HOWMET AEROSPACE

920D Diesel Powerig®

Hydraulic Power Source

Instruction Manual



Actual model may vary.

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September 11, 2024
HK1210

HOWMET AEROSPACE

EC Declaration of Conformity

Manufacturer:

Huck International, LLC, Industrial Products Group,
1 Corporate Drive, Kingston, NY, 12401, USA

Description of Machinery:

Model 920D family of Powerig® hydraulic power sources and specials based on their design (e.g. PR####).

Relevant provisions complied with:

- Council Directive related to Machinery (2006/42/EC)
- Supply of Machinery (Safety) Regulations 2008
- Safety of Machinery - Basic Concepts & Principles (BS EN ISO 12100)
- Safety of Machinery - Fluid Power Systems (BS EN ISO 982)

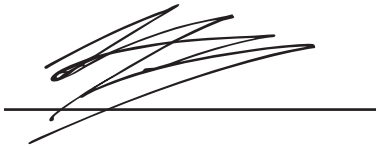
Representatives:

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Authorized Signature/date:

I, the undersigned, do hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Signature: 

Full Name: Nicholas Gougoutris

Position: Engineering Manager

Location: Huck International, LLC d/b/a
Howmet Fastening Systems
Kingston, New York, USA

Date: 2/6/23 February 6, 2023

UK CA

CE

HUCK

Declared dual number noise emission values in accordance with ISO 4871
A weighted sound power level, LWA: **100.4** dB (reference 1 pW) Uncertainty, KWA: 3 dB
A weighted emission sound pressure level at the work station, LpA: **89.4** dB (reference 20 µPa) Uncertainty, KpA: 3 dB
C-weighted peak emission sound pressure level, LpC, peak: **112.5** dB (reference 20 µPa) Uncertainty, KpC: 3 dB
Values determined according to noise test code ISO 15744, using as basic standards ISO 3744 and ISO 11203. The sum of a measured noise emission value and its associated uncertainty represents an upper boundary of the range of values which is likely to occur in measurements.

Test data to support the above information is on file at: Howmet Fastening Systems, Kingston Operations, Kingston, NY, USA.

DANGER - IMPORTANT

DO NOT EXCEED HOSE MINIMUM BEND RADIUS

Failure to heed the warnings below could lead to a damaged hose, damaged tool, damaged property, personal injury, or death.

- This high pressure hose is not to be used other than assembled in a genuine HUCK tool or hose assembly or used as a replacement hose of a genuine HUCK tool or hose assembly.
- Improper use of this product can cause ***property damage***, ***personal injury*** and ***death***, including but not limited to ***electrocution***, ***fluid injection*** or ***loss of limb*** caused by ***high pressure leak***, ***dangerously whipping hose*** or contact with suddenly moving or falling objects.
- Do not exceed rated working pressure ***(700 bar/10150 psi)*** or minimum bend radius (see chart below). Do not use in temperatures less than ***-40°C (-40°F)*** or greater than ***+100°C (+212°F)***. Do not exceed fluid working temperature of ***+70°C (+158°F)***.
- Do not use if hose is kinked, abraded, cut, bulged or leaking. Do not attempt to repair hose.
- Do not carry tool by hoses.
- Store hose assemblies in a clean dry area.
- Refer to a HUCK hydraulic tool manual for hose inspection & maintenance intervals.

Hose Type	Minimum Bend Radius	
126107 Series	2.76 Inches	70 mm
118944 and 124881 Series	2.17 Inches	55 mm
HA and HPH Series	1.97 Inches	50 mm

Glossary of Terms and Symbols			
UKCA CE	Product complies with requirements set forth by the relevant UK and European directives.	**NOTES**	Notes are reminders of required procedures.
	Read manual before using equipment.	**FONT STYLING**	Bold, italic type and underline: emphasize a specific instruction.
	Hearing protection is required while using this equipment.	**WARNINGS**	Must be understood to avoid severe personal injury.
	Eye protection is required while using equipment.	**CAUTIONS**	Show conditions that will damage equipment or structure.

Safety Instructions

I. GENERAL SAFETY RULES:

1. A half hour long hands-on training session with qualified personnel is recommended before using Huck equipment.
2. Howmet equipment must be maintained in a safe working condition at all times. Tools and hoses should be inspected at the beginning of each shift/day for damage or wear. Any repair should be done by a qualified repairman trained on Howmet procedures.
3. For multiple hazards, read and understand the safety instructions before installing, operating, repairing, maintaining, changing accessories on, or working near the assembly power tool. Failure to do so can result in serious bodily injury.
4. Only qualified and trained operators should install, adjust or use the assembly power tool.
5. Do not modify this assembly power tool. This can reduce effectiveness of safety measures and increase operator risk.
6. Do not discard safety instructions; give them to the operator.
7. Do not use assembly power tool if it has been damaged.
8. Tools shall be inspected periodically to verify all ratings and markings required and listed in the manual, are legibly marked on the tool. The employer/operator shall contact the manufacturer to obtain replacement marking labels when necessary. Refer to assembly drawing and parts list for replacement.
9. Tool is only to be used as stated in this manual. Any other use is prohibited.
10. Read MSDS Specifications before servicing the tool. MSDS specifications are available from the product manufacturer or your Howmet representative.
11. Only genuine Howmet parts shall be used for replacements or spares. Use of any other parts can result in tooling damage or personal injury.
12. Never remove any safety guards or pintail deflectors.
13. Never install a fastener in free air. Personal injury from fastener ejecting may occur.
14. Where applicable, always clear spent pintail out of nose assembly before installing the next fastener.
15. Check clearance between trigger and work piece to ensure there is no pinch point when tool is activated. Remote triggers are available for hydraulic tooling if pinch point is unavoidable.
16. Do not abuse tool by dropping or using it as a hammer. Never use hydraulic or air lines as a handle or to bend or pry the tool. Reasonable care of installation tools by operators is an important factor in maintaining tool efficiency, eliminating downtime and preventing an accident which may cause severe personal injury.
17. Never place hands between nose assembly and work piece. Keep hands clear from front of tool.
18. Tools with ejector rods should never be cycled with out nose assembly installed.
19. When two piece lock bolts are being used always make sure the collar orientation is correct. See fastener data sheet for correct positioning.

II. PROJECTILE HAZARDS:

1. Risk of whipping compressed air hose if tool is pneudraulic or pneumatic.
2. Disconnect the assembly power tool from energy source when changing inserted tools or accessories.
3. Be aware that failure of the workpiece, accessories, or the inserted tool itself can generate high velocity projectiles.
4. Always wear impact resistant eye protection during tool operation. The grade of protection required should be assessed for each use.
5. The risk of others should also be assessed at this time.
6. Ensure that the workpiece is securely fixed.
7. Check that the means of protection from ejection of fastener or pintail is in place and operative.
8. There is possibility of forcible ejection of pintails or spent mandrels from front of tool.

III. OPERATING HAZARDS:

1. Use of tool can expose the operator's hands to hazards including: crushing, impacts, cuts, abrasions and heat. Wear suitable gloves to protect hands.
2. Operators and maintenance personnel shall be physically able to handle the bulk, weight and power of the tool.
3. Hold the tool correctly and be ready to counteract normal or sudden movements with both hands available.
4. Maintain a balanced body position and secure footing.
5. Release trigger or stop start device in case of interruption of energy supply.
6. Use only fluids and lubricants recommended by the manufacturer.
7. Avoid unsuitable postures, as it is likely for these not to allow counteracting of normal or unexpected tool movement.
8. If the assembly power tool is fixed to a suspension device, make sure that fixation is secure.
9. Beware of the risk of crushing or pinching if nose equipment is not fitted.

V. REPETITIVE MOTION HAZARDS:

1. When using assembly power tool, the operator can experience discomfort in the hands, arms, shoulders, neck or other parts of the body.
2. When using tool, the operator should adopt a comfortable posture while maintaining a secure footing and avoid awkward or off balanced postures.
3. The operator should change posture during extended tasks to help avoid discomfort and fatigue.
4. If the operator experiences symptoms such as persistent or recurring discomfort, pain, throbbing, aching, tingling, numbness, burning sensations or stiffness, these warnings should not be ignored. The operator should tell the employer and consult a qualified health professional.

V. ACCESSORIES HAZARDS:

1. Disconnect tool from energy supply before changing inserted tool or accessory.
2. Use only sizes and types of accessories and consumables that are recommended. Do not use other types or sizes of accessories or consumables.

continued...

Safety Instructions (continued)

VI. WORKPLACE HAZARDS:

1. Be aware of slippery surfaces caused by use of the tool and of trip hazards caused by the air line or hydraulic hose.
2. Proceed with caution while in unfamiliar surroundings; there could be hidden hazards such as electricity or other utility lines.
3. The assembly power tool is not intended for use in potentially explosive environments.
4. Tool is not insulated against contact with electrical power.
5. Ensure there are no electrical cables, gas pipes, etc., which can cause a hazard if damaged by use of the tool.

VII. NOISE HAZARDS:

1. Exposure to high noise levels can cause permanent, disabling hearing loss and other problems such as tinnitus, therefore risk assessment and the implementation of proper controls is essential.
2. Appropriate controls to reduce the risk may include actions such as damping materials to prevent workpiece from 'ringing'.
3. Use hearing protection in accordance with employer's instructions and as required by occupational health and safety regulations.
4. Operate and maintain tool as recommended in the instruction handbook to prevent an unnecessary increase in the noise level.
5. Select, maintain and replace the consumable / inserted tool as recommended to prevent an unnecessary increase in noise.
6. If the power tool has a silencer, always ensure that it is in place and in good working order when the tool is being operated.

VIII. VIBRATION HAZARDS:

1. Exposure to vibration can cause disabling damage to the nerves and blood supply to the hands and arms.
2. Wear warm clothing when working in cold conditions and keep hands warm and dry.
3. If numbness, tingling, pain or whitening of the skin in the fingers or hands, stop using the tool, tell your employer and consult a physician.

X. HYDRAULIC TOOL SAFETY INSTRUCTIONS:

WARNING: Do not exceed maximum pull or return settings on tool.
Be sure all hose connections are tight. All tool hoses must be connected.

1. Carry out a daily check for damaged or worn hoses or hydraulic connections and replace if necessary.
2. Wipe all couplers clean before connecting. Failure to do so can result in damage to the quick couplers and cause overheating.
3. Ensure that couplings are clean and correctly engaged before operation.
4. Use only clean oil and filling equipment.
5. Power units require a free flow of air for cooling purposes and should therefore be positioned in a well ventilated area free from hazardous fumes.
6. Do not inspect or clean the tool while the hydraulic power source is connected. Accidental engagement of the tool can cause serious injury.
7. Be sure all hose connections are tight.
8. Wipe all couplers clean before connecting. Failure to do so can result in damage to the quick couplers and cause overheating.

IV. REPETITIVE MOTION HAZARDS:

1. When using assembly power tool, the operator can experience discomfort in the hands, arms, shoulders, neck or other parts of the body.
2. When using tool, the operator should adopt a comfortable posture while maintaining a secure footing and avoid awkward or off balanced postures.
3. The operator should change posture during extended tasks to help avoid discomfort and fatigue.
4. If the operator experiences symptoms such as persistent or recurring discomfort, pain, throbbing, aching, tingling, numbness, burning sensations or stiffness, these warnings should not be ignored. The operator should tell the employer and consult a qualified health professional.

Description

General

The models **920D** Huck Powerig® Hydraulic Power Source is a diesel-powered hydraulic power sources designed to operate Huck Installation Equipment.

This model can operate **two** pieces of equipment simultaneously and independently of each other. The unit is semi-portable and can be moved with a fork-lift truck.

Hydraulic pressure is developed by an axial piston pump driven by a diesel engine. Hydraulic pressure from the pump is directed to **Pull** and **Return** ports by combination valves controlled from the installation equipment by relays and solenoids.

Hydraulic fluid is stored in a reservoir. A 100 micron strainer in the suction line and a 10 micron filter in the **Return** line, assure clean, filtered hydraulic fluid for the hydraulic system. A filler-strainer is provided for adding hydraulic fluid. However, any hydraulic fluid that is added to the reservoir must be filtered by a 10 micron (or better) filter.

Before returning to the reservoir, circulating hydraulic fluid passes through the cooler where the temperature of fluid is lowered to proper operating level. A fan aids in dissipating heat from the cooler.

Combination Valve

Each combination valve contains a **Four-way solenoid-operated directional valve**, **Pressure Relief Valve** and **Idler Valve**.

The ***Four-way Valve*** is controlled by a tool trigger through a relay and solenoid and directs hydraulic fluid under pressure to PULL or RETURN hoses connected to installation tool, or other equipment.

The ***Pressure Relief Valve*** protects the Powerig and installation tools from excessive pressure during the *pull* cycle. The valve is factory preset to 4400 psi (*303 bar*).

continued...

Description (continued)

The ***Idler Valve*** (Figure 7) protects the Powerig and installation tools from excessive pressure during the *return* cycle. The Idler Valve is factory preset to provide 2800 psi (*193 bar*) return pressure and approximately 200 psi (*14 bar*) idling pressure.

Note: Various systems require different output pressures. See **Checking & Adjusting Pressures** before using the Powerig® Hydraulic Unit.

Principle of Operation

Turning the key switch to the **On** position with the engine off supplies voltage from the battery to the green **Power On** indicator light, the hour meter, the temperature-controlled cooler fan circuit, the red **Low Pressure** indicator light circuit and to the tool trigger circuits.

When the key switch is in the **On** position and the motor is not running:

- The green **Power On** indicator light should be on.
- The red **Low Engine Oil Pressure** indicator light should be on.
- The **Hour Meter** should be on.
- The cooling fan should be on only if the oil temperature sensor is reading above 120°F (49°C).

Turning the key switch to the **Glow** position supplies power to the glow plug which heats the cylinder and aids in low temperature operation. When the outside temperature is below 40°F (5°C) it is necessary to hold the key switch in the **Glow** position for 5 seconds prior to attempting to start the motor. The indicator lights and hour meter will not be on in the **Glow** position.

Turning the key switch to **Start** position energizes the starter solenoid (S3, refer to electrical schematic), which closes the S3 contact and engages the starter motor. The indicator lights and hour meter will not be on in the **Start** position. When the motor catches, the key switch is released and will spring return to the **On** position, opening the S3 contact and disengaging the starter motor.

When the engine is running, the dynamo and voltage regulator will supply approximately 14.5 volts to the control circuits and will recharge the battery. As the oil pressure builds to normal in the motor, the oil pressure switch will open and the red **Low Engine Oil Pressure** indicator light will go off.

When the trigger of the tool plugged into **Tool 1** is pressed, the **CR1** control relay is energized, closing the **CR1** contacts and energizing the **S1 Tool 1 Valve** solenoid. When the **S1 Tool Valve** solenoid is energized, the valve spool moves and high-pressure hydraulic fluid is directed out the **Pull** pressure port and hose to **Tool 1.** When tool trigger is released, the solenoid de-energizes and the valve spool returns to its original position, directing high-pressure hydraulic fluid to the **Return** port and hose to the tool. The **Tool 2** controls work in the same way as **Tool 1.** The **Tool 1** and **Tool 2** control circuits allow them to run simultaneously and independently.

Specifications

NOTE: The units are shipped <u>without</u> hydraulic fluid.

WARNINGS: DANGER: The 920D Powerig® hydraulic power source is intended for use in outdoor environments. Never use indoors. Carbon Monoxide gas is present during operation of the unit. Carbon Monoxide gas can cause serious injury or death.

Hose Kits: Use only genuine HUCK Hose Kits rated at 10,000 psi (689.5 bar) working pressure.

Hydraulic fluid: See Fluid Specification Chart below for details. Fire resistant fluid may be used if it's an ester based fluid such as Quintolubric HFD or equivalent. Water based fluid shall NOT be used as serious damage to equipment will occur.

DESCRIPTION	DETAIL	DESCRIPTION		DETAIL
POWER SOURCE Check diesel engine manual shipped with Powerig for additional information.	9.4 HP (7 kW) Diesel Engine with 1.5 gal (5.5 l) fuel tank and 1.7L (1.8 quarts) Crankcase oil capacity.	**FLUID CONTROL**		Four-way solenoid-operated directional valve, pressure relief valve and idler valve on each circuit.
		MAX. HYDRAULIC FLUID TEMPERATURE		150° F 65° C
MAX OPERATING TEMP	125 ° F 51.7 ° C	**HYDRAULIC FLUID RESERVOIR CAPACITY**		7 gallon (26.5 liters) center of sight gauge
REMOTE CONTROL	12 volt DC control circuit			
SYSTEM	Two (2) open-center circuits with 8,400 psi (580 BAR) maximum operating pressure	**WEIGHT**	**Operational**	375 lbs 170 kg
			Dry Value	350 lbs 159 kg

Actual model may vary from figures shown. Component part numbers may change without notice.

continued...

Specifications (continued)

DESCRIPTION		DETAIL	DESCRIPTION	DETAIL
MAX FLOW RATE (per circuit)		1.4 gpm 5.3 l/m	COOLER	Fan and radiator air/oil heat exchanger
OUTPUT PRESSURE	PULL RANGE	1,500–8,500 psi 103–586 bar	PUMP	Dynex/Rivet constant-displacement hydraulic piston pump, direct mounted to engine Pump has six axial pistons. Flow is split: 3 pistons per circuit.
	RETURN RANGE	1,000–8,000 psi 69–552 bar		

Note: 920D Powerig® is shipped with factory preset pressures of 4400 psi (303 bar) **Pull** and 2800 psi (193 bar) **Return**.

Fluid Specific Chart

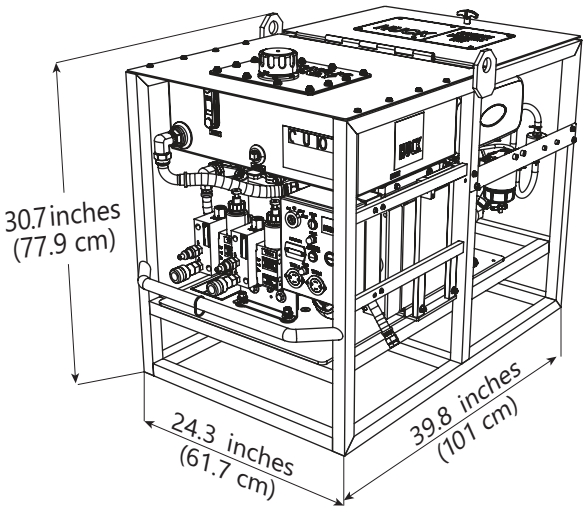
Note: Reference Diesel Engine Manual for Detailed Regional Specifications

FLUID TYPE	DESCRIPTION
Fuel	Ultra Low Sulfur No. 2 Diesel Fuel [Sulfur Content <0.0015% (15 ppm)]
Oil	API Service CF-Class (SAE# 30, 20, 10W30)
Hydraulic Fluid	Use 32AW (0°F - 70°F ambient), 46AW (30°F - 120°F), or ATF (30°F - 90°F ambient). ATF Hydraulic fluid shall meet DEXRON® III, DEXRON VI, MERCON, Allison C-4 or equivalent ATF specifications.

Note: For trade names are used in this manual:

DEXRON *is a registered trademark of General Motors Corporation.*
GLYD Ring *is a registered trademark of Trelleborg Sealing Solutions Germany GmbH*
KUBOTA *is a registered trademark of Kubota Corporation.*
Loctite *is a registered trademark of Henkel IP & Holding GmbH*
LUBRIPLATE *is a registered trademark of Fiske Brothers Refining Co.*
MERCON *is a registered trademark of Ford Motor Corp.*
MOLYKOTE *is a registered trademark of Dow Corning Corporation*
Never-Seez *is a registered trademark of Bostik, Inc.*
Quintolubric *is a registered trademark of Quaker Chemical Corp.*
Slic-tite *is a registered trademark of LA-CO Industries, Inc.*

Dimensions



Spirolox *is a registered trademark of Smalley Steel Ring Company*
Teflon *is a registered trademark of Chemours Company FC.*
Threadmate *is a registered trademark of Parker Intangibles LLC.*
TRUARC *is a trademark of TRUARC Co. LLC.*
Vibra-Tite *is a registered trademark of ND Industries, Inc. USA.*

Spare Parts and Accessories

Kits help simplify ordering parts for maintenance & operation. For safe working pressure to the tool, DON'T exceed 156 ft. (47.5 m) of hose length. Hose & Control Cord Kits can be used with Quick Disconnects & Adapter Unions (**P/N** 503697); available separately. Kit hoses are rated by the manufacturer at 10,000 psi (689.5 bar) max. working pressure.

WARNING: Abnormally high pressure can cause sudden failure of the Powerig and excessive wear. Severe personal injury could result.

HOSE ASSEMBLY

Contains 2 light-weight, flexible hydraulic hoses with 1 male & 1 female quick connect fitting at each end & 1 control cable with 1 male connector & 1 female connector for electrical trigger style, 2 yellow wire cords

HOSE LENGTH		INNER DIAMETER		PART NO. (NO SLEEVE)	PART NO. WITH RUBBER SLEEVE
12 FT	3.66 m	¼"	6.35 mm	HAY12-ECA03	HAY12-ECA33
26 FT	7.93 m	¼"	6.35 mm	HAY26-ECA03	HAY26-ECA33
52 FT	15.85 m	¼"	6.35 mm	HAY52-ECA03	HAY52-ECA33
12 FT	3.66 m	5/16"	7.94 mm	N/A	HAX12-ECA33
26 FT	7.93 m	5/16"	7.94 mm	N/A	HAX26-ECA33

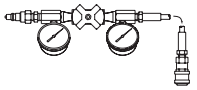
Options & Accessories - Available independently

DESCRIPTION	PART #	DESCRIPTION	PART #
Kubota Fuel Filter	132030	10 Micron Fuel Filter	509543
Kubota Air Filter	509325	Fuel Filter Clear Bowl Kit	509544
Kubota Fuel Pump	509318	Fuel Filter Metal Bowl Kit	509545
Kubota Fuel Injector Kit	132029	Fuel Filter Clear Plug Kit	509546

Options & Accessories

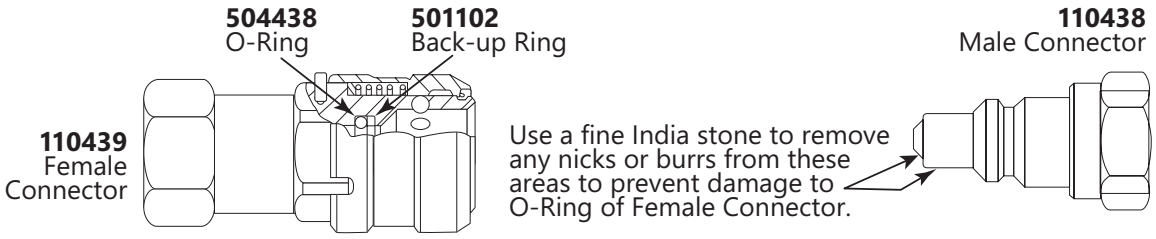
These are available independently.

DESCRIPTION	PART #
Gauge, Pressure Setting, CE.	T-124833CE
Auxiliary Electric Trigger Assembly: Contains switch, housing and 13-ft (3.9 m) cord.	113056
Hydraulic Quick Disconnects Contains a female and male connection for easy tool connection.	110440
Control Cord Connector Kit	110835
Directional Valve Seal Kit (2)	132093
Combination Valve Seal Kit	132086
920D Replacement Fuel Tank	509541



T-124833CE
Gauge, Pressure Setting, CE

110440 Hydraulic Couplings



Assembly of NPTF Threaded Components

AIR FITTINGS

1) Apply Teflon® stick to male threads which do not have pre-applied sealant per manufacturer's recommendations. (Proceed to All Fittings step 2)

HYDRAULIC FITTINGS

1) Apply Threadmate™ to male and female threads which do not have pre-applied sealant per manufacturer's recommendations. (Proceed to All Fittings step 2)

ALL FITTINGS:

2) Tighten to finger-tight condition.

3) Wrench tighten to 2-3 turns past finger-tight condition.

4) Final thread engagement can be checked (optional) by measuring the dimension from the flange of male fitting to the end of the thread before assembly and subtracting the distance under the flange after assembly.

Thread Size	Final thread engagement at full make-up	
⅛-27 NPTF	**.235 inch**	*.59 cm*
¼-18 NPTF	**.339 inch**	*.86 cm*
⅜-18 NPTF	**.351 inch**	*.89 cm*

Preparation for Use

WARNING: See PULL and RETURN pressures listed in applicable tool instruction manual. Improper settings of PULL and RETURN pressures could cause violent rupture of the system or tool. Fatal or severe injury from exploding components/hydraulic fluid could occur to anyone in the immediate vicinity.

Note: PULL and **RETURN** pressure requirements must be understood before preparing these Powerig® Hydraulic Units for first-time use. Set **PULL** and **RETURN** pressures for each tool according to tool instruction manual.

GOOD SERVICE PRACTICES

Foreign material in the hydraulic system results in poor performance and repair down time. To avoid this, observe the following good service practices:

1. Clean area around reservoir filler cap before removal.
2. When adding hydraulic fluid to the reservoir, use a clean funnel and filter the fluid with a 10-micron filter.
3. Do not let hose fittings and couplers lay on or drag around on a dirty floor, or on the ground.

FIRST TIME START-UP

1. Check that drain plug and hydraulic fluid accessory port plugs are tight.
2. Fill hydraulic fluid reservoir with 7 gallons of hydraulic fluid.
3. Attach battery cables, red cable first.
4. Use strainer (10-micron filter) to fill fuel tank with fresh, clean diesel fuel.
5. Remove plastic shipping plugs from **PULL** and **RETURN** pressure ports of **Tool 1**, **Tool 2**.
6. Attach T-Gauge to hydraulic quick connect fittings labeled 'Tool 1' and open center valve.
7. Attach trigger button socket labeled to 'Tool 1' on the electrical enclosure.

CAUTIONS: Do not use Teflon® tape on pipe threads. Tape can shred and break free into fluid lines, resulting in malfunctions. Apply Parker Threadmate, Loctite 567 or Slic-tite stick to male pipe threads per manufacturer's instructions.

8. Open Powerig® cover, then open compression release lever on top of motor (this will automatically close once motor starts). Close cover.
9. In a well-ventilated area, insert key, rotate clockwise to **'ON'.** All lights should illuminate on electrical enclosure.
10. Turn key to ***'START'*** and hold until motor starts. Release the key. Green power light should remain illuminated and hour meter should start to count. **Note: Turn key to 'GLOW' for 5 seconds if temperature is below 41°F (5°C) prior to 'START'. If the temperature is low enough that the glow plug is needed, connect the pull and return ports together on each tool station (using hose assembly) to reduce the cold starting load.**
11. Set output pressures for 'Tool 1' to correspond with the tool and fastener being used. See Checking & Adjusting Pressures section of this manual. **Note: Pull pressure adjustment is downward facing and return pressure adjustment is upward facing.**
12. Detach T-Gauge and trigger button from 'Tool 1'. Reattach T-Gauge and trigger button to 'Tool 2' and set output pressures for 'Tool 2' to correspond with tool and fastener being used.
13. Detach T-Gauge and trigger button from 'Tool 2'. Attach first hose kit to 'Tool 1' and attach T-Gauge to far end of hose kit. Open center valve on T-Gauge. Attach trigger button to hose kit. Hold button to run hydraulic unit for approximately two minutes to remove air from hose kit. Detach T-Gauge and trigger button from hose kit.

continued...

Preparation for Use (continued)

14. Attach installation tool to hose kit and cycle tool several times. Check for and correct any leaks.
15. Repeat steps 13 and 14 with second hose kit and installation tool.
16. Rotate key to OFF position, allow motor to stop.
17. Check hydraulic fluid level and add more if necessary.

WARNING: Using engine starting fluid will void the warranty.

REGULAR USE BEFORE EACH OPERATION

1. Check hydraulic fluid level in reservoir and add hydraulic fluid as required. Whenever hydraulic fluid is added, it must be filtered by a 10-micron filter.
2. Inspect hoses for damage and replace as required.
3. Check and correct any leaks.

CONNECTING INSTALLATION TOOLS TO POWERIG®

Hose and cord kits for connecting Installation Tools to the unit are shown in the **Kits and Accessories** section of this manual. Be sure that hose from port P of tool is connected to PULL pressure port on Powerig Hydraulic Unit and hose for port R of tool is connected to RETURN pressure port of unit.

Operating Instructions

WARNING: Severe personal injury may result if connections or hoses fail.

Before operating the Powerig® Hydraulic Power Source, make sure unit has been prepared for service as described in **Preparation for Use.** Connect hoses and control cords as shown in **Connecting Installation Tools to Powerig Hydraulic Unit.**

1. Check oil reservoir. Fill with Oil per **Specifications** if needed.
2. Check fuel tank. Fill with Diesel Fuel per **Specifications** if needed.
3. Check Hydraulic Fluid. Fill with Fluid per **Specifications** if needed.
4. Turn Key to start engine.
5. Press tool trigger to cycle tool. **Always be Alert for:**
   (a) leaks at hose connections,
   (b) damage to hoses and
   (c) hydraulic fluid level.

Checking and Adjusting Pressures

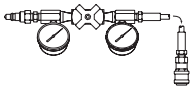
WARNINGS: Turn OFF Powerig before connecting or disconnecting tools. If you need to connect or disconnect a tool while the unit is running, use this procedure for maximum safety.

Connect tool's hydraulic hoses to unit before connecting tool's switch control cord to unit. If a malfunctioning cord switch is connected first, hydraulic unit may cycle unexpectedly. Unexpected cycling may lead to serious injury. When connecting hoses, switch MUST be connected last. When disconnecting hoses, switch MUST be disconnected first.

Maximum PULL pressure is 8400 psi (648 bar). Refer to specific tool instruction manual for PULL and RETURN pressures for Howmet installation equipment. Severe personal injury may occur if excessive pressures cause violent failure of equipment.

PREPARATION FOR USE WITH GAUGE T-124833CE

If necessary, prime and bleed the Powerig® Hydraulic Unit. See the **Preparation for Use** section of this manual. **Note:** Check each tool's pressure separately. See inset image with T-124883CE Gauge.



T-124833CE
Gauge, Pressure Setting, CE

1. Turn Powerig OFF. Connect male coupler of gauge to the female coupler (**PULL** pressure) of the Powerig.
2. Connect female coupler of gauge to male coupler (**RETURN** pressure) of the Powerig.
3. Turn needle valve of **T-124833CE** all the way out.
4. Install auxiliary electric switch and control cord assembly (P/N **113056**) in the control cord socket of the tool port being checked or use the tools' trigger connected to ports being checked. Fluid is directed out of the **PULL** pressure port when the switch is pressed. Start the diesel engine.

CAUTION: The following check must be completed quickly. Sustained high pressure will cause premature wear on the unit.

CHECK OUTPUT PRESSURES

1. Close the valve (turn it clockwise). Press and hold auxiliary trigger switch. Read the **PULL** pressure on right gauge. Release trigger switch.
2. Open valve by a few counterclockwise turns.
3. ***Press*** and ***Release*** auxiliary trigger switch to set the unit's internal valve. Hydraulic fluid is directed out RETURN pressure port.
4. ***SLOWLY*** close the valve. The pressure will rise and then sharply drop. Read the RETURN pressure on the left gauge just before the pressure drops.
5. Open the valve. Turn OFF the Powerig.
6. Disconnect auxiliary trigger, then pressure setting gauge.
7. Refer to installation tool's instruction manual for specific PULL and RETURN pressures.

WARNING: Turn hydraulic unit OFF. Accidental cycling of unit may cause severe injury when disconnecting couplings. Fluid may unexpectedly spray.

ADJUST OUTPUT PRESSURES

Prepare the Powerig for use as described in **Preparation for Use.** Use Gauge **T-124833CE** to check pressures before and after adjusting **PULL** and **RETURN** pressures.

ADJUST COMBINATION VALVE P/N 132402

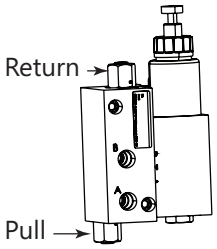
The 920D Powerig valves can be set at specific **PULL** and **RETURN** pressures (see the applicable instruction manual for your tool) with 2 socket-head screws.

continued...

Checking and Adjusting Pressures (continued)

One screw adjusts the **PULL** pressure and one adjusts **RETURN** pressure.

CAUTION: Set the Powerig pressures to the lowest recommended pressure to minimize wear on the equipment.



PULL/RETURN PRESSURE ADJUSTMENT

Use a ¼" hex key to adjust either the **PULL** pressure or **RETURN** pressure adjusting screws as needed.

a. Turn screw clockwise to increase pressure.
b. Turn screw counterclockwise to decrease pressure.
c. Use the **T-124833CE** Gauge to check the **RETURN** or **PULL** setting.

Maintenance

WARNINGS: After overhauling combination valve, PULL and RETURN pressures must be checked. Serious personal injury may occur if excessive pressure causes violent hose or installation equipment failure. Excessive pressures may cause violent rupture of some part of the fastening system. Exploding components may cause severe or fatal injuries to personnel in the vicinity. If the system does not rupture, continuous higher than normal pressure will cause premature wear of equipment.

PREVENTIVE MAINTENANCE

1. Make sure hydraulic and electrical fittings are secure.
2. Inspect hoses daily for signs of damage. Replace hoses if damage is detected.
3. Check for abnormal heating, vibration or leakage during use.
4. Inspect hydraulic fluid periodically. Replace if contaminated. Clean sump filter if fluid is dirty when being replaced.
5. Keep all exterior surfaces clean.
6. Keep hydraulic fittings clean & free of debris or damage may occur to internal pump & valve components.

Note: See **Preventive Maintenance Schedule** for detailed information.

KUBOTA ENGINE

Refer to engine manual shipped with the unit.

OUTPUT PRESSURES

To prevent malfunctions, check and adjust **PULL** and **RETURN** pressures of Powerig® Hydraulic Power Source.

Check pressures when:

- Unit is first used.
- The combination valve is repaired/replaced.
- Troubleshooting.
- Before a tool is connected.
- When a tool does not perform as expected.
- If unsure of the pressure setting.

RECYCLED MATERIALS

Recycle steel, aluminum and plastic parts in accordance with local lawful and safe practices.

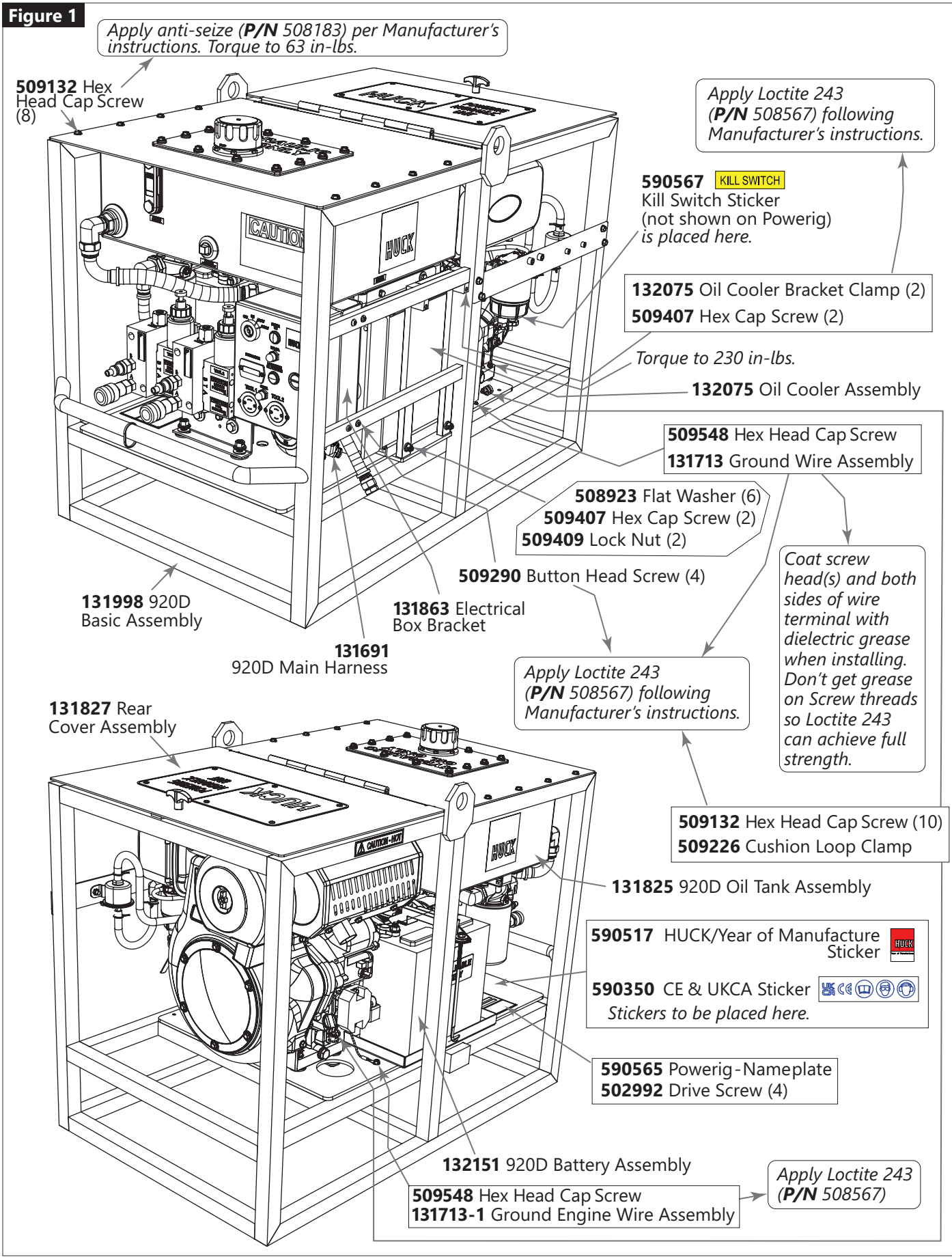
FLUID DISPOSAL

Fluids must be disposed of through authorized methods and following current legislation.
This symbol indicates that this product must be disposed of according to the WEEE Directive. These type of products must be forwarded to a designated collection point or to an authorized collection site for recycling waste electrical and electronic equipment (EEE). Improper handling of this type of waste could have a negative impact on the environment and human health due to potentially hazardous substances associated with EEE.

No.	Item		Service Maintenance Interval						
			Daily	Hourly					Annually
				25 hrs	100 hrs	500 hrs	800 hrs	1500 hrs	
1	Engine Oil	Checking	√						
		Changing		√	√				
2	Oil Strainer	Cleaning		√	√				
3	Rubber Hose and Clamp Bands	Checking	√						
		Changing							√
4	Air Cleaner	Cleaning			√				
		Changing	Once per year or after 6 cleanings						
5	Fuel Filter	Cleaning			√				
		Changing				√			
6	Valve Clearance	Checking					√		
7	Nozzle Injection Pressure and Spraying Conditions	Checking						√	
		Cleaning						√	
8	Hydraulic Oil	Checking	√						
		Changing			√				
9	Hydraulic Screens	Checking				√			
10	Hydraulic Oil Filter	Checking	√						
		Changing			√				
11	Hydraulic Suction Screen	**Changing**					√		
12	Hydraulic Valve Pressure Setting	Checking	√						

Component Drawings

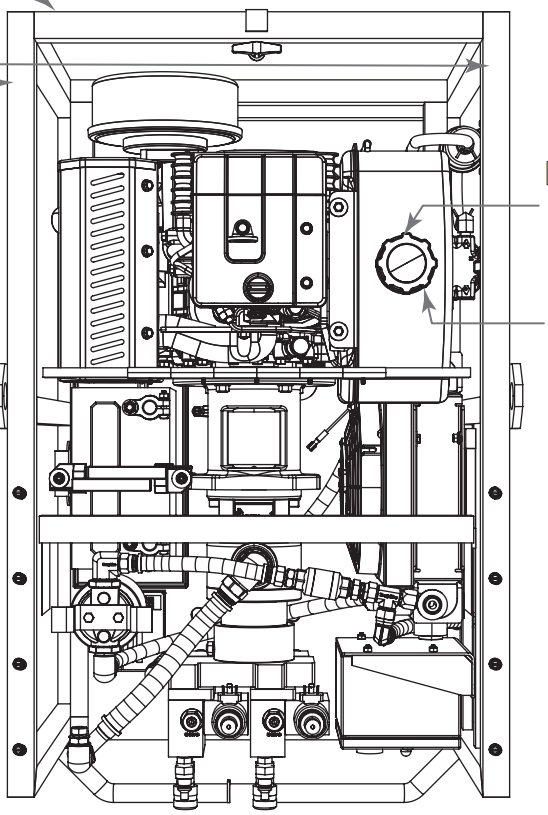
Figure 1

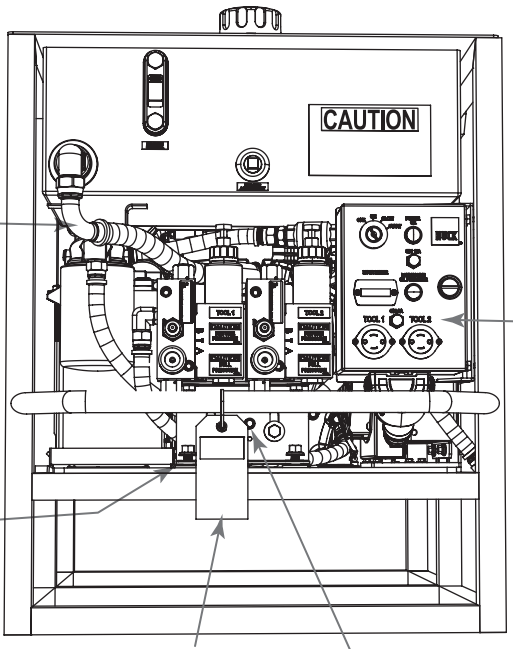


continued...

Component Drawings (continued)

Figure 2



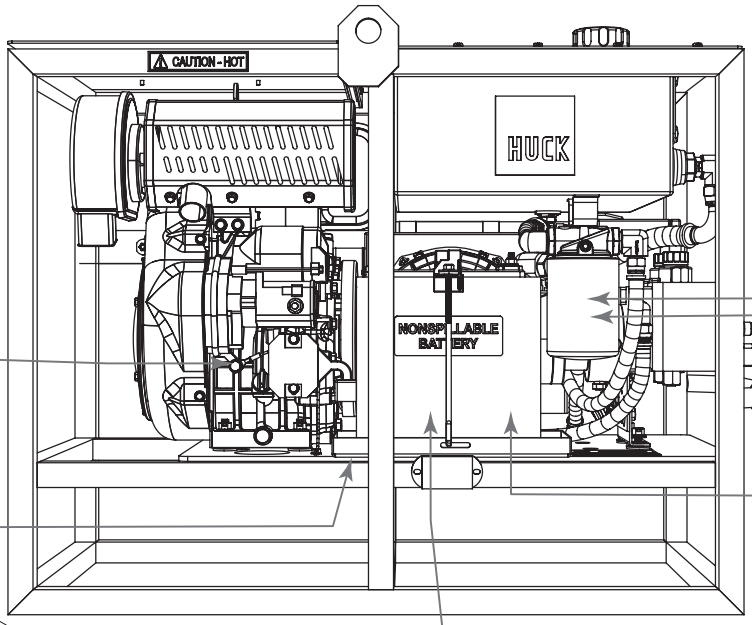


Note: **Install all JIC Hose Ends per Manufacturer's Installation Instructions. Recommended Method is 'Flats from Wrench Resistance' (FFWR).**

continued...

