YANMAR

M2215-04E140

YANMAR®

SERVICE MANUAL

SAIL DRIVE UNIT

SD40/SD40-4T
SD50/SD50-4T

YANMAR CO.,LTD.

History of Correction				Document No.	M2215-04E140
				Page No.	1
Manual Name:	YANMAR SERVICE MANUAL FOR SAIL DRIVE UNIT SD40/SD40-4T & SD50/SD50-4T				
UNIT Model:	SD40/SD40-4T, SD50/SD50-4T				
No.of Correction	Date of Correction	Cause for Correction	Outline of Correction	Corrected Item Number	Corrected by:
-	Mar. 2005	Added SD50/-4T	(1) Added SD50 series. (2) Changed document number. M9961-H13030 ↓ M2215-04E140	-	Quality Control Dept. Marine factory

CONTENTS

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

⚠ WARNING

• Sufficient Ventilation

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.

⚠ CAUTION

• Safe / Adequate Work Area

The service area should be clean, spacious, level and free from holes in the floor, to prevent "slip" or "trip and fall" type accidents.

⚠ CAUTION

• Clean, orderly arranged place

No dust, mud, oil or parts should be left on the floor surface.
[Failure to Observe]
An unexpected accident may be caused.

⚠ CAUTION

• Bright, Safely Illuminated Area

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.

⚠ CAUTION

• Safety Equipment

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)

⚠ CAUTION

• 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

⚠ WARNING

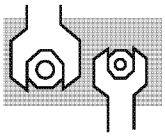
• Appropriate Lifting / Holding

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.

⚠ WARNING



• 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

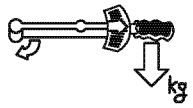
⚠ CAUTION

• 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

⚠ WARNING

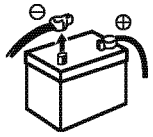


• Torquing Fasteners

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

⚠ WARNING



• 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

⚠ WARNING

• 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.

⚠ WARNING

• 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

Item		Unit	Contents				
Model			SD40-3, SD50-3		SD40-4, SD50-4		SD40-4T, SD50-4T
Clutch system			Cone clutch				
Reduction gear system			Bevel gear				
Direction of rotation	Input shaft		Counter-clockwise viewed from stern				
	Propeller shaft		Counter-clockwise or clockwise viewed from stern				
Reduction ratio	Ahead		2.32				
	Astern		2.32				
Lubrication system			Splash lubrication				
Lub.oil capacity		L	2.2 (SD40 old type 1.8)				
Dry mass		kg	39				41
Applicable eng.	Model		3JH3CE	3JH4CE	4JH3CE	4JH4CE	4JH3-TCE
	Output (DIN6270B)	kW (PS)	29.4(40)/3800	29.4(40)/3000	41.2(56)/3800	40.5(55)/3000	55.2(75)/3800
Allowable torque		N•m (kgf•m)	129(13.1)				140(14.3)
Allowable speed at Input shaft		min^{-1} (rpm)	4000				
Lube oil			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.
Max. propeller dia.		mm (inch)	457(18)				
Mounting size			SAE #5				SAE #4
Sealing method for bottom of ship			Double				
Engine installation direction			180° Acceptable				

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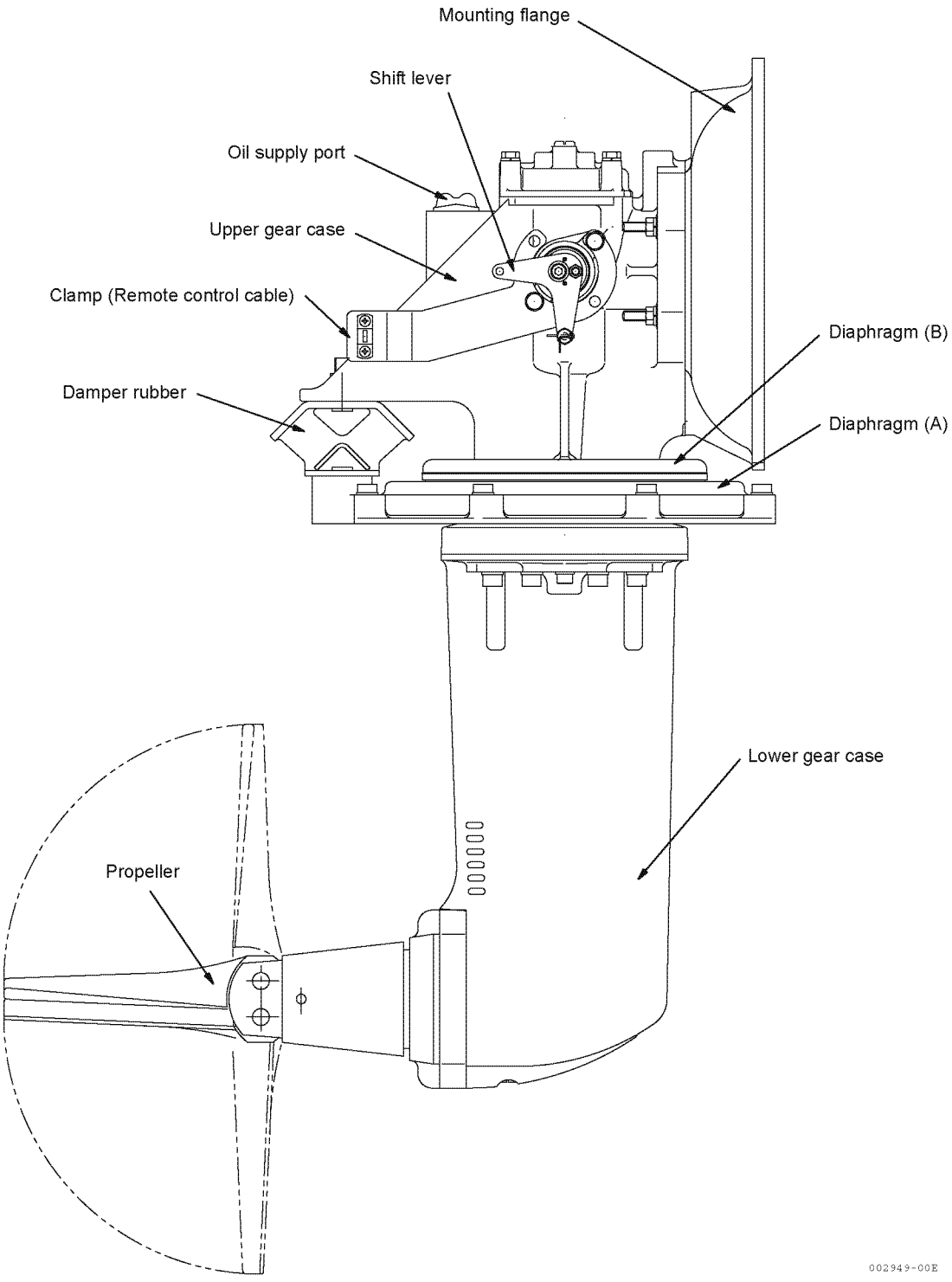
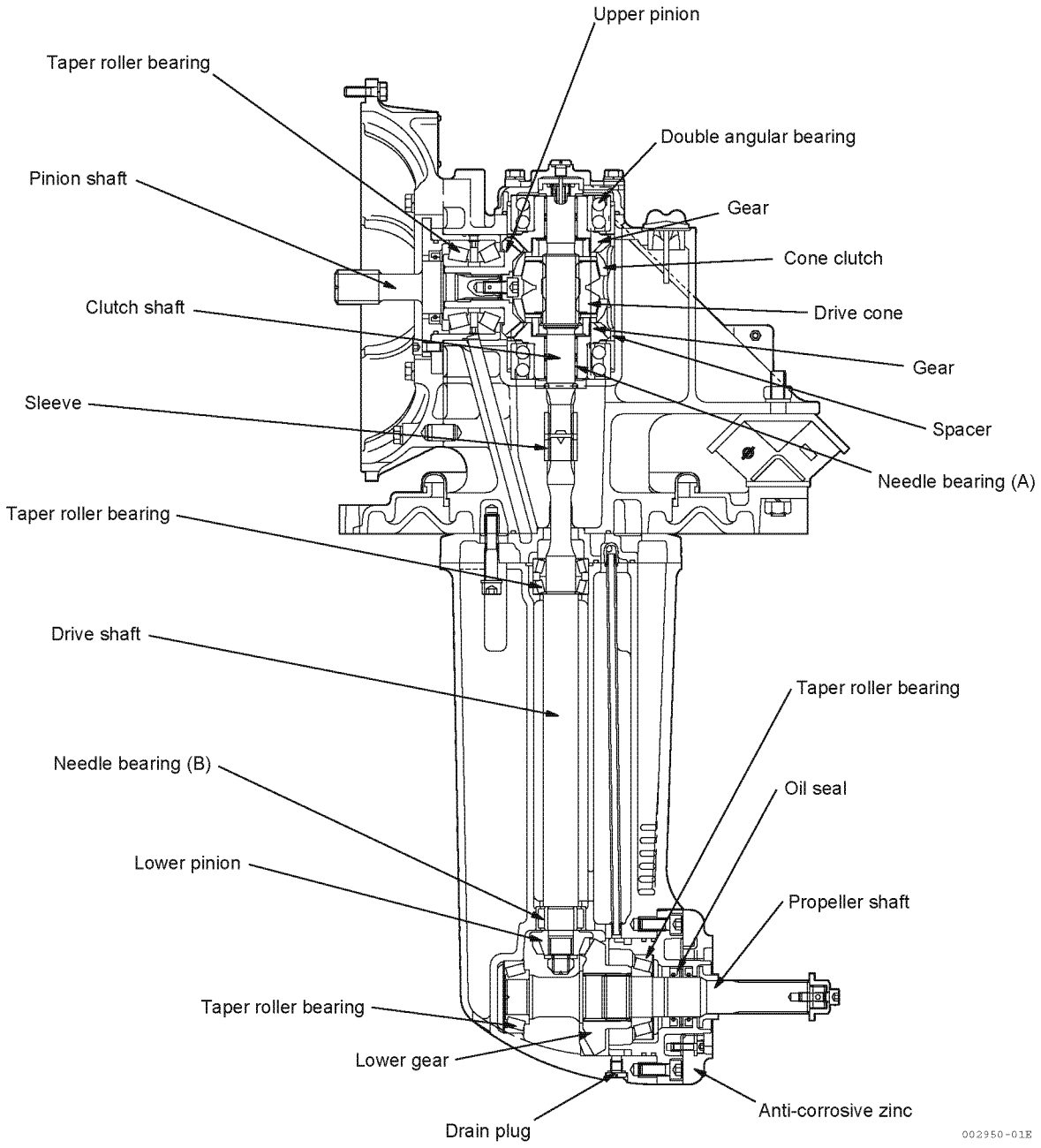
1.2 Exterior view



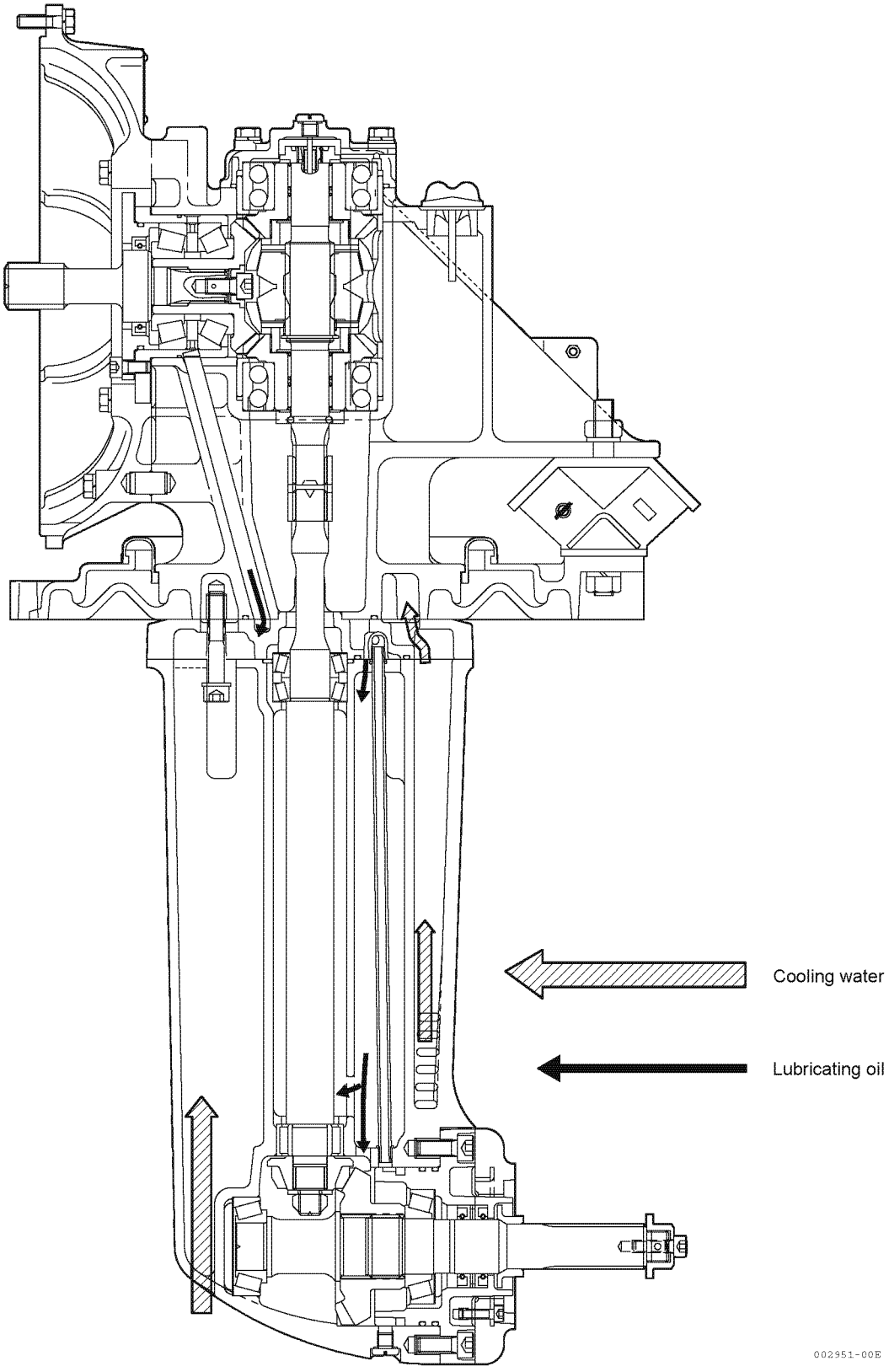
1.3 Sectional view



1.4 Criteria for replacing parts

		Criteria for replacement	
		Standard value	Standard service life
Bearing	Needle bearing (A) (K24 x 28 x 17)	Evidence of needle flaking or loss	Every 1500 hours
	Needle bearing (B)		
Anti-corrosive zinc		Weight : ≦400 g (with plug)	A half year or less than 1/2 of its original size
Oil seals		1) Lip hardening or hair cracks 2) Disassembly	Every 1000 hours or 2 years
O-ring		Disassembly	
Diaphragms (A) & (B)		Hair cracks	2 years
Steel band		Disassembly	

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.

