TUNNEL THRUSTER
MODEL S-300-L
SERIAL NOS. 86.000.435 AND 86.000.436

MANUFACTURED BY:
SCHOTTEL OF AMERICA, INC.
8375 N.W. 56TH STREET
MIAMI, FLORIDA, 33166-4806

T.O. NO.:

DATE ISSUED:

SCHOTTEL

SCHOTTEL-WERFT · Josef Becker GmbH & Co. KG · D-5401 Spay/Rhein

SCHOTTEL

Abnahmeprüfzeugnis
Test Certificate
Certificat d'Essais en Usine
DIN 50049-3. 1 B

Kunde
Customer
Client: HALTER MARINE, INC.

Projekt-Nr.
Project-No
nº de projet: 817

Klassifikation
Classification
Classification:

Gerät
Unit
Appareil: Schottel - TUNNEL THRUSTER

Typ
Type
Type: S-300-L

Bau-Nr.
Serial No.
Nº de serie: 86.000.435
86.000.436

Ausf. Nr.
Constr. No.
Nº de construction:

SRP Typ
SRP Type
SRP Type:

Bau-Nr.
Serial No.
Nº de serie:

Ausf. Nr.
Constr. No.
Nº de construction:

Motor
Prime Mover
Moteur

Fabrikat
Manufact.
Fabrication:

Typ
Type
Type:

Leistung KW/UPM
Power KW/RPM
Puissance kW-tr/mn:

Bau-Nr.
Serial No.
Nº de serie:

Kupplung
Clutch
Embrayage

Fabrikat
Manufact.
Fabrication:

Typ
Type
Type:

Ausf.-Nr.
Constr. No.
Nº de construction:

Bau-Nr.
Serial No.
Nº de serie:

Hydr. System
Système hydraulique:

Electr. System
Système électrique:

Kraftübertragung
Power Transmission
Transmission de force:

Propeller Nr.
Propeller No.
Nº d'hélice:

Steuerung Typ
Steering Type
Type du système d'orientation:

Nr.
No.
Nº.:

Bemerkung
Remark
Remarques:

Als von der Fertigung unabhängige Prüfstelle bestätigen wir aufgrund von zahlenmäßigen Ergebnissen aus Prüfungen an der Lieferung selbst, daß das Gerät den Vereinbarungen der Bestellung, insbesondere
a) den Werkstofforderungen b) der Maßhaltigkeit c) der Funktionstüchtigkeit entspricht.
Wir übernehmen hierfür die vertraglich vereinbarte Garantie.

We, independant control department, hereby certify, based on numeral results of tests, that the unit corresponds to the agreements of the order, especially
a) to material requisitions b) to respect of dimensions c) to efficiency.
We herewith overtake the contractually agreed guarantee.

Nous, soussignés, du département contrôle, indépendant du département production, certifions par le présent document, basé sur les résultats chiffrés des essais, que l'équipement correspond bien à la commande, en particulier en ce qui concerne:
a) les matières premières b) le respect des dimensions c) le bon fonctionnement.
Nous prenons donc en charge la garantie contractuelle.

Spay, 22. Januar 1987

SCHOTTEL Qualitätssicherung 82

Qualitätssicherung
Quality Assurance
Contrôle Qualité

SAFETY PROCEDURES

Before Operation

Make certain the operating area is clear of obstructions and personnel.

Keep excess grease, oil and other spillage from around exposed surfaces of the bow thruster unit.

During Operation

Always use the simple and fundamental rules of safety when operating this unit.

Do not perform maintanance on the unit while running.

After Operation

Make certain that the throttle is fully closed and the prime mover is properly secured.

Stop all operations when cleaning, adjusting or lubricating the unit.

Keep excess grease, oil and other spillage cleaned off the unit at all times.

When performing maintenance on the unit remember that due to size and weight of components, extreme care should be taken when moving, positioning, etc., to prevent personal injury as well as damage to components.

Use proper lifting procedures and proper equipment to lift, move and position components.

When maintenance procedures are terminated, take inventory of tools, shop cloths, etc., to ensure no foreign objects are inside the unit to cause potentially hazardous situations.

RECORD OF CHANGES

CHANGE No.	DATE	TITLE OR BRIEF DESCRIPTION	ENTERED BY

SCHOTTEL TUNNEL BOW THRUSTER

MODEL S-300-L

Schottel of America Contract No.

MILITARY SEALIFT COMMAND

Contract No. N00024-85-2046

Date of Contract:

Hull No.: T-AGOS 13 No. 1123
T-AGOS 14 No. 1124

NAVSHIPS I.D. NO.

TABLE OF CONTENTS

SECTION I

GENERAL INFORMATION

GENERAL INFORMATION

INTRODUCTION

This instruction Manual applies to the Type S-300-L Tunnel Thruster manufactued by Schottel of America, Inc., 8375 N.W. 56 Street, Miami, Florida 33166.

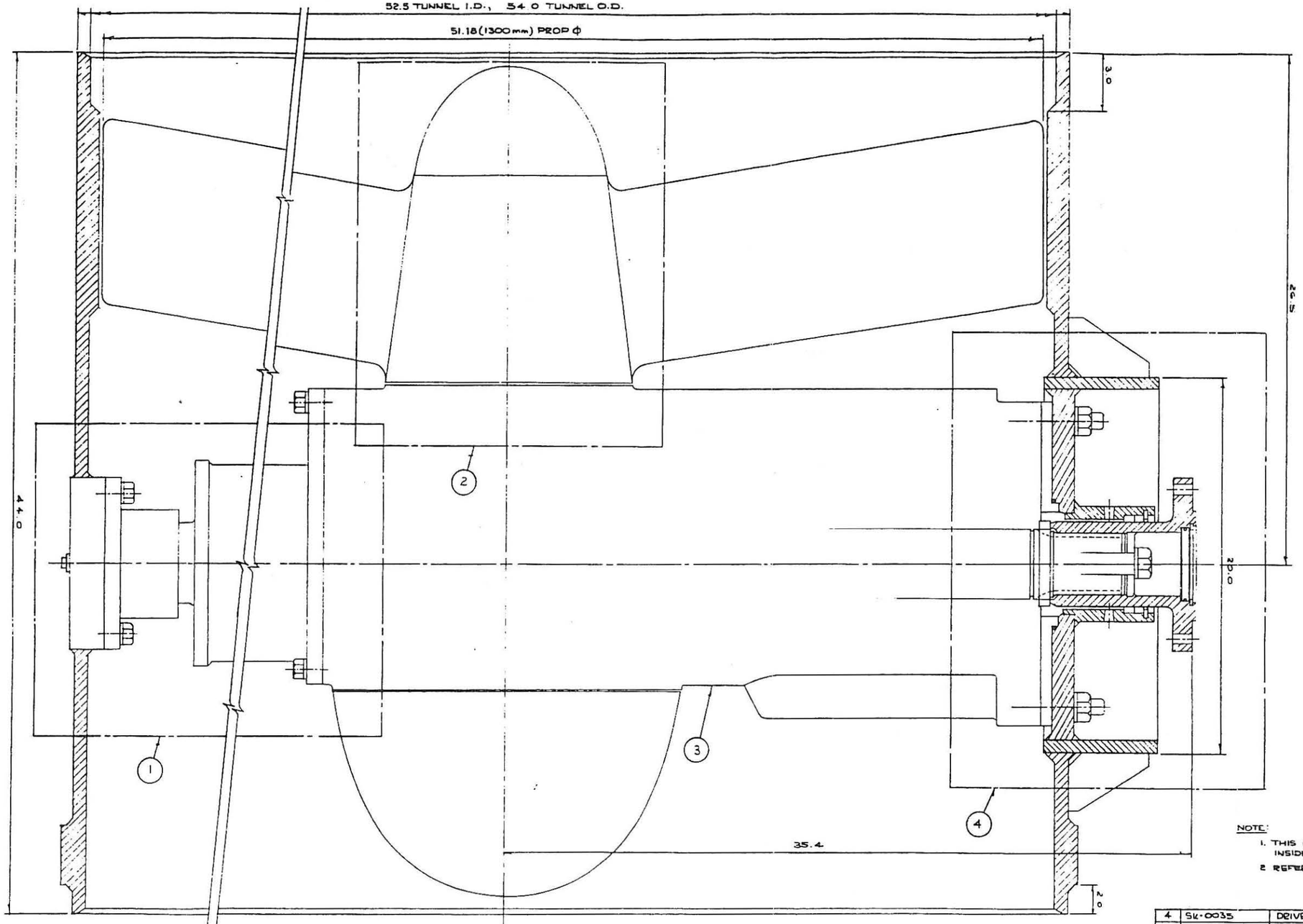
The Tunnel Thruster is a right-angle reduction gearbox designed for underwater operations and provides port-starboard thrust for slow speed maneuvering and docking applications.

The Thruster is designed to operated in either a clockwise or counter-clockwise direction as selected by the controls, and must be fully submerged during operation. Operation in air must be limited to 60 seconds or less.

The only operator's maintenance required is to check the oil level of the lube oil tank on a daily basis.

DESCRIPTION

Manufacturer:	Schottel of America, Inc.
Part Number:	S-300-L
Operating Fluid:	Gear Oil EP
Mounting:	Gearbox bolted on Tunnel Flange
Oil Operating Temp.:	Max. 185° Fahrenheit, 85° Celsius
Weight:	Approximately 4,300 Lbs. (1,954 Kg), with propeller
Lubrication:	External supply is required to maintain static head pressure on gearbox



NOTE:

1. THIS UNIT STANDARD S-300 EXCEPT FOR SKEG AND INSIDE MTD. WEAR RING
2. REFERENCE DWGS. 1062449-1 & -2 FOR FAB DETAILS.

ITEM	FIND NO.	PART NO.	DESCRIPTION	QTY	MATERIAL	CODE IDENT
4		SK-0035	DRIVE FLANGE ASSY.	1		
3		SK-0038	LOWER GEARBOX ASSY	1		
2		SK-0036	PROP HUB ASSY.	1		
1		SK-0037	SKEG ASSY	1		

LIST OF MATERIAL (LM)

HALTER MARINE PURCHASE ORDER No. 262844 ITEM No: 4
QTY PER SHIP: 1ea.
SHIPBUILDERS JOB No(s): M230-308-13 & M231-308-14
SHIPBUILDERS APPROVAL LETTER FILE No. & DATE:
ABS APPROVAL LETTER FILE No. & DATE:
USCG APPROVAL LETTER FILE No. & DATE: NOT REQ'D.

PROJECT T/AGOS 816-817

USED ON NEXT ASSY
APPLICATION

TOLERANCES UNLESS OTHERWISE SPECIFIED:
ANGULAR ±30' LINEAR .X = ±.1 IN. .XX = ±.010 IN. .XXX = ±.010 IN.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED:
- INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY
- SURFACE ROUGHNESS ✓ ALL OVER

MATERIAL SPEC
HEAT TREAT SPEC
FINISH

SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN LOUQUAD
CHECK
ENGR
STRESS
15 JAN 1986
APPROVED

GENERAL ARRANGEMENT
S-300-L TUNNEL THRUSTER T/AGOS

SIZE | CODE IDENT NO. | 1062450 | REV A

CHAPTER I
SECTION 1-2

THIS MANUAL COVERS SCHOTTEL TUNNEL
BOW THRUSTER TYPE S-300-L

1-1 The bow thruster is driven by a prime mover to be rated 550 h.p. at 1200 r.p.m.

1-2 The bow thruster will give equal thrust to port and starboard

1-3 The propeller shaft taper is 1 to 10.

1-4 Propeller Information

Diameter:	51.18 inches (300 mm)
Pitch: (mean)	40.51 inches (1029 mm)
Number of Blades:	4
Blade Area Ratio:	.617

1-5 A separate header oil tank is provided.

1-6 Tunnel Dimensions

Inside Diameter:	52.5 inches
Length:	44 inches
Steel Plate Thickness:	.75 inch
Bow Thruster Weight:	4300 lbs. (approx.)

LUBRICATION INSTRUCTIONS

TO MAINTAIN VALIDITY OF THE GUARANTEE AND INSURE TROUBLE-FREE OPERATION, IT IS IMPERATIVE THAT THE FOLLOWING INSTRUCTIONS BE FOLLOWED:

The transverse thruster unit must be completely filled with oil. A separate tank is supplied and must be mounted above the loaded water line. All oil connections must be in accordance with lube oil system drawing.

VISCOSITY	c St/50°C	30-53
	DIN	C-LP49 DIN 51 517
COMPANY		The load stage of the gearbox oil used must be above 12 of the FZG Test AB.3/90 according to DIN 59 354.
AGIP	Blasia 57	
ARAL	BG 24	
BP	Energol GR-XPG8	
CALTEX	Multipurpose Thuban LP 30	
CASTROL	Alpha 21Z Alpha 31Z	
CHEVRON	Non-Leaded Gear Compound 68	
EXXON	Spartan EP-68	
MOBIL	Mobilgear 626	
SHELL	Omala 68	
TEXACO	Multigear Lubricant EP80 Rando HD 315	

Check the oil level regularly during the first few hours of operation. The oil level will drop due to air trapped in the system; this makes periodic checks essential, as the addition of oil may be necessary.

OIL CHANGE

As with most machinery, the Schottel Bow Thruster unit has a breaking-in period, requiring that the oil be changed for the first time after 250 operating hours; thereafter, the oil should be changed every 2500 hours or at least once a year.

SECTION 2

MAINTENANCE & TROUBLESHOOTING

MAINTENANCE

RECOMMENDED MAINTENANCE SCHEDULE

DAILY	Check oil level in lube oil tank.
MONTHLY	Perform visual check for oil leaks.
SEMI-ANNUALLY	Check all fastenings.
ANNUALLY	Change oil.
BI-ANNUALLY	Check propeller and propeller seals.

THRUSTER TROUBLESHOOTING DATA

TROUBLE	PROBABLE CAUSE (REF. SECTION 4)	REMEDY
Banging Noise	Debris in Thruster Tunnel	Diver sent down to clear tunnel
Excess Vibration	Propeller Blade Damaged	Remove propeller for repair
Oil Leak (Visible)	Defective Seal or O'Ring Dwg. SK-0035 - 7, 8, 9	Locate defective part(s) and replace
Oil Leak (Loss of oil in tank, no visible signs of leak)	Defective Seal or O'Ring Dwg. SK-0035 - 11 SK-0037 - 1, 5, 7 SK-0038 - 4, 8, 44, 40-42, 23	Locate defective part(s) and replace
Water in Oil	Defective Seal or O'Ring Dwg. SK-0035 - 11 SK-0037 - 1, 5, 7 SK-0038 - 4, 8, 44, 40-42, 23	Locate defective part(s) and replace
Water Leak	Defective O'Ring, Loose Fastening Dwg. SK-0035 - 10, 1	Locate defective part(s) and replace
No Power Out-Put Engine Operating Normally	Defective Gears Dwg. SK-0028 - 29, 34	Remove defective part(s) and replace

SECTION 3

SERVICE

GEARBOX REMOVAL

LOWER GEARBOX REMOVAL

I. PURPOSE:

To establish procedures for removal and reinstallation of the LOWER GEARBOX unit from Schottel's Type S-300-L Tunnel Thruster.

