HINSHI–H8013-R1

T-NE

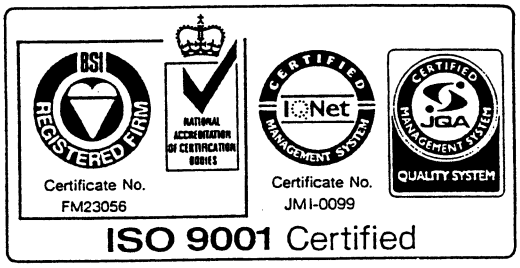
YANMAR

SERVICE MANUAL

INDUSTRIAL DIESEL ENGINE

MODEL 4TNE94·98·106(T)

(Direct Injection System)



YANMAR DIESEL ENGINE CO.,LTD.

(B) Working Wear

⚠ CAUTION

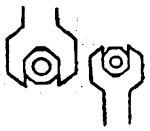
- **Wears for Safe Operation**
  Wear a helmet, working clothes, safety shoes and other safety protectors matching each job. Especially, wear well-fitting working clothes.
  [Otherwise]
  A serious accident such as trapping by a machine may arise.

(C) Tools to Be Used

⚠ WARNING

- **Appropriate holding and lifting**
  Never operate when the engine is supported with blocks or wooden pieces or only with a jack. To lift and hold the engine, always use a crane with a sufficient allowance in limit load or a rigid jack.
  [Otherwise]
  A serious accident may arise.

⚠ WARNING



- **Use of Appropriate Tools**
  Use tools matching the jobs to be done. Use a correctly sized tool for loosening or tightening a machine part.
  [Otherwise]
  A serious injury or engine damage may arise.

(D) Use of Genuine Parts, Oil and Grease

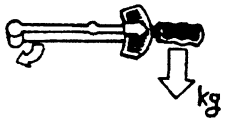
⚠ CAUTION

- **Always use genuine parts.**

  [Otherwise]
  Shortening of engine life or an unexpected accident may arise.

(E) Bolt and Nut Tightening Torques

⚠ WARNING



- **Always tighten to the specified torque if designated in the manual.**

  [Otherwise]
  Loosening or falling may cause parts damage or an injury.

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(3) 4TNE106

Engine name		Unit	4TNE106					
Engine specification class		–	CL		VM			
Type		–	Vertical, in-line, 4-cycle, water-cooled diesel engine					
Combustion chamber		–	Direct injection					
Number of cylinders		–	4					
Cylinder bore × stroke		mm × mm	106 × 125					
Displacement		ℓ	4.412					
Continuous rating	Revolving speed	min^{-1}	1500	1800	–			
	Output	kW (hp)	44.9 (60.2)	53.7 (72.0)	–			
Rated output	Revolving speed	min^{-1}	1500	1800	2000	2200	2400	2500
	Output	kW (hp)	49.3 (66.1)	58.8 (78.8)	56.6 (75.8)	61.4 (82.3)	65.5 (87.8)	67.7 (90.7)
Fuel injection timing (FID, bTDC)		deg	10 ± 1		12.5 ± 1			
Fuel injection pressure		MPa (kgf/cm^2)	21.57~ 22.55 (220~230)					
Ignition order		–	1–3–4–2 (No. 1 cylinder on flywheel side)					
Power take off		–	Flywheel					
Direction of rotation		–	Counterclockwise (viewed from flywheel)					
Cooling system		–	Radiator					
Lubrication system		–	Forced lubrication with trochoid pump					
Starting system		–	Electric					
Applicable fuel		–	Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (cetane No. 45 min.)					
Applicable lubricant		–	API grade class CD					
Battery capacity		V-Ah	12–88 (5HR) or above					
Lubricant capacity (oil pan)	Total	ℓ	12.5					
	Effective	ℓ	5.5					
Cooling water capacity (engine only)		ℓ	6.0					
Engine dimensions	Overall length	mm	789					
	Overall width	mm	535					
	Overall height	mm	750					
Engine mass (dry)		kg	301					

1.7 Precautions for Service Work

(1) Precautions for Safety

Read the safety precautions given at the beginning of this manual carefully and always mind safety in work.

(2) Preparation for Service Work

Preparation is necessary for accurate, efficient service work. Check the customer ledger file for the history of the engine.

(2.1) Preceding service date
(2.2) Period/operation hours after preceding service
(2.3) Problems and actions in preceding service
(2.4) Replacement parts expected to be required for service
(2.5) Recording form/check sheet required for service

(3) Preparation before Disassembly

(3.1) Prepare general tools, special service tools, measuring instruments, oil, grease, non-reusable parts, and parts expected to be required for replacement.
(3.2) When disassembling complicated portions, put matchmarks and other marks at places not adversely affecting the function for easy reassembly.

(4) Precautions in Disassembly

(4.1) Each time a parts is removed, check the part installed state, deformation, damage, roughening, surface defect, etc.
(4.2) Arrange the removed parts orderly with clear distinction between those to be replaced and those to be used again.
(4.3) Parts to be used again shall be washed and cleaned sufficiently .
(4.4) Select especially clean locations and use clean tools for disassembly of hydraulic units such as the fuel injection pump.

(5) Precautions for Inspection and Measurement

(5.1) Inspect and measure parts to be used again as reuqired to determine whether they are reusable or not.

(6) Precautions for Reassembly

(6.1) Reassemble correct parts in correct order according to the specified standards (tightening torques, and adjustment standards). Apply oil to important bolts and nuts before tightening when specified.
(6.2) Always use genuine parts for replacement.
(6.3) Always use new oil seals, O-rings, packings and cotter pins.
(6.4) Apply sealant to packings depending on the place where they are used. Apply oil or grease to sliding contact portions, and apply grease to oil seal lips.

(7) Precautions for Adjustment and Check

(7.1) Use measuring instruments for adjustment to the specified service standards.

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2.2 Troubleshooting by Measuring Compression Pressure

Compression pressure drop is one of major causes of increasing blowby gas (lubricating oil contamination or increased lubricating oil consumption as a resultant phenomenon) or starting failure. The compression pressure is affected by the following factors:

1. Degree of clearance between piston and cylinder
2. Degree of clearance at intake/exhaust valve seat
3. Gas leak from nozzle gasket or cylinder head gasket

In other words, the pressure drops due to increased parts wear and reduced durability resulting from long use of the engine.

