

# Points For Attention

## Dear users:

Thanks for your choice of our diesel engine. We would like to provide an excellent service for you and ask you to pay attention to the following items:

- Please read manual carefully before operating the engine, so as to make reliable operation, prolong the engine's working life, decrease the cost and improve the economic efficiency.
- A new engine or an overhauled engine should take a running-in period of 50 hours with light load ( $\leq 50\%$  of load) and low speed ( $\leq 2000\text{rpm}$ ) before going to its normal working condition. Check the engine from time to time, fill and replace the oil and oil filter cartridge and clean the screen filter timely.
- Use clean fuel oil. Clean or replace the cartridge of fuel filter timely and check for its soundness.
- Check, clean and replace the cartridge of air filter and the inlet connecting pipe. Make sure all are well air tight.
- Don't use metal or other conduct items such as screwdriver to check the generator condition. Otherwise it may lead to breakdown of some electric elements.
- After running 100 hours, the engine must be maintained through dismantling the oil sump to check connecting rod bearings and tightening torques of connecting rod and main bearing bolts.
- Do not run the engine at idle speed continuously over 10 minutes.
- In order to facilitate maintenance and spare parts servicing, please fill in the model type and production number of the engine according to the indications on the nameplate.

Model type: \_\_\_\_\_

Production number: \_\_\_\_\_

# Preface

With the help of technical consultations from Ricardo UK Ltd and Austrian AVL Company, 490B series diesel engines are jointly developed by our company and Shanghai Internal Combustion Engine Research Institute. Featuring direct combustion chamber, optimized valve train and advanced fuel injection system, the engines can meet the state requirements for emission and noise with good cold starting ability and low fuel consumption. 490B series engines can be widely used for 2–3 ton fork lift, construction machineries, tractors and combine harvesters.

For normal and reliable operation of the engine, making good use of the lifespan and to decrease operation cost, we compile this operation and maintenance manual to help users to know more about our engines and to run the engines correctly.

For more information, please contact with us.

September/2008

# INTRODUCTION

## SIGNS, MARKS AND EXPLANATION



**Warning!** Means it may be harmful to human



**Note!** Means it may be harmful to engine.



**Remark!** Means it is important but not harmful



**Fuel**



**Engine preheating**



**Coolant temperature**



**Oil pressure**



**Lubricating parts**



**Necessary checks**



**Showing tightening torque**

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# Chapter 1 General Description of Diesel Engine

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## 1.1 Model Types and Serial Numbers

### Nameplate:

<b>490B 型柴油機</b>	
Diesel Engine Model <b>490B</b>	
标定功率 Rated output	45.6kw—3200r/min
柴油機编号 Diesel Engine No.	<input type="text"/>
日期 Date	<input type="text"/>
生产许可证号 Manufacture Licence No.	XK06-205-00176
<b>浙江新柴股份有限公司</b> ZHEJIANG XINCHAI CO., LTD	

<b>IMPORTANT ENGINE INFORMATION</b>	
This Engine is Certified to Operated with "Type 2-D" Commercial Grade Diesel	
FAMILY NAME:	6ZHXL2.67XCD
ENGINE DISPLACEMENT:	2.67Liter
RATED POWER/SPEED:	kW/ r/min
ENGINE NO:	DATE:
This Engine Conforms to 2006 US EPA Regula- -tions Nonroad Compression-ignition Engines refer to user's manual for more information	
<b>ZHEJIANG XINCHAI CO., LTD</b> NO.613, THE FIRST QIANG ROAD, CHERKEEN TOWN, XINCHAI COUNTY ZHEJIANG PROVINCE, CHINA <b>MADE IN CHINA</b>	

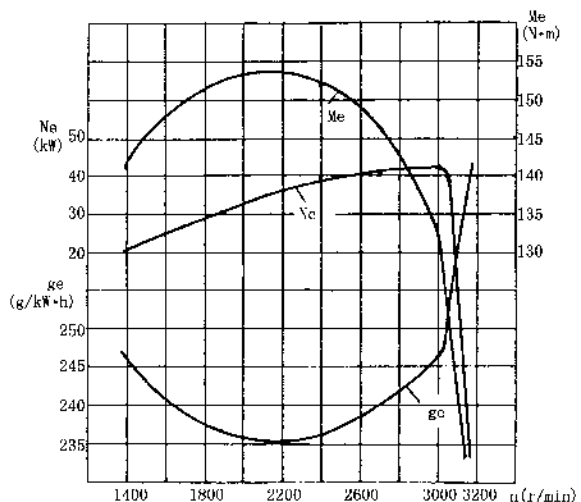
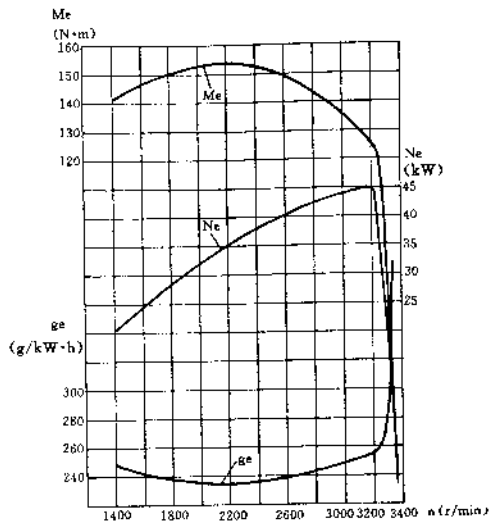
### The Nameplate Position:

The nameplate is on the top of the cylinder head cover. Before asking for maintenance or parts service, please look up the relative information indicated in the nameplate.

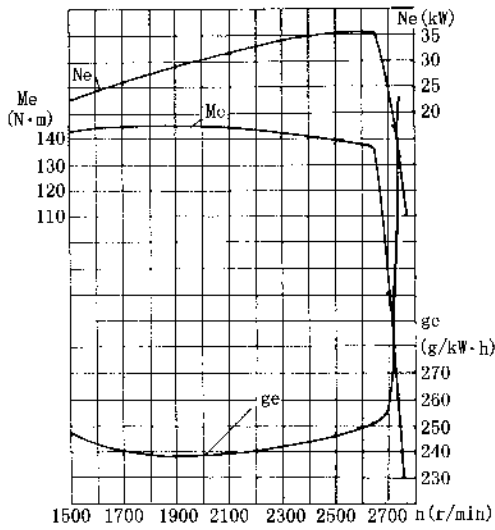
### The Position of Serial Number of the Block:

The stamped serial number is under the left side of the exhaust pipe and by the side of the flywheel.

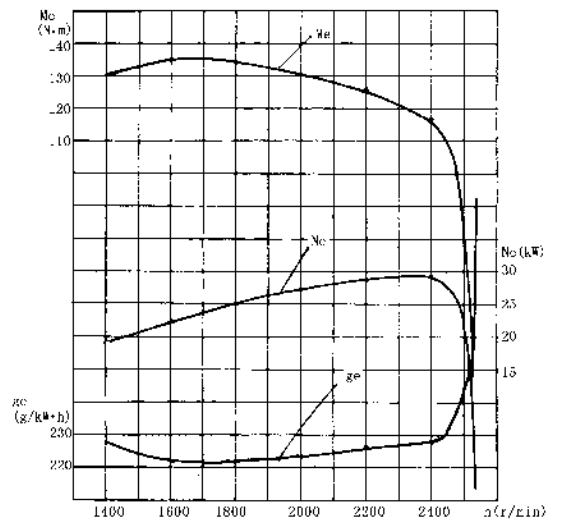
## 1.2 Engine Performance Curve



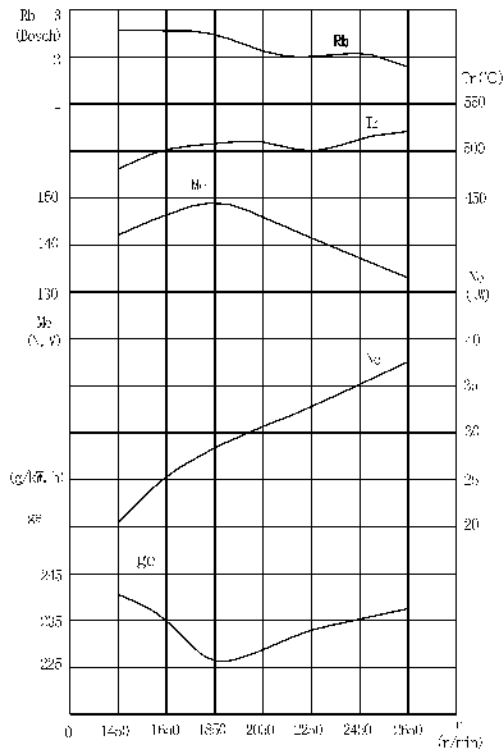
**490B**



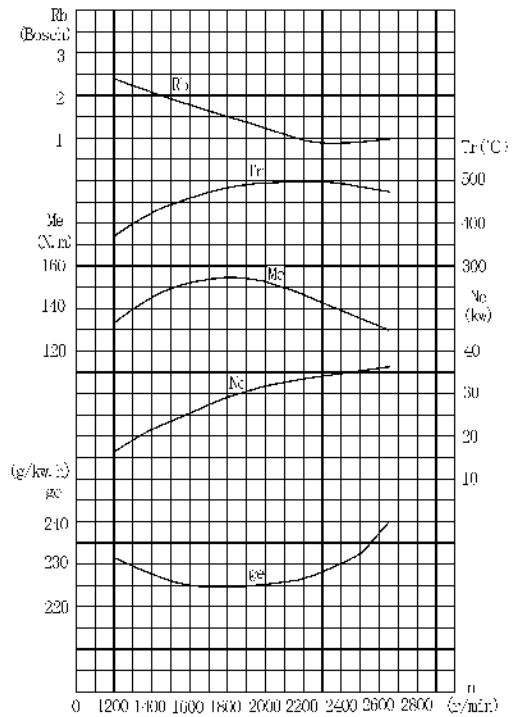
**490BPG**



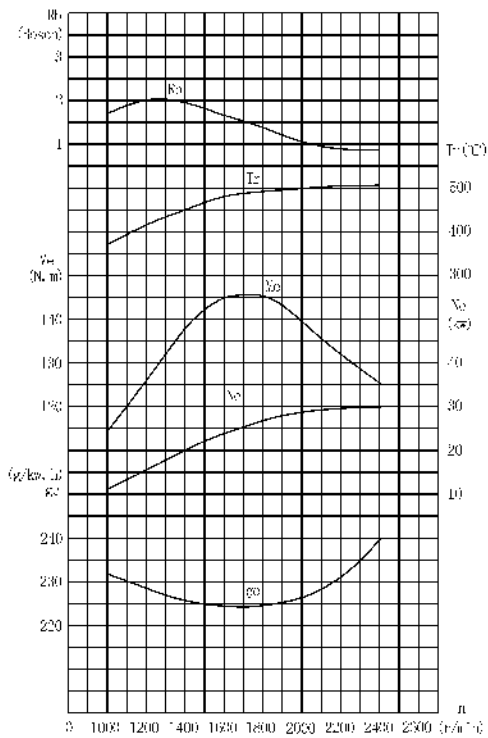
**490BT**



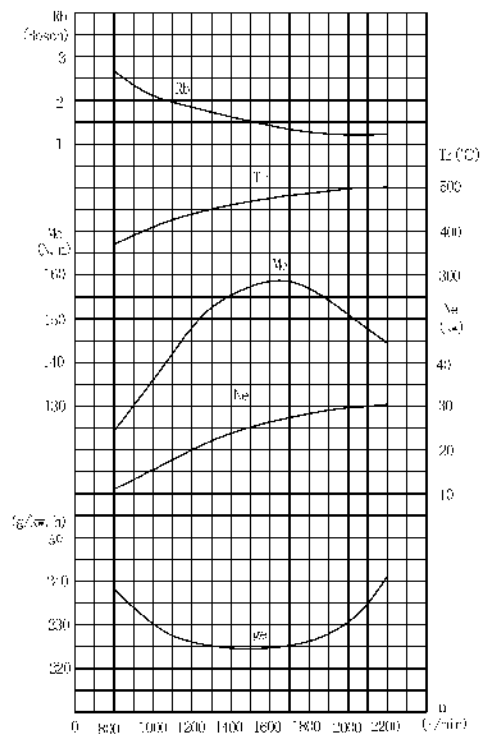
**A490BPG**



**C490BPG**



**C490BT**



**C490BG**



### 1.3 Engine Technical Performance Data

Usage type	Cars		Forklifts		
Model	490B	490BPG	A490BPG	B490BPG	C490BPG
Type	in-line, water cooled, 4-stroke, direct injection $\omega$ -shaped combustion chamber (Ring-like platform combustion chamber for A490BPG、C490BPG)				
No. of cylinders – bore – stroke (mm)	4-90-100	4-90-100	4-90-100	4-90-105	4-90-105
Total displacement (L)	2.54	2.54	2.54	2.67	2.67
Firing order	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2
Compression ratio	18:1	18:1	18.5:1	18.4:1	18.4:1
Rated speed (r/min)	3200   3000	2650	2650	2650	2650
Rated power (kW)	45.6   41.9	36.8	36.8	39	36.8
Max. torque (N·m)	$\geq 152.9$	$\geq 148$	$\geq 148$	$\geq 157$	$\geq 156$
Max. torque speed (r/min)	2000~2200	1800~1900	1800~1900	1700~1900	1700~1900
Maximum mean effective pressure (k Pa)	$\geq 756.4$	$\geq 732.2$	$\geq 659.6$	$\geq 738.3$	$\geq 738.3$
Min. fuel consumption at full load ( g/kW·h)	$\leq 238$	$\leq 238$	$\leq 230$	$\leq 230$	$\leq 228$
Oil consumption (g/kW·h)	$\leq 1.63$	$\leq 1.63$	$\leq 1.63$	$\leq 1.63$	$\leq 1.2$
Min. steady idle speed (r/min)	$\leq 850$	$\leq 750\pm 30$	$\leq 750\pm 30$	750 $\pm 30$	750 $\pm 30$
Direction of crank rotation viewed from flywheel end)	counterclockwise				
Noise dB(A)	$\leq 114$   $\leq 113$	$\leq 112$	$\leq 112$	$\leq 112$	$\leq 112$
Cooling system	closed cycle, forced water cooling				
Lubrication system	pressured and splashed				
Starting device	electric motor				
Net weight ( kg)	$\leq 250$	$\leq 260$	$\leq 260$	$\leq 265$	$\leq 265$
Overall dimension Length *width* height (mm)	700*581*670	751*565*690	751*565*690	751*565*704	751*565*704

Note: The rated power is the power at standard condition that means the atmospheric pressure is  $1 \times 10^5$  Pa (750mmHg), ambient temperature is 25°C, relative humidity is 30% without air filter, muffler or cooling fan.

