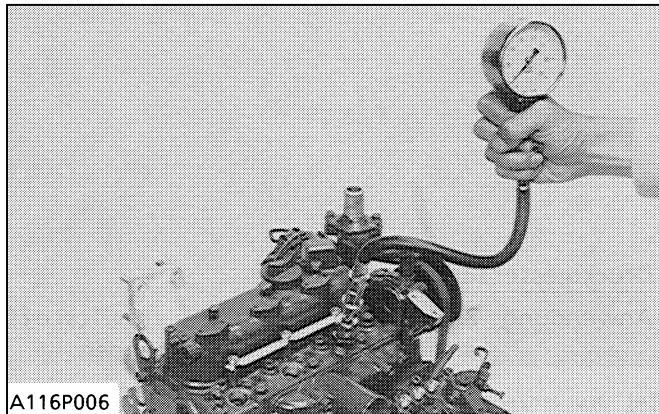


1 ENGINE BODY

CHECKING AND ADJUSTING



A116P006

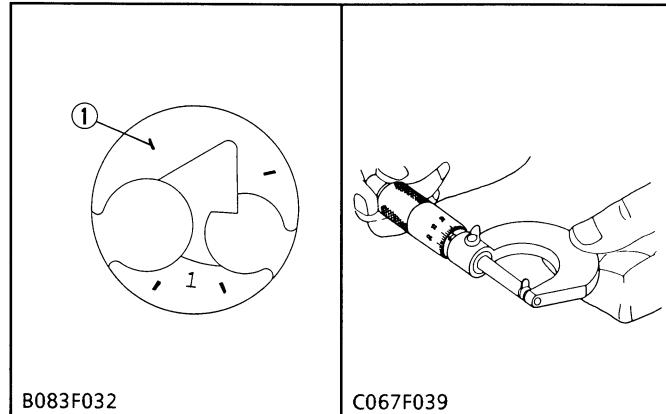
Compression Pressure

1. After warming up the engine, stop it and remove the air cleaner, the muffler and all nozzle holders.
2. Install a compression tester (Code No: 07909-30208) 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 200 to 300 r.p.m. 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.

■ NOTE

- Variances in cylinder compression values should be under 10%.

Compression pressure	Factory spec.	2.84 to 3.24 MPa 29 to 33 kgf/cm ² 412 to 469 psi
	Allowable limit	2.26 MPa 23 kgf/cm ² 327 psi



(1) Fuse

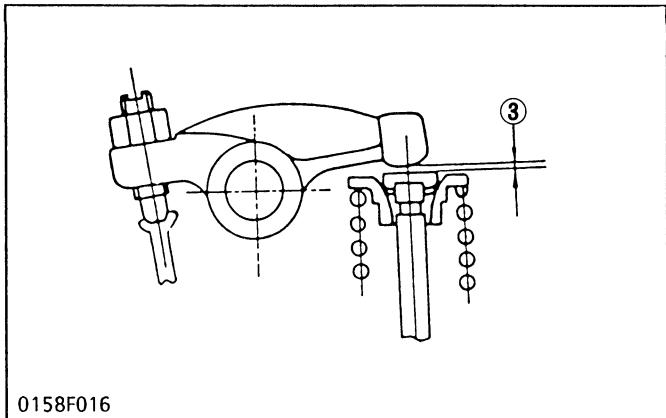
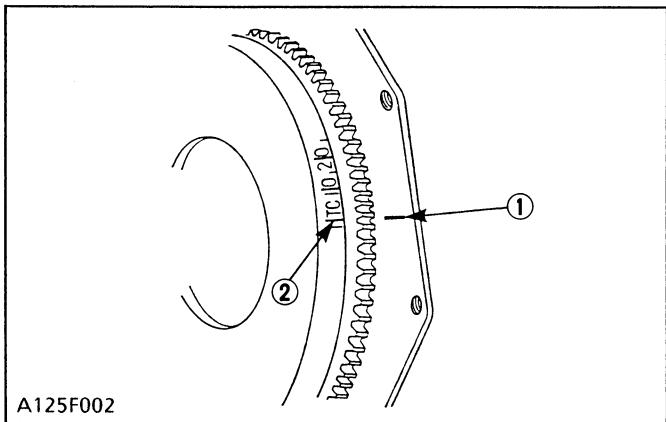
Top Clearance

1. Remove the cylinder head (then don't attempt to remove the cylinder head gasket).
2. Bring the piston to its top dead center fasten 1.5 mm dia. 5 to 7 mm long fuse wires to 3 to 4 spots on the piston top with grease so as to avoid the intake and exhaust valves and the combustion chamber ports.
3. Bring the piston to its bottom dead center, install the cylinder head, and tighten the cylinder head bolts to specification.
4. Turn the crank shaft until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure squeezed fuse wires for thickness.
6. If the measurement is not within the specified value, check the oil clearance of the crankpin journal and the piston pin.

Top clearance	Factory spec.	0.50 to 0.70 mm 0.0197 to 0.0276 in.
Tightening torque	Cylinder head mounting bolts	39.2 to 44.1 N·m 4.0 to 4.5 kgf-m 28.9 to 32.5 ft-lbs

■ NOTE

- Head gasket must be changed to new one.



- (1) Punch Mark
- (2) TC Mark Line
- (3) Valve Clearance

Checking Valve Clearance

■ IMPORTANT

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

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

Valve clearance	Factory spec.	0.145 to 0.185 mm 0.0057 to 0.0073 in.
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■ NOTE

- The "TC" marking on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.
- No. 1 piston comes to the T.D.C. position when the "TC" marking is aligned with the punch mark of the rear end plate. Turn the flywheel 0.26 rad. (15°) clockwise and counter-clockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance. (The piston is at the top dead center when both the IN. and EX valves do not move; it is at the overlap position when both the valves move.)
- Finally turn the flywheel 6.28 rad. (360°) to make sure the "TC" marking and the punch mark are perfectly aligned. Adjust all the other valve clearances as required.
- After turning the flywheel counterclockwise twice or three times, recheck the valve clearance.
- After adjusting the valve clearance, firmly tighten the lock nut of the adjusting screw.

Engine Model Valve arrangement Adjustable cylinder Location of piston		Z442-B (E), Z482-B (E)		D662-B (E), D722-B (E)	
		IN.	EX.	IN.	EX.
When No. 1 piston is compression top dead center	1st	○	○	○	○
	2nd		○		○
	3rd			○	
When No. 1 piston is overlap position	1st				
	2nd	○		○	
	3rd				○

DISASSEMBLING AND ASSEMBLING

■ NOTE

- The cylinder heads with serial numbers 489291 and on are partially modified in configuration because of the introduction of the nozzle heat seal.
For replacing the cylinder head, see the Parts List and choose the right one in reference to its serial number.

[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.

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

[2] EXTERNAL COMPONENTS

Air Cleaner and Muffler

- Remove the air cleaner.
- Remove muffler retaining nuts to remove the muffler.

(When reassembling)

- Install the muffler gasket so that its steel side face the muffler.

Dynamo and Fan Belt

- Remove the Dynamo (1).
- Remove the fan belt (2).

(When reassembling)

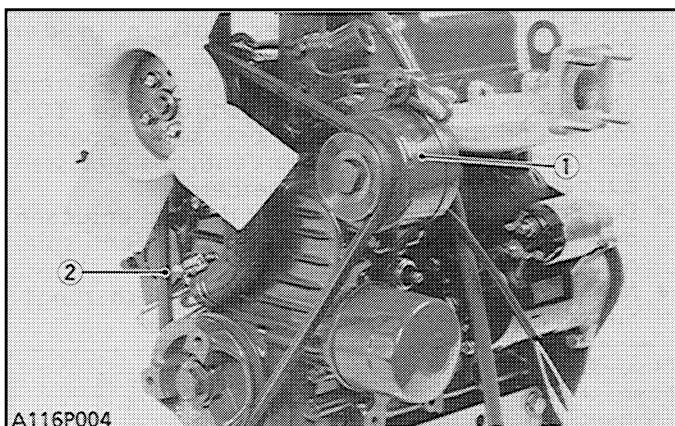
- Check to see that there are no cracks on the belt surface.

■ IMPORTANT

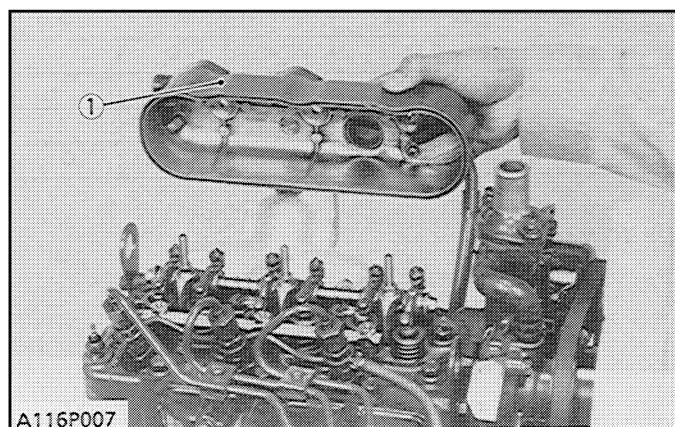
- After reassembling the fan belt, be sure to adjust the fan belt tension.

