



1. Maintenance

1.1 Diagnosis and troubleshooting

1.1.1 Start problems

1. The starter motor fails to work.		
Check	Causes	Remedies
Battery	The battery terminal post is loose. There is bad connection caused by oxidation or corrosion.	Clean and/or tighten the loose terminal post(s)
	The battery is uncharged or in shortage of charge.	Charge the battery or replace the old battery with a new one
	The belt of fan is loose or broken.	Adjust the belt of fan, or replace it
Fuse	The fuse is short circuited.	Replace the fuse with a new one
Starter switch	The starter switch or relay has failed.	Replace the starter switch or relay
Starter motor	The solenoid switch has failed.	Repair or replace the solenoid switch
	The starter motor has failed.	Repair or replace the starter motor
2. The starter motor works well, but the engine fails to run.		
Battery	The battery terminal post is loose. There is bad connection caused by oxidation or corrosion.	Clean and/or tighten the loose battery terminal post(s)
	The battery is uncharged or in shortage of charge.	Charge the battery or replace the old battery with a new one
	The belt of fan is loose or broken.	Adjust the belt of fan, or replace it
Starter motor	The pinion is broken.	Replace the broken pinion
	The solenoid switch has failed.	Repair or replace the solenoid switch
	The brush is worn or the brush spring is too soft.	Replace the brush and/or the brush spring
Engine	The piston or crankshaft bearing is jammed or damaged.	Repair or replace the damaged part(s)

3. The engine rotates but it cannot be ignited to start.		
Check	Causes	Remedies
Brake mechanism of engine	The fuel cut-off solenoid valve is broken.	Replace the fuel cut-off solenoid
The fuel fails to flow into the injection pump.		
Fuel	The fuel tank is empty.	Fill in the fuel tank
Fuel pipe system	The fuel pipe is clogged or broken. The fuel tube joint is loose.	Repair or replace the fuel pipe Retighten the fuel tube joint
Fuel filter	The fuel filter overflow valve cannot be closed.	Repair or replace the fuel filter overflow valve

✖		A fuel filter component is clogged.	Replace the fuel filter component or the filter element
	Fuel system	There is air in the fuel system.	Release the air from the fuel system
	Fuel feed pump	The fuel feed pump is broken.	Repair or replace the fuel feed pump
	The fuel flows into the injection pump.		
	Fuel	The fuel in service is incorrect.	Use the correct fuel
		There is water in the fuel system.	Replace the fuel
	Fuel system	There is air in the injection pump.	Release the air from the fuel system
	Fuel injector	The fuel injector is jammed.	Replace the fuel injector
		The opening pressure of fuel injector is too low.	Adjust or replace the fuel injector
		Atomizing is bad.	
	Injection pump	The damage of fuel injector results in fuel dripping after injection.	Replace the delivery valve
		Something is wrong with the control rack of injection pump.	Repair or replace the control rack of injection pump
		The injection pump plunger is worn or jammed.	Repair or replace the injection pump plunger assembly
		The drive shaft of injection pump is jammed or damaged.	Replace the drive shaft
		The governor spring of injection pump is jammed.	Replace the governor spring of injection pump

4. Quick start system

Preparation work		
1. Disconnect the connector of temperature switch		
2. Verify whether the glow plug is power on		
a) Confirm the start switch is at OFF position		
b) Use voltmeter to connect cylinder wall with any glow plug		
c) Switch the start switch to the ON position		
If the glow plug is power on, the voltmeter indicates 12 V. If the pointer of voltmeter doesn't move, it means the glow plug is power off.		
3. Trouble shooting		
The glow plug is power on.		
Check	Causes	Remedies
The indicator lamp of glow plug is off.	The indicator lamp is broken.	Replace the indicator lamp
Quick start timer	The quick start timer is broken.	Replace the quick start timer
The indicator lamp of glow plug is on for 0.3 s.	The quick start timer is broken.	Replace the quick start timer

✖	The indicator lamp of glow plug is on for 3.5 s.	After the engine is started, switch the start switch from ST (start) to ON. If the relay of glow plug keeps closed for less than 14 s, it indicates something is wrong with the quick start timer.	Replace the quick start timer
		Switch the start switch from OFF to ON. If the relay of glow plug keeps closed for less than 14 s, it indicates something is wrong with the quick start timer.	Replace the quick start timer
	Temperature switch	The temperature switch is broken.	Replace the temperature switch
	Connectivity of glow plug	The connectivity of glow plug is bad.	Replace the glow plug
The glow plug is power off.			
	The indicator lamp of glow plug is off.	The fuse of indicator lamp blows out.	Replace the broken fuse
	Quick start timer	The quick start timer is broken.	Replace the quick start timer
	The indicator lamp of glow plug is on for 3.5 s.	The glow plug relay is broken. When the start switch is switched from OFF to ON, the glow plug relay is not switched on.	Replace the glow plug relay
		The quick start timer is broken.	Replace the quick start timer
		A line fault occurs in the circuit of glow plug relay.	Repair or replace corresponding line(s)
		The fuse blows out or there is a line fault. When the start switch is switched from OFF to ON, the glow plug relay is switched on.	Replace the fuse or corresponding line(s)

1.1.2 Unstable idle speed

Check	Causes	Remedies
Idle speed system	The idle speed is not proper.	Adjust the idle speed
High idle speed control device	The high idle speed control device is broken.	Repair or replace the high idle speed control device.
Throttle control system	The adjustment of throttle control system is not proper.	Adjust the throttle control system
Fuel system	Leakage or blockage occurs in the fuel system.	Repair or replace the fuel system
	There is air in the fuel system.	Release the air from the fuel system
	There is water in the fuel system.	Replace the fuel

✖	Fuel filter	A fuel filter component is clogged.	Replace the fuel filter component or the filter element.
	Fuel feed pump	The fuel feed pump is broken.	Repair or replace the fuel feed pump.
	Fuel injector	The fuel injector is jammed.	Replace the fuel injector
		The opening pressure of fuel injector is too low. Atomizing is bad.	Adjust or replace the fuel injector
	Injection pump	The damage of delivery valve results in fuel dripping after injection.	Replace the delivery valve
		Injection timing is not proper.	Adjust injection timing
		The injection volume is too low.	Increase injection volume
		The idle speed spring is broken.	Replace the idle speed spring
		The shifter is broken	Repair or replace the shifter
		The regulator valve is not at proper position.	Adjust or replace the regulator valve
		The plunger spring is broken	Replace the plunger spring
		The plunger is worn.	Replace the plunger assembly
		The cam is worn.	Replace the worn cam
	Valve clearance	The valve clearance is not proper.	Adjust the valve clearance
	Compression pressure	The gasket of cylinder head is worn.	Replace relevant parts
		The cylinder liner is worn. The piston ring is sticky.	

1.1.3 Insufficient power

Check	Causes	Remedies
Air filter	An air filter component is clogged.	Clean or replace the filter component
Fuel	There is water in the fuel.	Replace the fuel
Fuel filter	A fuel filter component is clogged.	Replace the fuel filter component or the filter element
Fuel feed pump	The fuel feed pump is broken.	Repair or replace the fuel feed pump
Fuel injector	The fuel injector is jammed.	Replace the fuel injector
	The opening pressure of fuel injector is too low. Atomizing is bad.	Adjust or replace the fuel injector
High pressure fuel pipe	The high pressure fuel pipe is damaged or blocked.	Replace the high pressure fuel pipe
Injection pump	The regulator valve is damaged.	Repair or replace the regulator valve

✕		The delivery valve is damaged.	Replace the delivery valve
		The timer is broken.	Repair or replace the timer
		The cam is worn.	Replace the worn cam
		The control lever doesn't work well.	Adjust or replace the control lever
		The injection timing is not correct.	Adjust injection timing Repair or replace the injection pump timer
		The governing spring is too soft.	Replace the governing spring
		The plunger is worn.	Replace the plunger assembly
	Compression pressure	The gasket of cylinder head is worn. The cylinder liner is worn. The piston ring is sticky.	Replace relevant parts
	Valve clearance	The valve clearance is not proper.	Adjust the valve clearance
	Valve spring	The valve spring is too soft or broken.	Replace the valve spring
	Exhaust system	The exhaust pipe is clogged.	Clean the exhaust pipe
	Seal of full-load adjusting screw	The seal of adjusting screw is opened or improperly adjusted.	Properly adjust the seal of adjusting screw and seal again

1.1.4 High fuel consumption

Check	Causes	Remedies
Fuel system	There is a fuel leak.	Repair or replace corresponding parts of fuel system
Air filter	An air filter component is clogged.	Clean or replace the air filter component
Idle speed	The idle speed is not adjusted properly.	Adjust the idle speed
Fuel injector	The opening pressure of fuel injector is too low. Atomizing is bad.	Adjust or replace the fuel injector
Fuel injection timing	Fuel injection timing is not correct.	Adjust the fuel injection timing
Injection pump	The damage of delivery valve results in fuel dripping after injection.	Replace the delivery valve
Valve clearance	The valve clearance is not proper.	Adjust the valve clearance
Compression pressure	The gasket of cylinder head is worn. The cylinder liner is worn. The piston ring is sticky.	Replace relevant parts
Valve spring	The valve spring is too soft or broken.	Replace the valve spring

✖ 1.1.5 High oil consumption

Check	Causes	Remedies
Engine oil	The oil type is not correct.	Replace the engine oil
	The oil volume is too high.	Adjust the oil level
Oil seal and gasket	The oil leaks from the oil seal and/or gasket.	Replace the oil seal and/or gasket
Air vent	The air vent is blocked.	Clean the air vent
Intake valve and exhaust valve	The valve stem and valve guide are worn.	Replace intake valve, exhaust valve and valve guide

1.1.6 Engine overheating

Check	Causes	Remedies
Cooling water	The cooling water is insufficient.	Supply enough cooling water
Fan clutch	The oil leaks from the fan clutch.	Replace the fan clutch
Fan belt	Loose or damaged fan belt results in slipping.	Replace the fan belt
Radiator	The radiator cap is damaged or the radiator core is blocked.	Replace the radiator cap or clean the radiator core
Water pump	The water pump is broken.	Repair or replace the water pump
Cylinder head and cylinder block Sealed cap	Damaged cylinder head results in leakage of cooling water.	Replace the sealed cap
Thermostat	The thermostat is broken.	Replace the thermostat
Cooling system	The cooling system is clogged by foreign matters.	Remove foreign matters from the cooling system
Fuel injection timing	Fuel injection timing is not correct.	Adjust the fuel injection timing

1.1.7 White smoke coming out of engine exhaust

Check	Causes	Remedies
Cooling water	The cooling water is insufficient.	Supply enough cooling water
Fuel	There is water in the fuel system.	Replace the fuel
Fuel injection timing	Fuel injection timing is delayed.	Adjust the fuel injection timing
Compression pressure	The gasket of cylinder head is worn. The cylinder liner is worn. The piston ring is sticky.	Replace relevant parts
Intake valve and exhaust valve Valve oil seal	The valve oil seal is worn. The valve stem and valve guide are worn.	Replace valve oil seal, valve and valve guide

✖ 1.1.8 Black smoke coming out of engine exhaust

Check	Causes	Remedies
Air filter	An air filter component is clogged.	Clean or replace the air filter component
Fuel injector	The opening pressure of fuel injector is too low. Atomizing is bad.	Adjust or replace the fuel injector
Fuel injection timing	Fuel injection timing is not correct.	Adjust the fuel injection timing
Injection pump	The damage of delivery valve results in fuel dripping after injection.	Replace the delivery valve
	The injection volume is too high.	Reduce injection volume

1.1.9 Low oil pressure

Check	Causes	Remedies
Engine oil	The oil viscosity is not correct. The oil volume is too low.	Replace the engine oil Increase the oil volume
Oil pressure gauge or assembly	The oil pressure gauge or assembly is broken.	Repair or replace the oil pressure gauge or assembly
Oil pressure indicator light	The indicator light is broken.	Replace the indicator light
Oil filter	An oil filter component is clogged.	Replace the oil filter component or the filter element
Safety valve and bypass valve	The safety valve is jammed and/or the bypass valve spring is too soft.	Replace the safety valve and/or bypass valve spring
Oil pump	The oil pump strainer is blocked.	Clean the oil pump strainer
	A component in the oil pump is worn.	Replace relevant parts in the oil pump.
Rocker shaft	The rocker shaft bearing is worn.	Replace the rocker shaft bearing
Camshaft	The camshaft and its bearing are worn.	Replace the camshaft and its bearing
Crankshaft and bearing	The crankshaft and its bearing are worn.	Replace the crankshaft and/or its bearing

1.1.10 Abnormal engine noise

1. Engine slap Verify the engine is completely warmed up before troubleshooting.		
Check	Causes	Remedies
Fuel	The fuel is not correct.	Replace the fuel
Fuel injection timing	Fuel injection timing is not proper.	Adjust the fuel injection timing
Fuel injector	The opening pressure of fuel injector or atomizing is not proper.	Adjust or replace the fuel injector