A pressure drop may also be caused by scratched cylinder or piston by dust entrance from the dirty air cleaner element or worn or broken piston ring. Measure the compression pressure to diagnose presence of any abnormality in the engine.

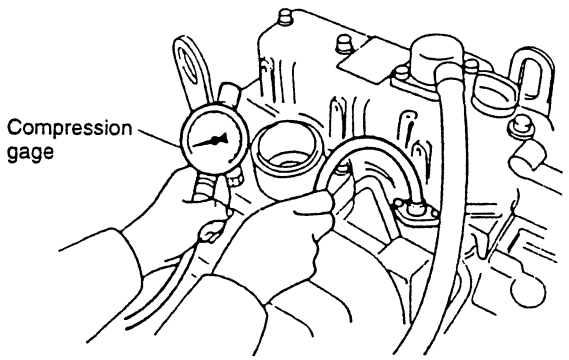
(1) Compression pressure measurement method

① After warming up the engine, remove the fuel injection pipe and valves from the cylinder to be measured.

② Crank the engine before installing the compression gage adapter.

*1. Perform cranking with the stop handle at the stop position (no injection state).

*2. See 11.2 – 18 in Chapter 11 for the compression gage and compression gage adapter.



Measurement of the compression pressure

③ Install the compression gage and compression gage adapter at the cylinder to be measured.

*Never forget to install a gasket at the tip end of the adapter.

④ With the engine set to the same state as in ② *1, crank the engine by the starter motor until the compression gage reading is stabilized.

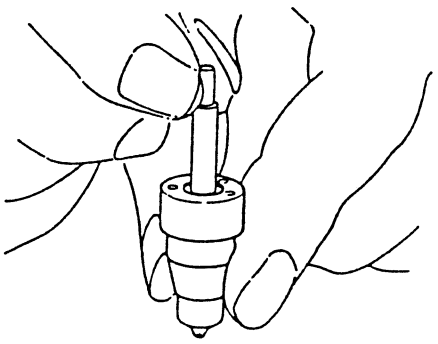
(2) Standard compression pressure

[Engine compression pressure list (reference value)]

Engine model	Compression pressure MPa (kgf/cm²) at 250 min⁻¹		Deviation among cylinders MPa (kgf/cm²)
	Standard	Limit	
4TNE94/98/106(T)	3.43±0.1 (35±1)	2.75 (28)	0.2 ~ 0.3 (2 ~ 3)

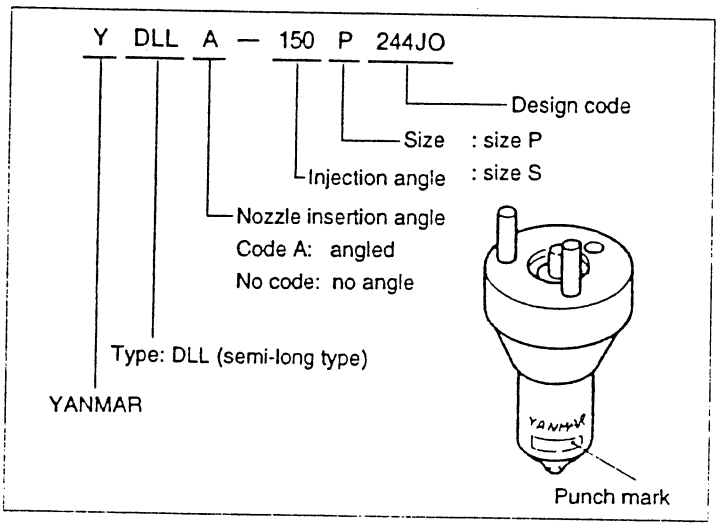
(3) Nozzle valve sliding test

Wash the nozzle valve in clean fuel oil. Place the nozzle body vertically and insert the nozzle into the body to about 1/3 of its length. The valve is normal if it smoothly falls by its own weight into the body. In case of a new nozzle, remove the seal peel, and immerse it in clean diesel oil or the like to clean the inner and outer surfaces and to thoroughly remove rust-preventive oil before using the nozzle. Note that a new nozzle is coated with rust-preventive oil and is pasted with the seal peel to shut off outer air.



Nozzle valve sliding check by gravity

(4) Nozzle punch mark



4. ENGINE BODY ..... 4-1~4-30

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① If the seat surface is slightly roughened: perform **[A]** and **[B]** below.

② If the seat is heavily roughened but the width is almost normal, correct with a seat grinder or seat cutter first. Then perform lapping **[A]** and **[B]** below.

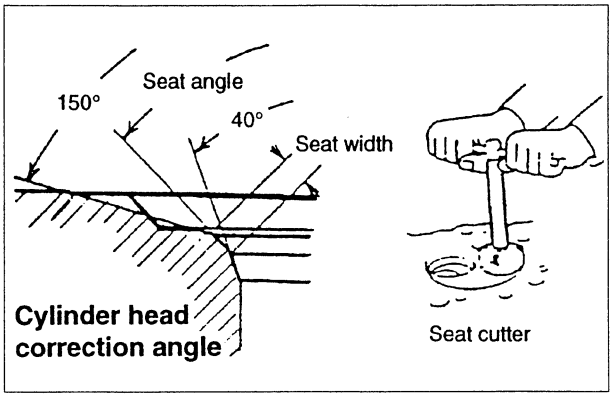
Seat cutter angle	Intake	Exhaust
	120	90

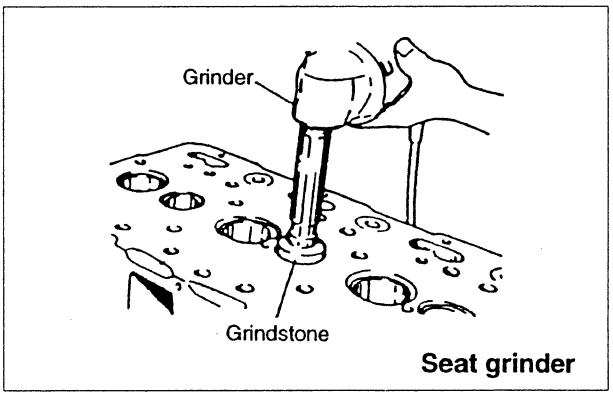
③ If the seat is heavily roughened and the width is much enlarged, grind the seat inner surface with a seat grinder whose center angle is 40°, then grind the seat outer surface with a grinder whose center angle is 150° to make the seat width match the standard. Then perform seat correction as described in ②, and then carry out lapping **[A]** and **[B]** below.

