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WEICHAI POWER

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中国驰名商标
CHINA FAMOUS TRADEMARK



中国名牌
CHINA TOP BRAND



WD12系列柴油机

使用保养说明书

Operation and Maintenance Manual for
WD12 Series Diesel Engine



质量安全
XK06-205-00261
XK06-205-00262

潍柴动力股份有限公司
WEICHAI POWER CO., LTD.

WD12系列柴油机

WD12 Series Diesel Engine

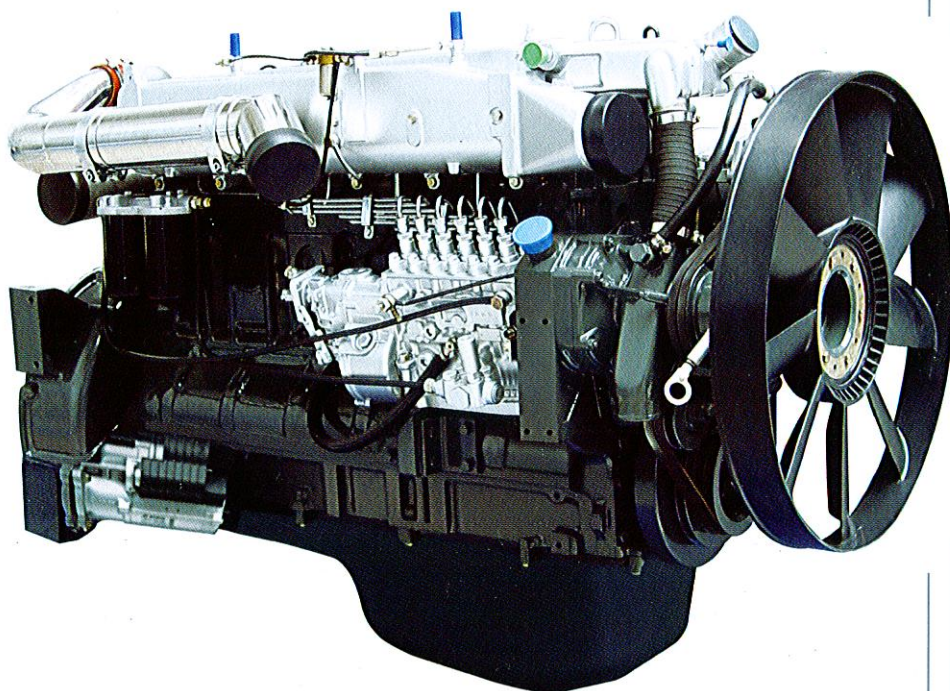


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Special Attention

● For the sake of safeguarding your lawful rights and interests, the customer is forbidden to break the fuel quantity lead seal of the fuel injection pump without permission; otherwise the warranty of the company will cease to be effective.

● The rotor of the supercharger is a high speed rotating component, the customer is not allowed to dismantle it, otherwise the warranty of the company will cease to be effective.

● The fuel injection pump is a precision component, the customer is not allowed to dismantle it, and otherwise the warranty of the company will cease to be effective.

● There are strict requirements on the torque and turning angle of the main bearing bolts and connecting rod bolts of the diesel engine. The customers are not allowed to loose or take them down; otherwise the warranty of the company will cease to be effective.

● The connecting rod bolts are disposable parts, and should not be re-used.



Points for Attention

1. The diesel engine operator must read the Operation and Maintenance Manual carefully, get familiar with the structure of this machine, and strictly observe the operation and maintenance regulations specified in the manual.
2. As for a new engine, it is necessary to perform 60 hours test run according to this instruction book.
3. After cold starting, please increase the engine speed slowly, never speed it up abruptly, nor run it at idle speed for a long time.
4. For engines not using antifreeze additive, after shutdown, if ambient temperature is likely to drop to below $+ 5^{\circ}\text{C}$, it is necessary to completely drain the water from the radiator and the engine after shut down.
5. It is forbidden to run the diesel engine without air filter so as to prevent the unfiltered air from entering cylinders.
6. Always use fuel and engine oil of specified grades. Use special and clean container. When filling fuel and oil, filters must be used. Fuel to be filled must be settled for at least 72 hours.
7. Before starting the diesel engine, it is imperative to check whether coolant is filled full and whether engine oil is sufficiently filled.
8. The check and repair of the electrical components should be conducted by the professionals.



Foreword

WD12 series diesel engines are China – made high – speed diesel engines modified on the base of WD615 series diesel engines with increased strokes . The engines possess greater displacement and power. With features of being compact in structure, high in power, quick to start, good in economical and technical indexes, easy to use and service, these engines are broadly used as power units for heavy trucks, engineering machinery, power generating set and other fields.

This manual offers you a brief introduction of the technical parameters, performance indexes, structural features, and maintenance precautions of the WD12 series diesel engines. The service life of the diesel engine will surely be extended greatly provided that the customer can really carry out the requirements specified in this manual.

To maintain, disassemble and assemble the diesel engine, the customer should read and get familiar with "Maintenance Manual for WD12 Series Diesel Engines" and purchase parts necessary as per "Illustrated Parts List of WD12 Series Diesel Engines".

With the continuous development of the production and technology, there will surely be improvement in the structure of WD12 series diesel engines. Please pay timely attention to the technical information issued by our company. Modifications would be made without prior notice. To obtain the latest product information, customers can visit the web site of Weichai Power Co. Ltd. The web site is: <http://www.weichai.com>

Welcome the customers to offer your suggestions and ideas on further improving the products. Please send your letter to Marketing Company of Weichai Power Co. , Ltd. , or Technical Center of Weichai Power Co., Ltd.

June, 2007

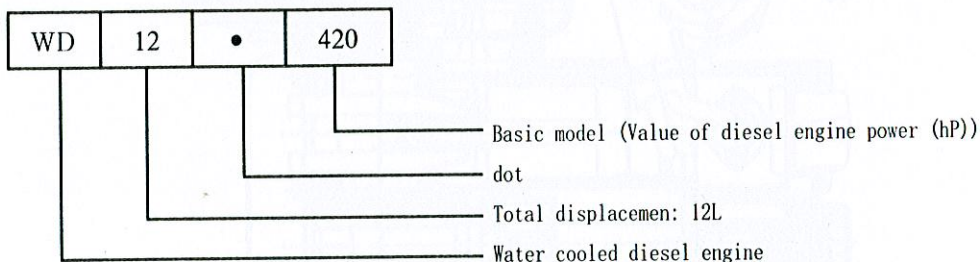


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Composition and meaning of product type and environmental conditions of operation



Composition and meaning of product type

Environmental conditions of operation

Standard operating condition:

Air temperature: $T_r = 298 \text{ K}$ ($t_r = 25^\circ\text{C}$) ;

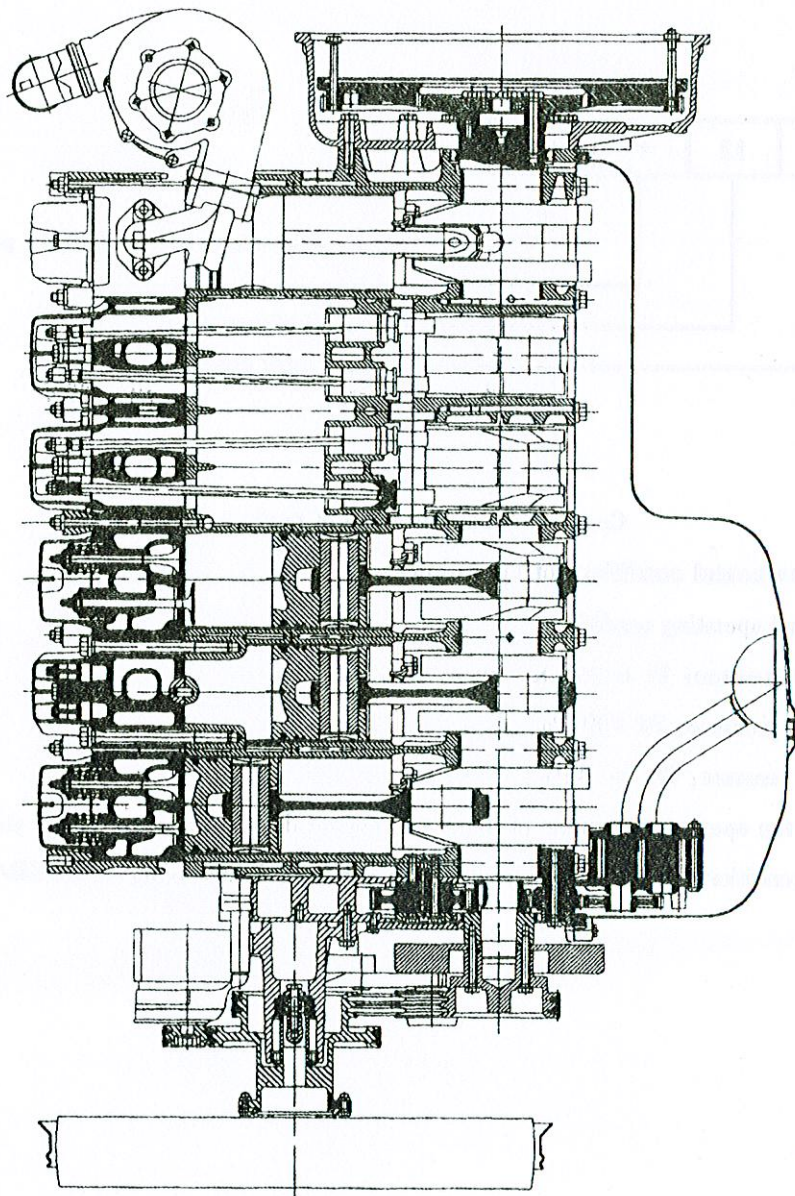
Dry air pressure: $P_d = 99 \text{ kPa}$;

Vapor pressure: $P_w = 1 \text{ kPa}$;

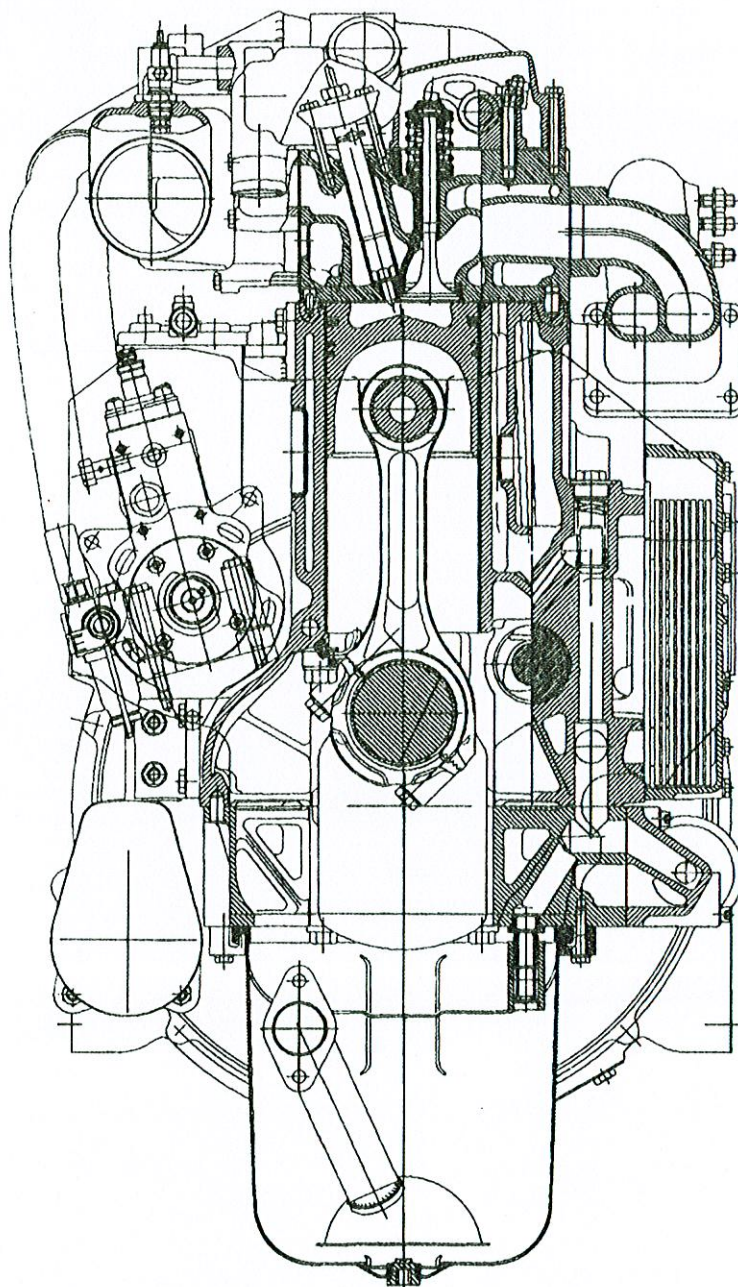
When the operating condition of the diesel engine does not agree with the standard environmental condition, its output power should be corrected in accordance with GB/T 18297 - 2001.



