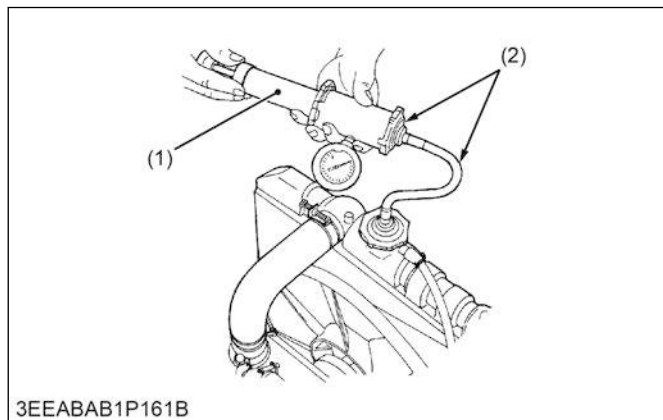
- When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.

NOTE

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

1. Pour a specified amount of water into the radiator.

- Set a radiator tester (1) and an adaptor (2) and raise the water pressure to the specified pressure.



(1) Radiator tester

(2) Adaptor

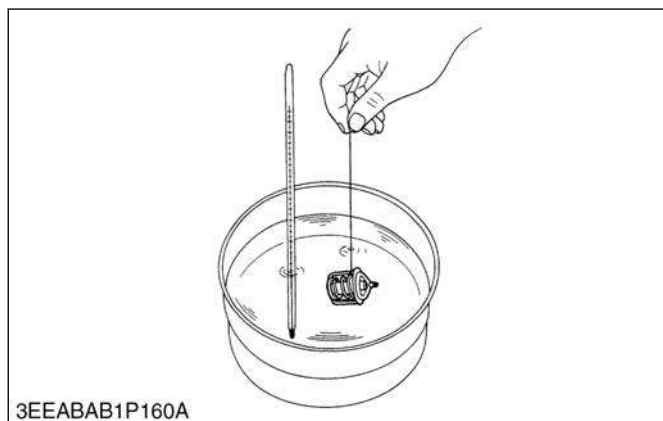
Radiator water leakage test pressure	Factory specification	No leak at specified pressure
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- Check the radiator for water leaks.
- For water leak from the pinhole, repair with the radiator cement. When water leak is excessive, replace the radiator.

4.3.5 Checking thermostat valve opening temperature

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.



- Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
- Heating the water gradually, read the temperature when the valve opens and leaves the string.
- Continue heating and read the temperature when the valve opens.

- If the measurement is not within the factory specifications, replace the thermostat.

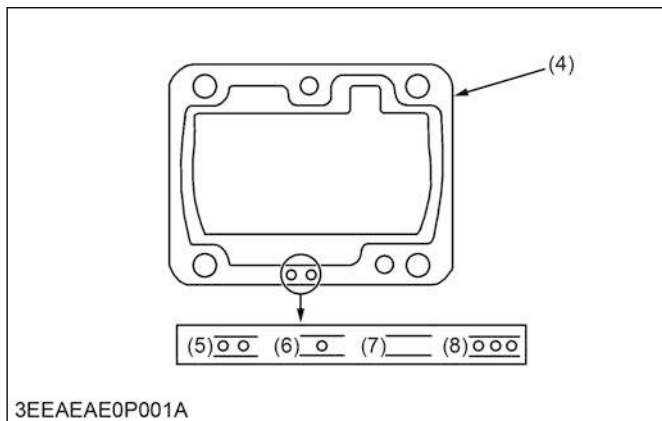
Thermostat's valve opening temperature (Approx. 8 mm (0.3 in.))	Factory specification	69.5 to 72.5 °C 157.1 to 162.5 °F
Temperature at which thermostat completely opens.		85 °C 185 °F

4.4 Fuel system

4.4.1 Checking injection timing

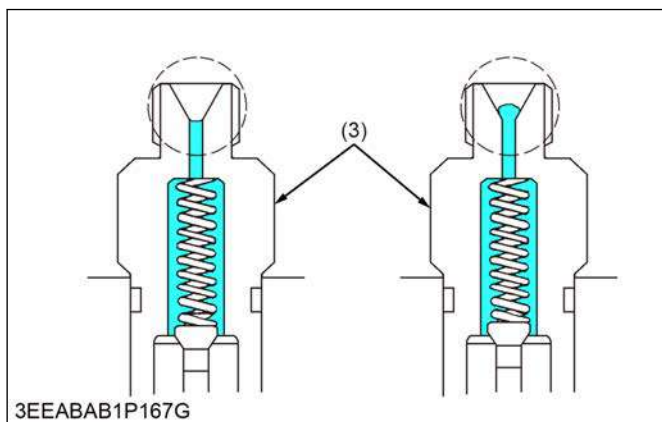
NOTE

- The liquid gasket is not required for assembling.
- Shims are available in thickness of 0.20 mm (0.0079 in.), 0.25 mm (0.0098 in.), 0.30 mm (0.012 in.), 0.35 mm (0.014 in.) and 0.175 mm (0.00689 in.). Combine these shims for adjustments.
- Addition or reduction of shim (0.025 mm, 0.00098 in.) delays or advances the injection timing by approx. 0.0044 rad (0.25°).
- In disassembling and replacing the injection pump, be sure to use the same number of new shims with the same thickness.
- The 0.175 mm thick shim is coated only on the lower face. Therefore, do not use the 0.175 mm thick shim as the top shim of the combination (injection pump side), because this can cause oil leakage.



- | | |
|--|--|
| (1) Timing line | (6) One-hole:
0.25 mm (0.0098 in.) |
| (2) Alignment mark | (7) Without hole:
0.30 mm (0.012 in.) |
| (4) Shim (Soft metal gasket shim) | (8) Three-holes:
0.35 mm (0.014 in.) |
| (5) Two-holes:
0.20 mm (0.0079 in.)
0.175 mm (0.00689 in.) | |

- Remove the injection pipes.
- Remove the solenoid.
- Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (3) for No. 1 cylinder.



- After the fuel fills up to the hole of the delivery valve holder for No. 1 cylinder, turn back (clockwise) the flywheel.

Turn the flywheel clockwise	Factory specification	1.6 rad (90°)
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- Turn the flywheel counterclockwise.

Turn the flywheel counterclockwise	Factory specification	0.44 rad (25°) before T.D.C.
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- Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
- Check to see the degree on flywheel.
The flywheel gas mark "1TC", "10" and "20" for the crank angle before the top dead center of No. 1 cylinder.
- If injection timing is out of adjustment, readjust the timing with shims.

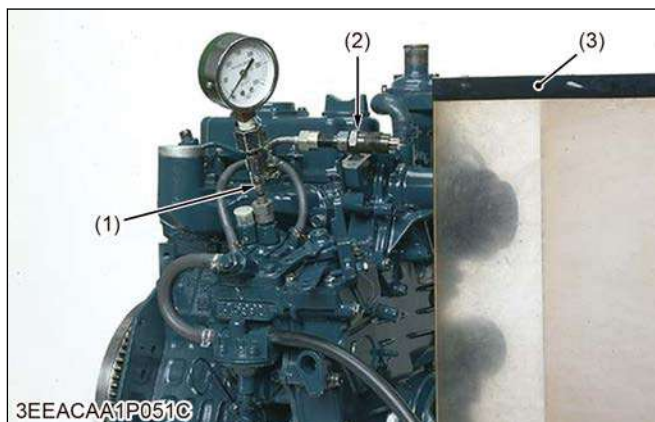
Injection timing (3000 min ⁻¹ (rpm))	Factory specification	0.2837 to 0.3097 rad (16.25 to 17.75°) before T.D.C.
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4.4.2 Checking fuel tightness of pump element

NOTE

- Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.

- Remove the solenoid.
- Remove the injection pipes and glow plugs.
- Install the injection pump pressure tester to the injection pump.
- Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the photo.)



- | | |
|------------------------------------|--------------------------------------|
| (1) Injection pump pressure tester | (3) Protection cover for jetted fuel |
| (2) Injection nozzle | |

- Run the starter to increase the pressure.

6. If the pressure cannot reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

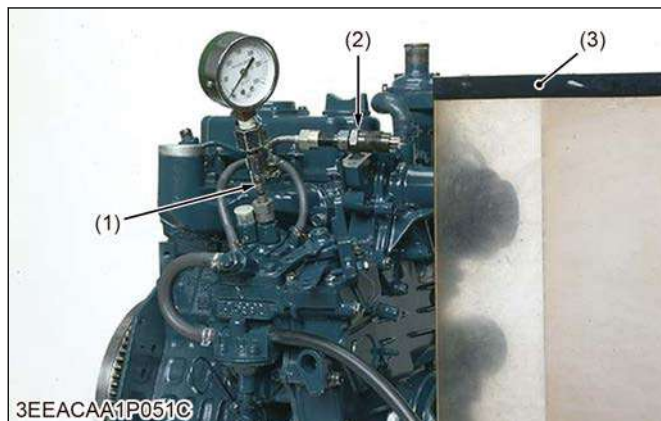
Fuel tightness of pump element	Allowable limit	13.73 MPa 140.0 kgf/cm ² 1991 psi
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4.4.3 Checking fuel tightness of delivery valve

NOTE

- Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.

- Remove the solenoid.
- Remove the injection pipes and glow plugs.
- Set a pressure tester to the fuel injection pump.
- Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).



- (1) Injection pump pressure tester (3) Protection cover for jetted fuel
(2) Injection nozzle

- Run the starter to increase the pressure.
- Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure.

Raise pressure	Approximately	13.73 MPa 140.0 kgf/cm ² 1991 psi
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- Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop.
- Measure the time needed to decrease the pressure.
- If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

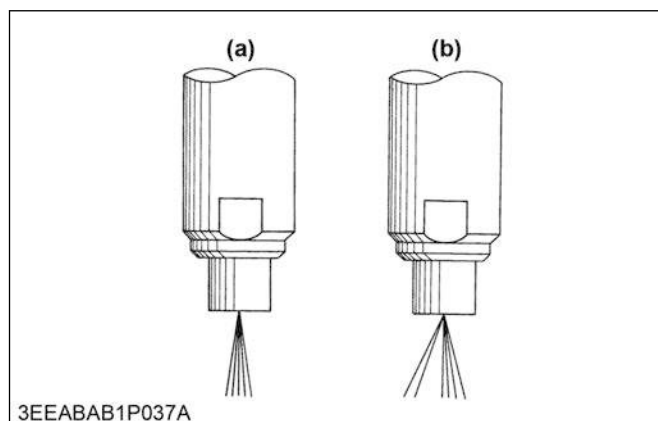
Fuel tightness of delivery valve	Factory specification	10 seconds 13.73 → 12.75 MPa 140.0 → 130.1 kgf/cm ² 1991 → 1850 psi
	Allowable limit	5 seconds 13.73 → 12.75 MPa 140.0 → 130.1 kgf/cm ² 1991 → 1850 psi

4.4.4 Checking nozzle spraying condition



CAUTION

- Check the nozzle injection pressure and condition after you make sure 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.



(a) Good

(b) Bad

- Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
- If the spraying condition is damaged, replace the nozzle piece.

4.4.5 Checking fuel injection pressure



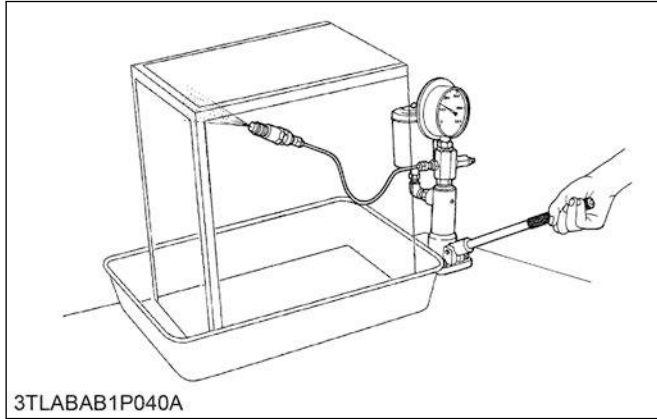
CAUTION

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

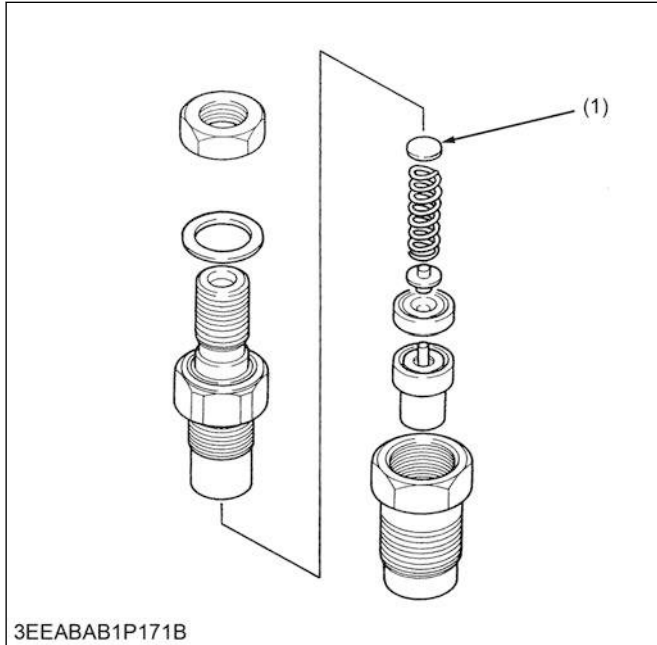
(Reference)

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

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.



- (1) Adjusting washer

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 specification	13.73 to 14.70 MPa 140.0 to 150.0 kgf/cm ² 1992 to 2133 psi
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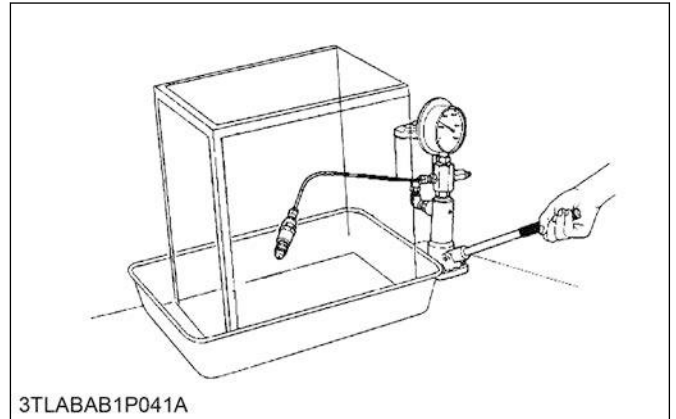
4.4.6 Checking valve seat tightness



CAUTION

- Check the nozzle injection pressure and condition after you make sure 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.



1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep for 10 seconds.

Valve seat tightness	Factory specification	No fuel leak for 10 seconds at 12.75 MPa 130.0 kgf/cm ² 1849 psi
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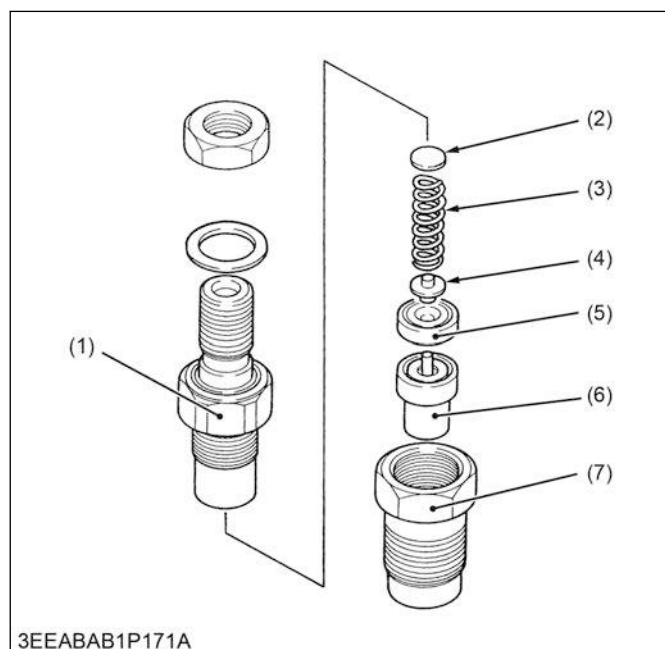
3. If any fuel leak is found, replace the nozzle piece.

4.4.7 Removing nozzle holder



CAUTION

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



- (1) Nozzle holder
(2) Adjusting washer
(3) Nozzle spring
(4) Push rod
(5) Distance piece
(6) Nozzle piece
(7) Nozzle retaining nut

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and remove parts inside.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.
- After assembling the nozzle, be sure to adjust the fuel injection pressure.

Tightening torque	Nozzle holder	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Overflow pipe retaining nut Serial No.: Below BTZ999	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Overflow pipe retaining nut Serial No.: Above BU0001	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 36 to 50 lbf·ft

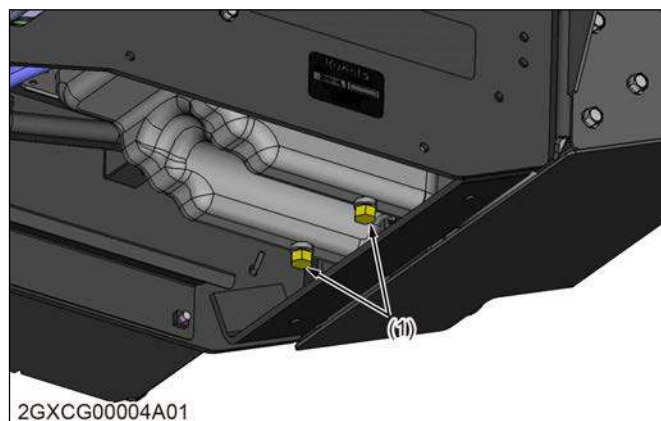
5. Disassembling and assembling

5.1 Separating engine

5.1.1 Draining engine oil

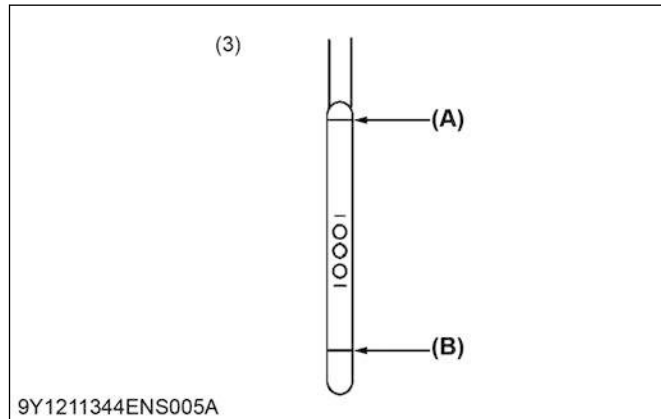
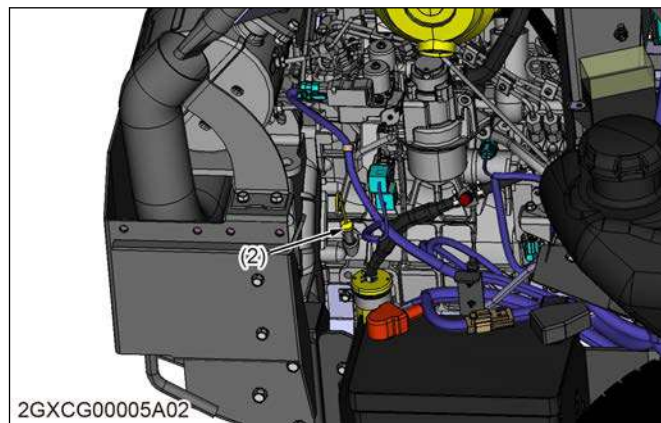
1. Park the machine on level ground.

2. Start and warm up the engine for approx. 5 minutes.
3. Place an oil pan underneath the engine.



- (1) Drain plug

4. Remove the drain plug (1) to drain oil and drain the oil completely.
5. After draining, screw in the drain plug (1).

(When refilling)

- (2) Dipstick
(3) Engine oil range
(A) Upper level
(B) Lower level

IMPORTANT

- Fill the engine oil up to the upper line (A) on the dipstick.
- Never mix two different types of oil.

- Use the proper SAE Engine Oil according to ambient temperatures.

Engine oil	Capacity	6.7 L 7.1 U.S.qts 5.9 Imp.qts
------------	----------	-------------------------------------

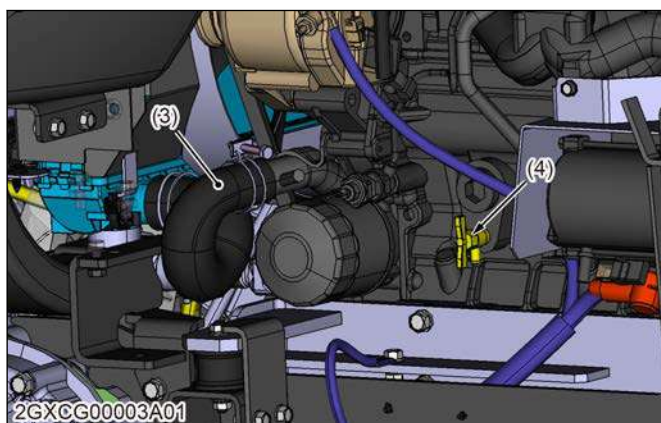
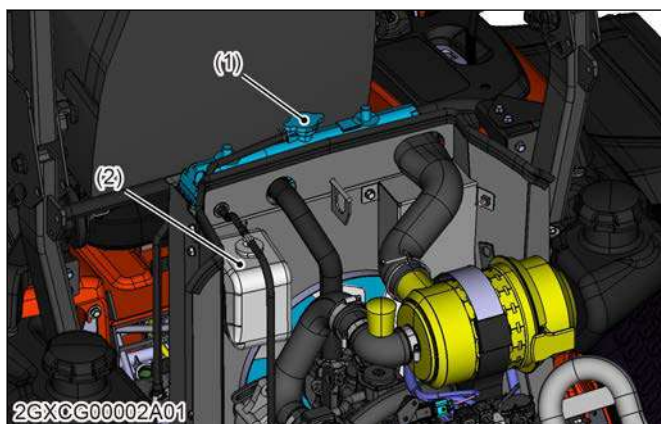
— RELATED PAGE —
[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

5.1.2 Draining coolant

! WARNING

To avoid serious injury or death:

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



- | | |
|-------------------|--------------------------------|
| (1) Radiator cap | (3) Lower radiator hose |
| (2) Recovery tank | (4) Engine coolant drain valve |

1. Stop the engine and let cool down.
2. Open the engine coolant drain valve (4) to drain the coolant from the engine.
3. Remove the lower radiator hose (3) from the engine side to drain the coolant from the radiator.

4. Remove the radiator cap (1) to completely drain the coolant.
5. After all coolant is drained, close the engine coolant drain valve (4).

(When refilling)

Coolant capacity	Radiator	4.6 L 4.9 U.S.qts 4.0 Imp.qts
	Recovery tank	1.1 L 1.2 U.S.qts 0.97 Imp.qts

— RELATED PAGE —
[LUBRICANTS, FUEL AND COOLANT on page 2-11](#)

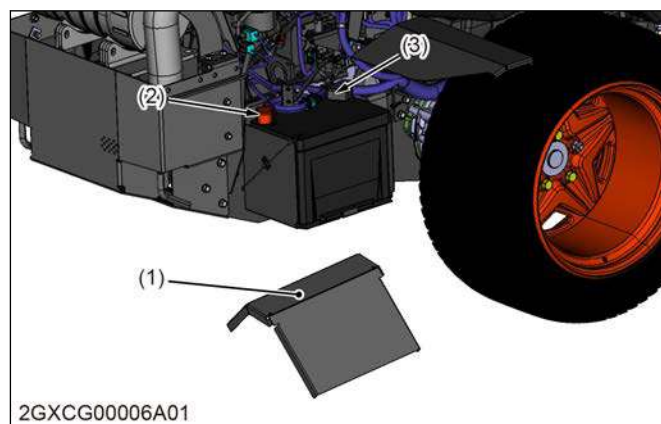
5.1.3 Removing the battery

! WARNING

To avoid serious injury or death:

- When disconnecting the battery cables, disconnect the negative cable from the battery first. When connecting, connect the positive cable to the battery first.

1. Remove the battery cover (1).
2. Disconnect the negative cable (3) from the battery.
3. Disconnect the positive cable (2) from the battery.
4. Remove the battery.

