YANMAR

SERVICE MANUAL

FM23056

JMI-0099

Certified by **ISO 9001**

(International Organization for Standardization
Standards for Quality Assurance System)

SAIL DRIVE

FOREWORD

This Service Manual covers the Model SD20, 30 & 31 sail drive unit only. For service information on the GMC series & 3HMC marine diesel engine which drives it, please refer to the respective GM/HM Series Manuals.
Since the lower gear case is located below the waterline, the hull must be raised and the sail-drive unit removed for inspection and adjustment. To cut down on this inconvenience, the unit must be kept in tip-top running condition. So, when a mechanical or other problem does arise, and you have gone to the trouble of lifting the hull out of the water, do not limit your maintenance to adjusting and/or repairing the defective part. Give the unit a thorough inspection to catch problems before they occur.
Before re-attaching the unit to the hull, always conduct a Bench Test.
Please refer to the Installation and Operation Manual for instructions on removing the unit from the hull.

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International Organization for Standardization
Standards for Quality Assurance System

This product has been developed, designed and produced in accordance with the Standards for Quality System of ISO 9001 (International Organization for Standardization) under the following authorized institutions: JMI (Japan Machinery and Metals Inspection Institute), BSI (British Standards Institution) and EQNET (The European Network for Quality System Assessment and Certification).

Certified under the following standards:
ISO 9001 - 1987 / BS 5750 : Part 1 : 1987 / EN 29001 - 1987 / JIS Z9901 - 1991

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SAIL DRIVE UNIT

Model SD20, SD30 & SD31

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1. Specifications

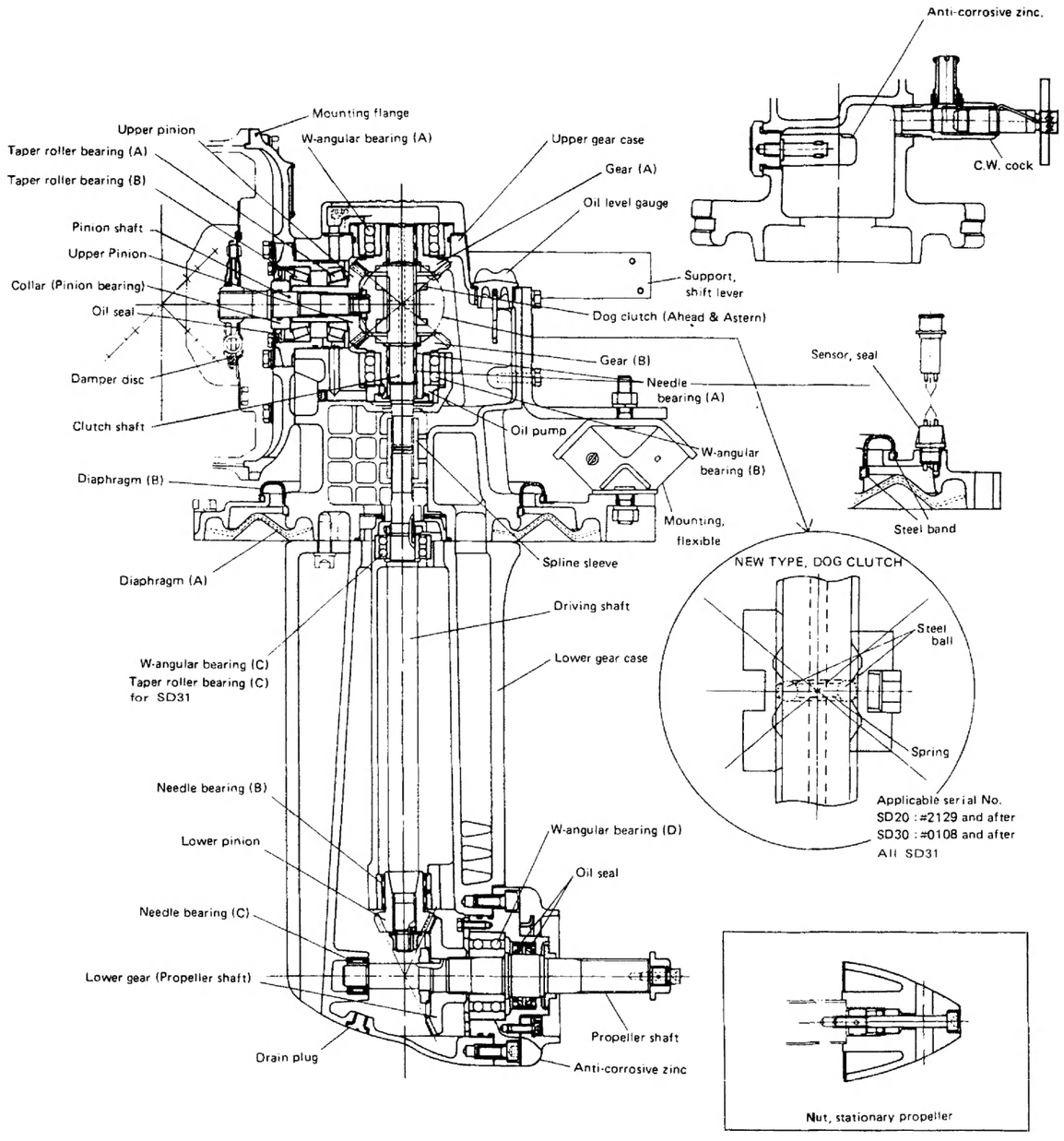
Model			SD20			SD30	SD31
Reduction gear system			Constant mesh gear with dog clutch				
Direction of rotation	Input shaft		Counter-clockwise viewed from stern				
	Propeller shaft		Counter-clockwise viewed from stern				
Reduction ratio	Ahead		2.64				2.31
	Astern		2.64				2.31
Propeller speed rpm (at DIN 6270A rating)			1289			1212	1472
Lubrication system			Splash lubrication				
Lub.oil capacity (liter)			2.2 (Standard unit) 2.5 (Long-reach unit)				
Dry weight kg (lbs)			30 (66)			32 (70)	33 (73)
Remote-control device	Control head		Single control lever, Travel 70mm (2 3/4")				
	Cable		"MORSE" 33C (equivalent)				
Applicable eng.	Model		1GMC	2GMC	3GMC	3HMC	**
	Output kw (HP) /rpm	DIN6270B	6.7 (9.1)/3600	13.4 (18.2)/3600	20.1 (27.3)/3600	25.4 (34.0)/3400	
		DIN6270A	5.9 (8.02)/3400	11.8 (16.0)/3400	17.7 (24.1)/3400	22.4 (30.0)/3200	
Flexible mount	Engine side		2	2	2	2	
	Sail-drive side		1	1	1	1	
Total dry weight kg(lbs)			95 (205)	123 (271)	153 (337)	176 (387)	

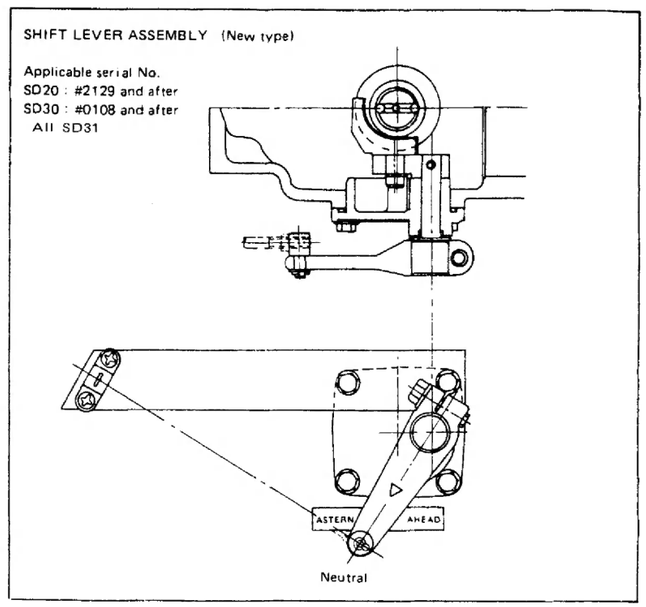
Applicable engine (New-GM/HM-series)	Model		*1GM10C	*2GM20C	*3GM30C	*3HM35C
	Output kw (HP) /rpm	DIN6270B	6.7 (9.1)/3600	13.4 (18.2)/3600	20.1 (27.3)/3600	25.4 (34.0)/3400
		DIN6270A	5.9 (8.02)/3400	11.8 (16.0)/3400	17.7 (24.1)/3400	22.4 (30.0)/3200
Flexible mount	Engine side		2	2	2	2
	Sail-drive side		1	1	1	1
Total dry weight kg (lbs)			104 (229)	134 (295)	153 (337)	180 (397)

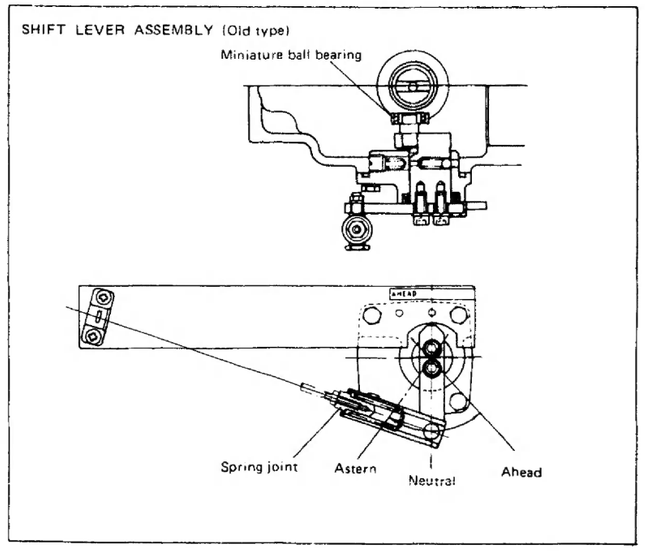
**Applicable engine model for SD31	Model		3JH2CE	3JH2-TCE	4JH2CE
	Output kw (HP) /rpm	DIN6270B	28.5 (38.7)/3600	35.0 (47.6)/3600	37.5 (51.0)/3600
		DIN6270A	25.7 (34.9)/3400	31.6 (43.0)/3400	33.8 (46.0)/3400
Number of flexible mount	Engine side		2	2	2
	Sail-drive side		1	1	1
Total dry weight kg (lbs)			202 (445)	207 (456)	233 (514)

2. Sectional View & Names of Parts

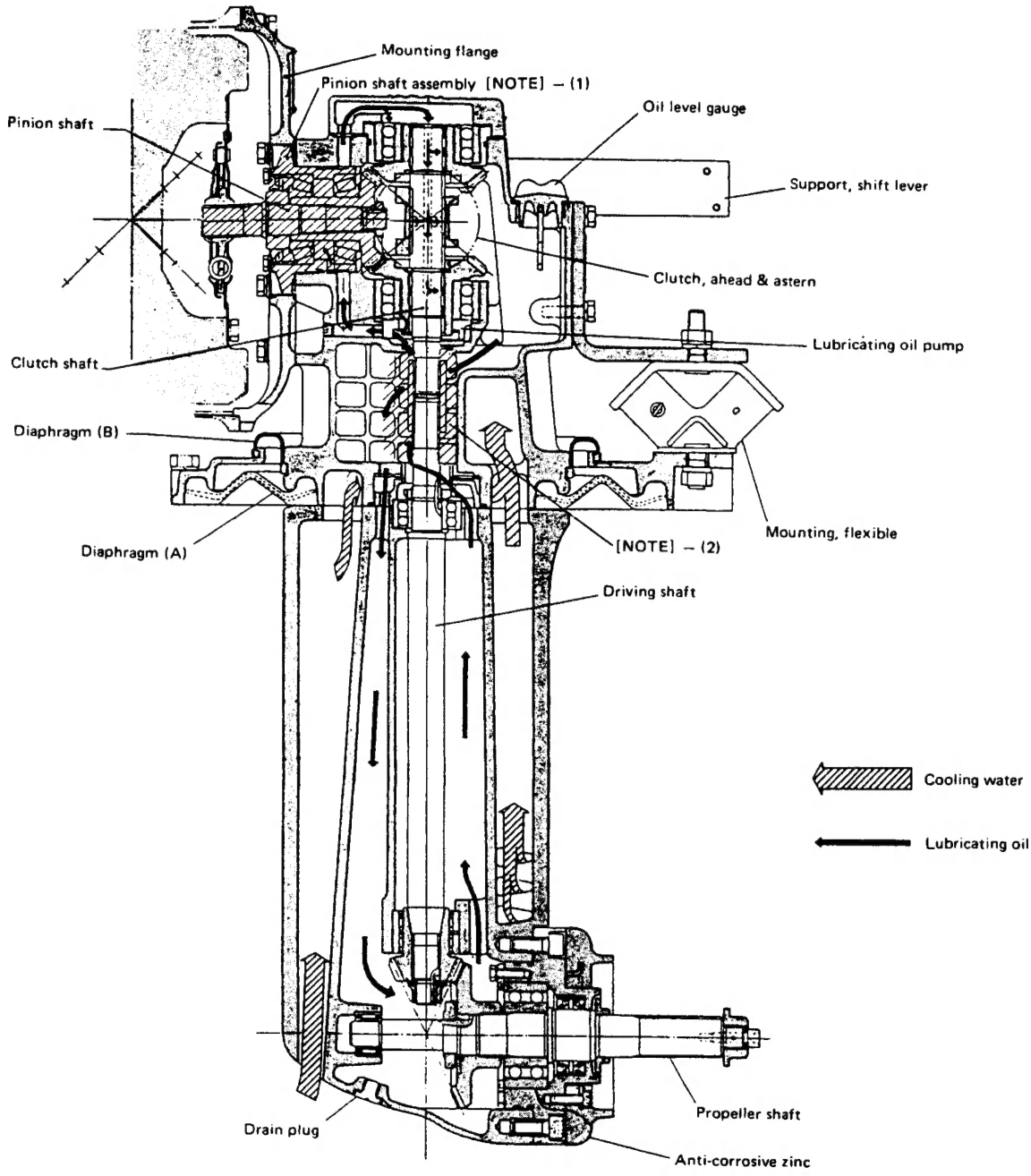
2-1 Sectional View & Names of Parts

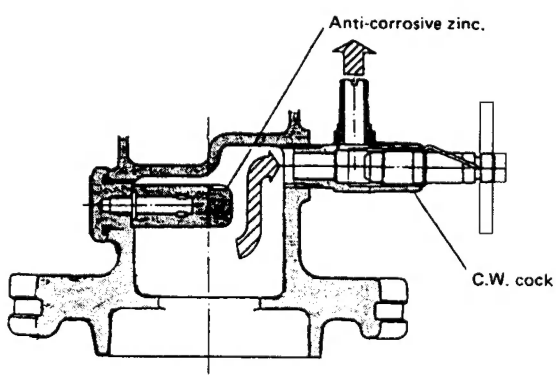






2-2 Route of Cooling Water & Lubricating Oil





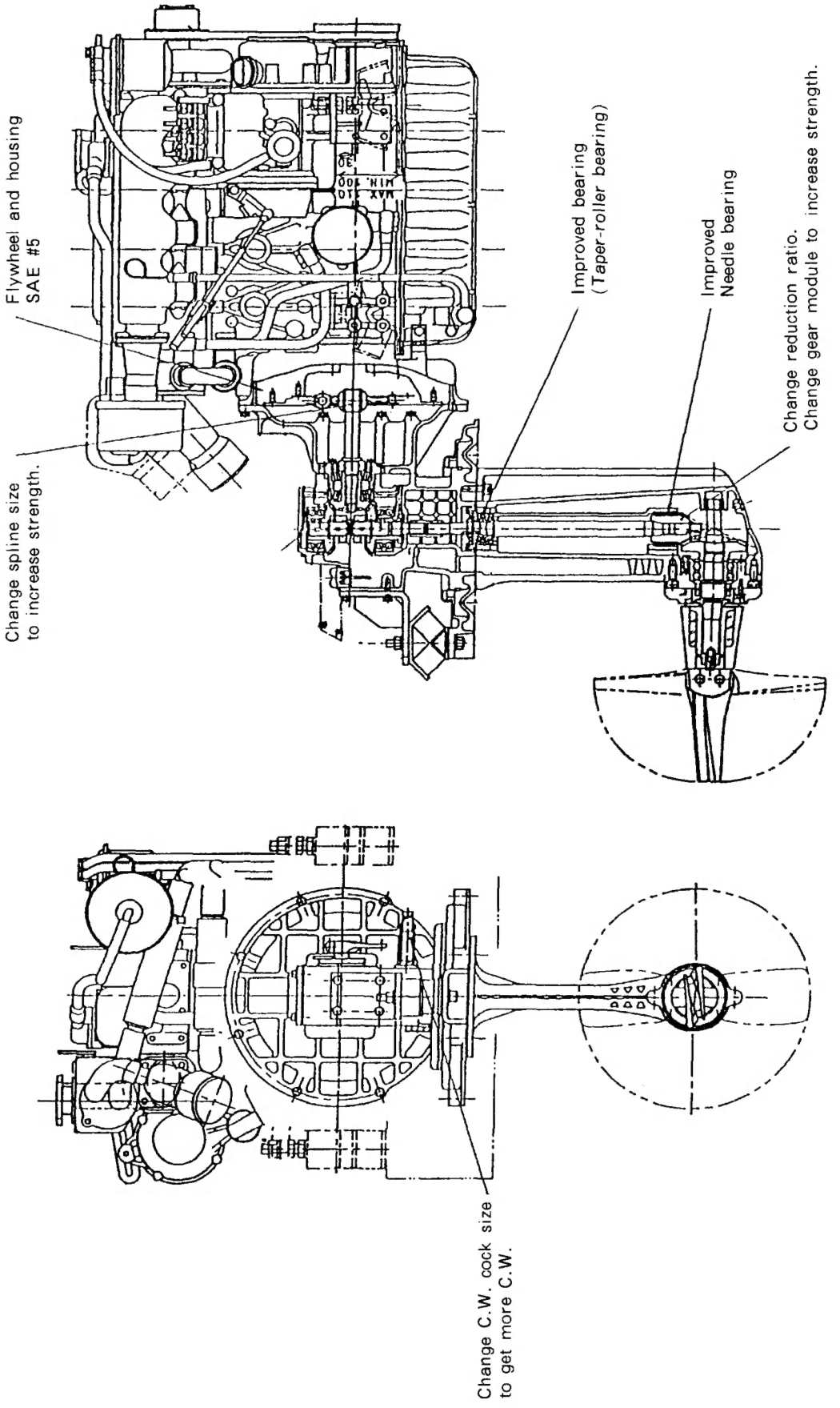
[NOTE]

The following changes have been incorporated in products prior to D/#0454:

(1) The pinion shaft assembly is provided with a lubricating oil pouring port in the upperward-facing direction. Refer to page 3-8.

(2) The spline sleeve in the upper gear case is fitted with an oil guide.

2-3 Sectional View with Engine



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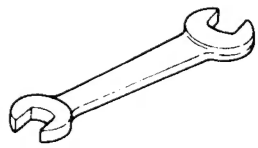
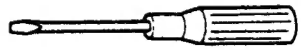
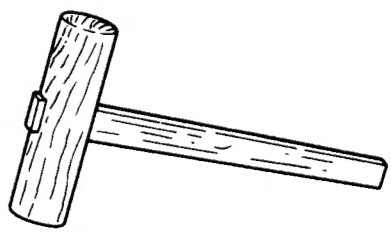
3. Criteria for Replacing Parts

Criteria for replacement		Criteria for replacement	
		Standard value	**Standard service life**
Bearings	Needle bearing (A) (B/# K20×24×13)	Evidence of needle flaking or loss	1,500 hrs.
	Needle bearing (B) (B/# RNA69/28) (RNA49/32RD2)		
	Needle bearing (C) (B/# NA5903)	1) Evidence of needle flaking or loss 2) Replacement of propeller shaft	
	Miniature ball bearing (B/# 609)	Axial internal clearance ≧ 0.1 mm	Total of 100,000 engagements and disengagements
Oil pump		Outer radius : ≦ 59.3 mm	2,000 hrs.
Anti-corrosive zinc parts	Anti-corrosive zinc parts (Upper gear case)	Weight : ≦ 140 g (with plug)	One year
	Anti-corrosive zinc parts (Lower gear case)	Weight : ≦ 400 g	A half year
Oil seals		1) Lip hardening or hair cracks 2) Disassembly	1,000 hrs. or 2 years
Diaphragms (A) & (B)		Hair cracks	2 years
Washers		Disassembly	
Steel band		Disassembly	
Clutch	Dog clutch	Dog corner — Standard : 0.2 C Replacement standard : ≧ 3.0 R	
	Upper gear (A)	Dog corner — Standard : 0.7 R Replacement standard : ≧ 3.0 R	
	Upper gear (B)		

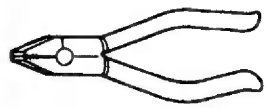
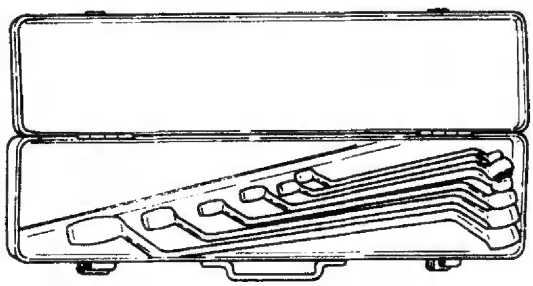
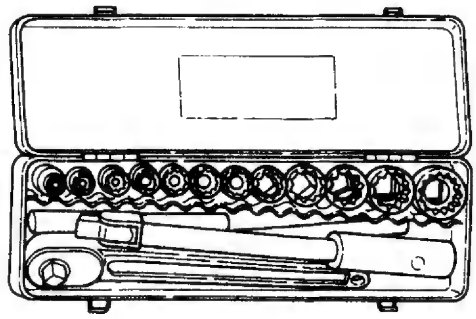
4. Disassembly and Reassembly Tools

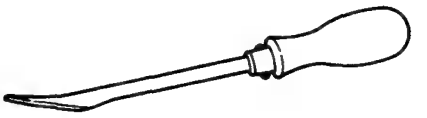
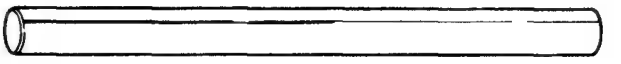
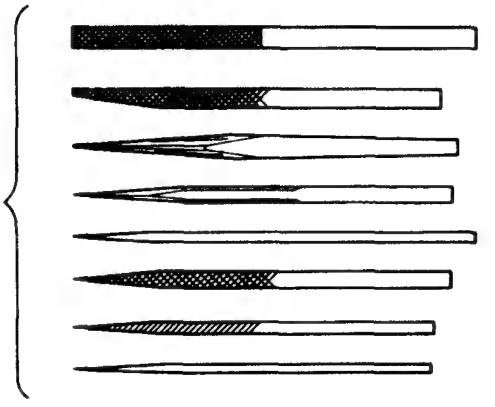
The following tools are necessary when disassembling and reassembling the engine. These tools must be used according to disassembly process and location.

