33-224KW

FDKGEN DIESEL GENSET

FE Series Diesel Engine

User Manual

Guangdong Fudiankang Diesel Gensets Co., LTD

Preface

This series of diesel engines is independently developed and manufactured by Guangdong Fudiankang Diesel Generator Co., Ltd.

The FE Series Diesel Engine features a compact structure, reliable performance, excellent power output, fuel efficiency, and emission standards, along with quick startup, user-friendly operation, and easy maintenance. Notably, its advanced emission technology meets international emission standards, making it an ideal power source for industrial applications.

This manual primarily covers the operating instructions, maintenance guidelines, and customer service information for the diesel engine. To ensure optimal performance and longevity, we strongly recommend thoroughly familiarizing yourself with the engine's structure, maintenance procedures, and proper usage. Adhering to the prescribed maintenance schedule will significantly extend the engine's service life.

As our FE Series continues to expand with new variants and upgrades, we encourage you to stay updated with the latest technical bulletins and announcements from our company.

Notes

Dear users:

Welcome to the Fudiankang FE Series! We sincerely appreciate your trust in our products. To ensure optimal performance and longevity of your diesel engine, please carefully read and strictly adhere to the Operation & Maintenance Manual provided.

(1) This diesel engine has undergone strict factory testing according to test specifications. The throttle is sealed with a lead limit - do not remove the seal or increase fuel injection arbitrarily. The main bearing bolts, connecting rod bolts and cylinder head bolts have strict torque and angle requirements. Users must not loosen or disassemble them without authorization. Any resulting engine damage will not be covered under warranty.

(2) The turbocharger rotor shaft is a precision high-speed rotating component. Disassembly or impact is strictly prohibited. The exhaust pipe must be properly supported during installation - its weight must not be imposed on the turbocharger.

(3) Never operate the diesel engine without an air filter to prevent unfiltered air from entering the cylinders and causing abnormal wear.

(4) Operators must carefully read this operation and maintenance manual, familiarize themselves with the engine structure, and strictly follow the specified technical operations and maintenance procedures.

(5) For new engines, a 50-hour break-in operation is required. The maximum load should not exceed 80%, and the average load should not exceed 60%.

(6) Before each startup, always check that the coolant is full and engine oil is sufficient.

(7) Before each startup, manually operate the oil pump to pre-lubricate the oil passages and lubrication points. This operation extends engine life and ensures smoother startup.

(8) For cold starts, warm up the engine by idling for 5-10 minutes before accelerating and loading. Never operate at high speed with heavy load when coolant temperature is below 60°C. Before shutdown, cool down the engine by idling without load for 5-10 minutes - do not stop suddenly.

(9) Avoid prolonged idling operation - generally do not exceed 10 minutes of idling.

(10) Maintenance of electrical system components must be performed by personnel with electrical expertise.

(11) The engine's preservation period is one year. For engines exceeding one year, inspection and necessary supplementary preservation measures should be taken.

Diesel Engine Run-in Specifications

The run-in period for the diesel engine shall be no less than 50 hours, following the load and duration specifications below:

Diesel genset load idling	Running time	
25%	10 minutes	Check the oil pressure, diesel engine if abnormal sound, etc
50%	2 hours	
75%	30 hours	
100%	15 hours	

During the diesel engine's running-in period, the throttle should be kept fully open. The load value can be estimated based on the load it is equipped with, but it is necessary to follow the principle of gradually increasing the load from a low level.

Due to the different supporting machinery of the diesel genset, such as tractors, automobiles, construction machinery, generator sets, harvesting machinery, etc., the running-in process should be carried out according to the requirements of the supporting machinery; for diesel engines used with agricultural and sideline machinery, such as new diesel engines equipped with power output devices like water pumps, threshers, and crushers, which have undergone preliminary running-in before leaving the factory, users can appropriately shorten the running-in time of the diesel engine.

Catalogue

Chapter 1 Main technical specifications and data of diesel engine

I. Main technical specifications

engine type	FE4M045D	FE4M075D	FE6M132D	FE6M165D	FE6M198D	FE6M231D
Air intake mode	normally aspirated	inter-cooling	inter-cooling	inter-cooling	inter-cooling	inter-cooling
number of cylinders	4	4	6	6	6	6
Cylinder diameter × stroke (mm)	105×120	105×125	105×120	105×130	105×135	110×135
displacement (L)	3.61	4.33	6.49	6.75	7.02	7.54
reduction ratio	19:1	16:1	16:1	16:1	16:1	16:1
power (KW)	33	60	92	121	132	170
Rpm (r/min)	1500					
Maximum idle Rpm (r/min)	≤1575					
Minimum no-load Stable speed (r/min)	≤700	≤600	≤600	≤600	≤600	≤600
fuel oil Consumption rate (g/kw.h)	258.4	231	224	225	225	228
12h power Fuel flow rate (L/h)	10.15	16.50	24.53	32.41	35.36	46.14
Axis rotation direction (Facing the flywheel)	anticlockwise					
cooling-down method	Forced water cooling					
lubricating system	Pressure splash composite					
starting mode	Electric start	Electric start	Electric start	Electric start	Electric start	Electric start
Cylinder working order	1-3-4-2	1-3-4-2	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Maximum exhaust temperature ℃	≤470℃	≤600℃	≤600℃	≤600℃	≤600℃	≤600℃
Total oil capacity L	13	15	18	18	18	18
Oil consumption g/kw.h	≤2.04	≤1.63	≤1.63	≤1.63	≤1.63	≤1.63
Cooling water total capacity L	12	17	24.5	24.5	24.5	26.5

2. Various temperature and pressure ranges

Oil temperature	≤105℃
Cooling water outlet temperature	≤90℃
Oil pressure	0.3 ~0. 50MPa
at idle	≥ 0.10MPa
injection pressure	20+1.0MPa

3. Main bolt tightening torque

cylinder head stud	180+ 10N.m
main bearing stud	210+ 10N.m
Flywheel bolts	210+ 10N.m
connecting-rod bolts	120+ 10N.m
Shaft seat bolt	50+5N.m
Quadrature belt pulley bolt	230+ 10N.m
Tighten the injector cap	80+ 10N.m

IV. Main adjustment data

Intake valve clearance (cold state):

intake valve	0.30~0.40mm
blast gate	0.40~ 0.50mm

Gas distribution phase: (crankshaft rotation Angle)

The intake valve is open	12. Before the top point.
Close the intake valve	38 after the bottom point.
The exhaust door is open	55 before the next stop.
Close the exhaust door	12 after the top point.
Compression clearance:	1~1.2mm
fuel supply advance angle：	Before the top point, 17. Shi 1.

V. Clearance and wear limit of main parts

order number	Cooperative parts	regular size		fit clearance	wear limit
1	Crankshaft spindle and main bearing	Shaft Φ85-0.0200 Kong Φ85+0.040+0.086		0.040-0.106	0.3
2	Shaft clearance			0.13-0.28	0.4
3	Crankshaft connecting rod journal and connecting rod bearing	Shaft Φ72+0.0200 Hole diameter 0.075		0.040-0.095	0.3
4	Connect the big end of the rod to the crankshaft	Shaft Φ35-0.200-0.100 Kong Φ35-0.100+0.200		end play 0.200-0.400	0.7
5	Live piston skirt and cylinder liner	pot type piston	Shaft Φ100-0.15-0.11 hole Φ1000+0.025	0.11-0.175	0.3
			Shaft Φ105-0.15-0.11 hole Φ1050+0.025	0.11-0.175	0.3
		Steel sheet inlaid piston	Shaft Φ100-0.066-0.046 hole Φ1000+0.025	0.046-0.091	0.15
			Shaft Φ105-0.066-0.046 hole Φ1050+0.025	0.046-0.091	0.15
6	Live piston pin and connecting rod bushing	Shaft Φ36-0.003+0.002 Kong Φ36+0.027+0.047		0.025-0.050	0.15
7	Piston pin and piston pin seat hole	Shaft diameter Φ36-0.003+0.002 hole Φ360+0.008		-0.002-0.011	0.05
8	First, the end face clearance of the air ring			0.065-0.105	0.4
9	The second air ring end face clearance			0.040-0.080	0.3
10	Oil ring end face clearance			0.045-0.080	0.25
11	First air ring opening gap	Quantitative scale Φ100+0.008 Quantitative scale Φ105+0.008		0.40-0.60 0.40-0.60	3.00
12	The second air ring opening	Quantitative scale Φ 100 + 0.000 Quantities Φ 105 + 0.000		0.30-0.50 0.30-0.50	3.00
13	Oil ring clearance	Quantitative scale Φ 100 + 0.000 Quantities Φ 105 + 0.000		0.20-0.40 0.20-0.40	3.00
14	Camshaft journal and bushing	Shaft Φ54-0.0250 Kong Φ54+0.0620.100		0.062-0.125	3.00
15	Camshaft thrust plate and journal	Shaft Φ6-0.01-0.05 hole Φ60+0.05		end play 0.05-0.15	3.00
16	Tappet and tappet hole	Shaft diameter Φ30-0.061-0.040 hole Φ300+0.021		0.040-0.082	3.00
17	Idler shaft and idler bushing			0.025-0.075	0.25
18	Idler gear and idler shaft			end play 0.038-0.095	

order number	Cooperative parts	regular size	fit clearance	wear limit
19	The meshing clearance of each timing gear	Shaft diameter 0.025 mm, hole Φ50.80+0.025 mm	The clearance between teeth is 0.10-0.15	0.6
20	Intake valve and valve guide	Shaft diameter Φ9.5-0.045-0.025 and hole Φ9.50+0.019	0.025-0.064	0.2
21	Exhaust valve and valve duct	Shaft diameter Φ9.5-0.058-0.038 and hole Φ9.50+0.019	0.038-0.077	0.3
22	Shaft and bushing	Shaft Φ25-0.040-0.020 hole Φ250+0.021	0.020-0.061	0.2
23	Cylinder liner and engine block stop	Protruding body (optional) 0.050-0.120		
24	Water pump impeller and pump body	Back gap 0.08-1.27		
25	Water pump impeller and spacer	Adjust the gap 0.395-1.365		

Chapter II Main structure of diesel engine

The cylinder head assembly is shown in Figure 1:

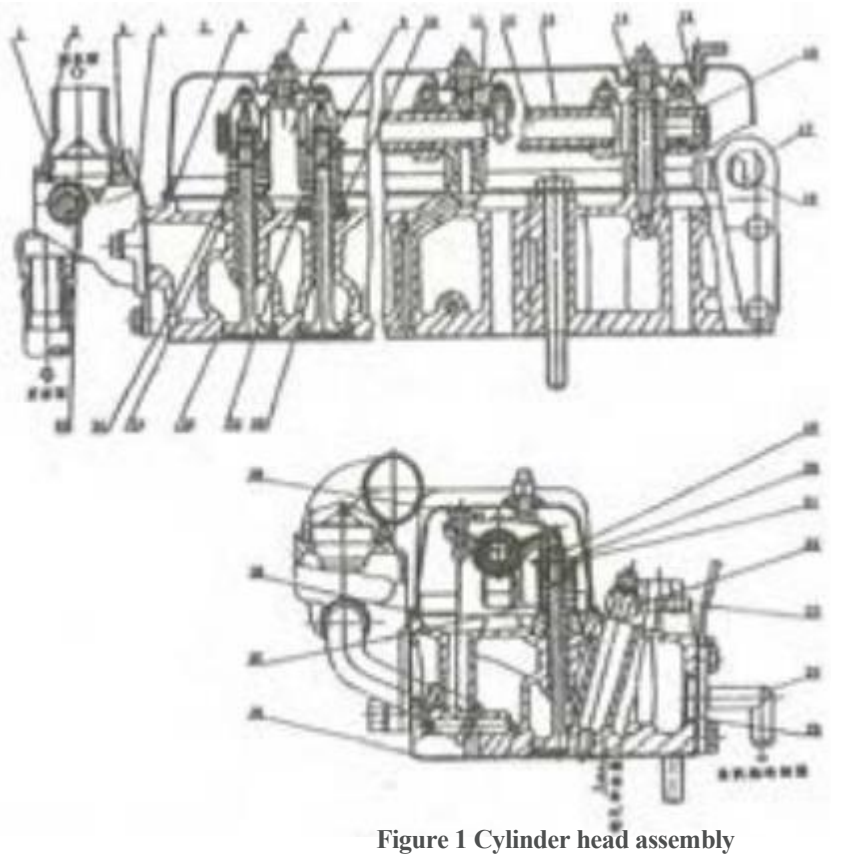


Figure 1 Cylinder head assembly

1 thermostat 2 thermostat cover 3 thermostat gasket 4 thermostat body 5 cylinder head cover 6 cylinder head 7 intake valve 8 rocker arm seat 9 exhaust valve 10 valve rotation mechanism
11 rocker arm seat (fuel supply) 12 rocker back shaft 13 rocker shaft spring 14 sealing washer 15 rocker shaft washer
16 rocker shaft end spring 17 lifting lug 18 heating pipe joint 19 valve stem cap 20 valve lock clip 21 valve spring seat 22 injector pressure plate
23 cylinder head bolt 24 return water joint 25 return water joint gasket 26 cylinder head gasket 27 valve spring 28 cylinder head cover seal
29 Valve clearance adjustment screw and locking nut 30 exhaust valve seat ring 31 exhaust valve spacer 32 intake valve seat ring 33 intake valve spacer
34 Bore 35 Temperature gauge joint

The cylinder head is a monolithic cast component, with intake and exhaust passages arranged on opposite sides. The intake duct employs a spiral channel design to reduce thermal load while accommodating turbocharged operation. Critical thermal zones in the base plate are designed with variable wall thickness. The valve nose area and injector bore are cooled by water injection. Valve guides and intake/exhaust valve seats are securely embedded within the cylinder head through interference fit, with valve seat rings made of chromium-molybdenum alloy cast iron that exhibits excellent heat resistance and wear resistance.

The intake valves are made of silicon-chromium steel, while the exhaust valves are crafted from austenitic chromium-manganese steel with conical surfaces coated in No.6 Hastelloy alloy. To enhance wear resistance in the valve stems, both intake and exhaust components feature thin chrome-plated surfaces, complemented by individually hardened protective caps at the ends. The exhaust valves incorporate a rotating mechanism to extend service life under heavy-duty turbocharged conditions. When this mechanism is not employed, standard valve shims can be used as substitutes.

The valve spring employs a single spring structure made from high-quality polished spring steel wire. To meet the performance requirements of different diesel engines, two designs are available: steel wire springs with φ4.5mm diameter for engines operating at 2600R/min or higher, and those with φ3.5mm diameter for other speeds. During maintenance or replacement, it's crucial to select matching valve spring seats and valve seat washers according to the specific spring type.

During operation, the intake and exhaust valves have already achieved proper valve-to-valve seat coordination. When disassembling or reassembling, carefully verify the cylinder number of each component to ensure proper replacement. If poor sealing occurs between the valve and valve seat, perform grinding and thoroughly clean them before assembly. For valves with contact width exceeding 2.5mm after prolonged use, or those showing severe seat burn or deformation, consider reaming the valve seat. Replacement may be necessary when required. During installation: Heat the cylinder head to approximately 200℃°C, insert the valve seat, then perform precision reaming and grinding on the contact area to achieve a 1.3-1.5mm contact width and 0.6-1.0mm valve drop.

The cylinder head is equipped with a cylinder head cover, the lower part of which is inlaid with a sealing ring, and a filling port is added to the top of the cylinder head cover.

The rocker arm mechanism is sealed within the cylinder head cover and securely mounted on the cylinder head. In four-cylinder diesel engines, a single rocker shaft is used, while six-cylinder models share two rocker shafts across every three cylinders. The rocker arm features valve clearance adjustment screws, with an X-shaped oil groove machined into its bushing. This design ensures optimal lubrication by directing lubricating oil through the rocker arm's oil passage to both the rocker arm head and the ball joint of the valve clearance adjustment screw.

The cylinder head is equipped with a thermostat, which can be installed at the front end of the cylinder head or on one side of the exhaust duct according to the need. The rear end can be installed with a return water part, which is connected to the return pipe of the oil cooler, and the top surface is processed with a heating water port.

The cylinder head and engine block are sealed using composite asbestos gasket seals. Four-cylinder diesel engines utilize 18 such gaskets, while six-cylinder models employ 26 high-strength

bolts with hardened washers to ensure secure mounting. Cylinder head bolts must be tightened in three stages according to the sequence shown in Figure 2, progressively applying torque until the specified value is achieved.

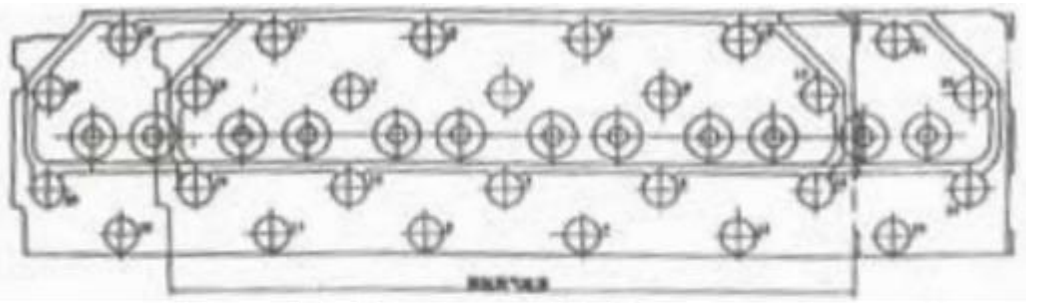


Figure 2 Schematic diagram of cylinder head bolt tightening sequence

II. Body and related assemblies

The body and related assemblies are shown in Figure 3.

