Introduction

Thank you for always supporting us. This manual provides maintenance instructions for accurate and effective maintenance performance of industrial WC30D ENGINE that we, HYUNDAI WIA, are manufacturing and selling.

This manual contains detailed information technical data, trouble-shooting, removal and installation, disassembly and assembly, and parts descriptions, according to each function.
Therefore, personnel shall be thoroughly familiar with the contents of this manual to ensure prolonged service life and high profitability of engine through immediate purchase of desired parts for proper maintenance in a timely manner.

Failure to comply with proper instructions may result in shortening engine life time by degradation. It is highly recommended to use 'Genuine Hyundai Parts' as replacements which manufactured by regulated specifications and passed quality tests to maintain specifying engine function. Any failure or quality problem resulted from non-genuine parts, or repair by non-designated maintenance or service center is not covered as the warranty repair.

We are willing to be close to customers through manufacturing high quality engines as well as developing parts and valuable technical information. We hope this manual to be valuable information to your asset. Thank you again for using our engines.

SEPTEMPBER 2014
HYUNDAI WIA

It is necessary to comply with appropriate methods and accurate procedures for maintenance to ensure personnel safety and proper engine performance. This manual also provides general instructions for effective maintenance methods and procedures.

There are various subjects concerning engine system such as operator's technique as well as instructions, method tools, and parts. It is not available to predict every circumstance or provide advice, warning for each of them. Therefore, attention shall be paid to avoid personnel damage or engine malfunction caused by instructions, methods, and parts which do not comply with instructions in this manual.

[NOTE, CAUTION and WARNING]

NOTE: Indicates additional information for specific procedures.
CAUTION: Indicates a hazardous situation that, if not obeyed, could result in injury to personnel or damage to engine.
WARNING: Indicates a hazardous situation that, if not obeyed, could result in death or serious injury

[Safety Precautions]

The followings provide general warnings that shall be complied with during maintenance performance.

- Wear protective goggles to protect eyes.
- Keep ignition switch in OFF position unless otherwise specified in procedure.
- Operate engine only in a well ventilated area to avoid carbon monoxide inhalation.
- Keep personnel and clothes away from parts during engine operating. Extra care shall be taken for drive belt.
- Do not touch hot metal parts such as radiator, exhaust manifold, tailpipe, catalytic converter, muffler to avoid serious burns.
- Do not smoke during maintenance performance.
- Remove rings, watches and jewelry before performing maintenance and avoid any clothing interrupting task.
- Do not contact hands or any objects with radiator fan during the task. Fan can be operated even if the ignition switch is in OFF position. Disconnect radiator fan motor connector.

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1. Description

1) Engine

The engine includes cast iron cylinder head and swirl type of combustion chamber.

The intake and exhaust valves located as OHV (Over Head Valve) type are operated by the push rod and rocker arm.

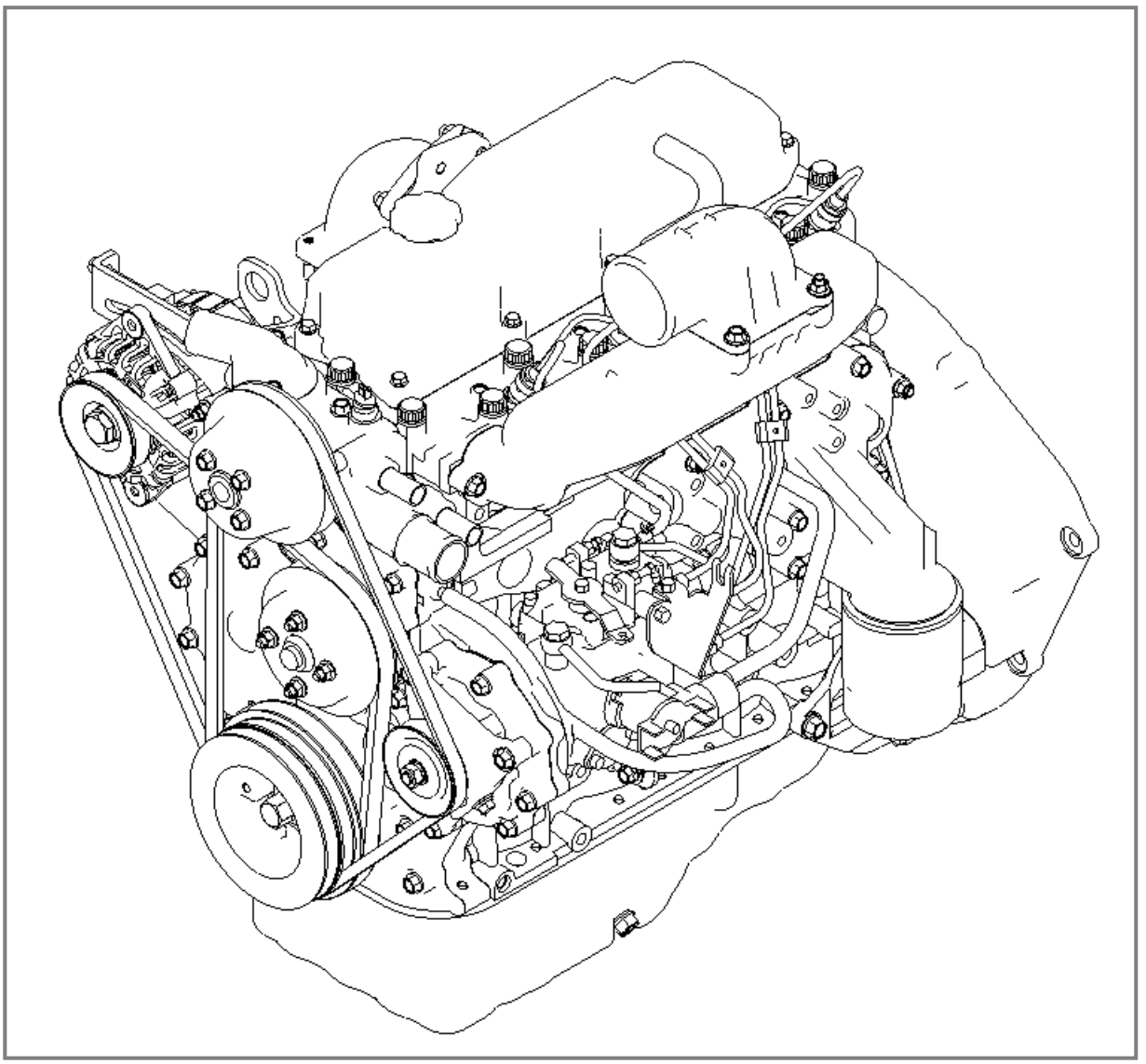
One inlet valve and one exhaust valve are installed to each cylinder.

The cylinder block is also made of cast iron and dry cylinder liner is press fitted into cylinder.

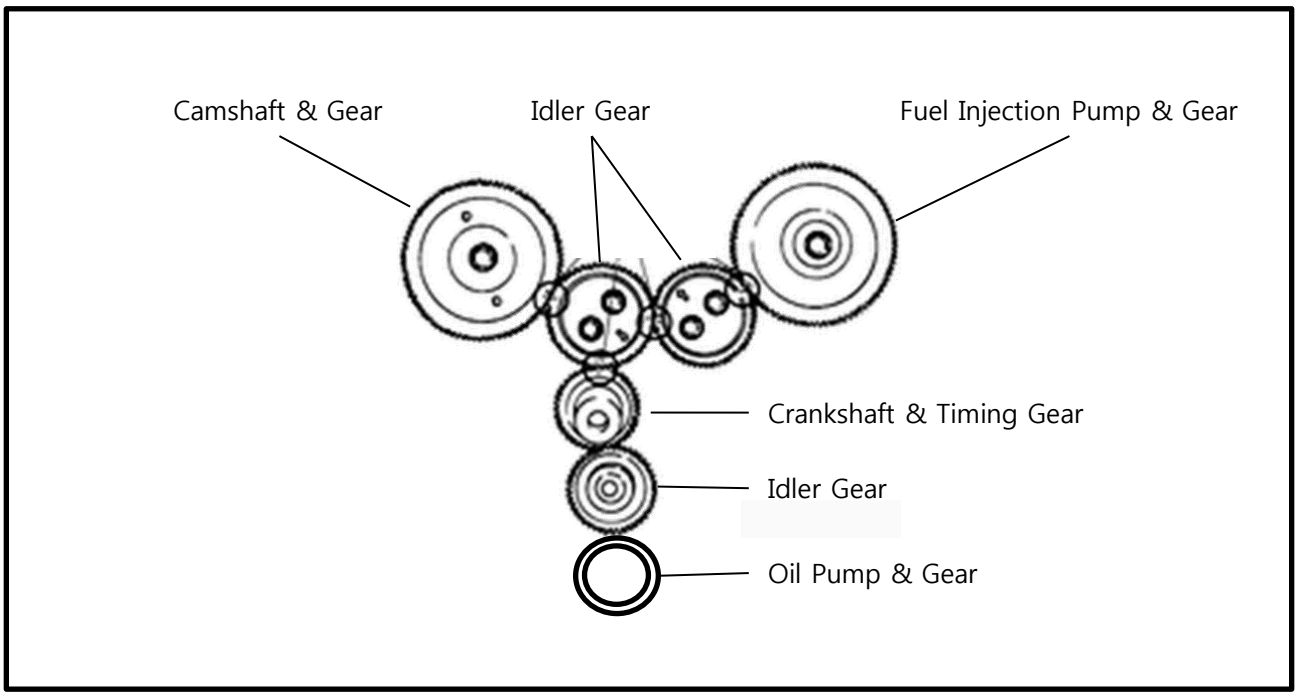
Water jacket is designed as siamese type, and special aluminum alloy of piston is engaged with connecting rod by full-floating piston pin.

The oil jet is installed at the lower of cylinder liner for piston cooling.

Engine Exterior View



Timing Gear



Camshaft, fuel injection pump and oil pump are operated by timing gear movement.

The crankshaft is made of forged steel and supported by five main bearings. Damper pulley with torsional damper mounted, is installed in front of the shaft.

The mechanical governor type of fuel injection pump is precisely tuned according to engine purpose.

The engine is primarily equipped with a CSD (Cold Start Device) to facilitate engine start during winter season and cold weather.

2) Lubrication System

Lubrication is made by oil pump with forced lubrication method. The pump forces oil to be delivered to each engine unit via oil cooler and oil filter. The maximum oil pressure is regulated by depressurization valve.

Lubrication System Specifications

Reference		WC30D Engine
Lubrication System		Force-fed by Gear Pump
Total Lubrication Oil Flow		7.4 ℓ (7.8 US qt, 6.5 lmp qt)
Oil Quantity in Oil Pan (F Position)		5.8 ℓ (6.1 US qt, 5.1 lmp qt)
Force-fed Pressure		3.6-4.4 kg/㎠ 3000rpm (353~432㎪, 51~63psi)
Oil Pump Type		Trochoid Type
Oil Filter Body	Regulating Valve Opening Pressure	4.0 kg/㎠ (392㎪, 57psi)
	Oil Filter Relief Valve Opening Pressure	1.0 kg/㎠ (98㎪, 14psi)
	Oil Cooler Relief Valve Opening Pressure	1.3 kg/㎠ (128㎪, 18psi)
Oil Filter Type		Full-flow, Paper element
Oil Cooler Type		Liquid-cooled Multi-plate (Built-in)
Oil Pressure for Warning Lamp Lighting		0.3 kg/㎠ (29㎪, 4.3psi)
Lubrication Oil Type		API CF-4 or Higher ACEA B2 or B3 SAE, 5W-30 (-25℃-40℃, -13℉~104℉) SAE, 10W-30 (-20℃-40℃, -4℉~104℉) SAE, 15W-40 (-15℃~, 5℉~) SAE, 20W-40 (-10℃~, 14℉~) SAE, #30 (0℃~, 32℉~)

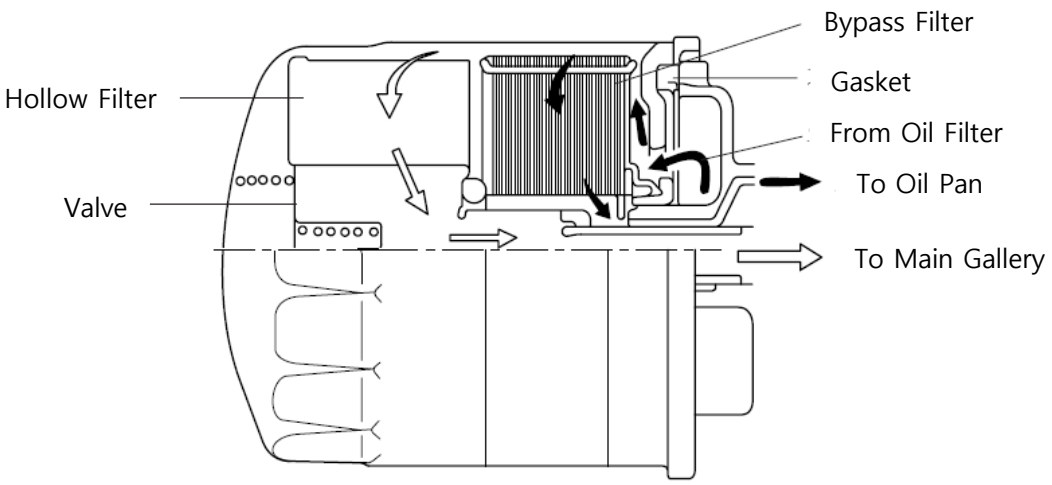
CAUTION

For the best engine performance and maximum effect, all lubrication oils shall:

1. *Satisfy requirements for API service categories.*
2. *Acquire proper SAE grade for ambient temperature. Do not use any lubrication oil that does not have the SAE grade and API service categories on its container.*

Description

The oil filter, combine type, has hollow filter and bypass filter. The bypass filter is designed to filter soot (smoke) mixed in engine oil through a fine-meshed net. When oil enters the oil filter, the oil filtered through hollow filter is sent to main gallery while the oil filtered through bypass filter is routed to oil pan.



3) Cooling System

The engine is cooled by coolant forcibly circulated by water pump. Wax type thermostat is used to regulate coolant circulation.

Cooling System Specifications

Reference		**WC30D Engine**
Thermostat	Type	Wax Type
	Initial Opening Temperature	80.5~83.5 ℃ (176.9~182.3℉)
	Full-open Temperature	95 ℃ (203℉)
	Full-open Lift	8.5㎜ or More
Coolant Capacity	Engine Only	Approx. 4.5ℓ

4) Electronic System

Altornator

The charging system included a battery, an alternator with a built-in regulator, and the charging indicator light and wire.

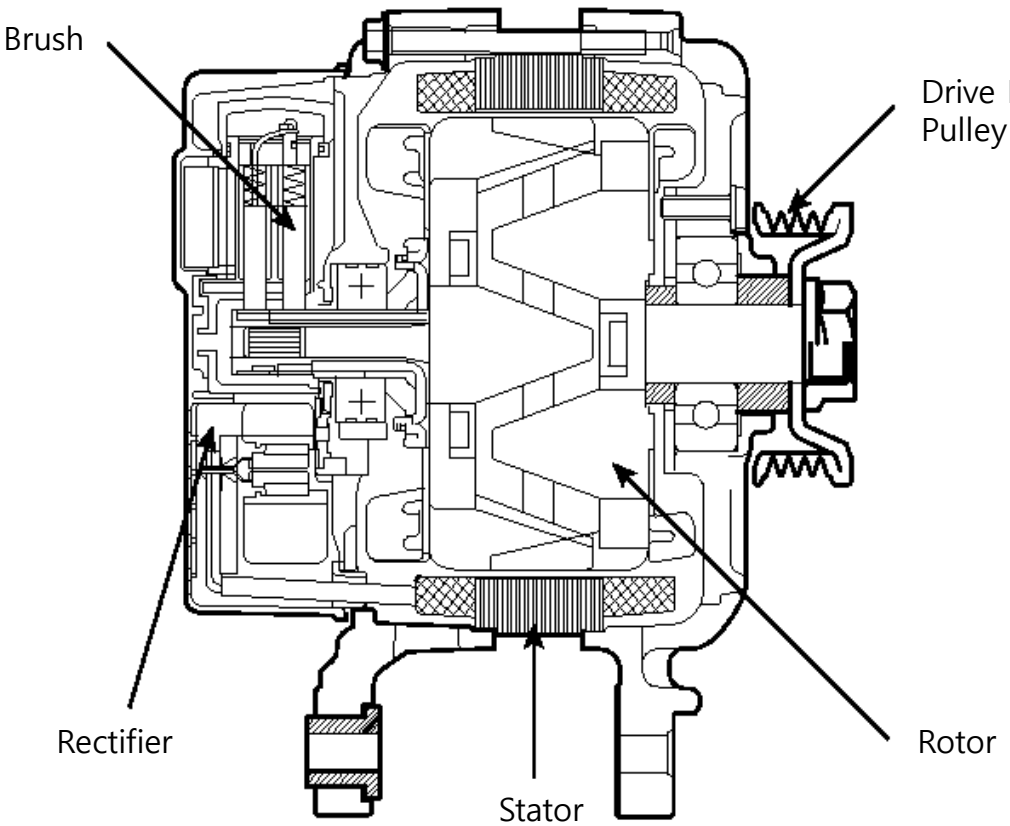
The Alternator has eight built-in diodes, each rectifying AC current to DC current.

Therefore, DC current appears at alternator "B" terminal.

In addition, the charging voltage of this alternator is regulated by the internal voltage of alternator.

The main components of the alternator

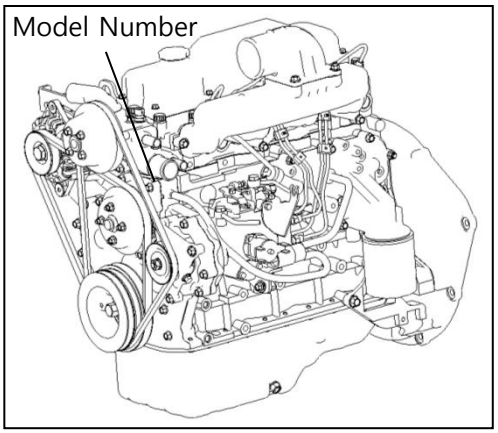
are the rotor, stator, rectifier, brushes, bearings and V-ribbed belt pulley. The brush holder contains a built-in electronic voltage regulator.



2. Engine Model Number

1) Location of Engine Number

The engine model number is engraved on the marked area (Refer to Figure on the right).



2) Description of Engine Model Number

WC30D - * * * * * *

Serial Number

Engine Type

3. Table - Tightening Torque for Standard Bolts and Nuts

Item	Tightening Torque
Gusset Plate Bolt	4.7-5.7 kgf·m (46.1~55.9 N·m, 34~41.2 lbf·ft)
Glow Plug	1.5-2.0 kgf·m (14.7~19.6 N·m, 10.8~14.5 lbf·ft)
Glow Plug Cord Nut	0.08-0.15 kgf·m (0.8~1.5 N·m, 0.6~1.1 lbf·ft)
Damper Pulley Bolt	39-41 kgf·m (382.5~402.1 N·m, 282~296.6 lbf·ft)
Rear Oil Seal Bolt	1.0-1.2 kgf·m (9.8~11.8 N·m, 7.2~8.7 lbf·ft)
Main Bearing Cap Bolt	8 kgf·m (78.5 N·m, 57.9 lbf·ft) → Loosen → 4.5 kgf·m (44.1 N·m, 32.5 lbf·ft) → 90˚
Exhaust Manifold Nut	2.0-2.6 kgf·m (19.6~25.5 N·m, 14.5~18.8 lbf·ft)
Exhaust Elbow Nut	2.2-3.2 kgf·m (21.6~31.4 N·m, 16~23.1 lbf·ft)
Valve Clearance Adjusting Nut	1.9-2.6 kgf·m (18.6~25.5 N·m, 13.7~18.8 lbf·ft)
Starter Bolt	4.0~5.0 kgf·m (39.2~49 N·m, 28.9~36.2 lbf·ft)
Cylinder Head Bolt (Long)	6 kgf·m (58.8 N·m, 43.4 lbf·ft) → 90˚ → 90˚
Cylinder Head Bolt (Short)	6 kgf·m (58.8 N·m, 43.4 lbf·ft) → 90˚ → 90˚
Cylinder Head Cover Bolt	1.0-1.2 kgf·m (9.8~11.8 N·m, 7.2~8.7 lbf·ft)
Thermostat Case Bolt	1.8-2.8 kgf·m (17.7~27.5 N·m, 13~20.3 lbf·ft)
Idle Gear Bolt	1.9-2.6 kgf·m (18.6~25.5 N·m, 13.7~18.8 lbf·ft)
Idler Pulley Lock Nut	4.0~5.0 kgf·m (39.2~49 N·m, 28.9~36.2 lbf·ft)
Idler Pulley Bracket Bolt	1.8-2.8 kgf·m (17.7~27.5 N·m, 13~20.3 lbf·ft)
Alternator Bracket Bolt	4.2-4.8 kgf·m (41.2~47.1 N·m, 30.4~34.7 lbf·ft)
Alternator Brace Bolt	4.0~5.0 kgf·m (39.2~49 N·m, 28.9~36.2 lbf·ft)
Alternator Bolt (Upper)	2.0-2.6 kgf·m (19.6~25.5 N·m, 14.5~18.8 lbf·ft)
Alternator Bolt & Nut (Lower)	2.0-2.6 kgf·m (19.6~25.5 N·m, 14.5~18.8 lbf·ft)
Engine Hanger Bolt	3.8-5.3 kgf·m (37.3~52 N·m, 27.5~38.3 lbf·ft)
Fuel Injection Nozzle	6.0-7.0 kgf·m (58.8~68.6 N·m, 43.4~50.6 lbf·ft)
Fuel Injection Pipe	2.65-3.35 kgf·m (26~32.9 N·m, 19.2~24.2 lbf·ft)
Fuel Injection Pipe Clip Bolt & Nut	0.25-0.35 kgf·m (2.5~3.4 N·m, 1.8~2.5 lbf·ft)

Item	Tightening Torque
Fuel Injection Pump Nut	1.9-2.7 kgf·m (18.6~26.5 N·m, 13.7~19.5 lbf·ft)
Fuel Injection Pump Bracket Bolt	3.8-5.3 kgf·m (37.3~52 N·m, 27.5~38.3 lbf·ft)
Fuel Injection Pump Timing Gear Nut	6.0-7.0 kgf·m (58.8~68.6 N·m, 43.4~50.6 lbf·ft)
Oil Strainer Bolt	1.9-2.6 kgf·m (18.6~25.5 N·m, 13.7~18.8 lbf·ft)
Oil Jet Bolt	1.3-1.8 kgf·m (12.7~17.7 N·m, 9.4~13 lbf·ft)
Oil Cooler Bolt	1.8-2.7 kgf·m (17.7~26.5 N·m, 13~19.5 lbf·ft)
Oil Pan Bolt	1.8-2.8 kgf·m (17.7~27.5 N·m, 13~20.3 lbf·ft)
Oil Pump Bolt (M10)	3.8-5.3 kgf·m (37.3~52 N·m, 27.5~38.3 lbf·ft)
Oil Pump Bolt (M8)	1.9-2.6 kgf·m (18.6~25.5 N·m, 13.7~18.8 lbf·ft)
Water Pump Bolt	1.8-2.8 kgf·m (17.7~27.5 N·m, 13~20.3 lbf·ft)
Water Pump Pulley Bolt	1.8-2.8 kgf·m (17.7~27.5 N·m, 13~20.3 lbf·ft)
Camshaft Gear Bolt	7.6-10.7 kgf·m (74.5~105 N·m, 55~77.4 lbf·ft)
Con Rod Cap Nut	7 kgf·m (68.6 N·m, 50.6 lbf·ft) → Loosen → 3 kgf·m (29.4 N·m, 21.7 lbf·ft) → 90˚
Timing Gear Cover Bolt	1.9-2.6 kgf·m (18.6~25.5 N·m, 13.7~18.8 lbf·ft)
Timing Gear Case Bolt	1.9-2.6 kgf·m (18.6~25.5 N·m, 13.7~18.8 lbf·ft)
Fan Pulley Bolt	1.8-2.8 kgf·m (17.7~27.5 N·m, 13~20.3 lbf·ft)
Fan Pulley Bracket Bolt	1.8-2.8 kgf·m (17.7~27.5 N·m, 13~20.3 lbf·ft)
Flywheel Bolt	16.3-17.3 kgf·m (160~170 N·m, 117.9~125.1 lbf·ft)
Flywheel Housing	8.5-9.5 kgf·m (83.4~93.2 N·m, 61.5~68.7 lbf·ft)
Intake Manifold Bolt & Nut	2.0-2.6 kgf·m (19.6~25.5 N·m, 14.5~18.8 lbf·ft)
Intake Elbow Bolt & Nut	1.9-2.4 kgf·m (18.6~23.5 N·m, 13.7~17.4 lbf·ft)

