

GENERAL CONTENTS

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Supplement

Engine Inspection Sheets

⚠ Warning Risk of burn

Do not touch the engine while it is running or for a while after it is stopped

Never touch any part of the engine while it is running or for a while after it is stopped. Otherwise, you may become burned.



Use a coolant temperature gauge to confirm that the engine has sufficiently cooled down before performing any inspection/service.

Be careful when opening/closing the radiator cap

Never attempt to open the radiator cap while the engine is running and for a while after it is stopped. Stop the engine and wait until the coolant temperature has sufficiently dropped before opening the cap.

Slowly open the radiator cap to allow the internal pressure to escape. To prevent possible burn, wear thick rubber gloves or cover the cap with cloth to protect your hands from escaping vapor.

Tighten the radiator cap firmly.

Coolant is extremely hot while the engine is running or for a while after the engine is stopped. You may become burned by extremely hot vapor or coolant that will gush out if the radiator cap is opened.

Replenish coolant only when the coolant in the system is cold

Do not replenish coolant for a while after the engine is stopped. Replenish coolant when the coolant in the system is sufficiently cold. Otherwise, you may become burned.

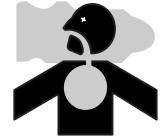
Do not remove heat insulating material

The exhaust system components become extremely hot and therefore are covered with heat insulating material. Never remove the material. If the material needs to be removed at all for inspection/service, be sure to install it again after the operation.

⚠ Warning Exhaust gas is poisonous

Ensure good ventilation while the engine is running

If the engine is installed inside a building and the exhaust gas is directed outside through a duct, regularly check the duct for any leakage through the joints etc.



Do not run the engine in a building (warehouse, tunnel, etc.), confined space, or other poorly ventilated places if the engine is used for a portable generator. If the engine needs to be run in a building at all, ensure to direct the exhaust gas outside and provide sufficient ventilation. Also, take care not to direct the exhaust gas towards nearby plants or animals, if any.

Engine exhaust gas contains carbon monoxide and other substances that are harmful to humans. Running the engine in a poorly ventilated place can cause exhaust gas poisoning.

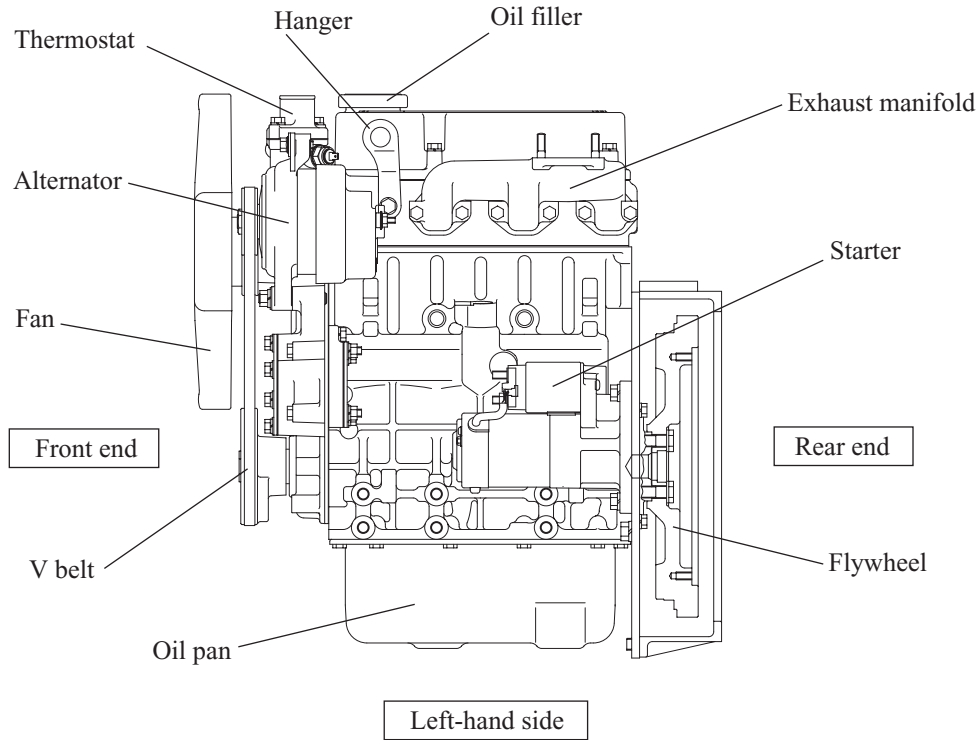
⚠ Warning Hearing difficulty

Wear ear protector

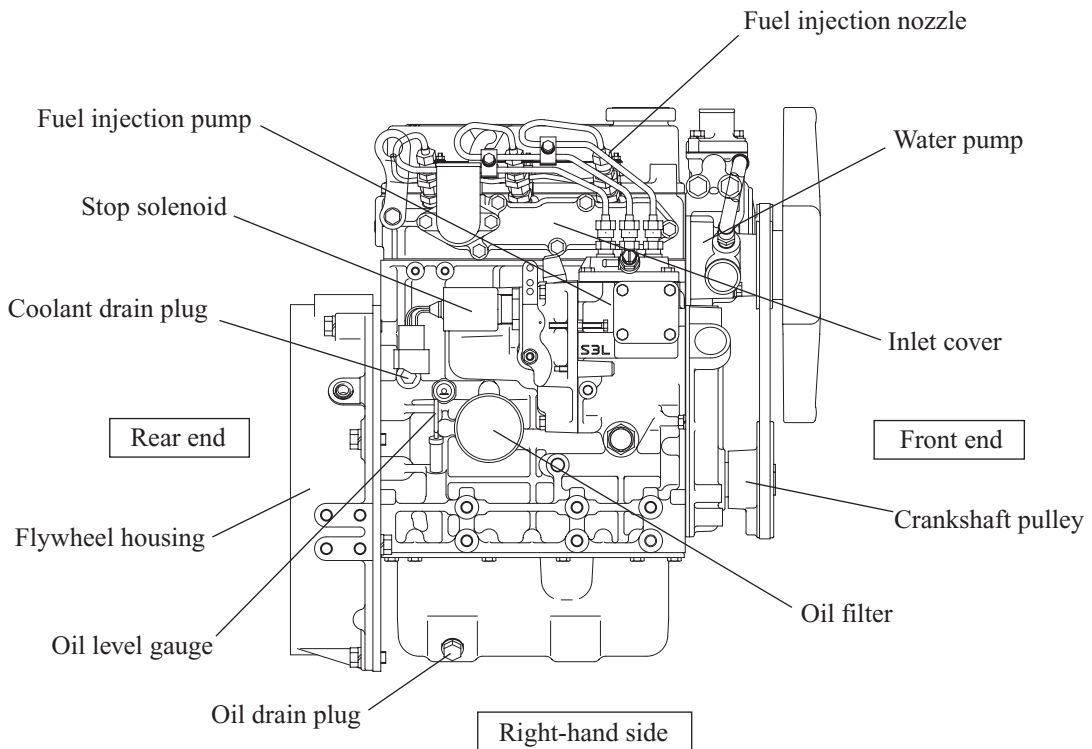
Wear ear protector whenever entering the engine room. Otherwise, the combustion and mechanical noises may cause you to develop hearing difficulty.



