

# ENGINE MECHANICAL SYSTEM (D4DD)

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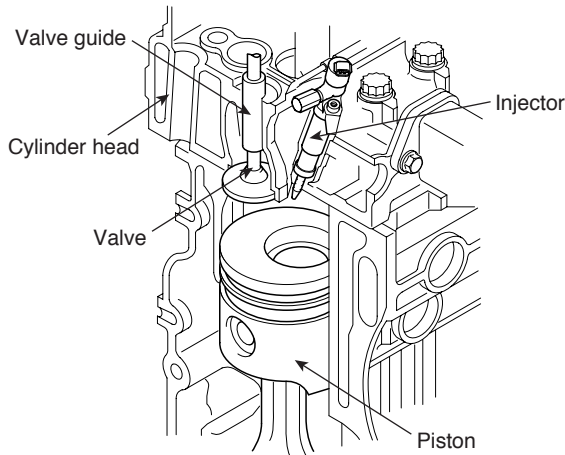
# GENERAL

## DESCRIPTION EFA0EBB7

### COMBUSTION

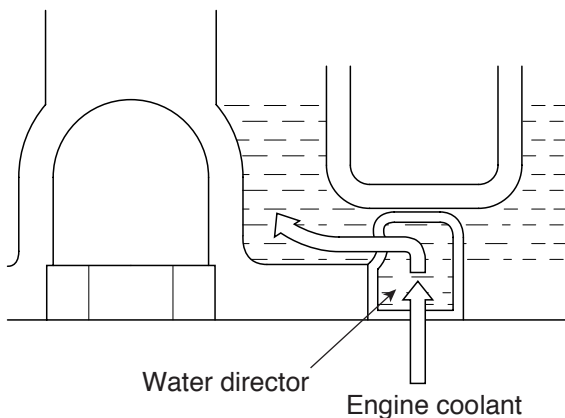
#### CHAMBER

1. Combustion chamber consists of cylinder head, piston, injector installed to the cylinder head and valve.



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2. Fuel is supplied to supply pump through the fuel filter installed to the frame. Fuel is also supplied to injectors through injection pipe No. 1, 2, 3 and 4 in common rail assembly.
3. Combustion is accomplished when fuel is injected directly into combustion chamber, at that time explosion pressure applies to the piston directly.
4. For better efficient cooling of combustion chamber, water director is press-fit under cylinder head floor, which induces the coolant flow.



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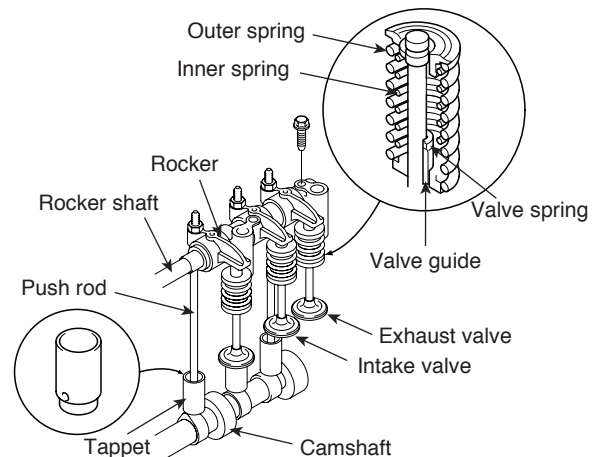
### VALVE MECHANISM

1. Heat resistant steel with surface treatment is used for intake and exhaust valve. The valve seat angle is  $45^\circ$ .
2. Valve stem seal, installed to the stem, adjusts the lubricant amount on the sliding surface of valve and valve guide.

