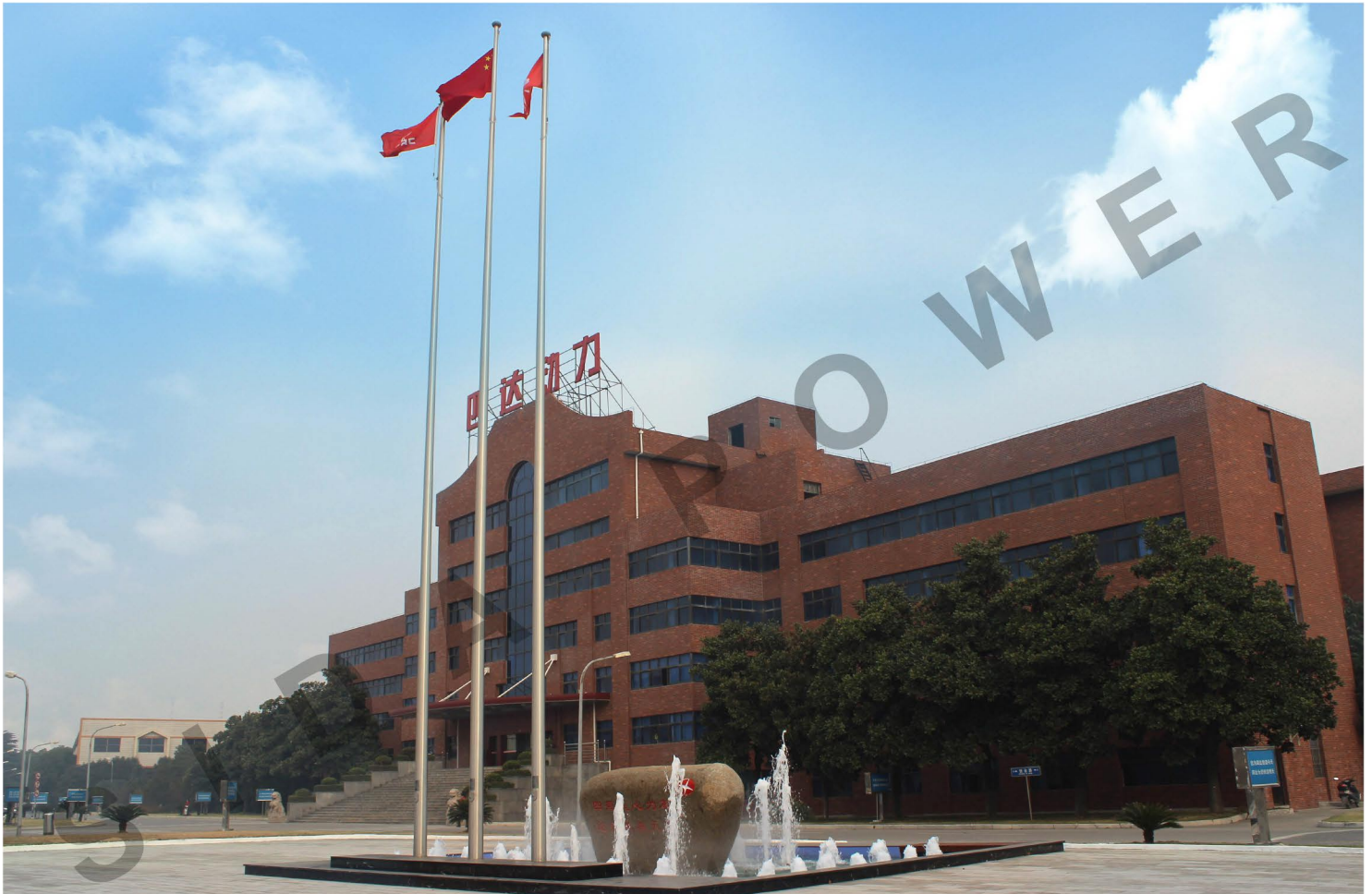


INSTRUCTION MANUAL OF M、Q SERIES DIESEL ENGINES



JIANGSU SIDA POWER MACHINERY GROUP CO.LTD
WUXI DIESEL ENGINE WORKS

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SIDA POWER

FOREWORD

M、Q series diesel engines are prime power for light-duty automobiles, agricultural transport vehicles from 1t to 2.5t, small-duty construction machinery, tractors, combines, generating sets and so on.

This instruction manual introduces M、Q series diesel engines in aspect of their main technical specifications, method of adjusting, demand of operating and maintenance. Operating and maintaining diesel engines correctly are very important to drive safely and prolong service life. Customers please read this carefully, operate and maintain diesel engines according to the regulations.

During productive practice, we will absorb advanced technology continuously, accumulate practice experience and make some improvements, so the content of the instructions may be different from the actuality of future product. Customers should pay more attention to this when operating diesel engines.

Since the construction of the engine is subject to frequent improvement and development during production and practice, it is possible that the engine supplied is somewhere not exactly the same as one described herein. Please pay more attention to this when operating diesel engines.

WARNING NOTICE

- 1.It is strictly forbidden to use inferior or dirty diesel and oil.
- 2.It is strictly forbidden to leak intake system (air filter, pipe and connection parts).
- 3.It is strictly forbidden to use hard water (well water & spring water) for cooling, if have to, please soften the water.
- 4.It is strictly forbidden to start or work under condition of lack of water or oil.
- 5.It is strictly forbidden to adjust the fuel injection pump and fuel appliance arbitrarily.
- 6.It is strictly forbidden to check whether the generator works by method of Short-circuit.
- 7.Control the start time and gap strictly when using electric start.
- 8.Must keep regular technology maintenance of the diesel engine.
- 9.When ambient temperature is below 0 °C, drain out the cold water to keep the machine from frost crake.
- 10.All of the filters (including the air filter) should be maintained or changed in accordance with requirements.

WINTER NOTICE

To ensure the diesel engines start smoothly in winter, users should pay attention to issues as follows:

- 1.Please use fuel type -10 light diesels.
- 2.Please use CC or CD 10W/30 or 5W/30 lubricating oil.
- 3.Please ensure that the access between battery and starter cable is reliable;
Battery capacity should be in accordance with the provisions of instruction manual;
Wire's cross-sectional area is not less than 40 mm² when total length of the fire wire and ground wire is less than 2 m;
Wire's cross-sectional area is not less than 70 mm² when total length of the fire wire and ground wire is more than 2 m.
- 4.Add hot water and hot lubricating oil when the start ambient temperature is below -5 °C.
- 5.Exclude the air in fuel system.
- 6.Check whether atomization of the injector is normal or not.

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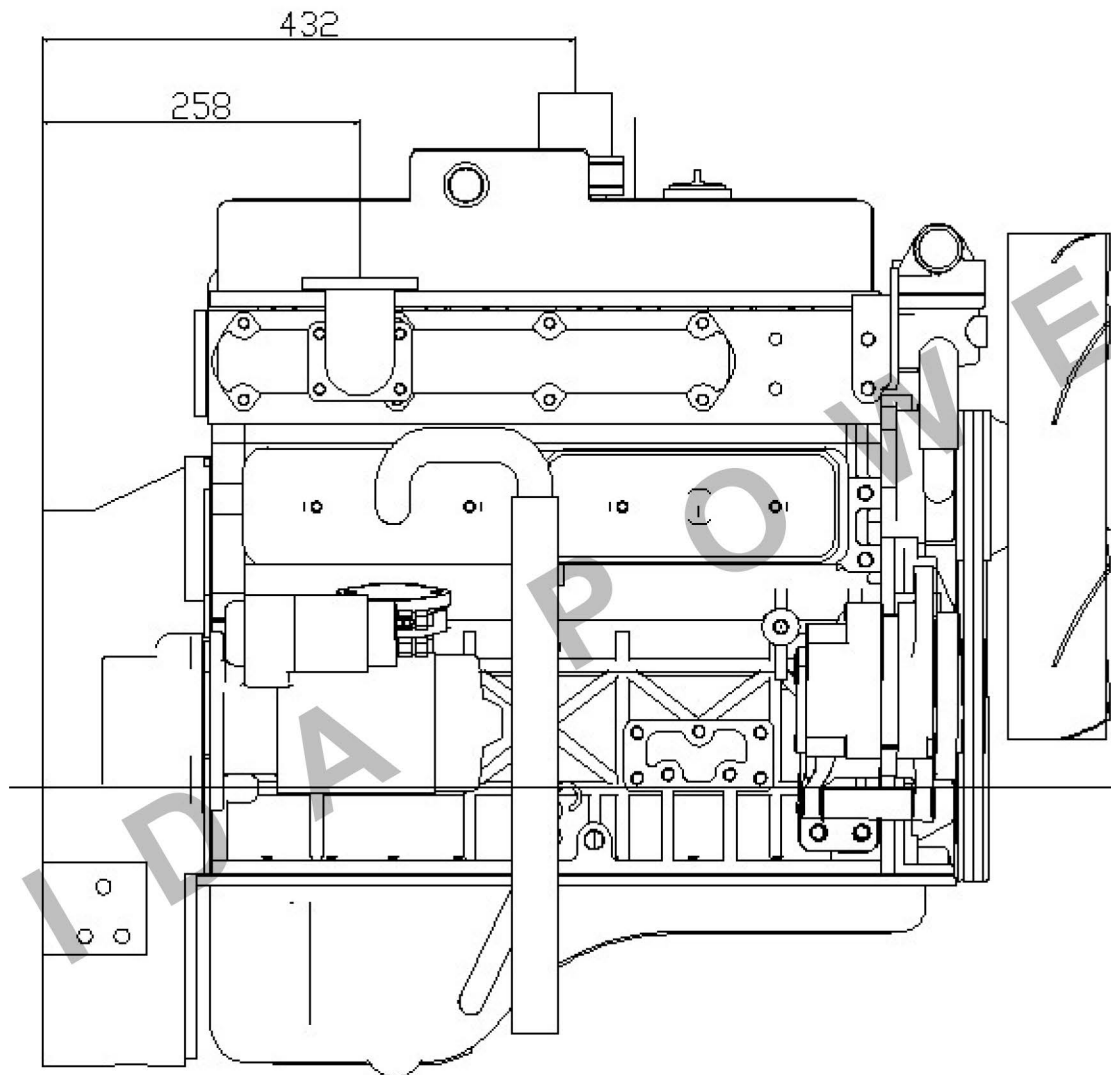