1. Overview
1.1 Outline Drawing
S3L, S3L2

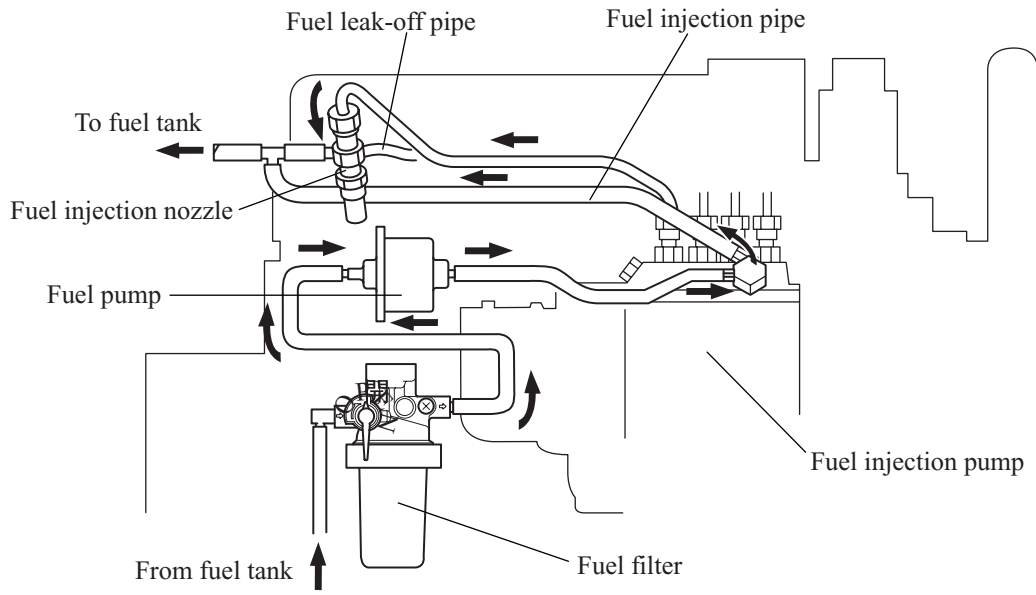


Engine LH side view



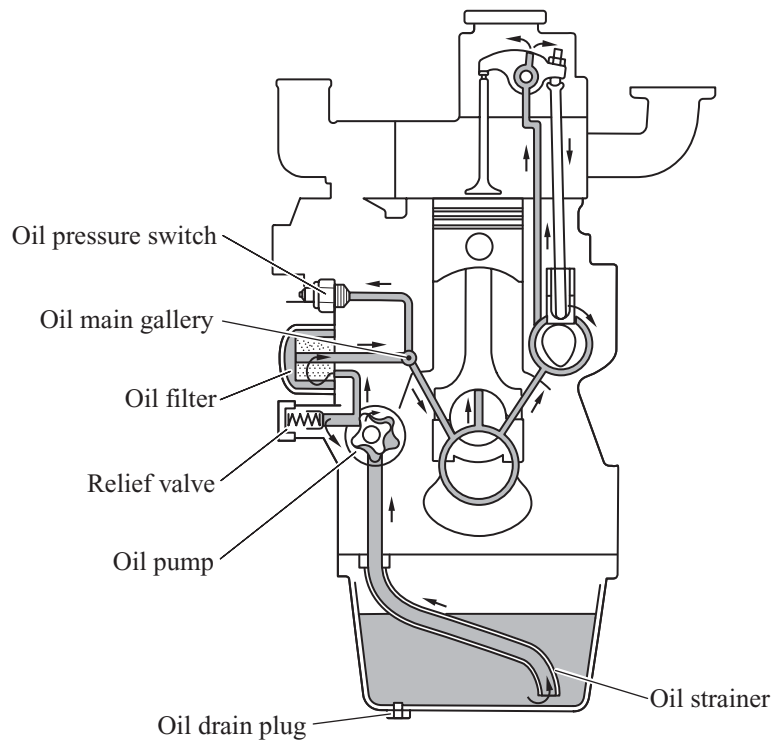
Engine RH side view

1.2 Fuel System Schematic



Fuel system schematic

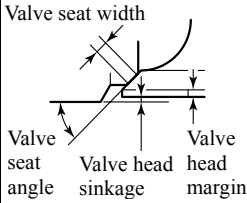
1.3 Oil System Schematic



Oil system schematic

1. Service Standards Table

Unit: mm (in.)

