CHAPTER GI

GENERAL INTRODUCTION

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GENERAL PRECAUTIONS

Some recommended and standard maintenance services for your engine are mentioned in this section. When performing maintenance on your engine be careful not to get injured by improper work. Improper or incomplete work can cause a malfunction of the engine which may result in personal injury and/or property damage.

WARNING

When working on your engine, observe the following general precautions to prevent personal injury and/or property damage in addition to the particular NOTES or WARNINGS.

- Most threaded fasteners are metric.
- Be careful not to mix with threaded fasteners using the inch system.

- Always wear safety glasses or goggles to protect your eyes.
- Remove rings, watches, ties, loose hanging jewelry and loose clothing before starting work on the engine.
- Bind long hair securely behind the head.
- To avoid serious burns, keep yourself away from hot metal parts such as the engine, exhaust manifold, radiator, muffler, exhaust pipe and tail pipe.
- Keep yourself, your clothing and your tools away from moving parts such as the cooling fan and V-belts when the engine is running.
- Always stop the engine by pulling out the engine stop knob. Leave the knob pulled out as long as the engine is stopped. And turn off the starter switch, unless the operation requires the engine running. Removing the key from the switch is recommended.
- Run the engine only in a well-ventilated area to avoid inhaling of carbon monoxide.
- Do not smoke while working on the engine since fuel and gases from the battery are flammable.
- Take utmost care when working on the battery. It contains corrosive sulfuric acid.
- Large electric current flows through the battery cable and starter cable. Be careful not to cause a short which can result in personal injury and/or property damage.
- Be careful not to leave any tool in the engine compartment. The tool may be hit by moving parts and can cause personal injury.
HOW TO USE THIS WORKSHOP MANUAL.

This workshop manual is designed as a guide for servicing engine. An INDEX is provided on the first page of each chapter. TROUBLESHOOTING is dealt with each chapter. When beginning operations, refer to the sections on for guide to appropriate diagnoses.

SPECIAL TOOLS are dealt with in each chapter. When ordering a special tool, make sure that the parts number is correct.

REPAIR PROCEDURES

Repair procedures which are self-explanatory such as simple installation and removal of parts have been omitted. Illustrations such as the one below have been provided to make such simple procedures clear. Only essential procedures requiring directions have been dealt with explicitly.

EXAMPLE:

TIMING GEAR AND CAMSHAFT

1. Thrust bearing
2. Camshaft gear
3. Oil pump drive gear
4. Idler gear
5. Bushing
6. Idler gear thrust plate
7. Straight pin
8. Idler gear shaft
9. Crankshaft gear
10. Injection pump drive gear
11. Idler gear thrust plate
12. Camshaft
13. Front end plate gasket
14. Front end plate

T = Tightening torque kg-cm (lb.ft)

T = 190–260 (14–18)

T = 1,100–1,300 (80–94)

T = 1,100–1,300 (80–94)

Marine Parts Supply of Canada
1930 Stewart Ave
Moncton, N.B.
559-401
Ph (800) 661-5353
Fax (250) 754-9471
GENERAL INTRODUCTION

In some cases, illustrations may be of parts which differ in some nonessential way from the parts found on your particular engine. In such cases, however, the principle or procedure being illustrated applies regardless of such nonessential differences.

IDENTIFICATION INFORMATION

ENGINE SERIAL NUMBERS

Please quote these numbers when ordering spare parts or reporting technical matters as they will give you prompt service attention.

The engine serial number is engraved on the engine cylinder block.
## GENERAL INTRODUCTION

## SPECIFICATIONS

### DIESEL ENGINE FOR MARINE USE

**HINO W06D-T1**  
5.759 liters, 4-cycle, 6-cyl., water-cooled, turbocharged and intercooled

### ENGINE DESCRIPTION

1. **Max. output, pleasure craft**  
   187 kW (250 HP)/3,000 rpm
2. **Max. output, work boat**  
   (light duty)  
   164 kW (220 HP)/3,000 rpm
3. **Type**  
   Diesel, 4-cycle, 6-cyl., in-line, over-head valve, water-cooled
4. **Aspiration**  
   Turbocharged and intercooled
5. **Combustion system**  
   Direct injection
6. **Cylinder Bore x Stroke**  
   104 x 113 mm (4.09 x 4.45 in.)
7. **Piston displacement**  
   5.759 liter (351.5 cu.in.)
8. **Compression ratio**  
   16.5
9. **Direction of rotation**  
   Counter-clockwise viewed from flywheel
10. **Dimensions with marine gear (L x W x H)**  
    Approx. 1,401 x 835 x 866 mm  
    (55.2 x 32.9 x 34.1 in.)
11. **Dry weight with marine gear**  
    Approx. 600 kg (1,323 lb)

### FEATURES

1. **Cylinder block**  
   Mono block cast iron with replaceable dry liner
2. **Cylinder head**  
   Single piece cast iron
3. **Crankshaft**  
   Induction hardened die forged special steel with counter weights
4. **Piston and rings**  
   Heat resistance aluminum alloy  
   Two compression rings, chrome plated  
   One oil ring, chrome plated with coil expander
5. **Camshaft**  
   Induction hardened carbon steel
6. **Valves**  
   Heat resistance steel
• EQUIPMENT

• ENGINE
1. Flywheel housing SAE No. 3
2. Flywheel SAE 11½
3. Fuel injection pump BOSCH “A” type with all speed governor
4. Fuel filter Paper element type
5. Water separator Equipped
6. Lube oil pump Full forced pressure feed by gear pump
7. Lube oil filter Paper element type (Full flow)
8. Lube oil cooler Multi plate type, Fresh water cooled
9. Fresh water pump Forced-circulation by volute pump
10. Raw water pump Self priming, Rubber impeller type
11. Intake manifold Inlet position at rear
12. Exhaust manifold Fresh water-cooled exhaust manifold, integrated heat exchanger with expansion tank
13. Turbocharger Cooled by fresh water, with air cleaner
14. Intercooler Cooled by raw water
15. Starter 12V, 2.5 KW
16. Alternator 12V, 80A, with built-in voltage regulator
17. Engine stop solenoid Equipped
18. Emergency stop relay Equipped
19. Starter block relay Equipped
20. Glow plug Equipped
21. Rigid mount bracket Equipped
22. Exhaust riser Cooled by raw water
23. Marine gear Equipped

• INSTRUMENT PANEL
1. Battery switch
2. Starter switch with key
3. Instrument panel lamp switch
4. Tachometer with hourmeter
5. Coolant temperature gauge
6. Oil pressure gauge
7. Fuel gauge
8. Volt meter
9. Pre-heater indicator lamp
10. Coolant temperature warning lamp
11. Charge warning lamp
12. Oil pressure warning lamp
NOTE: These specifications are subject to change without notice.

Hino Motors, Ltd.

TOKYO, JAPAN
### Tightening Torque of Standard Bolt

<table>
<thead>
<tr>
<th>Bolt Identification</th>
<th>Tightening Conditions</th>
<th>Bolt Diameter (in)</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc.</td>
<td>Optimum conditions.</td>
<td>18 - 20</td>
<td>1.2 - 1.7</td>
<td>9 - 12</td>
<td>14 - 19</td>
<td>18 - 22</td>
<td>22 - 27</td>
<td>26 - 32</td>
<td>30 - 37</td>
<td>34 - 42</td>
<td>38 - 45</td>
<td>42 - 50</td>
<td></td>
</tr>
<tr>
<td>Cast iron or aluminum tightening surface. Washers.</td>
<td>Medium conditions.</td>
<td>17 - 25</td>
<td>1.3 - 1.8</td>
<td>9 - 12</td>
<td>14 - 19</td>
<td>18 - 22</td>
<td>22 - 27</td>
<td>26 - 32</td>
<td>30 - 37</td>
<td>34 - 42</td>
<td>38 - 45</td>
<td>42 - 50</td>
<td></td>
</tr>
<tr>
<td>Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable.</td>
<td>Poor tightening conditions.</td>
<td>16 - 24</td>
<td>1.2 - 1.7</td>
<td>9 - 12</td>
<td>14 - 19</td>
<td>18 - 22</td>
<td>22 - 27</td>
<td>26 - 32</td>
<td>30 - 37</td>
<td>34 - 42</td>
<td>38 - 45</td>
<td>42 - 50</td>
<td></td>
</tr>
<tr>
<td>Cast iron or aluminum tightening surface. Washers.</td>
<td>Medium conditions.</td>
<td>22 - 27</td>
<td>1.8 - 2.3</td>
<td>9 - 12</td>
<td>14 - 19</td>
<td>18 - 22</td>
<td>22 - 27</td>
<td>26 - 32</td>
<td>30 - 37</td>
<td>34 - 42</td>
<td>38 - 45</td>
<td>42 - 50</td>
<td></td>
</tr>
<tr>
<td>Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable.</td>
<td>Poor tightening conditions.</td>
<td>22 - 28</td>
<td>2.0 - 2.5</td>
<td>9 - 12</td>
<td>14 - 19</td>
<td>18 - 22</td>
<td>22 - 27</td>
<td>26 - 32</td>
<td>30 - 37</td>
<td>34 - 42</td>
<td>38 - 45</td>
<td>42 - 50</td>
<td></td>
</tr>
<tr>
<td>Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc.</td>
<td>Optimum conditions.</td>
<td>24 - 28</td>
<td>2.0 - 2.5</td>
<td>9 - 12</td>
<td>14 - 19</td>
<td>18 - 22</td>
<td>22 - 27</td>
<td>26 - 32</td>
<td>30 - 37</td>
<td>34 - 42</td>
<td>38 - 45</td>
<td>42 - 50</td>
<td></td>
</tr>
<tr>
<td>Cast iron or aluminum tightening surface. Washers.</td>
<td>Medium conditions.</td>
<td>32 - 42</td>
<td>2.4 - 3.0</td>
<td>14 - 20</td>
<td>19 - 25</td>
<td>24 - 30</td>
<td>29 - 36</td>
<td>34 - 41</td>
<td>39 - 46</td>
<td>44 - 52</td>
<td>49 - 56</td>
<td>54 - 62</td>
<td></td>
</tr>
</tbody>
</table>

**Unit:** kg-cm (lb-ft)

**Note:** The torque values given in this table should be applied when bolt torque is not specified.
# RECOMMENDED LUBRICANTS FOR ALL HINO ENGINE

<table>
<thead>
<tr>
<th>LUBRICANTS</th>
<th>POSITIONS</th>
<th>A T M O S - P H E R I C TEMP</th>
<th>S. A. E. NO.</th>
<th>BP</th>
<th>CALTEX</th>
<th>CASTROL</th>
<th>ESSEO</th>
<th>GULF</th>
<th>MOBIL</th>
<th>SHELL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE OIL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above 32°C (95°F)</td>
<td>40</td>
<td>Vactrol C 30</td>
<td>RPM DELO 100 Oil</td>
<td>30</td>
<td>15W-40</td>
<td>Gulf Super Duty Oil 40</td>
<td>15W-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>32°F - 37°F</td>
<td>10</td>
<td>Vactrol C 30</td>
<td>RPM DELO 400 Oil</td>
<td>30</td>
<td>15W-40</td>
<td>Gulf Super Duty Oil 40</td>
<td>15W-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0°F - 12°C (32°F - 15°F)</td>
<td>20</td>
<td>Vactrol C 30</td>
<td>RPM DELO 400 Oil</td>
<td>30</td>
<td>15W-40</td>
<td>Gulf Super Duty Oil 40</td>
<td>15W-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COOLANT PUMP BEARING GREASE</td>
<td>IMI-G-102948I</td>
<td>Coolant Pump Bearing</td>
<td>Enegrease L 2</td>
<td>Multipurpose 2</td>
<td>Castrol LM Grease</td>
<td>Essohub 0 30</td>
<td>XG 3 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STARTER GREASE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GENERATOR &amp; STARTER BEARING GREASE</td>
<td></td>
<td>Generator Bearing Starter Bearing</td>
<td>Enegrease L 2</td>
<td>RPM Grease</td>
<td>Shell 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INJECTION PUMP TIMER GREASE</td>
<td>IMI-G-102948I</td>
<td>Injection Pump Timer</td>
<td>Enegrease L 2</td>
<td>Multipurpose 2</td>
<td>Castrol LM Grease</td>
<td>Essohub 0 30</td>
<td>XG 3 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANTI FREEZE</td>
<td></td>
<td>Engine, Radiator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Lubricants were amended according to new classification by A.P.I. (American Petroleum Institute)
CHAPTER EN

ENGINE
Model W06D-TI

DATA AND SPECIFICATIONS EN-DS13A - 1
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ENGINE OVERHAUL CRITERIA EN-OS3C - 1
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PISTON, CRANKSHAFT, CYLINDER BLOCK AND FLYWHEEL HOUSING EN-MP12A - 22
LIQUID GASKET AND APPLICATION PARTS EN-MP12A - 36
LUBRICATING SYSTEM EN-LS12A - 1
OIL PUMP EN-LS12A - 3
OIL COOLER AND OIL FILTER EN-LS12A - 5
FUEL SYSTEM EN-FS&B - 1
INJECTION NOZZLE EN-FS&B - 2
FUEL FILTER EN-FS&B - 4
COOLING SYSTEM EN-CS12A - 1
COOLANT PUMP EN-CS12A - 3
HEAT EXCHANGER EN-CS12A - 6
THERMOSTAT EN-CS12A - 8
AIR INTAKE AND EXHAUST SYSTEM EN-1E4A - 1
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MARINE TRANSMISSION DISMOUNTING AND MOUNTING EN-MT1A - 1
### DATA AND SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>HINO W06D-TI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Diesel, 4-cycle, vertical, 6-cylinder, in-line, overhead valve, water-cooled</td>
</tr>
<tr>
<td>Aspiration</td>
<td>Turbocharged and intercooled</td>
</tr>
<tr>
<td>Combustion system</td>
<td>Direct injection</td>
</tr>
<tr>
<td>Bore and stroke</td>
<td>104 x 113 mm (4.09 x 4.45 in)</td>
</tr>
<tr>
<td>Piston displacement</td>
<td>5.759 liters (351.4 cu.in)</td>
</tr>
<tr>
<td>Firing order</td>
<td>1-4-2-6-3-5</td>
</tr>
<tr>
<td>(A number of a cylinder is to be counted in order from the timing gear side.)</td>
<td></td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>Counter-clockwise viewed from flywheel</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>16.5 : 1</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>3,000 rpm</td>
</tr>
<tr>
<td>Idling speed</td>
<td>700–750 rpm</td>
</tr>
<tr>
<td>Dry weight with marine transmission</td>
<td>Approx. 600 kg (1,323 lb)</td>
</tr>
<tr>
<td>Valve timing (flywheel travel)</td>
<td></td>
</tr>
<tr>
<td>Intake opens</td>
<td>16° before top dead center</td>
</tr>
<tr>
<td>Intake closes</td>
<td>40° after bottom dead center</td>
</tr>
<tr>
<td>Exhaust opens</td>
<td>55° before bottom dead center</td>
</tr>
<tr>
<td>Exhaust closes</td>
<td>13° after top dead center</td>
</tr>
<tr>
<td>Valve clearance (when cold)</td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td>0.35 mm (0.0138 in)</td>
</tr>
<tr>
<td>Exhaust</td>
<td>0.50 mm (0.0197 in)</td>
</tr>
<tr>
<td>Injection nozzle opening pressure</td>
<td>220 kg/cm² (3,129 lb/sq.in)</td>
</tr>
<tr>
<td>Injection timing</td>
<td>20° before top dead center for No. 1 cylinder on compression stroke</td>
</tr>
</tbody>
</table>
PERFORMANCE CURVE

PLEASURE CRAFT RATING

<table>
<thead>
<tr>
<th>SAE J1349 (GROSS)</th>
<th>DHF-219</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTPUT</strong> (HP)</td>
<td></td>
</tr>
<tr>
<td>1,400</td>
<td></td>
</tr>
<tr>
<td>1,600</td>
<td></td>
</tr>
<tr>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>2,400</td>
<td></td>
</tr>
<tr>
<td>2,800</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
Engine performance at SAE standard J1349 conditions of 90m (300ft) altitude (100 kPa [29.61 in.Hg] barometric pressure), 25°C (77°F) air intake temperature, and 1 kPa (0.30 in.Hg) water vapor pressure with No.2 diesel fuel will be within 5% of that shown at the time of engine shipment. Actual performance may vary with different ambient conditions.

DESCRIPTION
## TROUBLESHOOTING

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Remedy/Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine overheating</td>
<td>• Insufficient coolant</td>
<td>Add coolant.</td>
</tr>
<tr>
<td></td>
<td>• Defective thermostat</td>
<td>Replace the thermostat.</td>
</tr>
<tr>
<td></td>
<td>• Overflow of coolant due to leakage of exhaust into cooling system</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>• Coolant leakage from cylinder head gasket</td>
<td>Replace gasket.</td>
</tr>
<tr>
<td></td>
<td>• Defective coolant pump</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td>Heat Exchanger</td>
<td>• Clogged with rust and scale</td>
<td>Clean heat exchanger.</td>
</tr>
<tr>
<td></td>
<td>• Clogged with iron oxide due to leakage of exhaust into cooling system</td>
<td>Clean coolant passage and correct exhaust leakage.</td>
</tr>
<tr>
<td></td>
<td>• Clogged or corroded heat exchanger due to mud or other debris</td>
<td>Clean or replace heat exchanger.</td>
</tr>
<tr>
<td></td>
<td>• Defective heat exchanger cap pressure</td>
<td>Replace heat exchanger cap.</td>
</tr>
<tr>
<td>Abnormal combustion</td>
<td>• Incorrect injection timing</td>
<td>Adjust injection timing.</td>
</tr>
<tr>
<td></td>
<td>• Reduced injection pressure</td>
<td>Adjust injection pressure.</td>
</tr>
<tr>
<td></td>
<td>• Poor fuel</td>
<td>Use good quality fuel.</td>
</tr>
<tr>
<td></td>
<td>• Poor nozzle spray</td>
<td>Adjust or replace nozzle.</td>
</tr>
<tr>
<td></td>
<td>• Unsatisfactory automatic timer advance angle</td>
<td>Repair or replace timer.</td>
</tr>
<tr>
<td>Other problems</td>
<td>• Defective or deteriorated engine oil</td>
<td>Change engine oil.</td>
</tr>
<tr>
<td></td>
<td>• Unsatisfactory operation of oil pump</td>
<td>Replace or repair.</td>
</tr>
<tr>
<td></td>
<td>• Insufficient oil</td>
<td>Add oil.</td>
</tr>
<tr>
<td></td>
<td>• Brake drag</td>
<td>Repair or adjust.</td>
</tr>
<tr>
<td>Cooling system</td>
<td>• Defective sea water pump</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>• Loose or slipping V-belt</td>
<td>Adjust V-belt tension or replace.</td>
</tr>
<tr>
<td></td>
<td>• Closed sea water intake valve (Seacock)</td>
<td>Open intake valve.</td>
</tr>
<tr>
<td></td>
<td>• Clogged sea water strainer</td>
<td>Clean strainer.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Cause</td>
<td>Remedy/Prevention</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Excessive oil consumption</td>
<td>Pistons, cylinder liners, and piston rings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Wear of piston ring and cylinder liner</td>
<td>Replace piston rings and cylinder liner</td>
</tr>
<tr>
<td></td>
<td>• Worn, sticking or broken piston rings</td>
<td>Replace piston rings and cylinder liner</td>
</tr>
<tr>
<td></td>
<td>• Insufficient tension on piston rings</td>
<td>Replace piston rings and cylinder liner</td>
</tr>
<tr>
<td></td>
<td>• Unsatisfactory break-in of piston rings</td>
<td>Replace piston rings and cylinder liner</td>
</tr>
<tr>
<td></td>
<td>• Unsuitable oil (viscosity too low)</td>
<td>Change oil as required and replace</td>
</tr>
<tr>
<td></td>
<td>• Incorrectly fitted piston rings (upside down)</td>
<td>piston rings and cylinder liners</td>
</tr>
<tr>
<td></td>
<td>• Gaps of piston rings in line with each other</td>
<td>Reassemble piston rings.</td>
</tr>
<tr>
<td>Valve and valve guides</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Worn valve stem</td>
<td>Replace valve and valve guide.</td>
</tr>
<tr>
<td></td>
<td>• Worn valve guide</td>
<td>Replace valve guide.</td>
</tr>
<tr>
<td></td>
<td>• Incorrectly fitted valve stem seal</td>
<td>Replace the stem seal.</td>
</tr>
<tr>
<td></td>
<td>• Excessive lubricant on valve stem</td>
<td>Check clearance of rocker arm and shaft</td>
</tr>
<tr>
<td>Excess oil feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Defective oil level gauge</td>
<td>Replace oil level gauge.</td>
</tr>
<tr>
<td></td>
<td>• Oil level too high</td>
<td>Drain excess oil.</td>
</tr>
<tr>
<td>Cooling system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Overcooled engine</td>
<td>Warm up engine before moving boat.</td>
</tr>
<tr>
<td></td>
<td>(low temperature wear)</td>
<td>Check cooling system.</td>
</tr>
<tr>
<td>Other problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Oil leakage from miscellaneous parts</td>
<td>Repair.</td>
</tr>
<tr>
<td>Operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Abrupt stoppage of engine after running at highspeed</td>
<td>Operate engine properly.</td>
</tr>
</tbody>
</table>
### Symptom: Piston seizure

**Possible cause**
- Insufficient oil
- Dirty oil
- Poor quality oil
- High oil temperature
- Low oil pressure
- Defective oil pump
- Reduced performance due to worn oil pump
- Suction strainer sucking air

**Remedy/Prevention**
- Add oil.
- Change oil.
- Replace with proper engine oil.
- Repair.
- Repair.
- Repair oil pump.
- Replace oil pump.
- Add oil and/or repair strainer.

### Symptom: Abnormal combustion

See Symptom: “Engine overheating.”

### Symptom: Coolant

See Symptom: “Engine overheating.”

### Symptom: Lack of power

#### Injection pump

Refer to CHAPTER IP, FUEL INJECTION PUMP.

#### Intake

- Clogged air cleaner
  - Clean element or replace element.

#### Overheating

See Symptom: “Engine overheating.”

#### Fuel and nozzle

- Poor nozzle spray
  - Adjust or replace injection nozzle.
- Clogged nozzle with carbon
  - Clean nozzle.
- Wear or seizure of nozzle
  - Replace nozzle.
- Air in fuel system
  - Repair and bleed air from fuel system.
- Clogged fuel filter
  - Replace element.
- Use of poor fuel
  - Use good quality fuel.

#### Abnormal combustion

See Symptom: “Engine overheating.”

#### Piston, cylinder liners, and piston rings

See Symptom “Engine overheating.”