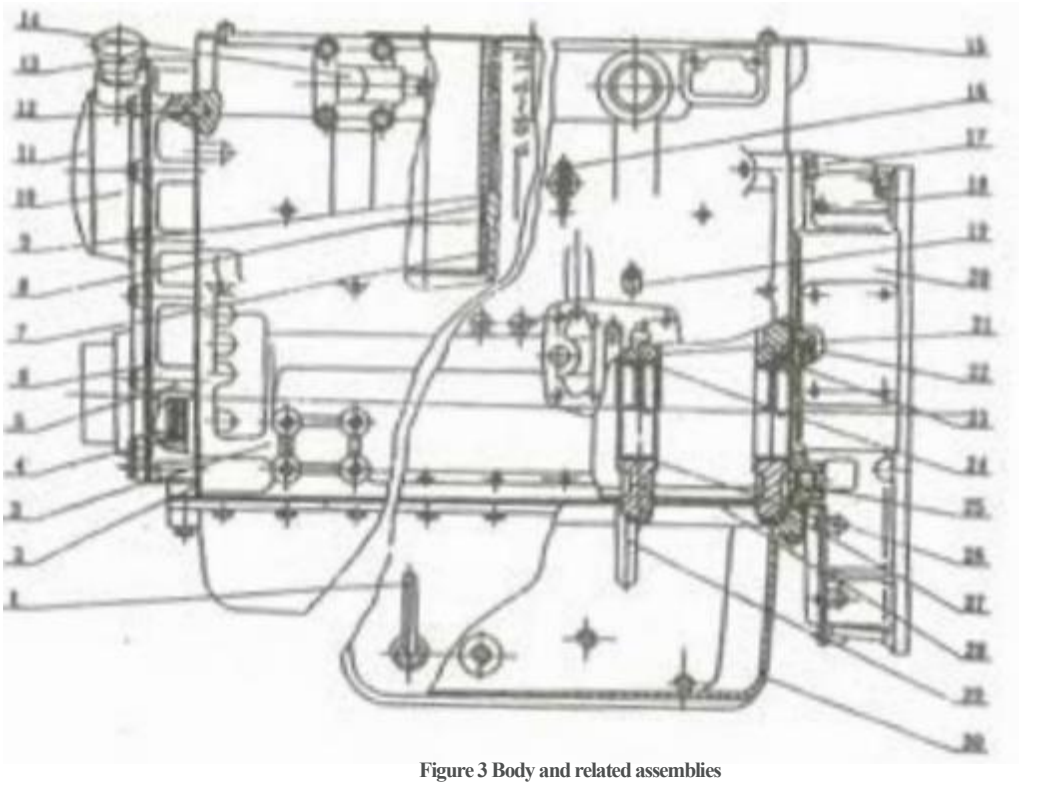


Figure 3 Body and related assemblies

1 Oil gauge parts and oil gauge casing 2 Gear chamber gasket 3 Body 4 Front oil seal of crankshaft 5 Gear chamber 6 Gear chamber cover gasket 7 Cylinder liner
8, 2nd and 3rd sealing rings 9, 1st sealing ring 10, gear chamber cover plate 11, oil pump inspection hole cover 12, locating pin 13, filling port components
14 cooler water supply joint 15 locating pin 16 drain valve 17 flywheel housing gasket 18 inspection window cover 19 oil pipe joint 20 flywheel housing
21 crankshaft thrust plate 22 crankshaft rear oil seal 23 rear oil seal nozzle 24 main bearing upper tile 25 hollow locating pin 26 main bearing lower tile
27 main bearing cover 28 oil gasket 29 main oil pressure relief valve return pipe 30 oil bottom shell

The FE series diesel engine features a short skirt structure without side windows at the front. The main oil passage is located on the left side of the engine block (viewed from the flywheel end), where components such as the fuel pump, oil filter, diesel filter, and oil cooler are arranged. On the right side lies the pushrod chamber, housing the crankcase ventilation system, generator, starter motor, air compressor, hydraulic pump, and other equipment.

The upper section of the engine housing features a wet-type cylinder liner with a 105mm bore diameter, which is laser-quenched to ensure adequate clamping force. Its upper edge protrudes 0.05-0.12mm above the housing top surface. The cylinder liner employs a traditional upper piston ring and skirt outer cylindrical positioning method. To prevent wear and subsidence of the piston ring during operation due to insufficient shoulder support area, a flame guard is installed around the cylinder liner opening on the upper shoulder surface. The cylinder head gasket is directly pressed onto the raised sealing band along the shoulder's outer edge for reliable sealing. A rubber seal is mounted on the lower ring band of the cylinder liner: the upper layer is a black water-blocking ring, while the lower two layers are red oil-blocking rings. When oil or water leaks through small holes on the housing side, it indicates that the relevant sealing rings need replacement.

The main bearings in the lower section of the machine body adopt a full-bearing configuration. The main bearing covers are laterally positioned by locating pins on both sides of the machine body and are integrally machined with the body, making them non-interchangeable. Each bearing cover bears a numbered triangular marking with its tip facing forward. All main bearings feature oil passages on their upper shells. The steel-backed aluminum alloy thin-walled bearings maintain fixed clearances with the shaft necks, which must be replaced when wear exceeds permissible limits.

In order to bear the axial load of the crankshaft and control the axial clearance of the crankshaft, a semi-circular thrust bearing is installed at both ends of the second main bearing at the rear end of the engine block.

When tightening the main bearing bolt, the two bolts on the same main bearing should be tightened alternately for several times to the specified torque. Because of the anti-loosening hardened washer, there is no locking washer for the main bearing bolt.

The main oil pressure relief valve return pipe is installed on the left side of the second (four-cylinder) or third (six-cylinder) main bearing at the rear end of the machine body. The overload relief valve component is installed on the left side of the second main bearing at the front end of the machine body.

The right side of the body has a long window, which is the valve push rod chamber. The cover plate of the push rod chamber is equipped with an oil-gas separator.

In addition to the four-cylinder and six-cylinder, different uses of diesel engines are arranged differently, local structure is also different, its main characteristics are as follows:

In addition to the length difference between the four-cylinder and six-cylinder engines, the left side of the six-cylinder engine body is often equipped with a centrifugal oil filter installation hole.

The body of the diesel engine with the hydraulic pump is installed at the rear end of the gear box. In order to install the hydraulic pump, the right side support is changed from four brackets to three brackets.

The model with the clutch housing has seven M8 threaded holes for installing the rear oil seal cover and two locating pin holes at the rear end of the body.

The engine body for the turbocharged diesel engine has a piston injection cooling oil channel and nozzle on the upper right of the main oil channel.

The front end of the body is equipped with a gear chamber, which is fastened with bolts and positioned by locating pins. The upper left rear end of the gear chamber is equipped with an oil pump,

The upper rear section of the gear chamber can accommodate either an LC126 air compressor or CBQ5 series gear pumps. The lower rear section and the gear chamber cover may be equipped with CB3 series hydraulic gear pumps. A booster return oil pipe can be installed at the right rear end. The upper left section of the gear chamber cover features an oil pump inspection port, which may be fitted with a lubrication port component as required. The electronic tachometer sensor mounting holes and front support bracket are also provided. When installing the front support bracket, hydraulic pumps cannot be mounted at the front end.

The rear end of the machine body is equipped with a flywheel housing, rear oil seal housing, or clutch housing as required, secured with bolts and positioned using locating pins. The flywheel housing includes standard models (dimensions and tolerances compliant with JB3922-85) designated as 2 and 3, along with various specialized variants. Standard flywheel housings can be connected to hydraulic torque converters such as the YBQ323B and YJ31502 models, LFO6S-CB type transmissions in First Automobile Works 'CA1092 vehicles, and MA142 marine gearboxes. Specialized flywheel housings can interface with Balkan 6844 or 6844.2 torque converters, as well as clutch housings in TN650L tractors. Different clutch housings are compatible with transmissions in FAW's CA1091 and DONGFANG's EQ1090 models. The rear oil seal housing connects to the clutch housing of TS650 tractors. Each side of the flywheel housing features four M12 threaded holes for connections, with an inspection port and top dead center pointer on the upper left side. A drive hole is also provided on the left side of the flywheel housing.

The bottom surface of the body is equipped with the oil pan, and the right side is equipped with the oil return pipe of the oil-gas separator, temperature gauge joint and oil drain plug. The oil gauge component and oil gauge sleeve are installed on the left side. The oil pan type is different for different models.

Diesel engines are typically connected to auxiliary machinery using either three-point or four-point support systems. The front end of the three-point support is mounted on the gear case cover, while the four-point support rests on screw holes at both sides of the engine block's front end (188mm from the crankshaft centerline for four-cylinder engines and 180mm for six-cylinder engines). The rear end is supported by either a flywheel housing or clutch housing.

3. Camshaft assembly

The camshaft assembly is shown in Figure 4.

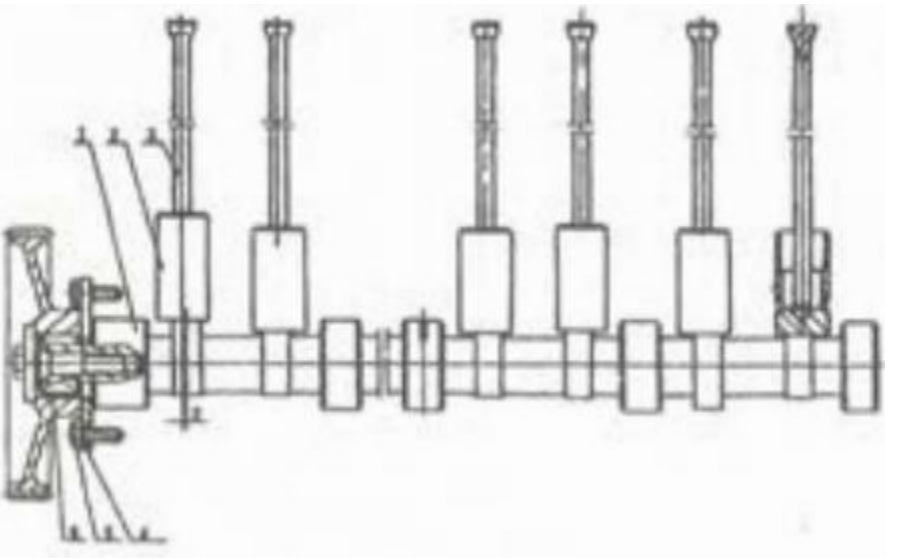


Figure 4 Camshaft assembly

1 camshaft 2 thrust column 3 push rod 4 camshaft thrust plate 5 bolt 6 key

The FE series diesel engine camshaft features full support with function cams designed to accommodate various operating speeds. The camshaft is driven by the crankshaft timing gear through an idler gear and camshaft timing gear. The timing gear, marked with engagement indicators, must be precisely aligned during installation. A thrust plate is installed between the camshaft timing gear and the shaft shoulder to control axial clearance of the camshaft.

The valve lifters are made of cold-worked nickel alloy cast iron, with a hardened and phosphated base surface. The lifters 'axis is offset 2mm from the cam's centerline to allow rotational movement around their own axis, ensuring uniform wear on contact surfaces. The theoretical valve timing for diesel engines is shown in Figure 5. To ensure proper engine operation, the intake and exhaust valve clearances should be adjusted within specified limits.

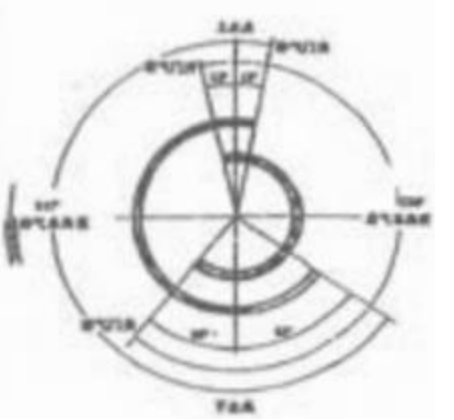


Figure 5 Theoretical valve timing diagram

IV. Piston connecting rod assembly

The piston connecting rod assembly is shown in Figure 6.

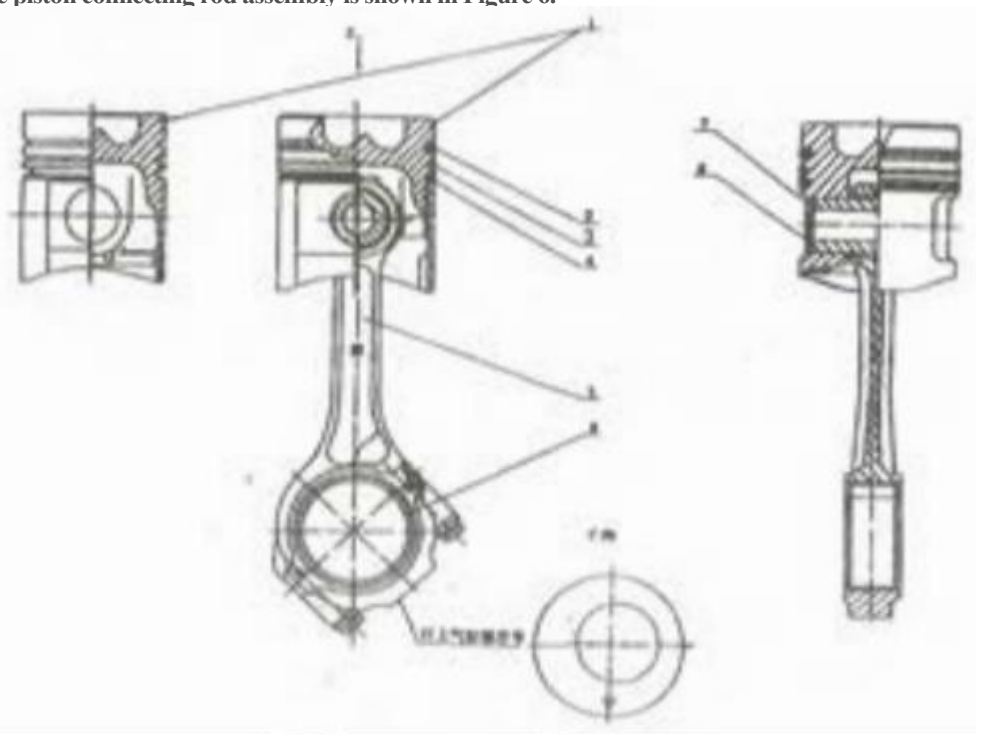


Figure 6 Piston connecting rod assembly

1 piston 2 first piston ring 3 second piston ring 4 oil ring 5 connecting rod section 6 connecting rod bushing 7 retaining ring 8 piston pin

Each piston in a diesel engine is equipped with two gas rings and one oil ring. The first gas ring is a twisted barrel surface chromium-plated steel ring made of ductile iron, designed to enhance wear resistance at high temperatures. The second gas ring is a conical ring. Both gas rings must be installed with the "up" side facing upward and never reversed. The oil ring is a composite type with an internal spring support. During assembly, ensure the spring's contact point aligns with the oil ring's opening. When assembling pistons, the arrow indicator on the piston head should match the "forward" mark on the connecting rod body, positioning the piston head toward the engine's front end. For piston ring installation: First insert the ring into the cylinder liner, then use a feeler gauge to check the clearance gap. If it's too tight, file it out. After installation, the ring should rotate freely within its groove. When inserting into the cylinder liner, ensure all three rings are staggered by 120 degrees and avoid the piston and pin hole direction. As shown in Figure 7, sufficient lubricating oil should be applied to components like piston rings, piston pins, connecting rod bushings, and bearing shells during engine installation. The FE series diesel engines feature a "ω" combustion chamber, with the piston head surface treated by graphite spraying or tin plating to improve running-in performance. The FE series reinforced diesel engines use controllable thermal expansion pistons with steel inserts in the skirt section. Their first ring groove is lined with cast iron rings, and the skirt's lower end has a notch aligned with the cooling nozzle.

Figure 7 Schematic diagram of piston ring clearance position in cylinder liner

The piston pin is fully floating. When the piston reaches operating temperature, it rotates within the pin hole to ensure even wear. However, during cold conditions, an interference fit exists between the piston pin and the pin hole. Therefore, when disassembling or reassembling the piston, the piston should be preheated in engine oil to 80-90°°C. Never attempt to install the piston pin under cold conditions using external force, as this may damage the pin hole. The non-load-bearing surface of the piston pin relative to the piston center should be offset by 1mm to minimize piston knocking.