Group	Item	Nominal value	Standard value	Limit	Remarks		
Engine general	Max. speed (based on the rated speed)		2700 ⁺³⁰ ₋₁₀ min ⁻¹				
	Min. speed		1000 ± 25 min ⁻¹				
	Compression pressure (at 290 min ⁻¹)		2.9 MPa (30 kgf/cm ²) [421 psi] or above	2.6 MPa (27 kgf/cm ²) [377 psi] or less	Both oil and coolant temperatures at 20 to 30 (68 to 86 F)		
	Engine oil pressure	Rated speed		0.29 to 0.39 MPa (3.0 to 4.0 kgf/cm ²) [42.07 to 56.57 psi]		Oil temperature at 60 to 95 (140 to 194 F)	
		Low idle speed		0.098 MPa (1.0 kgf/cm ²) [14.22 psi]			
	Valve timing [with 2 mm (0.079 in.) clearance on the valve side; cold engine]	Inlet valve open		BTDC 15°		The theoretical valve timing figures for inspection vary from the actual valve timing.	
		Inlet valve closed		ABDC 41°			
		Exhaust valve open		BBDC 54°			
		Exhaust valve closed		ATDC 10°			
	Valve clearance	Inlet valve		0.25 (0.01)		Cold engine	
		Exhaust valve		0.25 (0.01)			
Fuel injection timing (BTDC)			17 °				
Engine main parts	Rocker	Rocker arm inner diameter	19 (0.749)	18.910 to 18.930 (0.7450 to 0.7458)			
		Rocker shaft diameter	19 (0.749)	18.880 to 18.898 (0.7438 to 0.7445)			
		Arm-to-shaft clearance (oil clearance)		0.012 to 0.050 (0.0004 to 0.0019)	0.200 (0.0079)	Replace rocker arm.	
	Valve	Valve stem diameter	Inlet	6.6 (0.260)	6.565 to 6.580 (0.2586 to 0.2592)	6.500 (0.256)	
			Exhaust	6.6 (0.260)	6.530 to 6.550 (0.2572 to 0.2580)	6.500 (0.256)	
		Valve guide inner diameter	Inlet	6.6 (0.260)	6.600 to 6.615 (0.2600 to 0.2606)		
			Exhaust	6.6 (0.260)	6.600 to 6.615 (0.2600 to 0.2606)		
		Valve stem-to-guide clearance	Inlet		0.020 to 0.050 (0.0008 to 0.0020)	0.100 (0.004)	Replace valve and valve guide.
			Exhaust		0.050 to 0.085 (0.0020 to 0.0033)	0.150 (0.006)	
	Valve seat and valve	Valve seat angle		45°			
		Valve head sinkage		0	0.25 to 0.75 (0.0098 to 0.0295)	1.5 (0.0591)	
		Valve seat width		1.6 (0.063)	1.30 to 1.80 (0.0512 to 0.0709)	2.5 (0.0985)	
		Valve head margin		1.5 (0.0591)	1.35 to 1.65 (0.0531 to 0.0650)	0.5 (0.0197)	
		Installed valve guide protrusion		10 (0.394)	9.5 to 10.5 (0.3743 to 0.4137)		

3. Sealants List

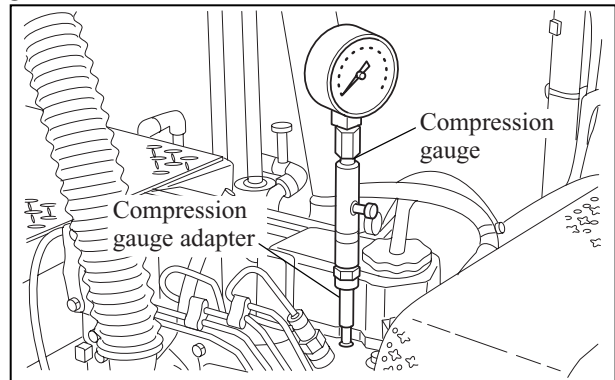
	Sealing item	Sealant	Mating component	Applied location
Threaded part	Stop solenoid	ThreeBond 1212	Governor case	Threaded portion
	Water drain joint	ThreeBond 1102	Block	
	Oil pressure switch			
	Torque spring set	ThreeBond 1212	Governor case	
Press - fit part	Sealing cap	ThreeBond 1102	Cylinder block	Holes in the cylinder head and block
			Cylinder head	
			Cylinder head, Cylinder block	
	Expansion plug		Cylinder block	
	Oil level gauge guide			
Other	Side seal	ThreeBond 1212	Cylinder block, Main bearing cap	Outer periphery
	Main bearing cap (front and rear)		Cylinder block	Contact faces with the cylinder block
	Oil pan	ThreeBond 1207C		

2. Measuring the Compression Pressure

- (1) Move the control lever to STOP position.
- (2) Remove the glow plugs from all cylinders. Install the special tool Compression Gauge Adapter and a compression gauge onto the cylinder being measured.

Special tool	Part number
Compression Gauge Adapter	ST332270

- (3) While cranking the engine with the starter, read the compression gauge. Note the reading at which the gauge needle stabilizes.
- (4) If the measured value is at or below the limit, overhaul the engine.



Measuring the compression pressure

⚠ CAUTION

- (a) Measure all cylinders for compression pressure. Do not measure only one cylinder and make assumption about the other cylinders as this will lead to a wrong conclusion.
- (b) Compression pressure varies depending on the engine speed. Keep the specified engine speed when measuring the compression pressure.

