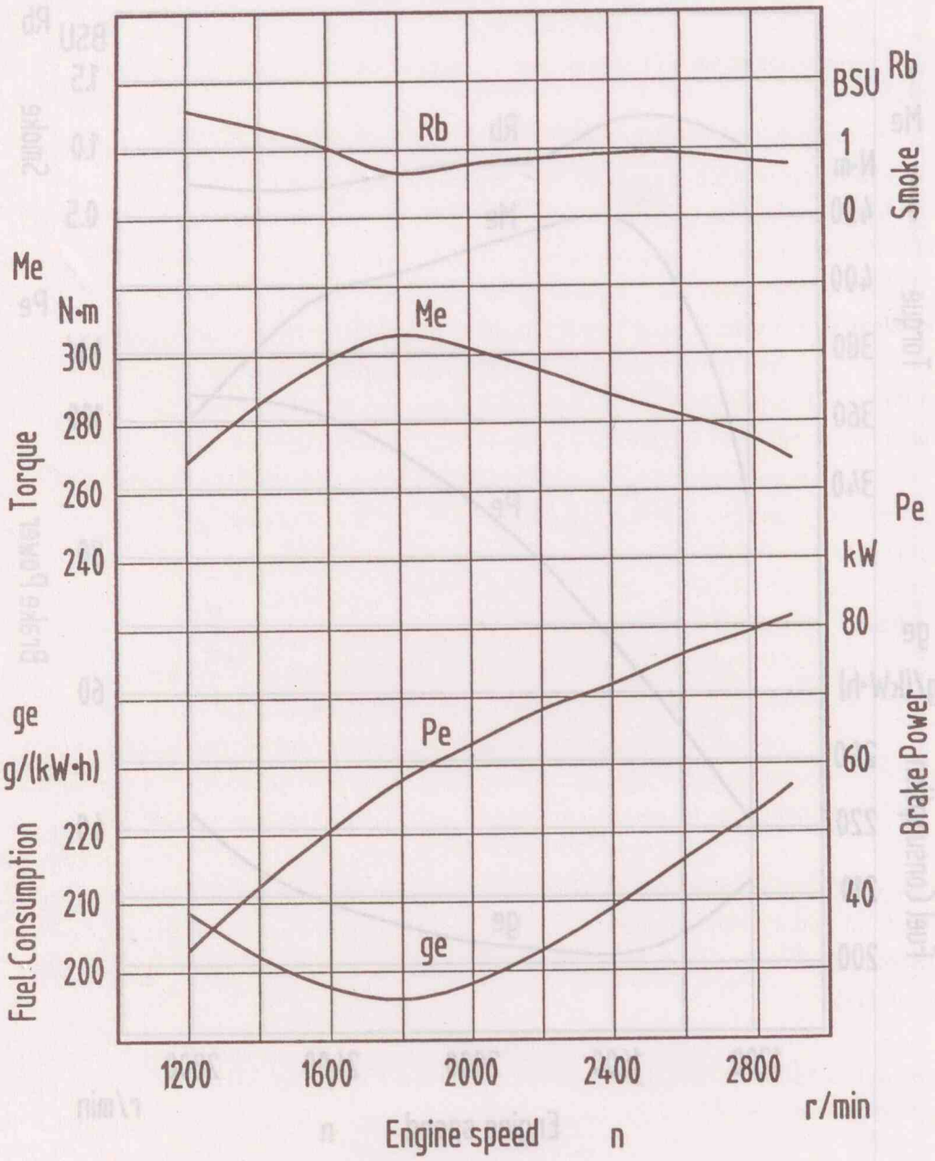
OPERATION INSTRUCTIONS

YZ4102ZLO
YZ4105ZLQ

DIESEL ENGINES

YANGZHOU DIESEL ENGINE CO., LTD.

Performance Curves of YZ4102ZLQ Engine



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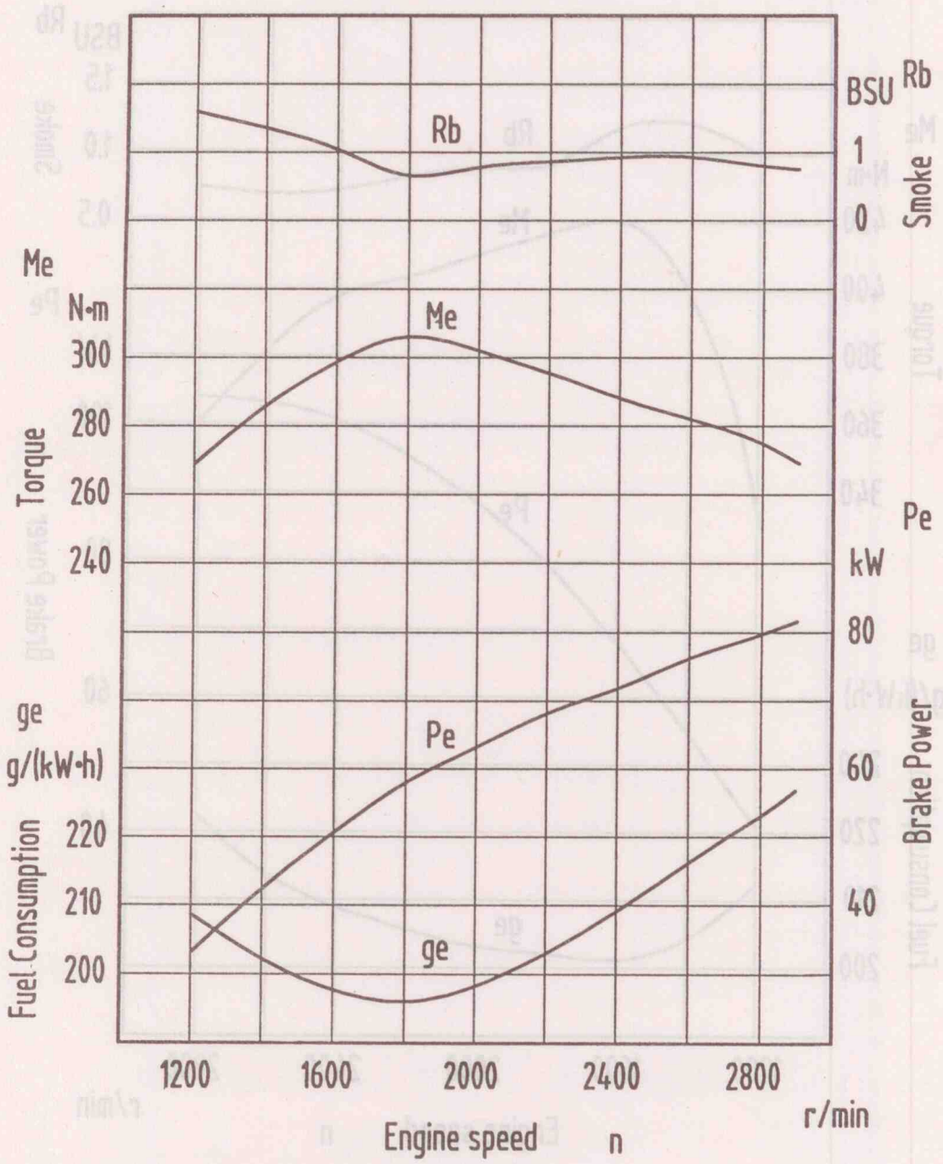

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Section I Main Specifications and Engine Data

1.1 Specifications of the Engines

Model		YZ4102ZLQ		YZ4105ZLQ	
Type		Water-cooled, vertical, in-line, four-stroke, turbocharged and intercooled			
No. of cylinders		4			
Bore	(mm)	102		105	
Stroke	(mm)	105		118	
Compression ratio		17.5 : 1		17 : 1	
Total displacement	(l)	3.432		4.087	
Type of combustion chamber		Direct injection			
Rated output/Speed	(kW /rpm)	75/2900	81/2900	95/2800	105/2800
Max.torque / Speed	(N.m/ rpm)	285/≤1800	310/≤1600	380/≤1600	420/≤1600
Maximum speed	(rpm)	3132～3277		3024～3164	
Idle speed	(rpm)	730～780			
Min.full-load specific fuel consumption	[g / (kW · h)]	≤210		≤205	
Ratio of oil consumption to fuel consumption	(%)	<0.5			
Firing order		1—3—4—2			
Direction of rotation (viewed from the flywheel side)		Counterclockwise			
Cooling method		Pressurized water-cooling			
Lubricating method		Combination of pressure and splash			
Starting method		Electric			
Dry weight	(kg)	330		350	
Overall dimensions (mm)	L	814		823	
	W	665		654	
	H	738		813	

1.2 Specifications of Main Components

Injection pump	In-line, plunger type			
	PL/PM		PW/PM	
Governor	Centrifugal, max.-min. speed type			
Injector type	Flange mounted	Clamp mounted	Flange mounted	Clamp mounted
Nozzle type	P46-49	F01910103	P46-49	F01910103
Injection-valve opening pressure (MPa)	21～23			
Timing advancer	Mechanical automatic type			
	JQ313(PL)、JQ319（PM）、JQ325（PW）			
Fuel filter	Paper cartridge type CX0710			
Lub.oil filter	Paper cartridge ,type J0814A		Paper cartridge, type J1012H	
Lub.oil pump	Gear type			
Rated speed (rpm)	1400			
Flow rate (l/min)	40			
Cooling water pump	Centrifugal type			
Rated speed (rpm)	3040		3060	
Flow rate (l/min)	200			
Starting motor	QD2636C			
Voltage (V)	24			
Power supply (kW)	4.5			
Generator	JFWB25C			
Voltage (V)	28			
Power output (W)	1000			
Vacuum pump	Vane type			
Glow plug	1F5			
Voltage (V)	24			
Power supply (W)	100			