4-1 General Handtools

Name of tool	Shape	Remarks
Spanner		10 × 13 12 × 14 17 × 19 21 × 23 21 × 24
Screwdriver for + (Cross recessed head) screws		
Screwdriver for − (Philips head) screws		
Steel hammer		
Copper hammer		
Mallet		

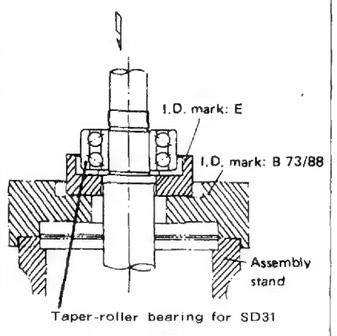
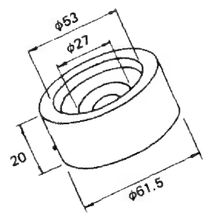
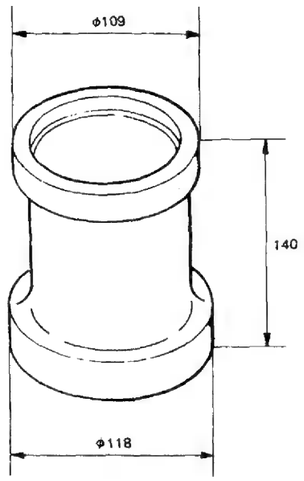
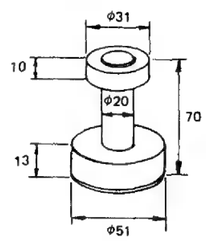
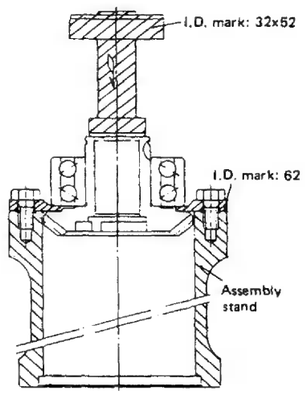
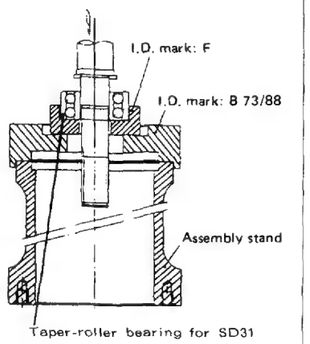
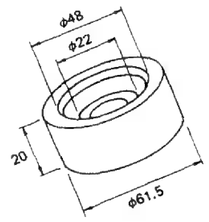
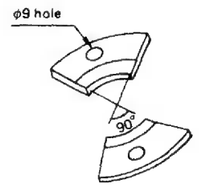
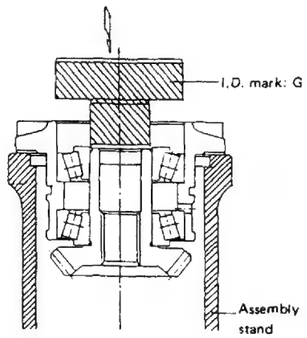
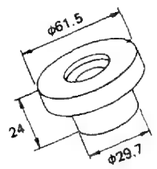
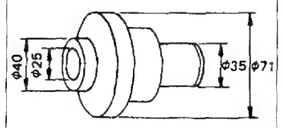
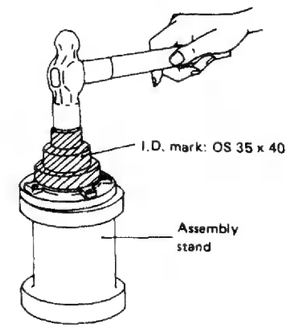
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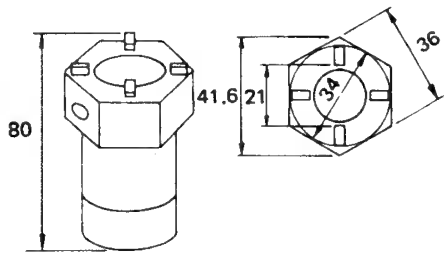
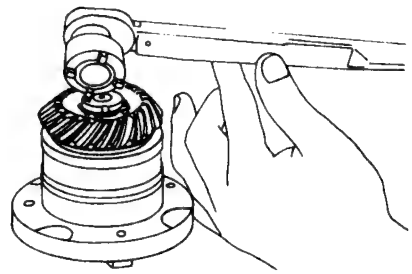
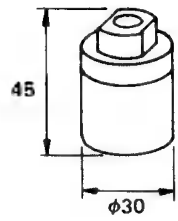
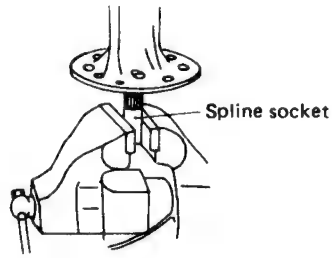
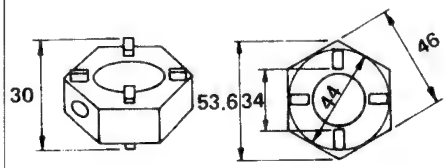
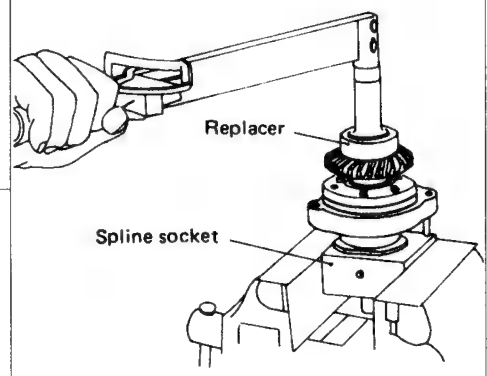
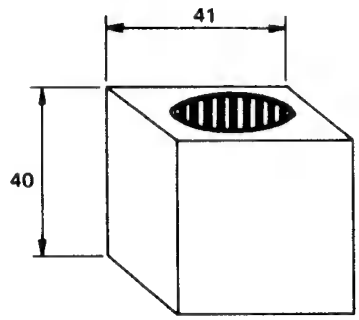
Name of tool	Shape	Remarks
Nipper		
Plier		
Starting plier		
Offset wrench		1 set
Box spanner		1 set

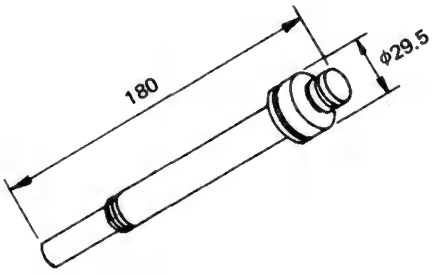
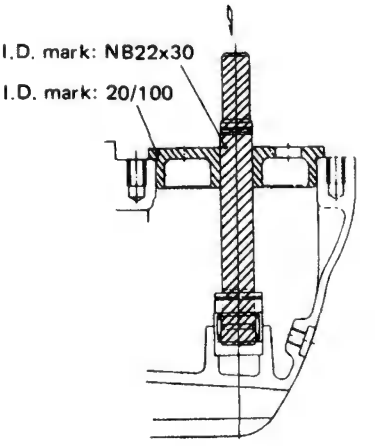
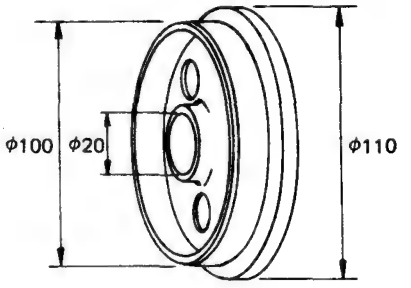
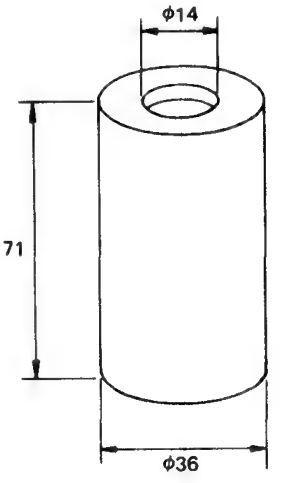
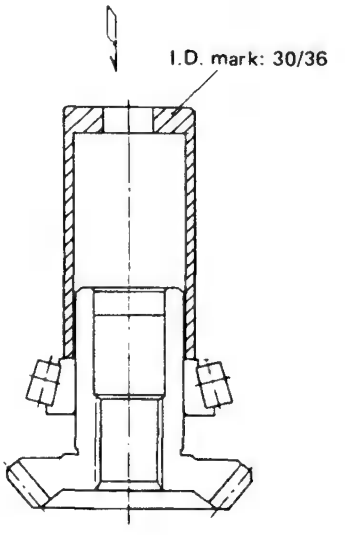
Name of tool	Shape	Remarks
Scraper		
Lead rod		
File		1 set
Rod spanner for hexagon socket head screws (L-type)		5 mm 6 mm 8 mm
Rod spanner for hexagon socket head screws (Straight type)		5 mm 6 mm 8 mm

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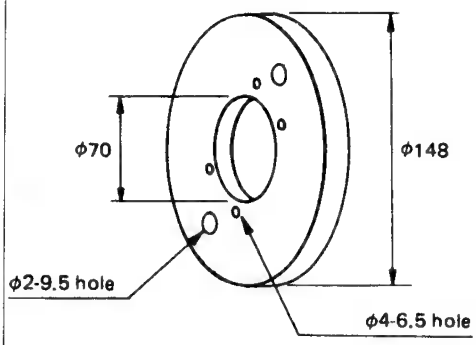
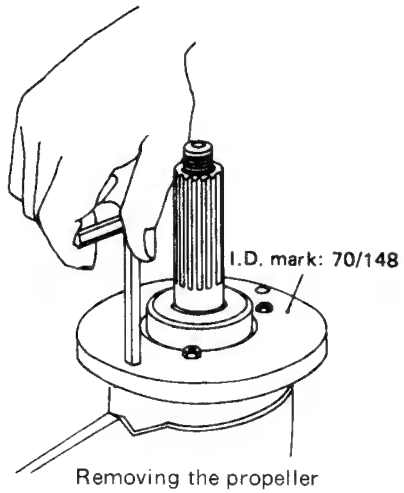
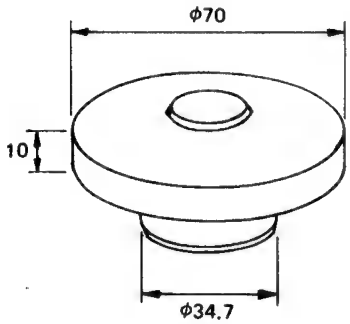
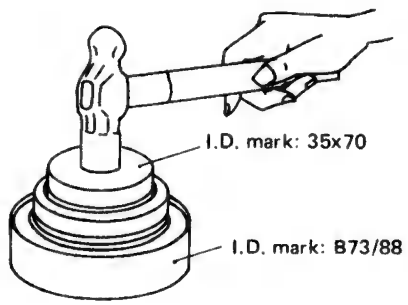
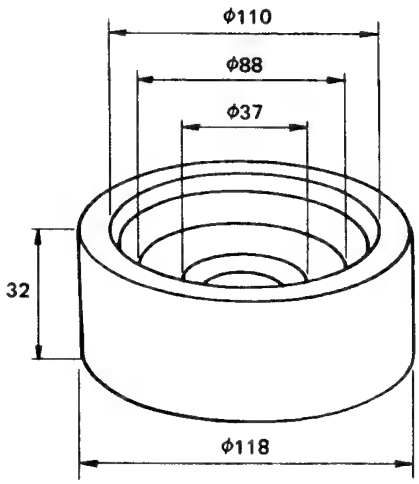
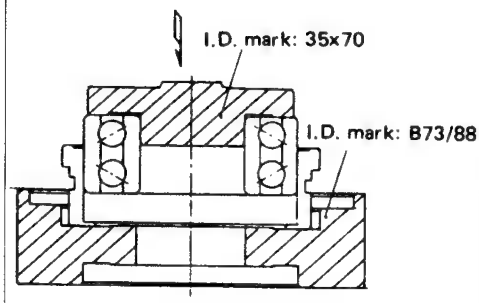
4-2 Special Tools

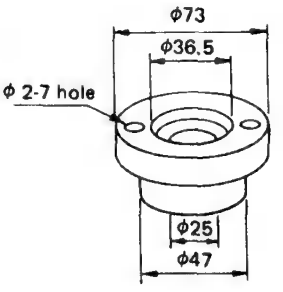
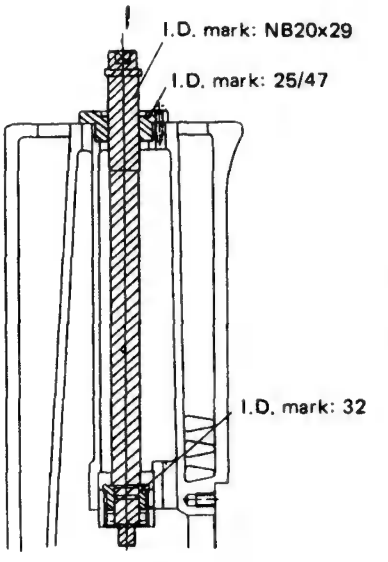
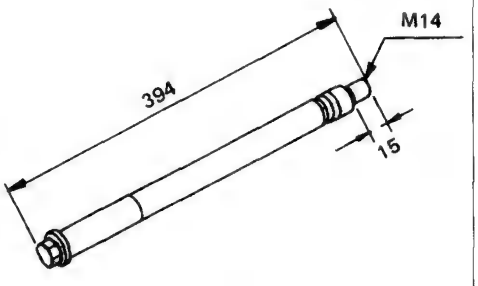
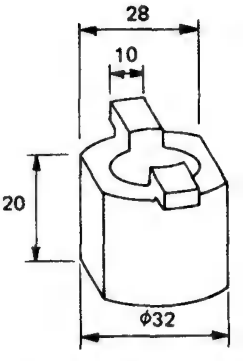
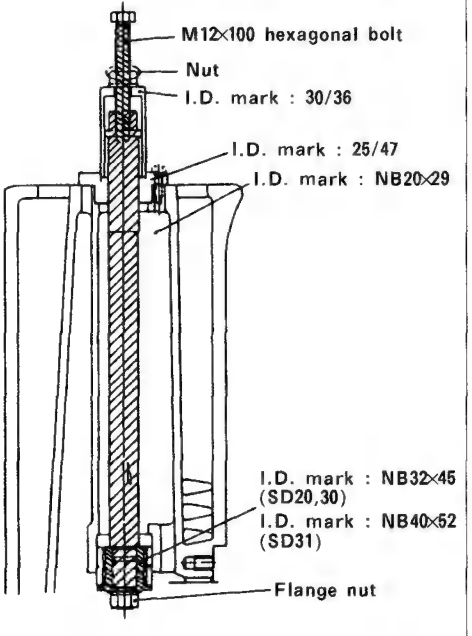
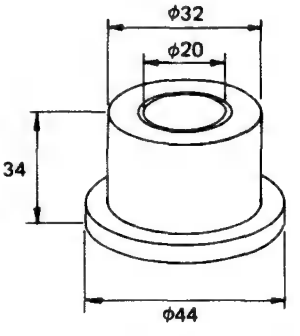
Ref.	Application	Name of tools & Shape and size		Application	Ref.
5–4	 Taper-roller bearing for SD31	I.D. mark : E  Part No. : 196311–92580	 ASSEMBLY STAND Part No. : 196420–92510	I.D. mark : 32 × 52  Part No. : 196311–92690		5–1 5–2
5–5	 Taper-roller bearing for SD31	I.D. mark : F  Part No. : 196311–92590		I.D. mark : 62  Part No. : 196420–92800		5–1
2–7 3–5 5–7		I.D. mark : G  Part No. : 196311–92600		I.D. mark : OS 35 × 40  Part No. : 196311–92860		3–6 5–8

Name of tools	Shape and size	Application	Ref.
Replacer	 Part No. : 196311–92030	 For propeller shaft in upper pinion	2–7 5–5
Spline socket	 Part No. : 196311–92010	 For drive shaft	3–3 5–4
Replacer	 Part No. : 196311–92020		2–10 3–2
Spline socket	 Part No. : 196320–92130	Disassembly and reassembly tools for propeller shaft	2–10 3–2

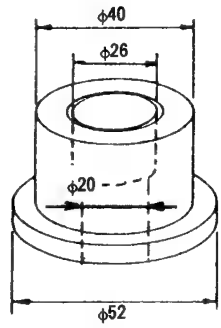
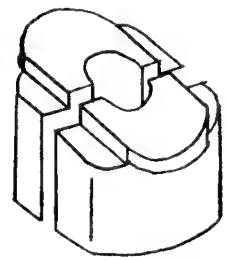
Name of tools	Shape and size	Application	Ref.
I.D. mark : NB 22×30	 Part No. : 196311–92631		4–7 5–11
I.D. mark : 20/100	 Part No. : 196420–92640		4–7 5–11
I.D. mark : 30/36	 Part No. : 196420–92690		3–5 3–6 5–10

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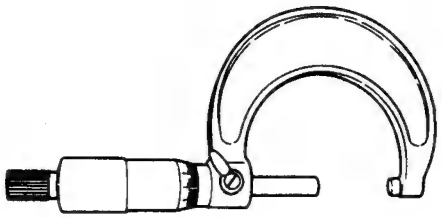
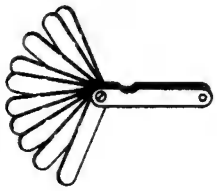
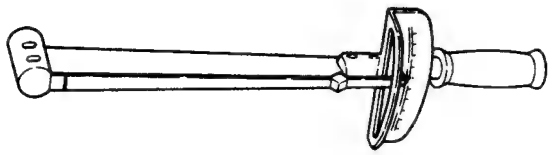
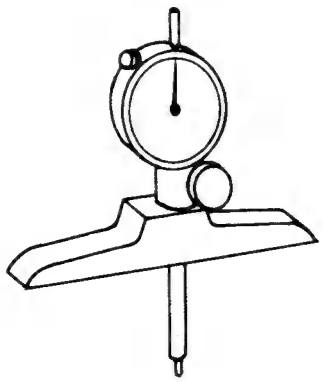
Name of tools	Shape and size	Application	Ref.
I.D. mark : 70/148	 Part No. : 196420-92040	 Removing the propeller shaft assembly	2-8
I.D. mark : 35×70	 Part No. : 196420-92550	 Reassembling the upper gear (A) bearing	
I.D. mark : B73/88	 Part No. : 196420-92560	 Reassembling the upper gear (A) and (B) bearing	5-2 5-4 5-5 5-6

Name of tools	Shape and size	Application	Ref.
I.D. mark : 25/47 Guide	 Part No. : 196420–92660	 Disassembling the drive shaft bearing	5–9 5–10
I.D. mark : NB 20×29	 Part No. : 196420–92650		5–9 5–10
I.D. mark : NB 32 for disassembling	 Part No. : 196420–92680	 Reassembling the drive shaft bearing	5–9
I.D. mark : NB 32 ×45 for reassembling	 Part No. : 196420–92700		5–10

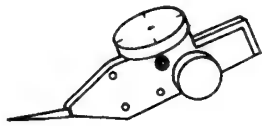
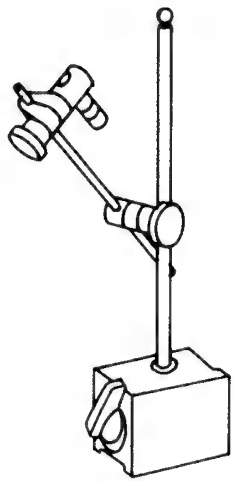
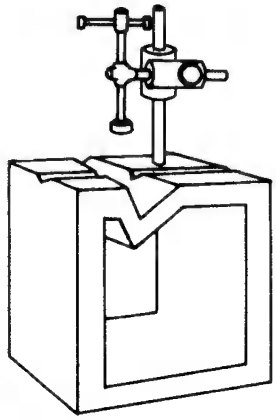
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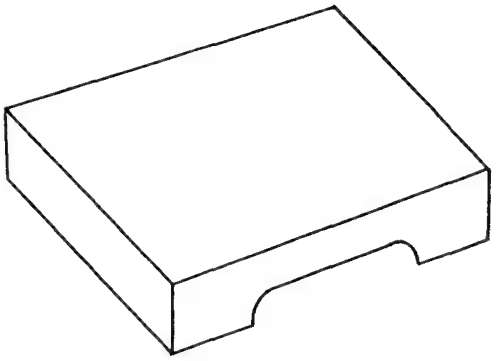
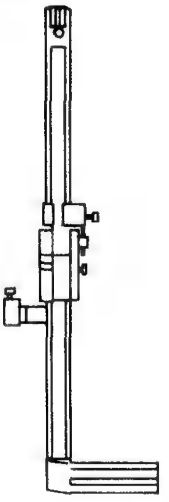
Name of tools	Shape and size	Application	Ref.
NB 40×52 for reassembling	 Part No. : 196320–92671		5–10
I.D. mark : NB 40×44	 Part No. : 196431–92680		

4-3 Measuring Instruments

Name	Illustration	Accuracy & range	Ref.
Vernier calipers		1/20 mm, 0–150 mm	
Micrometer		1/100 mm, 0–25 mm, 25–50 mm, 100–125 mm	4–4 4–7
Thickness gauge		0.05–2 mm	
Torque wrench		0–15 kgf-m	
Dial depth gauge		1/100 mm, 0–150 mm	4–3 4–4 4–7

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Name	Illustration	Accuracy & range	Ref.
Lever type dial test indicator		1/100 mm, 0–0.8 mm	4–7 4–8
Magnetic base			4–6
Clamp type box block		100 mm (K-type)	4–8

Name	Illustration	Accuracy & range	Ref.
Surface plate			4–7 4–8
Height gauge		500 mm	4–7 4–8

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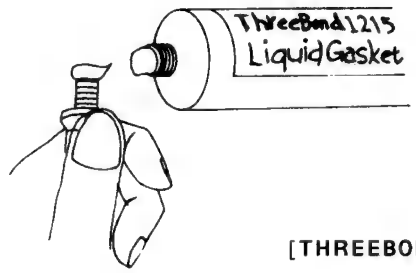
4-4 Others

4-4.1 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.



4-4.2 Liquid gasket



[THREEBOND 1215]

4-4.3 Paint

After completing maintenance, check the painted surfaces of the lower gear case for chips and cracks. Touch up any defects with the specified paints. If these defects are not taken care of, they can lead to corrosion of the lower gear case.

Painting and repairing of the sail-drive unit are usually made as follows though the method differs to some extent depending on the condition of flows.

Process	Material and paint used	Recommended interval of painting
1) Sanding	Repair flaws with abrasive paper (#300~#400).	—
2) Cleaning	Wipe off dust generated in repairing flaws.	—
3) Etching primer	Etching primer	1 hr/20℃
4) Under coating	Polyurethane undercoat	2 hrs/20℃
5) Top coating	Polyurethane enamel	1–2 days/20℃

5. 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.

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CHAPTER 2

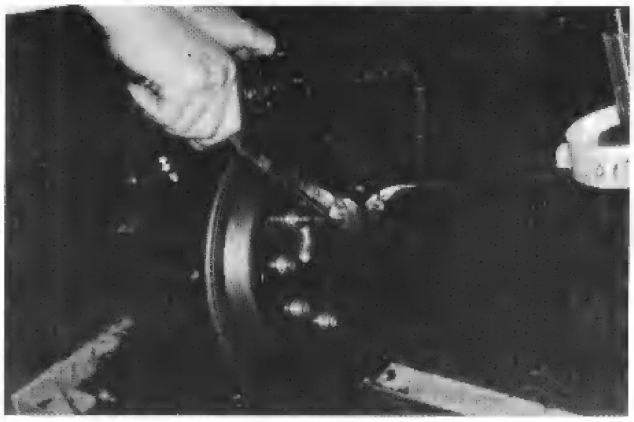
DISASSEMBLY

1. Disassembling the Upper Gear Case 2-1
   1-1 Removing the Diaphragm (B) 2-5
   1-2 Disassembling the Pinion Shaft Assembly 2-6
2. Disassembling the Lower Gear Case 2-8
   2-1 Removing the Drive Pinion Shaft 2-9
   2-2 Disassembling the Propeller Shaft Assembly 2-10

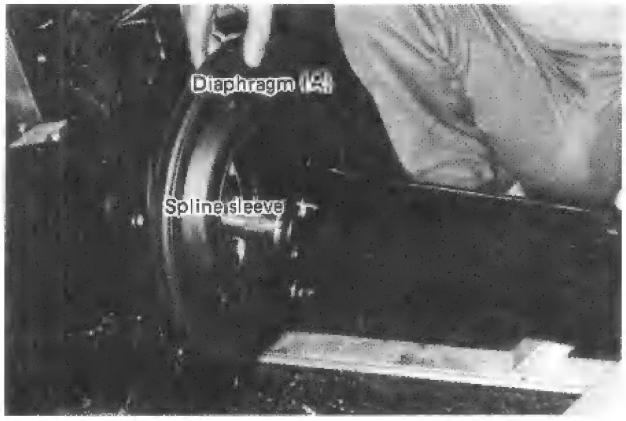
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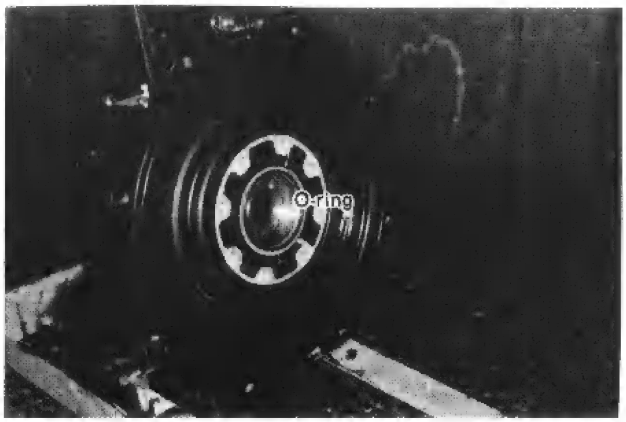
1. Disassembling the Upper Gear Case

(1) Loosen the bolts that connect the upper and lower gear cases.



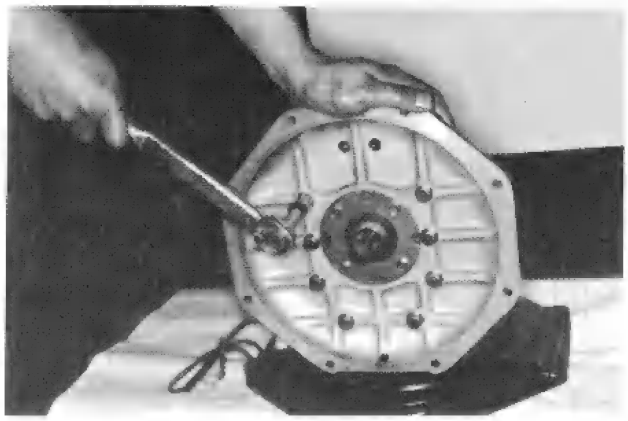
(2) Remove the lower gear case together with the diaphragm (A) and the spline sleeve.