Figure II Left view

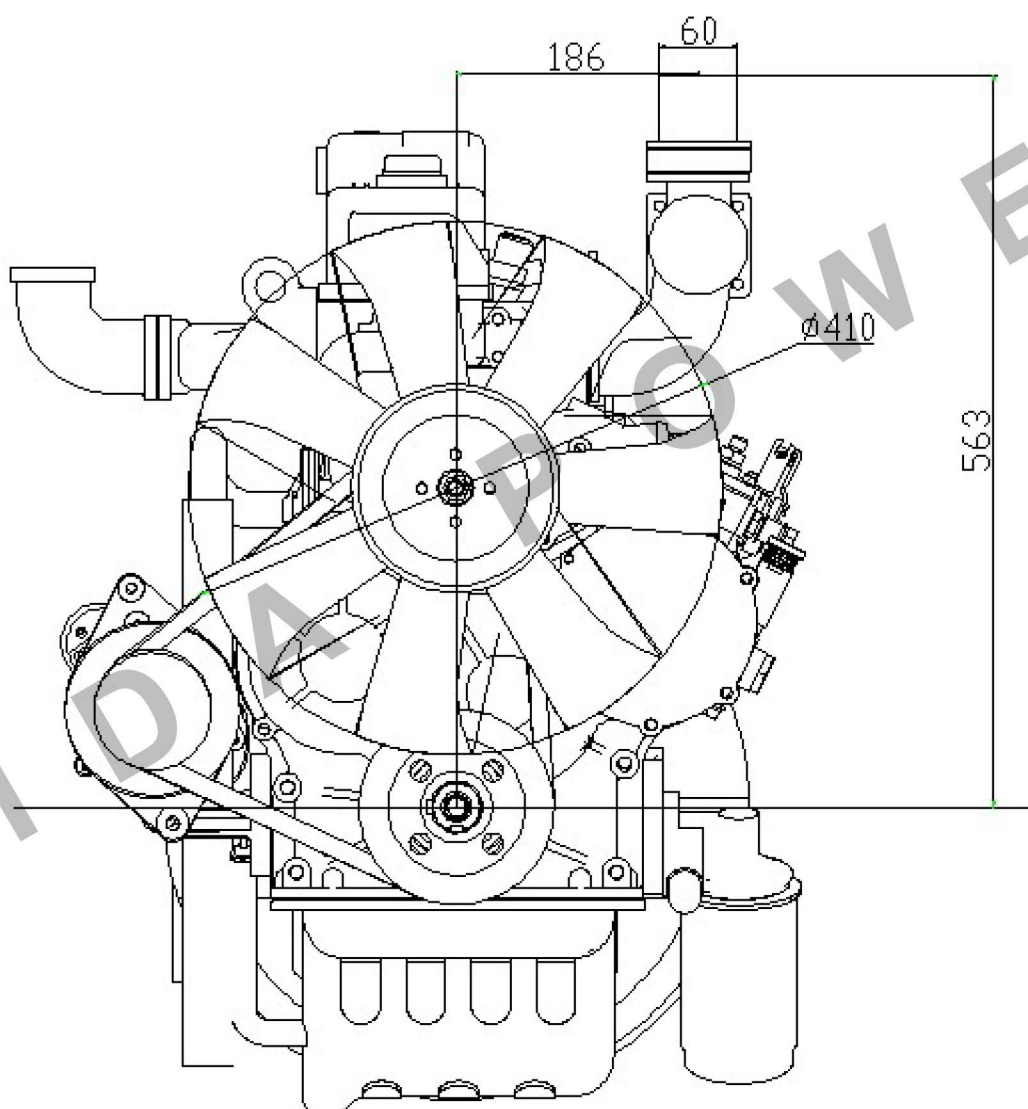


Figure III Front view

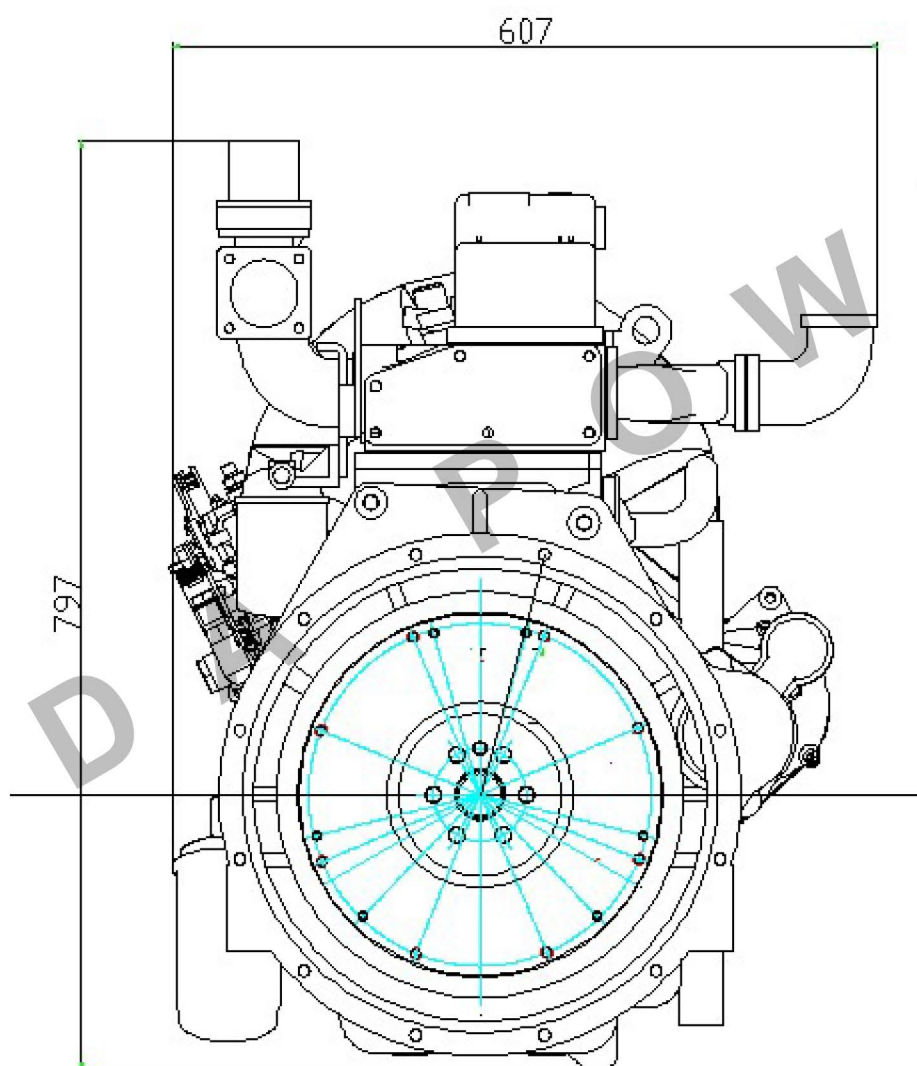


Figure IV Back view

II 4105、4105Z

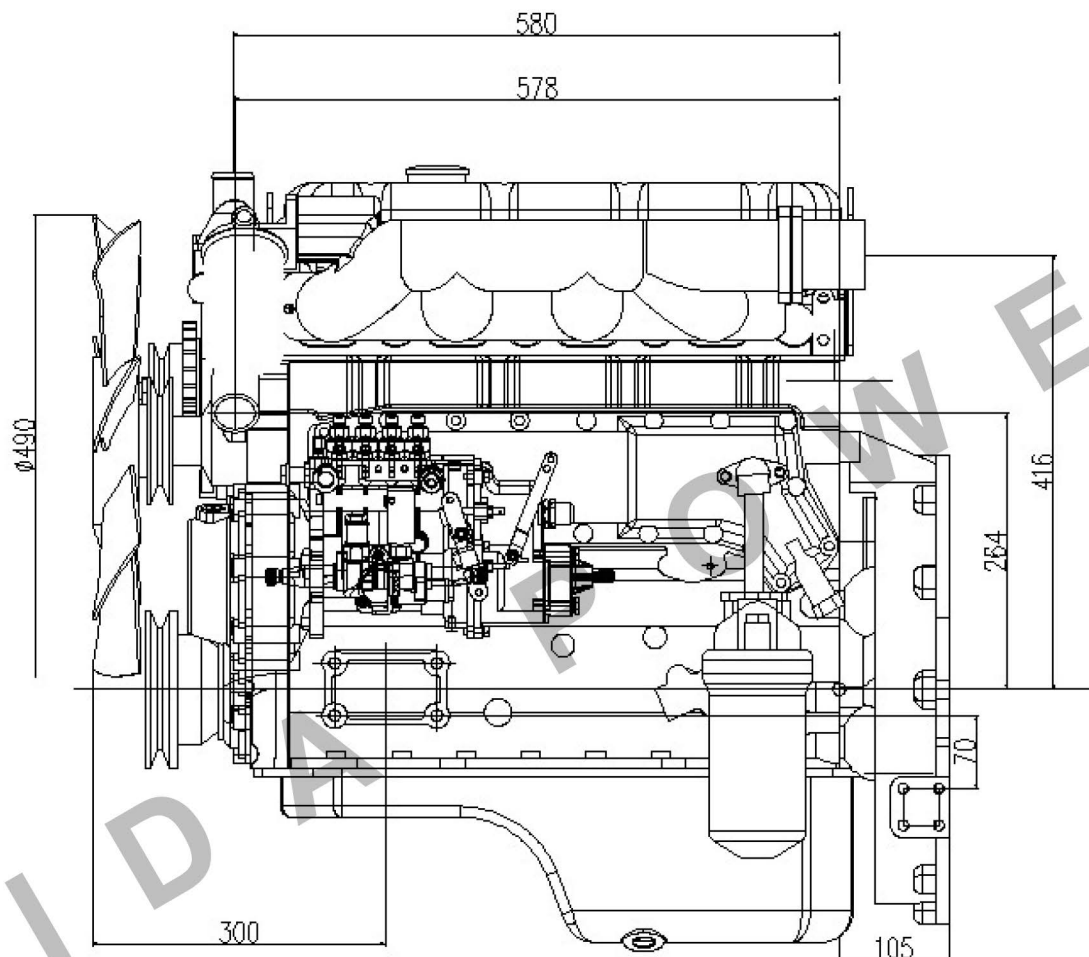


Figure I Right view

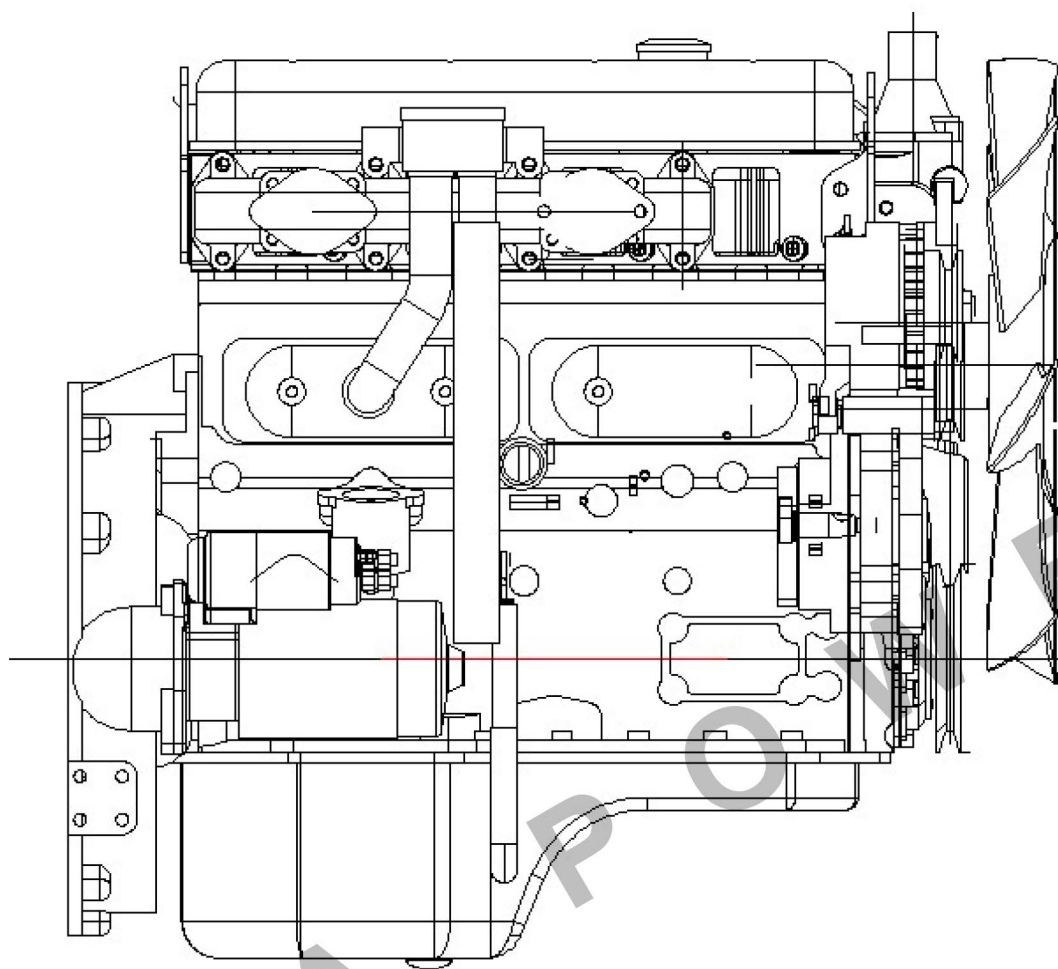


Figure II Left view

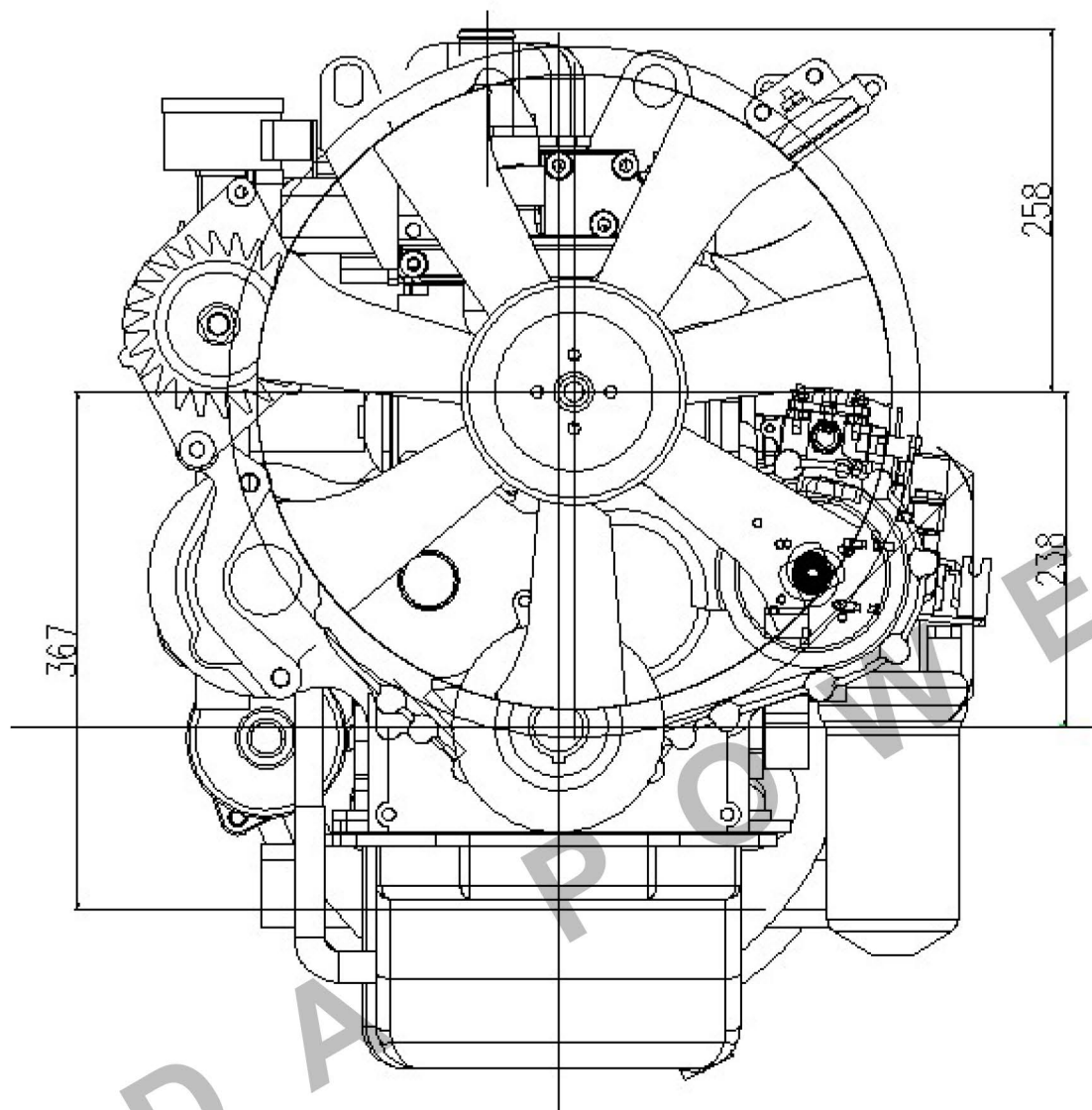


Figure III Front view

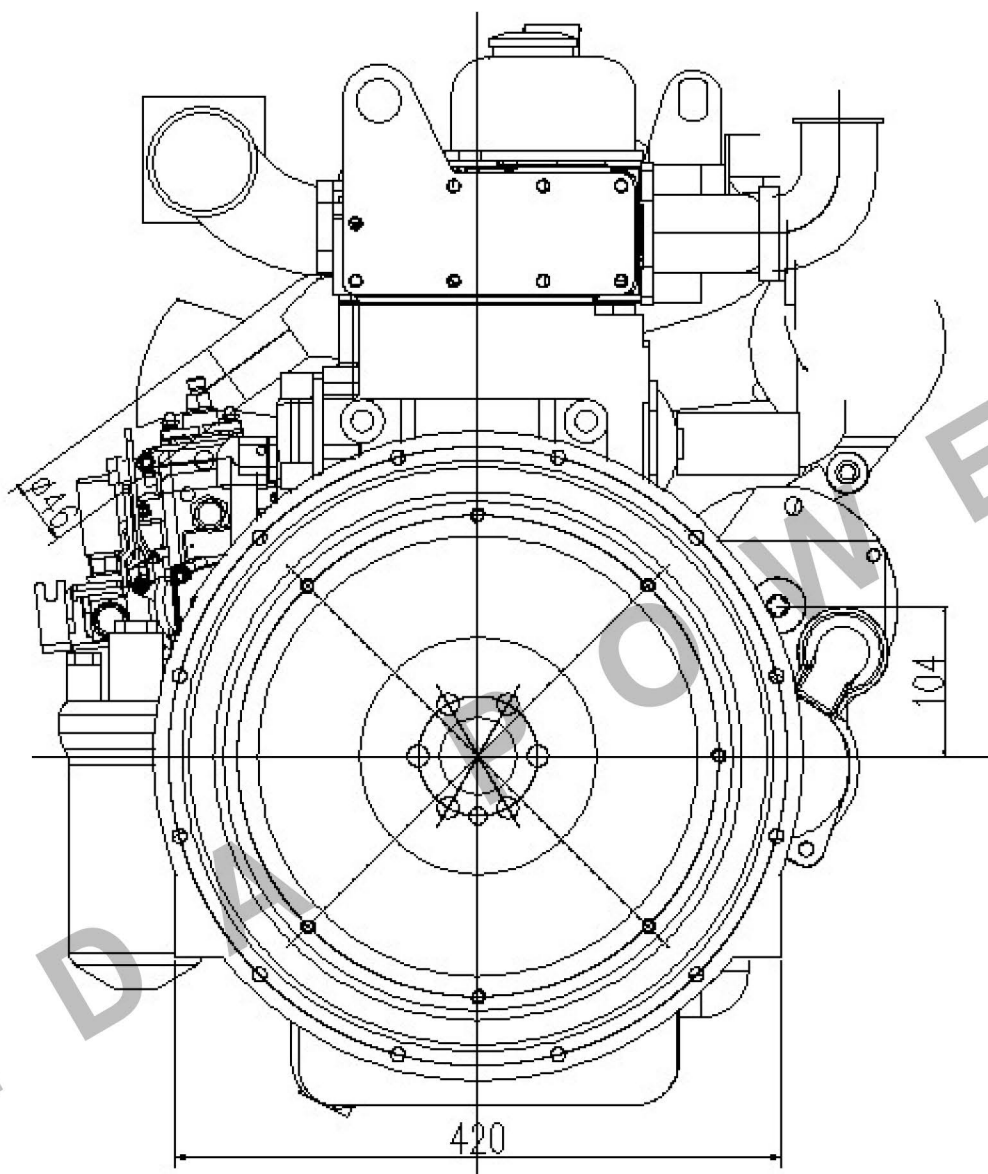


Figure IV Back view

Chapter 1 Technical Characteristics of Diesel Engine

1.1 Technical Performance Parameters of Diesel Engine

N o.	items	requirements	
1	Model	SD4102	SD4105
2	Type	Wet-sleeve, water-cooled, inline, four-stroke, natural aspiration	
3	Combustion chamber type	Direct injection	
4	Number of cylinders-bore × stroke(mm)	4—102×115	4—105×118
5	Work order	1—3—4—2	
6	Displacement (L)	3.76	4.087
7	Compression ratio	17.5±0.5:1	
8	Rated power (kw/r/min)	33/40/66 1500/1800/3000	38/45/70 1500/1800/3000
9	Characteristics fuel consumption (g/kwh)	≤230	≤230
10	Lubrication mode	Pressure and splash lubrication hybrid	
11	Oil, fuel consumption ratio	≤0.3	
12	Start mode	Electric start	
13	Crankshaft rotation direction (viewing toward after flywheel)	Counter-clock wise	
14	Outline size(mm)	822×569×835	822×569×835

No.	items	requirements	
1	Model	SD4102Z	SD4105Z
