MECHANISM

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⚠ SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and decals on the engine 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.**

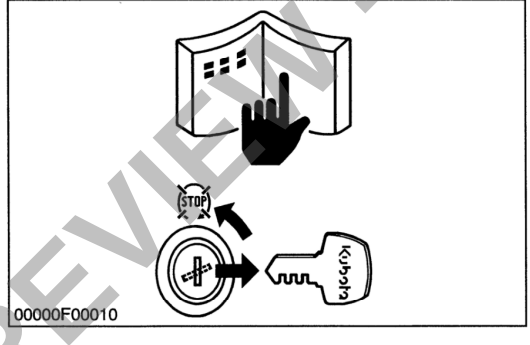
⚠ **WARNING**: **Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ **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

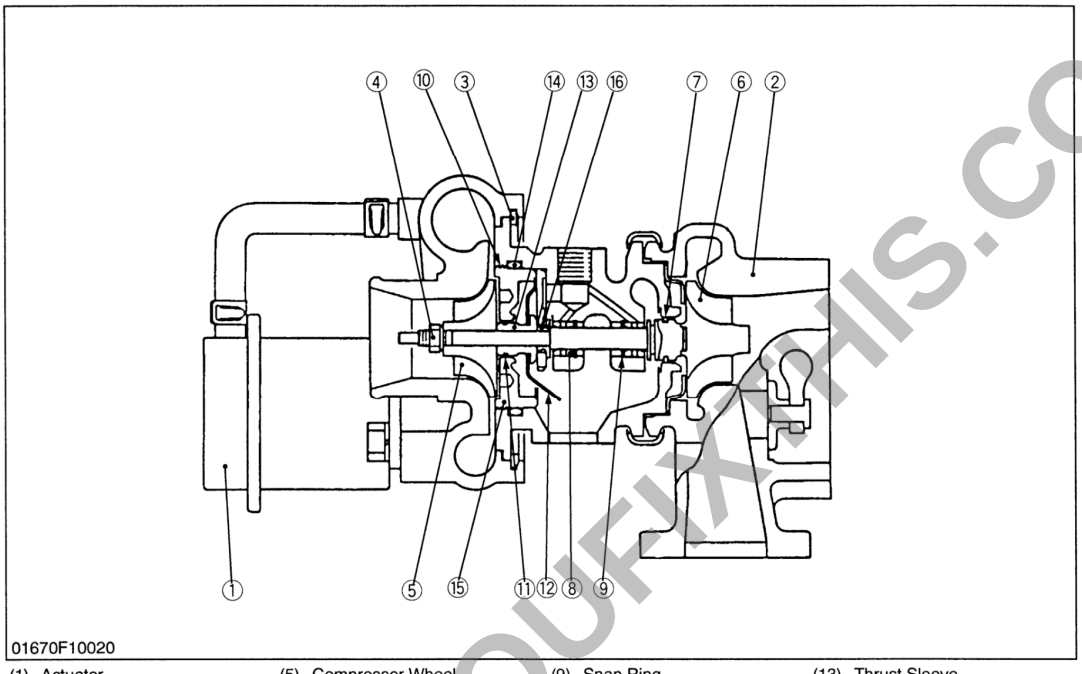
(1) Read all instructions and safety instructions in this manual and on your engine safety decals.
(2) Clean the work area and engine.
(3) Place the engine on a firm and level ground.
(4) allow the engine to cool before proceeding.
(5) Stop the engine, and remove the key.
(6) Disconnect the battery negative cable.

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7 TURBO CHARGER SYSTEM



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(1) Actuator
(2) Turbine Housing
(3) Snap Ring
(4) Lock Nut
(5) Compressor Wheel
(6) Turbine Wheel
(7) Piston Ring
(8) Bearing
(9) Snap Ring
(10) Snap Ring
(11) Piston Ring
(12) Oil Deflector
(13) Thrust Sleeve
(14) O-ring
(15) Thrust Bearing
(16) Thrust Ring

This turbo charger consists basically of a centrifugal compressor mounted on a common shaft with a double flow turbine driven by exhaust gas from the engine.

The turbo charger is capable of supplying far more air to the engine than for a non-supercharged engine, which is without such a charger.

In applications where the boost pressure is relatively low, the turbo charger is capable of reducing the smoke concentration, the concentration in the cylinder, fuel consumption, and deterioration in performance at elevated terrain by increasing the amount of air to the engine.