SD40, SD50			
Supplier	Brand name	API service	SAE No.
SHELL	Shell Spilax oil EP 90	GL-4	90
SHELL	Shell Spilax oil HD 90	GL-5	90
CALTEX	Multipurpose thuban EP	GL-4,GL-5	90
MOBIL	Mobilub HD 80W-90	GL-5	80W-90
ESSO	Esso gear oil GP 90	GL-4	90
ESSO	Esso gear oil GP 90	GL-5	90
SD40-4T, SD50-4T			
Quicksilver®	High performance gear lube		

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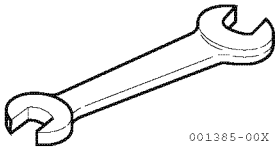
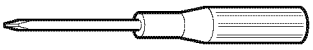
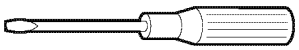
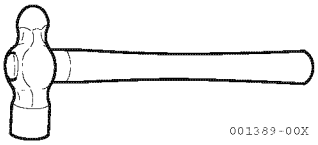
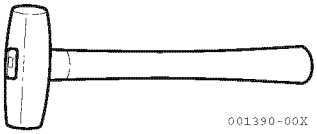
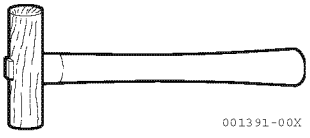
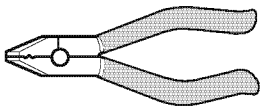
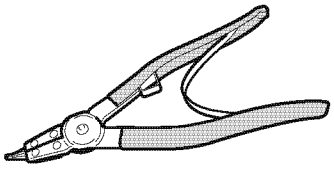
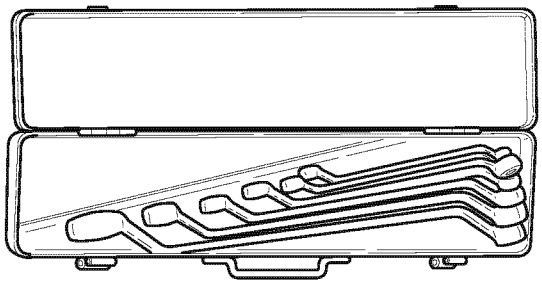
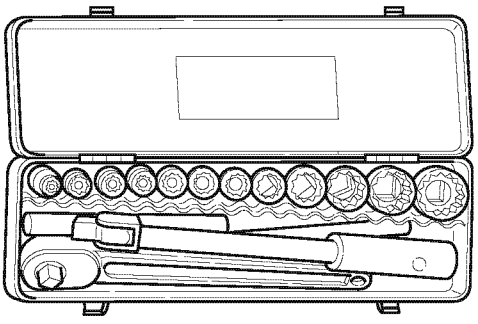
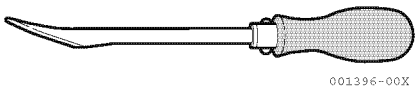
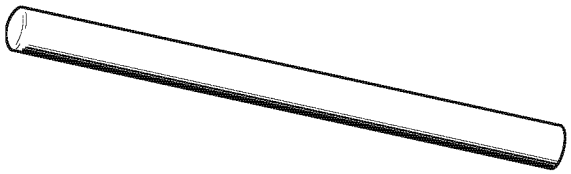
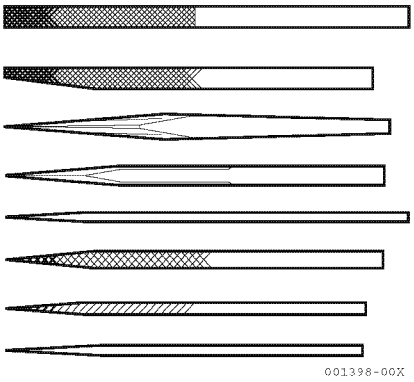
1.7 Disassembly and reassembly

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

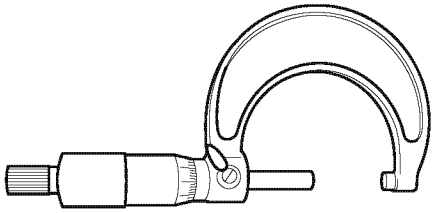
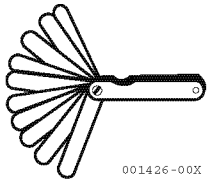
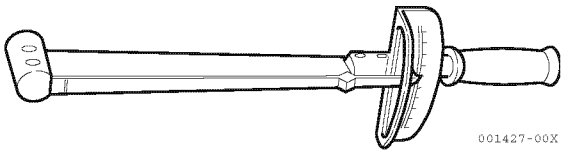
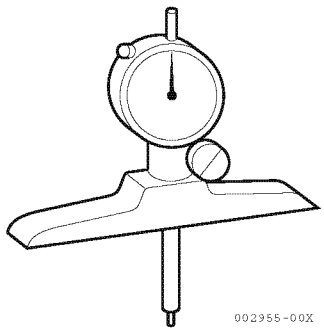
General hand tools

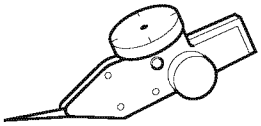
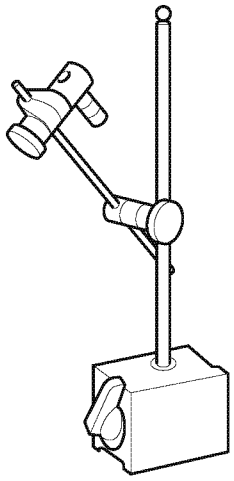
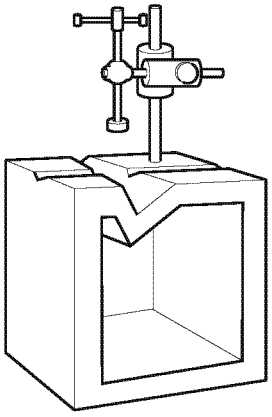
Name	Illustration	Remarks
Spanner	 001385-00X	10 x 13 12 x 14 17 x 19 21 x 23 21 x 24
Screwdriver for + (Cross recessed head) screws	 002952-00X	
Screwdriver for − (Philips head) screws	 002953-00X	
Steel hammer	 001389-00X	
Copper hammer	 001390-00X	
Mallet	 001391-00X	

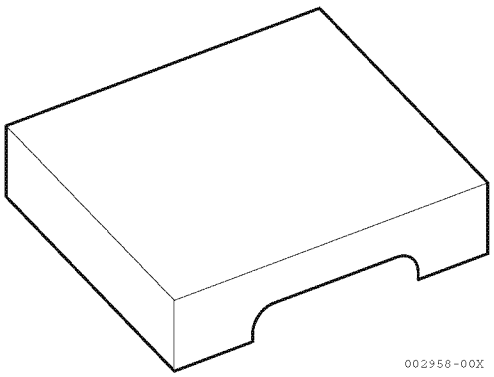
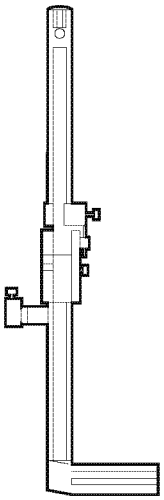
Name	Illustration	Remarks
Nipper	 001392-00X	
Plier	 001393-00X	
Starting plier	 003262-00X	
Offset wrench	 001394-00X	1set
Box spanner	 001395-00X	1set

Name	Illustration	Remarks
Scraper		
Lead rod		
File		1set
Rod spanner for hexagon socket head screws (L-type)		5 mm 6 mm 8 mm
Rod spanner for hexagon socket head screws (Straight type)		5 mm 6 mm 8 mm

Measuring instruments

Name	Illustration	Accuracy & range	Ref.
Vernier calipers	 001423-00X	1/20 mm, 0-150 mm	
Micrometer	 001424-00X	1/100 mm, 0-25 mm, 25-50 mm, 100-125 mm	
Thickness gauge	 001426-00X	0.05-2 mm	
Torque wrench	 001427-00X	0-147 N-m (0-15 kgf-m)	
Dial depth gauge	 002955-00X	1/100 mm, 0-150 mm	8.1.2

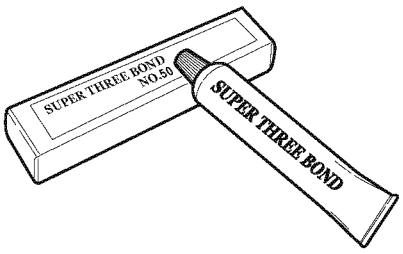
Name	Illustration	Accuracy & range	Ref.
Lever type dial test indicator	 003042-00X	1/100 mm, 0-0.8 mm	6.1
Magnetic base	 002956-00X		
Clamp type box block	 002957-00X	100 mm (K-type)	

Name	Illustration	Accuracy & range	Ref.
Surface plate	 002958-00X		
Height gauge	 002959-00X	500 mm	

Others

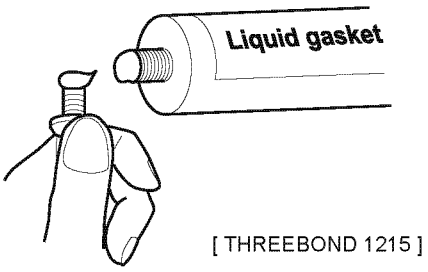
Supplementary packing agent

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



002960-00X

Liquid gasket



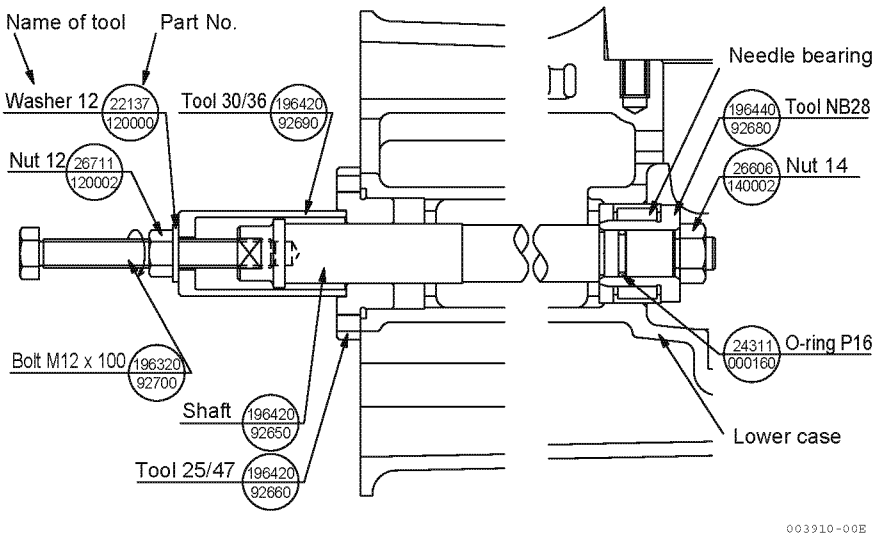
[THREEBOND 1215]

002961-00E

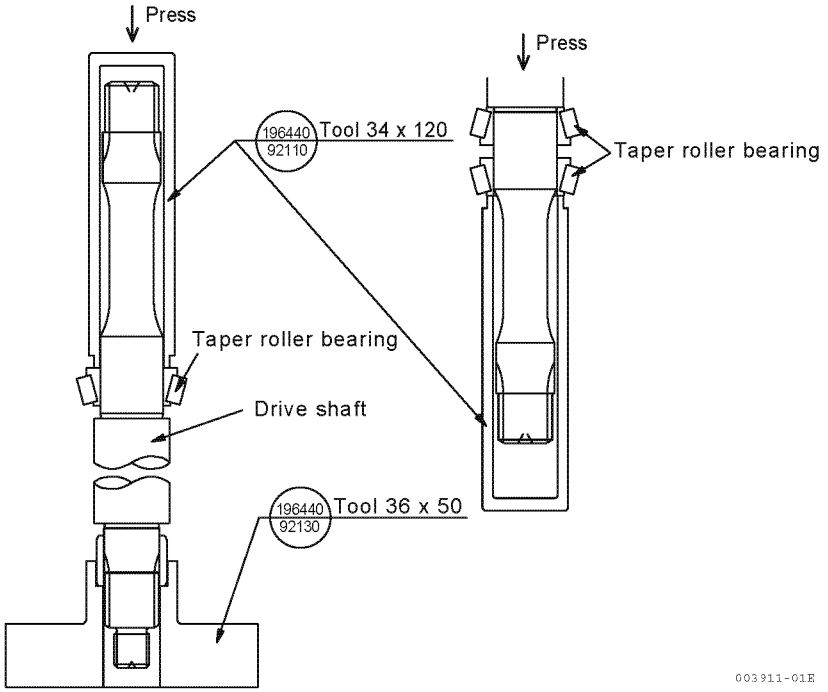
1.8 Special tools

Reassembly tools

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



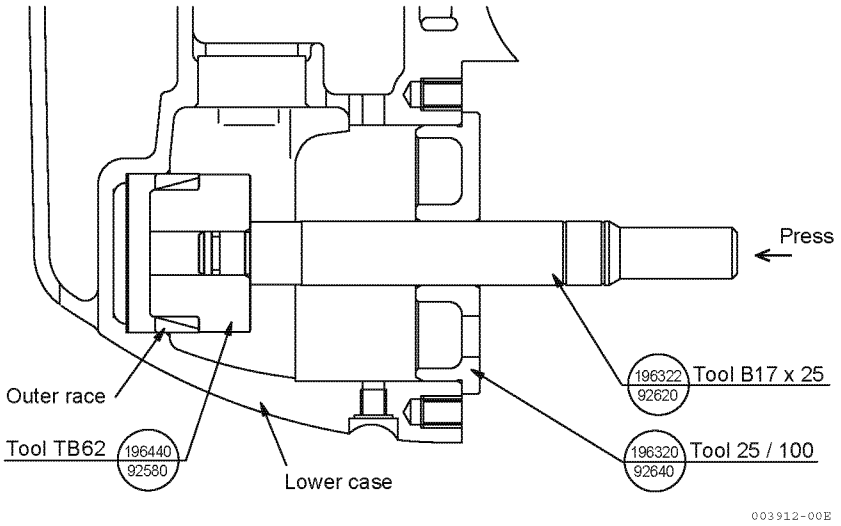
(2) For taper roller bearing at drive shaft
Use when reassembling the taper roller bearing at the drive shaft.
Press it as striking it with a hammer strongly.



(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.

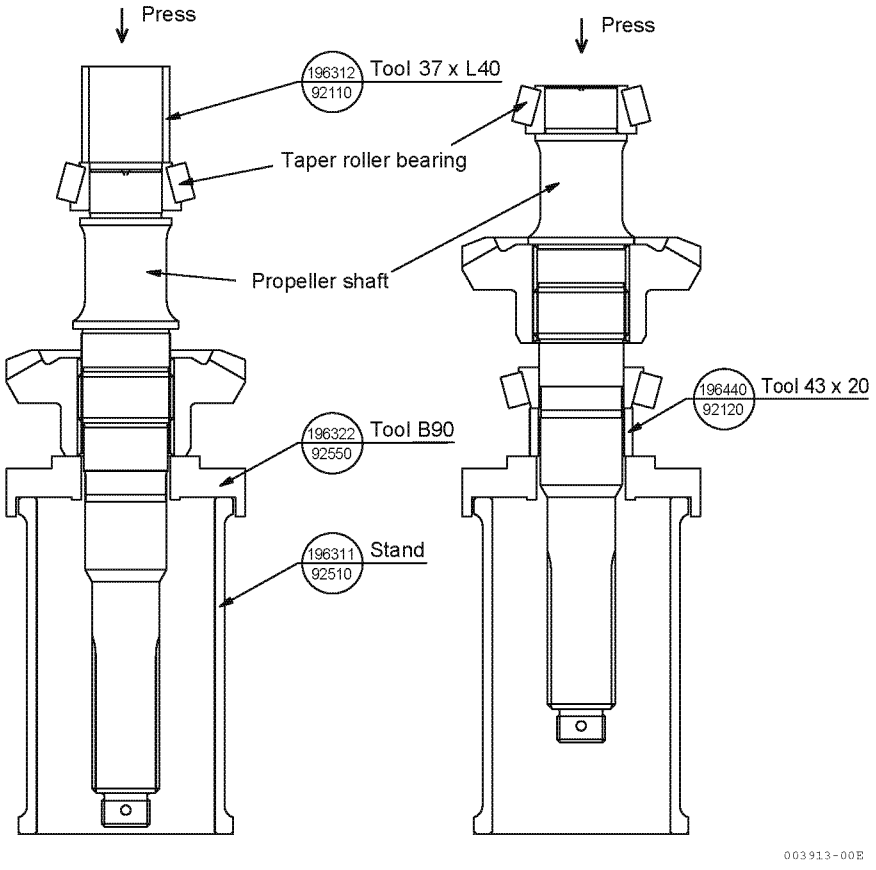
Press it as striking it with a hammer strongly.



