<table>
<thead>
<tr>
<th>No. of Correction</th>
<th>Date of Correction</th>
<th>Cause for Correction</th>
<th>Outline of Correction</th>
<th>Corrected Item Number</th>
<th>Corrected by:</th>
</tr>
</thead>
</table>
| -                | Mar. 2005        | Added SD50/-4T       | (1) Added SD50 series.  
(2) Changed document number.  
M9961-H13030  
M2215-04E140       | -                    | Quality Control Dept.  
Marine factory               |
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FOR SAFETY

1. SAFETY LABELS

- Most accidents are caused by negligence of basic safety rules and precautions. For accident prevention, it is important to avoid such causes before development to accidents. Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures. Attempting at a repair or maintenance job without sufficient knowledge may cause an unexpected accident.

- It is impossible to cover every possible danger in repair or maintenance in the manual. Sufficient consideration for safety is required in addition to the matters marked [CAUTION]. Especially for safety precautions in a repair or maintenance job not described in this manual, receive instructions from a knowledgeable leader.

- Safety marks used in this manual and their meanings are as follows:

  ![DANGER] DANGER - indicates an imminent hazardous situation which, if not avoided, WILL result in death or serious injury.

  ![WARNING] WARNING - indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

  ![CAUTION] CAUTION - indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

- NOTICE - indicates that if not observed, the product performance or quality may not be guaranteed.
2. Safety Precautions

(1) SERVICE AREA

- **Sufficient Ventilation**
  
  **WARNING**
  
  Inhalation of exhaust fumes and dust particles may be hazardous to ones health. Running engines, welding, sanding, painting, and polishing tasks should be only done in well ventilated areas.

- **Safe / Adequate Work Area**
  
  **CAUTION**
  
  The service area should be clean, spacious, level and free from holes in the floor, to prevent "slip" or "trip and fall" type accidents.

- **Clean, orderly arranged place**
  
  **CAUTION**
  
  No dust, mud, oil or parts should be left on the floor surface. [Failure to Observe] An unexpected accident may be caused.

- **Bright, Safely Illuminated Area**
  
  **CAUTION**
  
  The work area should be well lit or illuminated in a safe manner. For work in enclosed or dark areas, a "drop cord" should be utilized. The drop cord must have a wire cage to prevent bulb breakage and possible ignition of flammable substances.

- **Safety Equipment**
  
  **CAUTION**
  
  Fire extinguisher(s), first aid kit and eye wash / shower station should be close at hand (or easily accessible) in case of an emergency.
(2) WORK - WEAR (GARMENTS)

- **Safe Work Clothing**
  Appropriate safety wear (gloves, special shoes/boots, eye/ear protection, head gear, harness', clothing, etc.) should be used/worn to match the task at hand. Avoid wearing jewelry, unbuttoned cuffs, ties or loose fitting clothes around moving machinery. A serious accident may occur if caught in moving/rotating machinery.

(3) TOOLS

- **Appropriate Lifting / Holding**
  When lifting an engine, use only a lifting device (crane, jack, etc.) with sufficient lifting capacity. Do not overload the device. Use only a chain, cable, or lifting strap as an attaching device. Do not use rope, serious injury may result.
  To hold or support an engine, secure the engine to a support stand, test bed or test cart designed to carry the weight of the engine. Do not overload this device, serious injury may result.
  Never run an engine without being properly secured to an engine support stand, test bed or test cart, serious injury may result.

- **Appropriate Tools**
  Always use tools that are designed for the task at hand. Incorrect usage of tools may result in damage to the engine and or serious personal injury.

(4) GENUINE PARTS and MATERIALS

- **Genuine Parts**
  Always use genuine YANMAR parts or YANMAR recommended parts and goods. Damage to the engine, shortened engine life and or personal injury may result.
(5) FASTENER TORQUE

- Torquing Fasteners
  Always follow the torque values and procedures as designated in the service manual. Incorrect values, procedures and or tools may cause damage to the engine and or personal injury.

(6) Electrical

- Short Circuits
  Always disconnect the (-) Negative battery cable before working on the electrical system. An accidental "short circuit" may cause damage, fire and or personal injury. Remember to connect the (-) Negative battery cable (back onto the battery) LAST

- Charging Batteries
  Charging wet celled batteries produces hydrogen gas. Hydrogen gas is extremely explosive. Keep sparks, open flame and any other form of ignition away. Explosion may occur causing severe personal injury.

- Battery Electrolyte
  Batteries contain sulfuric acid. Do NOT allow it to come in contact with clothing, skin and or eyes, severe burns will result.