2	Type	Wet-sleeve, water-cooled, inline, four-stroke, pressure boost	
3	Combustion chamber type	Direct injection	
4	Number of cylinders-bore × stroke(mm)	4—102×115	4—105×118
5	Work order	1—3—4—2	
6	Displacement (L)	3.8	4.1
7	Compression ratio	17.5±0.5:1	
8	Rated power (kw/r/min)	42/48/84 1500/1800/3000	45/54/90 1500/1800/3000
9	Characteristics fuel consumption (g/kwh)	≤240	≤240
10	Lubrication mode	Pressure and splash lubrication hybrid	
11	Oil, fuel consumption ratio	≤0.3	
12	Start mode	Electric start	
13	Crankshaft rotation direction (viewing toward after flywheel)	Counter-clock wise	
14	Outline size(mm)	822×569×835	822×569×835

1.2 Main Technical Data of Diesel Engine

1. Valve timing

		4102	4105	4102Z	4105Z
Intake valve opens	bTDC	$24^{\circ} \pm 2^{\circ}$	$18^{\circ} \pm 2^{\circ}$	$12^{\circ} \pm 2^{\circ}$	$18^{\circ} \pm 2^{\circ}$
Intake valve closes	aBDC	$48^{\circ} \pm 2^{\circ}$	$54^{\circ} \pm 2^{\circ}$	$38^{\circ} \pm 2^{\circ}$	$54^{\circ} \pm 2^{\circ}$
Exhaust valve opens	bBDC	$65.3^{\circ} \pm 2^{\circ}$	$62^{\circ} \pm 2^{\circ}$	$50^{\circ} \pm 2^{\circ}$	$62^{\circ} \pm 2^{\circ}$
Exhaust valve closes	aTDC	$29.3^{\circ} \pm 2^{\circ}$	$18^{\circ} \pm 2^{\circ}$	$14^{\circ} \pm 2^{\circ}$	$18^{\circ} \pm 2^{\circ}$