(4) For taper roller bearing at propeller shaft

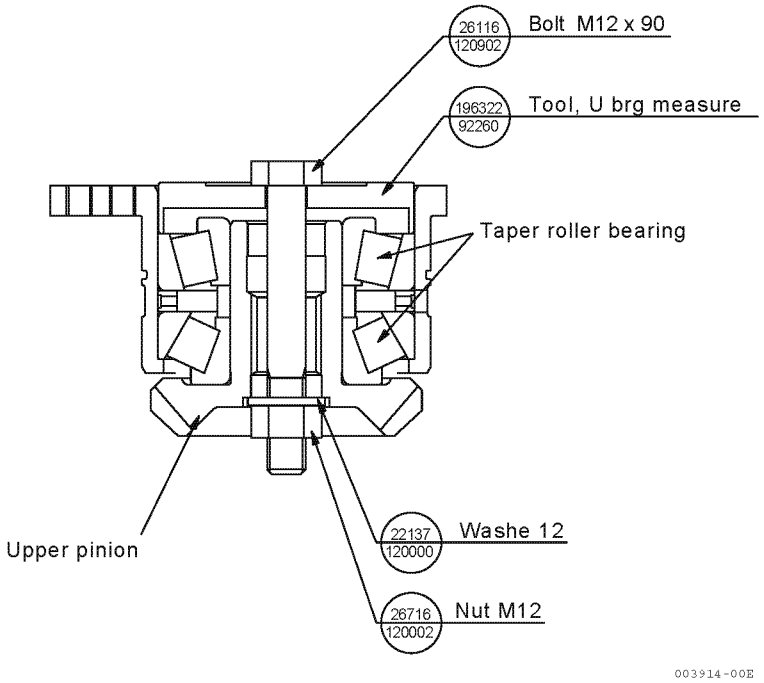
Use when reassembling the taper roller bearing at the propeller shaft.

Press it as striking it with a hammer strongly.

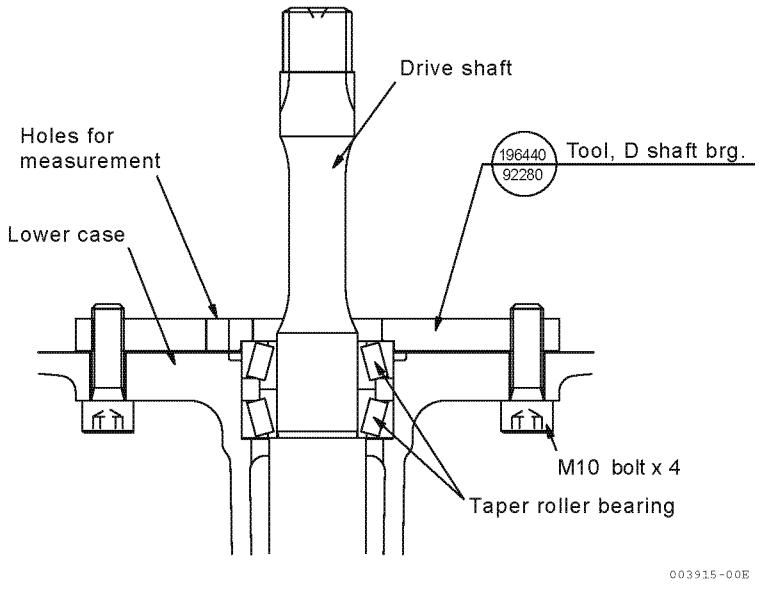


Tools for measuring dimensions

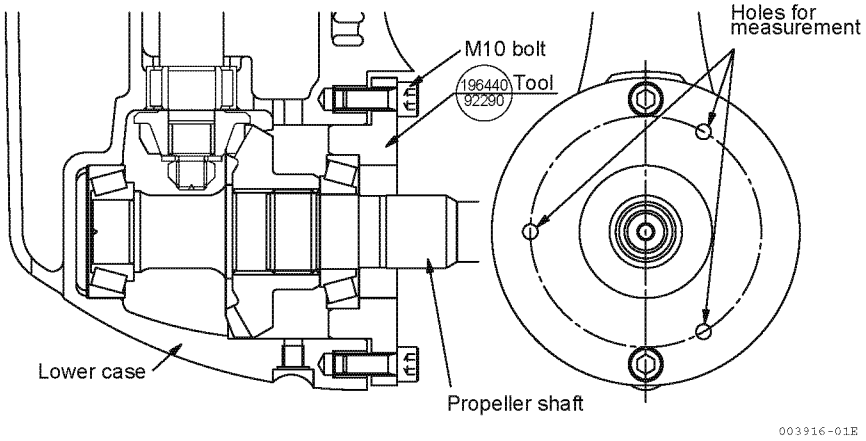
(1) For taper roller bearing at pinion shaft
Use when measuring the dimension of L_4(Refer to 5.2.1(1)).



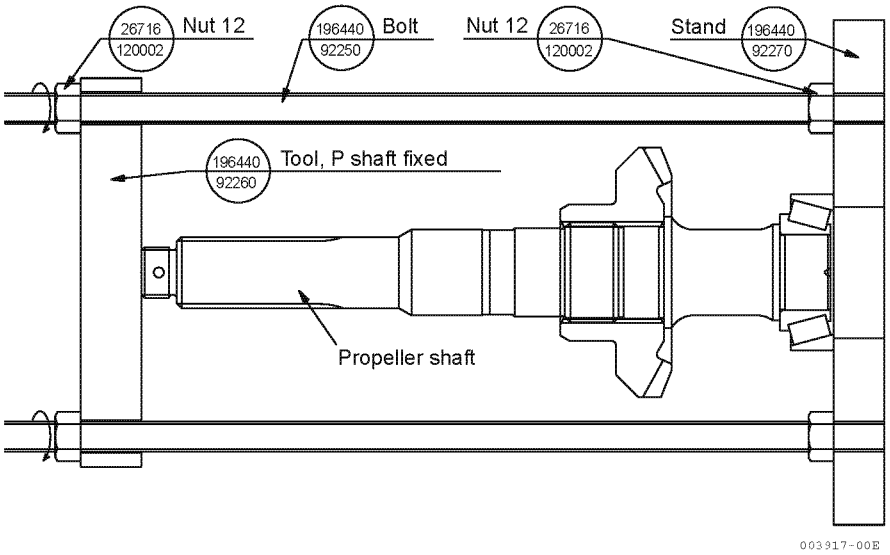
(2) For taper roller bearing at drive shaft
Use when measuring the dimension of M_2(Refer to 5.3.1(1)).



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



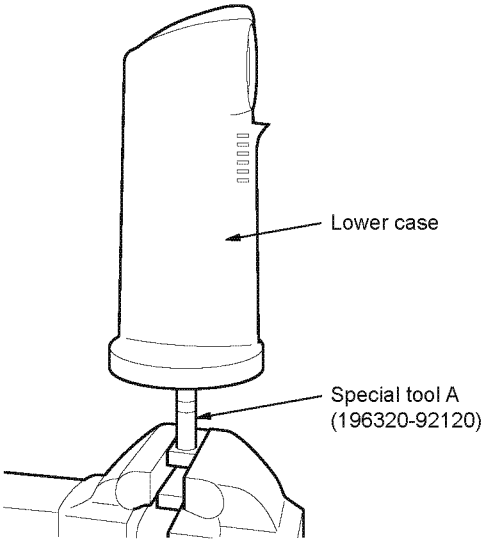
(4) For bevel gear on propeller shaft
Use when measuring the dimension of M3(Refer to 4.6.1).



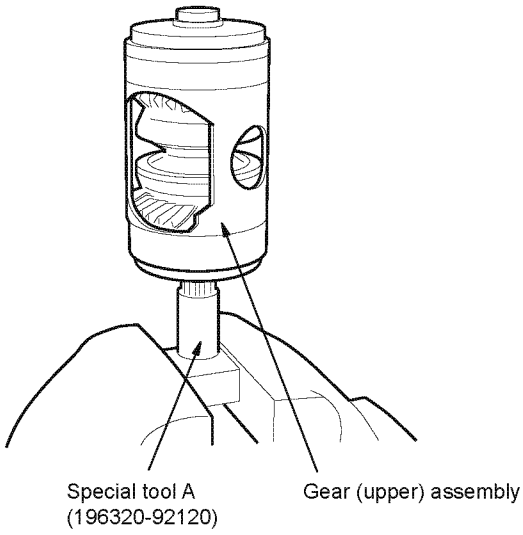
Disassembly tools

(1) Special tool A

1) Use when removing the drive pinion end nut.

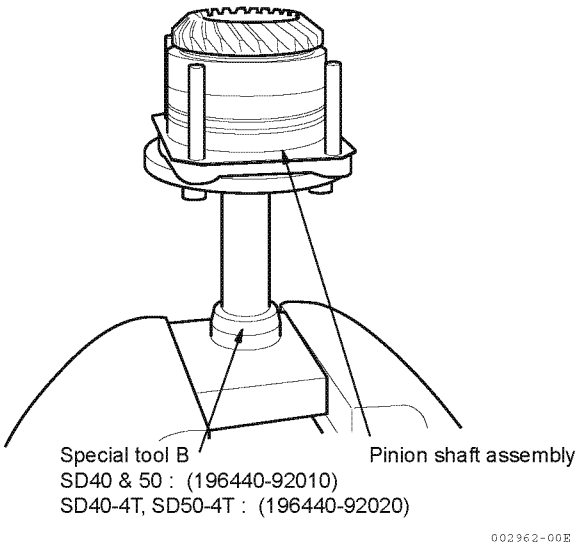


2) Use when disassembling the gear (upper) assembly.



(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.

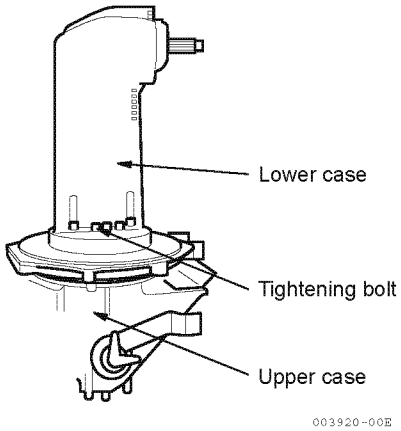
2 Disassembly

2.1 Disassembling the upper case

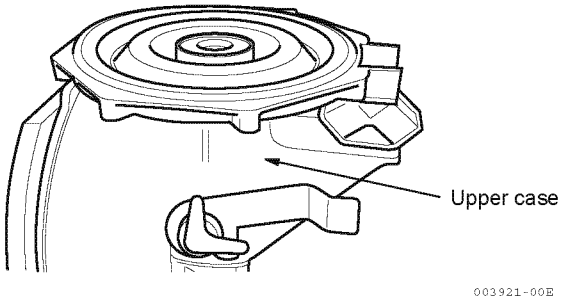
2.1.1 Removal of the unit

(1) Separation from the lower case

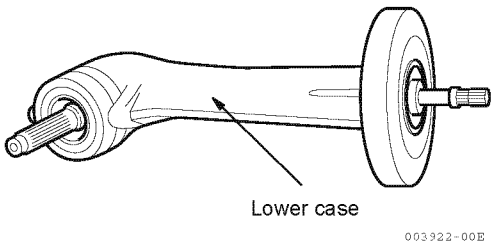
1) Remove the tightening bolts (M10) from the lower case.



2) Upper case separated from lower case.

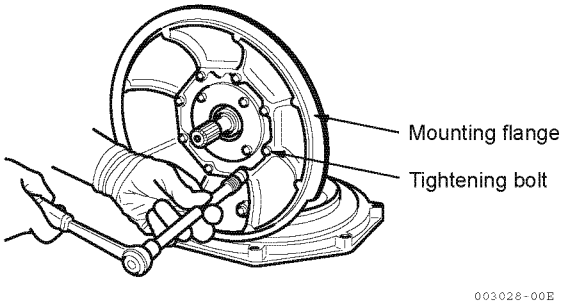


3) Lower case separated from upper case.

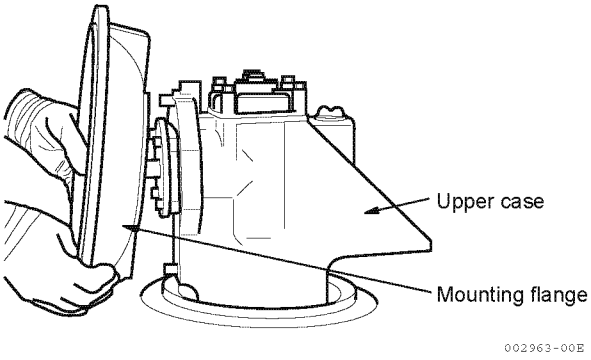


(2) Removal of the mounting flange

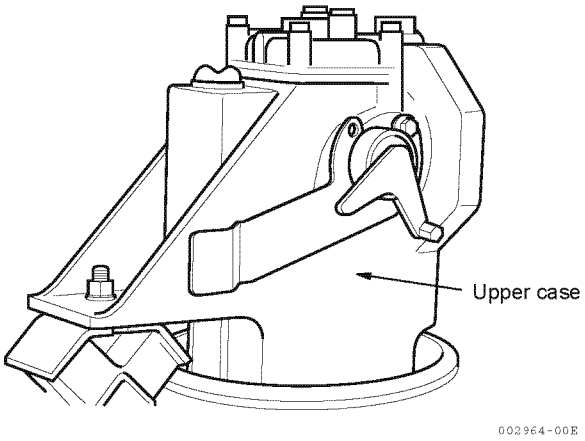
1) Remove the tightening bolts (M8) from the mounting flange and the upper case.



2) Removal of mounting flange.

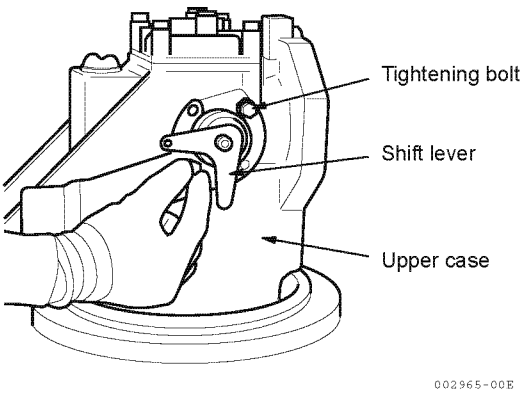


3) Upper case removed from mounting flange.

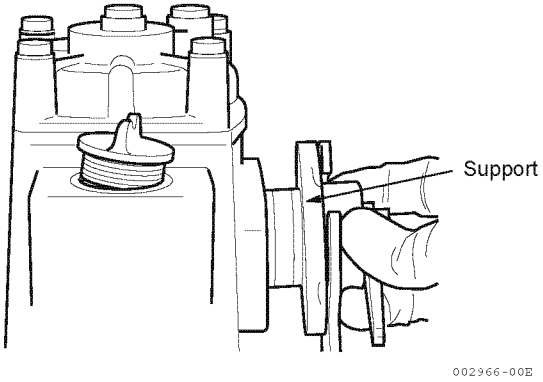


(3) Removal of the Shift Lever and Support

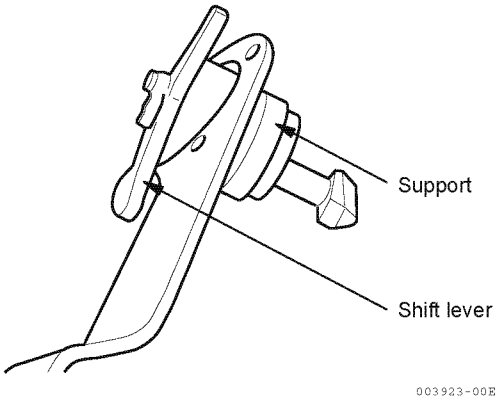
1) Remove the support tightening bolt (M8).



2) Remove the support.

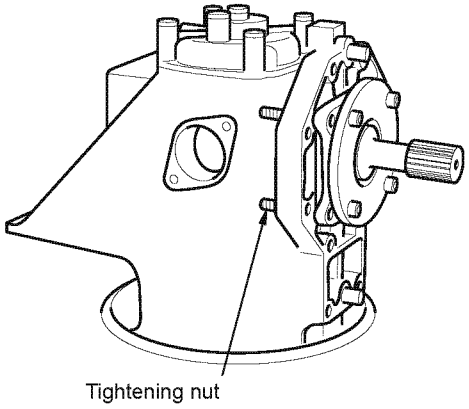


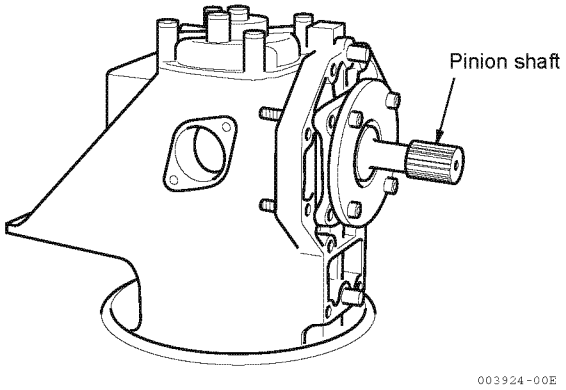
3) Shift lever assembly after removal.