In applications where the boost pressure is high, the charger is capable of providing a large increase in engine output by increasing the amount of air into the engine, in addition to the above mentioned advantages.

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[4] TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	• No fuel	Replenish fuel	–
	• Air in the fuel system	Vent air	S-17
	• Water in the fuel system	Change fuel and repair or replace fuel system	–
	• Fuel pipe clogged	Clean	S-17
	• Fuel filter clogged	Clean or change	–
	• Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	–
	• Fuel with low cetane number	Use specified fuel	–
	• Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	–
	• Incorrect injection timing	Adjust	S-67
	• Fuel camshaft worn	Replace	–
	• Injection nozzle clogged	Clean	S-70
	• Injection pump malfunctioning	Repair or replace	–
	• Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	–
	• Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	S-28
	• Improper valve timing	Correct or replace timing gear	S-38
	• Piston ring and cylinder worn	Replace	S-54, 61
	• Excessive valve clearance	Adjust	S-20
(Starter Does Not Run)	• Battery discharged	Charge	–
	• Starter malfunctioning	Repair or replace	S-71
	• Key switch malfunctioning	Repair or replace	–
	• Wiring disconnected	Connect	–
Engine Revolution Is Not Smooth	• Fuel filter clogged or dirty	Clean or change	–
	• Air cleaner clogged	Clean or change	S-18
	• Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	–
	• Injection pump malfunctioning	Repair or replace	–
	• Incorrect nozzle opening pressure	Adjust	S-70
	• Injection nozzle stuck or clogged	Repair or replace	S-70
	• Governor malfunctioning	Repair	
	• Bearing worn out	Replace the turbocharger assembly	S-29
	• Shaft bent		S-30
	• Fin or other part damaged due to foreign matters		S-30

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[5] SERVICING SPECIFICATIONS

(1) Engine Body

Cylinder Head

Item	Factory Specification	Allowable Limit
Cylinder Head Surface Flatness	–	0.05 mm 0.0019 in.
Top Clearance	0.55 to 0.70 mm 0.0217 to 0.0276 in.	–
Compression Pressure	3.53 to 3.72 MPa 36.0 to 38.0 kgf/cm^2 512 to 540 psi	2.45 MPa 26 kgf/cm^2 355 psi
Variance Among Cylinders	–	10 % or less

Valves

Valve Clearance (Cold)		0.18 to 0.22 mm 0.0071 to 0.0087 in.	–
Valve Seal Width	IN.	2.12 mm 0.0835 in	–
	EX.	2.12 mm 0.0835 in.	–
Valve Seat Angle	IN.	1.047 rad. 60°	–
	EX.	0.785 rad. 45°	–
Valve Face Angle	IN.	1.047 rad. 60°	–
	EX.	0.785 rad. 45°	–
Valve Recessing		– 0.05 to 0.15 mm –0.0020 to 0.0059 in.	0.4 mm 0.016 in.
Clearance between Valve Stem and Valve Guide		0.040 to 0.070 mm 0.0016 to 0.0026 in.	0.1 mm 0.0039 in.
		7.960 to 7.975 mm 0.3134 to 0.3140 in.	–
		8.015 to 8.030 mm 0.3156 to 0.3161 in.	–

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(4) Check Point of Every 150 / 200 hours

Changing Engine Oil

1. After warming up, stop the engine.
2. To change the used oil, remove the drain plug at the bottom of the engine and drain off the oil completely.
3. Reinstall the drain plug.
4. Fill the new oil up to the upper notch on the dipstick.

■ IMPORTANT

- **Engine oil should be have properties of API classification CE grades.**
- **Change the type of engine according to the ambient temperature.**
  Above 25 °C (77 °F)..... SAE 30 or 10W-30
  0 °C to 25 °C (32 °F to 77 °F)..... SAE 20 or 10W-30
  Below 0 °C (32 °F)..... SAE 10W or 10W-30

Oil pan depth / Models	Capacity	
	124 mm (4.88 in.)	90 mm (3.54 in.)
V2003-T-B	10.2 L 2.69 U.S.qts. 2.24 Imp.qts.	8.3 L 2.19 U.S.qts. 1.83 Imp.qts.
F2503-T-B	12.7 L 3.36 U.S.qts. 2.79 Imp.qts.	—

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(5) Check Point of Every 400 hours

Changing Oil Filter Cartridge

1. Remove the oil filter cartridge with a filter wrench.
2. Apply engine oil to the rubber gasket on the new cartridge.
3. Screw the new cartridge in by hand.