II. REFERENCED DRAWINGS:

The following drawings are referenced in these procedures for parts identification and torque specifications:

SK-0028 - General Arrangement
SK-0029 - Drive Flange Assembly
SK-0030 - Prop Hub Assembly
SK-0031 - Skeg Assembly

III. TOOLS/EQUIPMENT/MATERIALS REQUIRED:

The following must be on hand to implement these procedures:

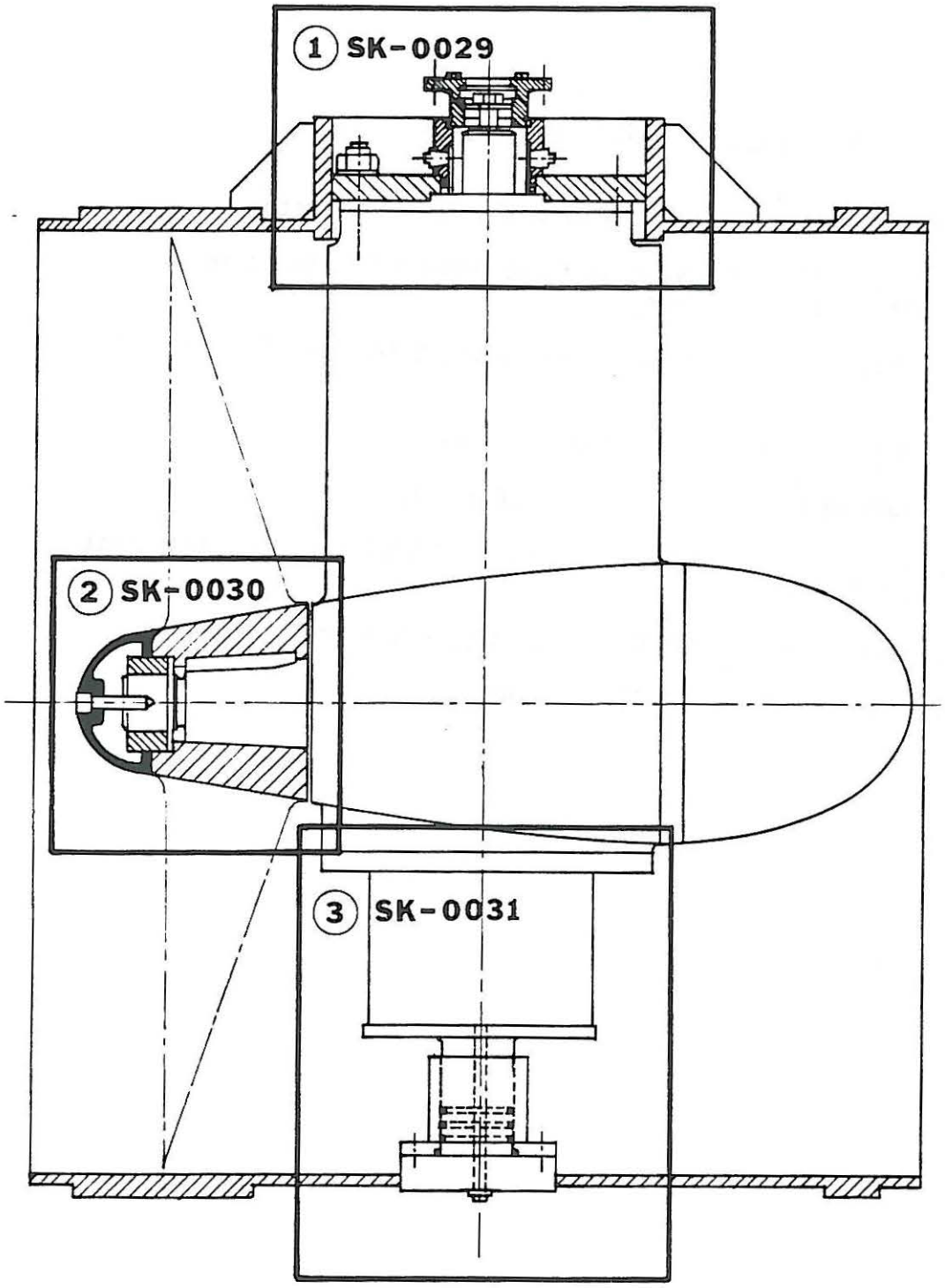
A. YARD SUPPLIED

1. Lifting Equipment
2. Metric Wrenches
3. Hydraulic Jack
4. Torque Wrench
5. Sealer - "Atmosit", Loctite "Master Gasket Eliminator" or equivalent.
6. Loctite "271"
7. Gear Puller
8. Metric Allen Wrenches
9. Snap Ring Pliers

B. S.O.A. SUPPLIED (With Thruster)

1. Propeller Nut Wrench: Drawing SK-0040
2. Threaded Rods, 3 each M20 x 8" lg; 3 each Nuts M20
3. Propeller Puller Plate: Drawing SK-0039

NOTE: Metric sizes used throughout.



SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**GENERAL ARRANGEMENT**
CHECK	
ENGR	
STRESS	SK-0028

DRIVE FLANGE REMOVAL: (Ref. Drawing SK-0029)

NOTE: The following may be done with the Tunnel Thruster submerged:

1. Drain Oil - Remove plug found under VENT connection at thruster input flange.

2. Disconnect intermediate drive shaft from DRIVE FLANGE (3) and remove.

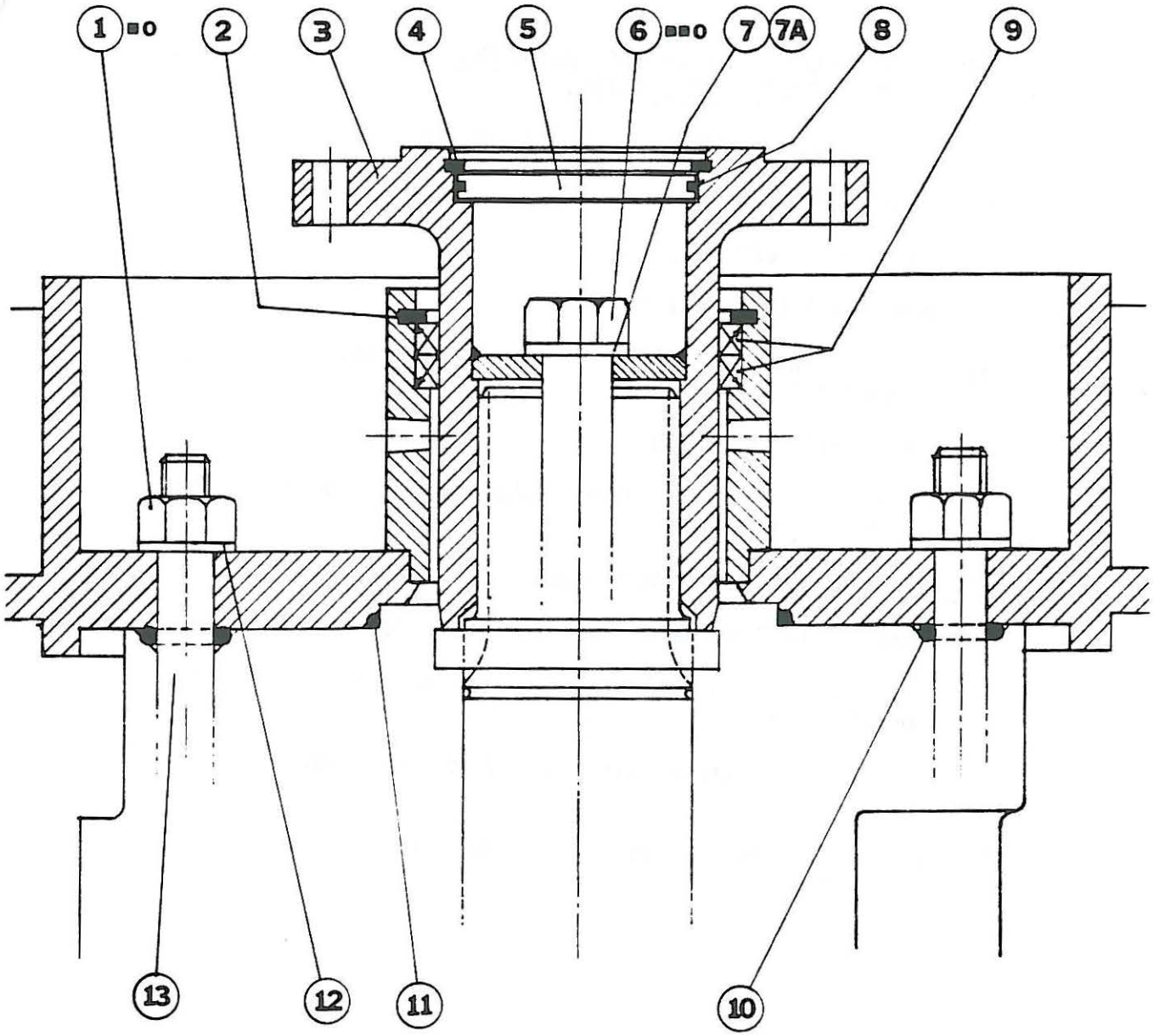
3. Remove drive flange SNAP RING (4).

4. Remove drive flange COVER PLATE (5).

5. Remove hex head BOLT (6), nylon WASHER (7), and steel flat WASHER (7A).

6. Remove DRIVE FLANGE (3) using gear puller.

7. Remove SNAP RING (2) and SEALS (9).



▪ Torque 180 ft. lbs.

▪▪ Torque 100 ft. lbs.

o Locktite 271

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**DRIVE FLANGE ASSY.**
CHECK	
ENGR	
STRESS	SK-0029

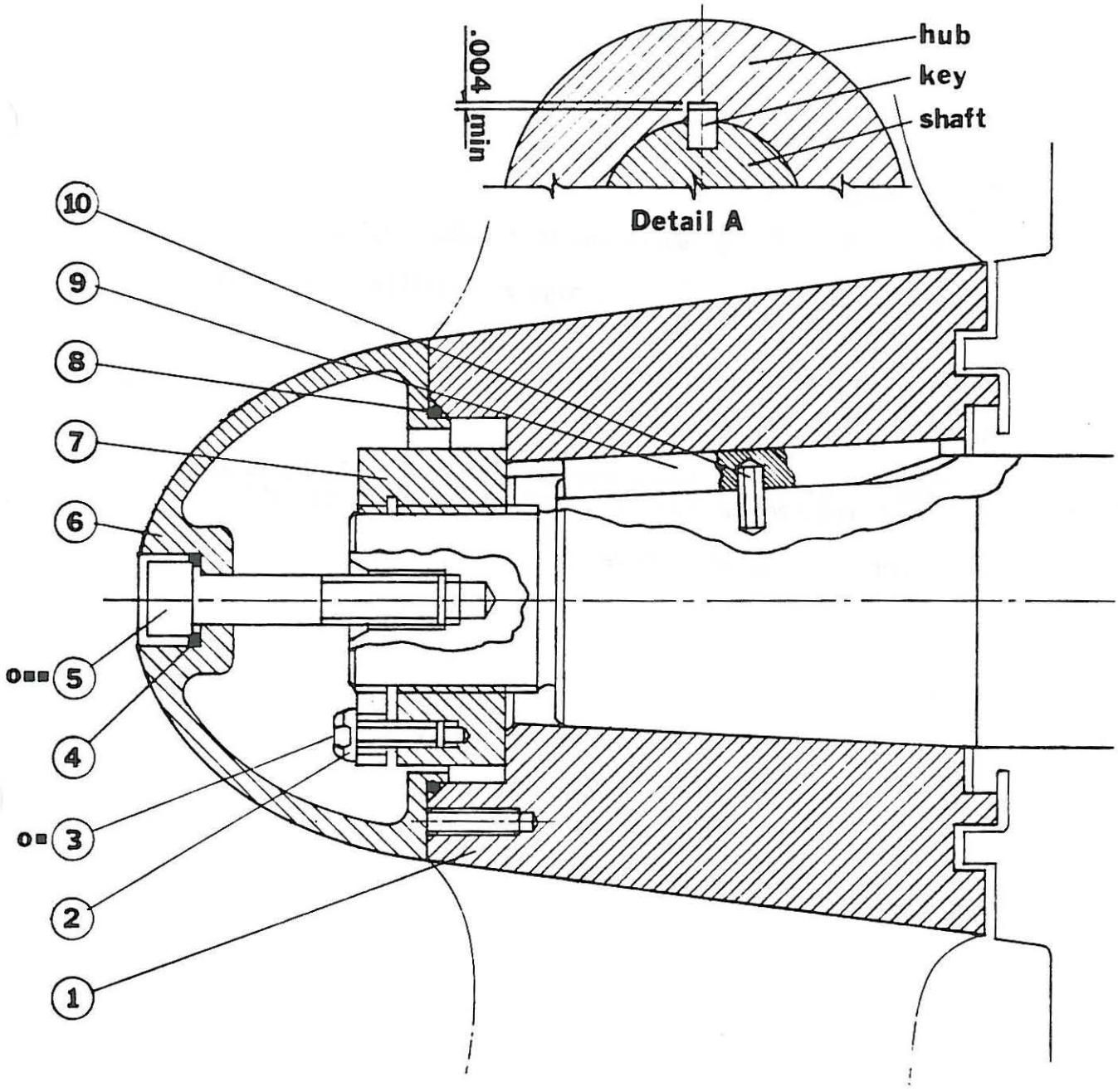
CAUTION: All procedures from this point MUST be done with TUNNEL THRUSTER OUT OF THE WATER.

PROPELLER REMOVAL: (Ref. Drawing SK-0030)

1. Remove CAP SCREW (5).
2. Remove PROP CAP (6).
3. Remove oil seal O'RING (8).
4. Remove TAPWASHERS (2), if supplied, or remove lockwire, as applicable.
5. Remove HEX SCREWS (3).
6. Loosen PROP NUT (7) 2 turns using special wrench supplied. Thread is LEFT HAND.

