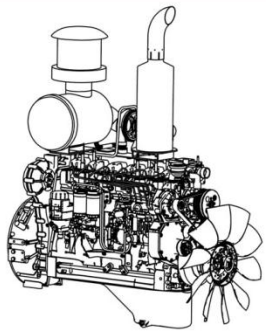
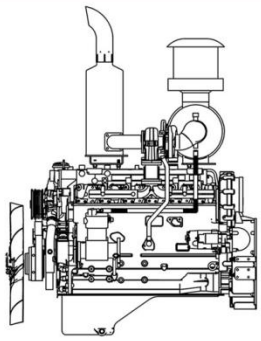
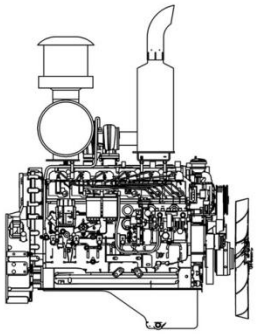
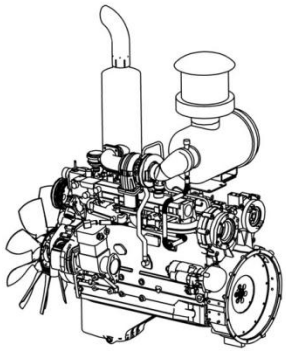
Service Manual for WP6 Diesel Engine









SDLG 山东临工

Special Tips

- Operators must carefully read Diesel Engine Instruction Manual, all technical operations and maintenance regulations specified in the manual must be strictly complied with, and also pay attention to warning instructions and labels;
- Each diesel engine has passed strict and specified pre-delivery test, accelerator throttle has been lead sealed, do not casually remove the lead seal to increase throttle;
- Turbocharger rotor is high-speed rotating component, it is strictly prohibited to approach the intake port of turbocharger with any removable object (such as hand, tools, gauze, etc.) when the engine is running, in order to avoid human body damage or machine damage; For rotor module, it can only be disassembled by qualified maintenance personnel in professional maintenance site authorized by Weichai Power;
- Various bolts like diesel engine main bearing bolts and connecting rod bolts have strict torque requirements and limiting use times, users are not allowed to loosen or remove the bolts casually; connecting rod bolts are disposable bolts, do not reuse them;
- The added engine oil or diesel oil, whose brand must complied with requirements specified in operation and maintenance manual, moreover, all oil must be filtered with specialized clean filter, fuel must be subsided for more than 72 hours; Before operating the machine each time, check and make sure coolant level and engine oil level meet the requirements;
- Test run a new machine for 50 hours (run-in period) before putting it into operation, replace engine oil and engine oil filter element after run-in period;
- Increase the engine rotating speed slowly after cold starting, neither increase the speed abruptly or long-term idling is proper; After heavy load running, do not stop the engine immediately (peculiar circumstance exception), you should run it at low speed for 5~10 minutes before shutting down;
- After parking, if the ambient temperature is likely to be lower than 0^{o}C and there is unused coolant in the machine, please be sure to drain the coolant in water tank and diesel engine out;
- It is forbidden to run the diesel engine without an air filter to prevent unfiltered air entering into cylinders. Air filter should be enlarged or replaced more frequently when operating in severe conditions, in order to prevent engine failure, such as premature wear;
- Overhaul of electrical components must be carried out by electrical professionals.

Preface

WP6 mechanical pump series diesel engine has the features of compact structure, reliable service, excellent dynamic property and economic efficiency, rapid start, easy operation and convenient maintenance. WP can achieve advanced emissions target, definitely an ideal engine for automobile, construction machinery, agricultural machinery, building machinery and main and auxiliary equipment of generator set. To help the vast consumers quickly learn and correctly use WP6 engine, we provide you this service manual.

This manual briefly introduced the technical parameters, structural features, operation and maintenance methods, and overhaul tips of WP6 mechanical pump series diesel engine, for users to refer to; provided service technologies of diesel engine to help serviceman profoundly understand disassembly and assembly methods of the engine, also laid a solid technical foundation for serviceman to do troubleshooting. Please carefully read this manual to make the best use of it. With development of product, some structures may be improved, so there might be a slight difference between technical specifications and graphic descriptions in this manual and the real machine in use, users should pay attention to the differences despite our company will continuously do the complements in the successive versions.

SDLG

Technology Department

June 2014

CONTENTS

1 Usage Instructions for Diesel Engine

11 External View of Diesel Engine

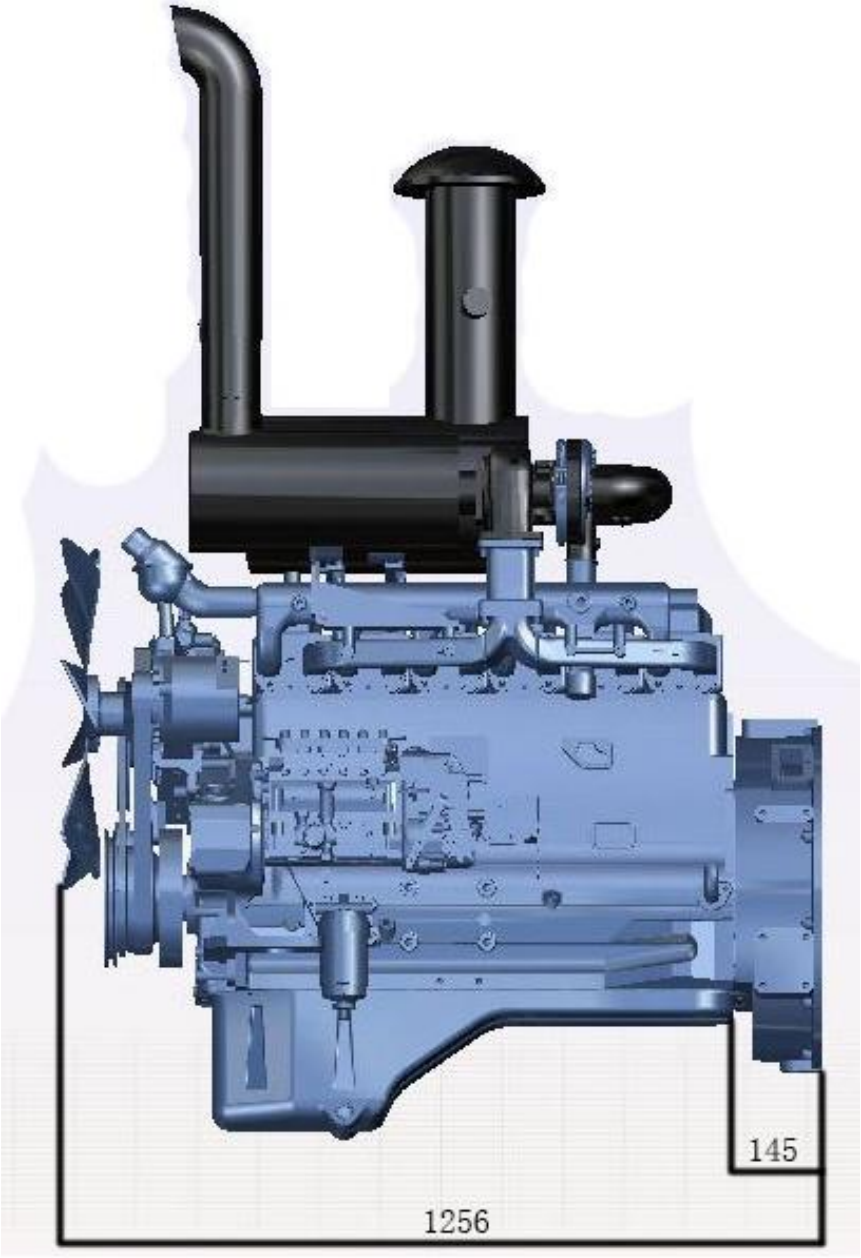


Fig. 1-1 WP6 mechanical pump series diesel engine (View 1)

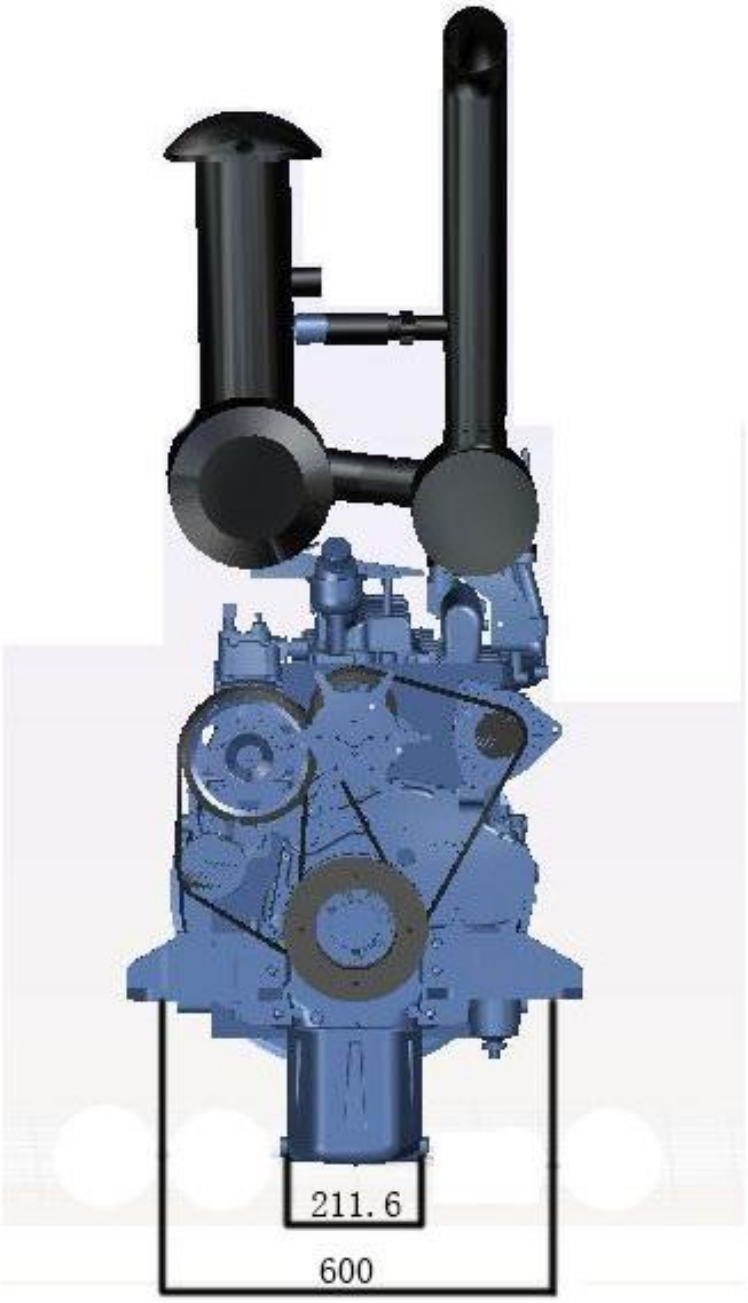


Fig. 1-2 WP6 mechanical pump series diesel engine (View 2)

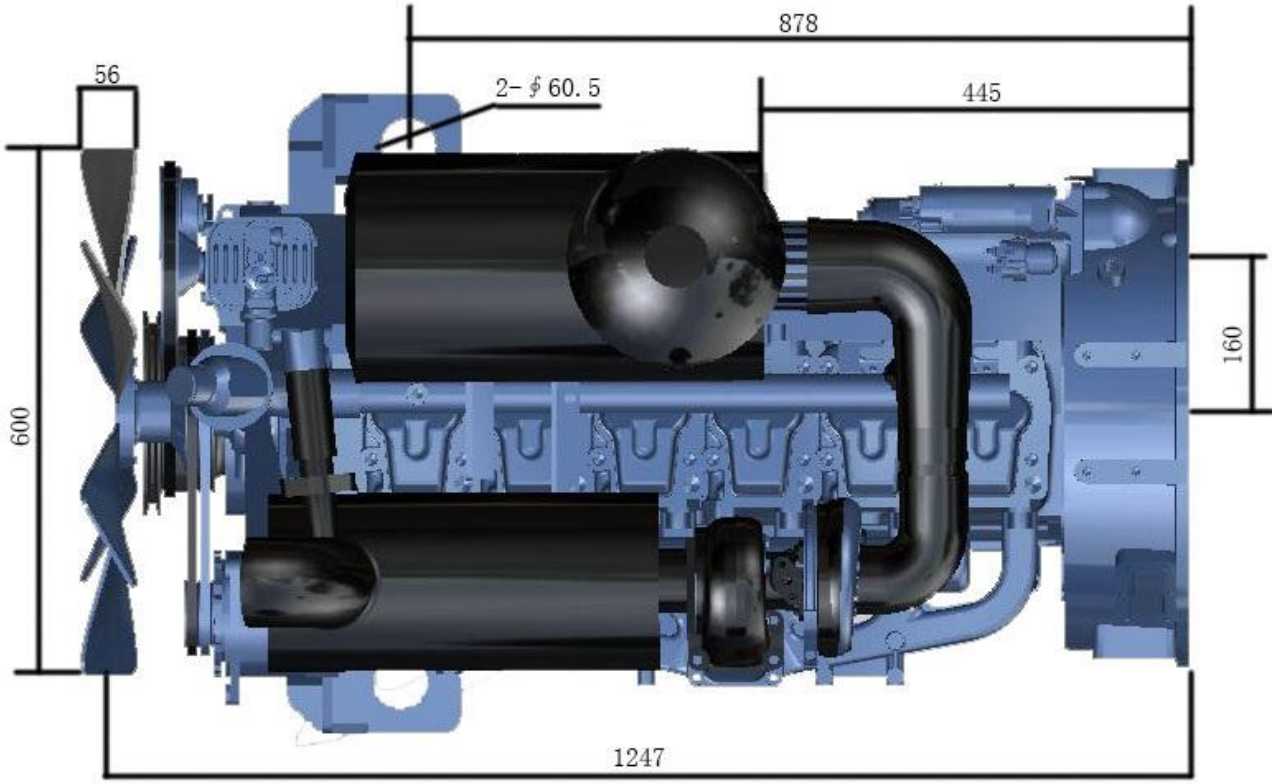


Fig. 1-3 WP6 mechanical pump series diesel engine (View 3)

12 Diesel Engine Model Composition and Significance

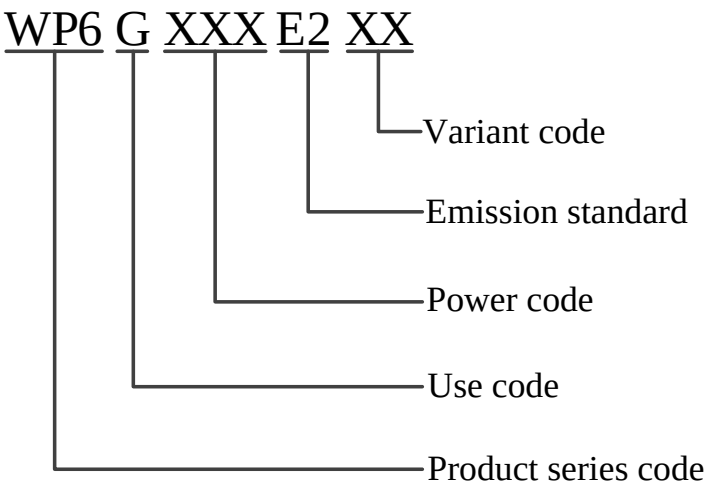


Fig. 1-4 Diesel Engine Model Composition and Significance

13 Diesel Engine Main Technical Parameters

Table 1-1 Main Technical Parameters of first-generation WP6 mechanical pump series diesel engine

Items	Unit	Type			
Engine model		WP6 mechanical pump series diesel engine			
		125	140	160	175
Engine type	—	4-stroke, water-cooling, in-line, direct injection, wet-type cylinder sleeve, high speed diesel engine			
Intake pattern	—	Turbocharged			
Displacement	L	6.75			
Cylinder diameter×Stroke	mm	105×130			
Number of cylinders	—	6			
Number of air valves for each cylinder	—	2			
Compression ratio	—	18:1			
Ignition order	—	1-5-3-6-2-4			
Fuel injection equipment	—	Mechanical pump			
Rated power	kW	92	105	118	129
Rated speed	r/min	2200	2200	2000	2200
Maximum torque	Nm	540	560	640	680
Speed at maximum torque	r/min	1300~1600			
Emission standard	—	China stage II			
Fuel consumption at rated power	g/kilom	≤250			
Minimum fuel consumption under full load	g/kilom	≤215			
Cold start—without aid	^{o}C	-10			
Cold start—with aid	^{o}C	-30			
Noise at 1m	dB	＜117			
B_{10} service life	km	500,000			

14 Unseal of Diesel engine

After opened the engine packing container, the user should firstly check the engine and its accessories according to the packing list, check whether engine appearance is damaged and whether connections are loose, and then perform the following work:

(1) Wipe up the antirust coat and anticorrosive agent on exposed surface of the engine.

(2) Drain seal fuel in fuel filter and parts of fuel system out (It's also allowed to start the engine without draining seal fuel in fuel system, but only can the engine be loaded after all seal fuel are consumed and normal diesel fuel is supplied in place). **The users also need to pay attention to that storage life for diesel engine before unpacking is one year, for new diesel engine that has been stored for more than one year should be inspected and taken additional measures:**

- Rotate the flywheel and spray solvent into engine intake tube, until all seal fuel in cylinders is expelled.
- Spray solvent into turbocharger intake and exhaust vent, until all seal fuel there is expelled.
- According to the service agreement with customer, we are obliged to add specified engine oil to engine without oil in oil sump; while for engine that has been filled with engine oil (with running-in accelerant) before being delivered, we suggest you replace the engine oil after run-in period (2000km or 50h).
- According to the service agreement with customer, for engine that has been filled with coolant before delivery under customer's requirements, the coolant performance should be checked after unpacking, if the coolant is subjected to -30^{o}C or -35^{o}C, its PH should be 7~8 (neutral) and hardness value should be 5~15 ?d [9~15 ?f (hardness)], otherwise, drain the old coolant and out and refill coolant with antifreeze additive.

(3) Check whether water blockage and grease blockage are unobstructed, check whether water temperature sensor and oil temperature sensor are in readiness.

NOTICE: Never start an engine before it is correctly installed and properly connected. When running the engine in enclosed environment, maintain good ventilation to ensure exhaust gas emissions into the atmosphere.

15 Lifting of Diesel Engine

Keep the center line of engine crankshaft horizontal during lifting, tilting or unilateral lifting is strictly forbidden. Keep the lifting-up and putting-down process slowly, incorrect lifting may damage the engine.

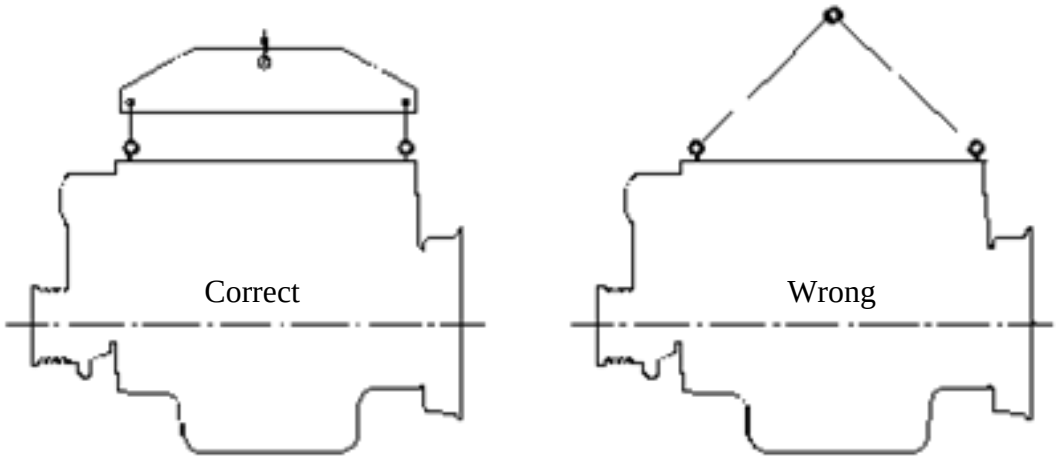


Fig. 1-5 Lifting of diesel engine

Each engine is installed with two special bolts on cylinder cover for lifting. On hexagonal head of the bolt, a M14 threaded rod is connected and lifting eye is installed on the rod. We suggest you apply lifting appliance as shown in left-hand chart of Fig. 1-5, and keep the center line of engine crankshaft horizontal during lifting. **It is inadvisable to lift the engine triangularly with only one rope (as shown in right-hand chart of Fig. 1-5); because at this point lifting rope and lifting bolts, lifting eyes are not aligned, it may damage, break the bolt, even damage the engine. The users should pay special attention to this.**

16 Installation of Engine

Flexible coupling should be adopted and ensure the center line of engine crankshaft and input shaft axis of transmission (transmission box, gearbox or generator) are coaxial. And make sure crankshaft is no subjected to additional axial force caused by assembly.

17 Preparation before Starting Engine

(1) Check coolant level

If the engine is already installed on a vehicle or platform, you can check the coolant level through the glass window on expansion water tank at any time, if the coolant is insufficient, open the filler cap to add coolant. When open a filler cap with pressure relief valve and exhaust button, be sure to press down exhaust button in advance if the engine is in hot state. Avoid filling plenty of coolant when the engine is hot, otherwise some parts may be damaged due to sharp temperature reduction. In an extraordinary situation, if there is no coolant in the engine, it is allowed to add not too cold water slowly until the water overflows. Start the engine, run the engine at 1000r/min and keep adding coolant until level gets stable, finally close the filler cap.

(2) Check fuel level

If the engine is already installed on a vehicle, turn on power switch, check the fuel level gauge on instrument panel or check the fuel tank.

(3) Check engine oil level

Engine oil level should between the bottom scale and top scale on oil dipstick, add engine oil through oil filling port if necessary.

(4) Check whether all accessories are reliably connected to the engine and eliminate abnormal phenomenon. Check whether start-up system wirings are normal, whether storage battery is fully charged. And then open fuel tank valve, loosen the air bleeding screw on fuel coarse filter, deflate the fuel system by using the hand pump on fuel coarse filter.

18 Start the Engine

Adjust diesel engine throttle to suitable position, appropriately increase the throttle when environment temperature is lower than 5^{o}C, and then press the start button to start the engine. To prevent damaging the engine, continuous starting time should not exceed 15s, if failed to start the engine in the first 15s, then restart it 2min later. But if failed three times in a row, you should stop trying, find out the cause and eliminate it.

After the engine is started, pay attention to all readings of gauges on instrument panel and keep the engine run idly, at this point engine oil pressure should not lower than 120kPa, idling time should not be too long.

Use starting aid to start the engine in cold weather. By controlling the relay to put heating equipment into work, the engine can be successfully started in -30^{o}C environment.

19 Run the Engine

After the engine is started, firstly let it run idly for 2~3min, engine oil pressure should higher than 120kPa. Do not suddenly run the engine in heavy load and high speed if coolant temperature is lower than 60°C, otherwise it may affect abrasion resistance and reliability of the engine. The load and speed should be increased gradually, try not to load or unload abruptly.

In run-in period (3000km), the engine is only suitable for moderate duty work and under.

It is allowed to run the engine in rated power and rated speed for normal use, but only no more than 20min is allowed for overload running (105% rated speed or 110% rated power). Only idling for 1~2min after unloading can the engine be shut down.

Parameters and check points that should always be noticed during normal use:

(1) Engine oil pressure (300~600kPa) (Idling≥120kPa);

(2) Engine oil temperature (80~105°C);

(3) Coolant outlet temperature (80~90°C);

(4) Turbine rear exhaust temperature≤550°C;

(5) Diesel fuel inlet temperature (40~45°C);

(6) Check the exhaust gas color to determine working quality of injector and load condition, if the color is serious bad, stop the engine for inspection.

NOTICE: When the engine is in operation, check it for water leakage, air leakage and oil leakage, and stop the engine immediately for troubleshooting.

Following diesel engine features should be fully aware by operator:

(1) The engine consumes less fuel when output torque is large, and fuel consumption rises as engine speed increases.

(2) Output torque reaches the best value at intermediate speed range (1200~1600r/min).

(3) Engine output power increases as rotating speed gets faster, and reaches rated power at rated speed.

NOTICE: To avoid damaging the diesel engine, cable to engine regulator and battery positive mustn't be disconnected. Unlike DC generator, it is strictly forbidden to check the voltage of AC generator by transient grounding.

Notes for running the engine in cold environment:

(1) Fuel oil: Choose different brands of diesel fuel based on ambient temperature.

(2) Engine oil: Choose engine oil of different viscosity according to season.

(3) Coolant: Antifreeze additive is required for cooling system, choose different brands and

different proportion based on ambient temperature.

(4) Starting: Use starting aid to start the engine in winter. Load and speed up the engine only after oil pressure and water temperature get normal.

(5) Storage battery: Be sure to check electrolyte level, viscosity and unit voltage before winter comes. If the engine needs to be stored in cold weather for long term, be sure to take down the battery and put it in warm environment.

(6) Stop: For shutting down the engine in cold weather, you should firstly unload it and run it idly for 1~2min, stop the engine after all temperature drops down. Notice that coolant with antifreeze additive mustn't be drained out after stop. For coolant without antifreeze additive, it must be drained out to prevent frost cracking the engine, open the water drain valve or cap on engine block, engine oil cooler, radiator and water inlet pipe to drain the coolant out.

2 Maintenance Guidelines for Diesel Engine

21 Fuel Oil, Engine oil, Coolant and Auxiliary Materials

211 Fuel Oil

Summer: 0# diesel fuel (GB252)

Winter: -10# diesel fuel is generally used, choose -20# diesel fuel if ambient temperature lower than -15°C, and choose -35# diesel fuel if ambient temperature lower than -30°C.

The chosen fuel should meet requirements in appendix C.6 of GB17691-2005 (Revised in June 2008).

212 Engine Oil

Diesel engine oil capacity: 16L, engine oil capacity is subjected to the marks on oil dipstick (there might slight differences between different models).

Selection of engine oil: To ensure safety and reliable operation of your diesel engine, please choose CD grade engine oil. (Weichai dedicated engine oil is recommended, and only choose Weichai dedicated engine oil for the first replacement). As shown in Fig. 2-1.

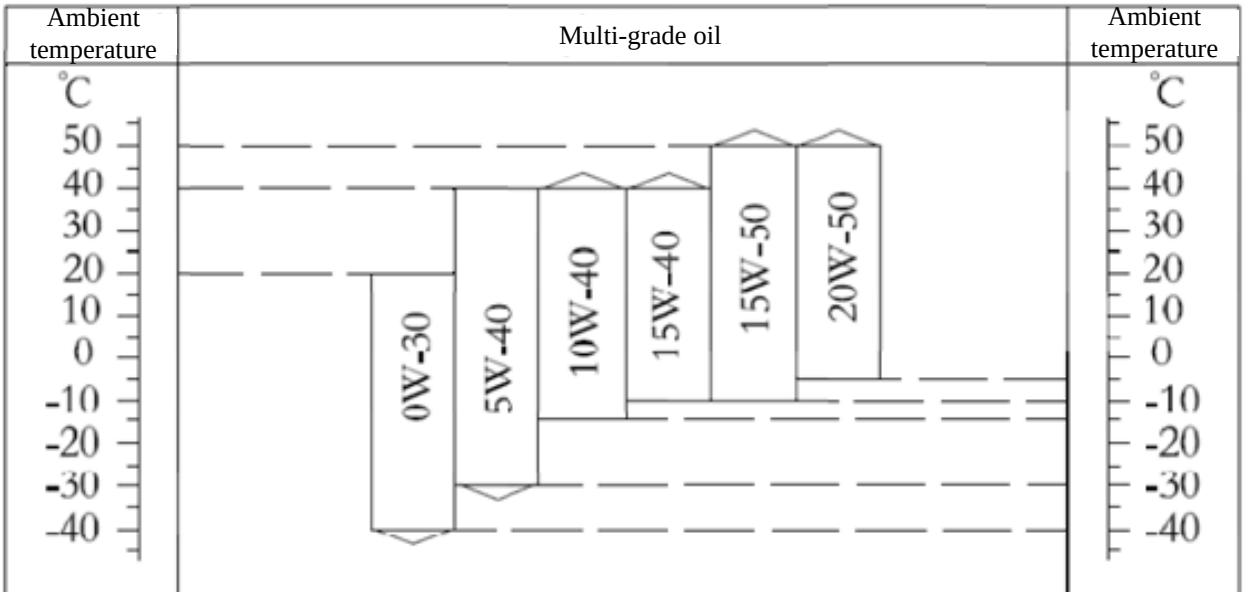


Fig. 2-1 Engine oil brand selection chart

NOTICE: It is allowed to replace low-grade engine oil brand with high-grade one. Replace the filter along with the engine oil replacement.

213 Lubrication of Tensioning Wheel

Apply general purpose lithium lubricating grease for lubrication of tensioning wheel (refer to GB/T5671-1995)

214 Antifreeze Additive in Engine Cooling System

The adopted antifreeze additive is ethylene glycol, and it is allowed to replace it with domestic long-acting antifreeze additive with reliable quality, refer to related description for specific application method. The following two long-acting antifreeze additives in china are recommended:

JFL－336# Long-acting antifreeze additive

FD－30# Long-acting antifreeze additive

It's important to note that long-acting antifreeze additive should be replaced periodically according to related requirements.

Calculation of antifreeze additive (for reference)

Coolant amount: 40L (for an engine with radiator)

Current application temperature of coolant: -20°C

Required minimum anti-freezing temperature: -30°C

Calculation method: Find the point of coolant amount “40L” on x-coordinate, and draw a vertical line through this point, and point 1 and 2 are the intersections between the vertical line and -20°C oblique line, -30°C oblique line respectively. (As shown in Fig. 2-2)

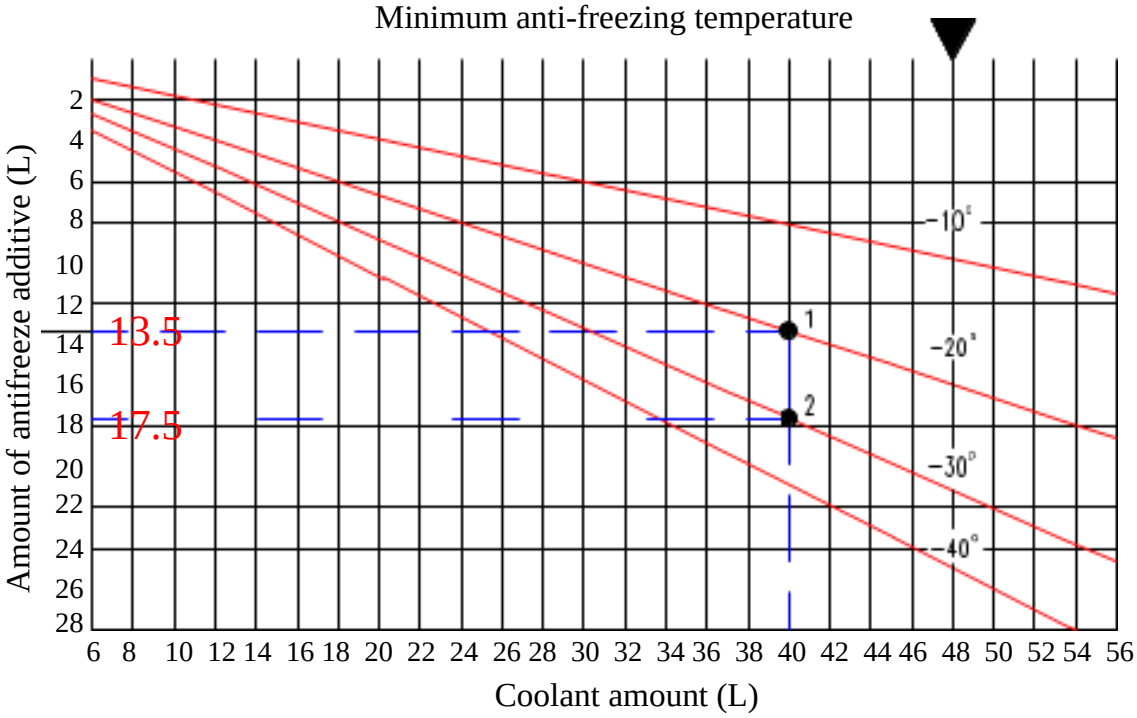


Fig. 2-2 Antifreeze additive calculation map

We can get that required antifreeze additive for -20°C is 13.5L

Difference value between -30°C and -20°C is 4L

For the difference value 4L, another 50% of that is required and necessary, because of before adding antifreeze additive, a part of coolant must be drained out, and antifreeze additive in this part of coolant will be drained out too.

So required antifreeze additive is: 4L+50%*4L=6L.

215 Auxiliary Materials

Table 2-1 Auxiliary materials

S/N	Designation	Color	Purpose and application
1	Molykotte Pulver (Fine molybdenum powder)	Black	Apply on smooth metallic surface to prevent occlusion. For example: Cylinder sleeve external surface.
2	Molykotte G.u.plus (Molybdenum disulfide oiling agent)	Dark gray	Play lubrication action before lubricating oil pressure is built-up. For example: Apply on intake valve rod.

Table 2-2 Reference table for grease application of diesel engine

Brand	Main application	Application position list	Additional remarks
Loctite 242	Apply on thread for fixation and to prevent loose, medium strength	Flywheel housing bolt Camshaft thrust plate bolt Camshaft timing gear bolt Middle idle gear bolt Engine front cover bolt Engine oil filter seat bolt, engine oil cooler bolt Plug screw of engine oil cooler regulating valve Bolt of fuel pump oil return pipe fixing device Air compressor shaft end thread Oil strainer bolt Bolt of sensor and wiring harness fixing device	It is optional to pre-coat DriLoc204.
Loctite 262	Apply on thread to lock, seal and prevent loose	Cylinder cover auxiliary bolt	
Loctite 271	Anti-loosing and fastening	Bowl type plug used to block oil hole	

Loctite 277	Used for the seal between core and hole	Other bowl type plugs	
Loctite 270	Used to seal top end face of cylinder cover	Pushrod bush Cylinder cover	
Loctite 518 (Renewed product of 510)	Apply on shining metallic surface for sealing	Fitting surface between cylinder block and crankcase, fitting surface between engine block and engine front cover Rear end face and flywheel connecting board Fitting surface between engine oil filter seat and crankcase Water pump rear cover—engine block front end face Flywheel connecting board—flywheel housing Fitting surface between cylinder block and engine oil cooler cap Fitting surface between cylinder block and engine oil filling port cover plate	

22 Daily Maintenance

221 Check Coolant Level and Temperature

Check the coolant level through the glass window, Open the filler cap to add coolant if it is insufficient.

NOTICE: Press down exhaust button in advance before open the filler cap to avoid injury caused by hot coolant.