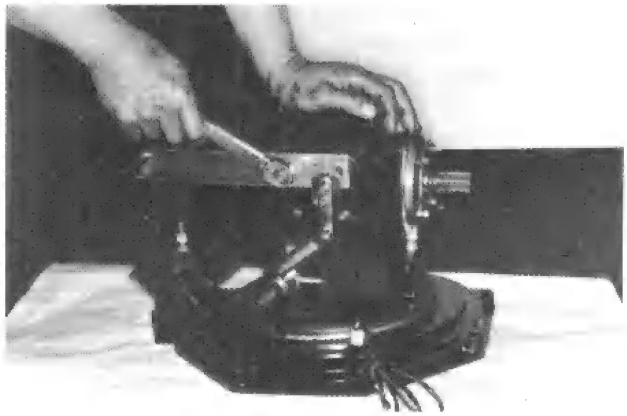


[NOTE]
Do not lose the O-ring!

(3) Remove the mounting flange.



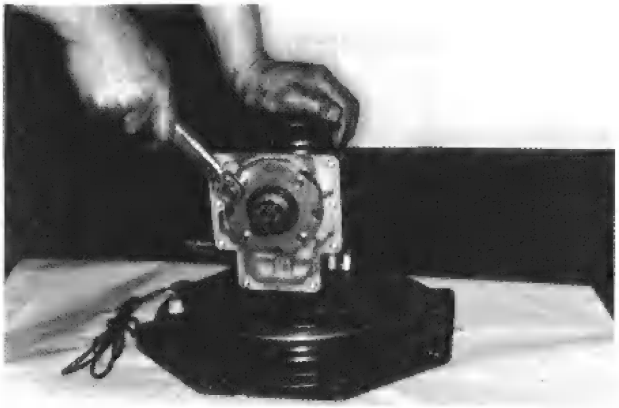
(4) Remove the remote control cable support.



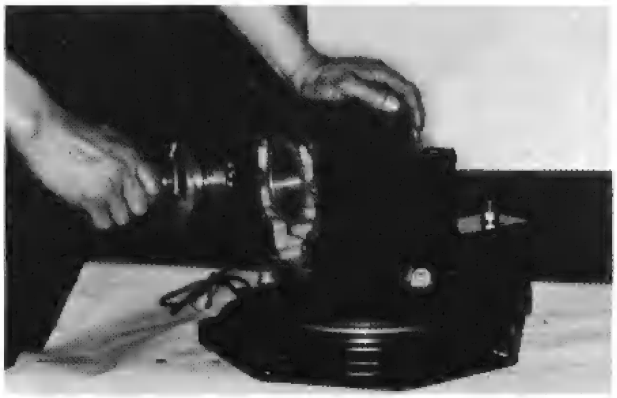
(5) Remove the shift lever and support.



(6) Remove the pinion shaft assembly (input shaft).







(7) Remove the upper cover.





[NOTE]
Do not lose the O-ring!

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(8) Remove the gear (A) assembly.

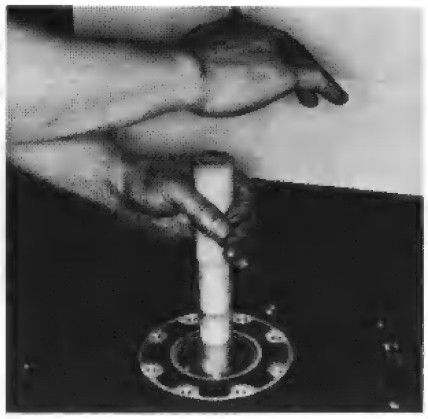




(9) Remove the clutch shaft and dog clutch.



(10) Remove the gear (B) assembly.





(11) Remove the anti-corrosive zinc.





[NOTE]
Replace the anti-corrosive zinc if it is worn down to 140g or less.

	Standard	Tolerance limit
Weight with plug	200 g	140 g

(12) Remove the flexible mounting bracket.





(13) Remove the seal sensor.



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1-1 Removing the Diaphragm (B)

(1) Remove and loosen the clamp on the large steel band.





[NOTE]
Always replace the steel (large) band with a new one.

(2) Remove the upper gear case from the seal flange.



(3) Remove the diaphragm (B) after loosening the small steel band inside.

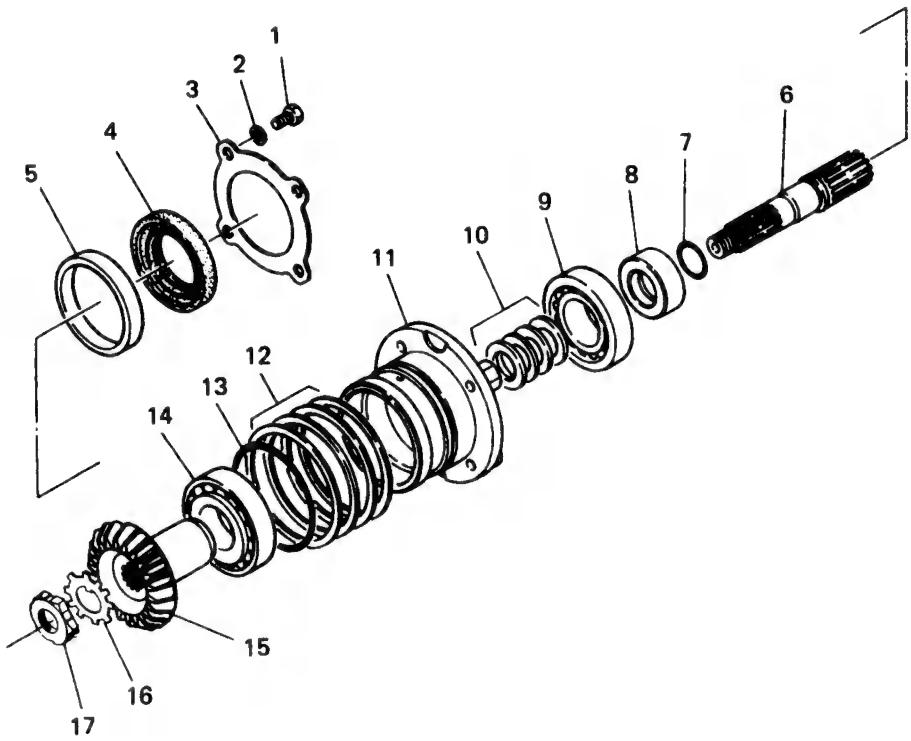


[NOTE]
1. *Fully check the diaphragm (A) and (B) for cracking. If any racks are found, replace.*
2. *Replace the steel band (small) with new one without fail.*

(4) Remove the flexible mounting.



1-2 Disassembling the Pinion Shaft Assembly



1. Bolt	7. O-ring	13. O-ring
2. Super lock washer	8. Coller (pinion shaft)	14. Bearing
3. Keep plate (seal)	9. Bearing	15. Pinion
4. Oil seal	10. Shim set	16. Washer
5. Spacer	11. Bearing housing	17. Nut
6. Pinion shaft	12. Shim set	

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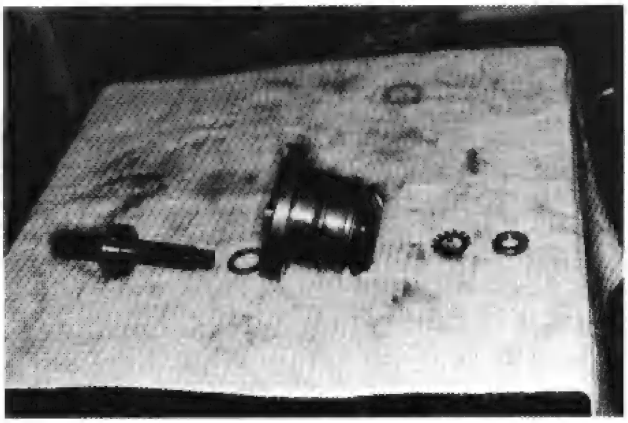
(1) Remove the lock from the lock washer.



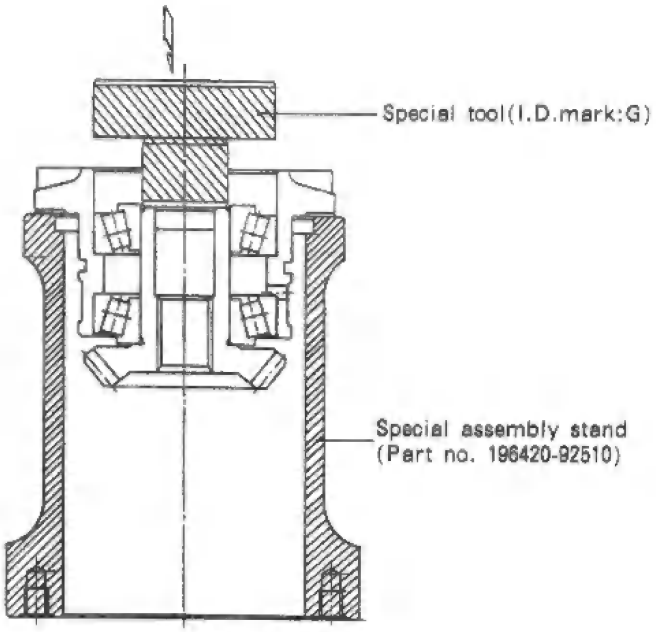
(2) Remove the lock nut with the special tool (Part No. 196311-92030).



(3) Remove the pinion shaft by tapping on the thread with a wooden or plastic hammer.

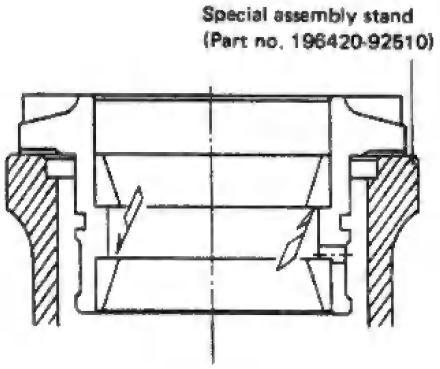


(4) Place the housing on the special assembly stand (Part No.196420-92510), remove the upper pinion with the special tool marked "G", and extract the bearing inner races.



(5) Remove the bearing outer races from the housing.



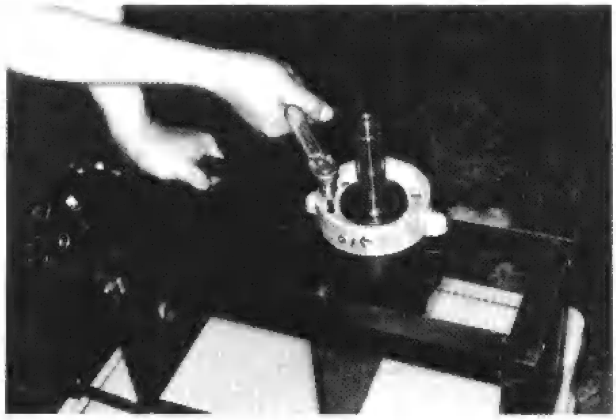


2. Disassembling the Lower Gear Case

(1) Remove the anti-corrosive zinc.

⚠ IMPORTANT

The anti-corrosive zinc reaches the wear limit in approximately 6 months.





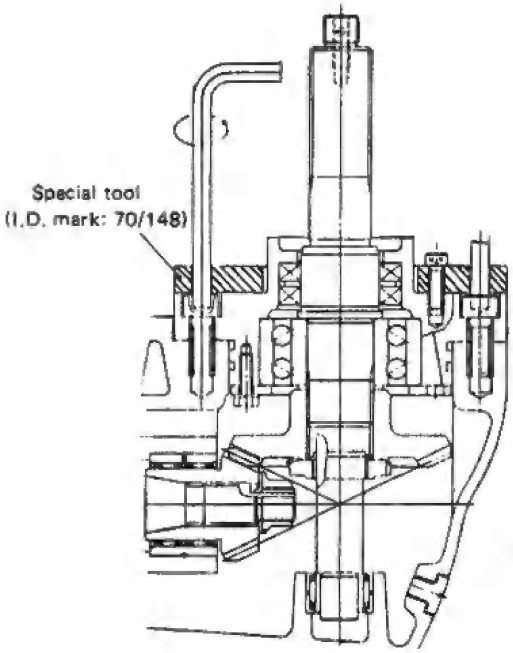
[NOTE]

The wear limit for the anti-corrosive zinc is 400g.

Standard weight	Wear limit
1,200 g	400 g

(2) Remove the propeller shaft assembly with the special rod spanner (I.D. mark: 70/148).





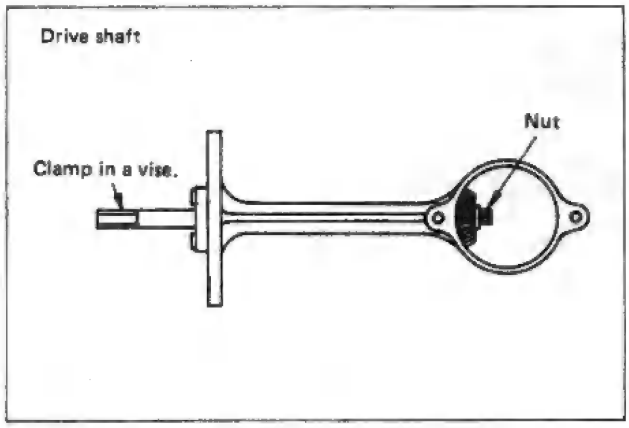
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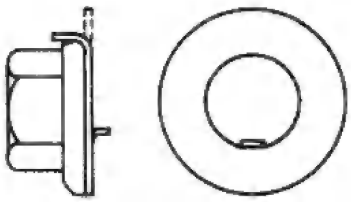
2-1 Removing the Drive Pinion Shaft

(1) Remove the washer that locks into the groove around the nut.



(2) Clamp the splined part in a vise and remove the nut and the washer.

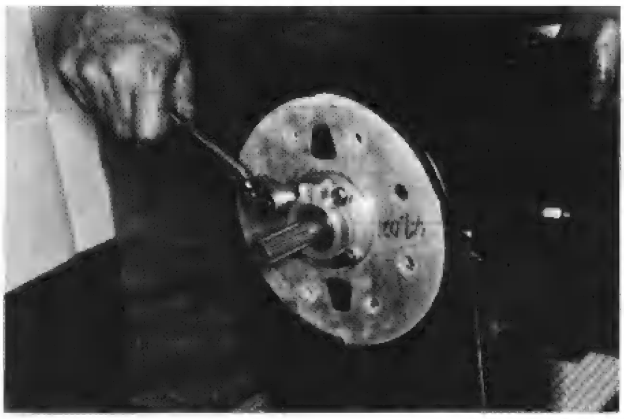




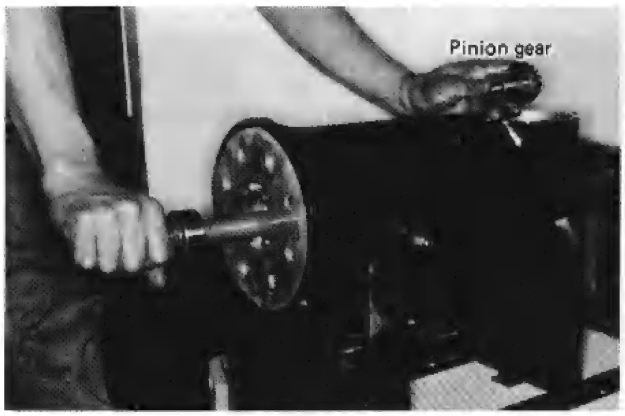
[NOTE]

Always replace the lock washer with a new one when assembling.

(3) Remove the bearing support.

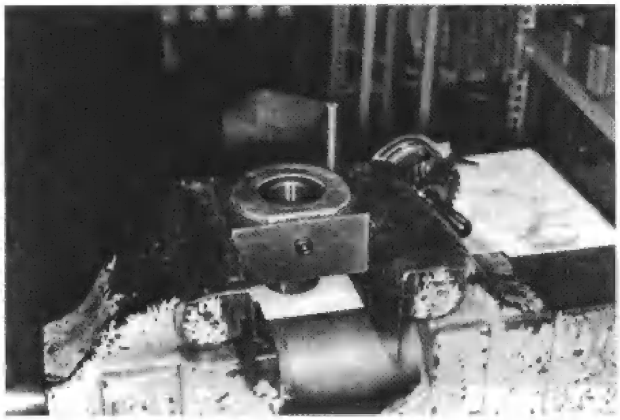


(4) Remove the drive pinion shaft and the pinion gear.



2-2 Disassembling the Propeller Shaft Assembly

(1) Clamp the special spline socket (Part No.196320-92130) in a vise and insert the splined part of the propeller shaft assembly.

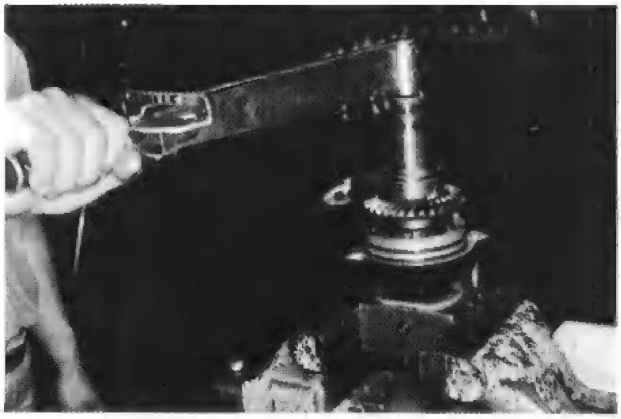


(2) Remove the washer that locks into the groove around the nut.



[NOTE]
Always replace the lock washer with a new one when re-assembling.

(3) Remove the lock nut with the special socket wrench (Part No.196311-92020).



(4) Remove the lower gear and gear collar.



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(5) Remove the bearing cap and shaft.





[NOTE]

After disassembly, replace the following with new parts:

(a) oil seals and lock washers.

(b) both the lower and pinion gears--if there is evidence of pitching or abnormal wear on the gear teeth.

(c) the oil seal lip--if wear on the sliding part exceeds the specified wear limit.

Wear limit: A groove depth of 0.1 mm or more

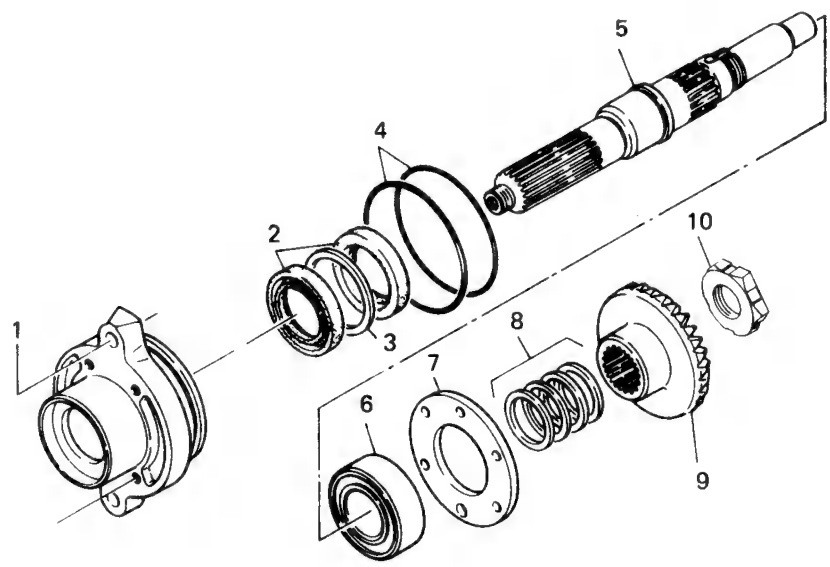
CHAPTER 3

REASSEMBLY

1. Reassembling the Propeller Shaft Assembly 3-1
   1-1 Reassembling the Lower Gear Case 3-3
2. Reassembling the Pinion Shaft Assembly (Input Shaft) 3-5
   2-1 Reassembling the Upper Gear Case 3-7
3. Reassembling the Upper and Lower Gear Cases 3-11
4. Lubrication 3-13
5. Attaching the Folding Propeller 3-14

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1. Reassembling the Propeller Shaft Assembly



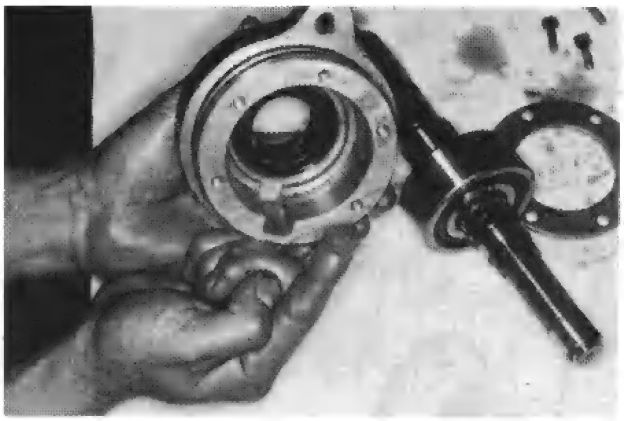
1. Rear cover	5. Propeller shaft	9. Lower gear
2. Oil seal	6. Bearing	10. Nut
3. Spacer	7. Bearing cap	
4. O-ring	8. Gear collar set (shim)	

[NOTE]

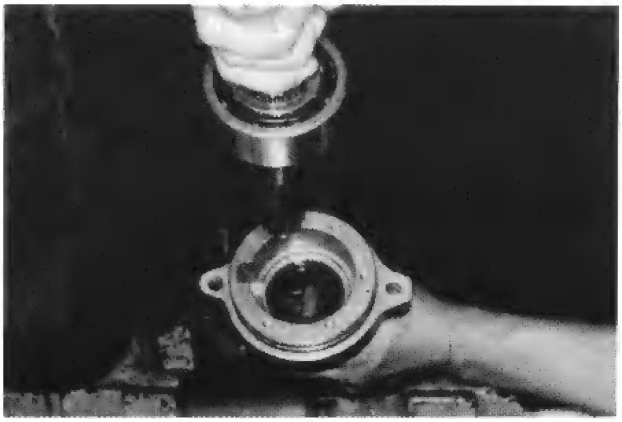
1. *For instructions on shim thickness, refer to CHAPTER 4: SHIM Adjustment (Gear Backlash).*
2. *For instructions on the insertion of the oil seal in the rear cover, refer to CHAPTER 5: BEARING & OIL SEAL REPLACEMENT.*
3. *For instructions on the insertion of the bearing propeller shaft, refer to CHAPTER 5: BEARING & OIL SEAL REPLACEMENT.*

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(1) Coat the oil seal with waterproof grease after inserting it into the rear cover.



(2) Fit the rear cover over the shaft along with its press-fit bearing.



[NOTE]
When inserting the shaft, be careful not to damage the oil seal lip, since this can lead to water seepage.

(3) Attach the bearing cap with M6 bolts.



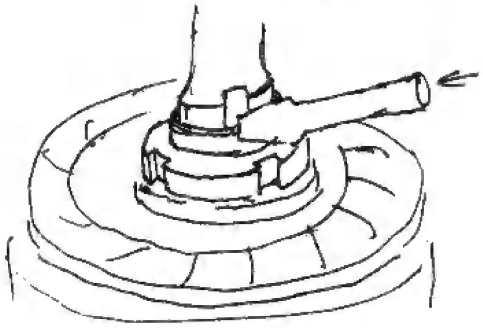
M6 bolt
Tightening torque : 0.5 – 0.7 kgf-m

(4) Clamp the special spline socket (Part No. 196320-92130) in a vise and insert the spline part of the propeller shaft. Attach the lower gear, shim, lock washer, and nut. Tighten the nut with the special socket wrench (Part No. 196311-92020).



M25 thread
Tightening torque : 21.0 – 23.0 kgf-m

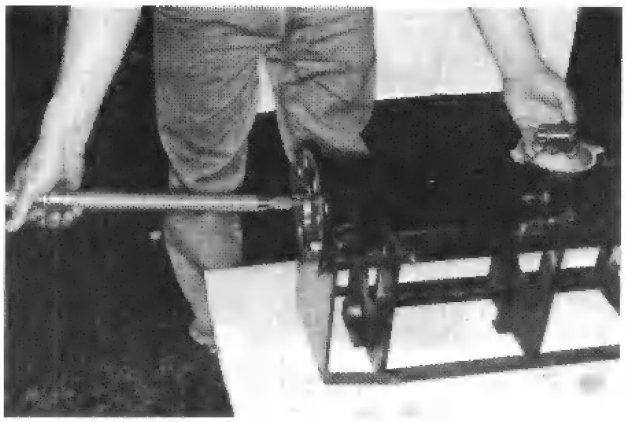
(5) Caulk the thin part of nut in the groove.