(7) WASTE MANAGEMENT

- CAUTION
  Observe the following instructions with regard to hazardous waste disposal. Negligence of these will have a serious impact on environmental pollution concerns.
  1) Waste fluids such as lube oil, fuel and coolant shall be carefully put into separate sealed containers and disposed of properly.
  2) Do NOT dispose of waste materials irresponsibly by dumping them into the sewer, overland or into natural waterways.
  3) Waste materials such as oil, fuel, coolant, solvents, filter elements and batteries, must be disposed of properly according to local ordinances. Consult the local authorities or reclamation facility.
(8) FURTHER PRECAUTIONS

**WARNING**

- **Fueling / Refueling**
  Keep sparks, open flames or any other form of ignition (match, cigarette, etc.) away when fueling/refueling the unit. Fire and or an explosion may result.

**WARNING**

- **Hot Surfaces.**
  Do NOT touch the engine (or any of its components) during running or shortly after shutting it down. Scalding / serious burns may result. Allow the engine to cool down before attempting to approach the unit.

**WARNING**

- **Rotating Parts**
  Be careful around moving/rotating parts. Loose clothing, jewelry, ties or tools may become entangled causing damage to the engine and or severe personal injury.

**WARNING**

- **Preventing burns from scalding**
  1) Never open the filler cap shortly after shutting the engine down. Steam and hot water will spurt out and seriously burn you. Allow the engine to cool down before attempt to open the filler cap.
  2) Securely tighten the filler cap after checking the cooling water. Steam can spurt out during engine running, if tightening loose.

**CAUTION**

- **Safety Label Check**
  Pay attention to the product safety label. A safety label (caution plate) is affixed on the product for calling special attention to safety. If it is missing or illegible, always affix a new one.
3. Precautions for Service Work

(1) Precautions for Safety
Read the safety precautions given at the beginning of this manual carefully and always mind safety in work.

(2) Preparation for Service Work
Preparation is necessary for accurate, efficient service work. Check the customer ledger file for the history of the engine.
- Preceding service date
- Period/operation hours after preceding service
- Problems and actions in preceding service
- Replacement parts expected to be required for service
- Recording form/check sheet required for service

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

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

(5) Precautions for Inspection and Measurement
Inspect and measure parts to be used again as required to determine whether they are reusable or not.

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

(7) Precautions for Adjustment and Check
Use measuring instruments for adjustment to the specified service standards.
### 1 General

#### 1.1 Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td></td>
<td>SD40-3, SD50-3 SD40-4, SD50-4 SD40-4T, SD50-4T</td>
</tr>
<tr>
<td>Clutch system</td>
<td></td>
<td>Cone clutch</td>
</tr>
<tr>
<td>Reduction gear system</td>
<td></td>
<td>Bevel gear</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td></td>
<td>Counter-clockwise viewed from stern</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Counter-clockwise or clockwise viewed from stern</td>
</tr>
<tr>
<td>Reduction ratio</td>
<td></td>
<td>Ahead 2.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Astern 2.32</td>
</tr>
<tr>
<td>Lubrication system</td>
<td></td>
<td>Splash lubrication</td>
</tr>
<tr>
<td>Lub. oil capacity</td>
<td>L</td>
<td>2.2 (SD40 old type 1.8)</td>
</tr>
<tr>
<td>Dry mass</td>
<td>kg</td>
<td>39 41</td>
</tr>
<tr>
<td>Applicable eng.</td>
<td></td>
<td>Model 3JH3CE 3JH4CE 4JH3CE 4JH4CE 4JH3-TCE</td>
</tr>
<tr>
<td>Output (DIN6270B)</td>
<td>kW (PS)</td>
<td>29.4/40/3800 29.4/40/3000 41.2/56/3800 40.5/65/3000 55.2/75/3800</td>
</tr>
<tr>
<td>Allowable torque</td>
<td>N·m (kgf·m)</td>
<td>129(13.1) 140(14.3)</td>
</tr>
<tr>
<td>Allowable speed at Input shaft</td>
<td>min⁻¹ (rpm)</td>
<td>4000</td>
</tr>
<tr>
<td>Lube oil</td>
<td></td>
<td>API service grade GL4 or higher, SAE80W-90 or 90, (High performance gear lube, as shown on the right, is also acceptable.) Quicksilver high performance gear lube.</td>
</tr>
<tr>
<td>Max. propeller dia.</td>
<td>mm (inch)</td>
<td>457(18)</td>
</tr>
<tr>
<td>Mounting size</td>
<td></td>
<td>SAE #5 SAE #4</td>
</tr>
<tr>
<td>Sealing method for bottom of ship</td>
<td></td>
<td>Double</td>
</tr>
<tr>
<td>Engine installation direction</td>
<td></td>
<td>180° Acceptable</td>
</tr>
</tbody>
</table>