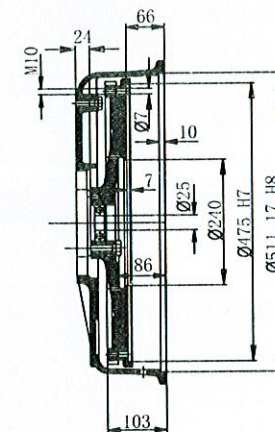
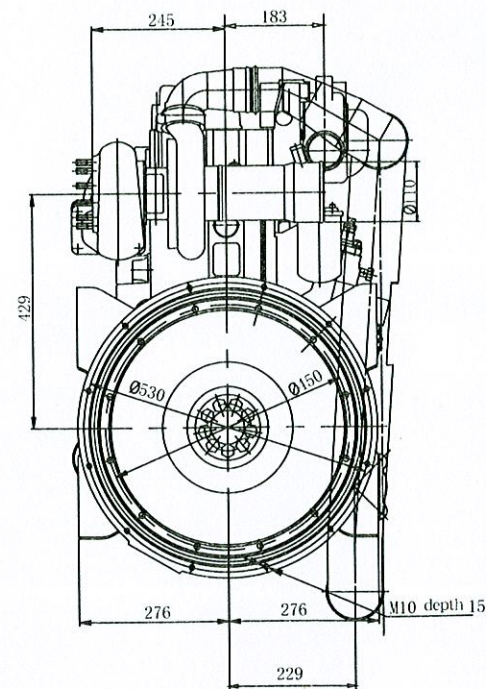
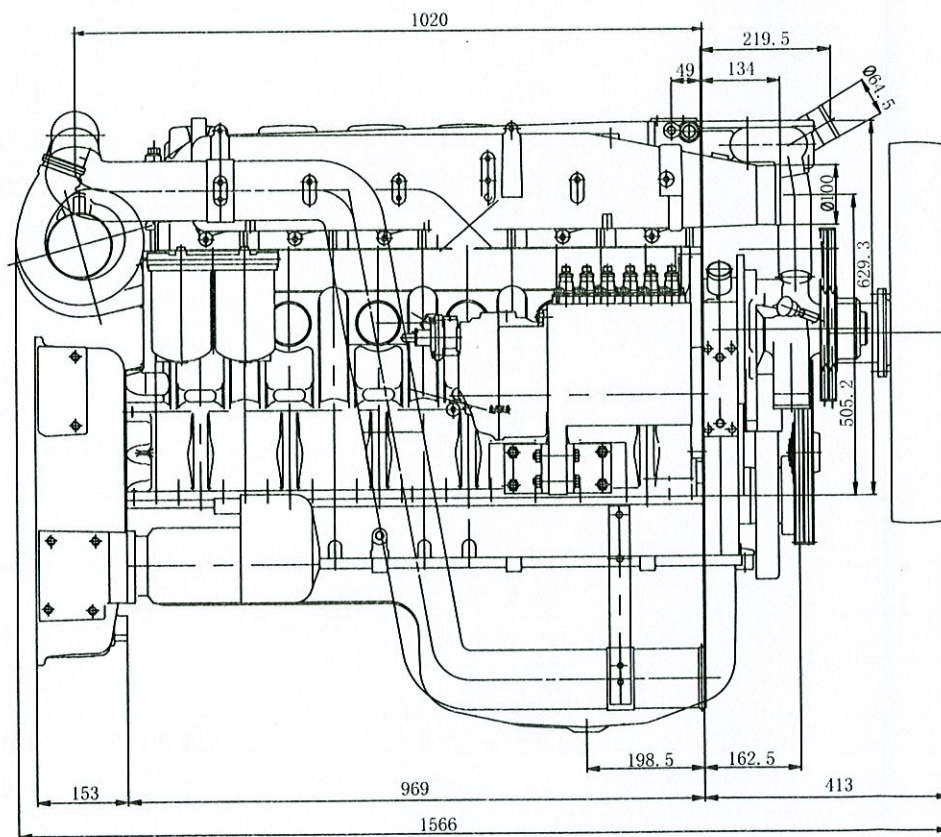
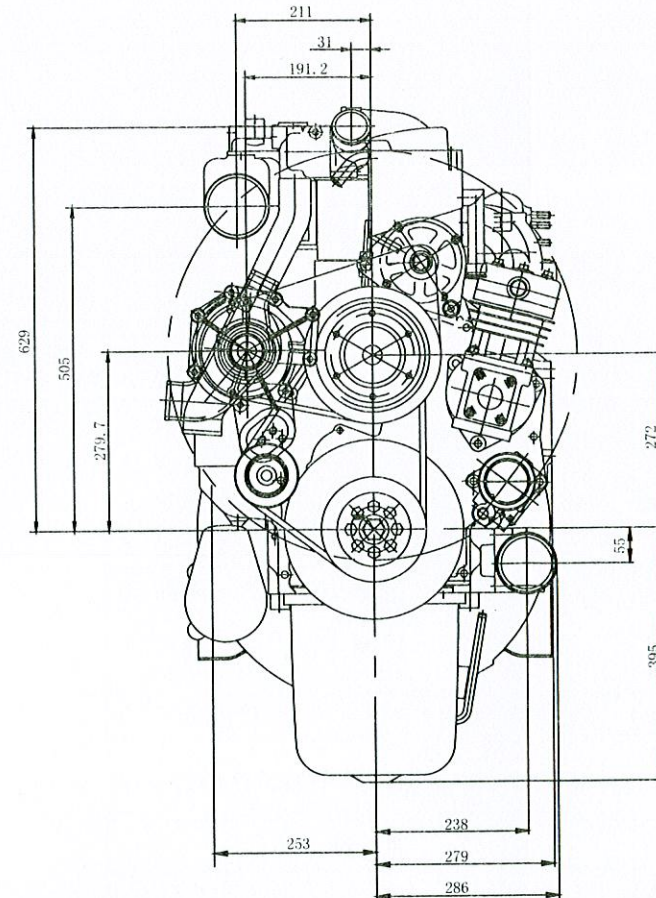
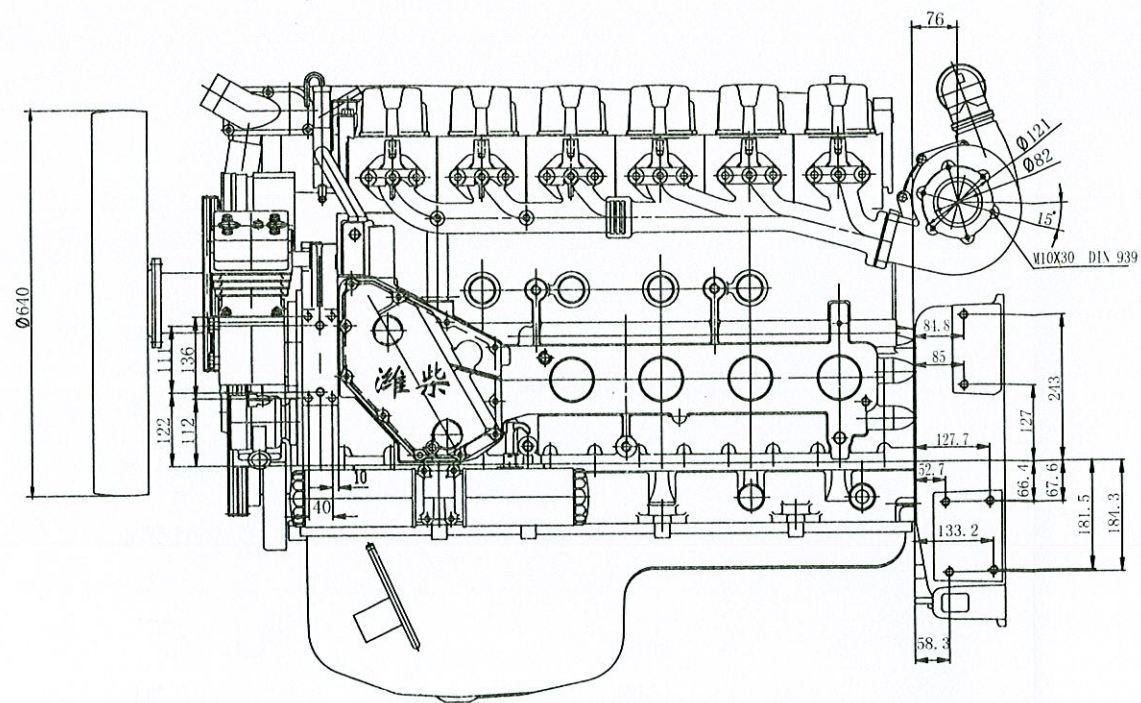
Operation and Maintenance Manual for WD12 Series Diesel Engine



Longitudinal section view of WD12 series diesel engine



Cross section view of WD12 series diesel engine

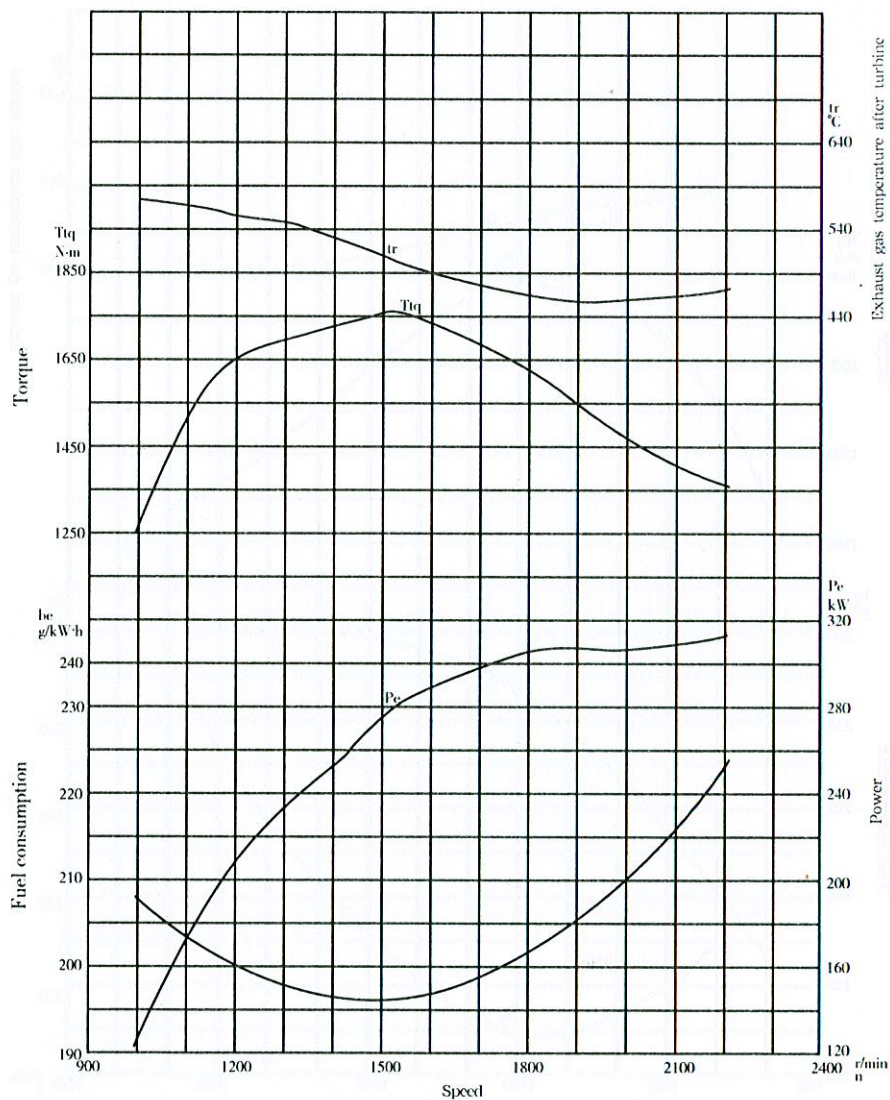


Installation Drawing of WD12 series diesel engine



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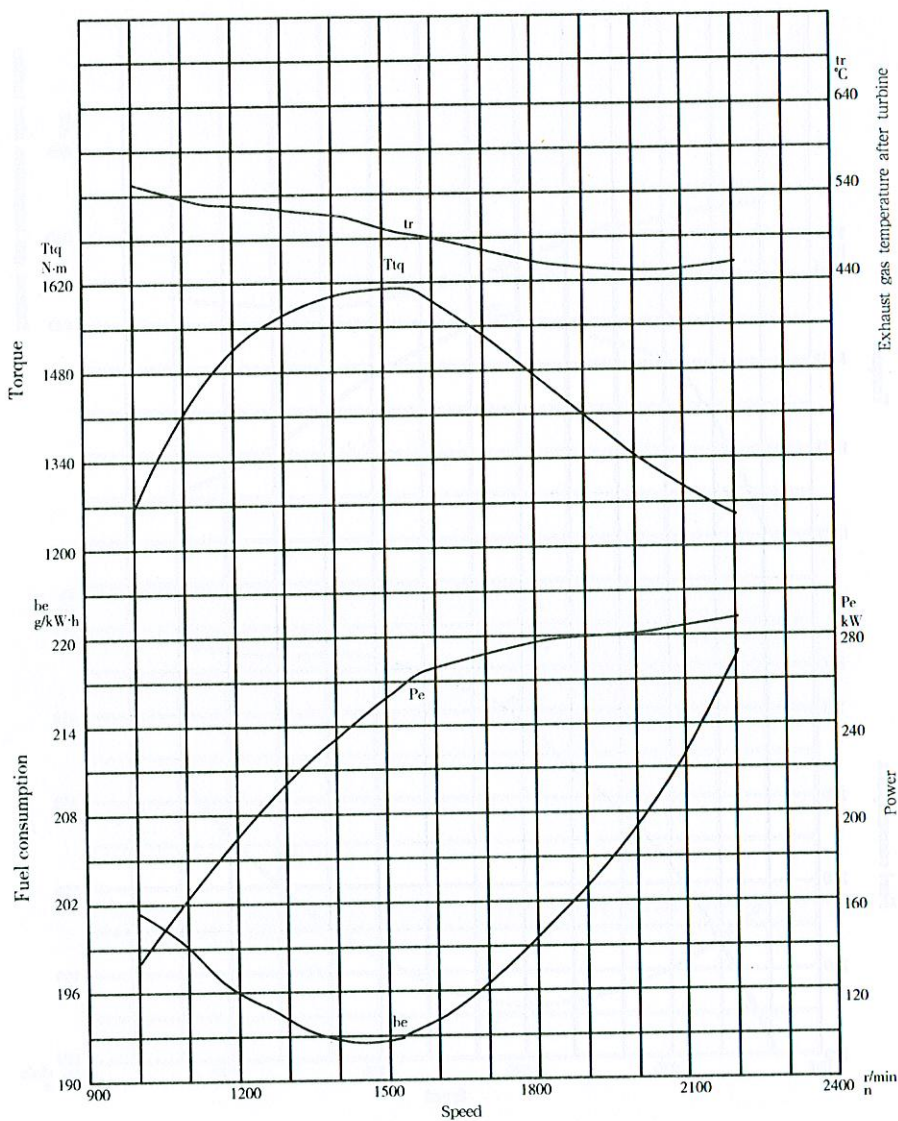
External characteristic curve of WD12 series diesel engine