#### Other problems

- Breakage of turbine or blower
  - Replace the turbine or blower or turbocharger.
## EN·TS1C-4 ENGINE

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Remedy/Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty starting engine</td>
<td><strong>Electrical system</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Discharged battery</td>
<td>Charge battery.</td>
</tr>
<tr>
<td></td>
<td>• Defective wiring in starter circuit</td>
<td>Repair wiring of starter.</td>
</tr>
<tr>
<td></td>
<td>• Loose or open-circuit battery cable</td>
<td>Tighten battery terminal connections or replace battery cable.</td>
</tr>
<tr>
<td></td>
<td>• Breakdown of starter</td>
<td>Replace starter.</td>
</tr>
<tr>
<td></td>
<td>• Break of glow plug or intake air heater (If so equipped)</td>
<td>Replace.</td>
</tr>
<tr>
<td></td>
<td><strong>Injection pump</strong></td>
<td>Refer to CHAPTER IP, FUEL INJECTION PUMP.</td>
</tr>
<tr>
<td></td>
<td><strong>Air cleaner</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Clogged element</td>
<td>Clean the element or replace the element.</td>
</tr>
<tr>
<td></td>
<td><strong>Fuel system</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No fuel in tank</td>
<td>Supply fuel and bleed air from fuel system.</td>
</tr>
<tr>
<td></td>
<td>• Clogged fuel line</td>
<td>Clean fuel line.</td>
</tr>
<tr>
<td></td>
<td>• Air sucked into fuel system through fuel line connections</td>
<td>Tighten fuel line connections.</td>
</tr>
<tr>
<td></td>
<td>• Clogged fuel filter</td>
<td>Replace element.</td>
</tr>
<tr>
<td></td>
<td>• Loose connection in high-pressure line</td>
<td>Tighten sleeve nut of high pressure line.</td>
</tr>
<tr>
<td></td>
<td>• Water in fuel</td>
<td>Drain and clean fuel system.</td>
</tr>
<tr>
<td>Difficulty starting engine</td>
<td><strong>Nozzles</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Seized nozzle</td>
<td>Replace nozzle.</td>
</tr>
<tr>
<td></td>
<td>• Broken or fatigue nozzle spring</td>
<td>Replace spring.</td>
</tr>
<tr>
<td></td>
<td><strong>Oil system</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Oil viscosity too high</td>
<td>Use proper viscosity oil, or install an oil immersion heater and warm up oil.</td>
</tr>
<tr>
<td></td>
<td><strong>Other problems</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Seized piston</td>
<td>Replace piston, piston rings, and liner.</td>
</tr>
<tr>
<td></td>
<td>• Seized bearing</td>
<td>Replace bearing and/or crankshaft.</td>
</tr>
<tr>
<td></td>
<td>• Reduced compression pressure</td>
<td>Overhaul engine.</td>
</tr>
<tr>
<td></td>
<td>• Ring gear damaged or worn</td>
<td>Replace the ring gear and/or starter pinion.</td>
</tr>
<tr>
<td></td>
<td>• Improperly adjusted or broken accelerator cable</td>
<td>Adjust or replace the accelerator cable.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible cause</td>
<td>Remedy/Prevention</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Rough idling</td>
<td>Injection pump</td>
<td>Refer to CHAPTER IP, FUEL INJECTION PUMP.</td>
</tr>
<tr>
<td></td>
<td>Nozzles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Uneven injection pressure</td>
<td>Adjust.</td>
</tr>
<tr>
<td></td>
<td>• Poor nozzle spray</td>
<td>Adjust or replace nozzle.</td>
</tr>
<tr>
<td></td>
<td>• Carbon deposit on nozzle tip</td>
<td>Remove carbon.</td>
</tr>
<tr>
<td></td>
<td>• Seized needle valve</td>
<td>Replace nozzle.</td>
</tr>
<tr>
<td></td>
<td>Engine proper</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Improper valve clearance</td>
<td>Adjust valve clearance.</td>
</tr>
<tr>
<td></td>
<td>• Improper contact of valve seat</td>
<td>Replace or repair valve and valve seat.</td>
</tr>
<tr>
<td></td>
<td>• Idling speed too low</td>
<td>Adjust idling speed.</td>
</tr>
<tr>
<td></td>
<td>• Coolant temperature too low</td>
<td>Warm up engine.</td>
</tr>
<tr>
<td></td>
<td>• Compression pressure of cylinders</td>
<td>Overhaul engine.</td>
</tr>
<tr>
<td></td>
<td>markedly different from one another</td>
<td></td>
</tr>
<tr>
<td>Leakage of exhaust</td>
<td>Cylinder head gasket</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fatigued gasket (aging)</td>
<td>Replace gasket.</td>
</tr>
<tr>
<td></td>
<td>• Damage</td>
<td>Replace gasket.</td>
</tr>
<tr>
<td></td>
<td>• Improper installation</td>
<td>Replace gasket.</td>
</tr>
<tr>
<td></td>
<td>Cylinder head bolts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Loose bolts</td>
<td>Tighten bolt.</td>
</tr>
<tr>
<td></td>
<td>• Elongated bolts</td>
<td>Replace bolt.</td>
</tr>
<tr>
<td></td>
<td>• Improper tightening torque or</td>
<td>Tighten properly.</td>
</tr>
<tr>
<td></td>
<td>tightening sequence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cylinder block</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cracking</td>
<td>Replace cylinder block.</td>
</tr>
<tr>
<td></td>
<td>• Surface distortion</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>• Fretting of cylinder liner insertion portion (insufficient projection of cylinder liner)</td>
<td>Replace cylinder liner or cylinder block.</td>
</tr>
<tr>
<td></td>
<td>Cylinder head</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cracking</td>
<td>Replace cylinder head.</td>
</tr>
<tr>
<td></td>
<td>• Surface distortion</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible cause</td>
<td>Remedy/Prevention</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Leakage of exhaust</td>
<td>Cylinder liners</td>
<td></td>
</tr>
<tr>
<td>• Cracking</td>
<td>Replace cylinder liner.</td>
<td></td>
</tr>
<tr>
<td>• Corrosion</td>
<td>Replace cylinder liner.</td>
<td></td>
</tr>
<tr>
<td>• Insufficient projection of</td>
<td>Replace cylinder liner.</td>
<td></td>
</tr>
<tr>
<td>cylinder liner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Incorrect injection timing</td>
<td>Adjust injection timing.</td>
<td></td>
</tr>
<tr>
<td>Seawater discharge is not</td>
<td>Seawater pump</td>
<td></td>
</tr>
<tr>
<td>sufficient</td>
<td>• Sucking air</td>
<td>Supply seawater and bleed air from cooling system.</td>
</tr>
<tr>
<td></td>
<td>• Damaged impeller</td>
<td>Replace impeller.</td>
</tr>
<tr>
<td></td>
<td>• Clogging of suction pipe and/or seawater strainer</td>
<td>Clean suction pipe and strainer.</td>
</tr>
<tr>
<td>Abnormal noise or vibration</td>
<td>Seawater pump</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Worn bearing</td>
<td>Replace bearing.</td>
</tr>
<tr>
<td></td>
<td>• Foreign material in the pump</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>• Incomplete mounting</td>
<td>Mount completely.</td>
</tr>
<tr>
<td>Bearing wears frequently</td>
<td>Seawater pump</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Too tight V-belt tension</td>
<td>Adjust V-belt tension.</td>
</tr>
<tr>
<td>Damage of impeller</td>
<td>Seawater pump</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• When it has been operated for a long period</td>
<td>Replace impeller.</td>
</tr>
<tr>
<td></td>
<td>• When it has been operated without seawater</td>
<td>Replace impeller.</td>
</tr>
<tr>
<td></td>
<td>• When it has been operated at higher RPM</td>
<td>Replace impeller and operate at normal RPM.</td>
</tr>
<tr>
<td></td>
<td>• Too high or low water temperature</td>
<td>Replace impeller and operate at normal temperature.</td>
</tr>
<tr>
<td></td>
<td>• When it has not been operated for an extended period</td>
<td>Replace impeller.</td>
</tr>
<tr>
<td></td>
<td>• Foreign material in the pump</td>
<td>Repair or replace.</td>
</tr>
</tbody>
</table>
ENGINE OVERHAUL CRITERIA

SPECIAL TOOL
Prior to starting an engine overhaul, it is necessary to have these special tools.

**COMPRESSION GAUGE ADAPTOR (NOZZLE HOLDER)**

![Image of compression gauge adaptor (nozzle holder)]

**COMPRESSION GAUGE ADAPTOR (GLOW PLUG)**

![Image of compression gauge adaptor (glow plug)]

**COMPRESSION GAUGE ADAPTOR**

![Image of compression gauge adaptor](09552-1070)

FACTORS WHICH DETERMINE WHEN AN ENGINE OVERHAUL IS NEEDED.

1. Lowered compression pressure
   a. Before the measurement
      1) Correct the valve clearance.
      2) Warm up engine [Bring the coolant temperature to about 80°C (176°F)].
      3) Charge the battery fully.
      4) Remove the air cleaner.
   b. Measurement
      1) Measure at nozzle holder hole.
      a) Remove the nozzle holders.
      b) Install the gauge adapter in the nozzle holder hole.
      Special Tool: Compression Gauge Adapter (09408-1041) (09552-1070)
     2) Measure at glow plug hole.
      a) Remove the glow plug.
      b) Install the gauge adapter in the glow plug hole.
      Special Tool: Compression Gauge Adapter (09552-1051) (09552-1070)
     c) Connect a compression gauge to the gauge adapter.
     d) Drive the engine with the starter and read the compression pressure.
   NOTE: Do not continuously operate the starter for more than 15 seconds at a time.
   e) Measure the compression pressure for each cylinder. If the compression pressure is low, be sure to repeat the measuring.
   NOTE: Be sure not to leak through sealing face.

<table>
<thead>
<tr>
<th>Engine model</th>
<th>Compression pressure</th>
<th>Unit: kg/cm² (lb/sq.in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard  Limit</td>
<td></td>
</tr>
<tr>
<td>W04D</td>
<td>33–36 (469–511) 25 (356)</td>
<td></td>
</tr>
<tr>
<td>W04C-T</td>
<td>30–33 (427–469) 22 (313)</td>
<td></td>
</tr>
<tr>
<td>W06D-Ti</td>
<td>30–33 (427–469) 22 (313)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Difference between each cylinder</th>
<th>Engine speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 (43)</td>
<td>350</td>
</tr>
<tr>
<td>Less than 3 (43)</td>
<td>280</td>
</tr>
</tbody>
</table>

MARINE PARTS SUPPLY of CANADA (800)661-5353
2. Decreased oil pressure
   Check the oil pressure warning lamp when the oil and coolant
temperature is hot (about 80°C (176°F)).
   a. If the warning lamp is lighted, check the oil level.
   b. Check oil deterioration.
      If oil quality is poor, replace with a suitable grade oil.
   c. Remove the oil pressure switch and install the oil pressure
gauge.
   d. Measure the oil pressure at coolant temperature 80°C (176°F)
or more.

<table>
<thead>
<tr>
<th>S.A.E. Grade</th>
<th>ATMOSPHERIC TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10 0 32 50 70 90 100</td>
<td>20°C 21°C 22°C 23°C</td>
</tr>
<tr>
<td>40</td>
<td>20°C 21°C 22°C 23°C</td>
</tr>
<tr>
<td>30</td>
<td>20°C 21°C 22°C 23°C</td>
</tr>
<tr>
<td>20W/20</td>
<td>20°C 21°C 22°C 23°C</td>
</tr>
<tr>
<td>15W/40</td>
<td>20°C 21°C 22°C 23°C</td>
</tr>
</tbody>
</table>

Standard oil pressure: 0.5—5.0 kg/cm² (7.11—71.10 lb/sq.in)
Service limit: Less than 0.5 kg/cm² (7.11 lb/sq.in)

3. Other factors
   a. The blow-by gas increases.
   b. The engine does not start easily.
   c. Engine output decreases.
   d. Fuel consumption increases.
   e. Engine makes greater noise.
   f. Excessive oil consumption.
ENGINE MOVING PARTS

DESCRIPTION
Representative engine model W06D-TI

1. Heat exchanger
2. Coolant filler cap
3. Pushrod
4. Rocker arm
5. Valve
6. Fuel injection nozzle
7. Intercooler
8. Fuel filter
9. Water separator
10. Piston
11. Fuel injection pump
12. Fuel feed pump
13. Starter
14. Oil pan
15. Exhaust pipe
16. Tappet
17. Camshaft
18. Oil cooler
19. Oil filter
20. Crankshaft
21. Oil strainer

SM3-1921
SPECIAL TOOL
Prior to starting an engine overhaul, it is necessary to have the following.

SLIDING HAMMER
(For nozzle holder)

ADAPTOR

WIRE

SLIDING HAMMER
(For idle gear shaft)

EYE BOLT
(For cylinder head)

VALVE SPRING PRESS

VALVE LAPPING TOOL

VALVE STEM SEAL PRESS

CYLINDER HEAD BOLT WRENCH

TIMER SETTING TOOL

PISTON RING EXPANDER

09420-1442

09462-1130
(Used with 09420-1442)

09433-1070
(Used with 09491-1010)

09470-1022

09431-1010

09472-1650

09411-1260

09512-2100

09420-1100

09482-1530

09442-1180
OVERHAUL
HE11-059-00X00 (1310)

Tightening torque: kg·cm (lb.ft)

1. Cylinder head
2. Rocker arm shaft
3. Rocker arm support
4. Adjusting screw lock nut
5. Rocker arm
6. Bushing
7. Valve clearance adjusting screw
8. Push rod
9. Tappet
10. Valve stem cap
11. Cotter key
12. Valve spring upper seat
13. Valve spring
14. Valve stem oil seal
15. Valve spring lower seat
16. Valve

SM3-1926

T = 190–260 (14–18)
**IMPORTANT POINTS - DISASSEMBLY**

CLEAN OFF SURROUNDING AREA OF THE INJECTION NOZZLE HOLDERS AND THE FUEL LINE CONNECTORS.

NOTE: If foreign matter is allowed to enter the combustion chamber, engine trouble may result.

**REMOVE THE INJECTION PIPES.**

NOTE: Cover open ends of the pipes and fuel injection pump to prevent entry of dirt.

**REMOVE THE INJECTION NOZZLE HOLDERS.**

Using a special tool, if the nozzle holder is difficult to remove by hand.

Special Tool: Sliding Hammer (09420-1442)
Adapter (09462-1130)

NOTE: After removal of the nozzle holder, cover the nozzle holder with cloth. Also cover the cylinder head with a cloth to prevent dust from getting in.

**REMOVE THE ROCKER ARM ASSEMBLY.**

Loosen the rocker arm support bolts and cylinder head bolt little by little in three stages and in the numerical order shown.

**LOosen THE CYLINDER HEAD BOLTS AND REMOVE THEM.**

Loosen the cylinder head additional bolts in the numerical order shown.
Loosen the cylinder head bolts little by little in three stages and in the numerical order shown.

LIFT THE CYLINDER HEAD FROM THE DOWELS ON THE CYLINDER BLOCK AND PLACE IT ON WOODEN BLOCKS.
1. Remove the valve stem cotters, upper valve seats, and valve springs from cylinder head.

   NOTE: Do not damage the machined surface of the head or block when removing the cylinder head.

   Special Tool: Eye Bolt (09433-1070)
   Wire (09491-1010)

REMOVE THE VALVE SPRINGS.
1. Remove the valve stem cotters, upper valve seats, and valve springs from cylinder head.

   Special Tool: Valve Spring Press (09470-1022)
2. Remove the intake and exhaust valves.
3. Tag valves to identify their cylinder numbers and to eliminate valve lapping.

IMPORTANT POINTS – ASSEMBLY
CLEAN THE CYLINDER HEAD THOROUGHLY WITH A SUITABLE SOLVENT.

NOTE: Be careful not to damage the cylinder head surface.

IF NECESSARY, HAND-LAP THE VALVE AND VALVE SEAT.
Lightly apply lapping compound to the valve face. Install the valve with a special tool, tap and rotate the valve against the seat.

Special Tool: Valve Lapping Tool (09431-1010)
IF NECESSARY, GRIND THE VALVES AND VALVE SEATS.

NOTE:
- Grinding of valves and valve seats should only be performed when hand-lapping does not result in proper seating.
- After grinding, always recheck the valve sink.

Standard:
- Valve Seat (Intake): $30^\circ - 30^\circ 30'$
- Valve Face (Intake): $29^\circ 45' - 30^\circ 15'$
- Valve Seat (Exhaust): $45^\circ - 46^\circ 30'$
- Valve Face (Exhaust): $44^\circ 45' - 46^\circ 15'$

IF NECESSARY, REPLACE THE VALVE SEAT.

1. Cut the circumference of a valve head at three places with a grinder and install it into the seat as shown and weld the valve to the seat. Then drive the valve and the seat out with a hammer and a brass block.

2. Valve seat section machining specifications. Unit: mm (in)

<table>
<thead>
<tr>
<th>Cylinder head</th>
<th>Intake</th>
<th>Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>46.500 – 46.516</td>
<td>41.000 – 41.016</td>
</tr>
<tr>
<td></td>
<td>(1.8208 – 1.8213)</td>
<td>(1.6142 – 1.6148)</td>
</tr>
<tr>
<td></td>
<td>8.8 – 9.0</td>
<td>7.2 – 7.4</td>
</tr>
<tr>
<td></td>
<td>(0.3465 – 0.3543)</td>
<td>(0.2836 – 0.2913)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>46.585 – 46.600</td>
<td>41.130 – 41.145</td>
</tr>
<tr>
<td></td>
<td>(1.8341 – 1.8346)</td>
<td>(1.6193 – 1.6198)</td>
</tr>
<tr>
<td></td>
<td>7.5 – 7.7</td>
<td>6.0 – 6.2</td>
</tr>
<tr>
<td></td>
<td>(0.2953 – 0.3031)</td>
<td>(0.2363 – 0.2440)</td>
</tr>
</tbody>
</table>

3. Valve seat installation

Heat the cylinder head to about $80^\circ – 100^\circ$C (176 – 212°F) with hot water. On the other hand, cool the valve seat with dry ice or liquid nitrogen for about 30 minutes. Hold the seat with pincers and place it into the heated cylinder head.
IF NECESSARY, REPLACE THE VALVE GUIDE.
1. Remove the valve stem seal.
2. Using a brass rod and hammer, drive out the valve guide.
3. Install the valve guide.

NOTE: Apply engine oil lightly to the valve guide outer circumference before installation.

IF NECESSARY, REPLACE THE VALVE STEM SEAL.
1. Remove the valve stem seal.
2. Install the valve stem seal.

First, install the lower spring seat (for stopper of special tool) and valve. Then apply engine oil to the lip of the stem seal and drive the special tool until it hits the lower spring seat.

Special Tool: Stem Seal Press (09472-1650)

NOTE: After installing stem seal, make sure that check the rubber position for cracks or any other damage.
Do not use the special tool if its tip (surface contacting lower spring seat) is worn or deformed.

ASSEMBLE THE CYLINDER HEAD.

NOTE: Apply engine oil to contact surfaces of all parts.
- Make sure that the valves are installed in the correct cylinders.
- Install the valve springs with their painted side down, since they have variable pitches.

Press upper spring seats and install the valve stem keys securely in the upper spring seats.

Special Tool: Valve Spring Press (09470-1022)

NOTE: When pressing with the valve spring press, be careful not to damage the stem seals by contacting the upper seats.
- Drive the valve stem lightly with a hammer to assure proper fit the valve stem key.
ASSEMBLE THE ROCKER ARM.
Lubricate the rocker arm shaft and bushing.

**NOTE:** Confirm that oil hole of rocker arm assembly No. 7 support aligns with shaft oil hole. Improper installation will result in burning of the entire valve assembly.

INSTALL THE TAPPETS IN THE CYLINDER BLOCK IN CORRECT ORDER.

**NOTE:** Apply engine oil to the tappet faces and tappet guide when installing them in the cylinder block.

INSTALL THE CYLINDER HEAD AND ROCKER ARM ASSEMBLY.

1. Install the cylinder head gasket.

**NOTE:** Always use new cylinder head gasket after cleaning the surfaces of the cylinder head, cylinder block and head gasket free of all dirt, water and grease.

2. Install the cylinder head over the dowels on the cylinder block.

3. Insert the push rods in correct order, after applying engine oil to both ends.

4. Mount the rocker arm assembly on the cylinder head, make sure that the push rods interlock with the adjusting screws.

**NOTE:** Always loosen the lock nut and raise the adjusting screws fully to the top.

5. Tighten the cylinder head bolts and rocker arm support bolts provisionally.

Tightening order: 1-2-3-4-5-6-7
6. Tighten the cylinder head bolts in three stages following the tightening order shown.
   Tighten the bolts φ12 mm to the specified torque.
   **NOTE:** Apply engine oil to the bolt threads and under the bolt head.
   • Mark bolts (cylinder head additional bolt): φ10 mm (0.39 in)
   • No. 1 – No. 26 Bolts (Cylinder head bolt): φ12 mm (0.47 in)
   Special tool: Wrench (09411-1260)

7. Tighten the cylinder head additional bolts and rocker arm support bolts in three stages following the tightening order.
   Tighten the bolts to the specified torque.
   **Tightening order:** 1–2–3–4–5–6

8. Retighten the cylinder head bolts.
   **NOTE:** Refer to section ENGINE TUNE-UP.
## Inspection and Repair

### Inspection Item

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder Head Flatness</td>
<td>Less than 0.06 (0.0019)</td>
<td>0.1 (0.0039)</td>
<td>Regrind or replace</td>
<td>SM3-831</td>
</tr>
<tr>
<td>Cylinder Head Height</td>
<td>87.0 (3.425)</td>
<td>86.8 (3.417)</td>
<td>Replace</td>
<td>SM3-887</td>
</tr>
<tr>
<td>Cylinder Head Cracks and Damage</td>
<td>--</td>
<td>--</td>
<td>Replace, if necessary</td>
<td>SM3-832</td>
</tr>
<tr>
<td>* Using a Dye Penetrant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Seating Condition</td>
<td>There should be good</td>
<td>Hand-lap with</td>
<td></td>
<td>SM3-833</td>
</tr>
<tr>
<td>* Using Red Lead Marking Compound</td>
<td>contact around entire</td>
<td>lapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>circumference of valve</td>
<td>compound</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>head.</td>
<td></td>
<td></td>
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<tr>
<td>Valve Seat Angle</td>
<td></td>
<td></td>
<td></td>
<td>SM3-899</td>
</tr>
<tr>
<td>Intake</td>
<td>30°-30°30'</td>
<td>Re grind or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust</td>
<td>45°-45°30'</td>
<td>replace valve</td>
<td>and/or valve seat</td>
<td></td>
</tr>
<tr>
<td>Valve Angle</td>
<td></td>
<td></td>
<td></td>
<td>SM3-391</td>
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<tr>
<td>Intake</td>
<td>26°45'-30°15'</td>
<td>Re grind or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust</td>
<td>44°45'-45°15'</td>
<td>replace valve</td>
<td>and/or valve seat</td>
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<tr>
<td>Nozzle Protrusion from Cylinder Head Surface</td>
<td>2.75 - 3.25 (0.1083 - 0.1279)</td>
<td>Replace nozzle gasket</td>
<td></td>
<td>SM3-95</td>
</tr>
<tr>
<td>Intake Valve Sink</td>
<td>-0.05 - -0.35 (-0.0020 - -0.0138)</td>
<td>Replace valve and/or valve seat</td>
<td>&quot;0&quot; IS CYLINDER HEAD SURFACE</td>
<td>SM3-236</td>
</tr>
<tr>
<td>Exhaust Valve Sink</td>
<td>-0.47 - -0.77 (0.0185 - 0.0303)</td>
<td>Replace valve and/or valve seat</td>
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<td>SM3-236</td>
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<td>Inspection Item</td>
<td>Standard</td>
<td>Limit</td>
<td>Remedy</td>
<td>Inspection Procedure</td>
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<td>-----------------------------------------------------</td>
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<tr>
<td>Intake Valve Stem Diameter</td>
<td>8.95–8.97</td>
<td>8.90</td>
<td>Replace valve guide and/or valve</td>
<td>SM3-834</td>
</tr>
<tr>
<td>Exhaust Valve Stem Diameter</td>
<td>8.93–8.95</td>
<td>8.80</td>
<td></td>
<td>SM3-835</td>
</tr>
<tr>
<td>Intake and Exhaust Valve Guide Diameter</td>
<td>9.000–9.015</td>
<td>A &amp; B: 9.05, C: 9.10</td>
<td></td>
<td>SM3-836</td>
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<tr>
<td>Clearance between Valve Stem and Valve Guide (Intake)</td>
<td>0.035–0.068</td>
<td>A &amp; B: 0.10, C: 0.18</td>
<td></td>
<td>SM3-837</td>
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<tr>
<td>Clearance between Valve Stem and Valve Guide (Exhaust)</td>
<td>0.050–0.083</td>
<td>A &amp; B: 0.12, C: 0.2</td>
<td></td>
<td>SM3-838</td>
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<tr>
<td>Rocker Arm Shaft Diameter</td>
<td>18.87–18.98</td>
<td>18.95</td>
<td>Replace rocker arm bushing and/or shaft</td>
<td>SM3-840</td>
</tr>
<tr>
<td>Clearance between Rocker Arm Shaft and Rocker Arm Bushing</td>
<td>0.036–0.079</td>
<td>0.1</td>
<td></td>
<td>SM3-841</td>
</tr>
<tr>
<td>Valve Spring Setting Load</td>
<td>27.4 kg (60.4 lb) at 45.5 (1.79)</td>
<td>25.5 kg (56.2 lb)</td>
<td>Replace</td>
<td>SM3-842</td>
</tr>
<tr>
<td>Valve Spring Straightness</td>
<td>2.0</td>
<td>Replace</td>
<td></td>
<td>SM3-843</td>
</tr>
<tr>
<td>Valve Spring Seat for Wear</td>
<td>A: 2.5 (0.0984)</td>
<td>B: 6.0 (0.1969)</td>
<td>C: 1.0 (0.0394)</td>
<td>SM3-844</td>
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<tr>
<td>Inspection Item</td>
<td>Standard</td>
<td>Limit</td>
<td>Remedy</td>
<td>Inspection Procedure</td>
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<td>-----------------------------------------------------</td>
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<tr>
<td>Valve Stem Tip Surface for Wear</td>
<td></td>
<td></td>
<td>Resurface or replace</td>
<td>Visual Check</td>
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<tr>
<td>Valve Stem Contact Surface of Rocker Arm for Wear</td>
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<td></td>
<td></td>
<td>SM3-837</td>
</tr>
<tr>
<td>Push Rod Bend</td>
<td></td>
<td>0.3</td>
<td>Replace</td>
<td>SM3-292</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0118)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tappet Diameter</td>
<td>26.95—26.97</td>
<td></td>
<td>Replace tappet</td>
<td>SM3-292</td>
</tr>
<tr>
<td></td>
<td>(1.0611—1.0618)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Tappet Guide Inside Diameter</td>
<td>27.00—27.02</td>
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<td></td>
<td>SM3-420</td>
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<tr>
<td></td>
<td>(1.0630—1.0637)</td>
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<td></td>
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<tr>
<td>Clearance between Tappet and Tappet Guide</td>
<td>0.025—0.071</td>
<td>0.1</td>
<td>Replace, if necessary</td>
<td>SM3-293</td>
</tr>
<tr>
<td></td>
<td>(0.0010—0.0027)</td>
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<td></td>
<td></td>
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<tr>
<td>Tappet for Wear</td>
<td>Should not be worn unevenly</td>
<td></td>
<td></td>
<td>Visual Check</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OVERHAUL

1. Cylinder block
2. Gasket
3. Timing gear plate
4. Connector
5. Expansion plug
6. Timing gear cover
7. O-ring
8. Retainer ring
9. Ball bearing
10. Bearing holder case
11. Oil seal
12. Crankshaft pulley
13. Plain washer
14. Oil pan
15. Tachometer drive assembly
16. Connector
17. Oil drain plug
18. Oil drain hose
19. Connector bolt
20. Soft washer
21. Oil level gauge
22. Oil level gauge guide
23. Engine mounting bracket
24. Engine hanger bracket

T = Tightening torque: kg·cm (lb.ft)

SM3-1928
OVERHAUL

$T = 1,100–1,300 \ (80–94)$

$T = 190–260 \ (14–18)$

$T = 300–350 \ (22–25)$

$T = $ Tightening torque: kg·cm (lb·ft)

1. Camshaft
2. Key
3. Thrust bearing
4. Camshaft gear
5. Thrust washer
6. Oil pump drive gear
7. Idler gear thrust plate
8. Straight pin
9. Idler gear shaft
10. Bearing
11. Idler gear
12. Crankshaft gear
13. Injection pump drive gear
14. Coupling flange
15. O-ring
16. Timer cover
17. Soft washer
18. Plug
IMPORTANT POINTS – DISASSEMBLY

REMOVE THE FUEL INJECTION PUMP ASSEMBLY.