Component Drawings (continued)

Figure 3



132220 Fuel Filter and Pump Assembly: *Remove fuel tank from engine first if you need to install banjo fitting (**P/N** 132222) on the Fuel Filter Assembly.*

507089 918 Return Filter Element

509418 Hex Cap Screw

509432 18" Black Battery Cable

509229 Lug Black Insulator (2)

Connect to Proper Battery Terminal Posts and Engine.

509548 Hex Head Cap Screw (2)

131713-1 Engine Ground Wire Assembly

509230 Lug Red Insulator (2)

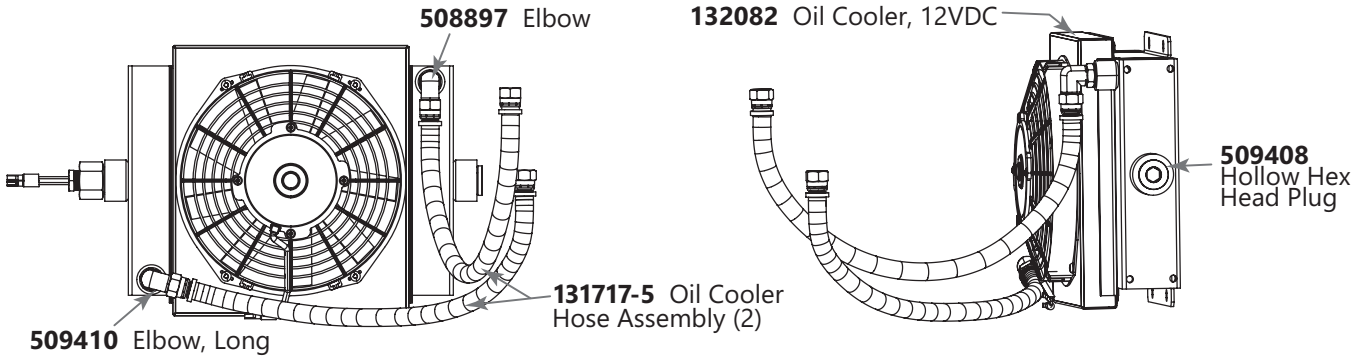
509431 12" Red Battery Cable

*Apply Loctite 243 (**P/N** 508567) following Manufacturer's instructions.*

Coat entire screw heads and both sides of wire terminal with dielectric grease when installing to prevent corrosion and ensure a good electrical connection. Don't get grease on Screw threads to allow Loctite 243 to achieve full strength.

Figure 4

132075 - Oil Cooler Assembly



508897 Elbow

132082 Oil Cooler, 12VDC

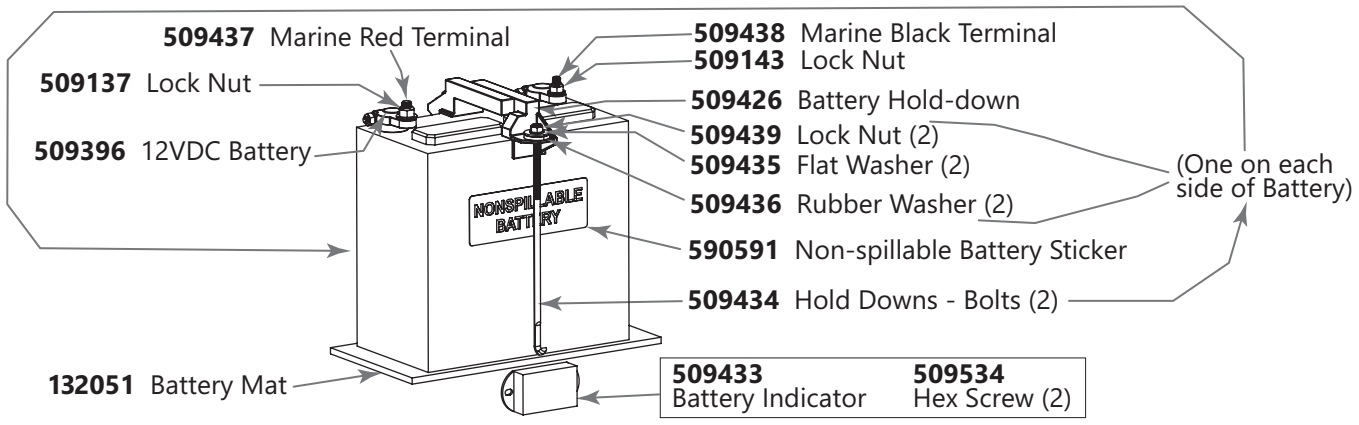
509408 Hollow Hex Head Plug

131717-5 Oil Cooler Hose Assembly (2)

509410 Elbow, Long

Figure 5

132151 - Battery Assembly



509437 Marine Red Terminal

509438 Marine Black Terminal

509143 Lock Nut

509137 Lock Nut

509426 Battery Hold-down

509396 12VDC Battery

509439 Lock Nut (2)

509435 Flat Washer (2)

509436 Rubber Washer (2)

(One on each side of Battery)

590591 Non-spillable Battery Sticker

509434 Hold Downs - Bolts (2)

132051 Battery Mat

509433 Battery Indicator

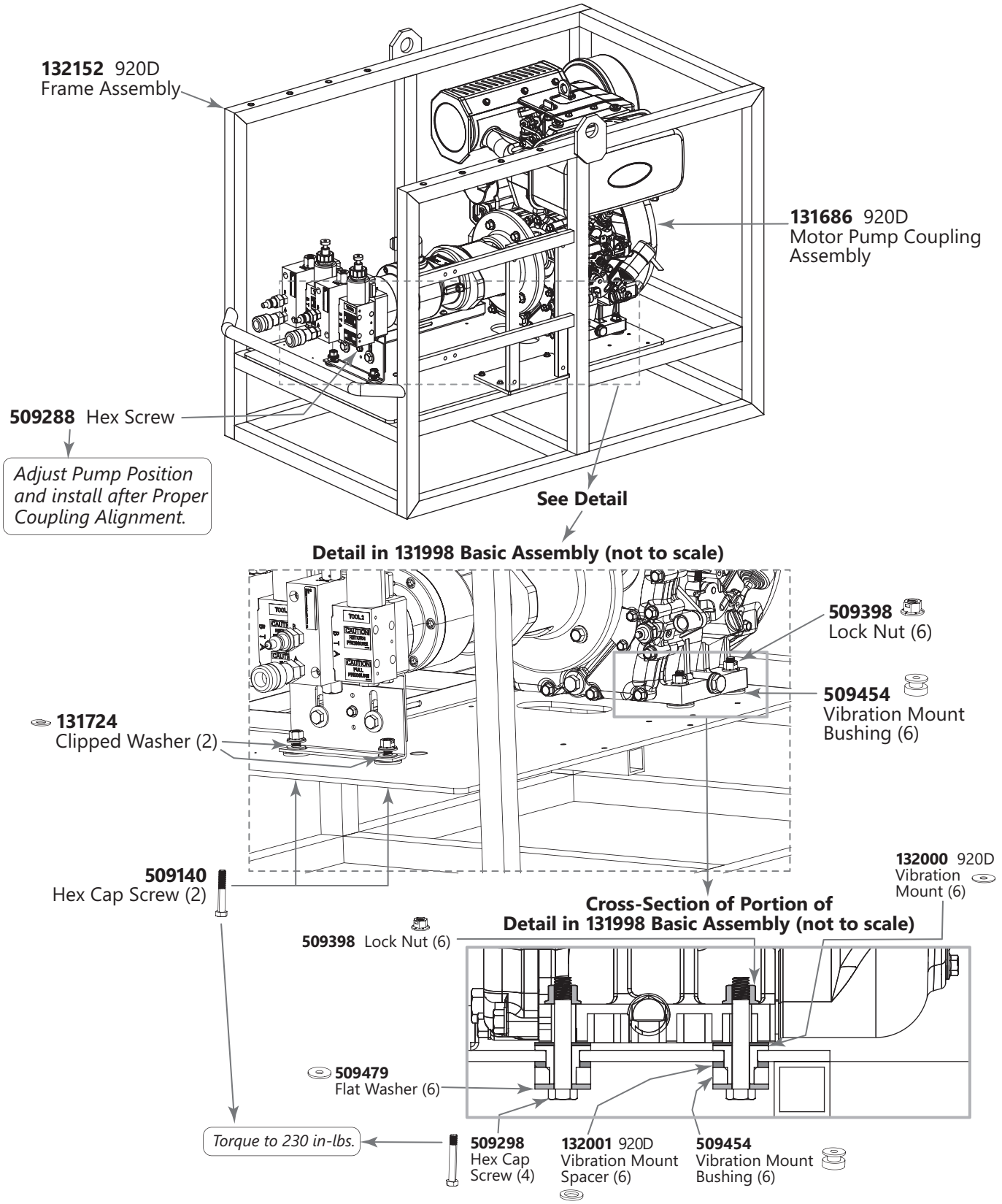
509534 Hex Screw (2)

continued...

Component Drawings (continued)

Figure 6

131998 - Basic Assembly



continued...

Component Drawings (continued)

Figure 7

132144 - 920D Engine Pump Coupling Sub-Assembly

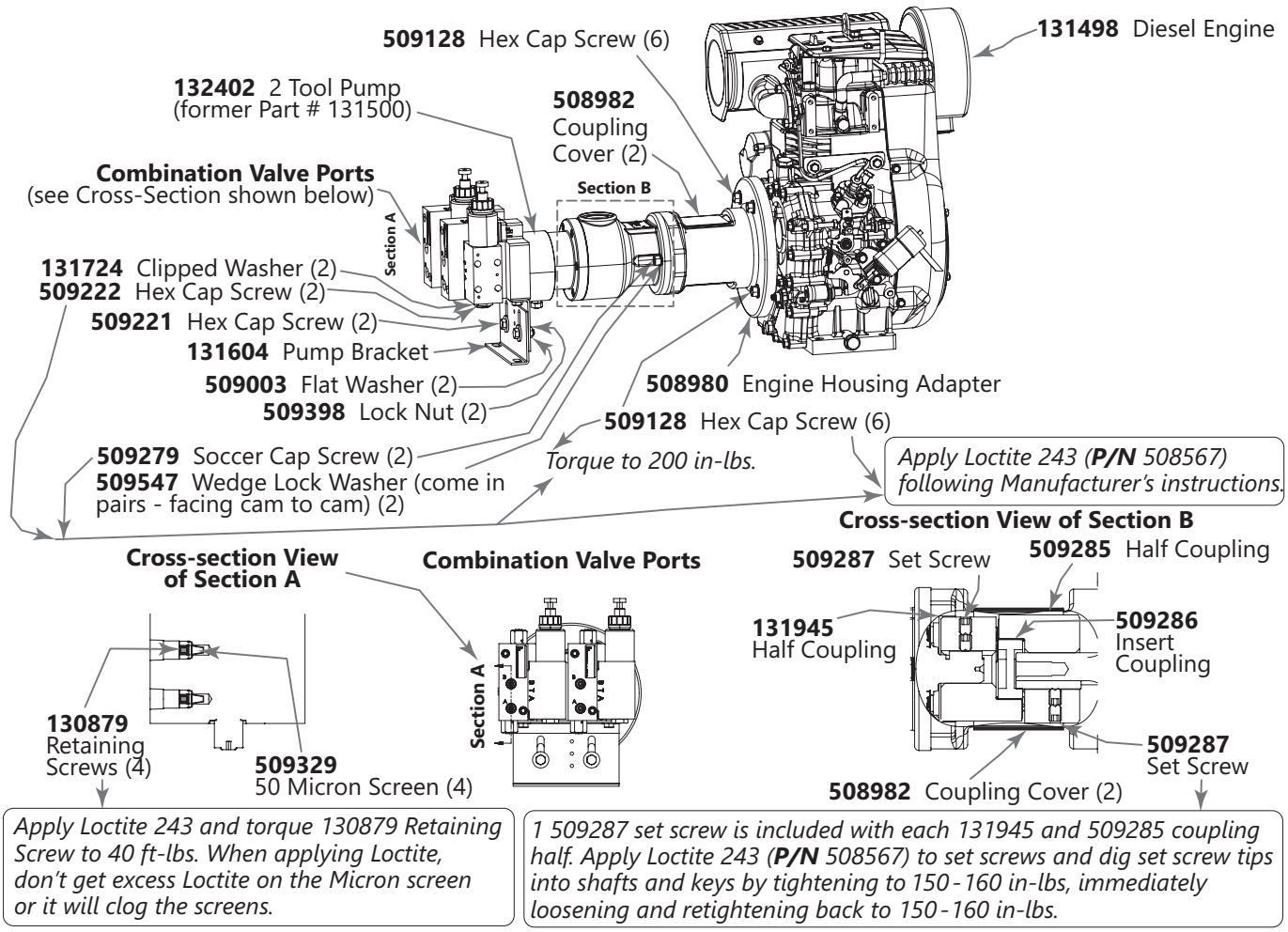
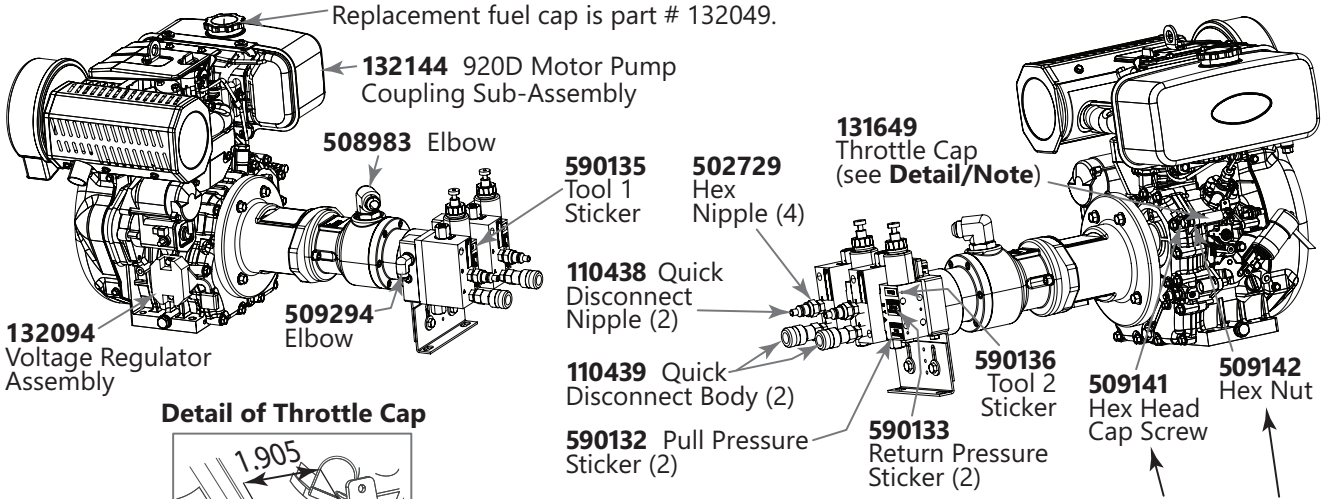


Figure 8

131686 - 920D Engine Pump Coupling Sub-Assembly



Note: *Remove Throttle Adjustment Screw/Locknut. Thread Hex Nut (509142) onto Hex Cap screw (509141). Thread Nut/Capscrew Assembly through Engine Throttle adjustment hole. Thread into Throttle Cap (131649). Use Loctite 243 (508567) on end of Cap Screw (509141) where it Threads into Throttle Cap (131649). Adjust Cap Screw/Throttle Cap Assembly to 1.905 Dimension. Tighten Hex Nut (509142) against Motor to lock in the 1.905 Dimension.*

continued...

Component Drawings (continued)

Figure 9

131690 - Oil Tank Cover Assembly

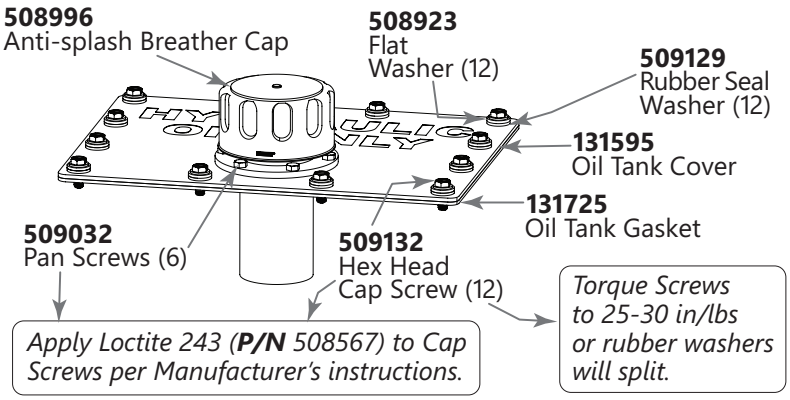


Figure 10

131827 - Rear Cover Assembly

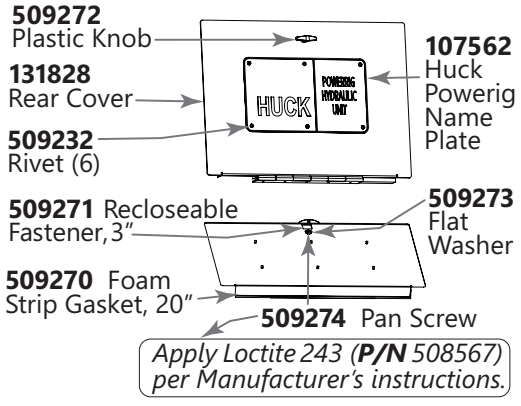


Figure 11

131825 - Oil Tank Assembly

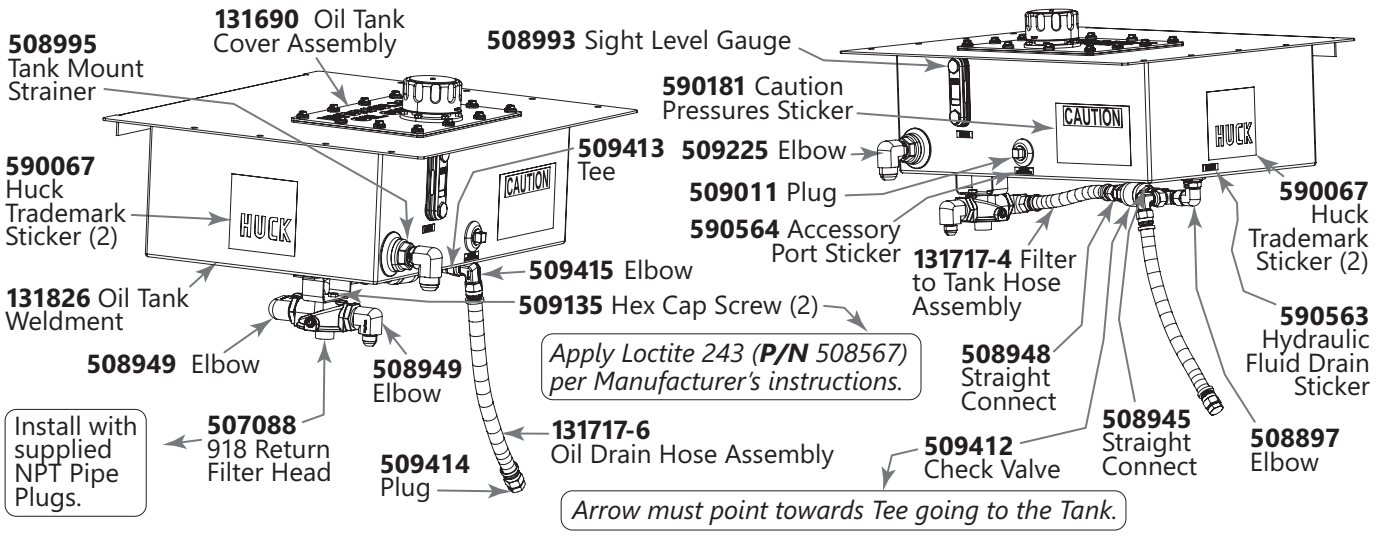
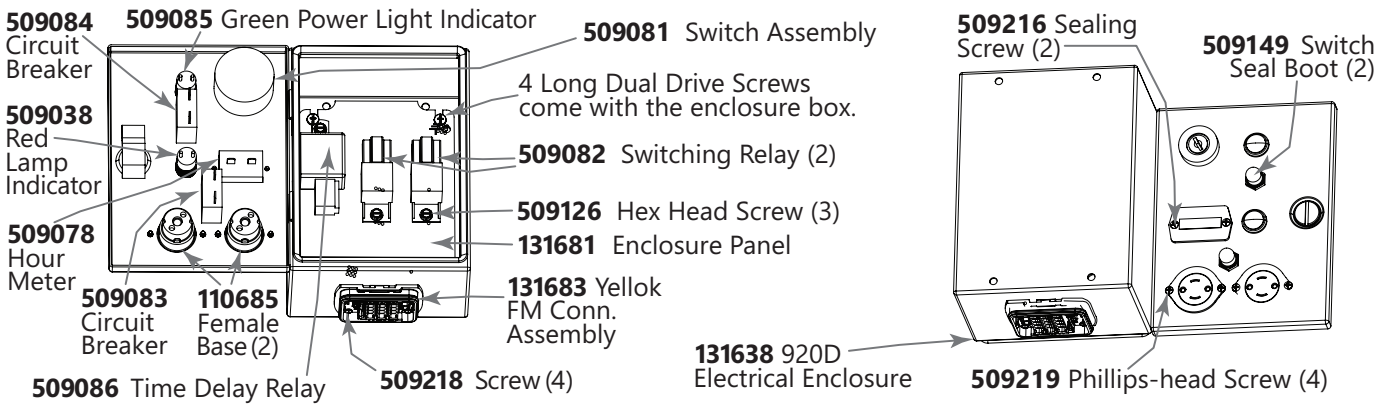


Figure 12

13677 - Electrical Enclosure

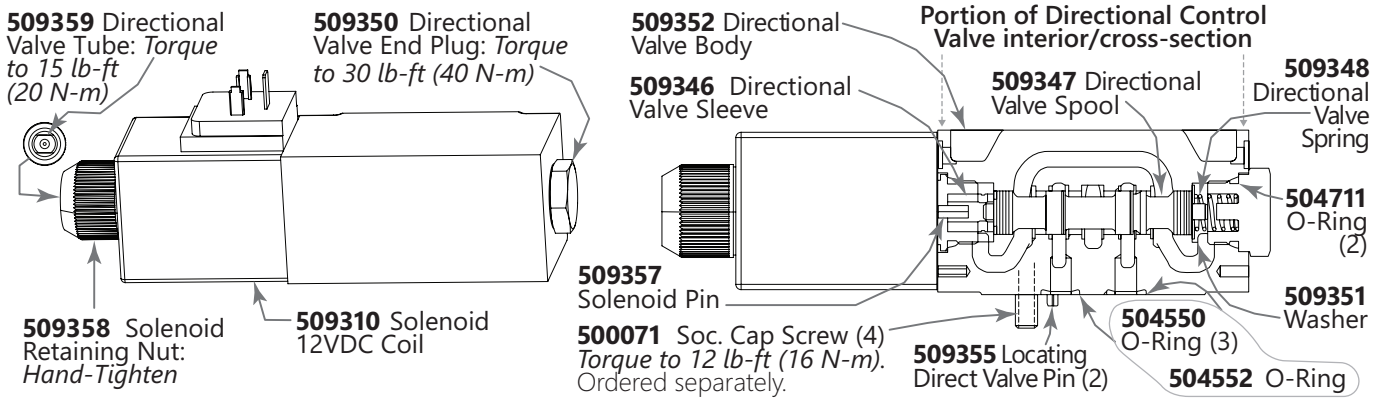


continued...

Component Drawings (continued)

Figure 13

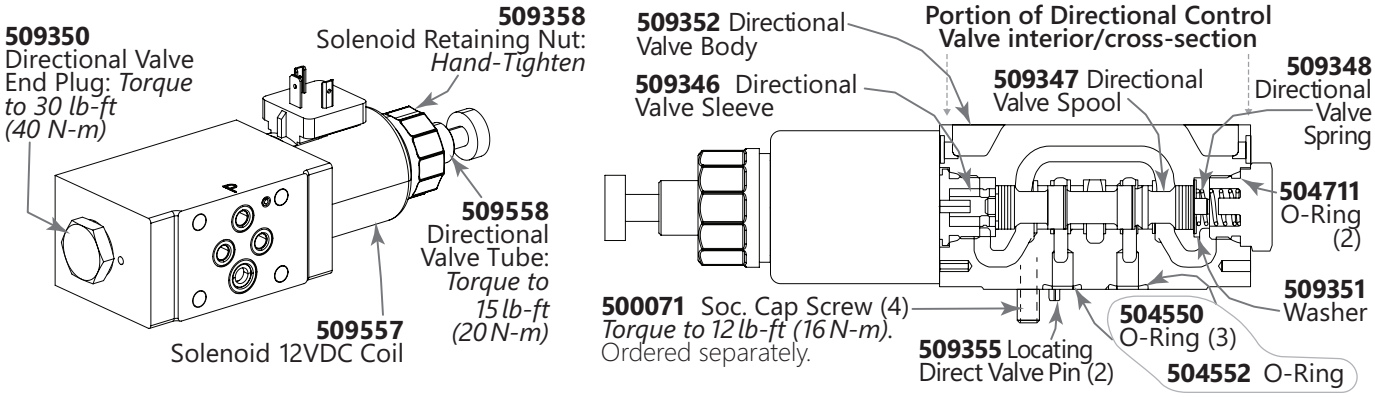
132087 - Directional Control Valve (Obsolete)



Note: New coil (**509557**) can't be used with this obsolete directional control valve.

Figure 14

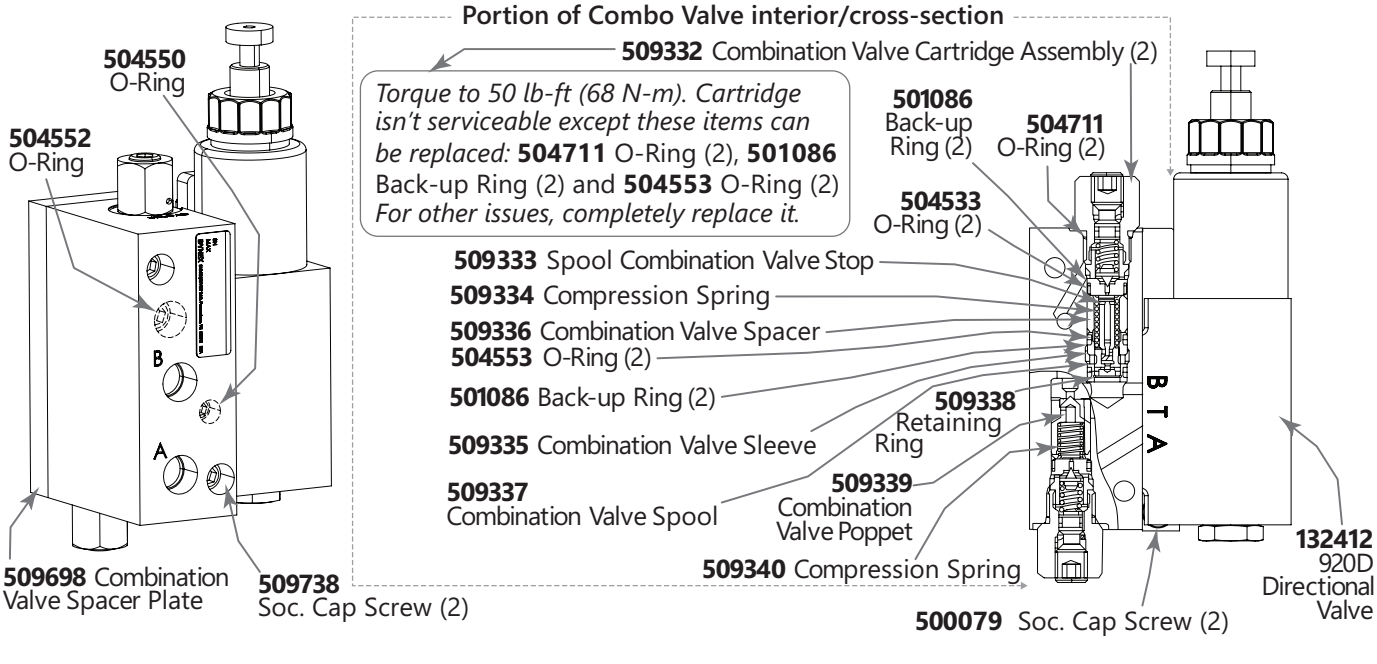
132412 - Directional Control Valve



Note: Old coil (**509310**) can't be used with this new directional control valve.

Figure 15

132411 - Combination Valve



continued...

Component Drawings (continued)

Figure 16

132402 - Piston Pump

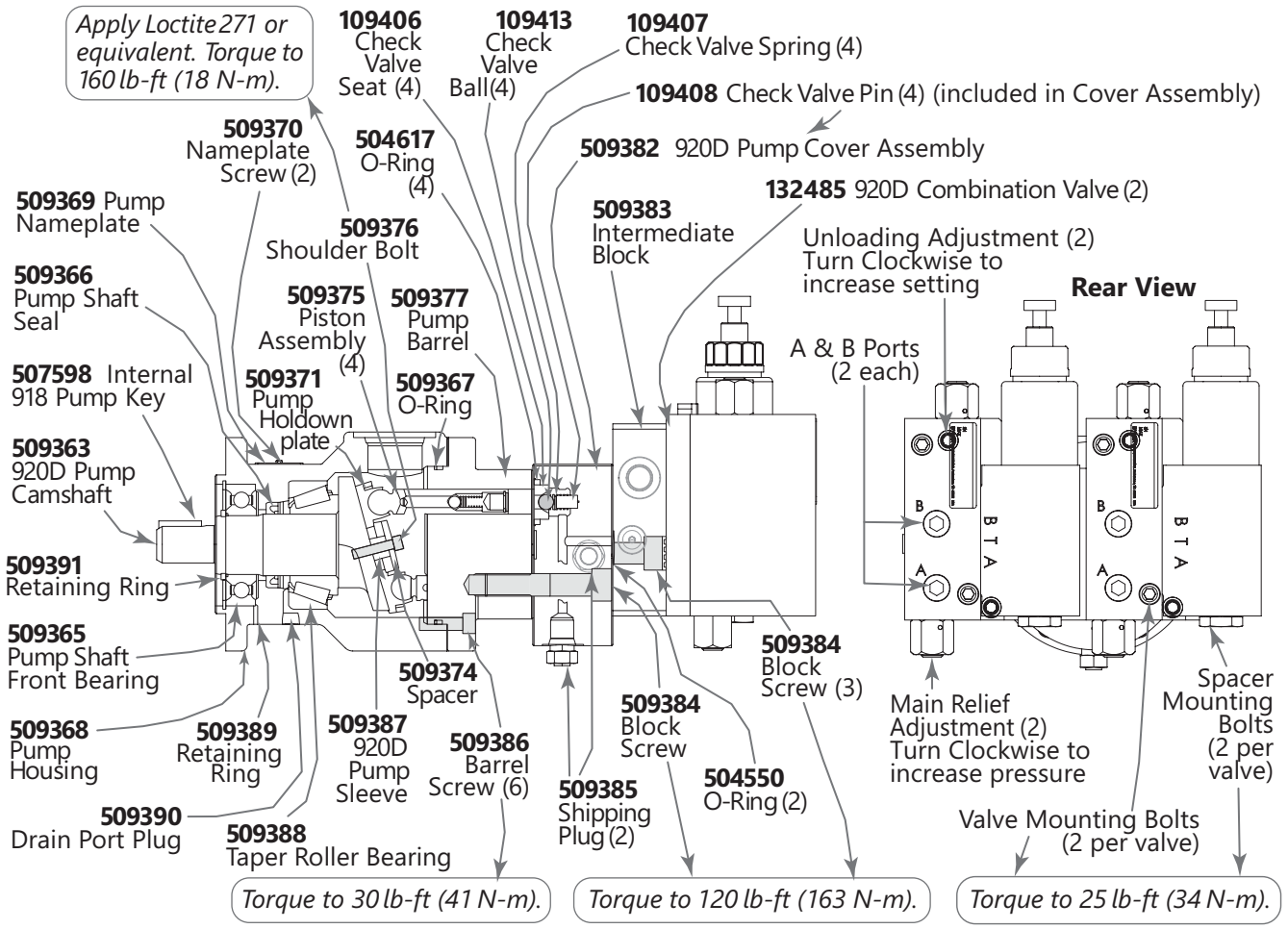
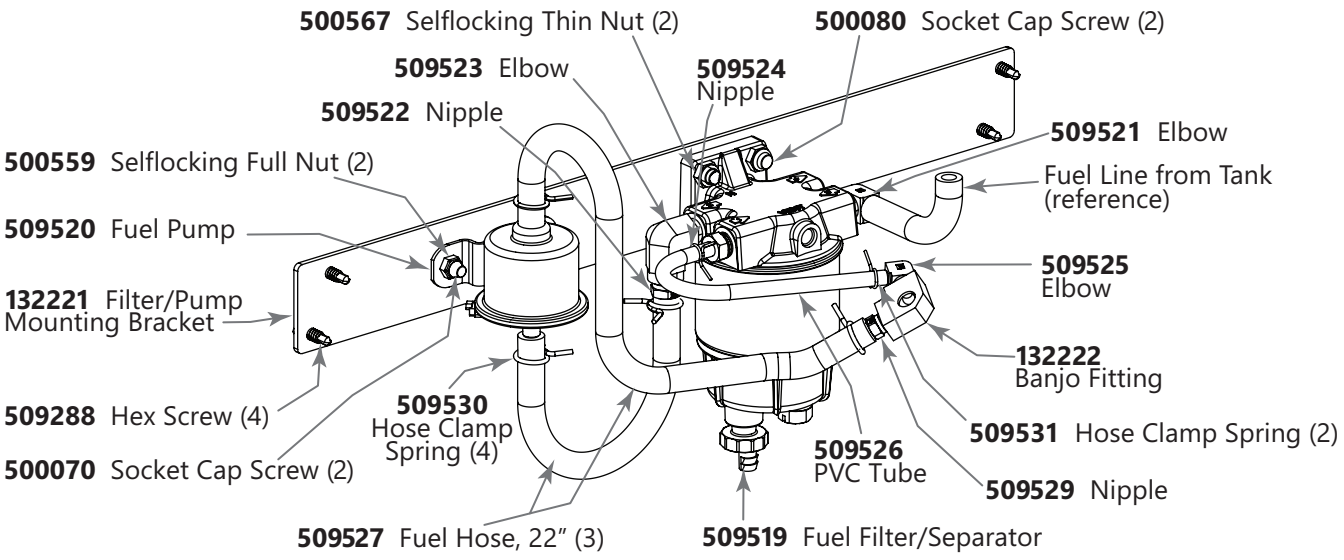


Figure 17

132200 - Fuel Filter and Pump Assembly

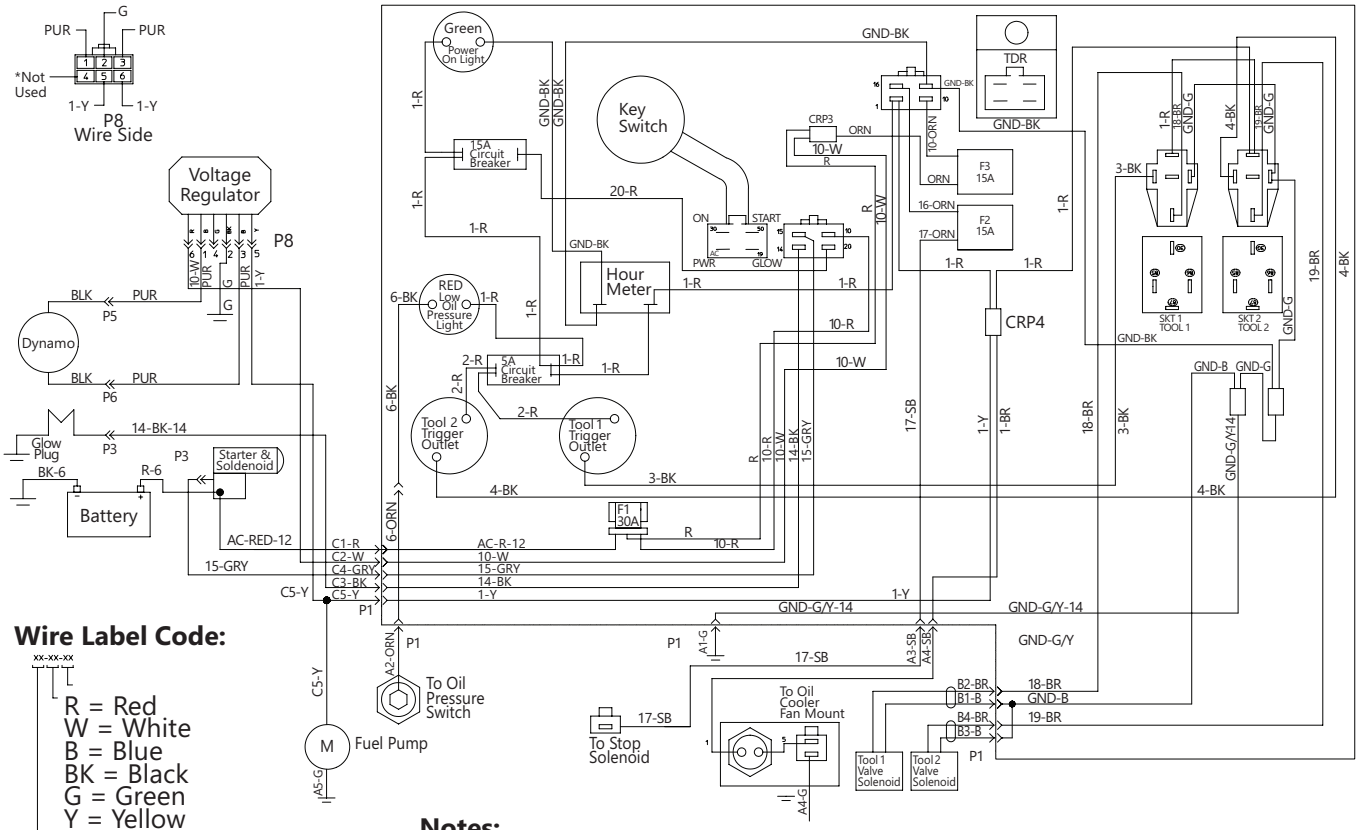


Note: *Make all crimps to Manufacturer Specifications. Crimp 1 of part # **509110** to end of yellow wire, **509532**, and attach clamp-on splice (**509528**) to other end. Crimp 1 of part # **509110** to end of white wire, **507050**, and crimp 1 of the ring terminals (**509103**) to other end.*

continued...

Component Drawings (continued)

Figure 18 Wiring Diagram



Wire Label Code:

xx-xx-xx

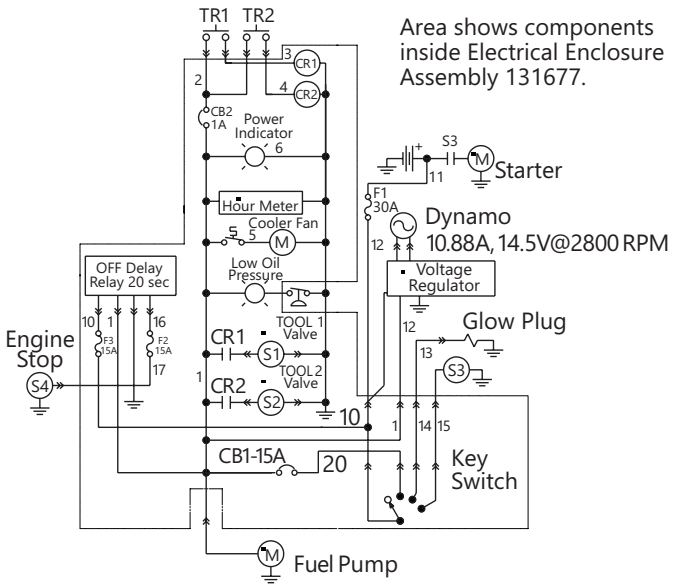
- R = Red
- W = White
- B = Blue
- BK = Black
- G = Green
- Y = Yellow
- SB = Sky Blue
- BR = Brown
- GRY = Grey
- ORN = Orange
- G/Y = Green/Yellow
- PUR = Purple

Indicates alphanumeric label to appear at both ends of conductor.

Notes:

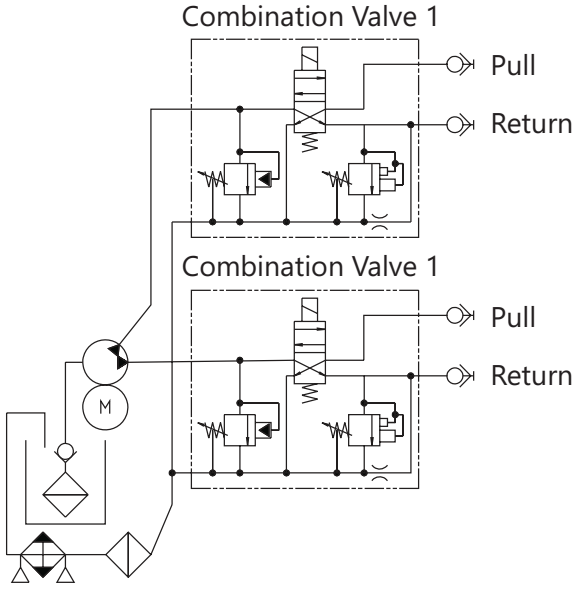
1. Unless otherwise specified, all conductor size is 18 AWG
2. All wires are stranded copper type THHN or MTW, 300Volt Min, 90°C Min. and UL listed, CSA approved.
3. All connectors are shown as if looking at open, unwired end of connector.
4. Enclosure terminate on Rig Frame or Motor. Remove paint if needed to make ground contact.
5. Connector P1 (Plug) side on harness wire markers and colors correspond with receptacle side attached to Electrical Enclosure.

Figure 19 Electrical Schematic



Area shows components inside Electrical Enclosure Assembly 131677.

Figure 20 Hydraulic Diagram



Troubleshooting

Be certain to use to the correct gauges and equipment when troubleshooting. Always check the simplest possible cause of a malfunction first. Review **Preparation for Use** and **First Time Start-up.**
Check fuses, circuit breakers, control cord, connections and hydraulic hose couplers. Where possible, substitute good parts for suspected bad parts. Use the following troubleshooting information to aid in locating trouble and correcting it. Also, refer to the electrical and hydraulic schematics and the wiring diagrams to trace defective circuits. Refer to **Preventive Maintenance.**

1. Voltage at battery is below 13.5V while running
   a. Check amperage using a clamp type ammeter at #10 wire (white - by power regulator), should show 6-9 amps.

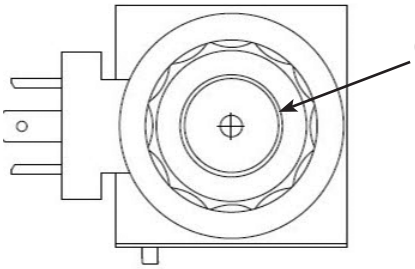
2. Trigger not working.
   a. Check circuit breaker (5A).
   b. Check trigger cords not broken.
   c. Check electrical connectors for secure connection.
   d. Check trigger continuity. Replace as needed.