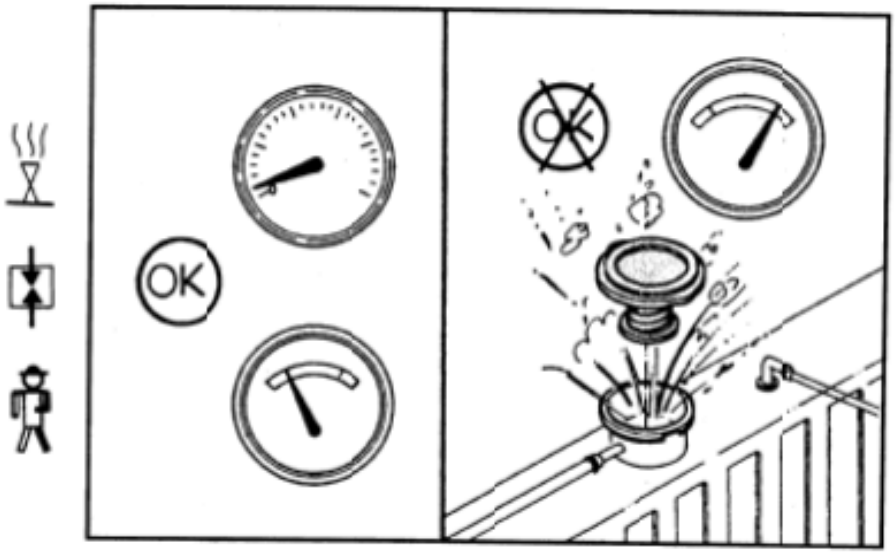


Fig. 2-3 Check coolant level and temperature

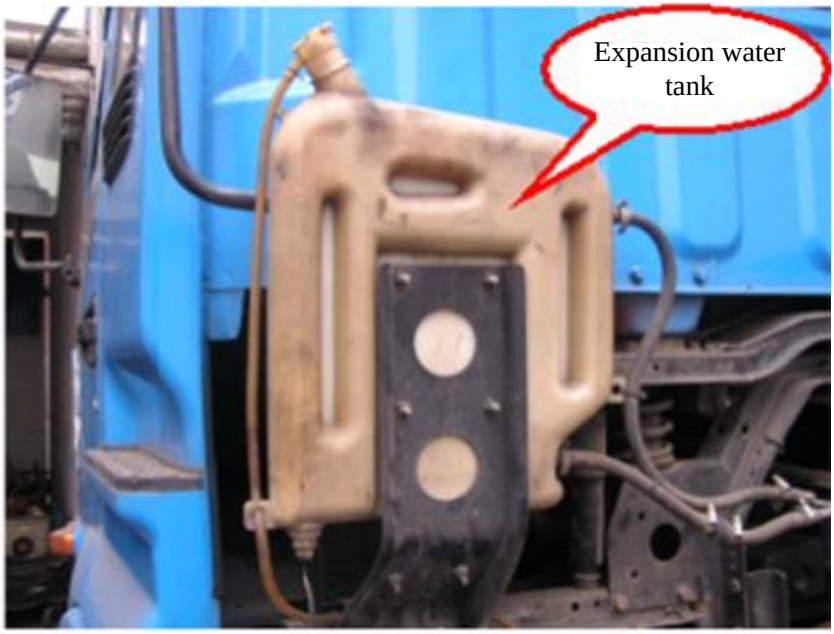


Fig. 2-4 Expansion water tank

NOTICE: Coolant level must be checked before starting the engine every time.

222 Check Engine Oil Level

Check whether engine oil level is between the bottom scale and top scale on oil dipstick. Under no circumstances should the engine be started if the oil level is lower than the bottom scale or higher than the top scale.

Oil level checking should be done at least 5min later after engine stopped, in order to let engine oil have enough time to return to oil sump.

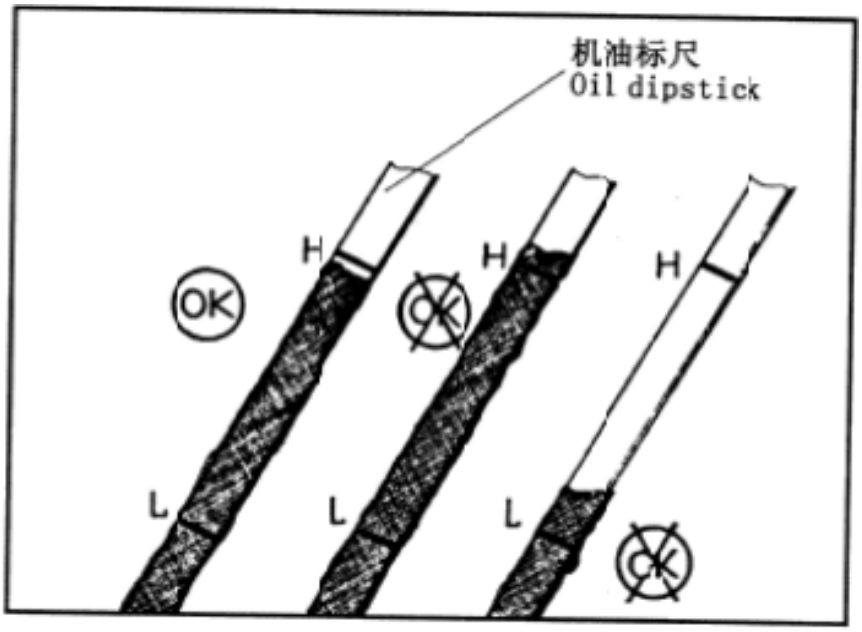


Fig. 2-5 Oil dipstick

NOTICE: Engine oil level must be checked before starting every time.

223 Check Fuel Level

Check fuel level gauge on instrument panel and add fuel timely. The fuel in use should meet the specifications. Pay attention to cleanliness of fuel and it is recommended that fuel should be subsided for more than 72 hours before adding. Diesel fuel should be filled into fuel tank through build-in filter screen.

Fig. 2-6 Check fuel level

NOTICE: Fuel level must be checked before starting every time.

224 Check "Three Leakages"

Check engine appearance for water leakage, air leakage and oil leakage.

225 Check Fan

Visually check whether fan blades are damaged, whether plastic fan is deformed, whether rivets of iron fan are loose, whether iron fan blades are bended, whether connecting bolts are tightened, to make sure the fan do reliable work.

226 Check Belt

The belt is automatically taken-up by a tightening wheel, user can check the tension of the belt by pressing it with hand. Check the triangle belt for crack and abrasion, replace it if necessary.

227 Check Whether Exhaust Gas Color is Normal

Normal exhaust gas color is light gray. Find out the cause and eliminate it if the color is abnormal.

Fig. 2-7 Check exhaust gas

228 Check Whether Running Sound is Normal

229 Check Whether Rotating Speed and Vibration are Normal

23 Periodic Maintenance

- **Replace engine oil**

Set the engine horizontal and put a container under the engine to recycle engine oil, screw off oil drain plug 2 on the bottom of oil sump to drain all engine oil out and then screw on the plug; Open the filler cap, add engine oil through filling port 1, use a filter for engine oil filling. Keep an eye on oil dipstick until oil level meets the requirements, install the filler cap.

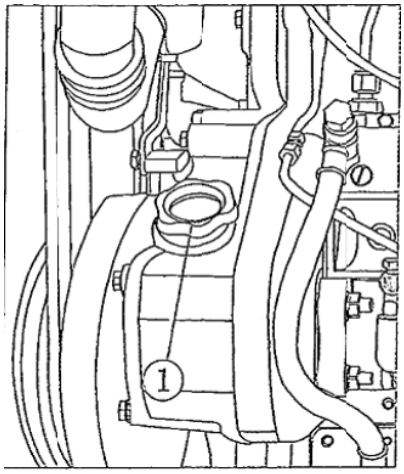


Fig. 2-8 Engine oil filling port

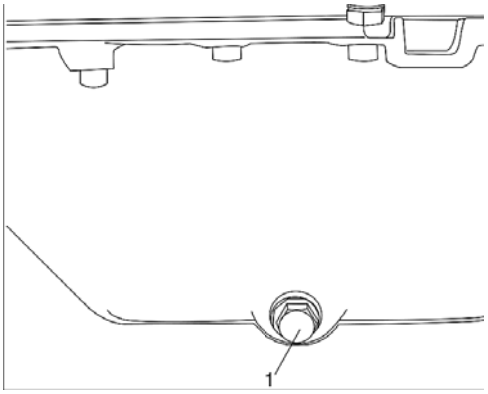


Fig. 2-9 Oil drain plug

● Replace engine oil filter and filter element

Follow the steps below to replace engine oil filter:

(1) Screw off the old engine oil filter with a dedicated wrench;

(2) Fill up the new filter with engine oil;

(3) Coat the new filter rubber gasket with oil before installing, and then tighten the filter by hand;

(4) After the rubber gasket touched the base, tighten the filter for another 3/4~1 circle to seal it up.

(5) Check whether there is oil leakage after engine started.

Fig. 2-10 Engine oil filter

● Check and adjust intake and exhaust valve clearance

Follow the steps below to check and adjust intake and exhaust valve clearance:

(1) Firstly make sure the engine is in cold state, and then rotate the flywheel positively with external force until cylinder 1, 6 get to TDC, at this point tick on flywheel is aligned to OT tick on flywheel housing.

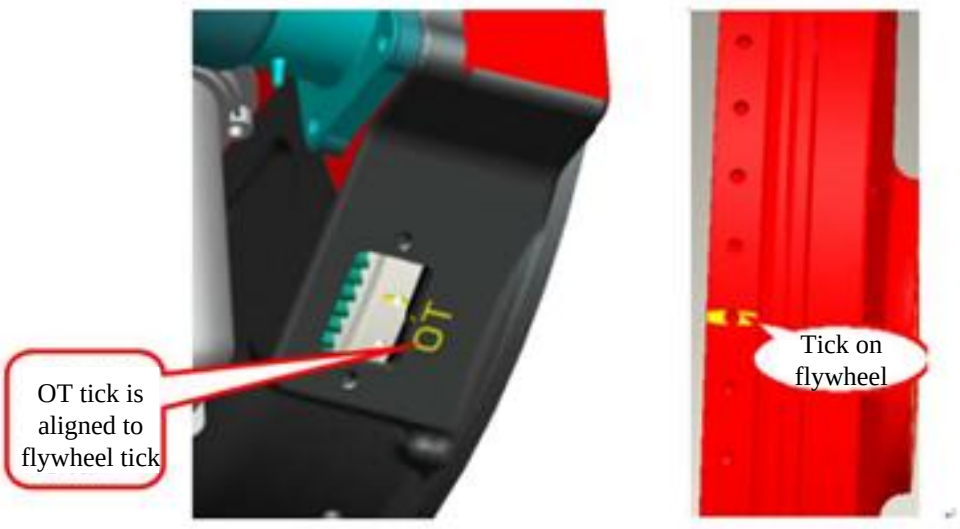


Fig. 2-11 Flywheel ticks

(2) Remove the valve rocker shield on cylinder cover, to determine whether it is cylinder 1 or cylinder 6 in compression stroke (for cylinder in compression stroke, there is clearance between intake valve (and exhaust valve) and rocker).

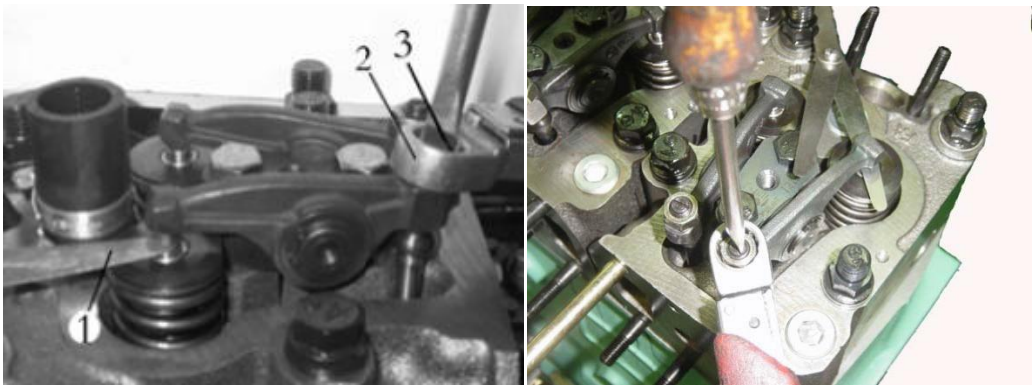


Fig. 2-12 Adjust valve clearance

(3) Measure the clearance between rocker and valve rod head with feeler gauge 1. Required intake valve clearance for WP6 mechanical pump diesel engine is 0.2mm; while that for exhaust valve is 0.3mm. If the clearance is too large or too small, you can loosen locking nut 2, and then turn adjusting screw 3 to change the clearance. Keep adjusting screw 3 still and tighten locking nut 2, and then measure the clearance again. Repeat the above procedures until the clearance meets the requirements.

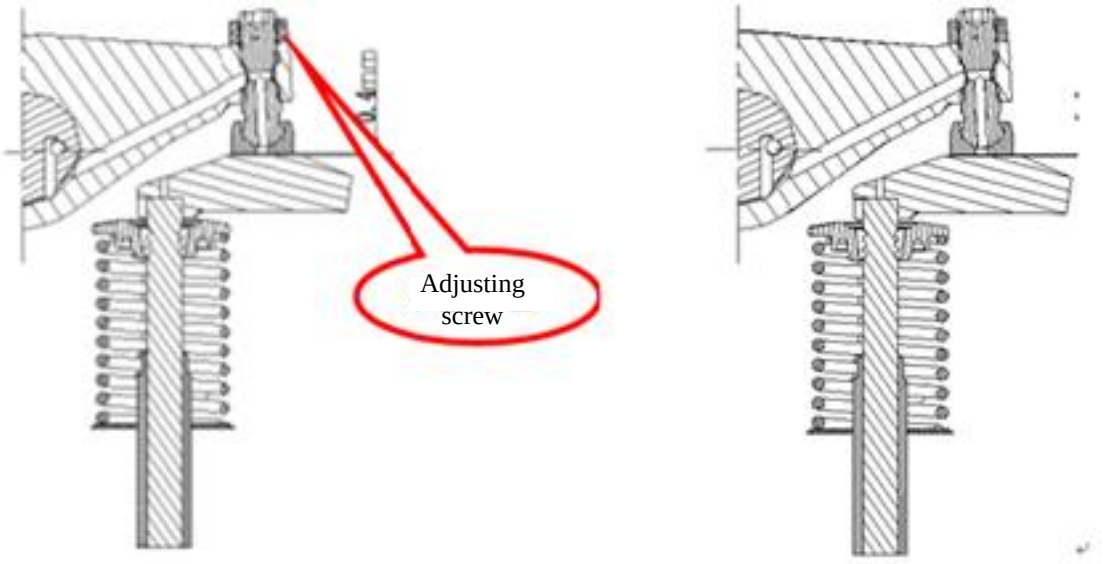


Fig. 2-13 Adjusting screw

(4) After checking cylinder 1 or cylinder 6, rotate the flywheel positively with external force for another 360 °to let cylinder 6 or 1 in power stroke, check and adjust other valves.

Table 2-6

	Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4	Cylinder 5	Cylinder 5
Cylinder 1 in compression stroke	Intake and exhaust valve	Intake valve	Exhaust valve	Intake valve	Exhaust valve	Cannot be adjusted
Cylinder 6 in compression stroke	Cannot be adjusted	Exhaust valve	Intake valve	Exhaust valve	Intake valve	Intake and exhaust valve

- **Replace fuel filter element**

Follow the steps below to replace fuel filter element:

- Remove the old fuel filter element; if the water collector that installed on coarse filter can be reused, please the take collector down.
- Lubricate the seal.
- Screw on the filter with hand until the seal touched the port.
- Continue to tighten the filter with hand until it is firmly installed (About 3/4 circle).
- Drain all air in fuel system out.
- Perform leakage test.

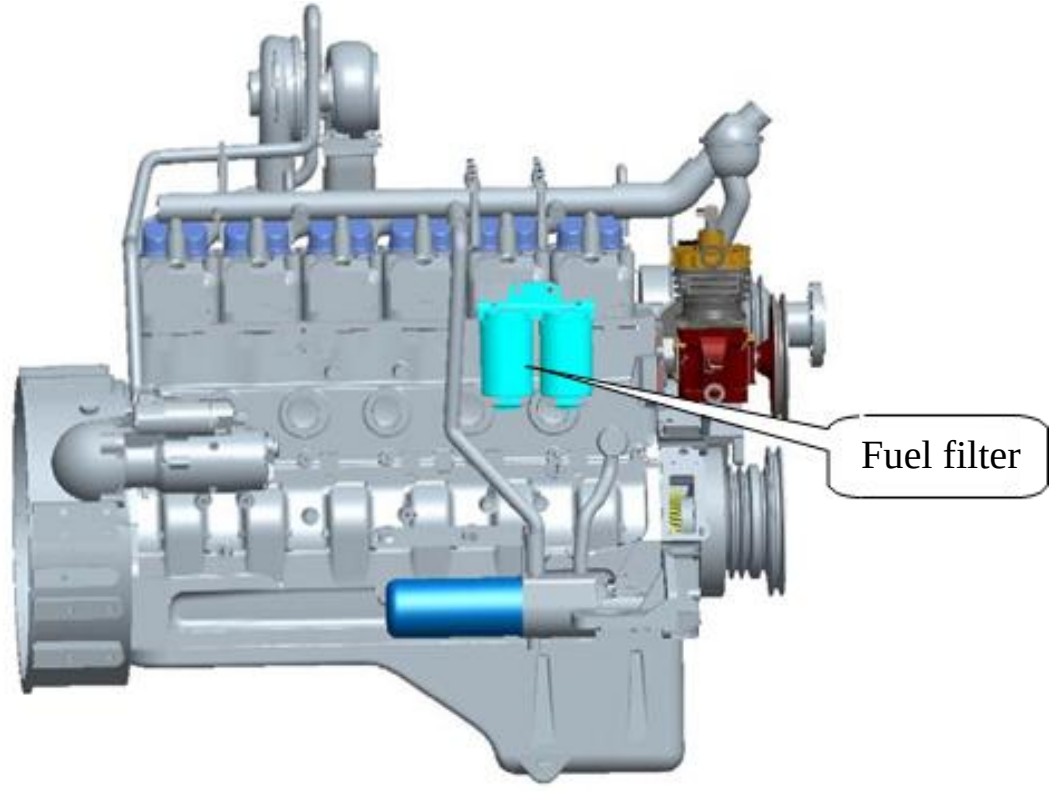


Fig. 2-14 Fuel filter

- **Check intake system**

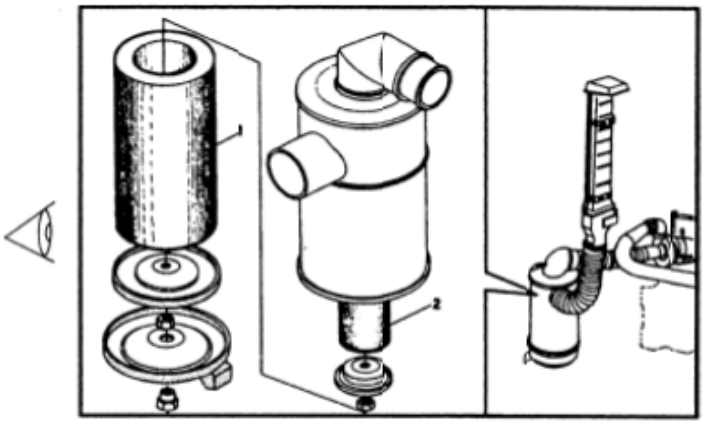
Check whether intake rubber hose is aged and cracked, whether the circumferential band is loose.

Fasten or replace some parts when necessary, in order to ensure good sealing performance of intake system.

Check air filter element

Maximum allowed intake resistance for the engine is 6kPa, maximum intake resistance must be measured when the engine is running in rated speed and full load, if the intake resistance exceeds maximum allowed value, the filter must be cleaned or replaced according to the regulations of manufacturer.

NOTICE: By no means should an engine without air filter be running, Otherwise infiltration of dust and impurities will lead to premature wear of engine.



1.纸质主滤芯 Paper filtering element
2.毛毡安全滤芯 Blanketry safety filtering element

Fig. 2-15 Air filter

Remove the filter element from air filter, pat its end faces gently to clean the dust on it, blow it with compressed air reversely (from inside to outside) is also feasible.

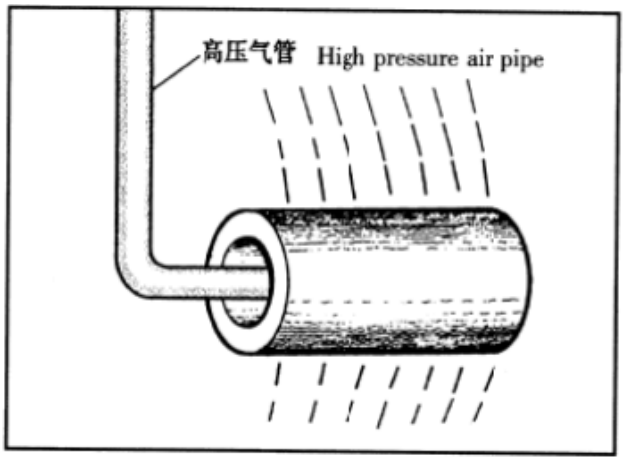


Fig. 2-15 Air filter element

NOTICE: Do not let the air broke filter paper and do not clean filter paper with water or oil, do not pat or strike the filter element fiercely and damaged filter element and seal ring must be replaced.

24 Maintenance for Long-Term Storage

241 Cleaning

Before putting the engine in storage, all rusty areas must be removed in a proper way, and all parts that have been processed with protective agent (lubricant circuit, fuel system, turbocharger etc.) must be cleaned thoroughly.

242 Protection

(1) Drain all engine oil in fan heater out and clean engine oil filter, add slushing oil into engine oil sump.

(2) Drain all fuel in fuel system out, and add slushing oil instead to protect the fuel circuit.

(3) If the diesel engine is not filled with cooling emulsion, after draining cooling water out, cooling emulsion and slushing oil should be filled into cooling water jacket for protection. Before putting the engine in storage, run it idly with the emulsion and slushing oil for 15~25min.

(4) Remove the cover plate on intake pipe end face, and inject slushing oil into the pipe with pressure nozzle. During the injecting, you should rotate the crankshaft with hand to open air valve, so that slushing oil can get to combustion chamber. Once all storage work is done, never rotate the crankshaft again to prevent oil coated on cylinder wall being scraped.

(5) Drain all kinds of oil and fluid in the engine out, open the valve on engine base to drain slushing oil or pump it out with a pump, drain cooling emulsion in cooling system out, all drain valves should be kept open.

(6) Remove the rocker shield, and then inject slushing oil into air valve spring and rocker.

(7) All engine processed parts and easy to be corroded parts must be applied with preservative oil. After finishing the above procedures, the engine can be stored.

To prevent humid air and impurities infiltrating into the engine, all open ports (intake pipe, exhaust pipe and cooling pips) should be sealed up with caps during transportation and storage, and also cover the engine plastic housing properly.

3 Disassembly & Assembly of Diesel Engine

31 Overview

Please comply with instructions in this manual strictly to disassemble and assemble the engine and pay special attention to operations which danger signs and safety signs are involved in this manual, in order to ensure personal safety and avoid accidents.

In this manual, the following signs are used to emphasize some specific instructions. No doubt that these instructions alone will not be enough to avoid all dangerous. The only way to avoid accidents is to strictly observe relevant detailed instructions and make good use of related knowledge.

311 Danger Signs

This sign is world-recognized danger sign. In this manual, this sign is used to emphasize the importance of following information. Make sure you are well aware of the consequence that the danger can bring and know how to avoid such danger. Acts in violation of the warning message may result in property loss, personal injury and even casualties.

The most common danger sign is generally for general warning. In this manual, warning messages are divided into different types according the consequence it could bring (minor wound, serious injury and death).

This warning sign is used for potential danger situation, fail to avoid this danger may result in serious injury or death or huge property loss.

This warning sign is used for potential danger situation, fail to avoid this danger may result in minor injury or property loss.This warning sign is also used for danger operations.

This manual provides all kind of notes and warning information to help the user correctly operate and safely use our engine. However, simply read these notes are not enough to avoid all kinds of potential danger, the user should correctly understand them. Safety information described in this manual cannot include all of the safety precautions, if the procedures or actions that are not recommended in this manual are used, you must ensure the safety of the operator and machine.

312 Safety Signs

Signs	Information
	Wear protective gloves
	Wear protective ear covers
	Wear protective googles
	Wear protective hat
	Wear protective shoes
	Wear protective mask
	Wear protective suit
	No open flames
	No smoking
	Mobile phone prohibited
	Danger: battery acid
	Danger: electrified cable, electric shock hazard
	Inflammable material
	Stay away from heavy objects
	Extinguisher nearby

Some unpredictable potential danger may occur during the use of engine, safety information described in this manual cannot include all of the safety precautions, if the procedures or actions that are not recommended in this manual are used, you must ensure the safety of the operator and machine and no property loss would bring.

313 Recommended Tools

Signs	Information
	2.5mm hexagon wrench
	5mm hexagon wrench
	8mm socket
	Slotted screw driver
	Dedicated tool
	10mm slotted hexagon wrench

If the methods or tools that are not recommended in this manual are used, you must ensure safety to avoid life risk to yourself or other people, in the meantime make sure the operating, maintenance and repair methods wouldn't bring damage to the engine or potential safety hazard.

314 Notes for Health Protection

The notes listed below aim at reducing contamination risk to engine maintenance personnel, related personnel should strictly observe these notes in the process of disassembling.

(1) Avoid exposing to used engine oil long-time repeatedly.

(2) Please wear protective suit and gloves if possible.

(3) Do not put oil stained rag in your pocket.

(4) Avoid dirtying your clothes with oil, especially underwear.

(5) Wash your work clothes as often as possible; get rid of oiled clothes and shoes that cannot be cleaned.

(6) Once get cut or be injured, seek for medical help as soon as possible.

(7) Be sure to use protective cream before work, so that stained oil on the skin can be easily cleaned.

(8) Use soap and hot water or use hand sanitizer nail brush to clear away all oil dirt on your hands. In case naturally secreted oils will be cleared in the same time, products that containing lanolin can replace the naturally secreted oils to help moisturize the skin.

(9) Never clean your skin with gasoline, kerosene, fuel oil, thinner or solvent.

(10) Be sure to seek for medical help immediately if any adverse reaction happened to your skin.

(11) If possible, clear away oil on parts before transporting them.

(12) Please wear googles or protective mask if there is risk of damaging your eyes. Eye washing fluid must be prepared within reach.

(13) When maintaining the engine, prevent oil or other liquid spilling on the ground. If hydrocarbon or other liquid is accidently leaked, be sure to take all requisite measures to quarantine this area, to keep the environment clean and avoid personal injury.

(14) Local safety and environmental standards must be strictly observed when transporting, storing and recycling chemicals, such as hydrocarbon, ethylene, ethylene glycol and petroleum.

315 Environmental Protection Measures

Please comply with the relevant laws and regulations on environmental protection when handling waste oil and hydrocarbon. For further instructions please contact local officials.

316 Notes for Disassembly and Assembly of Engine

Most engine-related (use, maintenance and repair) accidents are caused by failing to comply with safety regulations and basic notes. So you should be able to realize the danger ahead and take relevant preventive measures to avoid the accident. Relevant training is required for engine operator and maintenance personnel, good skills and appropriate tools pave the safety road. Any violation of instructions in this manual may result in serious accident, even death. SDLG cannot foresee all potential danger. Similarly, the rules and instructions in this manual cannot cover everything.

Before proceeding the maintenance or repair operation, place a sign or label with “Do Not Use” on starter switch.

Before using barring rod, necessary precautions should be taken:

- Ensure the maintenance site and its surroundings are suitable for safety operation.
- Ensure the maintenance shop or engine surrounding area is clean.
- Before operation, please take off your finger ring, necklace and watch. And wear appropriate close-fit work clothes.
- Before operation, please check whether relevant protective devices (googles, gloves, shoes, masks, work clothes and helmet etc.) are within validity period.
- Please don’t use failure or inappropriate tools.

NOTICE: The engine must be shut down during the maintenance.

32 Cylinder Cover Assembly

321 Disassembly and Assembly of Cylinder Cover Assembly

3211 Exploded View of Cylinder Cover Assembly

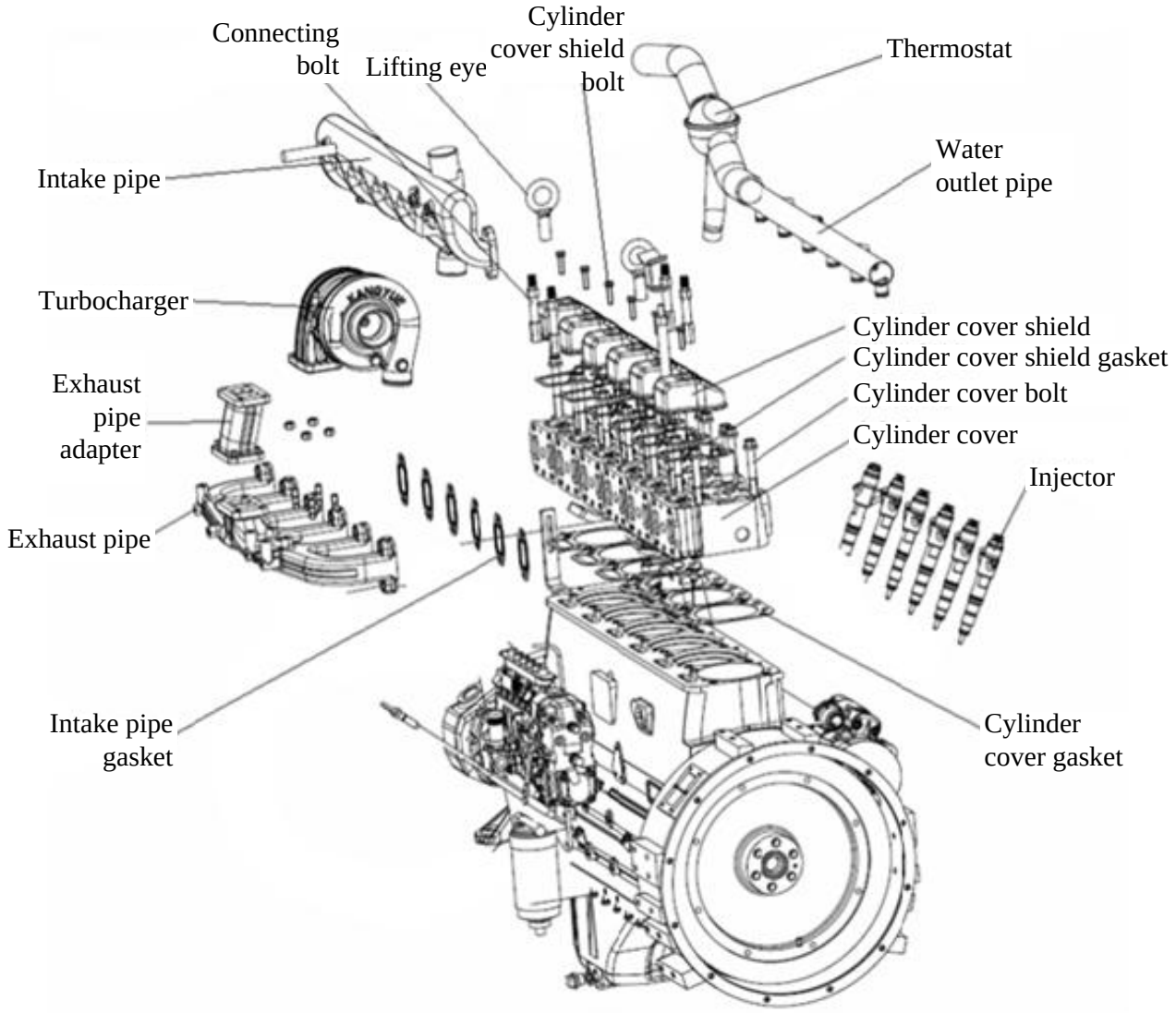


Fig. 3-1 Exploded view of cylinder cover assembly

3212 Steps to Disassemble Cylinder Cover Assembly

(1) Remove air filter, refer to disassembly of air intake and exhaust system for details;

(2) Remove turbocharger and its connecting pipes, refer to disassembly of air intake and exhaust system for details;

(3) Remove injector fuel return pipe, disconnect high pressure fuel pipe, refer to disassembly of fuel system for details;

(4) Remove thermostat and its water outlet pipe;

(5) Remove exhaust pipe, refer to disassembly of air intake and exhaust system for details;

(6) Remove intake pipe, refer to disassembly of air intake and exhaust system for details;

(7) Remove cylinder cover shields and its gaskets;

(8) Remove the injectors, refer to disassembly of fuel system for details;

(9) Remove rocker assembly and pushrod, refer to disassembly of valve mechanism for details;

(10) Remove lubricating pipe of cylinder cover;

(11) Remove cylinder cover assembly, and take down the gaskets;

(12) Remove inner and outer springs of intake and exhaust valves, and then take down the spring seats, valve collets and valves, refer to disassembly of valve mechanism for details;

(13) Remove seal cartridges of valve rod.

3213 Steps to Assemble Cylinder Cover Attachments

Assembling steps are contrary to disassembling ones.

322 Disassembly, Inspection, Maintenance and Assembly of Cylinder Cover Shield

3221 Exploded View of Cylinder Cover Shield

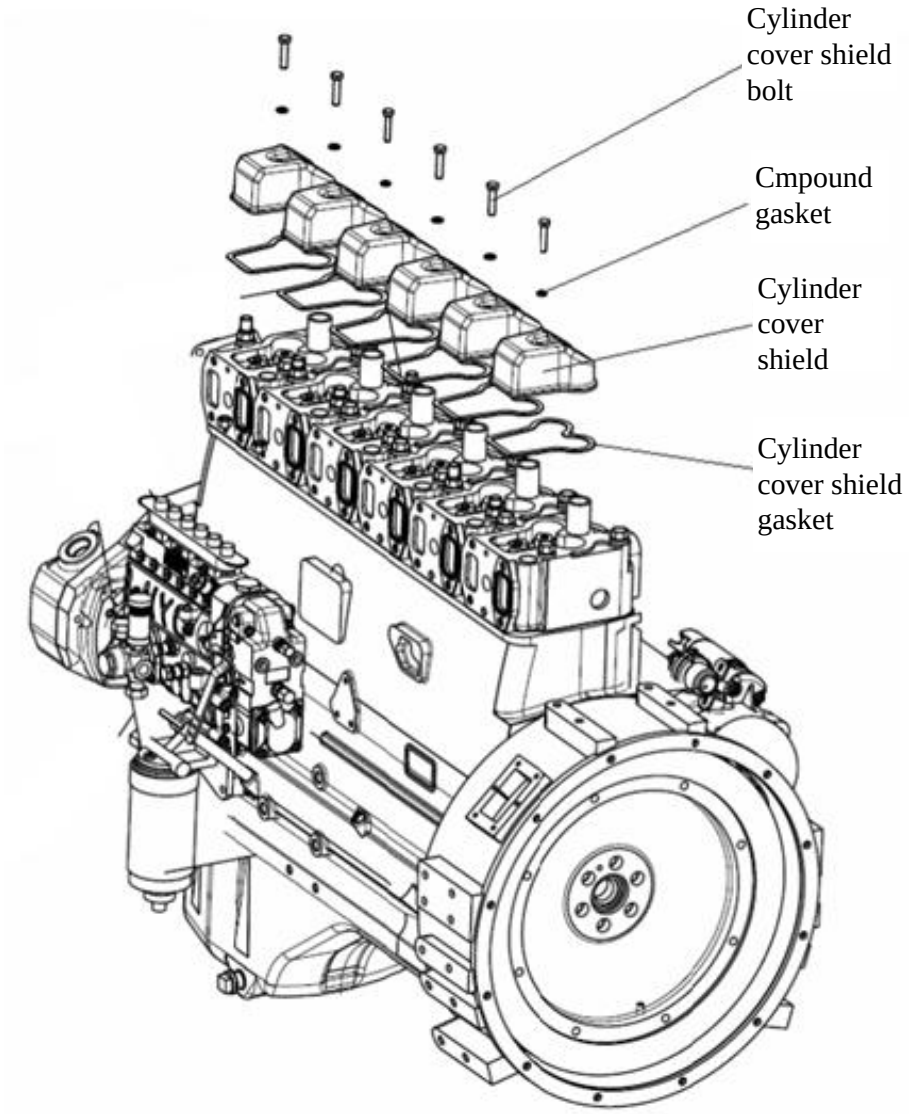


Fig. 3-2 Exploded view of cylinder cover shield

3222 Steps to Disassemble Cylinder Cover Shield

(1) Screw off cylinder cover shield bolts orderly;

(2) Pull the shield vertically up to take it and its gaskets down.

3223 Inspection and Maintenance of Cylinder Cover Shield

(1) Check whether there is damage like crack on the shield, a cracked shield must be replaced;

(2) If there is leakage in cylinder cover shield gasket, then the gaskets should be checked and all

gaskets should be replaced;

(3) Cylinder cover shield gaskets are disposable, and should be replaced during maintenance.

3224 Steps to Assemble Cylinder Cover Shield

(1) Check whether there is manufacturing defect, usage defect or damage on cylinder cover shield gaskets and cylinder cover before assembling;

(2) Apply engine oil on contacting area between rocker and valve, contacting area between rocker and pushrod and the area between them;

(3) Assemble cylinder cover shield gaskets, keep graphitic end upwards;

(4) Place cylinder cover shield;

(5) Adjust the gasket to align the two U-shape grooves on the gasket and cylinder cover separately, make sure the gasket is evenly revealed on cylinder cover. Ensure U-shape grooves and bottom middle midpoints of bolt and gasket are on the same line;

(6) Fasten cylinder cover shield bolts, required torque 10~15Nm, pay attention to gaskets and make sure they are not out of original position during fastening.