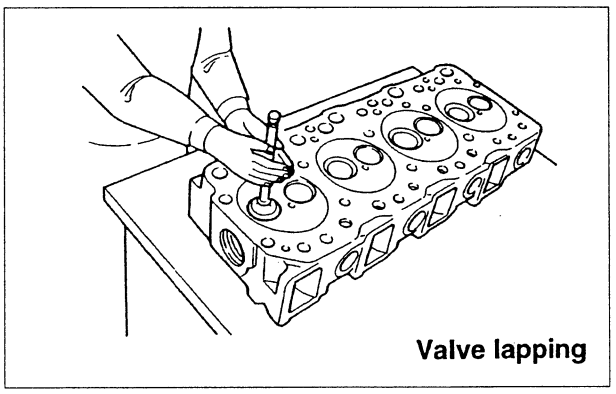
Grinding wheel angle	θ_1	θ_2
	40	150

[A]: Lap the valve and seat with a mixture of valve compound and engine oil.

[B]: Lap with engine oil only.







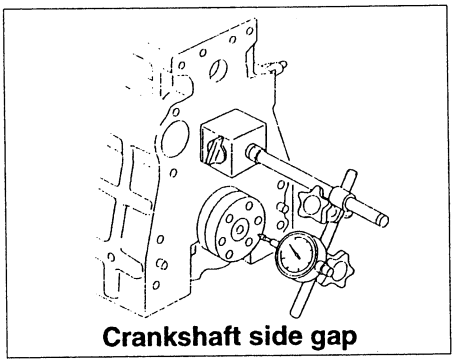
Point 4 Journal bearing cap

Disassemble:

- Before removing the journal bearing, measure the crankshaft side gap.

(mm)

–	Standard	Limit
4TNE94•98	0.11 ~ 0.21	–
4TNE106 (T)	0.13~0.23	–



Crankshaft side gap

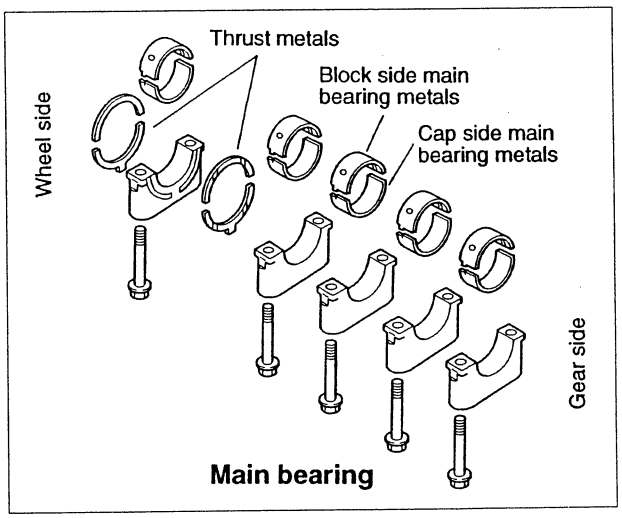
Reassemble:

- If the side gap exceeds the standard, replace the thrust metal with an oversize one.

0.25 DS	Thrust metal		Standard thickness (mm)
	Upper	Lower	
4TNE94•98	129900-02370	129900-02360	2.055~2.105
4TNE106 (T)	123900-02370	123900-02360	2.555~2.605

Disassemble:

- Remove the bearing caps, cap side bearings, and thrust metals. Place each thrust metal with identification of the position and direction.
- Carefully install each thrust metal so that the grooved one is positioned away from the cap.
- Do not confuse the upper and lower main bearing metals. The upper main bearing metal (block side) has an oil hole, and the lower one does not. The "wheel and arrow" marks on the cap shall face the flywheel.



Main bearing

Nm (kgf•m)

–	Standard (apply lube oil)
4TNE94•98	107.9~117.7 (11~12)
4TNE106 (T)	186.3~205.9 (19~21)

Point 5 Crankshaft

Disassemble:

- Remove the crankshaft. Remove each main bearing metal upper (block side) and pair it with the metal cap side lower metal.

⚠ CAUTION

Carefully prevent damage to the bearing or finger injury when removing the crankshaft because it is heavy.

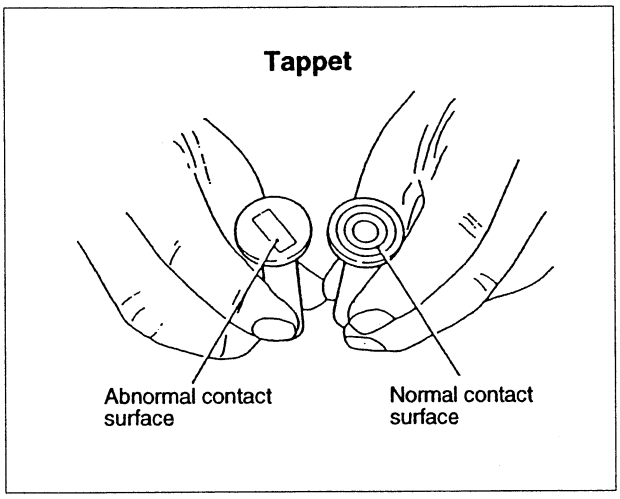
(5.6) Tappet

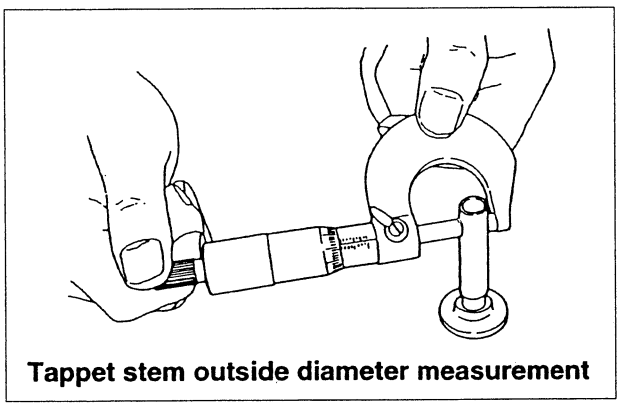
Mainly check the tappet contact surface with the cam and push rod. Slight surface defects shall be corrected with an oilstone.