3. Rig won't start.
   a. Check battery voltage (12.5v +/-.5v); replace if necessary.
   b. Check 30amp fuse in electrical enclosure.
   c. Check for loose battery or enclosure connections .
4. Engine cranks but won't start.
   a. Check fuel level.
   b. Check fuel filter.
   c. Check air filter.
   d. Check fuel system per Kubota Workshop Manual.
   e. Check return valve pressure setting. Back out if threaded all the way down and reset return and pull pressure to original factory setting (pages 8-9).

5. Fan not running on heat exchanger.
   a. Check connections to wire harness.

6. Fan running when rig is cold.
   a. Temperature switch has failed. Replace temperature switch.

7. Directional valve won't shift when trigger is depressed.
   a. Check manual operator.
   b. If valve shifts, replace solenoid coil.
   c. If still not working, remove spool from directional valve and clean.



   d. If still not working, remove unloader valve and clean. - Reference combo valve cross-section drawing. (pg. 17)
   e. If still not working, crack 509385 plugs, bleed the circuit until no air is present and re-torque plugs. (page 17)
   f. If still not working, replace combo valve assembly 132411.
   g. If still not working, replace pump assembly 132402.

8. Engine won't turn off when key is in the off position.
   a. Manually actuate stop solenoid; check fuses in enclosure (30A, 15A).
   b. Check for loose connection in enclosure.
   c. Check battery voltage.
   d. Check for loose ground connections.

9. Constant or "bouncing" pressure on the return port.
   a. Crack 509385 plugs, bleed circuit until no air is present and re-torque plugs. (page 17)
   b. If still not working, replace combo valve assembly 132411.
   c. If still not working, replace pump assembly 132402.

10. Fan is running in wrong direction.
    a. Wiring polarity is reversed; swap fan connections.

Limited Warranties

Limited Lifetime Warranty on BobTail® Tools:

Huck International, Inc. warrants to the original purchaser that its BobTail® installation tools manufactured after 12/1/2016 shall be free from defects in materials and workmanship for its ***useful lifetime***. This warranty does not cover special order / non-standard products, or part failure due to normal wear, tool abuse or misapplication, or user non-compliance with the service requirements and conditions detailed in the product literature.

Two Year Limited Warranty on Installation Tools:

Huck International, Inc. warrants that its installation tools and Powerig® hydraulic power sources manufactured after December 1, 2016 shall be free from defects in materials and workmanship for a period of two years from date of purchase by the end user. This warranty does not cover special order / non-standard products, or part failure due to normal wear, tool abuse or misapplication, or user non-compliance with the service requirements and conditions detailed in the product literature.

90 Day Limited Warranty on Nose Assemblies and Accessories:

Huck International, Inc. warrants that its nose assemblies and accessories shall be free from defects in materials and workmanship for a period of 90 days from date of purchase by the end user. This warranty does not cover special clearance noses, or special order / non-standard product, or part failure due to normal wear, abuse or misapplication, or user non-compliance with the service requirements and conditions detailed in the product literature.

Useful lifetime is defined as the period over which the product is expected to last physically, up to the point when replacement is required due to either normal in-service wear, or as part of a complete overhaul. Determination is made on a case-by case basis upon return of parts to Huck International, Inc. for evaluation.

Tooling, Part(s) and Other Items not manufactured by Huck:

HUCK makes no warranty with respect to the tooling, part(s), or other items manufactured by third parties. HUCK expressly disclaims any warranty expressed or implied, as to the condition, design, operation, merchantability, or fitness for use of any tool, part(s), or other items thereof not manufactured by HUCK. HUCK shall not be liable for any loss or damage, directly or indirectly, arising from the use of such tooling, part(s), or other items or breach of warranty or for any claim for incidental or consequential damages.

Huck shall not be liable for any loss or damage resulting from delays or non-fulfillment of orders owing to strikes, fires, accidents, transportation companies or for any reason or reasons beyond the control of the Huck or its suppliers.

Huck Installation Equipment:

Huck International, Inc. reserves the right to make changes in specifications and design and to discontinue models without notice.

Huck Installation Equipment should be serviced by trained service technicians only.

Always give the serial number of the equipment when corresponding or ordering service parts.

Complete repair facilities are maintained by Huck International, Inc. Please contact one of the offices listed below.

Eastern
One Corporate Drive Kingston, New York 12401-0250
Telephone (845) 331-7300 FAX (845) 334-7333

Outside USA and Canada
Contact your nearest Huck International location (see reverse).

In addition to the above repair facilities, there are Authorized Tool Service Centers (ATSC's) located throughout the United States. These service centers offer repair services, spare parts, Service Parts Kits, Service Tool Kits and Nose Assemblies. Please contact your Huck Representative or the nearest Huck International location (see reverse) for the ATSC in your area.

Howmet Inc. (NYSE: HWM) creates breakthrough products that shape industries. Working in close partnership with our customers, we solve complex engineering challenges to transform the way we fly, drive, build and power.

Through the ingenuity of our people and cutting-edge advanced manufacturing, we deliver these products at a quality and efficiency that ensures customer success and shareholder value.

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Tracy Operations
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Tracy, CA 95376
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Fax: +1-800-573-2645
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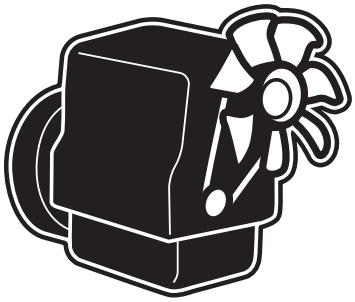
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Kubota

Bulletin No : OEM-21-001
Date : Feb. 26, 2021
Replace : OEM-20-008
Ref.PB No :

(Authorized by)

K. HIGUCHI

Service Training Gr.
Engine Service Dept.

SERVICE BULLETIN

SUBJECT :

STORAGE CONDITIONS AND OPERATION CHECK OF LONG-TERM STORAGE ENGINES (REVISED)

MODEL : ALL MECHANICAL & ELECTRICAL KUBOTA ENGINES
SERIAL No. AFFECTED : ALL
COUNTRY AFFECTED : ALL COUNTRIES
REASON FOR ISSUE :

This SB has been modified and reissued for use with all engines. It is based on SB No. (OEM-20-008) “STORAGE CONDITIONS AND OPERATION CHECK OF LONG-TERM STORAGE ENGINES” issued 2020 November, but includes additional information on horizontal diesel engines (OC/AC Series and EA Series engines).

☐ **WARRANTY INFORMATION**
- ☐ Mandatory Campaign : Allowable Man-hours ;
- ☐ Technical Bulletin : Allowable Man-hours ;
- ☐ Quality Related Information

☒ **SERVICE INFORMATION**

KBT Order No. : NA

STORAGE CONDITIONS AND OPERATION CHECK OF LONG-TERM STORAGE ENGINES

All kubota engines (mechanical diesel & gasoline/gas engines and electrical diesel (common rail type) & gasoline/gas engines) manufactured and inspected at Kubota factories are subjected to anticorrosion treatment such as filling and coating of rust preventatives and sealing of intake / exhaust manifold ports.
However, there may be a possibility of corrosion (s) due to improper storage conditions at customers' site and / or malfunction of key components (e.g. fuel injection pump) after "One (1) year (*)" of long storage due to degradation of residual fuel inside the engine.
In order to avoid such troubles, please follow the conditions listed below for engine storage and proper inspections prior to engines usage.
(*OC/AC Series engines: The information here applies to long-term inventory (six months or greater) engines.)

I. ENGINE STORAGE ENVIRONMENTS (ALL KUBOTA ENGINES)

Select a location such as the following for storage.
1. Keep engines inside the building in order to avoid direct contact with rain.
2. Keep engines in dry conditions with proper ventilation.
3. Keep engines away from direct exposure to sunlight.
4. Keep engines away from extreme thermal conditions.
5. Keep engines away from sea-breeze.
6. Keep engines away from wildlife (birds, rats, insects etc).

II. ENGINE STORAGE CONDITIONS (ALL KUBOTA ENGINES)

1. Keep engines within adequate packaging and place on a hard, flat surface.
2. Tighten up the oil fill cap well in order to seal the engine.
3. Insert the oil gauge adequately in order to seal the engine.
4. Cover all ports such as inlet manifold, exhaust manifold, breather pipe, fuel inlet locations, aftertreatment device outlet, sensor/ECU couplers, etc. in order to avoid air and dust ingress.
5. Apply plastic bag over the engine in order to avoid direct exposure to rain, air and dust.
6. When stopping or storing an LPG specification engine for a long period of time, drain gas prior to stopping operation to prevent sulfur-containing residual gas from damaging the motor.

III. INSPECTION BEFORE THE USAGE OF LONG-TERM STORAGE ENGINES

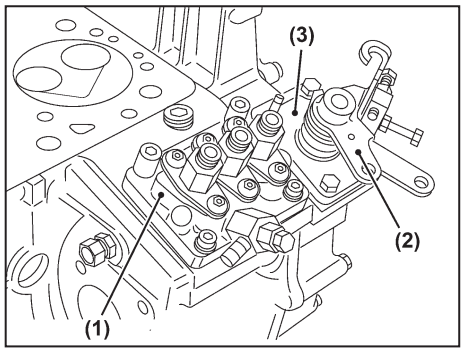
Please conduct below inspection before using engines which have been stored for more than One (1) year.

1. VISUAL CHECK (ALL KUBOTA ENGINES)

1) Check there is no rusting on the surface of the engines.
2) Check there are no discolorations and cracks of the cooling fan and/or degradations of the fan belt. Replace with new parts if necessary.
3) Check there are no breakages of exterior parts. Replace with new parts if necessary.
4) Check there are no signs of water, fuel and oil leakage. In case of any signs of leakage, identify the cause and make necessary repair.

2. OPERATIONAL CHECK OF FUEL INJECTION PUMP (MECHANICAL DIESEL ENGINES)

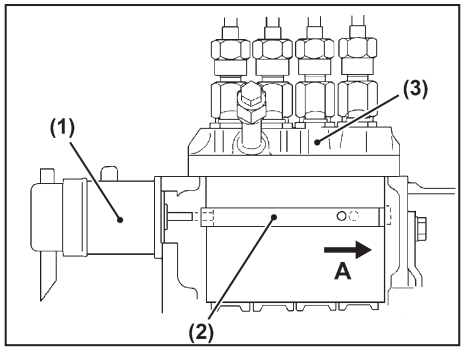
Fuel on the surface of the Plunger and the Barrel of Fuel Injection Pump work as anticorrosion material and lubricant. If the engines are kept for a long period in unchanged conditions, the Plunger and the Barrel of the Fuel Injection Pump may seize due to degradation and/or oxidation of the fuel. If an attempt is made to start the engine with a seized Fuel Injection Pump, the engine may have starting failure and/or overrun as a result of uncontrollable engine speed. Follow below instruction and check there is no seizure of the Plunger of Fuel Injection Pump before the use of the long-term storage engine.



NSM SERIES (MECHANICAL DIESEL ENGINES)

1. Refer to “Disassembling and Assembling of Fuel Injection Pump ”section of Work Shop Manual.
2. Check the Stop Lever (2) moves smoothly by hand (i.e. Control Rack of Fuel Injection Pump (1) moves smoothly).
3. In case the Fuel Injection Pump (1) is seizing, disassemble the Fuel Injection Pump (1) from the engine for repair or replace with the new Pump if necessary.

(1) Fuel Injection Pump
(2) Stop Lever
(3) Speed Control Plate

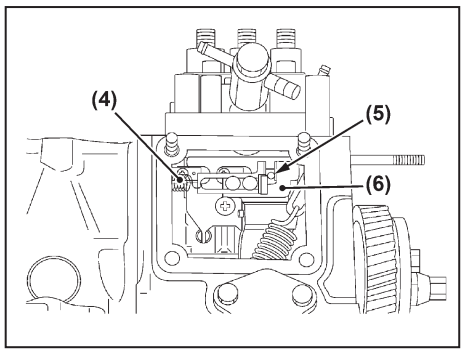


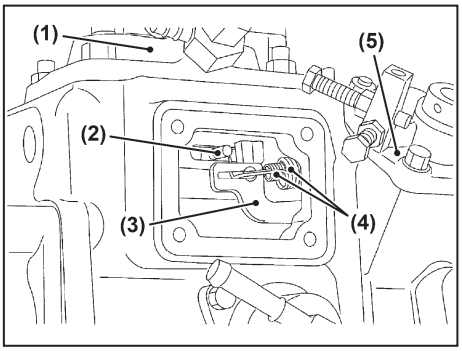
05 SERIES (MECHANICAL DIESEL ENGINES)

1. Refer to “Disassembling and Assembling of Fuel Injection Pump” section of Work Shop Manual.
2. Disassemble the Engine Stop Solenoid (1) and the Speed Control Plate from the engine.
3. Check the Control Rack (2) of the Fuel Injection Pump (3) moves smoothly by hand.
4. In case the Fuel Injection Pump (3) is seizing, disassemble the Fuel Injection Pump (3) from the engine for repair or replace with the new Pump if necessary.

(1) Engine Stop Solenoid
(2) Control Rack
(3) Fuel Injection Pump
(4) Start Spring
(5) Rack Pin
(6) Fork Lever

A : To Stop

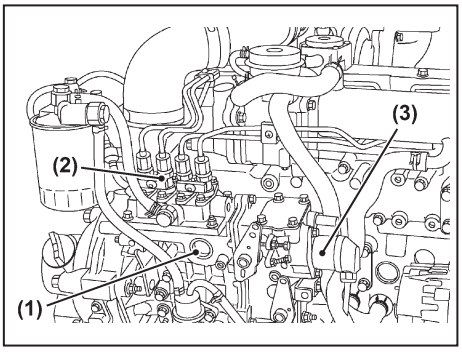




03 SERIES (APPLIED ONLY TO MECHANICAL DIESEL ENGINES)

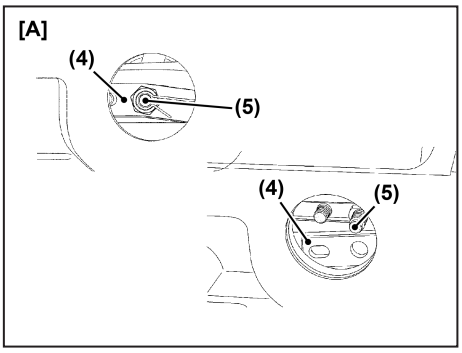
1. Refer to “Disassembling and Assembling of Fuel Injection Pump” section of Work Shop Manual.
2. Disassemble the Engine Stop Solenoid and the Cover from the engine.
3. Check the Control Rack (2) of the Fuel Injection Pump (1) moves smoothly by hand.
4. In case the Fuel Injection Pump (1) is seizing, disassemble the Fuel Injection Pump (1) from the engine for repair or replace with the new Pump if necessary.

(1) Fuel Injection Pump
(2) Control Rack
(3) Fork Lever
(4) Governor Spring
(5) Speed Control Plate



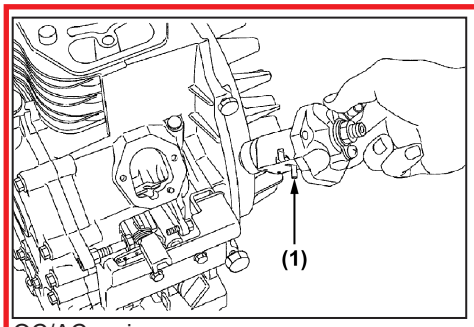
07 & V3 SERIES (APPLIED ONLY TO MECHANICAL DIESEL ENGINES)

1. Refer to “Disassembling and Assembling of Fuel Injection Pump” section of Work Shop Manual.
2. Disassemble the Engine Stop Solenoid (3) and the Cover Plug (1) from the engine.
3. Check the Connecting Rod (4) of the Fuel Injection Pump (2) moves smoothly by hand.
4. In case the Fuel Injection Pump (2) is seizing, disassemble the Fuel Injection Pump (2) from the engine for repair or replace with the new Pump if necessary.

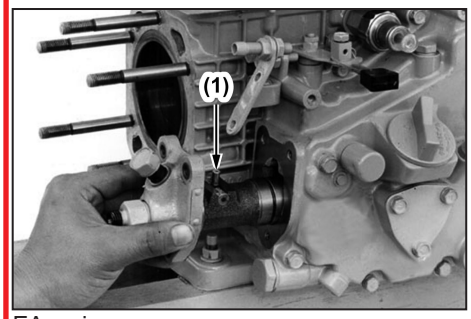


(1) Cover Plug
(2) Fuel Injection Pump
(3) Engine Stop Solenoid
(4) Connecting Rod
(5) Control Rack

[A] After the cover plug (1) is removed



OC/AC series



EA series

OC/AC SERIES AND HORIZONTAL DIESEL ENGINES (EA SERIES)

1. Refer to “Disassembling and Assembling of Fuel Injection Pump” section of Work Shop Manual.
2. Follow the instructions in the Workshop Manual to confirm that the injection pump can be removed.
3. Use your finger to confirm that the control rack pin (1) can be moved smoothly within the range of movement.
4. If the fuel injection pump is stuck.
   Either have it repaired at a designated service shop or replace it with a new fuel injection pump.

(1) Control Rack Pin

3. OPERATIONAL CHECK OF THE ROTATING PARTS (ALL KUBOTA ENGINES)

Rotate the Flywheel by hand and check the followings.

1) No abnormal noises.
2) Air compression inside each cylinder.

4. OPERATION AFTER LONG-TERM STORAGE (ALL KUBOTA ENGINES)

1) Bleed air before starting operation, including the injection pump.
2) Carry out sufficient warm-up operation while idling.

WSM

WORKSHOP MANUAL
DIESEL ENGINE

OC60-E2,OC95-E2

Kubota

TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of OC60-E2, OC95-E2. It is divided into three parts, "General", "Mechanism" and "Servicing".

■ General

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

■ Mechanism

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

Refer to Diesel Engine Mechanism Workshop Manual (Code No. 97897-01873) for the one which has not been described to this workshop manual.

■ Servicing

Information on the troubleshooting, servicing specification lists, tightening torque, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information illustrations and specifications contained in this manual are based on the latest product information available at the time of publication.

The right is reserved to make changes in all information at any time without notice.

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

February 2005

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SAFETY FIRST

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

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

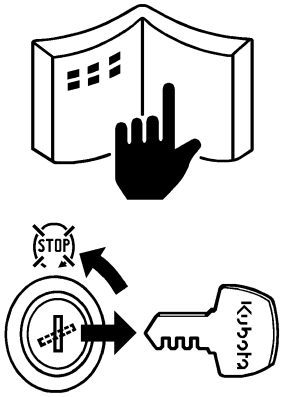
WARNING
- **Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

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

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

NOTE
- **Gives helpful information.**

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BEFORE SERVICING AND REPAIRING

- Read all instructions and safety instructions in this manual and on your engine safety decals.
- Clean the work area and engine.
- Park the machine on a firm and level ground.
- Allow the engine to cool before proceeding.
- Stop the engine, and remove the key
- Disconnect the battery negative cable

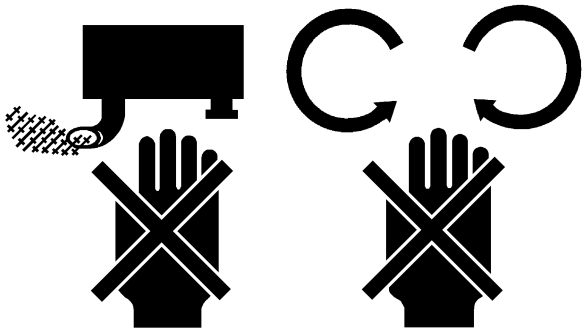
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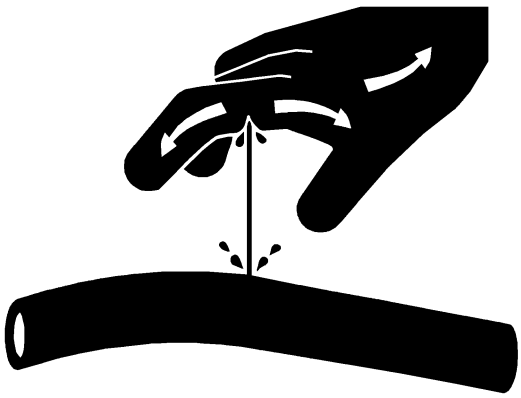


SAFETY STARTING

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

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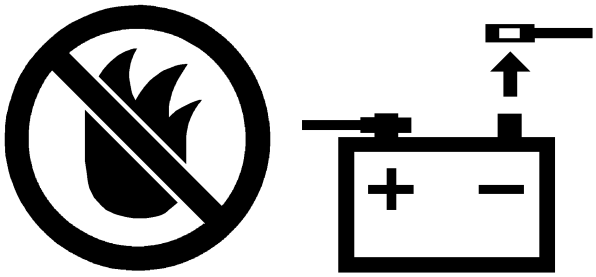




SAFETY WORKING

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

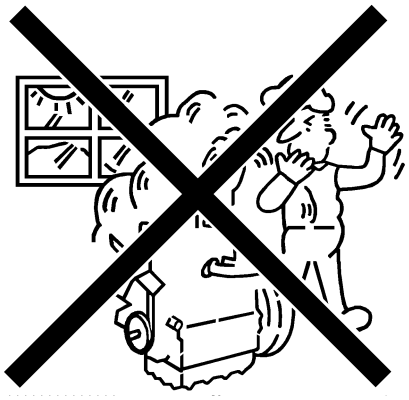
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AVOID FIRES

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

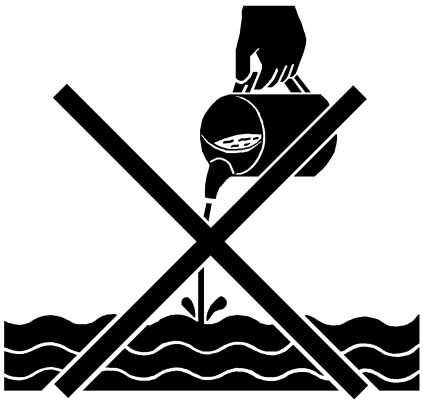
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VENTILATE WORK AREA

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

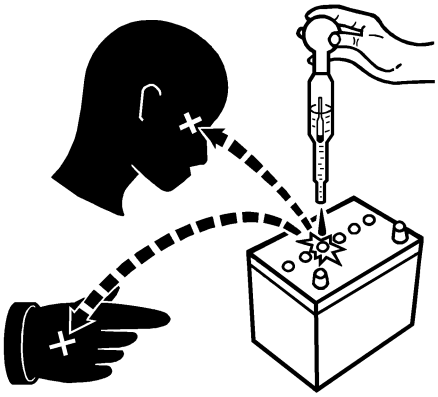
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DISPOSE OF FLUIDS PROPERLY

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

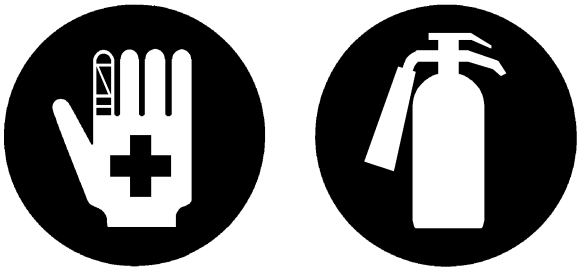
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PREVENT ACID BURNS

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

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PREPARE FOR EMERGENCIES

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

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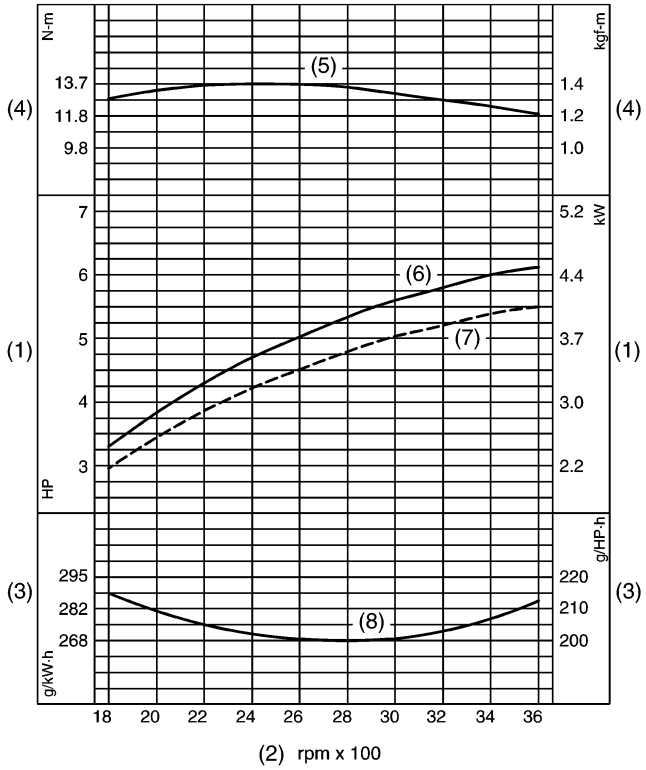
SPECIFICATIONS

Model	OC60-E2(-X)	OC60-E2(-X)-L	OC95-E2(-X)	OC95-E2(-X)-L
Number of Cylinders	1			
Type	Oil-cooled 4-cycle diesel engine			
Bore x Stroke mm (in.)	72 x 68 (2.83 x 2.68)		83 x 77 (3.27 x 3.03)	
Total Displacement cm^3 (cu.in.)	276 (16.8)	276 (16.8)	416 (25.4)	416 (25.4)
ISO Net Continuous kW / min^{-1} (rpm) (HP / min^{-1} (rpm))	4.2 / 3600 (5.6 / 3600)		6.3 / 3600 (8.5 / 3600)	
ISO / SAE Net Intermittent kW / min^{-1} (rpm) (HP / min^{-1} (rpm))	4.5 / 3600 (6.1 / 3600)		7.0 / 3600 (9.5 / 3600)	
Maximum Bare Speed min^{-1} (rpm)	3800			
Minimum Bare Idling Speed min^{-1} (rpm)	1300			
Combustion System	TVCS (Three-vortex combustion system)			
Fuel Injection Pump	ND type (DENSO)			
Governor	Centrifugal mechanical governor			
Direction of Rotation	Clockwise (View from flywheel side)			
Injection Nozzle	DN4PD82 (DENSO)			
Injection Timing (Static)	0.26 to 0.30 rad (15 ° to 17 °) before top dead center		0.23 to 0.26 rad (13 ° to 15 °) before top dead center	
Injection Pressure	13.7 MPa (140 kgf/cm^2, 1987 psi)			
Compression Ratio	24.5 : 1		24.0 : 1	
Lubricating System	Forced lubrication with trochoid pump			
Lubricating Filter	Oil strainer			
Cooling System	Oil cooling + Air cooling			
Starting System	Electric starting with starter			
Starting Motor	12 V 1.0 kW		12 V 1.2 kW	
Charging Alternator	12 V, 48 W	12 V, 150 W	12 V, 48 W	12 V, 150 W
Fuel	Diesel fuel No.2-D (ASTM D975)			
Fuel Tank Capacity	3.6 L (0.95 U.S.gals, 0.79 Imp.gals)		5.5 L (1.45 U.S.gals, 1.2 Imp.gals)	
Lubricating Oil	Quality better than API service CC class (SAE 10W-30)			
Lubricating Oil Capacity	1.3 L (1.37 U.S.qts, 1.14 Imp.qts)		1.7 L (1.80 U.S.qts, 1.49 Imp.qts)	
Weight (Dry) kg (lbs)	38(83.8)		55 (121.3)	

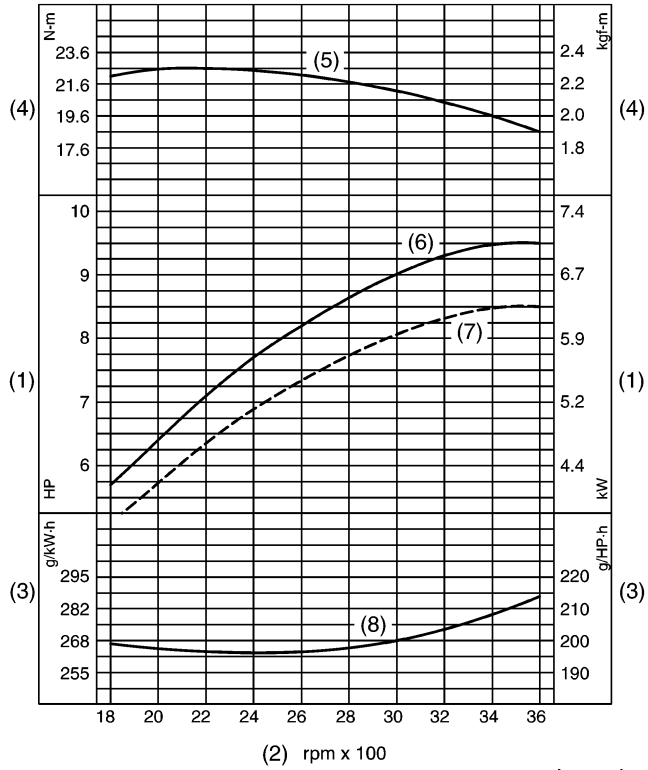
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PERFORMANCE CURVES

OC60-E2



OC95-E2



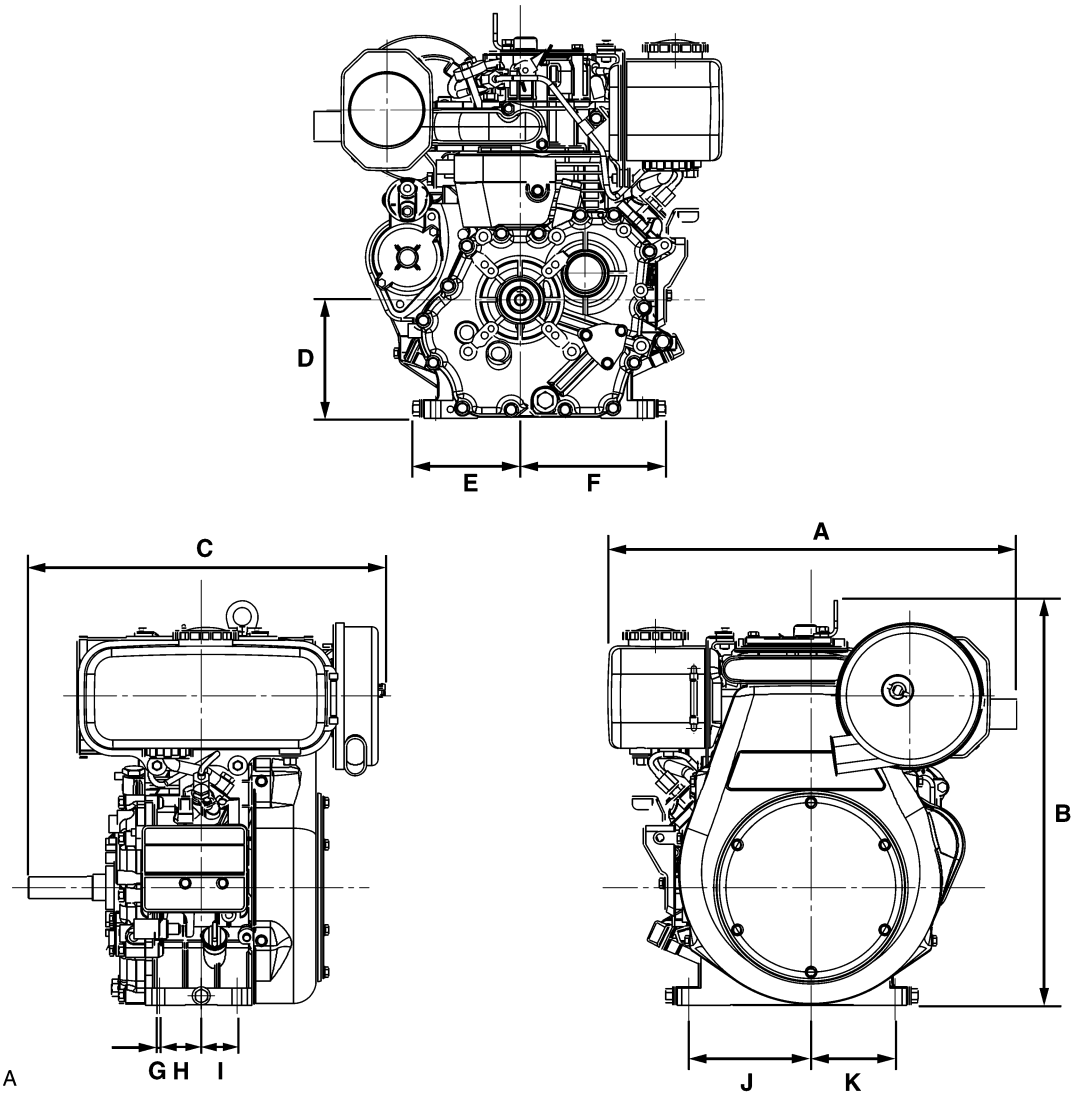
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(1) Brake Horsepower
(2) Engine Speed
(3) Fuel Consumption
(4) Torque
(5) Net Intermittent Torque
(6) Net Intermittent B.H.P.
(7) Net Continuous B.H.P.
(8) Net Intermittent B.S.F.C

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DIMENSIONS

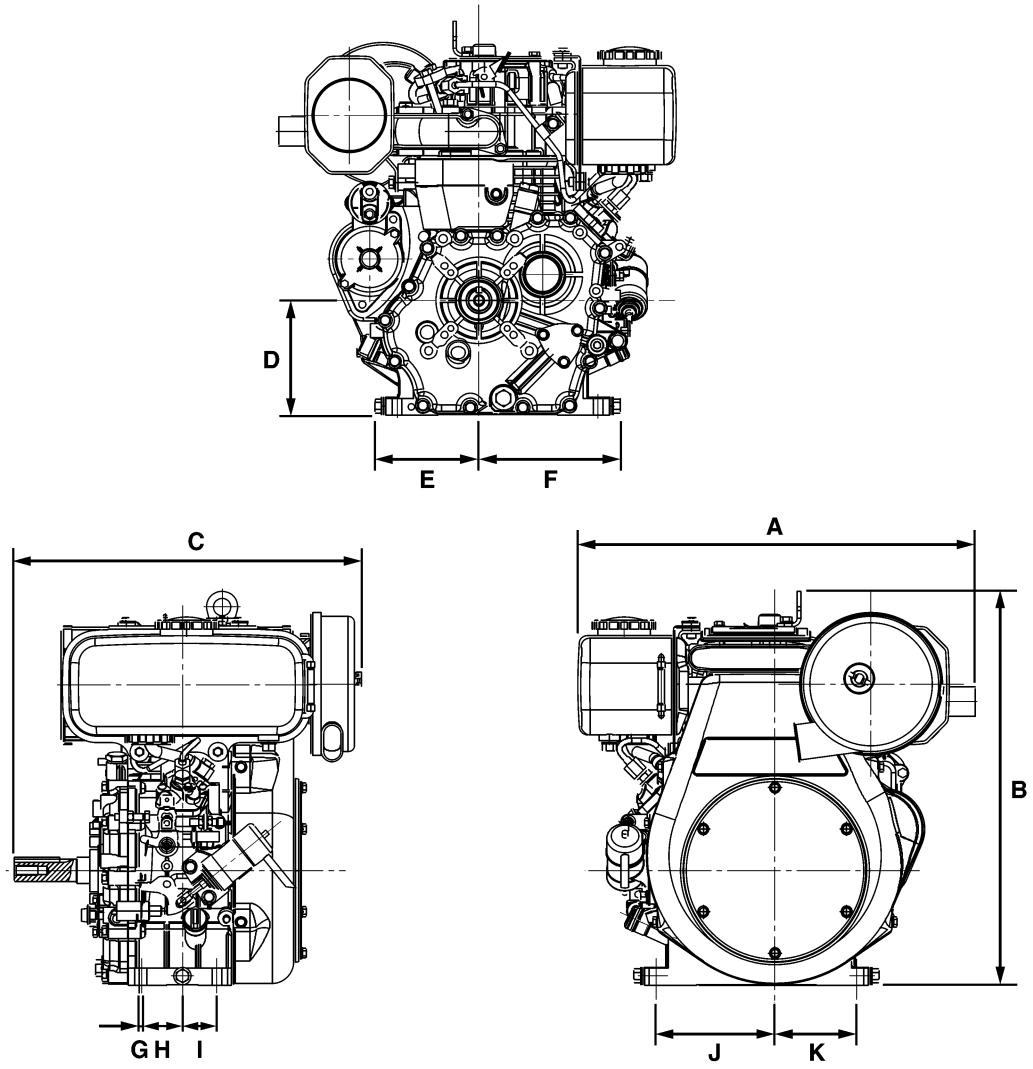
■ STANDARD TYPE [OC60-E2]



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■ X TYPE (WITH STOP SOLENOID) [OC60-E2]

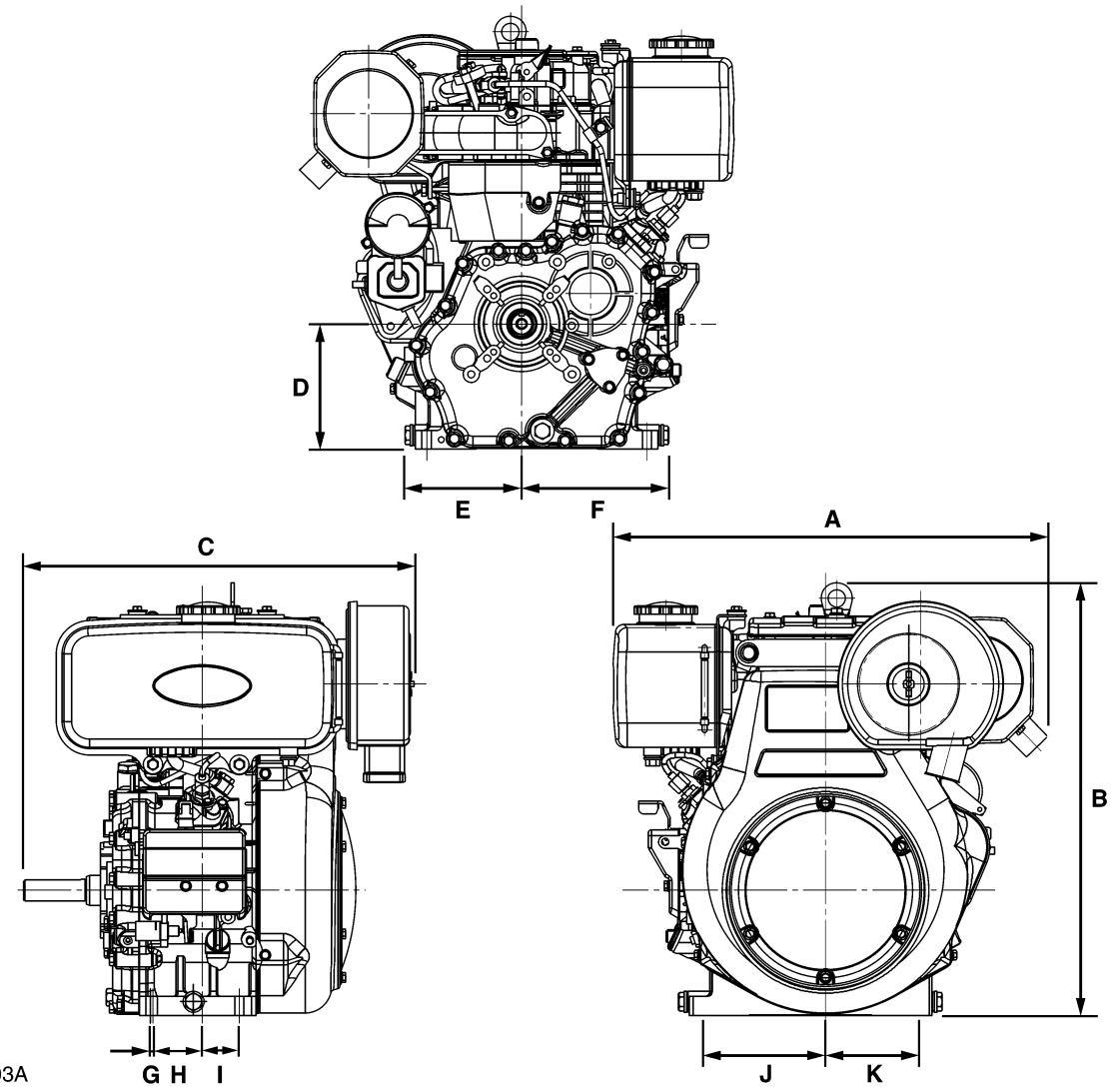


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	STANDARD TYPE	X TYPE
A	461 mm (18.15 in.)	461 mm (18.15 in.)
B	457.5 mm (18.02 in.)	457.5 mm (18.02 in.)
C	403 mm (15.87 in.)	403 mm (15.87 in.)
D	133.5 mm (5.26 in.)	133.5 mm (5.26 in.)
E	121 mm (4.77 in.)	121 mm (4.77 in.)
F	164 mm (6.46 in.)	164 mm (6.46 in.)
G	3 mm (0.12 in.)	3 mm (0.12 in.)
H	47 mm (1.85 in.)	47 mm (1.85 in.)
I	40 mm (1.57 in.)	40 mm (1.57 in.)
J	138 mm (5.43 in.)	138 mm (5.43 in.)
K	95 mm (3.47 in.)	95 mm (3.47 in.)

