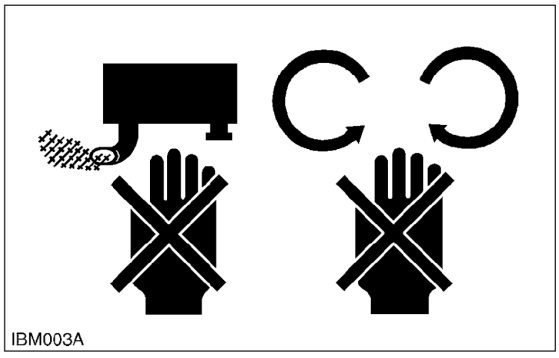
SERVICING

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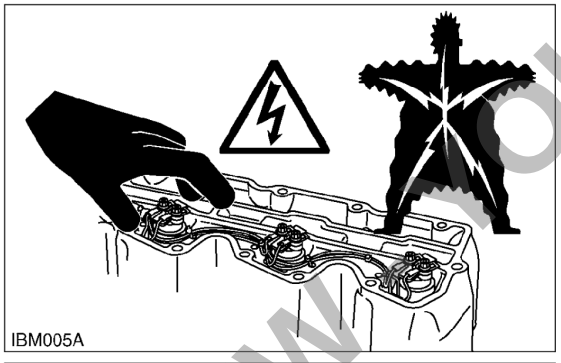
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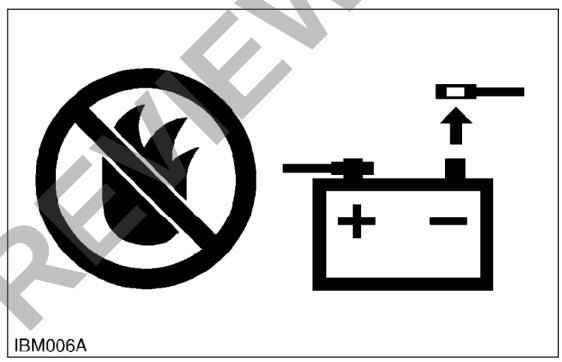
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OPERATE SAFELY

- Do not use the machine after you consume alcohol or medication or when you are tired.
- Put on applicable clothing and safety equipment.
- Use applicable tools only. Do not use alternative tools or parts.
- When 2 or more persons do servicing, make sure that you do it safely.
- Do not touch the hot parts or parts that turn when the engine operates.
- Do not remove the radiator cap when the engine operates, or immediately after it stops. If not, hot water can spout out from the radiator. Only remove the radiator cap when it is at a sufficiently low temperature to touch with bare hands. Slowly loosen the cap to release the pressure before you remove it fully.
- Released fluid (fuel or hydraulic oil) under pressure can cause damage to the skin and cause serious injury. Release the pressure before you disconnect hydraulic or fuel lines. Tighten all connections before you apply the pressure.
- Do not open a fuel system under high pressure. The fluid under high pressure that stays in fuel lines can cause serious injury. Do not disconnect or repair the fuel lines, sensors, or any other components between the fuel pump and injectors on engines with a common rail fuel system under high pressure.
- Put on an applicable ear protective device (earmuffs or earplugs) to prevent injury against loud noises.
- Be careful about electric shock. The engine generates a high voltage of more than DC100 V in the ECU and is applied to the injector.