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1.2 Exterior view
1.3 Sectional view
### 1.4 Criteria for replacing parts

<table>
<thead>
<tr>
<th>Criteria for replacement</th>
<th>Standard value</th>
<th>Standard service life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needle bearing (A)</td>
<td>Evidence of needle flaking or loss</td>
<td>Every 1500 hours</td>
</tr>
<tr>
<td>(K24 x 28 x 17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needle bearing (B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-corrosive zinc</td>
<td>Weight: 5400 g (with plug)</td>
<td>A half year or less than 1/2 of its original size</td>
</tr>
<tr>
<td>Oil seals</td>
<td>1) Lip hardening or hair cracks 2) Disassembly</td>
<td>Every 1000 hours or 2 years</td>
</tr>
<tr>
<td>O-ring</td>
<td>Disassembly</td>
<td></td>
</tr>
<tr>
<td>Diaphragms (A) &amp; (B)</td>
<td>Hair cracks</td>
<td>2 years</td>
</tr>
<tr>
<td>Steel band</td>
<td>Disassembly</td>
<td></td>
</tr>
</tbody>
</table>
1.5 Route of cooling water and lubricating oil
1.6 Lubricating oil

(1) Choice of lube oil
The selection of lube oil is very important to a Sail-drive. If an unsuitable oil is used, or oil change is neglected, it may result in damage and a shorter Sail-drive life. When selecting the lube oil, it must be one of the following.

(2) Kind of lube oil
See 1.2 specifications.

(3) Lube oil viscosity
The viscosity of the lube oil greatly influences Sail-drive performance.

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Brand name</th>
<th>API service</th>
<th>SAE No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHELL</td>
<td>Shell Spirax oil EP 90</td>
<td>GL-4</td>
<td>90</td>
</tr>
<tr>
<td>SHELL</td>
<td>Shell Spirax oil HD 90</td>
<td>GL-5</td>
<td>90</td>
</tr>
<tr>
<td>CALTEX</td>
<td>Multipurpose thuban EP</td>
<td>GL-4, GL-5</td>
<td>90</td>
</tr>
<tr>
<td>MOBIL</td>
<td>Mobilub HD 80W-90</td>
<td>GL-5</td>
<td>80W-90</td>
</tr>
<tr>
<td>ESSO</td>
<td>Esso gear oil GP 90</td>
<td>GL-4</td>
<td>90</td>
</tr>
<tr>
<td>ESSO</td>
<td>Esso gear oil GP 90</td>
<td>GL-5</td>
<td>90</td>
</tr>
<tr>
<td>SD40-4T</td>
<td>Quicksilver® High performance gear lube</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD50-4T</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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1.7 Disassembly and reassembly

The following tools are necessary when disassembling and reassembling the sail drive unit. These tools must be used according to disassembly process and location.

**General hand tools**

<table>
<thead>
<tr>
<th>Name</th>
<th>Illustration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanner</td>
<td><img src="001305-00X" alt="Spanner" /></td>
<td>10 x 13, 12 x 14, 17 x 19, 21 x 23, 21 x 24</td>
</tr>
<tr>
<td>Screwdriver for + (Cross recessed head) screws</td>
<td><img src="002951-00X" alt="Screwdriver for +" /></td>
<td></td>
</tr>
<tr>
<td>Screwdriver for − (Philips head) screws</td>
<td><img src="002953-00X" alt="Screwdriver for −" /></td>
<td></td>
</tr>
<tr>
<td>Steel hammer</td>
<td><img src="001169-00X" alt="Steel hammer" /></td>
<td></td>
</tr>
<tr>
<td>Copper hammer</td>
<td><img src="001150-00X" alt="Copper hammer" /></td>
<td></td>
</tr>
<tr>
<td>Mallet</td>
<td><img src="003391-00X" alt="Mallet" /></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Illustration</td>
<td>Remarks</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>Nipper</td>
<td><img src="image" alt="Nipper Illustration" /></td>
<td>001182-08X</td>
</tr>
<tr>
<td>Plier</td>
<td><img src="image" alt="Plier Illustration" /></td>
<td>001399-08X</td>
</tr>
<tr>
<td>Starting plier</td>
<td><img src="image" alt="Starting plier Illustration" /></td>
<td>003242-08X</td>
</tr>
<tr>
<td>Offset wrench</td>
<td><img src="image" alt="Offset wrench Illustration" /></td>
<td>003354-08X</td>
</tr>
<tr>
<td>Box spanner</td>
<td><img src="image" alt="Box spanner Illustration" /></td>
<td>001325-08X</td>
</tr>
</tbody>
</table>