4. Technical Data

Item	Reference			WC30D Engine
General Data	Type			4-Cycle Diesel Engine
	Number of Cylinders and Arrangement			In-line 4-Cylinder Longitudinal
	Combustion Chamber Type			Swirl Chamber Type
	Total Displacement			2,957 cc (3.12 US qt)
	Cylinder Bore X Stroke (㎜)			98 X 98 ㎜ (3.8583 X 3.8583 in)
	Compression Ratio			21.5
	Compression Pressure			30 kg/㎠, 200 rpm (2,942 ㎪, 426.7 psi)
	Valve Opening/ Closing Time	Intake	Open	BTDC 19˚
			Close	ABDC 47˚
		Exhaust	Open	BBDC 52˚
			Close	ATDC 14˚
	Valve Clearance	Intake (Cold)		0.30 ㎜ (0.012 in)
		Exhaust (Cold)		0.38 ㎜ (0.015 in)
	Idle Speed			760~810 rpm
	Injection Timing			ATDC 7˚
	Injection Order			1-3-4-2
Cylinder Head	Distortion of Head Surface (mm)	Longitudinal		0.25 ㎜ (0.010 in)
		Lateral		0.10 ㎜ (0.004 in)
	Distortion of Side Surface			0.15 ㎜ (0.006 in)
	Cylinder Head Bolt Length	Short Bolt	Standard	121.7-122.3 ㎜ (4.79~4.81 in)
			Limit	123.0 ㎜ (4.84 in)

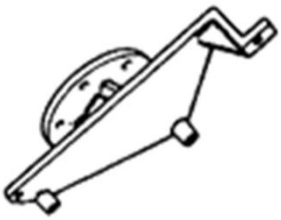
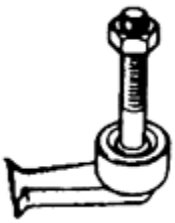
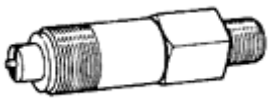
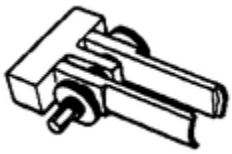
Item	Reference			WC30D Engine
Cylinder Head	Cylinder Head Bolt Length	Long Bolt	Standard	156.7-157.3 ㎜ (6.17~6.19 in)
			Limit	158.0 ㎜ (6.22 in)
Valve	Valve Thickness (margin)	Intake		1.5 ㎜ (0.06 in)
		Exhaust		1.5 ㎜ (0.06 in)
	Valve Stem Diameter	Intake	Standard	8.466-8.491 ㎜ (0.3333~0.3343 in)
			Limit	8.395 ㎜ (0.3305 in)
		Exhaust	Standard	8.440-8.491 ㎜ (0.3323~0.3342 in)
			Limit	8.396 ㎜ (0.3305 in)
	Valve Guide Inside Diameter			8.518-8.540 ㎜ (0.3354~0.3362 in)
	Oil Clearance	Intake		0.027-0.074 ㎜ (0.0011~0.0029 in)
		Exhaust		0.055-0.100 ㎜ (0.0022~0.0039 in)
		Limit		0.116 ㎜ (0.0046 in)
	Valve Seat Angle	Intake		45˚
		Exhaust		45˚
	Slope Width	Intake		1.7 ㎜ (0.067 in)
		Exhaust		1.98 ㎜ (0.078 in)
	Valve Seat Sinking	Standard	Intake	1.05-1.25 ㎜ (0.041~0.049 in)
			Exhaust	0.90-1.10 ㎜ (0.035~0.043 in)
		Limit	Intake	2.50 ㎜ (0.098 in)
			Exhaust	2.50 ㎜ (0.098 in)

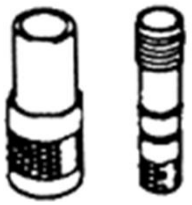
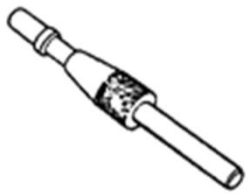
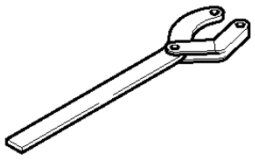
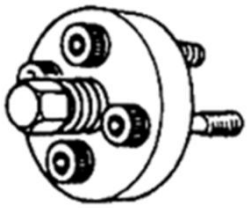
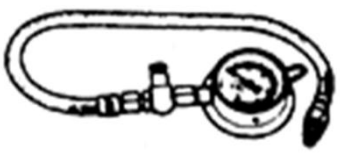
Item	Reference		WC30D Engine
Valve	Valve Spring Free Length	Standard	49.5 ㎜ (1.949 in)
		Limit	48.5 ㎜ (1.909 in)
	Valve Spring Squareness	Limit	1.63 ㎜ (0.064 in)
Rocker Arm and Rocker Arm Shaft	Rocker Arm Inner Diameter		19.000-19.021 ㎜ (0.748~0.749 in)
	Rocker Arm Shaft Outer Diameter		18.959-18.980 ㎜ (0.746~0.747 in)
	Oil Clearance	Standard	0.020-0.062 ㎜ (0.0008~0.0024 in)
		Limit	0.07 ㎜ (0.003 in)
Push Rod	Deflection		0.4 ㎜ (0.016 in)
Cylinder Block	Distortion	Longitudinal	0.25 ㎜ (0.0098 in)
		Lateral	0.10 ㎜ (0.0039 in)
	Cylinder Bore Inner Diameter	FR-RR	101.500-101.513 ㎜ (3.9961~3.9966 in)
		RH-LH	101.513-101.526 ㎜ (3.9966~3.9971 in)
	Cylinder Liner Outer Diameter	FR-RR	101.480-101.493 ㎜ (3.9953~3.9958 in)
		RH-LH	101.493-101.506 ㎜ (3.9958~3.6693 in)
Piston and Piston Pin	Piston Outer Diameter		97.942-97.968 ㎜ (3.856~3.857 in)
	Piston Clearance		0.045-0.071 ㎜ (0.0018~0.0028 in)

Item		Reference		WC30D Engine
Piston and Piston Pin		Ring Groove Clearance	Top Ring	0.06-0.10 ㎜ (0.0024~0.0039 in)
			Second Ring	0.04-0.08 ㎜ (0.0016~0.0032 in)
			Oil Ring	0.03-0.07 ㎜ (0.0012~0.0028 in)
			Limit	0.30 ㎜ (0.012 in)
		Piston Ring End Gap	Top Ring	0.26-0.36 ㎜ (0.0102~0.0142 in)
			Second Ring	0.30-0.50 ㎜ (0.0118~0.0197 in)
			Oil Ring	0.20-0.40 ㎜ (0.0079~0.0157 in)
			Limit	1.50 ㎜ (0.06 in)
		Piston Pin Out Diameter		29.994-30.000 ㎜ (1.1809~1.1811 in)
Connecting Rod		Bush Inner Diameter		30.012-30.033 ㎜ (1.1816~1.1824 in)
		Oil Clearance	Standard	0.012-0.039 ㎜ (0.0005~0.0015 in)
			Limit	0.05 ㎜ (0.002 in)
		Allowable twist		0.05 ㎜ (0.002 in) per 100 ㎜ (3.937 in)
Camshaft	Run-out			0.08 ㎜ (0.0031 in)
	Cam Height	Standard	Intake	44.116 ㎜ (1.7369 in)
			Exhaust	44.116 ㎜ (1.7369 in)
		Limit	Intake	43.616 ㎜ (1.7172 in)
			Exhaust	43.616 ㎜ (1.7172 in)

Item	Item		WC30D Engine
Camshaft	Journal Diameter (Wear Limit)	No. 1	51.910-51.940 ㎜ (2.0437~2.0449 in)
		No. 2	51.660-51.690 ㎜ (2.0339~2.0350 in)
		No. 3	51.410-51.440 ㎜ (2.0240~2.0252 in)
		No. 4	51.160-51.190 ㎜ (2.0142~2.0154 in)
		Limit	0.08 ㎜ (0.003 in)
	Camshaft Bearing Inner Diameter	No. 1	52.000-52.030 ㎜ (2.0472~2.0484 in)
		No. 2	51.750-51.780 ㎜ (2.0374~2.0386 in)
		No. 4	51.500-51.530 ㎜ (2.0276~2.0287 in)
		No. 5	51.250-51.280 ㎜ (2.0177~2.0120 in)
	Oil Clearance	Standard	0.06-0.12 ㎜ (0.0024~0.0047 in)
	End Play (Axial play)	Camshaft	0.02-0.18 ㎜ (0.0008~0.0070 in)
		Idle Gear	0.05-0.18 ㎜ (0.0020~0.0070 in)
		Crankshaft Pulley	0.14-0.30 ㎜ (0.0055~0.0118 in)
		Injection Pump Gear	0.15-0.55 ㎜ (0.0059~0.0217 in)

5. Special Tools

Tool No. & Name	Illustration	Application
0K130 160 007 Engine Stand		To disassemble and assemble engine
0K410 101 004 Engine Stand Hanger		To mount engine to engine stand
0K590 111 001 Ring Gear Brake		To prevent engine revolution
0K71E 131 001 Compression Gauge Adaptor		To measure compression pressure
0K993 120 001 Valve Spring Lifter Arm		To remove and install valve
0K993 120 004 Valve Spring Lifter Pivot		To remove and install valve

Tool No. & Name	Illustration	Application
0K710 120 004 Valve Seal Installer		To install valve seal
0K130 160 010 Clutch Disc Centering Tool		To install clutch disc
0K130 111 004 Coupling Flange Holder		To remove camshaft gear
0K670 131 005 Extractor		To remove injection pump gear
0K670 131 010 Cam Lift Measuring Device		To measure cam lift
0K993 120 006 Valve Seal Remover		To remove valve seal
0K670 140 015 Oil Pressure Gauge		To check oil pressure

Symbols

Symbol	Meaning	Type
	Apply oil	Applicable engine oil
	Apply grease	Applicable grease
	Apply sealant	Applicable sealant

6. Troubleshooting

1) Troubleshooting Chart

Symptom	Possible Cause	Corrective Action
Lack of Power	Low Compressed Pressure • Improper valve clearance • Compressed pressure leaks from valve seat • Seized valve stem • Weak and broken valve spring • Broken cylinder head gasket • Cracked and distorted cylinder head • Stuck or broken, worn piston ring • Cracked and worn piston	 • Adjust • Repair • Replace • Replace • Replace • Replace • Replace • Replace
	Fuel system malfunctioning Intake and exhaust system malfunctioning	Refer to fuel system Refer to intake and exhaust system
Excessive Engine Oil Consumption	• Worn or stuck piston ring or piston ring groove • Worn piston and cylinder • Faulty valve seal • Worn valve stem and guide	• Replace • Replace or repair • Replace
	Oil leaks	Refer to Lubrication System
Abnormal Start	Defective Engine Body • Worn piston, piston ring and cylinder • Broken, distorted cylinder head	 • Replace • Replace
	Defective Fuel System Defective Electronic System	Refer to fuel system Refer to starter system
Abnormal Combustion	Defective Engine Body • Improper valve clearance • Stuck or weak valve • Weak and broken valve spring • Carbon built in combustion chamber • Improper nozzle injection	 • Adjust • Replace •Replace • Remove • Replace
	Defective Fuel System	Refer to fuel system

Symptom	Possible Cause	Corrective Action
Engine Noise	Defective Crankshaft and Bearing	
	• Excessive oil clearance of main bearing	• Replace or repair
	• Seized or melt out main bearing	• Replace
	• Excessive axial end play of crankshaft	• Replace or repair
	• Excessive oil clearance of connecting rod	• Replace or repair
	• Seized or melt out connecting rod bearing	• Replace
	• Worn or seized connecting rod bush	• Replace
	Defective Piston	
	• Worn cylinder	• Replace
	• Worn piston or piston pin	• Replace
	• Seized piston	• Replace
	• Stuck and broken piston ring	• Replace
	• Bent connecting rod	• Replace
	Defective Valve and Timing	
	• Excessive valve clearance	• Adjust
	• Broken valve spring	• Replace
	• Excessive clearance of valve stem and guide	• Replace
	Other Troubles	
	• Faulty water pump bearing	• Replace
	• Improper fan belt tension	• Adjust
	• Faulty alternator bearing	• Replace
	• Faulty cooling fan pulley hub bearing	• Replace
	• Exhaust gas leaks	• Repair
	• Gas leaks from nozzle holder assembly	• Repair

2) Lubrication System Troubleshooting

Symptom	Possible Cause	Corrective Action
Engine Hard to Start	Improper type of engine oil Low engine oil level	Replace Add oil
Excessive Oil Consumption	Oil flowed up or down to combustion chamber Oil leaks	Inspect piston and piston ring Repair
Oil Pressure Drop	Low oil level Oil leaks Worn, broken oil pump gear or rotor Worn plunger (in oil pump) or faulty spring Clogged oil strainer Excessive main bearing or connecting rod clearance	Add oil Repair Replace Replace Clean Replace bearing
Warning Light On during Engine Operation	Dropped oil pressure Malfunction of oil pressure switch Malfunction of electrical device	Refer to Oil Pressure Drop above Replace Repair

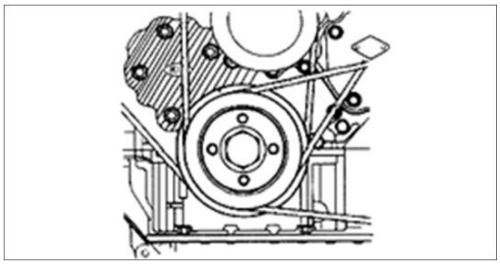
3) Cooling System Troubleshooting

Symptom	Possible Cause	Corrective Action
Leaks	Damaged radiator core	Replace
	Leaks from radiator hose and heater hose	Repair or Replace
	Leaks from cooling water temperature switch	Repair or Replace
	Faulty water seal (water pump)	Replace
	Loose or damaged thermostat cover, gasket	Repair or Replace
	Loose cylinder head bolts	Secondary tightening
	Loose or damaged cylinder head gasket	Replace
	Cracked cylinder block	Replace
	Cracked cylinder head	Replace
Corrosion	Impurities or scales included in coolant	Clean
Overheats	Clogged water jacket (water passage)	Clean
	Malfunction of thermostat	Replace
	Clogged radiator plate	Repair or Replace
	Malfunction of water pump	Replace
	Insufficient coolant	Add coolant

7. General Checks

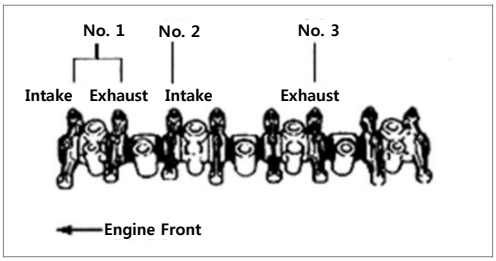
Valve Clearance

1. Remove cylinder head cover.
2. Rotate crankshaft to move piston No. 1 to Top Dead Center (TDC) position.



3. Check and adjust valve clearance.

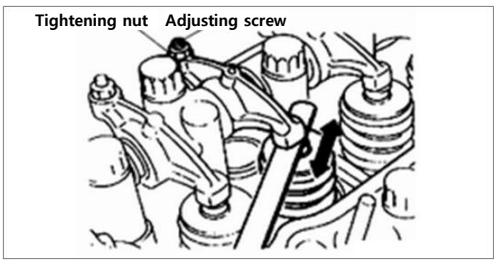
	Reference	Standard Value (Cold)
Intake	No. 1 & 2	0.30 ㎜ (0.012 in)
Exhaust	No. 1 & 3	0.38 ㎜ (0.015 in)



4. Loosen tightening torque and rotate adjusting screw to adjust valve clearance.

   Tightening Torque : 1.2-1.8 kgf·m

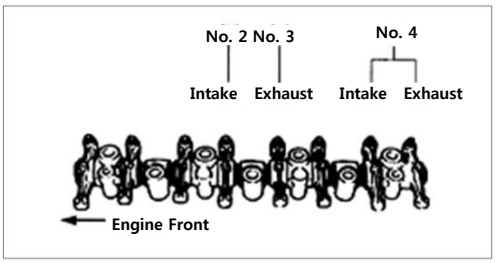
   (11.8~17.7 N·m, 8.7~13 lbf·ft)



5. Rotate crankshaft a turn and check another valve.

   Intake : No. 3 & 4

   Exhaust : No. 2 & 4



Idle Speed

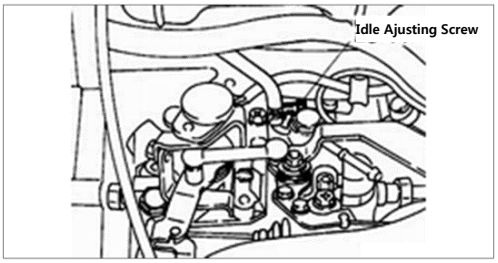
Preparation

1. Warm up engine to operating temperature.
   Coolant Temperature: 60 ℃

2. Run engine at idle.
   (1) Shift transmission to neutral position.
   (2) Set steering to neutral position.
   (3) Turn the ignition switch off.

3. Check accelerator cable for deflection.
   Deflection: 1-3 ㎜ (0.034~0.118 in)

Check and Adjustment



1. Measure idling rpm using revolution counter (tachometer).
   Idle Speed : 760~810 rpm

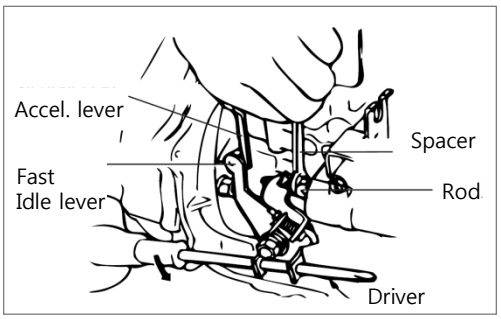
2. If it exceeds the specification, loosen tightening nut and rotate idle adjusting screw for adjustment
   Tightening Torque: 0.5-0.9 kgf·m
   (4.9~8.8 N·m, 3.6~6.5 lbf·ft)

CAUTION

Use idle adjusting screw to adjust idle speed.

Checking Before Adjusting Injection Timing

1. Release the function of Cold Start Device (CSD). Insert screwdriver into holes at the bottom of lever, turn it in the direction as shown in the figure.



CAUTION

Do not turn lever more than necessary.

2. Insert spacer (8~10 ㎜ (0.315~0.394 in) thick) between rod and adjustment screw..

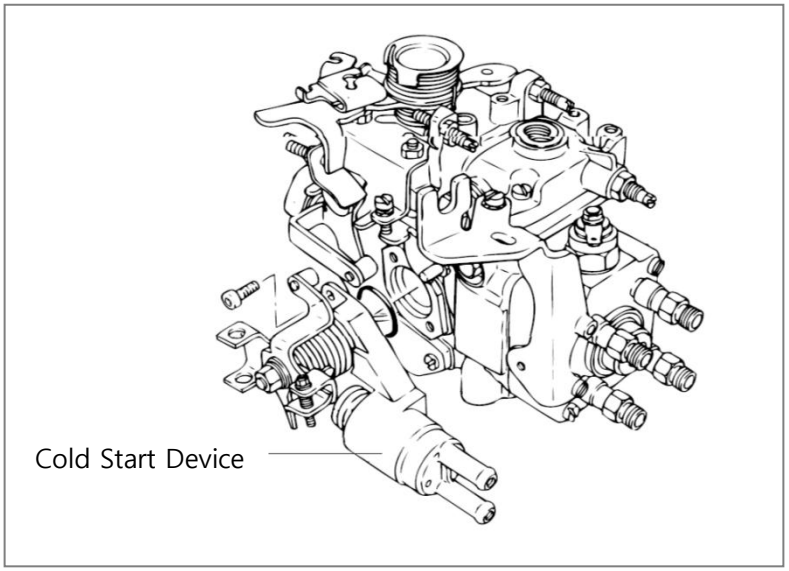
3. Pull out screwdriver.

CAUTION

In case of check and adjustment for the purpose of replacing injection pump in the cold, failure to release the timing function will cause insufficient power.

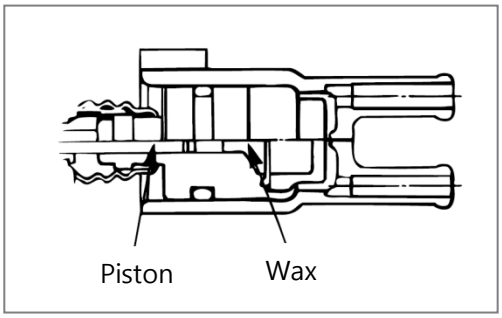
Wax Type Cold Start Device

Engine staring is not ensured at low temperatures. The wax type cold start device is provided to ensure proper fuel injection timing at engine start depending on the temperature of coolant.

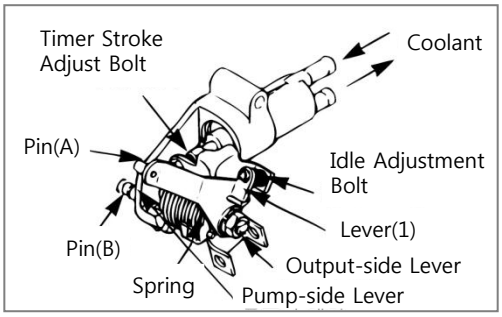


Structure

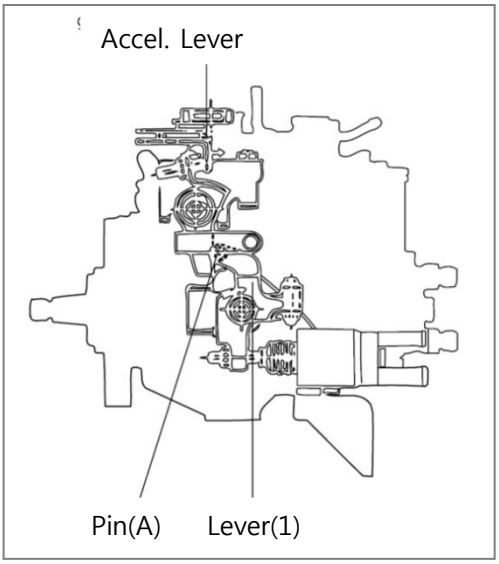
1. With wax inside cold start device, piston rod works depending on the temperature of engine coolant.



2. Piston turns lever shaft and pin(B) runs roller puller to retard or advance the injection timing. Torsion spring pushes piston in the direction of advance the injection timing.