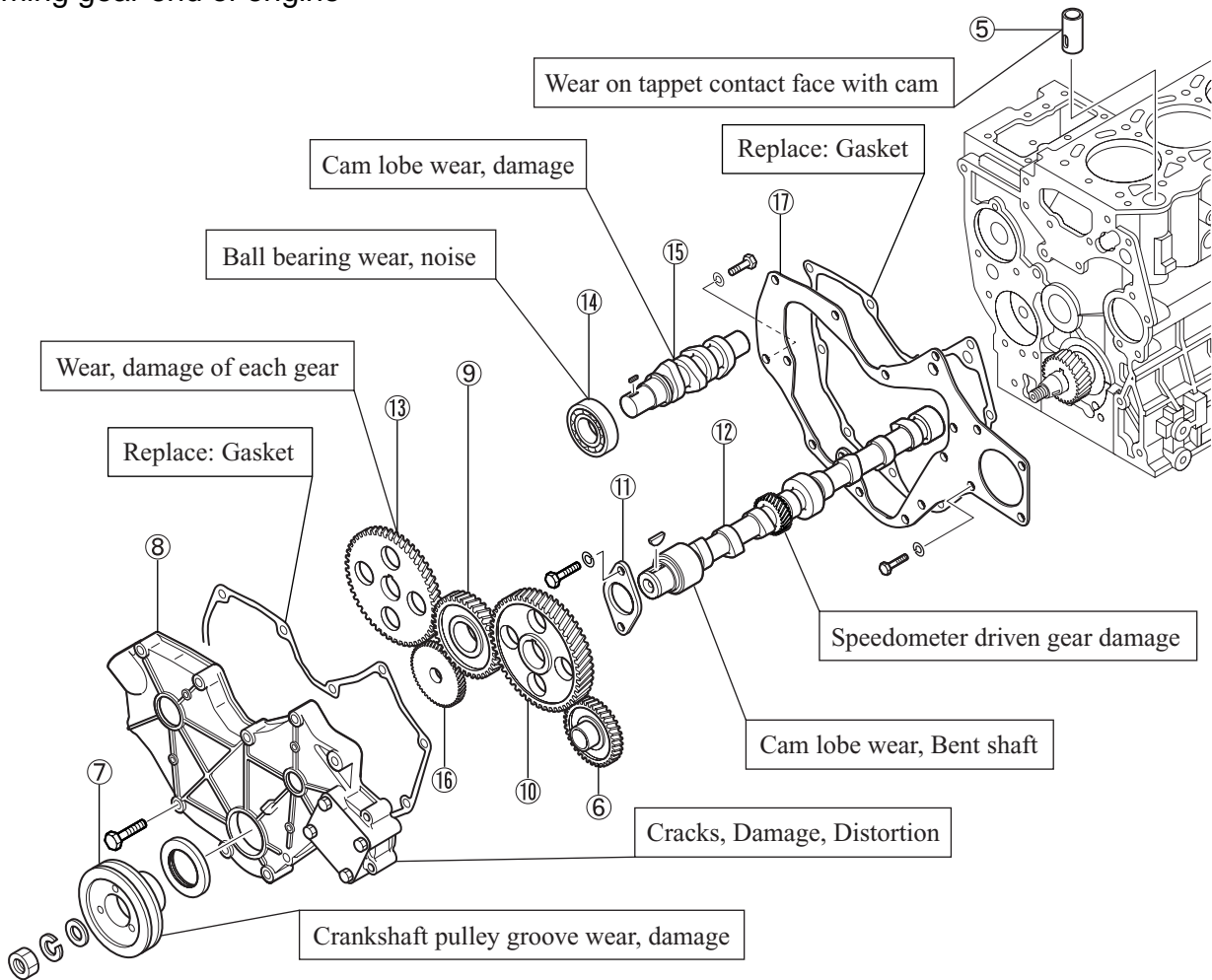
	Standard value	Limit
Engine speed	290 min ⁻¹	
Compression pressure	2.9 MPa (30 kgf/cm ²) [421 psi]	2.6 MPa (27 kgf/cm ²) [377 psi]
Tolerable difference between cylinders	0.29 MPa (3.0 kgf/cm ²) [42 psi] or less	

⚠ CAUTION

It is important to regularly check the compression pressure so that you can tell the difference.

- New or overhauled engines have slightly higher compression pressure.
- The compression pressure settles to the standard value as the piston rings and valve seats fit in.
- As wear progresses further, the compression pressure drops.

Timing gear end of engine



Disassembly of timing gear and camshaft

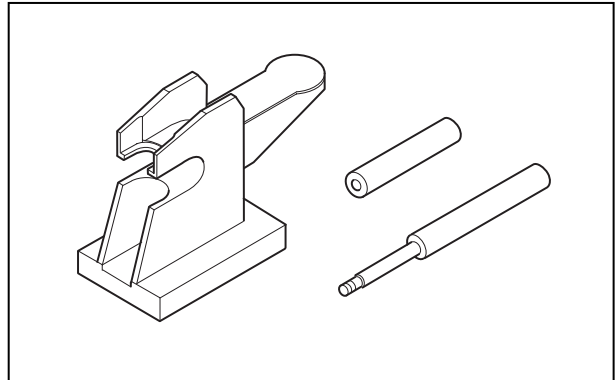
<Disassembly sequence>

- | | |
|-----------------------------|-----------------------------------|
| Tappet | Fuel injection pump camshaft gear |
| PTO gear | Ball bearing |
| Crankshaft pulley | Fuel injection pump camshaft |
| Timing gear case | (Remove to as an assembly.) |
| Idler gear | Oil pump |
| Camshaft gear | Front plate |
| Thrust plate | |
| Camshaft | |
| (Remove to as an assembly.) | |

3.8 Separating the piston from the connecting rod

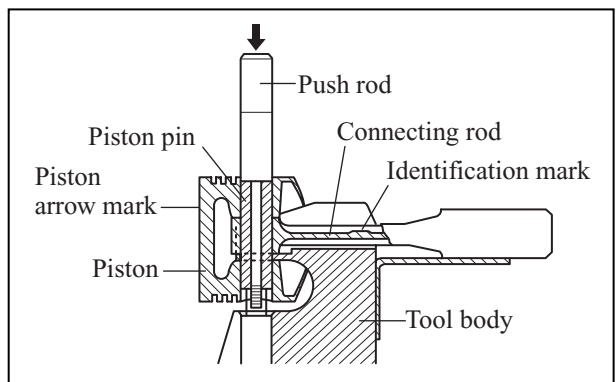
- (1) Remove the piston pin using the special tool Piston Pin Setting Tool.

Special tool	Part number
Piston Pin Setting Tool	31A91-00100



Piston Pin Setting Tool

- (2) Insert the tool's push rod into the piston pin hole. Using a press against the push rod, extract the piston pin.
- (3) Use the Piston Pin Setting Tool again to reassemble the piston and the connecting rod.