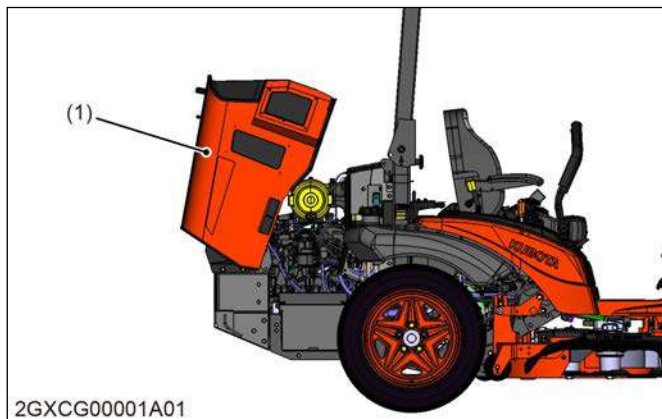


- | | |
|--------------------|--------------------|
| (1) Battery cover | (3) Negative cable |
| (2) Positive cable | |

5.1.4 Removing the bonnet

1. Remove the bonnet mounting bolts.

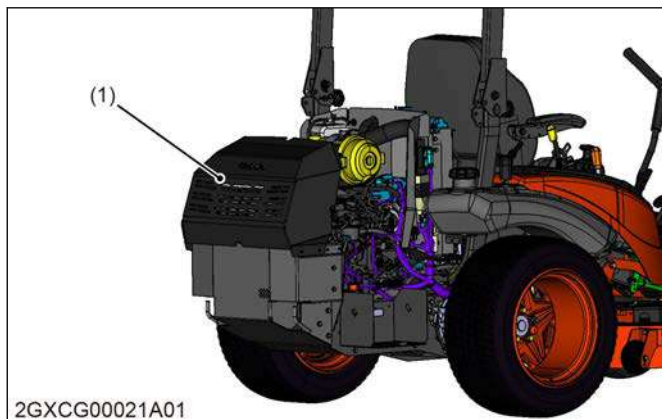
2. Remove the bonnet (1).



(1) Bonnet

5.1.5 Removing DPF cover

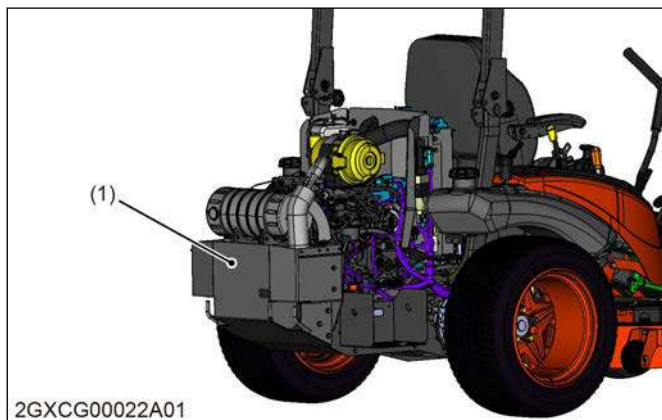
1. Remove DPF cover (1).



(1) DPF cover

5.1.6 Removing rear engine frame

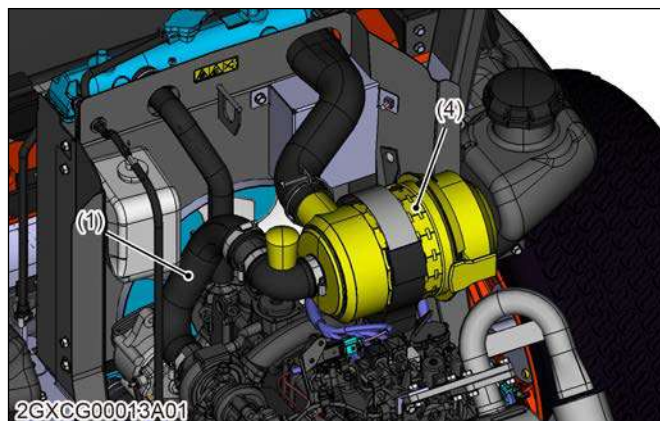
1. Remove rear engine frame (1).



(1) Rear engine frame

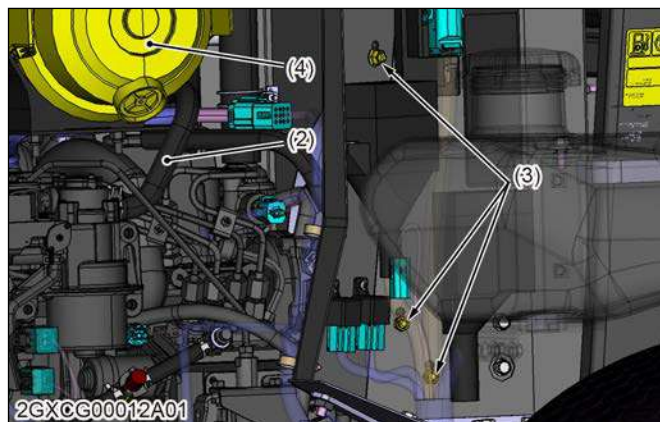
5.1.7 Removing air cleaner assembly

1. Disconnect air cleaner hose from turbocharger (1).



(1) Air cleaner hose (turbo-charger) (4) Air cleaner assembly

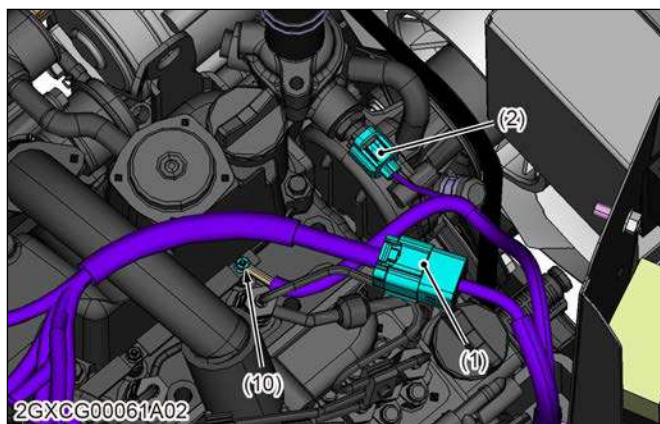
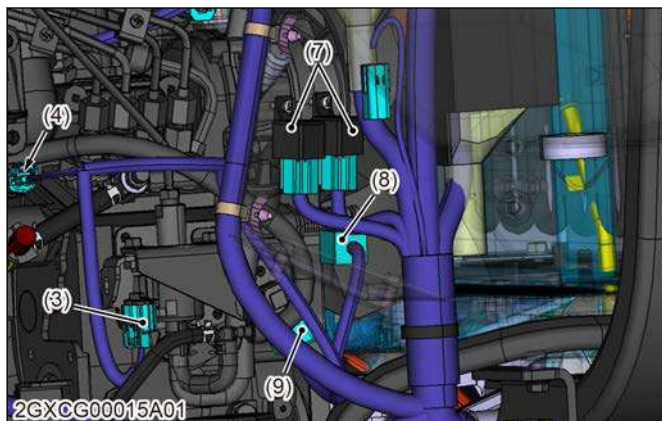
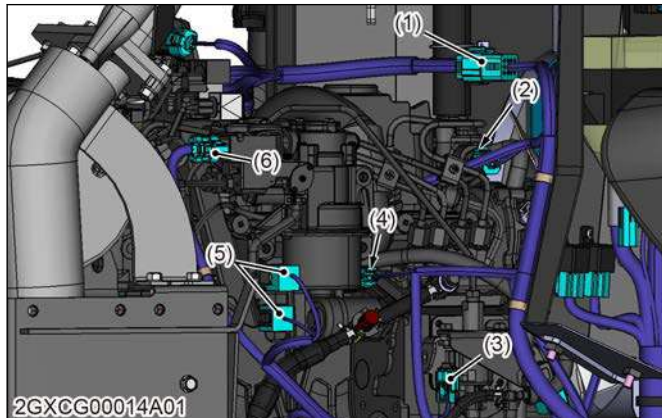
2. Disconnect air cleaner hose from blower (2).
3. Remove air cleaner stay bolts (3).
4. Remove air cleaner assembly (4).



(2) Air cleaner hose (blower) (4) Air cleaner assembly
(3) Air cleaner stay bolts

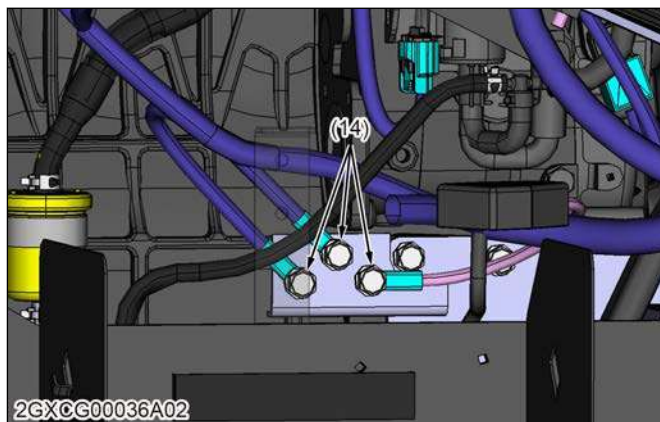
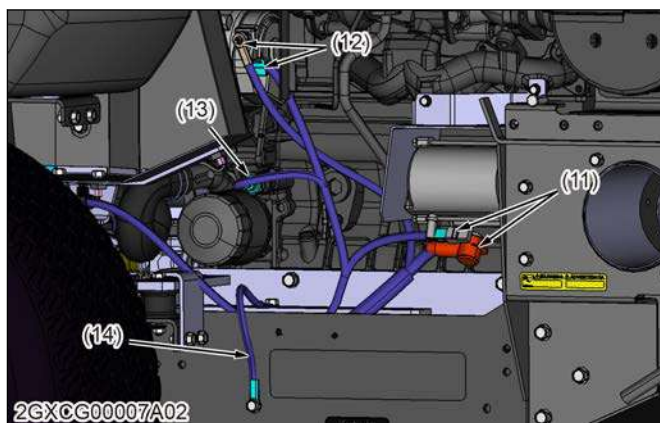
5.1.8 Disconnecting engine wiring harness

1. Disconnect each wiring connector.
 - DPF harness connector (1)
 - Water temperature sensor (2)
 - Doser fuel pump connector (3)
 - Engine stop solenoid connector (4)
 - Blower connectors (5)
 - Pressure sensor (6)
 - Relays (7)
 - Rack position sensor (8)
 - Rotation sensor (9)
 - Glow plug (10)



- | | |
|------------------------------------|--------------------------|
| (1) DPF harness connector | (6) Pressure sensor |
| (2) Water temperature sensor | (7) Relays |
| (3) Doser fuel pump connector | (8) Rack position sensor |
| (4) Engine stop solenoid connector | (9) Rotation sensor |
| (5) Blower connectors | (10) Glow plug |

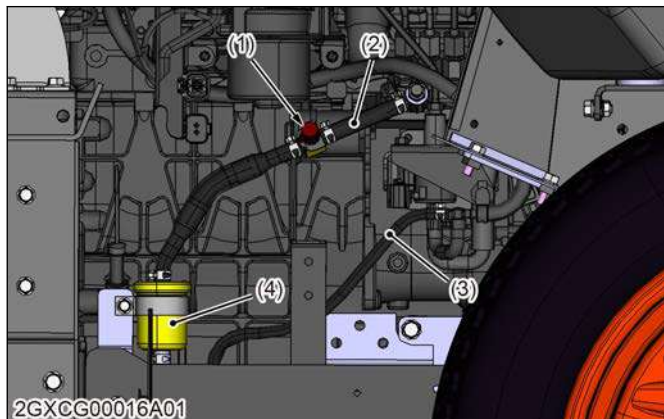
2. Remove positive cable and connector from starter motor (11).
3. Disconnect alternator connectors (12).
4. Disconnect oil switch (13).
5. Disconnect all ground cables (14).



- | | |
|----------------------------|--------------------|
| (11) Starter motor | (14) Ground cables |
| (12) Alternator connectors | |
| (13) Oil switch | |

5.1.9 Disconnecting engine fuel hoses

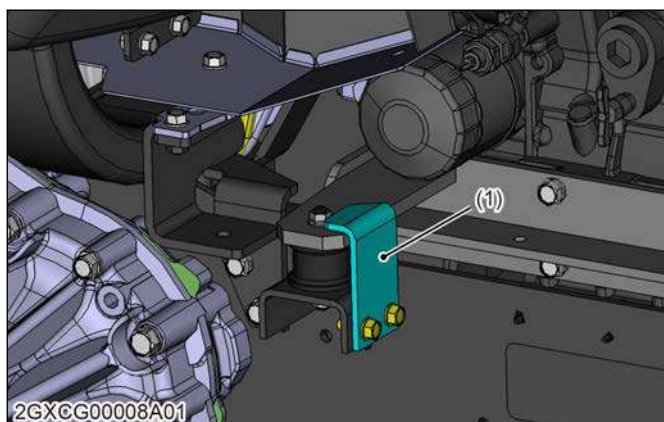
1. Turn off fuel cut off valve (1).
2. Disconnect fuel hose from engine (2).
3. Disconnect fuel hose from doser fuel pump (3).
4. Remove fuel filter assembly (4).



- (1) Fuel cut off valve
(2) Fuel hose (Engine)
(3) Fuel hose (Doser fuel pump)
(4) Fuel filter assembly

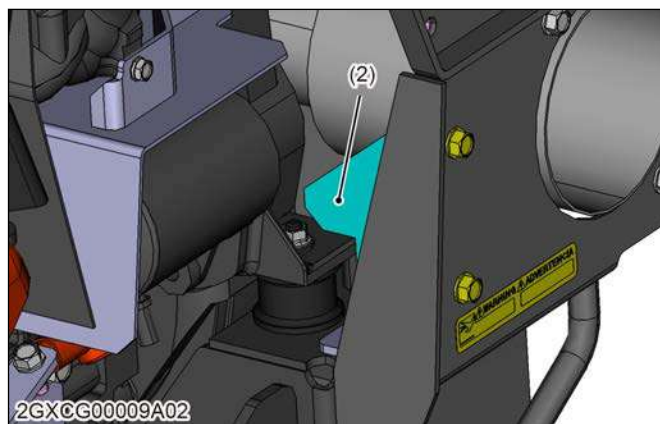
5.1.10 Removing engine stoppers

1. Remove front engine stoppers (1) on both sides of engine.



- (1) Front engine stopper

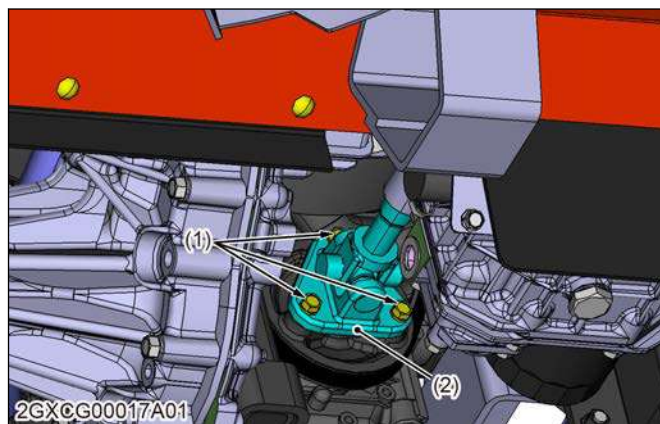
2. Remove rear engine stoppers (2) on both sides of engine.



- (2) Rear engine stopper

5.1.11 Removing universal joint from engine

1. Remove universal joint mounting bolts from engine (1).
2. Remove universal joint (2).



- (1) Universal joint mounting bolts (engine)
(2) Universal joint

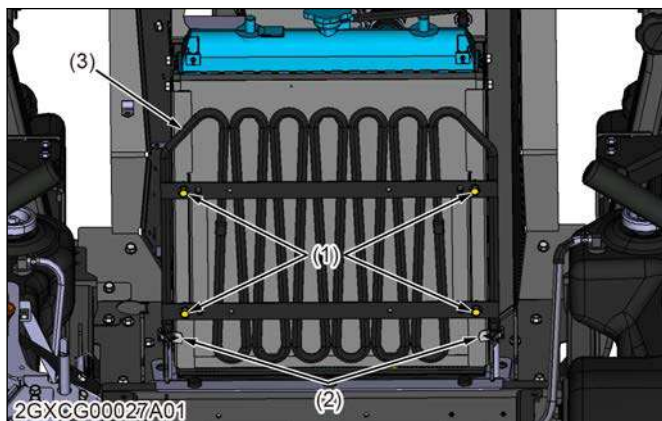
(When reassembling)

- Apply grease to the all splines on the drive shaft.

Tightening torque	Universal joint mounting bolt	26.0 to 28.0 N·m 2.70 to 2.90 kgf·m 19.2 to 20.7 lbf·ft
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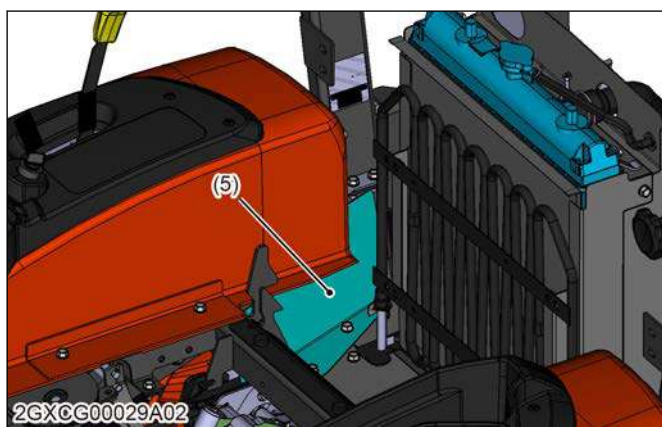
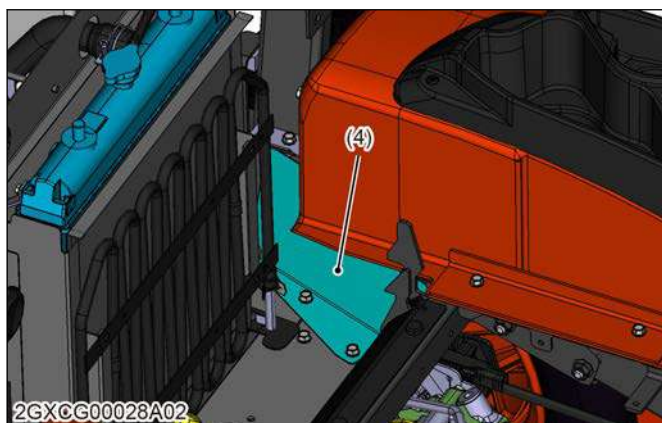
5.1.12 Disconnecting radiator assembly

1. Remove the oil cooler mounting bolts (1).



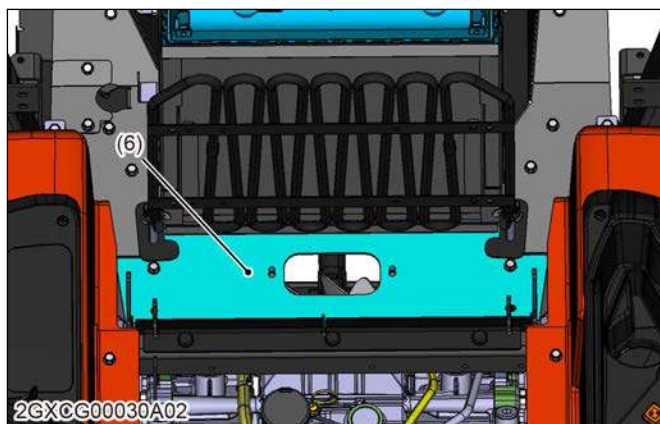
- (1) Oil cooler mounting bolts (3) Oil cooler
(2) Oil cooler clips

2. Remove L.H. and R.H. radiator plates (4), (5).



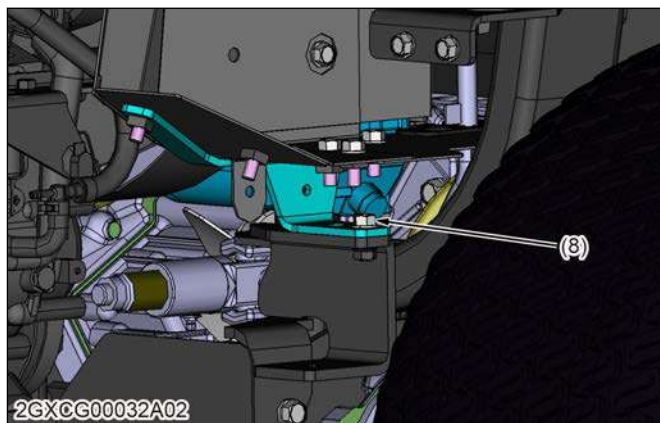
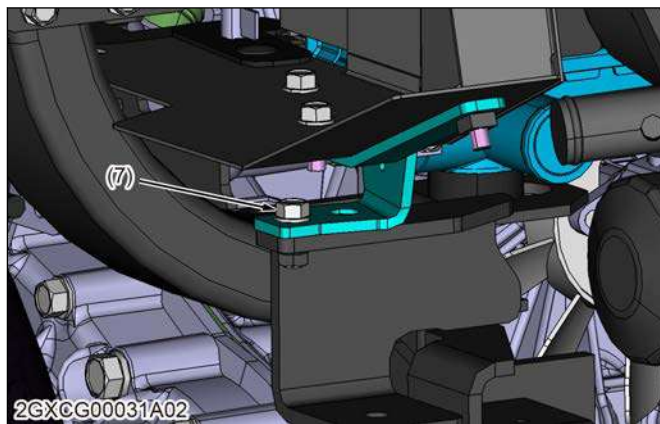
- (4) L.H. radiator plate (5) R.H. radiator plate

3. Remove center radiator plate (6).



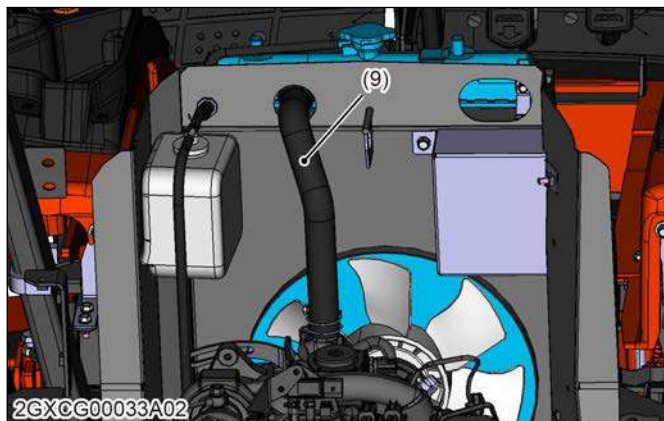
- (6) Center radiator plate

4. Remove radiator bracket mounting bolts (7), (8).



- (7) Radiator bracket mounting bolt L.H. (8) Radiator bracket mounting bolt R.H.

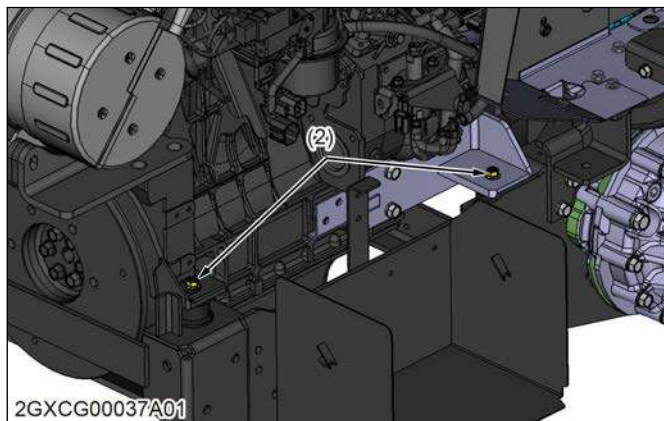
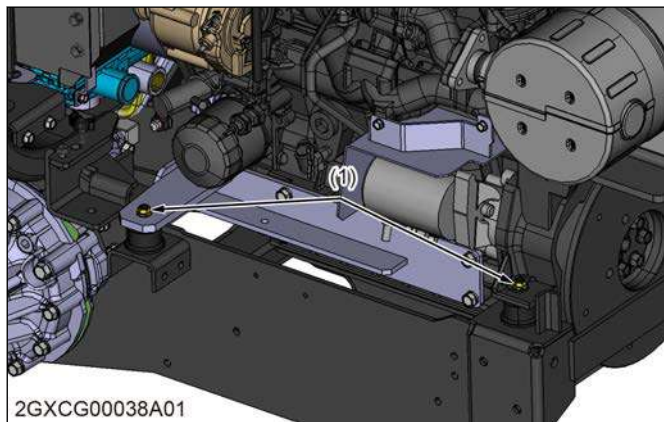
5. Remove upper radiator hose (9).



(9) Upper radiator hose

5.1.13 Separating the engine

1. Remove engine mounting nuts L.H. (1).
2. Remove engine mounting nuts R.H. (2).



(1) Engine mounting nuts L.H. (2) Engine mounting nuts R.H.

3. Attach hoist to engine.
4. Separate the engine.



(When reassembling)

- Apply grease to the all splines on the drive shaft.