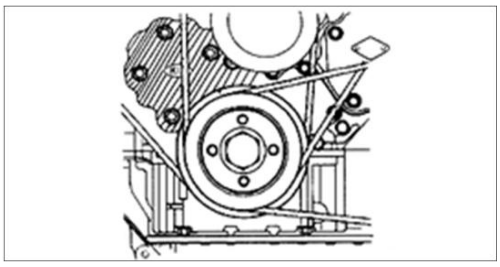
3. The rod, connected to accelerator lever, adjusts also the engine idle speed depending on the temperature of engine coolant.



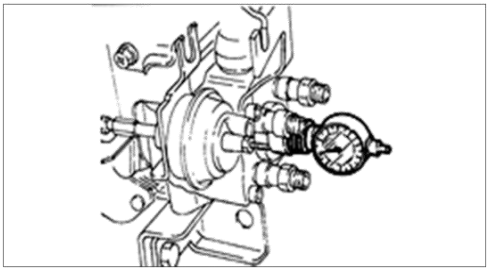
Injection Timing

Check and Adjustment

1. Slowly rotate crankshaft a turn clockwise and another turn counterclockwise to align shaft with TDC.
2. Remove the injection pipe between injection pump and nozzle.



3. Remove the cover and gasket from hydraulic head of injection pump and then install SST.



CAUTION

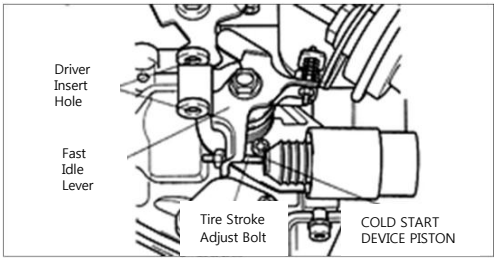
1) Make sure that there are no fuel leaks from injection pump during removing it.

2) Install it so that SST indicates about 2㎜ (0.079in).

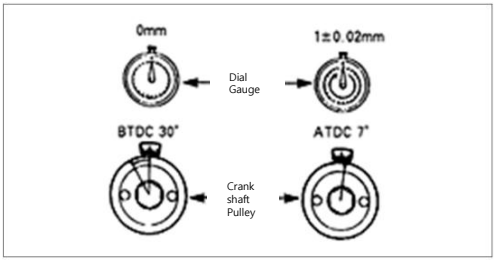
4. Release CSD from injection pump.

(1) Turn fast idle lever clockwise using screwdriver and insert 8-10 mm shim between CSD piston and timer stroke adjusting bolt.

(2) Make sure there is clearance between fast idle lever and control lever on CSD.



5. Slowly turn crankshaft pulley counterclockwise (the opposite direction of engine rotation) until dial gauge indicator does not move.



CAUTION

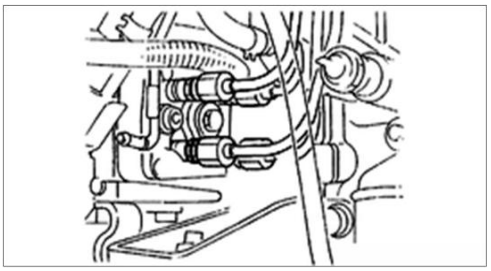
Dial gauge indicator shall stop if crankshaft turns approx. 30~50˚ BTDC.

6. Align dial gauge indicator to 0 turning crankshaft to right and left.
Then verify the position of dial gauge indicator again.

CAUTION

Make sure that dial gauge indicator is positioned to '0' when turning crankshaft pulley to right and left after adjusting dial gauge indicator to "0".

7. Rotate crankshaft pulley clockwise (the direction of engine rotation) and place at 7˚ ATDC to read dial gauge indicator.
   Specification: 1 ± 0.02 ㎜ (Lift)
   (0.0394 ± 0.00079 in)



8. If dial gauge indicator is not within the specification, allow gauge indicator to indicate 0.98~1.02 ㎜ (0.0390~040in) at 7˚ ATDC by inclining the upper section of injection pump towards engine or the outside of engine.

9. Tighten two flange nuts on injection pump.
   Tightening torque : 1.5~2.2 kgf·m (15~22 N·m, 11~16 lbf·ft)

10. Tighten two flange bolts on injection pump.
    Tightening torque : 2.0~2.7 kgf·m (20~26 N·m, 14~20 lbf·ft)

11. Make sure that dial gauge indicator indicates 0.98-1.02 mm (at 7˚ ATDC). If gauge indicator is not within the specification, repeat steps 8 ~ 10.

12. Remove the measuring device from injection pump.

13. Insert a new gasket and then install cap.
    Tightening torque : 1.4~2.0 kgf·m (14~20 N·m, 10~15 lbf·ft)

14. Tighten the injection pipe temporarily and tighten the four nuts on pump side.
    Tightening torque : 2.5~3.0 kgf·m (25~29 N·m, 18~22 lbf·ft)

15. Start engine and check for fuel leaks.

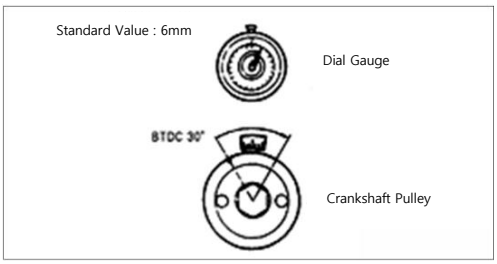
CAUTION

Do bleeding after adjustment of injection timing.

Cam Lift

Check

1. Check the maximum reading on dial gauge as soon as checking and adjusting injection timing.

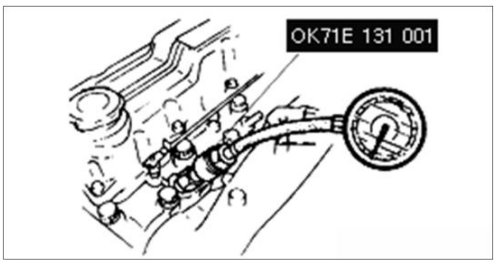


2. Rotate pulley so that it passes by TDC and then check maximum reading on dial gauge.
   Cam Lift : 2.6 ㎜ (0.1 in)

Compression Pressure

Check

1. Warm up the engine to normal operating temperature and stop the engine. Then disconnect connector for fuel cut solenoid.



2. Remove all injector pipes, nozzle and washers.

3. Install SST to nozzle hole.

4. Measure compression pressure by cranking engine.

Reference		WC30D Engine
Compression Pressure	Standard Value	30.0 kg/㎠ – 200 rpm (2942 ㎪, 427 psi)
	Limit Value	27.0 kg/㎠ – 200 rpm (2648 ㎪, 384 psi)
Pressure Difference per Cylinder		Within 3.0 kg/㎠ (294 ㎪, 42.7 psi)

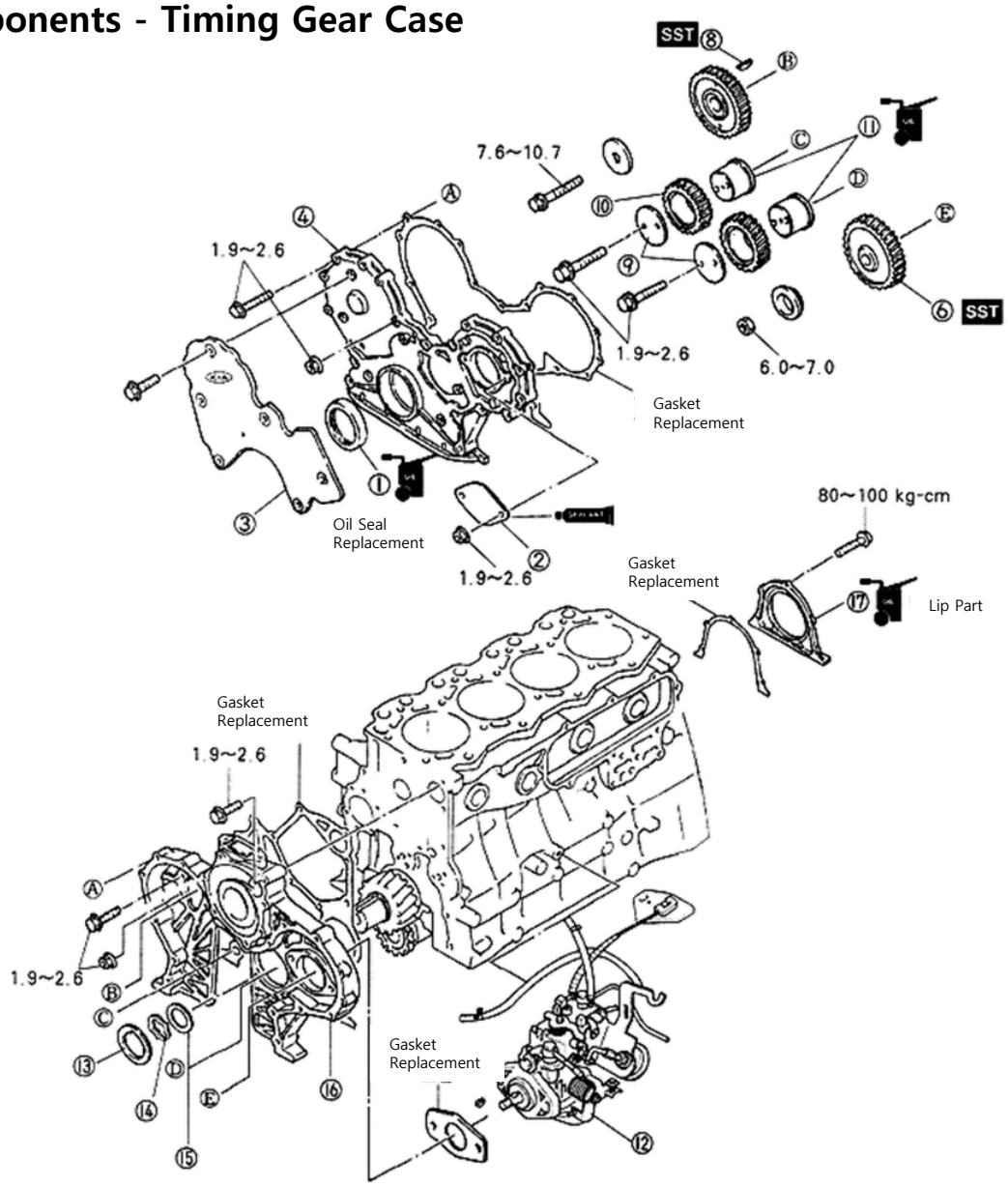
5. Perform steps 3 and 4 for each cylinder.

6. If readings are under the limit value, it is expected that there exist friction and damage to cylinder, piston and piston ring, improper connection of valve, or broken gasket.

Chapter 2. Engine Mechanical system

1. Timing system
2. Cylinder Head Assembly
3. Drive Belt
4. Piston and Connecting Rod
5. Crankshaft
6. Cylinder Block
7. Cooling System
8. Engine Oil
9. Oil Pan
10. Oil Pump
11. Oil Cooler
13. Other Lubrication System
14. Intake and Exhaust System

Components - Timing Gear Case

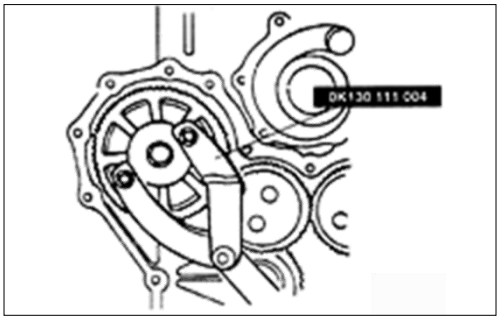


1	Front Oil Seal	11	Idle Gear Spindle
2	Injection Pump Gear Cover	12	Fuel Injection Pump
3	Seal Plate	13	Oil Deflection
4	Timing Gear Cover	14	Friction Gear Spring
6	Injection Pump Gear	15	Friction Gear
8	Cam Shaft Gear	16	Timing Gear Case
9	Thrust Plate	17	Rear Oil Seal
10	Idle Gear		

Disassembly

Cam Shaft Gear

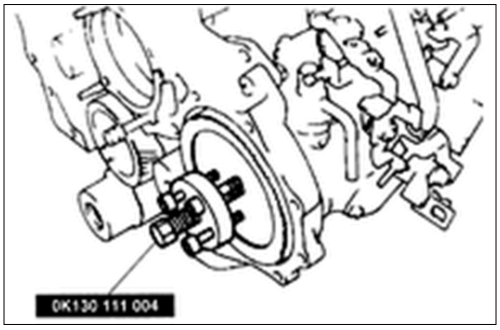
1. Prevent SST cam shaft gear from rotating and then remove it.



2. Remove the lock nut from injection pump gear.

3. Remove injection pump gear using SST.

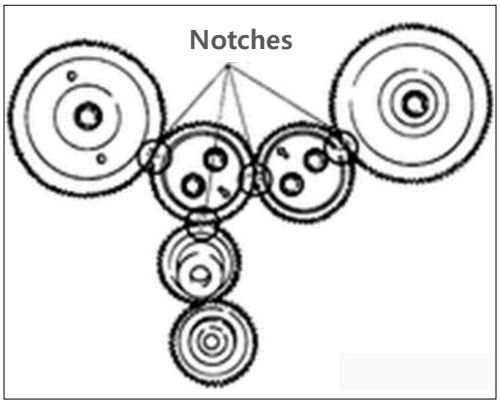
4. Remove cam shaft gear and idling gear.



Assembly

Timing Gear

1. Assemble timing gear so that notches on each gear are aligned with each other as shown in figure.



CAUTION

1) Assemble timing gear at 30˚ BTDC.

2) Idle gear outside diameter

- left : 78.4 ㎜ (3.087 in)

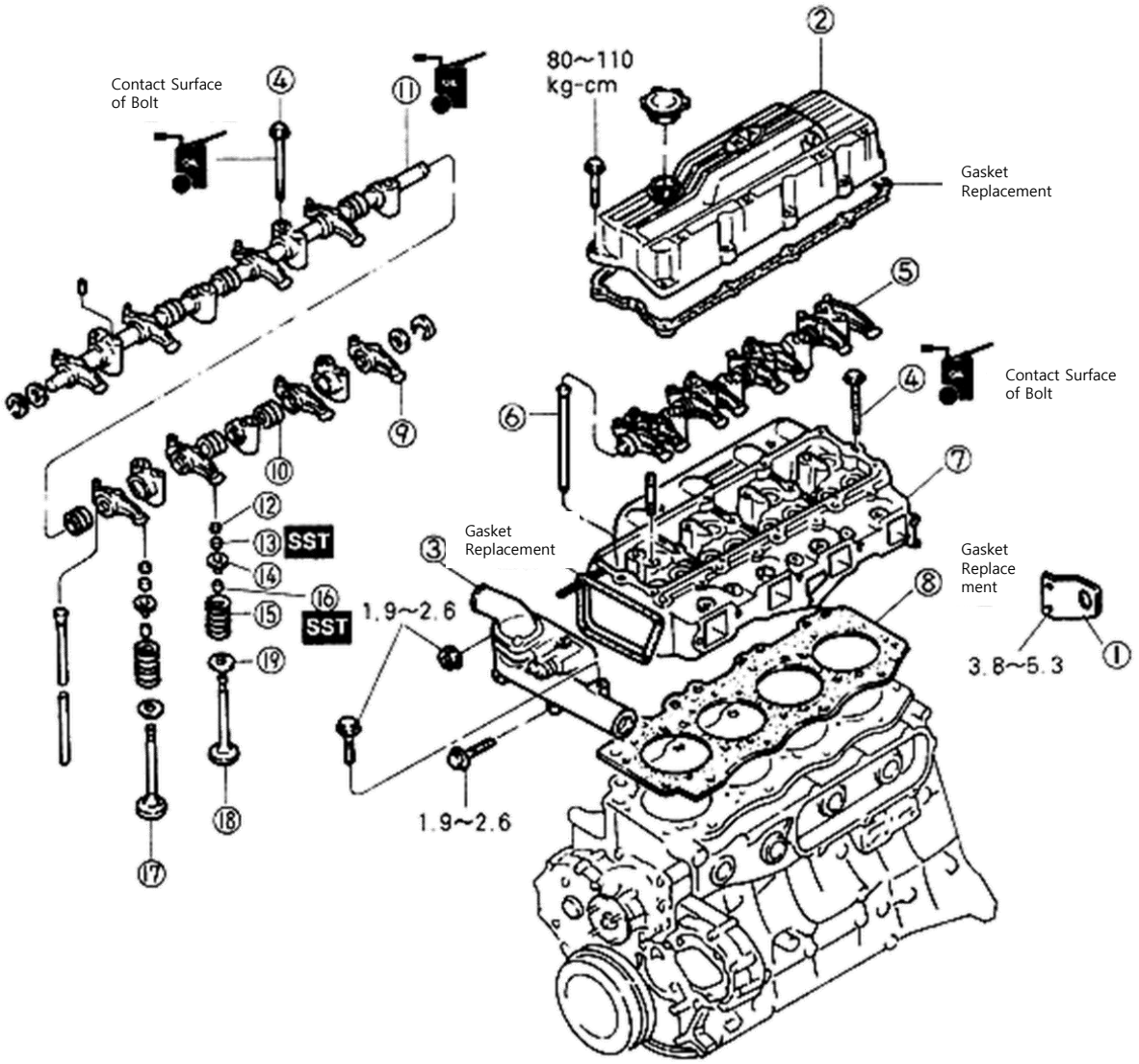
right : 77.5 ㎜ (3.051 in)

3) Back lash per gear

- standard : 0.06-0.14 ㎜ (0.0024~0.0055 in)

limit : 0.2 ㎜ (0.0079 in)

Cylinder Head Assembly

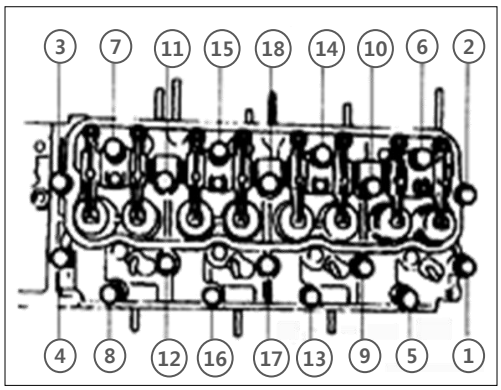


1	Engine Hanger	11	Rocker Arm Shaft
2	Cylinder Head Cover	12	Valve Cap
3	Thermo Case and Gasket	13	Valve Cotter
4	Cylinder Head Bolt	14	Upper Valve Spring Seat
5	Rocker Arm and Rocker Arm Shaft Assembly	15	Valve Spring
6	Push Rod	16	Valve Seal
7	Cylinder Head	17	Intake Valve
8	Cylinder Head Gasket	18	Exhaust Valve
9	Rocker Arm	19	Lower Valve Spring Seat
10	Rocker Arm Spring		

Disassembly

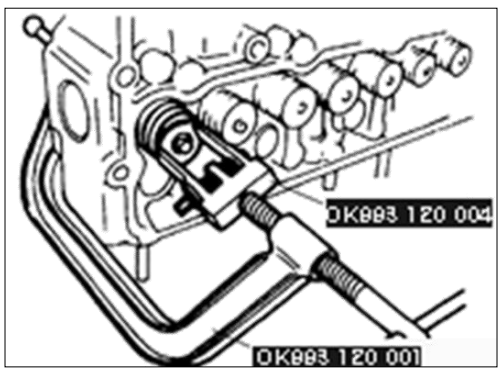
Cylinder Head Bolt

Loosen cylinder head bolts in order as shown
In figure.
Loosen bolts in two or three times, not at once.



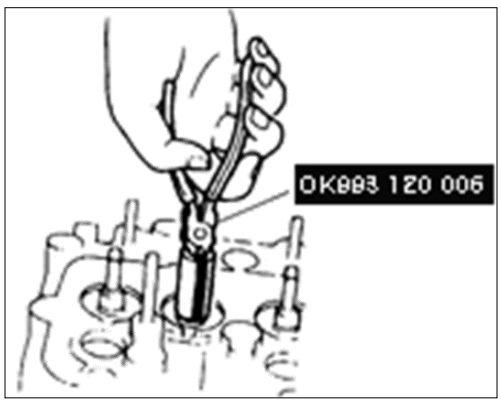
Valve Cotter

Remove the valve cotter using SST
as shown in figure.



Valve Seal

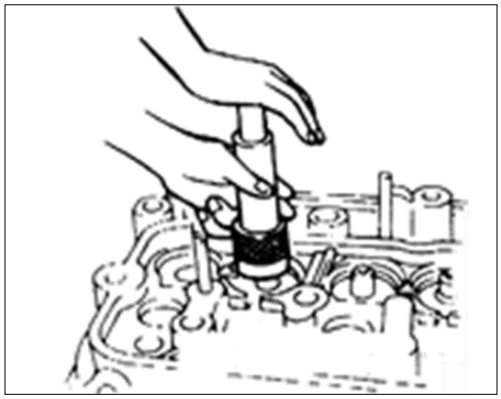
Pull out valve seal using SST.



Assembly

Valve Seal

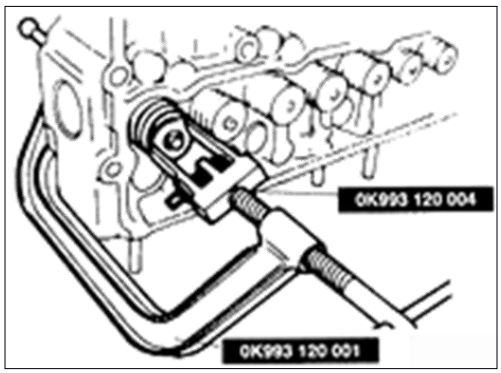
Press fit valve seal using suitable tool as shown in figure.



Valve Cotter

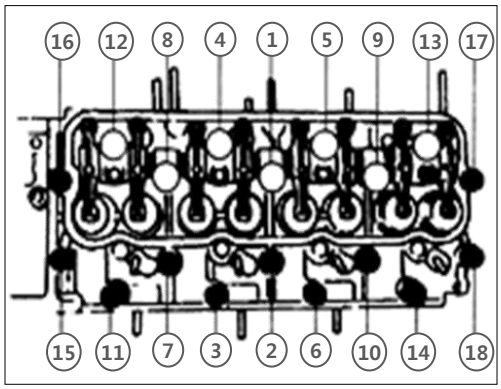
1. Using SST, press spring into assembly section until valve cotter appears and then install valve cotter.

2. Make sure that cotter is seated well by tapping on the end of valve stem with plastic hammer.



Cylinder Head Bolt

1. Apply engine oil to cylinder head bolts and thread, and then assemble it with cylinder head.



2. Tighten cylinder head bolts in order as shown in figure. (the first tightening)

Tightening Torque	**6.0 ㎏f·m (58.8 N·m, 43 lbf·ft)**

NOTE

Symbol in figure ● : Short bolt ○ : Long bolt

CAUTION

Measure the length of cylinder head bolt and replace if required.

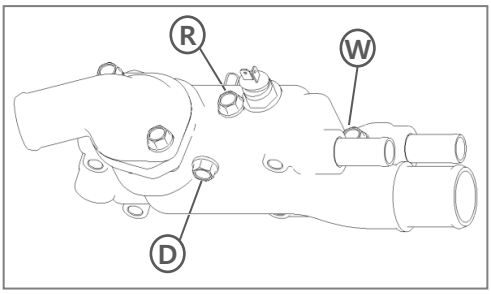
Long bolt : 158mm, Short bolt : 123mm

3. Tighten cylinder head bolts twice by each 90˚ as shown in figure.

Thermostat Case

1. Temporarily tighten thermostat case on cylinder head using bolt (D).

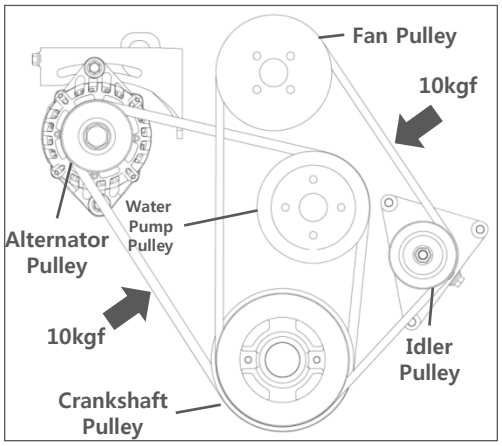
2. Fully tighten bolt (R) and (W), then (D).