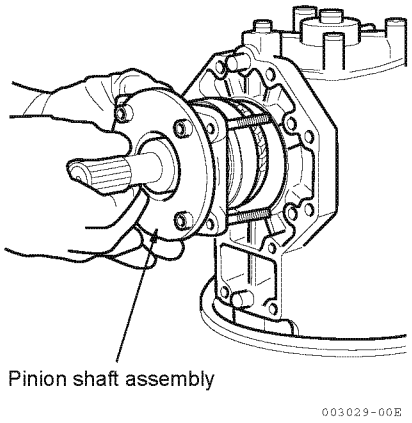
(4) Removal of the pinion shaft assembly

1) Remove the pinion shaft assembly nuts.

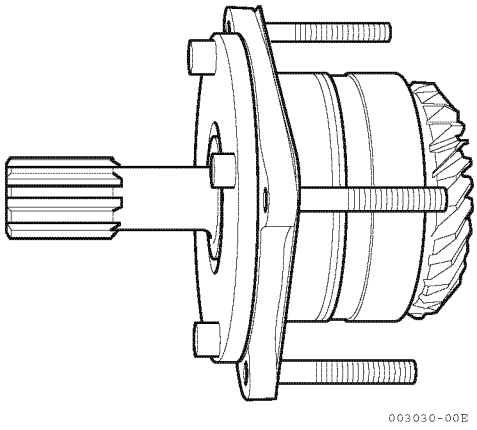




2) Remove the pinion shaft assembly from the upper case.

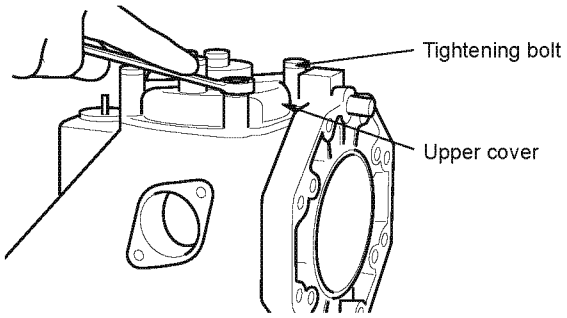


3) Pinion shaft assembly after removal.



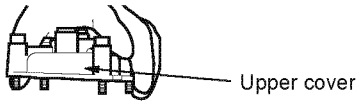
(5) Removal of the gear (upper) assembly

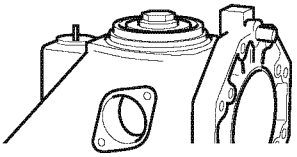
1) Remove the upper cover tightening bolts (M8).



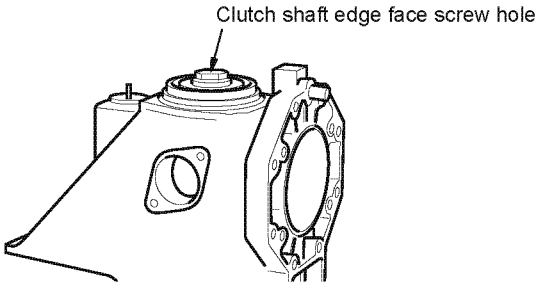
003031-00E

2) Remove the upper cover.



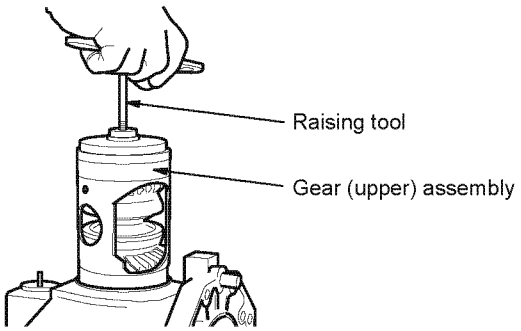


003032-00E



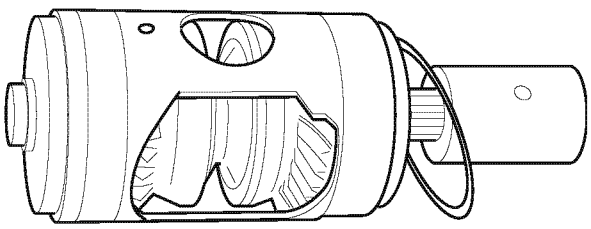
003033-00E

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



003034-00E

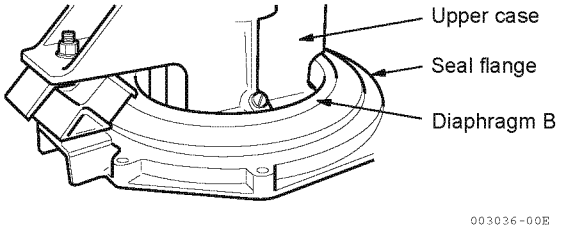
4) Gear (upper) assembly after removal.



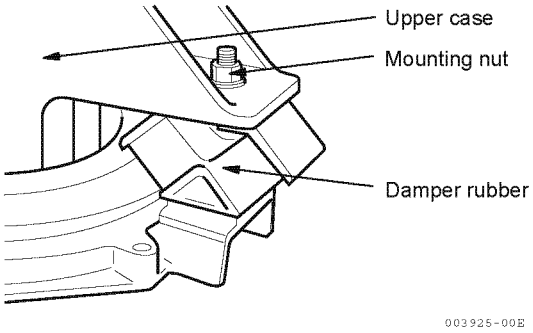
003035-00X

(6) Removal of the diaphragm

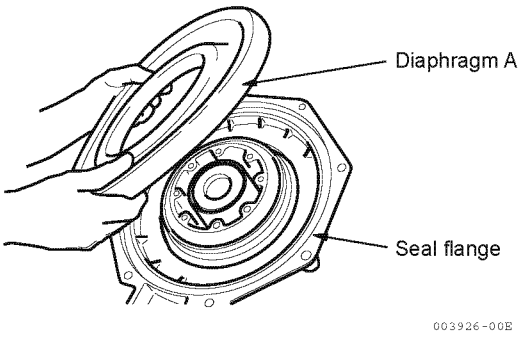
• Diaphragm A



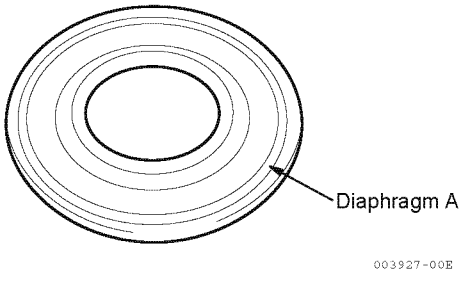
1) Remove the damper rubber mounting nut (M12) from the upper case.



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

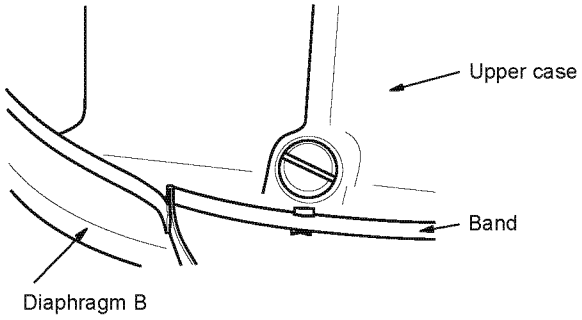


3) Diaphragm A after removal.

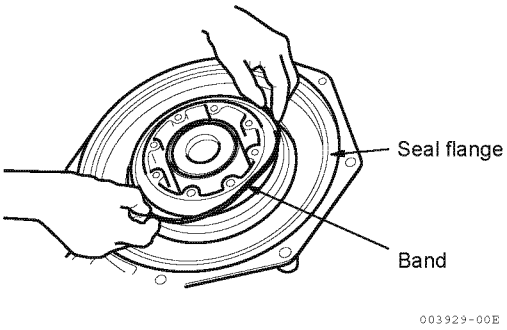


• Diaphragm B

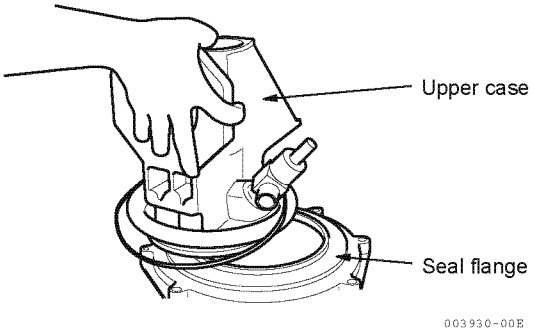
1) Remove the upper case bend.



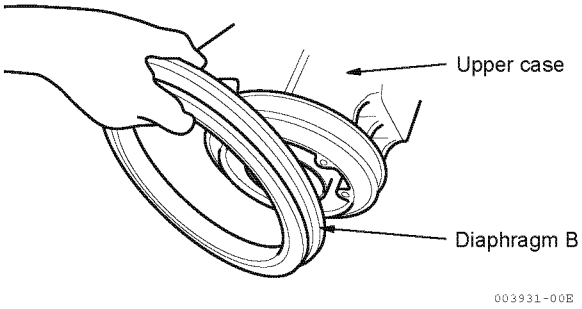
2) Remove the seal flange band.



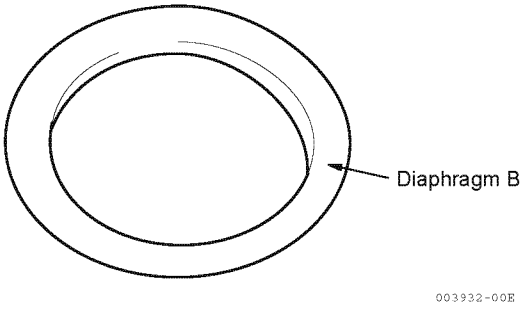
3) Remove the upper case and the seal flange.



4) Remove the diaphragm B from the upper case.



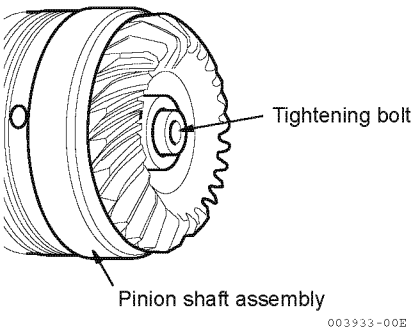
5) Diaphragm B after removal.



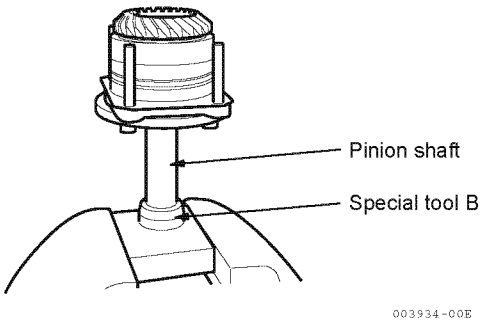
2.1.2 Disassembling the unit

(1) Disassembling the pinion shaft assembly

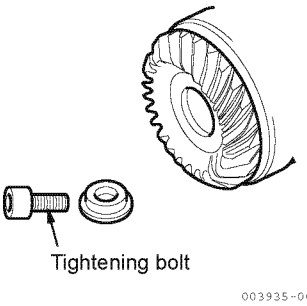
1) Remove the tightening bolt (M10) for pinion gear and the pinion shaft assembly to disassemble.



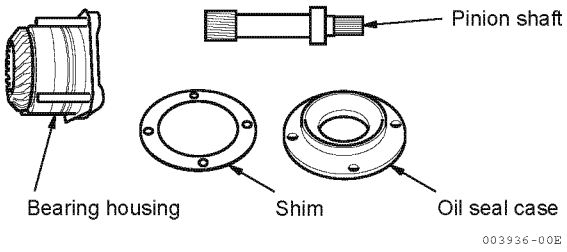
2) Insert the pinion shaft to the fixed special tool B (for stopping gear movement).



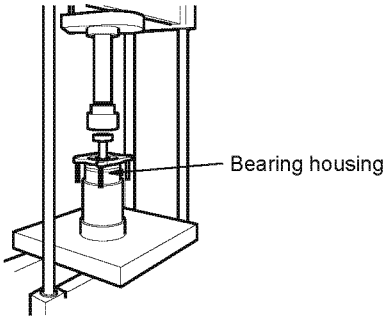
3) Remove the tightening bolt (M10).



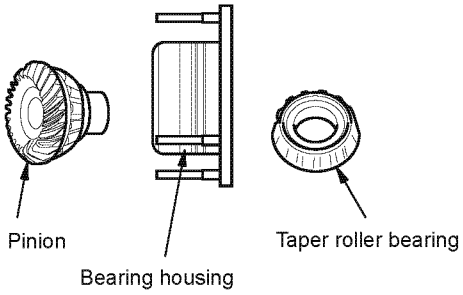
4) Pinion shaft assembly after removal.



5) Push out the pinion by using the press to separate the pinion from bearing housing.

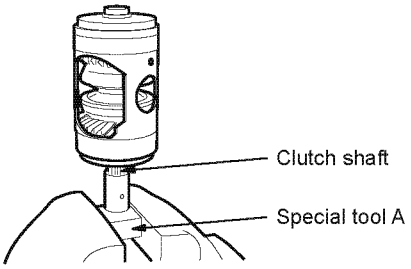


6) Pinion and taper roller bearing separated from bearing housing.

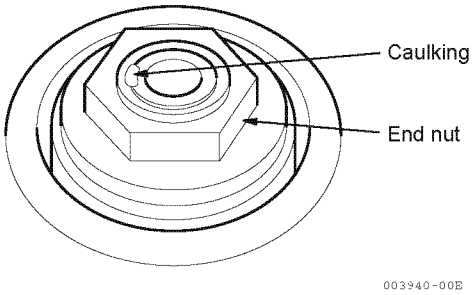


(2) Disassembling the gear (upper) assembly

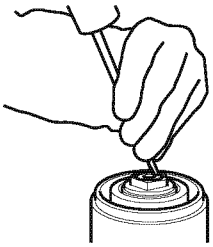
1) Insert the clutch shaft to the fixed special tool A (for stopping gear movement)



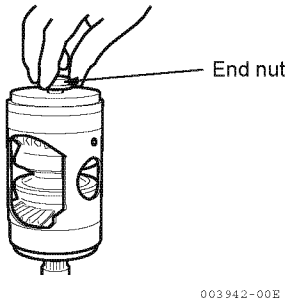
2) The edge of the clutch shaft end nut (M16 x 1.5 left-hand screw) is caulked to the clutch shaft.



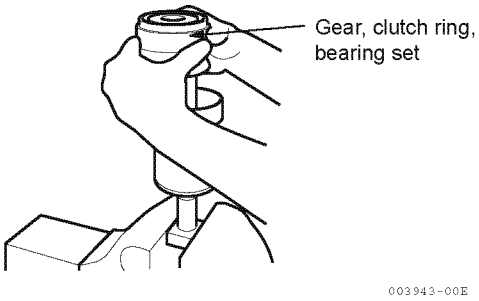
3) Lift up the caulking.



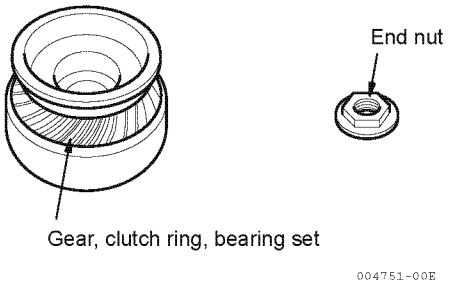
4) Remove the end nut.