Permissible time length for each preheating attempt (s)	<30	
Thermostat	Wax element type 145B	
Lub.oil cooler	Fin and tube type $28Z_3$	
Supercharger type	Exhaust gas turbocharger	
	J60-D	TD04

1.3 Main Engine Data

Temperature and pressure ranges at rated conditions	
1) Exhaust temperature (before turbine) (℃)	≤680
2) Cooling water temperature (℃)	80±5
3) Lub.oil temperature (℃)	95±5
4) Lub.oil pressure (MPa)	0.3～0.5
(Lubricating oil pressure at low idle speed≥100kPa)	
Tightening torque specifications (N · m)	
1) Cylinder head bolts	120～140
2) Flywheel bolts	130～150
3) Connecting rod cap bolts	100～120
4) Main bearing cover bolts	180～200
5) Camshaft gear clamping bolt	60～80
6) Rocker arm pedestal bolts	60～70
7) Crankshaft pulley clamping bolt	350～400
Valve timing (crank angle, deg.)	
Intake valves open (Before T.D.C.)	18
Intake valves close (After B.D.C.)	54
Exhaust valves open (Before B.D.C.)	62
Exhaust valves close (After T.D.C.)	18

(Compression clearance 0.9～1. 1 mm)		
Valve clearances (on cold engines) (mm)		
Intake valves	0.35～0.40	
Exhaust valves	0.40～0.45	
Injection pressure (MPa)	21～22	
Fuel delivery advance angle (crank angle, deg.)	12±1 BTDC	10±1 BTDC
Oil quantity in oil sump (kg)	6	8.8
Radiator heat dissipation area (m^2)	≥20	
Heat dissipation area of inter cooler (m^2)	5.5	
Flow rate of air cleaner (m^3/h)	500	600

Section II Running-in of the Engine

It is essential to run-in a new or an overhauled engine before putting it in service. In the running-in period, contact surfaces of the moving parts of an engine may gradually fit well with each other. Operating an engine under heavy load without going through running-in period would cause excessive wear and tear and the service life of the engine would be reduced significantly. It is necessary to adhere to the following programme in running-in an engine.

2.1 Preparations for Running-in.

(1) Clear the dust and oil sludge gathered on the engine.
(2) Check and tighten all external bolts and nuts.
(3) Grease bearings of the water pump.
(4) Fill oil sump with engine oil to the specified level.
(5) Fill fuel tank and cooling system.
(6) Check the wiring of electric system.

After finishing the preparations, proceed the running-in operation as described below.

2.2 Running-in Procedures

The whole period of running-in lasts for 60 hours. It can be completed on the road and the mileage should be no less than 2500 km.

No-load running-in should be carried out firstly for a mileage of 200 km. Inspect the working conditions of the engine at different speeds in no-load running-in period. Make sure that there is no leakage of fuel, oil or cooling water. Listen carefully to find out whether there is abnormal noise. Inspect exhaust conditions and the readings of all meters. In case of abnormal working conditions, find out the cause of trouble and do proper repair and adjustment work. Make sure that all troubles are eliminated before proceeding with the running-in under load.

Running-in under load should be carried out under the conditions specified in terms of the accumulated mileage and speed-load percentage as follows.

Running-in within the mileage of 800 km should be carried out with less than 50 percent of pay load at less than 75 percent of the rated speed of the engine.

Within 1500 km both load and speed should be less than 75 percent.

Within the mileage from 1500 km to 2500 km the load should be less than 90 percent and the speed lower than the rated speed.

Lubricating oil should be changed at the completions of 500 km、1000 km and 2500 km.

2.3 Inspection after Running-in

After running –in there are a large number of metal particles in the lubricating oil. The dirty oil should be drained off to prevent engine parts from premature wear.

1) Drain off the dirty oil when engine is hot. At this stage, impurities are still floating in the oil and are easy to clear away. Then clean the oil sump and strainer with diesel oil.
2) Clean or replace the cartridge of the oil filter.

3) Check and adjust valve clearances.
4) Check and retighten all external securing bolts and nuts.
5) Check for the wear of main bearings and connecting rod bearings
6) Retighten the securing bolts of the cylinder head, main bearings and connecting rod bearings in accordance with the instructions in this manual.
7) Check and eliminate other faults.
8) Apply grease where necessary.

Section III Operation of the Engine

3.1 Fuel, Lubricating Oil and Cooling Water

3.1.1 The fuel for the engine is the light diesel oil (Nos.10, 0, −10, −20 and −35) specified in the China National Standard GB 252. Before refilling, diesel oil should be stored in a container for at least 48 hours to settle down impurities and then filtered with a silk cloth. Proper grades of diesel oil for different ambient temperatures are shown in the table below.

Grade of diesel oil	10	0	-10	-20	-35

3.4 Operating the Engine

3.4.1 After starting, inspect the lubricating oil pressure gauge and the flow condition of outlet water. If there is anything abnormal, readjust right away or stop the engine for checking.

3.4.2 First run the engine at medium speed for about 5 minutes and then increase the speed gradually for warming up. Do not load the engine until the temperature of cooling water has reached 60℃.

3.4.3 Increase the speed and load gradually. The sudden increase in speed and load should be avoided as much as possible.

3.4.4 During operation, pay attention to smoke, noise and heat radiation. Check the temperatures of cooling water and lubricating oil and the pressure of lubricating oil.

3.4.5 The lubricating system incorporates a low oil pressure alarm which gives out acoustic and optical signals when lubricating oil pressure falls below the specified level. In that case, stop the engine immediately and then check and eliminate the trouble. Refill the oil sump if the oil level is too low.

3.5 Stopping the Engine

3.5.1 Before stopping the engine, reduce load and speed gradually and run the engine at lower-middle and idle speeds for several minutes. When the temperature of cooling water is below 70℃, cut off the fuel delivery to stop the engine by pulling the engine stop lever.

3.5.2 When it is necessary to make an emergency stop, pull the engine stop lever immediately to cut off the fuel delivery. If the engine does not stop or runs away after the pull on the engine stop level, carry out the following procedures without delay.

(1) Slacken the union nuts for the high pressure fuel pipes.

(2) Block up the intake pipe.

3.5.3 In winter, after the engine is stopped, it is necessary to drain off water by opening drain cocks on the cylinder block and radiator to protect the water pump, cylinder block and

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thoroughly. When installing valve springs, be sure to have their closely pitched ends downwards for proper function. The valves should be checked for leakage by pouring kerosene into the intake and exhaust ports and examining for two minutes .The standard valve recession, i.e. the distance of the valve head below the cylinder head surface is 0.6~0.7 mm. It should be checked after valve reconditioning.

When mounting the fuel injector into the cylinder head, make sure that the protrusion of the injector tip from the cylinder head reaches the specified value (see Fig.2). It can be adjusted with shims.

The glow plug is located beside the injector. The plug tip protrusion should be adjusted to 4～6 mm with shims.

The cylinder head is mounted on the cylinder block with 18 bolts. They should be evenly tightened in three steps. The tightening of the bolts in each step should be in the sequence as shown in Fig.3, i.e. starting in the middle and extending symmetrically on both sides. The final tightening torque is 120～140 N.m. When dismounting cylinder head, slacken the bolts in reverse order. The operation procedure should be followed to prevent leakage due to cylinder head deformation.

4.2 Cylinder Block

The cylinder block is made of high strength inoculated cast iron.

The cylinder block provides full-support for crankshaft main journals. The main bearing diameter of the engine YZ4105ZLQ is 5mm larger than that of YZ4102ZLQ engine. On the left side of the cylinder block mounted the injection pump, lubricating oil filter and oil cooler. On the right side are mounted the generator with a silicon rectifier, air conditioner compressor (on engines for buses), starting motor, push rod chamber covers, crankcase ventilator and water drain cock. On the front, there are the water pump and fan assembly, gear case and gear case cover. Timing gears are arranged inside the gear case and the front oil seal is fitted to the gear case cover. On the rear, there are the rear oil seal and cover assembly, flywheel and flywheel housing or clutch housing.

There are two inspection windows on gear case cover for timing the injection pump in service work. Before dismounting the injection pump, remove the inspection window covers, turn the crankshaft (less than two revolutions) so as to align the marks on camshaft gear and injection advancer with the points in the inspection windows respectively. The crankshaft should not be turned before mounting the injection pump again. When mounting, make sure that the mark on the injection advancer is aligned with the point in the inspection window.

The cylinder liner is of dry type. The cylinder liner is made of special cast iron containing copper and boron. The liner thickness is 3mm for the engine YZ4102ZLQ and 2mm for the engine YZ4105ZLQ. After the liners are pressed into the cylinder block, the top surface of each cylinder liner should be 0.04～ 0.12 mm higher above the surface of the cylinder block (see Fig.4). For the same cylinder block, the difference in the height between one cylinder liner and another should be less than 0.05 mm. If this dimensional tolerance is exceeded, replace the wrong cylinder liners with selected ones. When pressing-in a liner, be sure to apply the force

evenly and perpendicularly on its top.

There is a graphite-coated gasket between the cylinder block and cylinder head. Check to see that the holes in the gasket line up respectively with the water and oil holes in the cylinder block. Place an O-ring seal (Φ 16×1.9) in the oil hole of the gasket. After replacement of the gasket check the compression clearance between the piston top and cylinder head (0.9mm～1.1 mm).

The camshaft bushings are made of aluminum-tin alloy or ply metal. When pressing the bushings into the cylinder block, make sure that the oil holes on them line up with the holes in the cylinder block.