- Offset wrench: 1set
- Box spanner: 1set
<table>
<thead>
<tr>
<th>Name</th>
<th>Illustration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scraper</td>
<td><img src="001394-00X" alt="Scraper Illustration" /></td>
<td></td>
</tr>
<tr>
<td>Lead rod</td>
<td><img src="002297-00X" alt="Lead Rod Illustration" /></td>
<td></td>
</tr>
<tr>
<td>File</td>
<td><img src="001398-00X" alt="File Illustration" /></td>
<td>1set</td>
</tr>
<tr>
<td>Rod spanner for hexagon socket head screws (L-type)</td>
<td><img src="001399-00X" alt="Rod Spanner Illustration" /></td>
<td>5 mm  6 mm  8 mm</td>
</tr>
<tr>
<td>Rod spanner for hexagon socket head screws (Straight type)</td>
<td><img src="402956-00X" alt="Rod Spanner Illustration" /></td>
<td>5 mm  6 mm  8 mm</td>
</tr>
</tbody>
</table>
# Measuring instruments

<table>
<thead>
<tr>
<th>Name</th>
<th>Illustration</th>
<th>Accuracy &amp; Range</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernier calipers</td>
<td><img src="image" alt="Vernier calipers" /></td>
<td>1/20 mm, 0-150 mm</td>
<td></td>
</tr>
<tr>
<td>Micrometer</td>
<td><img src="image" alt="Micrometer" /></td>
<td>1/100 mm, 0-25 mm, 25-50 mm, 100-125 mm</td>
<td></td>
</tr>
<tr>
<td>Thickness gauge</td>
<td><img src="image" alt="Thickness gauge" /></td>
<td>0.05-2 mm</td>
<td></td>
</tr>
<tr>
<td>Torque wrench</td>
<td><img src="image" alt="Torque wrench" /></td>
<td>0-147 N-m (0-15 kgf-m)</td>
<td></td>
</tr>
<tr>
<td>Dial depth gauge</td>
<td><img src="image" alt="Dial depth gauge" /></td>
<td>1/100 mm, 0-150 mm</td>
<td>8.1.2</td>
</tr>
<tr>
<td>Name</td>
<td>Illustration</td>
<td>Accuracy &amp; range</td>
<td>Ref.</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
<td>------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Lever type</td>
<td></td>
<td>1/100 mm, 0-0.8 mm</td>
<td>6.1</td>
</tr>
<tr>
<td>dial test indicator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic base</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clamp type</td>
<td></td>
<td>100 mm (K-type)</td>
<td></td>
</tr>
<tr>
<td>box block</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Illustration</td>
<td>Accuracy &amp; range</td>
<td>Ref.</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>------------------</td>
<td>------</td>
</tr>
<tr>
<td>Surface plate</td>
<td><img src="002154-00E" alt="Surface plate illustration" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height gauge</td>
<td><img src="002939-00E" alt="Height gauge illustration" /></td>
<td>500 mm</td>
<td></td>
</tr>
</tbody>
</table>
Others

Supplementary packing agent
The surface to be coated must be thoroughly cleaned with thinner or benzene and completely dry. Moreover, coating must be thin and uniform.

Liquid gasket

[THREEBOND 1215]
1.8 Special tools

Reassembly tools

(1) For needle bearing
Use when reassembling the needle bearing to the lower case.

(2) For taper roller bearing at drive shaft
Use when reassembling the taper roller bearing at the drive shaft.
Press it as striking it with a hammer strongly.
(3) For outer race of taper roller bearing at propeller shaft
Use when reassembling the outer race of the taper roller bearing to the lower case.
Press it as striking it with a hammer strongly.

(4) For taper roller bearing at propeller shaft
Use when reassembling the taper roller bearing at the propeller shaft.
Press it as striking it with a hammer strongly.
Tools for measuring dimensions

(1) For taper roller bearing at pinion shaft
Use when measuring the dimension of L4 (Refer to 5.2.1(1)).