① Tappet stem outside diameter measurement

(mm)

–	Standard	Limit
4TNE94•98		
Tappet hole I.D.	12.000~12.018	12.038
Stem O.D.	11.975~11.990	11.955
Clearance	0.010~0.043	0.083
4TNE106 (T)		
Tappet hole I.D.	14.000~14.018	14.038
Stem O.D.	13.966~13.984	13.946
Clearance	0.015~0.052	0.092

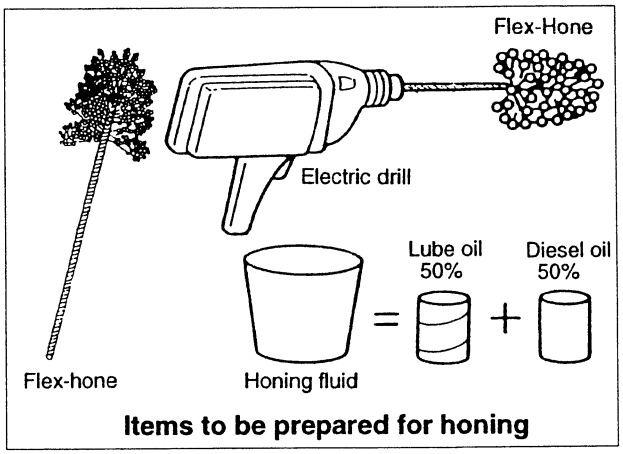




(6) Cylinder bore correction

① Slight uneven worn, flawed, etc. shall be corrected by honing only. If the cylinder is unevenly worn partially, flawed or otherwise damaged and cannot be repaired simply by honing, rebore the cylinder first and then hone. See (5) (5.1)③ for the boring dimension.

② Items to be prepared for honing
- Flex-Hone
  (see 11.1-8 in Chapter 11)
- Electric drill
- Honing fluid
  (50:50 mixture of lube oil and diesel oil)



7. FUEL INJECTION PUMP/ GOVERNOR ..... 7-1~7-9

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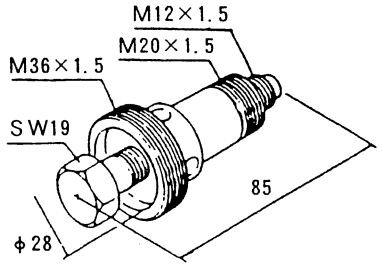
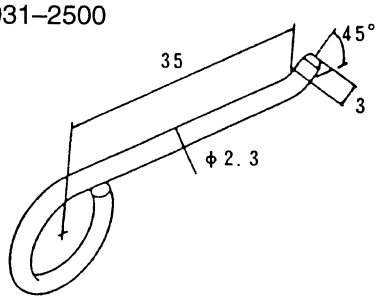
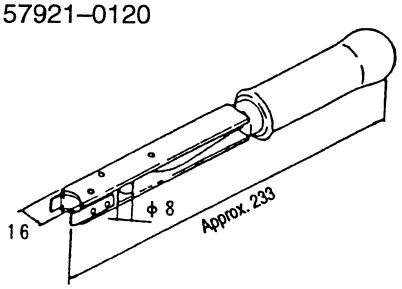
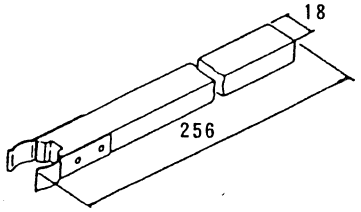
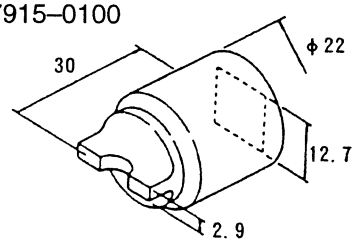
(3) Parts inspection and measurement

Generally end disassembly in this stage and wash the parts for inspection.
See that each parts is not worn excessively or play.

7.6 Special Service Tools for Disassembly/Assembly

No.	Tool name	Application	Manufacturer's code and illustration
1	Extractor	Flyweight removal	157926–5110 
2	Tappet holder	Tappet and cam contact separation	157931–2500 
3	Tappet insert	Pushing tappet up	157921–0120 
4	Clamp	Tappet removal	157931–6120 
5	Wrench	Flyweight nut removal	157915–0100 

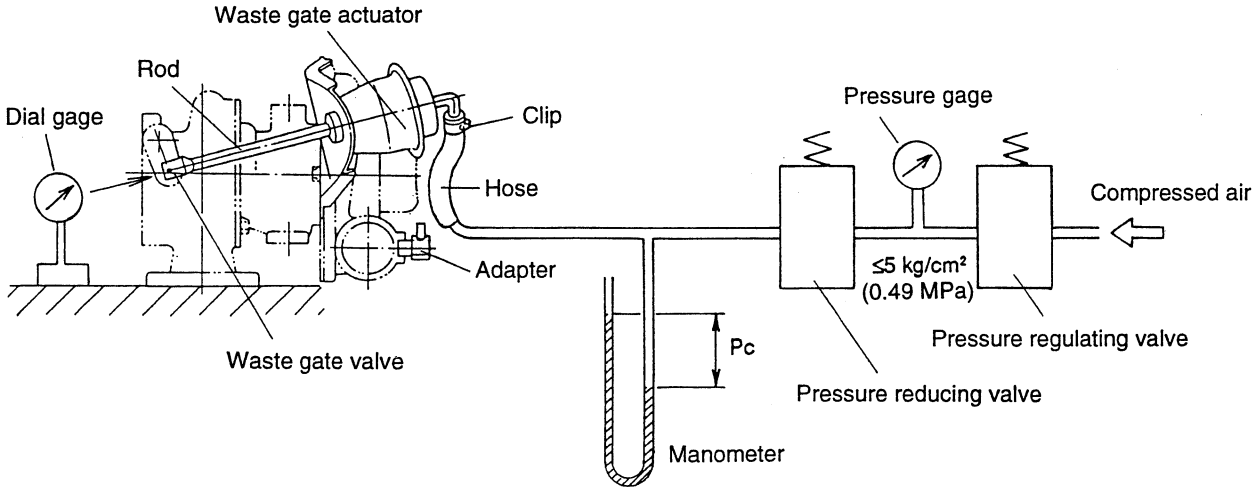
(3.1) Method for checking the waste gate valve opening pressure and lift

① Equipment

Prepare the equipment shown in the figure below.

