SERVICING

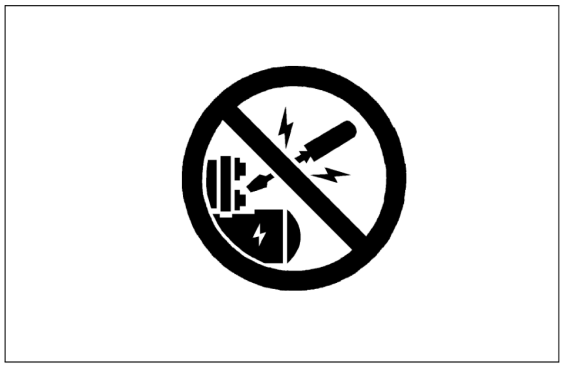
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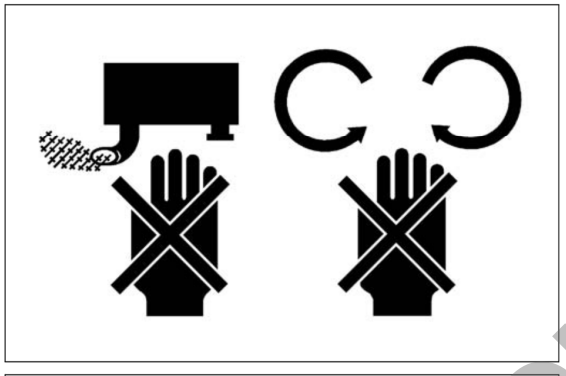
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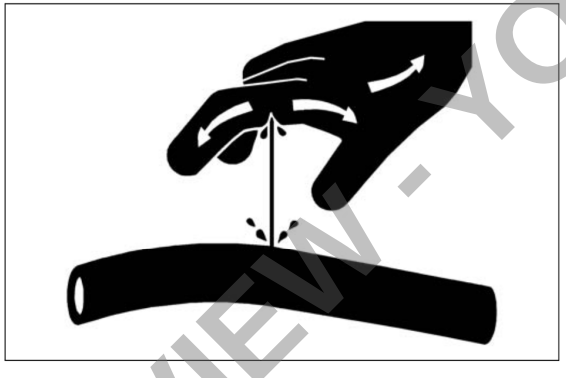
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SAFETY STARTING

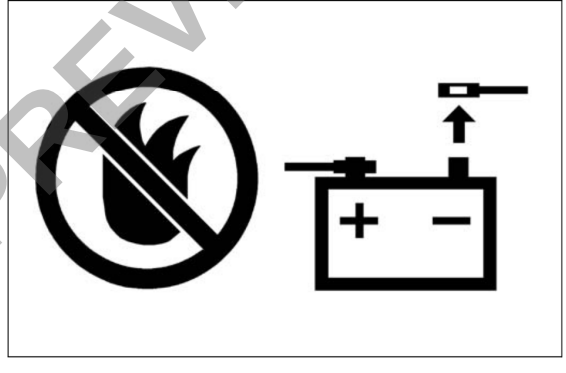
- Do not start the engine by shorting across starter terminals or bypassing the safety start switch.
- Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.





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.



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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SPECIFICATIONS