#### NOTE

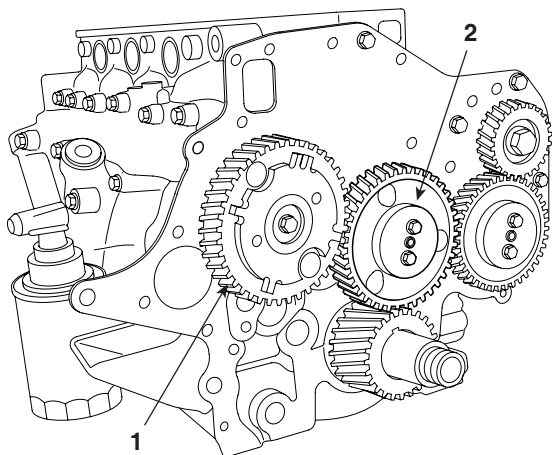
*Valve guide with carbon cutter is used for exhaust valve.*

3. Valve spring consists of two valve springs having irregular pitches. The coil directions of inner and outer springs are opposite each other.
4. Rocker shaft is hollow cylindrical rod, whose each end are sealed with sealing cap. Inner space of the shaft is an engine oil passage.
5. Steel ball is installed to the lower end of push rod and rocker assembly is installed to upper end.
6. Tappet has a cylindrical shape. As enlarging the contacting surface contacted with camshaft, it helps to prevent partial wear and to increase its durability.



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7. Camshaft assembly (1) consists of cam sensor plate, thrust plate, cam and journal. Camshaft gear is coupled with the idler gear A (2).

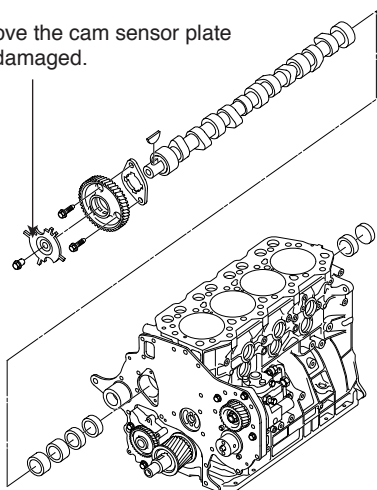


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**CRANKCASE AND CYLINDER SLEEVE**

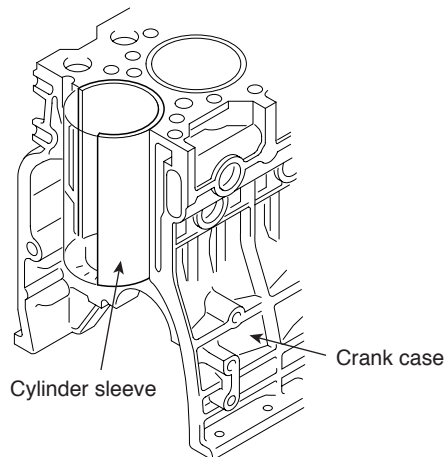
1. Crankcase is manufactured firmly with cast iron to prevent stress concentration and deformation.
2. The 5 camshaft bushes are installed to the camshaft bore of the crankcase. To facilitate the removal and installation of camshaft, inner diameter of bush is tapered to the rear side.

Do not remove the cam sensor plate unless it is damaged.



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3. Cylinder sleeve made of special cast iron is pressed fit into the crankcase.



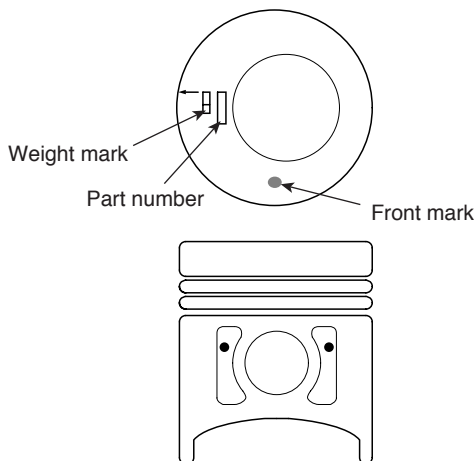
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**PISTON**

1. Piston pin type is full float type and piston pin is offset from thrust.
2. Marks on the piston indicate weight, part number and oversize. The front mark indicates the front direction of the engine.