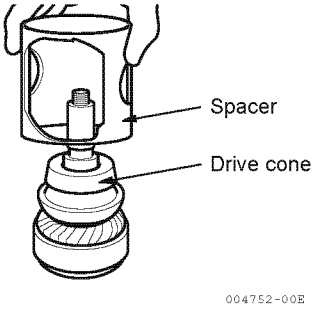


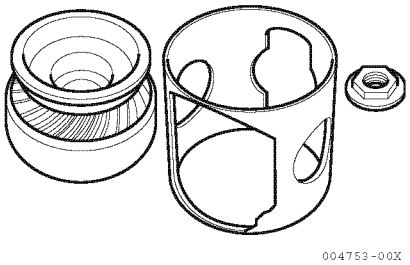
5) Pull out the gear, clutch ring and bearing as a unit.



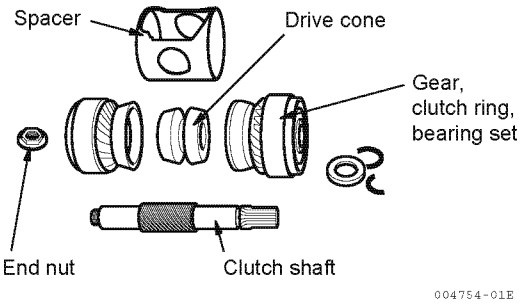
6) Gear, clutch ring and bearing as a unit after removal.



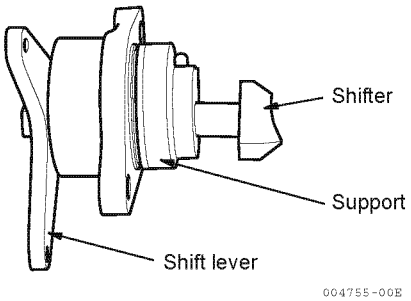


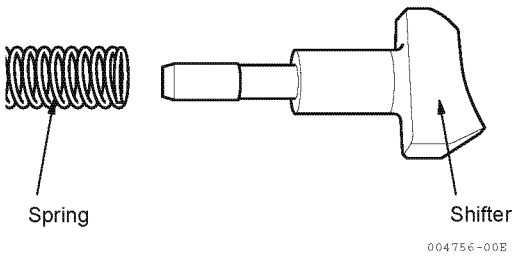


7) Gear (upper) assembly after disassembly.

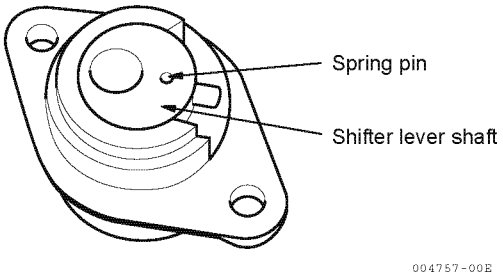


(3) Disassembling the shift lever assembly

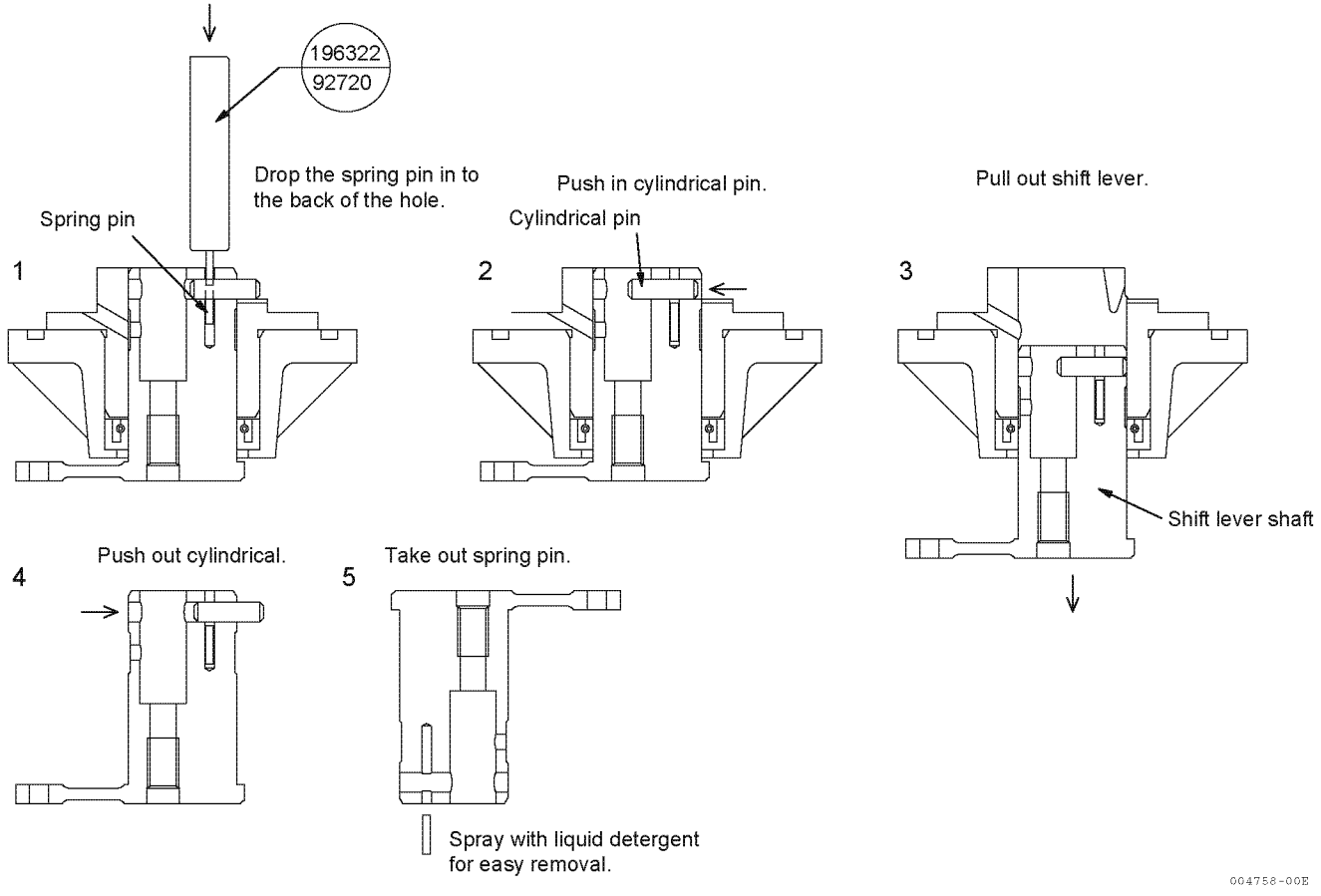




1) Disassemble in the order shown in the illustrations below.



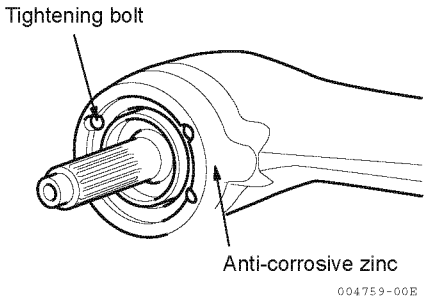
Disassemble in the order 1 - 5.



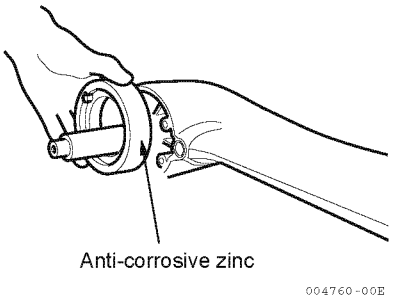
2.2 Disassembling the lower case

2.2.1 Removal of unit

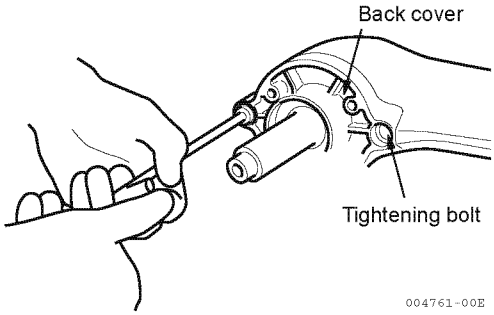
(1) Removal of anti-corrosive zinc



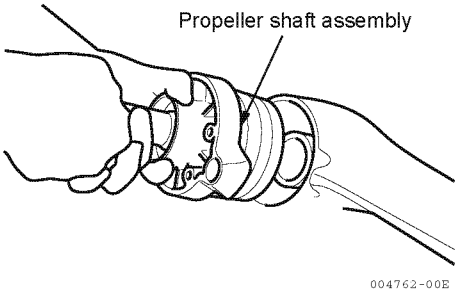
1) Remove the tightening bolts (M6) and take off anti-corrosive zinc.



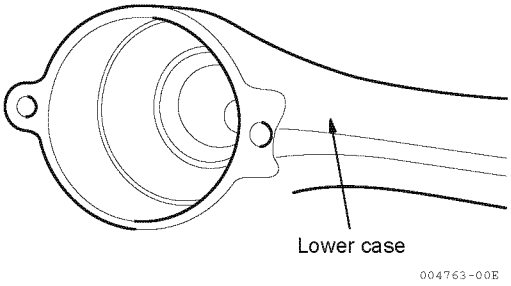
(2) Removal of the propeller shaft assembly



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

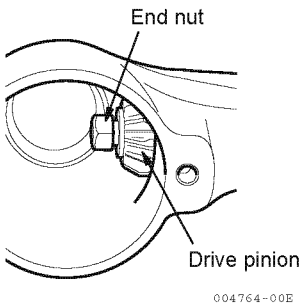


2) Lower case removed from propeller shaft assembly.

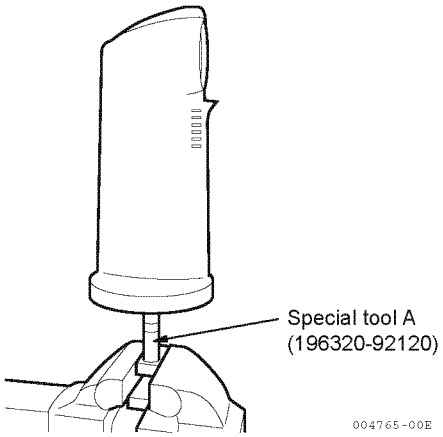


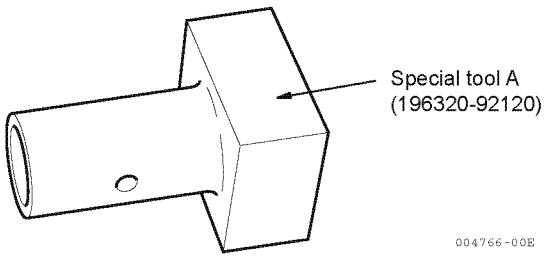
(3) Removal of the drive pinion end nut

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

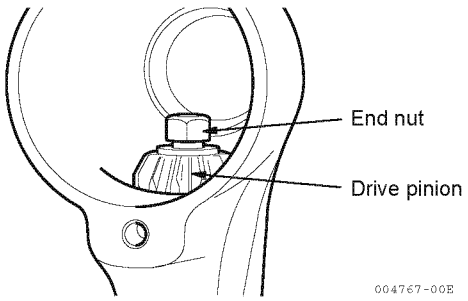


2) Insert the drive shaft to the fixed special tool A (for stopping the gear).
Loosen the end nut (M14).



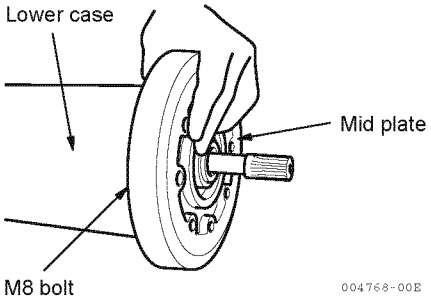


3) Remove the end nut (M14).



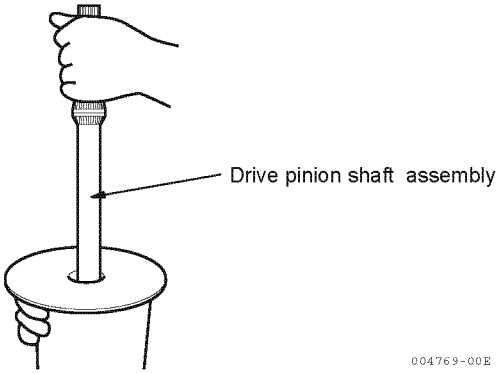
(4) Removal of the mid plate

1) Remove the two M8 bolts.
Remove the mid plate.



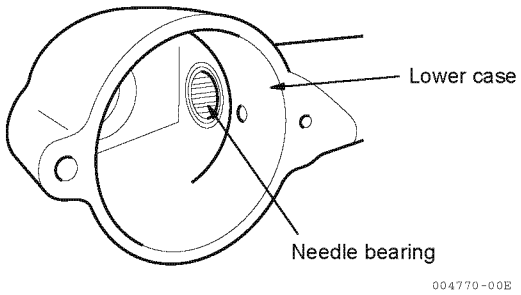
(5) Removal of the drive pinion shaft assembly

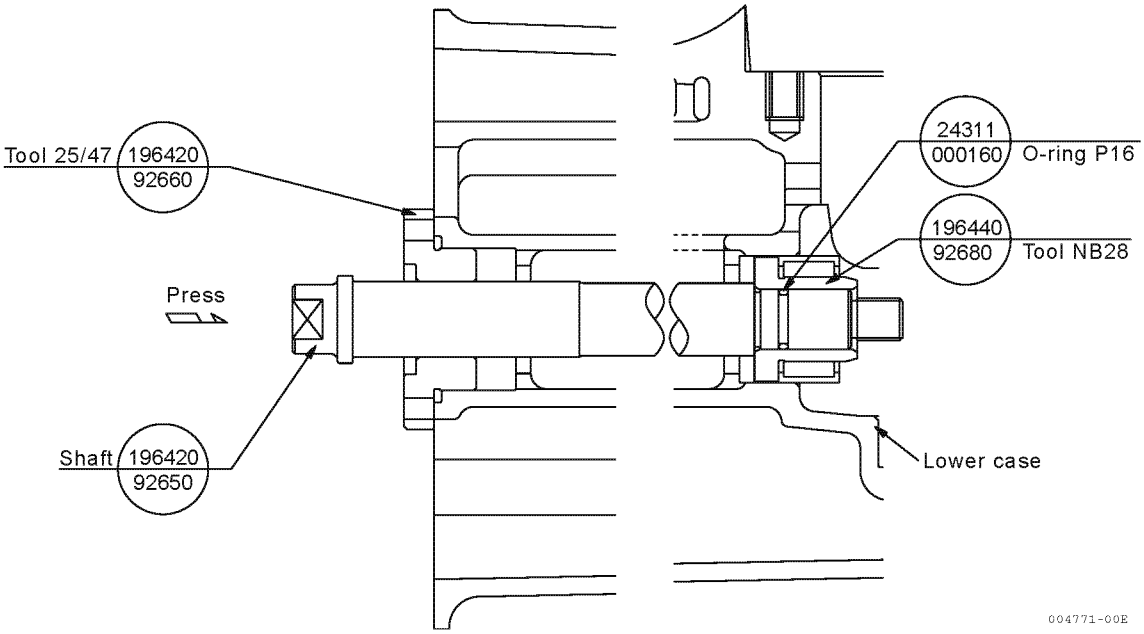
1) Remove the drive pinion shaft assembly.



(6) Removal of the needle bearing

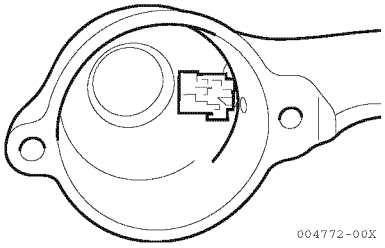
1) Remove the needle bearing with the tool shown in the illustration below.