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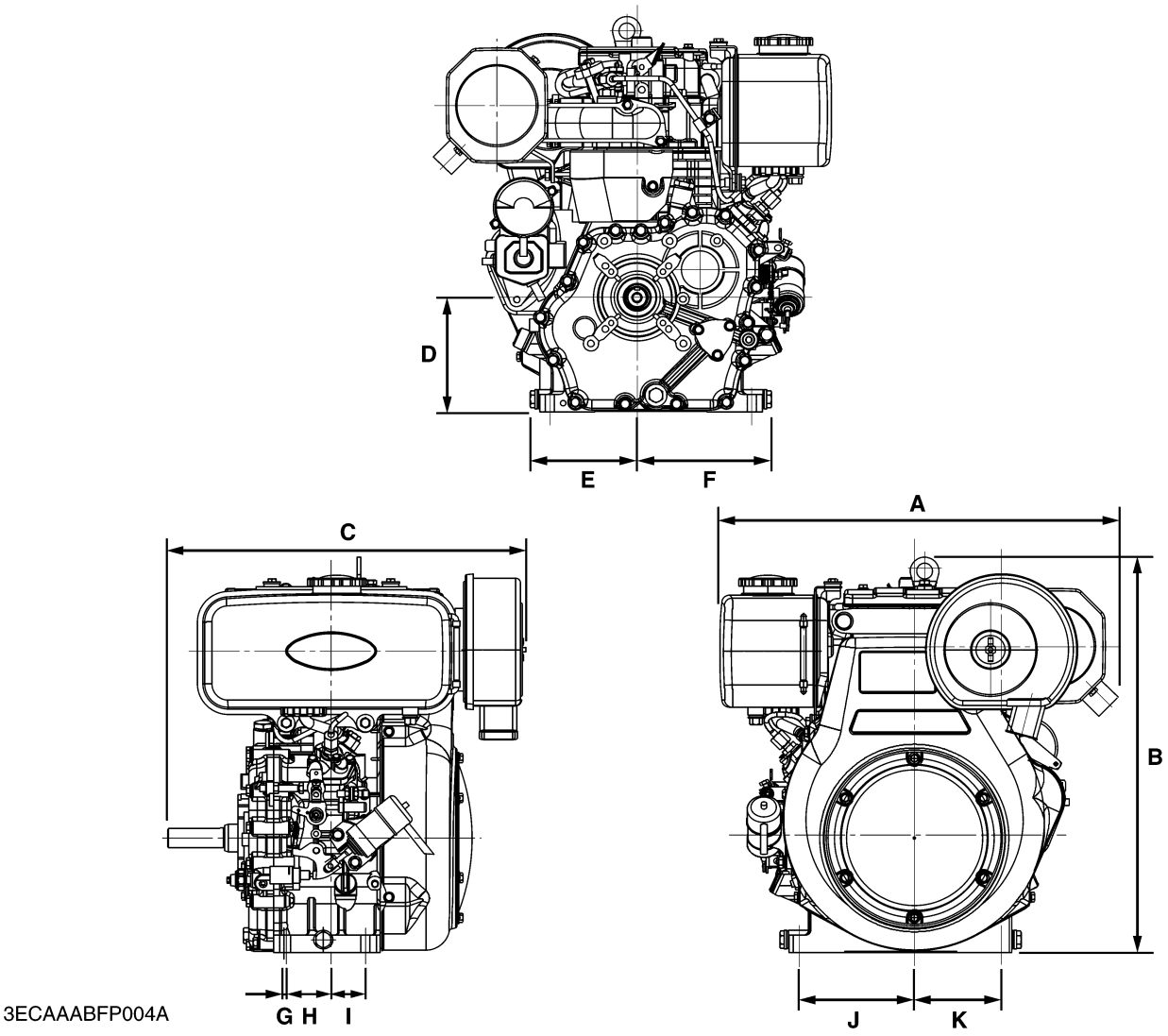
■ STANDARD TYPE [OC95-E2]



3ECAAABFP003A

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■ X TYPE (WITH STOP SOLENOID) [OC95-E2]



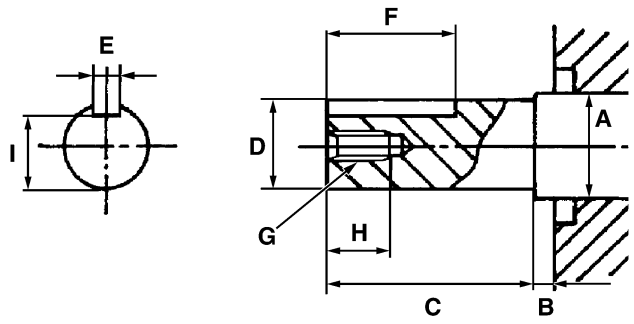
3ECAAABFP004A

	STANDARD TYPE	X TYPE
A	503 mm (19.81 in.)	503 mm (19.81 in.)
B	501 mm (19.73 in.)	501 mm (19.73 in.)
C	452 mm (17.80 in.)	452 mm (17.80 in.)
D	145 mm (5.71 in.)	145 mm (5.71 in.)
E	135 mm (5.32 in.)	135 mm (5.32 in.)
F	170 mm (6.69 in.)	170 mm (6.69 in.)
G	3 mm (0.12 in.)	3 mm (0.12 in.)
H	57 mm (2.24 in.)	57 mm (2.24 in.)
I	43 mm (1.69 in.)	43 mm (1.69 in.)
J	145 mm (5.71 in.)	145 mm (5.71 in.)
K	110 mm (4.33 in.)	110 mm (4.33 in.)

0000009664E

PTO SHAFT DIMENSIONS

D1-D



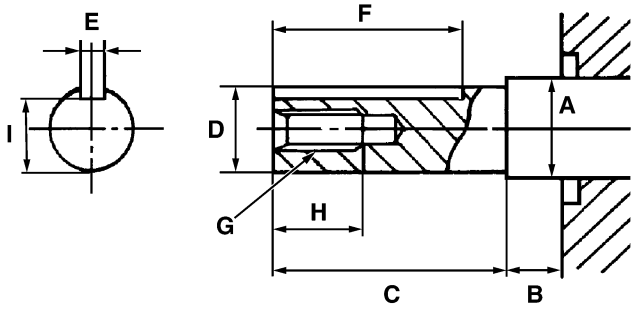
3ECAAABFP005A

■ **[OC60-E2]**

A	30 mm dia. (1.18 in. dia.)
B	2.9 mm (0.12 in.)
C	60 mm (2.36 in.)
D	24.979 to 25.000 mm dia. (0.9835 to 0.9842 in. dia.)
E	7.000 to 7.022 mm (0.2756 to 0.2764 in.)
F	38 mm (1.50 in.)
G	M 8 x 1.25 mm (M 0.31 x 0.05 in.)
H	22 mm (0.87 in.)
I	20.800 to 21.000 mm (0.8189 to 0.8267 in.)

0000009667E

D1-Q

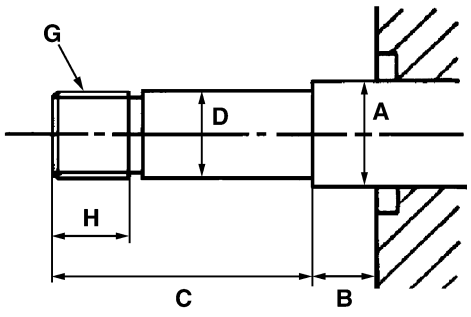


3ECAAABFP007A

A	30 mm dia. (1.18 in. dia.)
B	15.7 mm (0.62 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.000 in. dia.)
E	6.312 to 6.342 mm (0.2486 to 0.2496 in.)
F	56 mm (2.20 in.)
G	7 / 16 - 20 UNF
H	28 mm (1.10 in.)
I	21.619 to 21.819 mm (0.8512 to 0.8590 in.)

0000009668E

D1-P

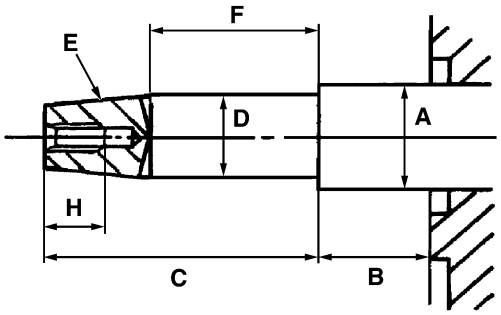


3ECAAABFP009A

A	30 mm dia. (1.18 in. dia.)
B	16.4 mm (0.65 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.000 in.dia.)
G	1 - 14 UNS
H	25 mm (0.98 in.)

0000009669E

D1-G

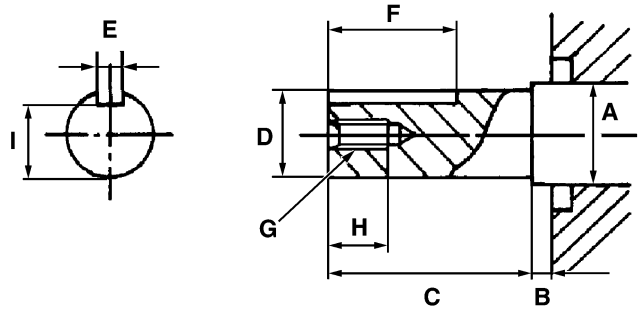


3ECAAABFP011A

A	30 mm dia. (1.18 in. dia.)
B	30.4 mm (1.20 in.)
C	75.5 mm (2.97 in.)
D	22.14 to 22.16 mm dia. (0.8717 to 0.8724 in. dia.)
E	Taper 2 - 1 / 4 per foot
F	46.5 mm (1.83 in.)
G	5 / 16 - 24 UNF
H	18 mm (0.71 in.)

0000009670E

D1-D



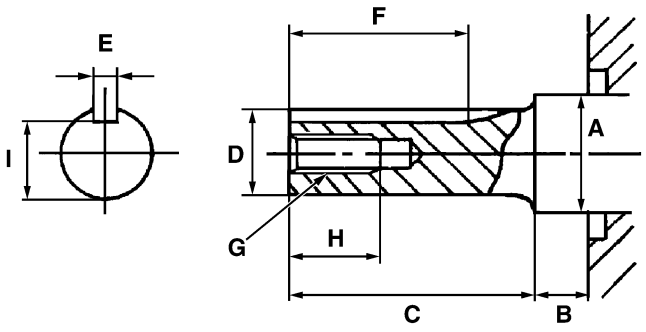
3ECAAABFP006A

■ **[OC95-E2]**

A	35 mm dia. (1.38 in. dia.)
B	2.9 mm (0.12 in.)
C	60 mm (2.36 in.)
D	24.979 to 25.000 mm (0.9835 to 0.9842 in.)
E	7.000 to 7.022 mm (0.2756 to 0.2764 in.)
F	38 mm (1.50 in.)
G	M 8 x 1.25 mm (M 0.31 x 0.05 in.)
H	22 mm (0.87 in.)
I	20.800 to 21.000 mm (0.8189 to 0.8267 in.)

0000009671E

D1-Q

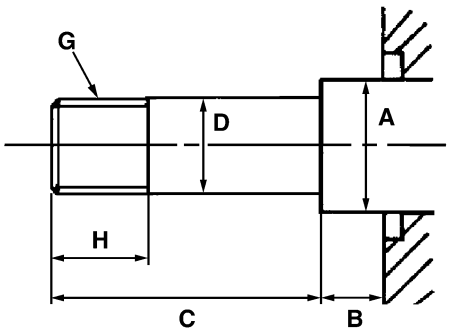


3ECAAABFP008A

A	35 mm dia. (1.38 in. dia.)
B	16.7 mm (0.66 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.0000 in. dia.)
E	6.312 to 6.342 mm (0.2486 to 0.2496 in.)
F	56 mm (2.20 in.)
G	7 / 16 - 20 UNF
H	28 mm (1.10 in.)
I	21.619 to 21.819 mm (0.8512 to 0.8590 in.)

0000009672E

D1-P

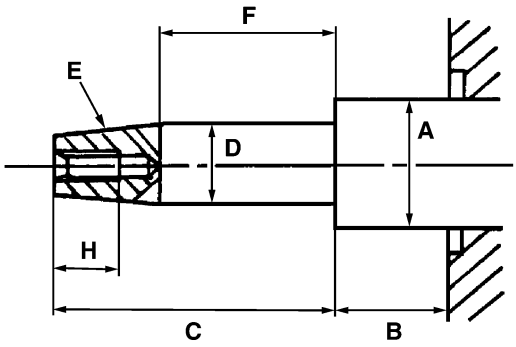


3ECAAABFP010A

A	35 mm dia. (1.38 in. dia.)
B	16.4 mm (0.65 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.0000 in. dia.)
G	1 - 14 UNS
H	25 mm (0.98 in.)

0000009673E

D1-G



3ECAAABFP012A

A	35 mm dia. (1.38 in. dia.)
B	30.4 mm (1.20 in.)
C	75.5 mm (2.97 in.)
D	22.14 to 22.16 mm dia. (0.8717 to 0.8724 in. dia.)
E	Taper 2 - 1 / 4 per foot
F	46.5 mm (1.83 in.)
G	5 / 16 - 24 UNF
H	18 mm (0.71 in.)

0000009674E

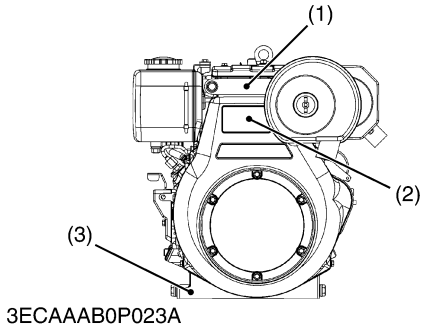
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1. ENGINE IDENTIFICATION

[1] MODEL NAME AND ENGINE SERIAL NUMBER

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

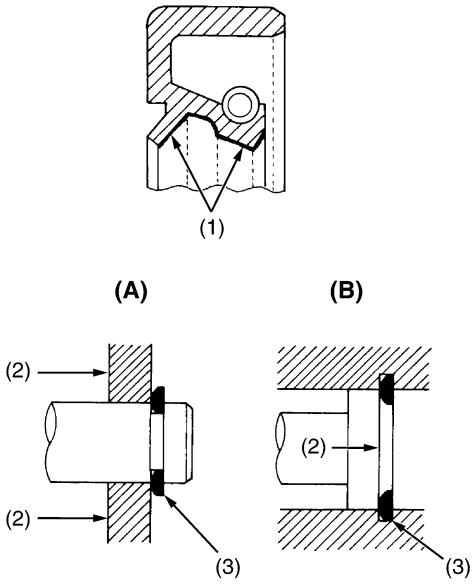


3ECAAAB0P023A

(1) Model Name
(2) Emission Label
(3) Serial Number

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2. GENERAL PRECAUTIONS



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

(1) Grease
(2) Force
(3) Place the Sharp Edge against the Direction of Force

(A) External Snap Ring
(B) Internal Snap Ring

0000001277E

3. E2 ENGINE

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

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

In order to discriminate the engines conforming to Tier 1 / Phase 1 requirements and those conforming to Tier 2 / Phase 2 requirements, we have adopted E2 as a new model name for the engines conforming Tier 2 / Phase 2 regulations.

In the after-sale services for E2 engines, only use the dedicated parts for E2 models and carry out the maintenance services accordingly.

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4. LUBRICANTS, AND FUEL

No.	Place	Capacity		Lubricants, fuel and coolant
		OC60-E2	OC95-E2	
1	Engine oil	1.3 L 1.4 U.S.qts 1.1 lmp.qts	1.7 L 1.8 U.S.qts 1.5 lmp.qts	Higher than CC class (API) Above 25 °C (77 °F) : SAE10W-30 SAE10W-40 SAE30 0 to 25 °C (32 to 77 °F) : SAE10W-30 SAE10W-40 SAE20 Below 0 °C (32 °F) : SAE10W-30 SAE10W-40 SAE10
2	Fuel	3.6 L 0.95 U.S.gals 0.79 lmp.gals	5.5 L 1.45 U.S.gals 1.21 lmp.gals	Diesel fuel No. 2-D (No. 1-D deisel fuel, if temperature is below -10 °C (14 °F).)

*KUBOTA original transmission hydraulic fluid.

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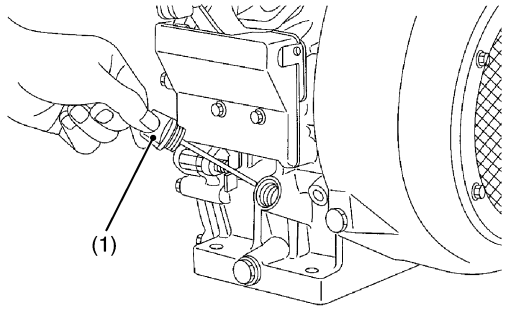
5. MAINTENANCE CHECK LIST

No	Item		Service interval								Refere-nce page
			Daily	Initial 25h	Every 100h	Every 500h	Every 800h	Every 1500h	Every 1 year	Every 2 year	
1	Engine oil	Checking	☆								G-6
		Changing		☆	☆						G-7
2	Oil strainer	Cleaning		☆	☆						G-7
3	Rubber hoses and clamp bands	Checking	☆								G-6
		Changing								☆	G-10
4	Air cleaner	Cleaning			☆						G-8
		Changing	Once year or after 6 cleanings								G-10
5	Fuel filter	Cleaning			☆						G-8
		Changing				☆					G-8
6	Valve clearance	Checking					☆				G-9
7	Nozzle injection pressure and spraying condition	Checking						☆			G-9, 10
		Cleaning						☆			G-9, 10

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6. CHECK AND MAINTENANCE

[1] DAILY CHECK



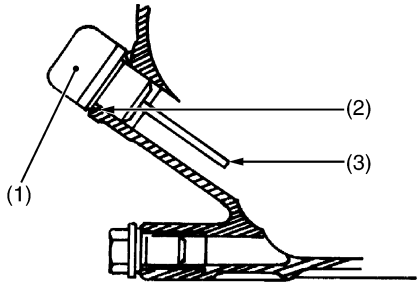
3ECAAAB0P002A

Checking Engine Oil Level

1. Put the engine on a flat surface, and check the amount and condition of the oil with an oil plug (1).
2. If the oil level is below the lower limit (2), add new oil up to the upper limit (3).
3. When using an oil of different maker or viscosity from the previous one, remove all old oil. Never mix two different types of oil.

■ **NOTE**

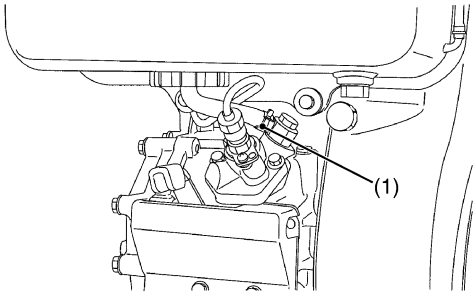
- **Use the proper engine oil viscosity (SAE) according to the ambient temperature.**



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(1) Oil Plug
(2) Lower Limit
(3) Upper Limit

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3ECAAAB0P006A

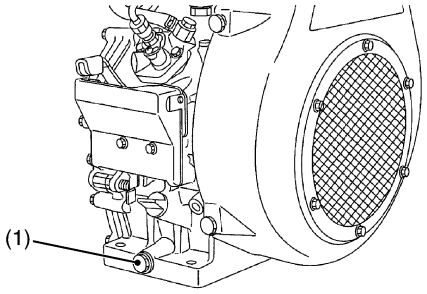
Checking Fuel Hose and Clamp Bands

1. If the clamps (1) are loose, replace with new ones.
2. The fuel and lubricating hoses are made of rubber and ages regardless of period of service. Change the fuel pipes together with the clamps every two year.
3. However, if the fuel and lubricating hose and clamp are found to be damaged or deteriorated earlier than two years, replace with new ones.

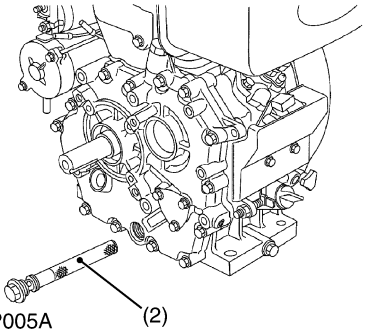
(1) Clamp

0000009344E

[2] CHECK POINT OF INITIAL 25 HOURS



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3ECAAAB0P005A

Changing Engine Oil and Cleaning Oil Strainer

1. After warming up the engine, remove the drain plug (1) and drain the oil completely.
2. Put the drain plug and supply the specified quantity of the specified oil through the oil inlet.

■ NOTE

- **Clean the oil strainer (2) each time oil is changed.**

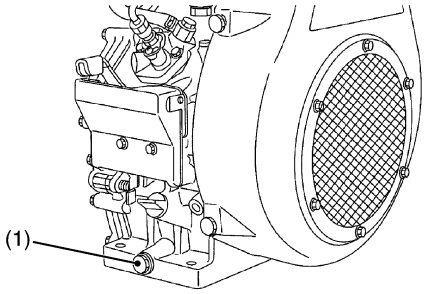
(When cleaning oil strainer)

1. Clean the oil strainer with fuel oil.
2. If the oil strainer is deformed or broken, replace it.

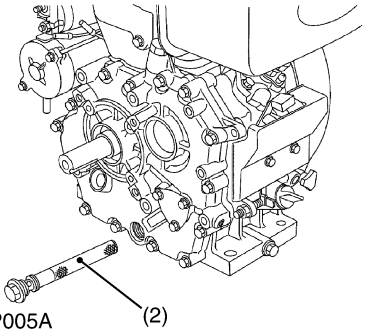
(1) Drain Plug (2) Oil Strainer

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[3] CHECK POINTS OF EVERY 100 HOURS



3ECAAAB0P004A



3ECAAAB0P005A

Changing Engine Oil and Cleaning Oil Strainer

1. After warming up the engine, remove the drain plug (1) and drain the oil completely.
2. Put the drain plug and supply the specified quantity of the specified oil through the oil inlet.

■ NOTE

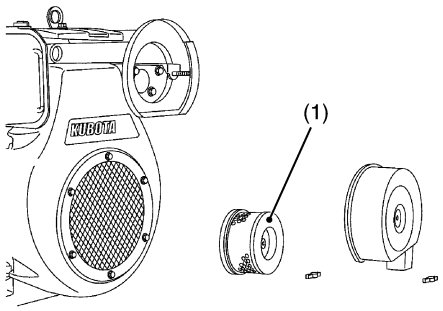
- **Clean the oil strainer (2) each time oil is changed.**

(When cleaning oil strainer)

1. Clean the oil strainer with fuel oil.
2. If the oil strainer is deformed or broken, replace it.

(1) Drain Plug (2) Oil Strainer

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3ECAAAB0P007A

Cleaning and Changing Air Cleaner Element

■ **NOTE**

- **Change air cleaner element (1) once a year or six times of cleaning.**

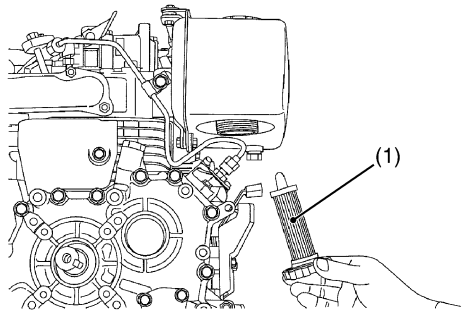
(Cleaning Air Filter Element)

- **When dry dust adheres**

1. To clean the element, use clean dry compressed air on the inside of the element.
   Air pressure at the nozzle must not exceed 205 kPa (2.1 kgf/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

(1) Element

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3ECAAAB0P008A

Cleaning Fuel Filter

1. Empty the fuel tank and disconnect the fuel pipe.
2. Loosen the ring nut and take out the filter (1).
3. Wash the filter clean off impurities with fresh fuel.
4. Take much care when handling the element because it is very fragile.

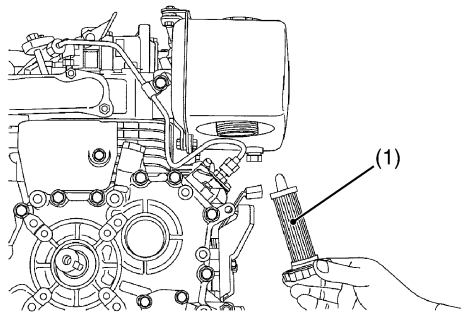
■ **NOTE**

- **If the element should have holes, replace it with a new one. A damaged element will shorten the service life of the nozzle and injection pump.**

(1) Filter

0000009677E

[4] CHECK POINT OF EVERY 500 HOURS



3ECAAAB0P008A

Changing Fuel Filter

1. Empty the fuel tank and disconnect the fuel pipe.
2. Loosen the ring nut and take out the filter (1).
3. Replace the filter (1).
4. Take much care when handling the element because it is very fragile.

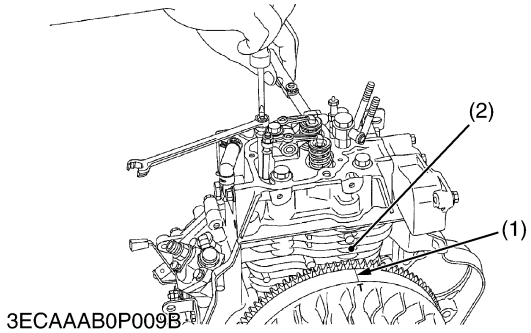
■ **NOTE**

- **A damaged element will shorten the service life of the nozzle and injection pump.**

(1) Filter

0000009370E

[5] CHECK POINT OF EVERY 800 HOURS



3ECAAAB0P009B

Checking Valve Clearance

■ IMPORTANT

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

1. Remove the cylinder head cover.
2. Align the "**T**" mark line (1) on the flywheel and the mark (2) on the fin at the T.D.C. in the compression stroke.
3. Check the intake and exhaust valve clearance with a thickness gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.
5. After adjusting the valve clearance, firmly tighten the lock nut on the adjusting screw.

■ NOTE

- **After rotating the flywheel clockwise twice or three times, check the valve clearance again.**

Valve clearance	Factory spec.	0.14 to 0.18 mm 0.0055 to 0.0071 in.

(1) **T** Mark Line (2) Mark

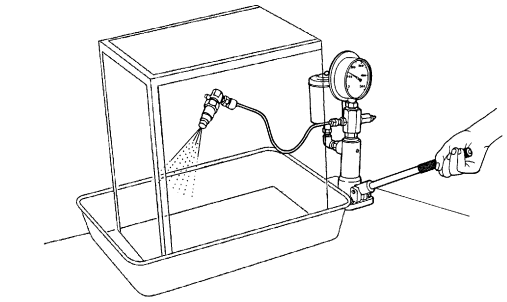
0000009371E

[6] CHECK POINTS OF EVERY 1500 HOURS

⚠ 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 penetrate the human body, cells may be destroyed and blood poisoning may be caused.**

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Checking Nozzle Injection Pressure

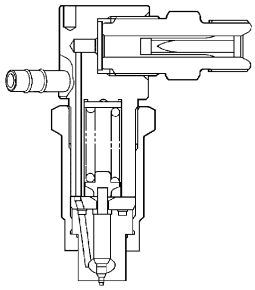
1. Set the injection nozzle to the nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, disassemble the injection nozzle, and change adjusting washer until the proper injection pressure is obtained.

Nozzle injection pressure	Factory spec.	13.9 to 14.7 MPa 142 to 150 kgf/cm^2 2019 to 2133 psi

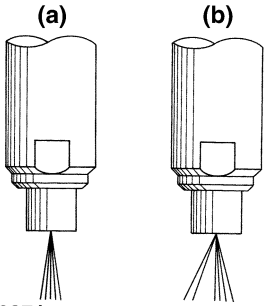
(Reference)

- Pressure variation with 0.15 mm (0.0059 in.) difference of adjusting washer thickness 981 kPa (10 kgf/cm^2, 142 psi).

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3ECAAAB0P010A



3EEABAB1P037A

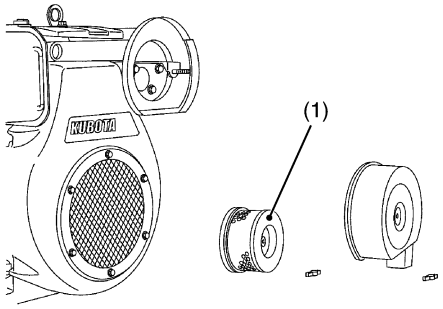
Nozzle Spraying Condition

1. Check the nozzle spray condition.
2. If the spray pattern and spraying direction are faulty, replace the nozzle piece.

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

0000009212E

[7] CHECK POINT OF EVERY 1 YEAR



3ECAAAB0P007A

Cleaning and Changing Air Cleaner Element

■ NOTE

- **Change air cleaner element (1) once a year or six times of cleaning.**

(Cleaning Air Filter Element)

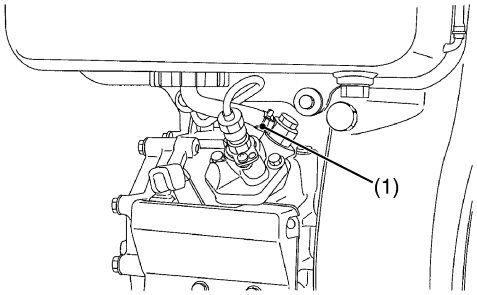
- **When dry dust adheres**

1. To clean the element, use clean dry compressed air on the inside of the element.
   Air pressure at the nozzle must not exceed 205 kPa (2.1 kgf/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

(1) Element

0000009368E

[8] CHECK POINT OF EVERY 2 YEARS



3ECAAAB0P006A

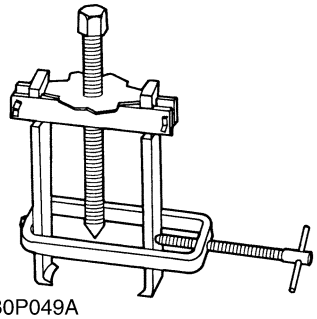
Checking Fuel Hose and Clamp Bands

1. If the clamps (1) are loose, replace with new ones.
2. The fuel and lubricating hoses are made of rubber and ages regardless of period of service. Change the fuel pipes together with the clamps every two year.
3. However, if the fuel and lubricating hose and clamp are found to be damaged or deteriorated earlier than two years, replace with new ones.

(1) Clamp

0000009344E

7. SPECIAL TOOLS



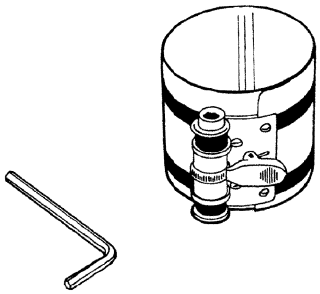
3TMABAB0P049A

Special Use Puller Set

Code No : 07916-09032

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

0000000677E



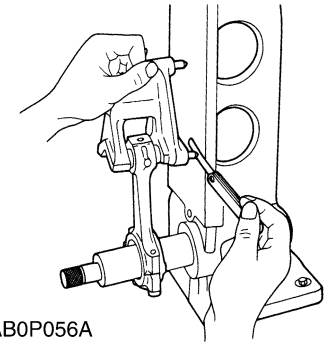
3TMABAB0P050A

Piston Ring Compressor

Code No : 07909-32111

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

0000000678E



3TMABAB0P056A

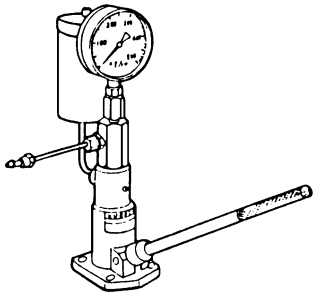
Connecting Rod Alignment Tool

Code No : 07909-31661

Application : Use to check the connecting rod alignment.

Applicable range : Connecting rod big end I.D. 30 to 75 mm (1.18 to 2.95 in.) dia. Connecting rod length 65 to 330 mm (2.56 to 12.99 in.)

0000009381E



3ECAAAB0P011A

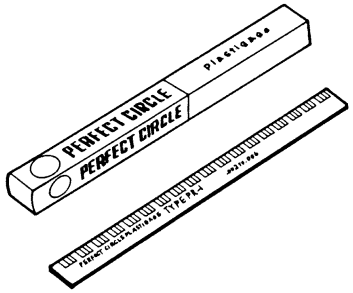
Nozzle Tester

Code No : 07909-31361

Application : Use to check the fuel injection pressure and spraying condition of nozzle.

Measuring range : 0 to 50 MPa (0 to 500 kgf/cm^2, 0 to 7000 psi)

0000009382E



3TMABAB0P058A

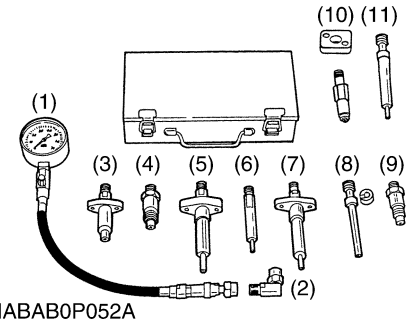
Press Gauge

Code No : 07909-30241

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

Measuring range : Green.....0.025 to 0.076 mm (0.01 to 0.03 in.)
Red.....0.051 to 0.152 mm (0.02 to 0.06 in.)
Blue.....0.102 to 0.229 mm (0.04 to 0.09 in.)

0000009383E



3TMABAB0P052A

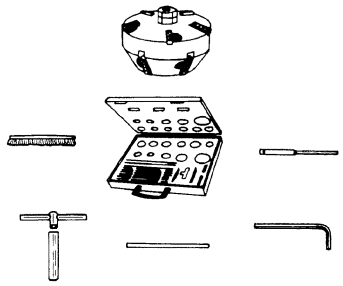
Diesel Engine Compression Tester

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

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

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

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Valve Seat Cutter

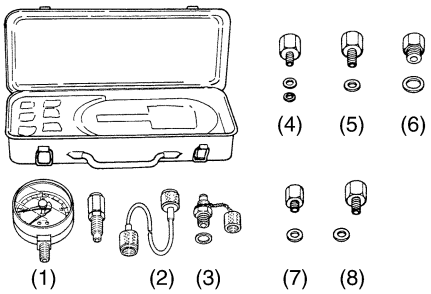
Code No : 07909-33102

Application : Use to reseat valves.

Angle : 0.785 rad (45°)
0.262 rad (15°)

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

0000000682E



3TMABAB0P053A

Oil Pressure Tester

Code No : 07916-32032

Application : Use to measure lubricating oil pressure.

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

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3ECAAAB0P013A

Flywheel Puller

Code No : 07916-30161

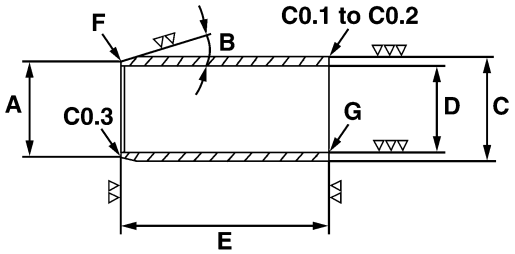
Application : Use for removing the flywheel from crankshaft.

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■ **NOTE**

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

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3ECAAAB0P014A

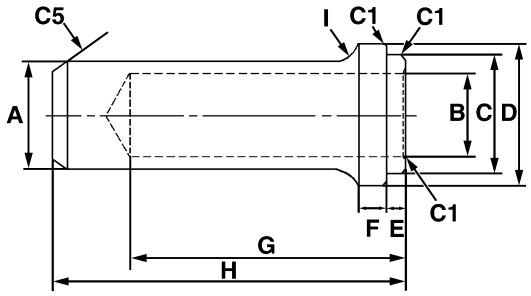
Side Cover Oil Seal Guide (OC60-E2)

Application : The oil sealing guide is helpful in fitting the side cover in position.

Material : S43C

	Q Type	G Type
A	26.9 to 27.1 mm dia. (1.060 to 1.066 in. dia.)	26.9 to 27.1 mm dia. (1.060 to 1.066 in. dia.)
B	0.2618 rad (15°)	0.2618 rad (15°)
C	29.75 to 29.85 mm dia. (1.172 to 1.175 in. dia.)	29.75 to 29.85 mm dia. (1.172 to 1.175 in. dia.)
D	25.500 to 25.533 mm dia. (1.004 to 1.005 in. dia.)	22.300 to 22.333 mm dia. (0.878 to 0.879 in. dia.)
E	70 mm (2.755 in.)	70 mm (2.755 in.)
F	R 0.5 mm (R 0.020 in.)	R 0.5 mm (R 0.020 in.)
G	R 2 mm (R 0.079 in.)	R 2 mm (R 0.079 in.)
C0.1	Chamfer 0.1 mm (0.012 in.)	Chamfer 0.1 mm (0.012 in.)
C0.2	Chamfer 0.2 mm (0.0039 in.)	Chamfer 0.2 mm (0.0039 in.)
C0.3	Chamfer 0.3 mm (0.0079 in.)	Chamfer 0.3 mm (0.0079 in.)

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3ECAAAB0P015A

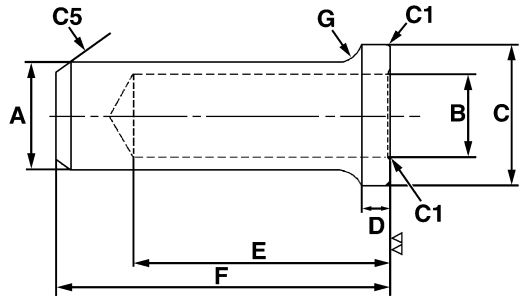
Side Cover Oil Seal Installing Tool

Application : Use to install the oil seal.

Material : S43C

	OC60-E2	OC95-E2
A	40 mm dia. (1.575 in. dia.)	46 mm dia. (1.811 in. dia.)
B	31 mm dia. (1.220 in. dia.)	36 mm dia. (1.417 in. dia.)
C	44.0 to 44.3 mm dia. (1.733 to 1.744 in. dia.)	49.0 to 49.3 mm dia. (1.930 to 1.940 in. dia.)
D	52 mm dia. (2.047 in. dia.)	58 mm dia. (2.283 in. dia.)
E	7 mm (0.276 in.)	7 mm (0.276 in.)
F	10 mm (0.394 in.)	10 mm (0.394 in.)
G	100 mm (3.937 in.)	100 mm (3.937 in.)
H	127 mm (5.000 in.)	127 mm (5.000 in.)
I	R20 mm (R0.79 in.)	R20 mm (R0.79 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)

0000009531E



3ECAAAB0P016A

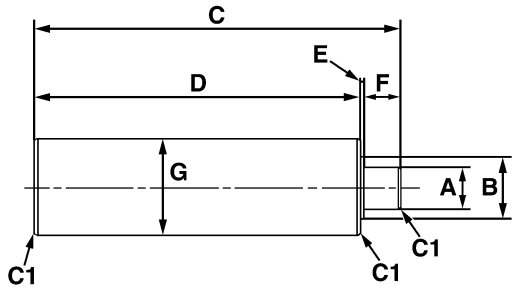
Crank Case Oil Seal Installing Tool

Application : Use to install the crank case oilseal.

Material : S43C

	OC60-E2	OC95-E2
A	40 mm dia. (1.575 in. dia.)	46 mm dia. (1.811 in. dia.)
B	31 mm dia. (1.220 in. dia.)	36 mm dia. (1.417 in. dia.)
C	52 mm dia. (2.047 in. dia.)	58 mm dia. (2.283 in. dia.)
D	10 mm (0.394 in.)	10 mm (0.394 in.)
E	100 mm (3.937 in.)	100 mm (3.937 in.)
F	120 mm (4.724 in.)	120 mm (34.724 in.)
G	R20 mm (R0.79 in.)	R20 mm (R0.79 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C5	Chamfer 5 mm (0.20 in.)	Chamfer 5 mm (0.20 in.)

0000009532E



3ECAAAB0P017A

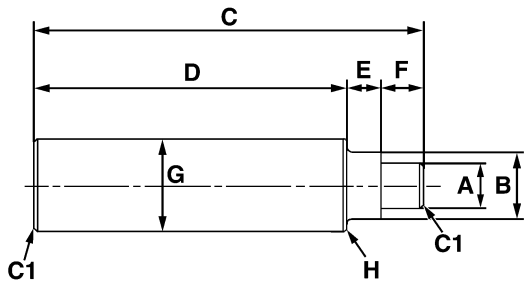
Balancer Bearing Installing Tool

Application : Use to install the balancer bearing.

Material : S43C

	OC60-E2	OC95-E2
A	13.8 to 13.9 mm dia. (0.544 to 0.547 in. dia.)	15.8 to 15.9 mm dia. (0.623 to 0.625 in. dia.)
B	19.8 to 19.9 mm dia. (0.780 to 0.783 in. dia.)	21.8 to 21.9 mm dia. (0.859 to 0.862 in. dia.)
C	112.5 mm (4.429 in.)	112.5 mm (4.429 in.)
D	100 mm (3.937 in.)	100 mm (3.937 in.)
E	0.4 to 0.6 mm (0.0158 to 0.0236 in.)	0.4 to 0.6 mm (0.0158 to 0.0236 in.)
F	12 mm (0.472 in.)	12 mm (0.472 in.)
G	30 mm dia. (1.181 in. dia.)	30 mm dia. (1.181 in. dia.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)

0000009533E



3ECAAAB0P018A

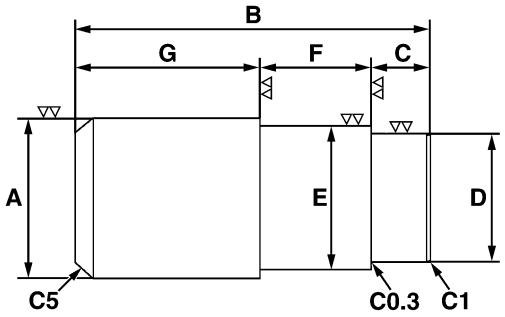
Camshaft Bearing Installing Tool (Crank Case)

Application : Use to install the camshaft bearing.

Material : S43C

	OC60-E2	OC95-E2
A	16.8 to 16.9 mm dia. (0.544 to 0.547 in. dia.)	19.8 to 19.9 mm dia. (0.780 to 0.783 in. dia.)
B	22.8 to 22.9 mm dia. (0.898 to 0.901 in. dia.)	25.8 to 25.9 mm dia. (1.016 to 1.019 in. dia.)
C	122 mm (4.803 in.)	122 mm (4.803 in.)
D	100 mm (3.937 in.)	100 mm (3.937 in.)
E	10 mm (0.394 in.)	10 mm (0.394 in.)
F	12 mm (0.472 in.)	12 mm (0.472 in.)
G	30 mm dia. (1.181 in. dia.)	30 mm dia. (1.181 in. dia.)
H	R2 mm (R0.08 in.)	R2 mm (R0.08 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)

0000009534E



3ECAAAB0P019A

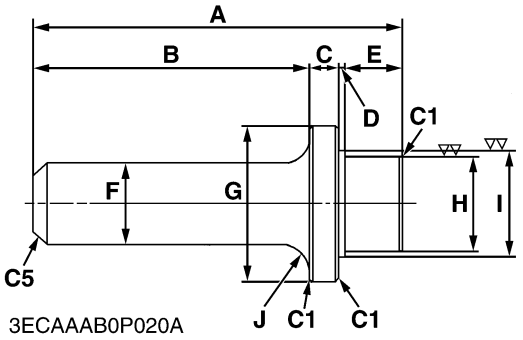
Crankshaft Bearing 1 Replacing Tool (For Extracting)

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

Material : S43C

	OC60-E2	OC95-E2
A	43.7 to 44.3 mm dia. (1.721 to 1.744 in. dia.)	48.7 to 49.3 mm dia. (1.918 to 1.940 in. dia.)
B	95 mm (3.740 in.)	96 mm (3.780 in.)
C	15 mm (0.590 in.)	16 mm (0.630in.)
D	34.6 to 34.9 mm dia. (1.363 to 1.374 in. dia.)	39.6 to 39.9 mm dia. (1.560 to 1.570 in. dia.)
E	38.7 to 38.9 mm dia. (1.524 to 1.531 in. dia.)	43.7 to 43.9 mm dia. (1.721 to 1.728 in. dia.)
F	30 mm (1.181 in.)	30 mm (1.181 in.)
G	50 mm (1.969 in.)	50 mm (1.969 in.)
C0.3	Chamfer 0.3 mm (0.012 in.)	Chamfer 0.3 mm (0.012 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C5	Chamfer 5 mm (0.20 in.)	Chamfer 5 mm (0.20 in.)