**NOTE**

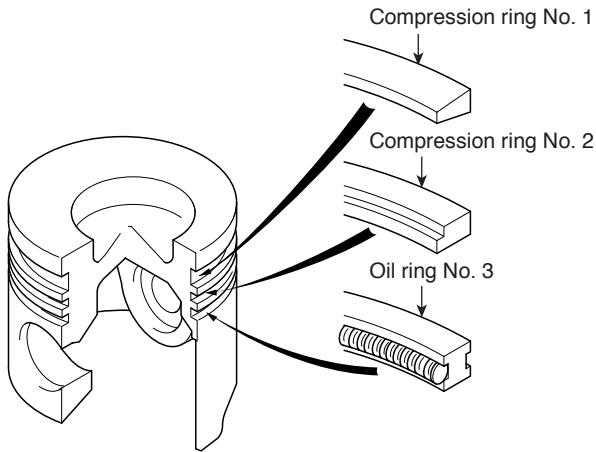
When assembling a piston, let the arrow mark (→) faced to the center of cylinder head bolt hole.



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**PISTON RING**

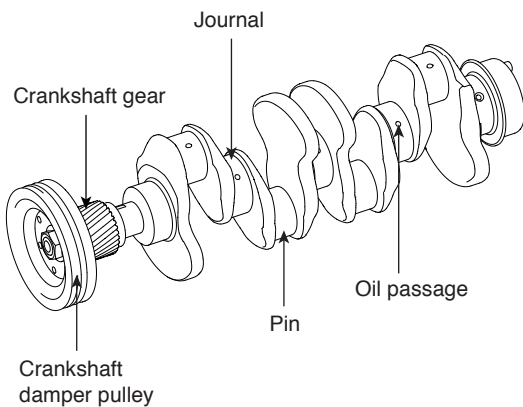
Piston has two compression rings and one oil ring. All sliding surfaces of rings are coated with hardened chrome.



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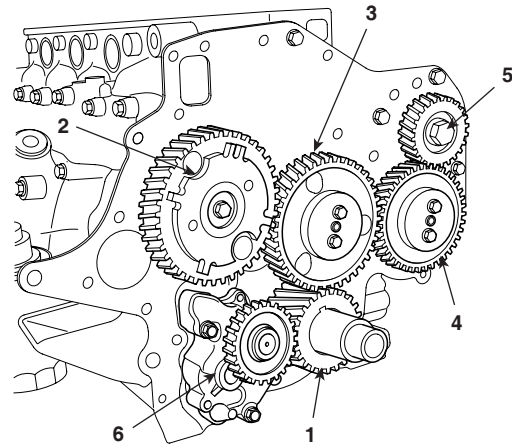
**CRANKSHAFT**

1. Crankshaft is forged with high-strength alloy built in with balance weight.
2. Pin, journal and oil seal sliding-surface are hardened with high frequency heat treatment to raise the resistance against frictional wear.
3. Through oil passage at the pin and journal, oil lubricates main bearing. Oil flows to the pin for the lubrication of connecting rod bearing.
4. Crankshaft pulley and crankshaft gear are installed at the front end of crankshaft. The crankshaft pulley drives alternator and water pump using V-belt.
5. Crankshaft damper pulley absorbs the distorting vibration of crankshaft.



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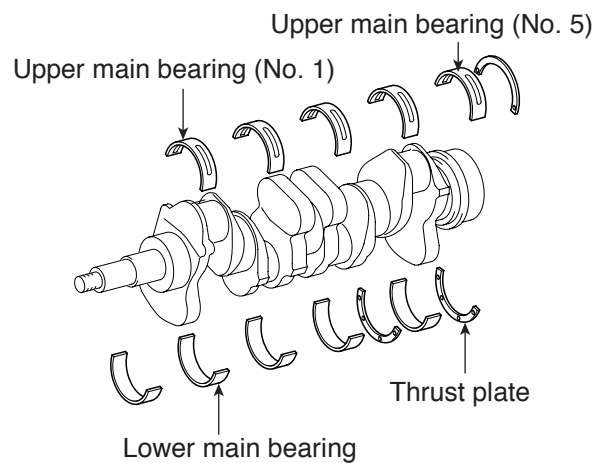
6. Crankshaft gear (1) drives camshaft gear (2), idler gear A (3), idler gear B (4), supply pump gear (5) and oil pump gear (6).