② Measuring instruments and devices

Dial gage	Capable of measuring 0 to 10 mm (A flat head type is recommendable.)
Manometer	Mercury column or electrical type (capable of measuring 0 to 1500 mmHg)
Pressure regulating valve	Allowing gradual adjustment in a range between 0 and 2 kgf/cm² (0.196 Mpa)
Pressure reducing valve	Used for suppressing the air supply pressure at 5 kgf /cm² (0.49 Mpa) or less.
Pressure gage	Bourdon tube pressure gage (0 to 10 kgf/cm² (0.98 Mpa))



[Note] Pc (controller pressure) varies with the set output in a range between 600 and 750 mmHg.

③ Check method

a. Set the manometer control pressure (Pc) applied to the waste gate actuator to 0 and set the dial gage to the zero point.
b. Gradually open the pressure regulating valve and measure the Pc value when the actuator rod is operated by 2 mm.
c. For the hysteresis, let the rod move to 3 mm first. The gradually close the pressure regulating valve, measure the pressure when the rod is moved to 2 mm and obtain the difference from the pressure measured in b. above.

④ Precautions

- Set the dial gage on the extension line of the actuator rod.
- The piping and joints shall completely be free from leak.
- Fix the turbocharger and dial gage securely.
- If an electric manometer is used, it shall have sufficient precision.
- Even when an electric manometer is used, use of a mercury column type manometer in combination is recommended for calibration and daily check.
- The speed for increasing/decreasing Pc by means of the pressure regulating valve shall be very slow near the measuring point. If the 2 mm position is exceeded, restart from the beginning.
- Do not apply over 5 kgf/cm² (0.49 MPa) to the actuator.

(3.2) Waste gate actuator leak test

Apply 1.2 kgf/cm² (0.12 Mpa) to the actuator and hold the state for 1 minute. The actuator is good if the pressure then is 1.1 kgf/cm² (0.11 MPa) or above.

8.8 Troubleshooting

Sufficient turbocharger performance and required engine output cannot be obtained if there is any fault. In such a case, first check each engine part to see there is no engine fault. Then inspect the turbocharger for troubleshooting according to the procedure shown below.

(1) Excessively exhaust smoke

<Insufficient intake air volume>

Cause	Corrective action
1) Clogged air cleaner element	• Replace or wash the element.
2) Blocked air intake port	• Correct to the normal state.
3) Leak from a joint in intake line	• Inspect and repair.

<Turbocharger revolution failure>

Cause	Corrective action
1) Deposit of impurities in oil sticking on the turbine side seal portion to make turbine revolution heavy	• Turbocharger overhaul (disassembly and washing) with lubricating oil replacement
2) Sticking bearing	• Turbocharger overhaul (disassembly and repair)
• Insufficient lubrication or clogged lubrication piping	• Lubricating oil line inspection, repair of defective portion and lubricating oil replacement
• Excessively high oil temperature	• Rotating part replacement or washing
• Unbalanced rotating part	• Strict observance of instructions in operation manual
• Insufficient warming up or sudden stop from loaded operation (no-load operation)	
3) Contact or breakdown of turbine wheel or blower vane	• Inspection and repair of each engine part
• Excessive revolution	• Perfect foreign matter elimination in disassembled state, followed by inspection and repair of individual air cleaner and engine components
• Excessive exhaust temperature rise	• Turbocharger overhaul (disassembly and repair)
• Foreign matter invasion	• Reassembly
• Worn bearing	
• Assembly defect	

<Influence of exhaust resistance>

Cause	Corrective action
1) Exhaust gas leak before the turbocharger to decrease its revolutions	• Joint inspection and correction
2) Deformed or clogged exhaust pipe to decrease turbocharger revolutions	• Correct to the normal state.

(2) White smoke generation

Cause	Corrective action
1) Clogged or deformed oil return pipe causing oil flow to the blower or turbine side	• Repair or pipe replacement
2) Excessive bearing wear causing abnormal wear or damage of seal ring	• Turbocharger disassembly and repair

12) Screw M4 (3)
13) Bearing retainer
14) Gear case

Remove screw M4, and the bearing retainer and clutch assy can be removed.

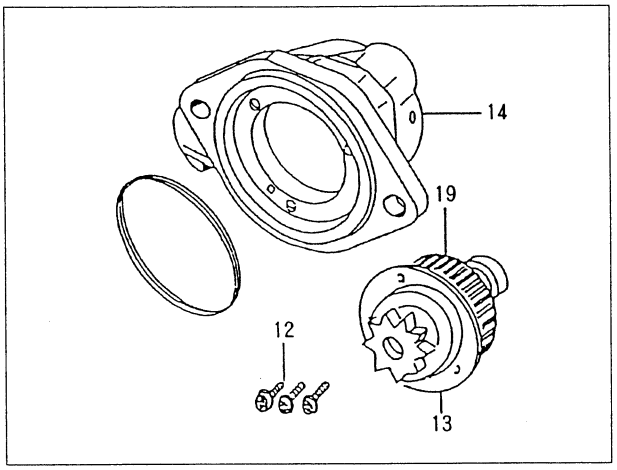


Fig. 7

15) Pinion stopper clip

Remove the bearing retainer at the edge and the bearing, and shift the pinion stopper toward the pinion. Use a plain screwdriver and pry to remove the pinion stopper clip.

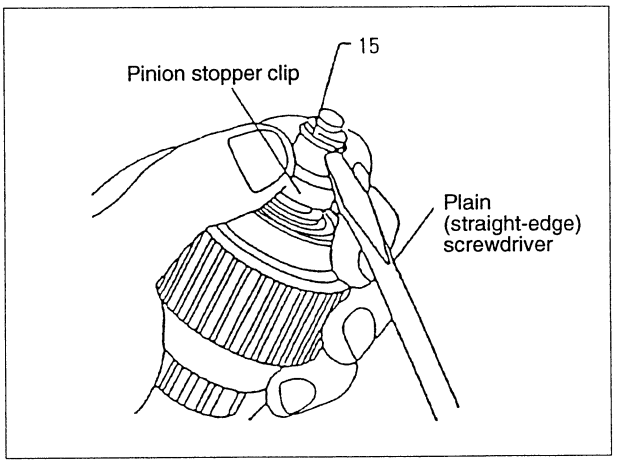


Fig. 8

16) Pinion stopper
17) Return spring
18) Pinion shaft
19) Clutch Assy

Remove the pinion stopper clip. The pinion stopper, return spring, pinion shaft and bearing retainer can be removed.
Disassembly is completed now.