The connecting rod body and cover are positioned with single-tooth alignment, featuring identical numbering on the same side that must be matched for assembly. The small end bushing of the connecting rod is a double-metal rolled bushing, with its oil holes aligned to correspond with the oil collection hole at the top of the small end, ensuring proper lubrication for both the piston pin and bushing. Connectors shall be tightened uniformly according to specified torque, with self-locking through friction. The mass difference between connecting rod assemblies from the same diesel engine shall not exceed 12 grams, while the mass difference between piston connecting rod assemblies shall not exceed 20 grams.

V. Crankshaft flywheel assembly

The crankshaft flywheel assembly is shown in Figure 8.

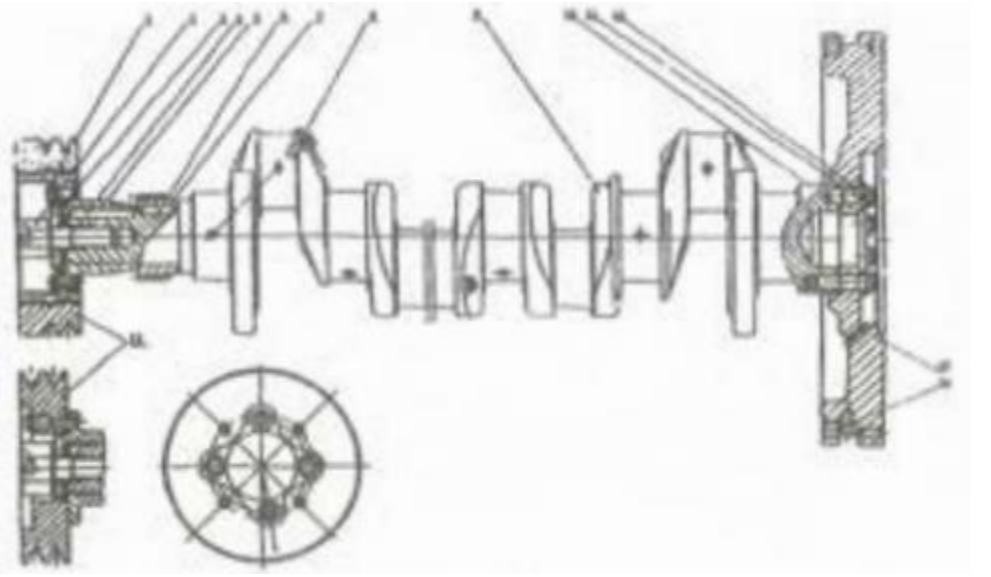


Figure 8 Crank flywheel assembly

1 bolt 2 starting claw 3 crankshaft pulley retaining ring 4 flat key 5 crankshaft pulley hub 6 flat key 7 crankshaft timing gear 8 crankshaft oil hole plug 9 crankshaft 10 pin 11 flywheel bolt 12 flywheel bolt washer 13 flywheel 14 flywheel gear ring 15 torsional vibration damper component or crankshaft pulley

The crankshaft material is QT800-3 high-strength ductile iron, using a full support type. All journal surfaces are quenched or nitrided to improve wear resistance. For the six-cylinder high-speed reinforced model, 45 steel shafts are used to enhance strength and reliability. The main journal and connecting rod journals undergo induction hardening treatment.

The crankshaft employs skeleton-type rubber oil seals at both front and rear ends for sealing. The front end features two connection configurations: a spline connection enabling full power output, and a flat key connection. When power output is required at the front end, a spline and cast iron pulley assembly should be used; otherwise, flat keys with spun-on pulleys may serve as alternatives. To mitigate torsional vibration stress in the crankshaft and reduce diesel engine noise, rubber-pressed torsional dampers can be installed when necessary.

The flywheel is positioned by a solid column pin and tightened by 7 high strength bolts

Fixed at the rear end of the crankshaft. The flywheel bolt should be in accordance with Figure 9

The sequence is gradually tightened to the specified torque. The flywheel bolt is used for the flywheel bolt

The plate makes it self-locking, and the flywheel bolt plate material is 15 steel

The surface is treated with carburizing and quenching. There are many flywheels according to the needs of the accessories

There are hydraulic torque converters, clutches and elastic ring pin in this form

Different flywheels are matched with couplings. The thickness of the flywheel spokes is

Therefore, there are two different lengths of flywheel fastening bolts.

To meet the supporting requirements, two positioning options are available for diesel engine rear end support bearings: one on the crankshaft rear end and another on the flywheel. Different models of starting motors are required due to varying configuration needs, resulting in two types of flywheel gear rings: one with 129 teeth (matching an 11-tooth starter motor) and another with 130 teeth (matching a 9-tooth starter motor).

The outer edge of the flywheel is engraved with an upper dead center mark and a 0-30 advance marking range for adjusting the fuel injection timing. Each scale corresponds to 1° of crankshaft rotation. Due to different application purposes, some models have the upper dead center mark engraved on the flywheel end face or the crankshaft pulley.

VI. Transmission system

The diesel engine transmission system includes the front ordinary V-belt drive and gear transmission in the gear chamber, as shown in Figure 10.

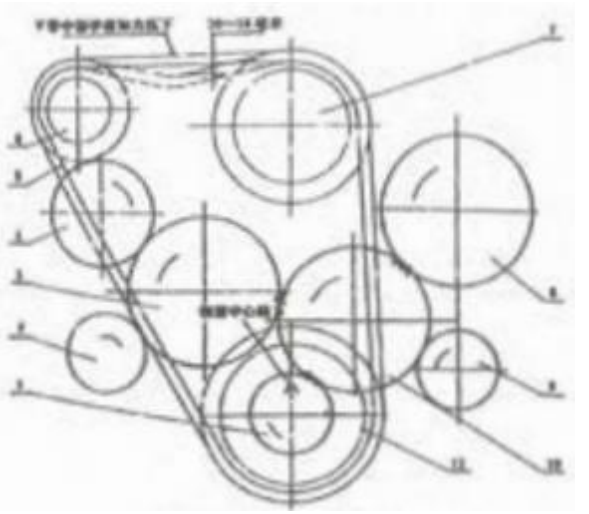


Figure 10 Schematic diagram of transmission system

1 crankshaft timing gear (Z=30)
2 hydraulic pump drive gear (Z-29)
3 camshaft timing gear (Z=60)
4 Air compressor or working pump drive gear (Z-39)
5 regular V-belt
6 Generator pulley
7 pump pulley
8 Injection pump timing gear (Z-60) 9 Oil pump transmission gear (Z-30) 10 Idler gear (Z-58)
1 crankshaft pulley

The drive pulley consists of two A-type V-belt pulleys: the pump pulley and the generator pulley. Different lengths of V-belts are used depending on the pump's center height and the generator's position. The V-belts are tensioned by the generator adjustment bracket. When applying finger pressure to both V-belt pulleys, they should be depressed by 10-15mm.

The crankshaft timing gear drives the idler gear, which in turn drives the camshaft. The timing gears for the fuel injection pump and oil pump are also driven by this mechanism. Depending on operational requirements, the camshaft timing gear can drive either the air compressor gear or the working pump gear. Additionally, the hydraulic pump gear can be connected to either the front or rear hydraulic pumps through a spline coupling, or it may be driven by one of these hydraulic pumps.

The working pump gear components are shown in Figure 11.

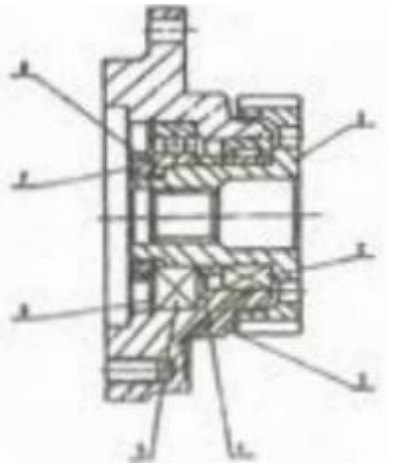


Figure 11 Working system gear components.

1 working pump gear 2 bearing 4544909
3 working pump gear seat 4 spacer 5 bearing 36209
6 retaining ring 85 7 locking nut KMO8
8 Locking washer MBO8

The hydraulic pump gear parts and spline sleeve are shown in Figure 12.

There are two kinds of structure of injection pump timing gear: with advance and without advance.

All drive gears are helical gears. The timing marks on the crankshaft timing gear, camshaft timing gear, fuel injection pump timing gear, and idler gear must be aligned according to the diagram during assembly. Failure to do so may cause severe operational issues in the diesel engine due to incorrect valve timing and fuel injection advance angle, potentially resulting in failure to start.

The gear material except the oil pump transmission gear is all alloy steel, with sufficient strength and hardenability. The tooth surface is hardened and polished or treated by glow ion nitriding, with low vibration and low noise. The oil chamber is equipped with a nozzle to spray oil on the non-engaging surfaces of the teeth in operation, providing sufficient lubrication for them.

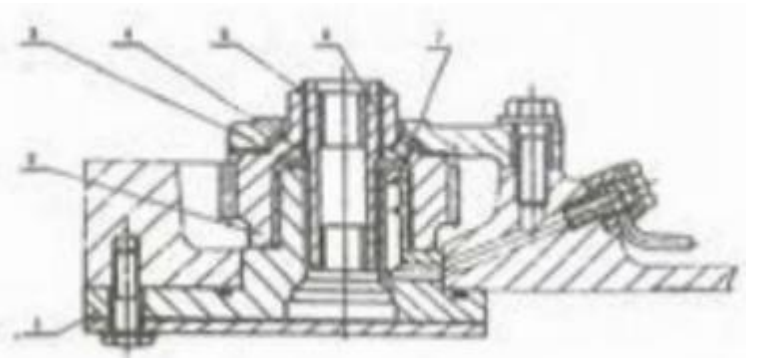


Figure 12 Hydraulic pump gear components and spline sleeve.

1 hydraulic pump transmission gear shaft 2 hydraulic pump gear components 3 hydraulic pump transmission gear thrust plate 4 retaining ring 5 retaining ring

6 Hydraulic pump drive spline sleeve 7 blockage

VII. Air intake and exhaust system

(1) Intake pipe

The basic structure of the intake pipe of FE series diesel engine is middle intake or end face intake, and the middle intake port has single port and double port

Two options.

The intake pipe is an integral aluminum structure, which is connected to the air filter or turbocharger compressor housing through the intake pipe. The design takes full advantage of the advantages

The supporting installation space is used to form a strong intake power effect. By selecting reasonable branch pipe length and sufficient

The total pressure regulating capacity of the diesel engine has obtained a higher charging efficiency value and improved the low speed performance of the diesel engine.

(2) Exhaust pipe

The FE series diesel engine exhaust pipe features an integral cast iron structure, connected to mufflers or turbocharger housings via components like exhaust manifolds. Classified by application, these pipes are divided into two types: naturally aspirated and turbocharged models. Naturally aspirated models include intermediate outlet and end outlet configurations, while turbocharged models are categorized into dual outlet pulse turbochargers and single outlet constant pressure turbochargers. For marine applications, a water jacket-equipped exhaust pipe has been designed to improve cabin working conditions, utilizing seawater or river water to reduce exhaust temperature.

(3) Air filter

During diesel engine operation, the air filter must supply clean, fresh air to ensure proper lubrication and maintain optimal performance of components including cylinder liners, pistons, piston rings, and valves. The selection criteria for air filters are threefold: first, the required filter element surface area based on the engine's hourly displacement; second, the overall layout requirements of the supporting machinery; third, the working environment conditions. For FE series diesel engines, air filters are typically available in two structural configurations, with exceptions where specific models are equipped by OEM manufacturers.

1. Single-stage paper core type (Figure 13)

A single-stage paper core air filter is composed of a housing, a top cover, and a paper filter element. Air enters the housing through the air inlet, passes through the paper filter element, and the dust in the air is filtered on the outside of the filter element. Clean fresh air is sucked into the cylinder.

The K2410 air filter is used for the four cylinder engine, and the K2712 air filter or two K2410 air filters are used for the six cylinder engine.

2. Double-stage paper core type (Figure 14)

The dual-stage paper-core air filter consists of an outer casing, main filter element, safety filter element, intake cap, ash tray, and dust discharge bag. This two-stage filtration system works as follows: Air enters through the intake cap and spirals into the casing cavity via the front spiral guide plates of the main filter element. Larger particles are thrown onto the ash tray by centrifugal force and automatically discharged through the dust bag. Smaller particles remain trapped outside the main filter element, while clean air is then drawn into the cylinder through the safety filter element.

The safety function of the safety filter has two functions. The first is to avoid the accumulated dust being rapidly sucked into the cylinder when the main filter is broken. The second is to avoid the dust and foreign matter being sucked into the cylinder without stopping the installation and removal of the main filter.

The KW1532 air filter is used for the four cylinder engine and KY1632 air filter is used for the six cylinder engine.

KW1532A type air filter is not equipped with intake cap; KW1532B1 type air filter is not equipped with ash plate; KW1532 type air filter is not equipped with intake cap and ash plate.

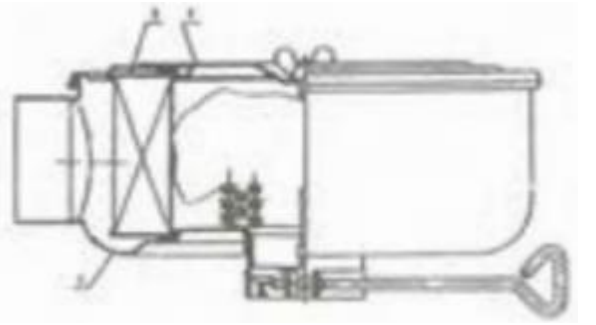


Figure 13 K2410 air filter

1 shell 2 filter element 3 top cover

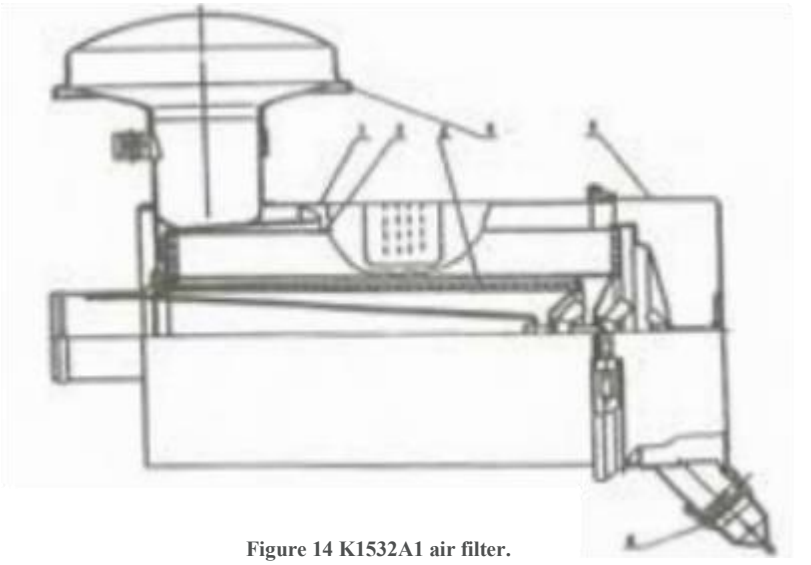


Figure 14 K1532A1 air filter.

1 shell 2 main filter 3 safety filter 4 air intake cap 5 ash tray 6 dust bag

(4) muffler

To reduce noise and improve the working environment for operators, the FE series diesel engines are equipped with exhaust silencers (Figures 15 and 16). The engine exhaust expands through mesh holes in the silencer's inner tube to achieve sound attenuation. Blockage of the silencer can lead to decreased power output. Therefore, it's essential to regularly remove carbon deposits and rust from the silencer based on operational conditions. The silencers for FE series four-cylinder and six-cylinder engines share similar structures but differ in volume capacity. Users may extend the connecting pipes as needed or provide their own components according to specific requirements.

According to the supporting requirements, the main installation methods of the muffler for FE series diesel engines are horizontal and vertical.

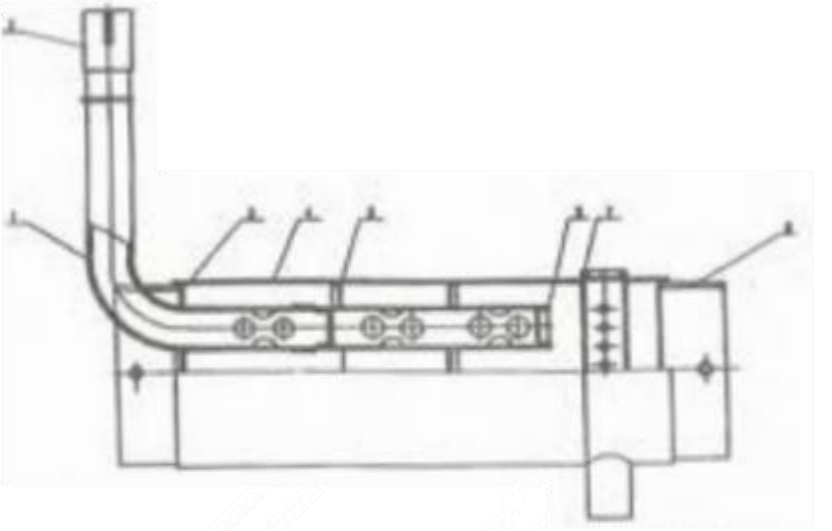


Figure 15 Horizontal muffler

1 inner pipe, 2 joint, 3 end cover, 4 outer cover, 5 partition, 6 tail pipe end cover, 7 tail pipe, 8 connection plate

(5) Turbocharger

The FE series turbocharged diesel engine is developed by installing a turbocharger between the intake and exhaust pipes of a standard diesel engine. This mechanical device converts exhaust energy into rotational energy through a turbine, which drives the compressor impeller to rotate at high speed. The compressed fresh air from the air filter is then delivered into the cylinders. By increasing the engine's air intake capacity, it enables more fuel to be fully combusted, thereby enhancing the engine's power output.