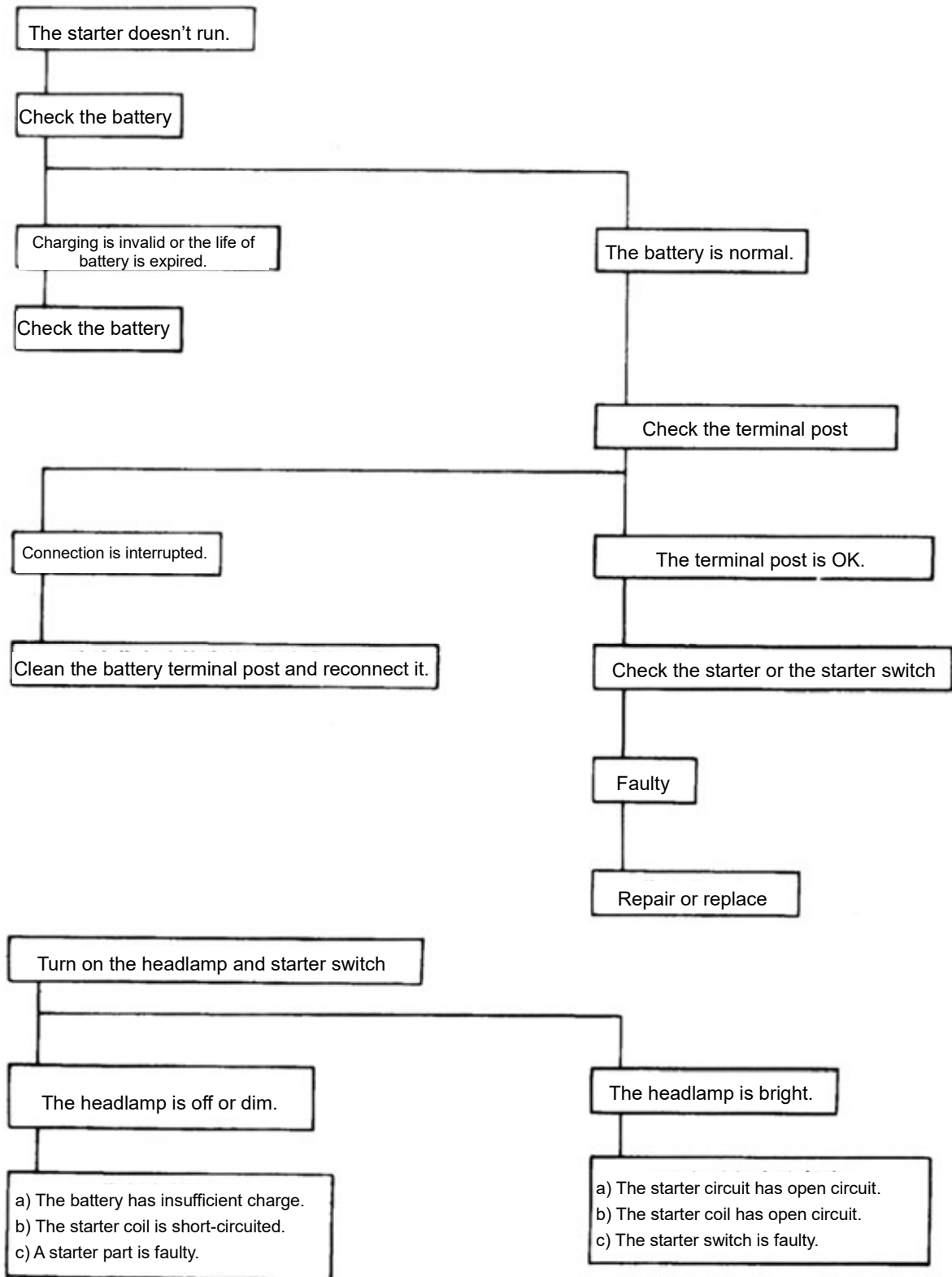
	Compression pressure	The gasket of cylinder head is worn. The piston ring is broken.	Replace the gasket of cylinder head or piston ring
	2. Air leak noise		
	Exhaust pipe	The connection of exhaust pipe is loose. The exhaust pipe is broken.	Tighten the connection of exhaust pipe Replace the exhaust pipe
	Fuel injector and/or glow plug	The fuel injector and/or glow plug are loose.	Replace the gasket Tighten the fuel injector and/or glow plug
	Exhaust manifold	The connection to exhaust manifold is loose.	Tighten the connection to exhaust manifold
	Cylinder head gasket	The cylinder head gasket is worn.	Replace the cylinder head gasket
	3. Continuous noise		
	Fan belt	The fan belt is loose.	Adjust the tightness of fan belt again.
	Cooling fan	The cooling fan is loose.	Retighten the cooling fan
	Water pump bearing	The water pump bearing is worn or damaged.	Replace the water pump bearing
Alternator or vacuum pump	The alternator or vacuum pump is broken.	Repair or replace the alternator or vacuum pump	
Valve clearance	The valve clearance is not proper.	Adjust the valve clearance	
4. Clapping noise			
Check	Causes	Remedies	
Valve clearance	The valve clearance is not proper.	Adjust the valve clearance	
Rocker arm	The rocker arm is broken.	Replace the rocker arm	
Flywheel	The flywheel bolt is loose.	Retighten the flywheel bolt	
Crankshaft and thrust bearing	The crankshaft and/or thrust bearing is worn or damaged.	Replace the crankshaft and/or thrust bearing	
Crankshaft and connecting rod bearing	The crankshaft and/or connecting rod bearing is worn or damaged.	Replace the crankshaft and/or connecting rod bearing	
Connecting rod bushing and piston pin	The connecting rod bushing and piston pin are worn or damaged.	Replace the connecting rod bushing and/or piston pin	
Piston and cylinder liner	The piston and cylinder liner is worn or damaged.	Replace the piston and cylinder liner	

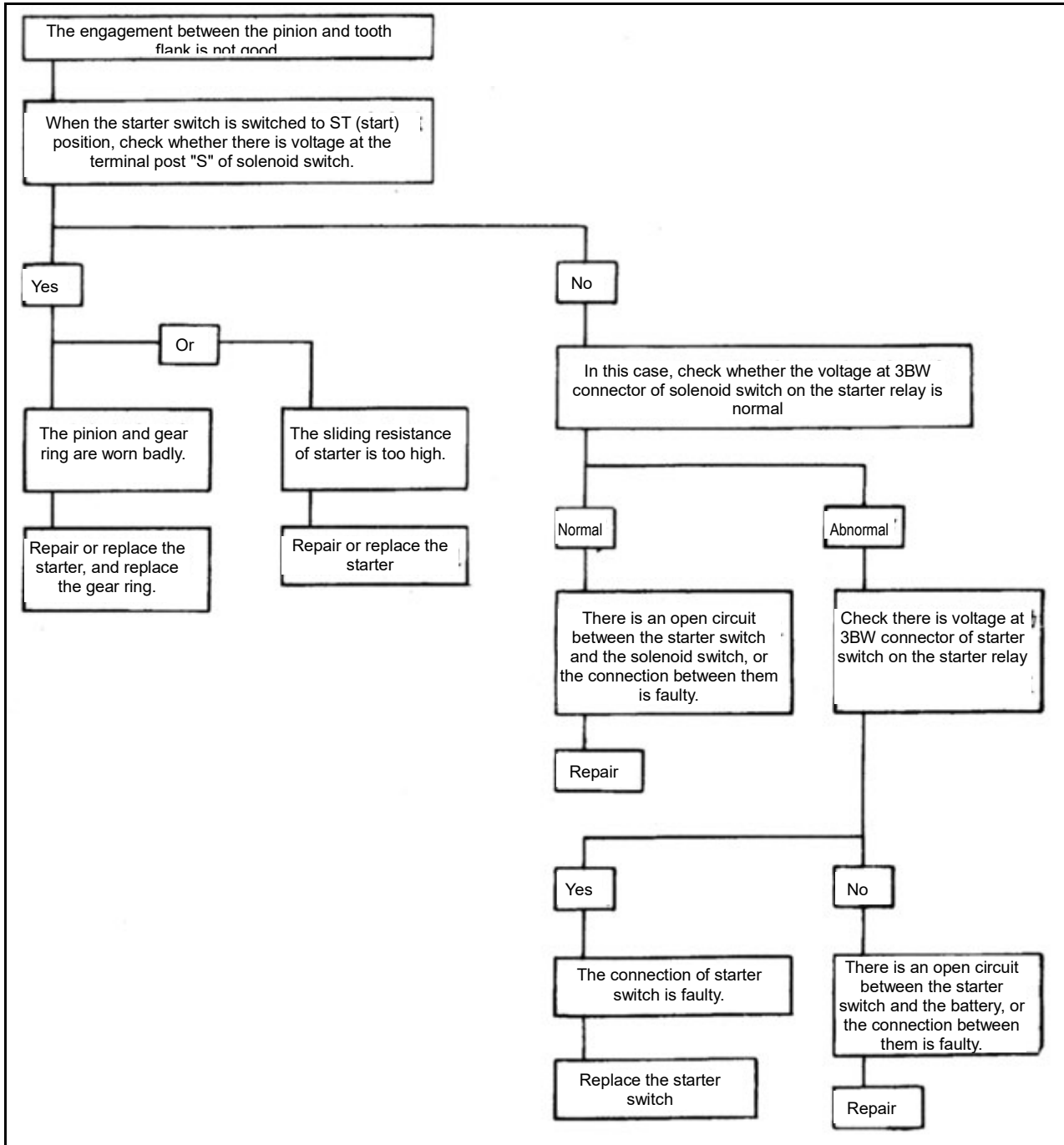
1.1.11 Engine cooling problem

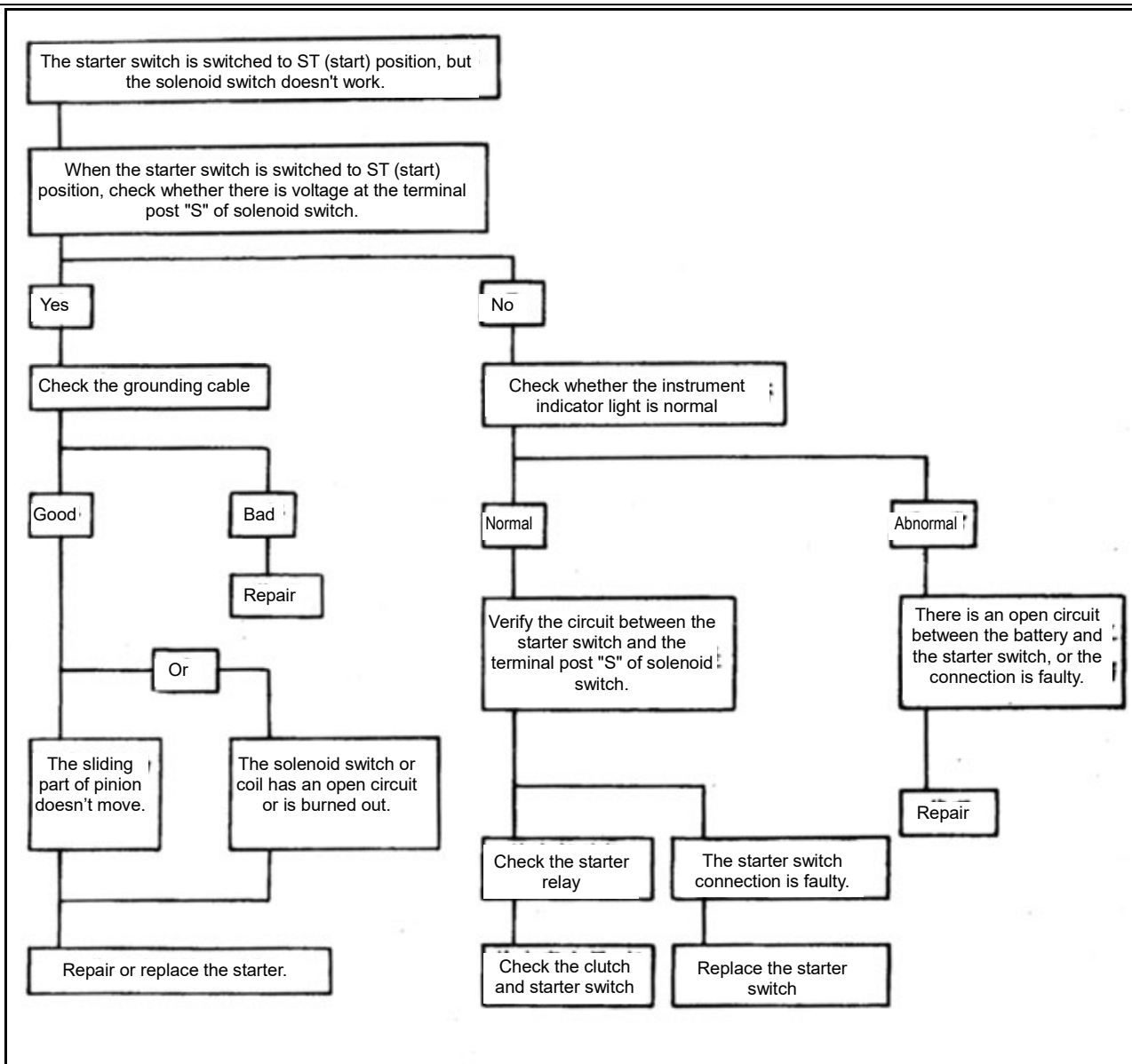
Check	Causes	Remedies
Engine overheating	The coolant level is too low.	Fill in the coolant
	The thermostatic control is broken.	Replace the thermostatic control
	The thermostat is broken.	Replace the thermostat