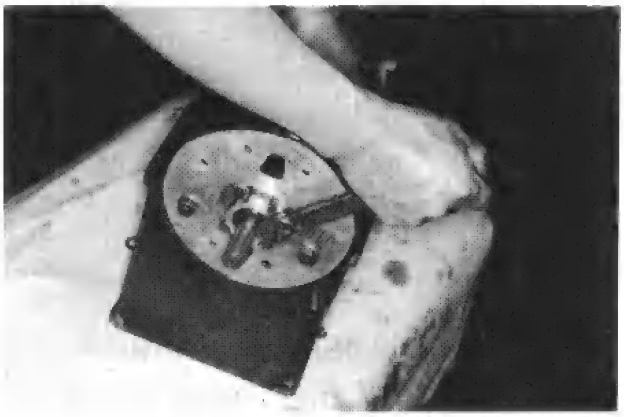
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1-1 Reassembling the Lower Gear Case

(1) Assemble the drive pinion shaft and pinion gear.

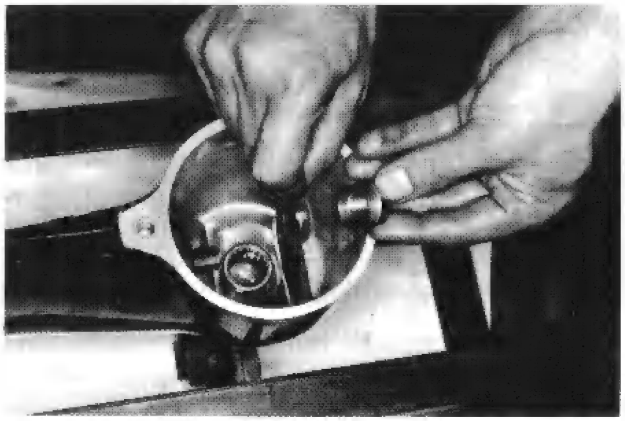


(2) Attach the bearing support.



M6 bolt
Tightening torque : 0.5 – 0.7 kgf-m

(3) Attach the lock washer and finger-tighten the lock nut.

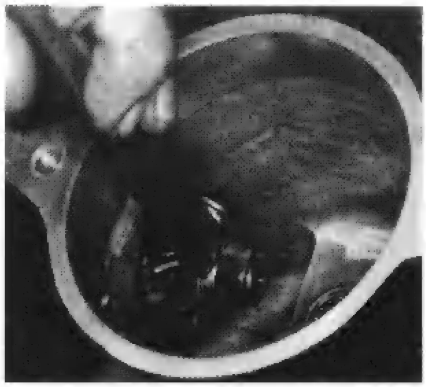


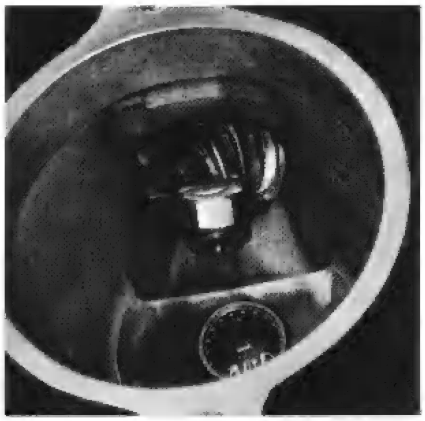
(4) Clamp the shaft in a vise with the special spline socket (Part No. 196311-92010) and tighten the lock nut to the specified torque.

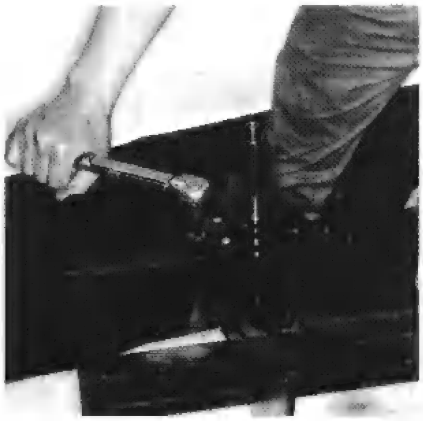


M14 nut
Tightening torque : 6.0 – 7.0 kgf-m

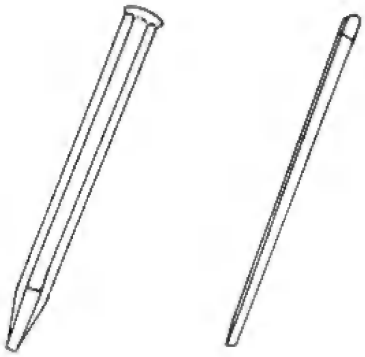
(5) Bend the lock washer to lock the nut

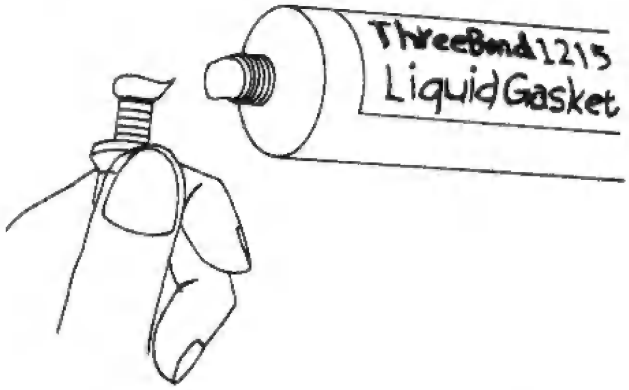






M10 bolt
Tightening torque : 2.8 – 3.2 kgf-m





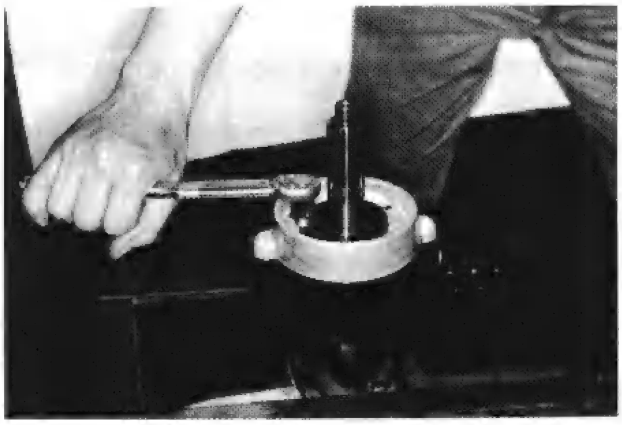
[Liquid Gasket: THREEBOND 1215]

[NOTE]
Coat all bolt threads with liquid gasket (THREEBOND 1215).

(6) Attach the propeller shaft assembly.



(7) Attach the anti-corrosion zinc.



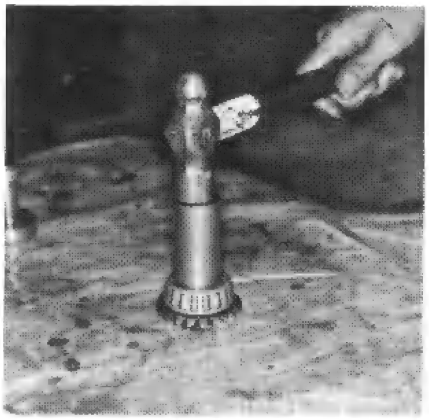
M6 bolt
Tightening torque : 0.5 – 0.7 kgf-m

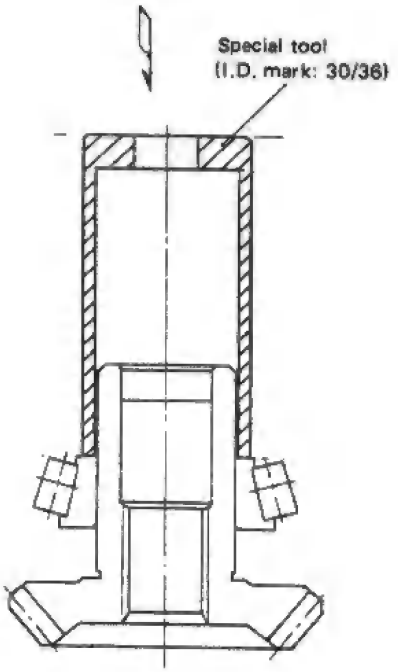
[NOTE]
Coat all bolt threads with liquid gasket (THREEBOND 1215).

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2. Reassembling the Pinion Shaft Assembly (Input Shaft)

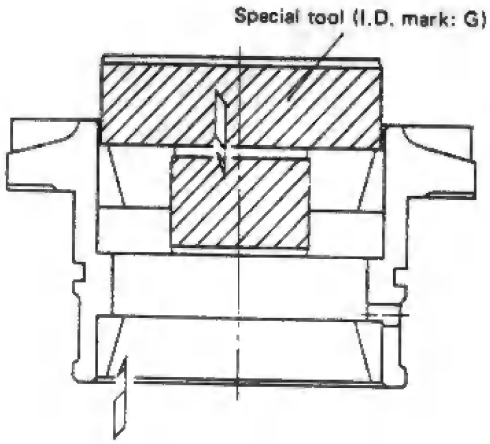
(1) Press fit the bearing inner races into the upper pinion with the special tool (I.D. mark: 30/36).



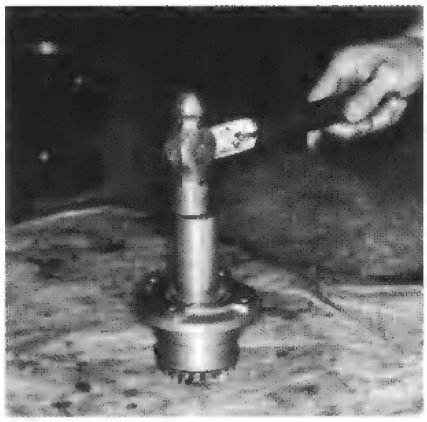


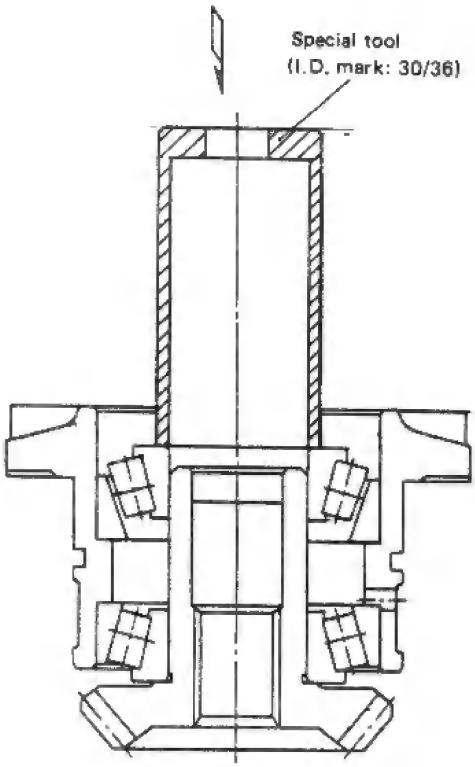
(2) Press fit the bearing outer races into the housing with the special tool (I.D. mark: G).





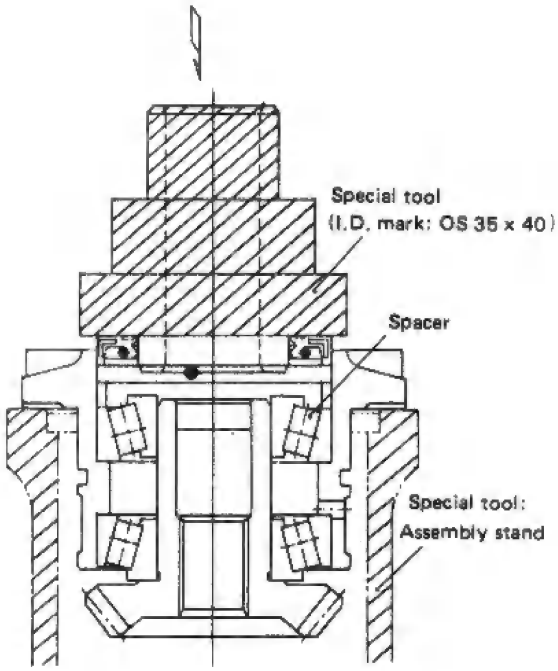
(3) Insert the upper pinion into the housing and press fit the bearing inner races with the special tool (I.D. mark: 30/36).





(4) Insert the spacer and press fit the bearing inner races with the special tool (I.D. mark: OS 35 x 40).





[NOTE]

Always use a new oil seal when reassembling the pinion shaft assembly.

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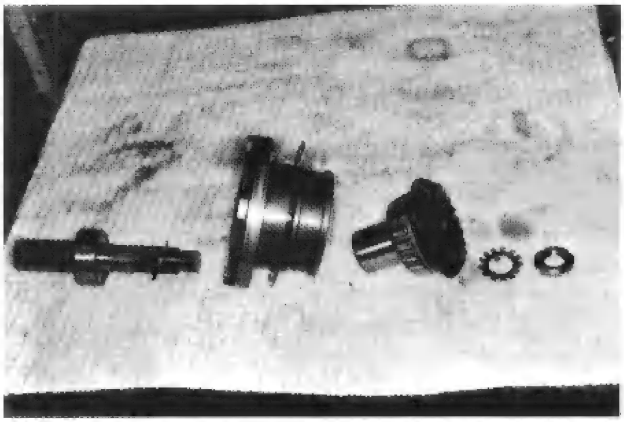
(5) Insert the pinion shaft, together with the collar and shims, into the housing and tighten the lock nut.



Tightening torque : 2.5 – 3.5 kgf-m

(6) Bend the lock washer to lock the nut.





⚠ IMPORTANT

When the housing, bearing, or upper pinion are replaced, backlash adjustments become necessary. For shim thicknesses, refer to CHAPTER 4 – 3. Adjusting the Upper Pinion Gap (T_1) (p.4-3).

2-1 Reassembling the Upper Gear Case

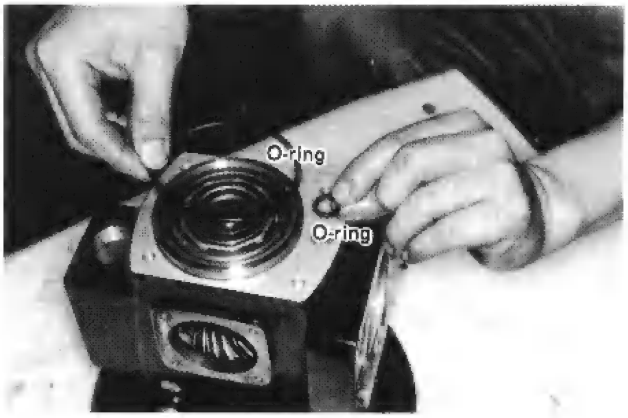
(1) Fit the shim onto the gear (B) assembly.



(2) Assemble the clutch shaft, dog clutch, gear (A), shim, bearing support, and O-ring.



(3) Insert the O-rings.



(4) Attach the upper cover with M8 bolts.



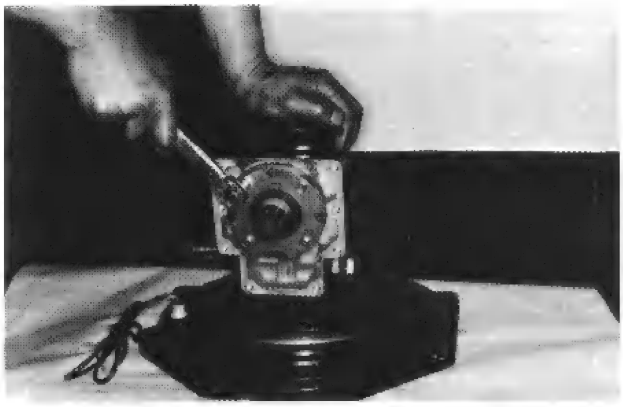
M8 bolt
Tightening torque : 1.4 – 1.6 kgf-m

(5) Assemble the pinion shaft assembly and the shim.



[NOTE]
Always insert the pinion shaft assembly with the lubricating oil hole facing downwards (i.e. on the lower gear case side). In pinion shaft assemblies prior to No. D/#0454, the lubricating oil hole is facing upwards. In the photograph it is facing upwards.

(6) Fix the seal plate with M6 bolts.



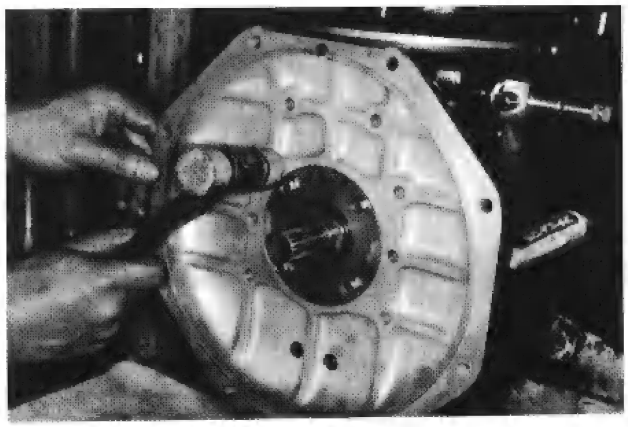
M6 bolt
Tightening torque : 0.5 – 0.7 kgf-m

(7) Attach the anti-corrosion zinc.



[NOTE]
Always attach an O-ring.

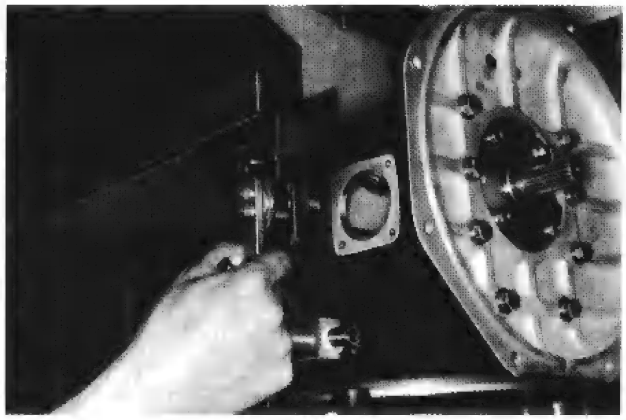
(8) Attach the mounting flange with M8 bolts.



M8 bolt
Tightening torque : 1.4 – 1.6 kgf-m

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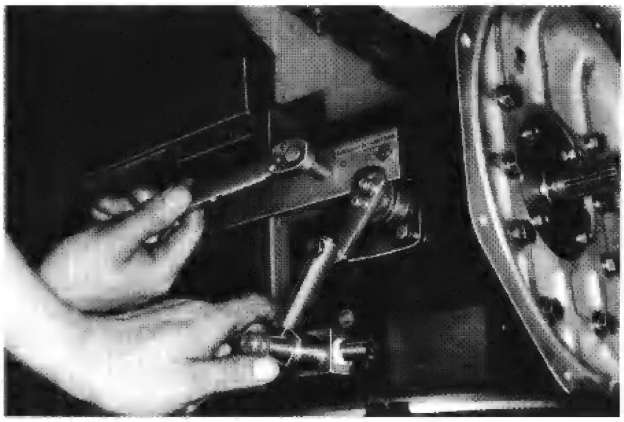
(9) Attach the shift lever assembly.





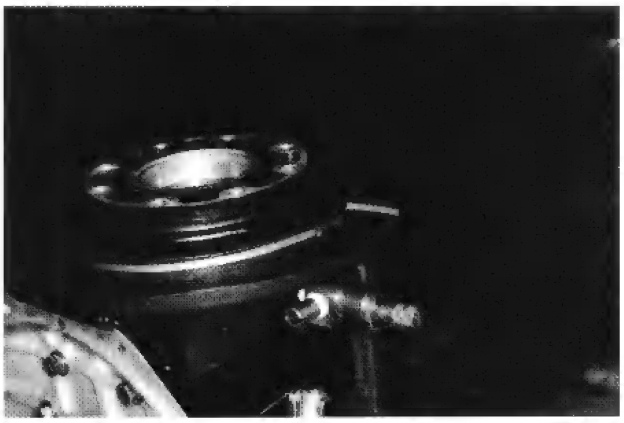
[NOTE]
Always attach an O-ring.

(10) Attach the remote control cable support with M6 bolts.

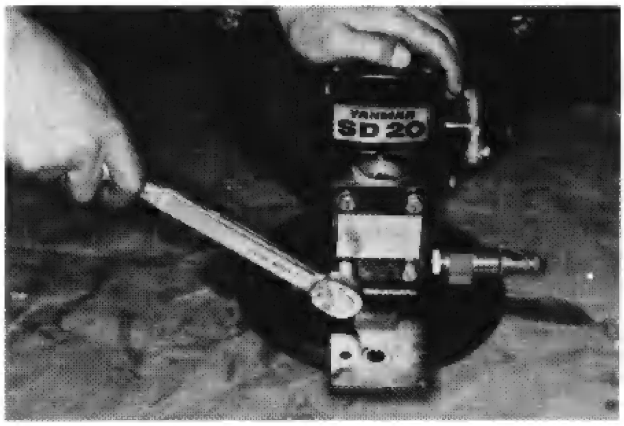


M6 bolt
Tightening torque : 0.5 – 0.7 kgf-m

(11) Attach diaphragm (B) and the small steel band.



(12) Attach the bracket for the flexible mounting with M8 bolts.



M8 bolt
Tightening torque : 1.4 – 1.6 kgf-m

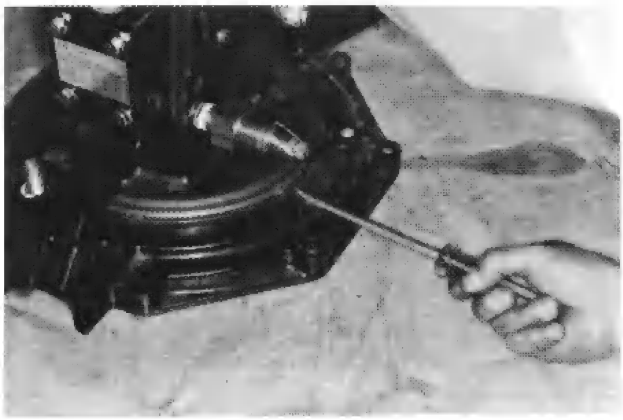
(13) Attach the flexible mounting to the seal flange.



(14) Attach the diaphragm (B) and clamp with the large steel band.



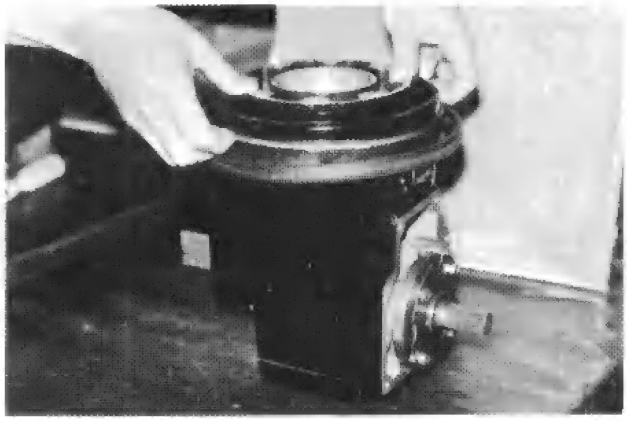
(15) Fold the large steel band in half and lock it with the clamp.



⚠ IMPORTANT

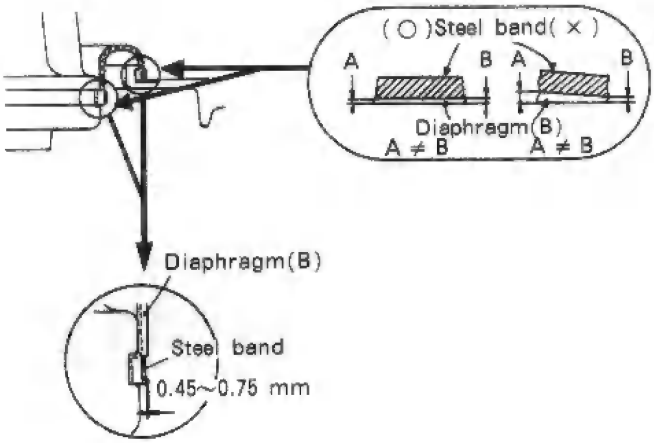
After installing the steel bands, make sure they:

(1) do not come off when pulled on as demonstrated in the photograph.



(2) are parallel.

(3) fit 0.45 – 0.75mm into the diaphragm, as shown in the illustration.



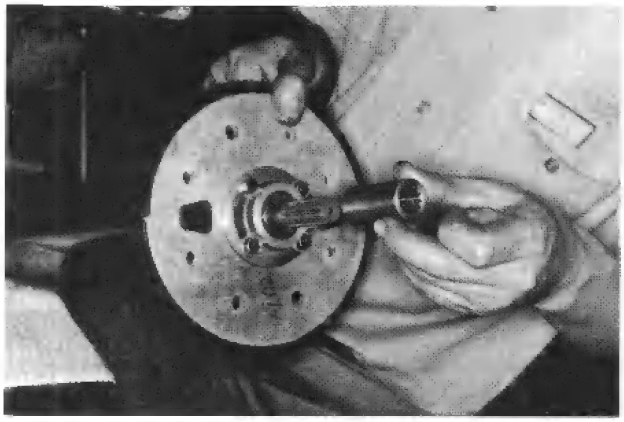
[NOTE]

These figures, 0.45 – 0.75mm, are only a guide. Some deviation is acceptable as long as the bands do not move or come off.