Model		D1503-M	D1703-M	D1803-M
Number of Cylinders		3		
Type		Vertical, Water-cooled, 4 cycle diesel engine		
Bore × Stroke		83 × 92.4 mm (3.27 × 3.64 in.)	87 × 92.4 mm (3.43 × 3.64 in.)	87 × 102.4 mm (3.43 × 4.03 in.)
Total Displacement		1499 cm^3 (91.47 cu.in.)	1647 cm^3 (100.51 cu.in.)	1826 cm^3 (111.43 cu.in.)
ISO Net Continuous		19.8 kW / 2800 min^{-1} (rpm) (26.5 HP / 2800 min^{-1} (rpm))	22.4 kW / 2800 min^{-1} (rpm) (30.0 HP / 2800 min^{-1} (rpm))	23.3 kW / 2600 min^{-1} (rpm) (31.2 HP / 2600 min^{-1} (rpm))
ISO/SAE Net Intermittent		22.8 kW / 2800 min^{-1} (rpm) (30.5 HP / 2800 min^{-1} (rpm))	25.7 kW / 2800 min^{-1} (rpm) (34.5 HP / 2800 min^{-1} (rpm))	26.9 kW / 2600 min^{-1} (rpm) (36.1 HP / 2600 min^{-1} (rpm))
SAE Gross Intermittent		24.9 kW / 2800 min^{-1} (rpm) (33.4 HP / 2800 min^{-1} (rpm))	27.4 kW / 2800 min^{-1} (rpm) (36.7 HP / 2800 min^{-1} (rpm))	28.4 kW / 2600 min^{-1} (rpm) (38.1 HP / 2600 min^{-1} (rpm))
Maximum Bare Speed		3000 min^{-1} (rpm)		2800 min^{-1} (rpm)
Minimum Bare Idling Speed		750 to 850 min^{-1} (rpm)		
Combustion Chamber		Spherical Type (E-TVCS)		
Fuel Injection Pump		Bosch Type Mini Pump		
Governor		All speed mechanical governor		
Direction of Rotation		Counter-clockwise (viewed from flywheel side)		
Injection Nozzle		Bosch Throttle Type Mini Nozzle (OPD)		
Injection Timing		0.314 rad (18 °) before T.D.C.		
Firing Order		1-2-3		
Injection Pressure		13.73 MPa (140 kgf/cm^2, 1991 psi)		
Compression Ratio		23 : 1	22.6 : 1	23.8 : 1
Lubricating System		Forced Lubrication by Trochoid Pump		
Oil Pressure Indicating		Electrical type switch		
Lubricating Filter		Full flow paper filter (cartridge type)		
Cooling System		Pressurized radiator, forced circulation with water pump		
Starting System		Electric Starting with Starter		
Starting Motor		12 V, 1.4 kW		12 V, 2.0 kW
Starting Support Device		By glow plug in combustion chamber		
Battery		12 V, 70 to 80 AH equivalent		12 V, 100 to 120 AH equivalent
Charging Alternator		12 V, 480 W		
Fuel		Diesel Fuel No.2-D (ASTM D975)		
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. If this class of lubricating oil is not available, preferably use Class CD or CE lubricating oil. For details on recommended lubricating oils, see page G-5, 12.		
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.54 in.)	5.6 L (1.48 U.S.gals)		
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.85 U.S.gals)		
Weight (Dry)		148 kg (326 lbs)		151 kg (333 lbs)

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

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3. MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

Item		Service Interval Every											
		50 hrs	100 hrs	150 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
* Checking fuel hoses and clamp bands													
Changing engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm, 3.54 in.)												
	(2) Oil pan depth (124 mm, 4.88 in.)												
*Cleaning air cleaner element (replace the element after 6-times cleanings)													
*Cleaning fuel filter (Element type)													
Checking battery electrolyte level													
Checking fan belt tension and damage													
Replacing oil filter cartridge	(1) Oil pan depth (90 mm, 3.54 in.)												
	(2) Oil pan depth (124 mm, 4.88 in.)												
Checking radiator hoses and clamp bands													
* Checking intake air line													
Replacing fuel filter cartridge													
Cleaning water jacket and radiator interior													
Replacing fan belt													
Recharging battery													
* Replacing air cleaner element													
Checking valve clearance													
* Checking injection nozzle pressure													
* Checking turbocharger													
* Checking injection pump													
* Replacing intake air line													
Replacing battery													
Replacing radiator hoses and clamp bands													
* Replacing fuel hoses and clamps													
Changing radiator coolant (L.L.C.)													

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

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

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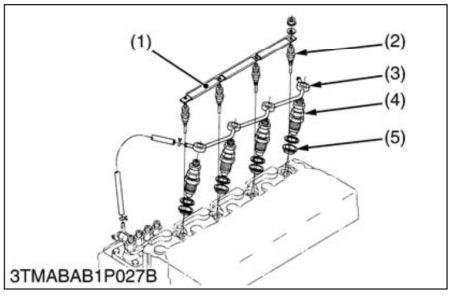
1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	G-9
	Air in the fuel system	Vent air	G-9
	Water in the fuel system	Change fuel and repair or replace fuel system	–
	Fuel hose clogged	Clean or replace	G-9
	Fuel filter clogged	Replace	G-16
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	4, 5, 6, G-8
	Fuel with low cetane number	Use specified fuel	4, 5, 6
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-31
	Incorrect injection timing	Adjust	S-20
	Fuel camshaft worn	Replace	S-44
	Injection nozzle clogged	Clean or replace	S-22, 31
	Injection pump malfunctioning	Repair or replace	S-21, 35, 36, 37
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	S-43 to 47 S-66 to 71
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	S-31, 32, 33
	Improper valve timing	Correct or replace timing gear	S-42, 43
	Piston ring and cylinder worn	Replace	S-15, 46, 47, 65, 70
	Excessive valve clearance	Adjust	S-16
	Stop solenoid malfunctioning	Replace	S-27, 35, 36
(Starter Does Not Run)	Battery discharged	Charge	G-19, 20
	Starter malfunctioning	Repair or replace	S-25, 28, 51, 72
	Key switch malfunctioning	Replace	–
	Wiring disconnected	Connect	–