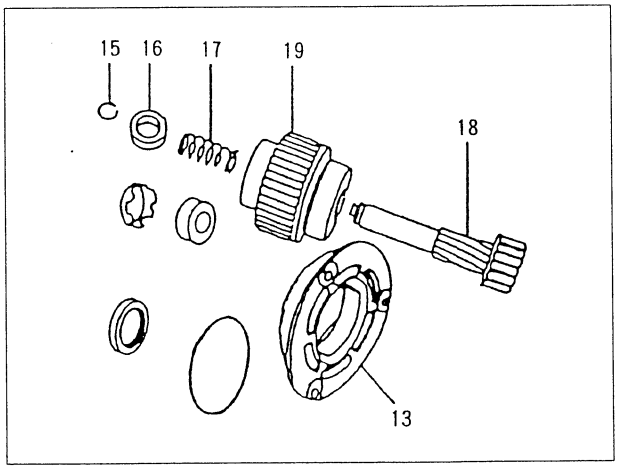


Fig. 9

9.1.8 Characteristic test

Since the characteristics can be checked roughly by means of a simple no-load test as explained below.

※ Complete the test quickly since the rating of the starting motor is 30 seconds.

1. No-load test

Fix the starting motor on a test bench and connect wiring as shown in Fig. 31. When the switch is closed, a current flows in the starting motor, which is rotated at no-load. Measure the current, voltage and number of revolutions then and check if they satisfy the specified characteristics.

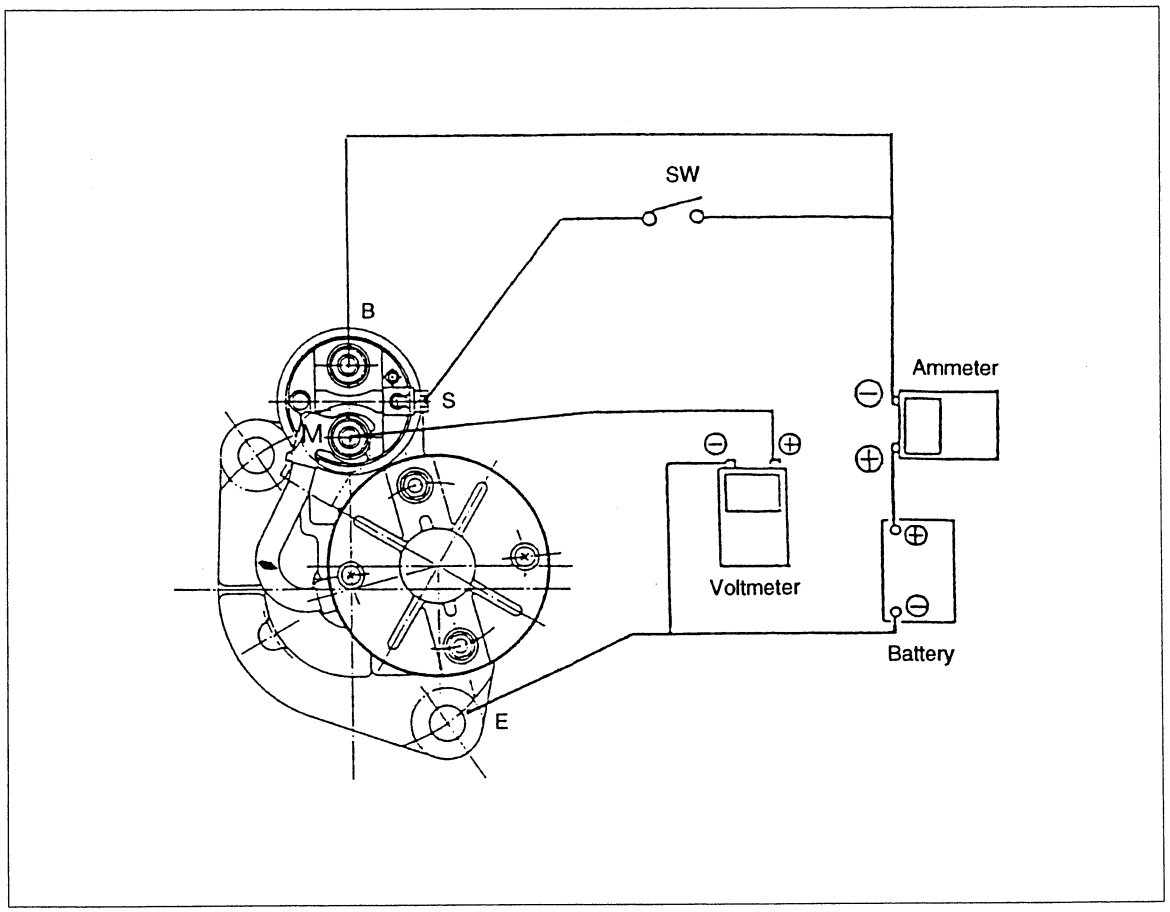
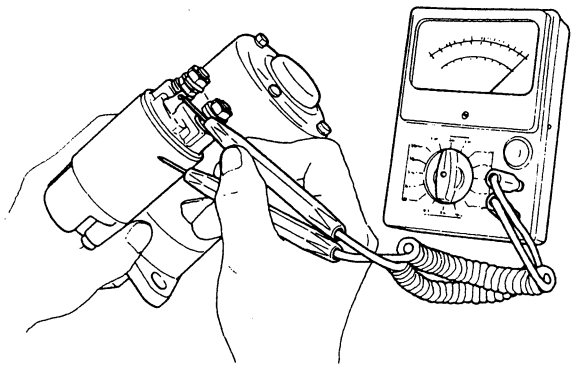
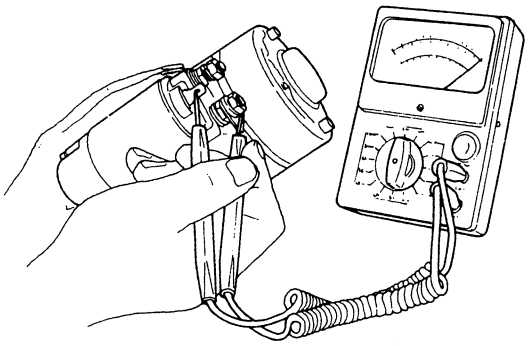


Fig. 31



(Shunt coil continuity test)



(Series coil continuity test)

(5) Pinion

a) Check the pinion teeth for wear and damage. Replace with a new one, if necessary.
b) Check if the pinion slides smoothly. If it is damaged or rusted or does not slide smoothly, repair.
c) Check springs for damage, and replace if necessary.