Turbochargers enhance diesel engine performance while improving fuel efficiency and reducing fuel consumption. They also lower noise levels and exhaust emissions, thereby improving the working environment for operators. Additionally, they decrease the volume and weight per unit of power output. Notably, turbochargers serve as an effective solution for restoring plateau recovery power in diesel engines. When selecting turbochargers, appropriate models should be chosen based on the specific requirements of different engine models.

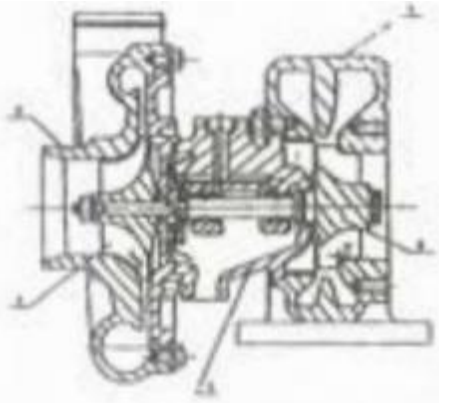
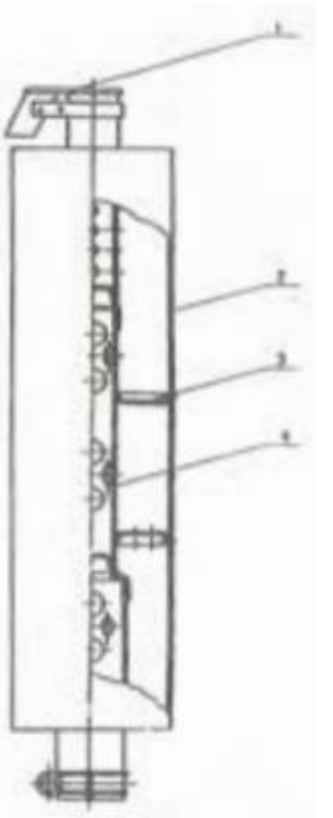


Figure 17 FE series turbocharger

1 turbine shell 2 turbine components 3 intermediate shell
4 compressor impeller 5 compressor housing

FE series turbocharger is shown in Figure 17.



1 rain cap 2 cover 3 partition 4 inner tube

The turbocharger is composed of fixed pressure single inlet turbo shell or pulse double inlet turbo shell, turbine components, compressor impeller,

The turbocharger, as a high-speed rotating mechanical component, directly determines the turbocharging efficiency of diesel engines. To ensure proper operation, the lubricating oil supplied to the turbocharger must undergo two-stage filtration. Users should strictly follow the turbocharger maintenance manual for timely technical upkeep. Regular cleaning of the compressor is mandatory according to operational specifications. The installation and disassembly of turbochargers must be performed by certified technicians. Special attention should be paid to aligning the calibration marks on the compressor end locking nuts with those on both the rotor shaft and compressor impeller during tightening, as improper alignment may disrupt rotor dynamic balance and compromise normal operation.

VIII. Fuel system

The fuel system is shown in Figure 18

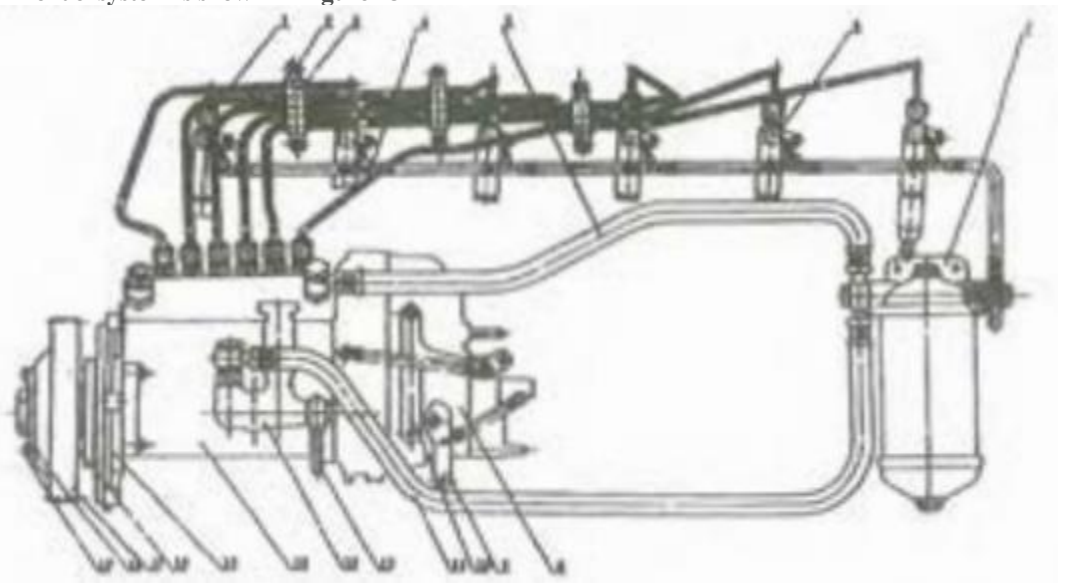


Figure 18 Schematic diagram of fuel system

1 high pressure oil pipe 2 clamp plate 3 rubber pad 4 fuel injector return pipe parts 5 fuel pump inlet pipe parts 6 fuel injector
7 Diesel filter parts 8 speed regulator 9 stop handle 10 speed control handle 11 diesel filter inlet pipe parts 12 oil pump inlet pipe parts
13 oil pump 14 injection pump 15 injection pump fixing flange 16 advanceer 17 injection pump gear 18 injection pump gear pressure plate 19 bolt

During diesel engine operation, fuel from the tank and intake line enters the diesel filter via the fuel pump. After filtration, it flows into the injection pump. The fuel is then compressed by the plunger assembly to generate high pressure, which passes through the outlet valve and enters the injector via high-pressure lines. When the pressure reaches the needle valve's opening pressure, fuel is atomized and sprayed into the combustion chamber through 4 or 5 injection ports. Following injection, the pressure drops, causing the needle valve to close under spring force, thereby stopping fuel flow from the ports.

The oil supply from the transfer pump exceeds the amount used by the injection pump and the oil leakage from the needle valve pair of the injection pump returns to the tank together with the diesel filter or the return oil of the injection pump.

(1) Oil pump

The piston type oil pump is shown in Figure 19.

The oil pump maintains a pressurized fuel supply in the low-pressure circuit. To ensure stable pressure, its piston operates as an automatic regulator. When the pressure in the low-pressure circuit exceeds the preset threshold, the fuel pressure compresses the return spring through the piston, gradually moving it away from the plunger. This adjustment either reduces or stops fuel flow, while increasing or maintaining continuous delivery accordingly.

The hand pump is used to fill the fuel system with fuel and to remove air before starting a diesel engine. When not in operation, the handle nut should be tightened.

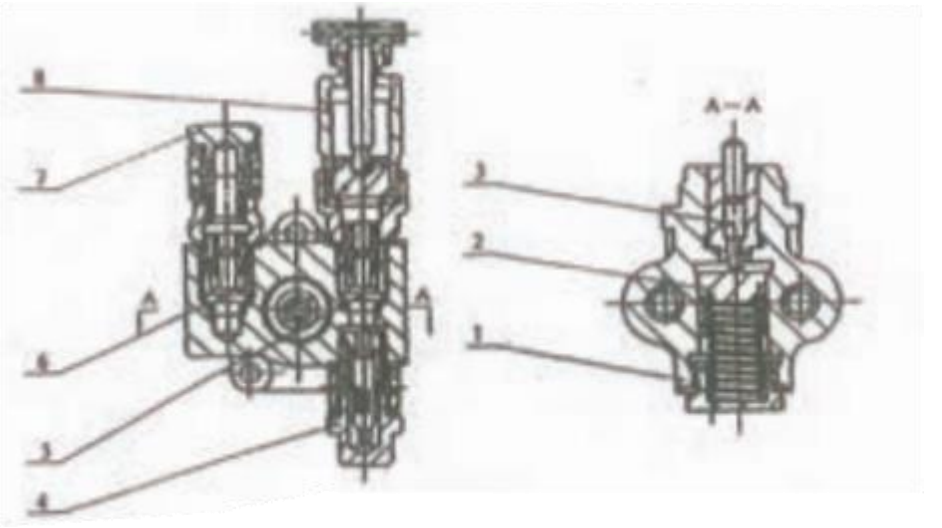


Figure 19, oil pump

1 pump body 2 piston 3 push rod 4 oil inlet screw 5 oil inlet valve 6 oil outlet valve 7 oil outlet screw 8 hand pump

(2) Diesel filter

In order to meet the requirements of different models, there are three types of diesel filters: CS0708B1, CS0712B1 and C0810S. The first two are single-stage, as shown in Figure 20, and C0810S is double-stage, as shown in Figure 21.

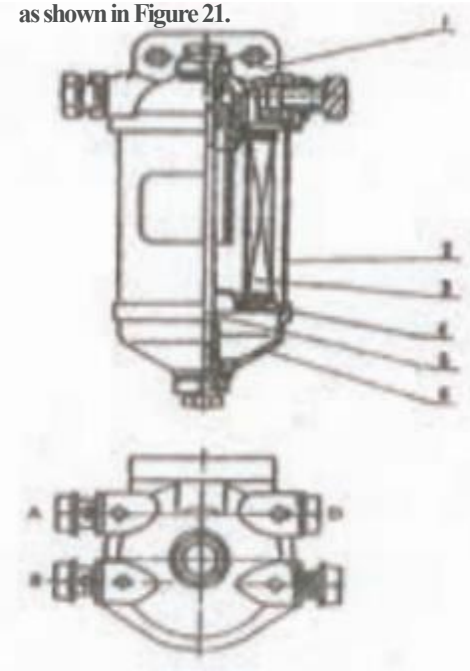


Figure 20 CS0708B1 diesel engine filter

1 filter seat 2 outer cover 3 filter element 4 sealing washer 5 pull rod 6 water cup

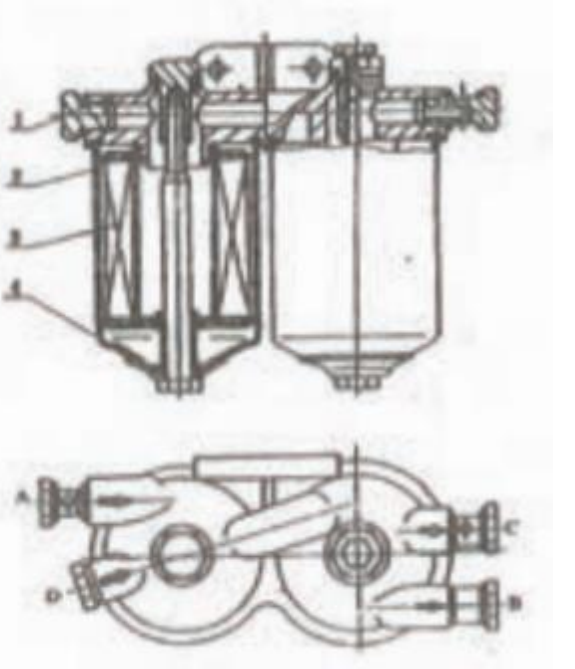


Figure 21 C0810S diesel engine filter

1 Filter seat 2 Shell 3 Paper filter element 4 seal ring

There are four screw holes on the top of the filter seat. Screw hole A is connected to the oil outlet pipe of the oil pump, screw hole B is connected to the oil inlet pipe of the oil pump, screw hole C is the return oil screw for the oil return valve, and screw hole D is sealed with a bolt.

The function of diesel filter is to filter out the particles in the fuel oil, so as to reduce the wear of precision parts in the injection pump and injector.

After the fuel is filtered by the filter element, the dirt is blocked on the surface of the filter element. The filter element is made of diesel filter paper and should be maintained or replaced regularly. For the filter with a water cup, the water in the water cup should be discharged regularly.

(3) Oil pump

There are two types of injection pumps: A type pump and BX pump. The body of the A type pump is integral, as shown in Figure 22, while the body of the BX pump is divided into upper and lower bodies, as shown

See Figure 23.

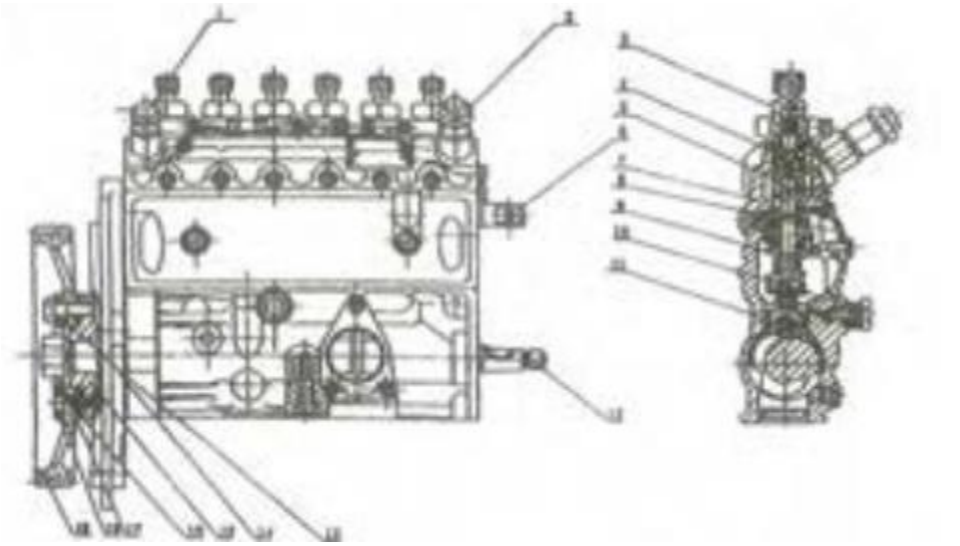


Figure 22 Six-cylinder A type oil pump

1 oil inlet joint of the injection pump 2 oil return joint of the injection pump 3 outlet valve seat 4 outlet valve 5 plunger pair 6 adjusting gear rod 7 adjusting gear ring
8 Inspection window cover 9 Plunger spring 10 Lubricating oil inlet screw 11 Pump body 12 Injection pump camshaft 13 bolt 14 Injection pump fixing flange
15 injection pump gear hub 16 injection pump timing plate 17 nut 18 injection pump gear pressure plate 19 injection pump gear

The oil supply of the injection pump changes with the load of the diesel engine, and it is adjusted by adjusting the axial movement of the rack to make the plunger rotate

The system achieves this through adjustable parameters: the fuel injection rate can be modified by adjusting the cam's working section and plunger diameter to meet diesel engine performance requirements. The front end of the fuel injector is secured to the gear chamber via a mounting flange, requiring precise alignment with the gear's engagement marks during installation to ensure proper fuel injection timing. To adjust the injection timing: remove the timing inspection cover from the gear chamber cover plate, loosen the clamping bolts on the fuel injector hub, then use a socket wrench to turn the hex nut at the fuel injector shaft end. Turning clockwise increases the injection timing, while counterclockwise rotation decreases it. After adjustment, retighten all four clamping bolts and secure the hex nut at the fuel injector shaft end to prevent loosening. For BX pumps with a starter delay slot milled into the plunger tip, set the speed control lever to high speed when measuring injection timing.