(1) Dynamo

(2) Fan Belt



[3] CYLINDER HEAD AND VALVES



Cylinder Head Cover

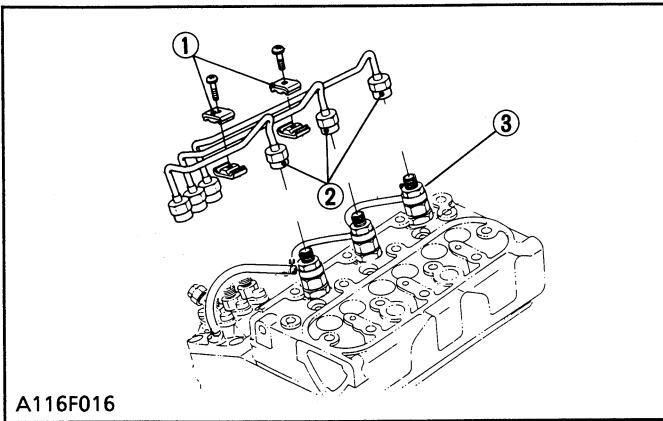
- Remove the cylinder head cover cap nuts.
- Remove the cylinder head cover (1).

(When reassembling)

- Check to see that the cylinder head cover gasket is not defective.

Tightening torque	Head cover nut	3.9 to 5.9 N·m 0.4 to 0.6 kgf·m 2.9 to 4.3 ft-lbs
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(1) Head Cover



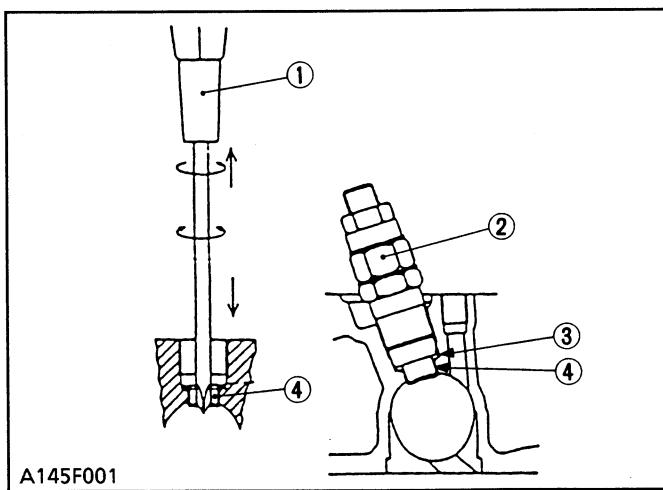
A116F016

- (1) Pipe Clamps
(2) Injection Pipes
(3) Nozzle Holder Assembly

Injection Pipe and Nozzle Holder Assembly

1. Loosen the pipe clamps (1).
2. Remove the injection pipes (2).
3. Remove the fuel overflow pipe.
4. Loosen the lock nuts, and remove the nozzle holder assemblies (3).
5. Remove the copper gaskets on the seats.
6. Remove the nozzle heat seal. (Serial No.: 489291~)

Tightening torque	Injection pipe retaining nuts	24.5 to 34.3 N·m 2.5 to 3.5 kgf·m 18.1 to 25.3 ft-lbs
	Nozzle holder assembly	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs



A145F001

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

Nozzle Heat Seal Service Removal Procedure

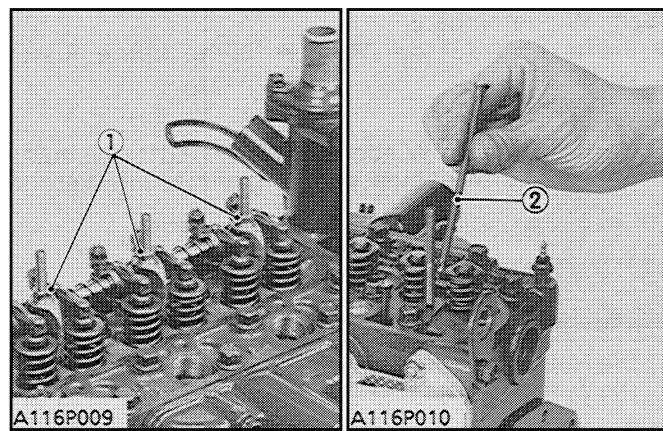
(Engine Serial Number : 489291 and beyond)

■ IMPORTANT

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

1. Drive screw driver 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 out together with the injection nozzle gasket.

If the heat seal drops, repeat the above procedure. Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.



A116P009

A116P010

Rocker Arm and Push Rod

1. Remove the rocker arm bracket mounting nuts (1).
2. Remove the rocker arm as a unit.
3. Remove the push rods (2).

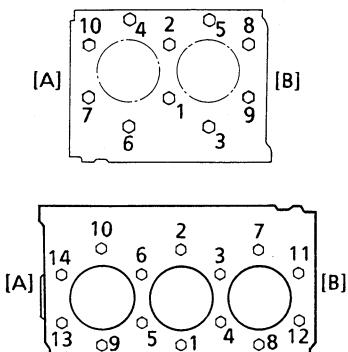
■ IMPORTANT

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

Tightening torque	Rocker arm brakcet nut	9.81 to 11.28 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
Valve clearance	Factory spec.	0.145 to 0.185 mm 0.0057 to 0.0073 in.

■ NOTE

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



A116F017

Cylinder Head

1. Loosen the pipe band, and remove the water return pipe.
2. Remove the cylinder head bolts in the order of (10), (11) to (1), and remove the cylinder head.

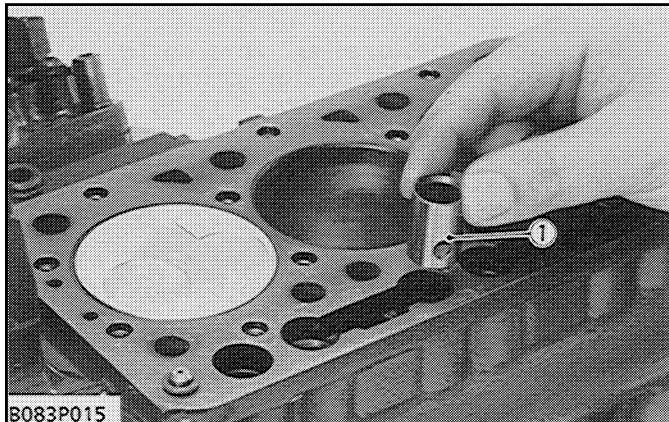
(When reassembling)

- Replace the head gasket with a new one.
- Install the cylinder head, using care not to damage the O-ring.
- Tighten the cylinder head bolts and nuts gradually in the order of (1) to (10, 11) after applying engine oil.
- Retighten the cylinder head screws and nuts after running the engine for 30 minutes.

Tightening torque	Glow plug	7.8 to 14.7 N·m 0.8 to 1.5 kgf·m 5.8 to 10.8 ft-lbs
	Cylinder head screw	39.2 to 44.1 N·m 4.0 to 4.5 kgf·m 28.9 to 32.5 ft-lbs

[A] Gear case side

[B] Flywheel side



B083P015

Tappets

1. Remove the cylinder head gasket and O-ring.
2. Remove the tappets from the crankcase.

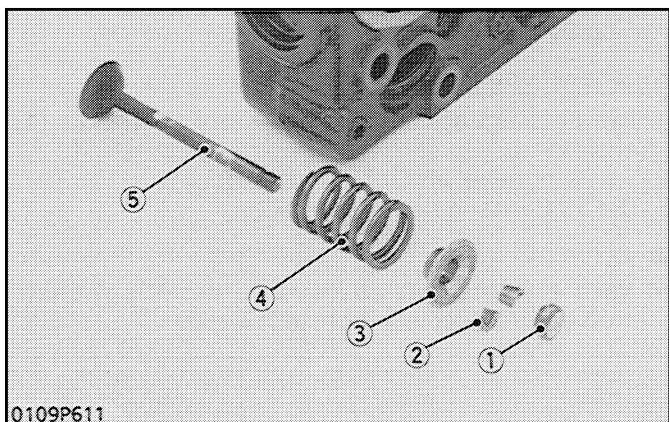
(When reassembling)