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Nozzle Holder Assembly and Glow Plug

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

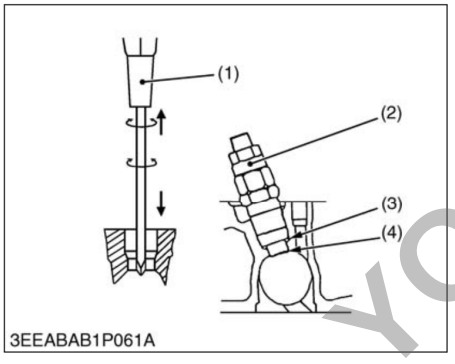
(When reassembling)

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

Tightening torque	Nozzle holder assembly	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs
	Overflow pipe assembly retaining screw	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Glow plug	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Lead
(2) Glow Plug
(3) Overflow Pipe Assembly
(4) Nozzle Holder Assembly
(5) Heat Seal

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Nozzle Heat Seal Service Removal Procedure

IMPORTANT

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

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

(When reassembling)

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

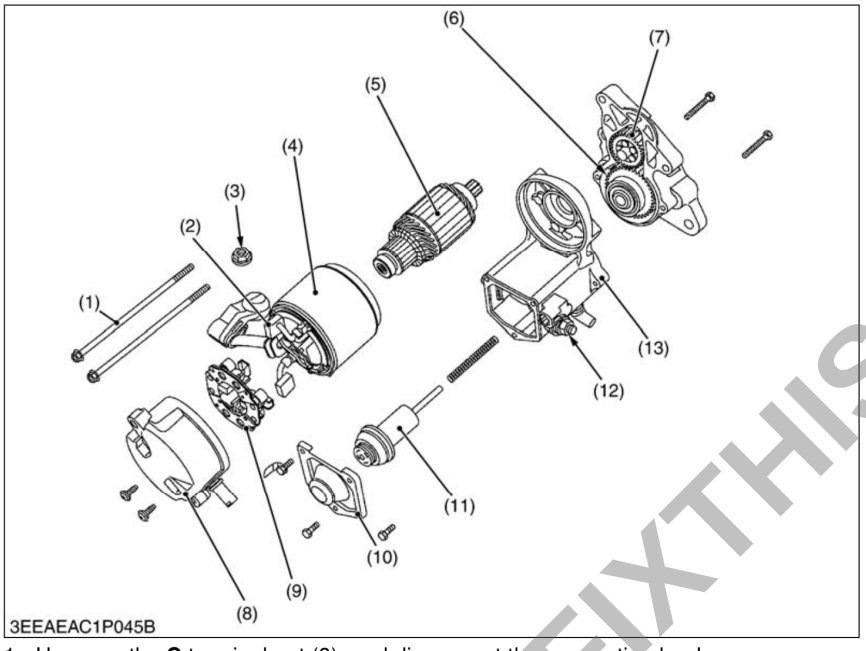
(1) Plus Screw Driver
(2) Injection Nozzle
(3) Injection Nozzle Gasket
(4) Heat Seal

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(7) Starter



(1) Through Bolt
(2) Brush
(3) **C** Terminal Nut
(4) Yoke
(5) Armature
(6) Overrunning Clutch
(7) Idle Gear
(8) End Frame
(9) Brush Holder
(10) Magnet Switch Cover
(11) Plunger
(12) **B** Terminal Nut
(13) Housing

W1222714

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

NOTE

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

(When reassembling)

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

Tightening torque	**B** terminal nut	5.9 to 11.8 N·m 0.6 to 1.2 kgf·m 4.3 to 8.7 ft-lbs

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

NOTE

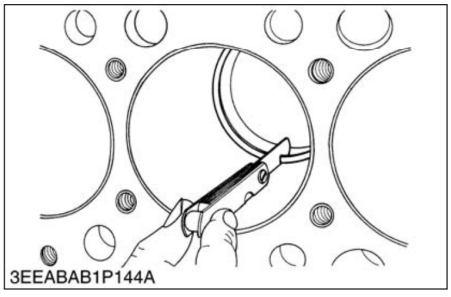
- **For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.**
- **The letter "M" in Size x Pitch means that the screw, bolt or nut dimension stands for metric. The size is the nominal outside diameter in mm of the threads. The pitch is the nominal distance in mm between two threads.**