The main bearing covers and the bearing saddles of the cylinder block are machined in couple. The main bearing covers are marked with sequence numbers and orientational arrow marks. They are not interchangeable and the arrow marks on them should point to the front of the engine in assembly. The fifth main bearing cover is fitted with a locating pin whose convex-to-convex axis should be parallel with the axis of crankshaft. When tightening the main bearing cover bolts, tighten the bolts for the middle cover first, then the ones on both sides symmetrically. Tighten them evenly in two or three steps till the tightening torque reaches 180～200 N.m. The two halves of main bearings are different and the upper one has an oil groove and an oil hole. On the last bearing cover and saddle (nearest to the flywheel) are installed two thrust plates which produce a crankshaft end play in the range of 0.07～0.25 mm. The grooved face of the crankshaft thrust plate is coated with antifriction alloy and should be in contact with the crankshaft collar in assembly.

Both engines adopt a diaphragm spring clutch, the size of which is 12" for the engine YZ4102ZLQ or 13" for the engine YZ4105ZLQ.

Different flywheels are used according to the clutch size, but they have the same number (128) of teeth of the ring gears on them.

Various supporting structures are incorporated in the cylinder block, gear case and gear case cover for the mounting of various accessories such as the air-conditioner compressor, air compressor or vacuum pump for braking system and steering hydraulic pump.

The pocket of the oil sump is arranged either in the front or in the rear to meet the requirements of the engine mounting on different chassis.

In the crankcase, four piston cooling oil jets are mounted and connected by special bolts and M10×1 thread holes to the bottom of the main oil gallery.

4.3 Valve System

The valve system consists of the camshaft gear, camshaft, valve tappets, push rod and valve mechanism. It is of the valve-in-head type with the camshaft located below in the cylinder block.

The camshaft is made of ductile nodular cast iron heat-treated through normalization. The end play of the camshaft should be within the range of 0.07～0.22 mm. It is controlled with a thrust plate. Insufficient clearance may lead to mechanical interference while excessive clearance may cause timing error and mechanical noise.

Both camshaft gear and injection pump gear are driven by the crankshaft gear via an idle

gear. The gears have dot marks on them. In assembly, all the marks should be correctly placed to ensure correct valve timing and injection timing.

The valves are opened and closed in certain timing events. They are driven by the camshaft through tappets, push rods and rocker arms.

The tightening torque for the camshaft gear clamping bolt should be 60～80 N.m.

4.4 Crankshaft and Connecting Rod Mechanism

The crankshaft and connecting rod mechanism is composed of the piston-connecting rod assembly and crankshaft-flywheel assembly.

The piston-connecting rod mechanism consists of the pistons, compression rings, oil scraper rings, piston pins, connecting rods, connecting rod bearings and connecting rod bolts.

The aluminum pistons for engines YZ4102ZLQ and YZ4105ZLQ rated above 75 kW have oil gallery in the piston crown for better cooling .The piston pin outside diameter for both engines is 38mm. The piston pin length is 82mm for YZ4102ZLQ and 86mm for YZ4105ZLQ.

Reentrant combustion bowl is employed to enhance the air swirl created by the intake port. Groove insert made of austenitic cast iron is used for the first compression ring.

Two compression rings and one oil scraper ring are fitted into the piston. The barrel type first compression ring is chromium-plated. The taper-faced second compression ring and the oil scraper ring are both alloy cast iron (For YZ4105ZLQ diesel engine, the material of the second compression ring is polynary alloy). When the rings are fitted into their grooves, their gaps should be 120 degrees apart from each other around the circumference of the piston. Furthermore the oil scraper ring should be so placed that its gap is 90 degrees apart from the pinhole centre around the circumference. The second compression ring should have its top surface (marked with STD in the area near the gap) upward in assembly. When checking the ring gap, place the ring into a standard cylinder liner and measure it with a feeler gauge. If the gap is too small, correct it by fine filing; if too large, replace it with a new one.

The piston and connecting rod should be placed in assembly with the inlet valve pocket on the left side of the exhaust valve pocket viewed from the side of matching marks on the connecting rod.

The connecting rod and cap are machined and marked in couples, because they are not interchangeable. The difference in weight between one connecting rod and another for the same engine should be less than 20 grammes .Before inserting the piston and connecting rod assembly into the liner smear them with clean lubricating oil. It should be placed into the cylinder liner with the matching marks facing the injection pump side.

The crankpin bearing is of trimetal and the piston pin bushing is composed of bronze and steel backing. When assembling the connecting rod onto the crankpin, tighten two bolts evenly in two or three steps to reach the torque of 100～120N.m.

The crankshaft-flywheel assembly consists of the crankshaft, flywheel, crankshaft timing gear and crankshaft pulley.

The crankshaft is made of high strength nodular cast iron. It has received toughening treatment and ion-nutriding treatment to enhance its fatigue strength and wear resistance. An oil

hole in each journal leading to the neighbouring crankpin is employed to supply lubricating oil to the crankpin bearing. Two alternative crankshaft pulley are available for different application. One is a double-groove pulley. The other is a three-groove pulley used for the engine to drive an air conditioner or an air compressor.

The flywheel gear ring has 128 teeth on them. When installing the flywheel, tighten the flywheel bolts evenly in two or three steps according to the sequence shown in Fig.5 to reach the tightening torque of 130～150 N.m.

On the crankshaft pulley, there are marks indicating the top dead centre and the fuel delivery advance angle (all refer to the first cylinder) for the convenience of check and adjustment (see Fig.6).

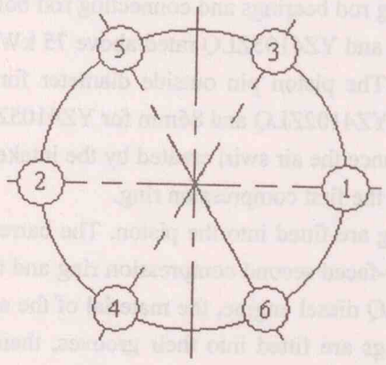

Fig.5

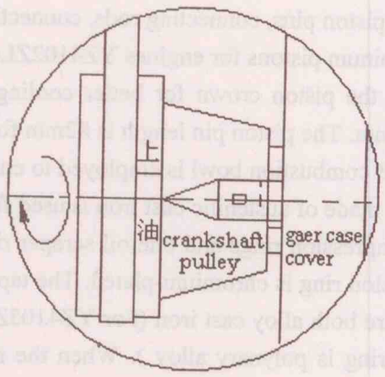

Fig.6

The tightening torque of the crankshaft pulley clamping nut should be 350～400N.m

4.5 Fuel and Air Supply System

The supply system of the engine consists of the fuel filter, fuel feed pump, injection pump and governor, injection advancer, injectors, fuel pipeline, intake manifold and air filter.

Fuel drawn by the feed pump from the fuel tank flows through the fuel filter to the injection pump. The injection pump delivers fuel at high pressure to injectors through fuel pipeline. From the injection pump and injectors superfluous fuel flows through the fuel return pipe and the back valves on the fuel filter and injection pump and returns to the fuel tank.

The filter element inside the fuel filter is a paper cartridge. Fuel should be kept absolutely clean to ensure a long service life of the parts in the fuel supply system. It is necessary to clean or replace the fuel filter cartridge periodically according to the maintenance schedule. When reassembling after maintenance, pay attention to the condition and proper positioning of the rubber seal rings, especially the seal rings on both ends of the cartridge.

The fuel feed pump is of single-acting plunger type incorporating a prime pump for bleeding air from inside the fuel pipeline. The fuel feed pump is driven by the injection pump camshaft. The actuating handle of the prime pump should be screwed down after bleeding operation.

The injection pump assembly includes the injection pump, fuel feed pump, governor,

automatic advancer, boost compensator, gear and mounting flange. The assembly is mounted onto the gear case with seven bolts clamping the mounting flange. At the rear of the governor, there is a supporting bracket. Timing marks are made on the gear case cover, gears and automatic advancer. Before disassembling the gears and injection pump, open the inspection window on the gear case cover and turn the crankshaft to align the mark on the rim of the advancer with the pointer in the inspection window. Correct valve and injection timing will be maintained as long as the gears (including the one for the injection pump) are not turned, otherwise the gear case cover should be removed and the marks on gears aligned during reassembling.

The injection pump plunger and sleeve pair as well as the delivery valve and seat pair are finely matched parts which are not interchangeable in assembly. The tightening torque of delivery valve holder is 39～44 N.m. The injection pump is lubricated with oil from the main oil gallery of the engine.

The fuel delivery setting screws and speed setting screws on the governor are adjusted correctly to the engine performance on the test rig in the engine factory. They are sealed and should not be readjusted by customers except when absolutely necessary. All the service operations should be carried out by the qualified servicemen on an injection pump tester according to the instructions in the service manual of the injection pump.

The long-stem type fuel injector has a five-hole nozzle. Check the injector for proper function and clean the nozzle periodically. The nozzle needle and valve seat are finely matched to each other and should not be interchanged.

There is a mechanical automatic advancer mounted on the shaft of the injection pump. As the pump speed increases from 700 rpm to the rated speed the advance angle of injection increases by 4° ±0.5° crank angle.

The air cleaner comprises whirl vanes and paper cartridge. When maintaining the air cleaner, first clear the dust chamber of dust. Then take out the cartridge and slightly knock it on both ends to remove dust. This can also be done by slightly brushing with a soft brush or blowing from inside the cartridge with compressed air under a pressure less than 300 kPa. Do not clean the cartridge with oil or water. Check to see if the cartridge is in good order. Replace it if it is torn or unglued. When reassembling, place the rubber seal ring in position to ensure reliable sealing, otherwise the dust would be sucked into the cylinder, causing premature wear-out of the cylinder liner, piston and piston rings.

The air cleaner incorporates a rubber dust-exhauster on the cover. When mounting the air cleaner cover, make sure the dust outlet is located toward the rear of the engine for easy exit of dust.