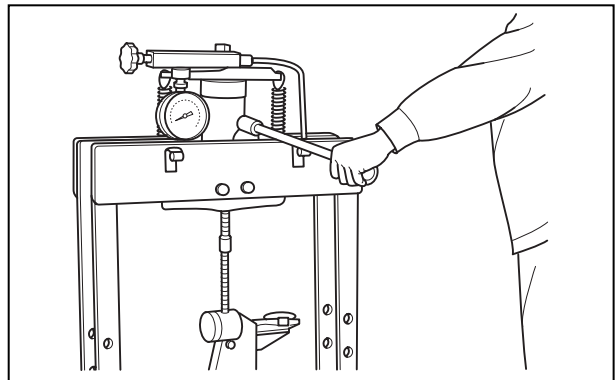


Removing the piston pin (1)

⚠ CAUTION

Do not try to remove the piston pin by tapping it.

If the piston has been agglutinated and requires a great force to remove, replace it with a new part.



Removing the piston pin (2)

3. Cylinder Block, Crankshaft, Pistons, Oil Pan

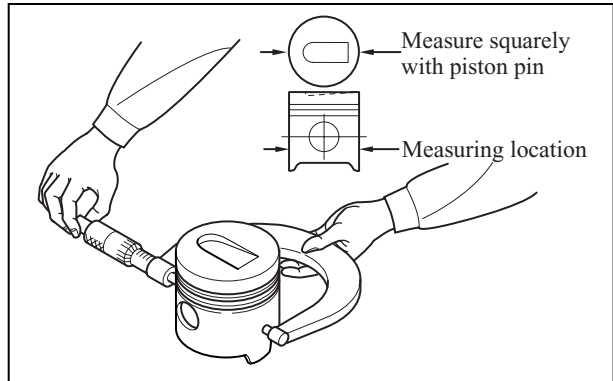
3.1 Measuring the piston diameter

Using a micrometer, measure the piston diameter across the piston skirt and squarely with the piston pin, as illustrated.

If the measured value is less than the limit, replace with a new part. The maximum allowable variation in weight among the pistons on the same engine is 5 grams (0.18 oz).

Unit: mm (in.)

		Nominal value	Standard value	Limit
Piston diameter	STD	78.00 (3.07)	77.93 to 77.95 (3.070 to 3.071)	77.80 (3.065)
	0.25 OS	78.25 (3.08)	78.18 to 78.20 (3.080 to 3.081)	78.05 (3.075)
	0.50 OS	78.50 (3.09)	78.43 to 78.45 (3.090 to 3.090)	78.30 (3.085)
	Max. allowable variation in weight among pistons on the same engine:		5 g (0.18 oz) or less	



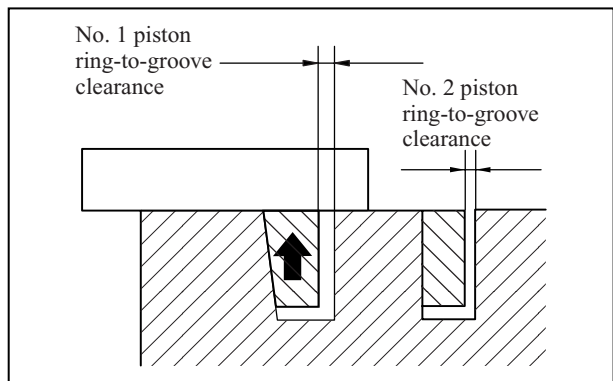
Measuring the piston diameter

3.2 Measuring the clearance between the piston ring and the ring groove

- (1) Measure the piston ring-to-groove clearance. If the measured value exceeds the limit, replace the piston ring.

Unit: mm (in.)

	Standard value	Limit
No. 1 ring	0.09 to 0.11 (0.0035 to 0.0043)	0.300 (0.012)
No. 2 ring	0.07 to 0.11 (0.0028 to 0.0043)	0.200 (0.008)
Oil ring	0.03 to 0.07 (0.0012 to 0.0028)	0.200 (0.008)



Measuring the piston ring-to-groove clearance

- (2) With the new piston ring installed, measure the ring-to-groove clearance again. If the measured value still exceeds the limit, replace the piston.

3.3 Measuring the piston ring gap

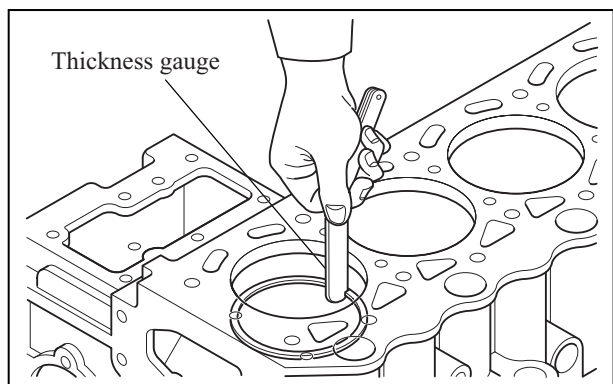
Install the piston ring being measured into the gauge or a new cylinder. Then, using a thickness gauge, measure the piston ring gap. If the measured value exceeds the limit, replace all rings of the relevant piston as a set.

$$\text{Gauge bore size} \begin{cases} \text{STD} = 78^{+0.03}_0 \text{ mm } (3.07^{+0.0012}_0 \text{ in.}) \\ 25 \text{ OS} = 78.25^{+0.03}_0 \text{ mm } (3.08^{+0.0012}_0 \text{ in.}) \\ 50 \text{ OS} = 78.50^{+0.03}_0 \text{ mm } (3.09^{+0.0012}_0 \text{ in.}) \end{cases}$$

Note: To install a piston ring into the gauge, use a piston to push the ring evenly.

Unit: mm (in.)