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

■ NOTE

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

(1) Tappet



0109P611

Valves

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

■ IMPORTANT

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

(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 Cap

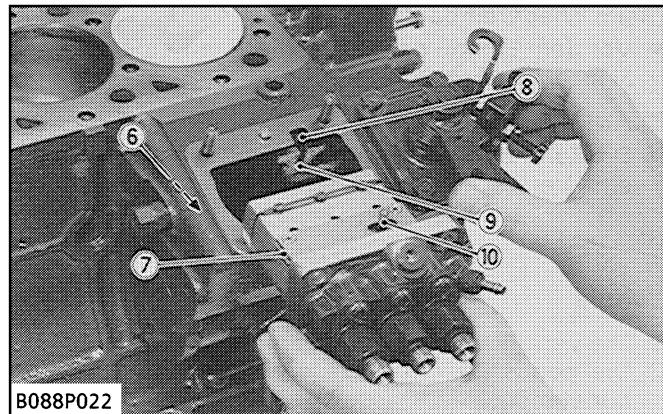
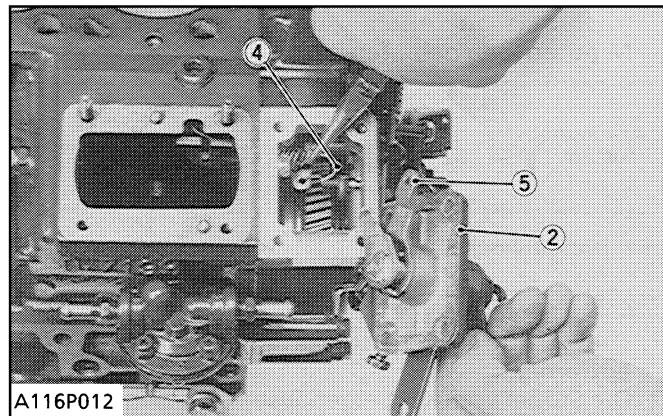
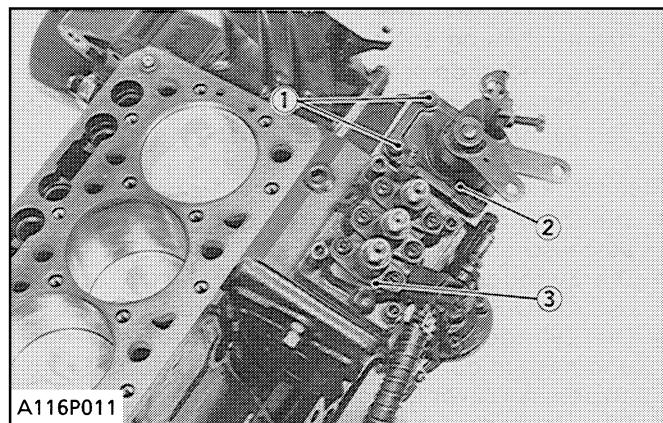
(2) Valve Spring Collet

(3) Valve Spring Retainer

(4) Valve Spring

(5) Valve

[4] TIMING GEAR AND CAMSHAFT



Injection Pump and Speed Control Plate

1. Remove the socket head screws and nuts, and remove the injection pump (3).
2. Remove the screws and separate the speed control plate (2), taking care not to damage the spring (4).
3. Disconnect the spring (4) and remove the speed control plate (2).

(When reassembling)

- Hook the spring (4) to the lever (5) first and install the speed control plate (2).
- Be sure to place the copper washers underneath two screws (1) (See photo).
- Position the slot (9) on the fork lever just under the slot (8) on the crankcase.
- Insert the injection pump so that the control rod (7) should be pushed by the spring (6) at its end and the pin (10) on the rod engages with the slot (9) on the fork lever (See photo).

■ NOTE

(Engine serial number : ~489290)

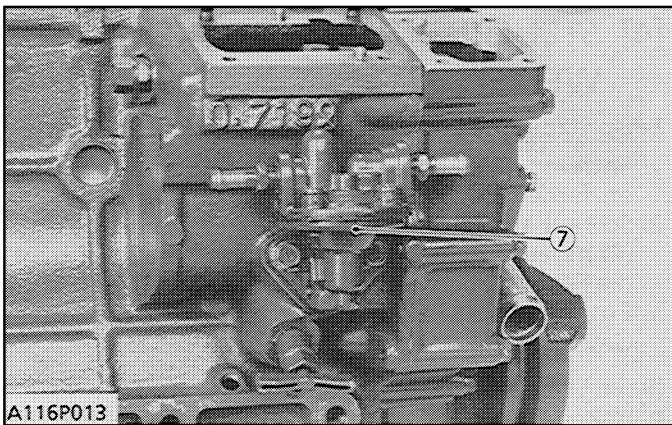
- Insert the same number of shims as used before between crank case and pump.
- Addition or reduction of shim (0.15 mm, 0.0059 in.) delays or advances the injection timing by approx. 0.026 rad (1.5°).
- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the injection pump shim before reassembling.

(Engine serial number : 489291~)

- The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.
- Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5°).
- In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.

Tightening torque	Injection pump retaining screw and nut	9.81 to 11.28 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
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- | | |
|-------------------------------|----------------------------|
| (1) Screws and Copper Washers | (6) Spring |
| (2) Speed Control Plate | (7) Control Rod |
| (3) Injection Pump | (8) Slot (Crankcase Side) |
| (4) Spring | (9) Slot (Fork Lever Side) |
| (5) Lever | (10) Pin |

**Pulley and Gear Case**

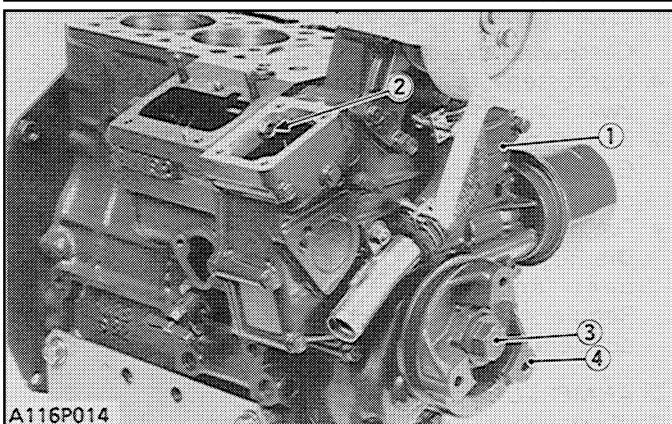
- (1) Remove the fuel feed pump (7).
- (2) Unscrew the fan drive pulley mounting screw (3) and remove the fan drive pulley (4).
- (3) Unscrew the screw (2) and disconnect the start spring (5) in the speed control plate mounting hole.
- (4) Unscrew the retaining screws and remove the gear case (1).

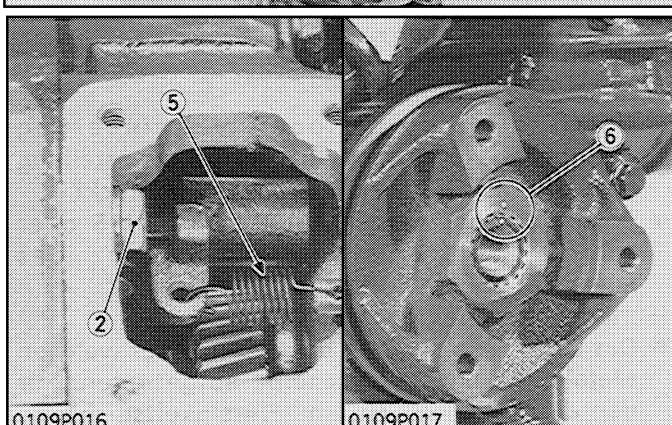
(When reassembling)

- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the gear case packing.
- Be sure to set three O-rings inside the gear case.
- Install the pulley to the crankshaft, aligning the marks (6) on them. (See photo)

Tightening torque	Fan drive pulley retaining screw	117.7 to 127.5 N·m 12.0 to 13.0 kgf·m 86.80 to 94.03 ft-lbs
	Gear case screw	9.81 to 11.28 N·m 1.0 to 1.15 kgf·m 7.23 to 8.32 ft-lbs

- | | |
|--------------------------------------|----------------------|
| (1) Gear Case | (4) Fan Drive Pulley |
| (2) Screw | (5) Start Spring |
| (3) Fan Drive Pulley Retaining Screw | (6) Aligning Mark |
| | (7) Fuel Feed Pump |