(2) For taper roller bearing at drive shaft
Use when measuring the dimension of M2 (Refer to 5.3.1(1)).
(3) For taper roller bearing at propeller shaft
Use when measuring the dimension of M4 (Refer to 5.4.1(1)).

(4) For bevel gear on propeller shaft
Use when measuring the dimension of M5 (Refer to 4.6.1).
Disassembly tools

(1) Special tool A
1) Use when removing the drive pinion end nut.

2) Use when disassembling the gear (upper) assembly.

(2) Special tool B
1) Use when disassembling the pinion shaft assembly.
1.9 Notes on disassembly, inspection and reassembly

(1) Carefully note the correct mounting position before removing or disassembling the unit.
(2) To avoid mix-ups when disassembling, keep the parts in order.
(3) Use liquid gasket wherever necessary to prevent oil or water leakage.
(4) When the tightening torque is specified, tighten the bolt to the specified torque with a torque wrench.
(5) Always use new gaskets, packing, and o-rings when reassembling.
(6) Always use genuine YANMAR replacement parts.
(7) Some repairs require special tools in fully equipped workshops.
    These repairs should be made with the proper tools and in the proper facilities.
(8) Disassemble in the order specified in this Service Manual.
2 Disassembly

2.1 Disassembling the upper case

2.1.1 Removal of the unit

(1) Separation from the lower case
1) Remove the tightening bolts (M10) from the lower case.

2) Upper case separated from lower case.

3) Lower case separated from upper case.
(2) Removal of the mounting flange
1) Remove the tightening bolts (M8) from the mounting flange and the upper case.

2) Removal of mounting flange.

3) Upper case removed from mounting flange.
(3) Removal of the Shift Lever and Support

1) Remove the support tightening bolt (M8).

2) Remove the support.

3) Shift lever assembly after removal.
(4) Removal of the pinion shaft assembly
1) Remove the pinion shaft assembly nuts.

2) Remove the pinion shaft assembly from the upper case.

3) Pinion shaft assembly after removal.
(5) Removal of the gear (upper) assembly

1) Remove the upper cover tightening bolts (M8).

2) Remove the upper cover.

3) Screw the gear (upper) assembly raising tool into the thread (M8) of the clutch shaft edge face and lift out the assembly.

4) Gear (upper) assembly after removal.
(6) Removal of the diaphragm

- Diaphragm A

1) Remove the damper rubber mounting nut (M12) from the upper case.

2) Remove the diaphragm A which was installed on the back of the upper case seal flange.

3) Diaphragm A after removal.
• Diaphragm B
  1) Remove the upper case bend.

  ![Diagram of Diaphragm B and Upper Case](image1.png)

  2) Remove the seal flange band.

  ![Diagram of Seal Flange and Band](image2.png)

  3) Remove the upper case and the seal flange.

  ![Diagram of Upper Case and Seal Flange](image3.png)

  4) Remove the diaphragm B from the upper case.

  ![Diagram of Diaphragm B and Upper Case](image4.png)

  5) Diaphragm B after removal.

  ![Diagram of Diaphragm B](image5.png)
2.1.2 Disassembling the unit

(1) Disassembling the pinion shaft assembly
1) Remove the tightening bolt (M10) for pinion gear and the pinion shaft assembly to disassemble.

2) Insert the pinion shaft to the fixed special tool B (for stopping gear movement).

3) Remove the tightening bolt (M10).

4) Pinion shaft assembly after removal.
5) Push out the pinion by using the press to separate the pinion from bearing housing.

6) Pinion and taper roller bearing separated from bearing housing.
(2) Disassembling the gear (upper) assembly
1) Insert the clutch shaft to the fixed special tool A (for stopping gear movement)

2) The edge of the clutch shaft end nut (M16 x 1.5 left-hand screw) is caulked to the clutch shaft.

3) Lift up the caulking.

4) Remove the end nut.

5) Pull out the gear, clutch ring and bearing as a unit.
6) Gear, clutch ring and bearing as a unit after removal.

7) Gear (upper) assembly after disassembly.
(3) Disassembling the shift lever assembly

1) Disassemble in the order shown in the illustrations below.

Disassemble in the order 1 - 5.

1. Drop the spring pin in to the back of the hole.
2. Push in cylindrical pin.
3. Pull out shift lever.
4. Push out cylindrical.
5. Take out spring pin.

Spray with liquid detergent for easy removal.
2.2 Disassembling the lower case

2.2.1 Removal of unit

(1) Removal of anti-corrosive zinc

1) Remove the tightening bolts (M6) and take off anti-corrosive zinc.
(2) Removal of the propeller shaft assembly

1) Remove the tightening bolts (M10) and take off propeller shaft assembly.

