

# OPERATION INSTRUCTIONS



4102

4105

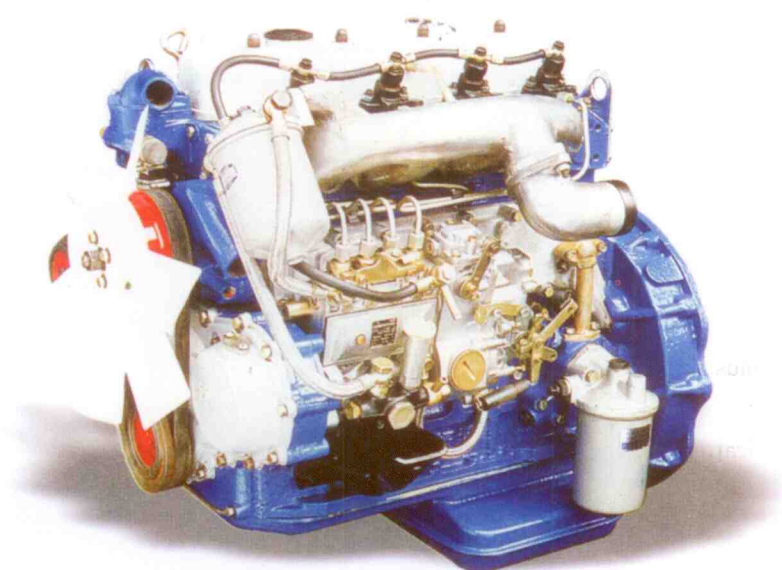
DIESEL ENGINES

# CONTENTS

|  |           |
|--|-----------|
| YZ4102Q1 Engine Full Load Performance                |           |
| YZ4102QB Engine Full Load Performance                |           |
| YZ4102QF Engine Full Load Performance                |           |
| YZ4105QF Engine Full Load Performance                |           |
| <b>Section I Main Specifications and Engine Data</b> | <b>1</b>  |
| 1. Specifications of the Engines                     | 1         |
| 2. Specifications of Main Components                 | 2         |
| 3. Main Data of Engine Operation                     | 3         |
| <b>Section II Running - in of the Engine</b>         | <b>5</b>  |
| 1. Preparations for Running - in                     | 5         |
| 2. Running - in Schedule                             | 5         |
| 3. Inspection after Running - in                     | 5         |
| <b>Section III Operation of the Engine</b>           | <b>7</b>  |
| 1. Fuel, Lubricating Oil and Cooling Water           | 7         |
| 2. Preparations for Starting                         | 7         |
| 3. Starting the Engine                               | 8         |
| 4. Operating the Engine                              | 9         |
| 5. Stopping the Engine                               | 9         |
| <b>Section IV Specialized Description</b>            | <b>10</b> |
| 1. Cylinder Head                                     | 10        |
| 2. Cylinder Block                                    | 11        |
| 3. Valve System                                      | 13        |
| 4. Crank - Connecting Rod Mechanism                  | 13        |
| 5. Fuel and Air Supply System                        | 14        |
| 6. Lubricating System                                | 16        |
| 7. Cooling System                                    | 17        |
| 8. Electrical System                                 | 17        |
| 9. Vacuum Pump                                       | 17        |
| <b>Section V Adjustment of the Engine</b>            | <b>19</b> |
| 1. Adjustment of Valve Clearances                    | 19        |
| 2. Adjustment of Fuel Delivery Advance Angle         | 20        |
| 3. Adjustment of Fuel Injection Starting Pressure    | 20        |
| 4. Adjustment of V - belt Tension                    | 20        |

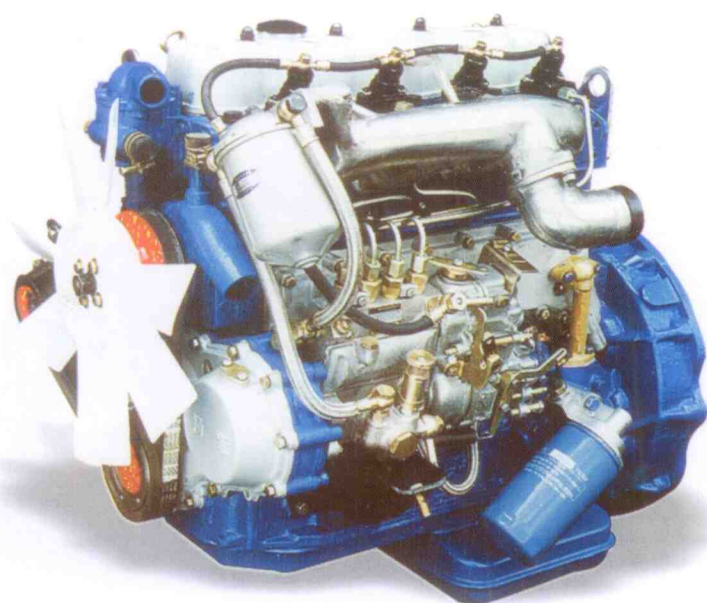
|  |           |
|--|-----------|
| 5. Adjustment of Lubricating Oil Pressure .....                                | 21        |
| <b>Section VI Technical Maintenance .....</b>                                  | <b>22</b> |
| 1. Shift Maintenance .....   | 22        |
| 2. Maintenance at the Completion of Every 125 hours or 1500 to 2000km .....    | 22        |
| 3. Maintenance at the Completion of Every 500 hours or 6000 to 8000km .....    | 22        |
| 4. Maintenance at the Completion of Every 1000 hours or 18000 to 24000km ..... | 23        |
| <b>Section VII Trouble Shooting .....</b>                                      | <b>24</b> |
| 1. Failure to Start .....  | 24        |
| 2. Lack of Power .....   | 25        |
| 3. Insufficient Compression Pressure in Cylinder .....                         | 26        |
| 4. Engine Stalls .....   | 27        |
| 5. Abnormal Noise .....  | 27        |
| 6. Black Exhaust .....   | 28        |
| 7. Overheat .....  | 29        |
| 8. Low Lubricating Oil Pressure .....  | 30        |
| 9. Excessive Oil Consumption .....   | 31        |
| 10. Degradation of Lubricating Oil .....                                       | 31        |
| 11. Trouble Shooting in Electrical System .....                                | 32        |
| 12. Trouble Shooting on Vacuum Pump .....                                      | 33        |
| <b>Appendix I Spare Parts of Diesel Engine 4102 .....</b>                      | <b>34</b> |
| <b>Appendix II Spare Parts of Diesel Engine 4105 .....</b>                     | <b>35</b> |
| <b>Appendix III Fits and Wear Limits of Diesel Engines 4102 and 4105 .....</b> | <b>36</b> |