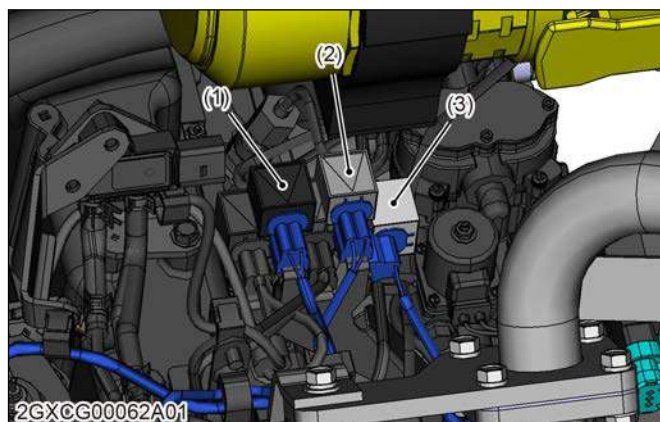
Tightening torque	Engine mounting nut	23.5 to 27.5 N·m 2.40 to 2.80 kgf·m 17.4 to 20.3 lbf·ft
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5.2 Disassembling the engine

5.2.1 External components

5.2.1.1 Removing DPF, alternator, starter and fan belt

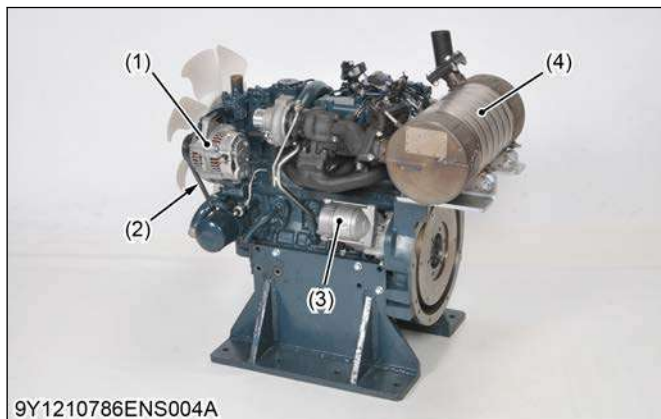
1. Remove each connector on the temperature sensor 0, 1 and 2 from the connector bracket.



(1) Sensor 0 (2) Sensor 1 (3) Sensor 2

2. Remove the DPF muffler (4).
3. Remove the alternator (1).
4. Remove the fan belt (2).

5. Remove the starter (3).



- | | |
|----------------|---|
| (1) Alternator | (4) Diesel Particulate Filter (DPF) muffler |
| (2) Fan belt | |
| (3) Starter | |

(When reassembling)

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

5.2.1.2 Removing turbocharger

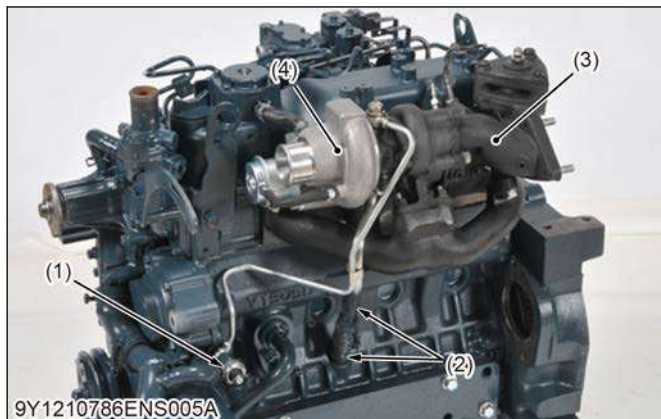


CAUTION

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

NOTE

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

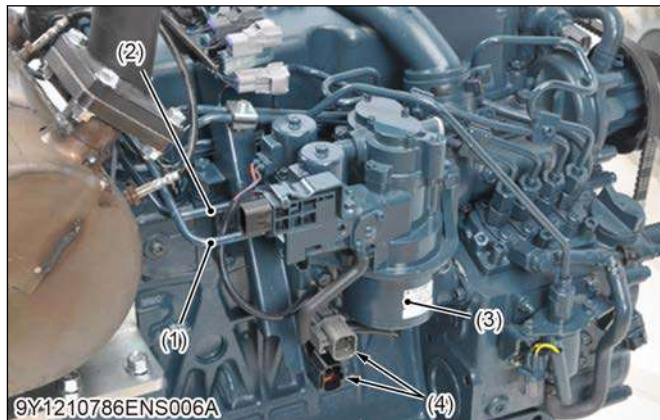


- | | |
|----------------|------------------|
| (1) Oil switch | (3) Doser flange |
| (2) Pipe band | (4) Turbocharger |

1. Disconnect the intake hose.
2. Remove the oil switch (1).

3. Disconnect the pipe band (2).
4. Remove the double flare pipe 1-1, the double flare pipe 1-2, and the double flare pipe 2 from the doser flange (3).
5. Remove the pressure pipe 1 from the doser flange (3).
6. Remove each connector on the temperature sensor 3 and 4 from the connector bracket.
7. Remove the exhaust manifold with turbocharger (4) and doser flange (3).

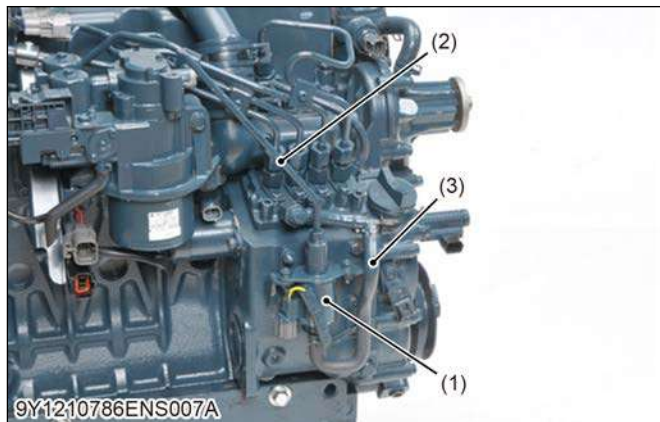
5.2.1.3 Removing air blower



- | | |
|---------------------------|----------------|
| (1) Double flare pipe 1-1 | (3) Air blower |
| (2) Double flare pipe 1-2 | (4) Connector |

1. Remove the air blower connectors (4) from the connector bracket.
2. Remove the double flare pipe 1-1 (1) and 1-2 (2) from the air blower (3).
3. Remove the air blower (3).

5.2.1.4 Removing doser fuel pump

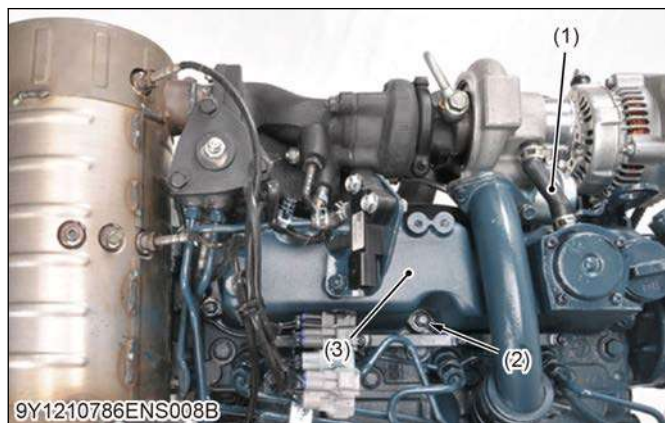


- | | |
|-------------------------|---------------|
| (1) Doser fuel pump | (3) Fuel hose |
| (2) Double flare pipe 2 | |

1. Remove the double flare pipe 2 (2) from the doser fuel pump (1).
2. Remove the fuel hose (3).
3. Remove the doser fuel pump (1).

5.2.2 Cylinder head and valve

5.2.2.1 Removing cylinder head cover



- (1) Breather hose
(2) Cylinder head cover screw
(3) Cylinder head cover

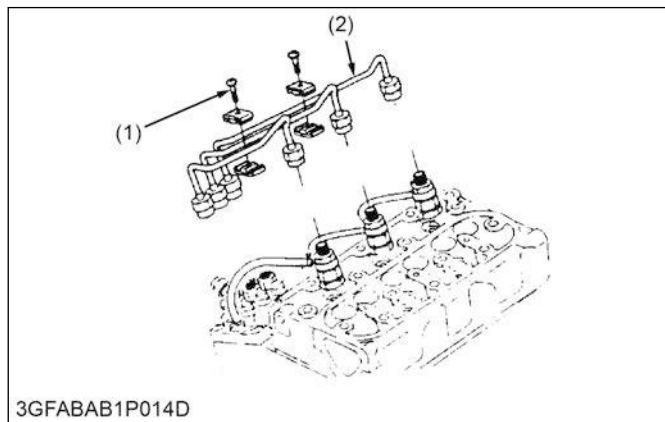
1. Disconnect the breather hose (1).
2. Remove the cylinder head cover screw (2).
3. Remove the cylinder head cover (3).

(When reassembling)

- Check to see if the cylinder head cover gasket is not damaged.

Tightening torque	Cylinder head cover screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
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5.2.2.2 Removing injection pipes



- (1) Pipe clamp
(2) Injection pipe

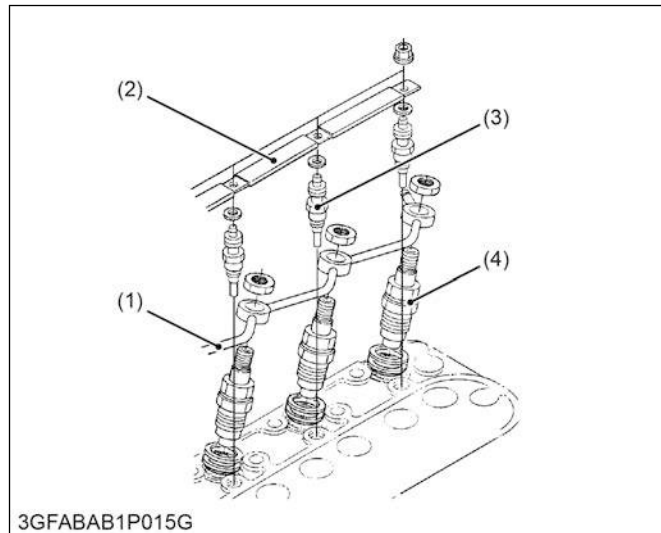
1. Loosen the screws to the pipe clamp (1).
2. Detach the injection pipes (2).

(When reassembling)

- Send compressed air into the pipes to blow out dust. Then, reassemble the pipes in the reverse order.

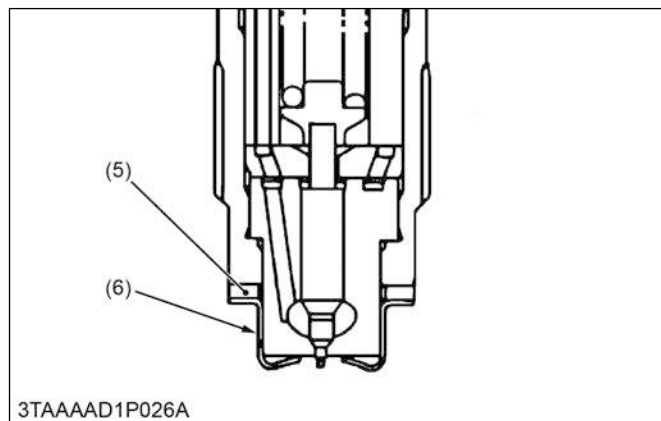
Tightening torque	Injection pipe retaining nut	25 to 34 N·m 2.5 to 3.5 kgf·m 18 to 25 lbf·ft
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5.2.2.3 Removing nozzle holder assembly and glow plug



- (1) Overflow pipe
(2) Lead
(3) Glow plug
(4) Nozzle holder assembly

1. Remove the overflow pipe (1).
2. Remove the nozzle holder assemblies (4).
3. Remove the copper gasket (5) and heat seal (6).



- (5) Copper gasket
(6) Heat seal

4. Remove the lead (2) from the glow plugs (3).
5. Remove the glow plugs (3).

(When reassembling)

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

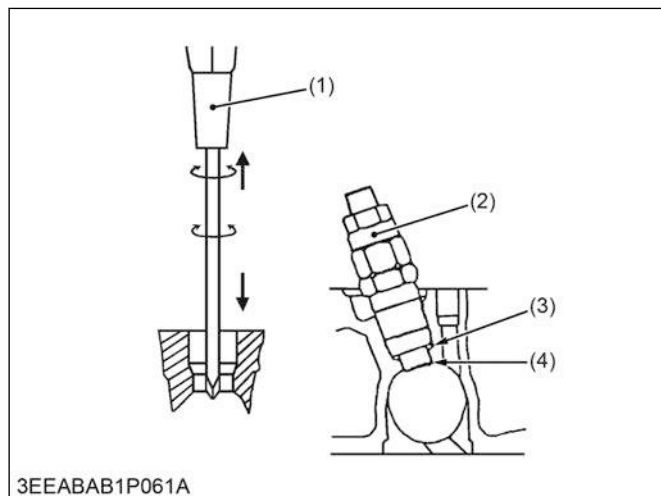
Tightening torque	Overflow pipe retaining nut Serial No.: Below BTZ999	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Overflow pipe retaining nut Serial No.: Above BU0001	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft
	Glow plug	7.9 to 14 N·m 0.80 to 1.5 kgf·m 5.8 to 10 lbf·ft

5.2.2.4 Removing nozzle heat seal

■ IMPORTANT

- Use a plus (phillips head) screw driver (1) that has a diameter which is bigger than the heat seal hole.

Diameter of seal hole	Approximately	6 mm (1/4 in.)
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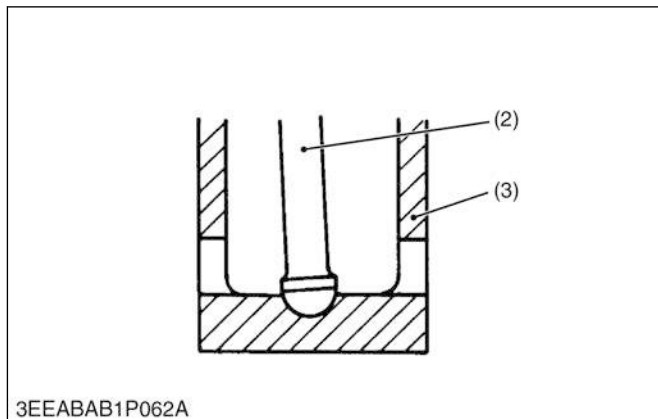
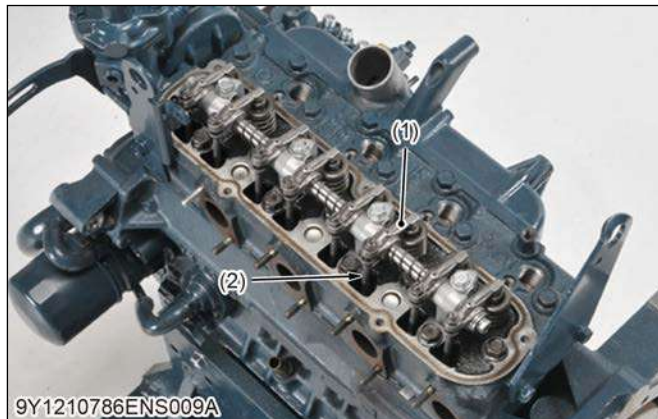
- (1) Plus screw driver (3) Injection nozzle gasket
(2) Nozzle holder (4) Heat seal

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

(When reassembling)

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

5.2.2.5 Removing rocker arm and push rod



- (1) Rocker arm assembly (3) Tappet
(2) Push rod

- Remove the rocker arm bracket screws / nuts.
- Detach the rocker arm assembly (1).
- Remove the push rods (2).

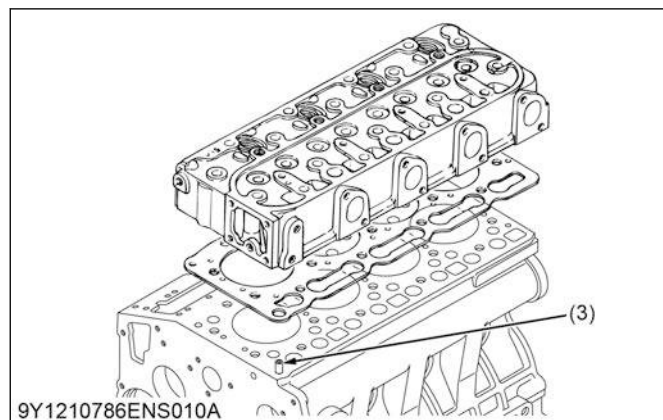
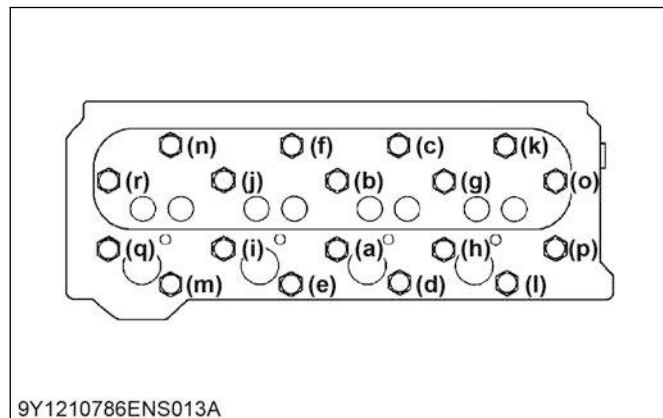
(When reassembling)

■ IMPORTANT

- After installing the rocker arm, be sure to adjust the valve clearance.
- When putting the push rods (2) onto the tappets (3), check to see if their ends are properly engaged with the dimples.

Tightening torque	Rocker arm bracket screw	22 to 26 N·m 2.2 to 2.7 kgf·m 16 to 19 lbf·ft
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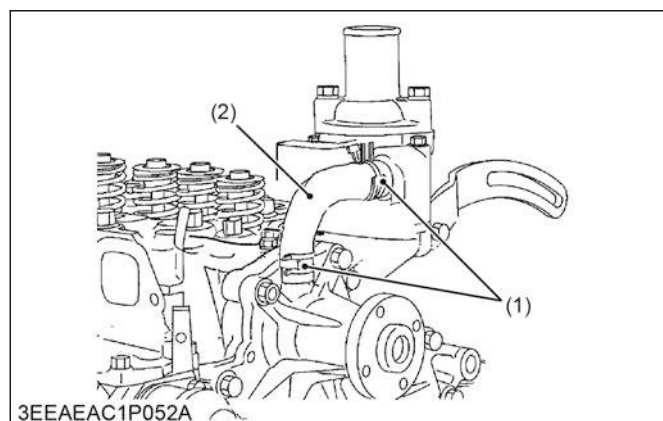
5.2.2.6 Removing cylinder head and cylinder head gasket



(3) Pin pipe

(a) To tighten
to
(n)
or
(r)

1. Loosen the pipe clamps (1), and remove the water return pipe (2).



(1) Clamp

(2) Return pipe

2. Remove the cylinder head screw in the order of (r) to (a) and remove the cylinder head.
3. Remove the cylinder head gasket.

(When reassembling)

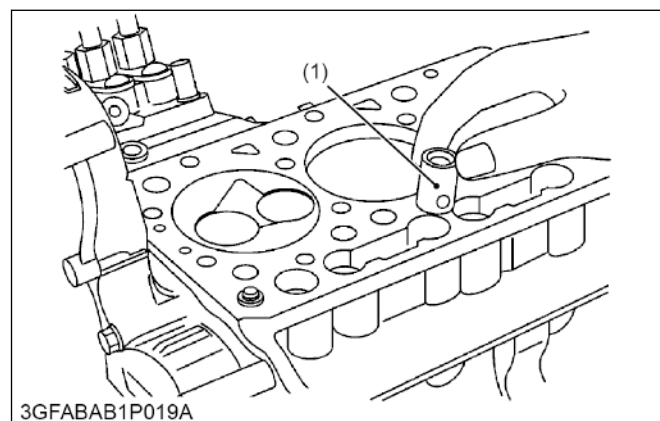
NOTE

- Do not use O-ring on the pin pipe.
- It is not necessary to retighten the cylinder head screw and to readjust valve clearance after engine warmed up.
- Replace the cylinder head gasket with new one.
- When mounting the gasket, set it to the pin pipe holes. Take care not to mount it reversely.
- The cylinder head should be free of scratches and dust.
- Install the cylinder head, using care not to damage the gasket.
- After applying engine oil to the thread of screws, tighten them in several steps and specified sequence (a) to (n) or (r).

Tightening torque	Cylinder head screw	64 to 68 N · m 6.5 to 7.0 kgf · m 47 to 50 lbf · ft
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5.2.2.7 Removing tappets

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



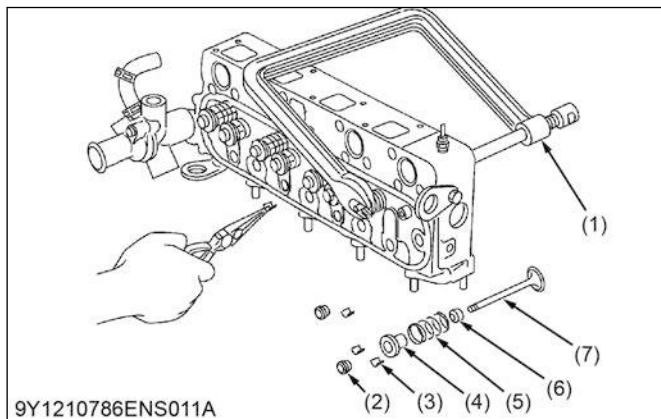
(1) Tappet

(When reassembling)

IMPORTANT

- Do not change the combination of tappet and tappet guide.
- Visually check the contact between tappets and cams for proper rotation. If problem is found, replace tappets.
- Before installing the tappets, apply engine oil thinly around them.

5.2.2.8 Removing valves



- | | |
|---------------------------|---------------------|
| (1) Valve spring replacer | (5) Valve spring |
| (2) Valve cap | (6) Valve stem seal |
| (3) Valve spring collet | (7) Valve |
| (4) Valve spring retainer | |

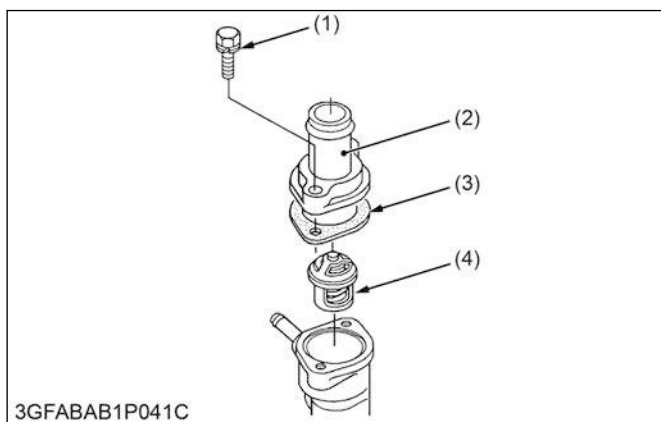
1. Remove the valve caps (2).
2. Remove the valve spring collet (3), pushing the valve spring retainer (4) by valve spring replacer (1).
3. Remove the valve spring retainer (4), valve spring (5) and valve stem seal (6).
4. Remove the valve (7).

(When reassembling)

■ IMPORTANT

- **Don't change the combination of valve and valve guide.**
- Wash the valve stem 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.

5.2.2.9 Removing thermostat assembly



- | | |
|-------------------------------------|-----------------------------|
| (1) Thermostat cover mounting screw | (3) Thermostat cover gasket |
| (2) Thermostat cover | (4) Thermostat assembly |

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

2. Remove the thermostat assembly (4).

(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the gasket (3).

5.2.3 Gear case and timing gears

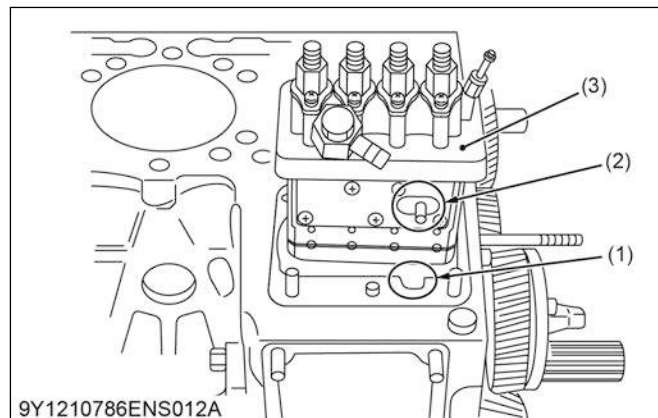
5.2.3.1 Removing injection pump

■ NOTE

- **Addition or reduction of shim delays or advances the injection timing.**
- **In disassembling and replacing, be sure to use the same number or new gasket shims with the same thickness.**

Addition or reduction of shim (0.05 mm, 0.0020 in.)	Delays or advances the injection timing by approx	0.0087 rad (0.5°)
---	--	-------------------

1. Remove the solenoid and rack sensor.
2. Align the control rack pin (2) with the notch (1) on the crankcase, and remove the injection pump (3).