(6) Ball bearing

If abnormalities such as irregular noises are detected to the ball bearing, replace with a new one.

9.2.7 Assembly

The assembly procedure is reverse of the disassembly procedure, but pay attention to the following points.

(1) Apply grease as instructed below.

Greasing point	Grease type
Sliding portions and head of plunger Pinion metal and metal portions of gear case Spline portions of pinion Sliding portions of shift lever	NPC-FC6A Grease
Deceleration gear	MALTEMP SRL Grease

(2) Armature thrust

No adjustments are needed for the thrust.

(3) Gear shaft thrust

Some thrust washers of 1.0 and 0.25 mm thickness are provided between the center bracket and gear shaft supporting surface. Make sure to check them at reassembly.
If washers are deformed or worn, replace them with new ones.
The appropriate thrust is from 0.05 to 0.3 mm. If it is over 0.3 mm, add the appropriate thrust washer, but pay attention so that the thrust is not 0.

Disassembly Procedures

1) Through bolt M5

Remove the M5 through bolt. Increase the temperature at the center of the rear cover by about 20°C using a soldering iron, insert two flat-head screwdrivers between the front cover and the stator core and separate the assembly into the front side (front cover and rotor) and the rear side (rear cover and stator).

Note: *Be careful not to damage the stator coil with the edges of the screwdrivers.*

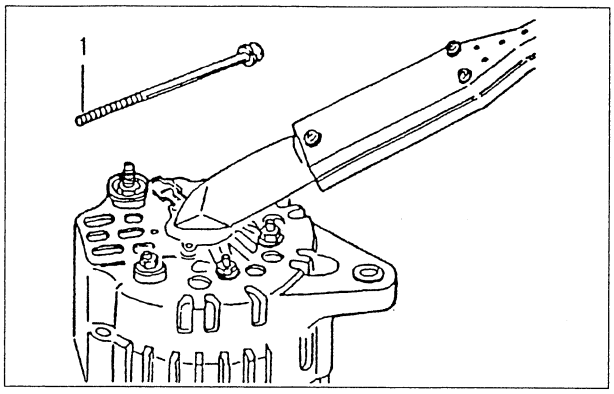


Fig. 1

2) Pulley nut
3) Pulley assembly
4) Rotor

Fix the rotor in a vice and remove the M15 (22 mm) pulley nut to separate the pulley, front cover and rotor.

※ *Dimensions shown in ( ) indicate the spanner sizes to be used.*

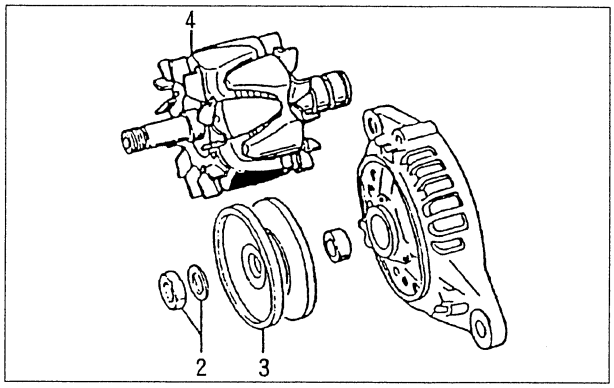


Fig. 2

5) Screw M4
6) Bearing retainer
7) Ball bearing
8) Front cover

Remove the M5 screw securing the bearing retainer to separate the bearing retainer, ball bearing and front cover.

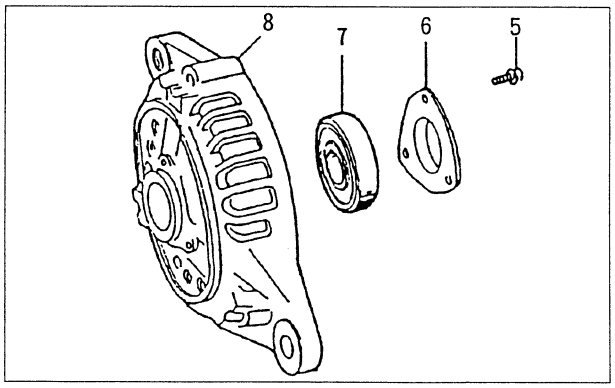


Fig. 3

9) Nuts M5 and M6
10) Rear cover
11) Lead wire assembly

Remove the M5 and M6 nuts securing the diode and IC regulator. Press in the grommet and lead wire of the lead wire assembly into the hole in the rear cover to separate the stay and rear cover.