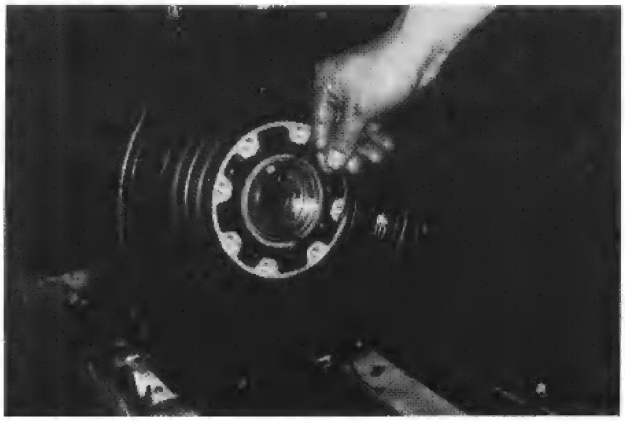
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3. Reassembling the Upper and Lower Gear Cases

(1) Slip the spline sleeve over the drive pinion shaft.



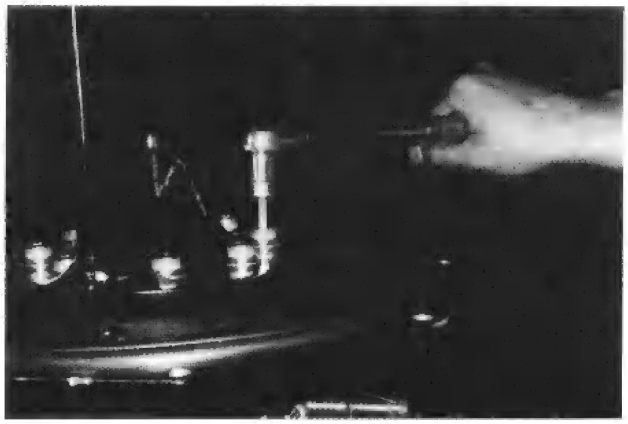
(2) Place an O-ring in the upper gear case.



(3) Place diaphragm (A) in the upper gear case and attach the lower gear case.

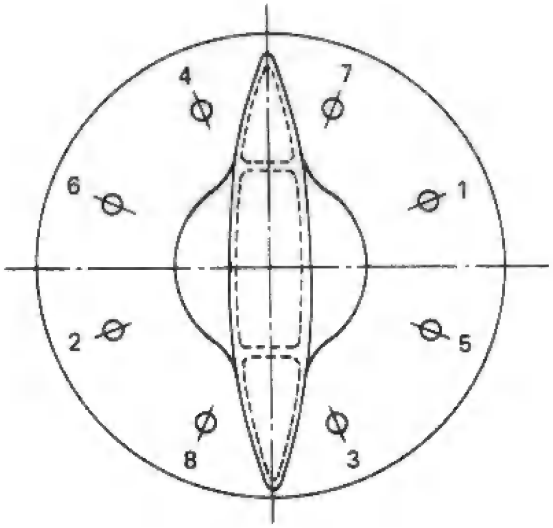


(4) Coat the threads of the M10 fastening bolts connecting the upper and lower gear cases with liquid gasket.



M10 bolt
Tightening torque : 2.8 – 3.2 kgf-m





[NOTE]
First finger-tighten the fastening bolts in the order shown in the illustration. Then, in the same order, tighten them to the specified torque.

(5) Clamp the flexible mounting to the bracket with M12 nuts and spring washers.



[NOTE]
There are two nut fastenings, an upper and a lower.

M12 nut
Tightening torque : 4.6 – 5.0 kgf-m

(6) Attach the seal sensor.



[NOTE]
Always insert a washer.

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4. Lubrication

(1) Attach the drain plug.

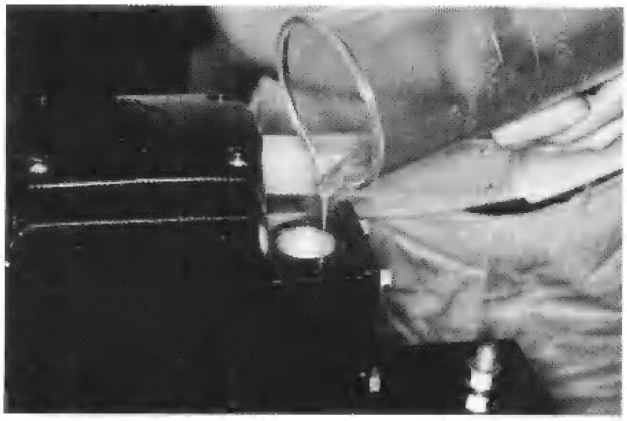


[NOTE]
Always use an O-ring.



M10 thread
Tightening torque : 2.8 – 3.2 kgf-m

(2) Add 2.2 or 2.5 liters of lubricating oil.



Volume :
Standard unit 2.2 ℓ
Long-reach unit 2.5 ℓ
Grade : at least API GL-4
Viscosity : SAE #90 or 80W-90

[NOTE]
Check the oil level with the dipstick.



[NOTE]
Always use gasket.

5. Attaching the Folding Propeller

⚠ IMPORTANT

For metthod of attaching, refer to attaching the propeller manual.

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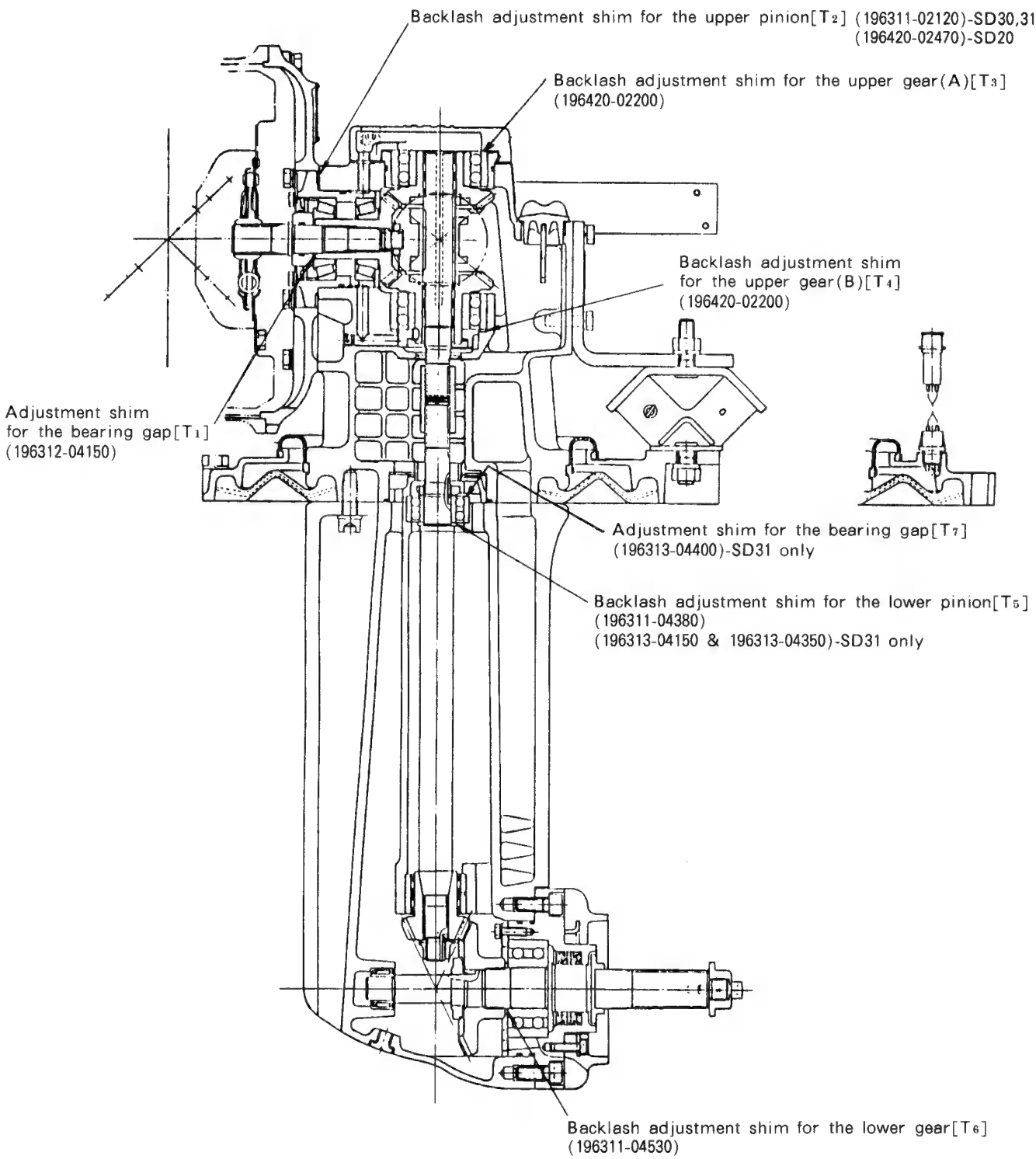
CHAPTER 4

SHIM ADJUSTMENT (Gear Backlash Adjustment)

1. Location of Adjustment Shims 4-1
2. Replacements Requiring Shim Adjustments 4-2
3. Adjusting the Upper Pinion Gap (T_1) 4-3
4. Adjusting the Upper Gear Backlash (T_2, T_3 & T_4) 4-4
5. Adjusting the Lower Gear Backlash (T_5, T_6 & T_7) 4-7

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1. Location of Adjustment Shims



2. Replacements Requiring Shim Adjustments

The Model SD20 & 30 sail-drive unit uses spiral bevel gears to transmit power from the engine. Control of the backlash in these gears is very important. Adjust the shims in accordance with the table below whenever parts are replaced.

Replacement parts		Criteria for replacement		Shim(s) to be adjusted						
		Standard value	Standard service life	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Gears	Upper gear CMP pinion & gears(A)&(B)	1)Siginificant damage on tooth surfaces caused by pitching and foreign particles. 2)Evidence of flaking on the rotating surface of the bearing.	2,000 hrs	○	○	○	○			
	Lower gear CMP pinion & gears							○	○	
Bearings	Taper roller bearing (A) (B/#30206)	1)Evidence of flaking on the rotating surfaces of the bearing. 2)Replacement of upper pinion.	1,500 hrs	○	○					
	Taper roller bearing (B) (B/#30206)			○						
	Taper roller bearing (C) (SD31) (B/#30204DF)	1)Evidence of flaking on the rotating surfaces of the bearing. 2)Replacement of drive shaft.								○
	W - angular bearing (A) (B/#5207)	1)Axle gap ≧ 0.1 mm 2)Replacement of upper gear (A).				○				
	W - angular bearing (B) (B/#5207)	1)Axle gap ≧ 0.1 mm 2)Replacement of upper gear (B).					○			
	W - angular bearing (C) (B/#5207)	1)Axle gap ≧ 0.1 mm 2)Replacement of drive shaft.						○		
	W - angular bearing (D) (B/#5306)	1)Axle gap ≧ 0.1 mm 2)Replacement of propeller shaft.							○	
Shafts	Input shaft coller	Depth of groove in the moving part of the oil seal lip ≧ 0.1 mm	1,500 hrs	○						
	Propeller shaft								○	

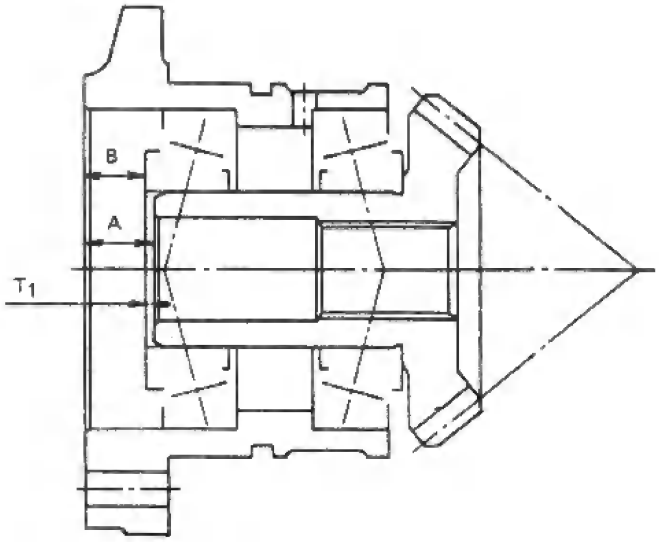
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3. Adjusting the Upper Pinion Gap (T_1)

(1) After press-fitting the bearings and upper pinion into the housing, measure dimensions A and B with a depth micrometer or a dial depth gauge.

A = the distance from the housing face to the upper pinion face

B = the distance from the housing face to the face of the bearing inner race

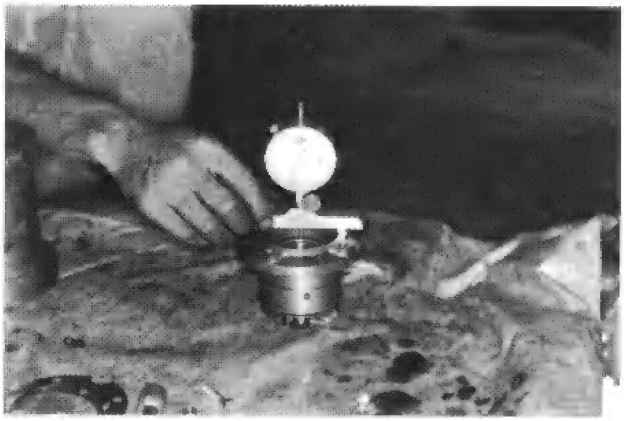


Standard value :
A = 12mm
B = 13mm

(2) Calculate the shim thickness T_1.

$A-B \leq T_1 \leq (A-B) + 0.1$

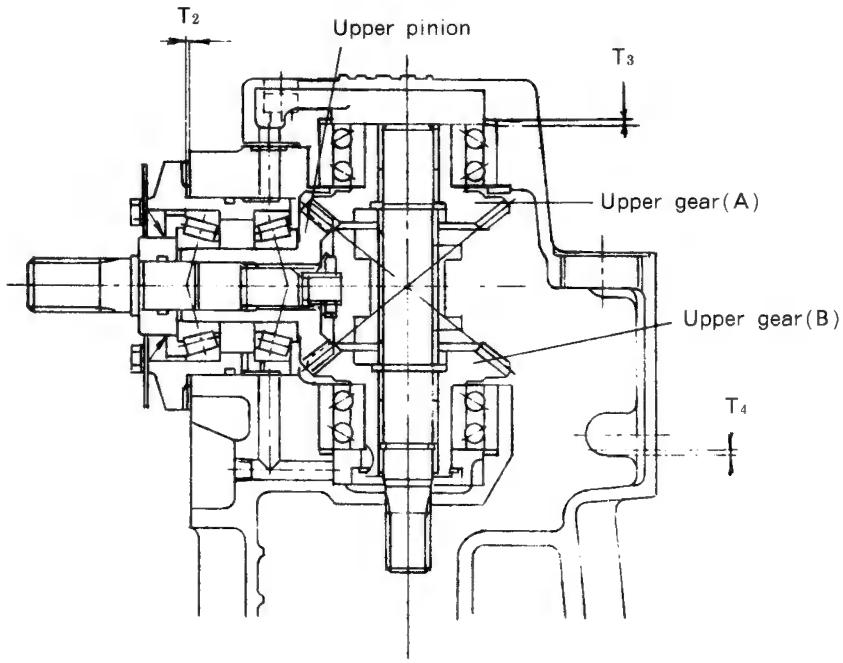
(3) Choose the shim thickness from the T_1 shim set (Parts No. 196312-04150).



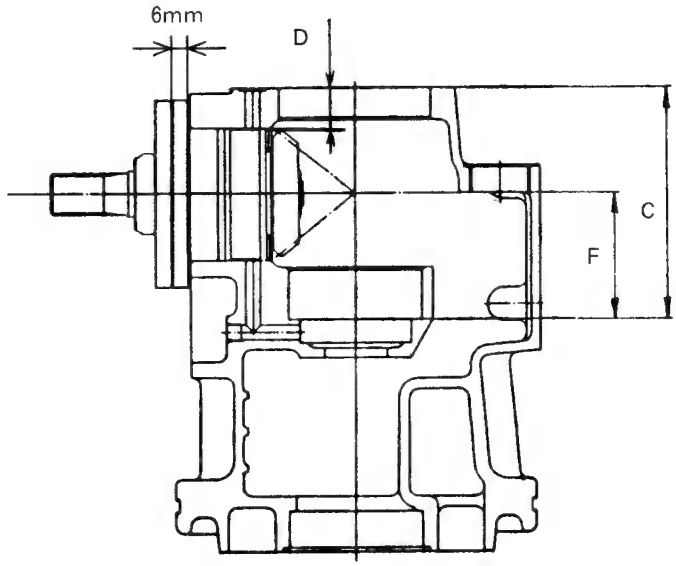
Shim thickness : 0.2, 0.25, 0.3, 0.35, 0.5, 1.0mm

Measuring instrument:
- Depth micrometer or dial depth gauge

4. Adjusting the Upper Gear Backlash (T_2, T_3 & T_4)



(1) Measure the dimension of the upper gear case (C & D) and determine F.

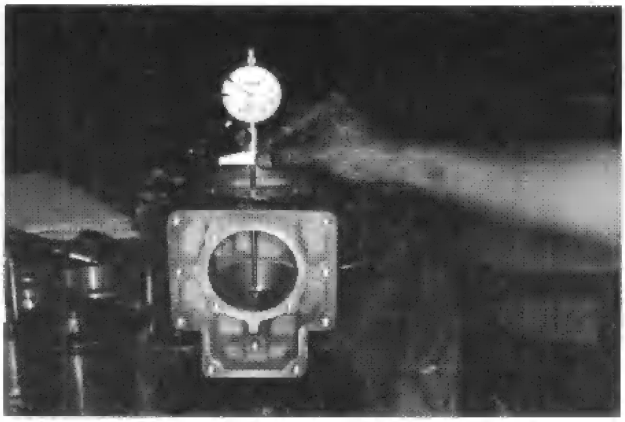


Standard value :
C = 126.5mm
D = 22.0mm

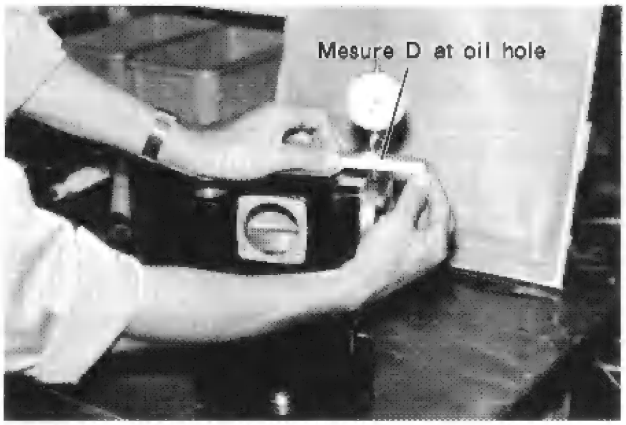
Measuring instrument :
- Depth micrometer or dial depth gauge
- Micrometer

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(1)-1 Measurement of C.



(1)-2 Measurement of D.

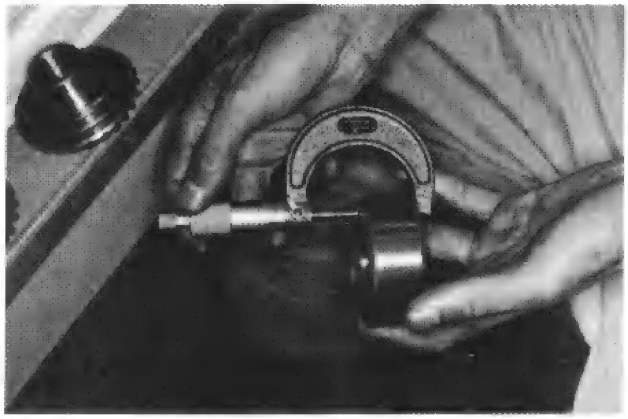


(2) Determine F, the press fit distance for the upper gear (B) bearing.

F = C − D − 36

Standard : 68.5mm

(3) Measure G, the width of the upper gear (B) bearing.

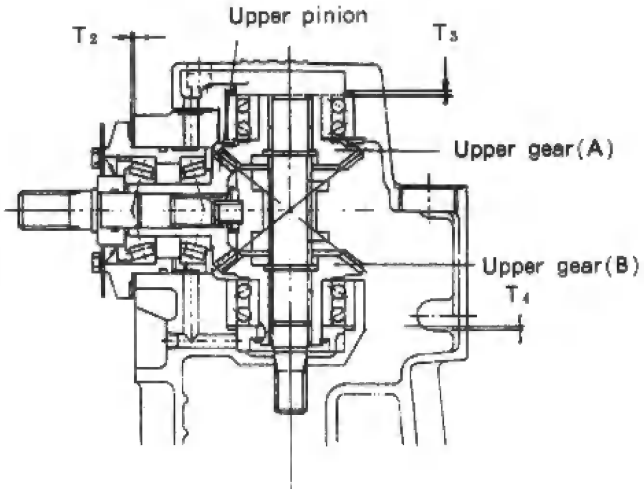


Standard : 27.0mm

(4) Calculate T_4, the thickness of the upper gear (B) shim.

T_4= F − G − 40

Standard : 1.5mm



(5) Measure the backlash between the upper pinion and the upper gear (B). If it exceeds the standard value, reduce T_2 the shim thickness.

Standard backlash : 0.1 − 0.2mm

Standard shim thickness(T_2) : 0.5mm

(6) Measure the backlash between the upper pinion and the upper gear (A). If it exceeds the standard value, reduce T_3, the shim thickness.



[NOTES]

(1) Measure the backlash at the center of the gear teeth.
(2) Measure the backlash with the pinion, gears (A) and (B), and the clutch shaft all in their normal positions. The O-ring may be removed to facilitate disassembly, but always replace it when reassembling the unit.
(3) Measure the backlash with a magnetic base and lever-type dial test indicator.

[Shim sets]

Shim	Parts No.	Thickness (mm)
T_2 (SD20)	196420 - 02470	0.2 , 0.3
T_2 (SD30,31)	196311 - 02120	0.2 , 0.3
T_3	196420 - 02200	1.4 , 1.5 , 1.6 , 1.7
T_4	↑ (Ditto)	↑ (Ditto)

Standard backlash : 0.1 – 0.2mm

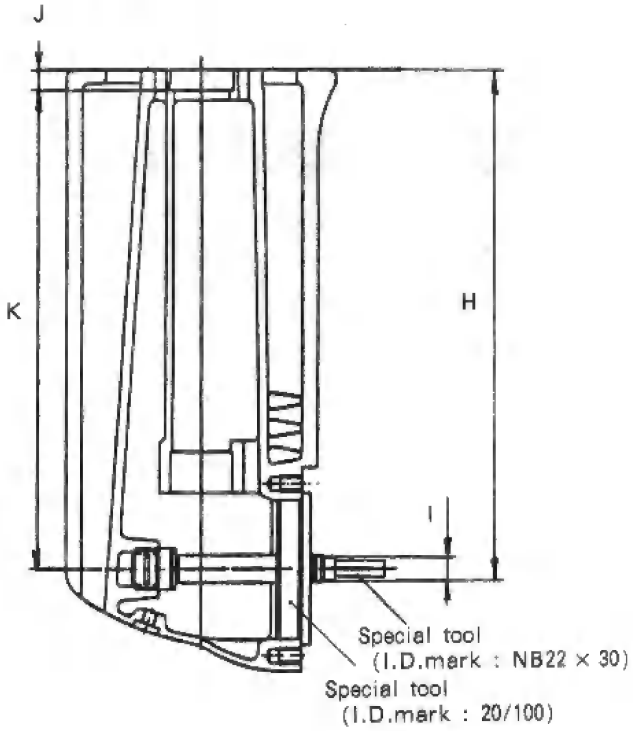
Standard shim thickness (T_3) : 1.5mm

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5. Adjusting the Lower Gear Backlash (T_5, T_6 & T_7)

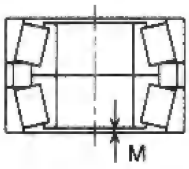
(1) Measure the dimensions of the lower gear case (H, I, & J) and determine K.

Measuring Instruments :
- Surface plate
- Height gauge and lever-type dial indicator
- Depth micrometer or dial depth gauge
- Micrometer
- Special tool
  (I.D. mark : NB 22 x 30)
- Special tool
  (I.D. mark : 20/100)



Standard value :
H = 372.0mm
I = 20.0mm
J = 15.0mm (SD20, 30)
J = 25.5mm (SD31)

Only for SD31



Standard value : M = 1.25mm

Measure the dimension of M of taper-roller bearing.