2) Lower case removed from propeller shaft assembly.
(3) Removal of the drive pinion end nut

1) The drive pinion is positioned to the drive shaft with the end nut.

2) Insert the drive shaft to the fixed special tool A (for stopping the gear).
   Loosen the end nut (M14).

3) Remove the end nut (M14).
(4) Removal of the mid plate
1) Remove the two M8 bolts.
   Remove the mid plate.

(5) Removal of the drive pinion shaft assembly
1) Remove the drive pinion shaft assembly.
(6) Removal of the needle bearing

1) Remove the needle bearing with the tool shown in the illustration below.
(7) Removal of the taper roller bearing outer race

1) Remove the taper roller bearing outer race with the tool shown in the illustration below.
3 Reassembly

Reassemble parts in the reverse order from disassembly. Refer to Chapter 9 for tightening torque.

3.1 Reassembling the bearing for lower case

3.1.1 Needle bearing

1) Reattach the needle bearing using the special tool.

2) Fix the needle to the outer race with grease.

3.1.2 Taper roller bearing outer race

1) Reattach using the special tool.
3.2 Reassembling the bearings of shaft

3.2.1 Propeller shaft

1) Reattach the taper roller bearing using the special tool.

3.2.2 Drive shaft

1) Reattach the taper roller bearing using the special tool.
4 Shim adjustment (Gear backlash adjustment)

4.1 Location of adjustment shims

- **T3**: Adjustment shim for the bearing gap
  Part No.: 196440-02250

- **T4**: Backlash adjustment shim for the upper pinion
  Part No.: 196440-02320

- **T5**: Adjustment shim for the bearing gap
  Part No.: 196322-02320

- **T2**: Backlash adjustment shim for the upper gear (A)
  Part No.: 196320-02230

- **T1**: Backlash adjustment shim for the upper gear (B)
  Part No.: 196322-02320

- **S1**: Adjustment shim for the bearing gap
  Part No.: 196313-04400

- **S3**: Backlash adjustment shim for the lower pinion
  Part No.: 196313-04400

- **S2**: Adjustment shim for the bearing gap
  Part No.: 196311-02310

- **S4**: Backlash adjustment shim for the lower gear
  Part No.: 196320-02650
### 4.2 Measurement of the dimensions of the cases

#### 4.2.1 Upper case

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>78.5</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
</tr>
</tbody>
</table>

The actual dimension A is engraved on the part A.

Example "A - 3"
That shows
\[ A = 78.5 - 0.03 = 78.47 \]

#### 4.2.2 Lower case

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>49</td>
</tr>
<tr>
<td>B</td>
<td>343</td>
</tr>
</tbody>
</table>

The actual dimension B is engraved on the part B.

Example "B - 3"
That shows
\[ B = 343 - 0.03 = 342.97 \]
4.3 Shim selection method for the clutch shaft

1) Calculate the thickness of the shim T1, shim T2 shown at the right with the following procedure.

4.3.1 Measurement of the dimensions (L1, L2, L3) of the gear

(1) Under gear (B)

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>68.2</td>
</tr>
<tr>
<td>L3</td>
<td>55.0</td>
</tr>
</tbody>
</table>

(2) Upper gear (A)

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>35.5</td>
</tr>
</tbody>
</table>
4.3.2 Calculation of the shim thickness

(1) Under gear (B)

Formula
\[ T_1 = (A - L_1 - 10) \]

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>See 4.2.1</td>
</tr>
<tr>
<td>L_1</td>
<td>See 4.3.1(1)</td>
</tr>
<tr>
<td>T_1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Make the thickness for the shim
\[ T_1 - 0.025 < T_1 + 0.025. \]

(2) Upper gear (A)

Formula
\[ T_2 = (L_2 + 20 - L_3) \]

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_2</td>
<td>See 4.3.1(2)</td>
</tr>
<tr>
<td>L_3</td>
<td>See 4.3.1(1)</td>
</tr>
<tr>
<td>T_2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Make the thickness for the shim
\[ T_2 - 0.025 < T_2 + 0.025. \]
4.4 Shim selection method for the pinion shaft

4.4.1 Measurement of the pinion dimensions

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L5</td>
<td>68.58</td>
</tr>
</tbody>
</table>

4.4.2 Calculation of the shim thickness

Formula
\[ T_4 = (L_5 + 32 - C) \]