M00000003INI0004US1

PREVENT A FIRE

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

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1. TROUBLESHOOTING

[1] ENGINE BODY

Symptom	Probable Cause	Solution	Reference Page
The engine does not start	No fuel	Fill up the fuel	G-11
	Air in the fuel system	Bleed the air	G-11
	Water in the fuel system	Change the fuel and repair or replace the fuel system	–
	The fuel hose is clogged	Clean or replace	G-11
	The fuel filter is clogged	Replace	G-19
	The viscosity of fuel or engine oil at low temperature is too high	Use the specified fuel or engine oil	I-4, G-10
	The cetane number of fuel is low	Use the specified fuel	I-4
	Fuel leakage because of loose injection pipe retaining nut	Tighten the retaining nut	1-S41
	Incorrect injection timing	Adjust	1-S24, 1-S25
	The fuel camshaft is worn out	Replace	1-S51
	The injection nozzle is clogged	Clean or replace (IDI)	1-S29, 1-S30, 1-S30, 1-S42
		Repair or replace (DI)	1-S29, 1-S30, 1-S42
	The injection pump is damaged	Repair or replace	1-S26, 1-S27, 1-S28, 1-S47
	Seizure of the crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	1-S51, 1-S51, 1-S52, 1-S53, 1-S54, 1-S55, 1-S56, 1-S76, 1-S77, 1-S78, 1-S79, 1-S80, 1-S81, 1-S82
	Compression leakage from the cylinder	Replace the head gasket, tighten the cylinder head screw, glow plug and nozzle holder	1-S41, 1-S42, 1-S42, 1-S44

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Blinking Pattern of Glow Lamp	Cause	Refer to Checking
(1-Long and 1-Short) 3EEAAAB1P005A	Overrunning (more than 115 %)	Solenoid
(1-Long and 2-Short)  3EEAAAB1P006A	Low oil pressure	Oil switch
(1-Long and 3-Short)  3EEAAAB1P007A	Problem of alternator	Alternator
(1-Long and 4-Short)  3EEAAAB1P008A	Coolant temperature is abnormal	Water temperature sensor
(1-Long and 5-Short)  3EEAAAB1P009A	Emergency stop switch operated	Emergency stop switch
(2-Long and 1-Short)  3EEAAAB1P010A	Abnormality of speed sensor	Speed sensor
(2-Long and 2-Short)  3EEAAAB1P011A	Solenoid malfunction	Solenoid
(2-Long and 4-Short)  3EEAAAB1P012A	Disconnection of water temperature sensor	Water temperature sensor
(2-Long and 5-Short)  3EEAAAB1P013A	Short circuit of water temperature sensor	Water temperature sensor
(2-Long and 6-Short)  3EEAAAB1P014A	Disconnection of alternator **L** Terminal	Alternator **L** Terminal

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2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Valve Clearance (When Cold)		0.18 to 0.22 mm 0.0071 to 0.0086 in.	–
Compression Pressure (When You Crank the Engine with the Starter) **[D1503-M-E4BG]**		3.24 to 3.72 MPa / 290 min^{-1} (rpm) 33.0 to 38.0 kgf/cm^2 / 290 min^{-1} (rpm) 470 to 540 psi / 290 min^{-1} (rpm)	2.55 MPa / 290 min^{-1} (rpm) 26.0 kgf/cm^2 / 290 min^{-1} (rpm) 370 psi / 290 min^{-1} (rpm)
Compression Pressure (When You Crank the Engine with the Starter) **[D1703-M-DI-E4B]** Difference among Cylinders		2.95 to 3.23 MPa / 290 min^{-1} (rpm) 30.0 to 33.0 kgf/cm^2 / 290 min^{-1} (rpm) 427 to 469 psi / 290 min^{-1} (rpm) –	2.35 MPa / 290 min^{-1} (rpm) 24.0 kgf/cm^2 / 290 min^{-1} (rpm) 341 psi / 290 min^{-1} (rpm) 10 % or less
Top Clearance **[D1503-M-E4BG]**		0.575 to 0.675 mm 0.0227 to 0.0265 in.	–
Top Clearance **[D1703-M-DI-E4B]**		0.60 to 0.70 mm 0.024 to 0.027 in.	–
Cylinder Head Surface	Flatness	–	0.05 mm / 500 mm 0.002 in. / 19.7 in.
Valve Recessing (Protrusion to Recessing) **[D1503-M-E4BG]**	Protrusion Recessing	0.05 mm 0.002 in. 0.15 mm 0.0059 in.	– 0.40 mm 0.016 in.
Valve Recessing **[D1703-M-DI-E4B]**	Recessing	0.65 to 0.85 mm 0.026 to 0.033 in.	1.20 mm 0.0472 in.
Valve Stem to Valve Guide • Valve Stem • Valve Guide	Clearance O.D. I.D.	0.040 to 0.070 mm 0.0016 to 0.0027 in. 7.960 to 7.975 mm 0.3134 to 0.3139 in. 8.015 to 8.030 mm 0.3156 to 0.3161 in.	0.10 mm 0.0039 in. – –
Valve Face **[D1503-M-E4BG]**	Angle (Intake) Angle (Exhaust)	1.0 rad 60° 0.79 rad 45°	– –
Valve Face **[D1703-M-DI-E4B]**	Angle (Intake) Angle (Exhaust)	0.79 rad 45° 0.79 rad 45°	– –