		Standard value	Limit
Piston ring gap	No. 1 ring	0.15 to 0.30 (0.006 to 0.012)	1.50 (0.06)
	No. 2 ring	0.15 to 0.35 (0.006 to 0.014)	
	Oil ring	0.20 to 0.40 (0.008 to 0.016)	



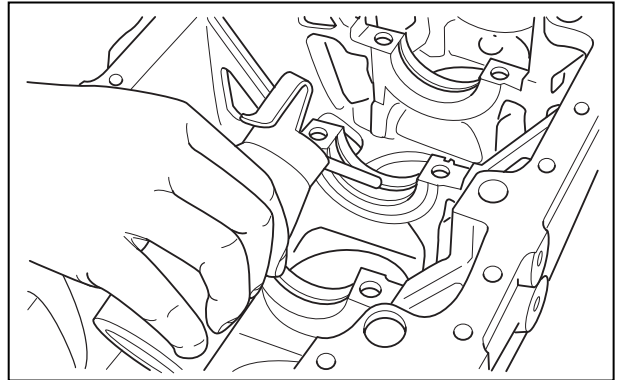
Measuring the piston ring gap

1. Cylinder Block, Crankshaft, Pistons, Oil Pan

To reassembly, follow the disassembly sequence in reverse.

1.1 Installing the main bearings

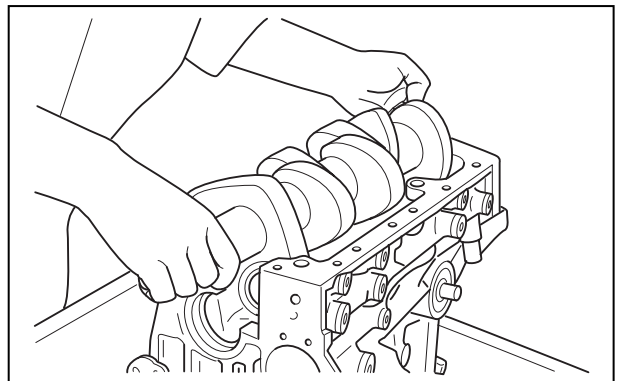
- (1) Install the main bearings (upper and lower) onto the cylinder block and the main bearing cap, ensuring that the lugs engage with the lug grooves.
- (2) The flanged main bearings should be installed onto the No. 3 crank journal.
- (3) Lightly coat the inner surface of each bearing with engine oil.



Installing the main bearings

1.2 Installing the crankshaft

- (1) Wash the crankshaft thoroughly in wash oil. Dry the crankshaft using compressed air.
- (2) While holding the crankshaft horizontally, lower it slowly onto the cylinder block.
- (3) Lightly coat the crank journals with engine oil.



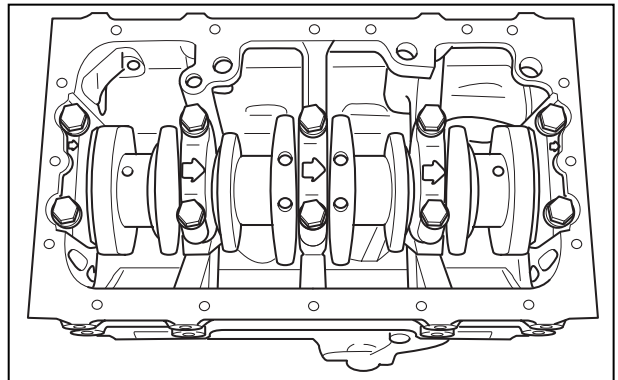
Installing the crankshaft

1.3 Installing the main bearing caps

- (1) Apply sealant onto the mating faces of the front and rear main bearing caps and the cylinder block.

Sealant	ThreeBond 1212
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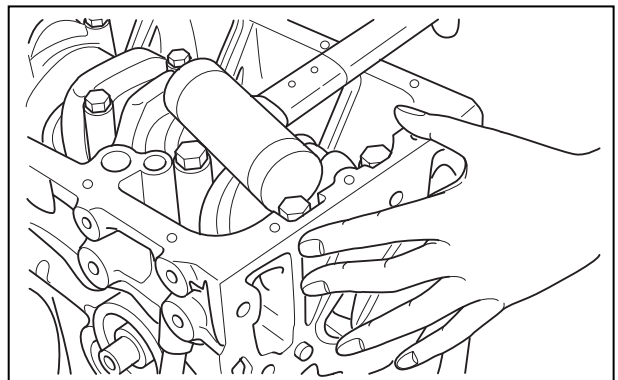
- (2) Install the main bearing caps so that their arrow marks point the front of the engine and that the cap numbers are in the order from the front to the rear of the engine.
- (3) Loosely tighten the cap retaining bolts.



Correct installation of main bearing caps

⚠ CAUTION

Install the front and rear main bearing caps so that they are flush with the cylinder block.



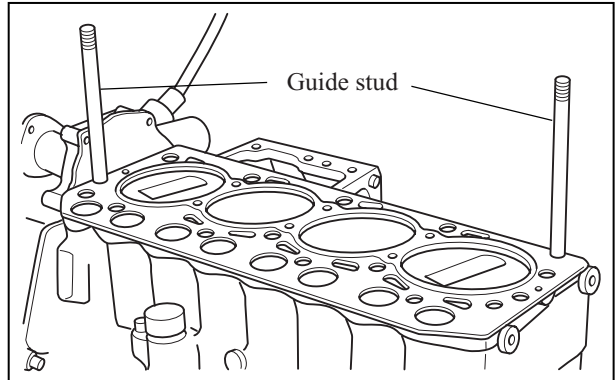
Installing the main bearing cap

3.5 Installing the cylinder head gasket

- (1) Ensure that the cylinder block top face and the piston top faces are clean.
- (2) Insert two guide studs (M10 × 1.25) into the bolt holes in the cylinder block.
- (3) Install the cylinder head gasket through the studs and onto the cylinder block.

⚠ CAUTION

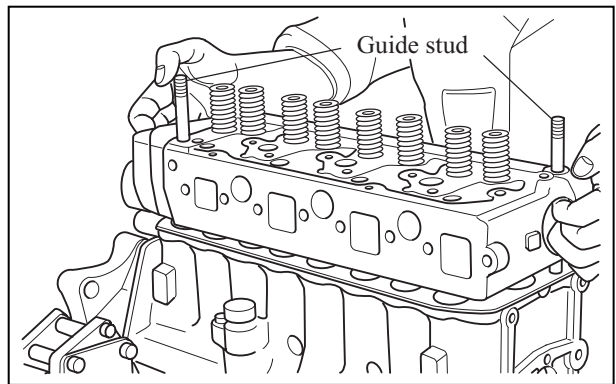
Do not use liquid packing or other similar sealant.



