2. Specifications

2.1 S4S in-line fuel injection pump specification (may differ in detail)

Engine type				S4S	S4S-DT
Main specifications	Type			Mitsubishi diesel engine	
	Cooling method			Water cooling	
	No. of strokes			4-stroke cycle	
	No. of cylinders - cylinder arrangement			4 in-line	
	Combustion method			Swirl chamber	Direct injection
	Valve mechanism			Overhead	
	Cylinder bore × stroke mm [in.]			94 × 120 [3.701 × 4.724]	
	Total displacement ℓ [cu in.]			3.331 [203]	
	Compression ratio			22:1	17:1
	Fuel			Diesel fuel (JIS No. 2 equivalent)	
	Firing order			1-3-4-2	
	Rotational direction			Counterclockwise as viewed from flywheel side	
	Dimension (with fan)	Overall length mm [in.]		781 [30.7]	
		Overall width mm [in.]		567 [22.3]	
		Overall height mm [in.]		717 [28.2]	815 [32.1]
	Dry weight kg [lb.]			245 [540]	250 [551]
Engine main parts	Cylinder sleeve	Type		Dry (integral with cylinder block)	
	Piston ring	No. of rings		Compression ring: 2	
				Oil ring (with expander): 1	
	Valve timing	Inlet valve	Open	BTDC 30°	BTDC 18°
			Close	ABDC 50°	ABDC 54°
		Exhaust valve	Open	BBDC 74°	BBDC 66°
			Close	ATDC 30°	ATDC 22°
	Starting system			Electric starter	
	Starting aid			Glow plug	
Fuel system	Injection pump	Type		In-line (Bosch Type A)	
		Plunger diameter mm [in.]		ϕ7 [0.28]	ϕ9 [0.35]
	Feed pump	Type		Piston pump (Bosch)	
	Governor	Speed control system		Centrifugal	
		Type		Bosch Type RSV	
	Injection nozzle	Type		Throttle nozzle (Bosch)	Hole nozzle (Bosch)
		No. of spray holes		1	4
		Spray hole diameter mm [in.]		ϕ1.0 [0.039]	ϕ0.28 [0.011]
		Spray angle		0°	155°
		Valve opening pressure MPa (kgf/cm²) [psi]		11.77 (120) [1707]	17.65 (180) [2561]
	Fuel filter	Type		Paper-element cartridge	

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2. Tightening Torque Table

2.1 Important Bolts and Nuts

(1) Engine main parts

Description	Threads Diameter × Pitch mm	Width across flats (mm)	Torque			Remark
			N·m	kgf·m	lbf·ft	
Cylinder head	M12 × 1.75	19	113 to 123	11.5 to 12.5	83.2 to 90.4	
Cylinder head plug	M16 × 1.5	14	39.2 to 49.0	4.0 to 5.0	28.9 to 36.2	
Rocker case	M8 × 1.25	12	10.0 to 13.0	1.0 to 1.3	7.2 to 9.4	
Rocker shaft brackets (long)	M8 × 1.25	12	10.0 to 20.0	1.0 to 2.0	7.2 to 14.5	
Main bearing cap	M14 × 2.0	22	98 to 108	10.0 to 11.0	72.3 to 79.6	
Connecting rod nut cap	M10 × 1.0	14	49.0 to 59.0	5.0 to 6.0	36.2 to 43.4	
Flywheel	M12 × 1.25	17	78.5 to 88.3	8.0 to 9.0	57.9 to 65.1	
Camshaft thrust plate	M8 × 1.25	12	10.0 to 13.0	1.0 to 1.3	7.2 to 9.4	
Front plate	M8 × 1.25	12	10.0 to 13.0	1.0 to 1.3	7.2 to 9.4	
Timing gear case	M8 × 1.25	12	17.0 to 20.0	1.7 to 2.0	12.3 to 14.5	
Crankshaft pulley nut	M30 × 1.5	46	480 to 500	49 to 51	354.4 to 368.9	
Idler gear thrust plate	M10 × 1.25	14	29.0 to 39.0	3.0 to 4.0	21.7 to 28.9	
Coolant drain plug	1/4-18NPTF	14	35.3 to 43.1	3.6 to 4.4	26.0 to 31.8	