CAUTION: Do not remove prop nut at this time.

7. Install the 3 threaded rods supplied into prop hub.
8. Install the prop puller plate supplied and secure with supplied nuts.
9. Jack prop off taper using hydraulic jack. Heat hub if necessary.
10. Remove PROP NUT (7) from prop shaft and remove prop from tunnel.



▪ Torque 47 ft. lbs.

▪▪ Torque 200 ft. lbs.

o Locktite 271

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**PROP HUB ASSY.**
CHECK	
ENGR	SK-0030
STRESS	

SKEG REMOVAL: (Ref. Drawing SK-0031)

1. Remove skeg flange BOLTS and LOCKWASHER (3,2).

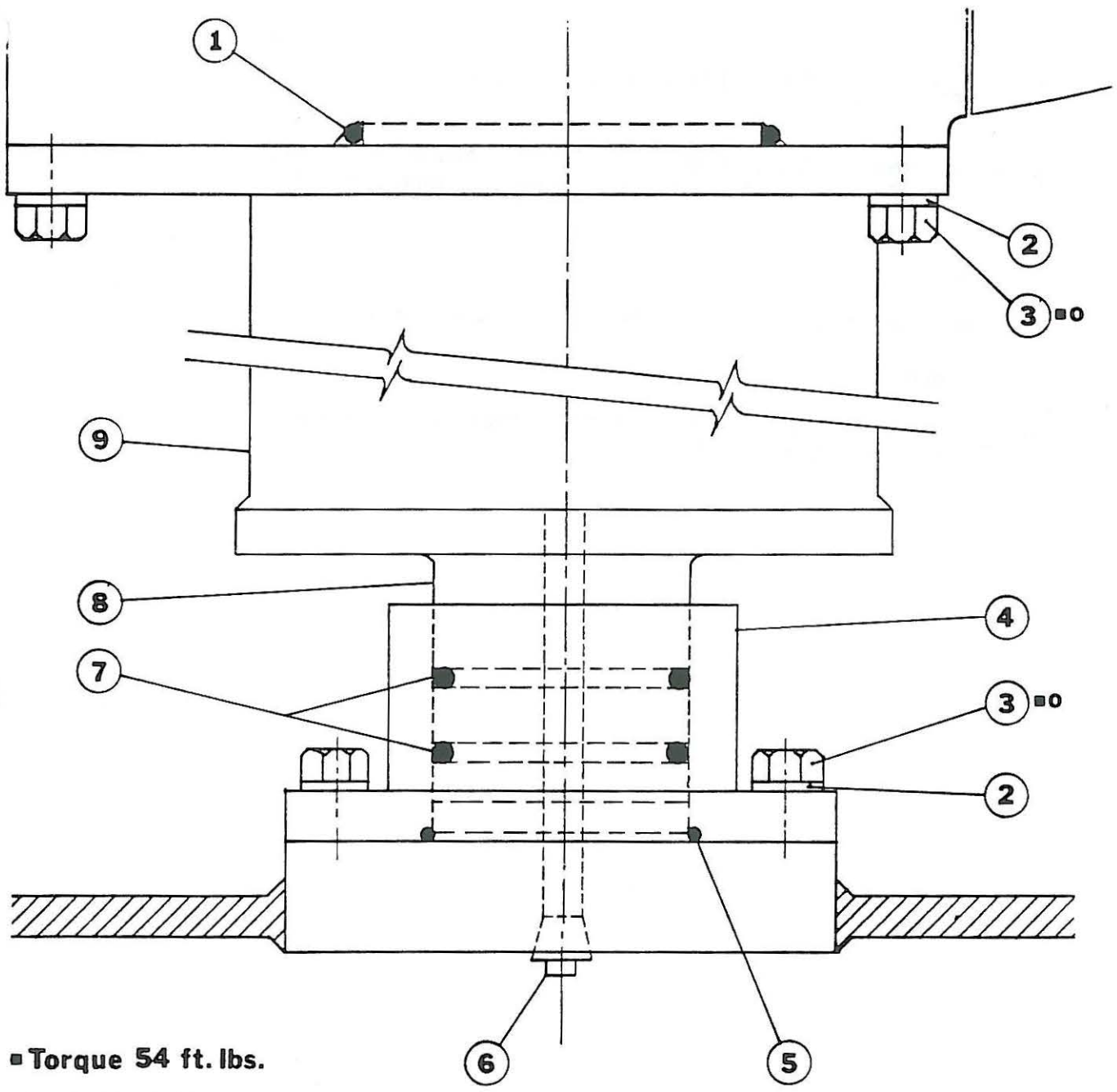
2. Work SKEG FLANGE (4) up as high as possible using bolts removed as jacking bolts.

3. Remove O'RING (5).

4. Remove skeg fin BOLTS (3,2).

CAUTION: SKEG (9) is heavy and will fall when all bolts are removed; support as required during disassembly.

5. Lower SKEG (9) and remove.



▪ Torque 54 ft. lbs.

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**SKEG ASSY.**
CHECK	
.NGR	SK-0031
STRESS	

LOWER GEARBOX REMOVAL: (Ref. Drawing SK-0029)

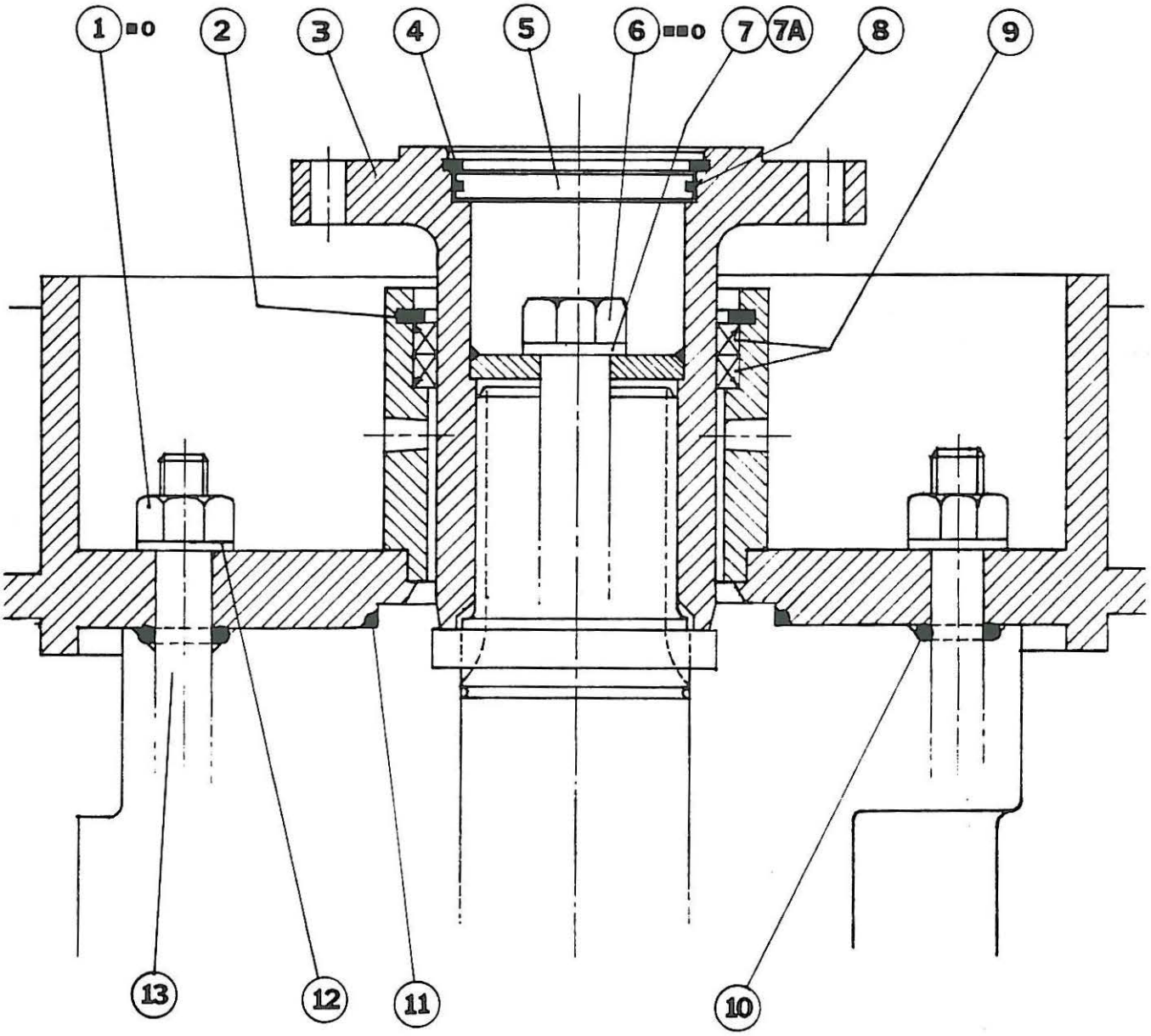
CAUTION: Gearbox must be adequately supported by a chainfall at this point. The gearbox weighs approximately 1200 Lbs.

1. Remove NUTS (1).

2. Lower gearbox into tunnel by means of chainfall.

3. Remove gearbox from tunnel.

NOTE: It may be necessary to weld pad eyes inside tunnel to facilitate gearbox removal.



▪ Torque 180 ft. lbs.

▪▪ Torque 100 ft. lbs.

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**DRIVE FLANGE ASSY.**
CHECK	
ENGR	SK-0029
STRESS	

GEARBOX INSTALLATION

CAUTION: Disassembly of the lower gearbox should not be attempted. If repair is indicated, the gearbox exchange program maintained by Schottel for the covenience of its customers should be utilized. Contact Schottel of America, Inc. for details.

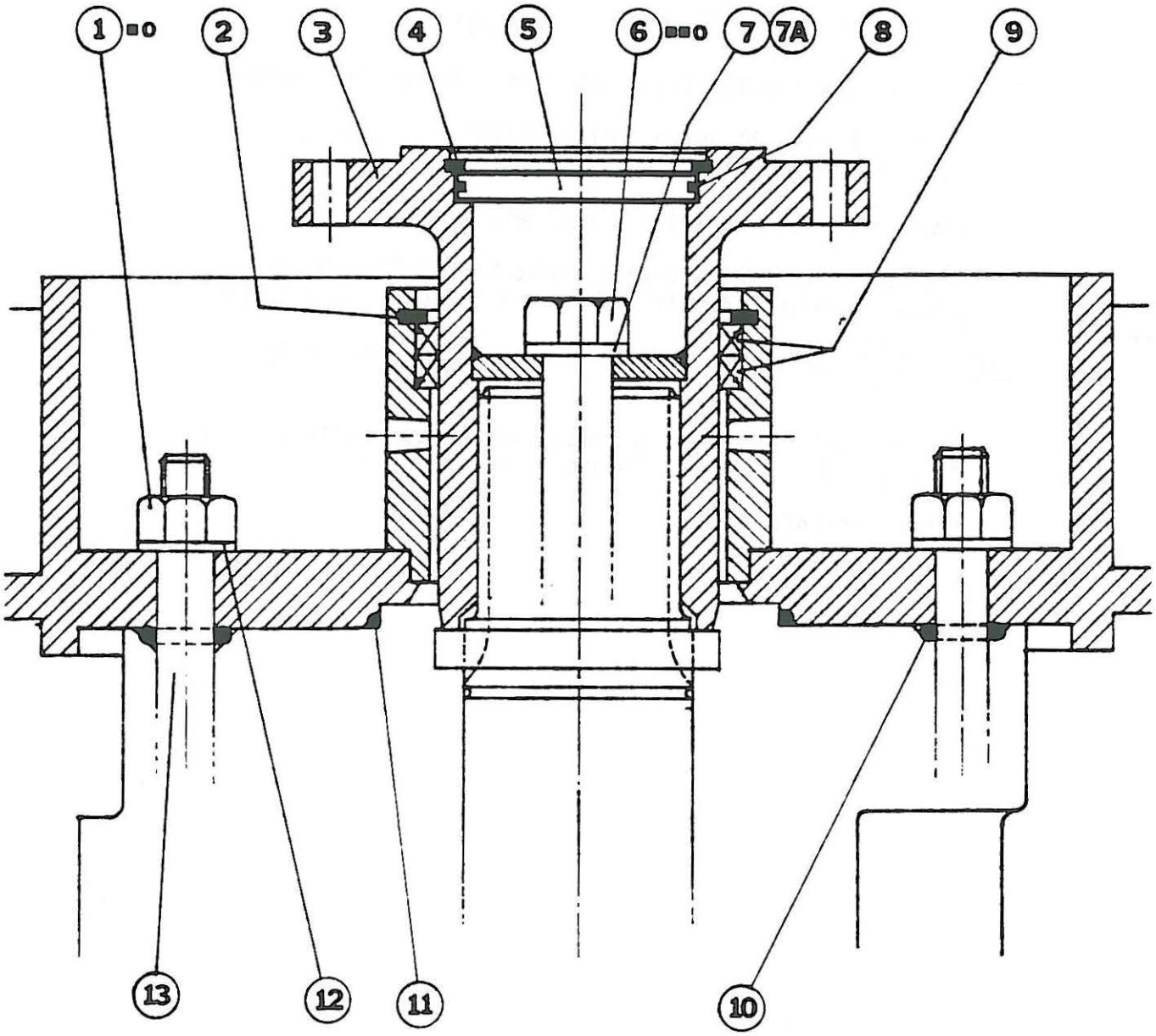
A. GEARBOX INSTALLATION: (Ref. Drawing SK-0029)

NOTE: Thoroughly clean all mounting surfaces prior to reassembly.

1. Install new O'RINGS (10, 11). Apply sealer on and around O'Ring and sealing surfaces.

2. Lift gearbox into position, install NUTS (1) handtight; do not tighten fully at this time.

NOTE: Leave chainfall in position.



▪ Torque 180 ft. lbs.

▪▪ Torque 100 ft. lbs.