Usage type	Tractors			Generators	Construction machineries
Model	490BT	B490BT	C490BT	490BD	C490BG
Type	in-line, water cooled, 4-stroke, direct injection $\omega$ -shaped combustion chamber (Ring-like platform combustion chamber for C490BT, C490BG)				
No. of cylinders - bore - stroke (mm)	4-90-100	4-90-105	4-90-105	4-90-100	4-90-105
Total displacement (L)	2.54	2.67	2.67	2.54	2.67
Firing order	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2
Compression ratio	18:1	18.4:1	18.4:1	18:1	18.4:1
Rated speed (r/min)	2400	2400	2400	1500	2200
Rated power (kW)	29.4	29.4	29.4	21	31
Max. torque (N·m)	$\geq 135$	$\geq 152$	$\geq 142$	-	$\geq 158.8$
Max. torque speed (r/min)	1500~1680	1500~1700	1500~1700	-	1600~1800
Maximum mean effective pressure (k Pa)	$\geq 667.8$	$\geq 738.3$	$\geq 738.3$	$\geq 661.4$	$\geq 666.9$
Min. fuel consumption at full load (g/kW·h)	$\leq 238$	$\leq 230$	$\leq 228$	$\leq 238$	$\leq 228$
Oil consumption (g/kW·h)	$\leq 1.63$	$\leq 1.63$	$\leq 1.2$	$\leq 1.63$	$\leq 1.2$
Min. steady idle speed (r/min)	$\leq 750\pm 30$	750 $\pm 30$	750 $\pm 30$	$\leq 750\pm 30$	750 $\pm 30$
Direction of crank rotation viewed from flywheel end)	counterclockwise				
Noise dB(A)	$\leq 110$	$\leq 110$	$\leq 110$	$\leq 107$	$\leq 110$
Cooling system	closed cycle, forced water cooling				
Lubrication system	pressured and splashed				
Starting device	electric motor				
Net weight (kg)	$\leq 290$	$\leq 295$	$\leq 295$	$\leq 280$	$\leq 280$
Overall dimension Length*width* height (mm)	788*726*719	787*726*719	787*726*719	698*541*690	698*541*690

Notes:1.C490BPG、C490BT、C490BG have got the certificate of EPA II (U.S Environmental Protection Agency)

2.C490BPG、C490BT has got the certificate of E-mark III.

## 1.4 Main Characteristic Data

### 1、Timing (in terms of crankshaft angle)

Intake valve open:  $11^\circ$  before top dead center.

Intake valve close:  $41^\circ$  after bottom dead center

Exhaust valve open:  $49^\circ$  before bottom dead center.

Exhaust valve close:  $11^\circ$  after top dead center.

Cold valve clearance intake valve 0.35mm  
exhaust valve 0.45mm

### 2、Injection advance angle: $10\text{--}12^\circ\text{CA}$ (C490BPG, C490BT, C490BG);

$21\pm 1^\circ\text{CA}$  (490BT, 490BD, B490BT);

$17\pm 1^\circ\text{CA}$  (490B, 490BPG, 490BT, A490BPG, B490BPG)

### 3、Temperature and pressure requirements:

1)、Exhaust temperature  $\leq 550^\circ\text{C}$  (490B  $\leq 620^\circ\text{C}$ ).

2)、Oil temperature:  $\leq 368\text{k}$  ( $95^\circ\text{C}$ ).

3)、Cooling water temperature:  $357\text{--}368\text{k}$  ( $85\text{--}95^\circ\text{C}$ ).

4)、Oil pressure at the main oil gallery:  $0.2\text{--}0.44\text{Mpa}$ .

### 4、Tightening torques for the main bolts in $\text{N}\cdot\text{m}$ :

Cylinder head bolt:  $117.6\text{--}137.2$ .

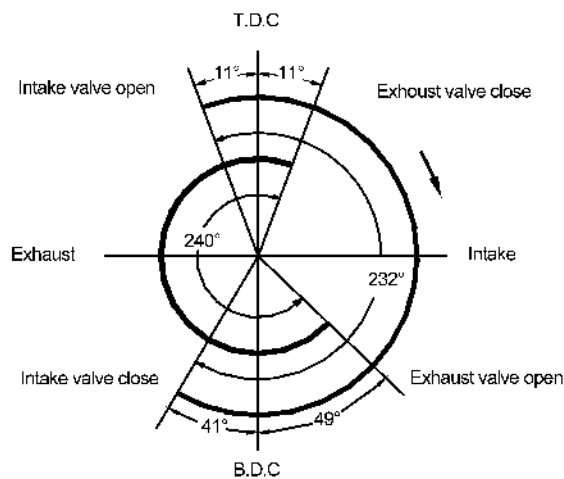
Main bearing bolt:  $137.2\text{--}156.8$ .

Connecting rod bolt:  $98.1\text{--}117.6$ .

Flywheel bolt:  $98.1\text{--}117.6$ .

Starting claw:  $100\text{--}120$ .

### 5、Oil capacity in the oil sump $\approx 6\text{L}$ .

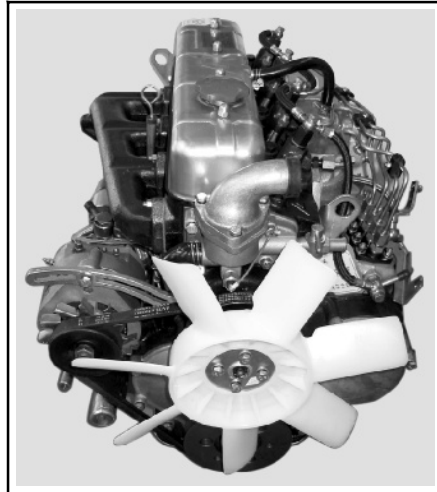


## 1.5 Overall Dimensions of Diesel Engine

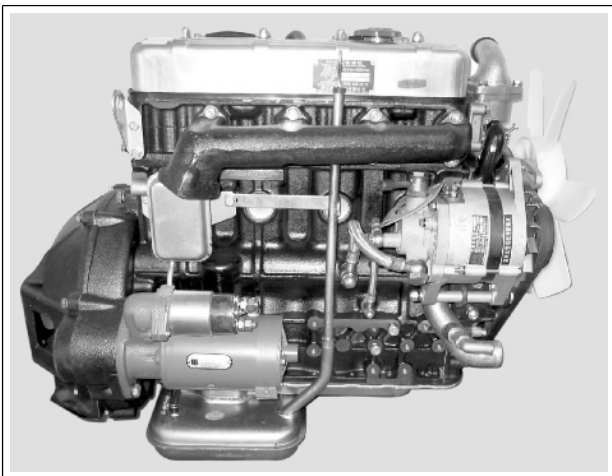
490B



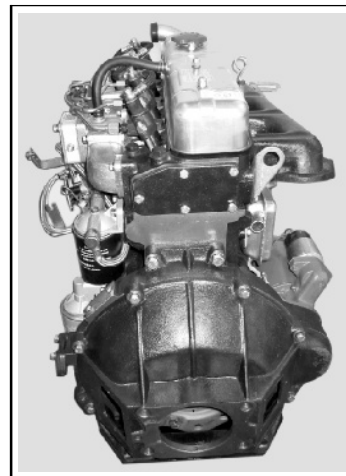
**Intake side view**



**Front view ( with fan)**

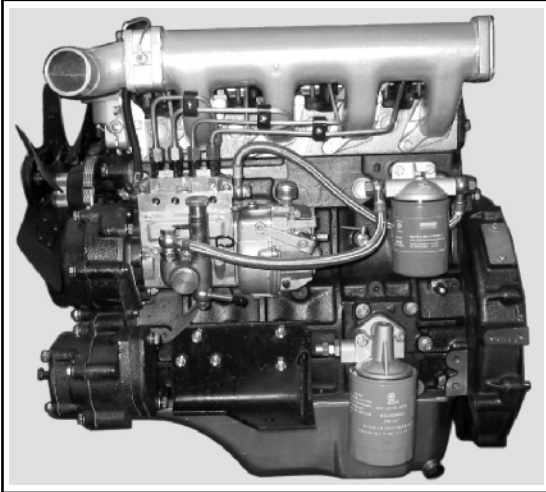


**Exhaust side view**

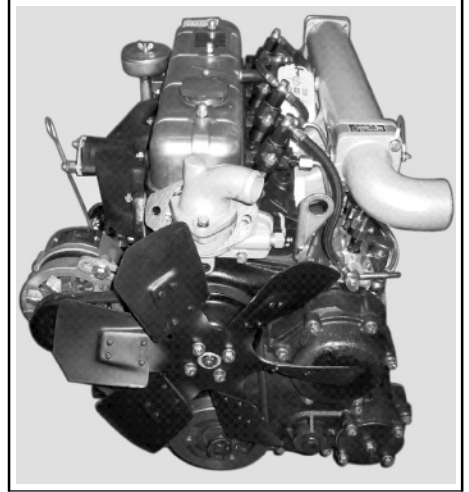


**Rear view**

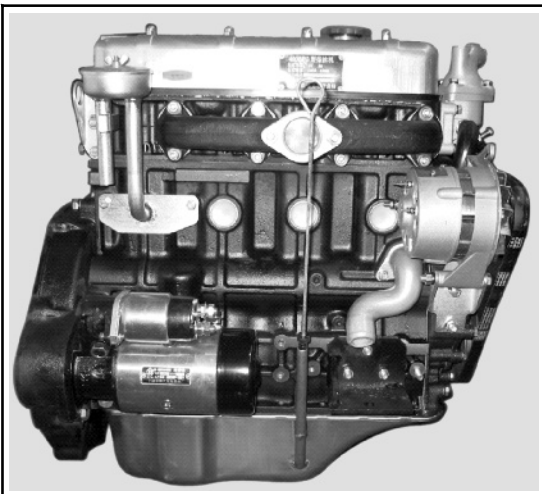
**490BPG**



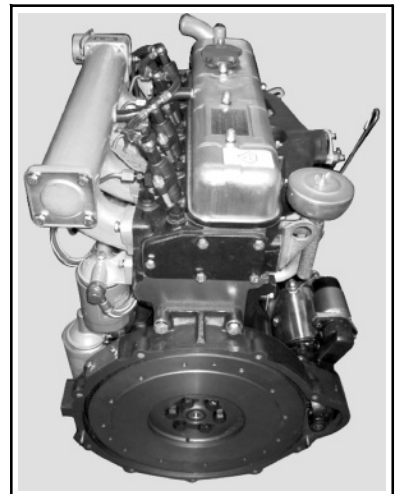
**Intake side view**



**Front view (with fan)**



**Exhaust side view**

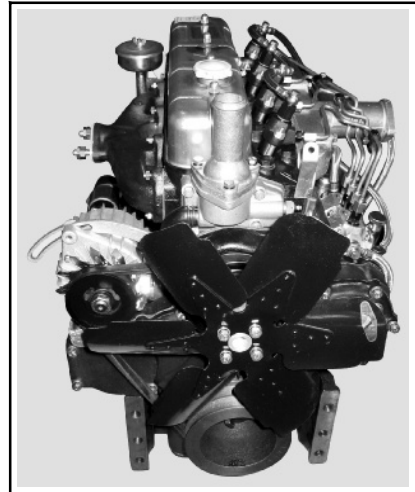


**Rear view ( with clutch)**

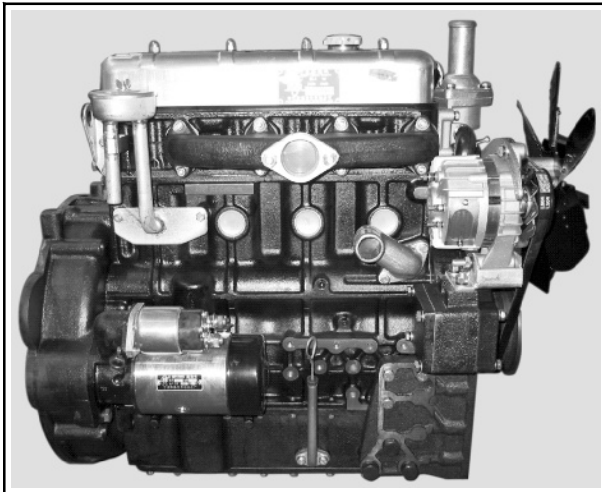
## 490BT Single Pump



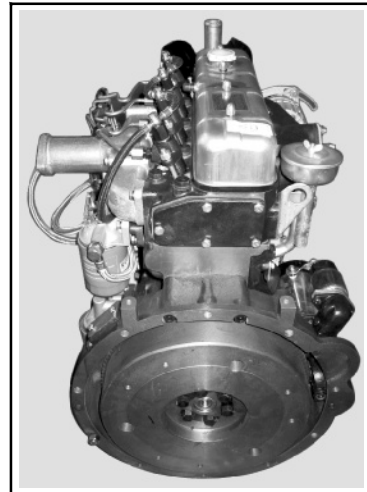
**Intake side view**



**Front view (with fan)**

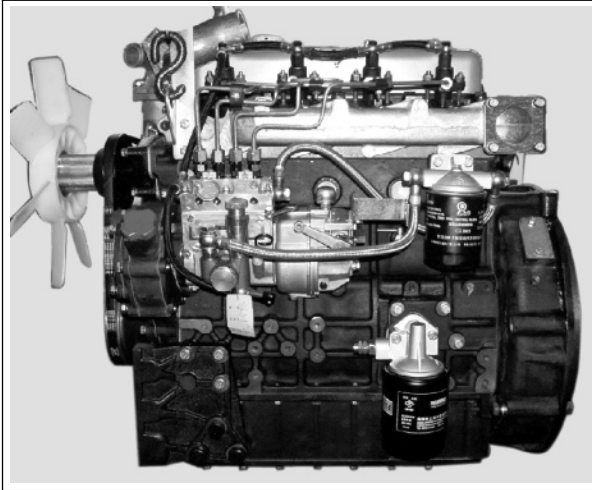


**Exhaust side view**

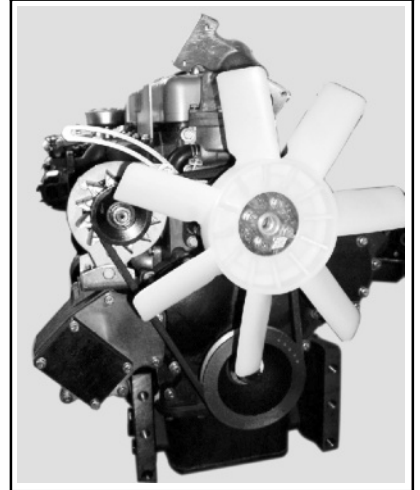


**Rear view ( with clutch)**

## 490BT Double Pump



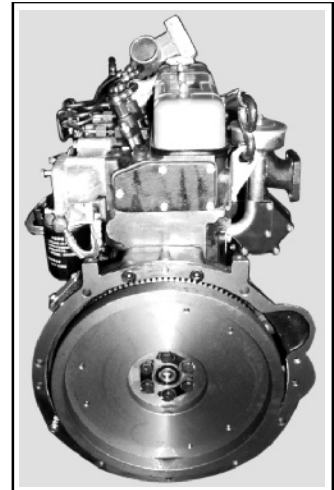
**Intake side view**



**Front view (with fan)**

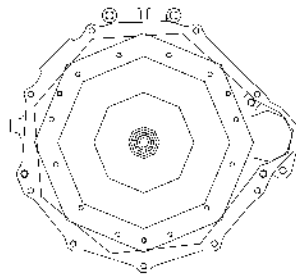
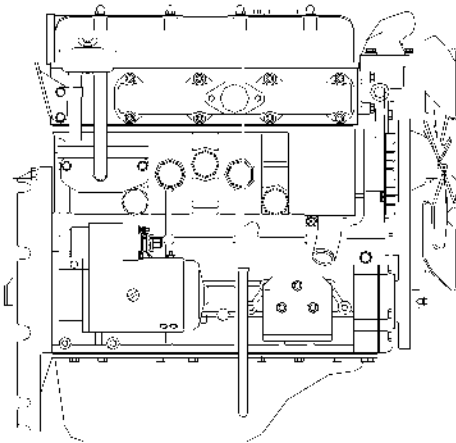
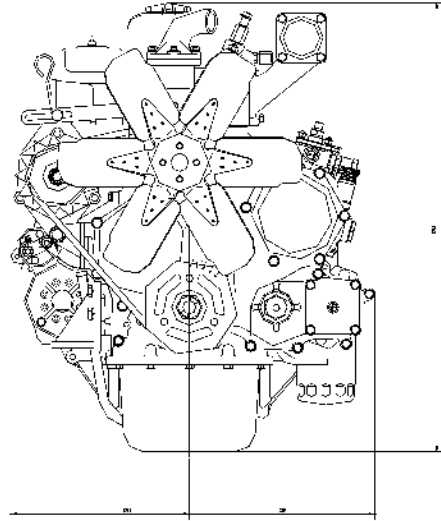
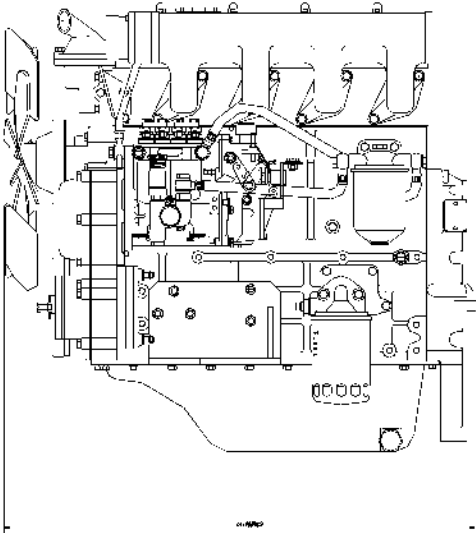