323 Disassembly, Inspection, Maintenance and Assembly of Cylinder Cover

3231 Exploded View of Cylinder Cover

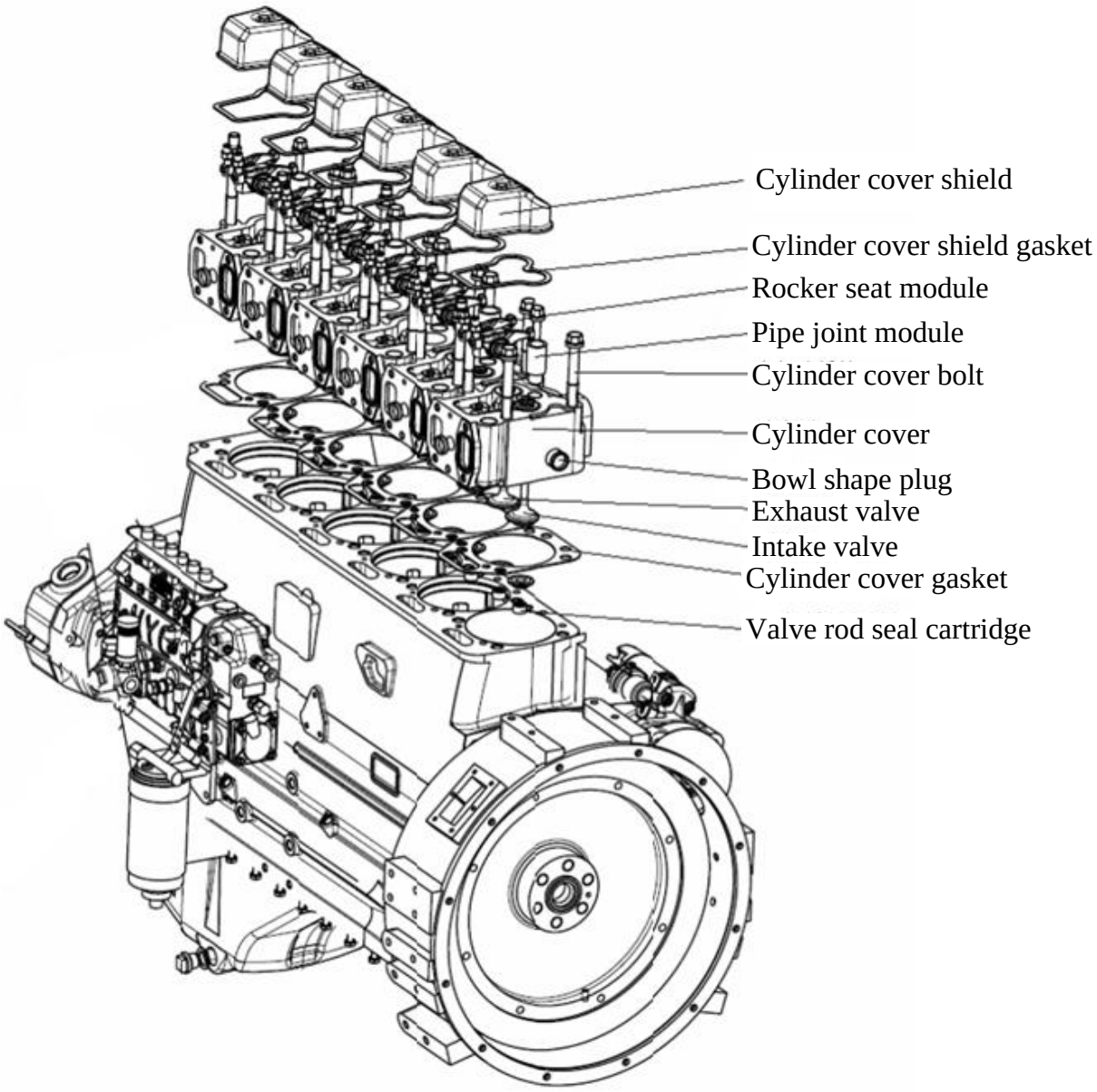


Fig. 3-3 Exploded view of cylinder cover

3232 Steps to Disassemble Cylinder Cover

(1) Remove cylinder cover shield, refer to disassembly of cylinder cover shield for details;

(2) Remove the injectors, refer to disassembly of fuel system for details;

(3) Screw off cylinder cover bolts, removal is the reverse of installation (refer to Fig. 3.6);

(4) Pull the cover vertically up to take it down (the injectors must be removed in advance to

prevent the cover crashing the injectors during removal), do not waggle the cover during removal, otherwise remnant coolant may outflow. If cylinder cover gasket is attached on the removed cylinder cover, take it down and put it back on engine block;

(5) Put the removed cylinder cover on paper board to prevent wearing upper surface of combustion chamber and other sealing surfaces. If more than one cylinder cover needs to be disassembled, then it is required to mark the cylinder number on the cover for fault analysis;

(6) Remove cylinder cover gasket, if more than one cylinder cover gasket needs to be disassembled, then it is required to mark the cylinder number on the gaskets for fault analysis;

(7) Remove intake and exhaust valve module, refer to disassembly of valve mechanism for details;

(8) Remove valve rod seal carriage.

3233 Inspection and Maintenance of Cylinder Cover

Check the cylinder cover for water leakage, oil leakage, air leakage and other abnormal phenomenon before disassembling, so as to locate and analyze the problem correctly.

Clean cylinder cover, focus on combustion chamber surface, valve seat, intake and exhaust valve, intake and exhaust passage, remove the carbon deposit and mucilage glue, and check the surface condition.

(1) Appearance inspection

Check the cylinder cover for discoloration and crack, if crack is discovered, liquid penetrant test should be done.

(2) Valve recession

Valve recession is the vertical distance between valve undersurface and cylinder cover undersurface, the difference between measured value and required value of valve recession can reflect wear degree of valve and valve seat. A depth micrometer can be used to measure valve recession, as shown in Fig. 3-4.

Fig. 3-4

Reference table for valve recession requirements:

	Required value of valve recession (mm)
Intake valve	1.0~1.45
Exhaust valve	1.0~1.45

If valve recession exceeds allowed range, the cylinder cover must be replaced to ensure reliability of diesel engine. If valve recession doesn't exceed allowed range, disassemble the valve to check the sealing surface between valve and valve seat for obvious wear and abnormal damage.

(3) Clearance between valve rod and valve guide pipe

Internal surface of valve guide pipe is the contacting surface between valve rod and valve guide pipe, if clearance between valve rod and valve guide pipe exceeds allowed value due to abrasion, then the guide effect will at state, which may affect reliability of the engine. The inner diameter of guide pipe can be measured with an inside micrometer, as shown in Fig. 3-5. Outer diameter of valve rod can be measured with an outside micrometer. Both allowed ranges for clearance between intake valve rod and its guide pipe, exhaust valve rod and its guide pipe are 0.03~0.06mm. If clearance exceeds allowed range, the cylinder cover must be replaced to ensure reliability of diesel engine.

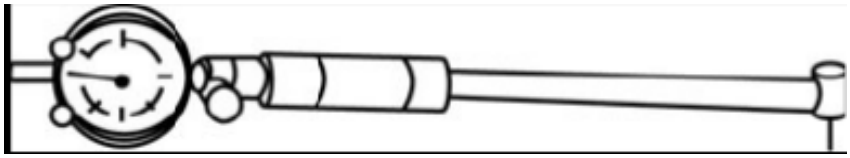


Fig. 3-5

(4) Cylinder cover gasket

If there is air leakage, water leakage or oil leakage in cylinder cover gasket, then the gasket should be checked and replaced;

Check the gasket for visible damage and analyze the cause, cylinder cover gaskets are disposable, and should be replaced during maintenance.

3234 Steps to Assemble Cylinder Cover

(1) Preassemble intake and exhaust valve module;

(2) Install cylinder cover gaskets, thickness of cylinder cover gasket should be 1.4mm, and the cylinder cover gasket cannot be reused.

(3) Assemble the cylinder cover to engine block;

(4) Loose-fit cylinder cover bolts;

(5) Fasten cylinder cover bolts, firstly pre-tighten each bolt to 30Nm, and then tighten each bolt for

120 °±4 °, and 120 °±4 ° again.

(6) Refer to Fig. 3-6 for pre-tightening and tightening order.

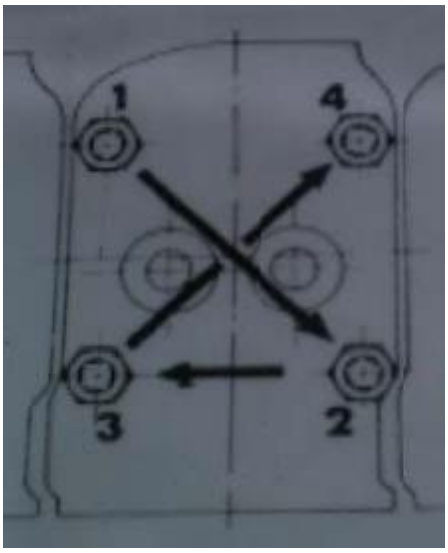


Fig. 3-6 cylinder cover bolts tightening order

324 Disassembly, Inspection, Maintenance and Assembly of Water Outlet Pipe

3241 Exploded View of Cylinder Cover

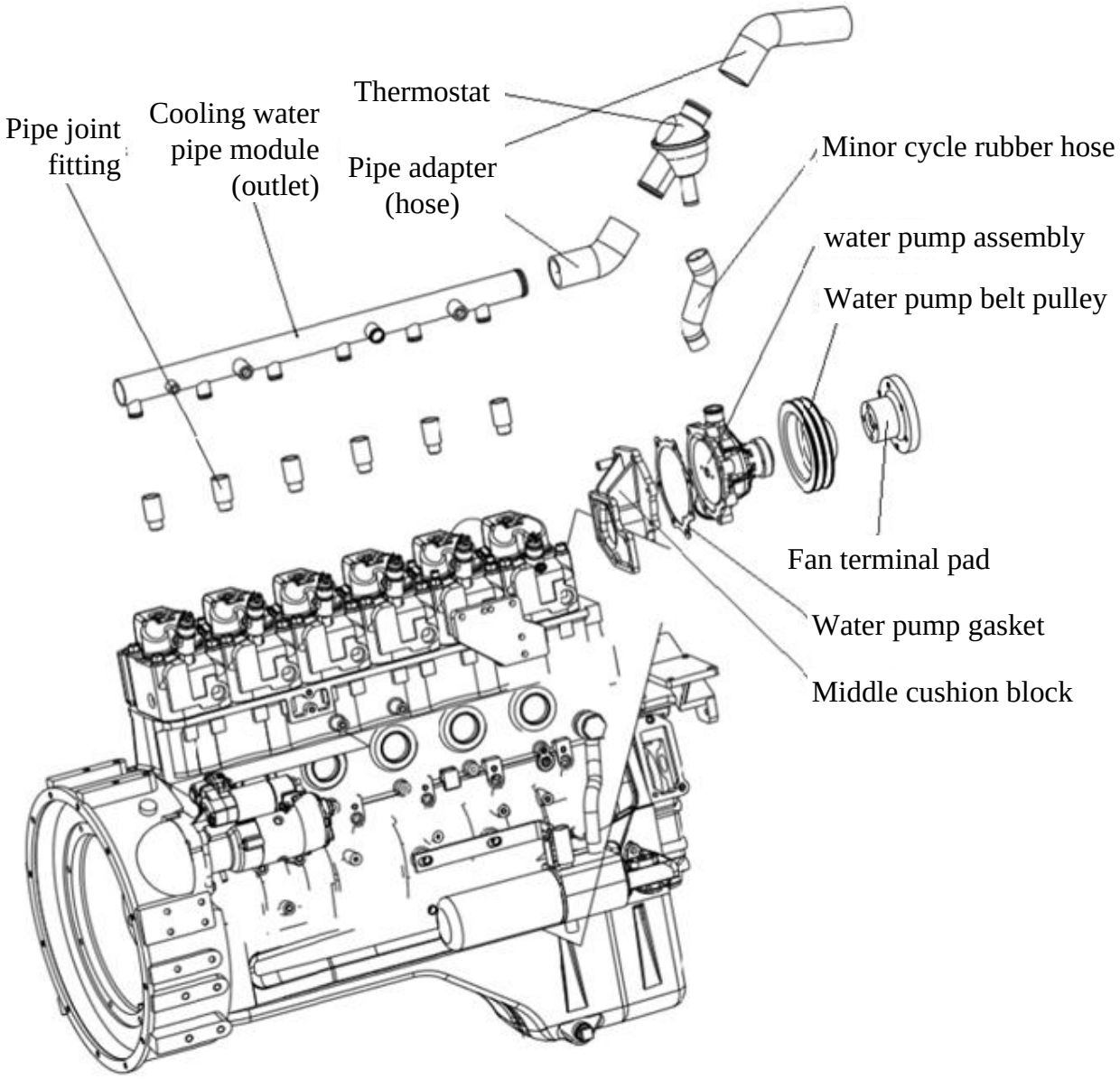


Fig. 3-7 Exploded view of water outlet pipe

3242 Steps to Disassemble Water Outlet Pipe

(1) Remove pipe clamps;

(2) Remove external thermostat;

(3) Remove relevant rubber hoses;

(4) Remove water outlet pipe;

(5) Control your force during disassembly to prevent damaging welding area.

3243 Inspection and Maintenance of Water Pipe

Check whether there is water leakage trace on the pipe before disassembling; check the pipe for damage like crack and corrosion, a cracked pipe should be replaced, for corrosion that may affect reliability of the pipe, the cause should be analyzed and corroded pipe should be replaced. WP6 engine water outlet pipe is of integral-type welded structure, the whole pipe should be replaced even if only one pipe joint is damaged or leaking.

3244 Steps to Assemble Water Outlet Pipe

(1) Install pipe joint fittings;

(2) Place pipe clamps;

(3) Install water outlet pipe;

(4) Connect thermostat water inlet port and outlet port of water outlet pipe with pipe adapter (hose), keep the clamps untightened;

(5) Connect water pump upper inlet port and thermostat slender water outlet port with minor cycle rubber hose, keep the clamps untightened;

(6) Check the rubber hoses for distortion and bend caused by unfit mounting, and tighten all hoses.

(7) Fasten all clamps and keep clamp heads in the same direction.

325 Disassembly, Inspection, Maintenance and Assembly of Oil-Gas Separator

3251 Exploded View of Oil-Gas Separator

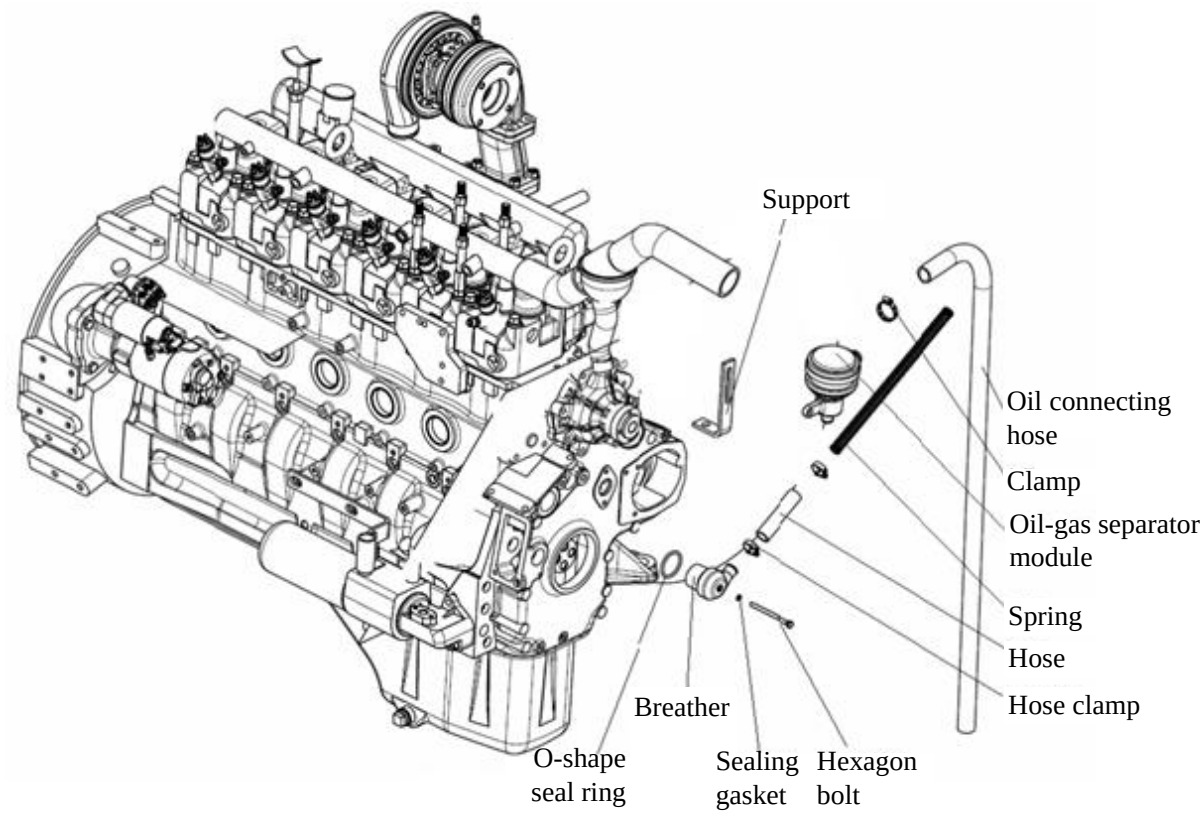


Fig. 3-8 Exploded view of oil-gas separator

3252 Steps to Disassemble Oil-Gas Separator

(1) Loosen all clamps;

(2) Disconnect oil connecting hose;

(3) Remove fixing bolts of oil-gas separator;

(4) Remove oil-gas separator and its support, take the spring out;

(5) Disconnect the hose that used to connect oil-gas separator and breather;

(6) Screw off hexagon bolt, and remove breather, O-shape seal ring, etc.

3253 Inspection and Maintenance of Oil-Gas Separator

(1) Check each rubber hose for aging crack, replace the cracked hose;

(2) Check external surface of breather and oil-gas separator for crack, if the crack is very deep that already or may lead to leakage, then the cracked part should be replaced;

(3) Check whether there is oil leakage trace on each joint, tighten the joint if so.

3254 Steps to Assemble Oil-Gas Separator

Assembling steps are contrary to disassembling ones.

326 Disassembly, Inspection, Maintenance and Assembly of Lifting Eyes

3261 Exploded View of Lifting Eye

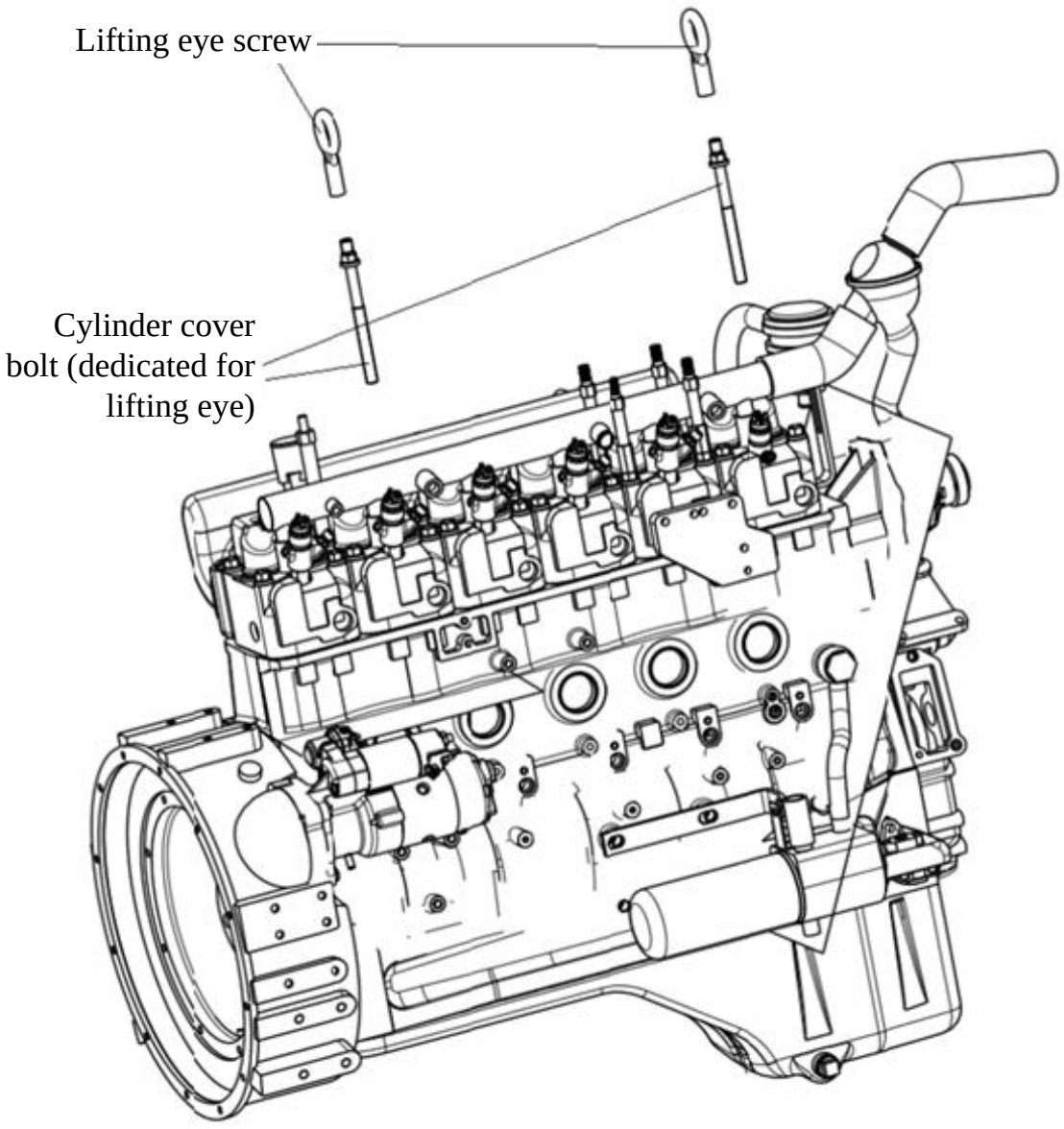


Fig. 3-9 Exploded view of lifting eye

3262 Steps to Disassemble Lifting Eye

After removing parts that used to cover lifting eye screw, screw off the screw.

3263 Inspection and Maintenance of Lifting Eye

Check whether there is crack on lifting eye screw and the threaded hole, replace the cracked parts.

3264 Steps to Assemble Lifting Eye

Assembling steps are contrary to disassembling ones.

33 Engine Block Assembly

331 Disassembly, Inspection, Maintenance and Assembly of Engine Block Assembly

3311 Exploded View of Engine Block Assembly

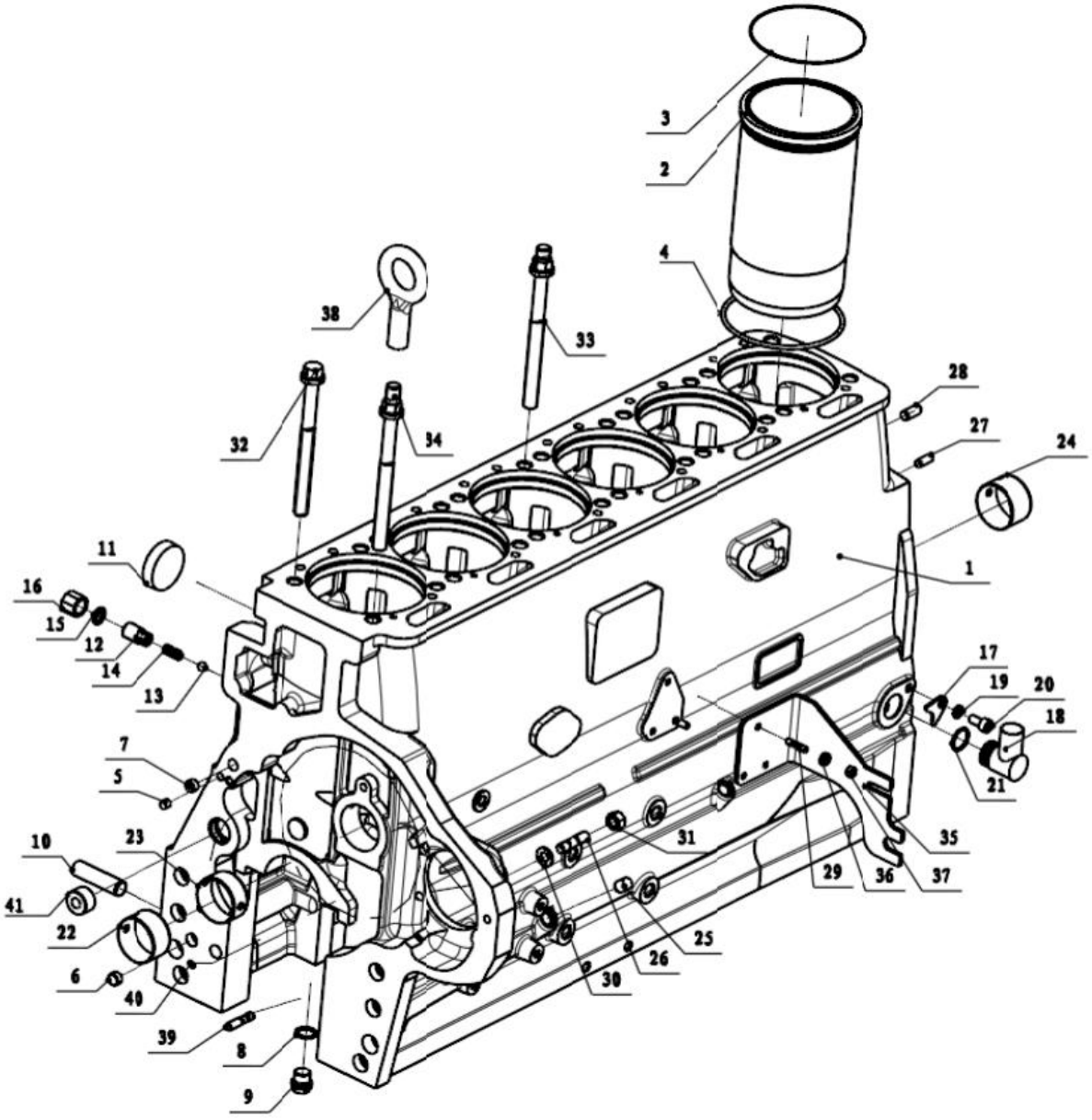


Fig. 3-10 Exploded view of engine block assembly

S/N	Name	S/N	Name	S/N	Name
1	Engine block module	15	Combination seal gasket	29	Stud
2	Cylinder sleeve	16	Cap shape nut	30	Flat gasket
3	O-shape seal ring	17	Dead plate	31	2-type hexagon nut
4	O-shape seal ring	18	Welded elbow	32	Cylinder cover bolt
5	Plug	19	Spring washer	33	Cylinder cover bolt
6	Plug	20	Hexagon socket cap screw	34	Cylinder cover bolt
7	Plug	21	O-shape seal ring	35	Fuel cut-off control wire support
8	Seal gasket	22	Camshaft sleeve	36	Gasket
9	Hexagon head plug	23	Camshaft sleeve	37	2-type hexagon nut
10	Sleeve	24	Camshaft sleeve	38	Lifting eye screw
11	Bowl shape plug	25	Cylindrical pin	39	Stud
12	Screw	26	Stud	40	Elastic cylindrical pin
13	Steel ball	27	Cylindrical pin	41	Sleeve
14	Spring	28	Cylindrical pin		

3312 Steps to Disassemble Engine Block Assembly

(1) Remove cylinder cover bolts (key point 1);

(2) Remove the welded elbow (key point 2);

(3) Remove the upright oil gallery plugs and gaskets;

(4) Remove cylinder cover (key point 3);

(5) Remove camshaft sleeve (key point 4);

(6) Remove the pressure-limiting valve between main and secondary gallery (key point 5).

3313 Inspection and Maintenance of Engine Block Assembly

Key point 1:

Assembling:

Apply lubricating oil on bearing surface and thread of cylinder cover bolts, and then tighten them according to following instructions:

(1) Tighten the four bolts of each cylinder cover with four-axis tightening machine, follow the procedures below:

a) Tighten to 15Nm b) Tighten to 60Nm c) Tighten for another 230 °±4 °

(2) If there is no suitable four-axis tightening machine, then tighten the bolts with a torque wrench according to the following procedures:

a) Pre-tighten each bolt to 30Nm b) Tighten for 120 °±4 ° c) 120 °±4 °again

Refer to Fig. 3-11 for pre-tightening and tightening order.

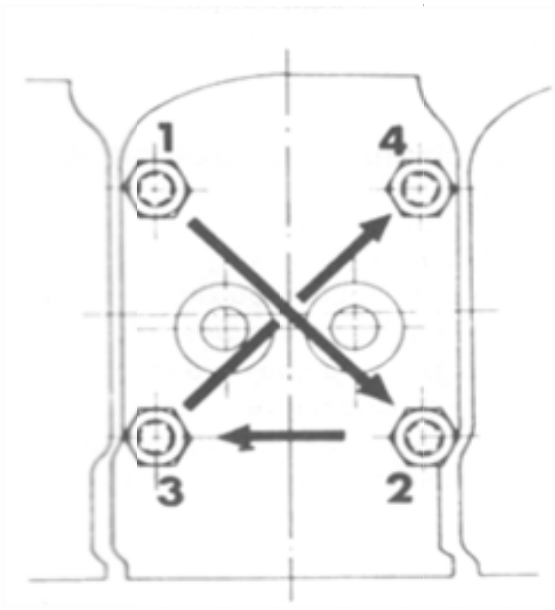


Fig. 3-11 Cylinder cover bolts tightening order

(3) Tightening order for the whole machine cylinder covers

Cylinder 3—Cylinder 4—Cylinder 5—Cylinder 2—Cylinder1—Cylinder 6

(4) Tightening torque control range for cylinder cover bolts

M14－12.9: (230~300)Nm

M14－10.9: (190~285)Nm

Key point 2:

Assembling:

Apply grease on seal ring and assemble it on welded elbow, and then insert welded elbow assembly

to the corresponding hole on engine block, fix it on the block with dead plate, inside hexagonal bolts and spring washers.

Key point 3:

Inspection:

(1) Measure the protrusion of cylinder sleeve (0.05mm~0.10mm is qualified).

Note that protrusion of cylinder sleeve is average value of X direction and Y direction; and the measurement should be done without seal rings. Cylinder sleeve for the same engine should be uniform.

(2) No corrosion, scratch and crash damage is allowed for fitting surface and friction surface, wipe them out and apply clean lubricating oil or grease before assembling.

Assembling:

Place cylinder sleeve vertically on engine block, install seal rings on the sleeve and engine block and then assemble the sleeve, knock it to the right place evenly with nylon rod.

Key point 4:

Disassembling:

Use dedicated tool to disassemble the camshaft sleeve, and try to protect other sleeves during disassembling.

Inspection:

Before assembling, grease on sleeve back, bush surface and fitting hole inner surface must be wiped out, and make sure there is no burr, overlap and scrap iron.

Assembling:

Apply oil on engine block hole, put camshaft sleeve into the dedicated tool and guide it into engine block, in the meantime align oil gallery holes on the sleeve and engine block.

Key point 5:

Assembling:

Screw on the threaded rod with dedicated tool, after tightening, orderly place steel ball, spring and cap shape nut (with gaskets), and then tighten the nut with open-end wrench.

3314 Steps to Assemble Engine Block Assembly

Assembling steps are contrary to disassembling ones.

332 Disassembly, Inspection, Maintenance and Assembly of Engine Block Module

3321 Exploded View of Engine Block Module

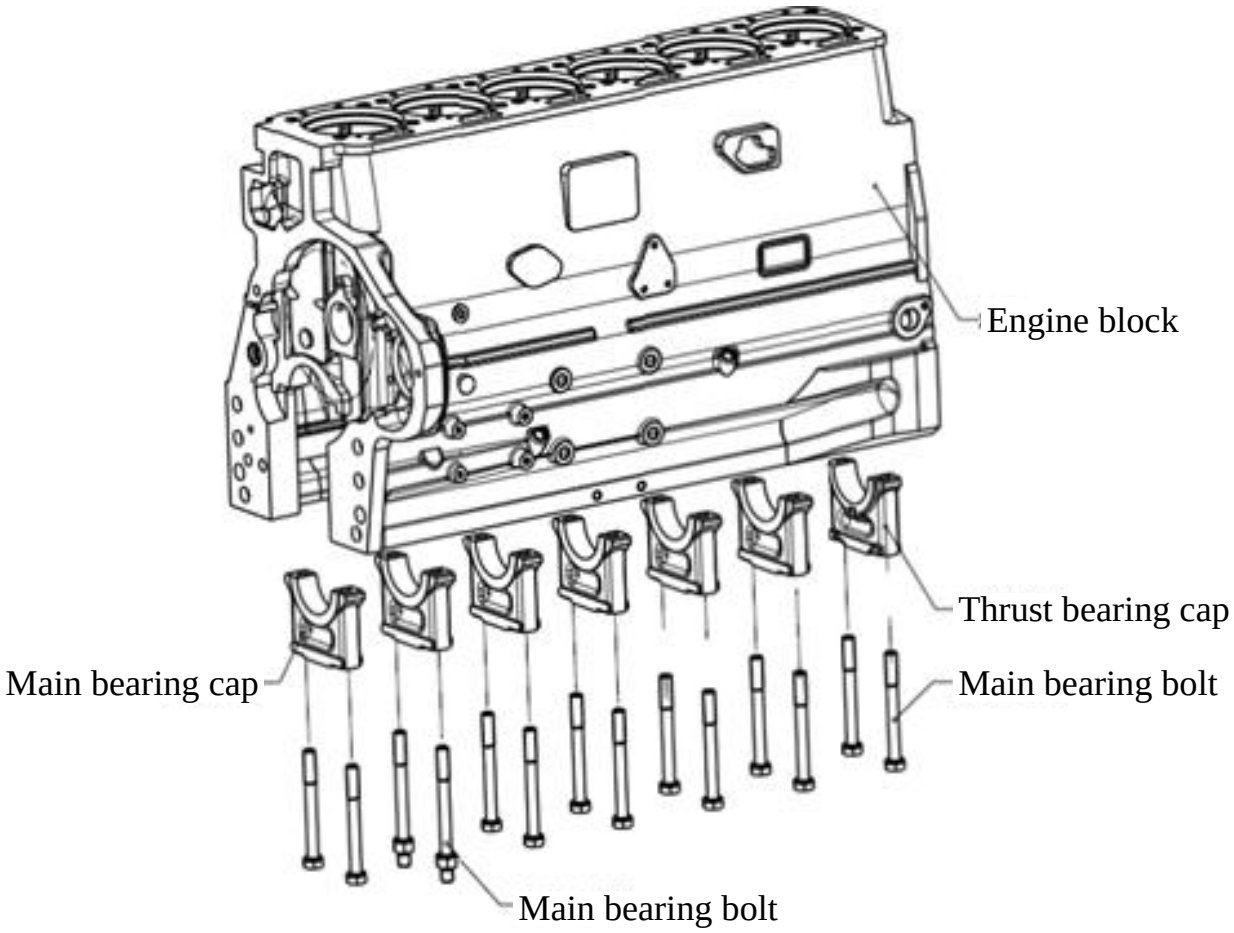


Fig. 3-12 Exploded view of engine block module

3322 Steps to Disassemble Engine Block Module

(1) Remove main bearing bolts (key pint 1);

(2) Remove main bearing caps (key pint 2);

3323 Inspection and Maintenance of Engine Block Module

Key point 1:

Inspection:

Check and clean engine block. Including but not limited to: Assembly environment must be clean; check engine block finished surfaces for crash damage, scratch and rust; do not bump and scratch the parts during assembling, and besides special requirements, sharp corner and edge on parts must be smoothed.