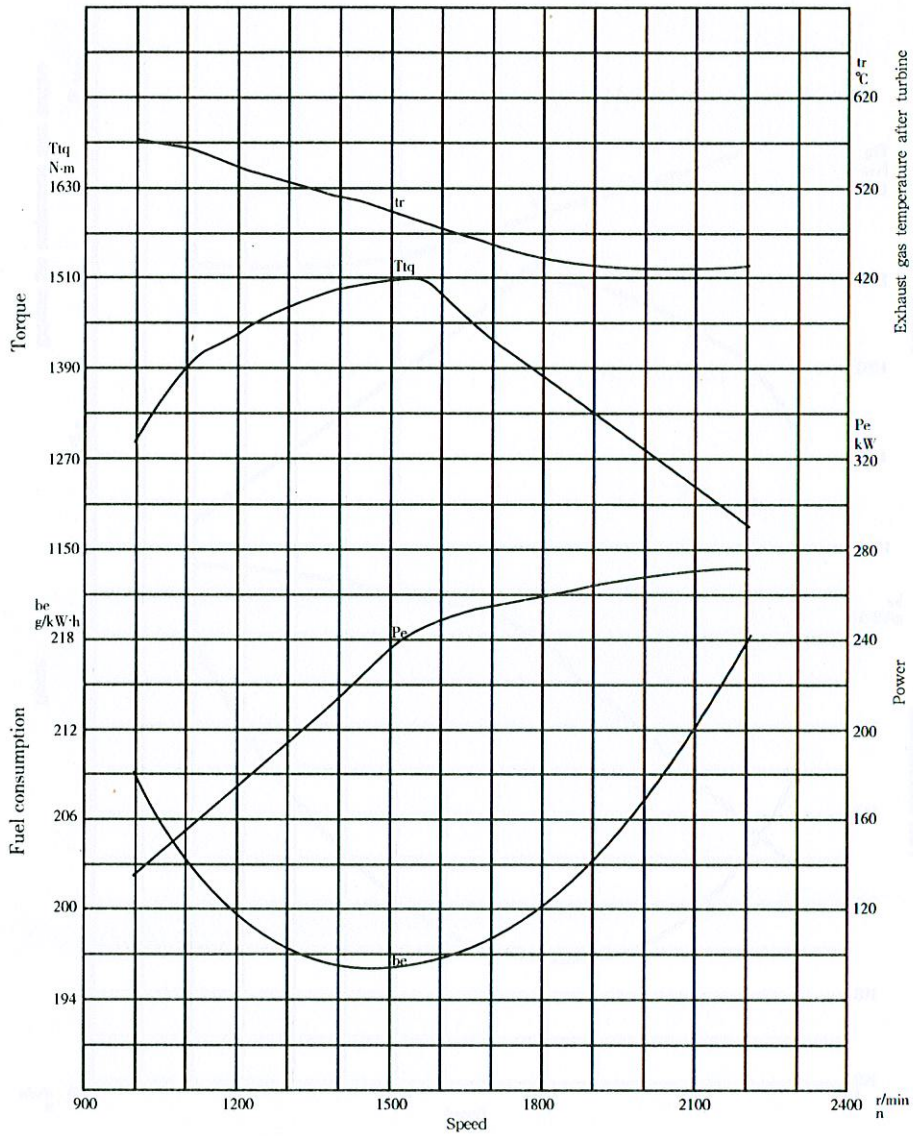
External characteristic curve of WD12.420 diesel engine



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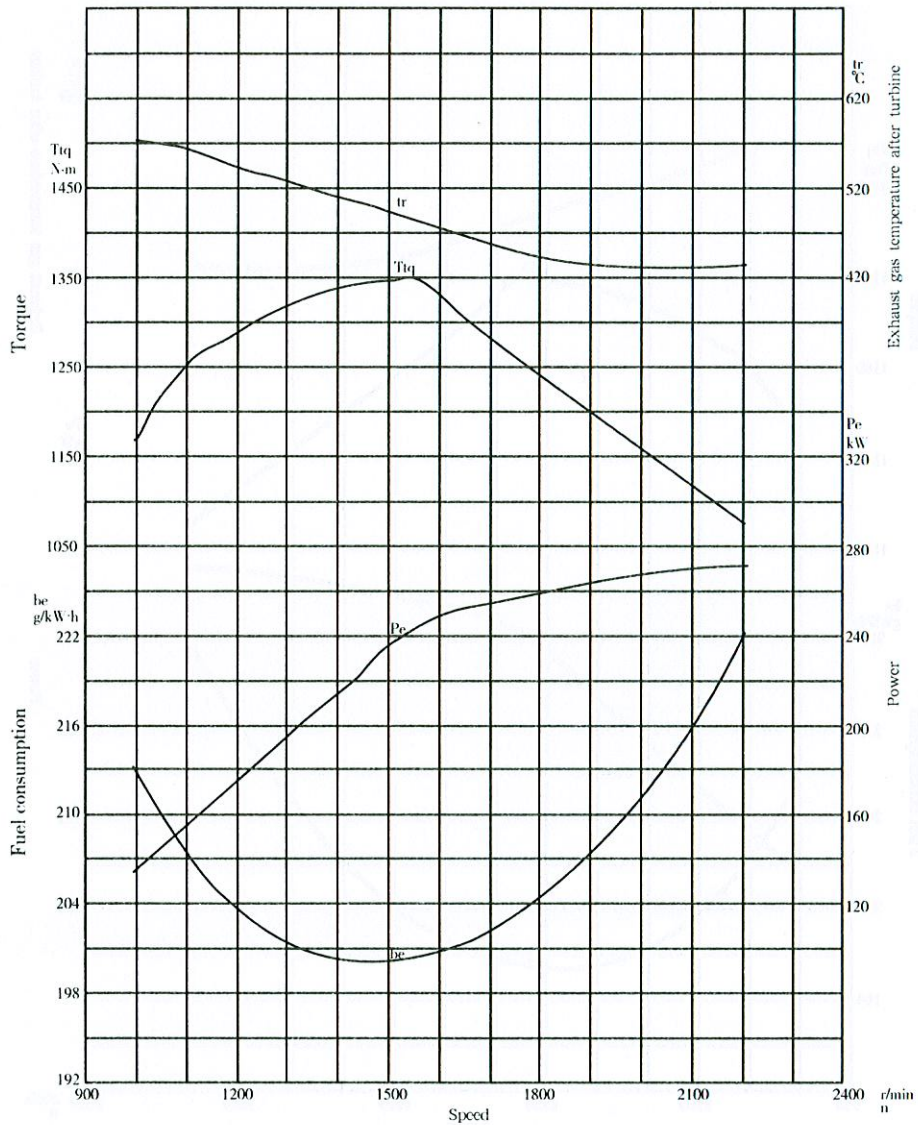
External characteristic curve of WD12.390 diesel engine



External characteristic curve of WD12.375 diesel engine



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External characteristic curve of WD12.336 diesel engine



CHAPTER 1 TECHNICAL DATA OF MAIN PRODUCTS

Table 1 – 1 Technical data of WD12 diesel engine

SN	Item	Model	WD12.420	WD12.390	WD12.375	WD12.336
1	IFN(GB/T6070.1), kW/(r/min)		309/2200	287/2200	276/2200	247/2200
2	Maximum torque, N·m		1750/1600	1600	1500	1350
3	Rotating speed at maximum torque, r/min		1300 ~ 1600			
4	Number of cylinder		6			
5	Type		4 – stroke, water – cooled, in – line, dry cylinder sleeve, direct injection			
6	Cylinder diameter × stroke, mm		126 × 155			
7	Displacement, L		11.596			
8	Mean speed of piston, m/s		11.4			
9	Compression ratio		17:1			
10	Aspiration mode		Supercharger intercooler			
11	Ignition sequence		1 – 5 – 3 – 6 – 2 – 4			
12	Cold – state valve clearance, mm		Inlet valve 0.35, exhaust valve 0.4			
13	Valve timing (with cold – state valve clearance)		Inlet valve opens: 18° before top dead center Inlet valve closes: 42° after the bottom dead center Exhaust valve opens: 66° before top dead center Exhaust valve closes: 20° after bottom dead center			
14	Starting method		Electric starting			
15	Lubricating method		Pressure lubrication			
16	Oil sump volume, L		24			
17	Cooling method		Water – cooling force – circulation			
18	Oil pressure, kPa		350 ~ 550			
19	Oil pressure at idle speed, kPa		≥ 100			
20	Exhaust gas temperature after the turbine, °C		≤ 580			
21	Permissible longitudinal inclination, °C	Front / rear	Long – term 10/10, short – term 30/30			
22	Permissible lateral inclination, °C	Exhaust pipe side / fuel – injection pump side	Long – term 30/15, short – term 30/30			
23	Crankshaft rotating direction (viewed from the free end)		Clockwise			
24	Net mass, kg		905			
25	external dimensions, mm	Length	1566			
		Width	582			
		Height	1024			



CHAPTER 2 FUEL, LUBRICANT, COOLANT and AUXILIARY MATERIALS USED for the DIESEL ENGINE

Fuel:

Summer: light diesel fuel No.0 (GB 252)

Winter: light diesel fuel No. -10 (GB 252)

Use No. -20 diesel fuel when the temperature is lower than -20°C in winters, and No. -35 diesel fuel when temperature is lower than -30°C .

Lubricating oil:

For the safe and reliable operation of your diesel engine, please use CF -4 class oil. It is permissible to use high grade oil instead of low grade oil. 15W/40CF -4 can be used at temperature of $-15^{\circ}\text{C} \sim +30^{\circ}\text{C}$, while 20W/40CF -4 can be used at temperature of $-10^{\circ}\text{C} \sim +30^{\circ}\text{C}$.

(WEICHA POWER special purpose oil is recommended).

Before starting the diesel engine, it is imperative to check the oil level in the oil sump, oil capacity is about 24L, and oil level should be between the upper and lower graduation marks of the dip stick.



1. Don't check the oil level while the engine is running
2. Do not use mixture of oils of different grades.

Grease:

The tension wheel cavity and the grease cup of water pump are filled with general - purpose vehicle lithium grease which meets the requirement of GB/T5671.

Coolant:

The antifreeze additive adopted for WD12 diesel engine is ethylene glycol. For details, refer to Steyr Standard NO5045. This liquid possesses the function of antirust and antifreeze. It is permissible to use China - made long lasting antifreeze additive instead, but its quality must be reliable. For its detailed using method, refer to relevant instructions. Two kinds of China - made long - lasting antifreeze additives are recommended:

JFL -336

FD -30



Table 2 - 1 China made long - lasting antifreeze additive

Grade \ Item	JFL318	JFL336	JFL345
Content of ethylene glycol %	33	50	56
Specific weight(15.6℃)	1.05	1.074	1.082
Boiling point,℃	104.5 ± 1	108.5 ± 1	110.0 ± 1
Freezing point,℃	- 18 ± 1	- 36 ± 1	- 45 ± 1
Lowest temperature of application,℃	- 10	- 26	- 35



1. When the air temperature is lower than 0℃ , check the concentration of the antifreeze additive regularly.

2. For the engine running in a region where the temperature is above 0℃ all the year round, water with rust prevention and antifouling treatment can be used as coolant.

Auxiliary materials:

In the process of engine assembly and repair, such sealing compounds and adhesives as Loctite 510, 242, 275, 648 and 270080 will be required. For concrete locations of application, see Table 2 - 2.

Table 2 - 2 List of auxiliary materials used in WD12 series diesel engines

SN	Description	Color	Use and application
1	Molykotte powder	Black	Used on smooth metal surface to prevent against binding e. g. To be coated on the outer surface of cylinder sleeve
2	Molykotte G. u. plus	Dark gray	Offer lubrication before oil pressure is built up e. g. To be coated on the inlet valve stem
3	Loctite 242	Blue	Used on thread and outer surface of bearing for security and prevention of looseness due to vibration, medium strength e. g. To be coated on threaded portion of the pressure limiting valve of main fuel passage
4	Loctite 262	Red	Used on outer surface of thread for locking, sealing and prevention of looseness due to vibration, high strength e. g. To be coated on cylinder head bolt thread



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SN	Description	Color	Use and application
5	Loctite 275	Green	Used on the surfaces of pipes and connecting sections for fixing. e. g. : To be coated on external surface of the water outlet pipe and water inlet pipe of heating device
6	Loctite 510	Red (orange)	Used on the bright metal surface for sealing. E. g. To be coated on the mating surface of the cylinder block and the crankcase
7	Loctite 648	Green	Used on the bright metal surface for fixing. e. g. To be coated on bearing bore of tension wheel and the external surface of shaft
8	Loctite 270080	Green	Used for sealing between plug and hole , applicable to oil cavity or oil passage. e. g. To be coated on all cylindrical mating surface of cup - shaped plugs on the cylinder head

CHAPTER 3 STRUCTURE AND SYSTEMS OF THE DIESEL ENGINE

3.1 Engine block and crankcase component

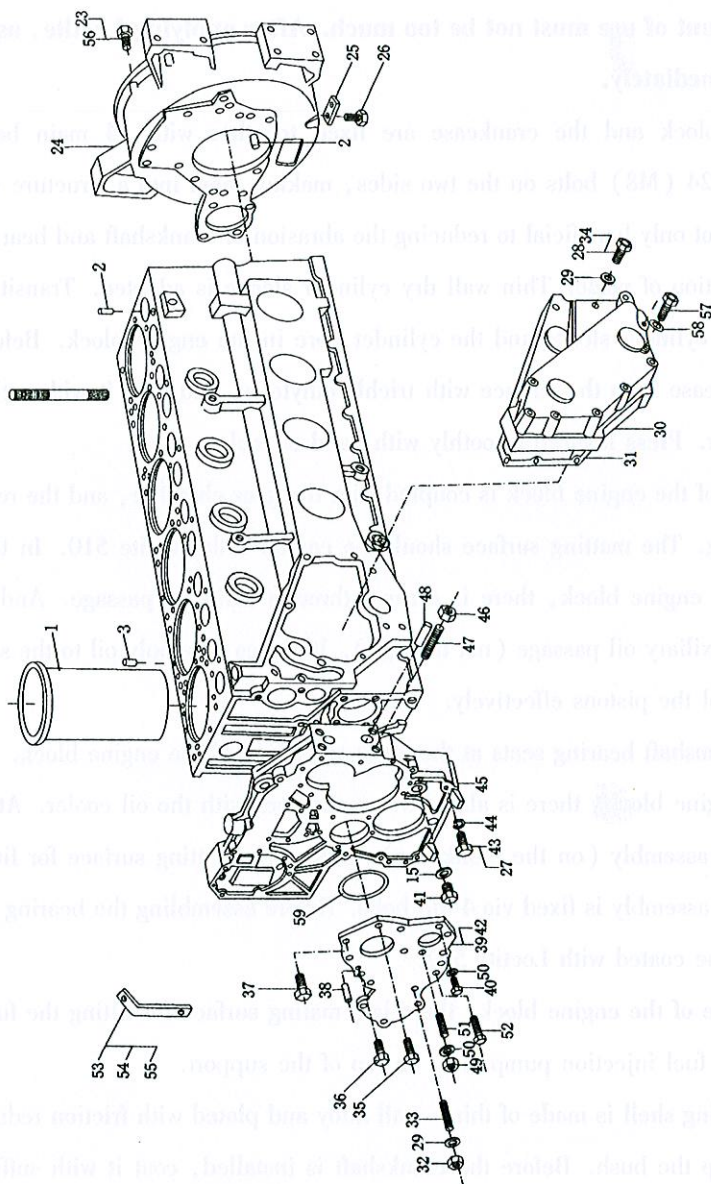


Fig.3-1 Structural diagram of engine block

1. cylinder sleeve 4. engine block 24. flywheel case 30. oil cooler cover 39. end cap



The engine block of WD12 diesel engine is divided into two parts from the center of the main bearing bore, the upper part is the cylinder block and the lower part is the crankcase. The crankcase together with the 7 main bearings forms an integral frame with excellent rigidity. There is no gasket between the cylinder block and the frame. When assembling, coat the bottom surface of the cylinder block with Loctite 510.