0000009535E



3ECAAAB0P020A

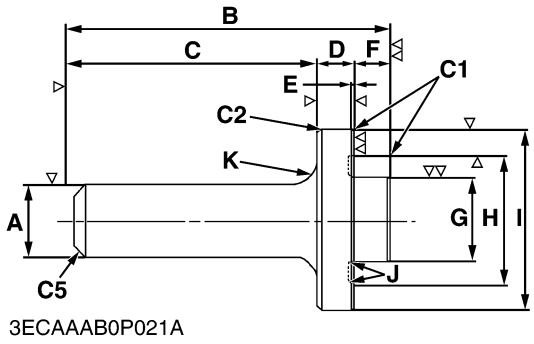
Crankshaft Bearing 1 Replacing Tool (for Installing)

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

Material : S43C

	OC60-E2	OC95-E2
A	133.5 mm (5.256 in.)	133.5 mm (5.256 in.)
B	100 mm (3.937 in.)	100 mm (3.937 in.)
C	10 mm (0.394 in.)	10 mm (0.394 in.)
D	0.9 to 1.1 mm (0.0355 to 0.0433 in.)	0.4 to 0.6 mm (0.0158 to 0.0236 in.)
E	21 mm (0.827 in.)	23 mm (0.906 in.)
F	30 mm dia. (1.181 in. dia.)	30 mm dia. (1.181 in. dia.)
G	57 mm dia. (2.244 in. dia.)	57 mm dia. (2.244 in. dia.)
H	34.7 to 34.9 mm dia. (1.367 to 1.374 in. dia.)	39.7 to 39.9 mm dia. (1.563 to 1.570 in. dia.)
I	38.7 to 38.9 mm dia. (1.524 to 1.531 in. dia.)	43.7 to 43.9 mm dia. (1.721 to 1.728 in. dia.)
J	R10 mm (R0.39 in.)	R10 mm (R0.39 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C5	Chamfer 5 mm (0.20 in.)	Chamfer 5 mm (0.20 in.)

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3ECAAAB0P021A

Crankshaft Bearing Installing Tool (Side Cover)

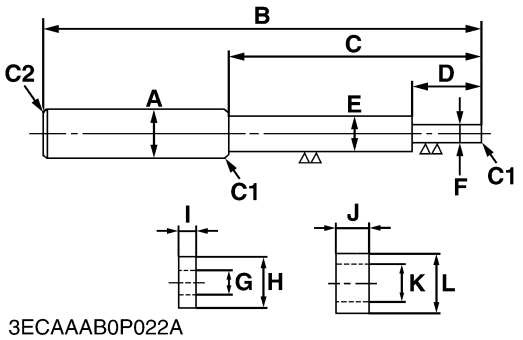
Application : Use to install the camshaft bearing.

Material : S43C

Model : OC95-E2

A	30 mm dia. (1.181 in. dia.)
B	130 mm (5.118 in.)
C	100 mm (3.937 in.)
D	15 mm (0.590 in.)
E	2 mm (0.0787 in.)
F	15 mm (0.590 in.)
G	34.7 to 34.9 mm dia. (1.367 to 1.374 in. dia.)
H	55 mm dia. (2.165 in. dia.)
I	75 mm dia. (2.953 in. dia.)
J	R2 mm (R0.079 in.)
K	R10 mm (R0.39 in.)
C1	Chamfer 1 mm (0.039 in.)
C2	Chamfer 2 mm (0.079 in.)
C5	Chamfer 5 mm (0.20 in.)

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3ECAAAB0P022A

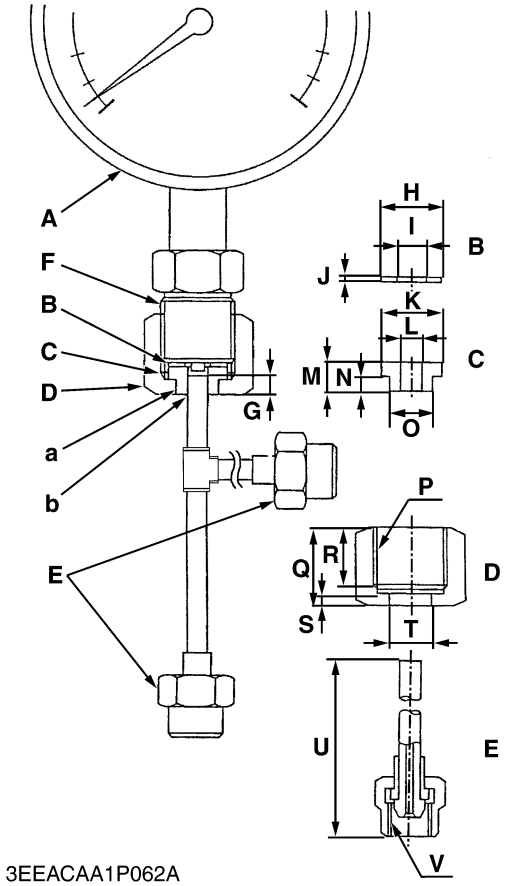
Valve Guide Replacing Tool

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

Material : S43C

	OC60-E2	OC95-E2
A	20 mm dia. (0.787 in. dia.)	20 mm dia. (0.787 in. dia.)
B	200 mm (7.874 in.)	200 mm (7.874 in.)
C	120 mm (4.724 in.)	120 mm (4.724 in.)
D	40 mm (1.575 in.)	40 mm (1.575 in.)
E	10 mm dia. (0.394 in. dia.)	11 mm dia. (0.433 in. dia.)
F	5.7 mm dia. (0.224 in. dia.)	6.4 mm dia. (0.252 in. dia.)
G	6 mm dia. (0.236 in. dia.)	6.7 mm dia. (0.264 in. dia.)
H	15 mm dia. (0.590 in. dia.)	15 mm dia. (0.590 in. dia.)
I	5 mm (0.197 in.)	5 mm (0.197 in.)
J	8 mm (0.315 in.)	8.5 mm (0.335 in.)
K	12.1 mm dia. (0.476 in. dia.)	12.1 mm dia. (0.476 in. dia.)
L	18 mm dia. (0.709 in. dia.)	18 mm dia. (0.709 in. dia.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C2	Chamfer 2 mm (0.080 in.)	Chamfer 2 mm (0.080 in.)

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3EEACAA1P062A

Injection Pump Pressure Tester

Application : Use to check fuel tightness of injection pumps.

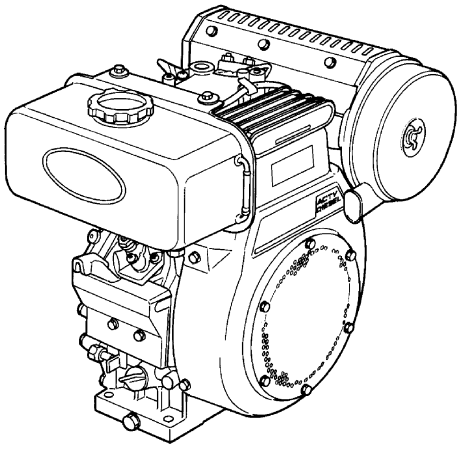
A	Pressure gauge full scale : More than 29.4 MPa (300 kgf/cm^2, 4267 psi)
B	Copper gasket
C	Flange (Material : Steel)
D	Hex. nut 27 mm (1.06 in.) across the plat
E	Retaining nut
F	PF 1/2
G	5 mm (0.20 in.)
H	17 mm dia. (0.67 in.dia.)
I	8 mm dia. (0.31 in.dia.)
J	1.0 mm (0.039 in.)
K	17 mm dia. (0.67 in.dia.)
L	6.10 to 6.20 mm dia. (0.2402 to 0.2441 in.dia.)
M	8 mm (0.31 in.)
N	4 mm (0.16 in.)
O	11.97 to11.99 mm dia. (0.4713 to 0.4721 in.dia.)
P	PF 1/2
Q	23 mm (0.91 in.)
R	17 mm (0.67 in.)
S	4 mm (0.16 in.)
T	12.00 to 12.02 mm dia. (0.4724 to 0.4732 in.dia.)
U	100 mm (3.94 in.)
V	M12 x P1.5
a	Adhesive application
b	Fillet welding on the enter circumference

0000001341E

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1. FEATURE



3ECAAAB1P001A

1. Operating noise as low as that with a water-cooled engine.

The ACTV system tremendously improves noise problem that is the biggest shortcoming with air-cooled diesel engines. The noise level has now come down competitive with water-cooled diesel engines.

2. Engine body as light-weight and compact as air-cooled gasoline engine.

With a small oil cooler, the ACTV system offers a new way of cooling. This makes the engine as light-weight and compact as an air-cooled gasoline engine.

3. Good fuel economy and pollution-free exhaust.

Compared to air-cooled gasoline engines, this engine with the TVCS (Three Vortex Combustion System) saves much fuel. The TVCS is so efficient that the engine does not emit any irritating smell and smarting exhaust. Much less black exhaust and much lower exhaust concentration.

4. Balancer standard equipped for much lower vibrations.

The engine is standard equipped with a uniaxial balancer highly effective to absorb vibrations.

5. Maintenace-free coolant system and fan belt.

Both oil cooling and air cooling are introduced for the cooling system. Some servicing required for a water-cooled engine checking and adding coolant, readjusting or replacing the fan belt, and so on is not needed any longer. And there is no ignition system trouble, carburetor trouble and others that are related to gasoline engines.

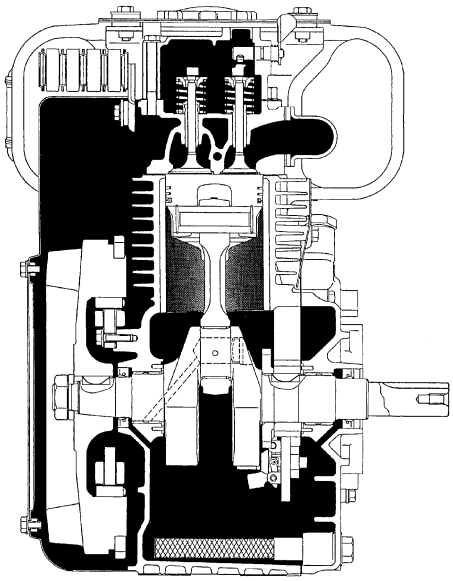
*The ACTV stands for Advanced Cooling Three Vortex, a tomorrow's combustion system based on the most advanced cooling techniques.

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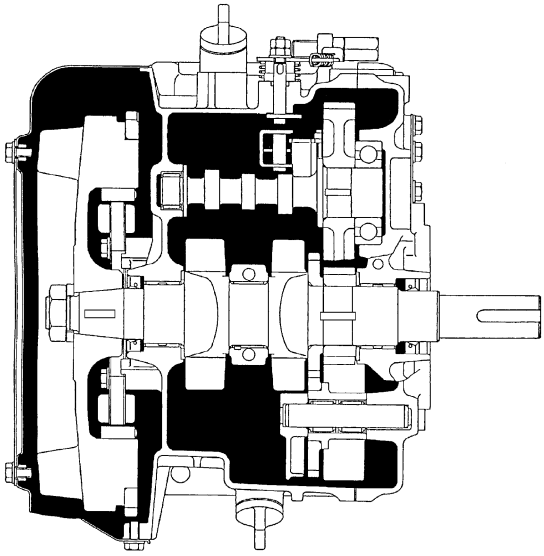
2. ENGINE BODY

The OC60-E2 and OC95-E2 are a 4-cycle diesel engine. Backed by Kubota's rich experience in engine research and development, this brand-new engine has come up with the ACTV (Advanced Cooling Three Vortex) system, introduced first in the world. The engine features low noise, light weight, compactness, good fuel economy, pollution-free exhaust and many others.

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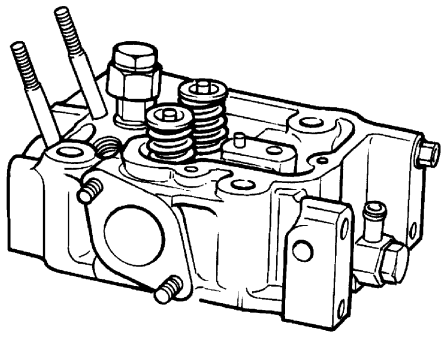


3ECAAAB1P002A



3ECAAAB1P003A

[1] CYLINDER HEAD



3ECAAAB1P004A

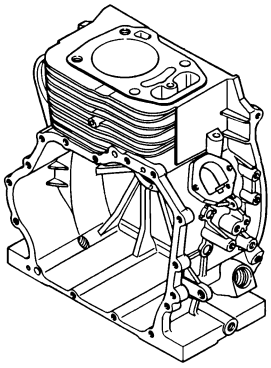
As the cylinder head is subjected to high temperature and high pressure, it is made of special cast iron.

This engine employs Kubota's exclusive TVCS (Three Vortex Combustion System) system. This system provides three swirls inside a spherical vortex chamber during the combustion stroke for effective combustion. Furthermore TVCS has been originally characterized by low noise, in comparison with direct injection type.

The combustion chamber is provided with oil passages around. This way, the injection nozzle is kept cool to prolong its service life. What's more, the explosive sound is suppressed by the oil's viscosity to keep the engine noise low.

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[2] CRANK CASE AND CYLINDER LINER



3ECAAAB1P005A

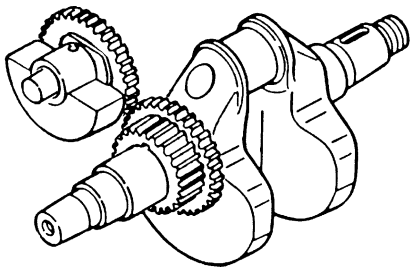
The crank case is made of aluminium die-cast.

The crank case is provided with oil galleries to lubricate the crankshaft, crank pin metal. Another oil passage is provided at the side of the cylinder liner. This passage, also, serves to keep the cylinder liner cool and to suppress the explosive sound for lower noise.

The cylinder liner made of special cast iron having excellent wear resistance, is casted into crank case.

0000009118E

[3] UNAXIAL BALANCER SYSTEM



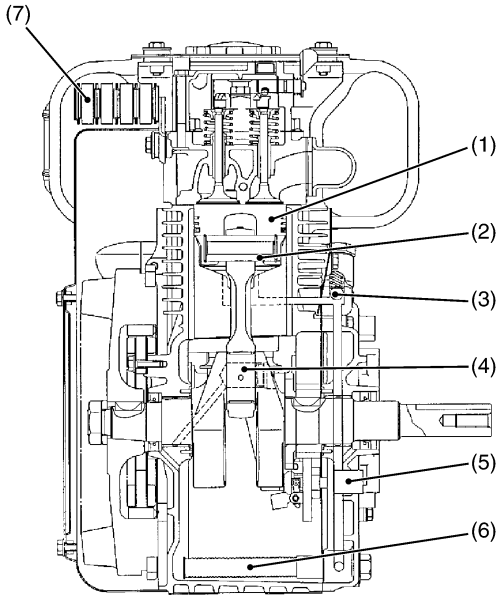
3ECAAAB1P006A

A unaxial balancer is adopted to reduce engine vibrations. There are two major vibration sources in a single-cylinder engine. One is the inertia force which is generated when the piston and the small end of the connecting rod are reciprocating. The other is the centrifugal force (kind of inertia force) generated when the large end of the connecting rod is turning. The resultant force of these two inertial forces can be directed freely by adjusting the weight, but the force itself remains unchanged. The balancer shaft is provided in order to offset these inertial forces. This shaft has a weight that turns in the direction opposite to, but at the same speed as the crankshaft.

0000009120E

3. LUBRICATING SYSTEM

[1] GENERAL



3ECAAAB1P007A

Lubrication is forced on with a trochoid pump. Lubrication oil is sucked in by the trochoid pump (5) via an oil strainer (6) mounted on the side of the gear case. The pressure of lubricating oil discharged from the trochoid pump is regulated by a relief valve (3) to 147 to 490 kPa (1.5 to 5 kgf/cm^2, 21 to 71 psi) (at the rated revolution speed of the engine) and the pressure-regulated oil then fed to the various portions through the oil gallery in the cylinder block.

Lubricating oil sent to the oil gallery in the crankshaft lubricates the crank pin portion (4).

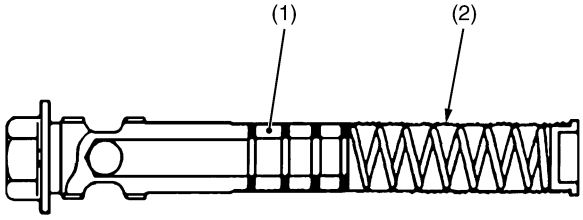
The oil passes along the cylinder liner and reaches the cylinder head to cool it down. The oil then flows into the oil cooler (7). The oil cooled there passes through the relief valve opening of the cylinder head and returns into the crankcase.

Other items such as the piston (1), piston pin (2), camshaft, tappet, bearing and rocker arm are lubricated by splash of the crankshaft, etc.

(1) Piston
(2) Piston Pin
(3) Relief Valve
(4) Crank PIn
(5) Trochoid Pump
(6) Oil Strainer
(7) Oil Cooler

0000009123E

[2] OIL STRAINER



3ECAAAB1P008A

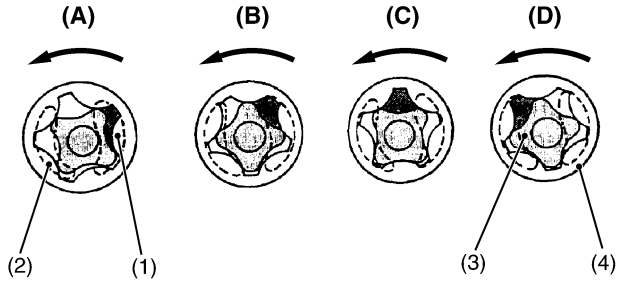
Entry of foreign material such as iron chips, dirt, etc. into the lubricating system may damage the lubricated parts. To prevent this, an oil strainer is equipped prior to the oil pump. This strainer has a double wounds stainless steel net (50 meshes) (2) at the outside, and magnets (1) are mounted inside.

This stainless steel net removes small dirt in the lubricating oil. Further, fine iron chips passing through this net are attracted by these magnets to prevent them from entering the lubricating system.

(1) Magnet
(2) Stainless Steel Net

0000009128E

[3] OIL PUMP



3ECAAAB1P111A

The oil pump in this engine is a trochoid pump.

Inside the pump body, the 4 lobe inner rotor (3) is eccentrically engaged with the 5 lobe outer rotor (4). The inner rotor (3) is driven by the governor gear shaft via gears, which in turn rotate the outer rotor (4).

When the inner rotor (3) rotates, the outer rotor (4) also rotates in the same direction.

The two rotors have differences in lobe number and center, which generates space between lobes as shown in the figure.

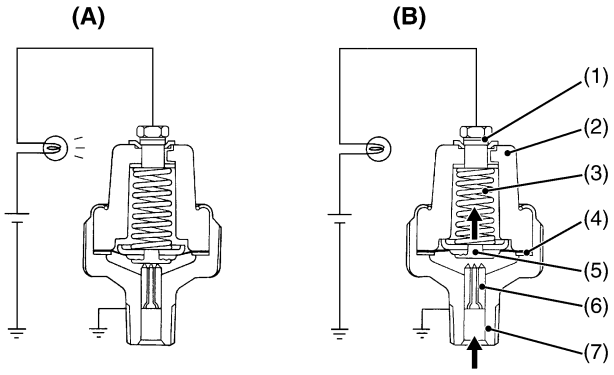
At position (**A**), there is little space between lobes in the inlet port (1). As the rotor rotates towards position (**B**), the space between the lobes becomes larger, creating a negative pressure which sucks in oil.

Outside the inlet port (1), as shown in position (**C**), the space between the lobes becomes gradually smaller, and oil pressure increases. At position (**D**), oil is discharged from the outlet port.

(1) Inlet Port
(2) Outlet Port
(3) Inner Rotor
(4) Outer Rotor

0000009139E

[4] OIL PRESSURE SWITCH



3ECAAAB1P113A

The oil pressure switch is mounted on the side cover, to warn the operator that the lubricating oil pressure is poor.

If the oil pressure falls below 49 kPa (0.5 kgf/cm^2, 7 psi), the oil warning lamp will light up, warning the operator. In this case, stop the engine immediately and check the cause of pressure drop.

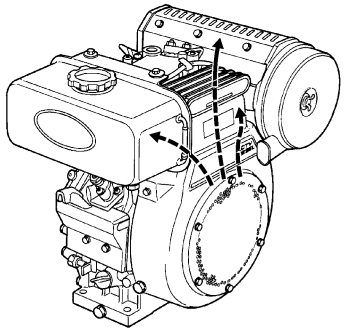
(1) Terminal
(2) Insulator
(3) Spring
(4) Diaphragm
(5) Contact Rivet
(6) Contact
(7) Oil Switch Body

[A] At Oil Pressures of 49 kPa (0.5 kgf/cm^2, 7 psi) or Less
[B] At Proper Oil Pressure

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4. COOLING SYSTEM

[1] GENERAL

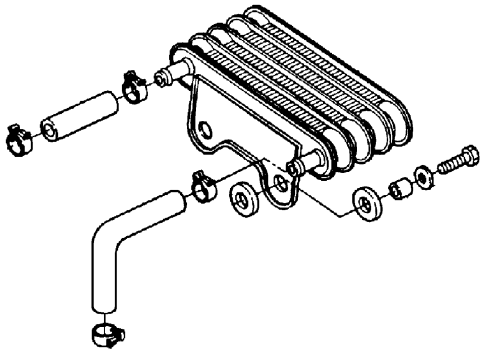


3ECAAAB1P009A

The cooling system comes in two way. The cylinder block is air-cooled, whereas the combustion area of the cylinder head is oil-cooled. Air sucked by the flywheel fan is accelerated in the spiral casing to cool down the cylinder liner as well as the oil cooler located atop the spiral casing. The lubricant cooled by the oil cooler, on the other hand, flows through the return opening of the cylinder head and back to the crankcase. The trochoid pump works to force the lubricant to the cylinder head again to cool the combustion system around. The lubricant finally comes back to the oil cooler. This series of actions is repeated while the engine is running.

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[2] OIL COOLER



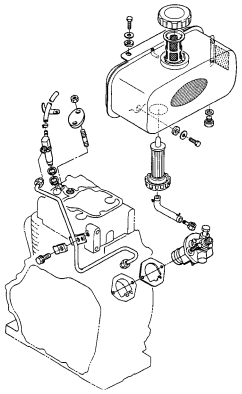
3ECAAAB1P010A

The oil cooler consist of oil carrying tubes and fins. Heat of heated oil in the tubes is radiated from the tube walls and fins. Kubota's engines are of louvered corrugated fin type, featuring light weight and better cooling/radiating effect.

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5. FUEL SYSTEM

[1] GENERAL



3ECAAAB1P011A

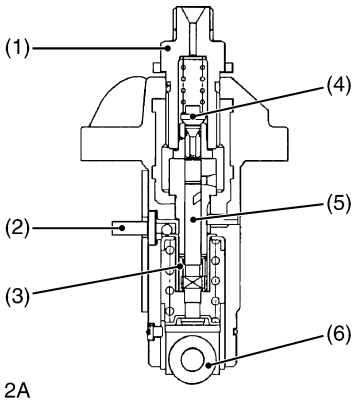
Fuel from the fuel tank passes through the fuel filter, and then enters the injection pump after impurities such as dirt, water, etc. are removed.

The fuel pressurized by the injection pump to the opening pressure (13.9 to 14.7 MPa, 142 to 150 kgf/cm^2, 2019 to 2133 psi), of the injection nozzle is injected into the combustion chamber.

Part of the fuel fed to the injection nozzle lubricates the moving parts of the plunger inside the nozzle, the returns to the fuel tank through the fuel over flow pipe from the upper part of the nozzle holder.

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[2] INJECTION PUMP



3ECAAAB1P012A

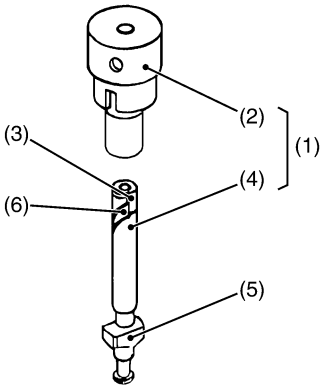
NC Type mini pump is used for the injection pump. It is small, lightweight and easy to handle.

The plunger (5) with a right-hand lead reciprocates via the tappet roller (6) by means of the camshaft fuel cam, causing the fuel to be delivered into the injection nozzle.

(1) Delivery Valve Holder
(2) Control Rack
(3) Control Sleeve
(4) Delivery Valve
(5) Plunger
(6) Tappet Roller

0000009154E

(1) Pump Element



3ECAAAB1P012A

The pump element (1) is consists of the plunger (4) and cylinder (2).

The sliding surfaces are super-precision machined to maintain injection pressure at engine low speeds. Since the driving face (5) fits in the control sleeve, the plunger (4) is rotated by the movement of the control rack to increase or decrease of fuel delivery.

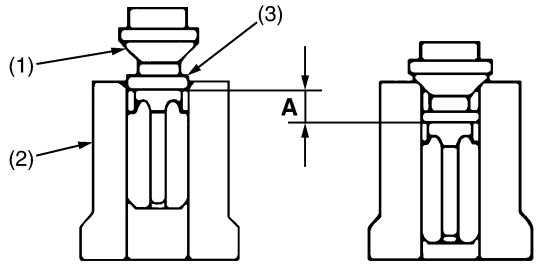
As described above, the plunger is machined to have the slot (3) and the control groove (6). The control groove has a right-hand lead.

The plunger is provided with a low speed retarder to maintain the combustion sound low under no load.

(1) Pump Element
(2) Cylinder
(3) Slot
(4) Plunger
(5) Driving Face
(6) Control Groove

0000009155E

(2) Delivery Valve



3ECAAAB1P014A

The delivery valve consists of the valve (1) and the valve seat (2).

The delivery valve prevents the fuel from flowing back into the delivery chamber through the injection pipe. It also prevents the fuel from dribbling at the injection nozzle.

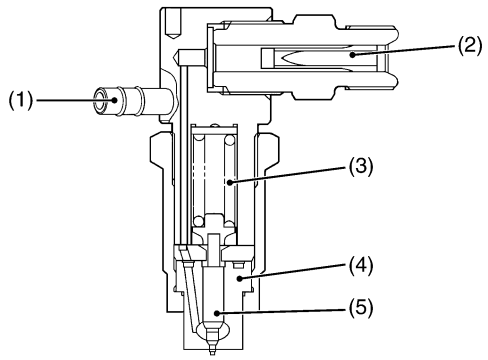
Reverse Suction Function (Dripping Prevention)

1. When the pressure-feeding of fuel ends, the delivery valve lowers and relief plunger (3) section comes into contact with the valve seat.
2. Furthermore, the valve descends until valve surface is in contact with delivery valve seat (2) but as the amount of fuel during interval **A** is sucked back from inside the injection pipe, pressure within the pipe is reduced giving improved cut-off of fuel injection by the nozzle, thereby preventing subsequent dripping of the injectors.

(1) Valve
(2) Valve Seat
(3) Relief Plunger

0000009156E

[3] INJECTION NOZZLE



3ECAAAB1P015A

Due to the use of a throttle type injection nozzle, the fuel injection quantity is small at the beginning of injection, and the fuel injection amount increases gradually for the main fuel injection. This type of injection nozzle features smooth combustion rise and quiet combustion.

The fuel is delivered into the nozzle body (4) by injection pump through the bar filter (2) where fine metallic particles, dirt and other in the fuel are removed.

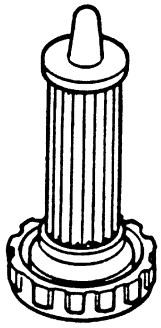
When the fuel pressure overcomes the force of the nozzle spring (3) (injection pressure: 13.92 to 14.51 MPa 142 to 150 kgf/cm^2, 2020 to 2133 psi) the needle valve (5) is pushed up and fuel is injected from the injection port. The fuel which has lubricated between the needle valve and nozzle body returns to the tank through the fuel overflow pipe (1).

Injection pressure is adjusted by changing an adjusting washer thickness.

(1) Fuel Overflow Pipe
(2) Bar Filter
(3) Nozzle Spring
(4) Nozzle Body
(5) Needle Valve

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[4] FUEL FILTER



3ECAAAB1P016A

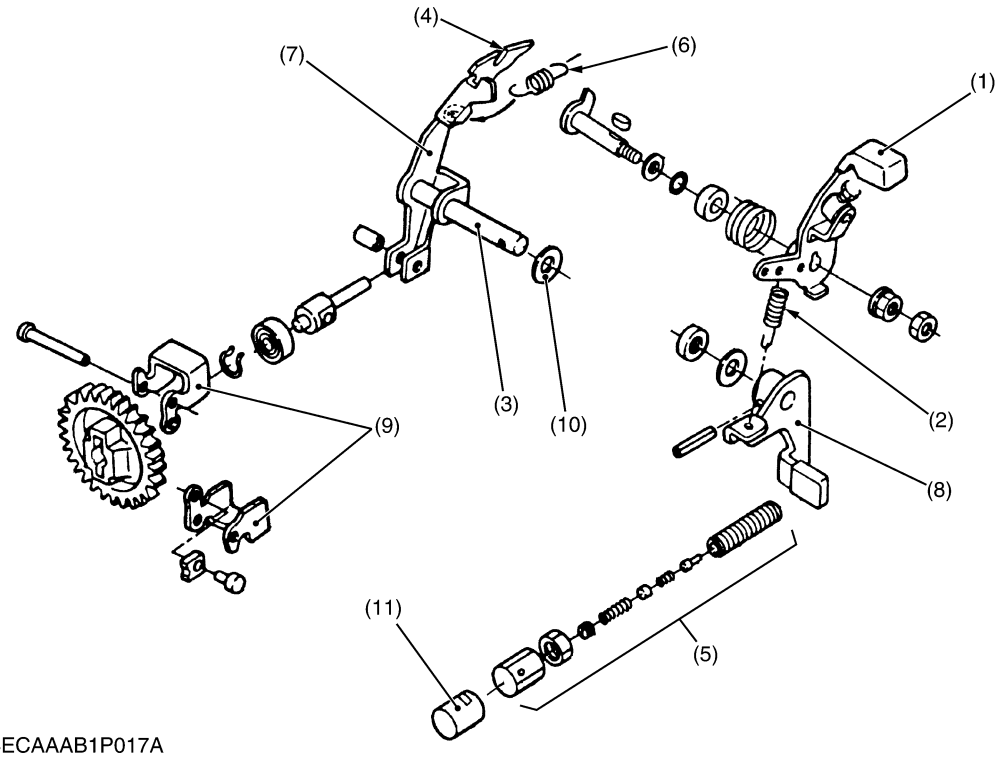
The fuel filter is fitted inside the fuel tank with a ring nut. High-quality filter paper is used to filter out fine particles as small as 30 μm.

Air may enter the filter when it is washed clean or replaced with a new one or when the tank is refueled. To cope with the trouble of discharging the air, the filter has an air vent at the end to allow automatic air removal.

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[5] GOVERNOR MECHANISM

(1) OC60-E2

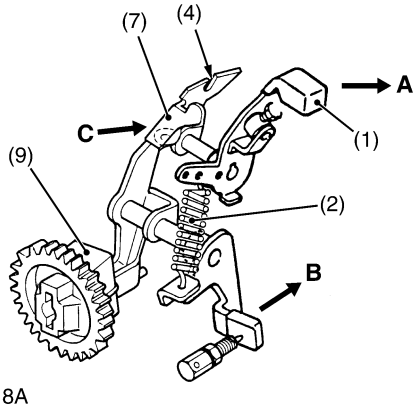


(1) Speed Control Lever
(2) Governor Spring
(3) Governor Shaft
(4) Control Rack
(5) Fuel Limiter
(6) Idle Spring
(7) Governor Lever 1
(8) Governor Lever 3
(9) Governor Weight
(10) Spacer
(11) Cap

3ECAAAB1P017A

A governor is a device which controls the fuel injection of an engine, depending on fluctuations in load, to keep the engine speed and out put power at a constant level. The governor used for this engine is of mechanical type which utilizes the balance between the centrifugal force of the governor weight and the tension of the springs. Its control covers the entire speed range from idling to max rpm. The mechanism consists of the following component part : governor weight, governor lever, governor spring, idle spring, fuel limiter with built in torque spring, speed control lever, and others.

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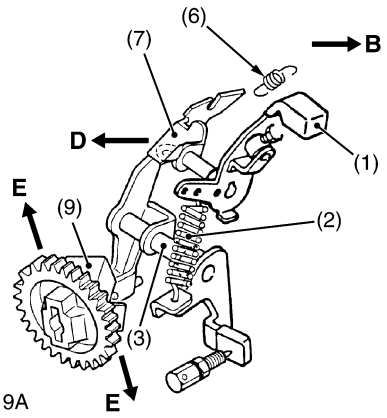


3ECAAAB1P018A

■ At Starting

When the speed control lever (1) is moved in the direction **A**, the governor lever 1 (7) is pulled in the direction **C** by the force of the governor spring (2). At this time, the governor weight (9) has no active centrifugal force, since the engine is not rotating. Thus, the control rack (4) moves to the maximum fuel injection position to facilitate starting of the engine.

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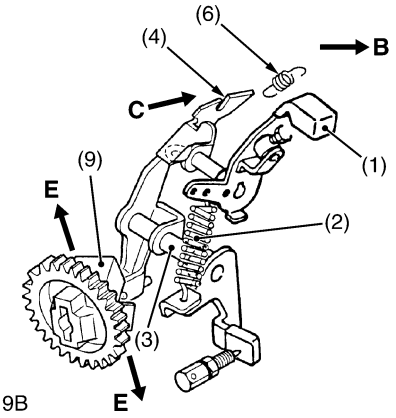


3ECAAAB1P019A

■ **At Idling**

When the speed control lever (1) is set in the idling position, the governor spring (2) is almost relaxed and the idling spring (6) of small tension alone is at work. This idling spring works in the direction **B** (to increase fuel supply). To the contrary, the governor weight (9) extends by the centrifugal force in the direction of E to push the governor shaft (3) and in turn move the governor lever 1 (7) in the direction of **D** (to decrease the fuel supply). The engine will idle in a condition in which the two forces are balanced with each other.

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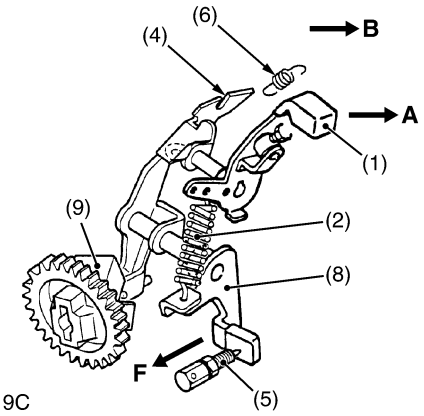


3ECAAAB1P019B

■ **At Idling to Maximum Speed**

When The engine rotates at idling to maximum speeds, engine rotates at a constant speed at the point where the governor spring tension and the governor weight's centrifugal force are well balanced. If the load is increased, the engine speeds down and the centrifugal force of the governor weight (9) becomes smaller, so that the control rack (4) is moved in the direction **C** in which fuel is increased to restore the original speed. In this way, the engine speed is automatically controlled for a constant revolution.

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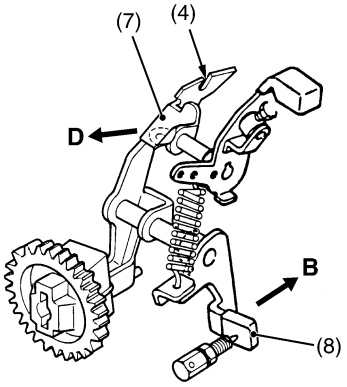


3ECAAAB1P019C

■ **At Maximum Engine Speed**

When the speed control lever (1) is moved in the direction **A**, the governor weight (9) is at the maximum centrifugal force, with the governor lever 3 (8) contacting the fuel limiter (5). As the load becomes large, the speed is reduced, decreasing the governor weight's centrifugal force. Then, the governor lever pushes the fuel limiter (the limiter contains a spring) and moves in the direction **F**. Thus, the control rack (4) is placed at the maximum fuel injection position, producing the maximum engine output power.

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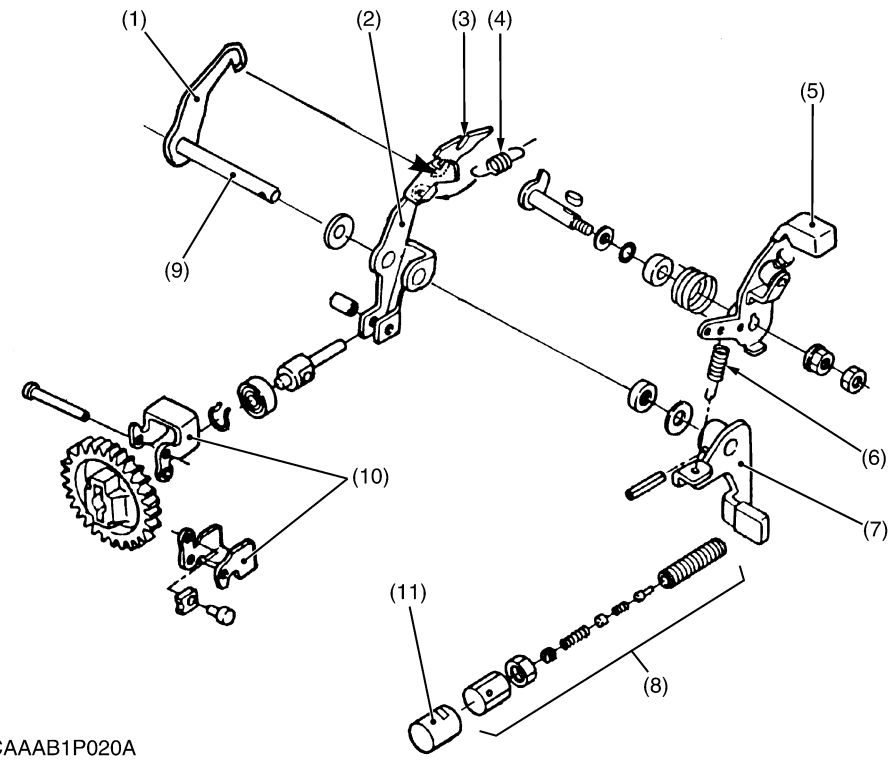
3ECAAAB1P018B

■ **At Engine Stop**

When the governor lever (8) is moved fully in the direction **B** to the stop position, the governor lever (7) moves in direction **D**, thus the control rack (4) is set to the stop position (No fuel injection) and the engine stops.

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(2) OC95-E2

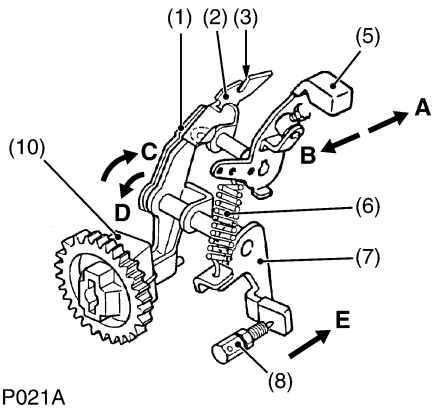


3ECAAAB1P020A

(1) Governor Lever 2
(2) Governor Lever 1
(3) Control Rack
(4) Idle Spring
(5) Speed Control Lever
(6) Governor Spring
(7) Governor Lever 3
(8) Fuel Limiter
(9) Governor Shaft
(10) Governor Weight
(11) Cap

A governor is a device which controls the fuel injection of an engine, depending on fluctuations in load, to keep the engine speed and output power at a constant level. The governor used for this engine is of mechanical type which utilizes the balance between the centrifugal force of the governor weight and the tension of the springs. Its control weight and the tension of the springs. Its control covers the entire speed range from idling to max rpm. The mechanism consists of the following component part: governor weight, governor lever, governor spring, idle spring, fuel limiter with built in torque spring, speed control lever, and others.

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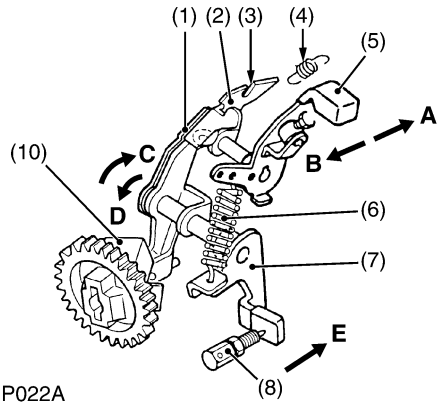


3ECAAAB1P021A

■ At Starting

When the speed control lever (5) is moved in the direction of arrow **A**, the governor lever 2 (1) is pulled by the governor spring (6) and the stop lever of the governor lever 3 (7) turns in the direction of arrow **C** until the stop lever comes into contact with the fuel injection limit pin. The governor lever 1 (2) moves together with the governor lever 2 in the same direction, but even when the governor lever 2 has stopped, the governor lever 1 remains pulled by the idling spring (4) to keep turning just by the clearance of the lever's slit in the same direction. This makes the injection pump's control rack move to the maximum fuel injection rate position, facilitating the start.

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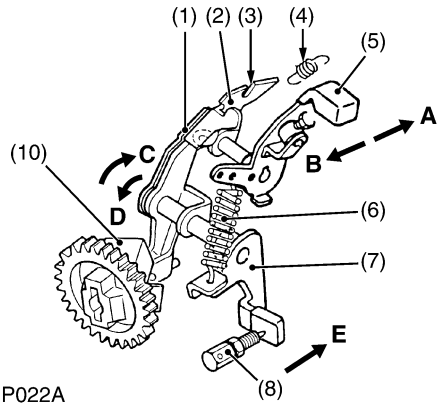


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■ **At Idling**

When the speed control lever (5) is moved in the direction of arrow **B** until it hits against the idling setting bolt (idling position), the governor spring (6) becomes almost dead and the small tension idling spring (4) alone sets to work. The engine starts idling when the idling spring tension and the governor weight's (10) centrifugal force become equal. The idling rpm can be adjusted by repositioning the idling setting bolt,

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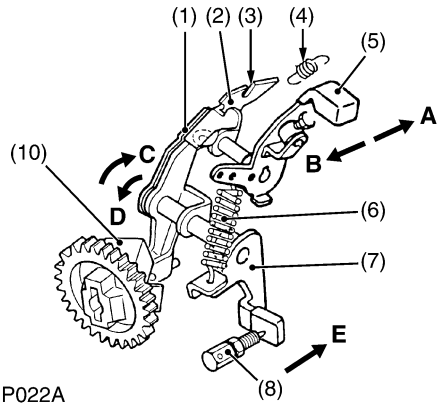
■ **At Idling to Maximum Speed**

While the load is constant, the governor lever 1 (2) is pressed in the direction of arrow **D** by the centrifugal force of the governor weight (10) and at the same time the governor lever 2 (1) is pulled in the direction of arrow **C** by the governor spring (6). The centrifugal force and the spring tension are now in balance against each other to keep the speed constant. With the speed control lever (5), the tension of the governor spring can be changed to control the engine rpm.

As the load increases, the engine rpm drops to reduce the centrifugal force of the governor weight. The governor lever 2 is therefore moved by the governor spring tension, which makes the governor lever 1 turn in the direction of arrow **C**. In so doing, the control rack (3) moves to raise the fuel injection rate and thus to increase the engine power output so that the engine rpm should go up.

As the load decreases, the reverse steps take place to drop the engine power output and thus to prevent an abrupt rise in rpm.

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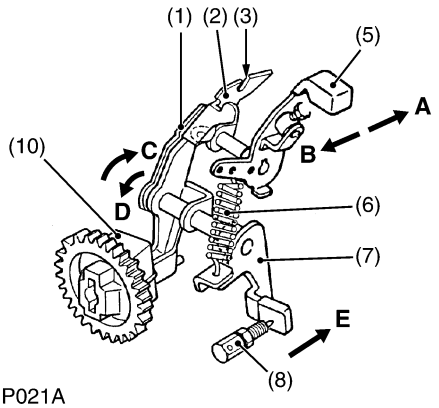


3ECAAAB1P022A

■ **At Maximum Engine Speed**

When the speed control lever is moved in the direction of arrow **A** until it hits against the maximum rpm adjust bolt, the governor lever 3 (7) comes into contact with the fuel injection limit pin to maintain the engine rpm at maximum. If in this state the load increases and the engine rpm starts dropping, the governor lever 3 is activated to push the fuel injection limit pin. This way, the governor levers 2 (1) and 1 (2) turn in the direction of arrow **C** to raise the engine power output.