4.6 Lubricating System

The lubrication of the engine is of the splash-and-pressure combined type. Some bearings such as the main bearing, connecting rod bearing, camshaft bearing, idle gear bearing and rocker arm bearing are pressure-lubricated (see Fig.7), while other moving parts such as the cylinder liner, piston, piston pin, valves and timing gears are lubricated by splashed oil. The bearings in

the water pump need greasing periodically.

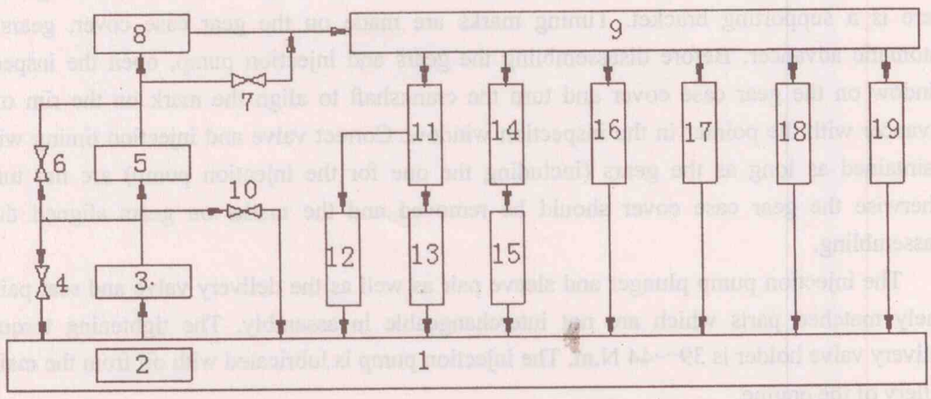

Fig.7

1. Oil sump 2.Oil pump strainer 3.Oil pump 4.Pressure limiting valve(max.800kPa) 5.Oil filter 6.Bypass valve in oil filter(opens at a pressure drop of 137kPa) 7.By-pass valve(opens at a pressure drop of 196kPa) 8.Fin and tube type oil cooler 9.Main oil gallery 10.Pressure regulating valve 11.Main bearings 12.Turbocharger 13.Connecting rod bearings 14.Camshaft bushings 15.Rocker arm bushings 16.Vacuum pump 17.Timing gears 18.Oil pump driving gear 19.Piston cooling jet

The lubricating oil pump is an externally-engaged gear pump driven by the gear on the camshaft. It is mounted on the side of the cylinder block in an inclined position. The oil sump of the engine YZ4102ZLQ is a steel pressing and that of the engine YZ4105ZLQ is a steel plate weldment.

The lubricating oil drawn by the oil pump flows into a full-flow oil filter with a paper cartridge .When assembling the oil filter, pay attention to the fitting of the rubber seal rings to prevent leakage and short circuit of oil flow. A pressure regulating valve and a by-pass valve are integrated into the filter. The pressure regulating valve serves to adjust the lubricating oil pressure within the specified range. If the oil pressure gets too high, the regulating valve will let the excessive oil flow back to the oil pump. The by-pass valve is employed to ensure the safety of lubrication. In case the cartridge is seriously chocked, the bypass valve will open at a pressure drop of 137 kPa, allowing unfiltered oil to flow directly to the oil cooler and oil gallery in the cylinder block. The unfiltered oil, however, would cause premature or excessive wear to engine parts. The opening pressure of the by-pass valve is adjusted on a special device. Do not dismantle the valve in maintenance. In case the fin and tube type oil cooler is chocked, the by-pass valve in the oil cooler will open at a pressure drop of 196 kPa and the uncooled oil will flow directly into the oil gallery.

4.7 Cooling System

The engine is provided with a closed-loop, pressurized cooling system. It consists of the

radiator, fan, water pump and thermostat. The centrifugal water pump is composed of the housing, impeller, shaft, pulley and water seal. On the inlet side of the water pump there is a water hose connector for recirculating water from the hot water heater in the driving compartment.

Two alternative water pump pulley are available for different applications. One is a single groove pulley. The other is a double-groove pulley used for the engine to drive an air conditioner or air brake compressor.

In the water pump are mounted two radial ball bearings (Type 60304), each with a dust cover. When assembling the water pump, place bearings with the dust cover of each bearing on the side opposite to the bearing spacer.

There are two types of fans. One is an axial-flow drawing fan with seven blade , the other is an axial-flow suction fan with six blades. The suction pipe of the water pump can be arranged on either side of the pump housing according to the layout of the cooling system.

Four oil jets are mounted in the cylinder block to cool pistons with the oil from the oil gallery.

4.8 Electrical System

The electrical system consists of the starting motor, glow plugs, and an A.C.generator with a silicon rectifier. Be sure to have the negative pole of the generator connected to the ground.

4.9 Vacuum Pump

A vacuum pump for servo-brake is integrated with the generator. It consists of the pump housing, eccentric rotor, vane, back valve, oil inlet banjo plug, air and oil outlet pipe and outlet banjo plug.

The oil from the oil gallery in the cylinder block is supplied to the vacuum pump for lubricating and sealing the moving parts. The oil and air pumped out of the vacuum pump flow into the gear case through the air and oil outlet pipe. When the vacuum pump does not work, the pressure difference between the vacuum reservoir and the pump housing will force the rubber seal onto its seat to keep up the vacuity in the vacuum reservoir and prevent oil from entering it.

4.10 Turbocharging and Intercooling System

4.10.1 Turbocharged diesel engines YZ4102ZLQ and YZ4105ZLQ are different from naturally aspirated engines in both intake and exhaust systems. The turbocharging and intercooling system is composed of the exhaust turbocharger, air-to-air intercooler and inlet and outlet oil pipes.

The turbocharger mounted on the outlet flange of the exhaust manifold is employed to compress the intake air to a greater density. The intake air flow rate of the turbocharger for the engine YZ4102ZLQ is rated at 470m3/h and that for the engine YZ4105ZLQ is rated at 590 m3/h. Therefore the capacity of the intake air cleaner for them should be higher than 500 m3/h for YZ4102ZLQ and higher than 600 m3/h for YZ4105ZLQ. The intercooler is used to cool the compressed air to increase the mass flow into the cylinder for better engine performance and lower exhaust emissions.

The turbocharger consists of a gas turbine and a compressor direct-coupled with a common shaft as shown in Fig.8. The compressor is driven by the exhaust gases through the turbine.

The intercooler located in front of the radiator utilizes the vehicle air stream and the fan wind to cool the compressed air.

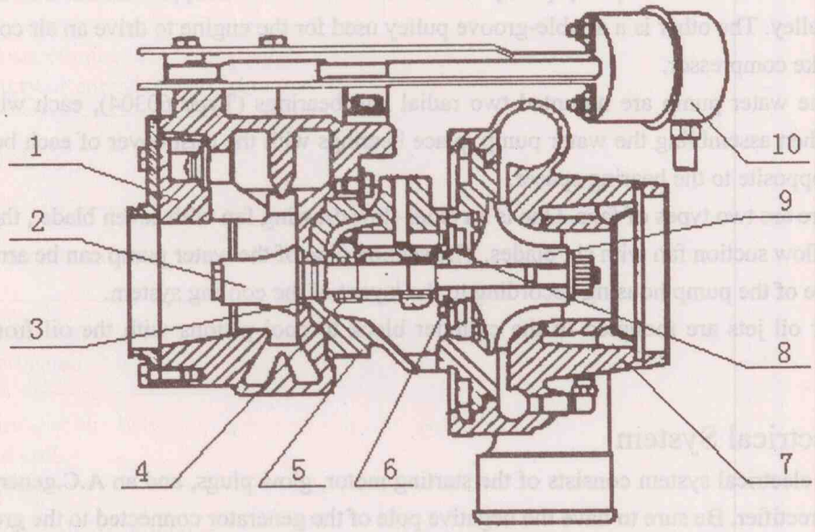

Fig.9

1. Turbine housing 2. Turbine rotor 3. Turbine seal ring 4. Floating bearing
5. Bearing housing 6. Thrust bearing 7. Compressor housing 8. Compressor seal ring
9. Compressor impeller 10. Wastegate actuator

4.10.2 Operation and maintenance of the turbocharger

(1) Operation instructions with respect to the turbocharger

(A) Starting the engine

(a) After starting the engine, idle the engine for at least 5 minutes until the lubricating oil temperature and pressure get normal. Otherwise the turbocharger would be damaged due to lack of lubrication. The lower the ambient temperature, the longer the idling period should be. During operation, take care not to speed up the engine abruptly.

(b) Renewal of lubricating oil

After cleaning the oil filter or leaving the engine unused for more than one week, disconnect the oil inlet pipe from the turbocharger, fill some clean oil into its bearing housing and turn its shaft several rounds to lubricate its bearing before staring the engine.

(B) Operating the engine

(a) Make sure that the inlet oil pressure for the turbocharger is in the range from 190 kPa to 390 kPa.

(b) Check the running conditions of the turbocharger to see if there is abnormal noise or vibration. Diagnose and eliminate abnormal conditions.

(C) Stopping the engine

Before stopping the engine, reduce its lead and speed gradually unless there is an emergency. Run the engine idle for several minutes to avoid the damage due to overheating and lack of lubrication. After a sudden brake in an emergency especially on a heavy truck at high speed, run the engine for at least half a minute before stopping it.

(2) Maintenance of the turbocharger

Regular maintenance of the turbocharger is essential to the engine performance.

(A) Daily maintenance

(a) Eliminate leakages of oil and gas.

(b) Clear dust and sludge from the turbocharger.

(c) Check the tightness of the mounting bolts of the turbocharger. Retighten them if necessary.

(B) Periodical maintenance

(a) At the completion of every 125 working hours or every 1500 to 2000km, check the conditions of tightening parts and movable parts.