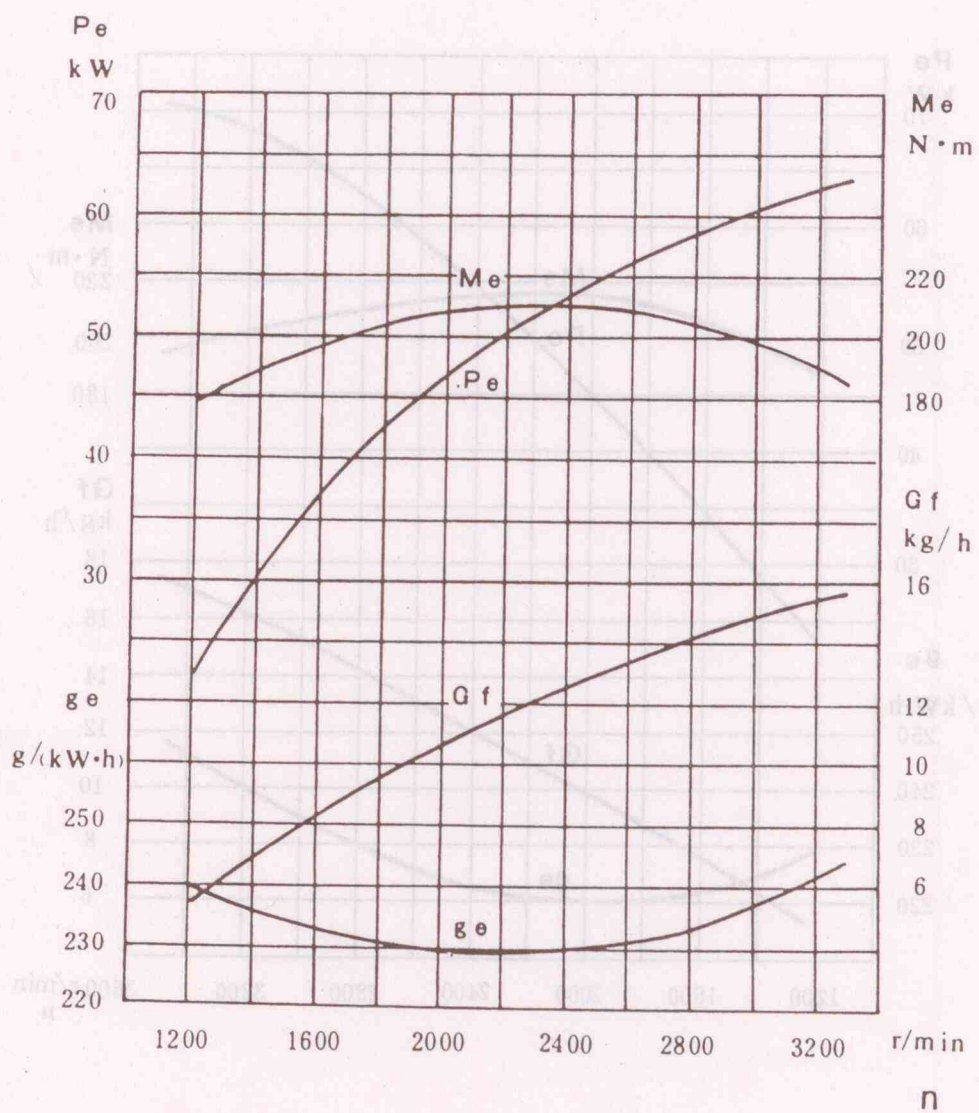
# 4102 DIESEL ENGINE



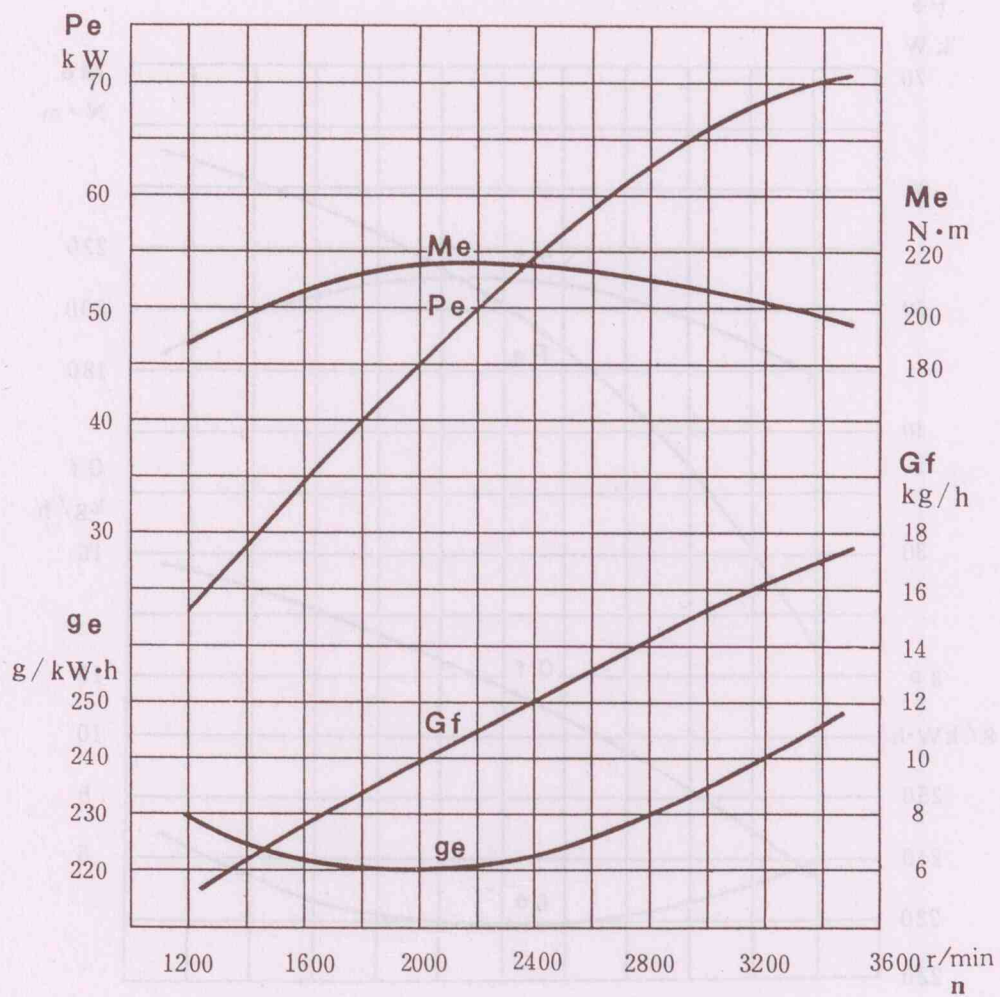


# 4105 DIESEL ENGINE

# YZ4102Q1 Engine Full Load Performance

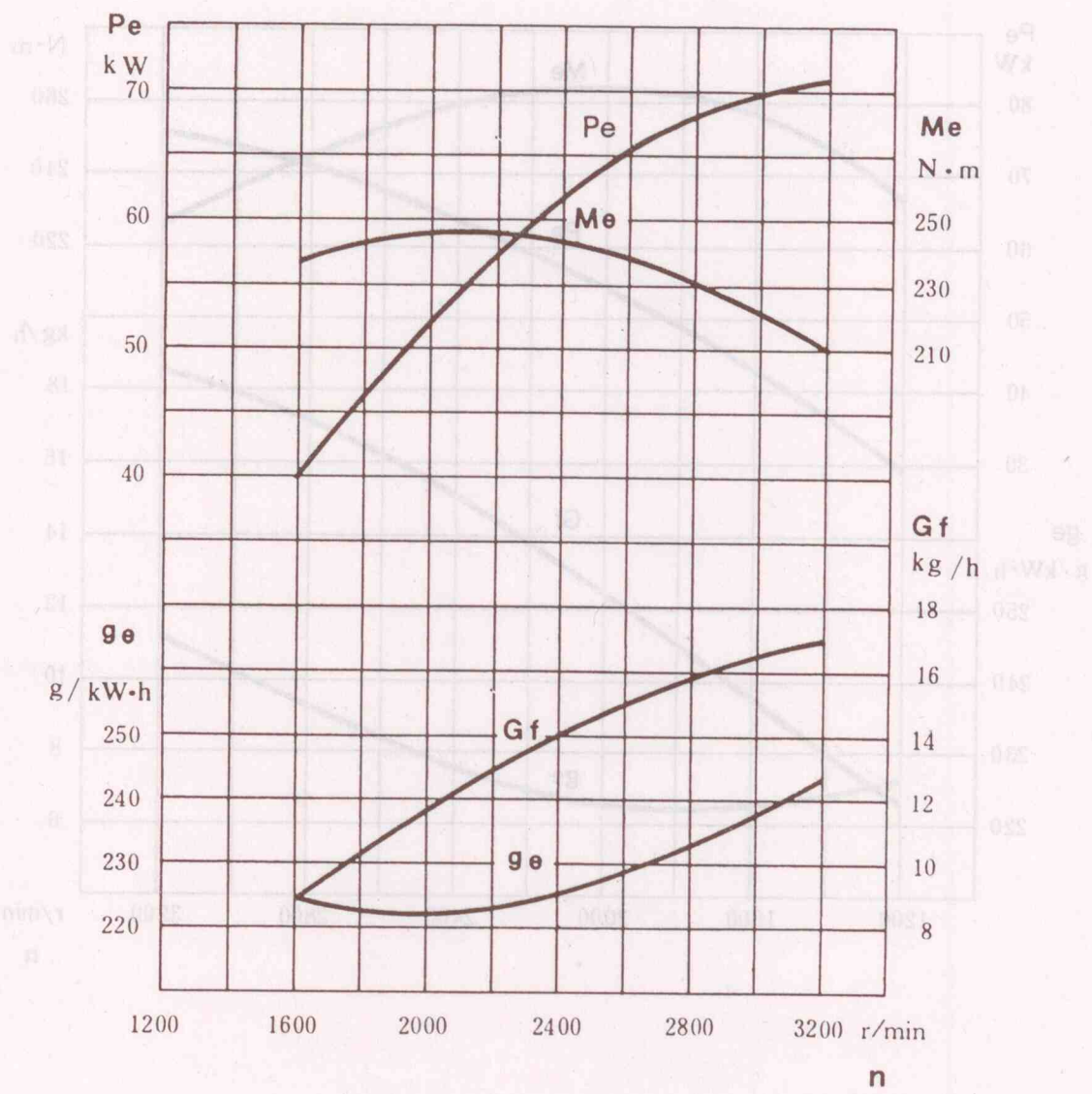


### YZ4102QB Engine Full Load Performance

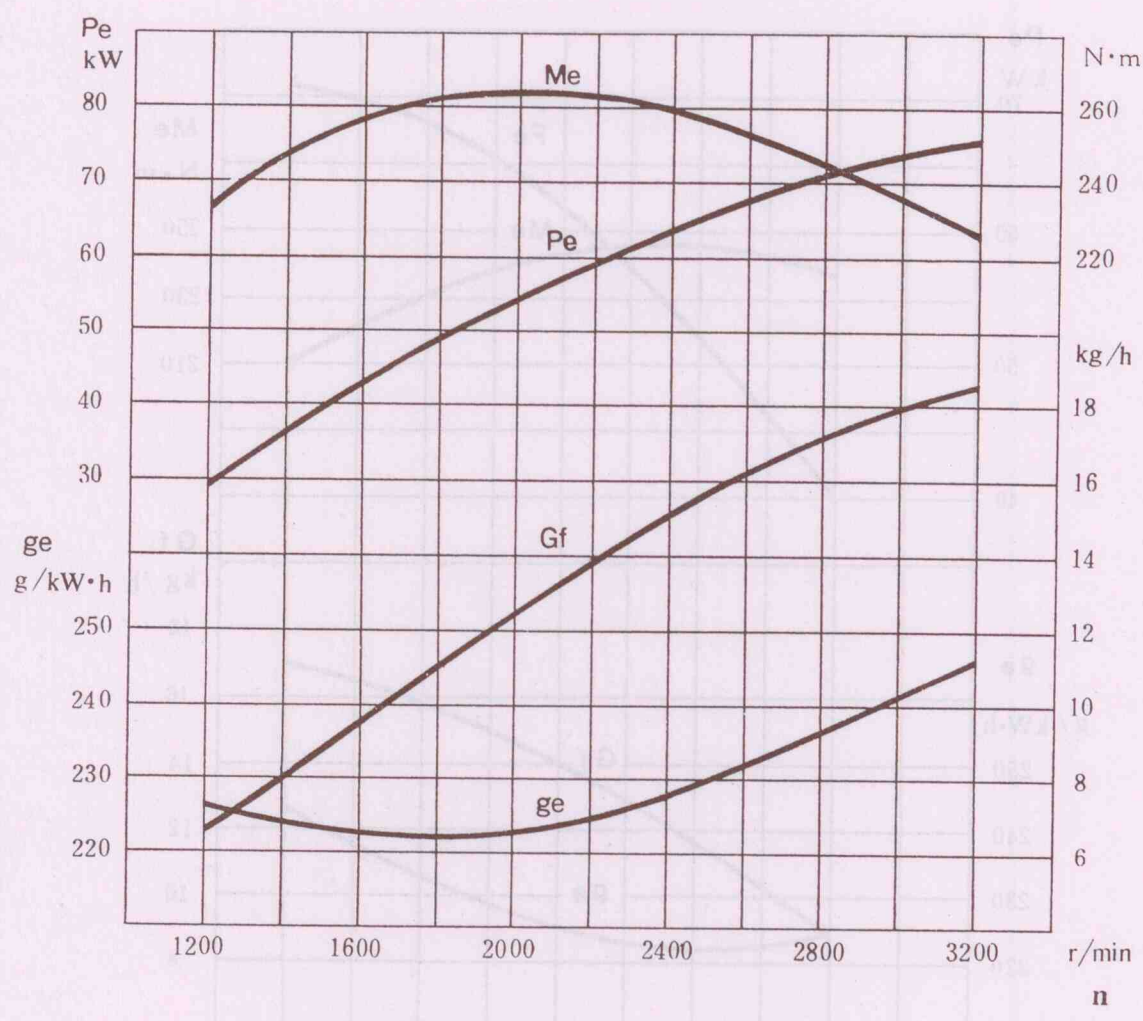




YZ4102QF Engine Full Load Performance



YZ4105QF Engine Full Load Performance



## Section I Main Specifications and Engine Data

### 1. Specifications of the Engines

| Model  |      | YZ4102Q1                            | YZ4102QB | YZ4102QF  | YZ4105QF |
|--|------|-------------------------------------|----------|-----------|----------|
| Type   |      | Water - cooled, vertical, in - line |          |           |          |
| Nos of cylinder  |      | 4                                   |          |           |          |
| Bore   | (mm) | 102                                 | 102      | 102       | 105      |
| Stroke   | (mm) | 105                                 | 105      | 118       | 118      |
| Type of combustion chamber                               |      | Direct injection chamber            |          |           |          |
| Compression ratio  |      | 17 : 1                              |          |           |          |
| Total displacement ( l )                                 |      | 3.432                               | 3.432    | 3.857     | 4.087    |
| Rated output/Speed (kW/r. p. m. )                        |      | 63/3300                             | 70/3500  | 70.5/3200 | 75/3200  |
| Maximum speed (r. p. m. )                                |      | 3630                                | 3850     | 3520      | 3520     |
| Idle speed (r. p. m. )                                   |      | 660                                 | 680      | 600       | 600      |
| Min. full - load specific fuel consumption (g/kW·h)      |      | 242                                 | 224      | 238       | 238      |
| Ratio of oil consumption to fuel consumption             |      | 1%                                  | 0.9%     | 1%        | 1%       |
| Firing order   |      | 1 - 3 - 4 - 2                       |          |           |          |
| Direction of rotation<br>(viewed from the flywheel side) |      | Counterclockwise                    |          |           |          |
| Cooling method   |      | Pressurized water - cooling         |          |           |          |
| Lubricating method                                       |      | Combination of pressure and splash  |          |           |          |
| Starting method  |      | Electric                            |          |           |          |
| Net weight (kg)  |      | 320                                 | 310      | 330       | 330      |
| Overall dimentions (mm)                                  | L    | 903                                 | 919      | 789       | 789      |
|  | W    | 600                                 | 600      | 600       | 600      |
|  | H    | 708                                 | 708      | 731       | 731      |



## 2. Specifications of Main Components

|                                      |   |                              |                    |                    |
|--------------------------------------|---|------------------------------|--------------------|--------------------|
| Model                                | YZ4102Q1  | YZ4102QB                     | YZ4102QF           | YZ4105QF           |
| Injection pump type                  | In - line, plunger type                                     |                              |                    |                    |
|                                      | 4A436 -<br>90R1650  | 4A408 -<br>90R1750           | 4A438 -<br>90R1600 | 4A428 -<br>90R1600 |
| Governor type                        | Centrifugal, maximum - minimum - speed<br>TypeRFD(RAD;R801) |                              |                    |                    |
| Injector type                        | PF68S02   | CKBEL90S02<br>9(5×0.25)      | PF68S02            |                    |
| Nozzle type                          | Long - stem, orifice type                                   |                              |                    |                    |
|                                      | ZCK154<br>S432  | DLLA150S1311<br>CDLLA150S018 | ZCK154<br>S432     |                    |
| Injection starting pressure<br>(MPa) | 19~19.5   | 23~23.5                      | 19~19.5            |                    |
| Fuel filter type                     | Paper cartridge type C0810B                                 |                              |                    |                    |
| Lub. oil filter type                 | Paper cartridge type J1012                                  |                              |                    |                    |
| Air cleaner type                     | K1317N  |                              | K1526              |                    |
| Lub. oil pump type                   | Gear type   |                              |                    |                    |
| Rated speed (r. p. m. )              | 1650  | 1750                         |                    | 1600               |
| Cooling water pump type              | Centrifugal type  |                              |                    |                    |
| Rated speed (r. p. m. )              | 3000  | 3170                         | 2900               |                    |
| Flow rate(l/min)                     | 200   |                              |                    |                    |
| Starting moter type                  | QD2636A   |                              | QD267              |                    |
| Voltage (v)                          | 24  |                              |                    |                    |
| Power supply (kW)                    | 4.2   |                              |                    |                    |
| Generator type                       | JFWB25C   |                              |                    |                    |
| Voltage (v)                          | 28  |                              |                    |                    |
| Power (W)                            | 500   |                              |                    |                    |
| Glow plug type                       | 1F5   |                              |                    |                    |

|   |                        |
|---|------------------------|
| Voltage (v)   | 24                     |
| Power supply (W)  | 100                    |
| Permissible time length for each preheating attempt ( s ) | < 30                   |
| Thermostat type   | Wax element type 145B  |
| Lub. oil cooler type                                      | Fin and tube type 28H2 |

### 3. Main Engine Data

| Main Engine Data                                    |          |          |          |          |
|---|----------|----------|----------|----------|
| Engine model  | YZ4102Q1 | YZ4102QB | YZ4102QF | YZ4105QF |
| Temperature and pressure ranges at rated conditions |          |          |          |          |
| 1) Exhaust temperature (℃)                          | ≤630     |          |          |          |
| 2) CoolingWater temperature(℃)                      | 75~95    |          |          |          |
| 3) Lub. oil temperature (℃)                         | ≤95      |          |          |          |
| 4) Lub. oil pressure (kPa)                          | 300~500  |          |          |          |
| (Lubricating oil pressure at low idle speed≥100kPa) |          |          |          |          |
| Tightening torque specifications (N·m)              |          |          |          |          |
| 1) Cylinder head bolts                              | 120~140  |          |          |          |
| 2) Flywheel bolts                                   | 130~150  |          |          |          |
| 3) Connecting rod cap bolts                         | 100~120  |          |          |          |
| 4) Main bearing cover bolts                         | 180~200  |          |          |          |
| 5) Camshaft gear clamping bolt                      | 60~80    |          |          |          |
| 6) Rocker arm pedestal bolts                        | 60~70    |          |          |          |
| 7) Crankshaft pulley clamping bolt                  | 140~160  |          |          |          |
| Valve timing(refer to crank angle)                  |          |          |          |          |
| Intake valves open<br>(Before T. D. C. )            | 18       | 18       | 12       | 12       |
| Intake valves close<br>(After B. D. C. )            | 54       | 54       | 48       | 48       |

|   |                        |      |      |      |
|---|------------------------|------|------|------|
| Exhaust valves open<br>(Before B. D. C. )             | 62                     | 62   | 56   | 56   |
| Exhaust valves close<br>(After T. D. C. )             | 18                     | 18   | 12   | 12   |
| Valve clearances(on cold engine) (mm)                 |                        |      |      |      |
| Intake valves   | 0.35~0.40              |      |      |      |
| Exhaust valves  | 0.40~0.45              |      |      |      |
| Fuel injection rate (ml)<br>(for 400 working cycles)  | 22.0                   | 21.5 | 23.5 | 25.0 |
| Fuel delivery advance angle<br>(refer to crank angle) | 12                     | 14   | 16   |      |
| Oil sump capacity ( l )                               | 8.5                    |      |      |      |
| Cooling system capacity ( l )                         | 8 (except in radiator) |      |      |      |