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[2] TIGHTENING TORQUES OF THE SCREWS, BOLTS AND NUTS FOR SPECIAL USE

■ **NOTE**

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

Item	Dimension × Pitch	N·m	kgf·m	lbf·ft
Cylinder head cover screw	M6 × 1.0	6.87 to 11.2	0.700 to 1.15	5.07 to 8.31
*Cylinder head screw	M11 × 1.25	93.2 to 98.0	9.50 to 10.0	68.8 to 72.3
*Screw 1 of main bearing case	M9 × 1.25	46 to 50	4.7 to 5.2	34 to 37
*Screw 2 of main bearing case	M10 × 1.25	69 to 73	7.0 to 7.5	51 to 54
*Flywheel screw	M12 × 1.25	98.1 to 107	10.0 to 11.0	72.4 to 79.5
*Connecting rod screw	M8 × 1.0	41 to 45	4.1 to 4.6	30 to 33
*Rocker arm bracket screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
*Idle gear shaft screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Mounting nut of fan drive pulley	M30 × 1.5	167 to 205	17.1 to 20.9	124 to 151
*Mounting screw of bearing case cover	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Glow plug	M10 × 1.25	15 to 19	1.5 to 2.0	11 to 14
Glow lead mounting nut	M4 × 0.7	0.98 to 1.77	0.10 to 0.18	0.72 to 1.30
Nozzle holder assembly (IDI)	M20 × 1.5	49 to 68	5.0 to 7.0	37 to 50
Nozzle holder (IDI)	–	35 to 39	3.5 to 4.0	26 to 28
Nozzle holder clamp screw (DI)	M10 × 1.25	26 to 29	2.6 to 3.0	19 to 21
Oil pressure switch	R 1/8	15 to 19	1.5 to 2.0	11 to 14
Injection pipe retaining nut	M12 × 1.5	25 to 34	2.5 to 3.5	18 to 25
Retaining nut of overflow pipe assembly (IDI)	M12 × 1.5	20 to 24	2.0 to 2.5	15 to 18
Retaining screw of overflow pipe assembly (DI)	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Camshaft set screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Hi-idling body	M14 × 1.0	45 to 49	4.5 to 5.0	33 to 36
Pulley nut of alternator	–	58.4 to 78.9	5.95 to 8.05	43.1 to 58.2
B terminal nut of starter	M8	5.9 to 11	0.60 to 1.2	4.4 to 8.6