Installing the cylinder head gasket

3.6 Installing the cylinder head

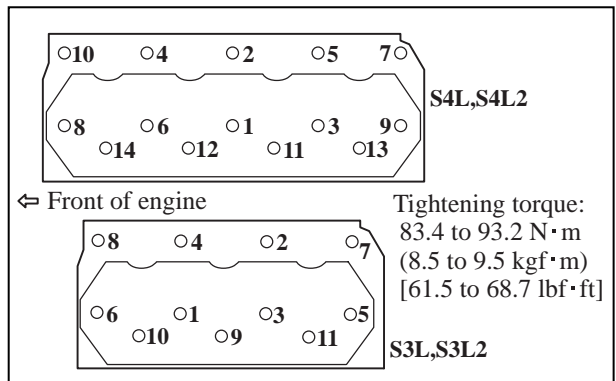
Install the cylinder head through the guide studs and onto the cylinder block.



Installing the cylinder head

3.7 Tightening the cylinder head bolts

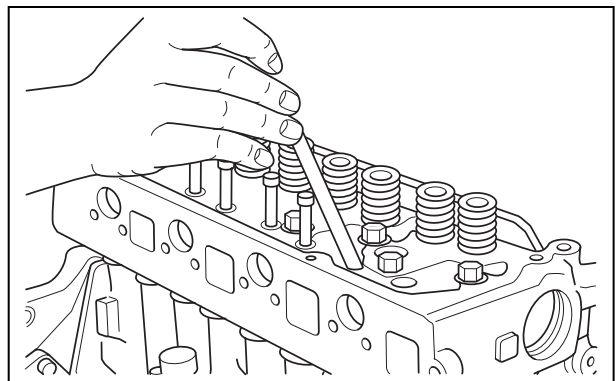
- (1) Remove the guide studs. Install the cylinder head bolts.
- (2) Tighten the cylinder head bolts in the order illustrated in a couple of steps, and finally tighten to the specified torque.



Tightening order for the cylinder head bolts

3.8 Inserting the push rods

- (1) Insert the push rods into the holes in the cylinder head.
- (2) Ensure that the ball end of the push rod rests on the recess of the tappet.



Inserting the push rod

- (c) If the measured pressure does not conform to the standard value, disassemble and adjust by changing the thickness of the washer.

Unit: MPa (kgf/cm²) [psi]

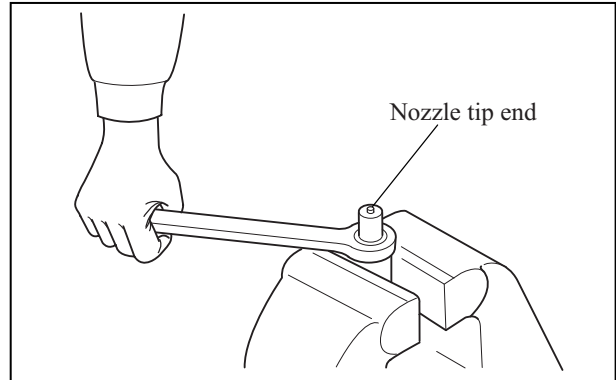
	Standard value
Injection valve opening pressure	14.22 to 15.00 (145 to 153) [2062 to 2176]

- (d) Change in washer thickness by 0.1 mm (0.004 in.) results in a pressure change of 1.0 MPa (10 kgf/cm²) [145 psi].

Washers are available in 10 different thicknesses at intervals of 0.05 mm (0.002 in.) in the range between 1.25 and 1.70 mm (0.049 and 0.067 in.).

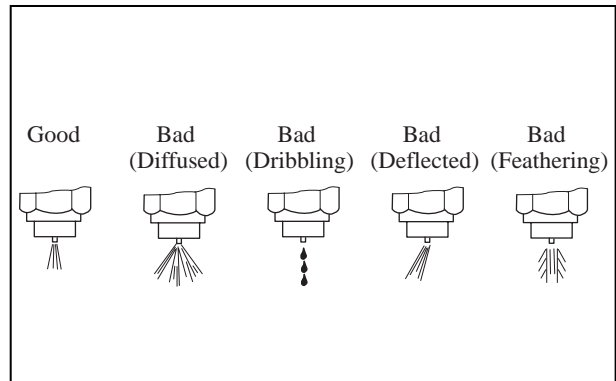
⚠ CAUTION

Never touch the spray of fuel from the fuel injection nozzle.



Replacing the fuel injection nozzle tip assembly

- (2) Inspecting the fuel spray pattern from the fuel injection nozzle
- (a) When inspecting the injection valve opening pressure using the nozzle tester, also check for such as clogged nozzle hole, fuel spray pattern and fuel leakage from the nozzle hole.
- (b) When the tester handle is pumped at a rate of approx. one cycle per second, fuel should be sprayed in a fairly straight pattern.

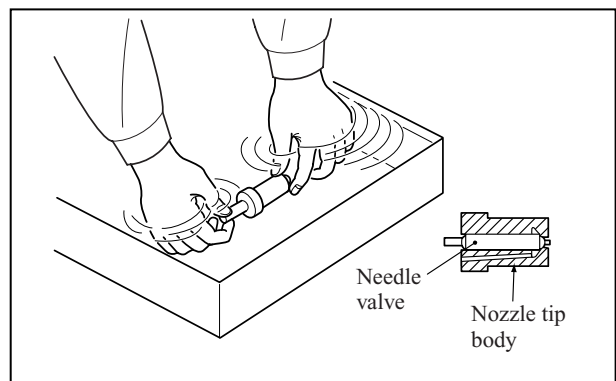


Fuel spray patterns

- (3) Clean or replace when spraying badly
- (a) Loosen the nozzle retaining nut to remove the nozzle tip assembly. Clean the needle valve and the nozzle tip body.