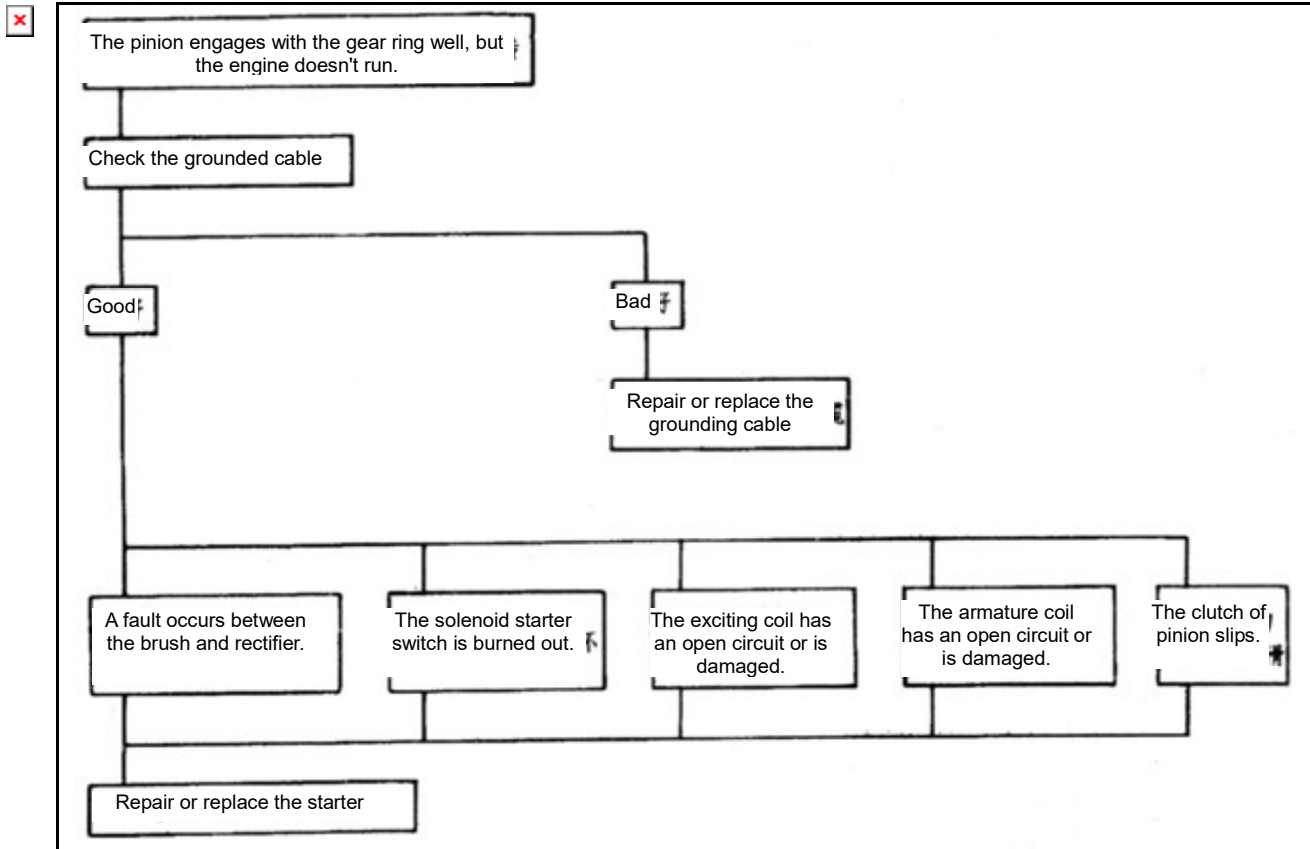
		Something is wrong with the cooling element.	Repair or replace the cooling element
		The radiator is blocked.	Clean or replace the radiator
		The radiator cap is damaged.	Replace the radiator cap
		The oil level is too low or the oil is disqualified.	Fill in or replace the oil
		The cylinder head gasket is worn.	Replace the cylinder head gasket
		The exhaust system is blocked.	Clean the exhaust system or replace the damaged parts
		The fan belt is loose.	Adjust the fan belt
		The fuel injection volume is too high.	Adjust the fuel injection
		The injection timing is not correct.	Adjust the injection timing
	Engine overcooling	The thermostat is broken.	Replace the thermostat
	Long engine preheating time	The thermostat is broken.	Replace the thermostat
		The thermostatic control is broken.	Replace the thermostatic control

Check the battery and make the following diagnoses.











The starter switch is switched from ST to ON, but the starter doesn't stop.

Disconnect the wiring of starter switch and verify the operation of starter switch

Connector No.		B-67				B-68				
Terminal Post No.		1	2	3	4	1	2	4	5	6
Terminal Post No.		ACC	B	ON	ST	B ₁	P ₁	P ₂	W	W
The position of starter switch key	OFF									
	Locked					○	○			
	Accessory	○	○			○	○			
	ON	○	○	○		○	○	○		
	Start		○	○	○	○	○	○		

Besides the wiring mentioned above, other circuits should be opening.

Yes

The solenoid switch contact is melted and hard to move. Otherwise, the return spring is broken or damaged.

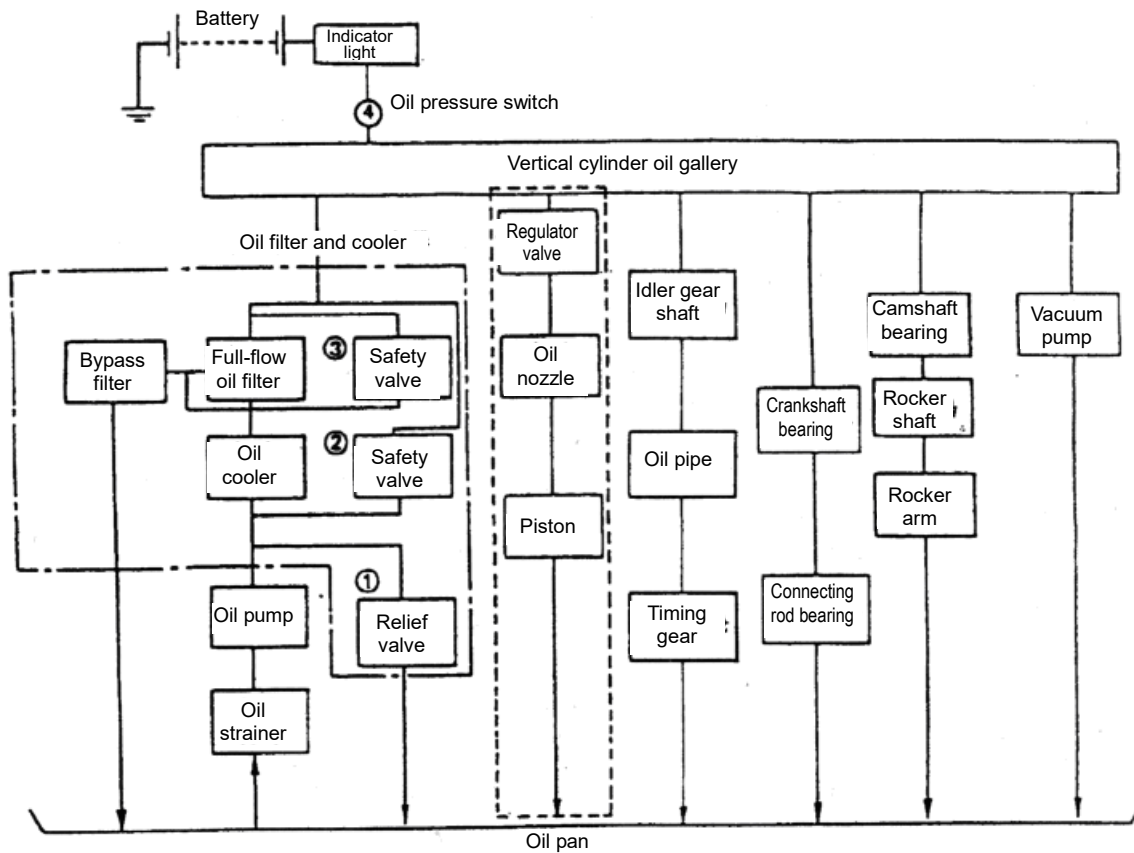
Replace the starter switch

No

Replace the solenoid switch

4DA1 Series oil filter and oil cooler with bypass-type filter

(kPa)



① Opening pressure of relief valve at oil filter: 430-470kPa

② Opening pressure of safety valve at oil filter: 960-100kPa

The lubrication system for 4DA1 Series engine is full-flow type.

The lubricant flows from the oil pump to the vertical cylinder oil gallery through oil cooler and oil filter pump (the replaceable oil filter is equipped on the oil filter). And then, the lubricant is delivered from the vertical cylinder oil gallery to the main parts of engine.

1.2 Data and specifications

1.2.1 Data and specifications

Engine model			4DA1		4DA1-1	
Item						
Engine type			Natural admission (NA)		Turbocharged Inter-cooling (TCI)	
			Four strokes, high mounted valve, water cooling			
Combustion chamber type			ω type direct injection			
Cylinder liner type			Dry type, thin-wall chrome-plated steel cylinder liner			
Cylinder number - cylinder bore × stroke		mm	4—93×102			
Number of piston ring			2 gas rings, 1 oil ring			
Total piston displacement		L	2.771			
Compression ratio			18.2		17.5	
Design compression pressure		kPa	3040			
Engine weight (net)		kg	230		240	
Fuel injection sequence			1—3—4—2			
Fuel injection timing °			16° to the top dead center (before)		12° to the top dead center (before)	
Required fuel type	Ambient temperature		Above 4 °C	Above -5 °C	Above -14 °C	Above -29 °C
	Light diesel fuel type		0 #	-10 #	-20 #	-35 #
Idle speed		r/min	750±50			
Valve clearance (cold)	Intake valve	mm	0.30~0.40			
	Exhaust valve	mm	0.30~0.40			
Valve clearance (hot)	Intake valve	mm	0.30			
	Exhaust valve	mm	0.30			
Intake valve	Open (before top dead center) °		24.5			
	Close (after bottom top dead center) °		55.5			
Exhaust valve	Open (before bottom top dead center) °		54			
	Close (after top dead center) °		26			
Lubricant system						
Lubrication method			Pressure feed lubrication and spray lubrication			
Required oil (class AP1)			CF-4 15W-40			
Oil pump type			External gearing			
Oil filter type			Full-flow type, paper element, replaceable			
Oil volume (including oil filter)		L	6			
Oil cooler type			Water cooling			

Item	Engine model	4DA1	4DA1-1
Fuel system			
Injection pump type		VE dispensing pump	
Speed governor type		Mechanical, all-speed	
Injector type		Small pressure cell, cellular type	
Injector opening pressure	MPa	19.0-20.0	18.6-19.6
Main fuel filter type		Paper cartridge and water separator	
Air filter type		Dry-type paper filter element	
Alternator output	V-A	14-60	
Starter motor output	V-kW	12-2.8	

1.2.2 Engine cooling

Coolant pump		Centrifugal impeller
Pulley drive ratio		1.12
Thermostat type		Wax-type thermostat, dual valves
Valve opening temperature	°C	82
Valve full opening temperature	°C	95
Coolant total volume	L	10

1.2.3 Starting system

Type		S14-204A
Rating		
Voltage	V	12
Output	kW	2.8
Time	s	30
Number of pinion		9
Rotation direction (view from the pinion end)		Clockwise
Weight (approximate)	kg	5.4
No load characteristics		
Voltage/current	V/A	11/160 or less
Revolution speed	r/min	4100 or above
Load characteristics		
Voltage/current	V/A	11/350 or less
Torque	N • m	8.5
Revolution speed	r/min	1750 or above
Brake characteristics		
Voltage/current	V/A	3/1300 or less
Torque	N • m	31

✖ 1.2.4 Charging system

Type		JFB161
Rated voltage	V	14
Rated output	A	60
Regulation voltage	V	14.4-15
Rated revolution speed	r/min	5000
Rotation direction (view from the pulley end)		Clockwise
Polarity		Negative earth
Operate mode		Continuous rating
Regulator type		IC regulator
Pulley effective diameter	mm	80
Weight (with pump)	kg	6.1

1.3 Maintenance standards

1.3.1 Engine mechanical system

No.	Designation	Standard dimension		Fitting way	Ex-work configuration Clearance (mm)	Wear limit (mm)
		4DA1	4DA1-1			
1.	Contact width of valve and retainer					
	Intake valve	1.7				2.2
	Exhaust valve	2				2.5
2.	Valve sinkage					
	Intake valve	0.65				1.28
	Exhaust valve	0.65				1.20
3.	Valve retainer bore angle	15° , 45° , 75°				
4.	Flank clearance	0.10-0.17				0.30
5.	Axial runout clearance of idler A	0.07				0.20
6.	Tappet outer diameter	$\Phi 13 \begin{smallmatrix} -0.010 \\ -0.028 \end{smallmatrix}$		Gapping	0.01~0.046	0.10
	Tappet bore	$\Phi 13 \begin{smallmatrix} +0.018 \\ 0 \end{smallmatrix}$				
7.	Push rod radial runout				0.3	
8.	Rocker shaft deflection				0.3	
9.	Rocker shaft outer diameter	$\Phi 19 \begin{smallmatrix} 0 \\ -0.02 \end{smallmatrix}$		Gapping	0.01~0.05	0.20
	Rocker bore	$\Phi 19 \begin{smallmatrix} +0.03 \\ +0.01 \end{smallmatrix}$				