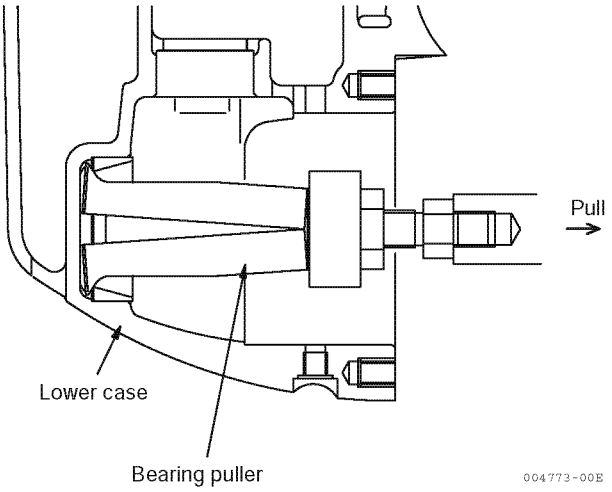




(7) Removal of the taper roller bearing outer race

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





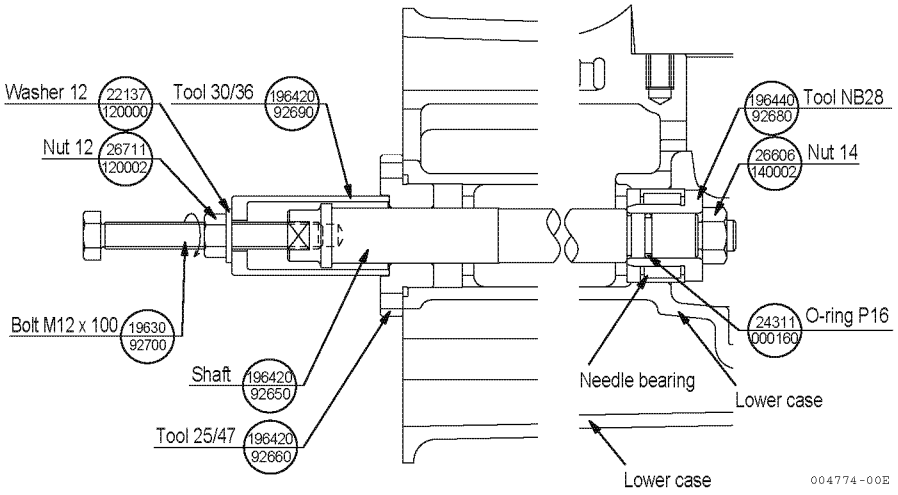
3 Reassembly

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

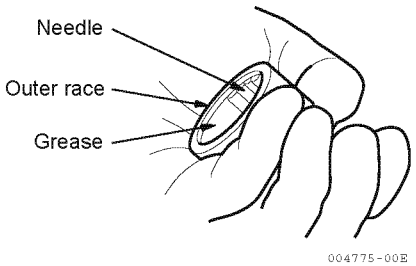
3.1 Reassembling the bearing for lower case

3.1.1 Needle bearing

1) Reattach the needle bearing using the special tool.

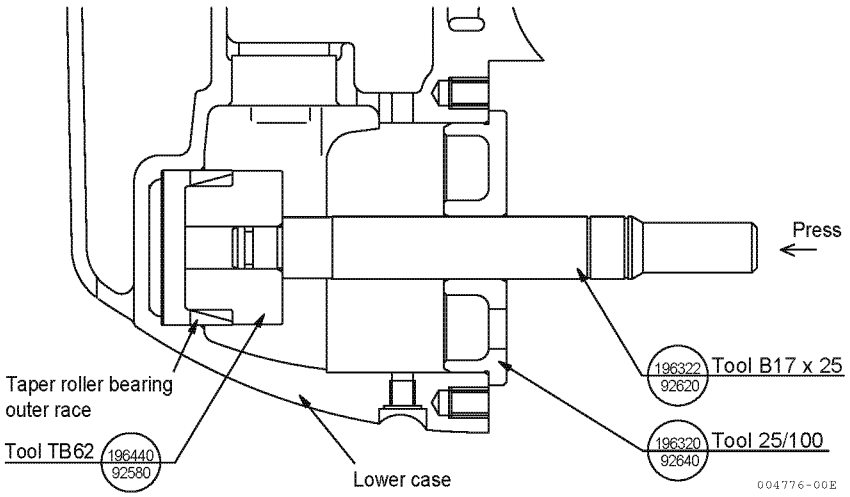


2) Fix the needle to the outer race with grease.



3.1.2 Taper roller bearing outer race

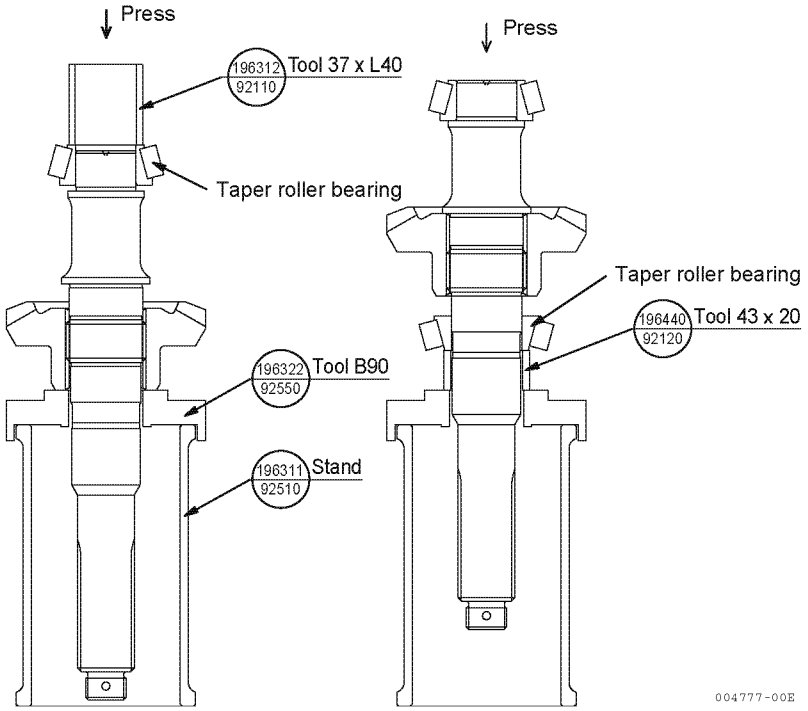
1) Reattach using the special tool.



3.2 Reassembling the bearings of shaft

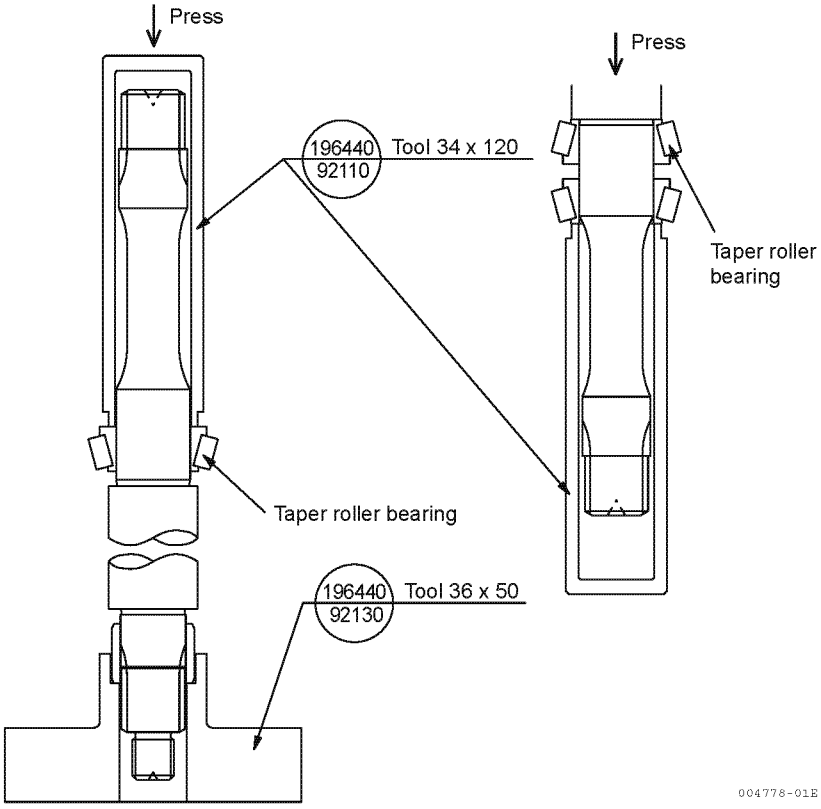
3.2.1 Propeller shaft

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



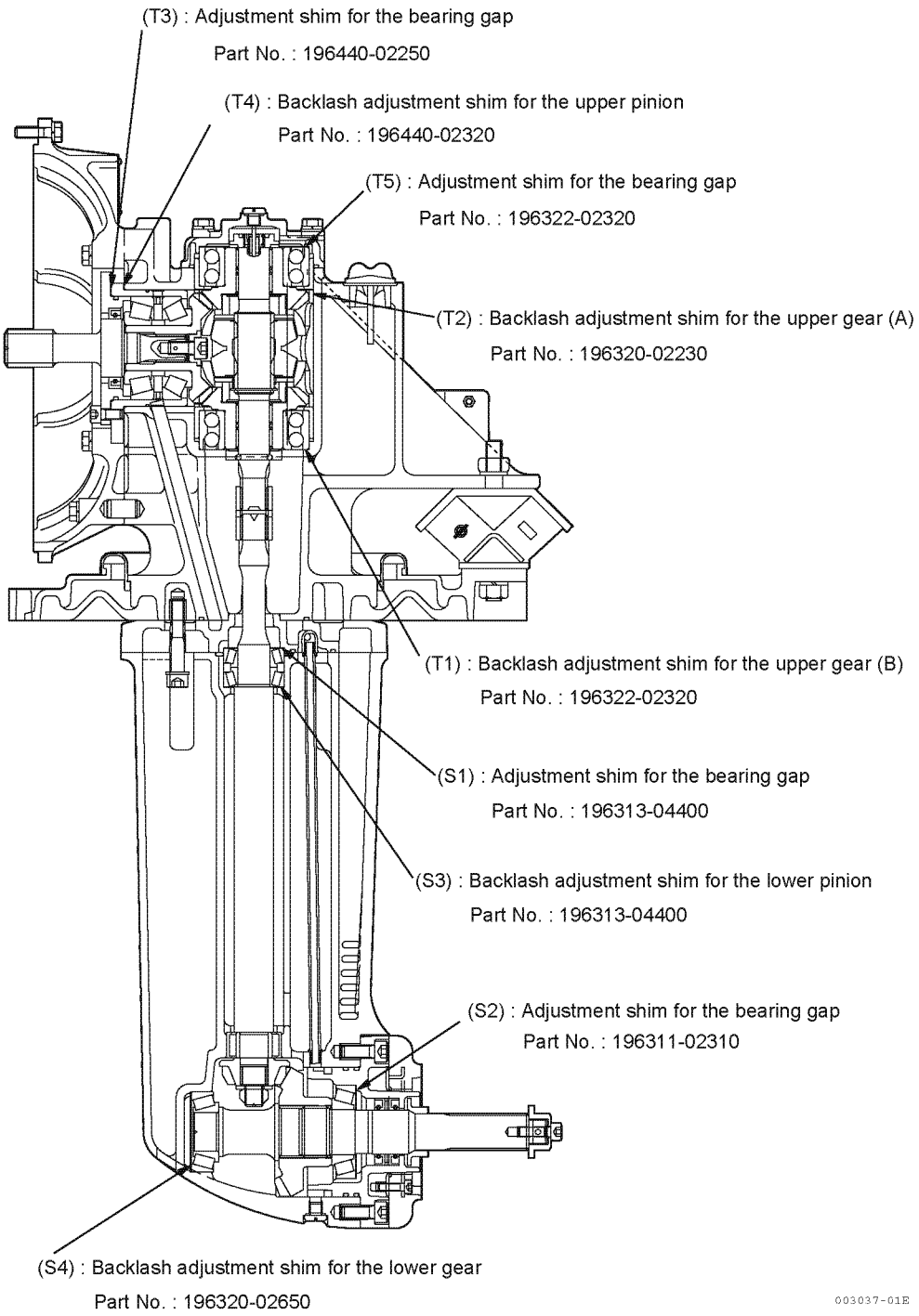
3.2.2 Drive shaft

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



4 Shim adjustment (Gear backlash adjustment)

4.1 Location of adjustment shims



4.2 Measurement of the dimensions of the cases

4.2.1 Upper case

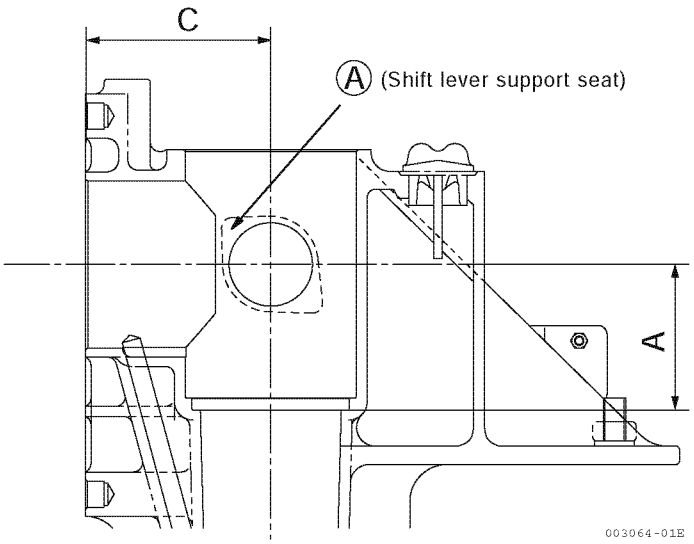
mm

	Standard value
A	78.5
C	100

The actual dimension A is engraved on the part Ⓐ.

Example " A - 3 "

That shows
A = 78.5 - 0.03 = 78.47



4.2.2 Lower case

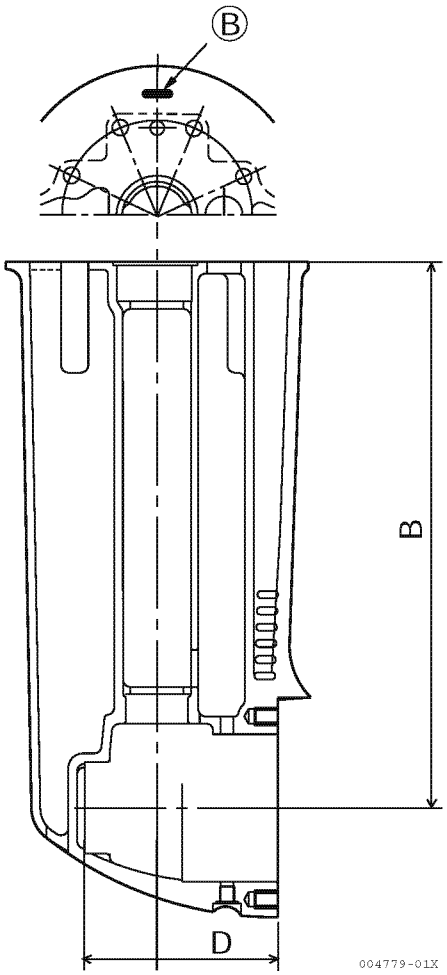
mm

	Standard value
D	49
B	343

The actual dimension B is engraved on the part Ⓑ.

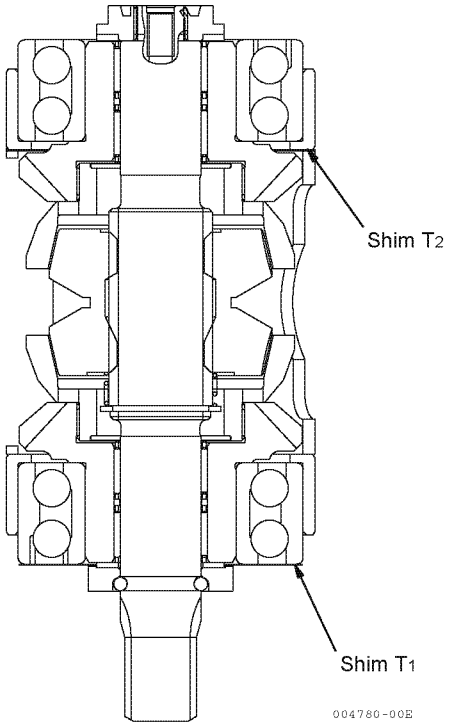
Example " B - 3 "

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.