Tightening Torque	**1.9~2.6 ㎏f·m (19~25 N·m, 14~19 lbf·ft)**

Belt Check

1. Verify that belts are put in pulley correctly as shown in the right figure.



2. Check that there is worn, cracked and broken belt. Replace if required.

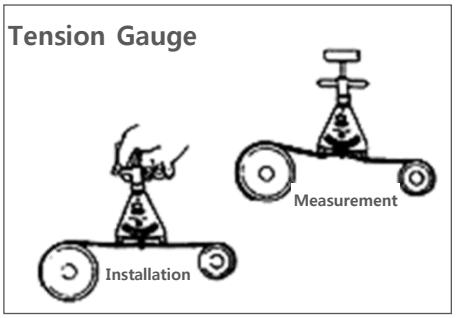
3. Check deflection by applying force of 10kg to the center of belt as shown in figure.

Classification	New	Used
Alternator Belt	8-10 ㎜ (0.32~0.39 in)	10-12 ㎜ (0.39~0.47 in)
Fan Pulley Belt		

4. Readjust if deflection is under the limit value.

CAUTION

1) Check the deflection of belt on the center of belt.
2) The value for new belt shall be used if the belt is used within 5 minutes. That for used belt shall be used if it is used more than 5 minutes.
3) If deflection of used belt is beyond limit, adjust the deflection according to the value for used belt.
4) Check the deflection under cold condition more than 30 minutes after engine stops for accurate measurement.



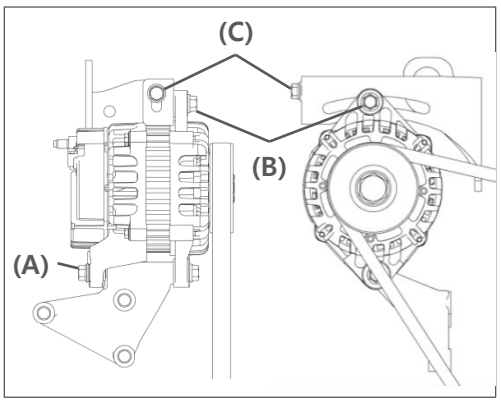
NOTE

If the deflection is checked by tension value using tension gauge

Classification	New	Used
Alternator Belt	45-55 kgf (441~539 N, 99~121 lbf)	39-45 kgf (382~441 N, 86~99 lbf)
Fan Pulley Belt		

Belt Adjustment

Alternator Drive Belt



1. Loosen alternator tightening nut (A) and bolt (B).

2. Adjust bolt (C) until belt deflection is within the standard value.

   Belt deflection standard value (at l0 kgf force)

Classification	New	Used
Alternator Belt	8-10 ㎜ (0.32~0.39 in)	10-12 ㎜ (0.39~0.47 in)

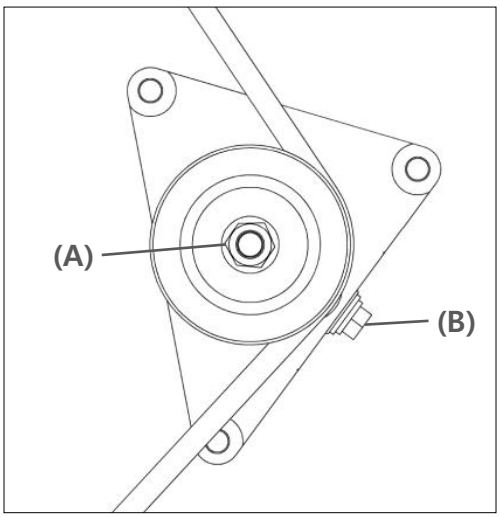
3. If deflection is within the standard value, tighten each bolt to specified torque. If not, repeat steps above.

Tightening Torque	**(A) 2.0~2.6 ㎏f·m (19.6~25.5 N·m, 14.5~18.8 lbf·ft)** **(B) 2.0~2.6 ㎏f·m (19.6~25.5 N·m, 14.5~18.8 lbf·ft)**

Fan Drive Belt

1. Loosen idler pulley mounting bolt (A).

2. Adjust belt deflection within the standard value adjusting bolt (B).
   Belt deflection standard value (at l0 kgf force)



Classification	New	Used
Fan Pulley Belt	8-10 ㎜ (0.32~0.39 in)	10-12 ㎜ (0.39~0.47 in)

3. If deflection is within the standard value, tighten each bolt to specified torque. If not, repeat steps above.

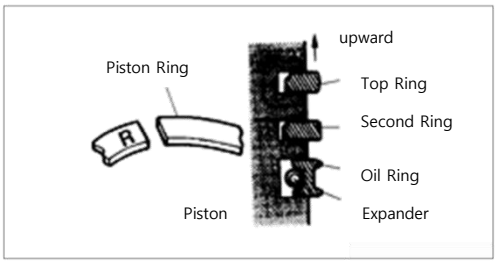
Tightening Torque	**(A) 4.0-5.0 ㎏f·m (39.2~49 N·m, 28.9~36.2 lbf·ft)**

Assembly of Piston Ring

1. Assemble in order of oil ring expander, oil ring, second ring and top ring.

NOTE

When assembling compression ring, "R" mark shall face the top of piston.

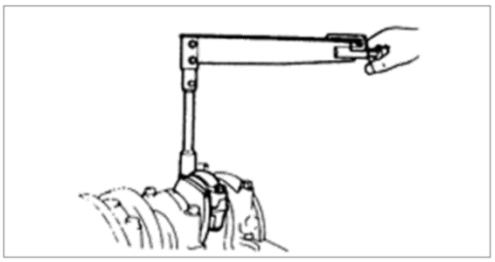


Check

1. Apply engine oil to lubrication surfaces of crank pin and connecting rod bearing.

2. Align connecting rod cap with the assembling mark.

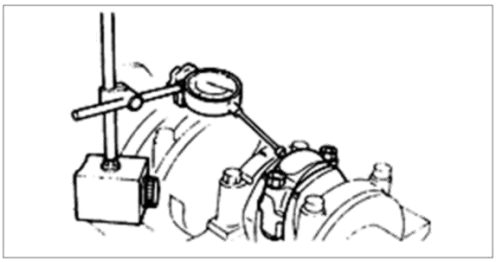
3. Apply engine oil to connecting rod thread and tightening nut, and tighten them together. hen loosen them again.



Tightening Torque	7.0 kgf·m (68.6 N·m, 50.6 lbf·ft)

4. Retighten to 3 kgf·m (29.4 N·m, 21.7 lbf·ft) tightening torque and then rotate bolt by 90° to be tightened fully.

5. Install dial gauge to connecting rod.



6. Measure side clearance by moving connecting rod back and forth.

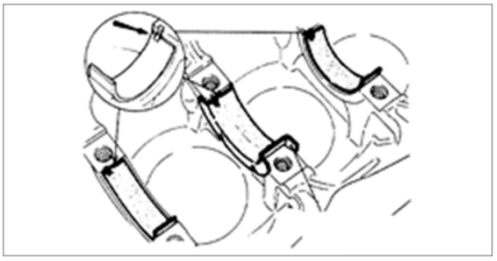
Standard Value	0.239-0.390 ㎜ (0.0094~0.0154 in)
Limit Value	0.35 ㎜ (0.0138 in)

7. If side clearance is over the limit value, replace connecting rod and cap.

Check

Crankshaft Main Journal Bearing Oil Clearance

1. Remove foreign material and oil from journal and bearing.

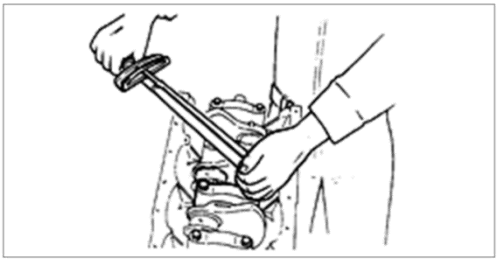


2. Install upper main bearing on cylinder block.

3. Position crankshaft on cylinder block.

4. Install plastic gauge on journal axially.

5. Install main bearing cap and tighten main bearing cap bolt. Then loosen it again.



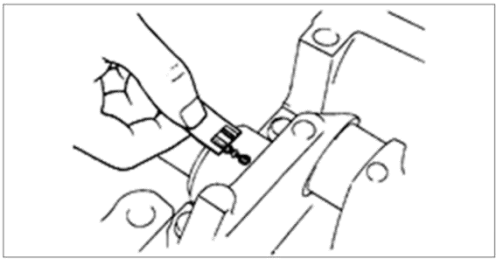
Tightening Torque	8.0 kgf·m (78.5 N·m, 57.9 lbf·ft)

6. Retighten to 4.5 kgf·m (44.1 N·m, 32.5 lbf·ft) tightening torque and then rotate bolt by 90° to be tightened fully.

CAUTION

When measuring oil clearance,
crankshaft shall not be rotated.

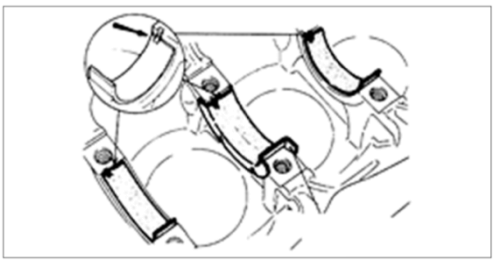
7. Remove main bearing cap from cylinder block and read plastic gauge on each journal.
If oil clearance is beyond the maximum, use undersize main bearing by grinding crankshaft.



Oil Clearance	
No. 1,2,4,5	0.045-0.079 ㎜ (0.0018~0.0031 in)
No. 3	0.067-0.101 ㎜ (0.0026~0.0040 in)

Crankshaft End Play

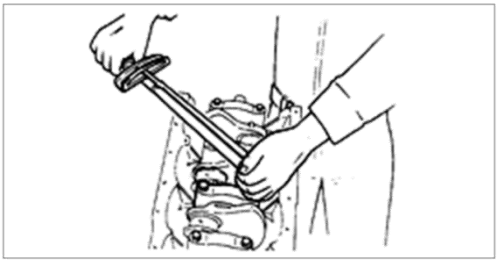
1. Install upper main bearing on cylinder block.



2. Position crankshaft on cylinder block.

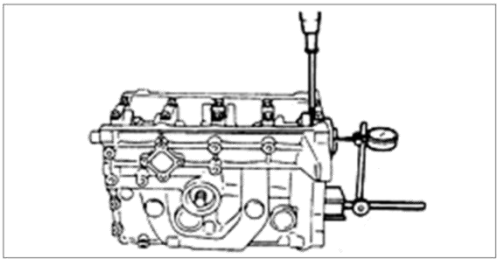
3. Apply sufficient oil to main bearing, thrust bearing and main journal.

4. Install main bearing cap and tighten main bearing cap bolt. Then loosen it again.



Tightening Torque	8.0 kgf·m (78.5 N·m, 57.9 lbf·ft)

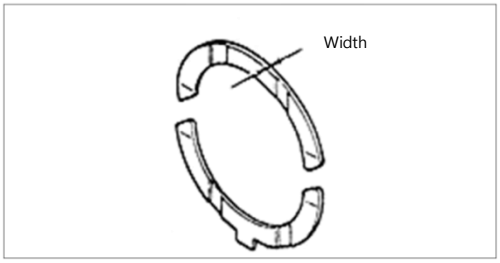
5. Retighten to 4.5 kgf·m (44.1 N·m, 32.5 lbf·ft) tightening torque and then rotate bolt by 90° to be tightened fully.



6. Check crankshaft end play.

End Play	0.014-0.039 ㎜ (0.0005~0.0015 in)
Maximum	0.032 ㎜ (0.0013 in)

7. If end play is beyond the maximum, grind crankshaft to install oversize thrust bearing or replace crankshaft and thrust bearing.

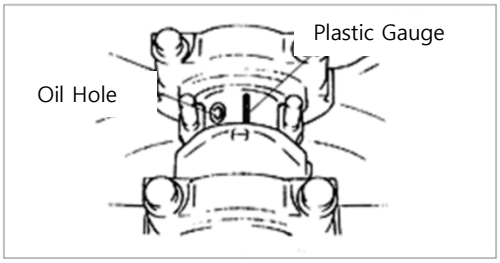


* Thrust Bearing Thickness

Over Size	WC30D Engine
Standard	2.320-2.325 ㎜ (0.0913~0.0915 in)
0.25	2.445-2.450 ㎜ (0.0963~0.0965 in)
0.50	2.570-2.575 ㎜ (0.1012~0.1014 in)
0.75	2.695-2.700 ㎜ (0.1061~0.1063 in)
1.00	2.820-2.825 ㎜ (0.1110~0.1112 in)

Crank Pin Oil Clearance

1. Align the length of plastic gauge with the width of connecting rod bearing and position oil hole parallel to crankshaft.



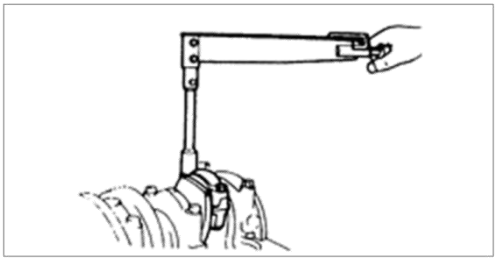
CAUTION

When measuring oil clearance,
do not rotate crankshaft.

2. Remove oil, dust on back side of lower connecting rod bearing and cap bearing, and install bearing to cap.

3. Align connecting rod with matching mark of cap and assemble.

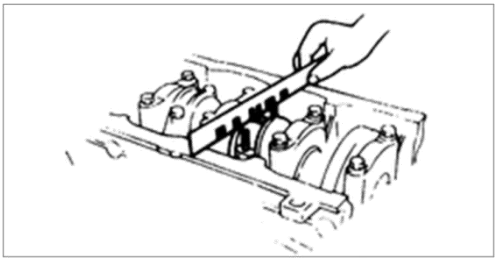
4. Apply engine oil to connecting rod thread and assembly face of tightening nut ; then tighten and loosen again.



Tightening Torque	7.0 kgf·m (68.6 N·m, 50.6 lbf·ft)

5. Retighten to 3 kgf·m (29.4 N·m, 21.7 lbf·ft) tightening torque and then rotate bolt by 90º to be tightened fully.

6. Remove connecting rod cap and measure oil clearance with plastic gauge.



Standard Value	0.036-0.067 ㎜ (0.0014~0.0026 in)
Limit Value	0.10 ㎜ (0.0039 in)

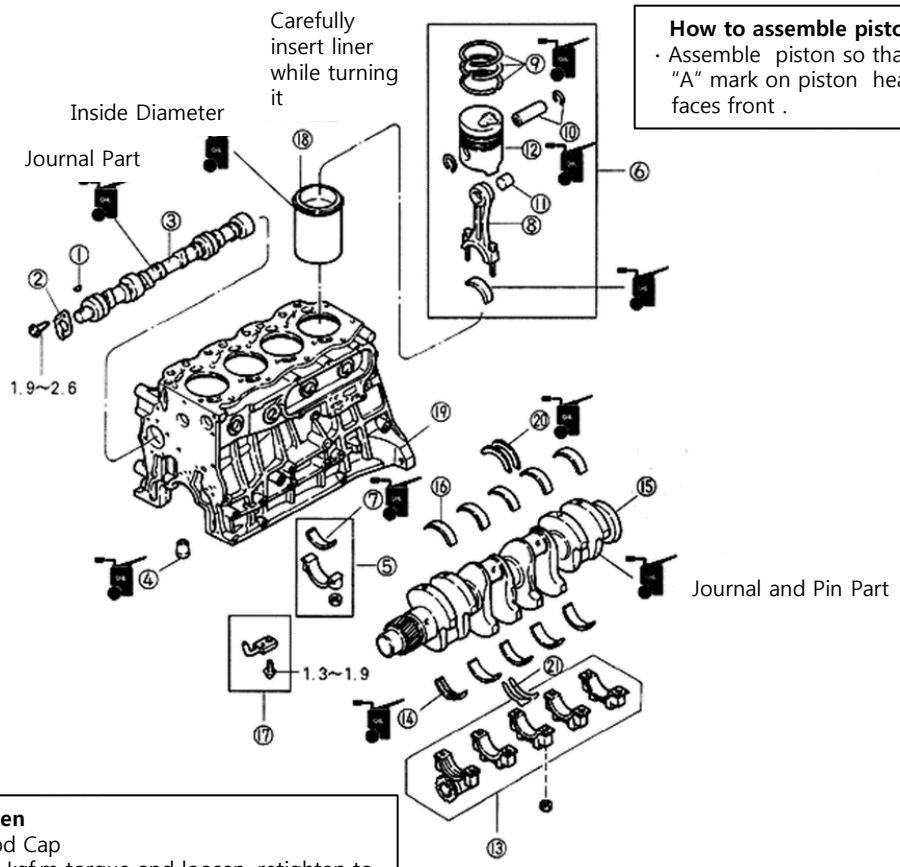
7. If the clearance exceeds the limit value, replace bearing or use undersize bearing with crank pin part grinded.

Bearing Size	Crank Pin Grinding Limit
Standard	57.106-57.124 ㎜ (2.2483~2.2490 in)
0.25 Undersize	56.856-56.874 ㎜ (2.2384~2.2391 in)
0.50 Undersize	56.606-56.624 ㎜ (2.2286~2.2293 in)
0.75 Undersize	56.356-56.374 ㎜ (2.2187~2.2194 in)

*** REFERENCE**

Item	Connecting Rod Big End		Connecting Rod Bearing		Bearing Clearance
	Symbol	Inner Diameter	Color	Bearing Thickness	
WC30D Engine	1	60.842-60.847 ㎜ (2.3954~2.3956 in)	Black	1.838-1.841 ㎜ (0.0724~0.0725 in)	0.036-0.065 ㎜ (0.00142~0.00256 in)
	2	60.837-60.842 ㎜ (2.3952~2.3954 in)	Brown	1.835-1.838 ㎜ (0.0723~0.0724 in)	0.037-0.066 ㎜ (0.00146~0.0026 in)
	3	60.832-60.837 ㎜ (2.3950~2.3952 in)	Green	1.832-1.835 ㎜ (0.0721~0.0723 in)	0.038-0.067 ㎜ (0.0015~0.00264 in)

Components and Parts Location



How to tighten
· Connecting Rod Cap
Tighten to 7.0 kgf·m torque and loosen, retighten to 3.0 kgf·m torque and then secondarily tighten by 90º.
· Crankshaft Main Bearing Cap
Tighten to 7.0kg-m torque and loosen, retighten to 3.0 kgf·m torque and then secondarily tighten by 90º.

1	Woodruff Key	12	Piston
2	Cam Shaft Thrust Plate	13	Main Bearing Cap
3	Cam Shaft	14	Lower Main Bearing
4	Tappet	15	Crankshaft
5	Connecting Rod Cap	16	Upper Main Bearing
6	Connecting Rod and Piston Assembly	17	Piston Cooling Jet
7	Connecting Rod Bearing	18	Cylinder Liner
8	Connecting Rod	19	Cylinder Block
9	Piston Ring	20	Upper Thrust Bearing
10	Snap Ring and Piston Pin	21	Lower Thrust Bearing
11	Connecting Rod Bushing		

Coolant

CAUTION

1) Do not open radiator cap when engine is heated.

2) Use thick cloth carefully when opening the radiator cap.

Coolant Level Check

1. Verify coolant level is near radiator port.
2. Check that the coolant level of reservior tank is between "F" and "L" mark. Refill if required.

Contamination Check

Verify that there is no foreign material in coolant and engine oil. Replace if required.

Replacement

CAUTION

1) Never open the radiator cap if the engine is hot.

2) Cover with thick cloth when removing radiator cap.

3) Be careful when draining hot coolant.

1. Remove radiator cap and loosen drain plug.
2. Drain coolant into a suitable container.
3. Close drain plug.
4. Fill with the right amount antifreeze (Ethylene Glycol) and coolant.

   Engine only : Approx. 4.5ℓ (4.8 US qt)
5. Pour the coolant to the neck of radiator port while engine is idling.
6. Install radiator cap.

Thermostat

Check

1. Visually inspect thermostat and valve for sealed condition.

2. Put the thermostat into water.

3. Heat water slowly and check the followings :

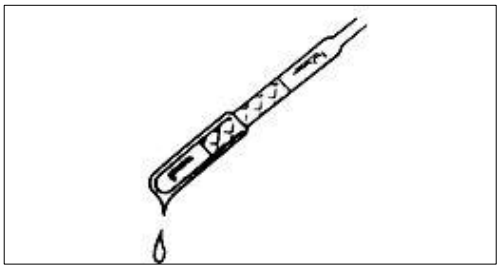
Reference	WC30D Engine
Initial Opening Temperature	80.5-83.7 ℃ (177~183 ℉)
Full-open Temperature	95 ℃ (203 ℉)
Full-open Lift	8.5 ㎜ (0.33 in) or More

Oil Level Check

1. Place vehicle on the ground.

2. Warm up the engine to operating temperature and then stop the engine.

3. Wait for 5 minutes and check oil level using dipstick.



4. Add oil as needed or change oil.

CAUTION

Overfilling oil above "F" mark could result in damage to engine.

NOTE

Oil level between "F "and "L" on dipstick is approx. 1.8ℓ (1.9 US qt).

Engine Oil

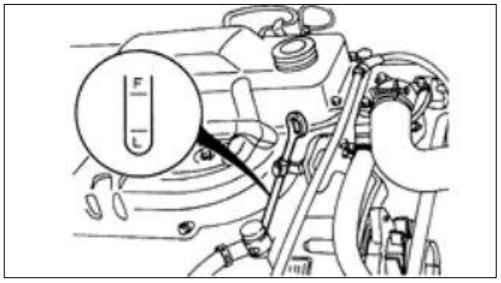
Check

1. Place vehicle on the ground.

2. Warm up the engine.

3. Stop the engine and wait for 5 minutes.

4. Check engine oil level and condition with dipstick.



5. Add oil as needed or change oil.

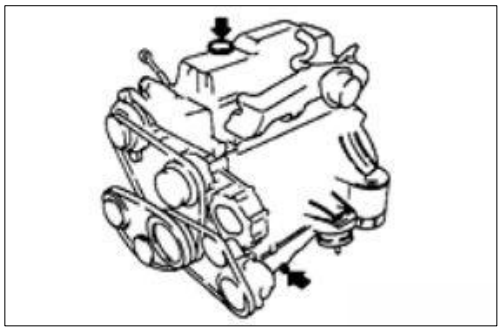
NOTE

Check that oil level is between "L" and "F" marks on dipstick .

Replacement

1. Warm up engine.

2. Remove oil filler cap and oil pan drain plug.



3. Drain oil into a suitable container.

CAUTION

If engine is staying hot, oil is very hot as well. Wait for a while and carefully drain oil.