Assembling:

For 6-cylinder engine, 14 M14－10.9 main bearing bolts are used to fix the bearings. As shown in Fig 3-13, start with middle bearings, do the tightening work from middle to two ends evenly, follow the procedures below: Firstly pre-tighten each bolt to 70Nm, and tighten the bolts for further 90 °±4 °.

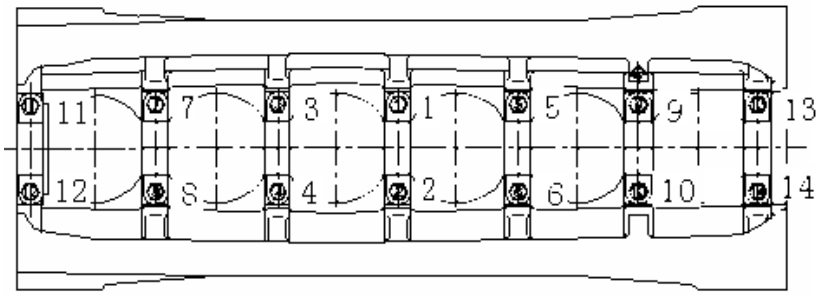


Fig. 3-13 Main bearing bolts tightening order

Key point 2:

Assembling:

Install the thrust bearing cap on rear end of engine block, and the others are non-thrust bearing cap. Take the cap two ends as locating basis when assembling; the main bearing bolts cannot be screwed on if the cap is inversely placed.

3324 Steps to Assemble Engine Block Module

Assembling steps are contrary to disassembling ones.

333 Disassembly, Inspection, Maintenance and Assembly of Engine Front Cover

3331 Exploded View of Engine Front Cover

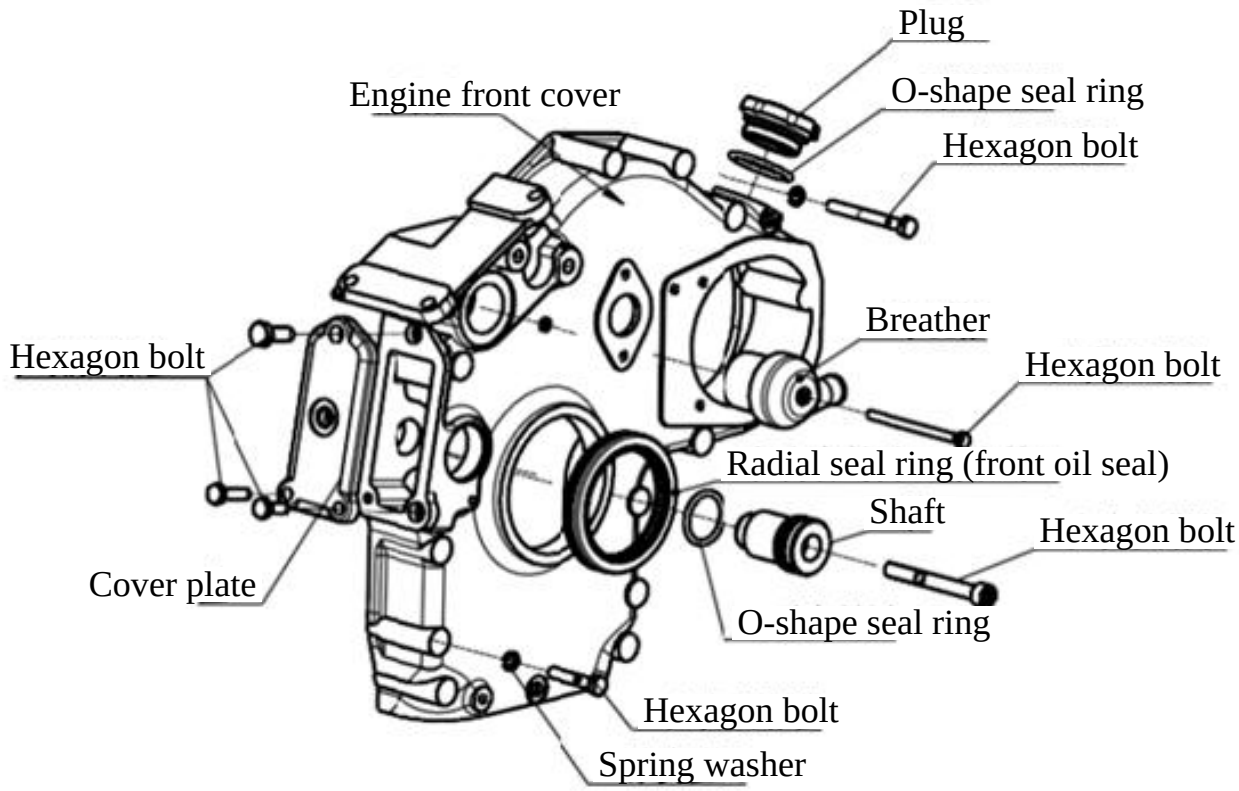


Fig. 3-14 Exploded view of engine front cover

3332 Steps to Disassemble Engine Front Cover

(1) Remove breather;

(2) Remove cover plate;

(3) Remove the plug;

(4) Remove engine front cover (key point 1);

(5) Remove radial seal ring (key point 2).

3333 Inspection and Maintenance of Engine Front Cover

Key point 1:

Inspection:

Check and make sure engine front cover is clean, no crash damage and burr on the fitting surface, ensure the seal rings are in good condition.

Assembling:

(1) Knock-in locating pins, as shown in Fig. 3-15;

Fig. 3-15 Knock-in locating pins

(2) Apply sealant on the fitting surface of engine front cover, make sure the sealant is evenly distributed and no discontinuity.

Fig. 3-16 Sealant application of engine front cover

(3) Place engine front cover and align pins and pin holes, knock the cover edge gently with nylon rod, so that the cover and engine block can joint closely.

Fig. 3-17 Knock engine front cover

(4) Place the bolts with gaskets to their corresponding holes and tighten them with pneumatic impact wrench and open-end wrench.

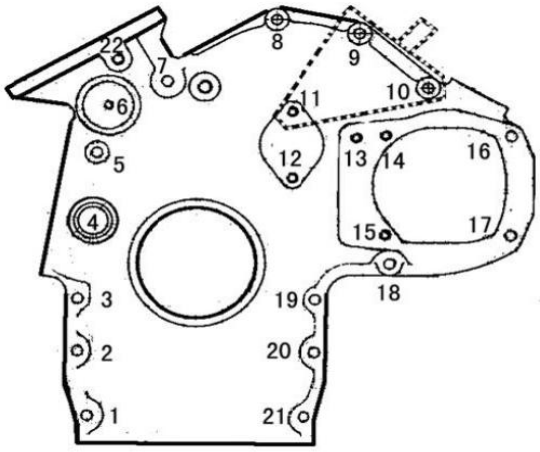


Fig. 3-18 Bolt tightening

Notes: Set pneumatic impact wrench to gear II for M8 bolts, and gear III for M10 bolts. Tightening order: 3-7-10-18, follow the sequence of arrows to tighten other bolts. A copper gasket should be assembled together with bolt 5, pre-tighten it with pneumatic impact wrench firstly and use 13# open-end wrench for final tightening. Specification of bolt 1, 2, 19, 20, and 21 is M8*45, specification of bolt 4 is M10*90, specification of bolt 5, 7, 8, 9, and 10 is M8*75. If position 9 and 10 in Fig. 3-18 are for installation of generator support, the bolt specification should be M8*90. Specification of bolt 11 is M8*25, specification of bolt 18 is M8*35, specification of bolt 16 and 17 is M8*90, specification of bolt 15 is M8*25.

Key point 2:

Assembling:

Oil seals and seal rings should be checked before assembling, make sure there is no damage and no dirt. For tight oil seal or seal ring, apply some clean engine oil on the shaft first, and then press-in the seal slowly with dedicated tool, make sure the press-in force is evenly distributed on the seal.

Disassembling:

Removed oil seal mustn’t be reused, replace it with a new one.

3334 Steps to Assemble Engine Front Cover

Assembling steps are contrary to disassembling ones.

334 Disassembly, Inspection, Maintenance and Assembly of Flywheel Housing

3341 Exploded View of Flywheel Housing

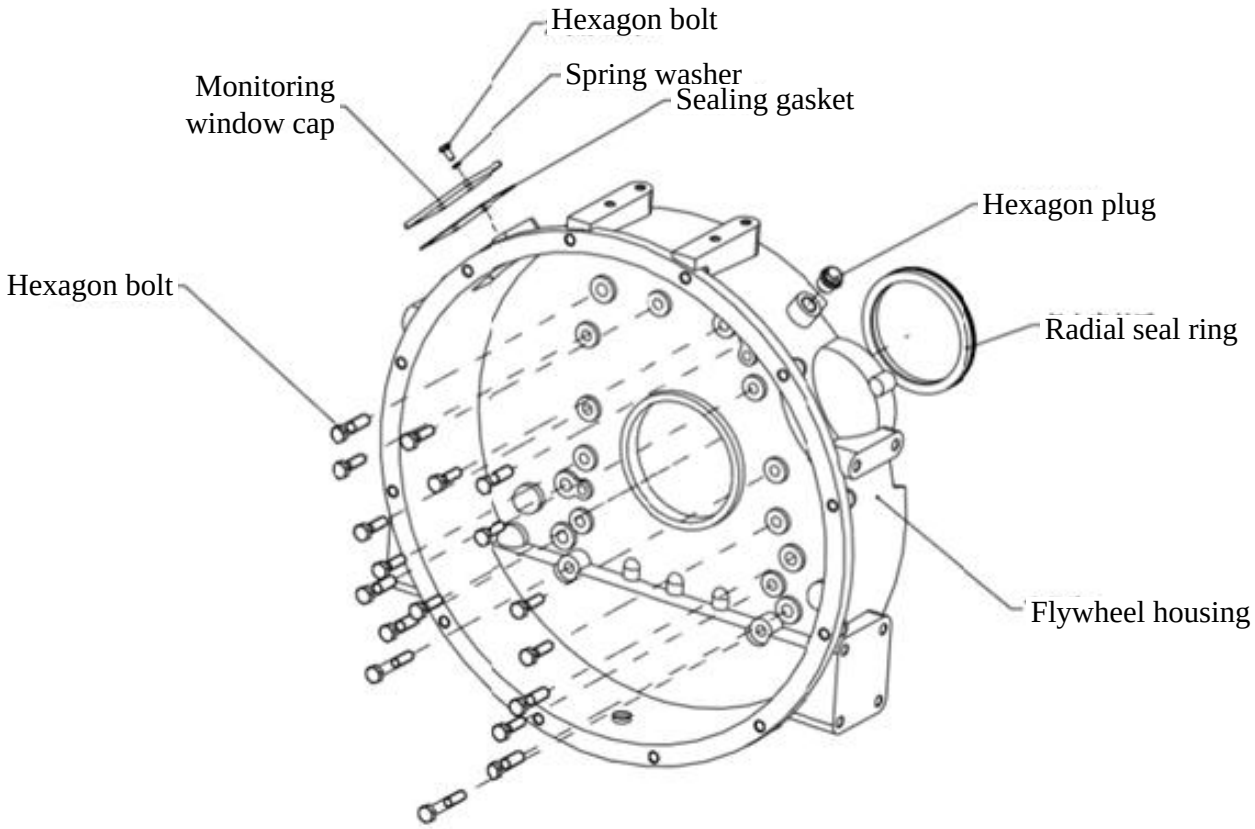


Fig. 3-19 Exploded view of flywheel housing

3342 Steps to Disassemble Flywheel Housing

(1) Remove fixing bolts of flywheel housing (key point 1);

(2) Remove fixing bolts of monitoring window cap on flywheel housing, take down the cap;

(3) Remove flywheel housing.

3343 Inspection and Maintenance of Flywheel Housing

Key point 1:

Assembling:

Check whether flywheel is cleaned up. Debur the corresponding fitting surface on engine block with 240# fine oil stone and clean the surface with ethyl alcohol. Apply sealant on fitting surfaces of flywheel housing and engine block. Bolts and tools: M10-10.9 hexagon bolts (×12), M12-10.9 hexagon bolts (×6), 17mm and 19mm socket spanner.

Step 1: Preassemble the bolts

Step 2: Follow the sequence of arrow to tighten the M10 bolts, tighten torque for M10 bolts is 80~85Nm. And then tighten the M12 bolts according to the marked order 1-2-3-4-5-6, tighten torque for M12 bolts is 140~145Nm.

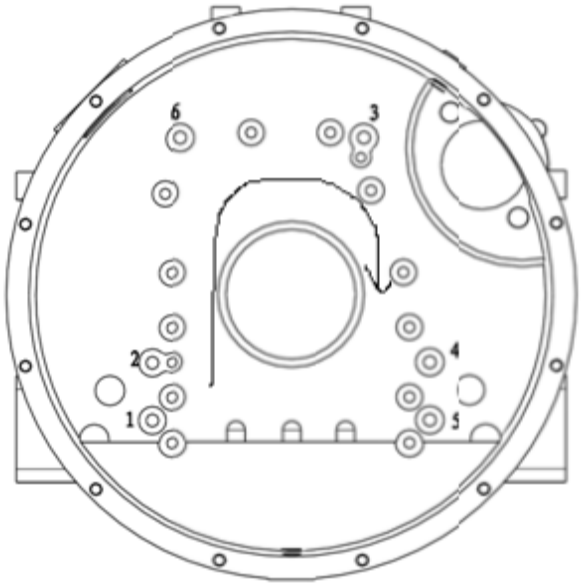


Fig. 3-20 Tightening order of flywheel housing bolts

NOTICE: For the strengthening bolts listed above, the thread and bearing surface of each bolt should be applied with lubricating oil before assembling.

3344 Steps to Assemble Flywheel Housing

Assembling steps are contrary to disassembling ones.

335 Disassembly, Inspection, Maintenance and Assembly of Oil Sump

3351 Exploded View of Oil Sump

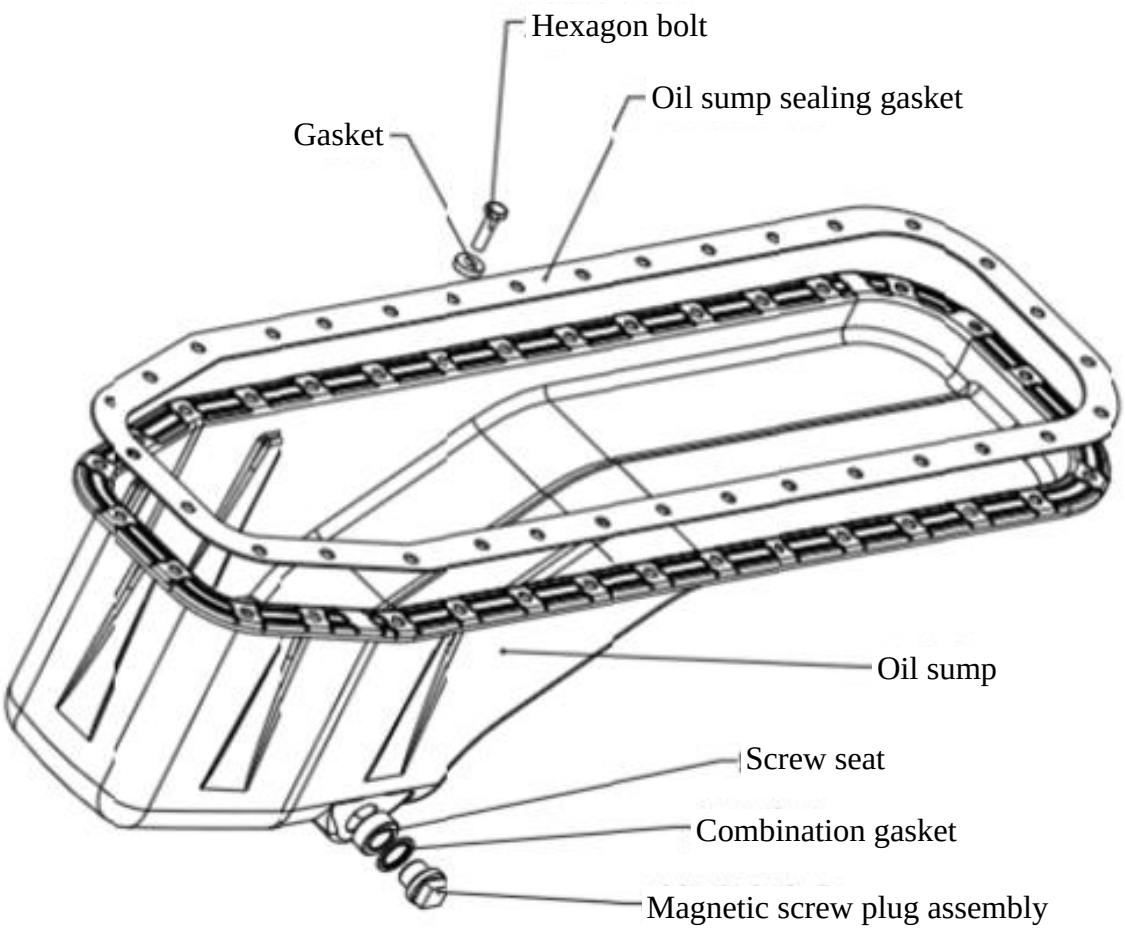


Fig. 3-21 Exploded view of oil sump

3352 Steps to Disassemble Oil Sump

(1) Turn over the engine to keep oil sump upward (key point 1);

(2) Remove oil sump fastening bolts (key point 2);

(3) Take down oil sump and sealing gaskets;

(4) Remove the combination gasket and magnetic screw plug assembly.

3353 Inspection and Maintenance of Oil Sump

Key point 1:

Disassembling:

Before the disassembling, all engine oil should be drained out. Put an engine oil container under drain screw plug of oil sump, screw off the plug with a plug wrench to drain oil out.

Key point 2:

Assembling:

(1) Apply sealant on fitting surface of engine block and partially apply sealant on oil sump, place sealing gasket on the fitting surface.

(2) Lift and place oil sump, be careful and avoid crashing the fitting surface.

(3) Place bolts and gaskets, and tighten the bolts with pneumatic impact wrench to 20~355Nm.

3354 Steps to Assemble Oil Sump

Assembling steps are contrary to disassembling ones.

336 Disassembly, Inspection, Maintenance and Assembly of Piston Nozzle

3361 Exploded View of Piston Nozzle

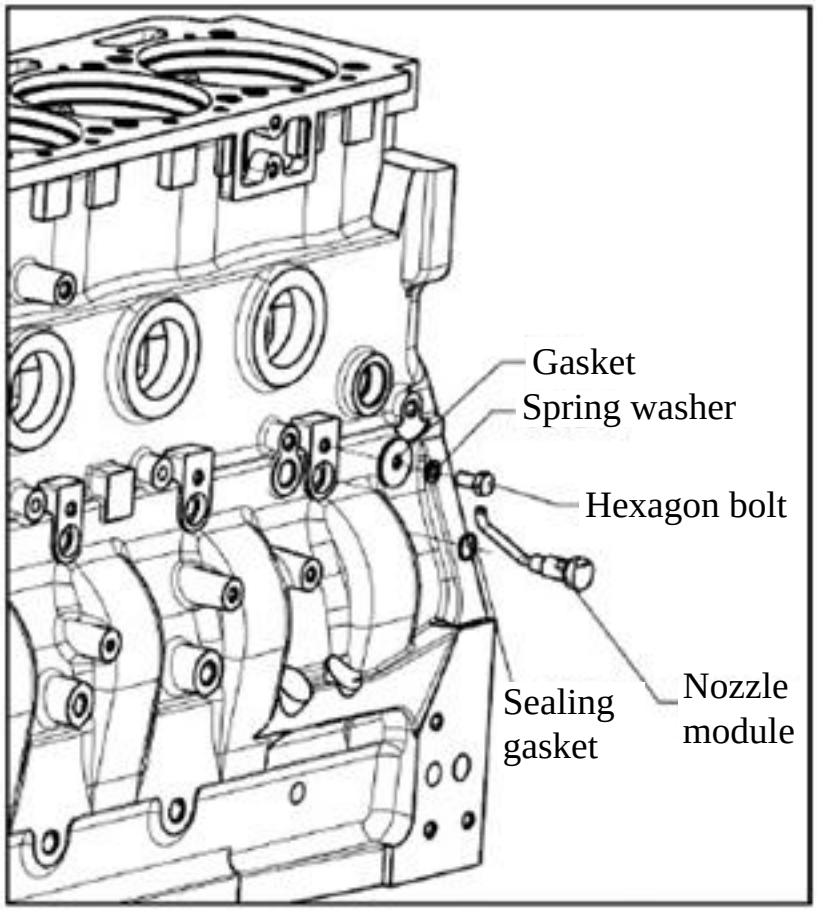


Fig. 3-22 Exploded view of piston nozzle

3362 Steps to Disassemble Piston Nozzle

(1) Remove the hexagon bolt (key point 1);

(2) Remove nozzle module (key point 2).

3363 Inspection and Maintenance of Piston Nozzle

Key point 1:

Assembling:

(1) Compress nozzle module tightly with bolt (with spring washer) and pressing plate;

(2) Place the pressing plate in nozzle end face groove.

(3) Bolts tightening: Set TOKU pneumatic impact wrench to gear II.

Key point 2:

Inspection:

Check O-shape seal ring for damage; make sure the nozzle is clean and free of burr.

3364 Steps to Assemble Piston Nozzle

Assembling steps are contrary to disassembling ones.

337 Disassembly, Inspection, Maintenance and Assembly of Thrust Plates

3371 Exploded View of Thrust Plates

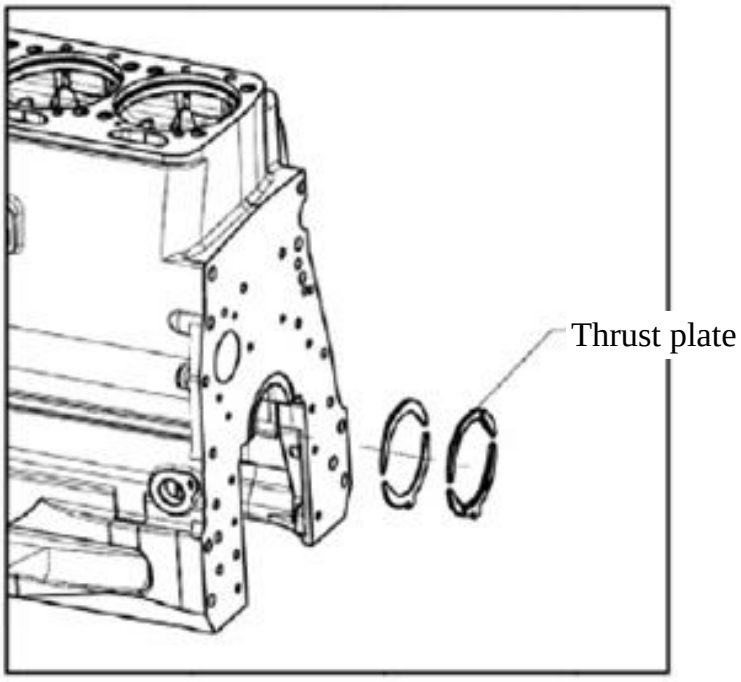


Fig. 3-23 Exploded view of thrust plates

3372 Steps to Disassemble Thrust Plates

(1) Remove main bearing cap (refer to section 332);

(2) Remove crankshaft (refer to section 344);

(3) Remove thrust plates (key point 1).

3373 Inspection and Maintenance of Thrust Plates

Key point 1:

Assembling:

Thrust plate should be used in pairs and the side with oil groove should be outward during assembling. Put the anti-misloading lug in corresponding groove of thrust bearing cap.

3374 Steps to Assemble Thrust Plates

Assembling steps are contrary to disassembling ones.

338 Disassembly, Inspection, Maintenance and Assembly of Front and Rear Oil Seals

3381 Exploded View of Front and Rear Oil Seals

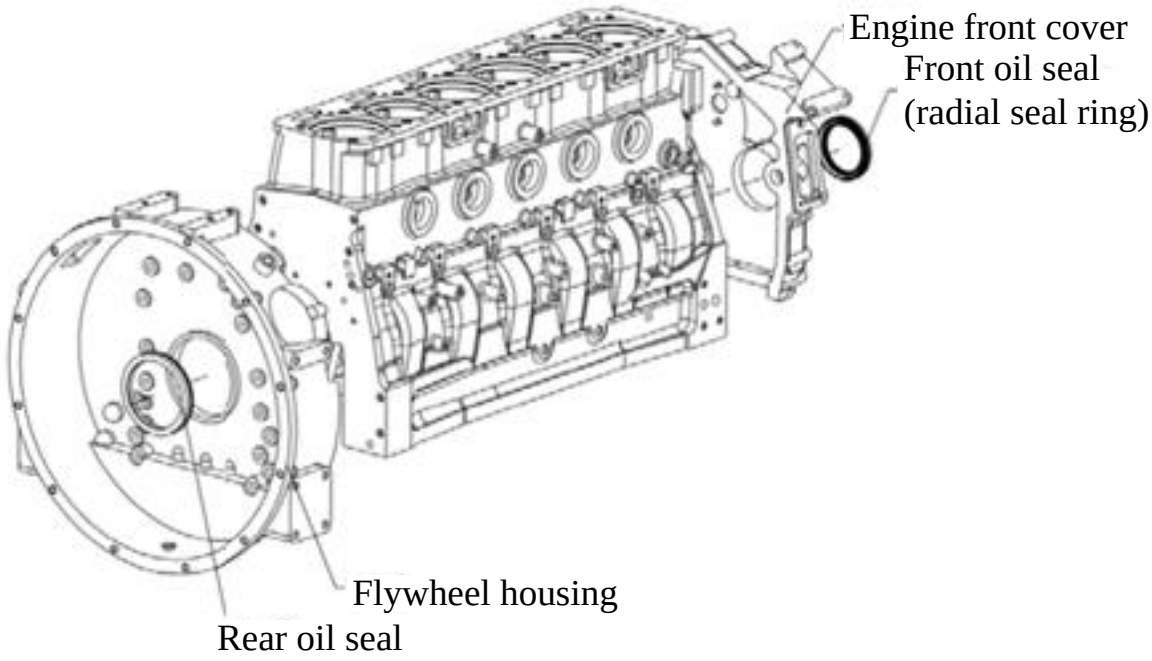


Fig. 3-24 Exploded view of front and rear oil seals

3382 Steps to Disassemble Front and Rear Oil Seals

(1) Remove engine front cover (refer to section 333);

(2) Remove front oil seal;

(3) Remove rear oil seal (key point 1);

3383 Inspection and Maintenance of Front and Rear Oil Seals

Key point 1:

Inspection:

Oil seals and seal rings should be checked before assembling, make sure there is no damage. Check whether rear oil seal cover is clean and whether its finished surface is free of obvious scratch.

Assembling:

Apply sealant on the rear oil seal outer ring first, and then press-in the seal slowly with dedicated tool. NOTICE: Do not damage the seal during assembling, and seal outer ring should be parallel and level to oil seal cap plane.

3384 Steps to Assemble Front and Rear Oil Seals

Assembling steps are contrary to disassembling ones.

34 Crank-Rod Mechanism

341 Disassembly and Assembly of Crank-Rod Mechanism

3411 Exploded View of Crank-Rod Mechanism

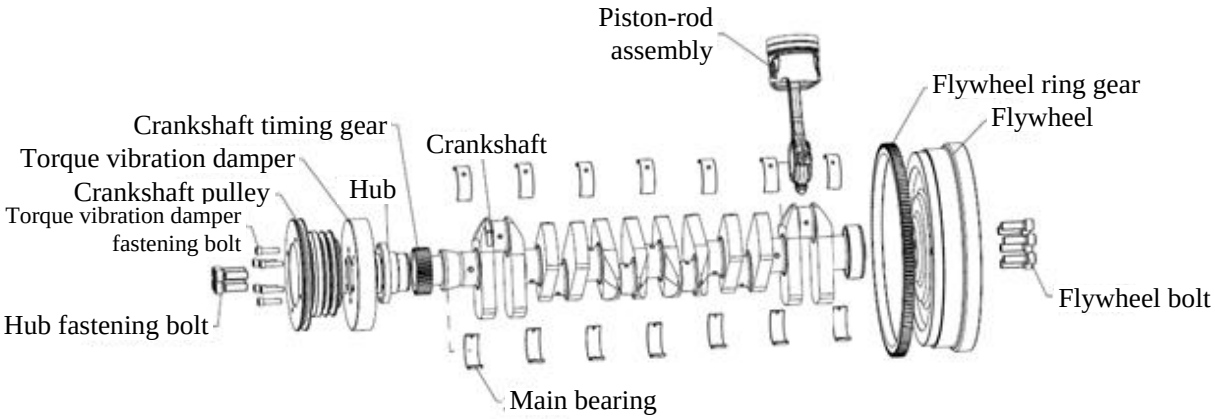


Fig. 3-25 Exploded view of crank-rod mechanism

3412 Steps to Disassemble Crank-Rod Mechanism

(1) Check before disassembling. Check connecting rod axial backlash, check tightening torque of connecting rod bolts; Tilt and lay the engine on its side, rotate the flywheel until the to-be removed piston is in BDC, remove connecting rod bolts and cap; Rotate the flywheel until the to-be removed piston is in TDC, knock the piston out with wooden hammer, proceed with caution to avoid jamming cylinder block with connecting rod tip. Remover other pistons in the same way, number and place them orderly.

(2) Screw off fastening bolts of torque vibration damper and fastening bolts of hub, take down crankshaft pulley, torque vibration damper and hub.

(3) Screw off flywheel bolts, take down flywheel assembly, bearing, etc.

3413 Steps to Assemble Crank-Rod Mechanism

Assembling steps are contrary to disassembling ones.

342 Disassembly, Inspection, Maintenance and Assembly of Piston-Rod Assembly

3421 Exploded View of Piston-Rod Assembly

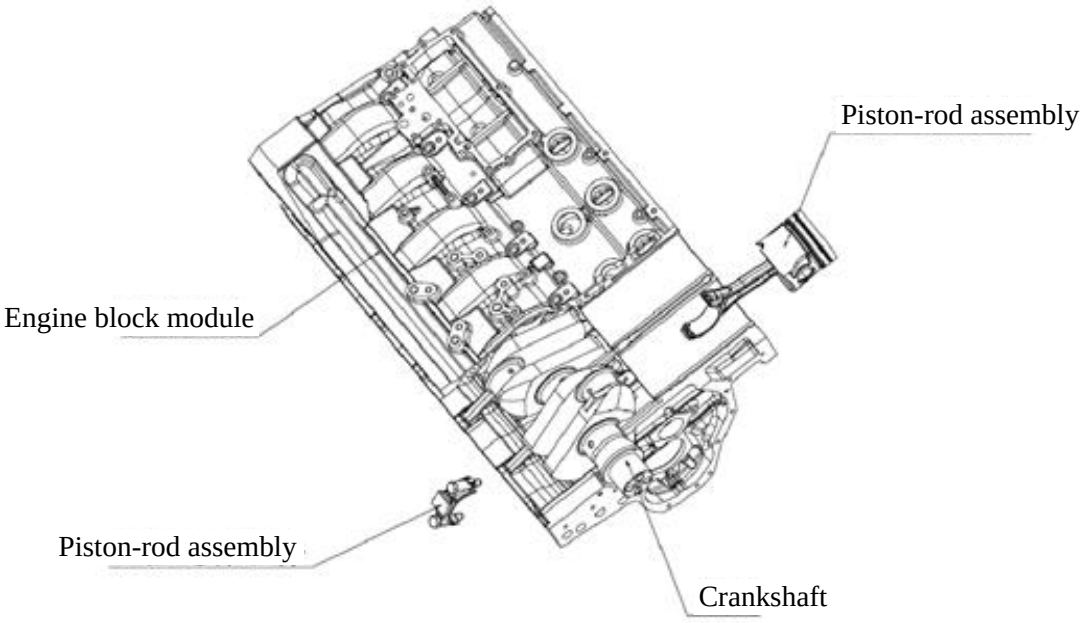


Fig. 3-26 Schematic diagram of piston-rod assembly

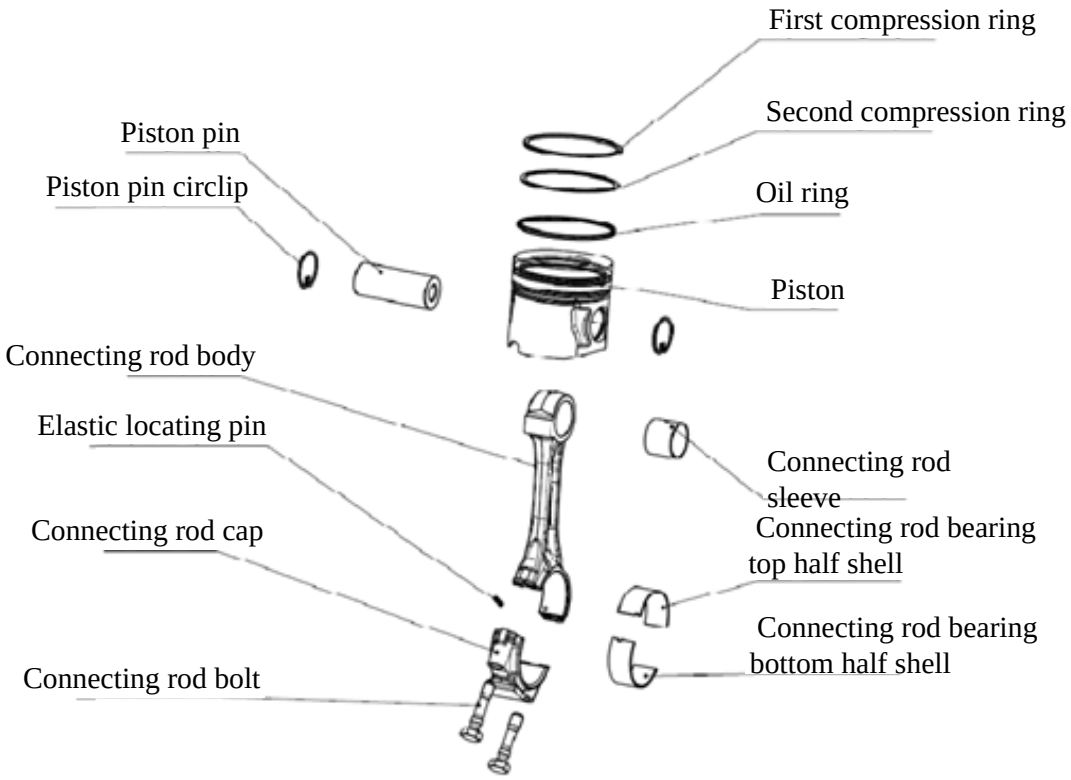


Fig. 3-27 Exploded view of piston-rod assembly

3422 Steps to Disassemble Piston-Rod Assembly

(1) Check before disassembling. Check connecting rod axial backlash, check tightening torque of connecting rod bolts;

(2) Tilt and lay the engine on its side, rotate the flywheel until the to-be removed piston is in BDC, and then remove connecting rod bolts and cap;

(3) Rotate the flywheel until the to-be removed piston is in TDC, knock the piston out with wooden hammer, proceed with caution to avoid jamming cylinder block with connecting rod tip.

(4) Remover other pistons in the same way, number and place them orderly.

(5) Remove circlip on two sides of piston with internal circlip plier and push piston pin out, take down the connecting rod body. Number the piston pins, connecting rod bodies and place them orderly.

(6) Remove first compression ring, second compression ring and oil ring with piston ring plier and mark them.

3423 Inspection and Maintenance of Piston-Rod Assembly

(1) Check whether there is crack on combustor throat fillet and piston pin boss; Check piston skirt and piston head for cylinder scoring phenomenon; Check wear condition of piston pin hole.

(2) Check wear condition of piston ring outer edge; Check wear condition of piston ring upper and lower end face.

(3) Check wear condition of piston pin external surface.

(4) Check whether there is crack on connecting rod tip bottom hole, connecting rod body and connecting rod small end oil hole; Check alloy layer of connecting rod shell for abnormal wear and peeling phenomenon; Check wear condition of connecting rod side faces, check crooking condition of connecting rod body.