2. Valve clearance (cold condition)

	4102	4102Z	4105	4105Z
Intake valve	0.30~0.35	0.30~0.35	0.35~0.40	0.40~0.45
Exhaust valve	0.35~0.40	0.35~0.40	0.40~0.45	0.35~0.40

3. Tightening torque of main bolt (N.m)

	4102	4105	4102Z	4105Z
Cylinder head bolts	160~200	120~140	160~200	185~205
The connecting rod bolt	100~140	120~140	100~140	120~140
Main bearing bolt	200~240	180~200	200~240	180~200
The flywheel bolt	100~140	170~190	100~140	170~190

4. Various temperature and pressure of diesel engine

	4102	4105	4102Z、4105Z
exhaust temperature (°C)	≤ 680	≤ 630	≤ 550
Lube. oil temperature (°C)	≤ 95	≤ 95	70~100
Cooling water outlet temperature	75~95		
Oil pressure	300~500kPa	294~490kPa	290~400kPa

Chapter 2 Operation and Safety Requirements Of Diesel Engines

2.1 Fuel, oil and cooling water

1. Fuel. Users can select the proper grade of fuel according to local ambient temperature. In general area in China, selection of fuel grade is on basis of GB252 light diesel fuel. Use grade “0” light diesel fuel in summer, while in winter, use grade “-10” light diesel fuel. Before being filled into the fuel tank, the diesel fuel should be settled for at least 27 hours and then draw out the upper part. When filling the fuel, silk cloth should be used to filter impurity. It will extend service life of fuel injection pumps and injectors by using the well settled diesel fuel.
2. Lubricating oil. You must select lubricating oil according to GB11122 diesel engine lubricating oil. Use grade 40 when the temperature is above 20°C, when it is 0~20°C, use grade 30 or 20W/40; when it is -20~-10°C in winter, use grade 10W/30, when it is below -20°C in alpine region, use grade 5W/30.
3. Cooling water. It is recommended to use rain water, city tap water or clean river water. It is unsuitable to use tap water coming from well or well water, because the water has more mineral substance and can produce more scale in the cooling system of diesel engines after using, thus affect the cooling effect and cause diesel engine failure. So, if have to use well water or spring water, it must be softened originally. There are two methods to soften the water: (1) boiling up the hot water; (2) add 20g caustic soda (NaOH) into 30L hard water to make up a solution. In cold winter, antifreeze can be added to the cooling system to protect it from freezing. The antifreeze used most widely is ethanediol (glycerol) water solution or alcohol. When it is hard for the diesel engine to start under low ambient temperature, heat the cooling water to about 80°C before filling it into the cooling system.

2.2 Examinations and preparations before starting

1. Check the tightness and reliability of all connecting parts. Check control levers (speed control lever and stopping lever) to see whether they can be moved freely.
2. Rotate the crankshaft several turns; be sure that all moving parts move freely.
3. Check the oil level in the oil sump and injection pump to see whether it is kept within two marks on the dipsticks. Make sure that the fuel tank has sufficient fuel and that the fuel pipelines are unblocked.
4. Open the fuel tank cock. check whether there is air in the fuel system. If necessary, loosen the vent screws on the fuel filter and injection pump, operate the priming pump on the fuel delivery pump by hand until the fuel flows out of these screws without bubbles, and retighten the vent screws. After that, loose the union nuts of injection pipes on the injectors and rotate the crankshaft to bleed air from injection

pipes, and then retighten the union nuts. Check all fittings of the fuel system to see whether there is any leakage at all joints.

5. Check the radiator to see whether it is filled fully with water and whether there is any leakage at all joints.
6. Check the accessories to see whether they are firmly and reliably connected. Check the electrical system to see whether the battery is fully charged, all wirings are correct and all connections are tightened.
7. Check the Power Supply switch to see whether the diesel generator is unload.

2.3 Starting of diesel engines

1. Turn the ignition switch to “preheating” position to heat the Preheating plug for 20~30s, when atmospheric temperature is low.(If the engine has Preheating plug)
2. Turn the ignition switch to “on” position. Press the starting button to start the engine. If it fails to start, release the button immediately. Wait 2~3 minutes before restarting the engine. If the engine fails to start after 3 attempts, check the cause and remedy the fault.
3. As soon as the engine has been started, release the press button immediately. Then turn the ignition switch to another position to charge the battery. At the same time ,check the operation of the engine to see whether there is any abnormal noise. Especially pay close attention to the readings of oil pressure gauge, which should be within specified pressure limits. Then warm the engine up without load .

2.4 Operating of diesel engines

1. Do not load the engine until the cooling water temperature is over 50℃ and the lube oil temperature is over 40℃. The engine should be operated under rated output before the outlet water temperature reaches approximately 80℃.
2. Increase or decrease the engine load and speed gradually and evenly. In normal case, do not load or unload the engine suddenly , especially engine speed upon 1500r/min.
3. During operation, observe the gauges on the instrument panel frequently where the readings should be within the specified limits. Pay close attention to the exhaust gas color and the operating noise. If there is any fault, stop the engine and inspect it.

2.5 Stopping of diesel engines

1. Before stopping, take off the load and reduce the engine speed gradually. Let it run at idling speed 900r/min for a while. Do not stop the engine until the outer temperature falls to below 70℃.
2. After stopping the engine, the ignition switch should be turned to the middle position.

3. In winter, when ambient temperature falls to below 5℃, after the engine stops and the cooling water temperature falls to below 60℃, open all drain cocks on the cylinder block and radiator to drain off all water remnant within the cooling system, in order to avoid damage of parts due to freezing. If anti-freezer is added to the cooling water, it is not necessary to drain off.

2.6 Safety requirements of diesel engines

1. When the diesel engine are used for the unit, all exposed rotating parts and transmission mechanisms that may pose a risk to the operator is must installed with protective devices alert tag. Protective casing, partitions and so on should be sufficiently rigid so that it can not be dismantled except using the tool.
2. Working condition for diesel engines must be well-ventilated. In places where there may be accumulation of flammable, toxic or asphyxiating gas, ventilation facilities should be installed.
3. Operating premises of diesel engine must be accompanied by anti-skid cover. Work access, control platforms, staircases and other operate regions must be installed with barriers to prevent the operator and goods from falling.
4. When the diesel engine is used, it must be equipped with water temperature table, hydraulic table, and other instrumentation and instruction system which are necessary to ensure the normal operation.
5. During the debugging operation of diesel engines, in the event of abnormal noise, speed, or a sudden lubrication interruption, or when the exhaust temperature exceeds the set limits in explosive environments, you should quickly cut off the fuel (press the parking handle, cut off fuel pipes etc.) and air intake (block it) or take other effective measures to stop the engine quickly.
6. Outlet position of refueling hole and vents of fuel tank should be away from high-temperature surfaces and electrical components, and the blocks should be to ensure that the turbulence of the fuel tank will not lead to fuel leaks.
7. Users should set warning signs in eye-catching location when profiling the radiator, warning the operator not to open the radiator cap immediately when engine is hot, so as not to burn high-temperature steam.
8. Diesel engine exhaust pipe and muffler have high-temperature surfaces, so the operator should be careful not to contact the above-mentioned high temperature surfaces in the hot engine, so as to prevent scalding. If users use insulation materials as a protective of exhaust pipe's and muffler's high-temperature surface, they should notice that fuel should not infiltrate insulation materials so as to prevent fire.
9. When diesel engines are used in places as follows, high-temperature surface should be cooled or effective protection facilities and warning signs should be set, and the insulation material should be non-combustible, and leaked fuel should not infiltrate to avoid fire.
①Marine ② Oil industry ③Coal mine④ chemical industry⑤Power generation
⑥ Fix

Chapter 3 Technical Maintenance of Diesel Engine

For reliable engine operation with less wear and longer service life, all maintenance work must be carried out as follows:

3.1 Routine maintenance

1. Check the oil level in the oil sump and it should be between two marks on the dipstick and near the upper one. For a new engine or the engine reused after stopping for a long period, the lube oil must be filled to the upper mark, and operate the engine at lower speed for 5~10 min, then stop the engine and measure the lube oil level once again.
2. Check the cooling water level in the radiator.
3. Check the lube oil level in the governor of the injection pump, replenish the oil to the specified level if need.
4. Eliminate oil, water and gas leakage of the engine.
5. Check tightness and correctness of all components attached to the engine.
6. Check tightness and reliability of engine foundation bolts and the connection between the engine and the driven machinery.
7. Keep the engine clean. Oil, water and dust gathered on the engine surface should be wiped away with a dry rag or cloth dipped in gasoline. Especially keep the electric equipment clean and dry and clean out the dust on the fins of the radiator.
8. For the new engine, after 50h trial running, renew the lube oil in the oil sump, fuel injection pump and governor, and flush the oil filter element, oil sump and oil strainer.
9. Promptly eliminate the troubles and faults found.

3.2 Maintenance after every 100 accumulated operating hours

Besides the “routine maintenance” work, it needs the following items:

1. Renew the oil in the sump.
2. Clean the oil filter or renew the paper element if necessary.
3. Clean the fuel filter or renew the paper element if necessary. (It may as well be replaced after every 200 accumulated operating hours.)
4. Check tightness of cylinder head bolts.
5. Check whether the valve clearance accord with the regulation, and adjust if necessary.
6. Check tension of the fan belt and adjust if necessary.
7. Inject ZG-4 calcium-based grease into the water pump bearing with oil gun.
8. Remove the dust which is in the dust disk of the intake pipe & air filter and is attached to the surface of paper element, and remove dust in exhaust pipe and

muffler.

9. Check the pressure and atomization performance of the injector after 200 hours' running accumulated, clean and adjust if necessary.
10. Check the voltage of the battery, the specific gravity of electrolytic liquid should be 1.27~1.28 (atmospheric temperature is 20°C). If it reduces to 1.14, it must be charged. Check up whether the level of electrolytic liquid surpasses the plate about 10~15mm, and add distilled water when inadequate.
11. To the parts which are disassembled for maintenance, they must be cleaned, and the correctness and reliability of the mounting position must be guaranteed when these parts are mounted again. After that start up the diesel engine and check the operation, exclude the failures and anomaly.

3.3 Maintenance after every 500 accumulated operating hours

Besides the work of maintenance after every 100 accumulated operating hours, the following items are needed:

1. Check the injection pressure and spray pattern of the injector. If necessary, dismantle the injector, clean the nozzle set and readjust the injection pressure.
2. Check fuel delivery of the injection pump, and recalibrate it on a test bench if possible. Check the injection timing, and readjust it if necessary.
3. Check the sealing of the intake and exhaust valves. If necessary, grind and lap the valve seats and readjust the valve lashes.
4. Check the tightness of the connecting-rod, main bearing cap and flywheel bolts.
5. Retighten the cylinder head bolts and adjust the valve lashes according to direction given in Section 4.
6. Clean or replace the paper element of air cleaner.
7. Clean the cooling system. The cleaning solution can be prepared by adding 150 grams of caustic soda (NaOH) to every litre of water. Before cleaning, drain the system completely and then fill in the same capacity with cleaning solution. Let it remain in the system for 8~12h. Then start the engine and run it until the temperature of cleaning solution reaches normal operating temperature. Stop the engine and drain the system immediately in order to avoid settling of scale within the system. Finally, flush the system with clean water until all sediment is flushed out.
8. Check whether the thermostat is in good order. Examine the water dropping out from a weep hole of the water pump. It is necessary to renew the water seal, if flowing out too much of water.
9. Check the wiring contacts of the electric equipment to see whether they are connected firmly and well. Burnt marks should be removed.
10. After every 1,000 accumulated operating hours, add the following items:
 - (1). Make an overall check on all parts and components. Make necessary adjustments and repairs.
 - (2). Dismantle the dynamo and starting motor. Clean out the dirty grease in the bearings and refill them with clean grease. Check the pinion of starting motor.