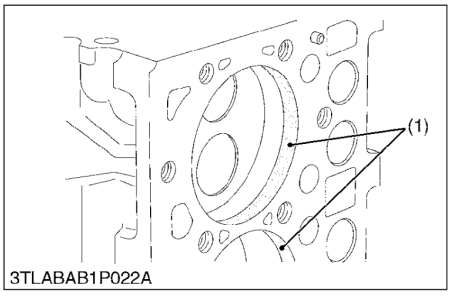
IDI: D1503-M-E4BG
DI: D1703-M-DI-E4B

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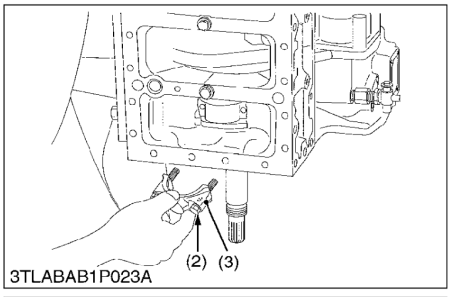
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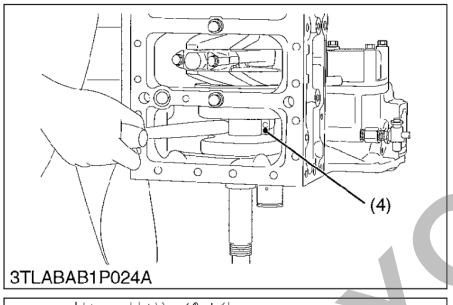
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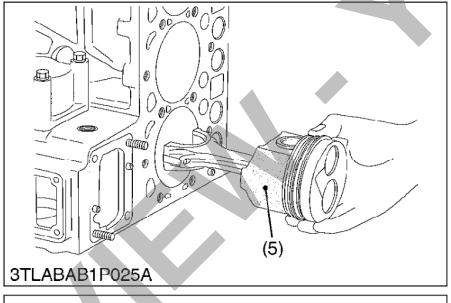
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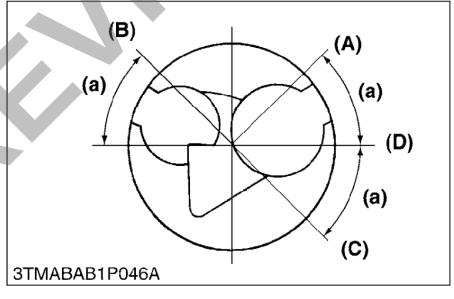
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Pistons

[D1503-M-E4BG]

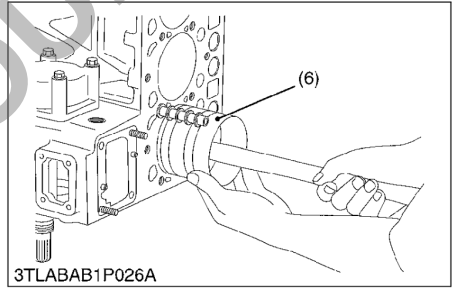
1. Fully clean the carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and move the piston to the top dead center.
4. Lightly tap the piston from the bottom of the crankcase with the grip of a hammer to pull the piston out.
5. Pull out the other piston in the same procedure as above.

(When reassembling)

- Before you install the piston into the cylinder, apply sufficient engine oil to the piston.
- When you install the piston into the cylinder, point the mark on the connecting rod to the injection pump.

■ **IMPORTANT**

- **Do not change the combination of cylinder and piston. Align the position of each piston by the its mark. For example, mark "1" on the No. 1 piston.**
- **Set the piston rings with their gaps at 0.79 rad (45°) from the direction of the piston pin (see the figure).**
- **Install the pistons with a piston ring compressor (6) carefully.**
- **When you install the piston in position, do not give a damage to the layer of molybdenum disulfide on the piston skirt. This layer can decrease the clearance with the cylinder liner. Immediately after you press-fit the piston pin, the piston is hot and the layer comes off easily. Only put in the piston after its temperature decreases.**



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Tightening torque	Connecting rod screw	41 to 45 N·m 4.1 to 4.6 kgf·m 30 to 33 lbf·ft

(1) Carbon
(2) Connecting Rod Screw
(3) Connecting Rod Cap
(4) Connecting Rod
(5) Layer of Molybdenum Disulfide
(6) Piston Ring Compressor

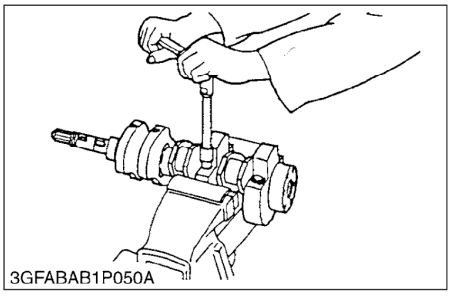
(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole

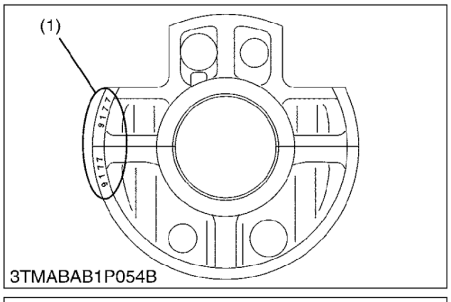
(a) 0.79 rad (45°)