(2) Fuel system

Description	Threads Diameter × Pitch mm	Width across flats (mm)	Torque			Remark
			N·m	kgf·m	lbf·ft	
Fuel injection pump delivery valve holders		22	34.0 to 39.0	3.5 to 4.0	25.3 to 28.9	
Fuel injection pump gear nut (distributor type)	M14 × 1.5	22	76.5 to 86.3	7.8 to 8.8	56.4 to 63.6	
Fuel injection pump gear nut (in-line type, VE swirl chamber)	M12 × 1.75	19	58.8 to 68.6	6.0 to 7.0	43.4 to 50.6	
Fuel injection pump gear nut (in-line type, VE direct injection)	M14 × 1.5	22	83.4 to 98.0	8.5 to 10.0	61.5 to 72.3	
Fuel injection pipe nuts	M12 × 1.5	17	26.5 to 32.4	2.7 to 3.3	19.5 to 23.9	
Fuel return pipe nut	M10 × 1.25	14	17.7 to 21.6	1.8 to 2.2	13.0 to 15.9	
Fuel leak-off pipe nut	M12 × 1.5	17	20.6 to 24.5	2.1 to 2.5	15.2 to 18.1	
Fuel injection pump overflow valve		17	15.0 to 20.0	1.5 to 2.0	10.8 to 14.5	
Fuel injection pump eye bolt	M14 × 1.5	22	15.0 to 20.0	1.5 to 2.0	10.8 to 14.5	
Nozzle (swirl chamber)	M20 × 1.5	21	53.0 to 64.7	5.4 to 6.6	39.1 to 47.7	
Nozzle glands (direct injection)	M8 × 1.25	12	21.0 to 23.7	2.0 to 2.4	14.5 to 17.4	
Fuel filter element (in-line type)	M20 × 1.5		11.7 to 15.7	1.2 to 1.6	8.7 to 11.6	
Fuel filter air bleeder plug (in-line type)	M8 × 1.25	12	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7	
Fuel filter element (distributor type)	M20 × 1.5		12.0 to 18.0	1.2 to 1.8	8.7 to 13.0	
Fuel filter level sensor (distributor type)	M20 × 1.5		4.0 to 6.0	0.4 to 0.6	2.9 to 4.3	
Fuel filter drain plug	M14 × 1.0		1.0 to 2.0	0.1 to 0.2	0.7 to 1.4	
Fuel filter air bleeder plug (distributor type)			2.0 to 4.0	0.2 to 0.4	1.4 to 2.9	

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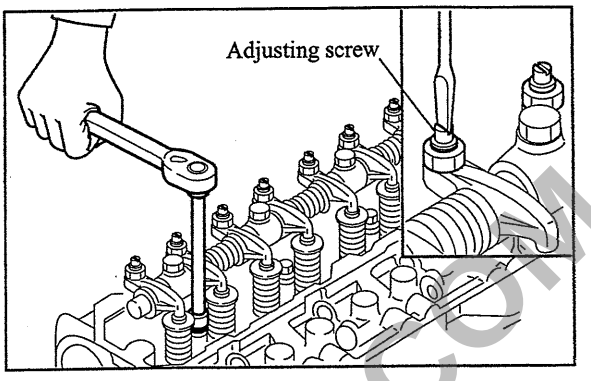
1.1 Removing Rocker Shaft Assembly

(1) Loosen the adjusting screw of the rocker by about one turn.

(2) Loosen the shorter bolt of the rocker shaft bracket first. Loosen the longer bolt, then. Remove the rocker shaft assembly from the cylinder head.

⚠ CAUTION

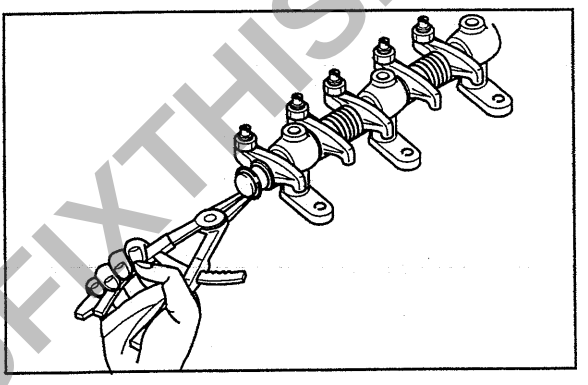
If these bolts are loosened in reverse order, the rocker shaft bracket may be damaged.