(1)-1 Measurement of H

Special tools : NB 22 x 30
20/100



(1)-2 Measurement of J



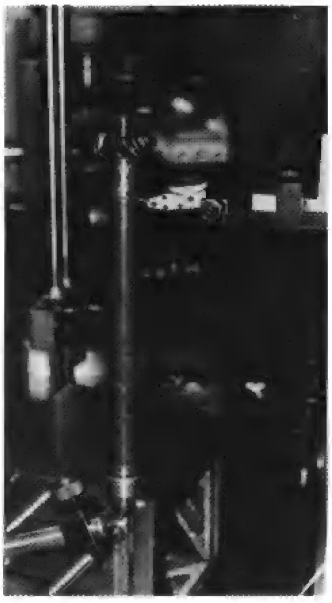
(1)-3 Measurement of I with micrometer

(2) Determine K, the distance between the center of the propeller shaft and the bottom of the bearing.

K = H − I/2 − J

Standard : 347.0mm (SD20,30)
336.5mm (SD31)

(3) Fit the lower pinion over the driving shaft and measure L.





Standard : 257.2mm (SD20,30)
237.6mm (SD31)

Measuring instruments:
- Surface plate
- Height gauge and lever-type dial indicator
- Clamp-type box block

[NOTE]
Attach with the normal tightening torque (6.0 − 7.0 kgf-cm), but without washer.

(4) Calculate T_5, the thickness of the lower pinion shim.

T_5 = K − L − 87 (SD20,30)

Standard : 2.8mm

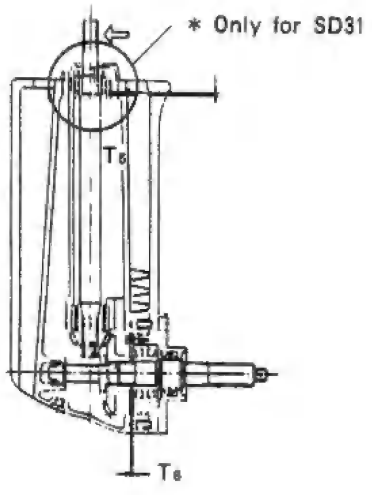
T_5 = K + M − L − 97 (SD31)

Standard : 3.1mm

[T_5 Shim sets]

Parts No.	Thickness (mm)
196311-04380 (SD20 , 30)	2.3 , 2.4 , 2.5 , 2.6 , 2.7 , 2.8 , 2.9 , 3.0
196313-04150 (SD31)	2.2 , 2.3 , 3.2
196313-04350 (SD31)	0.2 , 0.3





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(5) Measure the backlash between the lower pinion and the lower gear. If it exceeds the standard value, increase T_5, the shim thickness.

Standard backlash : 0.036 – 0.072mm

Standard shim thickness (T_6) : 2.0mm

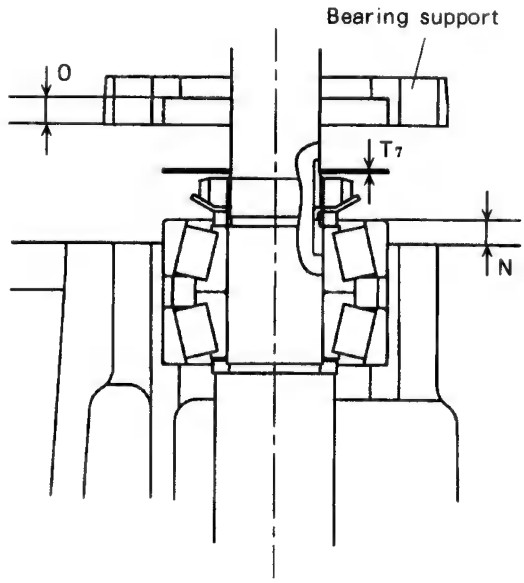
T_6 shim set (Parts No. 196311-04530)

Thickness : 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2mm

[NOTE]

Measure the backlash with the lower pinion, gear, and bearings all in their normal positions. The O-ring may be removed to facilitate disassembly, but always replace it when reassembling the unit.

* Only for SD31



1) Measure dimension of O.

Standard value : 5.6mm

2) Measure dimension of N
Distance from surface to top of bearing.

Standard value : 5.0mm

$0-N < T_7 \leqq (0-N) + 0.1$

Standard value : 0.6mm

T_7 shim set (Parts No. 196313-04400)

Thickness : 0.2, 0.25, 0.3, 0.35, 0.5mm

CHAPTER 5

BEARING & OIL SEAL REPLACEMENT

1. Replacing the Upper Gear (A) & (B) Bearing 5-1
   1-1 Disassembly 5-1
   1-2 Reassembly 5-2
2. Replacing the Clutch Shaft Dog Clutch & Needle Bearings 5-3
   2-1 Disassembly 5-3
   2-2 Reassembly 5-3
3. Replacing the Driving Shaft Bearing 5-4
   3-1 Disassembly 5-4
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4. Replacing the Propeller Shaft Bearing 5-6
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5. Replacing the Propeller Shaft Oil Seal 5-8
   5-1 Disassembly 5-8
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   6-2 Reassembling the Driving Shaft Needle Bearings 5-10
   6-3 Disassembling the Propeller Shaft Needle Bearings 5-11
   6-4 Reassembling the Propeller Shaft Needle Bearings 5-11

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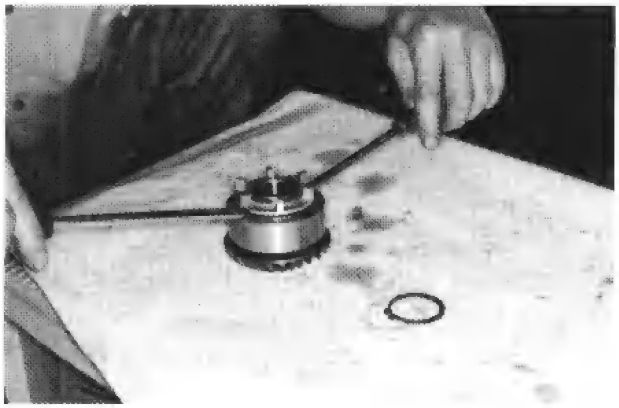
1. Replacing the Upper Gear (A) & (B) Bearing

1-1 Disassembly

(1) Remove the circlip.
Gear (B) only

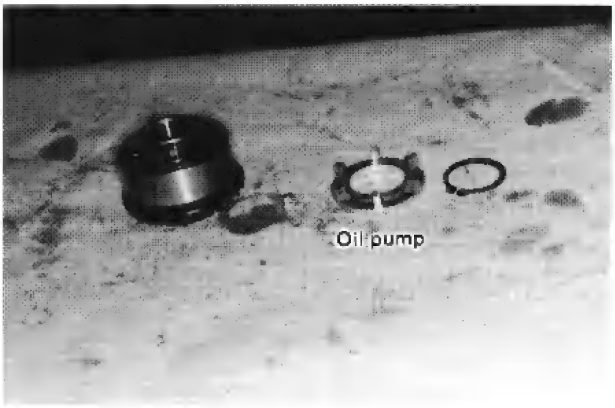


(2) To remove the oil pump, press up on the sides.
Gear (B) only



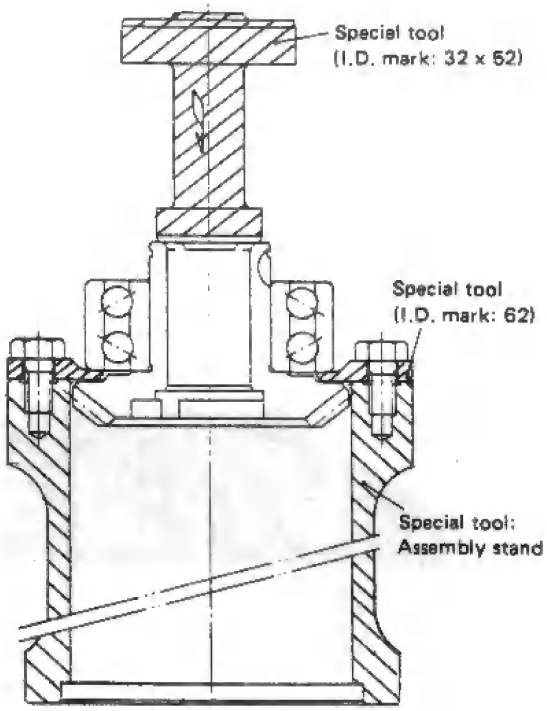
[NOTE]
Replace the oil pump if there are scratches or scars on its outer surface.

Replacement standard : an outer diameter ≦ 59.3 mm



(3) Remove the upper gear (B) from the bearing support with the special tool (I.D. mark: 32x52).

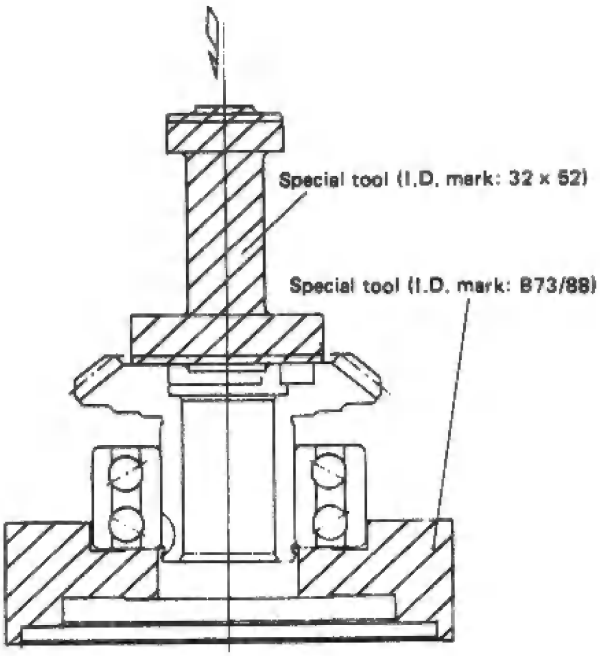




1-2 Reassembly

(1) Press fit the bearing into the upper gear (B) with the special tool.





(2) Drive the woodruff key into the upper gear (B), press fit the oil pump into place, and insert the circlip into the groove in the upper gear (B).

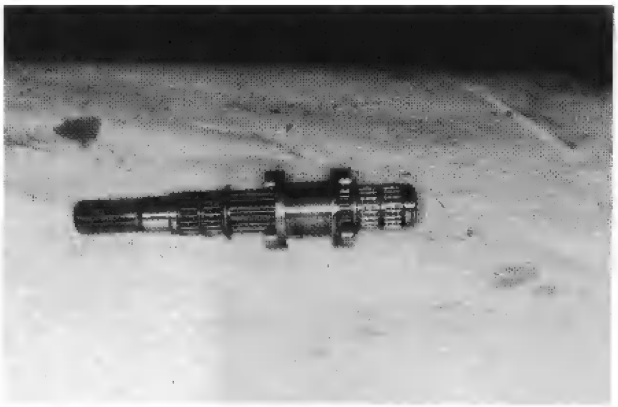


[NOTE]
Make sure that the circlip is firmly in place inside the groove.

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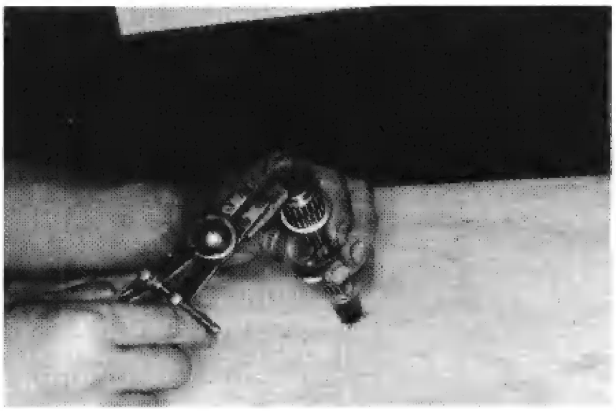
2. Replacing the Clutch Shaft, Dog Clutch & Needle Bearings

2-1 Disassembly



(1) Remove the circlip, dog clutch, and needle bearings.





2-2 Reassembly



Replacement criterion for the dog clutch
When the dog corner (Standard: 0.2 C) reaches the tolerance limit of 3.0 R.

[NOTE]
Replace all the needle bearings

(1) Assemble the needle bearings, collar, and dogs.



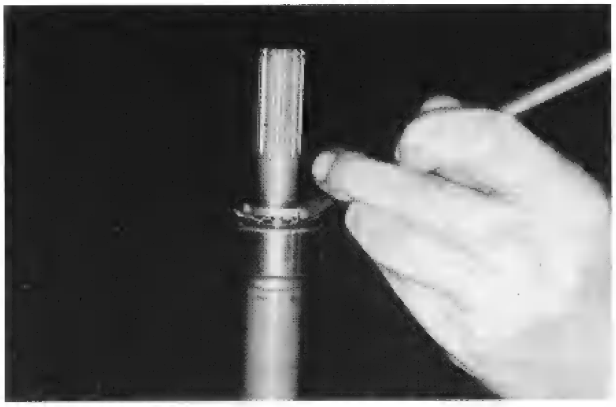
(2) Firmly fit the circlip into the groove in the shaft.



3. Replacing the Driving Shaft Bearing

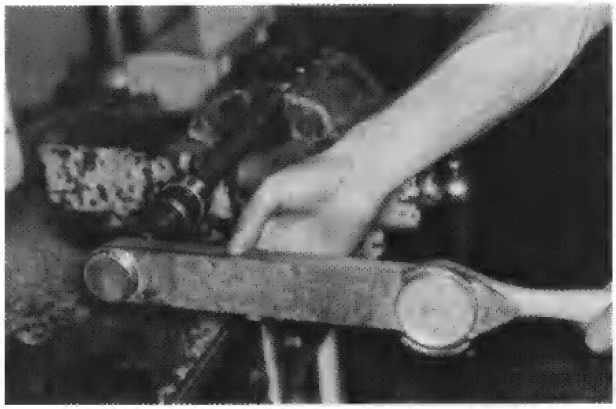
3-1 Disassembly

(1) Remove the lock washer from the lock nut.



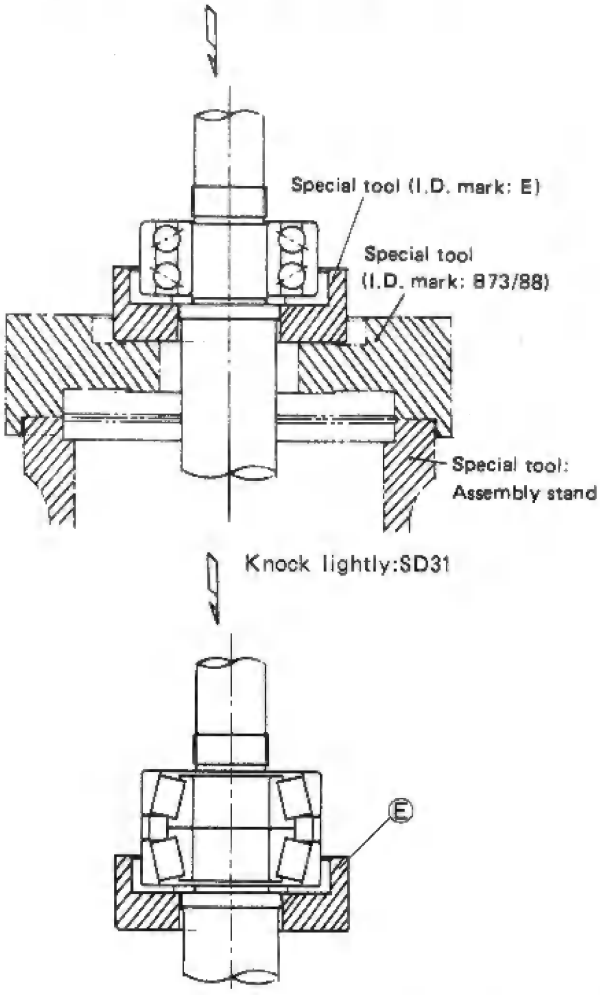
[NOTE]
Always replace the lock washer with a new one.

(2) Insert the splined part of the shaft into the special spline socket (Part No. 196311-92010), clamp the socket in a vise, and remove the lock nut.



(3) Assemble the special tools (I.D. marks: B 73/88 & E) on the special assembly stand and knock the bearing out with a copper hammer.

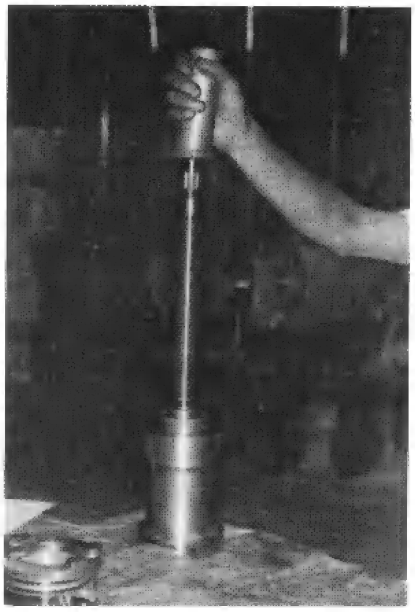


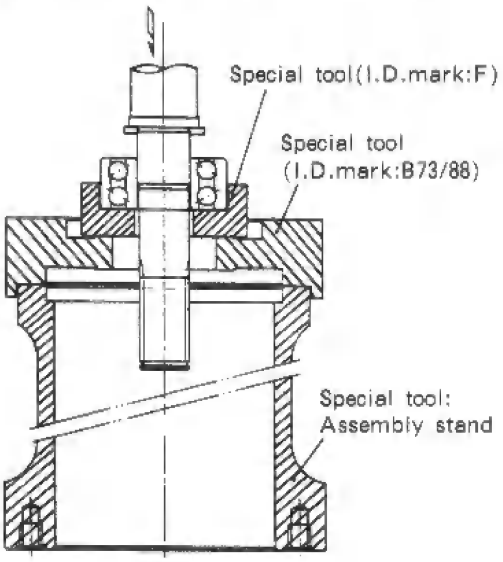


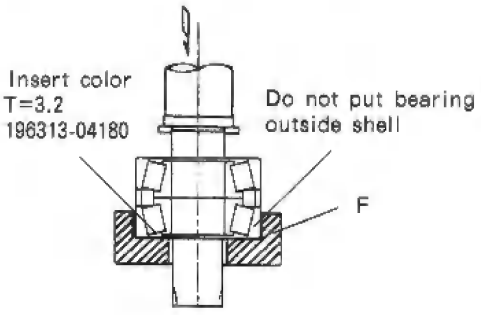
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3-2 Reassembly

(1) Arrange the special tools (I.D. marks: B 73/88 & F) on the special assembly stand and press fit the bearing onto the shaft by tapping the thread with a copper hammer.

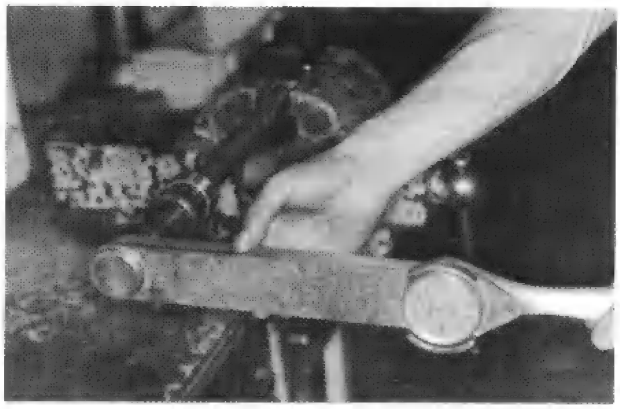






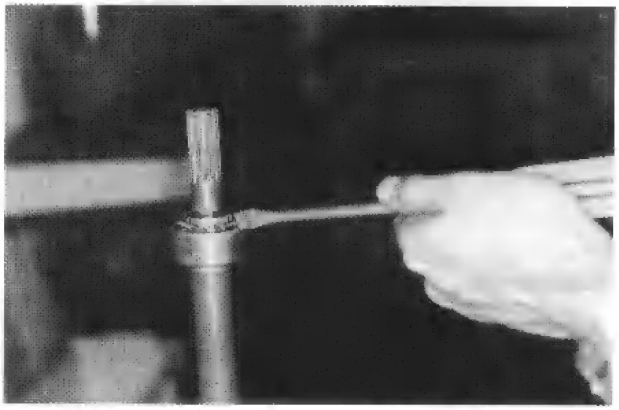
[NOTE]
Be careful not to strip the shaft threads.

(2) Tighten the lock nut with the special tool (Part No. 196311-92030).



Tightening torque : 6.0 – 7.0 kgf-m

(3) Bend the lock washer to lock the nut.

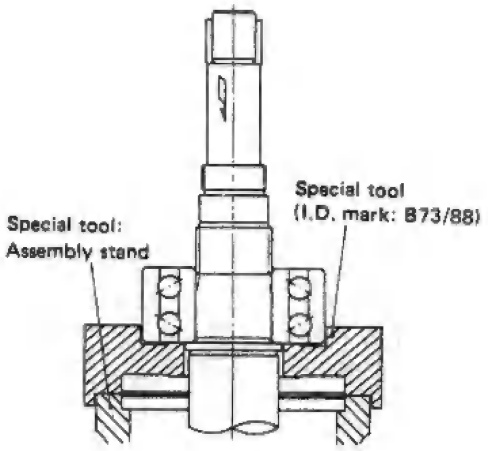


4. Replacing the Propeller Shaft Bearing

4-1 Disassembly

(1) Fit the special tool (I.D. mark: B 73/88) on the special assembly stand and knock the bearing out by carefully tapping the propeller shaft on the needle bearing side with a copper hammer.



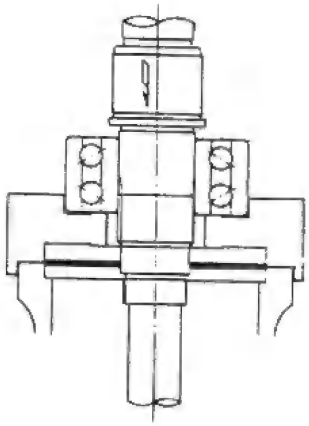


[NOTE]
Scars, scratches or other defects on the propeller shaft make it difficult to remove the needle bearing inner races. Tap lightly to avoid damage.

4-2 Reassembly

(1) Using the same special tools, tap the shaft on the threaded side with a wooden mallet or copper hammer to press fit the bearing onto the shaft.

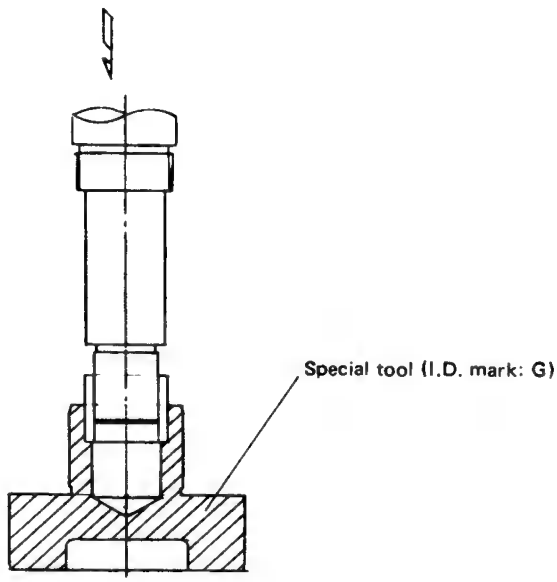




[NOTE]
Be careful not to strip or damage the shaft threads.

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(2) Use the special tool (I.D. mark: G) to press fit the needle bearing inner races onto the shaft.



5. Replacing the Propeller Shaft Oil Seal

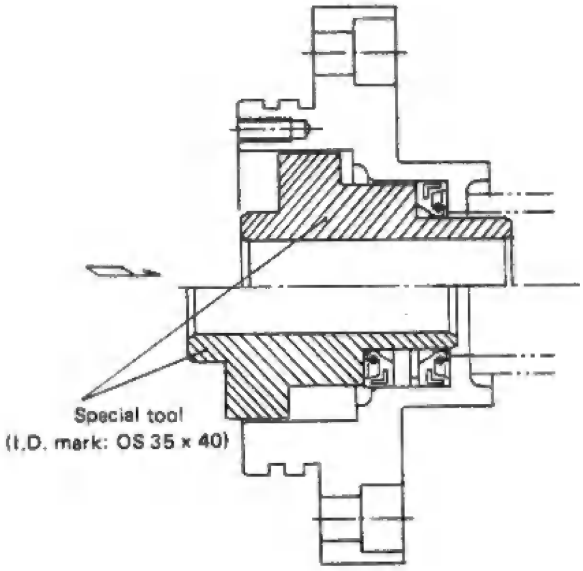
5-1 Disassembly

(1) Remove the oil seals from the rear cover by tapping them with a screwdriver or tool.

5-2 Reassembly

(1) Coat the inner and outer surfaces of the oil seals with waterproof grease.





(2) Insert the oil seals into the rear cover with the special tool (I.D. mark: OS 35x40).



(3) After insertion, once again coat them with grease and attach the rear cover to the lower gear case.