Caution: The application of Loctite 510 should be smooth and even without interruption! The amount of use must not be too much. After applying Loctite, assemble the cylinder block immediately.

The cylinder block and the crankcase are fixed together with 14 main bearing bolts (M18 × 2.5) and 24 (M8) bolts on the two sides, making them into a structure with favorable stiffness. It is not only beneficial to reducing the abrasion of crankshaft and bearing, but also well to the reduction of noise. Thin wall dry cylinder sleeve is adopted. Transition fit is adopted between the cylinder sleeve and the cylinder bore in the engine block. Before installation, remove the grease from the surface with trichlorethylene, and coat it with a thin layer of molybdenum powder. Press it down smoothly with hand or tool.

The front end of the engine block is coupled with the gear chamber, and the rear end with the flywheel housing. The mating surface should be coated with Loctite 510. In the waist on the right side of the engine block, there is a run-through main oil passage. And on the left side, there is an auxiliary oil passage (not through). It serves to supply oil to the six oil injection nozzles and cool the pistons effectively.

There are 7 camshaft bearing seats at the inner right side of the engine block. And on the right side of the engine block, there is also a water chamber with the oil cooler. At the bottom of the engine block assembly (on the crankcase), there is a mating surface for fitting the oil filter. The oil filter assembly is fixed via 4 M8 bolts. Before assembling the bearing seats, mating surface should be coated with Loctite 510.

On the left side of the engine block, there is a mating surface for fitting the fuel injection pump support. The fuel injection pump is fit on top of the support.

The main bearing shell is made of thin-wall alloy and plated with friction reducing layer. It is forbidden to lap the bush. Before the crankshaft is installed, coat it with sufficient clean oil.

When mounting the upper and the lower halves of the main bearing shell, special attention should be paid to installing them rightly, otherwise it will induce serious bad outcome.

3.2 Crankshaft, piston and connecting rod component

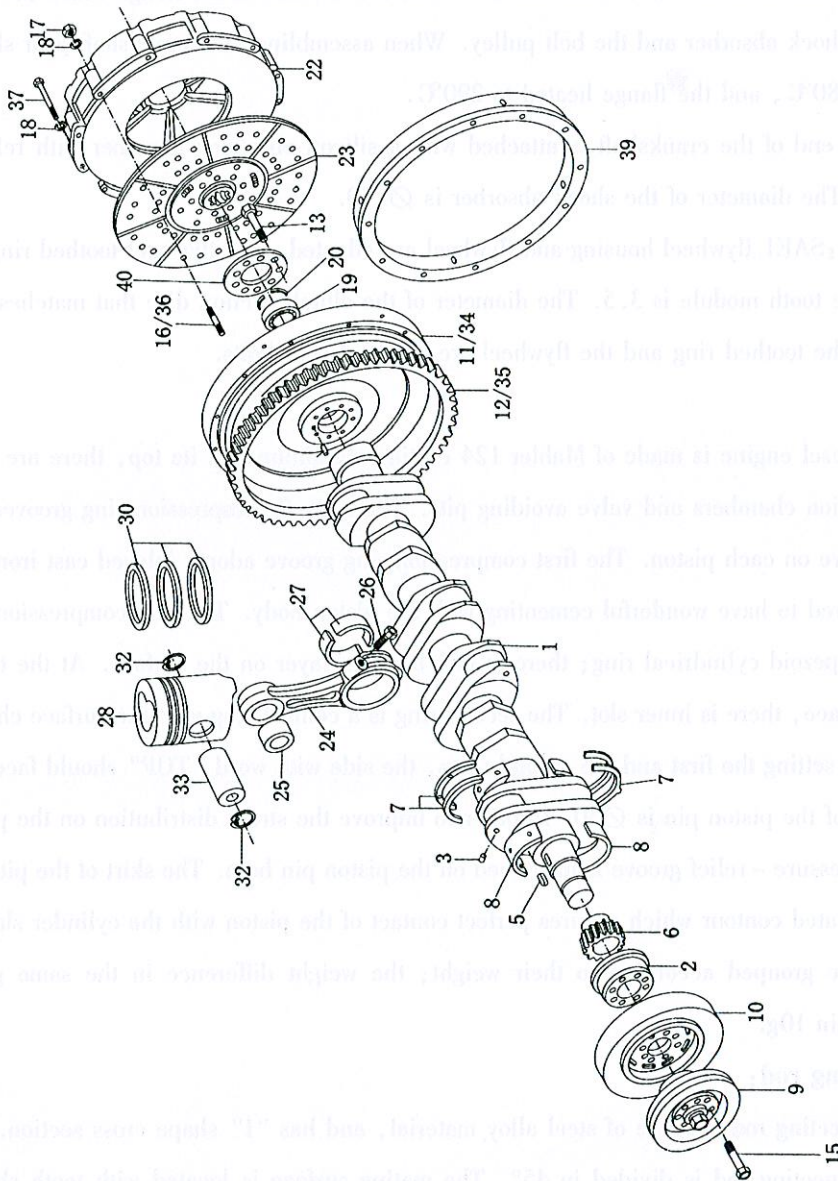


Fig. 3-2 Crankshaft, piston and connecting rod components

1. crankshaft 2. flange 3. 4. cylindrical pin 5. flat key 6. crankshaft gear 7. thrust spacer 8. main bearing shell 9. belt wheel 10. shock absorber 11. 34 flywheel 12. 35. tooth ring 13. flywheel bolt 15. hex-head bolt 16. double-headed bolt 19. rolling bearing 20. circlip for hole use 24. connecting rod 25. connecting rod bushing 26. connecting rod bolt 27. connecting rod bearing shell 28. piston 30. piston ring 32. retainer ring 33. piston pin 39. middle flange



The crankshaft of WD12 diesel engine is made of steel alloy by die forging. It has 12 balancing weights. It is nitridated and possesses good fatigue strength and wearability. The diameter the main journal of the crankshaft is $\varnothing 104$, and the diameter the connecting rod journal is $\varnothing 83$. The width of all the journals is 46mm.

There is a flange at the front end of the crankshaft. The outside of the flange is the sealing surface of the crankshaft oil seal. There are 8 M10 threaded holes in the flange which are used to secure the shock absorber and the belt pulley. When assembling, the crankshaft gear should be heated to 180°C , and the flange heated to 290°C .

The front end of the crankshaft is attached with a silicon oil shock absorber with reliable performance. The diameter of the shock absorber is $\varnothing 280$.

Flywheel: SAE1 flywheel housing and flywheel are adopted. The flywheel toothed ring has 136 teeth. The tooth module is 3.5. The diameter of the clutch friction disc that matches with it is $\varnothing 475$. The toothed ring and the flywheel are fastened with bolts.

Piston:

WD12 diesel engine is made of Mahler 124 casting aluminum. At its top, there are "ω" shape combustion chambers and valve avoiding pits. There are 2 compression ring grooves and 1 oil ring groove on each piston. The first compression ring groove adopts inlayed cast iron ring which is required to have wonderful cementing with the piston body. The first compression ring is a double trapezoid cylindrical ring; there is molybdenum layer on the surface. At the top of the inside surface, there is inner slot. The second ring is a conical ring with the surface chrome plated. When setting the first and the second rings, the side with word "TOP" should face up. The diameter of the piston pin is $\varnothing 50$. In order to improve the stress distribution on the piston pin boss, a pressure - relief groove is machined on the piston pin boss. The skirt of the piston adopts sophisticated contour which ensures perfect contact of the piston with the cylinder sleeve. The pistons are grouped according to their weight; the weight difference in the same group should be within 10g.

Connecting rod:

The connecting rod is made of steel alloy material, and has "I" shape cross section. The big end of connecting rod is divided in 45° . The mating surface is located with tooth shape. The small end of the piston rod is wedge - shaped, which increased the load carrying capacity



of the piston pin boss and the small end of the piston pin. There are mating marks on the connecting rod body and connecting rod cover, don't mis - fit them in maintenance and repair. The connecting rod body and the connecting rod cover are connected with two M14 × 1.5 load bearing disposable bolts, which must not be re - used. The connecting rods are grouped according to their weight; the weight difference in the same group should be within 29g. There is ternary alloy cladding on the inner surface of the connecting rod bushing, it is forbidden to scrape and lap it.

3.3 Cylinder head and air distribution system

Cylinder head:

It is made of alloy cast iron, one cylinder one head. An inlet valve and an exhaust valve are arranged on the cylinder head. The air inlet and outlet passages are located on the two sides. Fuel injector copper sleeve is embedded in fuel injector installation hole in the cylinder head. It is very beneficial to the cooling of the fuel injection nozzle and improving the operational reliability of the fuel injection nozzle. After entering the cylinder head, all cooling water flows through the water cavity of the nose bridge region of the cylinder head, and then sweeps over the fuel injector brass sleeve and enters the outlet pipe. In order to prevent oil from entering the air inlet passage from the clearance of valve guide, a sealing sleeve is fit on the upper part of the valve guide.

On each cylinder head, there are 4 M14 main bolts and 2 M12 double - headed studs which are shared jointly with the neighbor cylinder. Matched nuts are clamped via the clamping blocks. The main bolts and matched nuts of the cylinder head are tightened diagonally. There are two hanger plates at both ends of the cylinder head which are used to hoist the engine.

Fuel injectors are mounted on the left side (air inlet side) of the cylinder head. The included angle between the injectors and the bottom surface of the cylinder head is 75°. The fuel injectors protrude the bottom surface of the cylinder head by 3.2 ~ 4.0mm.



Air distributing system :

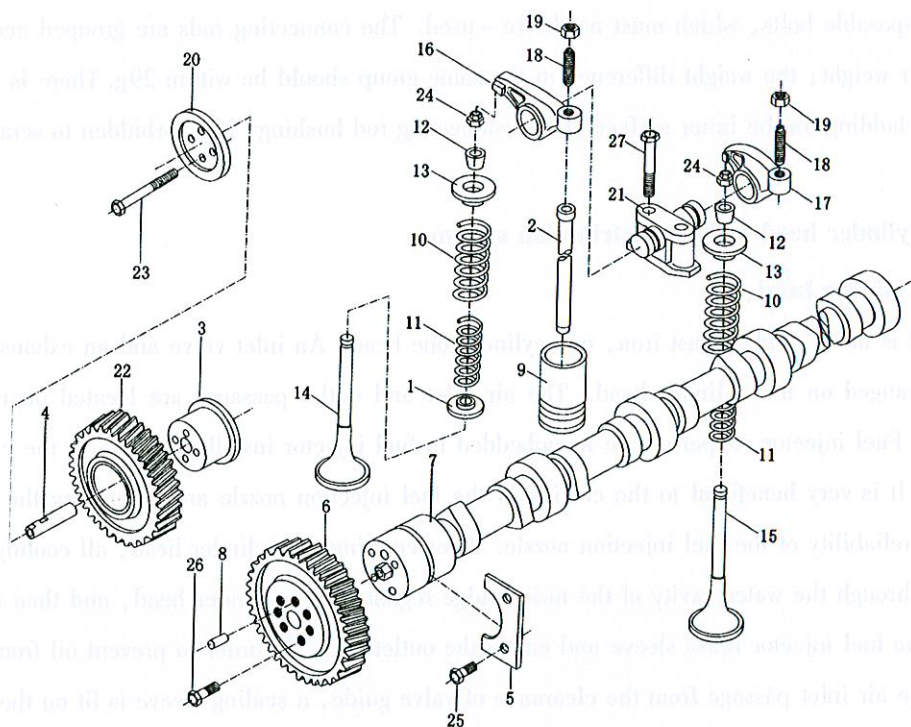


Fig. 3 -3 Structural diagram of air distribution mechanism

- 2. Push rod assembly 5. Camshaft thrust spacer 6. camshaft gear 7. Camshaft
- 9. Valve tappet 14. Inlet valve 15. Exhaust valve 16. Inlet valve rocker arm
- 17. Exhaust valve rocker arm 22. Intermediate gear assembly

The camshaft is made of high carbon steel. There are 7 main bearings. The rocker arm seat is of integral type. The stiffness of the entire air distribution mechanism is high. WD12 series diesel engine uses hollow push rod to supply oil to the cylinder head. At the bottom of the tappet, there are two circular grooves. In the upper circular groove, a slanting oil hole is drilled, which leads to the spherical recess at the bottom of the tappet. Oil flows from the main fuel passage in the cylinder block, via a thin slanting fuel passage, intermittently passing through the upper circular groove on the tappet, and enters the spherical recess. Then the oil flows to the rocker arm from the orifice in the center of the bulb at the bottom of the hollow push



rod. In the lower circular groove of the tappet, an oil return hole is also drilled.

Valve:

The material of inlet air valve is high strength chromium alloy steel, and the surface of its stem is chrome plated.

The exhaust valve is made by friction welding with two kinds of high – temperature resistant materials, and the stem is chrome – plated.