Removing rocker shaft assembly

1.2 Disassembling Rocker Shaft Assembly

In the course of disassembly, place removed rocker components neatly in the order of disassembly so that they can be reassembled back onto their original locations. Doing so, original clearances between the rocker arms and the rocker shaft are restored upon reassembly.

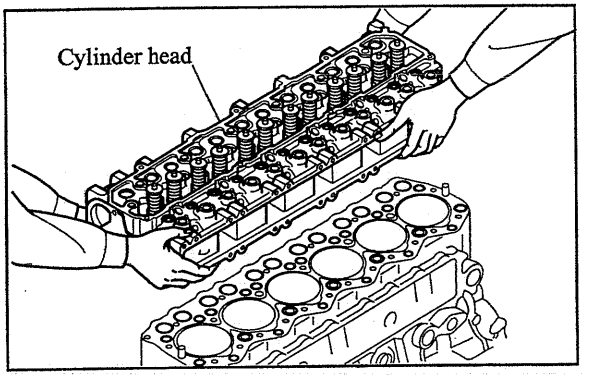


Disassembling rocker shaft assembly

1.3 Removing Cylinder Head Assembly

Remove the cylinder head bolts. Lift the cylinder head and remove it from the crankcase.

Note: Be careful not to damage the mount surfaces of the cylinder and crankcase when removing the gasket from the cylinder head.
Before removing the cylinder head bolts, check the cylinder head components for any defects or faults. If faulty or defective, check the bolts for tightness with a torque wrench.



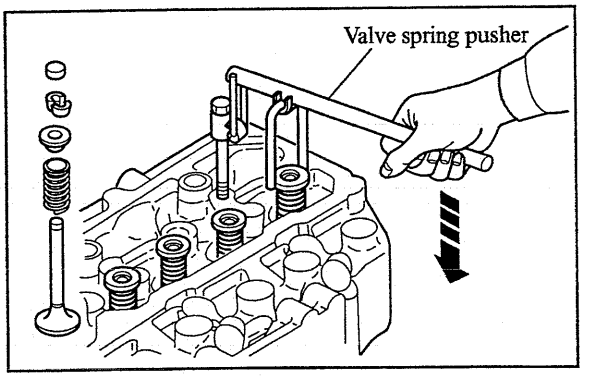
Removing cylinder head

1.4 Removing Valves and Valve Springs

Push the valve spring evenly using the valve spring pusher (special tool), and remove the valve cotter.

Special tool name	Part No.
Valve spring pusher	30691-04500

Note: Put match marks for easy identification of the mounting position if the valve may be reused. When reassembling, do not change the combination of the valve seat and valve guide.



Removing valve and valve spring

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Engine type			S4S	S4S-DT
Lubrication system	Lubricating method		Forced circulation (oil pump pressure feed)	
	Engine oil	Grade (API service classification)	Class CF (SAE30 equivalent)	
		Capacity ℓ [U.S.gal]	Entire engine: 10 [2.64], Oil pan: Maximum of 9 [2.38], oil filter: 1 [0.26]	
	Oil pump	Type	Trochoid	
		Speed ratio to crankshaft	0.74	
		Discharge capacity ℓ [U.S.gal] / min	28.6 [7.6] at 0.3MPa (3 kgf/cm^2) [43 psi] discharge pressure of pump running at 2230min^{-1}	
	Relief valve	Type	Piston valve	
		Valve opening pressure MPa (kgf/cm^2) [psi]	0.35±0.05 (3.6±0.5) [51±7]	
	Safety valve	Valve opening pressure MPa (kgf/cm^2) [psi]	—	1.1 (11) [156]
	Oil cooler	Type	—	Water-cooled, multi-plate
	Oil filter	Type	Paper-element cartridge	
Cooling system	Cooling method		Water-cooled, forced circulation	
	Coolant capacity (engine water jacket) ℓ [U.S.gal]		5.5 [1.45]	5 [1.32]
	Water pump	Type	Centrifugal volute pump	
		Speed ratio to crankshaft	1.3	
		Discharge capacity ℓ [U.S.gal] / min	160 [42.3] at 0.75 MPa (7.5 kgf/cm^2) [107 psi] discharge pressure of pump running at 3600min^{-1}	
	Cooling fan	Type	Pusher (PP fan)	
		No. of blades	6	
		Outside diameter mm [in.]	ϕ440 [17.3]	
	V-belt	Type	Raw-edge cog V-belt Type B × 1	
	Thermostat	Type	Wax	
		Valve opening temperature °C [°F]	76.5±1.5 [169.7±2.7] (Approx.90 [194] when fully opened)	
Inlet / exhaust system	Air cleaner	Type	Paper element	
	Turbocharger	Type	—	TD04H