11. After every 1,500 accumulated operating hours, add the following items:

- (1). Remove the cylinder head; check the valve seats and other parts of cylinder head assembly.
- (2). Remove the carbon deposits on the surface of cylinder head, liner, piston and piston ring, etc, and wash down them.
- (3). Check and measure wear of the pistons and piston rings.
- (4). Check and measure wear of the cylinder liner.
- (5). Check and measure wear of the crankshaft main journals and crank pins. Clean lube oil passages of the crankshaft.
- (6). Check wear of the main bearing and connecting-rod bearing shells.
- (7). Check oil passages of the cylinder block and replace lube oil.

3.4 Preservation and storage of engine

If the engine is to be put out of service for a comparatively long period of time, it is necessary to preserve it according to the following procedure:

1. After the engine stops and still does not cool yet, drain out completely the lube oil, cold water and fuel immediately. Clean the oil sump and oil strainer.
2. Clean out the dust and oil on the engine surface. With antirust oil smear all the unpainted exposed surfaces of engine except rubber and plastic parts.
3. Heat the filtered lube oil to 110~120°C, until all bubbles in the surface of oil disappear. Then pour the dehydrated oil into the oil sump until oil level reaches upper mark, and turn the engine, in order to make sure that the lube system is completely filled up with this oil.
4. Pour some dehydrated oil into cylinder through injector——assembled holes on the cylinder head, and turn the crankshaft to make sure that the piston, piston ring, cylinder liner and valve seat are all covered with a layer of this oil.
5. Block the outlets of intake and exhaust manifolds (silencer) with wooden plugs or wrap up properly with plastic film in order to prevent any dust from getting in.
6. The engine should be stored in a clean room with good ventilation and low humidity, and the engine should be covered. Chemicals near it are strictly prohibited.

The preservation according to the above procedure may be valid for 3 months. Over this period, repeat the procedure.

Chapter 4 Adjustment of diesel engine

4.1 Adjustment of valve lash

When the engine is maintained and repaired, it is necessary to check and adjust the valve lashes. The recommended method of adjusting the valve system and valve lash is as follows:

1. Remove the cylinder head cover. Check and tighten the nuts fastening the rocker arm shaft stands.
2. Turn the crankshaft to make sure that the piston of 1st cylinder is at the compression TDC position. The timing mark on the inspection window of the flywheel housing exactly points to the "o" mark on the flywheel rim, or the "o" mark on the crankshaft pulley is aligned with the pointer on the cover of timing gear housing.
3. Slip a feeler gauge between the rocker arm and the tip of the intake or exhaust valve stems of the 1st cylinder respectively to
4. check and adjust the valve lashes. Then, four-cylinder machine according to the working cylinder 1-3-4-2 to turn around the crankshaft in 180 ° and adjust each cylinder valve clearance.

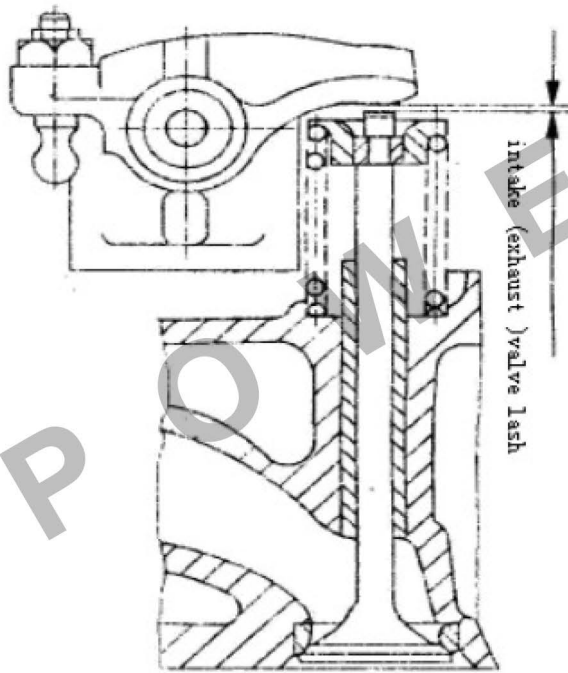


Figure 1

4.2 Adjustment of injection timing

To obtain the most economical specific fuel consumption and to ensure normal operation of the engine, injection timing should be adjusted properly. Right in front of the fuel delivery advance Angle shall be the check point on $16 + 1^\circ$

The adjusting method of injection timing is as follows:

1. Vent the air trapped in the fuel system, and turn the crankshaft to fill up the injection pump with fuel. Disconnect the injection pipe of the 1st cylinder, turn the crankshafts slowly in the direction of its rotation and at the same time observe the fuel level in the hole of fuel pipe union. When this fuel level just starts to rise, stop turn

the crankshaft immediately.

2. Check the timing mark on the injection window of flywheel housing to see whether it aligns with the correct granulated mark of specified advanced injection angle on the flywheel rim (or on the crankshaft pulley).
3. The advanced injection angle can be adjusted by loosening the three nuts on the triangular flange of injection pump and turn the injection pump shaft. Facing the front end of engines, when the injection pump rotates clockwise, the fuel injection will retard; while the injection pump rotates anticlockwise, the fuel injection will advance. After turn the injection pump once, it is must to tighten the three nuts and check the advance injection angle again until the advance injection angle fits the specified value.

4.3 Adjustment of injector

Injector test and adjustment must be performed on a injector tester in order to adjust injecting pressure, inspect spray pattern and remedy faults.

Too high or too low injector injecting pressure, and abnormal spray on damaged injector parts will cause engine troubles, such as black smoking, power and speed dropping, increasing exhaust temperature and diesel knocking, etc. Generally, the “shut off” method is recommended to check a faulty injector, i.e. loosen the nuts of injection pipe from the injector of every cylinder successively, and observe the exhaust smoke. When the cylinder with the faulty injector stops firing, black smoke would disappear and engine speed is not appreciably affected or not affected at all. It may also be checked by listening to the chattering action of the injector of every cylinder with the flywheel rotating. If the distinct clear sharp sound of certain cylinder could not be heard, the injector in this cylinder may be faulty.

1. Procedure of injector testing and adjustment

(1). Work the injector tester hand pump until the gauge pressure reaches about specified injection pressure. Then operate the hand pump slowly and adjust the injection pressure at which injection begins. The nozzle should not show any signs of leakage. If fuel drips around the nozzle tip after several tests, the nozzle set must be dismantled for cleaning and grinding. Then test it again.

(2). Adjust the injection pressure. Remove the pressure regulating nut of the injector, loosen or tighten the screw to make the injection pressure 13.7Mpa, then tighten the pressure regulating nut and conduct another retest.

(3). Work the hand pump at a rate of approximately 1 stroke per second and observe the nozzle spray. The fuel spray should be even and well atomized in a shape of cone. At any cross section of the cone, the atomized fuel should be finely and evenly distributed. Fuel droplets and irregular pattern which can be seen by naked eyes should not be present in the spray. There should be a distinct clear sharp sound at the end of injection. Generally, irregular pattern of the spray is caused by needle valve seizure, fuel dripping is generated by damaged conical sealing surface of needle valve and spray split results from carbon deposits on the tip of nozzle and its heat deformation.

2. Injector dismantlement and repair

(1). Before dismantling the injector, clean off the dirt gathered on it. Clamp the nozzle body in a vice lined copper sheets on its jaw with the nozzle upward. Turn off the nozzle cap nut and take out the nozzle set. Draw out the needle valve from the nozzle body and soak it in clean fuel oil. Then clamp the injector in the vice upside down again. Dismantle the adjusting nut, and adjusting screw, and then take out the injector spring and spindle.

(2). If the nozzle set is seized or emits fuel badly, it must be cleaned. Soak the seized nozzle in fuel oil for a while, and clamp the needle valve by pliers with cloth lined. Then rotate and draw it out slowly, just to avoid scratching its surface. Decarbonize the needle valve and nozzle body with wooden chip soaked in fuel oil. It is forbidden to clean them with metal chip. If the guiding surface of the needle valve and nozzle body are not smooth enough, it may be lapped with a little bit of clean fuel oil, then clean off any metal particulates in clean fuel. While lapping of needle valve with nozzle body, never knock the needle valve against the body.

4.4 Adjustment of lube oil pressure

See fig.2. Loosen the lock nut and turn the adjusting screw with a wrench to take the lube oil pressure within 200~400kPa (in cold state the pressure may be higher slightly). After adjustment, the pressure adjusting screw must be locked by the lock nut.

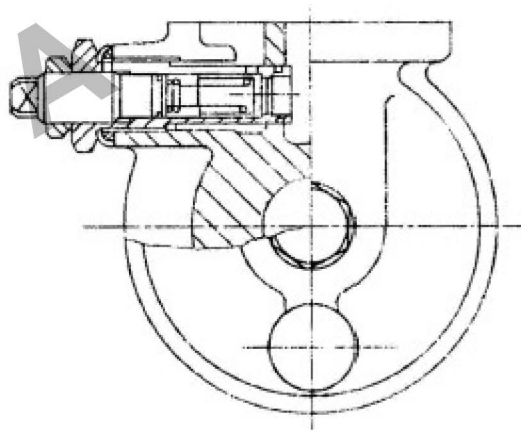


Fig.2 Adjustment of lube oil pressure

4.5 Adjustment of injection pump

The injection pump has tested and calibrated at the factory. If it is necessary to readjust, the readjustment must be performed in an injection pump test bench with a standard injector and injection pipes of standard length according to the instructions in Operation Manual of the injection pump.

Chapter 5 Construction of Diesel Engine

5.1 Cylinder head

Intake/exhaust valves, valve seats, valve guide pipe, valve springs, rock arms and supports are assembled on the cylinder head.

When assembling, cylinder head is fixed on the cylinder block with cylinder head bolts. A torsion spanner should be during tightening the bolts. The bolts are tightened several times in sequence shown in Fig. 3 until they reach the specified torque limit. After dismantling and assembling the cylinder head, it is necessary to shut down the engine when first warming up period is over. Retighten each bolts on the cylinder head according to the specified value of torque limit and readjust the valve lashes.

Injectors are inclined on the top of cylinder head with a angle to the centerline of cylinder. When injectors are assembled, the copper sleeve are put into the injectoe assembling holes, and the press plate shall be pressed evenly to avoid gas leakage, at the same time, the belve of the plate shall face down.

The intake and exhaust valves are made of different materials. Each couple of the valve and valve seat should be ground in order to prevent leakage.

It is necessary to grind when gas leaks out due to burning out, mechanical pitting and wear appeared on the sealing face of valve and valve seat. When grinding, apply a grinding paste (fine valve sand) on the conic sealing surface of valve. Then the valve and valve seat are lapped in pair until a even, continuous and lusterless sealing band appears. It is strictly forbidden that the grinding paste enters the valve guide. After lapping, clean the valve, valve seat and valve guide carefully. Wearing of the valve guide may cause the eccentric wear of valve sealing band which results in abnormal sealing. Pour some kerosene or diesel fuel into the gas passage, and observe whether there is any leakage, then check the valve sealing.

The sealing band of valve and valve seat is normally 1.2~1.7 mm in width. After a long period of service and regrinding many times, the width of valve sealing band may get wider, this may cause abnormal sealing. Being kept concentrically with respect to the valve guide hole, the contact band on valve seat is to be refaced by a reamer. Then gring the valve and valve seat in pair.