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3ECAAAB1P021A

■ **At Engine Stop**

When the stop lever of the governor lever 3 (7) is moved to the stop position, the governor lever 2 (1) is activated to move the governor lever 1 (2) in the direction of arrow **D**. The control rack (3) is now moved to the stop position (no fuel injection), thereby stopping the engine.

It should be noted that the fuel injection limit pin and the maximum speed adjust bolt have been factory adjusted with a proper maximum power output in consideration. They should never be readjusted.

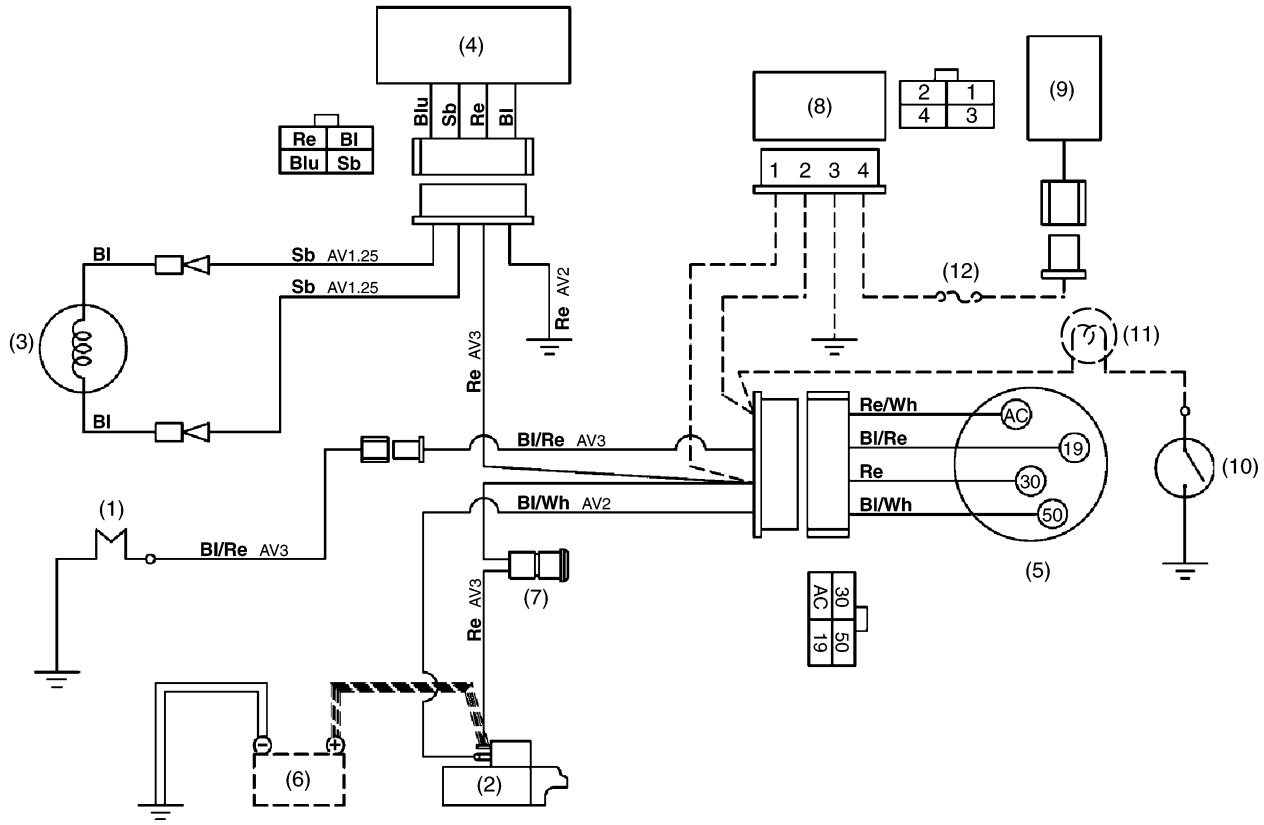
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6. ELECTRICAL SYSTEM

[1] GENERAL

The electrical system of the engine consists of a starting system (including a starter, glow plugs, etc.), a charging system (including a alternator, regulator, etc.), and key switch.

■ **[STANDARD TYPE]**



3ECAAAB1P023A

(1)	Glow Plug	(5)	Key Switch	(9)	Stop Solenoid	**Bl:**	**Black**
(2)	Starter	(6)	Battery (12V)	(10)	Oil Pressure Switch	**Re:**	**Red**
(3)	Dynamo (48 W)	(7)	Slow Blow Fuse	(11)	Warning Lamp (Option)	**Blu:**	**Blue**
(4)	Regulator	(8)	Timer	(12)	Fuse (15A)	**Sb:**	**Sky Blue**
						Bl / Wh:	**Black / White**
						Bl / Re:	**Black / Red**
						Re / Wh:	**Red / White**

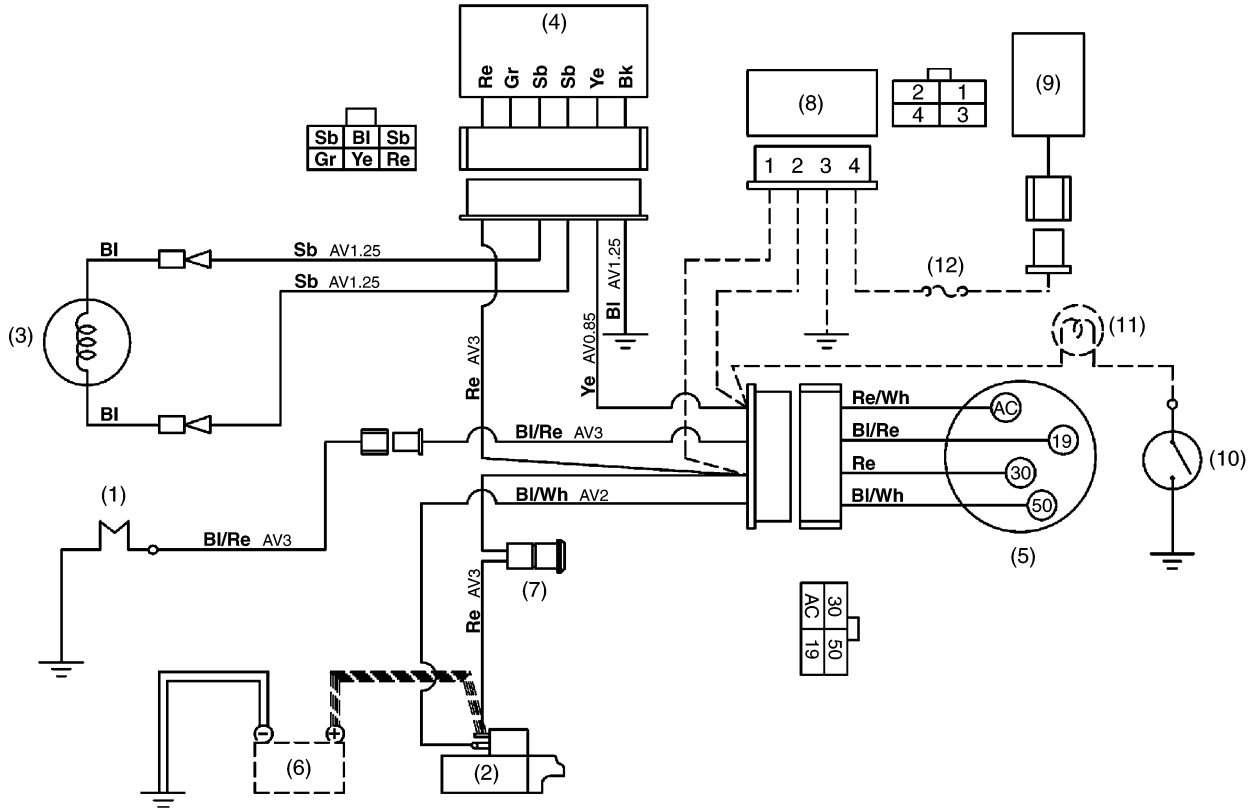
■ **NOTE**

- **The dot lines indicate option parts.**
- **The following modell is with stop solenoid.**

  OC60-E2-D1-QX
  OC60-E2-D1-GX
  OC95-E2-D1-GX

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■ [L TYPE]



3ECAAAB1P112A

(1)	Glow Plug	(5)	Key Switch	(9)	Stop Solenoid	**Bl:**	**Black**
(2)	Starter	(6)	Battery (12V)	(10)	Oil Pressure Switch	**Re:**	**Red**
(3)	Dynamo (150 W)	(7)	Slow Blow Fuse	(11)	Warning Lamp (Option)	**Blu:**	**Blue**
(4)	Regulator	(8)	Timer	(12)	Fuse (15A)	**Sb:**	**Sky Blue**
						Gr:	**Green**
						Ye:	**Yellow**
						Bl / Wh:	**Black / White**
						Bl / Re:	**Black / Red**
						Re / Wh:	**Red / White**

■ NOTE

- **The dot lines indicate option parts.**
- **The following modell is with stop solenoid.**

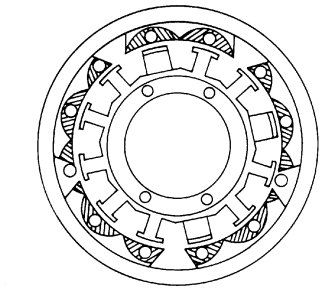
  OC60-E2-D1-QX-L1

  OC95-E2-D1-QX-L1

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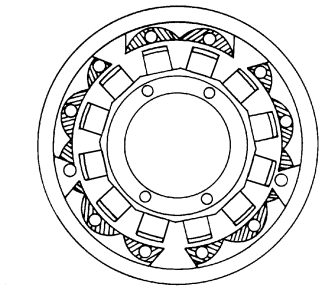
[2] ALTERNATOR

[A]



3ECAAAB1P024A

[B]



3ECAAAB1P025A

This alternator is 12 pole rotating magnet type generator. It is simple in construction, consisting of a stator and rotor.

A permanent magnet is attached on the inner face of the flywheel, which is connected with the engine's crankshaft. As the flywheel turns, the magnet induces electromotive force to each coil of the stator.

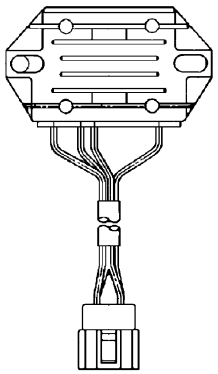
*Figure shows the flywheel, the arrangement of the stator poles, and the magnetized state of the magnet.

[A] Standard Type **[B] L Type**

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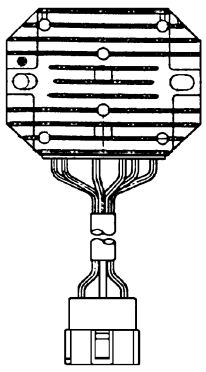
[3] REGULATOR

[A]



3ECAAAB1P114A

[B]



3ECAAAB1P116A

The regulator has a following functions.

- When the battery voltage is too low, it turns on the SCR (silicon controlled rectifier) to form a charging circuit to the battery.
- The figure shows the appearance and internal wiring.

[A] Standard Type **[B] L Type**

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1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	● No fuel	Replenish fuel	—
	● Air in the fuel system	Vent air	—
	● Water in the fuel system	Replace fuel and repair or replace fuel system	—
	● Fuel pipe clogged	Clean	—
	● Fuel filter clogged	Clean and replace	G-8
	● Excessively high viscosity of fuel or engine oil at low temperature	Use the specified fuel	G-4
	● Fuel with low cetane number	Use the specified fuel	G-4
	● Fuel leak due to loose injection pipe retaining nut	Tighten nut	—
	● Incorrect injection timing	Adjust	S-15
	● Fuel camshaft worn	Replace	S-47
	● Injection nozzle clogged	Clean	G-9, 10
	● Injection pump malfunctioning	Replace	S-26
	● Seizure of crankshaft, camshaft, piston, cylinder liner or bearing	Replace	S-44, 47
	● Compression leak from cylinder head	Replace head gasket, Tighten cylinder head bolt and nozzle holder Correct valve seat	S-12
	● Deficient compression	Check and correct valve	S-12
	● Improper valve seat alignment, valve spring broken, valve seized	Replace	S-42
	● Incorrect valve timing	Adjust	S-12
	● Piston ring and liner worn	Replace	S-44, 46
	● Excessive valve clearance	Adjust	G-9
Engine Revolution Is Not Smooth	● Fuel filter clogged or dirty	Clean	G-8
	● Air cleaner clogged	Clean or replace	G-8
	● Fuel leak due to loose injection pipe retaining nut	Tighten nut	—
	● Injection pump malfunctioning	Replace	S-26
	● Incorrect nozzle injection pressure	Repair or adjust	S-17
	● Injection nozzle stuck or clogged	Replace	—
	● Fuel overflow pipe clogged	Clean	—
	● Governor malfunctioning	Repair	M-10, 12

Symptom	Probable Cause	Solution	Reference Page
Either White or Blue Exhaust Gas Is Observed	● Excessive engine oil	Reduce to the specified level	G-6
	● Piston ring and liner worn or stuck	Replace	S-44
	● Incorrect injection timing	Adjust	S-15
	● Deficient compression	Check top clearance and correct valve recessing	S-12
Either Black or Dark Gray Exhaust Gas Is Observed	● Overload	Lessen load	—
	● Low grade fuel used	Use the specified fuel	G-4
	● Fuel filter clogged	Clean or replace	G-8
	● Air cleaner clogged	Clean or replace	G-8
Deficient Output	● Incorrect injection timing	Adjust	S-15
	● Moving parts show sign of seizing	Repair or replace	—
	● Deficient nozzle injection	Repair nozzle replace	S-17
	● Compression leak	Repair	S-12
Excessive Lubricant Oil Consumption	● Piston ring's gaps facing the same direction	Shift ring gap direction	S-32
	● Oil ring worn or stuck	Replace	S-46
	● Piston ring groove worn	Replace piston	S-46
	● Valve stem and guide worn	Replace	S-42
	● Oil leak	Repair	—
Fuel Mixed into Lubricant Oil	● Injection pump broken	Replace pump element or pump	S-26
Low Oil Pressure	● Engine oil insufficient	Replenish	G-6
	● Oil strainer clogged	Clean	G-7
	● Relief valve stuck with dirt	Clean	S-35
	● Relief valve spring weaken or broken	Replace	S-35
	● Excessive oil clearance of crankshaft bearing	Replace	S-47
	● Excessive oil clearance of crank pin bearing	Replace	S-47
	● Oil gallery clogged	Clean	—
	● Different types of oil	Use specified type of oil	G-4
	● Oil pump defective	Repair or replace	S-49, 50
High Oil Pressure	● Different types of oil	Use the specified type of oil	G-4
	● Relief valve defective	Replace	S-35

Symptom	Probable Cause	Solution	Reference Page
Engine Overheated	● Engine oil insufficient	Replenish	G-6
	● Overload running	Loosen the load	—
	● Head gasket defective	Replace	S-26
	● Incorrect injection timing	Adjust	S-15
	● Unsuitable fuel used	Use the specified fuel	G-4

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2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Cylinder Head Surface Flatness		—	0.05 mm 0.0020 in.
Top Clearance	OC60-E2	0.60 to 0.75 mm 0.0236 to 0.0295 in.	—
	OC95-E2	0.65 to 0.80 mm 0.0256 to 0.0315 in.	—
Cylinder Head Gasket Thickness (Gromet Section)	Free (OC60-E2)	1.05 to 1.20 mm 0.0413 to 0.0472 in.	—
	Free (OC95-E2)	1.35 to 1.55 mm 0.0531 to 0.0610 in.	—
	Tightened (OC60-E2)	0.95 to 1.05 mm 0.0374 to 0.0413 in.	—
	Tightened (OC95-E2)	1.25 to 1.35 mm 0.0492 to 0.0531 in.	—
Compression Pressure		35 to 40 kgf/cm^2 3.43 to 3.92 MPa 498 to 569 psi	25.2 kgf/cm^2 2.47 MPa 358 psi
Valve Clearance (Cold)		0.14 to 0.18 mm 0.0055 to 0.0071 in.	—
Valve Seat Width		2.12 mm 0.0835 in.	—
Valve Seat Angle		45 ° 0.785 rad	—
Valve Face Angle		45.5 ° 0.794 rad	—
Valve Recessing		0.60 to 0.85 mm 0.0236 to 0.0335 in.	1.3 mm 0.0512 in.
Clearance Between Valve Stem and Valve Guide	OC60-E2	0.030 to 0.057 mm 0.0012 to 0.0022 in.	0.1 mm 0.0039 in.
	OC95-E2	0.035 to 0.065 mm 0.0014 to 0.0026 in.	0.1 mm 0.0039 in.
Valve Stem O.D.	OC60-E2	5.968 to 5.980 mm 0.2350 to 0.2354 in.	—
	OC95-E2	6.960 to 6.975 mm 0.2740 to 0.2746 in.	—
Valve Guide I.D.	OC60-E2	6.010 to 6.025 mm 0.2366 to 0.2372 in.	—
	OC95-E2	7.010 to 7.025 mm 0.2760 to 0.2766 in.	—

Item		Factory Specification	Allowable Limit
Inlet Valve	Open	0.35 rad (20 °) before T.D.C.	—
	Close	0.86 rad (49 °) after B.D.C.	—
Exhaust Valve	Open	0.94 rad (54 °) before B.D.C.	—
	Close	0.26 rad (15 °) after T.D.C.	—
Free Length	OC60-E2	31.3 to 31.8 mm 1.2323 to 1.2520 in.	31.0 mm 1.2205 in.
	OC95-E2	36.5 to 37.0 mm 1.4370 to 1.4567 in.	36.0 mm 1.4173 in.
Setting Load / Setting Length	OC60-E2	6.1 kgf / 27.3 mm 59.8 N / 27.3 mm 13.5 lbs / 1.075 in.	5.3 kgf / 27.3 mm 52 N / 27.3 mm 11.7 lbs / 1.075 in.
	OC95-E2	8.4 kgf / 31 mm 82.4 N / 31 mm 18.5 lbs / 1.220 in.	7.6 kgf / 31 mm 74.5 N / 31 mm 16.8 lbs / 1.220 in.
Tilt		—	1.2 mm 0.0472 in.
Clearance Between Rocker Arm Shaft and Shaft Hole		0.016 to 0.045 mm 0.0006 to 0.0018 in.	0.12 mm 0.0047 in.
Rocker Arm Shaft O.D.	OC60-E2	11.973 to 11.984 mm 0.4714 to 0.4718 in.	—
	OC95-E2	13.973 to 13.984 mm 0.5501 to 0.5506 in.	—
Rocker Arm Shaft Hole I.D.	OC60-E2	12.000 to 12.018 mm 0.4724 to 0.4731 in.	—
	OC95-E2	14.000 to 14.018 mm 0.5512 to 0.5519 in.	—
Clearance Between Tappet and Guide		0.018 to 0.058 mm 0.0007 to 0.0023 in.	0.1 mm 0.0039 in.
Tappet O.D.		7.972 to 7.987 mm 0.3139 to 0.3144 in.	—
Tappet Guide I.D.		8.005 to 8.030 mm 0.3152 to 0.3161 in.	—
Camshaft Side Clearance	OC60-E2	0.05 to 0.20 mm 0.0020 to 0.0079 in.	0.35 mm 0.0138 in.
	OC95-E2	0.05 to 0.25 mm 0.0020 to 0.0098 in.	0.35 mm 0.0138 in.
Cam Height (IN., EX.)	OC60-E2 (IN, EX)	27.0 mm 1.0630 in.	26.5 mm 1.0433 in.
	OC95-E2 (IN)	28.0 mm 1.1024 in.	27.5 mm 1.0827 in.
	OC95-E2 (EX)	30.0 mm 1.1811 in.	29.5 mm 1.1614 in.

Item		Factory Specification	Allowable Limit
Oil Clearance of Camshaft Journal	OC60-E2	0.016 to 0.045 mm 0.0006 to 0.0018 in.	0.08 mm 0.0031 in.
	OC95-E2	0.020 to 0.054 mm 0.0008 to 0.0021 in.	0.08 mm 0.0031 in.
Camshaft Journal O.D.	OC60-E2	16.989 to 17.000 mm 0.6689 to 0.6693 in.	—
	OC95-E2	19.987 to 20.000 mm 0.7869 to 0.7874 in.	—
Crank Gear - Cam Gear		0.033 to 0.175 mm 0.0013 to 0.0069 in.	0.3 mm 0.0118 in.
Balancer Gear 1 - Balancer Gear 2		0.033 to 0.170 mm 0.0013 to 0.0067 in.	0.3 mm 0.0118 in.
Clearance Between Balancer Gear Shaft and Balancer Gear Bearing		0.016 to 0.042 mm 0.0006 to 0.0017 in.	0.08 mm 0.0031 in.
Shaft O.D.	OC60-E2	13.992 to 14.000 mm 0.5509 to 0.5512 in.	—
	OC95-E2	15.992 to 16.000 mm 0.6296 to 0.6299 in.	—
Bearing I.D.	OC60-E2	14.016 to 14.034 mm 0.5518 to 0.5525 in.	—
	OC95-E2	16.016 to 16.034 mm 0.6306 to 0.6313 in.	—
Balancer Gear Side Clearance		0.12 to 0.37 mm 0.0047 to 0.0146 in.	0.5 mm 0.0197 in.
Piston Pin Bore	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.	20.03 mm 0.7886 in.
	OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.	23.03 mm 0.9067 in.
Clearance Between Compression Ring 2 and Ring Groove	OC60-E2	0.030 to 0.065 mm 0.0012 to 0.0026 in.	0.15 mm 0.0059 in.
	OC95-E2	0.045 to 0.080 mm 0.0018 to 0.0031 in.	0.15 mm 0.0059 in.
Piston Ring Groove 2 Width	OC60-E2	1.520 to 1.535 mm 0.0598 to 0.0604 in.	—
	OC95-E2	2.035 to 2.050 mm 0.0801 to 0.0807 in.	—
Compression Ring 2 Width	OC60-E2	1.470 to 1.490 mm 0.0579 to 0.0587 in.	—
	OC95-E2	1.970 to 1.990 mm 0.0776 to 0.0783 in.	—
Clearance Between Oil Ring and Ring Groove		0.020 to 0.055 mm 0.0008 to 0.0022 in.	0.15 mm 0.0059 in.
Piston Oil Ring Groove Width	OC60-E2	3.510 to 3.525 mm 0.1382 to 0.1388 in.	—
	OC95-E2	4.010 to 4.025 mm 0.1579 to 0.1585 in.	—

Item		Factory Specification	Allowable Limit
OIl Ring Width	OC60-E2	3.470 to 3.490 mm 0.1366 to 0.1374 in.	—
	OC95-E2	3.970 to 3.990 mm 0.1563 to 0.1571 in.	—
Ring Gap	Compression Ring 1 (OC60, 95-E2)	0.15 to 0.30 mm 0.0059 to 0.0118 in.	1.2 mm 0.0472 in.
	Compression Ring 2 (OC60-E2)	0.25 to 0.45 mm 0.0098 to 0.0177 in.	1.2 mm 0.0472 in.
	Compression Ring 2 (OC95-E2)	0.30 to 0.50 mm 0.0118 to 0.0197 in.	1.2 mm 0.0472 in.
	Oil Ring (OC60, 95-E2)	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.2 mm 0.0472 in.
Connecting Rod Alignment		—	0.05 mm 0.0020 in.
Clearance Between Piston Pin and Small End		0.012 to 0.040 mm 0.0005 to 0.0016 in.	0.15 mm 0.0059 in.
Piston Pin O.D.	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.	—
	OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.	—
Small End I.D.	OC60-E2	20.025 to 20.040 mm 0.7884 to 0.7890 in.	—
	OC95-E2	23.025 to 23.040 mm 0.9065 to 0.9071 in.	—
Crankshaft Alignment		0.02 mm 0.0008 in.	0.8mm 0.0031 in.
Oil Clearance Between Crankshaft Journal and Crankshaft Bearing		0.028 to 0.090 mm 0.0011 to 0.0035 in.	0.2 mm 0.0079 in.
Crankshaft O.D.	OC60-E2	34.934 to 34.950 mm 1.3754 to 1.3760 in.	—
	OC95-E2	39.934 to 39.950 mm 1.5722 to 1.5728 in.	—
Crankshaft Bearing I.D.	OC60-E2	34.978 to 35.024 mm 1.3771 to 1.3789 in.	—
	OC95-E2	39.978 to 40.024 mm 1.5739 to 1.5757 in.	—
Oil Clearance Between Crank Pin and Crank Pin Bearing		0.025 to 0.087 mm 0.0010 to 0.0034 in.	0.2 mm 0.0079 in.
Crankshaft O.D.	OC60-E2	35.959 to 35.975 mm 1.4157 to 1.4163 in.	—
	OC95-E2	39.959 to 39.975 mm 1.5732 to 1.5738 in.	—

Item		Factory Specification	Allowable Limit
Crankshaft Bearing I.D.	OC60-E2	36.000 to 36.046 mm 1.4173 to 1.4191 in.	—
	OC95-E2	40.000 to 40.046 mm 1.5748 to 1.5766 in.	—
Crankshaft Side Clearance		0.05 to 0.20 mm 0.0020 to 0.0079 in.	0.35 mm 0.0138 in.
Cylinder Liner I.D.	OC60-E2	72.000 to 72.019 mm 2.8346 to 2.8354 in.	72.10 mm 2.839 in.
	OC95-E2	83.018 to 83.038 mm 3.2684 to 3.2692 in.	83.10 mm 3.272 in.
Difference Between I.D.'s at The Maximum and Minimum Wear Position		—	+ 0.10 mm 0.0039 in.

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LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	49 kPa (0.5 kgf/cm^2, 7 psi) or more	—
	At Rated Speed	147 to 490 kPa (1.5 to 5.0 kgf/cm^2, 21 to 71 psi)	98 kPa (1 kgf/cm^2 14.22 psi)
Clearance Between Inner Rotor and Outer Rotor		0.15 mm 0.0059 in.	0.2 mm 0.0079 in.
Clearance Between Outer Rotor and Pump Body		0.090 to 0.171 mm 0.0035 to 0.0067 in.	0.24 mm 0.0094 in.
End Clearance Between Inner Rotor and Cover		0.02 to 0.06 mm 0.0008 to 0.0024 in.	0.25 mm 0.0098 in.

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FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Timing (Static)	OC60-E2	0.26 to 0.30 rad (15 ° to 17 °) before T.D.C.	—
	OC95-E2	0.23 to 0.26 rad (13 ° to 15 °) before T.D.C.	—
Fuel Tightness of Pump Element		—	14.7 MPa 150 kgf/cm^2 2133 psi
Fuel Tightness of Delivery Valve		10 seconds or more 14.7 → 13.9 MPa 150 → 142 kgf/cm^2 2133 → 2019 psi	5 seconds or more 14.7 → 13.9 MPa 150 → 142 kgf/cm^2 2133 → 2019 psi
Fuel Injection Pressure		13.7 MPa 140 kgf/cm^2 1987 psi	—
Fuel Tightness of Nozzle Valve Seat		When the pressure is 12.7 MPa (130 kgf/cm^2, 1849 psi) the valve seat must be fuel tightness	—

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ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Starter	Commutator O.D. (OC60-E2)	28.0 mm 1.1024 in.	27.0 mm 1.0630 in.
	Commutator O.D. (OC95-E2)	30.0 mm 1.1811 in.	29.0 mm 1.1417 in.
	Mica Undercut (OC60-E2)	0.45 to 0.75 mm 0.0177 to 0.0295 in.	0.2 mm 0.0079 in.
	Mica Undercut (OC95-E2)	0.50 to 0.80 mm 0.0197 to 0.0315 in.	0.2 mm 0.0079 in.
	Brush Length (OC60-E2)	10.0 mm 0.3937 in.	6.0 mm 0.2362 in.
	Brush Length (OC95-E2)	15.0 mm 0.5906 in.	10.0 mm 0.3937 in.
Alternator	Changing Current (Standard type)	4 to 6 A at 3600 min^{-1}	—
	Changing Current (L type)	14 A or more at 3600 min^{-1}	—
Glow Plug	Glow Plug Resistance	1.09 to 1.29 Ω	—

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3. TIGHTENING TORQUES

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

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

Item	Size x Pitch	N·m	kgf·m	ft-lbs
**Cylinder head screws (OC60-E2)	M10 x 1.5	51.9 to 56.8	5.3 to 5.8	38.3 to 42.0
**Cylinder head screws (OC95-E2)	M12 x 1.75	68.6 to 73.6	7.0 to 7.5	50.6 to 54.2
**Connecting rod screws (OC60-E2)	M7 x 1.0	18.6 to 21.6	1.9 to 2.2	13.7 to 15.9
**Connecting rod screws (OC95-E2)	M8 x 1.25	27.5 to 30.4	2.8 to 3.1	20.3 to 22.4
*Flywheel nut (OC60-E2)	M20 x 1.5	137 to 157	14 to 16	101 to 116
*Flywheel nut (OC95-E2)	M24 x 1.5	235 to 255	24 to 26	174 to 188
Side cover screws	M8 x 1.25	23.5 to 27.4	2.4 to 2.8	17.4 to 20.3
**Rocker arm bracket mounting nut	M8 x 1.25	23.5 to 27.4	2.4 to 2.8	17.4 to 20.3
Injection pump mounting screw	M6 x 1.0	9.8 to 11.3	1.0 to 1.15	7.2 to 8.3
Injection pump eye joint bolt	M10 x 1.0	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection pipe retaining nuts	M12 x 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
Oil pipe eye joint bolt	M12 x 1.25	24.5 to 29.4	2.5 to 3.0	18.1 to 21.7
Grow plug	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle holder mounting nuts	M8 x 1.25	13.72 to 17.6	1.4 to 1.8	10.1 to 13.0
Oil switch taper screw	PT1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Exhaust manifold mounting nuts	M8 x 1.25	23.5 to 27.4	2.4 to 2.8	17.4 to 20.3

* Apply Molycoat oil to the threads of the nuts marked "*" and tighten them up.
** Apply enough engine oil to the threads and bearing surface of the bolts and nuts marked "**" and tighten them up.

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

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

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

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

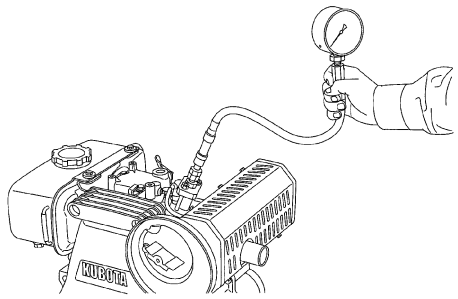
Punched number	Screw and bolt material grade
None or 4	Standard screw and bolt SS41, S20C
7	Special screw and bolt S43C, S48C (Refined)

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4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body



3ECAAAB1P027A

Compression Pressure

1. After warming up the engine, stop it and remove the air cleaner, and nozzle holder.
2. Install a compression tester for diesel engines to nozzle holder hole.
3. After making sure that the speed control lever is set at the stop position (Non-injection), run the engine at 3.3 to 5.0 1/s (200 to 300 rpm) with the starter.
4. Read the maximum pressure. Measure the pressure more than twice.
5. If the measurement is below the allowable limit, check the cylinder, piston ring, top clearance, valve and cylinder head.
6. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the nozzle hole and measure the compression pressure again.
7. If the compression pressure is still less than the allowable limit, check the top clearance, valve clearance and cylinder head.
8. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

■ NOTE

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for performing this test.**
- **Variances in cylinder compression values should be under 10 %.**

Compression pressure	Factory spec.	3.43 to 3.92 MPa 35 to 40 kgf/cm^2 497 to 568 psi
	Allowable limit	2.47 MPa 25.2 kgf/cm^2 358 psi

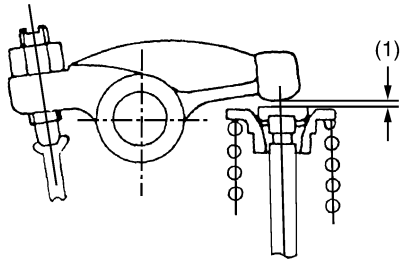
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Valve Clearance

■ IMPORTANT

- **The valve clearance must be inspected and adjusted as needed when the engine is cold (equal to the atmospheric air temperature).**

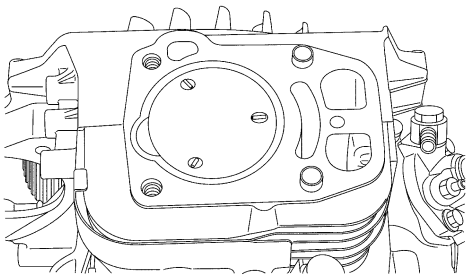
Valve clearance (Cold)	Factory spec.	0.14 to 0.18 mm 0.0055 to 0.0071 in.



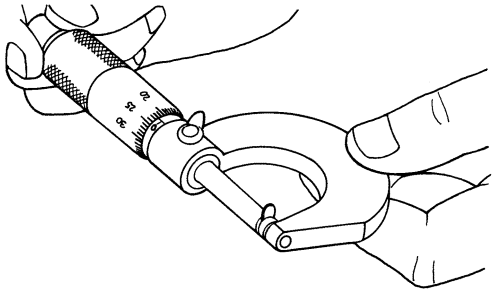
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(1) Valve Clearance

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Top Clearance

1. Remove the cylinder head. (Do not attempt to remove the cylinder head gasket.).
2. Move the piston up, and stick a strip of fuse [1.5 mm dia. (0.059 in. dia.), 5 to 7 mm long (0.197 to 0.276 in. long)] on the piston head at three positions with grease so as to avoid the intake and exhaust valves and the combustion chamber ports.
3. Lower the piston, and install the cylinder head and tighten the cylinder head screws to the specified torque.
4. Turn the flywheel until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure the thickness of the squeezed fuses.
6. If the measurement is not within the factory specifications, check the oil clearance between the crankpin and crankpin bearing and between the piston pin and small end bushing.

■ **NOTE**

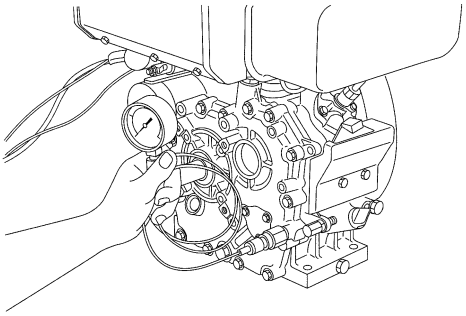
- **After checking the top clearance, be sure to assemble the cylinder head with a new cylinder head gasket.**

Top clearance	Factory spec.	OC60-E2	0.60 to 0.75 mm 0.0236 to 0.0295 in.
		OC95-E2	0.65 to 0.80 mm 0.0256 to 0.0315 in.

Tightening torque	Cylinder head mounting bolts	OC60-E2	51.9 to 56.8 N·m 5.3 to 5.8 kgf·m 38.3 to 42 ft-lbs
		OC60-E2 OC95-E2	68.6 to 73.6 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 ft-lbs

0000009193E

(2) Lubricating System



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Engine Oil Pressure

1. Remove the screw plug and install an engine 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 defective
- Oil strainer clogged
- Excessive oil clearance of bearing
- Foreign matter in the relief valve
- Oil gallery clogged

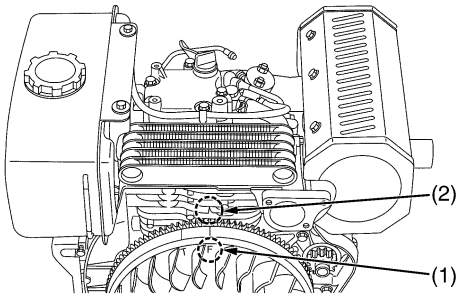
(Engine oil pressure)

At idle speed	Factory spec.	49 kPa or more 0.5 kgf/cm^2 or more 7 psi or more
At rated speed	Factory spec.	147 to 490 kPa 1.5 to 5.0 kgf/cm^2 21 to 71 psi
	Allowable limit	98 kPa 1.0 kgf/cm^2 14 psi

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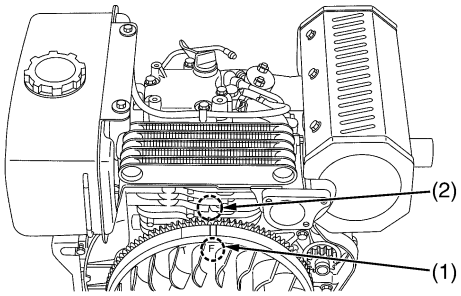
(3) Fuel System

[A]

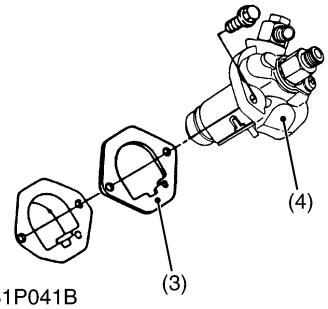


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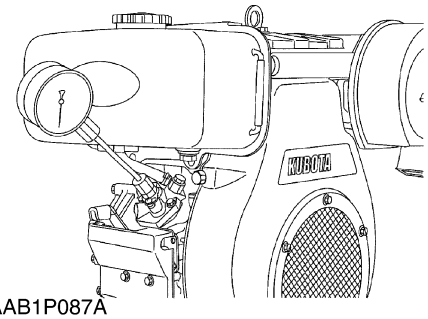
[B]



3ECAAAB1P115A



3ECAAAB1P041B



3ECAAAB1P087A

Adjusting Injection Timing

1. Connect the injection pipe to the injection pump as shown in the figure.
2. Set the speed control lever to the maximum speed position.
3. Turn the flywheel clockwise to check that fuel comes out from the tip of the injection pipe.
4. Turn the flywheel so that the **F** mark (1) on the flywheel circumference reaches near below the mark (2) on the fin slowly turn the flywheel clockwise from that position, and stop it immediately when the fuel level at the tip of the injection pipe begins rising. At this time, check if the **F** mark (1) on the flywheel circumference aligns with the fin mark.
5. If the timing is incorrect, adjust it with shims (3).

Injection timing	Factory spec.	OC60-E2	0.26 to 0.30 rad 15° to 17° before T.D.C.
		OC95-E2	0.23 to 0.26 rad 13° to 15° before T.D.C.

■ NOTE

- There are 2 **F** mark lines in **[B]**.
- Use the line near **T** mark to adjust.

(Reference)

- Adding or removing one shim (0.15 mm, 0.0059 in.) varies the crank angle by approx. 0.017 rad to 0.026 rad (1° to 1.5°)

(1) **F** Mark
(2) Mark
(3) Injection Timing Adjusting Shim
(4) Injection Pump

[A] OC60-E2
[B] OC95-E2

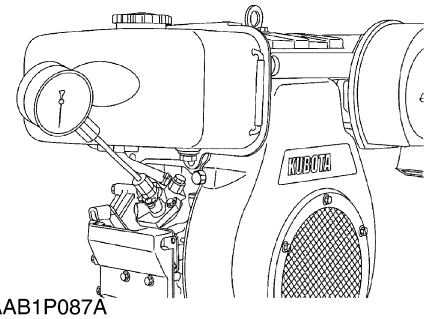
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Fuel Tightness of Pump Element

1. Set an injection pump pressure tester to the injection pump.
2. Set the speed control lever to the maximum speed position.
3. Turn the engine ten times or more with the starter to increase the pressure.
4. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Pump element fuel tightness	Allowable limit	14.7 MPa 150 kgf/cm^2 2133 psi

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3ECAAAB1P087A

Fuel Tightness of Delivery Valve

1. In the same way as to check the pump element fuel tightness, turn the engine ten times or more with the starter so that the pressure is increased to specified pressure.
2. Set the plunger at the bottom dead center to reduce the delivery chamber pressure to zero.
3. Measure the fall time for the pressure to drop to the reference pressure from the specified initial pressure.
4. If the measurement is less than the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

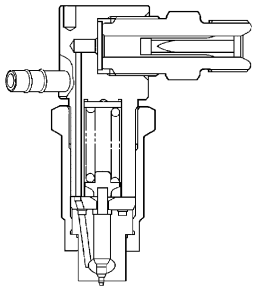
Delivery valve fuel tightness	Allowable limit	14.7 → 13.9 MPa 150 → 142 kgf/cm^2 2133 → 2019 psi	5 seconds or less

0000009207E

CAUTION

- **Be careful not to come into direct contact with the injected spray. The spray destroys any cells it touches. It may also cause blood poisoning, etc. Check the injection nozzle after confirming that nobody is standing in the direction of the spray.**

0000009211E

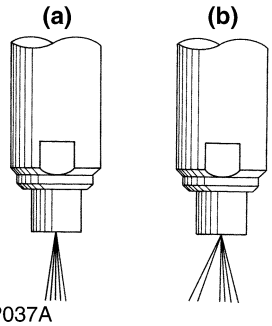

3ECAAAB0P010A

Nozzle Spraying Condition

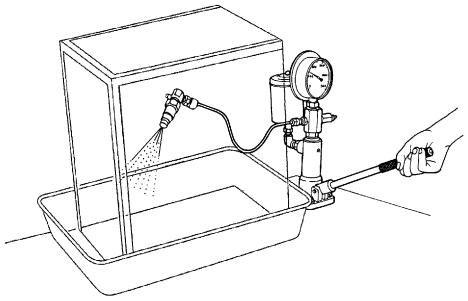
1. Check the nozzle spray condition.
2. If the spray pattern and spraying direction are faulty, replace the nozzle piece.

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

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3ECAAAB1P109A

Fuel Injection Pressure

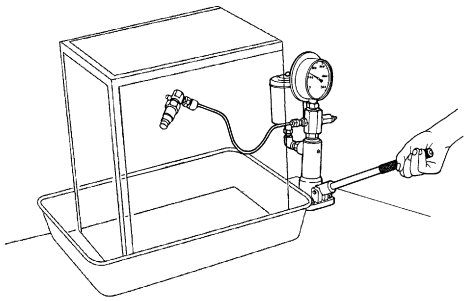
1. Set the injection nozzle to a nozzle tester.
2. Measure the injection pressure.
3. If the measurement is not within the factory specifications, adjust with the adjusting washer inside the nozzle holder.

Fuel injection pressure	Factory spec.	13.9 to 14.7 MPa 142 to 150 kgf/cm^2 2019 to 2133 psi

(Reference)

- Pressure change per 0.1 mm (0.039 in.) adjusting washer:
  Approx. 981 kPa
  10 kgf/cm^2
  142 psi

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3ECAAAB1P110A

Valve Seat Tightness

1. Apply a pressure 12.7 to 13.9 MPa (130 to 142 kgf/cm^2, 1849 to 2019 psi) lower than the fuel injection pressure.
2. After keeping the nozzle under this pressure for 10 seconds, check to see if fuel leaks from the nozzle.
3. If any fuel leak is found, replace the nozzle piece.