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(3) Lubricating system

Description	Threads Diameter × Pitch mm	Width across flats (mm)	Torque			Remark
			N·m	kgf·m	lb·ft	
Oil pump gear	M10 × 1.25	14	28.0 to 38.0	2.9 to 3.9	21.0 to 28.2	
Oil pan	M8 × 1.25	12	10.0 to 13.0	1.0 to 1.3	7.2 to 9.4	Extruded
	M10 × 1.25	12	27.5 to 33.4	2.8 to 3.4	20.3 to 24.6	Casting
Oil pan drain plug	M14 × 1.5	227	34.0 to 44.0	3.5 to 4.5	25.3 to 32.5	
	M20 × 1.5	24	73.0 to 83.0	7.5 to 8.5	54.2 to 61.5	
Relief valve	M22 × 1.5	27	44.1 to 53.9	4.5 to 5.5	32.5 to 39.8	
Safety valve	M18 × 2.0	24	64.0 to 74.0	6.5 to 7.5	47.0 to 54.2	
Fuel injection pump oil supplied pipe (in-line type)	M12 × 1.0	17	16.0 to 23.0	1.6 to 2.3	11.6 to 16.6	
Turbocharger oil supplied eye bolt	M10 × 1.25	14	13.7 to 18.6	1.4 to 1.9	10.1 to 13.7	

(4) Cooling system

Description	Threads Diameter × Pitch mm	Width across flats (mm)	Torque			Remark
			N·m	kgf·m	lb·ft	
Thermostat case	M8 × 1.25	12	17.0 to 20.0	1.7 to 2.0	12.3 to 14.5	

(5) Inlet and exhaust systems

Description	Threads Diameter × Pitch mm	Width across flats (mm)	Torque			Remark
			N·m	kgf·m	lb·ft	
Exhaust manifold (bolt only)	M8 × 1.25	12	27.5 to 33.3	2.8 to 3.4	20.3 to 24.6	
Exhaust manifold (with spacer)	M8 × 1.25	12	15.0 to 22.0	1.5 to 2.2	10.8 to 15.9	
Turbocharger air hose plate clamp		7	3.0 to 5.0	0.3 to 0.5	2.2 to 3.6	

(6) Electrical system

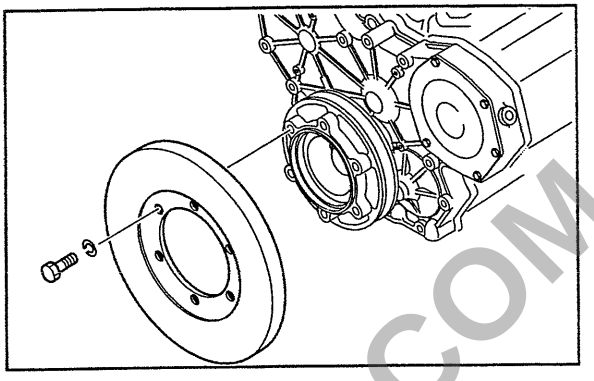
Description	Threads Diameter × Pitch mm	Width across flats (mm)	Torque			Remark
			N·m	kgf·m	lb·ft	
Starter terminal B	M8 × 1.25	12	9.8 to 11.8	1.0 to 1.2	7.2 to 8.7	
Glow plug (swirl chamber)	M10 × 0.7	12	15.0 to 20.0	1.5 to 2.0	10.8 to 14.5	
Glow plug (direct injection)	M10 × 0.7	12	20.0 to 30.0	2.5 to 3.0	18.1 to 21.7	
Glow plug (terminal)	M4 × 0.7	8	1.0 to 1.5	0.10 to 0.15	0.7 to 1.1	

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3.1 Removing Damper (S6S)

Remove the mounting bolts, and remove the damper.