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**CRANKSHAFT MAIN BEARING**

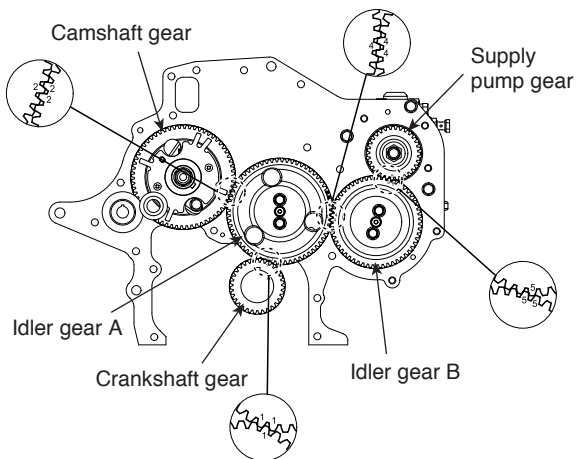
Upper main bearing has oil groove and oil hole which matches with oil hole of the crankshaft. Divided type thrust plate is installed to the both ends of the last bearing (No.5).



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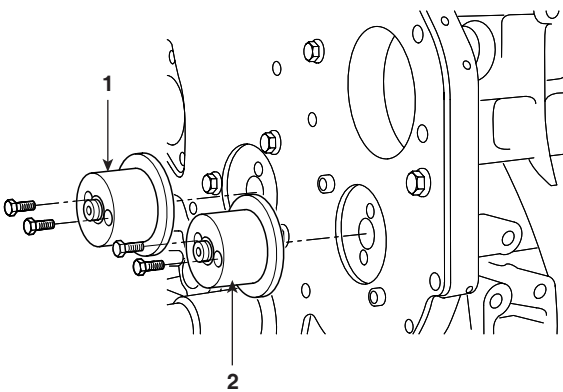
**TIMING GEAR**

1. Timing gear is installed in the timing gear case at the front of engine.
2. Each gear is helical gear manufactured with high precision and its surface is treated by heat to enhance the durability.
3. Timing marks are marked on the gear. When assembling, by aligning the timing marks, gears can be engaged correctly.



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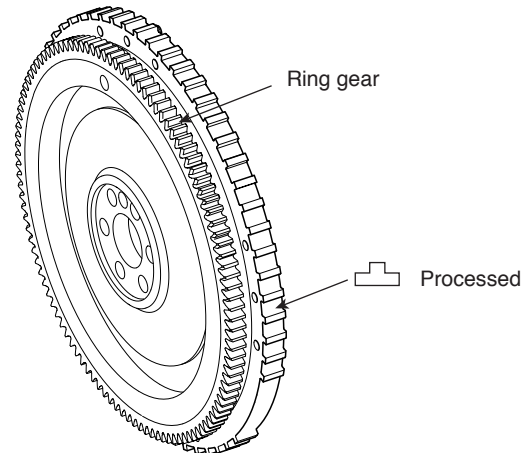
4. Bushes are press-fit into idler gear, which rotates idler shaft A (1) and idler shaft B (2). Idler shaft and gear oil hole provides oil passage to lubricate bush and gear.



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**FLYWHEEL**

1. Flywheel is made of forged iron. Pilot bearing of transmission drive pinion is disposed at the center portion. Ring gear which can be geared with starter pinion is pressed fit at the circumferential of the flywheel.
2. Processed is formed at the outer diameter of the flywheel to measure the engine rpm.