(5) Check wear condition of connecting rod bearing shell, check its alloy layer for discoloration, peeling and slippage phenomenon.

3424 Steps to Assemble Piston-Rod Assembly

(1) Install one circlip into piston circlip groove with internal circlip plier, and rotate the circlip to ensure it is properly fitted. The end with corner angle should face inward, and its opening should be upward.

(2) Insert small end of connecting rod into piston inner cavity and align it to piston pin holes, and then install piston pin, finally install the other circlip to the other side of the piston. Note that

connecting rod oblique incision and piston cooling oil gallery inlet should be in the same direction, apply proper clean lubricating oil on connecting rod small end hole and piston pin.

(3) Arrange the assembled piston-rod assembly in cylinder number order, and then install oil ring, second compression ring and first compression ring into piston ring grooves orderly with piston ring plier. The face with mark “TOP” should be upward, and the ring should be flexible in ring groove.

(4) Clean up cylinder inner wall, crankshaft connecting lever and piston-rod assembly, and apply clean lubricating oil on each motion pair.

(5) Adjust opening direction of each ring: The opening direction of first compression ring should be 30 °to piston pin center line, opening direction of the second compression ring should be 120 ° to that of the first compression ring, and opening direction of oil ring should be 120 ° to both that of first compression ring and second compression ring, also should be perpendicular to piston pin center line. As shown in Fig. 3-28.

(6) Rotate the flywheel with external force until cylinder 1, 6 get to BDC, install thrust plates of cylinder 1 and 6 (refer to section 337), and screw on connecting rod bolts. Rod parting surface should face left side of cylinder block (i.e. engine oil cooler side). The numbered pistons should not be mixed, install each piston to the corresponding cylinder; connecting rod cap and connecting rod should be used in pairs, apply clean lubricating oil on connecting rod bolts before assembling.

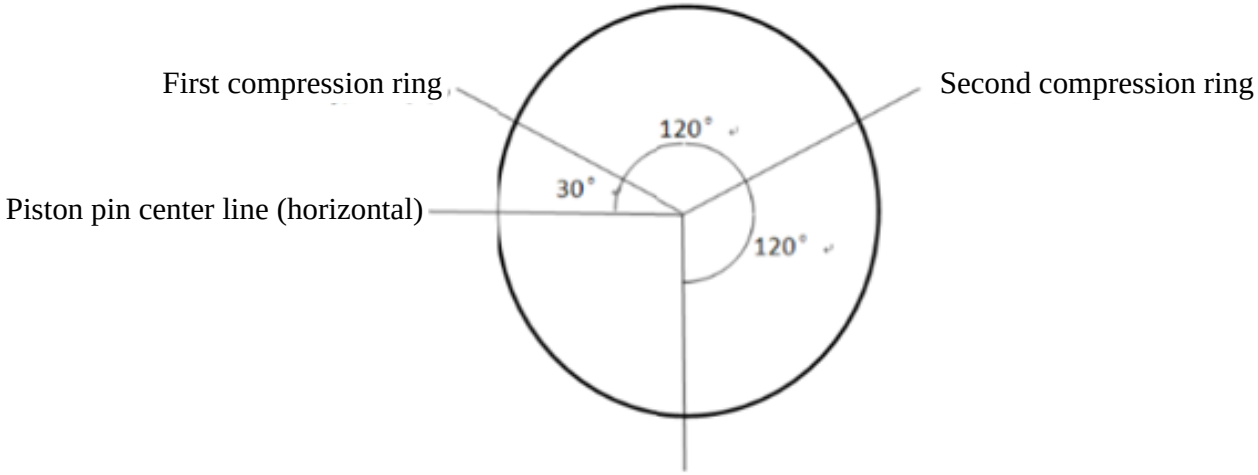


Fig. 3-28 Schematic diagram for installation of piston rings

(7) Tighten connecting rod bolts: Firstly tighten the bolts to 30Nm in symmetry, and then tighten each bolts for another 58 °~65 °, in the meantime tighten torque should be up to 85~135Nm. Assemble other piston-rods in the same way.

343 Disassembly, Inspection, Maintenance and Assembly of Crankshaft

3431 Exploded View of Crankshaft

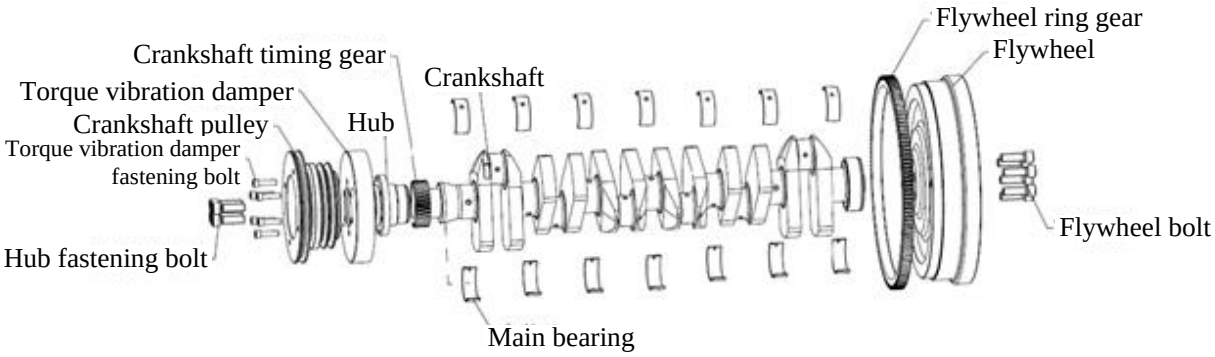


Fig. 3-29 Exploded view of crankshaft

3432 Steps to Disassemble Crankshaft

(1) Put the engine crankcase upward, and then remove main bearing bolts and place them orderly;

(2) Take down crankshaft and flywheel, remove front and rear thrust plates and flywheel bearing. Remove oil seals; place the crankshaft on bracket (for long time storage, the crankshaft should be placed vertical);

(3) Classify the removed parts according to the requirements.

3433 Inspection and Maintenance of Crankshaft

(1) Check whether there is crack on fillet area of crankshaft main journal and neck of crankshaft; Check the joint part of crankshaft and main bearing for crack, check and dredge the oil gallery.

(2) Check the wear condition of crankshaft main journal and neck of crankshaft, and check whether there is line-like puckering, metal peeling and crack.

(3) Check the wear condition of front and rear oil seals.

(4) Check whether there is failure like thread damage on main bearing bolts

(5) Check crankshaft flange bolt holes for crack.

(6) Check wear condition of crankshaft journal, check bend and distortion condition of crankshaft.

3434 Steps to Assemble Crankshaft

(1) Clean up cylinder bottom holes.

(2) Press main bearing upper shell into cylinder bottom holes and clean up scraped foreign matters.

a) The bearing shell should be strictly inspected for bump damage before assembling, and shell with bump damage should not be reused even if repaired.

b) The assembled upper bearing shell should be aligned to oil hole and oil groove on cylinder body, misalignment exceeds 1/5~1/4 of oil hole is strictly forbidden. The assembled upper bearing shell should be closely fit with cylinder bottom holes.

(3) Apply clean lubricating oil on inner surface of upper bearing shell.

(4) Clean up undersurface of cylinder block, and make sure there is no grease.

(5) Apply sealant on undersurface of cylinder block properly.

(6) Lift up crankshaft, and clean up oil holes with compressed air, wipe out main journal and connecting rod journal with a towel, and then drop the crankshaft into cylinder body slowly, prevent crashing the crankshaft in this process.

(7) Clean up upper thrust plate and press it into cylinder body. Then side with oil groove should face outward (face crankshaft).

(8) Check and make sure the oil seal is flat and free of distortion, and then place it into seal groove on cylinder undersurface with dedicated tool.

(9) Press lower bearing shell and lower thrust plate (the side with oil groove should face crankshaft) into crankcase and assemble the crankshaft.

(10) Apply clean lubricating oil on crankcase bolt bearing surface and main bearing bolt thread. Place main bearing bolts and pre-tighten them according to the order shown in Fig. 3-30. Firstly pre-tighten to 70Nm, and then tighten each bolt for another 90 °±4 °. Assembly of crank shaft is finished.

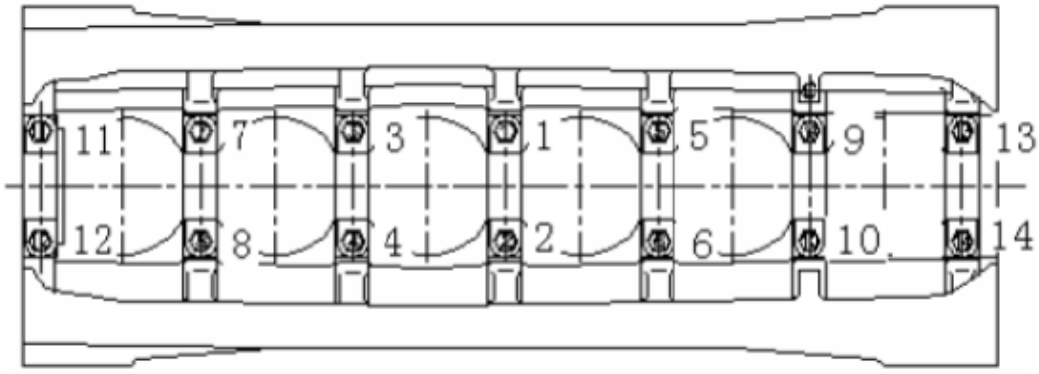


Fig. 3-30 Tighten order of main bearing bolts

344 Disassembly, Inspection, Maintenance and Assembly of Flywheel and Ring Gear

3441 Exploded View of Flywheel and Ring Gear

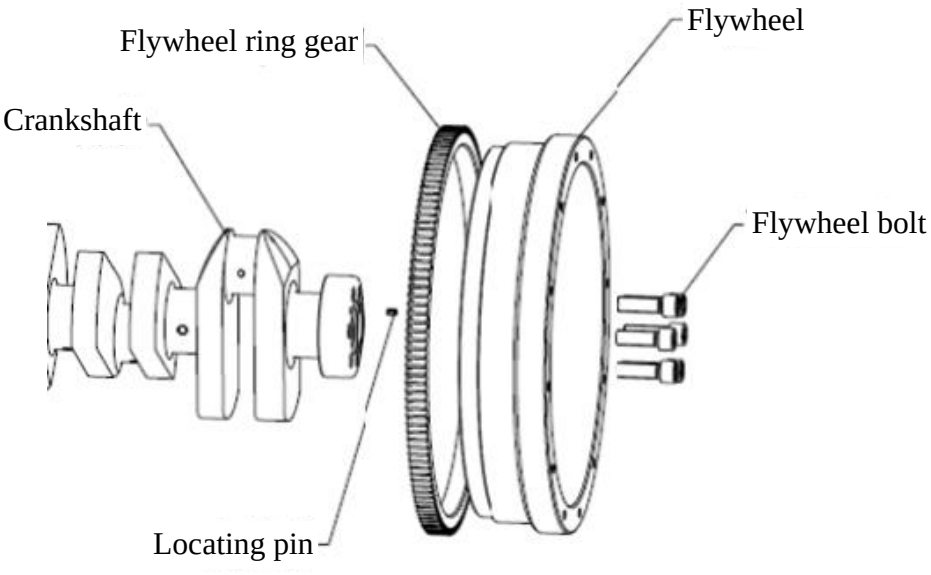


Fig. 3-31 Exploded view of flywheel and ring gear

3442 Steps to Disassemble Flywheel and Ring Gear

Disassembling steps are contrary to assembling ones.

3443 Inspection and Maintenance of Flywheel and Ring Gear

(1) Check whether there is failure like thread damage on flywheel bolts.

(2) Check flywheel surface for conquassation.

(3) Check whether flywheel ring gear is damaged.

3444 Steps to Assemble Flywheel and Ring Gear

(1) Fix the flywheel ring gear on flywheel with bolts;

(2) Knock the pin into crankshaft rear end fully.

(3) After inserting flywheel guide rod into crankshaft threaded hole, install flywheel and pre-tighten the bolts diagonally. Apply lubricating oil on bolt thread and bearing surface.

Flywheel bolts:

Bolt specification M16-12.9 (×6); Tightening torque: 285~295Nm; Test value: 285~340Nm.

345 Disassembly, Inspection, Maintenance and Assembly of Torque Vibration Damper, Crankshaft Pulley and Hub

3451 Exploded View of Torque Vibration Damper, Crankshaft Pulley and Hub

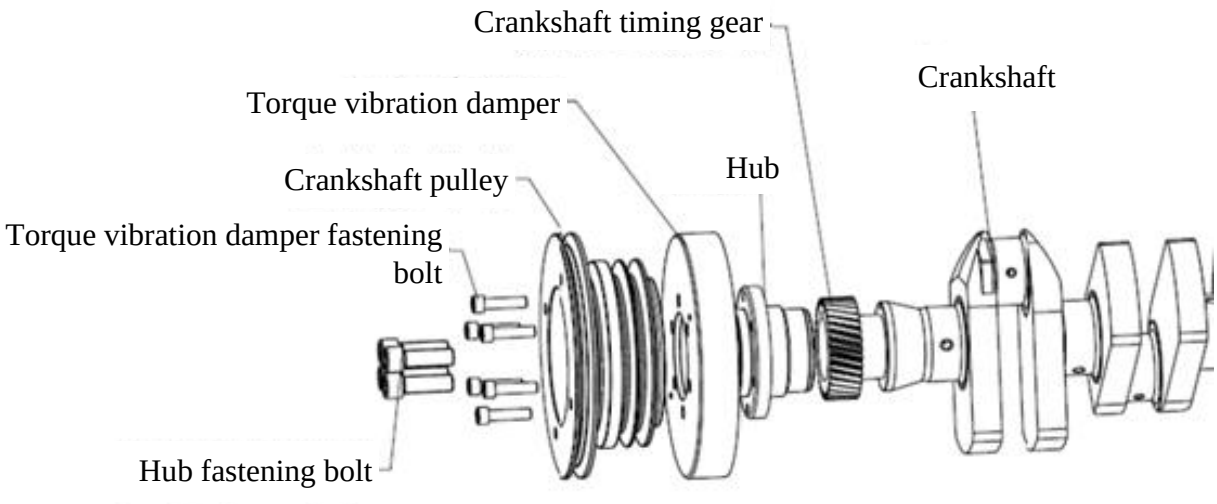


Fig. 3-32 Exploded view of torque vibration damper, crankshaft pulley and hub

3452 Steps to Disassemble Torque Vibration Damper, Crankshaft Pulley and Hub

Screw off pulley bolts and then take down pulley and damper orderly.

3453 Inspection and Maintenance of Torque Vibration Damper, Crankshaft Pulley and Hub

(1) Check crankshaft pulley for bump damage and distortion.

(2) Check whether crankshaft pulley and hub are damaged, whether the bolts are crushed.

(3) Check whether hub fastening bolts and damper fastening bolts are damaged.

3454 Steps to Assemble Torque Vibration Damper, Crankshaft Pulley and Hub

After assembling the timing gear, install the hub, torque vibration damper and crankshaft pulley orderly:

(1) Fasten the hub to crankshaft with bolts tightly.

Hub fastening bolts:

Bolt specification M16-12.9 (×4); Tightening torque: 300~310Nm; Test value: 300~360Nm.

(2) Fasten torque vibration damper and crankshaft pulley to the hub with bolts.

Torque vibration damper fastening bolts:

Bolt specification M10-10.9 (×6); Tightening torque: 60~70Nm; Test value: 65~80Nm.

346 Disassembly, Inspection, Maintenance and Assembly of Crankshaft Bearing Shell

3461 Exploded View of Crankshaft Bearing Shell

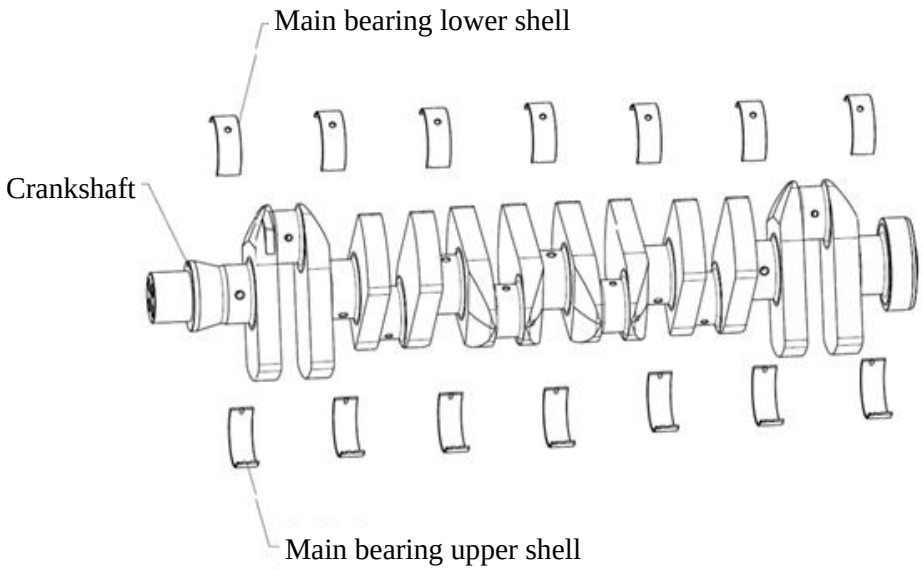


Fig. 3-33 Exploded view of crankshaft bearing shell

3462 Steps to Disassemble Crankshaft Bearing Shell

Push the shells out with hand, and mark the removed shells (should be corresponded with holes on engine block and crankcase).

3463 Inspection and Maintenance of Crankshaft Bearing Shell

(1) Clean the bearing shells and check their wear condition.

(2) Check and ensure there is no peeling, locating lip damage and transverse crack on the shell.

3464 Steps to Assemble Crankshaft Bearing Shell

(1) Clean up main bearing shells and the fitting holes.

(2) If no shell is replaced, then install the two shells into engine block (upper) and crankcase (lower) respectively (pay attention to the mark, shells should be installed into corresponding holes on engine block and crankcase), do not mix upper and lower shells, the one with oil groove is upper one. The shell lips should be aligned and applied with engine oil.

35 Valve Mechanism

351 Disassembly and Assembly of Valve Mechanism

3511 Exploded View of Valve Mechanism

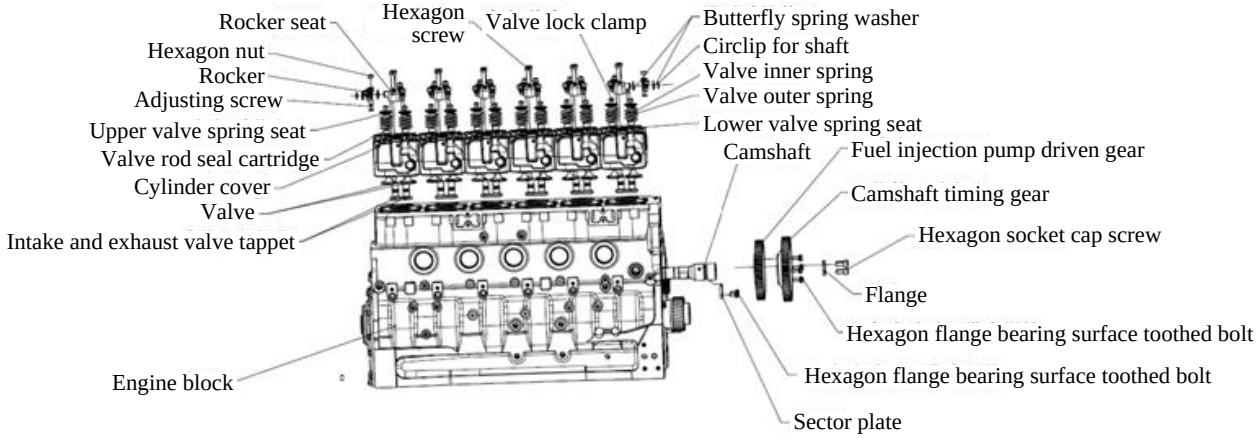


Fig. 3-34 Exploded view of valve mechanism

3512 Steps to Disassemble Valve Mechanism

(1) Remove rocker and rocker shaft, refer to disassembly of rocker and rocker shaft for details;

(2) Remove intake and exhaust valves, refer to disassembly of valves for details;

(3) Remove valve tappet and pushrod, refer to disassembly of valve tappet and pushrod for details;

(4) Remove camshaft and camshaft timing gear, refer to disassembly of camshaft and camshaft timing gear for details;

3513 Steps to Assemble Valve Mechanism

Assembling steps are contrary to disassembling ones.

352 Disassembly, Inspection, Maintenance and Assembly of Camshaft

3521 Exploded View of Camshaft

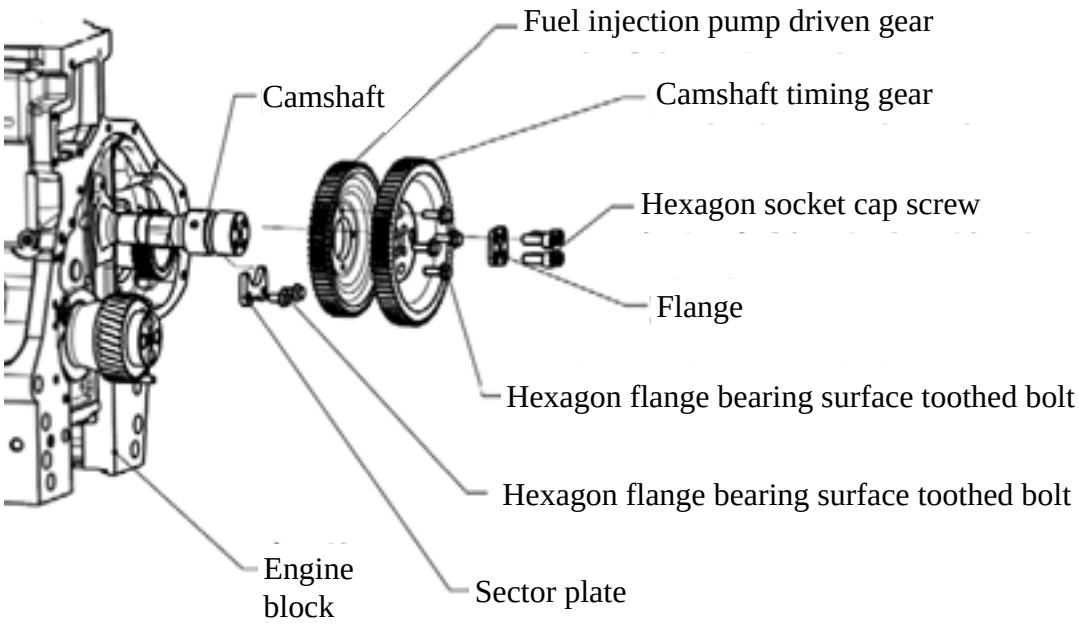


Fig. 3-35 Exploded view of camshaft

3522 Steps to Disassemble Camshaft

Disassembling steps are contrary to assembling ones.

3523 Inspection and Maintenance of Camshaft

(1) Check whether there is wear trace on cam face that contacting tappet, check main journal for seizure and abrasion.

(2) Check whether timing gear and hexagon bolts are distorted, check whether there is misengagement between camshaft timing gear and fuel injection pump driven gear, check whether there is severe wear on gear tooth surface.

3524 Steps to Assemble Camshaft

After disassembling, examine camshaft, timing gear and fuel injection pump driven gear, and part with wear or large parameter deviation should be repaired or replaced.

(1) Check camshaft for blur and bump damage, and make sure there is no rust, scratch and scrap iron.

(2) Apply clean engine oil on camshaft hole and tappet hole inner surface. Install the tappet, refer

to assembly of tappet for details; Install camshaft, do not damage camshaft surface and engine block hole during the push-in process of camshaft and the push-in strength should be equally, the end with thread should be on engine front cover side.

(3) Install sector plate, tightening torque of bolts should be 35±10Nm, seal up the bolts with lacquer.

(4) Install gaskets, flange, washers and hexagon bolts on camshaft threaded end. Measure the axial clearance of camshaft, which should be 0.1~0.29mm, if the clearance is too small, check whether there is burr between camshaft and sector plate. If fail to adjust the clearance to required range after deburring, then the camshaft should be replaced.

(5) Rotate the crankshaft until 0 tick on timing gear is closest to camshaft, firstly install fuel injection pump driven gear on the camshaft, and then install camshaft timing gear, make sure 0 tick of timing gear is engaged with 0 tick of fuel injection pump driven gear;

(6) After correctly installed the gears, mark 0 tick position of fuel injection pump driven gear and crankshaft timing gear with a marking pen.

(7) After adjusting the holes, install camshaft bolts (cleaned and applied with KB277 sealant) through flanges holes; pre-tighten camshaft timing gear fixing bolts with pneumatic impact wrench, and pre-tighten connecting bolts between camshaft timing gear and fuel injection pump driven gear. Tighten the bolts with torque spanner, tightening torque for M10 bolts: 85~90Nm, tightening torque for M8 bolts: 55~60.5Nm, seal up the bolts with lacquer after tightening.

Rotate crankshaft to check whether 0 tick of each gear is normally engaged.

353 Disassembly, Inspection, Maintenance and Assembly of Rocker and Rocker Shaft

3531 Exploded View of Rocker and Rocker Shaft

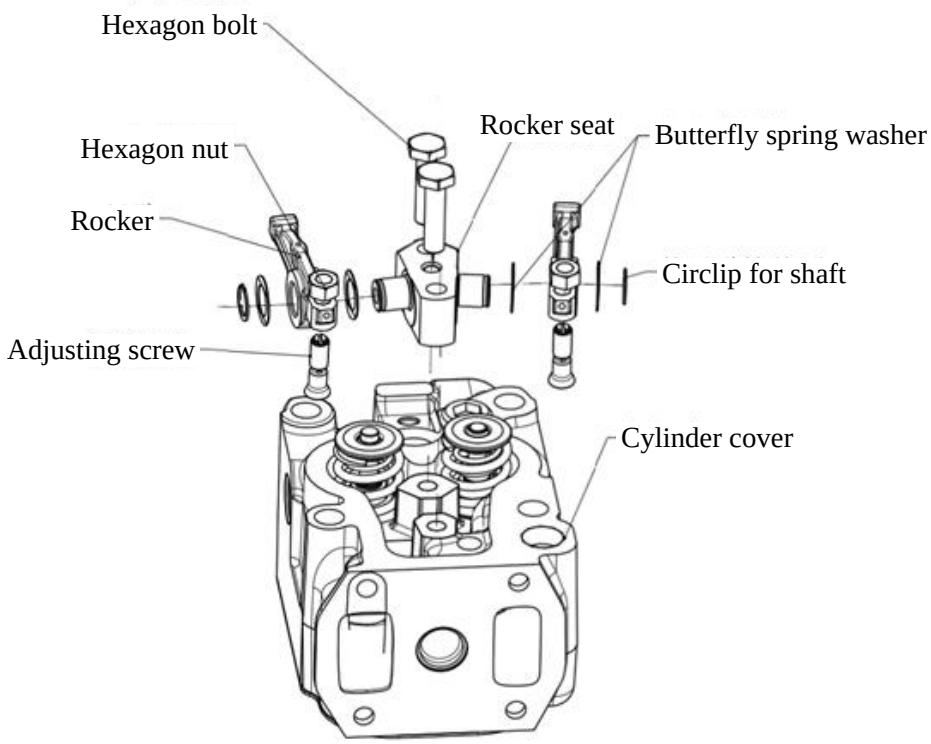


Fig. 3-36 Exploded view of rocker and rocker shaft

3532 Steps to Disassemble Rocker and Rocker Shaft

(1) Rotate crankshaft to check whether rocker is flexible.

(2) Measure each valve clearance, and check the change of valve clearance.

(3) If the rocker is not flexible or too big valve clearance, loosen hexagon screw and then take down rocker seat, circlip for shaft, butterfly spring washer, rocker and the other butterfly spring washer, mark them to prevent confusion.

3533 Inspection and Maintenance of Rocker and Rocker Shaft

(1) Clean up the rocker and check its appearance for crack.

(2) Check rocker inner hole for abrasion and scratch, and measure its diameter.

(3) Check rocker adjusting screw and the other end arc surface for abrasion.

(4) Check whether all oil galleries are smooth. Measure diameter of rocker inner hole and rocker shaft, and calculate the fit clearance.

3534 Steps to Assemble Rocker and Rocker Shaft

(1) Check whether all to-be assembled pars are clean, free of bump damage, scratch and rust;

(2) Install rocker adjusting screw and lock nut, the screw should be fully screwed in, while the lock nut only needs to be screwed in for 2~3 thread pitches;

(3) Apply lubricating oil on rocker seat and rocker inner hole, and install butterfly spring washer, rocker assembly, the other butterfly spring washer and circlip for shaft on rocker seat;

(4) Loose-fit rocker seat on cylinder cover with hexagon bolts;

(5) Install valve pushrod, refer to assembly of valve pushrod for details;

(6) Pre-tighten rocker seat, align rocker adjusting screw socket head to valve pushrod round head, tighten the hexagon bolts to 40~45Nm.

◆ Check and adjust intake and exhaust valve clearance

(1) Rotate the crankshaft until phase pointer points at 0 tick on phase plate, observe and make sure 0 tick of crankshaft timing gear is engaged with 0 tick of camshaft gear. Then adjust valve clearance of No. 1-2-3-6-7-10 rocker (count from the front end), intake valve adjustment: firstly fill in a 0.2mm plug gauge, and tighten the nuts with torque spanner to 20±5Nm, pull out the gauge (make sure the gauge can be easily pulled out), and check the clearance with a 0.25mm plug gauge (make sure the gauge cannot get through), adjusting of intake valve is finished. Exhaust valve adjustment: firstly fill in a 0.3mm plug gauge, and tighten the nuts with torque spanner to 20±5Nm, pull out the gauge (make sure the gauge can be easily pulled out), and check the clearance with a 0.35mm plug gauge (make sure the gauge cannot get through), adjusting of exhaust valve is finished.

(2) Further rotate crankshaft until phase pointer points at 0 tick on phase plate, observe and make sure 0 tick of crankshaft timing gear is engaged with the symmetry point of 0 tick (180^{o}) on camshaft gear. Then adjust valve clearance of No. 4-5-8-9-11-12 rocker (count from the front end), refer to (1) for adjusting method.

354 Disassembly, Inspection, Maintenance and Assembly of Valve Tappet and Pushrod

3541 Exploded View of Valve Tappet and Pushrod

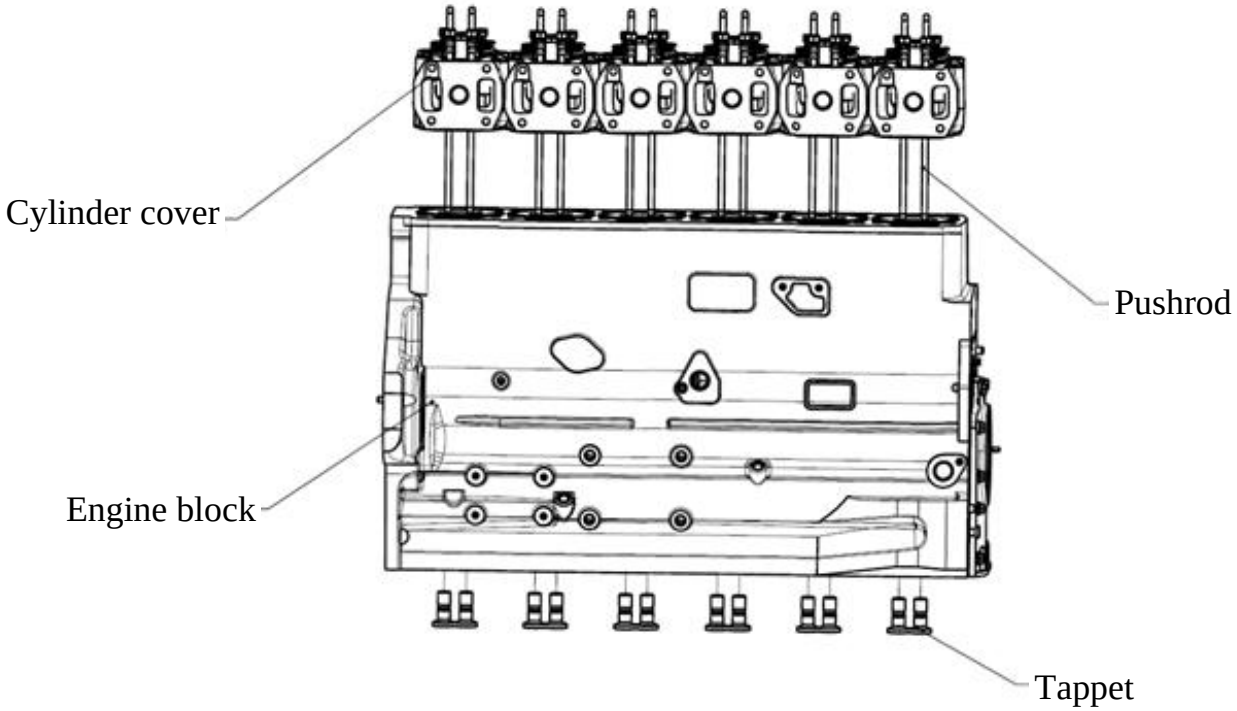


Fig. 3-37 Exploded view of valve tappet and pushrod

3542 Steps to Disassemble Valve Tappet and Pushrod

(1) After removing rockers and rocker shafts, directly take out pushrod, place them orderly;

(2) After removing camshaft, directly take out valve tappet, place them orderly;

3543 Inspection and Maintenance of Valve Tappet and Pushrod

(1) Clean up valve tappet and pushrod;

(2) Check whether oil channels of valve tappet and pushrod are smooth;

(3) Check whether pushrod is crooked, check wear condition of its outside surface;

(4) Check whether pushrod two ends are worn;

(5) Check whether valve tappet surface and undersurface are worn;

(6) Check whether valve tappet inner socket head is worn.

3544 Steps to Assemble Valve Tappet and Pushrod

(1) Check valve tappet and pushrod, replace them if necessary. Before installing the tappet, it must be cleaned with compressed air, and check whether the oil channel is smooth;

(2) Apply clean lubricating oil evenly on engine block tappet-fitting hole and valve tappet fitting surface.

(3) Install valve tappet into engine block tappet-fitting hole and make sure the tappet can rotate freely in the hole. Install camshaft, refer to assembly of camshaft for details.

(4) Loose-fit rocker seat on cylinder cover, check whether pushrod is clean and whether its welding area is intact;

(5) Apply clean lubricating oil on pushrod and ensure the round head is applied with sufficient oil.

(6) Install pushrod, put the pushrod into valve tappet through cylinder cover.

355 Disassembly, Inspection, Maintenance and Assembly of Valve

3551 Exploded View of Valve

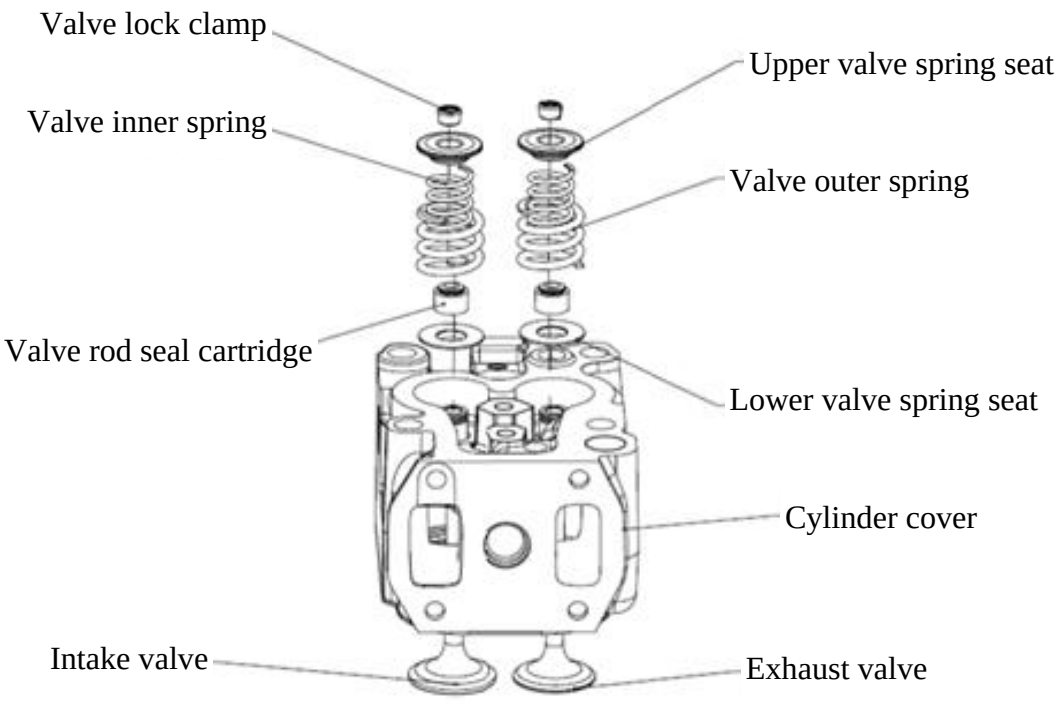


Fig. 3-38 Exploded view of valve

3552 Steps to Disassemble Valve

(1) Depress valve springs with vale spring compressor or valve overhead plier or other tools, take out valve lock clamp, upper valve spring seat and lower valve spring seat and valve springs orderly;

(2) Take valve out of valve seat.