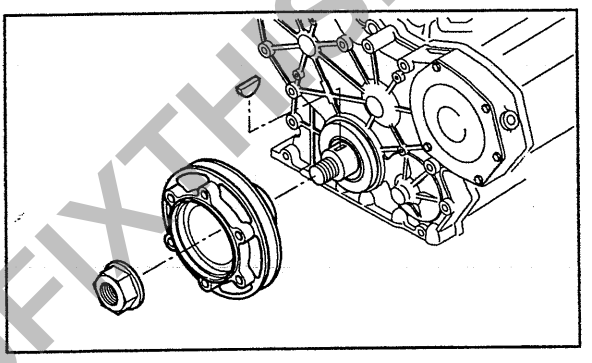
Removing damper

3.2 Removing Crankshaft Pulley

(1) Screw two bolts (M12 × 1.25) into the threaded holes at the rear end of the crankshaft. Prevent the crankshaft from rotating using a bar.
(2) Remove the nut, and remove the crankshaft pulley.

⚠ CAUTION

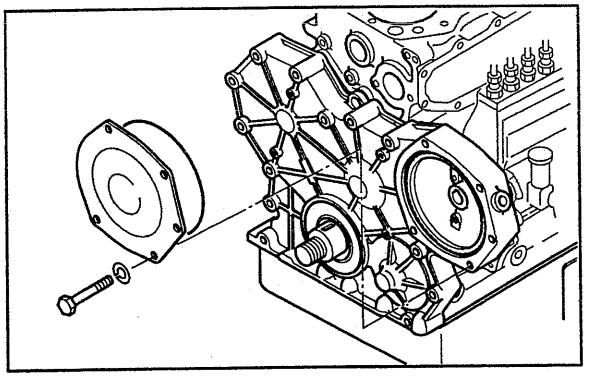
The bar may come off. Be very careful.



Removing crankshaft pulley

3.3 Removing Cover

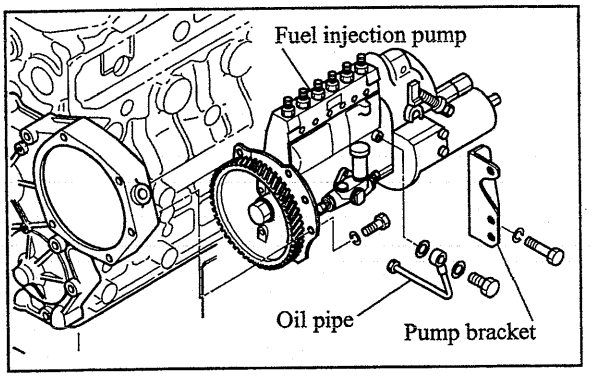
Remove the cover mounting bolts, and remove the cover.



Removing cover

3.4 Removing Fuel Injection Pump

(1) Disconnect the oil pipe.
(2) Remove the pump bracket.
(3) Remove the fuel injection pump mounting bolts, and remove the fuel injection pump.



Removing fuel injection pump

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Engine type				S4S	S4S-DT
Electrical system	Voltage - polarity			12 V - negative (–) ground	24 V - negative (–) ground
	Starter	Type		M8T75171	M2TS5071
		Pinion mesh type		Pinion shift	
		Output V-kW		12-2.2	24-3.2
		Pinion/ring gear ratio		10/122	
	Alternator	Type		3-phase alternating-current generator, built-in rectifier	
		Output V-A		12-50	24-25
		Working speed min^{-1}		1000 to 18000	
		Rated output generating speed min^{-1}		5000	
		Maximum permissible speed min^{-1}		22000	
		Speed ratio to crankshaft		2.0	
	Glow plug	Type		Sheathed	
		Rated voltage - current V-A		10.5-9.7 (30-second application)	23-3.0 (30-second application)
	Stop solenoid (option)	Type ETS (RUN-OFF)	Operating voltage V	8 to 14 (for 12 V)	16 to 27 (for 24 V)
			Operating temperature °C [°F]	–30 to 90 [–22 to 194]	
			Rated time sec	10 or less	
			Rated current A	22.6 or less	11.7 or less
		Type ETR (RUN-ON)	Rated voltage V	12	24
			Rated temperature °C [°F]	20 [68]	
			Rated absorbing current A	55	29
			Rated hold current A	1.1	0.6