1. Remove the bearing holder case.
   NOTE: Do not loosen the injection pump drive gear fitting bolts.

2. Remove the plug of the timer cover.
3. Turn the crankshaft counter-clockwise viewed from the flywheel to align the injection timing mark with pointer.

4. Install the setting tool.
   Special Tool: Timer Setting Tool (09612-2100)

5. Loosen the timer cover fitting bolts and remove the fuel injection pump with timer cover.
   NOTE: Do not loosen the fuel injection pump body fitting nuts.

REMOVE THE CAMSHAFT WITH GEAR.

NOTE: o Remove the tappets above the camshaft.
   o Pull out the camshaft, slowly turning it so as not to damage the bearings.

REMOVE THE IDLER GEAR SHAFT.

Using a special tool, remove the idler gear shaft.
Special Tool: Sliding Hemmer (09420-1100)
IF NECESSARY, REMOVE THE CAMSHAFT GEAR.
1. Hold the camshaft with a vice through wooden plates.
2. Remove the bolt and plain washer, then using a gear puller, remove the gear.

IMPORTANT POINTS - ASSEMBLY
IF NECESSARY, REPLACE THE TIMING GEAR COVER OIL SEAL:
1. Using a screwdriver, remove the oil seal.
2. Using a special tool, install the new oil seal.
Special Tool: Press (09482-1530)

ASSEMBLE THE CAMSHAFT GEAR AND SHAFT.
Install the camshaft gear with thrust bearing.
NOTE: When installing the gear to the camshaft:
- Heat the gear in hot water [Approx. 100°C (212°F)], then install the gear to the camshaft by using a press.
- When tightening the bolt, apply engine oil to the threads and plate surface of the bolt.

INSTALL THE CAMSHAFT.
Lubricate all journals of the camshaft and insert the camshaft assembly into the cylinder block.
NOTE: Insert the camshaft, slowly turning while inserting so that the bearing will not be damaged.
- When installing the camshaft, be sure that the match marks of the oil pump drive gear and camshaft gear are aligned correctly.
INSTALL THE IDLER GEAR SHAFT.
Install the idler gear shaft with thrust plate using a plastic hammer.

NOTE: Be sure that the oil hole is downward, if installed the wrong way, damage to the idler gear shaft and bushing can result.

INSTALL THE IDLER GEAR.
NOTE: When installing the idler gear, be sure that the matching marks of the crankshaft gear, oil pump drive gear and idler gear are aligned correctly.

INSTALL THE INJECTION PUMP TEMPORARILY.
NOTE: When installing the injection pump, be sure that the match marks of the idler gear and injection pump drive gear are aligned correctly.

MEASURE THE GEAR BACKLASH.
Measure the backlash of each gear using a dial indicator. Replace the gear if necessary. Refer to INSPECTION AND REPAIR.

INSTALL THE TIMING GEAR CASE.
1. Clean the faces.
2. Apply the liquid gasket as shown and install the timing gear cover within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width (A): 1.5 – 2.5 mm (0.06 – 0.10 in)
INSTALL THE OIL STRAINER.
Refer to Section LUBRICATING SYSTEM.

INSTALL THE OIL PAN.
1. Cut the protrusion of the timing gear plate gasket from the oil pan mounting surface.
2. Clean the faces.
3. Apply the liquid gasket as shown and install the timing gear cover within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width (A): Approx. 3–4 mm (0.12–0.15 in)

TIGHTEN THE CRANKSHAFT PULLEY.
NOTE: Apply engine oil to the nut threads.

INSPECTION AND REPAIR

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<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gear Teeth for Pitting or Wear</td>
<td>-</td>
<td>-</td>
<td>Replace, if necessary</td>
<td>Visual check</td>
</tr>
<tr>
<td>Idler Gear Shaft Diameter</td>
<td>49.95–49.97</td>
<td>49.83</td>
<td>Replace bushing and/or shaft</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.9666–1.9673)</td>
<td>(1.9657)</td>
<td></td>
<td>SM3-845</td>
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<tr>
<td>Idler Gear Bushing Inside Diameter</td>
<td>50.00–50.03</td>
<td>50.06</td>
<td></td>
<td>SM3-846</td>
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<td></td>
<td>(1.9685–1.9696)</td>
<td>(1.9705)</td>
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<tr>
<td>Oil Clearance between Idler Gear Shaft and Gear Bushing</td>
<td>0.03–0.08</td>
<td>0.10</td>
<td>Replace thrust plate</td>
<td>SM3-847</td>
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<tr>
<td></td>
<td>(0.0018–0.0031)</td>
<td>(0.0059)</td>
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<tr>
<td>Idler Gear end Play</td>
<td>0.04–0.10</td>
<td>0.15</td>
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<td></td>
<td>(0.0016–0.0039)</td>
<td>(0.0059)</td>
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<tr>
<td>Inspection Item</td>
<td>Standard Limit</td>
<td>Remedy</td>
<td>Inspection Procedure</td>
<td></td>
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<tr>
<td>---------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Camshaft Bend</td>
<td></td>
<td>Replace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camshaft Cam Height</td>
<td>Intake 49.44 (1.9465)</td>
<td>48.44 (1.9071)</td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaust 49.50 (1.9488)</td>
<td>48.50 (1.9095)</td>
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<tr>
<td>Camshaft End Play</td>
<td>0.10–0.18 (0.0040–0.0070)</td>
<td>0.30 (0.0118)</td>
<td>Replace thrust plate</td>
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</tr>
<tr>
<td>Camshaft Journal Diameter No. 1</td>
<td>57.0 (2.2441)</td>
<td>56.85 (2.2383)</td>
<td>Replace shaft and/or bearing</td>
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<tr>
<td>No. 2</td>
<td>56.8 (2.2362)</td>
<td>56.65 (2.2303)</td>
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<td>No. 3</td>
<td>56.6 (2.2283)</td>
<td>56.46 (2.2244)</td>
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<td>No. 4</td>
<td>56.4 (2.2206)</td>
<td>56.25 (2.2146)</td>
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<td>Camshaft Journal Bearing Inside Diameter No. 1</td>
<td>57.0 (2.2441)</td>
<td>57.15 (2.2500)</td>
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<tr>
<td>No. 2</td>
<td>56.8 (2.2362)</td>
<td>56.96 (2.2421)</td>
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<td>No. 3</td>
<td>56.6 (2.2283)</td>
<td>56.75 (2.2342)</td>
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<td>No. 4</td>
<td>56.4 (2.2204)</td>
<td>56.55 (2.2263)</td>
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<td>Oil Clearance between Camshaft Journal and Bearing</td>
<td>0.03–0.12 (0.0012–0.0047)</td>
<td>0.16 (0.0059)</td>
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<tr>
<td>Crankshaft Gear – Idler Gear</td>
<td>0.088–0.194 (0.0027–0.0076)</td>
<td>0.30 (0.0118)</td>
<td>Replace gear, if necessary.</td>
<td></td>
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<tr>
<td>Idler Gear – Oil Pump Gear</td>
<td>0.065–0.182 (0.0026–0.0071)</td>
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<tr>
<td>Idler Gear – Injection Pump Gear</td>
<td>0.065–0.182 (0.0026–0.0071)</td>
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<tr>
<td>Oil Pump Gear – Camshaft Gear</td>
<td>0.065–0.182 (0.0026–0.0071)</td>
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</tbody>
</table>
PISTON, CRANKSHAFT, CYLINDER BLOCK AND FLYWHEEL HOUSING

OVERHAUL

1. Piston ring
2. Piston
3. Piston pin
4. Retainer ring
5. Connecting rod
6. Piston pin bushing
7. Connecting rod cap
8. Connecting rod bearing
9. Crankshaft gear
10. Crankshaft
11. Key
12. Collar
13. Main-bearing
14. Crankshaft thrust bearing
15. Camshaft bearing
16. Cylinder block
17. Expansion plug
18. Cylinder liner
19. Oil pump drive shaft bearing
20. Straight pin
21. Main bearing cap

T = Tightening torque kg·cm (lb.ft)

T = 1,220–1,280 (89–92)

T = 1,400–1,600 (102–115)

SM3-1930

MARINE PARTS SUPPLY of CANADA (800)661-5353

1930 Stewart Ave
North Vancouver, B.C.
V7M 1E1
phon (604) 661-5353
fax (604) 754-3471
OVERHAUL

T = 450–500 (33–36)

T = 1,000–1,300 (73–94)

T = 1,800–2,000 (131–144)

T = 450–500 (33–36)

1. Cylinder block
2. Flywheel housing
3. Timing port cover
4. Oil seal
5. Ring gear
6. Flywheel
7. Torsion-elastic coupling
8. Spacer
9. Intermediate flange
10. Bracket

T = Tightening torque: kg·cm (lb. ft)
EN-MP12A-24

ENGINE

IMPORTANT POINTS - DISASSEMBLY

REMOVE THE PISTONS WITH CONNECTING RODS.

1. Remove the carbon from the upper end of the cylinder liner with a scraper or emery paper (recommended: No. 150) in a circular direction.

2. Extract the piston and connecting rod assembly out through the top of the cylinder.

NOTE: Arrange the piston and connecting rod caps in order.

REMOVE THE CRANKSHAFT.

NOTE: Arrange the caps, main bearings and thrust bearings in order.

DISASSEMBLE THE CONNECTING ROD AND PISTON.

1. Remove the retainer ring installed on both ends of the piston pin, by means of retainer ring pliers.

2. Apply a metal pad to the pin and strike out the pin with a hammer.

NOTE: Warm up the piston first in hot water 80–90°C (176–194°F) for about 5 minutes before removing the pin.

REMOVE THE PISTON RINGS.

Special Tool: Piston Ring Expander (09442-1180)

NOTE: Handle the piston rings carefully because they are made of a special casting which is easily broken.

- Keep the rings for each cylinder separate.
REMOVE THE CYLINDER LINER.
1. Place the match marks with a pen on the cylinder block and liner flange, before removing the cylinder liners.

NOTE: Do not put the match marks with a punch.

2. Using a special tool, remove the cylinder liners.

Special Tool: Cylinder Liner Puller (09420-1460)

NOTE: After removing the cylinder liners, put numbers on their periphery or arrange them in sequence.

IMPORTANT POINTS – ASSEMBLY

INSERT THE CYLINDER LINER INTO THE CYLINDER BLOCK.
1. When a new cylinder liner is used, make sure that the liner has the same mark as the mark on the cylinder block.

NOTE: There are 4 different liner and cylinder block matches. The flange section of each liner has a marking any, W, X, Y, Z, or indicating the size of the outer diameter of the liner on which it is stamped. The markings W, X, Y and Z, indicating the inner diameter of the cylinder bore supporting the liner on the sides and top of the cylinder block (the boss section for attaching the coolant gallery cover), are inscribed on each cylinder.

2. When reusing a liner, insert the liner its original position aligning the marking marked before disassembly.
Apply a small amount of fresh engine oil on the outer periphery of the liner, and apply pressure on the entire flange section of the liner. If insertion by hand is difficult, use a cylinder guide, and the cylinder liner will easily be pushed in.

Special Tool: Cylinder Liner Guide (09480-1120)

NOTE:
- Do not use a liner that has been dropped.
- Take extra care when handling the liner since the liner is easily deformed.

MEASURE THE PROJECTION OF THE CYLINDER LINER.

Tighten a special tool with a tightening torque of 100 kg·cm (7.23 lb·ft) and measure the amount of projection of the top end of the liner from the cylinder block with a dial gauge or straight edge and a thickness gauge.

Special Tool: Cylinder Liner Puller (09420-1460)

Tightening Torque: 100 kg·cm (7.23 lb·ft)

Assembly Standard: 0.01-0.08 mm (0.0004-0.0031 in)

IF NECESSARY, GRIND THE CRANKSHAFT AND USE UNDER SIZE BEARINGS.

**Dimension of Fillet R:**
- Crank pin: 3.50 - 4.00 mm (0.1378 - 0.1574 in)
- Journal: 3.05 - 3.50 mm (0.1201 - 0.1377 in)
INSTALL THE CRANKSHAFT.
1. Install the crankshaft bearings on the cylinder block and bearing cap.
   NOTE: Apply new engine oil to each bearing surface.
2. Install the crankshaft on the cylinder block.
3. Insert the crankshaft thrust bearings along the groove of the cylinder block.
   Install the thrust bearings on the No. 4 bearing cap sides.
   NOTE: Apply new engine oil to each thrust bearing surface.
5. Install the crankshaft bearing caps.
   Install the bearing caps in numbered order from timing gear side with the arrow point toward the timing gear side.
6. Tighten the cap bolts in three stages following the tightening order.
   NOTE: Apply engine oil to the bolt threads and under the bolt head.
   Tightening order: 4—3—6—2—6—1—7
   NOTE: ○ Make sure that the crankshaft rotates smoothly.
   ○ Inspect the crankshaft end play.
IF NECESSARY, REPLACE THE PISTON PIN BUSHING.

1. Prepare the special tools.
   - Assemble the guide and press sub assembly inserting its pin into the guide, then secure them with the wing nut.
   - Special tools: Guide (09481-1130)
     Press subassembly (09402-1460)
     Wing nut (9233-10360)

   NOTE: ○ Bring letter "W" punched on the guide above the pin.
   ○ Make sure to align both supporting surface of the guide and press sub assembly flush on a flat plane.

2. Using a special tool, remove the piston pin bushing.
   a. Set the connecting rod assembled without crank pin bore bearing on the guide and press subassembly.

   b. Install the spindle on the bushing.
      Special tool: Spindle (09402-1470)
      NOTE: Align the grooving of the spindle with the oil hole of the bushing.

   c. Using a hydraulic press, remove the bushing.
      NOTE: Always operate the press slowly and smoothly.
3. Assemble the piston pin bushing.
Chamfer one edge of the bushing hole at the small end of the connecting rod uniformly by C 0.5–1.0 mm (0.0196–0.0393 in).

NOTE:  
○ Irregular chamfering can cause out-of-roundness of the pressed bushing, which may result in jamming during insertion.
○ Remove dust from the inner surface of the small-end hole.

4. Mount the bushing on the spindle.
a. Set the bushing and guide on the spindle aligning oil hole (A) in the bushing the grooves on both the spindle and guide.
b. Secure the bushing and guide with the bolt.

Special Tool:
- Spindle (09402-1470)
- Guide (09481-1140)
- Bolt (9191-D8252)

NOTE:  
○ Be sure to slip the bushing over the spindle in the proper direction so that oil hole (A) will later align with the oil path in the connecting rod.
○ Apply fresh engine oil to the bushing and guide.

5. Install the bushing in the connecting rod.
Position the bushing—special tool assembly so that oil hole (A) align with the oil path through the connecting rod.

NOTE:  
○ Fully coat the bore in the connecting rod with fresh engine oil.
○ Always operate the press slowly and smoothly.

6. Inspect the bushing position after installation.

NOTE:  
○ Make sure that the oil holes of the bushing and connecting rod are aligned.
○ Insert a pin of 3.0 mm (0.1181 in) dia. into a hole at the end of the connecting rod, and make sure that the pin fully penetrates.
  If there is any deviation in the alignment of the oil holes correct it with a drill of 3.0 mm (0.1181 in) dia.
○ Misalignment of the oil holes leads to insufficient lubrication, which may result in seizure.
○ Insert a new piston pin and rotate it slowly to make sure that there is no rattling.
ASSEMBLE THE PISTON AND CONNECTING ROD.

Make sure that the O-mark at the top of the piston and the connecting rod match mark in opposite directions.

NOTE:  
- Use the new retainer rings.
- Heat the piston to about 80 – 90°C (176 – 194°F) in hot water about 5 minutes.

INSTALL THE PISTON RING.

1. Install the piston rings in the sequence oil ring, second ring and top ring with the identification mark at the top of the ring facing up.

NOTE:  
- Identification mark of second ring and oil ring is applied with gold paint.
- Apply oil to the piston pin.

Special Tool: Piston Ring Expander (09442-1180)

2. Connect the ends of the coil expander and then fit the coil inside the piston ring after ensuring that the gap of the piston ring is 180° away from the joint of the coil.

3. Arrange the piston rings so that their gaps are equally spaced.

INSTALL THE PISTON IN THE CYLINDER LINER.

Apply engine oil to the piston, cylinder liner and connecting rod bearing surface.

NOTE: Check the piston that the O-mark on the top is on the tappet chamber side.

Special Tool: Piston Ring Holder (09441-1260)
INSTALL THE CONNECTING ROD.
1. Apply engine oil to the cap bearing surface.
2. Align the matching marks on the connecting rod and cap.
3. Apply engine oil to the bolt threads and under the bolt head.
4. Tighten the cap bolt in three stages.

IF NECESSARY, REPLACE THE FLYWHEEL HOUSING OIL SEAL.
1. Using a screwdriver, remove the oil seal.
2. Install the new oil seal.

Special Tool: Flywheel Housing Oil Seal Press (09482-1540)

INSTALL THE FLYWHEEL HOUSING.
1. Clean the faces.
2. Apply the liquid gasket as shown and install the flywheel housing within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width: 1.5–2.5 mm (0.06–0.10 in)

INSTALL THE FLYWHEEL.
Install the flywheel and tighten the bolts through several repetitions of the tightening order so as to reach specified torque evenly and gradually, then slacken and tighten them one by one to the specified torque.

NOTE: o Align the “O” mark on the flywheel and crankshaft collar knock-in.
    o When tightening the bolt, apply engine oil to the threads and flywheel surface of the bolts.
<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston Diameter</td>
<td>103.852–103.884 (4.0887–4.0899)</td>
<td>≥ 103.884 (4.0899)</td>
<td>Replace piston and/or liner</td>
<td></td>
</tr>
<tr>
<td>Cylinder Liner Inside Diameter</td>
<td>104.008–104.040 (4.0949–4.0980)</td>
<td>≥ 104.15 (4.1003)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Clearance between Piston and Cylinder Liner</td>
<td>0.140–0.172 (0.0066–0.0067)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Piston Pin Diameter</td>
<td>36.987–37.003 (1.4562–1.4568)</td>
<td>≤ 36.98 (1.4558)</td>
<td>Replace piston and/or piston pin</td>
<td></td>
</tr>
<tr>
<td>Piston Pin Hole Inside Diameter</td>
<td>36.987–37.003 (1.4562–1.4568)</td>
<td>≤ 37.02 (1.4575)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Clearance between Piston Pin and Piston Pin Hole</td>
<td>0.013T–0.014L (0.00052T–0.00058L)</td>
<td>≤ 0.03 (0.0011)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Crankshaft end Play</td>
<td>0.05–0.22 (0.0020–0.0086)</td>
<td>≤ 0.4 (0.0157)</td>
<td>Replace thrust bearing</td>
<td></td>
</tr>
</tbody>
</table>

Unit: mm (in)

Remedy:
- Replace piston and/or liner
- Replace piston and/or piston pin
- Replace thrust bearing
<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecting Rod Small End Bushing Inside Diameter</td>
<td>37.015—37.025 (1.4573—1.4577)</td>
<td>37.07 (1.4594)</td>
<td>Replace bushing and/or piston pin</td>
<td></td>
</tr>
<tr>
<td>Piston Pin Diameter</td>
<td>36.987—37.003 (1.4562—1.4568)</td>
<td>36.98 (1.4569)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clearance between Piston Pin And Connecting Rod Small End Bushing</td>
<td>0.015—0.036 (0.0006—0.0014)</td>
<td>0.08 (0.0031)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connecting Rod Big end Inside Diameter without Bearing</td>
<td>65.985—66.000 (2.5979—2.5994)</td>
<td></td>
<td>Replace connecting rod assembly</td>
<td></td>
</tr>
<tr>
<td>Crank Pin Diameter</td>
<td>61.94—61.96 (2.4386—2.4393)</td>
<td>−0.20 (−0.0078)</td>
<td>Regrind and use undersize bearing</td>
<td></td>
</tr>
<tr>
<td>Clearance between Connecting Rod and Crank Pin</td>
<td>0.031—0.082 (0.0013—0.0032)</td>
<td>0.12 (0.0047)</td>
<td>Replace bearing</td>
<td></td>
</tr>
<tr>
<td>Connecting Rod end Play</td>
<td>0.20—0.52 (0.0079—0.0204)</td>
<td>0.6 (0.0236)</td>
<td>Replace the connecting rod.</td>
<td></td>
</tr>
<tr>
<td>Inspection Item</td>
<td>Standard</td>
<td>Limit</td>
<td>Remedy</td>
<td>Inspection Procedure</td>
</tr>
<tr>
<td>---------------------------------------</td>
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</tr>
<tr>
<td>Connecting Rod Straightness</td>
<td></td>
<td>0.1 (0.0039)</td>
<td>Replace</td>
<td>SM3-541</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Par 200 (7.874)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connecting Rod Twist</td>
<td></td>
<td>0.1 (0.0039)</td>
<td>Replace</td>
<td>SM3-542</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Par 200 (7.874)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connecting Rod Bearing Spread Dmension</td>
<td>67.05–67.55 (2.6398–2.6594)</td>
<td></td>
<td>Replace</td>
<td>SM3-268</td>
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<tr>
<td>Crankshaft Bend</td>
<td></td>
<td>0.04 (0.0015)</td>
<td>Repair or replace</td>
<td>SM3-861</td>
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<tr>
<td>Crankshaft Main Bearing Cap Inside</td>
<td>77.985–78.000 (3.0703–3.0709)</td>
<td></td>
<td>Replace</td>
<td>SM3-436</td>
</tr>
<tr>
<td>Diameter Without Bearing</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Crankshaft Journal Diameter</td>
<td>72.94–72.96 (2.8717–2.8724)</td>
<td>-0.20 (-0.0078)</td>
<td>Re grind and use undersize bearing</td>
<td>SM3-860</td>
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<tr>
<td></td>
<td></td>
<td>71.76 (2.8252)</td>
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<tr>
<td>Clearance between Crankshaft Journal</td>
<td>0.039–0.090 (0.0016–0.0035)</td>
<td>0.13 (0.0051)</td>
<td>Replace bearing</td>
<td>SM3-436</td>
</tr>
<tr>
<td>and Main Bearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Unit: mm (in)
<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crankshaft Main Bearing Spread Dimension</td>
<td>79.00–79.60</td>
<td>–</td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.1103–3.1338)</td>
<td></td>
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</tr>
<tr>
<td>Piston Ring Breadth Ring No.:</td>
<td>Top: Not easily measured</td>
<td></td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd: 2.47–2.49</td>
<td>2.32</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0972–0.0980)</td>
<td>(0.0913)</td>
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<tr>
<td></td>
<td>Oil: 4.97–4.99</td>
<td>4.96</td>
<td></td>
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<tr>
<td></td>
<td>(0.1957–0.1964)</td>
<td>(0.1949)</td>
<td></td>
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</tr>
<tr>
<td>Piston Ring Groove Breadth Ring No.:</td>
<td>Top: Not easily measured</td>
<td></td>
<td>Replace piston ring and/or piston</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd: 2.53–2.55</td>
<td>2.14</td>
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<tr>
<td></td>
<td>(0.0996–1.004)</td>
<td>(0.0842)</td>
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<tr>
<td></td>
<td>Oil: 5.01–5.03</td>
<td>5.08</td>
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<tr>
<td></td>
<td>(0.1973–0.1980)</td>
<td>(0.2000)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clearance between Piston Ring and Piston Ring Breadth Ring No.:</td>
<td>Top: Not easily measured</td>
<td></td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd: 0.04–0.08</td>
<td>0.30</td>
<td></td>
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<tr>
<td></td>
<td>(0.0015–0.0032)</td>
<td>(0.0118)</td>
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<tr>
<td></td>
<td>Oil: 0.02–0.06</td>
<td>0.08</td>
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<tr>
<td></td>
<td>(0.0008–0.0023)</td>
<td>(0.0031)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piston Ring Gap All Rings:</td>
<td>Top: 0.3–0.45</td>
<td>1.2</td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Insert the Piston Rings Where the Wear of the Liner is Small.</td>
<td>(0.0119–0.0177)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd: 0.3–0.45</td>
<td>(0.0472)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0119–0.0177)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oil: 0.3–0.45</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.0119–0.0177)</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder Block Flatness</td>
<td>Less than 0.05</td>
<td>0.1</td>
<td>Re grind and/or replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0019)</td>
<td>(0.0039)</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Flywheel Face Alignment</td>
<td></td>
<td></td>
<td>Re grind and/or replace</td>
<td></td>
</tr>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
LIQUID GASKET AND APPLICATION POINTS

The W06D-TI type engine use liquid gasket (Three Bond TB1207C, 04132-1207). Apply liquid gasket, therefore, taking the following items into account.