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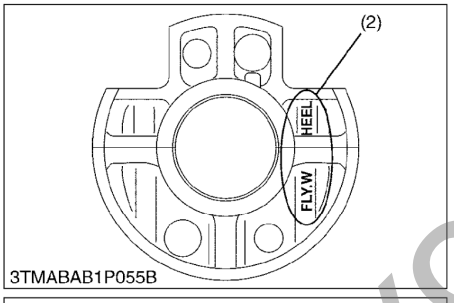
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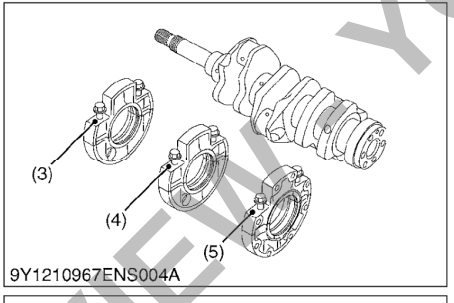

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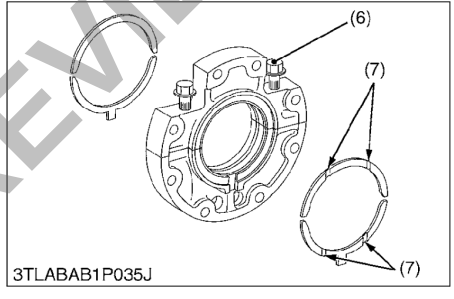
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Main Bearing Case Assembly

1. Remove the screws 1 of the main bearing case (6). Then remove the main bearing case.
2. Remove other main bearing cases as above.

(When reassembling)

- Clean the oil channel in the main bearing case.
- Apply clean engine oil on the bearings.
- Align the numbers (1) and mark (2) on the main bearing case.
- When you install the main bearing case 1 and 2, point the mark **"FLYWHEEL"** to the flywheel.
- When you install the thrust bearing, point the oil groove (7) externally.
- Install the main bearing case assemblies in the initial positions. Since the diameters of the main bearing cases are different, install them in the sequence of their marks (A, B) from the gear case side.
- After you tighten the screw 1 of the main bearing case (6) to the specified torque, make sure that the main bearing case moves smoothly.

Tightening torque	Screw 1 of main bearing case	46 to 50 N·m 4.7 to 5.2 kgf·m 34 to 37 lbf·ft

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

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3. MAINTENANCE CHECK LIST

To make sure that the engine operates safely for a long time, refer to the table below to do regular inspections.

[D1703-M-DI-E4B]

	Item		Service Interval										
			Every										
			50 hrs	100 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
*	Check of fuel hoses and clamp bands		☆										
	Change of engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆								
		(2) Oil pan depth (124 mm, 4.88 in.)	★			☆							
*	Cleaning of air cleaner element (replace the element after 6-times cleanings)			☆									
*	Cleaning of fuel filter (Element type)			☆									
	Check of battery electrolyte level			☆									
	Check of fan belt tension and damage			☆									
	Replacement of oil filter cartridge	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆								
		(2) Oil pan depth (124 mm, 4.88 in.)	★			☆							
	Check of radiator hoses and clamp bands				☆								
*	Check of intake air line				☆								
	Replacement of fuel filter cartridge					☆							
	Cleaning of fuel tank inside						☆						
	Cleaning of water jacket and radiator interior						☆						
	Replacement of fan belt						☆						
	Recharge of battery							☆					
*	Replacement of air cleaner element								☆				
	Check of valve clearance									☆			
*	Check of injection nozzle										☆		
*	Check of turbocharger											☆	
*	Check of injection pump											☆	
*	Replacement of intake air line												☆
	Replacement of battery												☆
	Replacement of radiator hoses and clamp bands												☆
*	Replacement of fuel hoses and clamps												☆
	Change of radiator coolant (L.L.C.)												☆

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

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

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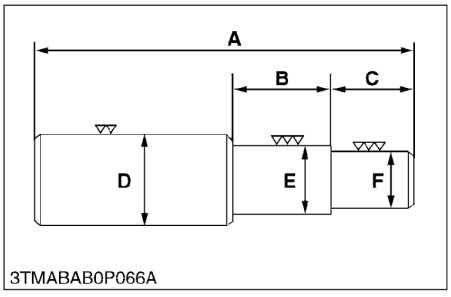
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Bushing Replacing Tools

Application

- To press out and press fit the bushing.