4. Install new gasket and tighten drain plug.

Tightening Torque	**3.5~4.5 ㎏f·m (34.3~44.1 N·m, 25.3~32.5 lbf·ft)**

5. Add specified oil to engine to "F" position.

6. Firmly tighten oil filler cap.

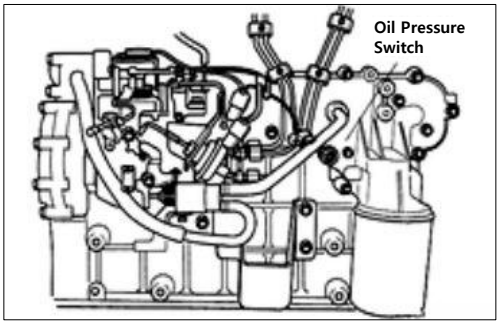
Oil Pan Capacity	**5.8 ℓ (6.1 US qt)**

7. Start engine and check the oil level.

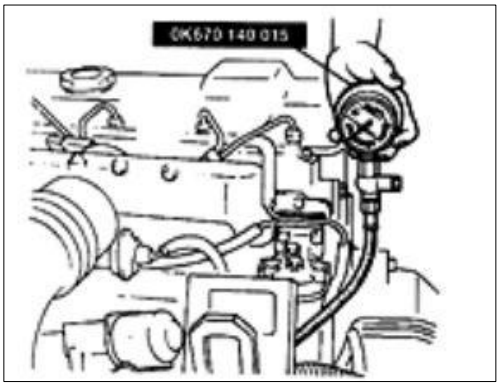
Oil Pressure

Check

1. Remove oil pressure switch.



2. Install SST to oil pressure switch assembling hole on cylinder block.



3. Start engine and maintain proper temperature.

4. Run engine at 2500 rpm and read gauge.

Standard value of oil pressure	**3.5~4.5 kg/㎠ (343~441 kPa, 50~64 psi)**

5. Check each area if pressure is out of standard value. Correct if required.

Removal

1. Disconnect hoses from sides of vacuum pump and oil pan.

2. Disconnect oil level gauge pipe from rubber hose.

3. Remove oil pan.

Installation

1. Remove dust or steel powder inside oil pan.

2. Check oil pan for cracks and drain plug thread for damage.

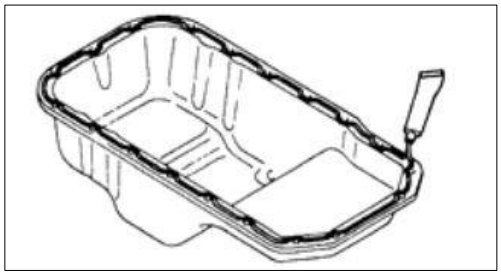
3. Check bolt hole for damage caused by excessive tightening.

4. Repair damage. If not repairable, replace oil pan.

5. Thoroughly remove old sealant from cylinder block and oil pan.

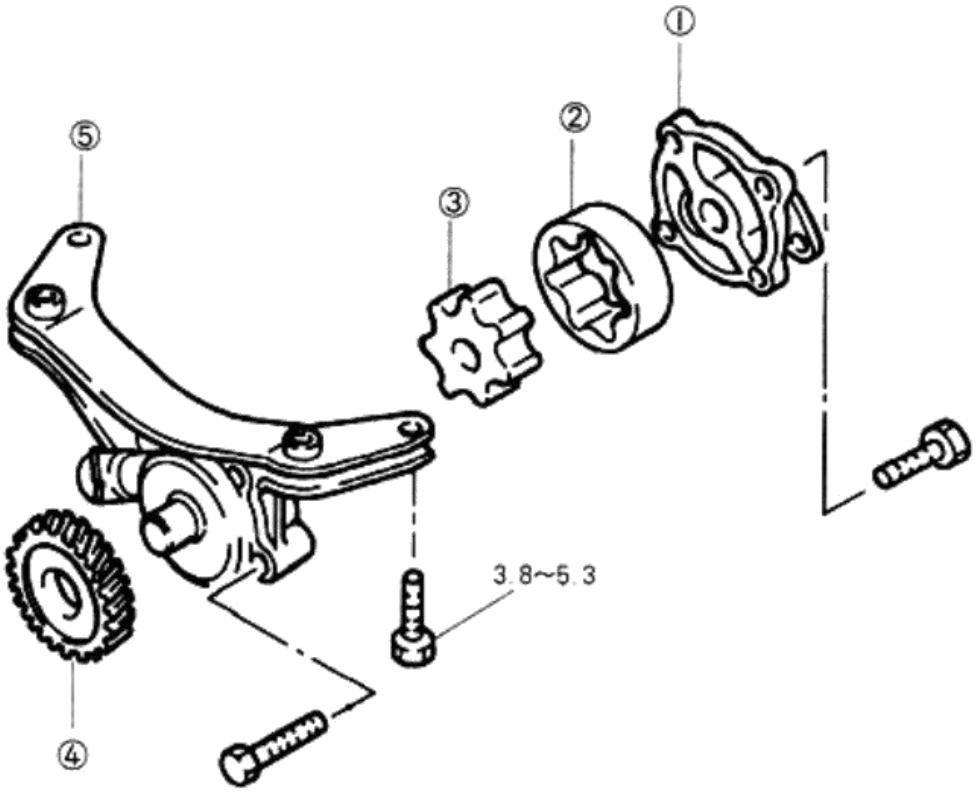
6. Apply sealant from bolt hole of oil pan. Overlap each end of sealant.

7. Position tightening bolt to oil pan and tighten to specified torque.



Tightening Torque	**1.6~2.3 kgf·m (15.7~22.6 N·m, 11.6~16.6 lbf·ft)**

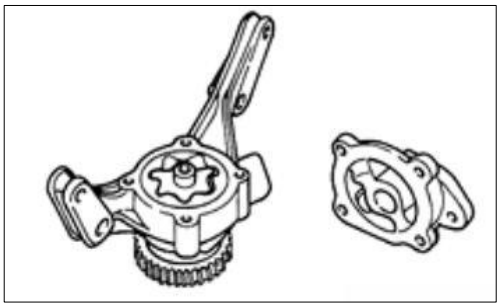
Components – Oil Pump



1	Pump Cover	4	Drive Grear
2	Outer Rotor	5	Pump Body
3	Inner Rotor		

Check

Check the followings for failure and repair if required.

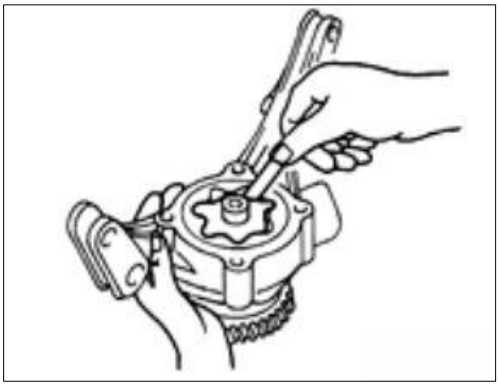


1. Distorted pump body or cover

2. Worn and broken valve

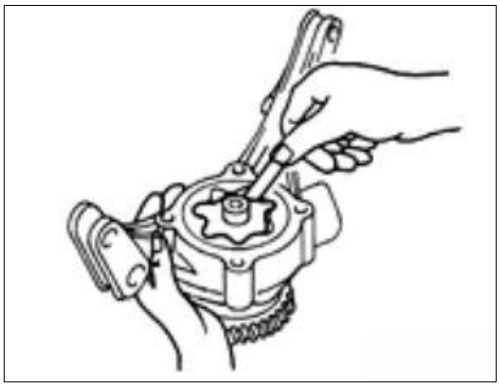
3. Weak or broken valve spring

4. Measure clearance between inner and outer rotors.



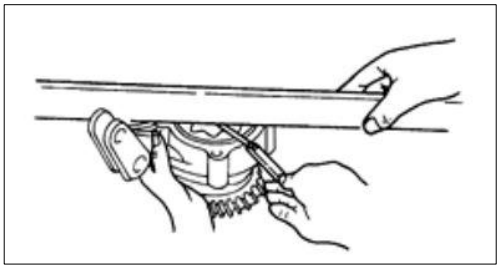
Standard Value	**0.04-0.08 ㎜ (0.0016~0.0031 in)**
Limit Value	**0.10 ㎜ (0.004 in)**

5. Measure clearance between outer rotor and pump body.



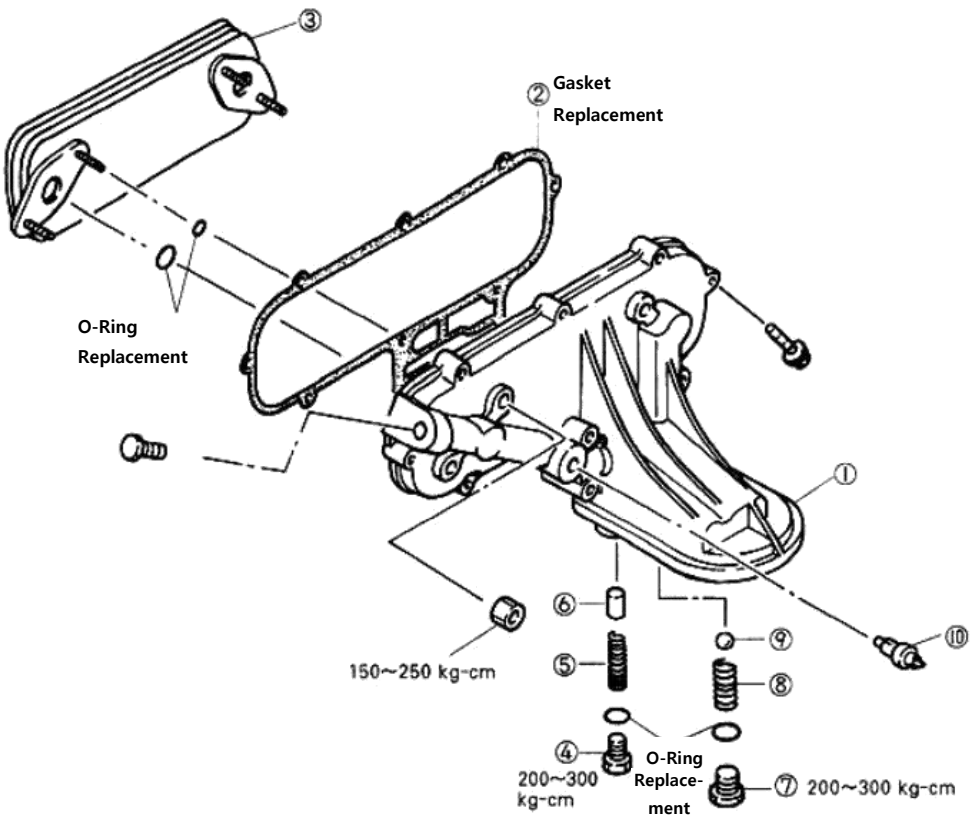
Standard Value	**0.10-0.21 ㎜ (0.004~0.0083 in)**
Limit Value	**0.25 ㎜ (0.001in)**

6. Measure clearance between rotor and pump cover.



Standard Value	**0.03-0.10 ㎜ (0.0012~0.004 in)**
Limit Value	**0.15 ㎜ (0.0059 in)**

Components – Oil Cooler

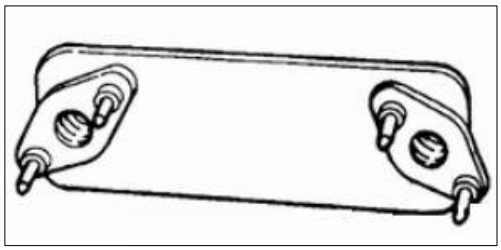


1	Oil Cooler Cover	6	Plunger
2	Gasket	7	Plug
3	Oil Cooler	8	Relief Valve Spring
4	Plug	9	Steel Ball
5	Control Spring	10	Oil Pressure Switch

Check

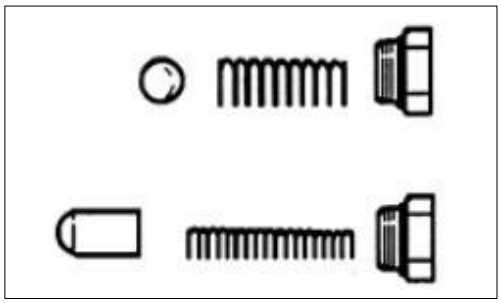
1. Oil Cooler

Visually check core for clogging and damage.
Replace if there is any failure.



2. Plunger Control

(1) Check plunger control for engagement and wear.
(2) Check plunger control spring for breaks.



3. Oil Relief Valve

(1) Check steel ball for wear and damage.
(2) Check relief valve spring for breaks.

Check

1. Lubricate O-ring of new oil filter to be replaced with engine oil.

2. Hand tighten the oil filter securely.

Tightening Torque	**2.2-2.5 ㎏f·m (21.6~24.5 N·m, 15.9~18.1 lbf·ft)**

CAUTION

Do not use tool for tightening.

3. Fill to the specified engine oil level.

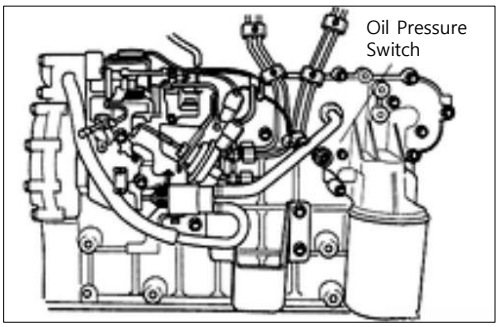
4. Start engine to check filter connections for leakage.

Oil Pressure Switch

Check

1. Turn the key to ON position (not start) to check that oil pressure warning lamp comes on.

2. Start engine and check that oil pressure warning lamp goes out.
   (1) Pressure switch is normal if oil pressure warning lamp comes on in step 1 and goes out in step 2.
   (2) Check electrical circuit if the oil pressure warning lamp remains out in step 1. Replace pressure switch if no abnormal condition is detected (refer to electrical wiring diagram).
   (3) Check for hydraulic pressure if oil pressure warning lamp comes on in step 1 and remains on in step 2. Replace pressure switch if the hydraulic pressure is normal.



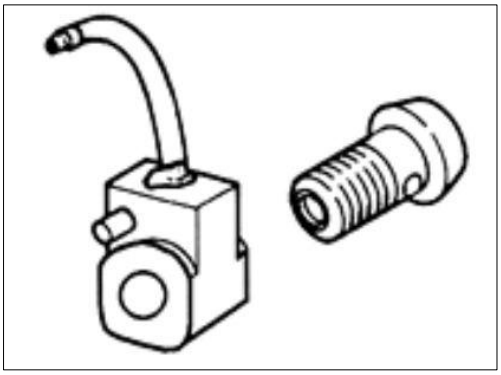
Oil Jet

Check

1. Check oil passage for obstruction.

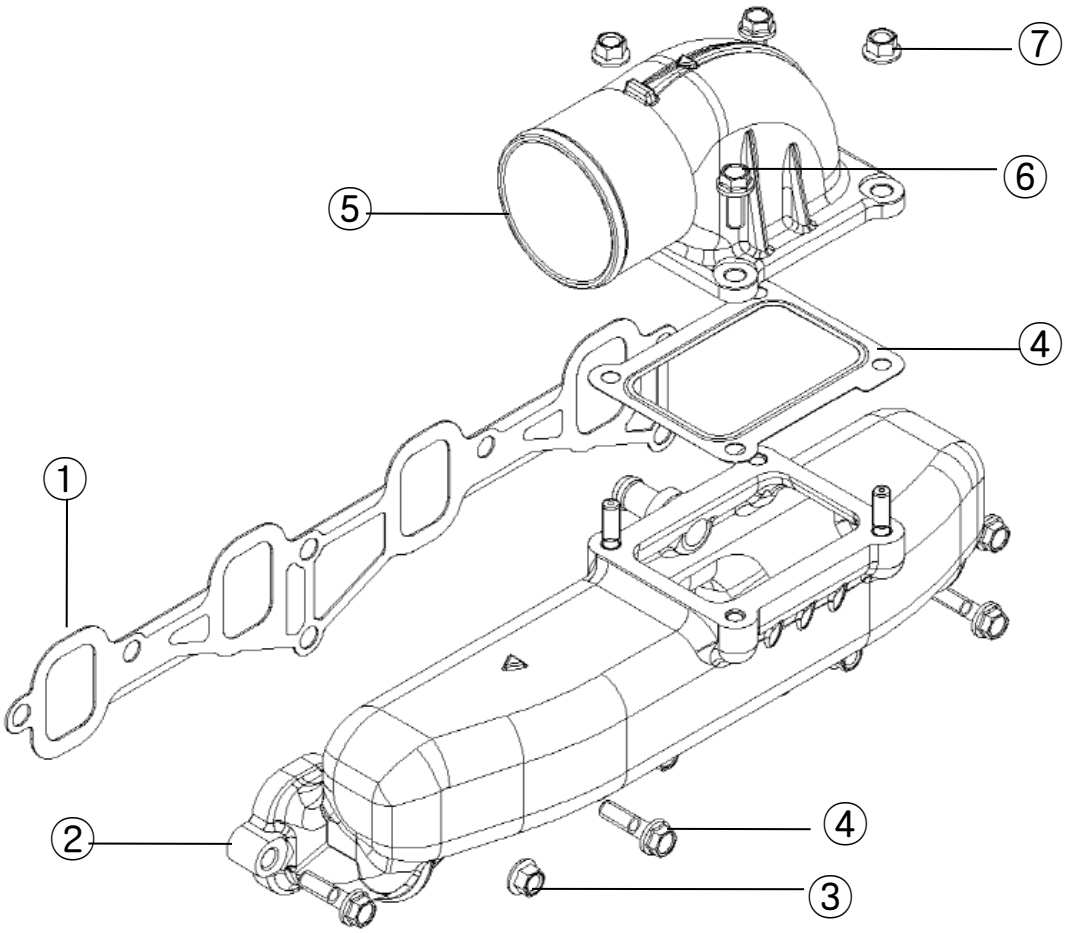
2. Check oil jet valve spring for damage and breaks.

Valve Opening Pressure	**2.0 kg/㎠ (196 kPa, 28 psi)**



Removal and Installation

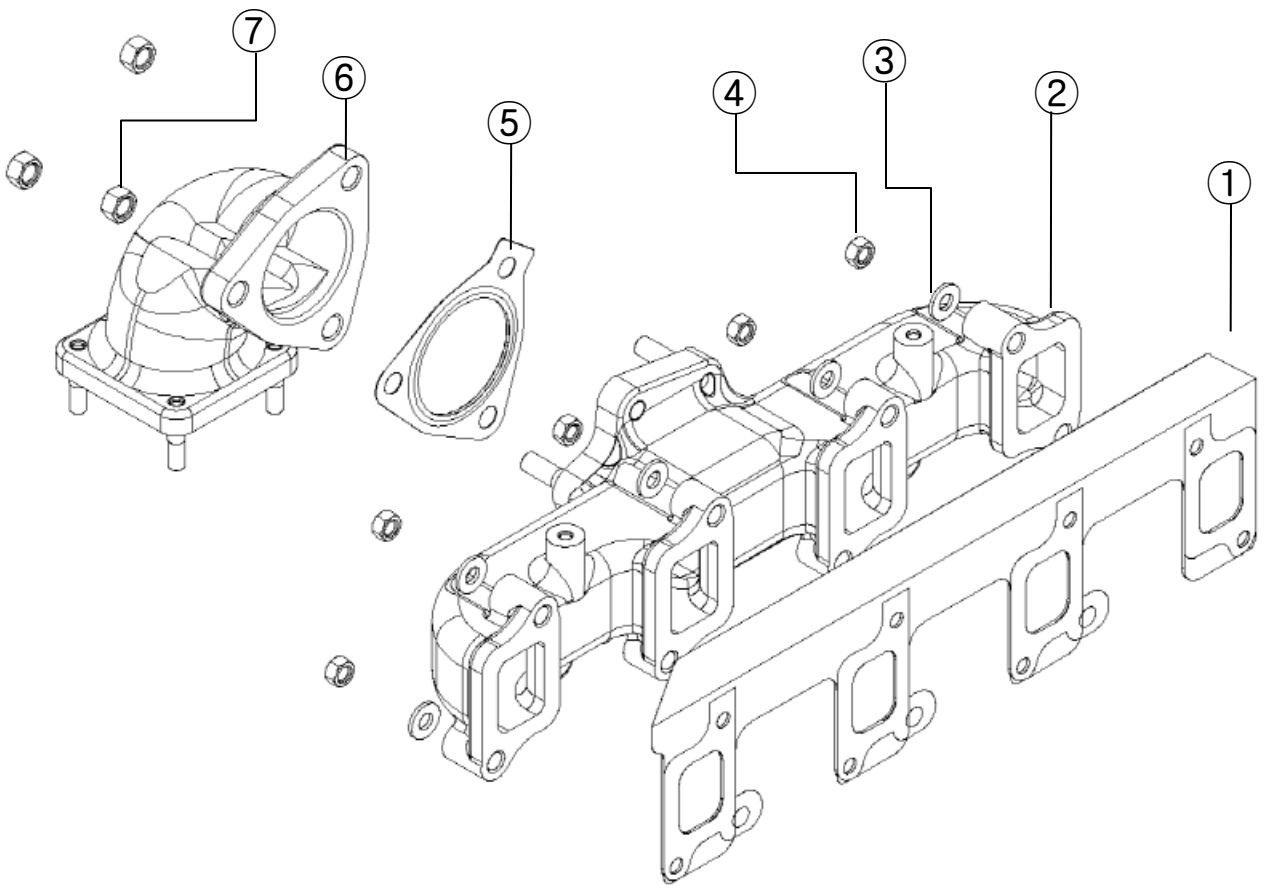
1. Remove parts in the sequence shown in the following Figure.
2. Check all parts and then repair or replace if required.
3. Install parts in reverse order.



1	Intake Manifold Gasket	5	Inlet Fitting
2	Intake Manifold	6	Inlet Fitting Bolt (1.9~2.4 kgf·m) (18.6~23.5 N·m, 13.7~17.4 lbf·ft)
3	Intake Manifold Nut (2.0~2.6 kgf·m) (19.6~25.5 N·m, 14.5~18.8 lbf·ft)	7	Inlet Fitting Nut (1.9~2.4 kgf·m) (18.6~23.5 N·m, 13.7~17.4 lbf·ft)
4	Intake Manifold Bolt (2.0~2.6 kgf·m) (19.6~25.5 N·m, 14.5~18.8 lbf·ft)		

Removal and Installation

1. Remove parts in the sequence shown in the following Figure.
2. Check all parts and then repair or replace if required.
3. Install parts in reverse order.