■ NOTE

- **Over-tightening may cause deformation of rubber gasket.**
- **Check the oil level and add new oil to the specified level.**

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[1] DRAINING WATER AND OIL

Draining Cooling Water and Engine Oil

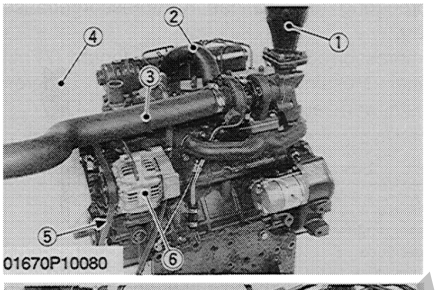
CAUTION

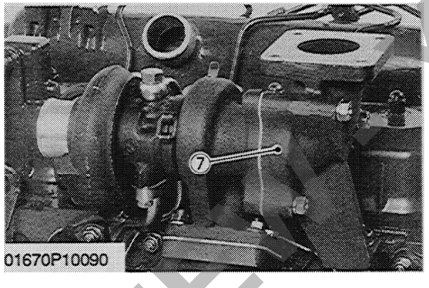
- **Never remove radiator cap until cooling water temperature is below its boiling point. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Prepare a bucket. Open the drain cock to drain cooling water.
2. Prepare an oil pan. Remove the drain plug to drain engine oil in the pan.

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[2] EXTERNAL COMPONENTS





External Parts

1. Remove the muffler (1), air cleaner and intake pipe (2, 3).
2. Remove the fan (4), fan belt (5) and the alternator (6).
3. Remove the muffler glange (7).

(When reassembling)

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

IMPORTANT

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**

(1) Muffler
(2) Intake Pipe
(3) Intake Pipe
(4) Fan
(5) Fan Belt
(6) Alternator
(7) Muffler Flange

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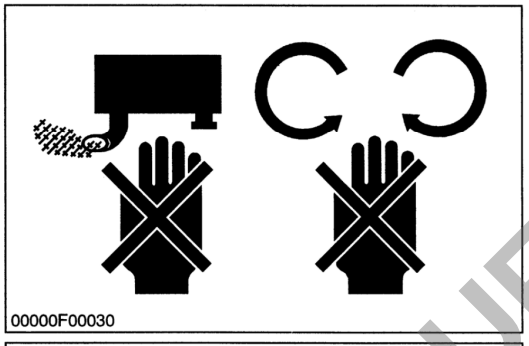
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SAFETY STARTING

(1) Do not start the engine by shorting across starter terminals.
(2) Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.

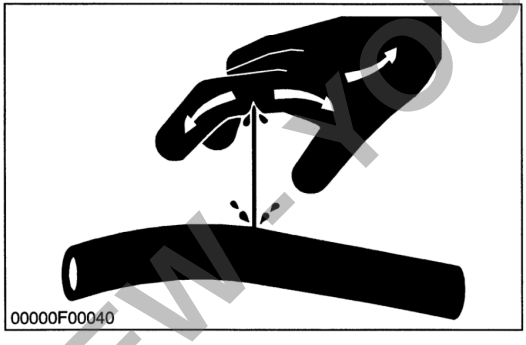
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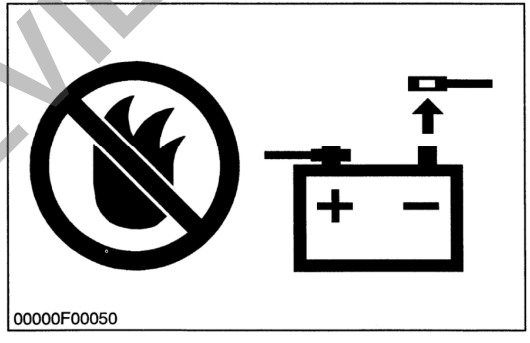

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SAFETY WORKING

(1) Do not work on the engine while under the influence of alcohol, medication, or other substances or while fatigued.
(2) Wear close fitting clothing and safety equipment appropriate to the job.
(3) Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
(4) When servicing is performed together by two or more persons, take care to perform all work safely.
(5) Do not touch the rotating or hot parts while the engine is running.
(6) 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.
(7) 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.
(8) Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