Item	Size x Pitch	N·m	kgf·m	ft-lbs
Cylinder head cover screw	M6 x 1.0	6.9 to 11.3	0.7 to 1.15	5.1 to 8.32
*Cylinder head screw	M11 x 1.25	93.2 to 98.1	9.5 to 10.0	68.7 to 72.3
*Main bearing case screw 1	M9 x 1.25	46.1 to 51.0	4.7 to 5.2	34.0 to 37.6
*Main bearing case screw 2	M10 x 1.25	68.6 to 73.5	7.0 to 7.5	50.6 to 54.2
*Flywheel screw	M12 x 1.25	98.1 to 107.9	10.0 to 11.0	72.3 to 79.6
*Connecting rod screw	M8 x 1.0	44.1 to 49.0	4.5 to 5.0	32.5 to 36.2
*Rocker arm bracket screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
*Idle gear shaft screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Fan drive pulley mounting nut	M30 x 1.5	137.3 to 156.9	14.0 to 16.0	101.3 to 115.7
*Bearing case cover mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Glow plug	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle holder assembly	M20 x 1.5	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
Nozzle holder	–	34.3 to 39.2	3.5 to 4.0	25.3 to 28.9
Oil pressure switch	R 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection pipe retaining nut	M12 x 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
Overflow pipe assembly retaining nut	M12 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Camshaft set screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Hi-idling body	M14 x 1.0	44.1 to 49.0	4.5 to 5.0	32.5 to 36.2
Balancer shaft set bolt (Balancer model only)	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Alternator's pulley nut	–	58.3 to 78.9	5.95 to 8.05	43.0 to 58.2
Idle gear 2 stopper set screw (Side PTO model only)	–	49.0 to 55.9	5.0 to 5.7	36.2 to 41.2
Idle gear 2 shaft set screw (Side PTO model only)	–	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Starter's terminal **B** mounting nut	M8	5.9 to 11.8	0.6 to 1.2	4.3 to 8.7

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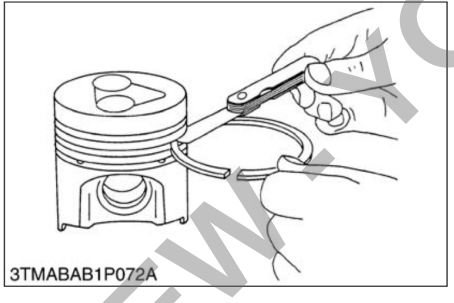


Piston Ring Gap

1. Insert the piston ring into the lower part of the liner (the least worn out part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the ring.

Top ring	Factory spec.	D1503-M V2003-M V2003-M-T	0.20 to 0.35 mm 0.0079 to 0.0138 in.
		D1703-M D1803-M V2203-M V2403-M	0.25 to 0.40 mm 0.0098 to 0.0157 in.
	Allowable limit		1.25 mm 0.0492 in.
Second ring	Factory spec.	D1503-M D1703-M D1803-M V2203-M V2403-M	0.30 to 0.45 mm 0.0118 to 0.0177 in.
		V2003-M V2003-M-T	0.40 to 0.55 mm 0.0157 to 0.0217 in.
	Allowable limit		1.25 mm 0.0492 in.
Oil ring	Factory spec.		0.25 to 0.45 mm 0.0098 to 0.0177 in.
	Allowable limit		1.25 mm 0.0492 in.

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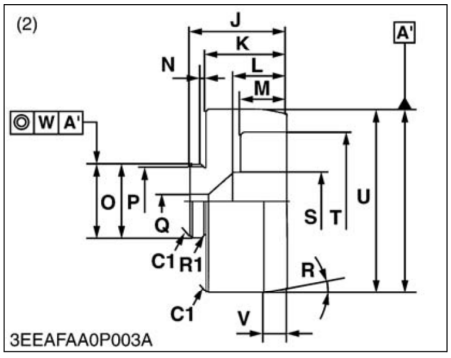
Clearance between Piston Ring and Groove

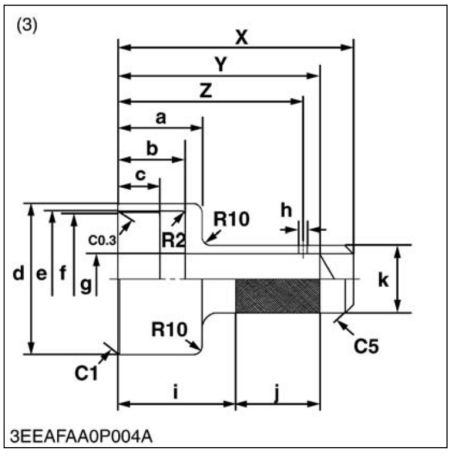
1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds the allowable limit, replace the piston ring.
4. If the clearance still exceeds the allowable limit with new ring, replace the piston.