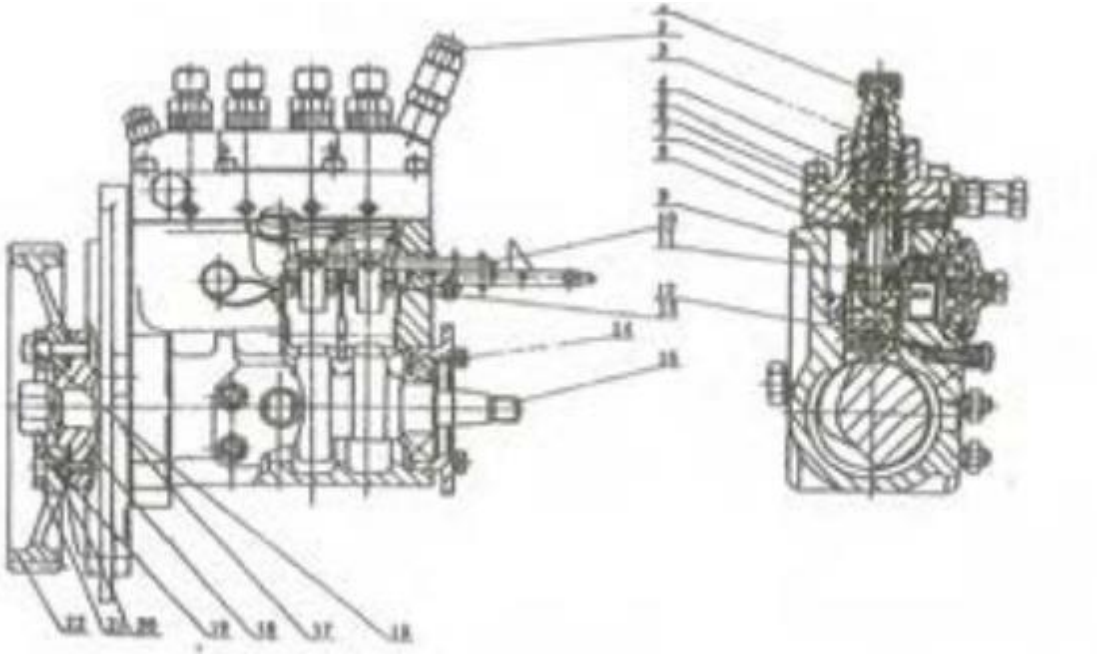


Figure 23 Four cylinder BX injection pump

1 outlet valve seat 2 oil pump return pipe joint 3 oil pump inlet pipe joint 4 outlet valve 5 upper body parts of the oil pump 6 window cover 7 plunger pair 8 plunger spring 9 lower body parts of the oil pump 10 adjusting rack rod 11 fork fastening block 12 lubricating oil inlet screw 13 adjustment fork 14 tapered roller bearing 15 injection pump camshaft 16 bolt 17 injection pump fixing flange 18 injection pump gear hub 19 injection pump timing plate 20 nut 21 injection pump gear pressure plate 22 injection pump oil wheel

When the injection pump assembly is disassembled, the first cylinder piston should be in the end compression position, then remove the M10 bolt on the flange, and use a special positioning pin to insert into the hole on the timing plate to remove the assembly. The positioning pin should still be used when returning.

The oil supply of the injection pump has been adjusted at the factory. It is strictly prohibited to open the window cover of the injection pump and turn the plunger to prevent changes in the oil supply and the uniformity of the oil quantity of each cylinder. If necessary, it should be adjusted on the injection pump test bench.

(4) speed regulator

The rear end of the injection pump is equipped with an RSV mechanical full-speed regulator, as shown in Figure 24.

The function of RSV full-process speed regulator is to keep the speed of the diesel engine working in a stable range within the fluctuation rate when the load of the diesel engine is constant. When the load of the diesel engine changes, it keeps the speed of the diesel engine working in a stable rate adjustment range.

By changing the flywheel, adjusting spring and correcting spring, the speed regulation performance and oil supply characteristics of diesel engines for different purposes can be met.

High-speed and low-speed limit screws are used to adjust the diesel engine's maximum no-load speed and minimum stable no-load speed, respectively. The fuel supply limit screw regulates the maximum oil delivery from the fuel pump. Engine operating conditions can be adjusted by moving the throttle lever. To stop the diesel engine, simply rotate the parking lever.

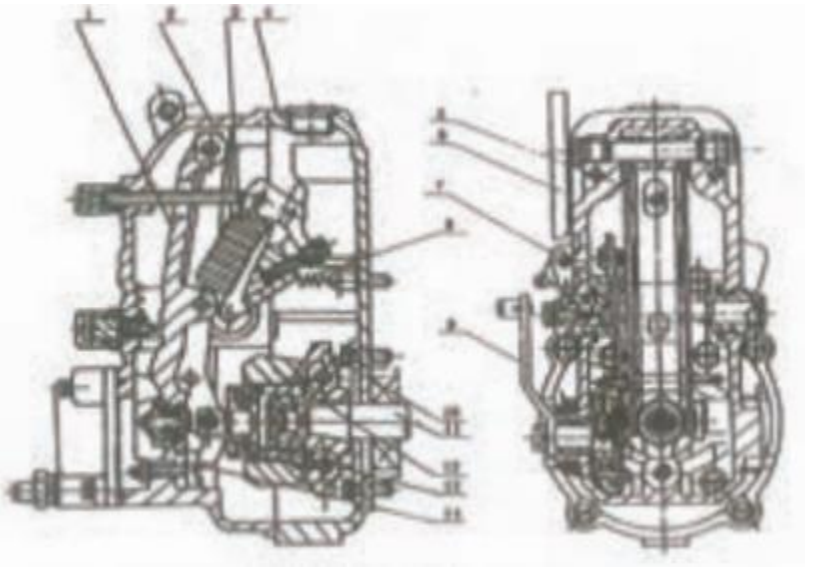


Figure 24 RSV type speed regulator

1 Adjust lever 2 front shell 3 adjust spring 4 rear cover 5 support rod 6 speed regulator handle 7 floating rod 8 thickening spring 9 stop handle 10 fly hammer bracket 11 fuel pump camshaft 12 fly hammer 13 torque corrector 14 oil limit screw

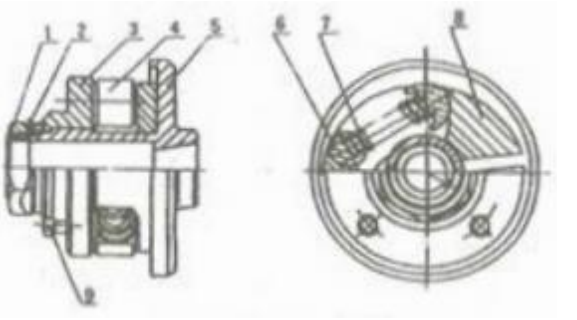


Figure 25 ZQN-2 type advance

(5) Advanceer

The ZQN-2 type advanceer is shown in Figure 25.

For models with a rated speed above 2600R/min, in order to modify the working process, the ZQN-2 advance is adopted. At 1100-2800R/min, the advance can advance the oil supply advance Angle by 0-10 degrees. Left and right crankshaft rotation angle.

The function of the advance rotor is to make the fuel supply advance angle of the fuel pump automatically increase when the speed of the diesel engine increases, so as to meet the performance requirements of the diesel engine.

When the diesel engine is stationary, the advance lever remains inactive. Under spring force, the flyweight is compressed to its minimum rotation radius. During engine startup, as speed increases, centrifugal force from the flyweight overcomes spring tension, compressing the spring. This causes the flyweight to rotate relative to its original position by a specific angle, which drives the driven disc and consequently the fuel injection pump's camshaft. The driving disc rotates through an angular displacement aligned with the fuel pump's rotational direction, thereby advancing the fuel injection timing by a predetermined degree.

The advance characteristics of the advance are designed according to the requirements of the diesel engine, and the user does not need to adjust the advance.

(6) Fuel injector

The injector is shown in Figure 26.

The function of the injector is to spray atomized fuel into the combustion chamber at a regular time and mix it with air to organize a perfect combustion process.

The FE series of diesel fuel injectors includes both the J and S series, both being lower-mounted spring-loaded low-inertia injectors. The needle valve assembly features elongated multi-hole designs, with the R105 model typically using 4-#0.30mm orifice needle valve assemblies. Fuel injection must achieve uniform atomization, with abrupt cutoff during fuel interruption and no dripping or leakage. When poor atomization occurs, inspection and adjustment should be performed on the injector test bench. The injector's activation pressure is 20+1.00MPa. If pressure is unsuitable, adjust the thickness of the pressure regulating gasket: each 0.1mm increase in gasket thickness approximately raises the injection pressure by 1MPa.

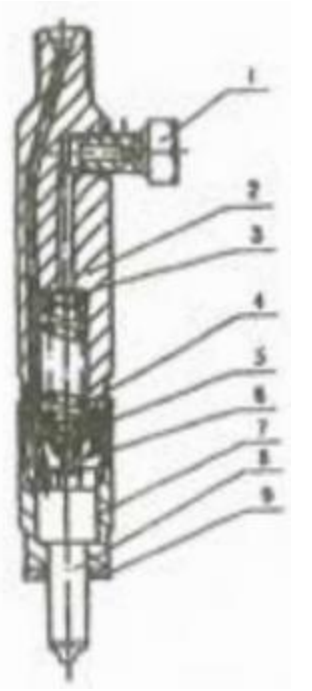


Figure 26 Injector assembly

1 oil joint screw 2 injector body 3 voltage regulator washer 4 injector spring 5 push rod 6 Intermediate parts 7 injector cap 8 injection nozzle pair 9 injector seal

The injection needle valve pairs are matched pairs and shall not be replaced when disassembled. The J series and S series needle valve pairs shall not be replaced, but their assemblies may be replaced. When the injector is mounted on the cylinder head, there is a brass gasket in front to ensure sealing.

IX. Lubrication system

The diesel engine adopts pressure and splash composite lubrication, and the lubricating oil circuit is shown in Figure 27.

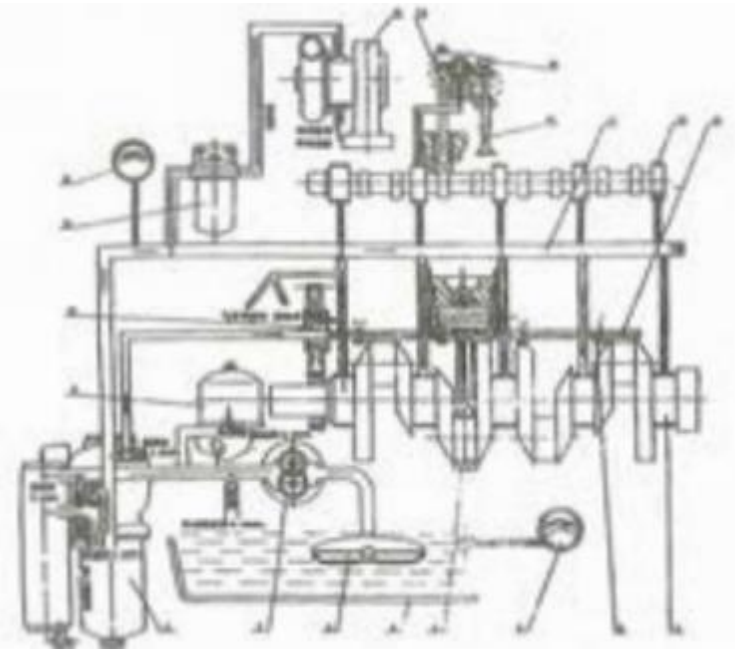


Figure 27 Schematic diagram of oil circuit of lubrication system

1 crankshaft and upper and lower bearing 2 piston cooling nozzle 3 oil temperature gauge 4 piston connecting rod assembly 5 oil pan 6 oil filter
7 oil pump 8 oil filter, cooler 9 split centrifugal oil filter 10 idler gear shaft and bushing 11 oil fine filter
12 oil pressure gauge 13 turbocharger 14 valve push rod, valve lift column 15 rocker arm and rocker shaft 16 valve and valve guide 17 main oil passage
18 camshaft and bushing 19 piston injection cooling oil passage

Oil is drawn from the oil pan through the oil filter and intake manifold by the oil pump. After being pressurized, it flows to the oil cooler and filter for cooling and purification before entering the main oil passage. In six-cylinder engines, a portion of the oil passes through a centrifugal oil filter where contaminants are separated by rotating blades before returning to the oil pan. Oil in the main passage is distributed to various components including main bearing shells, connecting rod bearings, camshaft bushings, gear train, high-pressure oil pumps, air compressors, and vacuum pumps. Oil from the intermittent fuel supply trough between camshafts lubricates the valve train through passages in the engine block and cylinder head. The pistons, piston pins, and cylinder liners are lubricated by oil splashes from the bearing shells.

In a supercharged diesel engine, there is a special oil channel in the body for cooling the piston. The oil is sprayed into the inner cavity of the piston through the oil channel and nozzle to cool the piston.

The lubrication of the turbocharger is to take a part of the oil from the main oil channel of the engine body, and then enter the turbocharger after being refined by another oil filter to lubricate and cool its bearings. The used oil returns to the diesel oil bed through the return oil pipe.

Pressure or magnetic and electric pressure gauge, temperature gauge, pressure and temperature alarm can be selected according to the needs of users, with the corresponding pipe fittings.

(1) Oil pump

The oil pump of four cylinder and six cylinder diesel engine adopts gear oil pump. The oil structure of four cylinder is shown in Figure 28.

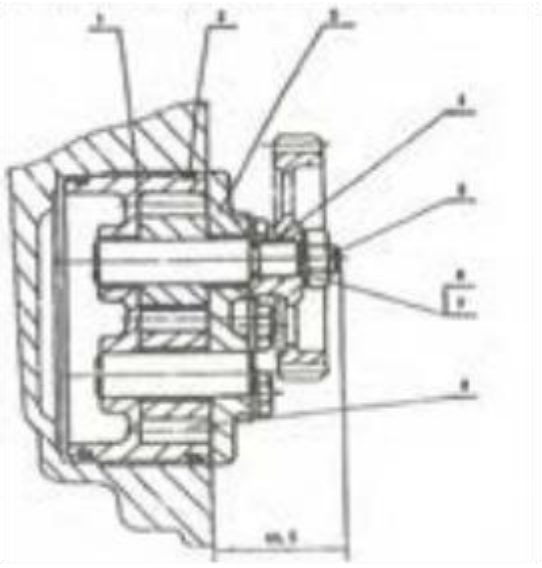
The oil pump is installed in the tunnel pit above the main bearing on the front face of the engine body. The transmission gear of the oil pump is driven by the crankshaft gear through the idler gear, and its speed is the same as that of the crankshaft.

When the oil pump is loaded into the body, attention should be paid to not to be too hard and skew. Before installation, lubricating oil should be applied on the seal ring to avoid cutting the seal ring.

(2) Overload relief valve

The overload relief valve, installed in the engine oil passage (see Figure 29), prevents excessive lubrication system pressure caused by low oil viscosity during cold conditions. This critical component safeguards the normal operation of the oil pressure gauge, oil pump, and lubrication lines. The valve undergoes specialized testing before leaving the factory, ensuring it requires no adjustments during regular use.

If the oil pressure is found to be reduced, check and adjust the overload relief valve after adjusting the pressure regulating valve on the oil filter cannot be solved. The opening pressure of the overload relief valve is 0.8MPa.



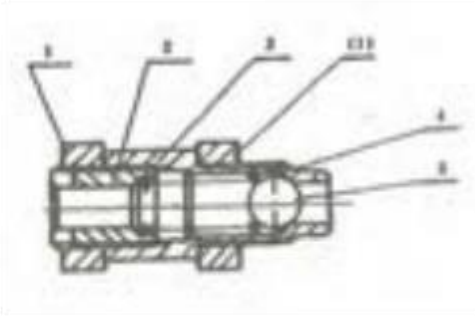


Figure 28, oil pump Figure 29, overload relief valve

Figure 28, oil pump Figure 29, overload relief valve

1 oil pump housing 2 "O" ring seal 3 oil pump cover 4 half round key 5 active shaft parts 6 nut 7 washer 8 driven gear parts

1 nut
3. Shell

2 Overload relief valve stopper 4 spring 5 steel ball

(3) Oil filter

1. The structure of JX0811A, J1012B and J0506 oil filter is shown in Figure 30 and Figure 31 respectively.

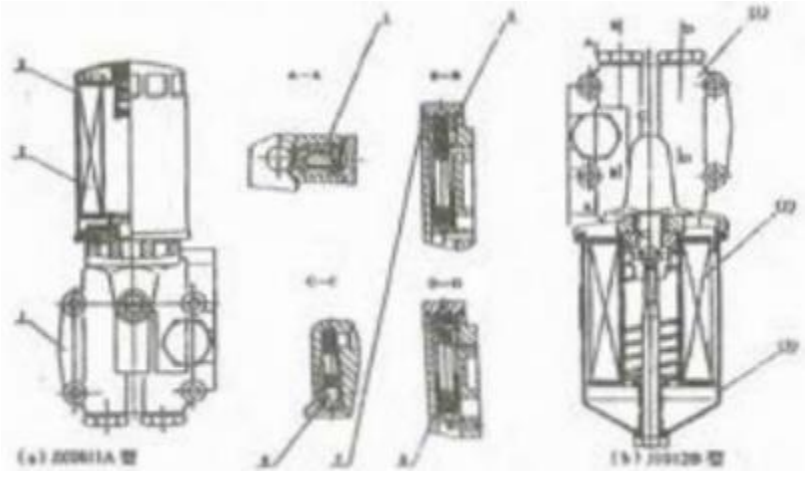


Figure 30 Oil filter

1 filter seat 2 filter element 3 housing 4 bypass valve 5 pressure limiting valve 6 pressure adjustment gasket 7 bypass

The JX0811A and J1012B oil filters are used to filter the oil for lubricated diesel engines; the J0506 oil filter is used to filter the oil for lubricated superchargers.

The oil filter housing contains a pressure relief valve and a bypass valve. When the oil cooler becomes clogged, the filter element surface gets blocked, or the oil viscosity increases excessively, the bypass valve opens. This allows oil to bypass the cooler or filter directly into the main oil passage, ensuring safe operation of the diesel engine. Users must not disassemble or adjust the bypass valve without authorization.

Paper filter elements should be maintained or replaced at the prescribed time.