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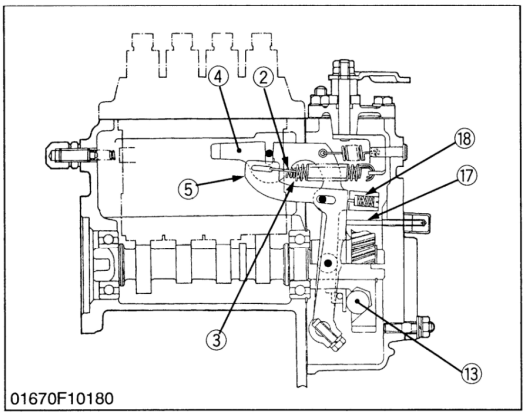
AVOID FIRES

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

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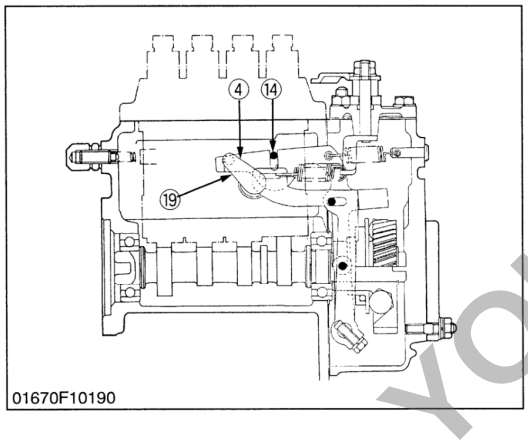
■ At high speed running with overload

When an overload is applied to the engine running at a high speed, the centrifugal force of steel ball (13) becomes small as the engine speed is dropped, and fork lever 2 (5) is pulled to the right by the governor springs 1 (2) and 2 (3), increasing furl injection. Though, fork lever 2 becomes ineffective in increasing fuel injection when it is stopped by the adjusting bolt (17).

After that, when the force of torque spring (18) becomes greater than the centrifugal force of the steel ball, fork lever 1 (4) moves rightward to increase fuel injection, causing the engine to run continuously at a high torque.

(17) Adjusting Bolt (18) Torque Spring

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■ To stop engine

When the stop lever (19) is moved to STOP position, fork lever 1 (4) is moved leftward and the control rack (14) is moved to the non-injection position, stopping the engine.

(19) Stop Lever

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(4) Fuel System

Injection Pump

Item		Factory specification	Allowable Limit
Injection Timing Without Timer	V2003-T-B	0.31 to 0.35 rad. (18 to 20°) Before T.D.C.	–
	F2503-T-B	0.30 to 0.33 rad. (17 to 19°) Before T.D.C.	–
Fuel Titghtness of Pump Element		–	14.7 MPa 150 kgf/cm^2 2133 psi
Fuel Tightness of Delivery Valve		More 10 seconds 14.7 → 13.7 MPa 150 → 140 kgf/cm^2 2133 → 1990 psi	5 seconds 14.7 → 13.7 MPa 150 →140 kgf/cm^2 2133 → 1990 psi

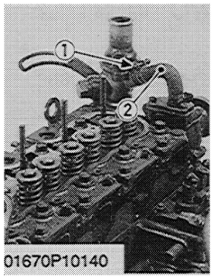
Injection Nozzle

Fuel Injection Pressure	13.73 to 14.71 MPa 140 to 150 kgf/cm^2 1991 to 2133 psi	–
Fuel Titghtness of Nozzle Valve Seat	When the pressure is 12.75 MPa (130 kgf/cm^2, 1849 psi), the valve seat must be fuel tightness	–

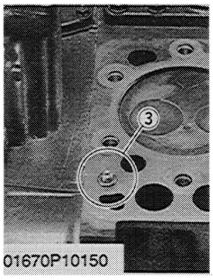
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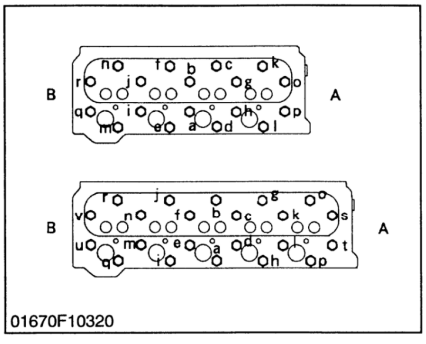
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Cylinder Head

1. Loosen the pipe band (1), and remove the water return pipe (2).
2. Remove the cylinder head screws in the order of (r, v) to (a), and remove the cylinder head.
3. Remove the cylinder head gasket and O-ring (3).