After service for a long period and regrinding many times, the sink age will increase. When it exceeds 2.0mm, replacing the valve seat should be considered.

Check the valve lashes frequently. The recommended adjusting method is shown on Section 1 of Chapter 4. If the lashes are too large, it may affect the correctness of valve timing and the noise level of valve device rises. On the contrary, it may cause leakage or valve burnt out.

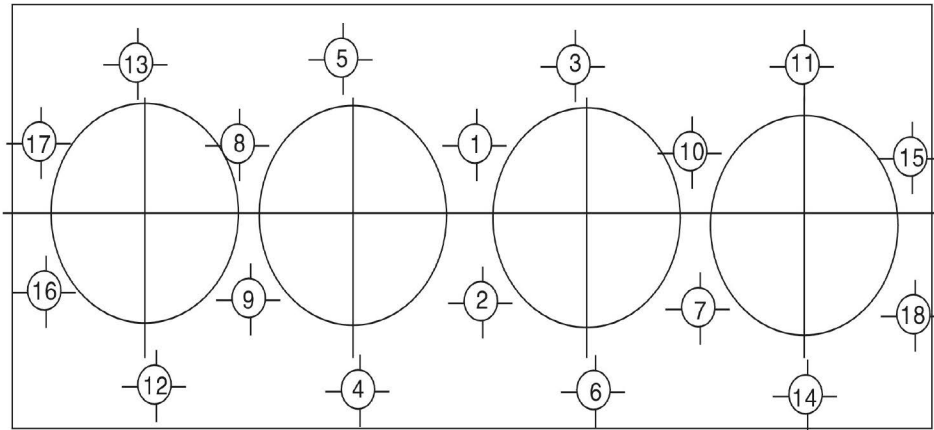


Fig.3 tightening sequence of cylinder head bolts

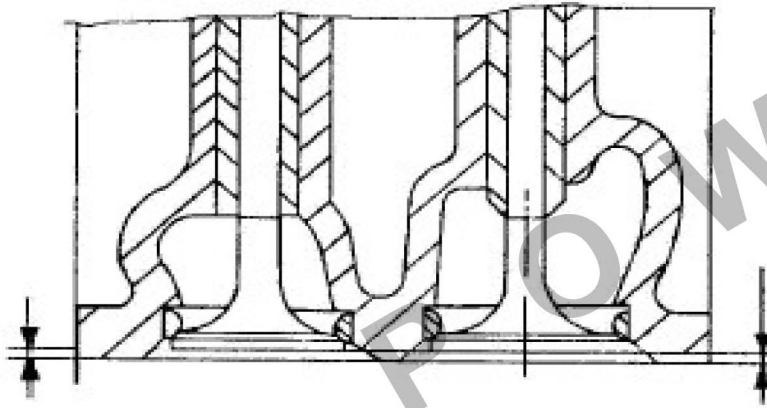


Fig.4 Valve sinkage

5.2 Cylinder block

The cylinder block uses a typical gantry structure.

Besides the fitting bores for the liner and the cylinder head bolt holes, on the top plane of the block there are holes leading water to the cylinder head. Near the rear end of the block there are channels delivering lube oil upwards to the cylinder head.

The water pump is mounted on the upper front face of cylinder block, and the gear system is on the lower part. The flywheel housing is installed at the rear face of the block. On the block bottom, there are a lube oil inlet, a hole for the lube oil pump and tap holes for installing the sump. There are a side cover and a breather on the left side of the block (facing to the front end). There are the lube oil filter, fuel filter and drain cock on the right side of this block. The main lube oil line and its branches are arranged in horizon. The lube oil passage delivering lube oil to the camshaft bushes are slant. When dismantling and repairing the diesel engine, flush all lube oil passage, and be sure that they are clean and locked. All passage plugs should be sealed reliably and leak proof.

The main bearings are of complete suspension-support type. Since the main bearing caps and cylinder block are matched to bore, the matching marks are both on

the block and main bearing caps. Misplacement or inverted installations, when dismantling for cleaning, make sure that the upper and lower bearing shells are in right places (the upper shell with an oil groove). The crankshaft thrust plates are assembled on the last main bearing with an upper piece and a lower piece on each side. The thrust plates bear the axial force from the crankshaft. There are oil channels on its operating surface which should be located against the thrust planes on the crank, and its back surface if smooth. Never locate them in reverse. When tightening the main bearing bolts, two bolts on the bearing cap should be tightened several times in turn. Before tightening the main bearing cap, strike the crankshaft forward and backward in order to keep the upper and lower thrust plates in the same plane. Then tighten the bolts until they reach the specified tightening torque. When completing the crankshaft assembly, turn it at the flywheel end by hand to check whether it can be moved freely.

The liner is slipped into the cylinder bore vertically so that deformation of the liner may be avoided. The liner flange plane should protrude out the top plane of cylinder block by 0.04~0.12mm to keep an excellent sealing between the cylinder liner and cylinder head, as shown in Fig.5.

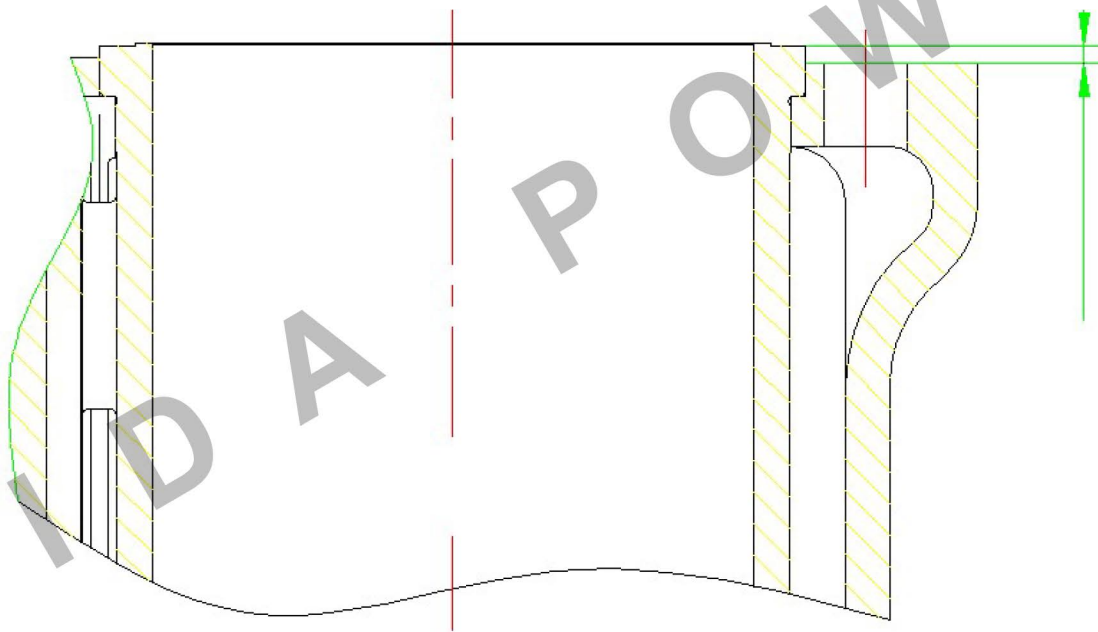


Fig.5 protruding height of the liner flange plane relative to the plane of cylinder block

Oil sump is stretched by cast aluminum or steel plate. When you clean the inside of the oil sump, be careful not to leave impurity on the wall, in order to avoid blockages in the copper wire net of the oil collector and oil filter element.

5.3 Piston and connecting-rod

The piston and connecting-rod assembly comprises the piston, piston rings, piston pin, retaining rings, connecting-rod, connecting rod cap, connecting-rod bolts and

connecting-rod bearing shells and bush, etc. The mass difference of piston and connecting-rod assemblies in the same engine should be within 20g, and that of the connecting rod assembly not exceed 10g.

Combustion chamber on the top of the piston is ω type. Skirt of the piston is machined in a shape of barrel along the height direction and ellipse along the circumference. There are two compression ring grooves and an oil ring groove machined in the piston.

All of the compression rings are made of alloy cast iron. The outer circle surface of the first ring is plated with porous chrome in order to decrease the wear between the cylinder liner and piston ring. The second ring has a conical surface. When assembling, the surface marked with a sign "up" should be kept against the top of piston and be careful to avoid assembling in reverse.

The oil-control ring is of tensioning ring type. The radial force of oil ring is still kept while decreasing the elasticity due to wear. Thus the service life of oil ring is prolonged.

Check the ring end gap before assembling the piston ring. The method measuring this gap is recommended as follows: press down the piston ring evenly into the cylinder liner by 15~20mm from the top surface of liner. Measure the clearance with a feeler gauge. In normal case, the measuring value should be specified value in Chapter 1 (Fig.6). In case the gap value is less, enlarge it by a file. If it is excess, replace it with another one. In addition, measurement should be made with a feeler (gauge) to check the side clearance between the piston ring and ring groove. The side clearance should be specified value in Chapter 1 as shown in Fig. 6.

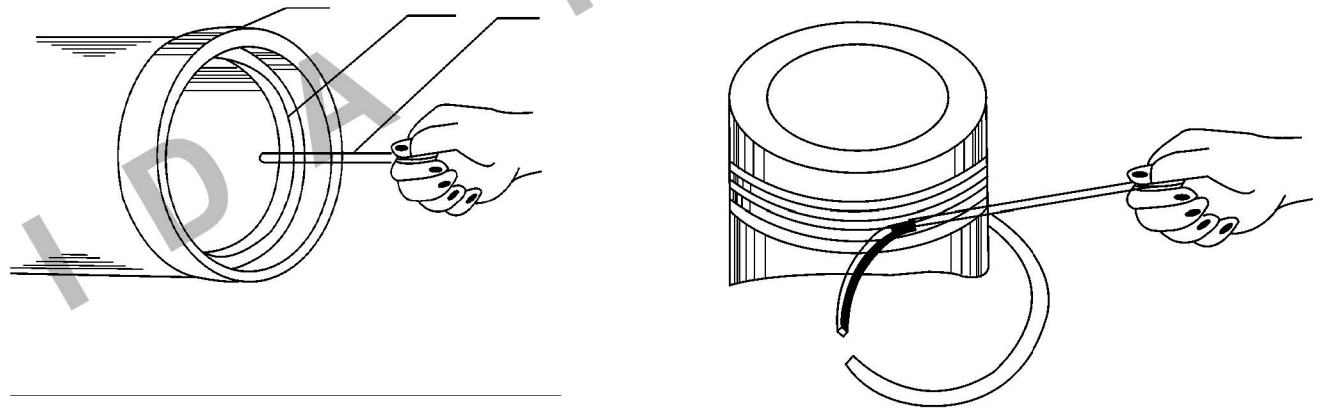


Fig.6 measurement of piston ring end gap and side surface gap

When dismantling and assembling the piston ring, a special tool may be used. The ring end gap of piston rings should be set off with each other by 120° to prevent being in line with the piston pin seat hole.

If the piston ring is seized and could not move when checking, soak it in diesel fuel (kerosene or gasoline) for 24h or more. Then knock the piston ring slightly to make it become flexible of itself. On getting out the piston ring, clean it in diesel fuel or carbon tetrachloride.

Check the piston to see whether there are any cracks or scars. Change the defective

piston and renew its rings.

The cross section of the connecting-rod is I-shaped, with the splitting surface of large end being perpendicular to the center line of connecting-rod. Boring the connecting-rod hole and connecting-rod cap must be mated. Therefore when assembling, pay close attention to the mating marks on both the connecting-rod and connecting-rod cap in order to avoid making mistakes. The connecting-rod bearing shell is made of steel with high tin aluminum alloy. When the clearance between the connecting-rod bushes and crankshaft journal exceeds the specified value after wearing or severe stripping and burning occur on their surfaces, they must be renewed in pair.