3553 Inspection and Maintenance of Valve

(1) Check whether valve rod and its end faces are worn;

(2) Check whether valve conical surface is worn or damaged;

(3) Check valve conical surface for carbon deposit;

(4) Check valve retainer end faces for carbon deposit and sintering.

3554 Steps to Assemble Valve

A valve with severe wear or carbon deposit or sintering should be replaced.

(1) Apply molybdenum disulfide cream on intake and exhaust valve rod, and then install intake and exhaust valve into cylinder cover, ensure the valve can slide smoothly in valve guide pipe;

NOTICE: Check and ensure spring in valve rod seal cartridge is in good condition before assembling.

(2) Assemble lower valve spring seat of intake valve, install valve rod protecting cover into valve guide pipe, and then install valve rod seal cartridge;

(3) Install valve inner and outer spring;

(4) Assemble upper valve spring seat, depress the springs and install valve lock clamp;

(5) Knock the valve with rubber hammer to settle the lock clamp, if the valve lock clamp or upper valve spring seat cannot be settled, please find out the cause and eliminate it.

36 Intake and Exhaust System

361 Disassembly and Assembly of Intake and Exhaust System

3611 Exploded View of Intake and Exhaust System

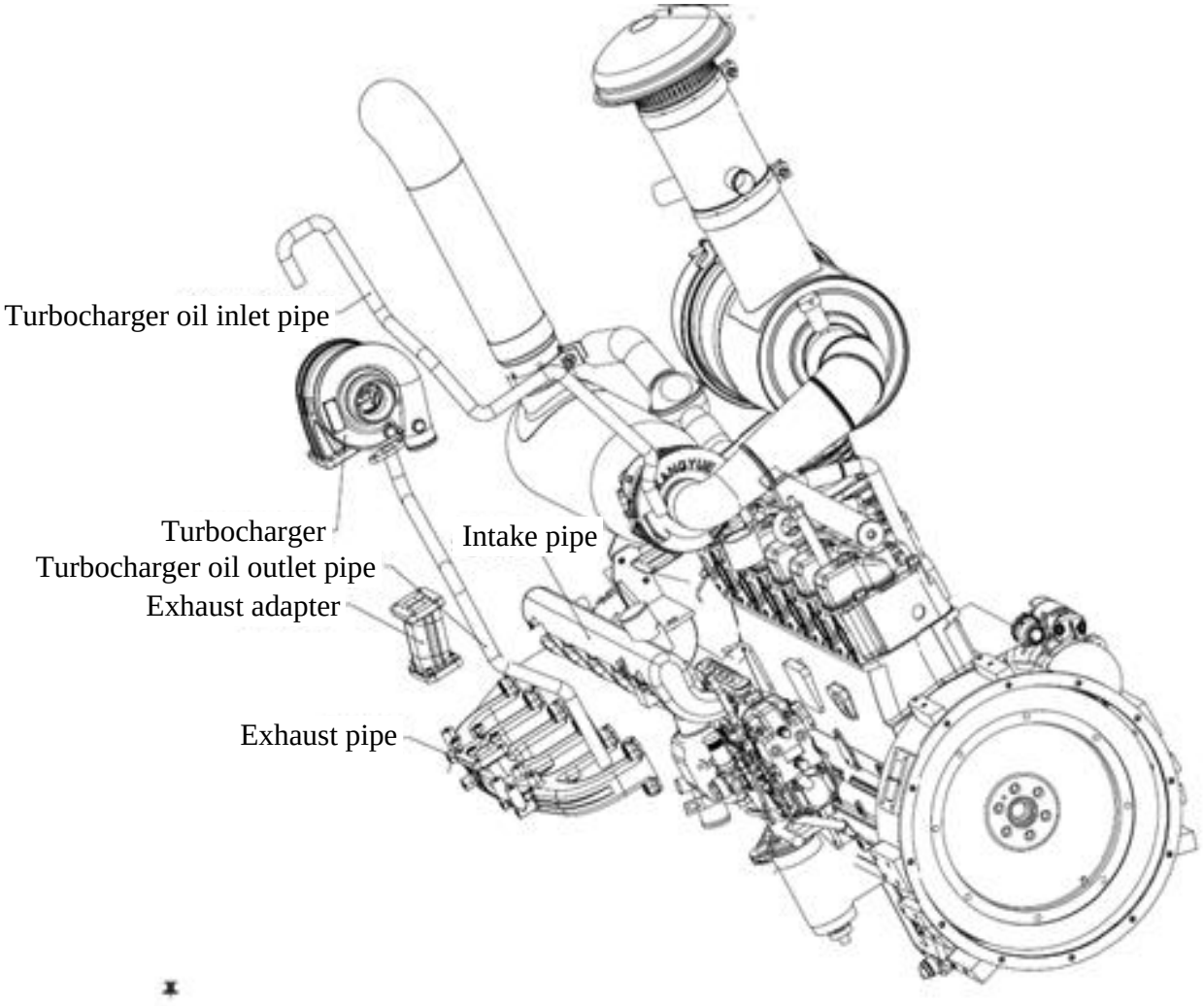


Fig. 3-39 Exploded view of valve intake and exhaust system

3612 Steps to Disassemble Intake and Exhaust System

(1) Loosen air filter fixing bolts and hose clamps, take down air filter and hoses.

(2) Loosen clamps of air circuit connecting hose, take down turbocharger compressor outlet hose.

(3) Remove fixing bolts of turbocharger oil inlet and outlet pipes, take down the pipes and gaskets.

(4) Remove tail pipe fixing bolts and turbocharger fixing bolts, take down turbocharger.

(5) Remove heat shield bolts and heat shield orderly; Screw off exhaust pipe fixing bolts, take down the pipe and gaskets, refer to **363 Disassembly, Inspection, Maintenance and Assembly of Exhaust Pipe** for details.

(6) Remove intake pipe fixing bolts, take down the pipe and gaskets, refer to **362 Disassembly, Inspection, Maintenance and Assembly of Intake Pipe** for details.

3613 Steps to Assemble Intake and Exhaust System

Assembling steps are contrary to disassembling ones.

362 Disassembly, Inspection, Maintenance and Assembly of Intake Pipe

3621 Exploded View of Intake Pipe

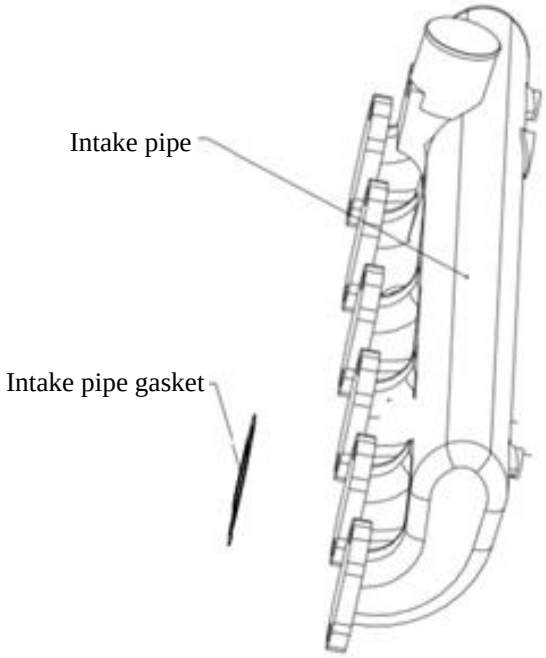


Fig. 3-40 Exploded view of intake pipe

3622 Steps to Disassemble Intake Pipe

(1) Remove intake pipe fixing bolts, take down the pipe and gaskets.

3623 Inspection and Maintenance of Intake Pipe

(1) Check whether there is weld defect on intake pipe, replace the pipe if necessary.

(2) Check intake pipe gasket for deformation and dilaceration, replace it if necessary.

3624 Steps to Assemble Intake Pipe

Assembling steps are contrary to disassembling ones. Recommended tightening torque for intake pipe fixing bolts is 23Nm.

363 Disassembly, Inspection, Maintenance and Assembly of Exhaust Pipe

3631 Exploded View of Intake Pipe

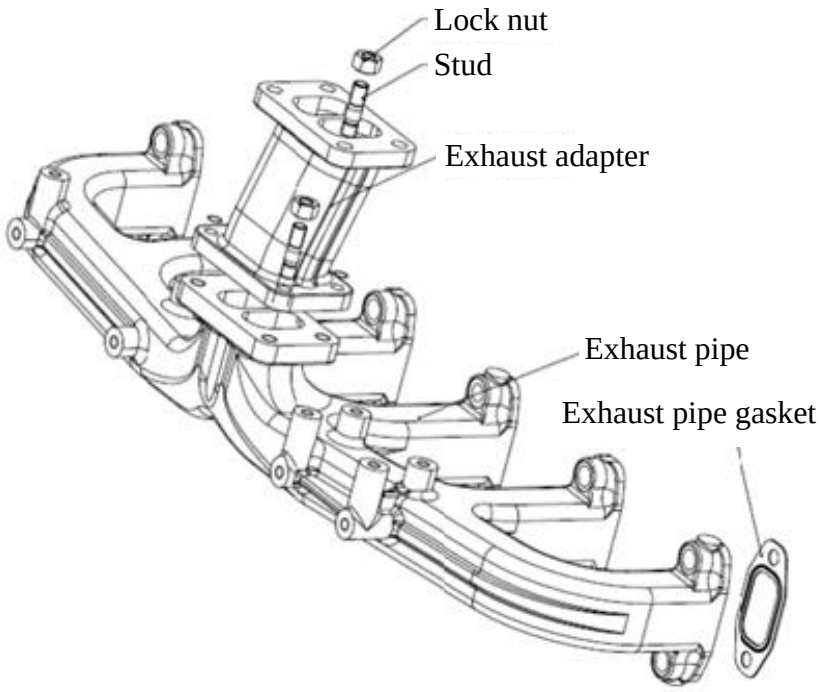


Fig. 3-41 Exploded view of exhaust pipe

3632 Steps to Disassemble Exhaust Pipe

(1) Remove lock nuts, take down exhaust adapter.

(2) Remove exhaust pipe fixing bolts, take down the pipe and gaskets.

3633 Inspection and Maintenance of Exhaust Pipe

(1) Check whether there is crack on exhaust pipe, whether the flange is deformed, replace the pipe if necessary.

(2) Check whether there is air leakage on exhaust pipe flange, replace the gasket if necessary.

(3) Check exhaust pipe gasket for deformation and dilaceration, replace it if necessary.

3634 Steps to Assemble Exhaust Pipe

Assembling steps are contrary to disassembling ones. Note the following points during assembly:

(1) Exhaust pipe fixing bolts should be applied with molybdenum disulfide, recommended tightening torque for exhaust pipe fixing bolts is 65~80Nm. Exhaust pipe fixing bolts cannot be reused more than twice.

364 Disassembly, Inspection, Maintenance and Assembly of Turbocharger System

3641 Exploded View of Turbocharger System

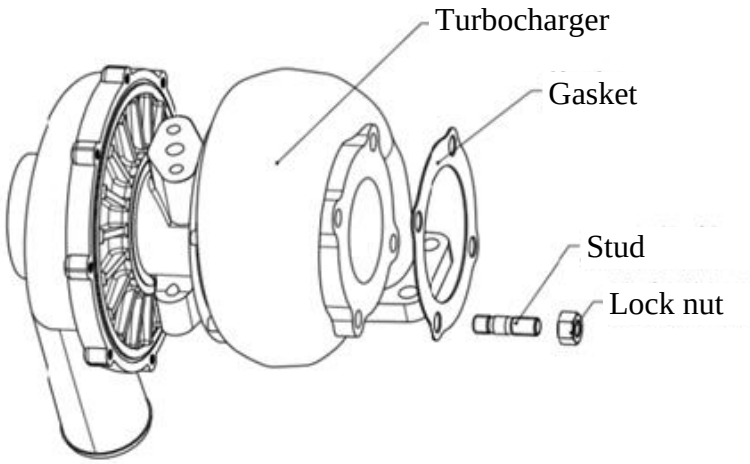


Fig. 3-42 Exploded view of turbocharger

3642 Steps to Disassemble Turbocharger System

Disassembling steps are contrary to assembling ones.

3643 Inspection and Maintenance of Turbocharger System

(1) Check service behavior of rotor

Stir compressor impeller gently with your finger, it is normal if the impeller can rotate for more than one round; if the impeller stopped soon, then it means the bearing is abnormally worn, or there is clash or jamming problem between rotating parts and fixed parts, you must find out the cause and eliminate the problem.

(2) Rotor axial movement checking

Press measuring head of dial indicator against compressor end, push and pull the shaft axially and record value difference of the indicator. As shown in Fig. 3-43. Required range is 0.088~0.118mm, if exceeds this range, then it indicates that thrust bearing plate or thrust plate and bearing is worn, you must find out the cause and eliminate the problem.

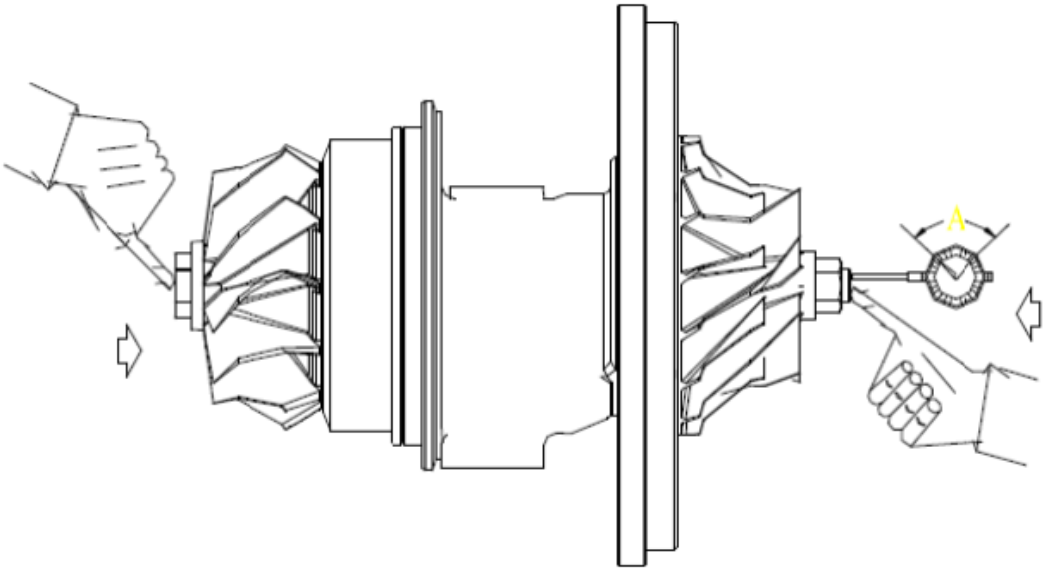


Fig. 3-43 Rotor axial movement measuring

(3) Compressor impeller radial clearance checking

Press the compressor impeller radially and measure the maximum and minimum clearance between compressor impeller and compressor volute, which should be within 0.4~0.8mm, if exceeds this range, then check the bearing and eliminate the fault.

NOTICE: Ensure the turbocharger is cold when performing the measurement.

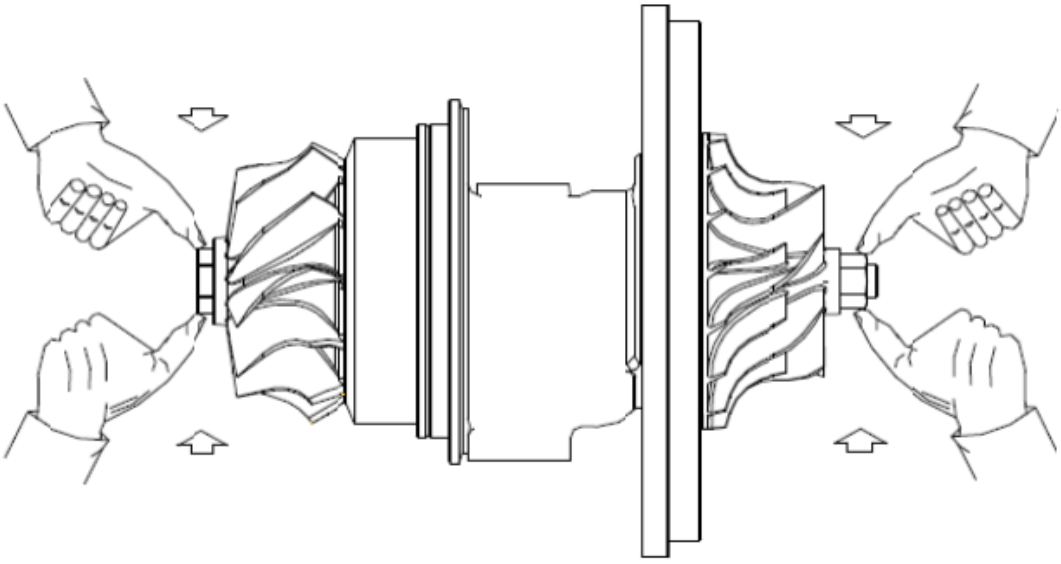


Fig. 3-44 Compressor impeller radial clearance measuring

Routine maintenance:

(1) Check whether the pipe connection between turbocharger and engine is loose, eliminate the problem in time.

(2) Check turbocharger for air leakage and oil leakage, eliminate the fault in time.

(3) Check whether turbocharger fastening screws are loose, eliminate the problem timely.

(4) Check air filter, clean it timely if there is too much dust accumulated in the filter.

3644 Steps to Assemble Turbocharger System

(1) Loose-fit one end of the preassembled turbocharger oil inlet pipe to engine block main oil port. Pay attention to adjust the poison of the pipe, so that it can be easily connected to turbocharger.

(2) Install turbocharger gasket on exhaust adapter flange.

(3) Install turbocharger oil return pipe and studs on turbocharger assembly, apply 0# molybdenum disulfide and clean lubricating oil on the studs. Tighten oil return pipe fixing bolts to 22~29Nm.

(4) Place a gasket on exhaust adapter flange and fix them on turbocharger assembly, loose-fit 2-type all-metal hexagon lock nuts and tighten them.

(5) Pour proper amount of clean lubricating oil into turbocharger oil inlet port, and clean up the overflowed oil.

(6) Connect oil inlet pipe to turbocharger with a gasket, fix them with hexagon bolts and self-locking gaskets, tighten the bolts to 22~29Nm. Rotate supercharger impeller and it should be flexible and free of resistance.

(7) Install turbocharger oil return hose and hose clamps, tighten the clamps. Note that the direction of two clamps should be uniform, straighten out the house.

(8) Install gaskets and studs, connect the muffle.

(9) All gaskets are disposable and should be replaced once removed.

37 Fuel System

371 Disassembly and Assembly of Fuel System

3711 Exploded View of Fuel System

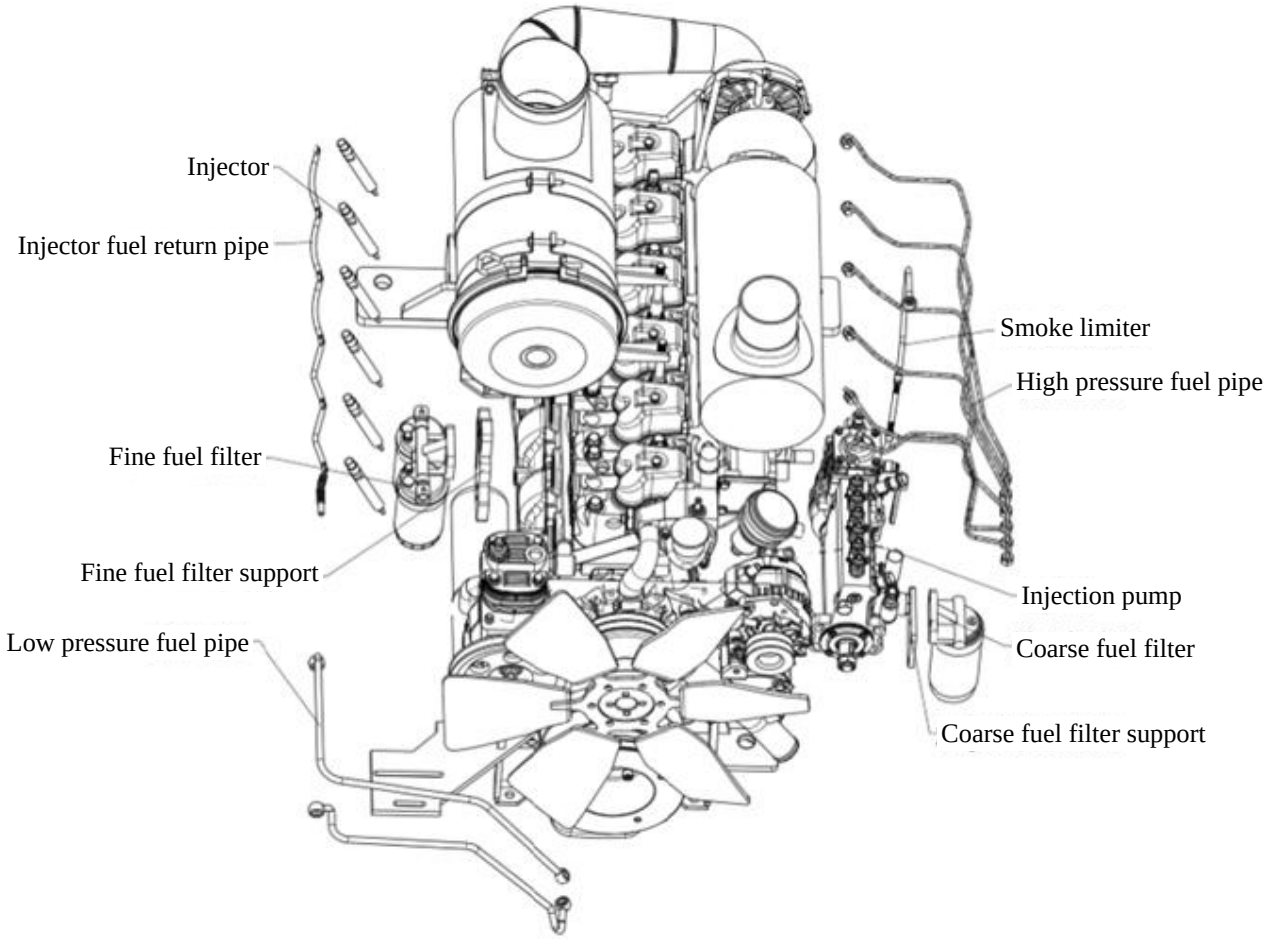


Fig. 3-45 Exploded view of fuel system

3712 Steps to Disassemble Fuel System

(1) Disconnect all external pipes and wiring harnesses of fuel system

(2) Remove low pressure fuel pipe module, refer to disassembly of low pressure fuel pipe for details.

(3) Remove air pipe of smoke limiter.

(4) Remove intake and exhaust pipe module, refer to disassembly of intake and exhaust pipe for details.

(5) Remove high pressure fuel pipe module.

(6) Remove filter module, refer to disassembly of filter for details.

(7) Remove injector module, refer to disassembly of injector for details.

(8) Remove engine front cover, refer to disassembly of engine front cover for details.

(9) Remove injection pump module, refer to disassembly of injection pump for details.

3713 Steps to Assemble Fuel System

Assembling steps are contrary to disassembling ones.

372 Disassembly, Inspection, Maintenance and Assembly of Fuel Injection Pump

3721 Exploded View of Fuel Injection Pump

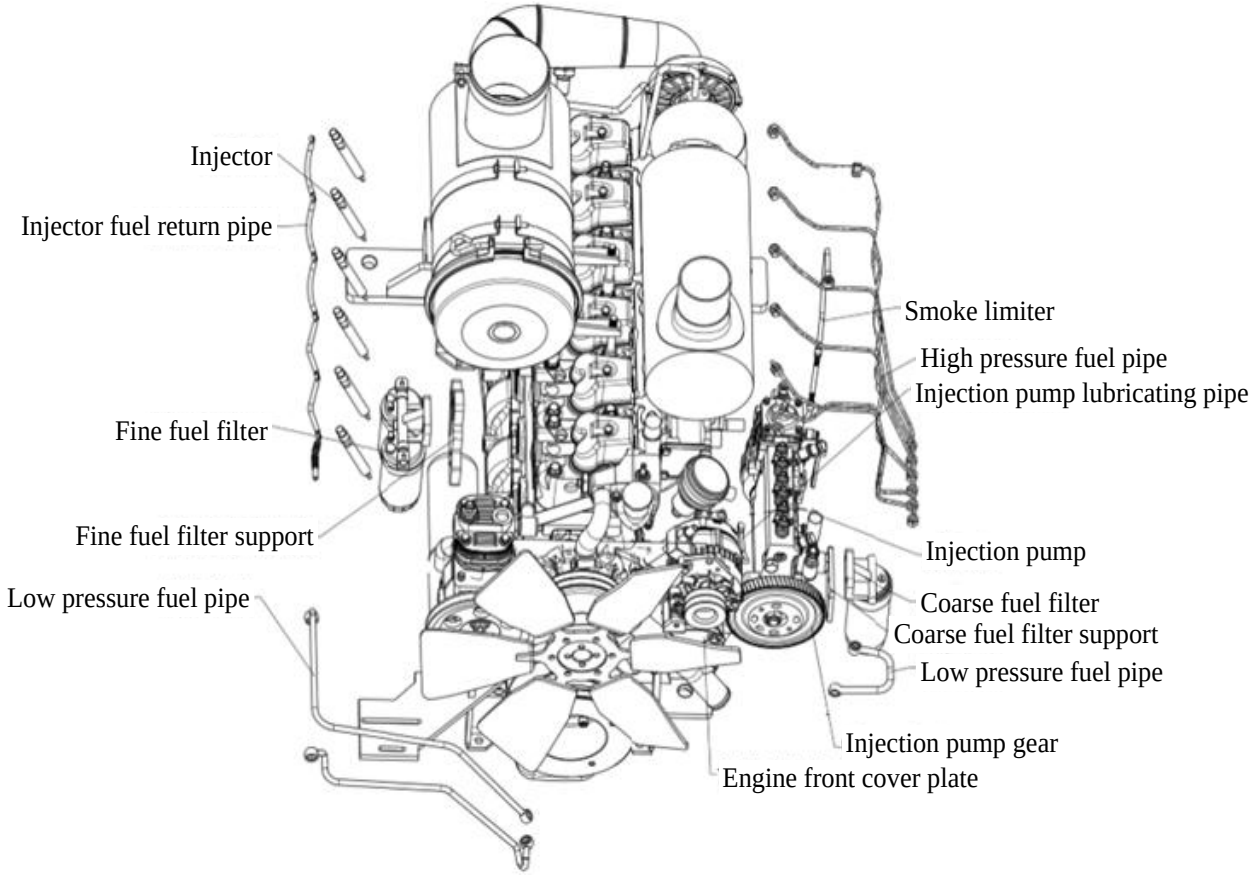


Fig. 3-46 Exploded view of fuel injection pump

3722 Steps to Disassemble Fuel Injection Pump

(1) Disconnect all external pipes and wiring harnesses of fuel injection pump.

(2) Remove the hollow bolts that connecting fuel injection pump and low pressure fuel pipe.

(3) Remove the hollow bolts that connecting fuel injection pump and smoke limiter air pipe.

(4) Remove the hollow bolts that connecting fuel injection pump and injector fuel return pipe.

(5) Remove the connecting nuts that connecting fuel injection pump and high pressure fuel pipe.

(6) Remove the hollow bolts that connecting fuel injection pump and lubricating pipe.

(7) Remove engine front cover upper plate, refer to disassembly of engine front cover for details.

(8) Screw off injection pump camshaft nuts, remove injection pump gear.

(9) Remove fixing nuts between injection pump and engine front cover, take down the pump.

3723 Inspection and Maintenance of Fuel Injection Pump

(1) Check fuel pump appearance for crack and oil leakage; if so, replace the pump or feedback the problem to the manufacturer.

(2) Check whether the lead seal on injection pump is damaged; if so, replace the pump or readjust fuel supply rate.

(3) Check whether there is crack on smoke limiter air pipe, whether there is air leakage in pipe joints, the pipe should be replaced if there is crack, and replace the bolt gaskets if there is air leakage.

(4) Check lubricating pipe for oil leakage; if so, replace the pipe or bolt gaskets.

3724 Steps to Assemble Fuel Injection Pump

Assembling steps are contrary to disassembling ones. But note that when assembling fuel injection pump gear, the mark on fuel injection pump gear should be aligned to the one on engine front cover. Before tightening the fixing nuts between injection pump and engine front cover, it is required to rotate the flywheel to set the engine in correct fuel supply advance angle, and then tighten the nuts.

373 Disassembly, Inspection, Maintenance and Assembly of High Pressure Fuel Pipe

3731 Exploded View of High Pressure Fuel Pipe

Refer to Fig. 3-46 Exploded view of fuel injection pump.

3732 Steps to Disassemble High Pressure Fuel Pipe

(1) Remove intake and exhaust pipe module, refer to disassembly of intake and exhaust pipe for details.

(2) Remove the high pressure fuel pipe fixing cylinder cover and the fixed support on engine block.

(3) Remove connecting nuts between high pressure fuel pipe and each injector successively.

(4) Remove connecting nuts between high pressure fuel pipe and each injection pump successively.

3733 Inspection and Maintenance of High Pressure Fuel Pipe

(1) Check high pressure fuel pipe appearance for crack and oil leakage; if so, replace the pipe or feedback the problem to the manufacturer.

(2) Check and ensure both connector conical surfaces of high pressure fuel pipe are intact.

3734 Steps to Assemble High Pressure Fuel Pipe

Assembling steps are contrary to disassembling ones. But note that high pressure fuel pipe should be clean and intact.

374 Disassembly, Inspection, Maintenance and Assembly of Fuel Injector

3741 Exploded View of Fuel Injector

Refer to Fig. 3-46 Exploded view of fuel injection pump.

3742 Steps to Disassemble Fuel Injector

(1) Remove the hollow bolts that connecting each injector and injector oil return pipe.

(2) Remove fastening bolts of injector pressing plate, take down the plate.

(3) Remove the injector with dedicated tool.

3743 Inspection and Maintenance of Fuel Injector

(1) Check copper seal gasket, replace it if it is severely deformed or damaged, clean fitting surface of injector seat, wipe out the carbon deposit and other foreign matters on it to ensure good sealing performance; For each injector, do not mix up the sealing gasket and adjusting gasket during assembling, to ensure injector protrusion meet the requirements.

(2) Check injector oil return pipe for oil leakage and damage, replace the pipe if necessary.

3744 Steps to Assemble Fuel Injector

Assembling steps are contrary to disassembling ones.

375 Disassembly, Inspection, Maintenance and Assembly of Fuel Filters

3751 Exploded View of Fuel Filters

Refer to Fig. 3-46 Exploded view of fuel injection pump.

3752 Steps to Disassemble Fuel Filters

(1) Remove the hollow bolts that connecting low pressure fuel pipe and coarse/fine fuel filter.

(2) Remove the bolts that connecting coarse/fine fuel filter and fixed support.

(3) Remove filter element and filter seat.

3753 Inspection and Maintenance of Fuel Filters

(1) Check whether the filters are intact.

(2) Check the fitting area between fuel filter and filer seat for oil leakage, replace the relevant parts if so.

(3) Check whether the fuel filter is blocked, replace the filter element if so. When replacing filter element, firstly remove the filter element, and then fill clean diesel oil into the new filter fully, in the meantime keep filter seat clean and apply lubricating oil on the rubber gasket; After the rubber gasket touched the seat, tighten the filter for another 3/4~1 circle to seal it up; finally, screw off the air bleed screw on filter seat, operate the hand pump on injection pump to bleed the filter.

3754 Steps to Assemble Fuel Filters

Assembling steps are contrary to disassembling ones. But note that when replacing filter element, firstly remove the filter element, and then fill clean diesel oil into the new filter fully, in the meantime keep filter seat clean and apply lubricating oil on the rubber gasket; After the rubber gasket touched the seat, tighten the filter for another 3/4~1 circle to seal it up; finally, screw off the air bleed screw on filter seat, operate the hand pump on injection pump to bleed the filter.

376 Disassembly, Inspection, Maintenance and Assembly of Low Pressure Fuel Pipe

3761 Exploded View of Low pressure Fuel Pipe

Refer to Fig. 3-46 Exploded view of fuel injection pump.

3762 Steps to Disassemble Low pressure Fuel Pipe

(1) Remove the low pressure fuel pipe fixing cylinder cover and the fixed support on engine block.

(2) Remove hollow bolts that low pressure fuel pipe and fuel pump.

(3) Remove hollow bolts that low pressure fuel pipe and coarse/fine fuel filter.

3763 Inspection and Maintenance of Low pressure Fuel Pipe

(1) Check low pressure fuel pipe appearance for crack and oil leakage; if so, replace the pipe or feedback the problem to the manufacturer.

(2) Check the two joints of low pressure fuel pipe for oil leakage, replace hollow bolt sealing gaskets if necessary.

3764 Steps to Assemble Low pressure Fuel Pipe

Assembling steps are contrary to disassembling ones.

38 Cooling System

381 Disassembly and Assembly of Cooling System

3811 Exploded View of Cooling System

The function of cooling system is to ensure diesel engine can continuously work at proper temperature. Forced circulation cooling offers the best guarantee to keep the engine in normal operating temperature, mainly consists of water pump, fan, expansion water tank, water tank and thermostat.