0000009214E

(4) Electrical System

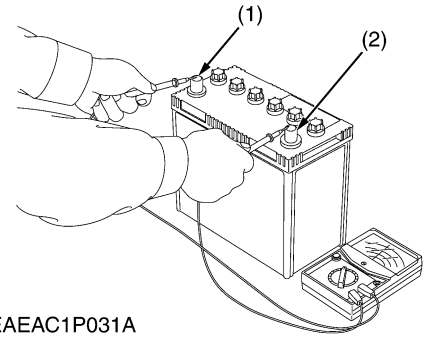
CAUTION

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

IMPORTANT

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

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3EEAEAC1P031A

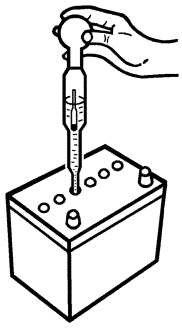
Battery Voltage

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

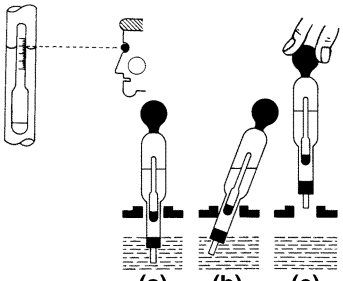
Battery Voltage	Factory spec.	More than 12V

(1) Positive Terminal (2) Negative Terminal

0000010713E



3EEABAB1P034A



3EEABAB1P035B

Battery Specific Gravity

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

■ NOTE

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

(Reference)

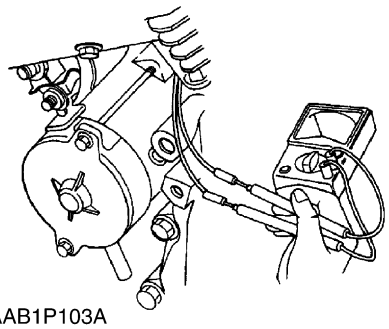
- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 ℃ (0.0004 with an increase of 1 ℉) in temperature, and increases by 0.0007 with a decreases of 1 ℃ (0.0004 with a decrease of 1 ℉).
  Therefore, using 20 ℃ (68 ℉) as a reference,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

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

At an electrolyte temperature of 20 ℃ (68 ℉)

(a) Good
(b) Bad
(c) Bad

0000001142E



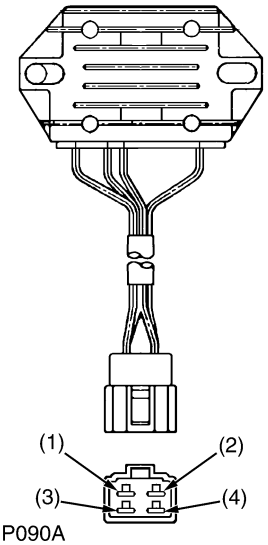
3ECAAAB1P103A

Alternator's No-load Voltage

1. Disconnect the lead wire from the alternator.
2. Start the engine and measure the voltage generated by the alternator.

No-load output	Factory spec.	Standard type	Approx. AC 38 V at 3600 min^{-1} (rpm)
		L type	Approx. AC 52 V at 3600 min^{-1} (rpm)

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3ECAAAB1P090A

Regulator (Standard Type)

1. The engine is started.
2. Measure the output voltage of the regulator with the voltmeter.

Output Voltage	(1) - (2)	14 V to 15 V at 3600 min^{-1} (rpm)

3. When the measurement is not the above table value, measure the input voltage of the regulator with the voltmeter.

Input Voltage	(3) - (4)	Approx. AC 38 V at 3600 min^{-1} (rpm)

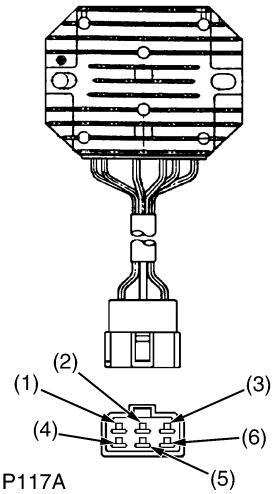
4. When the measurement is the above table value, the regulator is failure. Exchange it.

■ **NOTE**

- **When the input voltage of the regulator is out of specification, check the generator.**

(1) Terminal (Red)
(2) Terminal (Black)
(3) Terminal (Blue)
(4) Terminal (Sky Blue)
(5) Terminal (Yellow)
(6) Terminal (Green)

0000009218E



3ECAAAB1P117A

Regulator (L Type)

1. The engine is started.
2. Measure the output voltage of the regulator with the voltmeter.

Output Voltage	(6) - (2)	14 V to 15 V at 3600 min^{-1} (rpm)

3. When the measurement is not the above table value, measure the input voltage of the regulator with the voltmeter.

Input Voltage	(1) - (3)	Approx. AC 52 V at 3600 min^{-1} (rpm)

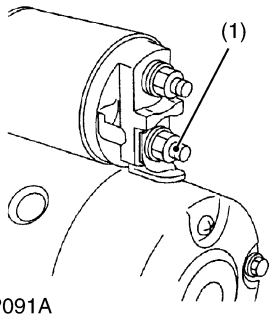
4. When the measurement is the above table value, the regulator is failure. Exchange it.

■ **NOTE**

- **When the input voltage of the regulator is out of specification, check the generator.**

(1) Terminal (Sky Blue)
(2) Terminal (Black)
(3) Terminal (Sky Blue)
(4) Terminal (Green)
(5) Terminal (Yellow)
(6) Terminal (Red)

0000009676E



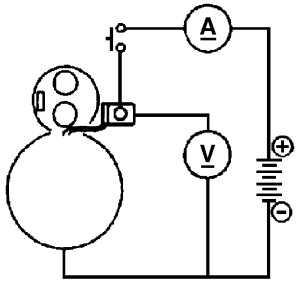
3ECAAAB1P091A

Motor Test (OC60-E2)

1. Disconnect the connecting lead to **M** terminal (1) and connect a voltmeter across the lead and the body of the starter.
2. Connect a cable between the negative terminal of the battery and the starter body.
3. Connect an ammeter and a switch in series between the positive terminal of the battery and the connecting lead, and run the starter.
4. The starter should run at the specified rate.

(1) **M** Terminal

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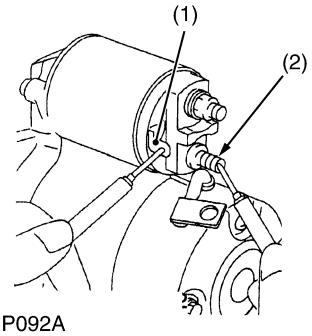
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Solenoid Switch (OC60-E2)

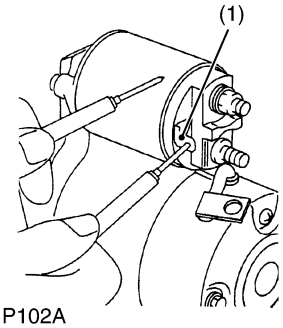
1. Check the continuity across **S** terminal (1) and **M** terminal (2), and across **S** terminal (1) and the body with an ohmmeter.
2. If not continuous, replace.

(1) **S** Terminal (2) **M** Terminal

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3ECAAAB1P092A



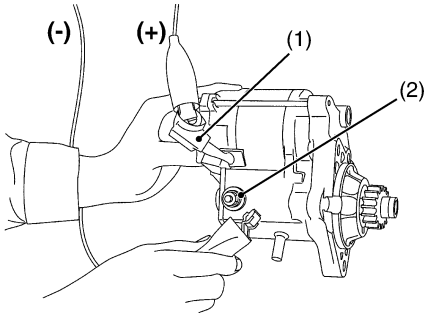
3ECAAAB1P102A

Motor Test (OC95-E2)

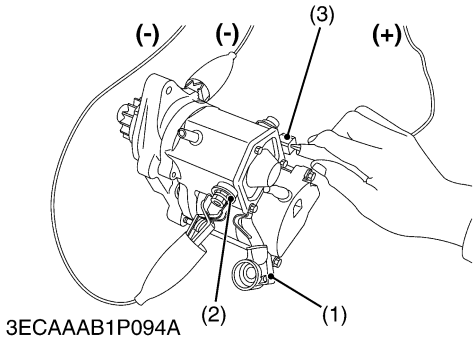
1. Remove the connecting lead (1) from the starter's **C** terminal (2) and connect it directly to the battery's positive terminal.
2. Then connect the battery's negative terminal to the starter body.
3. If motor rotates smoothly, it is O.K.

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

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3ECAAAB1P094A

Magnet Switch (OC95-E2)

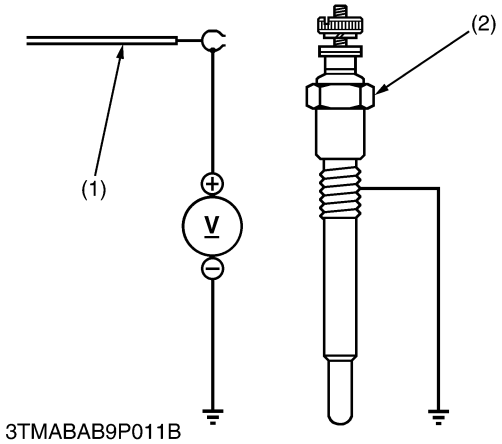
1. Disconnect the connecting lead (1) from the **C** terminal (2) of the starter.
2. Connect jumper leads from the negative terminal of 12V battery to the body and **C** terminal (2) of the magnet switch.
3. The pinion gear should pop out, when a jumper lead is connected between the positive terminal of the battery to the **S** terminal (3) of the magnet switch.
4. The pinion gear should stay out without the jumper from the negative terminal to the **C** terminal (2).

■ **NOTE**

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

(1) Connecting Lead (3) **S** Terminal
(2) **C** Terminal

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3TMABAB9P011B

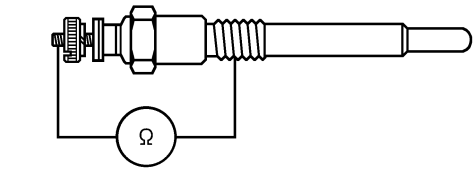
Lead Terminal Voltage

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

Voltage (Lead terminal - Chassis)	Main switch key at **"GLOW"**	Approx. battery voltage
	Main switch key at **"START"**	Approx. battery voltage

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

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3TMABAB9P012A

Glow Plug Continuity

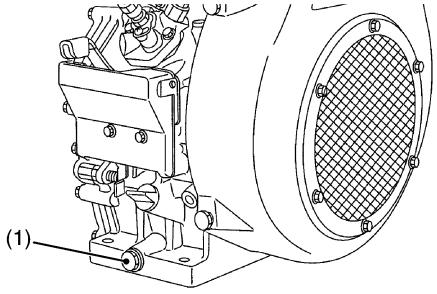
1. Disconnect the lead from the glow plugs.
2. Measure the resistance between the glow plug terminal and the chassis.
3. If 0 ohm is indicated, the screw at the tip of the glow plug and the housing are short-circuited.
4. If the factory specification is not indicated, the glow plug is faulty.

Glow plug resistance	Factory spec.	Approx. 0.9 Ω

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[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Engine Oil and Fuel



3ECAAAB1P029A

Draining Engine Oil

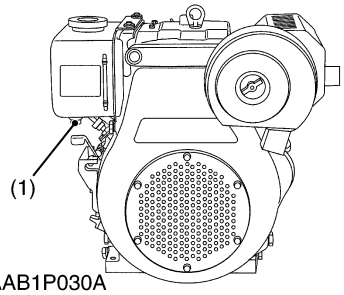
1. Prepare an oil pan.
2. Remove the drain plug (1) to drain engine oil in the pan.

■ **NOTE**
- Specified engine oil.

OC60-E2	1.3 L 1.37 U.S.qts 1.14 Imp.qts
OC95-E2	1.7 L 1.80 U.S.qts 1.49 Imp.qts

(1) Drain Plug

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3ECAAAB1P030A

Draining Fuel

1. Prepare a clean, dry bucket.
2. Remove the drain plug (1) and let the fuel flow in the bucket.
3. Remove the fuel tank cap to completely drain the fuel.

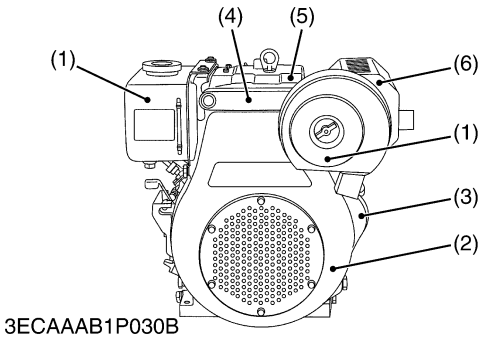
■ **NOTE**
- **The fuel tank capacity.**

OC60-E2	3.6 L 0.95 U.S.gals 0.79 Imp.gals
OC95-E2	5.5 L 1.45 U.S.gals 1.21 Imp.gals

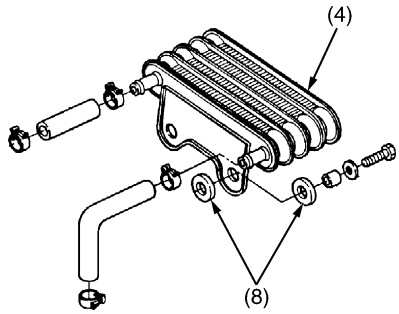
(1) Drain Plug

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(2) External Components



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3ECAAAB1P031A

External Components

1. Remove the following external components.

(When reassembling)

- **Oil Cooler**

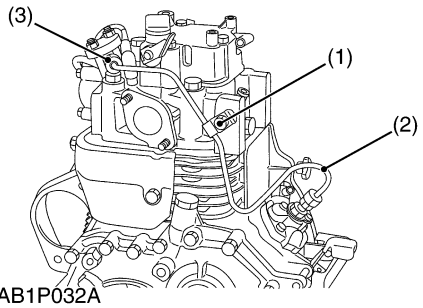
■ NOTE

- **Be sure to fit the anti-vibration rubber (8) in position.**

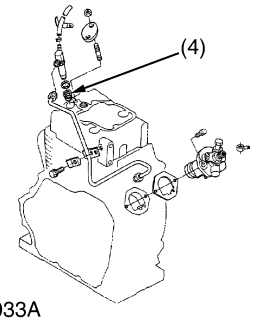
(1) Air Cleaner
(2) Spiral Case
(3) Cell Starter
(4) Oil Cooler
(5) Intake Air Manifold
(6) Muffler
(7) Fuel Tank
(8) Anti-vibration Rubber

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(3) Cylinder Head and Valves



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3ECAAAB1P033A

Injection Pipe and Nozzle Holder

1. Loosen the clamp mounting screw (1).
2. Remove the injection pipe (2).
3. Remove the nozzle holder (3).

(Heat seal type)

4. Remove the nozzle heat seal.

(When reassembling)

■ NOTE

- **Tighten up the nozzle holder mounting nuts evenly.**
- When reassembling the nozzle holder, take care that no carbon or dirt gets in.
- Replace the copper gasket with a new one.

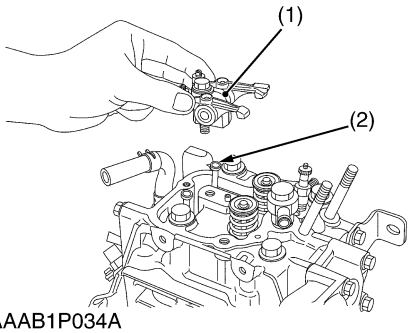
(Heat seal type)

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

Tightening torque	Retainer mounting nut	13.7 to 17.6 N·m 1.4 to 1.8 kgf·m 10.1 to 13.0 ft-lbs

(1) Pipe Clamp Mounting Screw
(2) Injection Pipe
(3) Nozzle Holder
(4) Heat Seal

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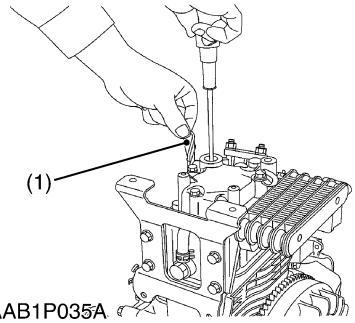
3ECAAAB1P034A

Cylinder Head Cover and Rocker Arm Bracket

1. Remove the cylinder head cover.
2. Remove the rocker arm bracket (1) and rocker arms together.
3. Pull out the push rods (2).

(1) Rocker Arm Bracket (2) Push Rod

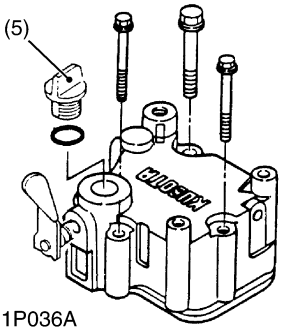
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3ECAAAB1P035A

Adjusting Decompression Device

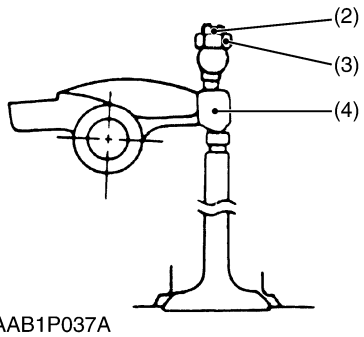
1. Align the "**T**" mark on the flywheel with the mark on the fin at the top dead center in the compression stroke.
2. Remove the head cover, and draw out the seal plug (5) from inside with due care. Place the head cover again in position and tighten up the screws to the specified torque.
3. Pull the decompression lever (1) to the operating position.
4. Loosen the lock nut (3) and screw in the decompression adjusting screw (2) until it contacts the rocker arm (4).
5. From the position where the adjusting screw contacts the rocker arm, further screw in the adjusting screw by one and a half turns.
6. Tighten the lock nut.
7. After adjustment, make sure that the piston does not push up the valve when slightly turning the flywheel with the decompression lever.
8. Apply Three-Bond 1501 or equivalent around the seal plug, and install it in place. If the plug is loose, replace it with a new one.



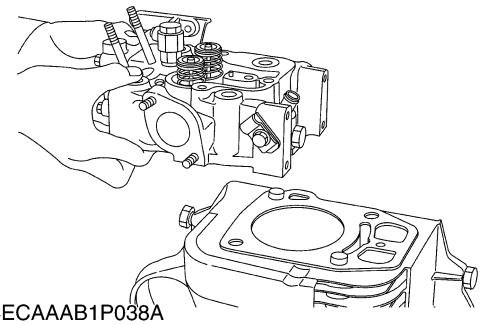
3ECAAAB1P036A

(1) Decompression Lever
(2) Decompression Adjusting Screw
(3) Lock Nut
(4) Rocker Arm
(5) Oil Plug

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Cylinder Head

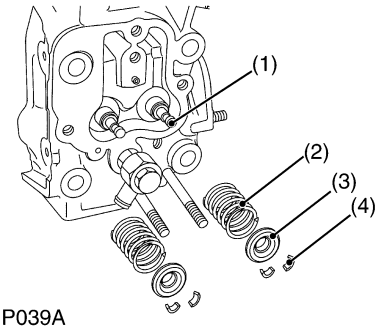
1. Remove the glow plug first to prevent the damage of it.
2. Remove four cylinder head bolts.
3. Tap the cylinder head with plastic or wooden hammer to separate it from cylinder block.

(When reassembling)

- Replace the head gasket with a new one.
- Tighten the cylinder head bolts gradually after applying engine oil.

Tightening torque	Cylinder head mounting bolts	OC60-E2	51.9 to 56.8 N·m 5.3 to 5.8 kgf·m 38.3 to 42 ft-lbs
		OC95-E2	68.6 to 73.6 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 ft-lbs

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Valves

1. Remove the valve spring collet (4) with a valve lifter.
2. Remove the valve spring retainers (3), valve spring (2) and valve (1).

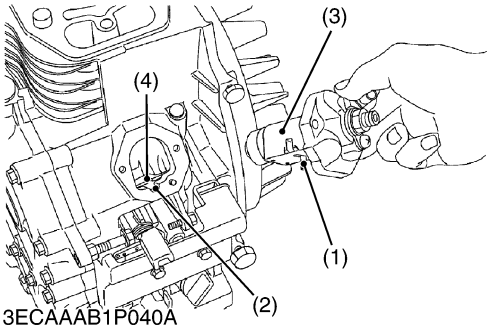
(When reassembling)

- 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.

(1) Valve
(2) Valve Spring
(3) Valve Spring Retainer
(4) Valve Spring Collet

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(4) Injection Pump and Injection Nozzle



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Injection Pump

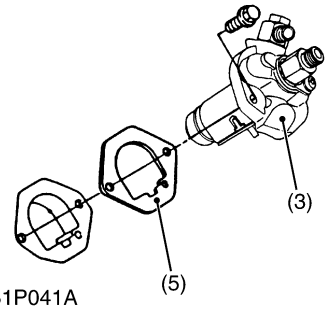
1. Remove the fuel inlet pipe.
2. Remove the injection pump mounting screw.
3. Align the control rack pin (1) with the notch (2) on the crank case, and remove the injection pump (3).
4. Remove the injection pump shims.
5. In principle, the injection pump should not be disassemble.

(When reassembling)

- When installing the injection pump, insert the control rack pin (1) firmly into the groove (4) of the fork lever.
- Addition or reduction of one shim delays or advances the injection timing by 0.018 to 0.026 rad (1° to 1.5°).

■ IMPORTANT

- **Insert the same number of shims (5) as used before between crank case and pump, and then check the injection timing.**

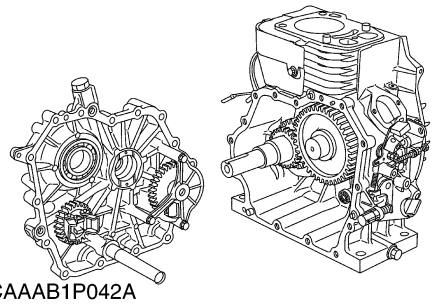


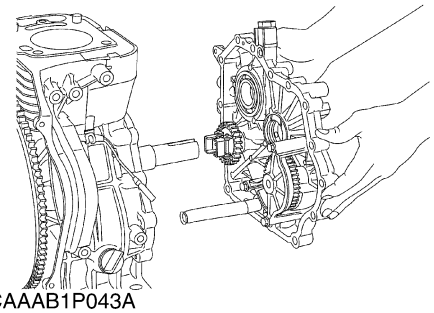
3ECAAAB1P041A

(1) Control Rack Pin
(2) Notch
(3) Injection Pump
(4) Groove
(5) Shim

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(5) Side Cover


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3ECAAAB1P043A

Side Cover

1. Remove the side cover mounting screws.
2. Tap the side cover lightly with plastic or wooden hammer to separate it from cylinder block.
3. Hold the side cover with a hand and push the end of crankshaft with thumbs to remove the side cover.

■ NOTE

- **The side cover is fixed at two places by straight pins and thus cannot be removed easily. Never try to pry it open with a screwdriver, etc.**
- **Remove the cover in parallel to the PTO shaft carefully to prevent the oil seal from scraping the lip surface of the oil seal.**
- **When the side cover cannot remove due to the camshaft comes out together with side cover, lift the both tappets of intake and exhaust from injection pump installing place.**

(When reassembling)

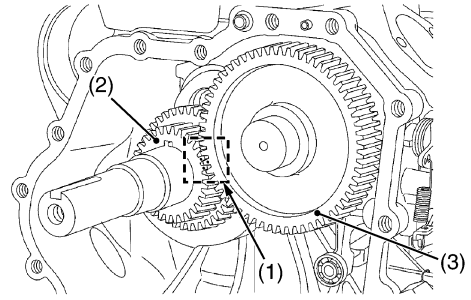
- There is no match marks on the balancer gear. Take the following steps to install it.

1. Level the crankcase.
2. Place the piston to the top dead center.
3. Hold the side cover with both hands and make sure the balancer weight faces straight downward.
4. Install the side cover, ensuring the oil seal's lip does not come off.

■ NOTE

- **When fitting the side cover, be sure to use the oil sealing guide to prevent the oil sealing against peel-off and other damages.**

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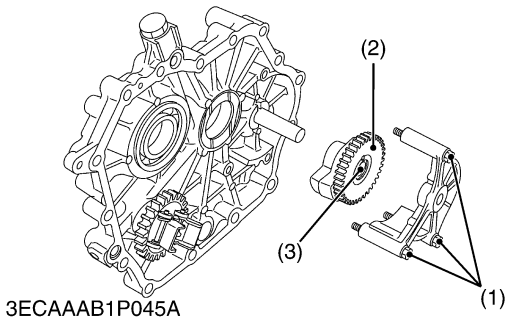
Timing Gear

(When reassembling)

- The alignment marks (1) of the crank gear (2) and the cam gear (3) must come together when the cam gear is installed.

(1) Alignment Marks
(2) Crank Gear
(3) Cam Gear

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3ECAAAB1P045A

Balancer

1. Remove the balancer case mounting screws (1).
2. Take out the balancer (2).

(When reassembling)

- Clean up the balancer needle bearing (3) and balancer shaft (at the side cover), and apply oil to them.
- Make sure the needle bearing turns smoothly. Install the balancer onto the balancer shaft from the balancer side. Finally place the balancer casing in position.

■ NOTE

- **Install the balancer with the gear facing toward the balancer casing. See the picture.**
- **Be sure that the balancer turns smoothly.**

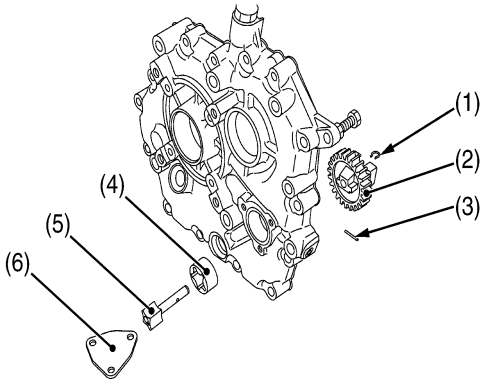
■ IMPORTANT

- **For replacing the bearing, clean up a new bearing and the drive-in opening. Force the bearing into position with its side mark facing outward.**

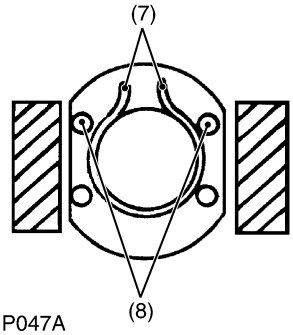
Side Clearance	Factory spec.	0.12 to 0.37 mm 0.0047 to 0.0146 in.

(1) Balancer Case Mounting Screw (3) Balancer Needle Bearing
(2) Balancer

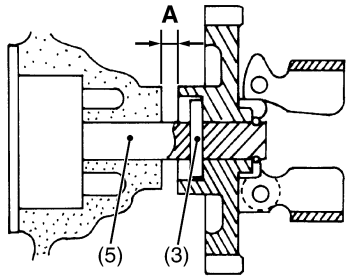
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3ECAAAB1P048A

Governor Gear and Oil Pump

1. Remove the stopper (1).
2. Pull out the gear (2).
3. Remove the spring pin (3).

- The circumference of the spring pin hole swells out when the pin has been taken out. Correct this area flat.

4. Remove the three screws retaining the oil pump cover.
5. Push out the inner rotor shaft (5) and outer rotor (4).

(When reassembling)

- Make sure the slit of the spring pin (3) faces the oil pump.
- Make sure the spring pin stretches at equal distance left and right out of the shaft.
- Place the stopper so that its knob (7) be fitted in between the two projection (8) of the gear. See the figure.
- Apply oil each section.

■NOTE

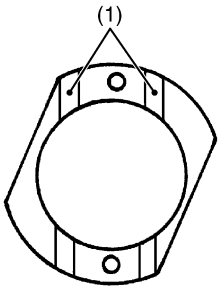
- **Finally pull the gear to see if it is tight in position.**

Clearance between gear case and governor gear **A**	OC60-E2	1.5 mm 0.059 in.
	OC95-E2	4.5 mm 0.177 in.

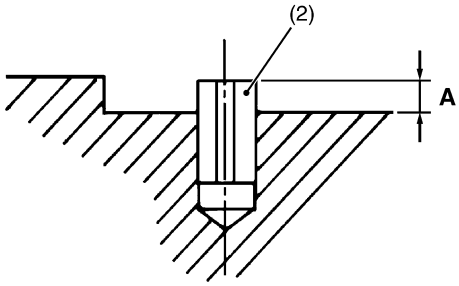
(1) Stopper
(2) Governor Gear
(3) Spring Pin
(4) Outer Rotor
(5) Inner Rotor
(6) Cover
(7) Knob
(8) Projection

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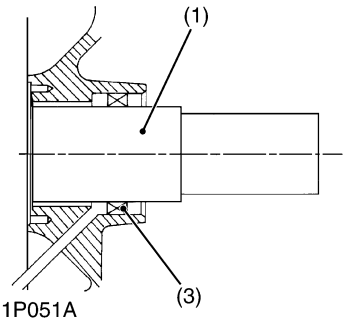


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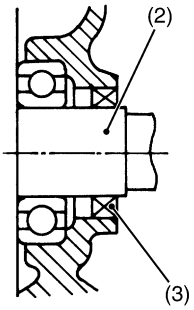
3ECAAAB1P050A

[A]



3ECAAAB1P051A

[B]



3ECAAAB1P052A

Side Bearing

(When removing)

- Lift up the side bearing by the flat screw driver as shown in figure.

(When reassembling)

- Make sure the oil groove (1) in the side bearing comes toward the crank gear.
- Make sure the anti-fall spring pin (2) for the side bearing is not stretching out of the bearing surface.
- Keep the spring pin head **A** above the surface (not greater than the side bearing thickness as table below).

■NOTE

- **Do not confuse the above side bearing with that at the crankcase.**

Spring pin head **A**	OC60-E2	1.5 to 1.7 mm 0.059 to 0.067 in.
	OC95-E2	1.7 to 2.2 mm 0.067 to 0.087 in.

(1) Oil Groove (2) Spring Pin

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Oil Seal

(When reassembling)

- Place the side cover on the crankcase and drive in the oil seal (3) with a special tool. (Apply oil to the inner and outer surfaces of the oil seal beforehand.)
- The oil seal mounting hole is used for the socket and spigot joint. Keep this hole 7 mm below the side cover as illustrated.

■NOTE

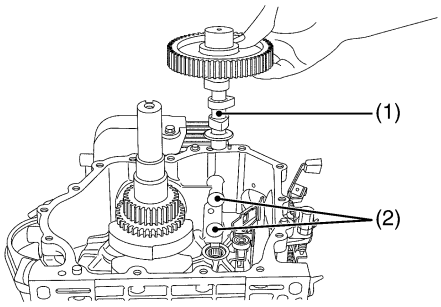
- **Use a special tool, because otherwise the oil hole may be covered.**

(1) Crankshaft
(2) Camshaft
(3) Oil Seal

[A] Direct Coupling
[B] 1/2 Camshaft Reduction

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(6) Piston and Connecting Rod



3ECAAAB1P053A

Camshaft and Tappet

1. Pull out the camshaft (1) and the cam gear as a unit.
2. Remove the tappet (2).

■ NOTE

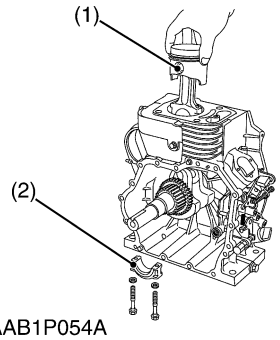
- **Intake and exhaust tappets are of an identical shape, and need to be distinguished with a tag, etc.**

■ IMPORTANT

- **Force the bearing into position with its side mark facing outward.**

(1) Camshaft (4) Tappet

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3ECAAAB1P054A

Piston and Connecting Rod

1. Remove the cap (2) at the big end of the connecting rod.
2. Put the parting mark (↑) (4) on the piston head as shown in the figure.
3. Pull out the piston (1) from the cylinder head side.

(When reassembling)

- Insert the piston with a piston ring compressor.

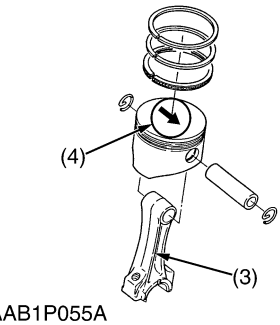
■ IMPORTANT

- **Be sure to assemble the connecting rod so that the casting mark (F) (3) of the connecting rod faces toward the flywheel.**
- **Align the mark on the side of the connecting rod and cap.**

(When reassembling piston and connecting rod)

■ IMPORTANT

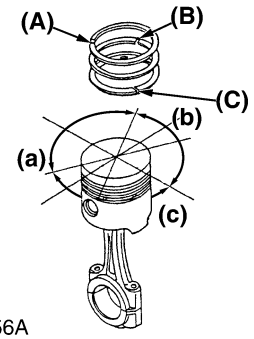
- **When installing the piston pin, immerse the piston in 100 ℃ (212 ℉) oil for 10 to 15 minutes and insert the piston pin to the piston.**
- **When installing the connecting rod to the piston, align the mark (3) on the connecting rod to the parting mark (4).**



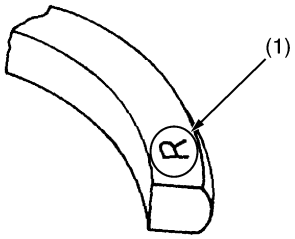
3ECAAAB1P055A

(1) Piston (3) Casting Mark **F**
(2) Connecting Rod Cap (4) Parting Mark

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3ECAAAB1P056A



3EEABAB1P101E

Piston Ring

(When reassembling)

■ IMPORTANT

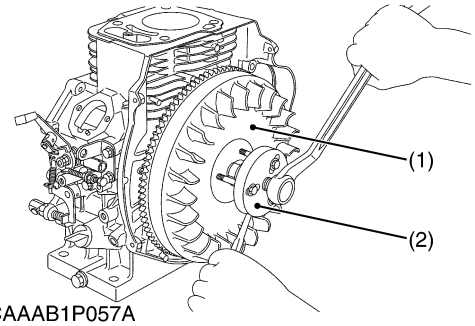
- **Assemble the piston ring with the manufacture's mark's (1) facing up (As shown in the figure).**
- **When inserting the piston into the cylinder, place the gap of the compression ring 1 on the opposite side of the combustion chamber and stagger the gaps of the compression ring 2 and oil ring making a right angle from the gap of the compression ring 1.**

(1) Manufacture's Mark's

(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(a) 2.09 rad (120°)
(b) 2.09 rad (120°)
(c) 2.09 rad (120°)

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(7) Crankshaft



3ECAAAB1P057A

Flywheel

1. Loosen the flywheel nut until it is nearly flush with the crankshaft end.
2. Set a flywheel puller (2) and remove it with the flywheel (1).

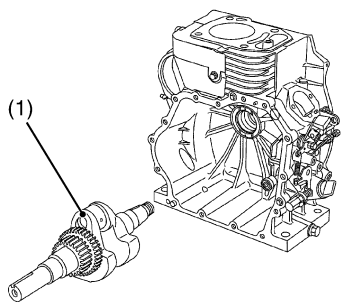
(When reassembling)

- The tapered section of the flywheel must be free of oil, etc. The rotor magnet must be free of foreign materials.

Tightening torque	Flywheel mounting nut	OC60-E2	137 to 157 N·m 14 to 16 kgf·m 101 to 116 ft-lbs
		OC95-E2	235 to 255 N·m 24 to 26 kgf·m 174 to 188 ft-lbs

(1) Flywheel (2) Flywheel Puller

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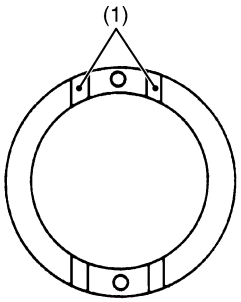
Crankshaft

1. Remove the flywheel key.
2. Pull out the crankshaft (1).

(1) Crankshaft

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3ECAAAB1P059A

Side Bearing (Crank Case)

(When removing)

- Lift up the side bearing by the flat screw driver as shown in figure.

(When reassembling)

- Make sure the oil groove (1) in the side bearing comes toward the crank gear.
- Make sure the anti-fall spring pin (2) for the side bearing is not stretching out of the bearing surface.
- Keep the spring pin head **A** above the surface (not greater than the side bearing thickness of 2 mm).

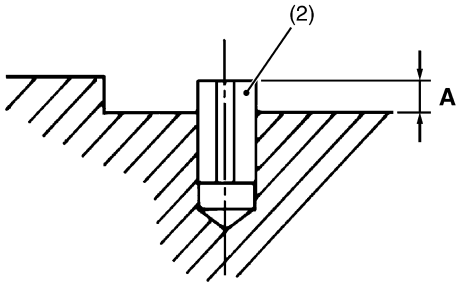
■NOTE

- **Do not confuse the above side bearing with that at the crankcase.**

Spring pin head **A**	OC60-E2	1.5 to 1.7 mm 0.059 to 0.067 in.
	OC95-E2	1.7 to 2.2 mm 0.067 to 0.087 in.

(1) Oil Groove (2) Spring Pin

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Main Bearing (Crank Case and Side Cover)

1. Remove the main bearing (1) with special tool.

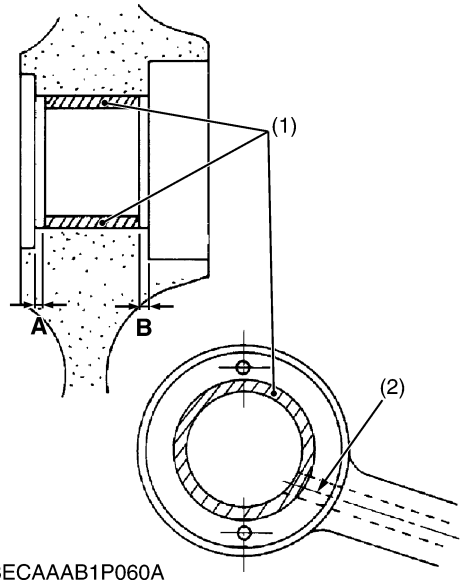
(When reassembling)

- Apply engine oil to all the fitting surface.
- As shown at left, be sure to align the oil hole (2) on the crank case and the bearing.
- Drive in the bearing **A** and **B** deep below the side bearing mounting face as shown at left.

Model		A	B
OC60-E2	Crank Case	1.0 mm 0.039 in.	1.0 mm 0.039 in.
	Side Cover		
OC95-E2	Crank Case	0.5 mm 0.020 in.	1.0 mm 0.039 in.
	Side Cover	0.5 mm 0.020 in.	0.5 mm 0.020 in.

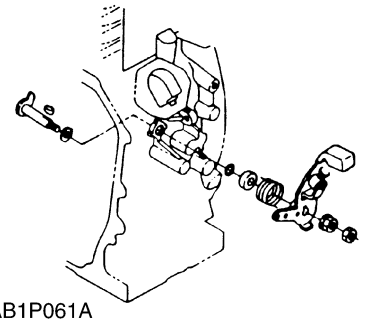
(1) Main Bearing (2) Oil Hole

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3ECAAAB1P060A

(8) Speed Control Lever and Governor Lever



3ECAAAB1P061A

Speed Control Lever and Speed Adjust Lever Shaft

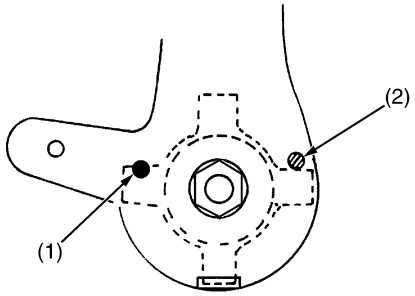
(When reassembling)

- Install the O-ring onto the crankcase, and apply oil. Place the flat washer, friction plate, key and spring in this order as shown in the figure.
- Hook the spring as illustrated.

1) Hooking to the speed control lever (1).
2) Hooking to the crankcase (2).

(1) Speed Control Lever (2) Crankcase

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Governor Lever 1, 3 and Governor Spring (OC60-E2)

(When reassembling)

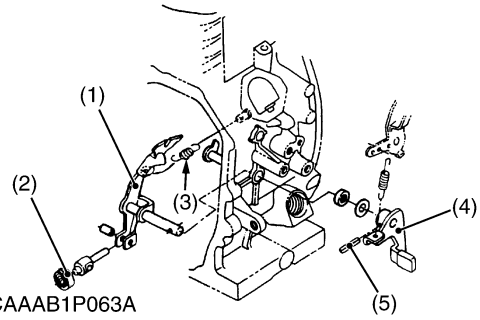
- Clean up the governor lever shaft and the shaft hole. Apply oil to them.
- Install the oil seal onto the crankcase.
- Make sure the bearing (2) of the governor lever 1 (1) moves smoothly.
- Put the governor lever into the hole.
- Hook the idle spring (3) into position.

■ NOTE

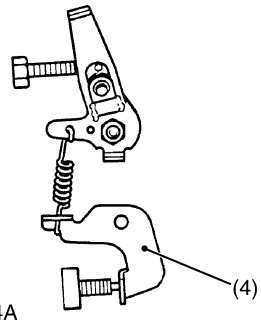
- **Position the stop lever of the speed control lever shaft behind the governor lever 1 (1). See the figure.**
- **Install the governor lever 3 (4) from outside the crankcase.**
- **Put the spring pin (5) and see if there is a clearance of 0.1 to 0.3 mm in the axial direction.**
- **Pull the speed control lever toward the stop position (toward the side cover), and hook the governor spring.**

■ NOTE

- **Hook the governor spring to the governor lever 3 (4) first and then into the second hole from outside in the speed lever.**



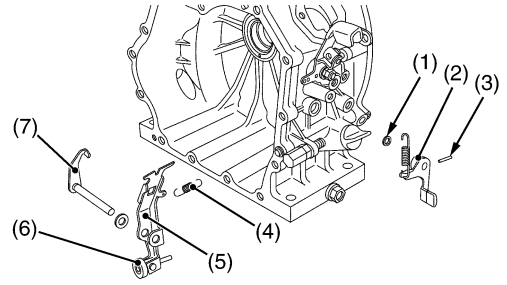
3ECAAAB1P063A



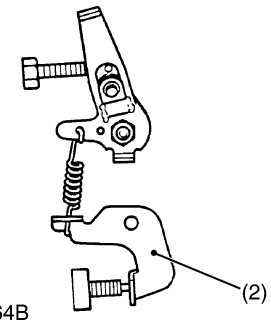
3ECAAAB1P064A

(1) Governor Lever 1 (4) Governor Lever 3
(2) Bearing (5) Spring Pin
(3) Idle Spring

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3ECAAAB1P065A



3ECAAAB1P064B

Governor Lever 1, 3 and Governor Spring (OC95-E2)

(When reassembling)

- Clean up the governor lever 2 (7) and the shaft hole. Apply oil to them.
- Install the oil seal (1) onto the crankcase.
- Make sure the bearing (6) of the governor lever 1 (5) moves smoothly.
- Assemble the governor lever 1 (5) and 2 (7).
- Put the governor lever 2 into the crankcase hole.
- Hook the idle spring (4) into position.