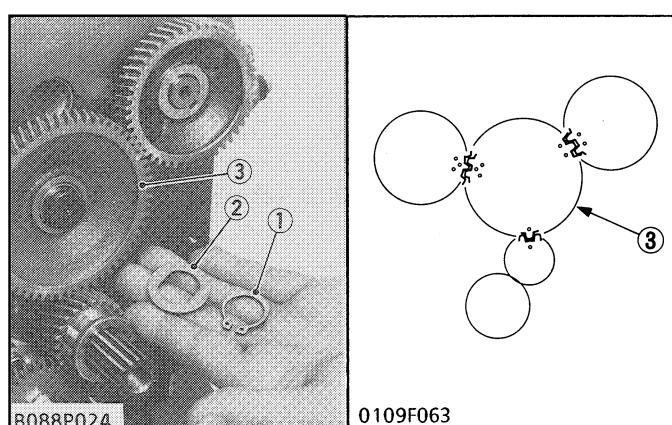
**Idle Gear**

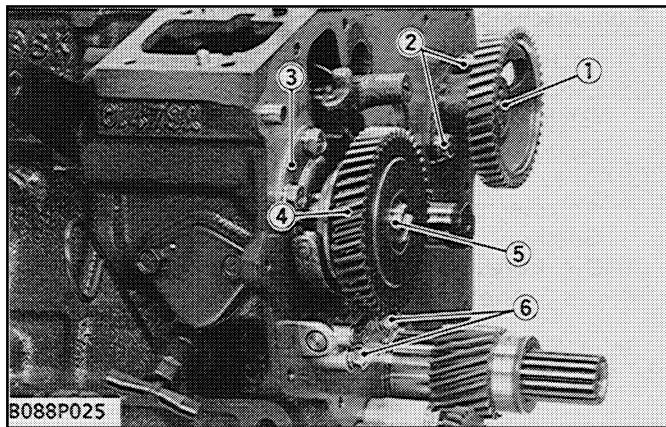
1. Remove the external snap ring (1), the collar (2) and the idle gear (3).

(When reassembling)

- Install the idle gear, aligning the marks on the gears referring to the figure.

- | | |
|------------------------|---------------|
| (1) External Snap Ring | (3) Idle Gear |
| (2) Idle Gear Collar | |

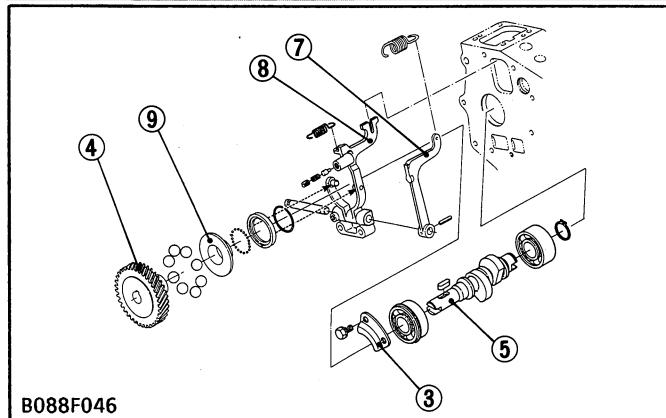


**Fuel Camshaft**

1. Remove the screws (2) and draw out the camshaft (1) with the gear on it.
2. Remove the retaining plate (3).
3. Remove the screws (6), then draw out the injection pump gear (4) and fuel camshaft (5) with the governor fork assembly.

(When reassembling)

- Hook the spring to the fork lever 2 (7) as shown in the figure before installing the fork lever assembly to the crankcase.



(1) Camshaft

(2) Screw

(3) Retaining Plate

(4) Injection Pump Gear

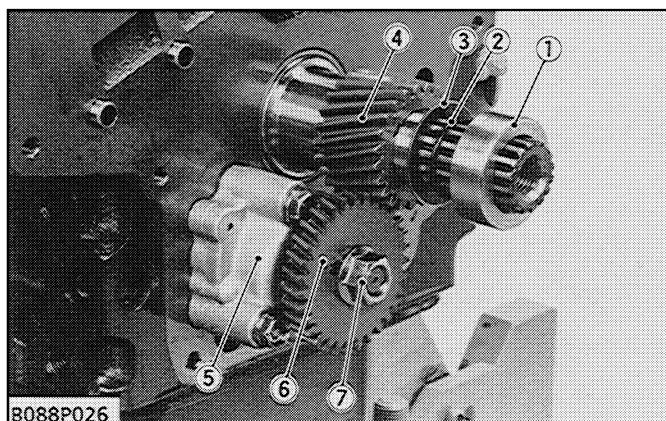
(5) Fuel Camshaft

(6) Screw

(7) Fork Lever 2

(8) Fork Lever 1

(9) Governor Sleeve

**Oil Pump and Crankshaft Gear**

1. Unscrew the flange nut (7) and remove the oil pump gear (6).
2. Unscrew the retaining screws and remove the oil pump (5).
3. Remove the collar (1), O-ring (2) and oil slinger (3).
4. Remove the crankshaft gear (4) with a puller.

(When reassembling)

- Install the collar after aligning the marks on the gears. (See the figure at "Idle Gear")

(1) Crankshaft Collar

(2) O-ring

(3) Crankshaft Oil Slinger

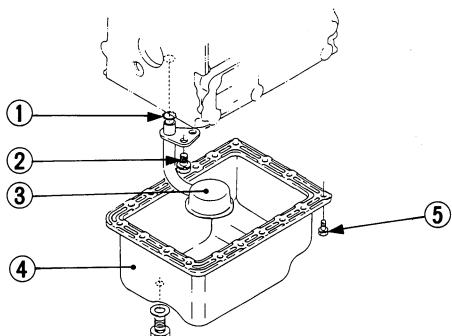
(4) Crankshaft Gear

(5) Oil Pump

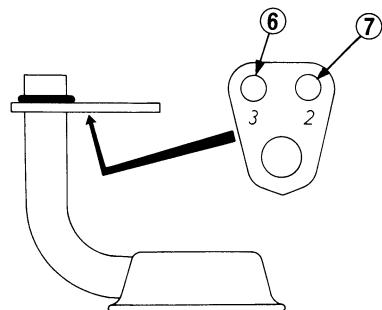
(6) Oil Pump Gear

(7) Flange Nut

[5] PISTON AND CONNECTING ROD



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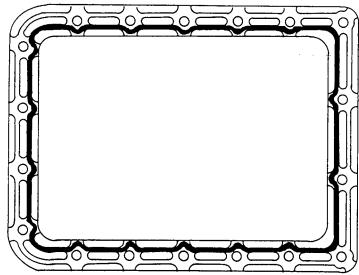
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Oil Pan and Oil Strainer

1. Unscrew the oil pan mounting screws (5), and remove the oil pan (4).
2. Unscrew the oil strainer mounting screw (2), and remove the oil strainer (3).

(When reassembling)

- Install the oil strainer, using care not to damage the O-ring (1).
- Using the hole (6) numbered "3", install the oil strainer by mounting screw (D662-B, D722-B).
- Using the hole (7) numbered "2", install the oil strainer by mounting screw (Z442-B, Z482-B).
- Apply liquid gasket (Three Bond 1270D or 1270C) to the oil pan as shown in the figure.

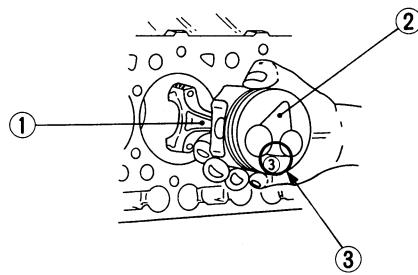


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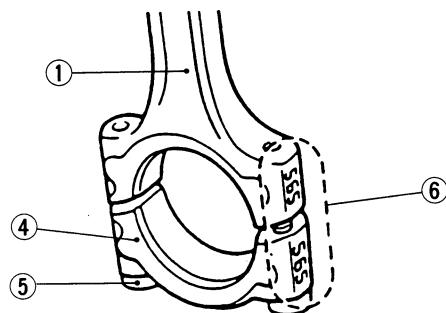
■ IMPORTANT

- Scape off the old adhesive completely. Wipe the sealing surface clean using waste cloth soaked with gasoline. Now apply new adhesive 3~5 mm thick all over the contact surface. Apply the adhesive also on the center of the flange as well as on the inner wall of each bolt hole.
- Cut the nozzle of the "fluid sealant" container at its second notch. Apply "fluid sealant" about 5 mm thick. Within 20 minutes after the application of fluid sealant, reassemble the components. Wait then for about 30 minutes, and pour oil in the crankcase.

(1) O ring	(5) Oil Pan Mounting Screws
(2) Screw	(6) Hole
(3) Oil Strainer	(7) Hole
(4) Oil Pan	



B083F043



0203F021

Piston and Connecting Rod

1. Unscrew the connecting rod screws (6), and remove the connecting rod cap (5).
2. Turn the crankshaft to bring the piston to top dead center.
3. Push the connecting rod from the bottom of the cylinder block with a hummer grip, and pull out the piston (2) and connecting rod (1).

■ IMPORTANT

- Do not change the combination of cylinder and piston.