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L5</td>
<td>See 4.4.1</td>
</tr>
<tr>
<td>B</td>
<td>See 4.2.2</td>
</tr>
<tr>
<td>T4</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Make the thickness for the shim
\[ T_4 - 0.025 < T_4 - 0.025 \].
4.5 Shim selection method for the drive shaft

4.5.1 Measurement of the dimensions (M1) of the pinion

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>286.5</td>
</tr>
</tbody>
</table>

4.5.2 Calculation of the shim thickness

Formula

\[ S_3 = (M1+57-B) \]

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>See 4.5.1</td>
</tr>
<tr>
<td>B</td>
<td>See 4.2.2</td>
</tr>
<tr>
<td>S3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Make the thickness for the shim

\[ S_3-0.025\leq S_3\leq S_3+0.025. \]
4.6 Shim selection method for the propeller shaft

4.6.1 Measurement of the dimensions (M3) of the gear

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M3</td>
<td>108.25</td>
</tr>
</tbody>
</table>

4.6.2 Calculation of the shim thickness

Formula

\[ S_4 = (D + 60 - M3) \]

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>See 4.2.2</td>
</tr>
<tr>
<td>M3</td>
<td>See 4.6.1</td>
</tr>
<tr>
<td>S4</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Make the thickness for the shim
\[ S_4 - 0.025 \leq S_4 \leq S_4 + 0.025 \]
5 Adjustment of bearing assembly gap

5.1 Upper gear bearing

5.1.1 Measurement of the dimension (L₆) of the bearing

(1) Measurement of bearing lug

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L₆</td>
<td>16.2</td>
</tr>
</tbody>
</table>

(2) Measurement of bearing case

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₆</td>
<td>16.5</td>
</tr>
</tbody>
</table>

5.1.2 Calculation of the shim thickness

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tₛ</td>
<td>0.30</td>
</tr>
</tbody>
</table>
5.2 Pinion shaft bearing

5.2.1 Measurement of the dimension (L4) of the bearing

(1) Measurement of the bearing position

<table>
<thead>
<tr>
<th>Standard value</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>L4</td>
<td>15.0</td>
</tr>
</tbody>
</table>

(2) Measurement of oil seal case

<table>
<thead>
<tr>
<th>Standard value</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>H4</td>
<td>15.5</td>
</tr>
</tbody>
</table>

5.2.2 Calculation of the shim thickness

Formula: \( T3 = (H4 - L4) \)

<table>
<thead>
<tr>
<th>Standard value</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>H4</td>
<td>See 5.2.1(2)</td>
</tr>
<tr>
<td>L4</td>
<td>See 5.2.1(1)</td>
</tr>
<tr>
<td>T3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Make the thickness for the shim \( T3 - 0.1 - T3 \).
5.3 Pinion drive shaft bearing

5.3.1 Measurement of the dimension (M2) of the bearing

(1) Measurement of the bearing position

\[
\begin{array}{|c|c|}
\hline
\text{Dimension} & \text{Standard value} \\
\hline
M2 & 3.50 \\
\hline
\end{array}
\]

(2) Measurement of middle plate

\[
\begin{array}{|c|c|}
\hline
\text{Dimension} & \text{Standard value} \\
\hline
J2 & 4.0 \\
\hline
\end{array}
\]

5.3.2 Calculation of the shim thickness

Formula
\[
S_1 = (J2 - M2)
\]

\[
\begin{array}{|c|c|}
\hline
\text{Dimension} & \text{Standard value} \\
\hline
J2 & \text{See 5.3.1(2)} \\
M2 & \text{See 5.3.1(1)} \\
S_1 & 0.5 \\
\hline
\end{array}
\]

Make the thickness for the shim
\[
S_1 - 0.075 \sim S_1 - 0.025.
\]
5.4 Propeller shaft bearing

5.4.1 Measurement of the dimension (M4) of the bearing

(1) Measurement of the bearing position

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M4</td>
<td>3.75</td>
</tr>
</tbody>
</table>

(2) Measurement of bearing case

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>J4</td>
<td>3.0</td>
</tr>
</tbody>
</table>

5.4.2 Calculation of the shim thickness

Formula: 

\[ S_2 = (M4 - J4) \]

<table>
<thead>
<tr>
<th>mm</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M4</td>
<td>See 5.4.1(1)</td>
</tr>
<tr>
<td>J4</td>
<td>See 5.4.1(2)</td>
</tr>
<tr>
<td>S2</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Make the thickness for the shim 

\[ S_2 - 0.075 \leq S_2 \leq 0.025. \]
6 Adjustment of the gear backlash

6.1 Upper gear

1) The measurement for the backlash of the upper gear is shown in the figure to the right.