Second ring	Factory spec.	0.093 to 0.128 mm 0.0037 to 0.0050 in.
	Allowable limit	0.20 mm 0.0079 in.
Oil ring	Factory spec.	0.020 to 0.060 mm 0.0008 to 0.0024 in.
	Allowable limit	0.15 mm 0.0059 in.

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Auxiliary Socket for Fixing Crankshaft Sleeve (Continued)

Application: Use to fix the crankshaft sleeve of the diesel engine.

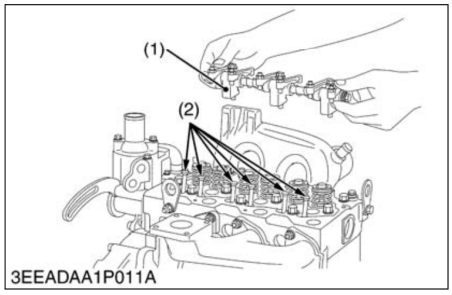
J	42.0 mm (1.6535 in.)
K	30.5 to 30.6 mm (1.2008 to 1.2047 in.)
L	23.0 mm (0.9055 in.)
M	20.0 mm (0.7874 in.)
N	2.0 mm (0.0787 in.)
O	31.911 to 31.950 mm dia. (1.2563 to 1.2579 in. dia.)
P	30.0 mm dia. (1.1811 in. dia.)
Q	5.0 mm dia. (0.1969 in. dia.)
R	0.087 rad (5 °)
S	25.0 mm dia. (0.9843 in. dia.)
T	60.0 mm dia. (2.3622 in. dia.)
U	79.80 to 79.85 mm dia. (3.1417 to 3.1437 in. dia.)
V	10.0 mm (0.3937 in.)
W	0.04 mm dia. (0.0016 in. dia.)
X	140 mm (5.5118 in.)
Y	120 mm (4.7244 in.)
Z	110 mm (4.3307 in.)
a	50.0 mm (1.9685 in.)
b	39.9 to 40.0 mm (1.5709 to 1.5748 in.)
c	25.0 mm (0.9843 in.)
d	90.0 mm dia. (3.5433 in. dia.)
e	81.0 mm dia. (3.1890 in. dia.)
f	80.10 to 80.15 mm dia. (3.1535 to 3.1555 in. dia.)
g	30.0 mm dia. (1.1811 in. dia.)
h	5.0 mm dia. (0.1969 in. dia.)
i	70.0 mm (2.7559 in.)
j	50.0 mm (1.9685 in.)
k	40.0 mm dia. (1.5748 in. dia.)
C1	Chamfer 1.0 mm (0.0394 in.)
C5	Chamfer 5.0 mm (0.1969 in.)
C0.3	Chamfer 0.3 mm (0.012 in.)
R1	1.0 mm radius (0.0394 in. radius)
R2	2.0 mm radius (0.0787 in. radius)
R10	10.0 mm radius (0.3937 in. radius)

(2) Sleeve Guide
(3) Auxiliary Socket for Pushing

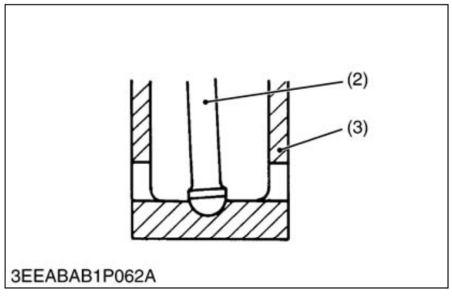
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3EEABAB1P062A

Rocker Arm and Push Rod

1. Remove the rocker arm bracket screws.
2. Detach the rocker arm assembly (1).
3. Remove the push rods (2).

(When reassembling)

- When putting the push rods (2) onto the tappets (3), check to see if their ends are properly engaged with the grooves.

IMPORTANT

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

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

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

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