(b) At the completion of every 500 working hours or every 6000 to 15000km, check the play of the wheel shaft of the turbocharger.

(C) Critical items to be checked on

(a) Check the bolts and nuts for connecting the intake or exhaust manifold and for fixing the turbocharger parts. Tighten loosen parts and replace faulty gaskets to eliminate leakage if necessary.

(b) Check to see if there is leakage on the inlet and outlet oil pipes for the turbocharger. Retighten loosen connecting parts and replace gaskets if necessary.

Service and repair work should be done by qualified technicians.

Section V Adjustment of the Engine

5.1 Adjustment of Valve Clearances

It is essential to adjust the valve clearances in operating an engine. If the clearances are too small, the valves will not close tight when they are heated and expand on a running engine. That will result in the leakage of valves and reduce the engine output. If the clearances are too big, the duration of the opening of intake and exhaust valves will be too short to ensure the sufficient induction and exhaustion. That will cause not only the reduction of engine output but strong impact on the valves, rocker arms and camshaft. Apart from the adjustment of valve clearances after the engine being reassembled, it is necessary to check and adjust the valve clearances periodically because of the possible loosening of adjusting screws and wear of parts in the valve system. The inspection interval is recommended to be 500 running hours or 8000 km.

The adjustment should be carried out on the cold engine. Remove the cylinder head cover. Turn the crankshaft until the mark of the top dead center of the first cylinder on the crankshaft pulley aligns with the pointer of the timing indicator (see figure 6). When the piston of the first cylinder is at its top dead center on the compression stroke, both intake and exhaust valves of the 1st cylinder are closed. In this position, check the clearances of intake valve and exhaust valve of the first cylinder, the intake valve of the second cylinder and the exhaust valve of the third cylinder (i.e. the clearances of the first, second, third and sixth valves counted from the front) +with a feeler gauge. The clearances of intake valve and exhaust valve are specified in Section I, Main Engine Data. To adjust the valve clearances, slacken the lock nut with a wrench and hold it, screw in or out the adjusting screw with a screwdriver until the feeler gauge inserted between the rocker head and the top surface of the valve stem feels neither too loose nor too tight. Then tighten the lock nut and check the clearance again. Readjust if necessary till it is properly set.

After the adjustment of the clearances of the above-mentioned four valves, rotate the crankshaft a complete turn to place the piston of the forth cylinder at its top dead center on the compression stroke. In this position, check the clearances of intake valve and exhaust valve of the fourth cylinder, the intake valve of the third cylinder and the exhaust valve of the second cylinder (i.e. the clearances of the fourth, fifth, seventh and eighth valves counted from the front). Adjust the clearances of these valves in the same way as described above.

5.2 Adjustment of Fuel Delivery Advance Angle

In order to maintain fuel economy and engine performance, it is necessary to check and adjust the fuel delivery advance angle after the engine being reassembled or running for 1000 hours or driving over 18000 km.

The procedure for checking and adjusting is as follows.

Remove the high-pressure fuel pipe of the first cylinder; connect a pipe joined to a thin glass tube with the first cylinder delivery valve holder of the injection pump. Set the speed control lever to the maximum delivery position and bleed off air in the fuel system. (Turn the crankshaft till there are no air bubbles in the fuel flowing out of the glass tube). Then turn the crankshaft slowly and watch attentively for the rise of the fuel level in the glass tube. Stop

turning the crankshaft at the beginning of the rise of fuel level, which implies the beginning of the fuel delivery to the first cylinder. Check to see if the mark scale "油" on the periphery of the crankshaft pulley aligns with the timing pointer on the gear case cover(see Figure 6). If it does not, readjust in the following procedures. Slacken the bolts, which fasten the injection pump onto the connecting flange. Turning the injection pump with its top towards the cylinder block results in the increase in the fuel delivery advance angle, and vice versa.

5.3 Adjustment of Fuel Injector Opening Pressure

Dismount the fuel injector from the cylinder head and mount it on a injector tester for checking and adjusting. Actuate the pump handle and watch the indication of pressure. The injector opening pressure should be within the range from 21MPa to 22MPa as specified in Section I, Main Engine Data. The fuel spray should be uniform and the puffing sound of injection should be short and clear. Procedures for the adjustment of two kinds of injectors are different. For the adjustment of the type P46-49 injector, dismount the lock nut from the injector holder and then screw in or out the adjusting screw to increase or decrease the opening pressure. After the pressure is adjusted to the specified level, remount and tighten the lock nut and check for the opening pressure again. The opening pressure of the type F01910103 injector can be adjusted by choosing from different adjusting shims of the thickness from 1.2mm to 2.0mm. The gauge step is 0.01mm. Most of the injector manufactures use the shims of the thickness from 1.2mm to 1.9mm. Before reassembling the injector, clean the nozzle valve and the adjusting shim. Care must be taken not to scratch the matching faces. After attaining the specified pressure, remount the lock nut and check for the opening pressure again.

5.4 Adjustment of V-belt Tension

Though very easy to adjust, the tension of V-belt has great influence on the rotational speed of the generator and water pump and hence the operation of the engine. It is recommended to adjust it periodically. When engine is not running, press on the middle of a straight section of the belt with a force of 30～40 N. The bending of V-belt should be within the range of 10～15 mm. If not qualified, loosen the adjusting bolt on the adjusting bracket to move the generator to adjust the belt to a proper tension. The excessive tension will shorten the service life of the belt and cause the premature wear of bearings in generator and water pump due to the heavy load resulting from excessive belt tension. The insufficient belt tension, however, will lead to the belt creep and fracture, causing the engine overheating.

5.5 Adjustment of Lubricating Oil Pressure

Pay frequent attention to the lubricating oil pressure. The normal oil pressure ranges from 200 kPa to 500 kPa. The adjustment of lubricating oil pressure should be carried out after the engine gets warm (when the lubricating oil temperature is around 80℃). Dismount the sealing nut from the adjusting screw on the oil filter. Turn the adjusting screw to adjust oil pressure. Screw in or out the adjusting screw to increase or decrease the oil pressure. After adjustment, put on the sealing washer and then tighten the sealing nut.

Section VI Technical Maintenance

Regular maintenance of the engine is essential to efficient and trouble-free operation, good mileage between major repairs and long service life. General procedures of different assignments of technical maintenance stipulated below should be followed in principle. Customers can make some alterations according to particular service conditions.

The maintenance work schedule is as follows:

1) Shift maintenance
2) Maintenance at the completion of 125 working hours or 1500～2000km.
3) Maintenance at the completion of 500 working hours or 6000～8000km.
4) Maintenance at the completion of 1000 working hours or 18000～24000km.

6.1 Shift Maintenance

A) Check the oil level in the oil sump. Refill to the specified level if necessary.
B) Check the water level in the radiator. Refill if necessary.
C) Check the fuel level in the fuel tank. Refill if necessary.
D) Check the tightness of mounting bolts of the engine and tightening bolts of components. Tighten them if necessary.
E) Check the leakages of air, oil and water. Repair if necessary.
F) Eliminate all faults and abnormal conditions found in operation.
G) Clear oil sludge and dust from the engine and accessories.
H) Clear dirt from dust chamber of air cleaner. Clear dust from paper cartridge if the engine works in a dusty environment.

6.2 Maintenance at the Completion of Every 125 Working Hours or 1500 to 2000 km

A) Complete all the procedures specified in item 6.1.
B) Grease the bearing of water pump with a grease gun.
C) Check the battery electrolyte level, which should be kept 10～15 mm high above the plates. Add distilled water if necessary. It is not allowed to add electrolyte. The specific gravity of electrolyte should be 1.25～1.28g/cm^3 at 20℃ambient temperature. If it drops to 1.14, recharge the battery.
D) Clear dust from the paper cartridge and dust chamber of air cleaner.
E) Check the tension of the fan belt. Adjust or replace it if necessary.
F) Clear away dirt from the commutator and brushes of the starting motor. Grease its bearings.

At the completion of every 250 working hours, clean the oil filter and replace oil filter cartridge and seal rings. Clean the fuel filter and its cartridge.

6.3 Maintenance at the Completion of Every 500 Working Hours or 6000 to 8000 km

A) Complete all the procedures specified in item 6.2.

B) Clean lubricating system. Change lubricating oil. For a new engine, these procedures should be carried out at the completions of driving distances of 500 km, 1000 km and 2500 km.

C) Check the injector opening pressure and spray characteristics of the injector. Readjust the pressure and wash the needle and valve seat if necessary.

D) Check the dripping from the weep hole of the water pump. Change the water seal if the dripping rate gets too high.

E) Check the installation of the generator and starting motor and the wear of their brushes and commutators.

F) Check all cable connections of the electrical system. Clean and correct if dark burned spots are found.

G) Check the tightening torque of the main bearing bolts and connecting rod bolts.

H) Check and adjust the valve clearances.

I) Check the thermostat.

J) Clean the crankcase ventilator.

K) Check the paper cartridge of the air cleaner.

6.4 Maintenance at the Completion of Every 1000 Working Hours or 18000 to 24000 km

A) Complete all the procedures specified in item 6.3.

B) Replace the cartridge and seal ring of the fuel filter.

C) Replace the cartridge of the air cleaner.

D) Clear the scale from the cooling system.

E) Clean the fuel tank and fuel piping.

F) Clean the oil cooler. If there is serious blockage, replace the oil cooler core.

G) Check and adjust the fuel delivery advance angle.

H) Check the seat lines of intake and exhaust valves. Relap the valves and adjust the valve clearances if necessary.

I) Check the flow rate of blow-by from the ventilator. Check the exhaust flow for blue smoke. Replace piston rings if necessary.

J) Check the wear of cylinder liners, connecting rod bearings and main bearings. Clear carbon deposits from the cylinder head, pistons and cylinder liners.