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**DRIVE FLANGE ASSY.**
CHECK	
ENGR	SK-0029
STRESS	

B. SKEG INSTALLATION: (Ref. Drawing SK-0031)

1. Install new O'RINGS (1, 7) and seal flange with sealer.

2. Install BOLTS (3) using Loctite "271". Torque as specified on drawing.

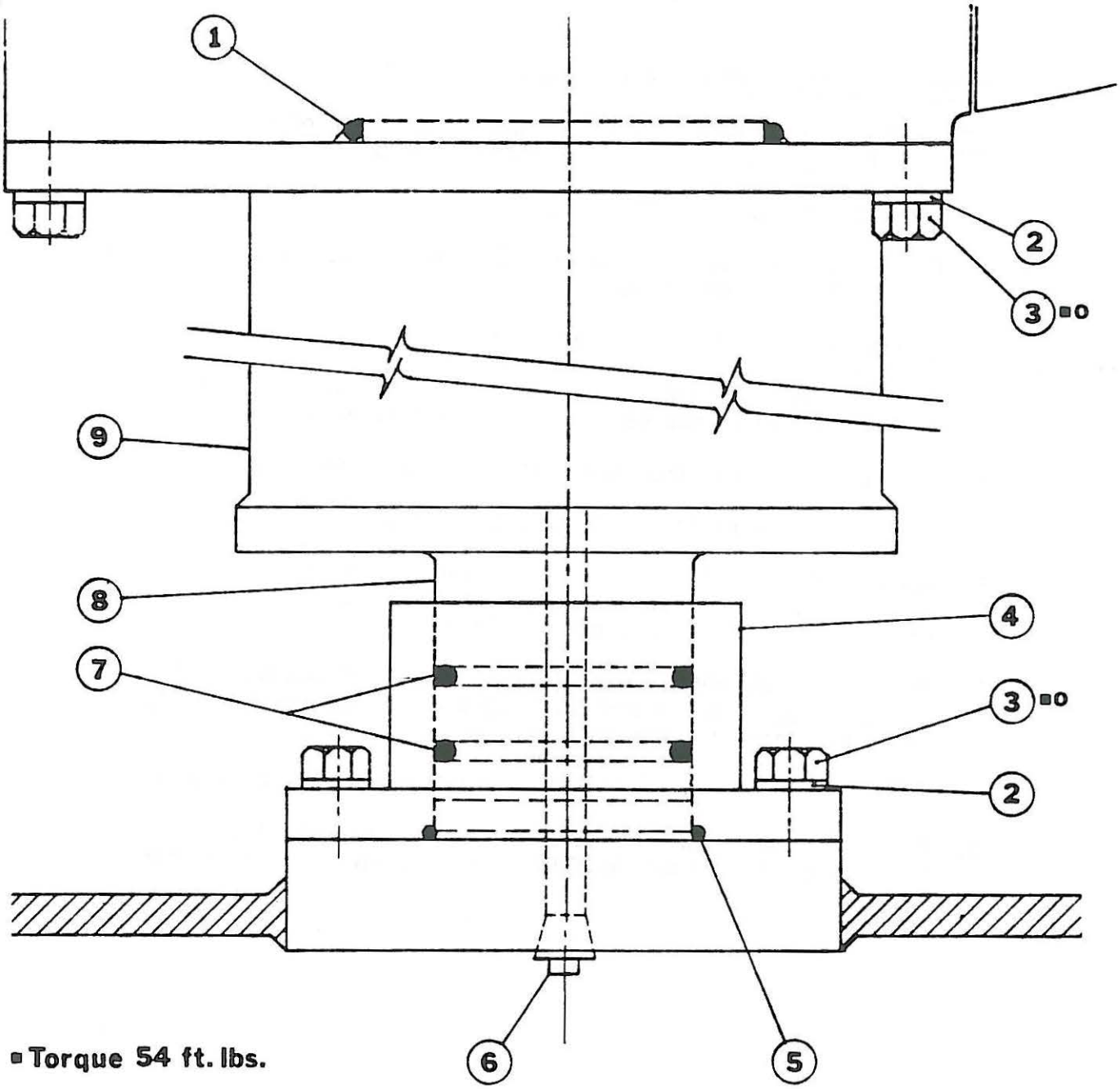
3. Install new O'RING (5) and seal with sealer.

4. Draw SKEG FLANGE (4) down to meet SKEG PLATE, install BOLTS (3) using Loctite "271", and torque as per drawing.

NOTE: Check that prop shaft is centered in tunnel before torquing nuts.

5. Remove NUTS (1) one at a time, coat threads with loctite "271", and reinstall. Torque as per drawing.

6. Remove chainfall.



▪ Torque 54 ft. lbs.

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**SKEG ASSY.**
CHECK	
ENGR	SK-0031
STRESS	

C. PROPELLER INSTALLATION: (Ref. Drawing SK-0030)

NOTE: Thoroughly clean prop shaft, key, and inside of hub prior to assembly. Prop shaft to be blued.

1. Fit taper for minimum 80% contact.

2. Check clearance of PROPELLER KEY (9) in accordance with Drawing SK-0030 Detail A.

3. Insure that taper is clean and dry.

4. Install prop on shaft, slide up as far as it will go, and take a reading of gearcase-to-prop hub clearance.

5. Take the chill off prop hub, heat to between 90° - 110° F.

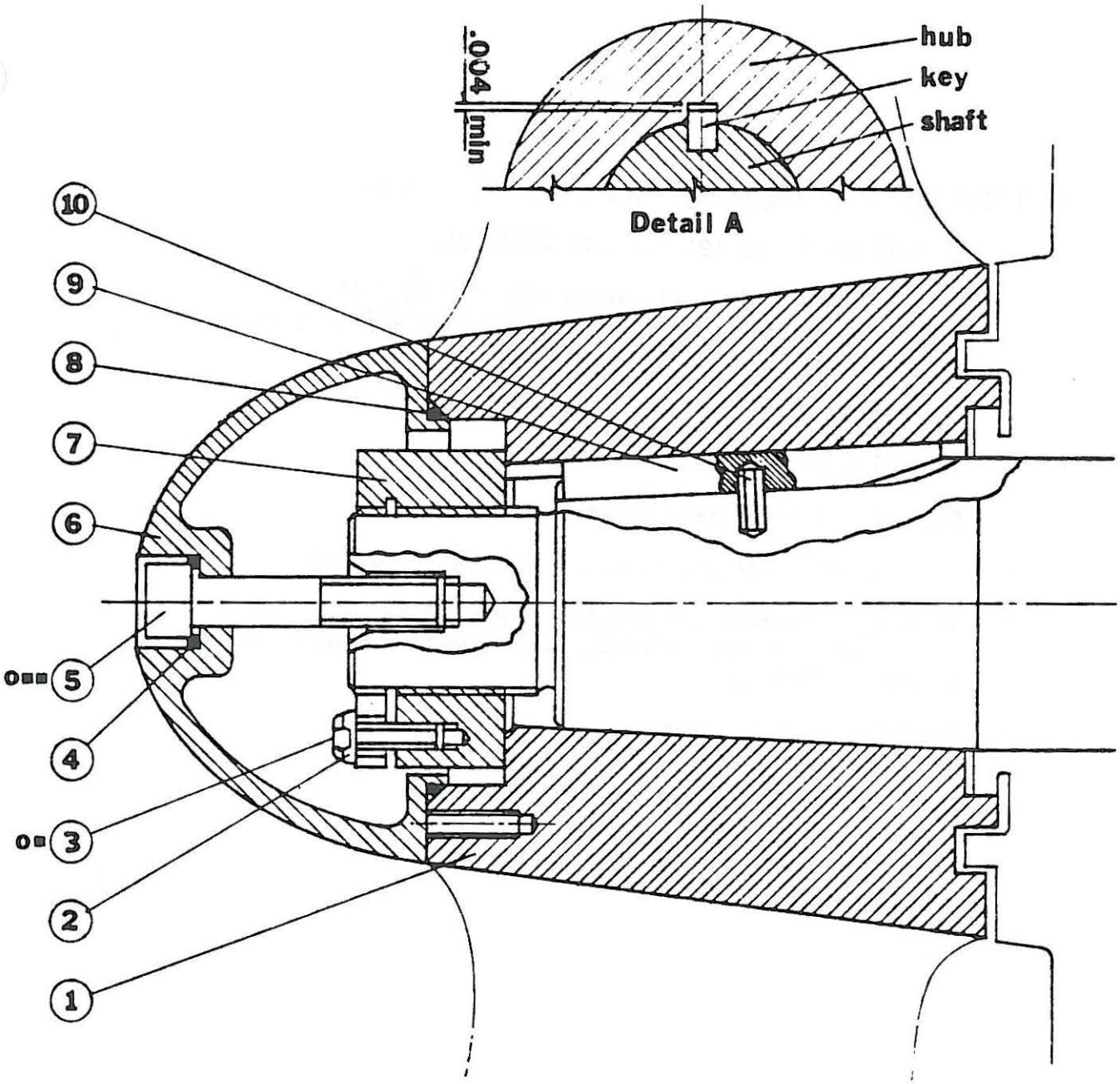
NOTE: Heating not necessary in tropical areas.

6. Harden PROP NUT (7) with special wrench provided. Take another clearance reading as in Step 4, above. Reading should be .020" minimum, preferably more.

7. Install TAP WASHERS (2), if supplied, and LOCKING BOLTS (3). Torque as per drawing and bend edges of tapwashers or safety wire bolt heads to lock in position, as applicable.

8. Install new O'RING (8) on PROP CAP (6) and seal with sealer.

9. Pack PROP CAP (6) with grease or tallow and install using CAP SCREWS (5) and new USIT RING (4). Torque as per drawing.



▪ Torque 47 ft. lbs.

▪▪ Torque 200 ft. lbs.

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**PROP HUB ASSY.**
CHECK	
ENGR	SK-0030
STRESS	

D. DRIVE FLANGE INSTALLATION: (Ref. Drawing SK-0029)

1. Install new SEALS (9) and SNAP RING (2).

2. Install DRIVE FLANGE (3) using HEX HEAD BOLT (6) and new NYLOC WASHER (7). Install steel flat WASHER (7A) and torque as per drawing.

3. Install drive flange COVER (5) using new O'RING (8).

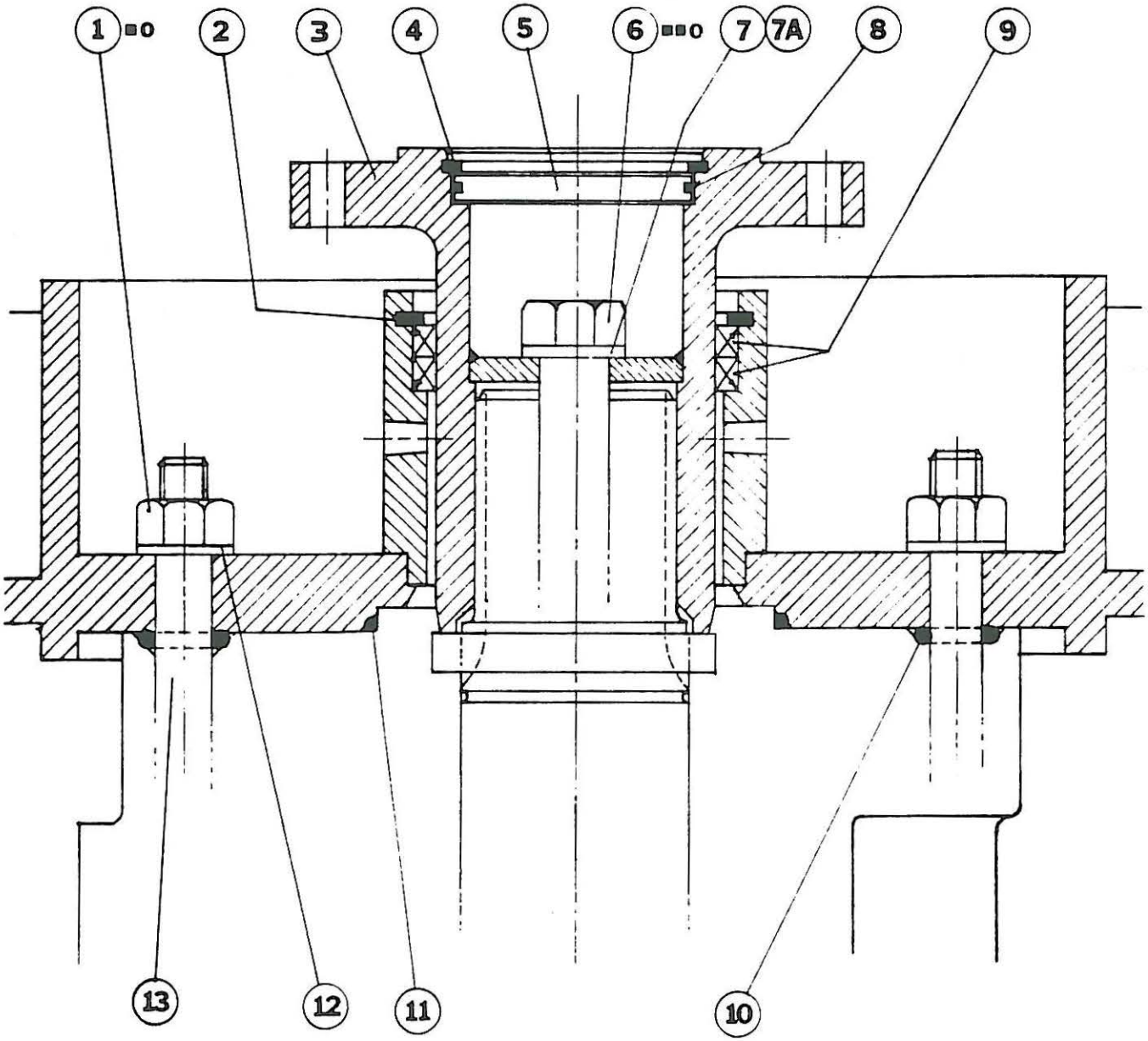
4. Install SNAP RING (4).

5. Reconnect intermediate drive shaft.

6. Fill gearbox with specified oil through head tank.

7. Thoroughly inspect all mounting surfaces for oil leaks, i.e.: skeg and skeg flange, lower gearbox mounting flange and drive flange.

8. Submerge tunnel thruster, test run.



▪ Torque 180 ft. lbs.

▪▪ Torque 100 ft. lbs.