During engine overhaul or renewing the connecting-rod, check the axis parallelism of the connecting-rod small end to the large end, which is specified to be within 0.01mm/100mm (both in vertical and horizontal direction). If it goes beyond the scope, alignment should be made.

Before dismantling the piston and connecting-rod assembly in cylinder liner or assembling, it is necessary to scrape and clean the carbon deposit and greasy dirt on the top part of cylinder liner. Before assembling, smear some clean oil on the cylinder liner bore, external surface of piston and piston rings, connecting-rod bearing shells and crankshaft journal. Then place the piston guide sleeve in the cylinder liner, fit the piston and connecting-rod assembly into the cylinder liner carefully, and tighten in turn the connecting-rod bolts according to the specified tightening torque limit in several separate times. After finishing the assembly, turn the crankshaft; be sure that it rotates smoothly.

5.4 Crankshaft and flywheel

The crankshaft timing gear and pulley are fitted on the front output end of crankshaft. Positioned by the locating pin, the flywheel is fitted on the rear end flange of the crankshaft with six bolts tightened according to the specified torque value. An angular calibrating line is marked on the crankshaft pulley and a pointer, which is fitted on the cover of the timing gear housing, indicates the reading of advanced injection angle.

A flywheel gear ring is bound on the outside diameter of flywheel in shrinking fit. A calibrating line, which provides observation for advanced injection angle, is marked on the flywheel.

5.5 Camshaft

There is a gear driving the lube oil pump in the front of the last set of cams (facing to the front end). When the camshaft revolves, the cam on the shaft drives the tappets, push rods, valve rocker arms and valves, which respectively control the intake and exhaust valves for each cylinder.

There is a thrust flange at the front end of camshaft, and a thrust plate of camshaft

is located at the front end to control the camshaft axial moving. The lube oil is delivered to the camshaft bushings separately through the main oil line. Before assembling the front bushing of camshaft, check whether the oil holes on the bushing and oil passage in the cylinder block communicate with each other.

The axis of the tappet deviates from the center line of cam width. During operating, the tappet rotates so as to provide an even wearing on the bottom surface and the cylindrical surface of tappet.

5.6 Gear transmission system

The gear transmission system consists of the crankshaft timing gear, timing idler, camshaft timing gear, injection pump timing gear and hydraulic pump gear.

Except the hydraulic pump gear, all the timing gears are all marked with timing signs which, when assembling, should align with each other at the meshing position (the single tooth marked with a sign is inlaid between the two adjacent marked teeth) in order to ensure the movement relationship of all moving parts, as shown in Fig.7.

Special tools are necessary for dismantling or assembling the crankshaft timing gear. The camshaft timing gear can be got out by two bolts M8 on the gear spoke which are turned staggeringly and evenly. The timing idler is located on the cylinder block by slide fit. The injection pump timing gear is assembled on the timing gear seat which is fixed on the camshaft of the injection pump. Whenever three bolts setting the injection pump gear are loosened, the injection pump gear can be drawn out. The injection pump gear is pushed out when the three bolts M8X35 are staggeringly tightened on the gear seat.

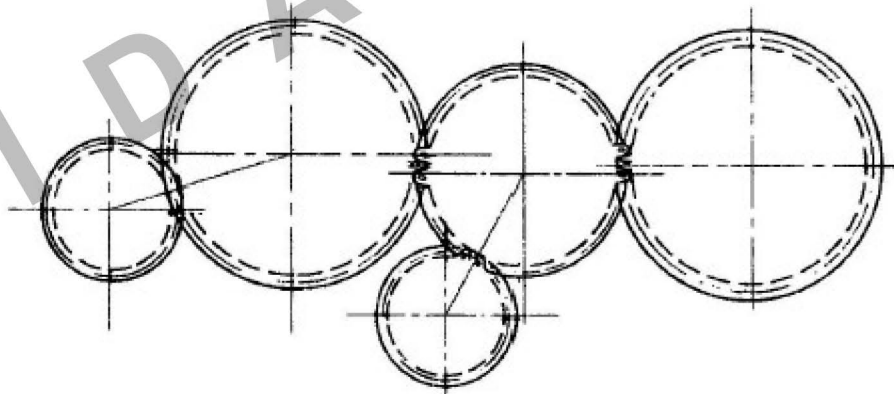


Fig.7 timing gear meshing signs

5.7 Fuel and governing system

The fuel and governing system is the main operating section of the diesel engine. It is composed of the fuel delivery pump, fuel filter, injection pump; governor, fuel injection and fuel return pipes, etc. as shown in Fig.8.

The fuel is pumped by the fuel delivery pump from the fuel tank into the injection

pump through the fuel filter. The diesel fuel is delivered through the injection pipe under high-pressure produced in the pump, and is then atomized by the injector before burning in the combustion chamber.

The fuel delivery pump is a single-acting piston type pump located on the outside of the injection pump. The eccentric cam, which is set on the camshaft of injection pump, drives the fuel delivery pump, which finally presses the fuel into the fuel cavity in the injection pump.

The injection pump has been calibrated by the manufacturer. Be sure not to dismantle it at will. When the dismantlement and adjustment are required, it is forbidden to interchange the plunger sets and discharging valve sets, and be sure to keep clean when assembling.

The all speed mechanical-centrifugal governor is applied. The governing handle can be operated to control the speed of diesel engine. When the governing handle is turned in the direction of tightening the governing spring, the fuel supply would increase and the engine speed would be up consequently. When this fuel supply would decrease and the relevant engine speed would go down. Do not move either the high speed or the idling speed set screws or screw the maximal fuel supply set screw on the governor at will during operating.

On the governor housing, a stop handle is mounted which, if necessary, can be operated to stop the engine at emergency.

The needle valve and its body are a precise set lapped in couple, therefore, close attention is paid to that, when dismantling and assembling them. Be sure not to interchange them and to keep them clean.

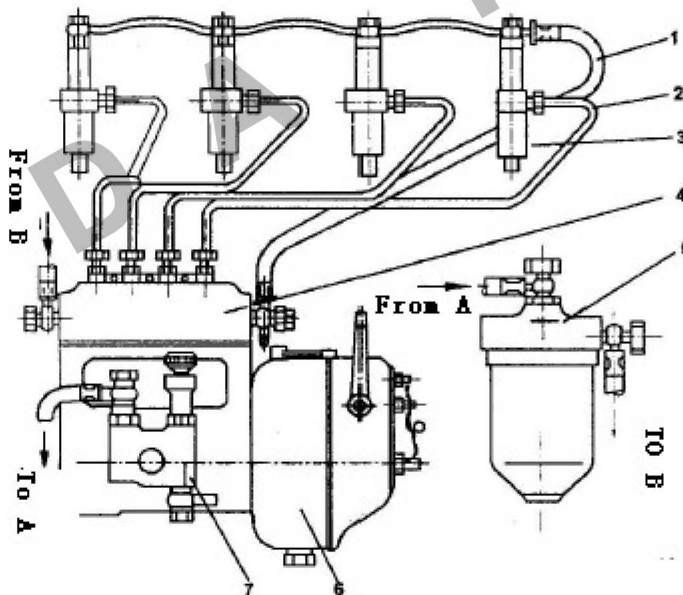


Fig.8 fuel and governing system

- 1. Fuel return pipe 2. Fuel injection pipe 3. Injector 4. Injection pump
5. Fuel filter 6. governor 7. Fuel delivery pump**

5.8 Lubricating system

The lubricating system is composed of the strainer, lube oil pump, oil filter and pipelines, as shown in Fig.11.

The engine adopts pressure and splash lubrication. The pressure lubrication is applied to the main bearing, connecting-rod bearing, camshaft bushing. The cylinder sleeve, piston pin, connecting-rod bushing, cam and its tappet, as well as valve and its guide are lubricated by splashed oil spray. The bearings for the water pump shaft are lubricated regularly by adding lubricating grease.

The lube oil is sucked up to the lube oil pump from the oil sump through the strainer and the oil inlet pipe, and pumped into main oil line through the oil filter. One path of the lube oil lubricates the main bearing and the connecting-rod bearing through the oil hole on the crankshaft; other path of the oil lubricates the camshaft bushing, and also the oil is supplied intermittently to the rocker arm shaft bushing through the eccentric oil channel in the rear journal of the camshaft; and the third path of the oil is fed to the timing idler bearing. The lube oil pump is of slantingly mounted type. A single stage paper cartridge oil pump is used. The filter element can be replaced regularly. In case of blocking up during operation, the oil flows into the main oil line by opening the safety valve while the oil filter loses the function of filtration, so it is necessary for the cartridge to be cleaned or replaced regularly according to the maintenance.

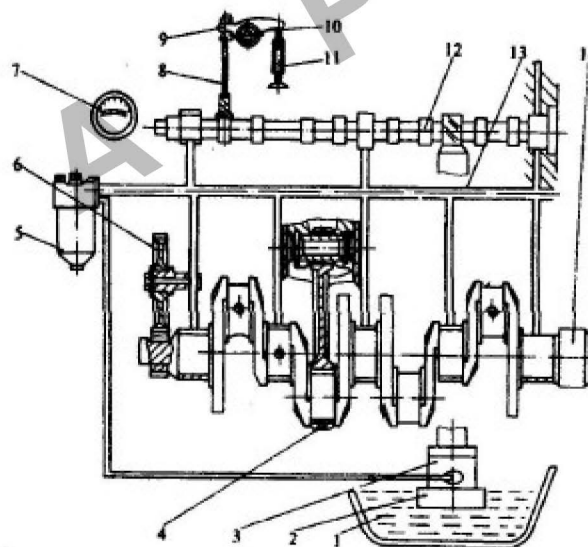


Fig.9 lubricating system

1. Oil sump 2. Strainer 3. Lube oil pump 4. Piston and connecting-rod assembly and cylinder liner 5. Lube oil filter 6. Gear train 7. Oil pressure gauge 8. Rocker arm 9. Valve push rod, valve tappet and block hole for tappet 10. Rocker arm shaft 11. Valve and valve guide 12. Camshaft and bushing 13. Oil lines in the block 14. Crankshaft and bearing

5.9 Cooling system

The cooling system is a forced circular water cooled type, as shown in Fig.10. The system consists of a radiator, water pump, cooling fan, thermostat and diversion hood, etc.

The cooling water, pumped from the radiator into the cylinder block water gallery, flows tangentially and round to the cylinder liner, then up to the cylinder head. The hot water from the front end of the cylinder head flows back into the radiator through the thermostat and outlet water pipe. When the temperature of cooling water is below 70°C, the thermostat closes, and the cooling water will be short-cut for circulation from the branch water pipe on the front end of the cylinder head to the water pump inlet pipe and the water pump; when the temperature of the cooling water is above 70~80°C, the thermostat opens, and the cooling water flows into the upper part of the radiator through the thermostat and flows downward the thermostat and flows downward along the flat-tube into the lower part of the radiator, during which the cooling water is cooled by the fan and completes the regular circulation. The cooling fan can be of either suction or blast type according to its application.

The centrifugal water pump is driven by the fan belt on the crankshaft pulley. In case of severe water dropping out from the weep hole at the lower part of the pump housing due to the damage of water seal during operation, it is necessary to replace the water seat but blocking the weep hole at the time of leakage is not permitted, or the water will enter the bearings, which causes their quick wear. Replacement must be considered while regularly with ZC-4 calcium based grease which amounts to about 1/2~1/3 of the capacity of bearing cavity according to the maintenance. The bearing will be overheated with excessive grease. The single valve type thermostat with corrugated pipe is filled with temperature-sensitive fluid which can automatically control the valve opening and closing.