- | | |
|----------------------|--------------------|
| (1) Notch | (3) Injection pump |
| (2) Control rack pin | |

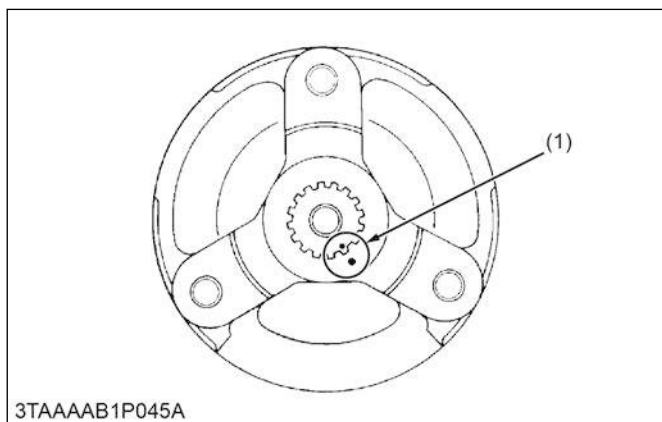
3. Remove the injection pump shims.
4. In principle, the injection pump should not be disassembled.

5.2.3.2 Removing fan drive pulley

1. Secure the flywheel to keep it from turning.
2. Remove the fan drive pulley screw.
3. Draw out the fan drive pulley with a puller.

(When reassembling)

- Install the pulley to crankshaft, aligning the mark (1) on them (3-cylinder engine).



(1) Aligning mark

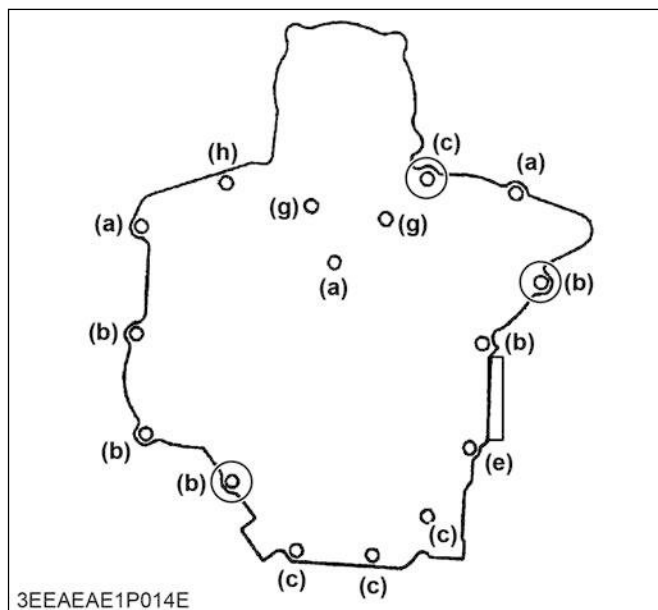
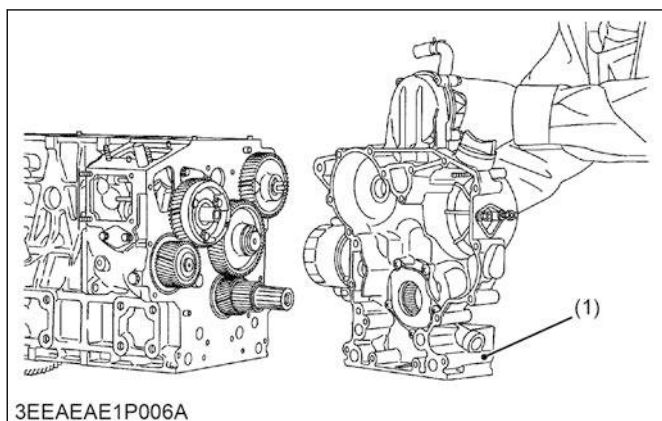
- Apply engine oil to the fan drive pulley retaining screw. And tighten it.

Tightening torque	Fan drive pulley screw	236 to 245 N·m 24.0 to 25.0 kgf·m 174 to 180 lbf·ft
-------------------	------------------------	---

5.2.3.3 Disassembling gear case

■ IMPORTANT

- Before disassembling the gear case (gasket), measure the "actual rack position" data with the engine off using a diagnostic tool.
- When assembling the gear case (gasket), measure the "actual rack position" data with the engine off using a diagnostic tool.
- Perform the "rack position offset correction" based on the actual rack position before and after replacing the gear case and write the information to the ECU.
- Refer to the failure diagnosis manual.



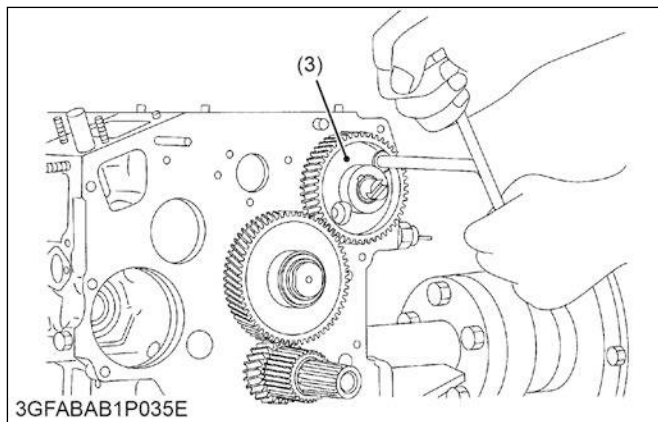
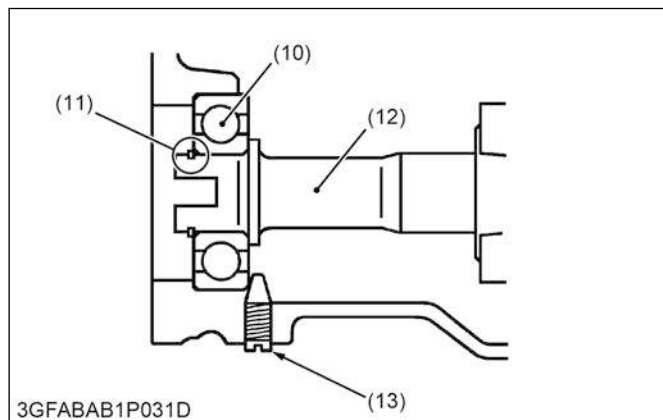
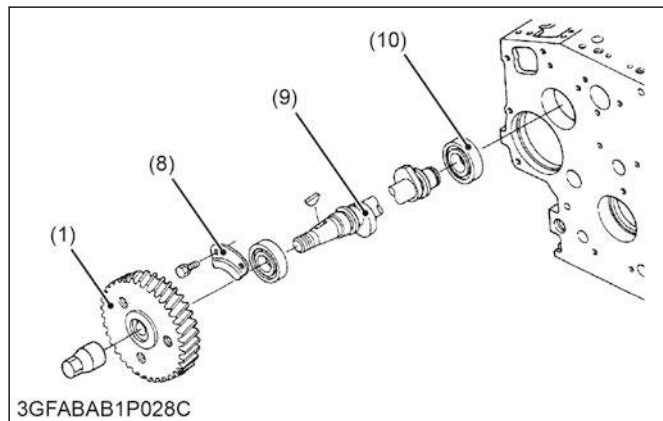
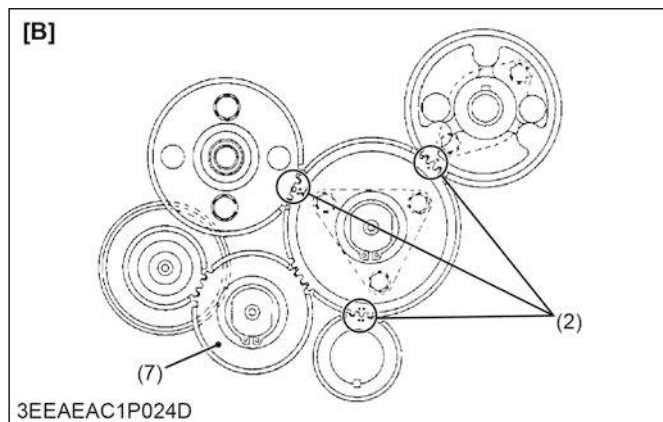
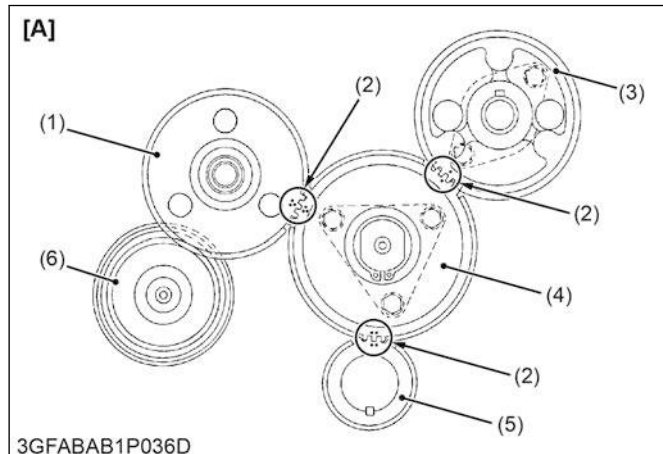
- | | |
|-----------------------------------|-----------------------------------|
| (1) Gear case | (e) Bolt length = 68 mm (2.7 in.) |
| (a) Bolt length = 45 mm (1.8 in.) | (f) Bolt length = 70 mm (2.8 in.) |
| (b) Bolt length = 50 mm (2.0 in.) | (g) Bolt length = 85 mm (3.3 in.) |
| (c) Bolt length = 55 mm (2.2 in.) | (h) Nut |
| (d) Bolt length = 65 mm (2.6 in.) | |

1. Remove the fuel feed pump.
2. Remove the gear case.

(When reassembling)

- Grease thinly to the oil seal, and install it, ensuring the lip does not come off.

5.2.3.4 Removing cam gear, idle gear 1, 2 and governor gear



- | | |
|---------------------------|-------------------------|
| (1) Fuel cam gear | (9) Fuel camshaft |
| (2) Alignment mark | (10) Ball bearing |
| (3) Cam gear | (11) External snap ring |
| (4) Idle gear 1 | (12) Governor shaft |
| (5) Crank gear | (13) Set screw |
| (6) Governor gear | [A] One idle gear type |
| (7) Idle gear 2 | [B] Two idle gear type |
| (8) Fuel camshaft stopper | |

1. Remove the idle gear 2 (7) / idle gear 1 (4).
2. Remove the fuel camshaft stopper (8).
3. Draw out the fuel cam gear (1) with fuel camshaft (9).
4. Remove the camshaft stopper bolt.
5. Remove the cam gear (3) with camshaft.
6. Remove the external snap ring (11) from the governor shaft (12).
7. Remove the governor gear (6) with governor shaft (12).

NOTE

- **Three-lever type fork lever**
To remove the governor shaft, follow the procedures in 5, 6 above and never remove fork lever and the max. torque limiter.

(When reassembling)

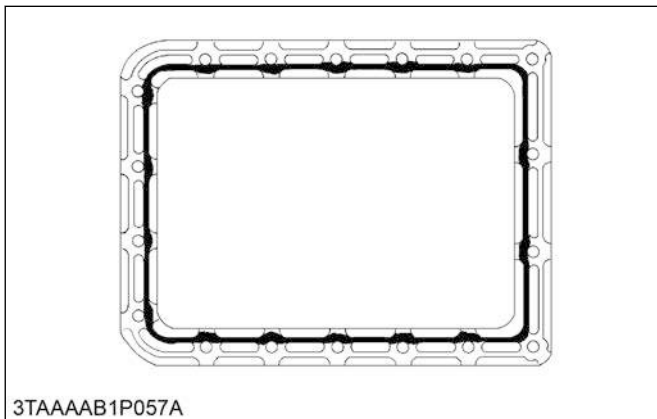
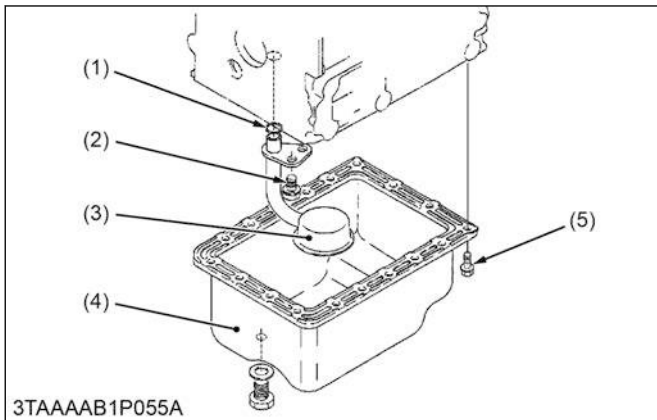
IMPORTANT

- There is a model of idle gear 1 (4) and idle gear 2 (7) by the difference of the method of transmission the power to the governor gear (6).
- When replacing the ball bearing of governor shaft, securely fit the ball bearing (10) to the crankcase, apply an adhesive (Three Bond 1324B or equivalent) to the set screw (13), and fasten the screw until its tapered part contacts the circumferential end of the ball bearing.
- When installing the idle gear, be sure to align the alignment marks on each gears.
- Apply engine oil thinly to the fuel camshaft before installation.
- Make sure to assemble the external snap ring of the governor shaft.

- Check the governor shaft for smooth rotation.

5.2.4 Piston and connecting rod

5.2.4.1 Removing oil pan and oil strainer (for standard oil pan)



- (1) O-ring
(2) Screw
(3) Oil strainer
(4) Oil pan
(5) Oil pan mounting screw

1. Remove the oil pan mounting screws (5).
2. Remove the oil pan (4).
3. Remove the oil strainer (3).

(When reassembling)

■ IMPORTANT

- Scrape off the old adhesive completely. Wipe the sealing surface clean using waste cloth soaked with gasoline.
- Apply "liquid gasket" (Three Bond 1207D or equivalent). Within 20 minutes after the application of liquid gasket, reassemble the components.
- After cleaning the oil strainer, check to see that the filter mesh is clean, and install it.
- Visually check the O-ring (1), apply engine oil, and install it.
- Securely fit the O-ring to the oil strainer.
- To avoid uneven tightening, tighten oil pan mounting screws in diagonal order from the center.

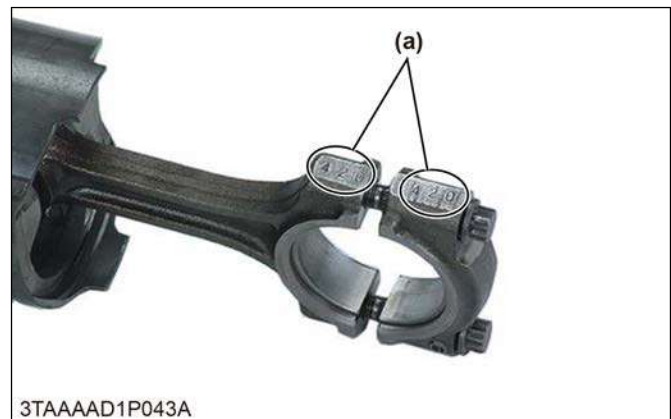
5.2.4.2 Removing connecting rod



1. Remove the connecting rod cap.

(When reassembling)

- Align the marks (a) with each other. (Face the marks toward the injection pump.)

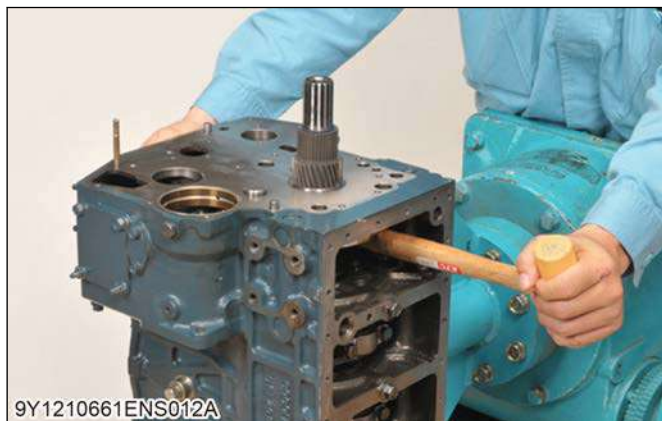


- (a) Mark

- Apply engine oil to the connecting rod screws and lightly screw it in by hand, then tighten it to the specified torque.
If the connecting rod screw won't be screwed in smoothly, clean the threads.
If the connecting rod screw is still hard to screw in, replace it.

Tightening torque	Connecting rod screw	42 to 46 N · m 4.2 to 4.7 kgf · m 31 to 33 lbf · ft
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5.2.4.3 Removing pistons

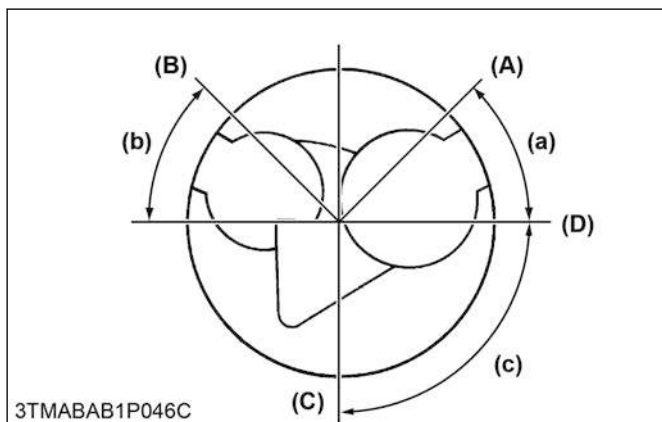


1. Turn the flywheel and bring the piston to top dead center.
2. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
3. Draw out the other piston in the same method as above.

(When reassembling)

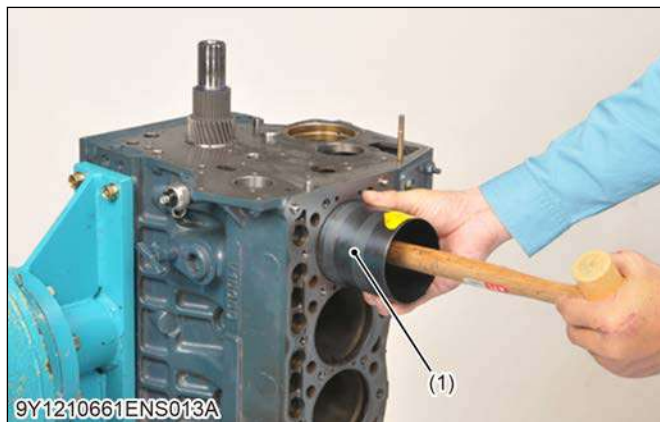
■ IMPORTANT

- 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.
- When installing the piston into the cylinder, place the gaps of all the piston rings as shown in the figure.



- | | |
|---------------------|--------------------|
| (A) Top ring gap | (a) 0.79 rad (45°) |
| (B) Second ring gap | (b) 0.79 rad (45°) |
| (C) Oil ring gap | (c) 1.6 rad (90°) |
| (D) Piston pin hole | |

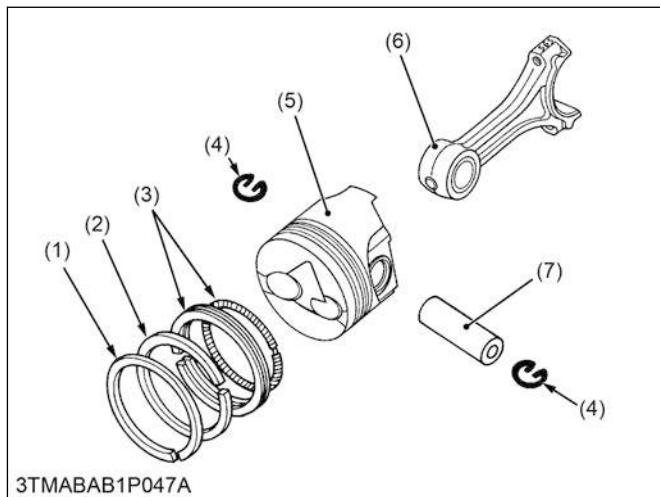
- Carefully insert the pistons using a piston ring compressor (1). Otherwise, their chrome-plated section may be scratched, causing trouble inside the cylinder.



(1) Piston ring compressor

- Before inserting the 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.

5.2.4.4 Removing piston ring and connecting rod



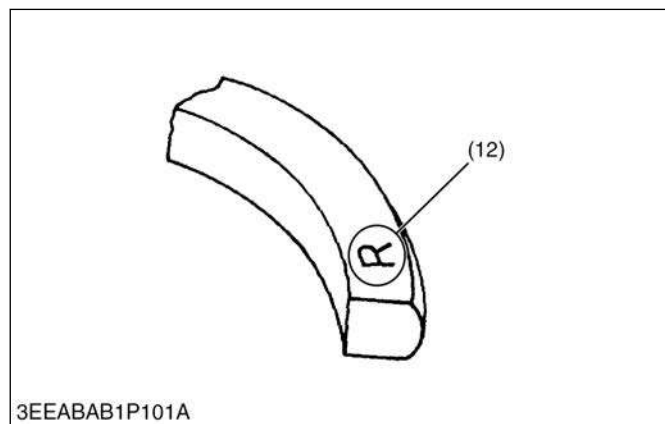
- | | |
|--------------------------|--------------------|
| (1) Top ring | (5) Piston |
| (2) Second ring | (6) Connecting rod |
| (3) Oil ring | (7) Piston pin |
| (4) Piston pin snap ring | |

1. Remove the piston rings using a piston ring tool.
2. Remove the piston pin (7), and separate the connecting rod (6) from the piston (5).

(When reassembling)

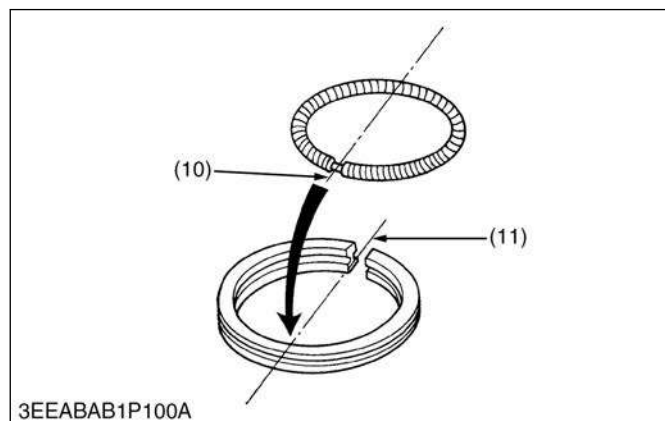
■ NOTE

- Mark the same number on the connecting rod and the piston so as not to change the combination.
- When installing the ring, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston.



(12) Manufacturer's mark

- When installing the oil ring onto the piston, place the expander joint (10) on the opposite side of the oil ring gap (11).



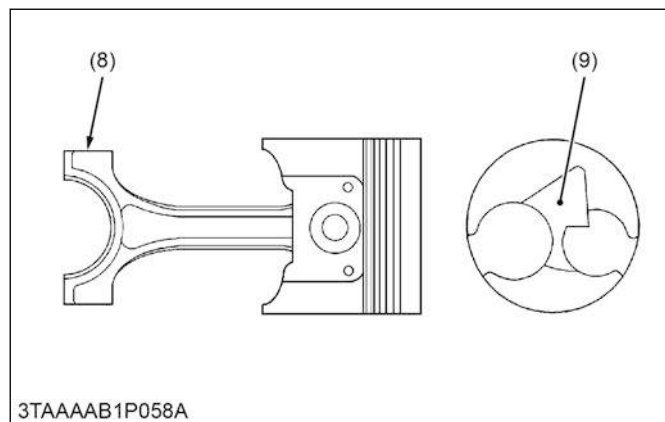
(10) Expander joint

(11) Oil ring gap

- Apply engine oil to the piston pin.
- When installing the connecting rod to the piston, immerse the piston in oil for specified time and then insert the piston pin to the piston.

Immerse piston in oil	10 to 15 minutes	80 °C (176 °F)
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- When installing the connecting rod to the piston, align the mark (8) on the connecting rod to the fan-shaped concave (9).



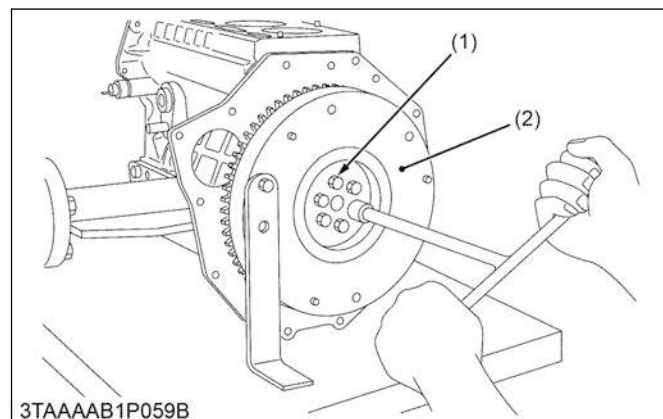
(8) Mark

(9) Fan-shaped concave

5.2.5 Flywheel and crankshaft

5.2.5.1 Removing flywheel

- Secure the flywheel to keep it from turning, using a flywheel stopper.
- Remove all flywheel screws (1) and then remove the flywheel (2).