(When reassembling)

- Before inserting the piston into the cylinder, apply enough engine oil to the inside surface of the cylinder.
- Apply engine oil to the crank pin bearings and connecting rod screws.
- Be sure to install the piston and connecting rod into the cylinder so that the number (3) on the piston head opposite side of the injection pump.
- Align the alignment marks (7) on the connecting rod (1) and connecting rod cap (5).
- When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

Tightening torque	Connecting rod screw	26.5 to 30.4 N·m 2.7 to 3.1 kgf·m 19.5 to 22.4 ft-lbs
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(1) Connecting Rod

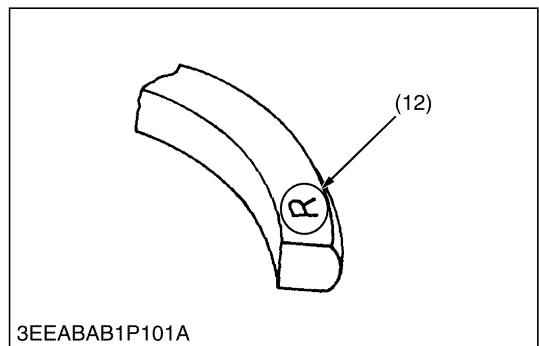
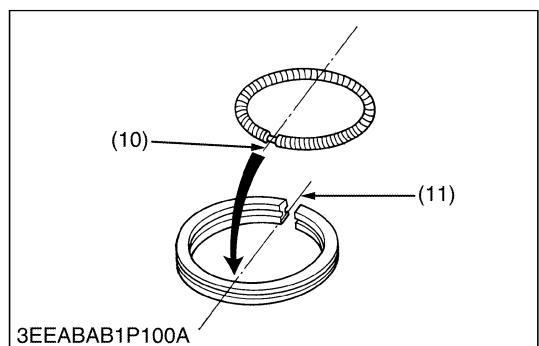
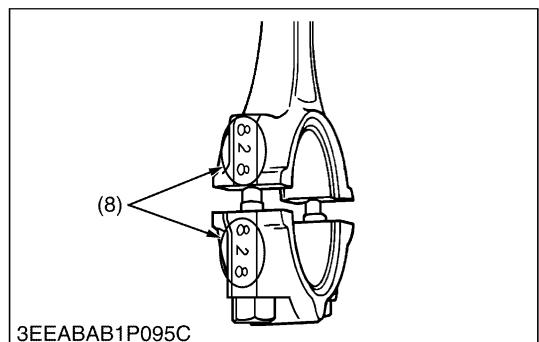
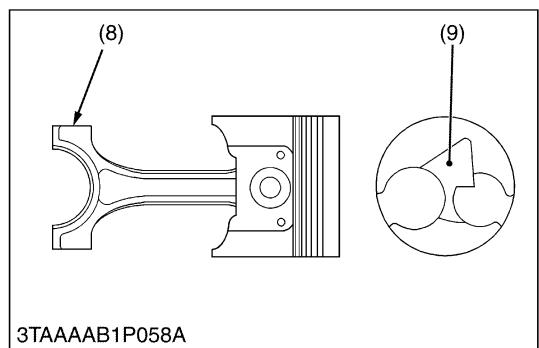
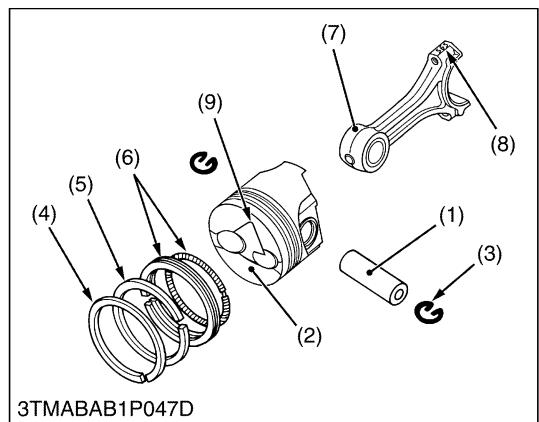
(2) Piston

(3) Number

(4) Connecting Rod Cap

(5) Connecting Rod Screw

(6) Alignment Mark



Piston Ring and Connecting Rod

1. Remove the piston rings using a piston ring tool (Code No. 07909-32121).
2. Remove the piston pin (1), and separate the connecting rod (7) from the piston (2).

(When reassembling)

- When installing the rings, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston.
- When installing the oil ring onto the piston, place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin.
- When installing the piston pin, immerse the piston in 80 °C (176 °F) 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 (8) on the connecting rod to the fan-shaped concave (9).

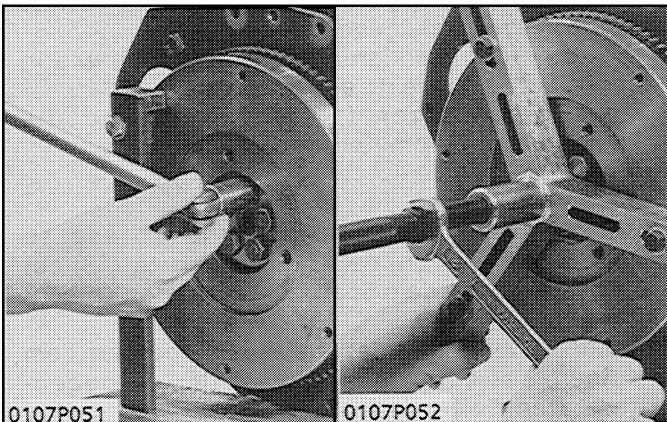
■ NOTE

- **Mark the same number on the connecting rod and the piston so as not to change the combination.**

(1) Piston Pin	(7) Connecting Rod
(2) Piston	(8) Mark
(3) Piston Pin Snap Ring	(9) Fan-Shaped Concave
(4) Top Ring	(10) Expander Joint
(5) Second Ring	(11) Oil Ring Gap
(6) Oil Ring	(12) Manufacturer's Mark

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[6] FLYWHEEL AND CRANKSHAFT



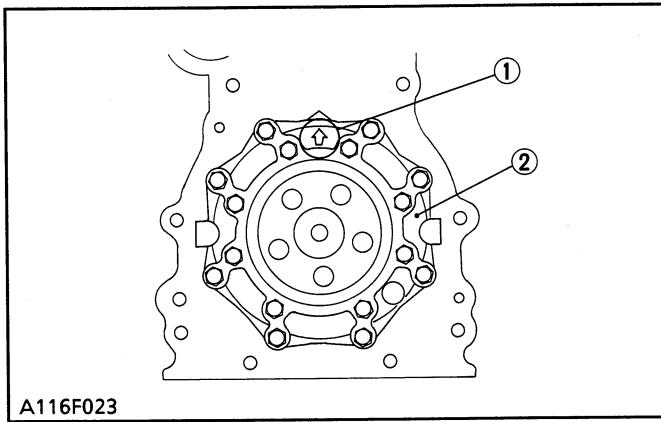
Flywheel

1. Lock the flywheel not to turn using the flywheel stopper.
2. Remove the flywheel bolts, except for two which must be loosened and left as they are.
3. Set a flywheel puller (Code No: 07916-32011), and remove the flywheel.

(When reassembling)

- Apply engine oil to the flywheel bolts.

Tightening torque	Flywheel bolts	53.9 to 58.8 N·m 5.5 to 6.0 kgf·m 39.8 to 43.4 ft-lbs
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Bearing Case Cover

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

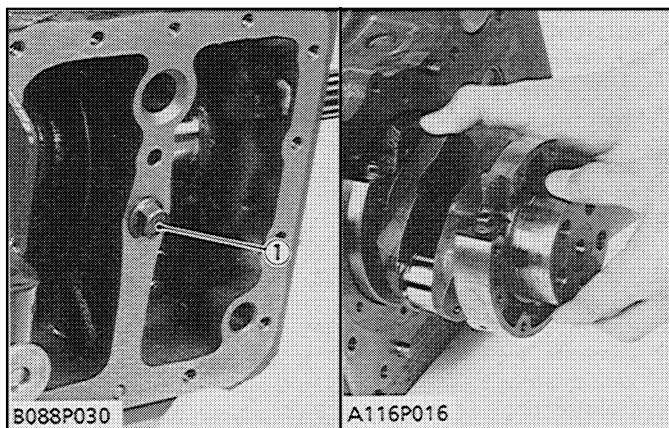
(When reassembling)

- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of a new bearing case cover gasket.
- Install the bearing case cover to position the casting mark "↑" (1) on it upward.
- Tighten the bearing case cover mounting screws with even force on the diagonal line.

Tightening torque	Bearing case cover mounting screw	9.81 to 11.28 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
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(1) Mark

(2) Bearing Case Cover



Crankshaft

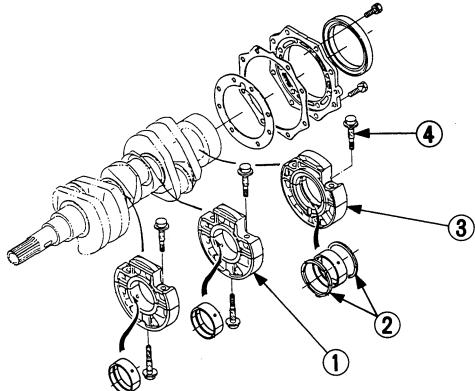
1. Unscrew the bearing case screws 2 (1), and draw out the crankshaft.