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HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

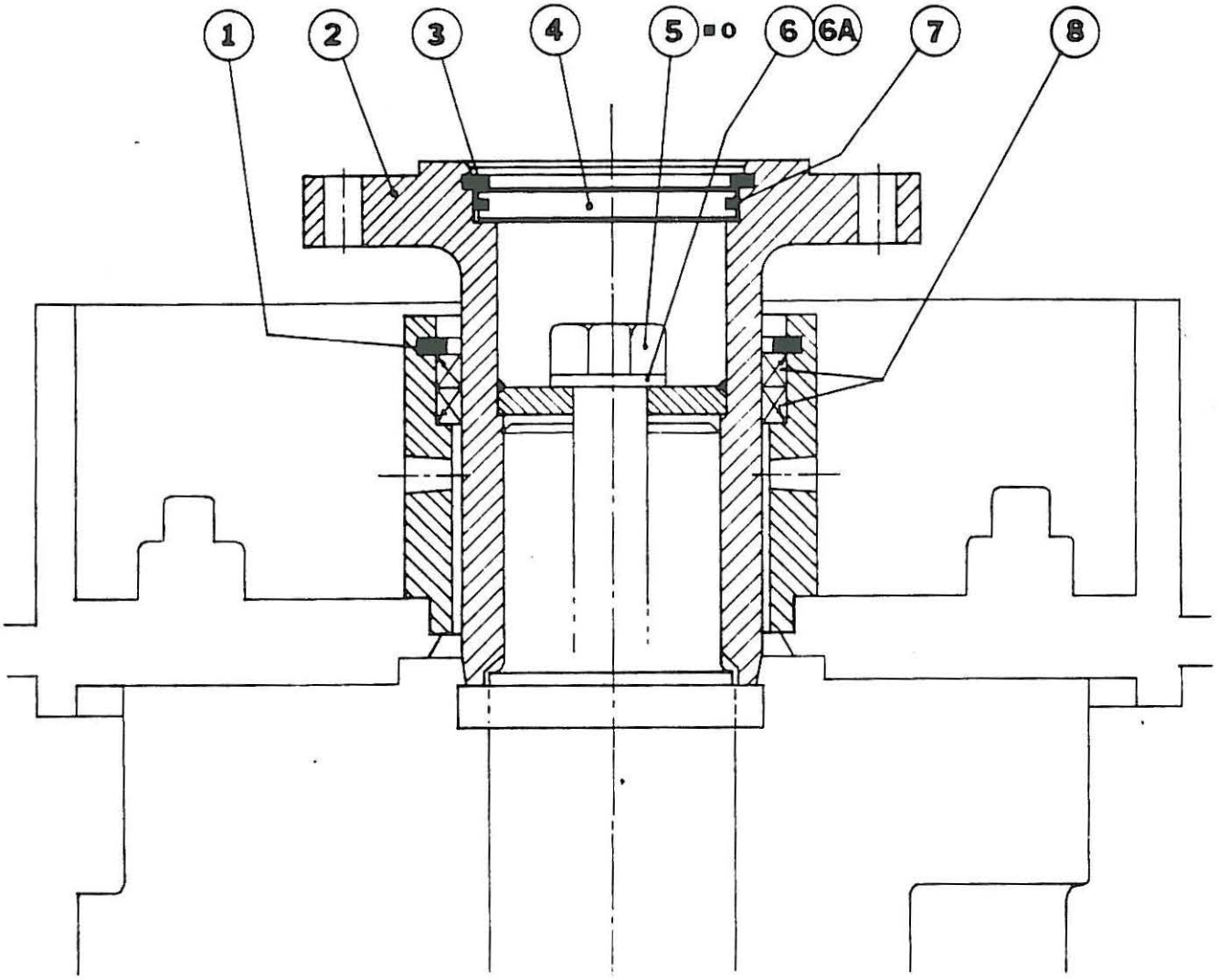
DRAWN	**DRIVE FLANGE ASSY.**
CHECK	
ENGR	
STRESS	SK-0029

DRIVE FLANGE SEAL REPLACEMENT

DRIVE FLANGE SEAL REPLACEMENT: (Ref. Drawing SK-0032)

NOTE: The following may be done with the Tunnel Thruster submerged:

1. Drain Oil - Remove plug found under VENT connection at thruster input flange.
2. Disconnect intermediate drive shaft from DRIVE FLANGE (2) and remove.
3. Remove drive flange SNAP RING (3).
4. Remove drive flange COVER PLATE (4).
5. Remove hex head BOLT (5), nylon WASHER (6) and steel flat WASHER (6A).
6. Remove DRIVE FLANGE (2) using gear puller.
7. Remove SNAP RING (1) and SEALS (9).
8. Remove SEALS (8) and replace with new seals.
9. Install SNAP RING (1).
10. Install DRIVE FLANGE (2) using HEX HEAD BOLT (5) and new NYLOC WASHERS (6). Install flat steel WASHER (6A) and torque as per drawing.
11. Install drive flange COVER PLATE (4) using new O'RING (7).
12. Install SNAP RING (3).
13. Reconnect intermediate drive shaft.
14. Fill gearbox with specified oil through head tank.
15. Inspect for oil leaks and test run thruster.



▪Torque 100 ft.lbs.

oLocktite 271

SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**DRIVE FLANGE**
CHECK	
ENGR	
STRESS	SK-0032

PROP SHAFT SEAL REPLACEMENT

PROP SHAFT SEAL REPLACEMENT

NOTE: The following must be done with Thruster out of the water.

1. Drain Oil - Remove plug found under VENT connection at thruster input flange.

2. Remove propeller in accordance with procedures outlined on page 3 - 6 of this manual.

3. Remove CAP SCREWS (2).

4. Remove COVER (1), SEALS (7) and SEAL RUNNING RING (4) as an assembly using 3 Jacking Bolts M12 in holes provided in COVER (1).

5. Inspect SEAL RUNNING RING (4), seal surface, and general condition to determine if replacement is necessary.

6. Remove SEALS (7), O'RINGS (3), (5), and (6).

7. Thoroughly clean all surfaces.

8. Replace SEALS (7): Lip on prop side must face water, lip on gearbox side must face oil.

   NOTE: It is possible to receive 2 different seal case materials: the prop side seal should be stainless steel case, gearbox side can be either stainless steel or steel. Check with magnet before installation.

9. Lubricate seals with EPZ grease after installation.

10. Install new O'RING (3).

11. Install COVER (1) Atmosit sealer between gearbox and cover.

12. Install BOLTS (2) using loctite 271 on threads, torque as per drawing SK-0033.

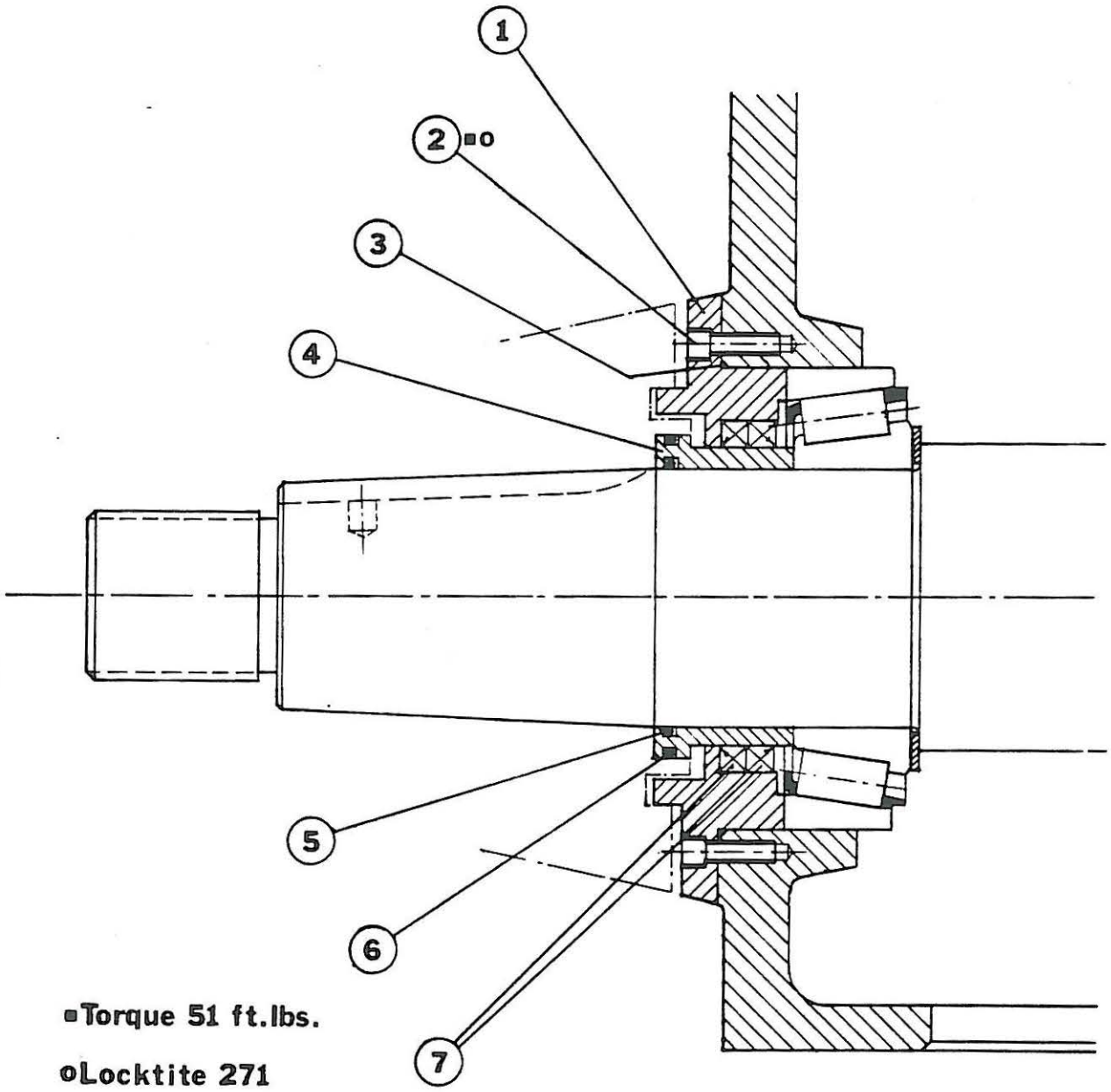
13. Replace O'RINGS (5) (6) on SEAL RUNNING RING (4).

14. Heat SEAL RUNNING RING (4) in water to 212° F (100°C), quickly place seal running ring on prop shaft and slide into place.

15. Install propeller in accordance with procedures outlined on page 3 - 17 of this manual.

16. Fill gearbox with specified oil through head tank.

17. Inspect for oil leaks before submerging Thruster.



▪Torque 51 ft.lbs.

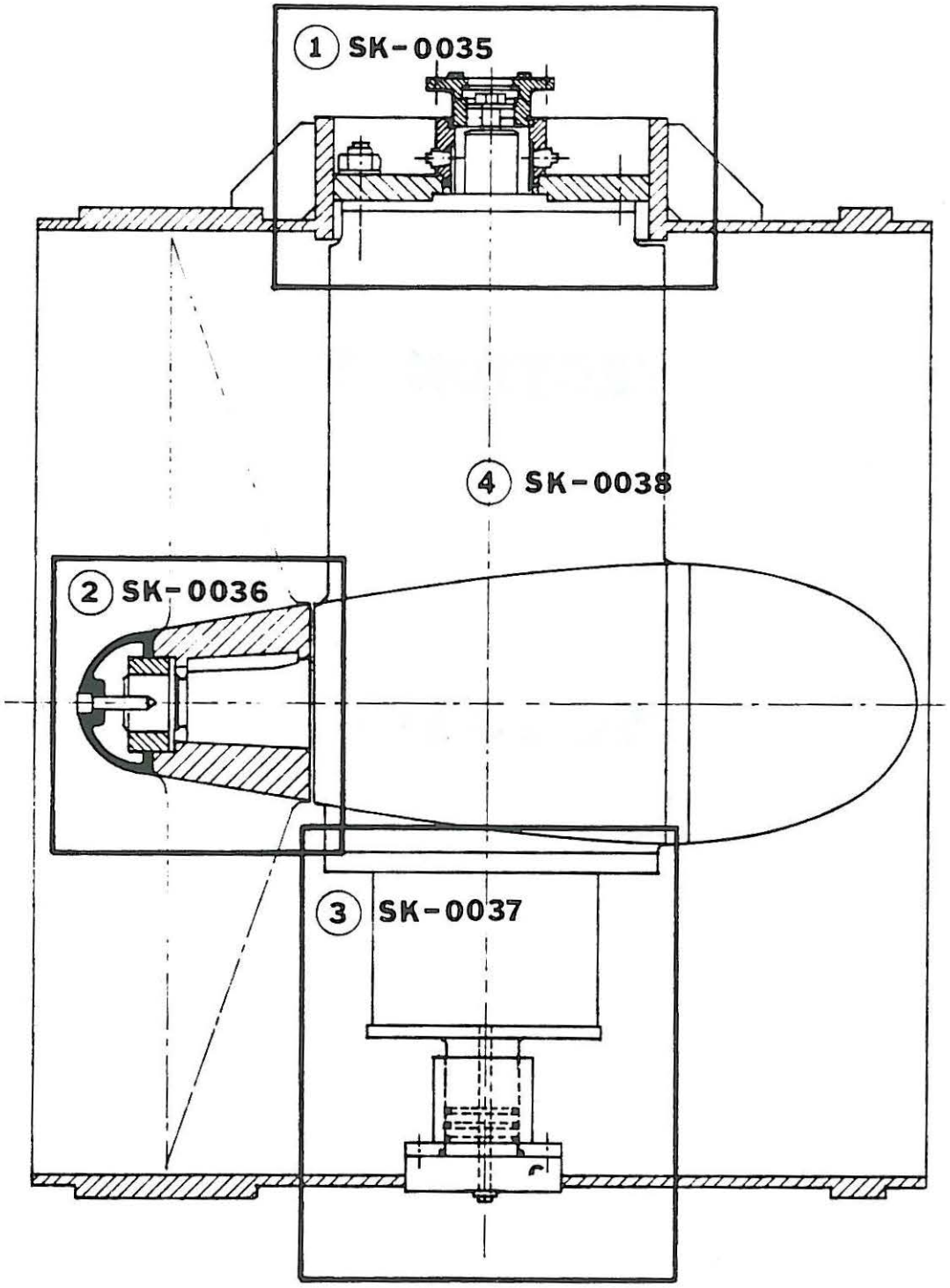
oLocktite 271

SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**PROP SHAFT**
CHECK	
ENGR	
STRESS	SK-0033