1. LIQUID GASKET APPLICATION POINTS AND COATING WIDTH

<table>
<thead>
<tr>
<th>Parts name</th>
<th>Application point</th>
<th>Coating width</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Oil pan</td>
<td>Flange face which mates with cylinder block and timing gear cover</td>
<td>3 – 4 (0.12 – 0.16)</td>
</tr>
<tr>
<td>(b) Timing gear cover</td>
<td>Face which mates with timing gear plate (flange face, boss face)</td>
<td>1.5 – 2.5 (0.06 – 0.10)</td>
</tr>
<tr>
<td>(c) Flywheel housing</td>
<td>Faces which mates with cylinder block (flange face, boss face)</td>
<td>1.5 – 2.5 (0.06 – 0.10)</td>
</tr>
</tbody>
</table>
2. COATING LIQUID GASKET AND PARTS ASSEMBLY PROCEDURE

(1) Completely remove old liquid gasket from each part and the respective mating part, and remove oil, water, and dirt using a cloth.

(2) Be careful not to apply excessive or insufficient liquid gasket. Also, be sure to overlap the start and end of each coating.

(3) When assembling coated parts, be careful that there is no misalignment between mating parts. If there is any misalignment, coat the parts again.

(4) Assemble the various parts within 20 minutes after applying liquid gasket. If more than 20 minutes have elapsed, remove the liquid gasket and apply it again.

(5) After assembling the various parts, wait for at least 15 minutes before starting the engine.
3. REMOVING PARTS

When removing each part, do not attempt to pry one portion of the flange alone but use the flange collar or clearance to pry the flange at several points alternately.

![Diagram showing removal of parts](image)

4. TIMING GEAR PLATE GASKET

When replacing the timing gear plate gasket, cut it so that no steps are formed in it, then liberally apply liquid gasket to the cut faces and assemble the oil pan.

![Diagram showing timing gear plate gasket](image)

**NOTE:** The flange of the oil pan may sometimes become deformed preventing it from being reused. To prevent this, therefore, first insert plates with a thin edge at several points around the periphery of the oil pan, then remove the oil pan using a screwdriver.
**LUBRICATING SYSTEM**

**DATA AND SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil pump</td>
<td>Full forced pressure feed by gear pump</td>
</tr>
<tr>
<td>Drive</td>
<td>By gear</td>
</tr>
<tr>
<td>Oil cooler</td>
<td>Multi plates type, water-cooled</td>
</tr>
</tbody>
</table>

**LUBRICATING SYSTEM DIAGRAM**

1. Oil pan
2. Oil strainer
3. Oil pump
4. Oil filter
5. Oil cooler
6. Main oil hole
7. Camshaft
8. Rocker arm shaft
9. Rocker arm
10. Crankshaft journal
11. Crankshaft pin
12. Connecting rod
13. Piston
14. Idler gear
15. Fuel injection pump drive gear
16. Fuel injection pump
17. Turbocharger
A. Oil cooler safety valve
B. Oil filter safety valve
C. Regulator valve
D. Check valve
OVERHAUL

HE11-059-00X00-03 (1400)

1. Oil filter
2. O-ring
3. Oil cooler
4. Soft washer
5. Connector pipe
6. Plug
7. Connector bolt
8. Oil pump cover subassembly
9. Gasket
10. Oil pump driven gear
11. O-ring guide
12. Oil strainer

T = Tightening torque: kg-cm (lb.ft)
OIL PUMP

DESCRIPTION

1. Drive gear (Inside)
2. Driven gear
3. Gasket
4. Drive gear (Outside)
5. Drive shaft
6. Driven shaft

[OPERATION]

DISCHARGE PORT
SUCTION PORT

DISCHARGE PORT
SUCTION PORT

DISCHARGE PORT
SUCTION PORT

IMPORTANT POINT – MOUNTING

INSTALL THE OIL PUMP.

1. Apply oil liberally to cylinder block pump case and bearing before installing oil pump.
2. Confirm smooth rotation of oil pump after tightening bolts.
## Inspection and Repair

<table>
<thead>
<tr>
<th>Inspection Item</th>
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<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gear Backlash</td>
<td>0.08–0.21 (0.0036–0.0082)</td>
<td>0.30 (0.0118)</td>
<td>Replace gear</td>
<td>SM3-867</td>
</tr>
<tr>
<td>Drive Gear Shaft Diameter</td>
<td>18.088–18.108 (0.7122–0.7128)</td>
<td>18.080 (0.7110)</td>
<td>Replace</td>
<td>SM3-870</td>
</tr>
<tr>
<td>Drive Shaft Bearing Inside Diameter</td>
<td>18.146–18.173 (0.7145–0.7154)</td>
<td>18.20 (0.7165)</td>
<td>Replace</td>
<td>SM3-1070</td>
</tr>
<tr>
<td>Clearance between Drive Shaft and Bearing</td>
<td>0.040–0.085 (0.0080–0.0033)</td>
<td>0.1 (0.0039)</td>
<td>Replace bearing and/or shaft</td>
<td>SM3-868</td>
</tr>
<tr>
<td>Driven Gear Shaft Diameter</td>
<td>17.979–17.997 (0.7079–0.7085)</td>
<td>17.970 (0.7074)</td>
<td>Replace</td>
<td>SM3-868</td>
</tr>
<tr>
<td>Driven Gear Inside Diameter</td>
<td>18.037–18.054 (0.7102–0.7107)</td>
<td>18.070 (0.7114)</td>
<td>Replace</td>
<td>SM3-869</td>
</tr>
<tr>
<td>Clearance between Driven Gear and Shaft</td>
<td>0.040–0.075 (0.0080–0.0023)</td>
<td>0.1 (0.0039)</td>
<td>Replace bearing and/or shaft</td>
<td>SM3-845</td>
</tr>
<tr>
<td>Gear Teeth Pitting or Wear</td>
<td>–</td>
<td>–</td>
<td>Replace, if necessary</td>
<td>Visual check</td>
</tr>
</tbody>
</table>

Unit: mm (in)
SPECIAL TOOL

Prior to starting an engine overhaul, it is necessary to have these special tools.

WRENCH

102 mm
(4.02 in)

09553-1010
For spin-on type oil filter:

OVERHAUL

1419M
1-No.21

T = 250–350 (19–25)

1425G
1-No. 20

T = 100–150 (8–10)

1. Oil filter
2. Oil filter cover
3. Valve
4. Spring
5. O-ring
6. Plug
7. Oil cooler case
8. Gasket
9. Oil cooler element

A. Oil filter safety valve
   1.3 kg/cm² (18.5 lb/sq.in)
B. Oil cooler safety valve
   4.0 kg/cm² (56.9 lb/sq.in)
C. Regulator valve
   4.0 kg/cm² (56.9 lb/sq.in)
ENGINE

IMPORTANT POINT — DISMOUNTING

REMOVE THE SPIN-ON TYPE OIL FILTER.

Using a special tool, unscrew the oil filter.

Special Tool: Wrench (09553-1010)

IMPORTANT POINTS — MOUNTING

INSTALL THE OIL COOLER.

1. Clean the faces.
2. Apply the liquid gasket as shown and install the oil cooler within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width (A): 1.5—2.5 mm (0.06—0.10 in)

INSTALL THE SPIN-ON TYPE OIL FILTER.

1. Apply a slight amount of engine oil to the gasket of the new filter.
2. Tighten the new filter by hand until the gasket touches the cover and the tighten another 3/4 to 1 full turn with a special tool.

Special Tool: Wrench (09653-1010)

INSPECTION AND REPAIR

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve and Springs of Oil Filter.</td>
<td>—</td>
<td>—</td>
<td>Replace, if necessary.</td>
<td>Visual check</td>
</tr>
<tr>
<td>Wear or Damage.</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
DATA AND SPECIFICATIONS

Injection nozzle
Type: Multi-hole nozzle type
Opening pressure: 220 kg/cm² (3,129 lb/sq.in)

FUEL SYSTEM DIAGRAM

NOTE: Figure illustrates 4-cylinder engine.

AIR BLEEDING FROM FUEL SYSTEM.

1. Loosen the bleeder plug on the fuel filter.
2. Loosen the priming pump knob.
3. Operate the priming pump knob until the air will not come out from the bleeder plug.
4. Tighten the bleeder plug.

Tightening Torque: 40–60 kg-cm (3–4 lb-ft)

NOTE: The bleeder plug should be tightened while the priming pump knob is operated.

5. Once again, operate the priming pump knob several times.
6. Push back the priming pump knob and tighten it.

NOTE: Wipe off any splashed fuel.
OVERHAUL
1530V
1-No. 20
For W04C-T, W04C-Ti, W06D, W06D-Ti, W06E

For W04D

1. Connector
2. Packing ring
3. Gasket
4. Joint bolt
5. Nozzle holder
6. Retainer ring
7. Shim
8. Spring
9. Nozzle holder pressure pin
10. Pin
11. Distance piece
12. Nozzle
13. Nozzle retaining nut

IMPORTANT POINTS – DISMOUNTING
REMOVE THE NOZZLE HOLDER ASSEMBLY.
Refer to Section ENGINE MOVING PARTS.
IMPORTANT POINTS — ASSEMBLY

TEST THE NOZZLE SKINKING.
Wash the nozzle properly with diesel fuel oil, then immerse it in diesel fuel oil.
Next slide the needle inside the nozzle properly and ensure that it moves smoothly. The needle valve should fall under its own weight when withdrawn vertically about 1/3 and released. If its motion is sluggish, replace the nozzle with a new one.

ADJUST THE INJECTION PRESSURE.
1. Connect the nozzle holder with a nozzle tester and move the lever at the rate of about 50 to 60 times per minute.
   Injection Pressure: 220 kg/cm² (3,129 lb/sq.in)

   WARNING
   ○ Diesel fuel is flammable.
     This nozzle adjusting should be done in a well-ventilated room and away from any open flames or electric spark.
   ○ The spray must always be covered. Keep your face and body away from the spray. This is because of the risk of fuel oil getting in your eyes or passing into your body.

2. If the injection pressure is not within specification, change the shim.

TEST THE SPRAY PROFILE.
   In the case of the new nozzle, operate the lever at the rate of 30 to 60 strokes per minute, and for a used nozzle, operate the lever at the rate of 15 to 60 strokes per minute.

TEST THE FUEL LEAKAGE.
When checking for fuel leakage from the nozzle, apply a pressure of about 10 to 20 kg/cm² (142–284 lb/sq.in) lower than the correct injection pressure to the nozzle by means of the nozzle tester. If there is no fuel leakage, the nozzle is normal.
FUEL FILTER

SPECIAL TOOL

Prior to starting an engine overhaul, it is necessary to have these special tools.

WRENCH

IMPORTANT POINT – DISMOUNTING

REMOVE THE SPIN ON TYPE FUEL FILTER.

Using a special tool, unscrew the fuel filter.

NOTE:
- Be careful not to spill diesel fuel.
- When removing the fuel filter for W04C-TI and W06D-TI, use a suitable wrench.

Special Tool: Wrench (09503-1040) for W04D, W04C-T, W06E

IMPORTANT POINT – MOUNTING

INSTALL THE SPIN-ON TYPE FUEL FILTER.

1. Apply a small amount of diesel fuel to the gasket of a new fuel filter.
2. Manually tighten the new fuel filter until its gasket touches the cover and then tighten another 2/3 turn with a special tool.

NOTE: When installing the fuel filter for W04C-TI and W06D-TI, use a suitable wrench.

Special Tool: Wrench (09503-1040) for W04D, W04C-T, W06E
COOLING SYSTEM

DATA AND SPECIFICATIONS

Coolant pump
Type ........................................... Forced circulation by volute pump
Drive ........................................ By V-belt

Seawater pump
Type ........................................ Self priming type (Flexible impeller pump)
Drive ........................................ By gear

Thermostat
Type ........................................ Wax type, bottom bypass system
Valve opening temperature ............... 76.5°C (170°F)

COOLING SYSTEM DIAGRAM

1. Seawater intake valve (Seacock)
2. Seawater filter
3. Seawater pump
4. Intercooler
5. Transmission fluid cooler
6. Heat exchanger
7. Water-cooled exhaust manifold
8. Exhaust pipe
9. Coolant pump
10. Cylinder block
11. Cylinder head
12. Thermostat
13. Engine oil cooler
14. Water cooled turbocharger
15. Coolant filler cap
16. Air bleeder plug
17. Coolant drain plug
OVERHAUL

HE11-059-00X01

1. Coolant pump
2. Coolant pump pulley
3. Seawater pump drive gear
4. O-ring
5. Seawater pump
6. Connector bolt
7. Soft washer
8. Coolant manifold
9. Thermostat
10. Thermostat gasket
11. Engine hanger
12. Thermostat case
13. Connector
14. Hose

T = 190–260 (14–18) kg·cm (lb·ft)

T = 190–260 (14–18) SM3-1934

Tightening torque: kg·cm (lb·ft)
COOLANT PUMP

OVERHAUL

1650N
1—No. 21

1. Pulley center
2. Pump case
3. Shaft subassembly
4. Slinger
5. Coolant seal
6. Vane

IMPORTANT POINT — DISMOUNTING
REMOVE BY PRYING LOOSE WITH SCREWDRIVER AT THE 2 POINTS ON THE FLANGE.

IMPORTANT POINTS — DISASSEMBLY
REMOVE VANE FROM SHAFT BY SCREWING IN A BOLT.

Bolt Size:
Diameter: 10 mm (0.394 in)
Pitch: 1.5 mm (0.059 in)
USING A PULLER, REMOVE THE PULLEY CENTER FROM THE SHAFT.

USING A STEEL PIPE AND PRESS, REMOVE THE SHAFT FROM BODY.
Steel Pipe Dimension:
A: More than 57 mm (2.244 in)
B: 18 – 21 mm (0.7087 – 0.8267 in)
C: Less than 29.5 mm (1.161 in)

IMPORTANT POINTS – ASSEMBLY
USING A STEEL PIPE AND PRESS, INSTALL THE SHAFT TO THE CASE.
NOTE: Bearing face must be aligned with edge of body.

USING A PRESS, INSTALL THE PULLEY CENTER.
DIMENSION (A): 90 mm (3.543 in)

INSTALL THE NEW COOLANT SEAL.
1. Apply a little liquid sealer to the coolant seal outer circumference and coolant pump body.
2. Install the slinger and coolant seal.
USING A PRESS, INSTALL THE VANE TO THE SHAFT.

NOTE: Apply a little engine oil to the coolant seal face.

AFTER THE COOLANT PUMP HAS BEEN ASSEMBLED, CHECK THAT THE SHAFT ROTATES SMOOTHLY.

IMPORTANT POINT – MOUNTING

INSTALL THE COOLANT PUMP TO THE TIMING GEAR COVER.

1. Clean the contacting surface of the coolant pump and timing gear cover free of old sealer, water and oil.

2. Apply the liquid gasket as shown and install the coolant pump within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width: 1.5–2.5 mm (0.06–0.10 in)

ENGINE EN-CS12A-5

MARINE PARTS SUPPLY of CANADA (800)661-5353
HEAT EXCHANGER

DESCRIPTION

1. Housing
2. Coolant filler cap
3. Element
4. O-ring
5. Engine coolant drain cock
6. Filler pipe seat
7. Gasket
8. Water gallery cover
9. Fitting

OVERHAUL

Tightening torque:
8 mm (0.315 in) diameter bolt and nut
150–180 kg·cm (11–13 lb·ft)

A. Engine coolant inlet
B. Engine coolant outlet
C. Seawater inlet
D. Seawater outlet

MARINE PARTS SUPPLY of CANADA (800)661-5353
**INSPECTION AND REPAIR**

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head changer (Exhaust Manifold), Flatness.</td>
<td>Less than 0.1 (0.004)</td>
<td>0.5 (0.019)</td>
<td>Resurface or replace.</td>
<td><img src="SM3-1936" alt="Visual check" /></td>
</tr>
<tr>
<td>Element, Clogged.</td>
<td></td>
<td></td>
<td>Clean with compressed air or sodium hydroxide</td>
<td><img src="SM3-1868" alt="Visual check" /></td>
</tr>
<tr>
<td>Coolant filler cap, Valve opening pressure.</td>
<td>0.4–0.6 kg/cm² (5.7–8.5 lb/sq.in)</td>
<td>–</td>
<td>Replace</td>
<td><img src="SM3-823" alt="Visual check" /></td>
</tr>
</tbody>
</table>
**THERMOSTAT**

**IMPORTANT POINT – ASSEMBLY**

**INSTALL THE THERMOSTAT.**

1. Remove water and dirt adhering to the thermostat case.
2. Replace the gasket without fail if it is corroded, damaged or flattened.
3. Before installing the thermostat, apply sealing compound to the hose installation portion of the coolant manifold.
4. Assemble the thermostat, gasket, case and coolant manifold as shown.

**IMPORTANT POINT – MOUNTING**

**INSTALL THE THERMOSTAT CASE.**

1. Clean the faces.
2. Apply the liquid gasket as shown and install the thermostat case on the cylinder head within 20 minutes.

**NOTE:** If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width: 1.5–2.5 mm (0.06–0.10 in)

**INVESTIGATION AND REPAIR**

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermostat Valve Opening</td>
<td>74.5–78.5°C</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>(166–173°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermostat Valve Lift</td>
<td>At least 10 (0.4)</td>
<td>–</td>
<td>Replace thermostat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>at 90°C (194°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermostat Closing Condition</td>
<td>Fully opened valve should close completely within 5 minutes when thermostat is immersed in water of normal temperature.</td>
<td>–</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SM3-888**
AIR INTAKE AND EXHAUST SYSTEM

OVERHAUL

1. Heat exchanger (Exhaust manifold)
2. Exhaust manifold gasket
3. Water hose
4. Clamp
5. Water pipe
6. Intake manifold
7. Intake air pipe
8. Gasket
9. Soft washer
10. O-ring
11. Air cleaner
12. Turbocharger
13. Intercooler
14. Air hose
15. Exhaust pipe
16. Bracket
17. Oil pipe
18. Engine coolant drain plug
19. Air bleeder plug
20. Seawater drain cock

T = Tightening torque: kg·cm (lb.ft)

T = 450–500 (33–36)

T = 190–260 (14–18)

SM3-1936
IMPORTANT POINTS – MOUNTING

INSTALL THE EXHAUST PIPES.
1. Install the turbocharger on the heat exchanger.
   - Tightening Torque: 450–500 kg-cm (33–36 lb.ft)
2. Temporarily install the mounting brackets and exhaust pipes.
3. Tighten the bolts to the specified torque in the tightening order as shown.
   - Tightening Torque:
     1: 500–600 kg-cm (37–43 lb.ft)
     2: 500–600 kg-cm (37–43 lb.ft)
     3: 500–600 kg-cm (37–43 lb.ft)
     4: 500–600 kg-cm (37–43 lb.ft)
     5: 500–600 kg-cm (37–43 lb.ft)
     6: 500–600 kg-cm (37–43 lb.ft)
     7: 500–600 kg-cm (37–43 lb.ft)
     8: 1,000–1,300 kg-cm (73–94 lb.ft)

INSTALL THE AIR INTAKE MANIFOLD AND PIPE.
1. Clean the faces.
2. Apply the liquid gasket to the intake manifold flange face and install it on the cylinder head within 20 minutes.
3. Apply the liquid gasket to the pipe flange face and install it on the intake manifold within 20 minutes.
   - Coating Width (A): 1.5–2.5 mm (0.06–0.10 in)
   - NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

INSPECTION AND REPAIR

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercooler element. Clogged</td>
<td>—</td>
<td>—</td>
<td>Clean or replace intercooler assy.</td>
<td>SM3-1817</td>
</tr>
</tbody>
</table>

NOTE: Do not separate the intercooler housing and element when cleaning.
ENGINE COMPONENT PARTS DISMOUNTING AND MOUNTING

SPECIAL TOOL

Prior to starting an engine overhaul, it is necessary to have these special tools.

**TIMER SETTING TOOL**

**V-BELT TENSION GAUGE**

---

**FUEL INJECTION PUMP**

**IMPORTANT POINTS – DISMOUNTING**

1. Disconnect the fuel lines, oil lines and engine control lines.
2. Turn the crankshaft counter-clockwise viewed from the flywheel side to align the injection timing mark on the flywheel at A\(^0\) before top dead center for No.1 cylinder on compression stroke with the pointer on the flywheel housing.

Injection Timing (A\(^0\)):

Refer to SECTION DATA AND SPECIFICATIONS.

**NOTE:** In case of marine engine equipped with seawater pump, never rotate crankshaft in reverse direction (Clockwise viewed from the flywheel side).

Reverse rotation may damage impeller in seawater pump.

3. Remove the timing inspection hole plug.

Check that the injection timing mark on the automatic timer is aligned with timer cover pointer.
4. If not, remove the timing gear cover and then loosen the drive gear fitting bolts.

   **NOTE:** Do not remove the drive gear fitting bolts.

5. Rotate the drive gear clockwise to align the injection timing and then tighten the drive gear fitting bolts.

   **Tightening Torque:** 300–350 kg·cm (22–25 lb·ft)

6. Lock the coupling flange with a special tool.

   **Special Tool:**
   - Timer Setting Tool
     - (09612-2090) for W04D
     - (09612-2100) for W04C-T, W04C-T1, W06D, W06D-T, W06E

7. Loosen the timer cover fitting bolts (B) and then remove the injection pump with timer cover.

   **NOTE:** Do not loosen the injection pump body fitting nuts (C).

---

**IMPORTANT POINTS – MOUNTING**

**INSTALL THE INJECTION PUMP.**

1. Check that the injection timing mark on the flywheel is aligned with flywheel housing pointer.

   **Injection Timing (A°):** Refer to **SECTION DATA AND SPECIFICATIONS**.

2. Check that the injection timing mark on the automatic timer is aligned with timer cover pointer.

   If not, adjust the injection timing.
ENGINE

3. Lock the coupling flange with a special tool.
   Special Tool:
   Timer Setting Tool
   (09512-2090) for W04D
   (09512-2100) for W04C-T, W04C-TI, W06D, W06D-TI, W06E

4. Install the injection pump with timer cover.
   Fitting Bolts Tightening Torque:
   190–260 kg·cm (14–18 lb·ft)

5. Remove a special tool and install the timing inspection hole plug.

6. Connect the fuel lines, oil lines and engine control lines.

GENERATOR

IMPORTANT POINT – MOUNTING

INSTALL THE GENERATOR ON THE ENGINE.

1. Install the V-belts, and adjust the belt tension.
   NOTE: o Do not under any circumstances apply the lever directly against the generator body owing to the risk of damaging the generator.
   o When installing a new V-belt or adjusting the tension, be sure to repeat the adjustment two or three times after running the engine for several minutes each time.

2. V-belt deflection
   Apply a load of about 10 kg (22 lb) by pressing with your finger or a special tool.
   Assembly Standard (A): 10–15 mm (0.40–0.59 in)
   Special Tool: V-belt tension gauge (09444-1210)
   NOTE: If the belt is excessively tensioned, there is a risk of damaging the bearings of the generator or coolant pump and also shorting the life of the V-belt.
   Conversely, if there is insufficient tension on the V-belt, the belt will slip, unusual noise will be emitted, the battery may run down and the engine may overheat.
   Through Bolt Tightening Torque:
   450–500 kg·cm (33–36 lb·ft)
**STARTER**

**IMPORTANT POINT – DISMOUNTING**

**REMOVE THE STARTER FROM THE ENGINE.**

1. Turn off the battery switch (if so equipped).
2. Put the match marks on the harness and starter terminals with a pen and then disconnect the harness.
3. Remove the starter from the engine.

**IMPORTANT POINT – MOUNTING**

**INSTALL THE STARTER ON THE ENGINE.**

1. Install the starter on the engine.
   - Fitting Bolt and Nut Tightening Torque:
     - 12 mm (0.47 in) dia.: 650–900 kg·cm (47–65 lb·ft)
     - 14 mm (0.55 in) dia.: 1,100–1,500 kg·cm (80–108 lb·ft)
2. Connect the starter harness to match the marks.
ENGINE TUNE-UP

NOTE: In case of marine engine equipped with seawater pump, never rotate the crankshaft in reverse direction (Clockwise viewed from flywheel). Reverse rotation may damage impeller in seawater pump.

VALVE CLEARANCE

INSPECTION AND ADJUSTMENT OF THE VALVE CLEARANCE

1. Set the No.1 piston to top dead center of compression stroke.

2. With the No. 1 piston positioned at top dead center and of the compression stroke, adjust the No. 1 valve clearance using a thickness gauge. The thickness gauge should move with a very slight pull.

Valve Clearance: Refer to SECTION DATA AND SPECIFICATIONS.