Section VII Trouble-shooting

7.1 Failure to Start

Possible Causes	Suggested Remedies
(1) Fuel tank empty or fuel tank cock not open.	Refill fuel tank. Open cock.
(2) Fuel line or fuel filter clogged.	Clean fuel filter or replace filter cartridge.
(3) Air within fuel system.	Bleed fuel system. Tighten all fuel pipe connections.
(4) Defective injection pump or incorrect injection timing.	Check fuel feed pump and injection pump. Adjust fuel delivery advance angle.
(5) No injection or poor characteristics of spray.	Clean and lap nozzle needle and body in pair. Readjust injector opening pressure.
(6) Ambient temperature too low and engine too cold.	Heat cooling water. Apply preheat-starting.
(7) Insufficient compression pressure in cylinders.	See item 7.3 hereafter.
(8) Defective starting motor or low battery output.	See item 7.11 hereafter.

7.2 Lack of Power

Possible Cause	Suggested Remedies
(1) Insufficient compression pressure in cylinders.	See item 3 hereafter.
(2) Wrong grade of fuel or fuel diluted with water	Use proper fuel. Clean fuel tank and refill.
(3) Clogged air cleaner.	Clean air cleaner cartridge. Replace cartridge if necessary.
(4) Choked exhaust silencer.	Clear carbon deposits or dirt from silencer.
(5) Air within fuel system.	Bleed fuel system. Tighten all fuel line connections.
(6) Incorrect valve timing.	Inspect camshaft and marks on gears. Check valve clearances. Replace camshaft if it is worn.
(7) Incorrect fuel delivery advance angle	Check marks on gears. Readjust fuel delivery advance angle.
(8) Low injection pressure or poor spray characteristics.	Readjust injector opening pressure.
(9) Uneven distribution of fuel among cylinders.	Readjust uniformity of fuel delivery from fuel injection pump to each cylinder.
(10) Engine unable to reach the rated speed.	Reset speed control lever.

7.3 Insufficient Compression Pressure in Cylinder

Possible Causes	Suggested Remedies
(1) Valve clearance too small or no clearance.	Readjust valve clearance.
(2) Carbon deposit on valve and seat. Worn valve and seat.	Clear away carbon deposits and relap valve and valve seat. Ream valve seat if necessary.
(3) Piston ring worn or lack of tension.	Replace piston ring.
(4) Piston ring stuck due to carbon deposits.	Clean piston ring in kerosene.
(5) Cylinder liner and piston worn. Clearance between liner and piston too big.	Replace liner and piston or rebore liner and use oversize piston.
(6) Leakage in cylinder head gasket face.	Retighten cylinder head bolts or replace gasket.
(7) Gas leakage in injector mounting bore.	Check copper washer. Reset injector.
(8) Broken valve spring.	Replace valve spring.
(9) Valve stuck in valve guide.	Clean valve in kerosene. Replace if it is worn out or deformed.

7.4 Engine Stops Completely

Possible Causes	Suggested Remedies
(1) No fuel in tank.	Refill fuel tank.
(2) Air and water in fuel system.	Bleed fuel system. Drain water from fuel tank.
(3) Clogged fuel filter.	Clean or replace cartridge.
(4) Choked air cleaner.	Replace air cleaner cartridge.
(5) Piston stuck in cylinder.	Repair or replace piston and cylinder liner.

7.5 Abnormal Noise

Possible Causes	Suggested Remedies
(1) Engine detonating with clear knock in cylinder.	Readjust fuel delivery advance angle.
(2) Delayed combustion. Backfire in exhaust pipe.	Readjust fuel delivery advance angle.
(3) Clearance between piston and cylinder liner too big, causing thudding noise (The noise disappears3 to 5 seconds after fuel delivery is cut off)	Check and repair. Replace piston and liner if necessary.
(4) Clearance between crankshaft journal and main bearing too big, causing low heavy pounding noise periodically.	Check and repair. Replace main bearing or thrust plates.

Possible Causes	Suggested Remedies
(5) Clearance between crankpin and bearing too big, causing dull pounding noise.	Check and repair. Replace connecting rod bearing.
(6) Clearance between piston pin and connecting rod bushing too big, causing sharp knocking noise.	Check and repair. Replace bushing.
(7) Valve clearance too big, causing chattering noise.	Readjust valve clearance.
(8) Piston striking valve head, causing clear pounding noise.	Readjust valve clearance and valve timing.

7.6 Black Exhaust

Possible Causes	Suggested Remedies
(1) Engine overloaded.	Reduce load.
(2) Fuel delivery uneven or too much.	Adjust injection pump and governor.
(3) Injection pressure too low, causing poor spray characteristics.	Readjust injector opening pressure.
(4) Fuel injection timing too late.	Readjust fuel delivery advance angle.
(5) Air cleaner choked.	Clear dust from cartridge or replace cartridge.
(6) Wrong grade of fuel.	Drain tank and fill with proper fuel.

7.7 Coolant Temperature Too High

Possible Causes	Suggested Remedies
(1) Loose fan belt causing reduction of cooling water flow.	Adjust belt tension or replace V-belt.
(2) Engine overloaded for a long time.	Reduce load.
(3) Cooling water insufficient.	Refill radiator.
(4) Cooling water flow reduced due to low water pump efficiency.	Check clearance between water pump impeller and housing. Replace impeller if necessary.
(5) Defective water pump impeller.	Replace impeller.
(6) Cooling water circulation blocked.	Clean cooling system.
(7) Defective thermostat.	Replace thermostat.
(8) Defective water thermometer.	Replace thermometer.
(9) Insufficient lubrication.	Inspect lubricating system and clean oil gallery.

7.8 Low Lubricating Oil Pressure

Possible Causes	Suggested Remedies
(1) Insufficient oil in oil sump.	Check oil level. Refill to the specified level.
(2) Defective low oil pressure alarm.	Replace alarm.
(3) Clogged oil gallery.	Clean oil gallery and blow away dirt with compressed air.
(4) Clogged oil strainer.	Clean oil strainer.
(5) Clogged oil filter and defective by-pass valve.	Clean oil filter or replace filter cartridge. Readjust by-pass valve if necessary.
(6) Excessive bearing clearances due to wear-out of main bearing and crankpin bearing.	Repair or replace bearing.
(7) Engine overheating, causing high temperature of lubricating oil.	Reduce load to lower oil temperature or refill with new oil.
(8) Too big clearance between oil pump gears and housing or between flanks of teeth of gears.	Replace gears or housing of oil pump.

7.9 Excessive Oil Consumption

Possible Causes	Suggested Remedies
(1) Oil scraper ring stuck in ring groove due to carbon deposits or worn piston ring.	Wash oil scraper ring in kerosene or replace defective ring.
(2) Oil return holes plugged due to carbon deposits.	Clean oil return holes in piston.
(3) Oil level too high.	Check with dipstick and drain oil to correct level.
(4) Leakage in lubricating system.	Tighten connectors and replace sealing washers and gaskets.

7.10 Deterioration of Lubricating Oil

Possible Causes	Suggested Remedies
(1) Piston ring worn or stuck in groove, causing combustion gas or fuel to leak into the oil sump.	Clean or replace piston ring.
(2) Water leaking into oil due to faulty cylinder head gasket.	Replace gasket.
(3) Water leaking into oil due to crack in cylinder head.	Replace cylinder head.

7.11 Trouble-shooting in Electrical System

Symptoms and Causes	Suggested Remedies
A) Faulty generator, no recharging of battery or current too weak.	
(1) Loose connections on generator and battery or corroded contacts.	Check and tighten all connections. Clean contacting surfaces and improve insulation.
(2) V-belt slip.	Readjust belt tension.
(3) Generator out of order.	Check and repair.
B) Current too strong and generator overheated.	
(1) Short-circuit between armature and field coil.	Repair or replace.
(2) Faulty voltage regulator.	Repair or replace.
C) Resistor of regulator burnt out	
(1) Battery polarity reversed	Correct battery connection.
(2) Cutout relay out of order, current reversed at low engine speed.	Repair or replace.
D) Starting motor fails to run.	
(1) Loose connection of cables.	Clear away dirt. Tighten connections.
(2) Battery not fully charged.	Check and recharge.
(3) Bad contact of brushes.	Clean and polish with fine sandpaper.
(4) Short-circuit within starting motor.	Check and repair.

Symptoms and Causes	Suggested Remedies
E) Starting motor running idle, unable to crank up the engine.	
(1) Bad contact of brushes.	Clean and polish with fine sandpaper.
(2) Bad contact of cable connection and switch.	Clear away dirt. Tighten all connections.
(3) Weak battery.	Check and recharge.

7.12 Trouble-shooting on Vacuum Pump

Symptoms and Causes	Suggested Remedies
(1) Oil leakage into vacuum reservoir or low suction efficiency causing insufficient vacuity in vacuum reservoir.	Check wear of pump vanes, replace if necessary. (See description below)
(2) Contaminated or deteriorated oil causing blockage in oil passage and defective sealing of back valve.	Clean oil passage and back valve. Replace valve core and valve spring.
(3) Defective valve core.	Replace valve core and valve spring.
(4) Leakage due to improper mounting of back valve and suction pipe.	Locate leaks and repair.