⚠ CAUTION

When removing the nozzle tip assembly, never tap on the end of the assembly.



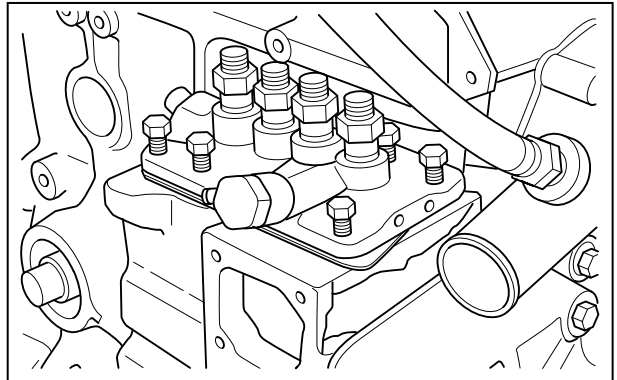
Cleaning the fuel injection nozzle tip components

- (b) Wash the needle valve and the nozzle tip body in clean wash oil. Reassemble them in clean light oil.

Note: The needle valve and the nozzle tip body are precision machined parts. Handle with care and never change their combination.

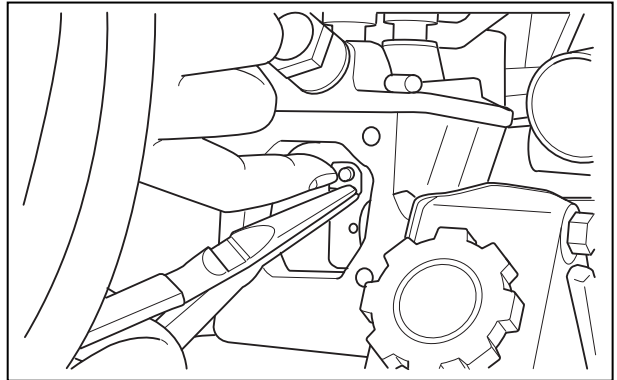
Installing the fuel injection pumps

- (1) Install the fuel injection pump housing complete with the pumps onto the cylinder block, and tighten the retaining bolts.



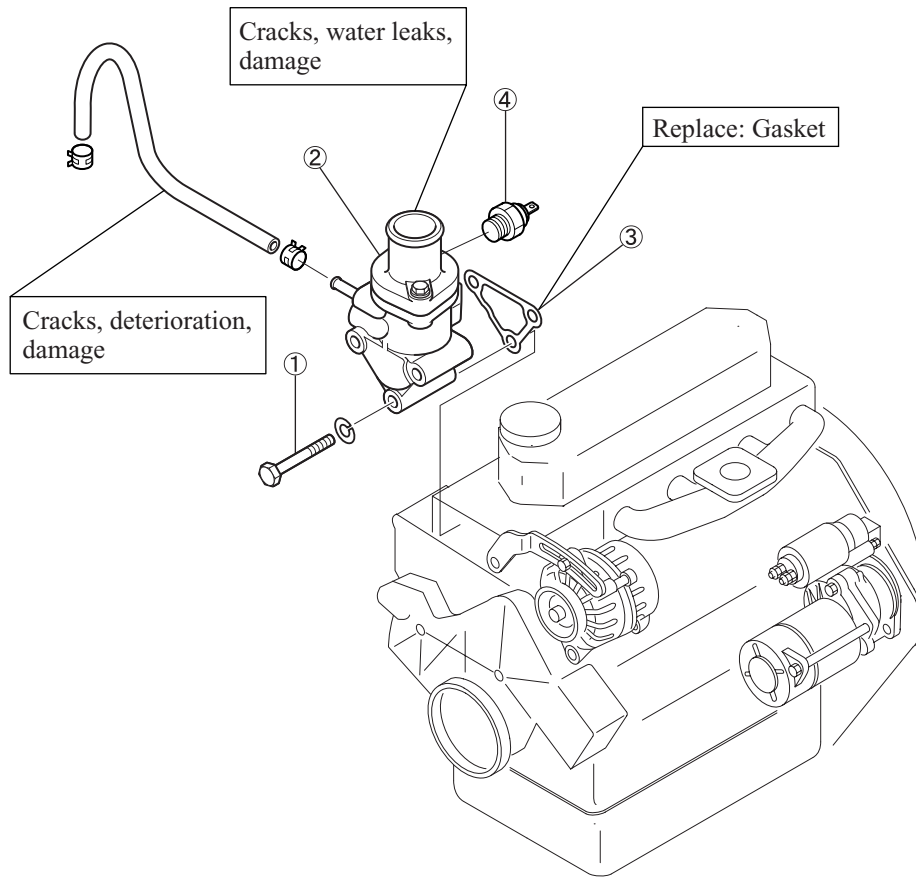
Installing the fuel injection pump housing complete with the pumps

- (2) Install the governor assembly, inserting the tie-rod and the tie-rod spring into the fuel injection pump housing.



Installing the tie-rod

2. Thermostat and Thermoswitch



Removing the thermostat and thermostat switch

<Removal sequence>

Bolt

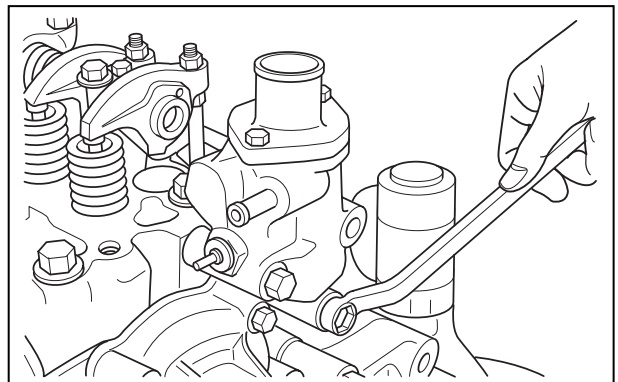
Thermostat

Gasket

Thermostat switch

Removing the thermostat case

Remove the thermostat case with thermostat.



Removing the thermostat case