**Exhaust side view**



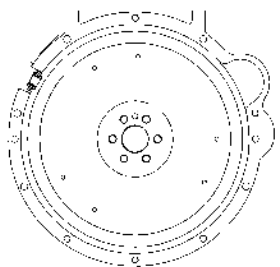
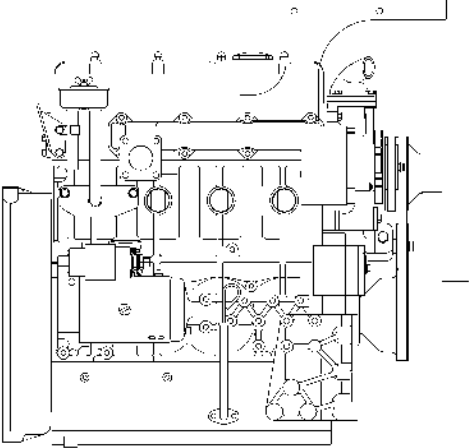
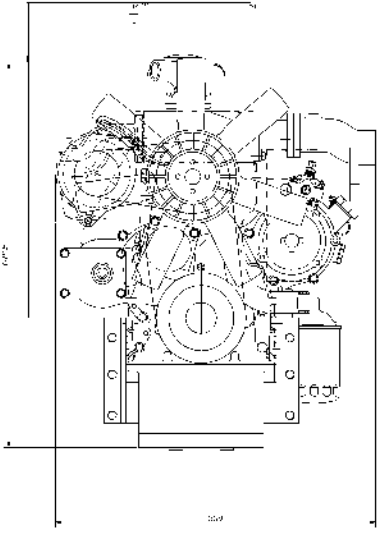
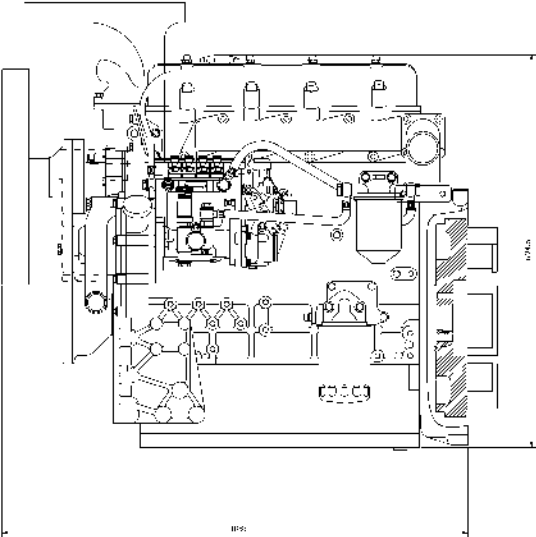
**Rear view (with clutch)**

**C490BPG:**

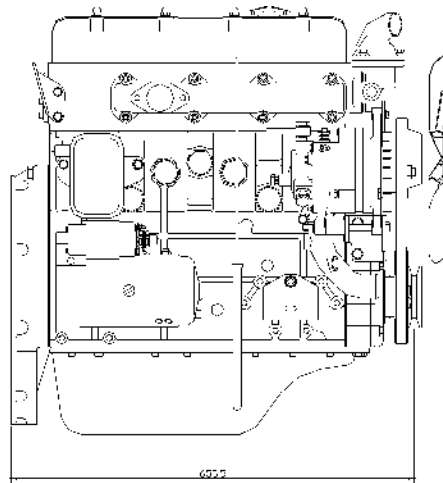
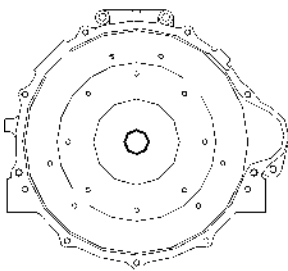
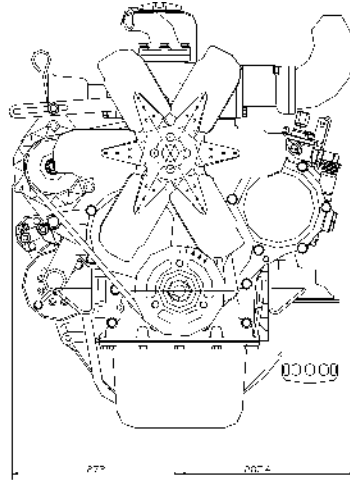
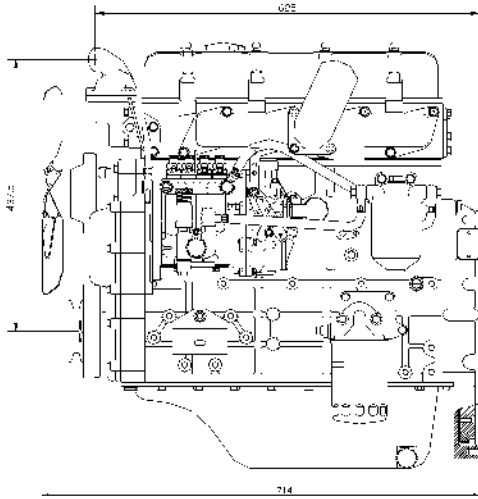




**C490BT:**



C490BG:



# Chapter 2 Operation of the Diesel Engine

<b>2.1 Preparation for the First Operation of the Diesel Engine</b>	<b>16</b>
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## **2.1 Preparation for the first Operation of the Diesel Engine**

### **1)、Fill the oil**

Generally, there's no oil filled in the engine when it is off the line. Customer should fill the oil by himself before operating the engine. When filling oil, please open the cover of the oil filling port on the cowl of the cylinder head first, take out the oil gauge, then fill the oil and check the oil level with the gauge. Check the oil level again after 3 minutes. Oil capacity: make sure the lubricating oil level in the oil sump should be between the upper mark and lower mark on the oil gauge when the lubricating system is filled full oil.

#### **▲Note:**

Only clean oil can be filed into engine, make sure no any deposit in the filled oil. Fuel injection pump assembly also needs to be filled with oil. The lubricating oil in the pump case should be between the upper mark and lower mark on the injection pump oil gauge.

### **2)、Fill diesel fuel**

Users can choose the corresponding diesel fuel for summer or winter according to the temperatures in their local places. The position of the fuel pipe joint position is on the lower part of the injection pump. Before filling into the engine, the diesel fuel should be keep still for more than 72 hours to clear out the water and impurities.

### **3)、Fill coolant**

- Open the cap and the drain cock.
- Fill the coolant to the mark of filler
- Close the drain cock when the coolant flows out.
- Screw on the cap

### **4)、Other preparing work before starting the engine**

Check whether all engine mounting fasteners are in good condition and whether the control handles such as throttle, shut down handle and etc can operate smoothly.

➤ Revolve the crankshaft several turns to check whether all moving parts can move smoothly.

➤ Check oil sump and injection pump for the oil level.

➤ Check whether the radiator is full of cooling water and there is no leakage at the joints.

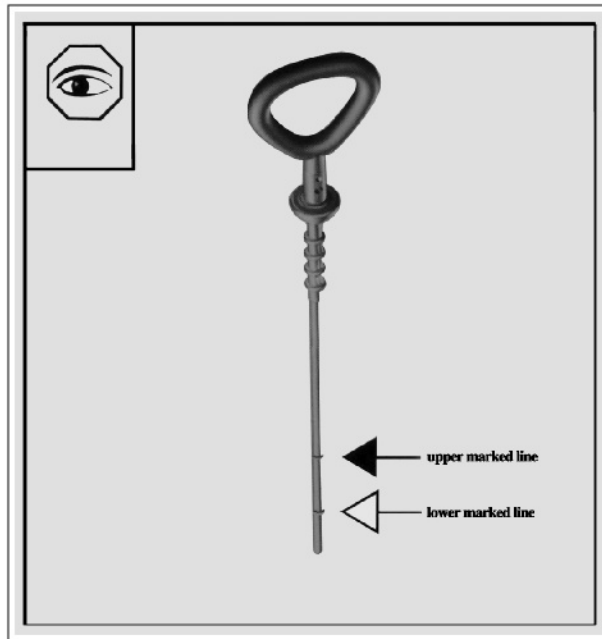
➤ Check whether the fuel is sufficient, fuel supply is unblocked and there is no leakage at the joints of fuel pipes. Check if the fuel cock at the fuel tank has been turned open.

➤ Check whether the battery has been fully charged and all joints between electric equipments are in good condition.

➤ Check all fixing fasteners for various components (injection pump, fuel supply pump, fuel filter, water pump, fan, generator and its bracket, v-belt of fan, electric starting motor, oil filter, water radiator, etc.)

➤ Check all joints between air filter, intake rubber pipe and intake pipe for secure air tightness.

➤ Check if power take off clutch is released.



The oil level shall be between the upper and lower marked line

## 2.2 Starting of the diesel engine

- 1)、Put the speed control lever at its middle speed position.
- 2)、Loose the vent screw on the fuel filter, press the hand fuel supply pump several times to release the air trapped in the fuel system. For a new engine or an engine having stood by for a long period, where a lot of air may have been existed in the fuel system, it may be necessary to loose the vent screw on the injection pump and to press the fuel supply pump repeatedly till all the trapped air is released. If the engine has been operated frequently, this work may be omitted according to the actual situation.
- 3)、Press the start button to start the engine. If it fails to start, the button should be released and restart it after waiting for two or three minutes. If the engine still fails to start after three consecutive attempts, the trouble cause should be found out and dealt with accordingly before starting it again.
- 4)、The starting button should be released immediately after starting. Watch the speedometer and adjust the speed control lever. Run the engine at 600–850rpm idle speed to see if the engine is working normally. Pay special attention to the oil pressure, which should be higher than 0.05MPa. Then, speed up the engine gradually to 1800 to 2000 rpm at idle load to warm it up.

## 2.3 Operation of the diesel engine

- 1)、The engine should not take load to work until the water temperature reaches 50°C and oil temperature reaches 40°C. And the rated load should not be taken until the water

temperature goes up to 80°C.

2)、Load and speed should be increased and decreased smoothly. Generally speaking, it is not allowed to be changed abruptly.

3)、During the operation of the engine, constantly watch the readings of the gauges on the control board to see whether they show normal values. Pay attention to exhaust smoke and its running sound. If any abnormal thing is found, shut down the engine and check it.

## 2.4 Shutting down of the diesel engine

1)、Before shutting down the engine, gradually reduce its load and speed. Run the engine at idle speed until the water temperature cools down to 70°C. Then operate the shut-down lever to shut down the engine.

2)、When ambient temperature goes below 5°C in the winter and the water temperature goes below 60°C after shutting down the engine, open the drain cocks on the cylinder block and the radiator to drain the cooling water to avoid freezing and damaging the engine(if anti-freezing fluid has been added, it will not be necessary to do so).

## 2.5 Precaution during Engine Operation

1)、Operation and maintenance of the engine should be done according to the manual.

2)、A new engine or an overhauled engine should not work at full load and high speed. It should take a running-in period of 50 hours with light load ( $\leq 50\%$  of load) and low speed( $\leq 2000\text{rpm}$ ) before going to its normal operation.

3)、Fuel should keep clean. It is recommended to keep the fuel still for one week or more to let the impurities settle down or filter the fuel with silk cloth.

4)、Keep a normal water temperature (70°C–95°C). The oil pressure should be 0.2–0.4MPa at medium speed.

5)、The engine should be shut down and checked when any abnormal phenomenon happens during the operation.

## 2.6 Working Media

### 1、Oil

Use CD grade oil.

Use different oil for different ambient temperature

SAE grade	temperature range	SAE grade	temperature range
20	-10---30°C	5W/30	-40---35°C
30	-10---35°C	10W/30	-30---35°C
40	-5---40°C	15W/40	-20---40°C
5W	-40---10°C	20W/40	-15---40°C
10W	-30---15°C	20/20W	-10---35°C
5W/20	-40---10°C		

## 2、 Diesel fuel

Customers can choose the light diesel fuel according to the actual ambient temperatures at their local places.

## 3、 Coolant

Special coolant is needed for some vehicles. In that case, use coolant according to the requirement of the vehicles. For general purposes, use cooling water which meets certain requirements.

**Cooling water:** it's good to be rain water, tap water or clean river water. It's not good to use well water because there are so much minerals in the water which will form scale deposited in the cooling system which is harmful to cooling effect and may damage the engine. It may need to add antifreeze into the cooling system to prevent water freezing in cold winter. The most common antifreeze is glycol water solution or alcohol.

**Filling coolant and precautions:**

- Fill cooling water up to the mark at the filler.
  - Pay attention to close the drain cock after water draining from it.
  - Tighten filler cap.
  - Start the engine, run it until it reaches normal working temperature and the thermostat opens and the water pipe of the major circuit apparently grows warmer.
  - Shut down the engine after the initial operation. Let the engine cool down and check the water level.
- ⚠ Caution:** Be careful of not getting burnt when you open the filler cap while the water temperature is still high.

# **Chapter 3 Technical Maintenance of the Diesel Engine**

<b>3.1 Maintenance Tools .....</b>	<b>21</b>
<b>3.2 Maintenance Periods.....</b>	<b>21</b>
<b>3.3 Technical Maintenance in winter .....</b>	<b>23</b>
<b>3.4 Storage for the Engine .....</b>	<b>23</b>



### 3.1 Maintenance Tools

Hexagon wrench

Spanner handle

Valve clearance gauge

Assembling and dismantling tool for spin-on filter

### 3.2 Maintenance Periods

These maintenance periods are suitable for general situation, if maintenance is required for the vehicles (cars, forklifts, tractors and so on) the shorter maintenance period is applied. When the engine operation should meet local regulations, the maintenance periods and procedures should be modified to ensure right operation.