(When reassembling)

- Install the crankshaft sub assembly, aligning the screw hole of main bearing case 2 with the screw hole of cylinder block.
- Apply engine oil to the seat and thread of bearing case screw 2. After tightening it.

Tightening torque	Bearing case screw 2	26.5 to 30.4 N·m 2.7 to 3.1 kgf·m 19.5 to 22.4 ft-lbs
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(1) Bearing Case Screw 2

**Main Bearing Case Assembly**

1. Remove the two bearing case screws 1 (4), and remove the main bearing case assembly 1 (3), being careful with the thrust bearing (2) and crankshaft bearing 2.
2. Remove the main bearing case assemblies 2, 3.

(When reassembling)

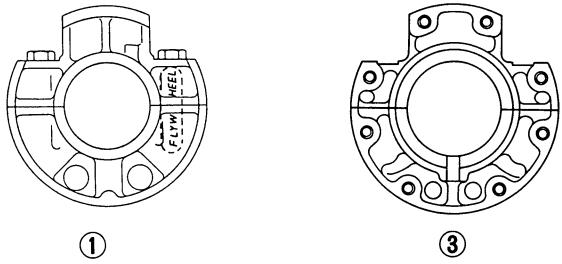
- Clean the oil passage in the main bearing case.
- Apply clean engine oil on the crankshaft bearing 2 and thrust bearings.
- Install the main bearing case assemblies in the original positions. Since diameters of main bearing cases vary, install them in order of makings (1, 2) from the gear case side.
- When installing the main bearing case assemblies 2, 3, face the mark "FLYWHEEL" to the flywheel.
- Be sure to install the thrust bearing with its oil groove facing outward.

(1) Main Bearing Case Assembly 2

(2) Thrust Bearing

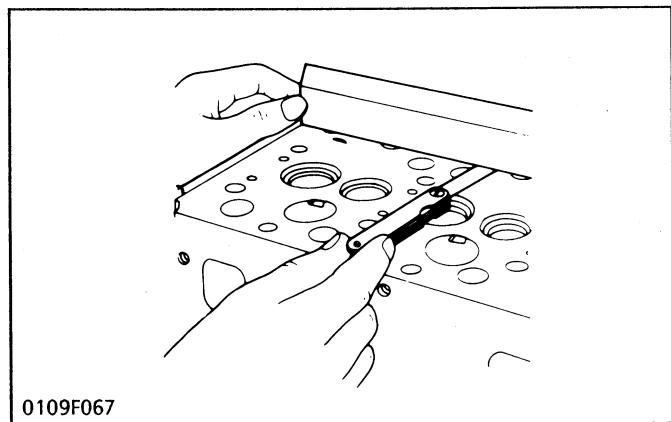
(3) Main Bearing Case Assembly 1

(4) Bearing Case Screw 1



SERVICING

[1] CYLINDER HEAD AND VALVES



Cylinder Head Surface Flatness

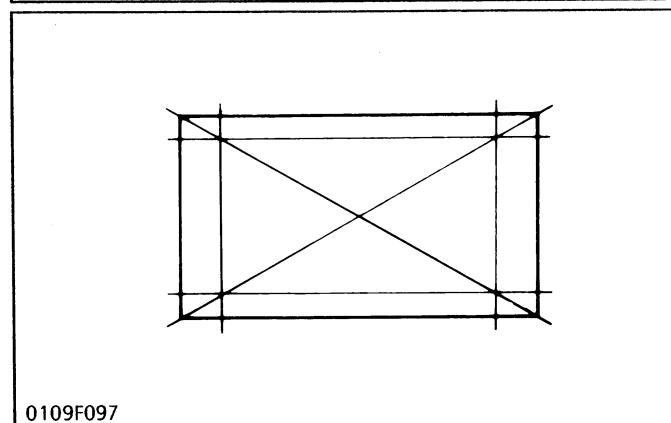
1. Thoroughly clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the figure.
3. Measure the clearance with a feeler gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ NOTE

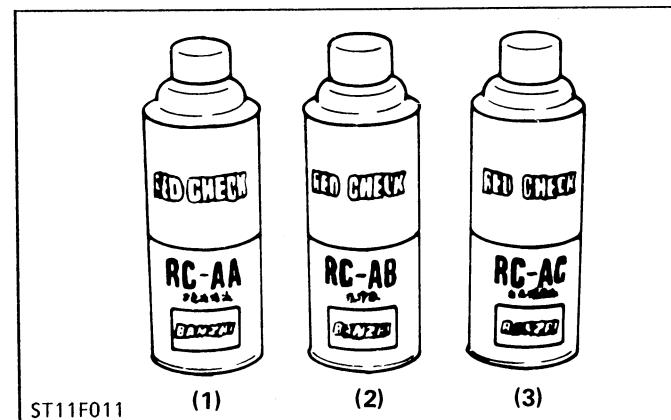
- Do not place the straightedge on the combustion chamber.

■ IMPORTANT

- Be sure to check the valve recessing after correcting.



Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.
Finishing	$8 \mu R_{\text{max}}$ $\nabla\nabla$	8 (320) unit: μm ($\mu\text{in.}$)

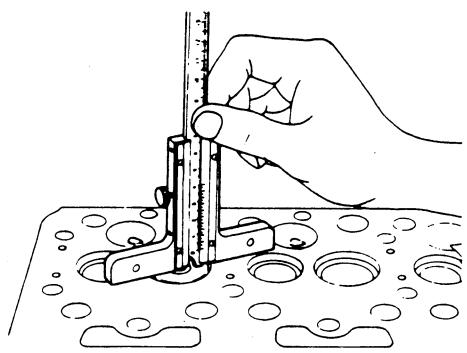


(1) Detergent
(2) Red Permeative Liquid

(3) White Developer

Cylinder Head Flaw

1. Prepare an air spray red check (Code No. 07909-31371).
2. Clean the surface of the cylinder head with detergent (1).
3. Spray the cylinder head surface with the red permeative liquid (2). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with white developer (3). If flawed, it can be identified as red marks.

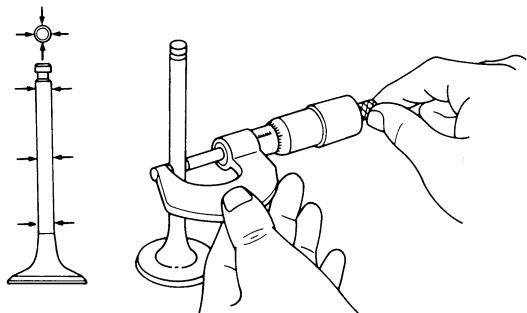


0109F070

Valve Recessing

1. Clean the cylinder head, the valve face and valve seat.
2. Insert the valve into the valve 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, correct the valve seat face of the cylinder head with a valve seat cutter (Code No. 07909-33102) or valve seat grinder. Then, correct the cylinder head surface with a surface grinder, or replace the cylinder head.

Valve recessing (Intake and exhaust)	Factory spec.	-0.10 to 0.10 mm -0.0039 to 0.0039 in.
	Allowable limit	0.30 mm 0.0118 in.



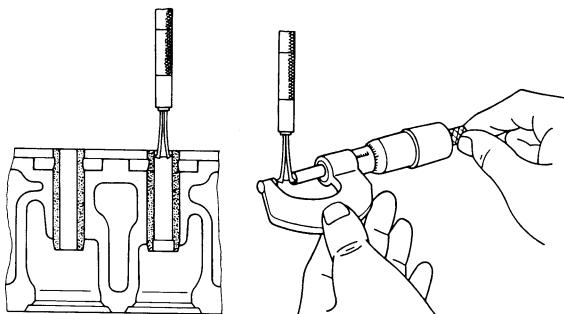
0347F029

Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valve guide or valve.

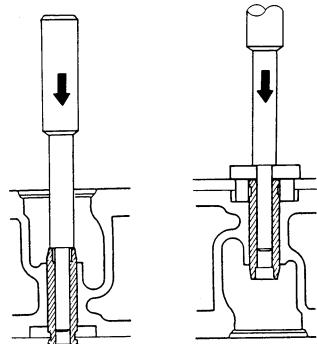
Clearance between valve stem and valve guide	Factory spec.	0.030 to 0.057 mm 0.00118 to 0.00224 in.
	Allowable limit	0.10 mm 0.0039 in.

Valve stem O.D.	Factory spec.	5.968 to 5.980 mm 0.23496 to 0.23543 in.
Valve guide I.D.	Factory spec.	6.010 to 6.025 mm 0.23661 to 0.23720 in.