|   |    |    |    |    |
|---|----|----|----|----|
| Valve timing (refer to crank angle)                     |    |    |    |    |
| Exhaust valves open<br>(Before T. D. C. )               | 18 | 18 | 12 | 12 |
| Exhaust valves close<br>(After T. D. C. )               | 24 | 24 | 18 | 18 |
| Lubricating oil pressure at low idle speed (1000 r/min) |    |    |    |    |
| 1) Lubricating oil pressure (kPa)                       |    |    |    |    |
| 2) Lubricating oil pressure (bar)                       |    |    |    |    |
| 3) Lubricating oil pressure (MPa)                       |    |    |    |    |
| 4) Lubricating oil pressure (psi)                       |    |    |    |    |
| 5) Lubricating oil pressure (mmHg)                      |    |    |    |    |
| 6) Lubricating oil pressure (in. Hg)                    |    |    |    |    |
| 7) Lubricating oil pressure (torr)                      |    |    |    |    |
| 8) Lubricating oil pressure (mm H <sub>2</sub> O)       |    |    |    |    |
| 9) Lubricating oil pressure (in. H <sub>2</sub> O)      |    |    |    |    |
| 10) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 11) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 12) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 13) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 14) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 15) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 16) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 17) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 18) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 19) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 20) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 21) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 22) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 23) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 24) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 25) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 26) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 27) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 28) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 29) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 30) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 31) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 32) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 33) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 34) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 35) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 36) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 37) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 38) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 39) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 40) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 41) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 42) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 43) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 44) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 45) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 46) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 47) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 48) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 49) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 50) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 51) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 52) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 53) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 54) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 55) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 56) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 57) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 58) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 59) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 60) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 61) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 62) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 63) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 64) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 65) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 66) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 67) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 68) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 69) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 70) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 71) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 72) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 73) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 74) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 75) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 76) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 77) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 78) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 79) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 80) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 81) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 82) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 83) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 84) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 85) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 86) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 87) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 88) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 89) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 90) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 91) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 92) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 93) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 94) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 95) Lubricating oil pressure (ft. H <sub>2</sub> O)     |    |    |    |    |
| 96) Lubricating oil pressure (m. H <sub>2</sub> O)      |    |    |    |    |
| 97) Lubricating oil pressure (cm. H <sub>2</sub> O)     |    |    |    |    |
| 98) Lubricating oil pressure (mm. H <sub>2</sub> O)     |    |    |    |    |
| 99) Lubricating oil pressure (in. H <sub>2</sub> O)     |    |    |    |    |
| 100) Lubricating oil pressure (ft. H <sub>2</sub> O)    |    |    |    |    |



## Section II Running – in of the Engine

It is essential to run – in a new or an overhauled engine before putting it in service. In the running – in period, contact surfaces of the parts of an engine may gradually fit well with each other. Operating an engine under heavy load without going through running – in period would cause such excessive wear and tear that the service life of the engine would be reduced significantly.

### 1. Preparations for Running – in.

- A) Clean the dust and oil sludge gathered on the engine.
- B) Check and tighten all external bolts and nuts.
- C) Grease bearings of water pump.
- D) Fill oil sump with engine oil to specified level.
- E) Fill fuel tank and cooling system.
- F) Check the wiring of electric system.

After finishing the preparations, proceed the running – in operation as described below.

### 2. Running – in Procedures

The whole period of running – in lasts for 60 hours. It can be completed on the road and the mileage should be no less than 2500 km. No – load running – in should be carried out firstly in a mileage of 200 km. Inspect the working conditions of the engine at different speeds in no – load running – in period. Make sure that there is no leakage of fuel, oil and cooling water. Listen carefully to find out whether there is abnormal noise. Inspect exhaust condition and the readings of all meters. In case of abnormal working conditions, find out the cause of trouble, do some repair and adjustment work. Make sure that all troubles are eliminated, then proceed with the running – in under load.

Running – in under load should be carried out under the conditions specified in terms of accumulated mileage and speed – load percentage as follows.

Running – in within the distance of 800 km should be carried out with less than 50 percent of payload at less than 75 percent of the rated speed of the engine.

Within 1500km percentages of both load and speed should be less than 75.

Throughout the distance from 1500km to 2500km the percentage of load should be less than 90 and the speed less than the rating.

Lubricating oil should be changed after the completions of distances of 500km, 1000km and 2500km.

### 3. Inspection after Running – in

After running – in, there are a large number of metal particles in the oil. The dirty oil should be drained off to prevent engine parts from premature wear.

- A) Drain off the dirty oil when engine is hot. At this stage, impurities are still floating in the oil

and are easy to be cleaned out. Then rinse oil sump and strainer with diesel oil.

- B) Clean or replace the cartridge of oil filter.
- C) Check and adjust valve clearances.
- D) Check and retighten all external securing bolts and nuts.
- E) Check for the wearing of main bearings and connecting rod bearings and the tightening torque of their securing bolts.
- F) Retighten the securing bolts of cylinder head, main bearings and connecting rod bearings in accordance with the instructions in this manual.
- G) Check and eliminate other faults.
- H) Apply grease where necessary.

## Section III Operation of the Engine

### 1. Fuel, Lubricating Oil and Cooling Water

- A) The fuel for the engine is the light diesel oil specified in the China National Standard GB 252 (Nos. +10, 0, -10, -20 and -35, five sorts for choice). The choice of the fuel depends on the ambient temperature. The principle is that the pouring point of fuel should be 3°C to 5°C lower than the ambient temperature. The Nos. -20 or -35 light diesel oil is used for the area where winter temperature is normally above -15°C and seldom below -20°C; the No. -10 for the area where winter temperature is normally above -5°C and seldom below -10°C and the No. 0 for the area above 0°C all the year.
- B) The lubricating oil for the engine should be of the quality grade CD specified in the China National Standard GB11123 (L-ECD). Use grade 5W/30 where ambient temperature is above -25°C. Use grade 10W/30 or 10W/40 at temperatures above -20°C and grade 15W/30 or 15W/40 at temperatures above -15°C.
- C) Cooling water for diesel engine should be the clean soft water, such as water from rain, snow or clean rivers. In case of hard water, such as water from wells and fountains, it should be softened beforehand. There are two methods to do it.
- (1) To boil up the hard water.
  - (2) To add caustic soda into the hard water (20 grams of caustic soda for 30 liters of hard water).

### 2. Preparations for Starting

- A) Check whether there is sufficient fuel in the fuel tank. Before refilling the tank with fuel, let it settle for at least 48 hours to separate dirt and water. It is necessary to filter it thoroughly and the refilling appliance should be kept clean. All these should be adhered to strictly, otherwise, troubles will arise in fuel supply system and precise parts will wear off at an excessive rate.
- B) Check whether there is air in the fuel supply system. If there is air, slacken the venting screws on fuel filter and injection pump. Bleed the air in the fuel system by actuating the handle of the fuel feed pump until fuel flowing out without air bubbles and then retighten the venting screw (see Fig. 1). After that slacken the cap nuts at the connection of injectors and high pressure fuel pipes, bleed air and then retighten the connecting nuts.
- C) Check the oil level in the oil sump. The oil level should be kept between the upper and lower marks on the dipstick. Refill the oil sump if necessary. Make sure the refilling appliance is clean to prevent impurities from contaminating the oil.
- D) In case the engine has been out of use for a long period or the oil and oil filter cartridge have been replaced, make sure that the lubricating system is full of oil.
- E) Check the tightness of all connecting parts. Check the electrical system to see if the batteries are fully charged, all wirings are correct and all connections tight.



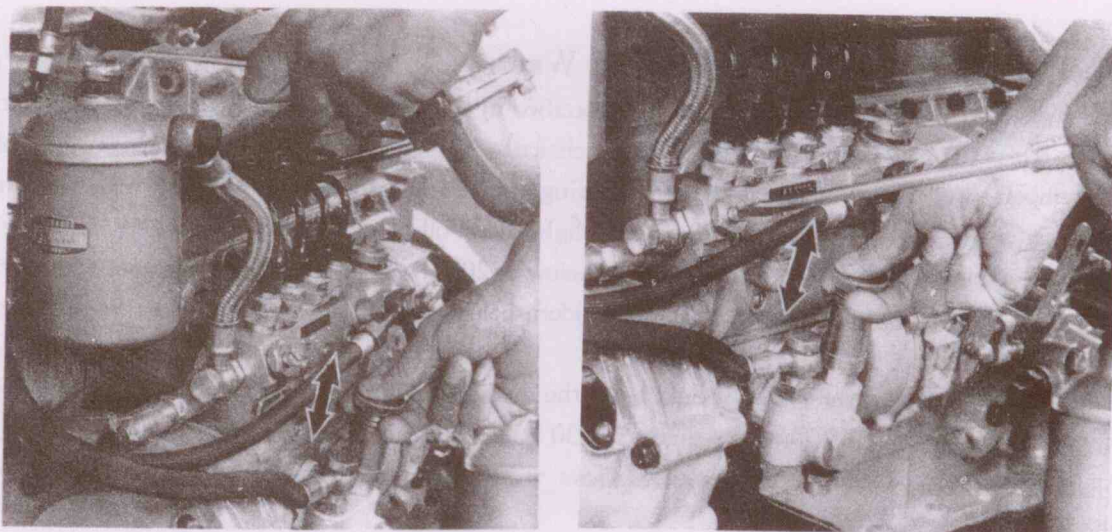


Fig. 1

### 3. Starting the Engine

After finishing the above - mentioned preparations, start the engine in the following procedures.

- A) Place the governor control lever at the medium - tension position, the control rod will move to the starting position (maximum delivery position) due to the function of the starting fuel enrichment device.
- B) Check the proper function of the fuel feed pump by feeling the resistance of the actuating handle. Turn the crankshaft and listen to the injection sound of nozzles. In case no resistance or sound can be perceived, it is necessary to bleed air from the fuel lines.
- C) When the ambient temperature is over  $5^{\circ}\text{C}$ , the engine can be started easily. First turn on the electric switch, then turn the preheat - starting switch to the "starting" position to start the engine. As soon as the engine is started up, release the preheat - starting switch. The time for each attempt should not exceed five seconds.
- D) When the ambient temperature is below  $5^{\circ}\text{C}$ , preheat - starting method is more helpful. The following procedure should be carried out. Turn the preheat - starting switch to "preheating" position and hold on for about forty five seconds, then turn to the "starting" position, the engine will be driven by the starting motor and soon begin to run by itself. If the engine fails to start at one attempt, wait for two minutes before making the next attempt.
- E) If the engine is difficult to start in cold weather, the following measures should be taken to pre-heat and start the engine.
  - (1) Pour hot water into the cooling system with the drain cock (on the cylinder block) open. After hot water flows out of the drain cock and the engine is warmed up, close the drain cock.
  - (2) Heat the lubricating oil to  $80^{\circ}\text{C} \sim 90^{\circ}\text{C}$ , then pour it into the oil sump.

#### 4. Operating the Engine

- A. After starting, inspect the lubricating oil pressure gauge and the flow condition of outlet water. If there is anything abnormal, readjust right away or stop the engine for checking.
- B. First run the engine at medium speed for about five minutes, then increase the speed gradually for warming up. Do not load the engine until the temperature of cooling water has reached 50°C.
- C. Increase the speed and load gradually. The sudden increase in speed and load should be avoided as far as possible.
- D. During operation, pay attention to smoke, noise and heat radiation. Check the temperature of cooling water and lubricating oil and the pressure of lubricating oil.
- E. The lubricating system incorporates a low oil pressure alarm which gives out acoustic and optical signals when lubricating oil pressure falls below the specified level. In that case, it is necessary to stop the engine immediately, then check and eliminate the trouble. Refill the oil sump if necessary.

#### 5. Stopping the Engine

- A. Before stopping the engine, reduce load and speed gradually, run the engine at lower – middle and idle speeds for several minutes. When the temperature of cooling water is below 70°C, cut off the fuel delivery by pulling the engine stop lever to stop the engine(see Fig 2).
- B. When it is necessary to make an emergency stop, pull the engine stop lever immediately to cut off the fuel delivery. If the engine does not stop after doing so or it runs away, carry out the following procedures without delay.

(1) Slacken the connecting nuts connecting the high pressure fuel pipes.

(2) Block up the intake pipe.

- C. In winter, after the engine is stopped, it is necessary to drain off water by opening drain cocks on cylinder block and radiator to protect water pump, cylinder block and radiator against cracking during freeze. When draining water, remove the radiator cap lest cooling water should not drain off completely.

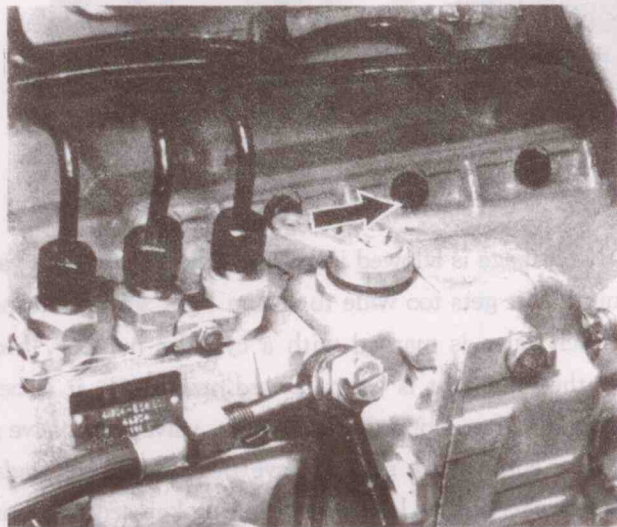


Fig.2



## Section IV Specialized Description

### 1. Cylinder Head

The cylinder head of 4105 engine is the same as that of 4102 engine.

The monoblock type cylinder head is made of high strength cast iron. The fuel injectors, glow plugs and valve train parts are mounted onto the cylinder head. Intake and exhaust manifolds are attached to the left and right sides respectively. The fuel filter is located at the front end of the intake manifold. Into the bottom surface of the cylinder head are pressed intake and exhaust valve inserts.

The front and rear sides of cylinder head are covered by plates. The thermostat is mounted on the front cover of the cylinder head.