The material of camshaft is high carbon steel. There are 7 mains bearings. The rocker arm seat is of one – piece type. The stiffness of the entire air distribution mechanism is high.

Adjustment of valve clearance:

(1) Rotate the flywheel to locate the piston of the 1st cylinder at the top dead center position of the compression stroke. Adjust the inlet valve clearance to 0.35 mm and the exhaust valve clearance to 0.4 mm by rotating the valve clearance adjusting screw. At the same time, adjust the clearances of the 2nd inlet, 3rd exhaust, 4th inlet and 5th exhaust valves.

(2) Turn the crankshaft to make the piston of the 6th cylinder at the top dead center of compression stroke. Adjust the clearances of the inlet valve and exhaust valve. At the same time, adjust the clearances of 2nd exhaust, 3rd inlet, 4th exhaust and 5th inlet valves.

Valve mechanism timing:

(1) Rotate the flywheel to make the OT mark on the flywheel align with the OT mark (it is visible after the window cover is removed) in the window at the bottom of flywheel housing and locate the first cylinder at compression stroke. By this time it indicates that the piston of the first cylinder is at the top dead center.

(2) Rotate the camshaft to make the mark on one of the teeth align with the OT mark on the timing gear chamber and tighten it to the specified torque.

(3) Install the big and the small intermediate gears and fix various intermediate shafts according to the given torque.

(4) Install the driving gear of the high – pressure fuel pump and the gear of the air compressor.

Exhaust valve brake system(WEVB)

"WEVB" is the abbreviation of "Weichai Exhaust Valve Brake". Oil supply of WEVB brake system employs the combination method of externally connected pipeline with the internal



oil supply passage. Oil is led out from the auxiliary oil passage in the engine block and flows to the head of the 6th cylinder. Cylinder heads are linked with stubs. All the externally connected pipes are arranged on the side of air inlet pipe. Oil feeding passages are arranged in the engine block, cylinder heads and valve rocker arm seats. In the exhaust valve rocker arm, a set of actuating mechanism is added (See Fig. 3 - 4). The supporting arm, adjusting bolt assembly for sealing oil, and oil supply pipeline of WEVB system are newly added. The height of cylinder head is increased by 32 mm.

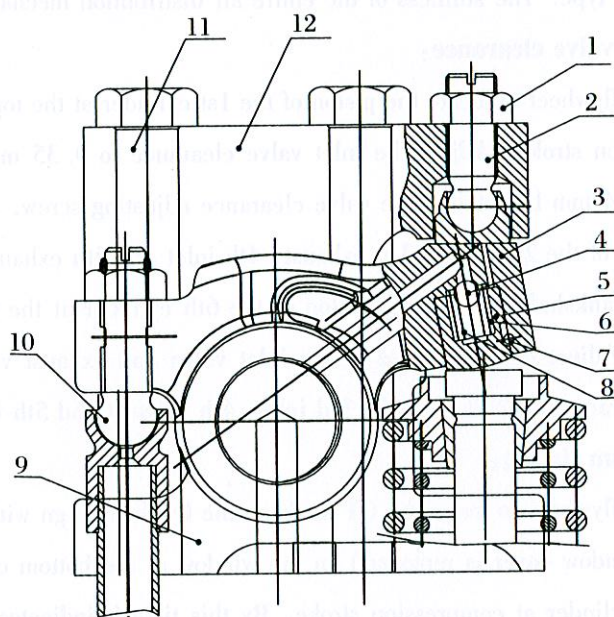


Fig. 3 - 4 WEVB structure diagram

1. valve clearance adjusting nut 2. adjusting bolt assembly 3. exhaust valve rocker arm assembly 4. steel ball 5. valve rocker arm piston 6. rocker arm piston spring 7. roller 8. ball valve spring 9. valve rocker arm seat assembly
10. valve clearance adjusting screw 11. hex - head bolt 12. support arm

Exhaust valve clearance adjusting methods after employing WEVB system:

- (1) Turn the piston of the cylinder to be adjusted to the top dead center position of compression stroke.
- (2) Loosen adjusting bolt assembly (2). Under the condition that exhaust valve rocker arm oil sealing surface is not compressed, by adjusting valve clearance adjusting bolt (10) at

the end of the push rod, adjust the valve clearance of the assembly to 0.4mm, and tighten the check nut, as shown in Fig. 3-5.

Caution: In the process of adjustment, it is necessary to rotate the valve clearance adjusting screw (11) until the feeler gauge is clamped, so as to ensure that the valve rocker arm piston (5) is pressed to the bottom, and there is no clearance between the piston and the bottom surface of the piston fitting hole in the exhaust valve rocker arm.

(3) Insert the feeler gauge of 0.25mm again between the piston of valve rocker arm (5) and the tip of exhaust valve stem or valve stem cap, by adjusting the adjusting bolt assembly (2), adjust the valve tip clearance to 0.25mm, and tighten the check nut, as shown in Fig. 3-6.

Caution: In the process of adjustment, it is necessary to rotate the valve clearance adjusting bolt assembly (2) until the feeler gauge is clamped, so as to ensure that the valve rocker arm piston (5) is pressed to the bottom, and there is no clearance between the piston and the bottom surface of the piston fitting hole in the exhaust valve rocker arm.

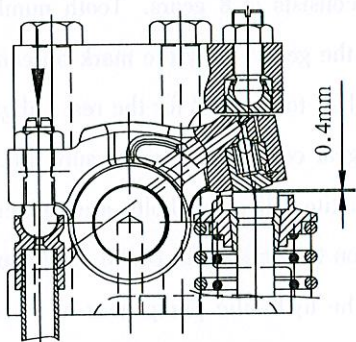


Fig. 3-5 Cold-state exhaust valve
total valve clearance 0.4mm

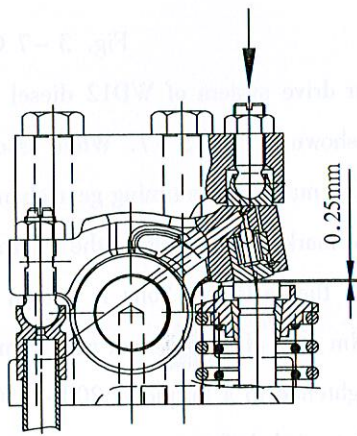


Fig. 3-6 Cold-state exhaust
valve tip clearance 0.25mm



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3.4 Gear drive system

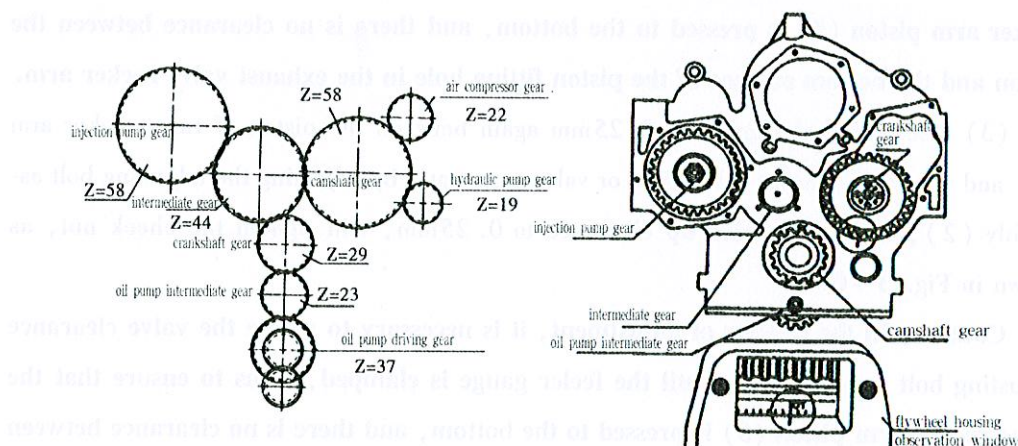


Fig. 3 - 7 Gear drive system

The gear drive system of WD12 diesel engine consists of 8 gears. Tooth numbers of the gears are as shown in Fig. 3 - 7. When assembling the gears, only the mark on camshaft gear should lead the mark on the timing gear chamber by half tooth, and for the rest, align them according to the marks. When fitting the intermediate gear cover plate, make sure that the threaded portion of the fastening bolts is coated with Loctite 242, the bolts are tightened to the torque of 32Nm, the air compressor gear is mounted on the crankshaft of the air compressor and the gear is tightened to a torque of 200 ~ 250Nm. The hydraulic pump gear is mounted offset underneath the crankshaft gear.

3.5 Fuel supply system

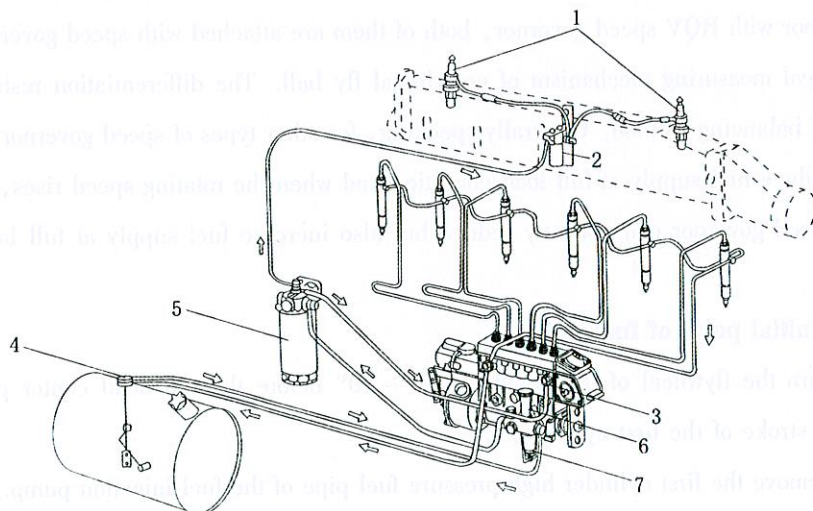


Fig. 3 - 8 Fuel system

The fuel supply system is as shown in the Fig. 3 - 8. The fuel pump sucks fuel from the fuel tank via the prefilter, and sends it to the high pressure fuel pump after the removal of foreign matter and water by fuel filter, and then sends it to the fuel injectors via the high pressure fuel pipe. Part of the fuel is injected into the combustion chambers for combustion, and the extra fuel returns to the fuel tank via the fuel pipe.

The fuel filter is of two stage filtration type, the coarse filtration and the fine filtration, which are connected in series in the fuel passage. The coarse filtration uses a felt cartridge while the fine filtration uses paper cartridge. The cartridge should be replaced according to the maintenance stipulations. When replacing the filter, pay attention to cleanliness and prevent dirt from entering the cartridge.

WD12 series diesel engine employs P - type high - pressure fuel pump and closed - type multiple orifice fuel injectors. The body of pump possesses favorable stiffness. The fuel - injection pump is driven by gears. It is fixed on the gear chamber via a flange and it has a smoke limiter. The smoke limiter can regulate fuel supply of fuel injection pump according to the pressure change in the air inlet pipe. Before the boost pressure reaches the specified value, the smoke limiter restricts the fuel supply, thus the low speed performance and starting performance



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of the supercharge diesel engine are improved.

WD12 series diesel engine uses RQV – K type speed governor. Compare RQV – K type speed governor with RQV speed governor, both of them are attached with speed governor spring and centrifugal measuring mechanism of centrifugal fly ball. The differentiation rests with the difference of balancing method. Generally speaking, for other types of speed governor, the purpose is to reduce fuel supply at full load condition and when the rotating speed rises, but RQV – K type speed governor can not only reduce but also increase fuel supply at full load condition.

Check the initial point of fuel supply:

(1) Turn the flywheel of the engine to 30 ~ 40° before the top dead center position of compression stroke of the first cylinder.

(2) Remove the first cylinder high pressure fuel pipe of the fuel injection pump. Turn the flywheel in clockwise direction until the fuel level in the first cylinder high pressure fuel pipe coupling plumps. Read out the number of degrees of fuel injection advance angle from the flywheel.

Adjust the initial point of fuel supply:

Turn the flywheel to the number of degrees of specified fuel supply advance angle before the top dead center of the first cylinder compression stroke (turn the flywheel in the engine rotating direction, and don't turn it reversely). Remove the first cylinder high pressure fuel pipe and set the throttle at maximum fuel supply position and release air from inside the fuel pipeline. Then turn the flywheel slowly in the engine rotating direction until fuel just starts to come out from the first cylinder fuel outlet valve. Note down this fuel supply position on the flywheel side. Keep the fuel pump at this position without moving and tighten up its fixing bolt. By this time observe the fuel supply advance angle. If it does not meet the requirement, loosen the fixing bolt of the fuel pump, and turn the fuel pump to adjust it.

3.6 Lubricating system

The schematic diagram of WD12 diesel engine lubricating system is as shown in Fig. 3 - 9. The main parts and components are lubricated by means of pressure lubrication.

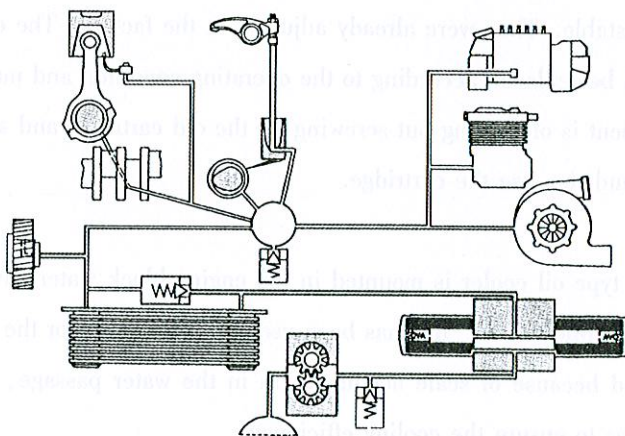


Fig. 3 - 9 WD12 series diesel engine lubricating system

The oil pump sucks in oil from the oil sump via the strainer, forces it to the oil filter and oil cooler for cooling and filtration. Then the oil enters the main oil passage. Most of the oil reaches the main bearing, and from there it flows through the connecting rod bearing, camshaft bearing, the air compressor and oil pipe, and lubricates various gears. Through a steel pipe at the rear end of the main oil passage, oil is led into the supercharger to lubricate the bearings of the supercharger. Part of the oil reaches the auxiliary oil passage and is sprayed through the nozzles to cool pistons and lubricate the cylinder sleeve surface and the piston pins. The injection pump is lubricated by taking oil from the auxiliary oil passage and the oil flows back to oil sump via the timing gear chamber.

when starting the diesel engine, owing to the low oil temperature, the viscosity is high, oil pressure will tends to be high in a short period of time, but as the water temperature of the engine rises, oil temperature will rise, and oil pressure will drop gradually. When the engine runs at full load and water temperature is $80 \sim 95^{\circ}\text{C}$, normal oil pressure is $350 \sim 550 \text{ kPa}$.