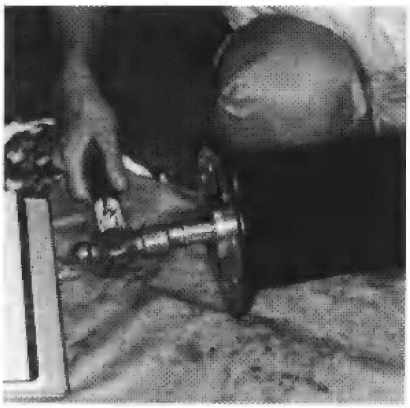


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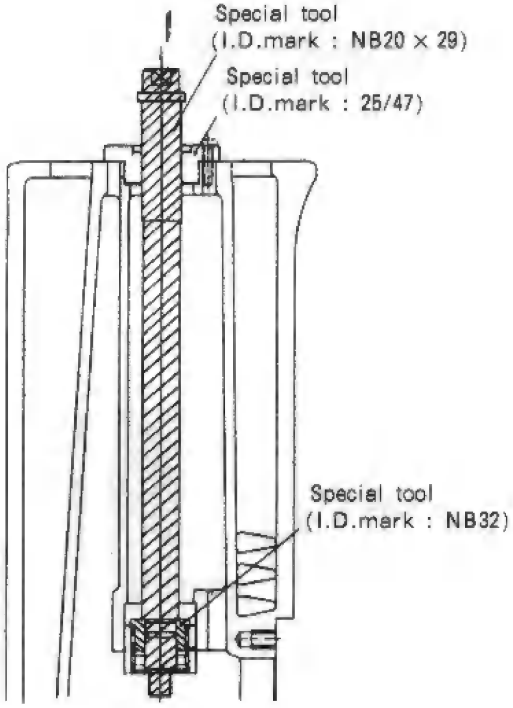
6. Replacing the Lower Gear Case Needle Bearings

6-1 Disassembling the Driving Shaft Needle Bearings

(1) Attach the special tools (I.D. marks: NB 20x29, 25/47, & NB 32) to the lower gear case. Tap the special tool (I.D. mark: NB 20x29) on the upper gear case to remove the needle bearings.







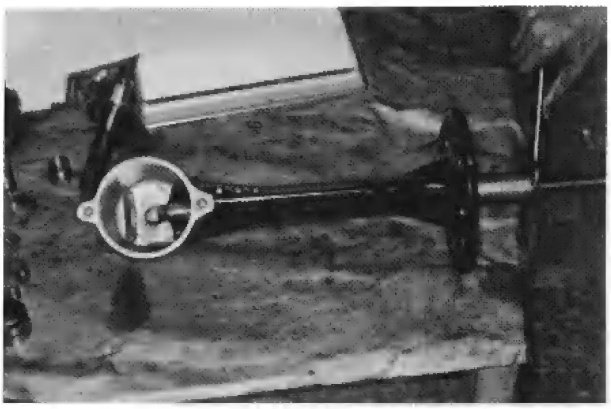
- Reference -

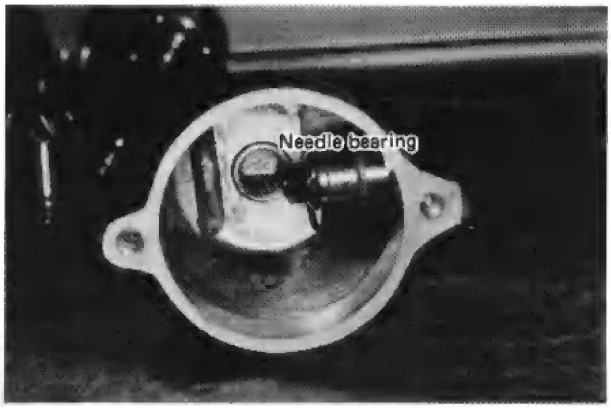
Special tool for removing the driving shaft needle bearings.

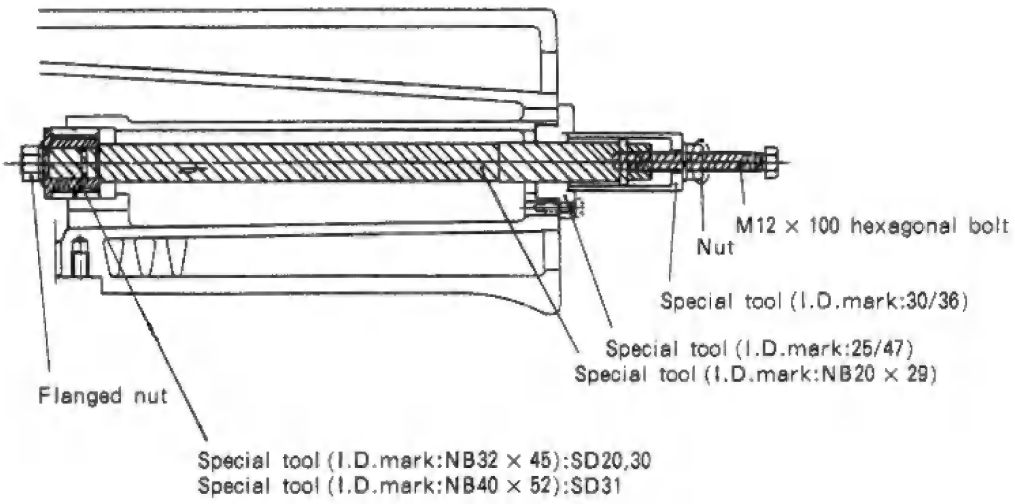
Refer to drawing of Z1-96431-0140 for SD31 disassemble

6-2 Reassembling the Driving Shaft Needle Bearings

(1) Attach the needle bearings to the special tools and fit them onto the lower gear case. Press fit the needle bearings with M12x85 hexagonal bolt. After press fitting, remove the special tools.







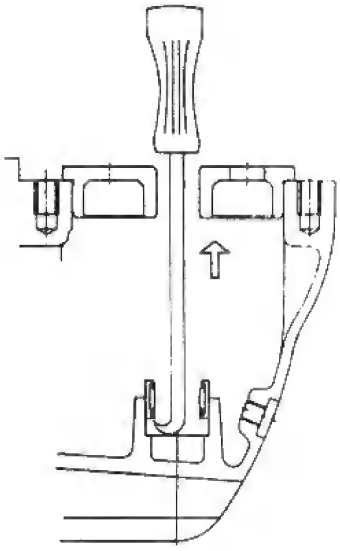
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6-3 Disassembling the Propeller Shaft Needle Bearings

(1) Soak the lower gear case, including the needle bearings, in oil heated 100°C for 10 to 15 minutes.



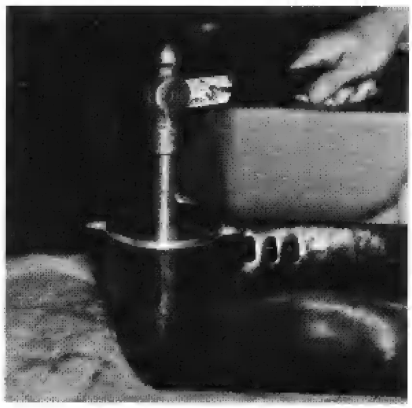
(2) Remove the heated needle bearings from the lower gear case with the special tool indicated in the illustration.

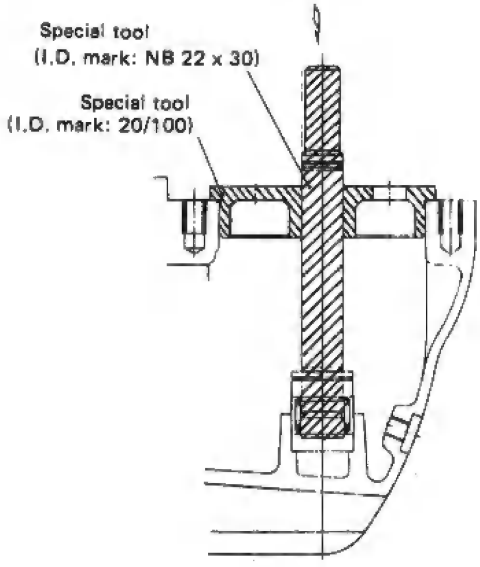


6-4 Reassembling the Propeller Shaft Needle Bearings

(1) Insert the needle bearings with the special tools (I.D. marks: NB 22x30 & 20/100).







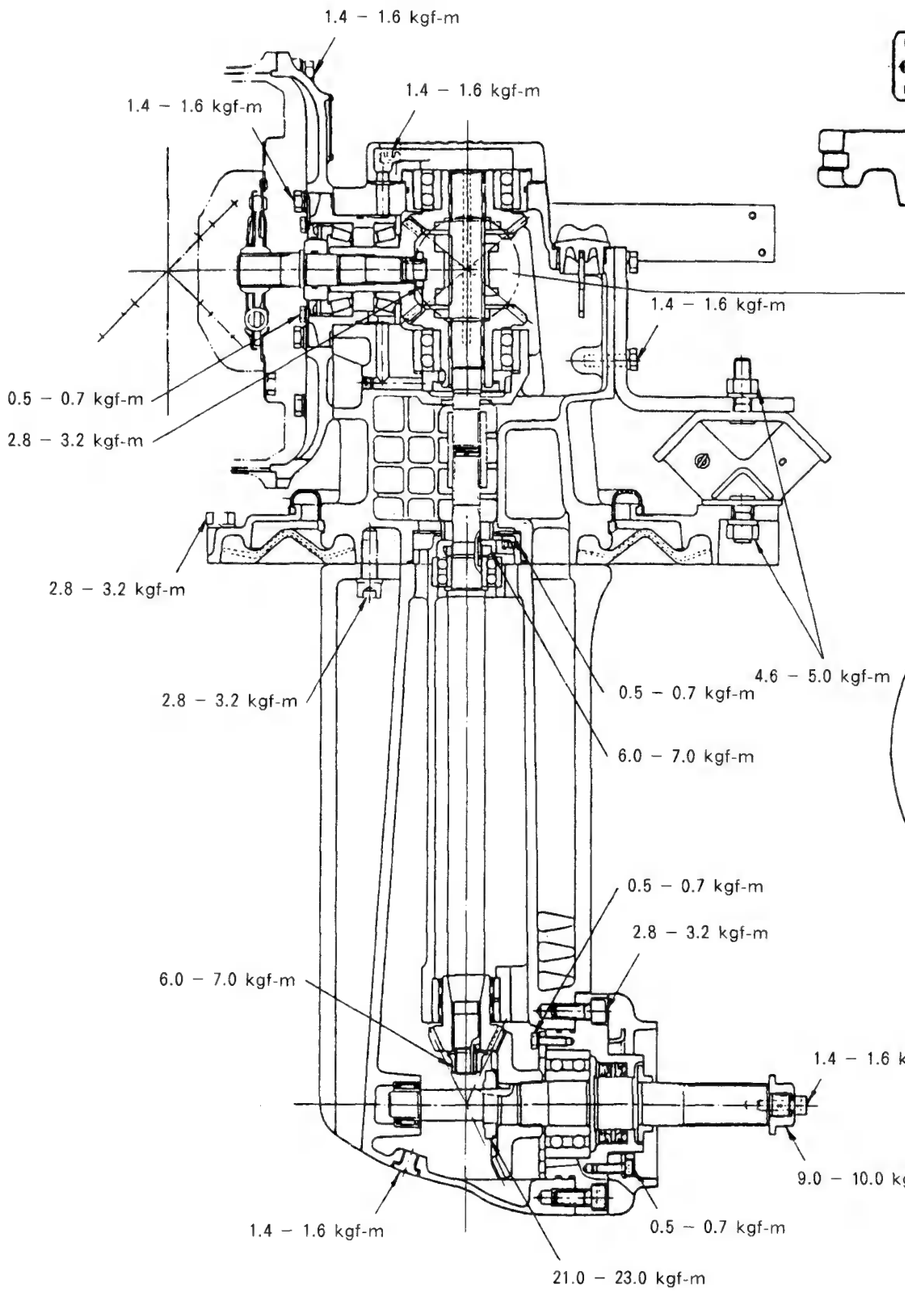
CHAPTER 6

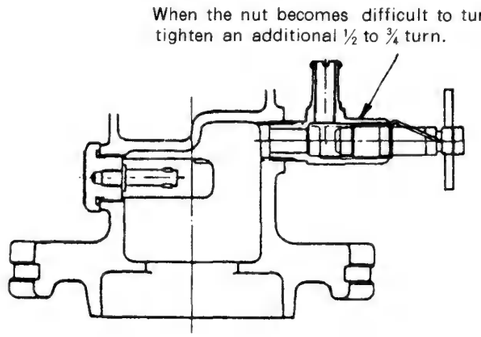
TIGHTENING TORQUES FOR NUTS AND BOLTS

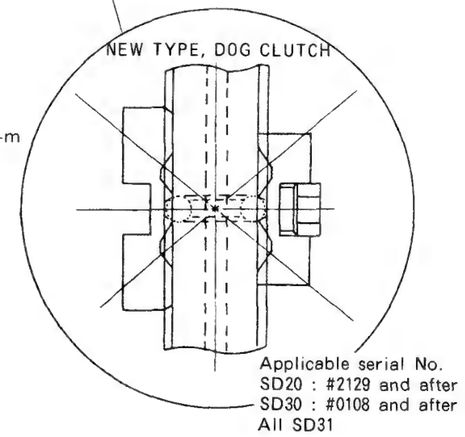
1. Tightening Torques for Nuts and Bolts 6-1
1-1 Tightening Torques & Adjustment Dimensions 6-2

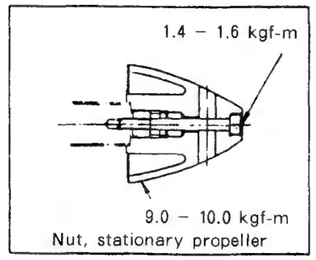
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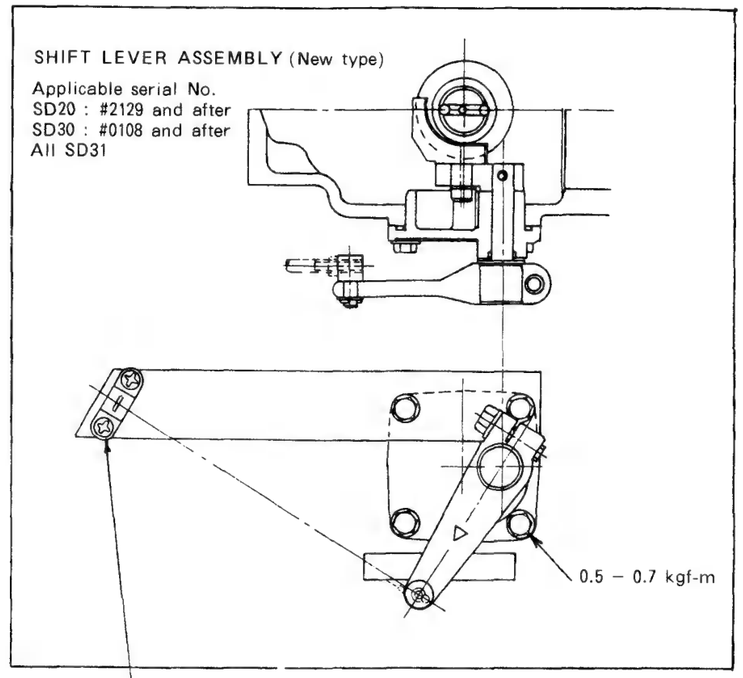
1. Tightening Torques for Nuts and Bolts

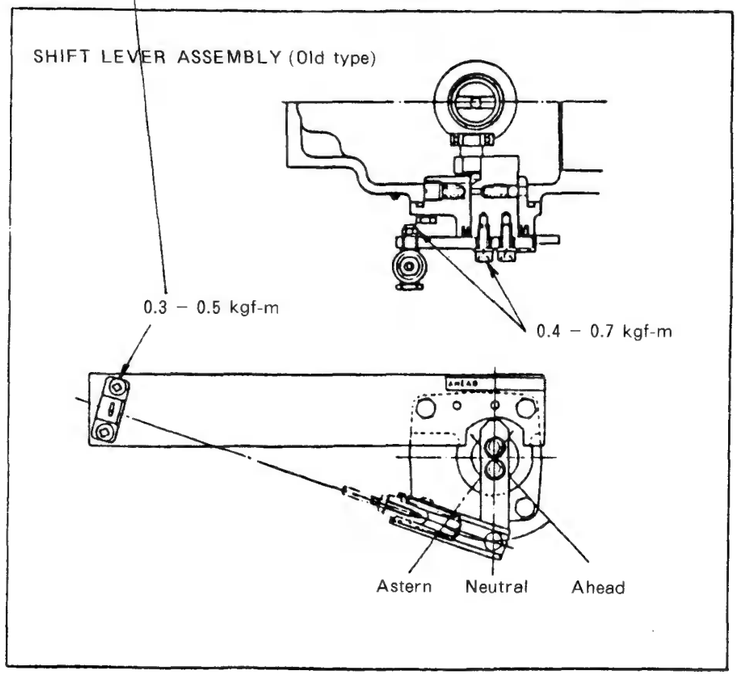












1-1 Tightening Torques & Adjustment Dimensions

Item			Standard value	Procedure
Tightening torque	Major parts	M14 nuts (lower pinion)	6.0 – 7.0 kgf-m	Lock with lock wahers.
		#15 bearing nuts (upper pinion)	2.8 – 3.2 kgf-m	
		#20 bearing nuts (driving shaft bearing)	6.0 – 7.0 kgf-m	
		#25 bearing nuts (lower gear)	21.0 – 23.0 kgf-m	
		PT 1/2 (CW cock) SD20,30 PT 1 (CW cock) SD31	When the nut becomes difficult to turn, tighten an additional ½ to ¾ turn.	Apply sealing tape.
	Other nuts and bolts	M5 bolts (cable clamps)	0.3 – 0.5 kgf-m	
		M6 bolts (anti - corrosive zinc, bearing supports, etc.)	0.5 – 0.7 kgf-m	
		M8 bolts (mounting flange, braces, upper cover)	1.4 – 1.6 kgf-m	
		M10 bolts (case, rear cover)	2.8 – 3.2 kgf-m	
		M12 bolts (rubber pads)	4.6 – 5.0 kgf-m	
Axial gap between the pinion shaft and its taper roller bearings			0 – 0.1mm	Adjustment shim T_1
Backlash	Pinion & gear (A)(upper)		0.1 – 0.2 mm	Adjustment shims T_2 & T_3
	Pinion & gear (B)(upper)		0.1 – 0.2 mm	Adjustment shims T_2 & T_4
	Pinion & gear (lower)		0.1 – 0.2 mm	Adjustment shims T_5 & T_6
Rubber diaphragm (B) interface		Between diaphragm (B) and upper case	dia.1 – 1.5 mm	Adjust by cutting the stick on the one - touch band.
		Between diaphragm (B) and sealing flange	dia.1 – 1.5 mm	

CHAPTER 7

ELECTRICAL WIRING

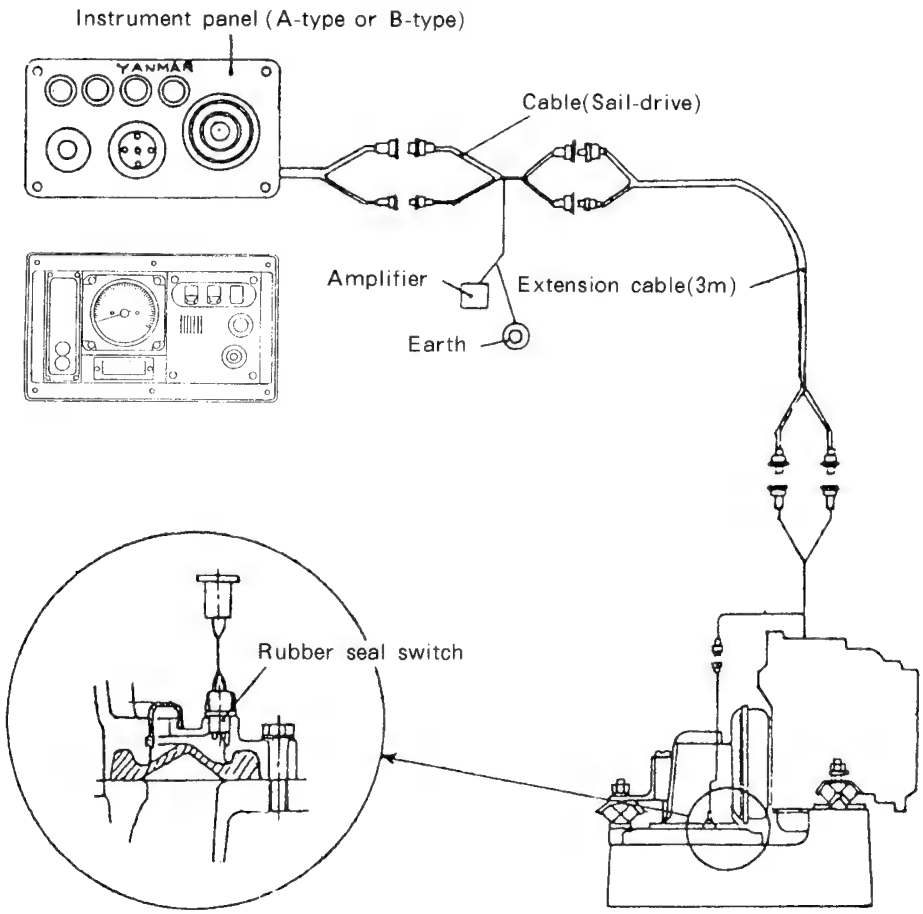
1. Electrical Wiring 7-1
2. Checking Rubber Seal Switch Operation 7-2
3. Electrical Wiring Diagram (A-Type Instrument Panel) 7-3
4. Electrical Wiring Diagram (B-Type Instrument Panel) 7-4

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1. Electrical Wiring

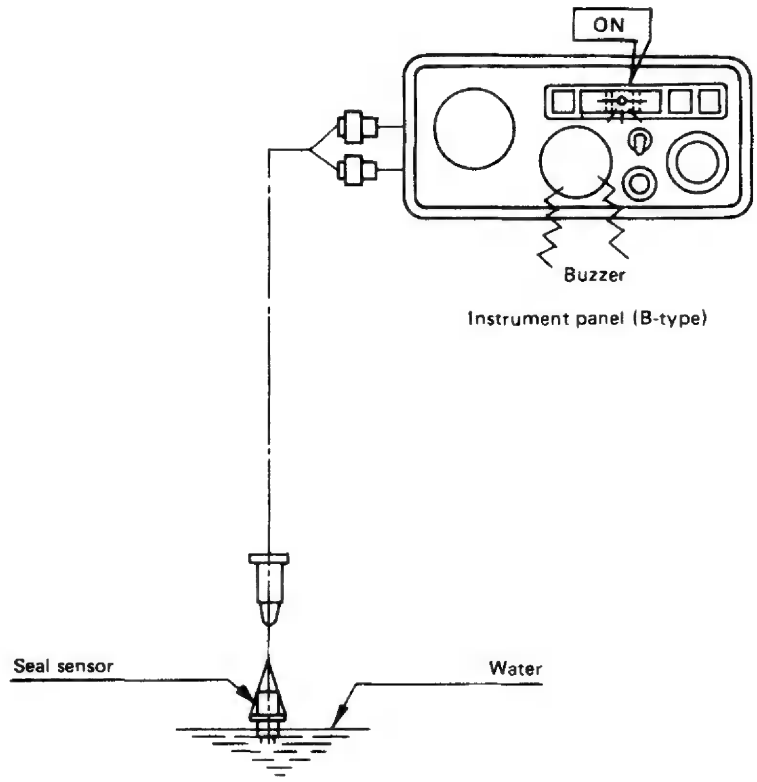
(1) For the Sail Drive rubber seal switch, connect black, white and red wires on the engine side.

(2) Connect the amplifier coupler between the wire harness coupler and extension cable coupler on the engine side.