There are two adapter locations in the front cover, one is a screw hole (size: 3/8" NPT) for mounting the water temperature sensor, the other is a pipe connector for hot water hose for cab heating (see Fig. 3).

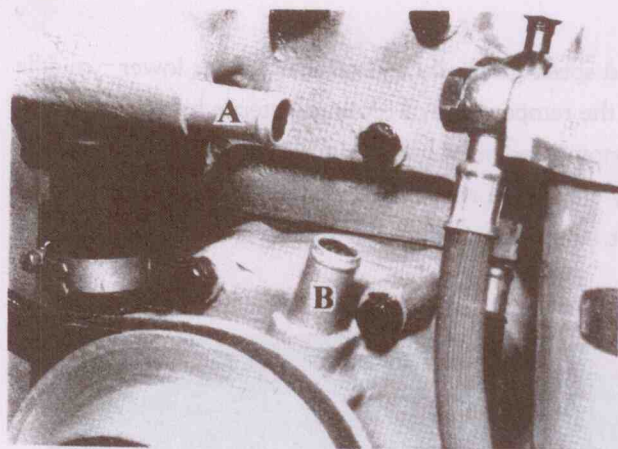


Fig. 3

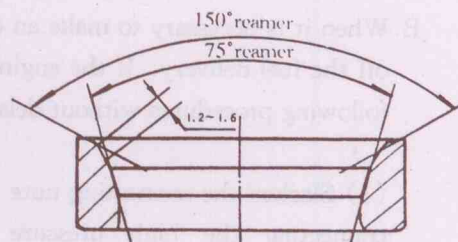


Fig. 4

No leakage is allowed in the seat line of valve and valve seat. The normal seat line width is 1.2 – 1.6mm. If it gets too wide to ensure tight sealing, reshape it by means of a special reamer (see Fig. 4). Each valve is marked with a cylinder number, because they are not interchangeable in assembly. When the valve seat is worn, pitted or burned, it is necessary to lap the valve with proper lapping compound. After lapping, clean valve, valve seat, valve guide and intake and exhaust ports. Then install valve springs, be sure to have their closed coil ends downwards for proper function. The valve should be checked for leakage by pouring kerosene into intake and exhaust ports and examining for two minutes. The standard valve recession, the specified distance the valve head is located from the cylinder head gasket surface, is 0.5~0.7mm. It is to be checked after valve reconditioning.

The fuel injector is mounted with a copper sleeve (wall thickness: 1.5mm) press-fitted to the cylinder head. To prevent water leakage, an O-ring seal ( $\varnothing 25 \times 2.4$ ) is arranged at the upper fitting

flange. After mounting onto the cylinder head, the protrusion of the injector tip from the cylinder head gasket surface should be  $3.8 \sim 4.2\text{mm}$  (see Fig. 5). It can be adjusted with shims.

The cylinder head is mounted on the cylinder block with 18 bolts. They should be evenly tightened in three steps. Tightening sequence in each step is starting in the middle and extending symmetrically on each side (see Fig. 6). The specified tightening torque is  $120 \sim 140\text{N}\cdot\text{m}$ . When dismantling cylinder head, slacken the bolts in reverse order.

The glow plug is located beside the injector. The plug tip protrusion should be  $4 \sim 6\text{mm}$ . It can be adjusted with shims.

The operation instruction should be followed to prevent leakage and cylinder head deformation.

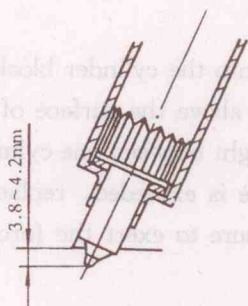


Fig. 5

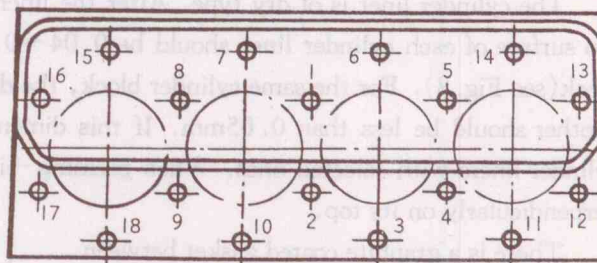


Fig. 6

## 2. Cylinder Block

The cylinder block is made of high strength cast iron. It provides full support for crankshaft main journals. On the left side of the cylinder block are mounted injection pump, lubricating oil filter, oil cooler and low oil pressure alarm. On the right side are mounted starting motor, generator with silicon rectifier, push rod chamber covers, crankcase ventilator and water drain cock. On the front, there are water pump and fan assembly, gear case and gear case cover. Timing gears are arranged inside the gear case and front oil seal is fitted to the gear case cover. On the rear, there are rear oil seal and cover assembly, flywheel and flywheel housing or flywheel and clutch housing.

There are two inspection windows on gear case cover for timing the injection pump in service work (see Fig. 7). Before dismantling the injection pump, remove the inspection window covers, turn the crankshaft (less than two revolutions) so as to align the marks on camshaft gear and injection advancer with the points in the inspection windows respectively. The crankshaft should not be turned before mounting the injection pump again. When mounting, make sure that the mark on the injection advancer is aligned with the point in the inspection window.



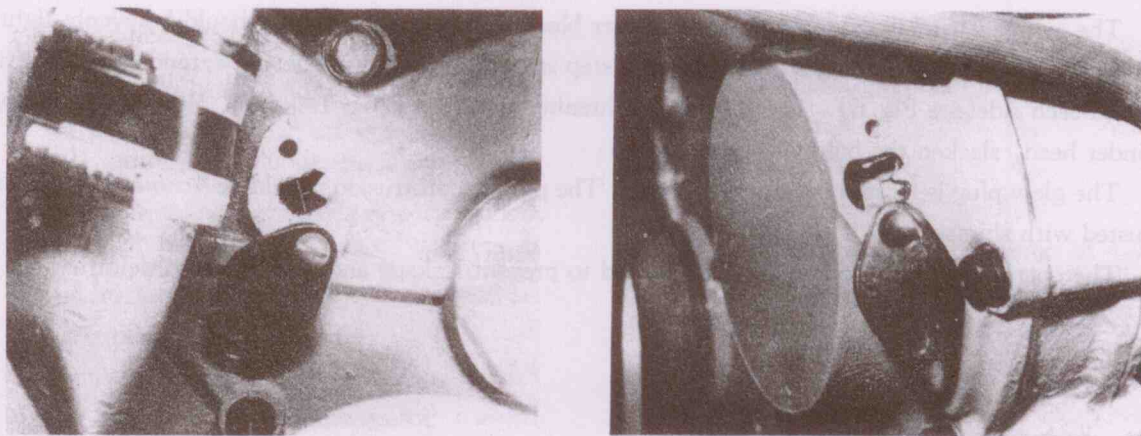


Fig. 7

The cylinder liner is of dry type. After the liners are pressed into the cylinder block, the flange top surface of each cylinder liner should be 0.04 ~ 0.12mm higher above the surface of the cylinder block (see Fig. 8). For the same cylinder block, the difference in height between one cylinder liner and another should be less than 0.05mm. If this dimensional tolerance is exceeded, replace the wrong cylinder liners with selected ones. When pressing in a liner, be sure to exert the force evenly and perpendicularly on its top.

There is a graphite coated gasket between cylinder block and cylinder head. Place the gasket in the position fixed by two locating sleeves. Check to see that the holes in the gasket line up respectively with water and oil holes in the cylinder block. Place an O-ring seal ( $\varnothing 16 \times 1.9$ ) in the oil hole of the gasket. After replacement of the gasket check the compression clearance between piston top and cylinder head (0.9mm - 1.1mm).

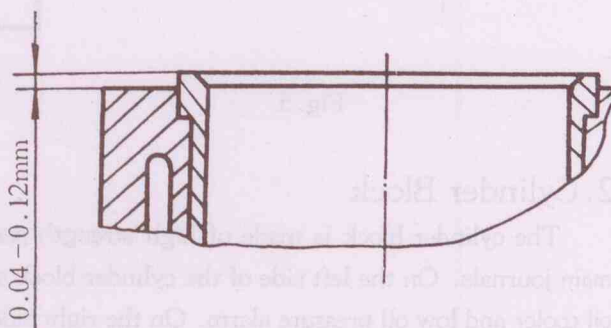


Fig. 8

The camshaft bushings are made of aluminum - tin alloy or ply metal. When pressing the bushings into the cylinder block, make sure that the oil holes on them line up with the holes in the cylinder block.

The main bearing covers and the bearing saddles on cylinder block are machined in couple. The main bearing covers are marked with sequence numbers and orientation arrow marks. They are not interchangeable and the arrow marks on them should point to the front of the engine in assembly. The fifth main bearing cover is fitted with a locating pin, its convex - to - convex axis should be parallel with the axis of crankshaft. When tightening the main bearing cover bolts, tighten the bolts for the middle ones first, then both side ones symmetrically. Tighten them gradually in two or three processes

till the tightening torque reaches 177 – 196 N·m. The two halves of main bearings are different and the upper one has an oil groove and an oil hole. On the last bearing cover and saddle (nearest to the flywheel) are installed two thrust washers which produce a crankshaft end play in the range of 0.07 – 0.25 mm. The grooved face of the crankshaft thrust plate is coated with antifriction alloy and should be in contact with the crankshaft in assembly.

### 3. Valve System

The valve system consists of camshaft gear, camshaft, valve tappets, push rod and valve mechanism. It is of valve-in-head type with the camshaft located below in the cylinder block.

The camshaft is made of ductile nodular cast iron and normalized. The axial clearance of camshaft should be within the range of 0.07 – 0.22 mm. It is adjusted with a thrust plate. Insufficient clearance may lead to part damage while excessive clearance may cause timing error and mechanical noise.

Both camshaft gear and injection pump gear are driven by the crankshaft gear via an idle gear. The gears have dot marks on them. In assembly, all the marks should be correctly placed to ensure correct valve timing and injection timing.

The valve are opened and closed in certain timing events, and driven by the camshaft through tappets and push rods.

The tightening torque for the camshaft gear clamping bolt should be 60 – 80 N·m.

### 4. Crank – Connecting Rod Mechanism

The crank – connecting rod mechanism is composed of piston – connecting rod assembly and crankshaft – flywheel assembly.

The piston – connecting rod mechanism consists of piston, compression rings, oil scraper ring, piston pin, connecting rod, connecting rod bearings and connecting rod bolts.

The crankshaft – flywheel assembly consists of crankshaft, flywheel, crankshaft timing gear and crankshaft pulley. If the engine drives an air conditioner, it will have a double groove crankshaft pulley.

Two compression rings and oil scraper ring are fitted into the piston. The barrel type first compression ring is chromium-plated. The taper-faced second compression ring is slotted on the top rim. When the rings are fitted into their grooves, their gaps should be 120 degrees apart from each other around the circumference of the piston. Furthermore the direction of the oil scraper ring gap should be so placed that its end gap is 90 degrees apart from the pin hole centre. The second compression ring should have its top surface (marked with STD in the area near the gap) upward in assembly. When measuring the ring gap, place the ring into a cylinder liner and measure it with a feeler gauge. If the gap is too small, correct it by fine filing. If too large, replace it with a new one.

Before installing piston pin, heat the piston in hot oil to the temperature of about 80°C, then assemble the piston pin and connecting rod. When assembling, the inlet valve pocket should be on the left side of the exhaust valve pocket viewed from the side of matching marks on the connecting rod.

The connecting rod shank and cap are machined and marked in couple, because they are not inter-



changeable in assembly. The difference in weight between one connecting rod and another for the same engine should be less than 15 grams, the difference in the weight of crank bore end between the connecting rods less than 10 grams and that of pinhole end less than 5 grams. Before assembly piston and connecting-rod should be smeared with a little clean oil. It should be placed into the cylinder liner with the matching marks facing the injection pump side.

The connecting rod bearing is made of aluminum-tin alloy. The upper and lower shells of the bearing are different in shell thickness and detail design and should not be exchanged in assembly. The lower shell marked with characters“下瓦”on its back has two wedge slots and should be installed onto the connecting rod cap. The upper shell marked with characters“上瓦”on its back has only one wedge slot and should be installed onto the connecting rod shank. When assembling the connecting rod onto the crankpin, tighten two bolts evenly in two or three processes to reach the torque of  $98 - 112\text{N}\cdot\text{m}$ .

The crankshaft is made of ductile nodular cast iron. There are five main journals and four crankpins on the crankshaft. An oil hole in each journal leading to the neighbouring crankpin is employed to supply lubricating oil to the crankpin bearing.

When installing the flywheel, tighten the flywheel bolts evenly in two or three processes according to the sequence shown in Fig. 9 to reach the tightening torque of  $130 \sim 150\text{N}\cdot\text{m}$ .

On crankshaft pulley and flywheel, there are marks indicating the top dead centre, the beginning of fuel delivery and opening of the intake valve(all refer to the first cylinder) for the convenience of check and adjustment(see Fig. 10).

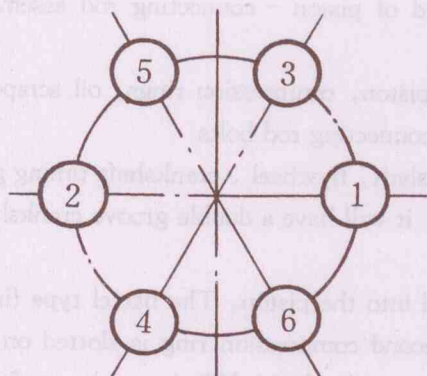


Fig. 9

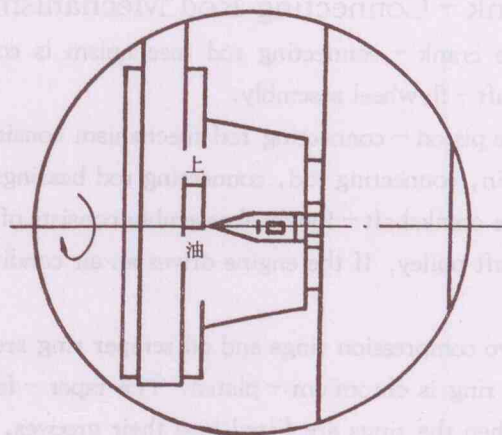


Fig. 10

## 5. Fuel and Air Supply System

The supply system of the engine consists of fuel filter, feed pump, injection pump and governor, injection advancer, injectors, fuel pipeline, intake manifold and air filter.