An oil pressure sensing plug is fit in the main oil passage of the engine. When the pressure in the main oil passage is lower than 25 kPa , an alarm is initiated. In order to prevent metal chips from entering the oil pump, a magnetic plug is mounted in the oil sump.



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Oil pump:

The oil pump is of gear type. Single - stage oil pumps are usually used, while double stage oil pumps are used for off - road vehicles and other special requirements. . . Oil pump safety valve, oil cooler bypass valve and main oil passage pressure limiting valve in the oil passage are all nonadjustable. They were already adjusted in the factory. The oil filter is of screw - in type. It should be replaced according to the operating condition and maintenance requirement. The replacement is of nothing but screwing off the old cartridge and screwing in the new one. Do not clean and re - use the cartridge.

Oil cooler:

The plate - fin type oil cooler is mounted in the engine block water cavity. The nine cartridges are made of stainless steel. If it has been used for a long time or the quality of the cooling water is not good because of scale accumulation in the water passage, necessary cleaning should be made so as to ensure the cooling efficiency.

Deaerator:

The deaerator is attached on the upper front side of the engine. Condensed oil from the deaerator flows back into the oil sump, and the separated air is led to the air inlet pipe of the supercharger air pump via a long rubber hose, and then enters the air inlet pipe of the engine. If the rubber hose is folded or blocked, the pressure in the crankcase will increase, and it will make oil spill out from the oil filler and the dipstick positions. In such case, the fitting condition of the rubber hose should be checked first.

3.7 Cooling system

The function of the cooling system is to guarantee the diesel engine to operate normally at a suitable temperature. The schematic diagram of WD12 diesel engine cooling system is as shown in Fig. 3 - 10

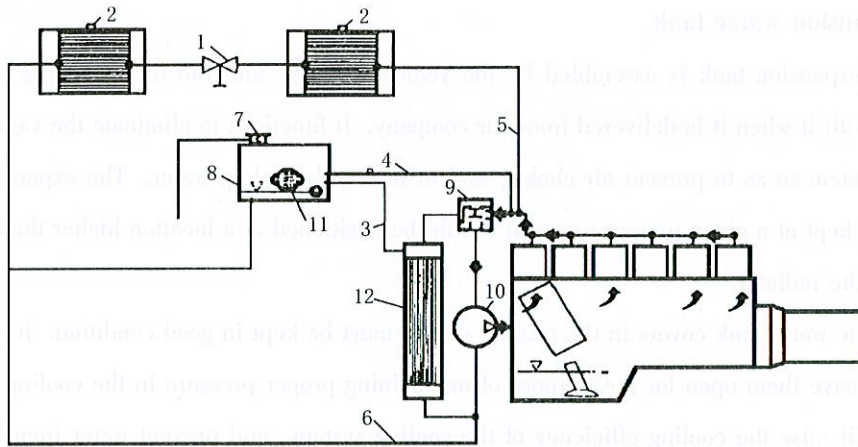


Fig. 3 - 10 WD12 diesel engine cooling system

1. cock 2. radiator 3. water tank air outlet pipe 4. expansion water tank water inlet pipe 5. radiator water inlet pipe 6. water pipe 7. pressure limiting valve 8. expansion water tank 9. thermostat 10. water pump 11. water filler cap 12. water tank

Water pump

The water pump of WD12 diesel engine is mounted in the front end of the engine, and the spiral casing is mounted over the timing gear chamber. The outlet water enters the water chamber on the right side of engine block. The cooling water sweeps through the oil cooler and flows into the interlayer of the cylinder sleeve from the access hole in the lower right part of the engine block. After cooling the cylinder sleeve, water comes out from the spiral casing and enters directly into the water cavity in the cylinder head via the top water hole. After cooling the cylinder head, it enters the outlet pipe from the outlet of the cylinder head. At the end of the water outlet pipe there is a duplex thermostat. The thermostat has two outlets. When water temperature is low (lower than 79°C), the thermostat closes, and the cooling water flows directly to the inlet of water pump, i. e., the small circulation, making the diesel engine temperature rises as quickly as possible and reaches the required thermal condition for operation. By so doing, it can reduce abrasion and extend the service life of the engine. When water temperature of the cooler is 79°C , the thermostat begins to open, at 90°C it is fully opened. And all the cooling water is pumped into the engine block after being cooled by the radiator, i. e., the big circula-



tion.

Expansion water tank

The expansion tank is assembled by the vehicle factory, and the diesel engine is not equipped with it when it is delivered from our company. It functions to eliminate the vapor in the cooling system so as to prevent air choke, and to replenish cooling water. The expansion tank should be kept at a given pressure, and it should be positioned at a location higher than the engine and the radiator.

All the water tank covers in the cooling system must be kept in good condition. It is not allowed to leave them open for the purpose of maintaining proper pressure in the cooling system. As this will raise the cooling efficiency of the cooling system, and prevent water from boiling.

Fan

The fan of WD12 diesel engine is driven by a silicon oil clutch. The driving wheel of fan clutch hub is driven by the diesel engine, the fan blade and the hub case are made into one piece, and there is a certain clearance between the driving wheel and hub body. When this space is filled with silicone oil, the driving wheel brings the hub body to rotate, and when the space loses silicone oil, the driving wheel idles (actually it still brings the fan to run at low speed). The bimetal probe is sensitive to temperature. When the fan inlet air temperature is lower than 50°C, the bimetal probe makes the valve of silicone oil chamber close, the fan separates with the driving wheel, the rotating speed of the fan is only 45% of the input rotating speed; when the fan inlet air temperature rises to 72 ~ 75°C, the bimetal probe makes the valve of the silicone oil chamber open, silicone oil fills the operating space and the rotating speed of the fan can reach 85% of the input rotating speed. Therefore, the rotating speed and power consumption of the fan is automatically regulated according to the magnitude of the diesel engine's load (reflected in the magnitude of radiator intake air temperature). At present, the adoption of such a fan is generally recognized as an important method for saving fuel.

The fan is driven by belt. Its diameter is $\varnothing 640$ mm. The fan support is fixed on the gear chamber.



The fan and the belt are high-speed rotating elements, and it is necessary to guard against them and prevent people from being hurt.

3.8 Air inlet and exhaust system

The air inlet and exhaust system of WD12 diesel engine is as shown in Fig. 3 - 11. It is mainly composed of the air filter, supercharger, intercooler, inlet pipe and exhaust pipe.

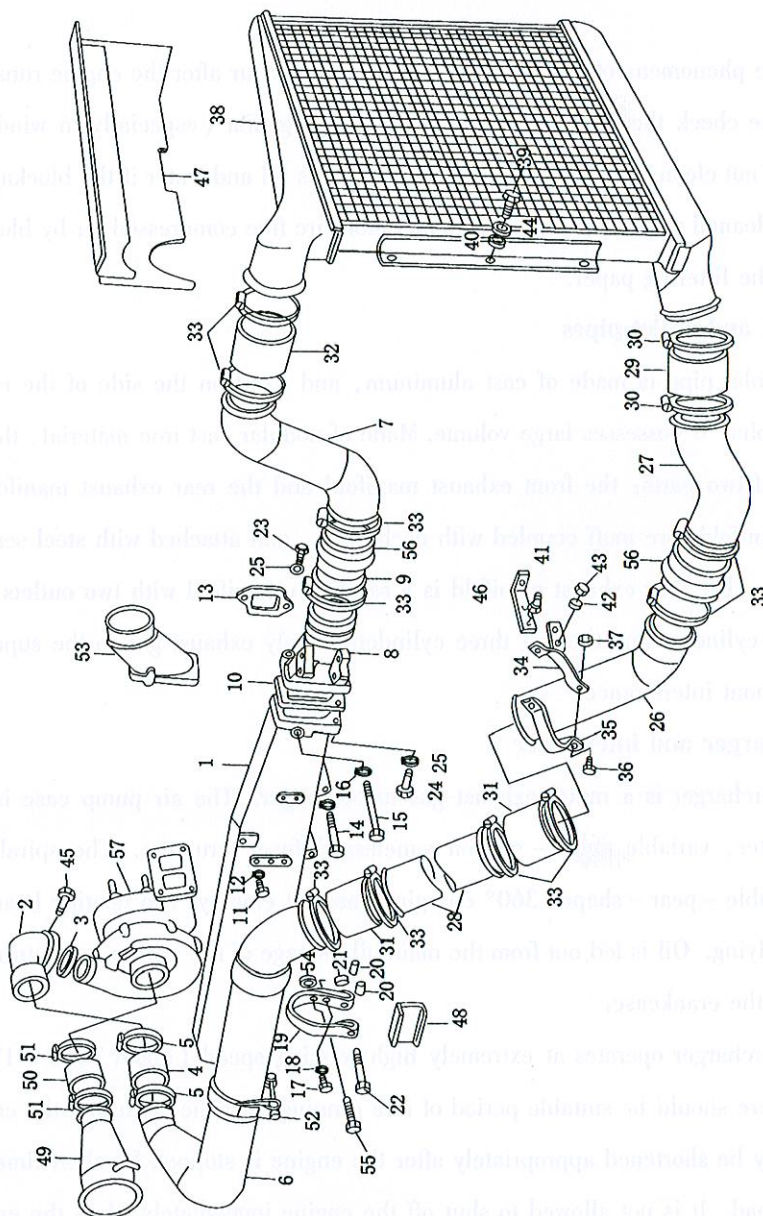


Fig. 3-11 Air inlet and exhaust system
1. air inlet pipe 2. elbow 6. 7. 26. 27. 28. pipes 8. air inlet pipe joint 38. intercooler
49. pressure retaining pipe 57. supercharger



Air filter

WD12 diesel engine employs double – stage air filter. The first stage is a cyclone dust extractor, and the second stage is air filter cartridge and safety cartridge. The maximum resistance of the air filter should be less than 5kPa. A pressure drop alarm indicator coupling is located at the outlet of the air filter. The indicator light comes on when the filter needs to be maintained or replaced.

When the phenomena of smoking and power falling occur after the engine runs for a period of time, please check the air filter cartridge for blocking first (especially in windy and sandy regions). Do not clean the cartridge with liquid such as oil and water if the blockage is severe. It should be cleaned with dry, oil mist free and moisture free compressed air by blowing off dust and sand on the filtering paper.

Air inlet and outlet pipes

The air inlet pipe is made of cast aluminum, and fixed on the side of the cylinder head with 12 M8 bolts. It possesses large volume. Made of nodular cast iron material, the outlet pipe is composed of two parts: the front exhaust manifold and the rear exhaust manifold. The two sections of manifolds are muff coupled with each other, and attached with steel sealing ring effective sealing. The rear exhaust manifold is a sandwich manifold with two outlets which make the first three cylinders and the last three cylinders supply exhaust gas to the supercharger respectively without interference.

Supercharger and intercooler

The supercharger is a radial exhaust gas turbocharger. The air pump case is of constant outside diameter, variable cross – section vaneless diffuser structure. The spiral casing is a symmetric double – pear – shaped 360° charging case. It employs two floating bearings and radial fuel supplying. Oil is led out from the main oil passage of the engine and returns directly to the bottom of the crankcase.

The supercharger operates at extremely high rotating speed (about 7000 ~ 12000 rpm). Therefore, there should be suitable period of idle running after the startup of the engine (about 5min). It may be shortened appropriately after the engine is stopped for short time) before increasing the load. It is not allowed to shut off the engine immediately when the engine runs at high speed and high load. It is necessary to reduce the load and speed gradually and run at idle

speed for 3 ~ 5 min. Otherwise it would cause damage to the supercharger bearing. When assembling the supercharger, it is necessary to fill clean oil into the oil inlet.

The intercooler is in the air - air form. The resistance of the intercooler should be less than 6kPa (rated operating mode). The air inlet of the intercooler is positioned at the bottom and the outlet is at the top. The diesel engine is not equipped with intercooler when it is delivered. When the intercooler is used for a long time, its cooling efficiency will decrease, and it is necessary to remove the oil stain on the cooling fins and the dirt in the pipe. After disassembling, cleaning and assembling, it is necessary seal test to the water cavity and air cavity. There should be no water leakage and air leakage.

3.9 Electric system

The electric system consists of AC generator, starter, water thermometer, sensor, oil pressure sensing plug and flame preheating device.

Ac generator: The output of three - phase AC generator is converted into dc current after rectification. It is equipped with a transistor regulator. It operates with the battery in parallel on the vehicle and by self - excitation. Its output is 28V, output current is 27A. It rotates in right - handed direction and the maximum permissible speed is 11000 rpm. Its rotating speed at rated load is 6000rpm. When the generator rotating speed reaches 500rpm, charging starts. The circuit of the generator is as shown in Fig. 3 - 12.

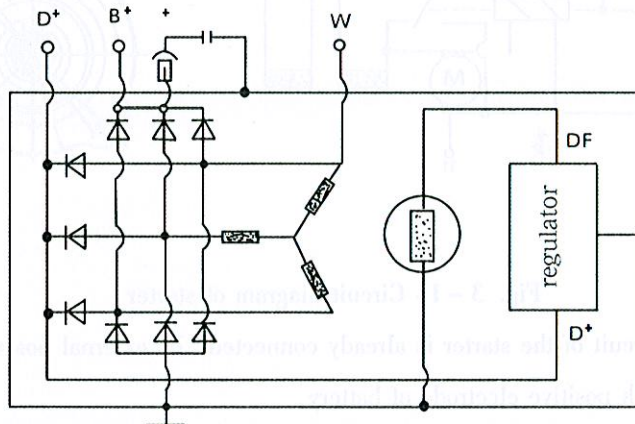


Fig. 3 - 12 Circuit diagram of the generator

Check belt tensioning force of the generator: Apply a load vertical to the belt at the center



of the joining line between the two tangency points of the belt with the belt pulleys. 3mm flexibility is normal. If it is a multi - wedge belt, the load for a new belt is 43N, after normal operation 36N. If it is a V - belt, the load of a new belt is 6N, and after normal operation the load is 5.