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2.2 Standard Bolts and Nuts

Threads Diameter × Pitch mm	Strength classification					
	4T			7T		
	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
6 × 1.0	2.94 to 4.90	0.3 to 0.5	2.2 to 3.6	7.85 to 9.80	0.8 to 1.0	5.8 to 7.2
8 × 1.25	9.80 to 12.7	1.0 to 1.3	7.2 to 9.4	14.7 to 21.6	1.5 to 2.2	10.8 to 15.9
10 × 1.25	17.7 to 24.5	1.8 to 2.5	13.0 to 18.1	29.4 to 41.2	3.0 to 4.2	21.7 to 30.4
12 × 1.25	29.4 to 41.2	3.0 to 4.2	21.7 to 30.4	53.9 to 73.5	5.5 to 7.5	39.8 to 54.2

Note: (a) This table lists the tightening torque for standard bolts and nuts.
(b) The numerical values in the table are for fasteners with spring washers.
(c) The table shows the standard values with a maximum tolerance value of ±10 %.
(d) Use the tightening torque in this table unless otherwise specified.
(e) Do not apply oil to threaded sections. (Dry)

2.3 Standard Eye Bolts

Threads Diameter × Pitch mm	Width across flats (mm)	Strength classification		
		4T		
		N·m	kgf·m	lbf·ft
8 × 1.25	12	8 ±1	0.8 ±0.1	5.9 ±0.74
10 × 1.25	14	15 ±2	1.5 ±0.2	11.1 ±1.48
12 × 1.25	17	25 ±3	2.5 ±0.3	18.4 ±2.21
14 × 1.5	22	34 ±4	3.5 ±0.4	25.1 ±2.95
16 × 1.5	24	44 ±5	4.5 ±0.5	32.5 ±3.69
18 × 1.5	27	74 ±5	7.5 ±0.5	54.2 ±3.69
20 × 1.5	30	98 ±10	10.0 ±1.0	72.3 ±7.38
24 × 1.5	36	147 ±15	15.0 ±1.5	108.4 ±11.1
27 × 1.5	41	226 ±20	23.0 ±2.0	166.7 ±14.8

(Dry)

2.4 Standard Union Nuts

Nominal diameter	Cap nut size M (mm)	Width across flats (mm)	N·m	kgf·m	lbf·ft
63	14 × 1.5	19	39	4	29
80	16 × 1.5	22	49	5	36
100	20 × 1.5	27	78	8	58
120	22 × 1.5	30	98	10	72
150	27 × 1.5	32	157	16	116
180	30 × 1.5	36	196	20	145
200	30 × 1.5	36	196	20	145
220	33 × 1.5	41	245	25	181
254	36 × 1.5	41	294	30	217

(Maximum tolerance value: ±10 %, dry)

2.5 Standard Plugs

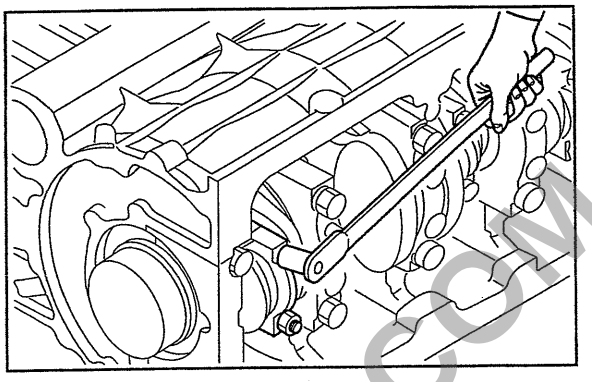
Thread Diameter	Torque for alminum materials			Torque for ferrous matirials		
	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
NPTF1/16	4.90 to 7.85	0.5 to 0.8	3.62 to 5.79	7.85 to 11.8	0.8 to 1.2	5.79 to 8.68
PT1/8	7.85 to 11.8	0.8 to 1.2	5.79 to 8.68	14.7 to 21.6	1.5 to 2.2	10.8 to 15.9
PT1/4, NPTF1/4	19.6 to 29.4	2.0 to 3.0	14.5 to 21.7	34.3 to 44.1	3.5 to 4.5	25.3 to 32.5
PT3/8	—	—	—	53.9 to 73.5	5.5 to 7.5	39.8 to 54.2

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4.1 Removing Connecting Rod Caps