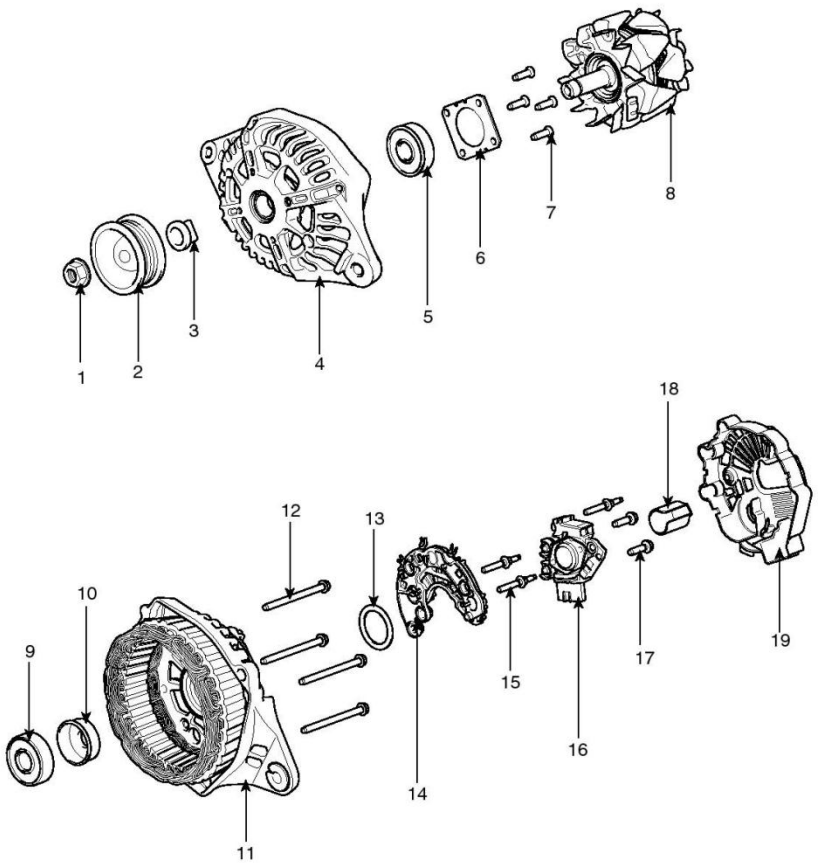


1	Exhaust Manifold Gasket	5	Elbow Gasket
2	Exhaust Manifold Assembly	6	Exhaust Elbow Assembly
3	Exhaust Manifold Washer	7	Exhaust Elbow Nut (1.8~2.2 kgf·m) (17.7~21.6 N·m, 13~15.9 lbf·ft)
4	Exhaust Manifold Nut (1.8~2.2 kgf·m) (17.7~21.6 N·m, 13~15.9 lbf·ft)		

Chapter 3. Engine Electronic System

1. Alternator
2. Starter
3. Glow Plug
4. Glow Controller

Alternator Structure



NO	Parts	NO	Patrs
1	Nut	11	Rear Bracket Assembly
2	Pulley	12	Bolts
3	Spacer	13	Seal
4	Front Bracket Assembly	14	Rectifier Assembly
5	Front Bearing	15	Stud
6	Bearing Cover	16	Regulator Assembly
7	Bearing Cover Bolt	17	Regulator Bolts
8	Rotor	18	Slip Ring Guide
9	Rear Bearing	19	Cover
10	Bearing Cover		

Specification

Item		WC30D 엔진
Rating		Continuous
Norminal Output		13.5 V- 75 A
Regulator Performance	Setting Voltage	14.7 ± 0.3 V
	Temperature Compensation	-7㎷ / ℃
Cut In Speed		MAX. 1500 rpm
Speed In Use		1000~18000 rpm
Rated Speed		6000 rpm

Troubleshooting

Symptom	Possible Cause	Corrective Action
Starter motor does not stop.	• Seized magnetic switch • Broken magnetic switch coil • Faulty starting switch	Replace Replace Replace
Starting disabled	• Faulty glow plug • Broken and shorted wire	Replace Replace
Battery discharged	• Loosened V-belt • Broken and shorted stator coil • Broken and shorted rotor coil • Faulty contact between brush and slip ring • Faulty IC regulator • Insufficient battery fluid • Faulty battery electrode • Faulty contact between battery terminals • Overload	Repair Replace Replace Clean or replace Replace Recharge Replace Clean and retighten Measure the overload
Battery overcharged	Faulty IC regulator	Replace

Removal and Installation

Charger

1. Remove parts in the sequence shown in the following Figure.
2. Install parts in reverse order.

CAUTION

1) Do not connect battery terminals in reverse polarity.

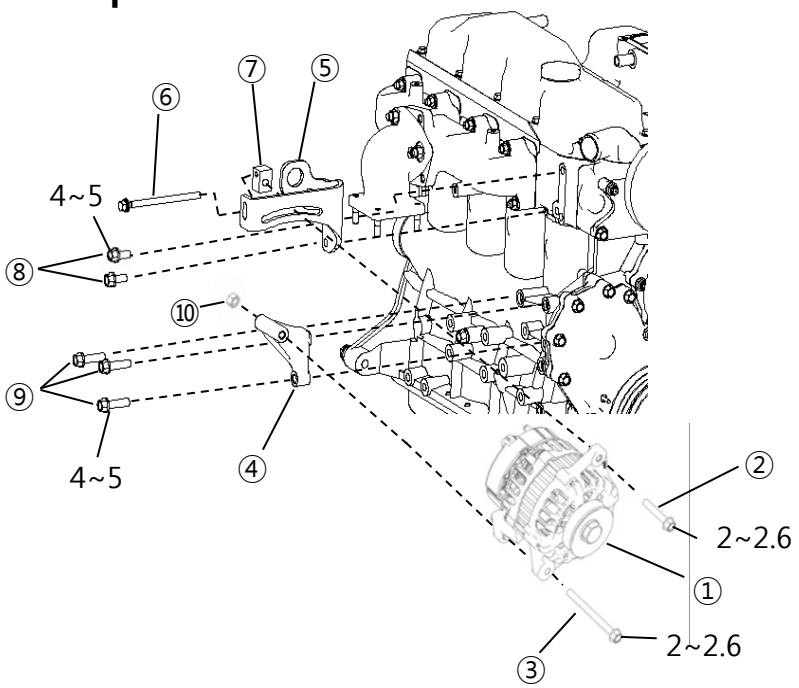
2) Do not use high voltmeter.

3) Remember that battery voltage is always applied to alternator B terminal.

4) Do not ground L terminal while engine is running.

5) Do not start engine while L terminal is disconnected.

Location of Components and Parts



(Unit: kgf·m)

NO	Parts	NO	Parts
1	Alternator Assembly	6	Washer and Bolt Assembly
2	Flange Bolt	7	Adjust Nut
3	Flange Bolt	8	Flange Bolt
4	Alternator Bracket	9	Flange Bolt
5	Alternator Brace	10	Nut

Visually Check Alternator Wiring And Listen For Abnormal Noises

1. Check that the wiring is in good condition.

2. Check that there is no abnormal noise from the alternator while the engine is running.

Check Discharge Warning Light Circuit

1. Warm up the engine and then turn it off.

2. Turn off all accessories.

3. Turn the ignition switch "ON". Check that the discharge warning light is lit.

4. Start the engine. Check that the light is lit. If the light does not go off as specified, troubleshoot the discharge light circuit.

Inspect Charging System

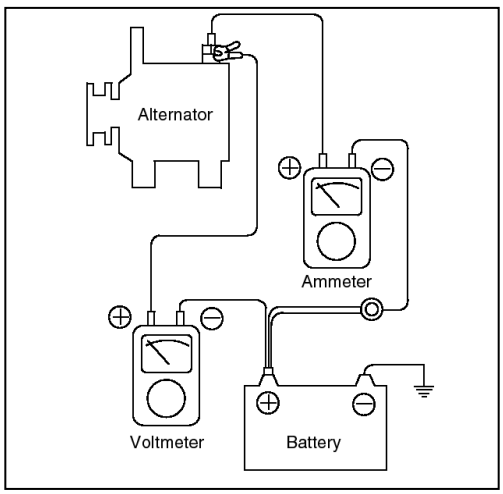
Voltage Drop Test Of Alternator Output Wire

This test determines whether or not the wiring between the alternator "B" terminal and the battery (+) terminal is good by the voltage drop method.

Preparation

1. Turn the ignition switch to "OFF".

2. Disconnect the output wire from the alternator "B" terminal. Connect the (+) lead wire of ammeter to the "B" terminal of alternator and the (-) lead wire of ammeter to the output wire. Connect the (+) lead wire of voltmeter to the "B" terminal of alternator and the (-) lead wire of voltmeter to the (+) terminal of battery.



Test

1. Start the engine.

2. Turn on the headlamps and blower motor, and set the engine speed until the ammeter indicates 20A. And then, read the voltmeter at this time.

Result

1. The voltmeter may indicate the standard value.

Standard value: 0.5V max

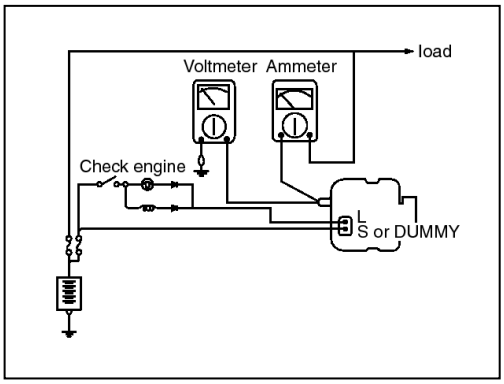
2. If the value of the voltmeter is higher than expected (above 0.5V max.), poor wiring is suspected. In this case check the wiring from the alternator "B" terminal to the battery (+) terminal. Check for loose connections, color change due to an over-heated harness, etc. Correct them before testing again.

3. Upon completion of the test, set the engine speed at idle. Turn off the headlamps, blower motor and the ignition switch.

Output Current Test

This test determines whether or not the alternator gives an output current that is equivalent to the normal output.

Preparation



1. Prior to the test, check the following items and correct as necessary.
   Check the battery installed in the equipment to ensure that it is good condition.
   The battery that is used to test the output current should be one that has been partially discharged.
   With a fully charged battery, the test may not be conducted correctly due to an insufficient load.
   Check the tension of the alternator drive belt.

2. Turn off the ignition switch.

3. Disconnect the battery ground cable.

4. Disconnect the alternator output wire from the alternator "B" terminal.

5. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Be sure to connect the (-) lead wire of the ammeter to the disconnected output wire.

NOTICE

Tighten each connection securely, as a heavy current will flow.
Do not rely on clips.

6. Connect a voltmeter (0 to 20V) between the "B" terminal and ground. Connect the (+) lead wire to the alternator "B" terminal and (-) lead wire to a good ground.

7. Attach an engine tachometer and connect the battery ground cable.

8. Leave the engine hood open.

Test

1. Check to see that the voltmeter reads as the same value as the battery voltage. If the voltmeter reads 0V, and the open circuit in the wire between alternator "B" terminal and battery (+) terminal or poor grounding is suspected.

2. Start the engine and turn on the headlamps.

3. Set the headlamps to high beam and the heater blower switch and air conditioner to HIGH, quickly increase the engine speed to 2,500 rpm and read the maximum output current value indicated by the ammeter.

NOTICE

After the engine start up, the charging current quickly drops. Therefore, the above operation must be done quickly to read the maximum current value correctly.

Result

1. The ammeter reading must be higher than the limit value. If it is lower but the alternator output wire is in good condition, remove the alternator from the vehicle and test it.

Limit value : 50% of the rate output

NOTICE

The nominal output current value is shown on the nameplate affixed to the alternator body.
The output current value changes with the electrical load and t he temperature of the alternator itself.
Therefore, the nominal output current may not be obtained.
If such is the case, keep the headlamps on the cause discharge of the battery, or use the lights of another equipment to increase the electrical load.
The nominal output current may not be obtained if the temperature of the alternator itself or ambient temperature is too high. In such a case, reduce the temperature before testing again.

2. Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.

3. Disconnect the battery ground cable.

4. Remove the ammeter and voltmeter and the engine tachometer.

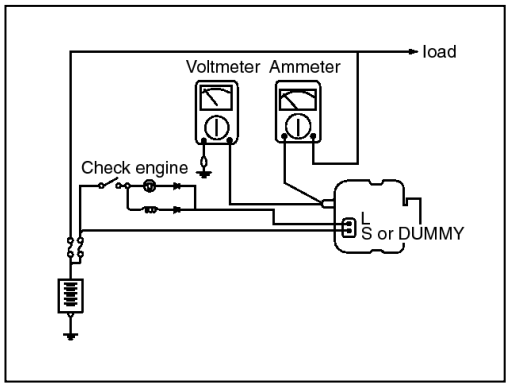
5. Connect the alternator output wire to the alternator "B" terminal.

6. Connect the battery ground cable.

Regulated Voltage Test

The purpose of this test is to check that the voltage regulator controls voltage correctly.

Preparation



1. Prior to the test, check the following items and correct if necessary. Check that the battery installed on the vehicle is fully charged. Check the alternator drive belt tension.

2. Turn ignition switch to "OFF".

3. Disconnect the battery ground cable.

4. Connect a digital voltmeter between the "B" terminal of the alternator and ground. Connect the (+) lead of the voltmeter to the "B" terminal of the alternator. Connect the (-) lead to good ground or the battery (-) terminal.

5. Disconnect the alternator output wire from the alternator "B" terminal.

6. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Connect the (-) lead wire of the ammeter to the disconnected output wire.

7. Attach the engine tachometer and connect the battery ground cable.

Test

1. Turn on the ignition switch and check to see that the voltmeter indicates the following value.

Voltage: Battery voltage

If it reads 0V, there is an open circuit in the wire between the alternator "B" terminal and the battery and the battery (-) terminal.

2. Start the engine. Keep all lights and accessories off.

3. Run the engine at a speed of about 2,500 rpm and read the voltmeter when the alternator output current drops to 10A or less.

Result

1. If the voltmeter reading is within 14.2 ~ 15.2 V, the voltage regulator is functioning correctly. If the reading is other than the standard value, the voltage regulator or the alternator is faulty.

2. Upon completion of the test, reduce the engine speed to idle, and turn off the ignition switch.

3. Disconnect the battery ground cable.

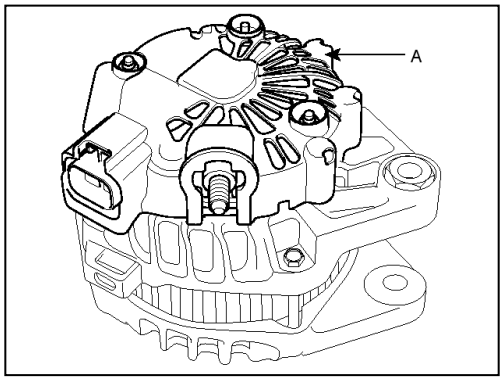
4. Remove the voltmeter and ammeter and the engine tachometer.

5. Connect the alternator output wire to the alternator "B" terminal.

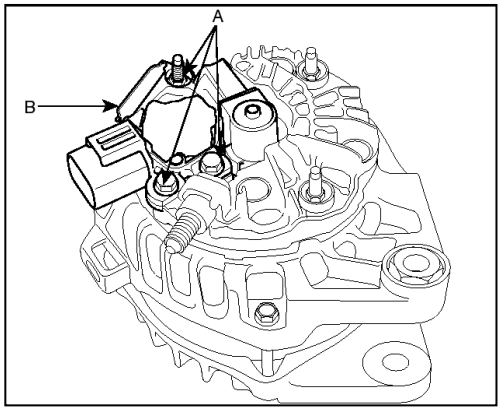
6. Connect the battery ground cable.

Disassembly

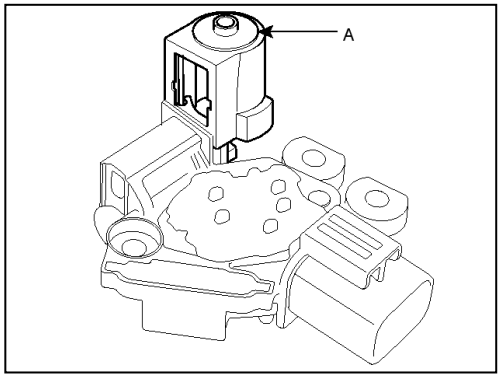
1. Remove the alternator cover (A).



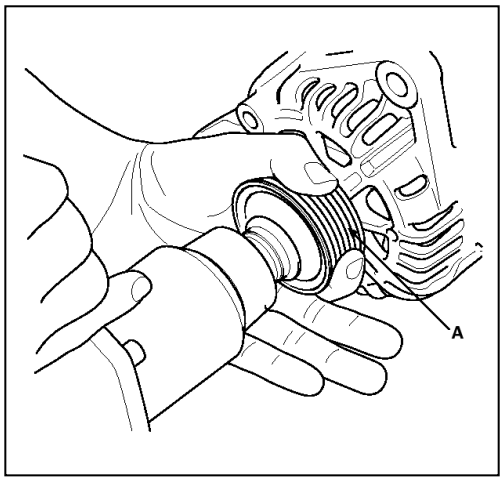
2. Loosen the mounting bolts (A) and disconnect the Regulator assembly (B).



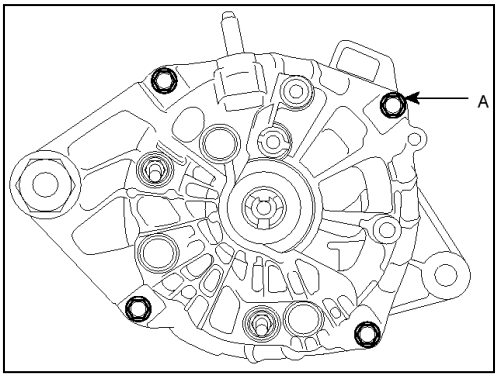
3. Remove the slip ring guide (A).



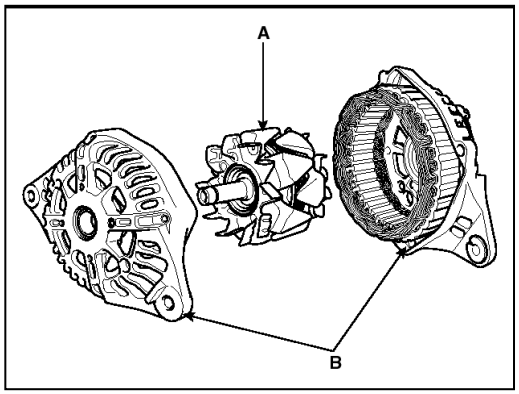
4. Remove the nut, pulley (A) and spacer.



5. Loosen the 4 through bolts (A).



6. Disconnect the rotor (A) and bracket (B).



7. Reassembly is the reverse of disassembly.

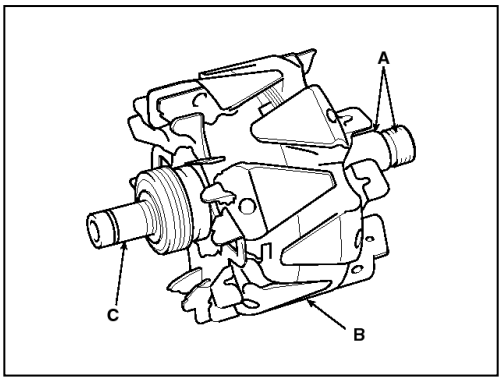
Inspection

Rotor

1. Check that there is continuity between the slip rings (C).

2. Check that there is no continuity between the slip rings and the rotor (B) or rotor shaft (A).

3. If the rotor fails either continuity check, replace the alternator

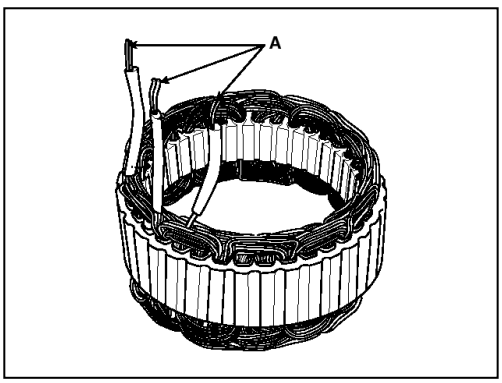


Stator

1. Check that there is continuity between each pair of leads (A).

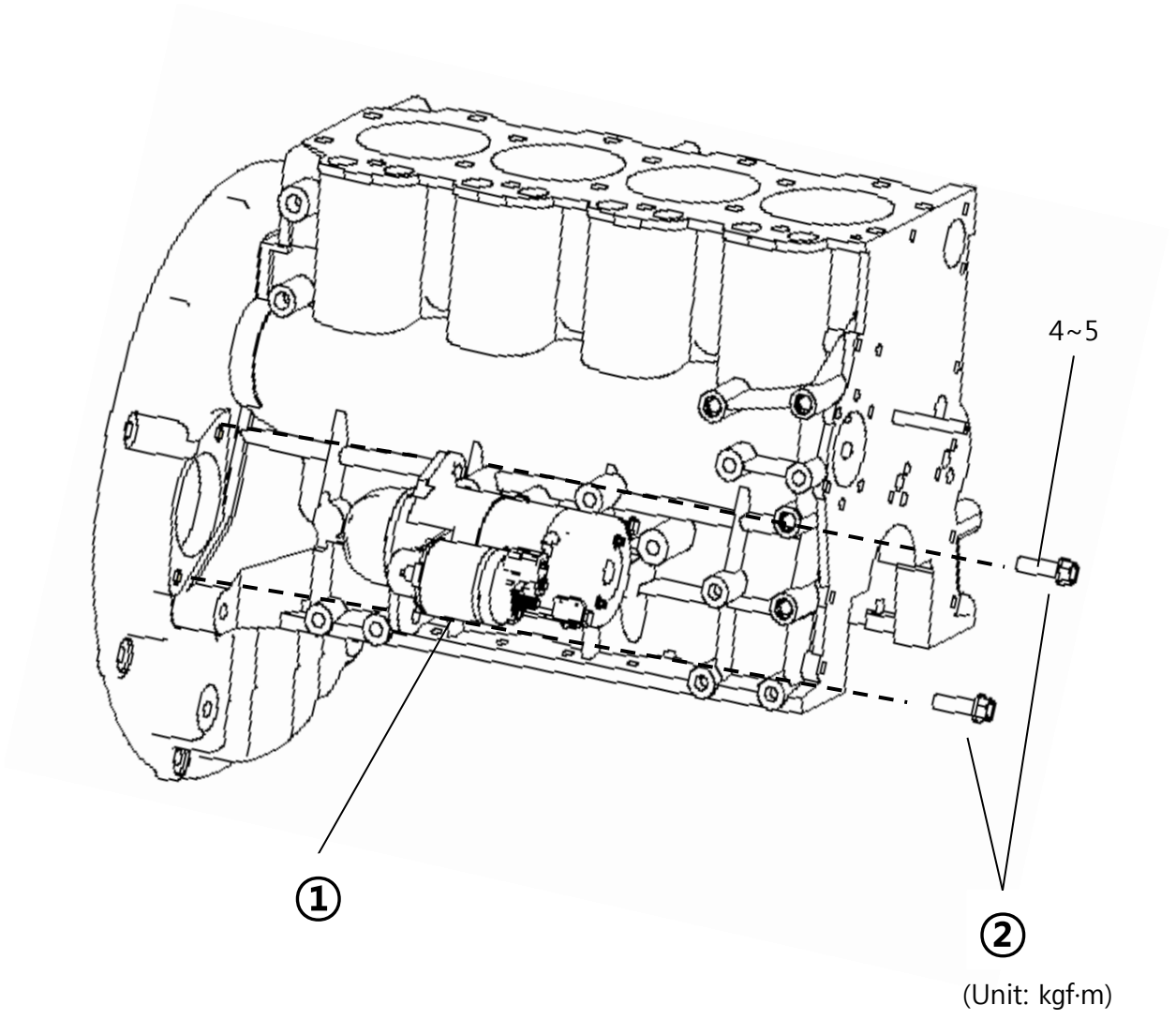
2. Check that there is no continuity between each lead and the coil core.

3. If the coil fails either continuity check, replace the alternator.



Removal and Installation

1. Disconnect negative (-) terminal of battery.
2. Remove parts in the sequence shown in the following Figure.
3. Install parts in reverse order.