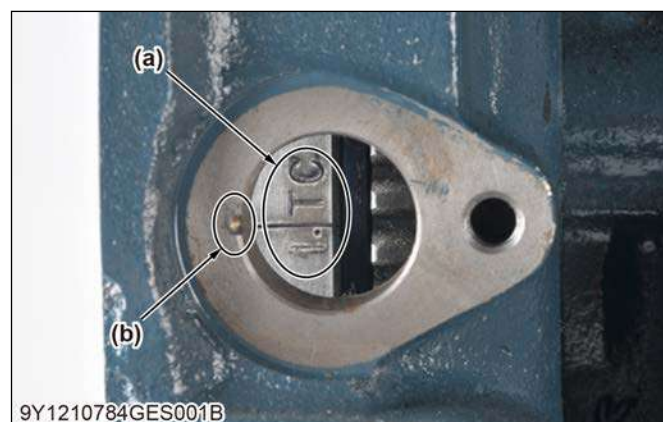


(1) Flywheel screw

(2) Flywheel

(When reassembling)

- Align the "1TC" mark (a) on the outer surface of the flywheel horizontally with the alignment mark (b) on the rear end plate. Now fit the flywheel in position.



(a) "1TC" mark

(b) Alignment mark

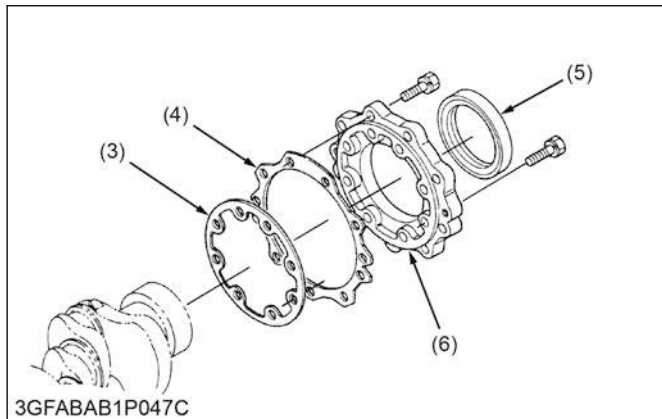
- Apply engine oil to the threads and the undercut surface of the flywheel screw and fit the screw.

Tightening torque	Flywheel screw	54 to 58 N·m 5.5 to 6.0 kgf·m 40 to 43 lbf·ft
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5.2.5.2 Removing bearing case cover

■ IMPORTANT

- The length of inside screws (1) and outside screws (2) are different. Do not make a mistake using inside screws and outside screws.

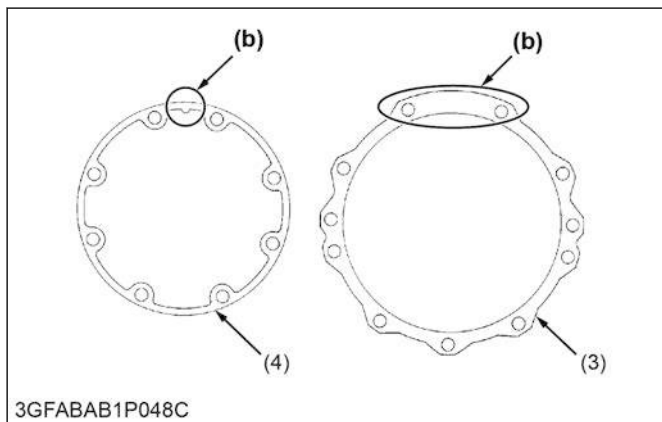


- (1) Bearing case cover mounting screw (Inside) (Long)
- (2) Bearing case cover mounting screw (Outside) (Short)
- (3) Bearing case gasket
- (4) Bearing case cover gasket
- (5) Oil seal
- (6) Bearing case cover
- (a) Top mark "UP"

1. Remove the bearing case cover mounting screws.
2. Remove the bearing case cover (6).

(When reassembling)

- Fit the bearing case gasket (3) and the bearing case cover gasket (4) with correct directions.



- (3) Bearing case gasket
- (4) Bearing case cover gasket
- (a) Top mark "UP"
- (b) Upside

- Install the bearing case cover (6) to position the casting mark "UP" on it upward.
- Apply engine oil to the oil seal (5) lip and take care that it is not rolled when installing.

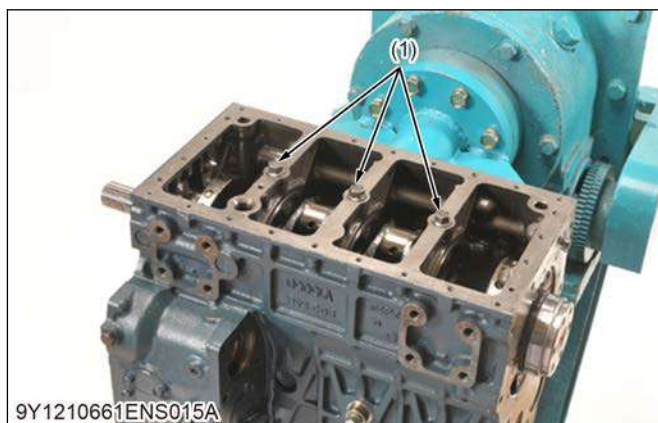
- Tighten the bearing case cover mounting screws with even force on the diagonal line.

Tightening torque	Bearing case cover mounting screw	10.8 to 12.2 N · m 1.10 to 1.25 kgf · m 7.96 to 9.04 lbf · ft
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5.2.5.3 Removing crankshaft assembly

■ IMPORTANT

- Take care to protect crankshaft bearing 1 from scratches, caused by the crank gear, etc. (Wrap the gear in vinyl tape, etc.)



- (1) Main bearing case screw 2

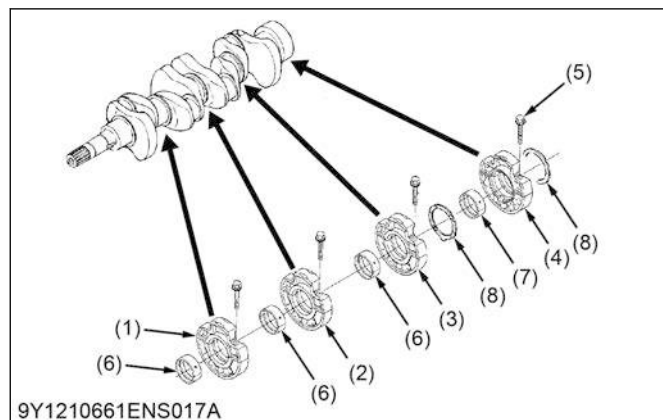
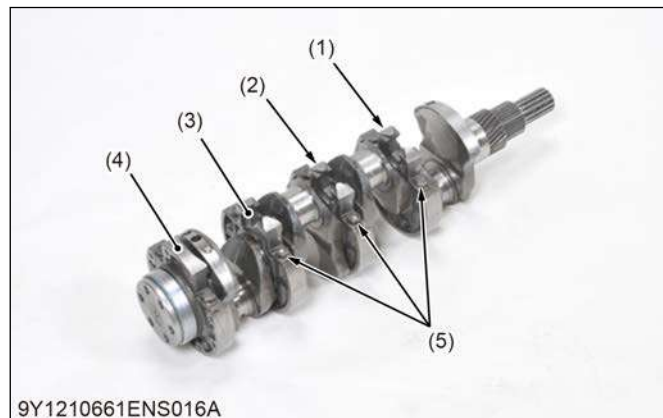
1. Remove the main bearing case screw 2 (1).
2. Pull out the crankshaft assembly.

(When reassembling)

- Clean the oil passage of the crankshaft with compressed air.
- Apply oil to the main bearing case screw 2 (1).
- Install the crankshaft assembly, aligning the screw hole of main bearing case with the screw hole of crankcase.

Tightening torque	Main bearing case screw 2	49 to 53 N · m 5.0 to 5.5 kgf · m 37 to 39 lbf · ft
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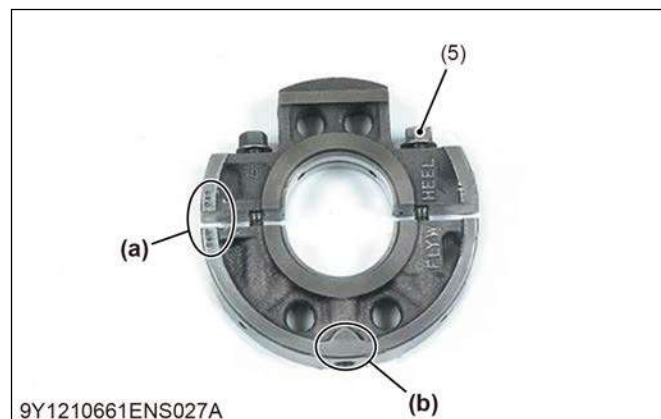
5.2.5.4 Removing main bearing case assembly



- | | |
|----------------------------------|----------------------------------|
| (1) Main bearing case assembly 1 | (4) Main bearing case assembly 4 |
| (2) Main bearing case assembly 2 | (5) Main bearing case screw 1 |
| (3) Main bearing case assembly 3 | (6) Crankshaft bearing 2 |
| | (7) Crankshaft bearing 3 |
| | (8) Thrust bearing |

1. Remove the two main bearing case screws 1 (5), and remove the main bearing case assembly 1 (1), being careful with crankshaft bearing 3 (7).
2. Remove the main bearing case assembly 2 (2), the main bearing case assembly 3 (3) and the main bearing case assembly 4 (4) as above. Keep in mind, however, that the thrust bearing (8) is installed in the main bearing case assembly 4.

(When reassembling)



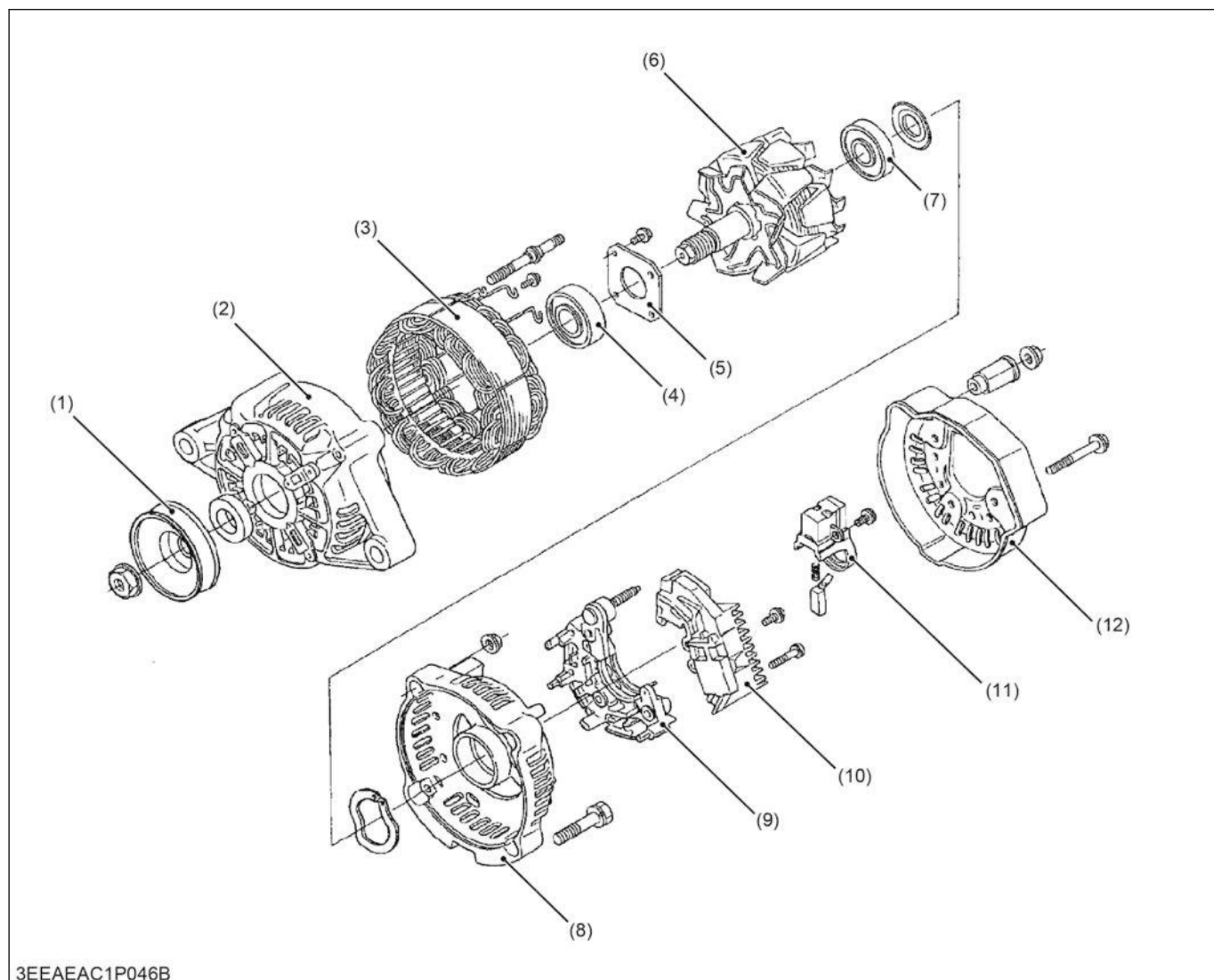
- | | |
|-------------------------------|-----------------------------|
| (5) Main bearing case screw 1 | (b) Marking ("A", "B", "C") |
| (a) Alignment number | (c) Oil groove |

- Clean the oil passage in the main bearing cases.
- Apply clean engine oil to the bearings.
- Install the main bearing case assemblies in original positions. Since diameters of main bearing cases vary, install them in order of marking (b) from the gear case side. (Refer to the figure.)
- Match the alignment numbers (a) on the main bearing case assembly 1 (1).
- Do the same for the main bearing case assembly 2 (2), the main bearing case assembly 3 (3) and the main bearing case assembly 4 (4) too.
- When installing the main bearing case 1, 2 and 3, face the mark "FLYWHEEL" to the flywheel.
- Install the thrust bearing (8) with its oil groove facing outward.
- Make sure that the main bearing case moves smoothly after tightening the main bearing case screw 1 (5) to the specified torque.

Tightening torque	Main bearing case screw 1	29.4 to 34.3 N·m 3.00 to 3.49 kgf·m 21.7 to 25.2 lbf·ft
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5.2.6 Alternator

5.2.6.1 Disassembling alternator



- | | | | |
|---------------------|--------------------|--------------------|---------------------|
| (1) Pulley | (4) Bearing | (7) Bearing | (10) IC regulator |
| (2) Drive end frame | (5) Retainer plate | (8) Rear end frame | (11) Brush holder |
| (3) Stator | (6) Rotor | (9) Rectifier | (12) Rear end cover |

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

(When reassembling)

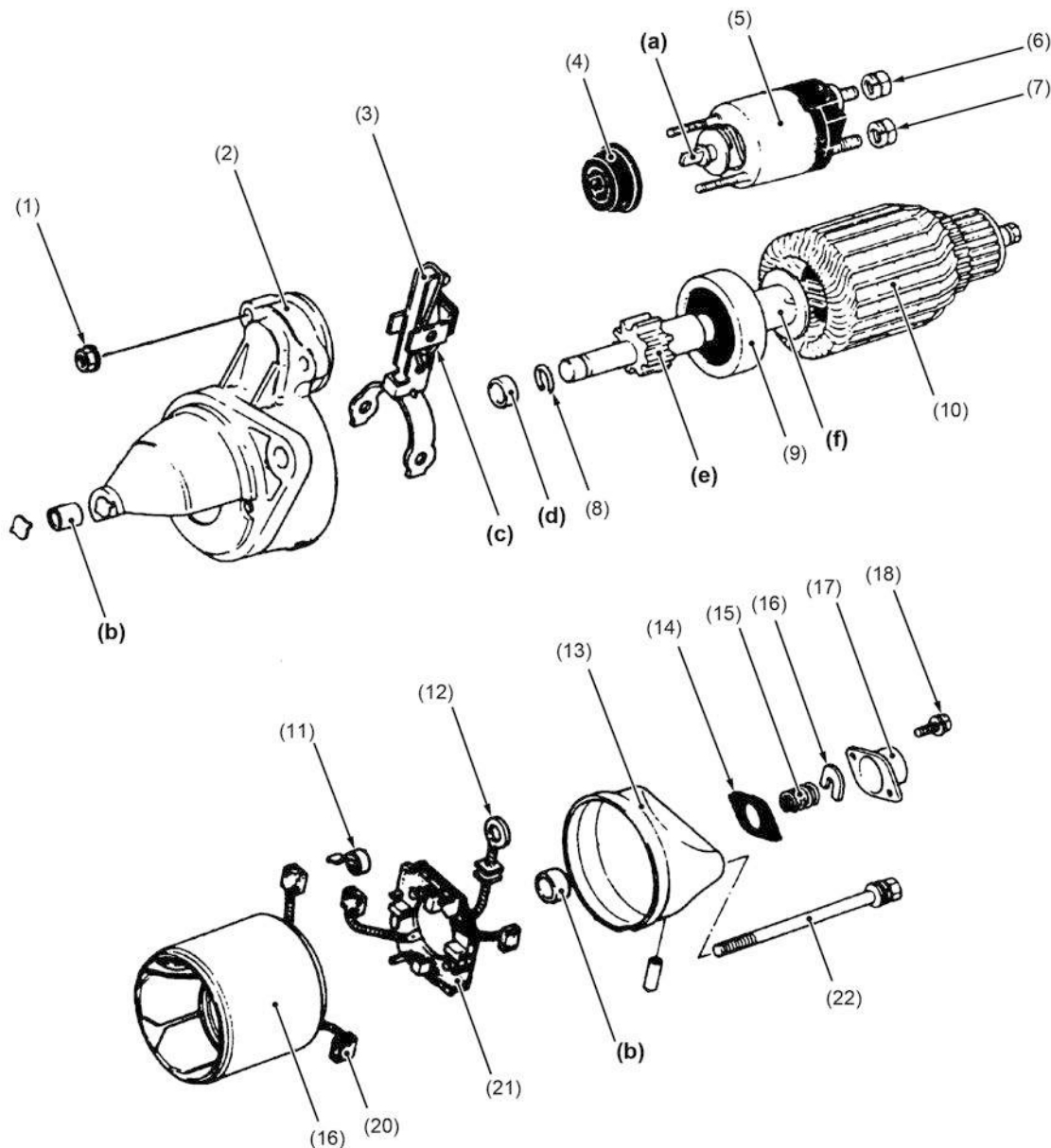
Tightening torque	Pulley nut	58.4 to 78.9 N·m 5.95 to 8.05 kgf·m 43.1 to 58.2 lbf·ft
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5.2.7 Starter

5.2.7.1 Disassembling starter (Electromagnetic drive type)

■ **NOTE**

- Do not damage to the brush and commutator.



3EBAAAB1P045C

- | | | | |
|----------------------------------|------------------------|--------------------|------------------------------|
| (1) Solenoid switch mounting nut | (8) Snap ring | (15) Brake spring | (22) Through bolt |
| (2) Starter drive housing | (9) Overrunning clutch | (16) Brake shoe | (a) Joint of solenoid switch |
| (3) Drive lever | (10) Armature | (17) End frame cap | (b) Bushing |
| (4) Gasket | (11) Brush spring | (18) Screw | (c) Drive lever |
| (5) Solenoid switch | (12) Connecting lead | (19) Yoke | (d) Collar |
| (6) B terminal nut | (13) Rear end frame | (20) Brush | (e) Teeth of pinion gear |
| (7) C terminal nut | (14) Gasket | (21) Brush holder | (f) Armature shaft |

1. Remove the C terminal nut (7), and disconnect the connecting lead (12).
2. Remove the solenoid switch mounting nuts (1), and remove the solenoid switch (5).
3. Remove the end frame cap (17).
4. Remove the brake shoe (16), brake spring (15) and gasket (14).
5. Remove the through bolts (22), and remove the rear end frame (13).
6. Remove the brush from the brush holder while holding the spring up.
7. Remove the brush holder (21).
8. Draw out the yoke (19) from the starter drive housing (2).

9. Draw out the armature (10) with the drive lever (3).

(When reassembling)

- Apply grease (DENSO.CO.LTD. No. 50 or equivalent) to the parts indicated in the figure.

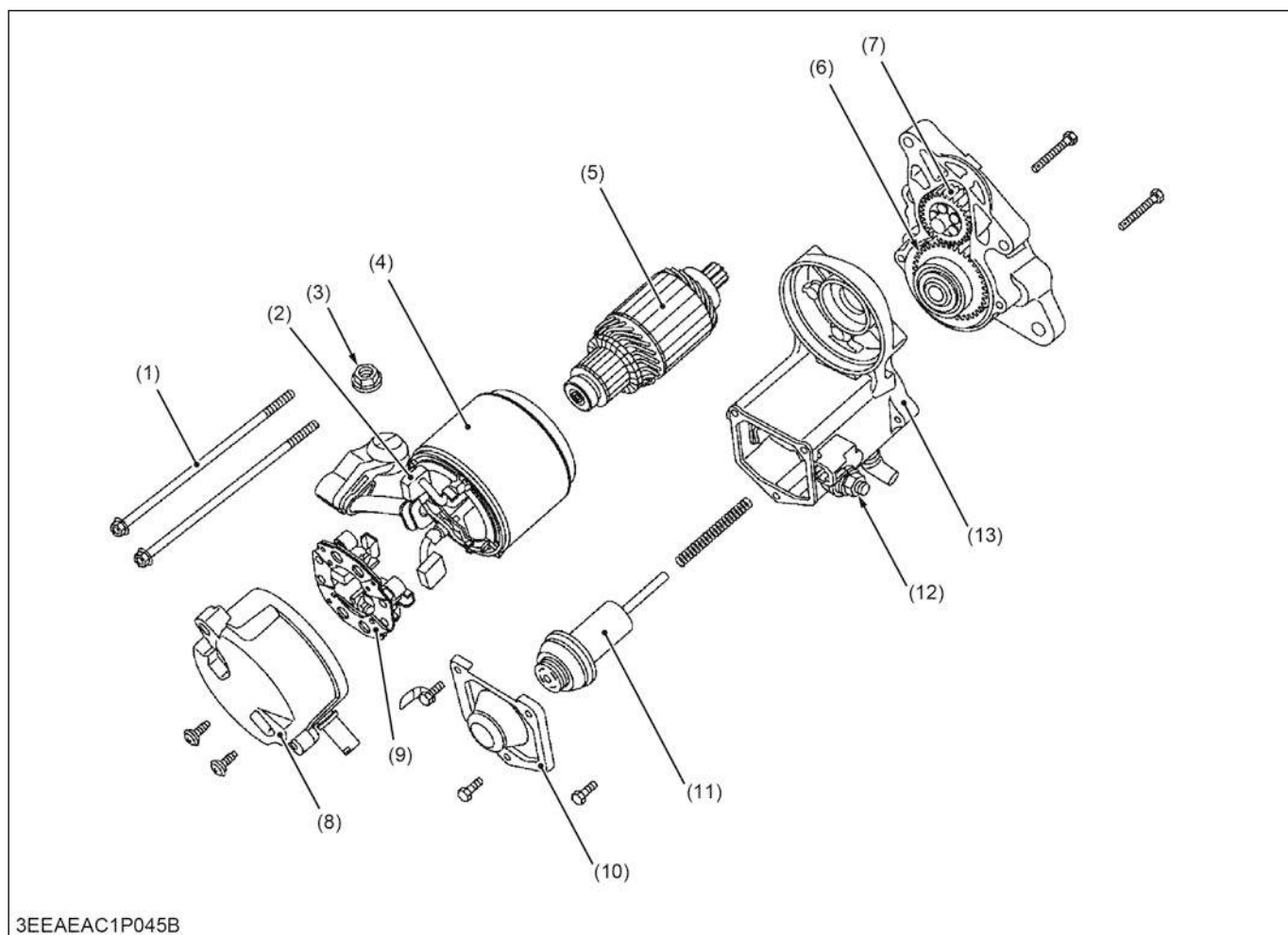
Tightening torque	B terminal nut	5.88 to 11.8 N · m 0.600 to 1.20 kgf · m 4.34 to 8.70 lbf · ft
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5.2.7.2 Disassembling starter

Gear reduction type

NOTE

- Do not damage to the brush and commutator.



(1) Through bolt	(5) Armature	(9) Brush holder	(13) Housing
(2) Brush	(6) Overrunning clutch	(10) Magnet switch cover	
(3) C terminal nut	(7) Idle gear	(11) Plunger	
(4) Yoke	(8) End frame	(12) B terminal nut	

1. Remove the C terminal nut (3), and disconnect the connecting lead.
2. Remove the two through bolts (1).
3. Detach the motor.
4. Remove the end frame (8).

5. Remove the brush from the brush holder while holding the spring up.
6. Remove the brush holder (9).
7. Draw out the armature (5) from the yoke (4).
8. Remove the housing (13).
9. Remove the idle gear (7) and the overrunning clutch (6).
10. Remove the magnet switch cover (10).
11. Remove the plunger (11).