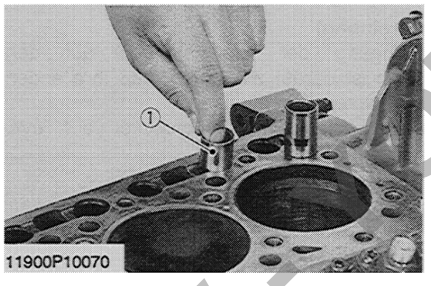
(When reassembling)

- Replace the head gasket with a new one.
- Install the cylinder head, using care not to damage the O-ring.
- Tighten the cylinder head screwsgradually in the order of (a) to (r, v) after applying engine oil.
- Retighten the cylinder head screws after running the engine for 30 minutes.

Tightening torque	Cylinder head bolts	93.1 to 98.0 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft-lbs

(A) Gear Case Side **(B) Flywheel Side**

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Tappets

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

(When reassembling)

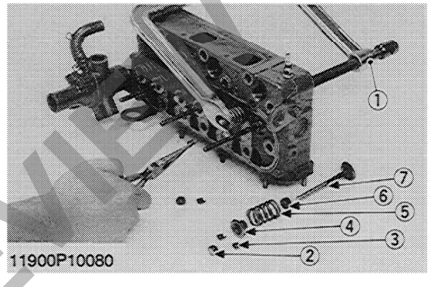
- Before installing the tappets, apply engine oil thinly around them.

■ IMPORTANT

- **Mark the cylinder number to the tappets to prevent interchanging.**

(1) Tappet

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Valves

1. Remove the valve cap (2).
2. Remove the valve spring collet (3) with a valve lifter.
3. Remove the valve spring retainer (4), valve spring (5) and valve (7).

(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.

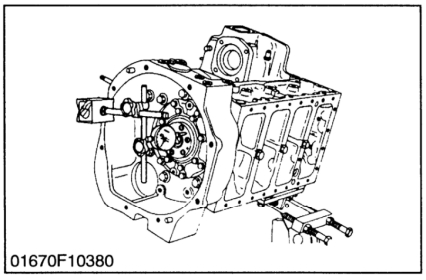
(1) Valve Lifter
(2) Valve Cap
(3) Valve Spring Collet
(4) Valve Spring Retainer
(5) Valve Spring
(6) Valve Stem Seal
(7) Valve

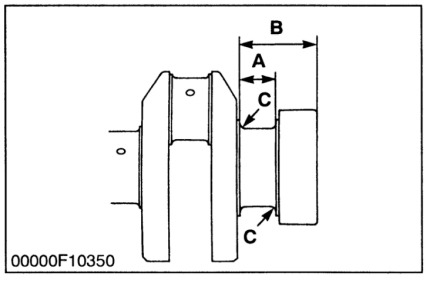
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[4] CRANKSHAFT


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Crankshaft Side Clearance

1. Set a dial indicator with its tip on the end of the crankshaft.
2. Measure the side clearance by moving the crankshaft to the front and rear.
3. If the measurement exceeds the allowable limit, replace the thrust bearings.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an oversize one referring to the table and figure.

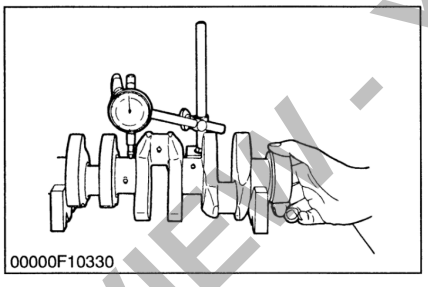
Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.50 mm 0.0197 in.

(Reference)

- Oversize dimensions of crankshaft journal

Oversize / Dimension	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	26.20 to 26.25 mm 1.0315 to 1.0335 in.	26.40 to 26.45 mm 1.0394 to 1.0413 in.
B	54.5 to 54.7 mm 2.1456 to 2.1535 in.	54.6 to 54.8 mm 2.1496 to 2.1574 in.
C	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
The crankshaft journal must be fine-finished to higher than $\overset{(0.8\text{-S})}{\nabla\nabla\nabla\nabla}$.		

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Crankshaft Alignment

1. Support the crankshaft with V blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0,02 mm 0.0008 in.

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