The fuel drawn by the feed pump from the fuel tank flows through the fuel filter to the injection pump. The injection pump delivers fuel at high pressure to injectors through fuel pipeline. From the injection pump and injectors superfluous fuel passes the fuel return pipe and the back valves on fuel fil-

ter and injection pump and returns to the fuel tank.

The filter element inside the fuel filter is a paper cartridge. When reassembling after maintenance, pay attention to the proper positions of rubber seal rings, especially the seal rings on both ends of the cartridge.

The fuel feed pump is of single-acting plunger type incorporating a prime pump for bleeding air from inside the fuel pipeline. The actuating handle of the prime pump should be screwed down after bleeding operation.

The injection pump is an in-line pump of type A or its derivative. In assembly, the parts in barrel-plunger pair or delivery valve-valve holder pair are not interchangeable. The tightening torque of delivery valve holder is  $39 \sim 44 \text{ N} \cdot \text{m}$ . The injection pump is lubricated with oil from the main oil gallery of the engine.

The injection pump assembly includes injection pump, fuel feed pump, governor, automatic advancer, gear and mounting flange. The assembly is mounted onto the gear case with seven bolts clamping the mounting flange. At the rear of the governor, there is a supporting bracket. Timing marks are made on the gear case cover, gears and automatic advancer. Before disassembling, open the inspection window on the gear case cover and turn the crankshaft to align the mark on the rim of the advancer with the pointer in the inspection window. To maintain correct injection timing crankshaft should not be turned before reassembling. In case the crankshaft is turned remove the gear case cover and align the marks on gears during reassembling.

The fuel delivery setting screws and speed setting screws on the governor are fixed on the engine test rig before delivery. They are sealed and should not be readjusted by customers except when it is absolutely necessary. The fuel injection pump delivery rate is specified in Section I, Main Engine Data. All the service operations should be carried out by the qualified service man on an injection pump tester. For detailed information on the service work, refer to the service manual of the injection pump.

There is a mechanical automatic advancer mounted on the shaft of the injection pump. As the pump speed increases from 800 r.p.m. to the rated speed, the advance angle of injection increases by  $5^\circ + 0.5^\circ \text{ crank angle}$ .

The fuel injector is of long-stem type. The protrusion of the injector tip from the bottom surface of the cylinder head should be  $3.8 \sim 4.2 \text{ mm}$  (see Fig. 5). Check the injector for proper function and clean the nozzle periodically as specified in Section VI. The nozzle body and needle are finely matched to each other and should not be interchanged. When washing the injector, scrape off carbon deposits with a brush and lap the nozzle body and needle in pair with clean oil, be careful not to bruise the sealing surface.

The air cleaner comprises whirl vanes and paper cartridge. When maintaining it, clean dust out of the dust chamber. Take out the cartridge and slightly knock it on both ends to remove dust. This can also be done by slightly brushing with a soft brush or blowing from inside the cartridge with compressed air under the pressure of less than 300kPa. Care must be taken to prevent dirt from entering the inside of the cartridge. Check to see if the cartridge is in good order, replace it if it is torn or unglued. When reassembling, place the rubber seal ring in position to ensure reliable sealing, otherwise the dust would be sucked into cylinder and cause premature wear-out of cylinder liner, piston



and piston rings.

The air cleaner incorporates a rubber dust - exhauster on the cover. When mounting the air cleaner cover, make sure the dust outlet is located toward the rear of the engine for easy dust extraction.

## 6. Lubricating System

It is of the combined type of splash and pressure lubrication. Some bearings such as main bearing, connecting rod bearing, camshaft bushing, idle gear bushing and rocker arm bushing are pressure - lubricated(see Fig. 11), while other moving parts such as piston, piston pin, valves and timing gears are lubricated by splashed oil. The bearings in water pump and generator need greasing periodically.

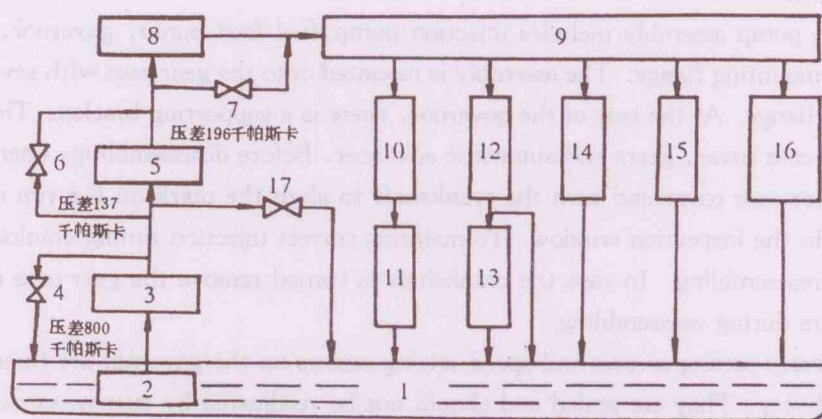


Fig. 11

1. Oil sump    2. Oil pump strainer    3. Oil pump    4. Pressure limiting valve(max. 800kPa)
5. Oil filter    6. Bypass valve in oil filter(opens at pressure drop 137kPa)    7. By - pass valve(opens at pressure drop 196kPa)
8. Fin and tube type oil cooler    9. Main oil gallery
10. Main bearings    11. Connecting rod bearings    12. Camshaft bushings
13. Rocker arm bushings    14. Vacuum pump    15. Timing gears    16. Oil pump driving gear
17. Pressure adjusting valve

The lubricating oil pump is an externally - engaged gear pump driven by the gear on the camshaft.

The lubricating oil drawn by the oil pump flows into the oil filter which is a sort of the full flow filter with paper cartridge. When assembling the oil filter, pay attention to the fitting of the rubber seal rings to prevent leakage and short circuit of oil flow. A pressure limiting valve and a by - pass valve are integrated into the filter. The pressure limiting valve serves to adjust the lubricating oil pressure within the specified range. If the oil pressure gets too high, the excessive oil would flow back to the oil pump. The by - pass valve is used to ensure the safety of lubrication. In case the cartridge is seriously choked, the bypass valve will open at a pressure drop of 137kPa, leading unfiltered oil directly to the oil cooler and oil gallery in the cylinder block. The unfiltered oil, however, would cause prema-

ture or excessive wear to engine parts. The opening pressure of the by-pass valve is adjusted on a special device. Don't dismantle it in maintenance. In the event that the fin and tube type oil cooler is choked, the by-pass valve in the oil cooler will open at a pressure drop of 196kPa and the uncooled oil will flow directly into the oil gallery.

## 7. Cooling System

The engine is provided with a closed-loop cooling system. It consists of radiator, fan, water pump and thermostat. The centrifugal water pump is composed of housing, impeller, shaft, pulley and water seal. On the inlet side of the water pump is fitted a water hose adaptor for recirculating water from the hot water heater in the driving cabin (see Fig. 3).

Two alternative water pump pulley are available for different adaptation. One is a single-groove pulley. The other is a double-groove pulley used for the engine to drive an air conditioner or air compressor.

When water leaks out continuously from the weep hole at the bottom of the water pump due to excessive wear of water seal, replace it in the following processes. Remove the water pump from the cylinder block, slacken and dismantle the impeller from the water pump shaft. Then take out the worn seal and replace it with a new one. In the water pump are mounted two radial ball bearings (Type 60303), each with a dust cover. When assembling the water pump, place bearings with the dust cover of each bearing on the side opposite to the bearing spacer.

The wax element thermostat is of type 145B.

## 8. Electrical System

The electrical system consists of glow plugs, and an A. C. generator with a silicon rectifier. Be sure to have the negative pole of the generator connected to the ground.

## 9. Vacuum Pump

A vacuum pump for servo-brake is integrated with the generator. It consists of pump housing, rotor, vane, back valve, oil inlet adaptor screw, air and oil outlet pipe, pipe adaptor screw, etc. (see Fig. 12).

The rotor which is eccentrically arranged in the pump housing is driven by the generator shaft. The four vanes inserted into the rotor are forced against the pump housing by centrifugal force. The pumping action is due to the volume variation of the space formed by rotor, vanes and housing. Air is sucked from the vacuum reservoir through the back valve. The oil from the oil gallery of cylinder block is supplied to the vacuum pump for lubricating and sealing the moving parts. The oil and air pumped out of the vacuum pump flow into the gear case through the air and oil outlet pipe. When the vacuum pump does not work, the pressure difference between vacuum reservoir and pump housing will force the rubber seal onto its seat to keep up the vacuity in vacuum reservoir and prevent oil from entering it.

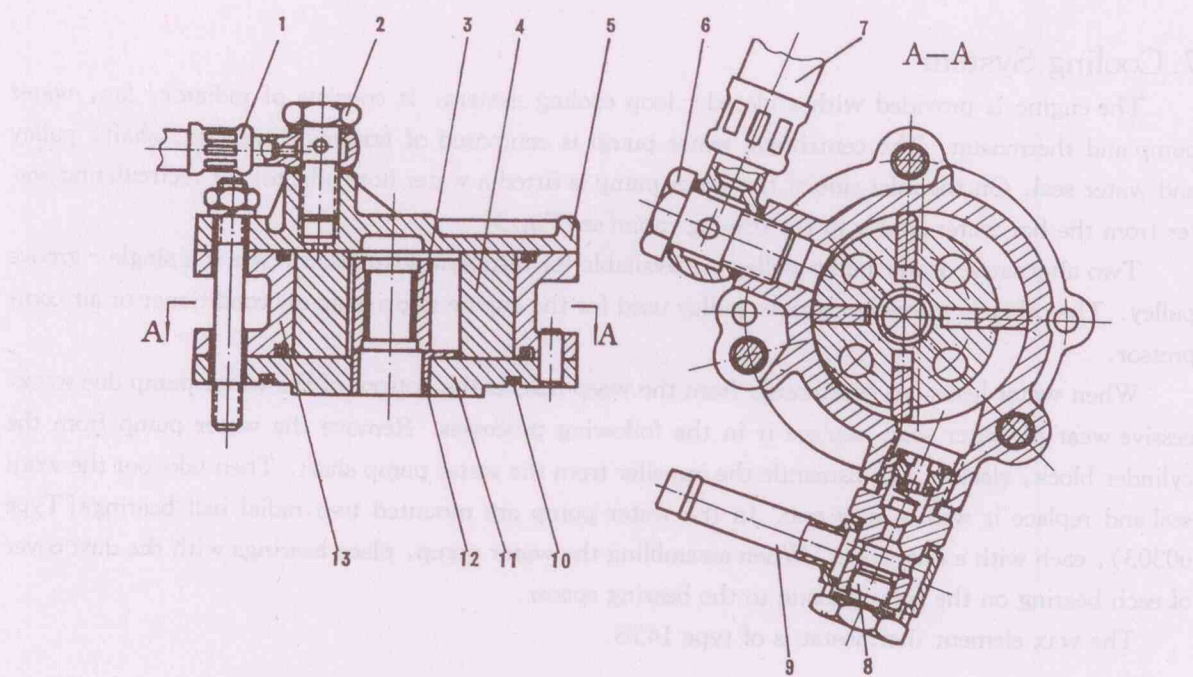


Fig. 12

1. Oil inlet pipe 2. Oil inlet adaptor screw 3. Rotor 4. Vane 5. Rear cover  
6. Air and oil outlet adaptor screw 7. Air and oil outlet pipe 8. Back valve 9. Suction pipe  
10. Seal ring 11. Front cover 12. Sleeve 13. Pump housing



## Section V Check and Adjustment of the Engine

### 1. Adjustment of Valve Clearances

It is essential to adjust the valve clearances in operating an engine. If the clearances are too small, the valves will not close tight when they are heated and will expand on a running engine. That will result in the leakage of valves and reduce the engine output. If the clearances are too large, the duration of the opening of intake and exhaust valves will be too short to ensure the sufficient induction and exhaustion. That will cause not only reduction of engine output but also strong impact on valves, rocker arms and camshaft. Apart from the adjustment of valve clearances after the engine being reassembled, it is necessary to check and adjust the valve clearances periodically because of the possible loosening of adjusting screws and wear of parts in the valve train. The inspection interval is recommended to be 500 running hours or driving time over 8000km.

The adjustment should be carried out on the cooled engine. The procedure is as follows(see Fig. 13).