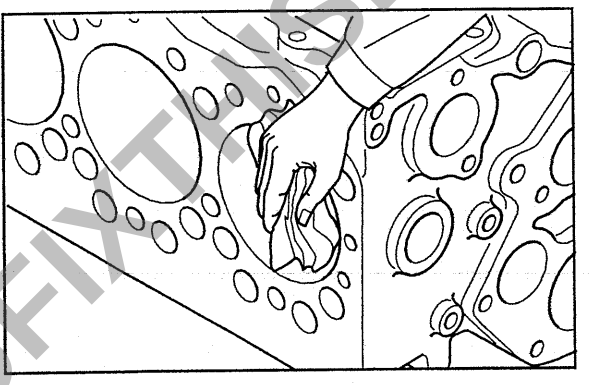
(1) Remove each connecting rod cap tightening nut, hit the tip of the tightening bolt evenly almost squarely with an iron hammer, and remove the cap when the cap-side reamer comes off.
(2) Clarify the cylinder number and the upper and lower parts of the removed connecting rod bearings.



Removing connecting rod cap

4.2 Preparation for Pulling Out Pistons

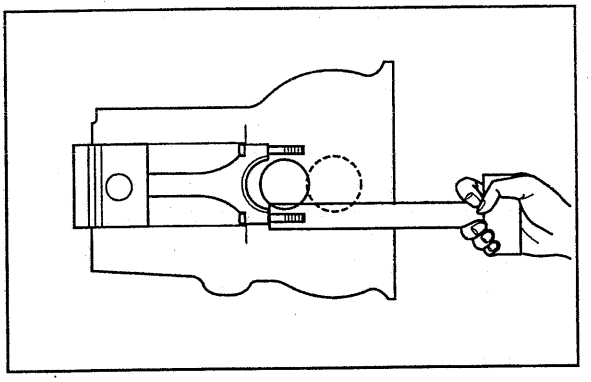
(1) Turn the crankcase on its side.
(2) If carbon adheres to the upper part of the cylinder, the piston may be difficult to draw up. Remove carbon with waste cloth or oil paper.



Preparation for pulling out pistons

4.3 Pulling Out Pistons

Move the connecting rod to the top, apply the hammer grip to the larger end of the connecting rod, and pull out the piston to above the crankcase.

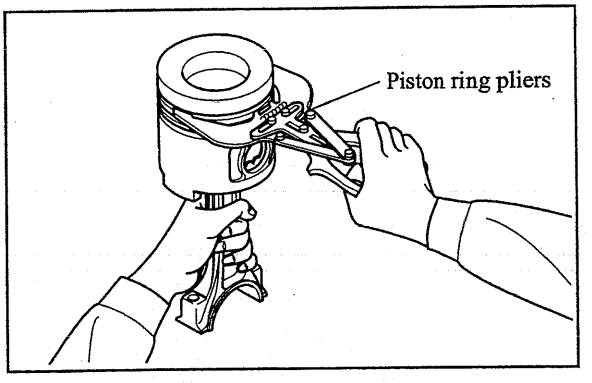


Pulling out piston

4.4 Removing Piston Rings

Remove the piston ring with the piston ring pliers (special tool).

Special tool name	Part No.
Piston ring pliers	31391-12900



Removing piston ring

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GENERAL CONTENTS

Group No	Group Name		Page
0	Safety Cautions		0 - 1
1	General		1 - 1
	Maintenance Standards		1 -35
	Special Tools		1 -47
	Overhaul Instructions		1 -51
	Preparation for Disassembly		1 -55
2	Main Engine Parts	Disassembly	2 - 1
		Inspection and Repair	2 -13
		Reassembly	2 -37
3	Fuel System	Removal	3 - 1
		Disassembly, Inspection and Reassembly	3 - 7
		Installation	3 -17
4	Lubrication System	Removal	4 - 1
		Disassembly, Inspection and Reassembly	4 - 5
		Installation	4 -13
5	Cooling System	Removal	5 - 1
		Disassembly, Inspection and Reassembly	5 - 5
		Installation	5 - 9
6	Inlet and Exhaust Systems	Removal	6 - 1
		Disassembly, Inspection and Reassembly	6 - 7
		Installation	6 - 9
7	Electrical System	Removal	7 - 1
		Disassembly, Inspection and Reassembly	7 - 5
		Installation	7 -23
8	Inspection, Adjustment, Break-In Operation And Performance Tests	Adjustment of Engine	8 - 1
		Break-In Operation	8 -13
		Performance Tests	8 -14
9	Others	Disassembly and Reassembly of General Parts	9 - 1

Supplement

Engine inspection record sheets

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⚠ WARNING Danger of Fire and Explosion

● Keep flames away



Do not use flames or smoke at a site where fuel or engine oil is handled or cleaning solvent is used for washing parts.
Flames can ignite such materials and result in a dangerous situation.
Spilled fuel and oil should be wiped immediately and thoroughly. Spilled fuel and oil can ignite and cause fire.
When storing fuel or engine oil, make sure that the storage area is well ventilated and the caps of containers are tightly closed.