SUDEM7014L

SPECIFICATION ECC41378

Items	Standard ([ ] indicates standard diameter)	Limit	Corrective action
General Type Cylinder inner diameter Cylinder stroke Displacement Compression ratio Firing order Maximum output  Maximum torque  Compression pressure (at 200rpm)	Serial 4-cylinder 4stroke common rail system 104mm 115mm 3,907cc 17.5 : 1 1-3-4-2 140ps/2800rpm (HD65, 72,78 Narrow) 140ps/2800rpm (HD65, 72,78 Wide) 140ps/2800rpm (County) 38kgf.m/1600rpm (HD65, 72,78 Narrow) 38kgf.m/1600rpm (HD65, 72,78 Wide) 38kgf.m/1600rpm (County) 26kg/cm <sup>2</sup>	20kg/cm <sup>2</sup>	Adjustment (As the difference between cylinders is within 4kg/cm <sup>2</sup> )
Valve timing Intake valve open (BTDC) Intake valve close (ABDC) Exhaust valve open(BBDC) Exhaust valve close (ATDC)	19° 53° 60° 16°		
Valve Intake valve length Exhaust valve length Outer diameter of intake valve stem Outer diameter of exhaust valve stem Valve face angle Thickness (margin) of intake/exhaust valve head Valve clearance (when engine is cold)	137mm 137mm 8.960~8.975mm 8.925~8.940mm 45° 1.5mm 0.4mm	8.85mm 8.85mm 1.2mm	
Gap between valve stem and valve guide Intake Exhaust	[9] 0.04~0.06mm [9] 0.07~0.10mm	0.15mm 0.2mm	Replace
Valve guide length Intake Exhaust	64mm 71.5mm		
Valve sinkage Intake Exhaust	0.75~1.25mm 0.75~1.25mm	1.5mm 1.5mm	Valve seat Replace insert
Push rod run out	—	0.4mm	Replace
Valve seat width Intake Exhaust	2.6~3.0mm 1.8~2.2mm	3.6mm 2.8mm	Replace

Items	Standard ([ ] indicates standard diameter)	Limit	Corrective action
Outer side valve Spring Free height Load installed Winding direction Out of squareness Inner side valve spring Free length Load installed Winding direction Out of squareness	66.1mm 26.5~29.3kg To the right 1.5mm 60.0mm 11.5~12.7kg Left side 1.5mm	63mm 23.7kg 2.1mm 57mm 10.3kg 2.1mm	Replace
Cylinder block Cylinder bore Torsion of upper crankcase Flatness of gasket surface Out of squareness of gasket surface Clearance between tappet and crankcase tappet hole	104.00~104.03mm Below 0.07mm 0.07mm 0.05mm [28] 0.045~0.096mm	0.2mm 0.2mm	Replace
Clearance between piston ring and piston ring groove No.1 ring No.2 ring Oil ring	0.106~0.170mm 0.07~0.11mm 0.03~0.07mm	0.2mm 0.15mm 0.15mm	Replace the piston ring
Piston ring end gap No.1 ring No.2 ring Oil ring	0.25~0.40mm 0.50~0.65mm 0.20~0.40mm	1.0mm 1.5mm 1.0mm	Replace
Average protrusion of piston Gasket grade A Gasket grade B Gasket grade C	0.466~0.526mm 0.526~0.588mm 0.588~0.648mm		Measure the average protrusion and replace the gasket with the corresponding grade gasket
Piston Piston outer diameter Clearance between piston and cylinder sleeve	103.91~103.92mm 0.080~0.130mm		Repair with oversize or replace
Piston pin Outer diameter of piston pin Clearance between piston pin and piston pin hole Clearance between piston pin and connecting rod end bush	37.994~38.00mm 0.007~0.021mm [38] 0.025~0.046mm	0.05mm 0.1mm	Replace Replace bush
Cylinder sleeve Inner diameter Out of roundness Out of cylinderness	104.00~104.03mm 0.005mm 0.015mm	100.25mm Below 0.01mm Below 0.03mm	Repair with oversize or replace
Cylinder head Flatness of cylinder head bottom Length from cylinder head top to bottom	Below 0.1mm 94.9~95.1mm	0.2mm 94.6mm	Repair or replace