✕	10.	Intake valve stem diameter Valve guide bore	$\Phi 8 \begin{smallmatrix} -0.039 \\ -0.054 \end{smallmatrix}$ $\Phi 8 \begin{smallmatrix} +0.017 \\ 0 \end{smallmatrix}$	Gapping	0.039~0.071	0.20
	11.	Exhaust valve stem diameter Valve guide bore	$\Phi 8 \begin{smallmatrix} -0.064 \\ -0.079 \end{smallmatrix}$ $\Phi 8 \begin{smallmatrix} +0.017 \\ 0 \end{smallmatrix}$	Gapping	0.064~0.096	0.25
	12.	Free height of valve spring Squareness of valve spring	48 $\Phi 1.4$			
	13.	Idler A bearing outer diameter Idler A bearing inner diameter	$\Phi 45 \begin{smallmatrix} -0.025 \\ -0.055 \end{smallmatrix}$ $\Phi 45 \begin{smallmatrix} +0.025 \\ 0 \end{smallmatrix}$	Gapping	0.025~0.080	0.20
	14.	Cylinder liner bore Overtopping height of the cylinder liner to the body	$\Phi 93 \begin{smallmatrix} +0.060 \\ +0.021 \end{smallmatrix}$ 0~0.08			
	15.	Axial runout clearance of camshaft Cam height of camshaft	 42.02 ± 0.05	Gapping	0.05~0.114	0.20 0.38
	16.	Inner diameter of camshaft bearing bush Camshaft journal diameter	$\Phi 50 \begin{smallmatrix} +0.025 \\ 0 \end{smallmatrix}$ $\Phi 50 \begin{smallmatrix} -0.025 \\ -0.055 \end{smallmatrix}$	Gapping	0.025~0.080	0.12
	17.	Camshaft bearing bush deflection			0.02	0.10
	18.	Piston pin Piston pin hole	$\Phi 31 \begin{smallmatrix} 0 \\ -0.005 \end{smallmatrix}$ $\Phi 31 \begin{smallmatrix} +0.010 \\ +0.002 \end{smallmatrix}$	$\Phi 34 \begin{smallmatrix} 0 \\ -0.005 \end{smallmatrix}$ $\Phi 34 \begin{smallmatrix} +0.010 \\ +0.002 \end{smallmatrix}$	Gapping	0.002~0.015 0.03
	19.	Connecting rod big end thickness Crankshaft connecting rod journal bore	$33 \begin{smallmatrix} 0 \\ -0.04 \end{smallmatrix}$ $33 \begin{smallmatrix} +0.250 \\ +0.175 \end{smallmatrix}$	Gapping	0.175~0.290	0.35
	20.	Intake/exhaust valve cold clearance		Gapping	0.3~0.4	
	21.	Main shaft diameter Main bearing halfshell (after assembly)	$\Phi 70 \begin{smallmatrix} -0.068 \\ -0.086 \end{smallmatrix}$ $\Phi 70 \begin{smallmatrix} -0.003 \\ -0.033 \end{smallmatrix}$	Gapping	0.031~0.066	0.11
	22.	Piston pin outer diameter Connecting rod bushing inner diameter	$\Phi 31 \begin{smallmatrix} 0 \\ -0.006 \end{smallmatrix}$ $\Phi 31 \begin{smallmatrix} +0.020 \\ +0.008 \end{smallmatrix}$	$\Phi 34 \begin{smallmatrix} 0 \\ -0.006 \end{smallmatrix}$ $\Phi 34 \begin{smallmatrix} +0.020 \\ +0.008 \end{smallmatrix}$	Gapping	0.008~0.026 0.05

✘	23.	Crankshaft connecting rod journal Connecting rod bearing halfshell hole (after assembly)	$\Phi 53 \begin{matrix} -0.070 \\ -0.085 \end{matrix}$ $\Phi 53 \begin{matrix} -0.016 \\ -0.041 \end{matrix}$	Gapping	0.029~0.069	0.10
	24.	Piston outer diameter grouping Group A Group B Group C Cylinder liner grouping (after pressing in) Group A Group B Group C	92.957~92.970 92.970~92.983 92.983~92.996 93.021~93.034 93.034~93.047 93.047~93.060	Grouping Gapping	0.051~0.077	
	25.	Piston ring end gap First gas ring Second gas ring Oil ring Piston ring end gap First ring Second ring Oil ring	0.2~0.4 0.2~0.4 0.1~0.3 0.09~0.125 0.05~0.075 0.03~0.07	0.2~0.4 0.6~0.85 0.35~0.65 0.078~0.139 0.045~0.09 0.03~0.07		1.5 0.15 0.15 0.15
	26.	Vertical height of injector to cylinder head lower undersurface	$3.94 \begin{matrix} +0.36 \\ -0.23 \end{matrix} \text{ mm}$ $2.41 \begin{matrix} +0.53 \\ -0.31 \end{matrix} \text{ mm}$			

1.3.2 General terms for diesel performance

Net power

The correction value for effective power outputted by the engine with all on-board parts

Total power

The correction value for effective power outputted by the engine with essential parts for operation

Rated power

The total output power given by the manufacturer at the specified rated speed according to the specific engine application, as indicated on the nameplates of engine HFC4DA1 and 4DA1-1

Maximum power

The maximum total power outputted by the engine at full-load working condition, which is generally greater than or equal to the rated power

Load

The ratio between the actual engine output power and the possible maximum power at the same speed, which is expressed by percentage

Maximum no load governed speed

The speed which the engine reaches when the accelerator reaches its limit and the engine runs under no load working condition

To avoid diesel overspeed, the speed indicates the maximum speed control given by the injection

- ✘ pump governor. The maximum no load governed speed of HFC4DA1 and 4DA1-1 is 4000~4200 rpm.

Maximum rated speed

The maximum speed that the governor allows at full load.

The maximum rated speed of HFC4DA1 and 4DA1-1 is 3600 rpm.

Minimum rated speed

1. The allowable minimum speed at the following three maximum speed of engine: 45% of maximum rated speed, 1000rpm and the speed provided by the idling governor, whichever is greater. The minimum rated speed of HFC4DA1 and 4DA1-1 is 1620 rpm.

2. The minimum speed specified by the manufacturer

Full load filter paper type smoke

Under full load (i.e. external characteristics) working condition, the blackening of filter paper in a specific area (working diameter: 32 mm) by the smoke in a specified length of air column taken from the engine exhaust pipe

To measure the speed range from the minimum to the maximum rated speed, arrange proper testing points including full load working conditions at the maximum power speed and maximum torque speed.

Free accelerating working condition

When the engine runs at idle speed, the condition that pedaling the accelerator pedal rapidly but gently to make the injection pump provide maximum fuel

Keep this condition before the engine reaches the allowable maximum speed given by the governor. Once it reaches the maximum speed, release the accelerator pedal to make engine returns to idling.

Free accelerating filter paper type smoke

Under free accelerating working condition, the blackening of filter paper in a specific area (working diameter: 32 mm) by the smoke in a specified length of air column taken from the engine exhaust pipe

Speed characteristics

The characteristics of main performance index (torque, power, oil consumption, exhaust temperature and smoke, etc.) changes depending on the speed when the engine fuel governing mechanism keeps the same

External characteristic

The speed characteristic when the engine fuel governing mechanism is fully opened

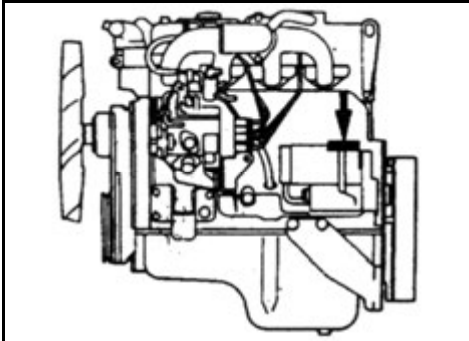
It is also called full load speed characteristic.

Load characteristic

The characteristic of performance index changes depending on load when the engine keeps running at the same speed



1.4 Maintenance work



Only qualified personnel should be allowed to perform general maintenance work.

Type marking

Engine Serial Number

The engine serial number is stamped at the left side of the rear end of cylinder block.

1.4.1 Air filter

Dry-type paper filter element

Depending on the type of filter element, the method for cleaning a filter element is different.

Dust accumulated at the filter element

Turn the filter element by hand and blow the compressed air into the filter element in order to blow off the dust.

Pressure of compressed air (392-490 kPa)

Caution:

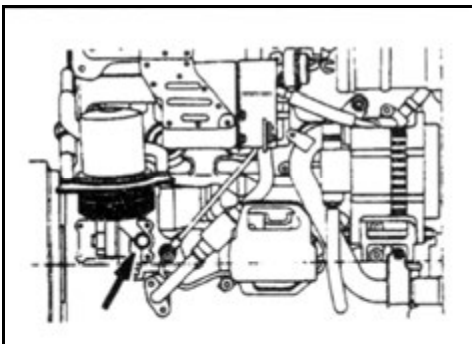
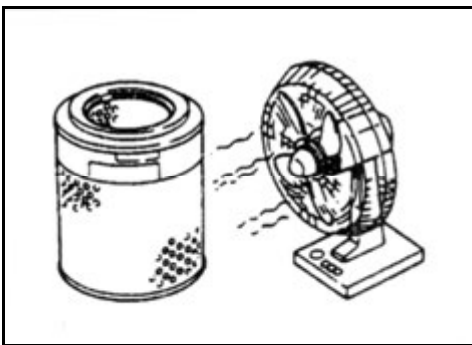
Protect the filter element from colliding by other objects in cleaning. Otherwise, the filter element may be damaged.



Carbon and dust accumulated at the filter element

1. Prepare the cleaning liquid for air filter (DonaldmnDI400) originally provided by JAC, and dilute it with water.
2. Immerse the filter element in the cleaning liquid for 20 minutes.





3. Take the filter element out of the cleaning liquid and flush it with running water.
The water pressure should be less than 274 kPa.

4. Dry the filter element at a place with good ventilation.
Use a fan for quick drying.

Note:

Never use the compressed air or open fire for quick drying.

It may result in damage of filter element.

Generally, it will take two to three days to completely dry a filter element. In this case, a standby should be prepared for temporary use.

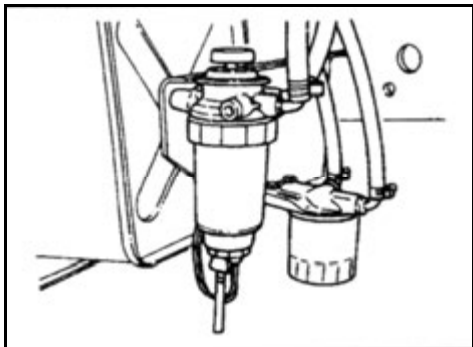
1.4.2 Lubricant system

Main oil filter (paper filter element)

Replace procedure

1. Loosen the oil drain plug to drain out the oil.
2. Several minutes later, retighten the oil drain plug.
3. Unscrew the used filter counter-clockwise with a filter wrench.
4. Clean the fitting surface of oil cooler to ensure suitable fitting with the new oil filter.
5. Apply a thin layer of oil to the O-ring.
6. Screw in the new oil filter until the filter O-ring makes perfect contact with the sealing surface.
7. Further screw in the filter by $1+1/4$ turn with a filter wrench.

Filter wrench: 1010300FA-9101



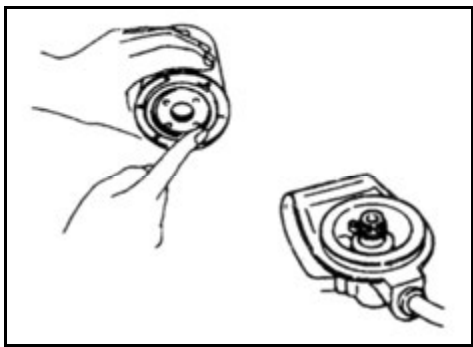
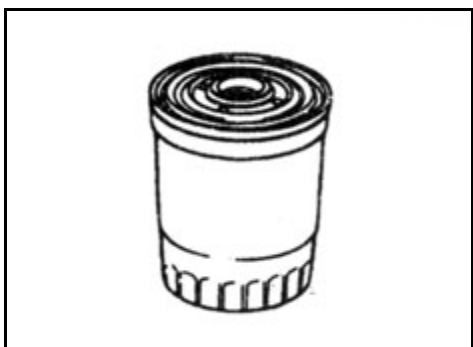
8. Check the oil level. If necessary, fill in some oil until the oil level reaches the specified level. The filling oil volume is approximate 0.7 L.
9. Start the engine and verify there is no oil leak from the main oil filter.