● Keep surrounding area neat and clean

Do not leave combustible or explosive materials, such as fuel and engine oil, near the engine. They can cause fire or explosion.
Remove dust, dirt and other foreign materials accumulated on or near the engine. They can cause fire or engine overheating. Be sure to remove dust from the top side of the battery after maintenance. Dust can cause a short-circuit.
The engine must be positioned at least 1 m [3.28 ft] away from buildings and other equipment to prevent possible fire caused by engine heat.

● Do not open crankcase until engine cools

After the engine stops operation, let the engine cool for at least 10 minutes before opening the side cover of the crankcase.
Inflow of fresh air into the crankcase of a hot engine can cause oil mist to ignite and explode.

● Check for fuel and oil leaks

When fuel or oil leaks are found, repair the leakage immediately.
Fuel or engine oil spilled on a hot surface of the engine can cause fire and result in personal injury or equipment damage.

● Use shatterproof light

Use a shatterproof light when inspecting the fuel system, lubrication system, cooling system or battery fluid level.
A non-shatterproof light may catch fire and explode.

● Do not short-circuit electrical wires

Do not inspect or repair the electrical system with the battery cables connected to the battery, since it can cause accidental short-circuiting and lead to fire. Be sure to disconnect the negative (-) battery cable from the battery before conducting work.
Loose terminals and damaged cables/wires can result in a short-circuit and cause fire. Inspect the terminals, cables and wires before servicing, and repair or replace when damage is found.

● Keep fire extinguishers and first aid kit nearby



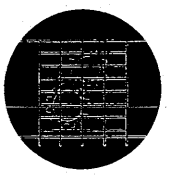
Always keep fire extinguishers nearby, and be familiarized with their usage.
Keep a first aid kit at a designated place, and make sure it is easily accessible whenever needed.
Also, establish emergency response procedures to follow in the event of a fire or accident, and post emergency contact locations and contact methods.

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⚠ WARNING Danger of Entanglement

● Install protective covers on rotating parts



Make sure the protective covers of the engine are installed correctly at rotating parts.
If protective covers are loose or damaged, repair.
Never remove the covers guarding rotating parts, such as the camshaft cover and rocker covers, when the engine is operating.
When the engine is coupled to other equipment or connected to a radiator, be sure to install covers on the exposed connecting belt and coupling.
Never remove protective covers.

● Check surrounding area for safety before starting engine

Before starting the engine, check to make sure no one is near the generator and tools are not left on or near the engine. Always verbally notify people within the immediate area when starting the engine.
When the starter switch is posted with a sign that prohibits startup operation, do not operate the engine.

● Stay clear of rotating parts while engine is in operation



Do not approach rotating parts while the engine is in operation.
Keep items that can be easily entangled away from rotating parts.
Rotating parts can entangle a persons' body or tools to cause serious.

● Lock out and tag out

Be sure to lock out and tag out before starting inspection and maintenance.
Lockout and tagout are effective methods of cutting off machines and equipment from energy sources.
To lock out and tag out, pull out the key from the starter switch, turn off the battery switch, and post a "Do Not Operate" tag or a similar sign on the starter switch.
The starter switch key should be kept by the person performing the inspection and maintenance.
If the engine is installed with an air starter system, close the main valve of the air tank, and post a "Do Not Open" tag on the main valve.

● Always stop engine before inspection and maintenance

Before inspection and maintenance, be sure to stop the engine. Never attempt to adjust the belt tension while the engine is operating. Operating belt can entangle your body and result in serious injury.

● Always return turning tools to original position after use

Be sure to remove all turning tools used in inspection and maintenance. Return the turning gear in the original position before starting the engine.
Starting the engine with the turning tools inserted or turning gear engaged may not only cause engine damage but personal injury as well.

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