3. Adjust the other valves. Turn the crankshaft counter-clockwise 120° viewed from flywheel side. Adjust the valve clearance for each cylinder in the firing order.

Firing Order: 1-4-2-6-3-5
(A number of a cylinder is to be counted in order from the timing gear side)

METHOD FOR DETERMINING IF THE NO. 1 OR NO. 6 PISTON IS AT THE TOP DEAD CENTER ON COMPRESSION STROKE.

Turning the crankshaft, align the mark "1-6" on the flywheel with the pointer on the flywheel housing. In this position either the No. 1 or No. 6 piston is at the top dead center on compression stroke.

1. If both the No. 1 intake and exhaust rocker arms can be moved easily by hand, the No. 1 piston is at top dead center on compression stroke.
2. If the injection timing mark is nearly aligned with the pointer, the No. 1 piston is at top dead center on the compression stroke.

NOTE: If not, turn the crankshaft one complete revolution and align marks as above.

3. While locking at the push rod of No. 1 and No. 6 pistons. Turn the flywheel counter-clockwise and clockwise about 30° to 40° (see left figure).

   If the piston whose exhaust and intake push rods do not move during the interval, it is at the top dead center on the compression stroke.

   If the piston whose push rods have moved, it is at the completion of the exhaust and begun of the intake stroke (overlapping stroke).

   NOTE: Always loosen the lock nut and raise the adjusting screws fully to the top. If the adjusting screws are too low, the piston and valves may strike each other during valve clearance adjustment.

INJECTION TIMING

INSPECT THE INJECTION TIMING.

1. Turn the crankshaft counter-clockwise viewed from the flywheel side to align the injection timing marks on the flywheel at A° before top dead center for No. 1 cylinder on compression stroke with pointer on the flywheel housing.

   Injection Timing (A°): Refer to section DADA AND SPECIFICATIONS.

2. Check that the injection timing mark on the automatic timer is aligned with timer cover pointer.

   If not, adjust the injection timing.

   NOTE: When adjusting the injection timing, refer to "FUEL INJECTION PUMP" in section ENGINE COMPONENT PARTS DISMOUNTING AND MOUNTING for details.
ENGINE

INJECTION NOZZLE

INSPECT AND ADJUST THE INJECTION PRESSURE.
Refer to “INJECTION NOZZLE” in SECTION FUEL SYSTEM.

TEST THE SPRAY PROFILE.
Refer to “INJECTION NOZZLE” in SECTION FUEL SYSTEM.

TEST THE FUEL LEAKAGE.
Refer to “INJECTION NOZZLE” in SECTION FUEL SYSTEM.

THERMOSTAT

INSPECT THE THERMOSTAT FUNCTION.
1. Place the thermostat in hot water and check the opening temperature and the lift.
2. Using a thermometer, check to see the thermostat opens at the specified temperature: Refer to “THERMOSTAT” in SECTION COOLING SYSTEM.
3. Immerse the thermostat in hot water and measure the lift of the pellet after a period of 5 minutes using vernier calipers. Measure the position of the bottom of the pellet before and after heating the thermostat.

Valve Lift: Refer to “THERMOSTAT” in SECTION COOLING SYSTEM.

4. Immerse a heated thermostat in water of normal temperature. If it completely closes within 5 minutes it is satisfactory. If it remains even slightly open, it is defective and must be replaced.

COOLANT FILLER CAP

INSPECT THE FILLER CAP FUNCTION.
Check the filler cap pressure using a cap tester.
0.5 : 0.4–0.6 kg/cm² (5.7–8.5 lb/sq.in)
0.9 : 0.75–1.05 kg/cm² (10.7–14.9 lb/sq.in)

NOTE: ○ The filler cap pressure is shown on the filler cap, and it should be confirmed.
○ If the cap pressure is incorrect, there is a risk of abnormally high pressure being generated in the cooling system, which may cause the hose to drop off or burst and, in turn, damage the engine.

WARNING
The cap should not be removed while the engine and cooling system are hot. This can result personal injury.
ENGINE CONTROL

ADJUST THE SOLENOID (ENGINE STOP) LINK ROD.

1. Adjust the link rod length so that the clearance between the stopper of the governor case and the engine stop lever becomes "A" when the solenoid plunger is fully pushed in.

Assembly Standard "A": 2–3 mm (0.08–0.11 in)

NOTE:
- Install the link rod with the nut(c) at the top.
- If the clearance adjustment is unsatisfactory or the action of the solenoid is sluggish, solenoid seizure, insufficient output or engine stoppage may result.

2. After the above adjustment is over, move the link rod by hand and make sure that it moves lightly.

ADJUST THE ENGINE IDLING SPEED.

When straight drive navigation is not smoothly made at the time of a sea trial in engine at idle, adjust it according to the following procedures.

1. Disconnect the throttle control cable from engine port (left) side and the starboard (right) side.
2. Loosen the idling speed stopper bolt lock nut.
3. Adjust through varying the engine speed using the idling speed stopper bolt on the injection pump so that straight drive navigation is made.

NOTE:
- To increase engine speed: Turn the idling speed stopper bolt clockwise.
- To decrease engine speed: Turn the idling speed stopper bolt counter-clockwise.

Engine Idling Speed: Refer to section DATA AND SPECIFICATIONS.

4. Upon completion of adjustment of engine idling speed, lock the stopper bolt with nut and apply paint on the stopper bolt and nut.

NOTE: When adjusting the all adjusting devices on the fuel injection pump governor, except the idling speed stopper bolt, refer to CHAPTER GV, INJECTION PUMP GOVERNOR.
ENGINE TUNE-UP ON TEST BENCH

NOTE: In case of marine engine equipped with seawater pump
- Never rotate the crankshaft in reverse direction (Clockwise viewed from flywheel).
  Reverse rotation may damage impeller in seawater pump.
- Do not run engine without water in the seawater cooling system. The seawater pump damage can result.
  Starting the engine when the generator is not connected to the battery may damage the generator. Always connect to the battery.

SET THE ENGINE ASSEMBLY ON A TEST BENCH.
1. Add the proper amount of the specified engine oil through the oil filler cap on the cylinder head cover.
2. Add coolant.

NOTE: In case of engine equipped with water-cooled turbocharger, bleed air from bleeder plug.

BLEED AIR FROM FUEL SYSTEM.
Refer to section FUEL SYSTEM.

CHECK THE INJECTION TIMING.
Refer to "FUEL INJECTION PUMP" in section ENGINE COMPONENT PARTS DISMOUNTING AND MOUNTING.

CHECK THE VALVE CLEARANCE.
START THE ENGINE

NOTE: Before starting the engine, mark sure that the fuel cut lever of the fuel injection pump is operating normally.

1. Check the oil feed to rocker arms.
   a. Set the engine speed: Refer to SECTION DATA AND SPECIFICATION.
   b. Within one minute after starting the engine, oil should flow to the head (Face A) of all push rods and the head (Face B) of all valves. If the time required for the oil to flow to the rocker arms is long, various troubles such as seizing, abnormal wear and unusual noise may occur.

2. Check the contact of the rocker arm and valve stem caps.
   After running the engine, a contact of approx. 8 mm (0.315 in) should be obtained at the cap contact face of the rocker arm.
   If the contact face is one sided, the valve will tilt, resulting in valve seizure, breakage, damage, or wear of the rocker arm stem cap.

3. Retighten the cylinder head bolts.
   After tightening cylinder head bolt to specified torque, run the engine for about 30 to 40 minutes at a water temperature of about 80°C. Then loosen cylinder each head bolt 1/8-1/4 turn and retighten, in sequence, to specified torque.

   Special Tool: Socket wrench (09411-1260)

   NOTE:
   - In case of marine engine equipped with heat exchanger (exhaust manifold), loosen the heat exchanger bracket fitting bolts before retightening the cylinder head bolts.
   - Be sure to loosen one bolt at a time, then retighten it before going on to the next bolt.
   - By retightening, face pressure of cylinder head is restored from point B to C as shown.
   - Retighten at the first 30 hours following servicing which involves the loosening or removal of any cylinder head bolt. Such servicing includes replacement of the cylinder head gasket, servicing of the valve gear parts, and the like.

RECHECK THE VALVE CLEARANCE, WHEN ENGINE IS COLD.
PROCEDURE FOR INSTALLING JOINTS AND GASKETS OF ENGINE PIPES

1. Gasket seal type (aluminum + rubber, asbestos or copper).

<table>
<thead>
<tr>
<th>Location of gasket seal</th>
<th>Clamping screw size (Diameter)</th>
<th>Tightening torque (kg-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>mm (in)</td>
<td>Tightening torque (lb.ft)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>8 (0.315)</td>
<td>120–170 (9–12)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>10 (0.394)</td>
<td>180–230 (13–16)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>12 (0.472)</td>
<td>230–280 (17–20)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>14 (0.551)</td>
<td>230–280 (17–20)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>16 (0.630)</td>
<td>300–350 (22–25)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>18 (0.709)</td>
<td>400–450 (29–32)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>20 (0.787)</td>
<td>400–450 (29–32)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>22 (0.866)</td>
<td>530–600 (36–43)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>24 (0.945)</td>
<td>720–800 (52–57)</td>
</tr>
<tr>
<td>JOINT BOLT GASKET JOINT BOLT</td>
<td>28 (1.102)</td>
<td>1,300–1,500 (94–108)</td>
</tr>
</tbody>
</table>

2. Metal seal type (Flares connector type).

<table>
<thead>
<tr>
<th>Location of metal seal</th>
<th>Clamping screw size (Diameter)</th>
<th>Tightening torque (kg-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONNECTOR FLARE NUT BRACKET NUT 3 WAY JOINT LOCK WASHER</td>
<td>mm (in)</td>
<td>Tightening torque (lb.ft)</td>
</tr>
<tr>
<td>CONNECTOR FLARE NUT BRACKET NUT 3 WAY JOINT LOCK WASHER</td>
<td>12 (0.472)</td>
<td>200–220 (15–16)</td>
</tr>
<tr>
<td>CONNECTOR FLARE NUT BRACKET NUT 3 WAY JOINT LOCK WASHER</td>
<td>14 (0.551)</td>
<td>330–360 (24–26)</td>
</tr>
<tr>
<td>CONNECTOR FLARE NUT BRACKET NUT 3 WAY JOINT LOCK WASHER</td>
<td>16 (0.630)</td>
<td>400–500 (29–36)</td>
</tr>
<tr>
<td>CONNECTOR FLARE NUT BRACKET NUT 3 WAY JOINT LOCK WASHER</td>
<td>18 (0.709)</td>
<td>600–700 (43–51)</td>
</tr>
<tr>
<td>CONNECTOR FLARE NUT BRACKET NUT 3 WAY JOINT LOCK WASHER</td>
<td>20 (0.787)</td>
<td>650–700 (47–51)</td>
</tr>
</tbody>
</table>
3. Metal seal type (Nipples connectors type)

<table>
<thead>
<tr>
<th>Location of metal seal</th>
<th>Tightening torque chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>GASKET NUT FLARE CONNECTOR</td>
<td>Clamping screw size (Diameter) mm (in)</td>
</tr>
<tr>
<td></td>
<td>10 (0.394)</td>
</tr>
<tr>
<td></td>
<td>20 (0.787)</td>
</tr>
</tbody>
</table>

**NOTE:**
- Before installing the joints, ensure that there is no dirt or burrs adhering to the various seat faces (pipe joints, gaskets, etc.)
- Because the pipes can move relatively free during installation and the seat faces are liable to tilt, first temporarily tighten the pipes, then tighten them to specification and ensure that there is no leakage from them.
- When tightening two pipes together, be very careful that they do not rotate together.
- After installing the pipes, apply the correct pressure to each pipe joint and ensure that there is no leakage.
- Ensure that the various tightening torques conform to the above table.
- If a soft washer #4840 FR-N (aluminum + rubber and carbon press fit part) is loosened or removed subsequent to being installed, be sure and replace it with a new one. There is no need to replace it, however, for normal retightening.
MARINE TRANSMISSION DISMOUNTING AND MOUNTING

OVERHAUL

1. Marine transmission
2. Fluid cooler
3. Remote control
4. Connection for temperature gauge
5. Neutral safety switch
6. Connection for shifting pressure control
7. Marine transmission output flange
8. Propeller shaft
9. Support bracket
10. Intermediate flange
11. Torsion-elastic coupling
12. Clutch, side A
13. Loose gear
14. Clutch, side B
15. Intermediate shaft
16. Output shaft

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OPERATION

Position of shifting lever when driving forward

<table>
<thead>
<tr>
<th>Propeller pitch</th>
<th>Propeller ratio</th>
<th>Shifting lever in position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right hand</td>
<td>Opposite to engine rotation</td>
<td>A</td>
</tr>
<tr>
<td>Left hand</td>
<td>As engine rotation</td>
<td>B</td>
</tr>
</tbody>
</table>

SM3-1822
IMPORTANT POINTS — DISMOUNTING

PUMPING OUT MARINE TRANSMISSION FLUID.
1. Turn the filter cover counter-clockwise to loosen the fluid fine filter (Item A).
2. Remove the filter cover complete with fluid fine filter.
3. Pump out old marine transmission fluid through suction pipe (Item B) in the filter compartment.

NOTE: Max. outside diameter of suction hose is 16 mm (0.625 in) (Item C).

DISCONNECT THE PROPELLER SHAFT (Item D) FROM THE MARINE TRANSMISSION OUTPUT FLANGE.

REMOVE THE FLUID COOLER WITH PIPES (Item E).
NOTE: Plug the openings of the line and marine transmission to prevent dirt entering.

DISCONNECT THE REMOVE CONTROL (Item F) FROM SHIFTING LEVER.

DISCONNECT THE ELECTRICAL LINE AND FLUID LINES.

REMOVE THE SUPPORT BRACKET (Item G).

REMOVE THE MARINE TRANSMISSION.
1. Put the match mark on the marine transmission and intermediate flange with a pen.
2. Suspend the marine transmission.

NOTE: The marine transmission without fluid and fluid cooler weights approx. 44 kg (97 lb).
3. Remove the marine transmission fitting bolts.
4. Pull the marine transmission away from the engine.

REMOVE THE INTERMEDIATE FLANGE FROM THE FLYWHEEL HOUSING.
Put the match mark on the intermediate flange and flywheel housing before removing.

REMOVE THE TORSION-ELASTIC COUPLING FROM THE FLYWHEEL.
IMPORTANT POINTS - MOUNTING

INSTALL THE TORSION-ELASTIC COUPLING.

1. Install the torsion-elastic coupling to the flywheel.
2. Check the axial tolerances of the connection between marine transmission and engine.
   a. Attach caliper linkage (Item H) to damper plate.
   b. Apply base of caliper at right angles to plane surface of flywheel housing.
   c. Pretension the gauge and set to "0".
   d. Turn the flywheel slowly. The gauge reading must not exceed 0.1 mm (0.004 in).

"X": Mounting surface of engine flywheel housing.

3. Check the radial tolerances of the connection between marine transmission and engine.
   a. Attach caliper linkage (Item H) to damper plate.
   b. Apply base of caliper at right angles to entering surface of flywheel housing.
   c. Pretension the gauge and set to "0".
   d. Turn the flywheel slowly. The gauge reading must not exceed 0.1 mm (0.004 in).

"X": Mounting surface of engine flywheel housing.
INSTALL THE INTERMEDIATE FLANGE.

1. Locate the intermediate flange on the flywheel housing to align the match mark.

2. Check the axial tolerances of the intermediate flange (Concentricity).
   a. Attach caliper linkage (Item H) to the damper plate (Item D).
   b. Apply base of caliper at right angles to centering surface of intermediate flange (Item K).
   c. Pretension the gauge and set to “0”.
   d. Turn the flywheel slowly. The gauge reading must not exceed 0.15 mm (0.0059 in).

2. Check the radial tolerances of the intermediate flange (parallel running).
   a. Attach caliper linkage (Item H) to the damper plate (Item J).
   b. Apply base of caliper at right angles to plane surface of the intermediate flange (Item K).
   c. Pretension the gauge and set to “0”.
   d. Turn the flywheel slowly. The surface deviation must not exceed 0.05 mm (0.0019 in) 100 mm (3.937 in) measured diameter.

INSTALL THE MARINE TRANSMISSION.

1. Apply grease containing molybdenum disulfide to the input shaft spline (Item L).
2. Install the marine transmission to the intermediate flange.

   Tightening Torque: 380–500 kg·cm (28–36 lb·ft)
   Axial Play (M): Minimum 1 mm (0.04 in)

   NOTE: Assure clearance of axial play of the crankshaft.

INSTALL THE SUPPORT BRACKET (Item G).

CONNECT THE PROPELLER SHAFT (Item D) TO THE MARINE TRANSMISSION OUTPUT FLANGE.

CONNECT THE ELECTRICAL LINE AND FLUID LINES.

CONNECT THE REMOVE CONTROL (Item F) TO THE SHIFTING LEVER.

INSTALL THE FLUID COOLER WITH PIPES (Item E).

FILL WITH AUTOMATIC TRANSMISSION FLUID (ATF).

   NOTE: The filter element must be renewed whenever the fluid is changed.

   1. Turn filter cover counter-clockwise and pull.
   2. Fill with 4.0 liters (1.06 US gallon) of Automatic Transmission Fluid (ATF).

Type of Fluid: ATF (Automatic Transmission Fluid)
   e.g. DEXRON II-D, FORD M 2 C-33G, ALLISON C-3

No other fluids unless authorized by HURTH
3. Remove filter element (Item N) from cover (Item P).
4. Check O-ring (Item Q) and place new filter element onto cover.
5. Check O-ring (Item R) and insert filter cover with fluid fine filter to its stop into the marine transmission housing.

6. Lock filter cover in place by turning clockwise and pushing.

NOTE: When inserting the filter cover, make sure that flat side of cover (Item S) matches with lug (Item T) in the filter.

7. Loosen fluid dipstick (Item U) turning the handle counterclockwise.
8. Wipe dipstick with a clean and dustfree cloth and insert dipstick to its stop.
9. Remove dipstick and check fluid level.
10. Insert the dipstick to its stop and lock it by turning the handle clockwise.
11. Let engine run at idle speed with shifting lever in neutral position until fluid cooler and all pipelines are filled in fluid.
12. Shut down engine and check fluid level again. If necessary, top up to the marking on the dipstick.

(K.P.)
CHAPTER EE

ELECTRICAL EQUIPMENT

DATA AND SPECIFICATIONS .................................. EE- 2
LOCATION OF ELECTRICAL EQUIPMENT .................... EE- 2
TROUBLESHOOTING ........................................... EE- 3
GENERAL INSTRUCTION ....................................... EE- 5
BATTERY ................................................................ EE- 6
ENGINE STARTING CIRCUIT .................................... EE- 7
PRE-HEAT CIRCUIT ................................................ EE- 8
ENGINE STOP AND WARNING LAMP CIRCUIT ............ EE- 8
METER AND GAUGE CIRCUIT .................................. EE-10
ELECTRICAL WIRING DIAGRAM
DATA AND SPECIFICATIONS

Electrical system
- Voltage: Direct current 12 volts or 24 volts
- Ground: Negative (-) ground
- Warning and indicator lamp: 1.4W, 4 pieces
- Gauge illumination lamp: 1.7W, 4 pieces
- Tachometer illumination lamp: 3.4W, 2 pieces

LOCATION OF ELECTRICAL EQUIPMENT

1. Water temperature receiver gauge
2. Engine tachometer
3. Fuel receiver gauge
4. Volt-meter
5. Starter switch
6. Oil pressure warning lamp
7. Battery charge warning lamp
8. Water temperature warning lamp
9. Intake air heater indicator lamp
10. Illumination lamp switch
11. Oil pressure receiver gauge
12. Water temperature receiver gauge
13. Water temperature sender gauge
14. Oil pressure sender gauge
15. Oil pressure switch
16. Glow plug
17. Starter block relay
18. Intake air heater relay
19. Solenoid
20. Emergency stop relay
21. Battery main relay
22. Intake air heater timer
23. Relay
24. Sensor amplifier
25. Fuel sender gauge
TROUBLESHOOTING

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Remedy/Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>A lot of exhaust is emitted but the engine does not start or is difficult to start. (Auxiliary starting device: Standard specifications)</td>
<td><strong>Auxiliary starting device</strong>&lt;br&gt;- Loose wiring of heater signal or defective heater signal.</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Defective heater plug</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Defective wiring between heater and plug</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Defective power relay</strong></td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td><strong>Defective heater plug</strong></td>
<td>Replace.</td>
</tr>
<tr>
<td></td>
<td><strong>Defective wiring between heater and plug</strong></td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td><strong>Defective sensing resistor</strong></td>
<td>Replace.</td>
</tr>
<tr>
<td></td>
<td><strong>Defective heater control timer</strong></td>
<td>Replace.</td>
</tr>
<tr>
<td>Solenoid does not operate when engine is running, even if abnormal signal is input. (Engine does not stop.)</td>
<td><strong>Emergency stop relay</strong>&lt;br&gt;- Alternator malfunctions</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Insufficient battery voltage</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Faulty connection at N terminal of emergency relay</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Defective solenoid</strong></td>
</tr>
<tr>
<td>Solenoid operates when starter switch is turned ON</td>
<td><strong>Emergency stop relay</strong>&lt;br&gt;- Faulty connection at R1 terminal</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faulty connection at B and C terminals</td>
</tr>
<tr>
<td>When the starter switch is turned OFF, the battery relay switch goes OFF and the solenoid fails to operate.</td>
<td><strong>Battery</strong>&lt;br&gt;- Insufficient voltage</td>
<td>Charge or replace.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Alternator</strong>&lt;br&gt;- Malfunctions</td>
</tr>
<tr>
<td>Starter chattering or improper plunging</td>
<td><strong>Battery</strong>&lt;br&gt;- Insufficient voltage</td>
<td>Charge or replace.</td>
</tr>
<tr>
<td></td>
<td><strong>Starter block relay</strong>&lt;br&gt;- Faulty connection at terminals</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Internal circuit abnormal</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Relay switch abnormality (faulty contacts)</strong>&lt;br&gt;- Improper sliding between rod and moving core, or open-circuit or burnt out coil</td>
</tr>
<tr>
<td></td>
<td><strong>Starter switch</strong>&lt;br&gt;- Faulty connection at terminals</td>
<td></td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible cause</td>
<td>Remedy/Prevention</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Improper disengagement of starter or defective hold function when</td>
<td>Alternator</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td>engine is rotating</td>
<td>• Defective (correct voltage not generated)</td>
<td></td>
</tr>
<tr>
<td>Re-plunging during inertial rotation</td>
<td>Starter block relay</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>• Improper terminal connection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reverse connections to terminals B and C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Starter block relay</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>• Reverse connections to terminals B and C</td>
<td></td>
</tr>
</tbody>
</table>
GENERAL INSTRUCTION

WARNING
Be sure to disconnect the ground cable before servicing the electrical circuits.

WIRING CODE
1. Wiring colors are indicated by a code.
   - B : Black
   - Br : Brown
   - G : Green
   - L : Blue
   - Y : Yellow
   - W : White
   - R : Red
   - Lg : Light green
   - Ln : Light blue

2. The first letter indicates the ground wire color and second letter indicates the stripe color.
3. Arabic numerals indicate the cross-sectional area of wire. 3 : $3 \text{ mm}^2$

CONNECTOR
- The connectors exist as male and female connectors.
- Male and female connectors are classified according to the shape of the terminals in the connector (refer to the figure on the left).
- Male and female connectors are provided with a lock, so that they cannot be separated easily.
- For connector separation, hold the connector, unlock the lock and separate the connector.

NOTE: When the connector is pulled by pulling the wires, the connection between the terminals and the wires will be damaged.

1. Remove the terminal from the connector.
   - Insert a miniature screwdriver or a terminal puller between terminal and connector and unlock the lock between terminal and connector.
   - When the lock has been released, pull the wire to remove the terminal.

2. Install the terminal in the connector.
   - Insert the terminal into the connector until the clicking sound of lock engagement can be heard.
   - Pull the wire to confirm correct lock engagement.

FUSE
- The power supply must be switched off for fuse replacement.
- Use a fuse with a suitable ampereage.

NOTE: Wire burning may be caused when a fuse with an excessively large current capacity is used.
- If the fuse should blow frequently, investigate the cause and remove it.
BATTERY

CONVERSION FORMULA FOR SPECIFIC GRAVITY.

- The specific gravity of electrolyte changes according to the temperature of the electrolyte itself, hence it is based on a temperature of 20°C (68°F). Consequently, if the temperature is not 20°C when the specific gravity is measured, it is necessary to convert the measured value to the equivalent value at 20°C.

Temperature conversion formula: \( S_{20} = S_t + 0.0007(t - 20) \)

Where,
- \( S_{20} \) is the specific gravity at 20°C (reference temperature)
- \( S_t \) is the specific gravity at the measuring temperature
- \( t \) is the temperature during measurement
- \( 0.0007 \) is the temperature coefficient of the electrolyte

NOTE: As a rough guide, if the temperature of the electrolyte rises or falls by 15°C (59°F), the specific gravity of the electrolyte will vary by about 0.01.