7.13 Trouble-shooting on Turbocharger

Symptoms and Causes	Suggested Remedies
1. Black exhaust and/or lack of power	
(1) Dirty air filter or chocked air suction pipe	Clean air filter or replace filter catridge
(2)Chocked or leaking pipes between turbocharger and intake /exhaust manifolds	Eliminate leakage or chockage
(3) Dirty compressor wheel and housing	Clean compressor wheel and housing
(4) Faulty turbocharger	Clean or replace turbocharger
2. Blue exhaust	
(1) Oil return restricted	Check and repair
(2) Oil leakage into exhaust pipe	Check and repair
3. Abnormal noise	
(1) Leakage or blockage in inlet or outlet pipe of compressor	Eliminate leakage or blockage
(2) Wheel touching housing due to excessive wear of bearing	Repair or replace turbocharger
4. Oil leakage into compressor or turbine housing	
(1) Dirty air filter or chocked air suction pipe	Clean or replace cartridge , clear blockage
(2) Oil return restricted	Clear blockage
(3) Oil sludge or product of oil carbonization accumulating in bearing housing	Clear bearing housing and replace oil
(4) Excessive wear in turbocharger	Repair or replace
5. Turbocharger surging	
(1) Chocked air suction pipe	Clean or replace pipe
(2) Dirty compressor wheel and housing	Dismount compressor housing and cleaning housing and wheel
6. Sluggish revolving of wheels	
(1) Oil sludge or product of oil carbonization in bearing housing adhering to bearing and shaft	Repair by service agency
(2) Friction between wheel and housing due to excessive wear of bearing	Repair by service agency
(3) Distortion of wheel axle	Repair by service agency

Appendix I Spare Parts of YZ4102ZLQ Diesel Engine

No	Drawing No.	Description
1	YZ4102ZQ-01121	Intake valve
2	T/Y102-01122	Exhaust valve
3	YZ4105ZQ-02119	Cylinder head gasket
4	T/Y102-02135	Lower main bearing
5	T/Y102-02134	Upper main bearing
6	YZ4102ZQ-03102	First compression ring
7	YZ4102ZQ-03103	Second compression ring
8	YZ4102ZQ-03012	Oil scraper ring assembly
9	T/Y102-03112	Connecting rod bearing
10	(F)B65×85×10	Front oil seal
11	PG105×130×14	Rear oil seal
12	AV17×1270	V—belt
13	AV17×1120	V—belt
14	J0814A	Oil filter cartridge
15	J0810A-0005	Oil filter cartridge seal ring
16	J0810S-0003A	Oil filter housing seal ring
17	CX0710-0000	Fuel filter cartridge
18	969DLLA155S054	Injector nozzle
19	YZ4102ZQ-02118	Cylinder liner
20	YZ4102ZLQ-03101	Piston

Appendix I Spare Parts of YZ4105ZLQ Diesel Engine

No	Drawing No.	Description
1	YZ4102ZQ-01121	Intake valve
2	T/Y102-01122	Exhaust valve
3	YZ4105ZQ-02119	Cylinder head gasket
4	YZ4110QA-02135	Lower main bearing
5	YZ4110QA-02134	Upper main bearing
6	YZ4105ZLQ-03102	First compression ring
7	YZ4105ZLQ-03103	Second compression ring
8	YZ4105ZLQ-03012	Oil scraper ring assembly
9	T/Y102-03112	Connecting rod bearing
10	(F)B65×85×10	Front oil seal
11	PG105×130×14	Rear oil seal
12	AV17×1270	V—belt
13	AV17×1120	V—belt
14	J1012H	Oil filter cartridge
15	J0810A-0005	Oil filter cartridge seal ring
16	C0810S-0003A	Oil filter housing seal ring
17	CX0710-0000	Fuel filter cartridge
18	KBAL-P028	Injector nozzle
19	YZ4105ZQ-02118	Cylinder liner
20	YZ4105ZLQ-03101	Piston

Appendix III Fits and Wear Limits of Main Parts of Diesel Engine YZ4102ZLQ

No	Item	Standard Dimension	Type of Fit	Assembly Clearance(mm)	Wear Limit (Reference)
1	Crankshaft main journal and main bearing bore	$\phi 80h6(^{0}_{-0.019})$ $\phi 80^{+0.116}_{+0.07}$	Clearance	0.07～0.135	0.23
2	Axial clearance between crankshaft and cylinder block		End play	0.07～0.25	0.40
3	Crankpin O.D. and connecting rod crankpin bore	$\phi 66h6(^{0}_{-0.019})$ $\phi 66(^{+0.079}_{+0.036})$	Clearance	0.036～0.098	0.20
4	Connecting rod large end thickness and crankpin length	$40^{+0.10}_{0}$ $40^{-0.15}_{-0.25}$	Clearance	0.15～0.35	0.60
5	Connecting rod small end bushing O.D.and small end bore	$\phi 41^{+0.07}_{+0.05}$ $\phi 41H7(^{+0.025}_{0})$	Interference	- 0.025～ - 0.07	
6	Piston pin and connecting rod small end bushing I.D.	$\phi 38^{0}_{-0.005}$ $\phi 38^{+0.037}_{+0.022}$	Clearance	0.022～0.042	

7	Piston pin and pin hole in piston	$\phi 38^{0}_{-0.005}$ $\phi 38^{+0.009}_{+0.001}$	Clearance	0.001～0.014	
8	Piston skirt O.D. and cylinder liner I.D.	A : φ101.85～φ101.86 φ102.005～φ102.015	Clearance	0.115～0.135	
9	Piston skirt O.D. and cylinder liner I.D.	B: φ101.86～φ101.87 φ102.015～φ102.025			
10	Piston skirt O.D. and cylinder liner I.D.	C: φ101.87～φ101.88 φ102.025～φ102.035			
11	The first compression ring and ring groove	$2.6^{0}_{-0.025}$ $2.605^{+0.10}_{+0.08}$	Side clearance	0.085～0.13	0.20
12	The second compression ring and ring groove	$2.35^{-0.01}_{-0.03}$ $2.425^{+0.01}_{-0.01}$	Side clearance	0.075～0.115	0.17
13	Oil scraper ring and ring groove	$4^{-0.010}_{-0.025}$ $4^{+0.06}_{+0.04}$	Side clearance	0.05～0.085	0.17

14	Ring gap of the first compression ring(measured in ϕ 102.03 gauge)	0.40～0.65	Gap	0.40～0.65	2.5
15	Ring gap of the second compression ring (measured in ϕ 102.03 gauge)	0.6～0.8	Gap	0.60～0.80	2.5
16	Ring gap of oil scraper ring (measured in ϕ 102.03 gauge)	0.35～0.60	Gap	0.35～0.60	2.5
17	Flywheel O.D .and gear ring I.D.	$\phi 346v8(^{+0.564}_{+0.475})$ $\phi 346H8(^{+0.089}_{0})$	Interference	- 0.386～ - 0.564	
18	Intake valve stem O.D. and valve guide I.D.	$\phi 9\ e8(^{-0.025}_{-0.047})$ $\phi 9\ H8(^{+0.022}_{0})$	clearance	0.025～0.069	0.23
19	Exhaust valve stem O.D. and valve guide I.D.	$\phi 9^{-0.05}_{-0.07}$ $\phi 9\ H8(^{+0.022}_{0})$	clearance	0.050～0.092	0.24
20	Valve guide O.D. and bore in cylinder head	$\phi 14\ u7(^{+0.051}_{+0.033})$ $\phi 14\ H8(^{+0.018}_{0})$	Interference	- 0.015～ - 0.051	

21	Intake valve seat insert O.D. and bore in cylinder head	ϕ 47 y7$(^{+0.139}_{+0.114})$ ϕ 47 H7$(^{+0.025}_{0})$	Interference	- 0.089～ - 0.139	
22	Exhaust valve seat insert O.D. and bore in cylinder head	ϕ 39 y7$(^{+0.119}_{+0.094})$ ϕ 39 H7$(^{+0.025}_{0})$	Interference	- 0.069～ - 0.119	
23	Rocker arm bushing O.D. and bore in rocker arm	ϕ 24 s7$(^{+0.056}_{+0.035})$ ϕ 24 H7$(^{+0.021}_{0})$	Interference	- 0.014～ - 0.056	
24	Rocker arm shaft O.D. and rocker arm bushing I.D.	ϕ 20 h7$(^{0}_{-0.021})$ ϕ 20 F8$(^{+0.053}_{+0.020})$	Clearance	0.020～0.074	0.20
25	Camshaft bushing O.D.and bore in cylinder block	ϕ 62$^{+0.094}_{+0.072}$ ϕ 62H7$(^{+0.030}_{0})$	Interference	- 0.042～ - 0.094	
26	Camshaft journal and camshaft bushing I.D.	ϕ 57 h6$(^{0}_{-0.019})$ ϕ 57$^{+0.08}_{+0.05}$	Clearance	0.05～0.099	0.20
27	Valve tappet O.D. and bore in cylinder block	ϕ 28 g6$(^{-0.007}_{-0.020})$ ϕ 28 F7$(^{+0.041}_{+0.020})$	Clearance	0.027～0.061	0.15

28	Thickness of camshaft thrust plate and width of camshaft notch	6 c11($^{-0.070}_{-0.145}$) 6 H11($^{+0.075}_{0}$)	Clearance	0.07～0.22	
29	Cylinder liner O.D. and bore in cylinder block	A: φ 107.995～φ 108.005 φ 108.000～φ 108.010	Interference	mean value −0.005～+0.015	
30	Cylinder liner O.D. and bore in cylinder block	B: φ 108.006～φ 108.015 φ 108.011～φ 108.020	Interference		
31	Cylinder liner O.D. and bore in cylinder block	C: φ 108.016～φ 108.025 φ 108.021～φ 108.030	Interference		
32	Height of cylinder liner flange and depth of flange recess in cylinder block	$10^{+0.07}_{+0.04}$ $10^{0}_{-0.05}$	Height above cylinder block top surface	0.04～0.12	Height differences among four cylinders less than 0.05
33	Idle gear shaft O.D. and idle gear shaft bushing I.D.	φ 55h6($^{0}_{-0.019}$) φ 55F6($^{+0.049}_{+0.030}$)	Clearance	0.030～0.068	