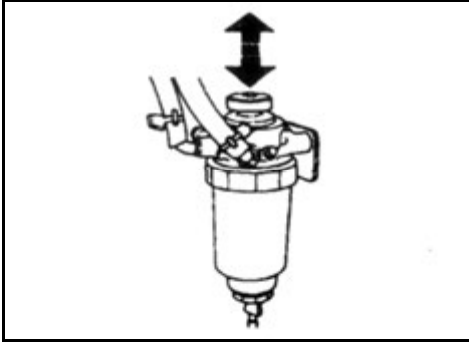
1.4.3 Fuel system

Fuel filter

Replace procedure

1. Unscrew the used filter counter-clockwise with a filter wrench.
2. Clean the fitting surface of the filter upper cover to ensure suitable fitting with the new fuel filter.
3. Screw in the fuel filter until it makes perfect contact with the sealing surface.
4. Further screw in the filter by N 2/3 turn with a filter wrench.

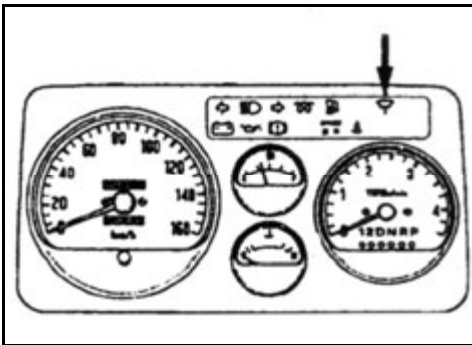




5. Loosen the bleeder plug on the overflow valve of injection pump.
6. Operate the priming pump until the fuel flows out of the fuel filter.
7. Retighten the bleeder plug.
8. Repeatedly operate the priming pump and verify there is no fuel leak.

Note:

It is strongly recommended that you should use a fuel filter provided by JAC or an original one.

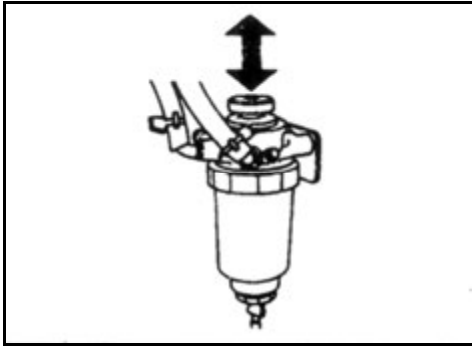
**Procedure of water drain from the fuel filter**

If water content in the water separator exceeds the specified value, the indicator light will light up. Discharge water and other impurities from the water separator according to the following steps.

1. Park the vehicle at a safe place.
2. Open the engine hood and put a container (approximate 0.2 L) at the end of ethylene hose under the water drain plug of water separator.
3. Unscrew the water drain plug counter-clockwise (about five turns) and operate the priming pump about ten times until approximate 0.1 L water drains out.
4. Once the water drains is finished, screw in the water drain plug clockwise and manually operate the priming pump several times.
5. Verify there is no fuel leak from the water drain plug after the engine starts.

Also, verify the indicator light of fuel filter is off.

If frequent water drain from a water separator is required, you may ask for a fuel tank for water drain from a local JAC distributor.



Bleeding

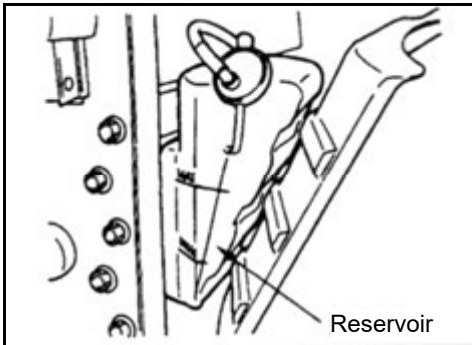
1. Loosen the bleeding screw on the overflow valve of injection pump.
2. Operate the priming pump until the fuel with foam flows out of the bleeding screw.
3. Tighten the bleeding screw.
4. Repeatedly operate the priming pump and verify there is no fuel leak.

1.4.4 Cooling system

Coolant level

Check the coolant level. If necessary, fill in the radiator reservoir.

If the coolant level falls under "MIN", carefully check whether there is a leakage in the cooling system. And then, fill in the coolant until it reaches "MAX".



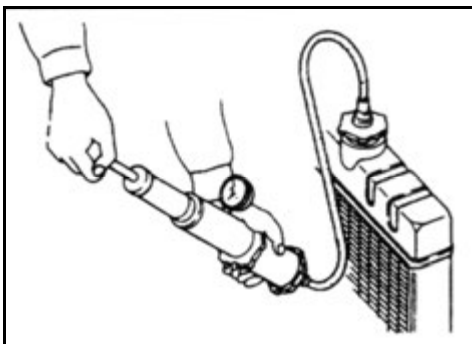
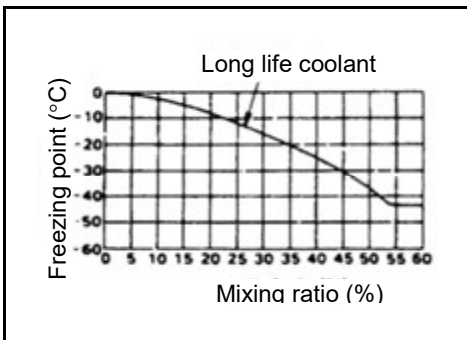
Note:

Never make a reservoir overflow.

The radiator filler cap should be opened only if it is very necessary.

Coolant level check can only be performed when the engine is cold.

For mixing ratio between the cooling water and anti-freezer, please refer to the left figure.



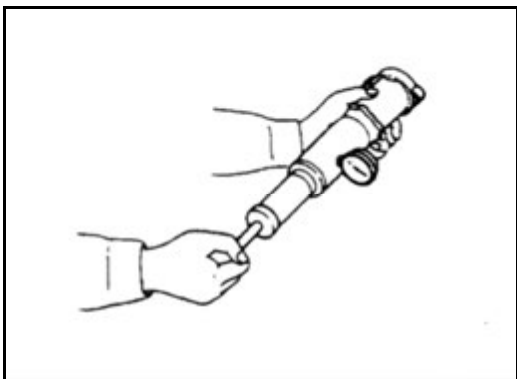
Cooling System Check

Place an American tester for radiator filler on the radiator.

Apply test pressure on the cooling system and check the leakage.

The test pressure shall not exceed the specified pressure.

Test pressure: 196kPa



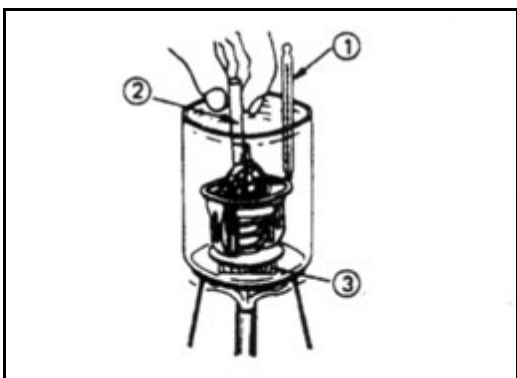
Radiator filler cap check

The radiator filler cap is designed to keep the pressure at 105 kPa in the cooling system. Use radiator filler cap tester to check the cap. If the radiator filler cap doesn't keep at the specified pressure in testing, it shall be replaced by a new one.

The pressure of radiator filler cap

Pressure valve 88-118 kPa

Negative pressure valve (reference value) 1.0 -3.9 kPa



Thermostat test

1. Completely immerse the thermostat in the water.

2. Heat up the water.

Continuously stir the water to avoid directly heating the thermostat.

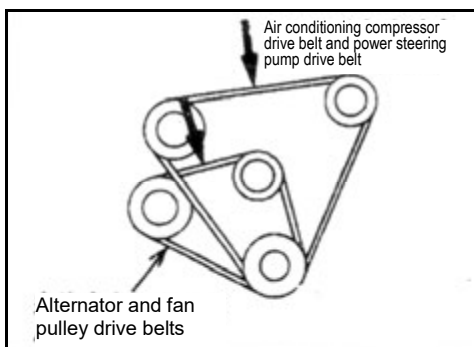
3. Check the initial opening temperature of thermostat.

The initial opening temperature of thermostat: 82°C

4. Check the full opening temperature of thermostat.

The full opening temperature of thermostat: 95°C

The valve lift at full opening: 8mm



1.4.5 Drive belt adjustment

Check whether the drive belt is worn or damaged. If necessary, replace it with a new one. Check the belt tension. If necessary, make proper adjustment.

- Check the belt tension.
- Press the central section of belt by a force of 100N and check deflection of each belt.
- Standard deflection

	mm
Alternator and fan pulley drive belts	8-10
Air conditioning compressor drive belt	
Power steering pump drive belt	

Alternator drive belt

- Mount the alternator drive belt and adjust the belt tension.
- Mount fixing bolts and tighten them to the specified torque.

Alternator

Fixing bolt torque 37.5

Adjusting plate fixing bolt torque 25

Air conditioning compressor pulley drive belt and power steering pump drive belt

- Move the oil pump to adjust the oil pump drive belt tension

Tighten the bolt to the specified torque.

Adjuster locking bolt torque 37 N · m



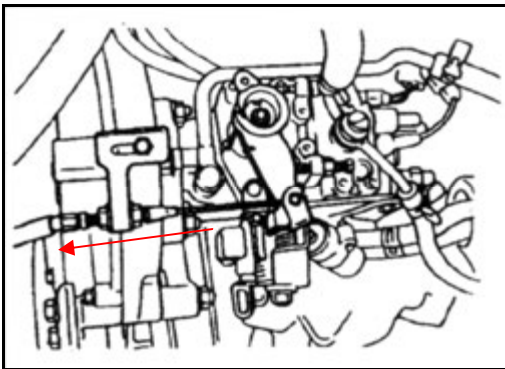
1.4.6 Engine control (governed speed, valve clearance, injection timing, compression pressure)

Idle speed check

1. Handle the parking brake and brake driving wheels.
2. Place the transmission at neutral position.
3. Start the engine and warm it up.
4. Remove the engine control cable from the control lever.
5. Mount the tachometer on the engine.
6. Check the engine idle speed.

If the engine idle speed exceeds the specified range, you must make adjustment.

Engine idle speed: 750 ± 50 r / min



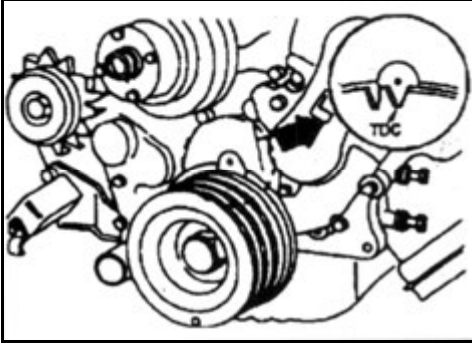
Adjust the idle speed

1. Loosen the locking nut (s) of idle adjusting bolt (s) on the injection pump.
2. Use idle adjusting bolt to adjust idle speed to the specified range.
3. Use the locking nut (s) to lock the idle adjusting bolt (s).
4. Check the idle speed control cable is tightened (no looses).

If necessary, eliminate any loose of the cable.

Accelerator control cable adjustment

1. Loosen clamp bolts for the accelerator cables.
2. Check whether the control knob is turned to the idle speed position.
3. Place the accelerator lever at the fully closed position, and then tighten the control cable in the arrow direction to eliminate any loose.



Valve clearance adjustment

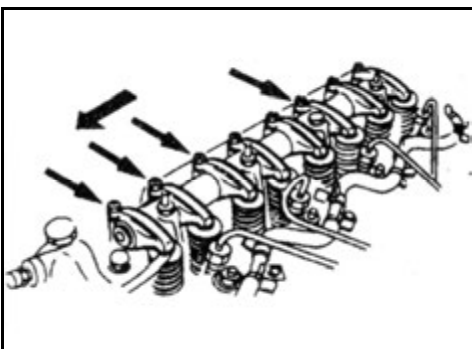
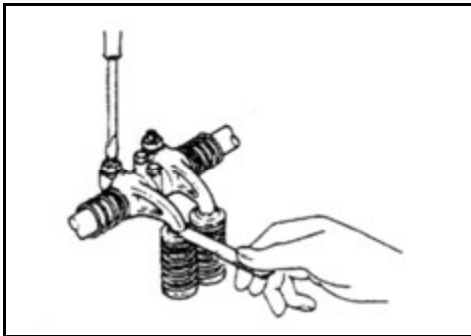
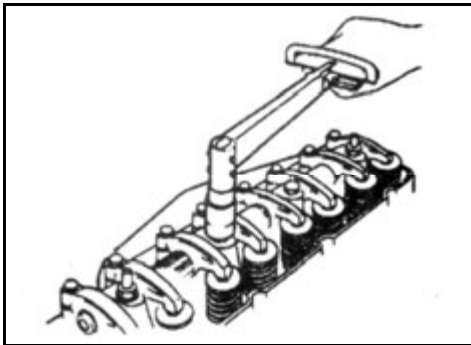
1. Turn the crankshaft until the crankshaft damper reaches the top dead center. When the line aligns the timing pointer, either the first cylinder piston or the fourth cylinder piston locates at the top dead center of compression stroke.