■ NOTE

- **Position the stop lever of the speed control lever shaft behind the governor lever 1 (5). See the figure.**
- **Install the governor lever 3 (2) from outside the crankcase.**
- **Put the spring pin (3) and see if there is a clearance of 0.1 to 0.3 mm in the axial direction.**
- **Pull the speed control lever toward the stop position (toward the side cover), and hook the governor spring.**

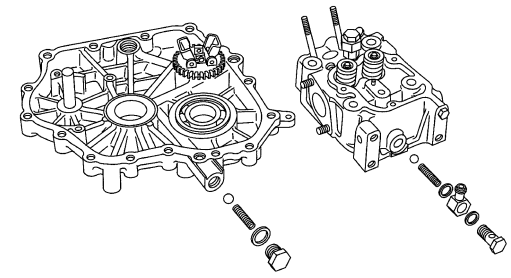
■ NOTE

- **Hook the governor spring to the governor lever 3 (2) first and then into the second hole from outside in the speed lever.**

(1) Oil Seal
(2) Governor Lever 3
(3) Spring Pin
(4) Idle Spring
(5) Governor Lever 1
(6) Bearing
(7) Governor Lever 2

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(9) Relief Valve



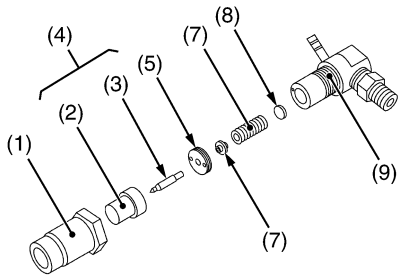
3ECAAAB1P084A

Relief Valve

1. Two relief valves are installed, one is on the top of the side cover and the other one is in cylinder head.
2. Remove the eye joint bolt and take out the spring and ball.

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(10)Injection Nozzle



3ECAAAB1P089A

Nozzle Holder

1. Secure the nozzle holder body (9) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod, noting its direction.

Tightening torque	Nozzle holder body and nut	97 to 116 N·m 10 to 12 kgf·m 73 to 88 ft-lbs

■ IMPORTANT

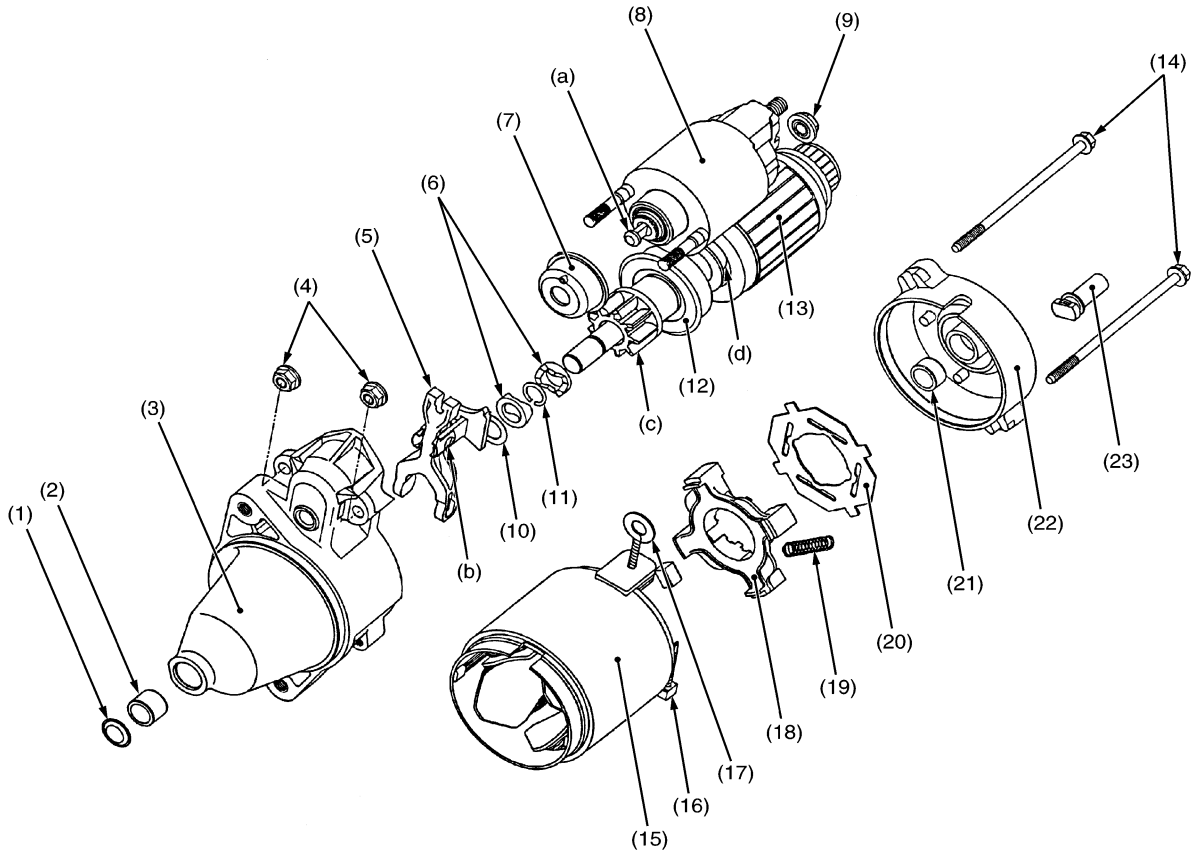
- **Since the nozzle piece is precision finished, a piece of wood must be used to remove carbon deposit. Do not use pieces of metal.**
- **After assembling the nozzle, be sure to adjust the fuel injection pressure.**

(1) Nozzle Holder
(2) Nozzle Body
(3) Needle Valve
(4) Nozzle Piece
(5) Distance Piece
(6) Push Rod
(7) Nozzle Holder
(8) Adjusting Washer
(9) Nozzle Holder Body

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(11)Starter

Disassembling Starter (OC60-E2)



3ECAAAB1P095A

(1)	Plug	(6)	Pinion Stop Nut	(12)	Overrunning Clutch	(18)	Brush Holder
(2)	Bushing	(7)	Gasket	(13)	Armature	(19)	Brush Spring
(3)	Starter Drive Housing	(8)	Magnet Switch	(14)	Through Bolt	(20)	Insulator
(4)	Magnet Switch Mounting Nut	(9)	Nut	(15)	Yoke	(21)	Bushing
		(10)	Washer	(16)	Brush	(22)	End Frame
(5)	Drive Lever	(11)	Snap Ring	(17)	Connecting Lead	(23)	Cover

1. Unscrew the mounting nut (9), and disconnect the connecting lead (17).
2. Unscrew the magnet switch mounting nut (4).
3. Remove the magnet switch (8) by sliding it up so that it is disconnected from the drive lever (5).
4. Unscrew the two through bolts (14).
5. Remove the end frame (22).
6. Remove the insulator (20).
7. Remove the brush (16) and brush spring (19), and pull out the brush holder (18).
8. Draw out the yoke (15) from the starter drive housing (3).
9. Draw out the armature (13) with the drive lever (5).

CAUTION

- **When removing the insulator (20), from popping out like a bullet.**
- **When removing the brush (16), prevent the brush spring (19) from popping out like a bullet.**

■ **NOTE**

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

(When reassembling)

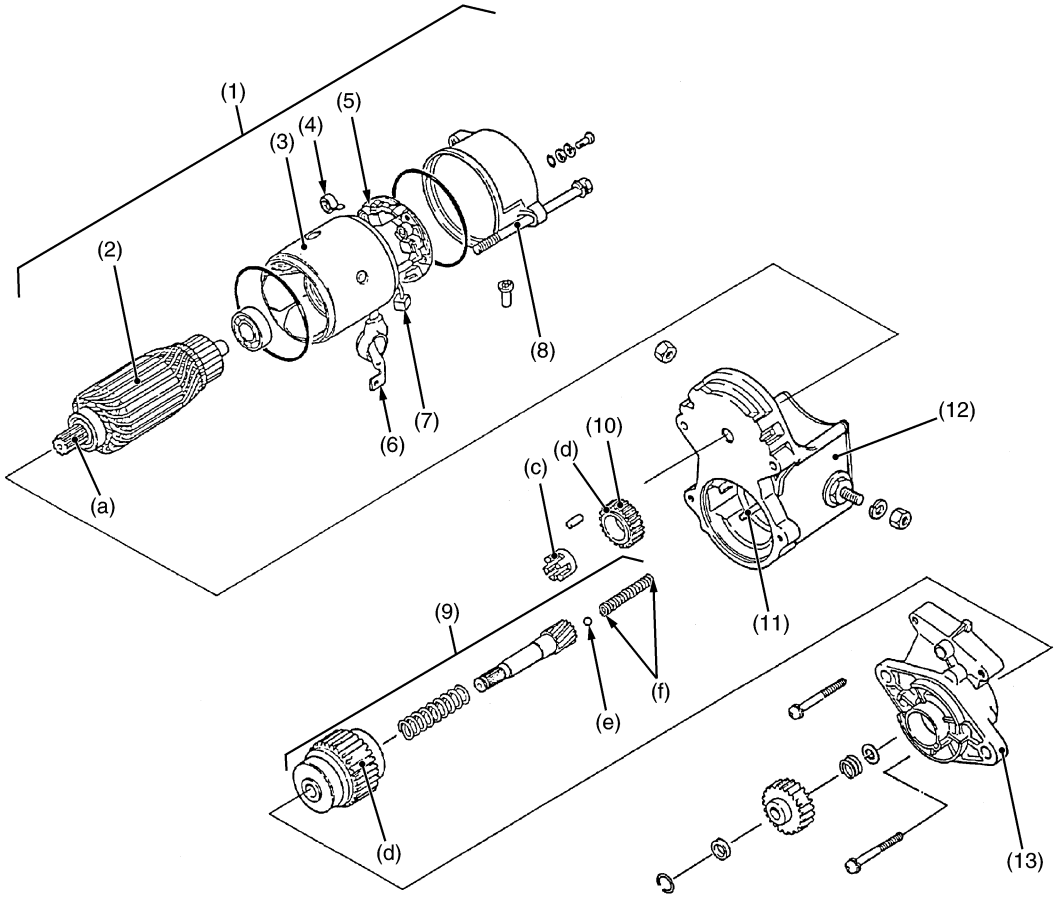
- Apply grease (Denso No.50 or equivalent) to the parts indicated in the figure.
  - **(a)** Joint of Magnet Switch
  - **(b)** Drive Lever
  - **(c)** Teeth of Pinion Gear
  - **(d)** Armature Shaft

CAUTION

- **When installing the brush springs (19), from popping out like a bullet.**

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Disassembling Starter (OC95-E2)



3ECAAAB1P096A

(1)	Motor	(5)	Brush Holder	(8)	Through Bolt	(11)	Plunger
(2)	Armature	(6)	Connecting Lead	(9)	Overrunning Clutch	(12)	Magnet Switch
(3)	Yoke	(7)	Brush	(10)	Idle Gear	(13)	Housing
(4)	Spring						

1. Disconnect the connecting lead (6).
2. Remove the two through bolts (8).
3. Detach the motor (1).
4. Draw out the brush (7) while holding the spring (4) up.
5. Remove the brush holder (5).
6. Draw out the armature (2) from the yoke (3).
7. Remove the housing (13).
8. Remove the idle gear (10) and the overrunning clutch (9).
9. Remove the end cover of magnet switch (12).
10. Remove the plunger (11).

■ **NOTE**

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

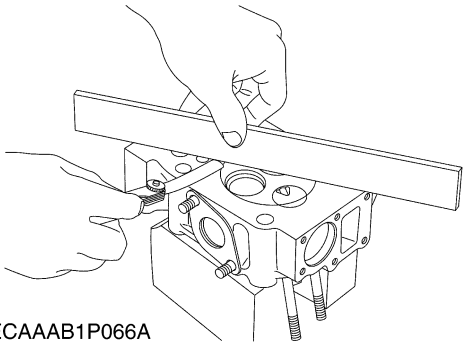
(When reassembling)

- Apply grease (Denso No.50 or equivalent) to the parts indicated in the figure.
  - **(a)** Armature Spline
  - **(b)** Teeth of idle gear
  - **(c)** Roller Retainer
  - **(d)** Clutch Gear
  - **(e)** Steel Ball
  - **(f)** End Surface of Spring

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[3] SERVICING

(1) Cylinder Head and Valves



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Cylinder Head Surface Flatness

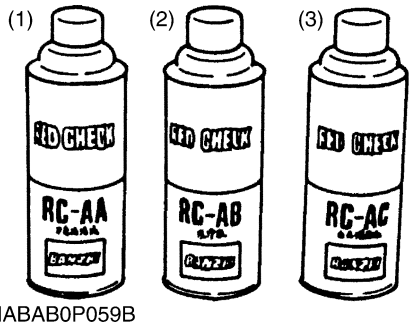
1. Thoroughly clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the photo.
3. Measure the clearance with a thickness gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ IMPORTANT

- **Do not place the straight edge on the combustion chamber.**

Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.

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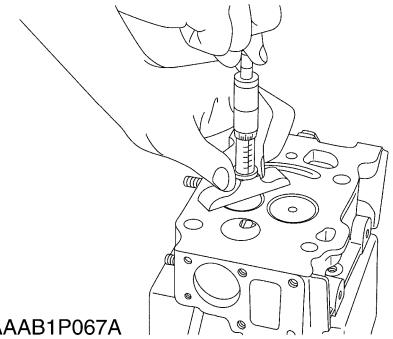
3TMABAB0P059B

Cylinder Head Flaw

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

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

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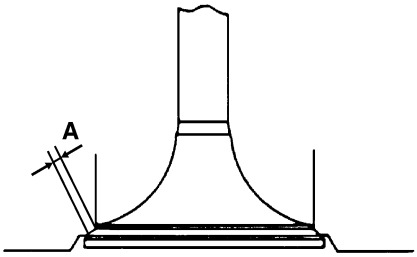
3ECAAAB1P067A

Valve Recessing

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

Valve recessing	Factory spec.	0.60 to 0.85 mm 0.0236 to 0.0335 in.
	Allowable limit	1.3 mm 0.0512 in.

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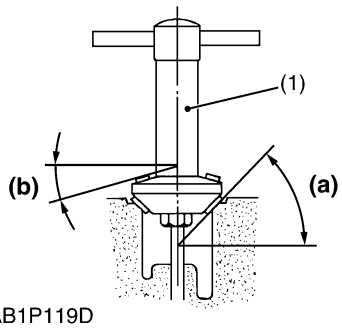
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Width of Contact between Valve and Valve Seat

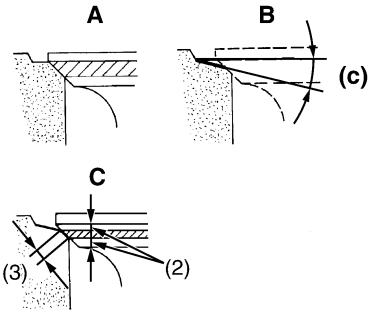
1. Check the contact between the valve face and valve seat.
2. If the contact is uneven or the width of contact **A** is excessively large. Either repair or replace the valve and valve seat. Lap the valve on its seat with lapping compound.

Valve seat width **A**	Factory spec.	2.12 mm 0.0835 in.

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3EEABAB1P120C

Correcting Valve Seat

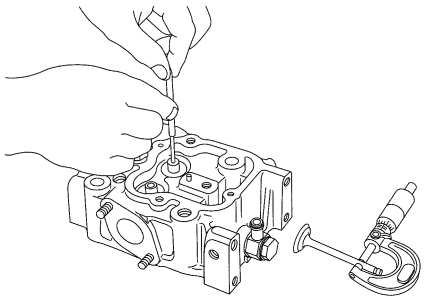
1. Slightly correct the seat surface with a 0.79 rad (45°) or 0.52 rad (30°) valve seat cutter (1).
2. Fitting the valve, check the contact position of the valve face and seat surface with red lead. (Visual check)
   If the valve is used for a long period of time, it deviates to the upper part of the valve face, causing the seat to contact.
3. Grind the seat surface with a 0.26 rad (15°) valve seat cutter so that the valve seat width contacts in the same dimensions from the center of the valve face width.
4. Repeatedly lap the valve and seat until the seated rate is more than 70%.

(1) Valve Seat Cutter
(2) Identical Dimensions
(3) Valve Seat Width

A : Check Contact
B : Correct Seat Width
C : Check Contact

(a) 0.79 rad (45°) or 0.52 rad (30°)
(b) 0.26 rad (15°)
(c) 0.26 rad (15°)

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Clearance between Valve Stem and Valve Guide

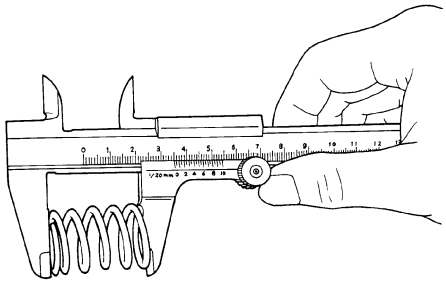
1. Measure the valve stem O.D. with an outside micrometer.
2. Measure I.D. of the cylinder head valve guide at the most worn part with a small hole gauge. and find the oil clearance.
3. If the clearance exceeds the allowable limit, replace the valve guide and valve.

Clearance between valve stem and valve guide	Factory spec.	OC60-E2	0.030 to 0.057 mm 0.0012 to 0.0022 in.
		OC95-E2	0.035 to 0.065 mm 0.0014 to 0.0026 in.
	Allowable limit	OC60-E2	0.1 mm 0.0039 in.
		OC95-E2	

Valve stem O.D.	Factory spec.	OC60-E2	5.968 to 5.980 mm 0.2350 to 0.2354 in.
		OC95-E2	6.960 to 6.975 mm 0.2740 to 0.2746 in.

Valve guide bore I.D.	Factory spec.	OC60-E2	6.010 to 6.025 mm 0.2366 to 0.2372 in.
		OC95-E2	7.010 to 7.025 mm 0.2760 to 0.2766 in.

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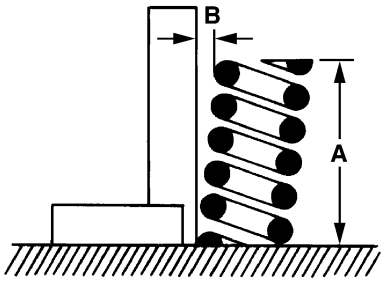
3TMABAB2P037A

Free Length and Tilt of Valve Spring

1. Measure the valve spring with vernier calipers.
2. If the measurement is less than the allowable limit, replace it.
3. Place the spring on the surface plate and square at its side.
4. Measure the maximum distance **A** (See figure) by rotating spring.
5. If the measurement exceeds the allowable limit, replace the valve spring.

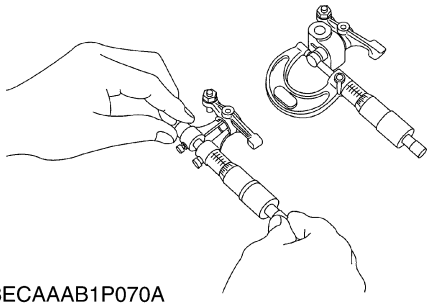
Valve spring free length **A**	Factory spec.	OC60-E2	31.3 to 31.8 mm 1.2323 to 1.2520 in.
		OC95-E2	36.5 to 37.0 mm 1.4370 to 1.4567 in.
	Allowable limit	OC60-E2	31.0 mm 1.2205 in.
		OC95-E2	36.0 mm 1.4173 in.

Tilt **B**	Allowable limit	1.2 mm 0.0472 in.



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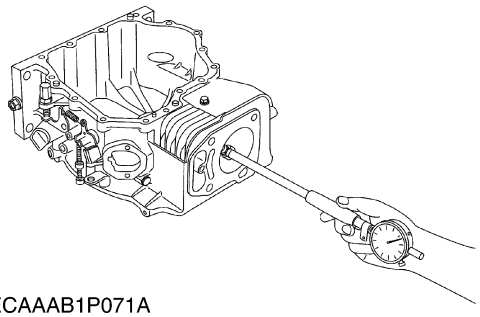
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Oil Clearance between Rocker Arm Shaft and Shaft Hole

1. Measure the rocker arm shaft O.D. with an outside micrometer.
2. Measure the rocker arm shaft hole I.D. with an inside micrometer, and calculate the oil clearance.
3. If the clearance still exceeds the allowable limit, replace the rocker arm.
4. If the clearance still exceeds the allowable limit after replacing the new rocker arm, replace the rocker arm shaft.

Oil clearance between rocker arm shaft and shaft hole	Factory spec.	0.016 to 0.045 mm 0.0006 to 0.0018 in.
	Allowable limit	0.12 mm 0.0047 in.

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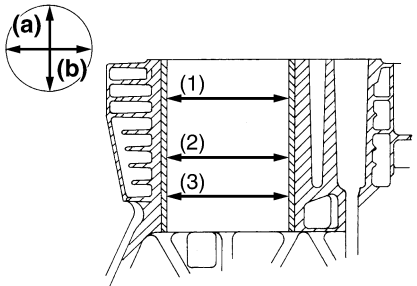


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Cylinder Wear

1. Measure the I.D. of cylinder liner with a cylinder gauge at 6 points as shown in the figure to obtain the maximum wear.
2. If the measurement exceeds the allowable limit, the cylinder liner needs to be bored to an oversize, and then hone-finished.
3. When the oversize allowable limit is exceeded, replace the cylinder block.

Cylinder liner I.D.	Factory spec.	OC60-E2	72.000 to 72.019 mm 2.8346 to 2.8354 in.
		OC95-E2	83.018 to 83.038 mm 3.2684 to 3.2692 in.
	Allowable limit	OC60-E2	72.10 mm 2.839 in.
		OC95-E2	83.10 mm 3.272 in.



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[Oversize Cylinder Liner (0.25 OS)]

Oversize cylinder liner I.D.	Factory spec.	OC60-E2	72.250 to 72.269 mm 2.8445 to 2.8452 in.
		OC95-E2	83.268 to 83.288 mm 3.2783 to 3.2791 in.

- Replace the piston and piston rings with oversize ones.

Oversize	Part Name	Model	Code No.
0.25 OS	Piston	OC60-E2	11420-21913
		OC95-E2	11460-21911

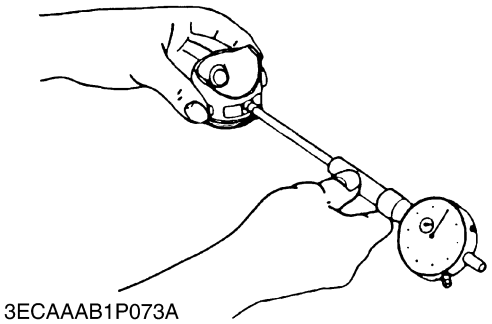
Oversize	Part Name	Model	Code No.
0.25 OS	Piton ring assembly	OC60-E2	11420-21092
		OC95-E2	11460-21091

(1) Top
(2) Middle
(3) Bottom

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

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(2) Piston and Connecting Rod



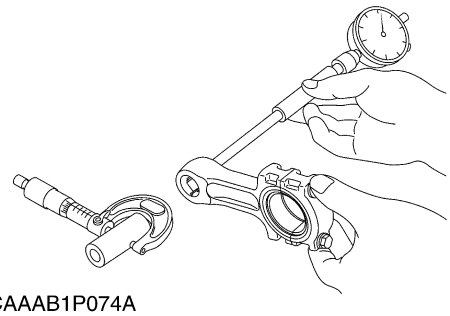
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Piston Pin Bore

1. Measure the Piston boss I.D. in both the vertical and horizontal direction with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace it.

Piston boss I.D.	Factory spec.	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.
		OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.
	Allowable limit	OC60-E2	20.03 mm 0.7886 in.
		OC95-E2	23.03 mm 0.9067 in.

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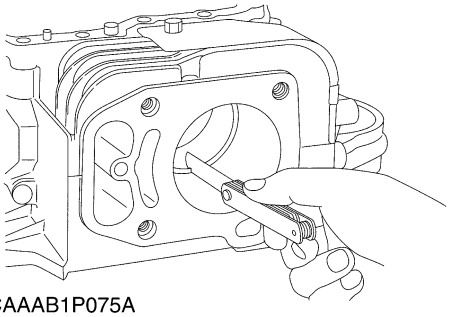
Oil Clearance between Piston Pin and Small End Bushing

1. Measure the piston pin O.D. and small end bushing I.D. with a micrometer. Then, calculate the clearance.
2. If the oil clearance exceeds the allowable limit, replace them.

Oil clearance between piston pin and small end bushing	Factory spec.	0.012 to 0.040 mm 0.0005 to 0.0016 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory spec.	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.
		OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.
Small end bushing I.D.	Factory spec.	OC60-E2	20.025 to 20.040 mm 0.7884 to 0.7890in.
		OC95-E2	23.025 to 20.040 mm 0.9065 to 0.9071 in.

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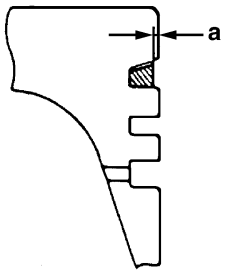
Piston Ring Gap

1. Insert the piston ring into the cylinder and push down to the bottom, where the wear is least, with a piston head.
2. Measure the ring gap with a thickness gauge.
3. If the ring gap exceeds the allowable limit, replace the ring.

Piston ring gap	Top ring	Factory spec.	OC60-E2	0.15 to 0.30 mm 0.0059 to 0.0118 in.
			OC95-E2	
		Allowable limit	OC60-E2	1.2 mm 0.0472 in.
			OC95-E2	
	Second ring	Factory spec.	OC60-E2	0.25 to 0.45 mm 0.0098 to 0.0177 in.
			OC95-E2	0.30 to 0.50 mm 0.0118 to 0.0197 in.
		Allowable limit	OC60-E2	1.2 mm 0.0472 in.
			OC95-E2	
	Oil ring	Factory spec.	OC60-E2	0.25 to 0.40 mm 0.0098 to 0.0157 in.
		Allowable limit	OC95-E2	1.2 mm 0.0472 in.

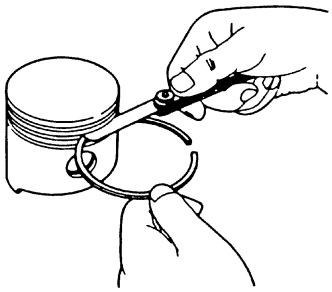
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(A)



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(B)



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Clearance between Piston Ring and Piston Ring Groove

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

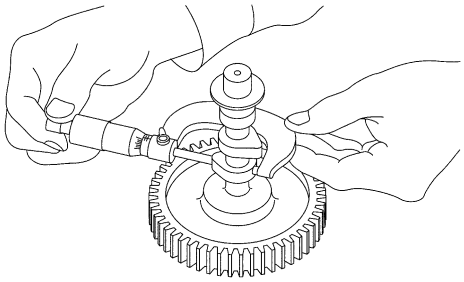
a	Factory spec.	More than 0.2 mm

Clearance between piston ring and piston ring groove	Factory spec.	Second ring	OC60-E2	0.030 to 0.065 mm 0.0013 to 0.0026 in.
			OC95-E2	0.045 to 0.080 mm 0.0018 to 0.0031 in.
		Oil ring	OC60-E2 OC95-E2	0.020 to 0.055 mm 0.0008 to 0.0022 in.
	Allowable limit	Second ring	OC60-E2 OC95-E2	0.15 mm 0.0059 in.
		Oil ring	OC60-E2 OC95-E2	0.15 mm 0.0059 in.

(A) Top Ring (Key Stone Type) **(B) Second, Oil Ring**

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(3) Crankshaft and Camshaft



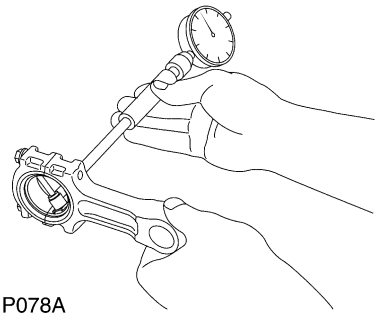
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Intake and Exhaust Cam Height

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 heights (IN)	Factory spec.	OC60-E2	27.0 mm 1.0630 in.
		OC95-E2	28.0 mm 1.1024 in.
	Allowable limit	OC60-E2	26.5 mm 1.0433 in.
		OC95-E2	27.5 mm 1.0827 in.
Cam heights (EX)	Factory spec.	OC60-E2	27.0 mm 1.0630 in.
		OC95-E2	30.0 mm 1.1911 in.
	Allowable limit	OC60-E2	26.5 mm 1.0433 in.
		OC95-E2	29.5 mm 1.1614 in.

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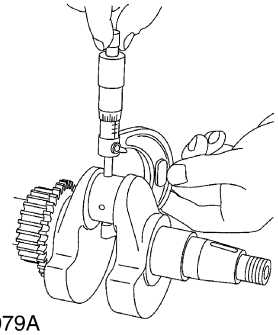
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Oil Clearance between Crank Pin and Bearing

1. Measure the crank Pin O.D. and the connecting rod big end bore after tighten the connecting rod screws to the specified torque with a micrometer, and calculate the clearance.
2. If the clearance exceeds the allowable limit, replace the bearing.

(Reference)

- When the crank pin wears further over a long period of use and oil clearance exceeds the allowable limit after replacing the standard bearing, use a undersize bearing. Machine the crank pin according to the precautions.



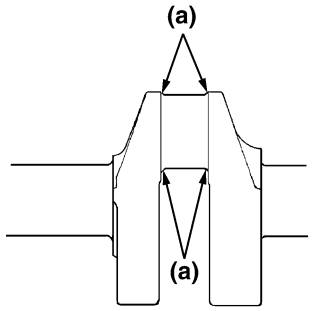
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Clearance between crank pin and bearing	Factory spec.	0.025 to 0.087 mm 0.0010 to 0.0034 in.
	Allowable limit	0.2 mm 0.0079 in.

Crank Pin O.D.	Factory spec.	OC60-E2	35.959 to 35.975 mm 1.4157 to 1.4163 in.
		OC95-E2	39.959 to 39.975 mm 1.5732 to 1.5738 in.

Crank Pin Bearing I.D.	Factory spec.	OC60-E2	36.000 to 36.046 mm 1.4173 to 1.4191 in.
		OC95-E2	40.000 to 40.046 mm 1.5748 to 1.5766 in.

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Correcting Crank Pin

If the standard-size crank pin bearing cannot be employed due to excessive wear of the crank pin, use an undersize crank pin bearing.

For undersize crank pin bearing use, be sure to correct the crank pin.

1. Grind the corner radius (1) of the crank pin precisely.
2. The crank pin surface must be fine-finished to higher than ▽▽▽▽ (0.4-S).

[Undersize crank pin (0.25 US)]

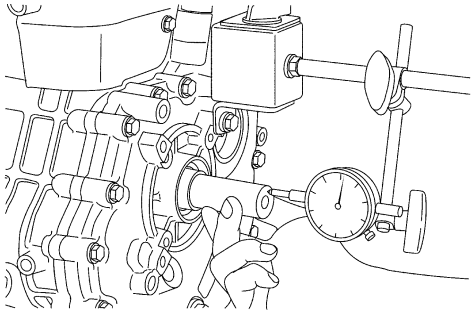
Undersize crank pin O.D.	Factory spec.	OC60-E2	35.709 to 35.725 mm 1.4059 to 1.4065 in.
		OC95-E2	39.709 to 39.725 mm 1.5633 to 1.5640 in.

[Undersize crank pin bearing (0.25 US)]

size	Part Name	Mark	Model	Code No.
0.25 mm U.S.	Undersize crank pin bearing	U.S. 0.25	OC60-E2	11420-22961
			OC95-E2	11460-22961

Dimension **(a)**	Factory spec.	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius

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Crankshaft Side Clearance

1. After a metal plate to the cylinder.
2. Set a dial gauge and push the shaft and measure the side clearance.
3. If the clearance exceeds the allowable limit, replace the bearing.

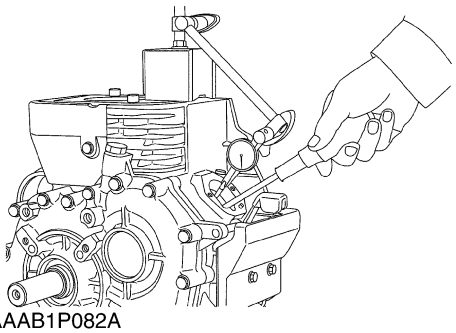
■ **NOTE**

- **If the clearance still exceeds the allowable limit after replacing the bearing with new one. Use an over size bearing.**

Size	Part Name	Model	Code No.
0.25 mm O.S.	Side Bearing 1	OC60-E2	11420-23951
		OC95-E2	11460-23951
	Side Bearing 2	OC60-E2	11420-23971
		OC95-E2	11460-23971

Side clearance of crankshaft	Factory spec.	0.05 to 0.20 mm 0.0020 to 0.0079 in.
	Allowable limit	0.35 mm 0.0138 in.

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Camshaft Side Clearance

1. Set a dial indicator (lever type) and put a screwdriver instead through the injection pump mount opening to see if there is a clearance on the right and left of the camshaft.
2. If the clearance exceeds the allowable limit, adjust the clearance with shims.

Side clearance of crankshaft	Factory spec.	OC60-E2	0.05 to 0.20 mm 0.0020 to 0.0079 in.
		OC95-E2	0.05 to 0.25 mm 0.0020 to 0.0098 in.
	Allowable limit		0.35 mm 0.0138 in.

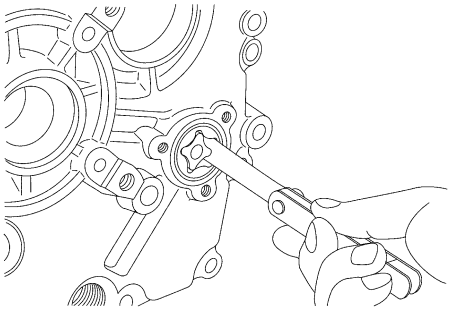
(Reference)

- Thickness of adjusting shims: 0.2 mm (0.079 in.)

Model	Code No.
OC60-E2	11420-16261
OC95-E2	11460-16261

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(4) Oil Pump

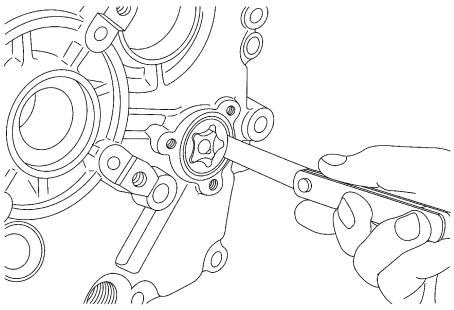

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Rotor Lobe Clearance

1. Measure the clearance between a high point on the inner rotor and high point the outer rotor with a thickness gauge.
2. If the clearance exceeds the factory allowable limit, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory spec.	0.15 mm 0.0059 in.
	Allowable limit	0.20 mm 0.0079 in.

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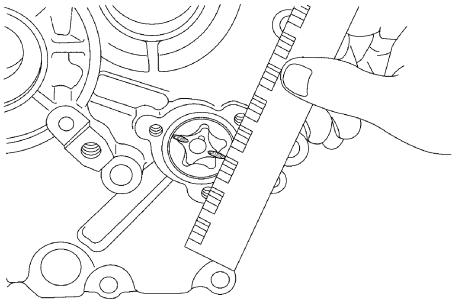

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Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a thickness gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory spec.	0.090 to 0.171 mm 0.0035 to 0.0067in.
	Allowable limit	0.24 mm 0.0079 in.

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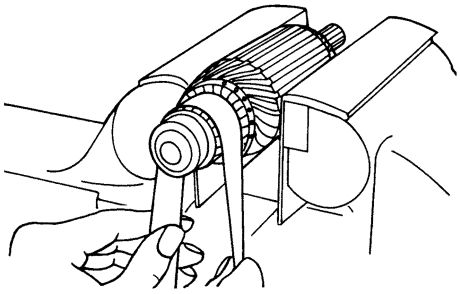
Clearance between Rotor and Cover

1. Put a strip of press gauge onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the depression of press gauge with a sheet of gauge.
4. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

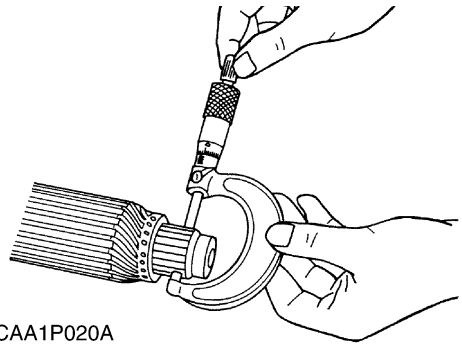
clearance between rotor and cover	Factory spec.	0.02 to 0.06 mm 0.0008 to 0.0024 in.
	Allowable limit	0.25 mm 0.0098 in.

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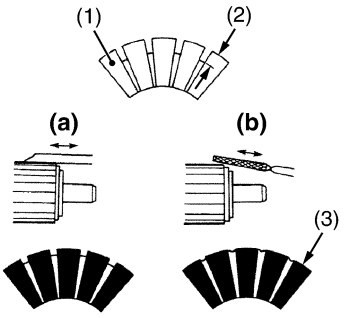
(5) Starter



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Commutator and Mica

1. Check the contact face of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

Commutator O.D.	Factory spec.	OC60-E2	28.0 mm 1.10 in.
		OC95-E2	30.0 mm 1.18 in.
	Allowable limit	OC60-E2	28.0 mm 1.10 in.
		OC95-E2	29.0 mm 1.14 in.

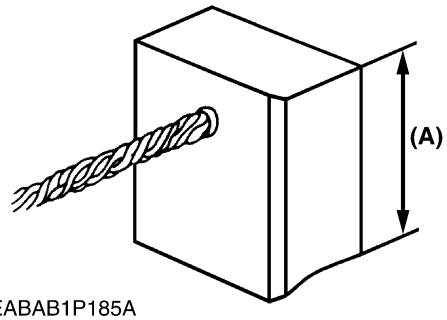
Difference of O.D.'s	Factory spec.	Less than 0.05 mm 0.0020 in.
	Allowable limit	0.40 mm 0.0157 in.

Mica undercut	Factory spec.	OC60-E2	0.45 to 0.75 mm 0.018 to 0.030 in.
		OC95-E2	0.50 to 0.80 mm 0.020 to 0.031 in.
	Allowable limit	OC60-E2	0.20 mm 0.0079 in.
		OC95-E2	

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

(a) Correct
(b) incorrect

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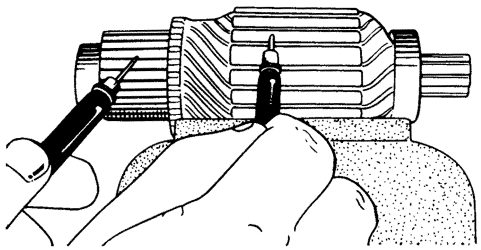
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Brush Wear

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

Brush length **(A)**	Factory spec.	OC60-E2	10.0 mm 0.3937 in.
		O95-E2	15.0 mm 0.5906in.
	Allowable limit	OC60-E2	6.0 mm 0.2362 in.
		OC95-E2	10.0 mm 0.3937 in.

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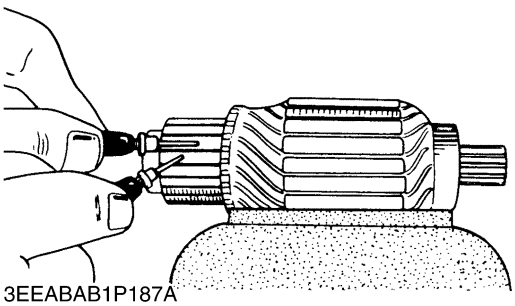


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Armature Coil

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

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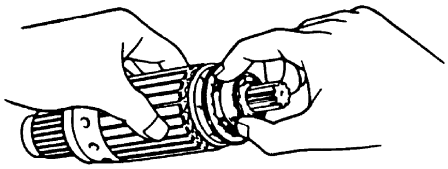


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Armature Bearing

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

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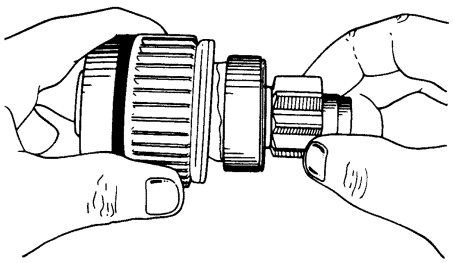


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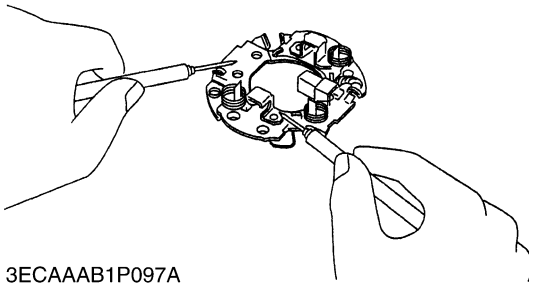
Overrunning Clutch (OC60-E2)

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

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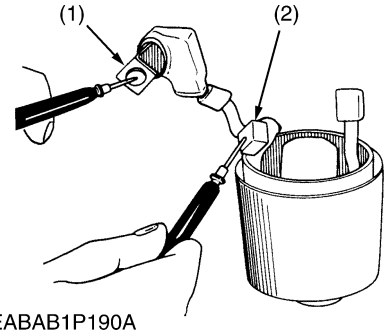
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Brush Holder (OC95-E2)

1. Check the continuity across the insulated brush holder and the brush holder support.
2. If continuous, replace the brush holder assembly.

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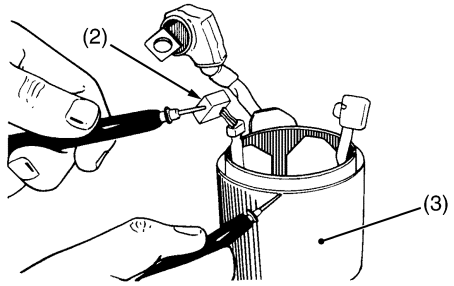
3EEABAB1P190A

Field Coil

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

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

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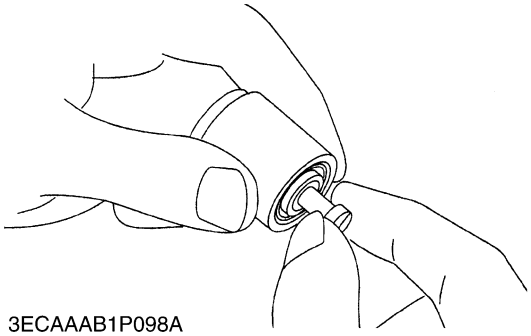
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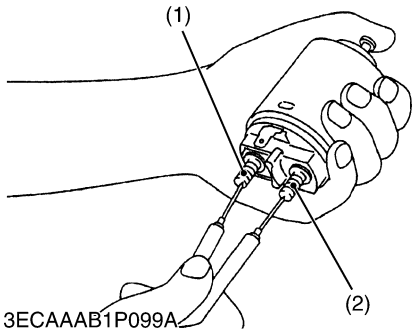
Magnet Switch (OC60-E2)

1. Check the continuity across the **C** terminal (1) and the **B** terminal (2) with an ohmmeter, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the solenoid switch.
3. Pull the pull-rod to check the spring built in the plunger.

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

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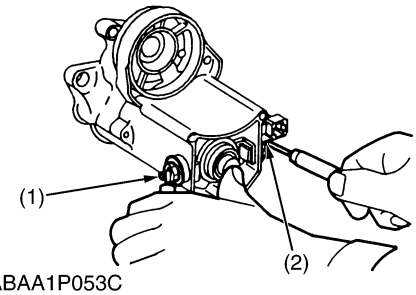
3ECAAAB1P099A

Magnet Switch (OC95-E2)

1. Check the continuity across the **C** terminal (1) and the **B** terminal (2) with an ohmmeter, pushing in the plunger.
2. If it dose not conducts, check the contacts.

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

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