▲ **Note:** Some maintenance periods should be shortened if the engine is worked in dusty environment or other rigorous conditions.

Engine maintenances are classified as follows:

1. Daily maintenance

2. Grade 1 maintenance ( After 50 hours or 2500km )

3. Grade 2 maintenance ( After 250 hours or 12500km )

4. Grade 3 maintenance ( After 1000 hours or 50000km )

Interval	Maintenance Items
Daily Maintenance	<ol style="list-style-type: none"><li>1. Check the oil sump, air filter and the oil level in the injection pump. If the oil level rises, find out the cause and deal with it; if the oil is not sufficient enough, fill the oil to the specified value.</li><li>2. Check the cooling water level in the water tank and fill it if the cooling water is not sufficient enough. When the temperature goes below 5 °C, all cooling water shall be drained out after the engine being shutting down (if there is no any antifreeze).</li><li>3. Check and fix bolts and nuts to eliminate any leakages phenomena.</li><li>4. Use the compressed air to eliminate the dust on the cartridge of air filter when working on the occasions with much dust.</li><li>5. Clean the mud, deposited dust and smear outside of the engine.</li><li>6. Pay attention to the sound when the engine is running. Watch the exhaust smoke and deal with the caused troubles and abnormal situations.</li></ol>

<p style="text-align: center;"><b>Grade 1 Maintenance</b></p>	<ol style="list-style-type: none"> <li>1. Same as the Daily Maintenance.</li> <li>2. Clean deposited dust on the cartridge of air filter and dust bin. Renew the oil in the oil filter.</li> <li>3. Check and adjust the tightness of fan belt.</li> <li>4. Fill the grease lubricant to the water pump bearing ( except the shaft-connecting water pump).</li> <li>5. Check every parts of engine make an adjustment if necessary.</li> <li>6. Start the engine to check its operation condition after finishing the maintenance and deal with the caused troubles and abnormal situations.</li> </ol>
<p style="text-align: center;"><b>Grade 2 Maintenance</b></p>	<ol style="list-style-type: none"> <li>1. Same as Grade 1 Maintenance.</li> <li>2. Renew the oil, clean the oil sump and oil filter.</li> <li>3. Clean the oil filter, and replace the cartridge of filter.</li> <li>4. Renew the oil in injection pump and air compressor.</li> <li>5. Clean the fuel tank, fuel pump filter screen and pipe alleys. Replace the cartridge of diesel oil filter.</li> <li>6. Use the compressed air to blow out the deposited dust in the generator. Check all the parts and deal with the troubles on the abnormal parts.</li> <li>7. Adjust the valve clearance and check the valve spring.</li> <li>8. Check the opening pressure of injector and the atomization quality. Adjust them if necessary.</li> </ol>
<p style="text-align: center;"><b>Grade 3 Maintenance</b></p>	<ol style="list-style-type: none"> <li>1. Same as Grade 2 Maintenance.</li> <li>2. Clean the cooling system, and wipe off the furring.</li> <li>3. Clean the oil cooler.</li> <li>4. Replace the cartridge of air filter and the cartridge of diesel oil filter.</li> <li>5. Dismantle the cylinder head. Check the leak tightness of valve and clean the deposited carbon.</li> <li>6. Check cylinder head bolts, tightening torques of connecting rod and main bearing bolts.</li> <li>7. Check water pump (except the shaft-connecting bearing water pump). Renew the grease lubricant and replace the water seal if necessary.</li> <li>8. Check the generator and starting motor. Fill the grease lubricant.</li> <li>9. Check the injection pump, adjust the advance timing, and adjust the injection pump according to the real situation.</li> <li>10. Check the air compressor, grind the valve and clean the deposited carbon.</li> </ol>

### 3.3 Technical maintenance in winter

△ Please pay special attention to maintenance of the engine when the temperature is below 5 °C.

1、 Oil and fuel for winter application should be used. Closely watch water content in the fuel to avoid fuel pipes being plugged.

2、 It's better to fill antifreeze in the cooling system. Or the cooling water should be drained out when the water temperature goes below 40–50°C after the engine is shut down.

3、 It's better not to park the vehicle in the open air in the cold season or cold regions. Otherwise, when start the engine, it is necessary to heat up the cooling water and warm up the engine first and use the air heater. If you get these jobs done, the engine can be started in cold regions.

Maintenance records:

Work time	Date	Signature/ stamp	Work time	Date	Signature/ stamp
50					
125			250		
375			500		
625			750		
875			.....		

### 3.4 Storage of the Engine

1)、 If the engine will not be used for a long time, the oil, cooling water and fuel should be drained out while the engine is still warm and clean the oil sump and screen filter.

2)、 Do relevant technical maintenance.

3)、 Dismantle the intake and exhaust manifolds. Fill every cylinder with 200g clean oil which is dehydrate treated through inlet and exhaust ports, and turn the crankshaft to make the oil uniformly adhere on the surfaces of the parts such as valves, cylinder liners and pistons.

4)、 Wipe away any oil, water traces and dust off the engine surfaces. Smear anticorrosion oil on the components which are not painted. Don't smear rubber and plastic parts.

5)、 Outlets of water pipes, intake and exhaust manifolds and muffler should be plugged by wood plugs or wrapped with plastic film.

6)、 The engine should be stored in a dry and clean place with good ventilation. It's prohibited to put chemicals near the engine.

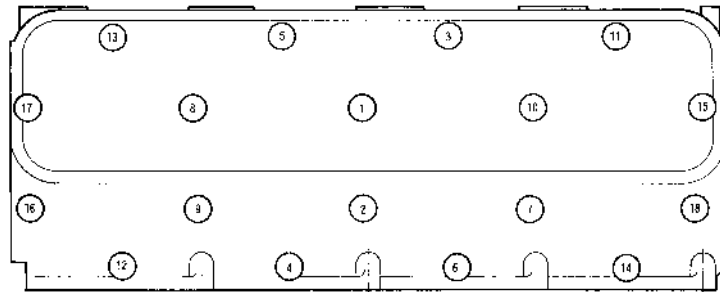
Note: In this way the engine can be well stored for three months. Beyond this period, the above procedures should be repeated.

# Chapter 4 Adjustment of the diesel engine

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4.2 Checking and Adjustment of Driving Belt .....	25
4.3 Notes about Thermostat .....	25
4.4 Adjustment of Starting Motor .....	26
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4.14 Adjustment of Injection Pump .....	29

## 4.1 Tightening Sequence of Cylinder Head Bolts

The cylinder head is fixed on the cylinder block with cylinder head bolts. When tightening these bolts, torque wrench should be used and the specified tightening torque value should be reached step by step following the tightening sequence shown in the figure. If the cylinder head has been dismantled and remounted, the engine should be shut down and the cylinder head bolts should be re-tightened to the specified tightening torque as well as the valve clearances should be re-adjusted after the engine is warmed up in its first running



## 4.2 Checking and Adjustment of Driving Belt

- 1)、 Check the whole belt and renew the broken belt.
- 2)、 Engine should work 15 minutes after the new belt is installed and then check the tightening of belt.
- 3)、 Driving belt should be kept under a certain tension status. Normally when exerting a force of 29~49N at the middle part of the belt a depressed distance not exceeding 10~15mm is recommended. Too tight belt will lead to excessive wear of bearings in generator, fan and water pump. Too loose belt will lead to drop of speeds of accessories. As a consequence, voltage from generator, air flow from fan and/or water flow from water pump will drop and normal function of the engine will be affected.
- 4)、 Adjust tension of belt:
  - Loosen two fixing bolts.
  - Turn the generator to the right or left to adjust the tension of belt until it reaches an appropriate value.
  - Tighten the two bolts.

## 4.3 Notes about Thermostat

▲ Note: it's prohibited to operate an engine without a thermostat.

When the temperature of the coolant through the thermostat reaches about 70°C, the thermostat valve should open, and it should fully open when the temperature reaches 85°C.

When checking the thermostat, if necessary, thermostat may be put into water and heat it up gradually, and then check the open temperature and fully open temperature of thermostat valve to see whether they are in the range specified above.

#### **4.4 Adjustment of Starting Motor**

The voltage of starting motor is 12v, power is 2.5kw. It is electro –magnetically controlled and mechanically driving. When starting an engine, put on the main switch and press down the start push button, and the engine will start to work. If it fails to start, wait till the starting pinion returns to its original position and stands still before trying the second time.

- 1、 Before using the starting motor, check the engine, starting system circuit and the charging situation of the battery.
- 2、 Normally, engine can start in just one attempt. The time used to start the engine each time should not exceed 10 seconds. The time interval between 2 consecutive tries should be longer than 1 minute. It's prohibited to restart the motor while the engine and motor are still moving, otherwise severe crash will happen between pinion and ring gear. After the engine start to work, loose the push button at once and let the pinion return to its original position.
- 3、 If the engine still fails to start after several attempts, do not try again before the trouble has been got rid of.

#### **4.5 Adjustment of Generator**

- 1、 Don't disconnect the wire from its terminal when the engine is running.
- 1、 Not be confused with the polarities.
- 2、 Use compressed air to clean out dust from inside the generator after long time operation.

#### **4.6 Expelling Air from Fuel System**

When the engine is working, air can enter the system under the following circumstances:

- 1、 Drain out fuel from the fuel tank when the engine is still working.
  - 2、 Low pressure fuel pipe or return pipe is broken or a joint hasn't been tightly fixed.
- Once the air enters the fuel system, it should be expelled before the engine begins to work.

Take steps as follows:

- 1、 Open vent plug of fuel filter, and operate the hand delivery pump till there is no air in the fuel flowing out the vent hole. Tighten the vent plug again.
- 2、 Open vent plug of injection pump, and operate the hand delivery pump till there is no air in the fuel flowing out the vent plug. Tighten the vent plug again.

#### **4.7 Maintenance of Air Filter**

- 1、 The intake air quality is closely related to the working environment and the size of air filter. If there is too much dust, relevant measurements should be taken.
- 2、 The maintenance periods should be adjusted according to the actual situation.
- 3、 Relevant detail clean method and maintenance periods should be taken according to the requirement of the vehicle.

## 4.8 Draining Out Coolant

**▲ Note:** the coolant should not be drained when the engine is still hot and the system is still pressurized. It's very dangerous to drain the coolant under high temperature and high pressure.

- 1、 Make sure that the vehicle or the machine is standing horizontally.
- 2、 Open the filling cap of the radiator.
- 3、 Put a container under the drain cock. Open the drain cock by the side of the cylinder block to drain out coolant.
- 4、 Open the drain plug at the radiator bottom to drain out water in the radiator. If the radiator does not have a drain plug, just dismantle the hose from the bottom of the radiator.
- 5、 Clean the cooling system with clean water.

## 4.9 Renew Spin-on Fuel Filter

- 1、 Clean the surface of the fuel filter.
- 2、 Loose drain device at the filter bottom. Drain water /fuel into a container.
- 3、 Dismantle the filter with special spanner shown or some other similar tools.
- 4、 Threaded adaptor should be tightly fixed with the filter cover. Be sure to keep the inside of filter clean.
- 5、 Smear the sealing of the new fuel filter with a little clean fuel. Tightly fix the new filter on to the filter cover.
- 6、 Expel the air in the fuel filter.



## 4.10 Renew Oil Filter

- 1、 Put a pan under the oil filter to collect the oil draining out.
- 2、 Dismantle the oil filter with special spanner or other similar tools. Make sure that the adaptor is tightly fixed in the filter cover.
- 3、 Clean the filter cover.
- 3、 Fill clean lubricating oil into the new filter.
- 4、 Smear the sealing of filter with clean lubricating oil.
- 5、 When installing the new filter, after turning tight by hand it can be further screwed in by only 3/4 turn. Much care should be taken when using the spanner to avoid damaging the sealing.
- 6、 Make sure there is lubricating oil in the oil sump.
- 7、 Operate the engine and check if there is leakage from the filter. After the engine stops for a while, check the oil level with the oil gauge, fill more lubricating oil if necessary.

## 4.11 Adjustment of Valve Clearances

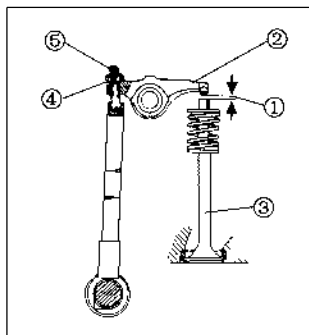
After repairing or technical maintenance, valve clearances of the engine should be checked and adjusted.

The method of adjusting valve clearances is as follows:

1、 Take off the cylinder head cover, check and fasten the bolts which hold the rocker bracket.

2、 Turn round the crankshaft until the first piston is at its top dead center when the mark at the observing window on the flywheel housing is just in line with the "0" mark on the flywheel, or the indicating pin on the gear housing cover is just pointing to the "0" mark on the V belt pulley.

3、 Measure the intake and exhaust valve clearances of the first cylinder with a feeler gauge. Adjust them to 0.35mm and 0.45mm respectively in cold state. Then turn the crankshaft for 180° CA to adjust the other cylinders' valve clearances.



Adjustment done as follows:

- Take off the cylinder head cover
- Shut down the engine and wait for 30 minutes before adjusting valve clearances.

Oil temperature should be below 80 °C.

- Using the feeler gauge to check the valve clearances between ② and ③.

Adjust the valve clearances in following steps:

- 1、 Loosen nut ④
- 2、 Turn bolt ⑤ with a screwdriver and tighten nut ④ to get correct valve clearances.
- 3、 Check and adjust other valve clearances.
- 4、 Install cylinder head cover

Adjust the valves marked ¥ in the table.

Cylinder Number	1		2		3		4	
	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake
Rocker Number	1	2	3	4	5	6	7	8
Compression TDC of No.1 Cylinder	¥	¥		¥	¥			

Cylinder Number	1		2		3		4	
	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake
Rocker Number	1	2	3	4	5	6	7	8
Compressing TDC of No.4 Cylinder			¥			¥	¥	¥



## **4.12 Adjustment of Injection Timing**

In order to get the lowest fuel consumption rate and good performance, it's necessary to adjust the injection timing.

The method of adjusting injection timing is as follows:

1、Release the air trapped in the fuel system. Repeatedly turn the crankshaft to and fro to fill up the injection pump with fuel. Dismantle No.1 high pressure pipe. Blow away the fuel in the delivery valve adapter. Slowly turn round the crankshaft clockwise and watch the fuel in the adaptor. Stop the crankshaft as soon as the first sign of the fuel moving up is discovered.

2、Check if the mark at the observing window on the flywheel housing or the indicating pin on the gear housing cover points to the right timing marks on the flywheel and V belt pulley respectively.

3、If the injection advancing angle is not right, loose three M8 nuts that fix the injection pump on the gear housing. Turn the injection pump off the cylinder block if the angle is too big or otherwise if too small.

## **4.13 Adjustment of Injector**

The test and adjustment of injector should be done on the test stand. The purpose is to adjust the injector pressure and watch the atomization quality and deal with the troubles.

The steps for the adjustment of injector:

1)Push the handle of the hand pump to raise the fuel pressure to 18MPa; Gradually push the handle to further raise to 20.3 to 20.8MPa; watch the nozzle tip to see if there is any fuel leakage or dripping. Check, wash, or lap the nozzle precision couple if necessary.

2)Take down injector screw cap, tighten or loosen adjusting screw to get the injector pressure to 20.3–20.8Mpa. Fix the screw cap and check again.