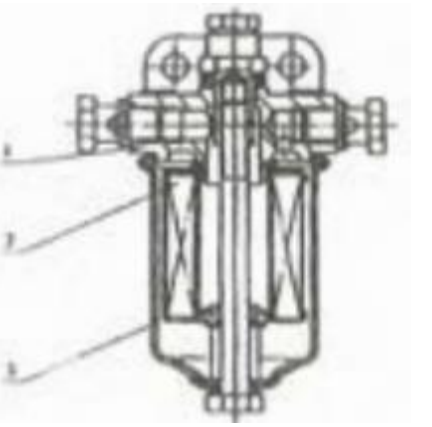


Figure 31 Oil filter

1 filter seat, 2 filter element, 3 housing

2. The structure of FL85 type centrifugal oil filter is shown in Figure 32.

The lubricating oil pumped from the engine flows through a pressure-limiting valve and the rotor shaft's central oil passage into the rotor chamber, where it is ejected at high speed through the nozzle to drive the rotor's rapid rotation. Under centrifugal force, contaminants in the oil are thrown against the inner wall of the rotor chamber. To maintain pressure in the main oil passage, a pressure-limiting valve is installed in the base's inlet duct. When the oil pressure drops below 0.2 MPa, the valve closes, halting the rotor's operation.

When the diesel engine is stopped, carefully listen to whether the internal rotor can produce a uniform sound for 1-2 minutes. If there is no such sound or the duration is very short, it should be checked and maintained.

When cleaning and assembling a split centrifugal oil filter, the nozzle holes can be cleaned with copper wire, but do not remove it. Do not over-tighten the compression nut and cover nut.

(4) Oil and gas separator

In order to improve the durability of diesel engines and prevent environmental pollution, a fully enclosed crankcase ventilation system is adopted. The system is used in diesel engines

The structure of the oil machine is shown in Figure 33.

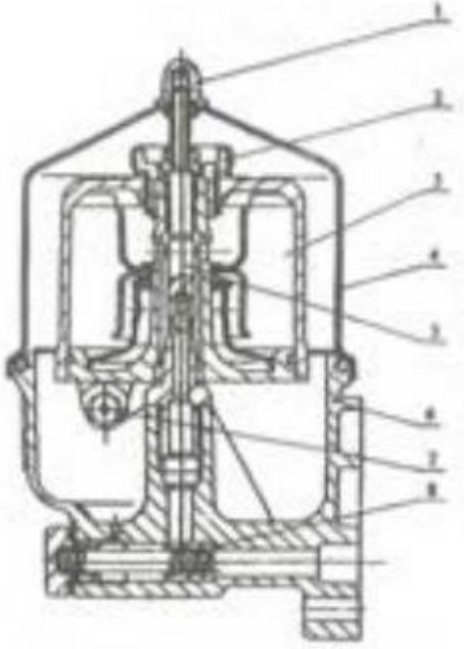


Figure 32 FL85 type diverter centrifugal oil filter

1 hex nut 2 compression nut 3 rotor 4 cover 5 rotor shaft 6 base 7 nozzle 8 pressure limiting valve

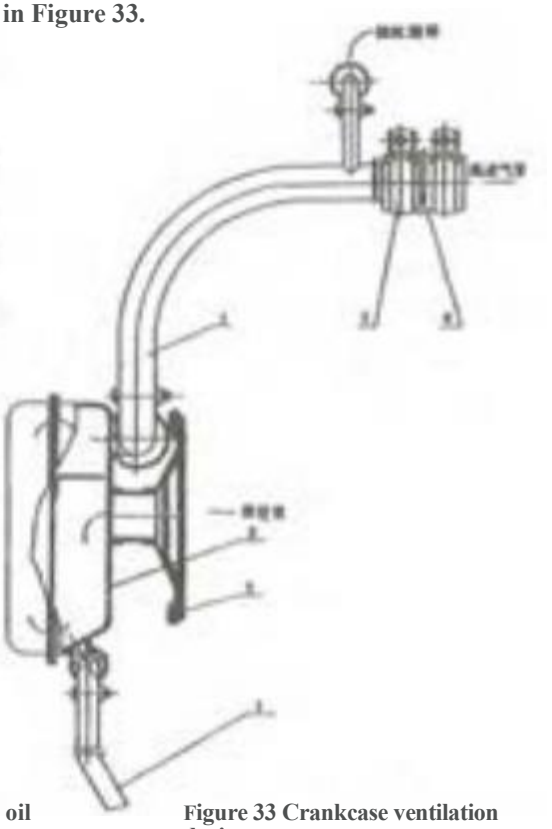


Figure 33 Crankcase ventilation device

1 oil pipe 2 push rod chamber gasket 3 rear push rod chamber cover and ventilation device 4 oil separator pipe parts 5 hose clamp parts 6 joint rubber ring

The baffle-type oil-gas separator is mounted on the rear cover of the engine's right valve pushrod chamber. This thin-walled steel welded structure features an expansion chamber divided into front and rear chambers by two small-hole main baffles. During operation, gases from the crankcase flow out at a controlled velocity through the pushrod chamber passage.

The gas then passes through the main ventilation pipe between the oil separator and pushrod chamber, the oil separator's rear chamber, and the main baffles before returning to the front chamber via the upper section of the baffles. From the outlet fitting, it flows into the intake manifold. Through the separation process in the baffle-type oil separator – involving expansion, throttling, and directional changes – oil droplets and vapor are separated. The separated components slide down the expansion chamber walls and enter the oil pan through the lower return oil pipe. The pipe's submergence below the oil surface prevents the separated oil from being carried away by the crankcase gases.

The ventilation pipe on the top of the cylinder head is connected with the gas pipeline led out by the separator, and its function is to maintain the pressure balance of the whole crankcase ventilation system.

(5) Oil cooler

The shell and tube oil cooler used in the FE series diesel engine is shown in Figure 34.

The oil cooler is typically installed alongside the oil filter. Oil from the oil pump enters the cooler housing through an inlet port on the casing. Cooling water is introduced via a dedicated outlet on the cylinder block's left side, connected to the cooler core through flexible hoses. The temperature difference between the oil and water, combined with their flow direction, facilitates heat exchange within the cooler, effectively cooling the oil. The cooled water returns to the cylinder head via hoses, while the filtered oil flows into the main oil passage.

During the use of diesel engines, it is necessary to pay attention to the observation of whether oil is mixed in the cooling water circulation system. If obvious oil-water mixing phenomenon is found in the cooling system, it is necessary to immediately check whether the oil cooler seal ring is ineffective or the core leakage, and the fault must be eliminated.

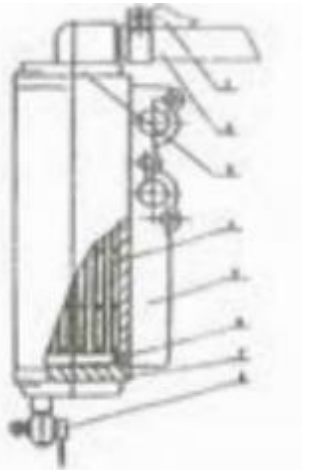


Figure 34 Oil cooler

1 inlet pipe, 2 outlet pipe, 3 cooler top cover
4 cooler core 5 cooler body 6 "O" ring
Cooler lower cover 8 drain valve

X. Cooling system

The diesel engine adopts a closed forced water circulation cooling system, as shown in Figure 35.

The cooling water in the radiator is pumped by a water pump into the front-to-back main water channels on the left side of the engine block, evenly distributing it to all cylinders for cooling the cylinder liners. Most of the water flows through water passages into the cylinder head, while the remainder passes through the oil cooler before reaching the rear section of the cylinder head. When no oil cooler is installed, the entire cooling water flows directly from the engine block into the cylinder head. Approximately 35% of the total water flow inside the cylinder head circulates laterally through holes drilled in the nose area to cool the high-heat-load triangular zone. The remaining water flows longitudinally: nearly 25% goes to the exhaust side, 30% reaches the cylinder head's end, and about 10% forms a bypass section. This distribution is controlled by the arrangement and dimensions of the water passages, ensuring uniform and efficient cooling throughout the cylinder head. All used cooling water returns to the radiator's upper chamber via the front of the cylinder head through the thermostat. During circulation, the water cools the air drawn in or expelled by the fan, completing the large cycle. When water temperature drops below set points, the thermostat shuts off, preventing water from entering the radiator's upper chamber. Instead, water flows back to the water pump through small pipes beneath the thermostat, forming a small cycle.

The FE series diesel engine 4 and 6 cylinder models all use the same water pump. The temperature gauge used in the FE series diesel engine can be selected according to user needs, and the corresponding temperature gauge connector or temperature sensor connector can be used.

In marine diesel engine cooling systems, seawater-to-diesel heat exchangers replace traditional radiator fans. The water circulation system consists of two distinct components: First, seawater pumped from the sea enters the heat exchanger to cool freshwater, which then flows into the exhaust pipe jacket for further cooling before being discharged through the marine gearbox oil cooler. Second, freshwater from the expansion compensation tank passes through the heat exchanger and is pressurized by the pump. This pressurized fluid circulates through the engine block, oil cooler, cylinder head, and finally returns to the expansion compensation tank via the thermostat, completing the freshwater circulation cycle for marine diesel engines.

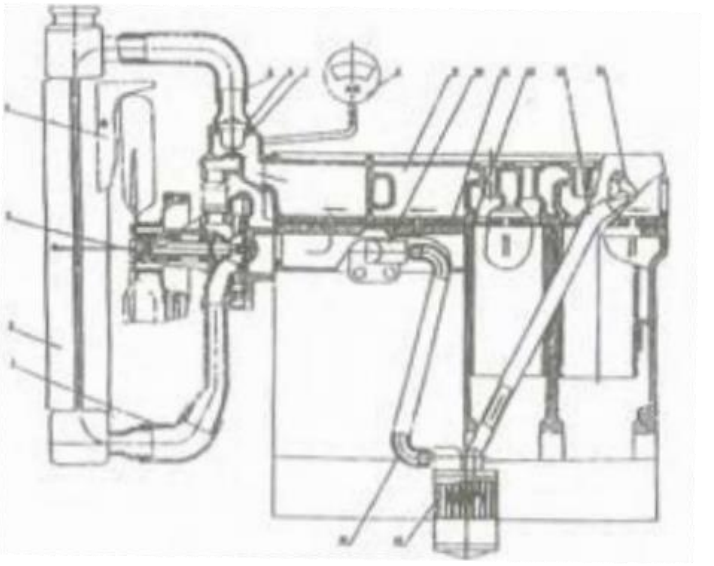


Figure 35 Schematic diagram of cooling system

1 tank outlet hose 2 tank 3 pump fan parts 4 air guide cover 5 tank inlet hose 6 thermostat cover
7 thermostat 8 water temperature gauge 9 cylinder head 10 cooler water supply joint parts 11 engine block 12 cylinder liner 13 cooler outlet pipe
14 Cooler return water joint component 15 oil cooler 16 cooler inlet pipe

(1) Water pump

The diesel engine adopts a centrifugal water pump, which is installed at the front end of the machine and driven by V-belt through crankshaft pulley, as shown in Figure 36.

The pump shaft is supported by two dust-proof bearings housed within the pump casing and rotates inside the pump body. The impeller is mounted at the rear end of the shaft, featuring a ceramic ring installed around its neck with a water seal component between it and the casing to prevent leakage. To protect the rolling bearings from water ingress, drainage holes are drilled below the bearing housing bore in the pump body, while splash rings are fitted on the bearing end face to allow water seeping into the bearing bore to escape through these holes. When severe dripping occurs at the drainage holes beneath the pump body during operation, the water seal should be replaced.

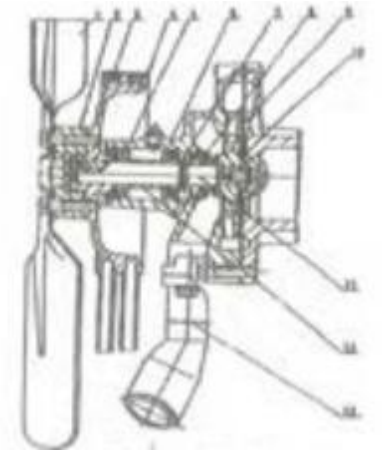


Figure 36 Pump fan

1 fan component 2 spacer block 3V belt 4 pump pulley 5 bearing 6 pump housing 7 water ring 8 water seal component 9 impeller component
10 pump rear cover 11 pump shaft 12 spacer 13 pipe

The water pump system features four distinct models based on the distance between the pump center and crankshaft center: 285mm, 302mm, 338mm, and 354mm. These models can be selected according to specific application requirements. While components like the pump housing and rear cover differ among these variants, all other parts remain identical. To accommodate various water tank outlet connections, the system provides multiple pump connection options tailored to user needs.

On the pump housing and cylinder head, heating connectors can be added according to the supporting requirements for user heating.

2) Fan

The diesel engine adopts a blade axial flow cooling fan. The cooling fan is installed at the front of the pump pulley and rotates synchronously with the pump shaft.

According to the use of diesel engine and supporting models, cooling fans can be selected as four-blade or six-blade cooling fans with suction or exhaust mode. The outer diameter is φ450mm and 490mm respectively, which can be selected according to the ambient temperature and required cooling air volume.

3) Water tank

The diesel engine adopts a closed integral water tank, whose core is composed of alternately arranged heat dissipation tubes and heat dissipation fins. The water filling port cover of the water tank is equipped with a steam valve and an air intake valve, as shown in Figure 37.

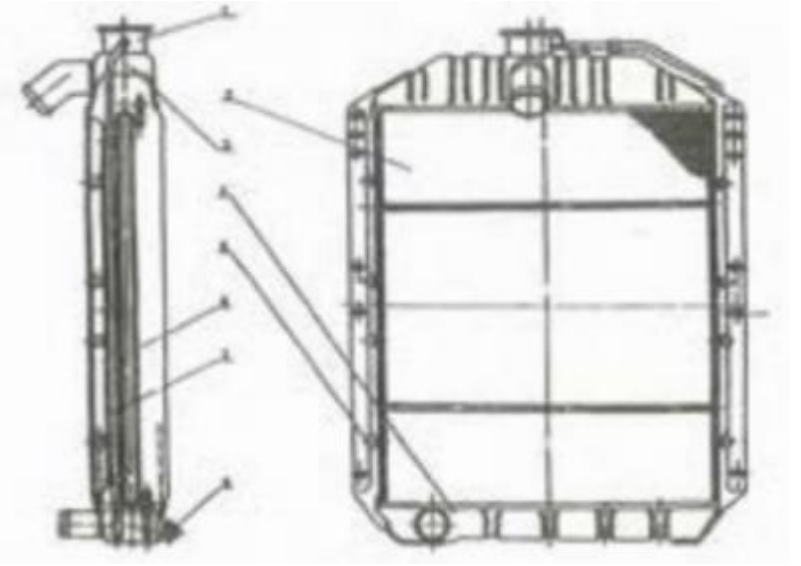


Figure 37 Water tank

1 water inlet cover component 2 core sub-component 3 upper water chamber sub-component 4 lower water chamber sub-component

5 Left panel 6 right panel 7 drain hose 8 drain valve

Water tanks come in various models depending on their heat dissipation area and structural design. The standard 12.9-square-meter tank is used for four-cylinder engines, while the 18.74-square-meter tank serves six-cylinder engines. Users can choose the appropriate tank based on specific application requirements, ensuring it meets thermal dissipation needs.

(4) Thermostat

The diesel engine uses a wax thermostat, as shown in Figure 38.

The thermostat is installed in the front end or side outlet of the cylinder head. The thermostat shell is used to control the flow of cooling water into the tank and adjust the temperature of cooling water, so that the diesel engine can always work in the best temperature range.

The thermostat's main valve opens at 77±2℃ and reaches full opening at 87±2℃. The valve lift during full opening must be no less than 9mm. If water flows from the thermostat cover before the engine warms up to 75℃ after cold start, or if no water flows when the engine runs with water temperature exceeding 79℃, this indicates a malfunctioning thermostat that requires disassembly for inspection. Never remove the thermostat arbitrarily during operation, as improper removal may compromise the engine's normal functioning.

Different thermostatic covers are designed to meet different supporting requirements.

(5) Sea and fresh water heat exchanger

The marine diesel engine uses a sea and fresh water heat exchanger, the structure of which is shown in Figure 39.

The seawater and fresh water heat exchanger is equipped with an expansion compensation tank on the top. The seawater pumped in by the seawater pump passes through the pipeline in the core of the heat exchanger to cool the fresh water. After the seawater flows out, the cooling exhaust pipe and the fresh water in the compensation tank pass through the heat exchanger and enter the pump for fresh water circulation.