1	Starter Assembly
2	Flange Bolt

Troubleshooting Charts

Symptom	Possible Cause	Corrective Action
Engine does not crank.	• Low charged battery	• Charge or replace battery after checking specific weight
	• Loose, rusty or worn battery cable	• Repair or Replace
	• Faulty fuse and wiring	• Repair or Replace
	• Faulty starter	• Repair or Replace
	• Faulty ignition switch	• Repair or Replace
Starter rotation speed is slow.	• Low charged battery	• Charge or replace battery after checking specific weight
	• Loose, rusty or worn battery cable	• Repair or Replace
	• Faulty starter	• Repair or Replace
Starter keep rotating.	• Faulty magnetic switch	• Repair or Replace
	• Faulty ignition switch	• Repair or Replace
	• Shorted wiring	• Repair
Starter slips. - Engine does not crank.	• Worn pinion gear or faulty starter	• Repair or Replace
	• Worn ring gear	• Replace

Specifications

Item		WC30D Engine
Starter	Type	Electronic press-fit
	Voltage (V)	12
	Output (kW)	2.2

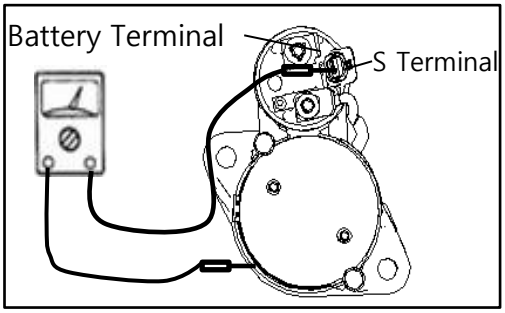
Maintenance Procedure

Pull-in Voltage

1. Check the battery voltage.
   Voltage: More than 12.4 V

2. Start the engine and Check that starter rotates smoothly.

3. Check S terminal voltage while starting the engine if the starter does not rotate.



   Voltage: More than 5 V
   - More than 8 V: Check the starter unit.
   - Less than 8 V: Check wiring (main fuse, ignition switch and inhibitor switch (ATX only)).

Magnetic Switch

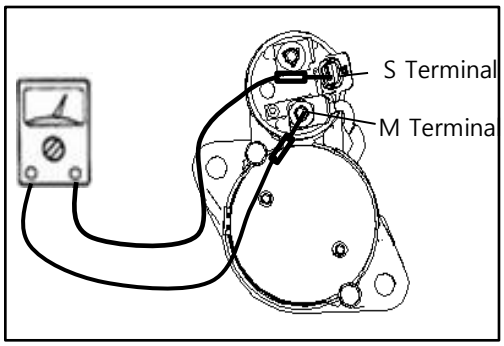
Pull-in Coil

NOTE

1) Disconnect negative (-) terminal of battery.

2) Disconnect M terminal of starter motor.

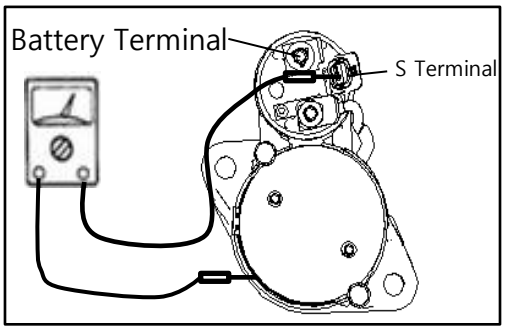
1. Check for continuity between S terminal and M terminal.



2. If there is no continuity, replace magnetic switch.

Hold-in Coil

1. Check for continuity between S terminal and switch body.

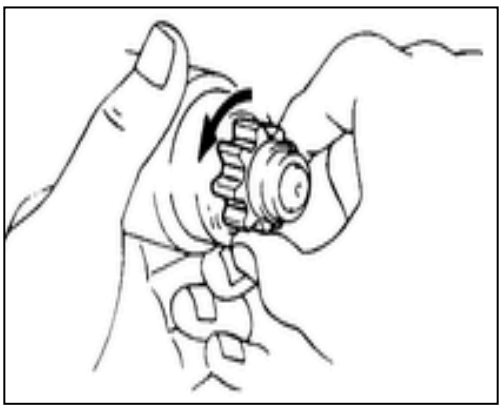


2. If there is no continuity, replace magnetic switch.

Check

Clutch and Gear

1. Check the gear teeth on the pinion gear, idle gear and clutch assembly for condition. Replace if damaged.



NOTE

If any damage is found, check ring gear on a flywheel for wear and damage.

2. Check pinion gear for rotation condition and replace clutch assembly if necessary.

NOTE

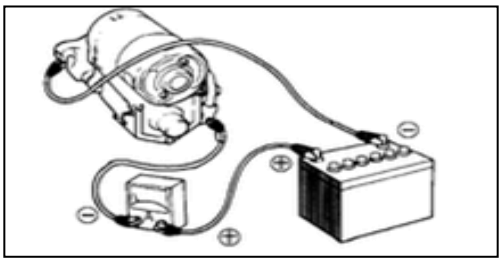
1) Clockwise: No rotation

2) Counter clockwise: Rotation

Cause of Failure	Symptom
Insufficient grease	Clutch seizure, armature burn out
Broken pinion teeth	Engine rotation decreases and gear noise is generated due to gear efficiency reduction.
Worn pinion end	Engine ring gear is worn.
Seized and worn pinion metal	Broken armature and lowered contact ratio caused by overrun increase gear noise.

No-load Check

1. Connect battery and ammeter to starter.



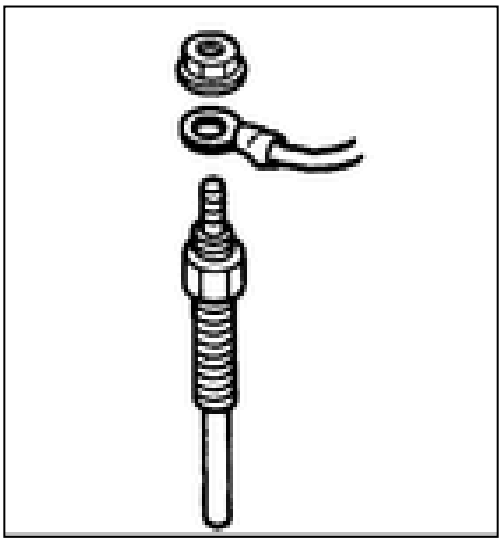
2. Check that starter rotates smoothly and steadily with pinion gear protruded.

3. Verify the specified current value with ammeter.
   Current: Maximum 130 A (at 11.0 V)

Removal and Installation

Remove the followings in order:

1. Glow plug connector tightening torque: 1.5-2.0 kgf·m
2. Glow plug connector
3. Glow plug

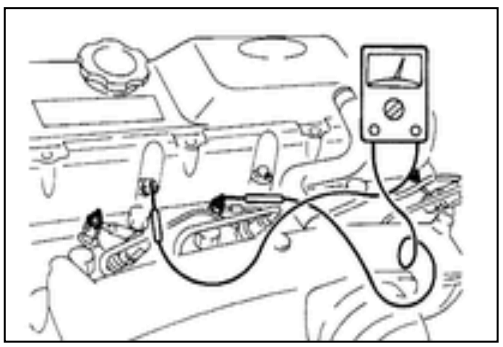


NOTE

Take care of assembly mark (red) on glow plug not to use unmatched glow plugs.

Check

1. Check for continuity between positive (+) pole of glow plug and cylinder head with multimeter.
2. Replace glow plug if there is no continuity.

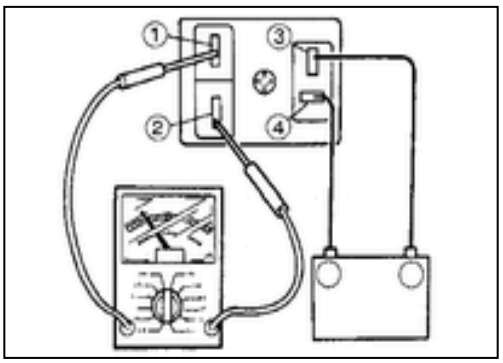


Glow Plug Relay

Check

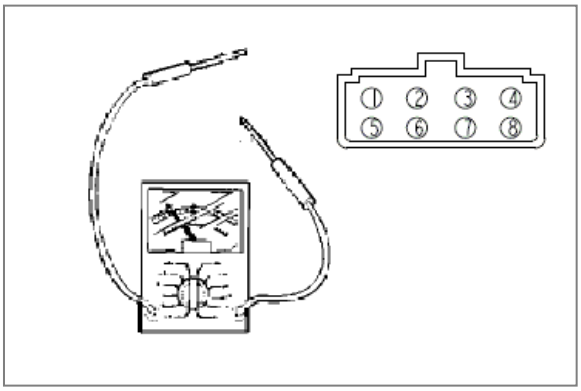
1. Check the coil resistance of glow plug relay (③, ④) with multimeter.

   Resistance: Approximately 13 Ω
2. Check for no continuity between terminals ① and ②.
3. Apply battery voltage to terminals (③, ④) and check for continuity between terminals ① and ②. Replace if necessary.



Inspection

1. Measure the resistance on each terminal of the glow control timer by ohmmeter.



2. Measurer resistance with ohmmeter between the terminal (+) ④,⑤,⑦ and (-) ③.

3. If measured resistance is not same as following as, replace it.

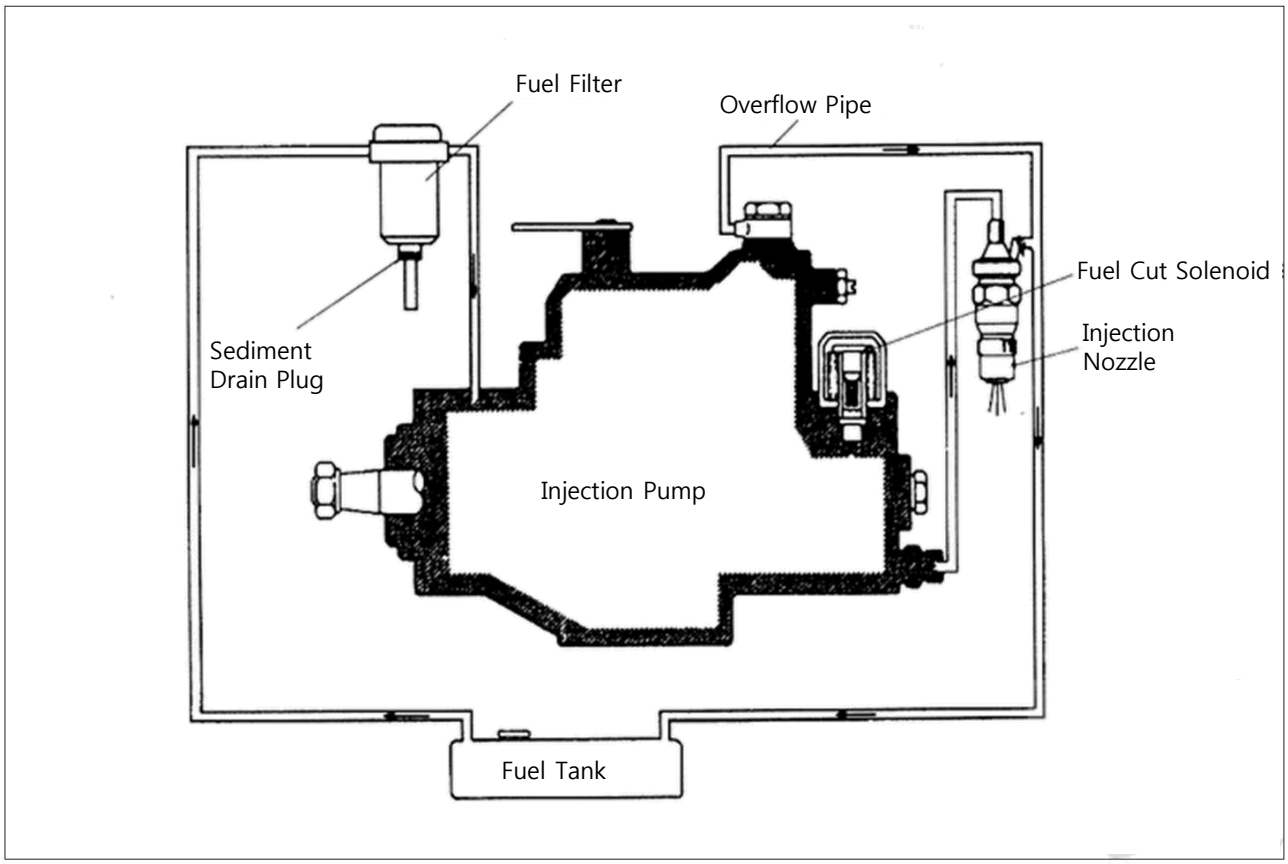
Each Resistance of terminal with grounded ③

④ : About 51㏀
⑤ : About 51 ㏀
⑦ : About 1.6~2㏁

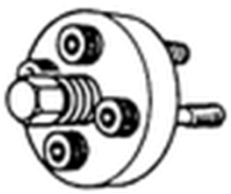
Chapter 4. Fuel System

1. Fuel System
2. Fuel Injection Nozzle
3. Mechanical Fuel Injection Pump
4. Fuel Filter

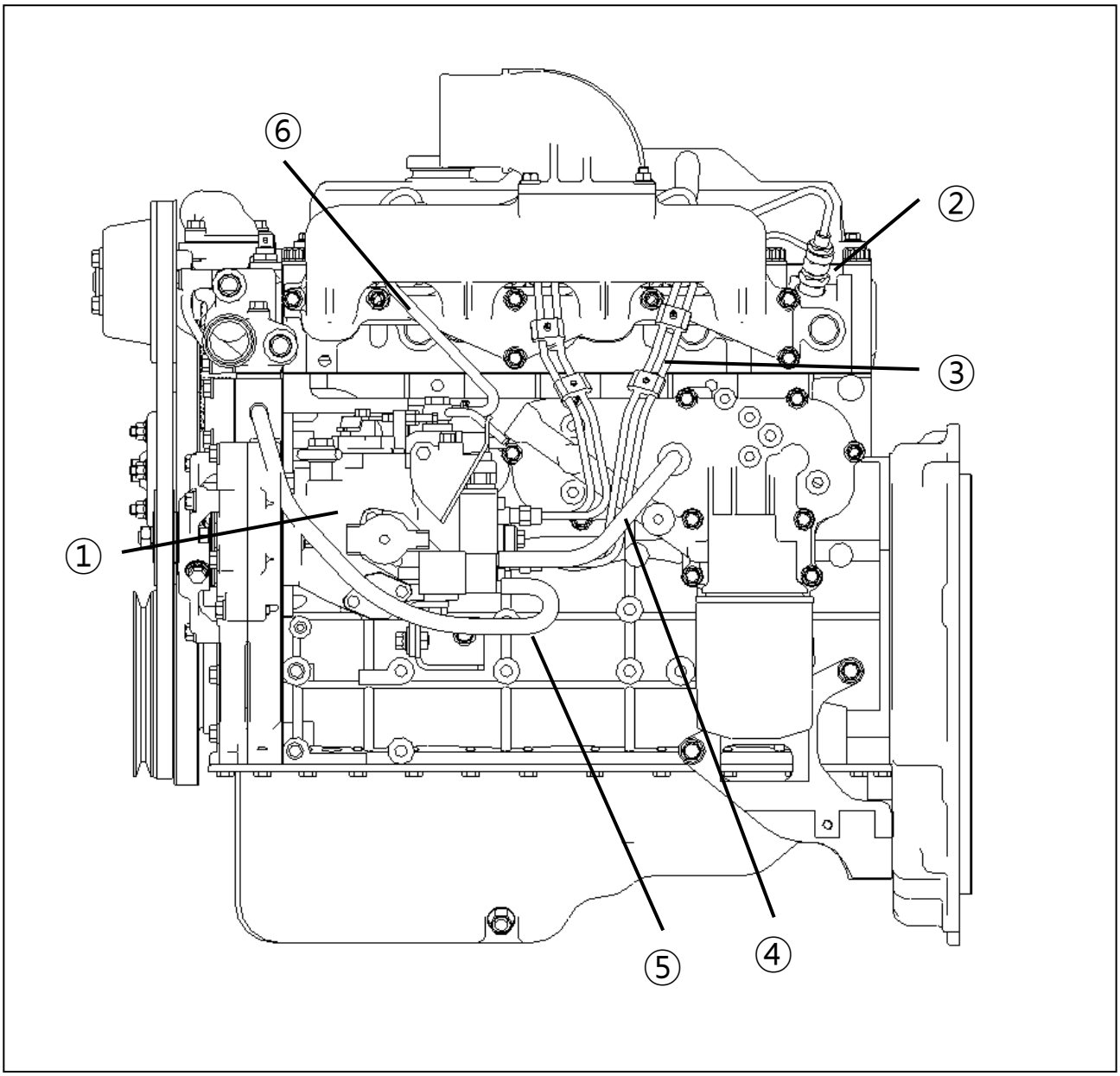
Schematic Diagram



Special Tools

Tool Name	Illustration	Application
0K670 131 010 Cam lift measuring device		To measure cam lift
0K670 131 005 Extractor		To remove injection pump gear

Schematic Diagram



NO	Nomenclature	NO	Nomenclature
1	Mechanical Fuel Injection Pump	4	CSD Hose #1
2	Fuel Injection Nozzle	5	CSD Hose #2
3	Fuel Injection Pipe	6	Fuel Return Hose

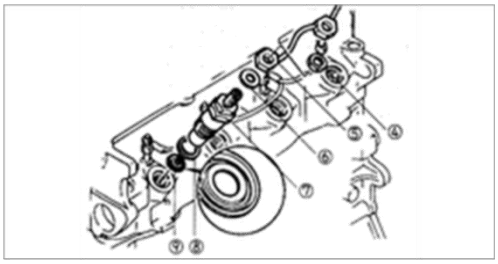
Specifications

Item		WC30D Engine
Fuel tank	Capacity	
Injection Pump	Type	Distribution Type (VE)
	Injection Timing	ATDC 7° (cam lift 1 ㎜) (cam lift 0.0394 in)
	Cam Lift	2.6 ㎜ (1.02 in)
	Direction of Rotation	Counterclockwise
	Type of Governor	ALL SPEED
	Driving Method	Gear Type
Idle Speed (rpm)		760~810
Fuel Filter (with sediment)		Cartridge (detector attached)
PCV Device	Type	Closed
Fuel Injection Nozzle	Nozzle Type	Throttle
	Orifice Diameter X Number	1.0 ㎜ (0.0394 in) X 1
	Injection Opening Pressure	135 kg/㎠ (13230 ㎪, 1918 psi)

Injector

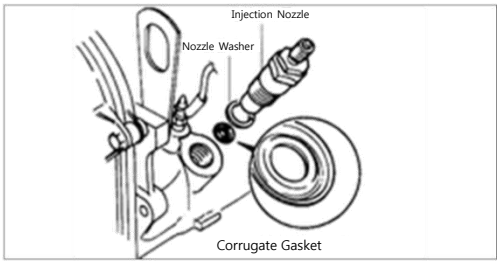
Removal

Remove the followings in order:



1. Battery negative (-) terminal
2. Fuel cut valve connector assembly
3. Fuel injection pipe
4. Fuel return pipe lock nut
5. Fuel return pipe
6. Washer
7. Fuel injection nozzle assembly
8. Nozzle washer
9. Corrugate washer

Important Safety Information during Installation



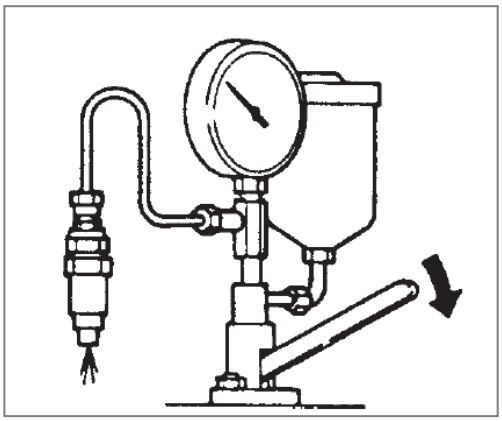
1. Washer and corrugate gasket shall not be reused.
2. The red painted surface must face towards injection nozzle when assembling corrugate gasket.
3. The specified torque must be applied to assemble injection nozzle.
   Tightening torque: 6.0-7.0 kgf·m (58.8~68.6 N·m, 43.4~50.6 lbf·ft)
4. Bleeding must be done after assembly of injection nozzle.

Check

NOTE

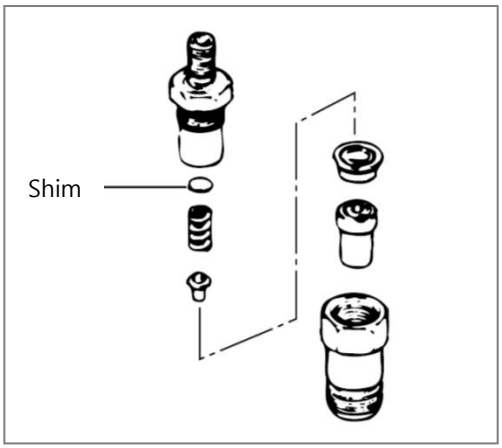
Check fuel injection nozzle using diesel at 20℃ .

1. Install nozzle to a nozzle tester and then activate handle several times to do bleeding.



2. Check opening pressure while slowly pressing against nozzle tester handle.
   Opening pressure: 135 kg/㎠
   (13230 ㎪, 1918 psi)

3. Adjust pressure using shim if opening pressure is not within the allowable value.



NOTE

1) Shim type: 0.50 ~ 1.54 ㎜ (0.02~0.04 in)
(total 27 types by 0.04 ㎜ (0.0016in))

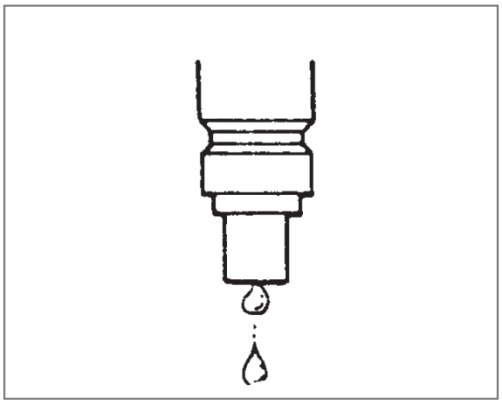
2) Adding 0.04 *㎜* adjusting shim increases the injection pressure by approx. *4.8 kg/㎠*
(471 ㎪, 68 psi)

4. If the opening pressure is not adjustable after the shim thickness is changed, replace injection nozzle with assembly.

Checking Needle Valve for Vibration

It is normal that tester handle makes its perculiar intermittent sound and the vibrations of needle valve travels to the handle while operating.

Injection Status



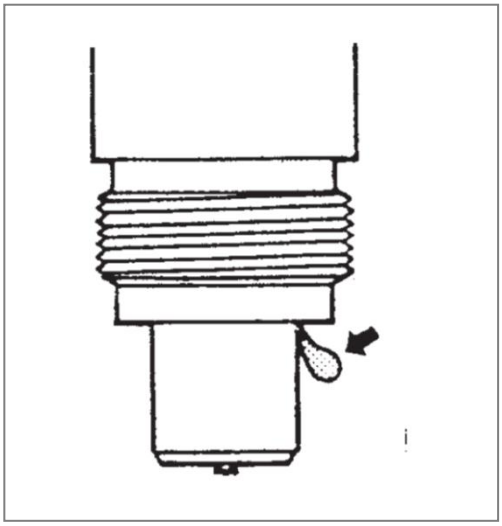
1. Check injection is good as shown in figure. Injected particle may be coarser and diesel may remain in injection hole, which occur when locked. It indicates nozzle functions normally.

2. Nozzle operates the handle of tester at speeds of 4 to 6 times per second.

3. Check injection is done at an angle of 0 degree and the status is good as shown in figure.

4. If unusual, remove injection nozzle and replace nozzle tube or with assembly.

Checking Nozzle for Oil Tightness



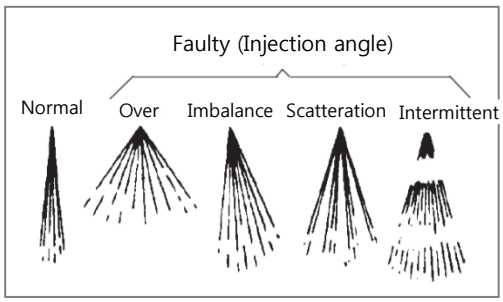
1. Test nozzle to maintain the pressure inside nozzle at 100 to 110 kg/㎠. (9807~10787 ㎪, 1422~1565 psi) Check nozzle tube for any fuel leaks.