3)Watch the atomization quality. Do the atomization test at a speed of every 1 second each. The fuel atomization should be fine and even. No splashed fuel should be seen and uneven or deflected spray is not allowed. Clear cut sound should be heard when the injection stops. Generally, abnormal injection is caused by sluggish movement of the nozzle needle valve, fuel dripping is caused by damaging of sealing surfaces, branching of spray is caused by carbon deposit at nozzle tip or thermal deformation.

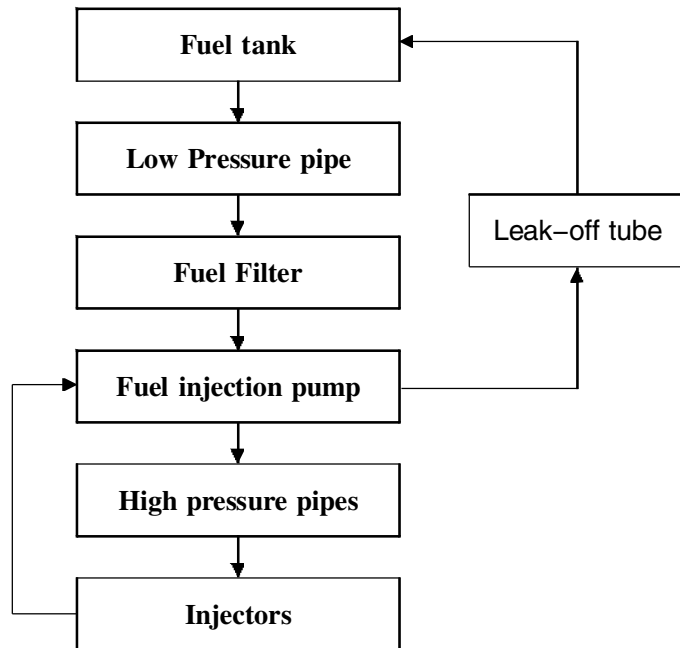
## **4.14 Adjustment of Injection Pump**

Injection pump has been checked and adjusted before being released off the line. If there is need to re-adjust, it should be done on a special testing machine by a professional mechanic.

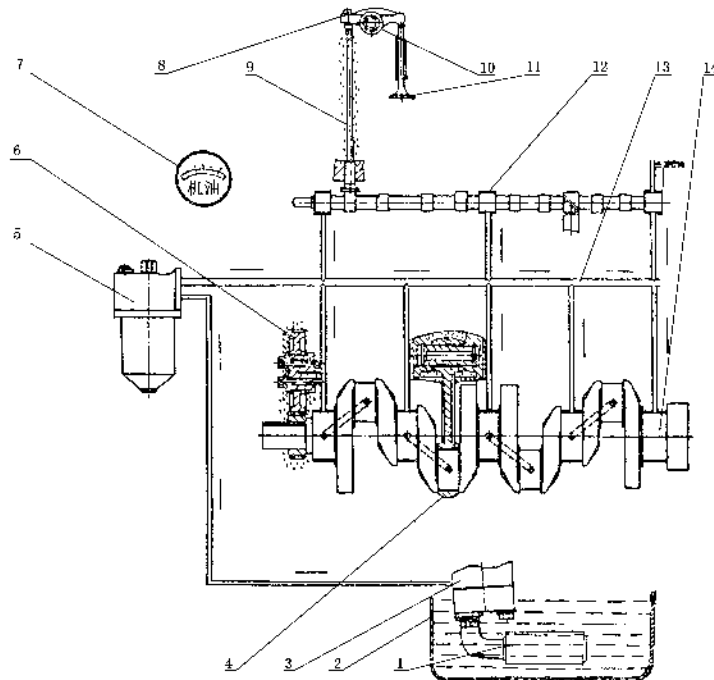
# Chapter 5 Sketch Maps for Five Main Systems of the Diesel Engine

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<b>5.5 Electrical System</b> .....	<b>34</b>

## 5.1 Fuel System

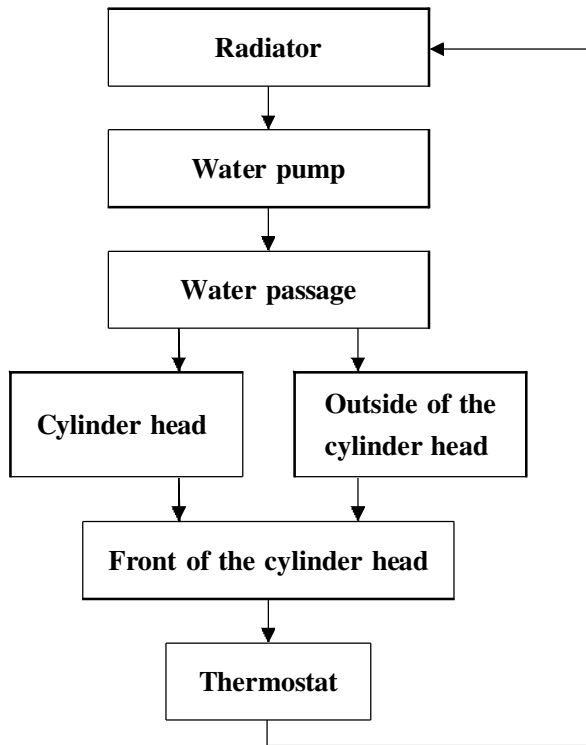


## 5.2 Lubricating System



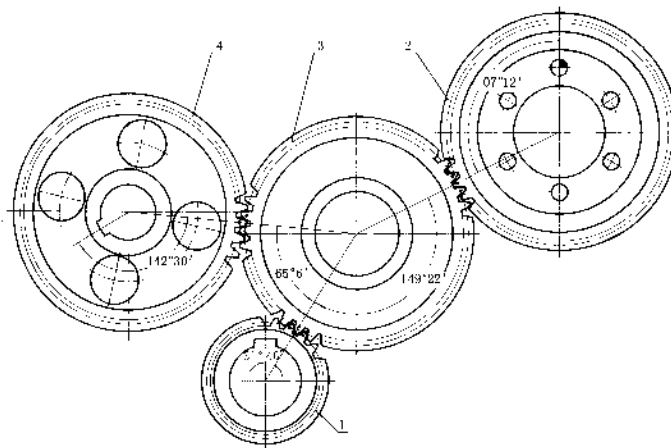
- 1-Strainer 2-Oil Sump 3-Oil Pump 4-Connecting Rod Bearings 5-Oil Filter  
 6-Gear Train 7-Oil Pressure Gauge 8-Valve Rocker Arms 9- Push Rods and Tappets  
 10- Valve Rocker Arm Shaft 11-Valves 12-Camshaft 13-Oil Galleries 14-Crankshaft

### 5.3 Cooling System



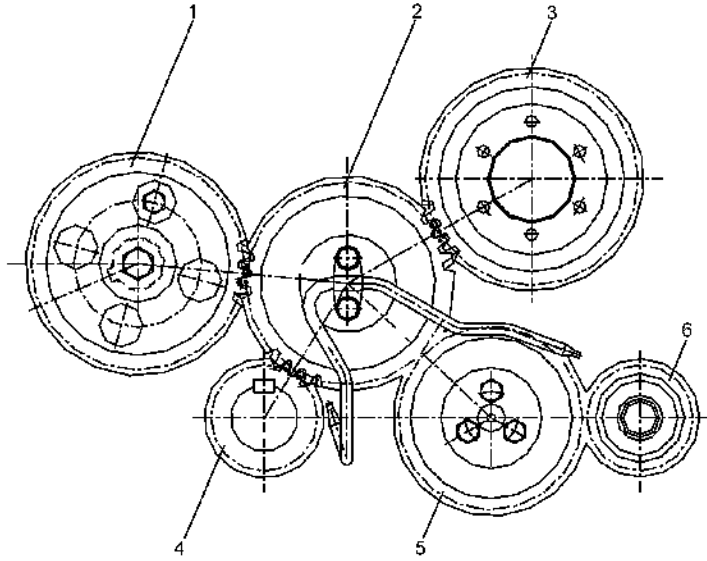
Flow chart of the cooling system

### 5.4 Gear Train System



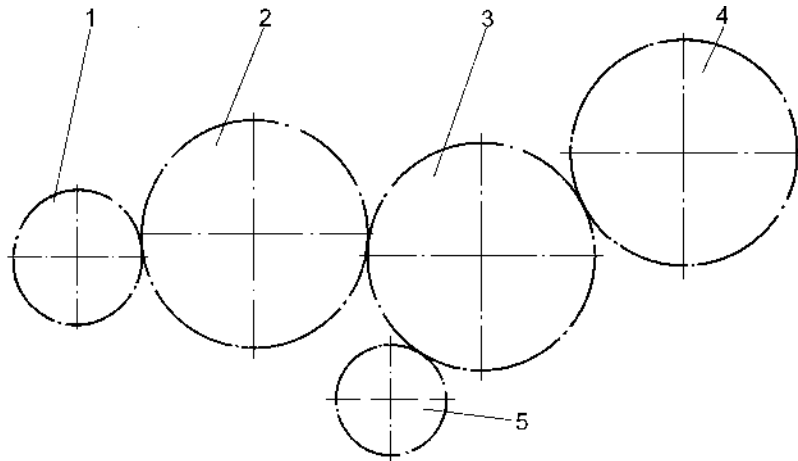
490B

- 1–Crankshaft timing gear
- 2–Injection pump timing gear
- 3–Timing idle gear
- 4–Camshaft timing gear



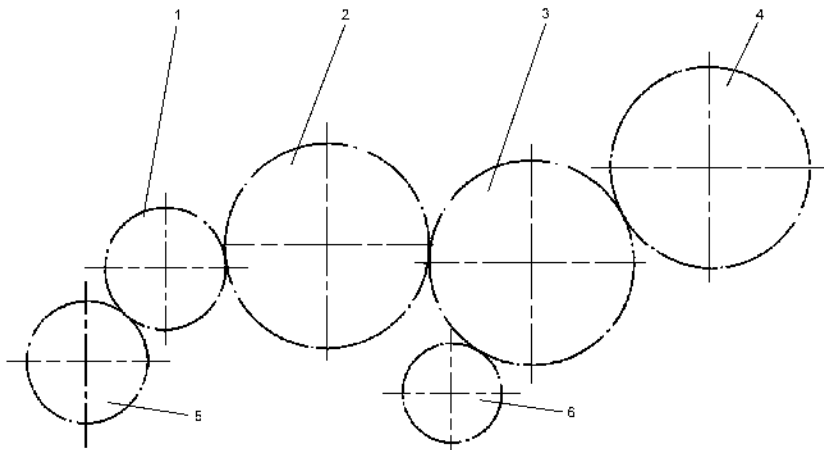
**490BPG、A490BPG、B490BPG、C490BPG**

- 1-Camshaft timing gear 2-Timing idle gear 3-Injection pump timing gear  
4-Crankshaft timing gear 5- Bridge gear 6-Hydraulic pump gear**



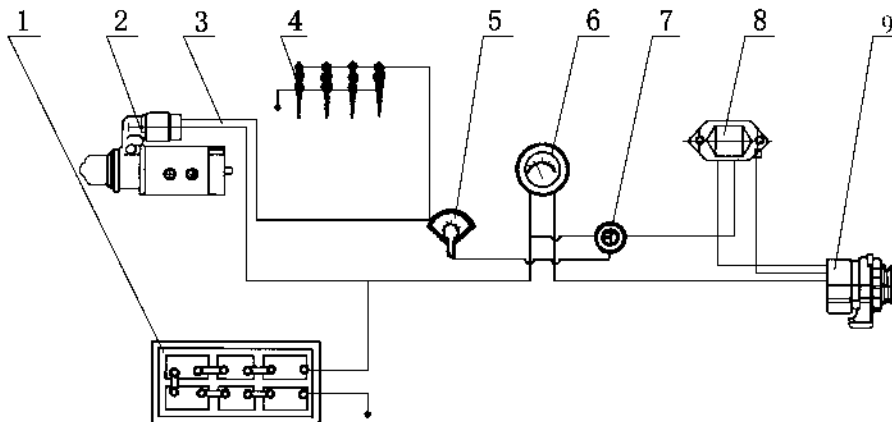
- 1- Hydraulic pump gear 2- Camshaft timing gear 3- Timing idle gear  
4- Injection pump timing gear 5- Crankshaft timing gear**

**490BT、B490BT、C490BT (Single Pump)**



1-Front hydraulic pump gear 2- Camshaft timing gear 3- Timing idle gear  
 4- Injection pump timing gear 5- Rear hydraulic pump gear 6- Crankshaft timing gear  
 490BT ,B490BT ,C490BT (Double Pump)

### 5.5 Electric System

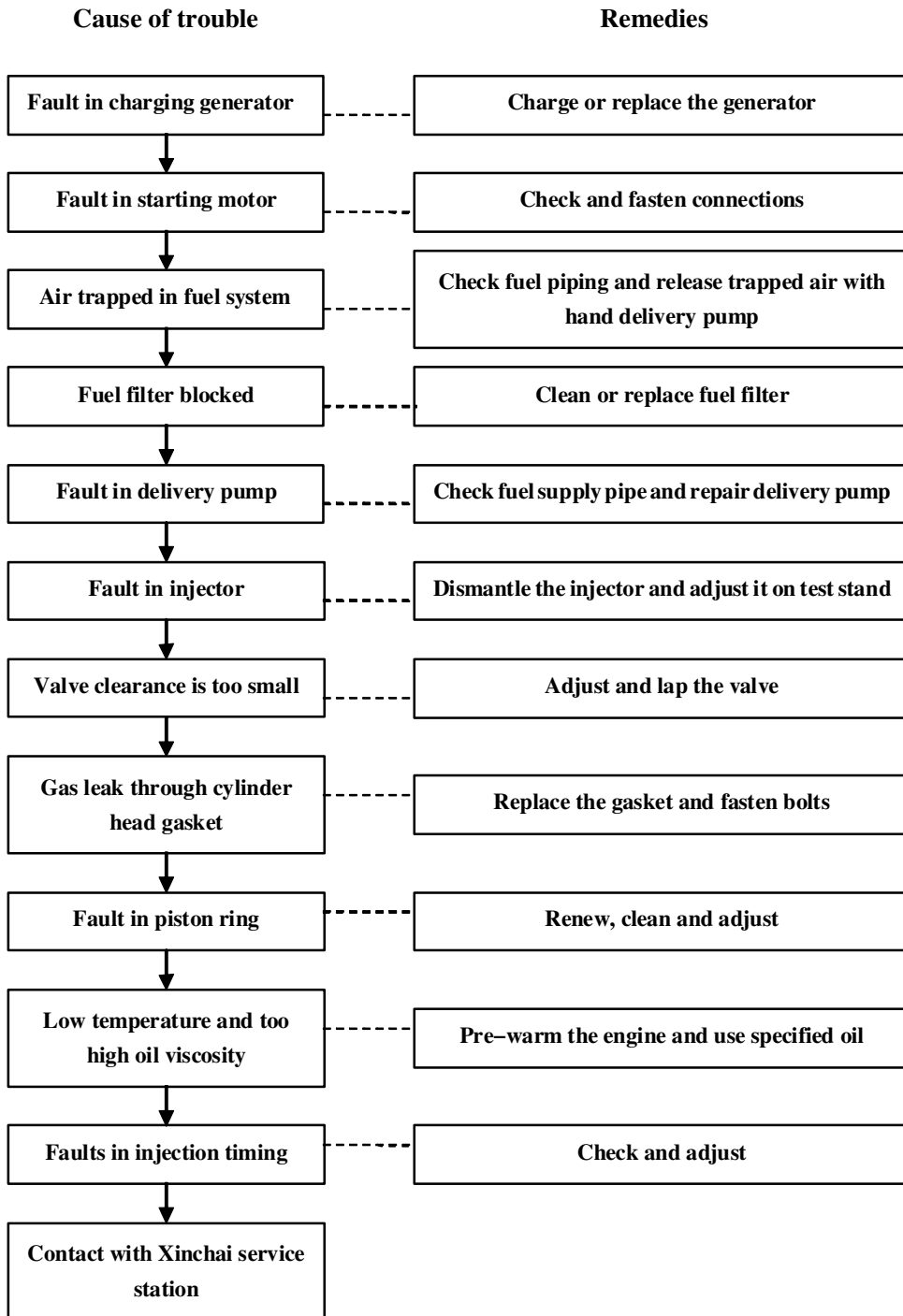


1-Battery 2-Starting Moor 3-Wire 4-Preheating Plugs 5-Starting and Preheating  
 Switch 6-Amperemeter 7-Main Switch 8-Regulator 9- Generator