The fan belt must be checked and adjusted regularly for its tension according to the procedures for the maintenance. The slack is 10~20mm when pressing the belt between the fan and the dynamo pulleys.

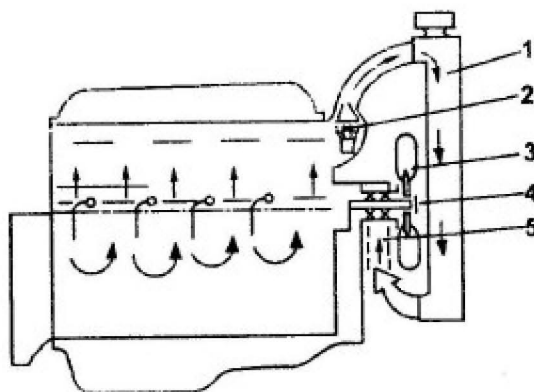


Fig.10 cooling system

1. Radiator 2. Thermostat 3. Cooling fan 4. Water pump 5. Inlet water pump

5.10 Electric system

The electric system is composed of the battery, starting motor, dynamo, electro thermal plug, starting button and instrument, etc., as shown in Fig.11.

The parallel excited silicon rectifying dynamo comprises the three —phase alternator and silicon diode rectifier. Be careful that the armature must be negative pole grounded, or the dynamo will be damaged. Refer to operation and maintenance manual for dynamo for the operation and maintenance of the dynamo.

After turning on the start switch, the flywheel gear is engaged with the motor pinion by the solenoid; meanwhile the flywheel is driven by closing the current circuit of starting motor.

As soon as the engine is started, the starting switch must be turned off immediately. Then the core along with the pinion returns to the original place under the actuation of spring. The continuous working time for the starting motor should not exceed 15 seconds. The interval between two starting operations is 2~3 minutes. It is necessary to check and eliminate the faults in case of starting failure for three attempts. The electrifying time of the air heater each time during operation is not permitted to be over 30 seconds.

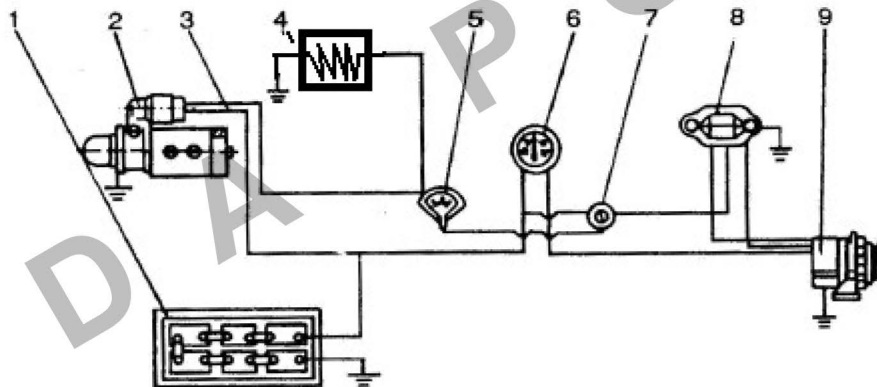


Fig.11 electric systems

1. Battery 2. Starting motor 3. Wire 4. air heater 5. Preheating and starting switch 6. Galvanometers 7. Ignition switch 8. Regulator 9. Dynamo

5.11 Pressurization、turbocharged system

Pressurization system main consists of turbocharger、oil pipe in and out. Turbocharged system mainly by the supercharger empty the supercharger oil pipe and cold composition, turbocharger consists of turbine and supercharging compressor. It works as follows: turbine inlet casing Connected with Diesel exhaust manifold, Have certain high temperature of the energy of the waste gas High speed into the turbine cavity push in the same shaft turbine and high speed rotary compressor impellers,

High speed rotary compressor impeller into the cylinder of fresh air flow and pressure be increased, To improve the power of diesel engine create conditions. Turbostructure see the **Fig.12**

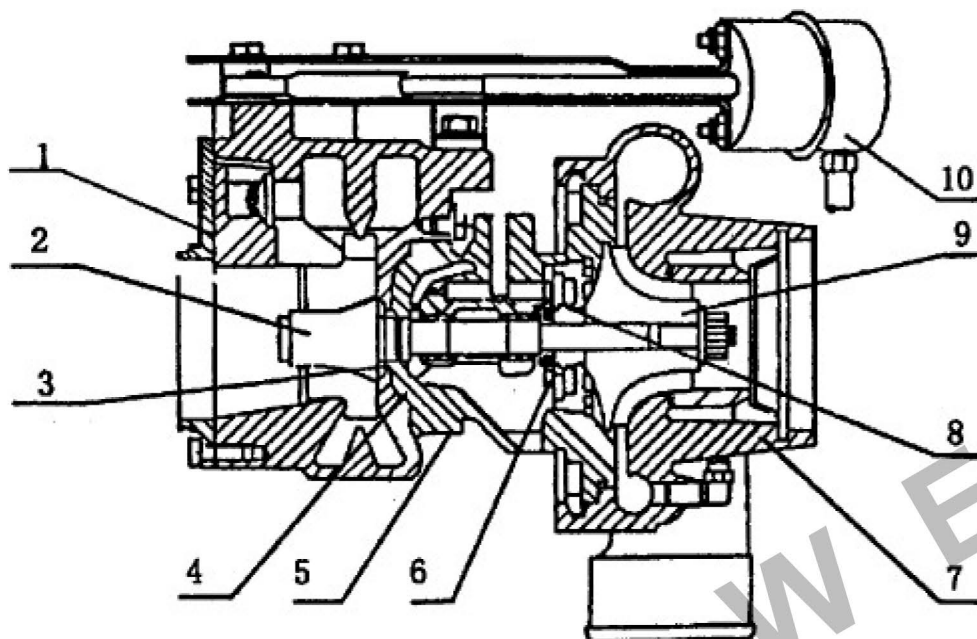


Fig.12

1-turbine shroud 2-components of turbocharger 3-Turbine sealing ring
4-floating bearing 5-middle case 6-thrust bearing 7-compressor casing
8-compressor sealing ring 9-blower impeller 10-air evacuation valve

Dectorate in front of the cold water tank empty fuction is use of diesel engine colling fan and vehicle head-on the sway of the wind colling when to reduce diesel engine temperature increase air density, To increase the diesel engine power to improve performance.

Because the supercharger turbo compressor rotor shaft speed work every minute as high as 200000turn around,Therefore guarantee the supercharger rotor floating bearing lubrication and cleaning lubricating oil is very important, Also note the supercharger tubing installation in importance.

Chapter 6 Faults and Remedies for Diesel Engine

6.1 Hard or refuse to start

Causes	Remedies
1. Fuel filters and fuel pipelines blocked.	1. Clean.
2. Air trapped in fuel system.	2. Exhaust air and tighten all fuel pipeline connector.
3. Advanced fuel injection angle incorrect.	3. Readjust it according to specifications.
4. Fuel spray abnormal.	4. Readjust fuel injection pressure according to specifications and clean or replace injector needle valve sets.
5. Compression pressure low.	5. Check or replace piston rings & cylinder liners. Grind valves. Cylinder head nuts should be tightened in case of leakage on cylinder head gaskets.
6. Valve lash incorrect.	6. Adjust it according to specifications and align gear marks.
7. Battery charge insufficient.	7. Charge it.
8. Wire connection loosened.	8. Check and tighten wire connections. Clean up contact points.
9. Ambient temperature too low, and oil too viscous.	9. Preheat cooling water & lube oil.

6.2 Insufficient

Causes	Remedies
1. Compression pressure inside cylinders too low.	1. Refer to item 5 in Paragraph 1 and replace components exceeding wear limits.
2. Advanced fuel injection angle incorrect.	2. Adjust it according to specifications.
3. Valve lash incorrect.	3. Adjust it according to specifications.
4. Fuel supply for each cylinder unbalanced.	4. Adjust fuel injection pumps to proper supply.
5. Air filter clogged.	5. Clean.
6. Fuel injection pumps, fuel injector sets worn off or fuel injection pressure incorrect.	6. Replace them with new sets, adjust fuel injection pressure and check fuel spray.
7. Rotation speed incorrect.	7. Adjust it with governing handle in order to reach specified speed.

6.3 Smoking exhaust

Causes	Remedies
- Engines overloaded. - Fuel injection not well atomized. - Fuel unqualified. - Combustion incomplete.	- Reduce the load properly and in case of unsuited matching adjustment should be made. - Check the injection pressure and fuel spray. Replace then in case of damage. - Use qualified fuel. - Mainly caused by unqualified fuel injectors, incorrect advanced fuel injection angle, leakage at cylinder head gaskets and low compression pressure. Remedy in accordance with specified problems.

6.4 Knocking noise in engine

Causes	Remedies
- Advanced fuel injection angle incorrect. - Air trapped in fuel systems. - Fuel supply for each cylinder unbalanced. - Fuel unqualified. - Wear of certain components exceeds limits.	- Readjust it according to specifications. - Exhaust it. - Readjust fuel supply. - Use qualified supply. - Replace them.

6.5 Oil insufficient or no pressure

Causes	Remedies
- Oil level in oil sumps too low. - Serious leakage from oil pipelines. - Oil strainers, oil filters and pipelines clogged. - Oil gauges damaged or gauge line clogged. - Oil too thin. - Oil pump gears seriously worn off, with excessive clearance. - Pressure relief valves of oil filter cease to function. - Main bearings, connecting-rod bearings and camshaft bushings seriously worn off with excessive clearance.	- Add oil up to mark line on dip sticks. - Eliminate leakage. - Clean and replace elements if necessary. - Check and replace elements if necessary. - Use qualified oil. - Adjust the clearance or replace them. - Check and repair or readjust them. - Check and repair or replace them.

6.6 Overheating of engine

Causes	Remedies
- Temperature of cooling water too high: - Insufficient cooling water or vapor lock in water pipes. - Bad working state of water pump. - Water scale in cooling systems too thick. - Oil temperature too high: - Insufficient or excessive oil. - Oil pressure too low with insufficient flow. - Engines overloaded.	(1) Fill the tank to make cooling water level higher than the center line of water pump. (2) Check water pump clearance and tightness of belts. Eliminate leakage. (3) Remove it. (1) check whether the oil level is between the dip stick scale lines. (2) Refer to section 5. - Relieve load.

6.7 Engine running-away

Causes	Remedies
- Malfunction of governors. - Control rod fuel injection pump gets stuck. - Injection pump delivery too much - Excessive oil burnt.	- Stop engines immediately, check and repair. - Stop engines immediately, check and repair. - Stop the engine and readjust injection pump delivery. - Stop engines immediately, check and repair.

Appendix:

Wearing parts of diesel engine

No.	Name	No.	Name
1	Cylinder liner	10	Water sealed ring
2	Piston ring	11	Fan belt
3	Piston	12	Bearing, bushing
4	Oil seal	13	Injector coupler
5	Generator	14	Injection pump plunger coupler
6	Starting motor	15	Injection pump valve coupler
7	Valve	16	Various gaskets
8	Valve seat ring	17	Filters filter
9	Valve guide pipe		

Service life of diesel engine wearing parts is closely related to users' operation and maintenance. Operating and making maintenance strictly according to product manual can extend the engine's service life; if not, its service life may be shortened seriously. Users should pay close attention to proper operation and maintenance of diesel engine.