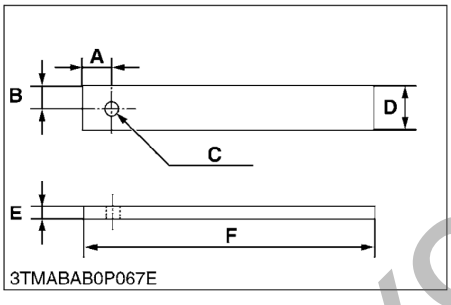
1) For small end bushing

A	162 mm (6.38 in.)
B	35 mm (1.4 in.)
C	27 mm (1.1 in.)
D	35 mm dia. (1.4 in. dia.)
E	27.90 to 27.95 mm dia. (1.099 to 1.100 in. dia.)
F	25.00 to 25.01 mm dia. (0.9843 to 0.9846 in. dia.)

2) For idle gear bushing

A	175 mm (6.89 in.)
B	40 mm (1.6 in.)
C	38 mm (1.5 in.)
D	45 mm dia. (1.8 in. dia.)
E	41.90 to 41.95 mm dia. (1.650 to 1.651 in. dia.)
F	37.950 to 37.970 mm dia. (1.4941 to 1.4948 in. dia.)

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Flywheel Stopper

Application

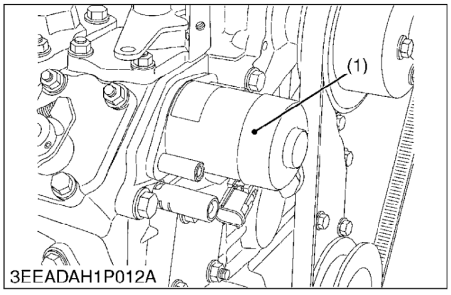
- To loosen and tighten the flywheel screw.

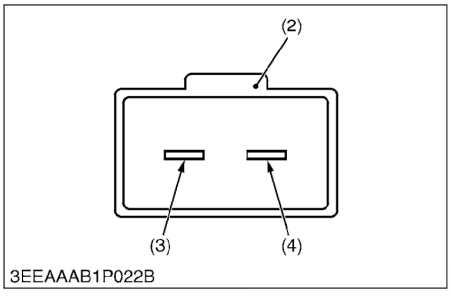
A	20 mm (0.79 in.)
B	15 mm (0.59 in.)
C	10 mm dia. (0.39 in. dia.)
D	30 mm (1.2 in.)
E	8 mm (0.3 in.)
F	200 mm (7.87 in.)

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Solenoid

1. Disconnect the connector of the solenoid (1) (2P).
2. Check the condition of the harness.
3. If the harness is damaged, replace it with a new one.
4. Turn the key switch to the ACC position.
5. Measure the voltage between the terminals of the connector (2) (harness side).
6. If the measurement is not in the factory specification, the ECU is damaged. Then replace the ECU with a new one.
7. If the measurement is in the factory specification, the ECU is correct.
   In this case, check the solenoid in the procedure below.

Voltage	Factory specification	Terminal **1** – Terminal **2**	12 V

(Reference)

1. Measure the resistance between the terminals of the connector (solenoid side).
2. If the measurement is not in the factory specification, the solenoid is damaged. Then replace the solenoid with a new one.
3. If the measurement is in the factory specification, the solenoid is correct electrically. Then check the movement of the solenoid.
4. Remove the solenoid (1) from the engine.
5. Apply the voltage of 12 V to the solenoid.
6. If the rod of the solenoid does not move smoothly, the solenoid is damaged. Then replace the solenoid with a new one.
7. If the rod of the solenoid moves smoothly, the solenoid is correct.

Resistance	Factory specification	Terminal **1** – Terminal **2**	2 to 4 Ω

(1) Solenoid
(2) Connector (Harness Side)
(3) Terminal **2** (−)
(4) Terminal **1** (+)

(A) Key Switch OFF Position
(B) Key Switch ON Position

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