The internal circuit of the generator is already connected. Its external posts:

D + is connected with charging indicator light;

W is connected with speed measuring motor;

B + is connected with the battery positive electrode and the load, the motor housing is earthed.

Starter:

The starter is electro - magnetically controlled, the gear moves and it transfers torque with a friction wafer type unidirectional unit. Its rated voltage is 24V, and power is 6kW. It rotates in right - handed rotation direction. Its tooth number is 11.

The starter circuit is as shown in Fig. 3 - 13.

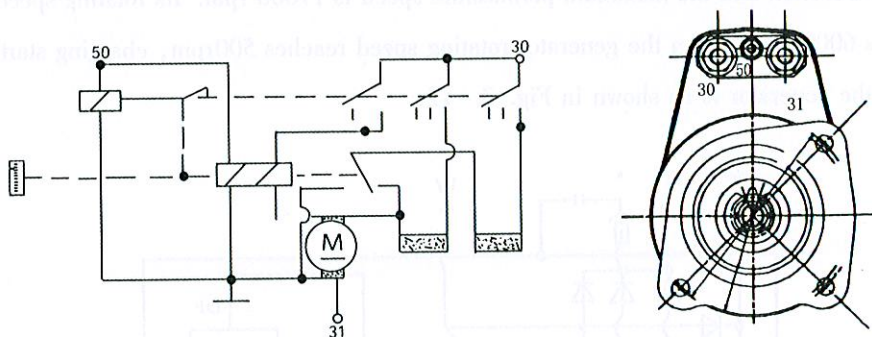


Fig. 3 - 13 Circuit diagram of starter

The internal circuit of the starter is already connected. Its external posts:

30 connects with positive electrode of battery,

31 ground lead,

50 connects with solenoid switch.

Oil pressure sensing plug:

Its operating temperature is $-25 \sim 100^{\circ}\text{C}$, the measuring range is $0 \sim 500\text{kPa}$, the alarming pressure is $25 \sim 40\text{kPa}$ (when the pressure drops, the contact points close), the maximum alarm on – off power is 5W , and the rated voltage is $6 \sim 24\text{V}$.

Water temperature gage sensor:

Its operating temperature is $-25 \sim 120^{\circ}\text{C}$, the permissible external torque is 20Nm (2kgm), and the rated voltage is $6 \sim 24\text{V}$.

Flame preheating device:

It can automatically control the heating time of the preheating plug mounted on the air inlet pipe of the engine and flame preheating time according to the difference of ambient temperature. The driver only needs to start the engine according to the flashing signal of the preheating indicator light. Its schematic diagram is as shown in Fig. 3 – 14.

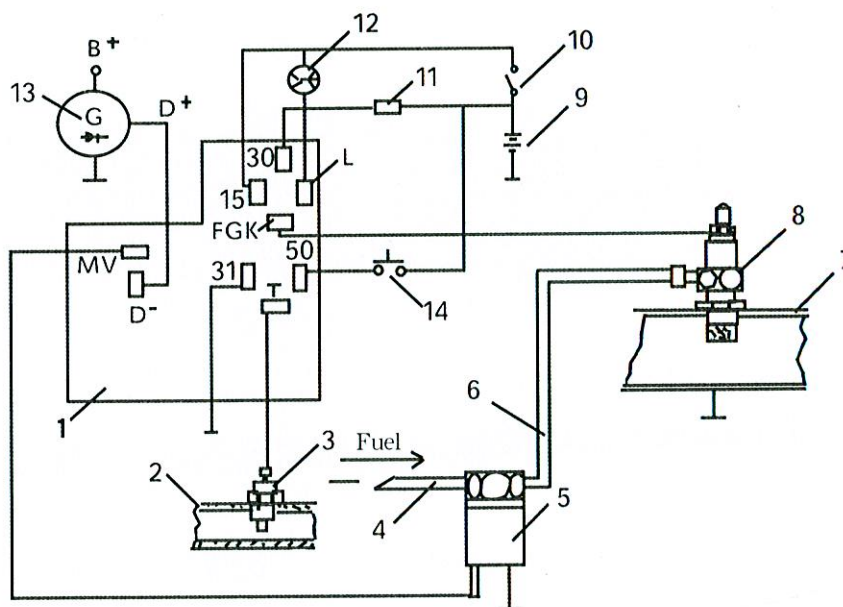


Fig. 3 – 14 Schematic diagram of flame preheating device

1. electronic control unit 2. engine cooling water pipe 3. temperature sensor R 4. to fuel delivery pipe of high – pressure fuel pump 5. solenoid valve Y21 6. fuel pipe
7. engine air inlet pipe 8. preheating plug R3 9. 24V battery 10. key switch 11. fuse 25A 12. preheating indicator light 13. generator 14. starting button



Air compressor

The air compressor of WD12 diesel engine is a single cylinder reciprocating type crank/connecting rod mechanism. It is positioned at the upper right side of the camshaft and driven directly by the front gear.

Oil is led into the air compressor via an oil pipe near the oil cooler. The oil flows back into the oil sump from the timing gear chamber. The air compressor is cooled by the water from the pipe which is connected from the cylinder block to the cylinder head of the compressor. Water comes out from the outlet of the cylinder head and flows to the inlet on the side of the water pump of the diesel engine.

The air at the inlet of the air compressor is filtered by the air filter. After flowing through the air filter the air enters the air compressor via a branch pipe.





CHAPTER 4 INSTALLATION AND COUPLING OF THE DIESEL ENGINE

4.1 Hoisting of the diesel engine

On both the front and the rear ends of the diesel engine cylinder head there is a special – purpose hanger plate respectively for hoisting. When hoisting the engine, the centerline of the crankshaft should be kept horizontal. It is forbidden to hoist it tipsily or hoist it by one side. Lifting and lowering should be slow. The correct hoisting method is as shown in the left diagram of Fig. 4 – 1.

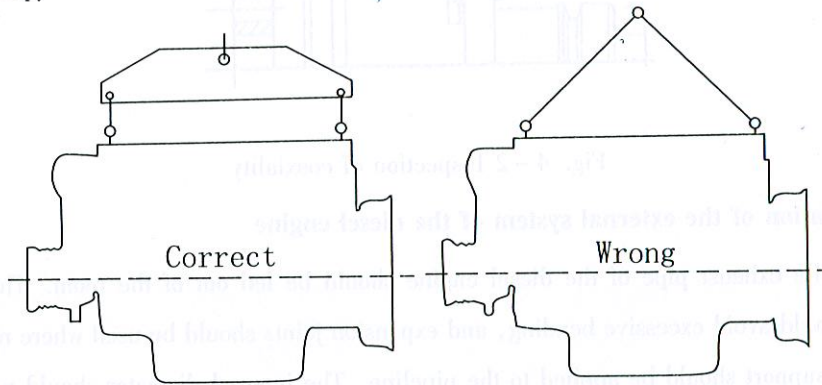


Fig. 4 – 1 Hoisting of the engine

4.2 Installation of the diesel engine

WD12 series diesel engine delivers power from the flywheel side. In matching installation, it is necessary to use flexible coupling and ensure that the engine crankshaft and the input shaft of the transmission are coaxial, and ensure that the crankshaft does not bear additional axial force as a result of improper installation. Coaxiality between the centerline of the crankshaft and the centerline of the transmission input shaft should be less than 0.2mm. And face runout should be less than 0.1mm. For coaxiality adjustment, see Fig.4 – 2.

In the course of operation, the customer should check it periodically according to the above – mentioned requirement. If it is out of the standard, correct it in time so as to ensure normal operation.

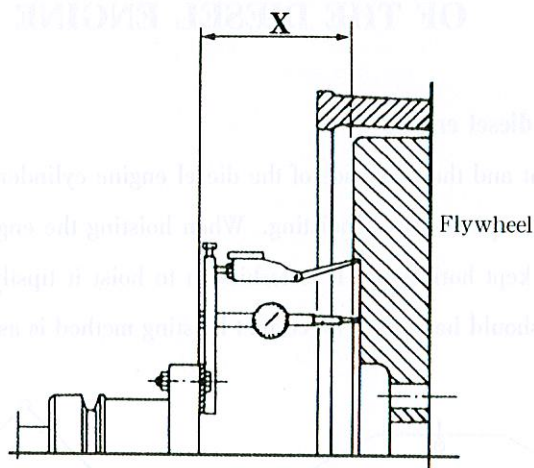


Fig. 4 -2 Inspection of coaxiality

4.3 Installation of the external system of the diesel engine

(1) The exhaust pipe of the diesel engine should be led out of the room. The exhaust pipeline should avoid excessive bending, and expansion joints should be used where necessary. Additional support should be applied to the pipeline. The internal diameter should not be less than 50mm, and the exhaust back pressure should not exceed 6kPa.

(2) Rain shield should be applied on the exit of exhaust pipe positioned outside the room. To drain out the condensed water from the exhaust pipe smoothly, a drain valve may be set at the lowest position of the exhaust pipe.

(3) The air inlet positioned outside the room (especially for marine engines) should be fit with tarpaulin so as to prevent rain from entering the system.

(4) The fuel tank capacity should satisfy 8 hours operation of the diesel engine at nominal load condition. It should be so positioned that its outlet is not lower than the inlet of fuel supply pump of the fuel injection pump. The diameter of the fuel pipe should not be less than 10mm.



CHAPTER 5 USE AND OPERATION OF THE DIESEL ENGINE

5.1 Preparation and inspection before operation

Depreservation:

After opening the packing box, customer should first of all sort and count the diesel engine and its accessories according to the packing list, check whether there is damage on the external surface of the diesel engine, whether the connectors are loose, and then do the following:

(1) Wipe off the anti-rust layer and anti-corrosion agent from the exposed parts of the diesel engine.

(2) Drain the preservative oil from the fuel filter and the components of the fuel system (It is permissible to start the engine without draining out the preservative oil. But it is imperative to run the engine at full load only after the preservative oil in the fuel system is completely consumed and normal diesel fuel is supplied).



The preservation period of the diesel engine is 1 year. After 1 year, inspections should be made and necessary measures taken.

(3) Rotate the flywheel and spray solvent into the inlet pipe until the preservative oil in the cylinder is completely expelled out.

(4) Spray solvent into the inlet and outlet of the supercharger until the preservative oil is completely expelled out.

(5) According to the agreement between the manufacturer and the customer, the oil sump that was not filled with oil should be filled with oil as specified; and for the oil sump that was filled with oil containing running in accelerant, it is suggested that when the customer runs 2000km (or operating 50 hours), drain out the old oil and fill in new oil.

(6) Basing on the agreement between the manufacturer and the customer, if coolant was filled according to the customer's requirement when the engine was delivered, the performance of the coolant should be checked when depreservation is made. The coolant can be used if its antifreeze capability can satisfy the requirement of -30°C or -35°C , its PH value is 7 ~ 8 (neutral) and its overall hardness value is 5 ~ 15°d [9 ~ 27°f]. If it is not up to the standard, drain it off and refill about 40L coolant containing antifreeze additive.



5.2 Pre – start inspection

Check coolant level:

If the engine has already been mounted on the vehicle or on the cradle, coolant level can be seen at any time through the glass eyehole on the expansion tank. If coolant is not enough, it can be filled by opening the coolant filler cap. When opening the coolant filler cap attached with a pressure relief valve and a gas exhaust button while the engine is still hot, it is imperative to press the gas exhaust button before opening the cover. Avoid by all means filling in large amount of coolant while the engine is hot. If coolant is not available in extraordinary case, it is permissible to fill in cold water slowly, and make sure that water temperature is not too low. Fill in the coolant from the coolant filler until it overflows. Start the engine. With the engine running, continue to fill up the coolant until its level is stabilized. And finally put on the filler cap.

Check fuel level

If the engine has been already mounted on the vehicle, turn on the power switch and check the fuel level with the fuel – gauge or check the fuel tank. **Check engine oil level**

Check and make sure that the oil level is between upper and lower scale graduation lines on the dip stick. Fill in oil from the oil filler on the engine body.

Check whether the connections of the diesel engine accessories are reliable, and remedy the abnormal phenomena. Check whether the wiring of the electric system is normal, and whether the battery is sufficiently charged. Then open fuel tank valve and press the hand pump on the fuel supply pump to expel the air in the fuel system.

5.3 Starting of the diesel engine

Set both the power switch and the electric key on the vehicle at the starting positions, place the gear lever at the neutral position, and fix the hand throttle at proper position (in bench test, only set the hand throttle at proper position), and then start the engine.

5.4 Normal running conditions

Main oil passage oil pressure is 350 ~ 550kPa, and at idle speed it is 100 ~ 180kPa.

Oil temperature in the oil sump < 110℃ .

Coolant temperature at the exit: 75 ~ 95℃

Exhaust gas temperature after turbine ≤580.



Inlet air temperature after intercooler is $55 \pm 5^{\circ}\text{C}$.

5.5 Precautions of operation

When starting the diesel engine, if it fails to start up within 15s, restart it after an interval of 2min. If the engine cannot be started at three successive attempts, the starting should be aborted until the reason is found and the fault is remedied.

After starting up, the diesel engine should run at idle speed for a few minutes. Then raise the rotating speed to 1000 – 1200rpm and add part of the load. It is allowed to apply full load only when the outlet water temperature is higher than 60°C and the oil temperature is higher than 50°C . Load and rotating speed should be increased gradually, and sudden increase and decrease of load must be avoided.

The diesel engine should operate under moderate duty conditions within the 60h running – in period (running the first 3000km), and it should not tow the trailer.

Slow up in time when running on a slope. The engine should not run in high torque operating mode for a long time. And the load should not be made too low and the rotating speed should not be made too low either.

In normal operation, the diesel engine is permitted to run continuously at rated power and rated rotating speed. But the maximum allowable running time at 105% of rated rotating speed and 110% of rated power is only 20 minutes. After load is removed, the diesel engine is allowed to shut down only after operating at idle speed for 5minutes.

5.6 Operation of the diesel engine in winter

Fuel: Choose diesel fuel of different grade according to the difference of outdoor temperature in winter.

Lubricant: Choose lubricating oil in different viscosity according to the seasons.

Coolant: Choose coolant of different grade and different quantity according to the difference of outdoor temperature in winter.