Items	Standard ([ ] indicates standard diameter)	Limit	Corrective action
Connecting rod Connecting rod twist and distortion Oil clearance Connecting rod bearing Free length of connecting rod bearing Bearing crush (measured load 600kg) Connecting rod endplay	— 0.04~0.099mm — 34.53~34.57mm 0.15~0.45mm	0.05mm 0.2mm Min. 69.5mm — 0.6mm	Repair or replace
Camshaft Intake cam max. length Intake cam min. length Intake cam lift Exhaust cam max. length Exhaust cam min. length Exhaust cam lift Camshaft endplay Clearance between camshaft journal and bushing	47.105mm 39.910mm 7.195mm 46.979mm 39.658mm 7.321mm 0.05~0.22mm Stamp mark #1,2,3,4 ([54.5] 0.04~0.09mm) Stamp mark #5 ([53] 0.04~0.09mm)	0.3mm 0.15mm	Replace busing
Crankshaft Out of roundness of pin and journal Out of cylindricity of pin and journal Crankshaft distortion (measured at journal No.1 and No.5) Crankshaft endplay	Below 0.01mm Below 0.006mm Below 0.02mm 0.10~0.26mm	0.03mm 0.03mm 0.05mm 0.4mm	Replace thrust plate
Crankshaft main bearing Oil clearance (#1, 2, 4, 5) Oil clearance (#3) Free length Bearing crush( measured load 500kgf)	0.036~0.098mm 0.056~0.118mm — 41.061~41.101mm	0.15mm 0.15mm Min 69.5mm —	Replace
Timing gear backlash Crankshaft gear and idler gear A Idler gear A and cam shaft gear Idler gear A and idler gear B Idler gear B and supply pump gear Camshaft gear and power steering pump gear Crankshaft gear and oil pump gear Power steering pump gear and vacuum pump gear	0.062~0.159mm 0.068~0.175mm 0.062~0.160mm 0.073~0.169mm 0.075~0.160mm 0.049~0.169mm 0.075~0.160mm		Repair or replace
Idler gear endplay	0.05~0.22mm	0.3mm	Replace thrust plate
Clearance between idler busing and idler shaft	[45] 0.025~0.06mm	0.1mm	Replace busing
Flywheel Distortion of frictional surface Height of frictional surface Run-out of frictional surface (while installed)	Below 0.05mm 24.5mm Below 0.1mm	0.2mm 23.5mm 0.2mm	Repair or replace



## TIGHTENING TORQUE

Items (diameter × length)		Screw size O.D×pitch (mm)	Nm	kgf.m	lb-ft
Cylinder block	Main bearing cap bolt	M14×2.0	49+90°	5.0+90°	36.4+90°
	Front plate flange bolt(8 ×16)	—	18.6~27.4	1.9~2.8	13.8~20.4
	Rear oil seal slinger flange bolt(6×12)	—	7.8~11.8	0.8~1.2	5.8~8.7
	Supply pump side timing gear case mounting bolt	—	18.6~27.4	1.9~2.8	13.8~20.4
	Supply pump flange bolt	—	16.7~25.5	1.7~2.6	12.4~18.9
	Oil jet check valve	M12×1.25	29.4	3.0	21.8
	Rear plate flange bolt(10×22)	M10×1.5	63.7	6.5	47.3
	Rear stiffener bracket flange bolt(8 ×55)	—	18.6~27.4	1.9~2.8	13.8~20.4
	Rear stiffener bracket flange bolt (10×90)	—	38.2~58.8	3.9~6.0	28.4~43.6
	Engine mounting bracket mounting bolt	—	32.3~49	3.3~5.0	24~36.4
	Crankcase oil line set screw	M10×1.5	24.5	2.5	18.2
Lubrication system	Oil strainer flange bolt(8 ×16)	—	18.6~27.4	1.9~2.8	13.8~20.4
	Oil strainer flange bolt (8 ×40)	—	18.6~27.4	1.9~2.8	13.8~20.4
	Oil pan mounting flange bolt (8×12)	M8×1.2	18.6~27.4	1.9~2.8	13.8~20.4
	Oil level gauge mounting flange bolt(8×16)	—	18.6~27.4	1.9~2.8	13.8~20.4
	Oil pan drain plug	M14×1.5	34.3~39.2	3.5~4.0	25.4~29.1
	Oil filter element	M26×1.5	19.6	2.0	14.5
	Oil cooler by-pass	M16×1.5	19.6	2.0	14.5
	Oil cooler relief valve	M16×1.5	19.6	2.0	14.5
	Oil cooler drain plug	M14×1.5	34.3	3.5	25.4
	Oil cooler mounting flange bolt	—	18.6~27.4	1.9~2.8	13.8~20.4
	Oil line flange bolt	—	7.8~11.8	0.8~1.2	5.8~8.7
	Oil line eyebolt	—	18.6~22.5	1.9~2.3	13.8~16.7
	Idler gear oil supply pipe	—	18.6~22.5	1.9~2.3	13.8~16.7
	Turbo charger oil pipe eyebolt	—	18.6~22.5	1.9~2.3	13.8~16.7
	Turbo charger oil pipe flange bolt(8×16)	—	18.6~27.4	1.9~2.8	13.8~20.4
Oil pump	Oil pump mounting flange bolt(8 ×55)	—	18.6~27.4	1.9~2.8	13.8~20.4
Cylinder head	Cylinder head mounting bolt	M14×2.0	147+90°	15.0+90°	109+90°
	Cylinder head stud (10×25)	—	34.3	3.5	25.4
	Cylinder head stud (10×48)	—	34.3	3.5	25.4