2) Use special tool (Part No. 196440-92300)
   Stop the moving of the gear one and another by the bolt.
   (Part No. 26116-060302)

---

<table>
<thead>
<tr>
<th>Reading of backlash</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial gauge reading</td>
<td>Conversion value at gear</td>
</tr>
<tr>
<td>0.031~0.062</td>
<td>0.10~0.20</td>
</tr>
</tbody>
</table>

Find the gear conversion value at the dial gauge on the shaft.
6.2 Lower gear

1) The measurement for the backlash of the lower gear is shown in the figure to the right.

<table>
<thead>
<tr>
<th>Reading of backlash</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial gauge reading</td>
<td>Conversion value at gear</td>
</tr>
<tr>
<td>0.056~0.113</td>
<td>0.14~0.28</td>
</tr>
</tbody>
</table>

Find the gear conversion value at the dial gauge on the shaft.
7 Adjustment of the gear dye pattern

7.1 Upper gear

1) After deciding the shim thickness T1, T2 and T4 in accordance with the section 4.2, 4.3 and 4.4 check the dye pattern of the gear faces and then adjust it.

2) After checking the dye pattern, adjust according to the table.

<table>
<thead>
<tr>
<th>DYE PATTERN</th>
<th>ADJUST</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>GOOD, NO ADJUSTING</td>
</tr>
<tr>
<td>B</td>
<td>INCREASE THE SHIM THICKNESS &quot;T1&quot;, DECREASE THE SHIM THICKNESS &quot;T2&quot;, INCREASE THE SHIM THICKNESS &quot;T4&quot;</td>
</tr>
<tr>
<td>C</td>
<td>DECREASE THE SHIM THICKNESS &quot;T1&quot;, INCREASE THE SHIM THICKNESS &quot;T2&quot;, DECREASE THE SHIM THICKNESS &quot;T4&quot;</td>
</tr>
</tbody>
</table>
7.2 Propeller shaft

1) After deciding the shim thickness S3 and S4 in accordance with the section 4.5 and 4.6 check the dye pattern of the gear faces and then adjust it.

2) After checking the dye pattern, adjust according to the table.

<table>
<thead>
<tr>
<th>GEAR, LOWER</th>
<th>DYE PATTERN</th>
<th>ADJUST</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>GOOD</td>
<td>NO ADJUSTING</td>
</tr>
<tr>
<td>B</td>
<td>DECREASE THE SHIM THICKNESS &quot;S3&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>INCREASE THE SHIM THICKNESS &quot;S4&quot;</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>INCREASE THE SHIM THICKNESS &quot;S3&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DECREASE THE SHIM THICKNESS &quot;S4&quot;</td>
<td></td>
</tr>
</tbody>
</table>
8 Adjustment of the shift lever

Adjust the operation of the shift lever with the thickness of shim $T$.

8.1 Measurement of the dimensions (H, A)

8.1.1 Shift Lever bolt

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>17.0</td>
</tr>
</tbody>
</table>

8.1.2 Shifter pin position

1) The measurement figure for the shifter pin position (A dimension) is shown in the figure on the right.

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>16.35</td>
</tr>
</tbody>
</table>

Keep the shift lever 10~15° from neutral position.
8.2 Calculation of the shim thickness

Formula
\[ T = (H - A) + 0.3 \]

<table>
<thead>
<tr>
<th></th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>See 8.1.1</td>
</tr>
<tr>
<td>A</td>
<td>See 8.1.2</td>
</tr>
<tr>
<td>T</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Calculation of the shim thickness
make the thickness for the shim
T = 0.1~T+0.1.

8.3 Caution of reassembly

- Fasten the shift lever bolt (Part No. 196440-06070) with "Threebond 1104".
- Check the smooth rotation of propeller shaft when change shift lever ± 15° from neutral position.
9 Tightening torque for nuts and bolts

Tightening torque 14.7 ± 1.0 N·m
(1.5 ± 0.1 kgf-m)

Tightening torque 147 ± 5.0 N·m (left screw)
(15 ± 0.5 kgf-m)

Tightening torque 73.5 ± 3.0 N·m
(7.5 ± 0.3 kgf-m)

Tightening torque 166.6 ± 5.0 N·m
(17 ± 0.5 kgf-m)

Tightening torque 29.4 ± 2.0 N·m
(3.0 ± 0.2 kgf-m)
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