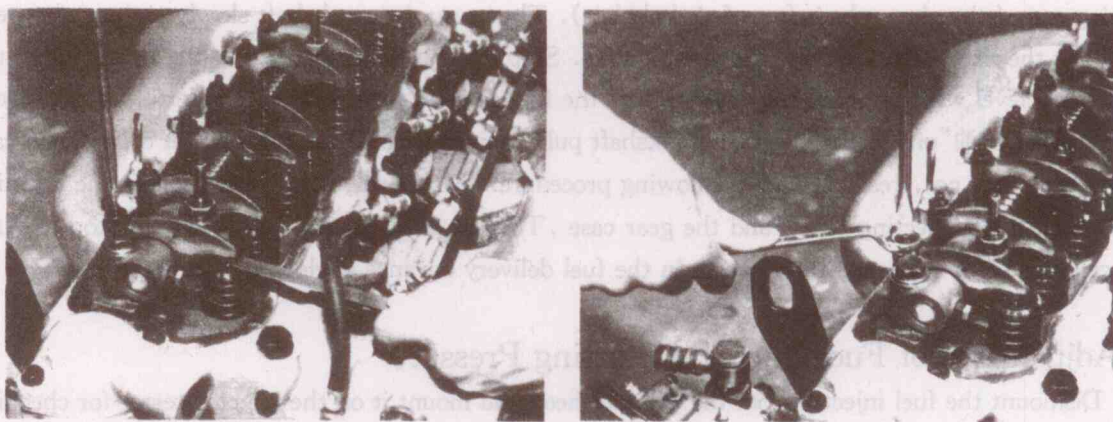


Fig. 13

Remove the cylinder head cover. Turn the crankshaft until the mark of the top dead center of the first cylinder on the crankshaft pulley aligns with the pointer of the timing indicator. When the piston of the first cylinder is at its top dead center on the compression stroke, both intake and exhaust valves of the 1st cylinder are closed. In this position, check the clearances of intake valve and exhaust valve of the first cylinder, the intake valve of the second cylinder and the exhaust valve of the third cylinder (i. e. the clearances of the first, second, third and sixth valves counted from the front) with a feeler gauge. The clearances of intake valve and exhaust valve are specified in Section I, Main Engine Data. To adjust the valve clearances, slacken the lock nut with a wrench and hold it, screw in or out the adjusting screw with a screw driver until the feeler gauge inserted between rocker head and top surface of the valve stem feels neither too loose nor too tight. Then tighten the lock nut and check the clear-



ance again. Readjust if necessary till it is properly set

After the adjustment of the clearances of the above mentioned four valves, rotate the crankshaft a complete turn to place the piston of the forth cylinder at its top dead center on the compression stroke. In this position, check the clearances of intake valve and exhaust valve of the fourth cylinder, the intake valve of the third cylinder and the exhaust valve of the second cylinder(i.e. the clearances of the fourth, fifth, seventh and eighth valves counted from the front). Adjust the clearances of these valves in the same way as described above.

## 2. Adjustment of Fuel Delivery Advance Angle

In order to maintain economic fuel consumption and efficient performance, it is necessary to check and adjust the fuel delivery advance angle after the engine having been reassembled or running for 1000 hours or driving over 18000km.

The procedure in checking and adjusting is as follows.

Remove the high pressure fuel pipe of the first cylinder, connect a pipe joined to a thin glass tube with the first cylinder delivery valve adapter of the injection pump. Set the speed control lever to the maximum delivery position and bleed off the air in the fuel system. (Turn the crankshaft till the fuel flowing out of the glass tube is free of air bubbles ). Then turn the crankshaft slowly and watch attentively for the rise of the fuel level in the glass tube. Stop turning the crankshaft at the beginning of the rise of fuel level which implies the beginning of the fuel delivery for the first cylinder. Check to see if the mark scale“油”on the periphery of crankshaft pulley aligns with the timing pointer on the gear case cover. If it does not, readjust in the following procedure. Slacken the bolts which fasten the injection pump onto the connecting flange and the gear case . Turning the injection pump with its top towards the cylinder block results in the increase in the fuel delivery advance angle and vice versa.

## 3. Adjustment of Fuel Injection Starting Pressure

Dismount the fuel injector from the cylinder head and mount it on the injector tester for checking and adjusting. Actuate the pumping handle and watch the indication of pressure at the beginning of injection. The pressure should be within the range as specified in Section I, Main Engine Data. The fuel spray should be uniform and the puffing sound of injection should be short and clear. If not qualified, adjust in the following procedure. Dismount the nut from the injector holder, screw in or out the adjusting screw with a screwdriver. Screwing - in results in the increase in fuel injection pressure and vice versa. After the adjustment, tighten the nut and check for the injection pressure again.

## 4. Adjustment of V - belt Tension

Though very easy to adjust, the tension of V - belt has great influence on the rotational speed of the generator and water pump and therefore the operation of the engine. It is recommended to adjust it periodically. When engine is not running, press on the middle of a straight section of the belt with a force of 29~39N, the bending of V - belt should be within the range of 10~15mm. If not qualified, loosen the adjusting bolt on the adjusting bracket to move the generator to adjust the belt to a proper

tension. The excessive belt tension will shorten the service life of the belt and cause the premature wear of bearings in generator and water pump due to the heavy load resulted from excessive tension. The insufficient belt tension, however, will lead to the belt creep and fracture and result in engine overheating.

### 5. Adjustment of Lubricating Oil Pressure

During the running of engine, it is necessary to pay close attention to lubricating oil pressure. The normal oil pressure ranges from 300kPa to 500kPa. The adjustment of lubricating oil pressure should be carried out after the engine gets warm (by this time the lubricating oil temperature will be around 80°C). First dismount the sealing nut from the oil filter, then turn the adjusting screw to adjust oil pressure. Screw in the adjusting screw to increase the oil pressure or screw out the adjusting screw to decrease it. After adjustment, put on the sealing washer and then tighten the sealing nut.

## Section VI Technical Maintenance

### 1. Shift Maintenance

- A) Check the oil level in oil sump. Refill to the specified level if necessary.
- B) Check the water level in the radiator. Refill if necessary.
- C) Check the fuel level in fuel tank. Refill if necessary.
- D) Check the tightness of mounting bolts of the engine and installing bolts of components. Tighten them if necessary.
- E) Check the leakages of air, oil and water. Repair if necessary.
- F) Eliminate all faults and abnormal conditions found in operation.
- G) Clean the oil sludge and dust gathered on the engine and accessories.

### 2. Maintenance at the Completion of Every 125 Working Hours or 1500 to 2000km

- A) Complete all the procedures specified in item 1.
- B) Grease the bearing of water pump with a grease gun.
- C) Check the electrolyte level, which should be kept 10~15mm high above the plates. Add distilled water if necessary. It is not allowed to add electrolyte. The specific gravity of electrolyte should be 1.25~1.28 at 20°C ambient temperature. If it drops to 1.14, recharge the battery.
- D) Clean off dust from paper cartridge and dust chamber of air cleaner.
- E) Check the tension of fan belt. Adjust it if necessary.
- F) Clean off the dirt on commutator and brushes of starting motor. Grease its bearings.

Notes:

At the completion of every 250 working hours, clean the oil filter and replace oil filter cartridge and seal rings. Clean fuel filter and its cartridge.

### 3. Maintenance at the Completion of Every 500 Working Hours or 6000 to 8000km

- A) Complete all the procedures specified in item 2.
- B) Clean lubricating system. Change lubricating oil. For a new engine, these procedures should be carried out at the completions of driving distances of 500km, 1300km and 2800km.
- C) Check the injection pressure and spray characteristics of injector. Readjust the injection pressure or wash the needle and nozzle body pair.
- D) Check the leakage from the weep hole of water pump, change the water seal if the leaking rate gets too high.
- E) Check the installation of generator and starting motor and the wear of their brushes and commutators. Check all cable connections of electrical system. Clean and correct if dark burned spots are found.



- F)Check the tightening torque of main bearing bolts and connecting rod bolts.
- G) Check and adjust valve clearances as specified. Check the thermostat.
- H) Clean the engine ventilator.
- I) Check the paper cartridge of air cleaner.

4. Maintenance at the Completion of Every 1000 Working Hours or 18000 – 24000km

- A) Complete all the procedures specified in item 3.
- B) Replace the cartridge and seal ring of fuel filter.
- C) Replace the cartridge of air cleaner.
- D) Clean off the scale in cooling system.
- E) Clean fuel tank and fuel piping.
- F) Clean oil cooler. If there is serious blockage, replace the oil cooler core.
- G) Check and adjust the fuel delivery advance angle.
- H)Check the seat lines of intake and exhaust valves. Relap valves and adjust valve clearances if necessary.
- I)Check the flow rate of blow – by from the ventilator. Check the exhaust flow for blue smoke. Replace piston rings if necessary.
- J)Check the tightening torque of connecting rod bolts and main bearing cover bolts. Check the wear of cylinder liners, connecting rod bearings and main bearings. Clean off carbon deposits from cylinder head, piston and cylinder liner.



## Section VII Trouble Shooting

### 1. Failure to Start

| Possible Causes   | Suggested Remedies  |
|---|---|
| 1) Fuel tank empty or fuel tank cock not open.                | Refill fuel tank.<br>Open cock.   |
| 2) Fuel pipeline or fuel filter clogged.                      | Clean pipeline or replace filter cartridge.   |
| 3) Air within fuel system.                                    | Bleed fuel system.<br>Tighten all fuel pipe connections.                                    |
| 4) Defective injection pump or incorrect injection timing.    | Check fuel feed pump.   |
| 5) No injection or poor characteristics of spray .            | Clean and lap nozzle needle and body in pair.<br>Readjust injection pressure.               |
| 6) Ambient temperature too low and therefore engine too cold. | Heat cooling water. Use proper lubricating oil (see Section III). Apply preheat – starting. |
| 7) Insufficient compression pressure in cylinders.            | See item 3 hereafter.   |
| 8) Defective starting motor or low battery output.            | See item 11 hereafter.  |

## 2. Lack of Power

| Possible Causes  | Suggested Remedies   |
|--|--|
| 1) Insufficient compression pressure in cylinders.       | See item 3 hereafter.  |
| 2) Wrong grade of fuel or fuel diluted with water        | Use proper fuel. Clean fuel tank and refill.   |
| 3) Clogged air cleaner.                                  | Clean air cleaner cartridge. Replace cartridge if necessary.                                 |
| 4) Choked exhaust silencer .                             | Clean off carbon deposits or dirt from silencer.   |
| 5) Air leakage in fuel system.                           | Bleed fuel system. Tighten all fuel line connections.  |
| 6) Incorrect valve timing.                               | Inspect camshaft and marks on gears. Check valve clearances. Replace camshaft if it is worn. |
| 7) Incorrect fuel delivery advance angle                 | Check marks on gears. Readjust fuel delivery advance angle.                                  |
| 8) Low injection pressure or poor spray characteristics. | Readjust injection pressure.   |
| 9) Uneven distribution of fuel among cylinders.          | Readjust uniformity of fuel delivery from fuel injection pump to each cylinder.              |
| 10) Engine unable to reach the rated speed.              | Reset speed control lever.   |

### 3. Insufficient Compression Pressure in Cylinder

| Possible Causes   | Suggested Remedies  |
|---|---|
| 1) Valve clearance too small or no clearance.                                     | Readjust valve clearance.   |
| 2) Carbon deposits or burned valve and its seat.                                  | Clean off carbon deposits and relap valve and valve seat. Ream valve seat if necessary. |
| 3) Piston ring worn or lack of elasticity.  | Replace piston ring.  |
| 4) Piston ring stuck due to carbon deposits.                                      | Clean piston ring in kerosine.  |
| 5) Cylinder liner and piston worn, clearance between cylinder and piston too big. | Replace liner and piston, or rebore liner and use oversize piston.                      |
| 6) Leakage in cylinder head gasket face.  | Retighten cylinder head bolts or replace gasket.  |
| 7) Gas leakage in injector mounting bore.   | Check copper washer. Remount injector.  |
| 8) Valve spring broken.   | Replace valve spring.   |
| 9) Valve stuck in valve guide.  | Clean it in kerosine. Replace if it is worn out or deformed.                            |



#### 4. Engine Stalls

| Possible Causes                  | Suggested Remedies                                  |
|----------------------------------|---|
| 1) No fuel in tank.              | Refill fuel tank.                                   |
| 2) Air and water in fuel system. | Bleed fuel system. Drain water from fuel tank.      |
| 3) Fuel filter clogged.          | Clean or replace cartridge.                         |
| 4) Air cleaner choked.           | Replace air cleaner cartridge.                      |
| 5) Piston stuck in cylinder.     | Repair or replace piston or cylinder liner or both. |

#### 5. Abnormal Noise

| Possible Causes   | Suggested Remedies                                       |
|---|--|
| 1) Engine detonates with clear knock in cylinder.   | Readjust fuel delivery advance angle.                    |
| 2) Delayed combustion. Backfire in exhaust pipe.  | Readjust fuel delivery advance angle.                    |
| 3) Clearance between piston and cylinder liner too big, causing pounding sound (The noise disappears 3 to 5 seconds after fuel delivery being cut off ) | Check and repair. Replace piston and liner if necessary. |

| Possible Causes  | Suggested Remedies                                      |
|--|---|
| 4) Clearance between crankshaft journal and main bearing too big, causing low heavy pounding sound periodically. | Check and repair. Replace main bearing or thrust plate. |
| 5) Clearance between crankpin and bearing too big, causing dull pounding sound.                                  | Check and repair. Replace connecting rod bearing.       |
| 6) Clearance between piston pin and connecting rod bushing too big, causing sharp knocking sound.                | Check and repair. Replace bushing.                      |
| 7) Valve clearance too big, causing clicking sound.  | Readjust valve clearance.                               |
| 8) Valves impingement with piston, causing clear pounding sound.   | Readjust valve clearance and valve timing.              |

## 6. Black Exhaust

| Possible Causes  | Suggested Remedies                                |
|--|---|
| 1) Engine overloaded.  | Reduce load.                                      |
| 2) Fuel delivery not uniform or too much.                          | Adjust injection pump and governor.               |
| 3) Injection pressure too low, causing poor spray characteristics. | Readjust injection pressure.                      |
| 4) Incorrect fuel injection timing.                                | Readjust fuel delivery advance angle.             |
| 5) Air cleaner choked.   | Clean off dust on cartridge or replace cartridge. |
| 6) Wrong grade of fuel.  | Drain tank and refill with proper fuel.           |

## 7. Overheat

| Possible Causes  | Suggested Remedies   |
|--|--|
| 1) Loose V – belt causing reduction of cooling water flow.             | Adjust belt tension or replace V – belt.   |
| 2) Engine overloaded for a long time.                                  | Reduce load.   |
| 3) Cooling water insufficient.   | Refill radiator.   |
| 4) Cooling water circulation reduced due to low water pump efficiency. | Check clearance between water pump impeller and housing.<br>Replace impeller if necessary. |
| 5) Defective water pump impeller .                                     | Replace impeller.  |
| 6) Cooling water circulation blocked.                                  | Clean cooling system.  |
| 7) Defective thermostat.   | Replace thermostat.  |
| 8) Defective water thermometer.  | Replace thermometer.   |
| 9) Insufficient lubrication.   | Inspect lubricating system and clean oil gallery.  |