SECTION 4

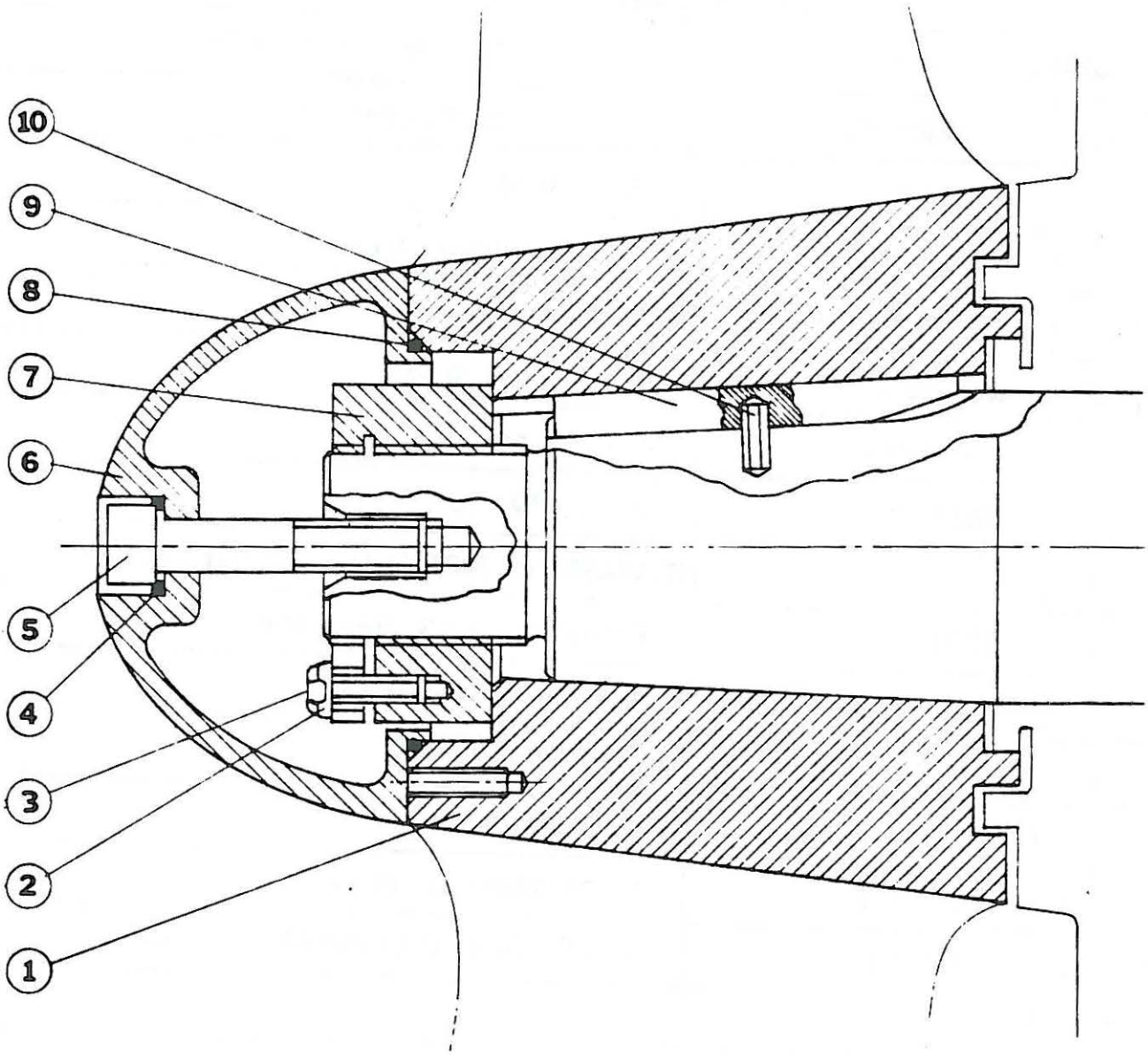
PARTS LIST



SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**GENERAL ARRANGEMENT**
CHECK	
ENGR	
STRESS	SK-0034

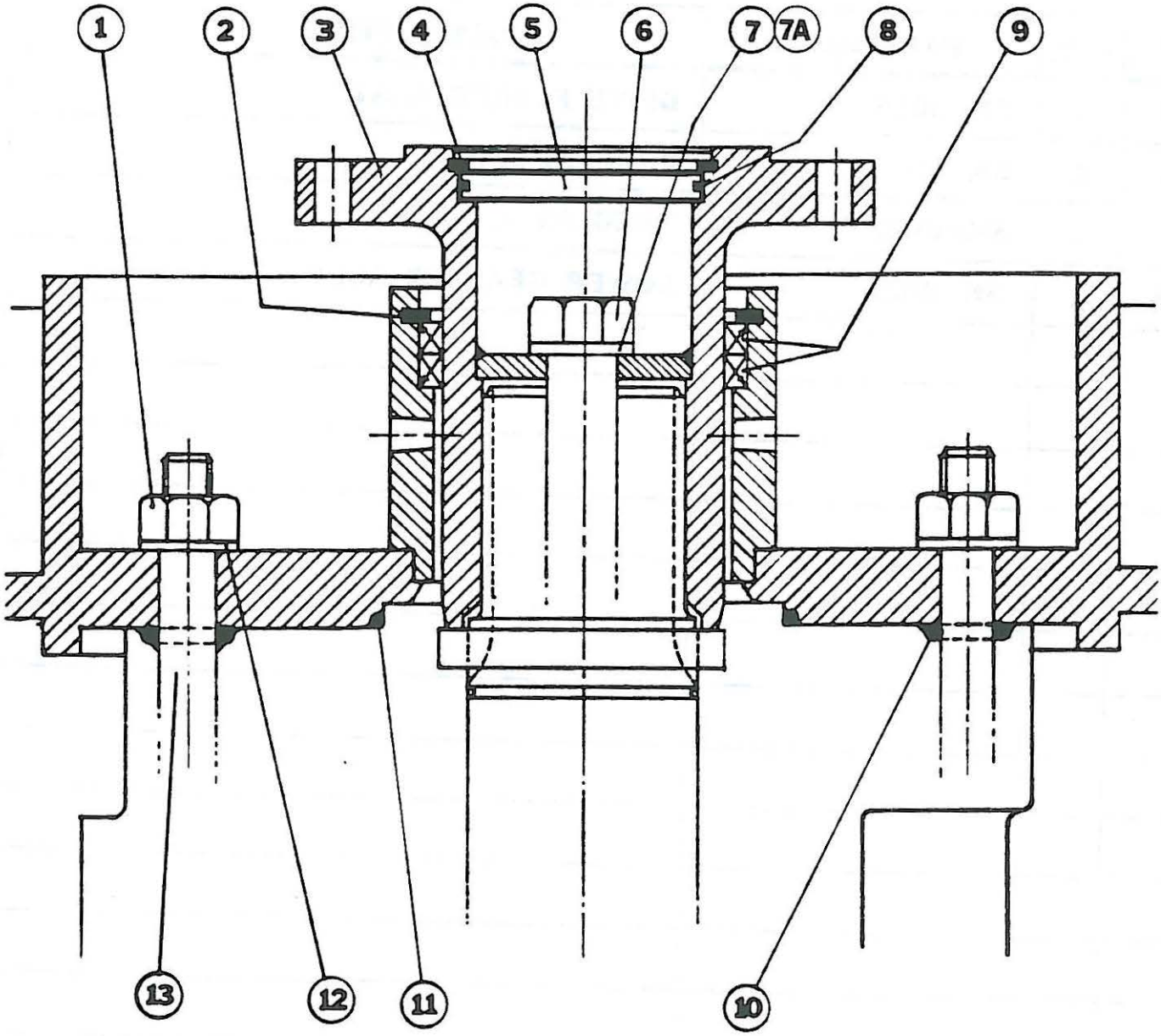
PARTS LIST			
Assy: DRIVE FLANGE			Dwg. No.: SK-0035
POS.	QTY.	PART NO.	DESCRIPTION
1	12	1001031	NUT, M24
2	1	N5000-525	RING, retaining, Truarc
3	1	1038924	FLANGE, drive
4	1	N5000-400	RING, snap, Truarc
5	1	1038925	PLATE, cover
6	1	1013920	BOLT, 30×70
7,7A	1		(7) WASHER, M30 Nyloc, (7A) Flat, stl. M30
8	1	1001379	O-RING, 95×3 Neoprene
9	2	1001174	SEAL, 110×130×13
10	12		O-RING, 4×24
11	1	1001414	O-RING, 4×160
12	12	1001575	LOCKWASHER, M24
13	12	1011480	STUD, M24×80, DIN939, B:38, L:80



SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**PROP HUB ASSY.**
CHECK	
ENGR	
STRESS	SK-0036

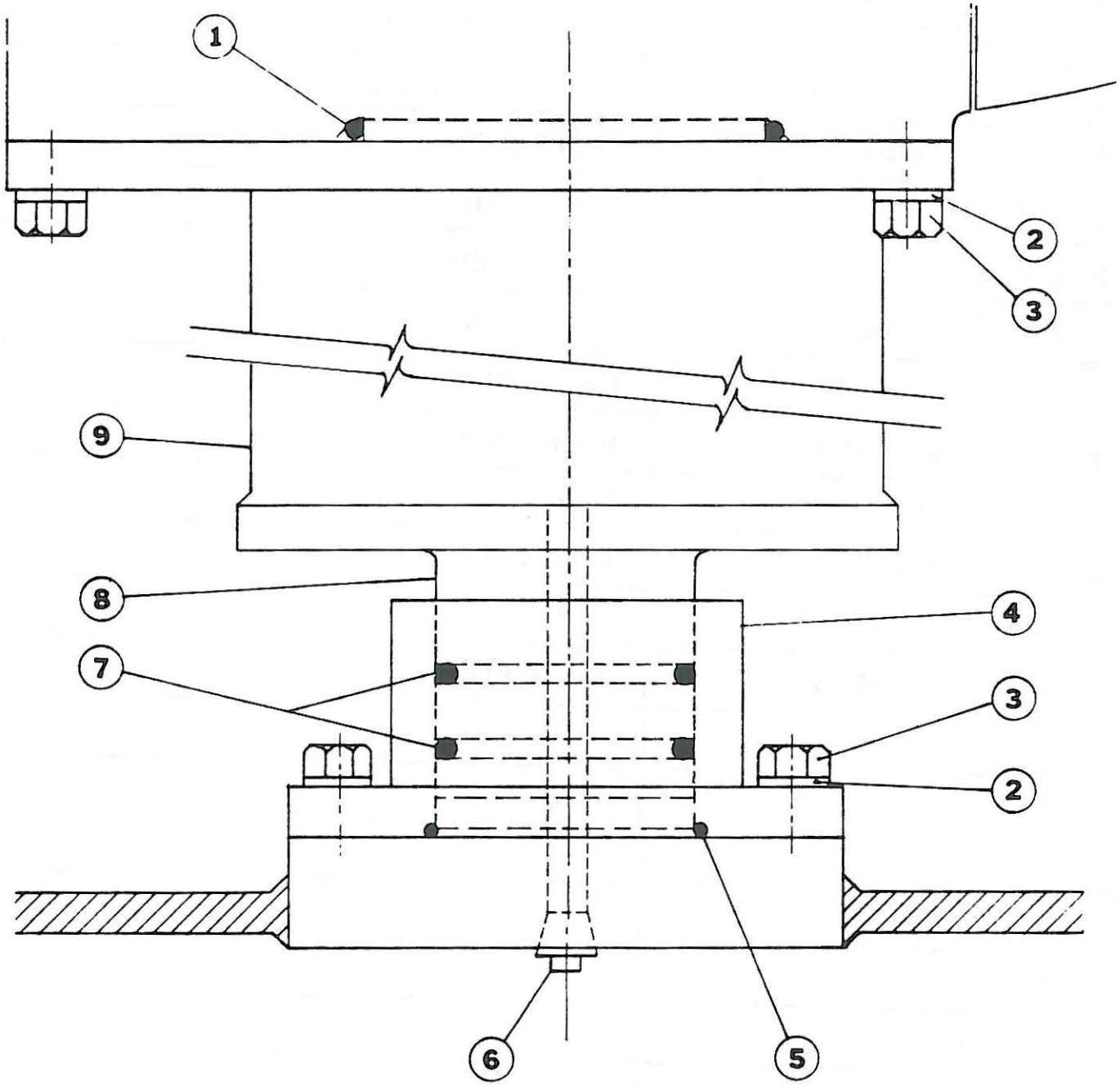
PARTS LIST			
Assy: S-300L GENERAL ARRG'MT			Dwg. No.: SK-0034
POS.	QTY.	PART NO.	DESCRIPTION
1	1	SK-0035	DRIVE FLANGE ASSY.
2	1	SK-0036	PROP HUB ASSY.
3	1	SK-0037	SKEG ASSY.
4	1	SK-0038	LOWER GEARBOX ASSY.



SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**DRIVE FLANGE ASSY.**
CHECK	
ENGR	
STRESS	SK-0035