(When reassembling)

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

Tightening torque	B terminal nut	5.88 to 11.8 N·m 0.600 to 1.20 kgf·m 4.34 to 8.70 lbf·ft
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6. Servicing

6.1 Cylinder head and valve

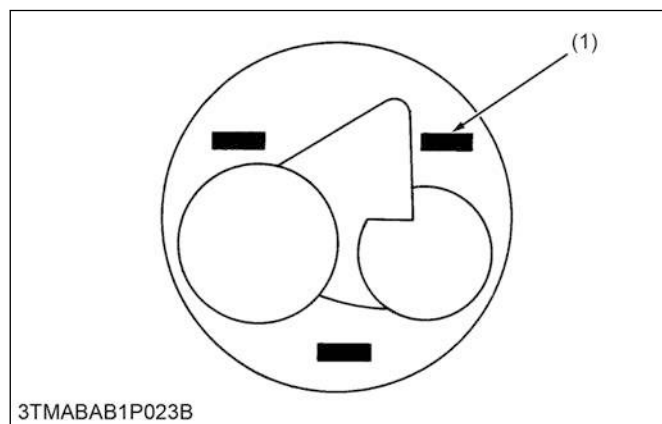
6.1.1 Checking top clearance

■ NOTE

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

1. Remove the cylinder head.
2. With the piston at T.D.C., use grease to affix three or four plastigauges (1) to the crown of the piston; keep the gauges away from the intake valve and combustion chamber fittings.

Diameter of plastigauges	Factory specification	1.5 mm (0.059 in.) × 5.0 to 7.0 mm (0.20 to 0.27 in.)
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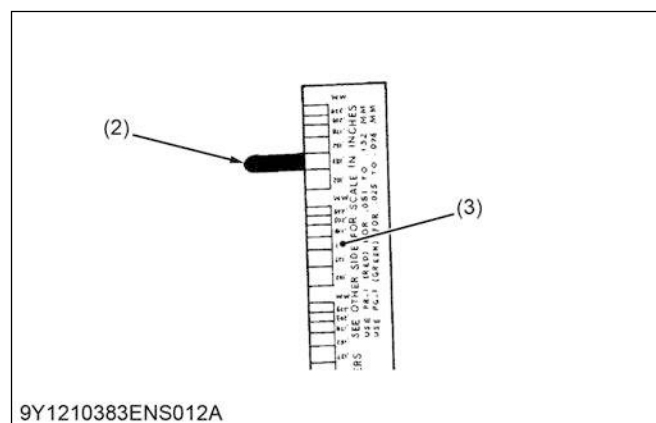
(1) Plastigauge

3. Take the piston to an intermediate position, install the cylinder head and tighten the head bolts to the specified torque.

Tightening torque	Cylinder head screw	64 to 68 N·m 6.5 to 7.0 kgf·m 47 to 50 lbf·ft
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4. Turn the crankshaft so the piston goes through T.D.C.

5. Remove the cylinder head and compare the width of the crushed plastigauges (2) with the scale.



(2) Crushed plastigauge (3) Scale

6. If they are out of factory specification, check the oil clearance of the crank pin, journals and piston pins.

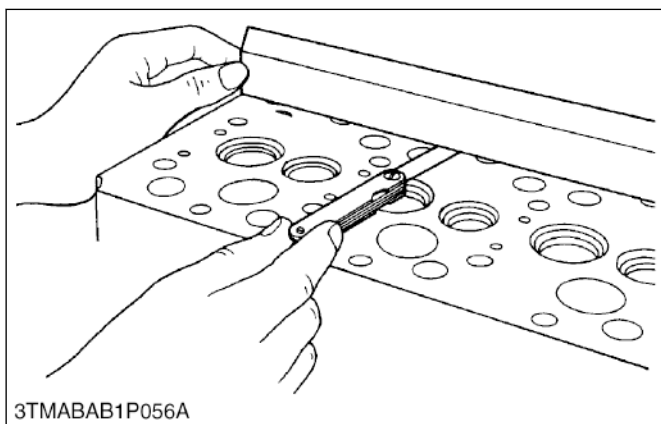
V1505-T-E4B

Top clearance	Factory specification	0.55 to 0.75 mm 0.022 to 0.029 in.
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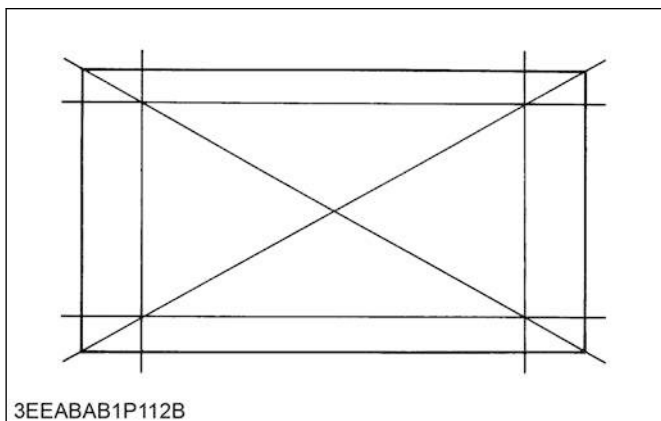
6.1.2 Checking cylinder head surface flatness

■ IMPORTANT

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



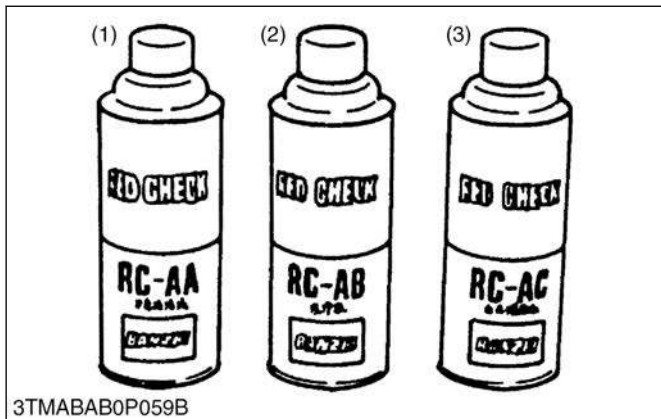
1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the figure.



3. Measure the clearance with a thickness gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

Cylinder head surface flatness	Allowable limit	0.05 mm 0.002 in.
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6.1.3 Checking cylinder head flaw

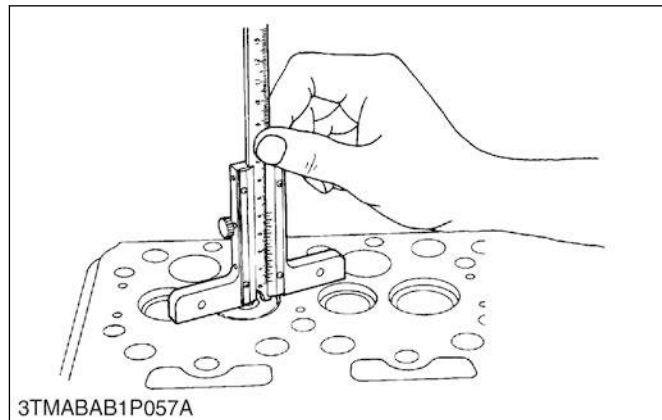


- (1) Red permeative liquid
(2) Detergent
(3) White developer

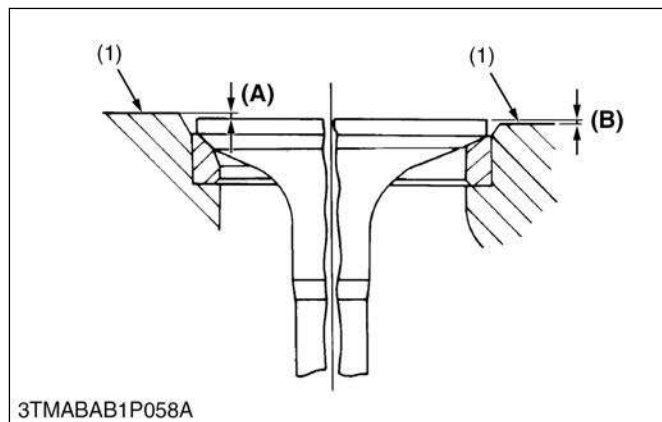
1. Prepare an air spray red check.

2. Clean the surface of the cylinder head with detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with white developer (3).
6. If flawed, it can be identified as red marks.

6.1.4 Checking 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.



- (1) Cylinder head surface
(A) Recessing
(B) Protrusion

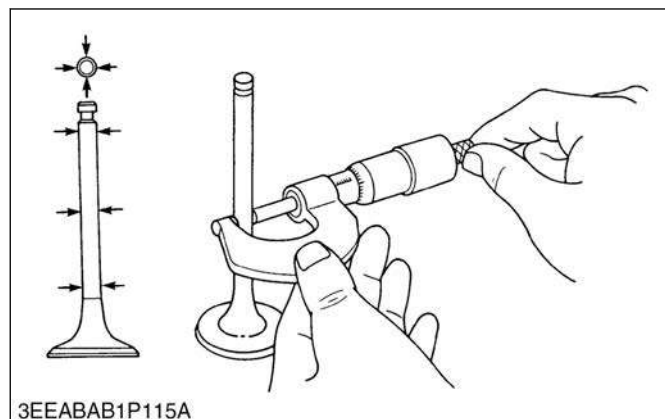
4. If the measurement exceeds the allowable limit, replace the valve.

Valve recessing	Factory specification	0.050 (protrusion) to 0.25 (recessing) mm 0.0020 (protrusion) to 0.0098 (recessing) in.
	Allowable limit	0.40 (recessing) mm 0.016 (recessing) in.

5. If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

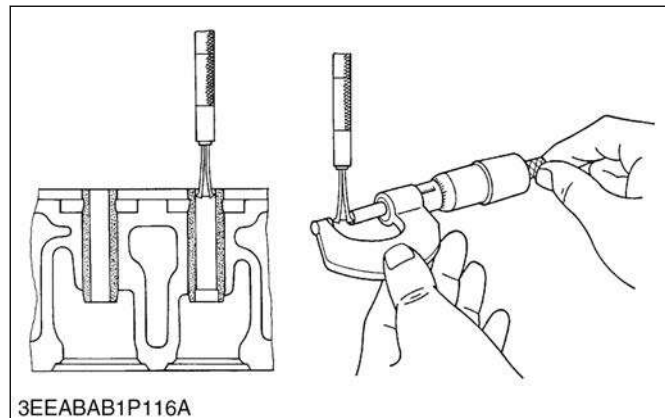
6.1.5 Checking clearance between valve stem and valve guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.



Valve stem O.D.	Factory specification	6.960 to 6.975 mm 0.2741 to 0.2746 in.
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3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.



Valve guide I.D.	Factory specification	7.010 to 7.025 mm 0.2760 to 0.2765 in.
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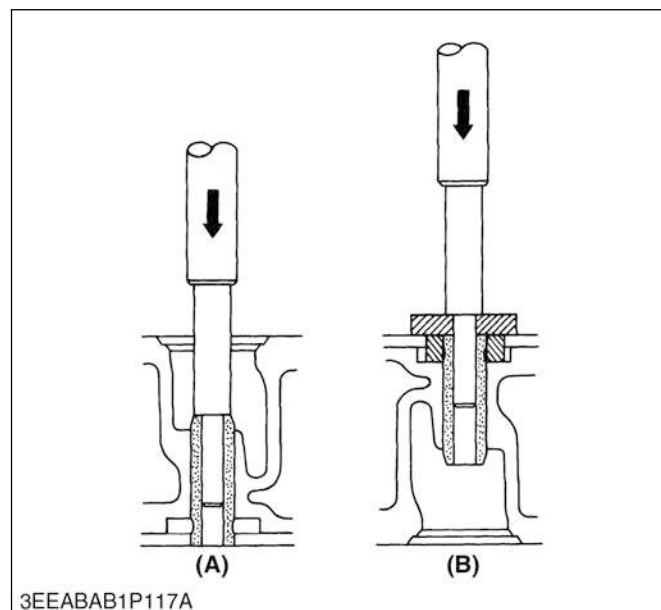
4. If the clearance exceeds the allowable limit, replace the valves. If it still exceeds the allowable limit, replace the valve guide.

Clearance between valve stem and valve guide	Factory specification	0.035 to 0.065 mm 0.0014 to 0.0025 in.
	Allowable limit	0.10 mm 0.0039 in.

6.1.6 Replacing valve guide

NOTE

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



(A) When removing

(B) When installing

(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 fit a new valve guide using a valve guide replacing tool.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

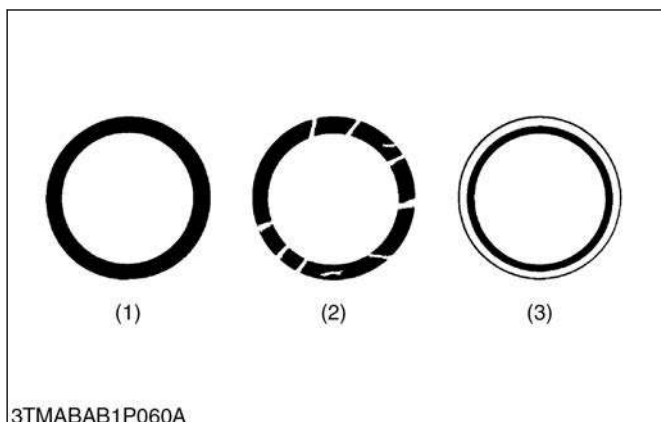
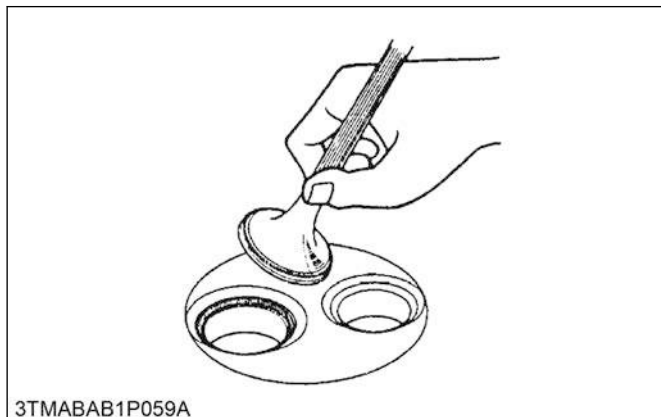
Valve guide I.D. (Intake and exhaust)	Factory specification	7.010 to 7.025 mm 0.2760 to 0.2765 in.
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— RELATED PAGE —

[1.5 Valve guide replacing tool on page 2-54](#)

6.1.7 Checking valve seating

1. Coat the valve face lightly with prussian blue and put the valve on its seat to check the contact.



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

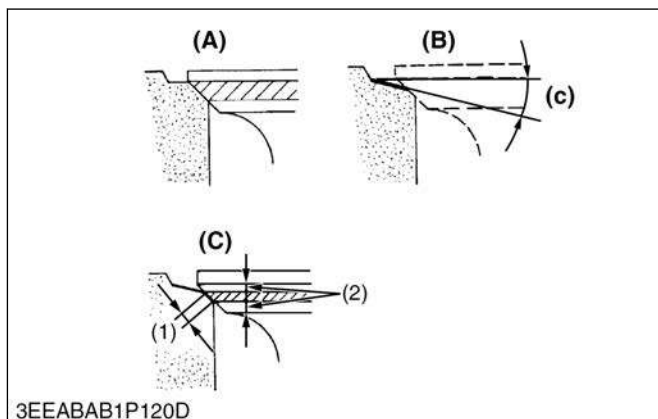
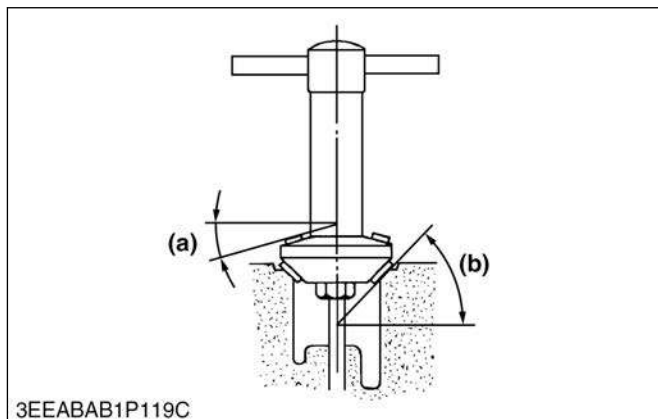
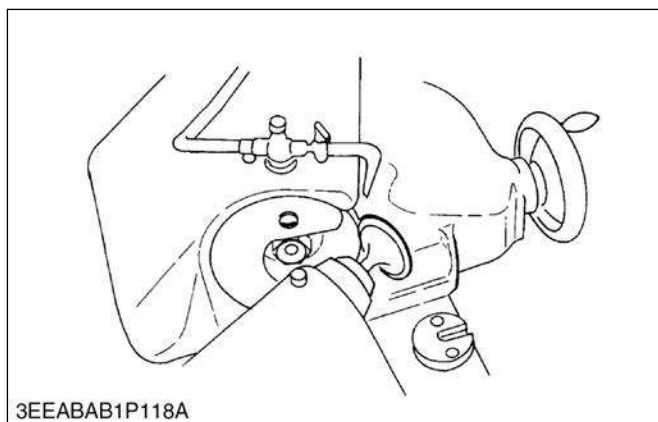
2. If the valve does not seat all the way around the valve seat or the valve contact is less than 70%, correct the valve seating as follows.
3. If the valve contact does not comply with the reference value, replace the valve or correct the contact of valve seating.

Valve seat width	Factory specification	2.12 mm 0.0835 in.
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6.1.8 Correcting valve

NOTE

- Before correcting the valve, check the valve stem and the I.D. of valve guide section, and repair them if necessary.



- (1) Valve seat width (2) Identical dimensions (A) Check contact (B) Correct seat width (C) Check contact (a) 0.26 rad (15°) or 0.52 rad (30°) (b) 0.79 rad (45°) or 1.0 rad (60°) (c) 0.52 rad (30°) or 0.26 rad (15°)

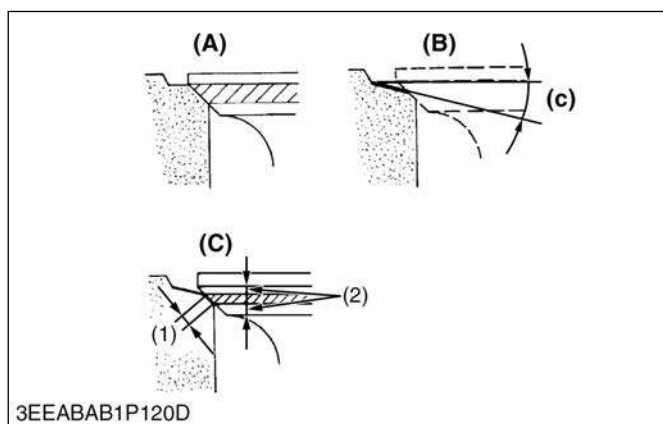
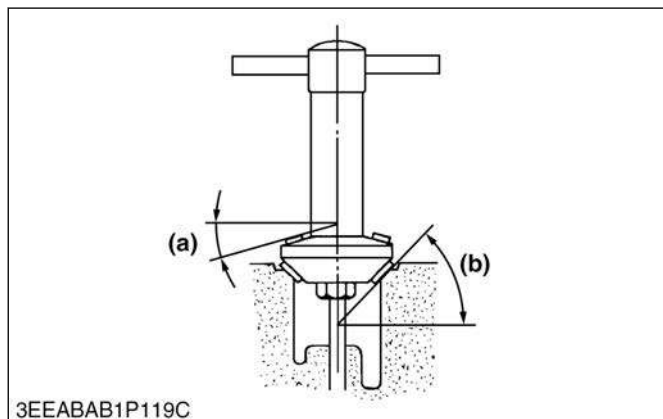
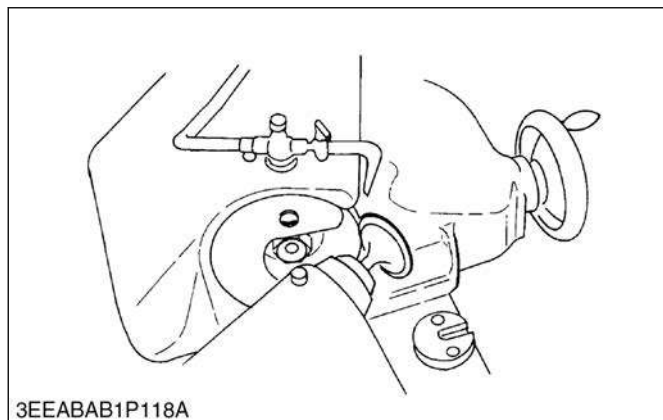
1. Correct the valve with a valve refacer.

Valve face angle	Factory specification	IN.	1.0 rad 60°
		EX.	0.79 rad 45°

6.1.9 Correcting valve seat

■ NOTE

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



- | | |
|--------------------------------------|--------------------------------------|
| (1) Valve seat width | (b) 0.79 rad (45°) or 1.0 rad (60°) |
| (2) Identical dimensions | |
| (A) Check contact | (c) 0.52 rad (30°) or 0.26 rad (15°) |
| (B) Correct seat width | |
| (C) Check contact | |
| (a) 0.26 rad (15°) or 0.52 rad (30°) | |

- Slightly correct the seat surface with a valve seat cutter.

Valve seat angle	Factory specification	IN.	1.0 rad 60°
		EX.	0.79 rad 45°

- Resurface the seat surface with a 0.52 rad (30°) valve seat cutter to intake valve seat and with a 0.26 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.).
- 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.
- Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

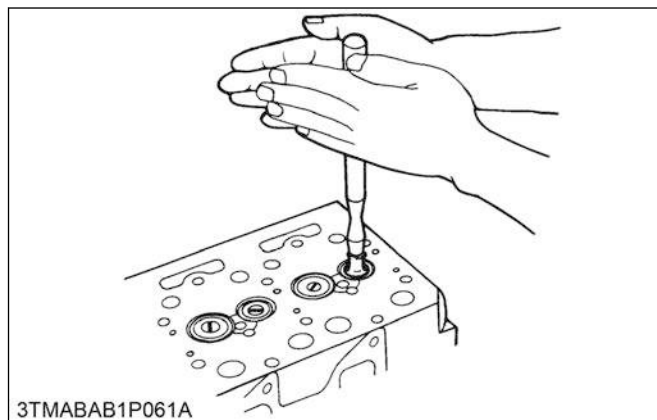
■ NOTE

- After you correct the valve seat, be sure to check the valve recessing.

6.1.10 Checking valve lapping

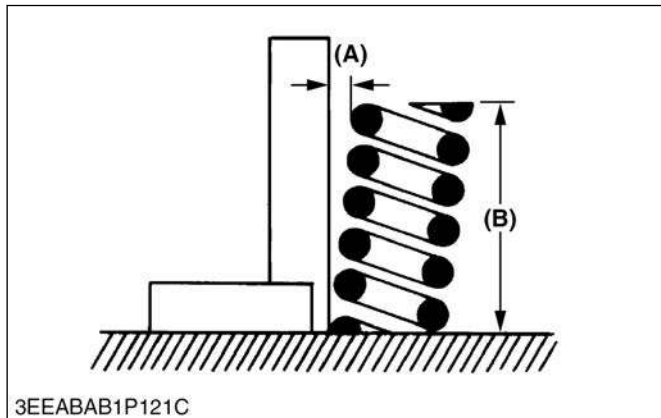
■ IMPORTANT

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



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

6.1.11 Checking free length and tilt of valve spring



(A) Tilt (B) Free length

1. Measure the free length (B) of valve spring with vernier calipers. If the measurement is less than the allowable limit, replace it.

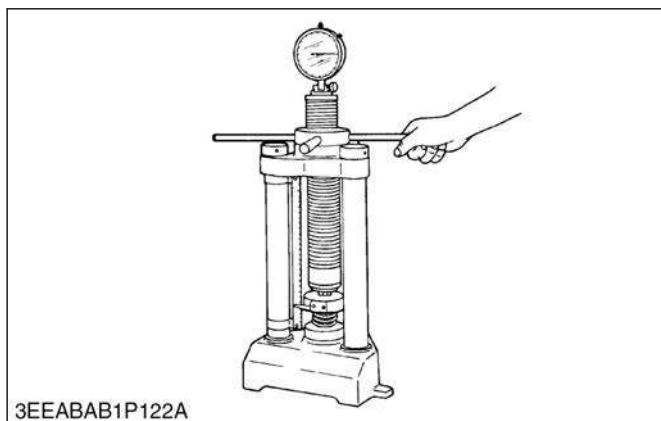
Free length (B)	Factory specification	37.0 to 37.5 mm 1.46 to 1.47 in.
	Allowable limit	36.5 mm 1.44 in.

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 (A). If the measurement exceeds the allowable limit, replace it.

Tilt (A)	Allowable limit	1.0 mm 0.039 in.
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4. Check the entire surface of the valve spring for scratches. If there is any problem, replace it.

6.1.12 Checking valve spring setting load



1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.