## 8. Low Lubricating Oil Pressure

| Possible Causes  | Suggested Remedies   |
|--|--|
| 1) Insufficient oil in oil sump.   | Check oil level.<br>Refill to the specified level.                                   |
| 2) Defective low oil pressure alarm.   | Replace alarm.   |
| 3) Oil gallery clogged.  | Clean oil gallery and blow away dirt with compressed air.                            |
| 4) Oil strainer clogged.   | Clean oil strainer.  |
| 5) Clogged oil filter and defective by – pass valve.   | Clean oil filter or replace filter cartridge. Readjust by – pass valve if necessary. |
| 6) Excessive bearing clearances due to wear of main bearing and crankpin bearing.            | Repair or replace bearing.   |
| 7) Overheated engine and high temperature of lubricating oil.                                | Reduce load to lower oil temperature or refill with new oil.                         |
| 8) Too big clearance between oil pump gears and housing or between flanks of teeth of gears. | Replace gears or housing of oil pump.  |

9. Excessive Oil Consumption

| Possible Causes   | Suggested Remedies  |
|---|---|
| 1) Oil scraper ring stuck in ring groove due to carbon deposits or deffective ring because of excessive wear. | Wash oil scraper ring in kerosine or replace deffective ring. |
| 2) Oil return holes plugged by carbon deposits.   | Clean oil return holes on piston.                             |
| 3) Oil level too high.  | Check with dipstick and drain oil to correct level.           |
| 4) Leakage in lubricating system .  | Tighten connectors and replace sealing washers and gaskets.   |

10) Deterioration of Lubricating Oil

| Possible Causes  | Suggested Remedies            |
|--|-------------------------------|
| 1) Piston ring worn or stuck in groove , causing combustion gas or fuel to leak into the oil sump. | Clean or replace piston ring. |
| 2) Water leaking into oil due to faulty cylinder gasket.   | Replace gasket.               |
| 3) Water leaking into oil due to cracks in cylinder head.  | Replace cylinder head.        |

## 11. Trouble Shooting in Electrical System

| Symptoms and causes   | Suggested Remedies  |
|---|---|
| A) Faulty generator, no recharging of battery or current too weak.  |   |
| 1) Loose connections on generator and battery or corroded contacts. | Check and tighten all connections. Clean contact-<br>ing surfaces and improve insulation. |
| 2) V – belt slip.   | Readjust belt tension.  |
| 3) Generator out of order.  | Check and repair.   |
| B) Current too strong and generator overheated.                     |   |
| 1) Short – circuit between armature and field coil.                 | Repair or replace.  |
| 2) Faulty voltage regulator.  | Repair or replace.  |
| C) Resistor of regulator burnt out                                  |   |
| 1) Battery terminals incorrectly connected.                         | Reconnect cables.   |
| 2) Cutout relay out of order, current reversed at low engine speed. | Repair or replace.  |
| D) Starting motor will not run.                                     |   |
| 1) Loose connection of cables.                                      | Clean off dirt. Tighten connections.  |
| 2) Battery not fully charged.                                       | Check and recharge it.  |
| 3) Bad contact of brushes.  | Clean and polish with fine sandpaper.   |
| 4) Short – circuit within starting motor.                           | Check and repair.   |
| E) Starting motor will run idle but can not crank the engine up.    |   |



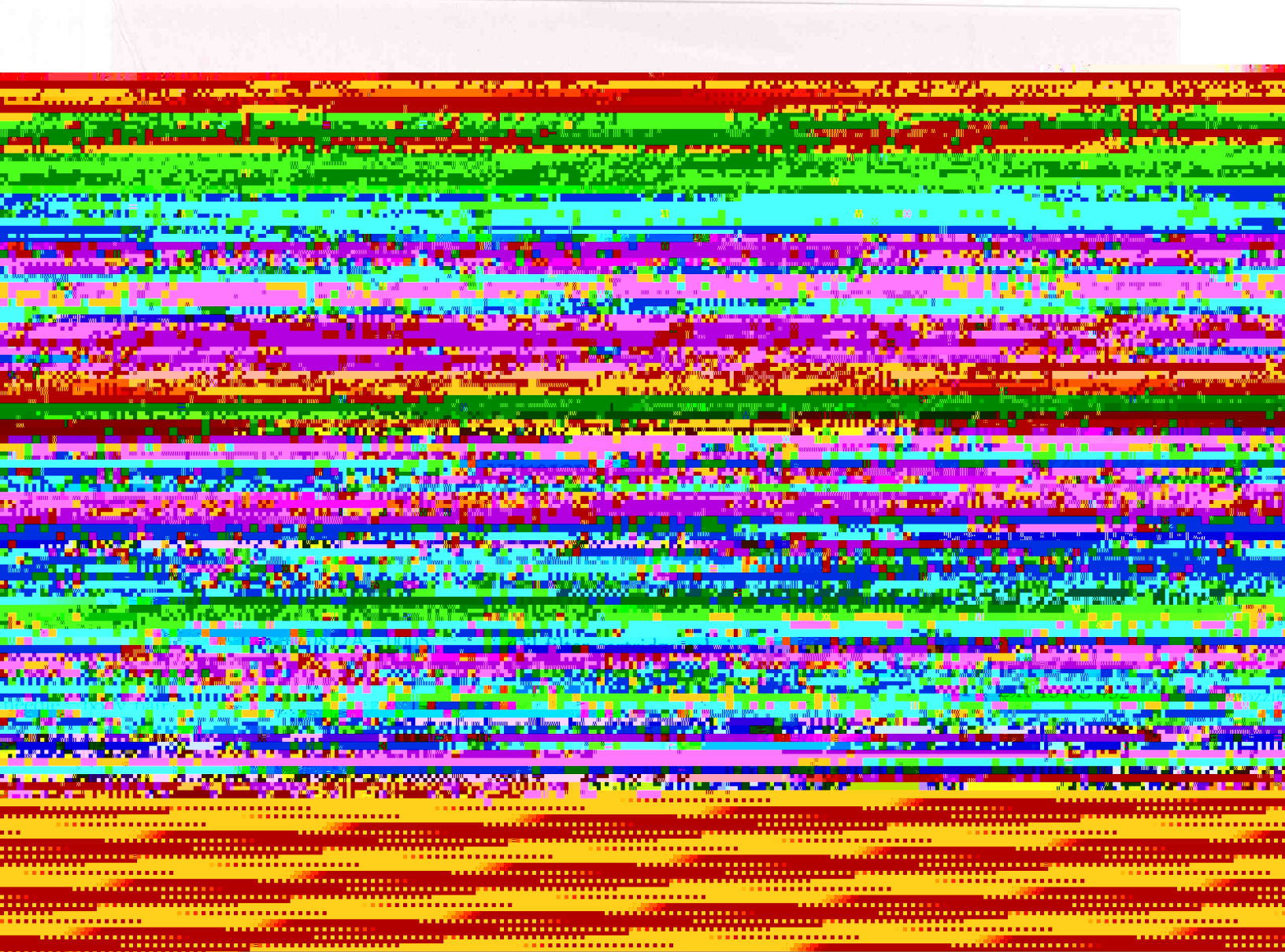
| Symptoms and causes                | Suggested Remedies                       |
|------------------------------------|--|
| 1)Bad contact of brush.            | Clean and polish with fine sandpaper.    |
| 2)Bad contact of cable and switch. | Clean off dirt. Tighten all connections. |
| 3)Weak battery.                    | Check and recharge it.                   |

## 12. Trouble Shooting on Vacuum Pump

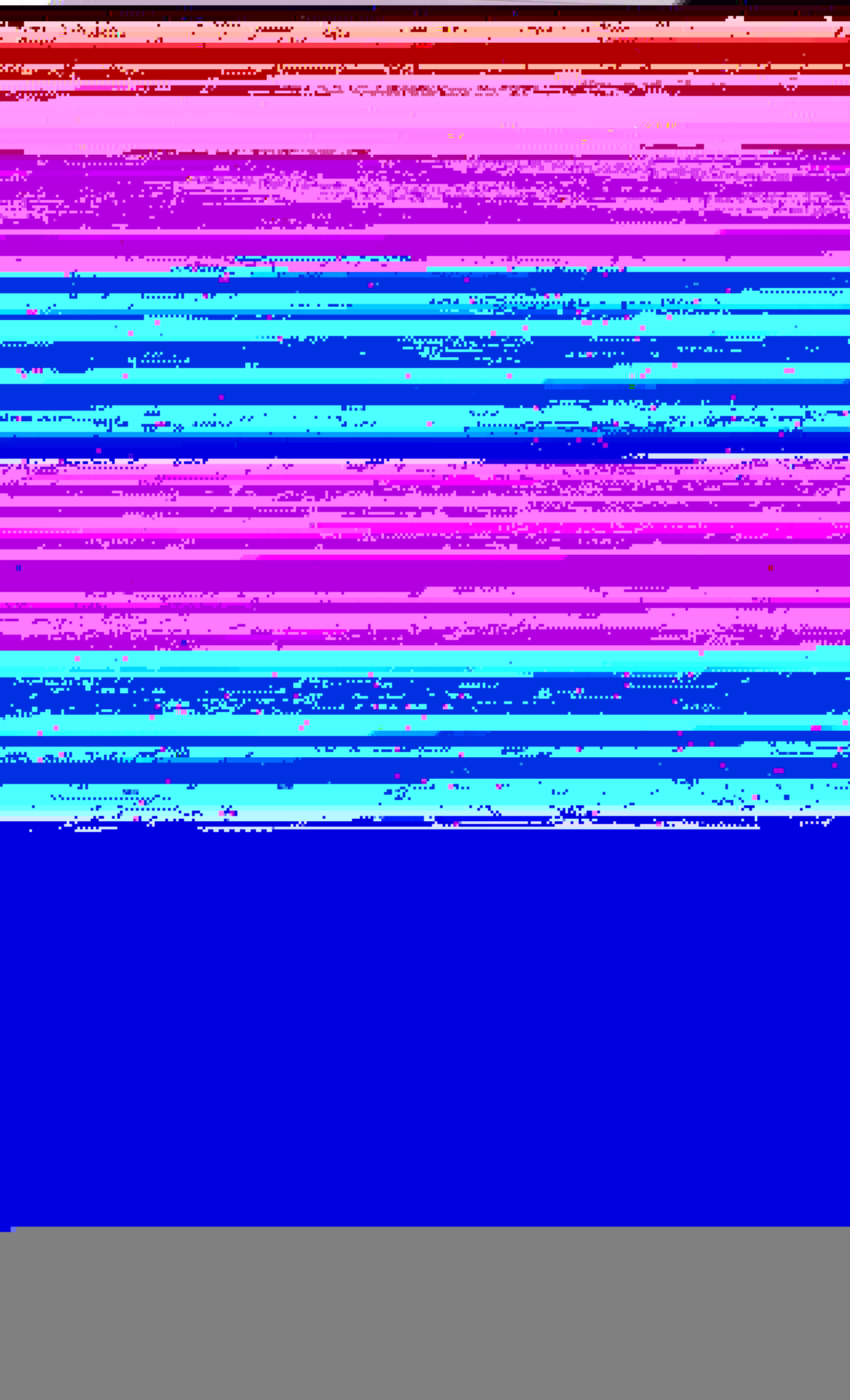
| Symptoms and Causes  | Suggested Remedies  |
|--|---|
| 1)Oil leakage into vacuum reservoir and low suction efficiency causing insufficient vacuity in vacuum reservoir. | Check wear of pump vanes, replace if necessary. (See the following description) |
| 2) Contaminated or deteriorated oil, causing blockage in oil passage and defective sealing of back valve.        | Clean oil passage and back valve, replace the valve core and valve spring.      |
| 3)Defective valve core.  | Replace valve core and valve spring.  |
| 4) Leakage due to improper mounting of back valve and suction pipe.  | Locate leaks and repair.  |

Appendix I Spare Parts of Diesel Engines  
4102Q1 ,4102QB and 4102QF

| No | Drawing No.       | Description                                |
|----|-------------------|--|
| 1  | T/Y102 - 01121    | Intake valve                               |
| 2  | T/Y102 - 01122    | Exhaust valve                              |
| 3  | T/Y102 - 01119    | Valve spring, outer                        |
| 4  | T/Y102 - 01120    | Valve spring, inner                        |
| 5  | T/Y102 - 01123    | Valve collet                               |
| 6  | T/Y102 - 02135    | Lower main bearing                         |
| 7  | T/Y102 - 02134    | Upper main bearing                         |
| 8  | YT4102Q - 02119   | Cylinder head gasket                       |
| 9  | GB9877.1 - 88     | Rear oil seal(PG 105x130x14)               |
| 10 | GB9877.1 - 88     | Front oil seal(PG 60x80x12)                |
| 11 | T/Y102 - 03102    | First compression ring                     |
| 12 | T/Y102 - 03103    | Second compression ring                    |
| 13 | T/Y102 - 03012    | Oil scraper ring assembly                  |
| 14 | T/Y102 - 03113    | Connecting rod bearing(upper)              |
| 15 | T/Y102 - 03114    | Connecting rod bearing(lower)              |
| 16 | GB12732 - 91      | V - belt(19 × 11 × 1074 or 19 × 11 × 1120) |
| 17 | J0812A - 2001     | Oil filter cartridge                       |
| 18 | J0812A - 0005     | Oil filter cartridge seal ring             |
| 19 | J0812A - 0003     | Oil filter housing seal ring               |
| 20 | C 0810 - 1000     | Fuel filter cartridge                      |
| 21 | ZCK 154 S 432     | Nozzle needle - body pair                  |
| 22 | YZ4102Q1 - 02118B | Cylinder liner                             |
| 23 | YZ4102Q1 - 03101B | Piston                                     |
| 24 | YZ4102QB - 02118  | Cylinder liner                             |
| 25 | YZ4102QB - 03101B | Piston                                     |
| 26 | YZ4102QA - 02118A | Cylinder liner(for YZ4102QF)               |
| 27 | YZ4102QF - 03101  | Piston(for YZ 4102QF)                      |