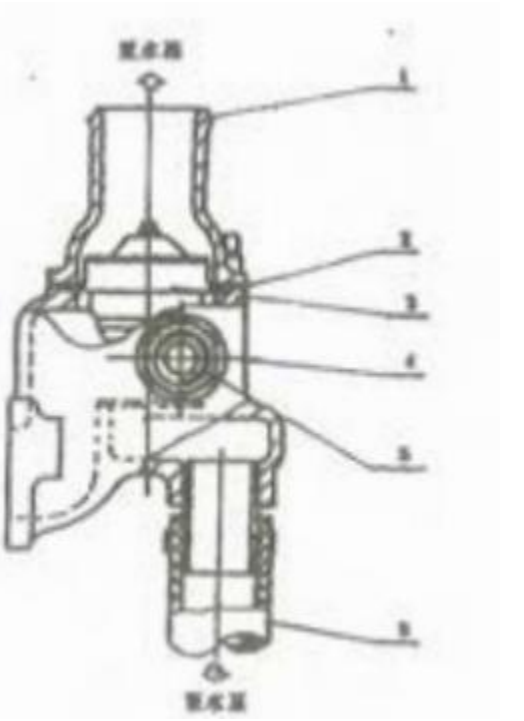


Figure 38 Thermostat and housing

1 thermostat cover, 2 gasket, 3 thermostat parts, 4 thermostat body, 5 temperature gauge connector, 6 hose

Figure 39. Seawater heat exchanger

1 double tank cover parts 2 return water flange 3 expansion water tank 4 heat exchange core parts 5 pipe flange 6 shell
7 front cover 8 zinc rod component 9 rear end cover 10 sealing ring 11 water pipe flange

11. Electrical System

1. Electrical system

FE series diesel engine electrical system has 12V and 24V, both of which are single-wire negative grounding, available for users to choose, as shown in Figure 40

As shown.

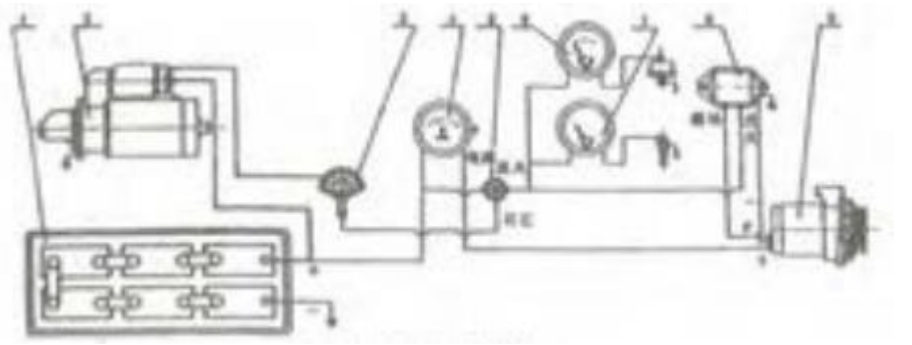


Figure 40 Schematic diagram of electrical system

1 Battery 2 starter motor 3 starter switch 4 current 5 circuit key switch 6 pressure gauge 7 temperature gauge 8 voltage regulator 9 silicon rectifier generator

Standard diesel engines typically use 12V electrical systems, while construction machinery employs 24V systems. These can be equipped with high-power 24V starter motors to enhance starting performance. The rated voltages of motors and electrical components in the system must match the electrical voltage. To improve low-temperature starting performance, users may install cold-start devices on intake manifolds as needed.

(1) Battery

The lead-acid battery serves as the power source for diesel engines, and its performance directly affects engine startup efficiency. When selecting a battery with specified capacity, consider the starter motor's characteristics. The battery should be installed as close to the starter motor as possible to minimize cable length between them, preventing excessive voltage drop during startup. Use 35mm² low-voltage cables for connections. During peak startup current conditions, the voltage drop should not exceed 0.5V for 12V starters and 1V for 24V starters.

The battery manufactured randomly is not charged. Before use, the battery should be initially charged according to the requirements of the battery. During the operation of the diesel engine, attention should be paid to the size of the charging current. When the indicator value of the ammeter approaches "0", it indicates that the battery has been fully charged and the charging circuit can be cut off.

(2) Silicon rectifier generator

The JF series silicon rectifier generator is used for charging generators. Due to different electrical system voltages, models such as JF1312YE, JF2312YE, JF2512YE, JFZ1512YE, and BJFW23B are available. The general-purpose diesel engine typically uses the 12V electrical system model JF1312YE, while other models predominantly employ the 24V electrical system. Models with vacuum pumps use the BJFW23B type, and six-cylinder vehicle diesel engines utilize the JF2512YE model.

Silicon rectifier generators boast compact size, simple structure, and excellent low-speed charging performance. The generator's rear cover contains two sets of silicon rectifier components (three units per set). Three-phase AC power from the windings is converted into DC through a three-phase bridge full-wave rectifier, with the output connected to the "+" terminal. During maintenance, never attempt to check power generation by grounding the device for spark detection, as this could damage the silicon rectifier components.

(3) Voltage regulator

The function of the voltage regulator is to output 13.5-14.5V or 27-29V range when the speed of the 14V or 28V generator changes. These two electric system generators are respectively equipped with FT111, FT211 and FT226 voltage regulators. The FT226 type regulator can be connected to the charging indicator light.

When using the FT111 and FT211 regulators, the circuit key switch should be cut off immediately after shutdown to prevent the battery from discharging to the magnetic field coil, resulting in battery loss and affecting the next start.

Regulators are precision instruments, generally do not arbitrarily disassemble and adjust, when necessary, should be checked and adjusted on special equipment.

(4) Start the motor

The starting motor is a fully enclosed DC series excited motor. The 12V electrical system uses QD1518E and QD154C models, while the 24V electrical system uses QD2637E. In the 12V electrical system, QD154C is a 9-tooth starter motor designed to improve starting performance, and QD154 is an 11-tooth starter motor.

When starting the motor, the current is large, so it can only work for a short time. The start time should not exceed 10 seconds each time. If continuous start is needed, the time interval should not be less than 2 minutes, and the number of consecutive starts should not exceed 10 times in general, so as to avoid damage to the starter and battery.

(5.) Circuit key switch

The circuit key switch has three working positions. When the key is in the middle position, the whole circuit is cut off. When the key is turned clockwise, the preheating start switch, voltage regulator and other electrical appliances can be connected at the same time, and the diesel engine can be started at this time. After the diesel engine starts, the key should be turned counterclockwise to the bottom, and the preheating start switch is cut off at this time to prevent accidents.

(6) Preheat the start switch

If a preheater is required, install the preheat start switch. This switch has four operational positions: When set to "Preheat", it only connects the preheater or electric heating plug; when set to "Preheat Start", both preheating and startup are activated; if no preheat is needed, simply rotate to "Start"; after releasing the switch, it will automatically return to position "0" and cut off the circuit.

Chapter III Use and operation of diesel engines

1. Handling, installation, sealing and storage

When moving the diesel engine, it should be lifted by front and rear lifting lugs, and attention should be paid to prevent surface, accessories, oil pipes and other damage and deformation.

When the diesel engine needs to be moved for a long distance, the air filter and muffler should be removed, and the inlet and exhaust pipe openings, water inlet and outlet of the pump, fuel inlet and return oil pipe openings should be sealed with plugs or plastic cloth. If necessary, the whole machine should be packaged with a plastic cover or packed in a wooden box.

When diesel engine is used for fixed operation, the installation foundation should be firm, the installation seat should be kept level, and the transmission device should meet the requirements. The working site should be spacious, with good air circulation, less dust and rainproof.

If the diesel engine is not used for a long time, it should be sealed and kept in accordance with the following methods.

1. Drain the fuel oil, engine oil and coolant.

2. Remove the fuel injector assembly and inject 200 grams of dehydrated clean engine oil into each cylinder (heat the oil to 100-200°C until all bubbles disappear). Rotate the crankshaft to ensure even oil distribution on valve surfaces, cylinder liners, pistons, and other components. Clean the needle valve assembly surface thoroughly, apply lubricating oil, then reassemble it onto the diesel engine.

3. Wrap the air filter tightly with plastic sheet, remove the muffler, and block the exhaust pipe with wooden plug.

4. Clean the oil, dust and rust on the outside of the diesel engine. Thinly apply a layer of anti-rust oil (calcium based grease) on the surface of the unpainted parts and cover it with paper.

5. Wrap the diesel engine with plastic sheeting.

6. The sealed diesel engine should be placed in a ventilated, dry and clean room. It is strictly prohibited to put it together with the items that are corrosive to the diesel engine. The above oil sealing method is valid for three months. After this period, the oil sealing should be replaced.

2. Fuel oil, engine oil and cooling water

1. Fuel oil

Diesel engines should be selected with different grades of light diesel oil according to atmospheric temperature (GB252-81)

free air temperature	Above 0℃	0~-10℃	-10~-20℃	-20~-35℃
Diesel grades	0	-10	-20	-35

Fuel oil must be kept highly clean. Before being injected into the fuel tank of a diesel engine, the fuel oil should be clarified for at least three days and nights to make it burn

Dust and moisture settle into the bottom of the oil, and clean fuel is taken from the top. The oil is filtered before being added to the tank.

2. Oil

Diesel engines should be selected with different grades of CC diesel oil (GB5323-85) according to different regions and different temperatures

territory of use (air temperature)	Winter in the cold region (-5~-10℃)	Whole year in general areas (0~30℃)	Summer in the south (>30℃)
Oil model	20	30	40

L-ECD diesel oil (GB11122-89) should be selected for turbocharged diesel engines

territory of use (air temperature)	Winter in the cold region (-5~-15°C)	Whole year in general areas (0~30°C)	Summer in the south (>30°C)
oil make	20/20W	30	40

The oil must be filtered before being injected into the diesel engine. It is forbidden to use other grades of oil to lubricate the diesel engine, so as not to cause premature damage to parts such as bearing shells and piston rings.

3. Cooling water

Clean soft water such as tap water, rainwater, river water, etc. should be used. If well water, spring water and other hard water with more minerals are used, they should be softened. Otherwise, the waterway of diesel engine will produce scale, block the flow of water, affect the cooling effect, and cause overheating of diesel engine.

Softening treatment may be performed by one of the following methods:

(1) Boil and precipitate, filter and use;

(2) Add 20 grams of trisodium phosphate to every 10 liters of water, filter after precipitation, and use it.

When the ambient temperature is below zero, antifreeze can be used as the cooling medium for the diesel engine. Antifreeze can be prepared by mixing water and alcohol in the following proportions.

Anti-freeze volume ratio (%)		Anti-freeze freezing point (°C)	
water	ethyl alcohol	Add denatured alcohol	Add water to the alcohol
90	10	-3	-5
80	20	-7	-12
70	30	-12	-19
60	40	-19	-29
50	50	-28	-50

Attention should be paid to the preparation and addition of antifreeze

(1) The antifreeze is toxic and should not be eaten;

(2) In the use of diesel engine, the temperature of antifreeze should not exceed 90°C to avoid alcohol volatilization;

(3) every 25-30 hours, the capacity of antifreeze should be checked, and it should be added in time if insufficient;

(4) The amount of antifreeze injection is 6% less than the amount of water injection, because the antifreeze will expand at high temperature.

3. Preparations before launch

1. Before starting the diesel engine, a comprehensive inspection should be carried out. Special attention should be paid to whether the connection and tightening of the foot bolts and the driven machinery are reliable, and whether the transmission parts and operating system are flexible. Only after the correct and problem-free start can the diesel engine be started.

2. Check and replenish the oil in the oil pan, so that the oil level is between the upper and lower lines of the oil scale. Add enough cooling water and fuel. Open the tank switch, check whether there is leakage in each system and eliminate it.

3. To eliminate air in the oil circuit, it is recommended to use the method of releasing air section by section:

First, loosen the vent screw on the filter and use a hand pump to drain air from the oil tank to the filter section. Then loosen the vent screw on the fuel pump until no bubbles are left in the fuel.

4. Check whether the battery is fully charged. Connect the battery to the circuit and check the power supply.

IV.Launch

The diesel engine can be started only after the pre-start preparations are completed and confirmed to meet the requirements. During start-up, the clutch should be disengaged and the following steps should be followed:

1. Put the throttle lever in a larger fuel supply position.

2. Turn the circuit key switch clockwise to open the circuit.

3. Turn the start switch to the "start" position. After starting the motor and turning the crankshaft quickly, the diesel engine can be started.

4. The start time should not exceed 10 seconds to protect the starting motor and battery. If continuous start is required, stop for 2 minutes before starting again. If it cannot be started for three consecutive times, the cause should be found out and the fault should be removed before starting again.

5. After starting the diesel engine, immediately turn the start switch to its original position. Put the throttle lever in idle position. Turn the circuit key switch counterclockwise to the charging position.

6. Check the oil pressure immediately after starting. The oil pressure at idle should not be lower than 0.1MPa. After maintaining the oil filter, stop the diesel engine after 5 minutes of starting and wait for 15 minutes until the oil flows back to the oil pan. Check the oil level and add oil to the specified level if necessary.

V. Operation

1. After the diesel engine starts, it should not be operated at full load immediately. The diesel engine should be run in low speed and idle to heat up successively, and then it is allowed to increase to the highest speed and put into full load operation only after the outlet temperature of cooling water reaches 60°C.

2. When the diesel engine is running, the speed and load should be increased and decreased slowly. Generally, sudden increase and decrease are not allowed.

3. During diesel engine operation, continuously monitor the oil pressure, oil temperature, coolant temperature, and charging current gauges. Carefully observe exhaust smoke coloration and listen for internal noises. If overheating, black smoke emission, knocking sounds, or other abnormal conditions are detected, immediately stop the engine for inspection and troubleshooting. Never operate a faulty diesel engine to prevent accidental damage to components.

4. During the operation of diesel engine, we should always pay attention to the operation of oil circuit and water circuit connection. If leakage is found, it should be removed in time to prevent waste and environmental pollution.

6. Do not let the diesel engine run at idle for a long time.

7. The fuel pump has been adjusted before leaving the factory, and the user shall not change it arbitrarily. If adjustment is needed, it must be carried out on the test bench of the fuel pump.

VI. Parking

1. Before stopping the diesel engine, the load should be removed and gradually reduced to idle speed. When the water temperature drops below 70°C, turn off the stop handle, and the engine can be stopped. After stopping, remove the switch key and close the fuel tank valve.

2. It is strictly prohibited to stop the machine suddenly when the water temperature is too high.

3. Do not stop by closing the fuel tank valve to avoid air mixing in the oil circuit.

4. When the temperature is lower than +5°C, if no antifreeze is used, drain the cooling water to prevent freezing and cracking of the body and pump.

5. After each shutdown, faults found during operation should be removed in time and necessary maintenance should be carried out.

VII. Safety technical operation procedures

1. Do not open the diesel engine if you do not understand the operation technology.

2. Do not start the diesel engine without proper preparation.

3. Pay attention to fire prevention. Open fire should not be close to the working diesel engine. When the diesel engine works in flammable products, a fire extinguishing device should be installed on the exhaust pipe.

4. The diesel engine is not allowed to be disassembled and adjusted during operation. The operator shall not leave the site.

5. It is strictly prohibited for the diesel engine to operate without oil pressure, low oil pressure or abnormal internal noise. In case of the above situation, it should be stopped urgently.

6. Once the diesel engine is overspeed, the stop handle should be turned immediately to stop and maintain. If the stop handle fails, the diesel engine can be stopped by blocking the air inlet.

Chapter IV Technical maintenance of diesel engines

Regular technical maintenance is an important part of rational use of diesel engines. In order to keep diesel engines in good technical condition and prolong their service life, it is necessary to conscientiously implement the technical maintenance system according to the specifications.

The maintenance of this diesel engine is classified as follows:

1. Shift maintenance (8-10 hours).
2. Level 1 technical maintenance (accumulated working hours: 50 hours).
3. Secondary technical maintenance (accumulated working hours: 250 hours).
4. Level 3 technical maintenance (accumulated working hours: 1000 hours).
5. Technical maintenance in winter.

1. Shift maintenance

1. Check the oil level in the oil pan, oil bath air filter and power output gearbox. If the oil level is high, find out the cause and eliminate it. If the oil is insufficient, add it to the specified value.

2. Check the cooling level in the water tank and refill it if insufficient. When the temperature may be lower than +5°C, drain the cooling water after shutdown (if there is no antifreeze).

3. Check and tighten the exposed bolts and nuts of the diesel engine, and eliminate oil leakage, water leakage and air leakage.

4. When working in a dustier environment, use compressed air to remove the accumulated dust on the air filter element.

5. Remove mud, dust and oil stains from the outside of the diesel engine.

6. When the diesel engine is running, pay attention to listen to the sound, observe the exhaust color, and eliminate the found faults and abnormal phenomena.

2. Level 1 technical maintenance

1. Implement all items of shift maintenance.

2. Clean the oil filter element with clean diesel oil. Clean the centrifugal oil filter every two maintenance cycles.

3. Remove the dust on the air filter element and in the dustpan. Replace the oil in the oil bath air filter.

4. Check and adjust the tension of the fan belt.

5. Add grease to the pump bearing.

6. Inspect all parts of the diesel engine and make necessary adjustments as needed.

7. After maintenance, start the diesel engine to check its operation and eliminate the found faults and abnormal phenomena.

Third, secondary technical maintenance

1. Implement all items of level 1 technical maintenance.

2. Change the oil, clean the oil pan and oil filter.

3. Clean the oil filter and replace the filter element.

4. Clean the fuel tank, oil pump filter and pipeline. Clean the diesel filter element with clean diesel oil.

5. Clean the compressor chamber and impeller of the supercharged model, and check the moving parts and fasteners.

6. Blow away the accumulated dust in the generator with compressed air, check whether all parts are normal, and deal with the abnormal parts.