2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load / Setting length	Factory specification	117.4 N / 31.0 mm 11.97 kgf / 31.0 mm 26.39 lbf / 1.22 in.
	Allowable limit	100.0 N / 31.0 mm 10.20 kgf / 31.0 mm 22.48 lbf / 1.22 in.

6.1.13 Checking oil clearance between rocker arm and rocker arm shaft



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

Rocker arm shaft O.D.	Factory specification	11.973 to 11.984 mm 0.47138 to 0.47181 in.
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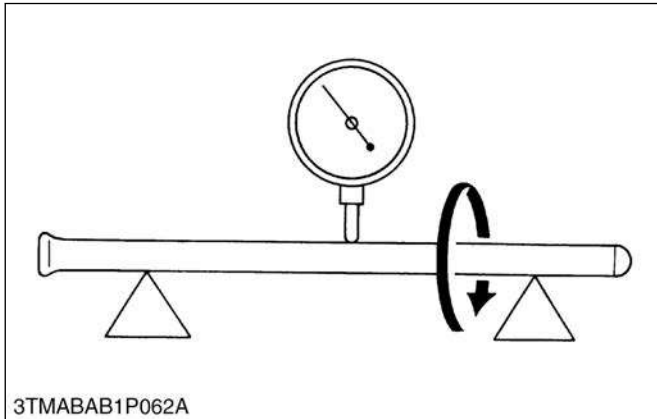
2. Measure the rocker arm I.D. with an inside micrometer, and then calculate the oil clearance.

Rocker arm I.D.	Factory specification	12.000 to 12.018 mm 0.47244 to 0.47314 in.
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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 specification	0.016 to 0.045 mm 0.00063 to 0.0017 in.
	Allowable limit	0.10 mm 0.0039 in.

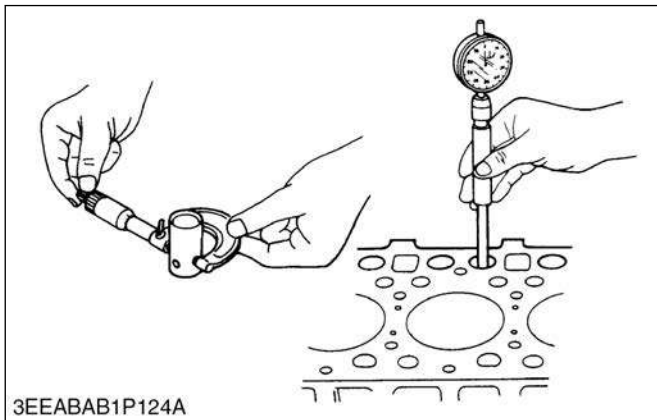
6.1.14 Checking push rod alignment



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

Push rod alignment	Allowable limit	0.25 mm 0.0098 in.
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6.1.15 Checking oil clearance between tappet and tappet guide bore



1. Measure the tappet O.D. with an outside micrometer.

Tappet O.D.	Factory specification	19.959 to 19.980 mm 0.78579 to 0.78661 in.
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2. Measure the I.D. of the tappet guide bore with a cylinder gauge, and calculate the oil clearance.

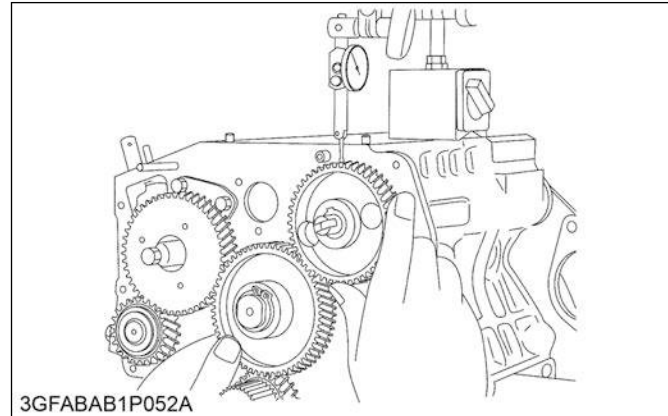
Tappet guide bore I.D.	Factory specification	20.000 to 20.021 mm 0.78740 to 0.78822 in.
------------------------	-----------------------	---

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 specification	0.020 to 0.062 mm 0.00079 to 0.0024 in.
	Allowable limit	0.07 mm 0.003 in.

6.2 Timing gears, camshaft and governor gear

6.2.1 Checking timing gear backlash



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

Backlash between idle gear 1 and crank gear	Factory specification	0.0320 to 0.115 mm 0.00126 to 0.00452 in.
	Allowable limit	0.15 mm 0.0059 in.

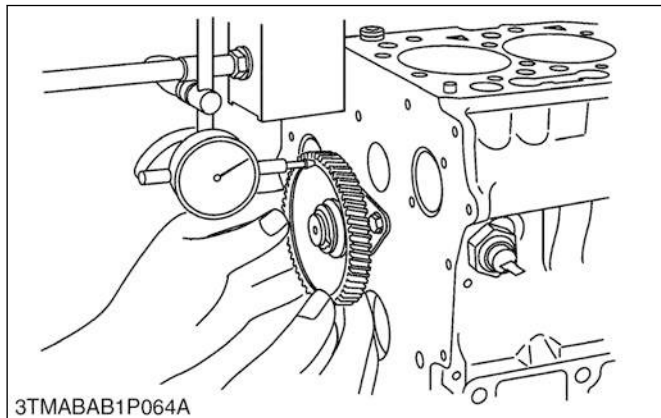
Backlash between idle gear 1 and cam gear	Factory specification	0.0360 to 0.114 mm 0.00142 to 0.00448 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear 1 and injection pump gear	Factory specification	0.0340 to 0.116 mm 0.00134 to 0.00456 in.
	Allowable limit	0.15 mm 0.0059 in.

(Equipped with idle gear 2) Backlash between idle gear 1 and idle gear 2	Factory specification	0.0330 to 0.117 mm 0.00130 to 0.00460 in.
	Allowable limit	0.15 mm 0.0059 in.

4. If the oil clearance is proper, replace the gear.

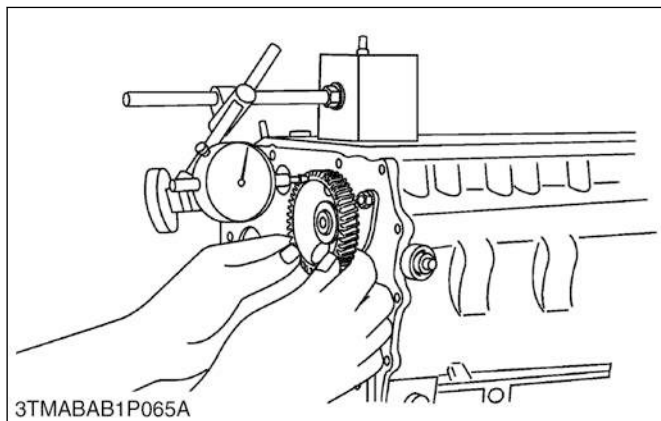
6.2.2 Checking idle gear 1 and 2 side clearance



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 1 and 2 side clearance	Factory specification	0.20 to 0.51 mm 0.0079 to 0.020 in.
	Allowable limit	0.80 mm 0.031 in.

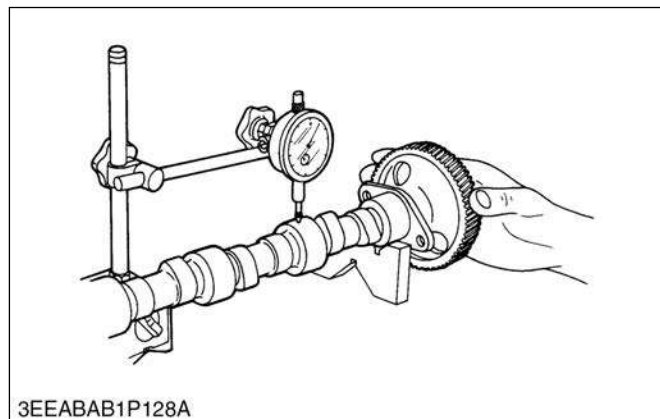
6.2.3 Checking camshaft side clearance



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

Camshaft side clearance	Factory specification	0.070 to 0.22 mm 0.0028 to 0.0086 in.
	Allowable limit	0.30 mm 0.012 in.

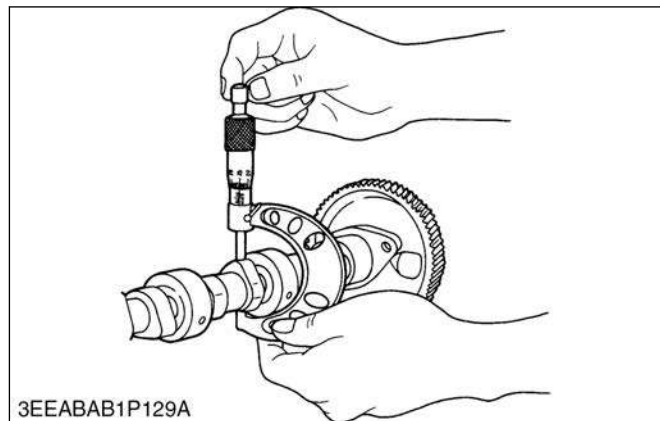
6.2.4 Checking camshaft alignment



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

Camshaft alignment	Allowable limit	0.01 mm 0.0004 in.
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6.2.5 Checking cam height



1. Measure the height of the cam at its highest point with an outside micrometer.

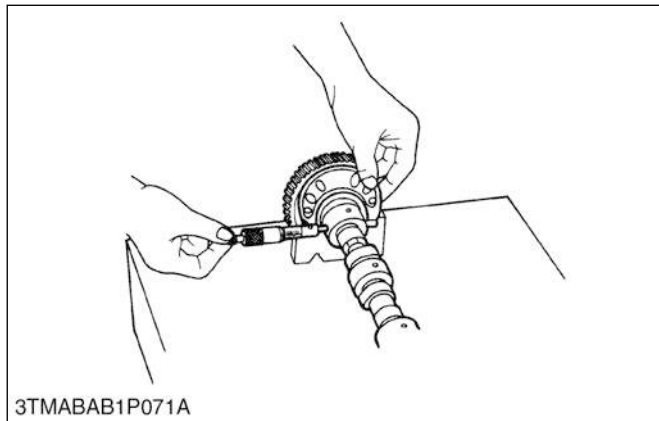
2. If the measurement is less than the allowable limit, replace the camshaft.

Cam height of intake	Factory specification	28.80 mm 1.134 in.
	Allowable limit	28.75 mm 1.132 in.

Cam height of exhaust	Factory specification	29.00 mm 1.142 in.
	Allowable limit	28.95 mm 1.140 in.

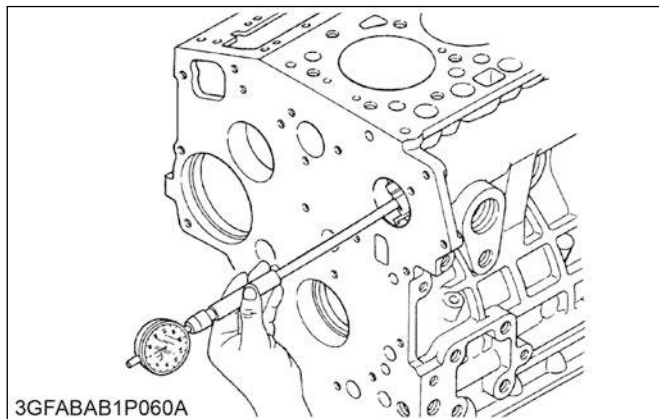
6.2.6 Checking oil clearance of camshaft journal

1. Measure the camshaft journal O.D. with an outside micrometer.



Camshaft journal O.D.	Factory specification	35.934 to 35.950 mm 1.4147 to 1.4153 in.
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2. Measure the cylinder block bore I.D. for camshaft with a cylinder gauge, and calculate the oil clearance.

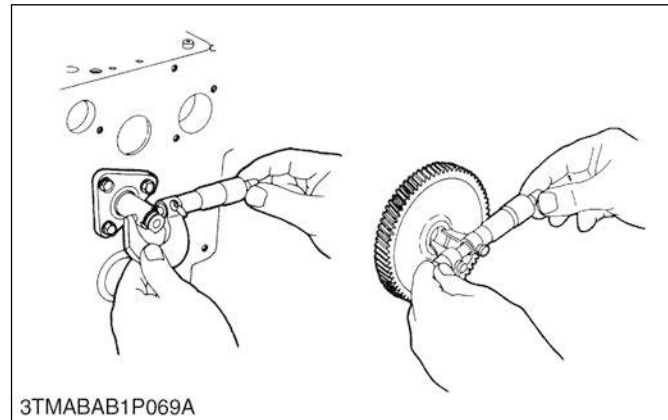


Camshaft bearing I.D. (Cylinder block bore I.D.)	Factory specification	36.000 to 36.025 mm 1.4173 to 1.4183 in.
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3. If the oil clearance exceeds the allowable limit, replace the camshaft.

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

6.2.7 Checking oil clearance between idle gear shaft 1 and 2 and idle gear bushing



1. Measure the idle gear shaft O.D. with an outside micrometer.

Idle gear shaft 1 and 2 O.D.	Factory specification	25.967 to 25.980 mm 1.0223 to 1.0228 in.
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2. Measure the idle gear bushing I.D. with an inside micrometer, and calculate the oil clearance.

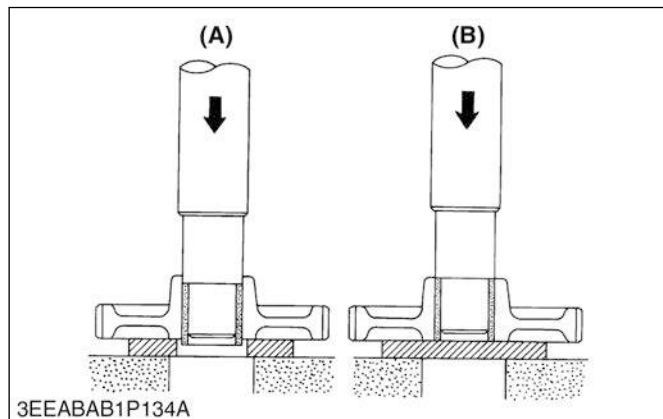
Idle gear bushing 1 and 2 I.D.	Factory specification	26.000 to 26.021 mm 1.0237 to 1.0244 in.
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3. If the oil clearance exceeds the allowable limit, replace the bushing.

Oil clearance between idle gear shaft (1 and 2) and idle gear bushing	Factory specification	0.020 to 0.054 mm 0.00079 to 0.0021 in.
	Allowable limit	0.10 mm 0.0039 in.

4. If it still exceeds the allowable limit, replace the idle gear shaft.

6.2.8 Replacing idle gear bushing



(A) When removing

(B) When installing

(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 fit a new bushing using an idle gear bushing replacing tool, until it is flush with the end of the idle gear.

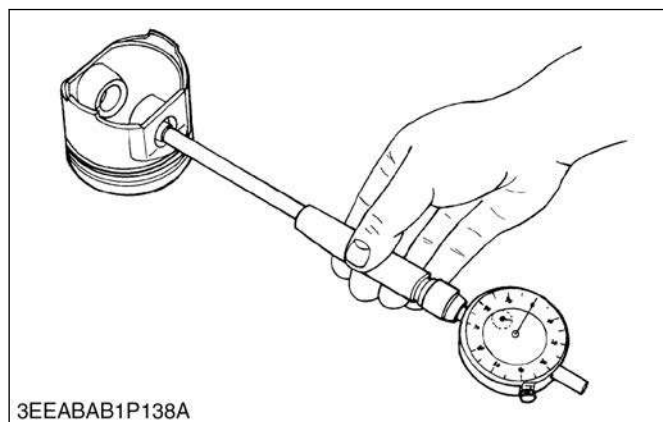
— RELATED PAGE —

[1.6 Bushing replacing tool on page 2-55](#)

6.3 Piston and connecting rod

6.3.1 Checking piston pin bore I.D.

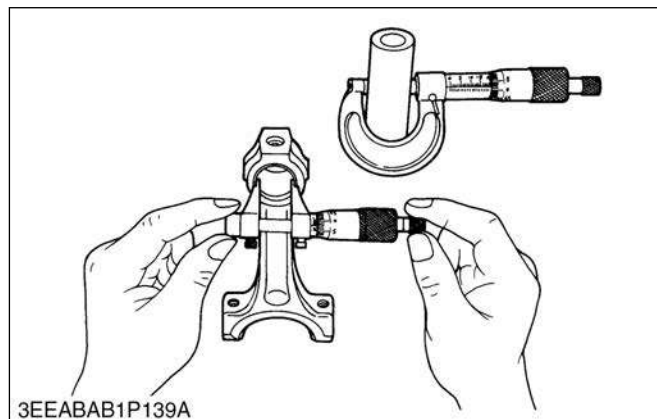
1. Measure the piston pin bore I.D. in both the horizontal and vertical directions with a cylinder gauge.



2. If the measurement exceeds the allowable limit, replace the piston.

Piston pin bore I.D.	Factory specification	22.000 to 22.013 mm 0.86615 to 0.86665 in.
	Allowable limit	22.03 mm 0.8673 in.

6.3.2 Checking 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.

Piston pin O.D.	Factory specification	22.002 to 22.011 mm 0.86622 to 0.86657 in.
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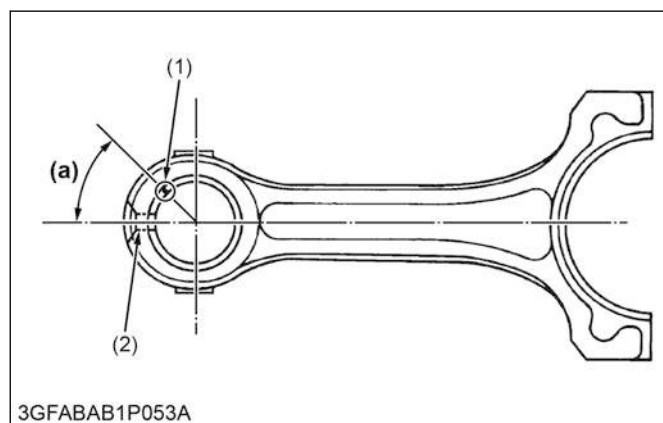
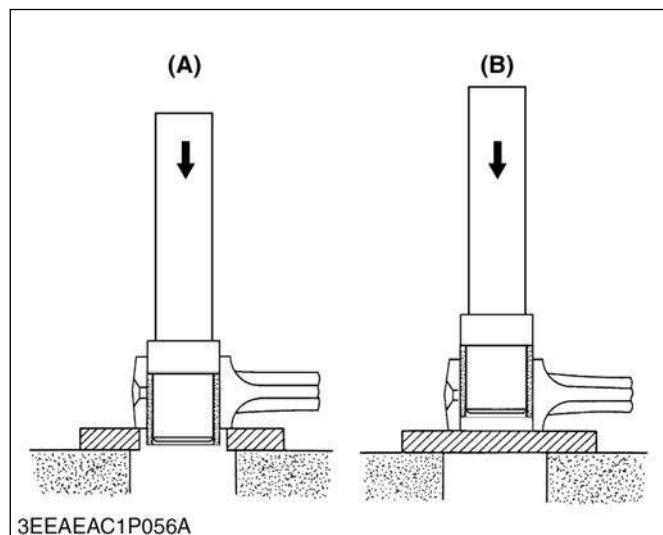
2. Measure the small end bushing I.D. with an inside micrometer, and calculate the oil clearance.

Small end bushing I.D.	Factory specification	22.025 to 22.040 mm 0.86713 to 0.86771 in.
------------------------	-----------------------	---

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 specification	0.014 to 0.038 mm 0.00055 to 0.0014 in.
	Allowable limit	0.15 mm 0.0059 in.

6.3.3 Replacing small end bushing



- (1) Seam
(2) Oil hole
(A) When removing

- (B) When installing
(a) 0.79 rad (45°)

Oil clearance between piston pin and small end bushing (Spare parts)	Factory specification	0.014 to 0.038 mm 0.00056 to 0.0014 in.
	Allowable limit	0.15 mm 0.0059 in.

Small end bushing I.D. (Spare parts)	Factory specification	22.025 to 22.040 mm 0.86713 to 0.86771 in.
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(When removing)

1. Press out the used bushing using a small end bushing replacing tool.

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Using a small end bushing replacing tool, press fit a new bushing (service parts) taking due care to see that the connecting rod oil hole matches the bushing hole.

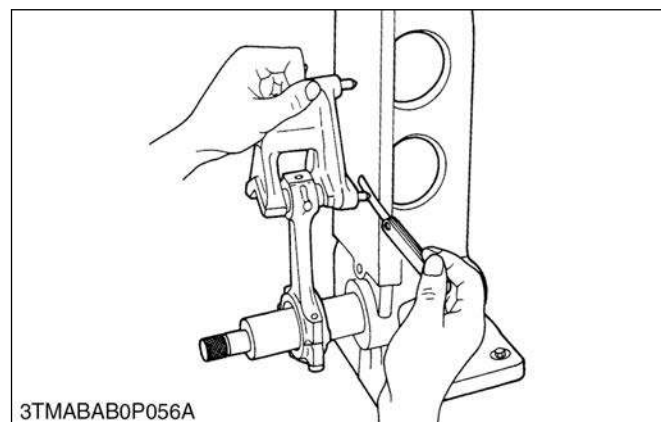
— RELATED PAGE —

[1.6 Bushing replacing tool on page 2-55](#)

6.3.4 Checking connecting rod alignment

NOTE

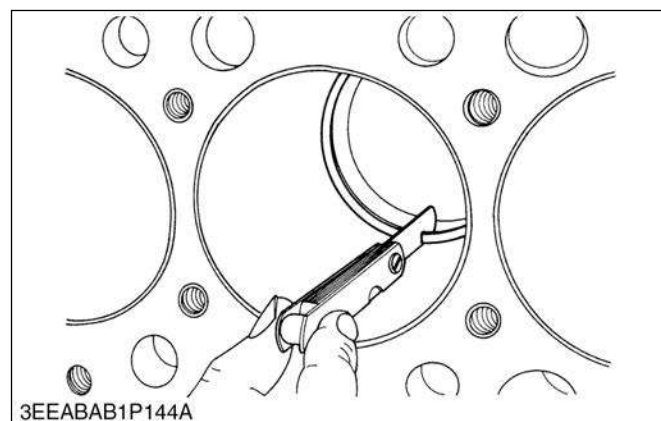
- Since the I.D. of the connecting rod small end bushing is the basis of this check, check bushing for wear beforehand.



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	Factory specification	0.05 mm 0.002 in.
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6.3.5 Checking piston ring gap

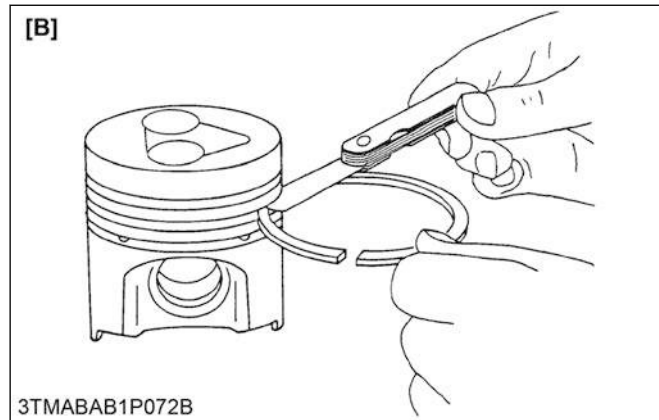
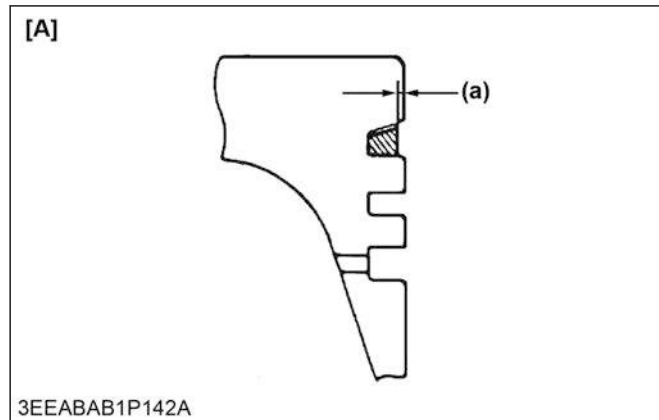


1. Insert the piston ring into the lower part of the cylinder (the least worn out part) with a piston.
2. Measure the ring gap with a thickness gauge.

3. If the measurement exceeds the allowable limit, replace the piston ring.

Piston ring gap	Top ring	Factory specification	0.15 to 0.25 mm 0.0059 to 0.0098 in.
		Allowable limit	1.20 mm 0.0472 in.
	Second ring	Factory specification	0.40 to 0.55 mm 0.016 to 0.021 in.
		Allowable limit	1.20 mm 0.0472 in.
	Oil ring	Factory specification	0.25 to 0.45 mm 0.0099 to 0.017 in.
		Allowable limit	1.25 mm 0.0492 in.