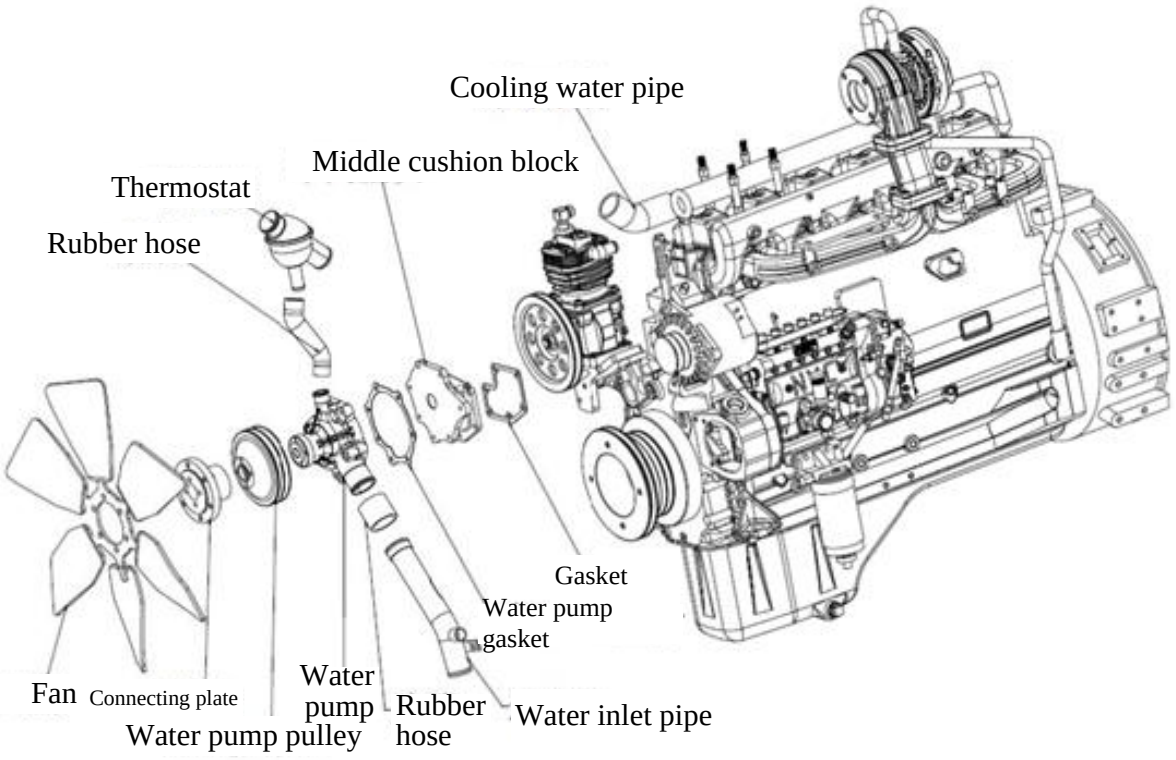


Fig. 3-47 Exploded view of cooling system

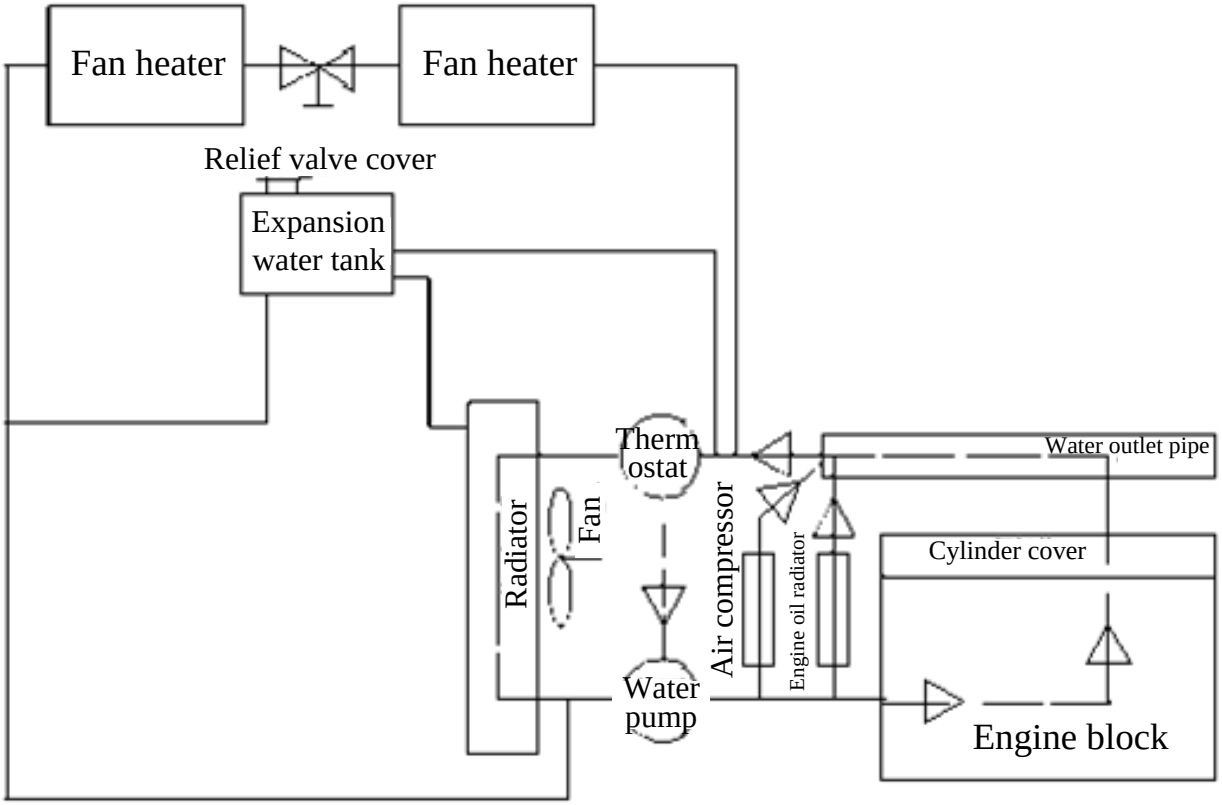


Fig. 3-48 Cooling route map of WP6 mechanical pump diesel engine

3812 Steps to Disassemble Cooling System

As shown in Fig. 3-47:

(1) Remove fan and connecting plate, refer to disassembly of fan for details.

(2) Remove the tensioning wheel.

(3) Remove the belt.

(4) Remove generator, generator support, crankshaft pulley and damper.

(5) Remove thermostat, refer to disassembly of thermostat for details. Remove water inlet pipe.

(6) Remove air compressor and hydraulic pump.

(7) Remove pipe joints of water pump and take down the pump, refer to disassembly of water pump for details.

(8) Remove the middle cushion block.

3813 Steps to Assemble Cooling System

Assembling steps are contrary to disassembling ones.

382 Disassembly, Inspection, Maintenance and Assembly of Fan

3821 Exploded View of Fan

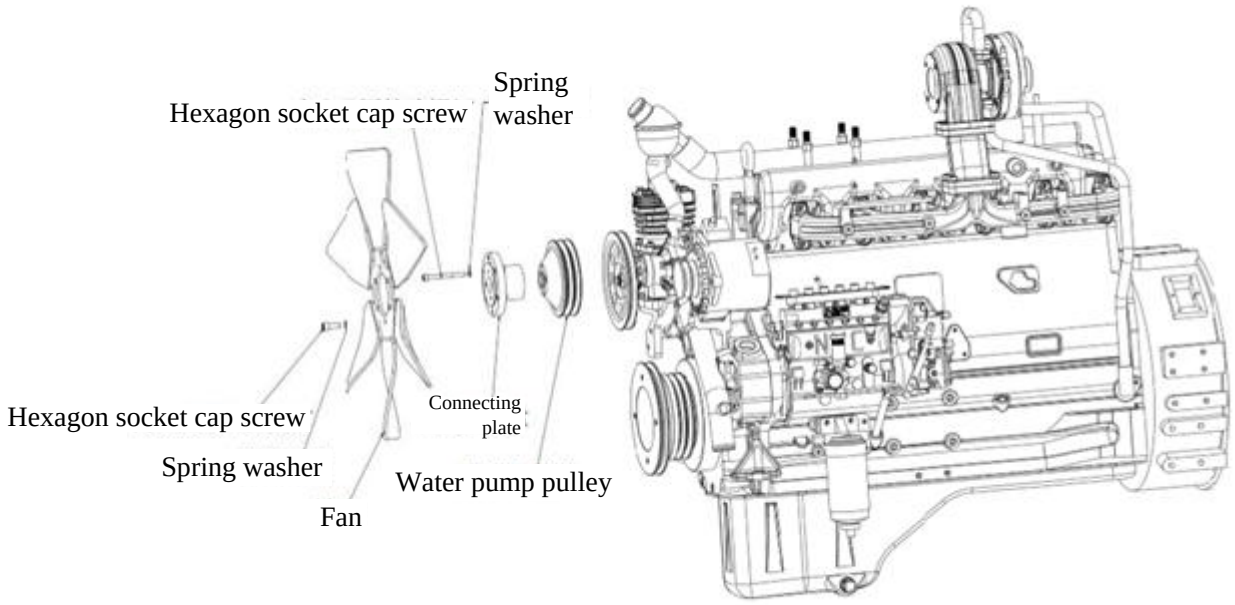


Fig. 3-49 Exploded view of fan

3822 Steps to Disassemble Fan

As shown in Fig. 3-49:

(1) Remove the screws and gaskets that connecting fan and connecting plate, take down the fan.

(2) Remove the screws and gaskets that connecting the pulley and connecting plate.

(3) Remove connecting plate.

(4) Take down the pulley.

3823 Inspection and Maintenance of Fan

Check fan, connecting plate and water pump pulley for crack and damage.

3824 Steps to Assemble Fan

Assembling steps are contrary to disassembling ones.

383 Disassembly, Inspection, Maintenance and Assembly of Water Pump

3831 Exploded View of Water Pump

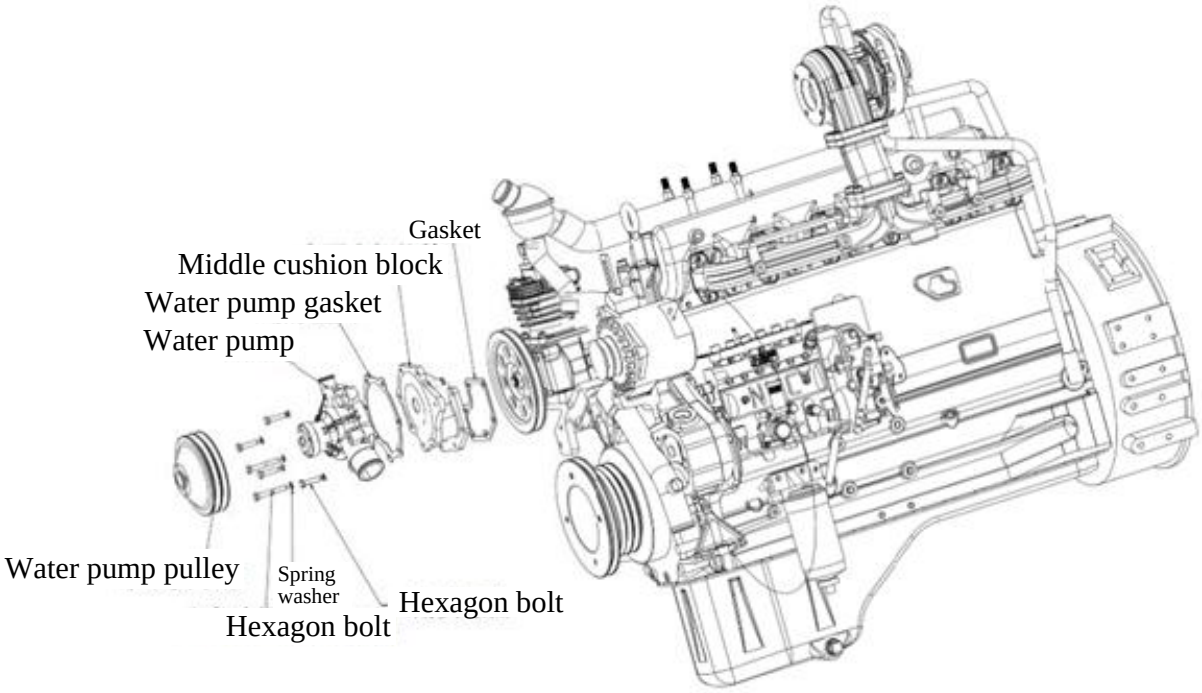


Fig. 3-50 Exploded view of water pump

3832 Steps to Disassemble Water Pump

As shown in Fig. 3-50

(1) Remove water pump pulley.

(2) Remove water pump inlet pipe, thermostat connecting hose and clamps.

(3) Remove the hexagon bolts, spring washers, take down the pump.

(4) Remove water pump gasket and middle cushion block.

3833 Inspection and Maintenance of Water Pump

(1) Check water pump gasket for crack damage, replace it if necessary.

(2) Check the bolts and studs for thread damage, replace if necessary.

(3) Check water pump and middle cushion block for crack damage, replace them if necessary.

3834 Steps to Disassemble Water Pump

Assembling steps are contrary to disassembling ones.

384 Disassembly, Inspection, Maintenance and Assembly of Thermostat

3841 Exploded View of Thermostat

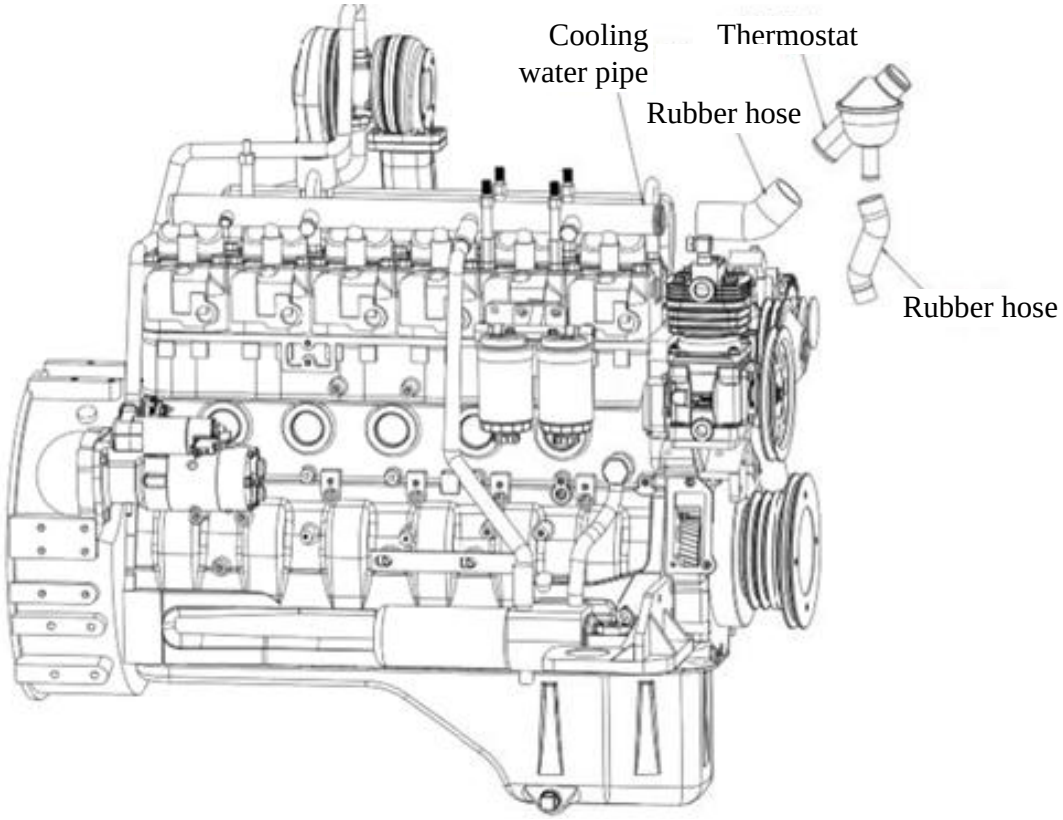


Fig. 3-51 Exploded view of thermostat

3842 Steps to Disassemble Thermostat

As shown in Fig. 3-51

(1) Remove clamp of upper rubber hose which connecting cooling water pipe and thermostat.

(2) Remove clamp of lower rubber hose which connecting water pump and thermostat.

(3) Remove thermostat.

(4) Remove the two coolant rubber hoses.

3843 Inspection and Maintenance of Thermostat

(1) Check whether the clamps are in good condition, replace if necessary.

(2) Check the two coolant rubber hoses for crack damage, replace them if necessary.

(3) Check thermostat for fracture damage, replace it if necessary.

3844 Steps to Assemble Thermostat

Assembling steps are contrary to disassembling ones.

39 Lubricating System

391 Disassembly and Assembly of Lubricating System

3911 Exploded View of Lubricating System

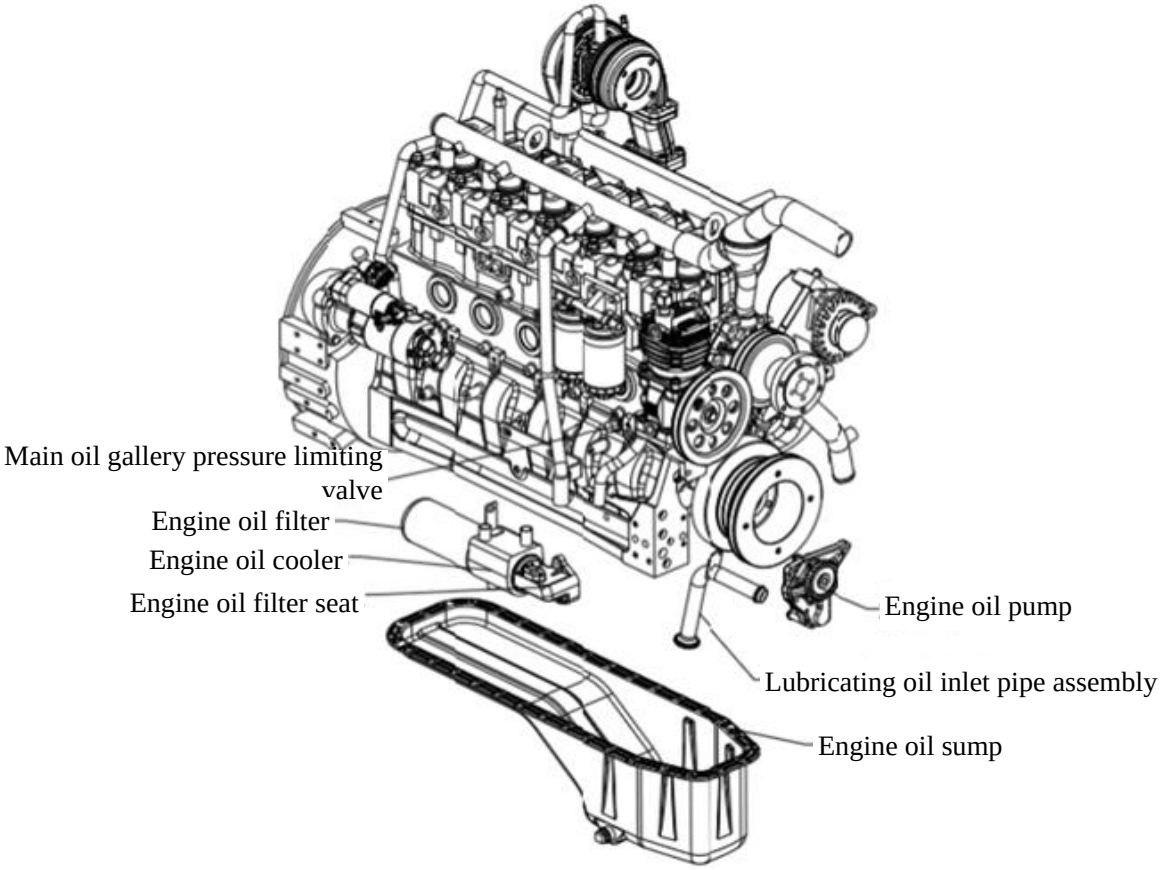


Fig. 3-52 Exploded view of lubricating system

3912 Steps to Disassemble Lubricating System

(1) Remove oil sump, refer to disassembly of oil sump for details.

(2) Remove crankshaft pulley, damper and the hexagonal head plug on gear room, refer to disassembly of crank-rod mechanism for details.

(3) Remove engine oil pump.

(4) Remove main oil gallery pressure limiting valve.

(5) Remove engine oil filter.

(6) Remove engine oil cooler.

3913 Steps to Assemble Lubricating System

Assembling steps are contrary to disassembling ones.

392 Disassembly, Inspection, Maintenance and Assembly of Engine Oil Pump

3921 Exploded View of Engine Oil Pump

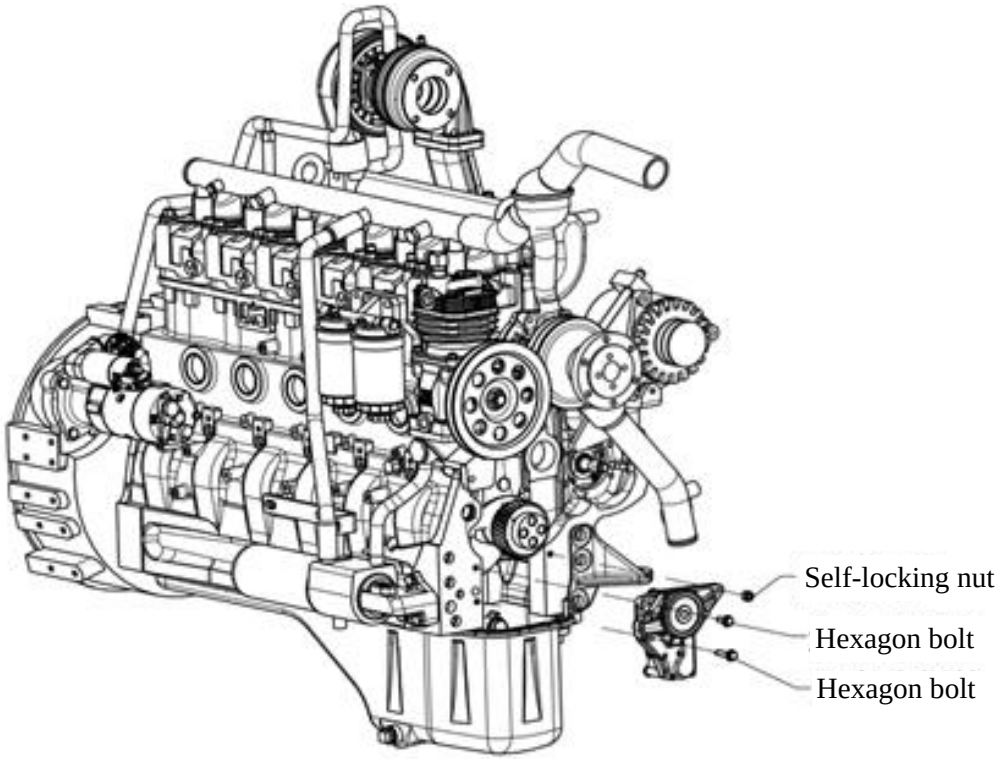


Fig. 3-53 Exploded view of engine oil pump

3922 Steps to Disassemble Engine Oil Pump

Remove the two hexagon bolts and self-locking nut, take down engine oil pump, as shown in Fig. 3-53.

3923 Inspection and Maintenance of Engine Oil Pump

(1) Check the engine oil pump for crack damage, check whether its inner cavity is smooth, replace it if necessary.

(2) Check whether engine oil pump shaft can rotate smoothly, replace it if necessary.

3924 Steps to Assemble Engine Oil Pump

(1) Check the pump before assembling, make sure there is no manufacturing defect and damage.

(2) Clean up the fitting surface between oil pump and engine block.

(3) Install engine oil pump.

(4) Install and tighten the two toothed hexagon bolts and self-locking nut.

393 Disassembly, Inspection, Maintenance and Assembly of Engine Oil Filter

3931 Exploded View of Engine Oil Filter

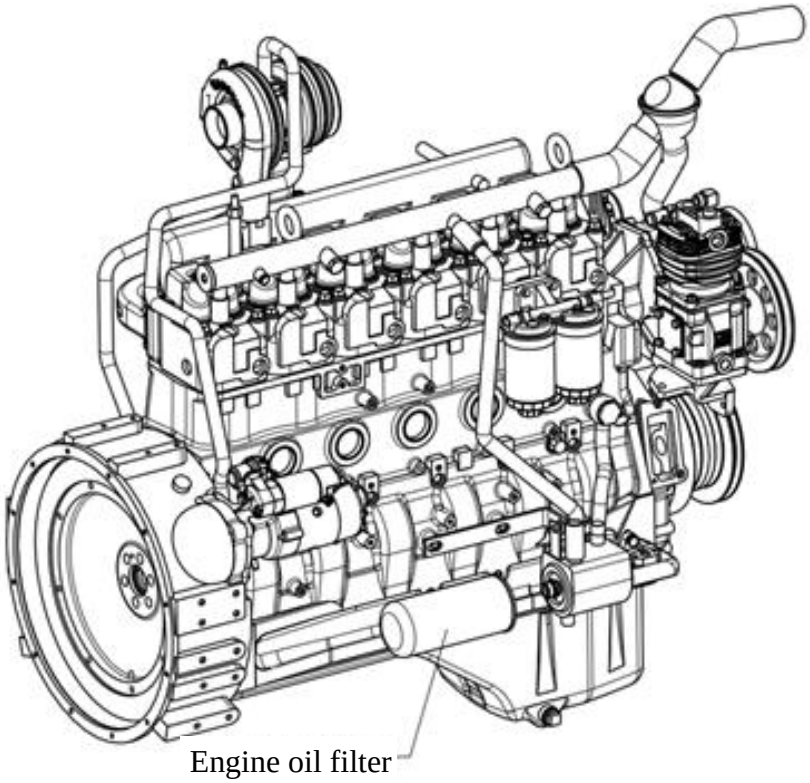


Fig. 3-54 Exploded view of engine oil filter

3932 Steps to Disassemble Engine Oil Filter

Remove the filter with dedicated tool, as shown in Fig. 3-54.

3933 Inspection and Maintenance of Engine Oil Filter

Check the engine oil filter assembly for damage, replace it if necessary.

3934 Steps to Assemble Engine Oil Filter

(1) Check the O-shape seal ring of engine oil filter before assembling, make sure there is no manufacturing defect and damage.

(2) Tighten the filter according to the requirements on filter cap.

394 Disassembly, Inspection, Maintenance and Assembly of Engine Oil Cooler

3941 Exploded View of Engine Oil Cooler

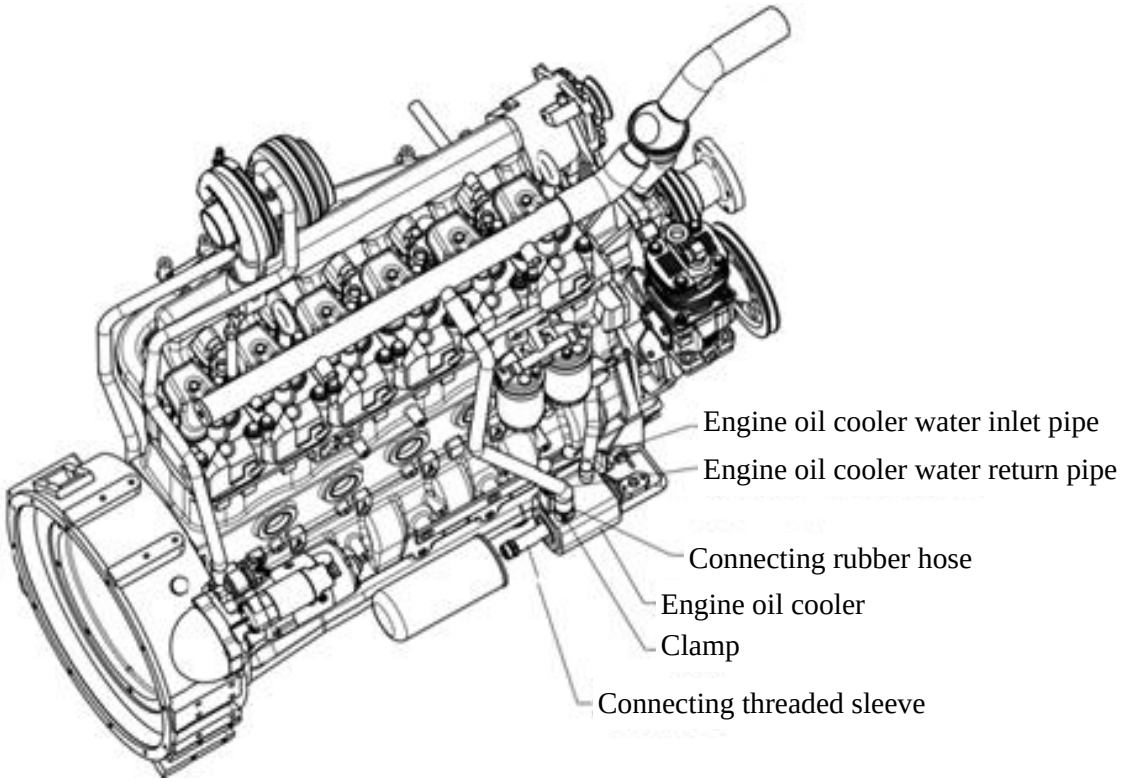


Fig. 3-55 Exploded view of engine oil cooler

3942 Steps to Disassemble Engine Oil Cooler

Loose the connecting threaded sleeve, remove the rubber hose and clamp that connected to engine oil cooler water return pipe, disconnect engine oil cooler water inlet pipe and take down the cooler, as shown in Fig. 3-55.

3943 Inspection and Maintenance of Engine Oil Cooler

Check the engine oil cooler for crack damage, replace it if necessary.

3944 Steps to Assemble Engine Oil Cooler

(1) Check the cooler before assembling, make sure there is no manufacturing defect and damage.

(2) Clean up the fitting surface between engine oil cooler and filter seat.

(3) Install engine oil cooler and the connecting thread sleeve, tighten it, connect engine oil cooler water inlet and return pipes and tighten them, install the clamps.

395 Disassembly, Inspection, Maintenance and Assembly of Main Oil Gallery Pressure Limiting Valve

3951 Exploded View of Main Oil Gallery Pressure Limiting Valve

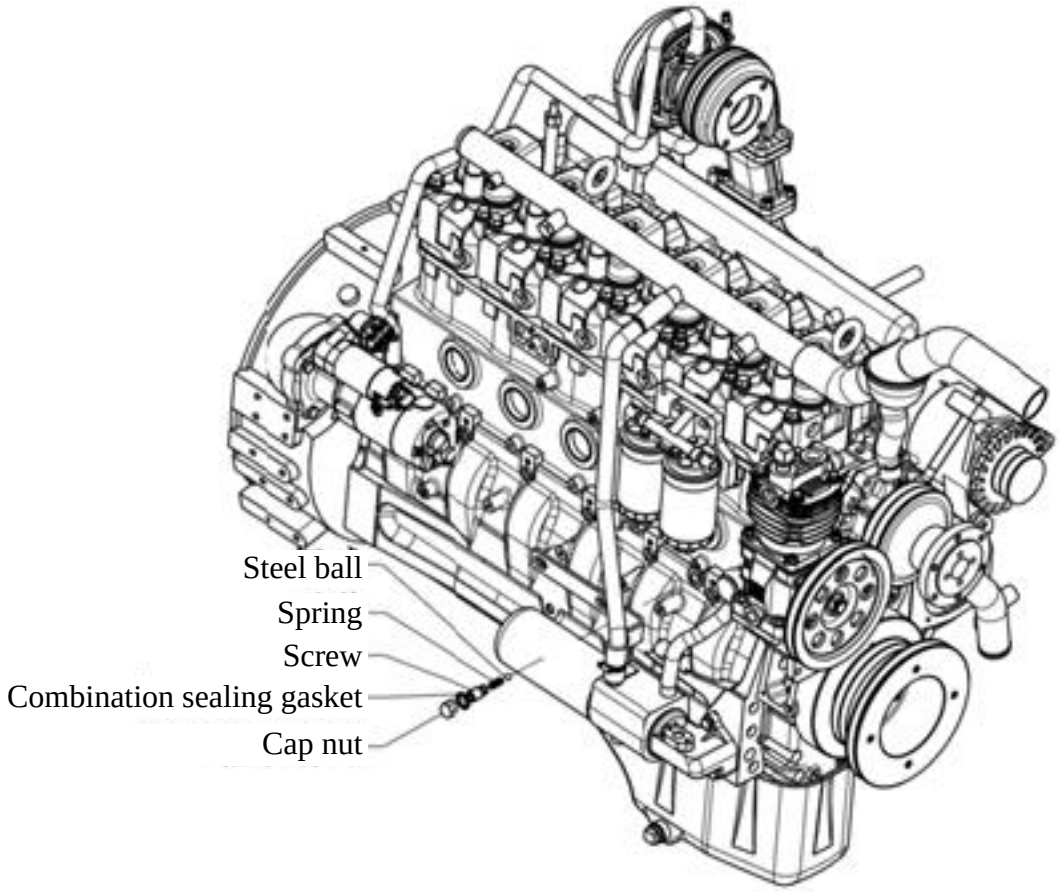


Fig. 3-56 Exploded view of main oil gallery pressure limiting valve

3952 Steps to Disassemble Main Oil Gallery Pressure Limiting Valve

Screw off main oil gallery pressure limiting valve, as shown in Fig. 3-56.

3953 Inspection and Maintenance of Main Oil Gallery Pressure Limiting Valve

(1) Check service condition of the valve spring, replace the spring if necessary.

(2) Check the valve for crack damage, replace it if necessary.

3954 Steps to Assemble Main Oil Gallery Pressure Limiting Valve

(1) Check the valve before assembling, make sure there is no manufacturing defect and damage.

(2) Clean up the valve and valve fitting hole on engine block.

(3) Install the valve and tighten it.

396 Disassembly, Inspection, Maintenance and Assembly of Engine Oil Strainer

3961 Exploded View of Engine Oil Strainer

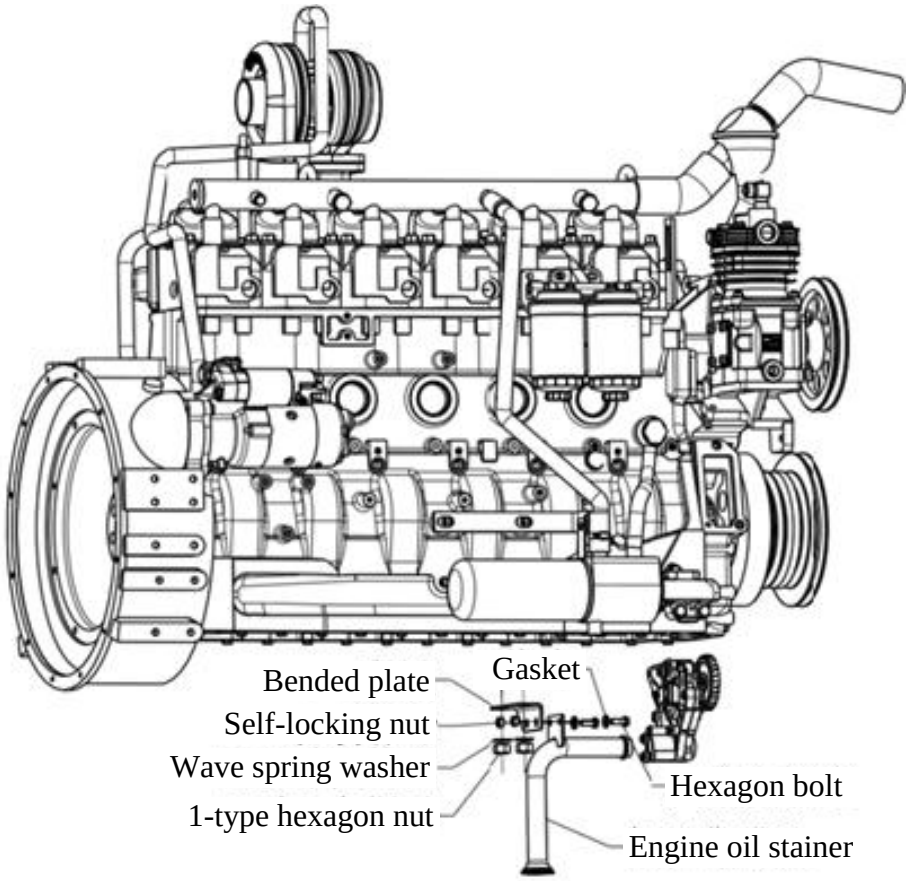


Fig. 3-57 Exploded view of engine oil strainer

3962 Steps to Disassemble Engine Oil Strainer

Screw off the 1-type hexagon nuts and two self-locking nuts on the bended plate, take down the oil strainer, as shown in Fig. 3-57.

3963 Inspection and Maintenance of Engine Oil Strainer

Check the strainer for crack damage, replace it if necessary.

3964 Steps to Assemble Engine Oil Strainer

(1) Check the strainer before assembling, make sure there is no manufacturing defect and damage.