7. Check and adjust the valve clearance.

8. Check the opening pressure and spray quality of the injector, and adjust it if necessary.

9. Check and adjust the working gap of the contact and iron core gap of the voltage regulator every two maintenance cycles.

IV. Third-level technical maintenance

1. Implement all items of secondary technical maintenance.

2. Clean the cooling system and remove scale.

3. Clean the oil cooler.

4. Replace the air filter element and diesel filter element.

5. Remove and inspect the cylinder head. Check the valve seal, remove carbon deposits, and grind the valve as needed.

6. Check the tightening of cylinder head bolts, main bearing bolts and connecting rod bolts. If the torque is insufficient, retighten them to the specified value.

7. Check the water pump, replace the grease, and replace the water seal if necessary.

8. Check the generator and starting motor, clean and maintain them and add new grease.

9. Check the fuel pump and adjust the fuel supply advance angle. Adjust the fuel pump according to the situation.

10. Check the turbocharger, clean the parts, remove carbon deposits, and check the rotor mobility.

V. Technical maintenance in winter

Diesel engines must be given special maintenance when temperatures may be lower than +5°C.

1. Winter oil and fuel must be used, and special attention should be paid to the water content in the fuel, so as not to block the oil circuit.

2. It is best to add antifreeze to the cooling system. Otherwise, after stopping the engine, the coolant must be drained when the water temperature drops to 40-50°C.

3. In cold seasons and regions, diesel engines should not be stored in the open air, otherwise the coolant should be heated to preheat the engine body when starting.

Chapter V Fault and troubleshooting

1. It cannot be started

Cause and characteristic of failure	Method of exclusion
1. Fuel system failure	1. Fuel system failure
(1) There is a blockage in the fuel system	(1) Disassembly and cleaning
(2) Air in the fuel system	(2) Use the oil pump to remove air from the system, Check the fuel line for oil and gas leaks
(3) The oil pump does not supply oil or supplies oil intermittently	(3) Inspection and repair
(4) The injector spray is not good	(4) Check, adjust or replace the needle valve pair
(5) The fuel supply advance angle is wrong	(5) Check and adjust
2. Insufficient compression pressure	
(1) Piston ring and cylinder liner wear	(1) Check and replace worn parts
(2) Piston ring glue	(2) Remove the glue
(3) Valve leakage	(3) The valve spring is broken or the elasticity decreases; the valve clearance is not right; the valve sealing is not good, so deal with it accordingly
(4) The compression end temperature is low	(4) Low ambient temperature, preheating start method is adopted
3. Fault of electrical equipment	
(1) Battery undercharge	(1) Recharge to the specified requirements
(2) Poor contact of electrical wiring	(2) Check the firmness of wiring
(3) The starting motor does not turn or is weak	(3) Start the maintenance motor
(4) Start motor clutch slip	(4) Start the maintenance of the motor clutch
(5) The starting motor gear cannot be embedded in the flywheel gear ring	(5) Find out the cause and repair

Second, the operation is unstable

Cause and characteristic of failure	Method of exclusion
Cause and characteristic of failure	1. Handle it according to Article 1(1), (2), (3) and (4) of No.1 Middle School
1. Fault of fuel system 2. Too much water in fuel oil	2. Check the water content of fuel oil
3. Oil leakage in fuel line	3. Check and eliminate
4. The regulator does not work properly	4. Check and calibrate the speed regulator
5. Cylinder gas leakage	5. Check the tightening torque of cylinder head bolts and the sealing of cylinder head gasket
6. Uneven oil supply to each cylinder	
(1) Uneven oil supply from each cylinder of the injection pump	(1) Check and adjust
(2) The spray quality of the injector is not good or the couple is stuck	(2) Check the spray quality of the injector. Replace the parts if necessary
(3) The plunger of the oil pump is worn or the spring is broken	(3) Check and replace

3. Insufficient power and sudden drop in power

Cause and characteristic of failure	Method of exclusion
1. Air filter is blocked	1. Clean or replace the filter element
2. Valve spring or push rod is damaged	2. Check and replace
3. Valve clearance is not right	3. Check and adjust
4. Insufficient compression pressure	4. Handle it according to Article 2 of No.1 Middle School
5. The fuel supply advance Angle is wrong	5. Check and adjust
6. The fuel system is air or blocked	6. Handle it according to Article 1(1), (2) and (3) of No.1 Middle School
7. Insufficient oil supply	7. Check the fuel pump plunger and outlet valve
8. The spray quality of the injector is not good	8. Check, clean and adjust the pressure
9. The speed regulator fails	9. Overhaul the speed regulator
10. Diesel engine overheating	10. Maintain the cooling system and remove scale
11. Too much carbon buildup in the diesel engine	11. Remove carbon deposits
12. The exhaust pipe is not smooth	

4. Abnormal noise during operation

Cause and characteristic of failure	Method of exclusion
1. The oil injection time is too early, resulting in a rhythmic crisp metal knocking sound in the cylinder	1. Adjust the fuel supply advance angle
2. The injection time is too late, and a low and unclear sound is heard in the cylinder	2. Adjust the fuel supply advance angle
3. The piston and cylinder liner clearance is too large, and the impact sound is heard in the cylinder after the diesel engine starts, which is reduced with the increase of the temperature of the diesel engine	3. Check the cylinder gap and replace the piston or cylinder liner
4. The gap between the piston pin and the pin hole is too large, and the sound is clear and sharp. It is more clear at idle speed	4. Replace parts to ensure the specified gap
5. The clearance between the main bearing and the connecting rod bearing is too large. When the speed of the diesel engine suddenly decreases, the impact sound of the machine parts should be heard, and the sound is heavy and powerful at low speed	5. Replace parts to ensure the specified gap
6. The axial clearance of the crankshaft is too large, and a crash sound can be heard at idle speed	6. Replace the thrust plate to ensure the specified gap

7. The valve spring is broken, the push rod is bent, and the valve clearance is too large. At the cylinder head cover, you can hear a chaotic sound or a light rhythmic knock	**7. Replace parts and adjust valve clearance**
8. Piston hits the valve, and a metallic knocking sound can be heard near the cylinder head at low speed	**8. Check the valve clearance and transmission gear marking**
9. The gear clearance is too large, and the impact sound can be heard at the gear chamber when the speed is suddenly reduced	**9. Check the tooth side clearance and replace the gear according to the situation**

5. Abnormal exhaust smoke color

Under normal operating conditions, diesel engines emit light gray exhaust smoke. Even during short-term heavy loads, the smoke color remains light gray. When the exhaust appears blue, white, or black, it indicates abnormal smoke characteristics. Blue signifies oil burning; white suggests incomplete combustion of diesel droplets in the cylinder or water presence within the cylinder; black indicates excessive fuel injection that fails to complete combustion.

Cause and characteristic of failure	Method of exclusion
1. Blue smoke	
(1) Oil leakage, piston rings are reversed, stuck or worn too much	(1) Check the piston rings and eliminate the fault
(2) The gap between the valve and the duct hole is too large	(2) Replace parts to ensure the specified gap
2. White smoke	
(1) The atomization quality of the injector is not good, and there are drops and leaks	(1) Check the oil pressure and couple sealing, adjust, clean or replace
(2) Too much water in fuel oil	(2) Check the fuel content
(3) There is water in the cylinder	(3) Check the sealing of cylinder head gasket, check whether there is any leakage in cylinder head and cylinder liner. Repair or replace
3. Black smoke	
(1) Overload of diesel engine	(1) Adjust to the specified load
(2) Too much oil is sprayed	(2) Adjust the fuel supply of the injection pump
(3) The oil supply is too late and the afterburning is serious	(3) Adjust the fuel supply advance angle
(4) The valve clearance is not right or the valve sealing is not good	(4) Check the valve clearance and seal to eliminate faults
(5) The air filter is blocked	(5) Clean the filter element

6. Insufficient oil pressure

Cause and characteristic of failure	Method of exclusion
1. The oil pressure gauge is damaged or the connecting pipeline is blocked	1. Replace the pressure gauge or unclog the pipeline
2. Too little oil in the oil bottom	2. Add oil to the specified oil level
3. The oil is too thin	3. Check the oil brand and whether the oil is diluted by fuel Or the engine oil temperature is too high, do corresponding treatment 4,
4. The main and driven gears of the oil pump wear	replace the main and driven gears
5. The filter screen of the collector or the filter element of the machine filter is blocked	5. Clean or replace
6. The spring of the pressure limiting valve and pressure regulating valve is broken	6. Check and replace
7. Oil pipe blockage or oil leakage	7. Check and take corresponding actions
8. The bearing clearance is too large	8. Check the cooperation gap and do corresponding treatment

7. The oil temperature is too high

Cause and characteristic of failure	Method of exclusion
1. Overload of diesel engine	1. Adjust the load
2. Too little or too much oil	2. Increase or decrease the oil quantity according to the regulations
3. The piston ring leaks seriously	3. Replace piston rings or cylinder liners
4. The oil cooler is blocked inside and covered with dust on the surface, which affects heat dissipation	4. Check and clean

8. The outlet temperature of cooling water is too high

Cause and characteristic of failure	Method of exclusion
1. The water temperature gauge or sensing plug is damaged	1. Check and replace
2. Insufficient cooling water	2. Add cooling water to discharge gas in the waterway
3. Too small cooling water flow	
(1) Small pump flow	(1) Check the clearance of the pump impeller and adjust the tension of the fan belt
(2) The water cavity inside the diesel engine is seriously fouled	(2) Remove scale
4. Poor heat dissipation effect of radiator	3. Clean up dust and dirt
5. Overload of diesel engine	4. Adjust to the specified load

9. Failure of the oil pump

Cause and characteristic of failure	Method of exclusion
1. No oil supply	
(1) Oil pump failure	(1) Ten percent treatment
(2) The diesel filter or oil circuit is blocked	(2) Clean or replace
(3) There is air in the oil supply pipeline	(3) Gas discharge
(4) The oil outlet valve spring is broken	(4) Replace the spring
2. Uneven oil supply	
(1) Air in the fuel line	(1) Gas discharge
(2) The oil outlet valve spring is broken	(2) Replace the spring
(3) The sealing surface and outer circular surface of the oil outlet valve are worn	(3) Repair or replacement
(4) Plunger pair wear or spring break	(4) Replace parts
(5) Impurities block the plunger pair	(5) Cleaning

10. Insufficient oil supply from the oil pump

Cause and characteristic of failure	Method of exclusion
1. The check spring is broken or the valve seat seal is not tight	1. Replace the spring or repair the check valve
2. Piston wear	2. Replace the piston
3. Leakage or blockage of the oil inlet pipeline	3. Check the sealing condition of the pipeline, tighten the screws and unclog the pipeline

11. Fuel injector failure

Cause and characteristic of failure	Method of exclusion
1. Less or no oil is sprayed	
(1) There is air in the oil circuit	(1) Gas discharge
(2) Needle valve is stuck	(2) Repair or replacement
(3) The needle valve and the valve parts are too loose	(3) Replacement
(4) Serious oil leakage in the fuel system	(4) Tighten the joint or replace parts
(5) The fuel supply of the injection pump is abnormal	(5) Check the fuel supply of the injection pump
2. Low oil pressure	
(1) The pressure regulating gasket is worn	(1) Add a shim of appropriate thickness
3. Too high oil pressure	
(1) Needle valve jam	(1) Clean or replace
(2) Clogging of nozzle	(2) Cleaning
(3) The pressure regulating gasket is too thick	(3) Adjust the pressure regulating gasket
4. Serious oil leakage	
(1) The needle valve is not tightly sealed	(1) Repair or replacement
(2) Needle valve is stuck	(2) Clean or replace
(3) The pressure cap is loose or deformed	(3) Fasten and replace parts
(4) The screw of the inlet and return oil joint is loose	(4) Tighten and replace the washer
5. Poor atomization	
(1) Needle valve deformation or wear	(1) Replacement
(2) The needle valve seal is not tight	(2) Tighten or replace parts
(3) nozzle blockage	(3) Cleaning
(4) Needle valve jam	(4) Clean or replace

12. Fault of the speed regulator

Cause and characteristic of failure	Method of exclusion
1. Unstable speed	
(1) The axial clearance of the camshaft is too large	(1) Readjustment
(2) The unevenness of oil supply to each cylinder is too large	(2) Readjustment
(3) The fly hammer assembly is not installed properly, so that the swing difference of the fly hammer bracket shaft is too large	(3) Re-inspect and assemble
(4) The oil outlet valve is worn or the seal is not good	(4) Repair or replacement
2. Too high idle speed	
(1) The handle is not in place	(1) Check and adjust
(2) The rack is not flexible	(2) Repair or repair
3. Cruise cars	
(1) Speed regulating spring deformation	(1) Replace the speed regulating spring
(2) The fly hammer component is loose	(2) Maintenance and tightening
(3) Too much internal friction resistance in the governor	(3) Maintenance and troubleshooting
(4) The axial clearance of the camshaft of the oil pump is too large	(4) Adjust the interval
4. Flying car	
(1) The rack is not flexible	(1) Re-adjust the repair
(2) Poor lubrication, speed regulator bushing burnout	(2) Maintenance and replacement
(3) The fly hammer component is loose	(3) Maintenance and tightening
(4) The high speed limit screw is loose	(4) Readjustment

13. Sudden automatic stop

Cause and characteristic of failure	Method of exclusion
1. The crankshaft cannot be turned after parking	
(1) Crankshaft and bearing seizure	(1) Maintenance and replacement of parts
(2) The piston and cylinder liner are locked	(2) Maintenance and replacement of parts
2. The crankshaft can be easily turned after parking	
(1) Air enters the fuel system	(1) Remove air
(2) Fuel system blockage	(2) Cleaning
(3) The air filter is blocked	(3) Maintain the air filter

14. Fault of the charging generator

Cause and characteristic of failure	Method of exclusion
1. No charging at all	
(1) Circuit wiring is open or short circuit, wiring is wrong	(1) Check the wiring
(2) The claw pole of the generator is loose, the rotor coil is broken and the brush contact is poor	(2) Maintenance inspection
(3) Damage of silicon components in the generator	(3) Replacement
2. Insufficient or unstable charging	
(1) The brush contact is poor, the spring pressure is insufficient, The pulley is oiled	(1) Inspection and maintenance
(2) Transmission belt slack	(2) Adjust the tension of the V-belt
(3) There is a single circuit break in the silicon element	(3) Replacement
3. Abnormal sound during work	
(1) Generator bearing damage	(1) Replacement
(2) Improper installation	(2) Adjustment
(3) Internal short circuit of stator coil or component short circuit	(3) Maintenance

15. Motor start-up fault

Cause and characteristic of failure	Method of exclusion
(1) Poor contact of the connecting wire (2) Battery charging is insufficient (3) Brush contact is poor (4) The circuit of the starting motor itself is open	(1) Clean and tighten the contact point (2) Recharge (3) Clean the commutator contact surface (4) Maintenance
2. The starting motor is weak (1) Bearing bushing wear (2) Brush contact is poor (3) Poor contact of the connecting wire (4) Poor contact of switch (5) The battery is not fully charged or the capacity is too small (6) Clutch slip	(1) Replace the bearing bushing (2) Clean the commutator contact surface (3) Clean and tighten the contact point (4) Maintenance switch (5) Recharge or replace the large capacity battery (6) Repair the clutch
3. Difficulty in gear return (1) The switch contact is burned and glued	(1) Maintenance switch

16. Fault of the regulator

Cause and characteristic of failure	Method of exclusion
1. No power generation at all (1) The voltage is too low (2) Wrong wiring (3) The relay coil is damaged and the contact is poor	(1) Check and adjust (2) Check the wiring (3) Maintenance
2. Insufficient or unstable charging (1) The voltage is too low (2) Contact dirt	(1) Check and adjust (2) Cleaning
3. Too much charging (1) The voltage is too high or out of tune and out of control	(1) Check and adjust

17. Fault of the turbocharger

Cause and characteristic of failure	Method of exclusion
1. Diesel engine power decreased	
(1) The air filter or compressor flow channel is contaminated	(1) Cleaning
(2) Leakage at the outlet connection of the compressor housing	(2) Fastening
(3) Gas leakage at the inlet connection	(3) Fastening
(4) The turbo intake is blocked or contaminated	(4) Cleaning
(5) Floating bearing wear	(5) Replacement
2. Black or blue smoke from the diesel engine	
(1) The air filter or compressor flow channel is contaminated	(1) Cleaning
(2) High altitude, high temperature	(2) Power correction
(3) The return oil pipe of the turbocharger is blocked	(3) Smooth flow
3. The turbocharger has abnormal sound	
(1) Scratching sound	(1) Maintenance
(2) Foreign matter or damage enters the impeller	(2) Disassembly, inspection and maintenance
(3) Sintering of sealing ring	(3) Replacement
4. The rotor does not rotate flexibly	
(1) Carbon buildup caused by oil leakage in the turbocharger	(1) Cleaning
(2) Floating bearing wear	(2) Replacement
(3) Deformation of parts caused by overtemperature	(3) Replacement
(4) Low dynamic balance precision	(4) Replacement

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