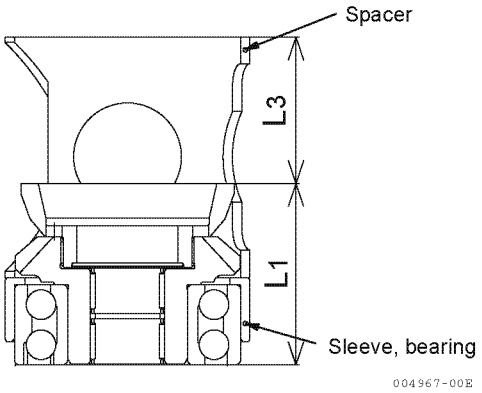


4.3.1 Measurement of the dimensions (L_1, L_2, L_3) of the gear

(1) Under gear (B)

mm

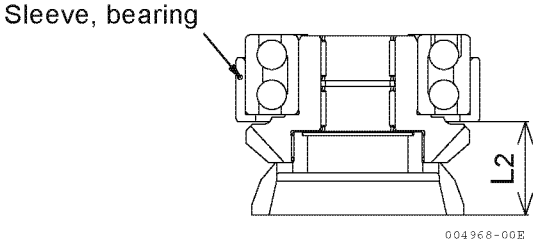
	Standard value
L_1	68.2
L_3	55.0



(2) Upper gear (A)

mm

	Standard value
L_2	35.5



4.3.2 Calculation of the shim thickness

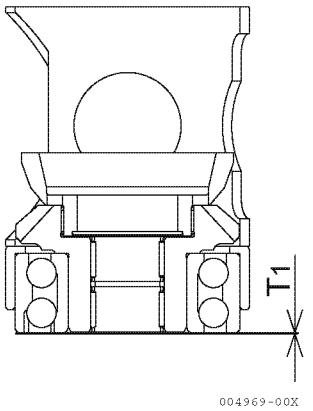
(1) Under gear (B)

Formula
$T_1=(A-L_1-10)$

mm

	Standard value
A	See 4.2.1
L_1	See 4.3.1(1)
T_1	0.3

Make the thickness for the shim
T_1-0.025~T_1+0.025.



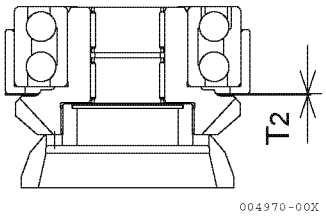
(2) Upper gear (A)

Formula
$T_2=(L_2+20-L_3)$

mm

	Standard value
L_2	See 4.3.1(2)
L_3	See 4.3.1(1)
T_2	0.5

Make the thickness for the shim
T_2-0.025~T_2+0.025.

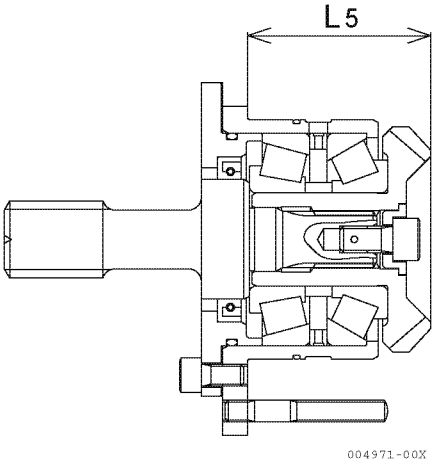


4.4 Shim selection method for the pinion shaft

4.4.1 Measurement of the pinion dimensions

mm

	Standard value
L_5	68.58



4.4.2 Calculation of the shim thickness

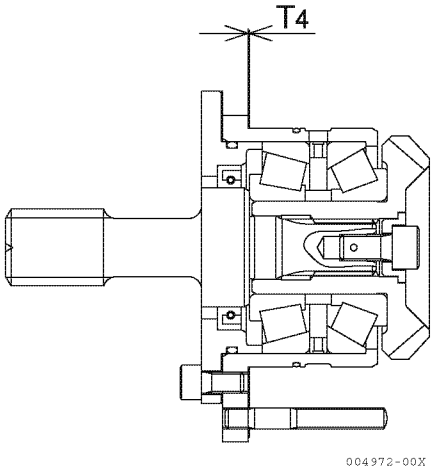
Formula

$T_4=(L_5+32-C)$

mm

	Standard value
L_5	See 4.4.1
B	See 4.2.2
T_4	0.6

Make the thickness for the shim T_4-0.025~T_4+0.025.

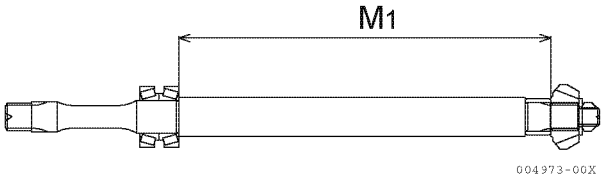


4.5 Shim selection method for the drive shaft

4.5.1 Measurement of the dimensions (M_1) of the pinion

mm

	Standard value
M_1	286.5



4.5.2 Calculation of the shim thickness

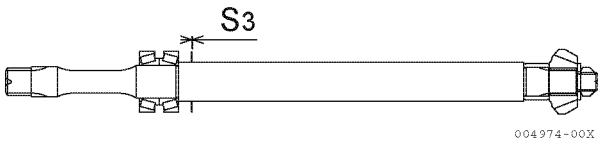
Formula

$S_3=(M_1+57-B)$

mm

	Standard value
M_1	See 4.5.1
B	See 4.2.2
S_3	0.5

Make the thickness for the shim S_3-0.025~S_3+0.025.

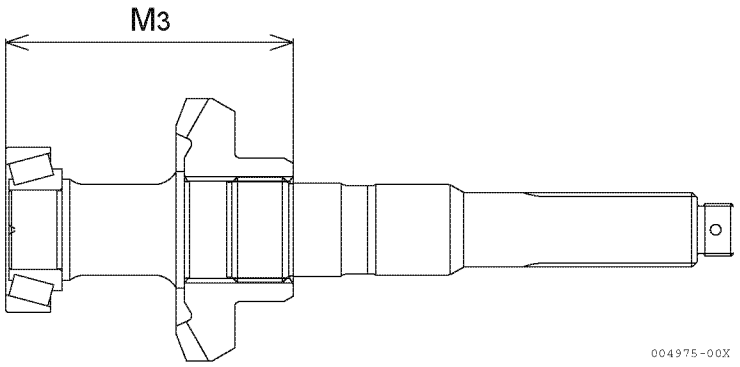


4.6 Shim selection method for the propeller shaft

4.6.1 Measurement of the dimensions (M3) of the gear

mm

	Standard value
M3	108.25



4.6.2 Calculation of the shim thickness

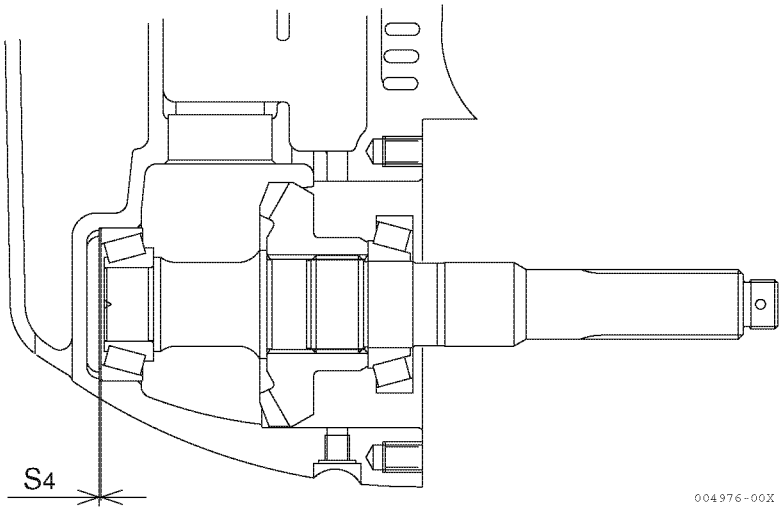
Formula

$S_4=(D+60-M_3)$

mm

	Standard value
D	See 4.2.2
M3	See 4.6.1
S4	0.75

Make the thickness for the shim $S_4-0.025 \sim S_4+0.025$.



5 Adjustment of bearing assembly gap

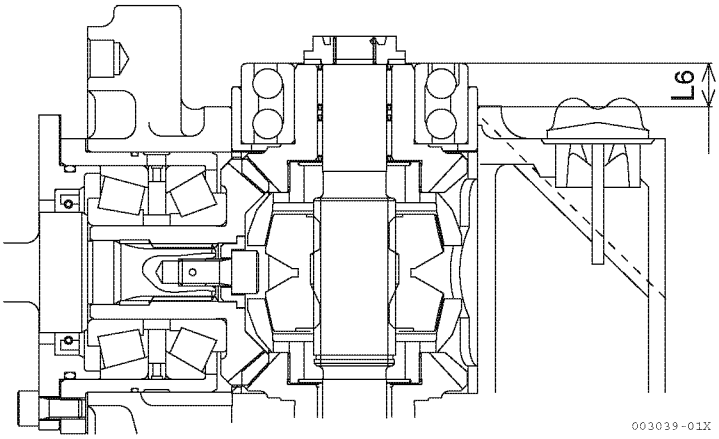
5.1 Upper gear bearing

5.1.1 Measurement of the dimension (L_6) of the bearing

(1) Measurement of bearing lug

mm

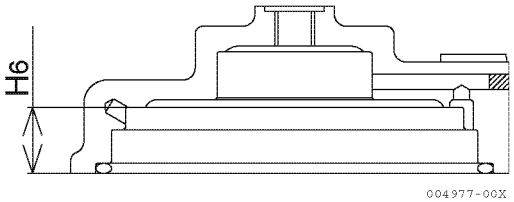
	Standard value
L_6	16.2



(2) Measurement of bearing case

mm

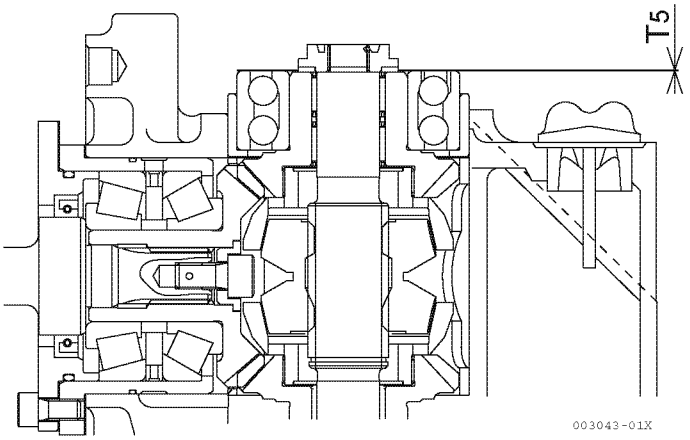
	Standard value
H_6	16.5



5.1.2 Calculation of the shim thickness

mm

	Standard value
T_5	0.30



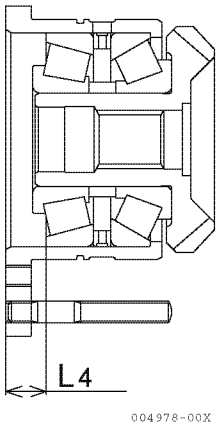
5.2 Pinion shaft bearing

5.2.1 Measurement of the dimension (L4) of the bearing

(1) Measurement of the bearing position

mm

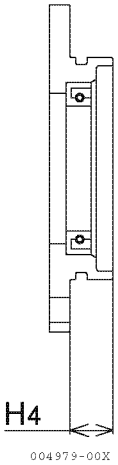
	Standard value
L4	15.0



(2) Measurement of oil seal case

mm

	Standard value
H4	15.5



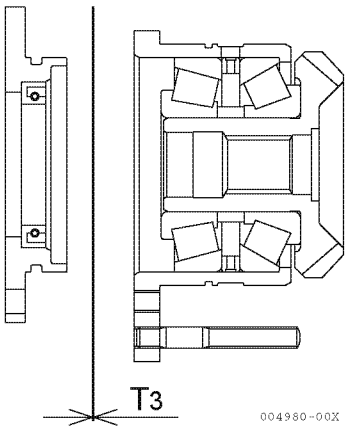
5.2.2 Calculation of the shim thickness

Formula
T3=(H4-L4)

mm

	Standard value
H4	See 5.2.1(2)
L4	See 5.2.1(1)
T3	0.5

Make the thickness for the shim T3-0.1~T3.



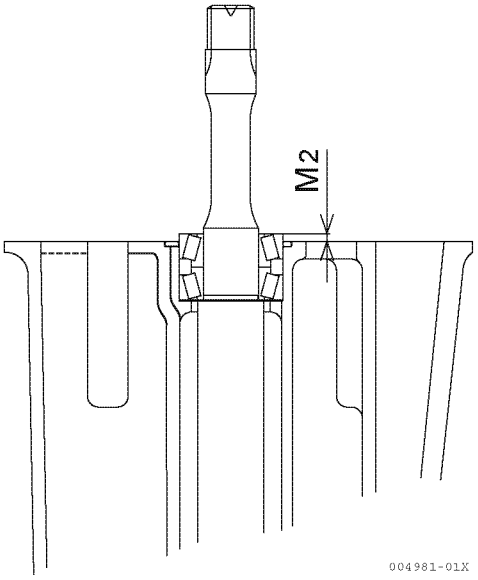
5.3 Pinion drive shaft bearing

5.3.1 Measurement of the dimension (M_2) of the bearing

(1) Measurement of the bearing position

mm

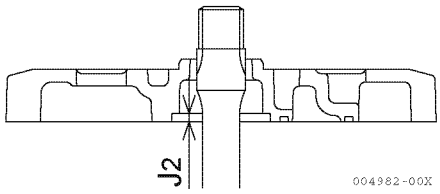
	Standard value
M_2	3.50



(2) Measurement of middle plate

mm

	Standard value
J_2	4.0



5.3.2 Calculation of the shim thickness

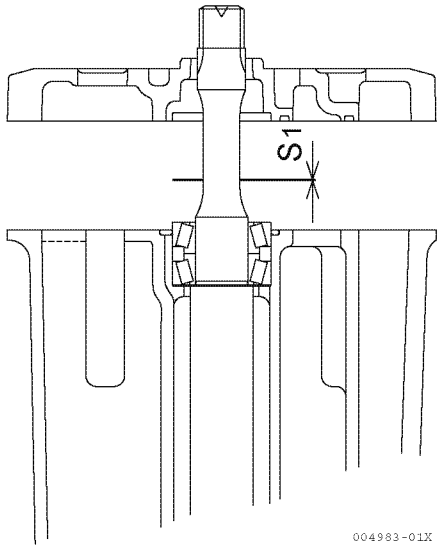
Formula

$S_1=(J_2-M_2)$

mm

	Standard value
J_2	See 5.3.1(2)
M_2	See 5.3.1(1)
S_1	0.5

Make the thickness for the shim S_1-0.075~S_1-0.025.