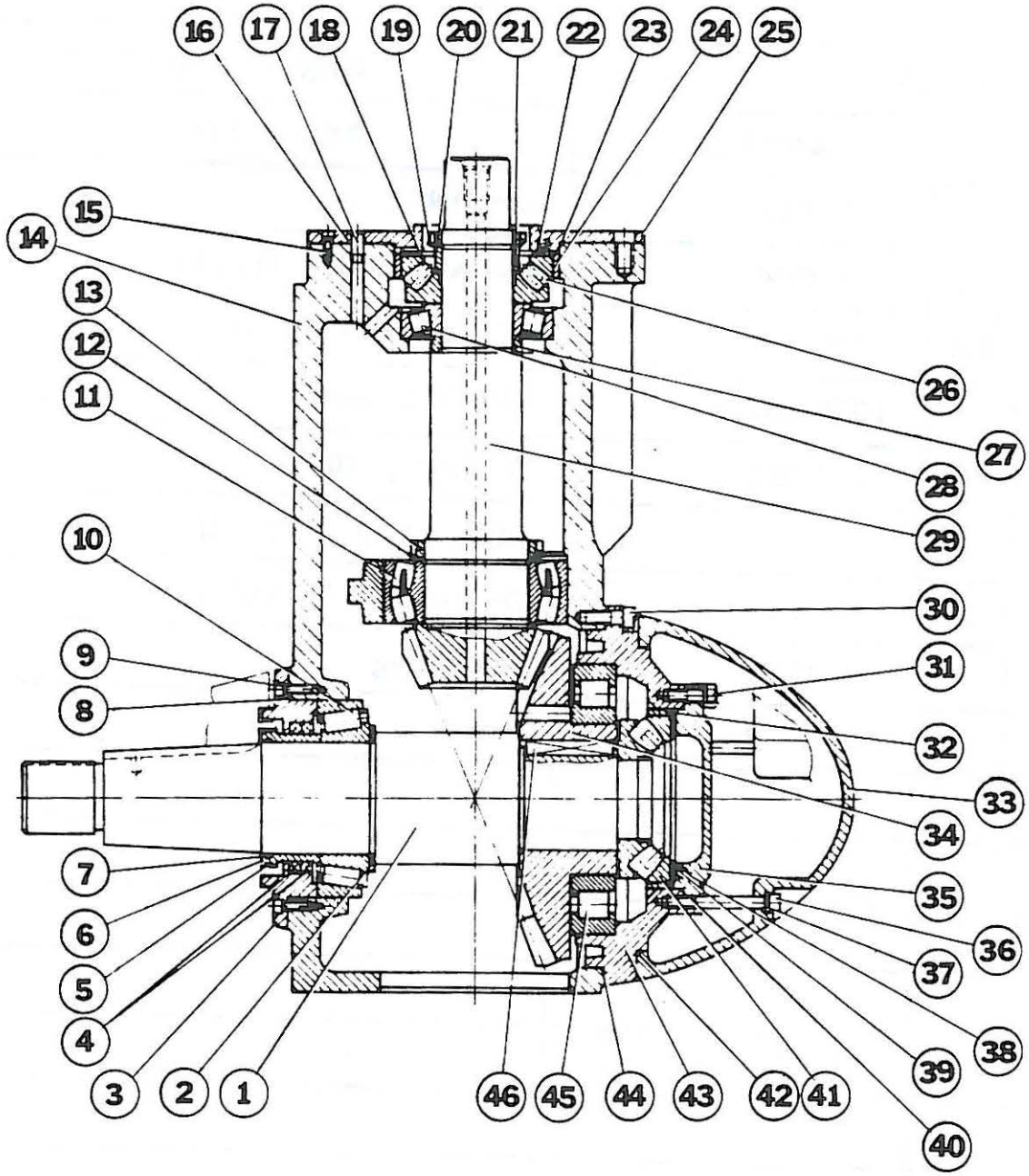
PARTS LIST			
Assy: PROP. HUB			Dwg. No.: SK-0036
POS.	QTY.	PART NO.	DESCRIPTION
1	1	1008872	PROPELLER
2	2	1003852	TAP WASHER
3	2	1000718	HEX. SCREW
4	1	1005990	USIT-RING
5	1	1000949	CAP SCREW
6	1	1008882	PROPELLER CAP
7	1	1004826	PROPELLER NUT
8	1	1001424	OIL SEAL
9	1	1003853	KEY
10	1	1005968	SPLIT SLEEVE



SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**SKEG ASSY.**
CHECK	
ENGR	SK-0037
STRESS	

PARTS LIST			
Assy: SKEG			Dwg. No.: SK-0037
POS.	QTY.	PART NO.	DESCRIPTION
1	1	1001511	O-RING, 4 × 230
2	22	1021604	LOCKWASHER, M16 ss
3	22	1000704	BOLT, M16 × 40 ss
4	1	1038756	FLANGE, Skeg
5	1	1001383	O-RING, 100 × 3
6	1		PLUG, 1/2" NPT, Stl.
7	2	1020805	O-RING, Ø 5.7 × 89.2
8	1	1038756	PIN, Skeg
9	1	1038963	SKEG



SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**LOWER GEARBOX**
CHECK	
ENGR	SK–0038
STRESS	

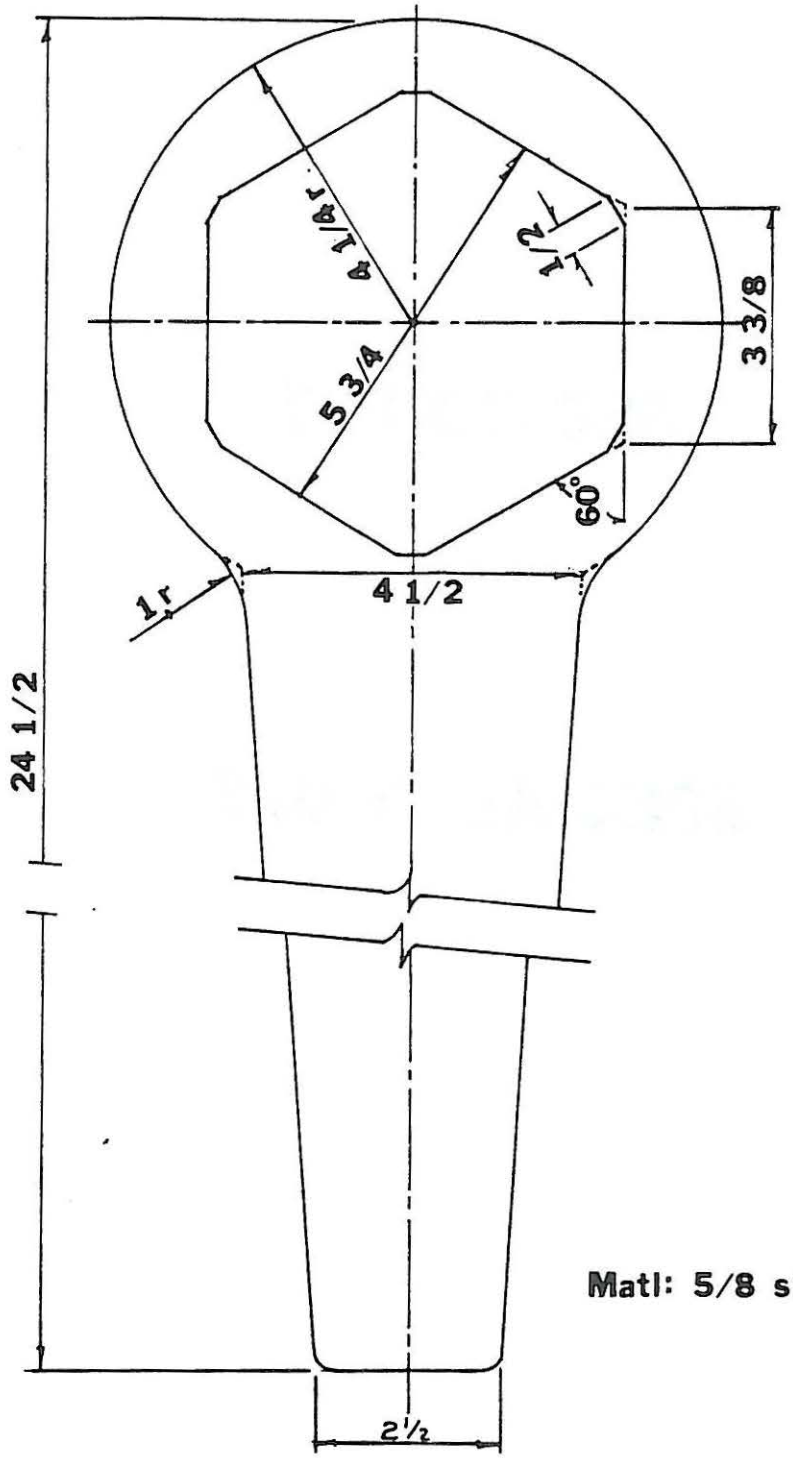
PARTS LIST			
Assy: LOWER GEARBOX			Dwg. No.: SK-0038
POS.	QTY.	PART NO.	DESCRIPTION
1	1	1009082	SHAFT, Prop
2	1	1003851	SPACER
3	1	1009160	COVER
4	2	1001705	SEAL 160x190x15
5	1	1001425	SEAL, Oil
6	1	1004831	BUSHING
7	1	1001402	SEAL,Oil
8	1	1001450	SEAL, Oil
9	9	1000855	CAP SCREW
10	1	1004161	BEARING
11	1	1005343	BEARING
12	1	1002050	WASHER, Lock
13	1	1002075	NUT, Lock
14	1	1008886	GEARCASE
15	10	1000962	CAPSCREW
16	1	1001314	SEAL, Oil
17	1	1014983	PLUG
18	1	1003749	SHIM
19	1	1002044	WASHER, Lock
20	1	1002069	NUT, Lock
21	1	1003747	DISTANCE RING
22	6	1003859	SPRING

PARTS LIST			
Assy: LOWER GEARBOX			Dwg. No.: SK-0038
POS.	QTY.	PART NO.	DESCRIPTION
23	1	1001437	SEAL, Oil
24	1	1004833	RING
25	1	1008860	FLANGE
26	1	1005319	BEARING
27	1	1003748	RING
28	1	1004127	BEARING
29	1	1012180	GEARSET
30	18	1000896	CAP SCREW
31	9	1000744	HEX. SCREW
32	1	1004900	RING
33	1	1008880	CAP
34	1	1012180	GEARSET
35	1	1008896	COVER
36	3	1000918	CAP SCREW
37	3	1005975	USIT RING
38	6	1003857	SPRING
39	1	1003750	SHIM
40	1	1001510	SEAL, Oil
41	1	1005320	BEARING
42	1	1001470	SEAL, Oil
43	1	1008884	COVER, Bearing
44	1	1001473	SEAL, Oil

PARTS LIST			
Assy: LOWER GEARBOX			Dwg. No.: SK-0038
POS.	QTY.	PART NO.	DESCRIPTION
45	1	1004023	BEARING
46	3	1002191	KEY

SECTION 5

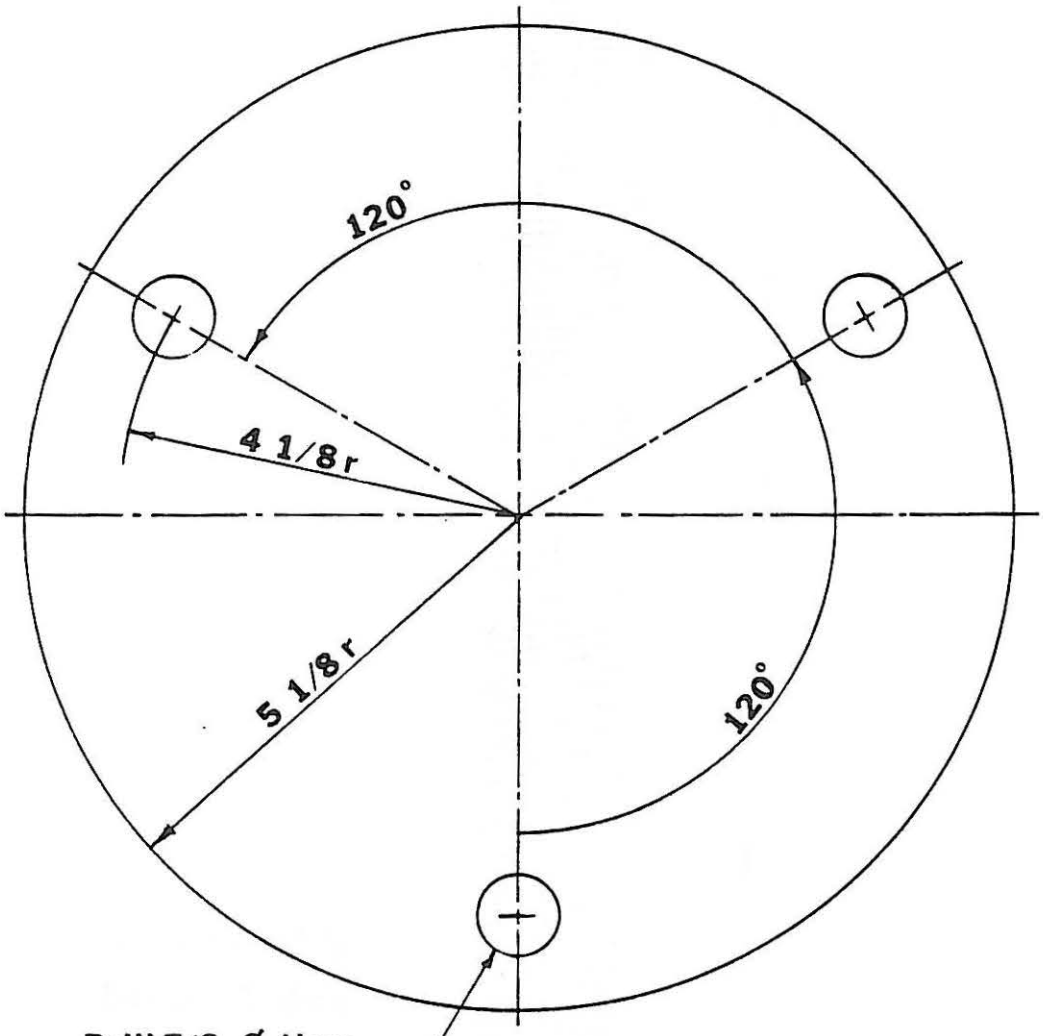
SPECIAL TOOLS



Matl: 5/8 stl.

SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN Lou Quad	**WRENCH, Prop Nut**
CHECK	
ENGR	SK-0040
STRESS	
NOV. 18, 1982	



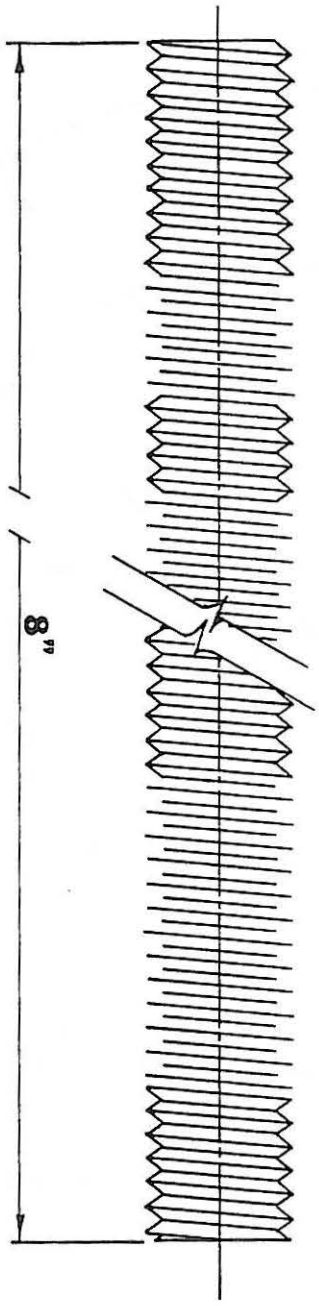
Matl: 5/8 stl.

SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	LOU QUAD
CHECK	
ENGR	
STRESS	
	NOV-19, 1982

PLATE, Prop Puller

SK-0039



Thd. M20 x 2.5 Pitch

3 Rods Required

SCHOTTEL OF AMERICA INC.
HEAVY DUTY MARINE PROPULSION EQUIPMENT
MIAMI, FLORIDA

DRAWN	**ROD, THREADED**
CHECK	
ENGR	
STRESS	SK–0040

SECTION 6

REFERENCE DATA

ARTICULATED SHAFTS FOR SCHOTTEL SYSTEMS

Operating Instructions

1. DESCRIPTION

1.1 GENERAL

In SCHOTTEL propulsion systems, articulated shafts are mainly used:

a) as a power transmission element between the clutch at the prime mover and the SCHOTTEL Rudder Propeller (SRP);

b) to transmit steering direction between the axiometer line and the SRP steering flange;

c) for auxiliary systems (pumps, etc.) driven directly off the forward end of the prime mover. However, as this application is relatively rare, it will not be covered herein.