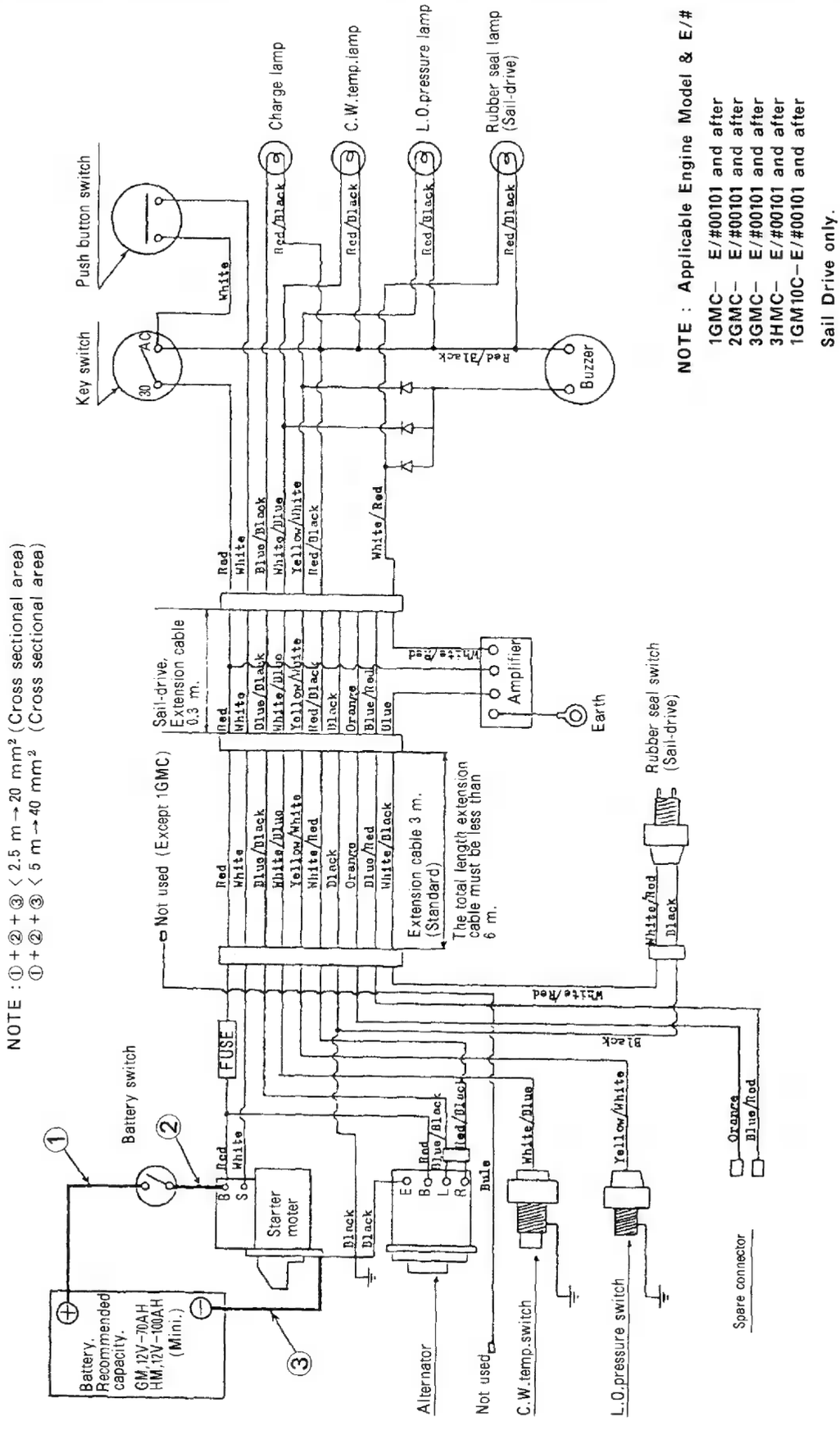
2. Checking Rubber Seal Switch Operation

Turn the battery switch ON. Remove the rubber seal switch from the seal flange. Insert the electrode in water. The rubber seal switch is operating normally if the rubber seal lamp lights and the alarm buzzer sounds.

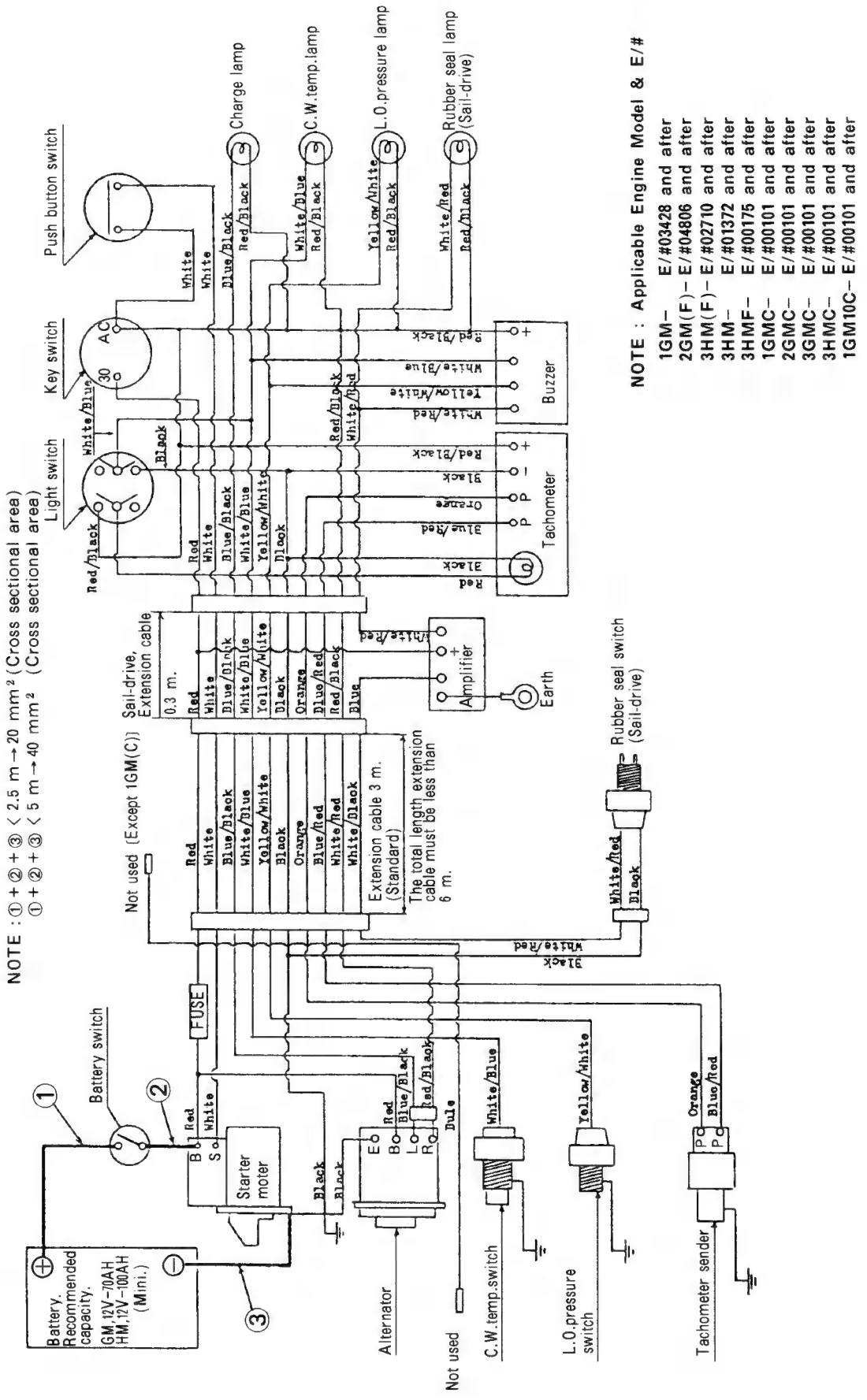


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3. Electrical Wiring Diagram (A-Type Instrument Panel)



4. Electrical Wiring Diagram (B-Type Instrument Panel)



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CHAPTER 8

MODIFYING, THE LONG-REACH UNIT (Optional Parts)

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   1-2 Modification Method 8-1
   1-3 Kit for Modification as a Long-reach Unit 8-1
2. Modification Method 8-2
   2-1 Disassembly 8-2
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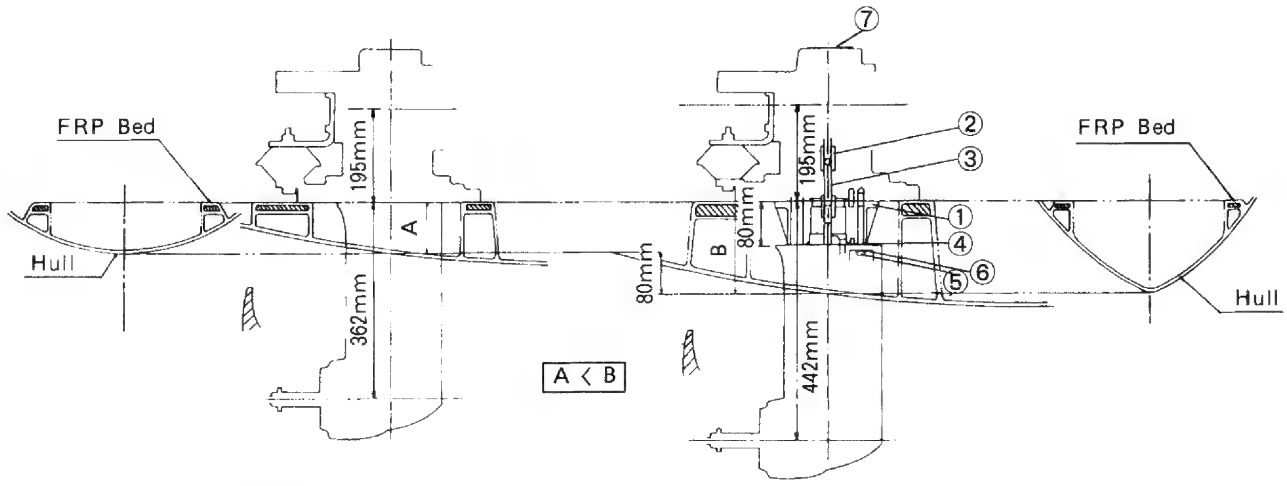
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1. General

1-1 Long-reach Unit (Extension 80 Ass'y Kit)

For installation in hulls with a high engine bed the SD20, 30 & 31 includes extended shaft models with an 80mm longer reach than the standard units.

Comparative Long-reach Unit Vs. Standard Unit



1-2 Modification Method

When modifying a standard unit to a long-reach unit, follow the sequence described in Section 2.

1-3 Kit for Modification as a Long-reach Unit

Extension 80 Ass'y Kit. Part No. 796420-02400

Detail parts for Kit

No.	Description	Q'ty/unit
①	Extension 80 (Spacer)	1
②	Spline sleeve & Circlip	1
③	Spline shaft	1
④	O-ring	2
⑤	Bolt, M10 × 105	8
⑥	Washer	8
⑦	Lube. oil capacity name plate	1

2. Modification Method

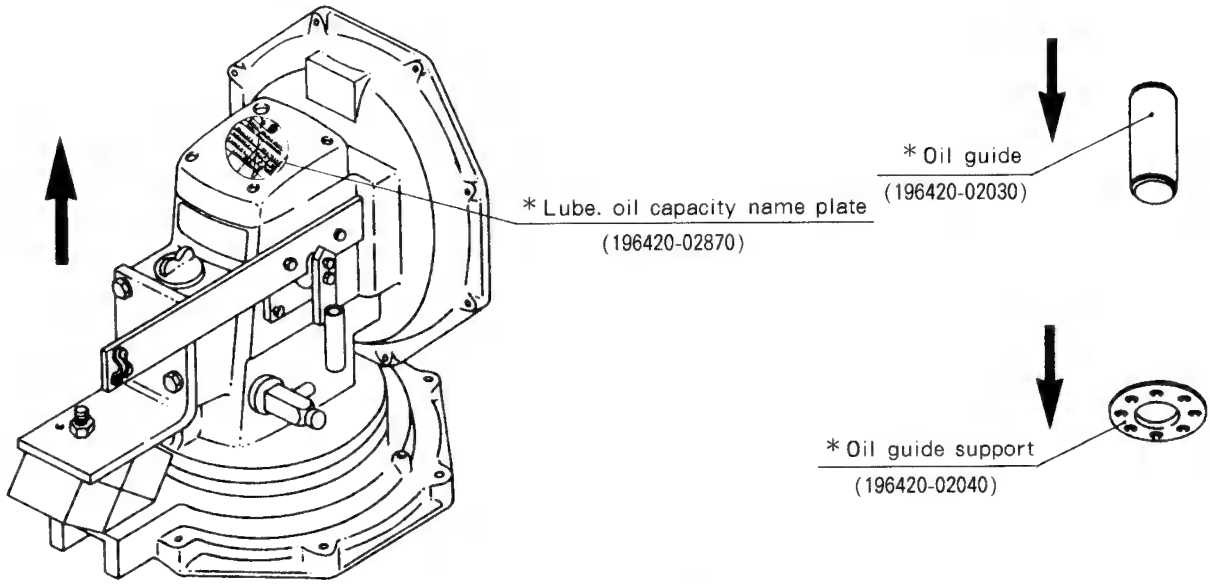
2-1 Disassembly

(1) Remove the lower gear case.

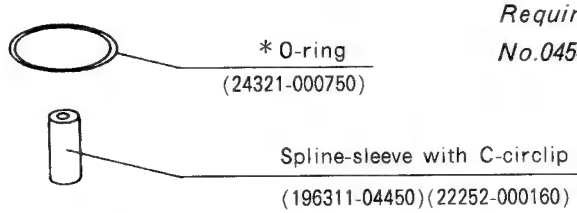
Remove the lower gear case from the upper gear case.

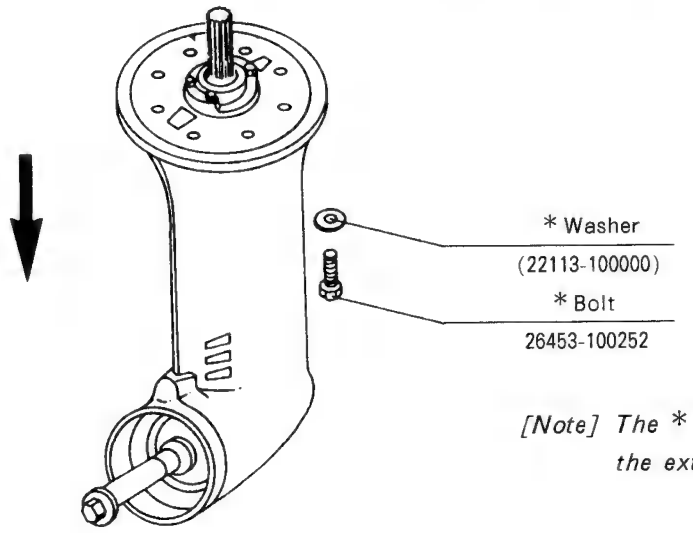
This step is the same as that mentioned on page 2-1 in Chapter 2 of Service Manual (SD20, 30 & 31). Refer to it.

[NOTE]
The oil guide and oil guide support are used in the SD20 serial No. 0001 - 0454 unit. However, they are not required for installing the extension 80 ass'y.



Required only defore installing the SD20 serial No.0454.





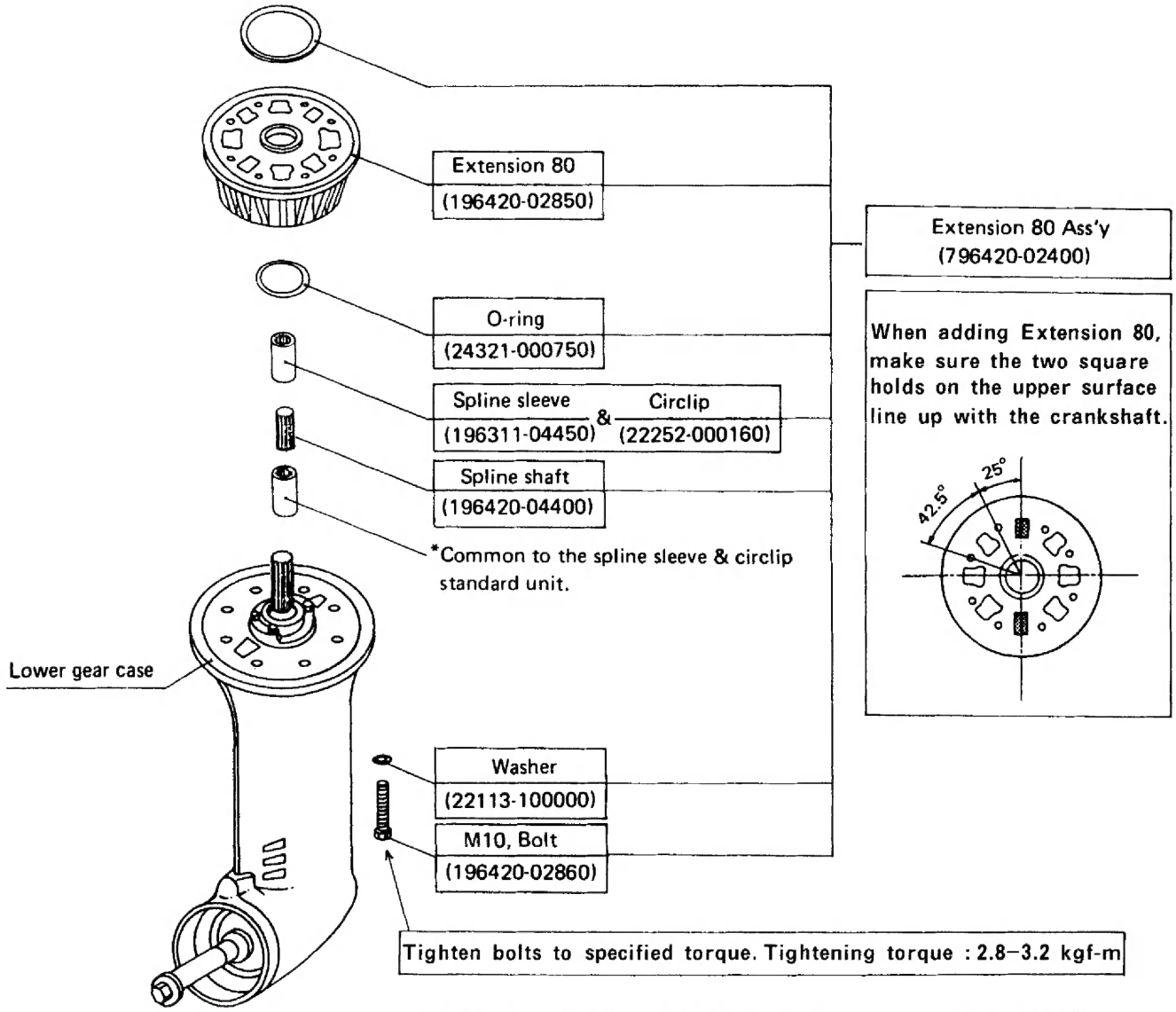
*[Note] The * mark parts are not necessary for installing the extension 80 ass'y.*

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2-2 Reassembly

(1) Assemble the extension 80 kit.

Fit the extension 80 ass'y between the upper and lower gear cases. Refer to page 3-11 in Chapter 3.



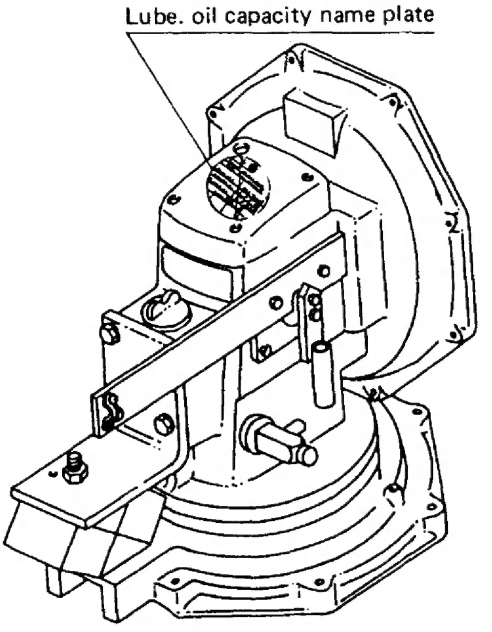
Coat the threads of the M10 fastening bolts connecting the upper and lower gear cases with liquid gasket. (Liquid gasket: Threebond 1215)

(2) Attaching lube oil capacity name plate.

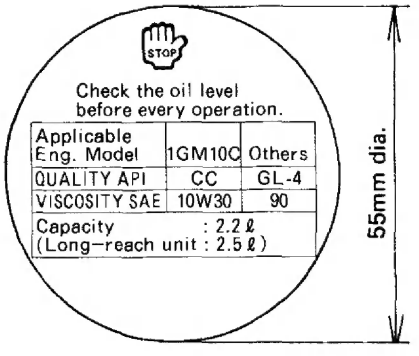
On the lube oil capacity name plate of the upper cover attach the 2.5 ℓ name plate for the long-reach unit.

⚠ IMPORTANT

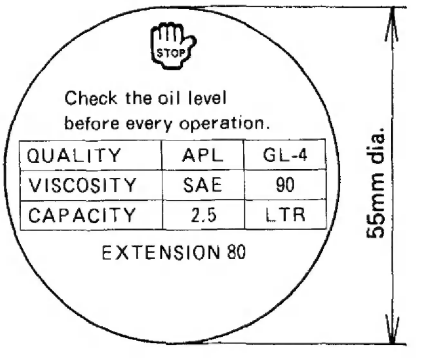
If the extension 80 ass'y kit is installed, the lube oil capacity of the long-reach unit becomes 2.5 ℓ (Standard unit : 2.2 ℓ) Therefore, the lube oil capacity name plate for the long-reach unit shall surely be attached. If the standard unit lube oil capacity 2.2 ℓ is applied to the long-reach unit, each bearing portion inside the unit will be damaged due to lube oil shortage.



[Detail of lub. oil capacity name plate]



Standard Unit
I.D. Color : Yellow



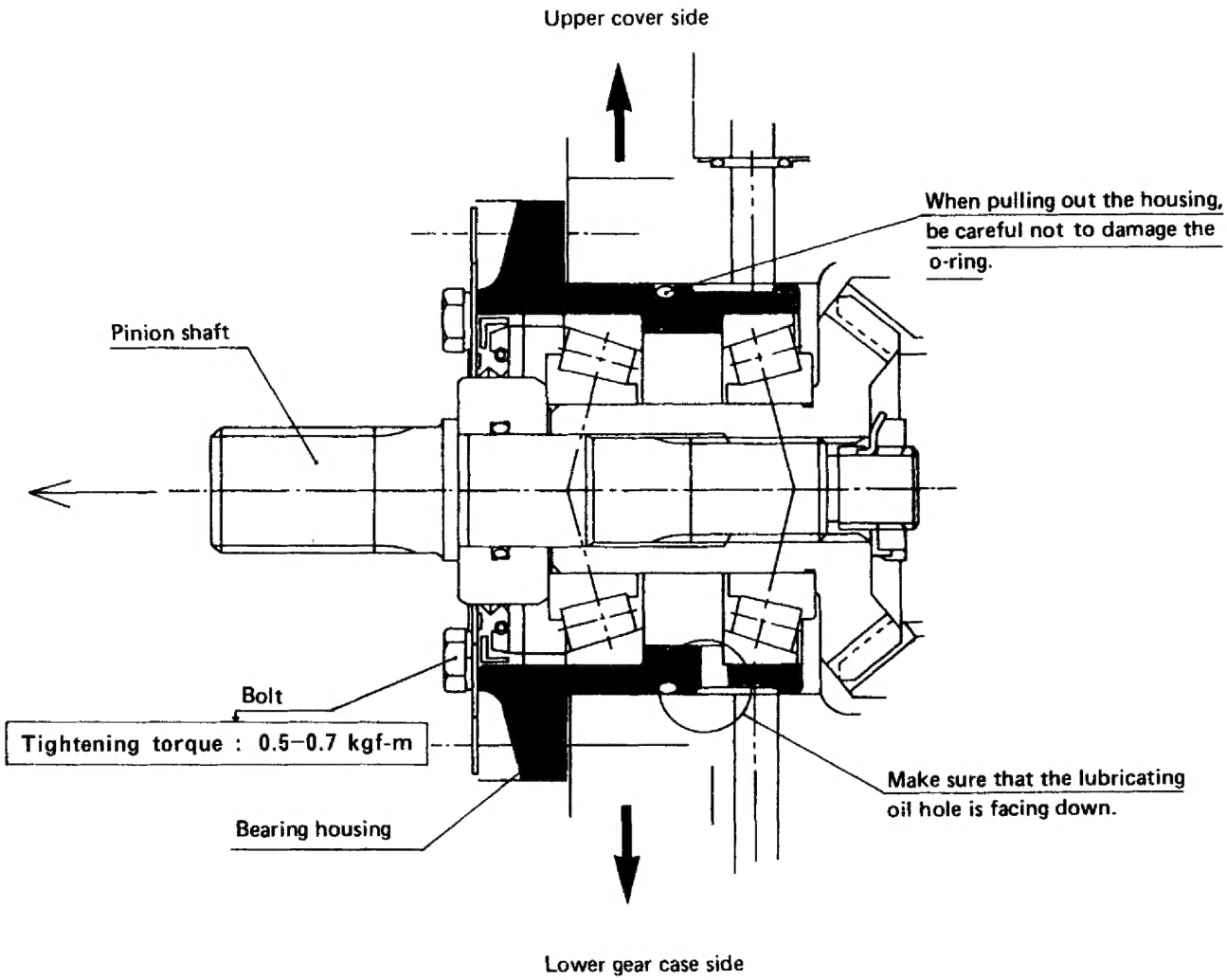
Long-reach Unit
I.D. Color : White

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When the extension 80 ass'y is fitted to the SD20 serial No. 0001 – 0454 unit, be sure to reassemble the bearing housing lube oil hole of the pinion shaft so that it faces the lower side (lower gear case side).

Remove the bolts on the bearing housing, and make sure that the lubricating oil hole is facing down.
Then retighten the bolts to the specified torque.

Tightening torque : 0.5 – 0.7 kgf-m



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