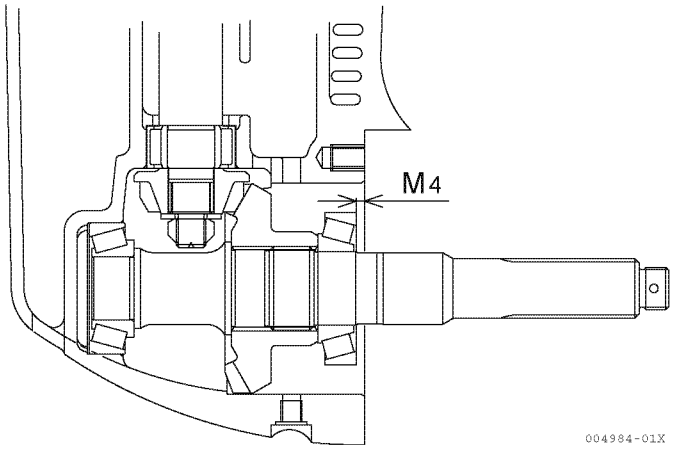
5.4 Propeller shaft bearing

5.4.1 Measurement of the dimension (M4) of the bearing

(1) Measurement of the bearing position

mm

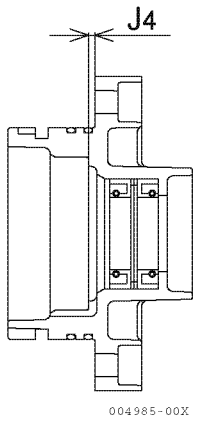
	Standard value
M4	3.75



(2) Measurement of bearing case

mm

	Standard value
J4	3.0



5.4.2 Calculation of the shim thickness

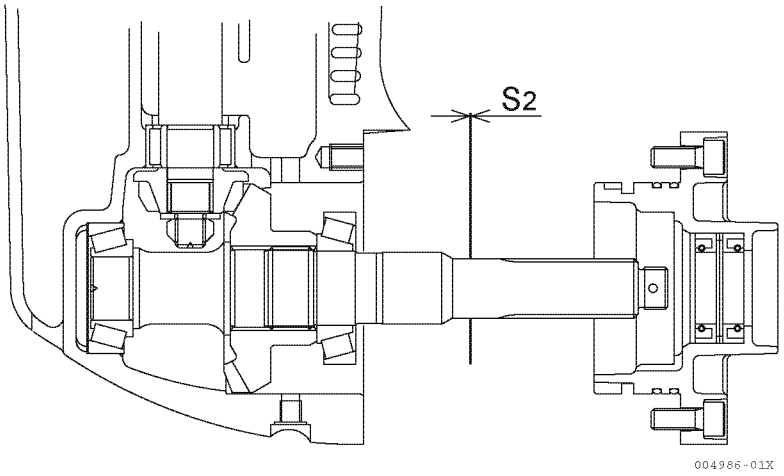
Formula

$S_2=(M_4-J_4)$

mm

	Standard value
M4	See 5.4.1(1)
J4	See 5.4.1(2)
S2	0.75

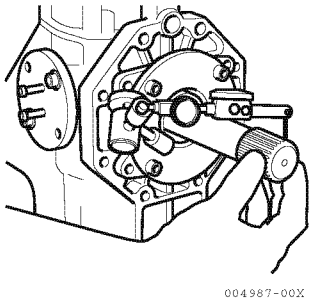
Make the thickness for the shim S_2-0.075~S_2-0.025.



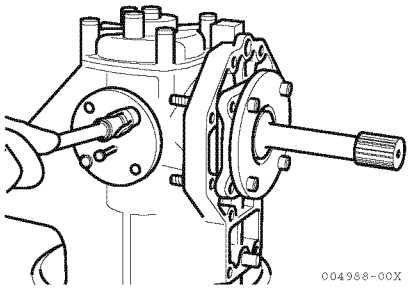
6 Adjustment of the gear backlash

6.1 Upper gear

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



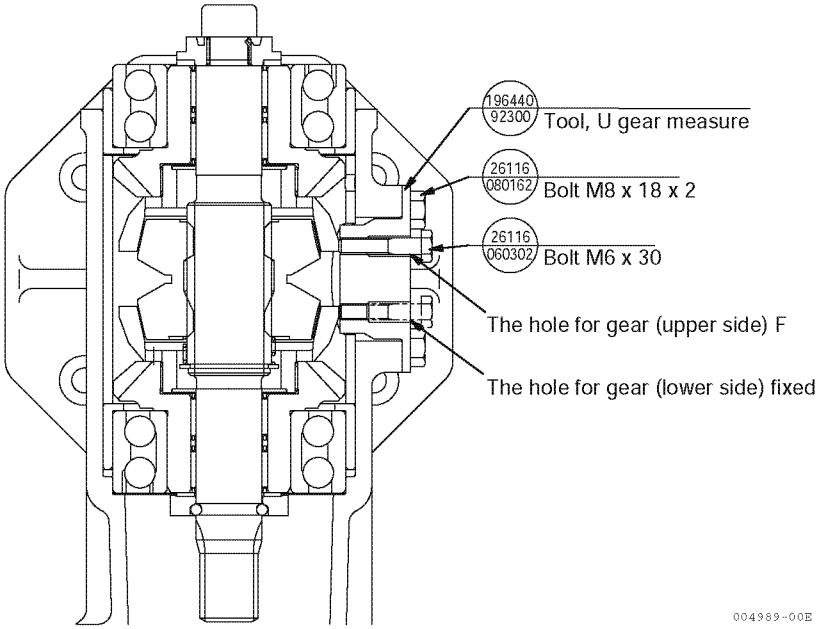
2) Use special tool (Part No. 196440-92300)
Stop the moving of the gear one and another by the bolt.
(Part No. 26116-060302)



Reading of backlash mm

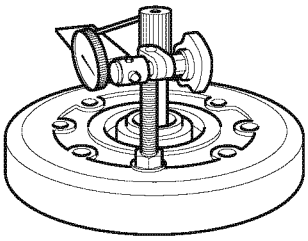
Dial gauge reading	Conversion value at gear
0.031~0.062	0.10~0.20

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.



Reading of backlash mm

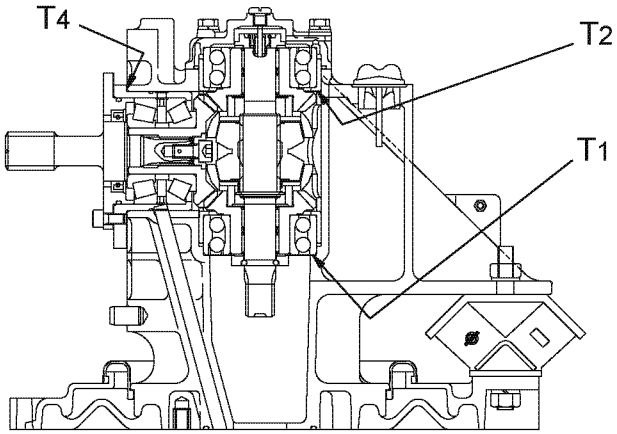
Dial gauge reading	Conversion value at gear
0.056~0.113	0.14~0.28

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

7 Adjustment of the gear dye pattern

7.1 Upper gear

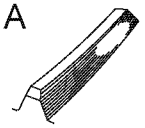
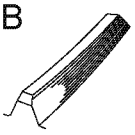
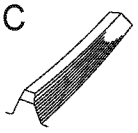
1) After deciding the shim thickness T_1, T_2 and T_4 in accordance with the section 4.2, 4.3 and 4.4 check the dye pattern of the gear faces and then adjust it.



003040-01X

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

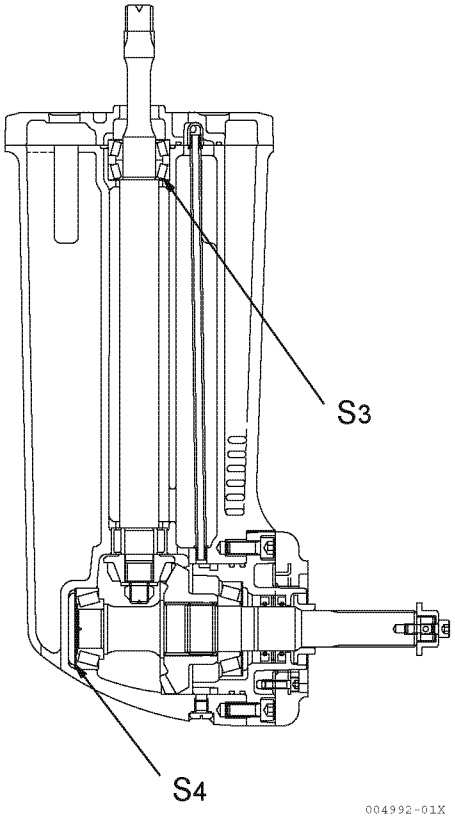
Check pinion dye patern and follow the table below

GEAR, UPPER	
DYE PATTERN	ADJUST
A 	GOOD NO ADJUSTING
B 	INCLEASE THE SHIM THICKNESS "T1" DECLEASE THE SHIM THICKNESS "T2" INCLEASE THE SHIM THICKNESS "T4"
C 	DECLEASE THE SHIM THICKNESS "T1" INCLEASE THE SHIM THICKNESS "T2" DECLEASE THE SHIM THICKNESS "T4"

004991-00E

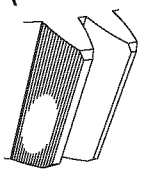
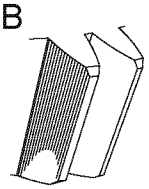
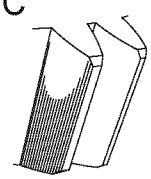
7.2 Propeller shaft

1) After deciding the shim thickness S_3 and S_4 in accordance with the section 4.5 and 4.6 check the dye pattern of the gear faces and then adjust it.



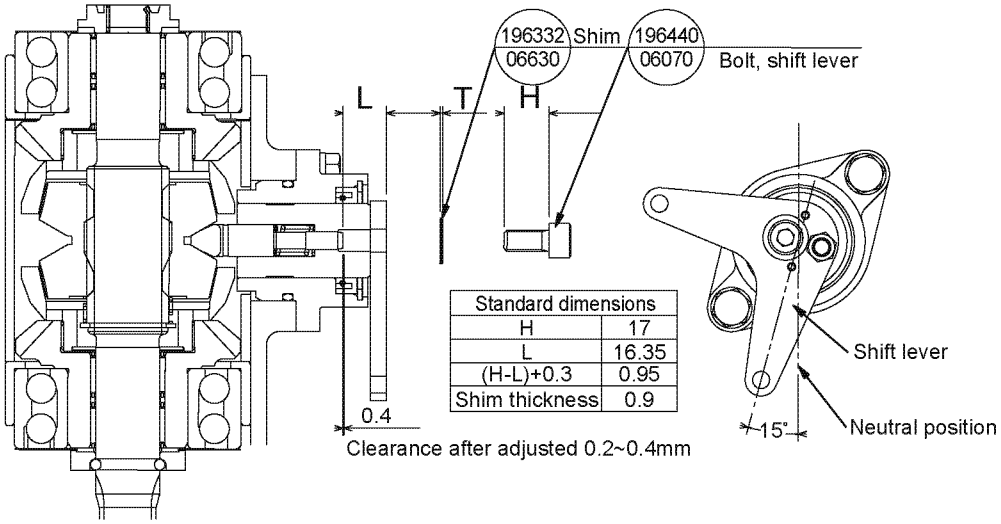
2) After checking the dye pattern, adjust according to the table.

Check pinion dye patern and follow the table below

GEAR, LOWER	
DYE PATTERN	ADJUST
A 	GOOD NO ADJUSTING
B 	DECLEASE THE SHIM THICKNESS "S3" INCLEASE THE SHIM THICKNESS "S4"
C 	INCLEASE THE SHIM THICKNESS "S3" DECLEASE THE SHIM THICKNESS "S4"

004993-00E

8 Adjustment of the shift lever



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

003263-00E

8.1 Measurement of the dimensions (H, A)

8.1.1 Shift Lever bolt

mm

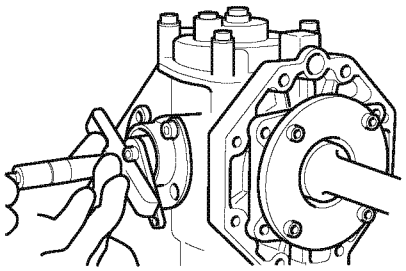
	Standard value
H	17.0

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.

mm

	Standard value
A	16.35



Keep the shift lever 10~15° from neutral position.

004995-00E

8.2 Calculation of the shim thickness

Formula

T = (H - A) +0.3

mm

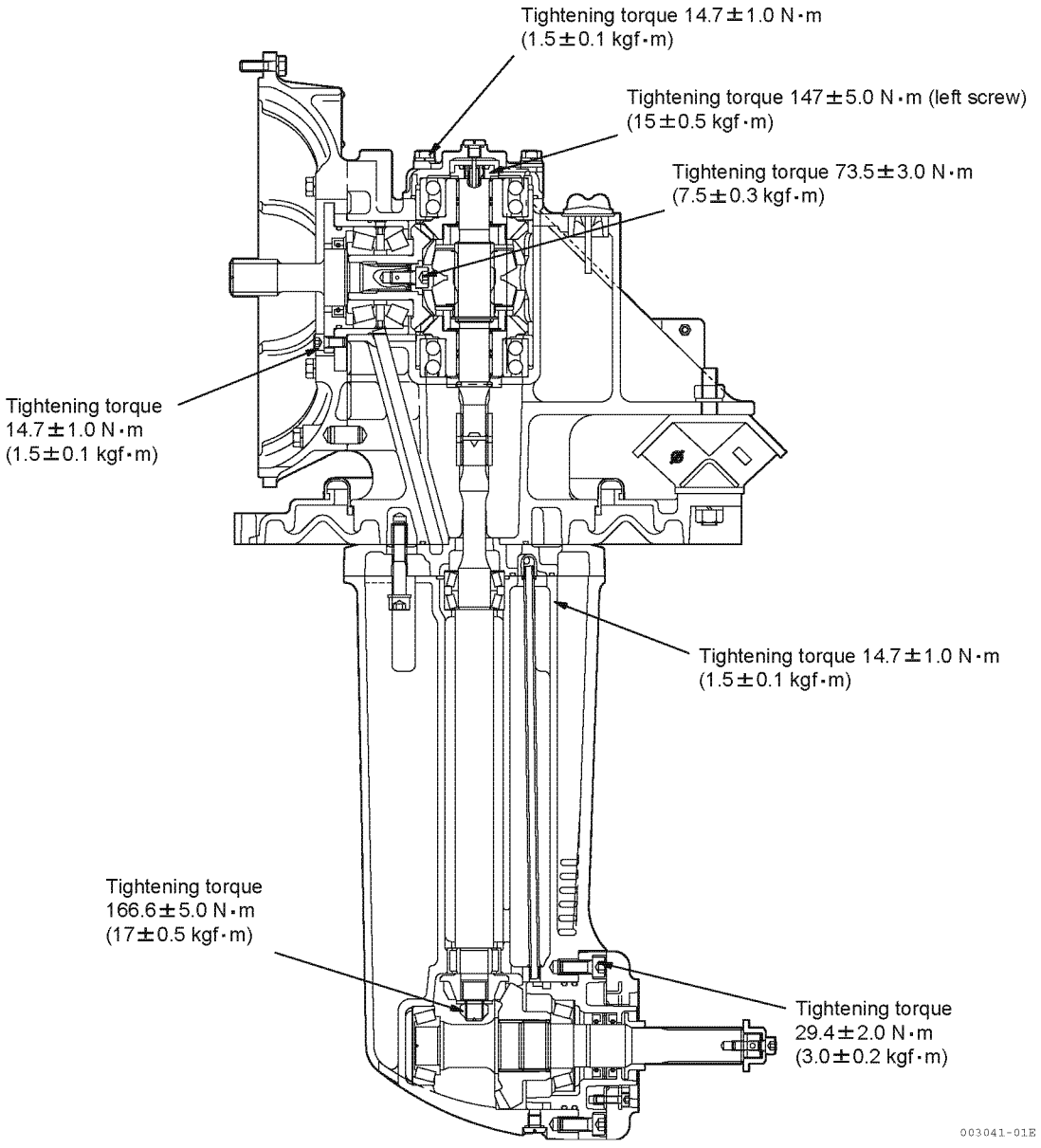
	Standard value
H	See 8.1.1
A	See 8.1.2
T	0.9

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



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HEAD OFFICE

1-32, CHAYAMACHI, KITA-KU, OSAKA 530-8311, JAPAN

YANMAR MARINE INTERNATIONAL B.V.

P.O. BOX 30112,1303AC ALMERE, THE NETHERLANDS
BRUGPLEIN 11, 1332 BS ALMERE-DE VAART, THE NETHERLANDS
PHONE: 31 36-5493211
FAX: 31 36-5493549
URL: WWW.YANMARMARINE.COM

YANMAR MARINE U.S.A CORPORATION

101 INTERNATIONAL PARKWAY, ADAIRSVILLE, GA 30103, USA
PHONE: 1 770-877-9894
FAX: 1 770-877-7565

YANMAR ASIA (SINGAPORE) CORPORATION PTE LTD.

4 TUAS LANE. SINGAPORE 638613
PHONE: 65 6861-3855
FAX: 65 6862-5195

YANMAR CO,. LTD.

MARINE FACTORY
LARGE POWER PRODUCTS OPERATIONS DIVISION
5-3-1, TSUKAGUCHI HONMACHI, AMAGASAKI-SHI, HYOGO 661, JAPAN
PHONE: 81-6-6428-3123
FAX: 81-6-6421-5549
URL: WWW.YANMAR.CO.JP