BATTERY CHARGING

- Be careful of the following points.
  1. While the battery is being charged, ensure that the temperature of the electrolyte does not rise above 45°C (113°F).
  2. While the battery is being charged, be particularly careful to keep it away from sources of fire.
  3. The amount of electrolyte must be within the specified level.

Specific gravity when battery is fully charged: 1.250 - 1.270 at 20°C (68°F)

CLEANING THE BATTERY

- If the terminals at the top of the battery are dirty, clean them with cold water or lukewarm water.
- Apply a light coating of grease to the terminals to prevent them from rusting so as to prevent faulty contact.

CONNECTING THE BATTERY CABLES

- Clamp the cables securely to prevent improper contact between the cables and the battery terminals.
- Be very careful not to connect the (+) and (-) leads in reverse. (because this may cause equipment run off the battery to be damaged.)
ENGINE STARTING CIRCUIT

CHECK THE CONTINUITY OF THE STARTER SWITCH.
Check the continuity between terminals. If continuity is not correct, replace the starter switch.

<table>
<thead>
<tr>
<th>Terminal Switch position</th>
<th>B</th>
<th>R1</th>
<th>R2</th>
<th>M</th>
<th>BR</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-HEAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>START</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CHECK THE OPERATION OF BATTERY RELAY.
1. Check that there is continuity between terminals 1 and 2.
2. Check that there is no continuity between terminals 3 and 4.
3. Connect the positive (+) lead from the battery to terminal 1. Connect the negative (−) lead to terminal 2. Check that there is continuity between terminals 3 and 4.
4. If operation is not correct, replace the battery relay.

CHECK THE OPERATION OF THE STARTER BLOCK RELAY.
1. Check that there is no continuity between terminals C and B.
2. Connect the positive (+) lead from the battery to terminal S. Connect the negative (−) lead to terminal E. Check that there is continuity between terminals C and B.
3. Connect the positive (+) lead from the battery to terminal P. Connect the negative (−) lead to terminal E. Check that there is no continuity between terminals C and B.
4. If operation is not correct, replace the relay.
**PRE-HEAT CIRCUIT**

CHECK THE OPERATION OF THE INTAKE AIR HEATER RELAY.

1. Check that there is continuity between terminals SW and L.
2. Check that there is no continuity between terminals SW and F.
3. Connect the positive (+) lead from the battery to terminal SW. Connect the negative (−) lead to terminal L. Check that there is continuity between terminals SW and F.
4. If operation is not correct, replace the relay.

CHECK THE CONTINUITY OF THE HEATER PLUG.

Check the continuity between terminal and body ground. If there is no continuity, replace the glow plug.

**ENGINE STOP AND WARNING LAMP CIRCUIT**

CHECK THE OPERATION OF THE SOLENOID AND ADJUST THE LINK ROD.

1. Connect the battery to the solenoid terminals and confirm that the solenoid is drawn in.
2. Push in the plunger by hand and confirm that there is a clearance between the stopper and the stop lever.

Standard clearance: 2 – 3 mm (0.01188 – 0.1181 in)

If there is no clearance, perform adjustment with the link rod.

**NOTE:**
- If the clearance adjustment is unsatisfactory or the action of the solenoid is sluggish, solenoid seizure, insufficient output or engine stoppage may result.
- Install the link rod with the nut at the top.

CHECK THE OPERATION OF THE WATER TEMPERATURE SWITCH.

Check the continuity between terminals. If continuity is not correct, replace the temperature switch.

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Water temperature: °C (°F)</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More than 96–100 (205–212)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less than 91 (196)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Marine Parts Supply of Canada
1930 Stewart Ave
North Vancouver, B.C.
V7N 2B8
Ph (604) 431-5553
Fax (604) 431-5554
MARINE PARTS SUPPLY of CANADA (800)661-5353
CHECK THE OPERATION OF THE PRESSURE SWITCH.
1. Check the continuity between terminal and body ground.
   a. Check that there is continuity when engine is stopped.
   b. Check that there is no continuity when engine is running.
2. If continuity is not correct, replace the oil pressure switch.

NOTE: Engine oil pressure should be more than 0.5 kg/cm² (7.2/sq.in).

CHECK THE OPERATION OF THE RELAY. (WATER TEMPERATURE WARNING LAMP RELAY)
1. Check that there is continuity between terminals 1 and 2.
2. Check that there is no continuity between terminals 3 and 4.
3. Connect the positive (+) lead from the battery to terminal 1. Connect the negative (-) lead to terminal 2. Check that there is continuity between terminals 3 and 4.
4. If operation is not correct, replace the relay.

METER AND GAUGE CIRCUIT

CHECK THE OPERATION OF THE TACHOMETER.
1. Connect a turn-up test tachometer, and start the engine.
2. Check the tester and tachometer indications.
   If the indicated value of tachometer is not correct, replace the tachometer.

<table>
<thead>
<tr>
<th>Standard revolution (rpm)</th>
<th>600</th>
<th>1,800</th>
<th>3,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable value (rpm)</td>
<td>± 100</td>
<td>± 100</td>
<td>± 100</td>
</tr>
</tbody>
</table>

CHECK THE OPERATION OF THE FUEL RECEIVER GAUGE.
1. Wire the receiver gauge, variable resistor and battery, as shown in the figure at left. Check the indicated value on the receiver gauge at the reference resistance value.
2. If the indicated value is not correct, replace the receiver gauge.

<table>
<thead>
<tr>
<th>Resistance: Ω</th>
<th>33.5</th>
<th>103</th>
<th>240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauge reading</td>
<td>F</td>
<td>1/2</td>
<td>E</td>
</tr>
<tr>
<td>Allowable reading: %</td>
<td>± 6</td>
<td>± 4</td>
<td>± 5</td>
</tr>
</tbody>
</table>
CHECK THE OPERATION OF THE FUEL SENDER GAUGE.
Measure the resistance between terminals.
If resistance is not correct, replace the sender gauge.

<table>
<thead>
<tr>
<th>Float position</th>
<th>F</th>
<th>1/2</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard resistance: Ω</td>
<td>30.1</td>
<td>103</td>
<td>250</td>
</tr>
<tr>
<td>Allowable value: Ω</td>
<td>± 3.4</td>
<td>± 10.3</td>
<td>± 24</td>
</tr>
</tbody>
</table>

CHECK THE OPERATION OF THE WATER TEMPERATURE RECEIVER GAUGE.
1. Wire the receiver gauge, variable resistor and battery, as shown in the figure at left. Check the indicated value on the receiver gauge at the reference resistance value.
2. If the indicated value is not correct, replace the receiver gauge.

| Resistance: Ω | 43.2 | 23.7 |
| Gauge reading: °C (°F) | 80 (176) | 100 (212) |
| Allowable value: °C (°F) | ± 3.5 (38) | ± 5.5 (42) |

CHECK THE OPERATION OF THE WATER TEMPERATURE SENDER GAUGE.
1. Wire the sender gauge and ohmmeter as shown in the figure at left. Check the resistance value of the sender gauge at the standard water temperature.
2. If resistance value is not correct, replace the sender gauge.

| Water temperature: °C (°F) | 50 (122) | 80 (176) | 100 (212) |
| Standard resistance: Ω | 130 | 48.5 | 26.7 |
| Allowable value: Ω | ± 4.2 | ± 2.5 |

CHECK THE OPERATION OF THE OIL PRESSURE RECEIVER GAUGE.
1. Wire the receiver gauge, variable resistor and battery as shown in the figure at left. Check the indicated value on the receiver gauge at the reference current value.
2. If the indicated value is not correct, replace the receiver gauge.

| Resistance: Ω | 19 | 81 | 112 |
| Gauge reading: bar (psi) | 0 | 4 (56) | 6 (84) |
| Allowable value: bar (psi) | ± 0.3 (4.1) | ± 0.7 (9.7) | ± 0.8 (8.4) |

CHECK THE OPERATION OF THE OIL PRESSURE SENDER GAUGE.
1. Wire the sender gauge and ohmmeter as shown in the figure at left. Check the resistance between the sender gauge and the body ground.
2. If the measured value is not correct, replace the sender gauge.

| Oil pressure kg/cm² (lb/sq.in) | 0 | 4 (56) | 6 (85) |
| Standard resistance: Ω | 19 | 80 | 110 |
| Allowable value: Ω | ± 2 | ± 5 | ± 9 |
CHECK THE OPERATION OF THE VOLTMETER.
1. Wire the voltmeter and transformer as shown in the figure at left. Check the indicated value on the voltmeter at the reference voltage value.
2. If the indicated value is not correct, replace the voltmeter.

<table>
<thead>
<tr>
<th>Gauge reading: V</th>
<th>12</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable value: V</td>
<td>±0.5</td>
<td>±0.5</td>
</tr>
</tbody>
</table>

CHECK THE OPERATION OF THE GENERALLY USE SWITCH (ILLUMINATION LAMP SWITCH).
Check the continuity between terminals.
If operation is not correct, replace the switch.

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Switch position</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ELECTRICAL WIRING DIAGRAM : MODEL W06DT1 (Page 1/2 to 2/2)

MAIN DECK

1. Starter switch
2. Battery change warning lamp
3. Water temperature warning lamp
4. Oil pressure warning lamp
5. Intake air heater indicator lamp
6. Thermometer
7. Fuel pressure gauge
8. Ignition temperature receiver gauge
9. Oil pressure receiver gauge
10. Volt-meter
11. Instrument illumination lamp switch
12. Fuses
13. Battery main relay
14. Battery
15. Junction block
16. Alternator with regulator
17. Starter black relay
18. Starter
19. Ignition air heater relay
20. Glow plug
21. Solenoid
22. Revolution sensor

FLYING DECK

1. Oil pressure switch
2. Water temperature switch
3. Oil pressure water gauge
4. Water temperature water gauge
5. Fuel water pressure gauge
6. Emergency stop relay
7. Intake
8. Rider
9. Swim
CHAPTER TU

TURBOCHARGER

DATA AND SPECIFICATIONS  ........................................... TU-2
DESCRIPTION  ............................................................. TU-2
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OVERHAUL CRITERIA  ..................................................... TU-5
SPECIAL TOOL  ............................................................. TU-6
TURBOCHARGER  ............................................................. TU-7
TU-2 TURBOCHARGER

DATA AND SPECIFICATIONS

<table>
<thead>
<tr>
<th>Type</th>
<th>RHC7 GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine type</td>
<td>Radial flow type</td>
</tr>
<tr>
<td>Blower type</td>
<td>Centrifugal type</td>
</tr>
<tr>
<td>Lubricating method</td>
<td>External lubrication type</td>
</tr>
<tr>
<td>Bearing type</td>
<td>Full floating type</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>Counterclockwise as seen from the turbine side</td>
</tr>
</tbody>
</table>

DESCRIPTION

1. Turbine casing
2. Turbine rotor
3. Heat protector
4. Bearing case
5. Blower case
6. Blower impeller
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Remedy/Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense black smoke</td>
<td>Insufficient air intake</td>
<td>Disassemble and clean or replace the air cleaner element.</td>
</tr>
<tr>
<td></td>
<td>• Air cleaner is choked with dust, causing greater intake air resistance.</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>• Air inlet is choked.</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>• Air is leaking from intake manifold.</td>
<td>Repair.</td>
</tr>
<tr>
<td>Turbocharger does not rotate smoothly.</td>
<td>• Engine oil impurities deposited on turbocharger rotor, resulting in heavy rotation or sticking.</td>
<td>Overhaul and clean turbocharger and/or change engine oil.</td>
</tr>
<tr>
<td>Bearing sticking</td>
<td>• Insufficient lubrication or blockage of lubricating oil lines.</td>
<td>Check lubricating oil system, and/or repair.</td>
</tr>
<tr>
<td></td>
<td>• Abnormal wear or damage of seal ring caused by wear of journal bearing, due to insufficient lubrication.</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>• Temperature of lubricating oil too high.</td>
<td>Check cooling system.</td>
</tr>
<tr>
<td></td>
<td>• Unbalanced rotating parts.</td>
<td>Change rotating parts.</td>
</tr>
<tr>
<td></td>
<td>• Incomplete warming-up, failure to idle before stopping engine, or jack rabbit starts.</td>
<td>Operate vehicle properly.</td>
</tr>
<tr>
<td>Loose or damaged turbine rotor or blower impeller</td>
<td>• Over-rotation.</td>
<td>Check and adjust the engine.</td>
</tr>
<tr>
<td></td>
<td>• Temperature of exhaust gas too high.</td>
<td>Check and adjust the engine.</td>
</tr>
<tr>
<td></td>
<td>• Foreign matter present.</td>
<td>Remove foreign material.</td>
</tr>
<tr>
<td></td>
<td>• Worn thrust bearing</td>
<td>Inspect the air cleaner and air intake manifold.</td>
</tr>
<tr>
<td></td>
<td>• Incomplete assembly</td>
<td>Repair if necessary.</td>
</tr>
<tr>
<td>High volume exhaust like noise</td>
<td>Exhaust gas leaking before turbocharger, therefore insufficient revolution.</td>
<td>Check and repair connections.</td>
</tr>
<tr>
<td></td>
<td>• Deformed or blocked exhaust gas lines, therefore insufficient revolution.</td>
<td>Repair.</td>
</tr>
<tr>
<td>White smoke</td>
<td>Choking defects, or deformation of oil return lines so that oil leaks around blower or turbine sides.</td>
<td>Repair and replace the lines.</td>
</tr>
<tr>
<td></td>
<td>• Seal ring may be broken or worn due to abnormal wear of thrust washer.</td>
<td>Replace the thrust washer.</td>
</tr>
<tr>
<td>Sudden Shortage of lubricating Oil</td>
<td>Abnormal wear or damage of seal ring caused by wear of journal bearing.</td>
<td>Overhaul and repair.</td>
</tr>
</tbody>
</table>

MARINE PARTS SUPPLY of CANADA (800)661-5353
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Remedy/Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of power</td>
<td>Gas leakage from exhaust system</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>Air leakage from air manifold</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>Clogged air cleaner element</td>
<td>Clean or replace.</td>
</tr>
<tr>
<td></td>
<td>Turbocharger dirty or damaged</td>
<td>Repair or replace.</td>
</tr>
<tr>
<td>Poor response of turbocharger</td>
<td>Carbon accumulation on the turbine side seal ring and heavy rotation</td>
<td>Change engine oil, clean turbocharger.</td>
</tr>
<tr>
<td></td>
<td>Poor combustion</td>
<td>Check fuel system and improve combustion.</td>
</tr>
<tr>
<td>High pitched noise and vibration</td>
<td>Noise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• So called “surging”</td>
<td>Overhaul and clean turbocharger.</td>
</tr>
<tr>
<td></td>
<td>• Surging sometimes occurs when the gas passage at the nozzle of the turbine housing is choked or when compressed air does not flow in proper responses to acceleration.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Loosen rotating parts</td>
<td>Replace.</td>
</tr>
<tr>
<td></td>
<td>Vibration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Joints loose between turbocharger</td>
<td>Check the mounting and repair.</td>
</tr>
<tr>
<td></td>
<td>• Jointed loose between turbocharger and intake, exhaust manifold or oil lines.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Damaged bearing, loose rotating parts,</td>
<td>Repair.</td>
</tr>
<tr>
<td></td>
<td>• Imbalanced rotating parts,</td>
<td></td>
</tr>
</tbody>
</table>

MARINE PARTS SUPPLY of CANADA (800)661-5353

Marine Parts Supply of Canada
1320 Stewart Ave
Vancouver, B.C.
V6S 4R1
Ph (604) 661-5353
Fax (604) 754-9471

MARINE PARTS SUPPLY of CANADA (800)661-5353

MARINE PARTS SUPPLY of CANADA (800)661-5353

MARINE PARTS SUPPLY of CANADA (800)661-5353

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MARINE PARTS SUPPLY of CANADA (800)661-5353
OVERHAUL CRITERIA

CONDITIONS WHICH DETERMINE WHEN TURBOCHARGER OVERHAUL MAY BE NEEDED.
THE ENGINE LACKS POWER OR ENGINE EXHAUST EMITS BLACK SMOKE.

BOOST PRESSURE IS BELOW THE NORMAL VALUE.
Inspect the turbocharger boost pressure according to the following procedures.

NOTE: Before measurement
- Coolant temperature should be approximately 80°C.
- Air cleaner element should be clean.

WARNING
When making a pressure test, be sure that personnel are adequately protected against any stream of pressurized air that might be released by a leak or the rupture of a hose.

1. Remove the blind plug on the intake pipe and install the hose and pressure gauge (special tools).
   Special Tools: Pressure Gauge (09444-1250)
   Hose (17108-1040)

2. Read boost pressure.
   If the boost pressure is below the specified value, turbocharger overhaul is needed.
   Boost Pressure: Less than 0.13 kg/cm² at no load with maximum revolution.

OTHER FACTORS
1. Noisy or excessive vibration of the turbocharger.
2. Excessive engine oil consumption.
3. Gas leakage at the turbine end or blower end.
4. Oil leakage from the turbocharger.
Prior to starting an turbocharger overhaul, it is necessary to have these special tools.

**ATTACHMENT FOR MEASURING TURBIN SHAFT RADIAL PLAY**

- 09444-1230

**BOOST PRESSURE GAUGE**

- 09444-1250

**BOOST PRESSURE GAUGE HOSE**

- 17108-1040

For assemble, disassemble or measuring of the turbocharger.

For removing the seal plate.
1. Turbine casing
2. Turbine rotor
3. Seal ring
4. Holding plate
5. Heat protector
6. Bearing casing
7. Retainer ring
8. Bearing
9. Thrust spacer
10. Oil thrower
11. Blower casing
12. Thrust bearing
13. Seal plate
14. Blower impeller
15. Lock nut

T = Tightening torque: kg-cm (lb*ft)

TURBOCHARGER

IMPORTANT POINT (S) — BEFORE DISASSEMBLY

1. Rotate the blower impeller by hand to see if it turns smoothly. If it does not turn smoothly, clean and inspect the bearing and turbine rotor.
2. Check the turbine rotor for axial play.
   If the axial play is greater than the service limit, replace the thrust bearing and/or thrust spacer.
   Axial Play: 0.06 - 0.09 mm (0.0023 - 0.0035 in)
   Service Limit: 0.11 mm (0.0043 in)

3. Check the turbine rotor for radial play using a special tool.
   If the radial play is greater than the service limit, replace the bearings and/or turbine rotor.
   Special Tool: 09444-1230
   Radial Play: 0.11 - 0.18 mm (0.004 - 0.007 in)
   Service Limit: 0.215 mm (0.0085 in)

IMPORTANT POINT(S) - DISASSEMBLY

REMOVE THE BLOWER CASING.

NOTE: o Make matching marks on the blower case and bearing case to aid alignment during reassembly.
   o If the blower casing cannot easily be removed by hand, tap it carefully all around using a plastic hammer and carefully remove it.
   o Be careful not to damage the blower impeller.

REMOVE THE BLOWER CASING.

NOTE: Be careful not to damage blower impeller.

REMOVE THE TURBINE ROTOR.

1. Remove the blower impeller fitting nut.

NOTE: Turn the lock nut to clockwise to loosen the nut (left-hand threads).
2. Remove the blower impeller and the turbine rotor with heat protector.

REMOVAL OF BEARINGS
1. Remove the seal plate.
   Pull out the seal plate used by special tool.

2. Remove the oil thrower.

3. Remove the thrust bearing and thrust spacer.
   Loosen the bolt, then remove the thrust bushing using a 10 dia. copper rod.
   **NOTE:** When removing the thrust bearing and thrust spacer, be careful not to damage the thrust bearing hole in the bearing case.

4. Remove the retainer rings of each bearing.
   **NOTE:** When removing the retainer ring, be careful not to damage the front face of the hole in the bearing case.

5. Remove the bearings.
REMOVE THE SEAL RINGS.
NOTE: When removing the seal ring, be very careful not to damage the groove of the seal ring.

IMPORTANT POINT (S) – ASSEMBLY
CLEAN ALL PARTS.
1. Before cleaning, the disassembled parts should be visually inspected to check for burning, abrasion, carbon deposits, gas and oil leakage.
2. Thoroughly clean all the parts with diesel fuel, using a soft brush, and dry with compressed air.
   NOTE: ○ Never use a caustic cleaning solution, as it may attack aluminum.
   ○ Never use a wire brush.
ASSEMBLE THE JOURNAL BEARINGS.
1. Install the first retainer ring in the bearing casing.
   NOTE: ○ Bevelled edge of the retainer ring should be towards the bearing.
   ○ Make sure that the retainer ring is securely fitted in the groove.
   ○ Install the retainer ring with the gap facing as shown in the drawing.
2. Install the bearing in the bearing case.
   NOTE: Apply clean engine oil.
3. Install the other retainer ring.
   NOTE: The only nearest turbine side of the retainer ring should be installed according to the figure on the left.
4. Repeat step 1) through 4) to install the second bearing.

ASSEMBLE THE TURBINE ROTOR.
1. Install a new seal ring in the seal ring groove of the turbine shaft.
2. Position the heat protector on the bearing case.
3. Coat the journals of the turbine rotor with clean engine oil and install the turbine rotor in the bearing case.

   **NOTE:**
   - The gap in the seal ring of the turbine shaft must face towards the oil inlet.
   - Insert the seal ring concentric with the turbine shaft. If it is inserted with unreasonable force, it may be damaged.
   - When inserting the turbine shaft, be very careful not to damage the journal bearing.

ASSEMBLE THE THRUST BEARING.
1. Install the thrust bush on the turbine shaft.
   **NOTE:** Lubricate thrust bush surface.
2. Coat the thrust bearing with clean engine oil and install the thrust bearing.
   **NOTE:** Always use new screws and lock washers.

INSTALL THE BACK PLATE.
1. Insert two new seal rings on the oil thrower.
2. Install the oil thrower in the back plate.
   **NOTE:** The openings of seal rings should be positioned as shown.
3. Install the back plate in the bearing plate.
   **NOTE:** The oil return hole should face the oil outlet side. Apply silicone R.T.V. sealer to the flanged surface of the back plate.
   - Take care that the silicone sealer does not protrude from the flange.

FIT THE BLOWER IMPELLER ON THE TURBINE ROTOR AND TIGHTEN THE LOCK NUT.
   **NOTE:** Remember that this nut has left-hand threads.
INSTALL THE TURBINE CASE TO THE BEARING CASE, BEING SURE TO ALIGN THE MATCHING MARKS.

NOTE: Always use new lock plates.

ASSEMBLE THE BLOWER CASE.
1. Install the blower case to the bearing case referring to the matching marks.

NOTE: Coat the flange face of the blower case with silicone R.T.V. sealant.
2. Tighten the six fitting bolts.