# Appendix III

## Fits and Wear Limits of Main Parts of Diesel Engines 4102 and 4105

| No  | Item  | Standard Dimension  | Type of Fit  | Assembly Clearance(mm)   | Wear Limit (Reference) |
|-----|---|---|--------------|--------------------------|------------------------|
| 1   | Crankshaft main journal and main bearing bore             | $\varnothing 80h6(\begin{smallmatrix} 0 \\ -0.019 \end{smallmatrix})$<br>$\varnothing 80(\begin{smallmatrix} +0.116 \\ +0.07 \end{smallmatrix})$  | Clearance    | 0.07~0.135               | 0.23                   |
| 2   | Axial clearance between crankshaft and cylinder block     |   | End play     | 0.07~0.25                | 0.40                   |
| 3   | Crankpin O. D. and connecting rod crankpin bore           | $\varnothing 66h6(\begin{smallmatrix} 0 \\ -0.019 \end{smallmatrix})$<br>$\varnothing 66(\begin{smallmatrix} +0.089 \\ -0.046 \end{smallmatrix})$   | Clearance    | 0.046~0.108              | 0.20                   |
| 4   | Connecting rod large end thickness and crankpin length    | $40(\begin{smallmatrix} -0.15 \\ -0.25 \end{smallmatrix})$<br>$40(\begin{smallmatrix} +0.10 \\ 0 \end{smallmatrix})$  | Clearance    | 0.15~0.35                | 0.60                   |
| 5   | Connecting rod small end bushing O. D. and small end bore | $\varnothing 40s7(\begin{smallmatrix} +0.068 \\ +0.043 \end{smallmatrix})$<br>$\varnothing 40H7(\begin{smallmatrix} +0.025 \\ 0 \end{smallmatrix})$   | Interference | -0.018~-0.068            |                        |
| 6   | Piston pin and connecting rod small end bushing I. D.     | $\varnothing 36(\begin{smallmatrix} 0 \\ -0.006 \end{smallmatrix})$<br>$\varnothing 36(\begin{smallmatrix} +0.035 \\ +0.020 \end{smallmatrix})$   | Clearance    | -0.003~0.02              |                        |
| 7*  | Piston pin and piston pin hole                            | $\varnothing 36(\begin{smallmatrix} 0 \\ -0.006 \end{smallmatrix})$<br>$\varnothing 36(\begin{smallmatrix} +0.003 \\ -0.013 \end{smallmatrix})$   | Transition   | 0.005~0.012              |                        |
| 8   | Piston skirt O. D. and cylinder liner I. D. (4102 engine) | $\varnothing 102(\begin{smallmatrix} -0.014 \\ -0.017 \end{smallmatrix})$<br>$\varnothing 102(\begin{smallmatrix} +0.03 \\ 0 \end{smallmatrix})$  | Clearance    | 0.14~0.20                |                        |
| 9** | Piston skirt O. D. and cylinder liner I. D. (4105 engine) | $\varnothing 105(\begin{smallmatrix} -0.14 \\ -0.17 \end{smallmatrix})$<br>$\varnothing 105(\begin{smallmatrix} -0.08 \\ -0.11 \end{smallmatrix})$<br>$\varnothing 105(\begin{smallmatrix} +0.03 \\ 0 \end{smallmatrix})$ | Clearance    | 0.14~0.20<br>(0.08~0.14) |                        |

\* Data in brackets refer to the piston with cast - in steel struts.

\*\* Piston and pin are classified into three dimensional groups and should be group - matched in assembly.

|    |   |   |                |               |      |
|----|---|---|----------------|---------------|------|
| 10 | The first compression ring and ring groove  | $3 \begin{smallmatrix} 0 \\ -0.015 \\ +0.10 \\ +0.08 \end{smallmatrix}$   | Side clearance | 0.08~0.115    | 0.20 |
| 11 | The second compression ring and ring groove   | $2.5 \begin{smallmatrix} 0 \\ -0.015 \\ +0.07 \\ +0.05 \end{smallmatrix}$   | Side clearance | 0.05~0.085    | 0.17 |
| 12 | Oil scraper ring and ring groove  | $5 \begin{smallmatrix} 0 \\ -0.015 \\ +0.060 \\ +0.040 \end{smallmatrix}$   | Side clearance | 0.04~0.075    | 0.17 |
| 13 | Ring gap of the first compression ring (measured in $\varnothing 102 \begin{smallmatrix} +0.005 \\ 0 \end{smallmatrix}$ gauge)  | 0.25~0.45   | Gap            | 0.25~0.45     | 2.5  |
| 14 | Ring gap of the second compression ring (measured in $\varnothing 102 \begin{smallmatrix} +0.005 \\ 0 \end{smallmatrix}$ gauge) | 0.2~0.4   | Gap            | 0.2~0.4       | 2.5  |
| 15 | Ring gap of scraper ring (measured in $\varnothing 102 \begin{smallmatrix} +0.005 \\ 0 \end{smallmatrix}$ gauge)                | 0.2~0.4   | Gap            | 0.2~0.4       | 2.5  |
| 16 | Flywheel O.D. and gear ring I.D.  | $\varnothing 346v8 \begin{smallmatrix} +0.564 \\ +0.475 \end{smallmatrix}$<br>$\varnothing 346H8 \begin{smallmatrix} +0.089 \\ 0 \end{smallmatrix}$ | Interference   | -0.386~-0.564 |      |
| 17 | Intake valve stem O.D. and valve guide I.D.   | $\varnothing 9 d7 \begin{smallmatrix} -0.040 \\ -0.055 \end{smallmatrix}$<br>$\varnothing 9 H8 \begin{smallmatrix} +0.022 \\ 0 \end{smallmatrix}$   | Clearance      | 0.040~0.077   | 0.23 |
| 18 | Exhaust valve stem O.D. and valve guide I.D.  | $\varnothing 9 \begin{smallmatrix} -0.05 \\ -0.07 \end{smallmatrix}$<br>$\varnothing 9 H8 \begin{smallmatrix} +0.022 \\ 0 \end{smallmatrix}$        | Clearance      | 0.050~0.092   | 0.24 |
| 19 | Valve guide O.D. and bore in cylinder head  | $\varnothing 14 u7 \begin{smallmatrix} +0.051 \\ +0.033 \end{smallmatrix}$<br>$\varnothing 14 H7 \begin{smallmatrix} +0.018 \\ 0 \end{smallmatrix}$ | Interference   | -0.015~-0.051 |      |
| 20 | Intake valve seat insert O.D. and bore in cylinder head   | $\varnothing 47 y7 \begin{smallmatrix} +0.139 \\ +0.014 \end{smallmatrix}$<br>$\varnothing 47 H7 \begin{smallmatrix} +0.025 \\ 0 \end{smallmatrix}$ | Interference   | -0.089~-0.139 |      |



|     |  |  |              |                      |      |
|-----|--|--|--------------|----------------------|------|
| 21  | Exhaust valve seat insert O. D. and bore in cylinder head      | $\begin{matrix} \phi 39 \text{ y7} ( \begin{smallmatrix} +0.119 \\ +0.094 \end{smallmatrix} ) \\ \phi 39 \text{ H7} ( \begin{smallmatrix} +0.025 \\ 0 \end{smallmatrix} ) \end{matrix}$      | Interference | $-0.069 \sim -0.119$ |      |
| 22  | Injector sleeve lower part O. D. and bore in cylinder head     | $\begin{matrix} \phi 13 \text{ r8} ( \begin{smallmatrix} +0.050 \\ +0.023 \end{smallmatrix} ) \\ \phi 13 \text{ H7} ( \begin{smallmatrix} +0.018 \\ 0 \end{smallmatrix} ) \end{matrix}$      | Interference | $-0.005 \sim -0.050$ |      |
| 23  | Rocker arm bushing O. D. and bore in rocker arm                | $\begin{matrix} \phi 24 \text{ s7} ( \begin{smallmatrix} +0.056 \\ +0.035 \end{smallmatrix} ) \\ \phi 24 \text{ H7} ( \begin{smallmatrix} +0.021 \\ 0 \end{smallmatrix} ) \end{matrix}$      | Interference | $-0.014 \sim -0.056$ |      |
| 24  | Rocker arm shaft and rocker arm bushing I. D.                  | $\begin{matrix} \phi 20 \text{ h7} ( \begin{smallmatrix} 0 \\ -0.021 \end{smallmatrix} ) \\ \phi 20 \text{ F8} ( \begin{smallmatrix} +0.053 \\ +0.020 \end{smallmatrix} ) \end{matrix}$      | Clearance    | $0.020 \sim 0.074$   | 0.20 |
| 25  | Camshaft bushing O. D. and bore in cylinder block              | $\begin{matrix} \phi 62 \text{ } ( \begin{smallmatrix} +0.094 \\ +0.072 \\ +0.030 \end{smallmatrix} ) \\ \phi 62 \text{ } ( \begin{smallmatrix} 0 \\ 0 \end{smallmatrix} ) \end{matrix}$     | Interference | $-0.042 \sim -0.094$ |      |
| 26  | Camshaft journal and camshaft bushing I. D.                    | $\begin{matrix} \phi 57 \text{ h6} ( \begin{smallmatrix} 0 \\ -0.019 \end{smallmatrix} ) \\ \phi 57 \text{ } ( \begin{smallmatrix} +0.08 \\ +0.05 \end{smallmatrix} ) \end{matrix}$          | Clearance    | $0.05 \sim 0.099$    | 0.20 |
| 27  | Valve tappet O. D. and bore in cylinder block                  | $\begin{matrix} \phi 28 \text{ g6} ( \begin{smallmatrix} -0.007 \\ -0.020 \end{smallmatrix} ) \\ \phi 28 \text{ F7} ( \begin{smallmatrix} +0.041 \\ +0.020 \end{smallmatrix} ) \end{matrix}$ | Clearance    | $0.027 \sim 0.061$   | 0.15 |
| 28  | Thickness of camshaft thrust plate and width of camshaft notch | $\begin{matrix} 6 \text{ c11} ( \begin{smallmatrix} -0.070 \\ -0.145 \end{smallmatrix} ) \\ 6 \text{ H11} ( \begin{smallmatrix} +0.075 \\ 0 \end{smallmatrix} ) \end{matrix}$                | Clearance    | $0.07 \sim 0.22$     |      |
| 29* | Cylinder liner O. D. and bore in cylinder block(4102 engine)   | $\begin{matrix} \phi 108 ( \begin{smallmatrix} 0 \\ -0.022 \end{smallmatrix} ) \\ \phi 108 \text{ } ( \begin{smallmatrix} +0.022 \\ 0 \end{smallmatrix} ) \end{matrix}$                      | Transition   | $-0.015 \sim 0.005$  |      |
| 30* | Cylinder liner O. D. and bore in cylinder block(4105 engine)   | $\begin{matrix} \phi 109 ( \begin{smallmatrix} 0 \\ -0.022 \end{smallmatrix} ) \\ \phi 109 \text{ } ( \begin{smallmatrix} +0.022 \\ 0 \end{smallmatrix} ) \end{matrix}$                      | Transition   | $-0.015 \sim 0.005$  |      |

\* Cylinder liner and bore in cylinder block are classified into three dimensional groups and should be group - matched.

| 31 | Height of cylinder liner flange and depth of flange recess in cylinder block | 10 <sup>+0.07</sup><br>+0.04<br>10 <sup>0</sup><br>-0.05                                | Height above cylinder block top surface | 0.04~0.12     | Height difference among four cylinders less than 0.05 |
|----|--|---|---|---------------|---|
| 32 | Idle gear shaft and idle gear shaft bushing I. D.                            | Ø55h6( <sup>0</sup> <sub>-0.019</sub> )<br>Ø55 <sup>+0.070</sup> <sub>+0.040</sub>      | Clearance                               | 0.040~0.089   |   |
| 33 | Lub. Oil pump driving gear shaft and bore in bearing cover                   | Ø16f7( <sup>-0.016</sup> <sub>-0.034</sub> )<br>Ø16H7( <sup>+0.018</sup> <sub>0</sub> ) | Clearance                               | 0.016~0.052   |   |
| 34 | Driving gear shaft bushing O. D. and bore in cylinder block                  | Ø32s7( <sup>+0.068</sup> <sub>+0.043</sub> )<br>Ø32 <sup>+0.025</sup> <sub>0</sub>      | Interference                            | -0.018~-0.068 |   |
| 35 | Lub. oil pump driving gear shaft and gear shaft bushing I. D.                | Ø16f7( <sup>-0.016</sup> <sub>-0.034</sub> )<br>Ø16H7( <sup>+0.018</sup> <sub>0</sub> ) | Clearance                               | 0.016~0.052   |   |
| 36 | Axial clearance between oil pump gear and oil pump housing                   | 0.065~0.125   | Clearance                               | 0.065~0.125   |   |
| 37 | Peripheral clearance between oil pump gear and oil pump housing              | 0.09~0.170  | Clearance                               | 0.090~0.170   |   |
| 38 | Oil pump driving shaft and hole in oil pump cover                            | Ø16h6( <sup>0</sup> <sub>-0.011</sub> )<br>Ø16E8( <sup>+0.059</sup> <sub>+0.032</sub> ) | Clearance                               | 0.032~0.070   |   |
| 39 | Oil pump shaft and hole in oil pump housing                                  | Ø16h6( <sup>0</sup> <sub>-0.011</sub> )<br>Ø16X7( <sup>-0.038</sup> <sub>-0.056</sub> ) | Interference                            | -0.027~-0.056 |   |
| 40 | Oil pump shaft and hole in driven gear                                       | Ø16h6( <sup>0</sup> <sub>-0.011</sub> )<br>Ø16F8( <sup>+0.043</sup> <sub>+0.016</sub> ) | Clearance                               | 0.016~0.054   |   |
| 41 | Oil pump driving shaft and driving gear                                      | Ø16h6( <sup>0</sup> <sub>-0.011</sub> )<br>Ø16U7( <sup>-0.026</sup> <sub>-0.044</sub> ) | Interference                            | -0.015~-0.044 |   |