# Chapter 6 Engine Trouble Shooting

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## 6.1 Engine fails to start

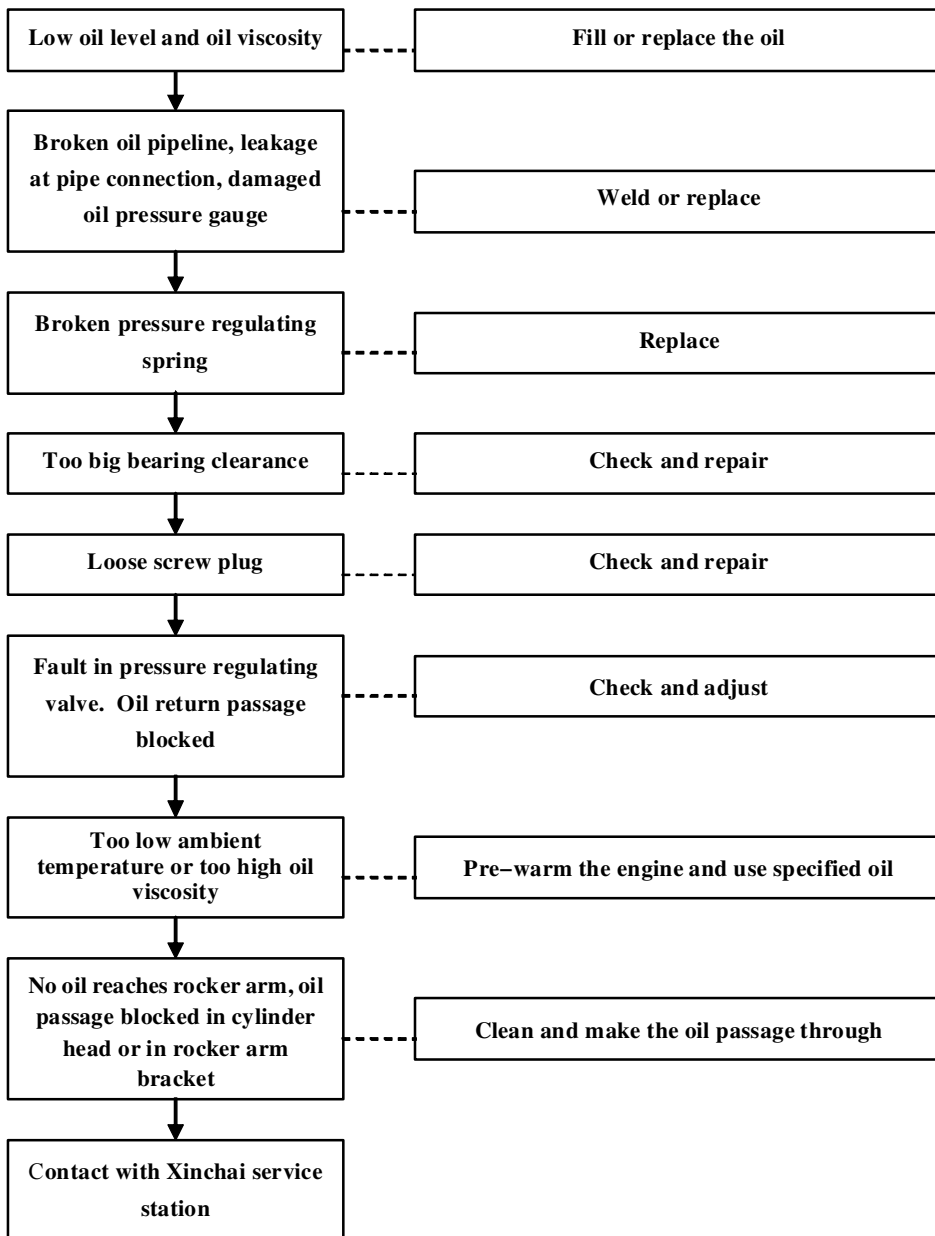




## 6.2 Abnormal oil pressure

Cause of trouble

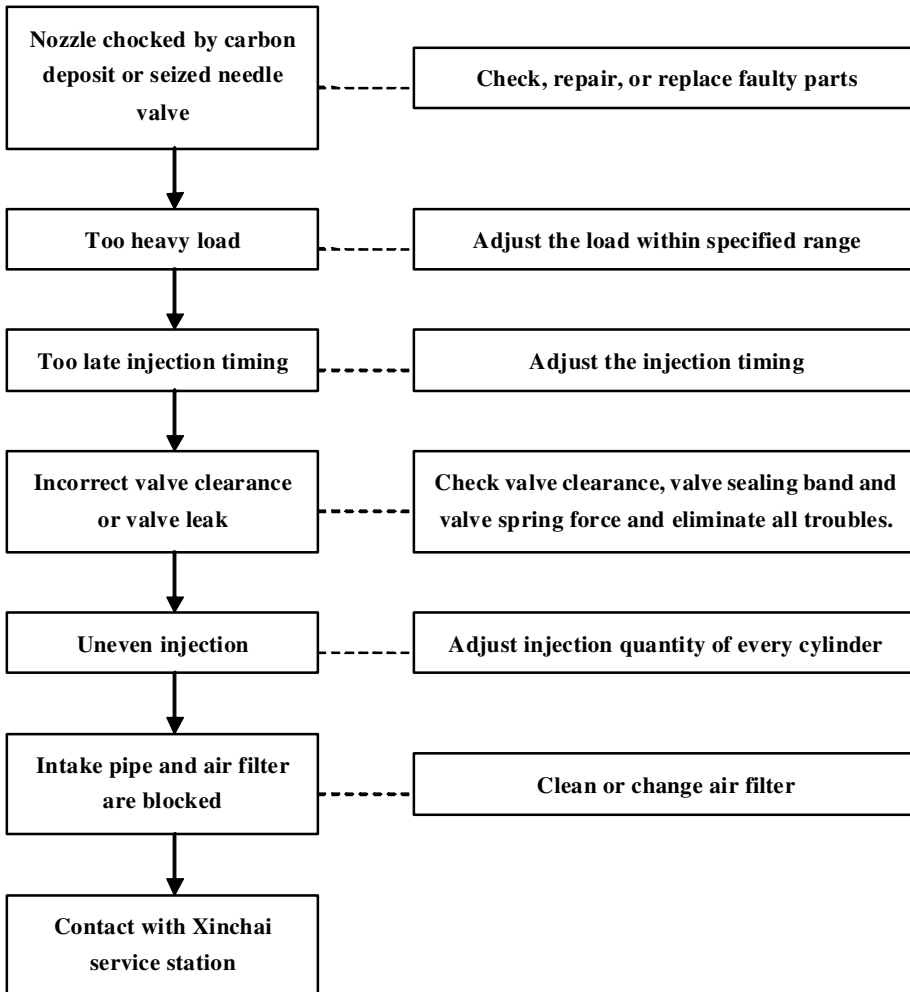
remedies



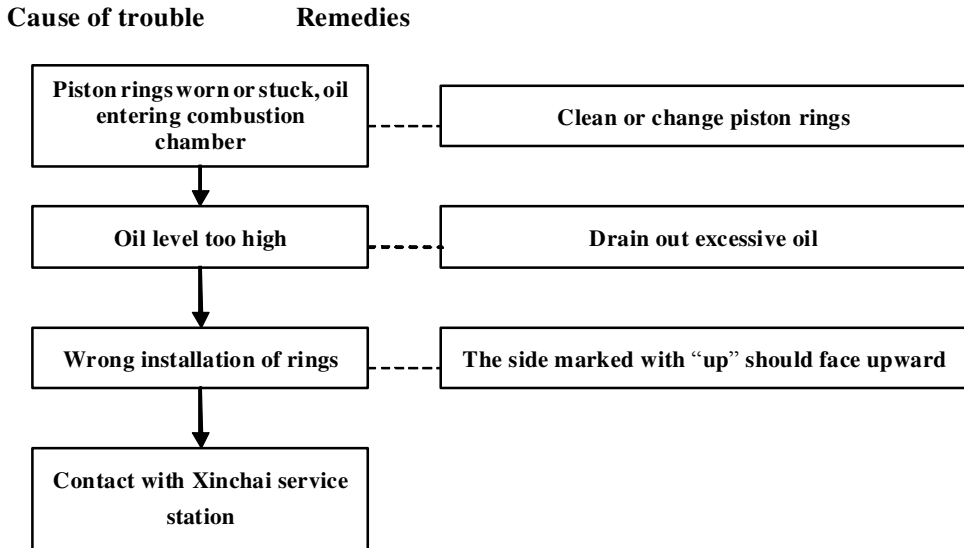
### 6.3 High exhaust smoke

#### Cause of trouble

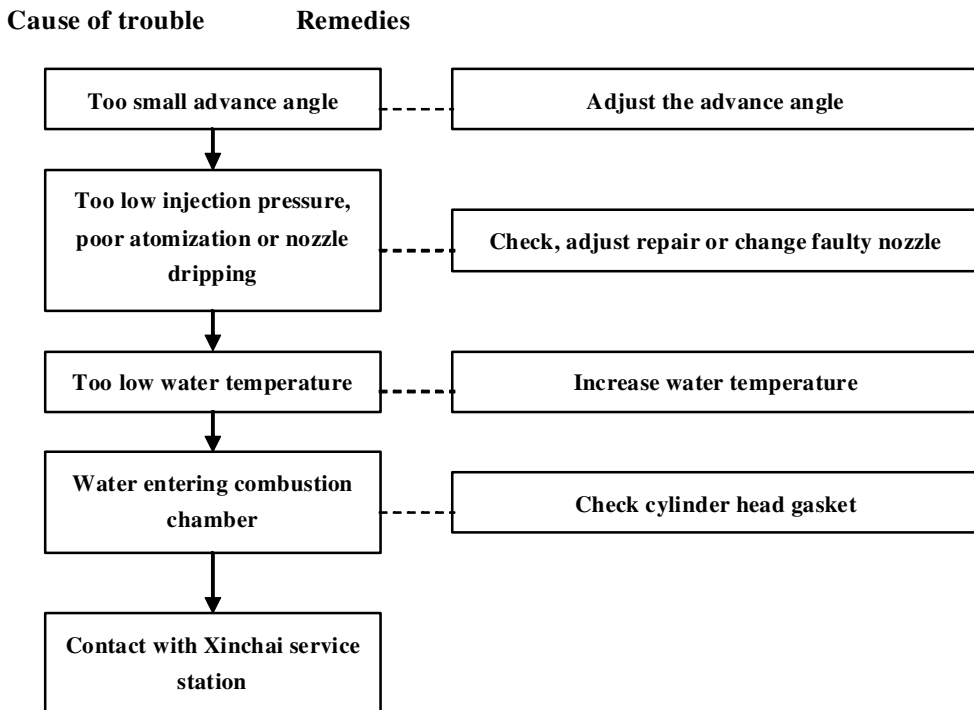
#### Remedies



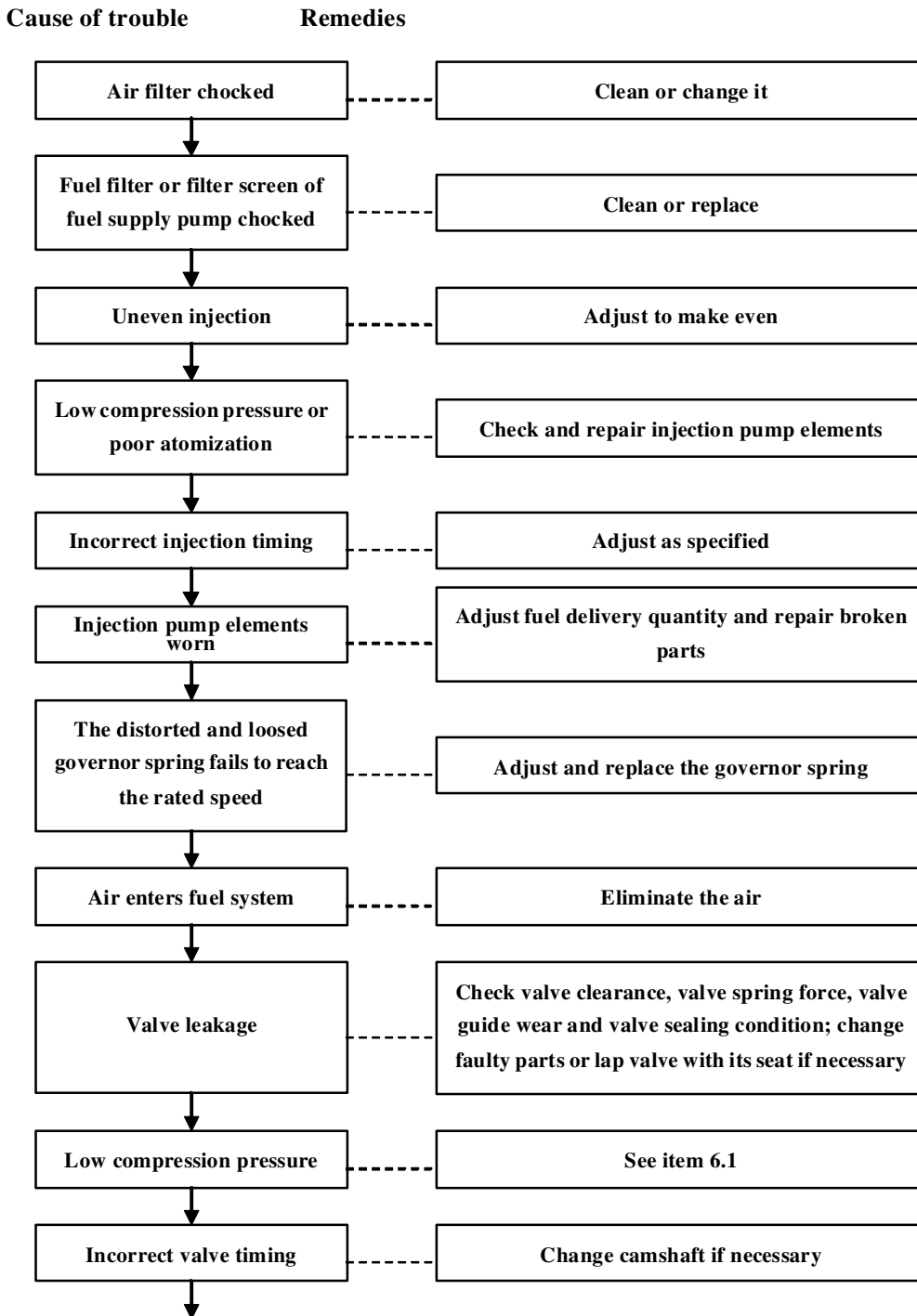
## 6.4 Blue Exhaust Smoke

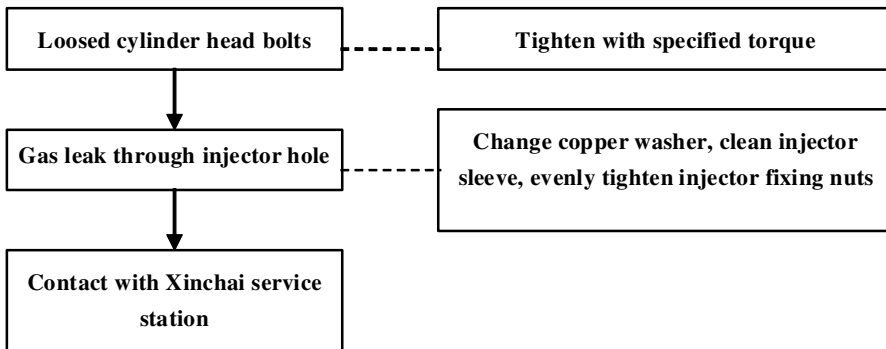


## 6.5 High white exhaust smoke



## 6.6 Insufficient power

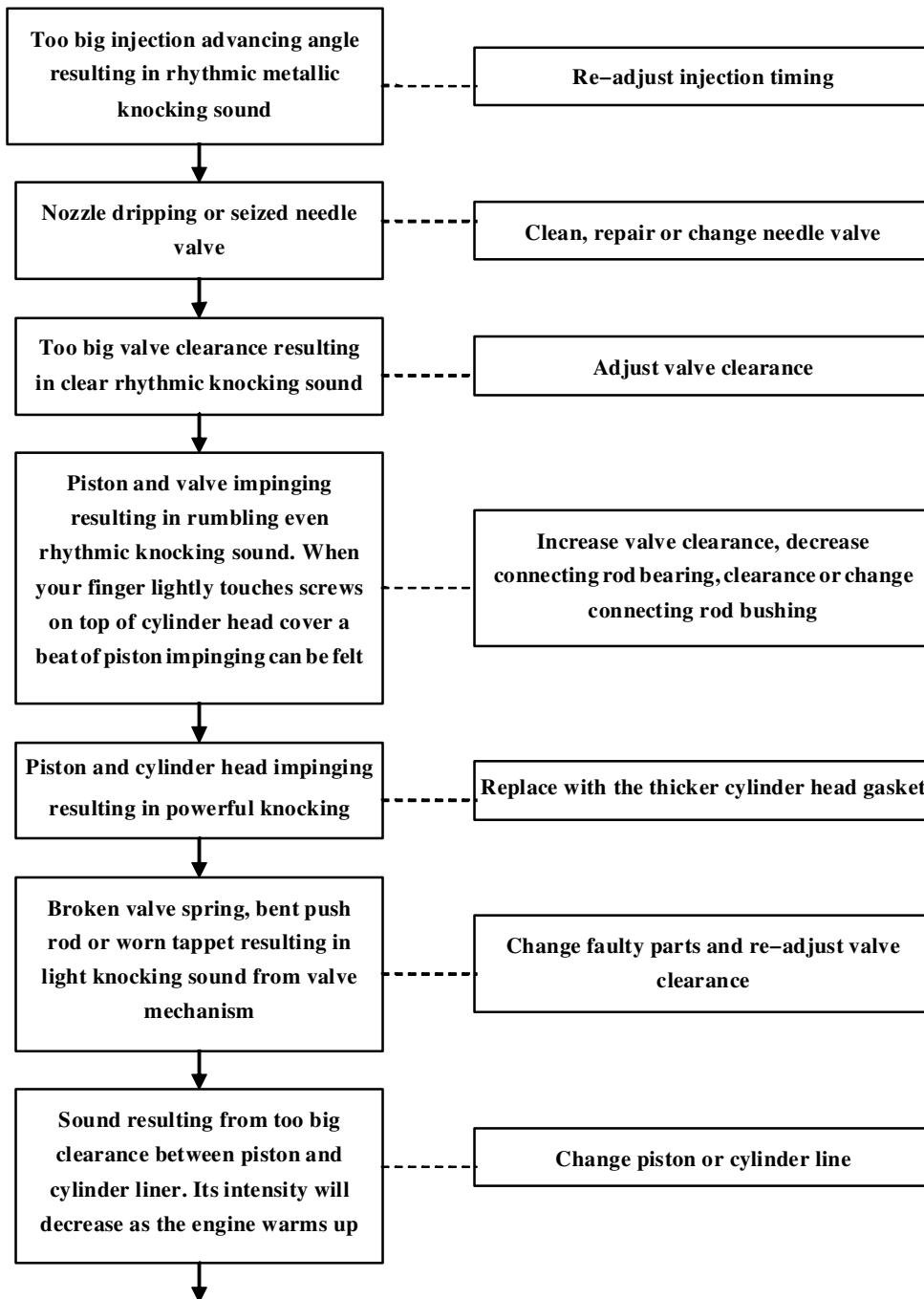


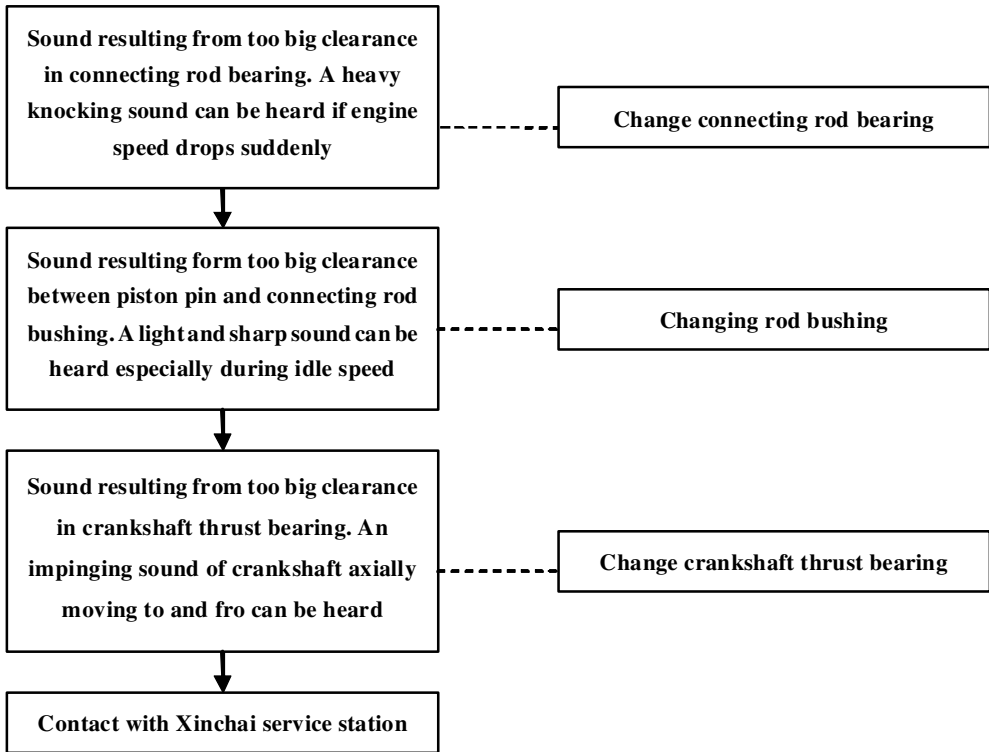


## 6.7 Abnormal noise

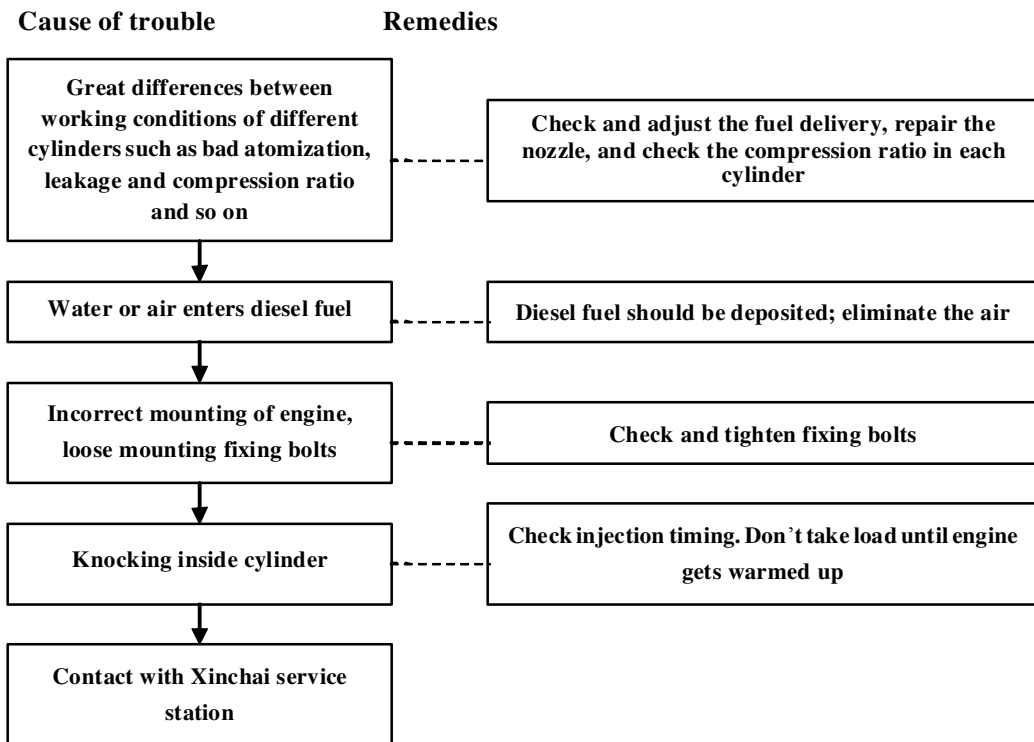
Cause of trouble

Remedies

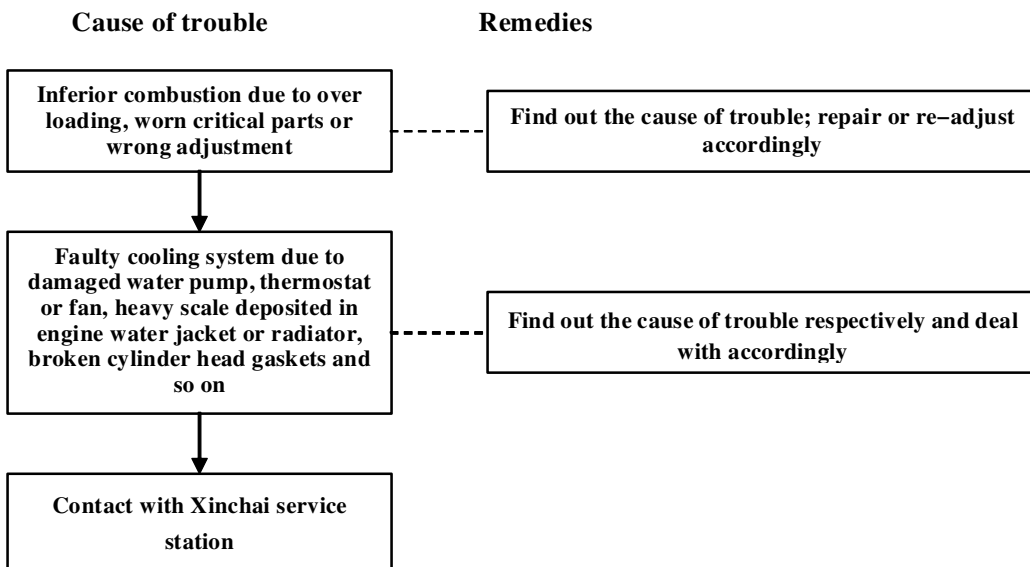




## 6.8 Severe Vibration



## 6.9 Engine over-heated

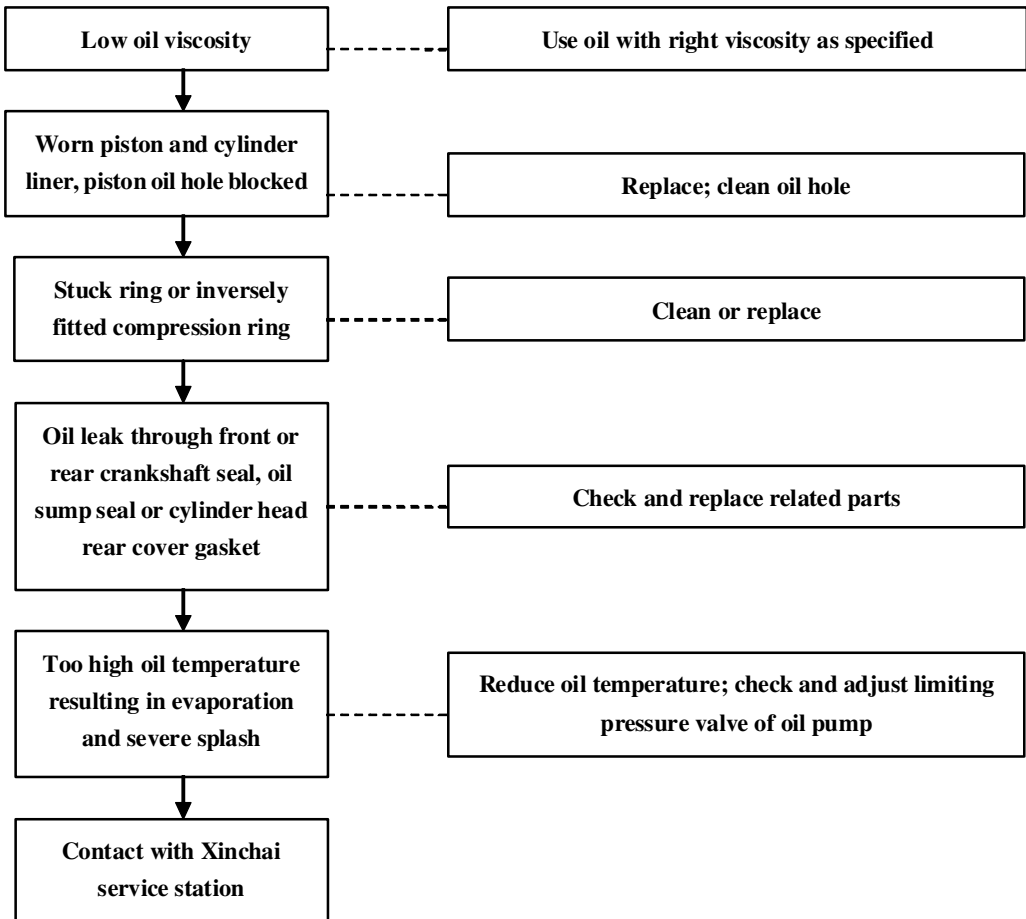




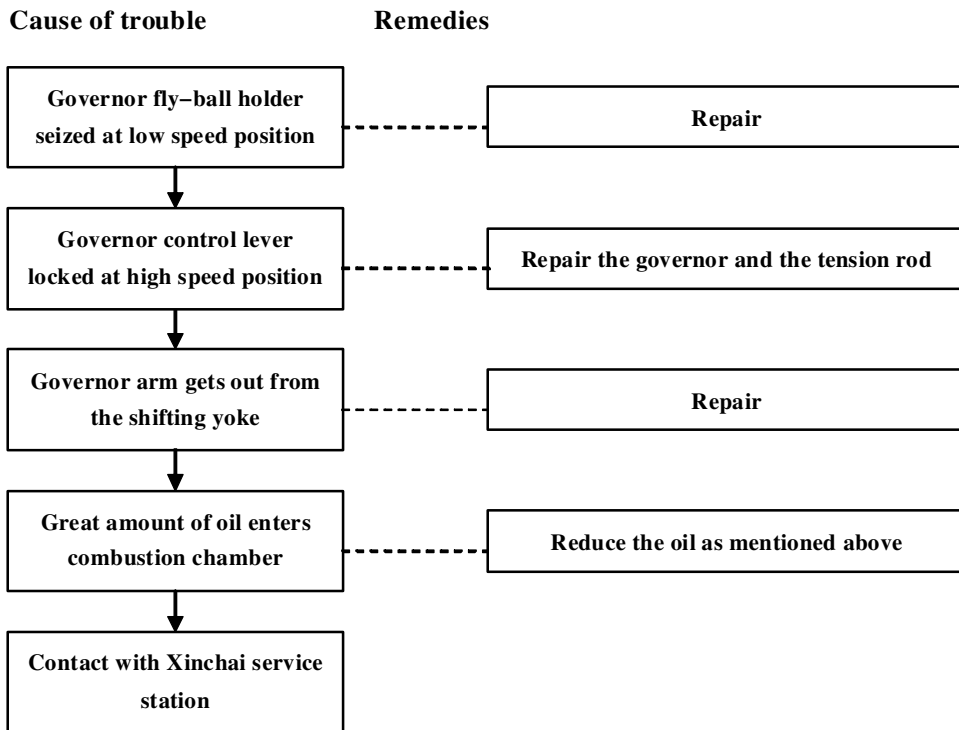
## 6.10 High oil consumption

### Cause of trouble

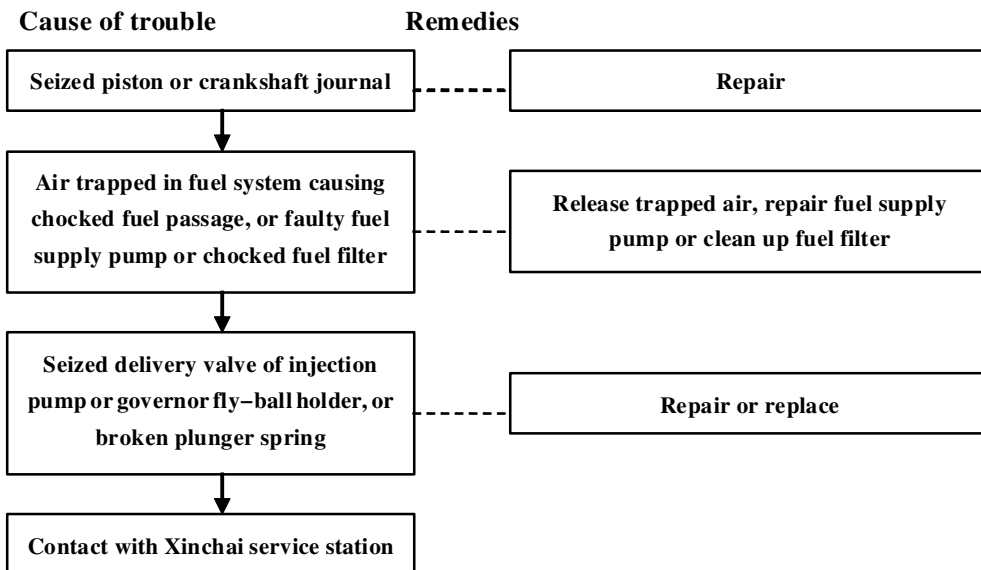
### Remedies



### 6.11 Speed going up out of control



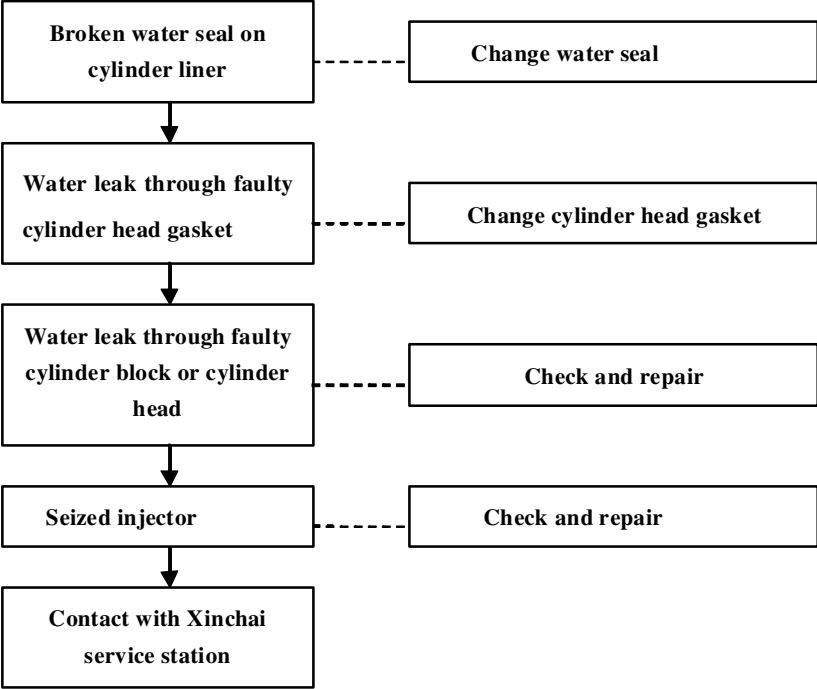
### 6.12 Engine shutting down automatically



### 6.13 Rising oil level

Cause of trouble

Remedies



## Appendix1 Special Parts List

### 490BPG

No.	Name	Part No.	Q' ty
1	Oil pipe	490BPG-02100	1
2	Bracket(right)	490BPG-15100	1
3	Bracket(lift)	490BPG-15200	1
4	Bracket(right)	490BPG-15100-1	4
5	Bracket(lift)	490BPG-15200-1	1
6	Pump timing gear	490BPG-02003	1
7	Timing idle gear	490BPG-02006	1
8	Crankshaft timing gear	490BPG-02007	2
9	Camshaft timing gear	490BPG-02009	1
10	Cover	490BPG-16001	1
11	Gasket	490BPG-16002	1
12	Timing gear housing	490BPG-16003	
13	Gasket	490BPG-16009	1
14	End plate	490BPG-82001	1
15	Screw	490BPG-82002	1
16	Washer	490BPG-82003	1
17	Bridge pear	490BPG-82004	6
18	Gear shaft	490BPG-52005	1
19	Snap plate	490BPG-82006	1
20	Hydraulic pump gear	490BPG-82007	1
21	Bearing cover	490BPG-82008	1
22	Gasket	490BPG-82009	1
23	Gasket	490BPG-82010	1
24	Connecting plate	490BPG-82011	1
25	Gasket	490BPG-82012	1
26	End cap	490BPG-82013	1
27	Adjusting screw	490BPG-82014	1

**490BT**

<b>No.</b>	<b>Name</b>	<b>Part No.</b>	<b>Q' ty</b>
1	Charging generator	490BT-52000	1
2	Fixing bracket	490BT-03300	1
3	Oil dipstick pipe	490BT-07300	1
4	Bolt	490BT-07800	4
5	Injector leak-off pipe	490BT-25100	1