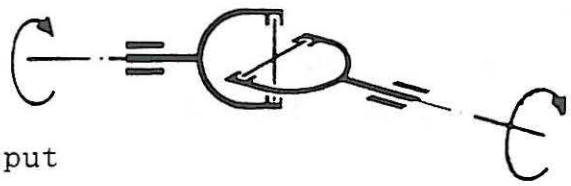
Articulated shafts are service proven and versatile elements of motive power engineering. They make it possible to connect two shafts offset in relation to each other. Changes in length during assembly and in service (such as for the SRP vertical adjustment) are compensated for by shaped sliding parts. The use of articulated shafts permits assembly without expensive alignment of the machinery sets to be connected.

Articulated drive shafts are mechanically balanced according to their max. rotational speed in service. The balancing plates tacked to the shafts are not to be removed under any circumstances. The shafts must be rebalanced upon completion of any repair work undertaken.

1.2 THEORY OF ARTICULATED SHAFTS

Whenever a simple Cardan joint or a ball-and-socket joint is evenly turned in a deflected condition, its output end will show a nonuniform motion (Fig. 1).

F i g. 1



Uniform input

Nonuniform output

This misalignment is compensated for when two simple joints are connected to form an articulated shaft. Complete compensation of the axial misalignment is subject to the following conditions:

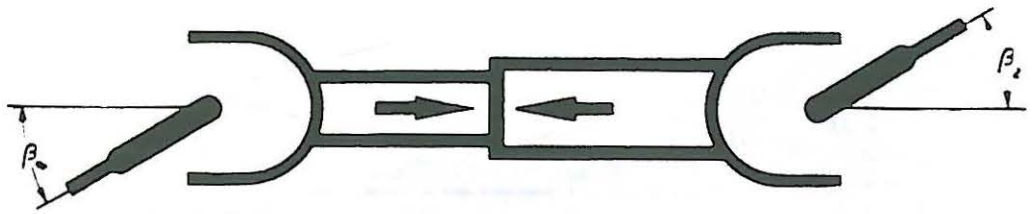
a) Same inflection angles at both joints ($_1 = _2$).

b) The two inner joint forks must be in the same plane.

c) Input and output shaft must also be in the same plane.

NOTE:

Incorrectly assembled articulated shafts increase axial misalignment at the output end. This may cause damage to the bearings in the joints, shaped sections of the splined shafts, and gears arranged downstream. Accordingly, care must be taken to insure that the marking arrows on the splined shaft and splined hub are opposed to each other when assembling the articulated shafts halves.

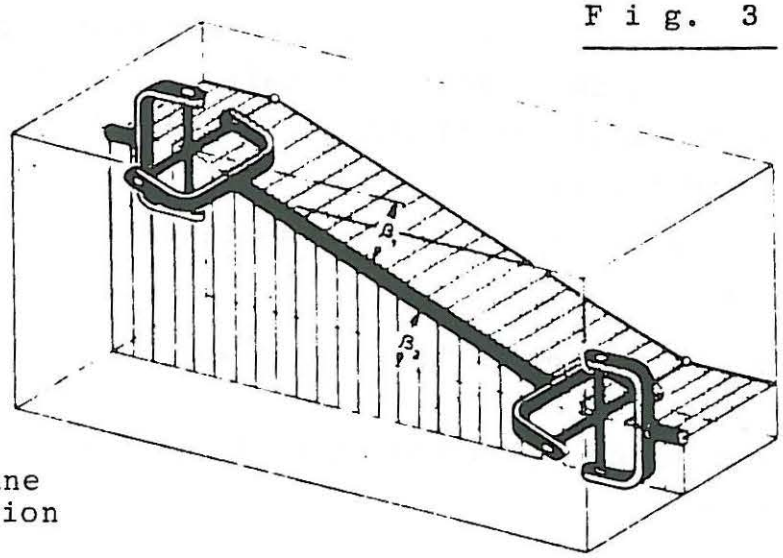


F i g. 2

1.3 TYPES OF ARRANGEMENT

Z-type arrangement: Input and output shaft are parallel to each other in the same plane (Fig. 3).

F i g. 3



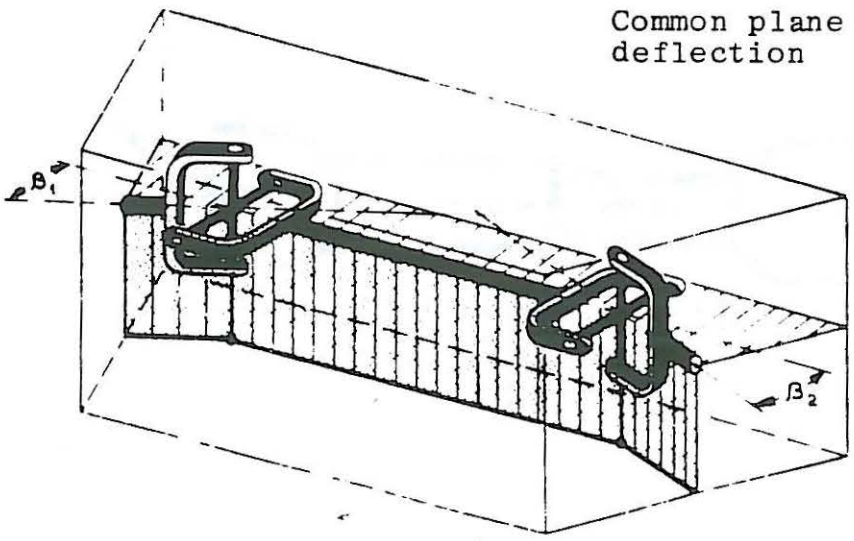
$\beta_1 = \beta_2$

Common plane of deflection

W-type arrangement: The axes of input and output shafts arranged in the same plane intersect in a point (Fig. 4).

F i g. 4

Common plane of deflection

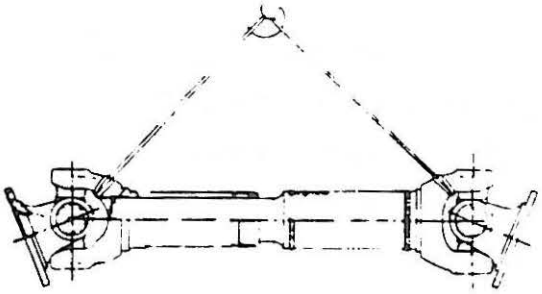


$\beta_1 = \beta_2$

1.4 TRANSPORTATION AND STORAGE

Articulated shafts are supplied as mechanically balanced and lubricated units ready for installation.

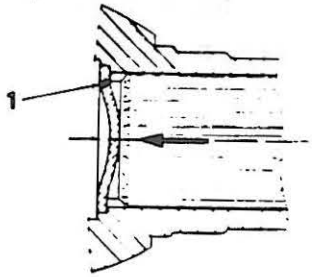
F i g. 5



Articulated shafts should be transported in a horizontal position. When transporting them in the vertical position, they must be additionally secured against their separating. The cap of the shaped seal is not to be stressed by the weight of the articulated shaft. Use hemp or nylon rope. (Fig. 5).

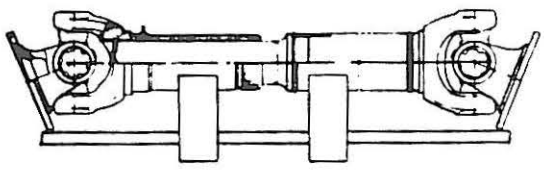
Do not remove balancing pieces or plates. An out-of-balance condition causes uneven operation which leads to premature destruction of the joint and connecting bearings.

F i g. 6



Avoid shocks and impacts during transportation and storage, as the sealing cap (Fig. 6/1) could be pressed out.

F i g. 7

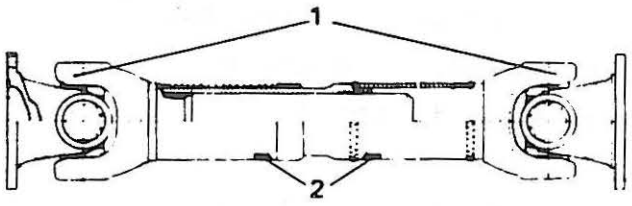


If possible, store shafts side by side with the flanges resting on a suitable wooden platform (Fig. 7).

2. INSTALLATION

2.1 INSTALLATION INSTRUCTIONS

Remove anticorrosive agents, dirt, grease, burrs, and paint from articulated shaft flanges and counterflanges. Upon installation and prior to placing in service, the articulated shafts are to be lubricated in accordance with Section 3.1.



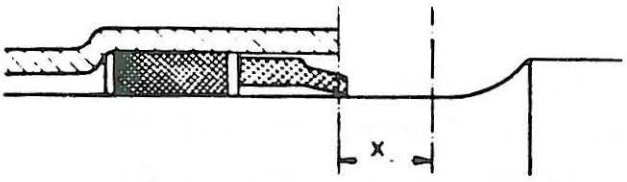
Check fork position (Fig. 8/1) while observing the marking arrows (Fig. 8/2). Remove any securing used during transportation.

F i g. 8

Check counterflanges for radial and axial run-out and center fit.
Do not turn articulated shaft by means of assembling levers inserted into the joints because bearing seals might be damaged and lubricating nipples broken off.

Prior to disassembly, measures must be taken to ensure that the original positioning of the articulated shafts can be duplicated during reassembly.

When painting the shaft, care must be taken so that the shaft areas on which the seal lip slides remain free from paint, as in Fig. 10/X.



F i g. 10

Attention:

When assembling articulated shafts without length or spline adjustment, one connecting part must be of movable configuration in order that the articulated shaft can be slipped over the centering adapter.
Changes in length caused by thermal expansion must be absorbed by adequate connecting bearings.

Caution:

Adequate safety measures are to be taken by the user where men and material might be endangered by rotating articulated shafts.

All accident prevention regulations are to be complied with.

2.2 FLANGE UNIONS

To ensure perfect operation of the articulated shafts, exact alignment of the counterflanges is necessary.
Only bolts of strength class DIN 10.9 or SAE grade 8 may be used as connecting bolts for articulated shaft attachments. For mounting purposes, the bolts are to be oiled slightly; lubricants containing MoS_2 additives (such as Molykote) are to be avoided.

Tighten bolts with torque wrench uniformly using cross pattern; see chart on page 10 for torque values.

3. MAINTENANCE

The articulated shafts used in SCHOTTEL propulsion systems are normally fitted with three DIN 71412 grease nipples, one of which is located at either universal joint while the third serves for relubricating the splined section.

Only class 2 lithium base greases, having a penetration number of 265/295 and a drop point of approx. 453 K (180°C), or the greases indicated in the

Chart of Recommended Lubricants on Page 11 are to be used for relubrication.

We recommend to relubricate the articulated shafts after every

250 OPERATING HOURS, BUT AT LEAST EVERY THREE MONTHS,

and to carry out the checks as to Section 3.2.

3.1 LUBRICATING THE ARTICULATED SHAFTS

Prior to relubrication, the nipples must be cleaned. We recommend lubricating the articulaed shafts at service temperature in order to keep the resistance of the old grease in the articulated shaft as low as possible.

Attention:

THE LUBRICATING PRESSURE IS TO BE LIMITED TO MAX. 15 bars ($15 \cdot 10^5$ Pa)(220 lbs. in ^{2}).

Grease universal joints until the used grease comes out at the seals.

When relubricating the splined sections of the sliding parts, take particular care to position a vertically adjustable SRP beforehand in such a way that the articulated shaft to be greased is in a horizontal position and/or is at its shortest length.

If no grease emerges when relubricating the splined section, the cap must be removed and the felt gasket either cleaned or replaced.

CHECKS

3.2 The following checks should be carried out prior to relubricating the articulated shafts:

- Check universal joints for wear (checking the play).
- Check splined section for wear (visual check and check of play).

- Check connecting bolts (flange unions) for tightness; retighten them if necessary.
  For tightening torques see page 10.

In operation, articulated shafts should be constantly checked for anomalous noise; whenever there are deviations from the normal running noise, the cause must be ascertained and eliminated immediately.

Tightening Torques for Fastening Bolts of

A: Articulated Propelling Shafts

B: Articulated Steering Shafts

Type of SRP		Flange Dia mm	Size of Thread	Opening of Wrench mm	Tightening Torque Nm (mkp)
10 ... 12 30/15 30/31 50/50 50/51	A	120	M 10	17	69 (7)
	B	90	M 8	13	35 (3,6)
76/75 76/76 100/100 100/103	A	150	M 12	19	120 (12,3)
	B	90	M 8	13	35 (3,6)
		100	M 8	13	35 (3,6)
150/152	A	180	M 14	22	190 (19,4)
	B	120	M 8	13	35 (3,6)
224/226 225/226 300/300	A	225	M 16	24	295 (30)
	B	150	M 10	17	69 (7)
502/502 502/503 503/505 505/505	A	285	M 20	30	580 (59)
		315	M 22	32	780 (80)
1100/1100	A	390	M 24	36	1000 (102)

RECOMMENDED LUBRICANTS

Brand	Lubricating Grease
ARAL	Grease HLP 2
BP	Energrease LS 2
Chevron	Polyurea EP 2
ESSO	Beacon 2
FINA	Marson EPL 2
Mobil	Mobilux 2
Shell	Alvania EP 2
TEXACO	Multifak EP 2

International SCHOTTEL GROUP Companies

Schottel Group companies specialize in providing technical assistance for all types of Schottel Tunnel Thrusters. Facilities and trained mechanics are available at these locations to handle service from routine maintenance to complete overhauls.

The following companies also maintain inventories of Schottel parts and specialized tooling and are part of the Schottel worldwide service network:

Schottel Werft, 5401 Spay/Rhein, West Germany; Tlx: 0862867

Schottel Nederland, The Hague, Netherlands; Tlx: 31166

Schottel of America, Inc., Miami, FL; Tlx: 51-9196

Schottel England, London; Tlx: 887179

Schottel Far East, Singapore; Tlx: 24715

Schottel SudAmericana, Buenos Aires; Tlx: 21500

Schottel Do Brazil, Puerto Allegre; Tlx: 2123782