ASSEMBLY TEST
1. Rotate the blower impeller by hand to see if it turns smoothly. Refer to page TU-7.
2. Check the turbine rotor for axial play. Refer to page TU-8.
3. Check the turbine rotor for radial play using a special tool. Refer to page TU-8.
# TURBOCHARGER

## INSPECTION AND REPAIR

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine Shaft Diameter</td>
<td>–</td>
<td>12.28 (0.4835)</td>
<td>Replace</td>
<td>SM51-033</td>
</tr>
<tr>
<td>Turbine Shaft Bend</td>
<td>–</td>
<td>0.011 (0.0004)</td>
<td>Replace</td>
<td>SM51-034</td>
</tr>
<tr>
<td>Seal Ring Groove Width of Turbine Shaft</td>
<td>–</td>
<td>1.63 (0.0642)</td>
<td>Replace shaft assembly</td>
<td>SM51-035</td>
</tr>
<tr>
<td>Bearing Case Inside Diameter</td>
<td>A: 18.55 (0.7303)</td>
<td>B: 17.11 (0.6736)</td>
<td>Replace</td>
<td>SM51-006</td>
</tr>
<tr>
<td>Journal Bearing Inside Diameter</td>
<td>–</td>
<td>12.36 (0.4866)</td>
<td>Replace</td>
<td>SM51-036</td>
</tr>
<tr>
<td>Journal Bearing Outside Diameter</td>
<td>–</td>
<td>16.98 (0.6686)</td>
<td>Replace</td>
<td>SM51-037</td>
</tr>
<tr>
<td>Thrust Spacer Height</td>
<td>–</td>
<td>4.48 (0.1764)</td>
<td>Replace</td>
<td>SM51-007</td>
</tr>
<tr>
<td>Seal Ring Groove Width of Oil Thrower</td>
<td>G1: 1.75 (0.0689)</td>
<td>G2: 1.52 (0.0598)</td>
<td>Replace</td>
<td>SM51-006A</td>
</tr>
</tbody>
</table>

**Unit:** mm (in)

---

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## TU-14 TURBOCHARGER

### INSPECTION AND REPAIR

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrust Bearing Thickness</td>
<td></td>
<td>4.48 (0.1764)</td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td>Sealing Bore of Seal Plate</td>
<td></td>
<td>H1: 16.05 (0.6319)</td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>H2: 14.05 (0.5531)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unit: mm (in)

---

**SM51-038**

**SM51-0068**
CHAPTER IP

FUEL INJECTION PUMP

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TROUBLESHOOTING ............................................ IP-3
SPECIAL TOOLS .................................................. IP-6
INJECTION PUMP ................................................. IP-7
FEED PUMP ......................................................... IP-15
ADJUSTMENT ....................................................... IP-17
DESCRIPTION

FUEL INJECTION PUMP

1. High pressure pipe
2. Delivery valve
3. Plunger barrel
4. Plunger
5. Control rod
6. Control sleeve
7. Plunger spring
8. Tappet
9. Cam shaft
10. Cam
11. Fuel feed pump
## TROUBLESHOOTING

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Remedy/Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine does not start</td>
<td>Fuel not reaching injection pump</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fuel lines clogged or damaged</td>
<td>Clean or replace fuel lines.</td>
</tr>
<tr>
<td></td>
<td>• Fuel filter clogged</td>
<td>Clean or replace the filter element.</td>
</tr>
<tr>
<td></td>
<td>• Air in fuel caused by improper connections of fuel line between fuel tank and feed pump</td>
<td>Repair connections.</td>
</tr>
<tr>
<td></td>
<td>• Filter incorporated in inlet side of feed pump clogged</td>
<td>Remove foreign material.</td>
</tr>
<tr>
<td></td>
<td>• Faulty feed pump check valve</td>
<td>Repair or replace it.</td>
</tr>
<tr>
<td></td>
<td>• Feed pump piston spring broken</td>
<td>Replace it.</td>
</tr>
<tr>
<td></td>
<td>• Feed pump push rod or tappet sticking</td>
<td>Repair or replace it.</td>
</tr>
<tr>
<td></td>
<td>Fuel reaching injection pump</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Faulty connection of accelerator wire to pump adjusting lever.</td>
<td>Repair connection.</td>
</tr>
<tr>
<td></td>
<td>• Control rack faulty or sticking</td>
<td>Repair it.</td>
</tr>
<tr>
<td></td>
<td>• Damaged camshaft bearing</td>
<td>Repair it.</td>
</tr>
<tr>
<td></td>
<td>• Plunger worn or sticking</td>
<td>Correct or replace it.</td>
</tr>
<tr>
<td></td>
<td>• Faulty connection of engine stop wire to pump stop lever.</td>
<td>Repair it.</td>
</tr>
<tr>
<td></td>
<td>Nozzle faulty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fuel leakage caused by loosened nozzle holder</td>
<td>Inspect and tighten it.</td>
</tr>
<tr>
<td></td>
<td>• Low opening pressure of nozzle</td>
<td>Adjust it.</td>
</tr>
<tr>
<td></td>
<td>• Nozzle pressure spring broken</td>
<td>Replace it.</td>
</tr>
<tr>
<td></td>
<td>• Nozzle needle sticking to nozzle body</td>
<td>Correct or replace it.</td>
</tr>
<tr>
<td></td>
<td>Pump out of timing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Improperly retarded injection timing</td>
<td>Correct injection timing.</td>
</tr>
<tr>
<td></td>
<td>• Incorrect timing caused by improper installation of pump.</td>
<td>Check engine timing and correct it.</td>
</tr>
<tr>
<td></td>
<td>• Woodruff key for pump camshaft cut off,</td>
<td>Replace it.</td>
</tr>
<tr>
<td></td>
<td>• Improper pre-stroke adjustment</td>
<td>Correct it to obtain specified injection timing.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible cause</td>
<td>Remedy/Prevention</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Excessive smoke</td>
<td>- Excessive fuel delivery caused by incorrect adjustment of fuel load stopper screw.</td>
<td>Adjust fuel delivery on test stand.</td>
</tr>
<tr>
<td></td>
<td>- Excessively advanced injection timing.</td>
<td>Correct it.</td>
</tr>
<tr>
<td></td>
<td>- Large spread in fuel delivery</td>
<td>Adjust it.</td>
</tr>
<tr>
<td></td>
<td>- Bad nozzle fuel spray characteristics</td>
<td>Check and correct them.</td>
</tr>
<tr>
<td>Black smoke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White smoke</td>
<td>- Improperly retarded injection timing.</td>
<td>Advance injection timing.</td>
</tr>
<tr>
<td></td>
<td>- Water in fuel</td>
<td>Check and clean fuel lines.</td>
</tr>
<tr>
<td>Low idle speed</td>
<td>Improper adjustment of idle button</td>
<td>Correct it.</td>
</tr>
<tr>
<td>irregular</td>
<td>Bad fuel spray characteristic of nozzles.</td>
<td>Check and repair them.</td>
</tr>
<tr>
<td></td>
<td>Incorrect injection timing</td>
<td>Correct it.</td>
</tr>
<tr>
<td></td>
<td>Incorrect initial tension setting of idling spring or the spring broken.</td>
<td>Adjust or replace it.</td>
</tr>
<tr>
<td></td>
<td>Control rack not smoothly move</td>
<td>Disassemble pump and repair it.</td>
</tr>
<tr>
<td></td>
<td>Large spread in fuel delivery</td>
<td>Adjust it.</td>
</tr>
<tr>
<td></td>
<td>Plunger worn</td>
<td>Replace it.</td>
</tr>
<tr>
<td></td>
<td>Governor linkage not smoothly move</td>
<td>Correct it.</td>
</tr>
<tr>
<td></td>
<td>Defective feed pump</td>
<td>Disassemble and repair it.</td>
</tr>
<tr>
<td>Engine always runs</td>
<td>Accelerator cable sticking</td>
<td>Check and correct it.</td>
</tr>
<tr>
<td>at high speed</td>
<td>Governor linkage sticking</td>
<td>Disassemble and repair the governor.</td>
</tr>
<tr>
<td></td>
<td>Control rack sticking</td>
<td>Check and correct it.</td>
</tr>
<tr>
<td>Engine starts and stops</td>
<td>Fuel lines clogged</td>
<td>Clean or replace fuel lines.</td>
</tr>
<tr>
<td></td>
<td>Air in fuel caused by damaged fuel lines or improper connection of fuel lines.</td>
<td>Repair fuel lines or replace fuel lines and gaskets.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible cause</td>
<td>Remedy/Prevention</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Engine has low power</td>
<td>Pump out of timing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Excessive advanced timing, resulting in loud knocking.</td>
<td>Check and correct it.</td>
</tr>
<tr>
<td></td>
<td>• Excessively retarded timing resulting in black smoke.</td>
<td>Check and correct it.</td>
</tr>
<tr>
<td></td>
<td>• Defective injection pump overflow valve.</td>
<td>Repair or replace it.</td>
</tr>
<tr>
<td></td>
<td>• Feed pressure too low</td>
<td>Repair the feed pump.</td>
</tr>
<tr>
<td></td>
<td>• Improper accelerator cable adjustment</td>
<td>Adjust it.</td>
</tr>
<tr>
<td>Nozzle faulty</td>
<td>• Fuel leakage from nozzle holder</td>
<td>Check and repair nozzle holder.</td>
</tr>
<tr>
<td></td>
<td>• Bad nozzle spray characteristic</td>
<td>Repair or replace it.</td>
</tr>
<tr>
<td></td>
<td>• Loosened adjusting screw in nozzle holder, resulting in low opening pressure.</td>
<td>Adjust it.</td>
</tr>
<tr>
<td></td>
<td>• Nozzle pressure spring broken</td>
<td>Replace it.</td>
</tr>
<tr>
<td>Pump faulty</td>
<td>• Fuel leakage from delivery valve holder.</td>
<td>Retighten the delivery valve holder if it is loosened or replace O-ring if the O-ring is defective.</td>
</tr>
<tr>
<td></td>
<td>• Detective seat of delivery valve assembly.</td>
<td>Repair or replace it.</td>
</tr>
<tr>
<td></td>
<td>• Delivery valve spring broken</td>
<td>Replace the spring.</td>
</tr>
<tr>
<td></td>
<td>• Plunger worn</td>
<td>Replace it.</td>
</tr>
<tr>
<td></td>
<td>• Large spread in fuel delivery</td>
<td>Adjust it.</td>
</tr>
<tr>
<td></td>
<td>• Wear of tappet roller</td>
<td>Replace the roller.</td>
</tr>
<tr>
<td></td>
<td>• Camshaft bearing worn or broken</td>
<td>Replace it.</td>
</tr>
<tr>
<td></td>
<td>• Improper adjustment of governor fuel load stopper screw.</td>
<td>Adjust it.</td>
</tr>
<tr>
<td>Loud knocking</td>
<td>Impriper injection timing</td>
<td>Correct it.</td>
</tr>
<tr>
<td></td>
<td>• Bad fuel nozzle spray pattern after-dribble</td>
<td>Check and correct it.</td>
</tr>
<tr>
<td></td>
<td>• High nozzle opening pressure</td>
<td>Adjust the opening pressure.</td>
</tr>
<tr>
<td></td>
<td>• Incorrect fuel deliveries to some nozzles.</td>
<td>Readjust the fuel deliveries.</td>
</tr>
</tbody>
</table>
Prior to starting an injection pump overhaul, it is necessary to have these special tools.

**PLUNGER CLAMP**
09512-1380

**TAPPET CLAMP**
09512-1120

**TAPPET ROLLER CLAMP**
09512-1130

**CAMSHAFT BEARING OUTER RACE PULLER**
09512-1160 (REAR)
09512-1430 (FRONT)

**TAPPET INERTER**
09512-138C

**CAMSHAFT CLEARANCE GAUGE**
09512-1150

**SPRING HOLDER**
09512-1370

**TAPPET GAP INSTRUMENT**
09512-1410

**HOLDING WRENCH**
09512-1710

**TIMER EXTRACTOR**
09512-1230 (SA-TYPE)
09512-1280 (SCZ-TYPE)

**SPRING HOLDER**
09512-1240
IMPORTANT POINT (S) — DISASSEMBLY

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Breaking of the lead seals or crimp caps by anyone other than HINO or pump manufacture authorized service stations to make these adjustments will void the warranty.</td>
</tr>
<tr>
<td>○ If fuel pump or governor difficulties are suspected, consult only HINO or pump manufacture authorized service stations, where the problem can be corrected and the injection pump lead seals and crimp caps can be reinstalled as required.</td>
</tr>
<tr>
<td>○ Measure and record the fuel delivery characteristics of the pump before disassembling it.</td>
</tr>
<tr>
<td>○ Keep the parts for each cylinder in separate groups and in an orderly arrangement. Parts to be replaced and parts to be used again must be kept separately.</td>
</tr>
</tbody>
</table>

REMOVE THE TIMER ASSEMBLY.
Refer to "TIMER AND COUPLING".

REMOVE THE GOVERNOR.
Refer to "GOVERNOR".

INSERT THE TAPPET INSERTER IN THE TAPPET HOLE.
Turn the camshaft and insert the tappet inserters in each tappet hole when their tappet is at the highest position.
Special Tool: Tappet Inserter (09612-1380)

MEASURE THE CAMSHAFT END PLAY.
1. Mount the camshaft end play gauge on the camshaft drive end and be sure tighten "B".
Special Tool: Camshaft End Play Gauge (09612-1150)
2. By turning “A”, create a clearance of about 1 mm (0.04in) between “A” and the bearing cover.
3. Lightly strike the end “B” 3 or 4 times with a plastic hammer.
4. Lightly tighten "A" until it comes into contact with the bearing cover.

5. Lightly strike the camshaft governor end 3 or 4 times a plastic hammer.

6. Lightly turn "A" until it comes into contact with the bearing cover, then read the clearance.

   Assembly Standard: 0.03–0.05 mm (0.0012–0.0019 in)
   Service Limit: 0.10 mm (0.004 in)

7. If the specification is not met, use appropriate shim plates at the drive end of camshaft.

**REMOVE THE TAPPET ASSEMBLY.**

1. Push the tappet with the tappet roller clamp and remove the tappet inspector.

   Special Tool: Tappet Roller Clamp (09512-1130)

2. Remove the tappet through the camshaft bearing hole.

   Special Tool: Tappet Clamp (09512-1120)
REMOVE THE PLUNGERS, SPRINGS AND CONTROL SLEEVE.
1. Use the plunger clamp hold the spring lower seat and remove it together with the plunger.
Special Tool: Plunger Clamp (09512-1380)

REMOVE THE TAPER BEARING FROM THE CAMSHAFT.
1. Remove the taper bearing from the drive end of the camshaft.
Special Tool: Bearing Remover (09510-1180)

2. Use the guide to remove the bearing at the governor side.

3. Use the outer race puller, to tap out the outer race in the bearing cover.
Special Tool: Outer Race Puller (09512-1430)
4. Lightly tighten "A" until it comes into contact with the bearing cover.

5. Lightly strike the camshaft governor end 3 or 4 times a plastic hammer.

6. Lightly turn "A" until it comes into contact with the bearing cover, then read the clearance.

   **Assembly Standard:** 0.03—0.05 mm (0.0012—0.0019 in)
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2. Remove the tappet through the camshaft bearing hole.

   **Special Tool:** Tappet Clamp (09512-1120)
IMPORTANT POINT(S) – ASSEMBLY

WARNING
- Wash all parts with clean diesel fuel before installing them, and any defective or damaged parts must be replaced.
- Do not allow dust or other foreign matter to enter the pump during assembly.
- Apply grease to O-rings and oil seals before installing them.
- Assemble the parts in correct order and to correct tightening torques, assembled dimensions etc.
- Assembly takes place in the reverse order of disassembly.

INSTALL THE PLUNGER BARRELS.

1. Before install the plunger barrels should be inspect the plunger barrels and plungers for wear, scratches, or discoloration.

2. Tilt the plunger to about 60°. Pull the plunger out approximately 10 to 15 mm (0.39–0.59 in) and release it to see if it slides down smoothly from its own weight.

3. Match the plunger notch with the injection pump housing knock pin.

INSTALL THE DELIVERY VALVES, SPRINGS AND HOLDERS.

1. Before install the delivery valves, inspect the delivery valves for scratches on the valve seat or the piston sections.
2. Install the gasket, spring, shim and stopper on the delivery valve.

3. Provisionally tighten the delivery valve holder with a new O-ring by hand.

NOTE: Tighten the delivery valve holder after installing the plunger.

INSTALL THE CONTROL SLEEVES ON THE BARRELS.

NOTE: Make sure that the control sleeve swings evenly right and left when the control rack is moved to the right and left.

INSTALL THE PLUNGER AND TAPPET.

1. Assembly the plunger and spring lower seat, inserting the driving face marked with a number and the lower seat notch part upward (cover plate side).

   Special Tool: Plunger Clamp (09612-1380)

2. Install the tappet to the pump housing with the adjusting shim.

   Special Tool: Tappet Roller Clamp (09612-1130)
               Tappet Clamp (09612-1120)

3. Using the tappet roller clamp to press in the tappet and hold it in with the tappet inserter.

   Special Tool: Tappet Inserter (09612-1380)
NOTE: 〇 Check that the driving face of the plunger fits to the groove of the control sleeve before inserting the tappet.
〇 When inserting the tappet, check that the control rack slides smoothly and without catching.

TIGHTEN THE DELIVERY VALVE HOLDER.
When one delivery valve holder is tightened, move the control rack to the right and left and inspect the tightness of the rack.
Tightening Torque: 400–450 kg·cm (29–32 lb.ft)

INSTALL THE CAMSHAFT WITH CENTER BEARING.
Place a small amount of oil or grease on the center bearing to hold it to camshaft and the install the camshaft in the pump housing.
NOTE: A-TYPE 4-cylinder pump is without center bearing.
### FUEL INJECTION PUMP

**INSPECTION AND REPAIR**

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plunger springs tension.</td>
<td>24.4 kg (49.4 lb) at 41.4 mm (1.63 in)</td>
<td>21.0 kg (48.3 lb)</td>
<td>Replace, spring.</td>
<td></td>
</tr>
<tr>
<td>Delivery valve springs tension.</td>
<td>3.1 kg (6.8 lb) at 17.0 mm (0.67 in)</td>
<td>2.7 kg (6.0 lb)</td>
<td>Replace, spring.</td>
<td></td>
</tr>
<tr>
<td>Tappet wear.</td>
<td>0.3 mm (0.012 in)</td>
<td></td>
<td>Replace, tappet assembly.</td>
<td></td>
</tr>
<tr>
<td>Camshaft run-out.</td>
<td>0.15 mm (0.006 in)</td>
<td></td>
<td>Replace, camshaft.</td>
<td></td>
</tr>
</tbody>
</table>
FUEL INJECTION PUMP

FEED PUMP

FP/KS-TYPE

M14, T = 130–150 (9–10)
Nylon gasket

M14, T = 200–250 (14–18)
Comet packing, Copper gasket

T = 400–450 (29–32)

T = 600–550 (36–39)

T = 800–900 (58–65)

T = 500–550 (36–39)

T = 50–80 (3.6–5.7)

T = Tightening torque: kg·cm (lb·ft)

1. Feed pump serial No.
2. Joint bolt
3. Soft washer
4. Connector
5. O-ring
6. Check valve spring
7. Check valve
8. Priming pump
9. Retainer ring
10. Tappet assembly
11. Roller
12. Tappet
13. Pin
14. Sliding block
15. Feed pump housing, push rod, & oil seal
16. Piston
17. Spring
18. Gasket
19. Plug
20. Soft washer
21. Filter

Marine Parts Supply of Canada
1930 Stewart Ave
North, B.C.
V9B 4E1
Phone (604) 955-5353
Fax (825) 734-9471
### INSPECTION AND REPAIR

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve Seat. Wear, Damage</td>
<td>-</td>
<td>-</td>
<td>Replace, if necessary.</td>
<td>Visual check</td>
</tr>
<tr>
<td>Piston, Cylinder and Oil Seal.</td>
<td>-</td>
<td>-</td>
<td>Replace, if necessary.</td>
<td>Visual check</td>
</tr>
<tr>
<td>Wear, Damage</td>
<td></td>
<td></td>
<td>Clean</td>
<td>Visual check</td>
</tr>
<tr>
<td>Filter, Clogged</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ADJUSTMENT

PREPARATION

1. Mount the injection pump correctly on the pump tester.

2. Attach a rack measuring device to the control rack and set to "0".

3. Install calibration nozzles and lines of the following specifications.
   a) Nozzle
      Nozzle type: 12SD12 (BOSCH Type)
      Opening pressure: 175 kg/cm (2,489 lb.ft)
   b) Line
      Outside diameter: 6.0 mm (0.24 in)
      Inner diameter: 2.0 mm (0.08 in)
      Length: 600 mm (23.6 in)

4. Calibration oil
   a) Calibration oil: SAE J967C
   b) Oil temperature: 40–45°C (104–113°F)

5. Install the cover on the feed pump mounting surface and fill the pump camshaft chamber with engine oil.

ADJUSTING THE INJECTION TIMING

1. Preparation of the pre-stroke.
   a) Remove the plate cover.
   b) Install a pre-stroke measuring instrument.
      Bring the tappet of the first cylinder to its bottom dead center, and set the pointer tip on the tappet.
2. Measure the pre-stroke (No.1 plunger)
   a) Set the control rack at full-load position.
   b) Loosen the overflow screw of each nozzle holder.
   c) Operate the high-pressure pump of the pump tester and let fuel run out of the overflow line.

   d) Move the angle dial to set the first cylinder of the pump to bottom dead center and adjust the pre-stroke gauge to zero.

   NOTE: Bottom dead center is the point at which the pointer of the dial gauge does not move even when the angle dial is rotated while fuel is flowing from the overflow line.

   e) Turn the camshaft clockwise with the angle dial and read the dial gauge when the fuel stops running out of the overflow line. This reading is the pre-stroke value of the pump.

   Pre-stroke: Refer to "CALIBRATION chart"

   f) If the pre-stroke value is not within specification, adjust by changing the tappet adjusting shim.

   Special Tool: Spring Holder (95092-10070)

**ADJUST THE INJECTION INTERVAL.**

1. Using the No.1 cylinder injection starting point as a base, inspect and adjust the injection interval in the order of injection.

   - **6-cylinder**
     - Injection Intervals: $59°45' - 60°15'$
     - Injection Order: $1 - 4 - 2 - 6 - 3 - 5$
2. If the injection intervals are not within specification, adjust by using the same procedure as for pre-stroke adjustment.

3. Set the No.1 cylinder at the injection starting point, and check that the marks on the coupling and the marks on the timer case are aligned.
   If the timing marks are not aligned, make a new mark on the coupling and erase the old mark.

CHECK THE TAPPET TOP CLEARANCE.
1. Set the No.1 cylinder at the injection starting point, then move the tappet with the handle.
   Tappet Top Clearance: More than 0.2 mm (0.0079 in)
   Special Tool: Tappet Handle (09612-1410)
2. Follow the above procedure to check the other cylinders (No.2 through No.6).
3. If the tappet clearance is less than 0.2 mm (0.0079 in), re-check the pre-stroke.

MEASURING AND ADJUSTING THE INJECTION VOLUME.
   Measure the injection volume for each control rack position and pump revolution.
   Injection Volume: Refer to "CALIBRATION chart."

To adjust the injection volume, loosen the pinion screw and insert the adjusting pin into the hole in the control sleeve, then move the sleeve slightly.
CHAPTER GV

INJECTION PUMP GOVERNOR
(MODEL: RSV with BOOST COMPENSATOR)

GOVERNOR .................................................. GV-2
SPECIAL TOOL ............................................ GV-3
BOOST COMPENSATOR ......................... GV-7
1. Governor housing
2. Stopper bolt
3. Woodruff key
4. Flyweight
5. Sleeve
6. Bearing
7. Shim
8. Guide lever assy
9. Link
10. Start spring
11. Tension lever
12. Full load stopper
13. Idle spring
14. Lock nut
15. Governor cover
16. Swivel lever
17. Governor spring
18. Gasket
19. Pin
20. Plug
21. Control lever
22. Woodruff key
23. Coller
24. Oil seal
25. Bush
26. O-ring
27. Snap ring
28. Idle stopper bolt
29. Idle sub spring
30. Nut
31. Cap nut
32. Closing cover
33. O-ring
34. Cap nut
35. Cap nut
36. Lock nut
37. Adjust screw
38. Cover fixing bolt
39. Cover
40. Diaphragm
41. Push rod
42. Spring
43. Adjusting shim
44. Gasket
45. Union bolt
SPECIAL TOOL

Prior to starting an injection pump governor overhaul, it is necessary to have these special tools.

**FLYWEIGHT EXTRACTOR**

**ROUND NUT WRENCH**

09511-1900

09511-1500

**IMPORTANT POINT (S) -- DISASSEMBLY**

**WARNING**

- Breaking of the lead seals or crimp caps by anyone other than HINO or pump manufacture authorized service stations to make these adjustment will void the warranty.
- If fuel pump or governor difficulties are suspected, consult only HINO or pump manufacture authorized service stations, where the problem can be corrected and the injection pump lead seals and crimp caps can be reinstalled as required.

**DISASSEMBLY THE GOVERNOR COVER FROM PUMP BODY.**

1. Disconnect the shackle from the control rack.

   **NOTE:** When remove the governor cover fitting bolt, hold the governor cover.

2. Disconnect the start spring.
REMOVE THE FLYWEIGHT ROUND NUT.
NOTE: Use the holding spanner to keep the camshaft from rotating.
Special Tools: Round Nut Wrench (09511-1500)

REMOVE THE FLYWEIGHT, USING THE FLYWEIGHT EXTRACTOR.
Special Tool: Flyweight Extractor (09511-1900)

IMPORTANT POINT (S) — Assembly

**WARNING**
- Wash all parts with clean diesel fuel before installing them, and any defective or damaged parts must be replaced.
- Do not allow dust or other foreign matter to enter the pump during assembly.
- Apply grease to O-rings and oil seals before installing them.
- Assemble the parts in correct order and to correct tightening torque, assembled dimensions etc.
- Assembly takes place in the reverse order of disassembly.

INSTALL THE ADJUSTING LEVER
1. Install the shaft of the adjusting lever so that wide side of the shaft head surface is toward the pump body.

NOTE: Installing in reverse may cause the floating lever to contact the speed control spring, resulting in operational malfunction.

CHECK THE GOVERNOR LINKAGE FOR SMOOTH OPERATION.
Hook under the guide lever, and pull upwards, using a spring balance.

Starting force: 140—180 g (4.9—6.3 oz)
INSTALL THE FLYWEIGHT TO PUMP CAMSHAFT.
Using a special tools, tighten the round nut.
Special Tools: Round Nut Wrench (09511-1500)

INSTALL THE GOVERNOR HOUSING TO PUMP BODY.
1. Connect the start spring.
2. Connect the shackle to control rack.

ADJUSTMENT OF THE GOVERNOR
[MODEL; RSV]
1. PREPARATION
   1. Connect the rack measuring device to the control rack and set to "0".
   2. Connect the fuel line.
   3. Refill the camshaft chamber with engine oil.
   4. Install the angle gauge on the adjusting lever.

2. STEPS IN GOVERNOR ADJUSTMENT.
   Perform governor testing and adjustment in the following sequence (For values of N. and R Refer to "CALIBRATION chart"):
   1. Adjustment of maximum speed control.
   2. Adjustment of speed droop.
   3. Adjustment of idling speed control.
1. Adjustment of maximum speed control
   NOTE: The control lever should be full load position.
   a) Adjust the full load stopper bolt.
      At a pump speed of Na rpm, adjust the rack position to Ra mm with the full load stopper bolt.
   b) Adjust the maximum speed stopper bolt.
      At a pump speed of Nb rpm, adjust the rack position to Rb mm with maximum speed stopper bolt.
      NOTE: The control rack should start to be pulled.