6	Fuel tube from filter cup to supply pump and injection pump	490BT-25400	1
7	Adjusting lever for generator	490BT-53100	1
8	Camshaft bushing	490BT-01007	2
9	Rear camshaft bushing	490BT-01008	1
10	Water pipe	490BT-01011	1
11	Timing idle gear	490BT-02006	1
12	Timing gear for crankshaft	490BT-02007	1
13	Camshaft timing gear	490BT-02009	1
14	Hydraulic pump gear	490BT-02010	1
15	Shaft sleeve	490BT-02015	1
16	Flywheel bolt	490BT-05002	6
17	V-belt	490BT-05006	1
18	Flywheel	490BT-05101A	1
19	Flywheel bearing retainer	490BT-05120	1
20	Camshaft	490BT-06001	1
21	Oil sump gasket	490BT-07002A	1
22	Oil sump bottom plate	490BT-07003	1

23	Oil sump gasket	490BT-07004	1
24	Main oil sump	490BT-07106	1
25	Gasket	490BT-07302	1
26	Elbow	490BT-08003	1
27	Intake pipe	490BT-09002	1
28	Intake manifold gasket	490BT-09004	1
29	Flywheel housing	490BT-13001	1
30	Flywheel housing gasket	490BT-13002	1
31	Flywheel housing plug screw	490BT-13008	1
32	Side bracket	490BT-15001	1(pair)
33	Cover	490BT-16001A	1
34	Gasket	490BT-16002	1
35	Gear housing	490BT-16003	1
36	gasket	490BT-16005	1
37	Gasket	490BT-16013	1
38	End cap	490BT-16014	1
39	Bearing seat	490BT-16015	1
40	Air compressor plate	490BT-16016	1
41	Back plate	490BT-42006	1
42	Adapter	490BT-42010	1
43	Gasket	490BT-42011	1
44	Thermostat cover	490BT-43001	1
45	Generator bracket	490BT-53002	1

**A490BPG**

<b>No.</b>	<b>Name</b>	<b>Part No.</b>
<b>1</b>	<b>Cylinder head</b>	<b>A490B-03101</b>
<b>2</b>	<b>Press plate</b>	<b>A490B-03016</b>
<b>3</b>	<b>WasherM10</b>	<b>GB/T849-1988</b>
<b>4</b>	<b>Oil seal</b>	<b>498B-03016</b>
<b>5</b>	<b>Sleeve tube</b>	<b>A490B-03109</b>
<b>6</b>	<b>Piston</b>	<b>A490B-04001</b>
<b>7</b>	<b>Cylinder head cover</b>	<b>A498B-11001</b>
<b>8</b>	<b>Rubber pad</b>	<b>A498B-11002</b>
<b>9</b>	<b>Stud M10 50</b>	<b>GB/T899-1988</b>
<b>10</b>	<b>Injector lead-off pipe</b>	<b>A490B-25100</b>
<b>11</b>	<b>Cylinder high pressure fuel tube</b>	<b>A490B-23000</b>
<b>12</b>	<b>Fuel injector</b>	<b>F019103006</b>
<b>13</b>	<b>Copper pad (2mm)</b>	<b>A490B-22001</b>
<b>14</b>	<b>Fuel injection pump</b>	<b>4QT72Z</b>
<b>15</b>	<b>Leak proof cap</b>	<b>498B-25001</b>
<b>16</b>	<b>Sebific duct</b>	<b>498B-25002</b>

**B490B**

No.	Name	Part No.	Q' ty
1	Cylinder body	B490B-01001	1
2	Cylinder liner	B490B-01005	4
3	Piston	B490B-04001	4
4	Crankshaft	B490B-05004	1
5	Push rod	B490B-06003	8
6	Main bearing cover	495B-01032A	4
7	Rear main bearing cover	495B-01023A	1