6.3.6 Checking clearance between piston ring and piston ring groove



[A] Top ring (Key stone type) [B] 2nd, oil ring

Dimension (a)	Factory specification	More than 0.2 mm 0.008 in.
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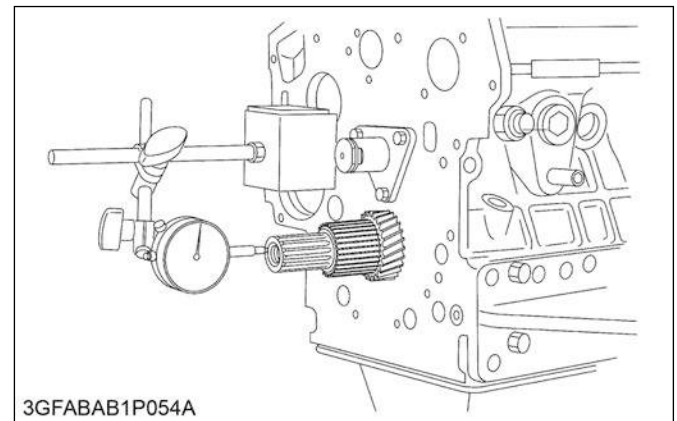
1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds the allowable limit, replace the piston ring.

Clearance between piston ring and piston ring groove	Second ring	Factory specification	0.0850 to 0.122 mm 0.00335 to 0.00480 in.
		Allowable limit	0.2 mm 0.008 in.
	Oil ring	Factory specification	0.02 to 0.06 mm 0.0008 to 0.002 in.
		Allowable limit	0.15 mm 0.0059 in.

4. If the clearance still exceeds the allowable limit with new ring, replace the piston.

6.4 Crankshaft

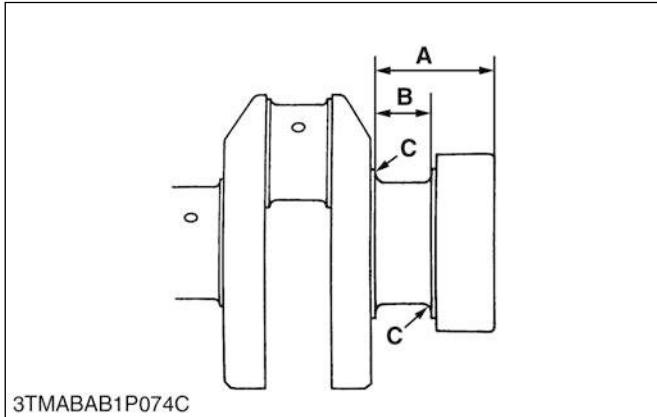
6.4.1 Checking crankshaft side clearance



1. Set a dial indicator with its point on the end of the crankshaft.
2. Move the crankshaft to the front and rear to measure the side clearance.
3. If the measurement is more than the allowable limit, replace the thrust bearings.

Crankshaft side clearance	Factory specification	0.15 to 0.31 mm 0.0059 to 0.012 in.
	Allowable limit	0.50 mm 0.020 in.

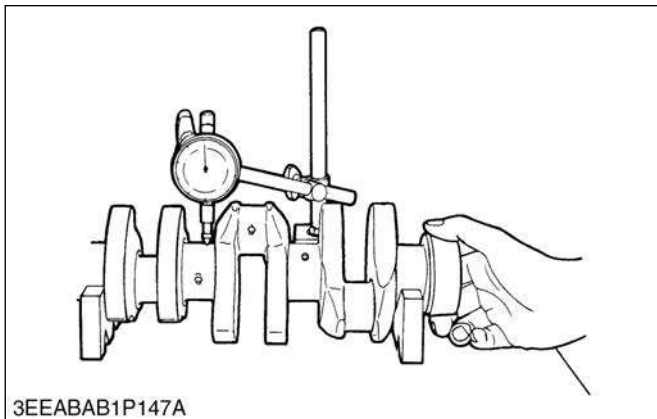
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an oversize one referring to the table and figure.
(Reference)



Oversize dimensions of crankshaft journal

Oversize	0.2 mm 0.0079 in.	0.4 mm 0.016 in.
Dimension A	51.50 to 51.70 mm 2.028 to 2.035 in.	51.60 to 51.80 mm 2.032 to 2.039 in.
Dimension B	28.20 to 28.25 mm 1.111 to 1.112 in.	28.40 to 28.45 mm 1.119 to 1.120 in.
Dimension C	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius
The crankshaft journal must be fine-finished to higher than Rmax. = 0.8S		

6.4.2 Checking crankshaft alignment



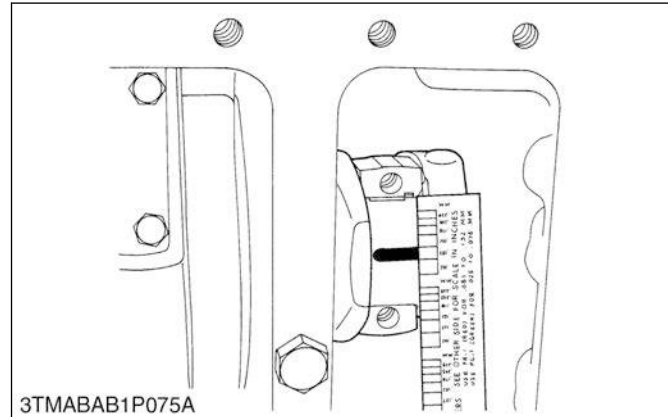
1. Support the crankshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the crankshaft alignment.
4. If the measurement exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.0008 in.
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6.4.3 Checking oil clearance between crankpin and crankpin bearing

NOTE

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



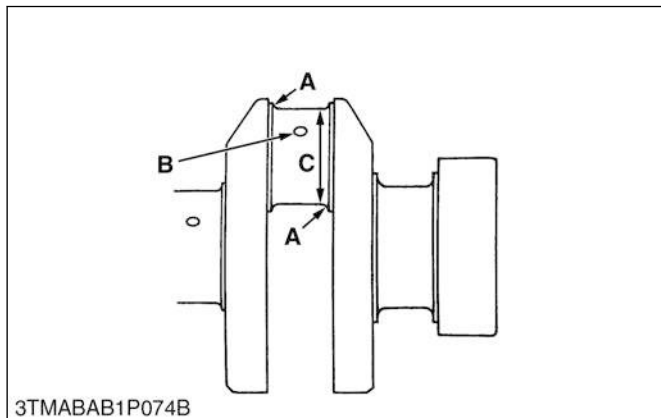
Crankpin O.D.	Factory specification	39.959 to 39.975 mm 1.5732 to 1.5738 in.
Crankpin bearing I.D.		40.040 to 40.050 mm 1.5764 to 1.5767 in.

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigauge on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the 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.

Oil clearance between crankpin and crankpin bearing	Factory specification	0.029 to 0.091 mm 0.0011 to 0.0036 in.
	Allowable limit	0.20 mm 0.0079 in.

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.

(Reference)



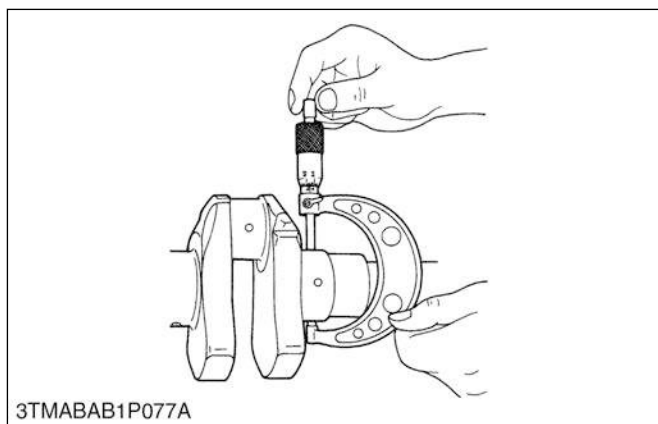
Undersize dimensions of crankpin

Undersize	0.2 mm 0.0079 in.	0.4 mm 0.016 in.
Dimension A	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	39.759 to 39.775 mm dia. 1.5654 to 1.5659 in. dia.	39.559 to 39.575 mm dia. 1.5575 to 1.5580 in. dia.
The crank pin must be fine-finished to higher than Rmax. = 0.8S		

* Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.

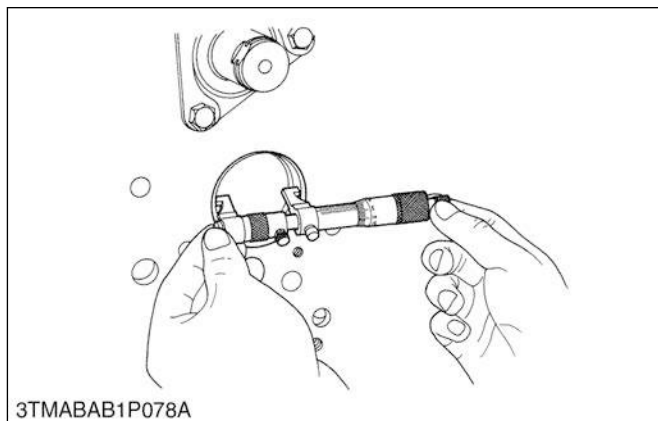
6.4.4 Checking oil clearance between crankshaft journal and crankshaft bearing 1

1. Measure the O.D. of the crankshaft front journal with an outside micrometer.



Crankshaft journal O.D.	Factory specification	47.934 to 47.950 mm 1.8872 to 1.8877 in.
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2. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer, and calculate the oil clearance.



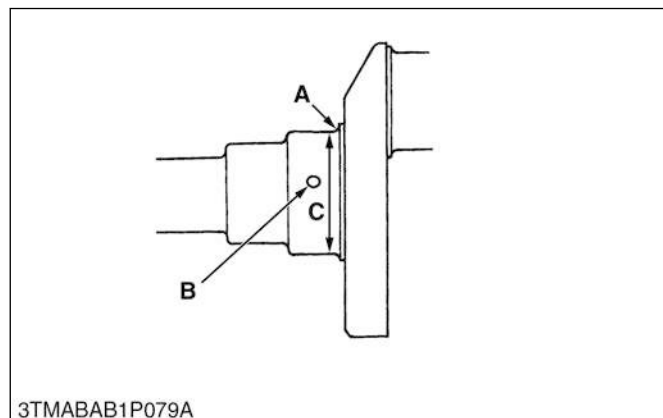
Crankshaft bearing 1 I.D.	Factory specification	47.984 to 48.048 mm 1.8892 to 1.8916 in.
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3. If the clearance exceeds the allowable limit, replace the crankshaft bearing 1.

Oil clearance between crankshaft journal and crankshaft bearing 1	Factory specification	0.0340 to 0.114 mm 0.00134 to 0.00448 in.
	Allowable limit	0.20 mm 0.0079 in.

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.

(Reference)



Undersize dimensions of crankshaft journal

Undersize	0.2 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension A	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	47.734 to 47.750 mm dia. 1.8793 to 1.8799 in. dia.	47.534 to 47.550 mm dia. 1.8715 to 1.8720 in. dia.
The crankshaft journal must be fine-finished to higher than Rmax. = 0.8S		

* Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.

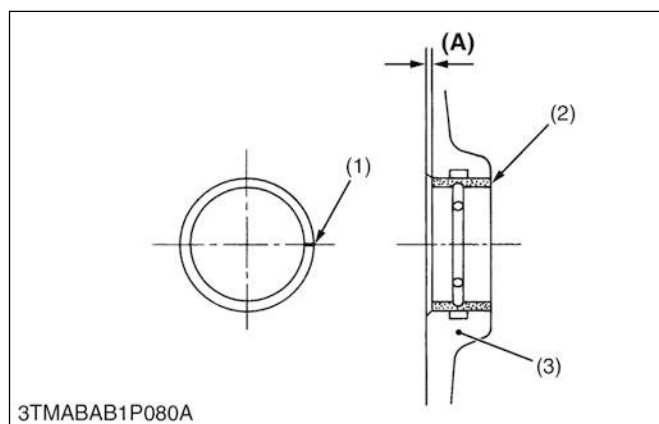
6.4.5 Replacing crankshaft bearing 1

(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 fit a new bearing 1 (2) so that its seam (1) directs toward the exhaust manifold side. (See figure.)



- (1) Seam
(2) Crankshaft bearing 1
(3) Cylinder block

(A) Dimension

Dimension (A)	Factory specification	0 to 0.3 mm 0 to 0.01 in.
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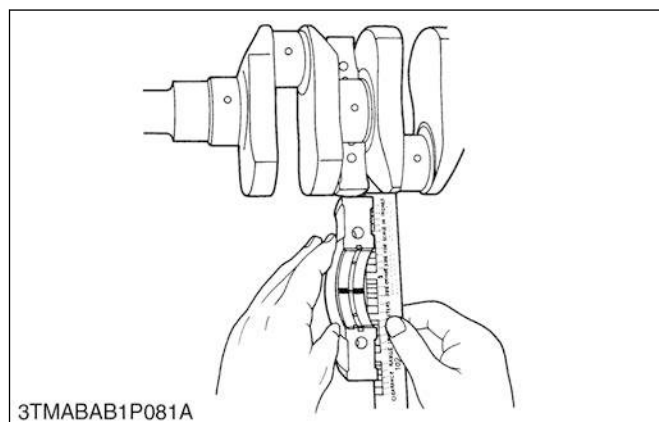
— RELATED PAGE —

[1.8 Crankshaft bearing 1 replacing tool on page 2-56](#)

6.4.6 Checking oil clearance between crankshaft journal and crankshaft bearing 2 (Crankshaft bearing 3)

■ NOTE

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



Crankshaft journal O.D. (Intermediate)	Factory specification	47.934 to 47.950 mm 1.8872 to 1.8877 in.
Crankshaft bearing 2 I.D.		47.984 to 48.029 mm 1.8892 to 1.8909 in.

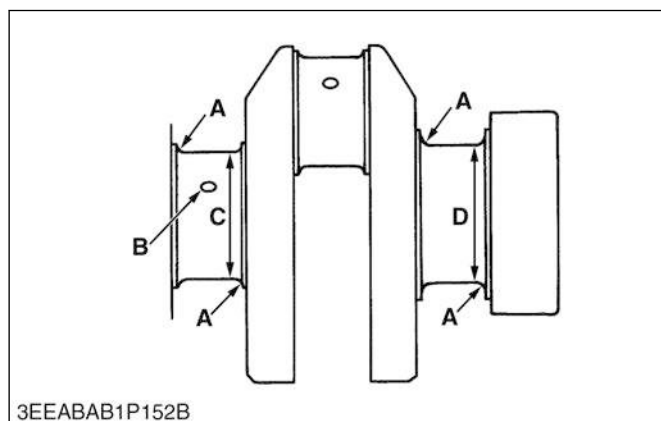
Crankshaft journal O.D. (Flywheel side)	Factory specification	51.921 to 51.940 mm 2.0442 to 2.0448 in.
Crankshaft bearing 3 I.D.		51.974 to 52.024 mm 2.0463 to 2.0481 in.

1. Put a strip of plastigauge on the center of the journal.
2. Install the bearing case and tighten the bearing case screws 1 to the specified torque, and remove the bearing case again.
3. Measure the amount of the flattening with the scale and get the oil clearance.
4. If the clearance exceeds the allowable limit, replace the crankshaft bearing 2 (1) and crankshaft bearing (3).

Oil clearance between crankshaft journal and crankshaft bearing 2	Factory specification	0.034 to 0.095 mm 0.0014 to 0.0037 in.
	Allowable limit	0.20 mm 0.0079 in.

Oil clearance between crankshaft journal and crankshaft bearing 3	Factory specification	0.0340 to 0.103 mm 0.00134 to 0.00405 in.
	Allowable limit	0.20 mm 0.0079 in.

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.
(Reference)



Undersize dimensions of crankshaft journal

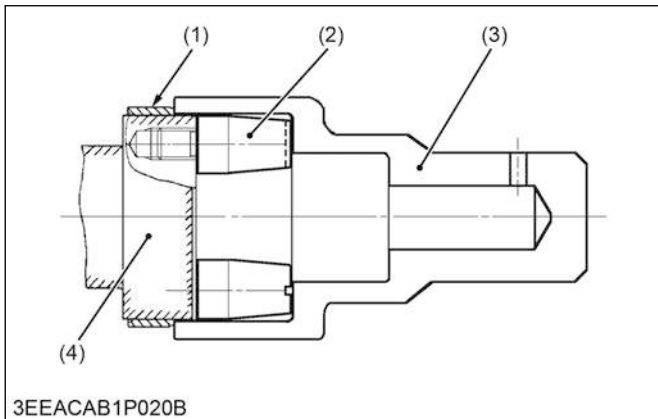
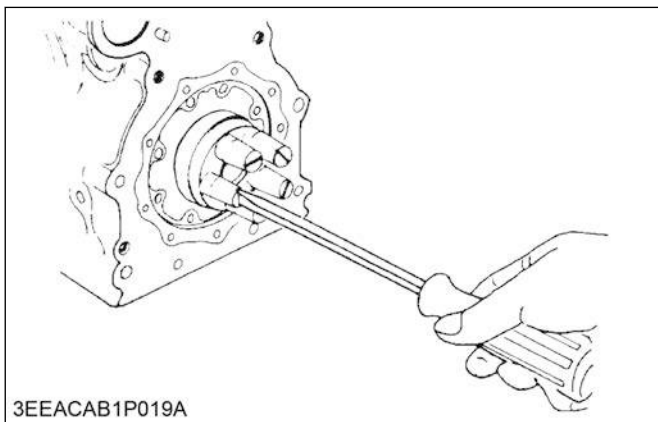
Undersize	0.20 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension A	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	47.734 to 47.750 mm dia. 1.8793 to 1.8799 in. dia.	47.534 to 47.550 mm dia. 1.8715 to 1.8720 in. dia.
Dimension D	51.721 to 51.740 mm dia. 2.0362 to 2.0370 in. dia.	51.521 to 51.540 mm dia. 2.0284 to 2.0291 in. dia.
The crank pin must be fine-finished to higher than Rmax. = 0.8S		

* Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.

6.4.7 Replacing crankshaft sleeve

NOTE

- Mount the sleeve with its largely chamfered surface facing outward.
- Should heating is not enough, a sleeve might stop halfway, so careful.



- (1) Crankshaft sleeve (3) Auxiliary socket for pushing
(2) Sleeve guide (4) Crankshaft

1. Remove the used crankshaft sleeve.
2. Set the sleeve guide (2) to the crankshaft.
3. Heat a new sleeve to temperature, and fix the sleeve to the crankshaft as shown in figure.

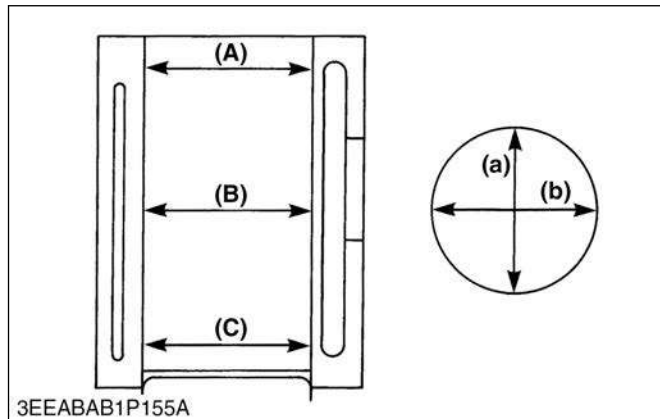
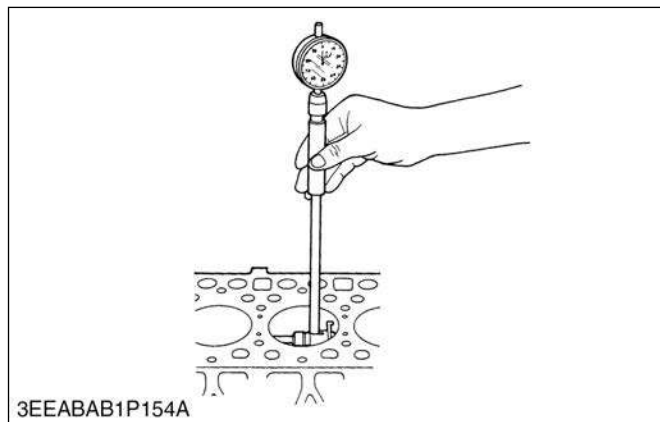
Temperature	Factory specification	between 150 and 200 °C (302 and 392 °F)
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4. Press fit the sleeve using the auxiliary socket for pushing (3).

6.5 Cylinder

6.5.1 Checking 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.



- (A) Top (a) Right-angled to piston pin
(B) Middle (b) Piston pin direction
(C) Bottom (Skirt)

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.

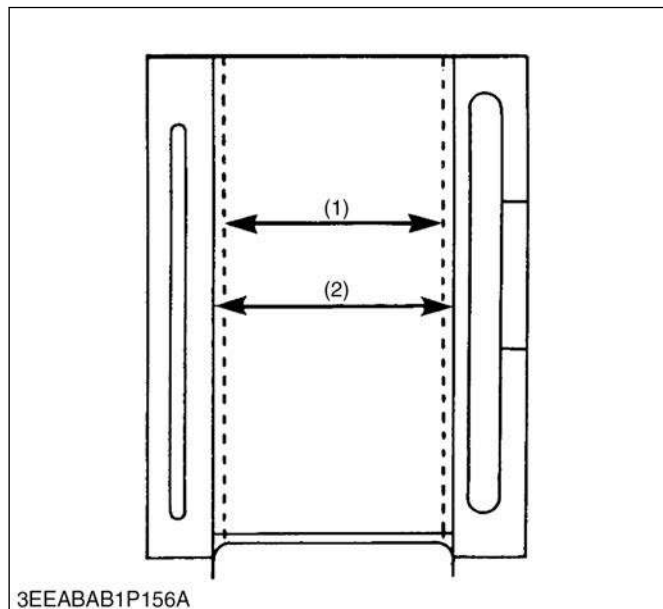
Cylinder I.D.	Factory specification	78.000 to 78.019 mm 3.0709 to 3.0716 in.
	Allowable limit	78.15 mm 3.077 in.

4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bored.

— RELATED PAGE —

[6.5.2 Correcting cylinder on page 3-77](#)

6.5.2 Correcting cylinder



- (1) Cylinder I.D. (Before correction) (2) Cylinder I.D. (Oversize)

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

Oversized cylinder liner I.D.	Factory specification	78.500 to 78.519 mm 3.0906 to 3.0912 in.
	Allowable limit	78.65 mm 3.096 in.
Finishing	Hone to 1.2 to 2.0 μ m Rmax. (48 to 78 μ in. Rmax.)	

- Replace the piston and piston rings with oversize one.

Oversize	0.5 mm (0.02 in.)
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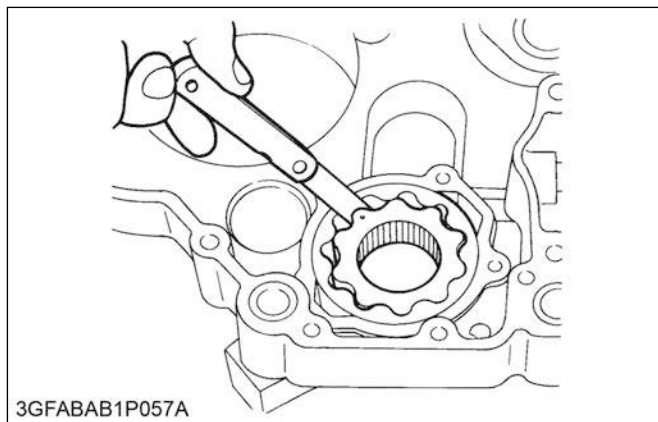
NOTE

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

6.6 Oil pump

6.6.1 Checking rotor lobe clearance

- Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.

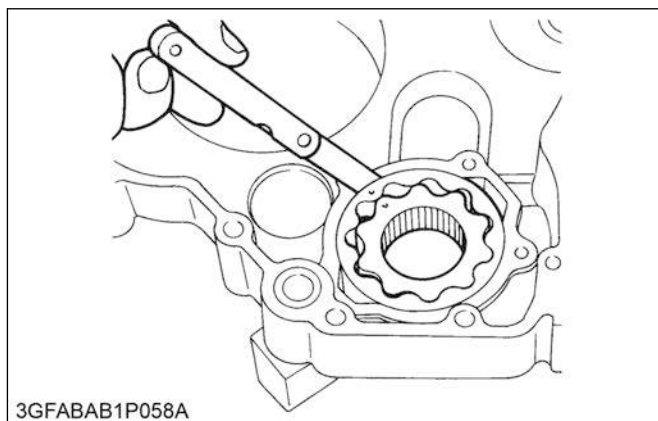


- If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Rotor lobe clearance	Factory specification	0.060 to 0.18 mm 0.0024 to 0.0071 in.
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6.6.2 Checking clearance between outer rotor and pump body

- Measure the clearance between the outer rotor and the pump body with a feeler gauge.



- If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory specification	0.100 to 0.180 mm 0.00394 to 0.00708 in.
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