Startup: If it is necessary, auxiliary starting unit can be used in winter. After starting up, load cannot be added and the engine cannot run at high speed until oil pressure and water temperature become normal.

Battery: Before the cold season begins, see to it that electrolyte level, viscosity and cell voltage are checked. If the vehicle will not be in use and be left at low temperature for a long



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time, the battery should be removed and kept in a warm room.

If the air inlet that can be controlled by a switch is adopted, turn the switch to "Winter" position in winter.

Shutdown of the engine: Before shutting down the engine in cold weather, it is necessary to remove the load first, and then let the engine run at idle speed for 5 minutes and wait all temperatures drop down. It should be noticed that after shutting down, it is not allowed to drain out the coolant with antifreeze additive. If there is no antifreeze additive the coolant, it is imperative to open the drain valves or water plugs on the engine body, radiator and water inlet pipe to drain out the coolant completely so as to prevent frost crack of the engine.



CHAPTER 6 PERIODIC INSPECTION AND TECHNICAL MAINTENANCE

During the operation of the diesel engine, operating log should be filled by the day for periodic inspection. In order to ensure reliable operation and extend its service life, strict technical maintenance system should be set up.

6.1 Periodic inspection and technical maintenance period

First inspection After 30 ~ 50 hours of operation

Routine inspection (P) Every 250 hours of operation

First - level maintenance (WD 1) Every 500 hours

Second - level maintenance (WD 2) Every 1000 hours

Third - level maintenance (WD 3) Every 2000 hours

Fourth - level maintenance (WD 4) Every 4000 hours

Remarks: The above maintenance cycle is calculated on the base that the diesel engine operates 1500 hours each year. If annual operating time is less than 500 hour, its maintenance cycle is 0.5 times of the above cycle, and if the annual operating time exceeds 1500hours, its maintenance cycle is 1.5 times of the above cycle.

Work required and parts and components needed to be replaced in the inspection and maintenance.

Table 6 - 1 Diesel engine technical maintenance inspection items

Item of inspection	First inspection	P	WD1	WD2	WD3	WD4
Renew engine oil	▲	▲	▲	▲	▲	▲
Water pump	▲	▲	▲	▲	▲	▲
Replace oil filter	▲	Every time renewing oil				
Check and adjust valve clearance	▲		▲	▲	▲	▲
Check fuel injection nozzle opening pressure					▲	▲



Replace fuel filter			▲	▲	▲	▲
Clean coarse filter of fuel pump			▲	▲	▲	▲
Check coolant capacity and makeup	▲	▲	▲	▲	▲	▲
Renew coolant	Every 24 months					
Tighten cooling pipe clamps	▲					
Fasten the air inlet pipeline, hoses, and flange couplings	▲		▲	▲	▲	▲
Check the air filter and service light			▲	▲	▲	▲
Clean the dust cup of air filter (except dust auto exhaustion type)		▲	▲	▲	▲	▲
Clean air filter main cartridge	When the indicator light comes on					
Replace air filter main cartridge	Refer to complete vehicle maintenance manual					
Replace air filter safety cartridge	After cleaning the main cartridge for 5 times					
Check and tighten V - belt	▲	▲	▲	▲	▲	▲
Check supercharger bearing clearance						▲
Check fuel injection pump in special work-shop						▲
Check and adjust clutch travel and the condition of cable wire	▲	▲	▲	▲	▲	▲
Adjust idle rotating speed	▲					

Oil renewing period of diesel engine varies with the following operating conditions. Normal operating conditions (The conditions listed in the above table are the normal operating conditions. Oil consumption is normal) : Ambient temperature is normal and the fuel with sulfur content less than 0.5% is used (calculated by weight).

Severe operating conditions (oil consumption is high)

(1) A: Tropic or frigid zone climate (temperature exceeds + 30℃ or lower than -10℃).

Oil renewing period is 0.5 times of that under normal operating conditions.



(2) B: Use the fuel with sulfur content 0.5 ~ 1.5% , oil renewing period is 0.5 times of that under normal operating conditions.

(3) Severe condition is A + B, oil renewing period is 0.25 times that of normal condition.

Note: The oil used for the diesel engine listed in the above table is grade CF -4 oil.

Specified items of daily inspection

After the engine stops, check the contents of various oils and liquids (including engine oil, coolant and fuel of the diesel engine), drain off water in the fuel filter, and check the charging indicator light and oil pressure indicator light. Check whether there is leakage from oil, water and air pipeline couplings; check whether the fasteners are tight and reliable and whether the instruments are normal.

6.2 Maintenance for long term storage

(1) Clean the diesel engine

Before preservation, remove all the rusts by proper means, and all protective - treated portions (oil passages, fuel system and supercharger) should be cleaned thoroughly.

(2) Protection procedures

After warming up, drain out all the oil. Clean the oil filter and fill the oil tank or oil sump with anticorrosive oil.

Drain out all the diesel fuel in the fuel system and refill it with mixture of 90% diesel fuel and 10% anticorrosive oil to protect the entire fuel passage.

If the diesel engine is not filled with cooling emulsion, drain off the cooling water and fill with emulsion and anticorrosive oil.

Before preservation, start the engine and run at idle speed for 15 ~ 25 minutes with the above - mentioned mixture.

Detach the inlet pipe end face cover plate and inject anticorrosive oil into the inlet pipe with pressurized nozzle. While injecting oil, rotate the crankshaft by hand to open the air valves to let the anticorrosive oil enter the combustion chamber. Once preservation is completed, it is not allowed to rotate the crankshaft again so as to prevent the oil film adhering on the cylinder wall from being scraped off.

Drain off all fuel, oil and liquid from the diesel engine. Take down the cylinder head cov-



er and spray anticorrosive oil on the valve springs and rocker arms.

All the machined surfaces of the diesel engine and the surfaces that are subject to corrosion should be coated with anticorrosive oil.

(3) Protective measures to be taken during storage

In order to prevent humid air and foreign matter from entering the diesel engine, the air inlet pipe, exhaust pipe and cooling water pipe of the diesel engine that communicate with the environment should be well protected by means of covers, and cover the engine with plastic jacket during transportation and storage.



CHAPTER 7 COMMON FAULTS AND REMEDY

7.1 Start failure of the diesel engine

Cause	Remedy
1. Fuel supply pump strainer mesh or fuel passage such as the hoses are blocked	Check and clear off the dirt, check cleanliness of fuel
2. There is air in the fuel system	Remove air. Check tightness of connectors and repair
3. The fuel injection pump is faulty	Check the plunger and fuel outlet valve, repair or renew the damaged part
4. Fuel injector is faulty	Check atomization of the fuel injector, and repair
5. Air distribution or fuel supply advance angle not correct	Check and adjust
6. High pressure fuel pipe is damaged or leaks	Repair or replace
7. Insufficient compression pressure of the cylinder	Check tightness of air valves, tightness of cylinder gasket and abrasion of piston rings. Repair or replace
8. Air temperature is too low	Add auxiliary starting device

7.2 Engine stops shortly after startup

Cause	Remedy
1. Fuel filter is blocked	Disassemble the filter body, clear off the inside dirt and water, renew the cartridge when necessary
2. Air entered the fuel system	Check tightness of fuel pipe and connector, whether the air bleed screw is tightened, remove the remaining air
3. Fuel supply pump does not operate	Check the plunger valve of the fuel supply pump, clean and repair
4. Fuel quality is poor, containing too much water	Clean the filter, renew the fuel
5. Idle speed is regulated too low	Readjust



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7.3 Engine power is insufficient

Cause	Remedy
1. Air inlet is blocked (air filter is blocked)	Check the air filter and inlet pipe, clean or renew the cartridge
2. Exhaust back pressure is too high	Check valve timing, whether exhaust pipe is blocked, adjust and repair
3. Supercharger system pressure is insufficient	Check and eliminate leakage at the joints of pipeline
4. Supercharger malfunctions	Replace the assembly
4.1 Air pump and turbine passage air dirty and blocked	Clean or replace
4.2 Floating bearing malfunctions	Renew
4.3 There is coking and oil sludge in the back gap of turbine and air pump	Clean
5. Intercooler is damaged and leaks	Replace, repair
6. Fuel passage leaks or is blocked	Check tightness of fuel pipe and connector, cleanness of the filter, fuel pipe, repair or remove dirt, renew cartridge
7. Fuel quality is poor	Clean the fuel tank, filtration parts and fuel pipe, renew the fuel
8. Excessive abrasion of fuel injection pump or speed governor	Repair or renew
9. Fuel injection pump smokes, limiter diaphragm is broken	Repair or renew
10. Smoke limiter air pipe is damaged or leaks	Renew
11. Poor atomization of fuel – injection nozzle	Check fuel injection pressure and fuel injection coking. Adjust and repair
12. Air distribution or fuel supply timing is not correct	Check and adjust
13. High – speed setting of speed governor is too low	Check governing characteristic and adjust



Cause	Remedy
14. Oil level in the sump is too high	Check the dip stick and drain off extra oil
15. Cylinder gasket leaks	Check compression pressure under hot engine condition, replace the damaged cylinder gasket
16. Piston ring is worn or fractured, excessive clearance of bushing	Replace worn parts or overhaul the engine
17. Cylinder sleeve or piston is worn or scuffing of cylinder bore	Overhaul the engine

7.4 Excessive fuel consumption

Cause	Remedy
1. Air inlet is blocked (air filter is blocked)	Check the air filter and inlet pipeline
2. Exhaust back pressure is too high	Check the exhaust pipeline and brake valve, clean
3. Fuel quality is poor	Renew the fuel as specified
4. Fuel pipeline is blocked	Check and repair
5. Fuel pipeline leaks	Check and repair
6. Poor atomization of fuel injector	Check and adjust or repair
7. Air distribution or fuel supply timing is not correct	Adjust valve clearance and fuel supply advance angle as specified
8. Cylinder gasket leaks	Check compression pressure
9. Excessive clearance of bearing shell, the engine needs overhaul	Check and overhaul
10. Cylinder failure	Replace the cylinder sleeve, piston and piston ring
11. Supercharger system pressure is insufficient	Check and eliminate leakage at the pipeline and joints



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Cause	Remedy
12. Supercharger malfunctions	Check and replace the assembly
13. Intercooler is damaged or leaks	Replace or repair

7.5 Black smoke

Cause	Remedy
1. Air inlet is blocked or exhaust back pressure is high	Clean
2. Fuel quality is poor	Clean and renew
3. Fuel supply or air distribution timing is not correct	Renew the fuel as specified
4. Poor atomization of fuel – injection nozzle	Check and repair or replace
5. Excessive fuel quantity of fuel injection pump	Check and readjust (by specialized factory)
6. Supercharger system pressure is insufficient	Check and eliminate leakage at the pipeline and joints
7. Supercharger malfunctions	Check and replace the assembly
8. Intercooler is damaged or leaks	Replace or repair
9. Functioning point of smoke limiter is incorrect	Readjust (by specialized factory)

7.6 White and blue smoke

Cause	Remedy
1. Fuel quality is poor, containing too much water	Renew the fuel
2. Temperature of cooling water is too low	Check operating temperature of thermostat, and replace if necessary
3. Air distribution or fuel supply timing is not correct	Check and repair
4. Poor atomization of fuel injector	Check and repair



Cause	Remedy
5. Compression pressure is low, combustion is incomplete and cylinder fails	Check piston rings, cylinder sleeve and cylinder gasket, repair
6. Insufficient running - in of piston rings and cylinder sleeve	Continue running - in
7. Piston ring openings are not staggered	Adjust, reassemble
8. Oil ring of piston malfunctions	Renew
9. Matching clearance between piston and cylinder sleeve is too large	Repair, renew
10. Sealing ring of supercharger is worn	Check, repair
11. Supercharger thrust bearing is worn	Check, repair
12. Supercharger return pipeline is blocked	Clean or repair

7.7 Unstable engine rotating speed

Cause	Remedy
1. Fuel quality is poor, containing too much water or wax	Clean the fuel system, renew the fuel
2. Air entered the fuel system	Check tightness of fuel pipe and connector, remove the air;
3. Speed governor weights and spring malfunction	Check and repair (by specialized factory)
4. Uneven fuel supply	Check and repair (by specialized factory)
5. Poor atomization of fuel - injection nozzle	Check and repair
6. Supercharger surges	Check and clean the air passage of air pump, eliminate fouling and clear off coking in the exhaust passage
7. Supercharger thrust bearing is damaged	Renew



7.8 Low oil pressure

Cause	Remedy
1. Oil level in the sump is too low or short of oil	Check oil level and whether there is oil leakage, make up oil
2. Main oil passage pressure regulating valve malfunctions	Check the valve, clean and repair
3. Lubricating system leaks	Check whether the suction strainer, oil pipeline and coupling gasket is blocked or fractured
4. Oil grade does not satisfy the stipulation	Renew the oil as specified, select oil of suitable grade
5. Oil pump inlet pipe leaks	Check the oil pipe and coupling
6. Water temperature in the cooling system is too high and oil temperature is high	Check the cooling system and repair
7. Oil filter resistance is too high	Replace with a new cartridge
8. Oil cooler is blocked	Check and repair
9. Main oil passage is blocked	Check and repair
10. Bearing shell clearance is too large or the shell is damaged	Check and repair
11. Excessive abrasion of the components	Check the number of operating hours of the engine, overhaul

7.9 Engine overheat

Cause	Remedy
1. Water level in the water tank is too low	Check whether there is water leakage and make up water
2. Water tank is blocked	Check the water tank, clean or repair
3. Water pump belt is loose	Adjust the tension force as specified



Cause	Remedy
4. Water pump gasket is damaged, water pump vane is worn	Check and repair or renew
5. Thermostat is faulty	Renew
6. Water pipe is damaged or air seeps in	Check the water pipes, connectors and washers and renew the damaged parts
7. Oil level in the sump is too low or short of oil	Check oil level and whether there is oil leakage, repair and make up oil

7.10 Generator does not generate power

Cause	Remedy
1. Wiring is open or shorted, the connectors are loose	Check the wiring of the generator and ammeter, repair
2. Coils of the rotor and stator is open, shorted or grounded	Repair or replace the assembly
3. Rectifier is damaged	Repair or replace the assembly
4. Pilehead paper insulation is damaged, wiring is broken	Replace the assembly
5. Regulated voltage of the regulator is too low	Repair
6. Contact points of the regulator are burnt	Repair

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