B083F052

(When removing) (When installing)



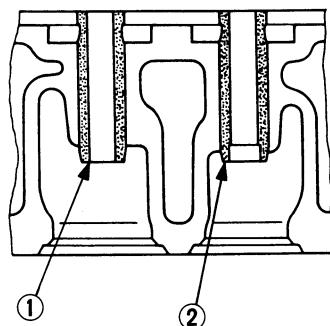
B088F051

Replacing Valve Guide**(When removing)**

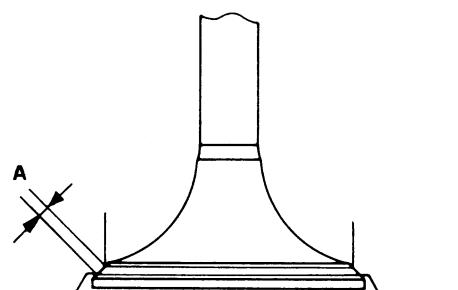
1. Using a valve guide replacing tool (see page S-22), press out the used valve guide.

(When installing)

1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

Valve guide I.D.
(Intake and exhaust)Factory
spec.6.010 to 6.025 mm
0.23661 to 0.23721 in.

B088F053

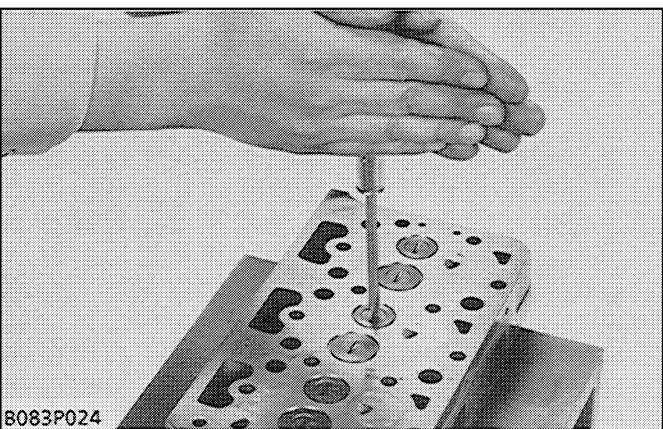


C066F044

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, correct the valve and valve seat referring to "Correcting Valve and Valve Seat".

Valve seat width

Factory
spec.2.12 mm
0.0835 in.

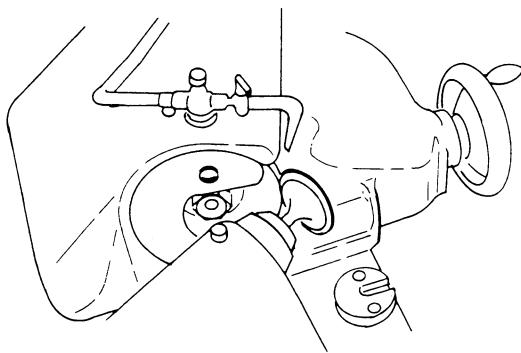
B088P024

Valve Lapping

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

■ IMPORTANT

- When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve. (See page S-19)



C066F050

Correcting Valve and Valve Seat

■ NOTE

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

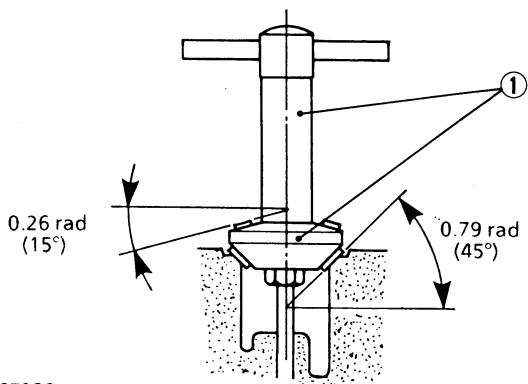
1) Correcting Valve

1. Correct the valve with a valve refacer.

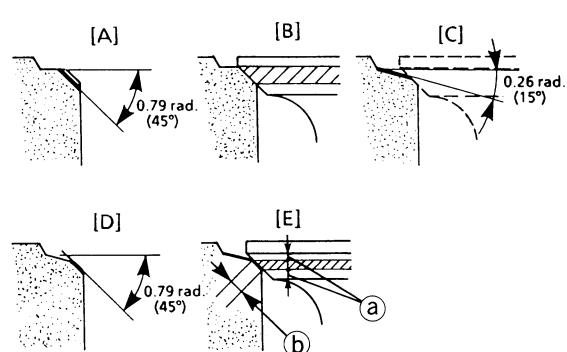
Valve face angle	Factory spec.	0.785 to 0.794 rad. 45.0° to 45.5°
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2) Correcting Valve Seat

1. Slightly correct the seat surface with a 0.79 rad. (45°) valve seat cutter (1) (Code No. 07909-33102).
2. Fitting the valve, check the contact position of the valve face and seat surface with red lead. (Visual check) [If the valve has been used for a long period, the seat tends to come in contact with the upper side of the valve face.]
3. Grind the upper surface of the valve seat with a 0.26 rad. (15°) valve seat cutter until the valve seat touches to the center of the valve face (so that a equals b as shown in the figure).
4. Grind the seat with a 0.79 rad. (45°) valve seat cutter again, and visually recheck the contact between the valve and seat.
5. Repeat steps 3 and 4 until the correct contact is achieved.
6. Continue lapping until the seated rate becomes more than 70% of the total contact area.



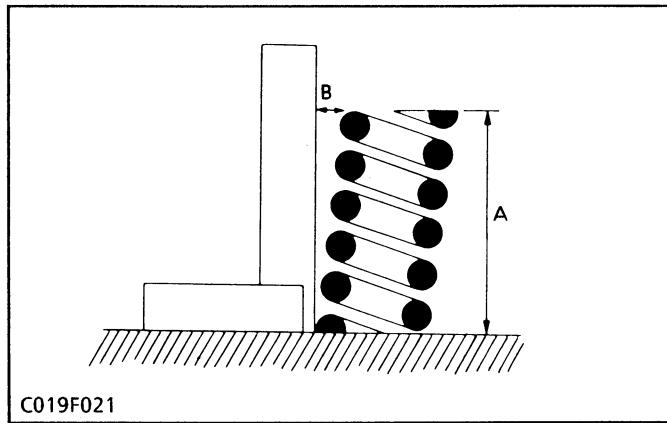
(1) Valve Seat Cutter



C056F039

Valve seat angle	Factory spec.	0.785 rad. 45.0°
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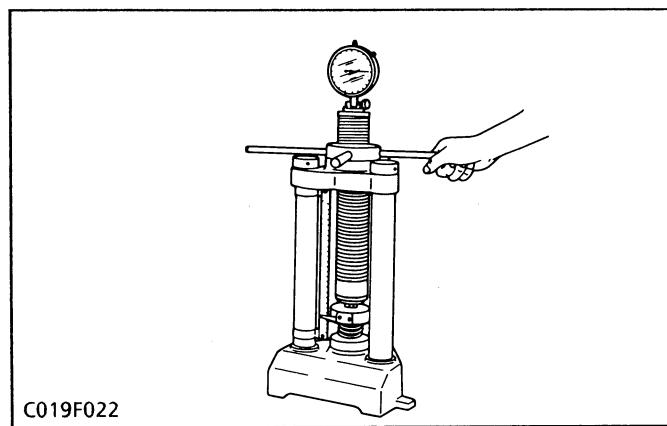
- (A) Slightly Correct
 (B) Check Contact
 (C) Correct Seat Width
 (D) Correct Seat Surface
 (E) Check Contact
- (a) Identical Dimensions
 (b) Valve Seat Width



Free Length and Tilt of Valve Spring

1. Measure the length A with varnier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the spring on a surface plate, place a square on the side of the spring.
3. Check to see if the entire side is in contact with the square. Rotate the spring and measure the maximum B.
If the measurement exceeds the allowable limit, replace it.
4. Check the entire surface of the spring for scratches. Replace it, if any.

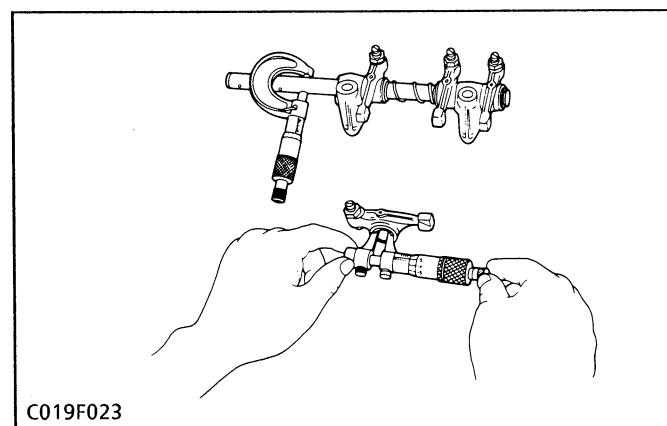
Free length A	Factory spec.	31.6 mm 1.244 in.
	Allowable limit	28.4 mm 1.118 in.
Tilt B	Allowable limit	1.2 mm 0.047 in.