2. Adjust of speed droop.
   At a pump speed of Nc rpm, adjust rack position to Rc mm with swivel lever adjusting screw.

3. Adjusting of idling speed control
   a) At a pump speed of Na rpm, adjust the rack position to Rd mm with idling screw.
   NOTE: The control lever angle, refer to CALIBURATION chart.
   b) At a pump speed of Ne rpm, adjust the rack position to Re mm with idling sub setting screw.
BOOST COMPENSATOR

1. Cap nut
2. Lock nut
3. Adjust screw
4. Cover fixing bolt
5. Cover
6. Diaphragm
7. Push rod
8. Spring
9. Adjusting shim
10. Gasket
11. Lock nut
12. Union bolt

ADJUSTMENT OF BOOST COMPENSATOR
TEMPORARY FIXING OF ADJUST SCREW FOR BOOST COMPENSATOR STROKE.
1. Remove the cap nut (1) and loose the lock nut (2).
2. Fully tighten the adjusting screw (3) and lock the lock nut (2) temporarily.

ADJUSTMENT OF MAXIMUM SPEED CONTROL.
1. Adjustment of full load position.
2. Adjustment of maximum speed control point.

ADJUSTMENT OF SPEED CHANGE RATE.
ADJUSTMENT OF ANGLEICH.
ADJUSTMENT OF BOOST COMPENSATOR STROKE.
1. Connect the air hose to union bolt (12).
2. Lock the control lever at the full load position.

3. Keep the pump revolution with in “Na” rpm, then adjust the control rack position “Rb” to “Ra” with adjust screw (3) and lock it with lock nut (2).

NOTE: No need to pressurization with this adjustment.

ADJUSTMENT OF BOOST COMPENSATOR SPRING (8).
1. Keep the pump revolution with in “Na” rpm then set the control lever to full load position.
2. Raise the boost pressure gradually and when reaches the “P1,” confirm of the control rack is start to move from “Ra” position to direction of “fuel delivery increase”.

3. In case of nonstandardized, replace with adjusting shim (9) as follow.
1) Remove the cover (5) with loosening three bolts of installing the cover (4).
2) Using a screwdriver to hold the push rod (7) to not turn it when removing the nut (11).

3) Remove the gasket (10), diaphragm (6), and spring (8).

4) Replace the adjusting shim (9).

A: Replace the adjusting shim (9) with thick one.
B: Replace the adjusting shim (9) with thin one.

4. Raise the boost pressure to "P2", confirm the control rack position is "Rb". In the case of nonstandardized, replace the spring (8) with new one.

NOTE: In case of change the boost compensator stroke, when remove the cover for this adjustment, reconfirm the boost compensator stroke.
GOVERNOR EXTERNAL LEAD SEALS AND CRIMP CAPS.

NOTE: All adjusting devices on the fuel injection pump governor, are wired and lead sealed as a protection for the customer. This is to prevent unauthorized readjustment which may cause engine malfunction and/or engine failure. Periodically check to insure that these seals are not broken as this will void the warranty.
CHAPTER C

INJECTION PUMP CALIBRATION
### Injection Pump Information

**Injection Pump Number:** 22020-3521A

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>WO6D-TI</td>
</tr>
<tr>
<td>Injection pump part number</td>
<td>22020-3521A</td>
</tr>
<tr>
<td>Injection pump type</td>
<td>NP-PES6A95C32ORS2</td>
</tr>
<tr>
<td>Governor type</td>
<td>NP-EP/RSV200-1600</td>
</tr>
<tr>
<td>Timer type</td>
<td>Not equipped</td>
</tr>
<tr>
<td>Feed pump type</td>
<td>NP-FP/KS-AS</td>
</tr>
<tr>
<td>Test nozzle type</td>
<td>105780-8140</td>
</tr>
<tr>
<td>Test nozzle opening pressure</td>
<td>175 kg/cm² (2,489 psi)</td>
</tr>
<tr>
<td>Injection pipe</td>
<td>Outer diameter: 6.0 mm (0.236 in)</td>
</tr>
<tr>
<td></td>
<td>Inner diameter: 2.0 mm (0.079 in)</td>
</tr>
<tr>
<td></td>
<td>Length: 600 mm (23.622 in)</td>
</tr>
<tr>
<td>Calibration oil</td>
<td>Type: SAE J967 C</td>
</tr>
<tr>
<td></td>
<td>Oil temperature: 40–45°C (104–113°F)</td>
</tr>
<tr>
<td>Fuel feed pressure</td>
<td>1.6 kg/cm² (22.8 psi)</td>
</tr>
<tr>
<td>Opening pressure</td>
<td>1.5–1.8 kg/cm² (21.33–25.59 psi)</td>
</tr>
<tr>
<td>Rotation</td>
<td>Clockwise viewed from drive side</td>
</tr>
<tr>
<td>Injection order</td>
<td>1–4–2–6–3–5</td>
</tr>
<tr>
<td>Injection interval</td>
<td>60° ± 15°</td>
</tr>
<tr>
<td>Pre-stroke</td>
<td>3.15–3.22 mm (0.125–0.127 in)</td>
</tr>
<tr>
<td>Rack position (mm in)</td>
<td>Pump speed (rpm)</td>
</tr>
<tr>
<td></td>
<td>Measuring strokes</td>
</tr>
<tr>
<td>A 10.2 (0.402)</td>
<td>1,600</td>
</tr>
<tr>
<td>B About 7 (0.276)</td>
<td>250</td>
</tr>
</tbody>
</table>

### Adjusting Position

- **Maximum Speed Stopper Bolt**
- **Swivel Lever Adjust Screw**
- **Idling Sub Setting Screw**
- **Control Lever**
- **Idling Screw**
- **Full Load Stopper Bolt**

### Governor Adjustment

- **Stop Lever**

### Control Lever Angle

**NOTE:**
- **ANGLE:** 1...31° ± 5°
- 2...14° ± 5°
- Lever angle "V.P." means Vertical position.

---

**SM4-831**
### GOVERNOR ADJUSTMENT

<table>
<thead>
<tr>
<th>Adjusting Item</th>
<th>Adjusting lever position</th>
<th>Pump speed (rpm)</th>
<th>Control rack position (mm/in)</th>
<th>Adjusting position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum speed</td>
<td>Full load</td>
<td>Na: 555–695</td>
<td>Ra: 10.2 (0.402 in)</td>
<td>Full load stopper bolt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nb: 1,610–1,620</td>
<td>Rb: Should be start to pulled control rack</td>
<td>Maximum speed stopper bolt</td>
</tr>
<tr>
<td>Idling speed</td>
<td>Idle</td>
<td>Nc: 1,710–1,760</td>
<td>Rc: 5.4 mm (0.213 in)</td>
<td>Swivel lever adjusting screw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nd: 250</td>
<td>Rd: 7.0 mm (0.276 in)</td>
<td>Idling sub-spring set</td>
</tr>
</tbody>
</table>

### GOVERNOR CHARACTERISTIC DIAPHRAGM

**GOVERNING RANGE:** 260–1,600 rpm

**BOOST COMPENSATOR CHARACTERISTIC DIAPHRAGM**

**NOTE:** REGULATED AT 600 rpm

**CONTROL RACK POSITION (mm)**

**BOOST PRESSURE (mmHg)**

**SM4-812**

**SM4-831**
CHAPTER GE
GENERATOR
(12V, 80A)

DATA AND SPECIFICATIONS ........................................ GE-2
DESCRIPTION ................................................................. GE-2
TROUBLESHOOTING ...................................................... GE-3
GENERATOR ................................................................. GE-4
### DATE AND SPECIFICATIONS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>27040–1261</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERATOR</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Alternator</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>12V</td>
</tr>
<tr>
<td>Rated output</td>
<td>80A</td>
</tr>
<tr>
<td>Operating output and speed</td>
<td>80A at 13.5V, 4,000 rpm</td>
</tr>
<tr>
<td>Rotating direction</td>
<td>Clockwise (seen from pulley side)</td>
</tr>
</tbody>
</table>

### DESCRIPTION

**SM21-224**

1. Stator coil
2. Rotor
3. Field coil
4. Ball bearing
5. Regulator
6. Diode
CHARGING SYSTEM CIRCUIT
1. Generator
2. I.C. regulator
3. Field coil
4. Stator coil
5. Resistor
6. Rectifier

TROUBLESHOOTING

Symptom
Ammeter does not move to negative side (remained at the neutral position) with starter switch on and engine off
Ammeter indicate the negative side with starter switch on and engine running

Possible cause
Fuse blown
Wiring connection loose
IC regulator faulty
Drive belt loose or worn
Battery cable loose, corroded or worn
Fuse blown
Fusible link blown
IC regulator or generator faulty
Wiring faulty

Remedy/Prevention
Determine cause and replace fuse
Tighten loose connections
Replace IC regulator
Adjust or replace drive belt
Repair or replace cables
Determine cause and replace fuse
Replace fusible link
Check charging system
Repair wiring
1. Pulley
2. Fan
3. Drive end frame
4. Spacer
5. Bearing
6. Spacer
7. Ring
8. Retainer plate
9. Stator coil
10. Rotor
11. Bearing
12. Insulator
13. Insulator
14. Brush spring
15. Brush
16. Rectifier assembly
17. Regulator
18. Rear end frame
19. Collar
20. Condenser

Tightening Torque: kg-cm (lb.ft)

T = 50–70 (3.7–5.0)
T = 800–1,000 (58–72)
T = 60–80 (4.4–5.7)
T = 30–60 (2.2–3.8)
IMPORTANT POINT(S) — DISASSEMBLY

1. REMOVE THE PULLEY AND FAN.
   1. Clamp the rotor in a soft jawed vise.
   2. Remove the pulley nut, spring washer, pulley and fan.

2. REMOVE THE ROTOR SHAFT FROM THE DRIVE END FRAME.
   1. Using a press and a socket wrench, remove the rotor shaft and
      spacer collars.
   2. Remove the bearing plate from the drive end frame.

3. REMOVE THE STATOR AND RECTIFIER FROM THE REAR END FRAME.
   1. Remove the nuts and tow insulators.
   2. Remove the stator and rectifier from the rear end frame.

4. UNSOLDER IC REGULATOR FROM THE RECTIFIER HOLDER.
   While holding the IC regulator with long nose pliers, unsolder
   the leads from the rectifier holder.

   NOTE: The long nose pliers are used as a heat sink to help protect
   the IC regulator and rectifier from heat.

5. UNSOLDER THE STATOR LEADS FROM THE RECTIFIER HOLDER.
   While holding the rectifier terminal with long nose pliers,
   unsolder the leads from the rectifier holder.

   NOTE: Protect the rectifier from heat.
6. REMOVE THE BEARING FROM THE ROTOR SHAFT.
1. Clamp the rotor in a soft-jawed vise.
2. Remove the bearing from the rotor shaft with a bearing remover.

IMPORTANT POINT(S) – TESTING RECTIFIER

1. Rectifier holder positive side
   Connect an ohmmeter (+) lead to rectifier holder, and (-) led of meter to rectifier terminal. If there is no continuity, rectifier assembly must be replaced.

   Reverse polarity of test leads and check again. If there is continuity, rectifier assembly must be replaced.

2. Rectifier holder negative side
   Connect an ohmmeter (+) lead to rectifier terminal, and (-) lead of meter to rectifier holder. If there is no continuity, rectifier assembly must be replaced.

   Reverse polarity of test and check again. If there is continuity, rectifier assembly must be replaced.
IMPORTANT POINT(S) — ASSEMBLY

1. INSTALL THE BEARING IN THE DRIVE END FRAME.
   1. Install the bearing in the drive end frame, then install bearing plate.
   2. Tighten the place.

2. INSTALL THE BEARING ON THE ROTOR SHAFT.
   Tap the rotor shaft on with a plastic hammer.

3. INSTALL THE DRIVE END FRAME.
   1. Slide the spacer collar on the rotor shaft.
   2. Using a press, install the rotor shaft in the drive end frame.

4. INSTALL THE FAN AND PULLEY.
   1. Hold the rotor shaft in a soft-jawed vise.
   2. Slide the spacer collar, fan, pulley, and spring washer on the rotor shaft.
   3. Install and tighten the pulley nut.

5. ASSEMBLE THE RECTIFIER AND STATOR.
   1. Solder each stator lead to the rectifier holder.
   2. Hold the rectifier terminal with long nose pliers while soldering the leads.
   
   NOTE: Protect the rectifiers from heat.
6. ASSEMBLE THE RECTIFIER AND IC REGULATOR.
   1. Solder each IC regulator lead to the rectifier holder.
   2. Hold the IC regulator leads with long nose pliers while soldering the leads.

7. INSTALL THE STATOR WITH RECTIFIER ON THE REAR END FRAME.
   1. Install the stator with rectifier on the rear end frame.
   2. Install the condenser, tow insulators, and tighten the nuts.
   3. Push in the brushes and temporarily lock them in place with a wire inserted through the access hole in the rear end frame.

8. CONNECT THE DRIVE END FRAME AND THE REAR END FRAME.
   1. Fit the drive end frame to the rear end frame.
   2. Install the three through bolts and tighten to the specified torque.
   3. Remove the wire from the access hole.
   4. Make sure that the rotor rotates smoothly.
PERFORMANCE TEST

NOTE:

1. Connect the leads, voltmeter, and ammeter as shown in left.
2. Close SW1 on and increase the generator speed until voltmeter reading reaches approx. 13.5V.
3. Close SW2. Regulating the load resistance, increase the generator speed, keeping the voltage at 13.5V, until the ammeter reading reaches 80A.

Generator Speed: Less than 4,000 rpm at 13.5V, 80A

2. VOLTAGE REGULATION TEST.

1. Connect the leads, voltmeter and ammeter as shown in left.
2. Close SW1 on and increase the generator speed until voltmeter reading reaches approx. 13.5V.
3. Close SW2. Regulating the load resistance, increase the generator speed to 4,000 rpm, keeping the ammeter reading at 10A.
4. Check the voltmeter reading.

Generated Voltage: 13.8V–14.4V
# Inspection and Repair

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance of field coil (at 20°C)</td>
<td>About 4 ( \Omega )</td>
<td>—</td>
<td>Replace</td>
<td>SM21-086</td>
</tr>
<tr>
<td>Insulation resistance of field coil</td>
<td>More than 1 M( \Omega )</td>
<td>Less than 0.5 M( \Omega )</td>
<td>Replace</td>
<td>SM21-087</td>
</tr>
<tr>
<td>Resistance of field coil (at 20°C)</td>
<td>U-V: About 0 ( \Omega ) &lt;br&gt; U-W: — &lt;br&gt; V-W: —</td>
<td>—</td>
<td>Replace</td>
<td>SM21-088</td>
</tr>
<tr>
<td>Insulation resistance of stator coil</td>
<td>More than 1 M( \Omega )</td>
<td>Less than 0.5 M( \Omega )</td>
<td>Replace</td>
<td>SM21-089</td>
</tr>
<tr>
<td>Slip ring outer diameter</td>
<td>32.5 (1.280)</td>
<td>32.1 (1.264)</td>
<td>Replace</td>
<td>SM21-090</td>
</tr>
<tr>
<td>Brush length</td>
<td>19.0 (0.748)</td>
<td>5.5 (0.217)</td>
<td>Replace</td>
<td>SM21-091</td>
</tr>
<tr>
<td>Wear or damage ball bearing</td>
<td></td>
<td></td>
<td>Replace, if necessary.</td>
<td>Visual check</td>
</tr>
</tbody>
</table>

Unit: mm (in)

---

MARINE PARTS SUPPLY of CANADA (800)661-5353
CHAPTER ST

STARTER
(12V, 2.5 KW)

DATA AND SPECIFICATIONS
ST-2

DESCRIPTION
ST-2

TROUBLESHOOTING
ST-3

STARTER
ST-5
DATA AND SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>28100-1561</th>
<th>28100-1960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Reduction gear type</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>12V, 2.5 KW</td>
<td></td>
</tr>
<tr>
<td>Number of teeth of pinion</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Module</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Rotation</td>
<td>Clockwise, viewed from pinion side</td>
<td></td>
</tr>
</tbody>
</table>

DESCRIPTION

1. Load wire
2. Brush
3. Field coil
4. Armature
5. Armature shaft gear
6. Idle gear
7. Clutch gear
8. Overrunning clutch
9. Pinion
10. Steel ball
11. Spring
12. Magnetic switch
### Symptom: Engine does not crank, or cranks slowly.

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Remedy/Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor contact</td>
<td>Polish or replace contacts</td>
</tr>
<tr>
<td>Battery</td>
<td>Charge</td>
</tr>
<tr>
<td>Poor contact at battery terminal</td>
<td>Polish or retighten</td>
</tr>
</tbody>
</table>

#### Battery
- Discharged battery
- Short circuit between electrodes
- Poor contact at battery terminal

#### Engine Oil
- Improper viscosity oil

#### Magnetic Switch
- Poor contact caused by burnt contact plate
- Contact plate worn out
- Hold-in coil disconnected
- Pull-in coil disconnected or short circuited

#### Starter Relay
- Defective or poor contact

#### Starter
- Brush worn out
- Commutator burnt out
- Commutator worn out
- Field winding shorted or grounded
- Armature winding shorted or grounded
- Insufficient brush spring tension
- Poor contact between magnetic switch
- Armature contacts pole core because of worn bearing bush or bent armature shaft
- Overrunning clutch malfunction

### Symptom: Engine does not crank while starter is running in good condition.

<table>
<thead>
<tr>
<th>Overrunning Clutch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overrunning clutch malfunction</td>
</tr>
<tr>
<td>Pinion teeth worn out</td>
</tr>
<tr>
<td>Poor sliding of spline teeth</td>
</tr>
<tr>
<td>Symptom</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Starter does not stop running</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
1. Felt washer
2. Armature assembly
3. Yoke assembly
4. Brush holder
5. Steel plate
6. Lead wire
7. Rear and flame
8. Through bolt
9. Through bolt
10. Drive end frame
11. Idle gear
12. Retainer
13. Roller
14. Overrunning clutch
15. Steel ball
16. Return spring
17. Steel washer
18. Magnetic switch assembly
IMPORTANT POINTS – DISASSEMBLY

REMOVE THE YOKE FROM THE MAGNETIC SWITCH.
1. Disconnect the lead wire from the magnetic switch.
2. Remove the through bolts from the magnetic switch.
3. Remove the steel plate from the magnetic switch.

REMOVE THE ARMATURE FROM THE YOKE.
1. Remove the rear end frame from the yoke.
2. Using a long-nose pliers, take off the brushes and remove the brush holder.
3. Loosen the two through bolts and detach the brush holder from the armature shaft.

REMOVE THE BALL BEARING FROM THE ARMATURE.
1. Using a press and a suitable tool, remove the ball bearing.

REMOVE THE OVERRUNNING CLUTCH.
1. Remove the screws from the drive end frame.
2. Remove the drive end frame from the magnetic switch.
3. Remove the overrunning clutch.
4. Remove the steel ball from the overrunning clutch.

REMOVE THE IDLE GEAR.
1. Remove the idle gear, retainer with rollers, and steel washer from the drive end frame.

NOTE: Do not drop the retainer and the rollers.
IMPORTANT POINT (S) – ASSEMBLY

BEFORE REASSEMBLING, APPLY THE RECOMMENDED GREASE TO THE FOLLOWING:

Nippondenso No. 50 grease or equivalent.

1. Felt washer
2. Bearing
3. Idle gear
4. Retainer
5. Roller
6. Overrunning clutch
7. Steel ball
8. Return spring

INSTALL THE STEEL WASHER, RETAINER WITH ROLLER, IDLE GEAR, RETURN SPRING, AND STEEL BALL IN THE MAGNETIC SWITCH.

INSTALL THE OVERRUNNING CLUTCH IN THE DRIVE END FRAME.

NOTE: Install the steel ball and the return spring.

1. Connect the drive end frame to the magnetic switch and tighten the screws.

INSTALL THE ARMATURE IN THE YOKE.

NOTE: Do not forget to place a felt washer on the armature shaft bearing.
INSTALL THE BRUSH HOLDER ON THE YOKE.
1. Install the negative brush (brush holder side) to the brush holder negative hole (not insulated), and the positive brush (yoke side) to the brush holder positive hole (separated from plate with insulator). Make sure that the positive brush lead wires are not grounded.
2. When assembling the brush holder to the yoke, take care not to damage and get oil on it.

NOTE: Match the lead wire grommet with the rear end frame groove.

INSTALL THE STEEL PLATE ON THE MAGNETIC SWITCH.
1. Install the steel plate on the magnetic switch.
2. Securely put the rubber boot over the terminal.
TEST

MAGNETIC SWITCH TEST

The following test should be performed with the starter assembled and the field coil lead wire disconnected.

NOTE:
- Each test should be performed for a short time only (3 to 5 sec.) to prevent the magnetic switch winding from burning.
- Each test should be performed with the specified voltage applied.

1. Pull-in test
   Connect the test leads as shown. When switch 1 (SW1) and switch 2 (SW2) are closed, the pinion should jump out.

2. Hold-in test
   In the same conditions as the pull-in test, open switch 1 (SW1). The pinion should remain in the jumped out position.

3. Return test
   In the same conditions as the hold-in test, open switch 2 (SW2). The pinion should return immediately.

PERFORMANCE TEST

The following test should be carried out after reassembling the starter. If suitable equipment is not available, at least the No-load test should be carried out.

1. No-load test
   With the starter securely clamped in a vice, and using a battery and suitable ammeter, connect the positive lead of the battery, and the ammeter to the "50" terminal. Connect the negative lead to the starter body. The starter should show smooth and steady rotation immediately after jumping out of the pinion and should draw less than the specified current.
2. Load test
Read the ammeter and voltmeter when the specified torque is applied. The ammeter should indicate less than the specified current, and the tachometer should indicate more than the specified speed.

3. Lock torque test
Read the torque meter and ammeter when the tachometer reading becomes 0 rpm after applying the load. The torque meter should indicate more than the specified torque and the ammeter should indicate less than the specified current.

<table>
<thead>
<tr>
<th>Test</th>
<th>Current</th>
<th>Voltage</th>
<th>Revolution &amp; torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>No load test</td>
<td>Less than 180 A</td>
<td>at 11V</td>
<td>More than 3,500 rpm</td>
</tr>
<tr>
<td>Load test</td>
<td>Less than 600 A</td>
<td>at 8V</td>
<td>More than 1,100 rpm</td>
</tr>
<tr>
<td>Lock torque test</td>
<td>Less than 1,200 A</td>
<td>at 3V</td>
<td>More than 3.5 kg-m at 0 rpm</td>
</tr>
</tbody>
</table>
## STARTER

### INSPECTION AND REPAIR

<table>
<thead>
<tr>
<th>Inspection Item</th>
<th>Standard</th>
<th>Limit</th>
<th>Remedy</th>
<th>Inspection Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armature Short Circuit Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armature Insulation</td>
<td>More than 1 M Ω</td>
<td>Less than 0.1 M Ω</td>
<td>Replace</td>
<td>SMST-091</td>
</tr>
<tr>
<td>Commutator continuity</td>
<td>Should be continuity at any point</td>
<td></td>
<td>Replace, if there is no continuity at any point</td>
<td>SMST-092</td>
</tr>
<tr>
<td>Commutator run-out</td>
<td>Less than 0.02 (0.0008)</td>
<td>0.05 (0.002)</td>
<td>Replace</td>
<td>SMST-093</td>
</tr>
<tr>
<td>Commutator Outside Diameter</td>
<td>36 (1.417)</td>
<td>36 (1.378)</td>
<td>Replace</td>
<td>SM22-055</td>
</tr>
<tr>
<td>Mica Depth</td>
<td>0.7 (0.0276)</td>
<td>0.2 (0.0078)</td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td>Conductance between the Field Coil and the Yoke</td>
<td>Should be conducted</td>
<td></td>
<td>Replace</td>
<td></td>
</tr>
<tr>
<td>Inspection Item</td>
<td>Standard</td>
<td>Limit</td>
<td>Remedy</td>
<td>Inspection Procedure</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>----------------</td>
<td>-----------------</td>
<td>----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Field Coil Insulation</td>
<td>More than 1 MΩ</td>
<td>Less than 0.1 MΩ</td>
<td>Replace</td>
<td>AB5167</td>
</tr>
<tr>
<td>Wear or Damage of the Bearing</td>
<td></td>
<td></td>
<td>Replace, if necessary</td>
<td>AB5184</td>
</tr>
<tr>
<td>Field coil and yoke damage</td>
<td></td>
<td></td>
<td>Replace</td>
<td>Visual check</td>
</tr>
<tr>
<td>Brush length</td>
<td>20.5 (0.807)</td>
<td>13 (0.512)</td>
<td>Replace</td>
<td>AB5140</td>
</tr>
<tr>
<td>Insulation between the Brush Holder and the Bracket</td>
<td>More than 1 MΩ</td>
<td>Less than 0.1 MΩ</td>
<td>Replace</td>
<td>AB5168</td>
</tr>
<tr>
<td>Overrunning clutch test</td>
<td></td>
<td></td>
<td>Replace</td>
<td>AB5169</td>
</tr>
<tr>
<td>Tension of the Brush Springs</td>
<td>3.9 kg (8.6 lb)</td>
<td>1.9 kg (4.2 lb)</td>
<td>Replace</td>
<td>AB5170</td>
</tr>
</tbody>
</table>