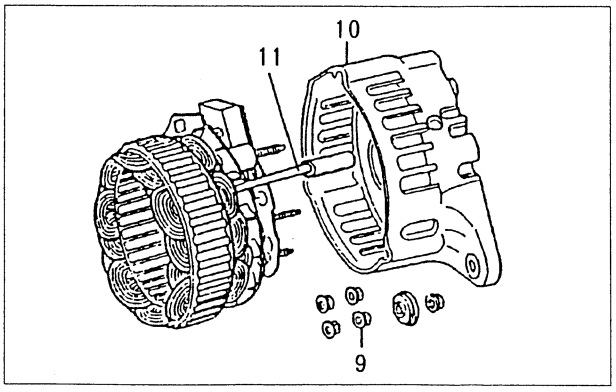
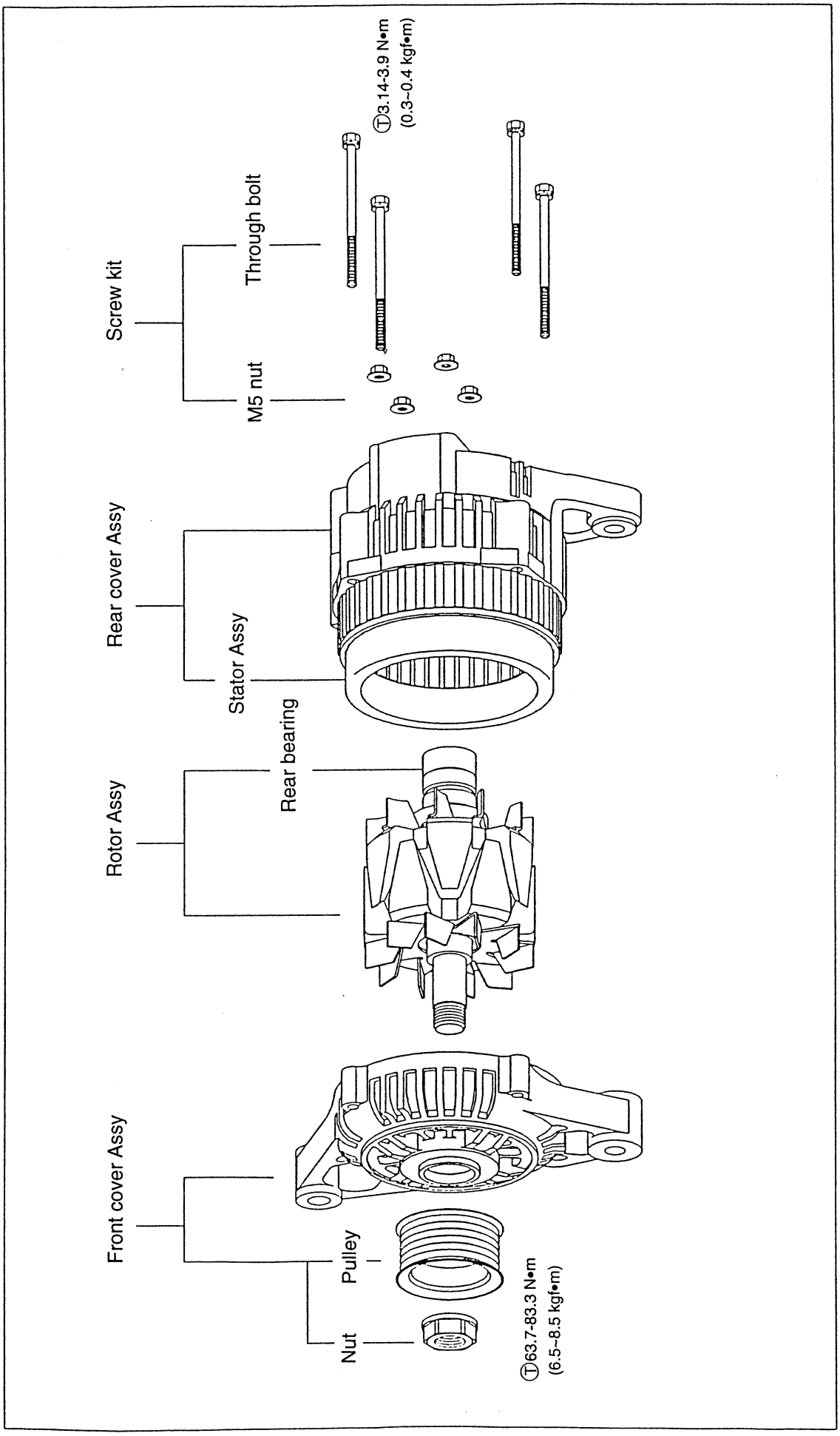
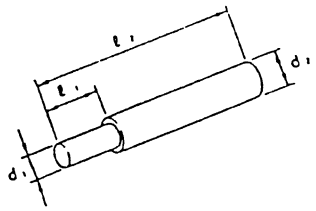
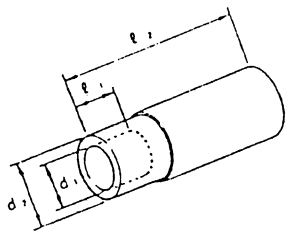
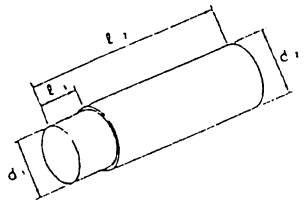
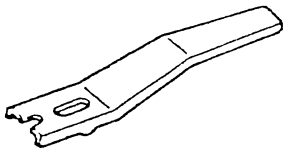
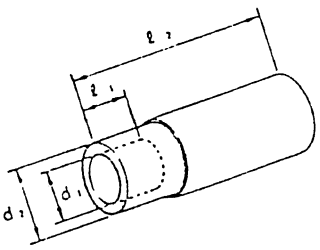


Fig. 4

10.2.2 Exploded View



11.1 Special Tools

<table>
<tr><th>No.</th><th>Tool name</th><th>Applicable model and tool size</th><th>Illustration</th></tr>
<tr><td>1</td><td>Valve guide tool (for extracting valve guide)</td><td>(mm)<table><tr><th>Applicable model</th><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>4TNE94•98</td><td>20</td><td>75</td><td>7.5</td><td>11</td></tr><tr><td>4TNE106 (T)</td><td>20</td><td>75</td><td>8.5</td><td>12</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
<tr><td>2</td><td>Valve guide tool (for inserting valve guide)</td><td>(mm)<table><tr><th>Applicable model</th><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>4TNE94•98</td><td>$15^{0}_{-0.3}$</td><td>65</td><td>13.5</td><td>20</td></tr><tr><td>4TNE106 (T)</td><td>$13.5^{0}_{-0.3}$</td><td>65</td><td>14</td><td>20</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
<tr><td>3</td><td>Connecting rod bushing replacer (for removal/ installation of connecting rod bushing)</td><td>(mm)<table><tr><th>Applicable model</th><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>4TNE94•98</td><td>20</td><td>100</td><td>$30^{-0.3}_{-0.6}$</td><td>$33^{-0.3}_{-0.6}$</td></tr><tr><td>4TNE106 (T)</td><td>20</td><td>100</td><td>$37^{-0.3}_{-0.6}$</td><td>$40^{-0.3}_{-0.6}$</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
<tr><td>4</td><td>Valve spring compressor (for removal/ installation of valve spring)</td><td><table><tr><th>Yanmar code No.</th></tr><tr><td>129100-92630</td></tr></table></td><td>  </td></tr>
<tr><td>5</td><td>Stem seal inserter (for inserting stem seal)</td><td>(mm)<table><tr><th>Applicable model</th><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>4TNE94•98</td><td>$21_{\pm 0.5}$</td><td>65</td><td>16.5</td><td>23</td></tr><tr><td>4TNE106 (T)</td><td>$17.5_{\pm 0.5}$</td><td>65</td><td>17</td><td>23</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
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