2. If unusual, remove injection nozzle and replace nozzle tube or with assembly.

Atomizing Condition (Spray Pattern)

1. Install nozzle to a nozzle tester and then activate handle several times to do bleeding.

2. Without any pressure in nozzle, check atomizing condition by quickly pressing handle several times (Press the handle as quickly as possible so that pulsation noise is heard).
   (1) Fuel shall be atomized uniformly and properly.
   (2) Injection angle and direction shall be normal.

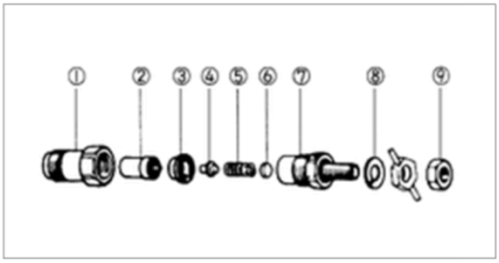


3. If atomization condition is not normal, disassemble injection nozzle to clean; then recheck or replace.

Disassembly

Disassemble the followings in order:

1. Retainer ring
2. Nozzle body and needle valve
3. Distance piece
4. Pressurizing pin
5. Compression spring
6. Shim
7. Nozzle holder
8. Washer
9. Nut



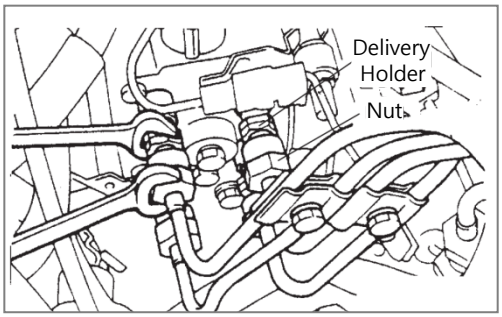
Assembly

1. Check opening pressure and atomization condition after assembly of injection nozzle.

2. The specified torque must be applied to assemble nozzle body and nozzle holder.
   Tightening torque: 3~5 kg/㎠ (294~490 ㎪, 43~71 psi) .

Removal of Injection Nozzle

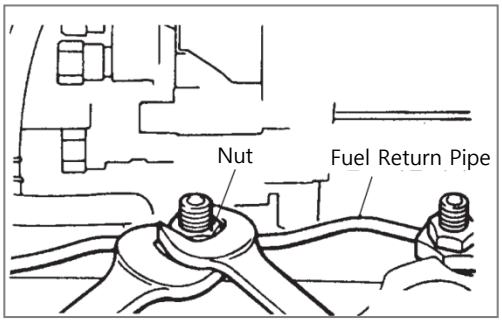
1. Loosen nuts on both ends of injection pipe with the opposite side (delivery holder on pump side, nozzle holder on nozzle side) secured using spanner.



2. Loosen nut from fuel return pipe with hex nut part secured using spanner.

CAUTION

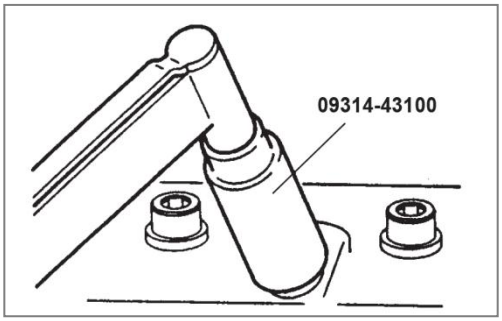
Loosening nut without fuel return pipe secured may cause damage to pipe.



3. Remove holder using special tool.

CAUTION

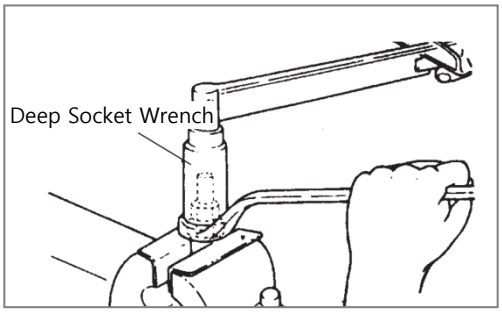
Attach a tag with cylinder number to removed injection nozzle holder.



Disassemble of Nozzle Holder

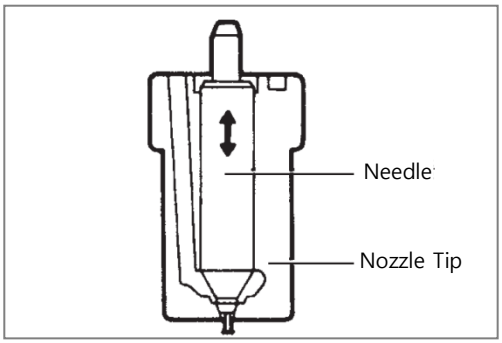
1. Slightly secure retaining nut using cushion bracket.

2. Secure retaining nut using box wrench and loosen nozzle holder body using deep socket wrench.



Nozzle Tip

1. Check nozzle tip for no carbon.
   If any, scrape off using a piece of wood and clean each part with cleaning oil (gasoline); then soak in diesel oil. Pay attention not to damage the needle valve of nozzle tip.

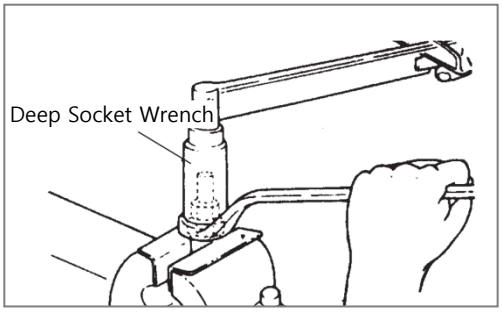


2. Soak nozzle tip in diesel oil and check needle valve for smooth operation.
   Replace any unusual one.
   Completely clean new nozzle tip with clean diesel oil prior to use.

3. Check "A" part of nozzle tip for deformation and brokenness. If any, replace.

Assembly of Retaining Nut

1. Firmly tighten nozzle holder body using hands.

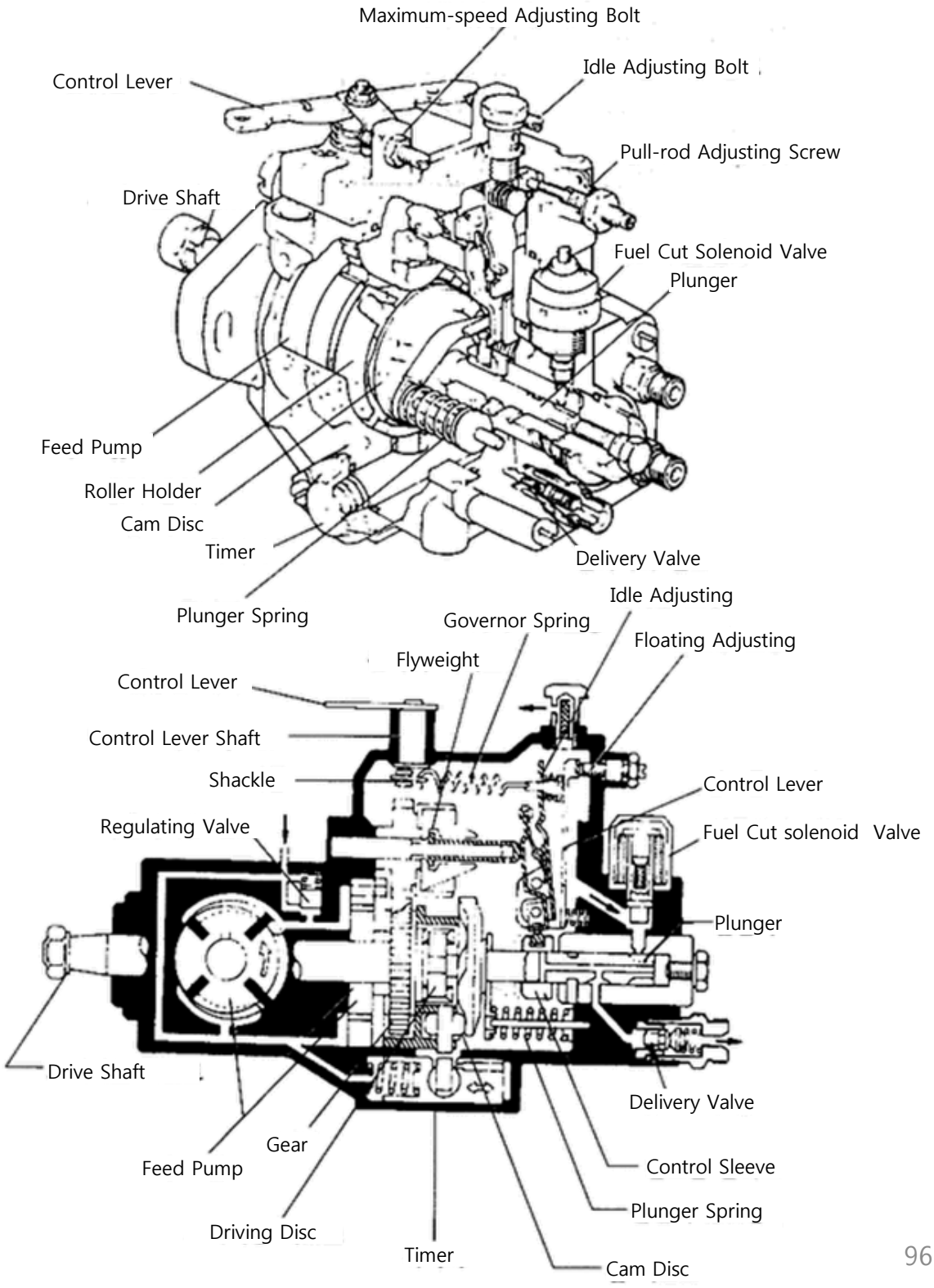


2. Slightly secure retaining bolt using vise with cushion plate.

3. Secure retaining nut using box wrench and tighten nozzle holder body to specified torque using deep socket wrench.

Mechanical Fuel Injection Pump

System Diagram



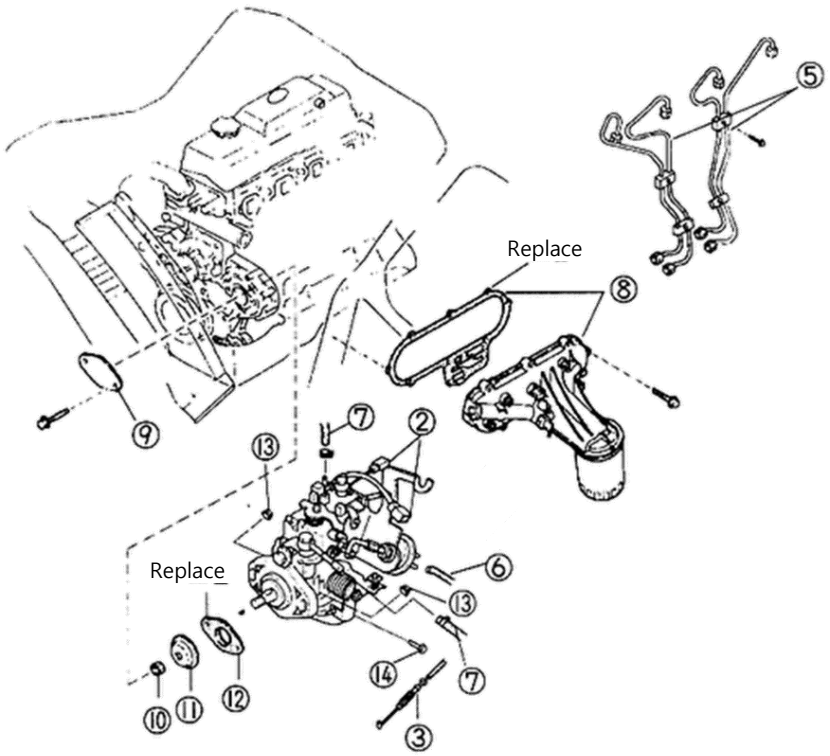
Removal and Installation

1. Disconnect battery negative (-) terminal.
2. Remove parts in the sequence shown in the following Figure, as indicated in reference.
3. Check all parts. Repair or replace if necessary.
4. Install parts in reverse order.

CAUTION

1) Check injection timing and then adjust the injection timing if necessary.

2) Do bleeding from injection pump after installation.



1	PCV Hose and Intake Manifold Assembly	9	Injection Pump Cover
2	Fuel Cut Solenoid Valve, Pickup Coil	10	Nut
3	Accelerator Cable	11	Washer
5	Injection Pipe	12	Gasket
6	Vacuum Hose	13	Nut
7	Fuel Hose	14	Bolt
8	Oil Filter Assembly		

Check

1. Allow the engine to warm up until it reaches normal temperature.
   Coolant temperature: 60℃ (140℉) or more

2. Measure the engine idling rpm using tachometer.
   Idling rpm: 760~810 rpm

If idling rpm exceeds the standard value, adjust it as follows:

Check

1. Disconnect battery negative (-) terminal and fuel cut solenoid valve connector.

2. Disconnect intake hose.

3. Disconnect fuel injection pipe from injection pump.

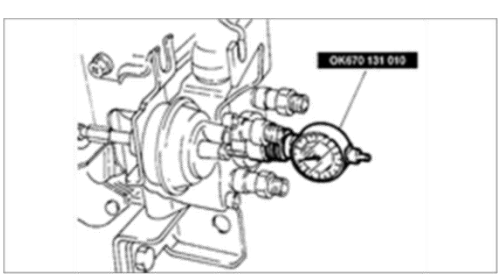
4. Slowly rotate crankshaft a turn clockwise and then repeat counterclockwise. Align crankshaft with TDC.

5. Disconnect hydraulic head plug on injection pump and insert STT (OK670 131 010) into plug hole on hydraulic head; then install dial gauge in such that indicator reaches the plunger of pump.

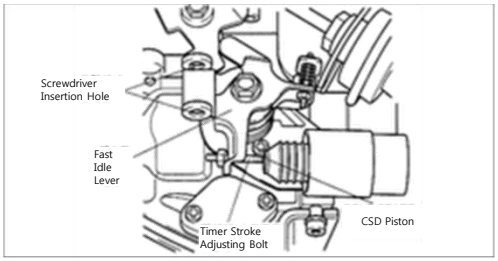
CAUTION

Make sure that there are no fuel leaks from injection pump while disassembling it.

Dial gauge must be installed so that the indicator of gauge indicates 2 ㎜ (0.079 in).



6. Remove CSD from injection pump.
   (1) Turn fast idle lever clockwise using screwdriver and insert 8~10 ㎜ (0.315~0.394 in) shim between CSD piston and timer stroke adjusting bolt.

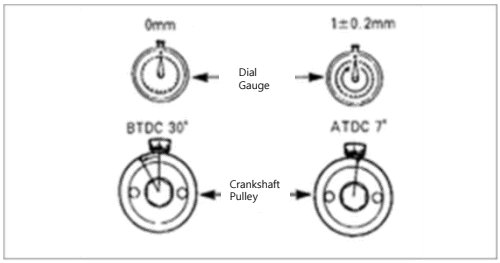


   (2) Make sure there is clearance between fast idle lever on CSD and control lever.

7. Slowly turn crankshaft pulley counterclockwise (the opposite direction of engine rotation) until dial gauge indicator does not move.

CAUTION

Dial gauge needle is stopped if crankshaft turns approx. 30˚~50˚ BTDC.



8. Adjust dial gauge indicator to 0 by turning crankshaft to right and left and then verify the position of dial gauge indicator again.

CAUTION

Make sure that dial gauge indicator is positioned to '0' when turning crankshaft pulley to right and left after adjusting dial gauge indicator to "0".

9. Rotate crankshaft pulley clockwise (the direction of engine rotation) and place to 7˚ ATDC to read dial gauge indicator.
   Standard value: 1 ± 0.02 ㎜ (0.0394 ±0.000787 in) (lift)

10. If dial gauge needle is not within the specified value, allow gauge indicator to indicate 0.98~1.02 ㎜ (0.0386~0.0402 in) (at 7˚ ATDC) by inclining the upper section of injection pump towards engine or the outside of engine.

11. Tighten two flange nuts on injection pump.
    Tightening torque: 1.5~2.2 kgf·m (14.7~21.6 N·m, 10.8~15.9 lbf·ft)

12. Tighten two flange bolts on injection pump.
    Tightening torque: 2.0~2.7 kgf·m (19.6~26.5 N·m, 14.5~19.5 lbf·ft)

13. Make sure that dial gauge indicator indicates 0.98-1.02 ㎜ (at 7˚ ATDC).
    If gauge needle is not within the allowable value, repeat steps 10 through 12.

14. Remove measuring instrument from injection pump.

15. Insert a new gasket and install cap.
    Tightening torque: 1.4~2.0 kgf·m (13.7~19.6 N·m, 10.1~14.5 lbf·ft)

16. Temporarily fix injection pump and tighten four nuts to pump.
    Tightening torque: 2.5~3.0 kgf·m (24.5~29.4 N·m, 18.1~21.7 lbf·ft)

17. Start engine and check for fuel leaks.

CAUTION

Do bleeding after adjustment of injection timing.

Cam Lift Check

1. Perform injection pump check procedure.

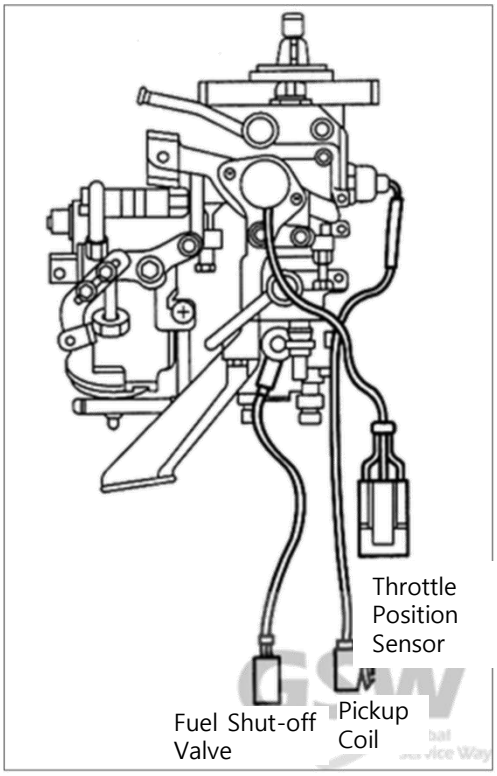
2. Rotate alternator pulley clockwise (the direction of engine rotation) to read the maximum value indicated by dial gauge.
   Cam lift: 2.6 ㎜ (0.1024 in)

NOTE

Cam lift less than the allowable value will cause problems in cam disc or roller assembly.

Fuel Cut Solenoid Valve Check

1. Check for engine stop when removing fuel cut solenoid valve connector with the engine running.
   Check associated wiring if engine does not stop. If the wiring is normal, replace fuel cut solenoid valve.



Pickup Coil Check

1. Disconnect pickup coil connector.
2. Check for continuity using multimeter.
3. If there is no continuity, replace pickup coil.

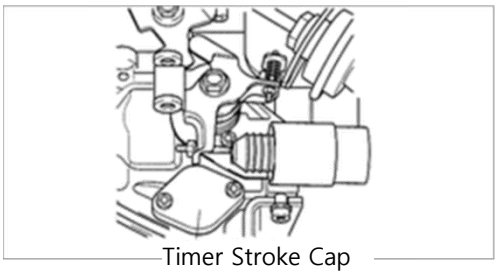
Cold Start Device Check

1. Disconnect injection pump from engine.

2. Remove timer stroke cap from injection pump.

3. Install timer stroke gauge in hole.

4. Set gauge indicator to zero by turning adjusting bolt of timer stroke.


Timer Stroke Cap

5. Check gauge indicator of timer stroke depending on the temperature of CSD.

   Allowable value: Stroke = -0.072 t + 1.71 ㎜ (-10 ℃, 14°F)
   Stroke = -0.068 t + 1.74 (10 ℃, 50°F)
   Stroke = 0 ㎜ (t > 25 ℃, 77°F)

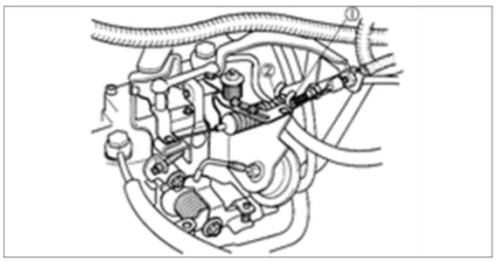
6. If gauge indicator is not within the allowable value, adjust timer stroke by turning adjusting bolt.

7. Remove timer stroke gauge and install timer stroke cap.

Idle Speed Adjustment

1. Run engine at idle.
   (1) Shift transmission to neutral position.
   (2) Set steering to neutral position.
   (3) Set power to OFF position.

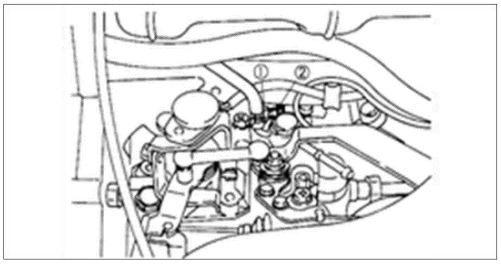
2. Check accelerator cable for deflection.
   Deflection: 1~3 ㎜ (0.0394~0.1181 in)



CAUTION

If deflection exceeds the specified value, loosen lock nut ① of accelerator cable and turn nut ② to adjust it.

3. Loosen lock nut ① of idle speed adjusting bolt and turn nut ② to adjust Idle speed.
   Tightening torque: 0.5~0.9 kgf·m
   (4.9~8.8 N·m, 3.6~6.5 lbf·ft)

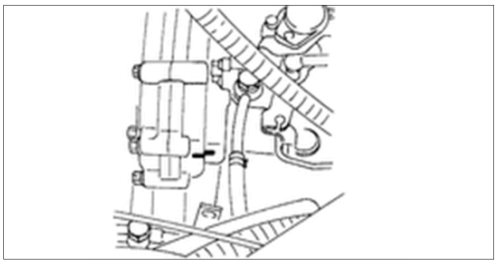


CAUTION

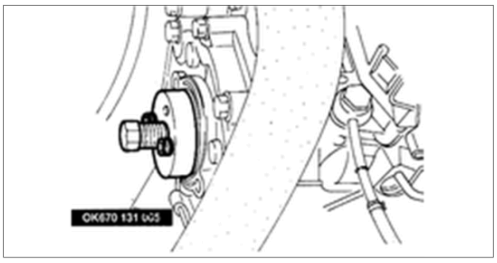
1) Turning the adjusting bolt clockwise will increase idle speed, and turning counterclockwise decrease idle speed.
2) Make sure the adjusting lever operates properly after adjusting the bolt.

Removal and Installation

1. Make matching mark on the injection pump flange and the bracket.



2. Remove lock nut of injection pump using SST.



CAUTION

Be careful not to damage woodruff key assembled to pump.

Fuel Filter

Check

1. If fuel tank is defueled and refueled during maintenance.

2. If fuel filter is replaced

3. If fuel main hose (pipe) is removed
   1) Remove air plug from fuel filter.
   2) Cover around air plug hole with cloth and repeat pumping and then tighten the air plug.
   3) Repeat until resistance is felt during pumping.

Draining Water from Fuel Filter

If fuel filter warning light comes on due to full of water in the filter, then drain the water in the following sequence:

1. Remove drain plug.

2. Drain water by operating manual pump and then tighten drain plug by hand.