## EM -10

## ENGINE MECHANICAL SYSTEM

Items (diameter × length)		Screw size O.D×pitch (mm)	Nm	kgf.m	lb-ft
Fan and pulley	Fan clutch mounting flange bolt (8)	—	21.6~32.3	2.2~3.3	16~24
	Fan clutch spring washer bolt(8×25)	—	16.7~25.5	1.7~2.6	12.4~18.9
	Fan flange nut (6)	—	3.9~5.9	0.4~0.6	2.9~3.6
Thermostat housing	Thermostat cover case flange bolt	—	21.6~32.3	2.2~3.3	16~24
	Engine coolant temperature sensor and gauge	—	29.4~39.2	3.0~4.0	21.8~29.1
	Thermostat case flange bolt(10×25)	—	35.3~52.9	3.6~5.4	26.2~39.3
Timing system	Timing gear case flange bolt	M8×1.25	18.6~27.4	1.9~2.8	13.8~20.4
	Rocker cover mounting flange bolt	M8×1.25	12.7~15.7	1.3~1.6	9.5~11.6
	Cam plate and thrust plate flange bolt	—	18.6~27.4	1.9~2.8	13.8~20.4
	Cam plate and oil drain plug	—	58.8~78.4	6.0~8.0	43.6~58.2
	Camshaft gear flange bolt	—	18.6~27.4	1.9~2.8	13.8~20.4
	Idler gear A, B mounting bolt	M8×1.25	18.6~27.4	1.9~2.8	13.8~20.4
	Supply pump of flower valve	—	7.8~12.7	0.8~1.3	5.8~9.5
Bleeder system	Blow-by return pipe and blow-by hose Protect clip flange nut	— —	9.8~14.7	1.0~1.5	7.3~10.9
	Oil separate mounting flange bolt	—	18.6~27.4	1.9~2.8	13.8~20.4
	PCV blow-by return coating clip flange bolt	—	7.8~11.8	0.8~1.2	5.8~8.7
	Blow-by return pipe mounting flange bolt	—	35.3~52.9	3.6~5.4	26.2~39.3
Alternator and vacuum pump	Alternator adjust plate mounting bolt(10×20)	—	35.3~52.9	3.6~5.4	26.2~39.3
	Alternator adjust shaft mounting nut (10)	—	18.6~27.4	1.9~2.8	13.8~20.4
	Alternator assembly mounting bolt	M12×134	78.4~107.8	8.0~11	58.2~80
	Vacuum pump pipe tightening bolt	M6×14	3.9~5.9	0.4~0.6	2.9~3.6
	Vacuum pump mounting flange bolt	M8×16	18.6~27.4	1.9~2.8	13.8~20.4
Piston and connecting rod	Connecting rod and connecting rod bearing cap mounting bolt	M12.5×1.25	29.4+90°	3.0+90°	21.8+90°
Flywheel and damper pulley	Flywheel mounting bolt	M14×1.5	39.2+40°	4.0+40°	29.1+40°
	Crankshaft damper pulley mounting nut	M24×1.5	588	60	436
Starter motor	Mounting flange bolt (12×25)	—	78.4~107.8	8.0~11.0	58.2~80
	Mounting flange bolt (12×55)	—	37.2~53.9	3.8~5.5	27.6~40
	Mounting flange bolt (12)	—	37.2~53.9	3.8~5.5	27.6~40
Glow plug	Glow plug harness flange nut	—	3.9~5.9	0.4~0.6	2.9~3.6
	Plain washer nut	—	1~1.5	0.1~0.15	0.7~1.1