34	Lub. oil pump driving gear shaft and bore in bearing cover	$\phi 16^{-0.09}_{-0.11}$ $\phi 16H7(^{+0.018}_{0})$	Clearance	0.09～0.128	
35	Driving gear shaft bushing O.D. and bore in cylinder block	$\phi 32s7(^{+0.068}_{+0.043})$ $\phi 32^{+0.025}_{0}$	Interference	- 0.018～ - 0.068	
36	Lub.oil pump driving gear shaft O.D. and gear shaft bushing I.D.	$\phi 16f7(^{-0.09}_{-0.11})$ $\phi 16H7(^{+0.018}_{0})$	Clearance	0.09～0.128	
37	Axial clearance between oil pump gear and oil pump housing	0.065～0.125	Clearance	0.065～0.125	
38	Peripheral clearance between oil pump gear and oil pump housing	0.09～0.17	Clearance	0.09～0.17	
39	Oil pump driving shaft and hole in oil pump cover	$\phi 16h6(^{0}_{-0.011})$ $\phi 16E8(^{+0.059}_{+0.032})$	Clearance	0.032～0.07	
40	Oil pump shaft and hole in oil pump housing	$\phi 16h6(^{0}_{-0.011})$ $\phi 16X7(^{-0.038}_{-0.056})$	Interference	- 0.027～ - 0.056	

41	Oil pump shaft and hole in oil pump gear	ϕ 16h6($^{0}_{-0.011}$) ϕ 16F8($^{+0.043}_{+0.016}$)	Clearance	0.016～0.054	
42	Oil pump driving shaft and driving gear	ϕ 16h6($^{0}_{-0.011}$) ϕ 16U7($^{-0.026}_{-0.044}$)	Interference	- 0.015～ - 0.044	
43	Oil pump cover and cylinder block	ϕ 25g6($^{-0.007}_{-0.020}$) ϕ 25H7($^{+0.021}_{0}$)	Clearance	0.007～0.041	
44	Axial clearance between water pump impeller and water pump housing	0.1～0.3	Clearance (adjusted with shims)	0.1～0.3	

Appendix III Fits and Wear Limits of Main Parts of Diesel Engine YZ4105ZLQ

No	Item	Standard Dimension	Type of Fit	Assembly Clearance(mm)	Wear Limit (Reference)
1	Crankshaft main journal and main bearing bore	$\phi 85h6(^{0}_{-0.022})$ $\phi 85^{+0.116}_{+0.070}$	Clearance	0.07～0.138	0.23
2	Axial clearance between crankshaft and cylinder block		End play	0.07～0.25	0.40
3	Crankpin O.D. and connecting rod crankpin bore	$\phi 66h6(^{0}_{-0.019})$ $\phi 66(^{+0.079}_{+0.036})$	Clearance	0.036～0.098	0.20
4	Connecting rod large end thickness and crankpin length	$40^{+0.10}_{0}$ $40^{-0.15}_{-0.25}$	Clearance	0.15～0.35	0.60
5	Connecting rod small end bushing O.D.and small end bore	$\phi 41^{+0.07}_{+0.05}$ $\phi 41H7(^{+0.025}_{0})$	Interference	- 0.025～ - 0.07	
6	Piston pin and connecting rod small end bushing I.D.	$\phi 38^{0}_{-0.005}$ $\phi 38^{+0.037}_{+0.022}$	Clearance	0.022～0.042	

7	Piston pin and pin hole in piston	$\phi 38^{0}_{-0.005}$ $\phi 38^{+0.009}_{+0.001}$	Clearance	0.001～0.014	
8	Piston skirt O.D. and cylinder liner I.D.	A : φ104.85～φ104.86 φ105.005～φ105.015	Clearance	0.115～0.135	
9	Piston skirt O.D. and cylinder liner I.D.	B: φ104.86～φ104.87 φ105.015～φ105.025			
10	Piston skirt O.D. and cylinder liner I.D.	C: φ104.87～φ104.88 φ105.025～φ105.035			
11	The first compression ring and ring groove	$2.605^{-0.01}_{-0.03}$ $2.605^{+0.10}_{+0.08}$	Side clearance	0.09～0.13	0.20
12	The second compression ring and ring groove	$2^{-0.01}_{-0.025}$ $2^{+0.09}_{+0.07}$	Side clearance	0.08～0.115	0.17
13	Oil scraper ring and ring groove	$4^{-0.010}_{-0.025}$ $4^{+0.06}_{+0.04}$	Side clearance	0.05～0.085	0.17

14	Ring gap of the first compression ring(measured in ϕ 105 gauge)	0.30～0.50	Gap	0.30～0.50	2.5
15	Ring gap of the second compression ring (measured in ϕ 105 gauge)	0.8～1.15	Gap	0.80～1.15	2.5
16	Ring gap of oil scraper ring (measured in ϕ 105 gauge)	0.3～0.5	Gap	0.3～0.5	2.5
17	Flywheel O.D .and gear ring I.D.	ϕ 346v8($^{+0.564}_{+0.475}$) ϕ 346H8($^{+0.089}_{0}$)	Interference	- 0.386～ - 0.564	
18	Intake valve stem O.D. and valve guide I.D.	ϕ 9 e8($^{-0.025}_{-0.047}$) ϕ 9 H8($^{+0.022}_{0}$)	clearance	0.025～0.069	0.23
19	Exhaust valve stem O.D. and valve guide I.D.	ϕ 9$^{-0.05}_{-0.07}$ ϕ 9 H8($^{+0.022}_{0}$)	clearance	0.050～0.092	0.24
20	Valve guide O.D. and bore in cylinder head	ϕ 14 u7($^{+0.051}_{+0.033}$) ϕ 14 H7 ($^{+0.018}_{0}$)	Interference	- 0.015～ - 0.051	

21	Intake valve seat insert O.D. and bore in cylinder head	ϕ 47 y7$(^{+0.139}_{+0.114})$ ϕ 47 H7$(^{+0.025}_{0})$	Interference	- 0.089～ - 0.139	
22	Exhaust valve seat insert O.D. and bore in cylinder head	ϕ 39 y7$(^{+0.119}_{+0.094})$ ϕ 39 H7$(^{+0.025}_{0})$	Interference	- 0.069～ - 0.119	
23	Rocker arm bushing O.D. and bore in rocker arm	ϕ 24 s7$(^{+0.056}_{+0.035})$ ϕ 24 H7$(^{+0.021}_{0})$	Interference	- 0.014～ - 0.056	
24	Rocker arm shaft O.D. and rocker arm bushing I.D.	ϕ 20 h7$(^{0}_{-0.021})$ ϕ 20 F8$(^{+0.053}_{+0.020})$	Clearance	0.020～0.074	0.20
25	Camshaft bushing O.D. and bore in cylinder block	ϕ 62$^{+0.094}_{+0.072}$ ϕ 62H7$(^{+0.030}_{0})$	Interference	- 0.042～ - 0.094	
26	Camshaft journal and camshaft bushing I.D.	ϕ 57 h6$(^{0}_{-0.019})$ ϕ 57$^{+0.08}_{+0.05}$	Clearance	0.05～0.099	0.20
27	Valve tappet O.D. and bore in cylinder block	ϕ 28 g6$(^{-0.007}_{-0.020})$ ϕ 28 F7$(^{+0.041}_{+0.020})$	Clearance	0.027～0.061	0.15

28	Thickness of camshaft thrust plate and width of camshaft notch	6 c11($^{-0.070}_{-0.145}$) 6 H11($^{+0.075}_{0}$)	Clearance	0.07～0.22	
29	Cylinder liner O.D. and bore in cylinder block	A: φ 109.011～φ 109.020 φ 109.004～φ 109.013	Interference	mean value −0.007	
30	Cylinder liner O.D. and bore in cylinder block	B: φ 109.021～φ 109.030 φ 109.014～φ 109.023	Interference		
31	Cylinder liner O.D. and bore in cylinder block	C: φ 109.031～φ 109.040 φ 109.024～φ 109.033	Interference		
32	Height of cylinder liner flange and depth of flange recess in cylinder block	$10^{+0.07}_{+0.04}$ $10^{0}_{-0.05}$	Height above cylinder block top surface	0.04～0.12	Height differences among four cylinders less than 0.05
33	Idle gear shaft O.D. and idle gear shaft bushing I.D.	φ 55h6($^{0}_{-0.019}$) φ 55F6($^{+0.049}_{+0.030}$)	Clearance	0.030～0.068	

34	Lub. oil pump driving gear shaft and bore in bearing cover	$\phi 16^{-0.09}_{-0.11}$ $\phi 16H7(^{+0.018}_{0})$	Clearance	0.09～0.128	
35	Driving gear shaft bushing O.D. and bore in cylinder block	$\phi 32s7(^{+0.068}_{+0.043})$ $\phi 32^{+0.025}_{0}$	Interference	- 0.018～ - 0.068	
36	Lub.oil pump driving gear shaft and gear shaft bushing I.D.	$\phi 16f7(^{-0.09}_{-0.11})$ $\phi 16H7(^{+0.018}_{0})$	Clearance	0.09～0.128	
37	Axial clearance between oil pump gear and oil pump housing	0.065～0.125	Clearance	0.065～0.125	
38	Peripheral clearance between oil pump gear and oil pump housing	0.09～0.17	Clearance	0.09～0.17	
39	Oil pump driving shaft and hole in oil pump cover	$\phi 16h6(^{0}_{-0.011})$ $\phi 16E8(^{+0.059}_{+0.032})$	Clearance	0.032～0.07	
40	Oil pump shaft and hole in oil pump housing	$\phi 16h6(^{0}_{-0.011})$ $\phi 16X7(^{-0.038}_{-0.056})$	Interference	- 0.027～ - 0.056	