Valve Spring Setting Load

1. Place the spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load	Factory spec.	64.7 N / 27 mm 6.6 kgf / 27 mm 14.6 lbs / 1.063 in.
Setting length	Allowable limit	54.9 N / 27 mm 5.6 kgf / 27 mm 12.3 lbs / 1.063 in.



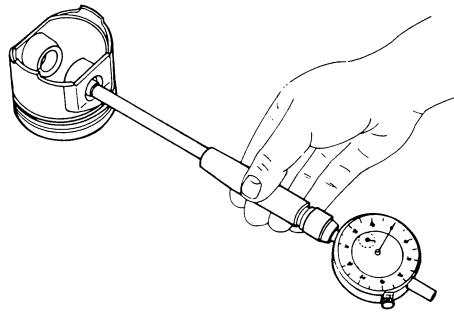
Oil Clearance between Rocker Arm and Rocker Arm Shaft

Shaft

1. Measure the rocker arm I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Oil clearance between rocker arm and rocker arm shaft	Factory spec.	0.016 to 0.045 mm 0.00063 to 0.00177 in.
	Allowable limit	0.15 mm 0.0059 in.
Rocker arm shaft O.D.	Factory spec.	10.473 to 10.484 mm 0.41232 to 0.41276 in.
Rocker arm I.D.	Factory spec.	10.500 to 10.518 mm 0.41339 to 0.41410 in.

[2] PISTON AND CONNECTING ROD

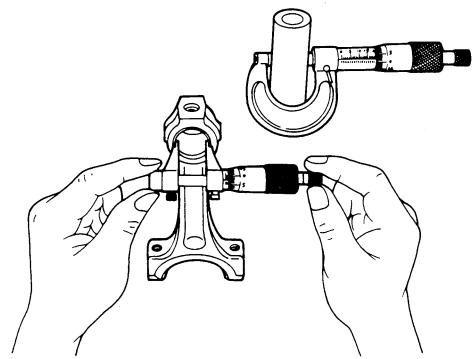


C083F040

Piston Pin-Bore I.D.

1. Measure the I.D. of the piston pin-bore in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

Piston pin-hole I.D.	Factory spec.	20.000 to 20.013 mm 0.78740 to 0.78791 in.
	Allowable limit	20.05 mm 0.7894 in.



C019F053

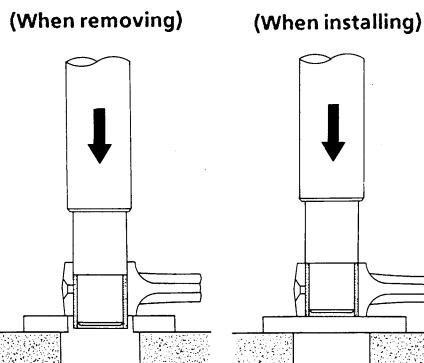
Oil Clearance between Piston Pin and Small End Bushing

Bushing

1. Measure the O.D. of the piston pin where it contacts the bushing with an outside micrometer.
2. Measure the I.D. of the small end bushing with an inside micrometer, and calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory spec.	0.014 to 0.038 mm 0.00055 to 0.00150 in.
	Allowable limit	0.10 mm 0.0039 in.

Piston pin O.D.	Factory spec.	20.002 to 20.011 mm 0.78748 to 0.78783 in.
Small end bushing I.D.	Factory spec.	20.025 to 20.040 mm 0.78839 to 0.78897 in.



B083F054

Replacing Small End Bushing

(When removing)

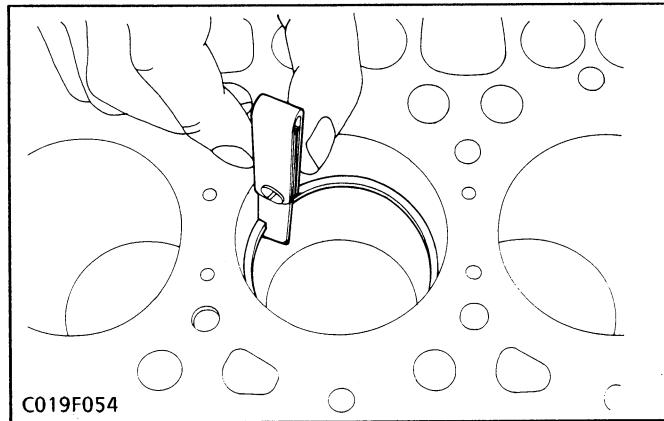
1. Using a small end bushing replacing tool (see page S-22), press out the used bushing.

(When installing)

1. Clean a new small end bushing and small end hole, and apply engine oil to them.
2. Using a small end bushing replacing tool, press in a new bushing (service parts) taking due care to see that the connecting rod hole matches the bushing hole.

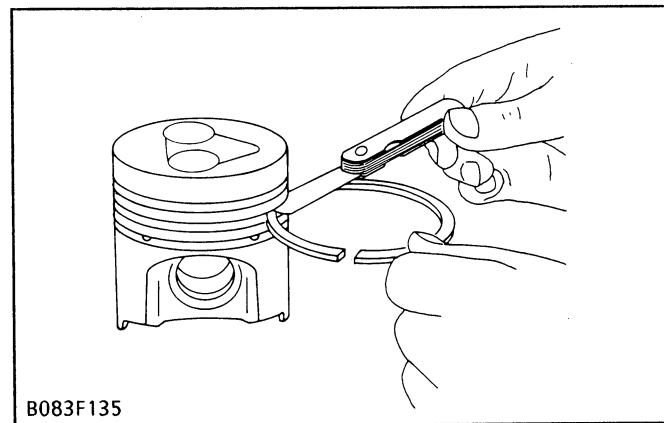
[Service parts dimension]

Oil clearance between piston pin and small end bushing	Factory spec.	0.015 to 0.075 mm 0.00059 to 0.00295 in.
	Allowable limit	0.10 mm 0.0039 in.

**Piston Ring Gap**

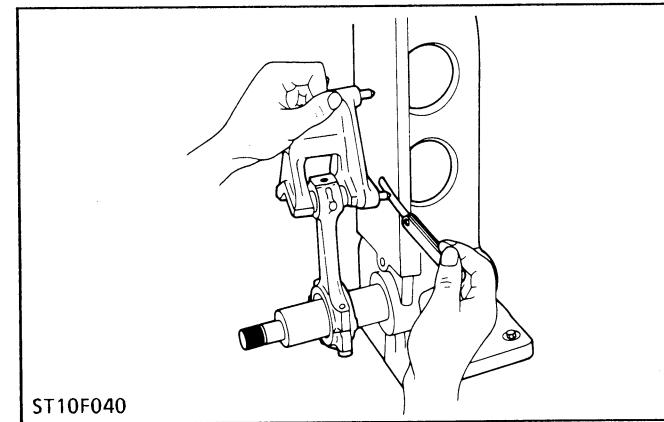
1. Insert the piston ring into the lower part of the cylinder (the least worn out part) with a piston ring compressor and piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the piston ring.

Piston ring gap	Top compression ring and oil ring	Factory spec.	0.15 to 0.30 mm 0.0059 to 0.0118 in.
	Allowable limit	1.2 mm 0.0472 in.	
	Second compression ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 in.
	Allowable limit	1.2 mm 0.0472 in.	

**Clearance between Piston Ring and Groove**

1. Remove carbon from the ring grooves.
2. Place the ring into each ring groove, and measure the clearance at several points around the ring groove with a feeler gauge.
3. If the clearance exceeds allowable limit, replace the piston ring since compression leak and oil shortage result.
4. If the clearance still exceeds the allowable limit after replacing the piston ring, replace the piston.

Clearance between piston ring and groove	Second compression ring	Factory spec.	0.085 to 0.115 mm 0.0033 to 0.0045 in.
	Allowable limit	0.15 mm 0.0059 in.	
	Oil ring	Factory spec.	0.02 to 0.06 mm 0.0008 to 0.0024 in.
		Allowable limit	0.15 mm 0.0059 in.

**Connecting Rod Alignment**

1. Remove the connecting rod crank pin bearing, and install the connecting rod cap.
2. Set the connecting rod to the connecting rod alignment tool (Code No. 07909-31661).
3. Install the piston pin into the connecting rod. Set the gauge on the piston pin.
4. Measure three point's gaps between the pins of the gauge and flat surface of the alignment tool. If the measurement exceeds the allowable limit, replace it.

Bend of connecting rod	Allowable limit	0.05 mm 0.0020 in. (gauge pin span at 100 mm, 3.94 in.)
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