8	Upper thrust bushing	495B-01026A	2
9	Lower thrust bushing	495B-01022A	2
10	Upper half ,main bearing	495B-01034A	5
11	Lower half ,main bearing	495B-01033A	5

**C490B**

No.	Name	Part No.	Q' ty
1	Piston	XC4D27-04001	4
2	Cylinder head cover	A498B-11001	1
3	Rubber pad	A498B-11002	1
4	Fuel injection pump	4QT72BZ	1



## Appendix2 Specification of Main Auxiliaries

<b>Lubricating Oil Pump</b> <b>Rotor</b> <b>Flow Rate L/min</b>	<b>JBZ5040</b> <b>29 ( 1500r/min )</b>	<b>Starting Motor</b> <b>Model</b> <b>Power kW</b> <b>Voltage V</b>	<b>QDJ1315X</b> <b>2.5</b> <b>12</b>
<b>Injection Pump</b>	<b>BQ</b> <b>4Q130T/41W247A</b>	<b>Charging Generator</b> <b>Model</b> <b>Power kW</b> <b>Voltage V</b>	<b>JF131A/JF11A</b> <b>350</b> <b>14</b>
<b>Injector</b> <b>Nozzle Hole Diameter</b> <b>mm</b> <b>Opening      Pressure</b> <b>Mpa</b>	<b>PF68S4</b>  <b>0.28</b> <b>20-21</b>	  <b>Fuel filter</b>	  <b>CX7085</b>
<b>Water Pump</b> <b>Model</b> <b>Flow Rate L/min</b>	<b>Centrifugal</b> <b>130 ( 3000r/min )</b>	<b>Oil Filter</b>	<b>JX85100-C</b>

### Special Parts For C490B

<b>Injection Pump</b>	<b>BH4QT90R9</b>	<b>Starting Motor</b> <b>Model</b> <b>Power kW</b> <b>Voltage V</b>	<b>QDJ1309-K</b> <b>2.5</b> <b>12</b>
<b>Injector</b> <b>Nozzle Hole Diameter</b> <b>mm</b> <b>Opening      Pressure</b> <b>Mpa</b>	<b>KBAL-P001F</b>  <b>0.25</b> <b>20.3-20.8</b>	<b>Charging Generator</b> <b>Model</b> <b>Power kW</b> <b>Voltage V</b>	<b>JF131A/JF11A</b> <b>350</b> <b>14</b>

### Appendix 3 Outsourcing Parts list

No.	Part	Manufacturer
1	piston ring	YIZHENG SHUANG HUAN PISTON RING CO.,LTD NANJING FEIYAN PISTON RING CO.,LTD
2	piston	SHANDONG BINZHOU BOHAI PISTON CO.,LTD
3	main bearing, connecting rod bearing	HANGZHOU XINDA SLIDING BEARING CO.,LTD. SHIJIAZHUANG DIAMONDBUSH BEARING CO.,LTD
4	intake and exhaust valve	HANGZHOU VALVE CO.,LTD
5	cylinder liner	HENAN ZHONGYUAN ENGINE FITTINGS STOCS CO.,LTD
6	cylinder head gasket	HANGZHOU CYLINDER PAD CO.,LTD ZIANGSHAN CYLINDER PAD CO.,TD
7	front and rear oil seals of crankshaft	SHANGHAI SHEEN FLUOROPLASTIC SEALS CO.,LTD
8	main bearing , cylinder head, connecting rod bolts	TAIZHOU HUADA MACHINE CO.,LTD
9	camshaft bushing	ANHUI WUHU XINDA POWDERMTALLURGY CO.,LTD
10	injector	WEIFU HIGH-TECHNOLOGY CO.,LTD
11	oil filter	SHANGHAI RIXIN AUTOMOBILE FITTING MANUFACTURE CO.,LTD
12	Fuel filter	SHANGHAI RIXIN AUTOMOBILE FITTING MANUFACTURE CO.,LTD