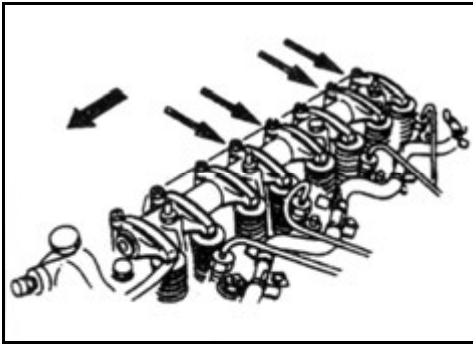
2. Check whether there is any loose rocker shaft seat nut.
Before adjust the valve clearance, tighten any loose rocker shaft support nut.
Torque of rocker shaft support nut 55 N • m

3. Check the clearance at the intake valve push rod and exhaust valve push rod in the first cylinder.

If there is clearance at the intake valve push rod and exhaust valve push rod in the first cylinder, the piston in the first cylinder locates at the top dead center of compression stroke.
If there is compression force applied on the intake valve push rod or exhaust valve push rod in the first cylinder, the piston in the fourth cylinder locates at the top dead center of compression stroke.

Adjust the valve clearance in the first or fourth cylinder when corresponding cylinder piston locates at the top dead center.





Valve clearance (cold) :
0.3-0.4 mm(optimum value: 0.35 mm)

4. Loosen each valve clearance adjusting screw as shown in the figure.
5. Insert a proper clearance gauge between the rocker arm and valve stem.
6. Turn the valve clearance adjusting screw until you feel there is slight resistance on the clearance gauge.
7. Screw down the locking nut.
8. Turn the crankshaft 360° .
9. Realign the timing marking at the crankshaft damper pulley to the line of top dead center.
10. Adjust clearance for other valves as shown in the figure.

✘ Adjust injection timing

Step 1 Remove the front screw (at the rear end of injection pump) on the injection pump distribution plunger.

Step 2 Mount special tools for injection advance angle adjustment: dial indicator and gauge stand.

Step 3 Turn the engine crankshaft clockwise to a position with approximate 45° to the top dead center of the first cylinder.

Step 4 Turn the engine crankshaft about 8° to left or right, the pointer of dial indicator shall stand still.

Step 5 Turn the dial indicator to zero the pointer. The position of dial indicator shall not be changed after zero adjustment.

Step 6 Turn the crankshaft clockwise to the top dead center. For assembly, to determine the top dead center, use a lever indicator to measure the height difference between top surface of piston in the first cylinder and upper surface of body. For commissioning and inspection, alignment timing marking (position marking of crankshaft pulley top dead center and timing marking on the gear case) is allowed to use.

Step 7 Unscrew two tight nuts to the injection pump flange and the connecting bolt to the injection pump support.

Step 8 Pull the injection pump inward or outward to make the reading of dial indicator show X mm.

Step 9 Screw down two tight nuts to the fuel pump flange and the connecting bolt to the injection pump support. Fuel pump running shall be avoided in screwing.

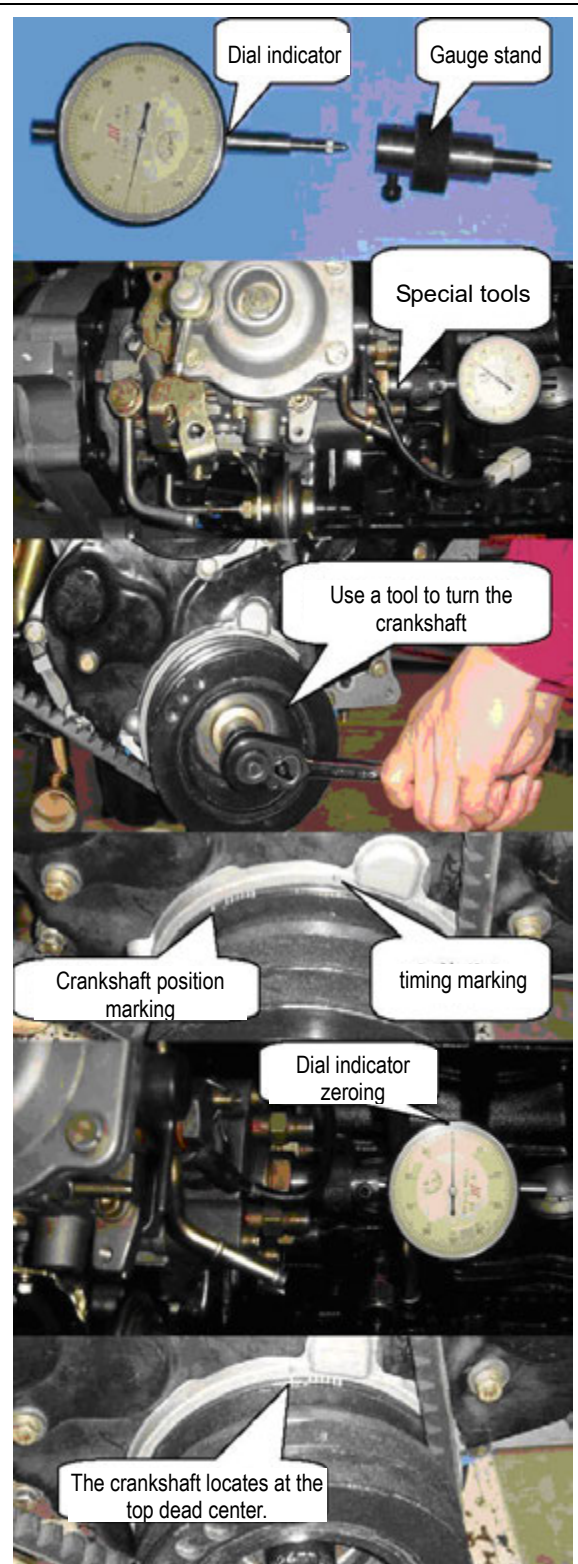
Step 10 Repeat Step 3 to verify zero adjustment. If the zero adjustment is not proper, return to Step 5.

Step 11 Repeat Step 6 to verify the reading of dial indicator. If the reading is not correct, return to Step 7.

Step 12 Remove the special tools: dial indicator and gauge stand.

Step 13 Mount the front screw on the injection pump distribution plunger. Injection advance angle adjustment is over.

Type	X Value (mm)
HFC4DA1	1.60
HFC4DA1-1	1.50



 The essential torque is given below.

Tightening torque for the tight nuts to the injection pump flange: $25 \pm 5 \text{ Nm}$;

Tightening torque for the connecting bolt to the injection pump support: $25 \pm 5 \text{ Nm}$;

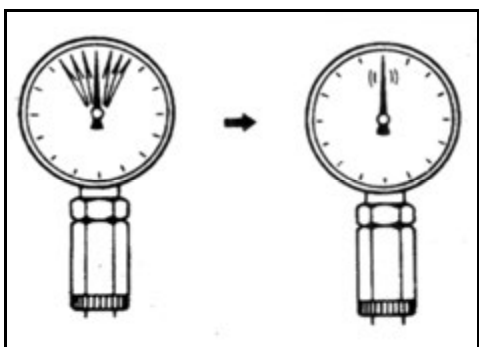
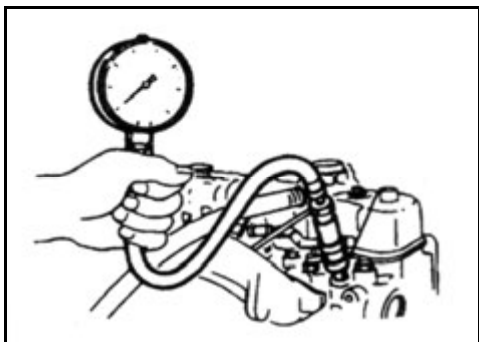
Tightening torque for the bolt to the distributive head of injection pump: $35 \pm 5 \text{ Nm}$;

Tightening torque for the nut to the high pressure fuel pipe: $30 \pm 5 \text{ Nm}$

If the special tools like dial indicator and seat stand are not available, it is allowed to use "Overflow" method to make injection advance angle adjustment.

Note:

A new cooper gasket must be used when you mount a plug at the top of distributor.



Compression pressure measurement

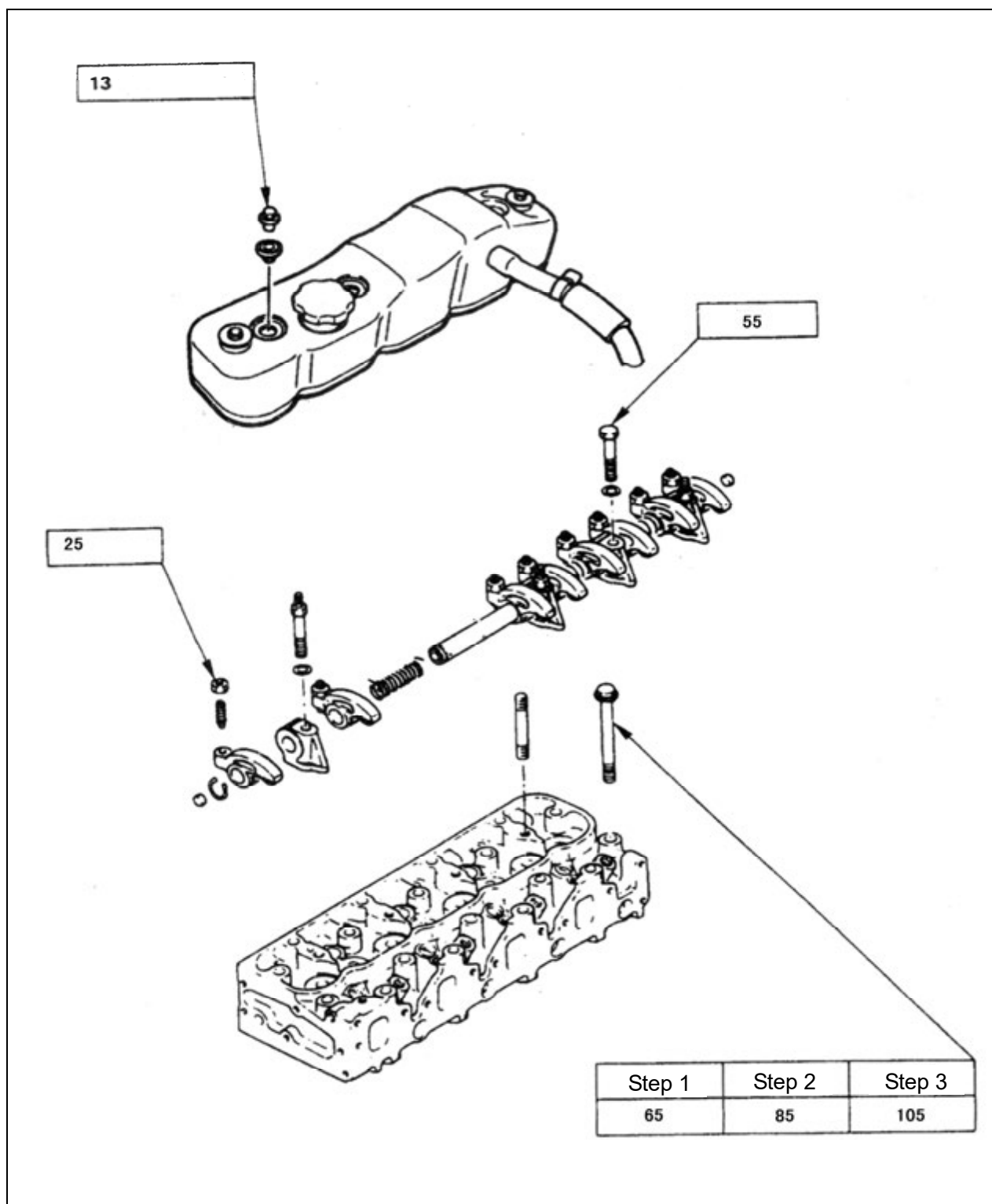
1. Start the engine and keep idling until the coolant temperature reaches 70-80°C.
2. Remove the following parts:
 - ★ All glow plugs (or injectors)(Measuring at the injector hole or the glow plug hole is optional depending on different gauge outfits.)
 - ★ Fuel cut solenoid connector
 - ★ Fuse for Quick On Start System(QOS) on a connector
3. Mount the joint and pressure gauge in the glow plug hole in the first cylinder (or in the injector hole).
 Compression pressure gauge
 (with joint): 1002100FA-9101
 Joint: 1002100FA-9102
4. Use the starter motor to run the engine and record the readings on the pressure gauge.
 Compression pressure at 200 r/min

Nominal	Limit
3040	2158
5. For other cylinders, repeat Step 3 and 4.
 If the measured value is less than the limit value, refers to the section "Diagnosis and troubleshooting" in this manual.