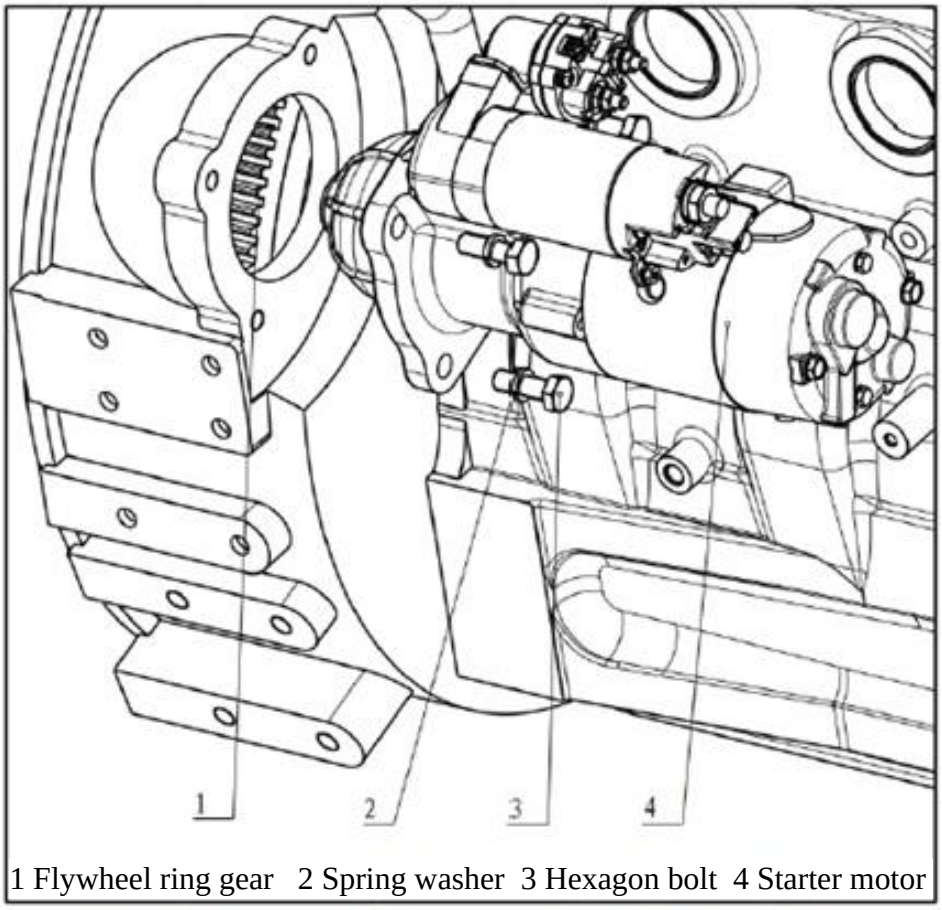
(2) Clean up fitting surface between oil strainer and engine oil pump, clean up the strainer inner cavity.

(3) Install the strainer, assemble and tighten the two hexagon nuts and two self-locking nuts.

310 Starting System

3101 Disassembly, Inspection, Maintenance and Assembly of Starting System

31011 Exploded View of Starting System



1 Flywheel ring gear 2 Spring washer 3 Hexagon bolt 4 Starter motor

Fig. 3-58 Exploded view of starting system

31012 Steps to Disassemble Starting System

(1) Remove hexagon bolt 3 and spring washer 2;

(2) Hold the starter motor firmly and pull it out.

31013 Inspection and Maintenance of Starting System

Check the starter motor gear for damage, replace it if necessary.

31014 Steps to Assemble Starting System

Assembling steps are contrary to disassembling ones.

311 Engine Accessory System

3111 Disassembly and Assembly of Engine Accessory System

31111 Exploded View of Engine Accessory System

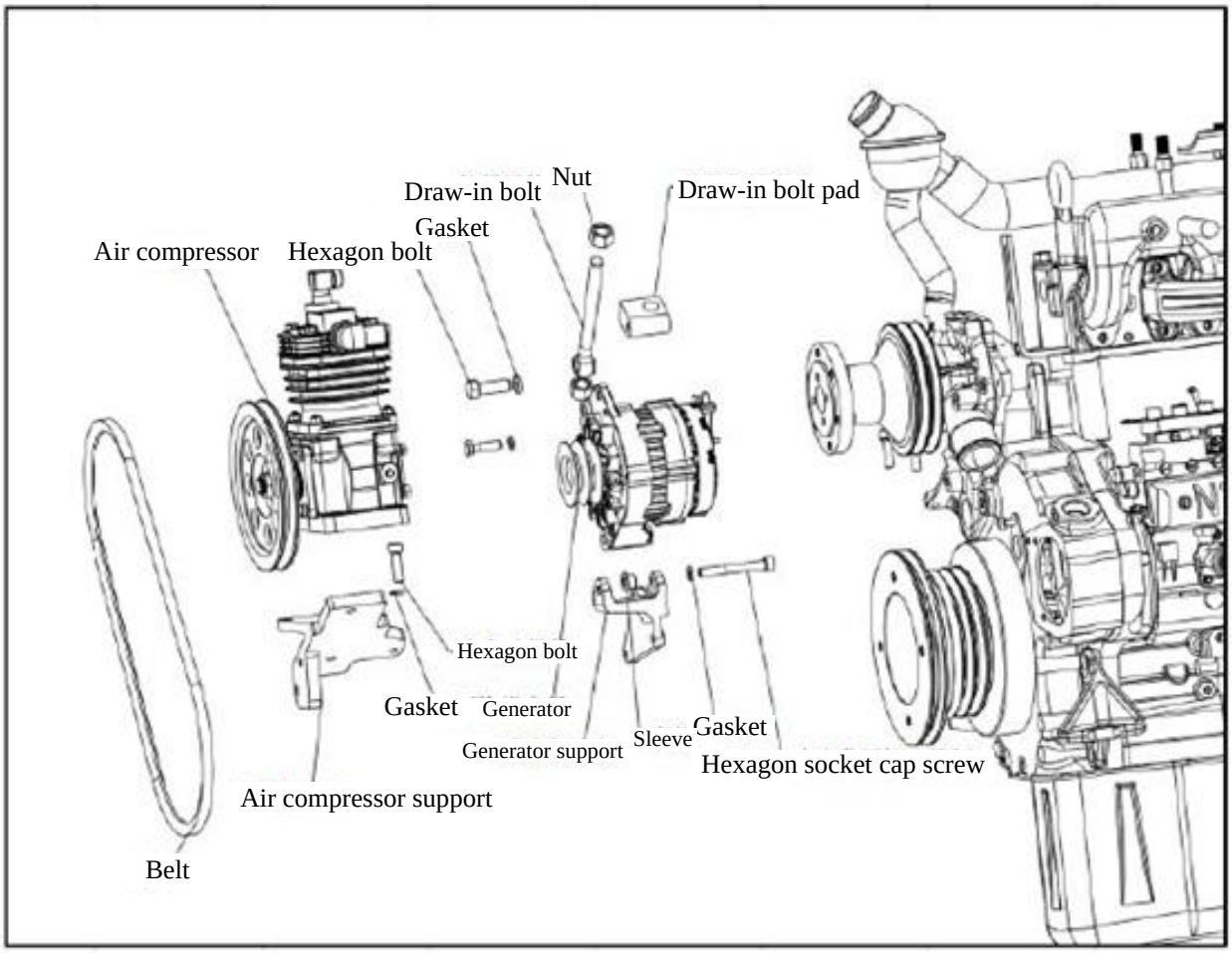


Fig. 3-59 Exploded view of engine accessory system

31112 Steps to Disassemble Engine Accessory System

(1) Remove air compressor pulley belt, air compressor and its connecting bolts, refer to disassembly of air compressor for details.

(2) Remove generator draw-in bolt and generator, refer to disassembly of generator for details.

3112 Disassembly, Inspection, Maintenance and Assembly of Generator

31121 Exploded View of Generator

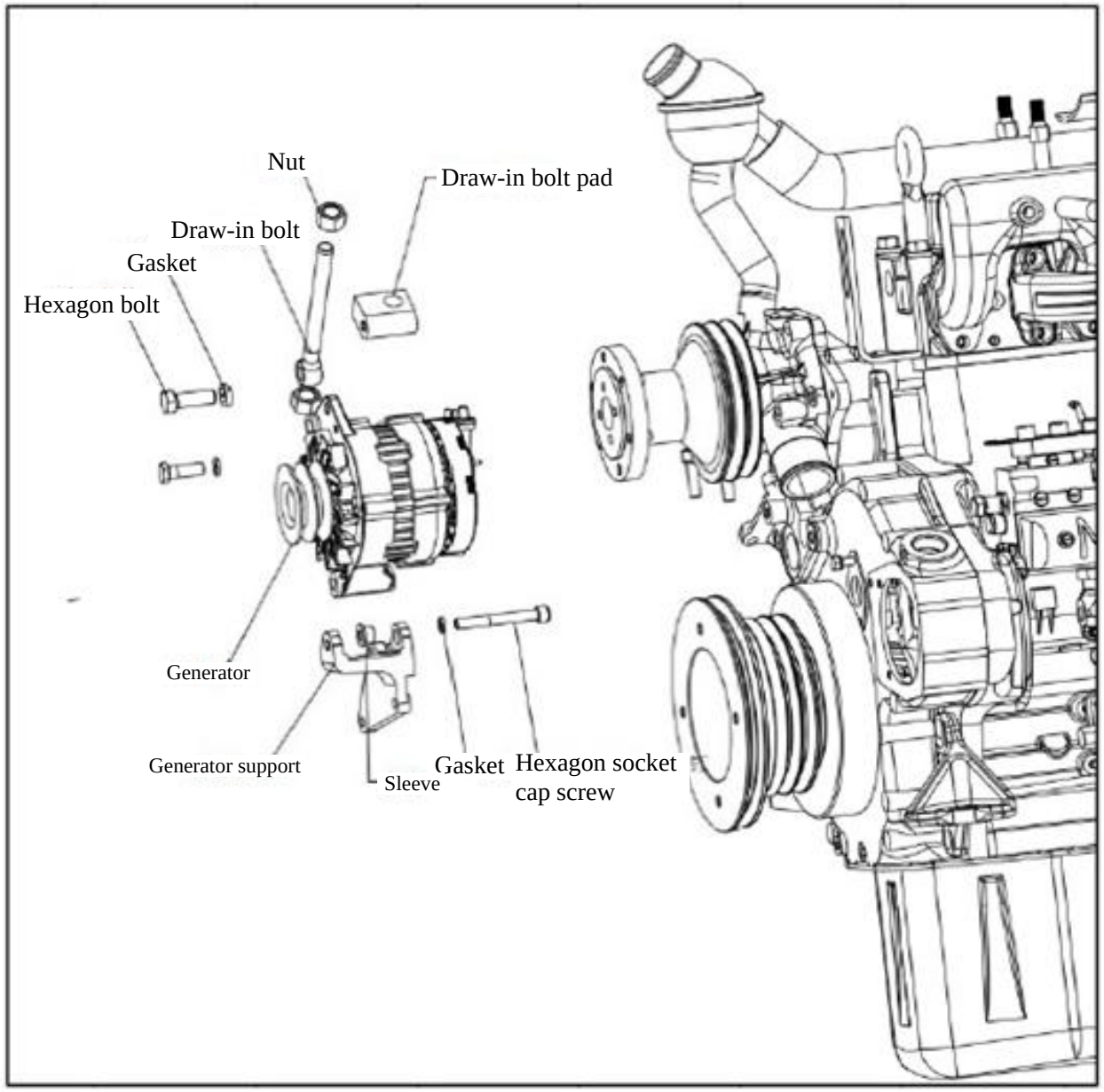


Fig. 3-60 Exploded view of generator

31122 Steps to Disassemble Generator

(1) Remove generator draw-in nut and connecting bolt and nut of draw-in bolt pad, take down the nuts, draw-in bolt and draw-in bolt pad;

(2) Remove the other generator fixing bolt, rotate the generator to remove the belt, take down the generator.

31123 Inspection and Maintenance of Generator

(1) Generator fault diagnosis flow

When a failure happens to the engine, firstly you should check whether it is generator failure.

Instrument: test lamp. Flow chart is shown in Fig. 3-61

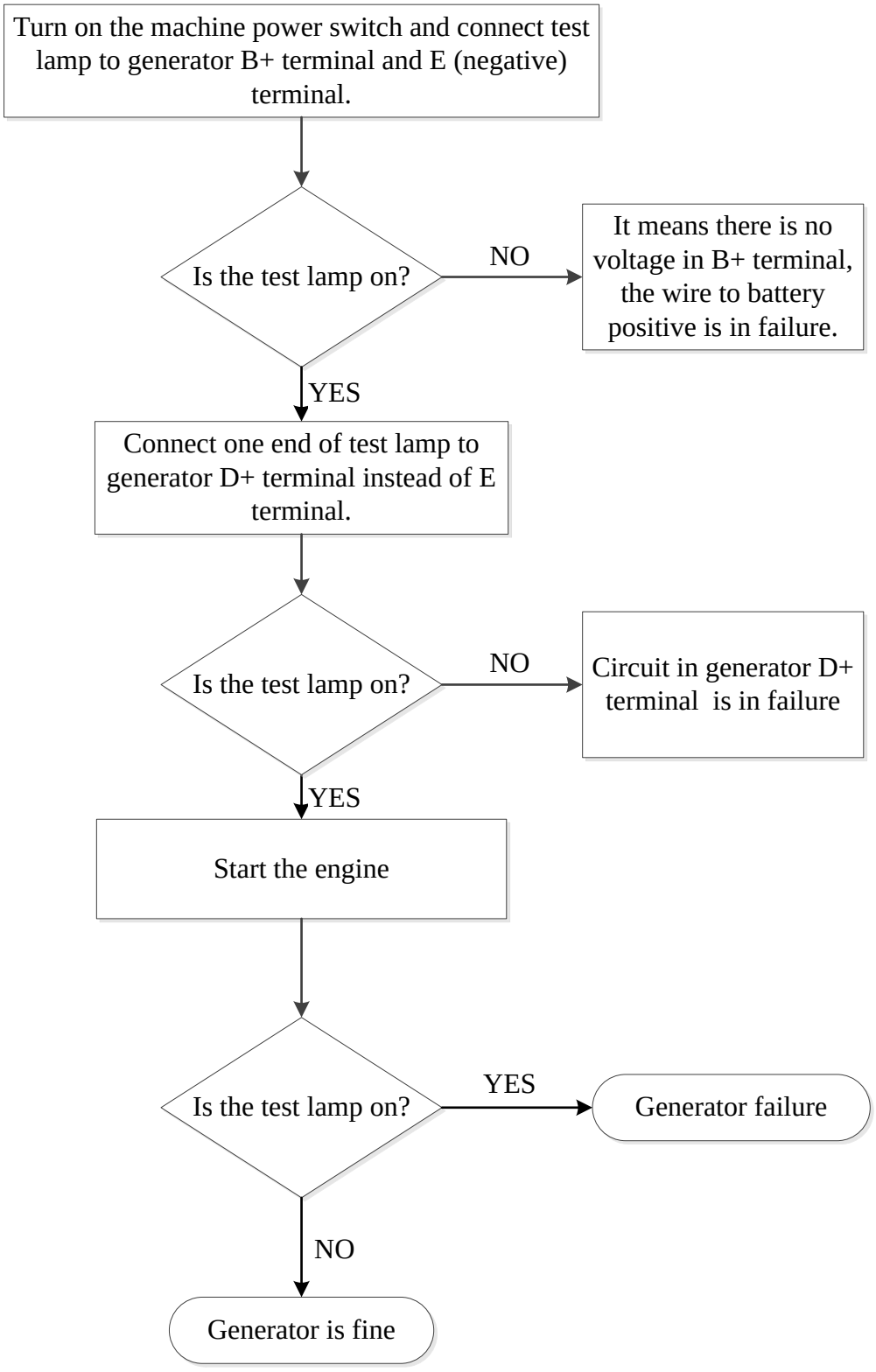


Fig. 3-61 Generator fault diagnosis flow chart

(2) Charging system fault diagnosis and troubleshooting

a) No charging

Fault 1: No charging		
Phenomenon	Fault detection	Troubleshooting
(1) Turn on starting key, but charging indicator doesn't light.	a. Check charging indicator lamp. b. Check whether there is open circuit in exciting circuit.	a. Check whether there is voltage between charging indicator and ground, if no voltage, replace the indicator lamp or check the circuit. b. If it is generator regulator failure or generator rotor failure, repair or replace the generator.
(2) Charging indicator doesn't go out when engine idling, it only goes out when engine is in high speed.	a. Rated power of indicator lamp is small or parallel exciting resistance gets loose. b. Too low idling speed.	a. 2~6w lamp is recommended, or repair the circuit. b. Adjust engine idling speed.
(3) Charging indicator doesn't go out when engine is working.	a. Check whether generator to ground voltage is within 1~3V; b. Check whether generator output end B+ to ground voltage is about 24V (battery voltage).	a. If voltage of generator indicator end is very small, then it means rated power of indicator lamp is small or there is fake connection in the circuit. Adjust indicator lamp power or check the circuit (connector and connecting point). b. If voltage of generator indicator end is zero, then it means there is short circuit in exciting circuit, check the circuit. c. If voltage of generator indicator end is battery voltage, then it means there is fault in exciting circuit, and generator regulator and exciting tube may be damaged in the same time, please amend the exciting circuit and then repair the generator. a. If B+ terminal to ground voltage is zero, then check generator to battery positive and negative circuits for breakover. b. If B+ terminal to ground voltage is obviously lower than battery voltage, then check whether generator to battery positive and negative circuits are loose or the battery is damaged. Recommended detection method: Connect a 2W indicator lamp to generator B+ terminal and exciting D+/L terminal, observe working condition of the indicator. Troubleshooting:

		● The brightness of indicator lamp is normal, and it goes out automatically after engine is started, generator output voltage is 27~28.5V; it means the exciting circuit has problem and needs to be repaired. ● The brightness of indicator lamp is normal, but it doesn't go out after engine is started, generator output voltage is 27~28.5V; it means generator regulator has problem and needs to be checked. ● The brightness of indicator lamp is normal, but it doesn't go out after engine is started, generator output voltage is battery voltage; it means there is fault in generator regulator, rectifier bridge, stator or inner connectors, and needs to be repaired or replaced.

b) Low charging voltage

Fault 2: Low charging voltage		
Phenomenon	Fault detection	Troubleshooting
Battery is occasionally underpowered, low charging voltage, and the voltage declines markedly once loaded.	Check whether generator output power is reasonably matched with electrical appliances. a. Check whether voltmeter is damaged. b. Check generator speed. c. Check the quality and tensioning situation of generator belt and relevant pulley belts. d. Check generator pulley. e. Check whether electric wires are reasonably connected, measure the voltage of generator and battery. f. Check whether wires in charging system are loose, oxidized and producing too much heat, check whether bolt connections are loose. g. Measure output voltage	Measure generator B+ terminal voltage, which should be within 27.8~28.4V, if the voltage is normal, then it means voltmeter failure or voltmeter sampling point is in fault, repair or replace. a. It is recommended the generator idling speed should exceed 1600rpm. b. Generator speed should be 2000rpm and above, or the voltage should be about 27V when high power load appliance like air condition is working c. Check the quality of generator belt and relevant pulley belts, for belt involved severe coking, breakage, deformation or wear should be replaced. d. Tension generator belt and relevant pulley belts. **NOTICE: If the to-be replaced belt is in twin-drive belt system, then the belts should be replaced together.** e. If voltage drop is bigger than 1V in heavy load condition (thin wire results in big voltage drop), the wire should be replaced. 0~35A S≥6mm^2 35~70A S≥12mm^2 70~100A S≥20mm^2 100~150A S≥25mm^2 f. If the wire or connector gets too hot in

	of generator W/R/AC terminal (should be about half of B+ terminal voltage). h. Check whether battery charging is normal.	heavy load condition, then the wire or connector should be replaced. g. Oxidized lead foot and the housing that used to install grounding bolts should be polished before reassembling. h. Retighten the loose nuts and lug plates, re-plug the loose connectors firmly. **NOTICE: Reassembled or retightened parts should be run in heavy load and will be overheat, check whether the overheat is still there 3~5min later.** If there is big difference between terminal W/R/AC output voltage and normal range and big voltage drop happened after the engine loaded, then it means failure in generator rectifier bridge or stator, repair or replace. If charging current drops to about 10A 10min later, or charging current reaches to 30-90A for a long time, then the battery is damaged, repair or replace the battery.

c) High charging voltage

Fault 3: High charging voltage		
Phenomenon	Fault detection	Troubleshooting
High charging voltage reading on voltmeter	a. Check whether voltmeter is damaged. b. Check whether wires, connectors and bolts in charging system are loose and producing too much heat, check whether there is short circuit in circuits and generator housing. c. Check whether the battery can work normally. d. Measure output voltage of generator W/R/AC terminal (should be about half of B+ terminal voltage). e. The fault is still existed after finishing above inspections.	Measure generator B+ terminal voltage, which should be within 27.8~28.4V, if the voltage is normal, then it means voltmeter failure and should be repaired or replaced. a. Retighten the bad-contact parts and loose wires, re-plug the loose connectors firmly. b. If there is short circuit, reconnect the wires. c. Check whether the charging current drops quickly in short time (from 50A to 10A or lower); consider a battery replacement if not. d. Check whether battery is clean and dry, whether its terminals and clamps are in good condition, replace them if damaged. If there is big difference between terminal W/R/AC output voltage and normal range and big voltage drop happened after the engine loaded, then it means failure in generator rectifier bridge or stator, repair or replace generator regulator, stator or the whole generator.

d) Unstable charging voltage

Fault 4: Unstable charging voltage		
Phenomenon	Fault detection	Troubleshooting
When the engine is running normally, voltmeter indicates charging, but the pointer is always oscillating and cannot be read (or charging indicator twinkling)	a. Generator belt and relevant pulley belts are loose. b. Bad contact in charging circuit. c. Collecting ring accumulates too much dirt, or electric brush is severely worn, or brush spring is weak or broken. d. Damaged regulator.	a. Tighten generator belt and relevant pulley belts. b. Check and fasten all connectors in charging circuit. c. Clean the dirt, or replace the brush and brush spring. d. Replace the regulator.

e) Generator produces abnormal sound

Fault 5: Generator produces abnormal sound		
Phenomenon	Fault detection	Troubleshooting
Running generator produces abnormal sound	a. Generator fixed support is deformed or interfered with other parts. b. Generator belt is loose and slipping. c. Generator pulley is loose. d. Generator bearing lack of lubricating oil or is damaged. e. Deep abnormal noise comes from generator inside. f. Howling noise comes from generator inside and changes with generator speed.	a. Improve generator fixed support installation strength and adjust installation condition. b. Replace generator belt. c. Fasten the pulley. d. Replace generator bearing. e. Stator coil is in short circuit, replace it.

3113 Disassembly, Inspection, Maintenance and Assembly of Air Compressor

31131 Exploded View of Air Compressor

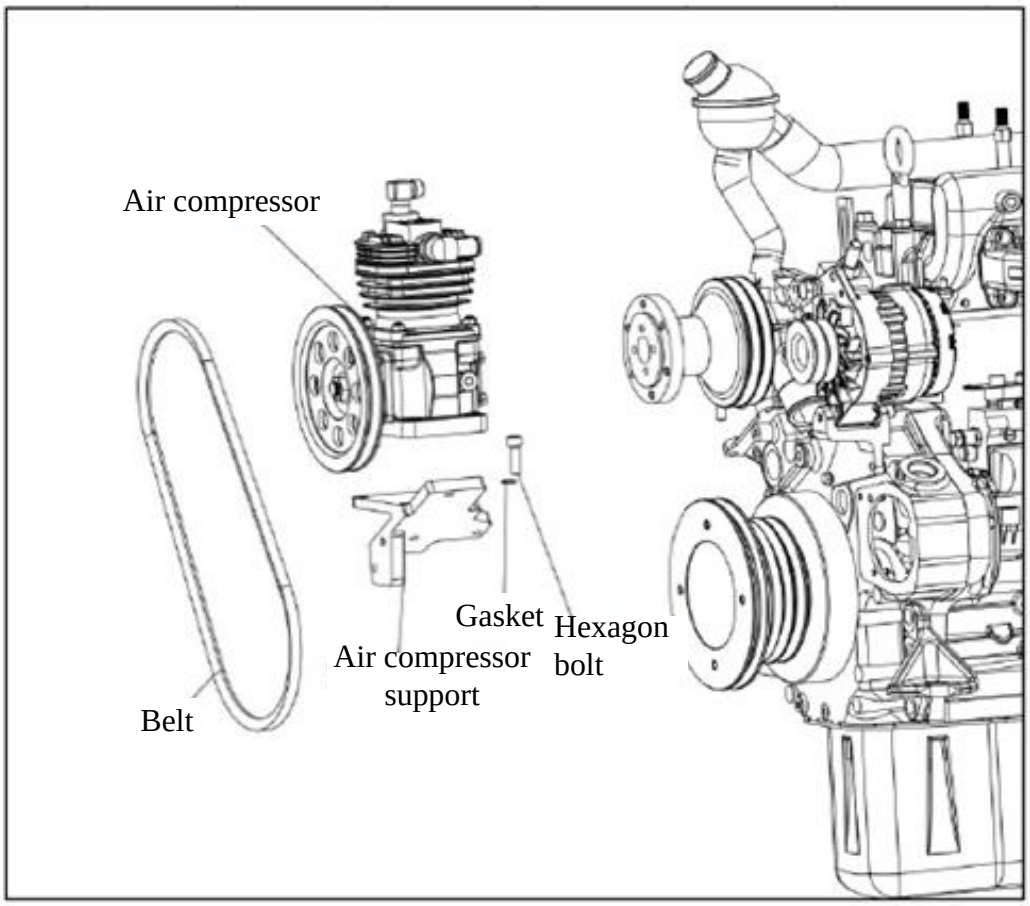


Fig. 3-62 Exploded view of air compressor

31132 Steps to Disassemble Air Compressor

(1) Remove air compressor belt;

(2) Remove the four bolts and gaskets that used to fix air compressor on support.

(3) Take down air compressor and remove air compressor support.

31133 Inspection and Maintenance of Air Compressor

(1) Air compressor doesn't produce compressed air.

Fault phenomenon: No compressed air comes out from air compressor.

Possible causes:

1) Compressor relief valve is jammed, valve plate is deformed or broken.

2) Too much carbon deposition accumulated in intake and exhaust port.

Troubleshooting:

1) Check compressor relief valve module, clean and replace the invalid parts.
2) Overhaul cylinder cover, check the valve plate, replace deformed or broken valve plate.
3) Overhaul cylinder cover, clean the valve seat and valve plate.

(2) Insufficient air pressure.

Fault phenomenon: When the engine is running and compressor is charging gasholder, the air pressure gauge indicates that air pressure cannot reach required starting pressure.

Possible causes:

1) Air pressure gauge failure.
2) The transmission belt between air compressor and engine is loose and slipping; pipe from air compressor to gasholder is fractured or air leakage in the joints.
3) Oil-water separator, pipeline or air filter is blocked due to too much deposit sediment.
4) Bad sealing of air compressor discharge valve, the valve spring is weak or broken; loose fixing bolts, sand hole and damaged gasket of air compressor cylinder cover that leading to air leakage.
5) Severe wear of air compressor cylinder sleeve, piston and piston ring that leading to air leakage.

Troubleshooting:

1) Observe air pressure gauge, if it indicates insufficient air pressure, try to keep the engine run at medium speed for several minutes, if the pressure doesn't rise or rises slowly, and when depressing the brake pedal, strong deflating sound comes out, then the air pressure gauge must be damaged, repair the gauge.
2) If there is no deflating sound or small deflating sound in the above test, then check whether air compressor belt is loose, whether pipe from air compressor to gasholder is fractured or whether there is air leakage in the joints.
3) If the air compressor doesn't charge gasholder, check whether oil-water separator, pipeline or air filter is blocked due to too much deposit sediment, clean away the sediment if so.
4) If still cannot find out the cause after the above inspections, then check air compressor discharge valve for air leakage, check whether the valve spring is weak or broken, check whether there is sand hole on cylinder cover, whether the gasket is damaged, repair or replace the damaged parts.
5) Check wear condition of air compressor cylinder sleeve, piston and piston ring.

6) Check and adjust installation direction of unloading valve (should be conform to the arrow).

(3) Air compressor pumping oil.

Fault phenomenon: There is engine oil overflows in air filter and air compressor exhaust port, and engine oil comes out with water when discharging the gasholder (wet).

Possible causes:

1) Large intake resistance or bad intake filter.
2) Large oil return resistance.
3) Severe wear of air compressor cylinder sleeve, piston and piston ring; inversely installed or jammed oil ring that results in air compressor pumping oil.
4) Insufficient cooling of air compressor.
5) Too much unclean matter in gasholder.
6) Long-running of air compressor.
7) High pressure in engine crankcase.
8) High engine oil pressure.
9) Deteriorated engine oil.
10) Defective air compressor.

Troubleshooting:

1) Check air compressor filter for damage and flaw, check whether the filter element is clean, replace the damaged parts; check whether air compressor intake pipe is twisted or deformed, ensure the intake pipe inner diameter meets the minimum requirements.

Table 1 Minimum inner diameter requirements for intake pipe and intake pipe joint

Theoretical air displacement (m^3/h)	Joint inner diameter (mm)	Pipe joint inner diameter (mm)	Pipe inner diameter (mm)	Pipe length (mm)
≤17	Φ14	Φ14	Φ18	≤500
>17~	Φ16	Φ16	Φ20	
>20~	Φ18	Φ18	Φ22	
>30~	Φ20	Φ20	Φ24	
>40~	Φ22	Φ22	Φ26	
>50~	Φ24	Φ24	Φ28	

Note: Theoretical air displacement $Q_0 = \frac{d^2}{4} \times \pi \times$ Piston displacement $\times$ n $\div$ 109 $\times$ Piston quantity, where n is compressor rated speed.

2) Ensure the exhaust pipe inner diameter meets the minimum requirements.

Table 2 Minimum inner diameter requirements for exhaust pipe

Air compressing system	Load	Pipe	Pipe
Single cylinder air compressor (Standard load cycle)	≤25	≥3.6	13m
Single cylinder air compressor (Heavy load cycle)	25~	3.6~	16m
Double-cylinder air compressor (All load cycle)	≤35	≥4.6	22m

3) Check measure wear condition and fitting condition of air compressor cylinder sleeve, piston and piston ring, severely worn parts should be replaced.

4) For compressor air cooling parts, please: Clean up accumulated oil dirt, soot and other dirty materials on cooling fin. Check the cooling fin and should replace the damaged parts. For compressor water cooling parts, please: Check the cooling pipe size (recommended minimum pipe diameter is 9.5mm), Check the flow rate of air refrigerant, minimum allowed flow rate is 5L/min when the engine is running. If refrigerant flow rate is small, check whether cooling pipe and accessories are rusted or twisted.

5) Check and ensure water temperature is under 93^{o}C; check the air valve on gasholder and ensure it can work normally. It is suggested to equip the machine with automatic exhaust valve and air drier.

6) When the brake is not used, air leakage (pressure drop) should not exceed 6.9kPa/min, and when depressing the brake, that value is 20.7kPa/min. If there is severe leakage, check the system and remove the fault. Check whether unloading system is working and repair it.

7) Check whether oil pressure in crankcase is too high, replace or repair ventilating device of crankcase if so. If the oil dipstick is loose or partially raised, then oil pressure in crankcase is in problem.

8) Check engine oil pressure (air compressor oil inlet port), compare it with rated pressure.

9) Replace with qualified lubricating oil (engine oil).

Only after ruling all the causes above out should the air compressor be repaired or replaced.

(4) Air compressor produces abnormal sound.

Fault phenomenon: Metal crash, rhythmic knock or grinding squeal

Possible causes:

1) Connecting rod sleeve or bearing shells are severely worn, connecting rod bolts are loose, main

bearing shell is worn or damaged that result in crash noise.

2) The belt is too loose, driving and driven pulley groove type is not uniform, which lead to slipping squeal.
3) No engine oil is supplied to air compressor, dry friction of metal leading to squeal.
4) Loose fixing bolts.
5) Loose gear fastening nuts results in oversized tooth space, which will bring rhythmic knock.
6) Foreign matter in piston head.

Troubleshooting:

1) Check whether connecting rod bearing shells, connecting rod sleeve and main bearing shell is worn or damaged, whether connecting rod bolts are loose; check whether air compressor main oil gallery is unblocked; replace the severely worn or damaged bearing shells, sleeve and main bearing shell; tighten connecting rod bolts to 35Nm~40Nm; unblock the main oil gallery with compressed air.
2) Check whether the driving and driven pulley groove type is uniform, replace if not. Adjust the belt tightness degree (press the belt with your thumb, it is suitable if the belt is depressed about 10mm).
3) Check engine oil pressure (air compressor oil inlet port), check whether engine oil pipe is damaged or blocked, adjust, clean or replace the invalid pipe if the oil pressure is insufficient; Check engine oil quality and impurity content, compare it with application standard, replace the oil immediately if out of limits; check whether there is engine oil supplied to air compressor, conduct a comprehensive inspection if not.
4) Check whether compressor fixing bolts are loose and tighten them.
5) For gear-driven compressor, check the fitting condition of the gears, tighten loose nuts, and replace the gear if there is fitting problem.
6) Clean up foreign matter.

(5) Air compressor “burning”

Fault phenomenon: For belt-driven compressor, its main shaft is locked; for gear-driven compressor, the bearing shell or connecting rod bearing shell is abnormally loose.

Possible causes:

1) The lubricating oil is deteriorated or too many impurities in the oil.
2) Insufficient oil supply or no oil supply.
3) Compressor inner oil channel is blocked by misplaced bearing shell.
4) Damaged bearing shell or connecting rod bearing shell, or too small fit clearance.

Troubleshooting:

1) Check engine oil quality and impurity content, compare it with application standard, replace the oil immediately if out of limits;
2) Check engine oil pressure (air compressor oil inlet port), check whether engine oil pipe is damaged or blocked, adjust, clean or replace the invalid pipe if the oil pressure is insufficient;
3) Check installation position of bearing shell, oil hole on bearing shell should be aligned to housing oil hole.
4) Check whether bearing shell and connecting rod bearing shell are damaged, check whether crankshaft is damaged or worn when replacing or repairing the shell.

Check and adjust bearing shell clearance.

(6) Air compressor leaking oil

Fault phenomenon: Lubricating oil oozes from air compressor housing.

Possible causes:

1) Oil seal has fallen off or oil seal is damaged.
2) Main shaft is loose.
3) Oil leakage in junction surface, oil inlet and return pipe joints are loose.
4) The belt is too tight, which results in wear of main bearing shell.
5) Casting or manufacturing deficiency

Troubleshooting:

1) Oil seal

   Check whether oil seal is fractured, whether its inner lip is cracked or turnup, replace the seal if any situation listed above occurred. Check the junction surface between oil seal and main shaft for scratch and flaw, scratched and flawed parts should be replaced. Check whether return oil is unblocked, blocked return oil will cause high oil pressure in crankcase that leading to oil leakage in seal or oil seal falling off. Oil return pipe diameter must meet the minimum requirements, and the pipe should not be twisted. Check the fit dimension of oil seal and crankcase, replace the unfitted seal.
2) Move the main shaft with all your strength to check whether the radial clearance is too large, replace the bearing shell and seal if so.
3) Check all sealing gaskets for sealing performance, repair or replace the gasket; check fixing bolts of oil inlet pipe joint, oil return pipe joint and the housing, and tighten them.
4) Check and adjust the belt tightness degree (press the belt with your thumb, it is suitable if the belt is depressed about 10mm).

5) Check compressor housing for casting or manufacturing deficiency (whether the oil return hole is unblocked), repair or replaced the flawed housing.

(7) Air compressor overheating

Fault phenomenon: Air compressor exhaust temperature is too high; the running parts are hot.

Possible causes:

1) The relief valve or unloading valve isn't working, which caused the compressor fail to take a break.
2) Severe leakage in air brake system, which caused the compressor fail to take a break.
3) Insufficient oil supply to the running parts or scuffing.

Troubleshooting:

1) Check relief valve module when unloading intake, clean the jammed valve or replace valid parts. Check unloading valve module when unloading exhaust, clean the jammed/blocked valve or replace valid parts.
2) Check brake system, replace unserviceable parts.
3) Poor lubrication between piston and cylinder sleeve, undersized clearance or scuffing will result in overheat, check and repair or replace unserviceable parts.

31134 Steps to Assemble Air Compressor

Assembling steps are contrary to disassembling ones.

山 东 临 工 工 程 机 械 有 限 公 司
Shandong Lingong Construction Machinery Co.,Ltd

地址：中国 临沂经济开发区临工工业园
Address:Lingong Industry Park,Linyi Economic Development Zone,Shandong,China
电话：86-0539-8785688
Tel : 86-0539-8785688
传真：86-0539-8785671
Fax: 86-0539-8785671
技术服务：86-0539-8785800
Web：www.sdlg.cn