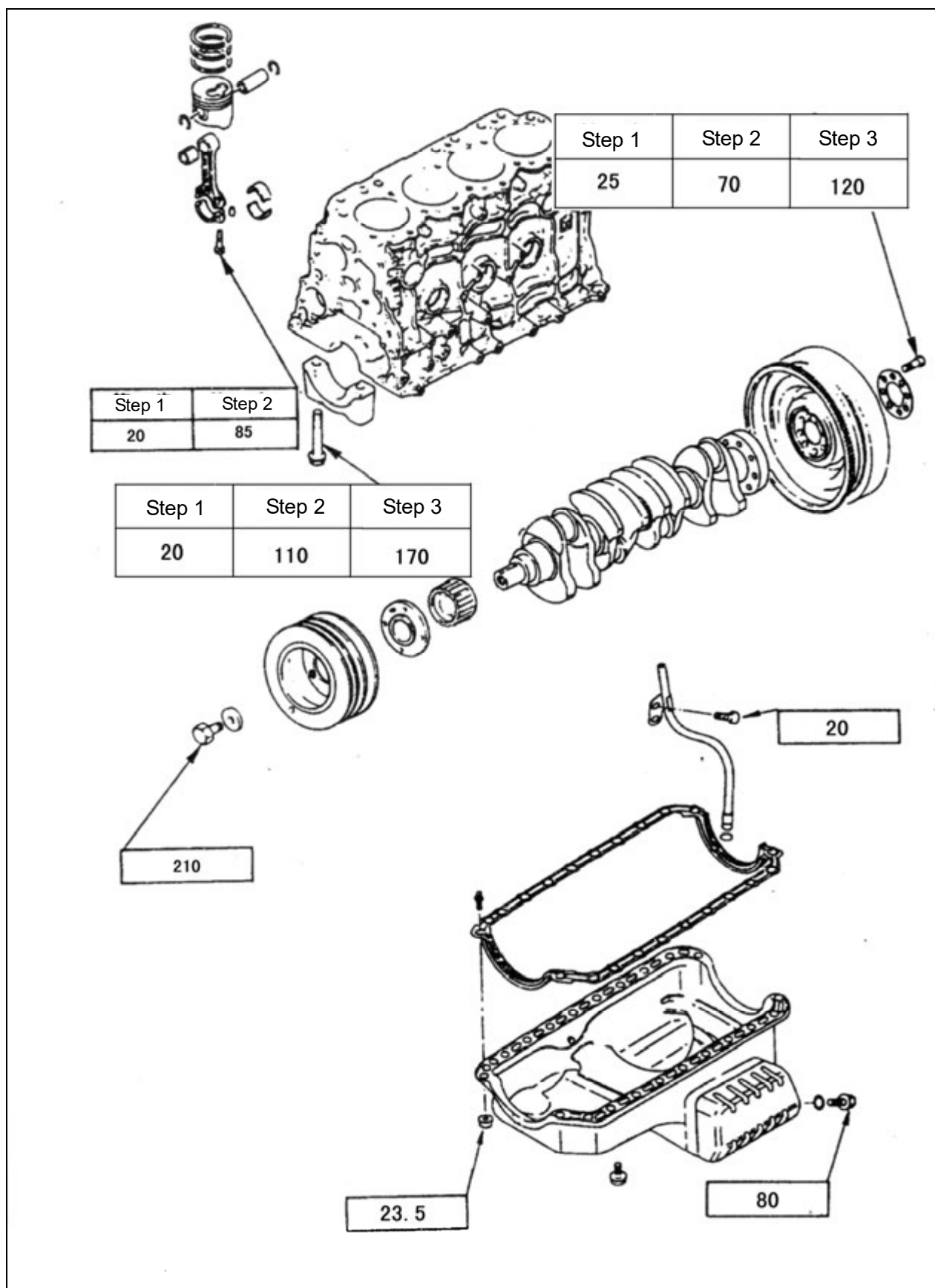
1.5 Tightening torque

1.5.1 Torque for cylinder head, cylinder head cover and rocker shaft support (N·m)

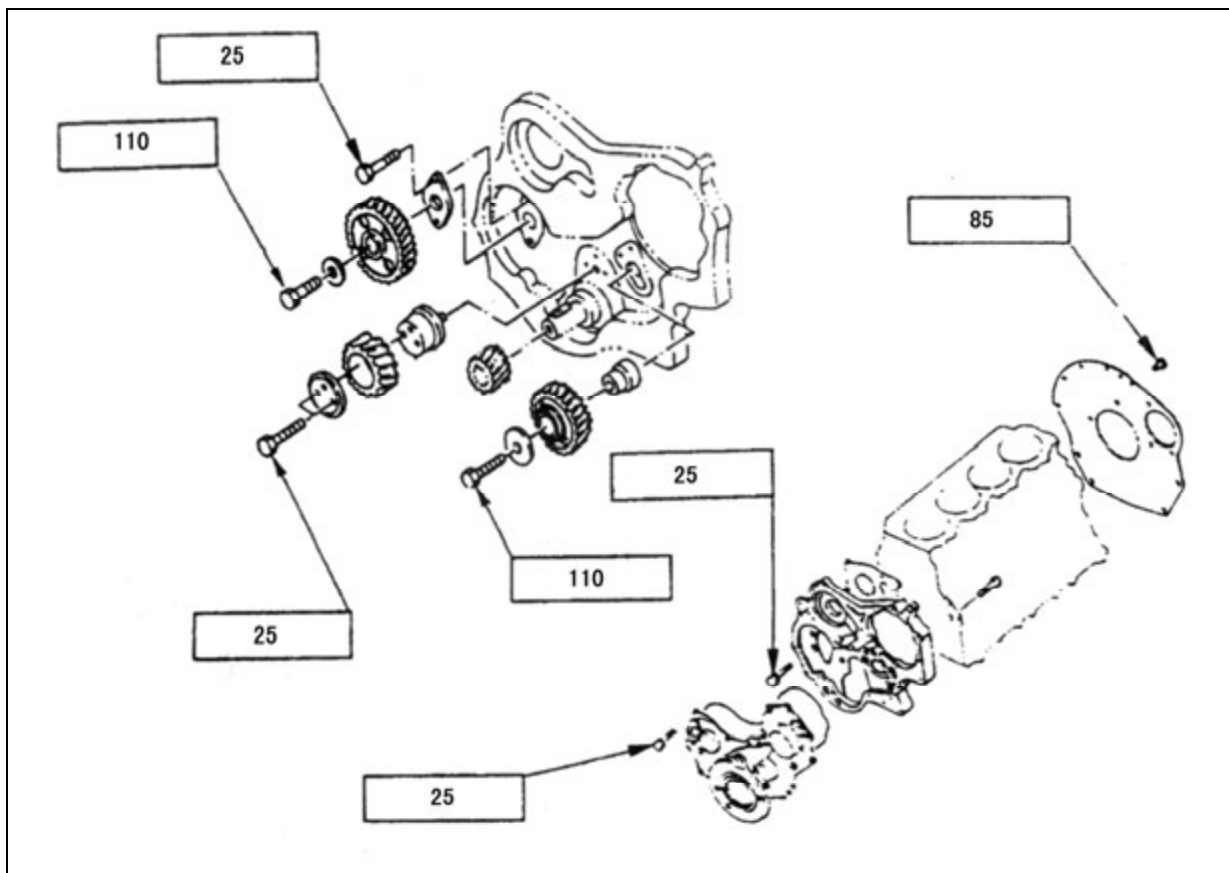




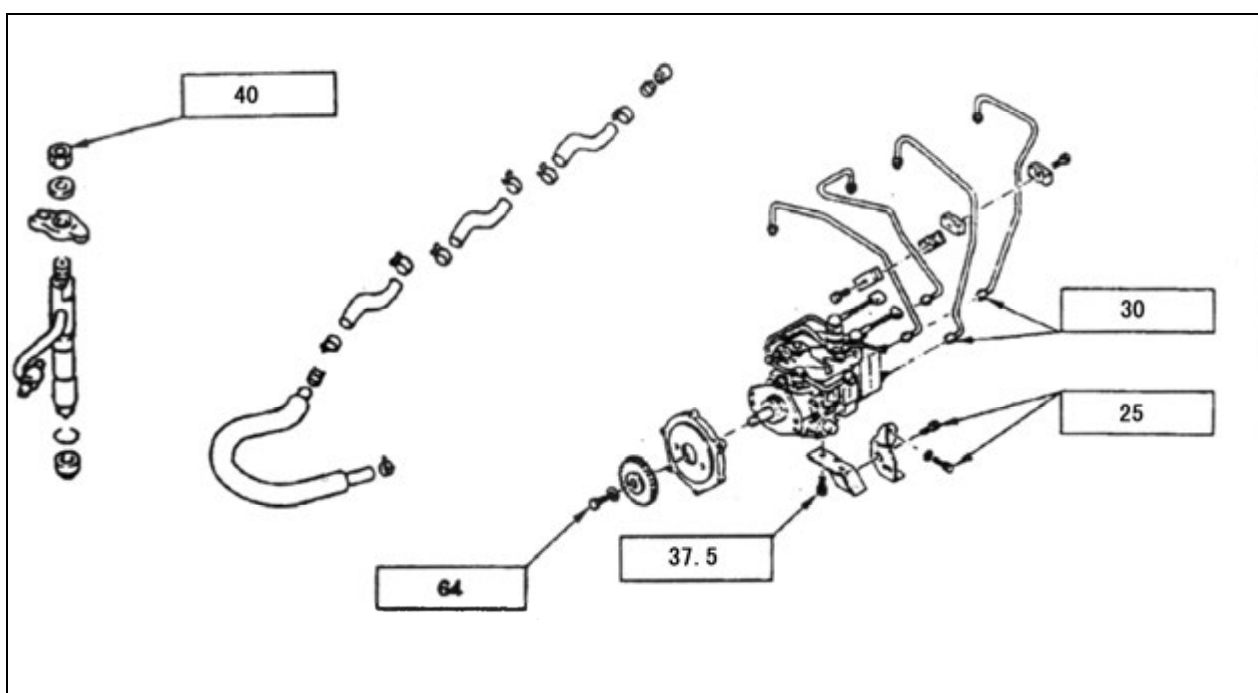
✖ 1.5.2 Torque for crankshaft, bearing cap, connecting rod bearing cap, crankshaft damper pulley, flywheel and oil pan (N·m)



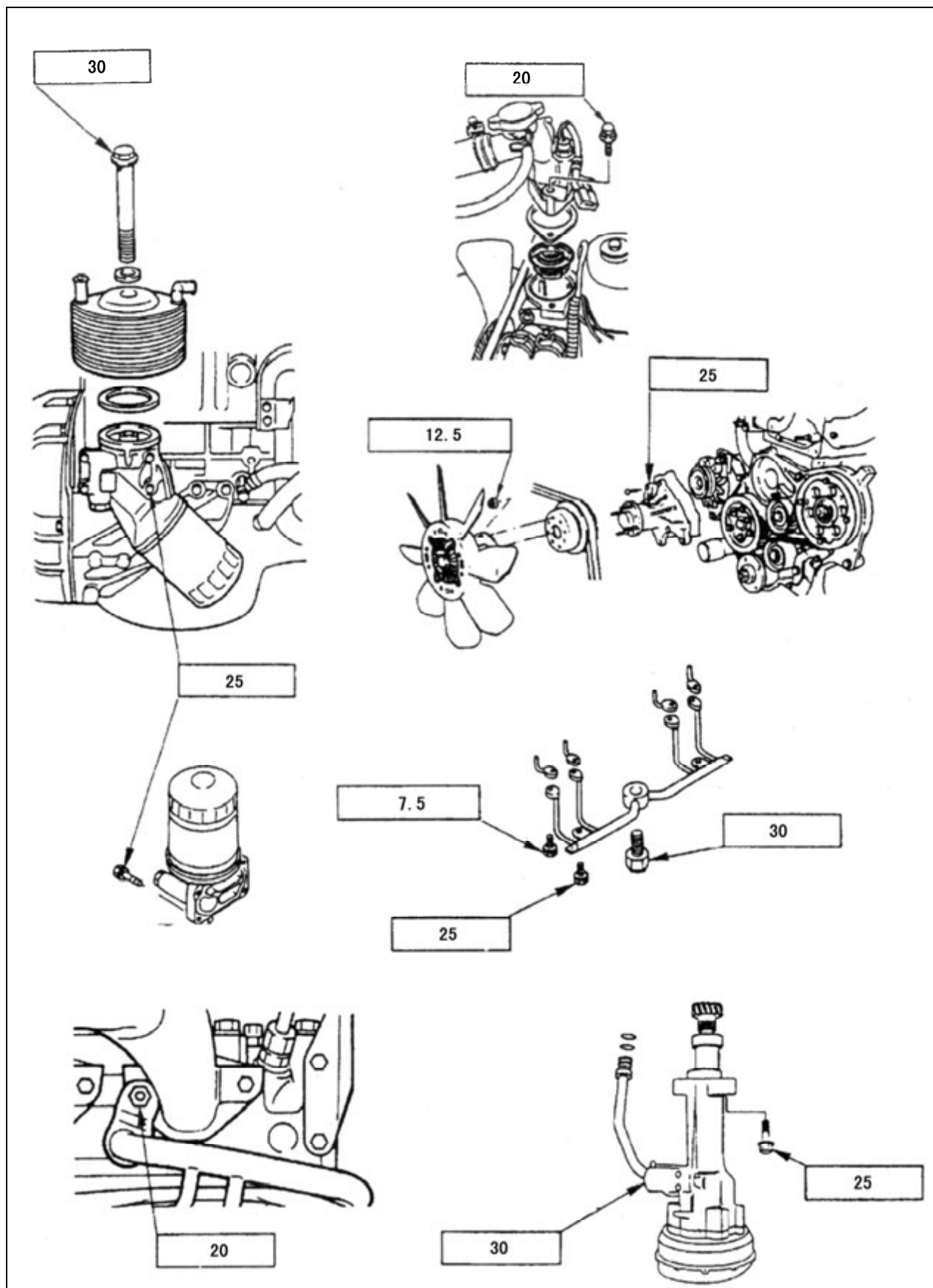
1.5.3 Torque for timing pulley chamber, timing pulley, timing gear and camshaft race (N·m)



1.5.4 Engine fuel system (N·m)

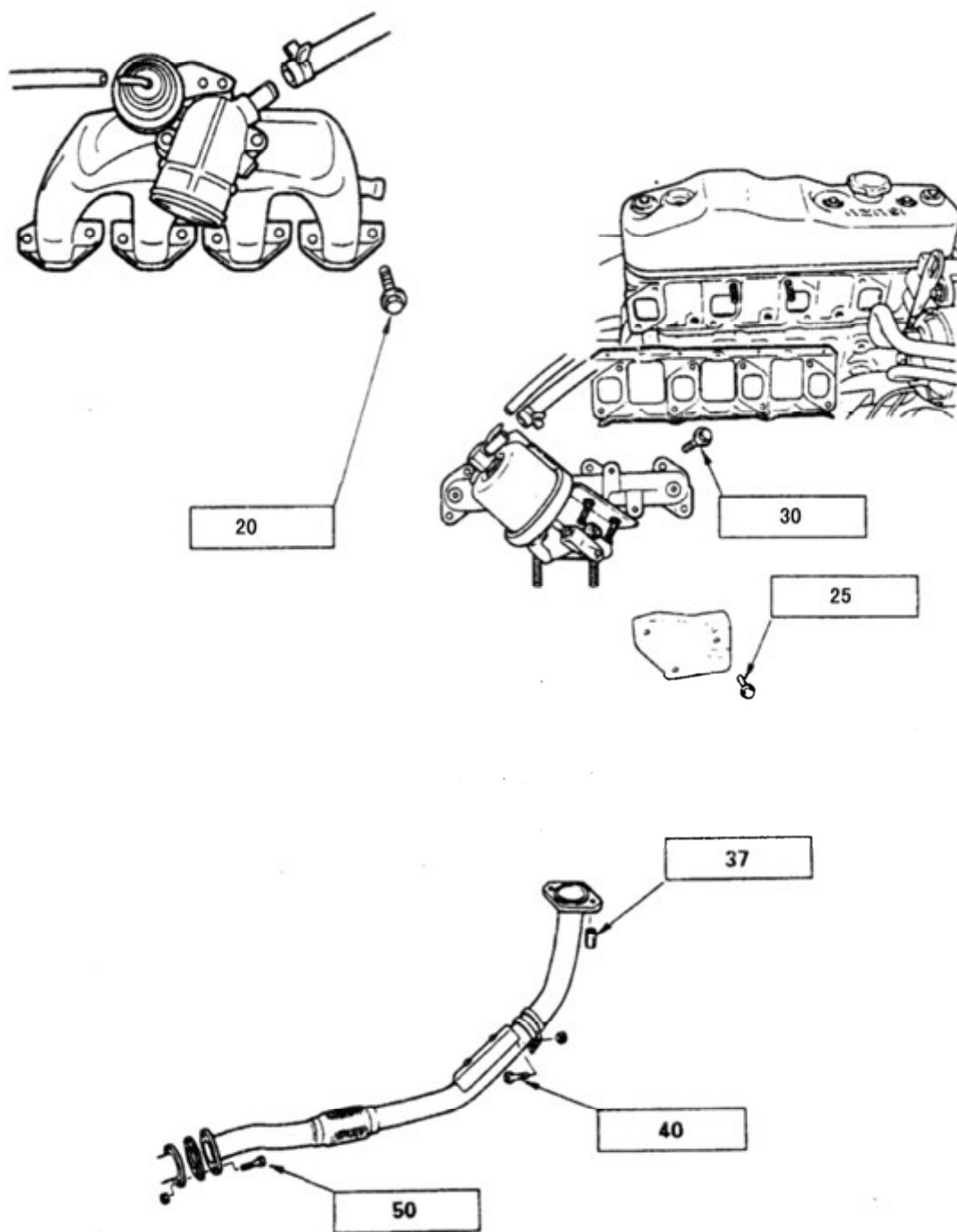


✖ 1.5.5 Torque for cooling system and lubricant system (N·m)

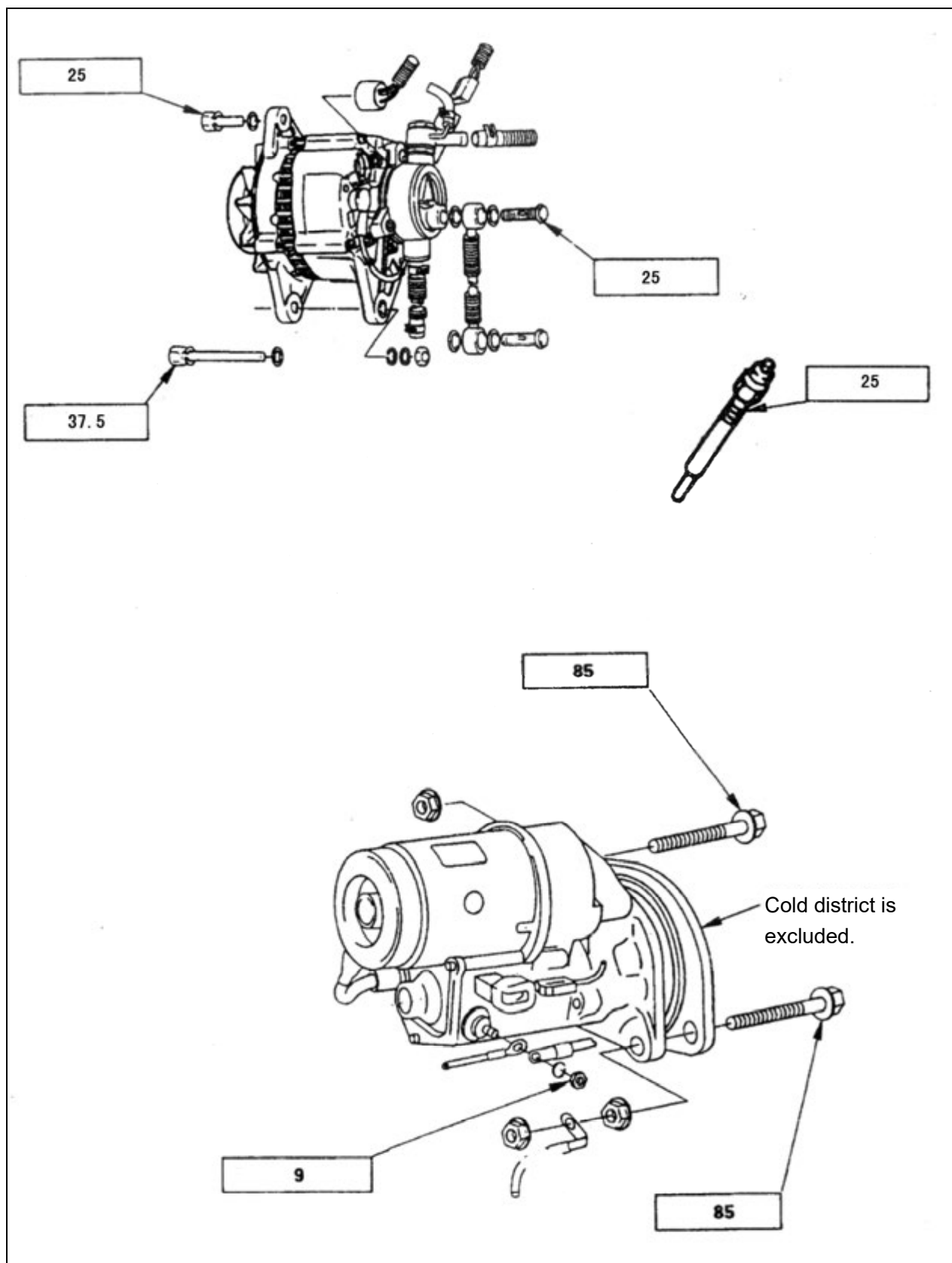




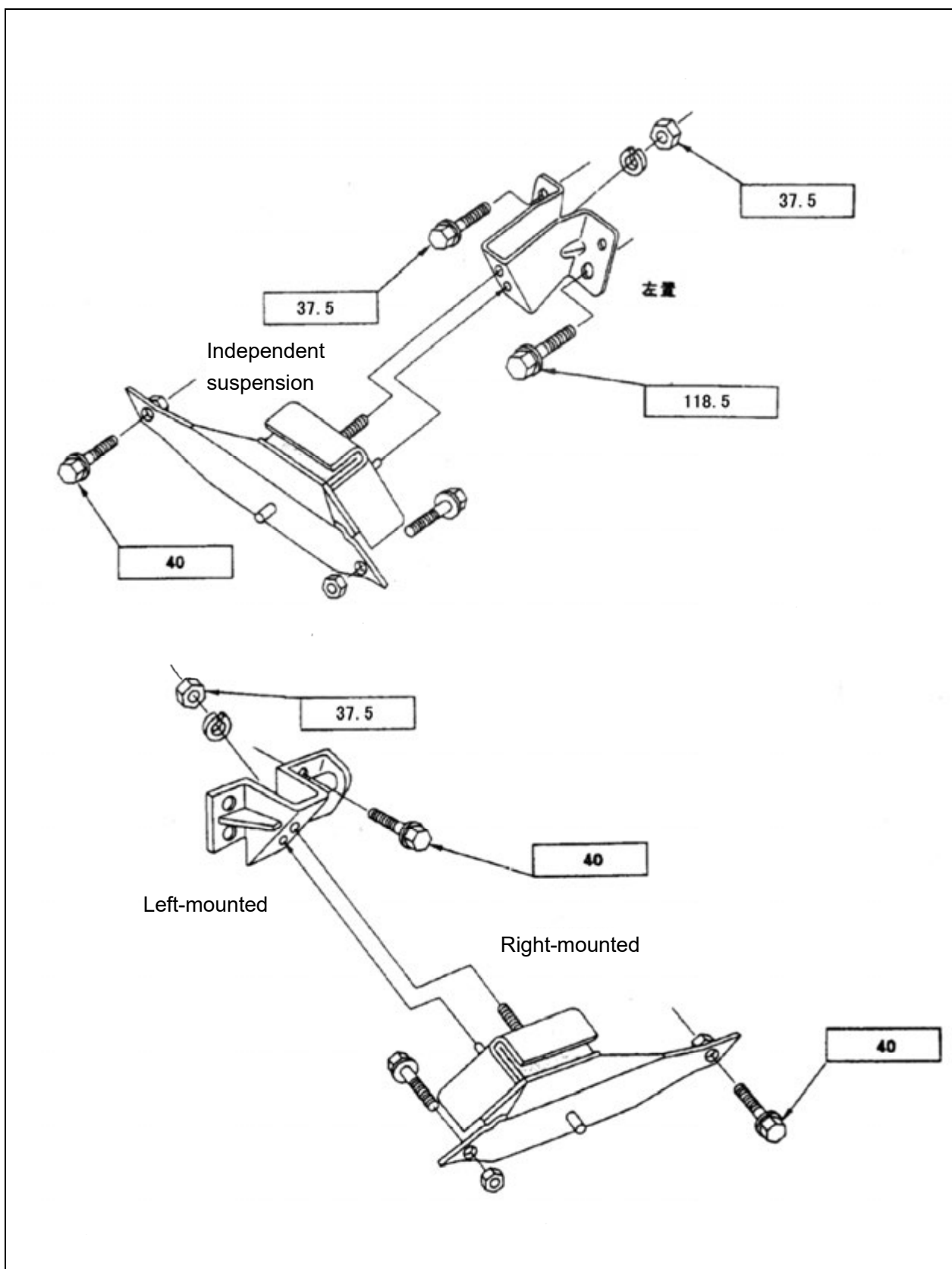
1.5.6 Torque for intake manifold, exhaust manifold and exhaust pipe (N·m)



✖ 1.5.7 Engine electrical system (N·m)

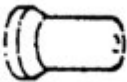


✖ 1.5.8 Torque for engine mounting bracket (N·m)



1.6 Special tools

Illustration	Tool No.	Tool Name
	1010300FA-9101	Oil filter wrench
	1003016FA-9101	Valve oil seal erector
	1003102FA-9101	Valve guide replacer
	1002100FA-9101	Compression pressure gauge
	1002100FA-9102	Pressure gauge joint
	1100300FA-9101	Measuring unit
	1002420FA-9101	Front oil seal erector
	1002430FA-9101	Rear oil seal erector
	1003015FA-9101	Valve spring compressor
	1007017FA-9101	Camshaft gear puller

	1002107FA-9101	Camshaft bearing replacer
	1002430FA-9102	Rear oil seal remover
	1002106FA-9101	Cylinder liner erector
	1002106FA-9102	Cylinder liner remover
	1004001FA-9102	Piston mounting taper sleeve
	1007011FA-9101	Timing gear puller
	1007011FA-9102	Crankshaft timing gear erector
	1002420FA-9101	Front oil seal erector